



CI-710

■ Miniature Leaf Spectrometer

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This Manual is written for software version 1.1.3.150

Unpacking the CI-710

The CI-710 is shipped with the following components:

- ◆ 1 Spectrometer (USB4000, Ocean Optics)
- ◆ 1 Leaf Probe (pre-installed on the spectrometer)
- ◆ 1 Fiber Optic Cable (30-cm bifurcated)
- ◆ 1 USB Cable
- ◆ 1 Allen Wrench (3/32)
- ◆ 1 Carrying Case
- ◆ 1 Software Installation (SpectraSnap!)
- ◆ 1 Reflectance Standard
- ◆ 1 Operation Manual (this document)

Caution: Handle the reflectance standard and fiber optics with care. Do not touch the surface of the reflectance standard and be careful not to flex the fiber optics beyond their limit.



Figure 1. Components of the CI-710

Specifications

Spectroscopic Specifications

Wavelength range:	400-950nm
Optical resolution:	~0.3-10.0 nm FWHM (grating dependent)
Integration time:	3.8 ms – 10 seconds
Stray light:	<0.05% at 600 nm; 0.10% at 435 nm
Optical Properties:	Light intensity, absorbance, Reflectivity, Irradiance
Optical Sample Size	7.6 mm

Electronic Specifications

Power consumption:	400 mA @ 5 VDC
Data transfer speed:	Full spectrum to memory every 5 ms with USB 2.0 port
Inputs/Outputs:	Yes, 8 onboard digital user-programmable GPIOs
Analog channels:	No
Auto nulling:	Yes
Breakout box compatible:	No
Trigger modes:	Automatic & Manual
Connector:	22-pin connector
Power Supply:	USB powered via laptop or PC

Computer Specifications

Operating system:	Windows 7/8/10 with USB port
Computer interfaces:	USB 2.0 @ 480 Mbps (USB1.1 compatible)

Detector Specifications

Detector	Toshiba TCD134AP Linear CCD array
Detector Range	400-950nm
Pixels	3648 pixels
Pixel Size	8 μ m x 200 μ m
Pixel well depth:	100,000 electrons
Signal-to-noise ratio:	300:1 (at full signal)
A/D resolution:	16 bit
Dark noise:	50 RMS counts
Corrected linearity:	>99.8%
Sensitivity:	130 photons/count at 400 nm; 60 photons/count at 600 nm
Dynamic range:	2 x 10 ⁶ (system), 1300:1 for a single acquisition

The Configuration of the CI-710

The CI-710 consists of two modules, a leaf probe and a CCD-based spectrometer, and is powered by a PC through an USB cable. A computer program, SpectraSnap, is used to set measurement parameters and display the spectral data. The leaf probe is equipped with a tungsten-LED dual light source that provides a broad range of wavelengths of light, suitable for visible and near infrared spectroscopy. The light then passes through a bifurcated fiber optic cable and connects to one of the two sampling light ports on the side of the leaf probe for the transmission and absorbance or the reflectivity measurements.

Mechanical Installation Guide

This section shows the step-by-step installation instructions. Please follow the steps carefully to install your new instrument.

- 1. Attach the leaf probe to the spectrometer.** Skip to the next step if the leaf probe is already attached to the spectrometer (the original form of the instrument from the manufacture). If the leaf probe is separated from the spectrometer, install the leaf probe on the spectrometer by the following steps.

Step 1. Screw the optical aligner onto the spectrometer (Fig. 2a). The color of the optical aligner may be different from the picture. Align the leaf probe to the optical aligner and align the 10-pin connector to the spectrometer. Push the leaf probe straight down to the spectrometer (Fig. 2b).

Step 2. Tighten the screws on both end of the leaf probe to the spectrometer with the attached Allen wrench (Fig. 3).



(a)



(b)

Figure 2. (a) Attaching the optical aligner to the spectrometer. (b) Aligning the leaf probe to the optical aligner to attach the leaf probe to the spectrometer

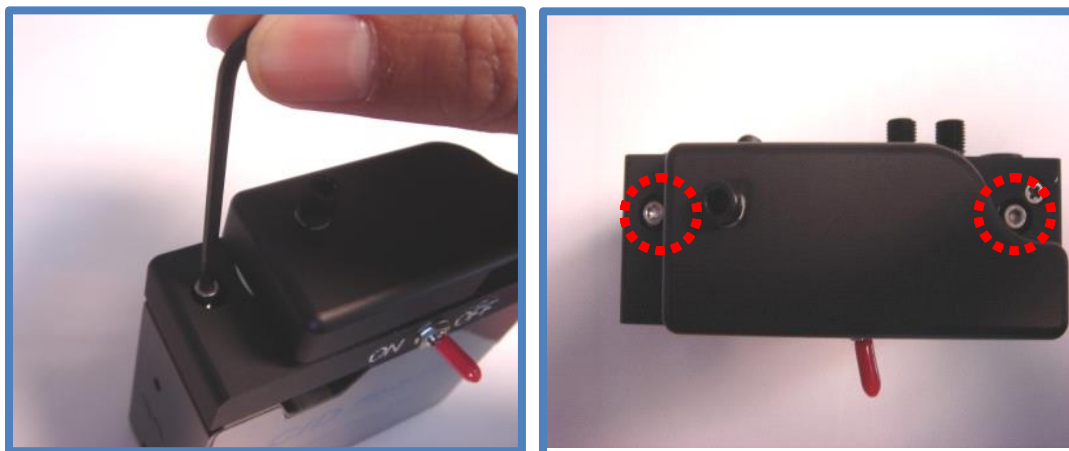


Figure 3. Tightening the screws on both ends of the leaf probe to secure the leaf probe on the spectrometer

- 2. Connect the bifurcated fiber optic cable to the leaf probe.** Hold the end of the cable with two connectors (SMA 905 connectors) and insert both connectors to the light source ports, as shown in Fig. 4. Tighten the screws of the fiber optic cable to the leaf probe.

