DLP® NIRscan™ Nano Alignment and Calibration Procedure

Revision 0.7
Creation Date 14 Apr 2015
Last Change 25 Sep 2015

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History

Revision	Date	Author	Descriptions
0.1	02 Oct 2014	E. Pruett	Initial version
0.2	03 Oct 2014	E. Pruett	Added Wavelength Calibration, Reference Calibration, and System Test sections
0.3	12 Oct 2014	E. Pruett	Added missing part numbers and edits from feedback
0.4	20 Oct 2014	E. Pruett	Added part numbers for third party components
0.5	05 Jan 2015	E. Pruett	Changed to Advanced Light Control
0.6	15 Apr 2015	M. Robinson	Added Section3 for GUI Start up input additional comments in sections 4,5,6,7, and 8
0.7	25 Sep 2015	M. Robinson	Added updates to the calibration procedure. These were incorporated to show the start position of the slit align and the wavelength calibration routine incorporating the EcoVis and RM-NIR standard cal.

1. Introduction

This document covers the suggested factory alignment and calibration procedure for the DLP® NIRscan™ Nano EVM. As the software is refined, this procedure will be updated to reflect any software changes. Procedural deviations are permitted, as long as the performance requirements as shown in the software are met.

2. Process Flow

A suggested process flow is shown in Figure 1, with guidance on what may need to be adjusted if any tests fail. For a unit to pass, all tests must pass.
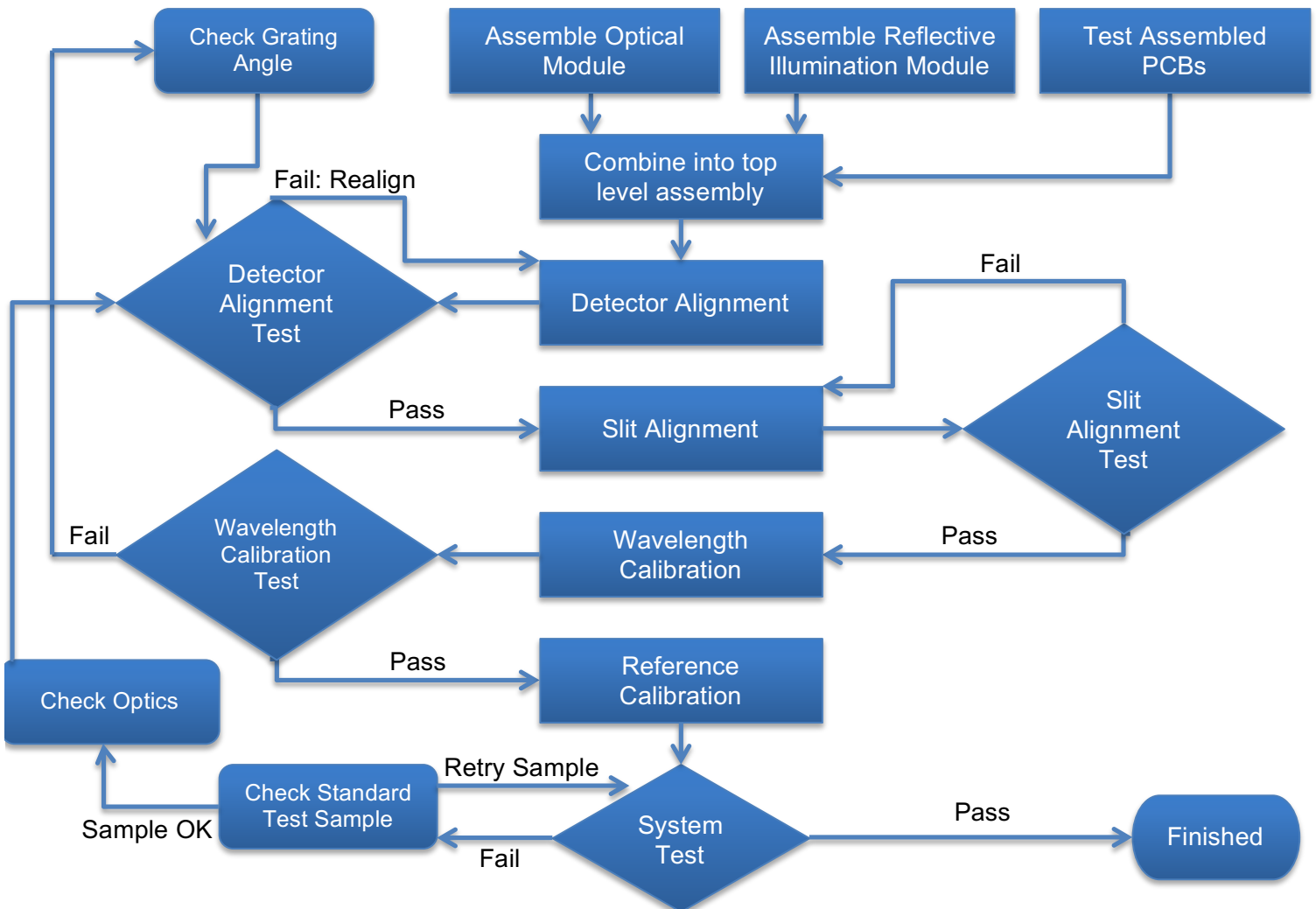

Figure 1 – Suggested Process Flow

# 3. Graphical User Interface (GUI) Initialization

Control of the NIRscanNano EVM is accomplished through use of a PC and the GUI software. The GUI software control will be used to perform the EVM alignment and calibration routines listed in this document.

**Starting the NIRscanNano GUI**

1. Connect the USB to MicroB cable from the TIVA board connector J1 to a Windows PC USB port (This will provide power and communication to the system).
2. Run the GUI installer. This will install the GUI in C:\Program Files (x86)\Texas Instruments\DLPNIRNANOGUI-version\. Sources are installed into C:\Users\$CURRENTUSER\Texas Instruments\NIRscan Nano\Sources
3. Start execution of the NIRscanNanoGUI by clicking to start the NIRscanNanoGUI_v0.34.2.exe file.
4. On new EVM units you will encounter the following prompts. Wipe the EEPROM data. Select Yes.
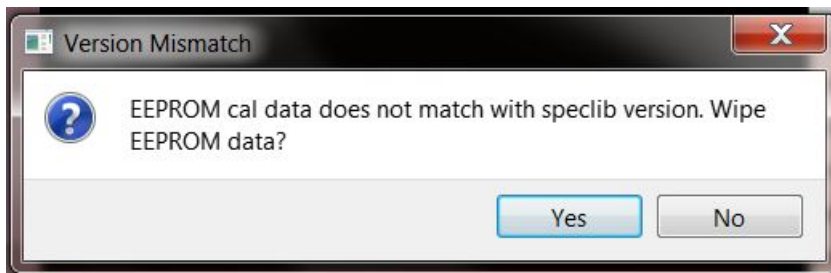

5. Next prompt is a reminder that calibration will need to be run on this unit. Select Ok.
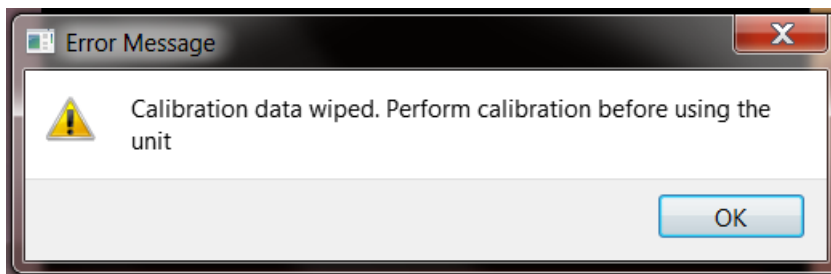
6. You will be asked to perform steps4 and 5 again.
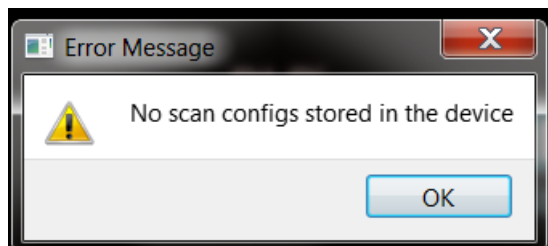
7. Select Ok to proceed from Scan Configuration prompt.
8. Once a valid Wavelength and Reference calibration scan has been performed the GUI prompts from steps4, 5, 6 will no longer appear.

