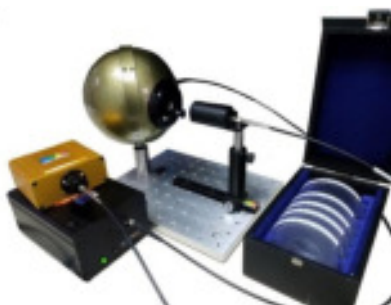2022

User Manual
Spectrometers, Software, and Accessories

A Universe of Spectroscopy Solutions

StellarNet Inc

**14390 Carlson Circle
Tampa, Fl 33626
Phone: (813) - 855-8687
Fax: (813) - 855 - 0394**

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StellarNet Welcomes You

StellarNet, Inc. is a global provider of low cost compact spectrometers, systems, and software for product analysis, research, education, and OEM. StellarNet instrumentation is research grade and rugged for any environment – lab, process, or field.

StellarNet has a long history in the spectroscopy business. Begun in the early 1990's, StellarNet revolutionized the miniature spectrometer market by creating the first holographic *concave grating spectrometer*. StellarNet also focused on instrument robustness and miniaturization, which led NASA to launch three Shock-Proof BLUE-Wave spectrometers into orbit to participate in a materials exploration study on-board the International Space Station.

Today StellarNet focuses on providing research quality spectrometer instrumentation and clever engineering at a low cost. Just about every university worldwide has a few StellarNet spectrometer systems either used for chemical research or teaching laboratories. Most systems are deemed "undergrad-proof" due to their rugged design. StellarNet is committed to keeping its spectrometers cost effective with the highest quality possible in compact crush proof metal enclosures (e.g. run over by SUV). This makes StellarNet spectrometers ideal for educational settings since they are robust enough for students to handle while also remaining cost effect for educators

StellarNet systems are also popular in many industries for these same reasons and are often put into production lines for process monitoring or used for field application. Within the past 10 years StellarNet has released a set of Analyzer systems designed for portable and handheld applications involving light or luminaire measurement, unknown substance identification, and even molecular and elemental analysis.

StellarNet is committed to designing high performance instruments excelling in durability, portability, size, and low price. StellarNet is proud of its R&D Engineers, Optical Engineers, and production staff and has teams of application sales scientists and worldwide distribution networks continuously focused on providing high quality spectroscopy solutions and excellent product support.

Popular Spectrometer Models and Features

StellarNet miniature spectrometers are portable and compact fiber optic instruments for UV, VIS, and NIR measurements in the 190-2300nm range. The StellarNet series of miniature spectrometers is a step up in low cost instrument design, offering CCD 2048 & PDA 512/1024 detectors. The units are engineered to have no moving parts, no detector sockets, ruggedized aluminum enclosure, and an integrated A/D digitizer for unmatched durability and quality that out performs any instrument in its class. Numerous models offer standard or high-resolution optics for selected spectral ranges, as shown in below.

> **BLUE-Wave Series** (15 models**)** with *Holographic and Ruled* 2048 pixel CCD with ranges 200-1150nm. Many options and upgrades available with BLUE-Wave models.

> **BLACK-Comet Series** (6 models) with Research Grade *Holographic, Concave Grating* 2048 pixel CCD with ranges (C) 190-850nm (CXR) 280-900nm, (C-SR) 200-1080nm, and (CXR-SR) 220-1100nm.

> **SILVER-Nova** widest range spectrometer with *Extreme Grating* 2048 element CCD High Resolution model with range 200-1100nm and integrated TE cooler.

> **GREEN-Wave Series** (8 models) with *Holographic and Ruled* 2048 pixel CCD with ranges 350-1100nm. No upgrades available with GREEN-Wave models.

> **High Resolution Series (HR)** (>20 models) for high resolution applications spanning 200-2300nm with resolutions as good as 0.1nm.

> **HR-X eXtreme Hi-Res Series** (>13 models) for highest resolution applications spanning 200-2300nm.

> **DWARF-Star and RED-Wave NIR InGaAs Series** (cooled 512 and 1024 PDA) with range 900-1700nm and 900-2300nm, respectively.

> **Raman-HR-TEC Spectrometers 405**/**532**/**633**/**785**/**830** high resolution spectrometers configured for 532nm, 784nm, or 1064nm Raman lasers. Custom wavelengths are available.

Optical Advantages

Making a spectrometer is both an art and a science. StellarNet's team of optical engineers and manufacturing technicians have unmatched experience and technical capability. A spectrometer must be optimized for system sensitivity as well as resolution across its wavelength range. StellarNet follows strict quality control and internal standards to make sure all spectrometers maintain high performance and consistency. Likewise our technical sales teams and distributing partners work closely with our optical manufacturing teams to provide system configuration advice pre-sale.

Additionally, StellarNet's flagship spectrometers, the **BLACK-Comet Series** utilize concave grating optics which have unmatched performance of any compact spectrometer. Most spectrometers use

crossed Czerny Turner optics which requires several mirrors and a plane grating in order to properly image the spectrum on the detector. In the BLACK-Comet series the concave grating holographic grating is the mirror and requires only once optical bounce! With applications that require the use of UV light, especially UV-Vis absorbance, fluorescence, and solar radiometry, multiple mirrors can be detrimental to the performance of an instrument. The use of a holographic concave grating can eliminate the sensitivity issues and provide other benefits including: stray light reduction, aberration correction, thermal stability, and improved ruggedness.

Go online to https://www.stellarnet.us/performance-advantages-concave-grating-optics-compact-fiber-optic-spectrometers/ to read more about Performance Advantages of Concave Grating Optics in Compact Fiber Optic Spectrometers.

Detector Quality and Options

Building spectrometers for over 25 years has taught us a thing or two about choosing the right detector and the right detector vendors. StellarNet offers SONY, Toshiba, Hamamatsu, & Sensors Unlimited CCD and PDA detectors. Depending on the specific model spectrometer you purchase we will install and calibrate the appropriate sensor. For UV and many visible applications we have specialty detector enhancing coatings that are applied to increase sensitivity as well as smooth spectral response. Our coating system and quality inspections will guarantee you to collect every photon possible!

Amazing Software

Each StellarNet spectrometer comes with the powerful SpectraWiz® 32/64 bit spectrometer software FREE of charge. It has many built in applications for SpectroRadiometry, SpectroColorimetry, SpectroChemistry, Optical Spectral Analysis, Spectral Library Matching, Calibration, and much more.

StellarNet also offers application specific software packages for LED Test Reporting, Haze Measurement, Thin Film Analysis, Chemometrics, graphing & display. Also, we have software developed for tablet interfaces such as the StellarRAD program which has large buttons for fat fingers and a reduced interface specifically designed for field radiometric measurement.

If you want complete control of your spectrometer we offer a SDK with full programs and sources in many languages such as C, C#, VB, LabVIEW, Pascal, and VBA for MS Excel. Linux drivers with a webserver capability allow even more flexibility and control of your spectrometer.

Focus on Ruggedness

StellarNet spectrometers are like no other on the market and are designed to withstand rugged applications. Spectrometers are enclosed in a rugged extruded aluminum enclosure where their optics are bolt mounted to an internal optical housing. Gratings are mill-bonded in place with no moving parts for an *eXtremely* robust, shock-proof experience.

Cost Performance Advantage

StellarNet has always been the industry leader in providing the highest quality spectrometers at the lowest cost. We dare you to find a better deal. Contact us for more information.

Sales, Service, and Delivery

We pride ourselves in offering the wonderful customer service. Focusing on the customer and their applications has enabled us to forge a strong relationship with our base and gain many repeat customers. Likewise having a customer focus has allowed us to make continual improvements to our products along the way, making *StellarNet Spectrometers* a popular brand in both academia and industry alike.

StellarNet delivery is almost as good as Amazon. Most items are "in stock." If not, lead times on instrument build is typically less than 1.5 weeks after receipt of order.

US Sales & Support Team 2018 Holiday Party

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Spectrometer Driver and Software Installation

Online registration

Go to www.StellarNet.us/register and register your StellarNet spectrometer to claim your one-year warranty and receive an email with StellarNet Driver and SpectraWiz Downloads.
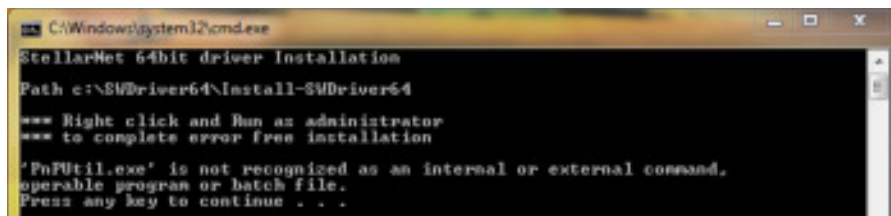
You must install the drivers before you try to install or run the SpectraWiz software.

Driver Installation

Automatic Install for 64-bit Windows Vista/7/8/10

1. SWDriver64 installation is ok with or without spectrometer attached via USB.

2. Select *my computer* → *properties* to verify you have a 64-bit operating system.

3. Download SWDriver64.exe driver

4. Save the file to your desktop

5. Right click on the SWDriver64.exe icon on your desktop and choose to "Run as administrator"

6. A command prompt will pop up and look like there is an error message but it is normal if it looks like the image below:
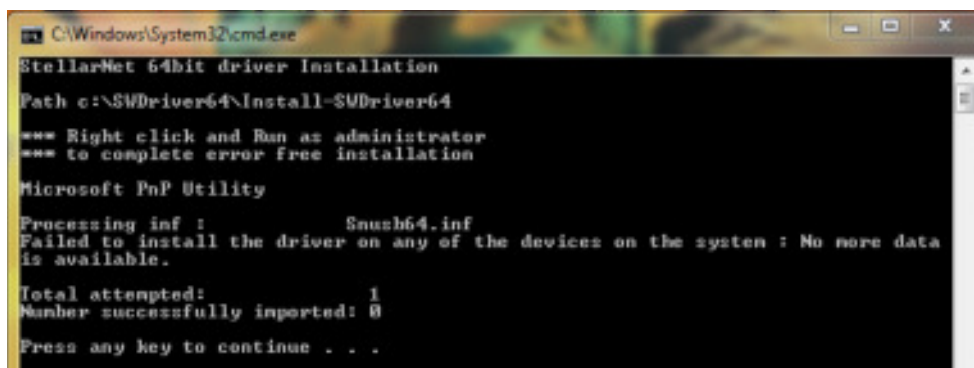
7. Now you need to open Windows Explorer

8. Right click on the start menu and choose "Open Windows Explorer"
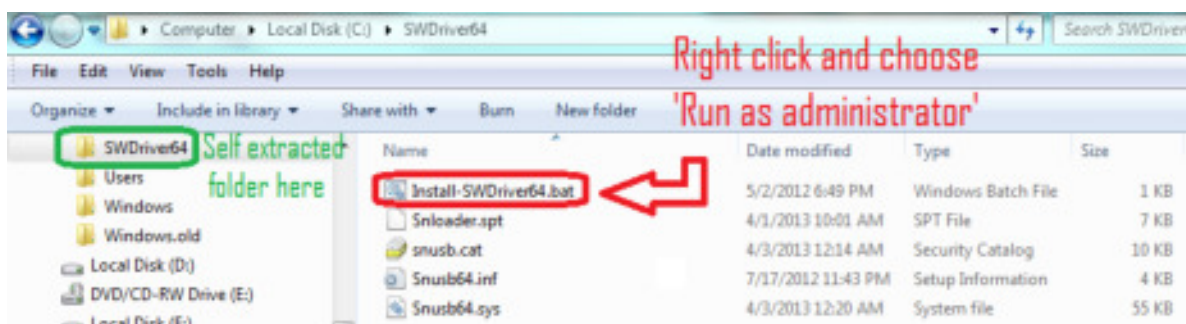
9. In the left-hand panel, scroll down to the C: drive and left click on it to display its contents in the right-hand panel

10. There should be a folder called SWDriver64

11. Open this folder

12. Right click on Install-SWDriver64.bat

13. Choose "Run as administrator"

14. If the spectrometer is not plugged in when you run this file, it will say this:

15. If you plug in the USB for the spectrometer into a properly functioning USB port, your instrument's green light should turn on.

16. If your green light doesn't turn on after following the above steps exactly, try following the steps again. If the 2nd attempt doesn't work try installing on a different USB port. If you are still having trouble, please contact StellarNet for assistance.

Manual Driver installation for 32-bit system (also works on 64-bit)

Select *my computer* → *properties* to verify you have a 32-bit operating system.

- Make sure you right click on the SWDrivers.zip file on our website and save it to your desktop.

- Unzip it/extract it to your desktop by right clicking and choosing extract or unzip.

- The procedure will vary for each version of windows but the driver must be installed manually from the Windows Device Manager. To find the device manager you can usually find under the icon view of the Control Panel.

- With the spectrometer plugged in, find the "Unknown" device under the USB section, right click and choose "Update Driver." Do *not* pick the option which searches automatically.
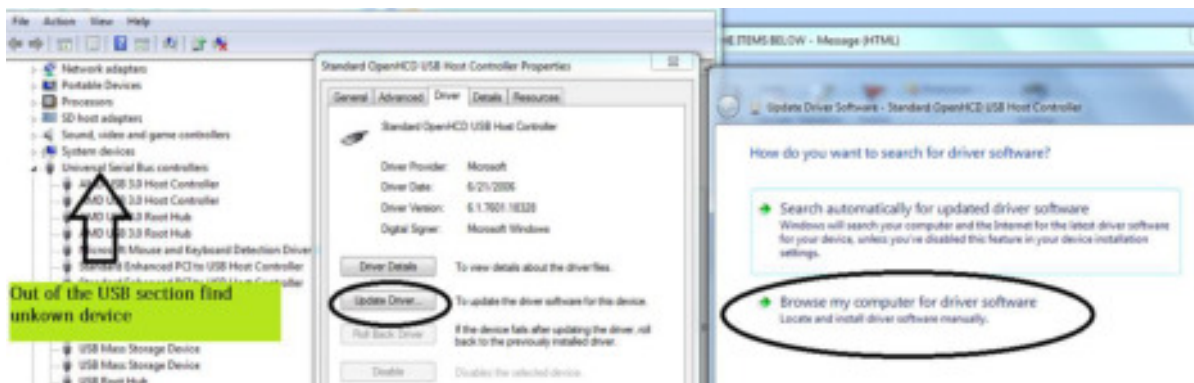
- Do pick the option which appears to manually search in a specific location or a deeper option may appear which says "Have Disk." For all modern spectrometers, the file is C:\Users*(YOUR NAME)*\Desktop\SWDrivers13\SWDrivers-USB2-Spectrometers\
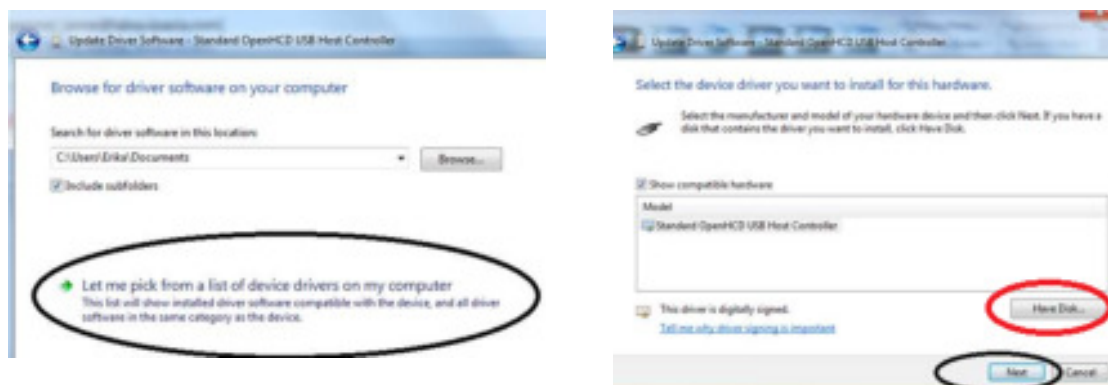
Software Installation

32-bit and 64-bit Windows Vista/7/8/10

After you have installed the correct driver you can proceed with installing the SpectraWiz Software on your computer.

Install the SpectraWiz Software by running the "SWUpdate-Install.exe" as Administrator. This is located in the StellarNet Software folder. A quick start desktop icon will appear.

1. Install latest version of SpectraWiz using SWUpdate.exe from StellarNet website. Click on SpectraWiz desktop icon to start, then verify continuous spectral graph display updates appear with spectrometer attached, then exit SpectraWiz.