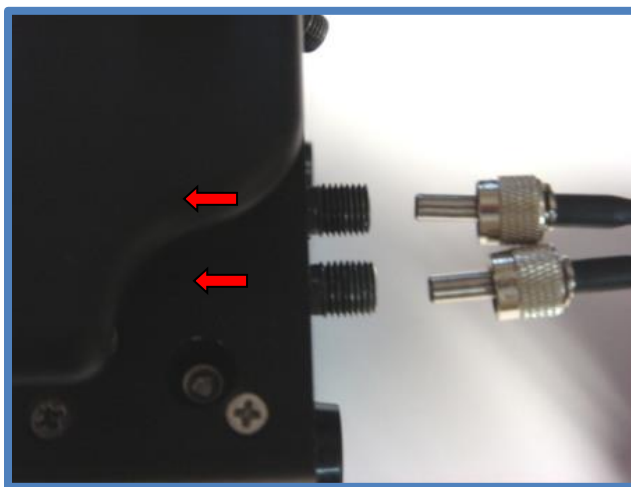


Figure 4. Connecting the bifurcated fiber optic cable to the leaf probe

- 3. Install the operating software, SpectraSnap.** Follow the steps in the Software Installation section of this operating manual to install the operating software and driver on the PC.
- 4. Connect the spectrometer to the computer.** Connect one end of the USB cable to the spectrometer and the other end to a computer. For Windows PC users: The PC will find new hardware USB4000 and launch the New Hardware Wizard. Follow instructions in the Driver Installation section of this operation manual to install the

CI-710 driver using SpectraSnap. **Note that the same USB port should be used every time.**

5. **Turn on the light source switch on the side of the CI-710.** A bright light should be observed at the end of the fiber optical cable. The installation is now successful and is ready to make measurements! *If no light is observed, please make sure the USB cable is securely connected and the leaf probe is properly attached to the spectrometer, or refer to the trouble-shooting guide for further information.*

Software

SpectraSnap! is the software included with the CI-710. This software requires a Windows 7 or above PC (32bit or 64bit) and a USB connection. You may install SpectraSnap! on as many PCs as needed for your CI-710 application.

Installation

1. Insert the software CD or navigate to <https://www.cid-inc.com/support/CI-710/software/> and click Install or run Setup.exe
2. A dialog may appear warning you that this software has not been signed by a Microsoft verified publisher. Select "Install" to continue.

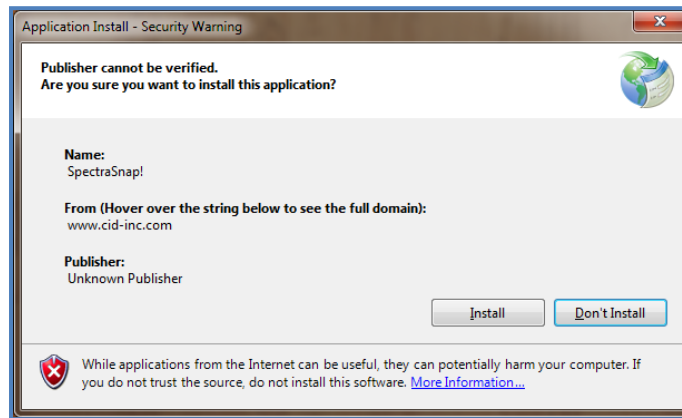


Figure 5: Security Warning about publisher verification.

3. If you are installing from the Internet a dialog will appear that tracks the progress of this download.

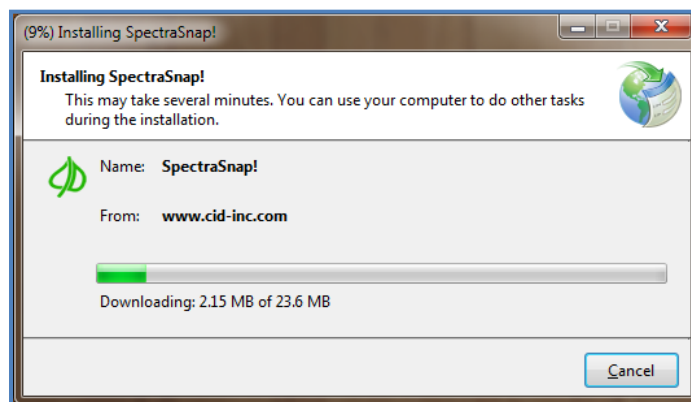


Figure 6: Installation of SpectraSnap!

4. When the installation is complete, open the software from the Start menu.

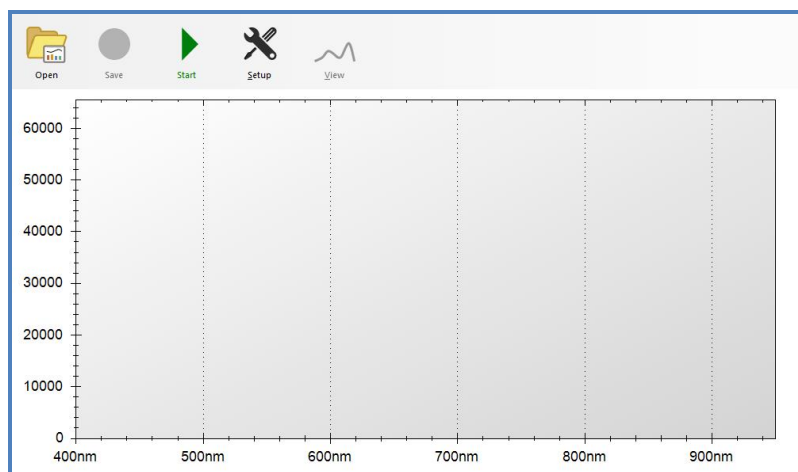
Automatic Update Feature

If the computer is connected to the Internet, SpectraSnap! will notify you of updates as they become available. You can revert to a previous version of software by using the add/remove programs feature in Windows.