9. GUI Panel is now active. The Connected light should be Green.
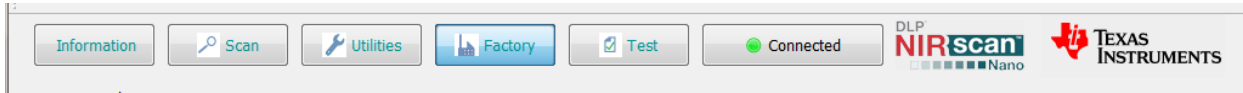
4. Detector Alignment

The detector must be positioned and then glued into the aligned position. Detector placement is crucial, and is done as a fly-in-place procedure to ease some of the other mechanical tolerances in the system. The goal is to center the detector in the area where it collects the most flux possible from all wavelengths of a scan. Software will aid the technician as they optimize the location of the detector and glue it in place.
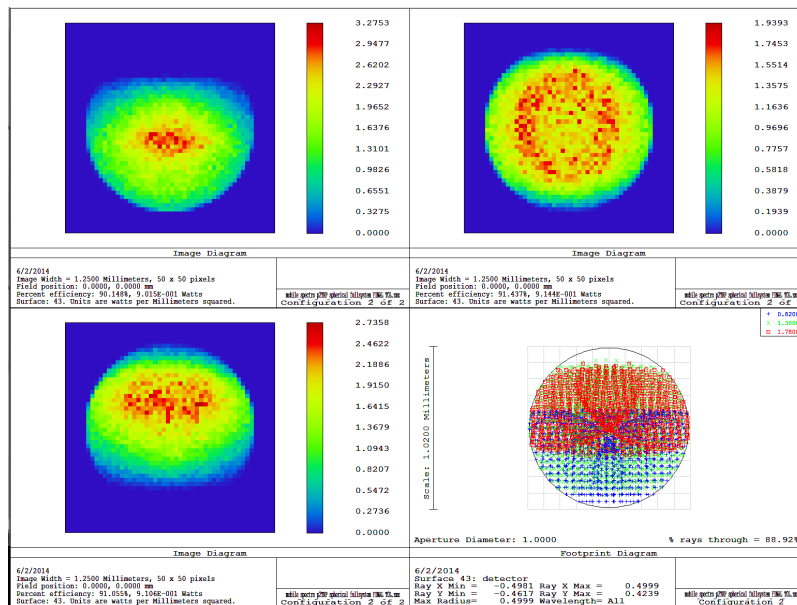

Figure 2 – Energy Distribution on Detector

A view of the short, middle, and long wavelengths as they strike the detector are shown in Figure 2. Different wavelengths focus at slightly different positions, so it is necessary to align the detector so that a certain amount of flux or greater from each of the short, medium, and long wavelengths are striking it. This flux level is shown in software in terms of digital count values.

Table 1 - Parts Used in Detector Alignment

Part Number	Description	Purpose
2513877	TOP LEVEL ASSY - ASSEMBLY / CALIBRATION FIXTURE NIRscan Nano	Fixture
2513941	CALIBRATION SAMPLE HOLDER ASSY NIRscan	Reference

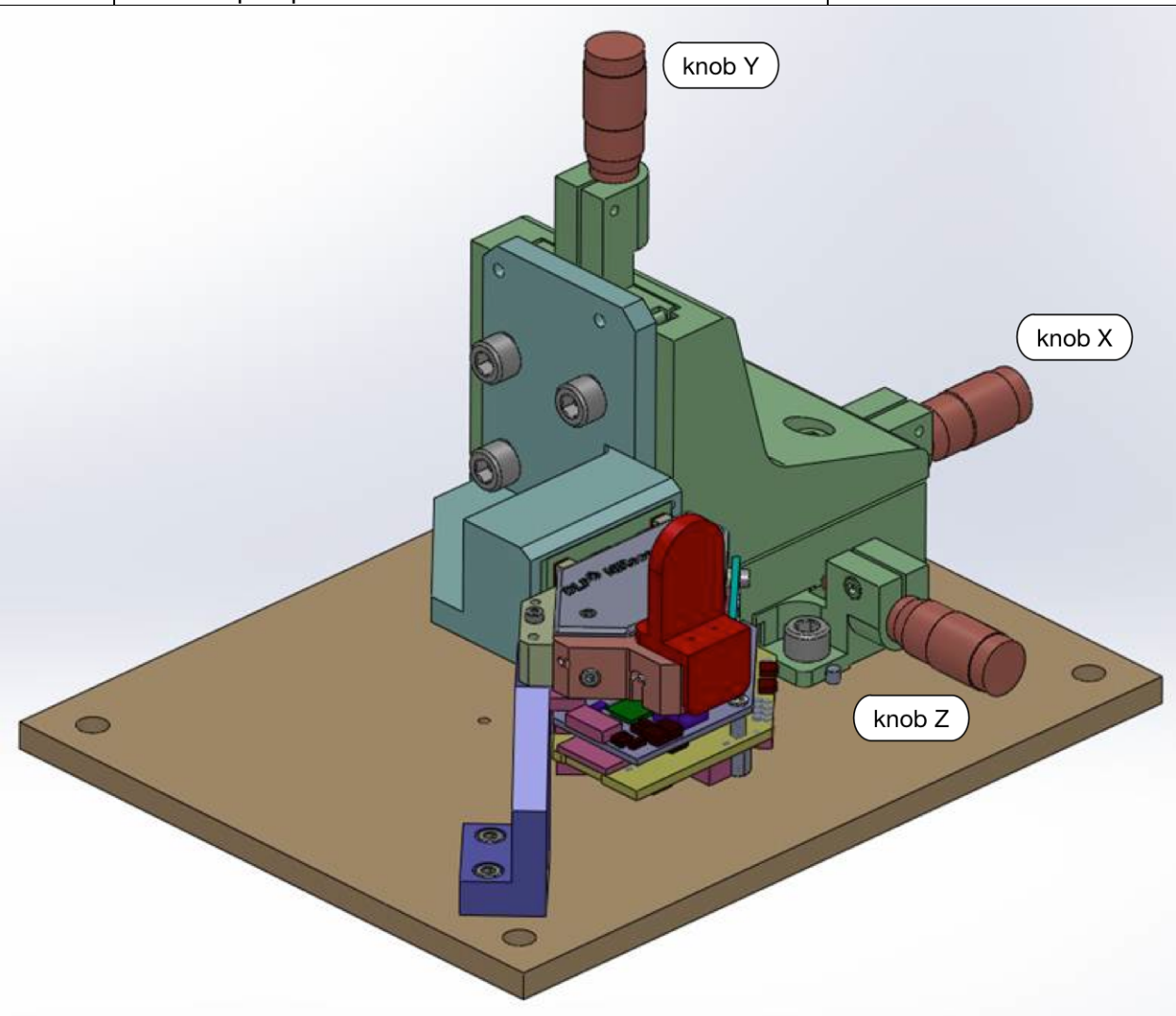|	Nano	
2513871	Top Level Assy Drawing NIRscan Nano	Engine to be aligned
	Vacuum tubing	
	Vacuum pump	

Figure 3 – Detector Alignment Overview

When the parts from Table 1 are assembled as shown in Figure 3 and connected to the external vacuum pump, the following detector alignment procedure can commence.

