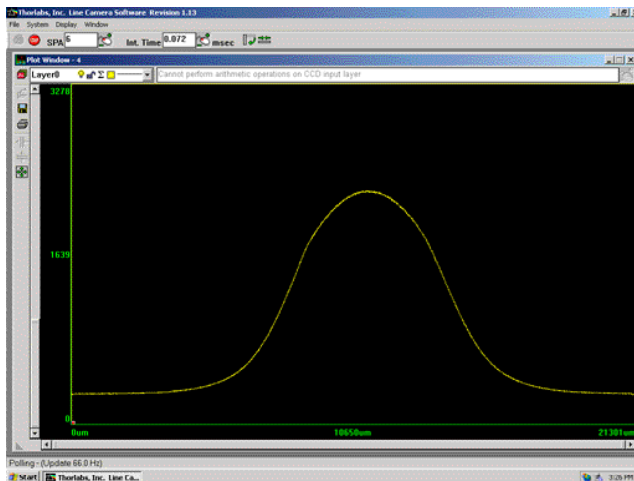

Operation Manual

Thorlabs
LC1 - USB

USB 2.0 CCD Line Camera



2005

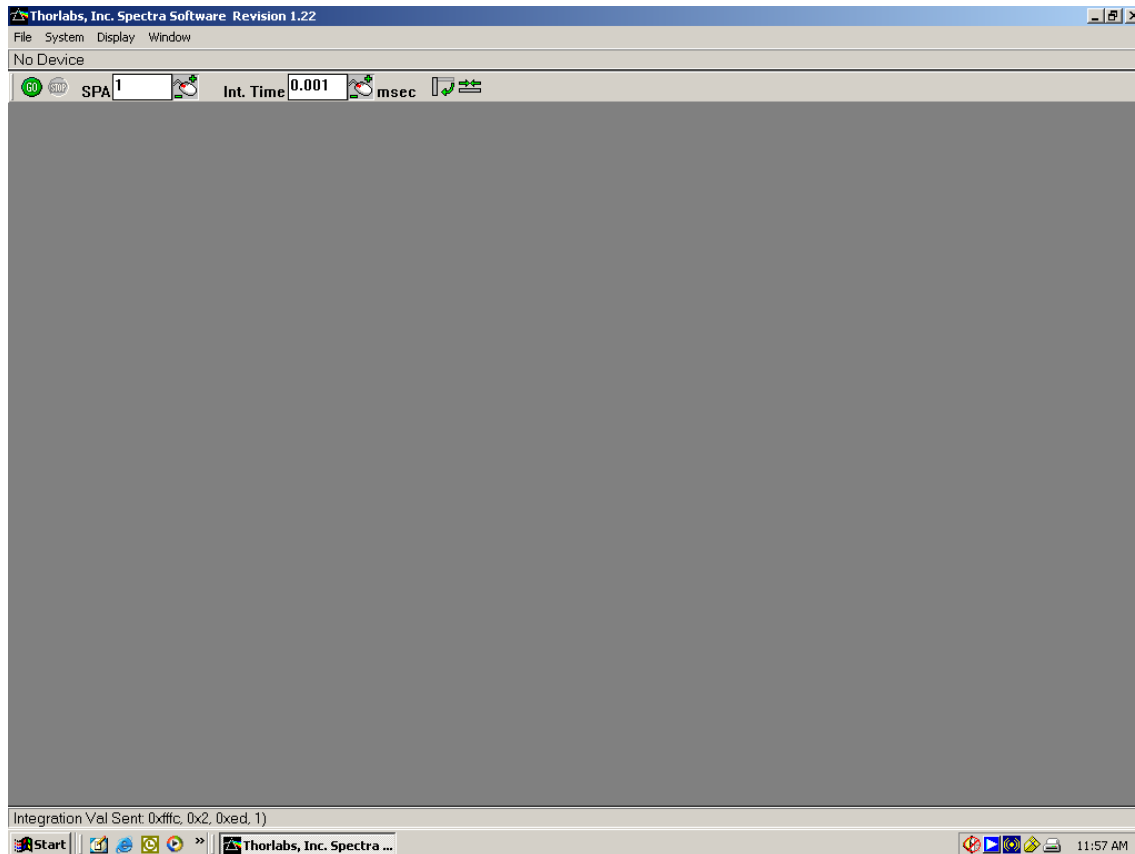
THORLABS

3. Spectra Software

3.1. Quick Start

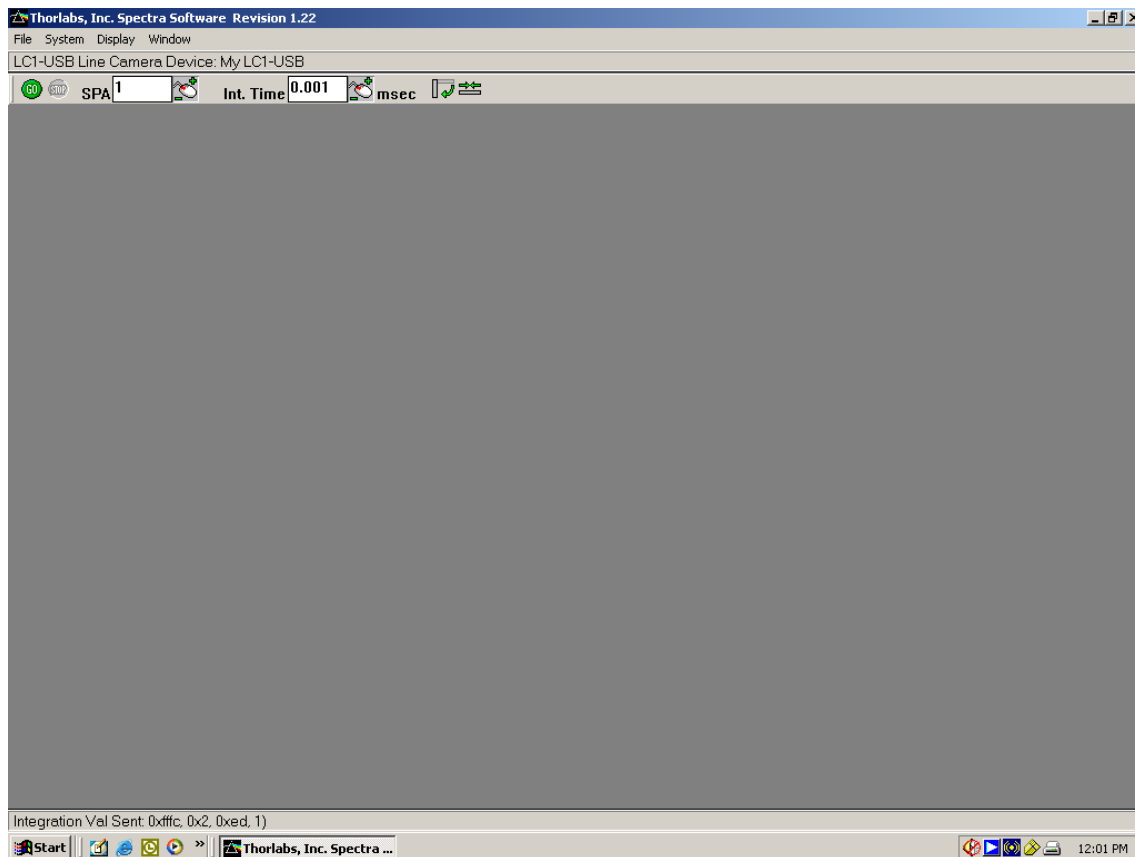
Assuming that all of the installation instructions have been followed, it is now time to run the line camera software.

Go to the Start Menu ⇒ Thorlabs ⇒ spectra.exe. The screen that appears is as follows:



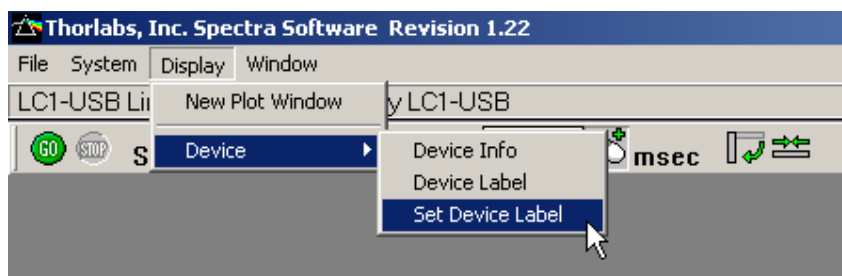
Note: The message "No Device" appears in the status bar. This indicates the LC1-USB is not connected to a USB port.

