1.0 PURPOSE

To provide methods for verification that absorbance measurements at a single wavelength made using the Thermo Scientific Evolution Spectrophotometer are traceable to a national standard and that the instrument is performing within specified limits.

NOTE: Users sometime employ the term 'calibration', but the appropriate terminology for the process of testing that a spectrophotometer is performing within manufacturer specifications is called, 'performance verification' (P.V.).

2.0 DEFINITIONS

2.1 Complete Performance Verification (Complete P.V.) – the process of testing the spectrophotometer using a full battery of tests including wavelength and photometric accuracy testing at three or more points to verify the instrument is performing within the tolerances of the published specifications for that instrument.

2.2 Short Performance Verification (Short P.V.) – the process of testing the wavelength and/or photometric accuracy at one point as an interim verification performed between Complete P.V. of the instrument.

2.2.1 NOTE: Short P.V. test (this is synonymous with terms such as "daily verification" or "daily check") performed at a frequency of 24 hours reduces the risk of measurement instruments giving erroneous results between the typically longer cycle of Complete P.V. tests.

3.0 FREQUENCY

3.1 Complete Performance Verification (Complete P.V.)

3.1.1 90 days ±15 days (assumes daily verification testing / Short P.V.)

3.1.1.1 30 days ±15 days is the suggested frequency if the user is not employing a performing Short P.V. method.

3.1.2 After any of the following events:

- Spectrophotometer installation;
- Location change;
- After instrument servicing from Thermo;
- Instrument is jarred or dropped;
- Before and after lamp replacement.

Note: External cleaning, replacing a PC, replacing the power cable, or replacing the USB cable that connects the spectrophotometer to a PC *are not* events that require any type of P.V. testing.

3.2 Short Performance Verification (Short P.V.)

3.2.1 Frequency is dictated by user policy (e.g., "every 24 hours at minimum") and must be justified by the user based on risk assessment.

4.0 MATERIALS

4.1 GEX Part# P4300 – Evolution Spectrophotometer

4.1.1 The Thermo Evolution spectrophotometer is available in two models. This document provides instructions for using

- **Thermo Evolution OnePlus:** Available beginning Nov 1, 2021, the Evo OnePlus model is functionally the same as the Evolution 220, with some improvements to align with current USP and EP requirements. The Evo OnePlus comes with the new **Thermo Insight Pro software**.
- **Thermo Evolution 220:** The Evo 220 model comes with **Thermo INSIGHT 2 software**.

4.2 GEX Part# P4330 – Evolution dosimetry holder system baseplate with beam tubes

4.3 GEX Part# P4334 – Film dosimeter holder (receiver only)

4.4 GEX Part# P4310 – Mercury Lamp Accessory (Method 1)

4.5 GEX Part# P4220 – Spectronic Standards Set 2 (Method 2)

4.6 GEX Doc# 100-269 - Spectrophotometer Performance Verification Forms

5.0 SETUP & DESCRIPTION OF TESTS

5.1 Refer to *GEX Doc# 100-221, Selecting a Performance Verification Method for the Thermo Evolution Spectrophotometer TIR* for a detailed description of the available methods, and a discussion on selecting methods for performance verification to match your needs and requirements for your business.

5.2 Once a method(s) is selected, follow only the applicable sections below.

6.0 SHORT P.V. METHOD ("DAILY CHECK")

6.1 Short P.V. is an abbreviated test of wavelength and photometric accuracy that each involves a single reference instead of multiple reference points to bracket the range of use.

6.2 Short P.V. is executed in the GEX DoseControl software using the Performance Verification module, and includes the following tests:

6.2.1 Wavelength Accuracy at 541.9nm (±0.8nm) using the internal Xenon Lamp of the Evolution as the reference.

6.2.2 Wavelength Repeatability (3 tests) at 541.9nm using the internal Xenon Lamp of the Evolution as the reference, and evaluation of the resulting Standard Deviation (0.5 or less is the specification for the Evolution).

6.2.3 Photometric Accuracy using a photometric reference defined by the DoseControl Application Administrator and performed at a wavelength that the Application Administrator configures within the DoseControl software.

6.3 For detailed discussion and procedure on configuring and executing Short P.V. ("Daily Check"), refer to Section 6 of *GEX Doc# 100-266, DoseControl Software User Guide: Configuration and Usage of the Performance Verification Module.*

6.4 Deviation of Short P.V. Method

6.4.1 If a failure occurs, the DoseControl software will prevent the user of the instrument from making dosimeter measurements with DoseControl.

6.4.2 The user will be forced to follow an explicit method in the software to return the instrument to service. For details refer to Section 6.4 of *GEX Doc# 100-266, DoseControl Software User Guide.*

6.4.3 After repeated failure to return the instrument to service used in accordance with the method within the software, refer to Section 10 below for further instruction.

7.0 COMPLETE P.V. - METHOD 1

Method 1 includes two parts executed separately:

- Part 1: Execution of photometric accuracy testing using the *Spectronic Standards Set 2 (GEX Part# P4220).*
- Part 2: Execution of wavelength accuracy testing using *Mercury Lamp Accessory* (*GEX Part# P4310)*.

Method 1, Part 1 – Photometric Accuracy Testing using Spectronic Standards Set 2

7.1 Method 1, Part 1: Preparation of Test Result Form

7.1.1 The objective of this P.V. testing is to determine if the measured photometric and wavelength results on the user's Evolution lie within an acceptable range.

7.1.2 To establish pass/fail criteria for the Evolution, the acceptable range is derived by adding/subtracting (±) the uncertainty of the Thermo Evolution spectrophotometer and the uncertainty of the Thermo Spectronic Standards.

7.1.3 Use *GEX Doc# 100-269(b), Spectrophotometer Performance Verification Form – Method 1* (Excel) as the Test Result Form to record the information and results of a P.V. test. GEX has set up this Test Form using the Thermo Evolution product specification. You will need to enter the information specific to your Spectronic Standards Kit 2, as instructed below.

7.1.4 First, enter the pertinent information for this P.V. test in the *Doc# 100-269(b)* Test Form, column D. Enter the date the test is performed, the instrument model (Evo One Plus or Evo 220), the instrument serial number (S/N), and the temperature and relative humidity (RH).

7.1.5 Next, use the information found on the calibration certificate for your Thermo Spectronic Standards Kit 2 to complete the remaining fields in *GEX Doc# 100-269(b)* Test Form:

7.1.5.1 Enter the Standards Set ID number in cell D7.

7.1.5.2 Enter the Calibration Certificate number in cell D8.

7.1.5.3 Use the Standard's Calibration Certificate to enter the Certified Value and Uncertainty for each standard in the sections for photometric accuracy.

- The 50%T, 30%T, 10%T, and 3%T Standards are used for Photometric Accuracy testing. Each standard is labeled with a serial number ID that is referenced on the Calibration Certificate.
- Each standard is certified at multiple wavelengths. This procedures tests at **465nm** and **590nm**, to bracket the B3 wavelength of measurement (552nm). Enter each Standards certified value at 465nm in cells G5-G8 and uncertainty in H5-H8; enter each Standards certified value at 590nm in cells G12-G15 and uncertainty in H12-H15. (See *Figure 1)*.
- If measuring other dosimeters, adjust this procedure as necessary using the values at other certified wavelengths.