2. Install intensity calibration files for SpectroRadiometer operation

   a. The calibration files are installed by clicking USB drive:\MyCal-nnnnn.exe where "nnnnn" = spectrometer serial # shown on label. This self-extracting zip file moves all ".cal" files (if you ordered more than one) to C:\Program Files\StellarNet\SpectraWiz\SwCals

   b. Start SpectraWiz and verify continuous spectral graph display updates appear. Get going FAST →WATCH the SpectraWiz software training videos on the USB-drive!

Additional information

Additional information is available in the Spectrometer Manual on StellarNet USB-drive. For StellarNet technical support, Phone: 813-855-8687 or email: Contactus@StellarNet.us

All spectrometers automatically load parameters from unit memory when SpectraWiz software is started from your windows computer.

Older spectrometers with parallel port connector plus USB2EPP cable (silver DB25 connector at other end of USB2 cable) require parameters to be entered the first time a unit is attached. Please contact StellarNet technical support for more information.

Troubleshooting Installation

Feel free to ContactUs@StellarNet.us for technical support. If you experience any trouble installing your instrument on your computer, please include the serial number and model name of your spectrometer in your inquiry. A StellarNet support representative will be assigned to your case and typically provide a response within 24 hours.

SpectraWiz Quick Start Guide

Connect spectrometer and computer

Connect the spectrometer and the accessories to be used to your computer with previously installed spectrometer drive and SpectraWiz software. Turn them on. The spectrometer's green light should be on if the drivers have been installed correctly. Refer to setup diagrams found at
https://www.stellarnet.us/wp-content/uploads/SpectroSetups.pdf

On your PC, navigate to SpectraWiz software and open.

Toolbar Icons

File open

- Click to open saved file, this is the same as menu, File->Open->Sample

Save sample spectrum

- Click to save the spectra, this is the same as menu File →Save →Sample (to disk

Print graph

- Left click to print graph.

Snapshot spectra

- Left click here to freeze graph trace; Left click again to resume; Right click to copy graph to Windows clipboard

Save dark spectrum (used for Absorbance, Transmittance, and Irradiance modes).

- Left Click after turning off light source;

- Right Click to release previous dark (zero)

Save reference spectrum (used for Absorbance and Transmittance modes).

- Left Click after turning light on without sample in place or with white reference.
- When viewing Irradiance → watts per square meter, clicking here starts the UV monitor application.

Move Data Cursor Left

Move Data Cursor Right

- After placing the data cursor (by pointing and clicking the right button), each subsequent click, using the left button, will move 1 pixel in direction selected. To remove data cursor click to left of graph. Clicking the right button on these icons will seek to the next peak in the selected direction, and place the data cursor there.

Zoom wavelength

- A reminder on how to X- and Y-zoom.
- Left click here again to un-zoom.
- Left click on the left side of graph to un-zoom.
- Right click to enable Y-zoom mode.

Re-scale Y axis

- Left click to auto scale Y-axis.
- Right Click to undo auto scale Y-axis.
- Also use View →Y set scale menu to override auto scale with selected scale.

Compute Area

- Left click to show the AreaPSD, Centroid, Peakwave, FWHM, and Centbase of a peak. If the data cursor is not on a peak, the icon will seek to a peak in the closest direction.
- Right Click to start dual data cursor measurement as outlined below.
- This information is printed in the graph title (concatenated to end of line) when printing a graph.

Auto-Integration

- Left Click to automatically adjust detector integration time and averaging using reference light source in scope mode

 Detector Integration Time

- Left click to set detector integration time

Integration Time Bar

- Slide bar with mouse to manually configure the integration time.

- Moving the bar to the left, decreases the integration time.

- Moving the bar to the right, increases the integration time.

Application Icons

 Solar Monitor

- Starts Solar/UV light monitor Application

 CIE Color Measurement

- Starts CIE color measurement Application

 ChemWiz Chemistry

- Starts ChemWiz Chemistry Application

Click on these words to quickly switch modes; this is equivalent to selecting the View menu options:

- Scope = View → Scope mode
- AU   = View → Absorbance
- %T:R = View → Transmission (or reflectance)
- Watts = View → Radiometer -> watts
- Lux = View → Radiometer -> Lumen
- Solar/UV = Application → Light Monitor (Solar/UV)
- Color   = Application → CIE Color Measurement
- Chem   = Application → ChemWiz Methods

Status Bar

Observe the system indicators appearing below the graph in the status panel.


```
SCOPE-> Wave:903.86nm Pix:1050 Val: 0.000 Time:30ms Avg:10 Sm:1 Sg:0 Tc:off Z Xt:3 Ch:1
```

- **SCOPE:** Currently selected mode (also TRANS/ABSOR/REFS/IRRAD)
- **Wave:** Wavelength at the data cursor location
- **Pix:**   Location of the data cursor (0-2050 pixels)
- **Val:**   Magnitude/value at the data cursor
- **Time:** Detector integration period in milliseconds (ms)
- **Avg:**   Number of samples averaged
- **Sm:**   Pixel smoothing
- **Z:**   An x-axis zoom has been performed
- **Y:**   A Y-rescale or Y-zoom has been performed
- **Y:**   Y-zoom mode has been enabled
- **Tc**:   Temperature compensation on/off
- **Xt:**   XTiming resolution control selected
- **Ch:**   Shows which channel is selected

SpectraWiz File Menu

- **Save:** Save current spectra sample data to disk file
- **Open:** Open spectra file for graph display & print
- **Print Setup:** Allows page layout selections for graph
- **Print:** Print current graph sample data to print device
- **Exit:** Terminate SpectraWiz program

SpectraWiz Setup Menu
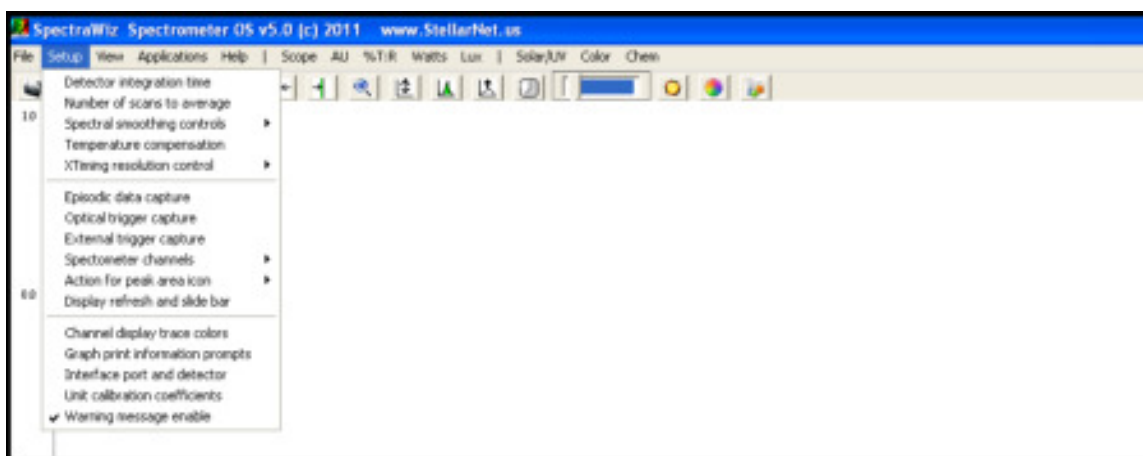
- **Detector integration time:** Sets new detector integration period
- **Number of scans to average:** Y axis smoothing improving S/N ratio
- **Spectral smoothing controls:** X axis smoothing improving S/N ratio
- **Temperature compensation:** Periodic baseline shift compensation
- **XTiming resolution control:** Selects modes for Standard/Extended
- **Episodic Data capture:** Collect spectral data over time

- Optical Trigger: Select wavelength and trigger level
- Spectrometer channel: Enable drift correct or mapping
- Actions for peak icon: Auto find and continuous mode
- Display Refresh rate: Scan request speed
- Channel display trace: Color selections
- Graph Print Info Prompts: Allows customization of title line
- Interface Port and detector: Hardware setup for instrument
- Unit cal coefficients: Setup for wavelength readout

Detector integration time

- Warning message Enable: Disable/enable new dark save needed

This should be adjusted for each experiment to maximize the detector output and signal to noise ratio. The integration time is reported in the status bar message at the bottom of the graph (as Time: xx milliseconds). The toolbar slide bar can be used to dynamically set the appropriate level without

## Number of scans to average (1…999)

saturating at the graph top.

Sets the number of spectra to signal average. Please note that the real-time display is updated AFTER these numbers of spectra have been acquired. This option provides a smoothing in the Y-axis, effectively increasing the system signal to noise by the square root of the number of scans being averaged. Set the averaging to the highest number tolerable when there is sufficient light signal and the detector integration time is short. Even when you have a moderate level of signal, it is best to wait a few seconds to improve the measurement quality.

Recommendations:

Integration Time	Sample Average
1-100 ms	10
100-500 ms	5
500+ ms	3

SpectraWiz View Menu
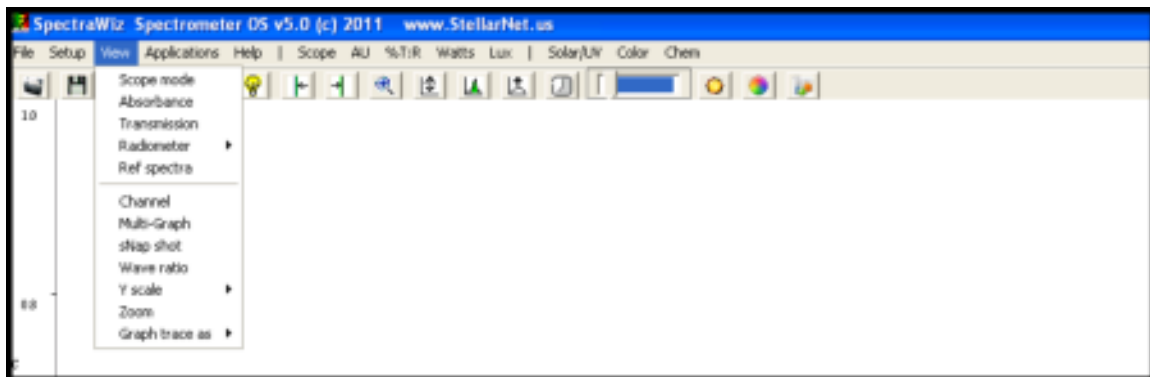
- Scope mode: Displays uncompensated/relative spectral data

- Absorbance mode: Requires dark & reference for AU

- Transmission mode: Requires dark & reference for %T also used for reflectance, etc....

- Irradiance mode: Requires dark & Displays Watts, Micro-Watts, Lumens, Moles, fc

- Ref spectra: Display of reference spectra minus dark

- Channel: Switches between multiple spectrometers when connected

- Multi-Graphs: Display all channels on one spectral graph

- Snapshot: Freeze display or run in real-time

- Wave Ratio: Select 2 wavelengths for ratio display

- Y scale: Setup max y-axis or set Y to log scale

- Zoom: X- and y-axis area to be displayed

- Graph Trace as: Overlay, 1st, or 2nd Derivative, and more options

SpectraWiz Applications Menu
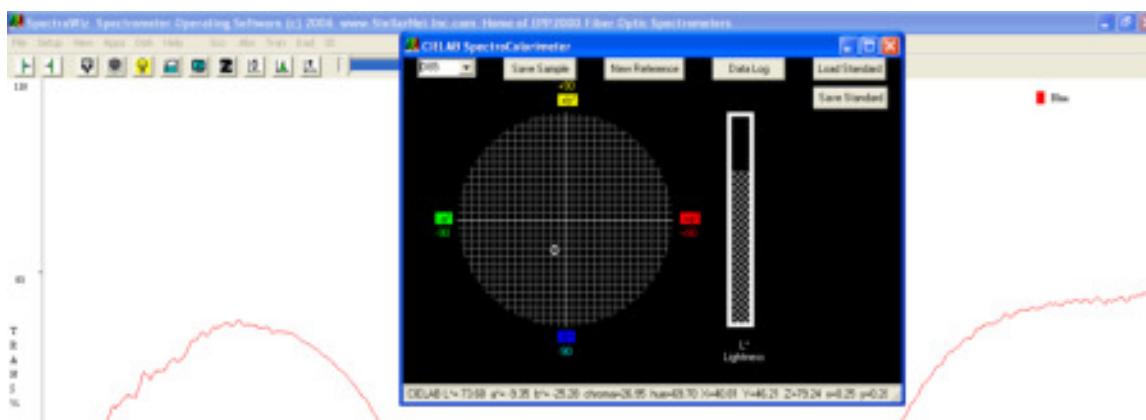
- CIE Color Monitor: For SpectroColorimeter

- Light Monitor: For UVabc and Solar measurements

- Irradiance Calibration: For SpectroRadiometer calibration

- ChemWiz Methods: For single wavelength Chemical concentrations

- ChemoMetric Predictor: For multi-component %c or IDs >requires builder

- Neural Net Predictor: For multi-component %c or IDs >requires trainer

- Spectral ID: For elemental identification (used with Porta-LIBS)

Permission Settings, File Extensions, and Locations

Run as Administrator

SpectraWiz software and the StellarNet drivers are located in your->

<mark>C:\Program Files\StellarNet\SpectraWiz</mark> directory and often need to be accessed by running as administrator. Be sure you have proper administrative settings turned on for successful access.

Virtual Directory

Some versions of Microsoft create a virtual directory when NOT running as administrator located->

<mark>C:\Users\yourcomputername\AppData\Local\VirtualStore\Program Files\StellarNet\SpectraWiz</mark>

File Extensions

- SSM = SCOPE mode file
- TRM = Transmission mode file
- ABS = Absorbance mode file
- IRR = Irradiance mode file
- EPX = Episodic mode file
- .cal = Calibration mode file
- .icf = Irradiance Calibration File = Calibration mode file in use
- sw.ini = main software settings configuration file

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Quickstart Guides for Modular Systems

Introduction to Modular Systems

StellarNet's lines of compact and modular spectrometers are ideal for a variety of different applications. Customer can purchase one spectrometer and perform many types of measurements. Our modular spectrometer's versatility is one of their largest benefits. In the quickstart guides to follow, we will provide a setup diagram of components as well as preliminary instructions on how to perform the measurements. Likewise we will include some useful considerations and pointers for a beginner with our systems.

If you ever have interest in performing another type of measurement that wasn't your initial intention contact one of our spectroscopy experts to see what additional components you may need.

Spectroradiometry

Many SpectroRadiometric measurements are similar but many require different instrumentation setups and calibrations. Please review calibration file installation section found in Chapter 2 before proceeding with the following quickstarts.

LED Measurement

1. Review the spectrometer system setup. Make sure that the spectrometer system resembles the diagram to the right.

2. Turn on your LED or device to be tested and look at its raw signal in SCOPE mode.

3. In SCOPE mode set the integration time so that your spectrum is not saturated but as close to 65,000 counts as possible. Click on the **integration time** icon or use **sliding scale** . A signal with a flat top indicates that you are saturating the detector and should decrease your integration time. If you do not see any signal increase your integration time until you do.

StellarNet LED Measurement System consisting of Black Comet spectrometer, F600-VISNIR fiber, IS6 6" integrating sphere, & a RAD-FLUX calibration service.

4. In SCOPE mode choose your favorite settings such as spectral smoothing controls or samples to average. A pixel box car set to 3 and averaging set to 5 often gives nice results.

5. Now, cover or turn off your LED. Wait several collection cycles and hit the **dark light bulb** icon in the toolbar at the top of the screen. You will see your baseline drop to zero.

6. Click on Watts mode to see your LEDs spectral curve and power output. Click CIE Color Measurement icon or from the Applications Menu to see colorimetric values.

> **Warning:** If your system saturates at all integration times or you need to reduce your exposure time <15ms to get a signal, then you must use a CR2-Aperture (CR2-AP) or inline neutral density filter to reduce light intensity to your system's detector. There are other possible solutions as well. Please contact a StellarNet technical sales associate to choose which solution is best for your application. For Radiometric applications it is recommended to use exposure times >15ms.

Solar & Grow Lamp Analysis

1. Review the spectrometer system setup. Make sure that the spectrometer system resembles the diagram on the right.

2. Turn on your Grow Light or point your CR2 towards the sun initially to see its raw signal in SCOPE mode. For solar applications try to make sure you do this initial setup when the sun is at its brightest and there are no clouds.