Procedure 1 – Detector Alignment

1. Install top level assembly (2513877) onto bracket (2513947), and attach the reflectance module (2513929)
2. Remove the Detector Board
3. Rotate Z-adjustment knob Z clockwise to increase distance between vacuum chuck and optical engine
4. Insert Detector into Detector Board and connect cable between detector board and TIVA board. Back of detector should be spaced away from the detector board PCB by 4.751mm
5. Place detector board into vacuum fixture
6. Rotate Z-adjustment knob Z counter-clockwise to place the detector at the nominal Z-position with a nominal 0.586mm between the PCB and the chassis mounting points.

7. Place the calibration sample holder (2513941) on the reflectance module (2513929)

8. From the active GUI panel select the Factory tab. Then under 'Detector Alignment' select Start button. The NIRscanNanoEVM should now be receiving active scans and updating the Current values on the GUI Panel.
9. Begin by optimizing with the Z control; this will increase all three readings.
10. Next optimize with the Y control, this will have greatest effect on the middle reading.
11. Next adjust X direction control for optimum readings, this will have greatest effect on 1st and 3rd readings.
12. Adjust each translation stage knobs X, Y, and Z, until a maximum is reached. All three readings from the short, middle, and long wavelengths must be above the required minimums. When best results are achieved select Stop button on the GUI to terminate the active scans.
13. Power down the system by removing the USB cable from the EVM.
14. Insert UV cured glue into area between the photodiode case and the Detector Encapsulation Plate (2513937)
15. Reconnect the USB cable to the EVM. Restart the Detector scans per step 8.
16. Verify that the three wavelength readings are still above the minimum required in the GUI software
17. Cure adhesive with UV light source
18. Verify that the three wavelength readings are still above the minimum required in the GUI software
19. Turn off vacuum.
20. Turn knob Z clockwise again to separate vacuum fixture (2513939) from Detector Board.
21. Push Detector Board toward optical module to seat against mounting surface and affix with screws.
22. Verify that the three wavelength readings are still above the minimum required in the GUI software.
23. Trim leads of detector so that the cover (2513923) will fit.
24. Remove temporary cover (2513922) and install final engine cover (2513923).
25. Detector Alignment Complete.

Detector Alignment Troubleshooting Aids:

1) Not receiving scan values while executing detector align scan.
 Possible Causes;
  -TIVA to Detector cable not connected or broken.
  -Detector Board or Detector Device not functional.

2) Detector Alignment Values are below Minimum Required.
 Possible Causes;
  -Check that Reference Sample is in place.
  -Detector misaligned, continue to adjust control knobs for proper alignment.
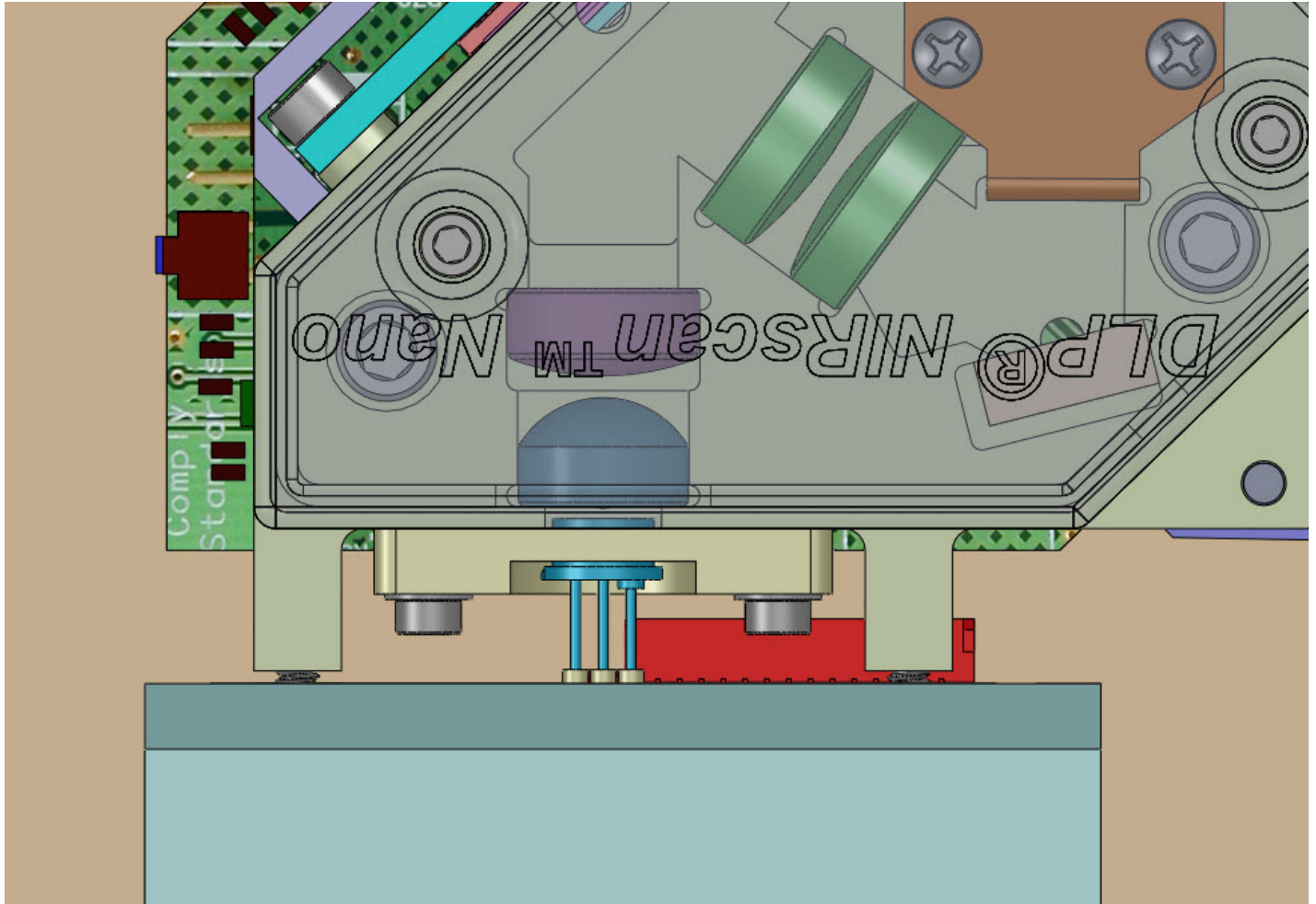 -Detector Board or Detector Device not functional.

Figure 4 – Detector Detail

5. Slit Alignment

Slit depth must be manually set to ensure best focus on the DMD. If the image of the slit is blurred on the DMD, spectrometer resolution will suffer.

This, and the remaining procedures in this document do not require the translation stage. As indicated in Table 2, additional stations can be built with a less complex mounting plate and the same mounting bracket. This should reduce equipment cost and ease production flow.