Photometric Performance at 465nm (values are in absorbance units)							
Standard ID (Filter ID)	Certified Value (from cert.)	Uncertainty (from cert.)	Evo Spec (instrument spec)	Lower Limit (calculated)	Upper Limit (calculated)	Value As Found	Pass/Fail
-1				0.0000	0.0000		PASS
-2				0.0000	0.0000		PASS
-3				0.0000	0.0000		PASS
-4				0.0000	0.0000		PASS
Photometric Performance at 590nm (values are in absorbance units)							
Standard ID (Filter ID)	Certified Value (from cert.)	Uncertainty (from cert.)	Evo Spec (instrument spec)	Lower Limit (calculated)	Upper Limit (calculated)	Value As Found	Pass/Fail
-1				0.0000	0.0000		PASS
-2				0.0000	0.0000		PASS
-3				0.0000	0.0000		PASS
-4				0.0000	0.0000		PASS

Figure 1: Photometric Performance section of GEX Doc# 100-269(b) Test Form. Enter values from the Standards calibration certificate in the yellow highlighted cells.

- *NOTE:* The *GEX Doc# 100-269(b)* Test Form calculates the upper and lower limits for each test by calculating the allowable variability from the sum of the uncertainty of each standard, plus the instrument specification for each test. The specifications and summation method are given in *GEX Doc #100-113, P4220 Thermo Spectronic Standards Kit Set 2 PSU*.
- *NOTE:* If preferred, this information can be entered in advance by a senior person, and the form protected so that a technician can simply enter measurement results later. The acceptance criteria are the same for any Evolution, so only one form is required to be pre-filled for each Spectronic Standards Set 2 on site. The form should be reviewed and updated each time the standards set is recertified.

7.1.6 Next, use the Thermo Photometric Accuracy specifications, as published by Thermo, to complete the "Evo Spec" section of the *GEX Doc# 100-269(b)* Test Form. Reference the Thermo product specification documentation for your instrument: the Evolution One Plus or the Evolution 220. Enter the Thermo instrument specification in cells I5-I8 and in cells I12-I15. (See Figure 2).

Photometric Performance at 465nm (values are in absorbance units)							
Standard ID (Filter ID)	Certified Value (from cert.)	Uncertainty (from cert.)	Evo Spec (instrument spec)	Lower Limit (calculated)	Upper Limit (calculated)	Value As Found	Pass/Fail
-1				0.0000	0.0000		PASS
-2				0.0000	0.0000		PASS
-3				0.0000	0.0000		PASS
-4				0.0000	0.0000		PASS
Photometric Performance at 590nm (values are in absorbance units)							
Standard ID (Filter ID)	Certified Value (from cert.)	Uncertainty (from cert.)	Evo Spec (instrument spec)	Lower Limit (calculated)	Upper Limit (calculated)	Value As Found	Pass/Fail
-1				0.0000	0.0000		PASS
-2				0.0000	0.0000		PASS
-3				0.0000	0.0000		PASS
-4				0.0000	0.0000		PASS

Figure 2: Evolution instrument specification cells of GEX Doc# 100-269(b) Test Form. Enter values from the current published Thermo product specification in the yellow highlighted cells.

7.1.6.1 *NOTE:* As of the date of this document, the Thermo specification for photometric accuracy is as follows:

- **Evolution One Plus: < 2A 0.004 A**; 2A and higher 0.008 A. (See Figure 3).
- **Evolution 220: < 2A ±0.006 A**; 2A and higher ±0.010 A. (See Figure 4).

Photometric	Range	>3.5 A
	Display Range	-0.3 to 4.0 A
	Accuracy—Instrument*	1A: ±0.004 A 2A: ±0.008 A Measured at 440 nm using neutral density filters traceable to NIST

Figure 3: Thermo Scientific Evolution One Plus product specification for photometric accuracy.

Photometric	Range	>3.5 A
	Display Range	-0.3 to 4.0 A
	Accuracy – Instrument	1A: ±0.006 A 2A: ±0.010 A Measured at 440 nm using neutral density filters traceable to NIST

Figure 4: Thermo Scientific Evolution 220 product specification for photometric accuracy.

7.1.7 When the cells in column D1-D8 are complete, and the Photometric Performance at 465nm and at 590nm sections of GEX Doc# 100-269(b) Test Form are complete, Method 1 can be executed. Follow the instructions in section 7.2 to execute.

7.2 Method 1, Part 1: Execution

7.2.1 Before beginning any testing ensure the following:

7.2.1.1 The GEX dosimeter holder baseplate system remains installed in the Evolution sample compartment during the P.V. testing.

7.2.1.2 The Evolution spectrophotometer is powered on with no dosimeter holder or receiver in the Evo's sample compartment, as described in *GEX Doc #100-156 P4300 Thermo Scientific Evolution Spectrophotometer PSU.*

7.2.1.3 The Evolution's sample compartment front panel is attached, and the lid is closed.

NOTE: The sample compartment lid must be closed for each measurement during this procedure because the acceptance criteria are derived from specifications established by Thermo with the lid closed.

7.2.2 **Insert the WINdose dosimeter holder receiver (GEX Part# P4334) into the baseplate** and ensure that it is fully and correctly seated in the baseplate. See Figure 5 below.

7.2.2.1 For PMMA capable systems with the Metralight MX2 Laser Micrometer installed and powered on (i.e., emitting the visible red laser), keel the WINdose holder fully inserted into the baseplate for the entire P.V. procedure below, including the "blank" or empty testing.

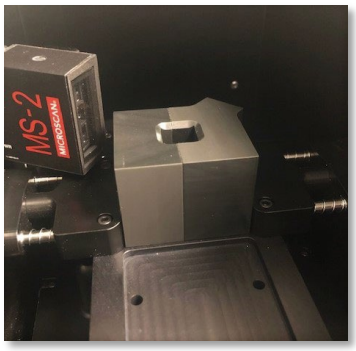


FIGURE 5: P4334 WINdose Dosimeter holder receiver installed in baseplate

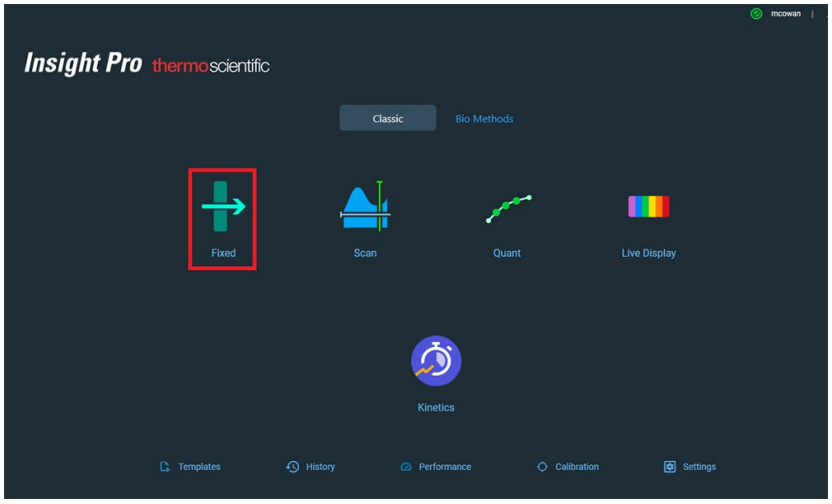
7.2.3 **Open form *GEX Doc# 100-269(b), Evolution 220 Performance Verification Form – Method 1* in MS Excel**. Use this Form to record the P.V. test results.

7.2.4 **Open the Insight Pro software** on the PC connected to the Evolution spectrophotometer and verify the instrument successfully connects to the software indicated by the green status icon in the upper right (Insight Pro) or lower left (INSIGHT 2) of the main screen.

7.2.4.1 **<u>Instructions for Insight Pro software:</u>**

Photometric accuracy tests are performed by using a Fixed measurement for each of the Thermo Spectronic photometric standards (or other NIST-traceable standard for appropriate for your application) at both the 465nm and 590nm wavelengths. Reference the Thermo Insight Pro Software User Guide, Performing Fixed Measurements.