3. In SCOPE mode set the integration time to 90% of full saturation or approximately 60,000 counts. Click on the **integration time** icon or use **sliding scale**. A signal with a flat top indicates that you are saturating the detector and should decrease your integration time. If you do not see any signal increase your integration time until you do.

StellarNet SolarRAD System consisting of Black Comet spectrometer, F600-VISNIR fiber, CR2 or CR2 Right Angle, & an IRRAD-CAL Irradiance calibration service.

4. In SCOPE mode choose your favorite settings such as spectral smoothing controls or samples to average. A pixel box car set to 3 and averaging set to 5 often gives nice results.

5. Now, cover or turn off your grow light or cover your CR2's active surface. Wait several collection cycles and hit the **dark light bulb** icon in the toolbar at the top of the screen. You will see your baseline drop to zero.

6. Click on Watts mode to see your Grow Lamp/Solar spectral curve and power output. Click CIE Color Measurement icon or from t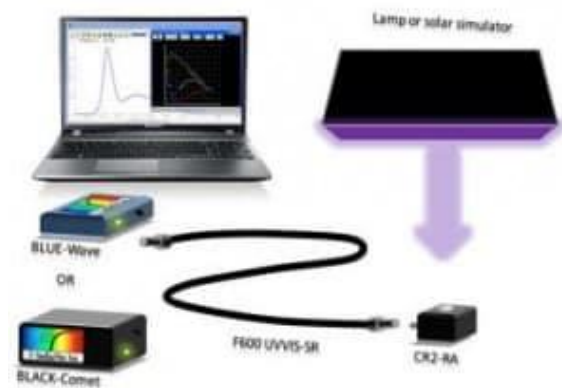he Applications Menu to see colorimetric values. Click the Solar Monitor icon to start the Solar Match & UV monitoring applications.

Warning: If your system saturates at all integration times or you need to reduce your exposure time <15ms to get a signal, then you must use a CR2-Aperture (CR2-AP) or inline neutral density filter to reduce light intensity to your system's detector. There are other possible solutions as well. Please contact a StellarNet technical sales associate to choose which solution is best for your application. For Radiometric applications it is recommended to use exposure times >15ms.

Display Measurement

1. Review the spectrometer system setup. Make sure that the spectrometer system resembles the diagram to the right.

2. Turn on your Display, Monitor, or Backlit LED. Display Measurements require RAD-CAL Radiance calibrations for results in W/m^2/sr or Cd/m^2.

3. In SCOPE mode set the integration time to 90% of full saturation or approximately 60,000 counts.

   Click on the **integration time** icon ⬛ or use **sliding scale** ▬▬. A signal with a flat top indicates that you are saturating the detector and should decrease your integration time. If you do not see any signal increase your integration time until you do.

StellarNet Display Measurement System consisting of Black Comet-TEC or SILVER-Nova spectrometer, F600-VISNIR fiber, CRLENS, & RAD-CAL Radiance calibration service.

4. In SCOPE mode choose your favorite settings such as spectral smoothing controls or samples to average. A pixel box car set to 3 and averaging set to 5 often gives nice results.

5. Now, cover or turn off your Display or cover your CRLENS. Wait several collection cycles and hit the **dark light bulb** icon 💡 in the toolbar at the top of the screen. You will see your baseline drop to zero.

6. Click on Watts mode to see your Display's spectral curve and power output. Click CIE Color Measurement icon 🎨 or from the Applications Menu to see colorimetric values.

Warning: If your system saturates at all integration times or you need to reduce your exposure time <15ms to get a signal, then you must use a CR2-Aperture (CR2-AP) or inline neutral density filter to reduce light intensity to your system's detector. There are other possible solutions as well. Please contact a StellarNet technical sales associate to choose which solution is best for your application. For Radiometric applications it is recommended to use exposure times >15ms.

Laser Monitoring

1. Review the spectrometer system setup. Make sure that the spectrometer system resembles the diagram to the right.

2. Laser monitoring is one of the easiest applications for a StellarNet system. Simply shoot your laser into a entrance diffuser such as the CR1-UVN and couple to your spectrometer.

3. In SCOPE mode you will see you laser's spectral profile and be able to use our peak tool icon to calculate AreaPSD, Centroid, Peakwave, FWHM, and Centbase of a peak.

4. If you have a high power laser it is advised to use more entrance diffusers and a small detector exposure time and slowly remove diffusers and increase your detector exposure time.
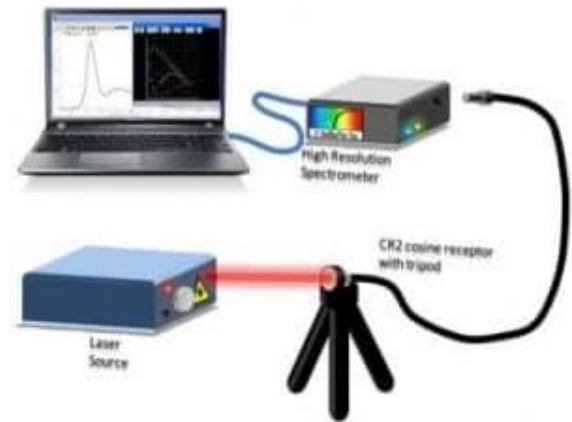
StellarNet Laser Monitoring System consisting of a High Resolution (HR) spectrometer, F600-VISNIR fiber, and CR1-UVN diffuser.

Plasma Optical Emission Spectroscopy

1. Plasma monitoring can also be a very simple application which typically only requires a spectrometer and an optical fiber collecting the signal.

2. Add Lens-Col to the end of your optical fiber to collect more light to your spectrometer and collect light from a small spot.

3. Add Jack-in TTL trigger to enable a spectrometer scan.

Color Measurement

1. Review the spectrometer system setup. Make sure that the spectrometer system resembles the diagram to the right. With the instrument and accessories connected, open the SpectraWiz program.

2. In SCOPE Mode; adjust the integration time, number of scans to average, and XTiming resolution control.

3. With the light source off, and no sample under the probe, wait several collection cycles and hit the **dark light bulb** icon [icon] in the toolbar at the top of the screen. You will see your baseline drop to zero.

4. Place the RS50 White Reflectance Standard under the probe and turn on light source; **Take the** *light reference* by clicking on the **yellow light bulb** icon [icon] in the toolbar at the top of the screen.

5. Enter into Transmission Mode and place sample under probe.

6. Begin collecting data. Click CIE Color Measurement icon [icon] or from the Applications Menu to see colorimetric values.
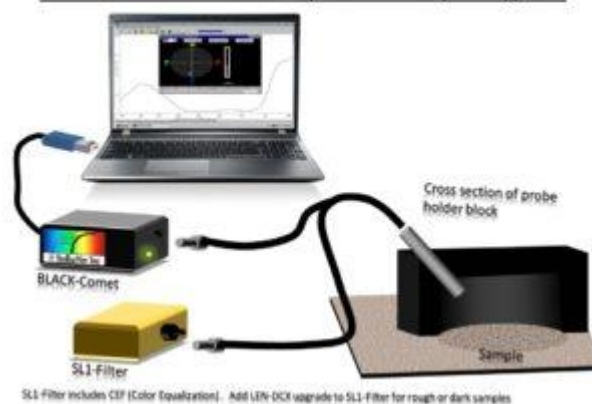

Color Measurement System Setup Diagram

Cross section of probe holder block

BLACK-Comet

SL1-Filter

Sample

SL1-Filter includes CEF (Color Equalization). Add LEN-DCX upgrade to SL1-Filter for rough or dark samples

StellarNet Color Monitoring System consisting of a BLACK-Comet or BLUE-Wave spectrometer, SL1-Filter, R600-8-VISNIR reflectance probe, Rs50 white standard, RPH probe holder, and SpectraWiz Software.

Chemical Absorbance Measurement

Spectrometer Setup

1. Review the spectrometer system setup. Make sure that the spectrometer system resembles the diagram to the right.

2. Remove the cuvette holder cap. Place your **blank** cuvette into the cuvette holder and replace the cuvette holder cap.

3. Turn on the computer. Open the StellarNet software by double clicking on the desktop icon *SpectraWiz* to open the application.

4. When you first open the software, you should see a screen similar to the one below:
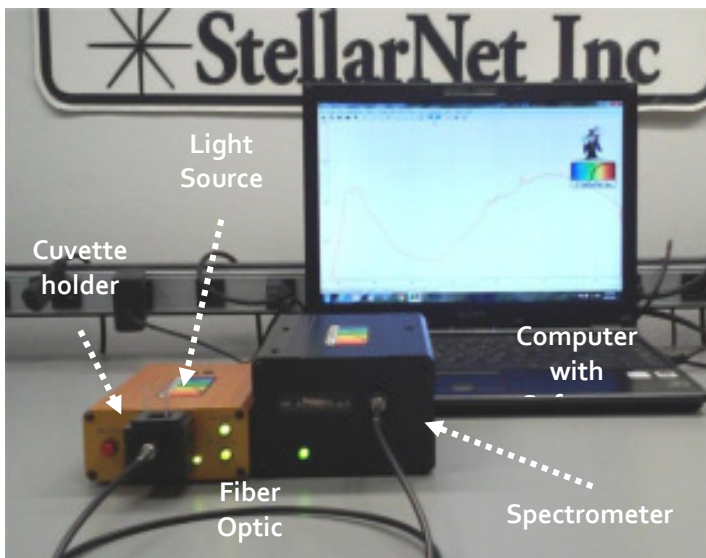
StellarNet spectrometer system (Black Comet spectrometer and SL5-CUV deuterium and halogen light source)
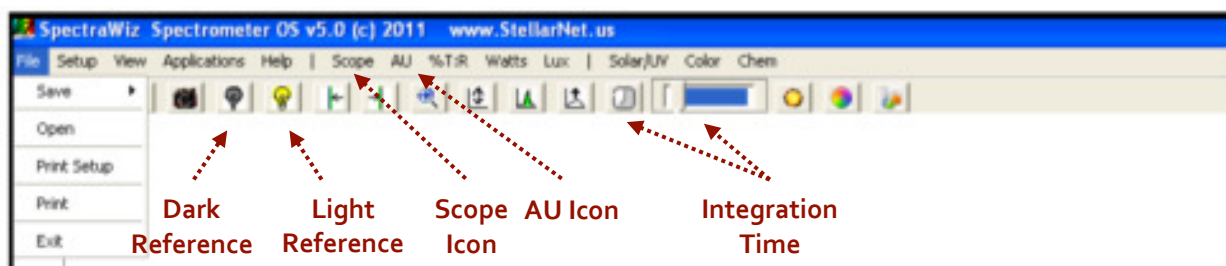
5. Click on the **Scope** icon. This will show you the number of counts (photons) the detector receives. You should see a spectrum of counts versus wavelength.

6. Set the integration time so that your spectrum is not saturated but as close to 65,000 counts as possible. Click on the **integration time** icon (and type in a value between 1 and 1000 ms) or use **sliding scale** .

   In the picture to the right, the spectrum is correctly optimized to be right below the saturation limit (65,536 counts). If a portion of the spectrum is off the screen reduce the integration time.

Saturation Limit

(65,536 Counts)
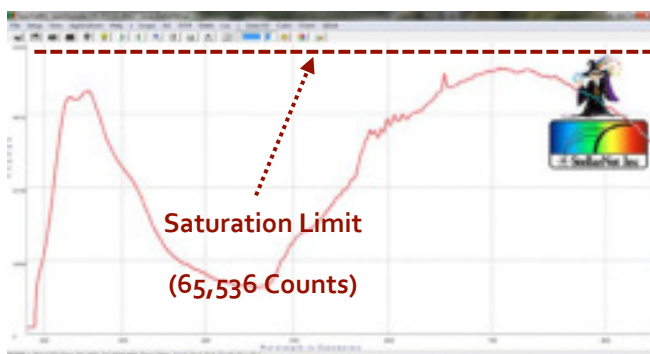
Dark and Light References

Red shutter button

1. Make sure that your **blank cuvette** is in the cuvette holder and the cap is on the cuvette holder. **Take the *light reference*** by clicking on the **yellow light bulb** icon 💡 in the toolbar at the top of the screen.

2. **Take the *dark reference***. First, hold the red shutter button for at least three seconds. You should see the spectrum fall flat everywhere on your graph (A).

   Second, while still holding the shutter button, click on the **dark light bulb** icon 🔲 in the toolbar at the top of the screen. The baseline will drop to zero (B).

   Finally, you can release the shutter button. You should see the spectrum return to its original profile.

3. Now that you have taken the dark and light reference, click on the **AU (absorbance)** icon in the toolbar at the top of the screen to display a spectrum in absorbance units.

4. You should see a nearly flat absorbance spectrum once you switch to absorbance if you have blanked and zeroed the spectrometer correctly.

> Depending on the cuvettes you use, you may see fluctuations below 300 nm. This is simply due to the cuvette absorbing UV radiation at these wavelengths.

A: Spectrum after holding shutter button

B: Spectrum after taking the dark reference
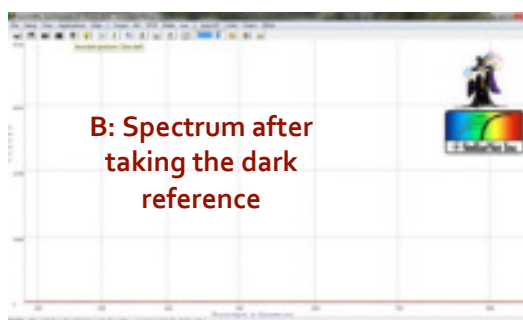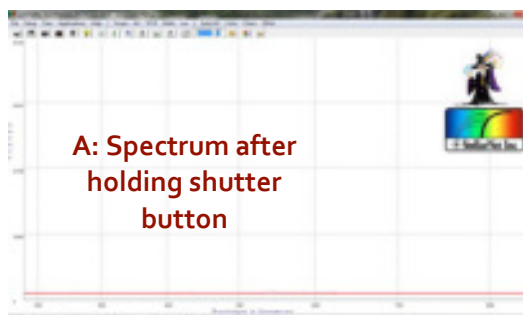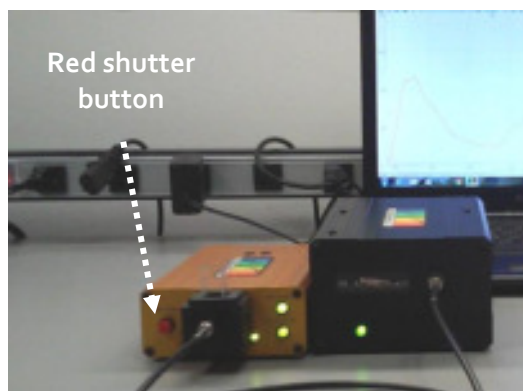
Taking Absorbance Measurements

1. Remove your blank sample from the cuvette holder. Place the most concentrated standard cuvette in the holder and replace the cuvette cap. The instrument will now display absorbance in real time.

2. Look at the spectrum and select the wavelength of maximum absorbance.

3. To find a peak, use the mouse to **right click** on either of the following icons:

The left arrow will find a peak to the left of the vertical line in the spectra. The right arrow will find a peak to the right of the vertical line in the spectra.
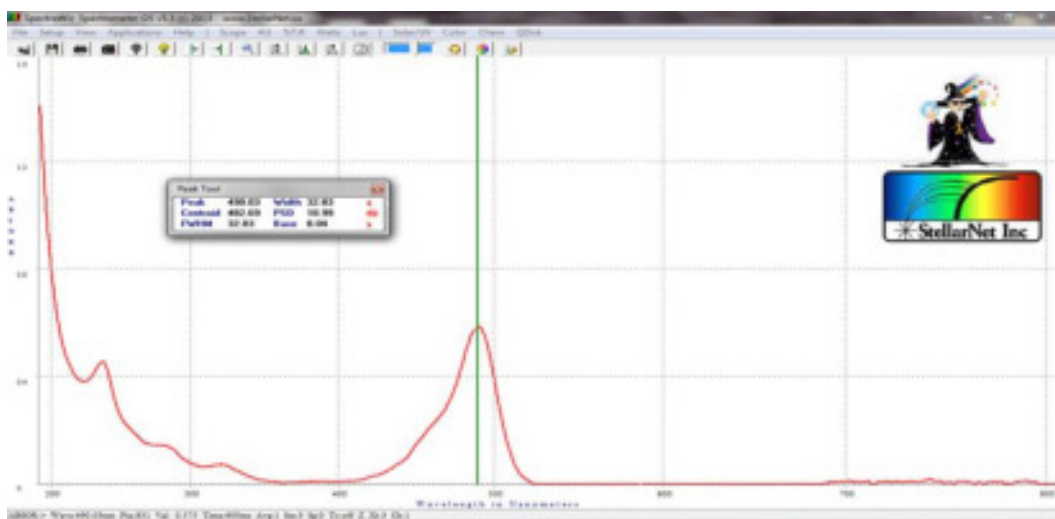
4. You can also **right click** directly onto the spectrum to find the absorbance of a specific point. To find the specific wavelength your cursor is at, look to the bottom of the spectrum. **Wave** gives the specific wavelength and **Val** gives the absorbance for that particular point in the spectrum.

