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Procedure for Performing Security Camera Optical Performance Analysis Tests

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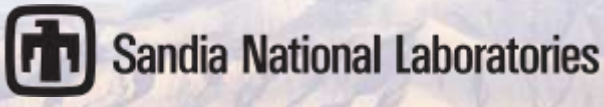

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Procedure for Performing Security Camera Optical Performance Analysis Tests

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Abstract

Digital security camera technologies proliferate the security marketplace with manufacturers extoling the functions, features, specifications and virtues of their cameras. A process to comparatively analyze security camera technologies using international camera analysis standards and methods provides a defensible means to assess camera image quality on a technically comparable basis. The procedures in this document use ISO standard camera test charts and camera image analysis software to perform test chart image analysis for comparative camera assessment. Step-by-step procedures for acquiring test chart images in the laboratory and producing analysis data using analysis software GUI controls and interfaces for comparative analysis of security camera image quality are detailed in this document. The procedures have been validated through the test and analysis of fixed box and 180 degree field of view multi-imager cameras as well as, fixed and varifocal lenses and analog-to-digital video encoder image quality performance attributes.

ACKNOWLEDGMENTS

Evangeline Delgado (E.D.) was mentored on the use of the procedures described in this document for acquiring camera images and conducting image analyses. Subsequently, she performed all the steps described herein and provided feedback as to how instructions and visual examples could be enhanced to improve document clarity and understanding. The document contains many instructions to click here and insert information there. To the novice, the movement from one GUI to another to perform activities can be formidable. E. D. is responsible for many of the numerous GUI page screenshots contained in this document to assist you the reader.

Christian Krebs of Image Engineering GmbH & Co KG provided me with considerable information and insight on the performance and nuances of the iQ-Analyzer image analysis software. A number of the "Note Boxes" contained in this document resulted from information obtained from Christian or observed during the performance of camera image acquisition and subsequent analysis.

Gabe Birch and John Griffin provided insight from an optical perspective regarding the underlying meaning of analysis results anomalies and suggested methods to employ to enhance the quality of analysis results.

Chris Turner provided insights related to camera comparative analysis from a customer utility perspective. He underscored the value of having comparative analysis camera datasets to assist in specifying the appropriate security camera for a particular application.

Ken Pascoe used comparative camera image analysis data obtained from tests and analysis of cameras using these procedures to enable determination of the leading wide angle, multi-imager camera candidate of five cameras tested. This effort helped hone the information contained in this procedure.

Blake Kinnan and Art Archibeque provided laboratory support and assistance with equipment setup, software and acquisition of cameras used during testing and analysis.

David Tarbell shepherded the activity that led to the establishment of the camera test laboratory, subsequent testing and comparative analysis of several camera types as well as the investigation into the stability and reliability of analysis results obtained.

CONTENTS

FIGURES

TABLES

NOMENCLATURE

ABS – Absolute (luminance meter measurement mode)

CAL - Calibration

CCF – Color Correction Function (luminance meter correction factor)

CIE – International Commission on Illumination (Commission Internationale de l'Eclairage) standard on chromaticity

dB – decibel

DCRAW – Name of image manipulation software

FSTOP – Dimensionless number that relates to the size of the lens opening (aperture). Each square root of two increase in f-stop reduces the amount of illumination reaching the camera imager by ½.

GUI – Graphical User Interface

ICC – International Color Consortium standards organization

.iea – File extension for Image Engineering file transfers

ISO – International Standards Organization

JPEG – Joint Picture Evaluation Group –describes type of image compression

LP/PH – Line Pairs per Picture Height

Lum – Luminance (luminance meter correction factor)

Lux – SI Unit of illuminance and luminance emittance (1 lumen per square meter)

Mpx – Megapixel(s)

MTF – Modulation Transfer Function (Response of the optical system to sinusoids of different spatial frequencies)

OECF – OptoElectronic Conversion Function

Pix – Picture

POE – Power over Ethernet

PPI – Pixels per Inch

RGB – Red, Green, Blue

ROI – Region of Interest

SFR – Spatial Frequency Response

SNR – Signal-to-Noise Ratio

WST – Wide, Standard, Telephoto

1. INTRODUCTION

This document describes procedures for acquiring camera images of standardized ISO camera test charts and performing image analysis using software specifically designed to analyze ISO test chart camera images.

This document contains seven sections. Section 1 provides an overview of this document. Section 2 discusses analyzer software installation. Section 3 contains a master equipment list of equipment required to perform all of the tests contained in this document. Section 4 contains a data entry table where camera manufacturer's data is entered. The data table when completed contains a detailed set of information about the features, specifications, and imaging properties associated with the camera being tested. Section 5 contains a detailed description of the common portions of the Image Engineering graphical user interface (GUI). Functions of buttons, metadata, information that is required to be entered in the text boxes and file export and import functions are described. Section 6 contains a description of the camera installation, focus, alignment and image acquisition procedures.

Section 7 contains detailed camera test chart image acquisition and analysis procedures. The OECF test measures the camera's transformation of grey scale patch luminance values to establish the camera's dynamic range and maximum contrast capability. The Shading test identifies the camera/lens capability to produce a flat white image. The Distortion test images a chart with rows and columns of black crosses on a white background to identify camera and lens distortion and chromatic aberration. The Resolution test measures camera resolution through measurement of modulation transfer function (MTF) and spatial frequency response (SFR) of Siemens star patterns. The Combination Reflectance Test employs a combination grey scale and color image chart. This chart provides a quick method to evaluate overall camera performance. The Appendix contains a copy of the User Manual for the commercial image analysis software.

The use of test chart analysis software requires diligence in camera setup and in ensuring that the images are square and not angularly skewed. It has been observed that the analysis software utilized exhibits some difficulty analyzing skewed images. The software can produce several different types of error messages if the image to be analyzed does not pass analysis software internal "goodness" tests prior to performing image analysis.

Contained within the step-by-step procedures are text boxes containing hints and tips to aid in producing the best images for analysis based on experience using the software. The meaning of error messages and methods to reduce the occurrence of error messages are also described. Because there are many instructions, numerous graphics and screenshots have been incorporated into this document to provide a visual means to explain the meaning of specific instructions.

These procedures evolved during the test and analysis of thirteen different digital megapixel cameras (1 to 22 megapixels) having lens focal lengths ranging from 1.7 to 70mm and multi-imager 180-degree field of view cameras. The change in optical performance produced by a variable focal length lens set at the entire range of lens focal lengths using the same camera was evaluated using the procedures, as well as, a comparative performance analysis of analog-to-digital camera encoders.

2. IQ-ANALYZER SOFTWARE INSTALLATION

iQ-Analyzer software is commercially available camera image analysis software available from Image Engineering.de. A software license is purchased and a USB dongle obtained before the downloaded iQ-Analyzer software becomes functional. ISO test charts, test stand, wheeled tripod and test chart illuminators used in the procedures are also available from Image Engineering at: http://www.image-engineering.de . The procedures in this document were developed using Image Engineering iQ-Analyzer version 5.2.17 software.

Image Engineering Software is installed on a Windows PC or MAC computer according to instructions found in the iQ-Analyzer user manual [1]. The manual describes the computer hardware and software requirements for interfacing the iQ-Analyzer software. The installation also necessitates the download of third-party software to facilitate iQ-Analyzer software functionality. Links are provided in the user manual for downloading the requisite third-party software.

It is advantageous to have the iQ-Analyzer user manual available when setting-up and conducting tests. The user manual test description and execution contains graphics that aid in understanding the steps to be performed for conducting test data evaluation using iQ-Analyzer software. A copy of the User manual is included (with permission) as Appendix A.

The iQ-Analyzer User Manual can also be accessed at:

http://www.image-engineering.de/downloads/data-sheets-and-manuals

2.1 Software Installation

1. Download and install Mathworks MATLAB Compiler Runtime (MCR) Version 7.14 available on the Image Engineering website at: http://www.image-engineering.de/ie-sw/MCR_Installer/
2. Log in as the user IE-Analyzer using the assigned password.

> Notes: MCR Version 7.14 must be loaded onto the computer for the analysis software to function.
>
> When installing a new MCR onto a target machine, you must delete the incorrect MCR version and then install the correct version.
>
> (Windows) - Only one version of the MCR can be resident on the computer. To remove the MCR, simply delete the MCR folder from /Applications. The MCR is installed in /Applications/MATLAB Compiler Runtime/Vx.xx or Vx.x, where 'x.xx' or 'x.x' indicates the MCR version number.
>
> (OS X) - Installing multiple MCR versions on the same machine is not supported on Mac OS X.
>
> If you experience difficulties is the software download, contact support@image-engineering.de

3. Download the iQ-Analyzer software from: http://www.imageengineering.de/index.php?option=com_content&view=article&id=441&Itemid=70
4. Extract the contents of the zip folder

- (Windows) - to any folder on your system.
- (OS X) - it must be to the local "Applications" folder.
- You must have write permission for the iQ-Analyzer folder and all of its subfolders.

Note: (OS X): The software will not start if it is not in the local "Applications" folder. If you want to use it from another directory location:
Open Automator
Drag and drop the iQ-Analyzer.app onto the Automator Icon
Modify the path in the script

5. Install additional open source software. [available at: http://www.image-engineering.de/]

FFmpeg [source code available at: http://ffmpeg.arrozcru.org/autobuilds/]

VLC media player [source code available at: http://www.videolan.org/vlc/download-sources.html]

ExifTool [source code available at: http://www.sno.phy.queensu.ca/~phil/exiftool/]

dcraw [source code available at: http://www.cybercom.net/~dcoffin/dcraw/]

Notes: (Windows) - users have to manually install VLC Media Player. It is necessary to make sure that the ActiveX Plugin option is selected during the installation.

(OS X) - users have to manually install ExifTool. The installation file is located in the "3rdParty" folder of the IQ-Analyzer software download package. Windows machine users can omit this step.

The Video Module is not currently supported on OS X.

3. MASTER EQUIPMENT LIST

The table below contains a list of all of the equipment used to perform the entire set of tests described in this document.

Table 1. List of Equipment Used to Conduct Tests

Equipment	Model Number
Image Engineering Chart Stand	ETC-TS-HOR
Image Engineering Monopod with Rail Includes:	ETC-MONOPOD
Linhof Studio Stand II Tripod Trolley Assembly	
Manfrotto 410 Junior Geared Tripod Head	
Image Engineering Extension Rail	ETC-RAIL
Image Engineering TE251 Test Chart	ETC-TE251-A1066
Image Engineering TE253-9X Test Chart-72Cycles	ETC-TE253-9X-72
Image Engineering TE253-9X Test Chart-144Cycles	ETC-TE253-9X-144
Image Engineering TE042 Test Chart	ETC-TE042-A 1066
Esser Test Chart Illuminator	ETC-LE6-100
Image Engineering TE269 Glass Test Chart	ETC-TE269-D280
Image Engineering TE255 Glass Diffuser Test Chart	ETC-TE255-D280
Camera Focus “Eye Chart”	
Black Photographer’s Cloth	
Konica Minolta Luminance Meter	LS100
Konica Minolta Chroma Meter	CL200A
Two Umbrella Light Sources Lowel Rifa Exchange	LC88EX
Two Impact Dimmer Switch	D-1000
Netgear Network Switch and Power Supply	GS108PE
Two Ethernet Cables	Cat 5 Minimum
Computer Dell Precision	T5400 with E5440 CPU, 4GB RAM, 640GB HDD, NVIDIA FX4600 video card or better
Windows 7 Operating System	
Internet Explorer Browser Software	
Firefox Browser Software	
Image Engineering iQ-Analyzer Software	Version 5.2.17
Bubble Level	with at least 2x2 inch flat bottom surface
Camera Under Test	

4. Data Sheet - Manufacturer's Specification Data

The Camera Information Data Sheet below captures salient camera data and precedes camera testing. Some data contained in this matrix is required as input to the iQ-Analyzer software.

Table 2. Camera Information Data Sheet

Attribute	Data
Imager Type Imager manufacturer, model, (obtain specification sheet for imager)	
Imager Aspect Ratio Ex; 4x3, 16x9	**4x3 16x9**
Format Ex; 1/3, 1/2.5, 1/2, 2/3	**1/3 1/2.5 1/2 2/3**
Lens Mount C, CS, other	**C CS Other _____**
Automatic Iris Control Y/N	**Y N**
Iris Control DC, Video	**DC Video**
Iris Modes Auto, Open, Closed, Prioritize Iris Direction	**A O PID Other _____**
Total Pixel Count Ex; 1.2 Mpx	**_____Mpx**
X and Y Pixel Count Ex; 1280x960	**_____x_____**
Sensitivity Color and B&W (lux) (at specified % of full output)	**M _____ lux @ _____ %FO** **C _____ lux @ _____ %FO**
Codec(s) Supported Ex. JPEG, H.264, MPEG	**JPEG MPEG H.264 Other_____**
Number of Parallel Video Streams Supported Ex; 1,2,3,4	**1 2 3 4**
Can Parallel Video Streams be a Different Codecs Y/N	**Y N**
Stream Options	
Frame Rate Maximum and Adjustable Range	**_____ FPSmax _____ to_____FPS Range**
Bandwidth Is bandwidth adjustable? Y/N	**Y N**
Image Bit Rate Adjustment CBR, VBR, CVBR	**CBR VBR CVBR**
Bitrate Adjustment Range Numeric (kB/s) or	**_____ kB/s max _____ to_____kB/s Range**
Maximum bitrate manually settable Y/N	**Y N**
Quality Levels (e.g. JPEG High)	
White Balance Adjustment Y/N	**Y N**

Manual Y/N	**Y N**
Automatic Features Y/N, Features	**Y N Features**
Lighting Type Automatic Adjustment (incandescent, fluorescent, daylight, color temperature)	**In Fl DL CT Other**
Manual red gain, blue gain adjustments Y/N	**Y N**
White Balance Area of Interest (window) Manually Settable Y/N	**Y N**
Can you set the area in the field of view that is used to adjust displayed image brightness? Y/N	**Y N**
Type of control area (window, grid pattern)	**Type:**
Effectiveness of Auto White Balance Adjustment	**Comments:**
Ex; Color corrects for sodium vapor lamps (does not produce goldy-brown images)	
Exposure Adjustment Y/N	**Y N**
Exposure Mode Prioritization (none, frame rate, picture quality, gain, exposure time etc)	**List:**
Exposure Offset (to produce lighter or darker images from auto algorithm determinations) Y/N	**Y N Type/Range**
Maximum Exposure Time Settable Y/N	**Y N**
Minimum Exposure Time Settable Y/N	**Y N**
Is Current Exposure Time Displayed on GUI? Y/N	**Y N**
Gain Adjustment	
Maximum Gain Settable Y/N	**Y N**
Minimum Gain Settable Y/N	**Y N**
Current Gain Value Displayed on GUI Y/N	**Y N**
Auto-Brightness Area of Interest Manually Settable Y/N	**Y N**
Type of control area (window, grid pattern)	**Type:**
Backlight Compensation Y/N	**Y N**
Is backlight compensation ON/OFF settable? Y/N	**Y N**
Sharpness Adjustment Y/N	**Y N**
Sharpness Adjustment Range (values)	**Range:**
Gamma Value Adjustable Y/N	**Y N**
Adjustment Range	**Range:**
Electronic Orientation Adjustment Y/N	**Y N**
Invert, Rotate, Mirror (horizontal, vertical, both)	**Types:**
Lighting Frequency Compensation Y/N	**Y N**

DC, 60 Hz, 50 Hz	**DC 60Hz 50Hz Other_____**
Day-Night Feature Y/N	**Y N**
Manually settable for day, night or automatic mode Y/N	**Y N**
Current IR filter state indication Y/N	**Y N**
IR filter wait time before state change actuation	**_____ sec _____ min**
Settable Day/Night Threshold Y/N	**Y N**
Exposure, gain,	
Is Duration at Threshold Values Before Transition into Day or Night Mode Settable (Time at exposure or gain)**?** Y/N	**Y N** **Describe:**
Automatic IR Filter Control with Day/Night Transition	
Can you command the IR filter to be permanently ON, OFF or Auto Mode If NO comment on available commands? Y/N	**Y N** **Comment:**
Manually Settable Camera Aiming Cross Hairs Y/N	**Y N**
Manually Settable Test Images Y/N	**Y N**
Type of Test Images List	**List:**
Triggered Video Control Input Function Y/N	**Y N**
Can an external trigger be caused when the video stream from the camera initiates? Y/N	**Y N**
Heartbeat Source Y/N	**Y N**
Can you enable camera's SNMP agent for using heartbeat missing alarm source? Y/N	**Y N**
Number of Control INPUTS (Bistatic) Accepted Number	**# _____**
Can you control On/Off function of control inputs? Y/N	**Y N**
Dry relay contact or semiconductor	**Relay Ct Semiconductor**
Number of Control OUTPUTS (Bistatic) Accepted Number	**# _____**
Can you control On/Off function of control outputs? Y/N	**Y N**
Dry relay contact or semiconductor	**Relay Ct Semiconductor**
Motion Detection Function Y/N	**Y N**
Motion Detection Area of Interest Manually Settable Y/N	**Y N**
Motion Detection Activities Selectable Y/N	**Y N**
Are there different settable motion detection algorithms that can be selectable? Y/N	**Y N**
Algorithm types (Ex. basic motion, tripwire, direction, area of interest)	**List:**

Privacy Areas of Interest Manually Settable Y/N	**Y N**
Can you set areas in the field of view that are masked? Y/N	**Y N**
Number of masks that can be set	**# _____**
Type of control area (window, grid pattern)	**List:**
Streaming Adjustments Y/N	**Y N**
Number of streams	**# _____**
Parameters Adjustable (Ex: quality, bit rate, max bitrate, output size, output scaling)	**List:**
Live buffer size	**_____ kB**
Pre alarm buffer size	**_____ kB**
Post alarm buffer size	**_____ kB**
Can you set time between I-frames? Y/N	**Y N**
Can you insert text overlay (camera ID) on camera image? Y/N	**Y N**
Can you adjust color, font of text overlay? Y/N	**Y N**
Can you set location of text overlay on camera image? Y/N	**Y N**
Can you set the location (server IP address) where alarm clips are stored? Y/N	**Y N**
Network Settings Adjustments Y/N	**Y N**
Network Parameters settable (DHCP RTSP QoS SNMP ONVIF)	**DHCP RTSP QoS SNMP ONVIF Others**
Can you observe the network traffic in and network traffic out data (kb/s)? Y/N	**Y N**
Serial Port Settings	
Does the camera have a serial port? Y/N	**Y N**
Are serial port settings adjustable? Y/N	**Y N**
List settings adjustable (Ex: mode, baud rate, line configuration, port, authentication, user name, password)	**List:**
Factory Default Setting Control Y/N	**Y N**
Can you easily reset to factory default settings? Y/N	**Y N**
Method for Setting Camera to Factory Default Settings (Ex: exterior accessible button, or software only reset)	**Method:**

Firmware Upload	
Can you easily upload firmware updates to camera? Y/N	**Y N**
Is there a mass download capability? Y/N	**Y N**
Web Browser Compatibility (Ex: IE, Firefox, Both)	**IE Firefox Both Other _____**
IP Addresses Settable Y/N	**Y N**
IP Address and Number of IP addresses settable	**IPAddr _____ . _____ . _____ . _____ #_____**
List IP Address Types (Ex: default, system, camera imbedded)	**List:**
GUI Functions Accessible	
Can all the control functions be accessed from the web page or are additional control functions accessible only through say, Telnet commands? Y/N	**Y N**
Documented API Manual	
Is there a well-documented API manual for the camera? Y/N	**Y N**
Telnet Command Functionality	
What commands can only be controlled through Telnet?	**List:**
Area of Interest Image Size Control Functionality Y/N	**Y N**
What sizes selectable? (Ex: 1280x960, 1280x720, 800x600)	**List:**
AOI Top, left, width and height values settable Y/N	**Y N**
Image Output Size Settable Y/N	**Y N**
Auto, Range of output sizes settable	**Auto Y N** **Output Sizes Settable List:**
Number of Image Buffers Number	**# _____**
Are Number of Image Buffers Selectable Y/N	**Y N**
What is range of image buffers selectable	**Range: _____ to _____ Buffers**
GUI Accessible Video Image Control Y/N	**Y N**
Stop, Still Image, Snapshot, Adj. Refresh Rate (List Options)	**List:**

Plug-in Support Y/N	**Y N**
Manual zoom in/out Y/N	**Y N**
Fit Window Selection Y/N	**Y N**
Physical Size of Camera HxWxD	**_____ H _____ W _____ D Units _____**
Mounting Orientations (Ex: Top, Bottom, Other)	**Top Bottom Other: _____**
Operating Temperature Range Max and Min Temperatures	**Max Temp _____ Min Temp _____ deg F or C**
Input Voltage Range	**Vac Range _____ Vdc Range _____**
Is there a well-documented User Manual available?	**Y N**
Is there a well-documented Installation Manual available?	**Y N**

5. IQ-ANALYZER GRAPHICAL USER INTERFACE (GUI)

Before using the iQ-Analyzer modules, information must be entered into the databases for subsequent use by analysis modules. The descriptions below discuss buttons and text box information entry using the iQ-Analyzer GUI interface.

5.1 Buttons

Across the top of the toolbar, there are four sets of buttons. From left to right the buttons perform the following actions:

5.1.1 Input

[Top left side of page]

Initiates the Video data entry page. Button connects to a video stream.

Initiates the RAW (dcraw) video image data entry page. Button toggles RAW data page on and off.

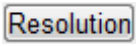
Initiates the Metadata entry page. Button toggles Metadata page on and off.

5.1.2 Test Module Access

[Page Center]

Initiates the OptoElectronic Conversion Function (OECF) Analysis module

Initiates the Color Analysis module



Initiates the Resolution Analysis module

Initiates the Shading Analysis module

Initiates the Distortion Analysis module

Initiates the Histogram Analysis module for detecting dead or hot pixels

Initiates the TE42 General Purpose Test Chart Analysis module

5.1.3 Settings and Export/Import


[Top right side of page]


[Settings] Brings up settings page for general, visual noise and output parameters


[Export/Import] Used for transferring analysis results from one module into another

5.2 Video Input

Video

The Video Module links video sources to the evaluation core of the iQ-Analyzer. Both live video signals and video files can be processed. The Video Module acquires frames of video and passes them to any other iQ-Analyzer Module for further analysis. In the Live Video Signal mode, analysis tools such as a waveform analyzer, vectorscope and histogram display of signal information can be displayed. The test sequences described in this test procedure employ analysis only of "still frame" image files rather than of live video feeds.

5.2.1 Settings

Depending on input source (live video or video file), the parameter selections and settings within the Settings space controls aspects of input data analysis.

> NOTE: Analysis will only be performed on "still frame" Test Chart images. Therefore Settings information for Live Video Sources and Video Files will not be covered.

5.3 Raw Video Input

RAW

iQ-Analyzer accepts raw data for still image analysis using DCRAW software. Raw still image analysis starts with DCRAW options defined on the DCRAW main page. The DCRAW commands are displayed in the "dcraw call:" text box. Results use the Colorspace, White Balance, White Level and Tonal Curve data text boxes. The main page for accessing the latest version of DCRAW software is: http://www.cybercom.net.~dcoffin/dcraw/.

1. Click the RAW button on the top left side of the toolbar.

Figure 1. Screenshot of Processing Portion of RAW Page

2. In the RAW – Processing space on the page select the following:

    a. Executable = **Default - /3rdParty/dcraw/**
    b. Demosaicing = **None** (no Scaling)
    c. Output Format = **Tiff**
    d. Outbut Bit Depth = **16 bit**
    e. Output Flip = **Default**

Figure 2. Screenshot of INFO Portion of RAW Page

3. In the **RAW-Info** space on the page, if the file type is **Bayer Image** or the output of DCRAW is **not demosiaced**, select the following:

    a. Interpolation = **None**
    b. Bayer Pattern = **RGGB**
    c. Bit Depth = **12**
    d. White Balance Multiplier R, G1, B, & G2 = **1.0000** (white balance can be enhanced manually by adjusting White Balance values)
    e. White Balance Offset R, G1, B, & G2 = **0** (white balance can be enhanced manually by adjusting White Balance Offset values)

Figure 3. Screenshot of Batch Processing Portion of RAW Image

4. In the Batch Processing space on the page, select the following:

    a. Use the + , - and C buttons at the bottom of the page to add, delete or clear all files in the processing list.

5.4 Metadata Information

Meta

The metadata for the image files are displayed in the Meta module and accessed by clicking on the Meta button on the top left side of the toolbar. The metadata provides information related to image properties for use by the calculation algorithms in the iQ-Analyzer modules.

Insert metadata information into iQ-Analyzer software as follows:

1. Click the Meta button on the top left of the iQ-Analyzer screen.

NOTE: The Meta button toggles between the metadata entry page and either the Camera Image or Result display depending on what button selection is made at the bottom of the Settings portion of the Test Module space. The Image / Result button toggles between the two options.

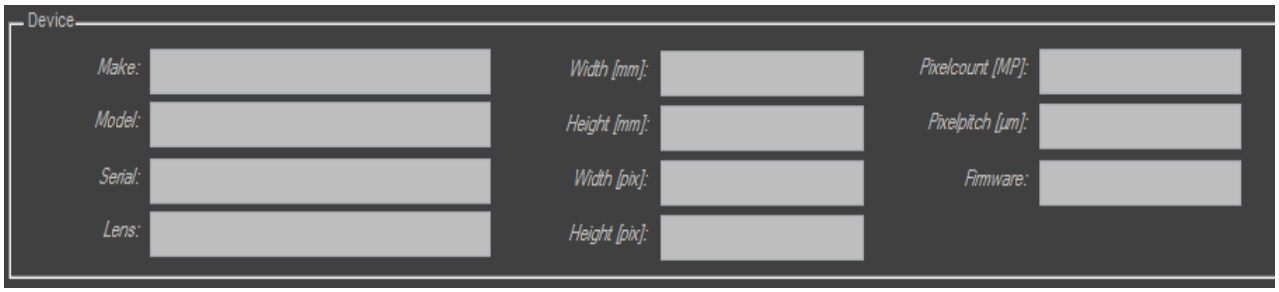


Figure 4. Screenshot of Device Data Input Portion of META Page

2. Insert camera data in the spaces provided in the **Device** section of the page:

    a. Camera Make (Manufacturer)
    b. Camera Model Number
    c. Camera Serial Number
    d. Lens Data (make, model #, focal length)
    e. Imager Width (mm)
    f. Imager Height (mm)
    g. Imager Pixel Count (e.g. 1.3 Mpx)
    h. Imager Pixel Pitch (um) (calculated after entering populating height & width & press the keyboard **ENTER** key)
    i. Camera Firmware Version

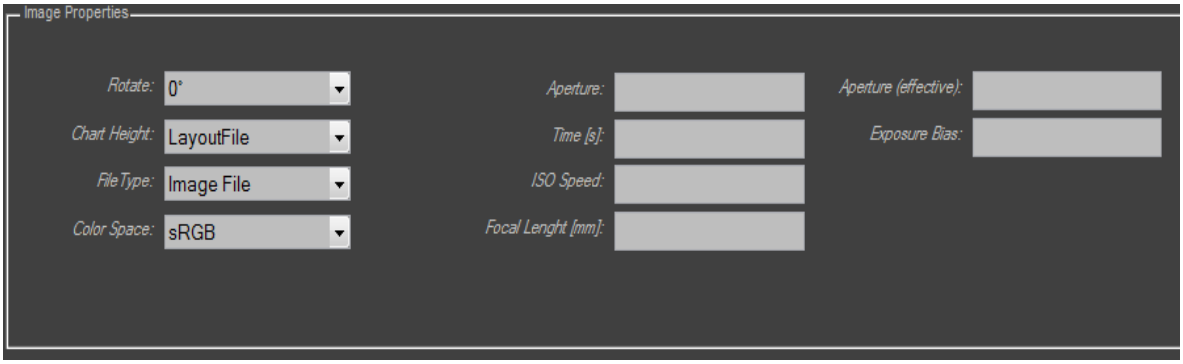


Figure 5. Screenshot of Image Properties Input Portion of META Page

3. Insert camera **Image Properties** data in the spaces provided:

    a. Rotation (rotate or flip images)
    b. Chart Height (select from dropdown choices - Default = **Layout File**)
    c. Test Save as type (select image file, raw file or bayer file choices – Default = **Image File**)
    d. Color Space (select from sRGB, Adobe RGB, ECI RGB V2, embedded profile or selected profile choices – Default = **sRGB**)
    e. Lens Aperture Setting (maximum f-stop)
    f. Time (date and time test started)
    g. ISO Speed (Calculated by the software after manually entering aperture & object distance [setup]
    h. Lens Focal Length (mm)
    i. Aperture – Effective (f-stop setting during testing)
    j. Exposure Bias (value if exposure bias is set)

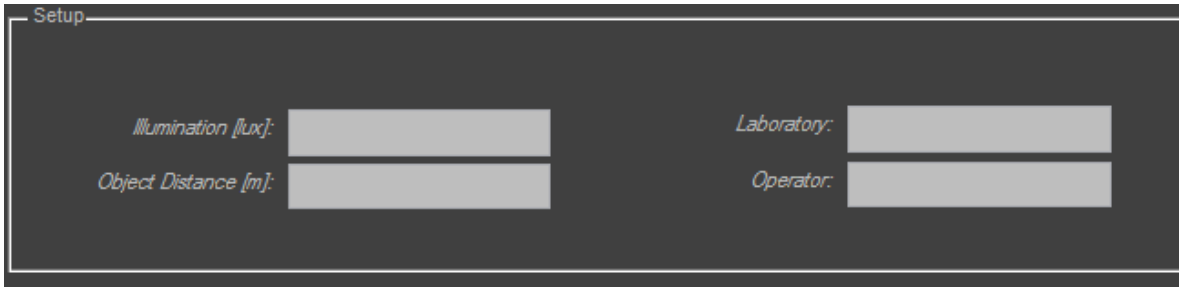


Figure 6. Screenshot of Setup Input Portion of META Page

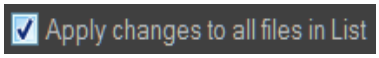
4. Insert camera **Setup** data in the spaces provided:

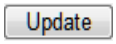
    a. Illumination (lux)
    b. Object Distance from Camera (m)
    c. Lab Name (Camera Test Lab)
    d. Operator (tester's name)

Figure 7. Screenshot of Notes Portion of META Page

5. Insert specific test-related information in the **Notes** space provided

    a. Insert additional data on camera specific settings used during testing (If the camera has the ability to output its settings data into an electronic file, the contents of the file should be inserted into the Notes box).

6. If the metadata applies to all tests performed, ensure that the 

box at the bottom of the page is checked.
7. Click the 

button at bottom of screen to update data.
8. Click the 

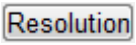
button to close the Metadata page.

5.5 Test Module Access

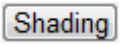
Image analysis modules can be accessed by clicking on the one of seven buttons:

Initiates the OptoElectronic Conversion Function (OECF) Analysis module

Initiates the Color Analysis module



Initiates the Resolution Analysis module



Initiates the Shading Analysis module

Initiates the Distortion Analysis module

Initiates the Histogram Analysis module for detecting dead or hot pixels

Initiates the TE42 General Purpose Test Chart Analysis module

5.6 Settings

In the  [**SETTINGS**] menu parameters for visual noise, output and general parameters such as file path can be described.

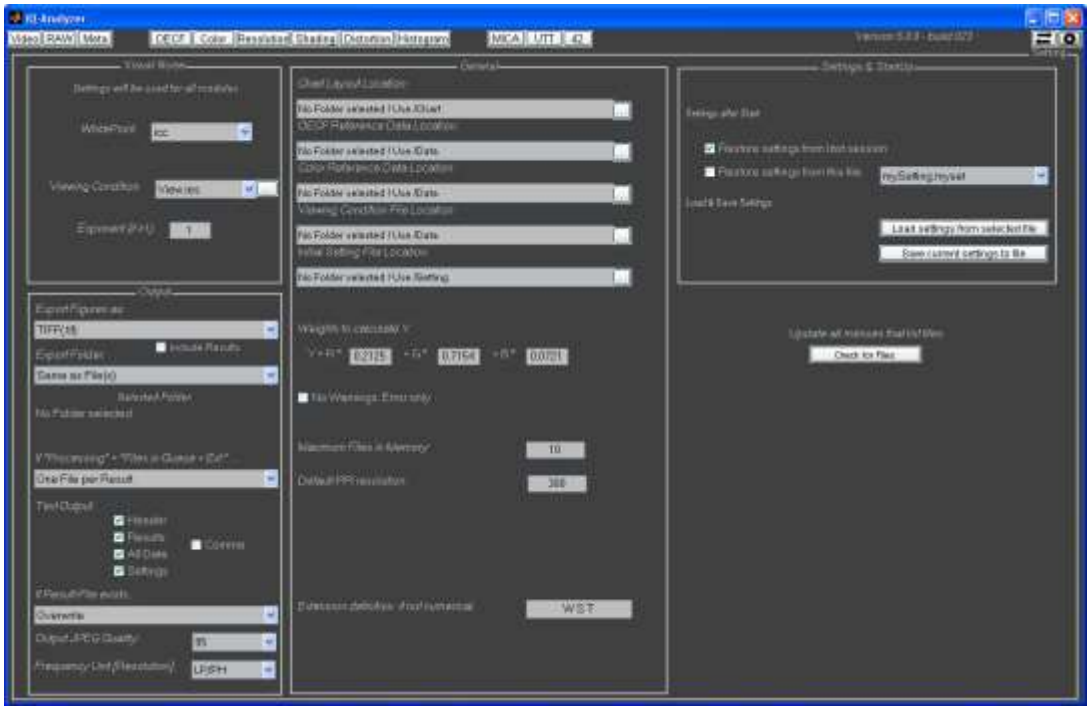


Figure 8. Screenshot of Settings Page

5.6.1 Visual Noise

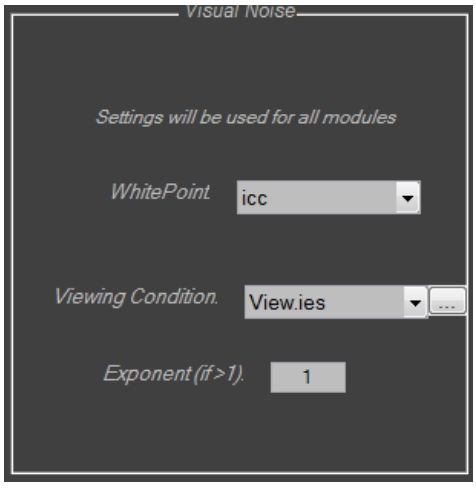


Figure 9. Screenshot of Visual Noise Portion of Settings Page

1. Click the [Settings] button on the top right side of the toolbar.
2. In the *Visual Noise* space in the top right side of the page:
    a. Select White Point = **ICC**
    b. Select Viewing Condition = **VIEW.IES**
    c. Select Exponent = **1**

5.6.2 Output

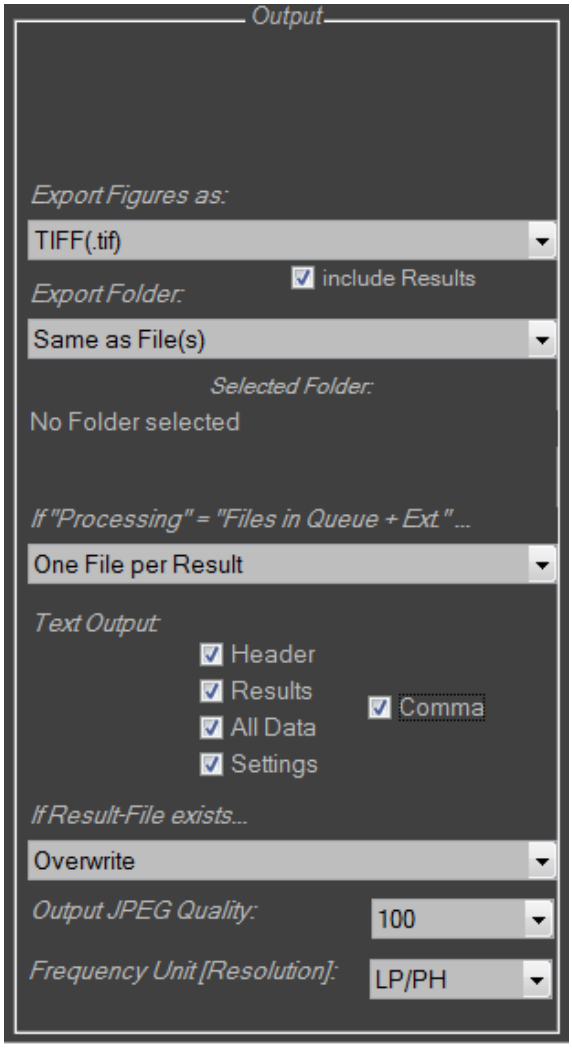


Figure 10. Screenshot of Output Portion of Settings Page

1. In the Output space:
    a. Select Export Figures as = **TIFF(tif)**
    b. Check the include Results box
    c. Select Export Folder = **Same as Files**
    d. Select if Processing = "Files in QUEUE + EXT" = **One file per result**
    e. Select Text Output = Check **Header, Results, All Data** and **Settings** boxes
    f. If Results File Exists = **Overwrite**
    g. Output JPEG Quality = **100**
    h. Frequency Unit [Resolution] = **LP/PH**

5.6.3 General

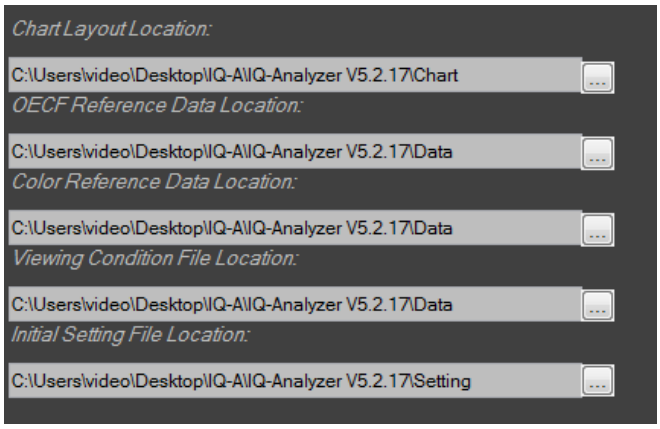


Figure 11. Screenshot of Chart Layout Location Portion of Settings Page

1. In the General space:

    a. Select Chart Layout Location = **Chart Local Folder** (default)
    b. Select OECF Reference Data Location = **Data Local Folder** (default)
    c. Select Color Reference Data Location = **Data Local Folder** (default)
    d. Viewing Condition File Location = **Data Local Folder** (default)
    e. Initial Setting File Location = **path location to settings file <…>.myset** (same as file name in mySetting.myset textbox in Settings & StartUp space

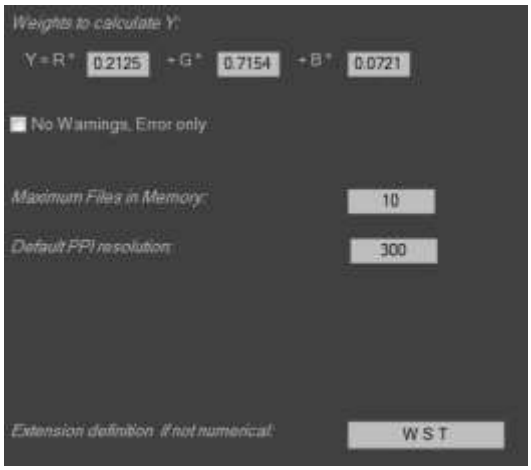
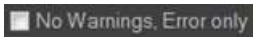


Figure 12. Screenshot of Data Entry Portion of Settings Page

    f. Weights to calculate Y, select from the following color weighting standards (ISO 12232 weights are the default):

ITU-R-BT.709 (recommended)	Y= 0.2126 R + 0.7152 G + 0.0722 B
ISO 12232	Y= 0.2125 R + 0.7154 G + 0.0721 B
NTSC	Y= 0.2989 R + 0.5870 G + 0.1140 B

g. Select 

box = **Unchecked**
h. Enter Maximum Files in Memory = **10**
i. Enter Default PPI Resolution = **300**
j. Select Extension Definition if not Numerical = **WST** (if needed for multiple lens analyses - Wide, Standard & Telephoto)

5.6.4 Settings & StartUp

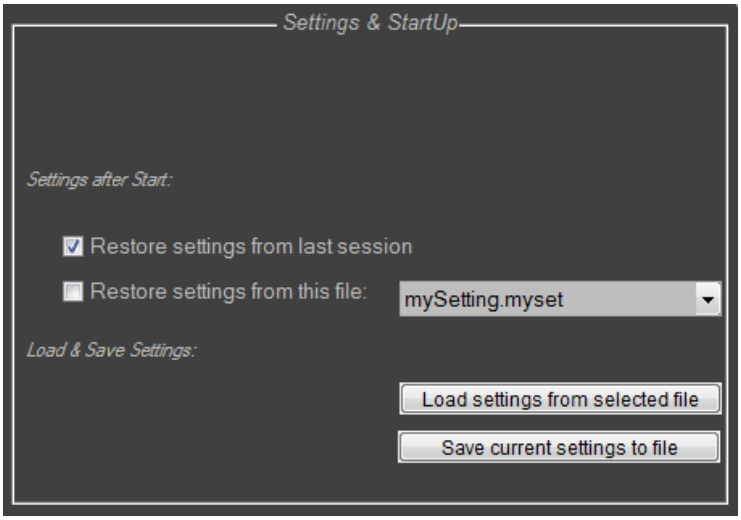


Figure 13. Screenshot of Settings & Startup Portion of Settings Page

1. In the 

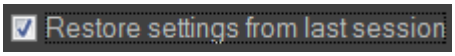
space, select the following:

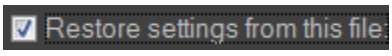
On first use of iQ-Analyzer software:

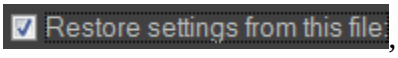
a. Restore settings from last session box = **not checked**
b. Restore settings from this file box = **checked**
c. Click the 

button.
d. A "**SAVE**" pop-up will appear. Enter the file name (e.g. TestSettings) in the text box.

On subsequent uses of the iQ-Analyzer Software:

a. Restore settings from last session box = **checked** (if using previous session settings) 

b. Restore settings from this file box = **checked** (if using data from a previously generated settings file) 

c. If you checked 

, under 

legend:
    a. Click the 

button to update from the [myset] file.

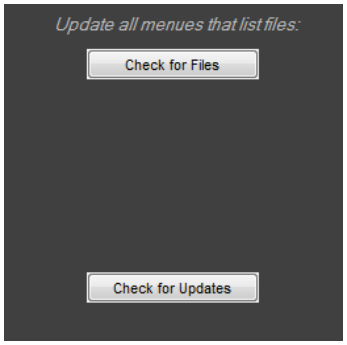


Figure 14. Screenshot of Check Files and Check Updates Portion of Settings Page

5.7 Export/Import

The Export/Import menu options are used for saving results and graphs in the camera test image folder for each module (e.g. OECF, DIST, SHDG, RESL & 42). The test file analysis results for each test module are saved in an Analyzer-internal file, formatted as a **.txt** file in the camera module's folder. The displayed results can be saved and stored in the various modules by selecting the module and clicking the Save Data or Restore Data buttons.

Result graphs can be saved either individually within each module by using the Export or  button in each module so that graphs can be exported as a group. The steps below describe some export/import options.

1. Click the  [EXPORT/IMPORT] button on the top right side of the toolbar.

Figure 15. Screenshot of Data/Results Portion of Settings Page

2. In the Data / Results space, select the following:

    a. Ensure that the ☑ All box is checked for both the Save Data and Restore Data options.
    b. Within each module, while a graph is displayed, right click on the graph.
    c. When the **Undock-Save-Add to List** pop-up occurs, select Add to List option.

3. In the Graphics section of the page, a list of files for **Export** is created.

    a. The + button adds files to the list.
    b. When the **Save List** pop-up appears, click the OK button.
    c. The - button deletes individual files in the list.
    d. The C button clears all files in the list.

4. The Export Now button at the bottom of the Graphics section executes a file save action. The file path and file format for exported files are defined in the [SETTINGS] data.

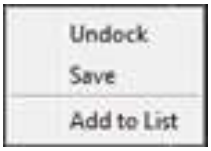
Figure 16. Screenshot Showing Files List for Export

5.7.1 Executing the Export Function

After an analysis is completed but before starting an export, click the ⇄ [**EXPORT/IMPORT**] button and a list of files to be transferred will appear. If there are files already populated in the list, click the C button to clear the files in the list. Some modules automatically populate files into the export list after an analysis is completed.

1. Click a module button at the top of the page for the module from which the file will be exported.

2. Right click on a particular graph. When the **Undock-Save-Add to List** pop-up occurs, select Add to List option.



3. Click the ⇄ [**EXPORT/IMPORT]** button and the file(s) to be transferred will appear.
4. Verify that the files to be exported are the only files listed. If there are unwanted files included in the list, delete them by clicking the file name in the box to the right of the file number. The file name box will turn blue. Then click the - button at the bottom of the file list space and the file will be removed from the list.
5. Click the Export Now button at the bottom of the page.
6. On the bottom left side of the page you will see pop-ups of the files that are being transferred to the module analysis folder.
7. After the transfer is completed, click the C button at the bottom of the file list space to clear the files from the file transfer box.

NOTE: Prior to performing tests on a particular camera, a thorough understanding of camera operation and functions of commands accessible through the camera's GUI, HTTP, or Command Line interface must be understood for achieving optimum test results.

Camera parameter adjustments may have to be made to produce optimum camera performance. A thorough understanding of the camera's User and API manuals prior to testing is advised. For example, it is very important the camera image quality is set to 100, gamma set to 1.0 (100 for some cameras) and the streaming data rate is set to produce the maximum bit rate allowable.

Camera brightness and contrast settings also affect analysis results when performing some analyses. Performing these tests with the camera set at manufacturer's default values may not produce optimum camera test results.

6. Camera Installation, Focus and Alignment Procedure

6.1 Installation and Alignment Procedure

6.1.1 Camera Installation and Alignment

1. Move a Test Chart in front of the Chart Illuminator or slide a glass chart down into the Test Chart Illuminator.

Figure 17. Test Chart Illuminator

NOTE: When moving the Test Charts, do not get fingerprints on the target surfaces. Either use gloves or touch only the very bottom of the targets when moving them.

2. Rotate the Tripod Head that attaches to the camera so that the top and bottom adjustment knobs face away from the Test Chart and the camera Mounting Shoe screw slot is parallel to the Test Chart. The rounded side of the camera attaching shoe faces the test chart.
3. Install and align the camera on the Tripod Head according to Steps 4-21.

Figure 18. Tripod Head Showing Knob Direction

4. Remove the camera Mounting Shoe from the Tripod Head by sliding the lever under the shoe to the right (when facing away from the chart). When the lever is moved to the right, press the silver button on the end of the lever to release the shoe lock and to move the lever a little further to the right.

Figure 19. Tripod Mounting Shoe Showing Silver Button and Captive Screw Locations

5. Attach the camera to the Mounting Shoe using the captive screw. Ensure that the rounded side of the Mounting Shoe is facing in the same direction as the camera lens. With the camera upside down, align the Mounting Shoe so that the center of the rounded side of the shoe is centered with the center of the lens. Just snug up the captive screw at this point.
6. Attach the Mounting Shoe to the Tripod Head by sliding the flat side of the shoe into the shoe holder and pressing down. An audible "click" is heard when the shoe attaches to the Tripod Head. The lever will also move to the left.
7. Push the tripod toward, and as close as possible to the Test Chart.
8. Visually observe that the center of the lens is centered horizontally with the center of the Test Chart. Figure 20 shows examples of monitor views of centered images.

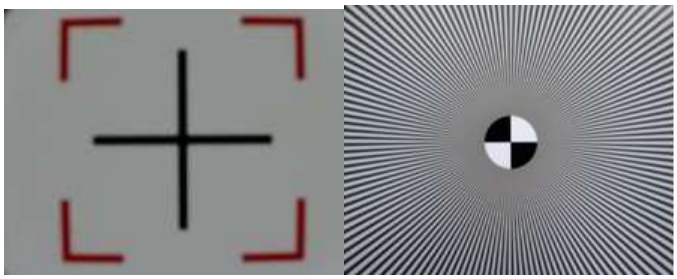


Figure 20. Centering Position Images - Distortion and Resolution Charts

9. If aligning to a sliding Test Chart, tighten the captive screw on the Mounting Shoe, re-install the Mounting Shoe on the tripod head. Slide the chart so that it is centered with the camera and then perform Step 12.

NOTE: Be extremely careful not to scratch the chart. Chart printing is very fragile!!

10. If centering with a glass Test Chart and the center of the lens is not centered horizontally with the chart, remove the Mounting Shoe, loosen the captive screw and move the camera to the right or left as needed to center the camera with the center of the OECF Test Chart attached to the illuminator and snug up the captive screw.

11. Once the camera horizontal position is centered with the center of the Test Chart, remove the Mounting Shoe, tighten the captive screw using a large screwdriver and re-install the Mounting Shoe onto the Tripod Head.
12. Visually observe the camera is horizontally perpendicular to the Test Chart. If not, rotate the camera on the Mounting Shoe so that it is visually perpendicular to the Test Chart. A 90-degree "L-shaped" device can be placed against the test chart and used to align the body of the camera if it has straight sides.
13. Visually observe that the center of the lens is centered vertically with the center of the Test Chart.
14. Adjust the camera vertical centering by loosening the vertical height adjustment clamp (in the middle of the tripod shaft) and rotating the height adjustment handle until the camera is centered vertically with the Test Chart.
15. Before tightening the tripod height adjustment clamp, rotate the top vertical tripod shaft clockwise so that the vertical gear mechanism is snug up against the notch in the bottom half of the tripod shaft.
16. Securely tighten the tripod height clamp.
17. Check that the tripod height clamp is sufficiently tight by attempting to rotate the top tripod shaft with respect to the bottom half of the tripod shaft.
18. Place a Bubble Level on the top of the camera (if it has a straight flat top) to observe if the camera is level (front-to-back) horizontally.
19. Adjust the top knob on the Tripod Head to level the camera front-to-back.
20. Rotate the Bubble Level 90 degrees to observe camera level (side-to-side) horizontally.
21. Adjust the bottom knob on the Tripod Head to center the camera side-to-side.

6.1.2 Camera Communications Setup

Figure 21. Camera Ethernet Connector

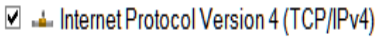
1. Attach an Ethernet cable between the camera and a POE network switch.
2. Attach and Ethernet cable between the POE network switch and the computer.
3. Ensure that the camera is functioning by observing the POE and Data lights on the camera's Ethernet connector.
4. On the computer, open either the Firefox or Internet Explorer browser to access the camera.

NOTE: Some cameras work only with Firefox and some only with Internet Explorer and some will interface with both – the use of Firefox is preferred when that option exists.

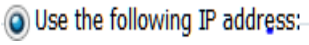
6.1.3 Setting Computer Static IP Address

1. It is highly likely that it may be necessary to set the computer to a static IP address that is compatible with the camera's factory IP addressing scheme. Set the computer's static IP address using the steps below:

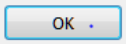
    a. Click on the Internet Access icon at the bottom right of the monitor screen.
    b. On the pop-up, click on Open Network & Sharing Center.
    c. Click on Local Area Connection.
    d. Click the 

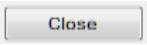
button at the bottom of the pop-up.
    e. Click the 

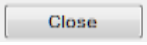
option and click the 

button.
    f. Click the 

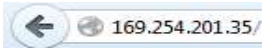
circle and enter the IP addressing scheme (see the following example):

    g. Click the 

button on the Internet Protocol Version 4 TCP/IPv4 Properties pop-up and the pop-up will disappear.
    h. Click the 

button on the Local Area Connection Properties pop-up and the pop-up will disappear.
    i. Click the 

button on the Local Area Connection Status pop-up and the pop-up will disappear.
    j. Click the  button to close the Windows page.

2. In the Firefox or Internet Explorer URL address box, enter the camera's IP address and depress the computer keyboard ENTER key. 

NOTE: Some camera images are viewable only with the camera manufacturer's proprietary software. If that is the case, the camera's reader/display software must be obtained from the manufacturer or download website, loaded on the computer and operated according to the manufacturer's instructions to obtain test images.

6.2 Camera Focus Procedure

NOTE: In some cases, achieving optimal focus using a Test Chart may be difficult. An 8.5 x 11 inch chart with different sized letters was produced to aid in the focusing task. This chart is referred to as the "Eye Chart" in this document.

Figure 22. Eye Chart

NOTE: The TE253 Resolution Test Chart in Figure 23. TE253 Resolution Test Chart, is a 3-piece chart. The three pieces are moved adjacent to each other when used with a camera having a 4x3 aspect ratio. When used with a camera having a 16x9 aspect ratio, the right and left portions of the chart must be separated such that the there is only about 1/8 to 1/4 inch of blank space to the right and left of the chart in the camera's displayed monitor image. If the pieces of the test chart are not separated when testing a 16x9 aspect ratio camera, the resolution analysis will produce invalid results.

When conducting a 1 Star resolution analysis, use the center star of either the right or left panel of the TE253 Test Chart (see Figure 23).

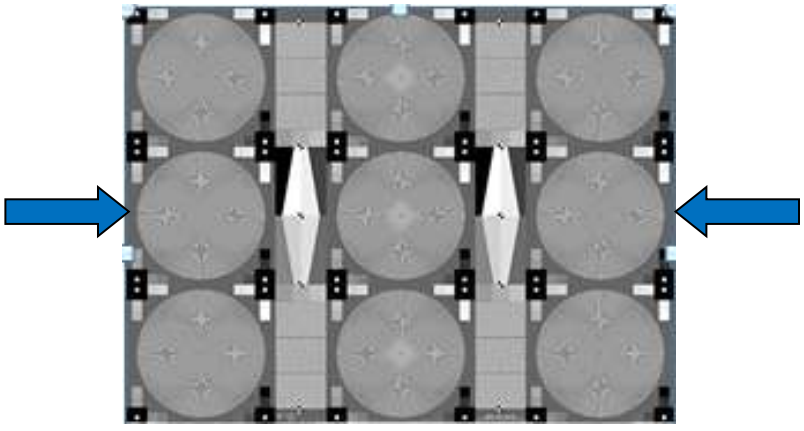


Figure 23. TE253 Resolution Test Chart - Arrows Show Location of Single Test Stars

Focus the camera using Steps 1-33 below.

1. Adjust the camera image so that the camera image is displayed as large as possible on the computer monitor. The method to accomplish this varies with each camera's GUI.
2. If the camera has a manual or software controlled auto-focus button or command, press the button or execute the command on the camera's GUI to initiate camera auto-focus.
3. If the camera does not have an auto-focus capability, manually focus the lens to achieve optimum image focus. The "Eye Chart" is very helpful in achieving proper focus.
4. Move the Tripod close to the chart to adjust camera horizontal and vertical centering.

> NOTE: Be extremely careful not to scratch the chart. Chart printing is very fragile!!

5. Adjust the camera location on the Camera Mounting Shoe to center the camera image with the center of the OECF glass chart or slide the movable charts to the right or left to center the camera image with the center of the chart.
6. Move the Tripod vertical height adjustment (near center of vertical Tripod tube) to center the camera image vertically with the center of the chart.
7. Move the Tripod Head Vertical Adjustment Knob (top knob) so the camera (front to back) is perpendicular to the chart.
8. Move the Tripod back from the chart enough to see the entire chart in the camera's field of view.

> Because of lens and imager optical and mechanical characteristics, moving the Tripod away from the chart may cause the camera image to no longer be centered with the chart. Readjust the Tripod height adjustment and/or slide the chart to re-center the chart in the camera image. For the OECF chart, the camera may have to be moved right or left on the camera Mounting Shoe.

9. When the camera's image is displayed, move the tripod closer to, or further from the chart so that the chart occupies the entire horizontal field of view for the imager aspect ratio (4x3 or 16x9).
10. If the camera has an automatic focus, click the camera's autofocus button on the GUI or push the mechanical button on the camera.
11. Manually focus the camera lens by placing the "Eye Chart" Figure 22, in front of the Test Chart.
12. Set the lens aperture adjustment to the wide-open position (lowest numerical f-stop).
13. When using a lens with an attachment collar, loosen the collar clamping band slightly so that there is noticeable friction when the lens is rotated. If the collar is too loose, tightening the collar will change lens focus.
14. When the camera is focused, remove the "Eye Chart."
15. Tighten the lens positioning stop or attachment collar.

16. Observing the computer's monitor image, adjust the camera rotation knob on the Tripod Head (center side knob) so that the camera image is rotationally square with the Test Chart. This is best achieved by viewing the Test Chart edge marks and ensuring that the spacing between the edge marks at the top and bottom of the right and left sides are equi-distant from the edge of the camera image. For the sliding Test Charts, this is achieved by observing the white spaces at the top and bottom of the charts and the blank spaces to the right and left of the chart.

NOTE: The three Tripod Head adjustment knobs have a spring-loaded brake mechanism that has to be rotated slightly to remove tension on the adjustment screws to make it easier to rotate the adjustment knobs. For large movements, rotating the brake mechanism disengages the knob's gear mechanism.

17. If necessary, move the Tripod further from, or closer to the Test Chart so that the target right and left side edge marks for the image size displayed (e.g. 4x3 or 16x9) align with the edges of the camera's field of view.
18. Move the Tripod Head Horizontal Adjustment Knob (bottom knob) so that the camera image is centered right-left with the chart.
19. Again, if necessary, move the tripod further from or closer to the test chart so that the target edge marks align with the edges of the camera's field of view.
20. Verify that the camera is level in by using the Bubble Level again as described in Section 6.1.1 *Camera Installation and Alignment* Steps 18 to 21.
21. If the camera had to be re-leveled, perform Steps 5 to 8 above until the camera is centered horizontally and vertically with the Test Chart.
22. If the camera requires manual focus, proceed to Step 24 below.
23. After completing the camera alignment procedure above, perform the auto-focus operation again as described in Step 10 above.
24. If the camera has to be manually refocused, place the "Eye Chart" Figure 22, in front of the Test Chart and adjust focus as described in Steps 11-15 above.
25. For a lens with a manually adjustable f-stop, adjust lens aperture to **f/4** after focusing the camera.
26. After the alignment and focus are completed, the specific camera test can be performed, image data acquired, and image file data processed by Analyzer software.

Because camera lenses do not always produce an image that is centered with the center of the camera or produces an image that bends or skews as it reaches the camera imager, carefully assessing camera monitor images, provides additional queues on how to improve image flatness. It has been observed that improvements in image flatness can produce improved analysis results.

Below are some tips. Figure 24 shows a properly adjusted image. Figures 25-31 show skewed camera angle images that produce error messages or inaccurate analysis results. The amount of skew in the images below is exaggerated to aid in observation of the direction of skew.

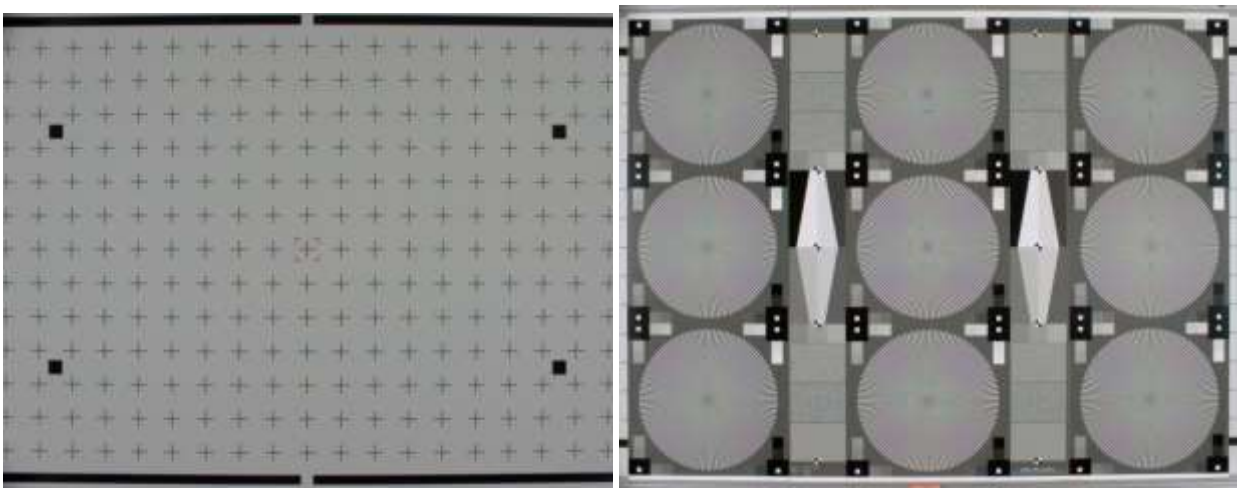


Figure 24. Examples of Images Properly Adjusted for Image Analysis

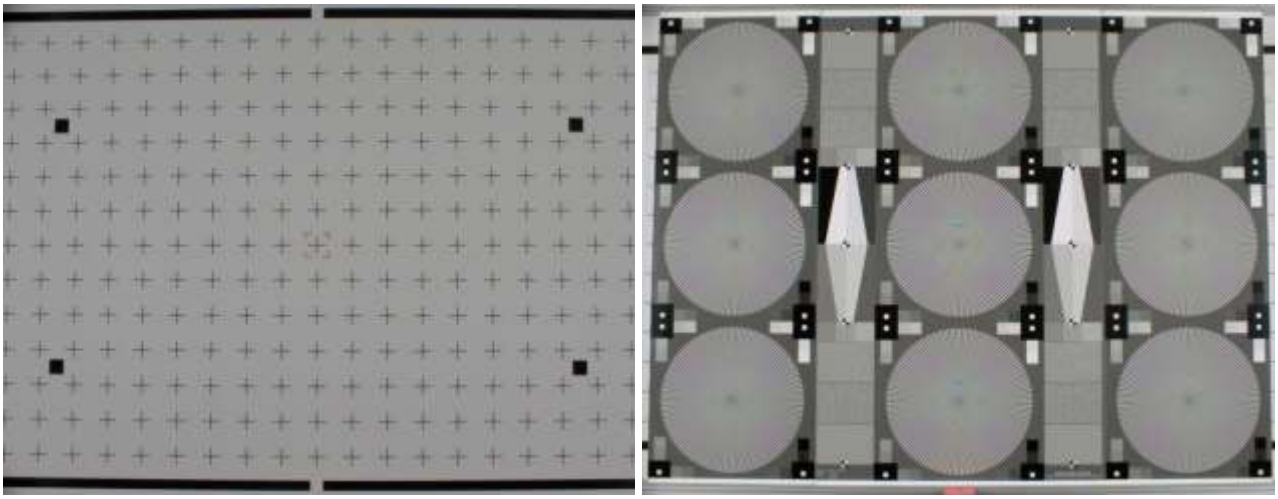


Figure 25. Examples of Images with Upward Camera Tilt

27. If the image appears wider at the top than at the bottom (Figure 25), adjusting the Tripod Vertical Angle Adjustment (top knob) so the front of the camera moves downward will "square-up" the image.

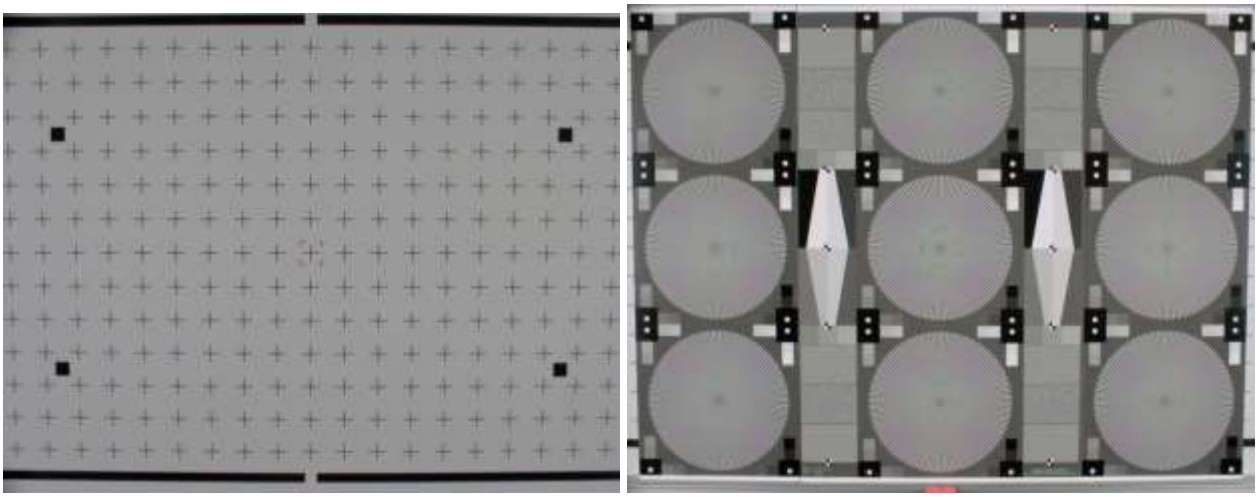


Figure 26. Examples of Images with Downward Camera Tilt

28. If the image appears wider at the bottom than at the top (Figure 26), adjusting the Tripod Vertical Angle Adjustment (top knob) so the front of the camera moves upward will "square-up" the image.

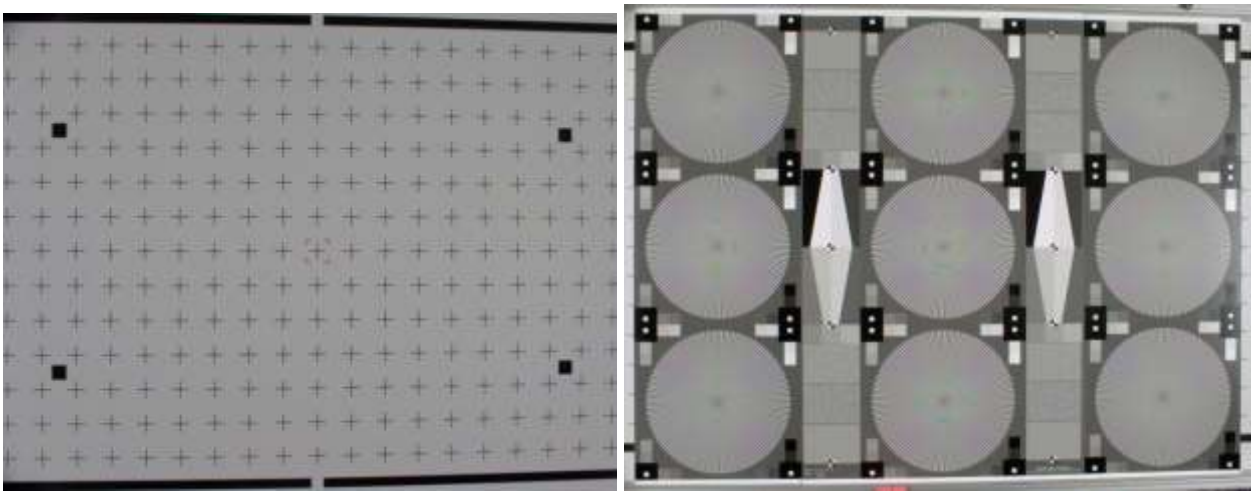


Figure 27. Examples of Images with Camera Rotation to the Right

29. If the right side of the image appears to shrink inwardly at both the top and bottom of the image (Figure 27), adjusting the Tripod Horizontal Rotation (center knob) so the front of the camera moves to the left as viewed from behind the camera will "square-up" the image.

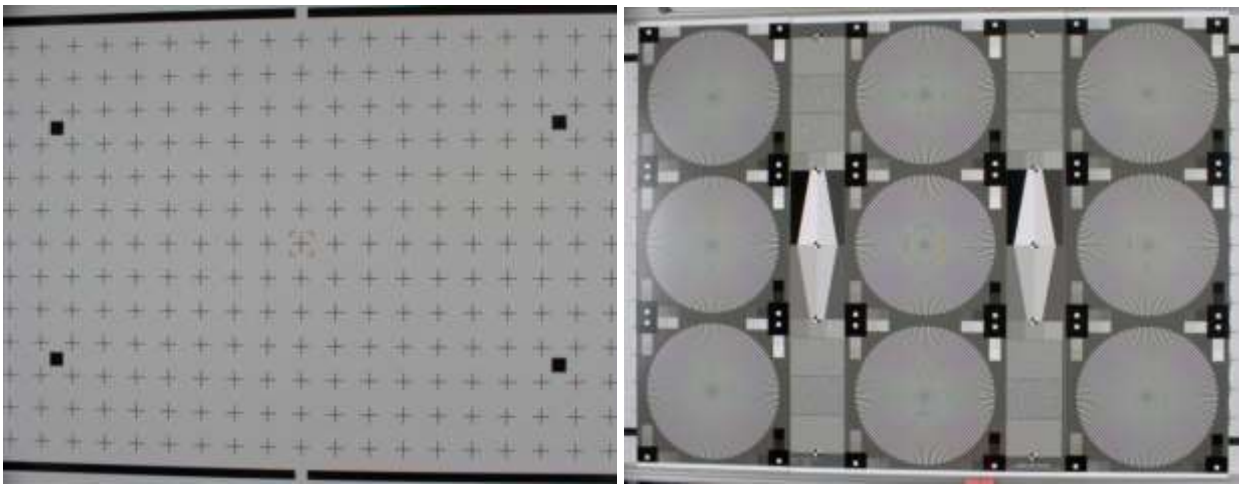


Figure 28. Examples of Images with Camera Rotation to the Left

30. If the left side of the image appears to shrink inwardly at both the top and bottom of the image (Figure 28), adjusting the Tripod Horizontal Rotation (center knob) so the front of the camera moves to the right as viewed from behind the camera will "square-up" the image.

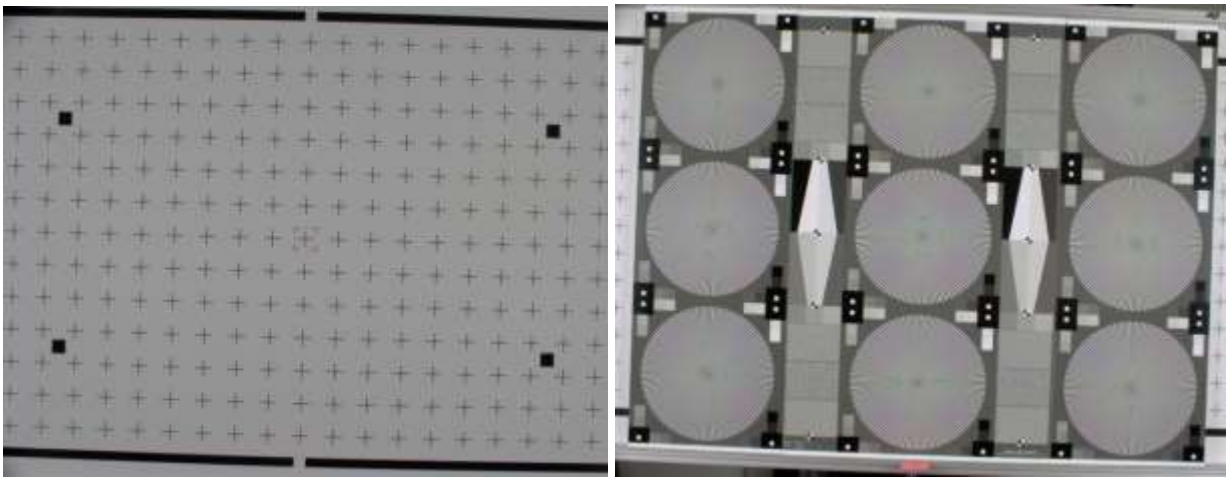


Figure 29. Examples of Images with Counter-clockwise Camera Rotation

31. If the image on the monitor appears to be lower on the right side than on the left side, but otherwise the image does not appear to shrink on the right or left side (Figure 29), adjusting the Tripod Angle Rotation (bottom knob) so the camera rotates clockwise as viewed from the back of the camera will "square-up" the image.

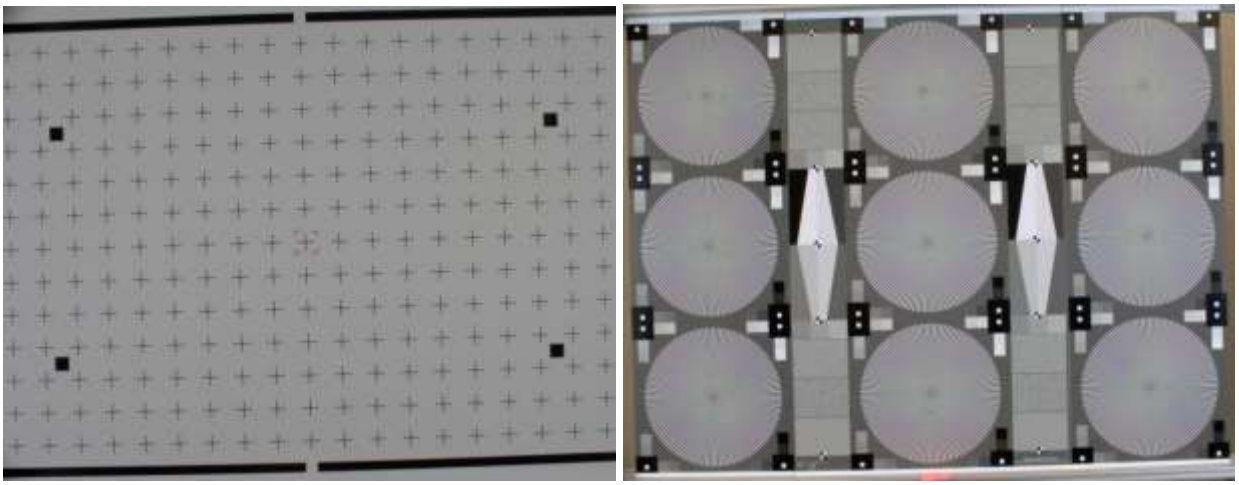


Figure 30. Examples of Images with Clockwise Camera Rotation

32. If the image on the monitor appears to be lower on the left side than on the right side, but otherwise the image does not appear to shrink on the right or left side (Figure 30), adjusting the Tripod Angle Rotation (bottom knob) so the camera rotates counter-clockwise as viewed from the back of the camera will "square-up" the image.

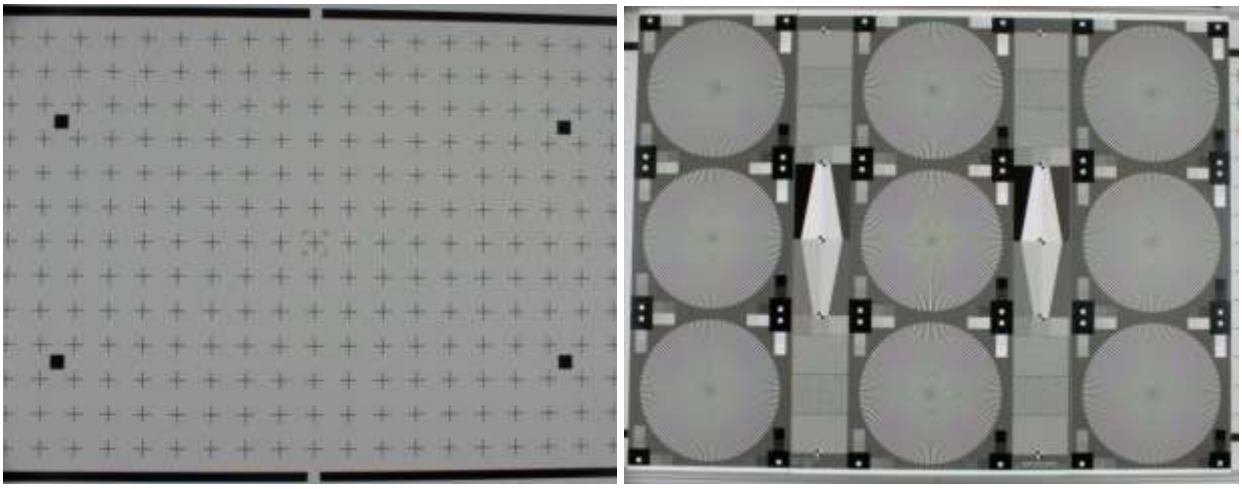


Figure 31. Examples of Images with Up, Right and Counter-clockwise Rotation

33. As examples, the images just above contain a combination of Up, Right and Counterclockwise tripod head rotations (Figure 31).

The Tripod axis adjustments are not absolute. Adjusting one axis may cause a slight shift in another axis. Therefore, it may be necessary to iteratively "touch up" the adjustments until the flattest image possible is achieved. Also, when making the adjustments, it may be necessary to slide the test chart to the right or left and raise or lower the camera tripod to re-center the chart in the monitor image.

Centering on and using the black borders of the Distortion Chart provides a very good means to achieve initial camera "squareness" and "flatness" adjustment.

6.3 Camera Image Acquisition

NOTE: Prior to acquiring test images, ensure that the camera text generator is turned off. Camera generated text appearing in the Test Chart image space will produce either error messages or invalid results.

1. On the computer hard drive or desktop, create a main folder to store data and image files generated during camera testing.
2. Identify the main folder with the make and model number of the camera. In the main folder, create sub-folders with the names: **OECF**, **SHDG**, **DIST**, **RESL** and **TE42**.

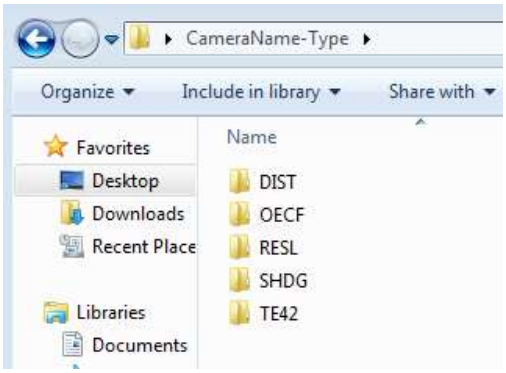


Figure 32. Screenshot of Test Image Folders

3. Insert the proper Test Chart for the specific test in the camera's field of view and verify that the camera's field of view is centered horizontally, vertically and rotationally with the Test Chart as described in Section 6.1.1 *Camera Installation and Alignment* Steps 18 to 21.
4. Obtain a snapshot or static image of the Test Chart using the camera's web interface.
5. Click the Snapshot or "Still Image" button/icon to create a static image of the Test Chart. Another pop-up showing the test chart image will appear.
6. Right click on the image and another pop-up will appear. Left click on the **Save Image As** option.

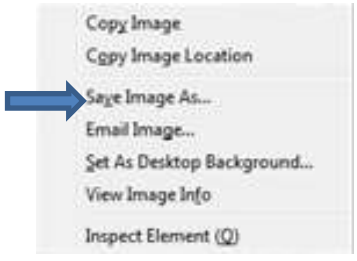


Figure 33. Screenshot of Image Options

7. A pop-up will appear requesting a file name and file storage location.
8. Click on the **Save as type** (.jpg or *.* all others) and enter **.bmp** or **.jpg** file suffix.
9. Enter the <filename> in the File name box with the.**bmp or .jpg** file suffix.