Table 2 – Parts Used in Slit Alignment

| Part Number	Description	Purpose
Either 2513877 or 2513878 is required, but no both. This is because this procedure does not use the translation stage.		
2513877	TOP LEVEL ASSY - ASSEMBLY / CALIBRATION FIXTURE NIRscan Nano	Fixture
2513878	TOP LEVEL ASSY - ASSEMBLY FIXTURE (NO CALIBRATION) NIRscan Nano	Fixture
2513886	SUB ASSY, FIBER INPUT MODULE NIRscan Nano	
BFL200LS02	Thor Labs Fiber	
AR-1	Ocean Optics Calibration Lamp Source	
	Allen Wrench	

2:07:11 PM 10/2/2014
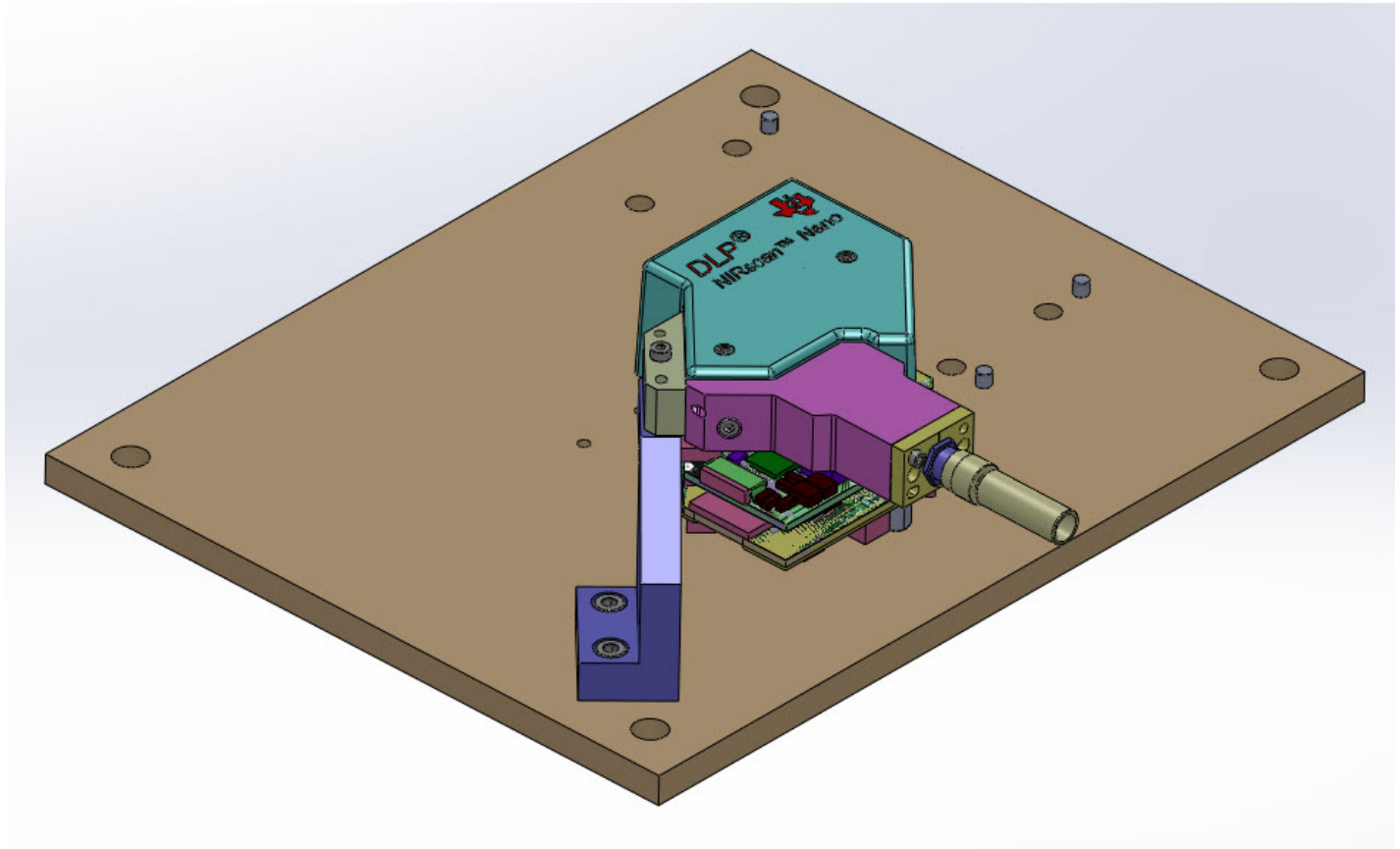
Figure 5 – Slit Alignment Overview

When the parts from Table 2 are assembled as shown in Figure 5, the following slit alignment procedure can commence.

Procedure 2 – Slit Adjustment

1. Remove the Illumination Lamp module from the Optical Engine (OE).
2. Tighten the slit adjustment screws to the slit housing is flush against the OE.
3. Install the linear end of the fiber with mark into the fiber input module, aligning the mark on the fiber housing to the groove in the illumination module; connect to the (OE) as in Figure 5.
4. Install the round end of the fiber without a mark into the AR-1 spectral calibration source.
5. Power on the AR-1 spectral calibration source.
6. For accurate alignment to occur, the NIRScanNano EVM must be shielded from external light, make sure the final engine cover (2513923) for the EVM module is in place.
7. From an active GUI panel, enter the Factory tab and under 'Slit Alignment' select the Start button to begin the test. The EVM should now be receiving active scans and updating the Current values on the GUI panel.
8. Make small adjustments counterclockwise (1/4 turns each side) to the two slit adjustment screws while monitoring the readings on the GUI Slit Focus sliders.
9. Find the optimal alignment setting for the slit, this will occur when all three sliders have moved to the highest setting point and any further adjustment to the alignment screws moves the sliders indicators in a downward direction.
10. Select the Stop button to terminate the GUI execution.
11. Power off the spectral calibration source.
12. Remove the fiber illumination module.
13. Apply adhesive to fix the slit plate in position.
14. Cure adhesive with UV light source.
15. Reinstall the fiber illumination module.
16. Power on the spectral calibration source.
17. Verify the finished alignment accuracy by checking the Slit Alignment scan readings. These readings may move slightly once secured in place with the UV adhesive, but should be close to values before UV curing and above the minimum required values on the GUI panel.
18. Power off the spectral calibration source.
19. Slit Alignment Complete.