SCOPE-> Wave:684.48nm Pix:1129 Val:295.525 Time:1000ms Avg:1 Sm:2 Sg:0 Tc:off Xt:3 Ch:1

Fluorescence Measurement

Spectrometer Setup

1. Transfer your standard cuvettes to the spectrometer. Make sure that your cuvettes are capped so you don't accidently spill solution on or near the spectrometer.

2. Review the spectrometer system setup. Make sure that the spectrometer system resembles the setup below. Make sure that you can identify all the components of the spectrometer system.
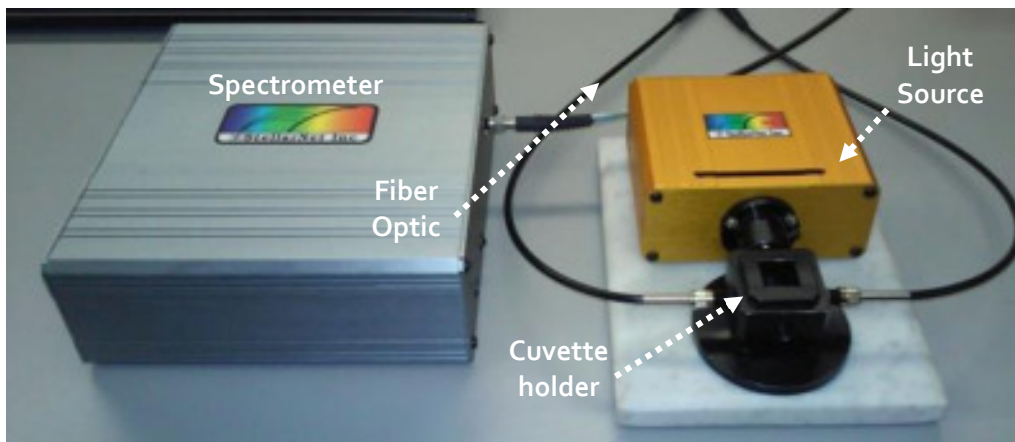
3. Turn on the computer. Open the StellarNet software by double clicking on the desktop icon *SpectraWiz* to open the application

4. When you first open the software, you should see a screen that looks like:
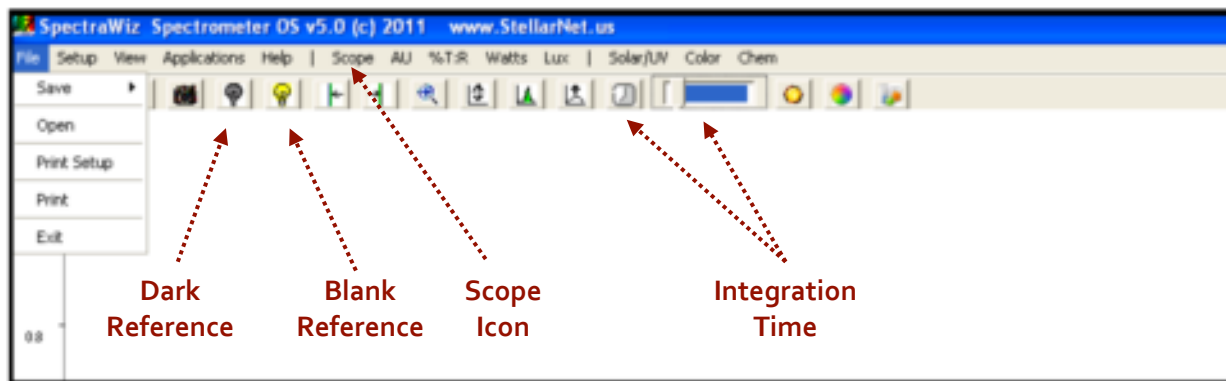
5. Click on the **Scope** icon (highlighted above). This will show you the number of counts (photons) the detector receives. You should see a spectrum of counts versus wavelength.

6. Remove the cuvette holder cap. Place your **most concentrated standard** cuvette into the cuvette holder and replace the cuvette holder cap.

7. Set the integration time so that your spectrum is not saturated but as close to 65,000 counts as possible. Click on the **integration time** icon ![integration time icon] (and type in a value between 1 and 1000 ms) or use **sliding scale** ![sliding scale] .

   In the picture to the right, the spectrum is correctly optimized to be right below the saturation limit (65,536 counts). If a portion of the spectrum is off the screen reduce the integration time.

Saturation Limit
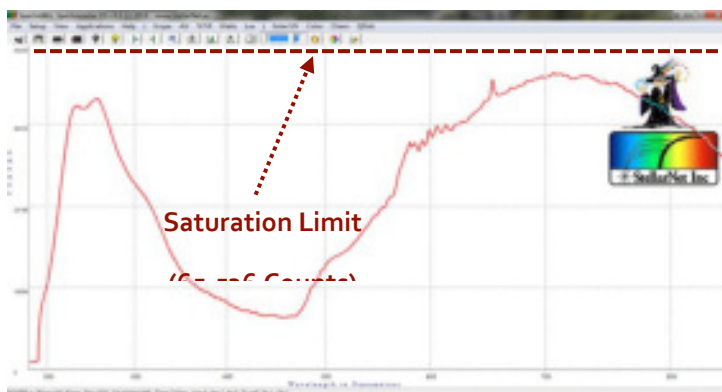
Dark Reference

1. **Take a *dark reference*.** Press the **red button** on the back of the light source (orange box). The button will be pressed in if the LED light is on. If the button is not pressed in then the LED light is off. After several minutes, the baseline will settle (A).

2. Once the baseline has settled, click on the **dark light bulb** icon ![dark light bulb icon] in the toolbar at the top of the

Taking Fluorescence Measurements

screen. The baseline will drop to zero (B).

1. Turn LED light on. Press the **red button** on the back of the light source (orange box). The button will be pressed in if the LED light is on. If the button is not pressed in then the LED light is off.

2. Remove the cuvette holder cap. Place the most concentrated standard cuvette in the cuvette holder and replace the cuvette holder cap.

3. Remain in **Scope** mode. The instrument will now display the photon count (intensity) versus wavelength in real time.

A: Spectrum after turning off LED light

B: Spectrum after taking the dark reference
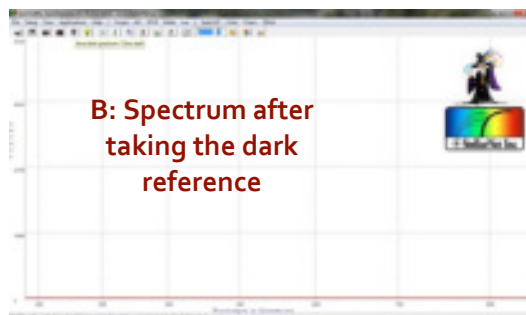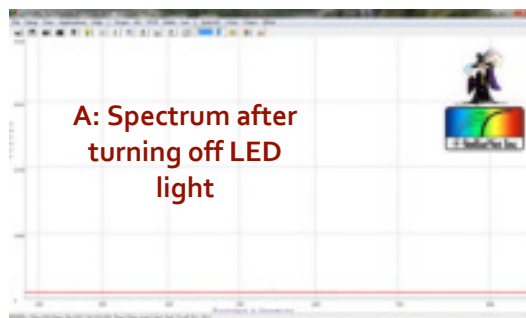
4. To find a peak, use the mouse to **right click** on either of the following icons:

The left arrow will find a peak to the left of the vertical line in the spectra. The right arrow will find a peak to the right of the vertical line in the spectra.
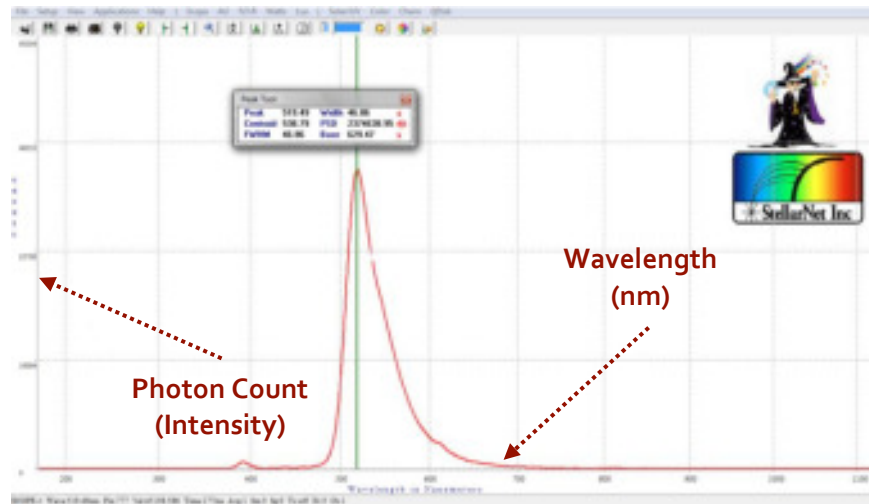

5. You can also **right click** directly onto the spectrum to find the photon count of a specific wavelength. To find the specific wavelength your cursor is at, look to the bottom of the spectrum. **Wave** gives the specific wavelength and **Val** gives the photon count for that particular point in the spectrum.

Raman Systems

Spectrometer Setup

1. Review the spectrometer system setup and make sure that the spectrometer system resembles the setup below.

   Top view   *Front view*

   Fiber optic
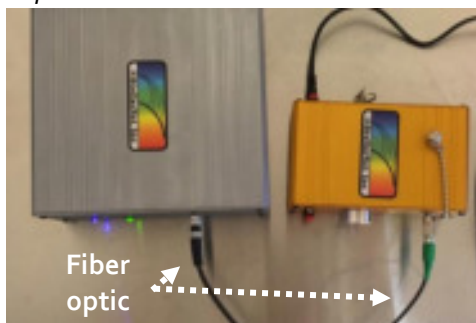
   Spectrometer   Laser

   Make sure the Raman probe fiber optic is securely connected to the laser. While working with this spectrometer never remove Raman probe from the sample holder. **The laser is powerful enough to cause serious eye injury.**

2. Look at the back of the laser. First, make sure the key is not in the laser yet. If you are running the laser **on battery power** push the red button on the back of the laser in. If you are **NOT running the laser on batter power** first make sure the red button on the back of the laser is not pressed in. Then make sure the power adaptor is connected to the outlet on the back of the laser.

   Battery

   Key   Remote   Power
           interlock   outlet

   Key:

   Vertical = OFF   Interlock jack
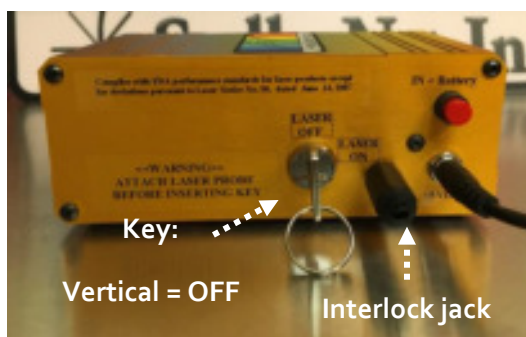
3. Make sure the interlock jack is placed in the remote interlock on the rear panel of the laser.
4. You may now you insert key into OFF (vertical) position.

Taking Raman Measurements

5. You may now enable the laser power by turning the key to the ON (horizontal) position.

1. Load your sample vial may be loaded into the sample holder.

Sample holder
without sample

Sample holder with
sample

2. Turn on the computer. Open the StellarNet software by double clicking on the desktop icon *SpectraWiz* to open the application

3. When you first open the software, you should see a screen that looks like:

Scope
Icon

Integration
Time

Spectral ID
Application
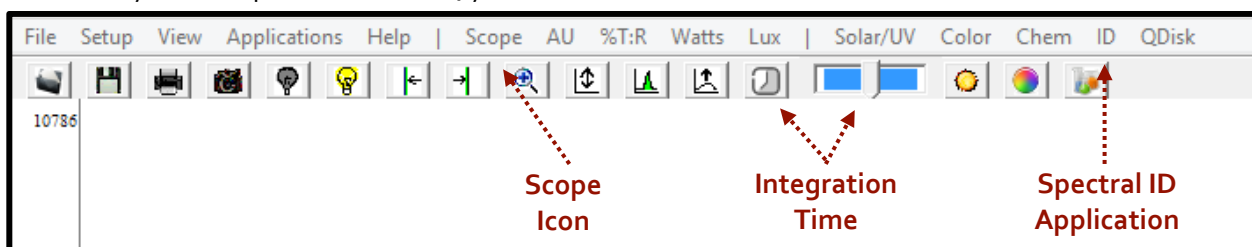
4. Click on the **Setup** dropdown menu and then select the **Raman laser wavelength** and enter the wavelength for the laser (xxx nm).
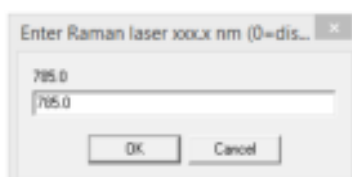
5. Click on the **integration time** icon and increase the exposure time to 5000 ms (5 sec). You may need to increase the integration time depending on your sample.
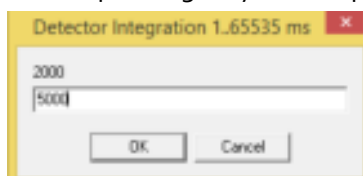
6. Click on the **Scope** icon (highlighted above). This will show you the number of counts (photons) the detector receives. You should see a spectrum of counts versus Raman shifts [cm^{-1}].

7. Click on the **ID** icon to open the Spectral ID application. You should see a panel like:
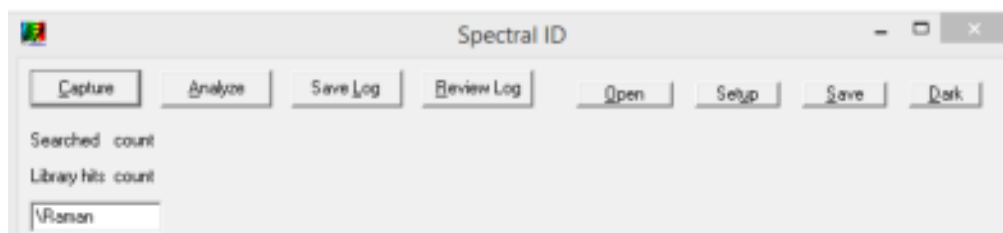
8. Turn the **laser power** to the lowest setting for your first trial spectrum. You should always start with the laser power as low as possible and then slowly increase it.

9. Press and hold left front panel button (marked **Fire Laser**) to fire the laser. The LED bulb next to this button will light up red indicating that the laser is in operation. You should see a spectrum appear on the computer screen in the SpectraWiz software.
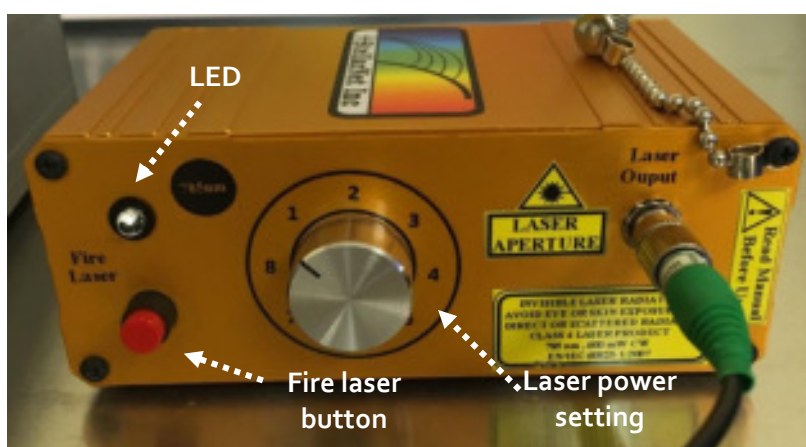
10. While still holding the **Fire Laser** button, click on the **Capture** button on the Spectral ID application to collect the displayed Raman spectrum. You can then release the **Fire Laser** button.
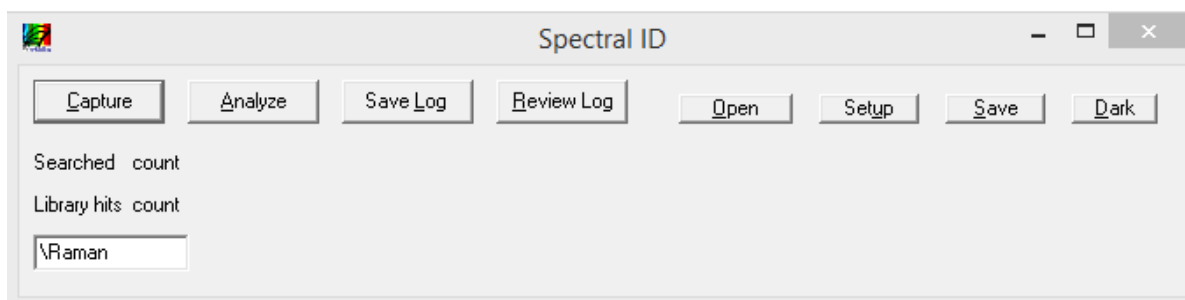
11. Adjust your integration time and laser power setting until you achieve the highest count spectrum without burning the sample.