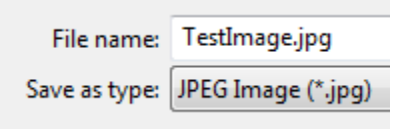


Figure 34. Screenshot of Image Save Option

10. The file storage location is the camera folder and appropriate sub-folder (OECF, SHDG, DIST, RESL and TE42) previously created to store image files for the camera being tested. The file naming convention and file storage sub-folder image file storage locations are described in the Section 7 *Test Procedure* sections.
11. Click the Save button at the bottom right of the pop-up.

6.4 Illuminator Setup and Adjustment

NOTE: For valid analysis results, the illuminators must be placed so that the illumination readings are flat to less than 5 %. However, with precision adjustment of the illuminators, it is possible to achieve an illumination flatness of less than ½%. It has been observed that increased illumination flatness produces improved analysis results.

Chart illumination must be the same for each camera tested. Changes in chart illumination and illuminator created reflections from the test chart produce different analysis results. This is particularly true when conducting tests using the TE253-9X-144 Resolution and TE42 Universal charts.

The analysis software performs self-calibration of the image using grey colored patches at specific locations on the chart and using the OECF patch pattern in the center of the TE42 chart. If the image to be analyzed contains calibration patches having direct reflected light from the illuminators, the analysis results can be significantly different than produced by a camera with the test chart properly illuminated.

1. Charts must be illuminated from the side. iQ-Analyzer software is very sensitive to illumination that is directly reflected back to the camera.
2. Install the Diffusers onto the Illuminators.
3. Energize the Illuminators by pressing their power buttons to the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
4. Turn the room lights **OFF**.
5. Adjust Illuminator height, angle, distance from the target and intensity so that the illumination at the center of the Test Chart is at least 300 Lux (with room lights off) and illumination across the target surface is flat to less than 5% and no visible shiny reflections are observed in the monitor image.

NOTE: It is important to look at the image on the monitor to observe for reflections and shiny spots. For certain lens configurations and camera-to-chart distance, the camera may pick up a reflection that is not visible to the human eye.

6. With the black cap on the Light Meter's sensor attached, energize the Light Meter by sliding the ON/OFF switch on the side of the meter to the **ON** (I) position.

Figure 35. Light Meter

7. Allow the automatic CAL (calibration) procedure to complete and then remove the cap covering the sensor.
8. Measure the illumination with the Light Meter at five places across the target area (top – right and left sides, center, and bottom – right and left sides of the Test Chart).
9. Record the five illumination readings or enter them into the Excel spreadsheet calculator with the filename: LightningFlatness.xlsx.

As an aid in performing illumination calculations, an Excel spreadsheet LightingFlatness.xlsx has been configured to perform the calculations and graphically display the relationship between sets of readings.

10. Divide the highest illumination reading by the Center Illumination value.
11. Divide the lowest illumination reading by the Center Illumination value.
12. The edge illumination values should be less than 5 % higher or lower than the center illumination value.

NOTE: Careful adjustments of the light sources have produced an illumination flatness of less than ½%. It has been observed that really flat test chart illumination produces better analysis results.

13. Adjust the illumination sources until the calculation in Steps 10-11 (or Excel spreadsheet calculation) achieves the best illumination flatness.
14. Record the average illumination value: **_____Lux**.
15. Turn off the Light Meter by moving the ON/OFF slide switch to the **OFF** (0) position and re-install the sensor cap.
16. Turn the room lights **ON** and de-energize the Illuminators by pressing their power buttons to the **OFF** position.

7. Test Procedures

NOTE: Optimum test efficiency is attained when camera tests are conducted in the sequence of: OECF, Shading, Distortion and Resolution. Using this preferred order minimizes the number of times the camera must be refocused because of camera position changes.

7.1 Camera OECF Test

The OptoElectronic Conversion Function (OECF) describes the camera transformation of object luminance values from the imager to a digital image. It is measured using grey scale patches on a Test Chart. The dynamic range of Test Chart patches should exceed the camera's dynamic range for credible results. The results of the test provides information regarding camera maximum contrast capture capability, white balance control, dynamic range, gamma or tonal correction, signal to noise ratios for a range of grey levels and camera ISO speed.

Camera OECF can be determined using the 36 grey patches/background on the glass TE269 Test Chart inserted into the Test Chart Illuminator located behind the movable charts. OECF is the camera characteristic that determines the camera's ability to transfer image Luminance into digital values. The OECF curve is analyzed for Y greyscale, Red, Green and Blue color channels.

7.1.1 Equipment

Table 3. List of Equipment for OECF Test

Equipment	Model Number
Image Engineering Chart Stand	ETC-TS-HOR
Image Engineering Monopod with Rail Includes:	ETC-MONOPOD
Linhof Studio Stand II Tripod Trolley Assembly	
Manfrotto 410 Junior Geared Tripod Head	
Image Engineering Extension Rail	ETC-RAIL
Esser Test Chart Illuminator	ETC-LE6-100
Image Engineering TE269 Glass Test Chart	ETC-TE269-D280
Camera Focus "Eye Chart"	
Black Photographer's Cloth	
Konica Minolta Luminance Meter	LS100
Two Umbrella Light Sources Lowel Rifa Exchange	LC88EX
Netgear Network Switch and Power Supply	GS108PE
Two Ethernet Cables	Cat 5 Minimum
Computer Dell Precision	M6600-i7 with NVIDIA N12E-Q5 video processor and Power Supply
Windows 7 Operating System	
Internet Explorer Browser Software	
Firefox Browser Software	
Image Engineering iQ-Analyzer Software	Version 5.2.17, Build xxx ; IQ-A_5-AMS
Camera Lens	Schneider Cinegon f/1.4, 6mm 21-012543
Camera Under Test	

7.1.2 Procedure

7.1.2.1 Initial Setup

1. Slide all targets to the right of the Test Chart Illuminator.
2. Turn the **SCALE** knob on the Test Chart Illuminator to the "**C**" position.

Figure 36. Test Chart Illuminator Showing Scale Knob Position and Lux Meter

3. Install the glass TE269-36 patch OECF chart into the Test Chart Illuminator (see Figure 41).
4. Loosen the Test Chart Illuminator Position Holding Knob (right side under Test Chart stand bottom rail) and move the Illuminator forward so that the front of the control panel face is resting against the back of the aluminum rail that holds the sliding test charts and the handholds are resting on top of the aluminum rail.

Figure 37. Moving Test Chart Illuminator Towards Camera

5. While pulling on the protruding rail piece towards the camera, secure the Illuminator in place by tightening the Position Holding Knob.

NOTE: There are two methods to acquire and input TE269 Test Chart data for input into the OECF module – Density data input or Luminance data input.

One method (Section 7.1.2.2) is to obtain the official chart calibration certificate from the chart's manufacturer (This is the most accurate option). The certificate contains patch Density data and the reference Density (background) on which the patch data is based.

The second method (Section 7.1.2.3) is to measure the Luminance of each patch. You must point the center of the Luminance Meter exactly at the center of the patch to get the most accurate reading.

Subsequently, enter data into the OECF module by creating either a **.den** or **.lum** file in the analysis database.

If OECF Test Chart data has previously been entered, proceed to Section 7.1.2.4.

7.1.2.2 Entering Chart Density Data from Chart Certificate

1. Click the OECF button in the toolbar at the top of the iQ-Analyzer page.
2. Click the Advanced button at the bottom of the Settings space in the OECF module.

Figure 38. Screenshot of Settings Portion of OECF Page

3. At the bottom of the OECF Advanced Settings space, click the Luminance and Density Data button.

NOTE: The legends for the Density patches and Noise patches in the pop-up are transposed. The top entry should be labeled "**Density Patches**" and the bottom entry should be labeled "**Noise Patches**".

4. A pop-up will appear with two columns of data entry boxes. The left column is titled Density and the right column is titled Luminance.

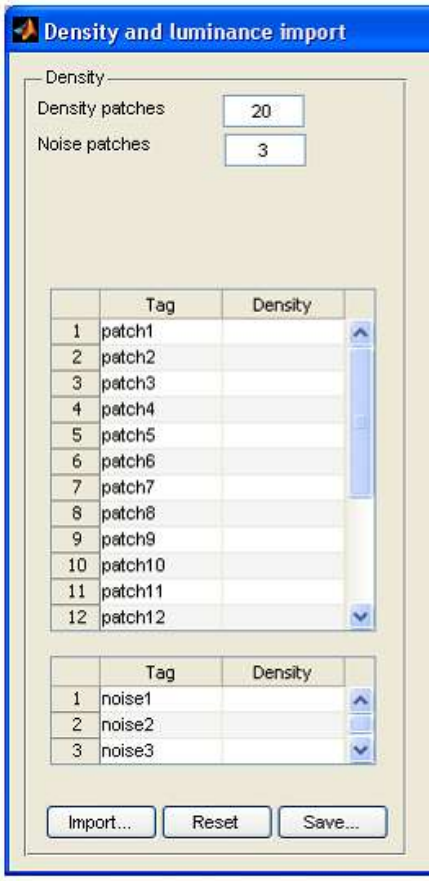


Figure 39. Screenshot of Density Patch Data Input Space

5. At the top of the Density column, enter **36** in the box to the right of the **Noise Patches** selection (20 is the default) [see Text Box note above].
6. If the chart has noise patches, enter the number of noise patches in the box to the right of the **Density Patches** legend. Otherwise, enter **0** in the **Density Patches** box.
7. Enter the data in the column labeled Density (Figure 39). In the space provided to the right of each patch number, enter the data from the certificate for each patch. Press the keyboard **down arrow** after each entry.
8. When all the patch data has been entered, click the Save... button at the bottom of the pop-up.
9. Another pop-up will appear that indicates "**Save In**" and "**IQ-Analyzer V5.2.17**".
10. Double click on the **DATA** folder and enter the file name at the bottom of the pop-up (e.g.TE269_OECF36SNL). The software automatically appends a **.den** file type extension onto the file name.
11. After the data is saved as a **.den** file, exit and restart the iQ-Analyzer application so that the new file is populated in the Settings - Patch file options selection space.
12. Proceed to Section 7.1.2.4.

7.1.2.3 Acquiring and Entering Data from Luminance Meter Measurements

> The procedure below describes the process for a 36 patch Test Chart. If a Test Chart having other than 36 patches is measured, substitute the number of patches in the chart where 36 is shown in the procedure.

1. Energize the Luminance Meter by sliding the ON/OFF switch to the **ON** position and setup the Luminance Meter according to the steps below.

Figure 40. Illuminance Meter and Close-up of ON/OFF Switch

2. Ensure the Luminance Meter switch settings are as follows:
    a. F button – Function button – used in conjunction with other top row buttons to unlock access to the parameter being changed
    b. Response = **SLOW**
    c. Measuring Mode = **ABS**
    d. Calibration = **PRESET**
    e. CCF/Luminance = No option to select in ABS mode
    f. Peak/Continuous = **CONTINUOUS**
    g. Up Arrow Button = Changes decimal point location when in Variable Mode
3. Remove the Luminance Meter lens cap.
4. Ensure that the Luminance Meter lens is focused at the minimum distance (~ 1m).
5. Adjust the eyepiece focus by rotating the rubber eyepiece (counterclockwise focuses at shortest distance).
6. Energize the Test Chart Illuminator by pressing the Power and Lux Meter buttons to the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
7. Turn the room lights **OFF** or place the black cloth over the Test Chart Illuminator to prevent stray light from reflecting off the chart's glass surface.
8. Measure and record the Luminance value for the target background using the Luminance Meter.

NOTE: When making Luminance Meter readings, view through the eyepiece and center the circle observed through the eyepiece on the center of the area or patch being measured. For correct readings, the entire patch must appear in the Luminance Meter viewing space.

9. When analyzed by the Image Engineering software, the background of the TE269 Test Chart should have an OECF analysis that produces a digital value of 119. The acceptable tolerance range is 100 to 140.
10. If the Test Chart Luminance requires adjustment, turn the adjustment knob on the bottom left of the Illuminator until the analysis produces a Test Chart background digital luminance near 119.
11. Measure and record the Luminance of each patch on the Test Chart. Figure 41, shows the location of each patch by number.

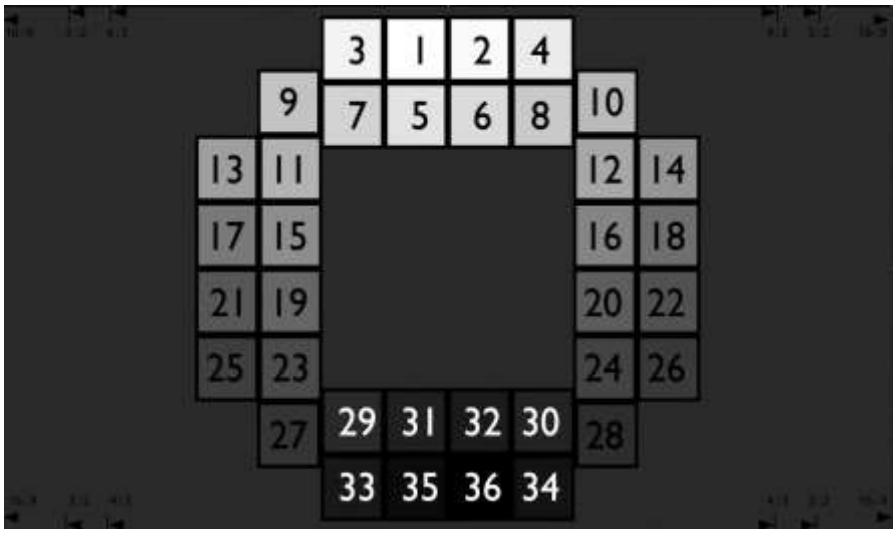


Figure 41. TE269 Test Chart Showing Location of Each Patch

12. When readings are completed, move the Luminance Meter power switch to the **OFF** position and reinstall the lens cap.
13. Turn the room lights **ON** if turned OFF in Step 7.
14. Deenergize the Illuminator by pressing the Power and Lux Meter buttons to the **OFF** position.
15. Enter the TE269 Test Chart patch Luminance values into the iQ-Analyzer OECF database according to Steps 16-26 below.
16. Click the OECF button in the toolbar at the top of the iQ-Analyzer page.
17. Click the Advanced button at the bottom of the Settings space in the iQ-Analyzer OECF module.
18. At the bottom of the OECF Advanced Settings space, click the Luminance and Density Data button.
19. A pop-up will appear with two columns of data entry boxes.

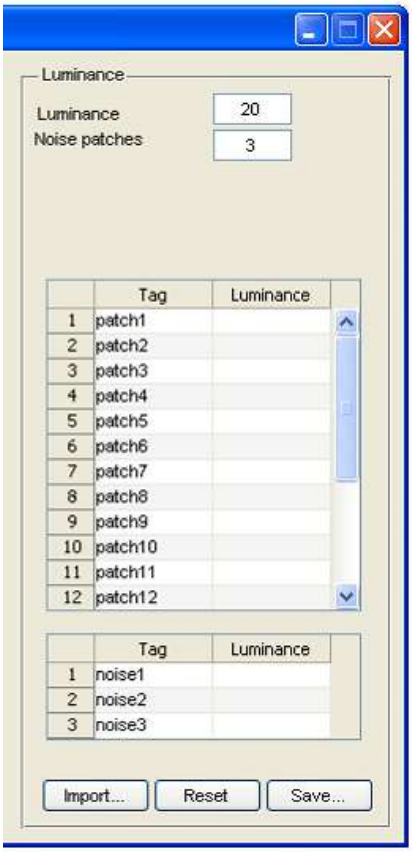


Figure 42. Luminance Patch Data Input Space

20. At the top of the Luminance column enter **36** in the box to the right of **Luminance** selection (20 is the default).
21. If the chart has noise patches, enter the number of noise patches in the box to the right of the **Noise Patches** legend; otherwise, enter **0**.
22. In the space provided to the right of each patch number, enter the Luminance value for each patch in the Luminance space.
23. When the patch Luminance data has been entered, click the Save... button at the bottom of the pop-up.
24. Another pop-up will appear that indicates "**Save In**" and "**IQ-Analyzer V5.2.17**."
25. Double click on the **DATA** folder and enter the file name at the bottom of the pop-up (e.g. TE269_OECF36SNL). The software automatically appends a **.lum** file type extension onto the file name.
26. After the data is saved as a **.lum** file, exit and restart the iQ-Analyzer application so that the new file can appear in the Settings file options.
27. Proceed to Section 7.1.2.4.

7.1.2.4 Applying Chart Data to Analysis

1. In the Settings space of the iQ-Analyzer OECF module, ensure that **Luminance** or **Density** option is checked Lumina... Density for the TE269 patch analysis depending on which Chart Template being used.
2. In the OECF Module Luminance-Patch Data box, select the **TE269_OECF36SNL.den** chart file option if using the (.den) Chart Template.

Figure 43. Screenshot of OECF .den Patch Option

3. In the OECF Module, left column, enter the **Illumination (Lux)** measured for the TE269 Test Chart background only if the Luminance Chart Template data (.lum) is being used.

Figure 44. Screenshot of OECF .lum Patch Option

7.1.2.5 Calibrating Test Chart Illumination

Before test images can be acquired and analyzed, test chart illumination must be adjusted so that only one to three of the test chart patches indicates Saturation. The process is described in the steps below.

1. Energize the Test Chart Illuminator by pressing the Power and Lux Meter buttons to the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
2. Rotate the Illuminator's Voltage Adjustment Knob (Figure 36) until the Lux Meter reads **100.0 Lux** and wait at least 5 minutes for the illumination level indicated on the Lux Meter to stabilize. It will be necessary to readjust the Voltage Adjustment Knob because the illumination reading decreases as the bulb warms up.
3. Install the camera on the tripod and align, center and focus the camera as described In Section 6.2 *Camera Focus Procedure*, Steps 1-33 with the "Eye Chart" Figure 22, placed in front of the TE269 OECF Glass Chart on the Illuminator. During the focusing procedure, ensure that the camera to chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the camera image.
4. Adjust the field of view to the inner horizontal registration marks on the OECF glass chart for a 4x3 imager or to the outer horizontal registration marks for a 16x9 imager.
5. If the camera has an adjustable lens, ensure that the camera lens f-stop is set at **f/4**.
6. Cover the Test Chart and camera with the black cloth to eliminate stray light from reflecting off the Test Chart.

7. If the camera has a manual or software controlled auto-focus button or command, press the button or execute the command to initiate camera auto-focus.
8. If the camera does not have an auto-focus capability, manually focus the lens (Step 3 above) to achieve optimum image focus.
9. Create a calibration test file using Steps 10-16 below.
10. On the camera's web page, click the Snapshot or "Still Image" button/icon to create a static image of the Test Chart. That action will produce a pop-up with the camera image.
11. Right click on the image and another pop-up will appear.
12. Left click on the **Save Image As** option.

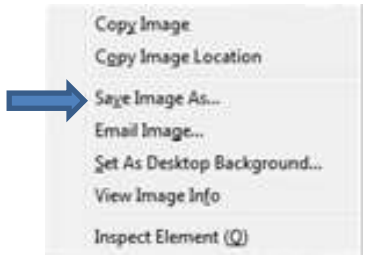


Figure 45. Screenshot of Image Options

13. A pop-up will appear requesting a file name and file storage location.
14. When prompted to name the file, enter: **camera name_type_OECF_CAL1** and the storage location as the camera's **OECF** file sub-folder.

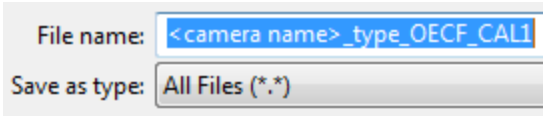


Figure 46. Screenshot of File Storage Option

15. Click on the **Save as type** box in the pop-up and select the .**jpg** option (default).
16. Click the Save... button at the bottom right of the pop-up.
17. Figure 47 below is an example of an image that does not produce error messages.

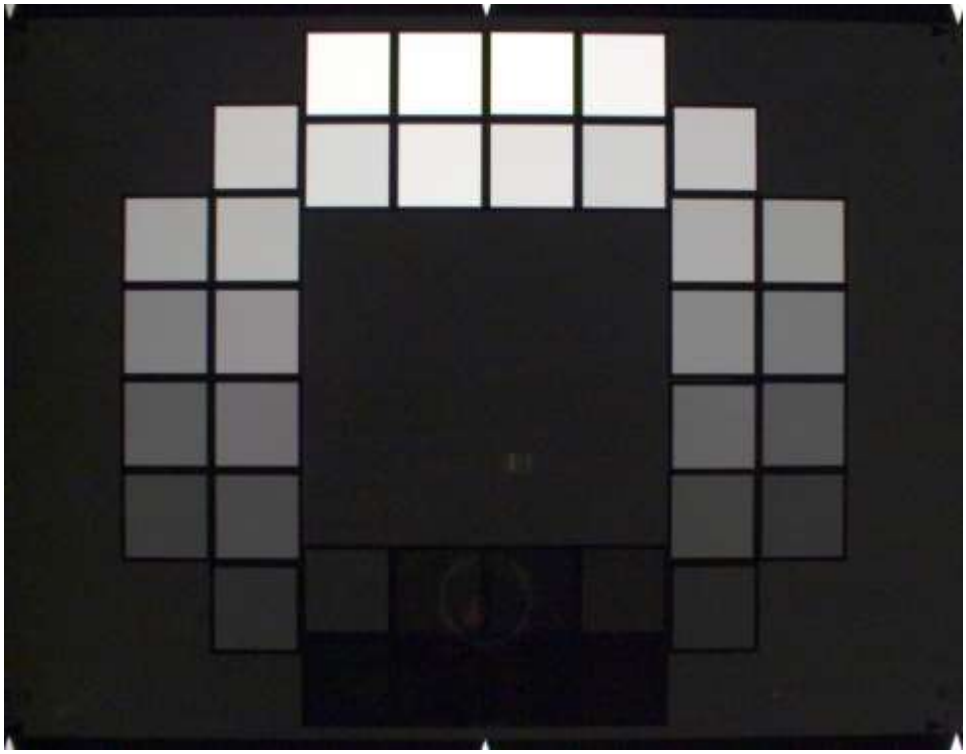


Figure 47. TE269 Image that Does Not Produce Error Messages

7.1.2.6 OECF Image Analysis

1. Perform analysis of the OECF test files using the procedure in Steps 2–26 below to ensure sufficient Test Chart illumination is present to generate valid analysis results.
2. In the iQ-Analyzer software, click the OECF button.
3. Click the Meta button at the top left of the OECF Module page.

> NOTE: The Meta button toggles between the Metadata entry page and either the Camera Image or Result display depending on what button selection is made at the bottom of the Settings portion of the Test Module space. The Image/Result button toggles between the two options.

4. Enter the data requested in the Metadata space and click the Update button at the bottom of the page (see Section 5.4, *Metadata Information*). After each entry, be sure to press the **Enter** key on the keyboard to save the entry. Entering all data except for the width and height of the imager will cause those values to automatically calculate – the keyboard **Enter** key must be used after each entry for this to happen.
5. After entering the Metadata, ensure the Apply changes to all files in List box is checked and click the Update button at the bottom of the page. Click the Meta button to toggle the space back in to the camera Image/Result mode.
6. In the Settings space (left column) of the OECF module page, ensure that the following are set:

a. Chart Layout = **TE269_OECF36 Chart**
b. Lumina... Density Buttons = Select Density or Luminance as appropriate
c. Patch Densities = **TE269_OECF36SNL (**either **.lum** or **.den** as appropriate**)**

7. Below the **FILE LIST** box are three buttons + , - and C to add, delete or clear all files in the processing list.
8. Click the + button.
9. A pop-up with folders containing test images will appear.
10. Click on the camera's folder and **OECF** sub-folder and double click on the image file. That file path and name will appear in the **FILE LIST** box.
11. Ensure that the following are set in the iQ-analyzer OECF page Settings space:

    a. Select Processing = **FILES IN QUEUE**
    b. Select Output = **AVERAGE**

12. Click the Advanced button at the bottom of the Settings space.
13. In the center of the Advanced Settings space, select the "**ISO15739 V1**" option and ensure that the boxes ☑ Warn of no Field in Saturati... and ☑ Check Number of saturated. are checked.
14. Click the Start button at the bottom of the left column.
15. The **Analyzing Image Status** box in center of the task bar will show a red line and a blue-background line that indicates the relative progress of analysis operations.

16. If several images are being analyzed, it will show how many images have been analyzed until the process is completed. When completed, a data plot will appear on the right side of the page.
17. Analysis of the Test Image may produce one of two pop-up error messages.

    a. If an error message stating "**More than 3 fields in full saturation. Check Exposure**" appears (Figure 48), reduce the Test Chart Illumination by reducing the voltage and performing steps in Sections 7.1.2.5 and 7.1.2.6 until the analysis error message no longer appears.

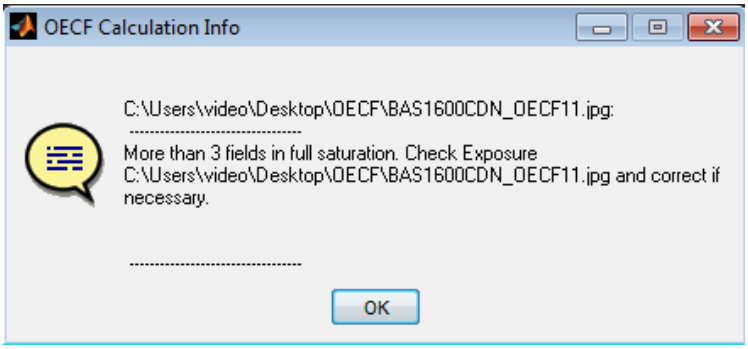


Figure 48. Screenshot of More Than Three Fields in Saturation Pop-up

b. If an error message stating "**Saturation is not reached. Dynamic Range might be larger**," (Figure 49) increase the Test Chart Illumination by increasing the voltage and performing steps in Sections 7.1.2.5 and 7.1.2.6 until the analysis error message no longer appears.

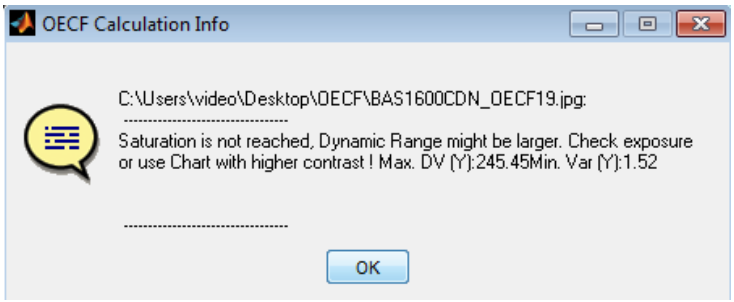


Figure 49. Screenshot of Saturation is not Reached Pop-up

NOTE: The exposure control algorithm in some cameras prevents the camera's exposure from allowing any of the OECF patches to reach saturation before switching to the next exposure increment no matter how bright the test chart's illumination. It may be necessary to adjust the camera's Shutter Speed, Auto-Iris or Image Brightness control to produce saturated patches.

In some cameras, the camera produces more than three saturated OECF patches before switching to the next exposure increment no matter how dark the test chart's illumination value is set. In these instances, it may be necessary to constrain camera Shutter Speed, Gain or Auto-Iris through the camera's GUI to produce only 1 to 3 patches in saturation.

18. When analysis pop-up error messages no longer appear, the proper level of Test Chart illumination can be fine-tuned using Steps 19-25 to produce valid OECF analysis results.
19. On the last test file analyzed, click the Result button at the bottom of the Settings space and click the CIE, RGBY, Luminance and logarithmic buttons under the Results display space (Figure 50).

Figure 50. Screenshot of OECF Display Option Buttons

20. An OECF analysis data plot should appear as shown in Figure 51 below. With the CIE, RGBY, Luminance and logarithmic buttons selected, the white line in the graph should intersect between 18 and 20 on the right side CIE-C axis.

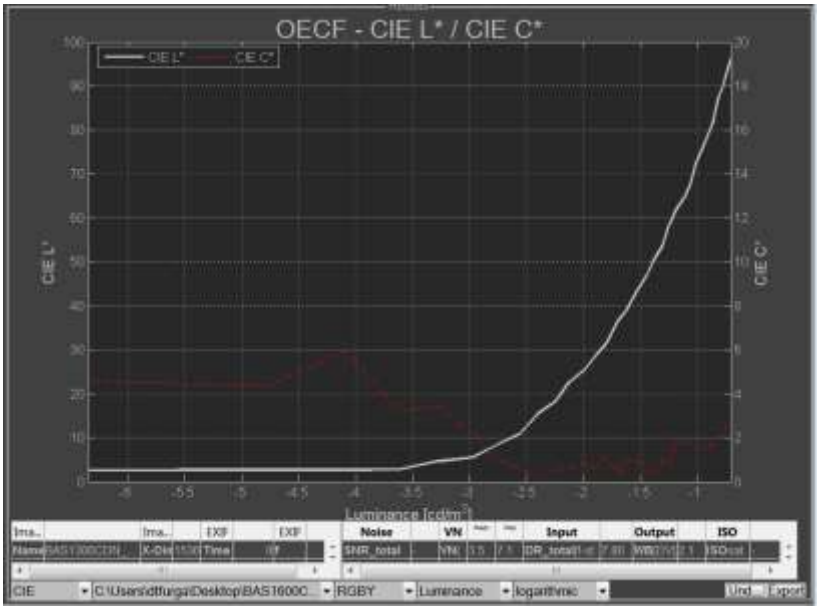


Figure 51. OECF-CIE Analysis Data Plot

21. If the data plot does not appear as shown in Figure 51 adjust the Illuminator Voltage.
22. If the white line intersects at below 18, the analysis software will give you an error message indicating that no patch is in saturation, **increase** the Illuminator Voltage and perform Steps 2-18.
23. If the white line "flat lines" before it intersects at 20, the software will produce an error message indicating that more than 3 patches are in saturation, **decrease** the Illuminator Voltage and perform Steps 2-18.

NOTE: It may be necessary to constrain camera Shutter Speed, Gain or Auto-Iris through the camera's GUI so that only 1 to 3 patches are in saturation in conjunction with adjusting the Illuminator voltage.

24. When the OECF CIE analysis data plot appears as shown in Figure 51 above and no error messages appear, the Test Chart image is properly calibrated.
25. Record the value indicated on the Illuminator's Lux Meter _____**Lux** and the values of the Shutter Speed, Gain and Auto-Iris values to obtain the calibrated image.
26. The Result, OECF, RGBY, Luminance and logarithmic button selections should be made to view the appropriate plot image (see Figure 50).
27. When the OECF Test Chart illumination has been calibrated, delete all of the .**jpg** *Test Image* files, **.jpg** *Check Image* files and **.txt** *Test Image text files* from the camera's **OECF** sub-folder.

7.1.2.7 Acquiring OECF Test Images

1. Energize the Test Chart Illuminator by pressing the Power and Lux Meter buttons to the ON position and wait for 15 minutes for the Illuminators to come up to full brightness.
2. Ensure that the Illuminator's Lux Meter reads the value recorded in Section 7.1.2.6 Step 25 above and wait at least 5 minutes for the illumination level indicated on the Lux Meter to stabilize. It will be necessary to readjust the Voltage Adjustment Knob because the illumination reading decreases as the bulb warms up.
3. Ensure that the camera GUI adjustments for Shutter Speed, Gain and Auto-Iris are set the same as for the Calibration Image (Section 7.1.2.6 Step 23).
4. Cover the Test Chart and camera with the black cloth to eliminate stray light from reflecting off the Test Chart.
5. On the camera's web page, click the Snapshot or "Still Image" button to create a static image of the OECF Chart. A another pop-up showing the test chart image will appear.
6. Right click on the image and another pop-up will appear. Left click on the **Save Image As** option.

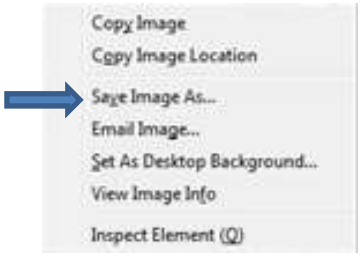


Figure 52. Screenshot of Image Options

7. A pop-up will appear requesting a file name and file storage location.
8. When prompted to name the file, enter: **camera name_type_OECF01**. The file storage location is the camera's **OECF** sub-folder.

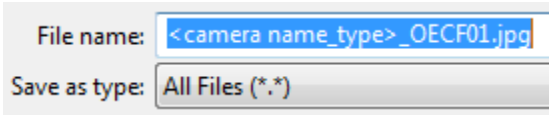


Figure 53. Screenshot of File Storage Options

9. Click on the **Save as type** box in the pop-up and select the .**jpg** option (default).
10. Click the Save... button at the bottom right of the pop-up.
11. Ten files are required for OECF analysis, each subsequent file should be named **camera name_type_OECFXY**; where XY = 02 through 10.
12. Repeat Steps 5 through 10 above for the additional 9 image files.

13. Deenergize the Test Chart Illuminator by pressing the Power and Lux Meter buttons to the **OFF** position.
14. Minimize the camera browser page.

7.1.2.8 Analyzing OECF Test Images

1. In the iQ-Analyzer software, click the OECF button.
2. Click the Meta button at the top left of the OECF Module page.

> NOTE: The META button toggles between the Metadata entry page and either the Camera Image or Result display depending on what button selection is made at the bottom of the Settings portion of the Test Module space. The Image/Result button toggles between the two options.

3. If the Metadata is not automatically repopulated from the Test Chart Illumination Calibration procedure information, enter the data requested in the Metadata space and click the Update button at the bottom of the page (see Section 5.4, *Metadata Information*).
4. After saving the Metadata, click the Meta button to toggle the space back in to the Camera Image/Result mode.
5. In the Settings space (left column), of the OECF module page, ensure that the following are set:
    a. Chart Layout = **TE269_OECF36 Chart**
    b. Luminance and Density Buttons = Select **Density** or **Luminance** as appropriate
    c. Patch Densities = **TE269_OECF36SNL (**either ***.lum*** or ***.den*** as appropriate**)**
6. Below the **FILE LIST** box are three buttons +, -, and c to add, delete or clear all files in the processing list.
7. Click the + button.
8. This will open up a pop-up with the camera's sub-folders.
9. Click on the camera's folder and **OECF** sub-folder.
10. To upload multiple files, click the filename of the first image to highlight it and hold the Shift key and click on the last file of the group to be uploaded into the OECF Module. If only certain files are to be analyzed, press the **Ctrl** key and click on each of the files to be analyzed. When all the files to be analyzed are highlighted, release the Shift or **Ctrl** key and press the keyboard **Enter** key and the selected files will appear in the **FILE LIST** box.
11. Ensure that the following are set in the Settings space:
    a. Processing = **FILES IN QUEUE**
    b. Output = **AVERAGE**
12. Click the Advanced button at the bottom of the Settings space.

13. In the center of the Advanced Settings space, select the **ISO15739 V1** option and ensure that the ☑ Warn of no Field in Saturati... and ☑ Check Number of saturated boxes are checked.
14. Click the Start button at the bottom of the left column.
15. The **Analyzing Image Status** box in center of the task bar will show a red line and a blue-background line that indicates the relative progress of analysis operations.

16. If several images are being analyzed, it will show how many images have been analyzed until the process is completed. When completed, a data plot will appear on the right side of the page.

7.1.2.9 Displaying OECF Test Results

At the bottom of the Settings space, there are two buttons.
The top Advanced button toggles the Advanced Settings center space on and off.
The bottom Image / Result button toggles between pictures of the Camera ORIGINAL IMAGE, ROI IMAGE, CHECK IMAGE and CENTER IMAGE analyzed and the Graphical RESULTS of the analysis.

1. Click on any file in the **FILE LIST** box to see the analysis results for that image and then use the keyboard **up/down** arrow keys to see other camera images and their analysis results.
2. Click the buttons at the bottom of the page under the Results display space to see plots of the various analysis results.
3. Click the Image button below the file list to display the captured Test Chart camera image.
4. In the Image mode, clicking the first button at the bottom of the frame underneath the Result Image, there are 4 selection options (Figure 54):

    a. **ORIGINAL** - shows original image captured
    b. **ROI** - shows close-up of image patches area region of interest
    c. **WAVEFORM (Y)** - shows luminance waveform of captured image
    d. **WAVEFORM (RGB)** - shows RGB waveforms of captured image

Figure 54. Screenshot of the Four Image Mode Selection Options

5. Click the Result button below the **FILE LIST** to display the analyzed results.
6. In the Result mode, clicking the first button at the bottom of the frame underneath the Result Image, there are 4 selection options (Figure 55):

a. **OECF** - shows OECF digital values as a function of luminance
b. **VN** - shows visual noise as a function of luminance, density exposure or reflectance for three viewing conditions defined in SETTINGS
c. **NOISE** - shows standard deviation noise as a function of luminance, density exposure or reflectance
d. **CIE** - shows CIE luminance & chrominance as a function of luminance, density exposure or reflectance

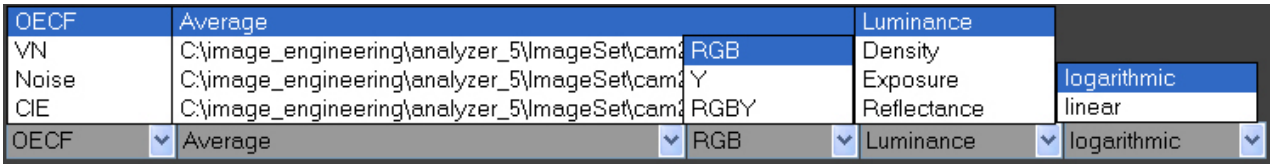


Figure 55. Screenshot of Result Mode Selection Options

7. Two images with filename extensions **.center** and **.check** are saved automatically to the location defined on the [**SETTINGS**] button page. One image shows the center of the Siemens stars and the other shows the marked regions of interest. The path for saving options, image quality and comparison image size are also defined in the [**SETTINGS**] button page.
8. Click on another file in the **FILE LIST** box to observe the graphical display of that image file's Resolution analysis.
9. If Results graphs need to be saved, perform steps in Section 5.7 *Export/Import* "Executing the Export Function."

7.2 Camera Shading Test

The camera Shading Test quantifies the loss of intensity from the center of an image to the corner. Shading includes the vignetting of the lens and all other effects that may cause a loss of light. iQ-Analyzer uses the OECF to calculate the shading in f-stops.

7.2.1 Equipment

Table 4. List of Equipment for Shading Test

Equipment	Model Number
Image Engineering Chart Stand	ETC-TS-HOR
Image Engineering Monopod with Rail Includes:	ETC-MONOPOD
Linhof Studio Stand II Tripod Trolley Assembly	
Manfrotto 410 Junior Geared Tripod Head	
Image Engineering Extension Rail	ETC-RAIL
Esser Test Chart Illuminator	ETC-LE6-100
Image Engineering TE255 Glass Diffuser Test Chart	ETC-TE255-D280
Camera Focus "Eye Chart"	
Black Photographer's Cloth	
Netgear Network Switch and Power Supply	GS108PE
Two Ethernet Cables	Cat 5 Minimum
Computer Dell Precision	M6600-i7 with NVIDIA N12E-Q5 video processor and Power Supply
Windows 7 Operating System	
Internet Explorer Browser Software	
Firefox Browser Software	
Image Engineering iQ-Analyzer Software	Version 5.2.17, Build xxx ; IQ-A_5-AMS
Camera Lens	Schneider Cinegon f/1.4, 6mm 21-012543
Camera Under Test	

7.2.2 Procedure

NOTE: The results of the Camera Shading Test may enhance the results of the Camera Resolution Test. It is advised to conduct the Camera Shading Test prior to performing the Camera Resolution Test. If the results of the Shading Test produce 3-D Plots that have a strong umbrella shape (click Luminance [f-stop] and 3-D plot options) (see Figure 56), the Shading Test data should be exported from the Shading Test module and imported into the Resolution Test module. Those procedures are described in the Shading Correction Adjustment steps in this Section and in Section 7.4 *Camera Resolution Test*.

7.2.2.1 Initial Setup

1. Slide all movable targets to the right of the Test Chart Illuminator.
2. Turn the **SCALE** knob on the Test Chart Illuminator to the "**D**" position (Figure 56).

Figure 56. Test Chart Illuminator and Close-up of Scale Knob

3. Install the TE255 Diffuser Glass Chart (milk colored glass) into the Test Chart Illuminator.
4. Loosen the Test Chart Illuminator Position Holding Knob (right side under Test Chart stand bottom rail) and move the Illuminator forward so that the front of the control panel face is resting against the back of the aluminum rail that holds the sliding test charts (Figure 57).

Figure 57. Moving Test Chart Illuminator Toward Camera

5. While pulling on the protruding rail piece towards the camera, secure the Illuminator in place by tightening the Position Holding Knob.

6. The camera should already be installed, aligned, centered and focused from the OECF test. If the camera has an adjustable lens, ensure the camera lens f-stop is set to **f/4**.
7. Move the camera tripod as close so that the lens touches the glass target. Do not refocus the camera at the new location.

7.2.2.2 Acquiring Shading Test Images

1. Energize the Test Chart Illuminator by pressing the Power and Lux Meter buttons to the **ON** position.
2. Rotate the Test Chart Illuminator's Voltage Adjustment Knob until the Lux Meter reads **1.080 kLux**.
3. Wait at least 5 minutes for the Lux Meter illumination level to stabilize.
4. Cover the Test Chart and camera with black cloth to eliminate stray light/images from reflecting off the glass Test Chart.
5. It will be necessary to readjust the Voltage Adjustment Knob as the illumination slowly drifts downward. When the illumination level stabilizes, adjust the reading to **1.000 kLux**.
6. On the camera's web page, click the Snapshot or "Still Image" button/icon to create a static image of the Shading Chart. Another pop-up showing grey image will appear.
7. Right click on the image and another pop-up will appear. Left click on the **Save Image As** option.

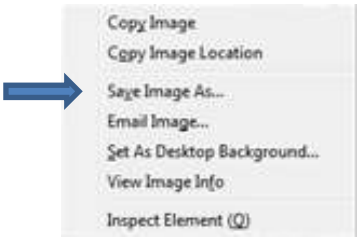


Figure 58. Screenshot of Image Options

8. A pop-up will appear requesting a file name and file storage location.
9. When prompted to name the file, leave the **.jpg** default File Type option in the **Save as type** box.
10. When prompted to name the file, enter: **camera name_type_SHDG01**. Select the camera's **SHDG** sub-folder as the file storage location.

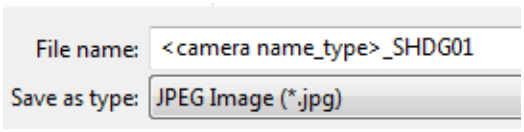


Figure 59. Screenshot of File Storage Options

11. Click the Save... button at the bottom right of the pop-up.
12. Ten files are required for Shading analysis, each subsequent file should be named **camera name_type_SHDGXY**; where XY = 02 through 10.
13. Repeat Steps 6 through 11 above for the additional 9 image files.
14. Place the black cloth on the top of the illuminator to gain access to the illuminator switches.
15. De-energize the Test Chart Illuminator by pressing the Power and Lux Meter buttons to the **OFF** position.
16. Minimize the camera browser page.

7.2.2.3 Analyzing Shading Test Images

1. In the iQ-Analyzer software, click the Shading button.
2. Click the Meta button at the top left of the Shading Module page.

> NOTE: The Meta button toggles between the Metadata entry page and either the Camera Image or Results display depending on what button selection is made at the bottom of the Settings portion of the Test Module space. The Image/Result button toggles between the options.

3. Enter the data requested in the Metadata space (see Section 5.4, *Metadata Information*).
4. Ensure that the Apply changes to all files in List box is checked.
5. Click the Update button at the bottom of the page.
6. After entering the Metadata, click the Meta button to toggle the space back in to the Camera Image/Result mode.
7. In the Settings space (left column) of the Shading module page, ensure that the following are set:

    a. Chart Layout = **TE255 FLAT FIELD CHART**
    b. OECF for Linearization = **ASSUME LINEARITY**
    c. Ensure that the Calculate Visual Noise box is checked
    d. Detection = **AUTOMATIC MODE**
    e. Processing = **FILES IN QUEUE**
    f. Output = **AVERAGE**

8. Below the **FILE LIST** box are three buttons +, - and C to add, delete or clear all files in the processing list.
9. Click the + button. This will open up a pop-up with folders containing test images.
10. Click the button and Look in: Cameras Main Folder and Look in: SHDG sub-folder.

11. To upload multiple files, click the filename of the first image to highlight it and hold the **Shift** key and click on the last file of the group to be uploaded into the Shading Module. If only certain files are to be analyzed, press the **Ctrl** key and click on each of the files to be analyzed. When all the files to be analyzed are highlighted, release the **Shift** or **Ctrl** key and press the keyboard **Enter** key and the selected files will appear in the **FILE LIST** box.
12. Click the Advanced button. In the Advanced Settings column that opens, do not change any of the Advanced Settings defaults.
13. Click the Advanced button to close the Advanced Settings column.
14. Click the Start button at the bottom of the left column.
15. The **Analyzing Image Status** box in center of the task bar will show a red line and a blue-background line that indicates the relative progress of analysis operations.

16. If several images are being analyzed, it will show how many images have been analyzed until the process is completed. When completed, a data plot will appear on the right side of the page.

7.2.2.4 Displaying Shading Test Results

At the bottom of the Settings space, there are two buttons.
The top Advanced button toggles the Advanced Settings center space on and off.
The bottom Image / Result button toggles between pictures of the Camera ORIGINAL IMAGE, ROI IMAGE, CHECK IMAGE and CENTER IMAGE analyzed and the Graphical RESULTS of the analysis.

1. Click the Result button to display plots of the analysis results.
2. Click on any file in **FILE LIST** box to see the analysis results for that image and then use the keyboard **up/down** arrow keys to see the other camera images and their analysis results (Figure 60).

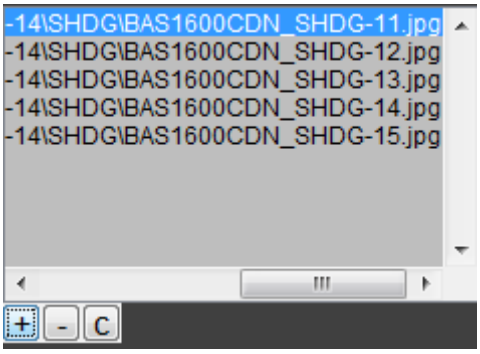


Figure 60. Screenshot of File List Box

3. Click the buttons at the bottom of the page to see displays of the various analysis results.

4. In the Image mode, the first button under the Results image space has 6 options (see Figure 61):

    a. **ORIGINAL** - Shows entire image viewed by the camera
    b. **ROI** - Shows a cropped version of the camera image with small blue boxes showing the locations where data was taken.
    c. **LumBoost** - Shows Luminance distribution based on boost value entered in Advanced Settings
    d. **SatBoos**t - Shows Saturation distribution based on boost value entered in Advanced Settings
    e. **WAVEFORM (Y)** - Shows Luminance waveform of camera image
    f. **WAVEFORM (RGB)** - Shows the distribution for R, G & B values

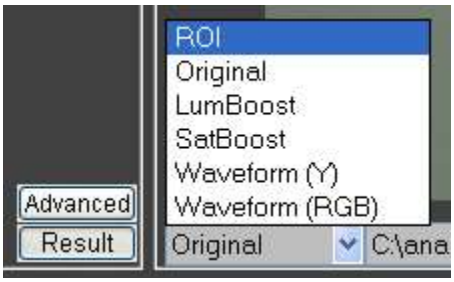


Figure 61. Screenshot of Shading Image Mode Display Options

5. In the Result mode, under the visual display space of the page, there are two buttons and a space indicating which file's data is being displayed.

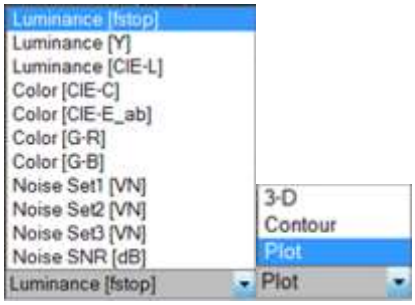


Figure 62. Screenshot of Shading Results Mode Display Options

6. The first button space allows you to choose one of the following ten display options (Figure 63):

    a. **Luminance FSTOP** – Maximum Luminance shading expressed in f-stops
    b. **Luminance Y** – Distribution of Luminance values
    c. **Color CIE-L** – Absolute average Luminance shading
    d. **Color CIE-C** – Absolute average Chrominance shading
    e. **Color CIE-E_ab** – Absolute average Chrominance shading without Luminance

f. **Color G-R** – Plots of average difference between green and red channels.
g. **Color G-B** – Plots of average difference between green and blue channels.
h. **Noise Set1 VN** – Maximum Visual Noise difference for viewing condition #1.
i. **Noise Set2 VN** – Maximum Visual Noise difference for viewing condition #2.
j. **Noise Set3 VN** – Maximum Visual Noise difference for viewing condition #3.

Figure 63. Screenshot of Results Mode Luminance Options

7. The third button space allows you to choose one of three data display options (Figure 64):

   a. **3D** - Shows 3D solid object type display of data.
   b. **Contour** - Shows shaded concentric circle plots of data.
   c. **Plot** - Shows plots of Y, R, G & B data.

Figure 64. Screenshot of Results Mode Display Options

8. If Results graphs need to be saved, perform steps in Section 5.7 *Export/Import* "Executing the Export Function" subsection.
9. Two images with filename extensions ***.center*** and ***.check*** are saved automatically to the location defined in the [⚙] [**SETTINGS**] button. One image shows the center of the Siemens stars and the other shows the marked regions of interest. The path for saving options, image quality and comparison image size are defined in Section 5.6 *Settings*.

7.2.3 Shading Correction Adjustment

NOTE: For the shading correction to properly "adjust" the results of Resolution Test analysis, the camera f-stop used when creating the shading correction file must be the same as the f-stop used when creating Resolution Test image files. Shading test results using a different f-stop can produce significantly different correction factors.

1. If the Shading Test analysis produces f;at-shaped 3-D image and data plot as shown in Figure 65 and Figure 66 (press **LUMINANCE [f-stop]** and **3-D** buttons) and (press **LUMINANCE [f-stop]** and **PLOT** buttons), Shading correction adjustment will most likely not be required in other analysis modules because the camera/lens combination produces an almost flat curve.

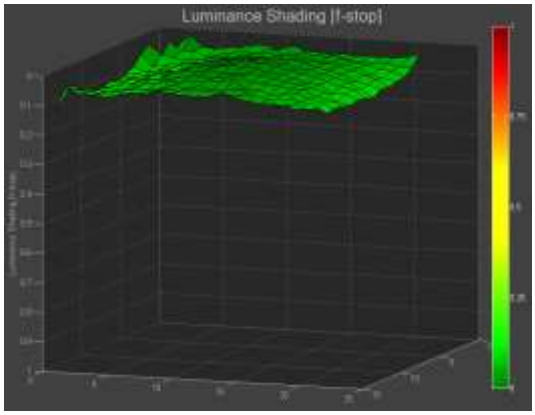


Figure 65. Luminance [f-stop] 3-D Image

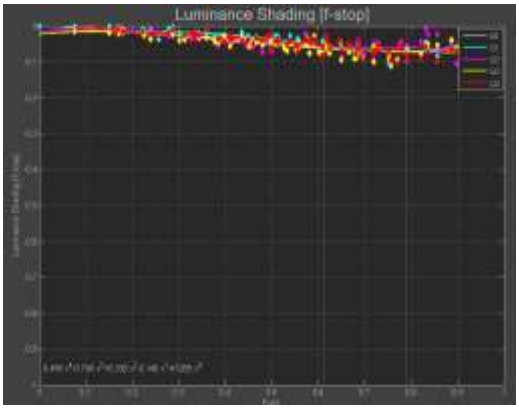


Figure 66. Luminance [f-stop] Plot Image

2. If the Shading Test analysis produces an umbrella-shaped 3-D image and data plot as shown in Figure 67 and Figure 68 (press **LUMINANCE [f-stop]** and **3-D** buttons) and (press **LUMINANCE [f-stop]** and **PLOT** buttons), the shading data should be used for compensation adjustment in other analysis modules.

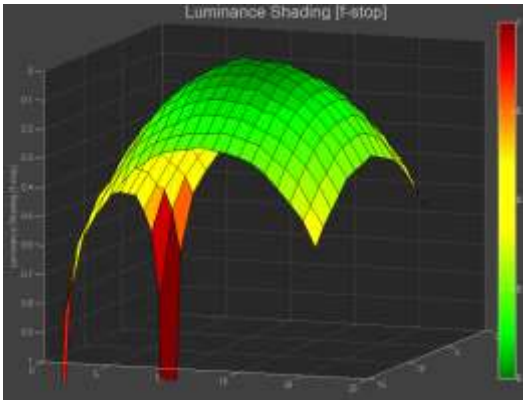


Figure 67. Umbrella-Shaped 3-D Image

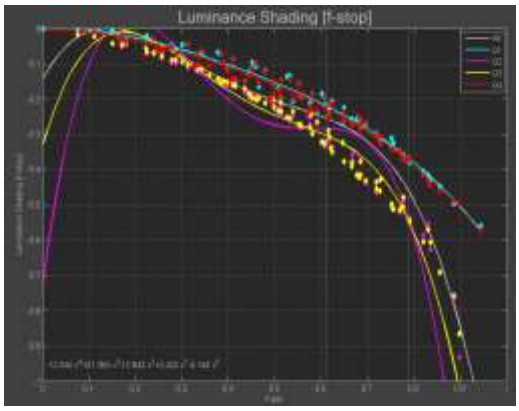


Figure 68. Data Plot Image

3. Create an Export file for the Shading Correction Adjustment using Steps 4-15 below.
4. Perform the Camera Shading Test as described in Sections 7.2.2.2 *Acquiring Shading Test Images*, 7.2.2.3 *Analyzing Shading Test Images* and 7.2.2.5 *Displaying Shading Test Results* above and create a Shading Correction file.
5. At the top right side of the Shading page, click the ⇄ [**EXPORT/IMPORT**] button on the top right side of the page.
6. The page will advance. On the Graphics (right) side of the new page there should be no entries under the heading "Save graphs as defined in the list."
7. If there are files listed in the **FILE LIST**, delete those files by clicking the C button under the file list space.
8. On the Data / Results (left) side of the page, both ☑ All boxes should be checked.
9. Click the Save Data button in the center of the Data / Results portion of the page.
10. A pop-up will appear indicating that the results will be saved as an **.iea** file.
11. Ensure that the "**SAVE IN**" box at the top of the pop-up indicates that the file will be stored in the camera's **SHDG** folder. If not, click the folder up arrow to the right of the "**SAVE IN**" box and browse for the **SHDG** file folder.

12. In the "**Filename**" box at the bottom of the pop-up, enter **<camera>_SHDG_CORRf40.iea**. The "f40" characters indicate that shading correction is for a **f/4** f-stop setting (see Figure 69).

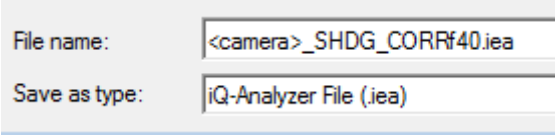


Figure 69. Screenshot of .iea File Storage Option

13. Click the Save button at the bottom right of the pop-up.
14. The **.iea** file will be saved in the camera's **SHDG** folder.
15. Click the Shading button at the top of the page to return to the Shading Analysis page.

7.3 Camera Distortion Test

The Camera Distortion Test analyzes a Test Chart with black crosses on a white background grouped in rows and columns to determine the camera and lens combination distortion and chromatic aberration. The Distortion analysis enables evaluation of the distortion and the lateral chromatic aberration in one step. The centers of the crosses in the TE251 chart are located with sub pixel precision in the analysis software. The distortion and the chromatic aberration are then calculated from these locations.

7.3.1 Equipment

Table 5. List of Equipment for Distortion Test

Equipment	Model Number
Image Engineering Chart Stand	ETC-TS-HOR
Image Engineering Monopod with Rail Includes:	ETC-MONOPOD
Linhof Studio Stand II Tripod Trolley Assembly	
Manfrotto 410 Junior Geared Tripod Head	
Image Engineering Extension Rail	ETC-RAIL
Image Engineering TE251 Test Chart	ETC-TE251-A1066
Konica Minolta Chroma Meter	CL200A
Two Umbrella Light Sources Lowel Rifa Exchange	LC88EX
Two Impact Light Dimmers	D1000
Netgear Network Switch and Power Supply	GS108PE
Two Ethernet Cables	Cat 5 Minimum
Computer Dell Precision	M6600-i7 with NVIDIA N12E-Q5 video processor and Power Supply
Windows 7 Operating System	
Internet Explorer Browser Software	
Firefox Browser Software	
Image Engineering iQ-Analyzer Software	Version 5.2.17, Build xxx ; IQ-A_5-AMS
Camera Lens	Schneider Cinegon f/1.4, 6mm 21-012543
Camera Under Test	

7.3.2 Procedure

7.3.2.1 Initial Setup

1. Push back and secure the Test Chart Illuminator so that it does not interfere with the sliding Test Charts.
2. Loosen the Test Chart Illuminator Position Holding Knob (right side under Test Chart stand bottom rail) and move the Illuminator backward as far as possible.
3. Secure the Illuminator in place by tightening the Position Holding Knob.

Figure 70. Pushing Back Test Chart Illuminator

4. Slide the TE251 Distortion Test Chart (see Figure 71) in front of the Test Chart Illuminator and center the Test Chart with the camera. The image shown in Figure 71 should appear on the monitor when the camera is horizontally and vertically centered with the Test Chart.

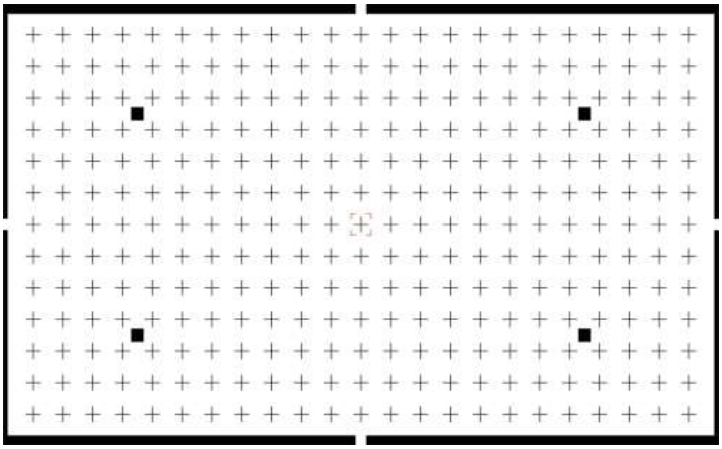


Figure 71. Distortion Test Chart

5. Set the camera lens f-stop to the maximum aperture.
6. Align and center the camera as described In Section 6.2 *Camera Focus Procedure*, Steps 1-33 with the "Eye Chart" Figure 22**,** placed in front of the TE251 Distortion Test Chart.
7. During the focusing procedure, ensure that the camera-to-chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the camera image.
8. If the OECF and Shading tests have already been completed, the initial camera installation and adjustment are not necessary.
9. Push the camera up to the chart to verify that the lens is centered with the center + mark. Adjust the tripod up or down for vertical centering and slide the chart to the right or left for horizontal centering.
10. Center the Distortion Test Chart with the camera's lens. The center of the camera lens should be centered with chart's center + mark with red box around it (Figure 72) is in the center of the camera's field of view.

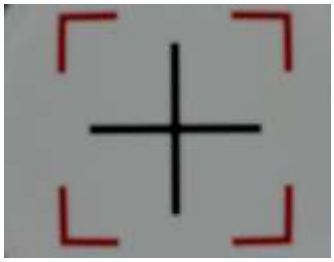


Figure 72. Center Mark on Distortion Test Chart

11. Push the camera up to the chart to verify that the lens is centered with the center + mark.
12. Adjust the tripod up or down for vertical centering and slide the chart to the right or left for horizontal centering.
13. Move the tripod back to capture the chart's upper and lower black lines.
14. Adjust the tripod up or down to center the image vertically in the camera field of view. The camera should be adjusted so that only the very bottom of the chart's top horizontal black line and the very top of the bottom horizontal black line are visible in the camera's image.
15. Slide the chart to the right or left so that the columns are centered in the camera's image. The extreme right and left columns may not be observable in the camera's field of view because of the camera imager's aspect ratio.
16. Section 6.2 *Camera Focus Procedure* contains details of the camera focusing procedure. Take particular note of the instructions in Section 6.2 *Camera Focus Procedure*, Steps 25-32 to "square-up" the image.
17. If the camera has an adjustable lens, after the camera has been focused ensure the camera lens f-stop is set at **f/4**.

7.3.2.2 Adjusting Test Chart Illumination

1. Assemble the Illuminators.
2. Install the Diffusers onto the Illuminators.
3. Energize the Illuminators by pressing the ON button position and wait for 15 minutes for the Illuminators to come up to full brightness.
4. Turn the room lights OFF.
5. Adjust Illuminator height, angle distance from the target and intensity so that the illumination at the corners of the target surface is flat to less than 5% when compared to the illumination at the center of the chart and no visible shiny reflections are observed.

NOTE: Careful adjustments of the light sources have produced an illumination flatness of less than ½%. It has been observed that really flat test chart illumination produces better analysis results.

6. With the black cap on the Light Meter's sensor attached, energize the Light Meter by sliding the ON/OFF switch on the side of the meter to the **ON** (I) position.

Figure 73. Light Meter

7. Allow the automatic CAL (calibration) procedure to complete.
8. Remove the cap covering the Light Meter sensor.
9. Measure the illumination with the Light Meter at five places across the target area (top, center and bottom locations at the right, center and left side of the Test Chart).
10. Record the five illumination readings or enter them into the Excel Spreadsheet Calculator with filename LightningFlatness.xlxs.

As an aid for performing the illumination calculations, an Excel spreadsheet LightingFlatness.xlsx has been configured to perform the calculations and graphically display the relationship between sets of

11. Compare the Center Illumination value with the Corner Illumination values.
12. Divide the highest illumination reading by the Center Illumination value.
13. Divide the lowest illumination reading by the Center Illumination value.

14. The edge illumination values should be less than 5 % higher or lower than the center illumination value.

NOTE: Careful adjustments of the light sources have produced an illumination flatness of less than ½%. It has been observed that really flat test chart illumination produces better analysis results.

15. Adjust the illumination sources until the calculation in Steps 12-13 (or Excel Spreadsheet Calculation) achieves the best illumination flatness.
16. Record the average illumination value: **_____Lux**.
17. Turn off the Light meter by moving the ON/OFF slide switch to the **OFF** (0) position and re-install the sensor cap.
18. If the camera has a manual or software controlled auto-focus button or command, press the **AUTO-FOCUS** button or execute the command to initiate camera auto-focus.
19. If the camera does not have an auto-focus capability, manually focus the lens to achieve optimum image focus as described In Section 6.2 *Camera Focus Procedure,* Steps 1-33 with Eye Chart, Figure 22 placed in front of the TE251 Distortion Test Chart.
20. During the focusing procedure, ensure that the camera to chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the camera image.
21. If the camera has an adjustable lens, ensure that the lens aperture is set to **f/4**.
22. After manually adjusting the lens focus, be sure to tighten the lens into position to prevent subsequent inadvertent rotation.

7.3.2.3 Calibration of Distortion Test Images

NOTE: Before successful analysis of Distortion images can occur, the camera focus, black level setting and illumination must be properly adjusted in order to produce viable test images. Steps 1 to 35 below describe the process to ensure that distortion test images will be properly analyzed by the software.

When viewing the Distortion Test Chart on the camera's web page, the crosses must appear as black objects against a white background. It may be necessary to adjust the camera's black level settings or sharpness setting to enhance the blackness of the crosses. If lens focus is not exactly correct or the camera edge enhancement algorithm is producing artifacts, some crosses will appear as partially black and partially white. This image condition will produce invalid results.

The lens focus and camera parameters must be adjusted to produce black crosses. If adjusting the camera's black level attributes does not sufficiently "blacken-up" the crosses, the lens might have to be rotated inward slightly toward the camera to "blacken-up" the crosses sufficiently to produce images that can be successfully analyzed.

1. After manually adjusting the lens focus, be sure to tighten the lens into position to prevent subsequent inadvertent rotation.
2. If the camera has an adjustable lens, ensure that the lens aperture is set to **f/4**.

3. If the Illuminators are off, energize the Illuminators by pressing the Power Switch to the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
4. Turn the room lights **OFF**.
5. On the camera web page, click the Snapshot or "Still Image" button/icon to create a static image of the Test Chart. That action will produce a pop-up showing the test chart image.
6. Right click on the image and another pop-up will appear. Left click on the **Save Image As** option.

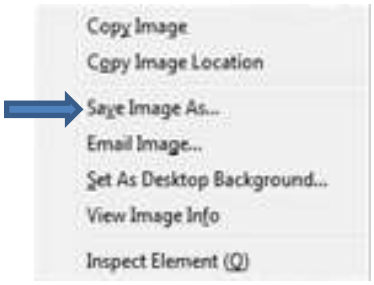


Figure 74. Screenshot of Image Storage Options

7. A pop-up will appear requesting a file name and file storage location.
8. Click on the **Save as type** box in the pop-up and select the **.jpg** option (default).
9. Enter: **camera name_type_DIST_CAL01.jpg**. The file storage location is the camera's **DIST** sub-folder.

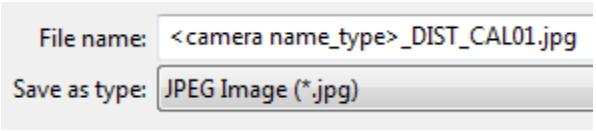


Figure 75. Screenshot of File Storage Options

10. Click the Save button at the bottom right of the pop-up.
11. Turn the room lights **ON**.
12. Deenergize the Illuminators by pressing the Power Switches to the **OFF** position.
13. Minimize the camera browser page.
14. In the iQ-Analyzer software, click the Distortion button (top left task bar).
15. Click the Meta button at the top left of the Distortion module page.

NOTE: The Meta button toggles between the Metadata entry page and either the Camera Image or Results display depending on what button selection is made at the bottom of the Settings portion of the Test Module space. The Image/Result button toggles between the options.

16. Enter the data requested in the Metadata space and click the Update button at the bottom of the page (see Section 5.4 *Metadata Information*).

17. After entering the Metadata, click the Meta button to toggle the space back in to the Camera Image / Result mode.
18. In the left column, of the Settings space of the Distortion module page, ensure that the following are set:

    a. Chart Layout = **TE251 DISTORTION CROSS CHART**
    b. Detection = **AUTOMATIC MODE**

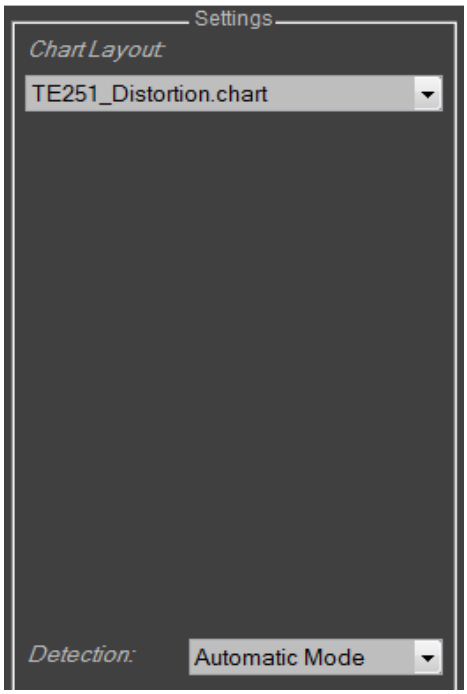


Figure 76. Screenshot of Settings Space Options

19. Below the **FILE LIST** box are three buttons + , - and C to add, delete or clear all files in the processing list.
20. Click the + button.
21. This will open up a pop-up with the camera's folder and sub-folders.
22. Click on the camera's folder and **DIST** sub-folder.
23. To upload the calibration test file, click on the CAL image file to highlight it. If several CAL files were created, hold the **Shift** key and click on the last file of the group to be uploaded into the Distortion Module. If only certain files are to be analyzed, press the **Ctrl** key and click on the files to be analyzed. When all the files to be analyzed are highlighted, press the **Enter** key and the selected files will appear in the Distortion page **FILE LIST** box.
24. Ensure that the following is set:

    a. Select Processing = **FILES IN QUEUE**

25. Click the Advanced button.
26. In the Advanced Settings pop-up, enter the following:

    a. Box to right of "Poly.Fit Degree:" - enter "**3**"
    b. Box to the left of "Fit Quadr…" should be Checked Fit Quadr...
    c. Box to right of "Display Limit LGD (2D)" - enter "**2**."
    d. Box to right of "Limit CA:" – enter "**1**."

27. Click the Start button at the bottom of the left column.
28. The **Analyzing Image Status** box in center of the task bar will show a red line and a blue-background line that indicates the relative progress of analysis operations.

    Chart Location File1 of 1

29. If several images are being analyzed, it will show how many images have been analyzed until the process is completed. When completed, a data plot will appear on the right side of the page.
30. Click the Image button and the ROI dropdown **Image Option** button below the file list to display the captured camera image.
31. The image is calibrated when a gold X appears over the top of each cross in the camera image analyzed. The darker the X appears, the greater the probability that the precise cross intersection was determined by the iQ-Analyzer software. If there is not an X on top of each cross in the image, camera focus, black level setting or illumination flatness must be adjusted.
32. Click the Result button below the file list to display the analyzed result. If there is an X over each cross in the Image mode (Step 31), clicking the Result button should produce a box grid pattern with red dots (Figure 77) at or near box line intersections.

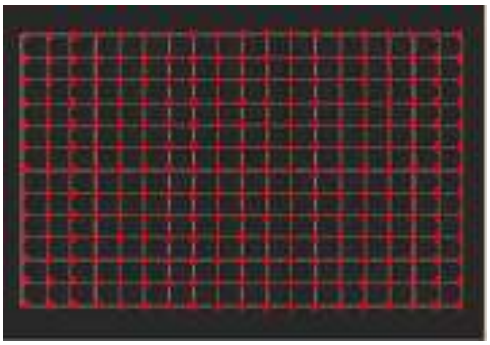


Figure 77. Example Red Dot Grid Pattern

33. Verify that the Distortion image has sufficient focus. Click the **CA- Longitudinal** button under the Results data plot area and observe the data plot.

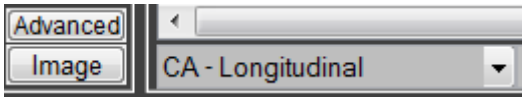


Figure 78. Screenshot of CA-Longitudinal Button

34. If the display appears like Figure 79 below, there is insufficient focus. Refocus the camera using the "Eye Chart" (see Section 6.2 *Camera Focus Procedure*) and perform steps 2-33 above.

Figure 79. Results Plot Showing Example of Insufficient Camera Focus

35. If the display appears with a deep sharp " V" shape like Figure 80 below, the focus adjustment is adequate.

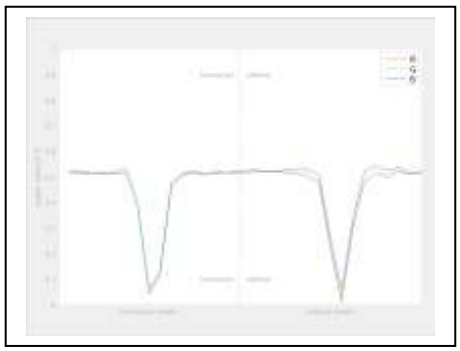


Figure 80. Results Plot Showing Example of Adequate Camera Focus

36. When the Distortion calibration camera image, Result **red dot** image and the **CA-Longitudinal analysis** data plot appear as shown in Figure 77 and Figure 80 above, the Test Chart image capture and camera focus are properly calibrated. The calibration will produce valid analysis results.
37. After the Distortion camera image has been calibrated, delete all of the .**jpg** CAL Image Files, and **.txt** Test Image Text files from the camera's **DIST** sub-folder.

7.3.2.4 Acquiring Distortion Test Images

1. Energize the Illuminators by pressing the Power Switch to the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
2. Turn the room lights **OFF**.
3. If the camera has an adjustable lens, ensure the lens aperture is set to **f/4**.
4. On the camera web page, click the Snapshot or "Still Image" button/icon to create a static image of the Test Chart. Another pop-up showing the Distortion test chart image will appear.
5. Right click on the image and another pop-up will appear.
6. Click the **Save Image As** option.

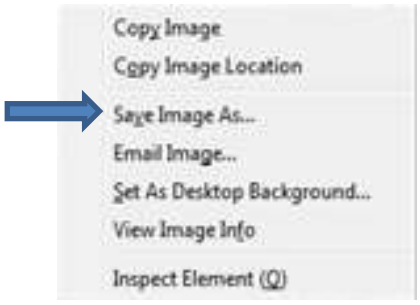


Figure 81. Screenshot of Image Storage Options

7. When prompted to name the file, leave the **.jpg** default File Type option.
8. Enter: **camera name_typeDIST01.jpg**. The file storage location is the camera's **DIST** sub-folder.

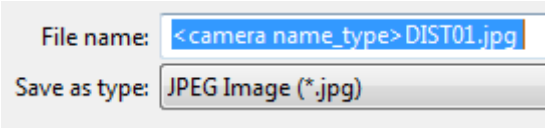


Figure 82. Screenshot of File Storage Options

9. Click the Save... button at the bottom right of the pop-up.
10. Ten files are required for each Distortion analysis, each subsequent file should be named **camera name_type_DISTXY**; where XY = 02 through 10.
11. Repeat Steps 4 through 9 above for the additional 9 image files.
12. Turn the room lights **ON**.
13. Deenergize the Illuminators by pressing the Power Switch in the **OFF** position.
14. Minimize the camera browser page.

7.2.3.5 Analyzing Distortion Test Images

1. In the iQ-Analyzer software, click the Distortion button (top left task bar).
2. Click the Meta button at the top left of the Distortion Module page.

> NOTE: The Meta button toggles between the Metadata entry page and either the Camera Image or Results display depending on what selection is made with the button at the bottom of the Settings portion of the Test Module space. The Image / Result button toggles between the options.

3. Enter the data requested in the Metadata space and click the Update button at the bottom of the page (see Section 5.4 *Metadata Information*).
4. After entering the Metadata, click the Meta button to toggle the space back to the Camera Image / Result mode.
5. In the left column, of the Settings space of the Distortion page, ensure that the following are set:
    a. Chart Layout = **TE251 DISTORTION CROSS CHART**
    b. Detection = **AUTOMATIC MODE**
6. Below the **FILE LIST** box are three buttons + , - and C to add, delete or clear all files in the processing list.
7. Click the + button.
8. This will open up a pop-up with folders containing test images.
9. Click on the camera's folder and **DIST** sub-folder.
10. To upload multiple files, click the filename of the first image to highlight it and hold the **Shift** key and click on the last file of the group to be uploaded into the Distortion Module. If only certain files are to be analyzed, press the **Ctrl** key and click on each of the files to be analyzed. When all the files to be analyzed are highlighted, release the **Shift** or **Ctrl** key and press the keyboard **Enter** key and the selected files will appear in the **FILE LIST** box. If only certain files are to be analyzed, use the **Ctrl** key in conjunction with mouse clicks of the selected files.
11. Ensure that the following is set:
    a. Processing = **FILES IN QUEUE**
12. Click the Advanced button. In the Advanced Settings column that opens, do not change any of the Advanced Settings defaults.
13. Click the Advanced button to close the Advanced Settings column.
14. Click the Start button at the bottom of the left column.

15. The **Analyzing Image Status** box in center of the task bar will show a red line and a blue-background line that indicates the relative progress of analysis operations.

16. If several images are being analyzed, it will show how many images have been analyzed until the process is completed. When completed, a data plot will appear on the right side of the page.
17. Click the Image button below the file list to display the captured camera image and marked-up camera images.
18. Click the Result button below the file list to display the analyzed result.

7.3.2.5 Displaying Distortion Test Results

1. Click on any file in the **FILE LIST** box to see the analysis results for that image and then use the keyboard **up/down** arrow keys to see analysis results for the other images.
2. Click the buttons at the bottom of the page to see displays of the various analysis results.
3. Click the Image button below the **FILE LIST** to display the captured camera image.
4. Check to ensure that each image is valid. The image is valid when a gold X appears over the top of each cross in the camera image analyzed.
5. If there is not an X on each cross in the image, camera focus, black level settings or illumination flatness must be adjusted.
6. Click the Result button below the **FILE LIST** to display the analyzed result.
7. If there is an X over each cross in the **IMAGE** mode (Step 4), clicking the Result button should produce a box grid pattern with red dots at or near box line intersections (see Figure 77).
8. If the images do not have an X over each cross, perform the Test Image Calibration as described in Section 7.3.2.3 *Calibration of Distortion Test Images* above.
9. Clicking the first button at the bottom of the frame underneath the Result Image, there are nine selection options:

Figure 83. Screenshot of Distortion Plot Selection Options

a. **Distortion – Grid Comp** (expected pattern –displayed as box pattern verses actual pattern displayed as rows & columns of red dots)
b. **Distortion – Grid Org** (actual pattern displayed as distorted box pattern)

c. **Distortion – 2D** (color shading rendition of lens image distortion, color represents binning of degree of distortion)
d. **Distortion – Quiver** (actual pattern displayed as distorted box pattern with red angular vector rays indicating relative amount of distortion, vector indicates direction of distortion)
e. **Distortion – vs Field** (plots of geometric distortion for every grid position and each of the 4 quadrants of the image)
f. **CA – GR** (chromatic aberration green-red: color shading of G-R distortion, color represents binning of degree of distortion)
g. **CA – GB** (chromatic aberration green-blue: color shading of G-B distortion, color represents binning of degree of distortion)
h. **CA – Max** (chromatic aberration maximum: color shading of maximum CA distortion of both GR & GB distortions, color represents binning of degree of distortion)
i. **CA-Longitudinal** (plot of RGB & Y longitudinal CA in horizontal & vertical planes)

10. If results graphs need to be saved, perform steps in Section 5.7 *Export/Import* "Executing the Export Function."

7.4 Camera Resolution Test

The Resolution module enables measurement of camera resolution parameters. The Modulation Transfer Function (MTF) and Spatial Frequency Response (SFR) of one or nine Siemens star patterns are calculated. Information about edges and reproduction of low contrast fine details from noise patches is also analyzed. Note that a number of camera settings can affect Camera Resolution Test results. Settings such as bandwidth, compression, sharpness enhancement, iso-speed and others affect test results. The TE253-1 Star and 9 Star test charts facilitate acquiring Siemens stars spatial frequency response (SFR), edges and information about the reproduction of low contrast fine details using patches showing noise.