Once the LC1-USB has been connected to a USB port, the display should resemble the following:

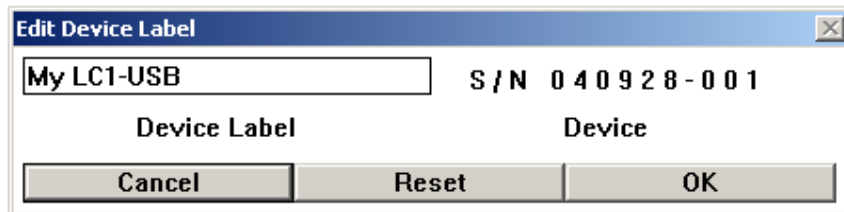


Note: Status bar indicates the LC1-USB device "My LC1-USB" is attached.

The status bar shows there is an LC1-USB device attached with the Device Label "My LC1-USB". You may change the Device Label by pulling down the Display menu and opening to "Set Device Label".



The following dialog box will appear:

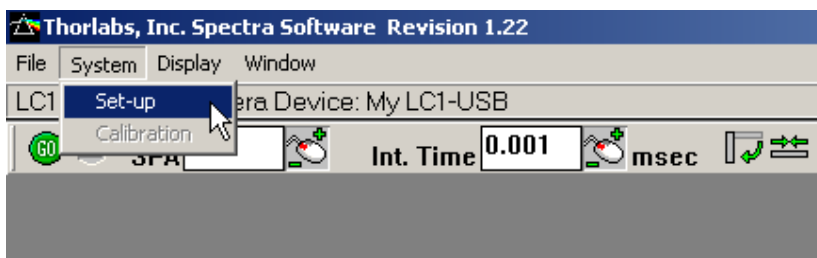


To change the label, click on the edit window above Device Label, type the new label, and click OK.

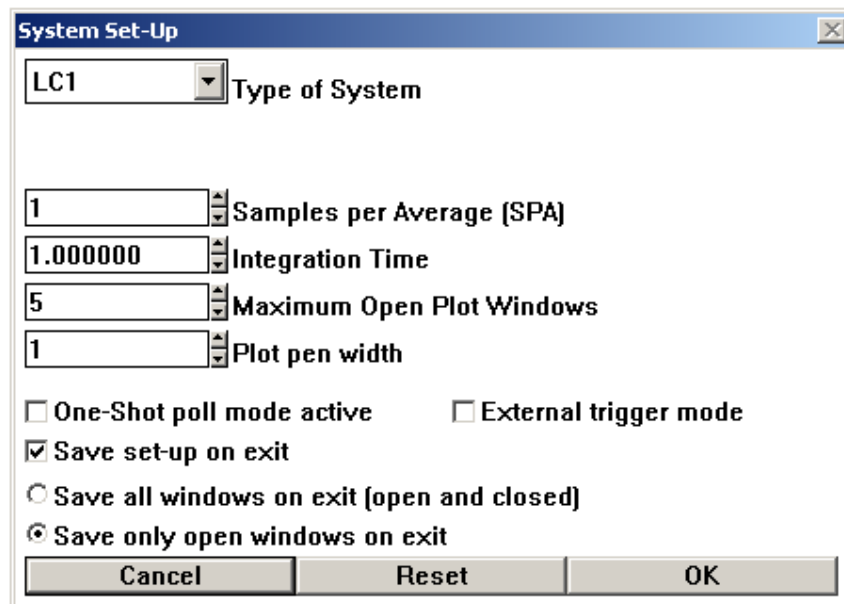
Note: The label can only be modified while the LC1-USB is in the idle state.