Building a Spectral Library

1. After you have collected a spectrum you can save it to a spectral library. Click on **Save** to add a spectrum to the library. This spectrum can then be used as a reference to identify unknown compounds in other samples.
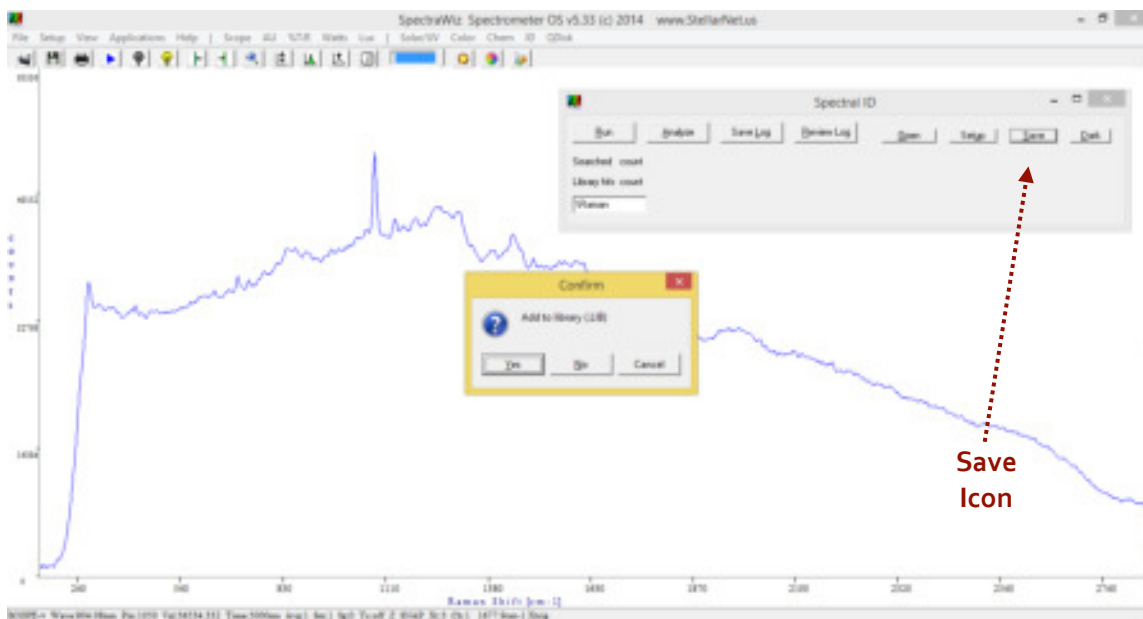
2. Choose a logical name for your sample and save.
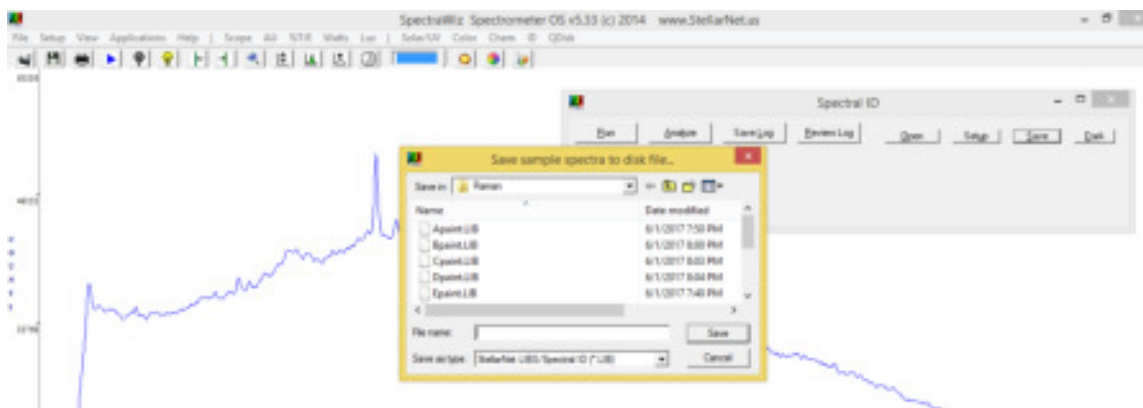
3. After you have added samples to your library you can then use it to identify unknown components in a sample. Obtain a spectrum of your unknown sample (i.e. a painting) and click on the **Analyze** button. This will match the unknown spectrum to spectra in your library. The number next to each match indicates how closely the spectrum in the library matches the unknown spectrum (i.e. 1 indicates a perfect match).

Analyze Icon

Laser Shutdown

1. Once you have collected all of your spectra you can shut the laser down.

2. Make sure to release the **Fire Laser** button and observe that the red LED turns off, which indicates the laser is no longer active.

3. For complete shutdown, turn the key switch on the rear panel to the OFF (vertical) position. This allows key removal and disables ALL power.

Assembling StellarScope Microscope System

StellarScope System

1. Locate all the pieces for the StellarScope Microscope system as shown to the right.

2. Remove Eyepiece: Loosen the eyepiece set screw with a hex key. The set screw is located on the right side of the microscope arm. Carefully remove the eyepiece from the mount.
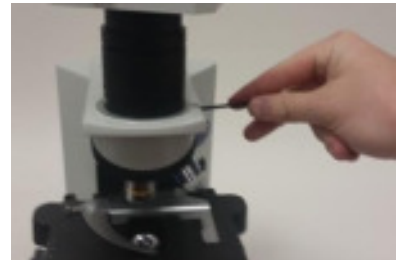
3. Assemble Upper Mount: Loosen the set screw on the U-TLU with hex key, and carefully insert the U-DPCAD. Once inserted, tighten the set screw to secure the U-DPCAD.

4. Attach Mount to Microscope: Carefully place the entire upper mount where the eyepiece was located. Use the eyepiece set screw on the right side of the arm to secure the upper mount in place.

5. Attach the DinoEye Digital Camera to the Upper Mount: The camera port is located on the opposite side of the view mode switch.

6. For more information about coupling your system to the microscope please review our StellarSCOPE Assembly Instructions

Haze Measurement

Assembly and System Overview

The integrating sphere attaches to the base by screwing directly into the 3-inch post. The fixture for the collimating lens will slide over the rail and can be set in place using the thumbscrew provided.

The sample can be mounted to the face cap by loosening the thumb screws and resting the sample on the threads. Tighten the thumbscrews to secure the sample.

The system comes with three caps: one cap for the front of the sphere, and two interchangeable caps for the

Front Cap
Face Cap with Sample Holder

Back Caps
Diffuse Transmission Cap

Total Transmission Cap

Integrating Sphere

Collimating Lens

Adjustable Rail

Fiber Optic to Spectrometer

Fiber Optic to Light Source

Removable Caps
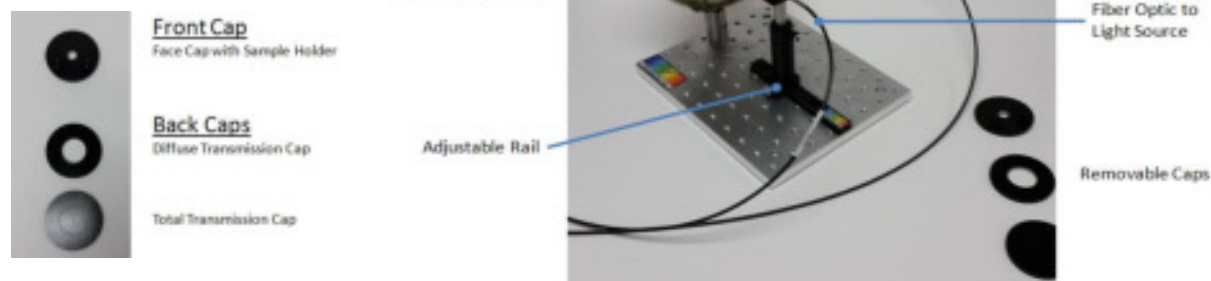
Aligning Light Source and Sphere for Haze Measurements

back of the sphere.

The collimating lens, sample, and sphere are adjustable, and have to be properly aligned in order to achieve accurate values. To properly align the system, remove the sample and illuminate the face port of the integrating sphere. The face cap of the system will have a smaller hole than the diffuse transmission cap.

By adjusting the lens, sphere, and rail setup, you should be able to illuminate a small spot on the back of the sphere.

Attach the *diffuse reflectance cap* to the back of the sphere.

You can use a piece of paper to view the spot size at the back of the sphere.

When properly aligned, the spot from the lens should be slightly smaller than the port at the back of the sphere.
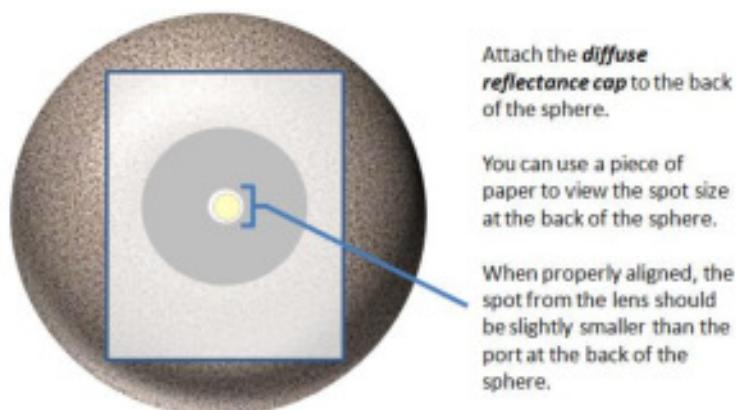
After the sphere is properly aligned, you can begin measurements without any other adjustments.

Haze Software Setup

IMPORTANT: Be sure to read all VBA setup guides before starting the software.

Verify SpectraWiz software is installed and is able to operate on the local computer. Before opening the Haze measurement software, make sure that the SpectraWiz software is closed before opening the Haze software. Open the excel software found on the USB key for Haze measurements.

The software screen will look like this:
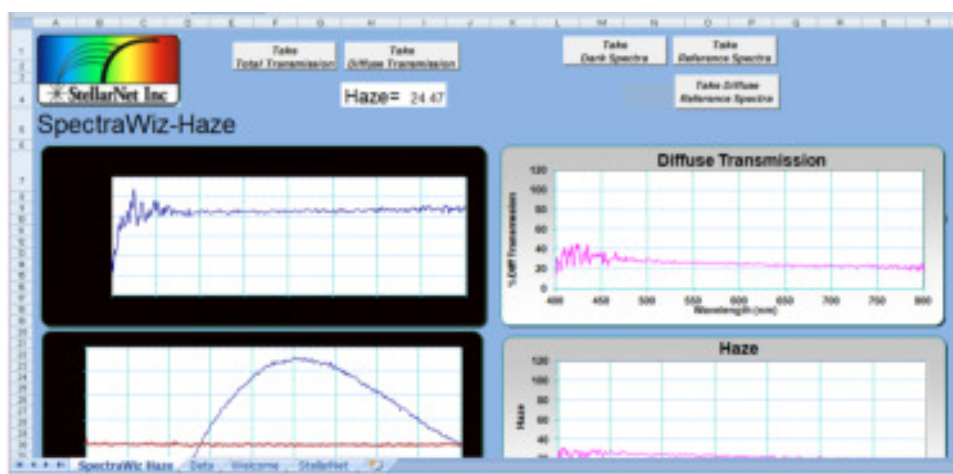
At the bottom of the software screen there will be four tabs:

> ***SpectraWiz Haze:*** Main measurement window

> ***Data:*** Raw data in counts vs wavelength

> ***Welcome:*** General operating tips

> ***StellarNet:*** Setting adjustments (integration time, scans to average, etc.)

Verify that the settings in the StellarNet tab are optimized. Make sure the coefficients loaded match those found on the bottom of your spectrometer. Then switch back to the SpectraWiz Haze tab. After the parameters are set, you can begin taking your measurements.

Measurement Procedure

Haze measurements require a few measurements to be included into a formula and generate a haze value. Once all of the measurements are saved under the data tab, the haze value will be displayed on top of the software screen. Please follow the procedure below for the best results:

1) Take Dark Spectra
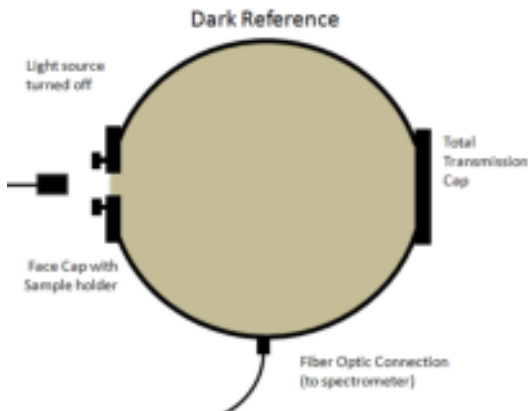
Be sure sample is removed from holder, and that *Total Transmission Cap* is secured on the back of the sphere. Turn off light source and select the *Take dark spectra* button.
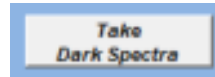
Take Dark Spectra

Note: *Because the software will update a formula in real time, it is not necessary to take a dark spectrum for every sample. A dark spectrum is only necessary when beginning your measurements for the day.*

2) Take Reference Spectra
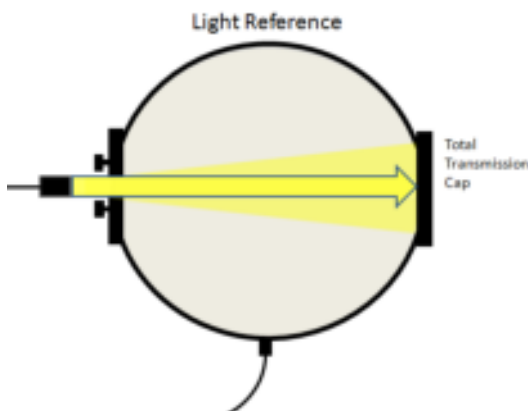
With sample still removed and *Total Transmission Cap* attached, turn on light source. Then select the *Take Reference Spectra* button.

Take Reference Spectra
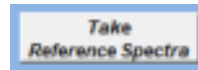
3) Take Total Transmission
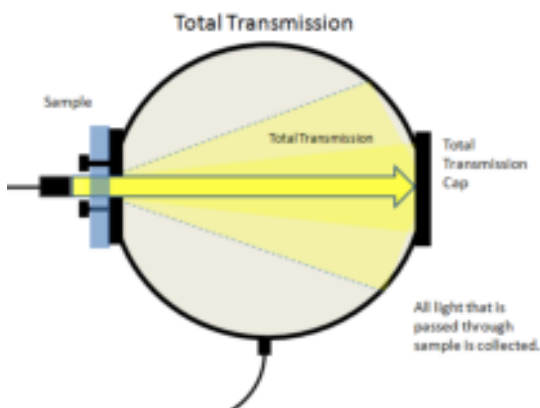
Place sample in sample holder. Make sure the port is properly illuminated and *Total Transmission Cap* is still attached. Select the *Take Total Transmission* button.