7.4.1 Equipment

Table 6. List of Equipment for Resolution Test

Equipment	Model No.
Image Engineering Chart Stand	ETC-TS-HOR
Image Engineering Monopod with Rail Includes:	ETC-MONOPOD
Linhof Studio Stand II Tripod Trolley Assembly	
Manfrotto 410 Junior Geared Tripod Head	
Image Engineering Extension Rail	ETC-RAIL
Image Engineering TE253-9X -72 or -144 Test Chart	ETC-TE253-9X
Camera Focus “Eye Chart”	
Konica Minolta Chroma Meter	CL200A
Two Umbrella Light Sources Lowel Rifa Exchange	LC88EX
Netgear Network Switch and Power Supply	GS108PE
Two Ethernet Cables	Cat 5 Minimum
Computer Dell Precision	M6600-i7 with NVIDIA N12E-Q5 video processor and Power Supply
Windows 7 Operating System	
Internet Explorer Browser Software	
Firefox Browser Software	
Image Engineering iQ-Analyzer Software	Version 5.2.17, Build xxx ; IQ-A_5-AMS
Camera Lens	Schneider Cinegon f/1.4, 6mm 21-012543
Camera Under Test	

7.4.2 Procedure

7.4.2.1 Initial Setup

1. Push back and secure the Test Chart Illuminator so that it does not interfere with the sliding Test Charts.
2. Loosen the Test Chart Illuminator Position Holding Knob (right side under Test Chart stand bottom rail) and move the Illuminator backward as far as possible.
3. Secure the Illuminator in place by tightening the Position Holding Knob.

Figure 84. Pushing Back the Test Chart Illuminator

4. Slide the TE253-1X (1 Siemens star) or TE253-9X (9 Siemens stars) Test Chart in front of the Test Chart Illuminator and center the Test Chart with the camera.

NOTE: The TE253 Resolution Test Chart, shown in Figure 86, is a 3-piece chart. The three pieces are moved adjacent to each other when used with a camera having a 4x3 aspect ratio. When used with a camera having a 16x9 aspect ratio, the right and left portions of the chart must be separated such that the there is only about 1/8 to 1/4 inch of blank space to the right and left of the chart in the camera's displayed image. If the pieces of the test chart are not separated when testing a 16x9 aspect ratio camera, the resolution analysis will not produce valid results.

When conducting a 1 Star resolution analysis, use the center star of either the right or left panel of the TE253 chart.

5. Set the camera lens f-stop to the maximum aperture.
6. Align and center the camera as described in Section 6.2 *Camera Focus Procedure*, Steps 1-33 with the "Eye Chart" placed in front of the TE253 Resolution Test Chart. During the focusing procedure, ensure that the camera to chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the camera image.

7. Below are examples of acceptable test chart images for viable analysis results.

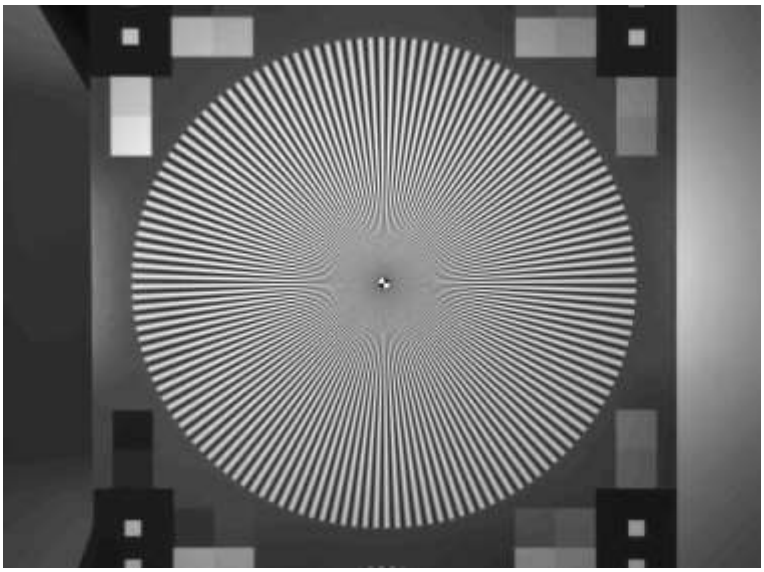


Figure 85. Single Star Resolution Image

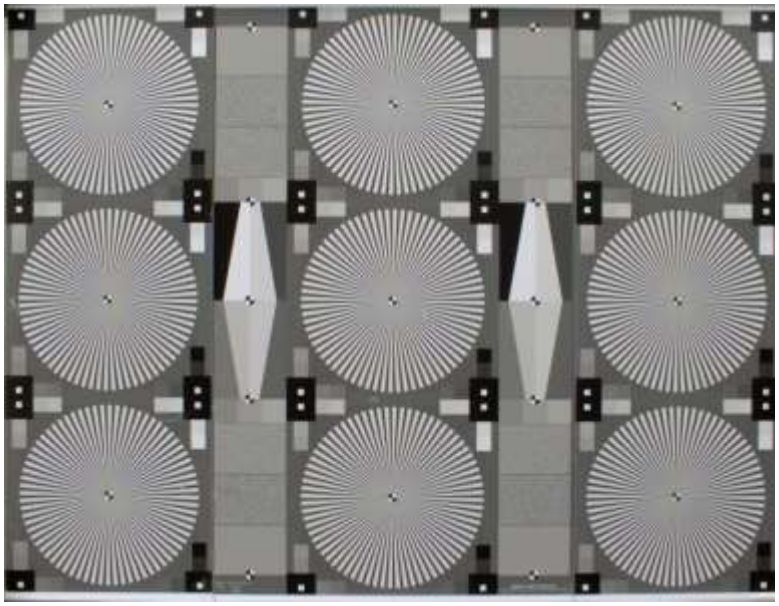


Figure 86. Nine Star Resolution Image

NOTE: Camera parameters must be adjusted to acquire viable Resolution Test images. Camera image enhancements such as adding sharpness, edge enhancement, black and saturation levels produce image distortions. Analysis software processing of images with added image enhancement may produce either software error messages or results that are significantly degraded from the camera's optimum performance. Adjust camera parameters as indicated in Step 8 below to create an optimum image.

8. Ensure the following camera parameters on camera GUI are set as follows:

    a. Set Sharpness to **zero (0)**.
    b. Deactivate **Blackness Enhancement** parameters or set them to zero (0).
    c. Set Gamma to **1.0 or 100**.
    d. Set Saturation to **camera default nominal** (cameras have different numbering systems for saturation settings).
    e. Set White Balance to **Automatic**.

7.4.2.2 Adjusting Test Chart Illumination

1. Assemble the Illuminators.
2. Install the Diffusers onto the Illuminators.
3. Energize the Illuminators by pressing the **ON** buttons and wait for 15 minutes for the Illuminators to come up to full brightness.
4. Adjust Illuminator height, angle distance from the target and intensity so that the illumination at the corners of the target surface is flat less than 5% when compared to the illumination at the center of the chart and no visible shiny reflections are observed.

NOTE: Careful adjustments of the light sources have produced an illumination flatness of less than ½%. It has been observed that really flat test chart illumination produces better analysis results.

Figure 87 below shows an example of a reflection from the illuminator on the left side of the chart.

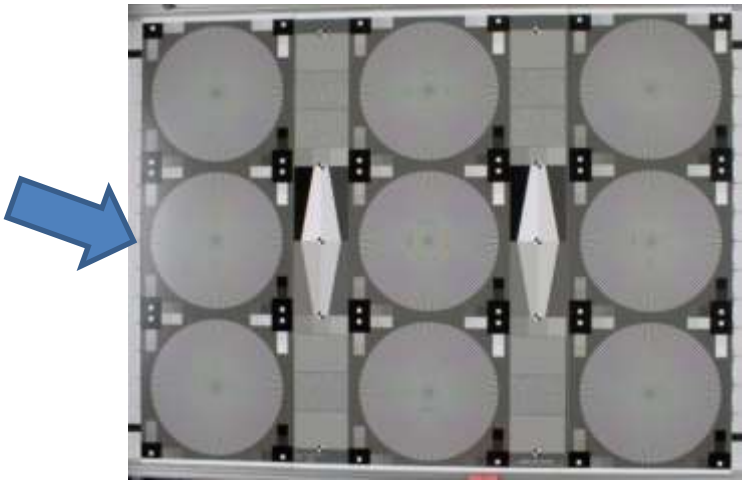


Figure 87. Camera Image Showing Illuminator Reflection on Left Side of Chart

5. With the black cap on the Light Meter's sensor attached, energize the Light Meter by sliding the ON/OFF switch on the side of the meter to the **ON** (I) position.
6. Allow the automatic CAL procedure to complete.
7. Remove the cap covering the Light Meter sensor.

Figure 88. Light Meter

8. Measure the illumination with the Light Meter at five places across the target area (center and corner locations of the Test Chart).
9. Record the five illumination readings or enter them into the Excel Spreadsheet Calculator with filename LightningFlatness.xlxs.

As an aid for performing the illuminations calculations, an Excel spreadsheet Lighting Flatness.xlsx has been configured to perform the calculations and graphically display the relationship between the sets of readings.

10. Compare the Center Illumination value to the Corner Illumination values.
11. Divide the highest illumination reading by the Center Illumination value.
12. Divide the lowest illumination reading by the Center Illumination value.
13. The highest and lowest illumination values should be less than 5.0 % of the Center Illumination value
14. Adjust the illumination sources until the calculation in Steps 11-12 achieves the best illumination flatness.
15. Record the average illumination value: **_____Lux**.
16. Turn off the Light meter by moving the ON/OFF slide switch to the **OFF** (0) position and re-install the sensor cap.
17. If the camera has a manual or software controlled auto-focus button or command, press the **AUTO-FOCUS** button or execute the command to initiate camera auto-focus.
18. If the camera does not have an auto-focus capability, manually focus the lens to achieve optimum image focus as described In Section 6.2 *Camera Focus Procedure,* Steps 1-33 with the "Eye Chart" placed in front of the TE253 Resolution Test Chart.
19. During the focusing procedure, ensure that the camera-to-chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the monitor image.
20. If the camera has an adjustable lens, ensure that the lens aperture is set to **f/4**.
21. After manually adjusting the lens focus, be sure to tighten the lens into position to prevent subsequent inadvertent rotation.

7.4.2.3 Acquiring Resolution Test Images

1. Energize the Illuminators by pressing the Power Switch in the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
2. Turn the room lights **OFF**.
3. If the camera has an adjustable lens, ensure the lens aperture is set to **f/4**.
4. On the camera web page, click the Snapshot or "Still Image" button/icon to create a static image of the Test Chart. Another pop-up showing the test chart image will appear.
5. Right click on the image and another pop-up will appear.
6. Click the **Save Image As** option.

Figure 89. Screenshot of Image Storage Options

7. When prompted to name the file, click the **Save as type** box and select the "**All Other (*.*)**" option (.jpg is the default).
8. When prompted to name the file, enter: **camera name_typeRESL01.bmp**. The file storage location is the camera's **RESL** sub-folder.

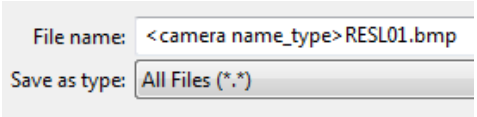


Figure 90. Screenshot of File Storage Option

9. Click the Save... button at the bottom right of the pop-up.
10. Ten files are required for Resolution analysis, each subsequent file should be named **camera name_type_RESLXY.bmp;** where XY = 02 through 10.
11. Repeat Steps 4 through 9 above for the additional 9 image files.
12. Turn the room lights **ON** .
13. Deenergize the Illuminators by pressing the Power Switch in the **OFF** position.
14. Minimize the camera browser page.

7.4.2.4 Analyzing Resolution Test Images

An effort is currently in progress at the Laboratory to develop a resolution test chart image analysis software tool that provides enhanced fidelity, accuracy, reliability and repeatability than currently available using commercial resolution test chart image analysis software. When that analysis tool is completed, tested and validated, the procedure for conducting the resolution test image analysis using that software will be incorporated into this section of the procedure.

7.5 Camera Combination Reflectance Test

The Camera Combination Reflectance Test employs a TE42 combination grey scale and color image chart. This encompassing test provides quick analysis of OECF, Dynamic Range, Resolution, Shading, Distortion, Lateral Dynamic Range, Color Reproduction and Texture Loss. A significant amount of data is created from the analysis of the TE42 Test Chart creating many data viewing options. Refer to descriptions in other Section 7 analysis sections above for specific test result and analysis details.

NOTE: Analysis of the TE42 Test Chart can only be made on a color image. Analysis of a black and white image will produce error messages and inaccurate analysis.

7.5.1 Equipment

Table 7. List of Equipment for Combination Reflectance Test

Equipment	Model No.
Image Engineering Chart Stand	ETC-TS-HOR
Image Engineering Monopod with Rail Includes:	ETC-MONOPOD
Linhof Studio Stand II Tripod Trolley Assembly	
Manfrotto 410 Junior Geared Tripod Head	
Image Engineering Extension Rail	ETC-RAIL
Image Engineering TE042 Test Chart	ETC-TE042-A 1066
Camera Focus “Eye Chart”	
Konica Minolta Chroma Meter	CL200A
Two Umbrella Light Sources Lowel Rifa Exchange	LC88EX
Netgear Network Switch and Power Supply	GS108PE
Two Ethernet Cables	Cat 5 Minimum
Computer Dell Precision	M6600-i7 with NVIDIA N12E-Q5 video processor and Power Supply
Windows 7 Operating System	
Internet Explorer Browser Software	
Firefox Browser Software	
Image Engineering iQ-Analyzer Software	Version 5.2.17, Build xxx ; IQ-A_5-AMS
Camera Lens	Schneider Cinegon f/1.4, 6mm 21-012543
Camera Under Test	

7.5.2 Procedure

7.5.2.1 Initial Setup

1. Push back and secure the Test Chart Illuminator so that it does not interfere with the sliding Test Charts.
2. Loosen the Test Chart Illuminator Position Holding Knob (right side under Test Chart stand bottom rail) and move the Illuminator backward as far as possible.
3. Secure the Illuminator in place by tightening the Position Holding Knob.

Figure 91. Pushing Back the Test Chart Illuminator

4. Slide the TE042 Test Chart in front of the Test Chart Illuminator and center the Test Chart with the camera.
5. Set the camera lens f-stop to maximum aperture
6. Align and center the camera as described In Section 6.2 *Camera Focus Procedure,* Steps 1-33 with the "Eye Chart" placed in front of the TE042 Universal Test Chart.
7. During the focusing procedure, ensure that the camera to chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the camera image.
8. Ensure the following camera parameters on camera GUI are set as follows:
    a. Set Sharpness to **zero (0)**.
    b. Deactivate **Blackness Enhancement** parameters or set them to zero (0).
    c. Set Gamma to **1.0 or 100**.
    d. Set Saturation to **camera default nominal** (cameras have different numbering systems for saturation settings).
    e. Set White Balance to **Automatic**.
9. Adjust the tripod up or down for vertical centering and slide the chart to the right or left for horizontal centering.
10. If the camera has an adjustable lens, ensure the camera lens f-stop is set at **f/4**.

7.5.2.2 Adjusting Test Chart Illumination

1. Assemble the Illuminators.
2. Install the Diffusers onto the Illuminators.
3. Energize the Illuminators by pressing the **ON** button.
4. Adjust Illuminator height, angle distance from the target and intensity so that the illumination at the corners of the target surface is flat to less than 5% when compared to the illumination at the center of the chart and no visible shiny reflections are observed.

NOTE: Careful adjustments of the light sources have produced an illumination flatness of less than ½%. It has been observed that really flat test chart illumination produces better analysis results.

5. With the black cap on the Light Meter's sensor, energize the Light Meter by sliding the ON/OFF switch on the side of the meter to the **ON** (I) position.

Figure 92. Light Meter

6. Allow the automatic CAL procedure to complete.
7. Remove the cap covering the Light Meter sensor.
8. Measure the illumination with the Light Meter at five locations across the test chart (top left, bottom left, center, top right and bottom right).
9. Record the five illumination readings or enter them into the Excel Spreadsheet Calculator with filename LightningFlatness.xlxs.

As an aid for performing the illumination calculations, an Excel spreadsheet LightingFlatness.xlsx has been configured to perform the calculations and graphically display the relationship between sets of readings.

10. Compare the Center Illumination value with the Corner Illumination values.
11. Divide the highest illumination reading by the Center Illumination value.
12. Divide the lowest illumination reading by the Center Illumination value.
13. The edge illumination values should less than $\pm$ 5 % higher or lower than the center illumination value.

NOTE: Careful adjustments of the light sources have produced an illumination flatness of less than ½%. It has been observed that really flat test chart illumination produces better analysis results.

14. Adjust the illumination sources until the calculation in Steps 11-12 (or Excel Spreadsheet Calculation) achieves the best illumination flatness.
15. Record the average illumination value: _____**Lux**.
16. Turn off the Light meter by moving the ON/OFF slide switch to the **OFF** (0) position and re-install the sensor cap.
17. If the camera has a manual or software controlled auto-focus button or command, press the AUTO-FOCUS button or execute the command to initiate camera auto-focus.
18. If the camera does not have an auto-focus capability, manually focus the lens to achieve optimum image focus as described In Section 6.2 *Camera Focus Procedure*, Steps 1-33 with the "Eye Chart," Figure 22 placed in front of the TE42 Test Chart.
19. During the focusing procedure, ensure that the camera to chart distance is adjusted so that the entire chart space for the camera's aspect ratio is visible in the monitor image.
20. If the camera has an adjustable lens, ensure that the lens aperture is set to **f/4**.
21. After manually adjusting the lens focus, be sure to tighten the lens into position to prevent subsequent inadvertent rotation.

7.5.2.3 Acquiring TE42 Test Chart Images

1. Energize the Illuminators by pressing the Power Switch to the **ON** position and wait for 15 minutes for the Illuminators to come up to full brightness.
2. Turn the room lights **OFF**.
3. If the camera has an adjustable lens, ensure the lens aperture is set to **f/4**.
4. On the camera web page, click the Snapshot or "Still Image" button.
5. Right click on the image and another pop-up will appear.
6. Click the **Save Image As** option.

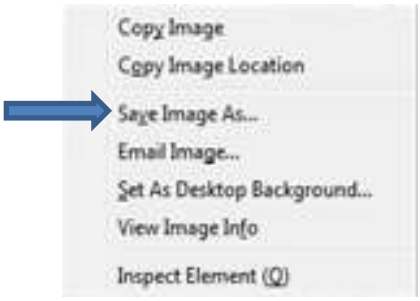


Figure 93. Screenshot of Image Storage Options

7. When prompted to name the file, click the **Save as type** box and select the "**All Other** (*.*)" option (.jpg is the default).

8. When prompted to name the file, enter: **camera name_type_42T01.bmp**. The file storage location is the camera's **TE42** sub-folder.

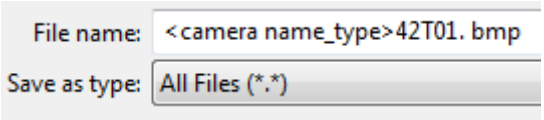


Figure 94. Screenshot of File Storage Option

9. Click the Save... button at the bottom right of the pop-up.
10. Ten files are required for Combination Chart analysis, each subsequent file should be named **camera name_type42TXY.bmp**; where XY = 02 through 10 for the number of files to be analyzed.
11. Repeat Steps 4 through 9 above for the additional 9 image files.
12. Turn the room lights **ON** .
13. Deenergize the Illuminators by pressing the Power Switch in the **OFF** position.
14. Minimize the camera browser pane.

7.5.2.4 Analyzing Test Chart Images

1. In the iQ-Analyzer software, click the 42 button (center of task bar).
2. In the left column of the TE42 module page, ensure that the following are set:
    a. Chart Layout = Select **TE42 CHART**
    b. Reference Data = Select **TE42_DATA 42**
    c. Illumination (Lux) = Enter Average Illumination Level calculated in Section 7.5.2.2 Step 15 above.
3. Below the **FILE LIST** box are three buttons + , - and C at the bottom of the page to add, delete or clear all files in the processing list.
4. Click the + button.
5. This will open up a pop-up with the camera's folder and sub-folders.
6. Click on the camera's folder and **42T** sub-folder and double click on the image file. That file path and name will appear in the **FILE LIST** box.
7. To upload multiple files, click the filename of the first image to highlight it and hold the **Shift** key and click on the last file of the group to be uploaded into the 42 Module. If only certain files are to be analyzed, press the **Ctrl** key and click on each of the files to be analyzed. When all the files to be analyzed are highlighted, release the **Shift** or **Ctrl** key and press the keyboard **Enter** key and the selected files will appear in the **FILE LIST** box. If only certain files are to be analyzed, use the **Ctrl** key in conjunction with mouse clicks of the selected files.

8. Ensure that the following are set:

    a. Select Processing = **FILES IN QUEUE**
    b. Select Output = **AVERAGE**

9. Click the Start button at the bottom of the left column.
10. The **Analyzing Image Status** box in center of the task bar will show a red line and a blue-background line that indicates the relative progress of analysis operations.

11. If several images are being analyzed, it will show how many images have been analyzed until the process is completed. When completed, a data plot will appear on the right side of the page.
12. Click the Image button below the file list to display the captured camera image.
13. Click the View button on the right side below the Image/Result space opens a new window and allows adjustment of the camera image (e.g. zooming in and out to see details in the camera image captured).
14. In the Image mode, clicking the first button at the bottom of the frame underneath the Result Image, there are 4 selection options:

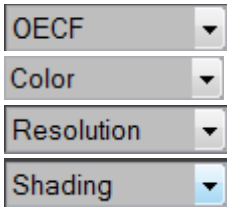
    a. **ORIGINAL** (shows original image captured)
    b. **ROI** (shows close-up of Region of Interest)
    c. **CHECK IMAGE** (shows grey mark-up of analyzed portions of image)
    d. **CHECK CENTER** (shows the stars from center to defined percentage of Nyquist frequency – star from center to 50% of Nyquist frequency)

7.5.2.5 Displaying Test Chart Results

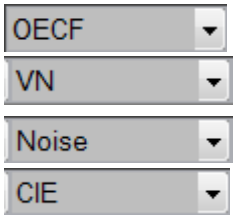
Display of test chart results for the Combination Reflectance Test Chart analysis is very similar to the procedure described in the previous sections. The buttons and the displays created by clicking those buttons are almost identical. Additional information related to the procedure for display of specific test chart data is contained in the OECF, Shading, Distortion and Resolution sections.

1. Click the Result button below the file list to display the analyzed result.
2. Two images with filename extensions ***.center*** and ***.check*** are saved automatically. One image shows the center of the Siemens stars and the other the marked regions of interest. The path for saving options, image quality and comparison image size are defined in the [SETTINGS] button space.
3. Graphical results are displayed in the right screen. Below the screen there are 6 buttons.

4. The first button allows viewing of 4 different analysis results. The options are:

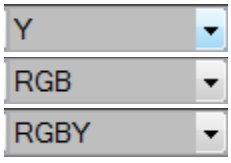


5. The second button allows viewing of 4 different graph modes. The options are:

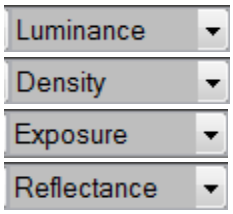


(Visual Noise)

6. The third button allows viewing of 3 different Y-RGB graph modes. The options are:

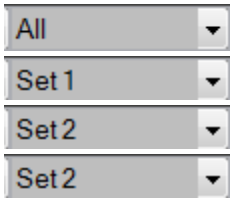


7. The fourth button allows viewing of 4 different parameter modes. The options are:



8. The fifth button allows viewing of 2 different data plotting modes. The options are:

9. The sixth button allows viewing of 4 different data sets. The options are:



Set 1, Set 2 and Set 3 are preset viewer distance-angle image options

10. OECF Analysis

a. OECF of the analyzed image depends on the luminance reflected from the Test Chart. The dynamic range of the device is displayed in two red vertical lines. The signal-to-noise ratio is the ratio of the net signal value to the standard deviation of the signal value. A Luminance Y is calculated by the iQ-Analyzer software for use in other analyses.
b. Visual Noise for three viewing conditions can be displayed. The conditions for each of the three conditions are determined by parameters set in the  [SETTINGS] space.
c. Noise is displayed in terms of standard deviation.
d. Graphs of CIE show luminance L and chrominance C as defined in the CIE LCH (luminance, colortone, hue) color space.

11. Color Analysis

a. Numerical Results of delta E, L, C, H and Visual Noise based on 3rd button selection.
b. Visual Comparison of camera image and reference image.
c. 3D Bar Graph of color patch delta E values.
d. CIE xyY 3D dot plot of camera image color patches and reference chart in xyY colorspace where x and y are the chromaticity coordinates and luminance Y.
e. CIE L*a*b* 3D dot plot of camera image color patches and reference chart in CIE L*a*b* colorspace where:
    i. **L** is luminance level (0-100),
    ii. **a** is position between red/magenta and green (positive values indicate red/magenta and negative values indicate green) and
    iii. **b** is a position between yellow and blue (positive values indicate yellow, negative values indicate blue).

12. Resolution Analysis

a. Graphical results of Siemens/MTF percentage of each star resolvable.
b. Graphical results of Noise Histogram of eight star segments.
c. Graphical results of computed noise and spectrum.

13. Shading Analysis

a. Luminance Shading FSTOP – maximum Luminance shading expressed in f-stops
b. Luminance Shading % - maximum Luminance shading expressed as percentages
c. CIE delta L – absolute average Luminance shading (CIE L)
d. Percentiles DV and FSTOP – based on values entered for analysis percentiles in Advanced Menu, Luminance distribution is expressed in Digital Values or FSTOPS depending on normalization values chosen.

14. Color Analysis

    a. CIE delta Eab – plots of average Color shading differences excluding Luminance.
    b. CIE delta C – plots of average Color shading C*reference* – C*image*.
    c. Delta G-R – plots of average difference between green and red channels.
    d. Delta G-B – plots of average difference between green and blue channels.

15. Noise Analysis

    a. SNR (db) – plots of maximum Signal-to-Noise difference shown in db.
    b. VNSet1 – maximum Visual Noise difference for viewing condition #1.
    c. VNSet2 – maximum Visual Noise difference for viewing condition #2.
    d. VNSet3 – maximum Visual Noise difference for viewing condition #3.

16. Click on another file in the **FILE LIST** box to observe the graphical display of that image file's Resolution analysis.

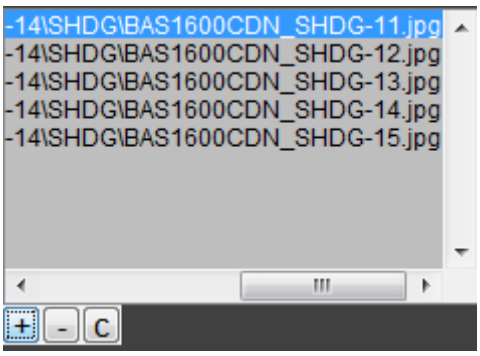


Figure 95. Screenshot of File List Box

17. If results graphs need to be saved, perform steps in Section 5.7 *Export/Import* "Executing the Export Function."

8. References

1. Image Engineering, iQ-Analyzer 5 User’s Manual (U) 2012.

DISTRIBUTION

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Appendix A iQ-Analyzer Version 5 User Manual

iQ-ANALYZER

user manual

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CONTENT

I. INTRODUCTION

The iQ- Analyzer is an executable program for Windows an MAC. It analyzes digital images and video frames using specified test charts. Depending on the version you received different test charts are supported.

Using the full version of the iQ-Analyzer you will get information about all important characteristics of a digital camera system including

- OECF
- Dynamic Range
- White Balancing
- Noise and ISO-Speed
- Visual Noise
- MTF
- Limiting resolution
- Distortion / lateral and longitudial chromatic aberration
- Vignetting / Shading
- Color reproduction

For more information please see our website www.image-engineering.de.

II. INSTALLING iQ-ANALYZER

System Requirements

	Windows (32bit and 64bit)	Mac (64bit only)
Operating Systems	Windows XP Service Pack 3 Windows XP x64 Edition Service Pack 2 Windows Server 2003 R2 Service Pack 2 Windows Vista Service Pack 1 or 2 Windows Server 2008 Service Pack 2 or R2 Windows 7	Mac OS X 10.5.8 (Leopard) and above Mac OS X 10.6.x (Snow Leopard)
Processors	Any Intel or AMD x86 processor supporting SSE2 instruction set*	All Intel-based Macs with an Intel Core 2 or later
RAM	2048 MB (4096 MB recommended)	2048 MB (4096 MB recommended)
Additional Hardware (for Video Module only)	DeckLink, Multibridge or Intensity products by Blackmagic Design Video input hardware supported by MATLAB**	Not supported

* SSE2 was introduced into Intel chips with the Pentium 4 in 2001 and AMD processors in 2003. Most computers produced in the last several years are equipped with SSE2. All Intel Macs are equipped with SSE2. If you are unsure about your particular Windows PC, you can determine SSE2 support by a free tool, ProcFeatures. It is available from Microsoft SysInternals that will indicate if SSE2 is present on your system or not (http://technet.microsoft.com/en-us/sysinternals/bb897554.aspx).

** In order to use the Video Module for live measurements (not for video files), an appropriate video input hardware is needed. If you do not use a DeckLink, Multibridge or Intensity product by Blackmagic Design, please refer to the list of the hardware supported by MATLAB's Image Acquisition Toolbox (http://www.mathworks.de/products/imaq/supportedio.html).

Software Protection

iQ-Analyzer is protected with an USB dongle. You have to connect the dongle to your system every time you use iQ-Analyzer. If you don't have a dongle, please contact info@image-engineering.de

Installation

1. Download and install MATLAB Compiler Runtime (MCR) Version 7.14. You will find it on our server (http://www.image-engineering.de/ie-sw/MCR_Installer/). Please log in as the user IE-Analyzer using the password ie47sw11. If you experience any problems, please contact info@image-engineering.de

Note: You need the MCR Version 7.14. Earlier versions of the Analyzer use other MCRs.

Note (for Mac OS X only): Installing multiple versions of the MCR on the same machine is not supported on Mac OS X. When you install a new MCR onto a target machine, you must delete the old version of the MCR and install the new one. You can only have one version of the MCR on the target machine. To remove the MCR, simply move the MCR folder from /Applications to the trash. The MCR is installed in /Applications/MATLAB Compiler Runtime/Vxx, where 'xx' is the version of the installed MCR.

2. Download the latest version of the iQ-Analyzer from our server (http://www.image-engineering.de/index.php?option=com_content&view=article&id=441&Itemid=70)

3. Extract the contents of the zip archive to any folder on your system (on Mac OS X it must be the local "Applications" folder). You need a write permission for the iQ-Analyzer folder and all of its subfolders.

Note (for Mac OS X only): The software will not start if it is not in the local "Applications" folder. If you want to use it from another location:

- Open Automator
- Drag and drop the iQ-Analyzer.app onto the Automator Icon
- Modify the path in the script

4. Install additional open source software.

a) Mac users have to manually install ExifTool by Phil Harvey. The installation file is located in the "3rdParty" folder of the iQ-Analyzer. PC users can omit this step.
b) In order to analyze video files using the Video Module, PC users have to manually install the VLC Media Player. It is necessary to make sure that the ActiveX Plugin option is selected during the installation. The Video Module is currently not supported on Macs.

Antivirus Issues

Some few anti-virus products may detect a virus in “iqa500_XXX.exe” in the iQ-Analyzer folder. This is a false alarm, some code blocks are accidentally detected as a virus. Please contact our support (support@image-engineering.de) if you experience this problem.

Note (for Mac OS X only): Umlauts and other special characters are not supported on Mac OS X.

Software by Third Parties

iQ-Analyzer uses open source software

.....

FFmpeg

Copyright © 2000-2010 by the FFmpeg developers

iQ-Analyzer is distributed with an automated FFmpeg 32-bit Windows build made by Ramiro Polla.
FFmpeg is licensed under GNU LGPL and GNU GPL licenses.
FFmpeg is linked with libX264 (GPL).
You can download the complete source code used to build FFmpeg here:
http://ffmpeg.arrozcru.org/autobuilds/

.....

VLC

Copyright © 1996-2010 by the VideoLAN-Team

iQ-Analyzer is distributed with a Windows installer of VLC Player. Please make sure the ActiveX plugin is installed in order to use the Video Module with video files.
VLC media player is licensed under GNU GPL (http://www.gnu.org/licenses/gpl.txt)
You can download the complete source code here:
http://www.videolan.org/vlc/download-sources.html

.....

ExifTool

Copyright © 2003-2010 by Phil Harvey

iQ-Analyzer is distributed with the stand-alone Windows executable of ExifTool. This is free software.
To install ExifTool on Mac OS X please follow the instructions on the ExifTool homepage (http://www.sno.phy.queensu.ca/~phil/exiftool/)
You can download the complete source code here: http://www.sno.phy.queensu.ca/~phil/exiftool/

.....

dcraw

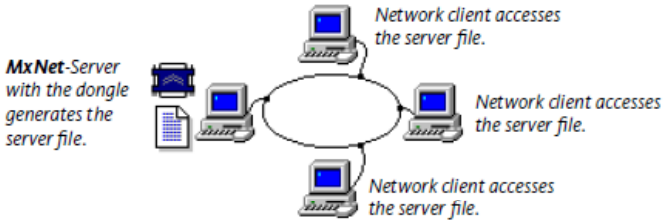
Copyright © 1997-2010 by Dave Coffin

iQ-Analyzer is distributed with custom builds of dcraw for Windows and Mac OS X. This is free software.
You can download the complete source code here: http://www.cybercom.net/~dcoffin/dcraw/

Network Site License (for WINDOWS only)

OVERVIEW

The network site license allows you to use iQ-Analyzer on a defined number of computers in a network using only one dongle. The management of the simultaneously running versions of iQ-Analyzer is performed with the help of user slots in a server file, generated by the MxNet server program by "TechnoData Interware GmbH".



MxNet functional principle is shown in the diagram above. The server program running on a computer with the dongle generates an encoded server file. Each running version of the iQ-Analyzer "connects" with the server file and occupies a user slot, that is being released when the application is closed. The network protection via MxNet does not use network protocols and can thus be used in any network system.

INSTALLATION

Copy mxnet32.exe from the \3rdParty\MxNet\ in the iQ-Analyzer installation folder to the C:\Windows\system\ directory on the computer that will act as the MxNet server.

Connect the dongle to this computer and run mxnet32.exe. The MATRIX-NET program is the MxNet server application and must run on the MxNet server PC (computer with the dongle). This application generates and refreshes the MxNet server file.

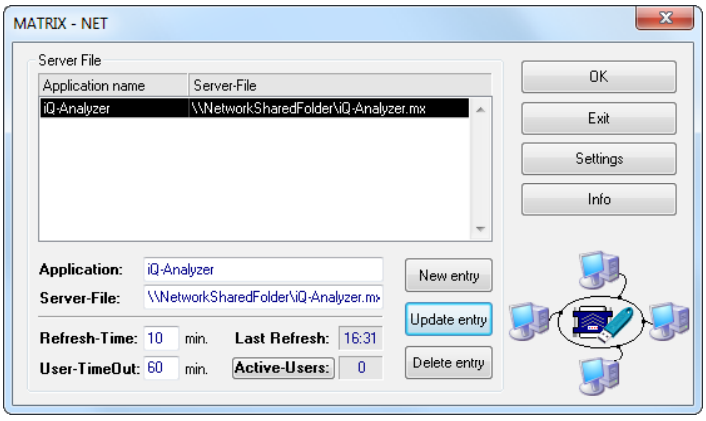
The MxNet server program can also be registered as a Windows service, so that the program is started automatically during the boot-up of Windows. The advantage of a service over an Autostart entry is that the service is also started if there is no User-Login in Windows. You can directly register MxNet as a service by starting MxNet with the corresponding parameters. The following call-up parameters are available:

mxnet32.exe -i (Install MxNET service)
mxnet32.exe -r (Uninstall MxNET service)

MATRIX-NET

After starting the MATRIX-NET program, a dongle symbol is displayed in the task bar. Clicking on this icon will activate the MATRIX-NET dialog.

Enter a name for the program in the field "Application" of the MxNet program (e.g. iQ-Analyzer). The name can be anything you like and it does not need to match the actual application name. The network licenses will be managed using the server file \\NetworkSharedFolder\iQ-Analyzer.mx in this example. The name of the server file must always be entered with the absolute path and correspond to the naming conventions of the operating system.



Refresh-Time

In this field, the time interval for the refresh of the server file is set. The last refresh carried out is displayed in the “Last Refresh” field. The refresh period should usually be selected to be between 5 and 10 minutes.

User-TimeOut

The User-TimeOut is the time limit after which the user is automatically removed from the server file. In the case of abnormal termination of the application (crash) on a client, this function ensures the release of the user slot in the server file, as this would otherwise remain occupied.

Active-Users

This field is continuously updated and shows the total number of active users for the selected application. The “Active-Users” button allows you to display a detailed list of the active users. A user entry can be manually removed from this list.

If your application is terminated abnormally on any terminal, you can either remove the user slot from the list or wait for the time out. When the user time out is reached, the user slot is automatically removed the next time the server file is refreshed.

It is not necessary to delete the user slot before the abnormally terminated application is restarted. The existing user slot will be found and refreshed automatically.

Important!

It is very important that the system time of the PC is synchronized in the network. Otherwise the "User-TimeOut" can not be correctly computed. The maximum allowed deviation of the system time between clients and server, may not exceed the number of minutes, which was selected in the MxNet server program in "Refresh-Time". The following command can be used to synchronize the system time of the clients with the system time of the server. This command can be implemented in the boot-up procedure of each client to make it an automatic function.

NET TIME \\<computername> /SET /YES

iQ-ANALYZER

After installing and running MxNet server, install iQ-Analyzer on every computer where it should be used. On each computer, open the file pathToMxNetFile.txt in the folder Setting in the iQ-Analyzer directory and put the full path to the server file into the first line (in the example above it was \\NetworkSharedFolder\iQ-Analyzer.mx). Save this file and start iQ-Analyzer.

Important!

Make sure that the server file is accesible from each computer.

III. COMMAND LINE INTERFACE

The user has two different interfaces to the capabilities of the iQ-Analyzer. The first one is the normal User Interface that will show up after you have started the iQ-Analyzer.

Additionally you can run the software using the command-line interface. This gives the possibility to integrate the iQ-Analyzer in your own workflow. You could even combine this with one of our USB controlled illumination devices, so you can script your own test series that runs without user interaction.

To start the UI, you just double click “iQ-AnalyzerV5.exe” in the main folder of the software. This .exe is a link to the main executable, which is called “iqa500_XXX.exe”. (XXX stands for the current build number) If you want to have access to the command line interface, just run this file adding the string “cmd”.

Syntax

If you just call the iQ-Analyzer with the cmd flag, you will get an output of the needed syntax to perform calculations.

Call:

```
c:\IE\iQ-Analyzer_V5.0.0_021>iqa500_021.exe cmd
```

Returns:

iQ-Analyzer CommandLine Version: 5.0 build: 001

Syntax: iea_XXX_XXX cmd <ImageFile> <SettingFile> <Module> <Options>

cmd: fixed flag as first argument (use always "cmd")
ImageFile: Path to imagefile. Wildcart can be used for filename (e.g. c:/temp/*.jpg)
SettingFile: Path to Setting.txt File
Module: Which module to use
Options: Overwrite settings in Setting.txt File, see Documentation

You have to define at least three arguments, with additional optional ones:
<ImageFile> <SettingFile> <Module> <Options>

<ImageFile>

This is the path to the image to be analyzed.

Example: c:\Images\oecf20.jpg

Like in the analyzer, you can also analyze a set of images by selecting the first one.

Example: c:\Images\oecf20_00.jpg

The software analyzes the specified image plus all images that have the same name but a different counter, like oecf20_01.jpg, oecf20_02.jpg and so on. (if enabled in the settings)

You can also use wildcarts.

Example: c:\Images\oecf20_*.jpg

The software will analyze all images which filename matches the names including the wildcart.

<SettingFile>

The iQ-Analyzer can handle two different types of setting files: A text file and a myset file.

Text-File:

The software comes with a preconfigured .txt file in the Data Folder. This file (“iea_set.txt”) contains a list of settings, all can be edited.

Please make sure, that the file remains in its basic configuration, so it s always:

variable = value % comment (note that there is a tab before and after the “=”.

If there is a problem with the settings, you will receive a message like:

“The value XXX for variable YYY is not a valid filepath. Please check.”

.myset File:

A .myset file is configuration file that is written by the iQ-Analyzer. You can obtain that file by pressing the button “Save current settings to file” in the “Settings”-Module.

We recommend to use a .myset File as the configuration is easier to handle.

<Module>

A string that specifies the module you want to use. That can be the full name or just the first character.

Example: “OECF”, or “o”.

<Options>

Options are always a pair of arguments <setting> and <value>

<setting> this is the name of the variable that can be set in the settings. See the iea_set.txt for the names.

<value> the new value, so this setting in the seting file is overwritten.

Example:

OECF.Illumination 1000

So you have set the variable OECF.Illumination to 1000, regardless what th setting in the specified setting file was. You are not limited to a number of options to set. The idea of the options is, that make most settings in the setting file, but you se still able to make adjustments to it by each call. That way you do not need to have several different settings file if the difference between these file is just one or slightly more entries.

Example for a full call:

```
c:\IE\iQ-Analyzer_V5.0.0_021>iqa500_021.exe cmd c:\IE\Sample\oecf20.JPG Setting\
IEA_set.txt oecf
```

Output:

---

iQ-Analyzer CommandLine Version: 5.0 build: 001

Start

Locate Chart(s) .

Locate ROIs .

Correct ROIs .

Analyze .

Calculate Results .

c:\IE\Sample\oecf20.JPG:

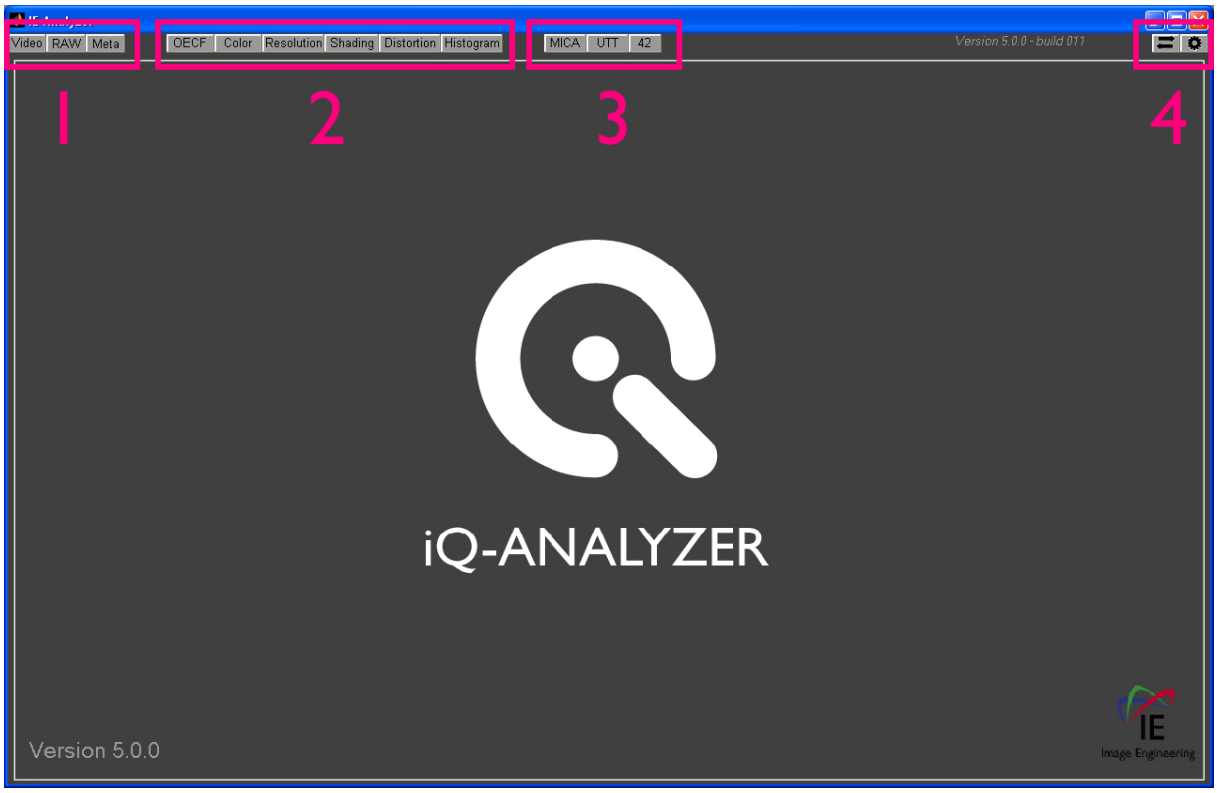
Background of Chart is rendered to an Output Level of: 74.2 This is out of the ISO15739 V2 specification. Check Exposure !

Write Results

Done

IV. GRAPHICAL USER INTERFACE

Run “iqa500_XXX.exe”. It takes a while until the MCR (MatLab component runtime) starts and the start screen appears.



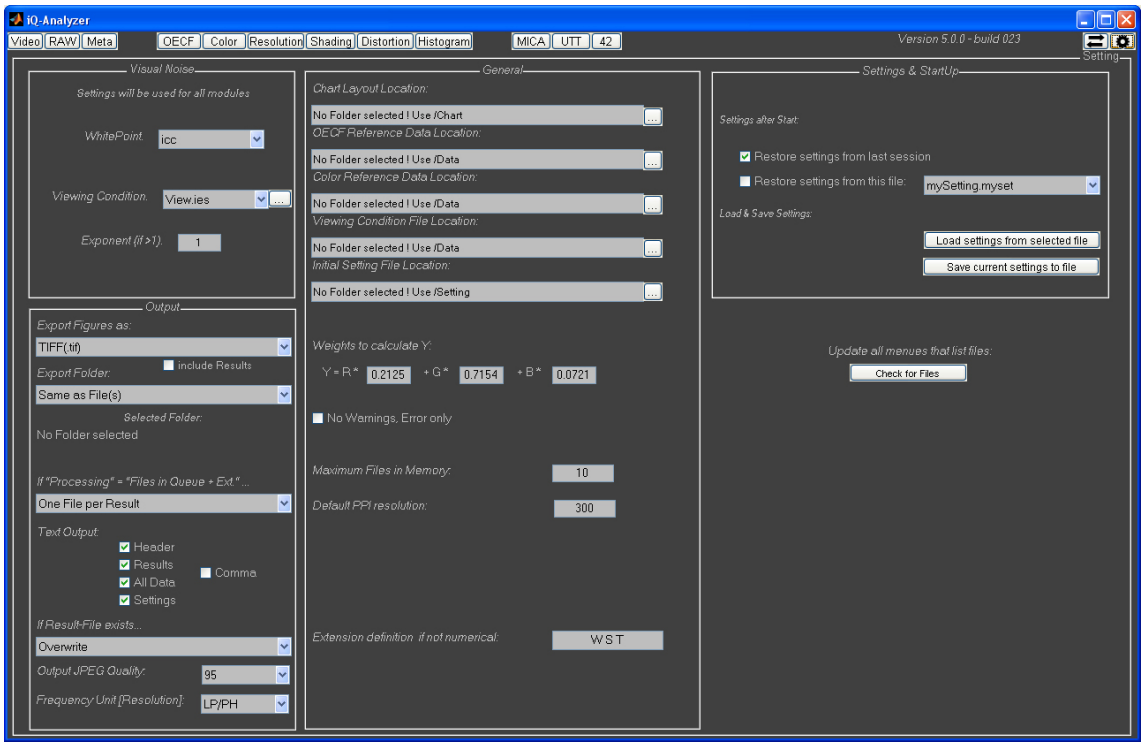
iQ-Analyzer start screen

The tabs in top of the screen enable navigating to the different groups:

1) Input: Video, RAW, Meta
2) Dedicated Modules: OECF, Color, Resolution, Shading, Distortion, Histogram
3) Multi-Modules: MICA, UTT, 42
4) Settings: Export/Import, Settings

1. SETTINGS

In the **Settings** menu all important parameters regarding **visual noise**, **output** and **general** parameters such as file path to reference data can be adjusted.



SETTINGS overview

1.1 Visual Noise

Unlike the ISO 15739 camera signal-to-noise ratio the visual noise is evaluated as an output referred noise. Visual noise takes into account that the spatial distribution of noise could be different and considers that human observers react different on color intensity noise. Visual noise quantifies how well a human observer can recognize noise.

With the aid of six transformation steps the visual noise of RGB images can be calculated.

RGB image

↓

XYZ

↓

opponent space

based on analysis of color receptors of human eye and of processing the resulting color signals

↓

(CSF-)frequency filtering

with the aid of the contrast sensitivity function
the CSFs describes the contrast which is required for identifying defined frequencies

↓

XYZ

↓

Luv

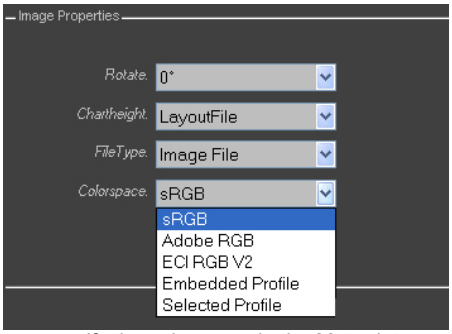
the Luv color space is better suited for viewing smaller field than the Lab color space

↓

weighted standard deviation

in the Luv the standard deviation is calculated for every patch
and weighted with the aid of the formula: 1.000L + 0.8520u + 0.3230v

The flow chart above shows that for calculation of visual noise, the RGB image data has to be converted into the CIE XYZ space (as one of several steps). The colorspace of the input can be specified in the Meta data (see below).

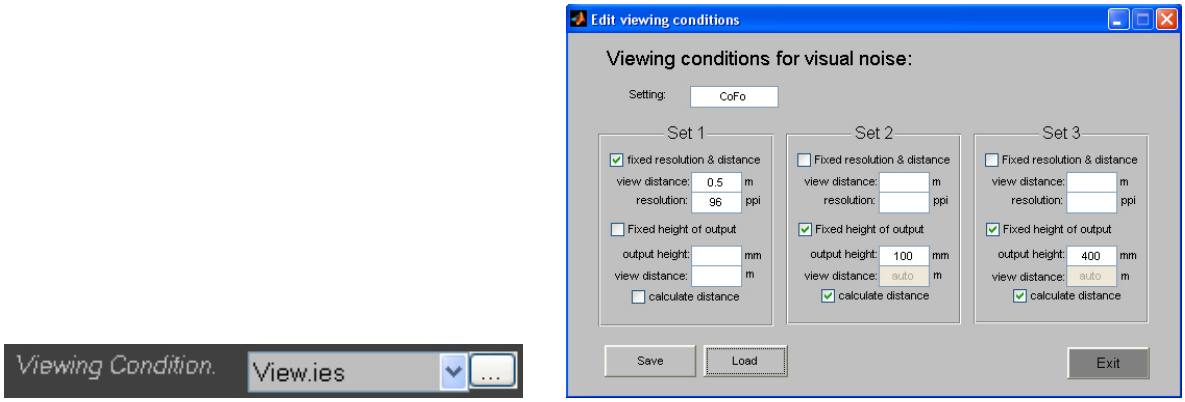


specify the colorspace in the Meta data

Specify the **White Point** that should be used to calculate the visual noise.

Icc: Use the icc standard white point (D50). The color managment specified by the ICC is based on this white point.
Profile: Use the white point specified in the profile header (illuminant).

As the visual perception of noise depends on the **viewing conditions**, you have to specify these. Select an .ies file for the visual noise calculation by pressing " ... " and the "Load" button in the new opening window.

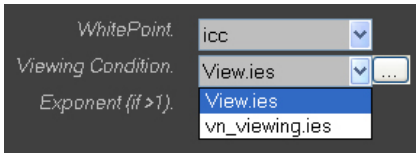


select and edit the viewing conditions

The .ies files are stored in the folder you select in the "General" settings (middle box). "Data" folder is default. The default "View.ies" contains three settings:

Set 1: 100% view on a monitor, 0.5 m viewing distance, 96 ppi monitor resolution
Set 2: Print with 10 cm height, calculate viewing distance auto
Set 3: Print with 40 cm height, calculate viewing distance auto
Both prints are supposed to be observed at a viewing distance of the diagonal of the print (auto). The minimum is 25 cm. To edit and/ or create your own .ies files, load one .ies file and change the default values. Name your setting and press the "Save" button.

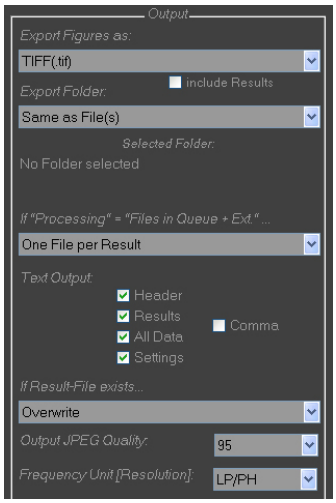
The several viewing conditions can be selected by using the dropdown menu.



viewing conditions dropdown menu

The results of the visual noise calculation can be spread out. Specify an **Exponent (if > 1)**. We recommend an exponent = 1 to get the original results.

1.2 Output



output properties

Export figures as: Among numeric results you get figures you can export. Select the file format of exported figures: Tiff, JPEG, EPS, PDF

include Results: if selected, the results are also seen in the exoprted figures

Export Folder: Selection of the export folder

Same as File(s): figures are exported into the same folder as the original image files

Select each time: the export folder can be selected at each analysis

Selected Folder: selection of a standard export folder

If "Processing" = "Files in Queue + Ext." ...

In every module you can choose which files will be analyzed:

Only the files you add into the file list (**"Files in Qeue"**) or if you have made several images and named them with extensions (e.g. colorchecker_01, colorchecker _02, colorchecker_03, ...) you only have to add the image file with the lowest extension and iQ-Analyzer analyzes the further ones, too (**"Files in Queue + Ext."**). If you extension s are not numerical you can define your extension at "**Extension definition if not numerical".**

When you choose **"Files in Queue + Ext."** you can now define the number of result files you get:

One File per Result: for every image one result file is created

Multiple Results in one File: in one file the results of all images are saved

Text Output

You can choose which information is saved in the result file.

Header: information about evaluation software version, file name, file data, EXIF data

Results: relevant results

All Data: all measured values

Settings: setting information are saved to the output text file

Comma: if enabled, the text output is given with a decimal comma (instead of point), which can make the import to MS Excel much easier

If Result-File exists ...

Add Index to ResultFiles: new results are saved in a new file with an index (e.g. ‘oecf’, ‘oecf1’, ‘oecf2’)

Overwrite: new results are saved under the same name and the old file is deleted

Ask for new name: if the result file exists you are asked for a new file name

Output JPEG Quality: depending on the module, some images are saved automatically. Define the qualtity of exported JPEG images (100 correspond best quality).

Frequency Unit [Resolition]: Select the unit of spatial frequency that is used in the output of Resolution module (LP/PH linepairs per picture height, LP/Pix linepairs per pixel, PPI pixel per inch)

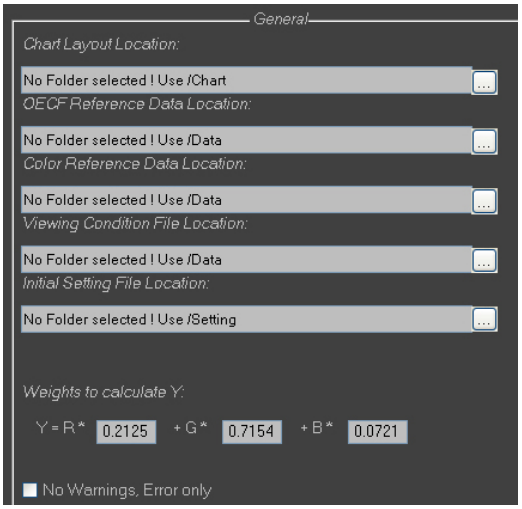
1.3 General

Chart Layout Location: path to the reference data of the chart layout. The local folder “Chart” is set as default. With “...” you can browse to a different folder

OECF Reference Data Location: path to the OECF reference data. The local folder “Data” is set as default. With “...” you can browse to a different folder

Color Reference Data Location: path to the color reference data. The local folder “Data” is set as default. With “ ... ” you can browse to a different folder

Viewing Condition File Location: path to the reference data of the viewing condition file. The local folder “Data” is set as default. With “ ... ” you can browse to a different folder



general properties

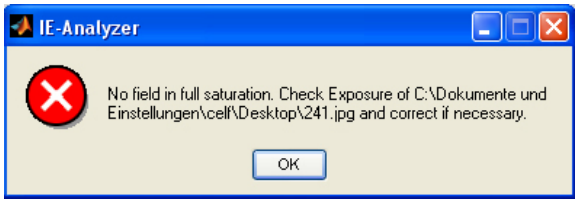
Initial Setting File Location: path to the setting file .myset that you can choose in “Restore settings from this file” (right side)

Weights to calculate Y

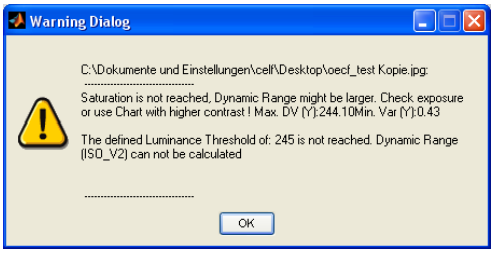
You can specify weights for R, G and B to calculate the luminance Y. Weights of usual standards are:

ITU-R BT.709 (recommended)	Y= **0.2126** R + **0.7152** G + **0.0722** B
ISO 12232	Y= **0.2125** R + **0.7154** G + **0.0721** B
NTSC	Y = **0.2989** R + **0.5870** G + **0.1140** B

No Warnings, Error only: iQ-Analyzer displays errors (marked in red) and warnings (marked in yellow). These warnings (e.g. if the exposure is not saturated) can be turned on/ off by selecting the checkbox. This can be helpful for users who want to analyze images out of the “normal” settings.

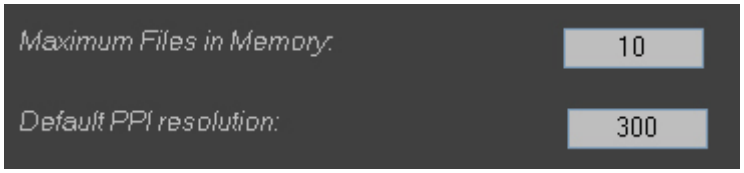


displayed error

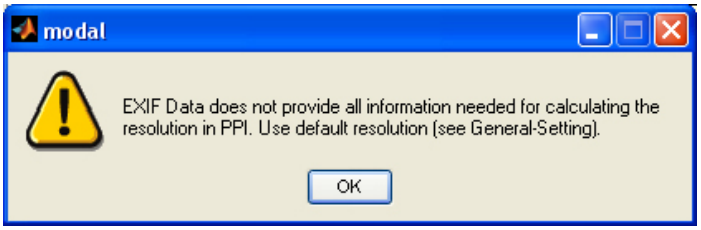


displayed warning

Maximum Files in Memory: define the maximum number of files that are at the same time in memory. To find a tradeoff between reading the files and keeping them in memory depends on machine memory. A usual value is 10. If you have huge files select a smaller value.

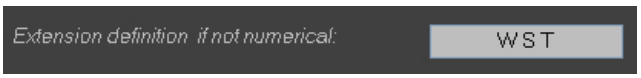


Default PPI resolution: Mainly used for scanners. If no EXIF data exist this value is used in the **Resolution** module. A warning appears after calculation.



warning in the resolution modeule if EXIF data does not contain all information for calculation resolution in PPI

Extension definition if not numerical: later in the modules you can either add all pictures into the file list or if you have made several pictures and named them with extensions, you can add the picture with the lowest numerical extension and select “Files in Queue + Extension”. If your extensions are not numerical you can specify them here. E.g. you have made three pictures, named “shading_w.jpg”, “shading_s.jpg” and “shading_t.jpg”, define the extension with “W”, “S” and “T” (W, S, and T stand for wide, standard and tele). Working with extensions is intended for image series.



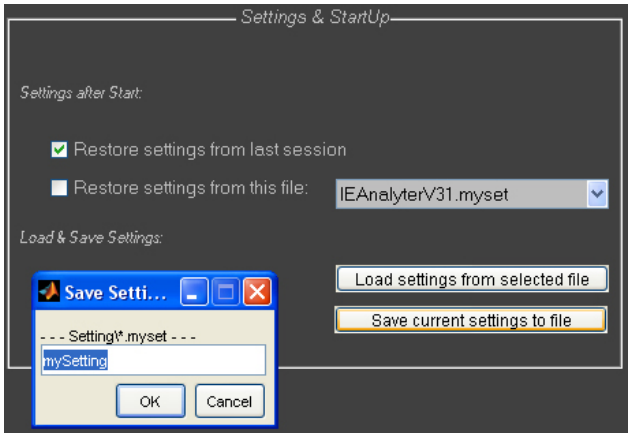
define extension if not numerical

1.4 Settings & StartUp

You can save and load your settings you made in the iQ-Analyzer by using the buttons “**Save current settings to file**” and “**Load settings from selected file**”.

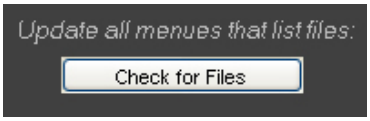
If you have selected “**Restore settings from last session**” the current settings will be used when a new session is started.

If you have selected “**Restore settings from this file**” the selected file (from dropdown menu) will be used when a new session is started.



save your settings

All menus that contain data (.chsrt, .den,.lum,.myset etc.) are reloaded. It is useful if you have added data or have changed files in "XXX Location" at “General”



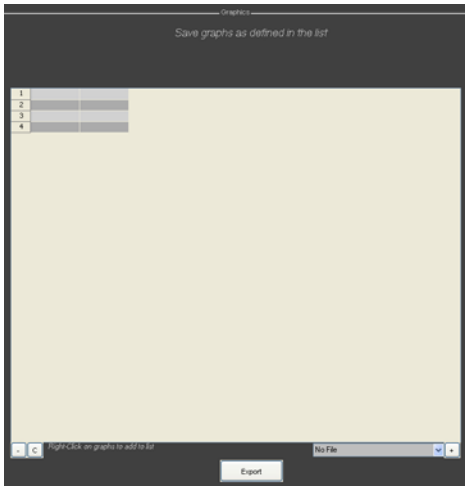
2. EXPORT/IMPORT

In the Export/Import menu settigs can be made for daving results and graphs.

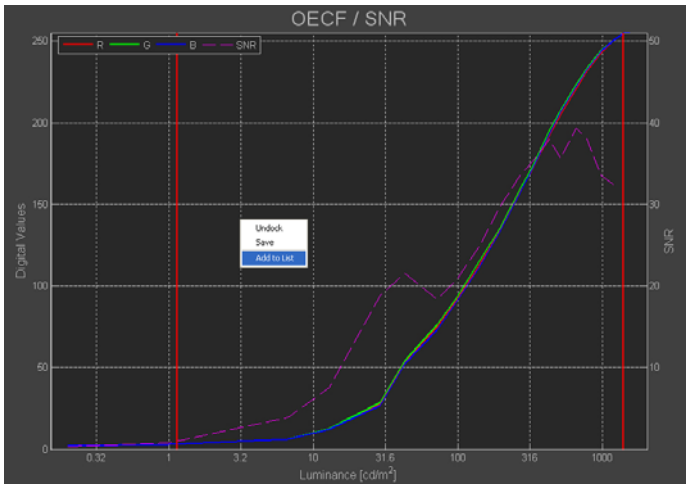
The results of all modules (if calculated) are saved in one file in an Analyzer-internal file format.

You can save and restore the results displayed in the different modules. Select the modules and press “Save Data” or “Restore Data”.

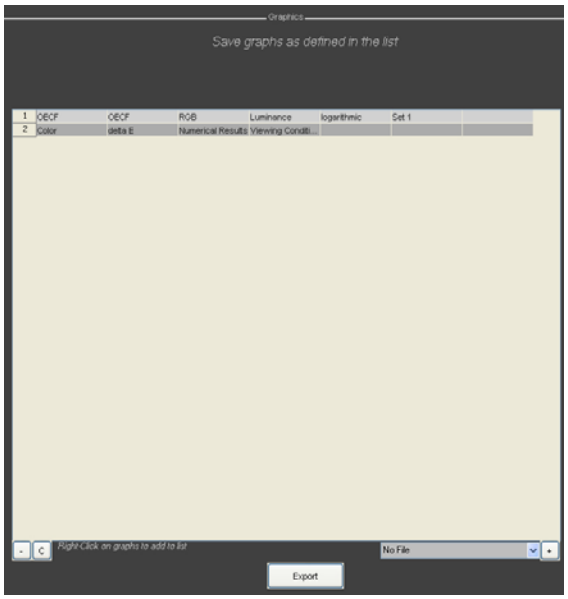
Result graphs can be saved either individually in every module by using the Export button (in every module) or the graphs can be collected first and then exported altogether.



List befor inserting results



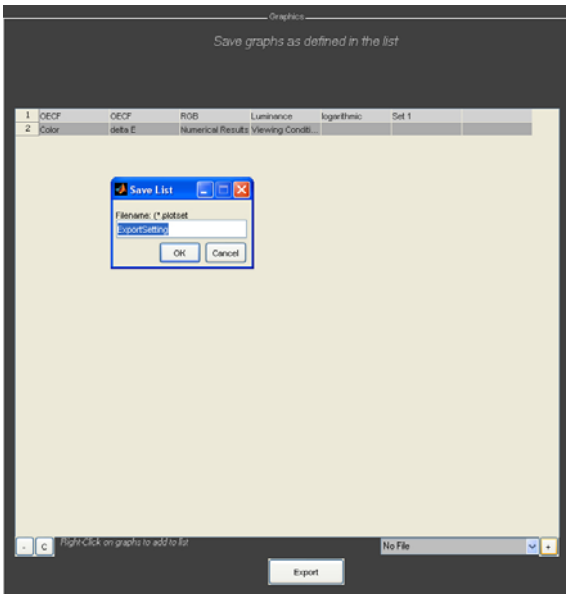
After calculation in the modules make a right klick on the graph and choose “Add to List”

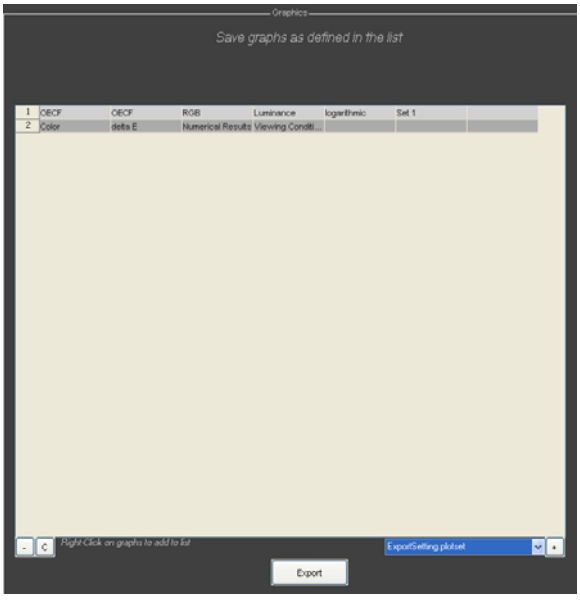


By using the “Export” button the graphs are saved. File path and file format are defined in the SETTINGS.

Marked graphs are deleted by using the “-“ button and the complete list by using the “C” buton.

Two graphs are added.





Using the “+” button the list is saved and shown in the right down dropdown menu.

3. VIDEO

The Video Module is designed to link video sources to the powerful evaluation core of the iQ-Analyzer. Both, live video signals and video files can be processed. The Video Module introduces convenient acquisition of frames and passing them to any other iQ-Analyzer Module for deep analysis. For live video signals, measurement tools are available, such as waveform monitor, vectorscope and histogram display. Furthermore, the versatile live analysis of color distance and creating own device-specific color reference datasets can easily be accomplished.

"Video" tab

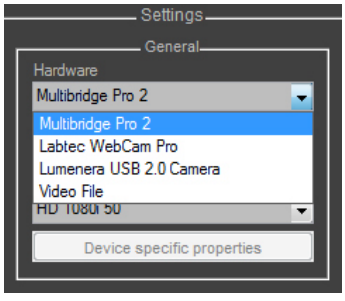
3.1 Settings

Depending on the input source (live video or video file), the Settings panel provides specific settings to control the worklflow.

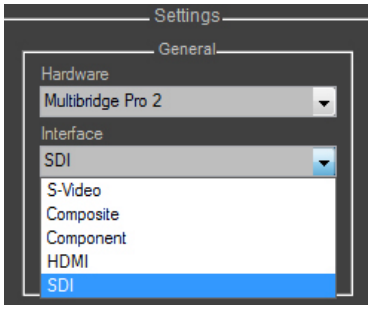
Settings for Live Video Sources

General

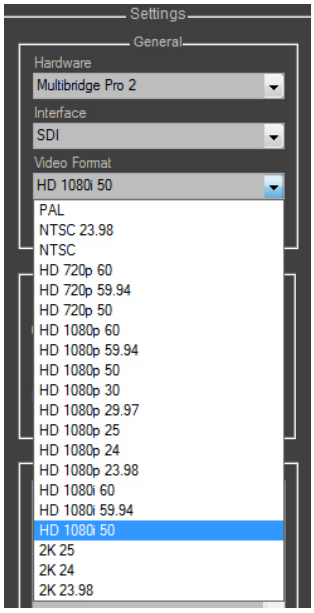
In the "General" section of the Settings panel you can select the connected video input hardware, used interface and video format. Please note that the selection of the interface and video format are device dependent. For video file sources please select "Video File" in the Hardware dropdown menu and refer to the next section "Video File Sources" of this documentation.



General settings - Hardware

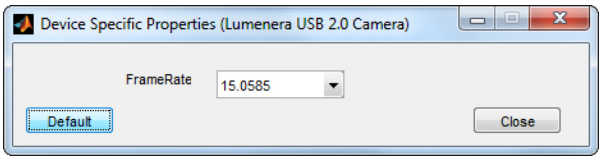


General settings - Interface



General settings – Video Format

Device Specific Properties



device specific properties

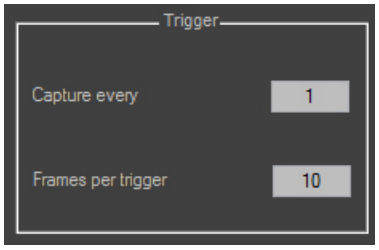
If the driver of your video input device (e.g. framegrabber or web-camera) provides more detailed adjustments, such as gain, frame rate or sharpnesss, you can set them in the “Device Specific Properties” window. To access these settings please use the button in the “General” section. If not available, the button will be inactive. Please note that these settings are device and driver dependent.

Trigger

In order to analyze the video data using the other iQ-Analyzer modules, a number of frames has to be acquired. The trigger section provides control over the acquisition.

Capture every: Defines which frames should be captured. Select 1 to acquire every frame, 2 for every second frame etc.

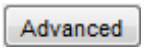
Frames per trigger: Defines the number of frames to be captured on the next acquisition triggered by the “Capture” button.



settings for number of

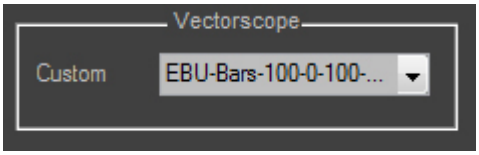
Advanced Settings

The Advanced Settings panel is activated using the “Advanced” button on the bottom of the Settings panel.



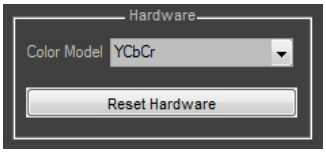
Vectorscope/Custom

Custom layout files for the vercorscope’s graticule containing the positions of the target fields can be selected here. Custom files are provided on request.



Hardware/Color Model

Choose the color model that is used for the representation of the video signal (RGB, YCbCr or grayscale).

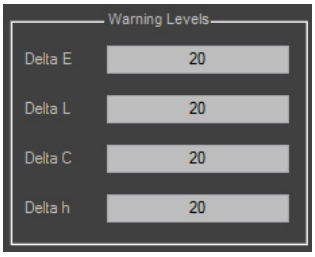


Hardware/Reset Hardware

Press this button if you have connected or detached a hardware device. The search for the available devices is performed without the necessity to restart the iQ-Analyzer.

Warning Level

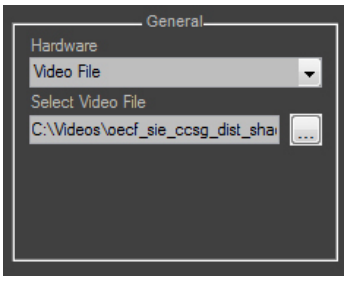
Define the warning levels for the visualization of the color differences in the Comparison Mode. Setting Delta E warning level to 20, for example, will mark the color patches in your test target red if they exhibit Delta E equal or greater than 20. The patches with Delta E smaller than 20 will be marked in the shades of yellow and green, depending on their Delta E.



Settings for Video Files

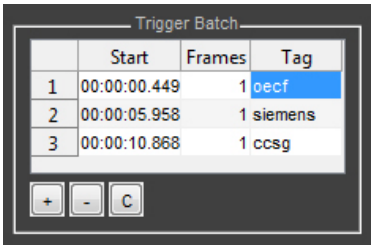
General

If you want to analyze a video file, select “Video File” in the Hardware dropdown menu. The selection of the video file is accomplished in the edit field below. Please press “...” in order to select the video file. The file name and path are then displayed in the edit field.



Trigger Batch

A trigger defines the position in the video file from that the defined number of frames will be captured on the next acquisition triggered by the “Capture” button.

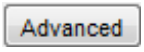


You can create multiple triggers for a single video file. Please navigate to the desired position in the video file using the timeline slider and press the “+” button. You can also press this button when playing the video. Selecting a trigger in the table will navigate to its position in the video file. You can delete triggers from the table using the “-” button or clear the entire table using the “C” button.

The amount of frames to be captured can be edited in the trigger batch table for every single trigger. You can also set a specific tag for every trigger in this table. This tag is added to the file name of the acquired frames in order to easily handle multiple acquisitions.

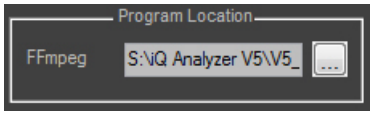
Advanced Settings

The Advanced Settings panel is activated using the “Advanced” button on the bottom of the Settings panel.



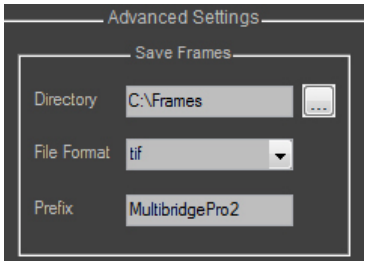
Program Location/FFmpeg

iQ-Analyzer is distributed with an automated FFmpeg 32-bit Windows build in order to extract frames out of a video file. It is located in the “3rdParty” folder of the iQ-Analyzer. If you want to use another version of Ffmpeg, you can select its program location using the “...” button.



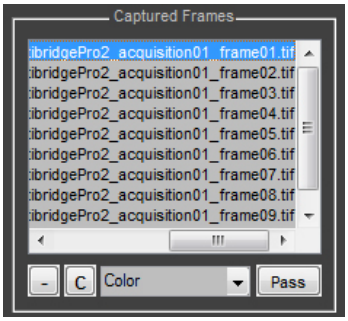
3.2 Capturing and Passing Frames

Pressing the “Capture” button triggers an acquisition. A number of frames, as defined by the Trigger/Trigger Batch settings, is captured and shown in the file list. The folder for saved files, file format and file name prefix can be defined in the “Advanced” menu.



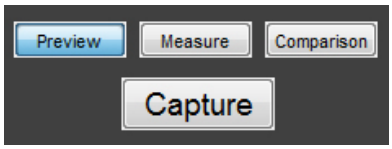
You can delete selected captured frames from the list using the “-” button or clear the entire list pressing the “C” button. The captured image files will not be removed.

Select an iQ-Analyzer module in the dropdown menu and press the “Pass” button to pass the frames to another module for an extensive analysis.



3.3 Preview, Measurement and Comparison Modes

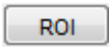
Please note that Measurement and Comparison modes are only available for the live video sources. You can switch between the modes using the toggle buttons “Preview”, “Measure” and “Comparison”.



Preview (Live Video Sources)

A preview window showing video and allowing a first visual evaluation. For the live video sources, this helps you to easily set up your environment and adjust your camera's position and the scene lighting.

The ROI (region of interest) can be selected. Press the “ROI” button in the bottom left corner. Select the ROI by adjusting the rectangle in the display. Press the “Confirm” button to crop the image. To see the full image again, press the “Full” button.



Preview

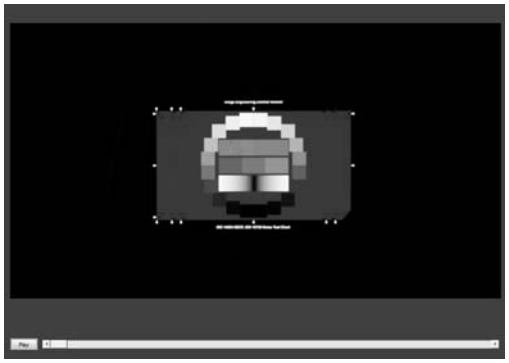
initial ROI

adjusted ROI

confirmed ROI

Preview (Video Files)

You can navigate through the video file using the timeline slider or play and pause the video using the “Play/Pause” button.



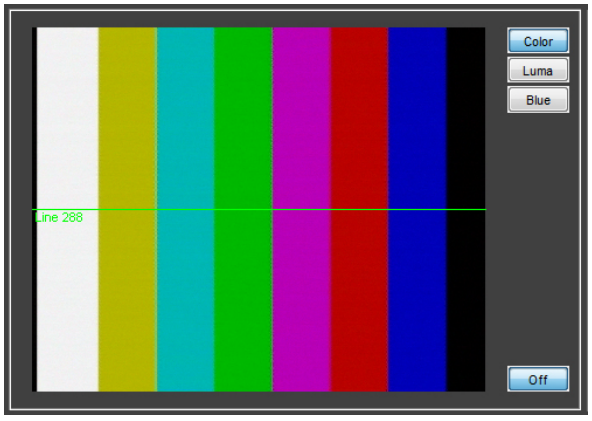
Measure

Measurement instruments, such as histogram display, waveform monitor and vectorscope, provide a quick overview.

Preview Display

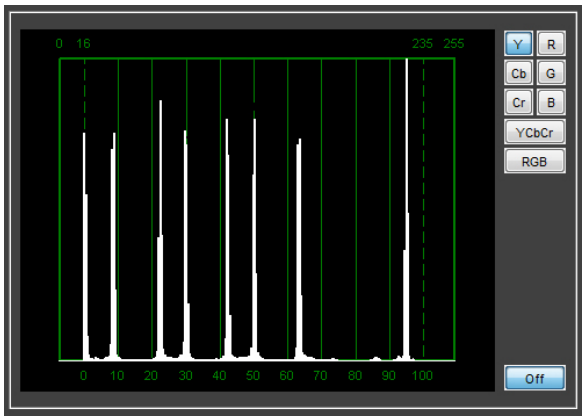
Select a single video line to be analyzed by clicking into the display on the preview panel. Choose between Color, Luma and Blue view. The latter is helpful for monitor calibration.

The preview display can be switched off if not used, this can improve the performance of the other displays.



