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Leaders in
high-speed
imaging



High-Speed Image Acquisition and Analysis with LabVIEW

By Scott Walkington

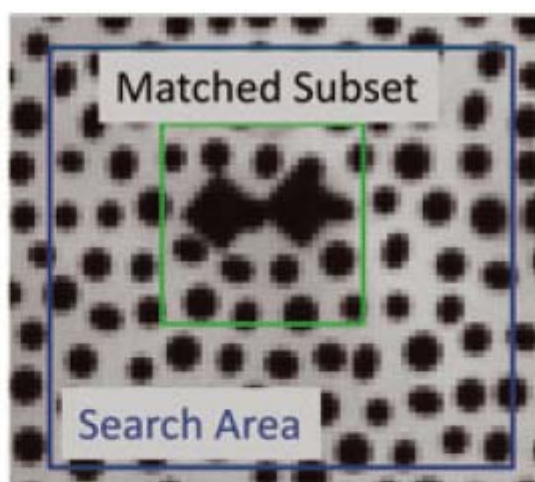
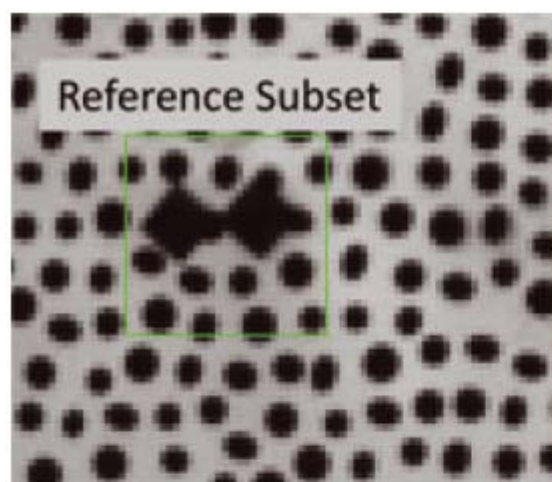


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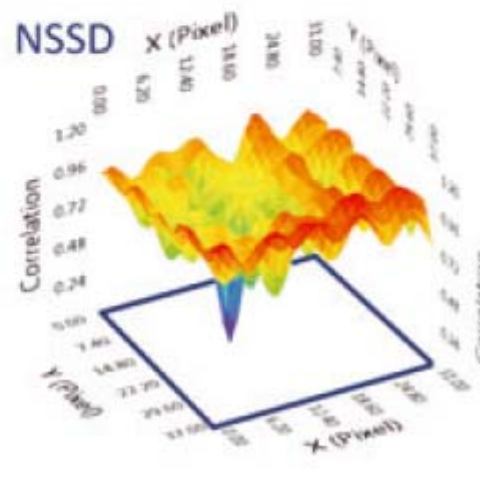
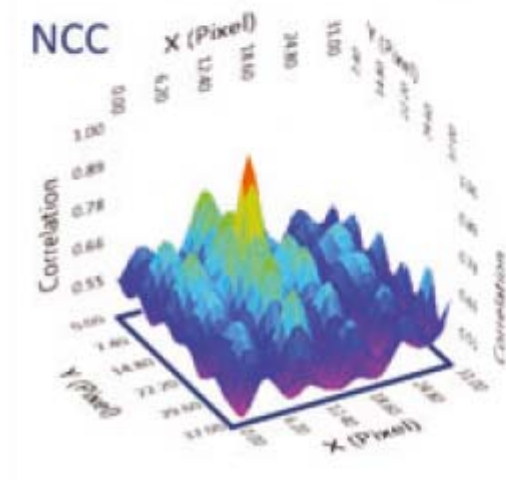
Outline

- Digital Image Correlation (DIC)
- Production Environment
- Problems with Commercial-of-the-Shelf Software(COTS)-
PCC and VIC 2D
- Hardware for High-Speed Video System
- Creating DLL from .h Files
- Vision Research SDK
- Speckle Track Software
- Camera Control Software
- Proper Architectures
- Error Handling Vs. Error Recovery
- Conclusion

Digital Image Correlation (DIC)



1. Sum Squared Difference (SSD)
2. Normalized Sum Squared Difference (NSSD)
3. Zero Normalized Sum Squared Difference (ZNSSD)



sigma [pixel] - this is the confidence interval for the match at this point, in pixels.

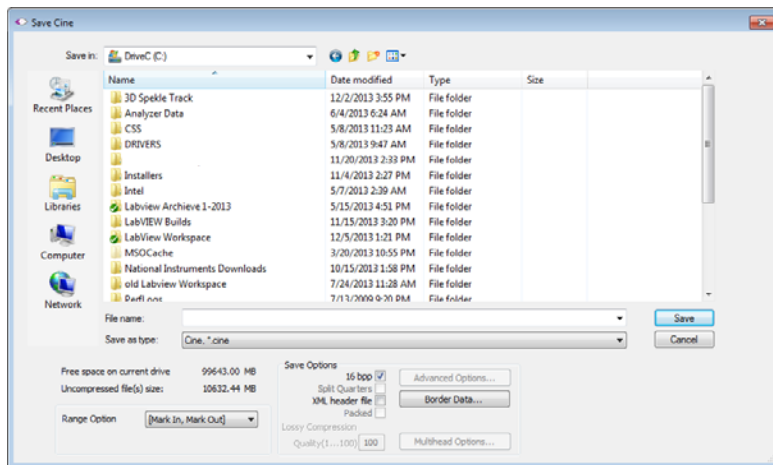
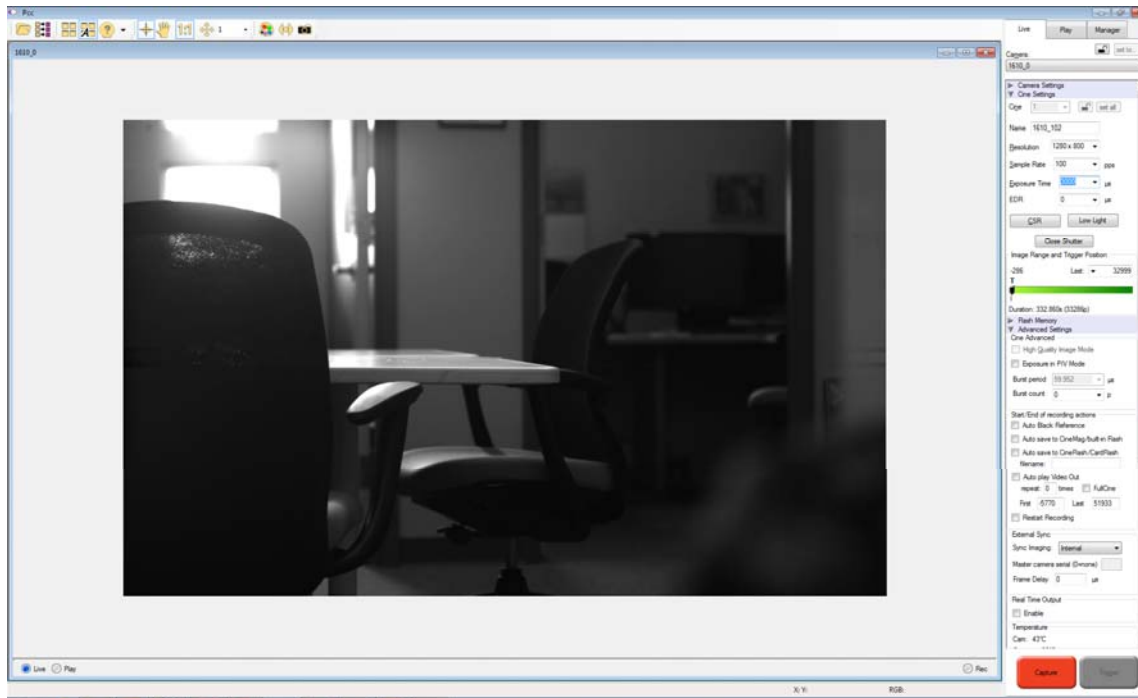
Different Environment- Production



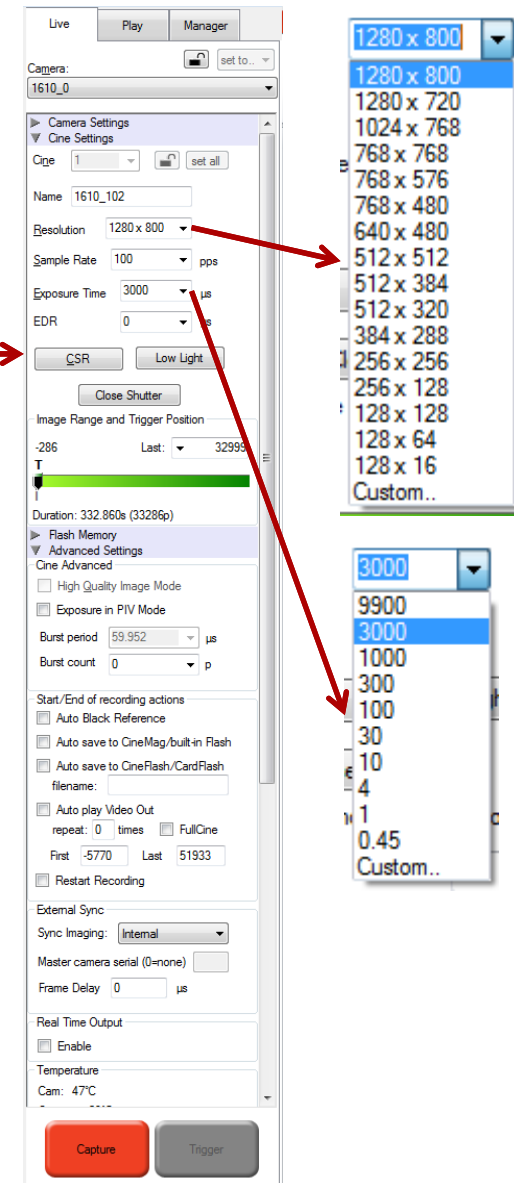
- Sandia National Laboratories- R&D Laboratory
 - Development
- Production Factory
 - Speed
 - Repeatability
 - Production line- Deadlines
 - **Reliability, Maintainability, and Supportability of the Systems**