3.2. First Time Start

If this is the first time starting the line camera there are a couple of settings that must be checked. Left-click on System \Rightarrow Set-Up on the menu bar.



The following menu will appear:



The Type of System must be set to LC1. The default setting of the Maximum Open Plot Windows is five, which should work well on most systems. Each plot window consumes memory; so on systems without much RAM, this number should be lowered.

One-Shot poll mode active should not be checked unless the LC1-USB will be used for single shot data. SPA (Samples per Average) and Integration Time are arbitrarily set since they can be controlled actively in the main window.

3.2.1. The Main Toolbar



Below are descriptions of each of the buttons:



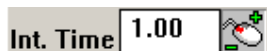
The GO button starts polling of the line camera.



The STOP button stops polling of the line camera.



SPA stands for samples per average. When the SPA is set at one, there is no averaging occurring. Any number greater than one represents the number of samples averaged together for the data displayed.



Int. Time is the integration time. This represents how sensitive the CCD is to incoming light. CCD pixels act like light buckets, gathering photons. The integration time display represents how many milliseconds the bucket is open. For very bright sources, low integration times are required, whereas for weak sources, longer integration times should be used. As in the light bucket analogy, CCD pixels can be overfilled. This is called saturation and will cause the output to be misleading.

TOOLBAR TIP



The mouse with +/- symbols can be used to quickly change the value of the quantity associated with it. Move the pointer over the icon and press the left button. While holding the button down, moving the mouse up increases the value, and moving the mouse down decreases the value. Button down, moving the mouse up increases the value, and moving the mouse down decreases the value.





Toolbar Settings are manipulated by this pair of buttons. The button on the left controls the orientation of the tool bar and the button on the right controls its length.

3.2.2. Getting Your First Line Scan

With an understanding of the main toolbar, it is easy to bring up your first data. If no plot window appears in the line camera main window, first go to [Display](#) ⇒ [New Plot Window](#). With light being fed into the line camera and SPA set to one, click on the GO icon. If there is no signal, increase the integration time until a signal starts to appear. Once a signal is attained, there are ways to zoom in on it. This is explained in the next section on scroll bars.

3.2.3. Scroll Bars

Scroll bars are used to scale the graphical output in the plot window. The image to the right shows a portion of the vertical scroll bar. The vertical scroll bar controls the relative amplitude of the peaks of a line scan that is being viewed. Move the cursor around the bar. The cursor symbol will change from  to  when the cursor is in a position to change the vertical scale. While in that position, hold down the left button and move the cursor up and down noting the change in the scale. Changes in the vertical scroll bar affect the amplitude and changes in the horizontal scroll bar affect the position range. At the top of the plot window, a button bar appears as indicated.



3.3. Layers

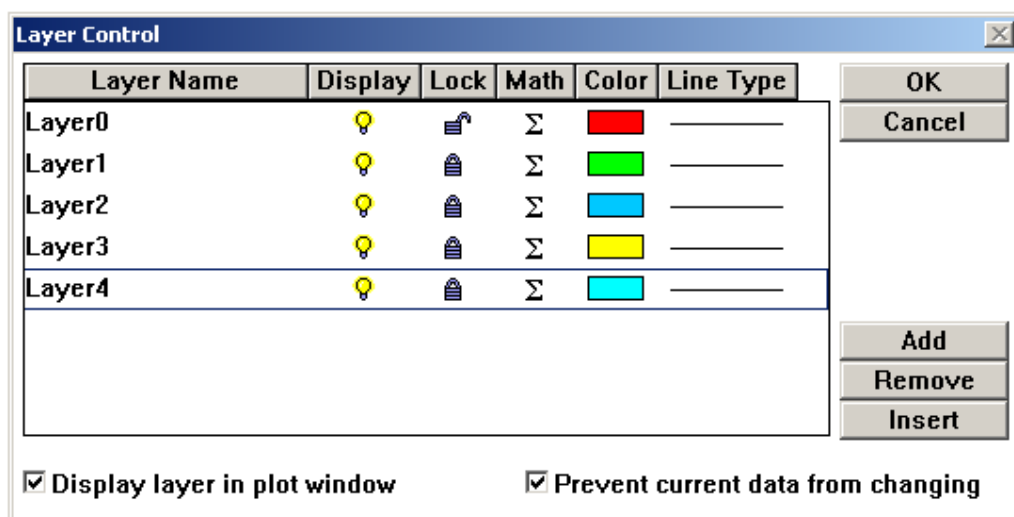


One of the unique features of the software for the LC1-USB is the ability to see the raw data while performing mathematical functions on various other layers. At the top of the plot window, a button bar appears as indicated.