Slit Alignment Troubleshooting Aids

If Slit Alignment scan values are reading below minimum required some possible causes may be the AR-1 Light Source signal is not present on EVM. Check connections and functionality of the light source. The most common problem is that the Slit Panel is not aligned properly; continue the alignment steps 7-9 to properly align the slit panel. If scan values above the minimum cannot be achieved through alignment check the slit panel assembly and that it moves inward and outward when adjusting the alignment screws. Check for any mechanical restrictions to the slit panel movement. It is also possible that the optical engine has an alignment problem, check for proper assembly from the slit panel into the optical engine lenses.
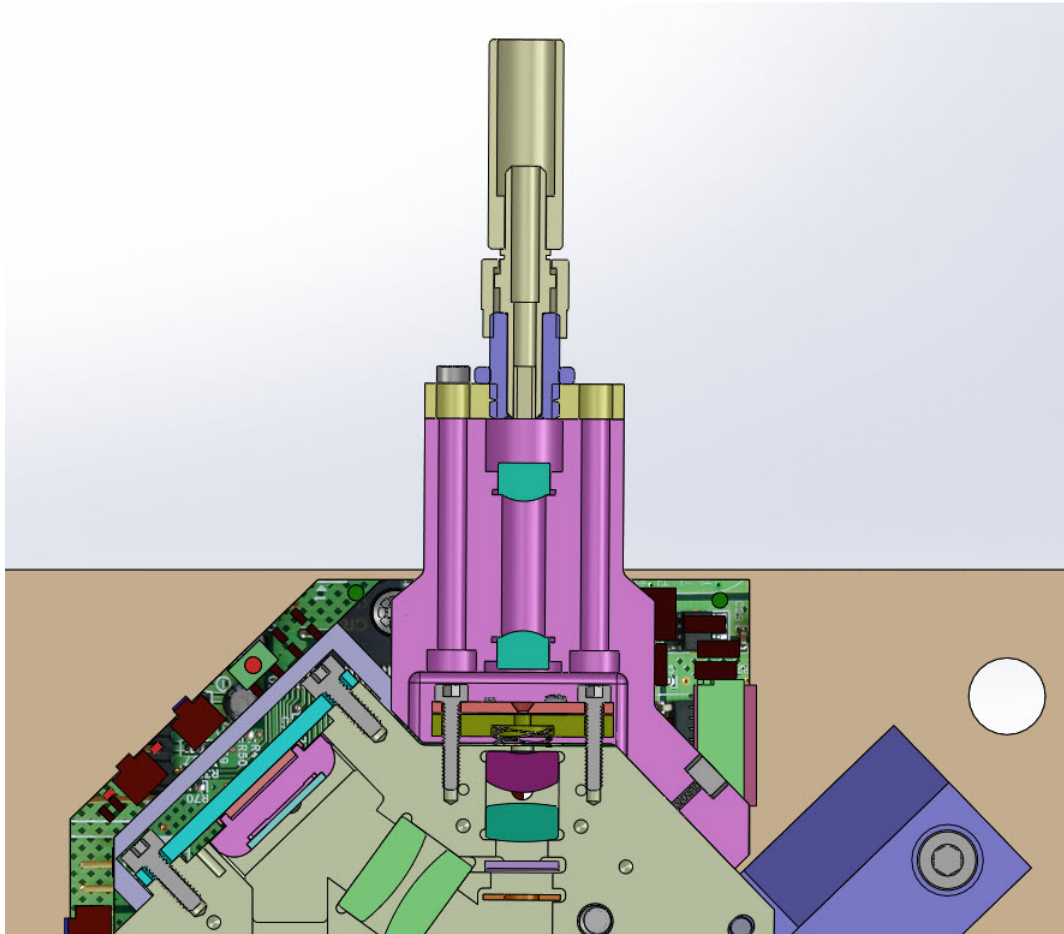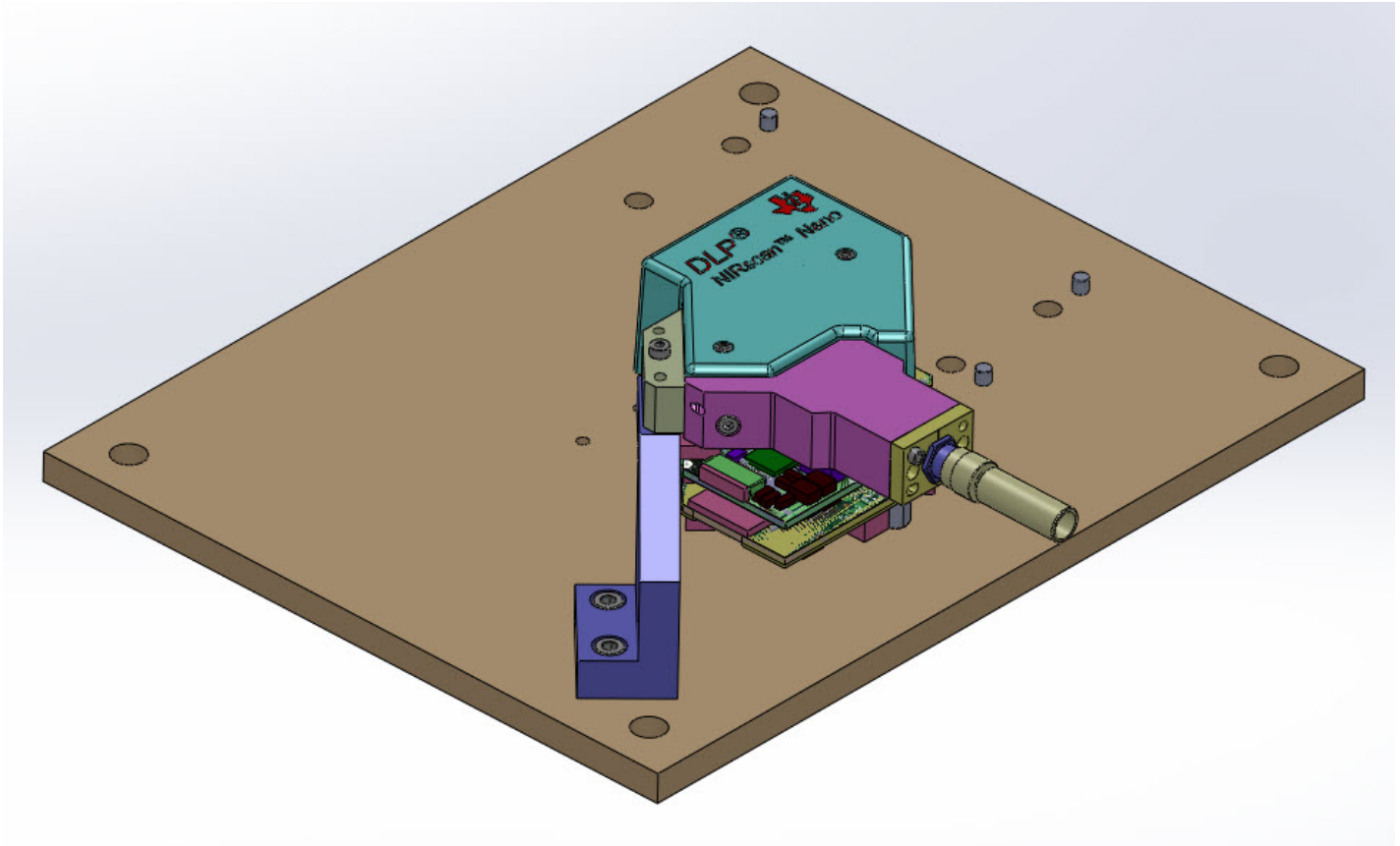
Figure 6 – Slit Alignment Detail

6. Wavelength Calibration

Electronic calibration maps known wavelengths to specific DMD pixel locations. The instrument can then provide information necessary to design patterns that direct particular wavelengths of light to the detector.

There is no change from the slit alignment setup, so it may be completed with the same setup as the slit alignment.

