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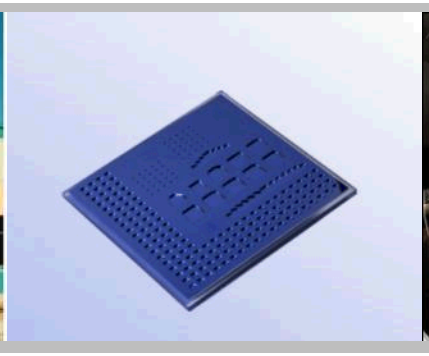

Measurement of Surface Topography and Additive Manufacturing Process Characterization

Gabriela Barrera
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Class of 2017

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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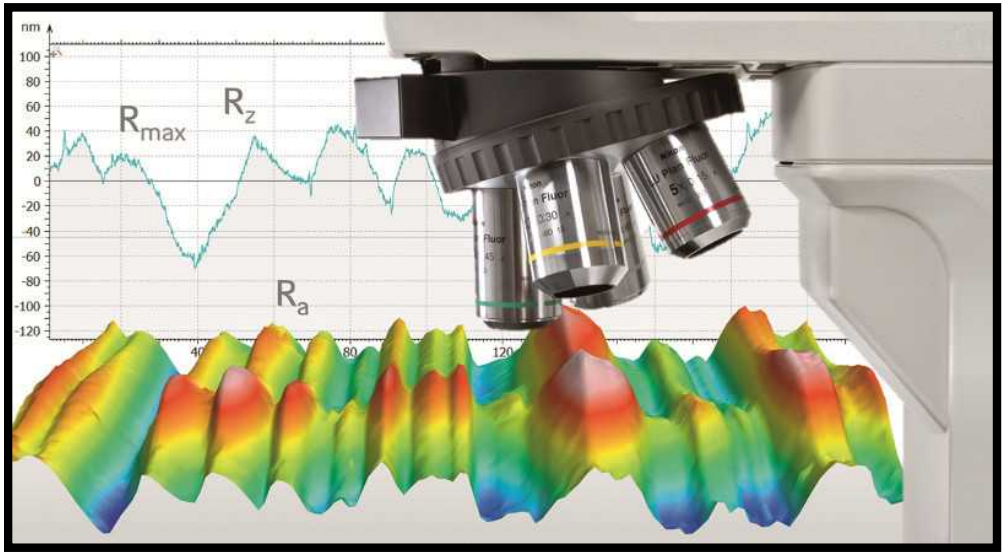
Outline

- Metrology
- Project 1
- Project 2
- Lessons Learned

Surface Metrology

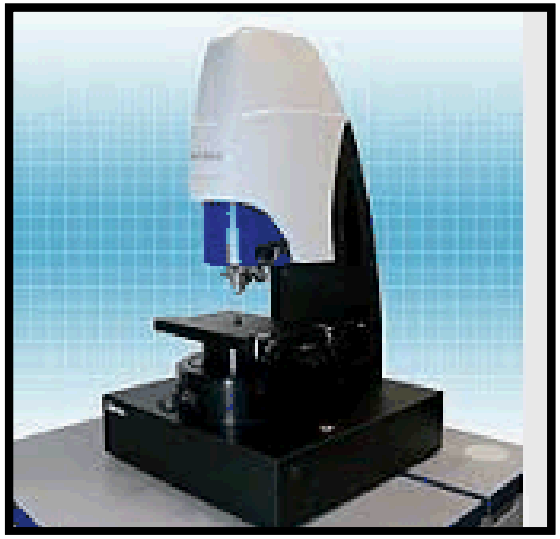
- Study of Surface Texture
- Applications
  - Measurements and Accuracy
  - Wear
  - Corrosion
  - Conductivity



Project 1- Research

- Talysurf CCI
  - White light interferometer
  - Advantages
  - Disadvantages
- TalyMap Platinum

- ISO 5436
- ISO 25718
- ASM B46
- Previous Research for Qualification



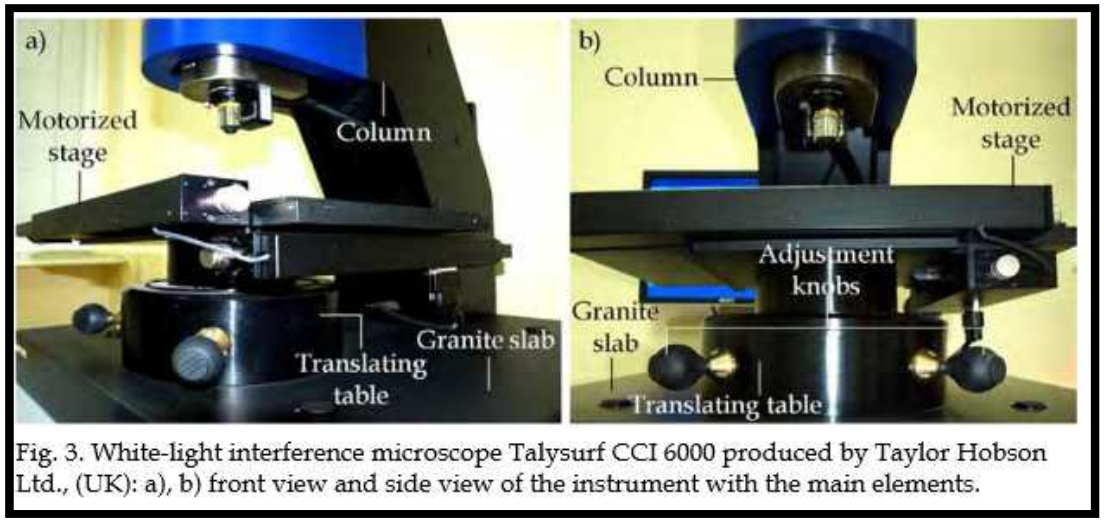
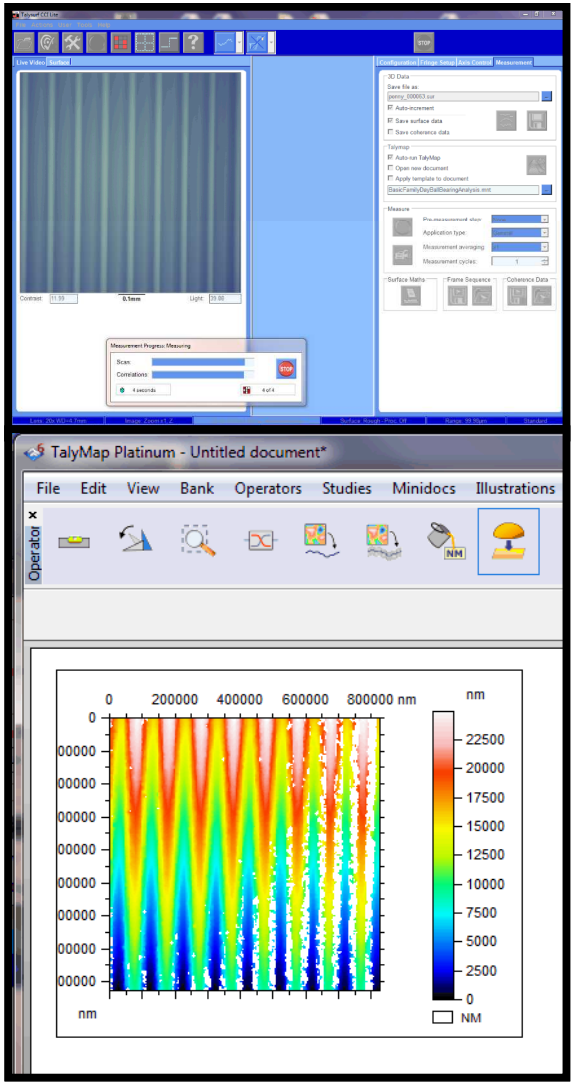