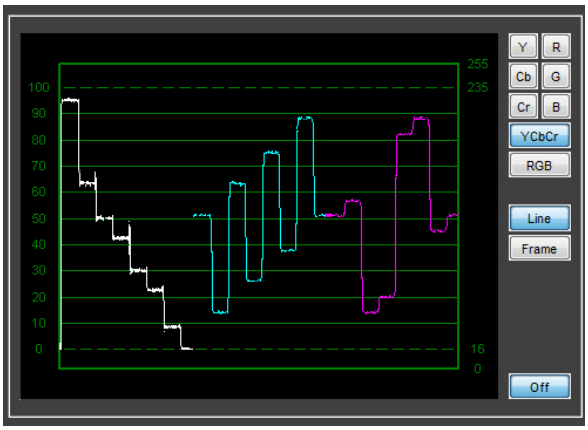
Histogram Display

The histogram can be displayed for the luma signal Y, the color difference signals Cb, Cr and the color signals R, G and B. The upper horizontal axis shows digital values (0 – 255). Digital video signals range from 16 to 235 (indicated with the dotted line). Values between 0 and 16 and 235 and 255 are reserved for the foot- and the headroom. The lower horizontal axis displays the digital values 16 – 235 as percentage. The histogram display can be switched off if not used, this can improve the performance of the other displays.



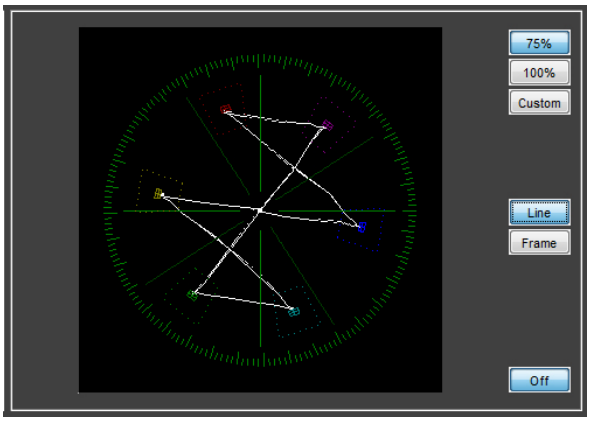
Waveform Monitor

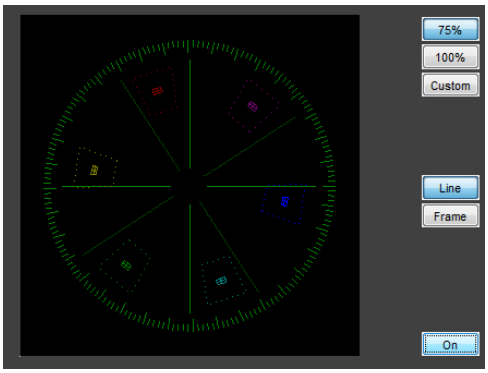
The video signal can be visualized for one line or the entire frame. This can be performed for the luminance signal Y, the color difference signals Cb, Cr and the color signals R, G and B as single channel or parade view. You can also toggle between single line and full frame display. The right vertical axis shows digital values (0 – 255). Digital video signals range from 16 to 235 (indicated with the dashed line). Values between 0 and 16 and 235 and 255 are reserved for the foot- and the headroom. The left vertical axis displays the digital values 16 – 235 as percentage. The waveform monitor can be switched off if not used, this can improve the performance of the other displays.



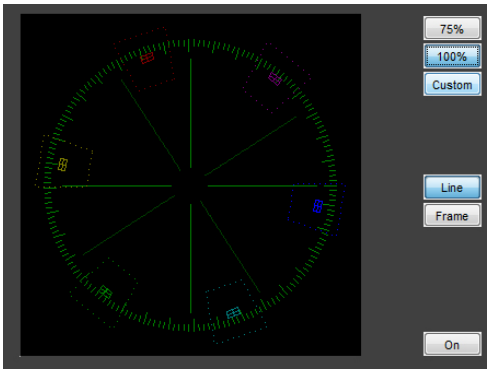
Vectorscope

The vectorscope graticule can be set up for 75% or 100% (referred to EBU Color Bars). If you have a custom graticule layout file, you can select it in the Advanced Settings and use it by the “Custom” toggle button. You can switch between single line and full frame display. The vectorscope can be switched off if not used, this can improve the performance of the other displays.





vectorscope set up for 75%



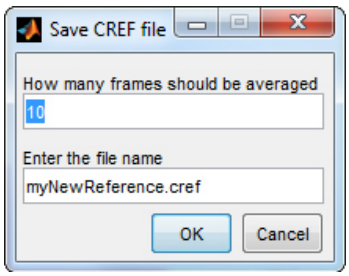
vectorscope set up for 100%

Comparison

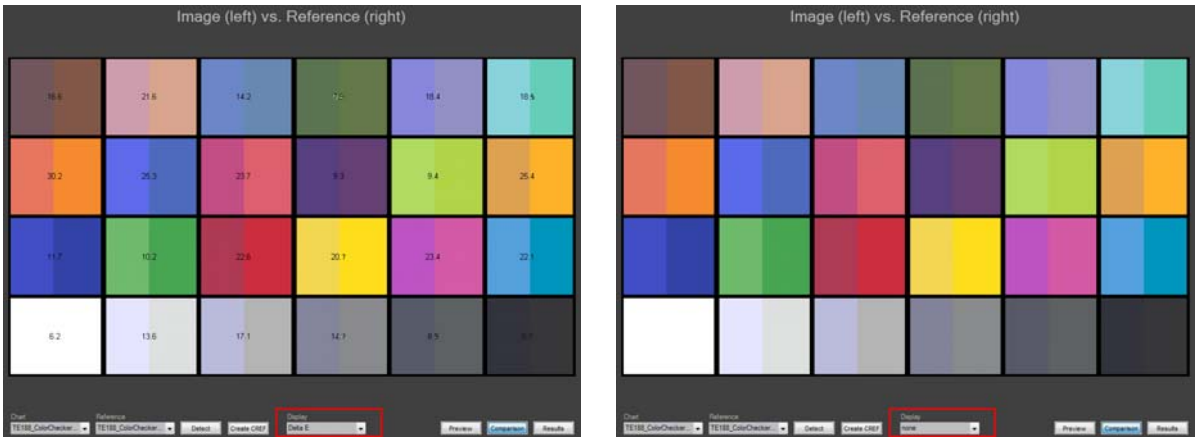
The comparison module allows a fast and easy color evaluation of live video signals. The human eye is a very sensitive instrument for color comparison, especially for a side by side comparison. Numerical evaluation of color distance can also be performed. For more extensive numerical evaluation based on ISO and CIE standards just capture some frames and pass them on to the iQ-Analyzer's Color Module.

For the comparison, you first have to define the chart layout (“Chart” dropdown menu) and the according reference file (“Reference” dropdown menu). Press the “Detect” button and the blue ROIs (regions of interest) will appear.

The color data from the video stream can be saved and used as a reference file for other devices, e.g. for matching cameras in a studio environment. Open the creation dialog pressing the “Create CREF” button. The saved reference file will appear in the “Reference” dropdown menu. Press “Detect” button again in order to use it.



For visual comparison (Image vs. Reference) press the “Comparison” button. For numerical results press the “Results” button. The dropdown menu “Display” allows changing the representation for Delta E, Delta L* (lightness), C* (chroma/saturation)and Delta h* (hue). You can turn off the numerical results in the visual comparison mode selecting “none” in the “Display” dropdown menu.



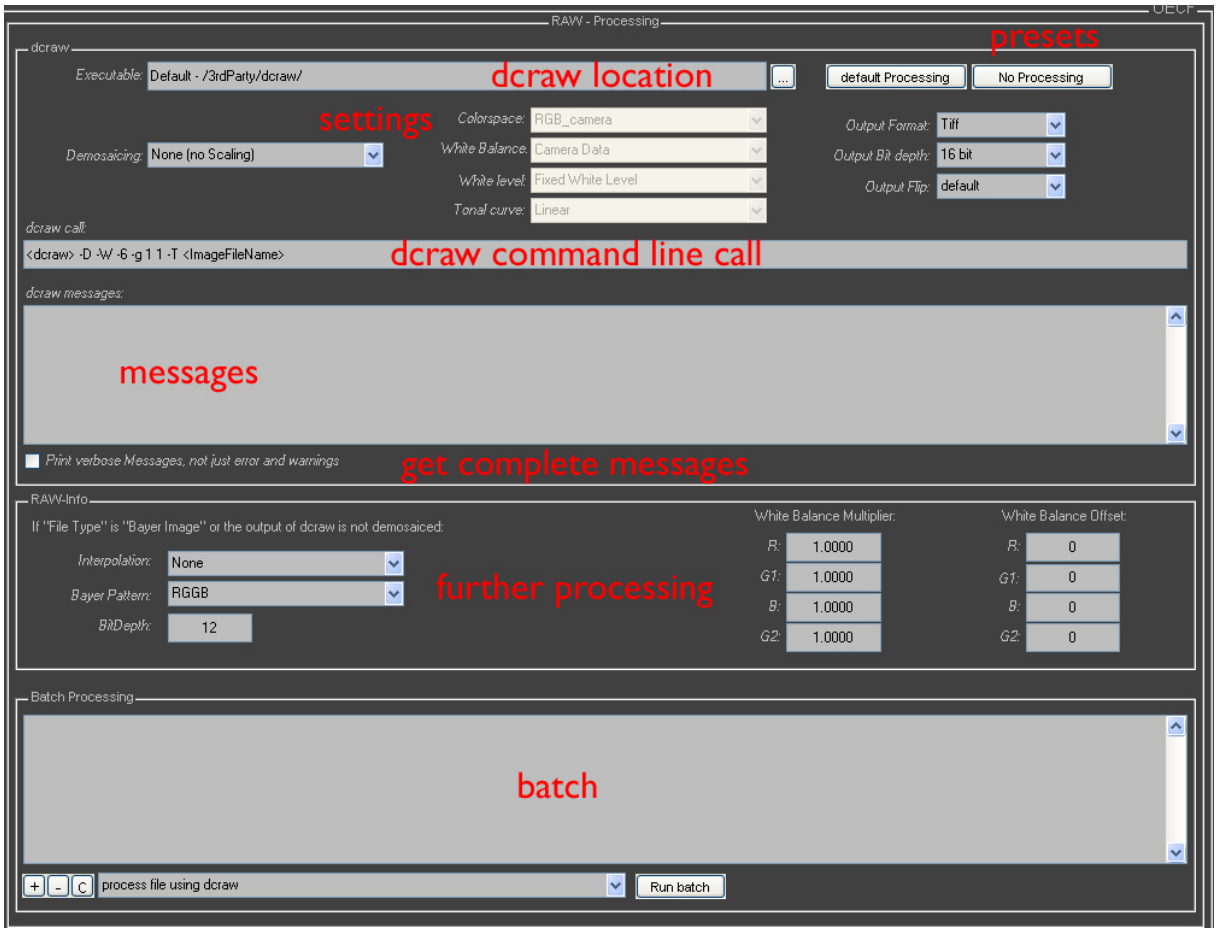
Visual comparison with and without numerical results

numerical results

4. RAW

iQ-Analyzer 5 supports RAW data for still image analysis based on dcraw.

RAW tab



dcraw location : the location of the dcraw excecutable. The iQ-Analyzer comes with a version, but you might want to use the latest one. The default location is in /3rdParty/dcraw in the iQ-Analyzer man Folder.

Manpage of dcraw:http://www.cybercom.net/~dcoffin/dcraw/dcraw.1.html

iQ-Analyzer starts dcraw with options that are defined on the dcraw manpage. The dcwaw commands are displayed in the “dcraw command line call” (dcraw call) and result from the settings (above). In the “presets” standard configurations are stored. If settings are done, in the modules (e.g. OECF) RAW images can be analyzed in addition to JPG files.

messages: if the checkbox „Print verbose Messages, not just errors and warnings” is marked, you are only informed that the file XXX is coressed successfully. Otherwise all process steps are listed.

further processing: if the image to be processed is one without demosaicing (Bayer Image) or the output of dcraw is an image without demosaicing, the image is further processed.

- **Interpolation** (“None” or "Gradient Corrected linear"): Select if the image shall be demosaiced or not. If "None" is selected, the image is handled as an RGB+G2 Image (channel) and given to the measurement modules. If an interpolation algorithm is selected, the image is demosaiced.
- **Bayer Pattern**: Define the Bayer Pattern of the sensor. Each string represents the order of the red, green, and blue filtered pixels by describing the four pixels in the upper-left corner of the image (left-to-right, top-to-bottom.
- **BitDepth**: Define the BithDepth of the RAW Data.

White Balance Multiplier

The values are multiplier for each channel of the sensor data. If this is different than "1", you can chnge the slope of the channel and therefore make a white balancing on he data. To get this data, you can run dcraw with the options "-i -v" to get informations about the file. Note: The data might be stored differently in the different raw-files. Most likely, you have to normalize the data to the green channel.

White Balance Offset

The dark current might be different for the different channels. The offset is added to each channel (the offset can be negative) before the multiplier is applied to the data.

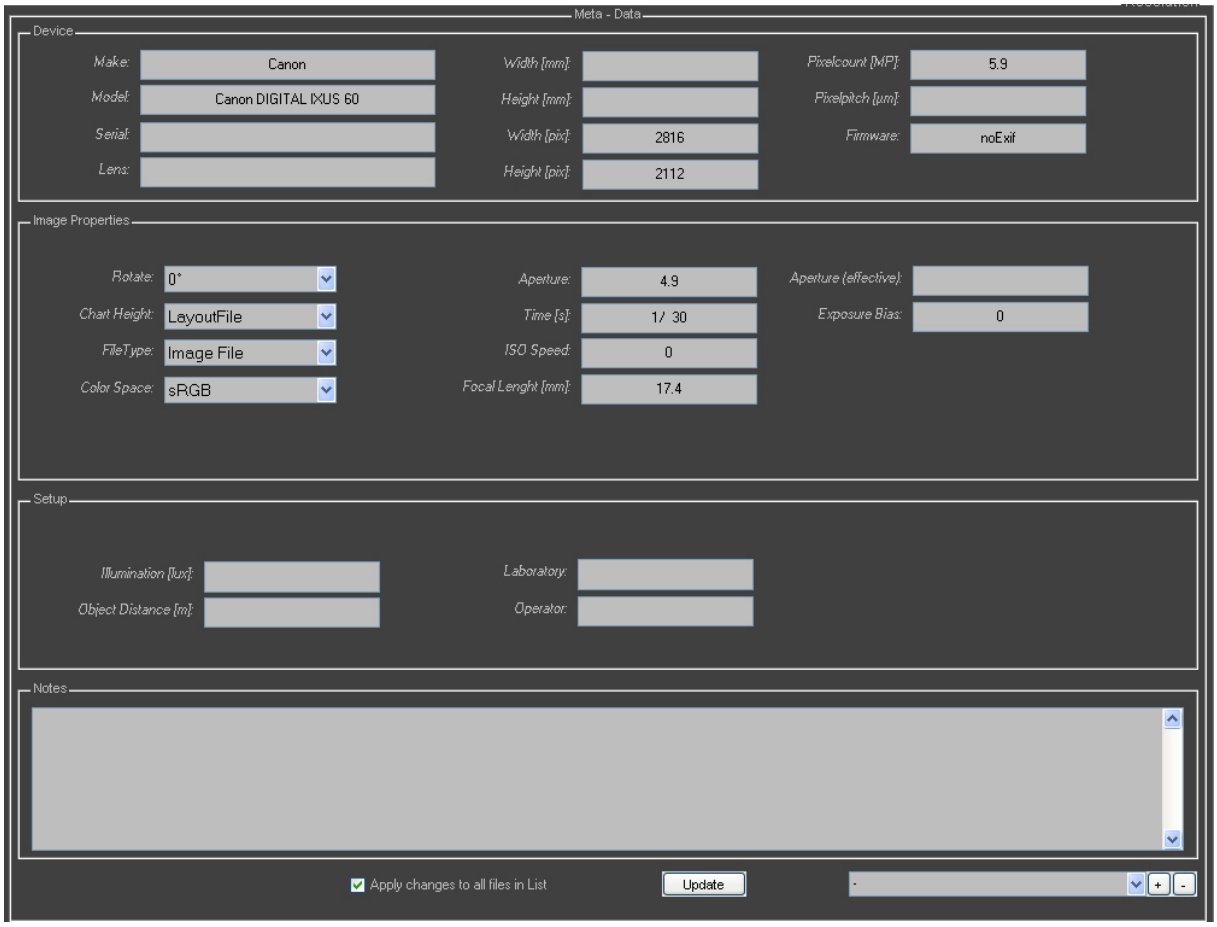
batch

To start the batch processing, add image files with “+” (delete with “-“ and clear list with “C”) and press “Run batch”.

5. META

The meta data of the image files are red out and displayed in the META module. You are able to add data and make adjustments. These information of “Image Properties” (e.g. color space, image direction are used for calculation). In the result text file all meta data are integrated in the header.

META tab



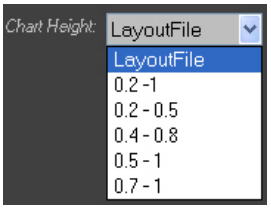
Device

Information about the device. Pixepitch [µm] is calculated by insertig values for Width [mm] and Height [mm] and pressing the Enter Key.

Image Properties

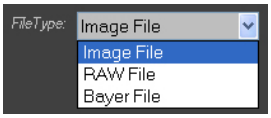
Rotate: By using the dropdown menu you can rotate and flip the images. The image must have landscape orientation and show the chart accurate to side.

Chart Height: The dropdown menu enables to define the chart size related to the image file to reduce calculation time.

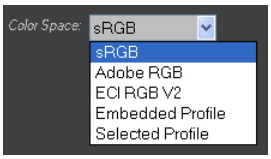


Example: When you have several pictures with different chart sizes related to the image size, choose “0.2-1”. When you have several pictures with similar chart sizes related to the image size, e.g. 0.4, 0.5, 0.7, you can choose “0.4-0.8”. “LayoutFile” is default and describes the size of the reference Layout File. Setting limits reduces calculation time.

File Type: Depending on the imported image file the file type is indicated in the dropdown menu.



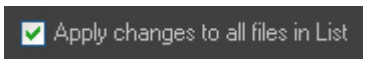
Color Space: For color calculations RGB values are converted to XYZ. Select a profile that is used for conversion.



ISO Speed: The ISO speed is calculated by inserting values for “Aperture” and “Object Distance [m]” (Setup) and pressing the Enter Key.

Notes

You can insert your notes that are also diplayed in the result text file.



Apply changes to all files in List: if the checkbox is marked the meta settings are applied to all files in the active module.

Pressing “Update” the image is read out again and the meta data are updated

You can save “+” and load your meta settings using the dropdown menu..

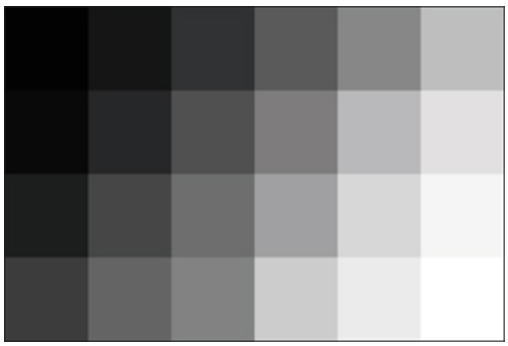
6. OECF

With the aid of arranged gray scales the opto electronic conversion function (OECF) can be determined. This phrase describes the characteristic property of digital cameras, to transfer luminance into digital values in the picture. The curve is specified for all three color channels red, green and blue in color images.

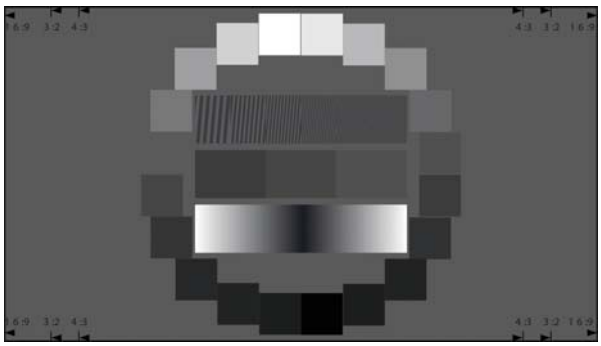
OECF tab

The chart has to be illuminated homogeneously. Regarding exposure there are two recommendations for the new and old version of ISO standard 15739: For the old version ISO_V1 we recommend to choose an exposure on the camera that way, that the brightest patch is in full saturation and the next not. That way you can get comparable results between different cameras. In the new Version of ISO 15739 (ISO_V2) the background must have a digital value of 119 (tolerance range 100-140).

You can analyze several charts. Two default charts are the TE240 (ISO 21550 Scanner Dynamic Range Chart) and TE241 (OECF/Noise Chart with 20 gray patches 10.000:1, ISO 14524, ISO 15739, contrast range of 10.000:1). The denotation of patches in some of the used OECF charts you find in chapter IV. Besides the default charts other designs and custom designs can be added on request.



TE240



TE241

6.1 Settings

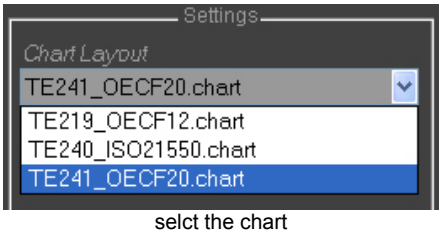
Before starting OECF analysis you have to define some settings.

Chart Layout

Select the Chart Layout File. It contains all neccessary information about the chart layout. Two of the default charts:

TE240_ISO21550.chart:
ISO 21550 Scanner Dynamic Range Chart; 24 gray patches with a maximal density of 4 or 6

TE241_OECF20.chart:
OECF/Noise Chart with 20 gray patches 10.000:1, ISO 14524, ISO 15739, contrast range of 10.000:1



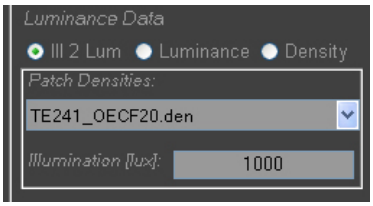
selct the chart

Luminance Data

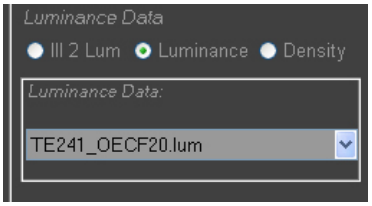
As the OECF is a function of digital number depending on the luminance of a target, you have to supply the actual luminance of each patch in [cd/m²]. You can choose between three methods:

- **Ill 2 Lum**: simple method, not quite accurate, no luminance meter required
- **Luminance**: most accurate method, complex measurement
- **Density**: used for devices with constant illumination, e.g. scanner

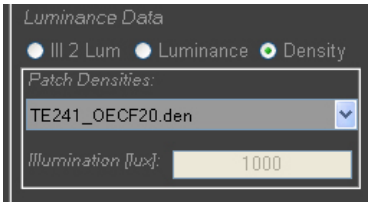
Note: Take care by using tele-photometers (e.g. Minolta LS). In dark patches the measured luminaces can differ because of stray light in lenses.



Ill 2 Lum



Luminance



Density

a) Ill 2 Lum (Illumination to Luminance)

Luminance is calculated from the illumination and the densities of the chart patches.

Patch Densities: choose the density file of the choosen chart, e.g.

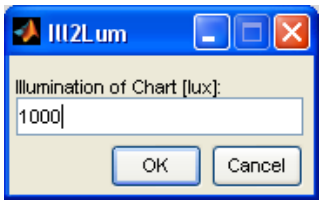
TE240_ChartNo1.den

myOECF20chart.den

In the “Advanced Settings” (see below) you can create own density files, import existing ones, make changes according to the datasheet which is delivered with the testchart and save them.

by using the button (in the Advanced Settings) you can create your own density files and/ or edit existing ones

Illumination [lux]: set the illumination of the chart. If you do not insert a value for illumination, a popup window will appear when you press the “Start” button.



popup appears if you do not have set illumination

b) Luminance

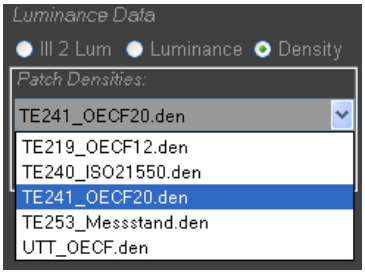
If there are already existing luminance data or the light source is not homogeneous, you can choose the direct method for setting luminance data.

Luminance Data: Select the file for luminance data. In the “Advanced Settings” (see below) you can import already existing luminance data, make changes and save them.

by using the button (in the Advanced Settings) you can create your ownluminace files and/ or edit existing ones

c) Density

OECF analysis is calculated directly with density. In the graphical results the OECF ist displayed depending on luminance, log luminance and density. This method is recommended for scanners.

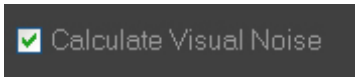


Patch Densities: choose the density file of the choosen chart, e.g. TE241_OECF20.den

In the “Advanced Settings” (see below) you can create own density files, import existing ones, make changes according to the datasheet which is delivered with the testchart and save them.

by using the button (in the Advanced Settings) you can create your own density files and/or edit existing ones

Calculate Visual Noise: you can choose, if visual noise also will be calculated, saved and displayed in the graphical result. This will increase the processing time.



Advanced Settings

By using the toggle button “**Advanced**“ the Advanced Menu opens. 

V/N – Ignore for Mean: used for average calculation of the visual noise (VN). It could happen, that more than one field is in full saturation. To reduce the influence of the number of fields in full saturation you can set the amount of fields ignored. (In saturated VN would be zero.)

- First/Last: The first and the last field will be ignored
- First2/Last2: The two first and two last field will be ignored
- None: All fields are taken into account

Measure temporal noise: activate if temporal noise also shall be calculated (possible if you have captured a miniumum of eight images). The ROI position is not corrected for each image as this would destroy the temporal noise information.

Ill 2 Lum Factor: Set the factor for calculation of luminance if you choose “Ill 2 Lum” for Luminance Data. The factor depends on the measurement setup and takes into account differences in the spherical illuminator and the measuring head. The Ill 2 Lum Factor does not have influence in the results and dynamic range.

The Ill2Lum Factor (illumination factor) is calculated by the formula

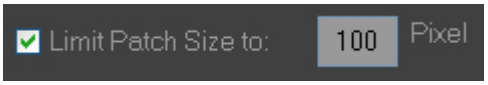
$$Ill2LumFactor = \frac{LUMINANCE}{\frac{ILLUMINATION}{\pi} * 10^{D}}$$

ILLUMINATION: illumination in the brightest patch
D: density of the brightest patch

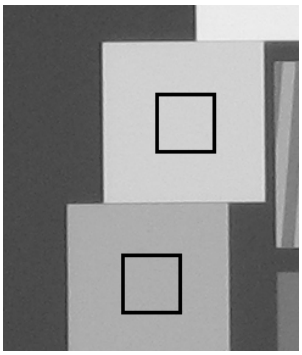
With the aid of this factor the luminance for every patch will be calculated.

$$LUMINANCE = \frac{\frac{ILLUMINATION}{\pi} * 10^{D}}{Ill2LumFactor}$$

Limit Patch Size to: To reduce calculation time you can limit the the size of the analyzed patches. The default value is 100 pixel. So 100x100 pixels will be evaluated in each patch.



limit the paztch size



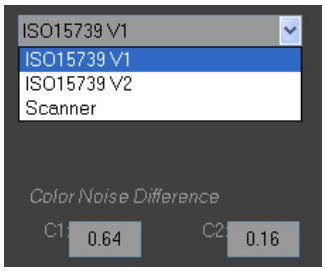
patch size for analyze

Color Noise Difference

For color images, the total noise σ total is calculated using the formula

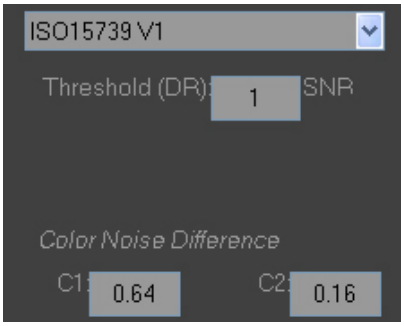
$$\sigma_{total} = \sqrt{\sigma_Y^2 + C_1\sigma_{R-Y}^2 + C_2\sigma_{B-Y}^2}$$

By using the dropdown menu you can select betwen the different versions of the ISO standards. The color noise difference coefficients C1 and C2 are changed automatically..

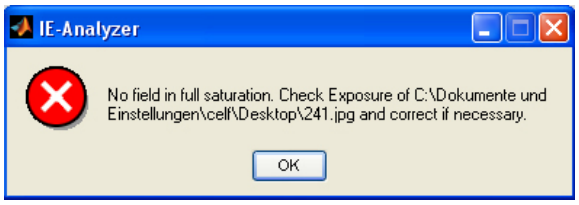


Noise coefficients based on ISO 15739:
ISO 15739 V1 (old version of ISO 15739): C1 = 0.64, C2 = 0.16
ISO 15739 V2 (new version of ISO 15739): C1 = 0.279, C2 = 0.088
SCANNER: equals to ISO 15739 V1

Threshold (DR, ISO V1): The Dynamic Range is calculated from the difference of the illumination needed to reach saturation on one side and the specific SNR (signal to noise ratio) on the other side. The standard use is SNR = 1. This may lead to problems due to processing. It might be increased.



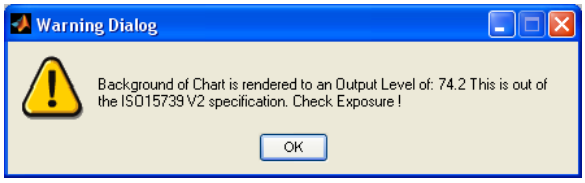
Warn of no Field in Saturation: if the checkbox is enabled a warning appears, if no field is in saturation



displayed warning

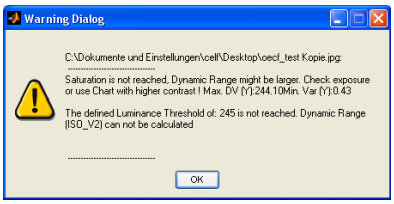
Saturation is Variance <: saturation means variance = 0 . If there is fixed pattern noise, the variance is greater than 0, but the image is saturated anyhow. You can set a tolerance value up to this saturation in one field can vary and is noted as saturated..

Check Background: in the new version of ISO 15739 the exposure is adjusted to the background with a digital value DV of 119 (range between 100 and 140) in sRGB. If the checkbox is enabled a warning appears, if the required values are not reached.



a warning appears if the reqired exposure values of 100-140 are not reached

Check number of saturated Patches: if more than three patches are in saturation a warning is displayed (important for calculation refering to the old version of ISO 15739)

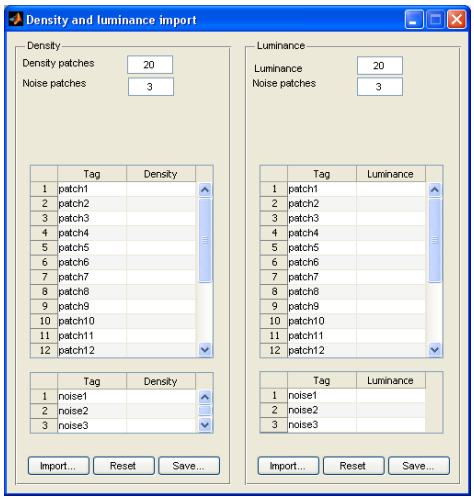


Luminance and Density Data

If you want to create new luminance and density data or edit existing ones use the button “Luminance and Density Data”.

An editing window appears.
left: setting Density
right: setting Luminance

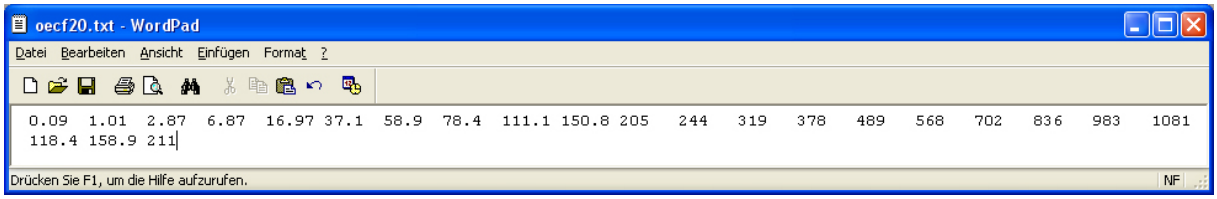
Depending on the chart, insert the number of patches used for **OECF** and used for **noise** measurement.



by using the button the Import/Editing

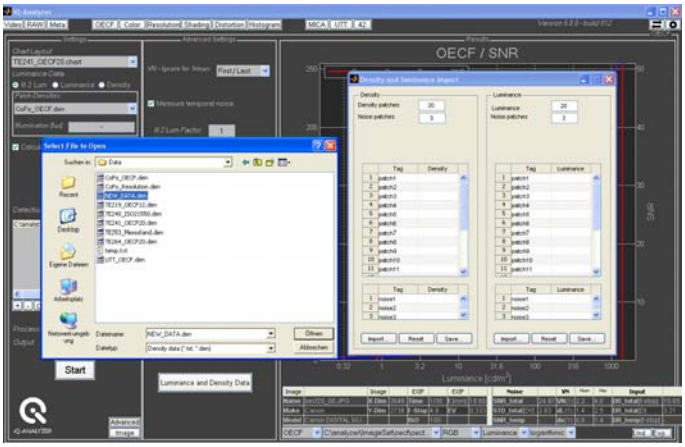
For every patch the density respectively luminance values have to be inserted. You can enter data either manually or use the “Import” button to import existing files (possible files are .den, .lum, .I20, .I12, .txt files for density and luminance). The structure of the txt files that can be imported has to be as follows:

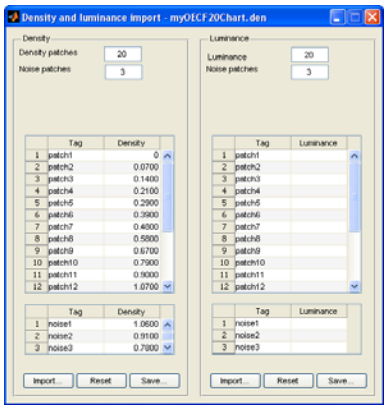
- First row: density/luminace values (decimal points) separated by using tabs
- Second row: values of the three noise patches (decimal points) separated by using tabs



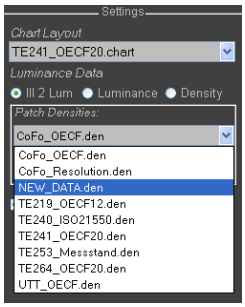
txt file of density/luminance data

You can save your settings by using the “Save” button and clear the list by using the “Reset” button. To use your created/ edited data, you have to save the data into the folder which is defined in the Settings (OECF Reference Data). The local folder “Data” is set as default. After saving, close the window and your new created density or luminance data will appear in the dropdown list.





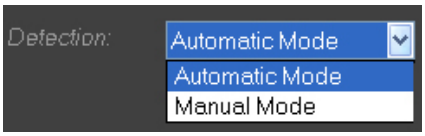
you can enter data manually, import and edit data



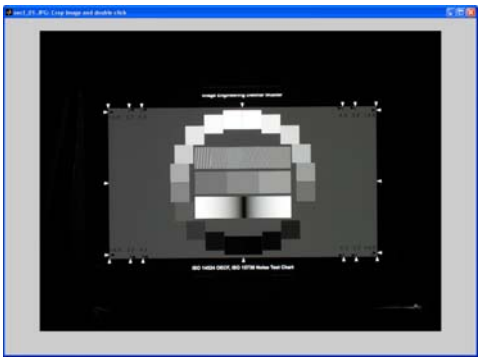
after saving data into the correct folder, your new data will appear in the dropdown list

Detection

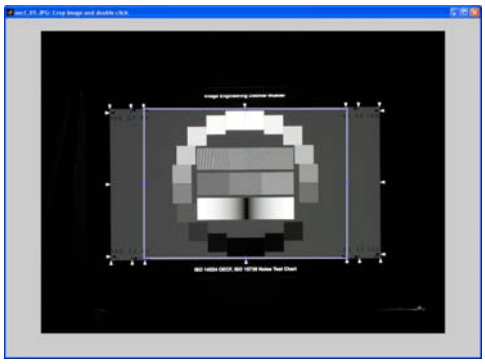
By using the dropdown menu you can choose if the ROI (region of interest) detection is done automatically ("**Automatic Mode**") or manually ("**Manual Mode**").



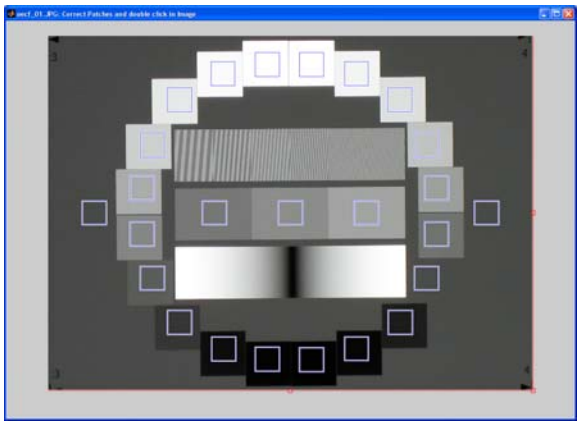
Manual Mode: After doing all settings, press the "Start" button. You can select the OECF chart by drawing a rectangle around the chart (aspect ratio 4:3) and double click on it or use the right mouse button and press "Crop Image". The ROIs are indicated by rectangles. "Activate" the rectangles by clicking the border. Now you can adjust the ROIs manually.



window for manual ROI detection



rectangle around the TE241 (aspect ratio 4:3)

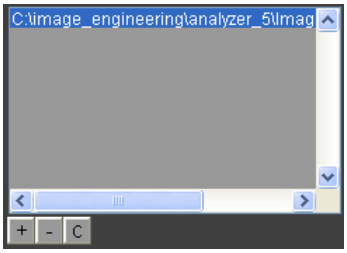


cut out TE241 and ROIs

When the manual adjustment of ROIs is done, double click on the image and the analyzing process starts.

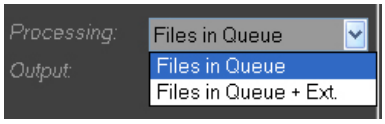
Files

Files for analysis have to be added to the built in file list using the " + " button. Delete selected files with the " - " button and clear the list with the " C " button.



Processing

Files in Queue: All added files will be analyzed

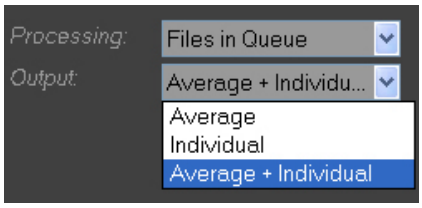


Files in Queue + Ext.: If you have made several pictures and named them with extensions (e.g. oecf_01, oecf_02, oecf_03, ...) you only have to add the image file with the lowest extension and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS. Use **Files in Queue + Ext.** if you have made an image series with same settings.

Output

By using the dropdown menu below the file list you can configure the output properties.

Average: the average results of the images and its following images are saved in the text file, if you have selected "Files in Queue + Ext"
Individual: separate results for every image are saved in the text file
Average+Individual: the average and separate results are saved



If all settings are made press the " **Start** " button to run the analysis of the image(s).

6.2 Analyzing process and graphical presentation

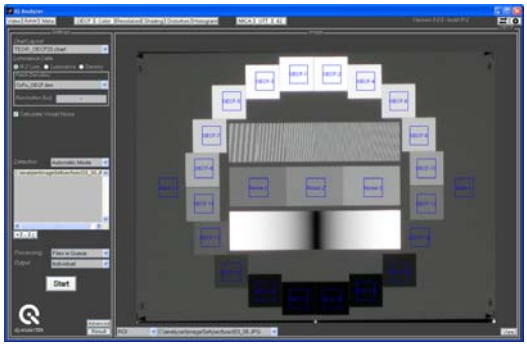
6.2.1 General

Having done the setup up you can press the "**Start**" button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results and an image with marked ROIs are saved automatically as text and JPEG files (depending on your export settings made in the "Setting" tab above). Using the "Stop" breakes the analyzing process.

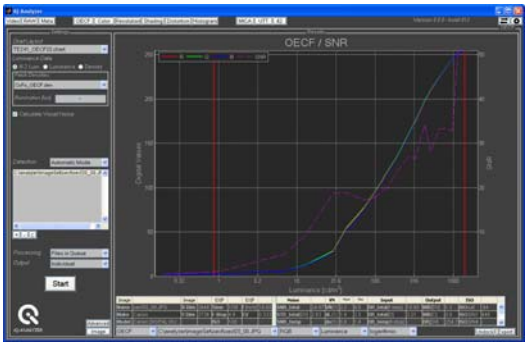
progress bar and Stop button

By pressing the "**Image**" button below the file list the image of the selected image file is displayed. After analyzing you can switch between "**Image**" and "**Result**" view.

"Image" and "Result" button



"Image" view



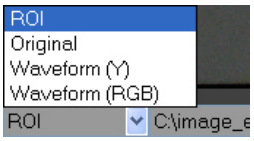
"Result" view

By pressing the "**View**" button in the lower right corner of the "Image" view, the image opens in a new window and enables viewing the file content e.g. zooming in/out. This "View" is used for visual analysis and should be reviewed at 100%.

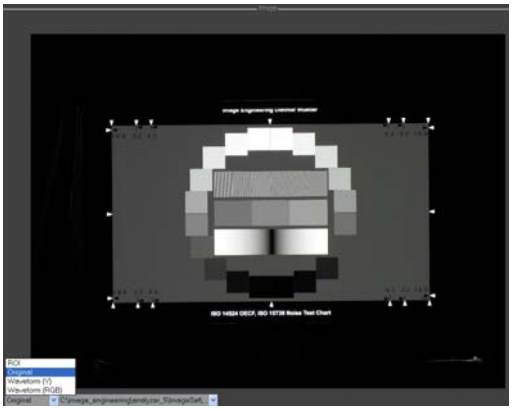
"View" button

editing window and the image in a new window

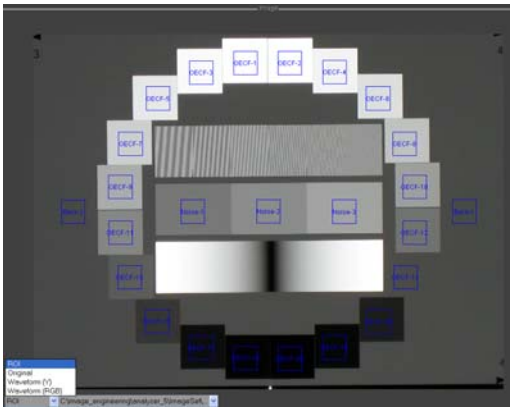
In the “Image” View you can choose the representatoin of the **Original** image or the **ROI** (region of interest) by using the dropdown menu.



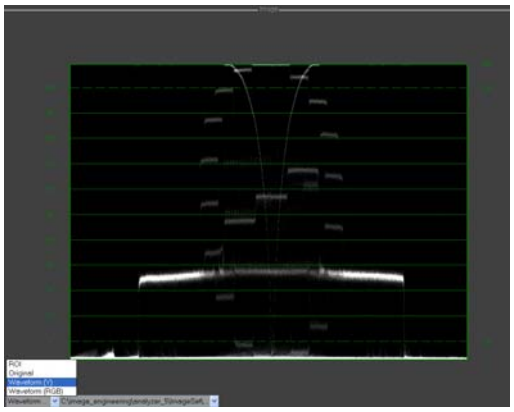
dropdown menu in “Image View”



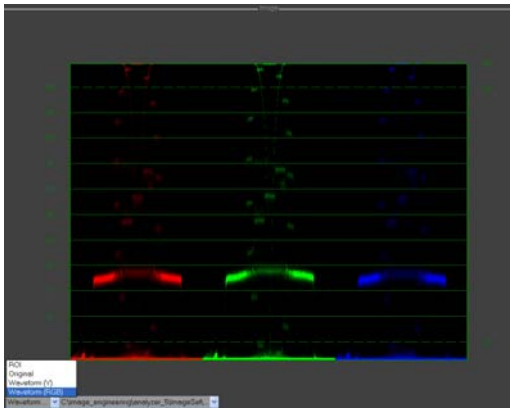
Original



ROI with marked patches



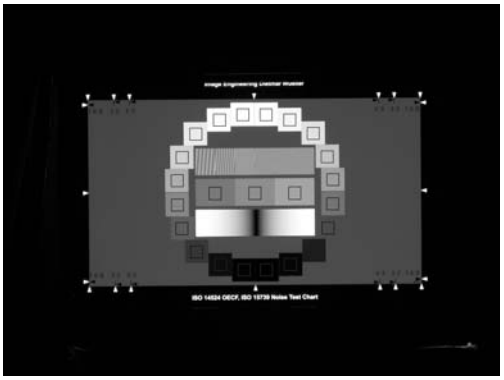
Waveform (Y)



Waveform (RBG)

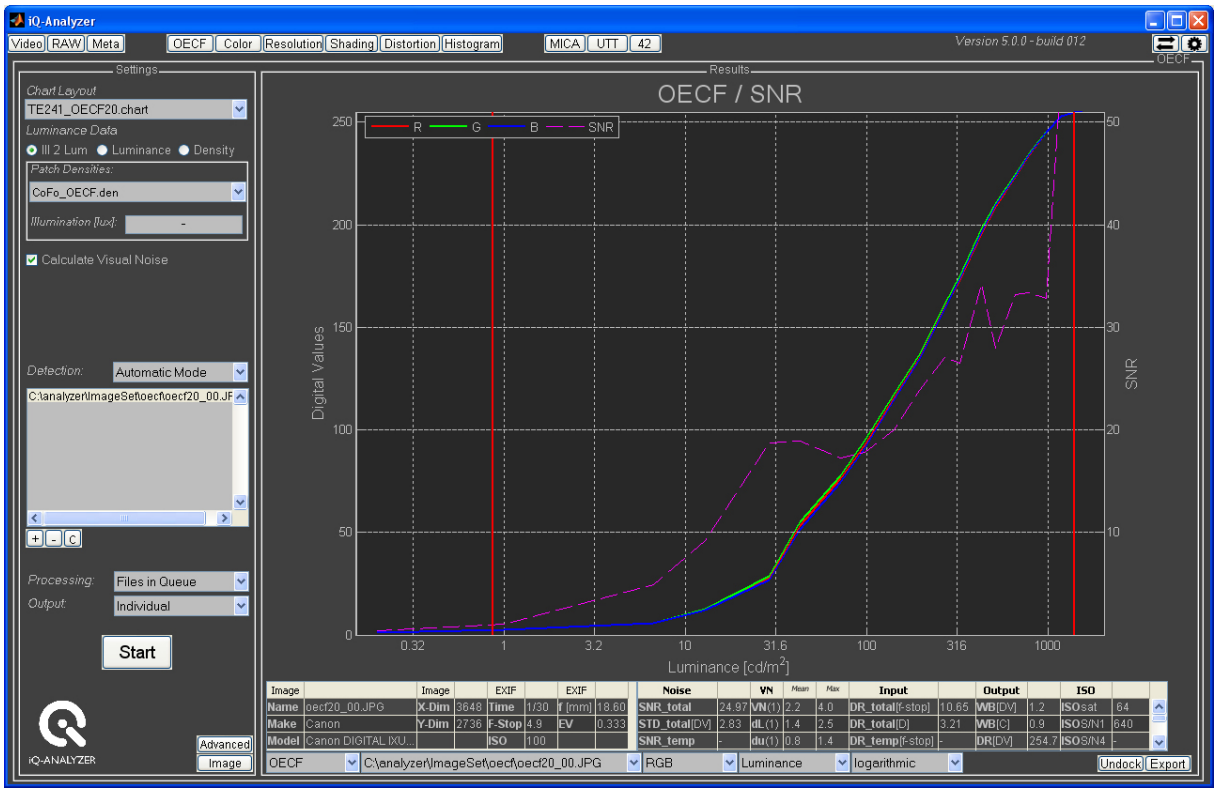
The waveform visualized the distribution of luminace values (Y) and RGB values in the image. The image is read line by line (x-axis) and the luminance values are outlined as percental (left y-axis) or digital values (right y-axis). The brighter the graph the higer the appearance of the luminance value. The RGB waveform displays the the distibution each for R, G and B values.

An image, named with the extension “filename_**check**” is saved automatically. In this image the ROIs are marked. Path for saving and image quality can be defined in the “Setting” tab.



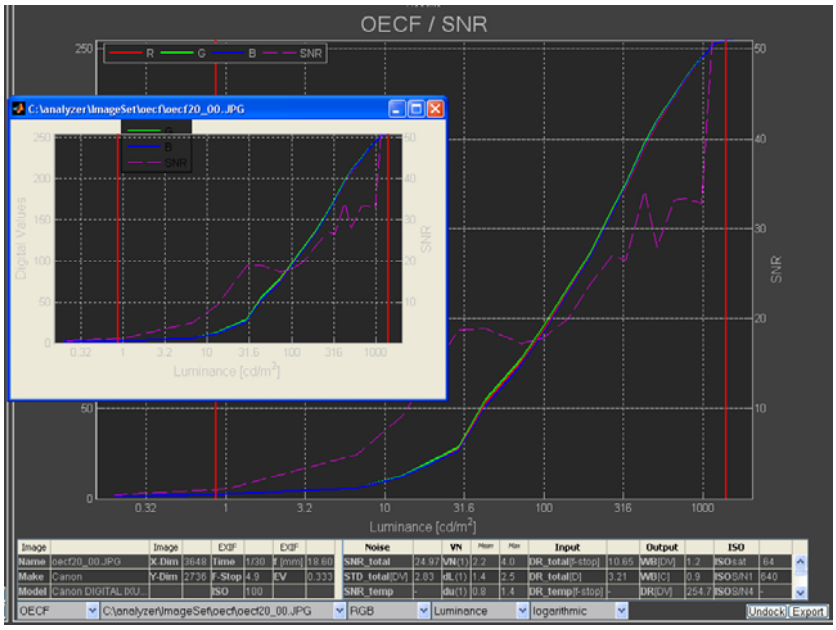
automatically saved image with marked ROIs

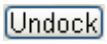
By pressing the “Result” button, the graphical and numerical results are displayed in the right screen.



settings (left screen) graphical results (right screen)

Undock: The graphical result is displayed in a new window. This can be used to compare different settings.

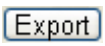




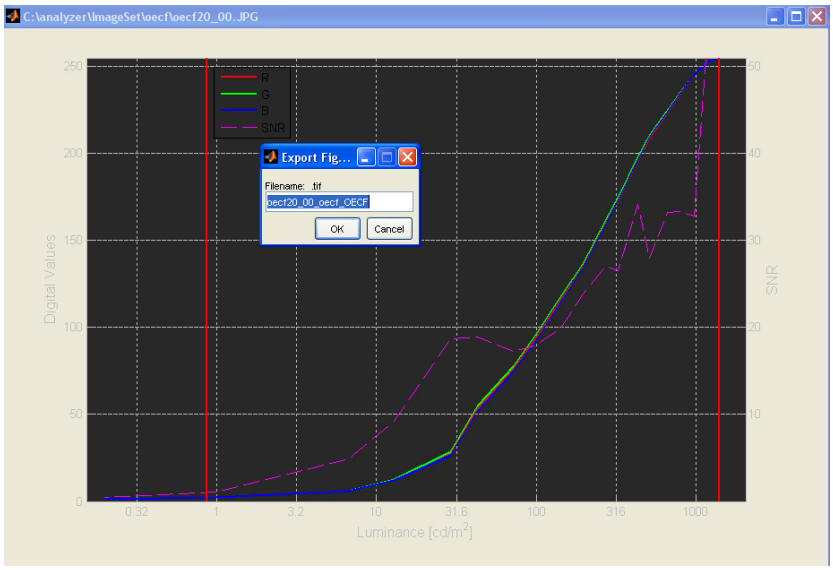
“Undock” button

the undocked window

Export: The result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “Setting“ tab above.



“Export” button



the undocked window and saving options

6.2.2 Numerical and graphical results

Below the graph **two tables** are shown.

I EXIF (exchangeable image file format) data

Image		Image		EXIF		EXIF	
Name	cam2_oecf20 iso 1...	**X-Dim**	2816	**Time**	1/30	**f** [mm]	17.40
Make	Canon	**Y-Dim**	2112	**F-Stop**	4.9	**EV**	0.000
Model	Canon DIGITAL IXU...			**ISO**	00		

II RESULTS

Noise		VN	Mean	Max	Input		Output		ISO	
SNR_total	31.77	**VN**(1)	1.9	3.3	**DR_total** [f-stop]	10.85	**WB** [DV]	1.3	**ISO**sat	320
STD_total[DV]	2.24	**dL**(1)	1.2	2.3	**DR_total** [D]	3.27	**WB** [C]	0.9	**ISO**S/N1	2500
SNR_temp	-	**du**(1)	0.7	1.2	**DR_temp** [f-stop]	-	**DR** [DV]	254.1	**ISO**S/N4	-
STD_temp[DV]	-	**dv**(1)	0.5	1.0	**DR_temp** [D]	-				
SNR_fp	-	**VN**(2)	1.1	1.9						
STD_fp[DV]	-	**dL**(2)	0.6	1.1						
		du(2)	0.5	0.8						
		dv(2)	0.3	0.5						
		VN(3)	1.4	2.4						
		dL(3)	0.8	1.5						
		du(3)	0.6	1.0						
		dv(3)	0.3	0.7						

Noise

SNR is defined as the ratio of the net signal value to the standard deviation of the signal value. iQ-Analyzer calculates a Y (luminance) image and uses this for further calculations. The results are also indicated as digital values **[DV].**

Two results are calculated: **ISO_V1** (old version of ISO 15739) and **ISO_V2** (new version of ISO 15739). The two results are different regarding the calculation of noise and exposure. ISO_V1 uses the three noise patches, ISO_V2 measures noise at the defined luminance value.

ISO_V2 – new Version of ISO 15739: For the focal plane OECF the reference exposure shall be determined as the log exposure value corresponding to a digital level of 245 on the focal plane OECF curve. The total, fixed pattern and temporal signal to noise ratios are measured at the luminance value that is 13% of the luminance at the reference exposure

$$L_{SNR} = 0.13 * L_{ref}$$

Lref is the inverse logarithm of the log luminance value at the reference exposure *Rref.*

Rref is the log luminance value at the reference exposure

$$R_{ref} = S^{-1}(I)\big|_{I=245}$$

SNR_total

Total noise means all unwanted variations captured by a single exposure.

The signal to noise ratio is determined by

$$SNR_{total} = \frac{L_{SNR} * gain_{incremental}}{\sigma_{total}}$$

$$\sigma_{total} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} \sigma^2{}_{total,i}}$$

σ_{total} is the standard deviation of the total noise (**STD_total**)

SNR_temp

Temporally varying noise means random noise due to the sensor dark current, photon shot noise, analogue processing and quantization, which varies from one image to the next.

If you have captured a minimum of eight images in a single session, the temporal SNR is calculated, too. The temporal SNR is determined by measuring the standard deviation of the difference of each image and the average image (minimum of eigt images) and applying a correction to determine the true level of the temporal noise.

$$SNR_{temp} = \frac{L_{SNR} * gain_{incremental}}{\sigma_{temp}}$$

σ_{temp} is the standard deviation of the temporal noise (**STD_temp**)

$$\sigma_{temp} = \sqrt{\frac{n}{n-1}\sigma^2_{diff}}$$

σ_{dif} average standard deviation of the code values of all the differences of the average and the individual images that make up the average.

SNR_fp

Fixed pattern noise means unwanted variations which are constant for every exposure.

The ISO standard camera fixed pattern SNR is determined by

$$SNR_{ISO\_FP} = \frac{L_{SNR} * gain_{incremental}}{\sigma_{fp}}$$

$$\sigma_{fp} = \sqrt{\sigma_{ave}^2 - \frac{n}{n-1}\sigma_{diff}^2}$$

σ_{fp} standard deviation of the fixed pattern noise (**STD_fp**)

σ_{ave} standard deviation of the code value of the average of "n" images

σ_{diff} average standard deviation code values of all the differences of the average and the individual images that make up the average.

Visual Noise (VN)

The numerical value for the Visual Noise is a weighted sum of the standard deviation of each channel in the CIE-Luv colorspace. To give further insight into the noise characteristics, we also provide these values (for all three viewing conditions that can be specified in the **Settings**):

VN: weighted sum of standard deviations in CIE-Luv

dL (delta L): standard deviation in L

du (delta u): standard deviation in u

dv (delta v): standard devition in v

Input (referred results)

New version of ISO 15739 (V2)

The ISO DSC (digital still camera)dynamic range is the ratio of the maximum unclipped luminance level to the minimum luminance level that can be reproduced with a signal to temporal noise ratio of at least 1. In order to avoid black level clipping problems, the camera dynamic range is obtained by measuring the camera signal to noise ratio using a 2.0 density "black reference". The dynamic range is determined as the ratio between the saturation luminance level (L_{sat}), and the minimum luminance level (L_{min}).

$$ISO.DSC.dynamicrange = \frac{L_{sat}}{L_{\min}}$$

The value for L_{min} shal be calculated as

$$L_{\min} = \frac{\sigma_{temp}(2.0)}{incremental.gain}$$ for temporal noise and

$$L_{\min} = \frac{\sigma_{total}(2.0)}{incremental.gain}$$ for total noise

σ_{temp} (2.0) is the black tempral noise measured at density of 2.0. The black temporal noise is derived by measuring the standard deviation of the difference of each image and the average image, and then applying a correction to determine the true level of the temporal noise

$$\sigma_{temp} = \sqrt{\frac{n}{n-1}\sigma_{diff}^2}$$

σ_{temp} is the standard deviation of the temporal noise

σ_{diff} is the average standard deviation of the code values of all three differences of the average and the individual images that make up he average

σ_{total} (2.0) is the black totall noise measured at density of 2.0

$$\sigma_{total} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\sigma^2{}_{total,i}}$$

In the table you get results for DR_total (dynamic range total) in f-stops and density - old and new version of ISO 15739 - and DR_temp (dynamic range temporal) - only new Version of ISO 15739.

Old version of ISO 15739 (V1)

The given dynamic range is the difference of the luminance that leads to saturation and the luminance that leads to SNR of 1 (or the Threshold that is defined in the Advanced Settings).

$L_{sat} – L_{SNR} = X$

X = Threshold (1)

SNR = 1 (or the value defined in the Advanced Settings)

Output (referred results)

WB [DV]: Whitebalance represented in digital values. The mean difference between Red-Green and Blue-Green. As the chart is perfect gray the ideal would be 0.

WB: average of the CIE-C (chrominance) values

DR[DV]: dynamic range explained in digital values means the difference between mean digital value of the last patch (i.e. patch 20) and mean digital value of patch 1. Ideal would be 256 (8 bit)

ISO

The ISO speed is calculated. There are three different definitions in the ISO standard. The idea is to measure the light intensity on the sensor which leads to a specific result in the image:

Saturation based: ISOsat

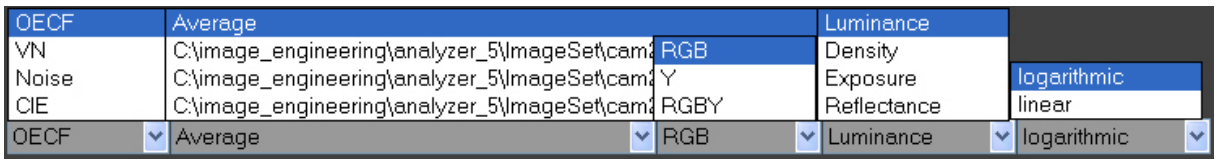
The ISO speed is calculated on the light intensity that is needed to reach saturation.

Noise based: ISO S/N10 / ISO S/N40

The ISO speed is calculated on the light intensity that is needed to reach a signal to noise ratio of 40 (first excellent) or 10 (first acceptable)

Note: To get reliable results form the ISO speed measurement, you should make sure that the "Luminance Data" is set correctly, we strongly recommend to measure the luminance on each patch directly, so to specify a .lum file rather than a .den file and the illumination. Under some circumstances the effective aperature can differ significantely from the numerical aperature, so make sure that you have specified the focal-lenght and the object distance in the "Meta" module.

Below the graph some **drop down menus** exist. The first one allows choosing the **result** you want to be displayed (OECF, Visual Noise VN, Noise, CIE). In the file list (left screen) you can select the different images. By using the second drop down menu you can choose between result representation of the particular image file (file path is shown) and representation of the average ("**Average**") if you have selected "Files in Queue + Extension" and "Average" in the output properties below the file list. By using the third dropdown menu you can make a selection which components shall be displayed in the graph - color components **RGB**, the luminance **Y** or all **RGBY**. The fourth dropdown menu allows choosing the representation depending on luminance, density, exposure, reflectance. The further menus are depending on the previous ones.

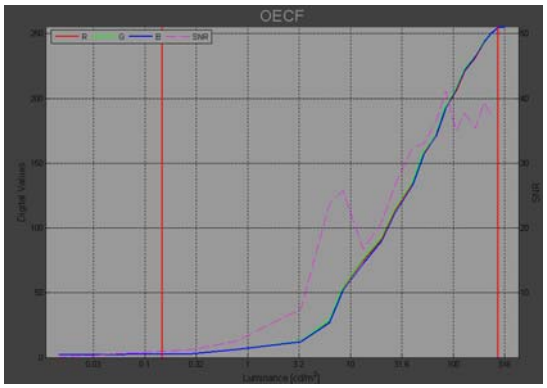


dropdown menu

Results

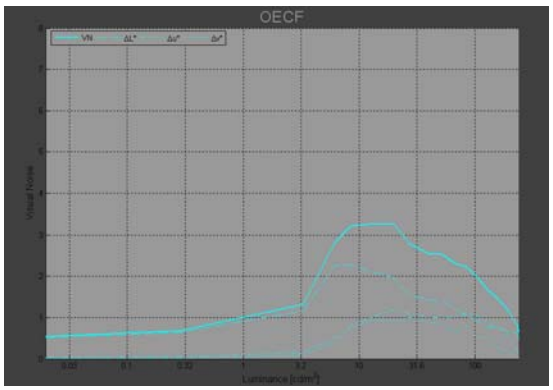
OECF

The OECF of the analyzed image(s) are shown. It is a function of the digital number depending on the luminance. The two red vertical lines show the dynamic range of the device. Settings for the dynamic range can be made in the **Advanced Menu** (the lower limit you define in “Threshold”).



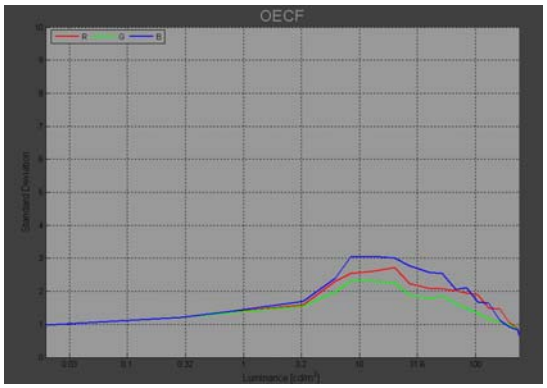
VN

The Visual Noise for the three Viewing Conditions are displayed that are defined in the “Settings”.



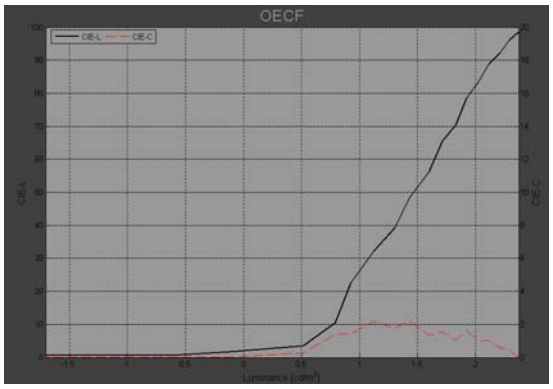
Noise

Noise diplayed as Standard Deviation**.** The Standard Deviation is defined as the square root of the absolute value of the sum of variances from the signal region.



CIE

Presentaion of luminance L and chrominance (saturation) C, defined in the CIE LCH color space. The colorspace is in the form of a sphere with the three axes L, C and H (hue, colortone). The L axis is vertical; from 0 which has no lightness at the bottom, through 50 in the middle to 100 which has maximum lightness at the top. The C axis ranges from 0 at the center of the circle, which is completely unsaturated (i.e. a neutral gray, black or white) to 100 at the edge of the circle for maximum chroma or saturation.



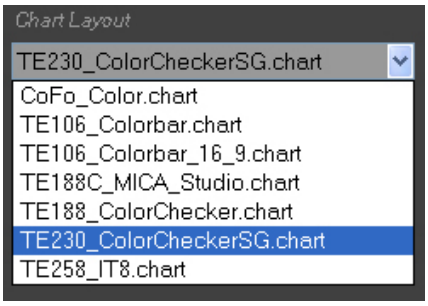
7. COLOR

In the COLOR module you can analyze images for their color reprodroduction quality. You should consider that a perfect color reproduction could, but does not have to, lead to a “nice looking” image. The color charts, e.g. the ColorChecker SG, have to be illuminated homogeniously. Some of the used COLOR charts are shown in chapter IV.

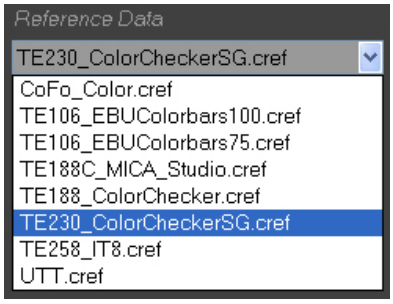
“Color” tab

7.1 Settings

Before starting COLOR analysis you have to define some settings.



setting “Chart Layout” in Color menu



setting “Reference Data” in Color menu

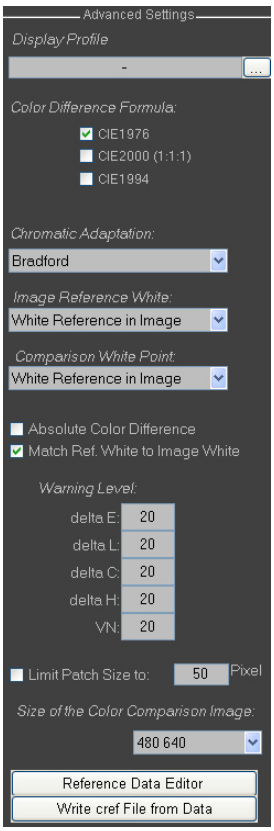
Chart Layout: select the Chart Layout file by using the dropdown menu. It contains all neccessary information about the chart layout.

Reference Data: reference file for the color charts. By using the dropdown menu you can choose the reference data of the chart you would like to analyse. In the Advanced Menu (see below) you can edit existing or create new reference data.

Calculate Visual Noise: you can choose, if visual noise also will be calculated, saved and displayed in the result. 

Advanced Settings

By using the toggle button "**Advanced**" the Advanced Menu opens.



Display Profile: By using the " ... " button select an icc./icm. profile for your display (important for the presentation of color differences). If no display profile is selected, sRGB is used.

Color Difference Formula: iQ-Analyzer calculates two Lab data sets, the reference and the image sample. From this data the color difference Delta E is calculated.

You can choose between three methods and formulas for calculation of color differences (most common is CIE1976):

1) CIE1976

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

$$\Delta L = L_{reference} - L_{sample}$$
$$\Delta a = a_{reference} - a_{sample}$$
$$\Delta b = b_{reference} - b_{sample}$$

If you express the Lab in polar coordinates you get **LCH**, where L is the luminance, **C** the chrominance (saturation) and **H** the hue (colortone). **Delta E** indicates the overall difference between reference and sample. To get more detailed information about the difference it is interesting to see the difference in Luminance (**Delta L**) and hue (**Delta H**).

$$\Delta L = L_{reference} - L_{sample}$$
$$\Delta C = C_{reference} - C_{sample}$$
$$\Delta H = \sqrt{(\Delta a)^2 + (\Delta b)^2 - \Delta C^2}$$

2) CIE2000 (1:1:1)

$$\Delta E = \sqrt{\left(\frac{\Delta L}{k_L S_L}\right)^2 + \left(\frac{\Delta C}{k_C S_C}\right)^2 + \left(\frac{\Delta H}{k_H S_H}\right)^2 + R_T\left(\frac{\Delta C}{k_C S_C}\right)\left(\frac{\Delta H}{k_H S_H}\right)}$$

Compared to CIE1994 (see next method) the rotation term is added as the fourth element. This term only takes effect in blue region.

3) CIE1994

$$\Delta E = \sqrt{\left(\frac{\Delta L}{k_L S_L}\right)^2 + \left(\frac{\Delta C}{k_C S_C}\right)^2 + \left(\frac{\Delta H}{k_H S_H}\right)^2}$$

in iQ-Analyzer the following parameters for graphic and photography are used:

$k_L = k_C = k_H = 1$

$S_L = 1$

$S_C = 1 + 0.045C_{sample}$

$S_H = 1 + 0.015C_{sample}$

Chromatic Adaption

Since the Lab TIFF specification, the ICC profile specification and Adobe Photoshop all use a D50, 2° standard observer basis for Lab, all of the working spaces that are not similarly defined have been adapted from their native reference white to D50 using different methods. The chromatic adaptation algorithms may all be implemented as a linear transformation of a source color (X_S, Y_S, Z_S) into a destination color (X_D, Y_D, Z_D) by a linear transformation [M] which is dependent on the source reference white (X_{WS}, Y_{WS}, Z_{WS}) and the destination reference white (X_{WD}, Y_{WD}, Z_{WD}):

$$[X_D\ Y_D\ Z_D] = [X_S\ Y_S\ Z_S]\ [M]$$

The idea behind all of these algorithms is to follow three steps:

1. Transform from XYZ into a cone response domain (ρ, γ, β).
2. Scale the vector components by factors dependent upon both the source and destination reference whites.
3. Transform from (ρ, γ, β) back to XYZ using the inverse transform of step 1.

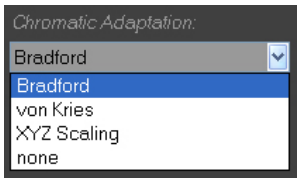
These steps are represented by the three matrices:

$$[M] = [M_A] \begin{bmatrix} \rho_D / \rho_S & 0 & 0 \\ 0 & \gamma_D / \gamma_S & 0 \\ 0 & 0 & \beta_D / \beta_S \end{bmatrix} [M_A]^{-1}$$

$$[\rho_S \quad \gamma_S \quad \beta_S] = [X_{WS} \quad Y_{WS} \quad Z_{WS}][M_A]$$

$$[\rho_D \quad \gamma_D \quad \beta_D] = [X_{WD} \quad Y_{WD} \quad Z_{WD}][M_A]$$

By using the dropdown menu you can choose a method for chromatic adaption. The differences among the three methods lie in the definition of the cone response domains [M_A].



Bradford: The Bradford method is the newest of the three methods and is considered by most experts to be the best of them. This is the method used in Adobe Photoshop.

von Kries: use von Kries for chromatic adaption

XYZ Scaling: XYZ Scaling is generally considered to be an inferior chromatic adaptation algorithm. Incidentally, this is the method that would result from transforming the source XYZ color to Lab using (X_{WS}, Y_{WS}, Z_{WS}) followed by conversion back to XYZ using (X_{WD}, Y_{WD}, Z_{WD}).

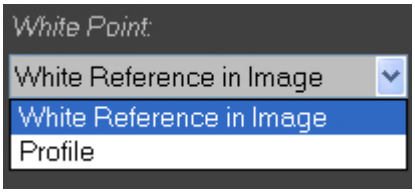
none: no chromatic adaption method is used

Method	$[M_A]$			$[M_A]^{-1}$		
XYZ Scaling	1.0 0.0 0.0	0.0 1.0 0.0	0.0 0.0 1.0	1.0 0.0 0.0	0.0 1.0 0.0	0.0 0.0 1.0
Bradford	0.8951 0.2664 -0.1614	-0.7503 1.7135 0.0367	0.0389 -0.0685 1.0296	0.986993 -0.147054 0.159963	0.432305 0.518360 0.049291	-0.00825 0.040043 0.968487
Von Kries	0.40024 0.70760 -0.08081	-0.22630 1.16532 0.04570	0.00000 0.00000 0.91822	1.859936 -1.129382 0.219897	0.361191 0.638812 -0.000006	0.000000 0.000000 1.089064

definition of the cone response domains of the three methods for chromatic adaption

White Point

By using the dropdown menu you can choose the image white point which is required for transfoming XYZ to Lab.



dropdown menu for Image Reference White

White Reference in Image: the white patch in the image is used as white point
Profile: the white point saved in the image profile is used as white point

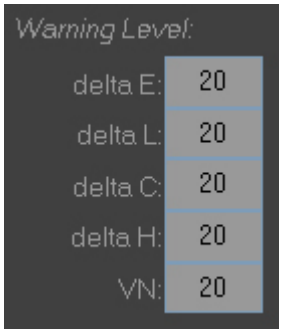
Note: The profile is defined in the 'Color Space' option in the META section. E.g. if you select sRGB the sRGB profile is used.

Absolute Color Difference: select this check box if you want to get results with absolute values (absolute values only represent the amount of color diferences, not the direction)

Match Ref. White to Image White: If enabled, the white patch of the Color Chart is forced to become Lab (100,0,0)

Warning level

By inserting values for delta E, L, C, H and VN (visual noise) you can scale the color bar right to the graphical results.

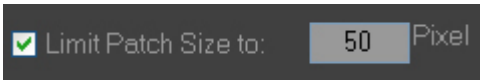


warning level

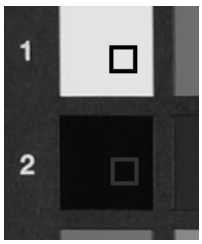
color bar

Limit Patch Size to

To reduce calculation time you can limit the the size of the analyzed patches. The default value is 50x50 pixel.

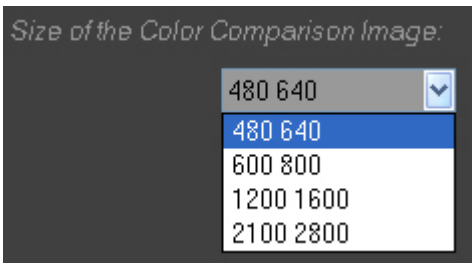


limit the paztch size

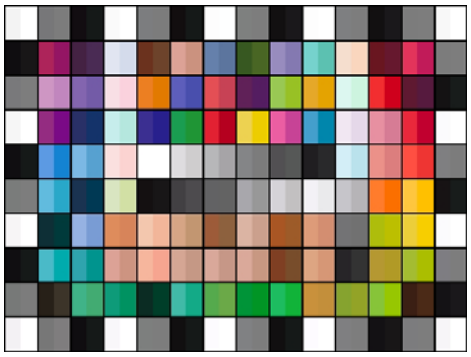


patch size for analyze

Size of the Color Comparison Image: in the COLOR module a color comparison image is saved during the calculation. You can choose the size of this comparison image.



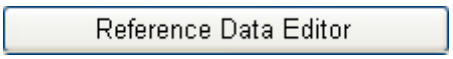
dropdown menu for Color Comparison Image



Color Comparison Image

Edit/Create Reference Data

By using the button you can edit existing reference data or create new ones. Insert your own values or import existing files by using the “Import ...” button.



use the button to open the editing window

Pressing this button will start a wizard helping you to edit existing reference data or create new dataset.

Select action: Choose between creating a new reference dataset or opening an existing .cref file.

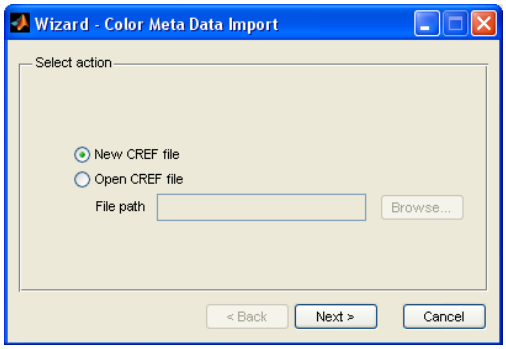
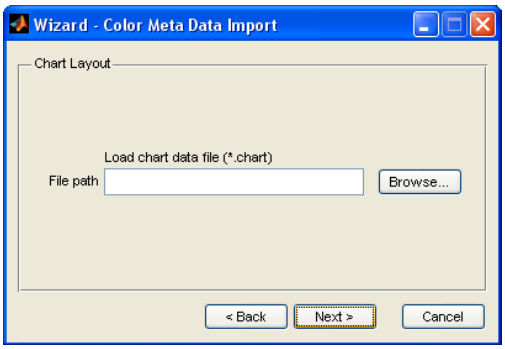
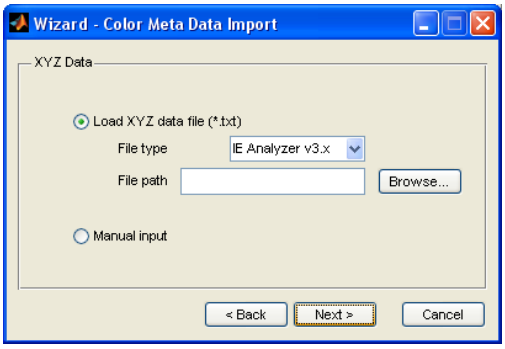


Chart Layout: Load chart layout data file (*.chart) matching your chart to create new dataset. You will find these files in the *Chart* folder of your Analyzer installation.



XYZ Data: You can load XYZ data from a text file or put it in manually. Supported data formats are iQ-Analyzer v3.x files, eyeOne/eyeOne Pro files or custom file formats. The measurement order for the IT-8 charts must be row by row.



Custom XYZ File Format: If your XYZ dataset is available in a custom file format you need to provide information about the file structure. It concerns the number of header and footer lines, number of a column containing patch names as well as a delimiter character. Note that the data must be ordered in a table form.

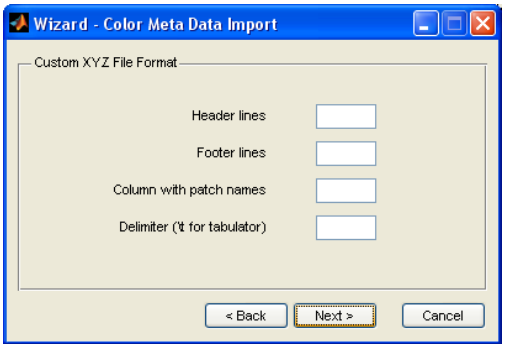
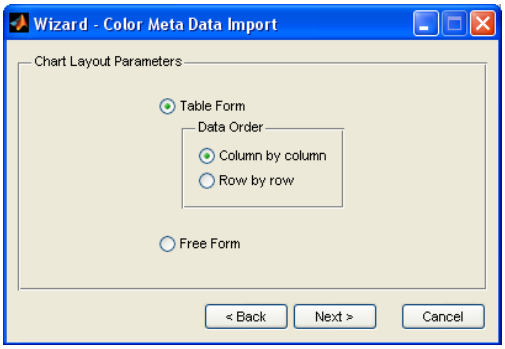
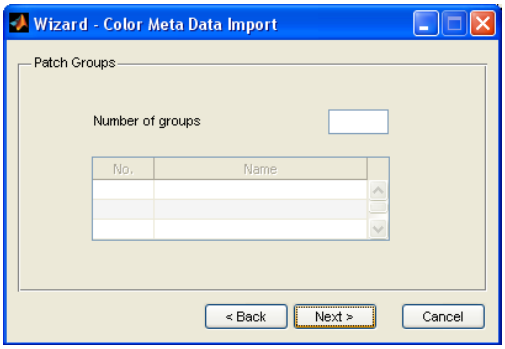


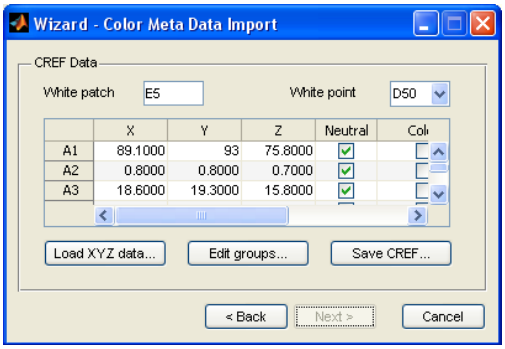
Chart Layout Parameters: If the patches on your chart are ordered in a table form (e.g. Color Checker), select how data was obtained. Choose between *Column by column* and *Row by row* depending on the order the data was measured.