Complexity of Phantom(PCC) HSV Software



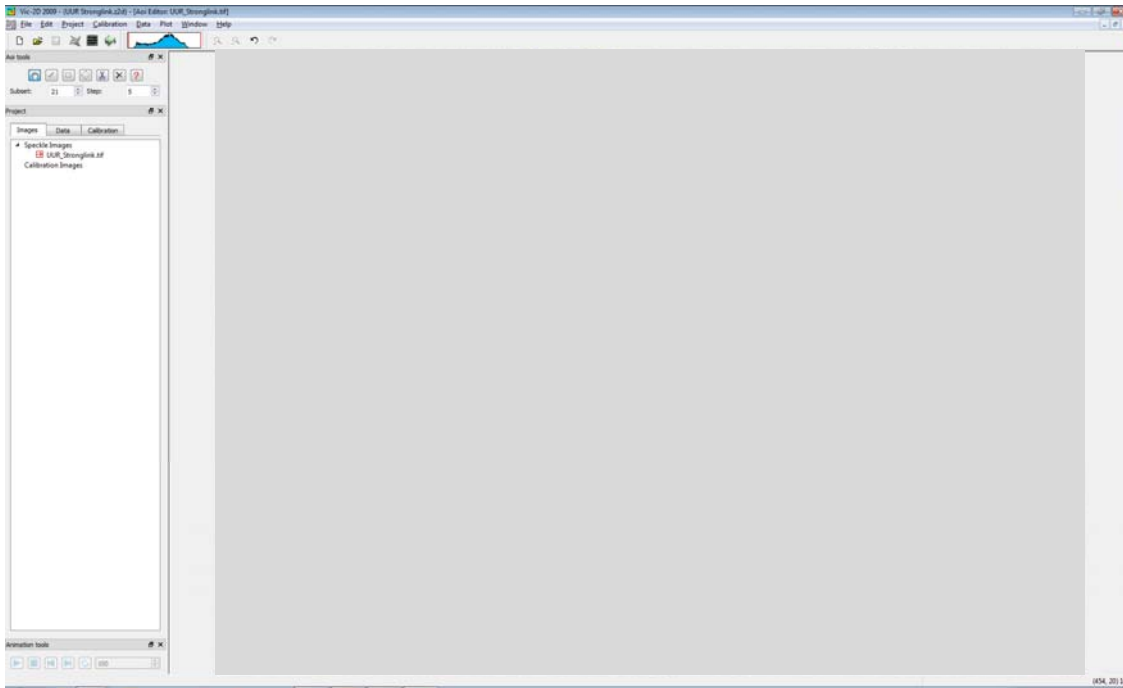
To much control/
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Easy to make
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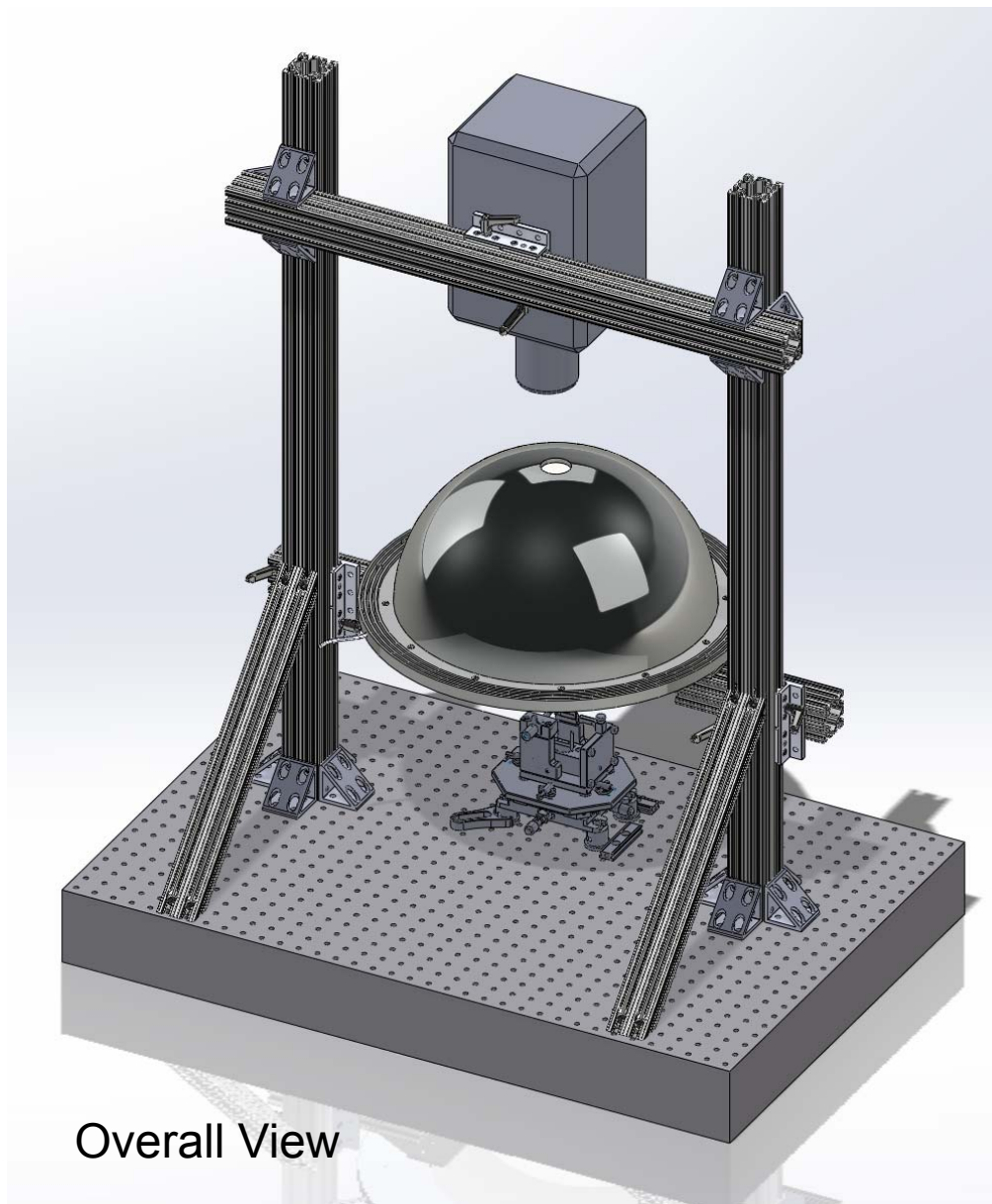
Complexity of VIC 2D- Commercial DIC Software

Disadvantages

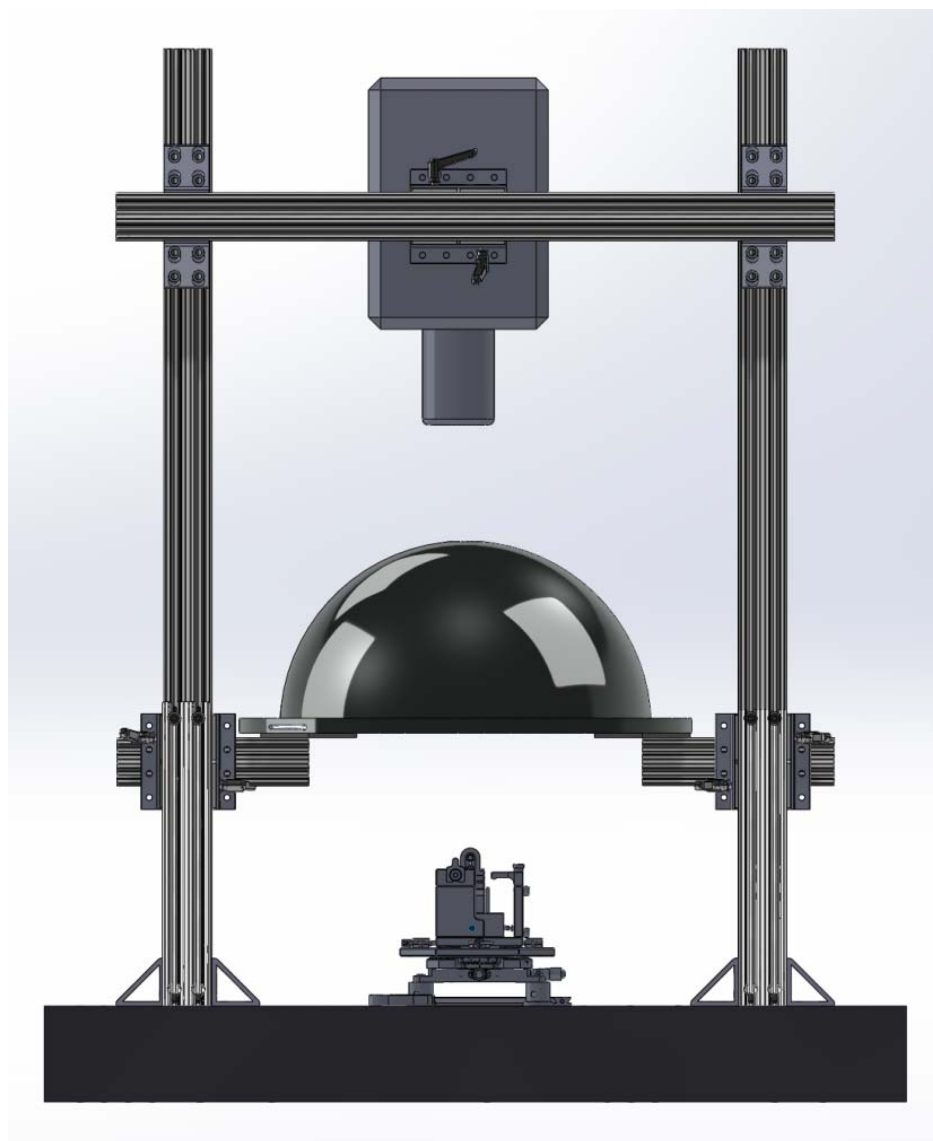
- Long time to track a full run of a unit (about 8 hours)
- No easy way to save ROI
- Must convert .cine to .tiff
- Manually Save Tracked data to file
- No Batch Mode!