Take Total Transmission

4) Take Diffuse Reference Spectra

Diffuse Reference

Diffuse Transmission Cap Attached

Light Trap
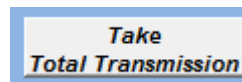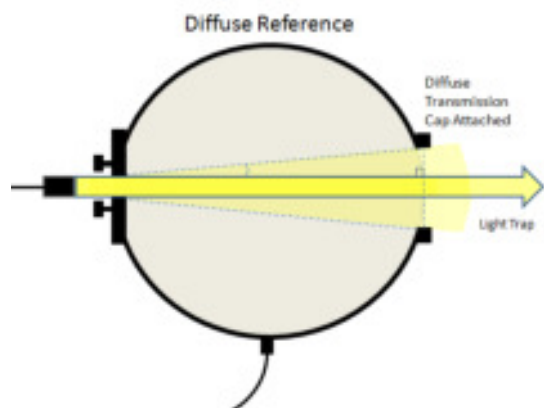
Remove sample, and attach *Diffuse Transmission Cap* to the back of the sphere.

Take Diffuse Reference Spectra

5) Take Diffuse Transmission

Diffuse Transmission

Diffuse Transmission Cap Attached

Diffuse Transmission

Light Trap

Only light that is refracted greater than 5° is collected
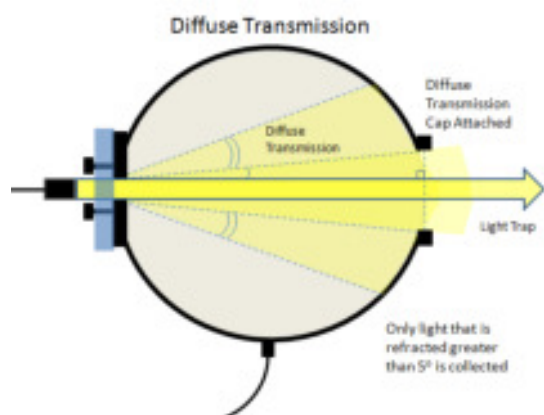
Place sample in sample holder. Make sure the port is properly illuminated and *Diffuse Transmission Cap* is still attached. Select the *Take Diffuse Transmission* button.

Take Diffuse Transmission

After the 5 measurements are taken, the correct value will update on the main screen.

Important Notes:

- Because the software will update a formula (found in the data tab) in real time there are few things to remember:

- The order of measurements is not important. It is only important that **all measurements** (measurements 2-5) are taken **for the specific sample** before you record a haze value. Each value in the formula needs to be updated in order to properly produce a haze value.

- Taking light and dark references should factor out ambient light. However, for the most reliable results, it is ideal to turn off room lighting, and make sure any computer displays are not directly illuminating the sphere.

Thin Film Thickness Measurement

Please refer to our Thin Film System User Guides

Uniform Illumination Sphere – Light Source (UIS-LS)

1. Review the UIS setup. Make sure that the system resembles the Figure.

2. Power Control Module (PCM) supplies power to both the lamp and the fan.

> Warning: Do NOT run the lamp without the fan turned ON. Leaving the lamp on without the fan can cause heat damage to entire system and cause failure & permanent damage

24V Power

Uniform Source Plane Calibration data provided for Radiance (standard) or Irradiance at 2" port hole.

UIS Power Control Module Standard option comes with 9 incremental steps to full power. If not purchased the UIS sphere will still be delivered with gold power box with lamp ON/OFF switch. Also, includes power to cooling fan.

UIS-IRIS Set- For lamp attenuation with constant Color Temperature (K)

3. UIS-IRIS can be added between IS-Lamp housing and integration sphere by screwing in place. IRIS's provide lamp attenuation without changing lamp Color Temperature (K) of the UIS. Make sure the lamp cools down for 3-5 minutes before exchanging IRIS.

4. Spectral calibration data is supplied with each UIS for Radiance (standard) or Irradiance at 2" port hole at the highest power setting. Total Radiance is then included at subsequent lower levels (i.e. with PCM or IRIS's); however, complete spectral curves for lower power levels must be purchased additionally (item: UIS-CAL).

5. <u>Using the UIS</u> – Allow 5 minutes warm up and do not leave the lamp on unattended or for extended periods of time. Use tissue paper or kimwipes when touching the bulb directly to avoid leaving fingerprints.

> The IRIS set, IS-Lamp cap, and UIS all have in internal BaSO4 white high reflective coating. Touch up paint is included with each system order and can also be purchased

Quickstart Guides for Open and Measure Analyzers

Introduction to Open and Measure Analyzers

StellarNet line of rugged StellarCASE systems are integrated portable case systems for material identification and composition analysis using NIR, Raman, and LIBS spectroscopy. They include interior mounting of spectrometer instrumentation pre-configured for "Open & Measure" application, with no additional setup required. With a simple press of the "Analyze" button instantaneous match results or sample % composition can be displayed on your screen.

Each StellarCASE System is delivered with standard StellarNet spectrometer modules and mounted inside of a rugged pelican case. The Systems contain an internal main power control system with ON, OFF, & Charge buttons. Additionally, there is a USB Hub which you can connect a mouse OR USB storage device. Each system comes with a mounted tablet with pre-installed SpectraWiz Software and is tested with sample verification standards prior to shipment. The systems are ready for use as soon as they arrive at your facility. Please review the system diagrams below to understand system powering, buttons, and safety features. For software tutorials please review our StellarNet Manual and Tech Support Webpage http://www.stellarnet.us/stellarnet-technical-support-online/ and YouTube Channel.

StellarCASE-Raman™
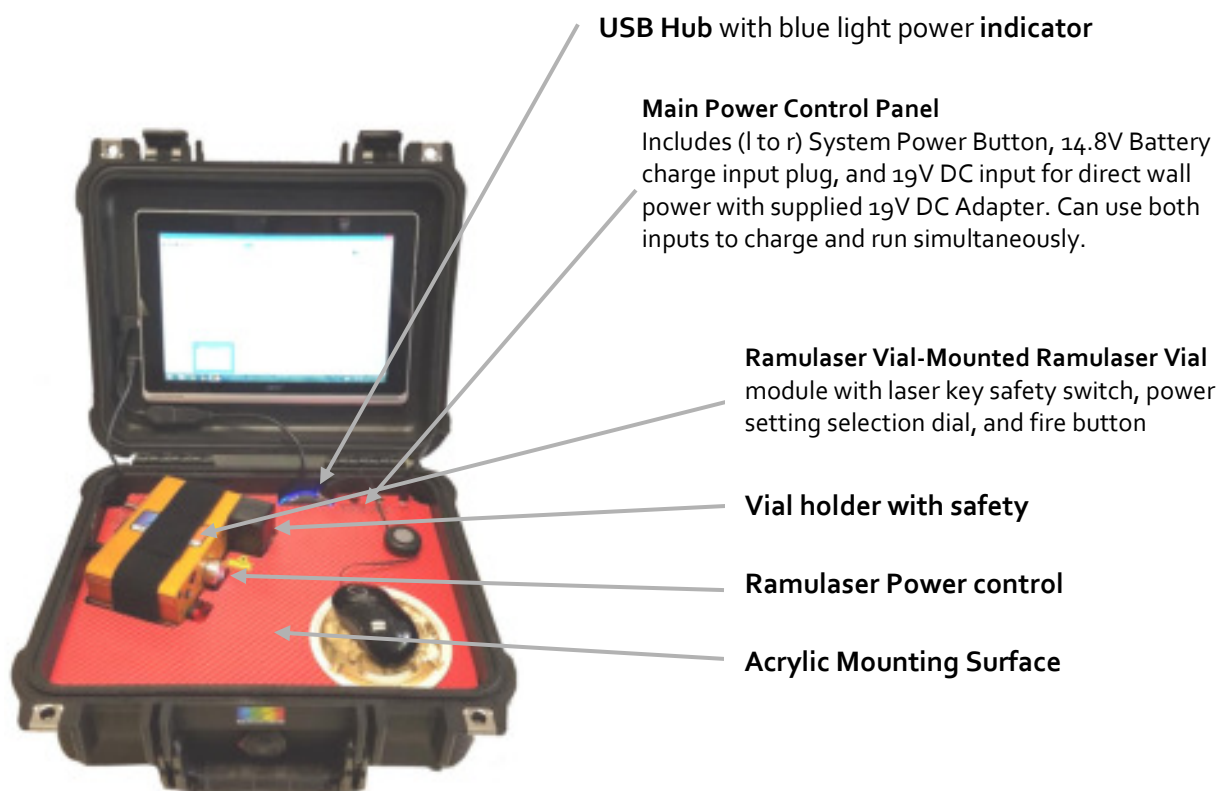
USB Hub with blue light power **indicator**

Main Power Control Panel
Includes (l to r) System Power Button, 14.8V Battery charge input plug, and 19V DC input for direct wall power with supplied 19V DC Adapter. Can use both inputs to charge and run simultaneously.

Ramulaser Vial-Mounted Ramulaser Vial module with laser key safety switch, power setting selection dial, and fire button

Vial holder with safety

Ramulaser Power control

Acrylic Mounting Surface

Ramulaser Fire Button
Always use Laser Safety Goggles and cover sample vial holder with safety lid when firing laser

Ramulaser Safety Key

F1000 fiber output to spectrometer Caution: Fragile

5VDC Ramulaser

Ramulaser Power Button

Ramulaser mounting strap

VISIBLE AND INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

Note: System automatically switches to battery power if AC adapter is unplugged while the main power button is on

StellarCASE-LIBS™

USB Hub with blue light power indicator

Main Power Control Panel
Includes (l to r) System Power Button, 14.8V Battery charge input plug, and 19V DC input for direct wall power with supplied 19V DC Adapter. Can use both inputs to charge and run simultaneously.

Laser Safety Key

Laser Fire Button

Sample

Acrylic Mounting Surface

Note: System automatically switches to battery power if AC adapter is unplugged while the main power button is on

StellarCASE-NIR™

USB Hub with blue light power indicator

Main Power Control Panel
Includes (l to r) System Power Button,
14.8V Battery charge input plug, and 19V
DC input for direct wall power with supplied
19V DC Adapter. Can use both inputs to
charge and run simultaneously.

Lamp On/Off Control

Sample Reflectance

Reflectance Standard

Note: System automatically switches
to battery power if AC adapter is
unplugged while the main power
button is on

Acrylic Mounting

StellarRad- Handheld SpectroRadiometer

The Stellar-RAD Handheld SpectroRadiometer system is delivered pre-installed and has pre-loaded calibration files. All a user must do is to power up the tablet by holding down the PWR On/Off button on the system for 3-5 seconds and the tablet computer will boot. Once logged into Windows the Stellar-RAD can be run with either of two software options both installed on the tablet. The first is called SpectraWiz (http://www.stellarnet.us/software/) which has many applications built in for light measurement and control of your portable spectroradiometer. The second is called StellarRAD and is a slimmed down program designed for a tablet with simple radiometric

Measurements using the Stellar-Rad Software

measurement capability.

StellarRAD is a fast, easy-to-use spectroradiometer in a touchscreen, tablet format. It incorporates live spectrum and CIE 1931 color space chromaticity displays among other real-time features. It is designed specifically for touch-screen use.
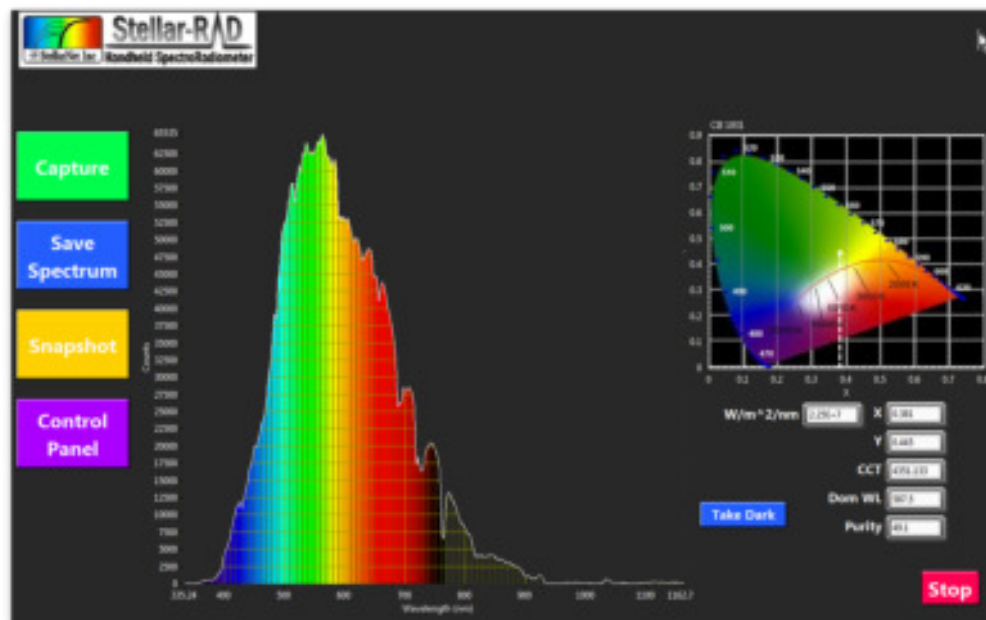
Special features include:

- Timestamped .PDF reports may be generated at any time and are saved to disk. You can choose whether or not to display reports as they are generated. (See Capture section.)
- Spectra may be saved as a tab-delimited spreadsheet file of virtually universal compatibility.
- Dark and comparative spectra functionalities are supported.
- A built-in command parser provides local or remote scriptability via MATLAB, Python and other languages, allowing repetitive tests to be programmed without a deep-dive into

Operation

instrumentation programming.

Begin StellarRAD execution by tapping the "Go" button at the upper left corner of the screen:
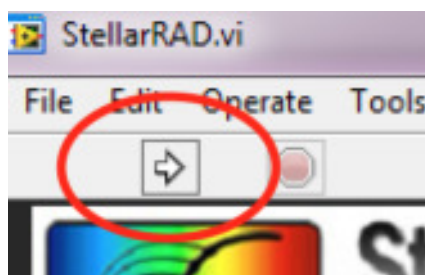
To adjust operating parameters such as integration time, click the Control Panel button. The Control Panel pane will open:

To adjust a parameter: click in its field, type in or select the desired value, then press the Return button. To take a dark spectrum, click its button on either the main operating panel or the Control Panel, and follow the on-screen instructions.
Certain operating parameters are saved to disk. These files are stored in the user's home directory (usually c:/Users/[username]).

Capture Button: Generate a .PDF Report

Pressing the Capture button will quickly generate a .pdf report that includes the full front panel plus summary information.
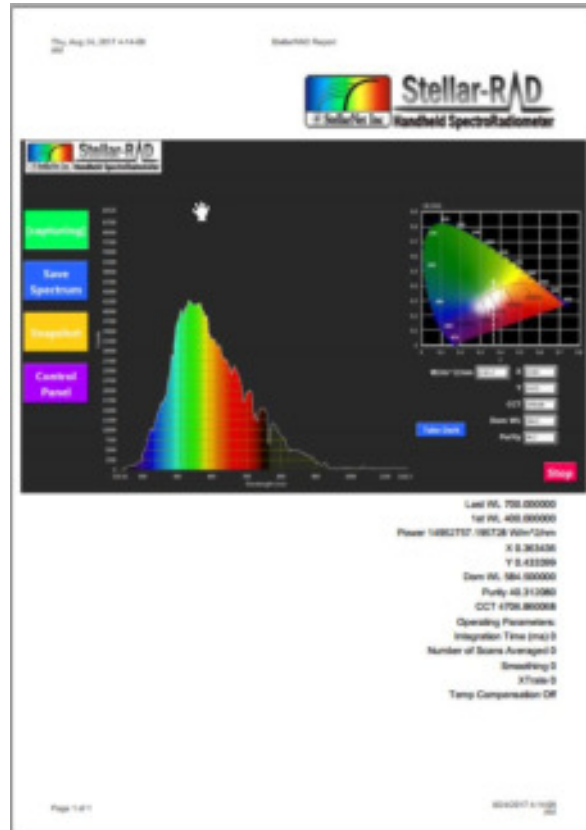
By default, each generated .pdf will open using your Windows computer's default .pdf viewer. You can turn this auto-view feature off and on by pressing the Control Panel, then clicking the Show/Don't Show button.

The .pdfs are written to disk in the user's documents directory (typically c:/Users/[username]/My

Save Spectrum as Spreadsheet

Documents).

Pressing the Save Spectrum button will instantly save the current spectrum to disk as a tab-delimited spreadsheet text-file. These can be opened with Excel, MATLAB, Python, R, databases and most other software. The filenames are uniquely named with a timestamp.

The spectrum spreadsheets are written to disk in the user's documents directory (typically c:/Users/[username]/My Documents).