Patch Groups: You can create groups (e.g. *SkinTones*, *Glossy*) and assign them to the patches. Creating a new dataset the group *Neutral* will be created automatically and the *Color* group will be created while saving the file. Therefore these names are reserved and must not be used.



CREF Data: Here you can see and edit the reference data. If you have chosen to open existing reference file in the beginning you will immediately see this dialog.



Define or edit reference white patch which is used as white reference for further calculations and set the white point (D50, D55, D65, A, C).

Fill in or change XYZ data typing the values into the table.

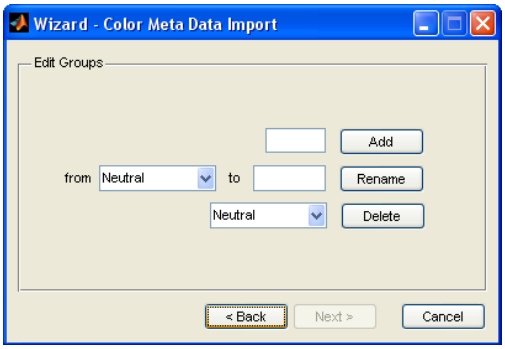
To assign a group to a patch click on the corresponding check box. Note that saving your file, a group *Color* will be created or updated, containing all the non-neutral patches referring to the check boxes in the *Neutral* column.

To load new or another XYZ dataset from a file use the *Load XYZ data...* button.

To edit groups press *Edit groups...* button. You will be able to add, remove and rename your groups.

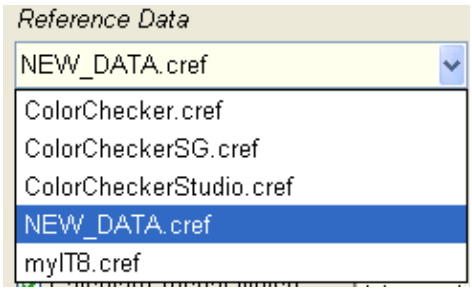
When done save your reference file by pressing *Save CREF...* button.

Edit Groups: You can add a new group putting its name into the empty field and pressing *Add*. To rename or remove a group choose it from the list, give it a new name in case of renaming and confirm your action with *Rename* or *Delete* respectively. Return to the *CREF Data* dialog pressing the *Back navigation* button.



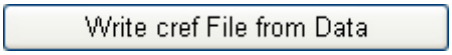
In order to use the edited/created data, they have to be saved into the folder which is defined in the “Settings” (Color Reference Data). The local folder “Data” is set as default.

After closing the editing window you can select your new reference data in the dropdown menu



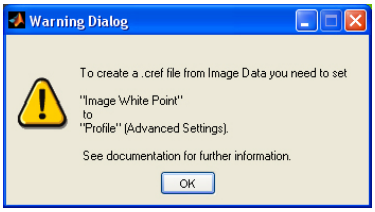
dropdown menu with the new reference data

Write cref File from data

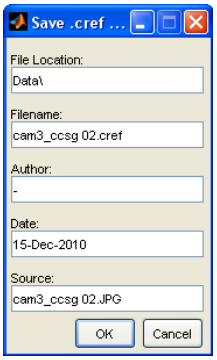


If you want to match all cameras in your studio or if you want to describe objectively how a new image pipeline changed the colors. You can make one camera or one setup to your "golden master" and compare how well another camera or other settings match these values.

First analyze the reference image. “White Point” has set to “Profile”. These make sure that the image data is not changed due to chromatic adaptations. Otherwise a warning dialog appears.



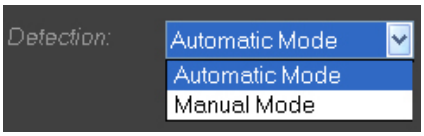
Then write cref file from data. Press the button “Write cref File from Data” and a little window will pop up. Make your settings and press "O.k.". You should save the file at the current location of all the other .cref files. so these can be read in directly in the pop-up menu.



Select cref file as new reference. Directly after you have saved the new c.ref file, you can select this file in the Reference file Menu (Reference Data). Now you can make your measurements as you are used to do. Add files to the list and press "Start". What you get is the difference of your master against the current image.

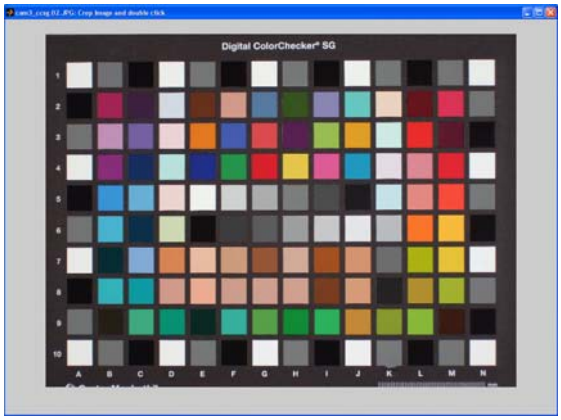
Detection

By using the dropdown menu you can choose if the ROI detection is realized automatically ("**Automatic Mode**") or manually ("**Manual Mode**").

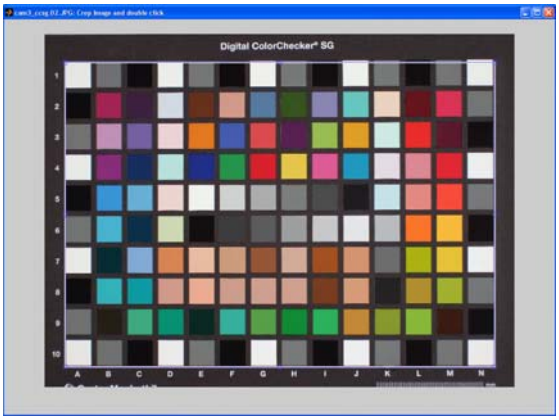


dropdown menu ROI detection

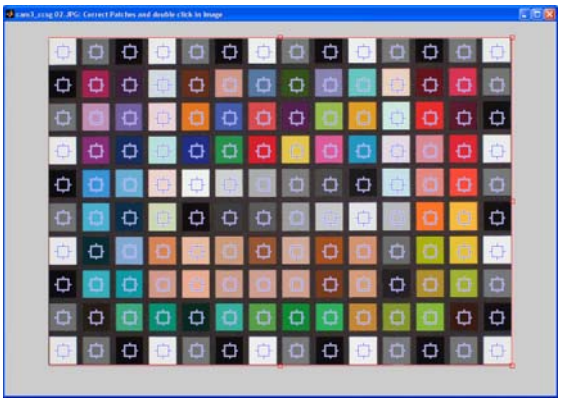
Manual Mode: After doing all settings, press the "Start" button. You can select the color chart by drawing a rectangle around the chart and double click on it or use the right mouse button and press "Crop Image". The ROIs are indicated by rectangles. "Activate" the rectangles by clicking the border. Now you can adjust the ROIs manually.



window for manual ROI detection



rectangle around the ColorChecker SG

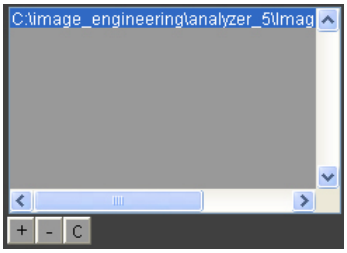


cut out ColorChecker and ROI

When the manual adjustment of ROIs is done, double click on the image and the analyzing process starts.

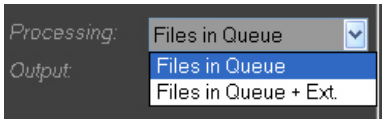
Files

Files for analysis have to be added to the built in file list using the " + " button. Delete selected files with the " - " button and clear the list with the " C " button.



Processing

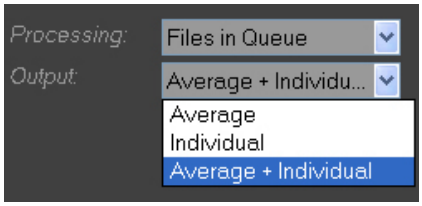
Files in Queue: All added files will be analyzed



Files in Queue + Ext.: if you have made several pictures and named them with extensions (e.g. colorchecker_01, colorchecker_ 02, colorchecker_ 03, ...) you only have to add the image file with the lowest extension and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS. Use **Files in Queue + Ext**.if you have made an image series with same settings.

Output

By using the dropdown menu below the file list you can configure the output properties.



Average: the average results of the images and its following images are saved in the text file, if you have selected "Files in Queue + Ext"

Individual: separate results for every image are saved in the text file

Average+Individual: the average and separate results are saved

If all settings are made press the " **Start** " button to run the analysis of the image(s).

7.2 Analyzing process and graphical presentation

7.2.1 General

After having done the setup up you can press the "**Start**" button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results and two images (filename_check.jpg with ROIs and the color comparison image filename_color.jpg) are saved autimatically as text and JPEG files (depending on your export settings made in "Setting"). Using the "Stop" breakes the analyzing process.

progress bar and Stop button

By pressing the "**Image**" button below the file list the image of the selected image file is displayed. After analyzing you can switch between "**Image**" and "**Result**" view.

"Image" and "Result" button

"Image" button

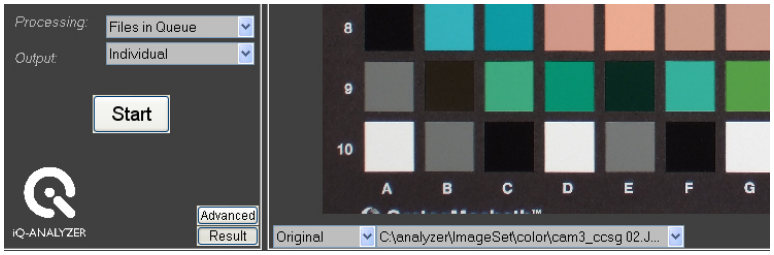
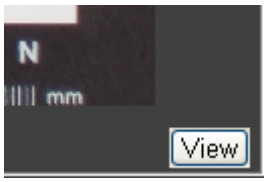


image of the selected image file

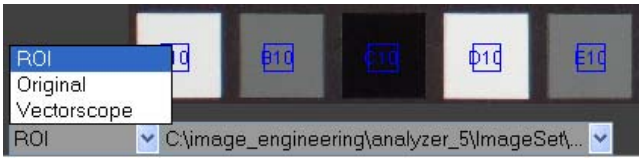
By pressing the "**View**" button in the down right corner of the "Image" view, the image opens in a new window and gives a 100% view to the image for visual analysis.



“View” button

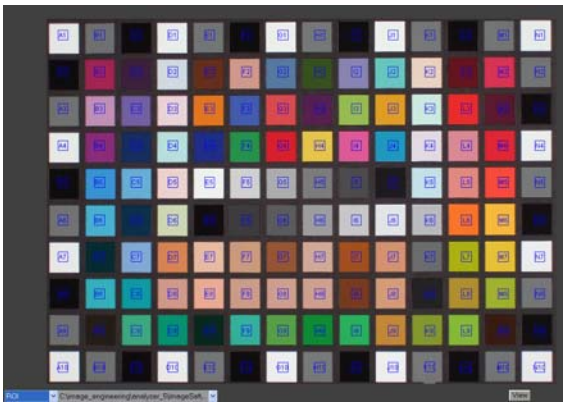
editing window and the image in a new window

In the “Image View” you can choose the representatoin of the **Original** image or the **ROI** by using the dropdown menu.

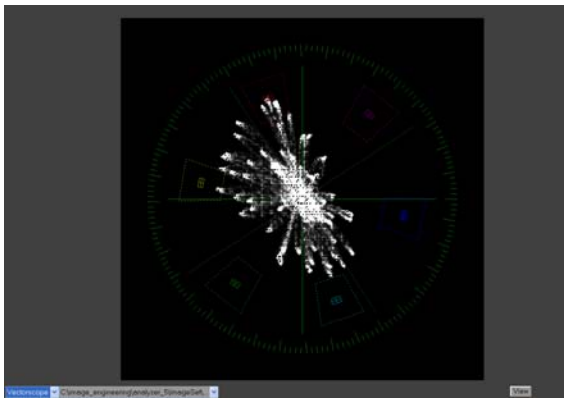


dropdown menu in “Image View”

Original



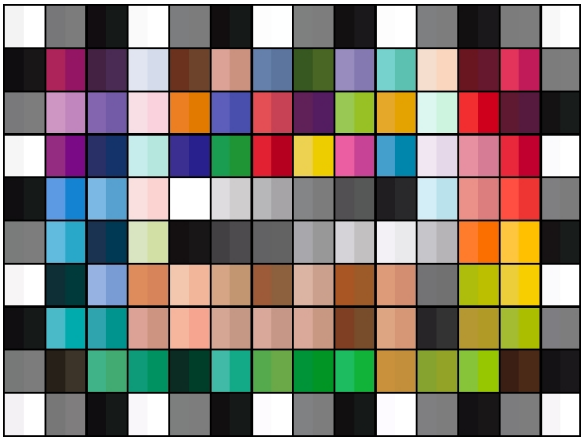
ROI



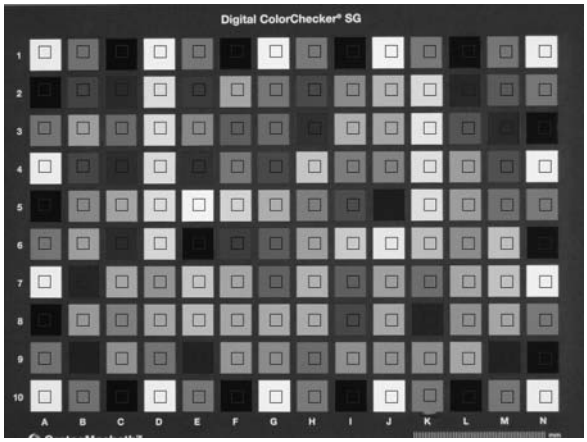
Vectorscope

Vectorscope: The color vectors are displayed optically in a circular scale. The higher the color saturation the farther away from center is the shown chromaticity coordinate. Achromatic tones result points in the center.

Two images, named with the extension “filename_**check**” and “filename_**color**” are saved automatically. One image shows the color comparison and one the marked ROIs. Path for saving, image quality and size of the comparison image can be defined in the “Setting” tab.

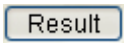


saved image with color comparison “filename_color.jpg”

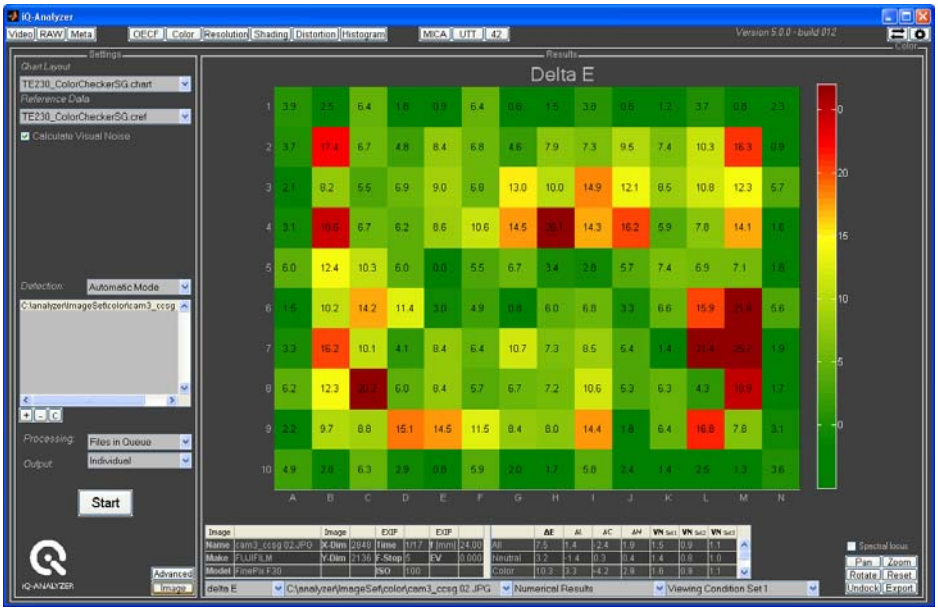


saved image with marked ROIs “filename_check.jpg”

By pressing the “Result” button the results (graphical and numeric) are displayed in the right screen.

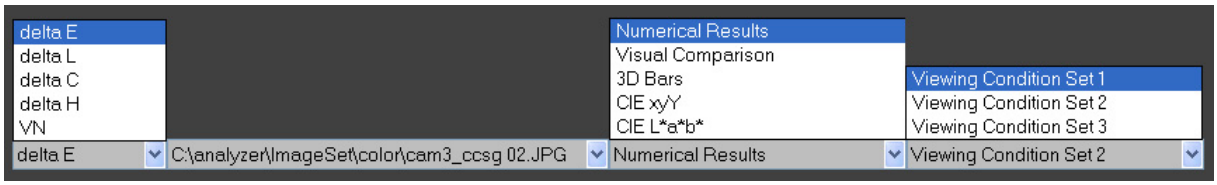


Result button



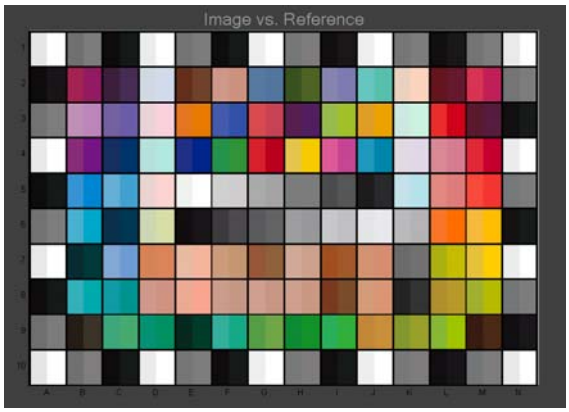
settings (left screen) graphical and numerical results (right screen)

By using the left dropdown menu below the illustration you can choose which results shall be displayed (delta E, delta L, delta C, delta H, Visual Noise).



dropdown menu for graphical representation

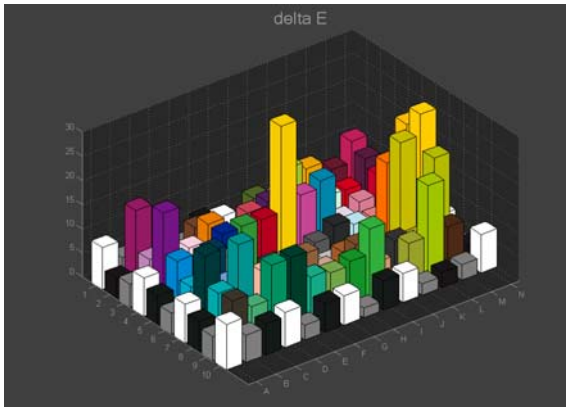
By using the second drop down menu you can choose between result representation of the particular image file (file path is shown) and representation of the average ("**Average**") if you have selected "Average" in the output properties below the file list on the left side. By using the third dropdown menu you can choose between displaying **Numerical Results, Visual Comparison** (Image vs. Reference), **3D Bars, CIE xyY** and **CIE L*a*b***. The values of the **warning scale** can be defined in the Advanced Settings. The right dropdown menu enables switching between the three defined viewing condition sets.



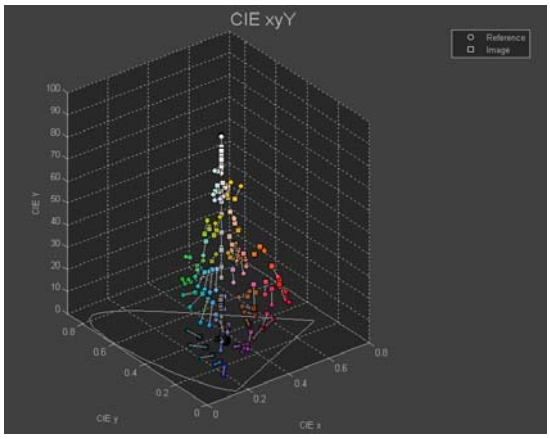
Visual Comparison

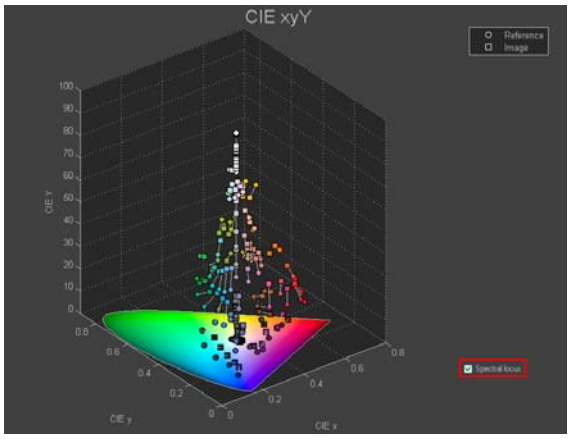
Numeric Results and the Warning Scale

The illustration "3D Bars" display the Delta E values of the color patches in a three-dimensional way.

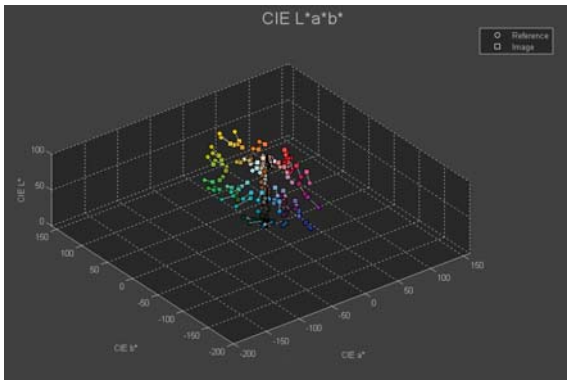


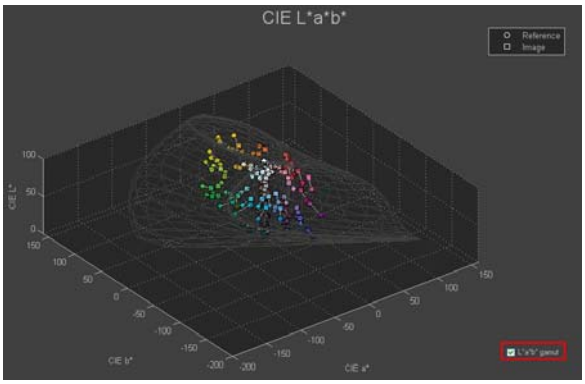
3D Bars





CIE xyY: The color patches of the image (square) and the reference (circle) are displayed in the CIE xyY colorspace, where x and y are the chromaticity coordinates and Y the luminance. If the checkbox “Spectral locus” is enabled the CIE 1931 color space chromaticity diagram is also shown.





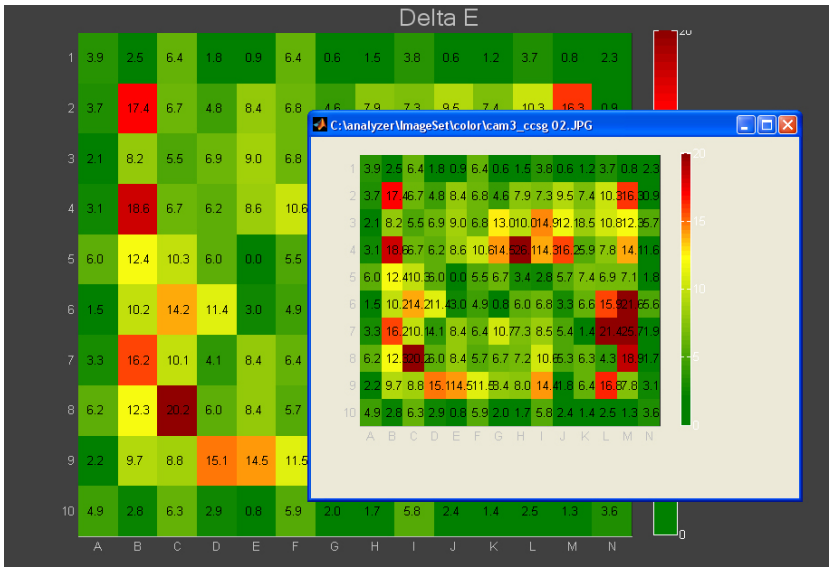
CIE L*a*b*: The color patches of the image (square) and the reference (circle) are displayed in the CIE L*a*b*. L* is the luminance (L* = 0 yields black and L* = 100 indicates diffuse white), a* describes the position between red/magenta and green (negative values indicate green while positive values indicate magenta), b* describes the position between yellow and blue (b*, negative values indicate blue and positive values indicate yellow). If the checkbox “L*a*b* gamut” is enabled the L*a*b* gamut is also shown.

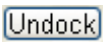
By using the “Zoom” Button you can zoom in (left mouse click on the graph) and zoom out (right mouse click on the graph. The graph can be adjusted horizontally and vertically by using the “Pan” button first than adjusting the graph with the mouse pointer (in the shape of a hand.)

Using the mouse the graph can be rotated. The cursor looks like a circle.
Reset button: Back to starting position

Cursor

Undock: The graphical result is displayed in a new window.

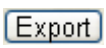




“Undock” button

the undocked window

Export: The result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “Setting“ tab..



“Export” button

the undocked window and saving options

7.2.2 Numerical and graphical results

EXIF data and umerical results are arranged below the illustration.

Image		Image		EXIF		EXIF	
Name	cam3_ccsg 02.JPG	X-Dim	2848	Time	1/17	f [mm]	24.00
Make	FUJIFILM	Y-Dim	2136	F-Stop	5	EV	0.000
Model	FinePix F30			ISO	100		

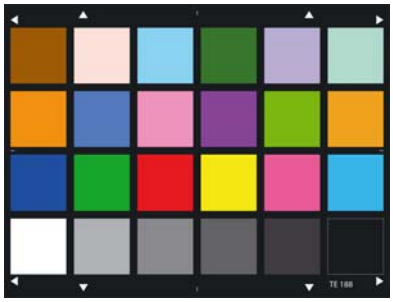
EXIF data

	ΔE	ΔL	ΔC	ΔH	VN Set1	VN Set2	VN Set3
All	7.9	-1.6	-3.5	1.9	1.5	0.8	1.0
Neutral	4.9	-4.2	0.0	0.1	1.4	0.8	1.0
Color	9.9	0.1	-5.9	3.1	1.6	0.9	1.1
CC	9.0	0.6	-4.6	2.1	1.5	0.9	1.1
Skin	5.4	0.4	-1.2	-0.1	1.6	0.9	1.1

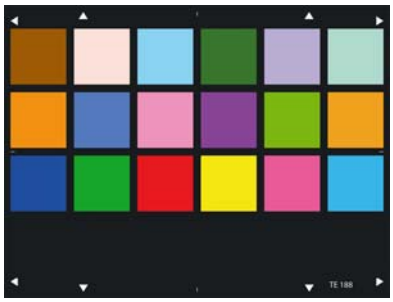
numerical results

The average values for Delta E, L, C, H and for the visual noise (VN), depending on the three in the Avanced Menu defined viewing condition sets (VN Set1, VN Set2, VN Set3), are displayed. The charts can be divided into groups which are defined in the .cref file. Examples of groups:

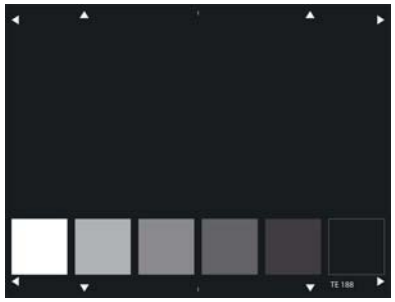
ColorChecker



ColorChecker “**All**”

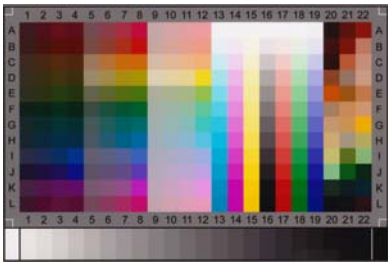


ColorChecker “**Color**”

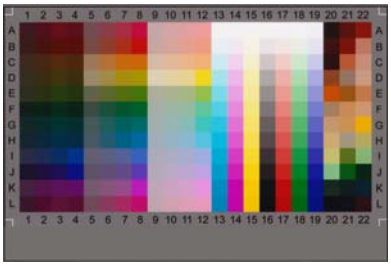


ColorChecker “**Neutral**”

IT8



IT8 “**All**”

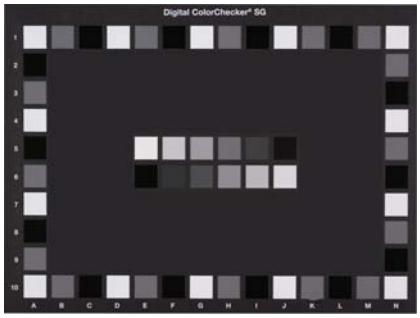


IT8 “**Color**”

IT8 “**Neutral**”

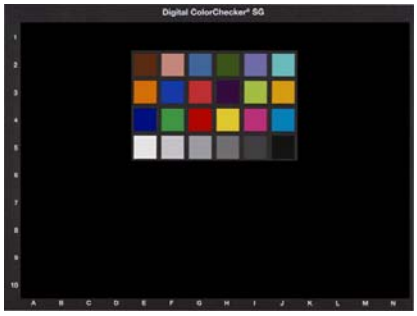
ColorChecker SG

All - all patches of the ColorChecker SG are part of calculation

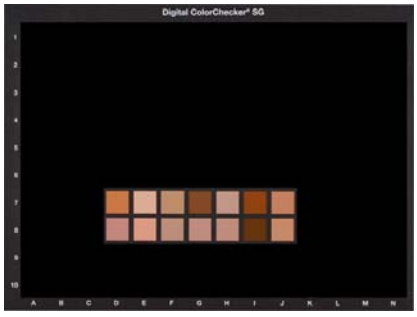


Neutral - only the neutral patches are part of calculation

Color - all patches except neutral patches are part of calculation



CC - patches of ColorChecker are part of calculation



Skin - skin tone patches are part of calculation

8. RESOLUTION

The RESOLUTION module enables you to measure the resolution of a digital camera system. Depending on the used test chart you get the SFR (spatial frequency response) of siemens stars, of edges and information about reproduction of low contrast fine details using patches showing noise.

"Resolution" tab

The charts have been illuminated homogeneously, the camera should be filxed on a tripod to minimize motion blur. Be aware that a lot of different settings in the camera influenece the resolution (e.g. compression, sharpness enhancement, iso-speed). Set them carefully. The denotation of patches in some of the used RESOLUTION charts you find in chapter IV.

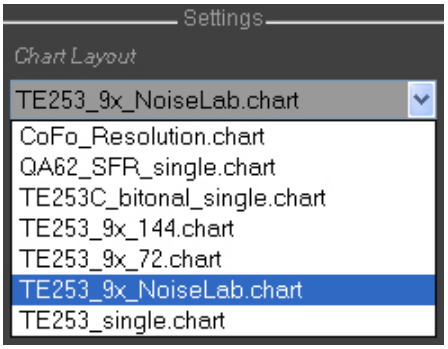
8.1 Settings

Before starting analysis of the RESOLUTION charts you have to define some settings.

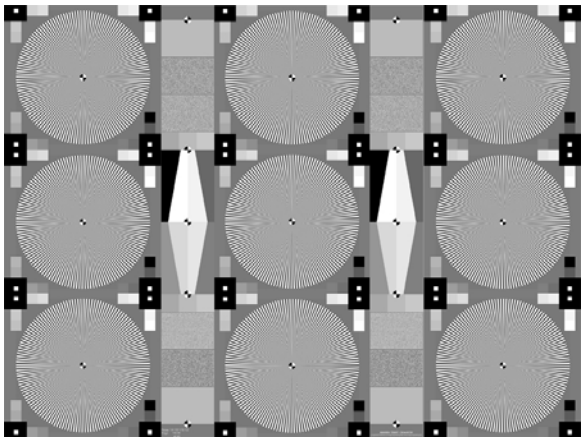
Chart Layout

Select the layout of the chart you want to analyze. Amongst others the following charts can be analyzed:

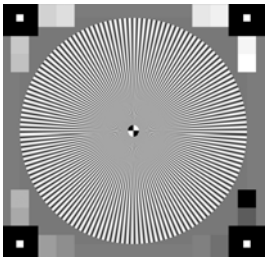
TE253_9x_NoiseLab.chart: use if the image shows all nine siemens stars, edges and white noise patches
TE253_single.chart: use if you only want to analyze a single siemens star (TE253)
QA-62_single.chart: SLANT EDGE TARGET / Scanner SFR & OECF



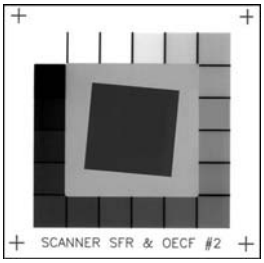
dropdown menu for chart layout



TE253 9x + NoiseLab



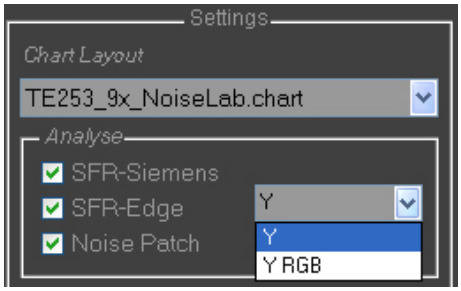
TE253 single



QA-62

Analyse

Depending on the choosen chart, you can select the structure(s), which shall be part of calculation.



Analyse checkboxes depending on selected charts

SFR-Siemens: spatial frequency response of the Siemens star(s). The aim is to get a system MTF.

SFR-Edge: spatial frequency response resulting from analysis of an edge

Noise Patch: the four noise patches (gaussian noise: σ = 1/4, σ = 1/8, σ = 1/16, σ = 1/2) are analyzed to get information about texture reproduction.

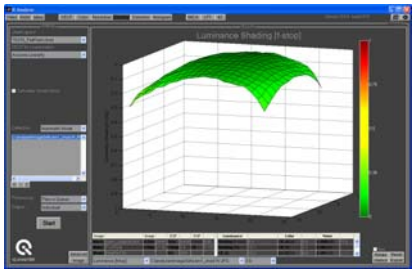
By using the dropdown menu you can decide if analysis is made on luminance values **(Y)** or on luminance and RGB values **(Y RGB)**.

For every analyzed structure you can make settings by using the “Advanced” button. 

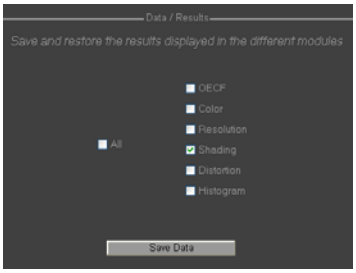
Reduce Shading

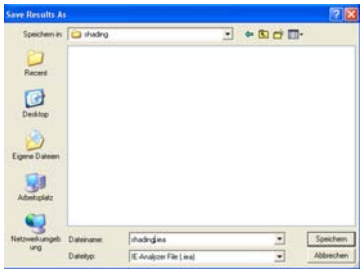
In case of strong shading you have the opportunity to use a shading correction based on the shading measurement. Using this method produces better results for stron shading.

Make a shading calculation in the **Shading module** and export the results by using the **Export/Import** button. Import the saved shading data and resolution is calculated with shading correction.

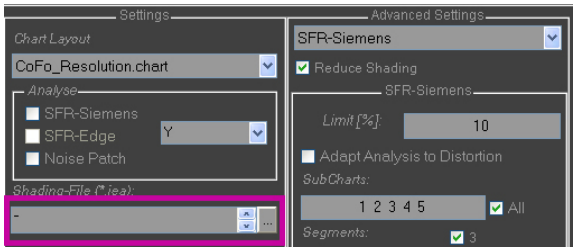


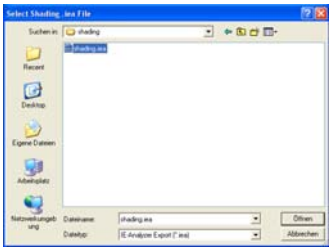
Make shading calculation in the Shading module

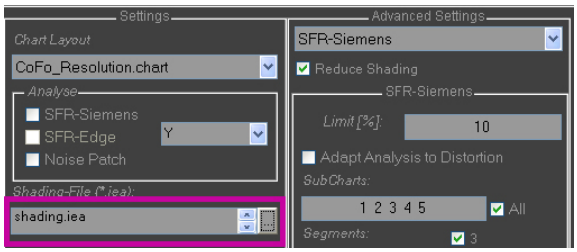




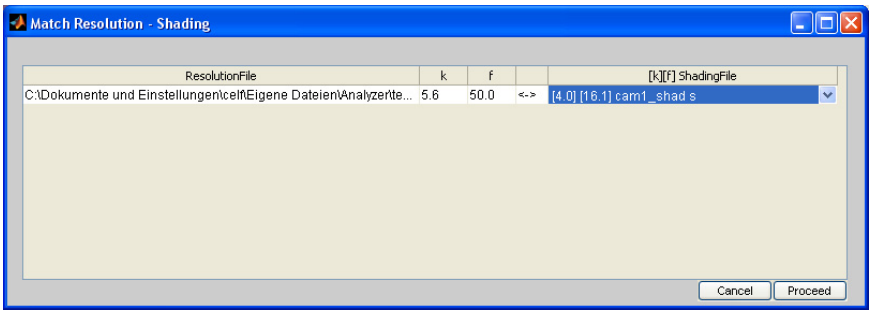
Save the shading data by using the Export/Import button





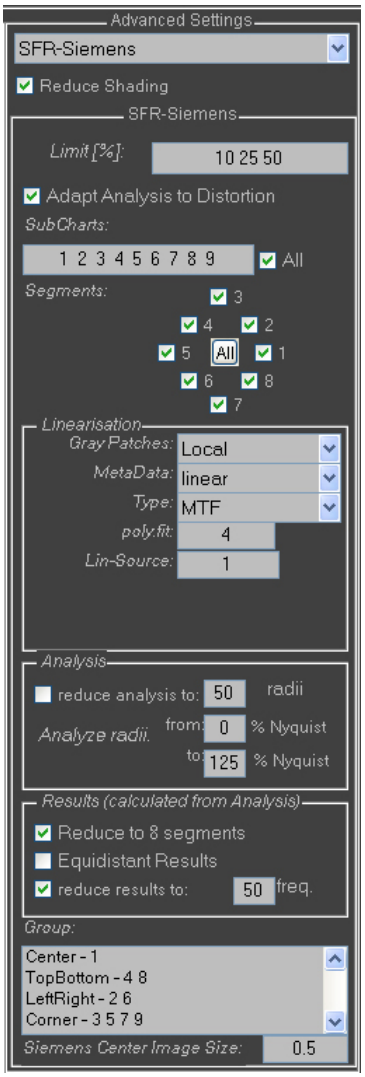


Select the shading data and start the analyzing process



A window appears that shows a list of selected resolution files with information about fstop (k) and focal length (f). Use the popup menu on the right to match the resolution file with its corresponding shading file and press Proceed.

I Advanced Settings SFR-Siemens



Limit [%]: iQ-Analyzer calculates a limiting resolution from the MTF data, which is the frequency that leads to a modulation as specified. iQ-Analyzer does a linear interpolation to determine the frequency. Common values are 10% for limit and other like MTF25 or MTF50. Frequencies derived from the SFR data based on these modulation. E.g. “50” equals a MTF50 value (the modulation is 50% at this frequency). Default is “10 25 50”, so three values are calculated MTF10, MTF25 and MTF50.

Adapt Analysis to Distortion: if the checkbox is marked, the analysis can be adapted to the distortion of the chart; the image is unchanged. iQ-Analyzer can detect and correct the influence of distortion. Disable to accelerate the calculation. Recommended is to activate “Adapt Analysis to Distortion”. If activated, iQ-Analyzer multiplies the radii with a measured correction factor, so it ensures that the analysis is done on the right position in the image.

SubCharts: select the subcharts (stars) you would like to analyze. If “All” is enabled, all posible subcharts are listed. For declaration of the subcharts see chapter IV “TE253 / TE253 9x”.

Segments: select the segments you would like to analyze. If “All” is enabled, all eight segments are part of calculation.

Linearisation

Most cameras for photography use have a non-linear response to luminance in the scene. This is called gamma function and tries to adjust the image to the human eyes reception of light. To analyze an image, this function should be inverted, also called the image shall be “linearized”. This is done by reading the gray patches in the chart, creating an OECF (Opto Electronic Conversion Function) and inverting this function.

You can define the patches that should be basis for OECF calculation.

Gray Patches

Local: use gray patches in each subchart

Global: Use one set of gray patches for complete image (define the set in “Global Source”)

None: No linearisation will be applied for calculation.

Note: In version 3 only center patches were used (global, # 1). Now you can use all patches.

MetaData

Linear: assume gray patches to be linear

den. files: you can select a file with patch densities for linearization

Type

Defines the aim function.

Lin_{min} is the minimum in linearized image, Lin_{max} is the maximum in linearized image

I_{min} is the minimum in linput image, I_{max} is the maximum in input image

MTF: All values in the image are forced towards zero by the minimum value. So the minimum in the input image is set to zero in the linearized output image. The maximum in the input image is set to the maximum signal level, so the result is 0 to Imax-Imin.

FullDataRange: Lin_{min} = 0, Lin_{max} = 2^(bitdepth-1), 255 for 8 bit

FullImageRange: result is Imin to Imax, $Lin_{min} = I_{min}$, $Lin_{max} = I_{max}$

poly.fit.: the degree of polynomial fit for linearisation can be adjusted. The default value is 4.

Lin-Source: if “Global” (Gray Patches) is selected, define which subchart is source for linearization

Analysis

Reduce analysis to ___ radii: if you enable this option, analysis is only applied to this specific number of radii.

Analyse radii from ___% Nyquist to ___ % Nyquist: you can select in which range of radii iQ-Analyzer calculates modulation. The values are given as a percentage of the Nyquist frequency. So if the Nyquist frequency is 1000 LP/PH and you set the values “from 50% to 125%”, iQ-Analyzer will analyze the radii that equals frequencies from 500 LP/PH to 1250 LP/PH. If you want iQ-Analyzer to analyze the radii starting from the border of the stars, set the first value to “0”.

Results (calculated from Analysis)

Reduce to 8 segments: iQ-Analyzer calculates the MTF for 24 segments of each star. If you select the checkbox, the average of three segments will be written to the result txt file.

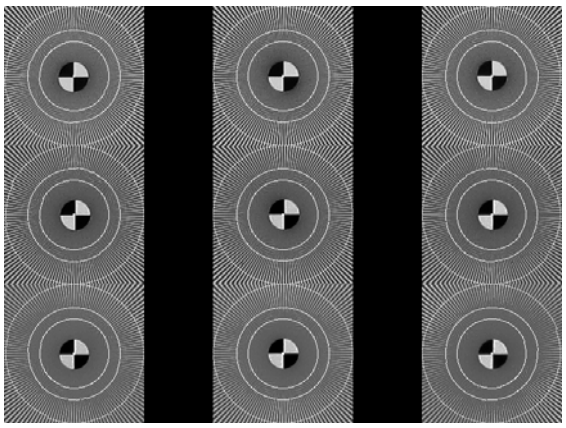
Equidistant Results: if reduction is enabled, the frequencies in the output are equidistant.

reduce result to ___ freq.: the results are reduced to the specified number of frequencies. It is useful for working with Excel spreadsheets.

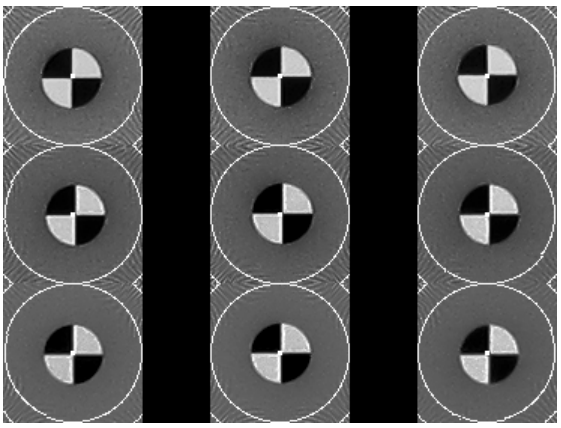
Group

Center, TopBottom, Left, Right, Corner: assign subcharts to the groups, which will be displayed in the graphical results

Siemens Center Image Size: in the RESOLUTION module – analyzing the modulated Siemens star TE253 – an image namend “CenterImage” is saved, which shows the center(s) of the Siemens star(s). You can define the size of the center image relatively to Nyquist. E.g. “0.5” equals an image which shows the star from its center to 50% Nyquist.

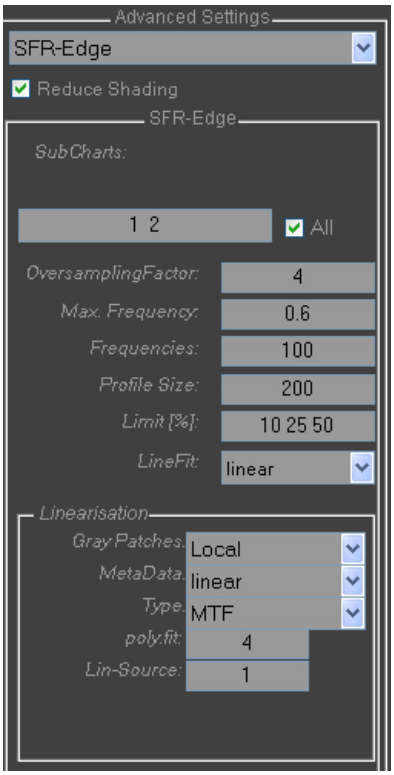


Center Image Size 0.5



Center Image Size 1

II Advanced Settings SFR-Edge



SubCharts: select the subcharts you would like to analyze. For the TE261 A830 you can choose up to five subcharts, for the TE253 9x up to two subcharts. If "All" is enabled, all possible subcharts are listed. For declaration of the subcharts see chapter IV.

OversamplingFactor: Degree of oversampling the slanted edge. Default is "4".

Max. Frequency: The highest frequency, that shall be reported in unit "LP/pix". Default is "0.6" - Nyquist frequency is 0.5.

Frequencies: number of frequencies in the output. Default is "100".

Profile Size: number of points to describe the edge profile. Size in pixel is the quotient of "Profile Size" and "OversamplingFactor". Default is "40" (+/- 5 pixel around edge).

Limit [%]: Frequencies derived from the SFR data based on these modulation. E.g. "50" equals a MTF50 value (the modulation is 50% at this frequency). Default is "10 25 50", so three values are calculated MTF10, MTF25 and MTF50.

LineFit: one important step of the algorithm is to fit a line along the edge. This can be straight line (linear, ISO 12233 standard) or a bended line (polynomial). The aim is to reduce the fit error which is shown in the numerical results.

Linearisation

Most cameras for photography use have a non-linear response to luminance in the scene. This is called gamma function and tries to adjust the image to the human eyes reception of light. To analyze an image, this function should be inverted, also called the image shall be "linearized". This is done by reading the gray patches in the chart, creating an OECF (Opto Electronic Conversion Function) and inverting this function.

Gray Patches

Local: use the corresponding gray patches in each subchart

Global: Use one set of gray patches for complete imgae (define the set in "Global Source")

None: No linearisation will be applied for calculation.

Default is "Local"

MetaData

Linear: assume gray patches to be linear

den. files: you can select a file with patch densities for linearization

Type

Defines the aim function.

Lin_{min} is the minimum in linearized image, Lin_{max} is the maximum in linearized image

I_{min} is the minimum in linput image, I_{max} is the maximum in input image

MTF: All values in the image are forced towards 0 by the minimum value. So the minimum in the in the linearized Image Lin_{min} becomes 0, the maximum beomes $I_{max} - I_{min}$

FullDataRange: $Lin_{min} = 0$, $Lin_{max} = 2^{(bitdepth-1)}$, 255 for 8 bit

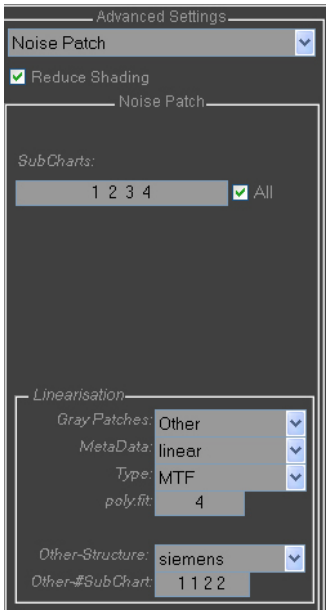
FullImageRange: result is Imin to Imax, $Lin_{min} = I_{min}$, $Lin_{max} = I_{max}$

Default is **FullImageRange.**

poly.fit.: the degree of polynomial fit for linearisation can be adjusted. The default value is 4.

Lin-Source: if “Global” (Gray Patches) is selected, define which subchart is source for linearization.

III Advanced Settings Noise Patch



SubChart: select the subcharts (noise patch) you would like to analyze. If "All" is enabled, all possible noise patches are part of calculation. For declaration of the subcharts see chapter IV "TE253 / TE253 9x".

Linearisation

Most cameras for photography use have a non-linear response to luminance in the scene. This is called gamma function and tries to adjust the image to the human eyes reception of light. To analyze an image, this function should be inverted, also called the image shall be "linearized". This is done by reading the gray patches in the chart, creating an OECF (Opto Electronic Conversion Function) and inverting this function.

Gray Patches

None: No linearisation will be applied for calculation.

Other: Use set of gray patches in the structure, specified in "Other-Structure".

MetaData

Linear: assume gray patches to be linear

den. files: you can select a file with patch densities for linearization

Type

Defines the aim function.

Lin_{min} is the minimum in linearized image, Lin_{max} is the maximum in linearized image

I_{min} is the minimum in linput image, I_{max} is the maximum in input image

MTF: All values in the image are forced towards 0 by the minimum value. So the minimum in the in the linearized Image Lin_{min} becomes 0, the maximum beomes $I_{max} - I_{min}$

FullDataRange: $Lin_{min} = 0$, $Lin_{max} = 2^{(bitdepth-1)}$, 255 for 8 bit

FullImageRange: result is Imin to Imax, $Lin_{min} = I_{min}$, $Lin_{max} = I_{max}$

poly.fit.: the degree of polynomial fit for linearisation can be adjusted. The default value is 4.

Other-Structure: Select the patches for linearization if you have choosen "**Gray Patches: Other"**

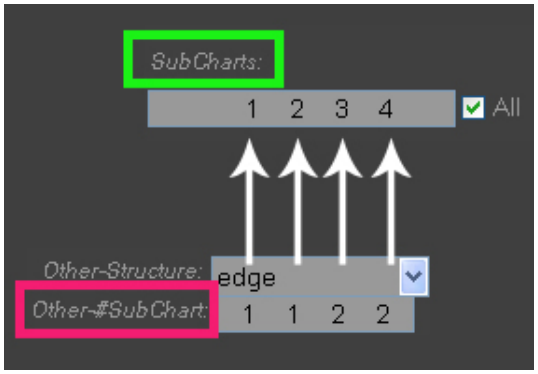
siemens: use the 14 gray patches around the siemens star

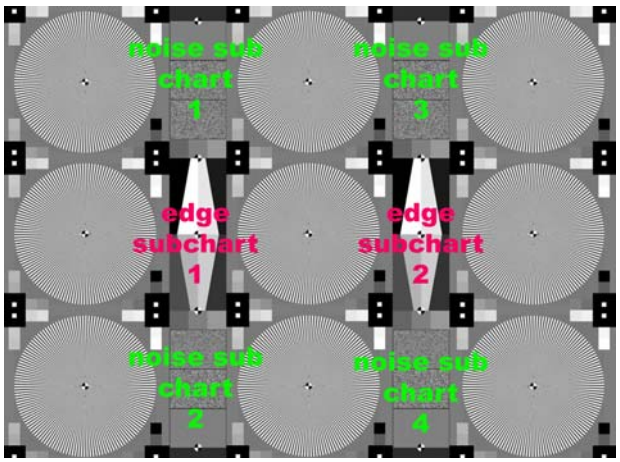
edge: use the additional gray patches 0.4, 0.5, 0.6 is the "edge structure"

noise: the noise patches do not contain gray patches

Other-#Subchart: choose which subcharts of the selected patches (in “Other-Structures”) is used for linearization.

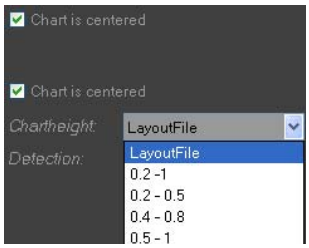
Example: for the four noise subcharts (1 2 3 4) the patches of edge subcharts are used for linearization. Noise subchart 1 uses edge subchart 1, noise subchart 2 uses edge subchart 1, noise subchart 3 uses edge subchart 2, noise subchart 4 uses edge subchart 2.





Single Chart

If you want to anaylze single charts (e.g. TE253_single.chart or QA-62_SFR_single.chart) and insert a “complete” chart with all subcharts, you can define the size of the subchart related to the image height. The smaller the range, the faster the detection.

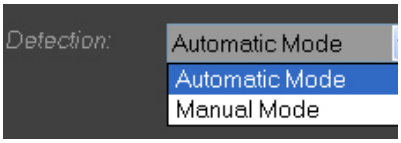


E.g. the subchart has a height of 300 pixel in an image of 1280x960 pixel. The scale is 0.3125, so select “0.2-0.5”. If you do not want to specify the scale or want to use different images as batch processing with different scales, you can set it to 0.2-1 or “LayoutFile”.

Enable “**Centered**” if the subchart you want to analyse is in the image center. If enabled, the search region can be reduced, which speeds up the location process (if ROI Detection - see below - is in “Automatic Mode”). If disabled, the software tries to locate a chart with the specified height in the entire image.

ROI Detection

By using the dropdown menu you can choose if the ROI detection is realized automatically (“**Automatic Mode**”) or manually (“**Manual Mode**”). The manual ROI detection is provided for all charts, exemplarily shown for QA-62.



dropdown menu ROI detection

Manual Mode: After doing all settings, press the “Start” button. You can select the subchart you want to analyze by drawing a rectangle around this chart and double click on it or use the right mouse button and press “Crop Image”. The ROIs are indicated by rectangles. “Activate” the rectangles by clicking the border. If small reactangles are located within an “activated” larger one, first click outside the image. The large rectangle will be deactivated and you can ‘activate’ the small rectangles. Now you can adjust the ROIs manually.

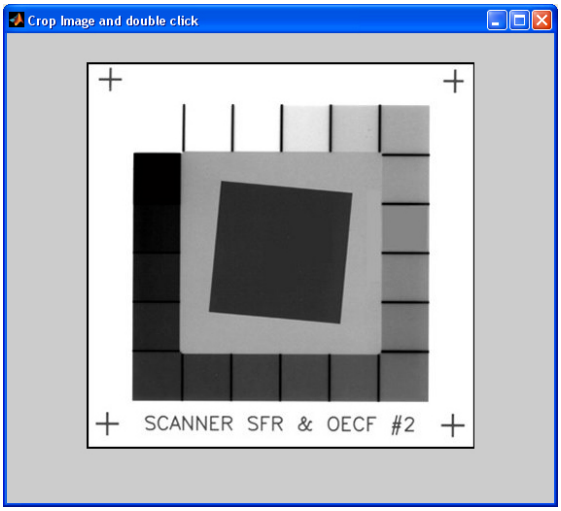
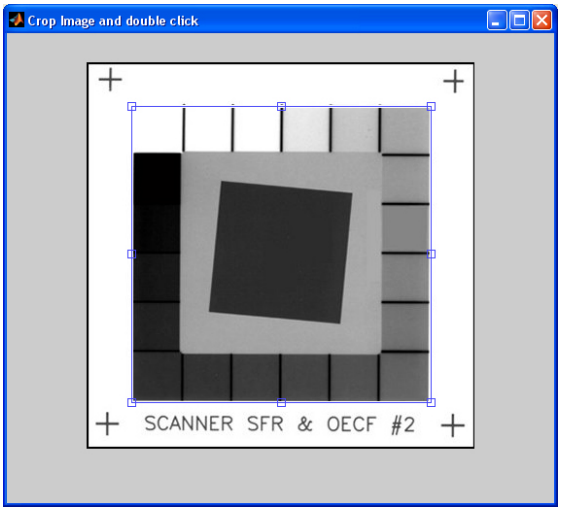
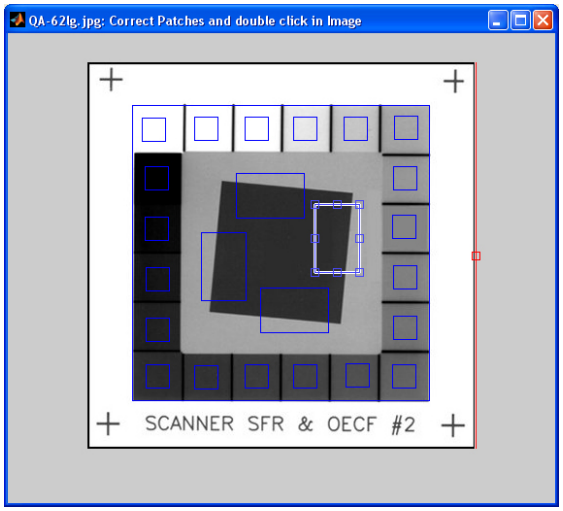


chart with all subcharts



rectangle around the centered subchart



ROIs for manual adjustment

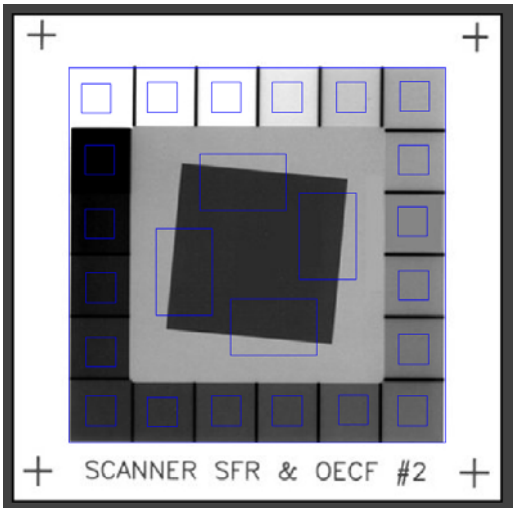
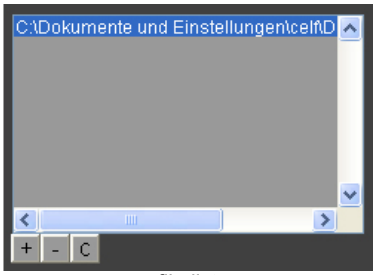


chart with marked subcharts and ROIs for analysis

When the manual adjustment of ROIs is done, double click outside the rectangle and the analyzing process starts.

Files

Files for analysis have to be added to the build in file list using the " + " button. Delete selected files with the " - " button and clear list with the " C " button.

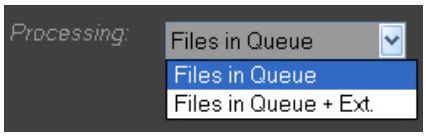


file list

Processing

Files in Queue: all added files will be analyzed

Files in Queue + Ext.: if you have made several pictures and named them with extensions (e.g. QA62_01, QA62_02, QA62_03, ...) you only have to add the image file with the lowest extensions and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS.



dropdown menu for processing

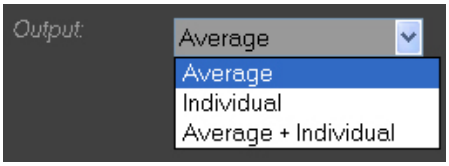
Output

By using the dropdown menu below the file list you can configure the output properties.

Average: the average results of the selected images are saved in the text file (if you have inserted "Files in Queue + ext.")

Individual: the separate results for every image are saved in the text file

Average + Individual: the average and separate results are saved in the text file



drop down menu for output

If all settings are made press the " **Start** " button to run the analyssis of the image(s).

"Start" button

8.2 Analyzing process and graphical presentation

8.2.1 General

After having done the setup up you can press the "**Start**" button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results and some images (_center.jpg and _check.jpg) are saved autimatically as text and JPEG files (depending on your export settings made in the SETTING tab above). Using the "Stop" breakes the analyzing process.

progress bar and Stop button

By pressing the "**Image**" button below the file list the image of the selected image file is displayed. After analyzing you can switch between "**Image**" and "**Result**" view.

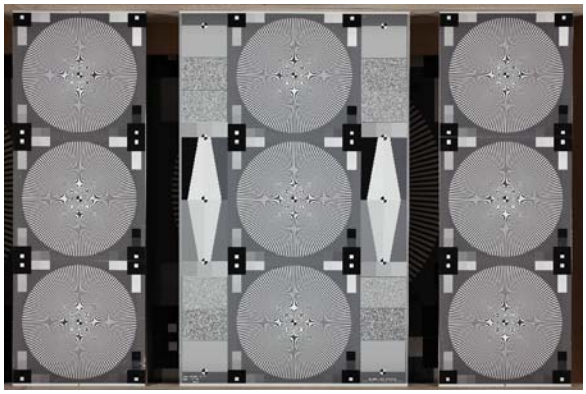
"Image" and "Result" button

Image View

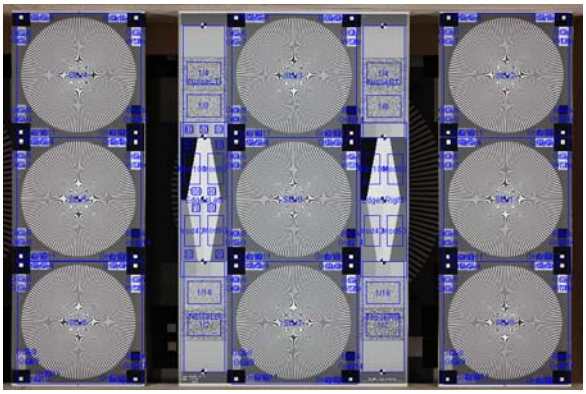
The dropdown below the image offers several views:

ROI: the ROIs (regions of interest)of the analyzed patches are marked in blue
Original: the original image is shown
CheckImage: the analyzed regions are marked in gray
CenterImage: the star from center to a defined percentage of the Nyquist frequency is shown. The size of CenterImage you define in the SETTINGS.

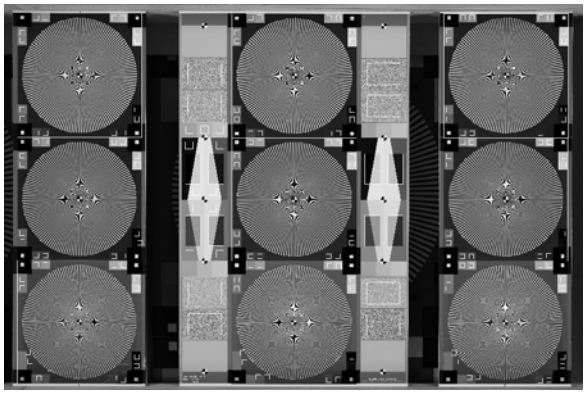
The CheckImage and the CenterImage, named with the extension "filename**_check**" and "filename**_center**" are saved automatically. Path for saving, image quality and size of the comparison image can be defined in the SETTINGS.



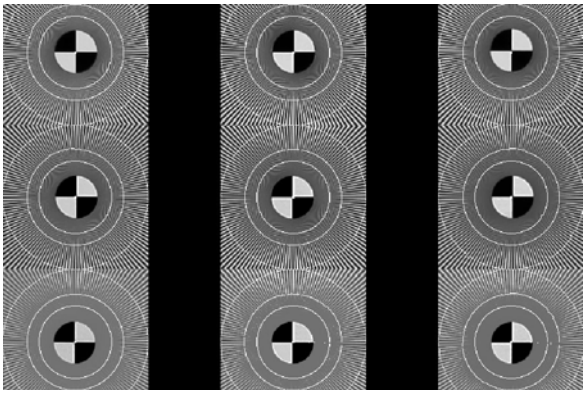
Original



ROI

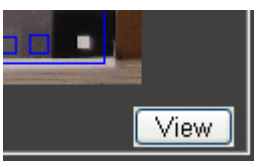


CheckImage

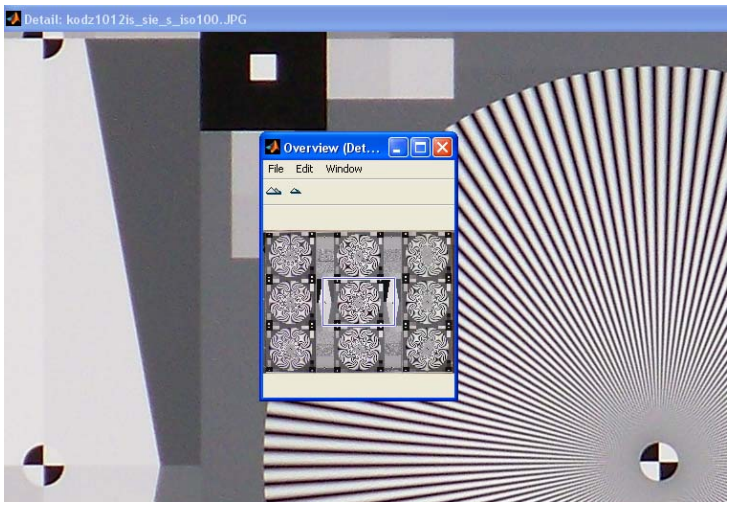


CenterImage

By pressing the "**View**" button in the down right corner of the "Image" view, the image opens in a new window. A new opening window enables editing the figure e.g. zooming in/out. Use the 100% view for visual analysis.



"View" button



editing window and the image in a new window

The graphical results are displayed in the right screen. Below the graphical results some **dropdown menus** exist. The <u>first</u> one allows choosing the **result** you want to be displayed (Siemens/MTF, Edge/SFR, Edge/Profile, Nise/Spectrum, Noise/Histogram). The furtherdropdown menus allow different views depending on the result you choose in the first menu (e.g. for which stars, segements, groups etc. the MTF shall be displayed). You can also choose representation of results in linepairs per picture height (LP/PH), linepairs per pixel (LP/Pix) , linepairs per mm (LP/mm) and pixel per inch (PPI). The information about resolution in PPI is obtained from EXIF data or the dehault value made in “Setting”.

depending on the the diplayed result (selected with the first dropdown menu) the further menus offer different views

Also EXIF data and numerical results are shown which vary depending on the selection using the dropdown menus.

Image		Image		EXIF		EXIF	
Name	cam_sie_s_iso100...	X-Dim	3648	Time	1/20	f [mm]	12.52
Make	Canon	Y-Dim	2736	F-Stop	4.5	EV	0.333
Model	Canon DIGITAL IXU...			ISO	100		

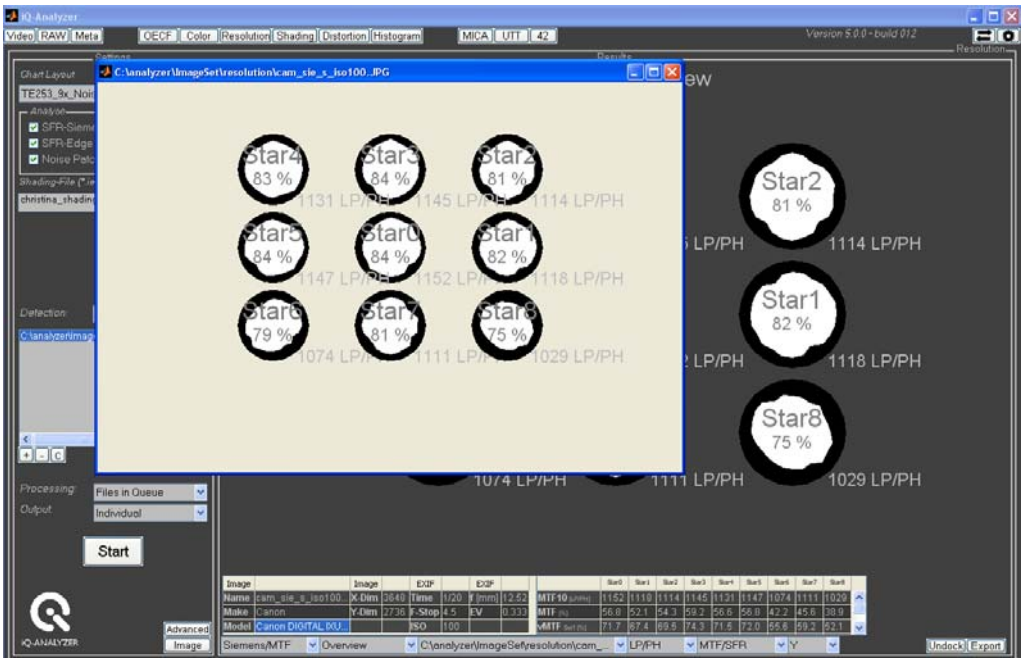
EXIF data

	Star0	Star1	Star2	Star3	Star4	Star5	Star6	Star7	Star8
MTF10 [LP/PH]	1189	1151	1151	1187	1175	1189	1101	1151	1044
MTF25 [LP/PH]	1065	1016	1020	1058	1043	1057	958	1001	904
MTF50 [LP/PH]	912	854	887	944	915	905	687	721	642
MTF [%]	64.6	59.6	61.4	67.5	64.6	64.7	48.3	52.1	44.1
vMTF Set1 [%]	75.0	70.6	72.5	77.8	74.8	75.3	58.2	62.0	54.4
vMTF Set2 [%]	93.7	91.4	90.0	93.3	90.7	94.4	78.7	83.4	75.4
vMTF Set3 [%]	88.6	85.6	85.7	89.6	86.9	89.2	72.8	77.0	69.3

numerical depending on the options choosen by using the dropdown menu

Note: The **exclamation point** indicates, that the frequency cannot be calculated and is set to Nyquist. In the text output these frequencies are signed with a minus sign.

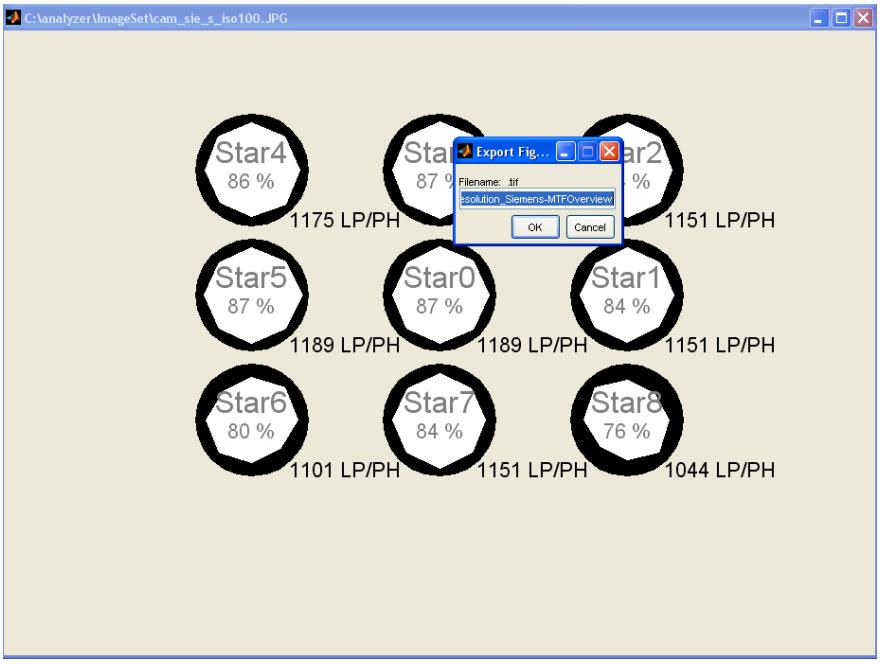
Undock button: The graphical result is displayed in a new window.



Undock

by pressing the “Undock” button the graphical result is displayed in a new window

Export button: The graphical result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “Setting” tab.



Export

by pressing the “Export” button the graphical result is displayed in a new window and can be saved

8.2.2 Numerical and graphical results

By using the first dropdown menu you can choose the displayed result, according to the used chart.

- MTF/Siemens
- Edge/SFR
- Edge/Profile
- Noise/Spectrum
- Noise/Histogramm

Visual MTF (vMTF)

For Siemens/MTF and Edge/SFR, additional to the MTF, the visual MTF (vMTF) is calculated and displayed.

	Star0	Star1	Star2	Star3	Star4	Star5	Star6	Star7	Star8
MTF10 [LP/PH]	1189	1151	1151	1187	1175	1189	1101	1151	1044
MTF25 [LP/PH]	1065	1016	1020	1058	1043	1057	958	1001	904
MTF50 [LP/PH]	912	854	887	944	915	905	687	721	642
MTF [%]	64.6	59.6	61.4	67.5	64.6	64.7	48.3	52.1	44.1
vMTF Set1 [%]	75.0	70.6	72.5	77.8	74.8	75.3	58.2	62.0	54.4
vMTF Set2 [%]	93.7	91.4	90.0	93.3	90.7	94.4	78.7	83.4	75.4
vMTF Set3 [%]	88.6	85.6	85.7	89.6	86.9	89.2	72.8	77.0	69.3

for Siemens/MTF and Edge/SFR, additional the visual MTF (vMTF) is calculated

Similar to the visual noise, which quantifies how well a human observer can recognize noise, the visual MTF implicates the three in the SETTINGS defined viewing condition sets. The calculated and the ideal MTF are multiplied with the contrast sensitivity funftion (CFS) which depends on the viewing condition sets for visual noise. The two integrals are devided. Multiplied with 100 you get the visual MTF (vMTF) in percent.

calculated MTF → **calculated MTF * CFS set x** → **integral real**

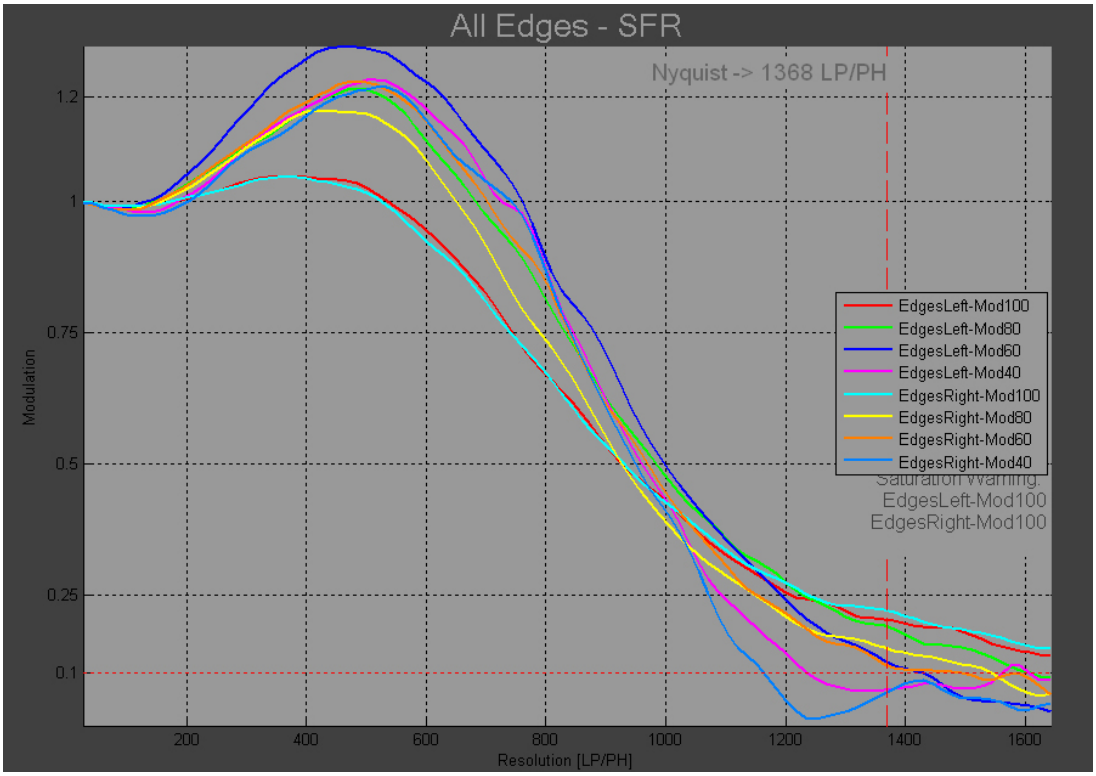
ideal MTF → **ideal MTF * CFS set x** → **integral ideal**

integral real ↘ ↙ **integral ideal**

100 • integral real / integral ideal = vMTF [%]

By using the fifth dropdown menu you can choose between representation of the MTF/SFR and vMTF for the three viewing condition sets.

The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal line indicates the lowest modulation which is specified as limiting resoution in the Advanced Settings.



for Siemens/MTF and Edge/SFR the vMTF can be dispalyed by using the right dropdown menu

By using the third dropdown menu you can select for which picture (or average) the results shall be diplayed.

Numerical and graphical representation of the results

I MTF/SIEMENS

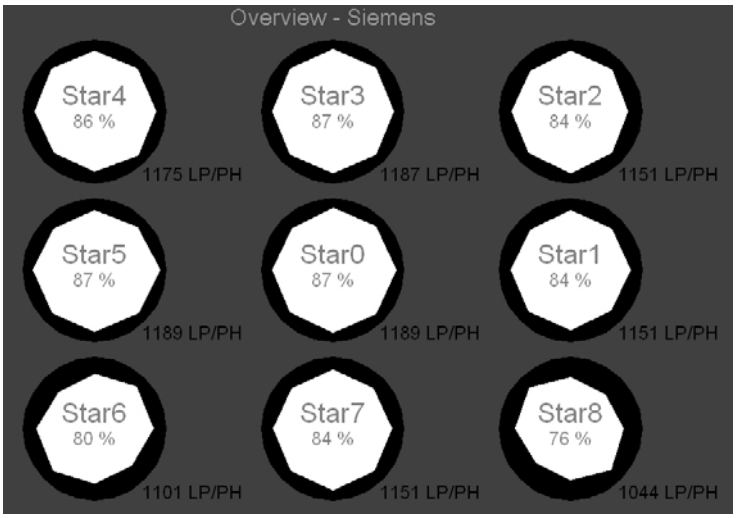
SFR Siemens uses a Siemens star with a harmonic function. The aim is to get a MTF (modulation transfer function. The MTF describes the loss of modulation depending on the spatial frequency fspatial.