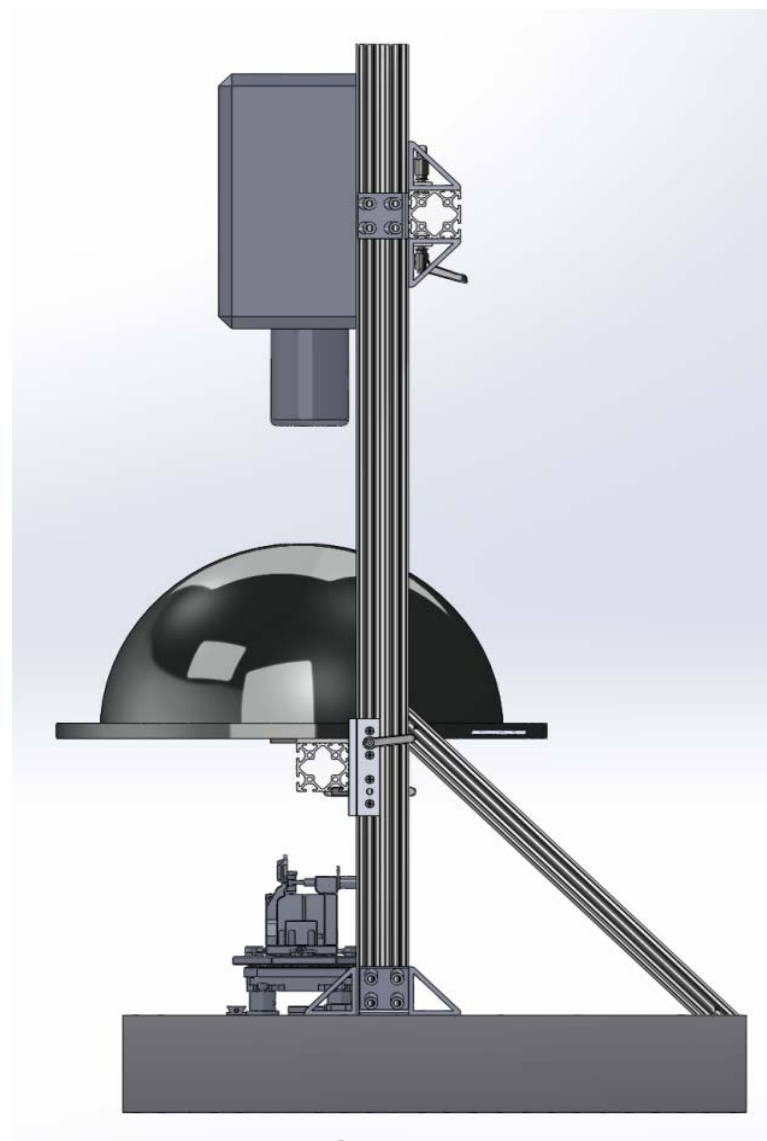
Camera and Light Dome Mount + Fixture.



Overall View



Front View



Side View

Start of the Solution: LabVIEW!!

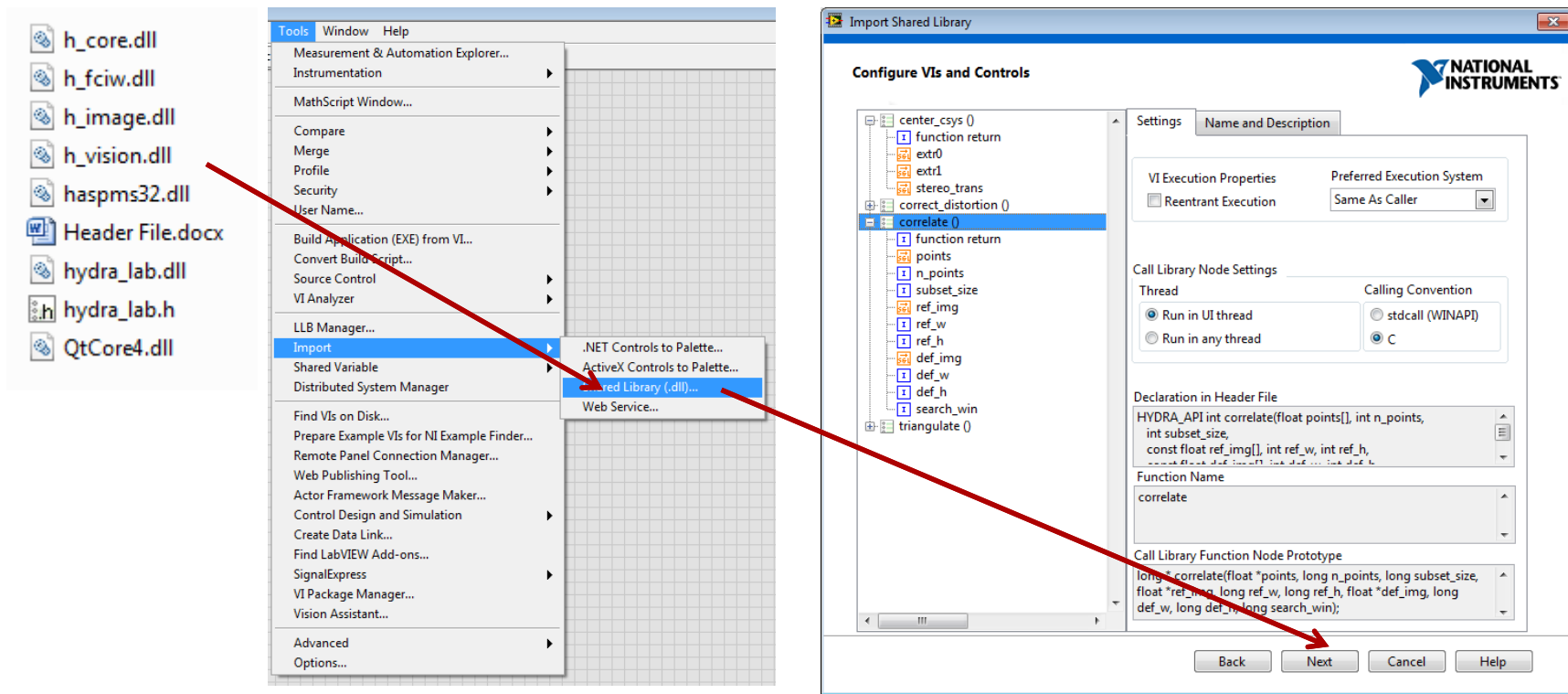
Started with Phil Reu's initial Speckle Track program, which could bring in .cine and then could search the current image for a ROI. The program was a great starting point. Also, Vision Research provided a SDK which had a Sample Program to control a camera.

1. Drastic improvements in time because of far fewer points being tracked
2. Improved the user interface
3. Made possible the entire .cine to be tracked
4. Save and open ROI
5. Save data directly to .csv
6. Most Importantly added a Batch Mode.
7. Many more additions