Take a Snapshot for comparing spectra

Press the Snapshot button to display a static outline of a spectrum you wish to use as a baseline for comparing changing data.
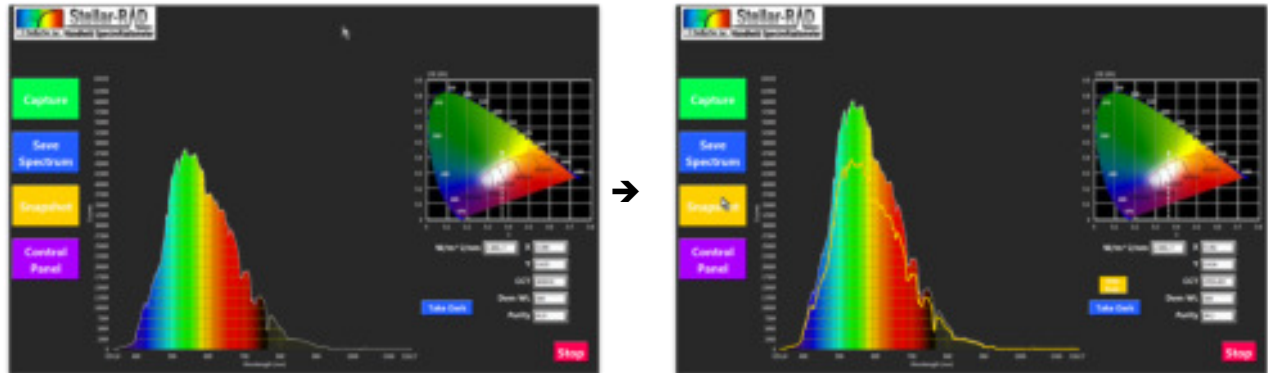
Assembly/Disassembly of the Stellar-Rad

The Stellar-Rad consists of a BLUE-Wave spectrometer, Tablet computer, SMA-Coupler, cosine receptor, USB Hub, & and rugged case. The case is designed so a user can take the system apart if they wish. Some users will often purchase other research grade light collecting accessories such as integrating spheres and will want to connect the spectrometer in a laboratory fashion. The Stellar-Rad can easily be assembled and taken apart and used with desktop computer as well. Often when trouble shooting the Stellar-Rad system it is advised to hook directly to another laptop or desktop computer, install SpectraWiz, & StellarNet drivers located here and test spectrometer functionality. Please review the StellarRAD User Guide for more information.

Spectrometer Features and Upgrades

Electronics Features

StellarNet spectrometers are delivered with all important information loaded into internal memory. When the spectrometer is connected to a computer the SpectraWiz software automatically reads its internal data and loads spectrometer detector type and x-axis calibration information. Older models may require manual settings. Review the SpectraWiz "in detail" chapter for more information.

All StellarNet spectrometers are high speed USB2 and include 16-bit detector digitization. Depending on the specific model spectrometer chosen you may have 512, 1024, or most commonly 2048 pixels/ data points. Most exposure times are detector limited but our electronics can capture as fast as 1ms all the way up to 1 minute. With the release of our new 2018 firmware updates exposure times can be as long as 8 minutes!

Detector Options

StellarNet offers are variety of different spectrometer detectors for UV-VIS and NIR applications. The detector arrays include Charge Coupled Devices (CCDs), complementary metal-oxide semiconductors (CMOS), silicon Photo Diode Arrays (PDAs), or NIR InGaAs PDAs. Detector specifications for various spectrometer models are available on the StellarNet website. Sensitivity for these devices is extremely high and range from 100 to 200 V/ (lx * s) as found in the detector manufacturer's specs (e.g.: Sony/Toshiba/Sensors Unlimited/Hamamatsu).

The most common UV-Vis detector StellarNet uses is the SONY ILX CCD that has 2048 elements with 14um x 200um tall pixels each with a 14um pitch. These detectors are the best made for spectroscopy. Additionally, StellarNet offers a uniformity and UV enhancement coating for all of these detectors.

For the near-infrared InGaAs PDA's supplied by Sensors Unlimited are the most popular. These high performance detectors have pixels that are 25um x 500um tall pixels with a 25um pitch. Also, the arrays have < 1% non-adjacent pixel defects. Additionally, due to our close relationship with our vendors we can special order zero defect detectors as well as low noise requirements for many application specific requirements.

Optical Performance

Many StellarNet spectrometers utilize a holographic concave grating to eliminate sensitivity issues, reduce stray light, correct aberrations, improve thermal stability, and improve ruggedness. The concave grating provides superior optical imaging and has many benefits over other standard optical techniques (Czerny turner) designs. Among the advantages are decreased stray light, uniform resolution, better spectral shapes, and increased sensitivity. A flat field is projected onto the detector array directly, thus avoiding the focus of scattered light into the focal plane. An additional intrinsic aberration correction deems it worthy of being called *Research Grade* for spectrometer optics in a small ruggedized package.

Resolving-power Resolution

In order to precisely control optical resolution, a slit is permanently installed in the fiber optic connector. This allows the instrument to maintain resolution when a different fiber size is connected. Optical resolution determines the instrument's ability to resolve adjacent spectral peaks which (for example) could relate to component concentrations or identify elemental composition in plasma analysis.

When closely spaced spectral peaks are clearly resolved via RR (such as the 577nm + 579nm Mercury doublet) they can be seen to be separated at Half the Max peak height (HM). The distance between the peak and where its slope intersects the HM position is defined as the resolving resolution in nanometers.

In a spectrograph with a perfectly imaged detector array, the RR will be the nm/pixel dispersion. Larger slits decrease resolution as the image spreads to adjacent detector pixel elements.

Line-width Resolution

When a single peak is measured at its Full Width Half Max (FWHM), the difference where the slopes intersect the HM is the Line-width resolution in nanometers.

Conversion from LR to RR use: LR ~= 2 x RR.
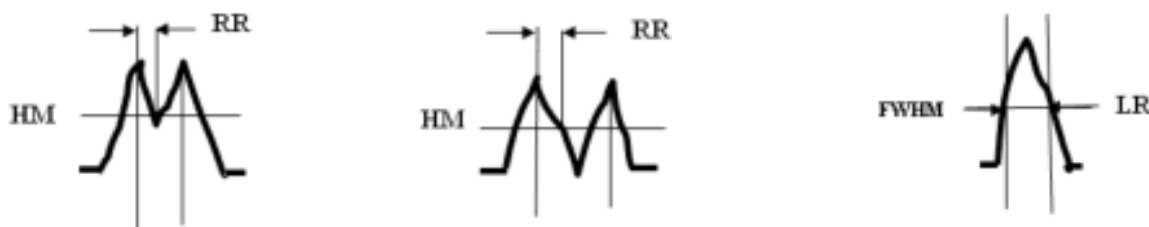
StellarNet estimates the spectrometer optical resolution using RR (Resolving-power Resolution) for standard spectrometer models and FWHM for the HR (High Resolution) series spectrometers.

Upgrades

External Trigger

StellarNet spectrometers can be configured with a TLL input (StellarNet Part # JACK-IN to enable the spectrometer to scan when triggered by an external light source (i.e. laser, flash lamp, etc.). These are the same that are used for our PORTA-LIBS systems for elemental analysis.

For the Jack-in trigger, the spectrometer must be upgraded to our newest electronics, if not already configured. This input is located on the back of the spectrometer and a TTL signal pulse is 0 to +5VDC and 1ms wide. When the trigger is at zero level no spectrometer scans are taken. During the rising edge of the pulse the spectrometer is requested to scan and occurs 500ns (500 x 10-9 seconds) later. We are not able to detect jitter as it is virtually instantaneous.

When the Jack-in trigger is engaged it will be set to a low level which prevents the spectrometer from continuously returning spectra. To override the driver "time-out", set the SpectraWiz -> Setup -> External trigger capture = on (checked). Additionally, the detector integration time must be set to 30ms with XTIMING resolution control set to level 3 to capture at the highest resolution.

When testing, a TTL signal is not needed because the positive input is internally tied to the +5 level using a pull-up resistor and in this state the spectrometer runs normally. Here's how to easily test the triggering function: Plug into trigger jack with cable and the 2 wires exposed. With spectrometer running short the 2 wires and the spectrometer stops updating spectra on the screen. Open the 2 wires and the spectra starts updating again.

Detector TE Coolers (1 & 2 Stage Options)

StellarNet, Inc. offers Thermo Electric Cooling (TEC) upgrades for certain spectrometer models. TECs reduce spectrometer dark noise and increase their overall performance and S/N value. Detector dark current increases with increasing exposure time. Lowering the temperature of the detector with a specialized TE cooled package, heat sink, and airflow design can reduce this effect, most effectively at long exposure times.

At the StellarNet factory, our engineers tune the TE detector coolers for highest performance. Each spectrometer model is designed to run off the provided 5VDC power regulators delivered with the spectrometer and will run at its coolest and highest performing temperature.
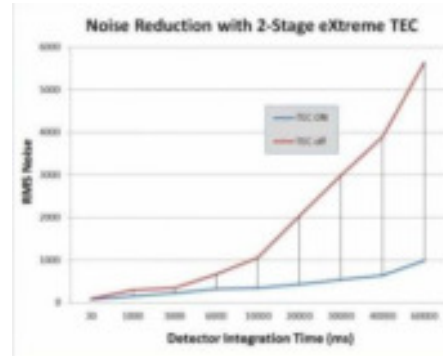
Models that can support the TEC upgrade include:

- BLACK-Comet-C/CXR/C-SR/C-XR-SR -TEC
- Raman-HR-TEC
- Raman-TEC-X2
- SILVER-Nova (includes 1-stage TEC)
- SILVER-Nova-TEC-X2
- DWARF-Star (includes 1-stage or 2-stage TEC)
- RED-Wave-NIRX-SR (includes 2-stage TEC)

    *TEC-X2 = 2-stage

TEC DISCLAIMER: Thermo Electric Coolers (TEC) installed in spectrometers are not intended to be run for extended periods of time. If left on continuously, damage to detector or spectrometers can occur. When spectrometer is not in use, please disconnect the 5V power from TEC.

Detector Lens

Detector Lenses (DLENS) are nice upgrades for BLUE-Wave spectrometers for 3x signal gain when using 600um or 1000um fiber optic input cables. The DLENS is permanently installed at our factory and can also be upgraded at a later time. However, if upgraded later an x-axis recalibration service and inspection would also be required.

Most other spectrometer models already contain some sort of detector lens assemblies so this upgrade is primarily for BLUE-Wave spectrometers.

UV Detector Upgrades

UV Detector upgrades (UDET) are often included in the model spectrometer and added to the spectrometer's price. The process of UV upgrade requires a specialized phosphor coating applied to the CCD's active surface. This special phosphor enhances the silicon detectors sensitivity to UV light below 400nm and, in addition, smooths the overall response of the detector as a function of wavelength. Most wide range spectrometers from StellarNet include this upgrade as part of the model.

Over time and with constant UV light measurements this phosphor can break down; however, most of these cases are for spectrometers over 10 years old with continuous UV applications. In these cases, detector replacement can easily be performed to get you up and running again.

Interchangeable Slits

The interchangeable slit upgrade is available for StellarNet HR optics, SILVER-Nova, SILVER-Nova-X2, Raman-HR-TEC, and Raman-HR-TEC-X2 spectrometers. This upgrade includes modification to the optical bench entrance and a pack of interchangeable slits. 14, 50, 100, 200um are included in the pack and a 25um slit is installed and delivered in the instrument when ordered. The smallest slit (14um) is used for best resolution and largest slit (200um) is used for highest sensitivity.

The spectrometer's entrance modification includes precision internal mounting hardware which allows the interchangeable slits to lock in place when arriving at proper alignment location. The spectrometers are calibrated with the smallest slit and all production paperwork will reflect the smallest slit being installed.

- There are alignment arrows provided on the entrance and slits for easy input.
- Also, a slit extractor is included with the slit pack to allow you to easily pull the slits out of their tight alignment locations. To use the slit extractor simply screw onto the slits SMA threading and pull.

When not in use always make sure there is a slit installed. Leaving the interchangeable slit entrance "open" can lead to accumulated dust and debris which ultimately can cause instrument failure.

Electronics Upgrades

StellarNet offers zAutomation Processor (or zAP) options 1 and 2 for their spectrometer electronics available in most spectrometer models. These new features allow users a variety of powerful automation control not before seen in a low cost, compact spectrometer.

zAP1 allows a user to control the electronic gain and baseline of their spectrometer via software. This feature is extremely useful for applications where long exposure time or detector cooling may increase the detector's baseline dark scan. The user can now "reset" or "optimize" the baseline for their specific set of experimental conditions allowing for the highest possible dynamic range. Likewise, the detector gain can also auto-adjust to find the best condition for measurement. Another feature of **zAP1** is a "Burst Mode" that allows up to 120 consecutive spectra to be saved onto the spectrometers internal memory. This allows for automatic high speed burst captures of events often critical for time decay and pulsed applications where typical USB lag may bottleneck results.

zAP1 upgrade includes the new version of SpectraWiz which can handle not only **zAP1** spectrometers but your regular spectrometers!.

zAP1 is currently available for new purchases of certain model spectrometers. Check individual spectrometers specifications for more information.

Check out our *zAP1 User Manual* for more details.

zAP2 upgrade adds an integrated CPU with Wi-Fi access to your spectrometers. This feature automates applications for OEMs and end users and turns your spectrometer into a portable wireless analyzer with real world data output for just about any application you can dream of.

Current users can upgrade their spectrometer to add **zAP2** at any time and once added the spectrometer will run as normal pulling power from your computer's USB port. With the new **zAP2** upgrade you can stream your full spectrum over Wi-Fi and still using your regular *SpectraWiz* and any *customizable Windows program* as if you had the device directly connected to your USB.

Each **zAP2** also comes preprogramed with our latest *SpectraWiz Mobile App* set which allows streaming of pre-processed data.

Check out our *zAP2 User Manual* for more details.

SMART-Control

The **SMART-Control** device offers communication flexibility and application specific customization for any StellarNet spectrometer. This add-on interface includes an integrated CPU with 1GB RAM and many communication protocols such as RS232, SPI, 4-20mA Analog for PLCs, Digital I/O, Ethernet, Wi-Fi and many other options. The **SMART-Control** allows customers to move their spectrometers into process or OEM environments and stream their selected real world data.

Each **SMART-Control** will come preprogramed with our latest **SpectraWiz Mobile App** set written in Python. Using its local access point and your own mobile device, you can easily run applications for General Spectroscopy, Radiometry, Colorimetry, and Concentration analysis. Using the Set Export feature you can select which output protocol suits your requirements.

Check out our *SMART-Control user manual* and *SpectraWiz Mobile Apps user manual* for more details.

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Additional Software Options

SpectraWiz LabVIEW

Customizable Programs with Source Codes

StellarNet provides fully functional customizable spectroscopy programs for National Instruments LabVIEW free with every spectrometer. The LabVIEW programming environment allows rapid customization to adapt the software to any application. Current features include setting of all instrument configuration parameters, plotting of spectral data in Scope mode, Absorbance mode, Transmission mode, and even Irradiance mode. In addition, a time series function is built in that enables the user to select independent wavelengths and follow them as a function of time. This time series data can be exported to file and post-processed for kinetic parameters. In addition to the Spectroscopy Suite, basic VIs are available that allow the user to integrate StellarNet's spectrometer into their existing LabVIEW application.

StellarNet init, read, close.vi

The StellarNet Init, Read, Close.vi is a general-purpose subVI for programming episodic spectral readings in LabVIEW. When called, it:

1.   Initializes the instrument using either programmatic parameters or parameters stored on disk by SpectraWiz,
2.   Acquires the spectrum, returning it to the calling VI as a graph-ready cluster that includes amplitude and wavelength information, and
3.   Checks for error information from the .dll during the scan process, providing this in a LabVIEW-compatible format.

Since it is entirely self-contained, it can be used interactively as well as called as a subVI
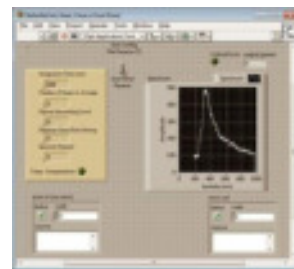
Single Channel

The StellarNet SpectraWiz for LabVIEW spectrometry application is a full spectroscopy program that provides an easy-to-use graphical user interface for any of up to eight StellarNet USB spectrometers plus logging of process data on local or network storage.

It is designed to work independently of the SpectraWiz software utility. Spectrometer calibration parameters are managed by this application, either automatically in the case of BLUE-Wave and other advanced units onboard parameter storage, or manually when the spectrometers are first connected.

The software utilizes an easy-to-use and space-efficient tabbed-panel design. Data logging and snapshots are supported, and time series may be logged to show changes of three wavelengths of any channel.