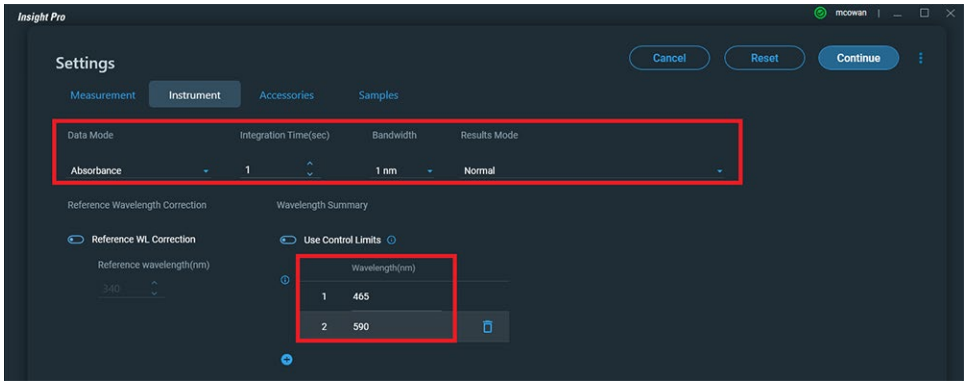
Step 1: From the Insight Pro main screen, click Fixed.



Step 2: On the Fixed measurement settings screen, configure the settings. Click the "Continue" button after configuring the settings as follows:

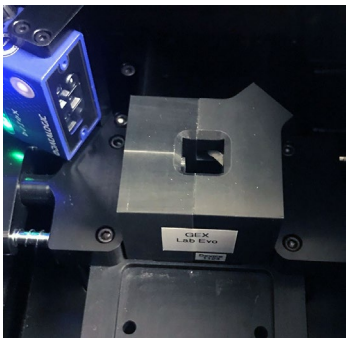
- Wavelength 1: 465
- Wavelength 2: 590
- Data Mode: Absorbance

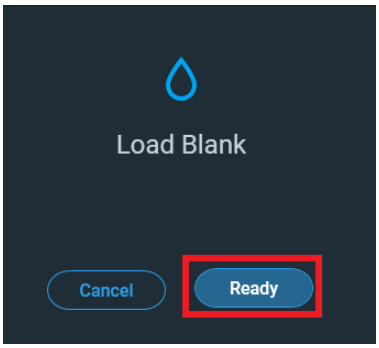
- Integration time: 1 second
- Bandwidth: 1nm
- Results Mode: Normal



Step 3: Zero the instrument by clicking the "Blank" icon. Click the "Confirm" button to confirm the name of the test.

Step 4: The "Load Blank" prompt appears. Click "Ready" after confirming the Windose dosimeter receiver is empty and the lid is closed. The Evolution will zero.





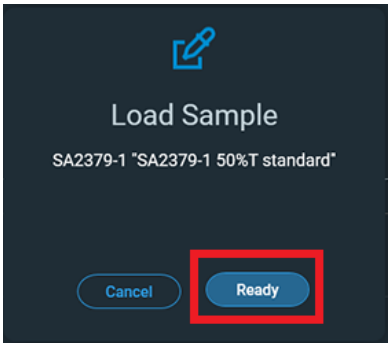
In the next steps, measure each of the photometric Standards, and zero between each measurement.

Step 5: Click the "Play" icon to begin a measurement.

Step 6: Type a Sample ID and Description for the Standard when prompted (example: Standard ID XXXXX-1 50%T).

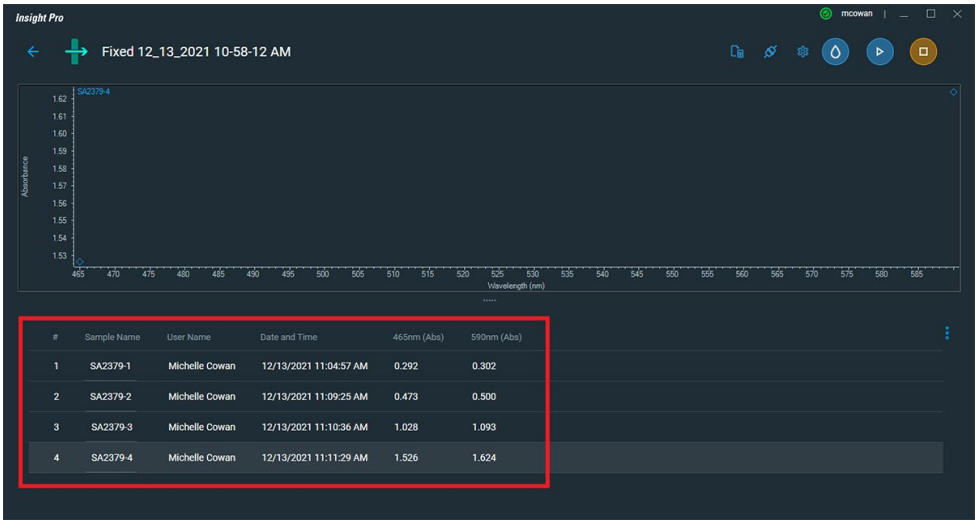
Step 7: Carefully remove the Standard from the kit and ensure there are no fingerprints or dust on the Standard. Place the Standard into the Windose receiver in the Evo's sample compartment; close the lid. NOTE: The Standards fit into the holder in only one direction; with the glass facing to the right. Use caution when placing the Standard to avoid damage.

Press "Ready" button to measure the Standard.



Step 8: The measurement Absorbance value will appear in a list on the screen. Record the values for the 465nm and 590nm measurements in GEX Form # 100-269(b).

Step 9: Repeat Steps 5-8 and measure each of the photometric Standards, and zero between each measurement. The measurements for each Standard will appear in a list on the screen. Record the measured values in GEX Doc# 100-269(b) Excel Form. Record the Absorbance values for 465nm in the Form cells L5-L8, and values for 590nm in cells L12-L15. See *Figure 6*.



Test Method: 100-271 Evolution P.V. Method 1: Optical Standards and Hg Lamp

Instrument S/N: 5A2R352002
Instrument Model: Evo One Plus
Date: 10-Dec-2021
Relative Humidity (%): 21.0
Temperature (°C): 19
Calibration Standards Set ID#: SA2379
Calibration Certificate #: CC
Notes:

Photometric Performance at 465nm (values are in absorbance units)

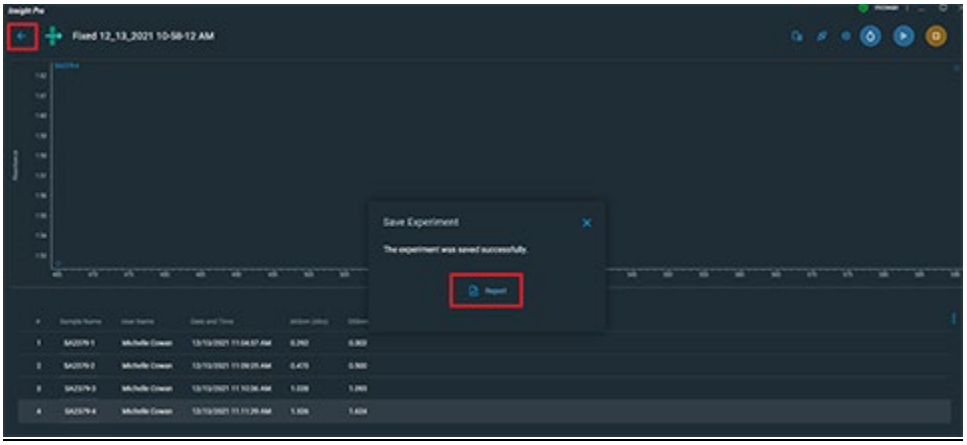
Standard ID (Filter ID)	Certified Value (from cert.)	Uncertainty (from cert.)	Evo Spec (instrument spec)	Lower Limit (calculated)	Upper Limit (calculated)	Value As Found	Pass/Fail
SA2379-1	0.2924	0.0026	0.0040	0.2858	0.2990	0.2920	PASS
SA2379-2	0.4734	0.0026	0.0040	0.4668	0.4800	0.4730	PASS
SA2379-3	1.0285	0.0031	0.0040	1.0214	1.0356	1.0280	PASS
SA2379-4	1.5262	0.0070	0.0040	1.5152	1.5372	1.5260	PASS