Table 3 – Parts Used in Wavelength Calibration

| Part Number	Description	Purpose
Either 2513877 or 2513878 is required, but no both. This is because this procedure does not use the translation stage.		
2513877	TOP LEVEL ASSY - ASSEMBLY / CALIBRATION FIXTURE NIRscan Nano	Fixture
2513878	TOP LEVEL ASSY - ASSEMBLY FIXTURE (NO CALIBRATION) NIRscan Nano	Fixture
2513886	SUB ASSY, FIBER INPUT MODULE NIRscan Nano	
BFL200LS02	Thor Labs Fiber	
AR-1	Ocean Optics Calibration Lamp Source	

Figure 7 – Wavelength Calibration Overview
**Procedure 3 – Wavelength Calibration**

1. Install the linear end of the fiber with mark into the fiber input module, aligning the mark on the fiber housing to the groove in the illumination module
2. Install the round end of the fiber without a mark into the spectral calibration source.
3. From the active GUI panel, enter the Factory tab and enter the Device Serial Number of the Unit. The entry format is Year(1digit)/Month(2digits)/Serial Number(4digits). Enter number and select Set.
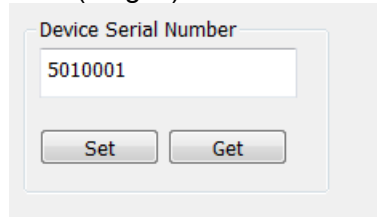
4. Setting a serial number will erase previous stored calibration data. Select Yes.
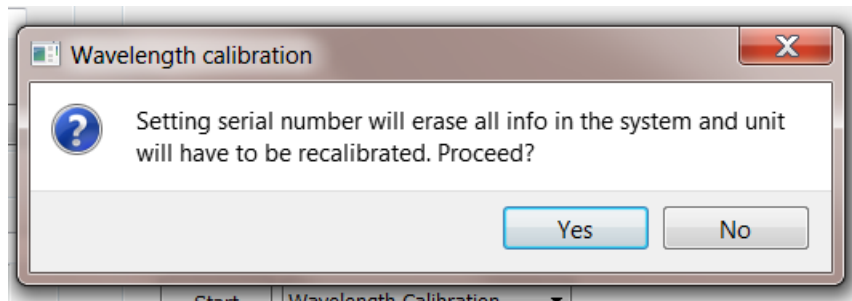
5. From an active GUI panel, enter the Factory tab and under the Factory tab. Select 'Wavelength Calibration' from the scroll down menu bar.
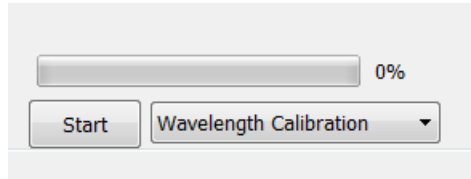
6. Select Start to begin the calibration.

7. Connect the empty EcoVis Light Source Sampling Module to the EVM through the Fiber Module. Turn the light source ON.   Figure 7a shows the EcoVis Module setup. With proper setup in place select Yes on the menu.
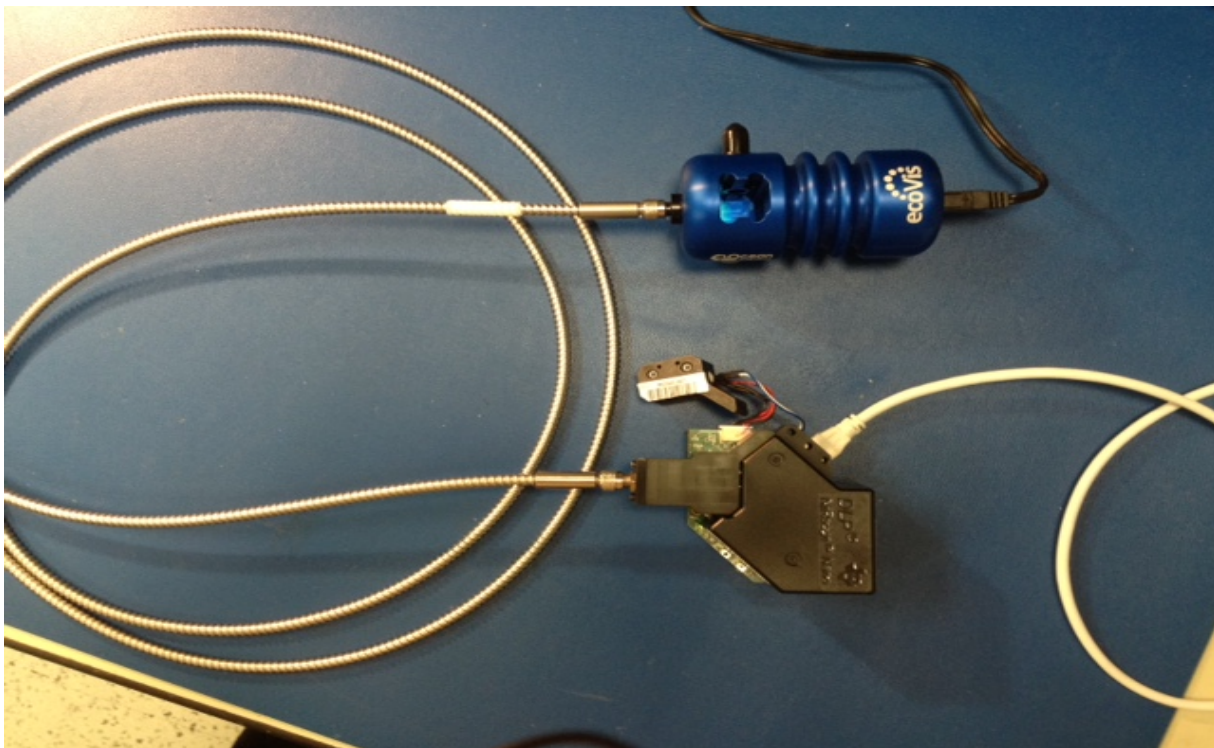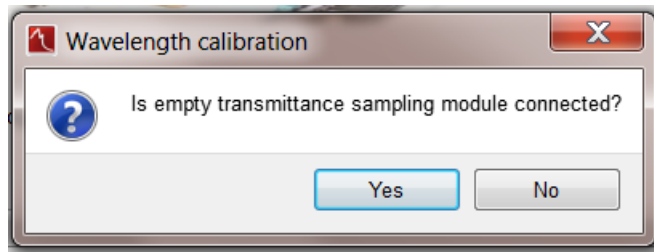

Figure 8a – Wavelength Calibration Overview

8. Place the RM-NIR sample in the EcoVis sampling Module. (Figure 7b) After placing sample select Yes.
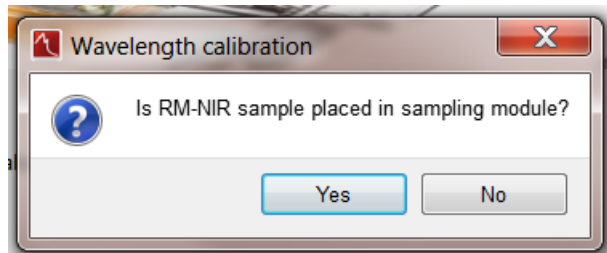
Figure 9b – Wavelength Calibration Overview