Fig. 3. White-light interference microscope Talysurf CCI 6000 produced by Taylor Hobson Ltd., (UK): a), b) front view and side view of the instrument with the main elements.

Project 1- Task

- Develop criteria for the CCI-Lite interferometer
  - Establish the best configurations and settings
  - Calculate Roughness Parameters and Uncertainty
- Test it against known values
  - 4 types of surfaces with varying profiles



Methods

- Measure surface according to different settings varying:
  - Lens and Zoom
  - Surface Height Mode
  - Mode
    - XY
    - xyz
    - Z

Surface	Ra (nm)
P16T3	108.9 ± 9.7
P1D1	411.3 ± 12.2
PAOQ	2928 ± 63
PB11331	2992 ± 16

- Manipulate readings and calculate Ra values in software with settings that match ISO and ASME standards

Leveling

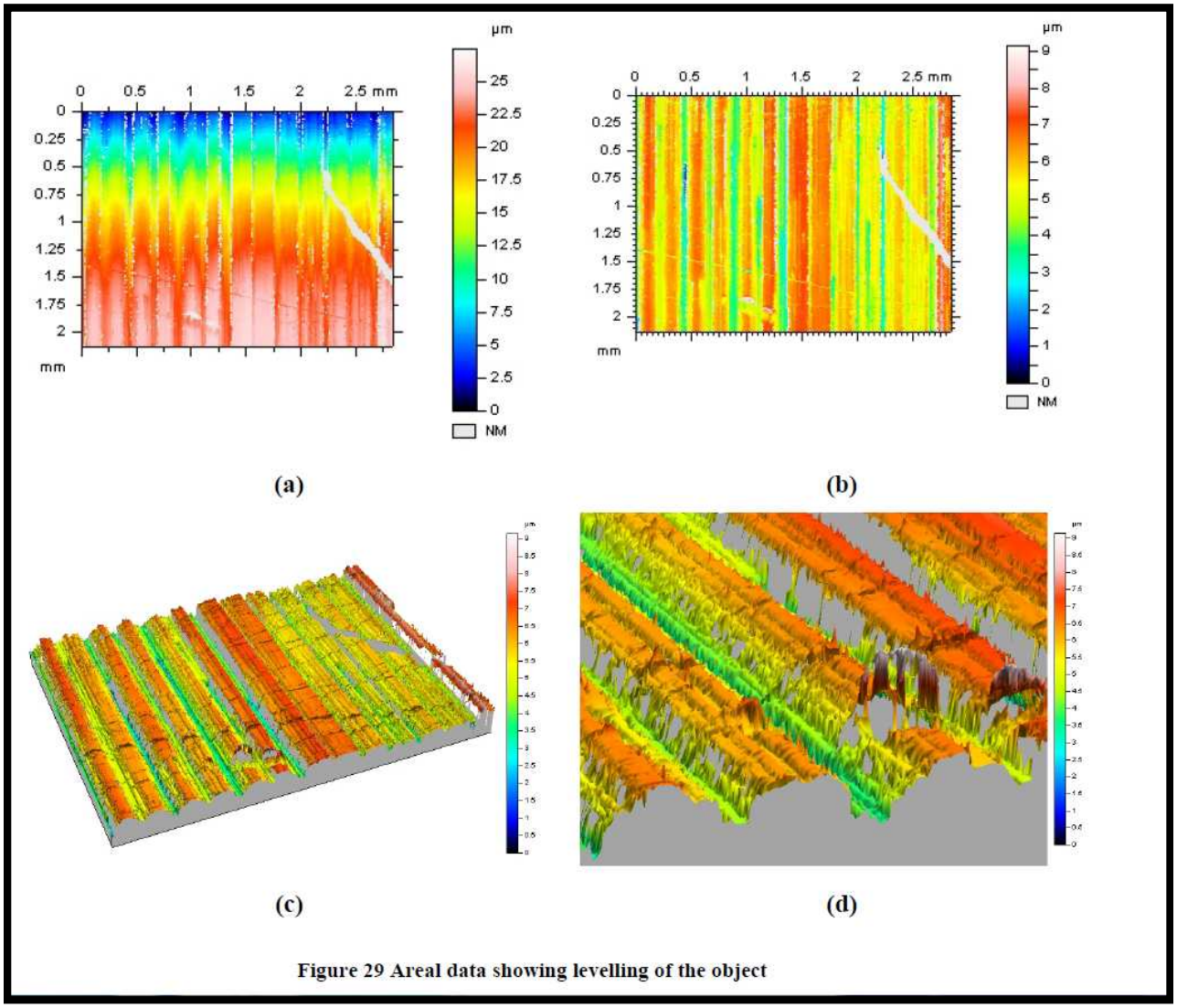


Figure 29 Areal data showing levelling of the object

Filtering

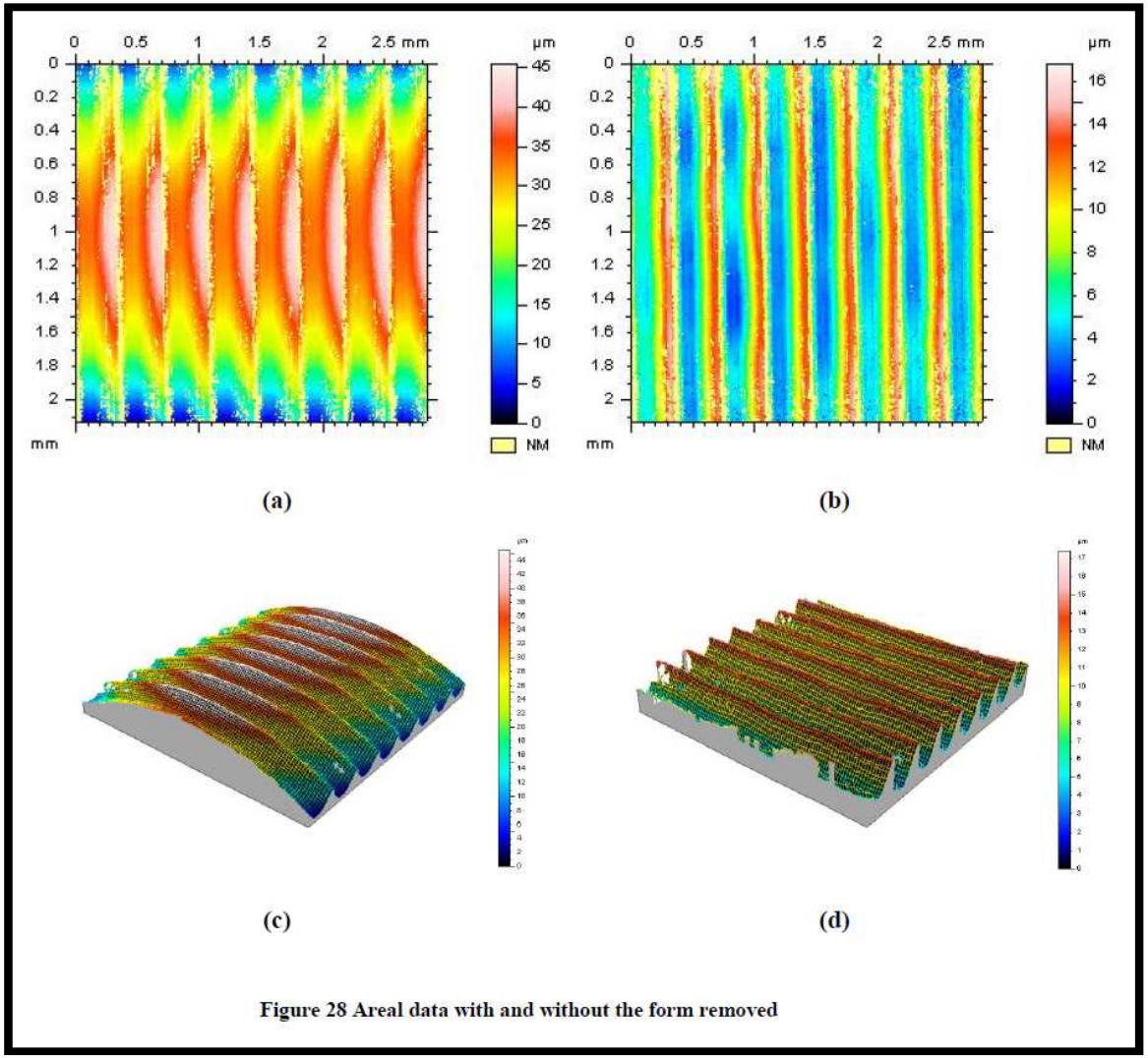
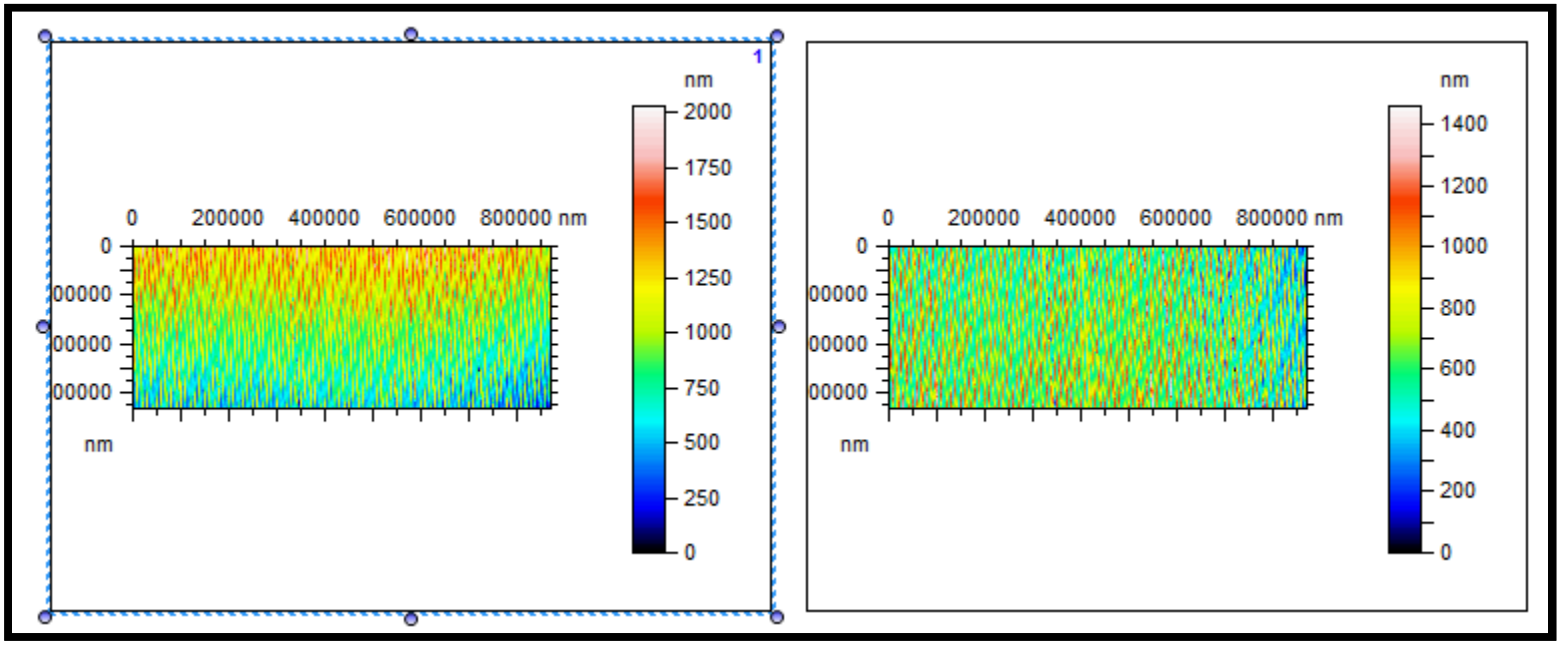
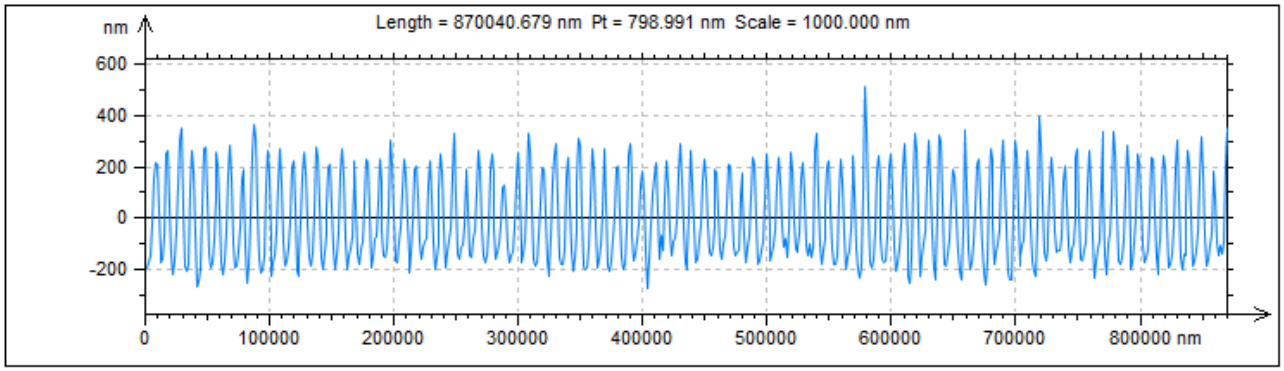
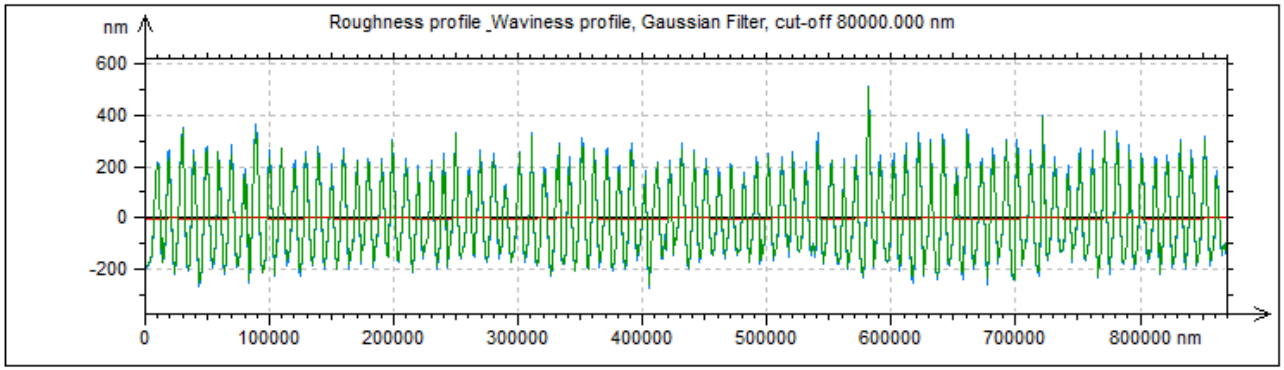