Photometric Performance at 590nm (values are in absorbance units)

Standard ID (Filter ID)	Certified Value (from cert.)	Uncertainty (from cert.)	Evo Spec (instrument spec)	Lower Limit (calculated)	Upper Limit (calculated)	Value As Found	Pass/Fail
SA2379-1	0.3031	0.0026	0.0040	0.2965	0.3097	0.3020	PASS
SA2379-2	0.5009	0.0026	0.0040	0.4943	0.5075	0.5000	PASS
SA2379-3	1.0933	0.0031	0.0040	1.0862	1.1004	1.0930	PASS
SA2379-4	1.6232	0.0070	0.0040	1.6122	1.6342	1.6240	PASS

Figure 6: (Above) List of measurements in Insight. (Below) Measurement values recorded into GEX Doc# 100-269(b) Excel Form.

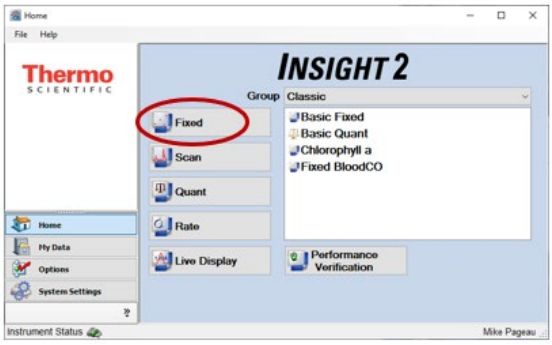
NOTE: To view and print a report of the raw data from Insight Pro, click the Back arrow icon (upper left corner) of the measurement screen. Click the Report link to view and print the data.



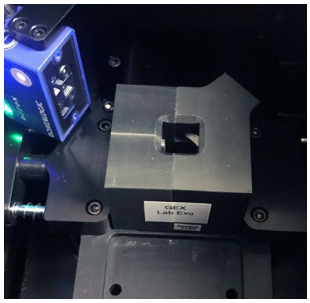
7.2.4.2 **Instructions for INSIGHT 2 software:**

Photometric accuracy tests are performed by using a Fixed measurement for each of the Thermo Spectronic photometric standards (or other NIST-traceable standard for appropriate for your application) at both the 465nm and 590nm wavelengths. Reference the Thermo INSIGHT 2 Software User Guide, Performing Fixed Measurements.

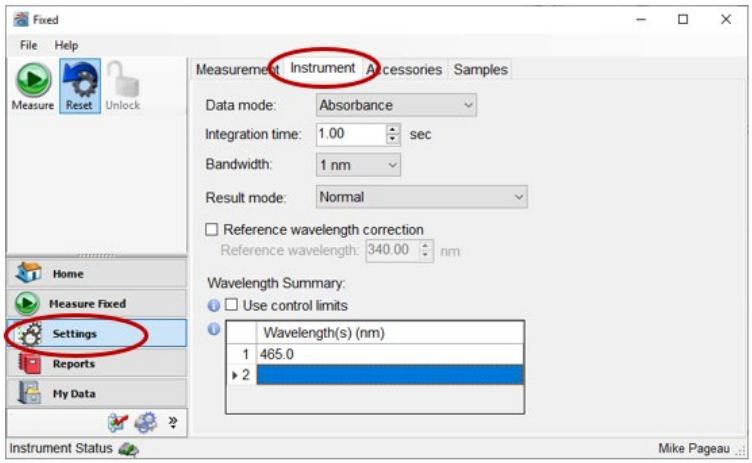
Step 1: On the INSIGHT 2 main screen, select the **Fixed** menu button to create a measurement session using a single (fixed) wavelength setting.



Step 2: Verify the Windose dosimeter holder receiver is empty and close the sample compartment lid of the Evolution.



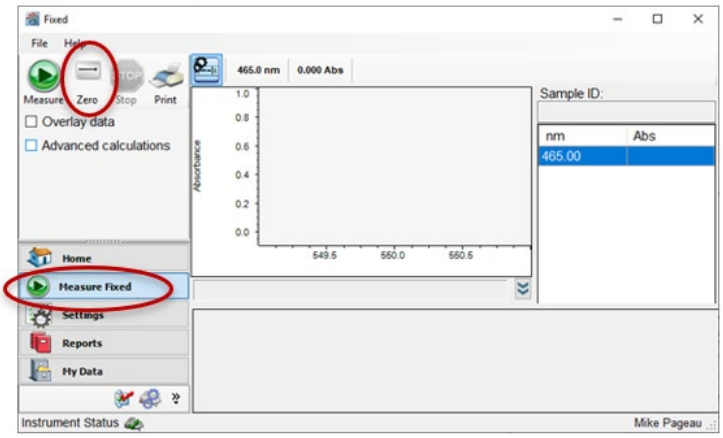
Step 3: Select the "Settings" button on the lower left of the screen and then select the "Instrument" tab.



Configure the Instrument settings as follows:

- Wavelength: **465**
- Data Mode: Absorbance
- Integration time: 1 second
- Bandwidth: 1nm
- Results Mode: Normal

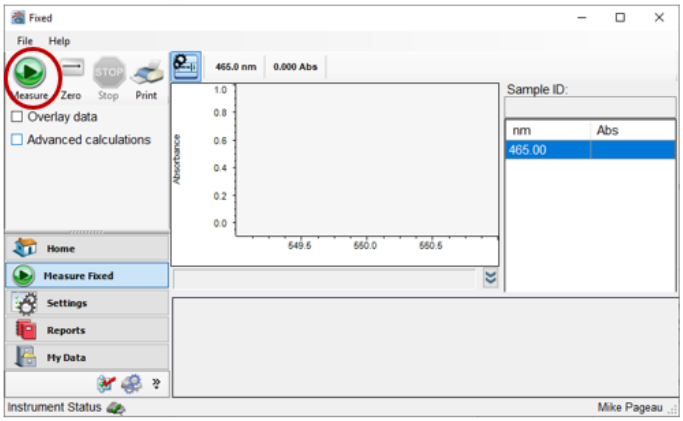
Step 4: Select the "Measure Fixed" button on the lower-left of the screen. Then press the "Zero" button on the top-left. The instrument makes a few sounds as it zeros. When the instrument status on the bottom-left again has the green check mark, the instrument is ready.



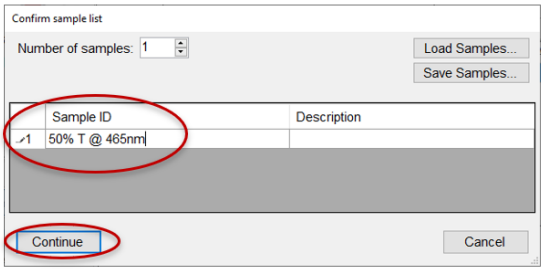
Step 5: Carefully remove a photometric Standard (example: Standard ID XXXXX-1 50%T) from the Spectronic Standards Kit 2 case. Ensure there are no fingerprints or dust on the Standard. Insert the Standard into holder in the Evolution's sample compartment; close the Evo's compartment lid.

NOTE: The Standards fit into the holder in only one direction; with the glass facing to the right. Use caution when placing the Standard to avoid damage.