Running the Software

The software can be started from any shortcut that points to the program on your PC. By default a shortcut is created in the Start Menu. It can be accessed by:

1. Select the Window's **Start** button.
2. Select **All Programs**.
3. Select **CID Bio-Science**.
4. Select **SpectraSnap!**



Note: You can optionally right-click on SpectraSnap! and create a shortcut on your Start Menu or Taskbar.

Figure 7: SpectraSnap! as it appears after starting the software.

Driver Installation

If the CI-710 has never been used on the PC running SpectraSnap!, a driver must be installed before the spectrometer can be used.

1. Attach the CI-710 device using the supplied USB cable.
2. Start SpectraSnap!
3. Select the **Setup** icon.
4. Select the **Advanced** submenu.
5. Select the **Install CI-710 Driver** option.

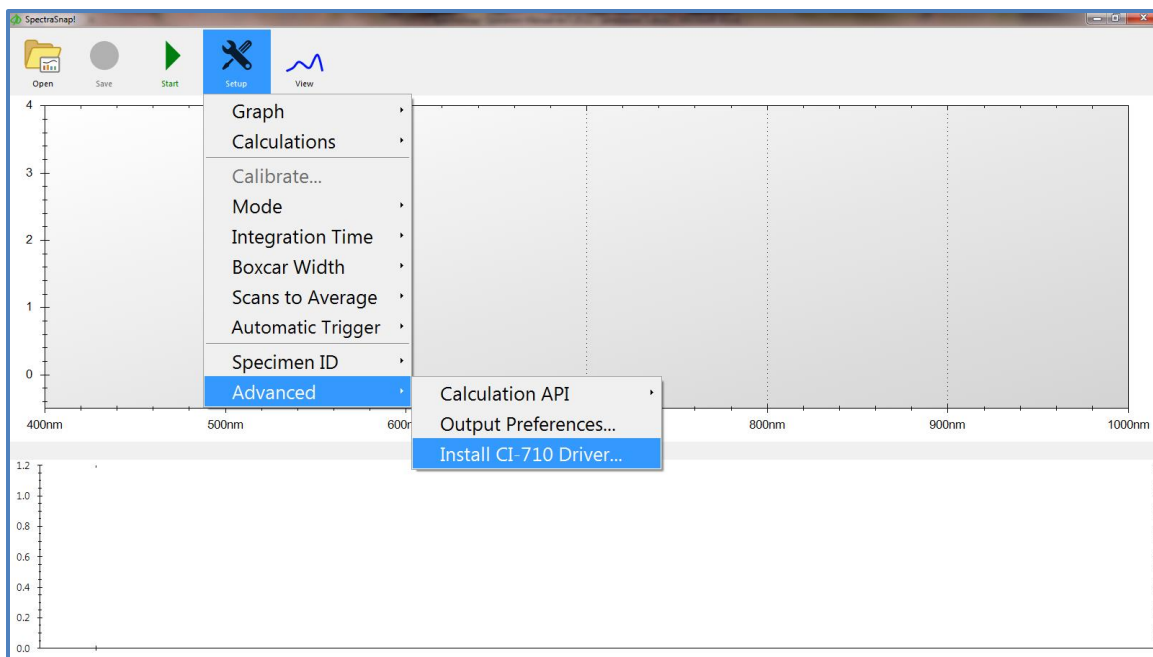


Figure 8: Following steps 3 – 5 to install driver.

6. A confirmation dialog will appear, click OK to confirm your selection.
7. Follow the on-screen prompts to complete the driver installation wizard.
8. A dialog will appear once the driver has been successfully installed.
9. Restart your computer.

Calibrating the CI-710

These instructions should be followed each time the CI-710 is used. Calibration is required before first using the CI-710. The instrument should also be calibrated when switching between modes. It is recommended to re-calibrate the CI-710 frequently when using it, especially in Reflectance Mode.

For best results allow the CI-710 to warm-up for 15-30 minutes prior to calibration and measurements. The light sources in the CI-710 are affected by heat. Allowing time for warm-up reduces spectrum drift. The user cannot calibrate in scope mode.

1. Start SpectraSnap!
2. Select the green **Start** button on the toolbar.
3. Open the **Setup** menu. Click **Mode** and select **Scope**. This means the raw data from the spectrometer will be displayed.
4. Place the reflectance standard in the leaf clip with the white circle facing the light. The light will either come from the top or bottom depending on where the fiber optic cable is connected (see Fig. 9 & 10)
5. Select **Setup** and increase or decrease the **Integration Time** until the data displayed is fully on the graph (below 60,000 on the y-axis). This ensures maximum resolution for the entire spectrum. If the line appears to go higher than 60,000, decrease the integration time until the entire line appears on the graph. For more details about the Integration Time, see the next page of this manual.



Note: If you are only inspecting a specific band, you could increase the Integration Time until that band reaches the ceiling of 60,000.

If the integration time is set to high, an error message will appear after calibration indicating: "The integration time is causing the spectrometer to be over saturated at some wavelengths. Switch to Scope mode to see which areas are over-saturated. Lower the integration time to prevent this problem."

6. Change the **Boxcar Width** and **Scans to Average** as desired. *Explanation of Integration Time, Boxcar Width and Scans to Average are at the end of this section.*
7. Select the Mode of operation for the CI-710.
8. Select **Calibrate...**

9. Follow the on-screen prompts.

Note: Refer to the images below for a visual guide to connecting the fiber-optics.



Figure 9: Fiber-optic attached to the top of the CI-710 for Absorbance and Transmittance mode.



Figure 10: Fiber-optic attached to the side of the CI-710 for Reflectance mode.

Integration Time, Scans to Average and Boxcar Width

The integration time of the CI-710 is the amount of time of signal collection by the sensor. This is similar to the shutter speed of a camera. A longer integration time is usually desirable to minimize “noise”. The same effect can be achieved by increasing the number of scans to average.

Integration time must be changed because the amount of light reaching the sensor varies in different modes. For example, the amount of incident light reaching the sensor is much lower in reflectance mode, and therefore the integration time is higher.