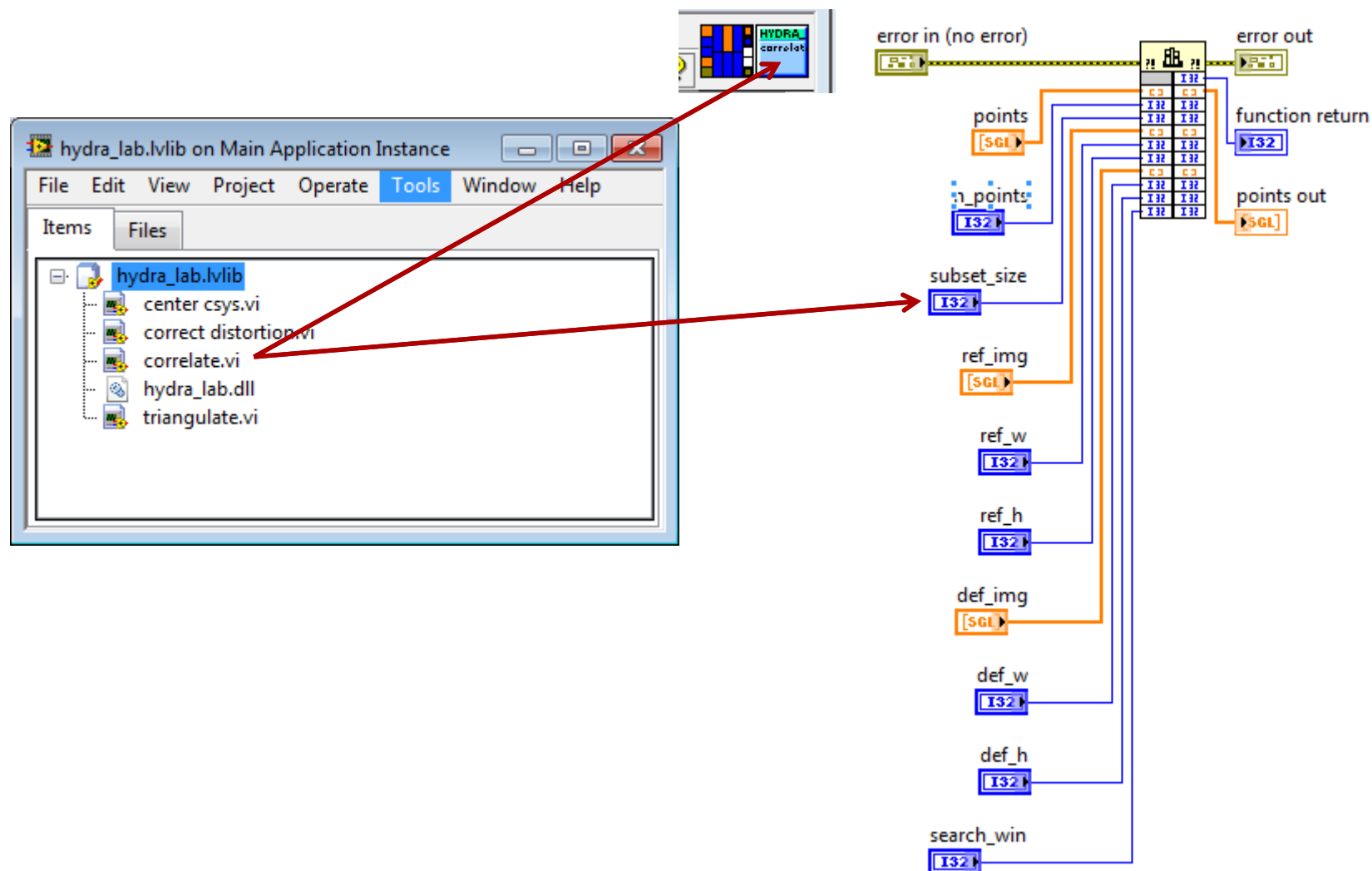


Creating DLL from .h Files

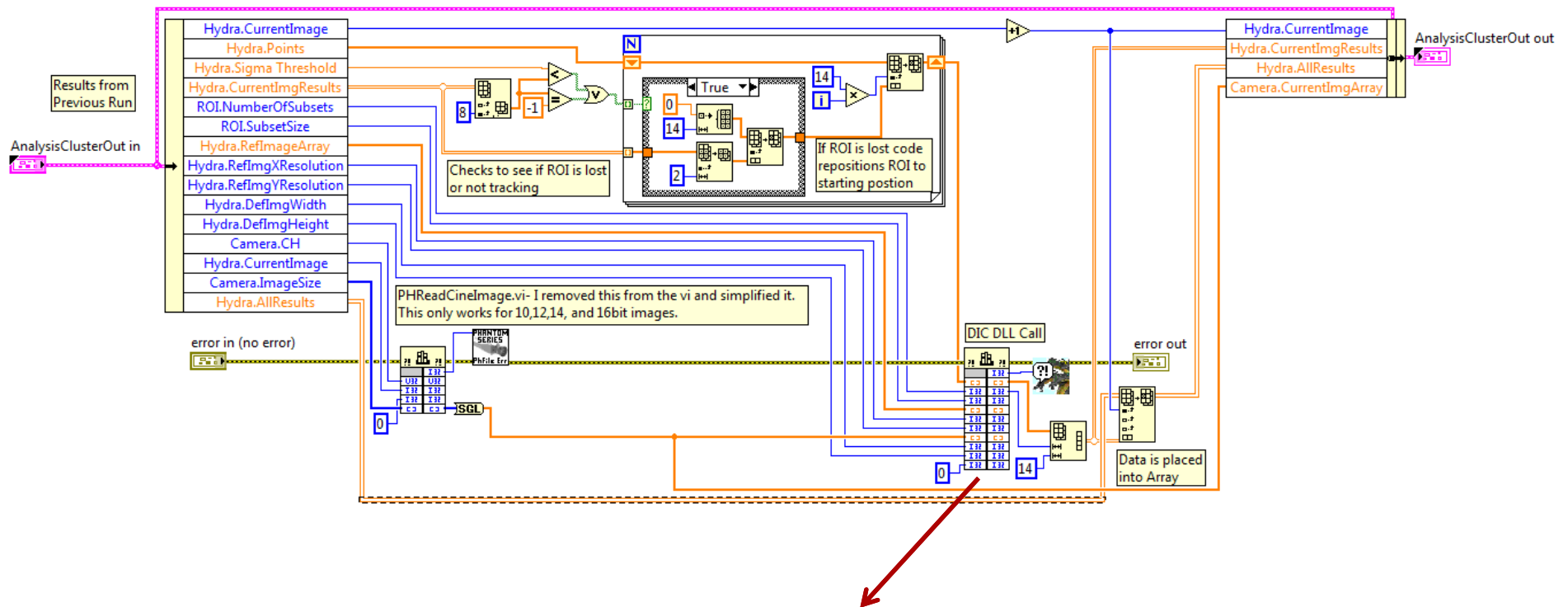
- Correlated Solutions provided the .h files



Creating DLL from .h Files

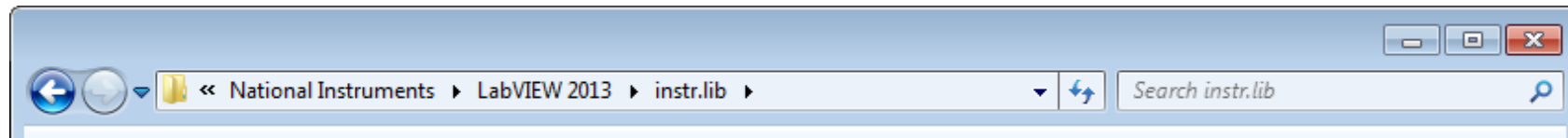


More practical use of DLL call

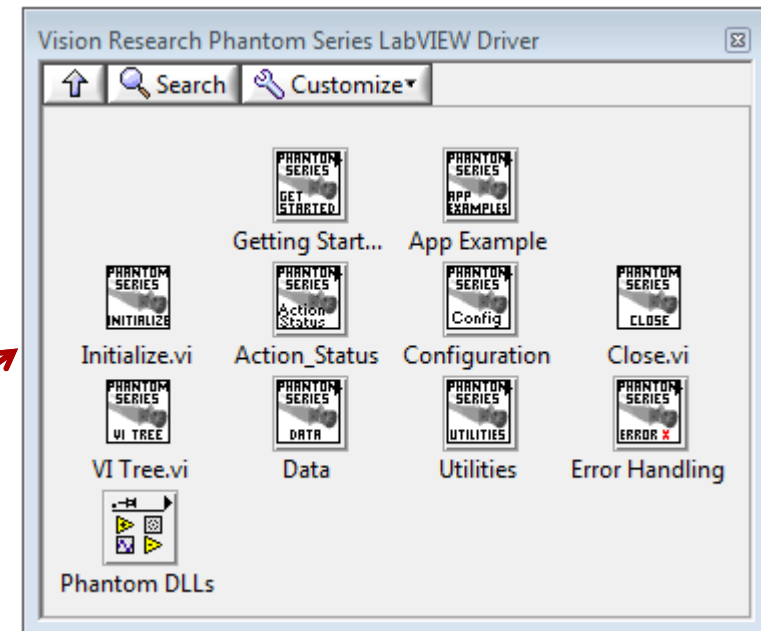


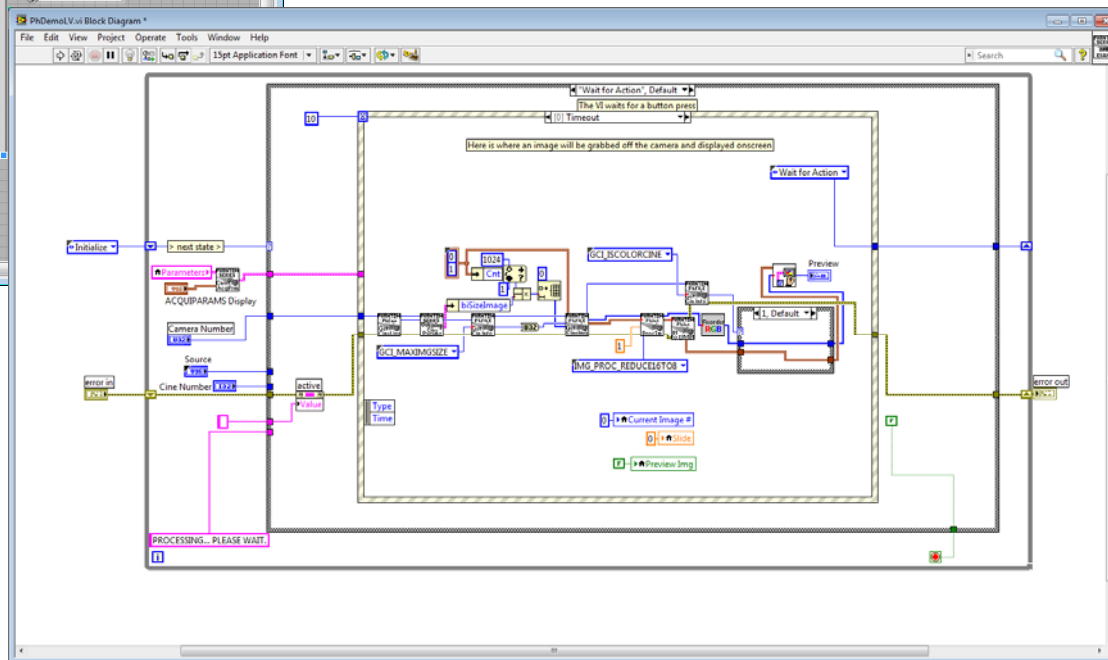
Third-Party DLL that does the correlation and gives the displacement .
LabVIEW code generates everything that goes into the DLL.