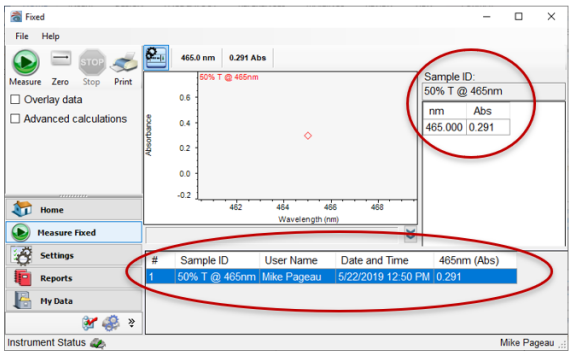
Step 6: Press the "Measure" button on the upper-left of the screen.



Step 7: Type a Sample ID and Description for the Standard when prompted (example: Standard ID XXXXX-1 50%T). Click "Continue" to measure the Standard.



Step 8: The Absorbance measurement will appear on the screen. Record the value for the measurement in GEX Form # 100-269(b).



Step 9: Repeat Steps 4-8 to measure the other photometric Standards in the kit at the 465nm wavelength. Always zero before each measurement.

The list of measurements will be displayed in INSIGHT 2, as each measurement is completed. When complete with all four measurements for each of the Standards, transcribe the absorbance values in cells L5 through L8 of *GEX Doc# 100-269(b), Spectrophotometer Performance Verification Form – Method 1.*

If desired, print the report of the raw data from INSIGHT to attach with the Doc# 100-269 Test Form (see *Figure 7* below).

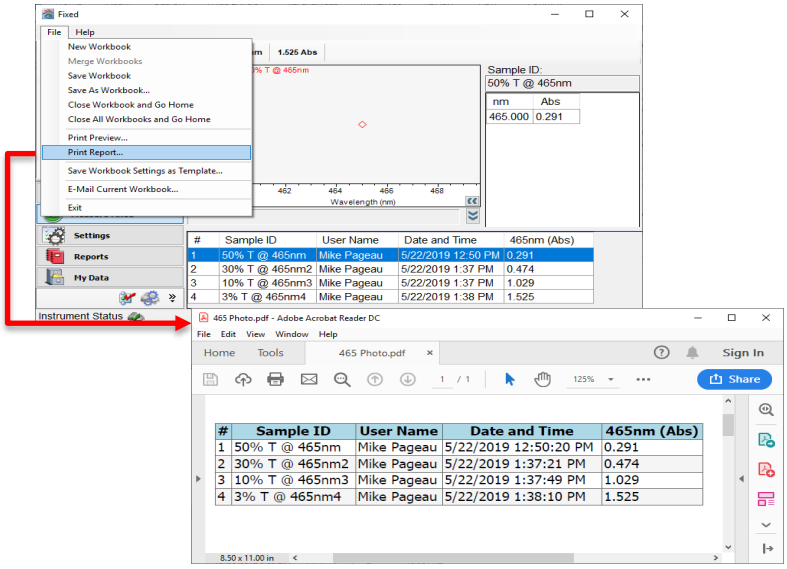


Figure 7: Print raw data from INSIGHT 2

Step 10: Repeat all the Step 1-9 using the **590.0 nm** wavelength setting on the **Fixed** measurement > **Instrument** tab. Record the measurement results in L12-L15 of the *GEX Doc# 100-269 Test Form*.

7.3 Method 1, Part 1 Review and Approval

7.3.1 Review all entries in the *GEX Doc# 100-269 Test Form* for formatting completeness.

7.3.2 If any of the values fall outside the limits, the form will report "FAIL". Otherwise, all tests will display "PASS".

7.3.3 Print and sign the Form. Obtain the reviewer's signature.

7.4 Method 1, Part 2 – Wavelength Accuracy Testing using Mercury Lamp

7.4.1 Install the Mercury Lamp in accordance with the instructions given in *GEX Doc #100-157, P4310 Thermo Scientific Mercury Lamp Accessory PSU.*

7.4.2 Follow the instructions to perform a Mercury Lamp Wavelength Accuracy test in Thermo Insight software (Insight Pro or INSIGHT 2), as per *GEX Doc #100-157, P4310 Thermo Scientific Mercury Lamp Accessory PSU*

7.4.3 A .pdf file with the results appears on the Insight screen upon completion of the testing. Print, sign and date the reports for the Mercury Lamp verification tests.

7.5 Method 1: Completion

7.5.1 After Method Part 1 and Part 2 are completed, have a reviewer sign and date the results of both the Method 1, Part 1 (photometric accuracy test using the Spectronic Standards), and Method 1, Part 2 (wavelength accuracy test using the Mercury Lamp). Append the Mercury Lamp test report to the *GEX Form # 100-269(b)* for a complete Performance Verification of the Evolution.

7.5.2 For deviations (failure) of any test refer to **Section 9** below.

8.0 COMPLETE P.V. - METHOD 2

Description of Method 2:

- Method 2 allows the user to keep the GEX Dosimetry system baseplate always installed, just as in Method 1.
- Method 2 is a manual procedure for photometric and wavelength accuracy testing using only the *Thermo Spectronic Standards Set 2 (GEX Part# P4220)*.

8.1 Use *GEX Doc #100-269(c), Spectrophotometer Performance Verification Forms – Method 2*.

8.2 First, execute **Method 1: Part 1** (section 7.0 above) to complete the photometric accuracy test. Record results in GEX Doc #100-269(c).

8.3 Next, execute the Wavelength Accuracy Test using the wavelength standard in the Spectronic Standards Set 2.

8.3.1 Test Preparation: *GEX Doc #100-269(c)*

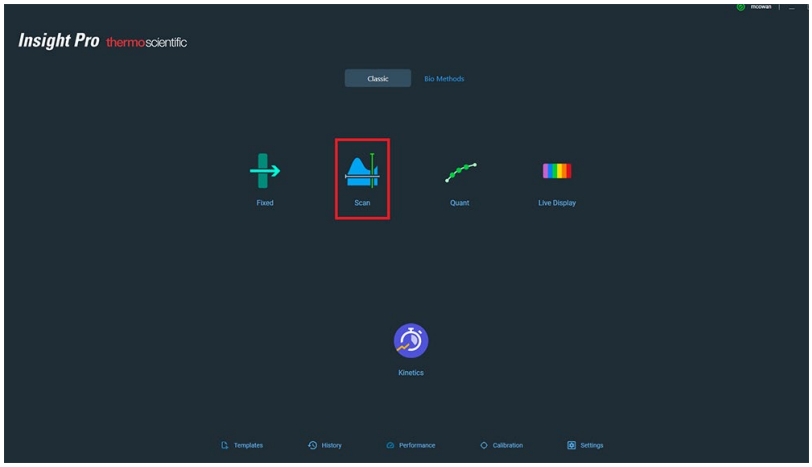
8.3.1.1 Use the information found on the calibration certificate for your Thermo Spectronic Standards Kit 2 for the wavelength standard at **4nm SBW** to complete the Wavelength Accuracy Test fields in *GEX Doc# 100-269(c) Test Form*:

- **Wavelength Accuracy Test at <u>525nm</u> (nominal)** – Using the nearest certified wavelength peak; enter the certified value in cell H23. Enter the uncertainty value in cell H24.
- **Wavelength Accuracy Test at <u>782nm</u> (nominal)** – Find the certified wavelength peak; ; enter the certified value in cell H23. Enter the uncertainty value in cell H24.