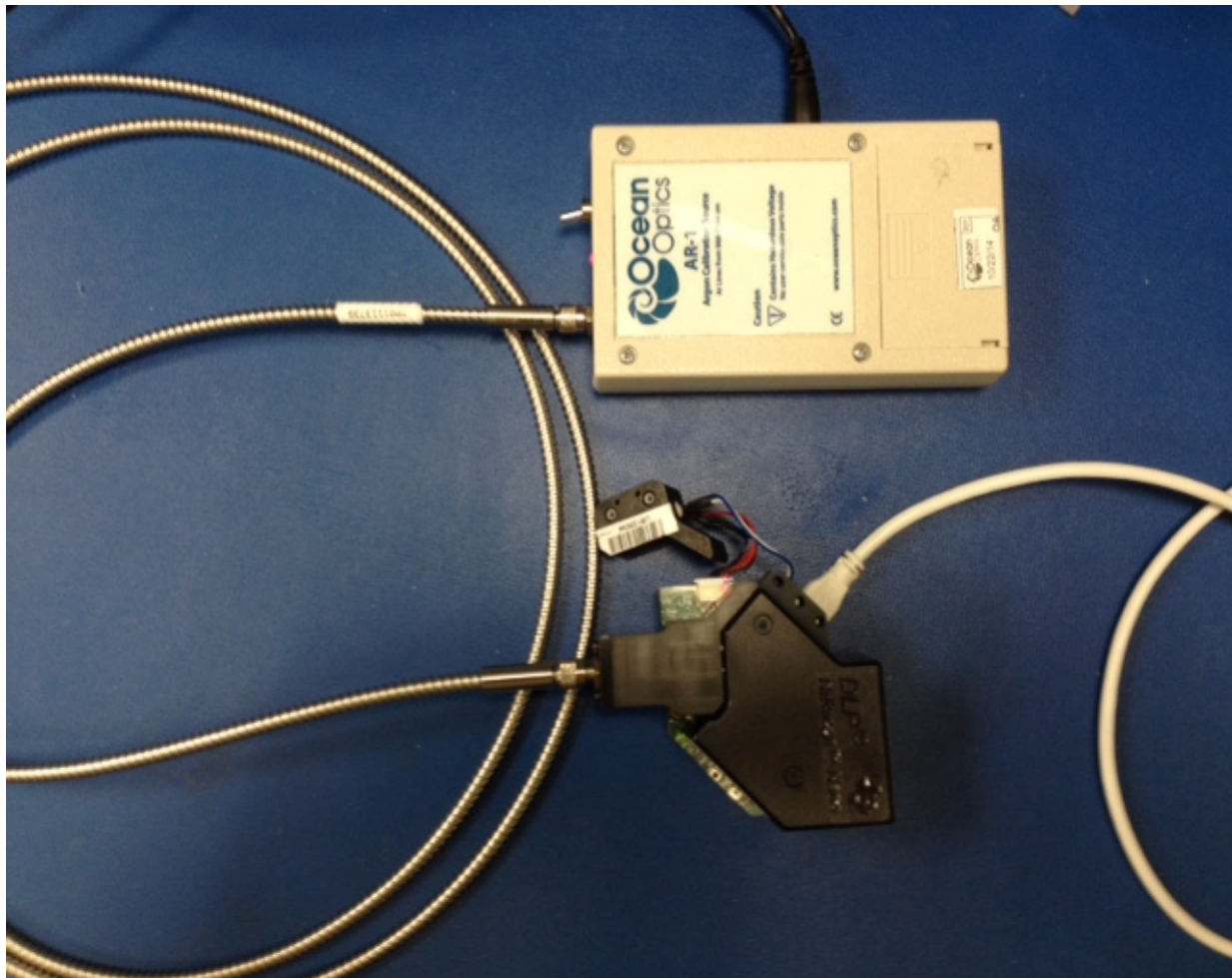9. The AR-1 Light source should be connected to the system and powered ON.(Fig7c) Select Yes.
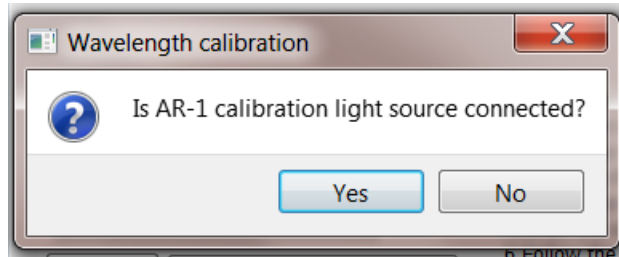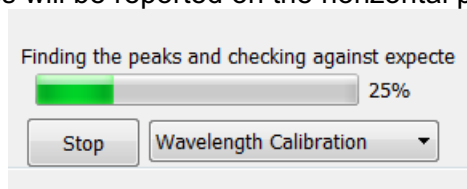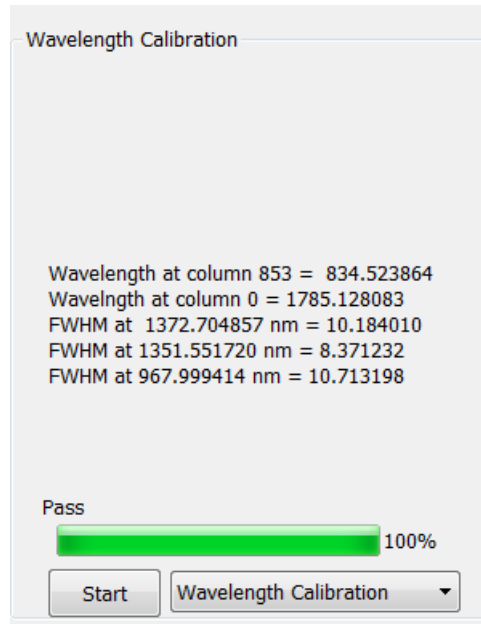

Figure 10c – Wavelength Calibration Overview

10. Calibration progress will be reported on the horizontal progression bar.

11. When the wavelength calibration is complete the FWHM results are recorded on the GUI panel. Check these numbers for accuracy: The measured values of FWHM pass when all three readings are FWHM ≤12nm.

In some cases, the calibration routine may fail with an error. First re-execute the Wavelength Calibration routine steps5-8. If repeated failures occur the cause of the failure is often an improperly installed grating or metal burrs on the grating area. Very small angular deviations of the grating can cause the spectrum to shift so it is no longer contained within the DMD. Error messages will attempt to give an idea of the reason for the failure, but troubleshooting may be necessary to determine the opto-mechanical cause for this issue. Repeated errors of the same kind may indicate an assembly procedure that needs to be refined.

Once the cause of the error is corrected, Procedure 3 should be repeated. If the cause was optics or mechanics related, also execute the following:

1. Verify again that FWHM is less than the limit in 'Slit Alignment' from the PC software (Procedure 2 – Slit Adjustment, step **Error! Reference source not found.**)
2. Set up for the Reference Calibration by removing the fiber illumination module and installing the reflectance module and reference standard

7. Reference Calibration

A scan of the reflectance standard is executed in order to baseline the unit for reflectance measurements. This step involves placing the reflectance illumination module on again, along with the reference standard.

Table 4 – Parts Used in Reference Calibration

Part Number	Description	Purpose
Either 2513877 or 2513878 is required, but not both. This is because this procedure does not use the translation stage.		
2513877	TOP LEVEL ASSY - ASSEMBLY /	Fixture