Example Program From Vision Research



Name	Date modified
_iviclass	10/24/2013 2:37 PM
_niInstr	12/2/2013 6:15 PM
_Template - Counter	10/24/2013 2:31 PM
_Template - DC Power	10/24/2013 2:31 PM
_Template - DMM	10/24/2013 2:31 PM
_Template - Function Generator	10/24/2013 2:31 PM
_Template - Generic	10/24/2013 2:31 PM
_Template - Power Meter	10/24/2013 2:31 PM
_Template - Register	10/24/2013 2:31 PM
_Template - Scope	10/24/2013 2:31 PM
_Template - Spectrum Analyzer	10/24/2013 2:31 PM
Agilent 34401	10/24/2013 2:31 PM
ni579x	12/2/2013 6:14 PM
niDCPower	12/2/2013 6:15 PM
niDMM	12/2/2013 6:17 PM
niFgen	12/2/2013 6:18 PM
niHSDIO	12/2/2013 6:19 PM
niHWS	12/2/2013 6:26 PM
niModInst	12/2/2013 6:25 PM
niRFSA	12/2/2013 6:22 PM
niRFSG	12/2/2013 6:23 PM
niScope	12/2/2013 6:25 PM
niSwitch	12/2/2013 6:09 PM
niTCIk	12/2/2013 6:25 PM
niVST	12/2/2013 6:16 PM
Vision Research Phantom Series Labview Driver	10/24/2013 4:06 PM
dir.mnu	7/1/2013 8:02 PM





Pro's and Con's of 3rd party DLL's

Pro's

- Enable developer to control all aspects of hardware.
- Streamline processes.
- Develop custom software.
- Eliminate user mistakes when using hardware.
- Allows consistent results by limiting what the user can see and do.

Con's

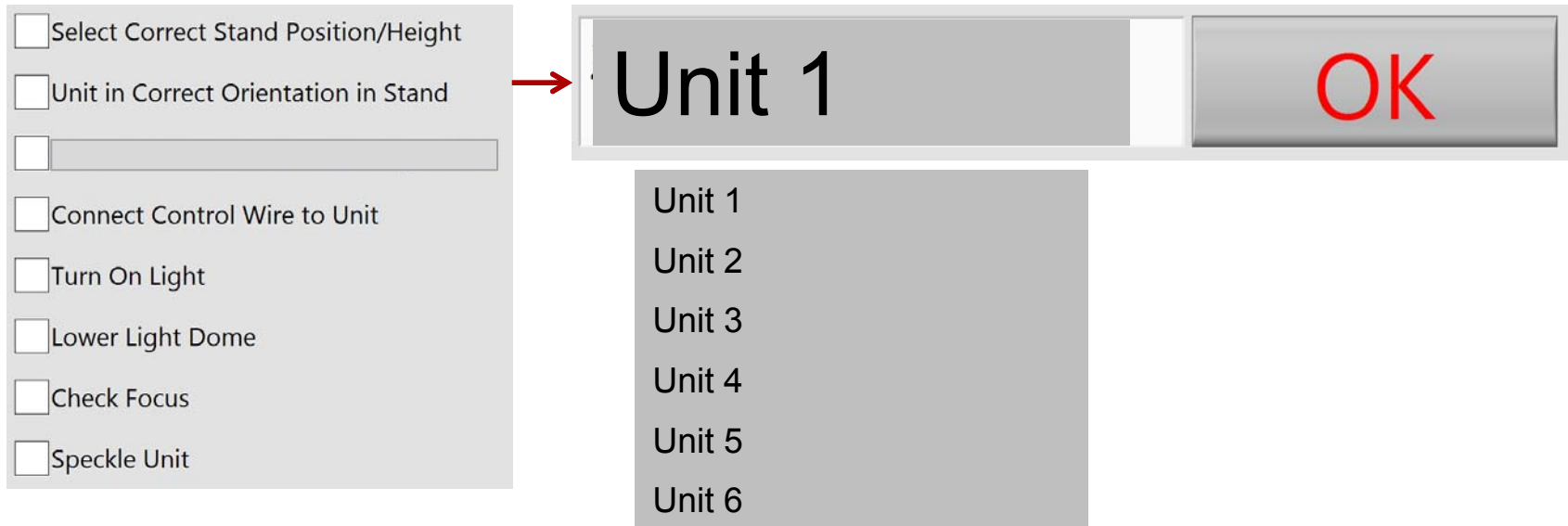
- Can cause LabVIEW to crash spectacularly!
- Poor documentation.
- Odd behavior between runs of the program- Need to completely exit LabVIEW to correct issue.
- Lots of guess work to figure out what the dll is doing.
- No support in many cases.

Camera Control Software:

- Knowing how tricky it has been to train individuals and get quality videos here at Sandia I set out to create a program that was easy to use for anyone.

1st: Checklist to remind operator to perform certain tasks- No longer needed

2nd: Operator Selects the unit they are running



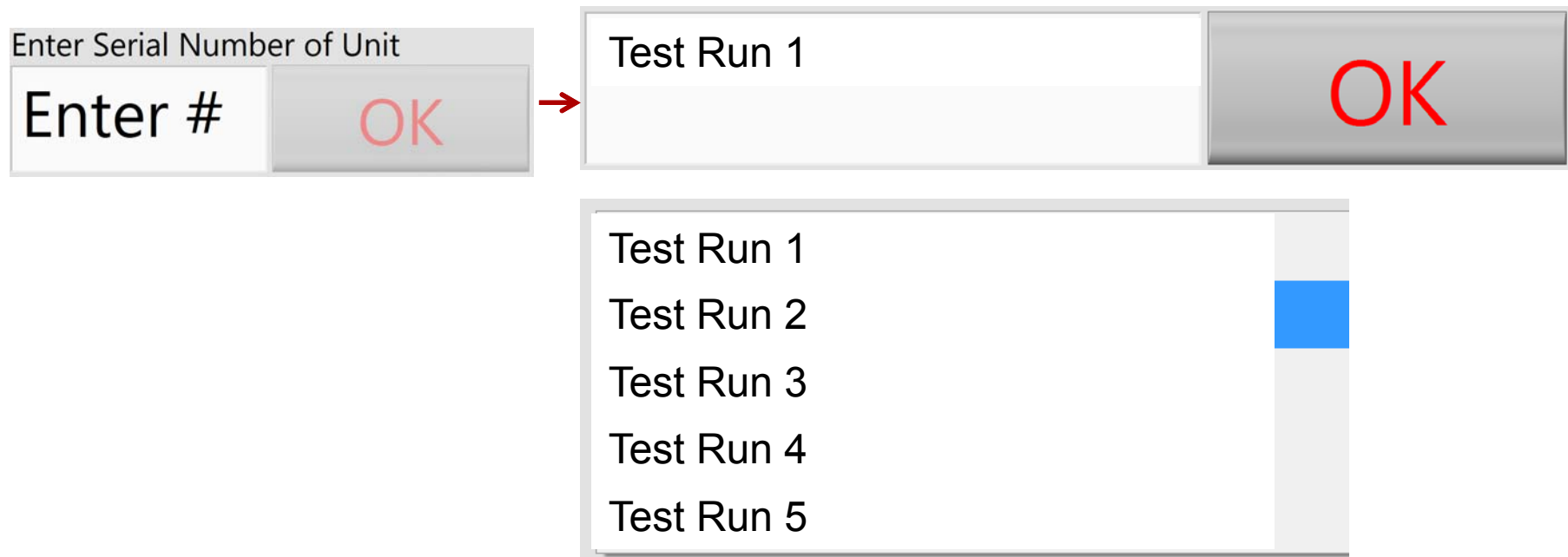
The screenshot displays the software interface. On the left is a checklist with seven items, each preceded by an unchecked checkbox: 'Select Correct Stand Position/Height', 'Unit in Correct Orientation in Stand', an empty text box, 'Connect Control Wire to Unit', 'Turn On Light', 'Lower Light Dome', 'Check Focus', and 'Speckle Unit'. A red arrow points from the second checkbox to a dialog box on the right. The dialog box has a title bar and contains a list of units: 'Unit 1', 'Unit 2', 'Unit 3', 'Unit 4', 'Unit 5', and 'Unit 6'. 'Unit 1' is selected and highlighted. To the right of the list is a large 'OK' button in red text.

☐ Select Correct Stand Position/Height	→ Unit 1 Unit 2 Unit 3 Unit 4 Unit 5 Unit 6	OK
☐ Unit in Correct Orientation in Stand		
☐		
☐ Connect Control Wire to Unit		
☐ Turn On Light		
☐ Lower Light Dome		
☐ Check Focus		
☐ Speckle Unit		

Camera Control Software:

3rd: Operator enters serial number of unit- Only time operator needs to type anything into the program

4th : Operator Selects the test to be run



The flowchart illustrates the operator's workflow. It begins with a dialog box titled "Enter Serial Number of Unit" containing an input field labeled "Enter #" and an "OK" button. A red arrow points from this dialog to a second dialog box. This second dialog has a text field containing "Test Run 1" and an "OK" button. Below this, a third dialog box is shown, featuring a list of five options: "Test Run 1", "Test Run 2", "Test Run 3", "Test Run 4", and "Test Run 5". In this list, "Test Run 2" is highlighted with a blue selection bar on its right side.