8.3.2 Execute the wavelength accuracy testing in the Thermo Insight software, using the **Scan** measurement function.

8.3.2.1 **<u>Instructions for Insight Pro software:</u>**

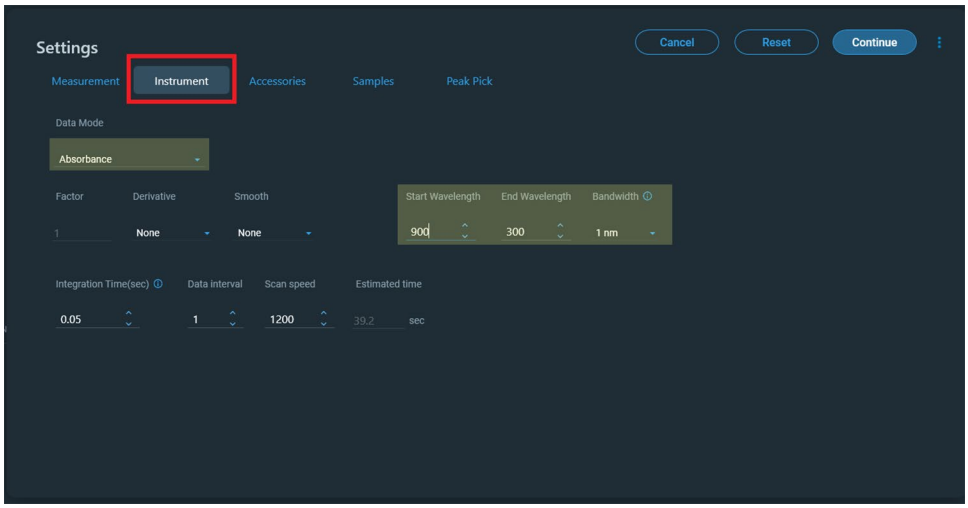
Step 1: On the main screen, click the **Scan** button.



Step 2: On the Scan measurement screen, select the **Instrument** tab. Configure the Instrument as follows:

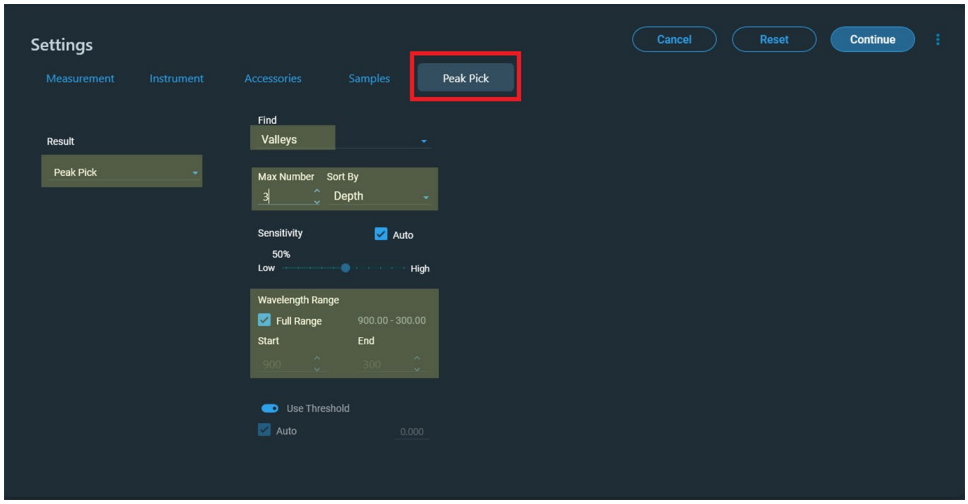
- Data Mode: Absorbance

- Start wavelength: 900
- End wavelength: 300
- Bandwidth: 1 nm
- Integration time: 0.05, Data Interval: 1, Scan speed: 1200 (default settings)



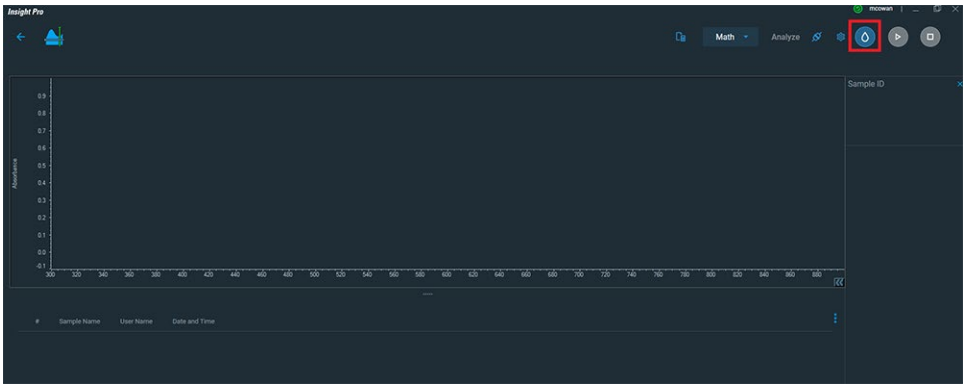
Step 3: Select the **Peak Pick** tab. Configure the Peak Pick settings as follows:

- Result: Peak Pick
- Find: Valleys
- Max Number: 3, Sort By: Depth
- Wavelength Range: full range (900-300)

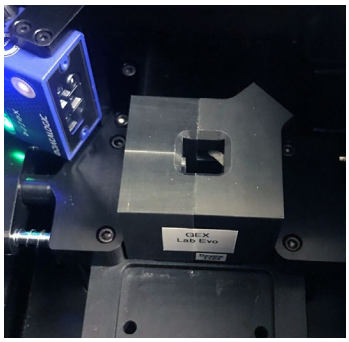


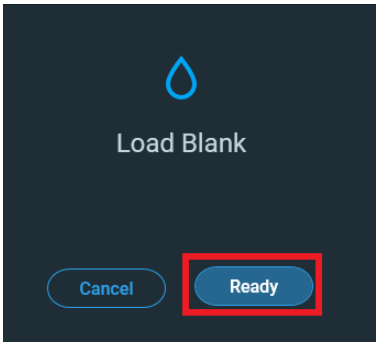
Step 4: Click “Continue” button to go to the scan measurement screen.

Step 5: Zero the instrument by clicking the "Blank" icon Click the "Confirm" button to confirm the name of the test.



Step 6: The "Load Blank" prompt appears. Click "Ready" after confirming the Windose dosimeter receiver is empty and the lid is closed. The Evolution will zero.



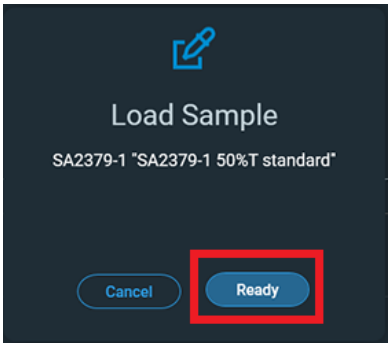


Step 7: Click the "Play" icon to begin a measurement.

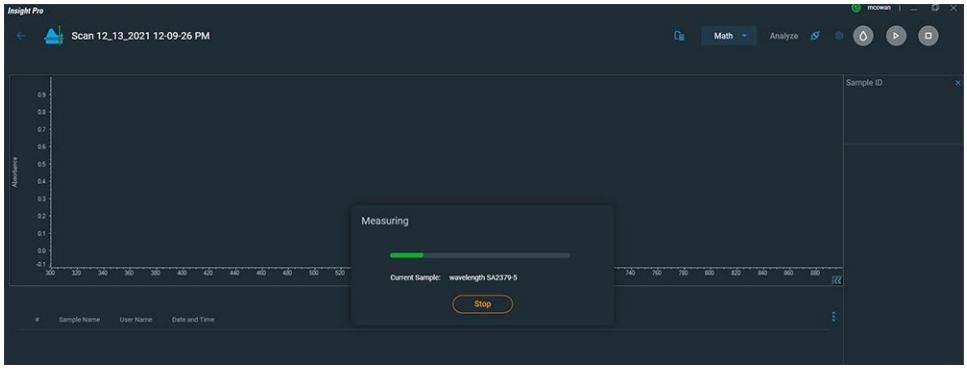
Step 8: Type a Sample ID for the wavelength standard when prompted (example: Standard ID XXXXX-5).