Figure 28 Areal data with and without the form removed

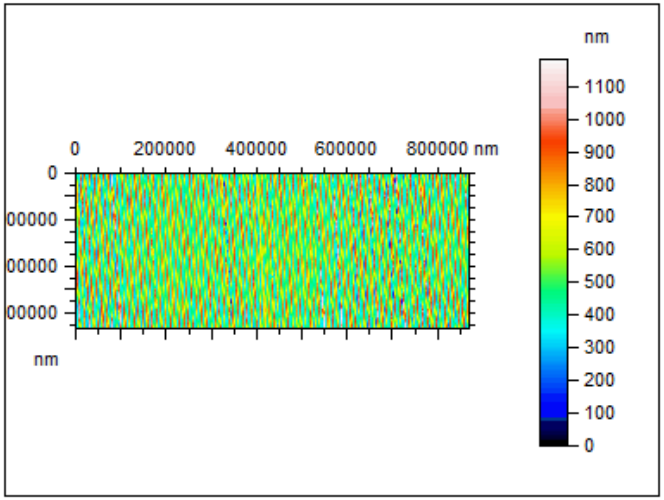
Example

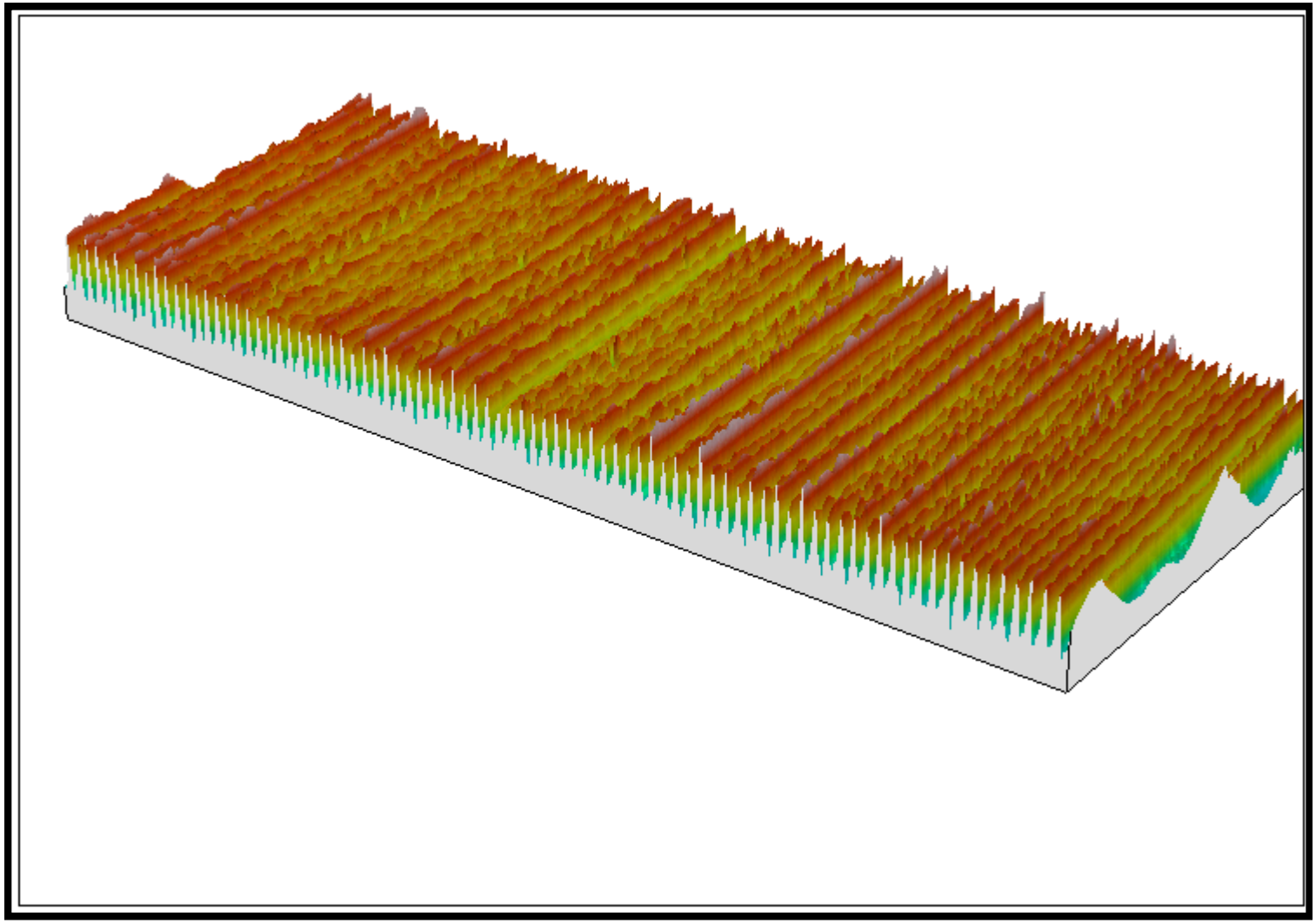

1
nm
2000
1750
1500
1250
1000
750
500
250
0
0
200000
400000
600000
800000 nm
nm
nm
1400
1200
1000
800
600
400
200
0



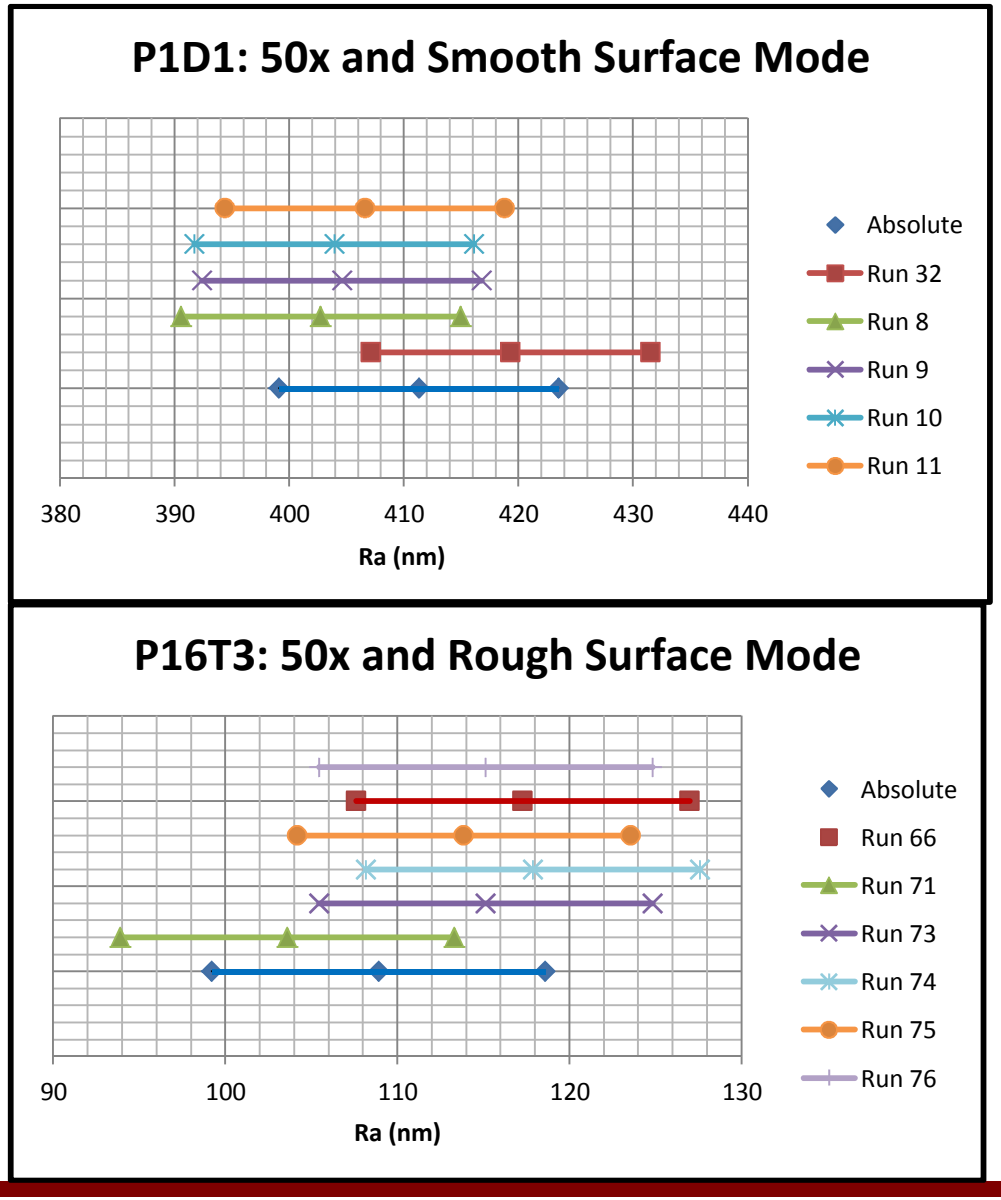


ISO 4287			
Amplitude parameters - Roughness profile			
Ra	136.588	nm	*Gaussian filter, 0.08 mm*
Rp	339.190	nm	*Gaussian filter, 0.08 mm*
Rz	563.986	nm	*Gaussian filter, 0.08 mm*
Rq	155.298	nm	*Gaussian filter, 0.08 mm*
Rsk	0.420		*Gaussian filter, 0.08 mm*
Rku	2.049		*Gaussian filter, 0.25 mm*
ASME B46.1			
2D Parameters			
Ra	136.800	nm	*Gaussian filter, 0.08 mm*
Rp	514.298	nm	*Gaussian filter, 0.08 mm*
Rz	556.936	nm	*Gaussian filter, 0.08 mm*
RSm	*****	nm	*Gaussian filter, 0.8 mm*