The table with text results contains information about the MTF for stars, segments and groups (selectable by using the second dropdown menu). The limiting modulations for which the resolution in LP/PH (line pair per picture hight), LP/Px (line pair per pixel) and PPI (pixel per inch) is shown (here 10, 25 and 50) can be specified in the Advanced Menu. Also the visual MTF for the three viewing conditions sets is displayed.

	Star0	Star1	Star2	Star3	Star4	Star5	Star6	Star7	Star8
MTF10 [LP/PH]	1189	1151	1151	1187	1175	1189	1101	1151	1044
MTF25 [LP/PH]	1065	1016	1020	1058	1043	1057	958	1001	904
MTF50 [LP/PH]	912	854	887	944	915	905	687	721	642
MTF [%]	64.6	59.6	61.4	67.5	64.6	64.7	48.3	52.1	44.1
vMTF Set1 [%]	75.0	70.6	72.5	77.8	74.8	75.3	58.2	62.0	54.4
vMTF Set2 [%]	93.7	91.4	90.0	93.3	90.7	94.4	78.7	83.4	75.4
vMTF Set3 [%]	88.6	85.6	85.7	89.6	86.9	89.2	72.8	77.0	69.3

numerical results after MTF calculation of the siemens star(s)

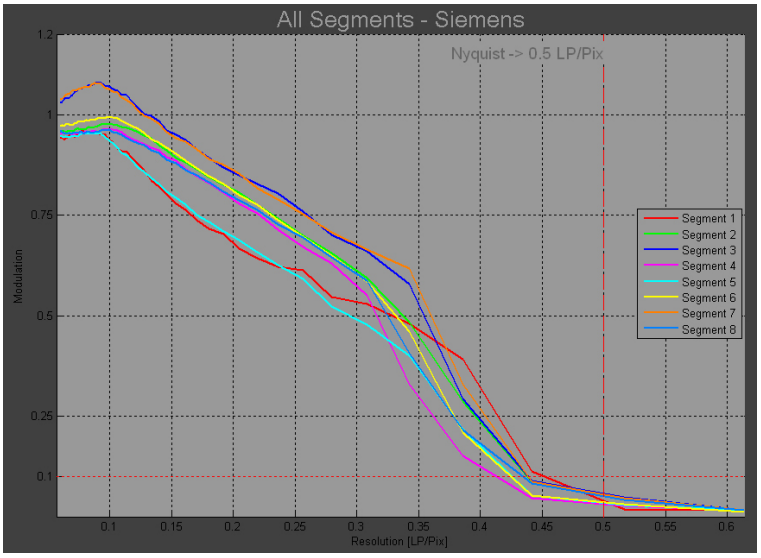
Siemens/MTF Overview



Siemens/MTF Overview

Overview of the SFR calculation of the siemens stars. The black circle represent the Nyquist frequency, the white polygon the limiting resolution of each segment. So the more the polygon covers the black circle the better. The percentage value in the center gives the ratio between Nyquist frequency and the limiting resolution of the average of all segments. Centering problems of devices can be seen easiliy in this illustration.

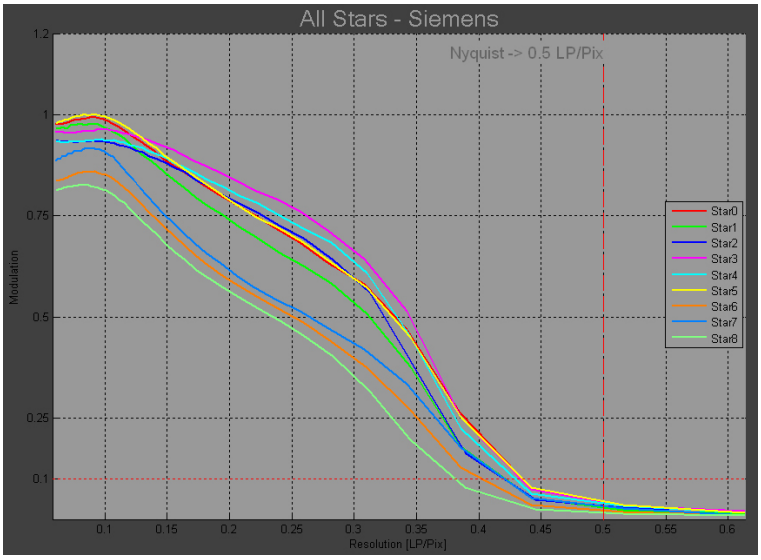
Siemens/MTF Segments



Siemens/MTF Segments (LP/Pix)

The MTF of each segment in one star. The y axes represents the modulation, the x axes the spatial frequency. This illustration is usefull to see differences in horizontal und vertical resolution. In the table you find the limiting resolutions of each star (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”). The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal line indicates the modulation which is specified as limiting resoution in the Advanced Settings.

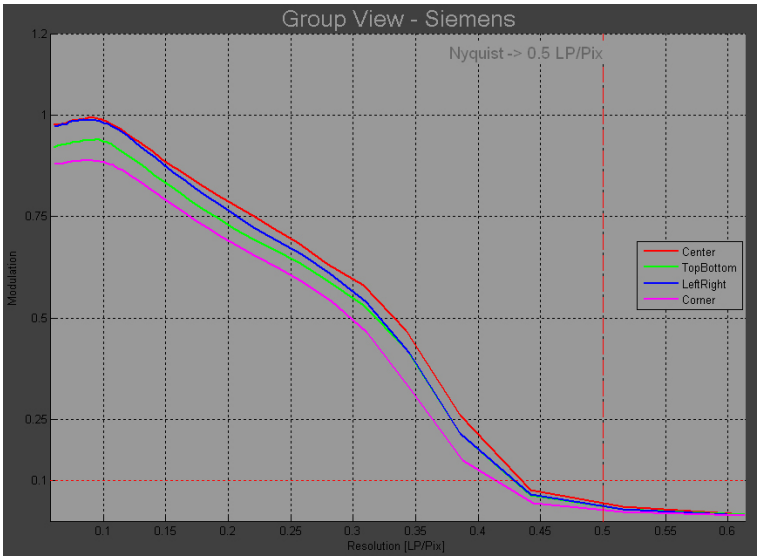
Siemens/MTF Stars



Siemens/MTF Stars (LP/Pix)

This plot shows the MTF of each siemens star. The MTF is calculated as the average of all segments. In the table you find the limiting resolutions of each star (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”). The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal line indicates the modulation which is specified as limiting resoution in the Advanced Settings.

Group



Group (LP/PIX)

This is a more compact illustration of the MTF of the siemens stars. In the “Advanced Settings” for SFR Siemens you can combine stars to groups. iQ-Analyzer calculates the average for each group. In the table you find the limiting resolutions of each group (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”). The red dashed vertical line indicates the Nyquist frequency. The red dashed horizontal line indicates the modulation which is specified as limiting resoution in the Advanced Settings.

II EDGE/SFR

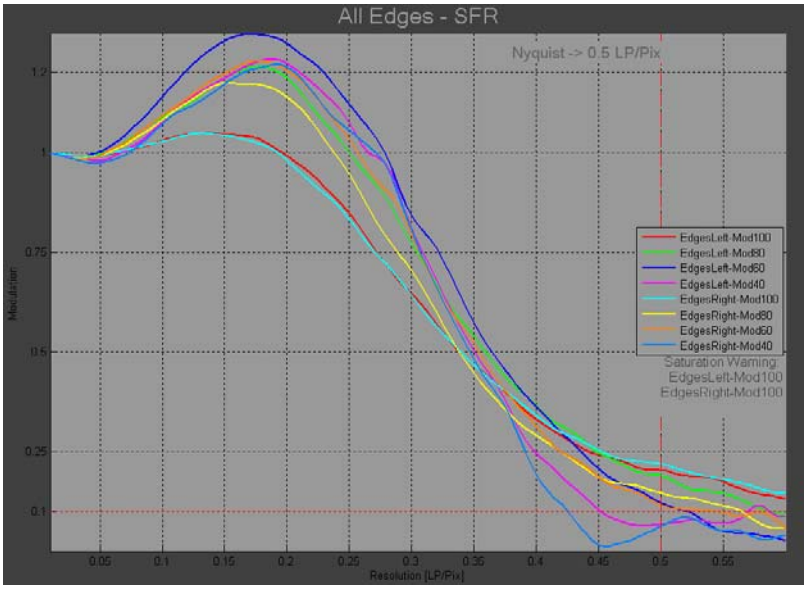
In case of TE253 NoiseLab the SFR measurement is done on edges with four different modulations starting from 100% to 40%. The assumption is, that the denoising algorithms have to detect edges to distinguish between information and noise in the image signal. Using the different modulatons, it can be checked if the edge is treated differentially.

The table with text results contains information about the Edge/SFR for the edges (selectable by using the second dropdown menu). The limiting modulations for which the resolution in LP/PH (line pair per picture hight), LP/Px (line pair per pixel) and PPI (pixel per inch) is shown (here 10, 25 and 50) can be specified in the Advanced Menu. Also the visual MTF for the three viewing conditions sets is displayed.

	EdgesLeft Mod100	EdgesLeft Mod80	EdgesLef Mod60	EdgesLef Mod40	EdgesRig Mod100	EdgesRig Mod80	EdgesRig Mod60	EdgesRig Mod40
MTF10 [LP/Px]	0.500	0.588	0.523	0.453	0.5...	0.565	0.547	0.426
MTF25 [LP/Px]	0.442	0.449	0.436	0.399	0.453	0.420	0.420	0.392
MTF50 [LP/Px]	0.338	0.359	0.365	0.351	0.340	0.338	0.354	0.347
MTF [%]	54.2	61.1	63.5	58.0	54.4	56.0	59.4	55.3
vMTF Set1 [%]	74.7	85.8	92.2	85.8	74.4	81.1	85.9	83.7
vMTF Set2 [%]	100.6	113.5	122.5	115.0	100.1	111.5	115.0	113.3
vMTF Set3 [%]	94.7	108.1	116.9	109.8	94.1	105.0	109.5	108.1
FitError	4.0	4.0	4.0	4.1	4.1	4.1	4.1	4.0
Misreg.RG	0.02	0.31	0.03	0.31	0.03	0.45	0.30	0.06
Misreg.BG	0.04	0.01	0.34	0.49	0.02	0.13	0.16	0.20
Over/Under	16/ 3	19/18	20/21	11/18	16/ 0	18/29	16/27	13/16
Modulation	98%	72%	56%	39%	98%	71%	56%	39%

numerical results after SFR calculation of the edges

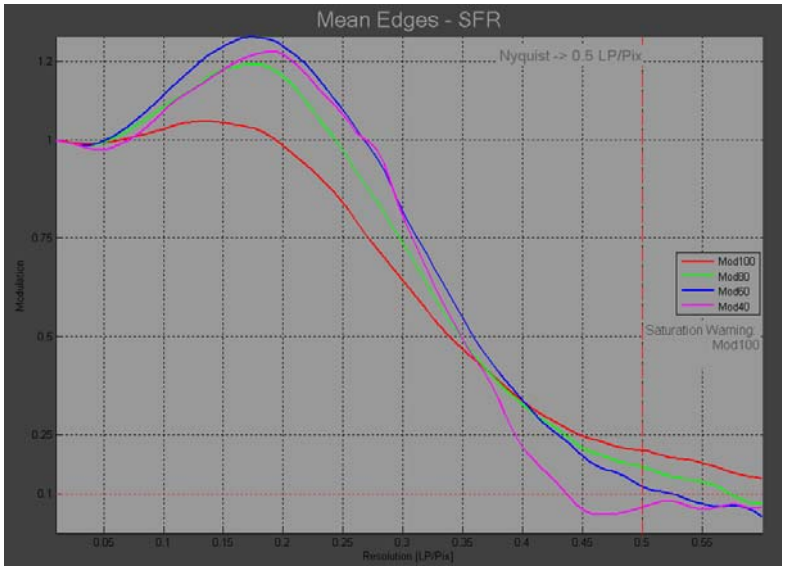
Edge/SFR All



Edge/SFR All

This plot shows the MTF of each edge with the different modulations (e.g. for TE253 NoiseLab left and right edges with modulations of 100%, 80%, 60%, 40%).In the table you find the limiting resolution of each segment (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”).

Edge/SFR Mean/Edge



Edge/SFR Mean/Edge (LP/Pix)

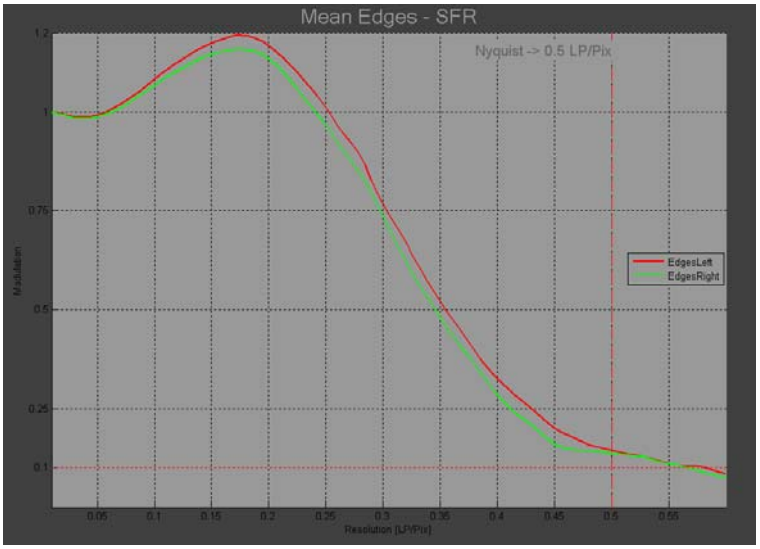
This is a more compact illustration of the SFR Edge. iQ-Analyzer calculates the average of all edges with the same name over subchart.

E.g. for TE253 NoiseLab iQ-Analyzer calculates each the average of the left and the right edges with same modulation.

Mod100 = mean (edges left 100, edges right 100)
Mod 80 = mean (edges left 80, edges right 80)
Mod 60 = mean (edges left 60, edges right 60)
Mod 40 = mean (edges left 40, edges right 40)

The modulation of these four averages are shown. In the table you find the limiting resolutions of mean edges left and right (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”).

Edge/SFR Mean/Sub



Edge/SFR Mean/Sub (LP/Pix)

This is a more compact illustration of the SFR Edge. iQ-Analyzer calculates the average of all edges in one subchart.

E.g. for TE253 NoiseLab, iQ-Analyzer calculates each the average of the left and the right edges.

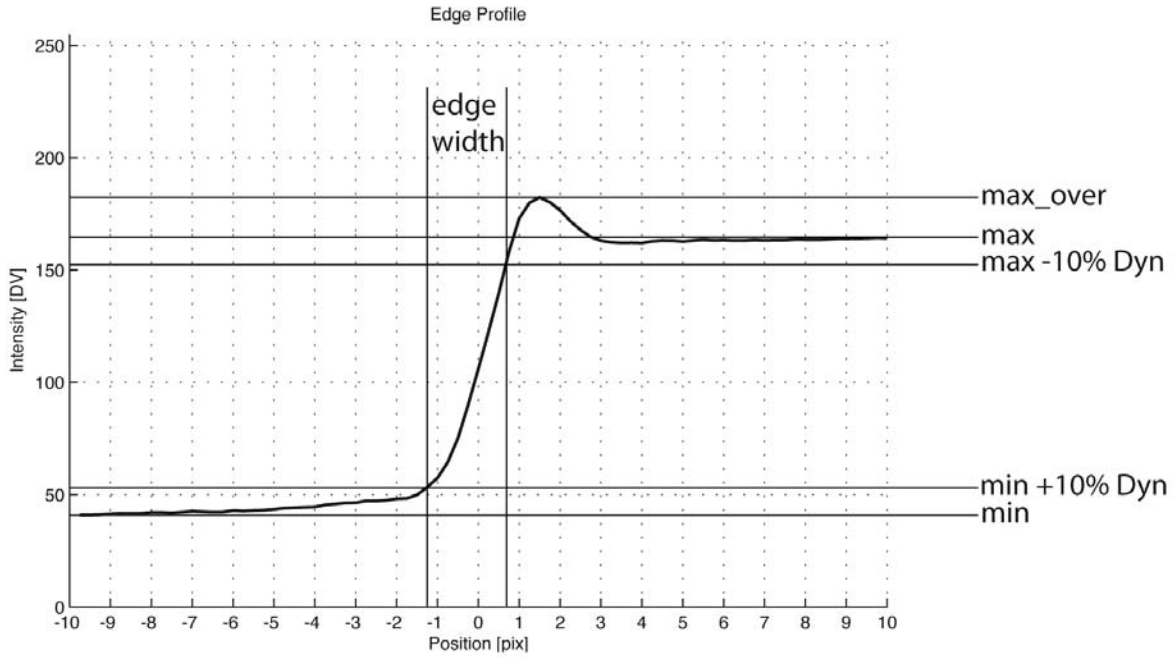
EdgesLeft = mean (edges left 100, edges left 80, edges left 60, edges left 40)
EdgesRight = mean (edges right 100, edges right 80, edges right 60, edges right 40)

The modulation of these two averages are shown. In the table you find the limiting resolutions of mean edges left and right (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”).

III EDGE/PROFILE

The edge profile gives information about over and undershoot and edge width. The pixels are bined by their distance to the fitted edge despcription.

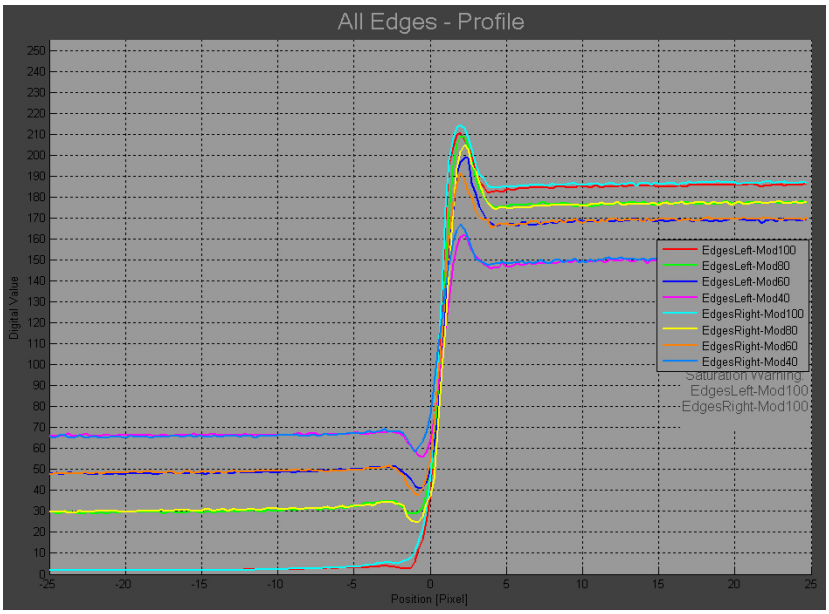
The y axes is the intensity in digital values (for a 8 bit image from 0 to 255). The x axes represents the position related to the edge. So value 0 is the position of the maximum of the first derivative of the edge profile. For example a value of 4 means 4 pixel right of the edge, therefore a value of -4 means 4 pixel left to the edge. Left always represents the low intensity, right the high intensity side of the edge.



The reported value is the 10% edge width. The edge width is the distance in pixel between two points in edge profile. First point is reached by an increase of the intensity by 10%Dyn, second point is reached at max - 10%Dyn, with

$$10\%Dyn = 0.1 \cdot (\max - \min)$$

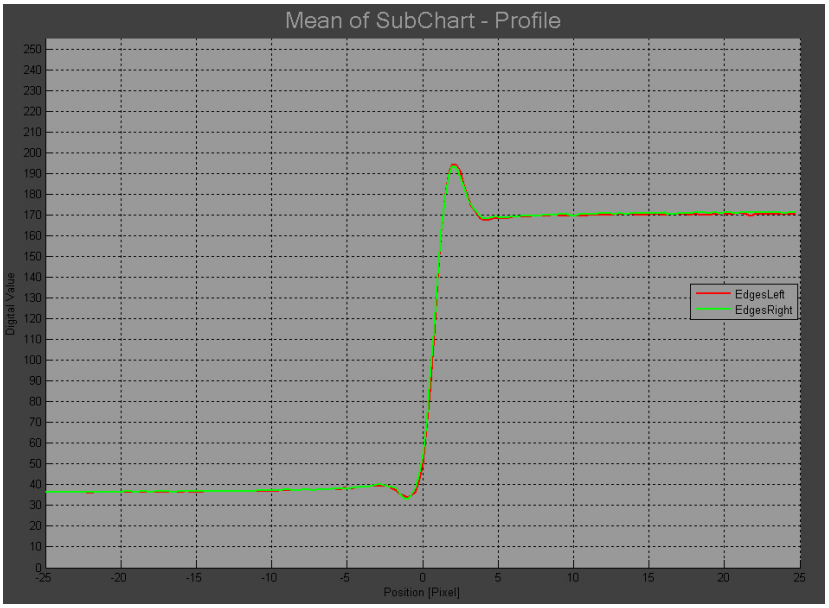
Edge/Profile All



Edge/Profile All

The illustration represents the edge profile intensity of all edges with different modulations (e.g. eight edges in TE253 NoiseLab). In the table you find the edge width.

Edge/Profile Mean/Sub

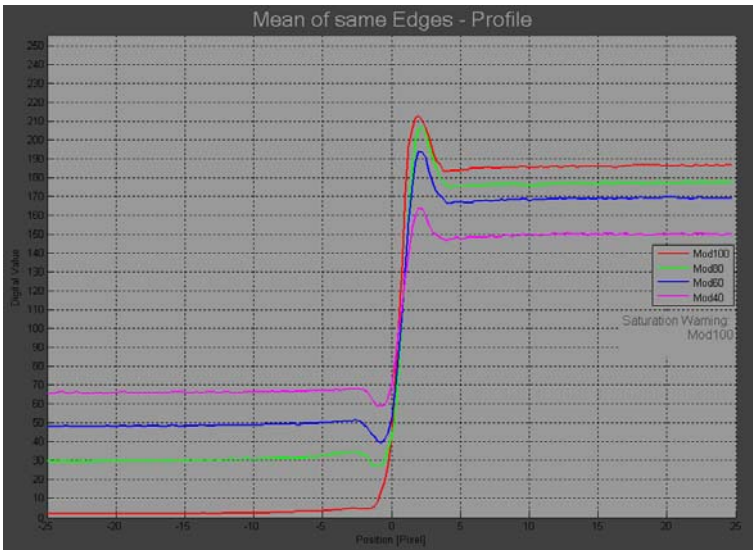


Edge/Profile Mean/Sub

The illustration represents the edge profile intensity of the average of all edges in one subchart.

(e.g. the average of the left edges and the average of the right edges in TE253 NoiseLab).

Edge/Profile Mean/Edge



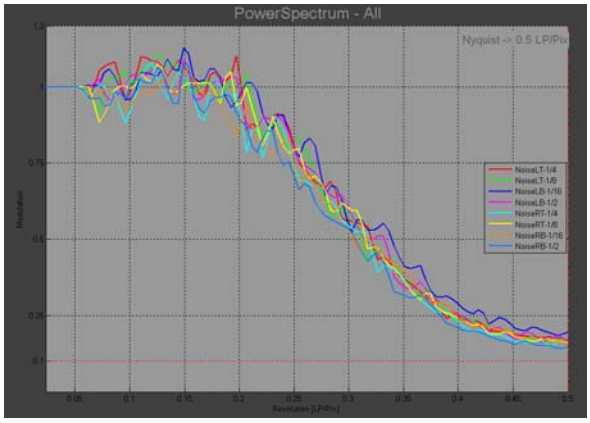
Edge/Profile Mean Edge

This is a more compact illustration of the edge profile. iQ-Analyzer calculates the average of all edges with the same name over subchart. E.g. for TE253 NoiseLab iQ-Analyzer calculates each the average of the left and the right edges with same modulation.

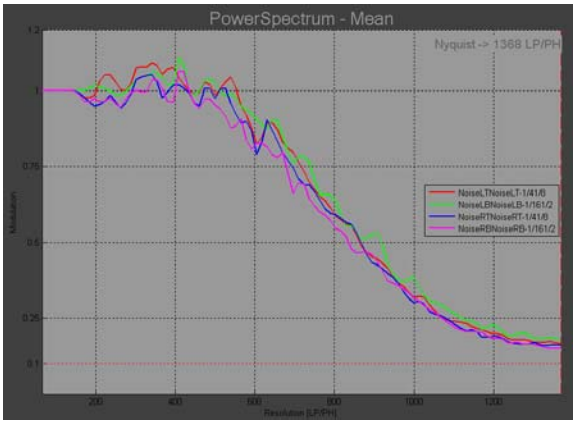
Mod100 = mean (edges left 100, edges right 100)
Mod80 = mean (edges left 80, edges right 80)
Mod60 = mean (edges left 60, edges right 60)
Mod40 = mean (edges left 40, edges right 40)

The edge profile intensities of these four averages are shown. In the table you find the edge width.

IV NOISE/SPECTRUM



Noise/Spectrum All



Noise/Spectrum Mean

This plot shows the MTF of the different noise patches. In the table you find the limiting resolution of each noise patch (the limiting value can be set in the “Advanced Settings” for “SFR Siemens”).

V NOISE/HISTOGRAM

The histogram of noise hold different information about the noise characteristics. But the histogram would change for different mean values of the noisy image signal, so the first derivative is used. The target is a gaussian white noise, so all digital values appear in the image with a probability defined by the gaussian distribution around the mean value. In the processed image, the mean value becomes zero, as the first derivative of a flat image is zero.

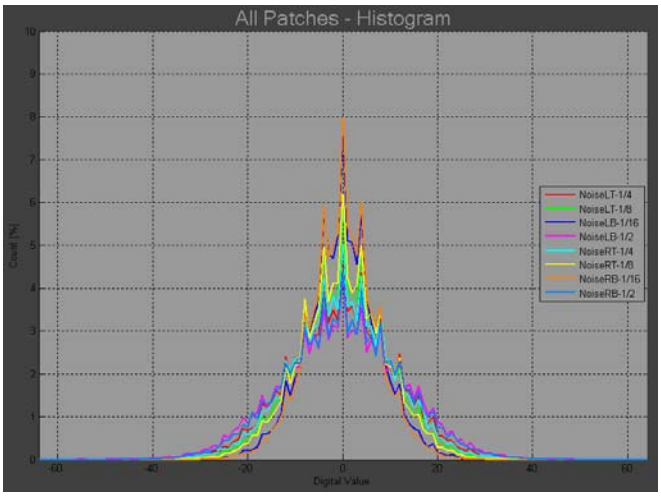
To describe the shape of the distribution, the excess kurtosis is calculated. The value becomes 0 for a normal distribution and is increased for leptokurtic distributions. The kurtosis is calculated as the fourth moment devided by the square of the second moment of the distribution. The second moment is the variance.

$$kurt = \frac{m_4}{m_2^2} - 3 = \frac{m_4}{\sigma^4} - 3 = \left(\frac{1}{n} \sum_{i=1}^{n} \left(\frac{x_1 - \mu}{\sigma} \right)^4 \right) - 3$$

The kurtosis is calculated for the for different noise patches (σ = 1/4, σ = 1/8, σ = 1/16, σ = 1/2). The y-axes represents the relative count of digital values in the x-axes. The count of the values is expressed in percentage, so a count of 10% means, that one tenth of all pixel have this value.

	NoiseLTNoiseRT-1/41/4	NoiseLTNoiseRT-1/81/8	NoiseLBNoiseRB-1/161/16	NoiseLBNoiseRB-1/21/2
Kurtosis	0.58	0.74	1.23	0.44

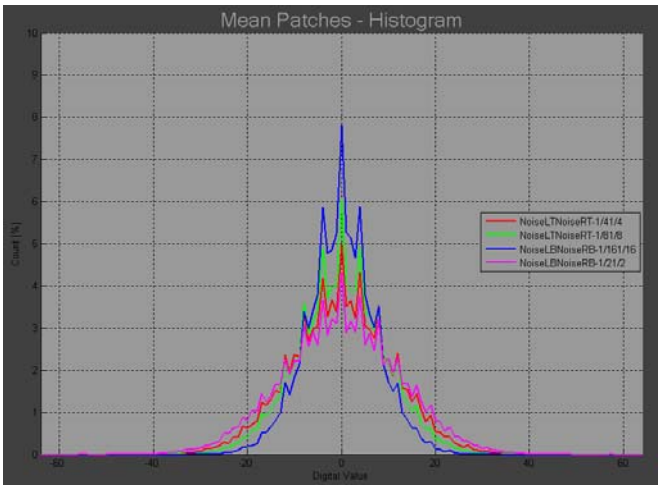
Noise/Histogram All



Noise/Histrogram All

This illustration shows the derivative of the four different noise patches on every side (left top 1/4, left top 1/8, left bottom 1/16, left bottom 1/2, right top 1/4, right top 1/8, right bottom 1/16, right bottom 1/2).

Noise/Histogram Mean



Noise/Histrogram Mean

This is a more compact illustration of the noise histogramm. iQ-Analyzer calculates each the average of the left and the right edges with same noise.

9. SHADING

SHADING describes the loss of intensity from the center of an image to the corner. Shading includes the vignetting of the lens and all other effects that may cause a loss of light. iQ-Analyzer uses the OECF to calculate the shading in f-stops.

"Shading" tab

9.1 Settings

Before starting analysis of SHADING charts you have to define some settings.

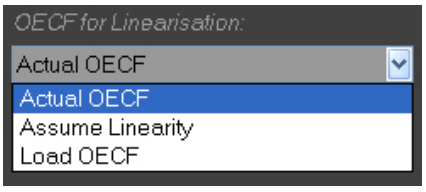
Chart Layout: select the Chart Layout File. It contains all neccessary information about the chart layout. iQ-Analyzer uses the TE255 (diffusor plate) for calculation shading.

select the chart layout for calculation of shading

iQ-Analyzer needs **OECF data for Linearisation**.

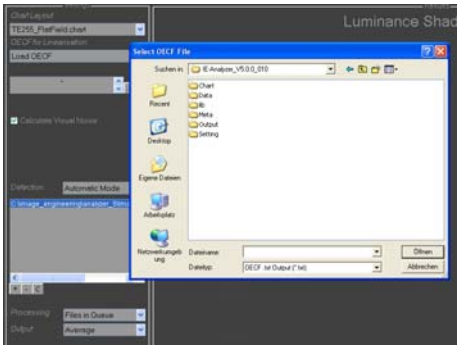
Actual OECF: iQ-Analyzer uses OECF data that is actually calculated and displayed in the OECF module.

Assume Linearity: Shading can be calculated without a related OECF file. If no OECF is specified, a linear OECF can be used. If you use the linear OECF and your device does not work linear, the results for the shading calculated in f-stops will be incorrect.



dropdown menu for OECF data

Load OECF: If you want to use another OECF (or an idealized OECF), you can read in an OECF result file from the iQ-Analyzer OECF module. Use the "..." button and select an OECF file.



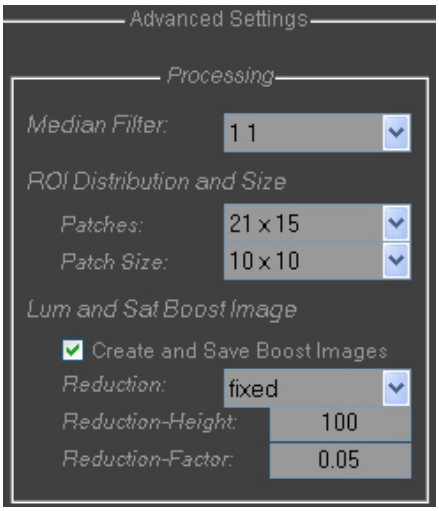
by using the button you can select an OECF file

Calculate Visual Noise: you can choose, if visual noise also will be calculated, saved and displayed in the result. 

In the “Advance” menu further settings can be made. Press the “Advanced” button. 

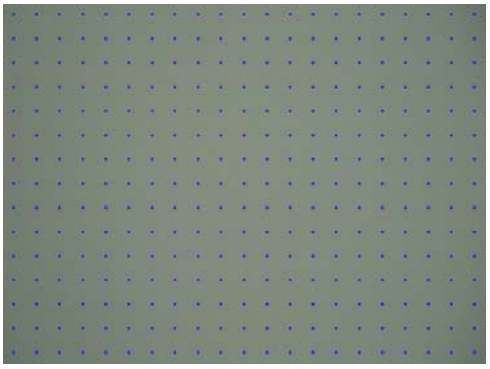
Processing

Median Filter: to reduce noise the image is filtered before analyzing. Define the matrix size of the median filter. 1x1 means no filtering, by using the 11x11 matrix the picture is filtered most.

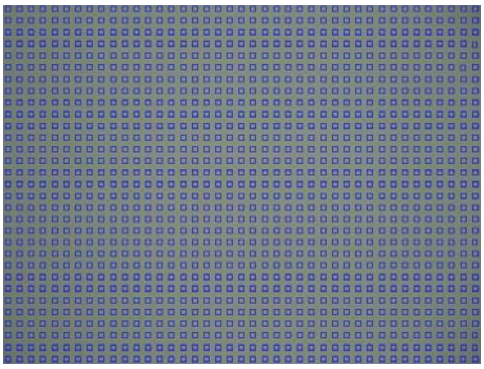


Note: if size of median filter is not 1x1 noise measurement has no significance

ROI Distribution and Size: choose number and size of ROI patches. The higher the number and size, the exact is the shading calculation. But it also will increase calculation time.



patches 21x15, patch size 10x10



patches 41x31, patch size 30x30

Lum and Sat Boost Image

Create and Save Boost Images: select, if boost images (luminace and saturation) shall be created and saved while calculation

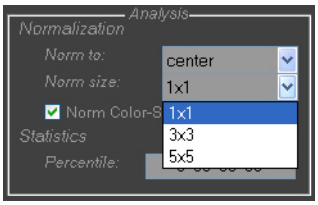
Reduction: to reduce calculating time the image size can be reduced. By using the dropdown menu you can define the reduction mode.

- **fixed:** the pciture height will be reduced to the value defined in “Reduction Height” (picture width will be adjusted proportional), e.g. original image 2000x3000 px, Reduction-Height 50, reduced image 50x75 px
- **relative:** the picture height will be reduced percetal to the value defined in “Reduction-Factor”, e.g. original image 2000x3000 px, Reduction-Factor 0.05, reduced image 100x150 px

Analysis

Normalization

By using the dropdown menus you can specify the normalization process



Norm to: specify the region that is used for normalization

- **center:** the center of the image is used for normalization and becomes 0
- **maxpos:** the coordinate with the maximal luminance is used for normalization and becomes 0

Norm size: by using the dropdown menu you can set the norm size, e.g 1x1 just one patch, 3x3 average of 3 patches

Norm Color-Shading to Mean: activate if the color shading shall be normalized to mean value of image (according to CPIQ).

Statistics

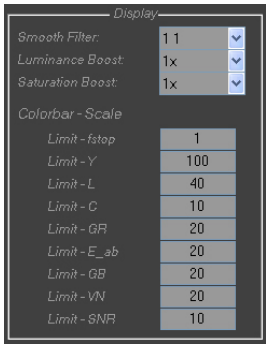
Percentile: The percentile rank of a score is the percentage of scores in its frequency distribution which are lower or equal to it. Insert values for the percentiles you want to get from calculation. In the results the percentiles are displayed in digital values (DV) and f-stops.

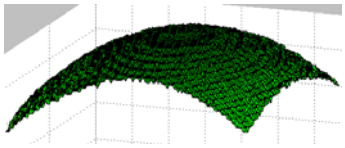
percentiles Y [DV]	-18.1/-1.2/-0.2/0.4
percentiles Y [f-stop]	-0.20/-0.01/-0.00/0.00

insert values for percentiles in the Advanced menu and you will get results explained in digital values (DV) and f-stop

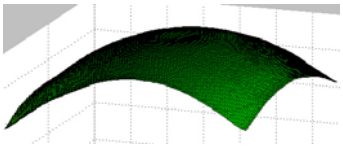
Display

Smooth Filter: the graphical results can be displayed smoothed. By using the dropdown menu define the filter matrix. 1x1 means no filtering, filtering with an 11x11 matrix effects most.





1x1 matrix



11x11 matrix

(**Luminace Boost)** and saturation (**Saturation Boost**).

Luminace Boost 1x

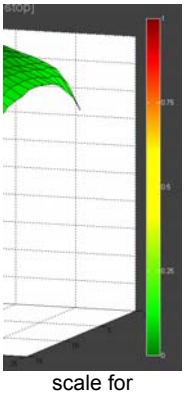
Luminace Boost 5x

Saturation Boost 1x

Saturation Boost 5x

Colorbar - Scale

By inserting values for fstop, Y, L, C, GR, GB, SNR, VN and E_ab you can scale the color bar right to the graphical results.



scale for lumninace shading (f-stops)

Limit - fstop: define the scale for the graphical representation of luminance shading in f-stops

Limit - Y: define the scale for the graphical representation of luminance shading

Limit - L: define the scale for the graphical representation of luminance shading (CIE-L)

Limit - C: define the scale for the graphical representation of color shading (CIE-C)

Limit - GR: define the scale for visualization of the difference between the green and red channel

Limit - E_ab: define the scale for visualization of delta E_ab

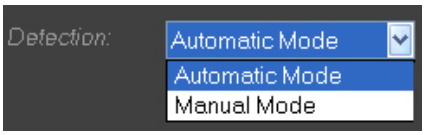
Limit - GB: define the scale for visualization of the difference between the green and blue channel

Limit - VN: define the scale for visualization of the visual noise

Limit - SNR: define the scale for visualization of the signal to noise ratio

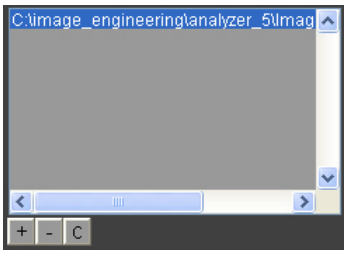
Detection

By using the dropdown menu you can choose if the ROI (region of interest) detection is done automatically ("**Automatic Mode**") or manually ("**Manual Mode**").



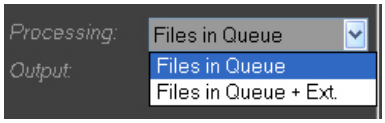
Files

Files for analysis have to be added to the built in file list using the " + " button. Delete selected files with the " - " button and clear the list with the " C " button.



Processing

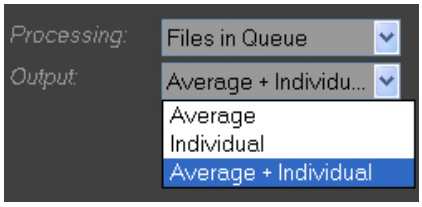
Files in Queue: All added files will be analyzed



Files in Queue + Ext.: if you have made several pictures and named them with extensions (e.g. te255_01, te255_02, te255_03, ...) you only have to add the image file with the lowest extensions and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS.

Output

By using the dropdown menu below the file list you can configure the output properties.



Average: the average results of the images and its following images are saved in the text file, if you have selected “Files in Queue + Ext”

Individual: separate results for every image are saved in the text file

Average+Individual: the average and separate results are saved

If all settings are made press the “ **Start** “ button to run the analysis of the image(s). 

9.2 Analyzing process and graphical presentation

9.2.1 General

After having done the setup up you can press the "**Start**" button and the analyzing process starts. In the upper frame you see the progress bar The numeric results and some images (_lumboost.jpg and _satboost.jpg) are saved autimatically as text and JPEG files (depending on your export settings made in "SETTINGS" above). Using the "Stop" button breakes the analyzing process.

progress bar and Stop button

By pressing the "**Image**" button below the file list the image of the selected image file is displayed. After analyzing you can switch between "**Image**" and "**Result**" view.

"Image" and "Result" button

Image View

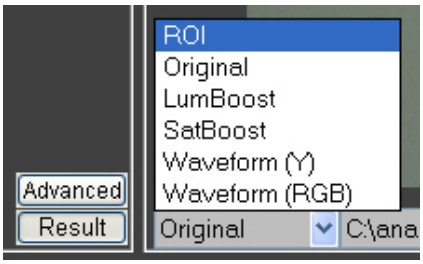
The dropdown below the image offers several views:

ROI: the ROIs of the analyzed patches are marked in blue. The patch size can be set in the Advanced Menu.

Original: the original image is shown

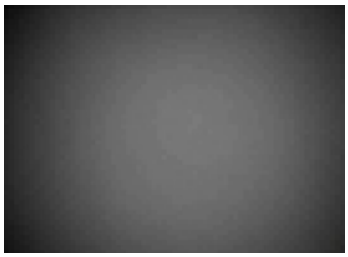
LumBoost: during the analysing process, the image is converted to the LCH colorspace (luminace, saturation, hue). The luminace distribution is shown depending on your defined boost (Advanced Menu); C=0

SatBoost: the saturation distribution is shown depending on your defined boost (Advanced Menu); L=50



The LumBoost and the SatBoost, named with the extension "filename_**lumboost** and "filename_**satboost**" are saved automatically. Path for saving, image quality can be defined in the "SETTINGS".

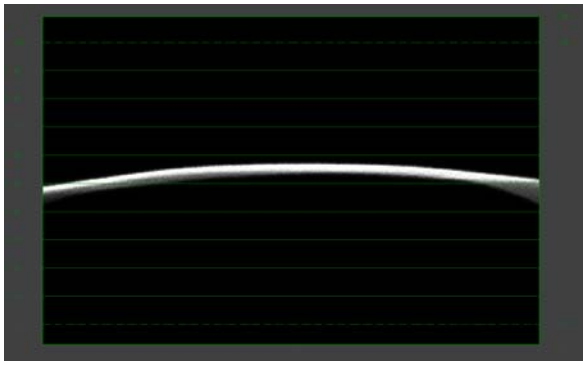
original



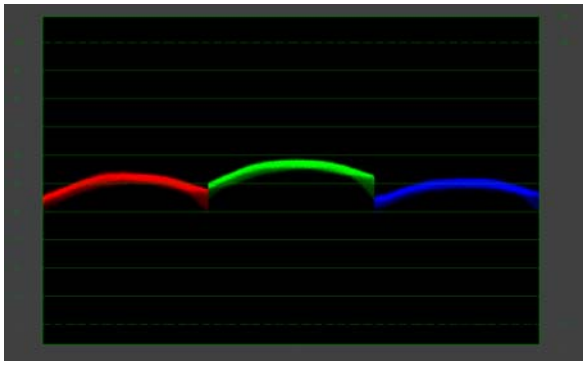
LumBoost

SatBoost

Waveform (Y) / Waveform (RGB): The waveform visualized the distribution of luminace values (Y) and RGB values in the image. The image is read line by line (x-axis) and the luminance values are outlined as percental (left y-axis) or digital values (right y-axis). The brighter the graph the higer the appearance of the luminance value. The RGB waveform displays the the distibution each for R, G and B values.

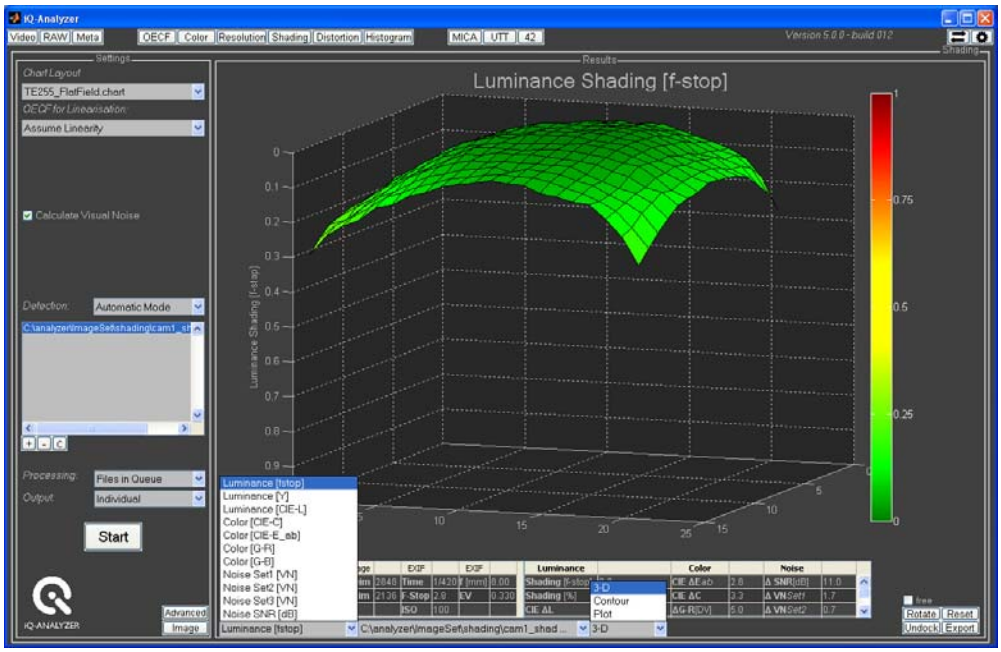


Waveform (Y)

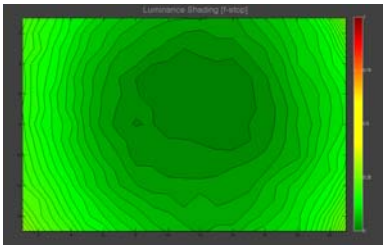


Waveform (RGB)

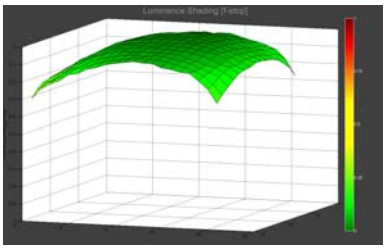
The graphical results are displayed in the right screen. Below the graphical results some **dropdown menus** exist. The first one allows switching between the result plots. By using the second dropdown menu you can choose between result representation of the particular image file (file path is shown) and representation of the average ("**Average**") if you have selected "Average" in the output properties below the file list on the left side. By using the right dropdown menu you can switch between 3-D, Contour plot (2-D) and Plot ("field" means the picture height and the fourth-degree polynomial describes the curve "All").



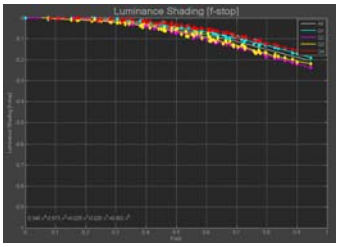
settings in the left screen results and dropdown menus in the right screen



Contour



3-D



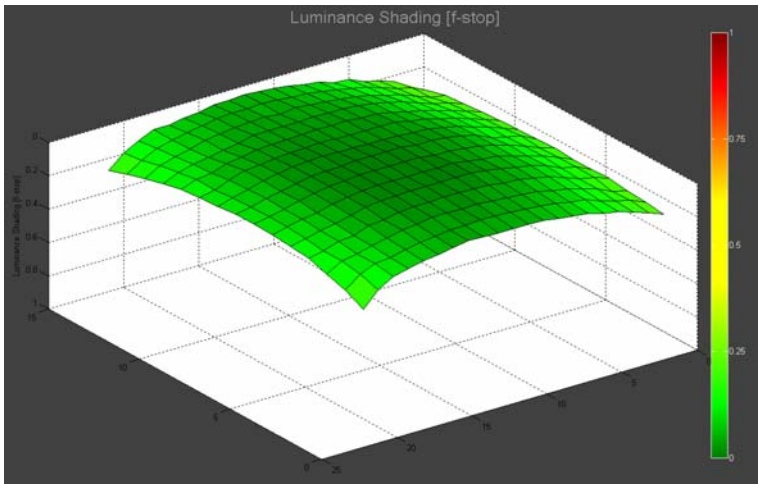
Plot

In 3D view it is possible to rotate the graphic.

By using the **Rotate** button the 3D graphic turns once through 360° around the ordinate.

If **free** is enabled an the **Rotate** button selected you can rotate the graph in every direction by using the mouse. The cursor turns into a circle.

curser for free rotation

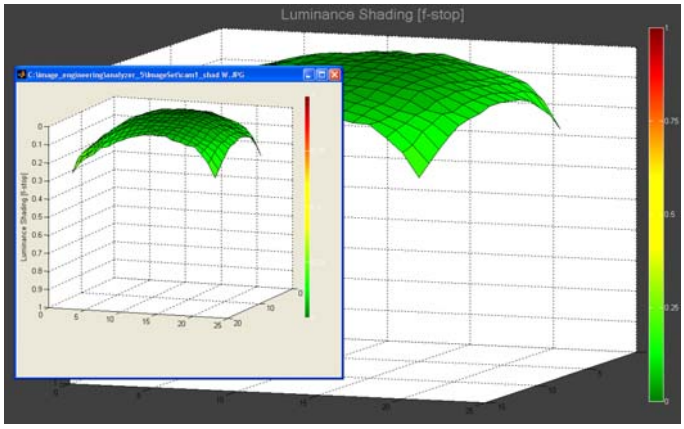


free rotated image

By using the “Reset” button the image view is rested to the starting position.

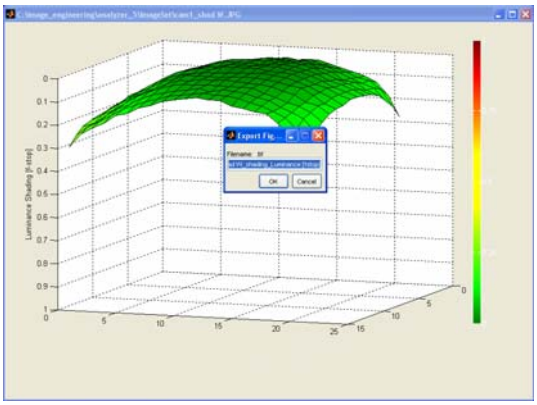
Undock button

The graphical result is displayed in a new window.



by pressing the “Undock” button the graphical result is displayed in a new window

Export button: The graphical result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “SETTINGS”.



Export

by using the “Export” button the graphical result is displayed in a new window and can be saved

9.2.2 Numerical and graphical results

The EXIF data are displayed in the left table below the illustration.

Image		Image		EXIF		EXIF	
Name	cam1_shad W.JPG	X-Dim	2848	Time	1/420	f [mm]	8.00
Make	FUJIFILM	Y-Dim	2136	F-Stop	2.8	EV	0.330
Model	FinePix F30			ISO	100		

EXIF data

The numerical results are shown in the right table.

Luminance		Color		Noise	
Shading [f-stop]	0.3	CIE ΔE*ab*	2.8	Δ SNR[dB]	11.0
Shading [%]	18.7	CIE ΔC	3.3	Δ VN*Set1*	1.7
CIE ΔL	10.2	ΔG-R[DV]	5.0	Δ VN*Set2*	0.7
percentiles Y	-18.1/-1.2/-0.2/0.4	ΔG-B [DV]	5.9	Δ VN*Set3*	1.0
percentiles Y	-0.20/-0.01/-0.00/0.(				

numerical results

Luminance

Shading [f-stop]: the maximum shading of luminance in f-stops
Shading [%]: the maximum shading of luminance as percentage
CIE Δ L: the absolute average shading of luminace (CIE L)

$$\Delta L = L_{\max} - L_{\min}$$

percentiles [DV] and [f-stop]: by inserting values for percentiles (in the Advanced mnenu) you get information about the luminance distribution explained in digital Values (DV) and f-stops depending on the choosen normalization.

Example: a percentile of 5 results in a digital value of -17.1. This means, 5% are less and 95% greater than -17.1.

define values for percentiles in the Advanced menu

percentiles Y	-18.1/-1.2/-0.2/0.4
percentiles Y	-0.20/-0.01/-0.00/0.00

reults after calculation

Color

CIE Δ E_{ab}: the average color shading expressed in Delta E (CIE E)
In contrast to the Delta E calculation that is used in the COLOR module, in the SHADING module the calculation of Delta E_{ab} is done without luminance L. So you get informtaion only about differences in colors without luminance.

$$\Delta E_{ab} = \sqrt{(\Delta a)^2 + (\Delta b)^2}$$

$$\Delta E(CIE1976) = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

$$\Delta L = L_{reference} - L_{sample}$$
$$\Delta a = a_{reference} - a_{sample}$$
$$\Delta b = b_{reference} - b_{sample}$$

CIE Δ C: the average color shading expressed in Delta C (CIE C)

$$\Delta C = C_{reference} - C_{sample}$$

Δ**G-R:** the average difference between green and red channel, explained in digital values
Δ**G-R:** the average difference between green and blue channel, explained in digital values

Noise

Δ **SNR [dB]:** the maximum difference of SNR, explained in dB
Δ **VNSet1:** the maximum difference of visual noise (viewing condition set 1)
Δ **VNSet2:** the maximum difference of visual noise (viewing condition set 2)
Δ **VNSet3:** the maximum difference of visual noise (viewing condition set 3)

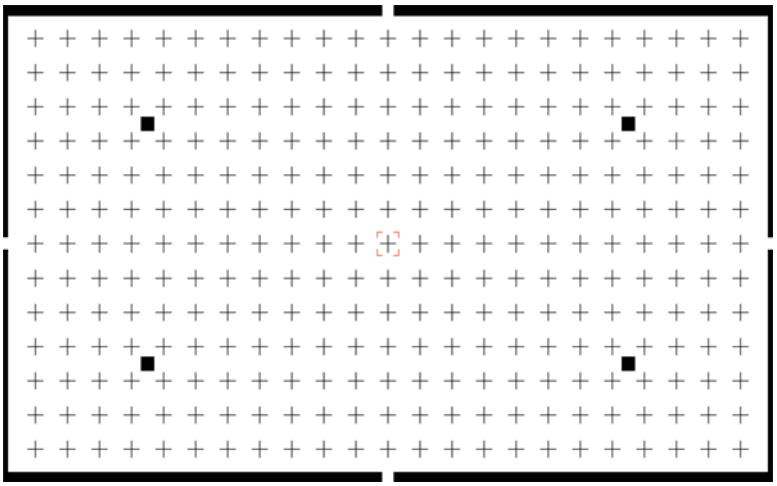
10. DISTORTION

The DISTORTION module enables you to evaluate the distortion and the lateral chromatic aberration in one step. Therefore iQ-Analyzer uses a special test charts, the TE251. The chart consists of crosses (or points) distributetd over the complete image. The center of the crosses (points) are located with sub pixel precision for all three channels. The distortion and the chromatic aberration can be calculated from these locations.

"Distortion" tab

There are some requirements for the image as they could affect the results:

- make sure that the camera is not tilted in any direction
- the center cross in the chart (surrounded by markers) has to be the center cross in the image as well
- arrange the camera in such a way that the image shows the full chart height.The image aspect ratio specifies how many crosses you cover in width
- the image must show only complete crosses
- the chart should be illuminated homogeneously

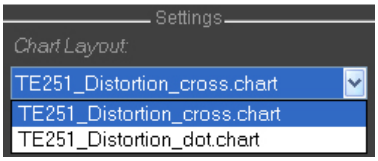


TE251 – the test chart for calculation of distortion and the chromatic aberration

10.1 Settings

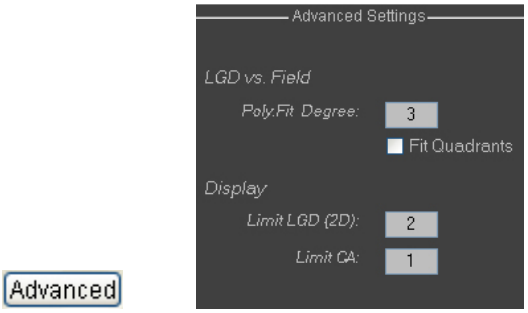
Before starting analysis of the DISTORTION charts you have to define some settings.

Chart Layout: select the Chart Layout File. It contains all neccessary information about the chart layout. iQ-Analyzer uses the TE251 for calculation of distortion and chromatic aberration.



select the chart layout for calculation of distortion and chromatic aberration

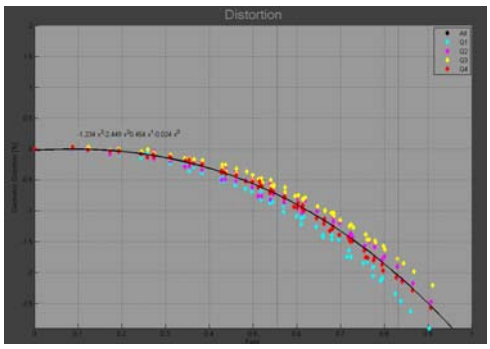
By using the “Adanced” button the Advanced menu opens.



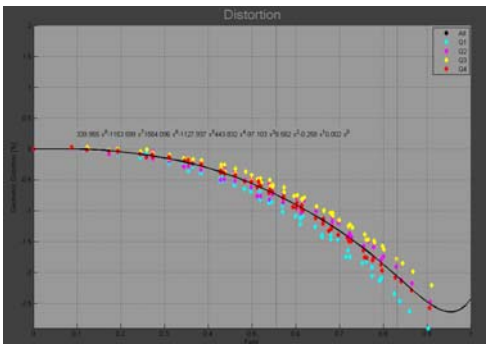
“Advanced” button and the opening Advanced menu

LGD vs. Field

Poly.Fit Degree: in the “Distortion vs. Field” view the distortion of every cross is plotted and a line of best fit is calculated. You can set the degree of the polynom.

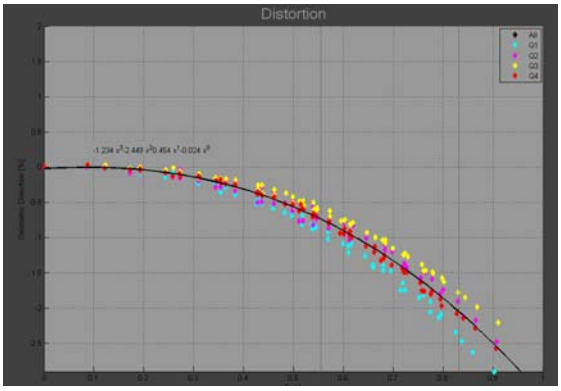


Poly.Fit Degree: 3

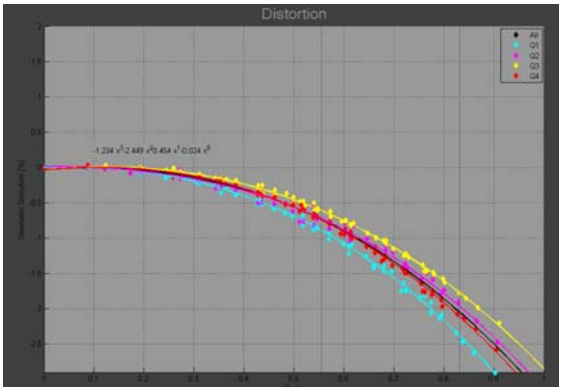


Poly.Fit Degree: 8

Fit Quadrants: in the “Distortion vs. Field” view the distortion of every cross is plotted and a line of best fit is calculated. The crosses are devided into the four quadrants of image. If you select “LGD vs. Field – Fit Quadrants” additionally to the one line of best fit, for every quadrant a line of best fit is displayed.



one line of best fit is diplayed

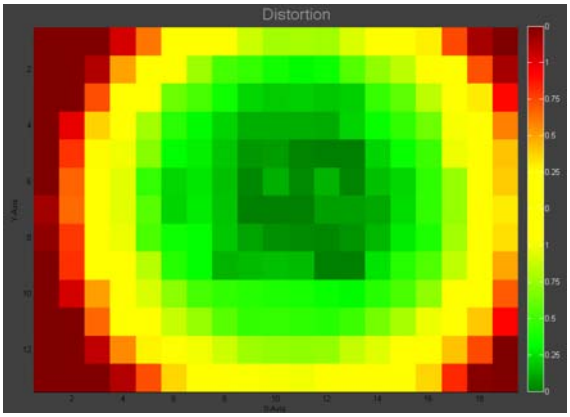


for every quadrant a lien of best fit is displyed, too

Display

Limit LGD (2D): you can scale the warning scale for the 2D view of distortion.

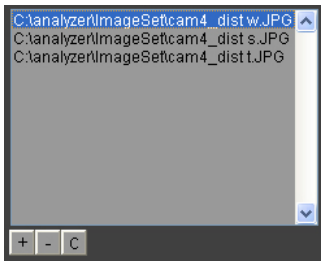
Limit CA: you can scale the warning scale for the view of chromatic aberratoon



Warning level in the 2D view of distortion

Files

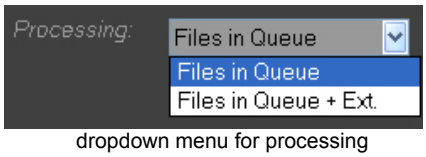
Files for analysis have to be added to the build in file list using the “ + “ button. Delete selected files with the “ - “ button and clear list with the “ C “ button.



file list

Processing

Files in Queue: all added files will be analyzed



dropdown menu for processing

Files in Queue + Ext.: if you have made several pictures and named them with extensions (e.g. te251_01, te251_02, te251_03, ...) you only have to add the image file with the lowest extensions and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS.

Output

In the DISTORTION module only output of individual results is supported.

drop down menu for output

If all settings are made press the " **Start** " button to run the analyssis of the image(s). 

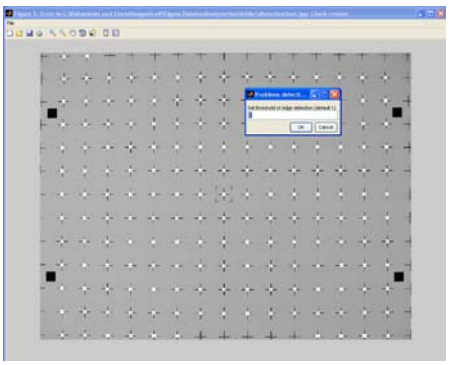
10.2 Analyzing process and graphical presentation

10.2.1 General

After setting up you can press the “**Start**” button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results saved autimatically as text (depending on your export settings made in “SETTINGS”). Using the “Stop” button breakes the analyzing process.

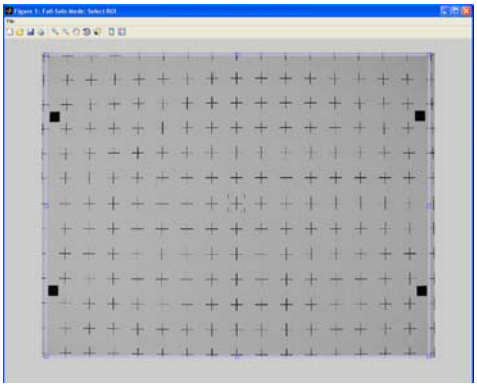
progress bar and Stop button

If there is a problem detecting all crosses, you are directed automatically into the fail-safe mode. First you have to select another threshold for detection. Default value is “1”. Set this value to a lower value (e.g. 0.5) if the image is blurred or has a great loss of sharpness to the corners. Set this value to a higher value (e.g. 3) if the image is sharpened strongly (e.g. mobile phones).

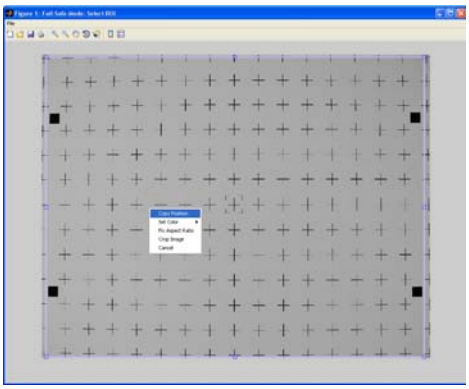


select threshold

Then select a region of interest in the image. You have to select the ROI so that you still have 13 rows of crosses. If you do happen to cut a column of crosses in the image, do not include this column into the ROI. Use the right mouse “Crop Image” or double click on the image and the analysing process starts.



select ROI



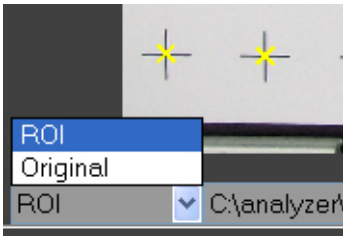
crop image and the anlysing process starts

By pressing the “**Image**“ button below the file list the image of the selected image file is displayed. After analyzing you can switch between “**Image**“ and “**Result**“ view.

“Image“ and “Result“ button

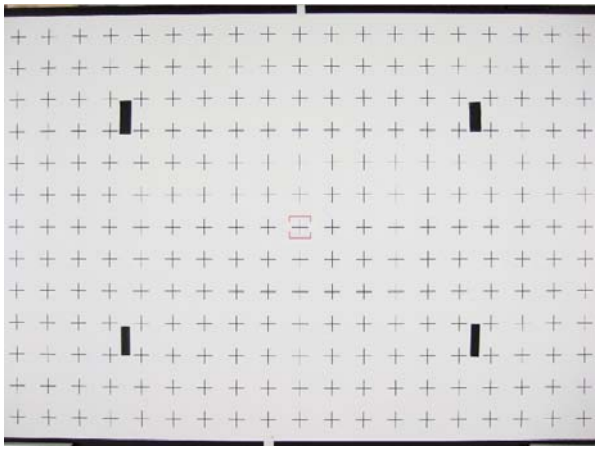
Image View

The dropdown below the image offers several views:

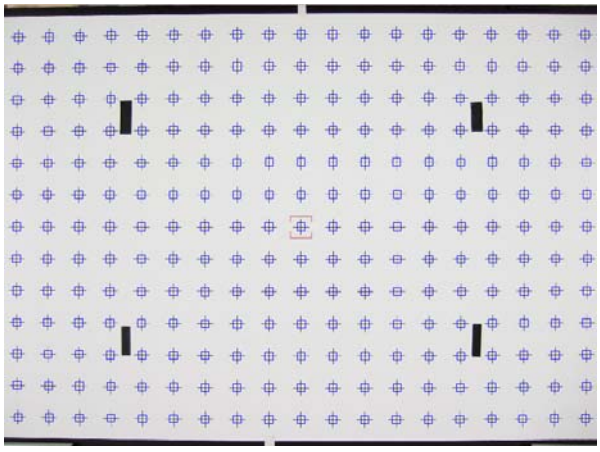


ROI: the ROIs of the analyzed patches are marked in blue

Original: the original image is shown

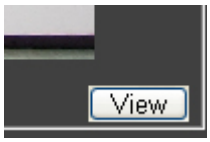


Original

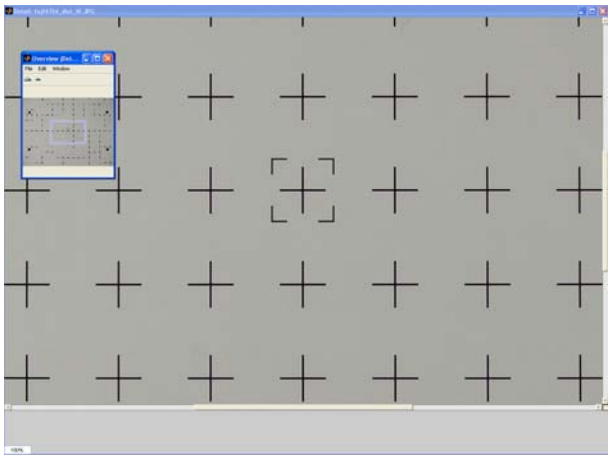


ROI

By pressing the “**View**” button in the down right corner of the “Image” view, the image opens in a new window. A new opening window enables editing the figure e.g. zooming in/out.

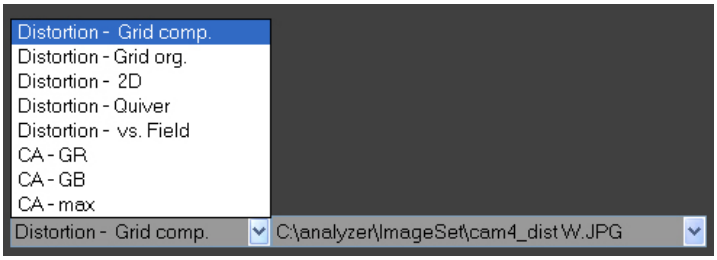


"View" button



editing window and the image in a new window

The graphical results are displayed in the right screen. Below the graphical results some **dropdown menus** exist. The first one allows choosing the **result** you want to be displayed (Distiortion – Grid comp, Distortion – Grid org., Distortion – 2D, Distortion – Quiver, Distortion – vs. Field, CA – GR, CA – GB, CA – max). By using the second dropdown menu you can select the image for which the result shall be displayed.



by using the dropdown menus you can select an image file and choose the displayed result

Below the illustration EXIF data and numerical results are shown which vary depending on the selection by using the dropdown menus.

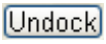
Image		Image		EXIF		EXIF	
Name	cam4_dist W.JPG	**X-Dim**	2848	**Time**	1/25	f [mm]	8.00
Make	FUJIFILM	**Y-Dim**	2136	**F-Stop**	2.8	**EV**	0.670
Model	FinePix F30			**ISO**	100		

EXIF data

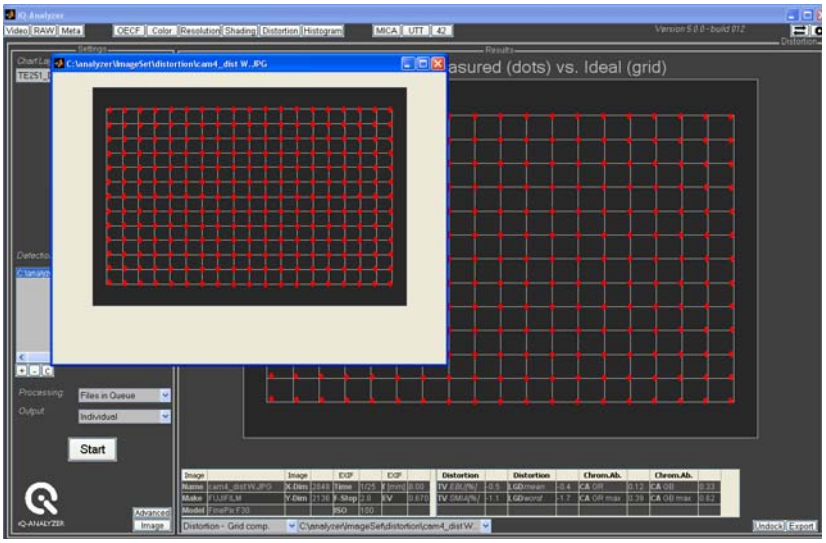
Distortion		**Distortion**		**Chrom.Ab.**		**Chrom.Ab.**	
TV *EBU[%]*	-0.5	**LGD** *mean*	-0.4	**CA** GR mean	0.11	**CA** GB mean	0.34
TV *SMIA[%]*	-1.0	**LGD** *worst*	-1.7	**CA** GR max	0.32	**CA** GB max	0.58

numerical results

Undock button: The graphical result is displayed in a new window.

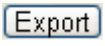


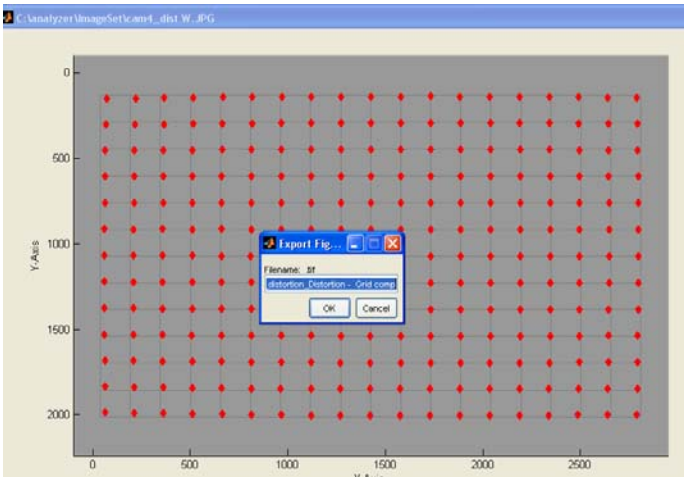
“Undock” button



undocked window

Export button: The graphical result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “SETTINGS”.





by pressing the “Export” button the graphical result is displayed in a new window and can be saved

10.2.2 Numerical and graphical results

By using the first dropdown menu you can choose the displayed result.

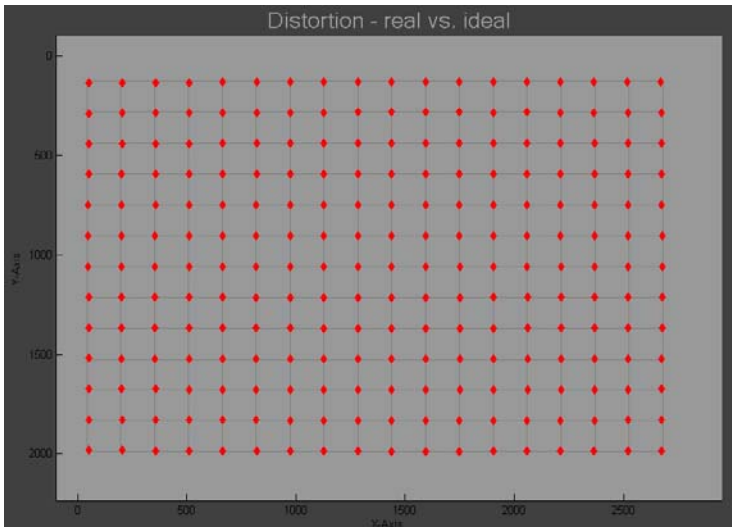
Distortion

- Distortion – Grid comp.
- Distortion – Grid org.
- Distortion – 2D
- Distortion Quiver
- Distortion – vs.Field

Chromatic Aberation

- CA – GR
- CA – GB
- CA – max

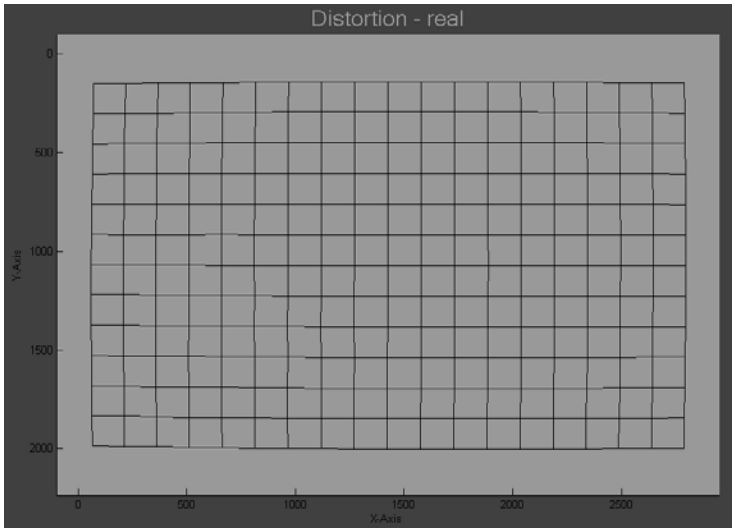
Distortion – Grid comp.



Distortion – Grid comp.

The illustration visualizes the distortion in the image. Each dot represents a cross in the real image. The black grid represents the original image. X and Y are height and width of the image in pixel. The geometric distortion is plotted as a function of radial distance from the center of the image versus the lens geometric for each grid point.

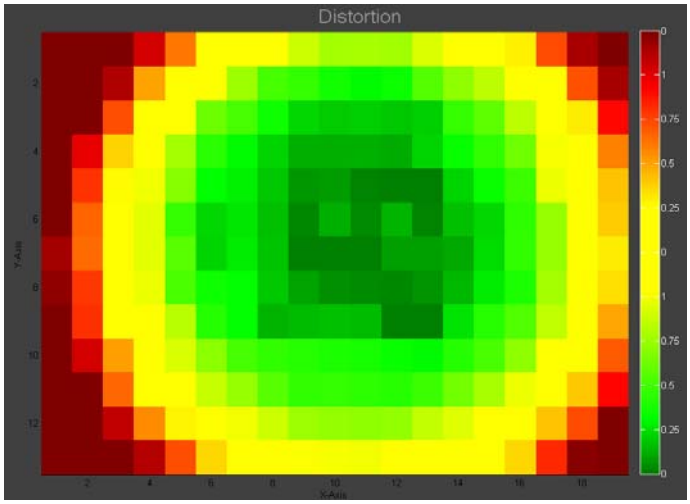
Distortion – Grid org.



Distortion – Grid org.

The illustration visualizes the distortion in the image with the aid of a distorted grid. X and Y are height and width of the image in pixel. The geometric distrotion is plotted as a function of radial distance from the center of the image versus the lens geometric for each grid point.

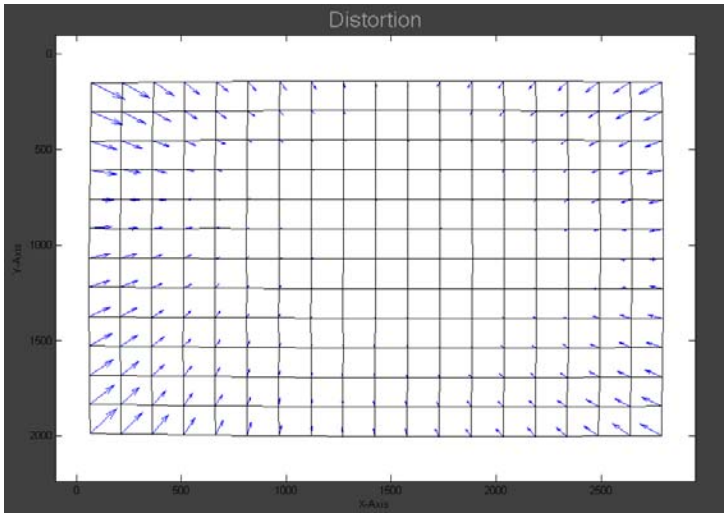
Distortion – 2D



Distortion – 2D

Distortion is shown in 2D view. Lens geometric distortion is visualized with colors. The warning level can be adjusted in teh Advanced Settings. Each patch represents a cross in the image.

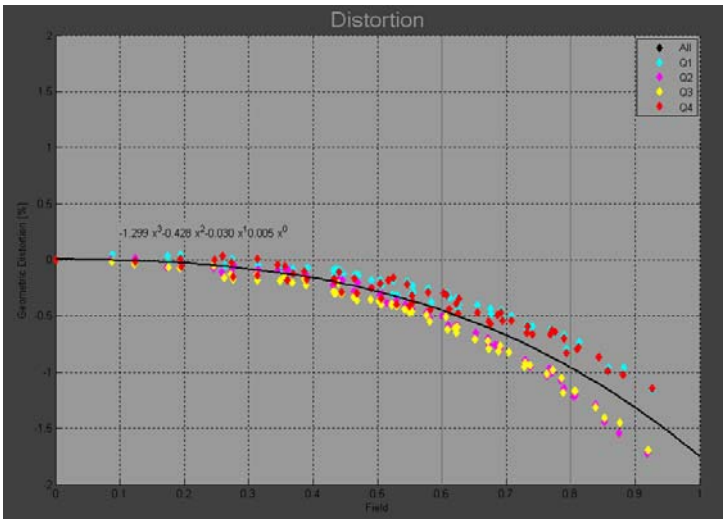
Distortion – Quiver



Distortion - Quiver

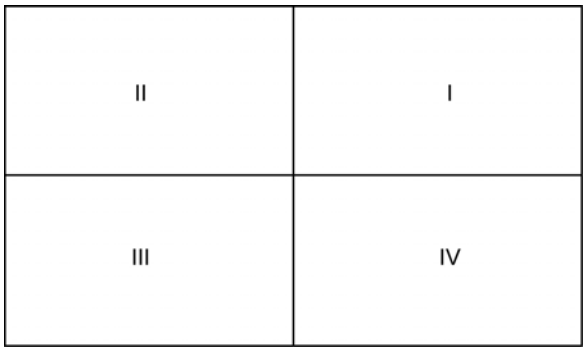
Distortion is displayed by vectors. The vector direction indicates the direction of distortion. Each dot represents a cross in the image. X and Y are height and width of the image in pixel.