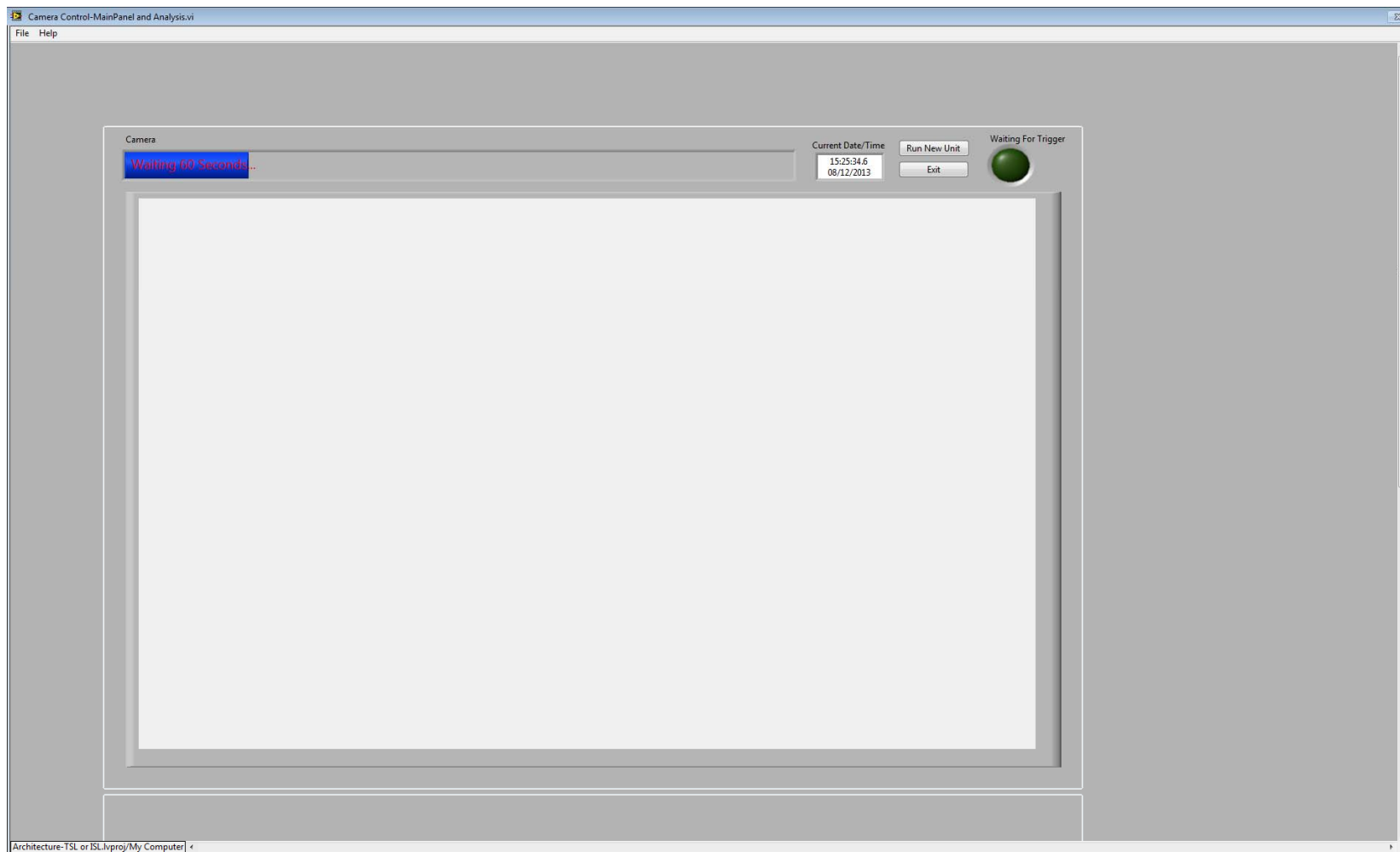
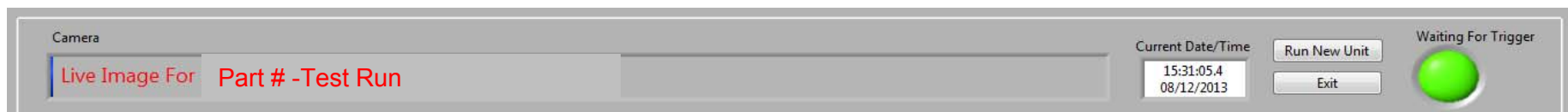
Camera Control Software



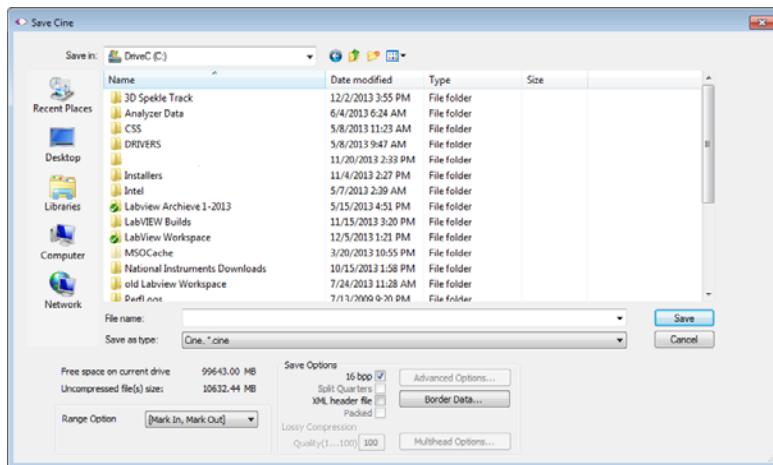
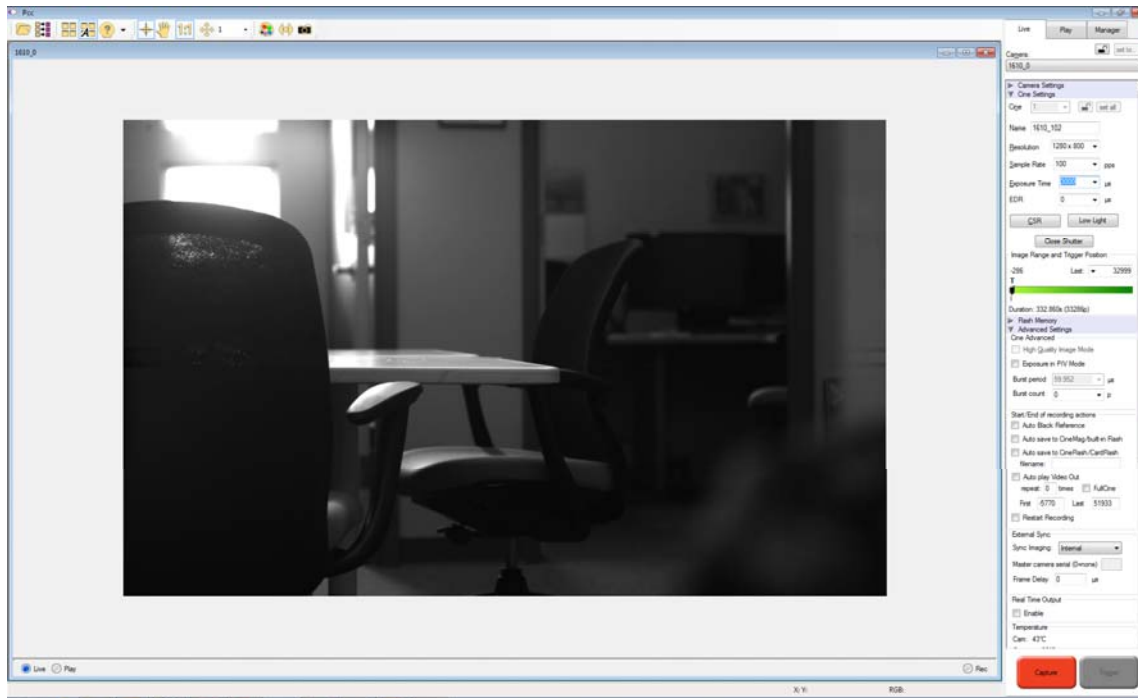
- Based on the prompts the correct settings are sent to the Camera
 - Frames Per Second
 - Resolution
 - Range to Save
 - Performs a Current Session Reference
 - Adjusts the lens to the correct focus position
 - Intelligent enough to know what test should be run next.
 - Creates a file path to save the .cine