3.3.1. Layer Control



The Detailed Layers Adjustment icon is used to access the layer control menu. It allows for general control of all layers. Additional layers and controls on existing layers may be specified here. The following sample menu is displayed:



This menu allows for the user to add and remove layers as well as control the display features of each layer.

- The bulb represents whether or not the layer is displayed in the plot window. represents that the layer is on and represents that it is off.
- The lock specifies whether the layer may be changed. is unchangeable and may be changed.

This function allows access to another menu that controls the math functions acting on the data. Any layer, with the exception of Layer0, may be made up of existing layers in combination.

The Add button adds a new layer to the end of the list of layers. The Insert button inserts a layer above the selected layer. The Remove button removes the selected layer (CCD input layer cannot be removed).

Later sections of the manual go into more detail with the mathematics, but it is worthwhile to mention here that +, -, * and / are all acceptable functions. For example, Layer3 might equal $\text{Layer2} * \text{Layer0} / \text{Layer1} + \text{Layer1}$. The math submenu appears as follows:

+	-	*	/	Layer0					Insert
{	}	Smoothing							Insert
Format: SMOOTH(layername,iterations)									
Cancel			Accept			Reset			

3.3.2. Layer Changing Example

As a simple example, here are the steps so the input line is doubled:

Step 1: Click on the icon in order to bring up the layer control menu. In the example, there were no previous layers, so only Layer0 appeared. If there are other layers, it is simple to highlight them and remove them. The screen that comes up looks as follows:

Layer Name	Display	Lock	Math	Color	Line Type
Layer0					

Buttons: Add, Remove, Insert, OK, Cancel

☒ Display layer in plot window ☐ Prevent current data from changing

Step 2: Click on the Add button as in the picture and Layer1 will appear that can now be used to display the math function.

Layer Name	Display	Lock	Math	Color	Line Type
Layer0					
Layer1					

Buttons: Add, Remove, Insert, OK, Cancel

☒ Display layer in plot window ☐ Prevent current data from changing

Step 3: Click on the math symbol as in the illustration. This will bring up the math menu for Layer1.

Layer Name	Display	Lock	Math	Color	Line Type
Layer0					
Layer1					

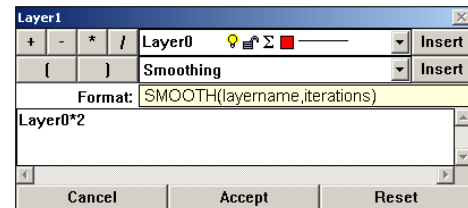
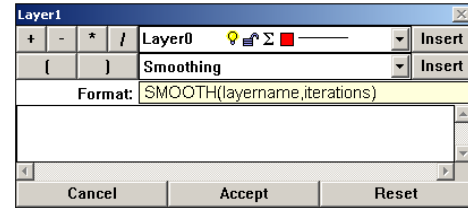
Buttons: Add, Remove, Insert, OK, Cancel

☒ Display layer in plot window ☐ Prevent current data from changing

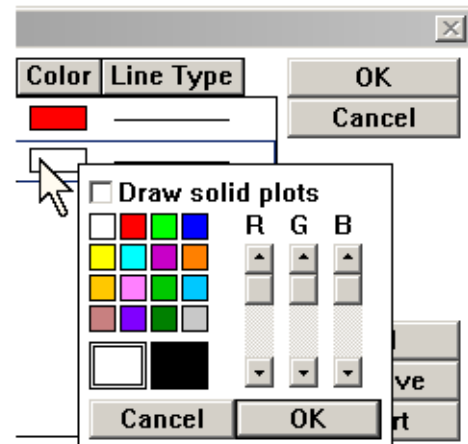
Step 4: The math menu should appear as follows:

Layer1 will be Layer0*2. First select layer for calculation, then click Insert. Next, select the * button. Finally, type in the number 2.