Distortion – vs. field

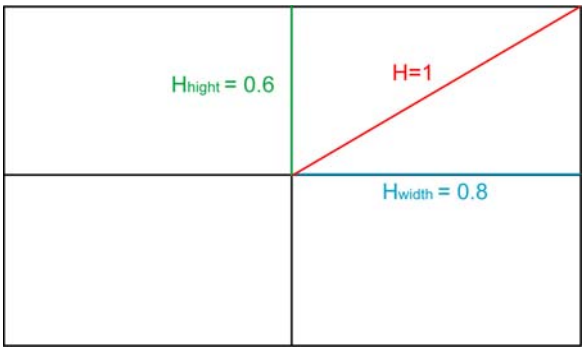


Distortion vs. Field

The illustration shows the geometric distortion for every grid position (cross). The crosses are devided into the four quadrants and colored. The black curve indicates the line of best fit for all grid positons. The coefficients are also displayed. The degree of the polynom can be set in the Advanced Settings (Poly.Fit Degree). If you select “LGD vs. Field – Fit Quadrants” in the Advanced settings, a line of best fit ist displayed for every quadrant additionally.



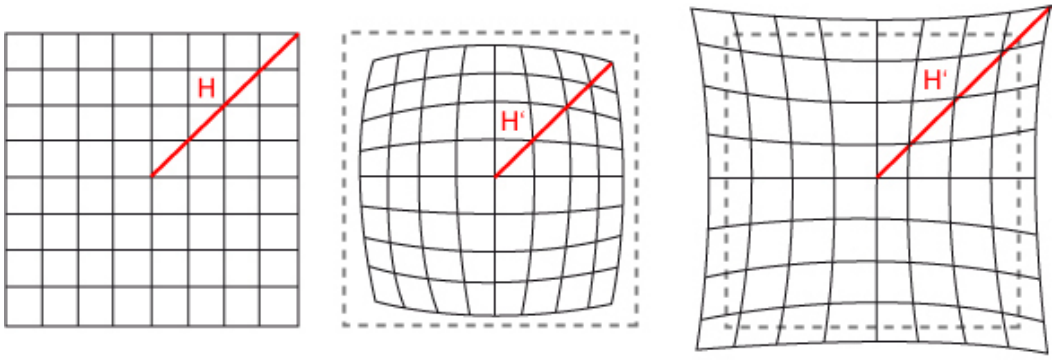
the four quadrants (Q1, Q2, Q3, Q4)



height and width

The x axis indicates the distance from center. The distance from center to one corner is set to H = 1. The two black vertical lines mark the half of picture height (0.6) and the half of picture width (0.8).

Undistorted Grid | Barrel Distortion (negative) | Pincushion Distortion (positiv)



Lens Geometric Distortion Definition

The lens geometric distortion is defined as

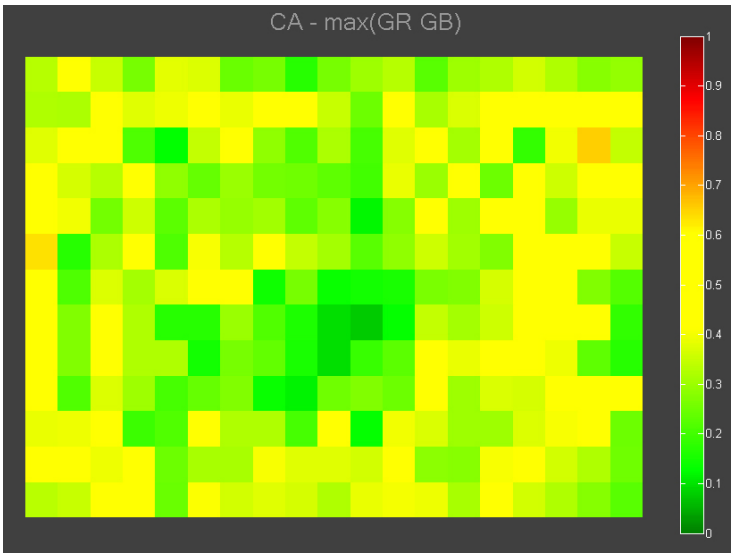
$$LGD = 100 \cdot \frac{(H` - H)}{H}$$

H' = dot distance from center of image
H = undistorted dot position

The geometric distortion for a grid position is the delta between the radial distance of the actual grid position H' and radial distance to the ideal grid position H, devided by the ideal grid position H.

H'<H indicates negativ distortion (barrel distortion)
H'>H indicates positive distortion (pincushion distortion)

CA – GR, CA – GB, CA - max



chromatic aberration

The illustration visualizes the chromatic aberration in the image. You can choose representation of distance in pixel between the green and red channel (CA – GR), the green and blue channel (CA – GB) and the maximum of both.

Numerical results

Below the illustrations you find numerical results in the table.

Distortion		Distortion		Chrom.Ab.		Chrom.Ab.	
TV *EBU[%]*	-0.5	LGD *mean*	-0.4	CA GR mean	0.11	CA GB mean	0.34
TV *SMIA[%]*	-1.0	LGD *worst*	-1.7	CA GR max	0.32	CA GB max	0.58

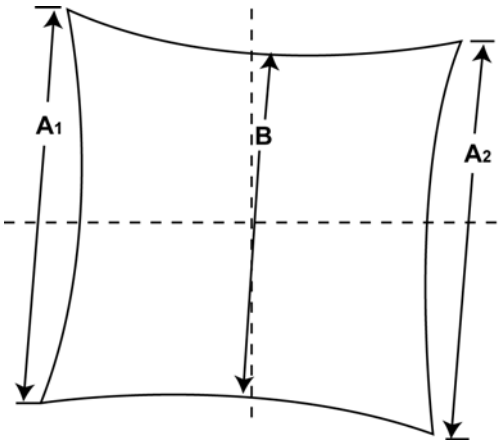
numerical result of distortion calculation

Distortion (TV)

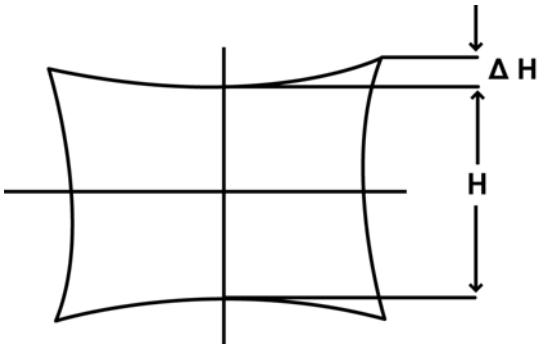
The results of distortion calculation are shown as SMIA TV-Distortion (SMIA = Standard Mobile Imaging Architecture) and (EBU-) TV-Distortion. The SMIA definition has been widely adopted in the mobile imaging industry. In the traditional definition, TV distortion is the change (Δ) in the center-to-top distance divided by by the bottom-to-top distance. In the SMIA definition, both A and B, are bottom-to-top distances.

$$SMIA - TV - Distortion = \frac{A - B}{B} * 100$$

$$A = \frac{A_1 + A_2}{2}$$



$$TV - Distortion = \frac{\Delta H}{H} * 100$$



Distortion (LGD)

LGD mean: the average of lens geometric distortion of all grid positions

LGD worst: the maximal value of distortion

Chromatic Aberration

CA G-R mean: the average distance in pixel between the green and red channel

CA G-R max10: the mean value of the ten largest distances between green and red

CA G-B mean: the average distance in pixel between the green and red channel

CA G-B max10: the mean value of the ten largest distances between green and blue

11. HISTOGRAM

The HISTOGRAM modul calculates the intensity histogram and detects pixel that are outside the expected tonal range (dead or hot pixel). These dead or hot pixel are saved in a table that can be imported by a camera for correction or used by external software.

The tool can be used to analyze “black”, “gray” and “white” images. A black image is produced by blocking all light from reaching the sensor, e.g. take an image in a total dark room or cover the lens. A white and gray image can be produced by taking pictures of a white or gray background.

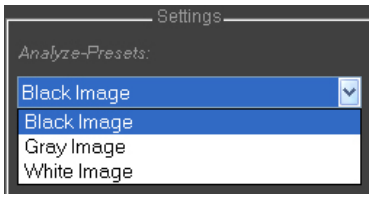
“Histogram” tab

11.1 Settings

Before starting analysis of HISTOGRAM charts you have to define some settings.

Analyze-Presets: select the image layout. You can choose between presets (black, gray and white image)

.

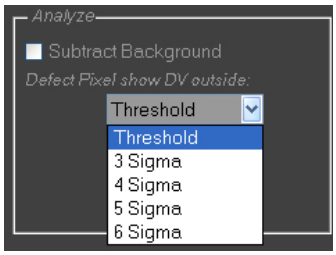


select the chart layout for calculation of shading

Analyze

Subtract Background: it is more important for white and gray images than for black ones. Pixel that are outside the expected tonal range shall be detected. To avoid the influence of inhomogeneous illumination and shading, the background can be subtracted from the image. Therefore a 7x 7 filter is used to calculate the background.

Defect Pixel show DV outside: the threshold that is used to detect a pixel as defect can be set individually. You can choose between “Threshold” and several values for the standard deviation “Sigma”.

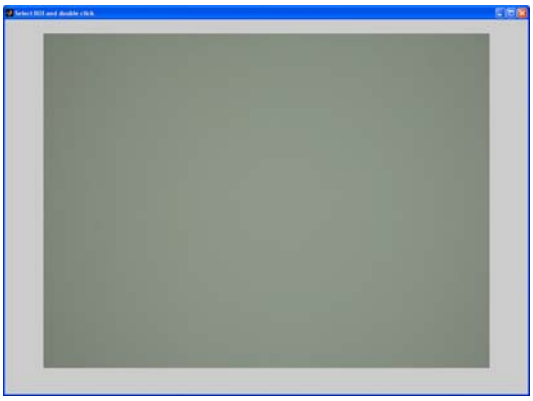


3 Sigma = 99.7300204%
4 Sigma = 99.993666%
5 Sigma = 99.99994267%
6 Sigma = 99.9999998027%

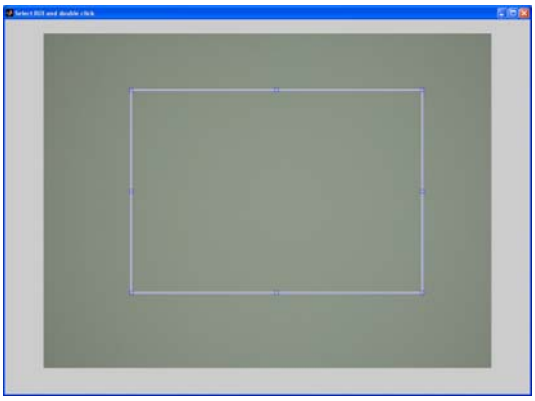
Thresholds: if you have subtracted background, insert values vor “ - Mean” and “ + Mean ” (values greater and less than the calculated mean value). If you do not have subtracted background, insert values for “Min” and “Max”.

insert values for threshold depending on “subtract background”

Select ROI: enable the checkbox if you want to select the region of interest yourself. After doing all settings, press the “Start” button. You can select the region of interest by drawing a rectangle around the region and double click on it or use the right mouse button and press “Crop Image” and the analyzing process starts.



window for manual ROI detection

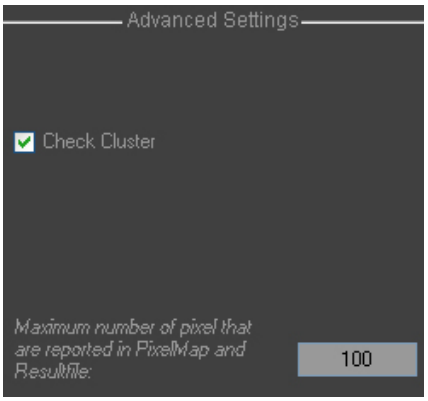


rectangle around your region of interest

Advanced Settings

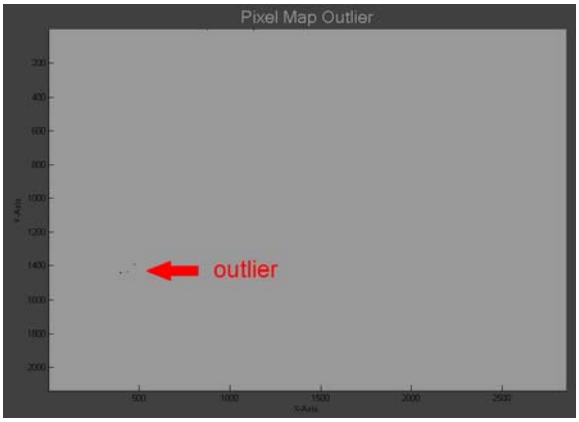
By using the toggle button " **Advanced** " the Advanced Menu opens. 

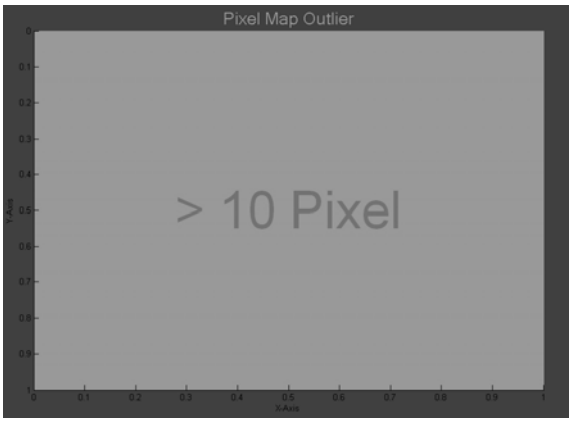
Check Cluster: enable this checkbox, if the defect pixel also shall be analyzed for clusters. A cluster contains of at least two adjacent pixel. This will encrease the computing time.



Advanced Menu

Maimum number of pixel that are reported in PixelMap and Resultfile: set the level from this no display of outlier pixels in the pixelmap is shown.

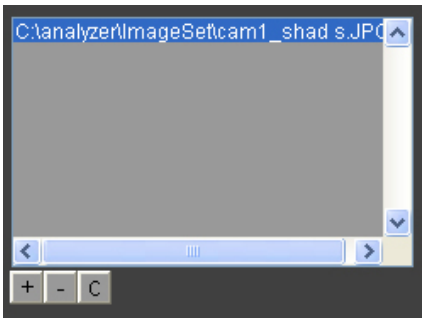




left: number of outlier pixel is less than the level set in "Max Count PixelMap" and the pixels are shown in the pixel map
right: number of outlier pixel is greater than the level set in "Max Count PixelMap" and an information ist shown

Files

Files for analysis have to be added to the build in file list using the " + " button. Delete selected files with the " - " button and clear list with the " C " button.

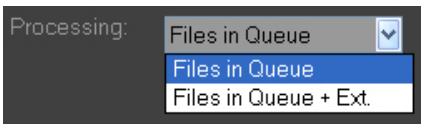


file list

Processing

Files in Queue: all added files will be analyzed

Files in Queue + Ext.: if you have made several pictures and named them with extensions (e.g. black_01, black_02, black_03, ...) you only have to add the image file with the lowest extensions and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS.

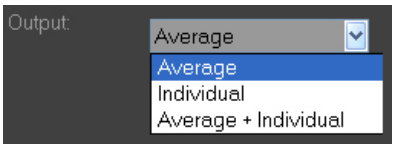


dropdown menu for processing

Output

By using the dropdown menu below the file list you can configure the output properties.

Average: the average results of the selected images are saved in the text file (if you have inserted "Files in Queue + ext.")
Individual: the separate results for every image are saved in the text file
Both: the average and separate results are saved in the text file



drop down menu for output

If all settings are made press the " **Start** " button to run the analyssis of the image(s). 

11.2 Analyzing process and graphical presentation

11.2.1 General

After setting up you can press the "**Start**" button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results saved autimatically as text (depending on your export settings made in "SETTINGS"). Using the "Stop" button breakes the analyzing process.

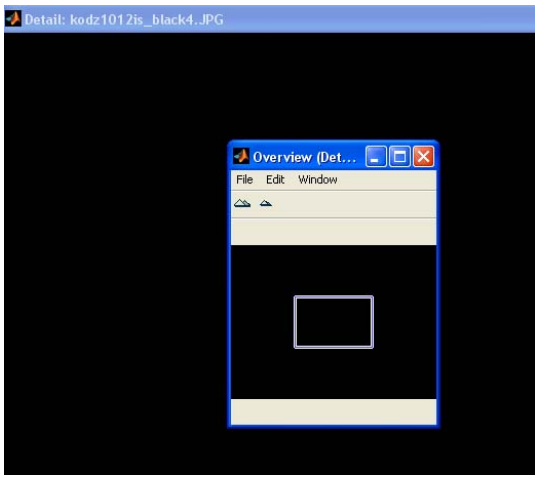
progress bar and Stop button

By pressing the "**Image**" button below the file list the image of the selected image file is displayed. After analyzing you can switch between "**Image**" and "**Result**" view.

"Image" and "Result" button

By pressing the "**View**" button in the down right corner of the "Image" view, the image opens in a new window. A new opening window enables editing the figure e.g. zooming in/out.

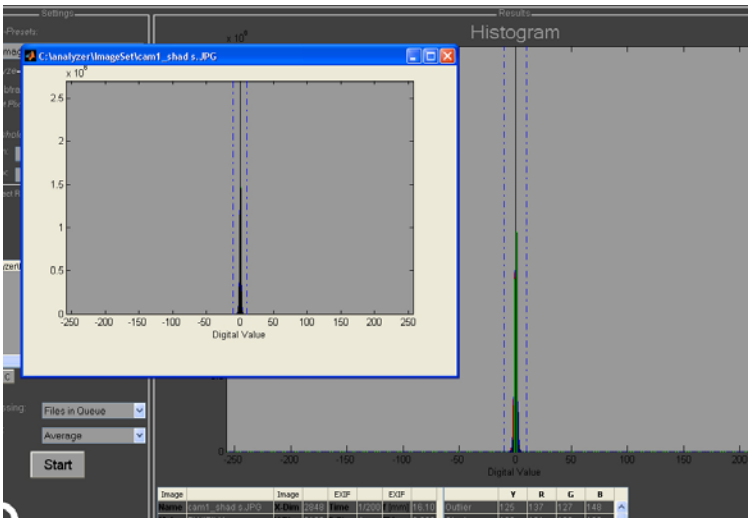
"View" button



editing window and the image in a new window

Undock button

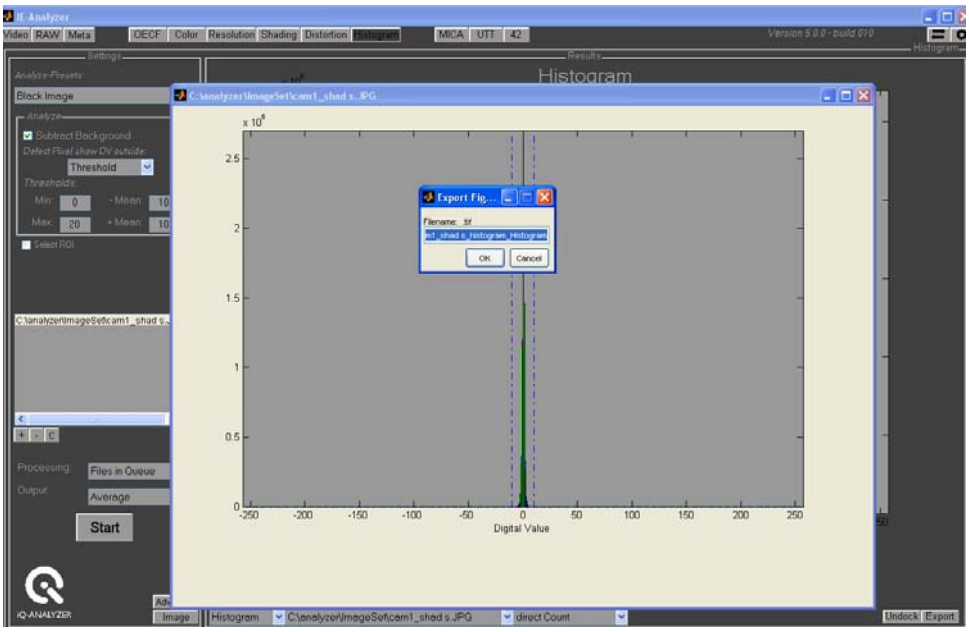
The graphical result is displayed in a new window.



Undock

by pressing the “Undock” button the graphical result is displayed in a new window

Export button: The graphical result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “SETTINGS”.

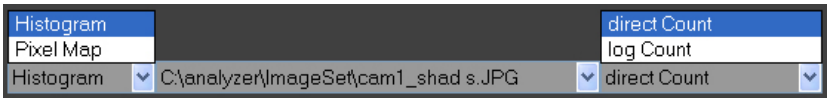


Export

by using the “Export” button the graphical result is displayed in a new window and can be saved

11.2.2 Numerical and graphical results

By using the first dropdown menu you can choose the displayed result: Histogram or Pixel Map. In case of Histogram you can choose between repesentation of direct and logarithmic (third dropdown menu). The analyzed images can be selected by using the second dropdown menu.



dropdown menu for selecting results, images and representation

Below the graph two tables are shown with EXIF data and numeical results.

Image		Image		EXIF		EXIF	
Name	cam1_shad s.JPG	X-Dim	2848	Time	1/200	f [mm]	16.10
Make	FUJIFILM	Y-Dim	2136	F-Stop	4	EV	0.330
Model	FinePix F30			ISO	100		

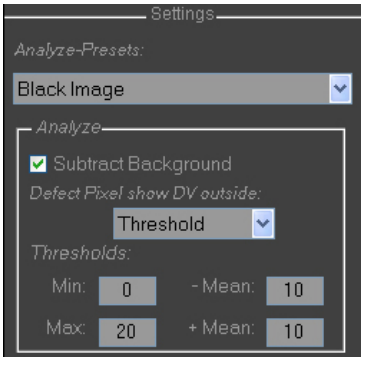
EXIF data

	Y	R	G	B
Outlier	125	137	127	148
Cluster	108	121	109	130
Mean	-0.0	-0.0	-0.0	-0.0
Sigma	1.0	1.1	1.0	1.1
Thres.High	10.0	10.0	10.0	10.0
Thres.Low	-10.0	-10.0	-10.0	-10.0

numerical results

Numerical and graphical results

The following settings serve as example for explanation of numerical and graphical results:



example settings

	Y	R	G	B
Outlier	4	4	4	4
Cluster	1	1	1	1
Mean	-0.0	-0.0	-0.0	-0.0
Sigma	0.1	0.1	0.1	0.1
Thres.High	10.0	10.0	10.0	10.0
Thres.Low	-10.0	-10.0	-10.0	-10.0

numerical results

Outlier: 4 pixel are outside the expected tonal range

Cluster: a cluster contains of at least two adjacent pixel

Mean: the mean value for luminance Y and the three color channels R, G and B is 0

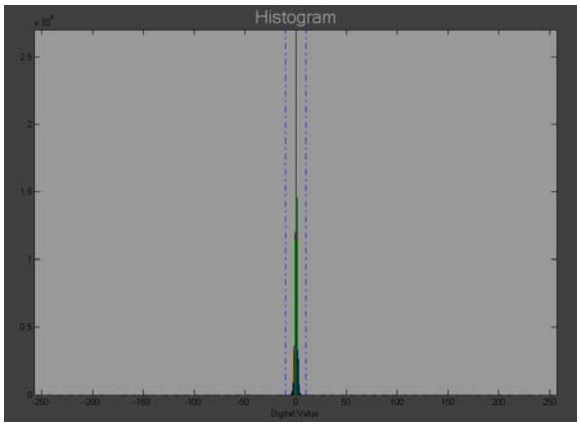
Sigma: the standard deviation for luminance Y and the three color channels R, G and B is 0.1

Thres.High: the mean value was set as 10

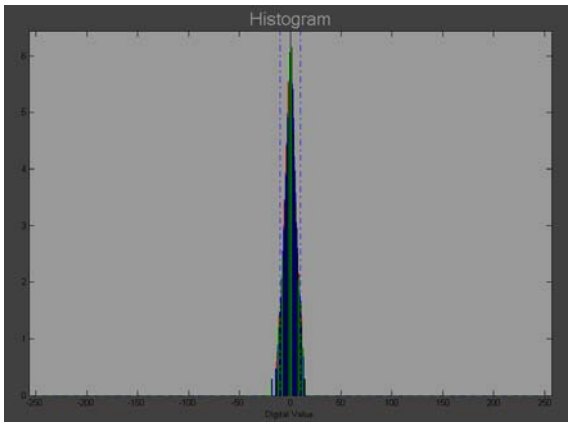
Thres.Low: the mean value was set as 10

Histogram

In the histogram view the counts (direct or logarithmic) are displayed depending on the digital values. In this example “subtract background” is enabled, so that the digital value of the filtered image is set to 0.

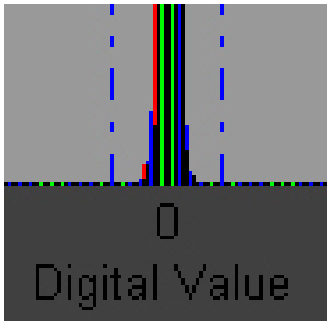


Histogram direct count



Histogram log count

The two blue dashed vertical lines marke the defined tolerance range. Pixel inside are inside the expected tonal range. Pixel outside are detected as dead or hot pixel. In this example four pixel (outlier) are outside the range.



the dashed blue lines marke the tolerance range

Pixel Map

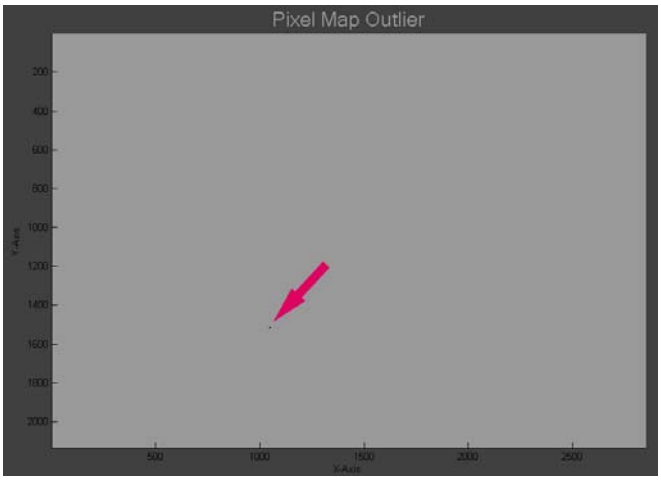
The Pixel Map indicates the outlier pixel in the image. X and y axes are image width and height displayed in pixel. In the result txt file the exact pixel postion for Y, R, G and B are displayed and saved. In this example the four outliers have the XY coordinates (for Y, R, G and B):

Outlier 1: X=1034, Y=1598

Outlier 2: X=1034, Y=1599

Outlier 3: X=1035, Y=1598

Outlier 4: X=1035, Y=1599



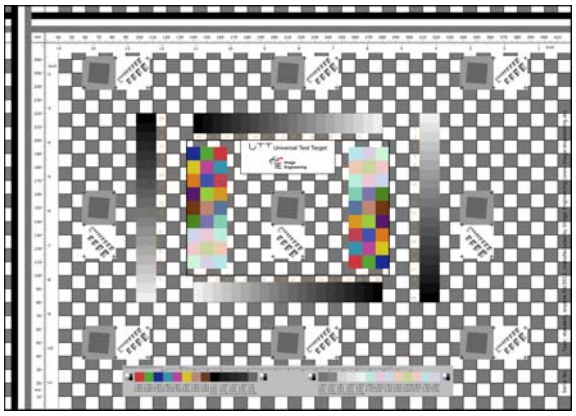
Pixel Map with outliers, indicated with the red arrow

12. UTT

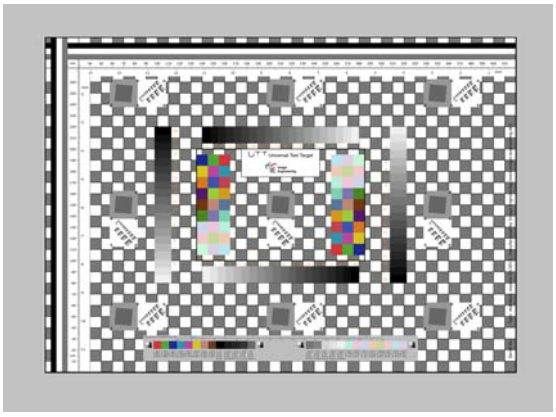
The UTT module is designed to analyze the Universal Test Target (UTT) and provides an insight into the complete image quality of all types of high end cameras and scanners used for archiving.

"UTT" tab

The UTT chart has either to be cropped exactly or the environment has to be nearly homogeneous; most suitable is a homogeneous white, gray or black background.



Croped UTT target (DIN A3)



UTT targt (DIN A3) in a homogeneous environment

Note: If an error message about not enough memory appears, you may try one of the following points:

- restart the software or
- reboot windows or
- reduce volume of data (crop unnecessary areas, reduce to 8 bit)

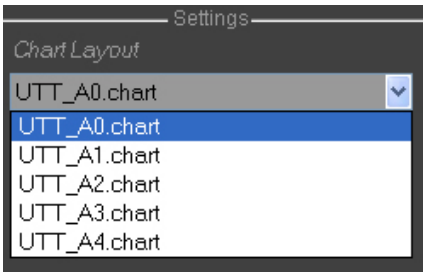
Solution in Windows: increase virtual Memory and/or activate /3G switch (see Tech Note)
http://technet.microsoft.com/en-us/library/bb124810(EXCHG.65).aspx
Large image flles might always lead to a memory error. Try to reduce the amount of data, e.g. by reducing from 16bit to 8bit externally.

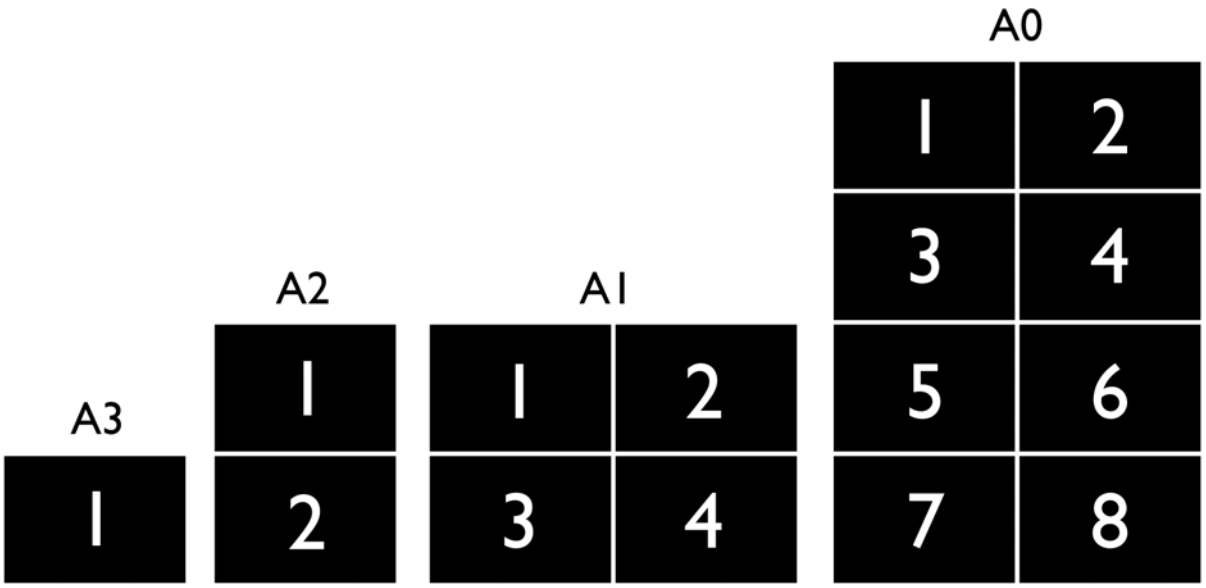
If you have a memory issue, please do not use the "Manual Mode" for ROI Detection and leave the "Rotate Image" menu to "0°"

12.1 Settings

Before starting the analysis of the UTT charts you have to define some settings.

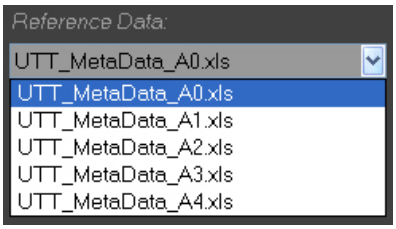
Chart Layout: select the chart layout file. It contains all neccessary information about the chart layout. The UTT target is available in the DIN sizes A4 and A3 to A0. The formats A3 to A0 consist of tiles. A3 is one tile, A2 consists of two tiles, A1 of four tiles and A0 of eight tiles. The A4 format has a slightly modified design (only two gray scales and one set of color patches).



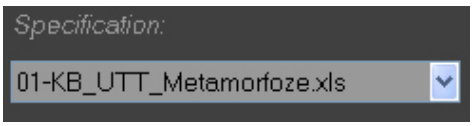


The UTT formats consist of tiles

Reference Data: reference file for the UTT charts. By using the dropdown menu you can choose the reference data of the chart you would like to analyse.



Specification: the tolerance ranges are defined in the specifications.



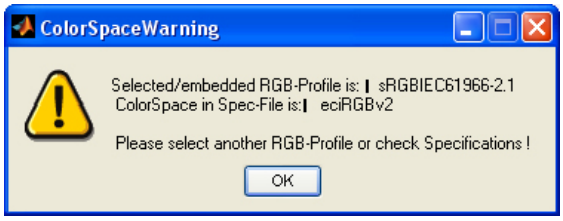
Advanced Settings

By using the toggle button " **Advanced** " the Advanced Menu opens. 

RGB Profile (if embedded Profile cannot be read)

For calculation of the image the embedded profile is used. If the profile cannot be read or no profile is embedded, the profile is used that is set in the Advanced menu.

The specifications describe the profile that is used for comparison of the image. Most specifications use the eciRGB profile version 2 for calculations and comparison. If the image contains a different profile than eciRGB v2 a warning appears, that the profile of the image do not conform to the profile of the specification.



"Manual Mode" in "ROI Detection"

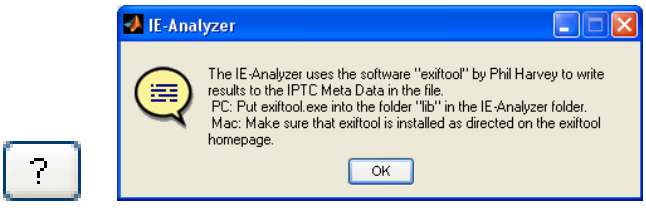
Beside the automatic mode for ROI (region of interest) detection a manual mode can be chosen. If the manual mode is selected, there are two alternatives

- Crop Image: you can select the chart, further detections are done automatical
- Crop Image & Adjust Patches: you can select the chart and also adjust the patches

The manual mode is time and memory consuming. In most cases the automatic mode works satifactorily.

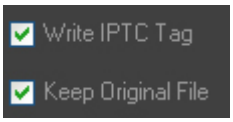
Writing Meta Data to File

The results are written into the IPTC tag. Using the "?" button a popup window with information appears and you are linked to the website with the Exif tool of Phil Harvey you need and you have to install if you use MAC OS X (under Windows exiftool.exe is installed already).

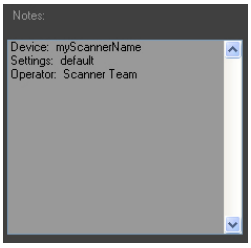


"?" button and popup window with information about the required Exif tool

Write IPTC Tag: enable the checkbox if IPTC tags shall be written



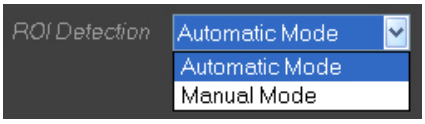
Keep Original File: if the checkbox is enabled the Exif tool first makes a copy of the original file ("filename.tif_original") and modifies the original file. If you want to use the original file, you have to delete the part "_original" from the filename. If the checkbox is not enabled, the original file is modified during the analyzing process.Recommended is to enable the checkbox.



Notes: the inserted notes are also written into the IPCT tag.

ROI Detection

By using the dropdown menu you can choose if the ROI (region of interest) detection is done automatically ("**Automatic Mode**") or manually ("**Manual Mode**").



Manual Mode: After doing all settings, press the "Start" button. You can select the UTT chart by drawing a rectangle around the chart and double click on it or use the right mouse button and press "Crop Image". If "Crop Image & Adjust Patches" is enabled in the Advanced Menu, you can adjust the ROIs manually

drawing a rectangle around the UTT target (DIN A3)

cut out UTT (DIN A3) and adjustable patches

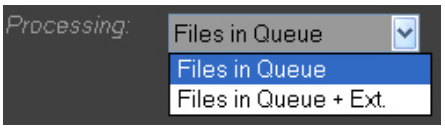
When the manual adjustment of ROIs is done, double click on the image and the analyzing process starts.

Files

Files for analysis have to be added to the file list using the " + " button. Delete selected files with the " - " button and clear the list with the " C " button.

Processing

Files in Queue: All added files will be analyzed



Files in Queue + Ext.: If you have made several pictures and named them with extensions (e.g. UTT_01, UTT_02, UTT_03, ...) you only have to add the image file with the lowest extension and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS. Use **Files in Queue + Ext.** if you have made an image series with same settings. Do not use this function if your charts consitst of several tiles.

Output

Individual: separate results for each image are saved in the text file

If all settings are done, press the " **Start** " button to run the analysis of the image(s).

12.2 Analyzing process and graphical presentation

12.2.1 General

After setting up you can press the "**Start**" button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results saved autimatically as text (depending on your export settings made in "SETTINGS"). Using the "Stop" button breakes the analyzing process.

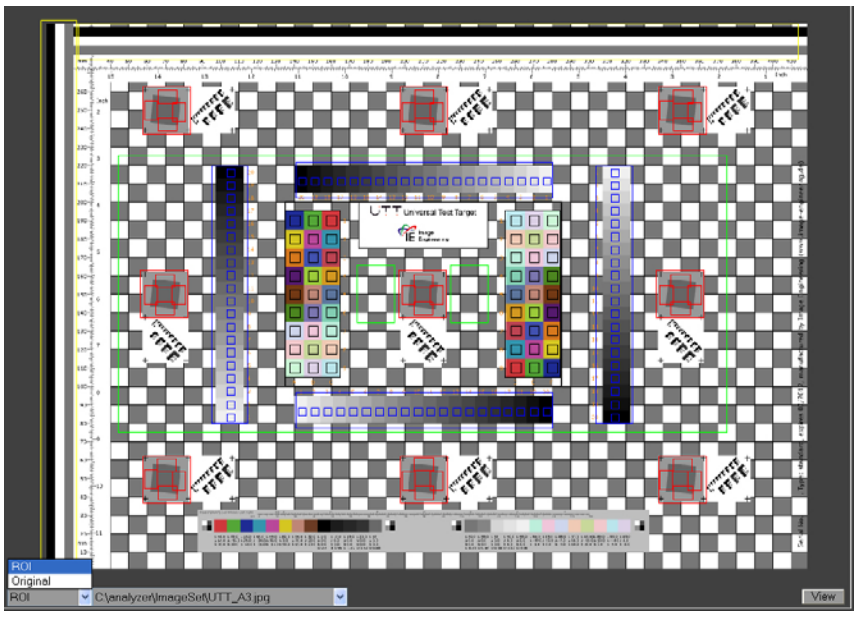
progress bar and Stop button

By pressing the "**Image**" button below the file list the image of the selected image file is displayed. After analyzing you can switch between "**Image**" and "**Result**" view.

"Image" and "Result" button

Image View

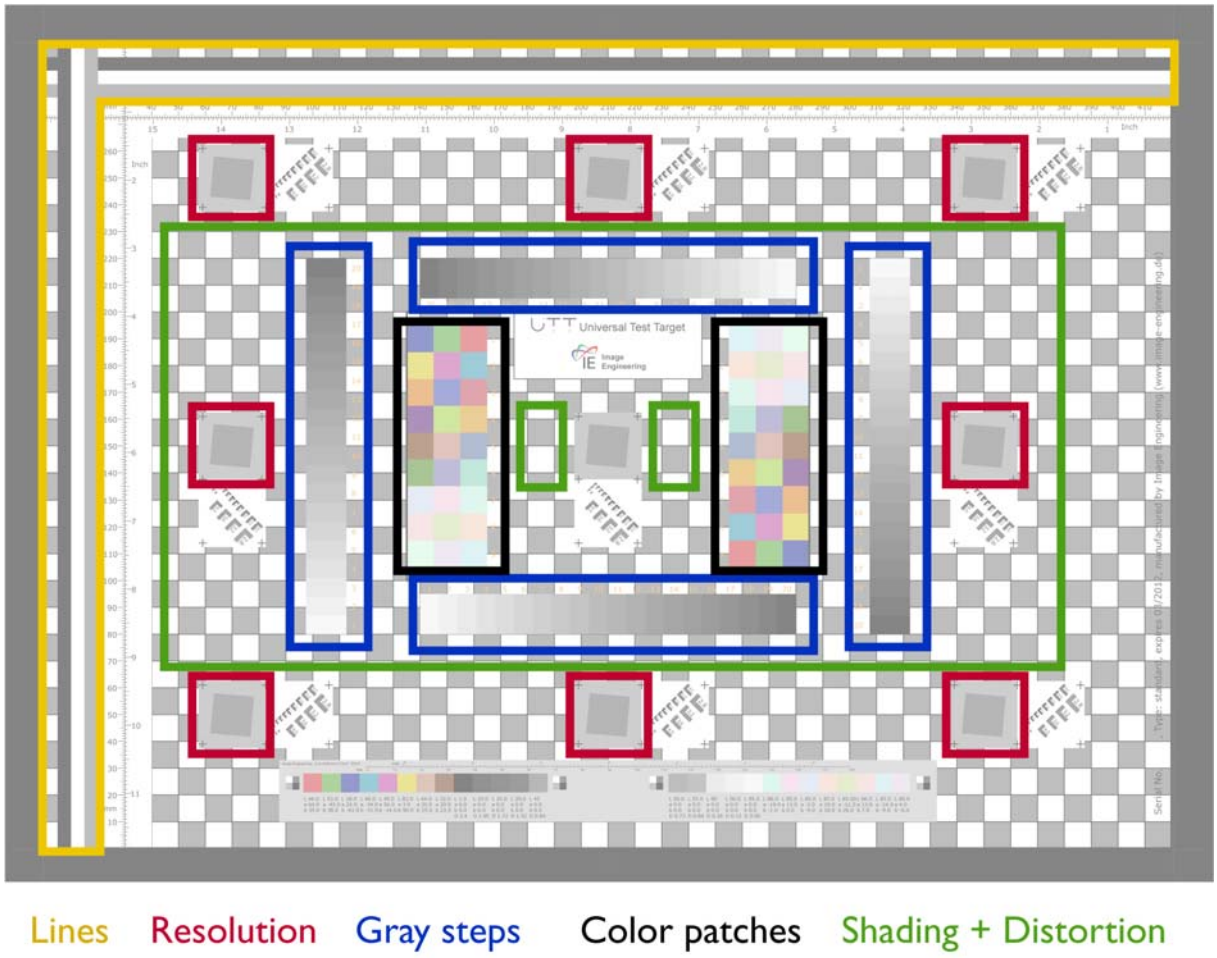
The dropdown menu below the image offers two views:



ROI: the ROIs (regions of interest)of the analyzed patches are marked in different colors

Original: the original image is shown

Short explanation of the patches for measurements (exemplified by the A3 format):



Lines: The yellow marked areas are used to test for dead lines that can occur during the scanniung process and for shading (loss of intensity).

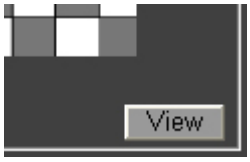
Resolution: The nine red marked areas are used for resolution measurements.

Gray steps: The blue marked areas are the four gray steps.

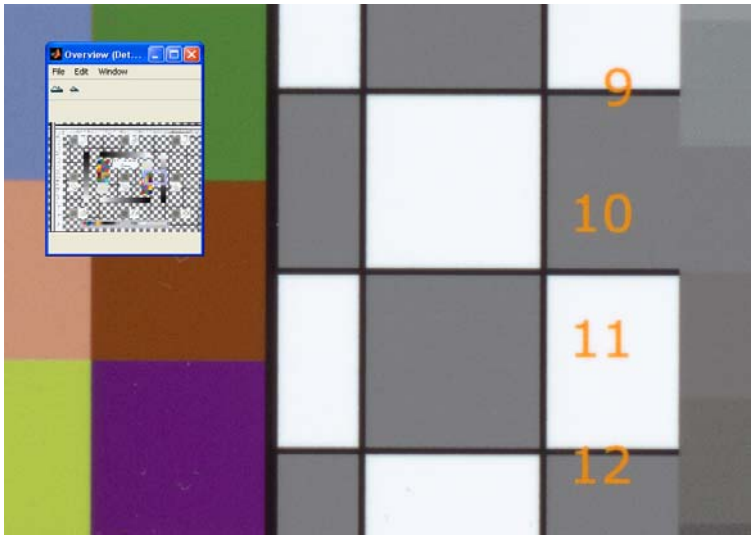
Color patches: The two black marked areas are used for color measurements.

Shading + Distortion: The green marked ares are used for measurement of shading and distortion. Within the green rectangles the average of the white and the the average of the gray patches are determined for calculation of shading. Also the distances of the black lines are determined for distortion measurement.

By pressing the “**View**” button in the down right corner of the “Image” view the image opens in a new window and gives a 100% view to the image for visual analysis.



“View” button



overview window and the image in a new window

12.2.2 Numerical and graphical results

The EXIF data are displayed in the lower left corner.

Image		Image		EXIF		EXIF	
Name	UTT_A3.jpg	X-Dim	1195	Time	0.00	f [mm]	0.00
Make	-	Y-Dim	856	F-Stop	0.0	EV	-
Model	-			ISO	00		

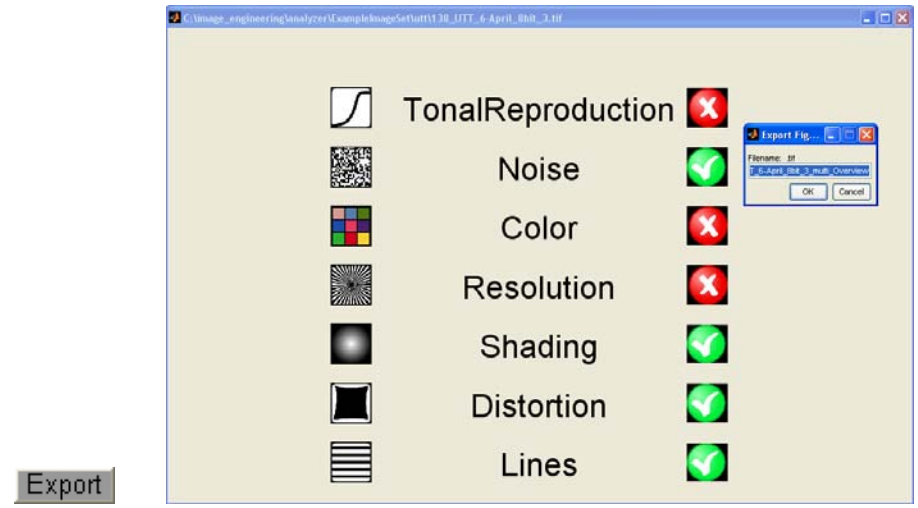
EXIF data

Undock: The graphical result is displayed in a new window. This can be used to compare different settings.

"Undock" button

the undocked window

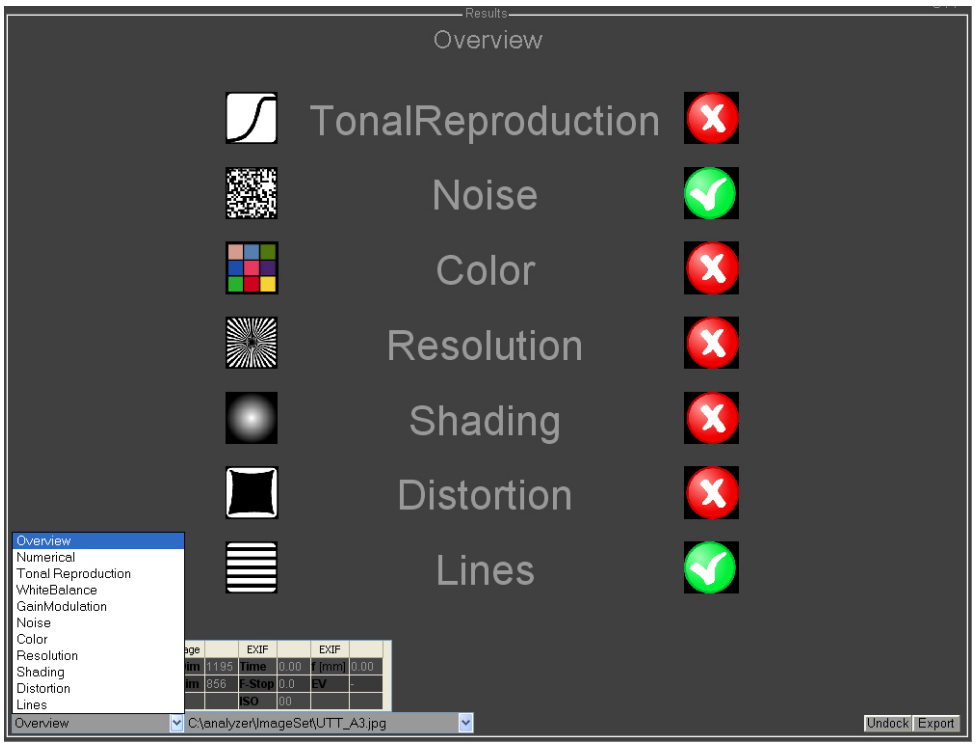
Export: The result is displayed in a new window and you can save it as an image file. You can set/change the file format in the "Setting" tab above.



“Export” button

the undocked window and saving options

In the **“Result”** view you can choose the results by using the dropdown menu at the bottom left.



OVERVIEW

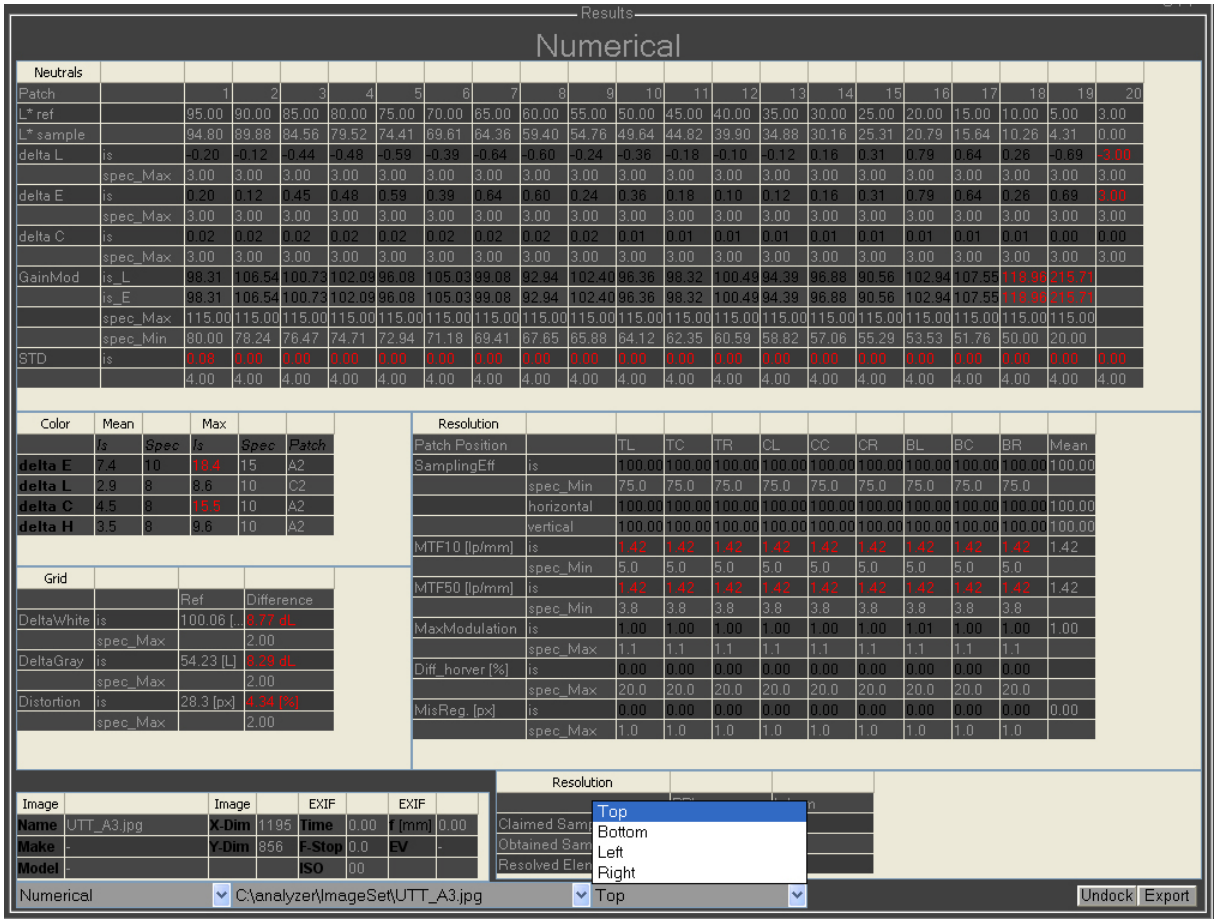
You get a overview of the analyzed parameters (Tonal Reproduction, Noise, Color, Resolution, Shading, Distortion, Lines).

values are outside the tolerance that are specified in the selcted specifications (Artwork, Unique Library, Non-Unique Library).

values are within the selected tolerance

NUMERICAL

The numerical results are diplayed.



Short background information: Lab, LCH, Delta E, Delta L, Delta C, Delta H

If you express the **Lab** color space in polar coordinates you get **LCH**, where **L** is the luminance, **C** the chrominance (saturation) and **H** the hue (color tone). **Delta E** indicates the overall difference between reference and sample. The calculation method is defined in the specifications. To get more detailed information about the difference it is interesting to see the difference in Luminance (**Delta L**) and hue (**Delta H**).

Neutrals

The results are displayed for the 20 gray patches of the gray scales. Using the dropdown menu you can switch between the four gray scales (top, bottom, left, right). Values outside the tolerance range are indicated red.

L*ref	Luminance of the reference (specifications)
L*sample	Luminance of the image
delta L is	Calculated luminance difference (L*sample - L*ref)
delta L spec_Max	Tolerance limit defined in the specifications
delta E is	Calculated color difference
delta E spec_Max	Tolerance limit defined in the specifications
delta C is	Calculated chrominance difference (C*ref - C*sample)
delta C spec_Max	Tolerance limit defined in the specifications
GainModulation is_L	(Sample ΔL / Reference ΔL) x 100
GainModulation is_E	(Sample ΔE / Reference ΔE) x 100
GainMod spec_Max	Maximum tolerance limit defined in the specifications
GainMod spec_Min	Minimum tolerance limit defined in the specifications
STD is	Calculated standard deviation of each patch
STD spec_Max	The standard deviation is not relevant for the specifications

Example for Gain Modulation

Sample L*a*b* values of the horizintal lower gray patches number 1 and number 2 of the UTT.

UTT	L*	a*	b*	Delta L	Delta E
Gray patch 1	92.59	-0.88	-0.12		
Gray patch 2	89.82	-0.74	0.82	2.77	2.93

Reference L*a*b* values of the lower gray patches 1 and 2 of the UTT.

UTT	L*	a*	b*	Delta L	Delta E
Gray patch 1	95	0	0		
Gray patch 2	92	0	0	3	3

Gain Modulation based on Delta L is: 2.77 / 3.00 = 0.92 ≙ 92% (OK)

Gain Modulation based on Delta E is: 2.93 / 3.00 = 0.98 ≙ 98% (OK)

Color

delta E is	The average (Mean), the maximum (Max) Delta E of all color patches
delta E Spec	Tolerance limit defined in the specifications
delta E Patch	Patch number with the highest Delta E
delta L is	The average (Mean) and the maximum (Max) Delta L (luminance) of all color patches
delta L Spec	Tolerance limit defined in the specifications
delta L Patch	Patch number with the highest Delta L
delta C is	The average (Mean) and the maximum (Max) Delta C (chrominance) of all color patches
delta C Spec	Tolerance limit defined in the specifications
delta C Patch	Patch number with the highest Delta C
delta H is	The averge (Mean) and the maximum (Max) Delta H (hue) of all color patches
delta H Spec	Tolerance limit defined in the specifications
delta H Patch	Patch number with the highest Delta H

Grid

Delta White is	Absolute reference values (Ref) for the luminance of the white patches of the checker board and the differences Delta L between the reference and the sample
Delta White spec_Max	Maximum tolerance limit defined in the specifications
Delta Gray is	Absolute reference values (Ref) for the luminance of the gray patches of the checker board and the differences Delta L between the reference and the sample
Delta Gray spec_Max	Maximum tolerance limit defined in the specifications
Distortion is	The width of the squares are compared to the average width over the whole image. The result of the distortion measurement is given as percentage. The reference value “Ref” is the average width over the whole image.
Distortion spec_Max	Maximum tolerance limit defined in the specifications

Resolution

Resolution is measured on the nine resolution patches (topf left, top center, top right, center left, center center, center right, bottom left, bottom center, bottom right), at each horizontal and vertical slanted edges (left, right, top, bottom). Also the mean average is calculated.

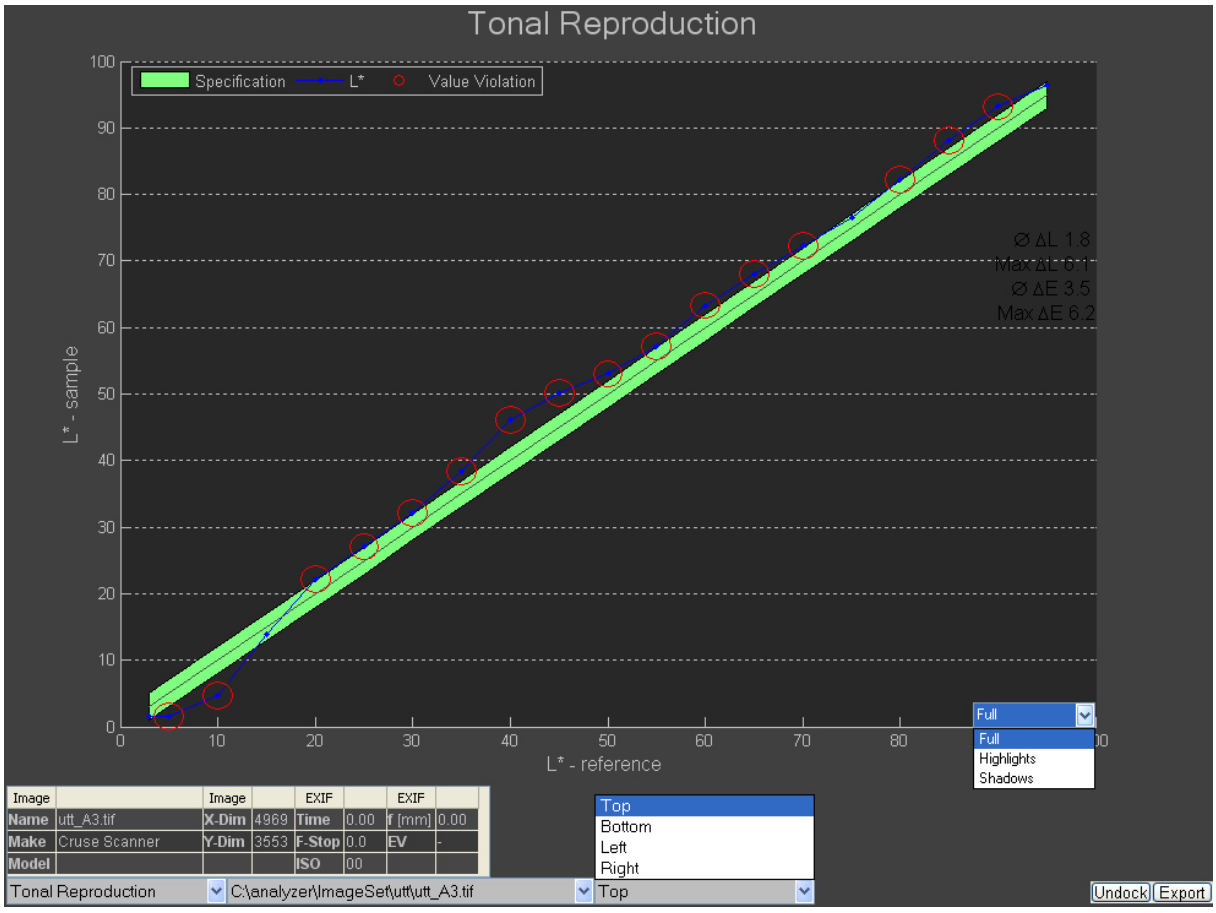
SamplingEff is	Average of the the sampling efficiency of the four edges
SamplingEff spec_Min	minimum tolerance limit defined in the specifications
Sampling Efficiency (horizontal vs. vertical)	If the limiting frequency equals Nyquist frequency, sampling efficiency ist 100%
MTF10[lp/mm] is	MTF10 is the highest spatial frequency with a modulation greater than 10% (linepairs/mm or ppi).
MTF10[lp/mm] spec_Min	Minimum tolerance limit defined in the specifications
MTF 50 [lp/mm]	MTF50 is the highest spatial frequency in linepairs/mm with a modulation greater than 50%.
MTF50[lp/mm] spec_Min	Minimum tolerance limit defined in the specifications
MaxModulation is	The calculated modulation of the sample
MaxModulation spec_Max	Maximum tolerance limit defined in the specifications; due to sharpening during the digitalization of the image, values could be greater than 1.
Diff_horver [%] is	Difference between the horizontal and vertical resolution
Diff_horver [%] spec_Max	Maximum tolerance limit defined in the specifications
MisReg. [px] is	On the four slanted edges the maximal shift of the color channels is measured (shift of the red an green channel and shift of the blue and green channel).
MisReg. [px] spec_Max	Maximum tolerance limit defined in the specifications

Resolution

Claimed Sampling Rate	sampling rate specified in the meta information of the file. Most likely the sampling rate is set in the control software (ppi and the related lp/mm). If it can not be obtained the default setting will be used instead. It can be changed in the SETTINGS tab.
Obtained Sampling Rate	sampling rate measured on the image (using the average distance of the black lines in the background).
Resolved Elements	obtained sampling rate x sampling efficiency (usable sampling rate)

TONAL REPRODUCTION

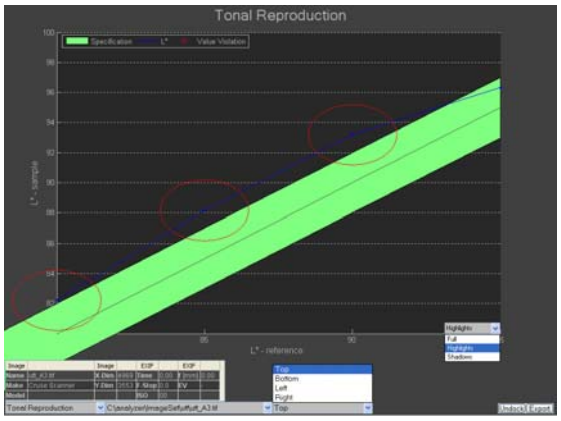
The graph displays the tonal reproduction of the gray scales: luminance of the reference (specification) vs. luminance of the sample. The four gray scales can be selected by using the dropdown menu.



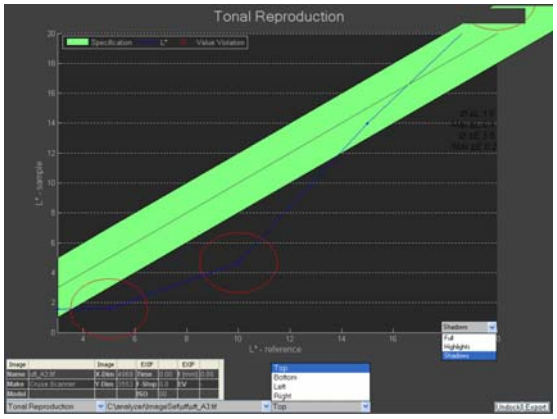
Tonal Reproduction “Full”

The thin black line represents the luminance reference values L*-Ref (defined in the specifications, the blue line represents the luminance results L* of the analyzed UTT chart. The tolerance range, that is also defined in the specifications is displayed in green. Values that are outside the tolerance range are outlined in red “Value Violation”. Numeric results are diplayed for the average and the maximum of ΔL (luminance difference) and ΔE (color difference).

The dropdown menu down right of the graph enables an enlarged view of parts of the graph: Highlights and Shadows.



Tonal Reproduction “Highlights”



Tonal Reproduction “Shadows”

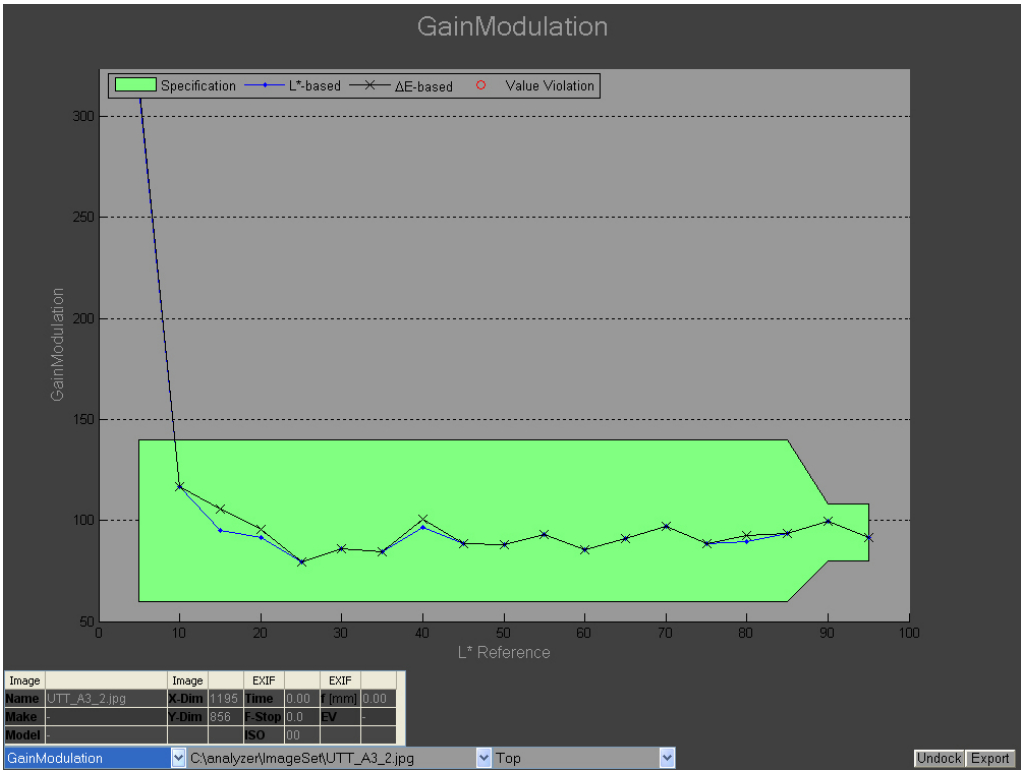
WHITE BALANCE

The graph diplays the adjustment to keep the gray scale neutral. Outlined are the luminance L* vs. the color difference ΔC* of the gray scales. The four gray scales can be selected by using the dropdown menu.

At best ΔC* is 0 (no color cast). The tolerance range, that is defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red “Value Violation”.

GAIN MODULATION

Gain modulation describes the reproduction of the sample in digital values. It is a comparison between the steps of the sample and the resulting digital values. At a reproduction of 1:1 (e.g. 4 ΔL between two patches in the sample correspond to 4 ΔL in the digital scanned image) the result is 100%.

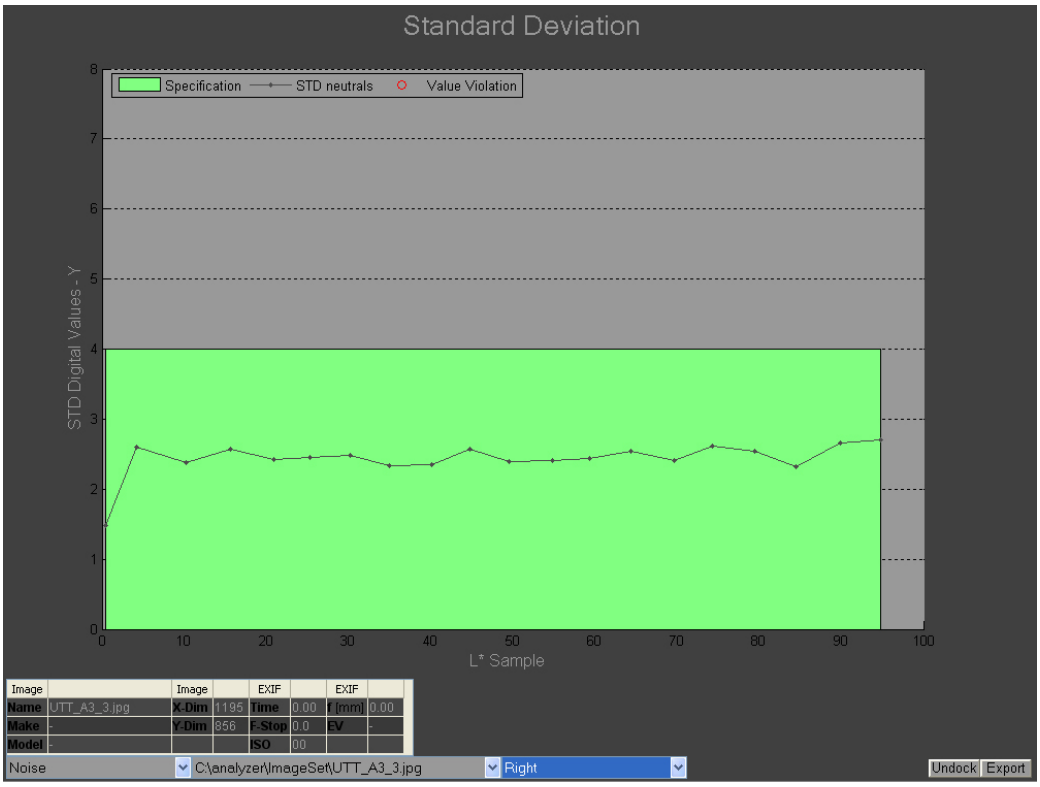


The thin black line represents the gain modulation based on ΔE, the blue line represents the gain modulation based on L*. The tolerance range, that is defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red “Value Violation”.

NOISE

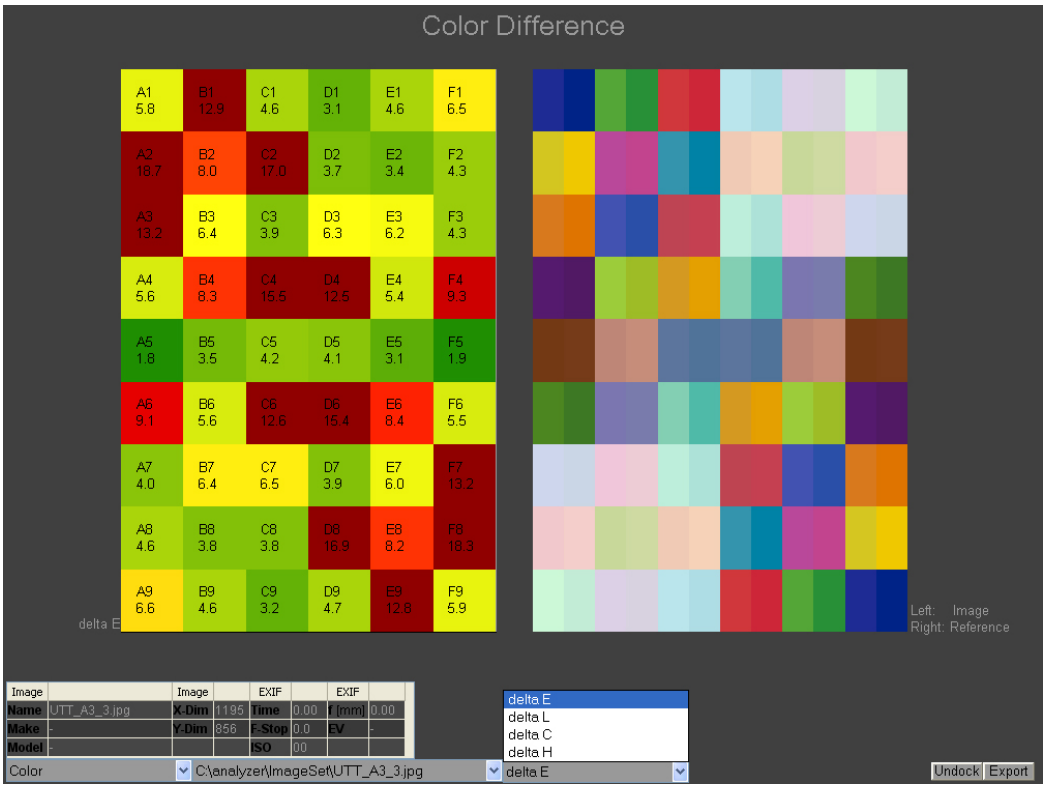
Noise measurement (standard deviation, STD) is made using two methods.

1. STD neutrals (thin black line): noise ist calculated on the patches of the gray steps. Due to the production process of the chart, the neutrals may show slight structures which lead to higher measured STD.
2. STD sfrnoise (blue line): The resolution patches are selected because these patches do not exhibit any structure. The measured standard deviation is a result of the noise introduced by the scanning device.



The tolerance range, that is defined in the specifications, is displayed in green. Values that are outside the tolerance range are outlined in red “Value Violation”.

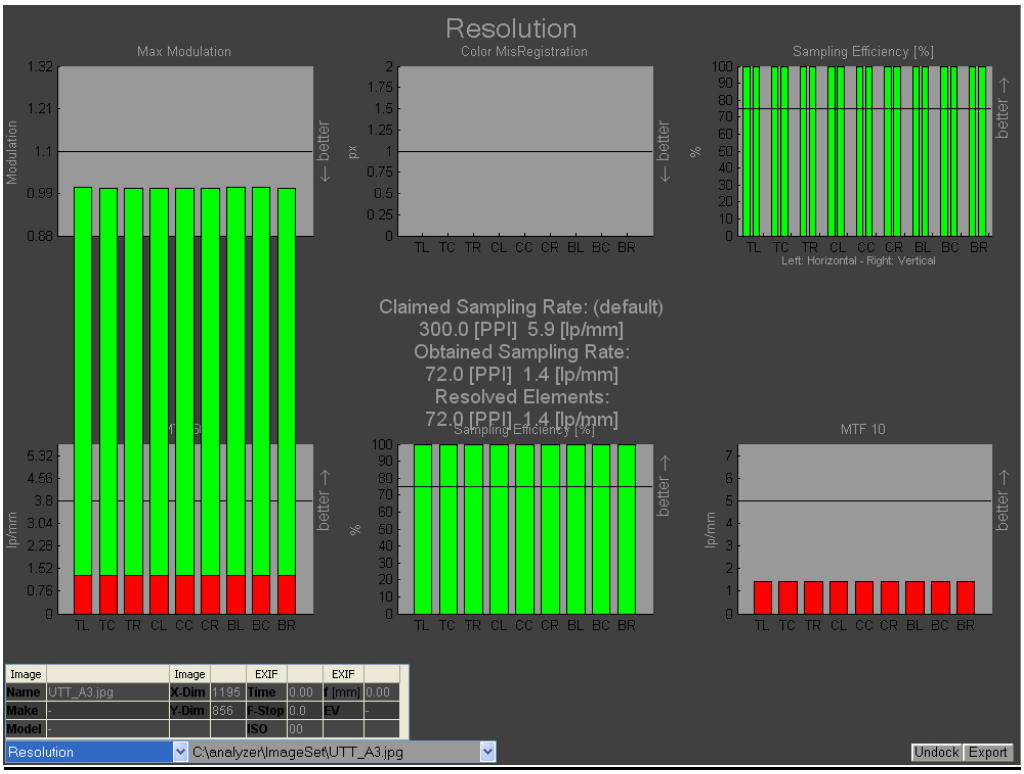
COLOR



On the left side the numeric results for each patch are shown and the amount of the color diffence is visualized by colors - from dark green (ΔE = 0) to dark red (ΔE = maximum value defined in the specification). On the right side a visual comparison of the color paches are shown (left: image, right reference). The values for the color differences are defined in the specifications. You can choose between the display of results for ΔE (color difference), ΔL (luminance), ΔC (saturation), ΔH (hue).

color bar for visualization of color differences:
from dark green (ΔE = 0) to dark red (ΔE = maximum value defined in the specification)

RESOLUTION



Resolution is measured on the nine resolution patches (slanted edges):

Top left (TL)	Top center (TC)	Top right (TR)
Center left (CL)	Center center (CC)	Center right (CR)
Bottom left (BL)	Bottom center (BC)	Bottom right (BR)

The thin black horizontal lines illustrates the specification limits. The bars are colored green or red depending on wether the results are within (green) or outside (red) the tolerance.

Max Modulation: The maximum Modulation is 1 for an unsharpened image. If sharpening is applied in the image processing the modulation may rise. It shall not be higher than the value set in the specifications.

Color MisRegistration: The diagram represents the shift of color channels to each other.

Sampling Efficiency (horizontal vs. vertical):
If the limiting frequency (at 10% modulation) equals Nyquist frequency, sampling efficiency ist 100%. The absolute comparison is shown in the lower center diagram.

MTF 10: MTF 10 is the highest spatial frequency with with a modulation greater or equal 0.1 (10%).

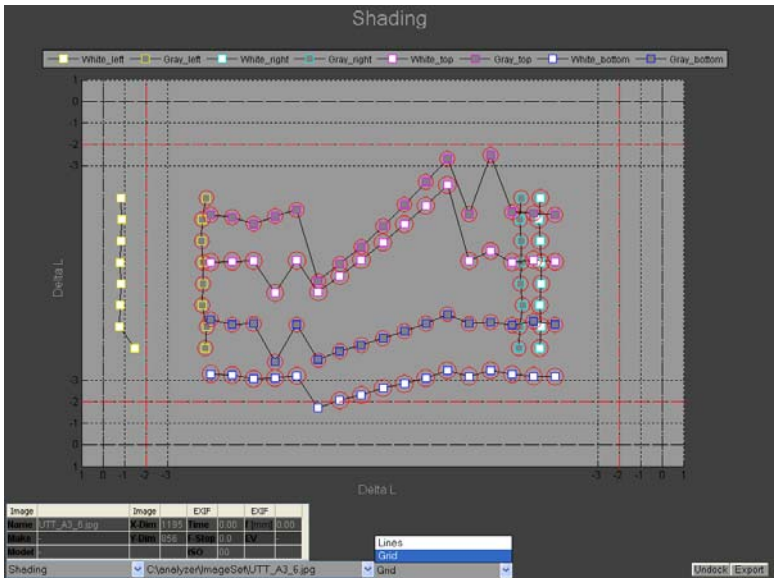
MTF 50: MTF 50 is the highest spatial frequency with a modulation greater than 50%.