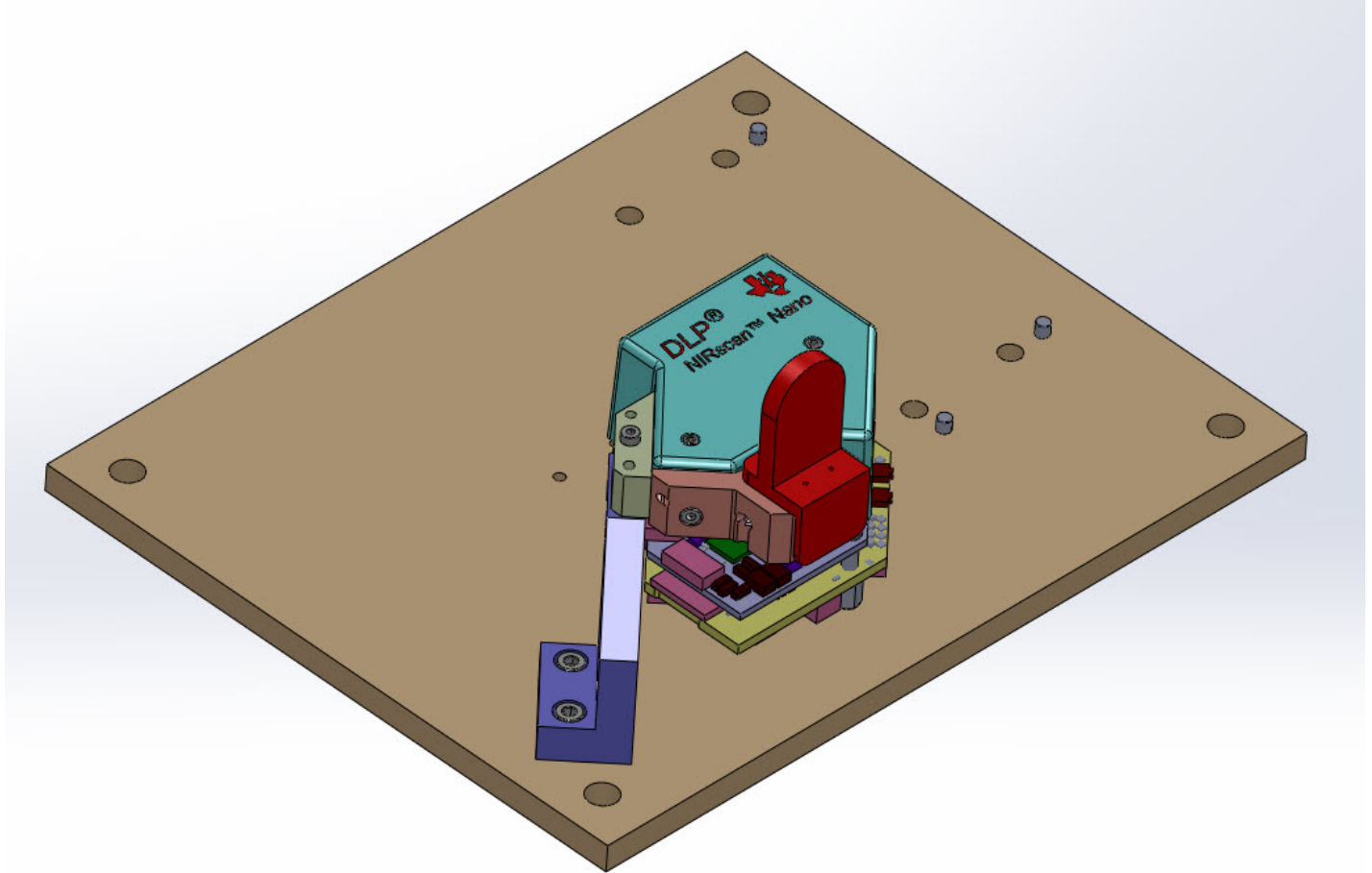|	CALIBRATION FIXTURE NIRscan Nano	
2513878	TOP LEVEL ASSY - ASSEMBLY FIXTURE (NO CALIBRATION) NIRscan Nano	Fixture
2513941	CALIBRATION SAMPLE HOLDER ASSY NIRscan Nano	Reflectance Reference

Figure 11 – Reference Calibration Overview

When the parts from Table 4 are assembled as shown in Figure 11, the following reference calibration procedure can commence. Procedure 4 – Reference Calibration

1. From an active GUI panel, enter the Factory tab and under the Factory tab and select 'Reference Calibration' from the scroll down menu bar.
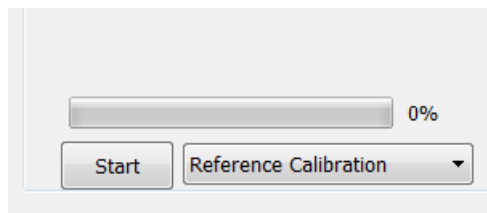

2. Select Start to begin the calibration.
3. Progress will be reported on the horizontal progression bar. A Pass condition will be sent when test is completed.
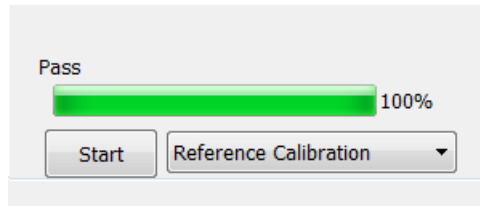
4. Next perform the SNR Computation. From the GUI Factory tab, select SNR Computation from the scroll down menu bar. Select Start button to begin the Computation test.
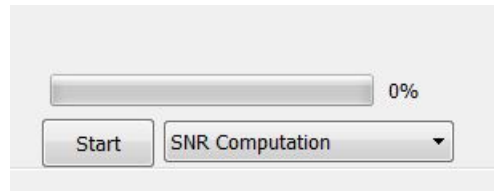
5. SNR values are captured at 17ms, 133ms, and 600ms. Measured values are displayed on the GUI panel. Check these numbers for accuracy. The passing limits are **SNR ≥800 @17ms, SNR ≥1200 @133ms, and SNR ≥2600 @600ms.**
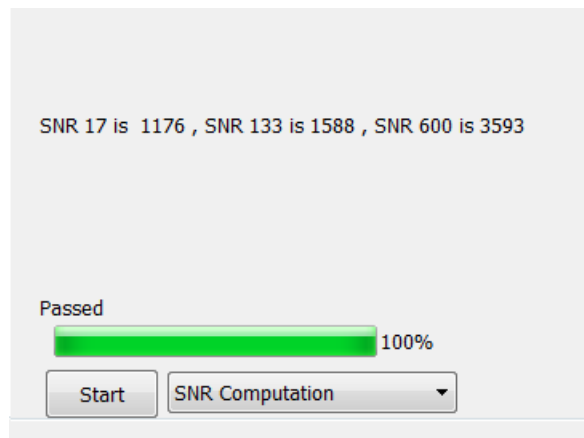
If the SNR numbers fall below the test limits one possible source of the problem could be the illumination module is not producing adequate light.

8. System Test

A scan of a known substance is performed to validate operation of the DLP® NIRscan™ Nano EVM.

Table 5 – Parts Used for System Test

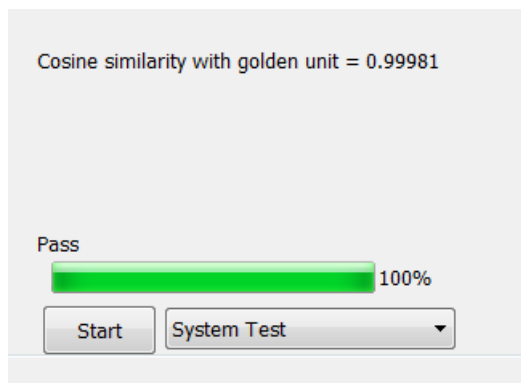| Part Number	Description	Purpose
Either 2513877 or 2513878 is required, but not both. This is because this procedure does not use the translation stage.		
2513877	TOP LEVEL ASSY - ASSEMBLY / CALIBRATION FIXTURE NIRscan Nano	Fixture
2513878	TOP LEVEL ASSY - ASSEMBLY FIXTURE (NO CALIBRATION) NIRscan Nano	Fixture

| | Standard Test Sample | Sample |

The only setup after commence. Procedure 4 – Reference Calibration is to remove the reflectance reference (2513941) and instead hold the test sample up to the unit.

Procedure 5 – System Test

1. From an active GUI panel, enter the Factory tab and under the Factory tab and select 'Systems Test' from the scroll down menu bar. Select Start.
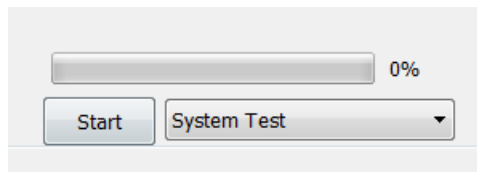
2. Follow the software prompts to complete the scan. A Pass condition will be sent when the test completes.

End of calibration routines.