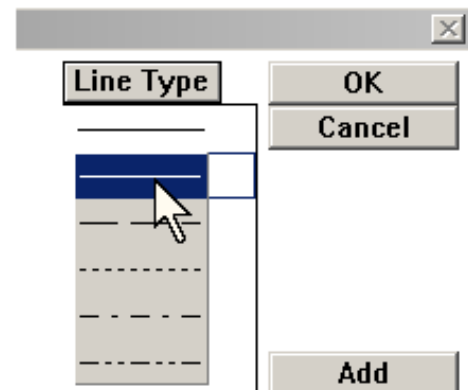
The end result should appear as follows:



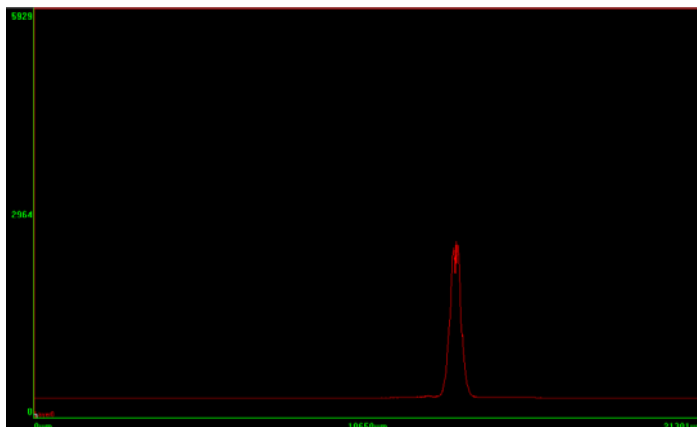
Step 5: This will bring us back to the layer control menu. Click on the color for Layer1 to bring up the color menu. This allows the choice of color for the display. To change the color, click on the color square, or use the RGB (red, green, blue) sliders to make a new color.



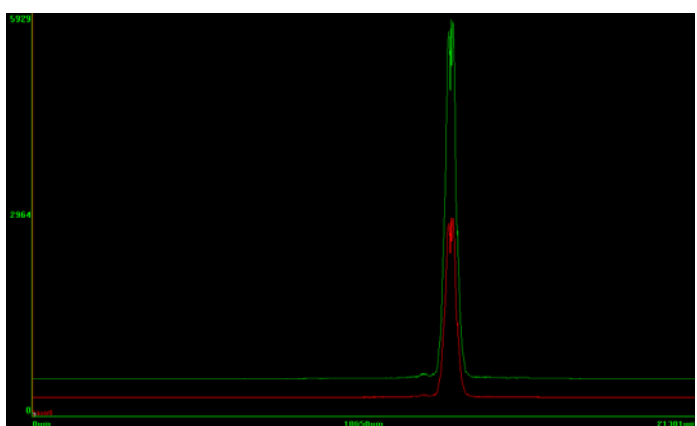
Step 6: To change the line type that Layer1 will display in, click on the line for Layer1 as shown to the right. This will allow a number of different choices. Then click on OK to continue



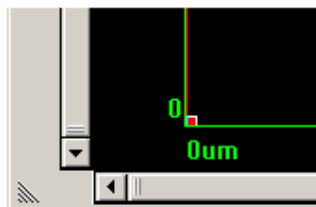
The following page will show the results of the above actions on a profile of a laser module's collimated beam.



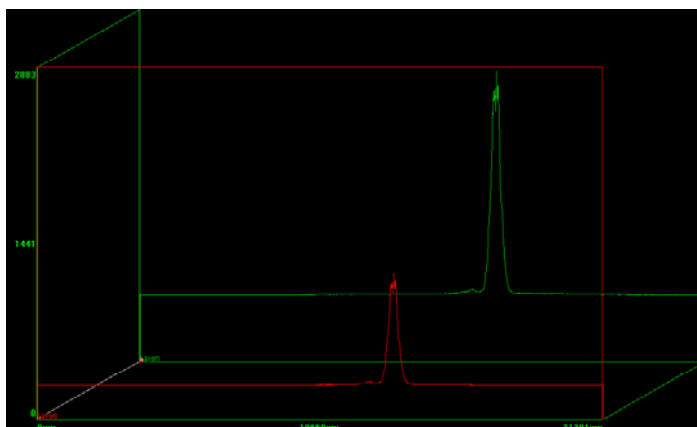
In the diagram, Layer0 is turned on and shows a laser profile.