Part #_Serial #_IP_Test Run_Date_Time.cine

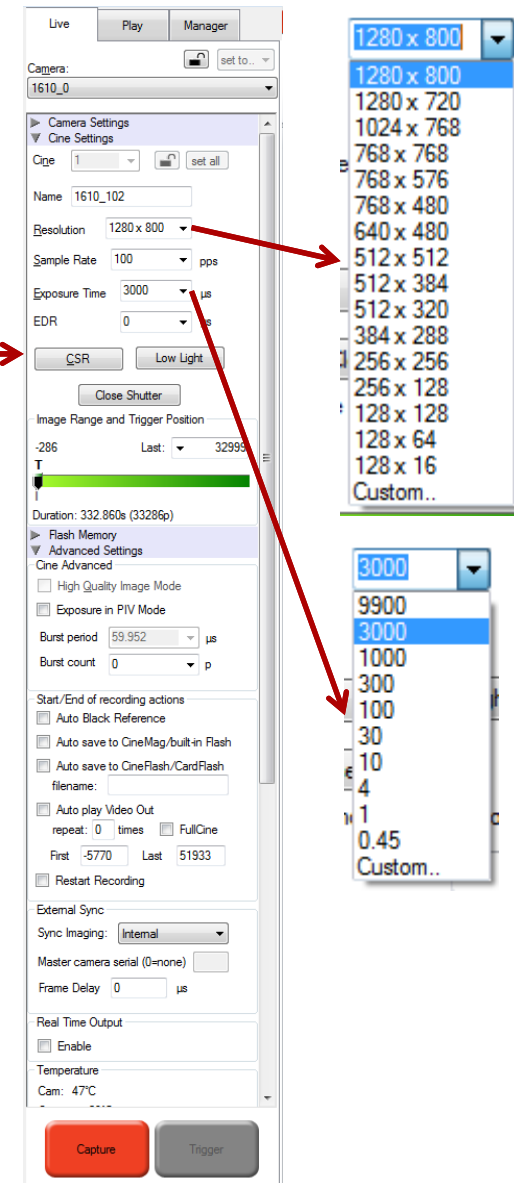
Camera Control Software



Reminder of Phantom(PCC) HSV Software

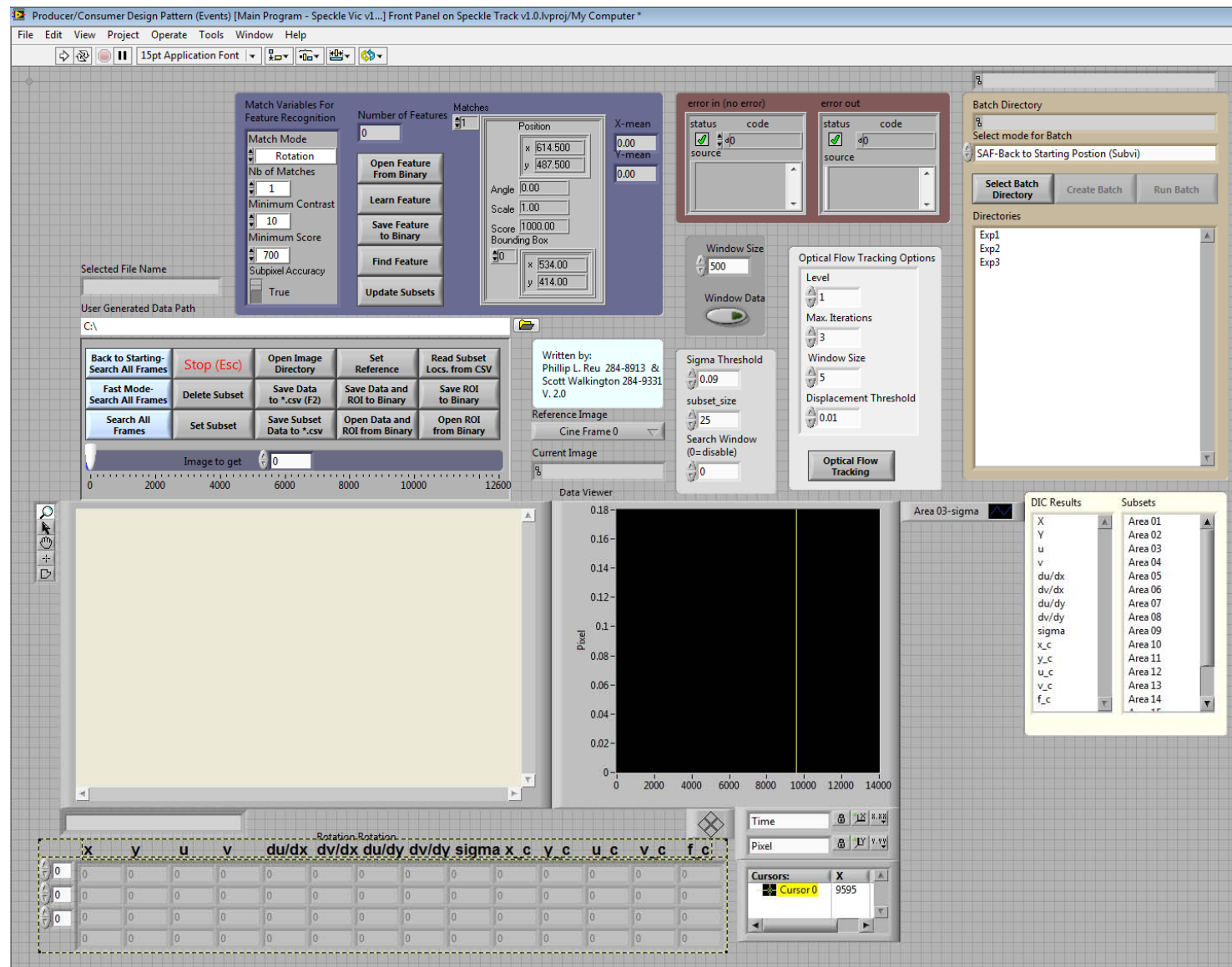


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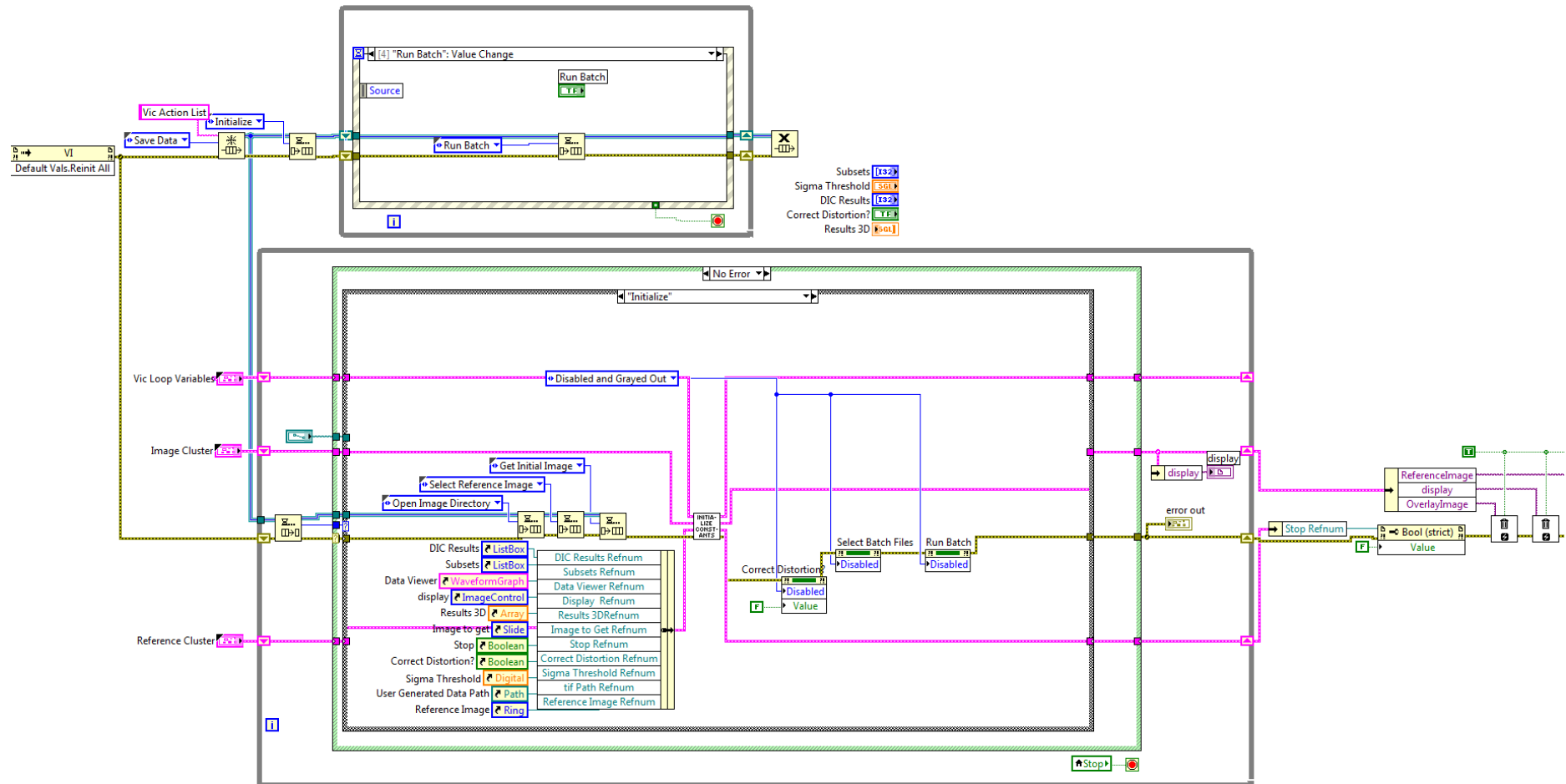