The Scans to Average value specifies the number of scans the CI-710 will take or accumulate before displaying the spectrum. The higher the number of scans to average, the better the signal-to-noise ratio (S:N).

The Boxcar Width is a data smoothing method. It is recommended to try a boxcar width of 10 and then adjusting with different boxcar width values until the CI-710 produces a smooth looking line. The greater the boxcar width value, the higher the signal-to-noise ratio and the smoother the data. However, if the boxcar width value is set too high, resolution will be lost.

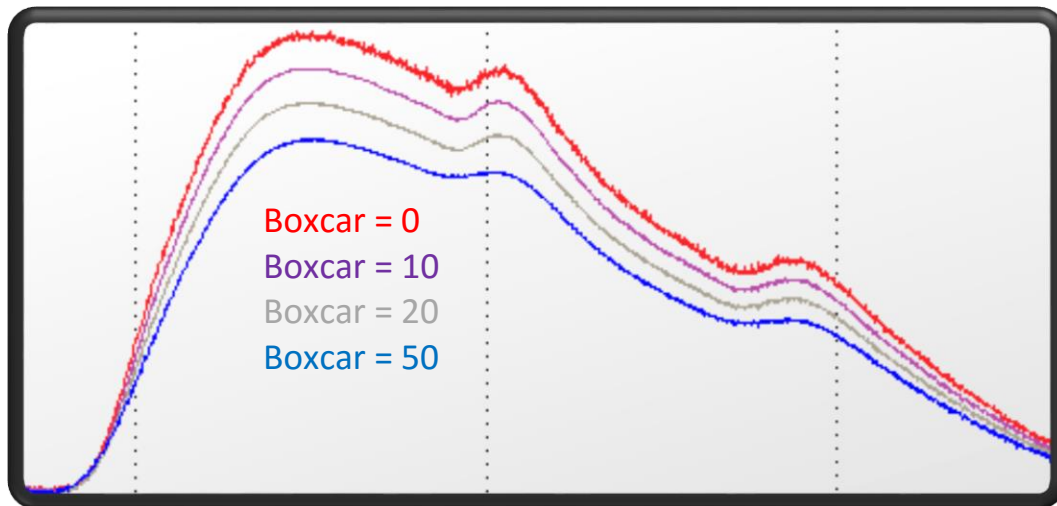


Figure 11: Resolution and noise at various boxcar widths.

Scope, Reflectance and Transmission Mode

The spectrum displayed when the CI-710 is in Scope Mode is the raw voltage coming out of the A/D converter. Scope mode is used during set-up and to see the effects of adjusting integration time and boxcar width. This mode provides complete control of signal processing functions before taking measurements in other modes, such as reflectance or transmission.

Reflectance mode shows light that has been reflected or scattered from a sample. *For reflectance measurements, the fiber optic cable should be connected to the side of the CI-710. To make measurements of the upper, axial side of the leaf, turn the instrument upside down so that the CI-710 spectrometer box and light probe are on top of the leaf. The leaf clip will attach on the bottom, abaxial side of the leaf. To eliminate light loss, place a black backing on the opposite side of the leaf, the black side of the reflectance standard can be used for this purpose.*



Transmission mode compares light that has passed through a sample to light that has not. Please refer to Figure 9 and Figure 10 to properly set-up the CI-710 in each of these modes.

Saving and Opening Measurements

By default, SpectraSnap! will store measurements in the My Documents folder of your computer under a CI-710 subfolder.

Changing Output Preferences

1. Select **Setup** from the toolbar.
2. Select the **Advanced** submenu
3. Select **Output Preferences...**
4. Change the settings as desired.
5. Select the **Save** button.

Saving Measurements

1. Select the red **Save** button. A shutter sound will play to notify you that the measurement has been recorded.

Note: Multiple files are saved for each measurement. The data file (either as XML or CSV) along with two images files, one for each graph (in PNG or BMP format).

Opening Measurements

1. Select the **Open** button on the toolbar.
2. Choose the SpectraSnap! measurement to load.

Trigger Function

The Trigger function is a new feature which allows rapid, one handed measurements. Currently there is only one Trigger selection. 'Add Layer' turns the trigger feature on, 'Disabled' turns it off. The 'Delay' function sets the amount of time from when the top is lifted (exposed to light) until a measurement is taken and saved.

The 'Sensitivity' function has a default of 10, which should be adequate for most applications. In a few applications (very low Integration Time or high Boxcar Width) the Sensitivity may need to be increased.

Navigating Graphs

The graph can be panned and zoomed to focus on your spectrum of interest.

Using a Mouse or other pointer

1. Press and hold the left button while moving the mouse to pan.
2. Scroll the mouse-wheel to zoom.

Using a Touch-Screen

1. Touch and move your finger to pan.
2. Pinch to zoom.

Resetting to the Default Perspective

Occasionally you may zoom or pan inadvertently and lose your place on the graph. Follow these instructions to revert to the default perspective...

1. Select the **Setup** button on the toolbar.

2. Select the **Graph** submenu.
3. Select **Fit To Screen**.

Customizing Graphs

Viewing a Specific Range of Spectrum

By default, SpectraSnap! displays data from 400-1000nm (specifications are 400-950nm). The band currently being viewed can be customized by following these instructions...

1. Select the **Setup** button on the toolbar.
2. Select the **Graph** submenu.
3. Select the **Spectrum** submenu.
4. Select the **Start** and **End** of the band to view.