In this diagram, Layer1 is green and turned on. The arithmetic used to derive Layer1 is $2 \times \text{Layer0}$

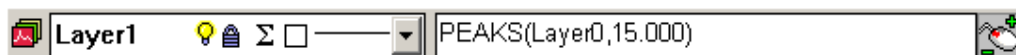


To better see the two separate layers the plot window can be shifted into 3D mode. To do this, move the cursor to the origin where there is a small red dot. When the cursor is over the small red dot, it will change from to . At this point, hold down the left mouse button and move the cursor towards the center of the plot window. This will cause the plot to fold out in 3D.



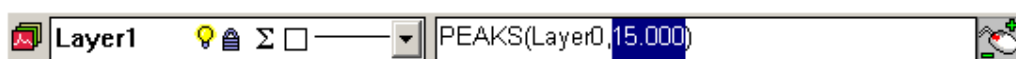
The resulting effect should look like this image. More about 3D views will be discussed later in the manual.


3.3.3. Current Layer



The layer that is displayed at the top of the plot window is considered to be the current layer. Whatever functions are called act upon this layer. If snap cursors, vertical cursors, or horizontal cursors are displayed, they show up on this layer. The area to the right of the layer name and attributes shows the mathematical function that is operating on the layer. At the far right is a mouse control that allows for interactively controlling the values within the math function. This is used as follows:

Highlight the numeric part of the mathematical expression that will be altered.



Move the mouse over the  button.

While holding down the right mouse button, move the mouse forward to increase the value, and backward to decrease the value.

Note: When decreasing values in this manner, it is very easy to decrease the value to zero. This can cause errors such as division by zero that will stop the polling of the line camera.

3.3.4. Averaging & Smoothing

3.3.4.1. Averaging



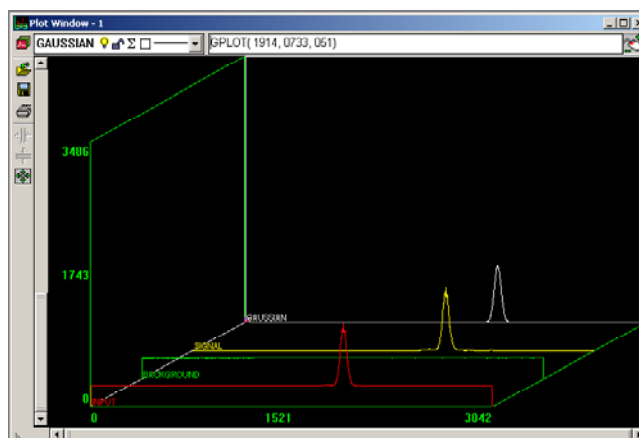
The averaging routine uses the SPA (Samples Per Average) function. This function is accessible through the main toolbar. Averaging works on Layer0 as a rolling average and the number in the SPA function represents the number of complete data sets averaged. When a source is noisy or fluctuating, the SPA function can act to provide a stable output.

3.3.4.2. Smoothing

Smoothing uses a mathematical algorithm to attempt to remove noise. Unlike the averaging function, smoothing is done on an existing layer and presented in another layer (i.e. Layer1 can display Layer0 smoothed). Layer0 can never display another layer smoothed because it always represents the raw data.

The screen now appears as in the figure below:

In this example, it is important that the background noise has been filtered out. In the 3D view, the offsets are clearly shown, as can be seen in this close-up view of the right edge of the plot window. As expected, the offsets are displayed in the INPUT and BACKGROUND layers, but not in the SIGNAL layer.





3.3.9. Cursors

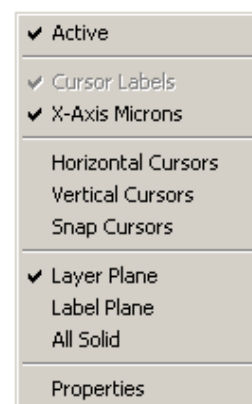
A number of different cursor and display features can be accessed through right clicking of the mouse. In the plot window, click the right mouse button. This image should appear. Each of the options will now be explained:



Active – determines whether the window is running or not. This is particularly useful when there are multiple plot windows being displayed.


Cursor Labels – mark the cursor with labels such as x1 or x2 so the cursor may be easily identified.

X-Axis Microns – switches between measurement of microns and pixel number. When it is checked, the measure is in microns.

Horizontal Cursors – draws a pair of horizontal cursors that may be moved from up and down to define a region of interest. When the mouse is moved over a horizontal cursor line the arrow will change to . While the mouse is in this state, holding down the left mouse button will allow the horizontal cursor line to be dragged. A readout is given that gives the location of y1, y2, and the difference between y1 and y2. The readout may be dragged to anywhere on the plot window, by holding down the left mouse button while the mouse pointer is over it. With Horizontal Cursors displayed, clicking on the Zoom to current horizontal cursors button  (on the toolbar on the left side) will zoom to the area between the Horizontal Cursors.



Vertical Cursors – draws a pair of vertical cursors that may be moved from side to side to define a region of interest. When the mouse is moved over the vertical cursor line the arrow will change to . While the mouse is in this state, holding down the left mouse button will allow the vertical cursor line to be dragged. A readout is given that gives the location of x1, x2, and the difference between x1 and x2. The readout may be dragged to anywhere on the plot window, by holding down the left mouse button while the mouse pointer is over it. With Vertical Cursors displayed, clicking on the Zoom to current vertical cursors button  (on the toolbar on the left side) will zoom to the area between the Vertical Cursors.



Snap Cursors – provides a movable vertical cursor and draws a horizontal cursor corresponding to the data point that the vertical cursor crosses. This is a way to zero in on local maxima and minima. Click and hold the left mouse button while  is on a vertical cursor to change its location.

Layer Plane – boxes the current layer. In the 2D view this has no effect, but in the 3D view it helps in distinguishing which layer is current and being operated on.

All Solid – makes the graphical output opaque for each layer. It helps in visualization when doing a monochromatic printout of the 3D view. In the 2D view, it acts to partially block viewing the layers behind Layer0.

Properties – allows the altering of all of the functions on one menu.

3.4. Storing and Retrieving Data

One of the more useful features of the line camera is the ability to store and retrieve data. Storing the active layer is done by hitting the SAVE  button. The save window is displayed asking in which directory to save the data. The spectral files are saved with the extension .prn in the chosen directory. The data in the .prn file is saved in a text format so it may be imported into other programs for analysis. To view the data, open Windows Notepad and then open the saved .prn file inside of it. To retrieve a saved spectrum, first select an open layer by using the layer pull-down menu. Then use the LOAD  button to load a saved layer.

5. LC1-USB Specifications

Software Compatibility

The LC1-USB Software is compatible with Windows 98 / ME / 2000 & XP by means of system device drivers. The following files are provided.

WINDRVR6.SYS

WINDRVR6.INF

THORLABS.INF

Graphics:

X axis: 0-21301 μm Points (Scalable)

Y axis: 0-10,000 Units (Scalable)

Data Display: Continuous or One Shot Poll Mode

Data Update: Better than 90Hz (CPU Speed Dependant)

PC Requirements:

500MHz Pentium III or Higher with 256MB RAM

Hard-Drive

CD-ROM

Dedicated USB 2.0 Port

Optical Head:

Spectral Range: 350 to 1000 nm

CCD Integration Time: 1 μs to 200 ms

CCD Sensitivity: 300 V/(lx · s)

CCD Pixel Size: 7 μm x 200 μm (7 μm pitch)

Dimensions (LxWxH): 3.6x2.6x1.0 Inches

Weight: 1 lb

Cables:

USB 2.0 Cable 6ft. length