Claimed Sampling Rate: sampling rate specified in the meta information of the file. Most likely the sampling rate is set in the control software (ppi and the related lp/mm). If it can not be obtained the default setting will be used instead. It can be changed in the SETTINGS tab.
Obtained Sampling Rate: sampling rate measured on the image (using the average distance of the black lines in the background).
Resolved Elements: obtained sampling rate x sampling efficiency (usable sampling rate)

SHADING

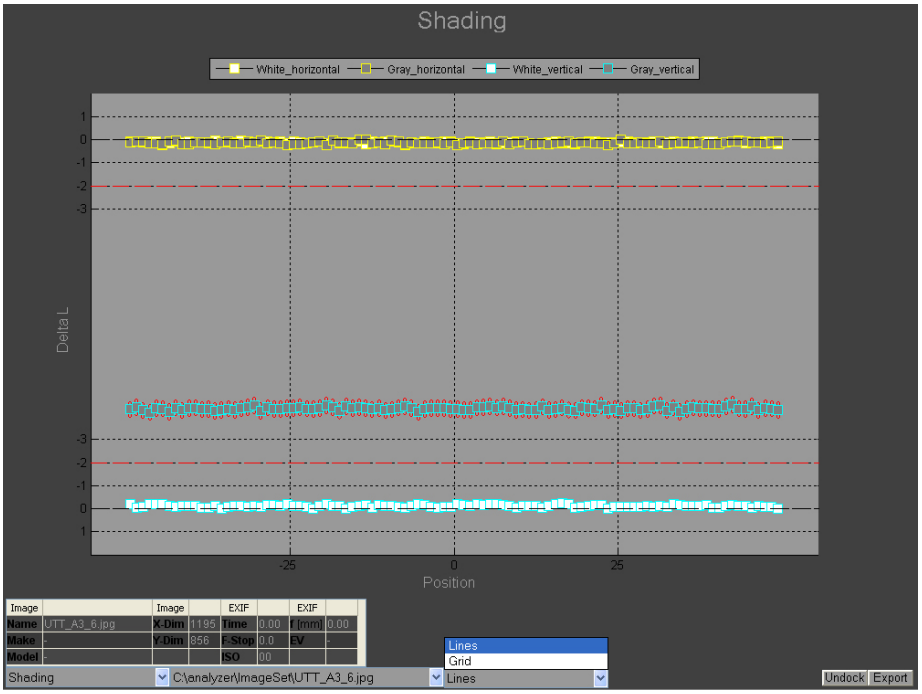
Shading describes the lost of intensity. Using the dropdown menu you can switch between reprensentation “grid” and “lines”.

Grid: The shading measurement is done inside the green marked rectangle displayed in the “Image” view. The ΔL values are shown for the right, left, upper and lower border of the rectangle respectively for the white and gray patches. Each measuring point is one white respectively one gray patch within the rectangle.



Shading grid

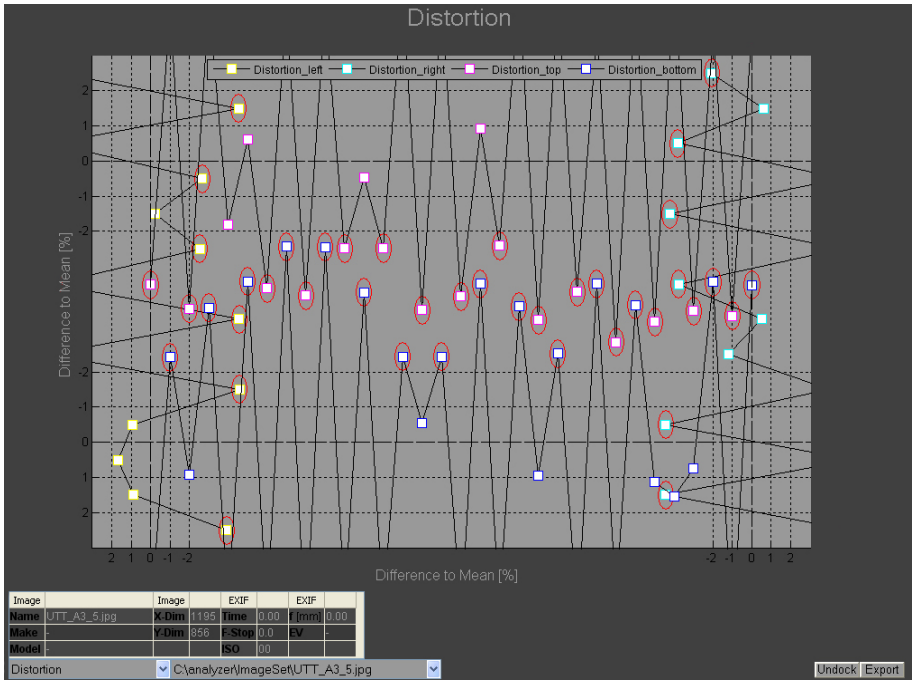
Lines: The shading measurement is done on the white and gray lines at the uper (horizontal) and left (vertical) border. 50 measuring points uniformly distributed over the lines.



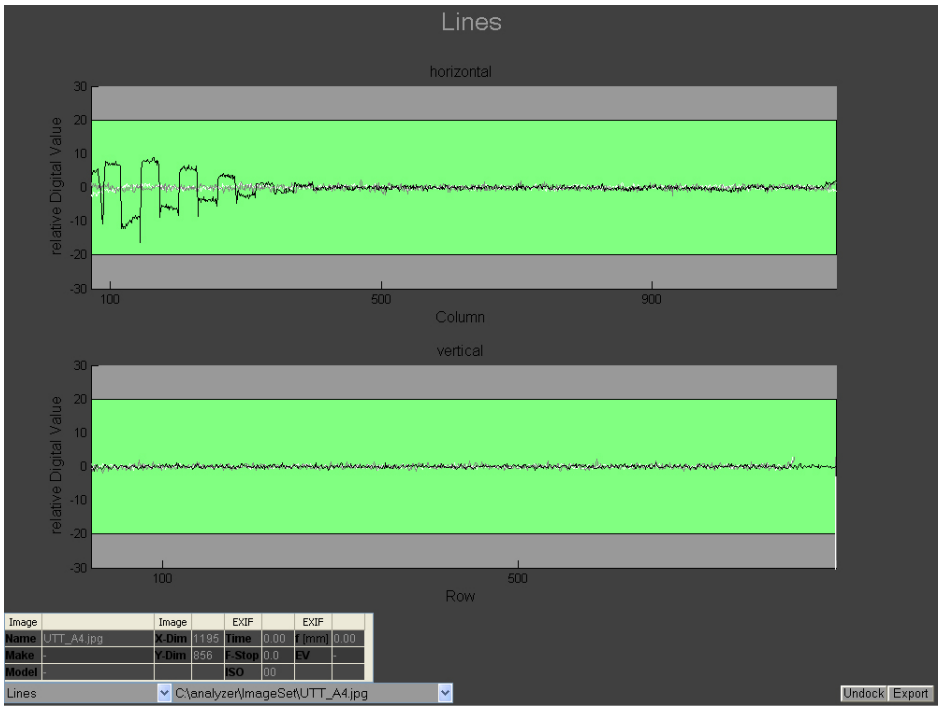
Shading lines

DISTORTION

The distortion measurement is done inside the green marked rectangle displayed in the “Image” view. The width of the squares are compared to the average width over the whole image. The results of the distortion measurement are expressed as percentage.



LINES



The white, black and gray lines at the upper (horizontal) and left (vertical) boarder are checked if lines are outside the expected values. So e.g. stripe patterns can be identified. Before calculation, the lines are shading corrected.

13. 42

The module 42 is designed to analyze the test chart “Forty Two” (TE42). With one single chart OECF (Opto Electronic Conversion Function), dynamic range, resolution, shading, distortion, lateral chromatic aberration, color reproduction, and kurtosis parameters can be measured according to ISO standards and analysed with the corresponding software (iQ-Analyzer). The settings in the different modules that are used for the module 42 can be seen if you load the TE42.myset in the SETTING module.

“UTT” tab

13.1 Settings

Before starting 42 analysis you have to define some settings.

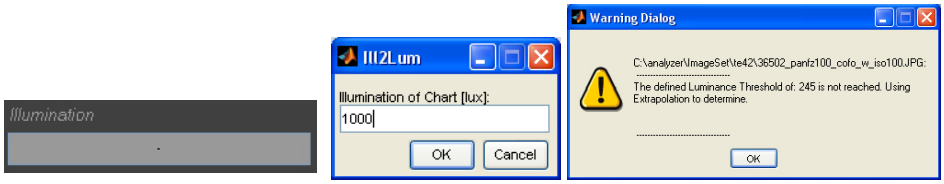
setting “Chart Layout”

setting “Reference Data”

Chart Layout: select the Chart Layout file. It contains all neccessary information about the chart layout.

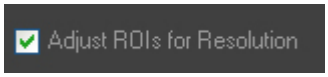
Reference Data: reference file for the TE42 charts.

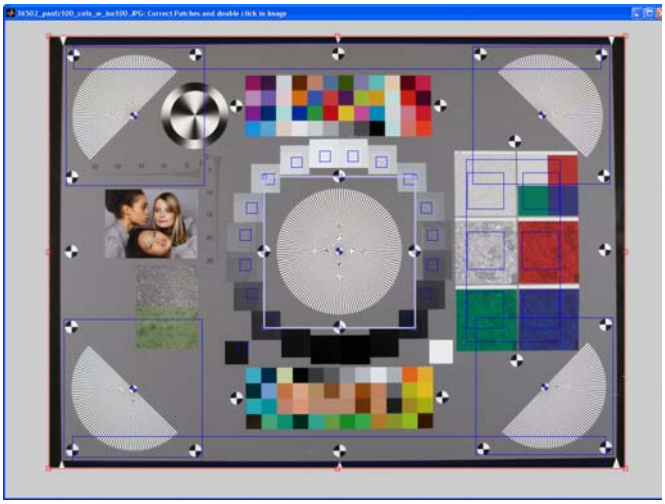
Illumination [lux]: set the illumination of the chart. If you do not insert a value for illumination, a popup window will appear when you press the “Start” button.



popup appears if you do not have set illumination

Adjust ROIs for Resolutio: After doing all settings, press the “Start” button. You can adjust the ROIs that are indicated by rectangles. “Activate” the rectangles by clicking the border. Now you can adjust the ROIs manually. When the manual adjustment of ROIs is done, double click on the image and the analyzing process starts.

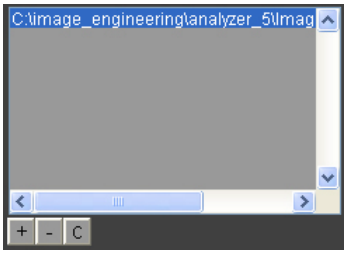




adjustable ROIs that are indicated by rectangles

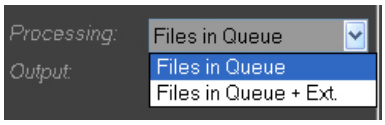
Files

Files for analysis have to be added to the built in file list using the “ + “ button. Delete selected files with the “ - “ button and clear the list with the “ C “ button.



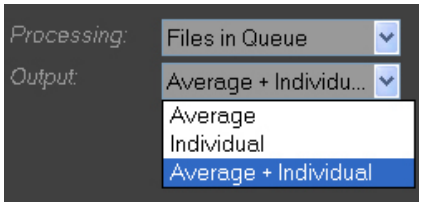
Processing

Files in Queue: All added files will be analyzed



Files in Queue + Ext.: If you have made several pictures and named them with extensions (e.g. oecf_01, oecf_02, oecf_03, ...) you only have to add the image file with the lowest extension and iQ-Analyzer analyzes the further ones, too. If your extensions are not numerical, specify them in the SETTINGS. Use **Files in Queue + Ext.** if you have made an image series with same settings.

Output



By using the dropdown menu below the file list you can configure the output properties.

Average: the average results of the images and its following images are saved in the text file, if you have selected “Files in Queue + Ext”

Individual: separate results for every image are saved in the text file

Average+Individual: the average and separate results are saved

If all settings are made press the “ **Start** “ button to run the analysis of the image(s). 

13.2 Analyzing process and graphical presentation

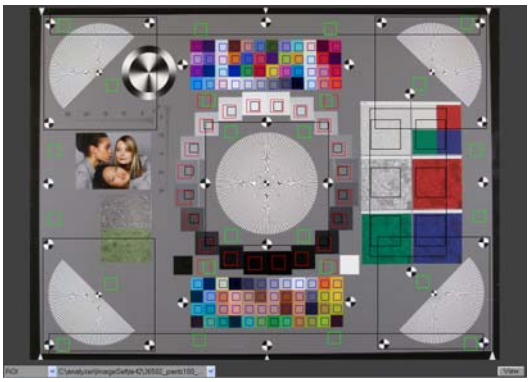
13.2.1 General

Having done the setup up you can press the “**Start**” button and the analyzing process starts. In the upper frame you see the progress bar. The numeric results and an image with marked ROIs are saved automatically as text and JPEG files (depending on your export settings made in the “Setting” tab above). Using the “Stop” breakes the analyzing process.

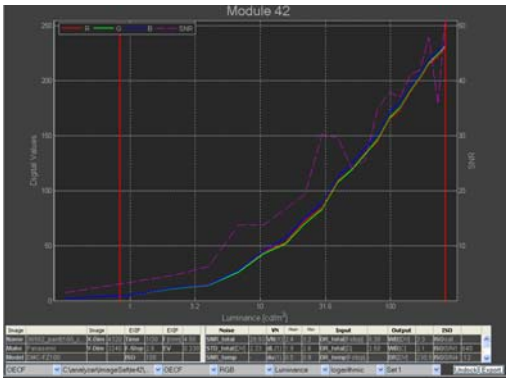
progress bar and Stop button

By pressing the “**Image**“ button below the file list the image of the selected image file is displayed. After analyzing you can switch between “**Image**“ and “**Result**“ view.

“Image“ and “Result“ button

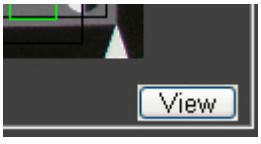


“Image” view



“Result” view

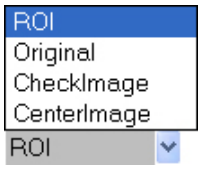
By pressing the “**View**” button in the lower right corner of the “Image” view, the image opens in a new window and enables viewing the file content e.g. zooming in/out. This “View” is used for visual analysis and should be reviewed at 100%.



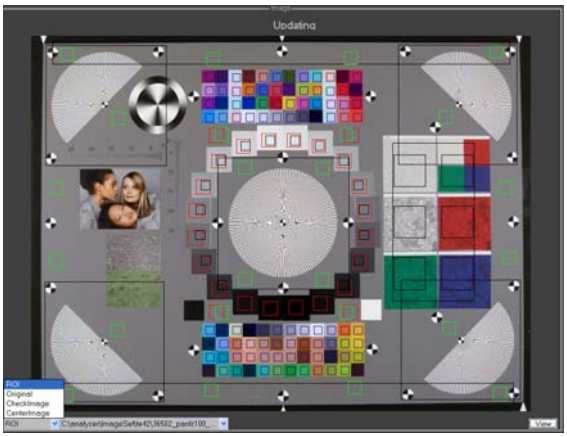
“View” button

editing window and the image in a new window

In the “Image” View you can choose between different presentations.

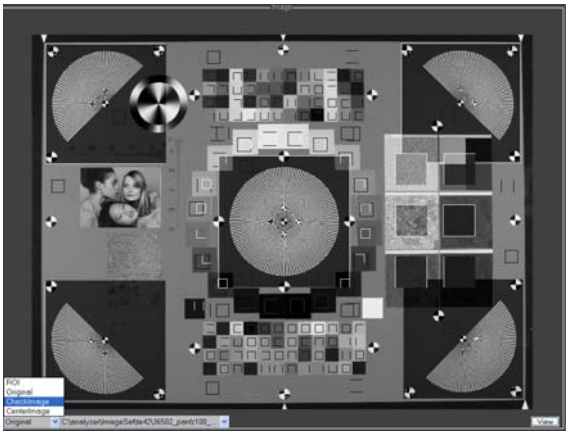


dropdown menu in “Image View”

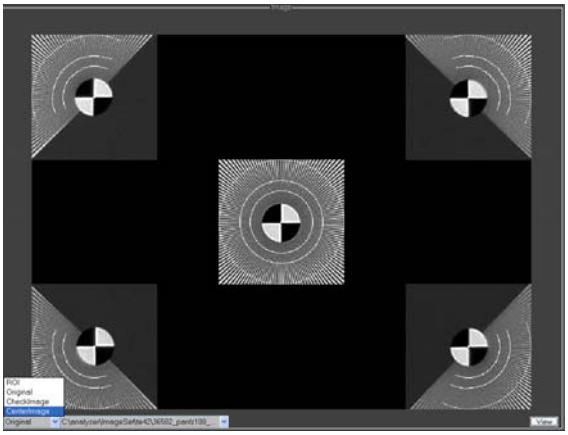


ROI with marked patches

Original



Check Image



CenterImage

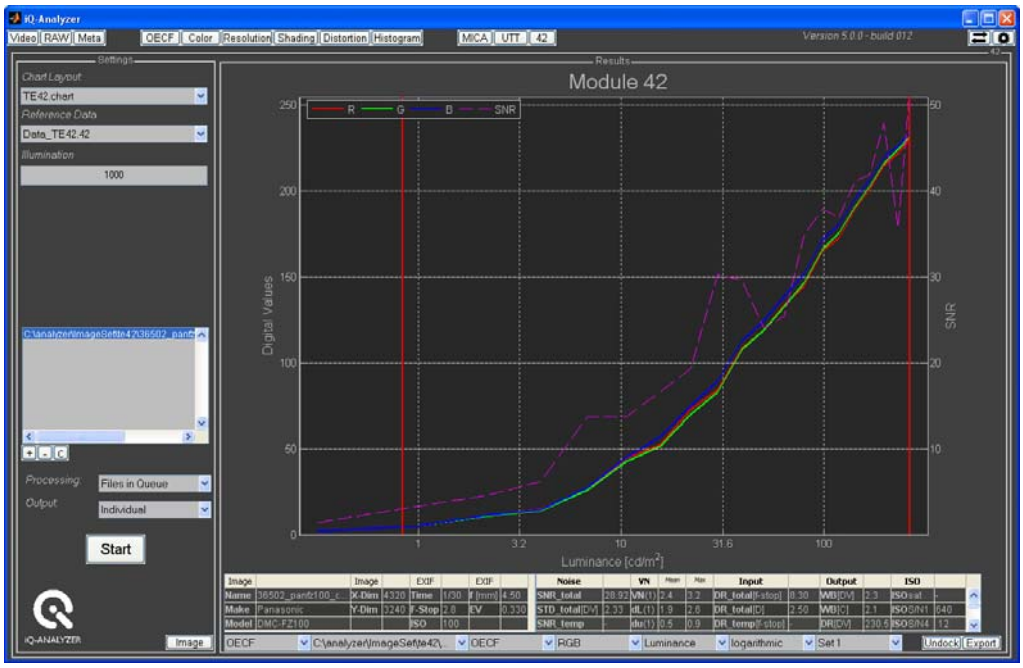
ROI: the ROIs (regions of interest)of the analyzed patches are marked in different colors

Original: the original image is shown

CheckImage: the analyzed regions are marked in gray

CenterImage: the stars from center to a defined percentage of the Nyquist frequency is shown. The size of CenterImage is 0.5 (0.5 equals an image which shows the star from its center to 50% Nyquist).

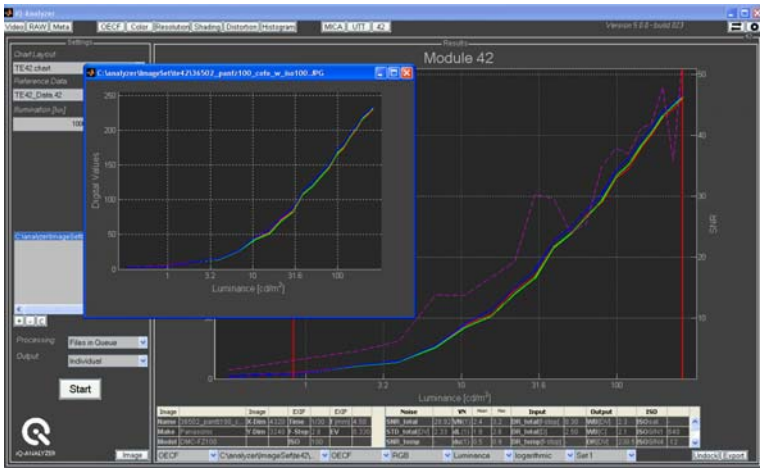
By pressing the “Result” button, the graphical and numerical results are displayed in the right screen.



settings (left screen) graphical results (right screen)

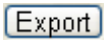
Undock: The graphical result is displayed in a new window. This can be used to compare different settings.

“Undock” button

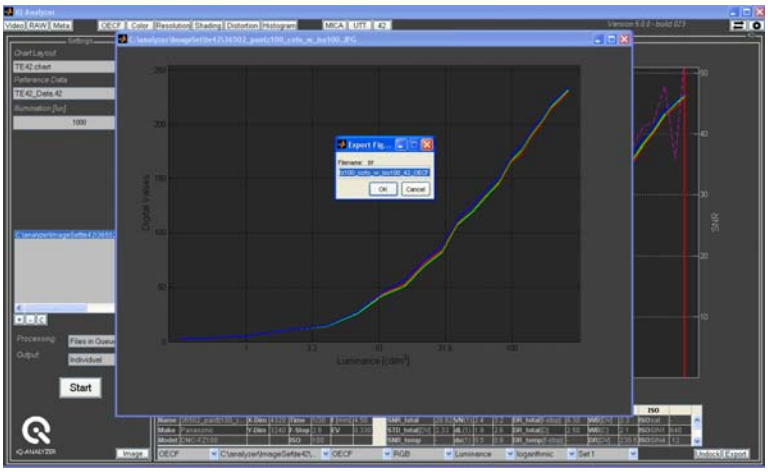


the undocked window

Export: The result is displayed in a new window and you can save it as an image file. The file format you can set/change in the “Setting“ tab above.

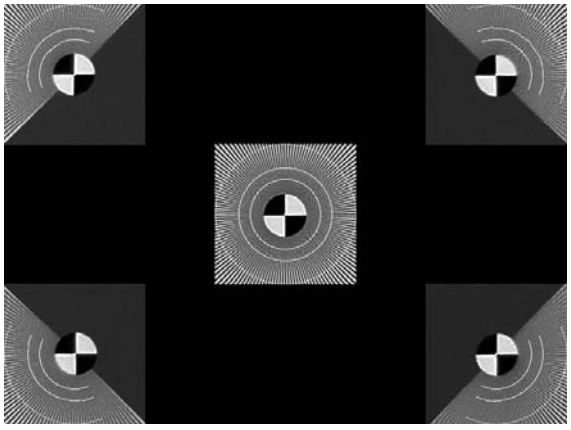


"Export" button

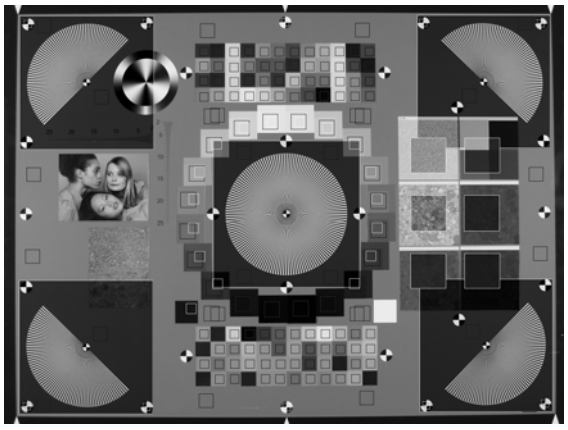


the undocked window and saving options

Two images, named with the extension "filename_**center**" and "filename_**check**" are saved automatically. One image shows the center of the Siemens stars and one the marked ROIs. Path for saving, image quality and size of the comparison image can be defined in the "Setting" tab.

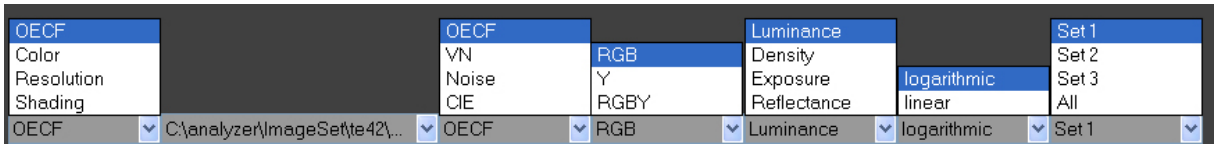


saved image with color comparison "filename_color.jpg"



saved image with marked ROIs "filename_check.jpg"

The graphical results are displayed in the right screen. Below the graphical results some **dropdown menus** exist. The <u>first</u> one allows choosing the **result** you want to be displayed (OECF, Color, Resolution, Shading). The furtherdropdown menus allow different views depending on the result you choose in the first menu (e.g. Delta E, Delta L, Delta C, Delta H for color analysis).



depending on the the diplayed result (selected with the first dropdown menu) the further menus offer different views

13.2.2 Numerical and graphical results

EXIF data and numerical results are shown which vary depending on the selection using the dropdown menus. For further information of the results for OECF, COLOR, RESOLUTION and SHADING please consult the relevant chapter in this documation.

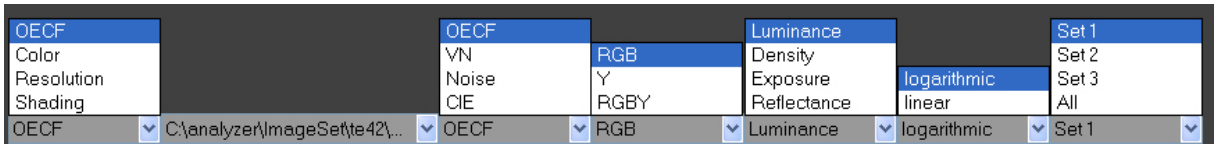
Image		Image		EXIF		EXIF	
Name	36502_panfz100_c...	X-Dim	4320	Time	1/30	f [mm]	4.50
Make	Panasonic	Y-Dim	3240	F-Stop	2.8	EV	0.330
Model	DMC-FZ100			ISO	100		

Luminance		Color		Noise	
Shading [f-stop]	0.6	CIE ΔE*ab*	2.7	Δ SNR[dB]	2.4
Shading [%]	17.1	CIE ΔC	1.7	Δ VN*Set1*	0.7
CIE ΔL	9.2	ΔG-R[DV]	4.0	Δ VN*Set2*	1.1
percentiles Y	-8.3/11.6/13.5/14.1	ΔG-B [DV]	5.8	Δ VN*Set3*	1.0
percentiles Y	-0.27/0.28/0.32/0.3				

EXIF data and numerical results depending on the options choosen by using the dropdown menu

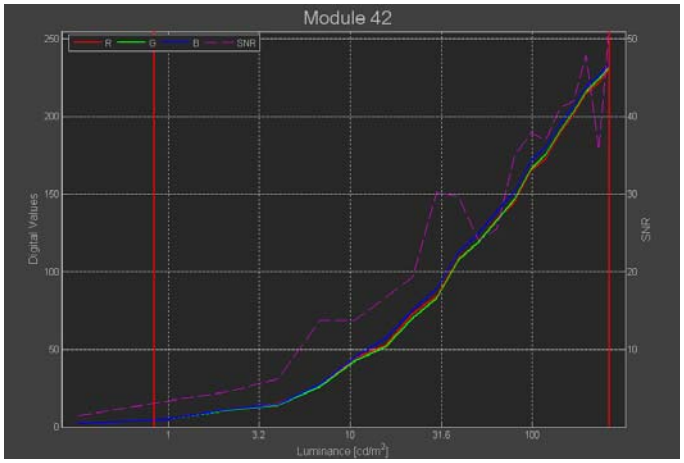
OECF

If you have chossen “OECF” the further dropdown menus offer different results and views.



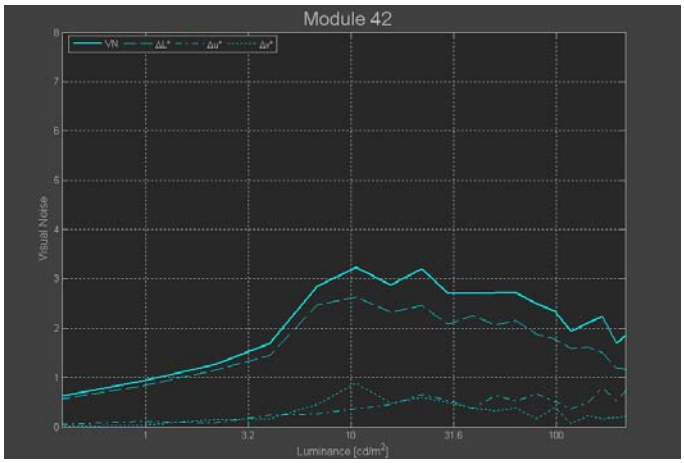
Noise		VN	Mean	Max	Input		Output		ISO	
SNR_total	28.92	VN(1)	2.4	3.2	DR_total[f-stop]	8.30	WB[DV]	2.3	ISOsat	-
STD_total[DV]	2.33	dL(1)	1.9	2.6	DR_total[D]	2.50	WB[C]	2.1	ISOS/N1	640
SNR_temp	-	du(1)	0.5	0.9	DR_temp[f-stop]	-	DR[DV]	230.5	ISOS/N4	12
STD_temp[DV]	-	dv(1)	0.3	0.9	DR_temp[D]	-				
SNR_fp	-	VN(2)	1.2	2.1						
STD_fp[DV]	-	dL(2)	0.9	1.7						
		du(2)	0.3	0.7						
		dv(2)	0.2	0.5						
		VN(3)	1.4	2.3						
		dL(3)	1.0	1.8						
		du(3)	0.4	0.8						
		dv(3)	0.2	0.6						

The results are explained in chapter OECF.



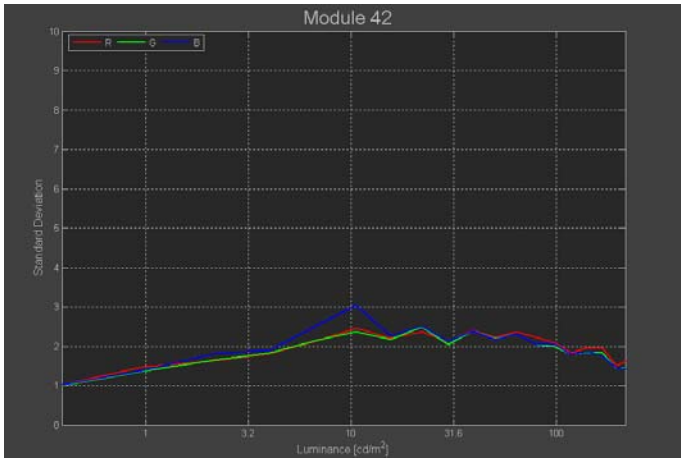
OECF

The OECF of the analyzed image(s) is shown. It is a function of the digital number depending on the luminance. The two red vertical lines show the dynamic range of the device. SNR is defined as the ratio of the net signal value to the standard deviation of the signal value. iQ-Analyzer calculates a Y (luminance) image and uses this this for further calculations.



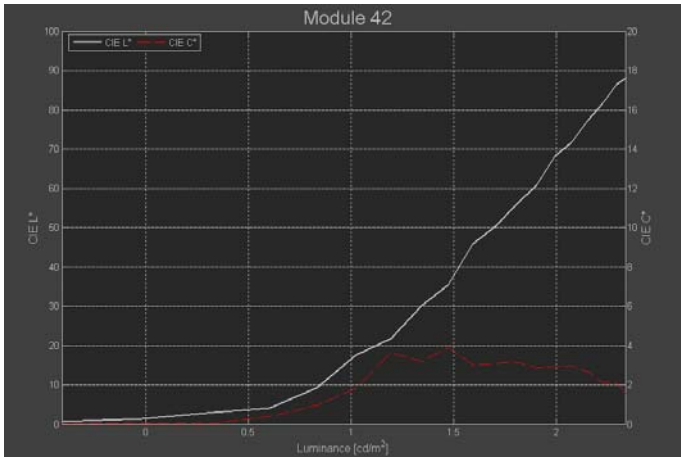
VN

The Visual Noise for the three Viewing Conditions are displayed that are defined in the “Settings”.



Noise

Noise diplayed as Standard Deviation**.** The Standard Deviation is defined as the square root of the absolute value of the sum of variances from the signal region.

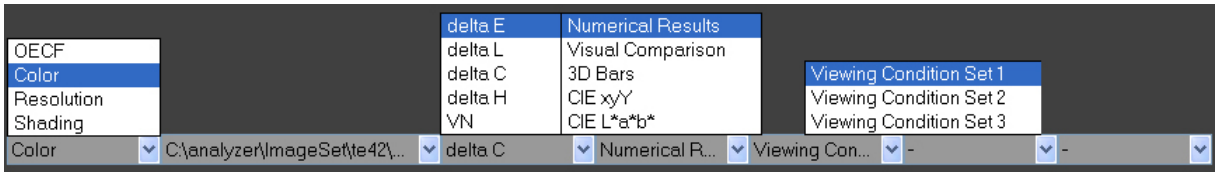


CIE

Presentaion of luminance L and chrominance (saturation) C, defined in the CIE LCH color space. The colorspace is in the form of a sphere with the three axes L, C and H (hue, colortone). The L axis is vertical; from 0 which has no lightness at the bottom, through 50 in the middle to 100 which has maximum lightness at the top. The C axis ranges from 0 at the center of the circle, which is completely unsaturated (i.e. a neutral gray, black or white) to 100 at the edge of the circle for maximum chroma or saturation

COLOR

If you have choosen “Color” the further dropdown menus offer different results and views.

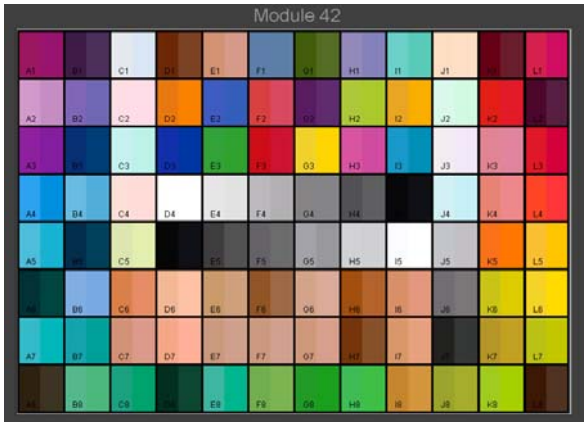


	ΔE	ΔL	ΔC	ΔH	VN Set1	VN Set2	VN Set3
All	8.5	-1.8	-1.8	3.4	3.3	1.5	1.9
Neutral	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Color	8.5	-1.8	-1.8	3.4	3.3	1.5	1.9

numerical results

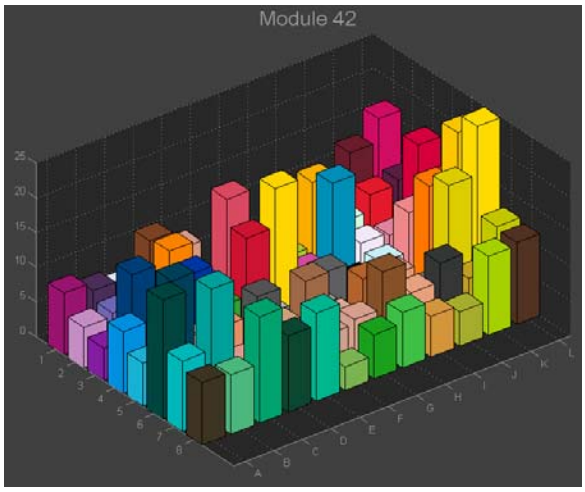
Numerical Results

Numerical results of delta E, L, C, H, Visual Noise (VN) depending on whar choose by using the third dropdown menue.



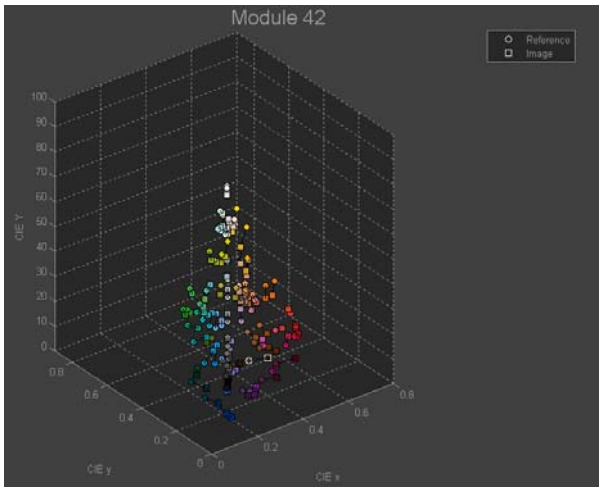
Visual Comparison

Image (left) vs. Reference (right)



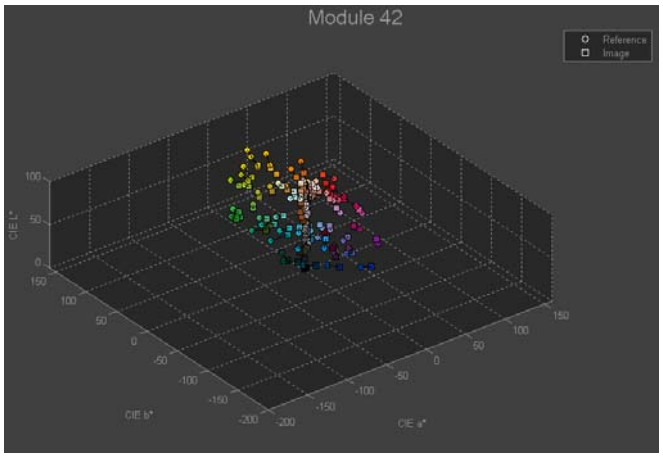
3D Bars

Delta E values of the color patches in a three-dimensional way



CIE xyY

The color patches of the image (square) and the reference (circle) are displayed in the CIE xyY colorspace, where x and y are the chromaticity coordinates and Y the luminance.



CIE L*a*b*

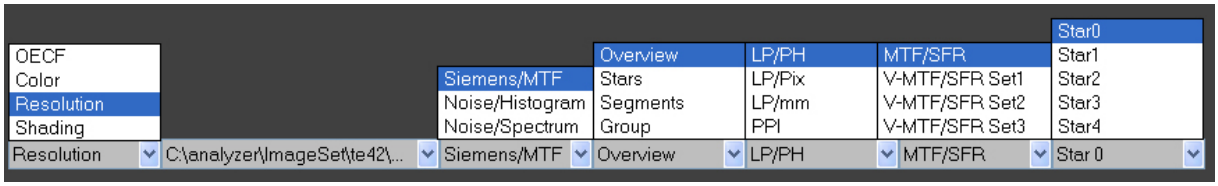
The color patches of the image (square) and the reference (circle) are displayed in the CIE L*a*b*. L* is the luminance (L* = 0 yields black and L* = 100 indicates diffuse white), a* describes the position between red/magenta and green (negative values indicate green while positive values indicate magenta), b* describes the position between yellow and blue (b*, negative values indicate blue and positive values indicate yellow).

The graphs of 3D Bars, CIE xyY, CIE L*a*b* can be rotated using the mouse the graph can be rotated. The cursor looks like a circle.

Cursor

RESOLUTION

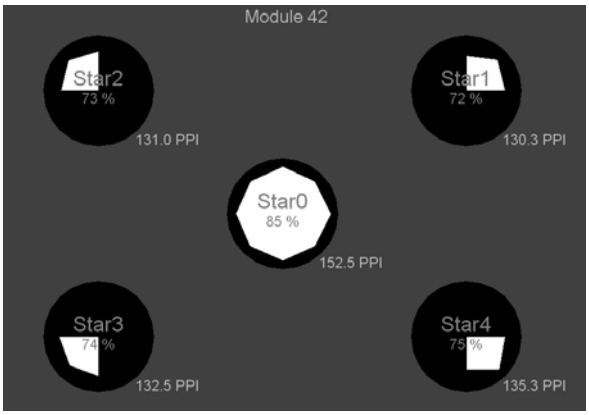
If you have choosen “Resolution” the further dropdown menus offer different results and views.



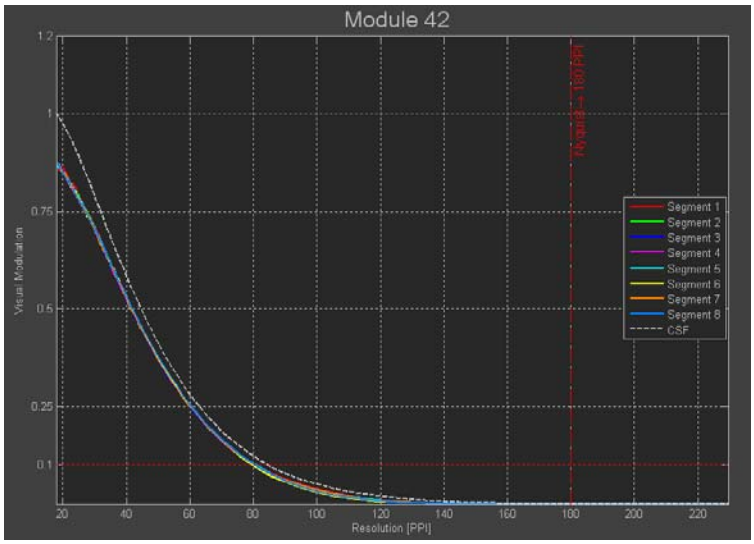
Selection of RESOLUTION results

	Star0	Star1	Star2	Star3	Star4
MTF10 [LP/PH]	1373	1173	1179	1192	1218
MTF25 [LP/PH]	1220	987	1001	1048	954
MTF50 [LP/PH]	1028	773	802	845	742
MTF [%]	59.5	40.5	41.0	44.0	40.2
vMTF Set1 [%]	73.4	54.5	54.9	58.3	54.3
vMTF Set2 [%]	88.6	75.5	72.7	76.0	77.0
vMTF Set3 [%]	87.1	72.5	71.1	74.3	73.6
TV-Distortion	0.90				
CA_gr	1.27				
CA_gb	0.59				

numerical results Siemens/MTF



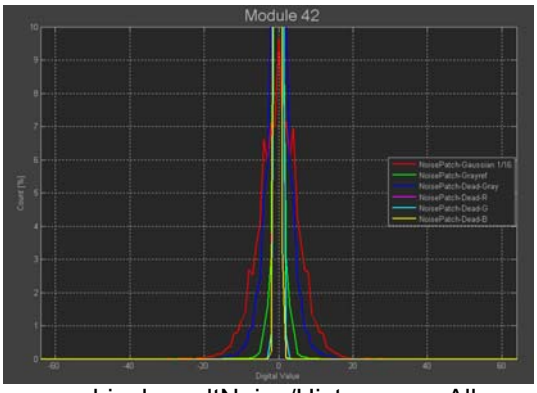
graphical resultSiemens/MTF - Overview



Siemens/MTF – Segements

	NoisePatch-Gaussian 1/16	NoisePatch-Grayref	NoisePatch-Dead-Gray	NoisePatch-Dead-R	NoisePatch-Dead-G	NoisePatch-Dead-B
Kurtosis	0.80	116.57	3.75	1.22	2.34	1.14
TV-Distortion	0.90					
CA_gr	1.27					
CA_gb	0.59					

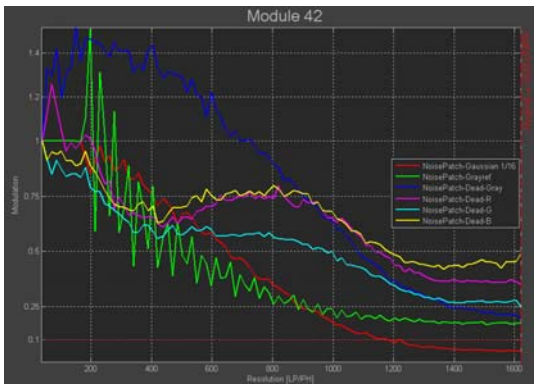
numerical results Noise/Histogram



graphical resultNoise/Histogram – All

	NoisePatch-Gaussian 1/16	NoisePatch-Grayref	NoisePatch-Dead-Gray	NoisePatch-Dead-R	NoisePatch-Dead-G	NoisePatch-Dead-B
MTF10 [LP/PH]	NaN	!1620	!1620	!1620	!1620	!1620
MTF20 [LP/PH]	NaN	1007	NaN	!1620	!1620	!1620
MTF50 [LP/PH]	NaN	321	1083	1137	994	1183
MTF [%]	41.7	42.4	83.1	64.1	51.7	65.8
vMTF Set1 [%]	56.4	53.2	104.2	71.2	59.0	71.7
vMTF Set2 [%]	91.1	91.0	135.1	92.1	77.8	84.5
vMTF Set3 [%]	83.1	80.4	131.1	84.8	72.2	80.5
TV-Distortion	0.90					
CA_gr	1.27					
CA_gb	0.59					

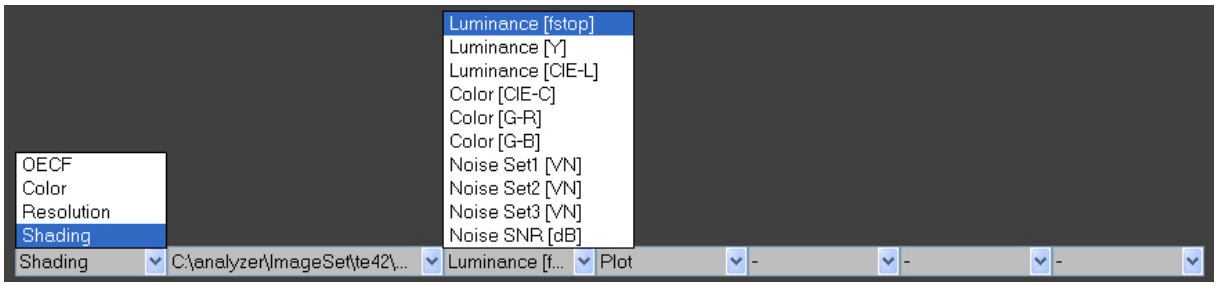
numerical results Noise/Spectrum



graphical result Noise/Spectrum – All

SHADING

If you have choosen “Shading” the further dropdown menus offer different results and views.



Luminance		Color		Noise	
Shading [f-stop]	0.6	CIE **Δ***Eab*	2.7	**Δ SNR**[dB]	2.4
Shading [%]	17.1	CIE **ΔC**	1.7	**Δ VN***Set1*	0.7
CIE **ΔL**	9.2	**ΔG-R**[DV]	4.0	**Δ VN***Set2*	1.1
percentiles Y	-8.3/11.6/13.5/14.1	**ΔG-B** [DV]	5.8	**Δ VN***Set3*	1.0
percentiles Y	-0.27/0.28/0.32/0.33				

numerical results

Luminance

Shading [f-stop]: the maximum shading of luminance in f-stops

Shading [%]: the maximum shading of luminance as percentage

CIE Δ L: the absolute average shading of luminace (CIE L)

$$\Delta L = L_{\max} - L_{\min}$$

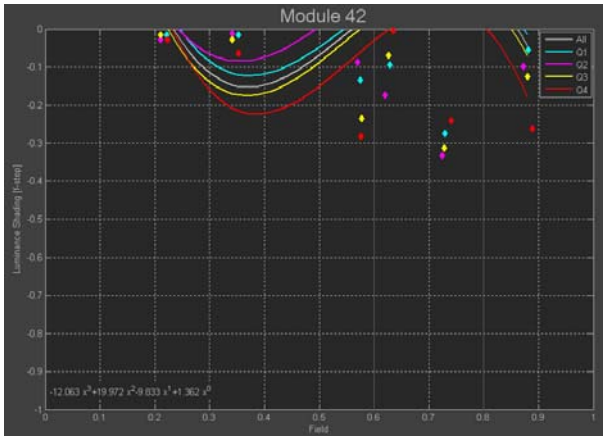
percentiles [DV] and [f-stop]: by inserting values for percentiles (in the Advanced mnenu) you get information about the luminance distribution explained in digital Values (DV) and f-stops depending on the choosen normalization.

Example: a percentile of 5 results in a digital value of -17.1. This means, 5% are less and 95% greater than -17.1.

define values for percentiles in the Advanced menu

percentiles Y	-18.1/-1.2/-0.2/0.4
percentiles Y	-0.20/-0.01/-0.00/0.00

reults after calculation



one graphical result : luminance shading

Color

CIE Δ Eab: the average color shading expressed in Delta E (CIE E)

In contrast to the Delta E calculation that is used in the COLOR module, in the SHADING module the calculation of Delta Eab is done without luminance L. So you get informtaion only about differences in colors without luminance.

$$\Delta E_{ab} = \sqrt{(\Delta a)^2 + (\Delta b)^2}$$

$$\Delta E(CIE1976) = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

$$\Delta L = L_{reference} - L_{sample}$$

$$\Delta a = a_{reference} - a_{sample}$$

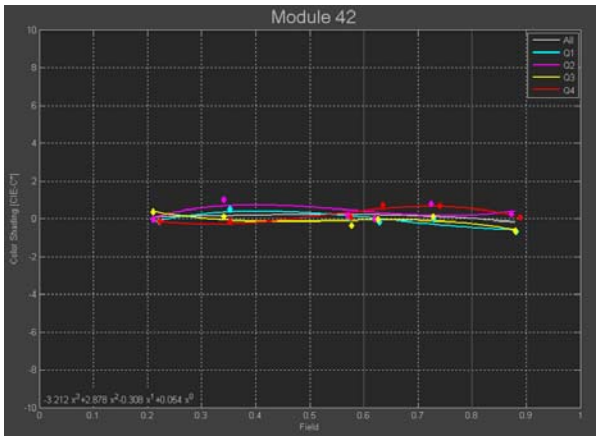
$$\Delta b = b_{reference} - b_{sample}$$

CIE Δ C: the average color shading expressed in Delta C (CIE C)

$$\Delta C = C_{reference} - C_{sample}$$

Δ**G-R:** the average difference between green and red channel, explained in digital values

Δ**G-R:** the average difference between green and blue channel, explained in digital values



one graphical result : color shading

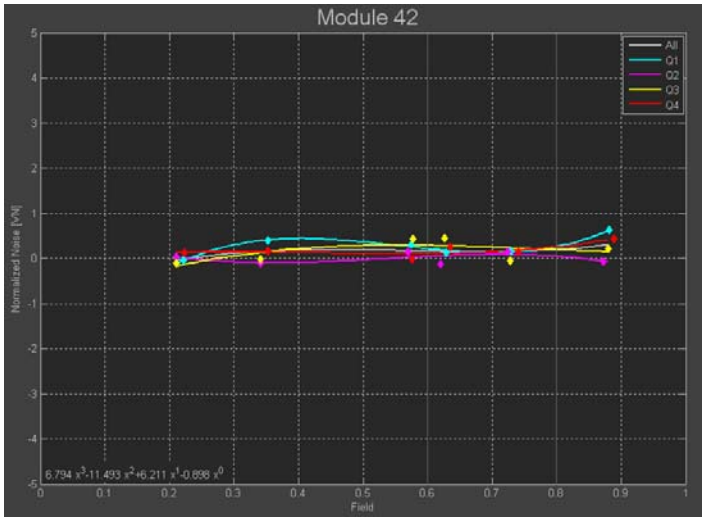
Noise

Δ **SNR [dB]:** the maximum difference of SNR, explained in dB

Δ **VNSet1:** the maximum difference of visual noise (viewing condition set 1)

Δ **VNSet2:** the maximum difference of visual noise (viewing condition set 2)

Δ **VNSet3:** the maximum difference of visual noise (viewing condition set 3)

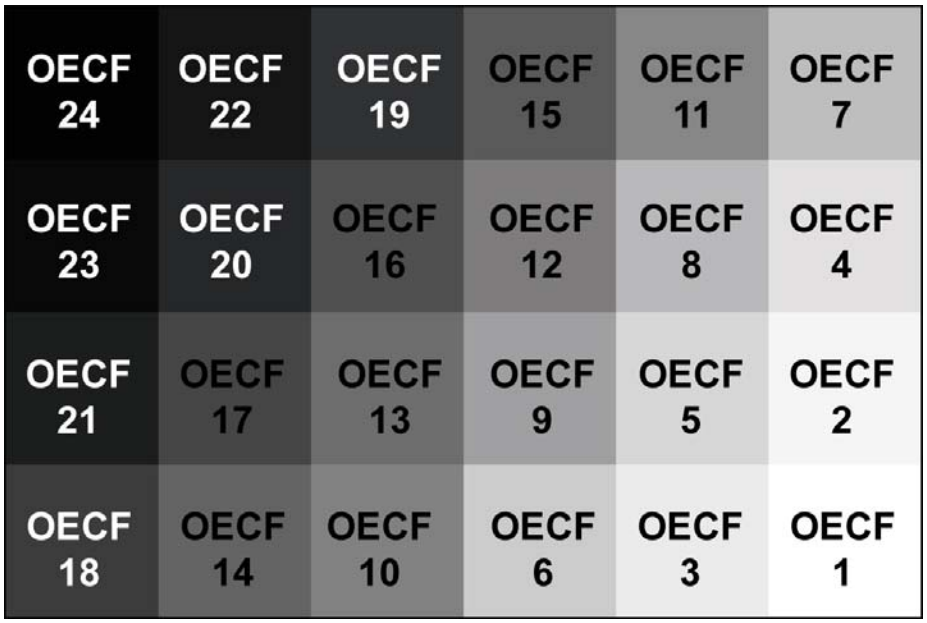


one graphical result : noise

V. SELECTION OF CHARTS USED FOR iQ-ANALYZER

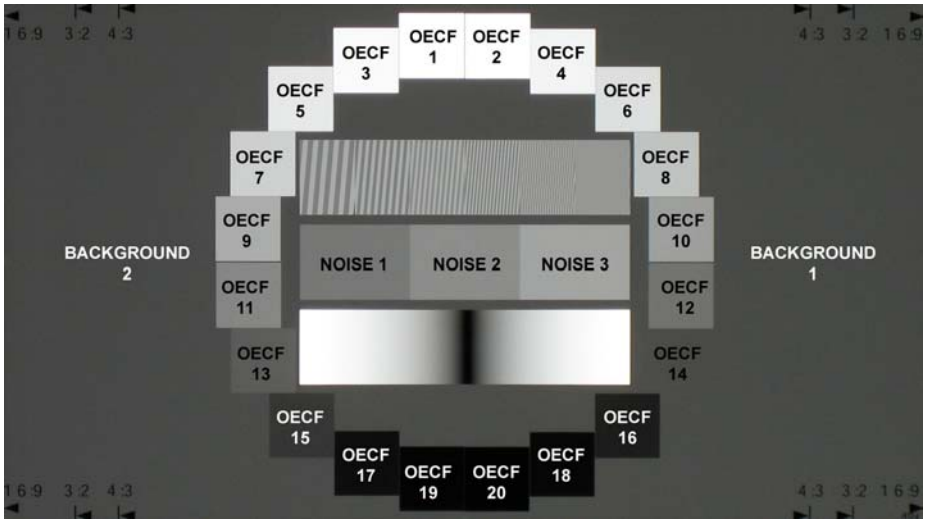
1. TE240

ISO 21550 Scanner Dynamic Range Chart

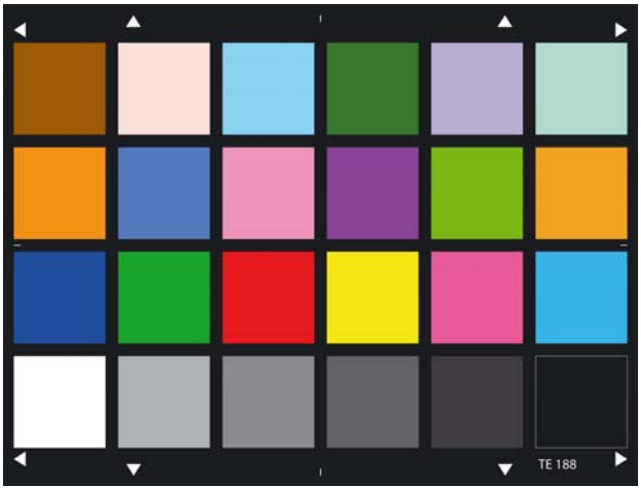


2. TE241

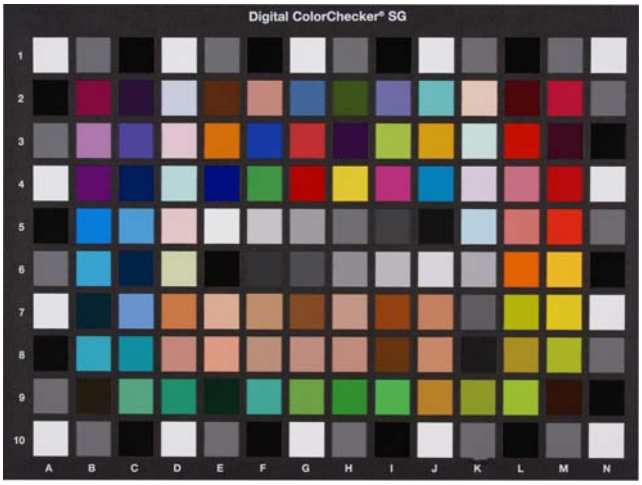
ISO 21550 OECF/Noise Chart with 20 gray patches, ISO 14524 / 15739, 10.000:1



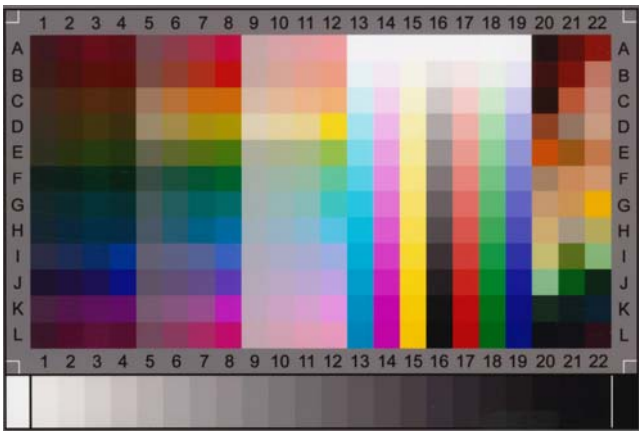
3. ColorChecker TE188



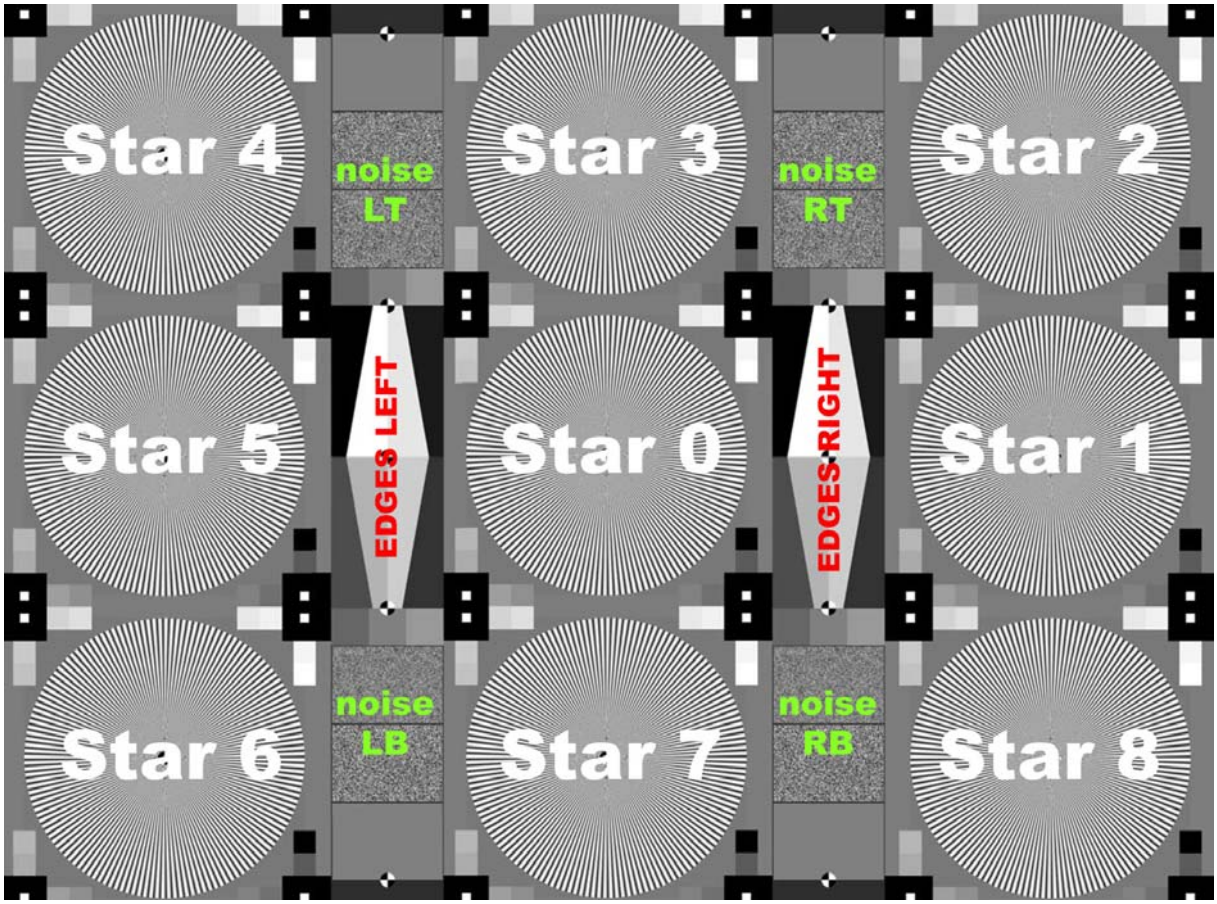
4. ColorChecker SG (TE230)



5. IT8 (TE258)

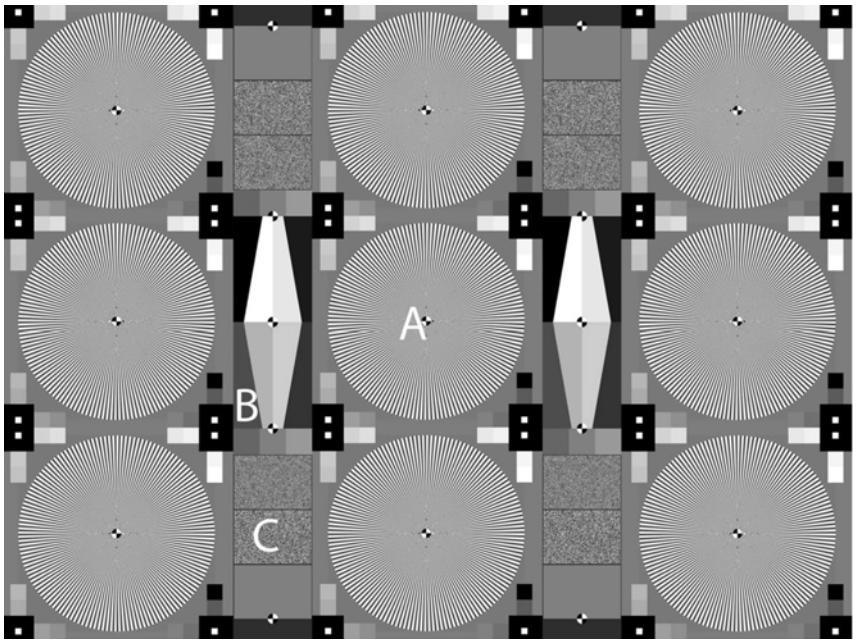


6. TE253 / TE253 9x



survey of the structures of the TE253 9x

The TE253 9x contains three main structures:

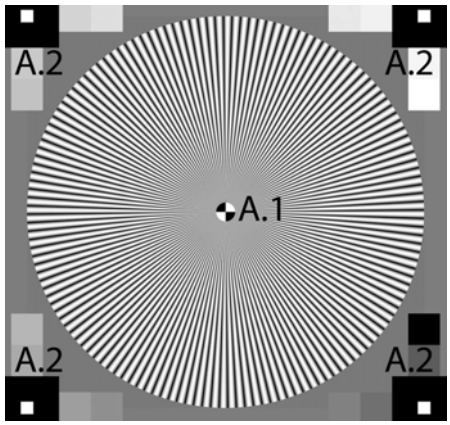


A - harmonic **Siemens stars** for SFR Siemens on 9 positions in the image, additional gray patches for linearization

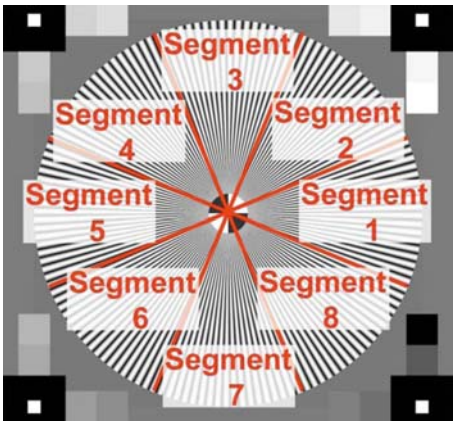
B - **edges** for SFR Edge, four different modulations, additional gray patches for independent linearization

C - gaussian **white noise** with different variances, a gray line between patches, four flat patches without noise

A - Siemens stars



Structure A: harmonic Siemens star

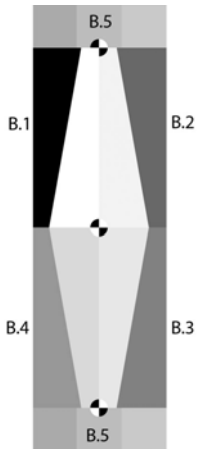


Segments of Siemens star

A.1 Harmonic Siemens star, 144 cycles per circle

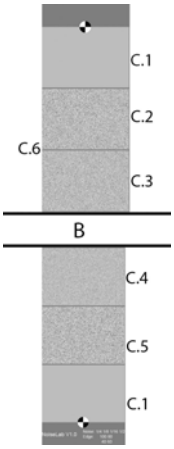
A.2 Gray patches for linerization, even distributed between minimum and maximum density

B Edges



B.1 Edge, slanted by 10°, 100% modulation
B.2 Edge, slanted by 10°, 80% modulation
B.3 Edge, slanted by 10°, 60% modulation
B.4 Edge, slanted by 10°, 40% modulation
B.5 Additional gray patches, 0.4, 0.5 and 0.6 reflectance

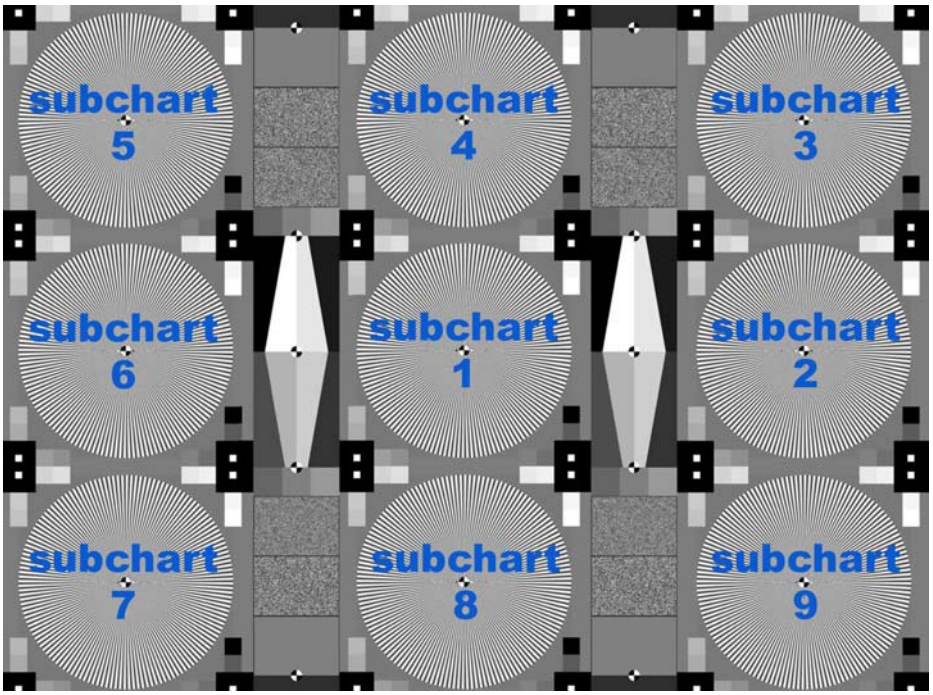
C White Noise



C.1 no noise, 0.5 of Dmax-Dmin
C.2 gaussian white noise, σ = 1/4, mean as C.1
C.3 gaussian white noise, σ = 1/8, mean as C.1
C.4 gaussian white noise, σ = 1/16, mean as C.1
C.5 gaussian white noise, σ = 1/2, mean as C.1
C.6 lien between patches C.2 and C.3, mean as C.1

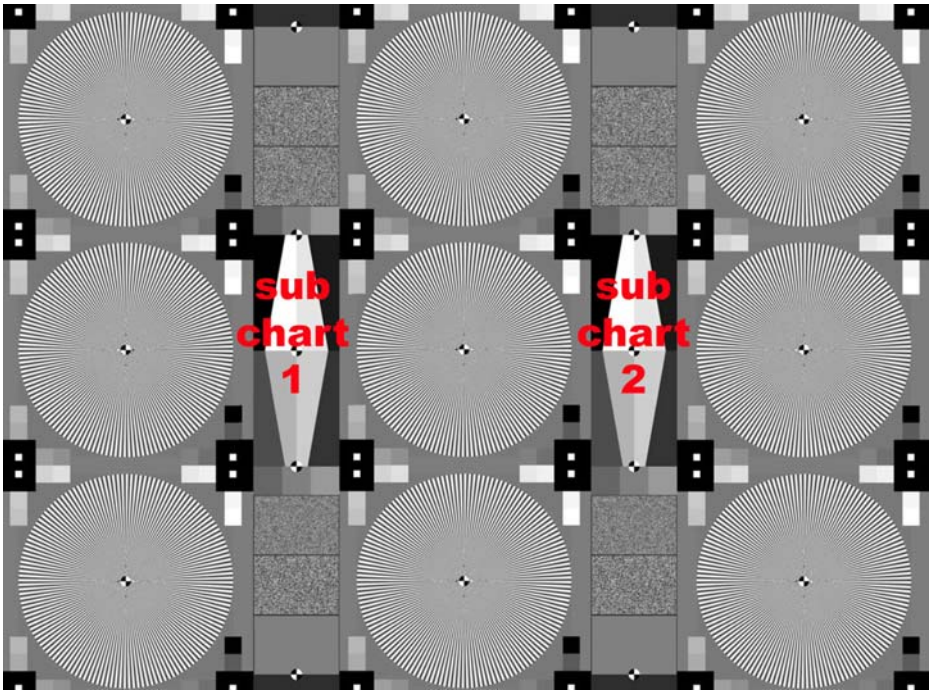
Declaration of subcharts

Subcharts SIEMENS



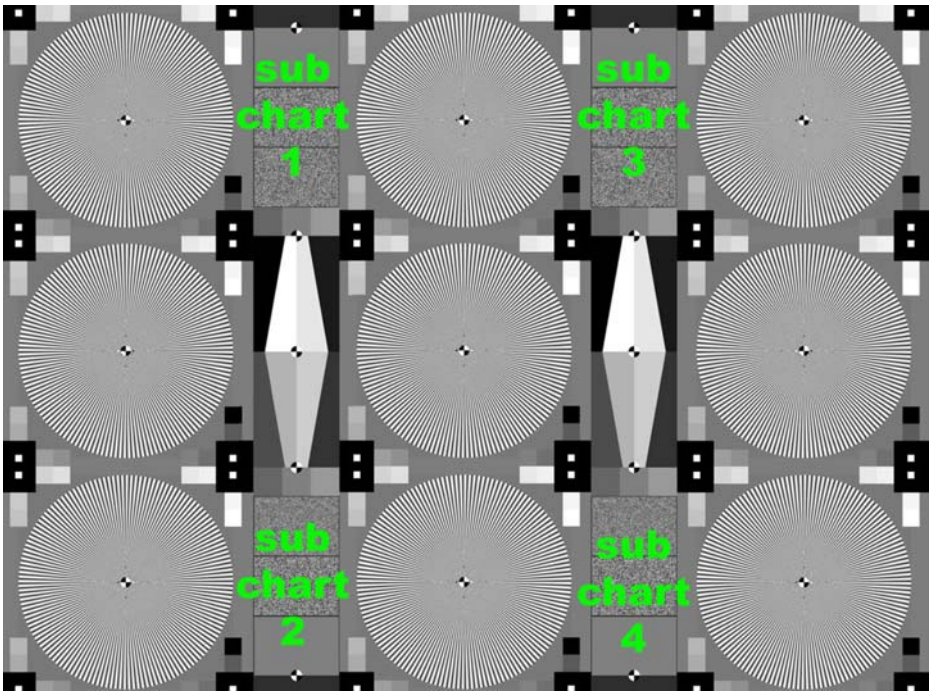
subcharts siemens

Subcharts EDGE



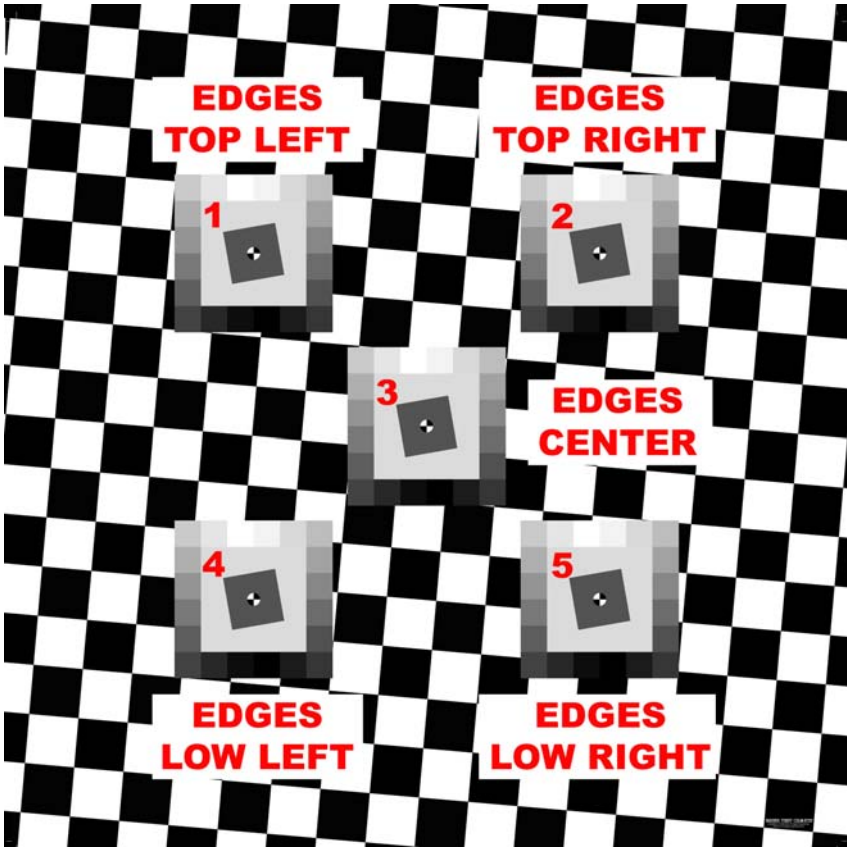
subcharts edge

Subcharts NOISE



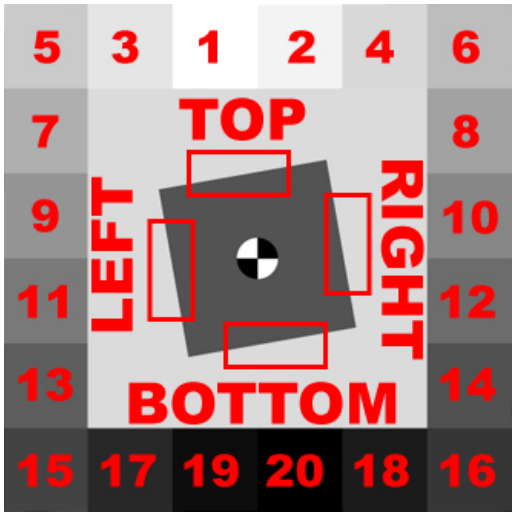
subcharts noise

7. TE261 A830



TE261 A830 composed of five subcharts

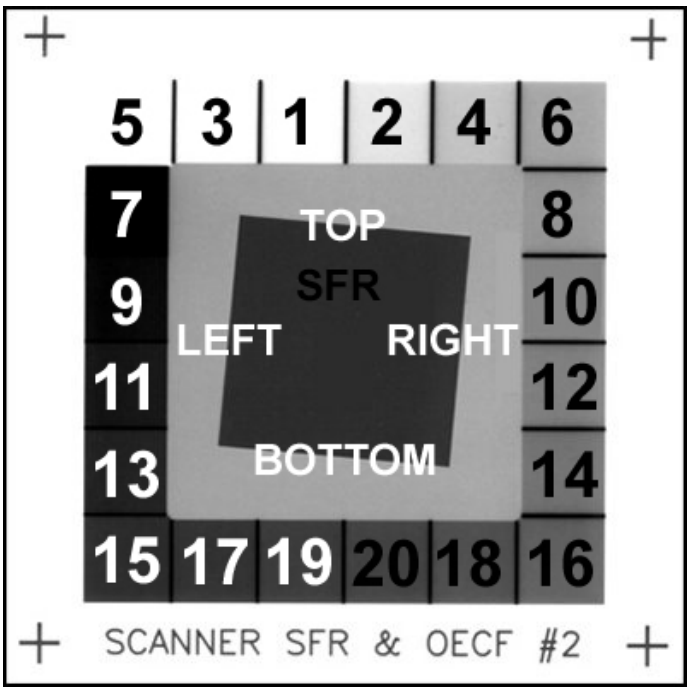
1. Top Left
2. Top Right
3. Center
4. Low Left
5. Low Right



One of the five subcharts composed of 20 graypatches and four edges

Edge right
Edge left
Edge Top
Edge Bottom

8. QA 62


5
3
1
2
4
6
7
8
TOP
SFR
9
10
LEFT
RIGHT
11
12
13
BOTTOM
14
15
17
19
20
18
16
SCANNER SFR & OECF #2

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You can download the complete source code used to build FFmpeg here:
http://ffmpeg.arrozcru.org/autobuilds/

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You can download the complete source code here: http://www.videolan.org/vlc/download-sources.html

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To install ExifTool on Mac OS X please follow the instructions on the ExifTool homepage.
You can download the complete source code here.

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