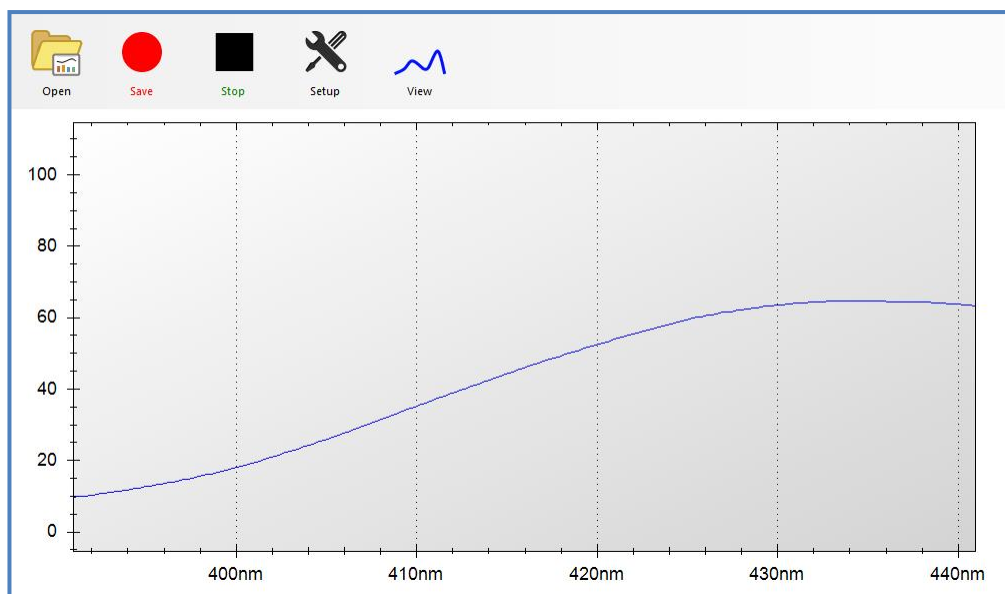


Figure 12: SpectraSnap! set to show the spectrum from 390 – 445nm.

Displaying Spectrum Peaks

To display the intensity of peaks in the graph follow these instructions...

1. Select the **Setup** button on the toolbar.
2. Select the **Graph** submenu.
3. Select the **Peaks** submenu.
4. Select the **Baseline** and **Minimum Width** of the peaks to display.
5. Select **Show** to display peaks.

Note: This option's text changes to Hide as it is used to toggle visibility.

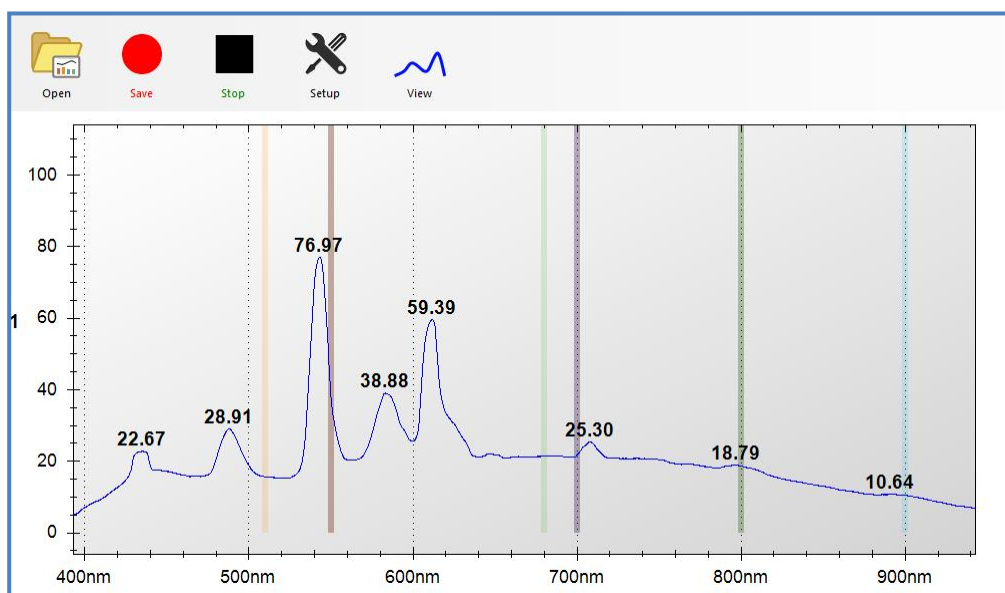


Figure 13: The graph displaying spectrum peaks.

Note: Peaks are displayed when they are wider than the Minimum Width and reach above the Baseline.

Displaying Spectrum Layers

To display one measurement layered on-top of another follow these instructions...

1. Select the **Setup** button on the toolbar.
2. Select the **Graph** submenu.
3. Select the **Layers** submenu.
4. Select **Add...** to add the current data as a layer or **Reset** to clear the layers.

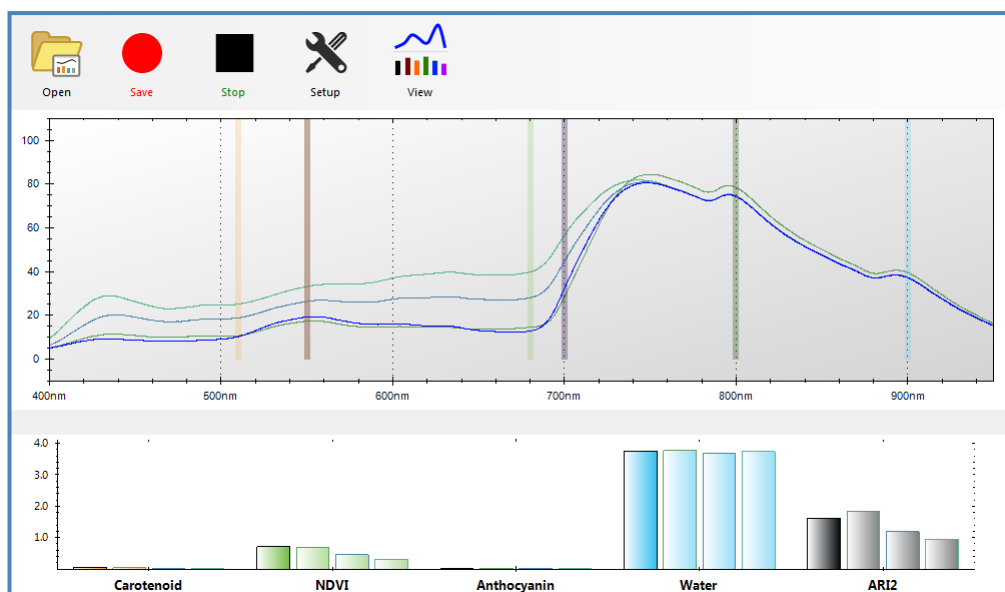


Figure 14: Multiple layers being displayed simultaneously.