Evolution of Speckle Track Software

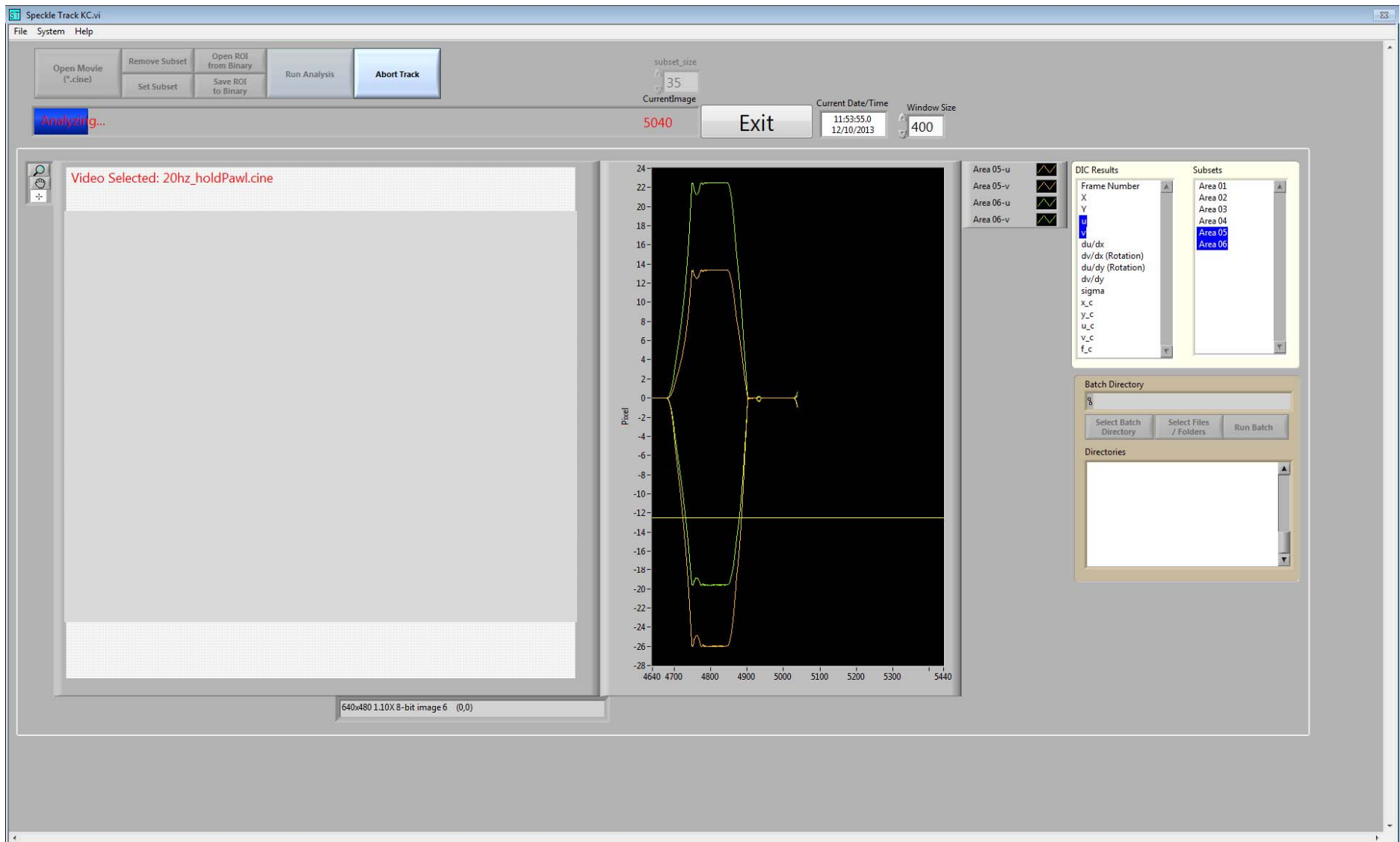


Evolution of Speckle Track Software

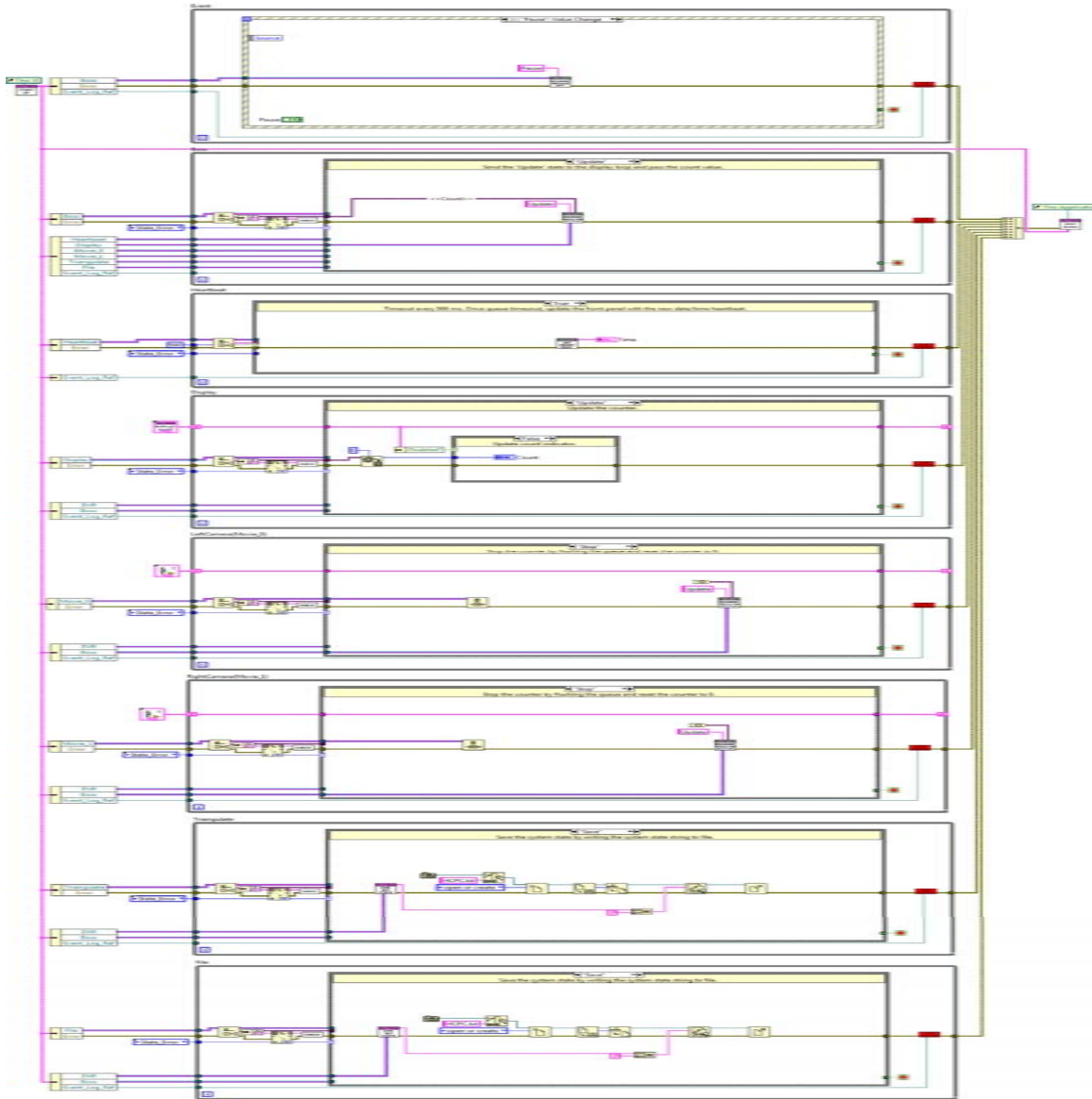




Speckle Track Software

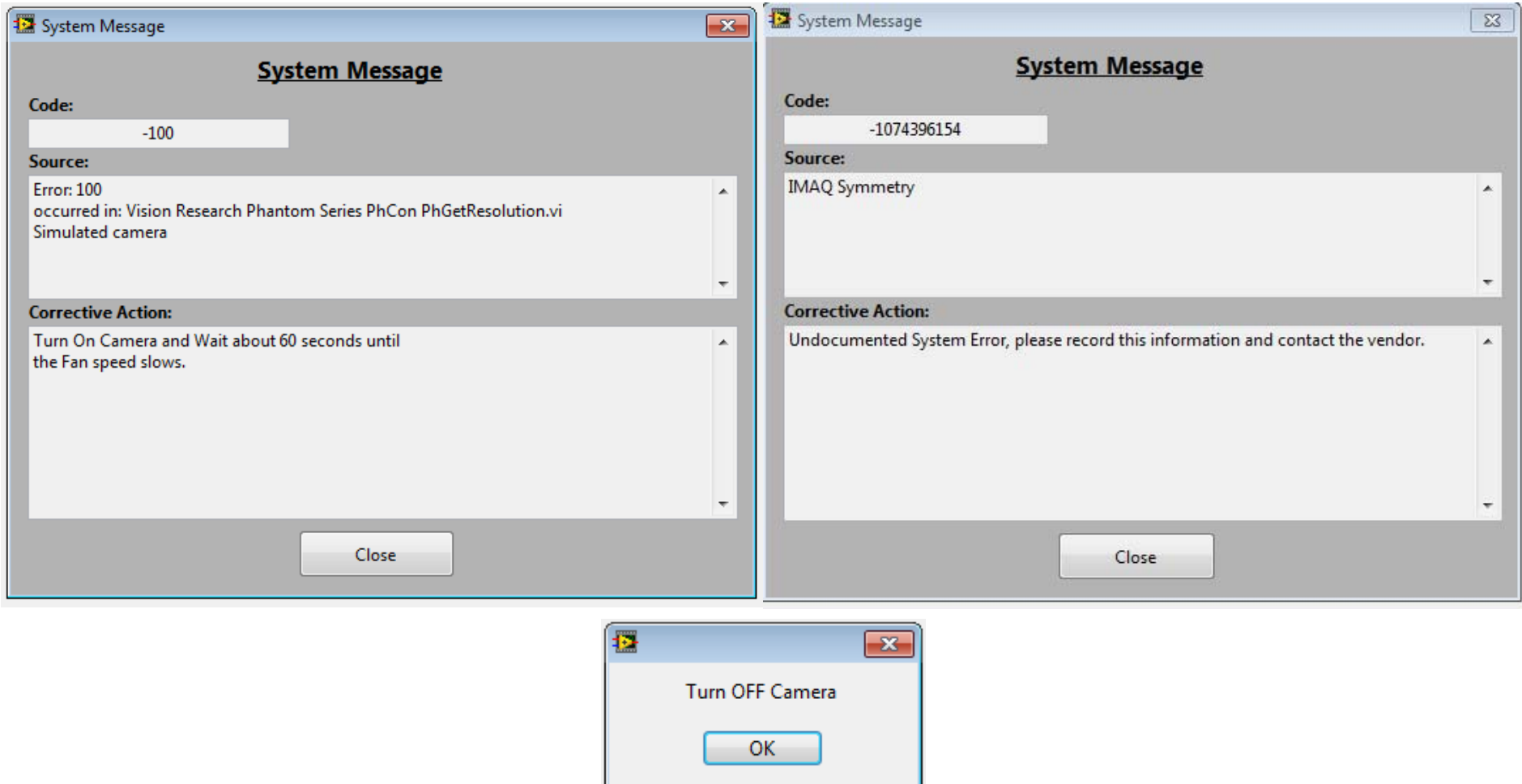


Proper Architecture



- Need way to Pass Error Message and data around.
- Limit local/global Variables
- Left to Right flow then down
- Producer/Consumer is a great start but need another loop.
 - Fundamental flaw is that the producer loop has no idea if an error has occurred in the consumer loop.
 - Complex applications need multiple loops

Error Handling Vs. Error Recovery



Conclusion

- Using 3rd party DLL comes with certain challenges but benefits out-weigh cons.
- Vision and motion toolkits have become incredible powerful tools.
- Producer/consumer great for quick development but lack the ability to handle errors gracefully and cannot handle multiple process simultaneously.
- Custom software is the only way this technology can be incorporated into a production environment.

Questions??