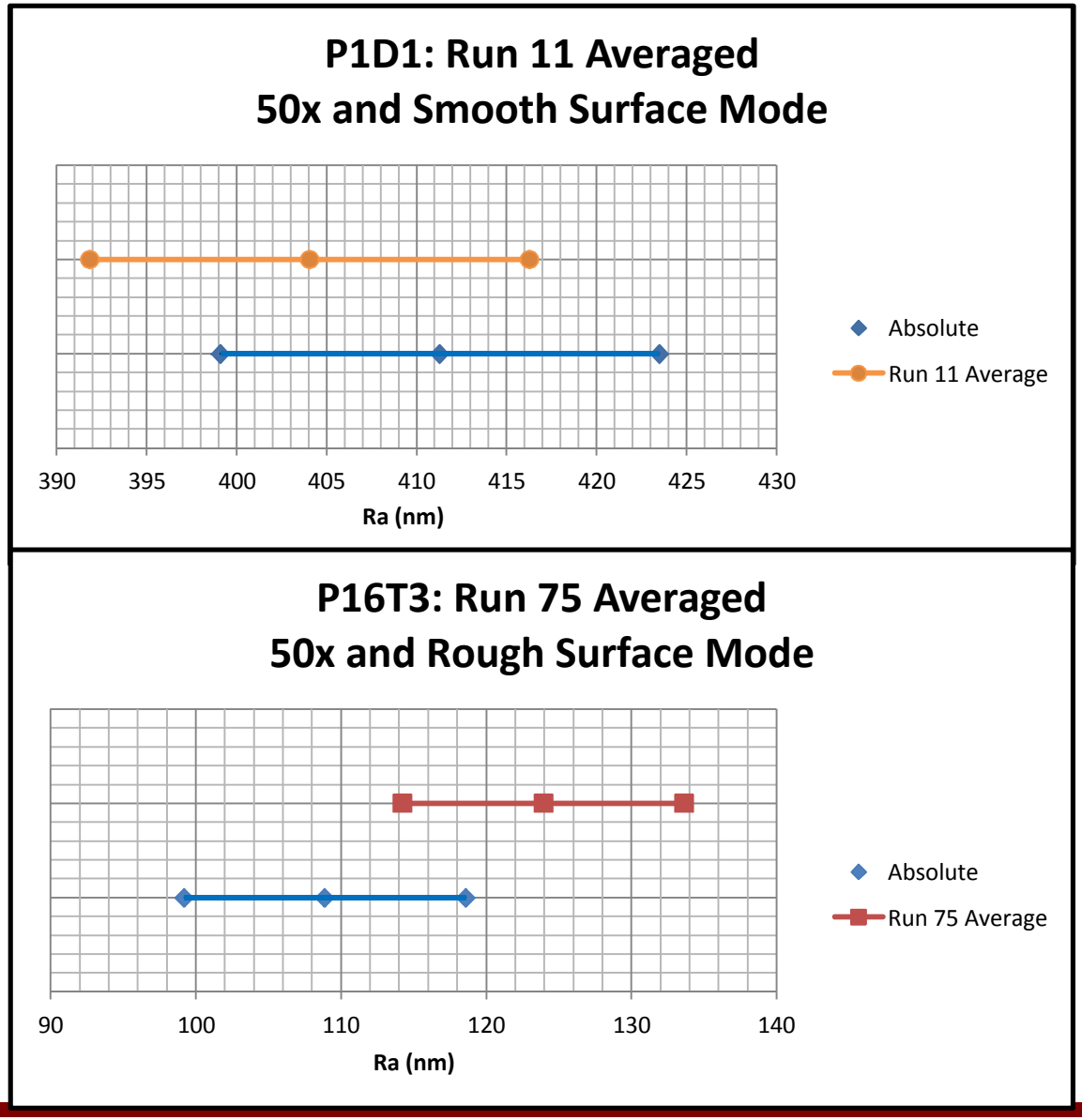




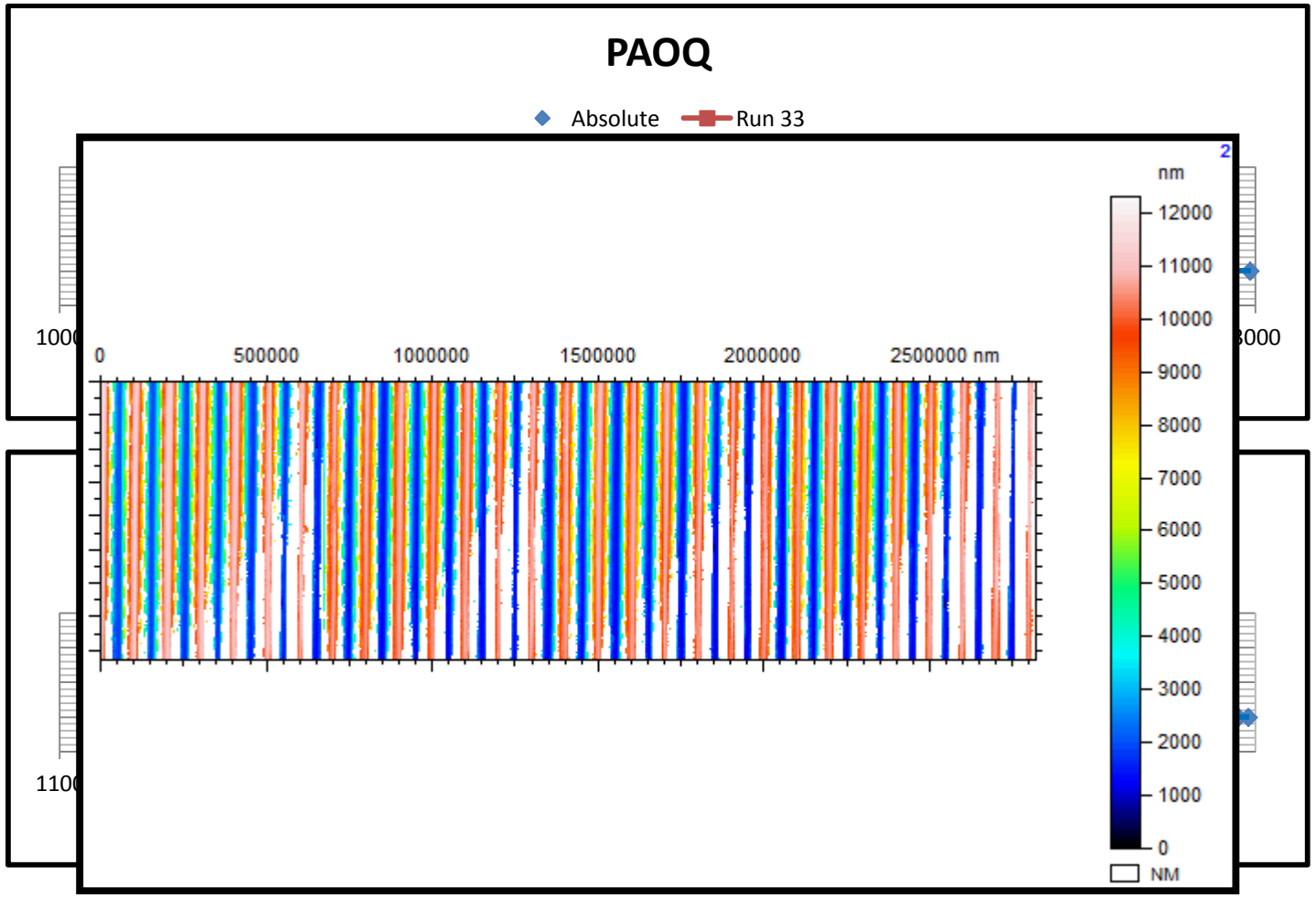
Results


P1D1: 50x and Smooth Surface Mode
380
390
400
410
420
430
440
Ra (nm)
Absolute
Run 32
Run 8
Run 9
Run 10
Run 11
P16T3: 50x and Rough Surface Mode
90
100
110
120
130
Ra (nm)
Absolute
Run 66
Run 71
Run 73
Run 74
Run 75
Run 76

Results


P1D1: Run 11 Averaged
50x and Smooth Surface Mode
390
395
400
405
410
415
420
425
430
Ra (nm)
Absolute
Run 11 Average
P16T3: Run 75 Averaged
50x and Rough Surface Mode
90
100
110
120
130
140
Ra (nm)
Absolute
Run 75 Average

Results



No signal in the interference microscope caused by irregularities of slope occurs when, the slope angles of inequality θ exceed the maximum value θ_{max} given by the numerical aperture of the lens (Petzing et al., 2010):

Conclusions

- Measurement Speed
- Data Fill-In
- Lens Objectives
- Rough Surface Behavior

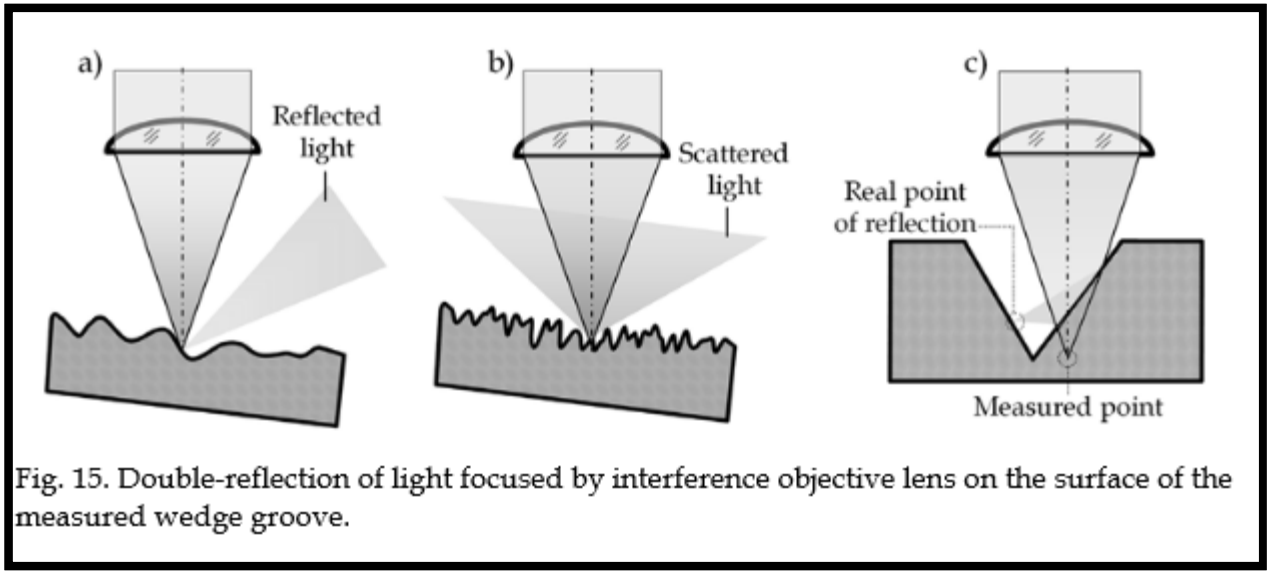
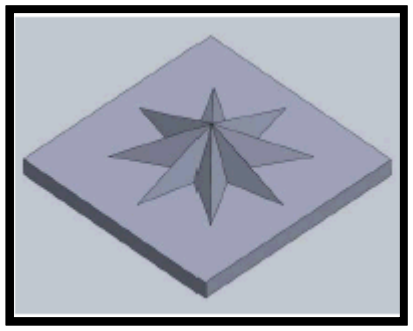


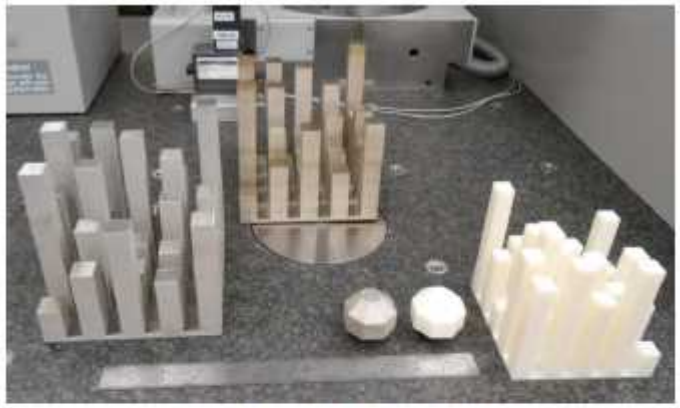
Fig. 15. Double-reflection of light focused by interference objective lens on the surface of the measured wedge groove.

Project- 2

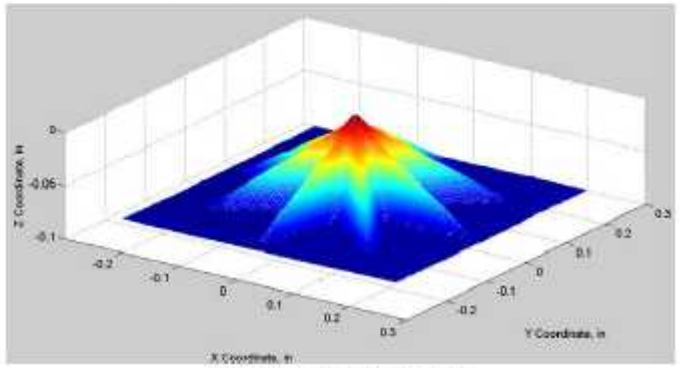
- Small part in process characterization
- Investigate size, location, form, & orientation
- Find Minimum Feature Size
  - Artifact Based
  - Siemens Star

2D Siemens star, Wikipedia





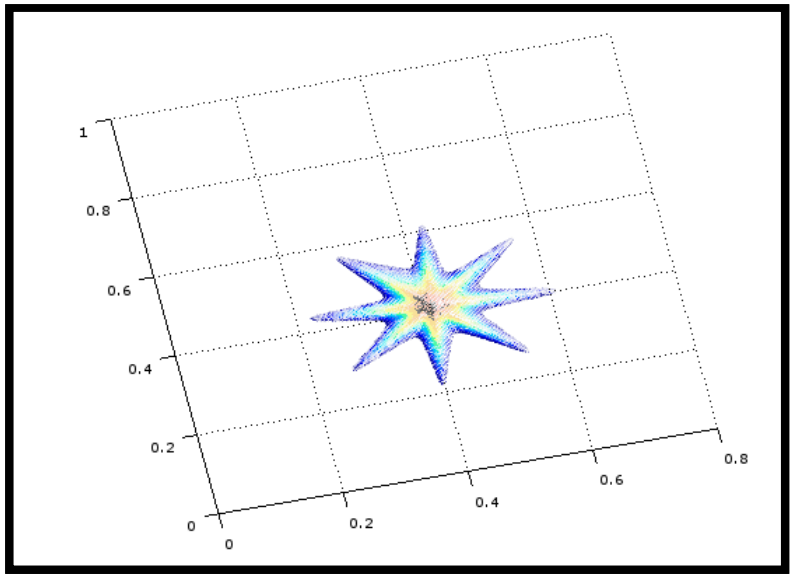
artifacts ready for measurement

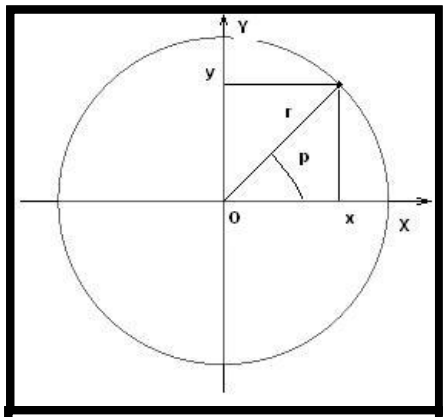


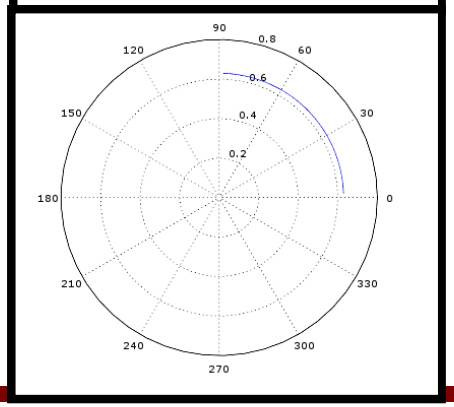
Siemens star profile data

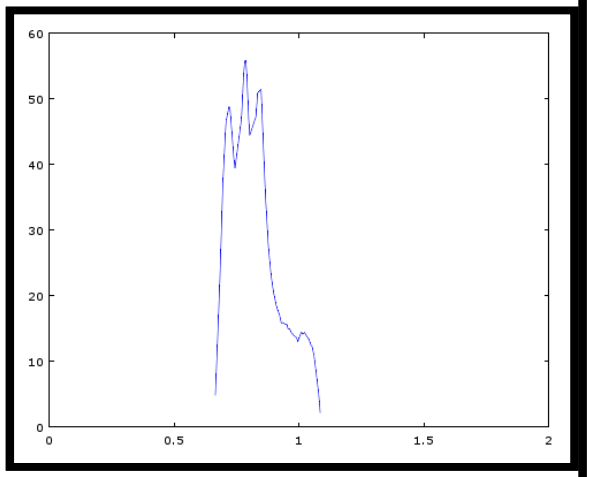
Project- 2

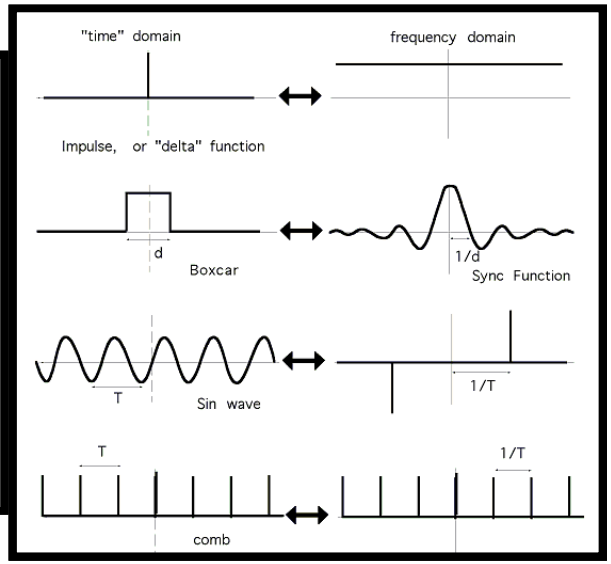
GNU Octave





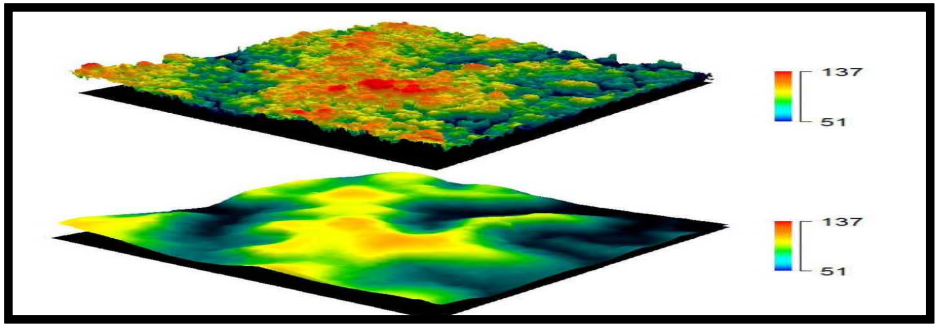






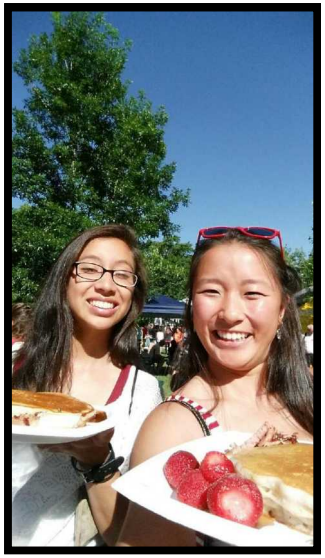
What I learned

- How metrology works in industry and research
  - Importance of knowing surface parameters
  - Reasons behind and problems with accuracy
  - Instrument Familiarity
- Versatility and use of metrology
- Signal Processing
- National Lab Opportunities and Importance



My time in Albuquerque

- Tours
- Hiking
  - Tres Pistolas
  - Sandia Mountains
  - La Luz
- The Rio Grande & Safari Grill
- New Mexican Food
- Santa Fe
- Old Town
- Atomic and Natural History Museum
- Carlsbad
- Petroglyphs Monument



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Acknowledgements

- Hy Tran
- Rick Mertes
- Bradley Jared
- PSL
- Staci Dorsey
- Sandia

Questions?

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