Note: The calculations below the graph will display multiple values, one for each layer, with the outline of the value bar corresponding to the color of the layer in the graph. Calculations are not available in scope mode.

User-Defined Calculations

Calculations in SpectraSnap! are user defined formulas displayed on the screen in real-time along with the spectrometer data. Calculations are not available in Scope mode.

Adding a Calculation

1. Select the **Setup** button on the toolbar.
2. Select the **Calculations** submenu.
3. Select **Add New...**
4. Select a pre-defined index or choose Custom.
5. Select the color, title, description and notes to use for this calculation.

Note: The color and title are displayed in the Calculations bar chart graph. Other fields are for reference only.

6. Select **Next** to continue.
7. Enter the formula to use for this calculation. If you chose a pre-defined index you may opt to leave it as is or modify it.
8. Select **Test** to test your formula against the spectrometer data currently being displayed on the main screen.

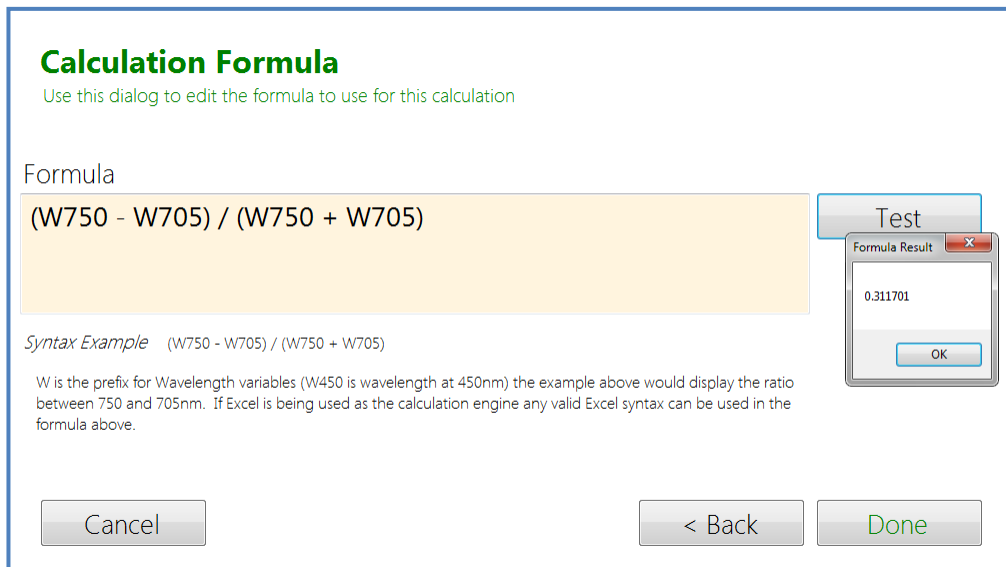


Figure 15: A formula being tested at Step 8 in the instructions above.

9. Select **Done** to save the calculation and return to the main screen.

Removing Calculations

1. Select the **Setup** button on the toolbar.
2. Select the **Calculations** submenu.
3. Select the calculation to remove.
4. Select **Delete** to remove that calculation.

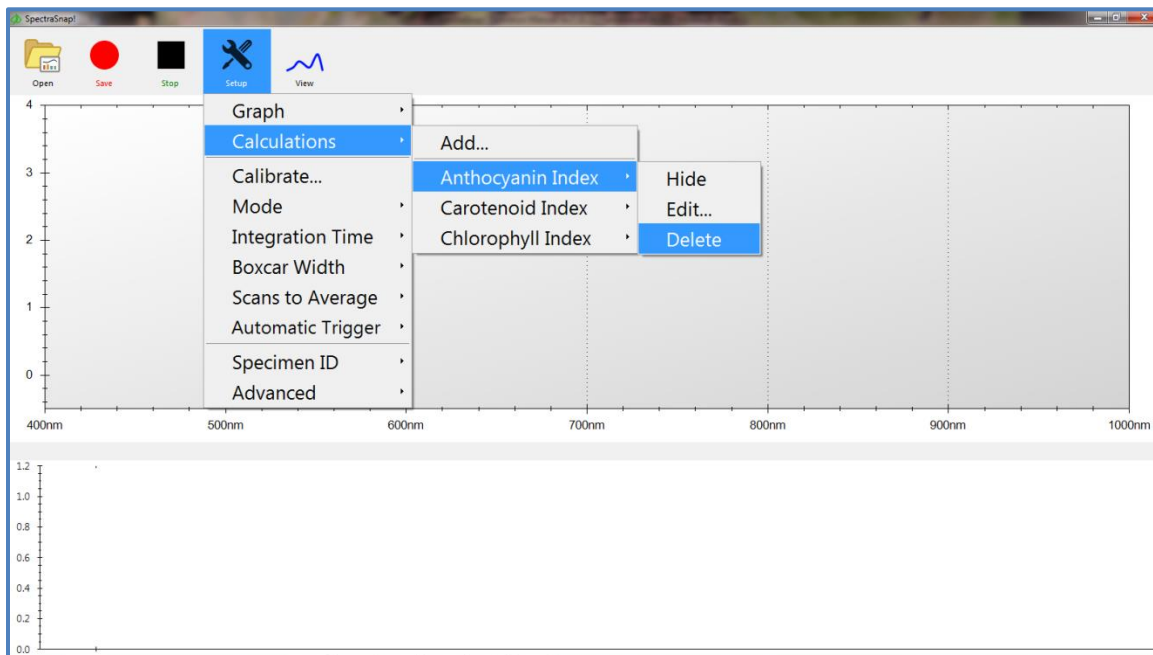


Figure 16: Following Step 4 to delete a calculation.