Step 9: Carefully remove the Wavelength Accuracy test standard XXXXXX-5 with the lambda (λ) symbol label on the top of the filter from the standards kit. Ensure there are no fingerprints or dust on the standard. Place the Standard into the Windose receiver in the Evo's sample compartment; close the lid. NOTE: The Standards fit into the holder in only one direction; with the glass facing to the right. Use caution when placing the Standard to avoid damage.

Press "Ready" button to measure the standard.

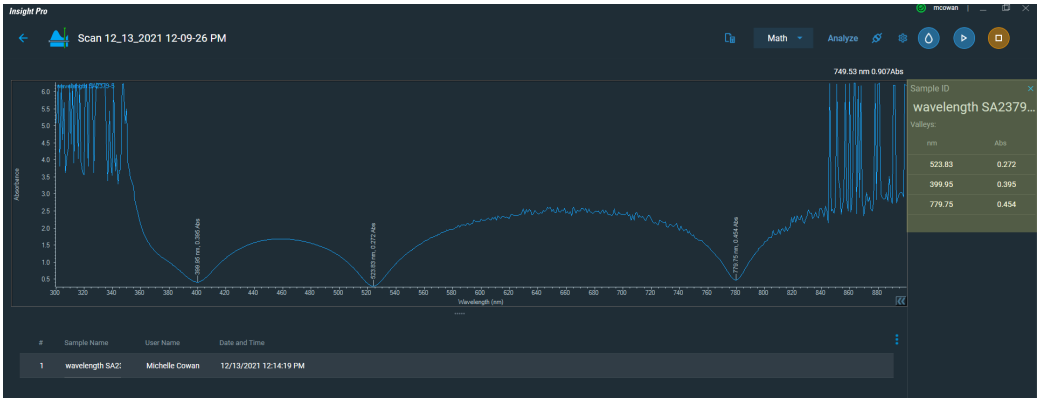


Step 10: The scan measurement will begin and a status bar will appear.



Step 11: When complete, the measurement will appear in a list on the screen. Record the measured values in GEX Doc# 100-269(c) Excel Form.

- Record the value for the Peak as Found for the measurement nearest to 525nm in cell **H29**.
- Record the value for the Peak as Found for the measurement nearest to 782nm in cell **L29**.

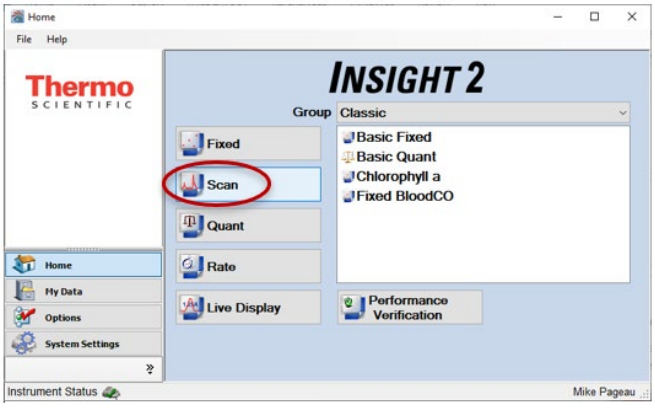


NOTE: To view and print a report of the raw data from Insight Pro, click the Back arrow icon (upper left corner) of the measurement screen. Click the Report link to view and print the data.

Wavelength Accuracy Test at 525nm (nominal)		Wavelength Accuracy Test at 782nm (nominal)	
Standard ID:	SA2379-5	Standard ID:	SA2379-5
Certified Value (nm):	523.9	Certified Value (nm):	779.1
Uncertainty (nm):	1.0	Uncertainty (nm):	1.0
Evo220 Spec (nm)	0.8	Evo220 Spec (nm)	0.8
Lower Limit (nm):	522.1	Lower Limit (nm):	777.3
Upper Limit (nm):	525.7	Upper Limit (nm):	780.9
Valley As Found (nm):	523.8	Valley As Found (nm):	779.8
Pass/Fail:	PASS	Pass/Fail:	PASS

8.3.2.2 **Instructions for INSIGHT 2 software:**

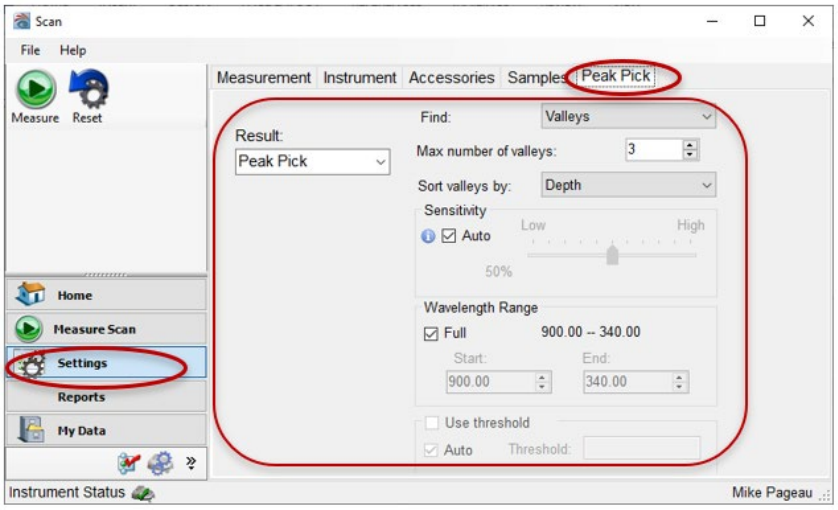
Step 1: Open the Insight software and select the “Scan” button.



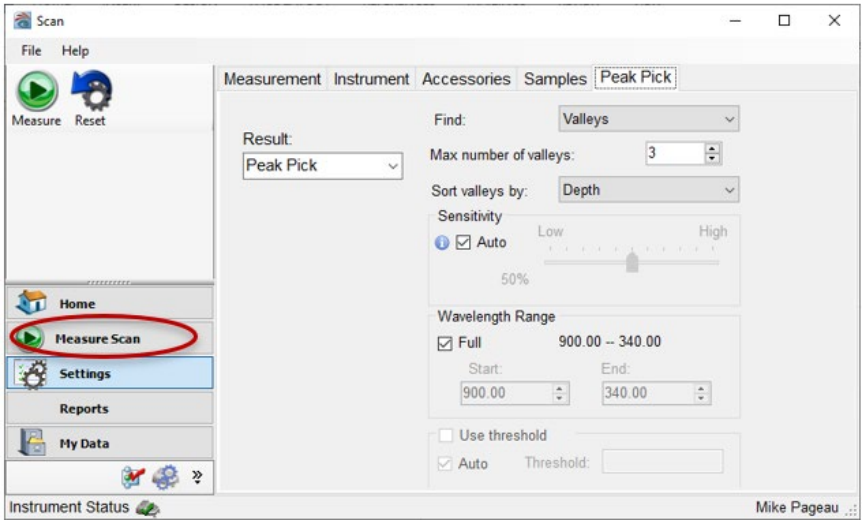
Step 2: Select the “Settings” button on the lower left of the screen (see image below).

Step 3: Select the "Instrument" tab and set the wavelength range to 900-340nm, data mode to Absorbance, and bandwidth to 1nm.