The software was entirely coded in LabVIEW 8.2 and interacts with the spectrometers via swdll.dll. In the graphical user interface, spectrometers (channels) are numbered 1-8, consistent with SpectraWiz usage.
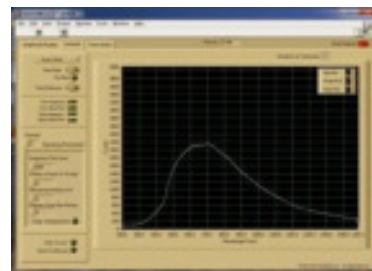
Multi-Channel

LabVIEW Mega Program in LabVIEW ver 7.x & 8.x – controls up to 8 simultaneous spectrometers & radiometers – includes source diagram and is compatible with Wizard-Runtime engine for chemometrics models.
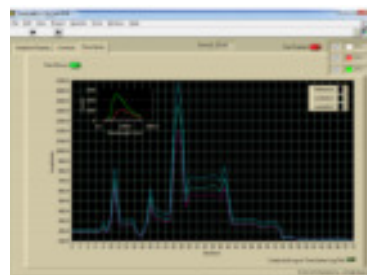
StellarRad Radiometry Program (Handheld unit)

The StellarRAD software is fast, easy-to-use, and specifically designed for a touchscreen tablet. It incorporates live spectra and CIE 1931 color space chromaticity display among other real-time features. Pressing the Capture button will quickly generate a .pdf report that includes the full front panel plus summary information. Press the Snapshot Display button to display a static outline of a spectrum you wish to use as a baseline for comparing other lamps and luminaries in real time. This software is perfect for multi field measurement with quick data capture and easy to view comparison spectra with under the curve color representations.
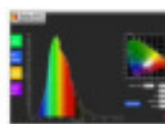
Large buttons and simplified interface designed for field measurements with beautiful colorimetric displays
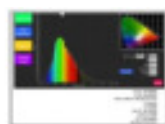
One click comprehensive .pdf report generated by the Capture button.

Snapshot button draws an outline of the current spectrum for easy comparison as illumination conditions change. Great feature for showing light quality comparisons!

SpectraWiz VBA

StellarNet also offers the customizable StellarNet VBA programs for MS Excel that instantly grabs and graphs data from a StellarNet spectrometer.

Setup and run from Excel in absorbance, transmission, or scope mode. With our VBA modules, you can rapidly customize your spectral analysis to meet your unique research requirements. You can integrate this module's data acquisition capabilities into your existing analytical spreadsheet, thereby enabling acquisition and analysis of spectral data without leaving the Microsoft Excel environment. Create custom reports, calculate and graph absorbance or percent transmission, all at the push of a button. It's all here and more importantly, it is included free with your StellarNet spectrometer.

Excel's VBA script functionality enables the user to query an instrument directly from Microsoft Excel. Data from the device is imported directly onto an Excel page for post data processing using user defined algorithms. Above is the processed data graphics page of the module. Scope, absorbance, and transmission data is displayed simultaneously.
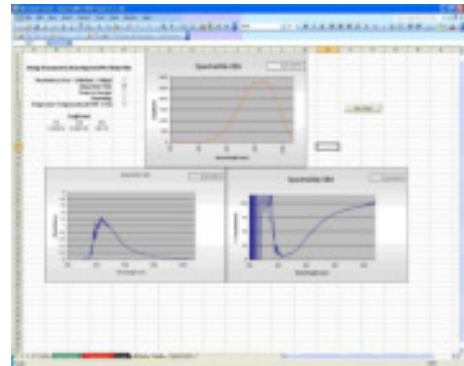
CRI & CQS Software

CRI & CQS calculations are performed in a comprehensive spreadsheet written by the folks at NIST. If you purchase a StellarNet spectrometer we'll send you our free modified version that reads your instrument!
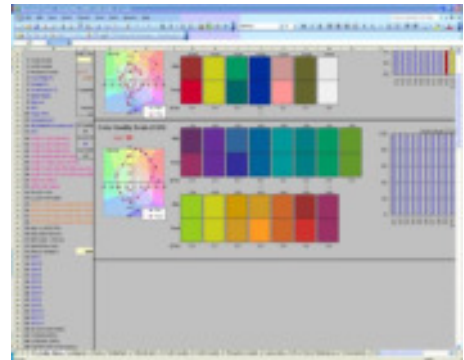
LED Test Report

The SpectroRadiometer Test Report Software now enables customers to display and print all of the relevant test data on one sheet making quality control and R&D efforts much more efficient. The test report also shows the CIELAB diagram with the xy/u'v' chromaticity values automatically updated for your light. Additionally, CCT (Correlated Color Temperature), PAR, dominant wavelength, and % color purity are calculated. The software also includes NIST created calculations for CRI (Color Rendering Index) and CQS (Color Quality Scale) and total power measurements in Lumens, Watts, or associated irradiance values with efficiency and efficacy values calculated as well based on your input electrical parameters.
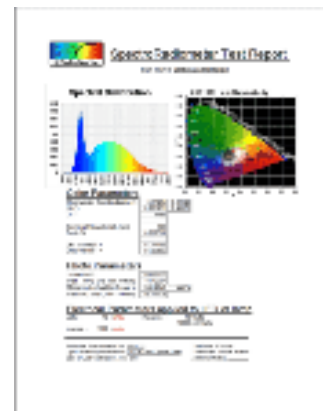
Software SDK (C, C#, VB, Pascal)

StellarNet provides with each spectrometer purchase a complete software development toolbox of sample source codes and programs including SwDemo for Delphi Pascal – SwDemo for C# Sharp compiler – SwDemo for C SDK compiler – SwDemo for Visual Basic 5+.

Thin Film Companion

Specialty Software Programs

Thickness and optical constants (n and k) can be measured quickly and easily using powerful user-friendly software which make daily complex measurements quick and simple.

TF software includes a large library of materials data that enables measurement of the wide range of layer structures: multilayer, freestanding, rough, thick and thin layer structures are supported. New materials can be added easily by measuring corresponding sample or importing data from the text file.

The measurement process consists of two steps: data acquisition and data analysis.TF Systems defines all the process in a measurement recipe and makes it transparent to the user. At the same time the user has the ability to store measured data and analyze it later.

TF supports Parameterized materials e.g. Cauchy, Sellmeir, EMA (effective-medium approximation), Harmonic oscillator, Tauc-Lorentz oscillator, Drude-Lorentz and many more approximations. These approximations represent optical dispersion of materials in desired spectral range using few coefficients that can be adjusted. For example, oxides are frequently represented using Cauchy and glasses using Sellmeir approximation, amorphous materials (e.g. SiNx, aSi) can be represented using Tauc-Lorentz and phase-mixed materials (e.g. poly-Si) using EMA approximation.

Measurements are made using: reflectance/transmittance spectroscopy which measures the optical response of the layer structure. The user creates an optical model of the layer structure and uses data analysis to determine physical properties: the results are inferred from the best fit of measured and modeled data. TF software provides many options to easily analyze simple and most complex filmstacks, graded layers, periodic structures, very thick films, films on thin substrates, multi-sample measurements, etc. Simulation and error-estimator tools allow user better understand data and the expected precision.

During in-situ, in-line or other long running measurements conditions like surface roughness, ambient light, etc. may be changing. TF software supports roughness and scaling correction that allows factoring in these effects.
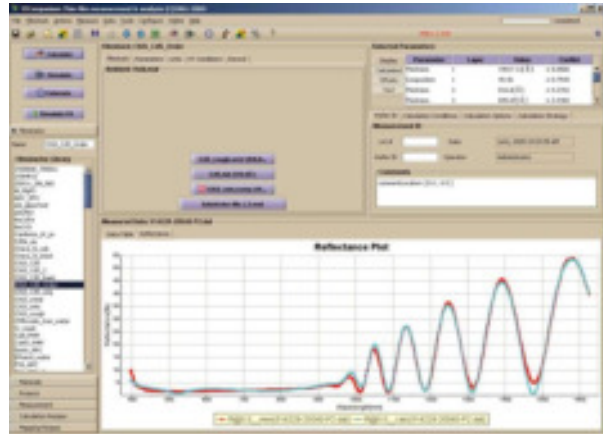
Spectroscopy Pro-Tools

Add-on software for creating amazing interactive multi-spectrum plots, tons of options for spectral processing, and even spectral acquisition.
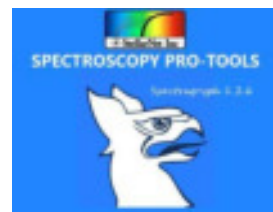
Spectroscopy Pro-tools software has:

- Advanced baseline correction capabilities which can help adjust your spectra and remove unwanted fluorescence or glass signal
- A variety of color palettes and other customization features (multiple plot windows, drag and drop spectral files, adjust line widths, legend and key text sizes, adjust background grids, hide and remove spectra)
- The ability to label peaks and can normalize to a peak maximum, create peak lists of all loaded spectra, and even create calculated FWHM values
- A lot of great features for Fluorescence Spectroscopy such as emission sensitivity correction, excitation intensity corrections, lamp removal peaks, 2D plots of excitation and emission matrix

Spectroscopy Pro-tools allows you to easily stack multiple spectra and customize for display or publication. To the right is an example of a DWARF-Star NIR spectrometer measuring a calibrated light source. One graph shows the raw SCOPE Mode data in relative counts and the other curve is the calibrated spectral irradiance of the same lamp in Watts/m^2/nm. Graphing tools like this give users more control over how their values are interpreted and presented. Area under the curves (integral) can also be calculated and presented per spectrum.
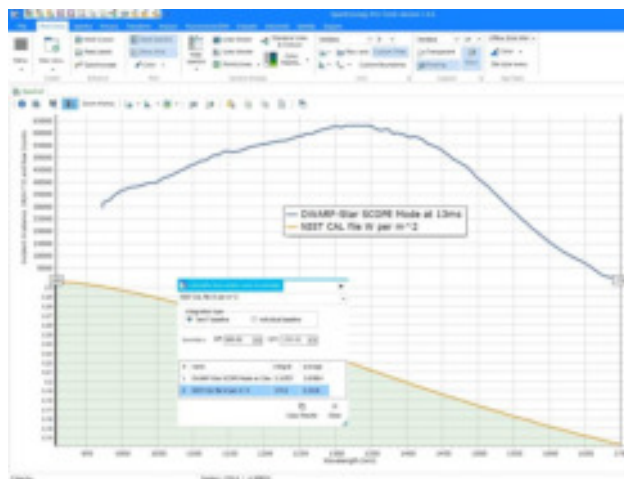
ChemWiz Chemometrics

Full spectrum chemometric analysis for multiple components can now be performed using the ChemWiz® Analyzer Development Kit (ADK). This software toolkit, when combined with StellarNet spectrometer instrumentation and SpectraWiz operating software, enables rapid development of complex analyzers needed to provide custom measurement solutions for many applications.

Real-time spectral data is used as input to measure concentrations of up to 6 components such as moisture, fat, protein, alcohols, acids, or chemicals such as pesticides. Alternatively, the ChemWiz® ADK can be used to classify samples, such as the types of plastic.

The toolkit includes a model builder which is used to process spectra from a set of known component concentrations. Here the spectral pre-processing techniques are selected such as multivariate scatter correction (MSC), smoothing, derivatives, and mean centering. The multivariate analysis type is then selected such as partial least squares (PLS). Finally, a cross validation technique is chosen and used to improve the reported statistics indicating accuracy and fitness of the calibration model created.
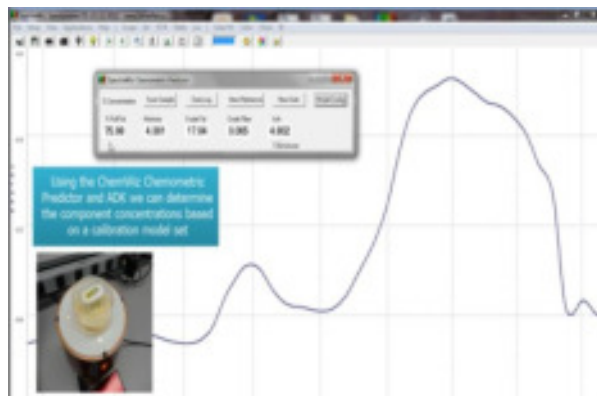
The ADK includes a runtime engine that performs the analysis in real-time with little to no sample preparation. The measurement results are displayed on the SpectraWiz Application panel for "Chemometric Predictor" which is also provided in our Multi-Chanel LabVIEW software program for OEM developers.

Each analyzer system can be tailored with sampling accessories to measure liquids, solids, and powders. For liquids, absorbance is measured via flow cells, dip probes, or cuvettes. For solids and powders, reflectance is typically used to measure sample absorbance. Near infrared diode array spectrometers such as the DWARF-Star NIR-512 with TEC cooling are typically configured for analyzer development.

SpectraWiz Mobile Apps

Each **zAP2** and **SMART-Control** includes our latest **SpectraWiz Mobile App** set written in the form of *.bin* files (Linux executable) and *dynamic library* for USB drivers as *stellarnet_driver.so* and *stellarnet.hex* files. We also provide with simple data acquisition script written in *python* (*data.py*) that can communicate with *stellarnet_driver.so* and perform simple operation to set device parameter and acquire spectrum data.

Using the local access point and your own mobile device, you can easily run applications for *General Spectroscopy, Radiometry, Colorimetry, and Concentration analysis*.


At the startup of each Smart-Control system you will see the home page of SpectraWiz Mobile apps where you can launch the application of your choice by tabbing or clicking corresponding icons.
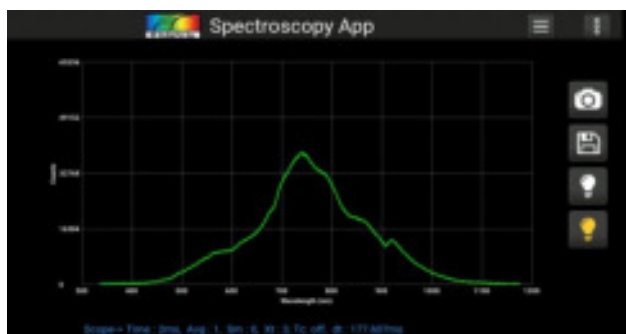
The Spectroscopy app was designed for general spectroscopic visualization in different modes such as *Scope, Absorption, Transmission and Radiometer*. It also has option to take screenshot, save data and export data in various protocols.
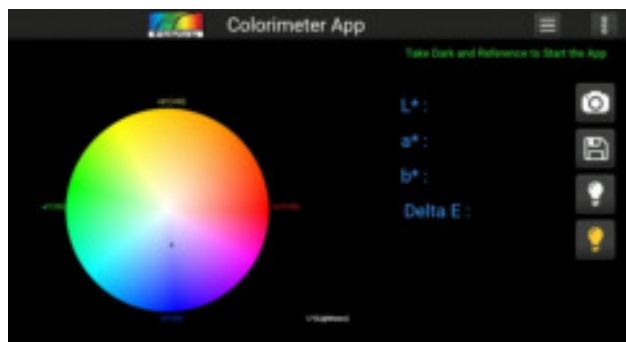
Color app is design to give CIELAB D65 reference values for L*, a*, b* in numeric and graphical form. Additionally, it also gives information about x, y chroma and hue.
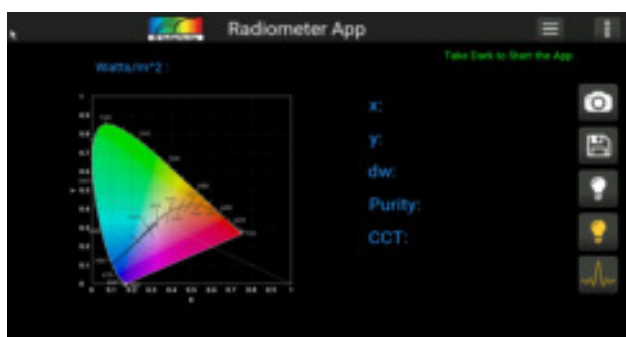
By click the Radiometer app form the home page you can launch the radiometer app which is design to give x, y, dominant wavelength, purity and correlated color temperature using the radiometer calibration.

Concentration app is designed to use *absorption data* and the *linear model* to give concentration values for the defined wavelengths.

In-app purchases allow users to download source codes, which can be further customized to suite each user's requirements. Using the powerful Python language you can create your own onboard apps to stream only the data you need.

Check out our ***SpectraWiz Mobile Apps user manual*** for more details.