Temporarily Showing/Hiding Calculations

1. Select the **Setup** button on the toolbar.
2. Select the **Calculations** submenu.
3. Select the calculation to remove.
4. Select **Hide** to temporarily hide that calculation without deleting it.

Note: This option's text changes to Show for hidden calculations and causes hidden calculations to reappear.

Editing Calculations

1. Select the **Setup** button on the toolbar.
2. Select the **Calculations** submenu.
3. Select the calculation to edit.
4. Select **Edit...** to change the calculation.

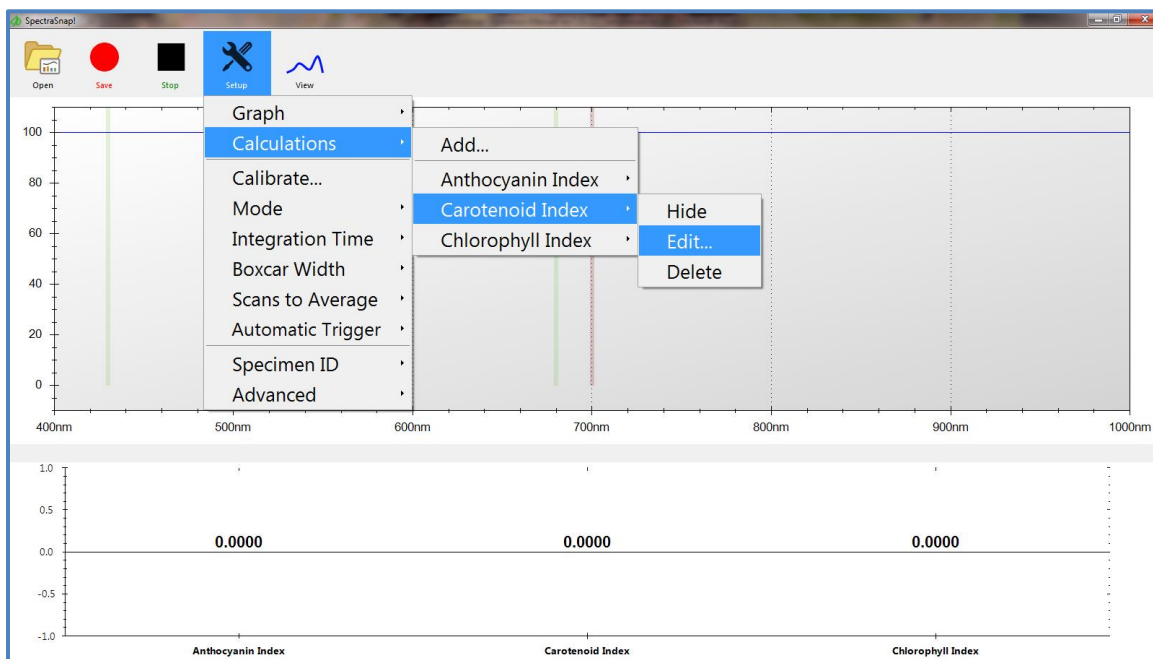


Figure 17: Following Step 4 to edit a calculation.

Changing the Calculation API

Calculations are evaluated by the software using either Microsoft Excel or Flee (Fast Lightweight Expression Evaluator) which is a free alternative integrated in SpectraSnap! When Excel is selected the user has the ability to include Excel functions in calculation formulas.

Note: To use Excel you must have an activated version of Excel installed on the PC.

1. Select the **Setup** button on the toolbar.
2. Select the **Advanced** submenu.
3. Select the **Calculation API** submenu.
4. Select **Flee** or **Excel** based on your preference.

Troubleshooting

Technical Support

If you have a question about the CI-710 software features and functions, first look in the CI-710 Operation Manual. There is also online support available for the CI-710 and SpectraSnap! at <https://www.cid-inc.com/support/CI-710/>. If you cannot find the answer, you can contact a Technical Support Representative located in your country. CID Bio-Science, Inc. is committed to provide customers with high quality, timely technical support. Technical support representatives are to answer your technical questions by phone or by e-mail at support@cid-inc.com.

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E-mail: support@cid-inc.com

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FAQs

If there are any questions about the CI-710 or SpectraSnap! software, please check the Frequently Asked Questions below, as well as the CID Bio-Science support webpage and forum at <https://www.cid-inc.com/support/CI-710/>

1. What is happening if **no spectrometer is recognized** by the computer or there is **no spectral data** with the instrument connected and installed?
 - a. Check the USB connection to see if it is loose.
 - b. Check the USB port. Always use the same USB port that had the CI-710 driver installed.
 - c. Check that the driver is properly installed. Try uninstalling and re-installing driver.

2. How do I get a spectrum that is not **saturated**?
 - a. Lower the integration time if the spectrum is saturated (cannot see tops of peaks).

3. What if there is **no intensity** from the light source?
 - a. Check that the switch on the spectrometer is set to "On."
 - b. Try setting the integration time higher.
 - c. Check that the fiber optic cable is not broken. Light should appear at single end of cable when instrument turned on.
 - d. Check for broken light bulbs. Remove the fiber optic cable and check if any light comes out of the leaf probe.

4. What if there is a strong presence of **stray light**?
 - a. Make sure that the sample covers the entire measurement area.
 - b. If the sample is thick, adjust the leaf clip to accommodate.
 - c. Use your hand to cover the leaf clip and sample while taking a measurement.

5. How can I smooth the wavelength and possible increase the range?
 - a. Increase the integration time to around 400 ms. Try to find the maximum time that does not lead to signal saturation. Also, set the boxcar width to 10. Doing this will smooth the data a bit.

6. What is the unit of measurement?
 - a. Typical measurements with the CI-710 are unit-less. They are measures of relative intensity.

7. What are the Y-axis units in SpectraSnap?
 - a. In Reflectance Mode, the y-axis is the percent of light reflected compared to a standard (0-100%).
 - b. In Transmission Mode, the y-axis is the percent of light transmitted (0-100%).
 - c. In Absorbance Mode, the y-axis is the optical density on a scale of 0-4.
 - d. The calculations are unit-less.