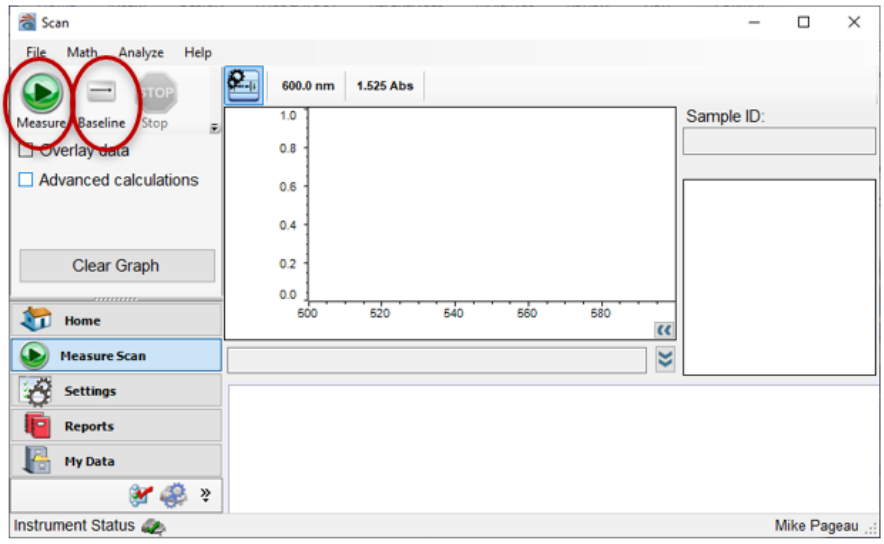
Step 4: Select the "Peak Pick" tab and use the exact settings shown in the image below.



Step 5: Select the "Measure Scan" button in the lower-left of the screen; the measurement screen will appear.



Step 6: Open the sample compartment lid. Ensure the Windose receiver is installed in the baseplate. Remove the dosimeter holder or any samples. Push the "Baseline" button to take a zero-absorbance scan of the empty sample compartment over the range of wavelengths.

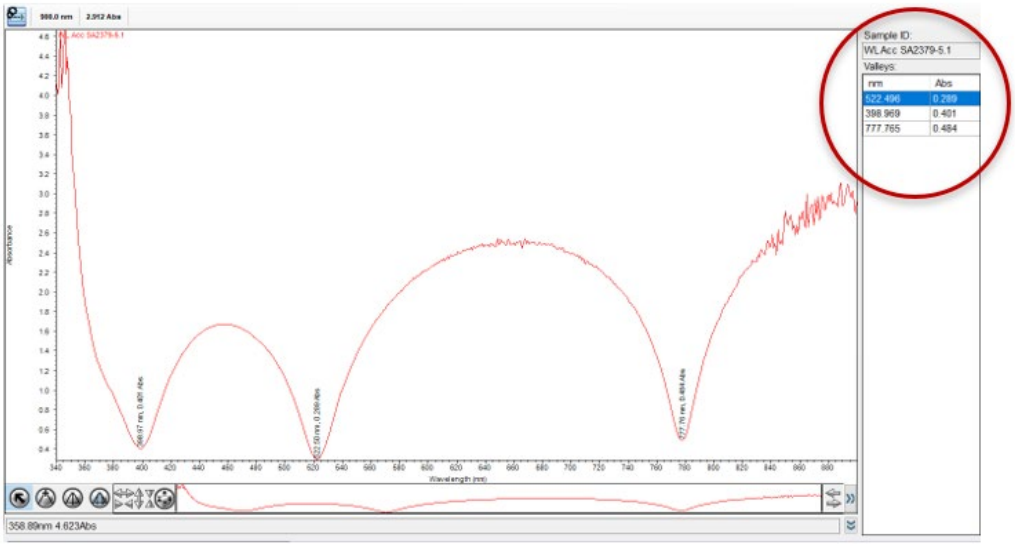


Step 7: Insert the Wavelength Accuracy test standard XXXXXX-5 with the lambda (λ) symbol label on the top of the filter. Close the sample compartment lid.

Step 8: Push the "Measure" button to begin the scan.

When the scan has completed, the software will identify the values of each valley which are the required results. Record the measured values *in GEX Doc# 100-269(c) Excel Form*.

- Enter the value of the wavelength valley nearest to 525nm into cell **H29**.
- Enter the value of the wavelength valley nearest to782 into cell **L29**.



Step 9: Testing is complete. Print the raw data results using the same method as described in section 7.2.4.2, step 9 (photometric accuracy test instructions for INSIGHT 2).

8.4 Method 2 Completion

8.4.1 For deviations (failure) of any test refer to **section 9** below.

9.0 DEVIATION OF PERFORMANCE VERIFICATION (P.V.)

9.1 These instructions apply to any test deviation or failure for the "complete P.V" described in Method 1 and 2, as well as any deviation or failure of a "short P.V" or daily check of the Evolution.

9.2 If any P.V. testing described in this document or otherwise fails, turn off the Evolution and then re-start the Evolution and allow the instrument to fully initialize. Then repeat the P.V. procedure to determine if the failure is repeatable.

9.2.1 If the instrument passes the second P.V. testing, always repeat the testing a 3rd time to confirm that the instrument is passing. Retain all failed and passing test results together.

9.2.2 If the instrument fails the second P.V. test, this confirms the failing result. The instrument will require service.

9.2.2.1 First, attempt self-service by calibrating the wavelength accuracy against the Xenon lamp or the Mercury Lamp accessory. See *GEX Doc# 100-156, P4300 Thermo Scientific Evolution Spectrophotometer PSU.*

9.2.2.2 After re-calibration of the instrument, repeat the P.V. testing.

9.2.2.3 After repeated failure, contact GEX Customer Service at support@gexcorp.com for assistance or contact Thermo Scientific directly to arrange service for the instrument.

10.0 ASSOCIATED DOCUMENTS

- GEX Doc #100-113, P4220 Thermo Spectronic Standards Kit Set 2 PSU
- GEX Doc #100-156, P4300 Thermo Scientific Evolution Spectrophotometer PSU
- GEX Doc #100-157, P4310 Thermo Scientific Mercury Lamp Accessory PSU
- GEX Doc #100-221, Selecting a Performance Verification Method for the Thermo Evolution Spectrophotometer TIR
- GEX Doc #100-269, Spectrophotometer Performance Verification Forms
- Thermo Scientific Evolution Spectrophotometer User Guide (Performance Verification section)
- Thermo Scientific Mercury Lamp User Guide
- Thermo Scientific Spectronic Standards Set 2 User Guide

11.0 REVISION HISTORY

DATE	CHANGE DESCRIPTION	REVISION
12/01/2020	Step 7.1.1 removed and the numbering of the other 7.1.X actions adjusted. Step 8.2.17 changed to read "repeat steps 8.2.11 through 8.2.16". ECO 10005.	B
12/15/2021	- Changed title from "Evo220 Performance Verification Procedure" to "Evolution Performance Verification Procedure". - Added 4.1.1: referenced the two Evo models: Thermo Evolution OnePlus and Evo220. - Section 4.0: Removed reference of CVC accessory (GEX part #4320). - Section 7.0: Removed instructions for the CVC accessory (GEX part #4320). - Section 7.0: Method 1 is now P.V. testing of the Evolution using the Spectronic Standards Kit and the Mercury Lamp. - Section 8.0: Method 2 is now P.V. testing using the Spectronic Standards Kit only. - Added instructions and screenshots to each Method to include the Thermo Insight Pro software. ECO 70595	C
01/14/2025	- Updated company logo in header. - Added 7.2.2.1, for PMMA capable systems with the Metralight MX2 Laser Micrometer installed and powered on (i.e., emitting the visible red laser), keel the WINdose holder fully inserted into the baseplate for the entire P.V. procedure below, including the "blank" or empty testing. - 10.0 Associated Documents – removed reference to 100-159 and updated titles and hyperlinks to current list. ECO 75050	D

APPROVED
By Dominique Taylor at 11:37 am, Jan 15, 2025