8. Can the CI-710 measure chlorophyll content?
 - a. The CI-710 can measure the green-ness of leaves, which is related to chlorophyll content. The measurements are relative. A researcher can combine measurements from the 710 and data from chlorophyll extraction to develop a species-specific correlation for absolute quantitation.

9. How do I position the CI-710 to make measurements in reflectance mode?
 - a. For reflectance measurements, the fiber optic probe should be connected to the side of the CI-710. To make measurements of the upper, axial side of the leaf, turn the instrument upside down so that the CI-710 spectrometer box and light probe are on top of the leaf. The leaf clip will attach on the bottom, abaxial side of the leaf, seen below. *To eliminate light loss, place a black backing on the opposite side of the leaf, the black side of the reflectance standard can be used for this purpose.*



Standard positioning for a reflectance measurement.

SpectraSnap! Software Agreement

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8. Export Restrictions and Reservation of Rights. Customer certifies that neither the Software nor the Confidential Information nor any portion thereof will be exported to any country in violation of any applicable laws including, without limitation, the United States Export Administration Act and regulations there under, as applicable.

9. Term and Termination. This Agreement will continue in effect for so long as Customer is engaged in using as specified above. Customer agrees to discontinue the use as specified above upon request by an authorized representative of CID Bio-Science, Inc. Following termination of this Agreement for any reason, the provisions of this Agreement with respect to non-disclosure and limited use of the Software, indemnification, and warranty and liability disclaimers, will survive. Upon termination of this Agreement, Customer shall cease using, and upon request, return to CID Bio-Science, Inc. all materials, data, documentation and information constituting or relating to the Software, including all copies and regardless of the form or media on which same is contained. At the request of CID Bio-Science, Inc., Customer shall certify that the terms of this Section have been complied with.

10. Entire Agreement and Governing Law. This Agreement: (a) constitutes the entire Agreement with respect to the Software. It supersedes all prior or contemporaneous oral or written agreements concerning the Software and; (b) may not be amended except by the written agreement signed by authorized representatives of both parties; (c) will be governed by and in accordance with the laws of the State of Washington as applied to agreements and to be performed entirely within Washington with Washington residents, and is not governed by the United Nations Convention on Contracts for the International Sale of Goods, the application of which is expressly excluded. The parties agree that any litigation relating in any way to this Agreement shall be filed and initiated in and only in Camas, Washington and the parties consent to personal jurisdiction and venue in the Federal and State Courts in Camas, Washington.

Hardware Warranty

Seller's Warranty and Liability:

CID Bio-Science warrants new equipment of its own manufacturing against defective workmanship and materials for a period of one year from date of sale. The results of ordinary wear and tear, neglect, misuse, accident and excessive deterioration due to corrosion from any cause is not to be considered a defect.

CID Bio-Science, Inc.'s liability for repairing or replacing defective parts during the warranty period is contingent on examination by a CID Bio-Science authorized representative. CID Bio-Science, Inc.'s liability will not extend beyond repairing or replacing parts from the factory where they were originally manufactured. Repair or alteration by an unauthorized technician voids warranty.

Material and equipment which is not manufactured by CID Bio-Science, Inc. is to be covered only by the warranty of its manufacturer. CID Bio-Science will not be liable to the Buyer for loss, damage, or injury to persons or to property by the use of equipment manufactured by other companies.

Buyer accepts the terms of warranty through use of this instrument and any accessory equipment. There are no understandings, representations, or warranties of any kind, express, implied, statutory, or otherwise (including, but without limitation, the implied warranties of merchantability and fitness for a particular purpose), not expressly set forth herein.

All instrument repairs or replacement covered under warranty require a Returned Material Authorization (RMA) number. Please contact CID Bio-Science technical support department at support@cid-inc.com to obtain an RMA number before shipping instrument to CID Bio-Science, Inc.

Buyer is responsible for shipping charges to CID Bio-Science, Inc. headquarters:

1554 NE 3rd Ave.
Camas, WA 98607
USA

CID Bio-Science, Inc. is responsible for return shipping charges on repairs and/or replacement covered by warranty.

Warranty Registration Card



1554 NE 3rd Ave, Camas, WA 98607, USA
 Phone: (360) 833-8835 Fax: (360) 833-1914 e-mail: sales@cid-inc.com Web: www.cid-inc.com

PRODUCT REGISTRATION CARD

Please complete and return this form to CID within 30 days to validate your Warranty on Parts and Labor.

Registration Information:

Your Name: _____ Title: _____

Company/University: _____

Address: _____

City: _____ State: _____ Zip: _____

Country: _____ Email: _____

Phone: _____ Fax: _____

CID Serial Number(s): _____

Purchase Date: _____ Purchase Price: _____

FOLD ON DOTTED LINE

Your opinions will help improve our service. Please answer the following questions.

1. What was the basis of your product selection?

- | | |
|--|---|
| <input type="checkbox"/> Representative Recommendation | <input type="checkbox"/> Price |
| <input type="checkbox"/> Product Features | <input type="checkbox"/> Product Design |
| <input type="checkbox"/> Technical Specifications | <input type="checkbox"/> Brand Name |
| <input type="checkbox"/> Warranty | <input type="checkbox"/> Service |
| <input type="checkbox"/> Other _____ | |

2. What other competing brands did you consider? _____

3. Where did you first learn of this product?

- | | |
|---|---|
| <input type="checkbox"/> Advertisement in _____ | <input type="checkbox"/> Representative |
| <input type="checkbox"/> Friend/Colleague | <input type="checkbox"/> Exhibit |
| <input type="checkbox"/> Other _____ | |

4. Who selected this product?

- | | |
|--|---|
| <input type="checkbox"/> I did | <input type="checkbox"/> Research Group |
| <input type="checkbox"/> University Department | <input type="checkbox"/> Purchasing |
| <input type="checkbox"/> Other _____ | |

5. Comments/Suggestions:

