THORLABS

Smart Line Camera

LC100
Operation Manual

2012

Version: 4.3.0
Date: 06.06.2012

Contents

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and improve our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

Warning

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

Attention

Paragraphs preceeded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

Note

This manual also contains "NOTES" and "HINTS" written in this form.

Please read these advices carefully!

1 General Information

The Smart Line Camera is designed for general laboratory use. Integrated routines allows averaging, smoothing, as well as saving and recalling data sets.

The initial setup is simple to complete. Following installation of the software, the LC100 line camera is ready to use. Simply plug it into a USB 2.0 port and run the application software SPLICCO. The remainder of this manual is devoted to the setup procedure and features of the line camera. A troubleshooting section and detailed specifications of the various components are provided to further assist. The description of the instrument driver commands can be found in the VXIpnp VISA instrument driver package.

Application software SPLICCO

SPLICCO is an acronym for "**SP**ectrometer and **LI**ne **C**amera **CO**ntrol". This software can be used for acquiring direct, transmittance and absorbance measurements in conjunction with Thorlabs line cameras and spectrometers.

After the installation the software is able to communicate with the line camera. Additionally, two virtual devices are included: a line camera and a spectrometer, to demonstrate the functionality of SPLICCO.

1.1 Safety

Attention

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.
All modules must only be operated with proper shielded connection cables.
Only with written consent from *Thorlabs* may changes to single components be carried out or components not supplied by *Thorlabs* be used.
This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for a replacement package.

1.2 Ordering codes and accessories

Ordering code	Short description
LC100	Smart Line Camera, 350 - 1100 nm

1.3 Requirements

Hardware Requirements:

CPU: 1 GHz or higher
RAM: 256 MB
Graphic card with at least 32 MB memory
Hard disc with at least 100 MB free storage space
free USB2.0 port
USB cable according the USB 2.0 specification

Software Requirements:

Windows ® XP (32-bit) SP3,
Windows ® Vista (32-bit, 64-bit),
Windows ® 7 (32-bit, 64-bit)
VISA runtime (version 5.1 or higher)

2 Installation

2.1 Parts List

Inspect the packaging for damage. If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the LC100 smart line camera mechanically and electrically.

Please verify that you have received the following items:

1x LC100 USB 2.0 CCD line camera

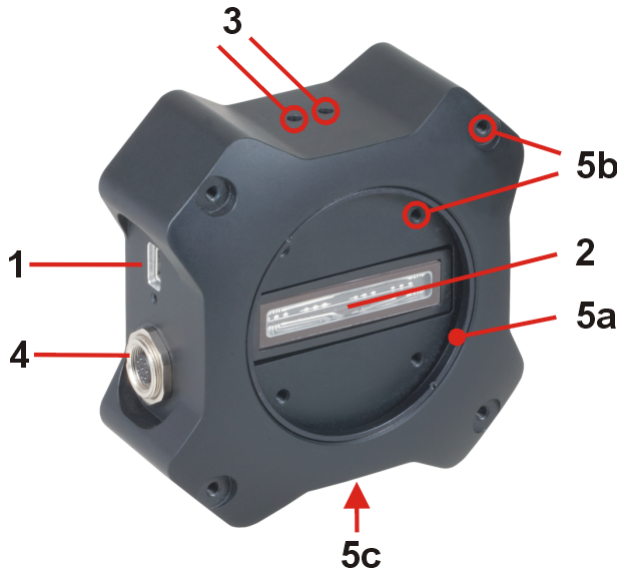
1x Line camera user manual

1x SM2 to Nikon F-mount Objective adapter

1x CD-ROM with application software SPLICCO and drivers

1x USB 2.0 A -B cable 2 meters

1x Trigger Input Cable



LC100 USB line camera with all user relevant ports and signal LEDs

(1) USB port

(2) Linear CCD array

(3) Status LEDs
LED "ON" - Green: Lights up, when the device is ready for operation
LED "BUSY"- Orange: Lights up every time the CCD exposure starts

(4) Trigger Input and GPIO connector

(5) a) SM2 internal thread
b) mounting threads for Thorlabs cage systems
c) mounting threads for Thorlabs posts

2.2 Getting started

The line camera must **NOT** be connected to your PC while the software is being installed.

Once the software has been installed, please connect the USB cable to the USB 2.0 port on your PC and the USB B mini connector to the line camera . You will be prompted to allow the automatic installation of the drivers. After completing, run the application program SPLICCO.

2.2.1 USB requirements

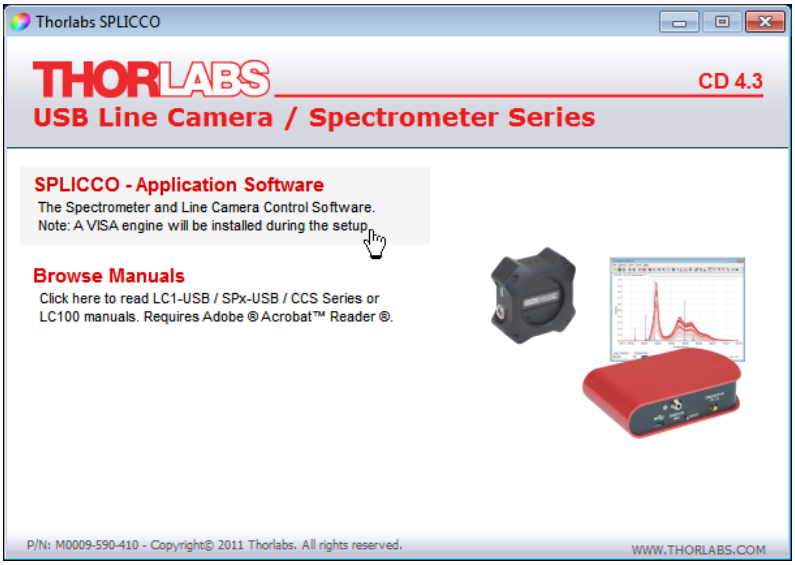
To achieve the maximum performance benefit from your LC100 USB line camera, you must have a dedicated USB 2.0 port available on your PC (a built-in USB 2.0 port is recommended).

2.3 Installing Software

2.3.1 The installation menu

Before installing SPLICCO, please make sure that no LC100 USB line camera is connected. After you inserted the SPLICCO installation CD an autorun menu will appear, see figure below. If autorun is disabled on your system you have to browse the installation CD and run

"[CD-Drive]:\Autorun\Autorun.exe".



Note

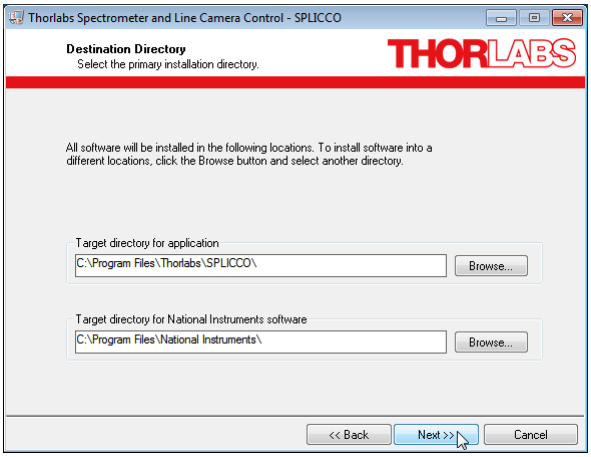
Please be aware that SPLICCO software requires the NI VISA runtime engine V5.1 or above installed on your system. The installer checks for installed VISA software and, if necessary, will install the NI VISA automatically. You will be notified accordingly:

Administrator privileges are required for installation. Please contact your system administrator, if you get an appropriate error message.

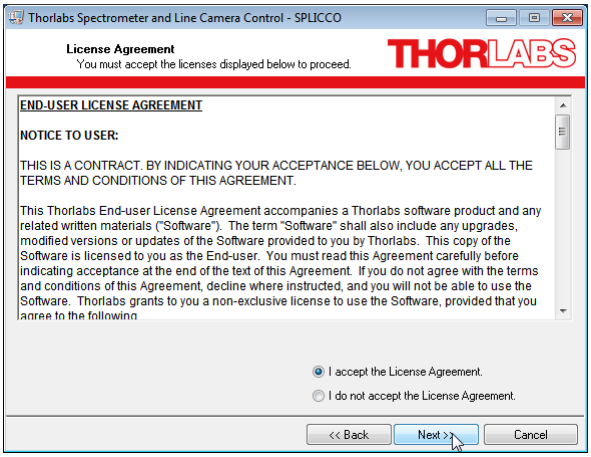
In the following section are shown in detail the installation steps for an installation on a Windows 7© operating system.

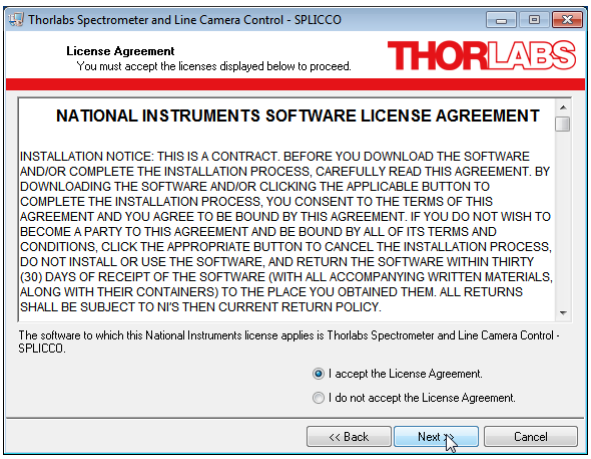
2.3.2 Installing SPLICCO

Select "SPLICCO - Application software" from the installation menu to start the installation wizard. You will be prompted to specify the installation path. Confirm with "Next" when you selected the installation path of your choice.

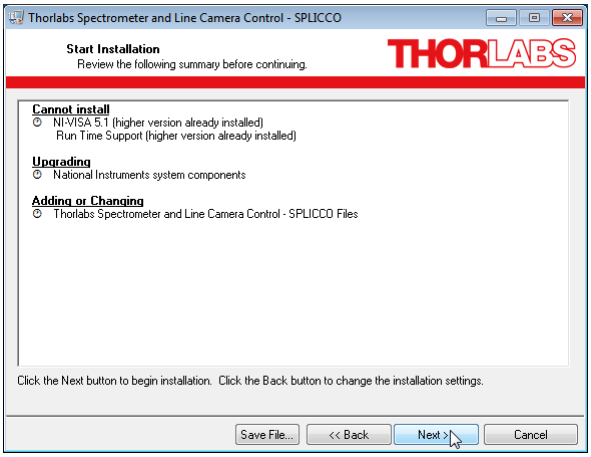


Please read the end user agreement carefully, choose "I accept the License Agreement(s)" if you do so and press "Next" in the following two screens:

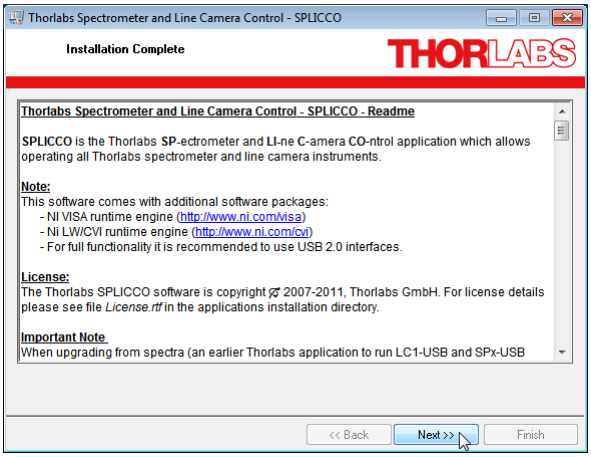




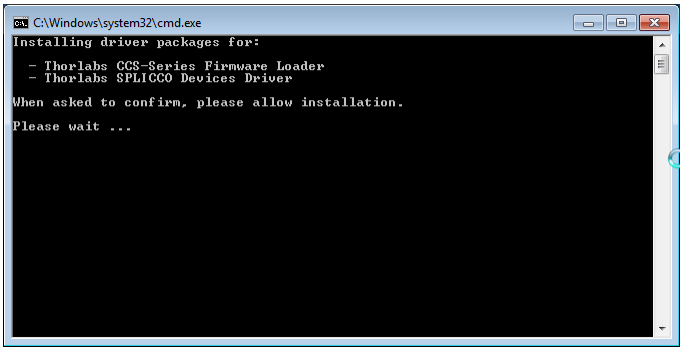
The following window states the next installation steps and notifies, which software will be installed. Click the "Next" button to begin installation or click the "Back" button to change the installation settings.



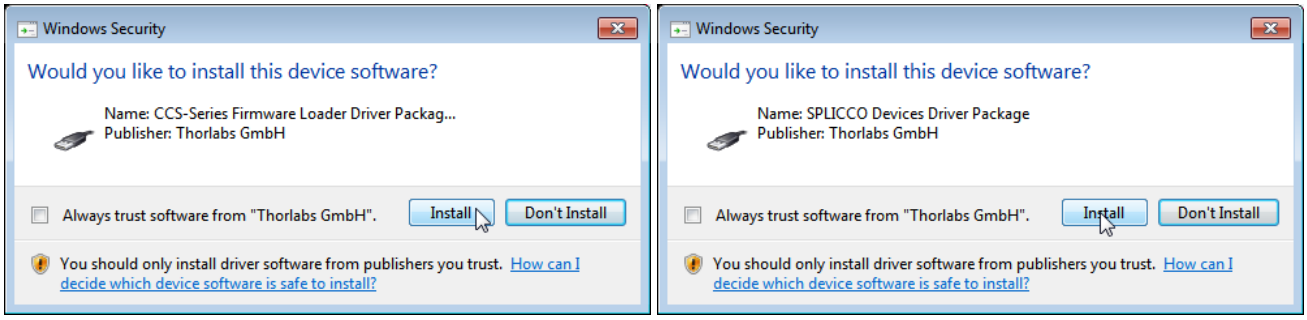
After the installation was successful you will see a window containing information about a log file (change log) and other notes. Press "Next" to finish installation.



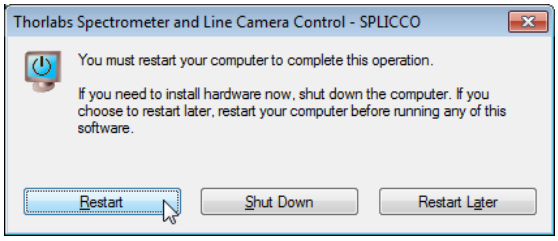
Now the device drivers will be copied into the system folders. This might take a few moments and a command prompt window will pop up, which will start the driver installation routine of windows.



Windows Security system will notify you about device driver installation. You may check the box "Always trust software from "Thorlabs GmbH" prior to click the Install button. A firmware and driver package for all supported devices will be installed as SPLICCO software is designed to control several hardware devices.



Finally, you will be prompted to restart you computer in order make changes effective:



2.3.3 Driver Installation

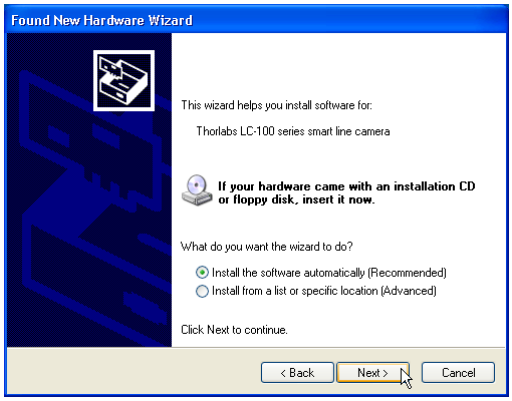
Upon first connect of a LC100 smart line camera Windows recognizes a new hardware and starts the driver installation.

Using Windows XP©

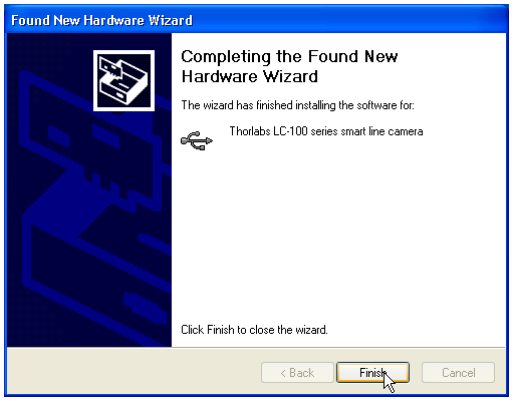
Windows starts the driver installation. A popup in the left bottom corner appears, displaying the name of the device.

The "Found New Hardware Wizard" starts to install the new device. Depending on the configuration of your system, you may be asked if you want to connect to "Windows Update to search for software" shown in the following figure.

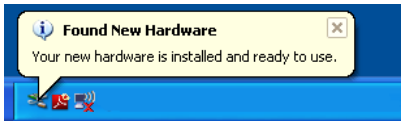
Please select "No, not this time" and click "Next" to continue.



Select "Install the software automatically" and click "Next" to continue.



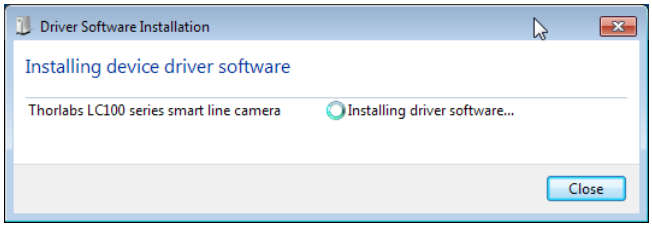
Finalize the installation by clicking "Finish". Now the device is installed and can be used by SPLICCO.

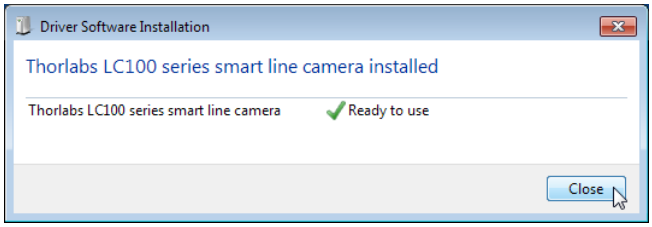


The green status LED lights up, the device is installed and ready for use with SPLICCO.

Using Windows 7©

Connect your LC100 line camera. Windows recognizes the connected device and automatically installs the driver:





The green status LED lights up, the device is installed and ready for use with SPLICCO.

2.3.4 Start the GUI

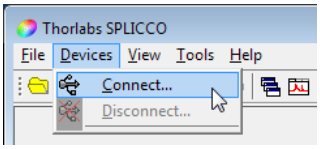
To start SPLICCO click on the desktop icon 

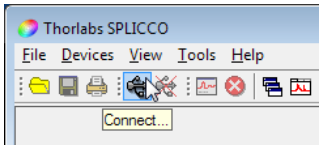
or select 'Programs' via the START button in the Windows task bar and navigate to 'All Programs / Thorlabs / SPLICCO / SPLICCO'.

3 Operating Instruction LC100 Smart Line Camera

3.1 Connecting a Device

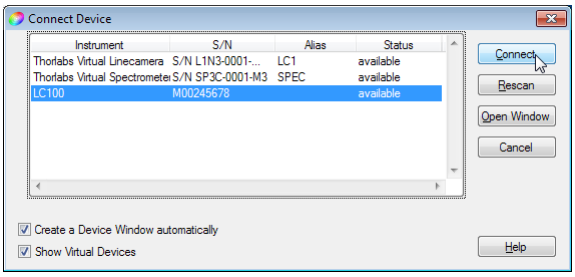
1. To start a measurement with a LC100 Line Camera connect it to a USB port of your PC with the supplied cable.
2. The SPLICCO connects automatically to all detected devices.
3. A device can be connected manually: Select 'Connect...' from the **Devices** menu or click to the Connect icon from the tool bar.





The following window appears and shows all connected devices and additionally two virtual devices. Now you can select a device to be used. A panel will be created according to your selection by default. If the "Create a device window automatically" option is not checked, please use the according panel icon from the main interface.

Press "Cancel" to leave this dialog and "Rescan" to scan the system again for new devices.



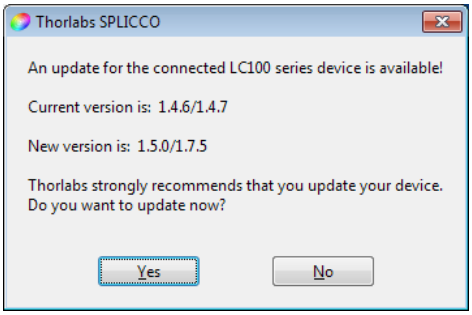
Every device can only be opened once. Devices already opened by SPLICCO are marked with the "running" status and are grayed out in the device selection dialog. Devices used by another application than SPLICCO are marked with the "locked" status.
Press "Open Window" to switch to the "Open Window" dialog to connect a window to an already running device.

Furthermore, you can start a virtual line camera, which can simulate a scan. Through this feature you can familiarize yourself with SPLICCO, without the need of a light source or signal. You can select to display or hide those virtual devices by checking or unchecking the "Show virtual devices" box.

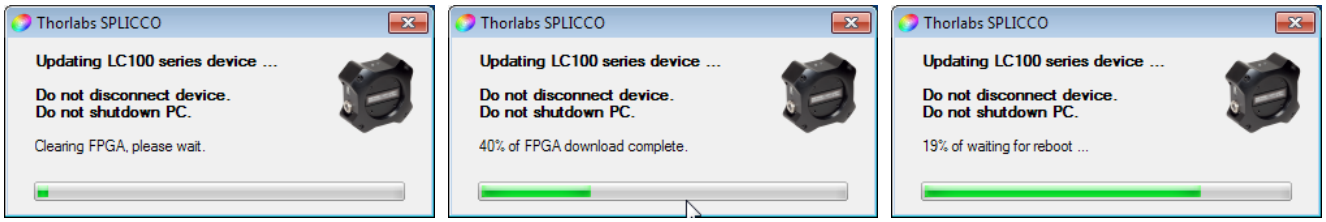
For a detailed description about the virtual devices refer to section Virtual devices 58.

3.2 LC100 Software update

The SPLICCO software comes with a driver update function. The LC100 has a software for the internal FPGA and one the for the USB interface, their versions are being checked upon Connecting a device by SPLICCO software. In case that the installed SPLICCO version requires a firmware update, the following warning appears:



Click "Yes" to update. Several message windows appear:



After successful installation, the above Connect Device window appears.

If you decline the LC-100 update, the camera might not work properly with the current SPLICCO version.

Note

The content of the LC100's internal memory (EEPROM), i.e., the device label 36 and a saved I/O Setup configuration 53, are not being overwritten.

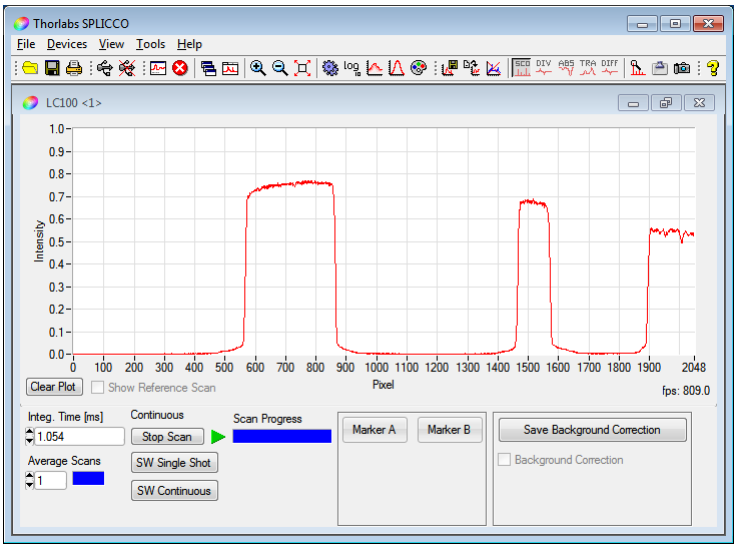
3.3 Integration time

The integration time represents how long the CCD interacts with incoming light. CCD pixels act like light buckets, gathering photons. The integration time displays the duration for which 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 ("blooming"). This is called saturation and will cause the output to be misleading.

Note

If no intensities are displayed, please enter the shortest integration time and increase it continuously until an intensity curve is displayed. As mentioned above, CCDs are very sensitive, and if over-exposure occurs, no intensity can be displayed.

Also, please make sure the background correction is disabled (see section Background Correction 38)



Integration time can be set via the control on the lower left corner of the device window. The supported range is defined by the line camera and ranges from 1.054 ms to 50 s. The integration time input window uses milli seconds, therefore the values of 1.054 ms - 50000 ms have to be used to cover the range. A window, which only shows a loaded from a file spectrum does not offer those controls in the left bottom corner.

For integration time values below 1000 ms, in the lower right corner is displayed the actual frame rate ("fps" = frames per second). When exceed 1s integration time, the according parameter is changing to "sec per frame".

A change of the integration time affects all windows connected to this device, which are then updated to show the same integration time.

The status LED "BUSY" (orange) lights up every time the CCD exposure starts. At short exposure time values this appears to the human eye as "continuous ON".

Higher integration times results in higher peaks in the measurement data.

3.4 Program navigation

SPLICCO can be operated by using the menu or the toolbar.

Menu

File menu

The 'File' menu contains all functions for saving, loading and exporting measurement data.

You can save the current measurement data as a *.jdx or *.csv file. This kind of file can be loaded into the application. You can also save and load reference data directly.

Devices menu

In the 'Devices' menu you find all functions regarding your actual connected devices. You can connect / disconnect devices as well as set the properties of the devices.

View menu

The 'View' menu contains all functions to configure the display windows. All active windows are listed here. Windows can be opened/closed/zoomed or you can switch between the released and tabbed view.

Tools menu

All functions to calculate with reference curves like transmittance can be found here. Furthermore there are tools like taking snapshots from the actual window or copying the current measurement data to the clipboard.

Help menu

You will find the online help in this menu. Furthermore, there is a link to the Thorlabs web page to check for the latest drivers or software version. You can check the current version by selecting 'About...'.

Tool Bar

The toolbar offers quick access to important functions.

 Opens an existing file (*.jdx)

 Saves the current measurement in a file (*.jdx)

 Prints the current window with user's comment and timestamp

 Connect a device

 Disconnect a device

 Creates and connects a new window to a device

 Closes the actual window

 Switches to released windows view

 Switches to tabbed windows view

 Zooms in by factor 2

 Zooms out by factor 2

 Resets the zoom to full scale

 Opens the Devices Settings Panel

 Switches between logarithmic and normal y scale

 Opens a dialog to configure persistence

 Opens a dialog to configure Gaussian transformation

 Opens a dialog to configure colors

 Stores the actual measurement plot as reference plot

 Loads a reference plot out of a JCAMP-DX file

 Deletes the actual windows reference curve

 Switches to scope view

 Switches to division view

 Switches to absorbance view

 Switches to transmittance view

 Opens the peak finder dialog for the actual window

 Copies actual measurement data values to clipboard

 Makes a snapshot from the actual window

 Opens the windows help for SPLICCO

3.5 Save and Export Data

SPLICCO can save data either in JCAMP-DX or CSV format.

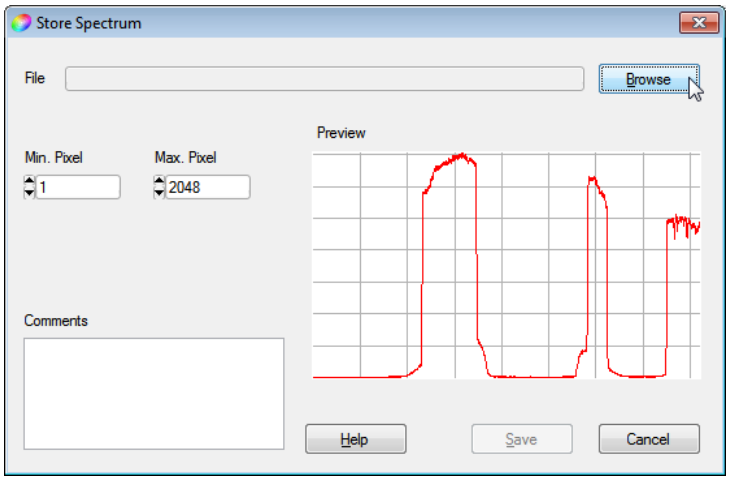
JCAMP-DX:

- stores data and comments
- visit "http://www.jcamp-dx.org/" for more information

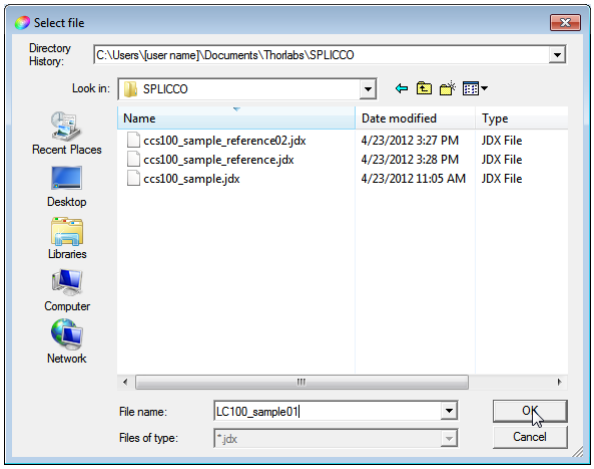
CSV:

- comma separated values
- later use with third party software like Microsoft Excel™ or Mathlab™
- human readable

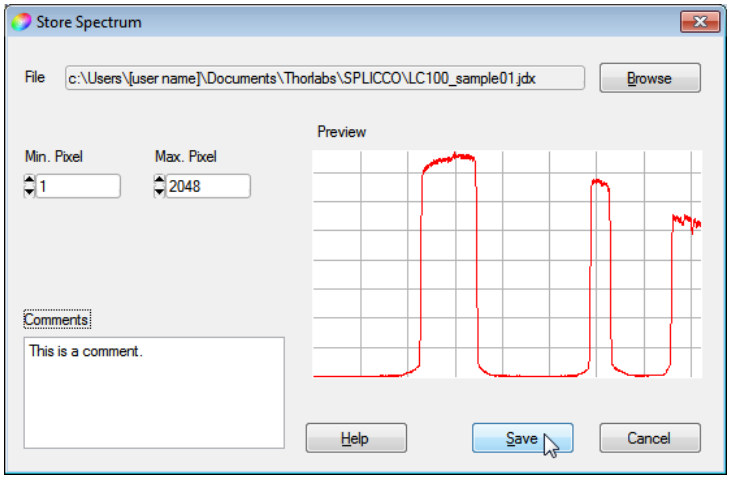
To save the measurement data to a JCAMP-DX file select 'Save As ...' from the **File** menu or click the button from the toolbar. A file dialog window appears and you can choose the filename and directory.



Click to "Browse" to define the location of the file to be saved to:



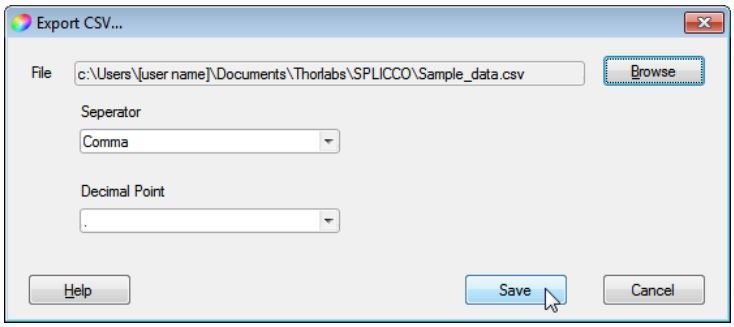
The file extension of this file is *.jdx. Additionally you can choose the range to store. Text entered in the "Comments" field will be stored together with the data.



Export Data

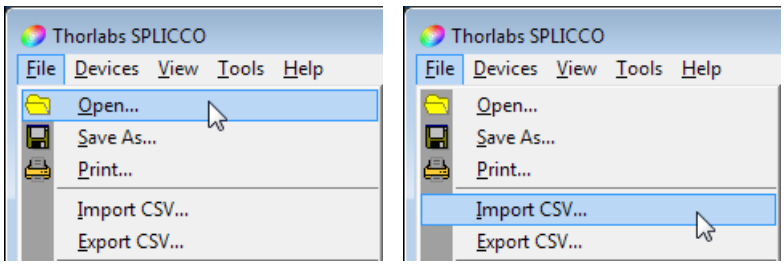
Measurement data can be exported to a *.csv file for use with e.g. Microsoft Excel™ or MathLab™. To export the current measurement data to a *.csv file select 'Export CSV...' from the **File** menu. A popup panel appears to choose the target directory, filename and the characters for "**Separator**" and "**Decimal Point**".

Reference data can be handled in the same way.



3.6 Load and Import Data

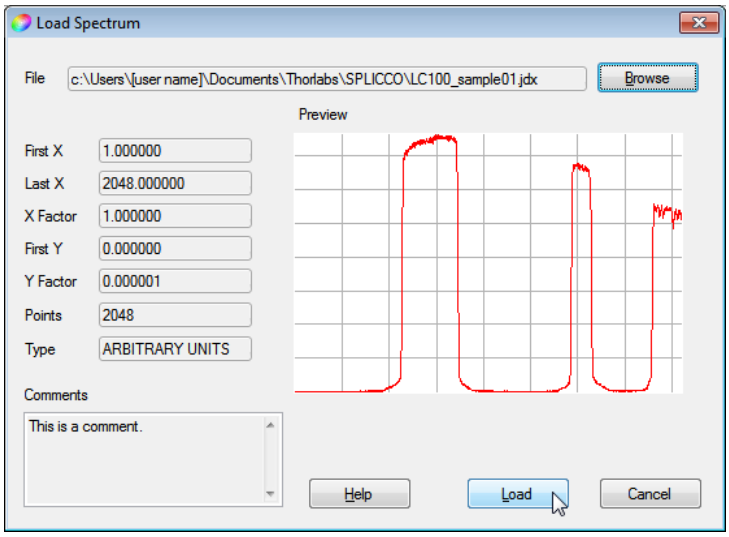
Previously captured and saved measurement scans can be reopened with SPLICCO without connecting a device. This can be done from the **File** menu by selecting "Open..." (icon) or "Import CSV..." .



Opening a file

SPLICCO can load most JCAMP-DX 18 files with file extension *.jdx either as a reference 41 to use with the live measurement data or in an individual window to show formerly saved data.

To open a *.jdx file, choose "Open" or click to the icon. Choose the appropriate file using the Browse button, the selected file is shown in the preview window. Eventually saved comments are shown in the "Comments" field.



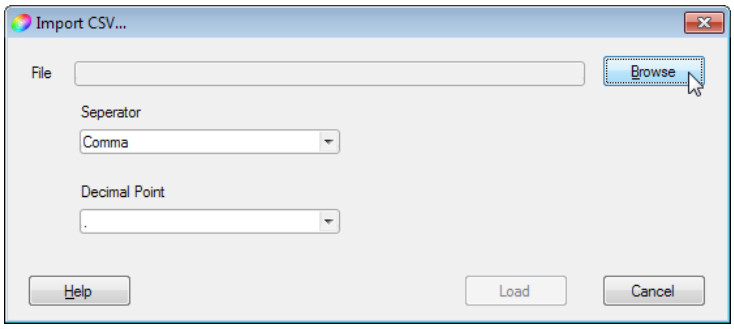
X and **Y Factors** represent the resolution. The resolution of the X axis is 1 pixel, the resolution of Y axis results from the resolution when the file was saved. By pressing **Load** the curve is opened in a new window.

Note

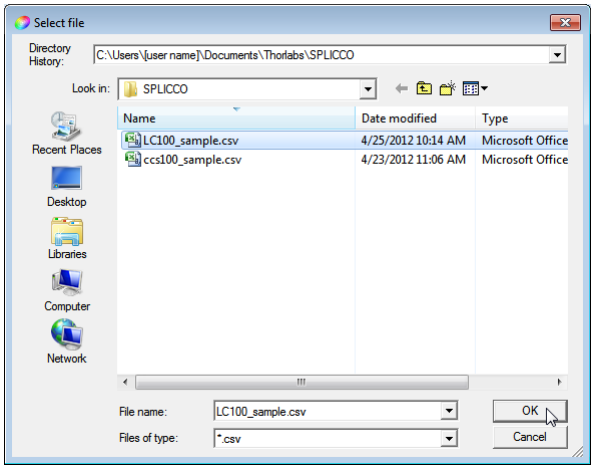
The **Load** function is used also for loading a reference scan to the current live window. Details are explained in section References 41.

Import data

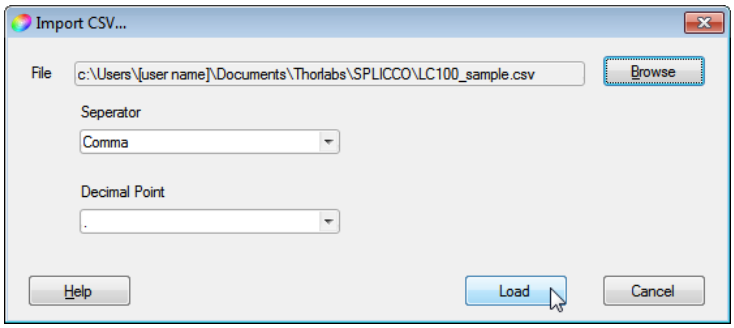
To import measurement data from a *.csv file select 'File -> Import CSV...' from the menu.



Please specify the character separating the x & y columns and choose which character marks the decimal position in the appearing window. Then click to **Browse** to select the required file:



Click OK to confirm:



Clicking to **Load** imports the data to a new window.

Note

The Y axis will be displayed only for values between the min and the max intensity; scaling factor as for *.jdx is not available.

3.7 Save and Load Device Settings

SPLICCO allows to save device settings to and load them from a configuration file in xml format.

The advantage is that you can exactly reproduce your measurement conditions say, next day or even in a different lab. The only condition is that the type of device (e.g. LC100) must match.

The following parameters are saved:

- Device type and Device Label 36
- Serial number
- Trigger mode 33
- Integration time 14
- Smoothing mode and settings 34
- Averaging mode 34 and settings
- Persistence and settings 40
- Gaussian transformation and settings 41
- Flip / Revert Picture 36
- Scaling 30 Y axis (intensity) and X axis (pixel # or wavelength)
- Progress indicator 36 on/off

Additionally, an individual comment can be entered.

Sample of a configuration file:

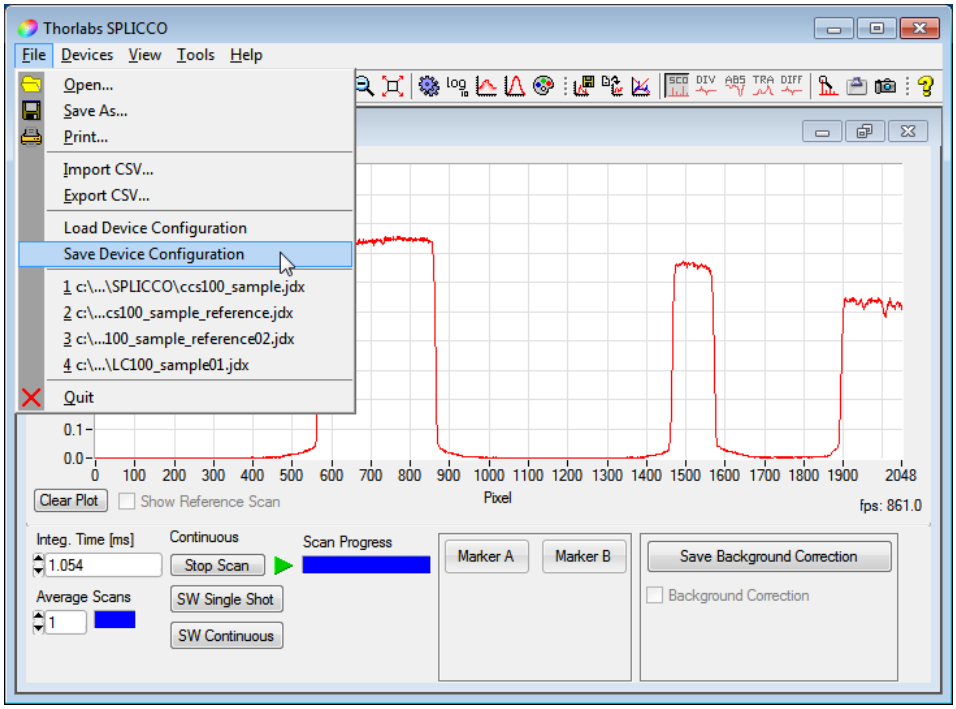
```
<?xml version="1.0" ?>
- <device_config>
  - <general>
      <devicetype>Line camera</devicetype>
      <DLL>Splicco_LC100_Series.dll</DLL>
      <comment>This is a comment</comment>
      <userlbl>LC100</userlbl>
      <sernr>M00252817</sernr>
      <rsrc>USB0::0x1313::0x80A0::M00252817::RAW</rsrc>
      <trgsrc>0</trgsrc>
      <trgmode>0</trgmode>
      <dispmode>0</dispmode>
      <smoothmode>0</smoothmode>
      <smoothwidth>0</smoothwidth>
      <averaging>0</averaging>
      <averagescans>1</averagescans>
      <persistance>0</persistance>
      <persistancetime>0</persistancetime>
      <persistanceintens>10.000000</persistanceintens>
      <flipped>0</flipped>
      <reverted>0</reverted>
      <progressbar>1</progressbar>
      <logyscale>0</logyscale>
      <gauss>0</gauss>
      <gausssmooth>15</gausssmooth>
      <gausssignificance>0.001000</gausssignificance>
      <integrationtime>1.054000</integrationtime>
      <xmin>0.000000</xmin>
      <xmax>2048.000000</xmax>
      <ymin>0.000000</ymin>
      <ymax>1.000000</ymax>
    </general>
  </device_config>
```

The background correction is ***NOT*** being saved!

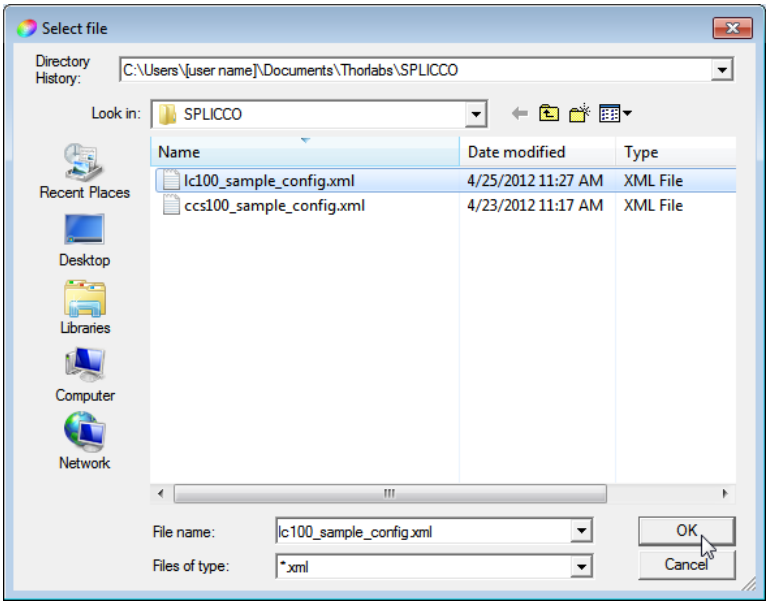
Also, settings of the graphic user interface, like color settings, released or tabbed view of multiple windows, cannot be saved to the device configuration file.

3.7.1 Save Settings

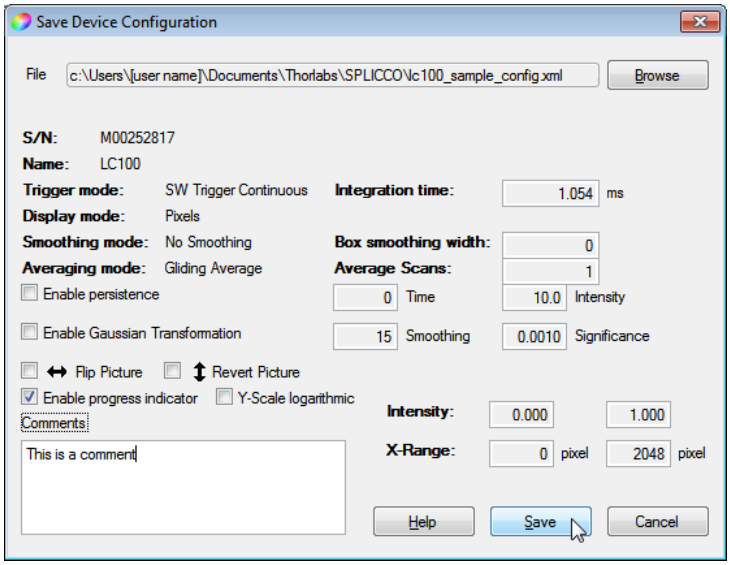
Open from the File menu the topic "Save Device Configuration":



Select a file name and destination for the configuration file.

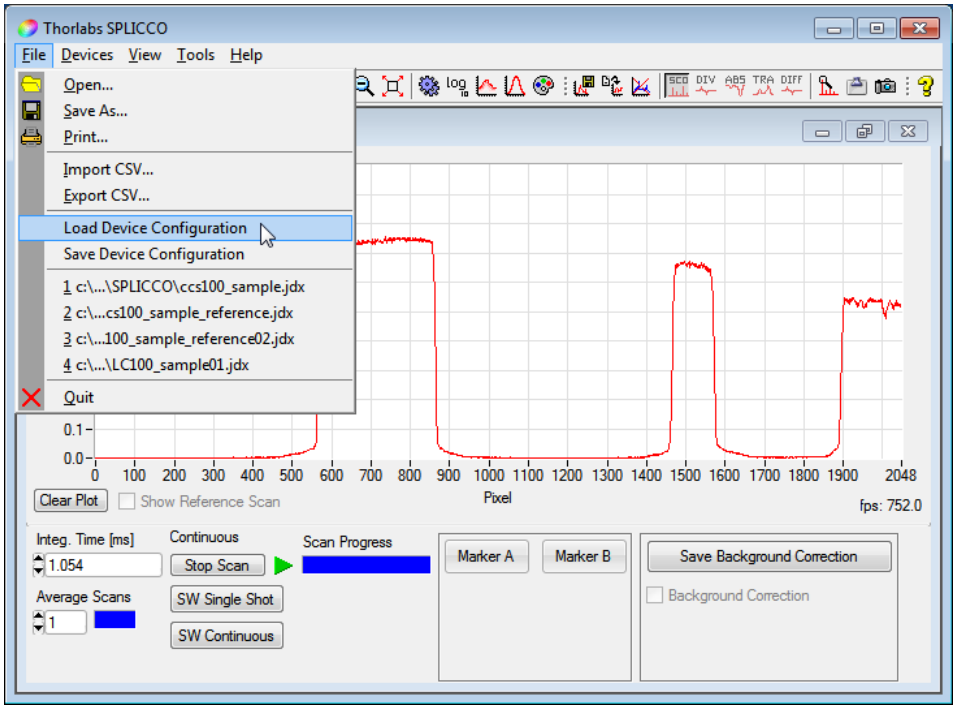


and click "Save".

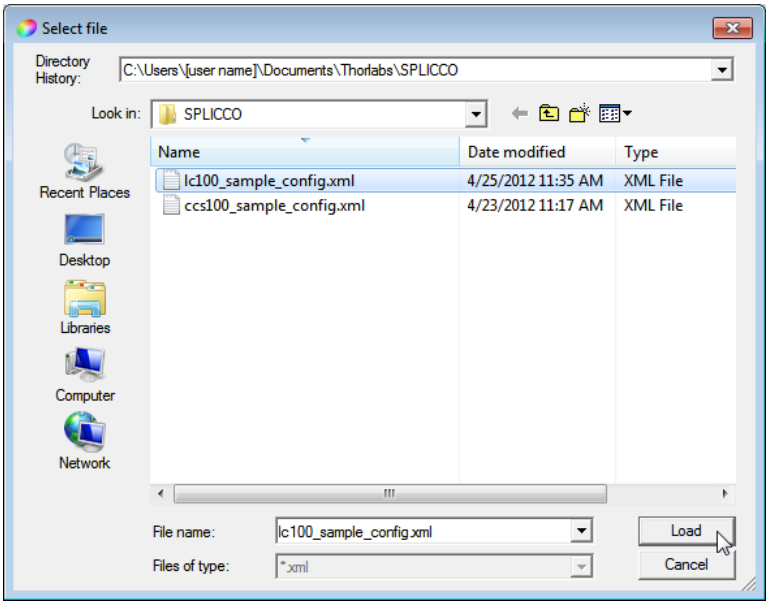


3.7.2 Load Settings

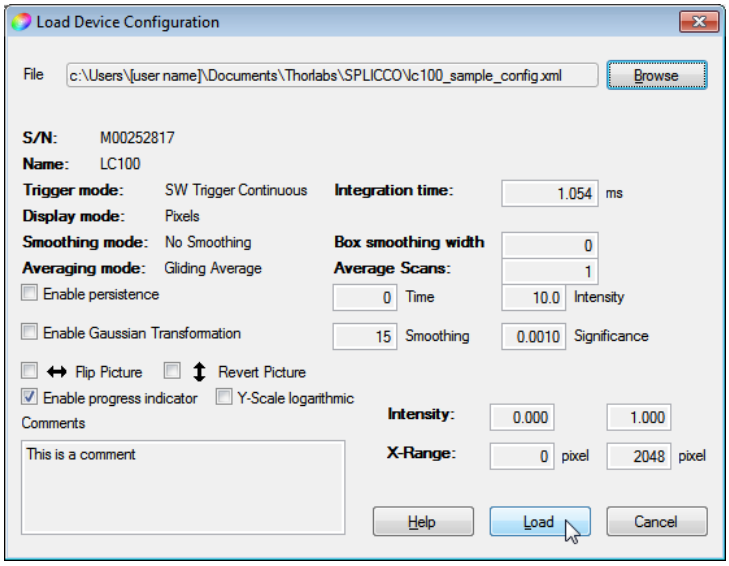
Open from the File menu the topic "Load configuration":



Select a file name of the configuration file

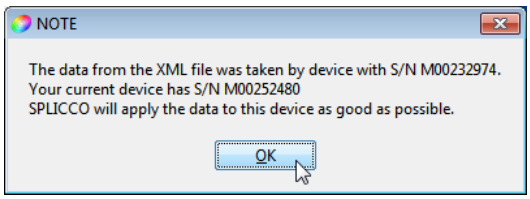


and click "Load". A preview pane comes up showing the settings saved to the selected configuration file:



Click "Load" to apply these settings.

In case the instrument's serial numbers do not match, you will be noticed about that:



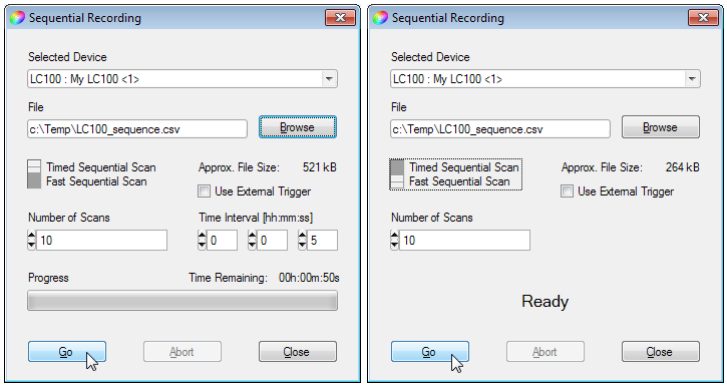
Click Ok to get back to the preview pane. You may choose then another configuration file ("Browse") or even load the mismatching file.

3.8 Sequential Recording

SPLICCO software allows a sequential recording of individual scans. The scan results are saved in *.csv file format 18. Importing sequential results to an appropriate software, e.g., Microsoft EXCEL©, scans can be displayed in a 3rd dimension - time. A maximum of 1000 scans can be recorded.

The **Sequential Recording** function can be reached via **Tools** menu.

There are 2 types of recording modes - Timed Sequential Scan and Fast Sequential Scan.



3.8.1 Timed Sequential Scan

Timed Sequential Scan

The Timed Sequential Scan mode is ideally used for long term monitoring. In this mode, a time interval between the start of 2 subsequent scans can be entered. The interval ranges from 1 sec to 8760h:59min:59sec. Alternatively, the scan can be triggered externally, using the hardware trigger input.

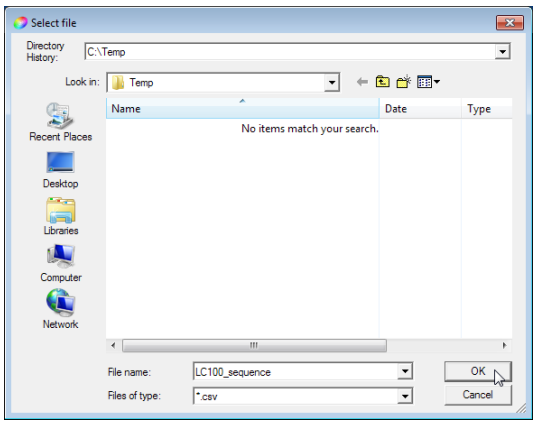
Each scan will be saved to a separate file. To the chosen file name (e.g. LC100_sequence.csv) a time stamp is being appended. The format of the time stamp is

_YYYYMMDD_xxhxxmxxsxxxms

(e.g., "_20110506_09h02m15s030ms" stands for May 06, 2011, 09h:02min:15sec:030ms.)

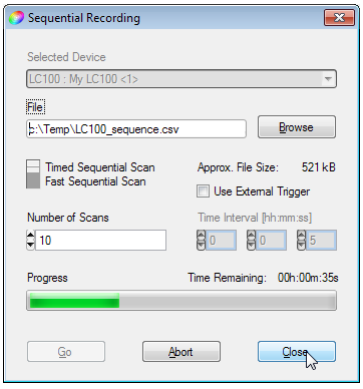
Example:

- Select the desired device
- Click **Browse** to open the dialog for selecting a file name

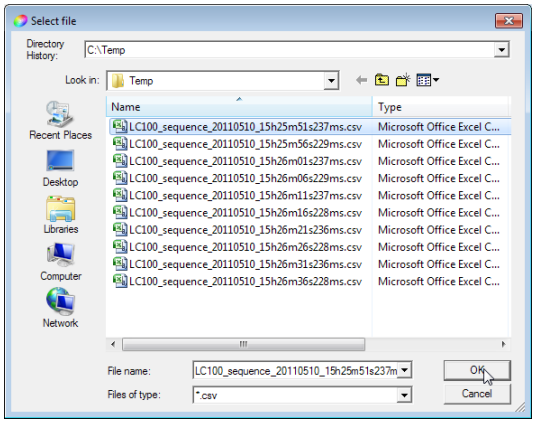


- Confirm the entered file name
- Define the number of scans to be recorded
- Define the time interval between scans - alternatively, choose "External trigger"

- Click **Go**; the progress will be shown in the bar and the remaining time will count down.



- After processing the entered number of scans the files will be saved and the window closed



- Each result file contains 2 columns - first column is the pixel number, second column states the intensity measured from the actual pixel. Small negative intensity values (below 0.01) are caused by CCD noise and/or ADC noise or background correction.

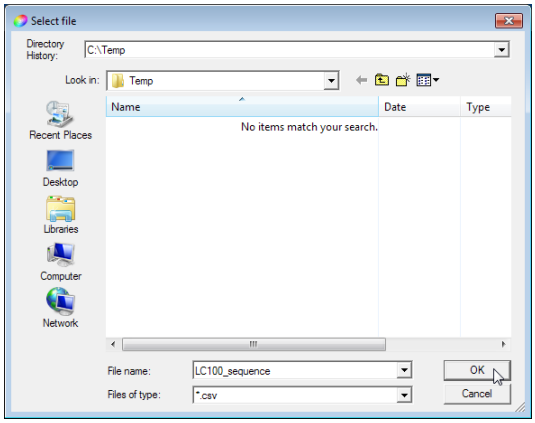
3.8.2 Fast Sequential Recording

Fast Sequential Recording

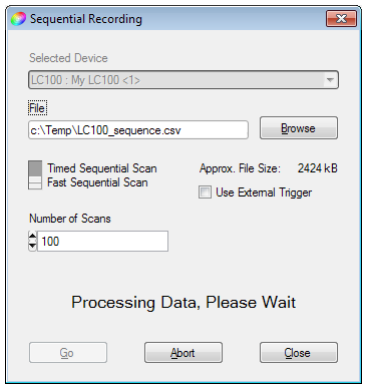
The Fast Sequential Recording mode allows to record fast changes. The time interval between two subsequently recorded scans depends on the integration time, if ≥ 10ms. For smaller integration time values it depends on system performance and CCD read-out time. Results are being saved to a single file.

Example:

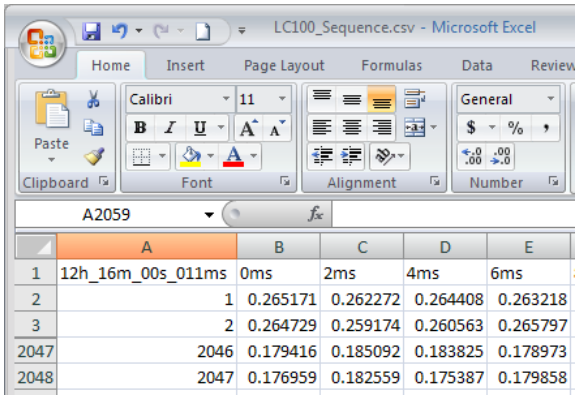
- Select the desired device
- Click **Browse** to open the dialog for selecting a file name



- Confirm the entered file name
- Define the number of scans to be recorded.
- For triggered recording, check the box "External trigger"
- Click **Go**; the recording starts. After finishing, the software needs to process data, which takes some time, depending on the number of scans to be recorded.



- During processing data, in above window header may appear "Sequential Recording (Not responding)", eventually the screen may gray out - this is just a reaction of the operating system to extended processing time and does not impact the function of SPLICCO software, so please ignore it.
- A sample result file is shown below:



	A	B	C	D	E
1	12h_16m_00s_011ms	0ms	2ms	4ms	6ms
2	1	0.265171	0.262272	0.264408	0.263218
3	2	0.264729	0.259174	0.260563	0.265797
2047	2046	0.179416	0.185092	0.183825	0.178973
2048	2047	0.176959	0.182559	0.175387	0.179858

The 1st line of the file contains the time stamps: A1 is the scan start time with accuracy to 1ms, columns B1, C1, ... contain the start time delay between 1st and actual scan. If the scans were recorded free running, the delay between subsequent scans is equal to the integration time set value. The time stamp has a tolerance of ± 1ms.

Further, 1st column (A2, A3,...) states the pixel number and in the same line are recorded the intensities measured from the actual pixel during the scans. Small negative intensity values (below 0.01) are caused by CCD noise and/or ADC noise or background correction.

3.9 Print

SPLICCO allows to print out an actual scan to any printer installed on the operating system. The appropriate dialog can be opened via the menu **File** -> 'Print...' or by clicking to the icon in the menu bar.

The print-out has a header with information on

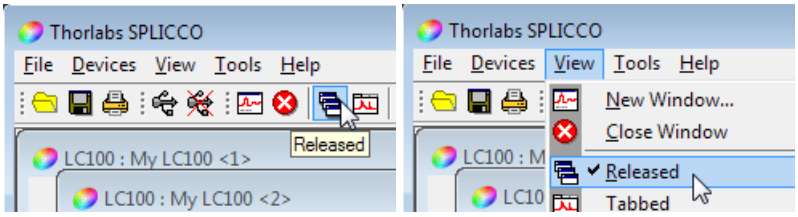
- device type and device label 36
- date and time
- user name
- settings for integration time 14 and averaging counts 34

3.10 Device windows

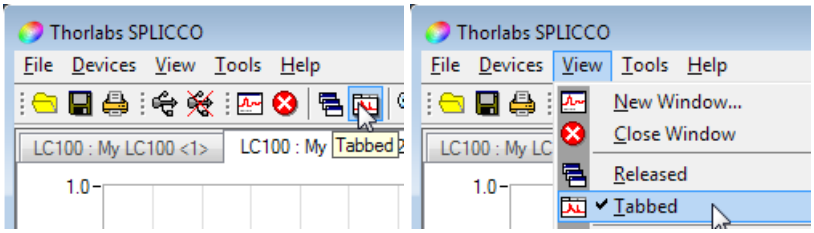
You can open up to 10 measurement windows for every device. Parameters like integration time, number of scans to be averaged and trigger control take effect on all of the device windows. All options, which are selected by right click mouse menus, influence only the active window, with the exception of "Properties" and "Color settings".

There are several views for multiple windows.

Released view - The child windows can be arranged tiled or cascaded:



Tabbed view - The child windows are arranged in tabs:



3.11 Zooming and panning

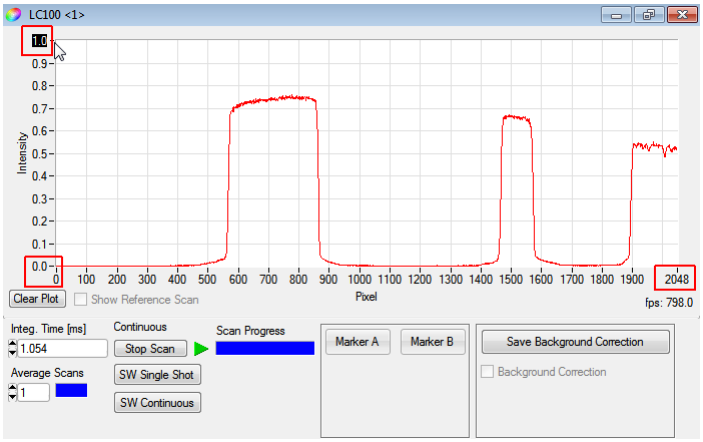
SPLICCO offers several possibilities to zoom/expand areas of interest.

In case the window is in "Zoom mode", you can box-in a region by pressing and holding the left mouse button.

By pressing the "Zoom in" (🔍) and the "Zoom out" (🔍) button in the toolbar you can step in or step out on the actual windows graph. Use the "Zoom home" (⛶) button in the toolbar to zoom to the original size. You can also zoom home by a right click on the graph and selecting "Zoom home" in the appearing menu.

The third option to zoom is the use of the editable graph axis. On each axis you can double click the minimum or maximum value for editing. The axis is rescaled after confirming the changes.

Another way to zoom is holding the CTRL key on the keyboard and left clicking on the graph to zoom in and right clicking to zoom out.



Note

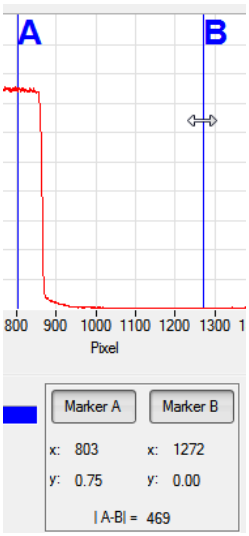
The zoom is limited to 1% of the original size of each axis. Furthermore you cannot zoom out more than the original size.

Panning

Press and hold the CTRL and SHIFT key on the keyboard to use the mouse to pan the actual graph.

Another option is to double click the left or right pixel value and to type-in the range of interest via the keyboard. The same can be done for the intensity axis. This is especially useful for zooming or panning-in, in only one axis, while keeping the second one static.

3.12 Markers



SPLICCO provides two markers for instantaneous readout of pixel position and amplitude (intensity).

The markers are being enabled by clicking to the appropriate button. Each marker appears as a vertical line named "A" or "B". These lines can be shifted along the X axis using the mouse (right click and hold).

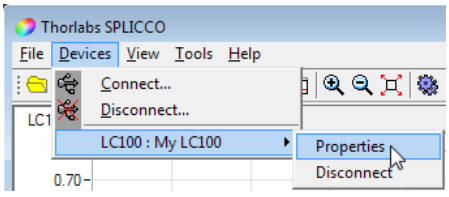
Below the buttons the actual X and Y values are displayed: X stands for wavelength or pixel number, depending on the setting, while Y stands for the relative intensity at position X.

If both markers were enabled, additionally the distance |A-B| on X axis is shown.

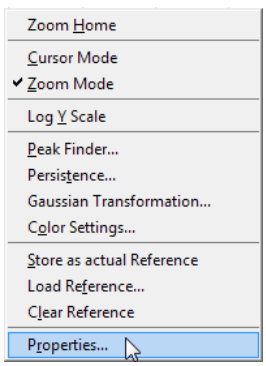
3.13 Device Settings

The Device settings dialog can be opened in different ways:

- Click to  icon in the toolbar
- From the **Device** menu:

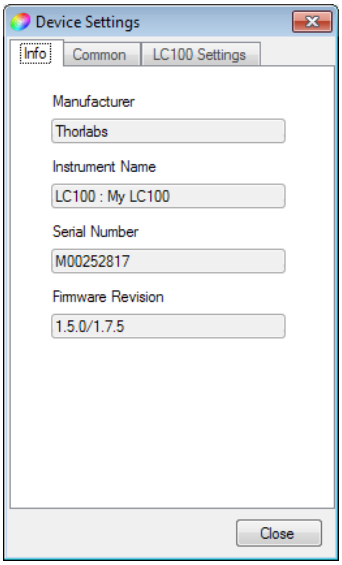


- By right-clicking to the diagram area and choosing "Properties":



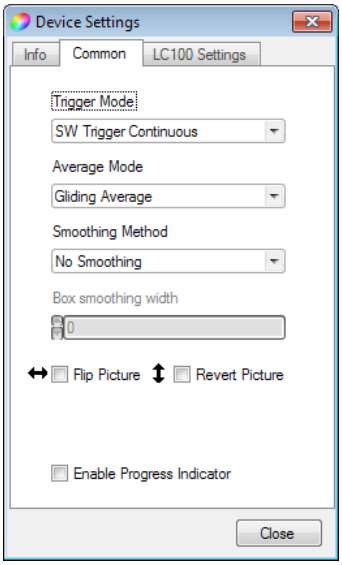
3.13.1 Tab Info

The tab Info contains information about manufacturer, device name, serial number and firmware revision:

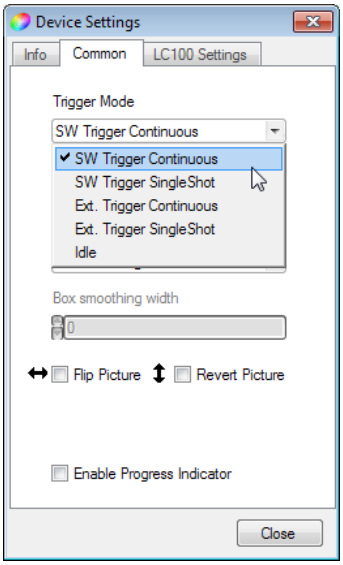


3.13.2 Tab Common

In this tab, trigger and averaging modes can be set, a smoothing can be enabled and the graphical display can be changed.



3.13.2.1 Trigger mode



SPLICCO is able to generate internal trigger signals (SW) or use external trigger signals to take readings at defined time intervals.

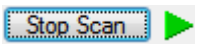
You can set the trigger mode in the **Device Settings**, tab 'Common'.

The control offers five trigger modes: SW Trigger Continuous, SW Trigger Single Shot, External Trigger Continuous, External Trigger Single Shot and the Idle mode. According to the trigger mode the status symbol and the trigger button in the bottom of each device windows changes. The trigger buttons labels shows the possible option, e.g. "Stop Loop", "Scan 1x", "Arm Trigger" or "---".

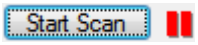
Software trigger

SW Trigger Continuous:

The default trigger mode. The software triggers as fast as possible for maximal data refresh rate. The figure below shows the status symbol and the trigger button.

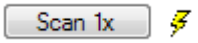


By pressing the "Stop Loop" button the data readout is stopped and the symbol changes to:



SW Trigger Single Shot:

In this mode for each click on the trigger button a data set is read out and shown. The status symbol and the trigger button will appear:



Hardware Trigger

The LC100 line camera is equipped with a hardware trigger input. This input will be enabled by selecting either the "Ext. Trigger Continuous" mode or the "Ext. Trigger Single Shot" mode.

Ext. Trigger Continuous:

This mode is similar to the "SW Trigger Continuous" mode, except that the data readout is triggered by an external signal. After each data readout the external trigger will be armed again. The status symbol and the trigger button will look the same way as in the software continuous mode.

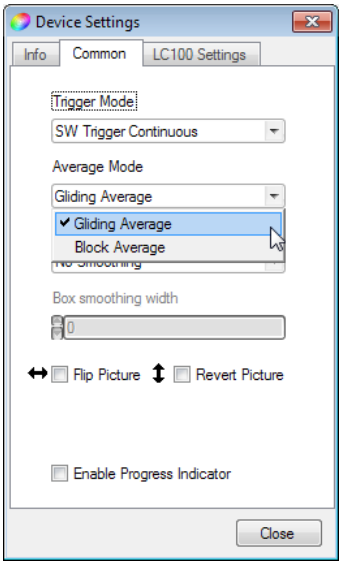
Ext. Trigger Single Shot:

You have to press the trigger button to arm the external trigger before you can readout data. While the software is waiting for an external trigger signal the status symbol changes; see the following two figures below.

Idle:

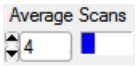
This mode causes the device to be idle. In this mode the device does not take any measurements.

3.13.2.2 Average Mode



Very noisy or weak signals can be amplified by adding several scans, which is known as averaging. SPLICCO provides two kinds of averaging - Gliding Average and Block Average. The averaging mode can be set in the Device Settings panel:

Click to icon in the toolbar and open the 'Common' tab: The number of scans to average can be set in the bottom of the active panel:



To the right of the number of scans to be averaged a status box is displayed, indicating the fill level of the buffer used for averaging.

Gliding Average

This method averages over the most recent number of scans and is being updated with every new scan. The advantage is that the graph is being updated with every scan.

Example: The number of scans to be averaged is set to 10. After starting acquisition, the software calculates the average out of the first two data sets, then out of the first three sets and so on until the desired number (10) is reached. Then the first data set will be subtracted and the newest data set will be added to calculation of average. This can be seen also in the buffer fill level - it grows up to the max and stays there.

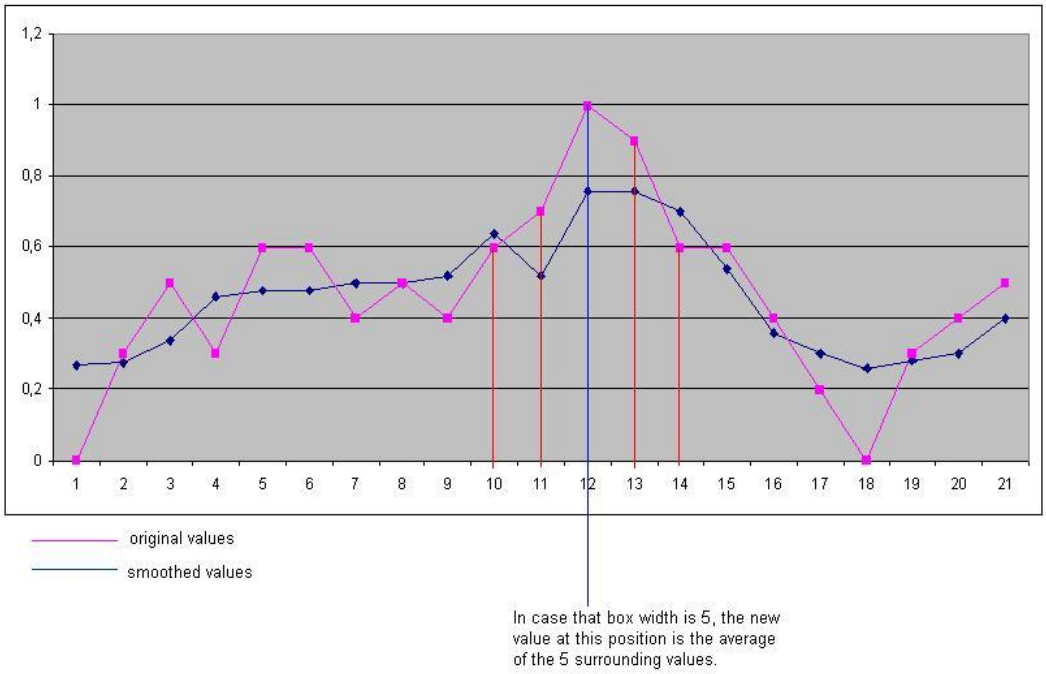
Block Average

This method accumulates a number of scans, after that calculates the average, displays it and starts the averaging process from beginning. The display is updated only after n scans.

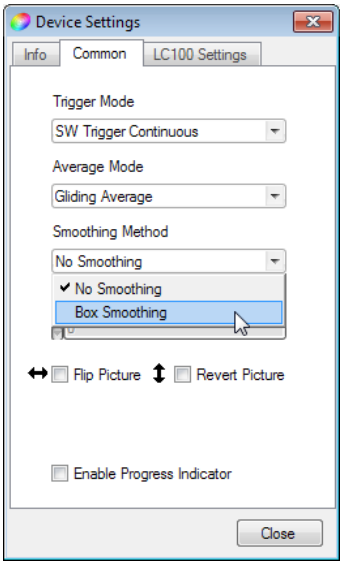
Example: The number of scans to be averaged is set to 10. The software accumulates 10 scans (can be seen from the buffer fill level), calculates the average over these 10 scans, displays the result and restarts acquisition. (It's obvious that block averaging decreases the frame rate.)

3.13.2.3 Smoothing Method

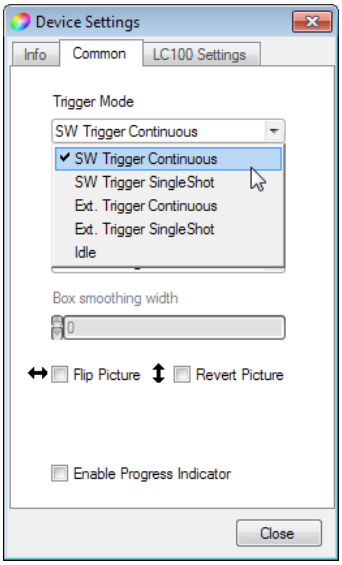
SPLICCO provides the standard smoothing method called "Moving Area Smoothing", also known as "Box Smoothing". This kind of smoothing is comparable to a low pass filter, suppressing the high frequent noise. This is the simplest form of smoothing. The only parameter needed is the box width, which indicates how many values are averaged. There is no weighting of those values.



Click to icon in the toolbar, open the 'Common' tab and enable "Box Smoothing". The smoothing box width can be set below this control. Zero means no smoothing at all. Any change will instantly affect the actual graph.

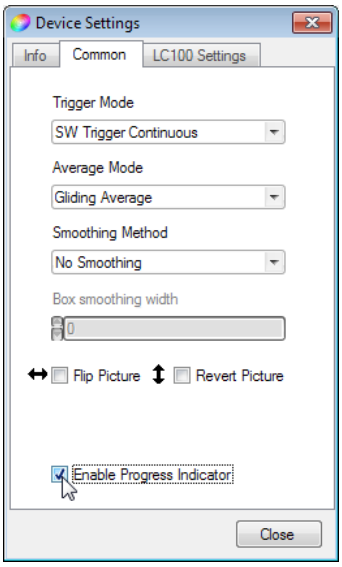


3.13.2.4 Flip and revert picture

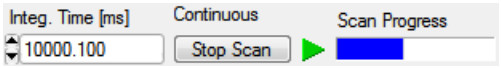


SPLICCO provides the possibility to mirror the actual measurement data displayed vertically and/or horizontally in a window. Click to icon in the toolbar and open the 'Common' tab:

3.13.2.5 Progress Indicator



In case of long integration time, it can be useful to know the progress of the actual scan. Therefore, a progress bar can be enabled:



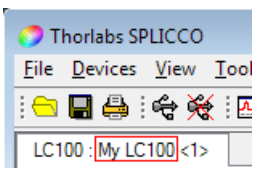
To enable this function, just check the appropriate box. The scan progress is being indicated for integration time > 500ms.

3.13.3 Tab LC100 Settings

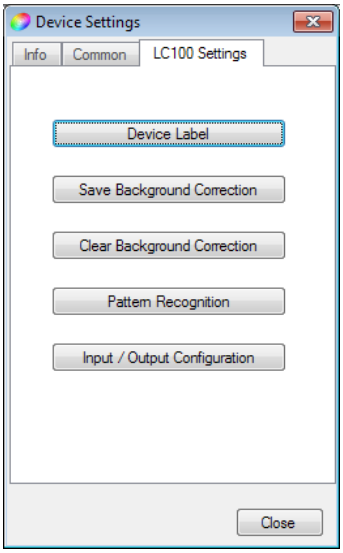
The LC100 Settings tab allows to set a custom device label, save and clear background correction as well as to configure the pattern recognition and the GPIO ports. The two latter topics are explained in detail in the GPIO Port section 43.

3.13.3.1 Device Label

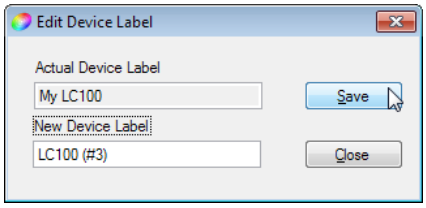
SPLICCO allows to assign an individual name to any connected device, called "Device Label". This device label is an identifier, which eases the operation of multiple connected devices; it can be found in the upper left corner of the measurement window:



Click to icon in the Toolbar and open the 'LC100 Settings' tab. The button "Device label" opens a dialog box:

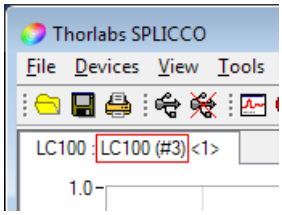


Enter a new device label name and press "Save"



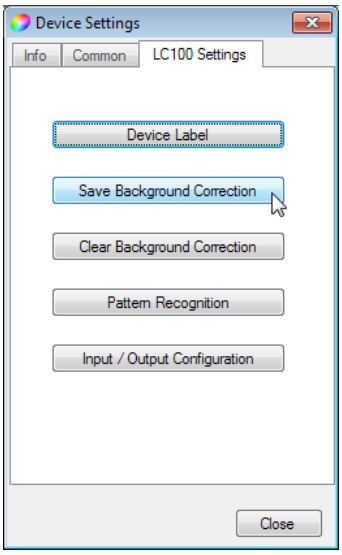
Reconnect the device to activate changes:

The new device label is displayed in the software:



3.13.3.2 Background Correction

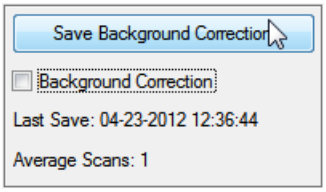
You can subtract a background reading to reduce noise from your ambient surrounding (for instance if your room light offsets your base line).



"Save Background Correction" overwrites the currently saved data and remains effective only during the current SPLICCO session. That means, the background correction will be cleared automatically, when SPLICCO software is terminated and/or a device is disconnected.

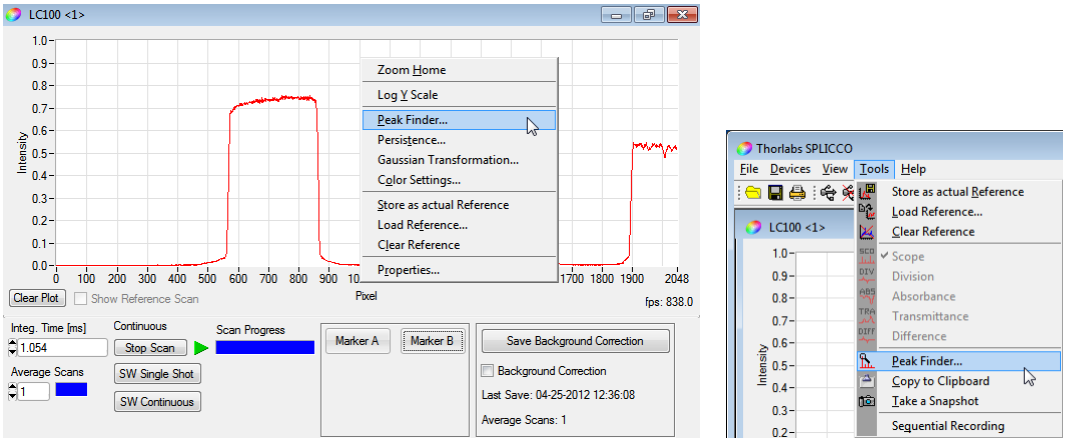
"Clear Background Correction" deletes the correction data immediately.

The background correction can be easily saved and turned on/off from the panel below the scan:

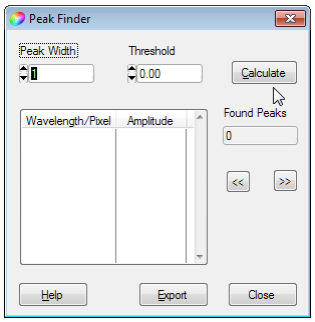


3.14 Peak finder

SPLICCO offers the possibility to find peaks in an actual measurement. The peak finder can be selected by right clicking on the actual window and selecting "Peak finder..." or from the **Tools** menu:

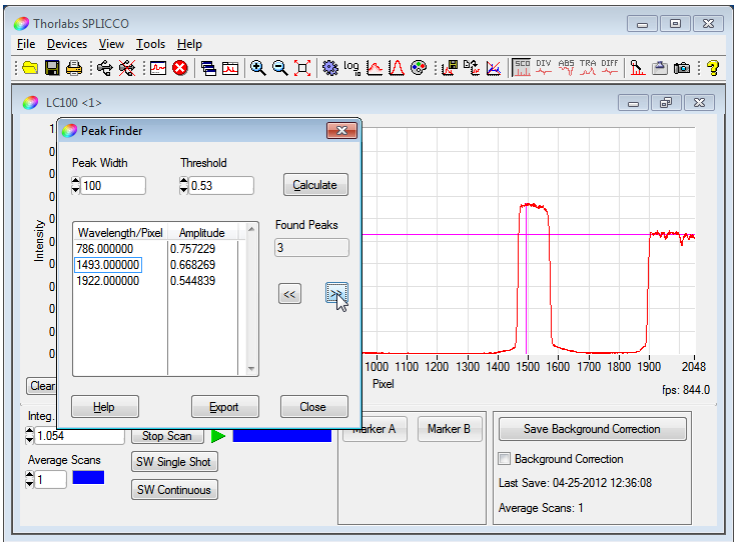


or just click the icon in the toolbar. The following wizard will appear:



In order to specify the relevant peaks, a peak width and a peak threshold can be set. A higher threshold and a higher peak width will reduce the found peaks.

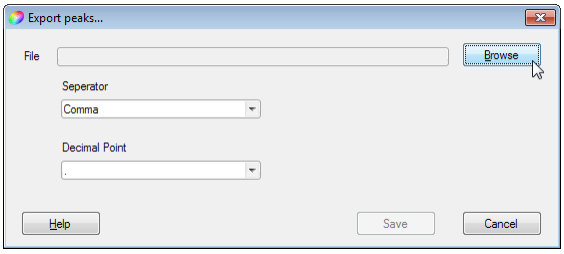
By pressing the "Calculate" button the peaks specified by those two parameters are calculated and the list is filled with the found peaks.



The found peaks can be sorted by their location ("Wavelength/Pixel") or by intensity ("Amplitude") - just click to the desired header - and can be iterated with the help of the arrow buttons ("<<" and ">>").

Only one peak can be marked at the same time, but you can export the full list into a tab

separated text file with the "Export" button.

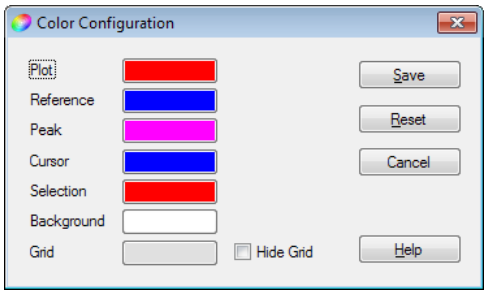


3.15 Logarithmic Y Scale

The intensity axis can be scaled linearly or logarithmical. Default display is linear, in order to switch to logarithmic just click the log icon in the toolbar. Alternatively, the **Log Y Scale** can be activated via the **View** menu or from the dialog after right clicking to the diagram area.

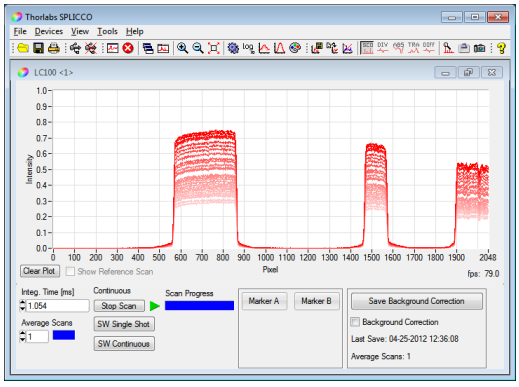
3.16 Color setup

The colors of the graph and its curves can be set by selecting 'Color settings...' from the **View** menu or from the right click dialog to the window area or simply by clicking the icon in the the toolbar. The following dialog appears and you can set the colors to the desired value. Furthermore you can select to hide the grid or not. If you click on the button 'Reset' the factory default will be restored. Click on 'Save' to confirm the setting.



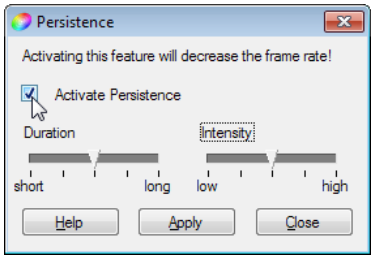
3.17 Persistence

SPLICCO offers the possibility to change the persistence attributes for each panel. Activated persistence leads to a fading out of previous scans. This function requires extra processing time and might influence the frame rate. The screenshot below illustrates persistence:



The persistence dialog can be reached either by clicking to the icon in the menu bar, by choosing **Persistence** from the **View** menu or from the right click to the diagram area dialog. It offers two sliders for duration and intensity of the persistence feature. After you have chosen the parameters, press "Apply" to make the changes effective. Press "Done" to leave the

dialog.

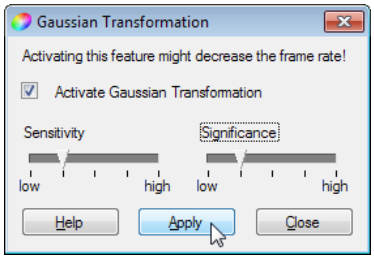


3.18 Gaussian Transformation

SPLICCO is able to display the measurement data as the best-fit Gaussian distribution. The Gauss Transformation dialog can be reached either by clicking to the icon in the menu bar, by choosing **'Gauss Transformation...'** from the **View** menu or from the right click to the diagram area dialog.

The appearing dialog offers two sliders for sensitivity and significance, which influences the Gaussian fit. As persistence, this might decrease the frame rate.

After you have chosen the parameters, press "Apply" to make the changes effective. Press "Done" to leave the dialog.



3.19 References

An actual scan can be stored as reference. This reference will appear in a different color (see Color Setup 40) and remains unchanged during the current SPLICCO session unless cleared.

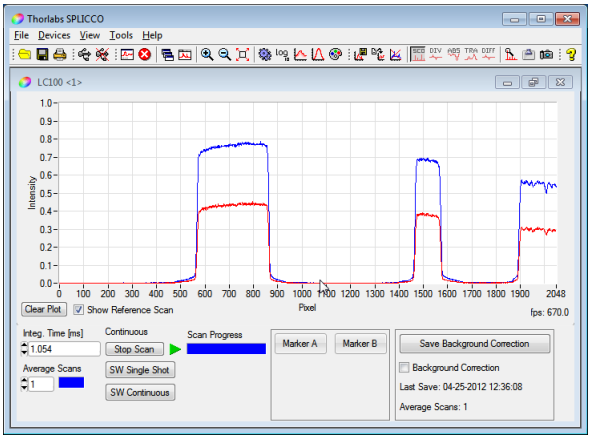
Click the icon in the toolbar, or select **'Store as actual Reference'** from either the **Tools** menu or from dialog, which appears after a right click on the diagram area.

Delete a reference by selecting **'Clear Reference'** or by clicking the icon.

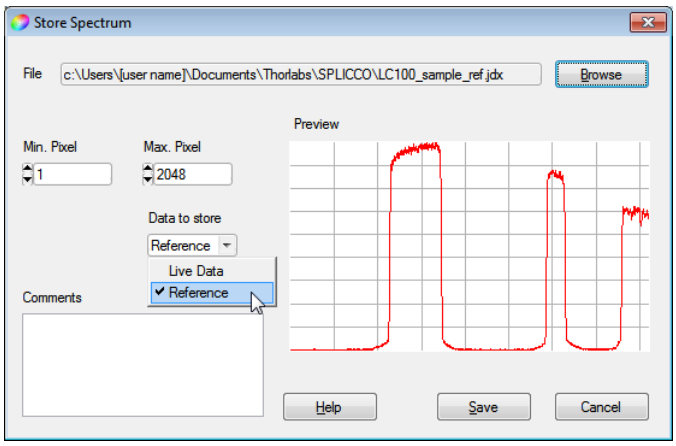
A scan can be saved as a *.jdx file for later use.

Save a reference

- Store the actual scan as reference. (**Note**: In order to distinguish the reference scan in the following screenshot, the integration time was changed after defining the reference. Actually, the actual scan and the reference are congruent)

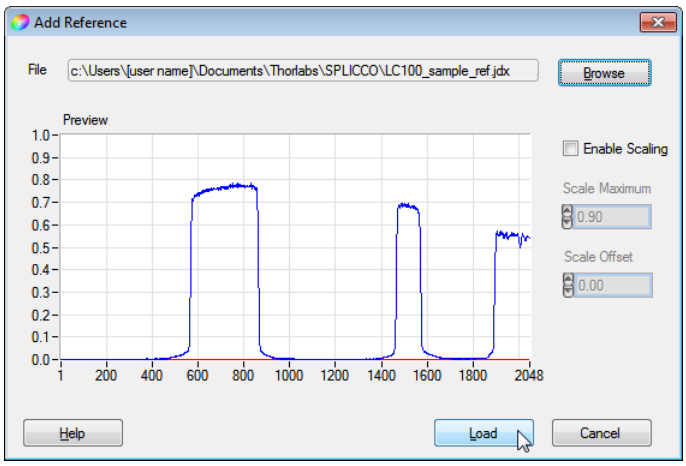


- Open the 'Save As...' menu, choose a location and file name, select '**Data to store: Reference**' and click **Save**



Load a reference

- Click the icon in the toolbar, or select **'Load Reference...'** from either the **Tools** menu or from dialog, which appears after right clicking the diagram area. A dialog box opens:



- Browse for the file location, select the desired reference file and click **Load**.
- The reference curve is copied into the actual window and can be used for future calculations.

Note

The reference can be scaled: check the "Enable Scaling" box - then the intensities can be scaled and an offset can be entered.

3.20 Copy to Clipboard

The actual scan data can be copied to the clipboard via the menu **Tools**, choose **Copy to Clipboard**, or by clicking to the icon in the toolbar.

These data can be pasted to a different application, e.g. Microsoft EXCEL© , for further processing. The data are comma separated pairs of values, where the first value represents the pixel number, the second - the intensity measured at this pixel.

3.21 Snapshot

A **Snapshot** of the actual scan includes the actual scan diagram area and a header:

- device type and device label 36
- date and time
- user name
- settings for integration time 14 and averaging counts 34

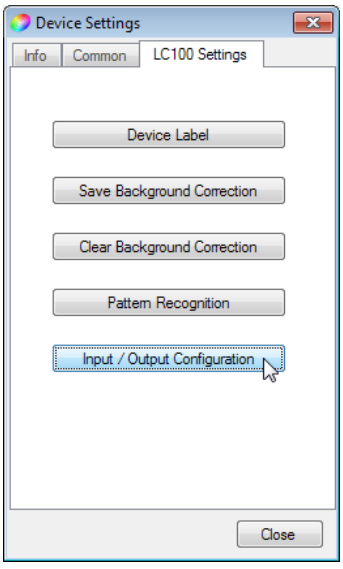
To make a snapshot, choose **Take a Snapshot** from the menu **Tools**, or by click to the icon in the toolbar. A Select File dialog appears, asking for a file name and format. Snapshots can be saved as *.bmp, *.jpg or *.png files.

3.22 Input / Output Configuration

LC100 Smart Line Camera provides a number of auxiliary ports, available through the GPIO port connector 72.

- Analog Output
- TTL Trigger Input
- 5 programmable TTL GPIO (General Purpose I/O) ports

The I/O setup dialog can be reached via LC100 Device Settings menu, either via the toolbar icon or by right clicking to the diagram area, and then selecting "Properties":

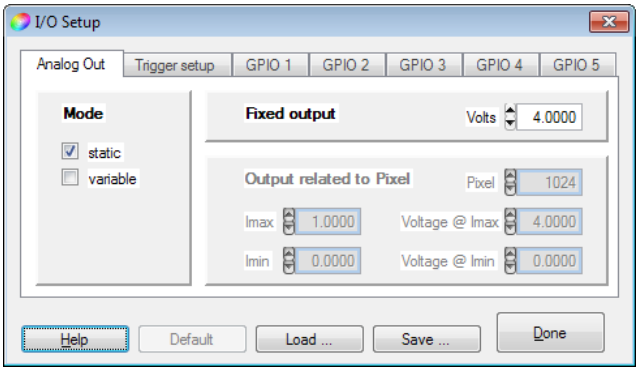


3.22.1 Analog Output

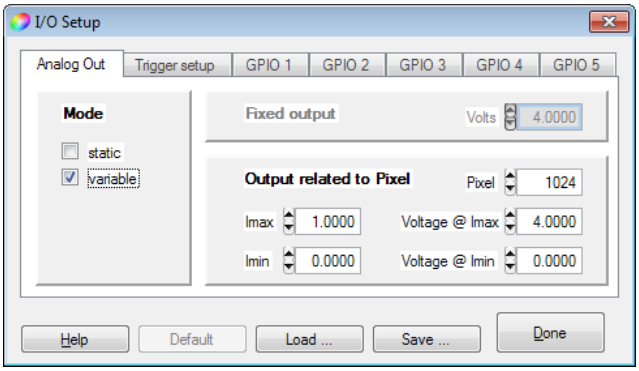
The analog output delivers a DC voltage of *0 - 4V in 4096 increments*, the max. current is 16mA.

Programming

Analog output can be programmed as a static or variable output. In **static** mode, a constant, adjustable output voltage can be assigned.



In the **variable** mode, the output voltage depends on the intensity of a selected pixel.

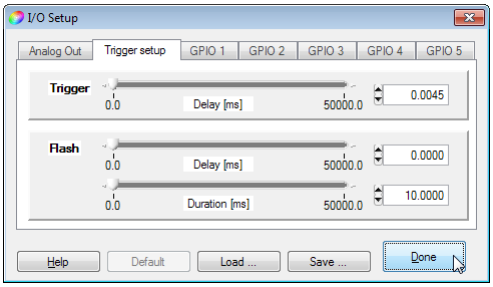


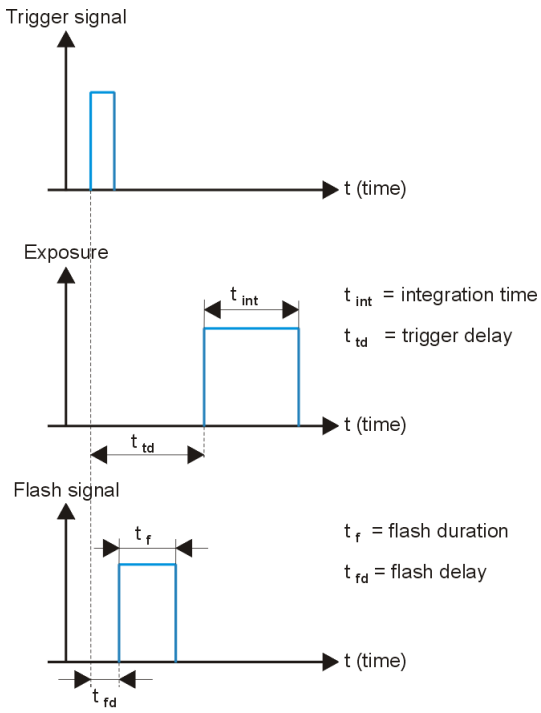
In above dialog box this dependency can be exactly defined:

- select the pixel of interest;
- define a maximum and a minimum intensity (in arbitrary units between 0.0000 and 1.0000);
- assign to both the min and max intensity an output voltage between 0 and 4 V. The output voltage for the minimum intensity can be higher or lower than that for the maximum intensity.

3.22.2 Trigger Setup

Trigger Setup allows to independently set the timing between internal (software) or external (hardware) trigger event, exposure control and flash signal. Therefore, 3 sliders are in the tab Trigger Setup:





Trigger In Delay

This delay adjusts the delay between the trigger (internal single shot or external) slope and start of CCD exposure. Time delay range: 4.5µs...50s.

Flash Delay

Flash delay is the time interval between the trigger (internal or external) slope and flash 45 control pulse. Time delay range: 0...50s

Flash Duration

This slider allows to a set the duration of the flash control pulse. Flash duration range: 0...50s.

Note

The trigger-in delay can be set even higher than the sum of flash delay and flash duration. In this case, the exposure of the CCD will be started only after the flash lapsed (extincted). This can be useful for fluorescent applications where a flash or a UV LED is used for excitation of a probe. The time diagram to the left illustrates the timing.

3.22.3 GPIO

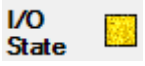
The LC100 smart line camera has 5 programmable I/O ports. These ports are logical ports, i.e., the input/output signals are TTL level, active = HIGH:

- input voltage: max. 3.3V
- logical level "LOW": 0 - 0.4V
- logical level "HIGH ": 2.4 - 3.3 V

All five GPIO ports can be linked each to the other by an AND relation.

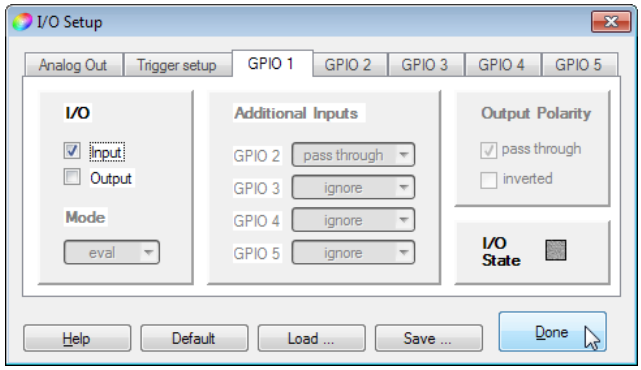
I/O State

I/O - inactive, low, off



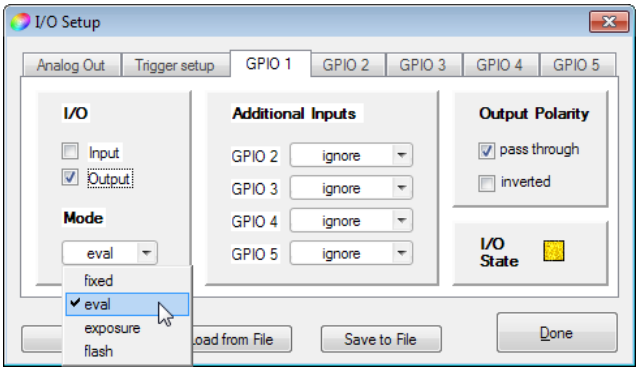
I/O - active, high, on

GPIO state - Input



Select the GPIO from the appropriate tab and check the **Input** box. Now the internal state of this port (**I/O State**) will follow the input state.

GPIO state - Output



Select the GPIO from the appropriate tab and check the **Output** box.

Output Mode

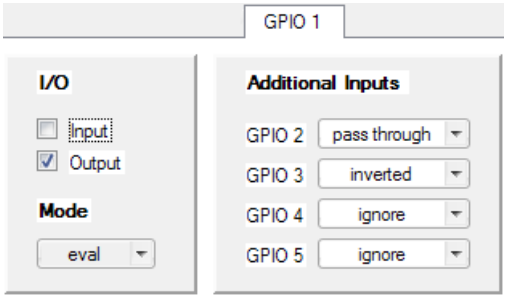
There are several output modes available from the drop down **Mode** menu:

- fixed: In this mode, to the appropriate GPIO will be assigned a fixed logical HIGH level.
- eval: In the evaluation mode, the output state depends on the result condition(s) of the active evaluation box(es) - see section Pattern Recognition 48
- exposure: In exposure mode, the output is pulsed: pulse duration = 0.5 ms. The rising edge of the pulse is synchronized with start of exposure of the CCD. If the LC100 is in Software Trigger Continuous 33 mode, the pulse is synchronized with starting of a new scan.
- **flash**: In flash mode, this GPIO port serves as flash control and can be used to release an external flash or switch on an external light source. This function is based on the trigger function; the duration of the "flash-active" state and it's delay with respect to a trigger signal are set in the tab Trigger Setup 44.

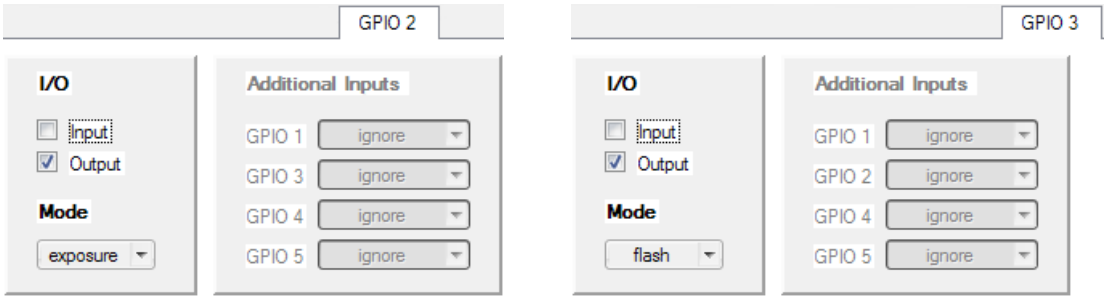
Additional Inputs

As mentioned earlier, the output state of any GPIO can be linked by an AND gating with the output state of any other GPIO. This is possible only in evaluation mode. The selected additional logical inputs can be **pass**ed **through** or **inverted** from the appropriate GPIO output. If **ignore** is selected, the GPIO is not linked.

Example:



GPIO 1 is in **eval** mode and linked with GPIO 2 and GPIO 3; GPIO 2 state is **passed through**, GPIO 3 - **inverted**. Let's see what the linked GPIOs stand for:



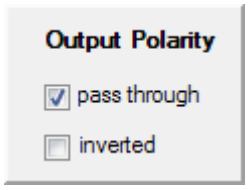
GPIO 2 is in exposure mode, it's output is active during exposure. GPIO 3 is in flash mode, so it's output is active during flash. The logical formula for the GPIO 1 output state is:

$$GPIO1 = eval \wedge GPIO2 \wedge \overline{GPIO3}$$

$$= eval \wedge exposure \wedge \overline{flash}$$

That means, GPIO 1 is active only if the result of the evaluation 48 is true ***and*** in the same time exposure is going on ***and*** in the same time no flash is active.

Output Polarity



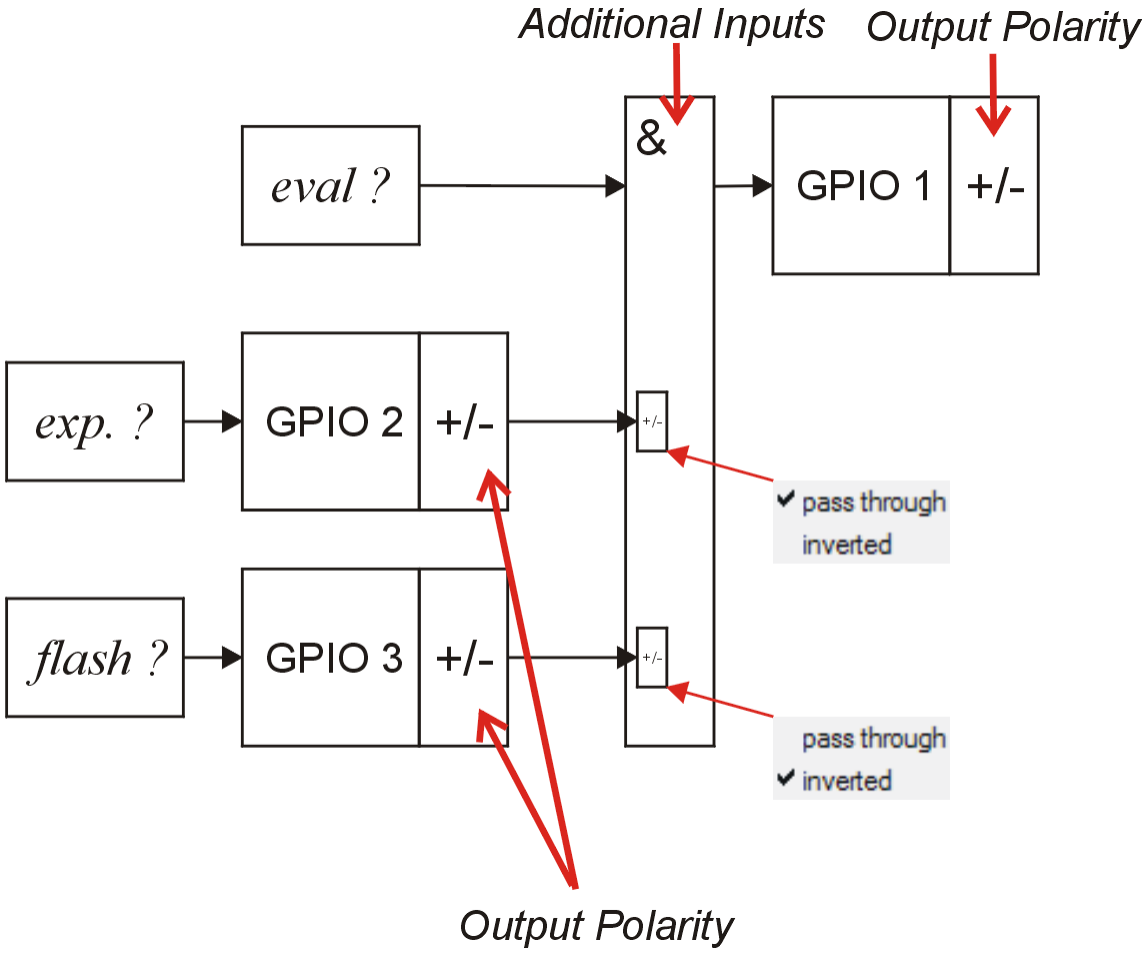
Using this feature, the logical polarity of each GPIO output can be inverted. This is possible only if the appropriate GPIO is set to output mode.

- **pass thro**ugh: if the output state is active, the logical signal is HIGH; if inactive - LOW
- inverted: if the output state is active, the logical signal is LOW; if inactive - HIGH

In input mode, it's set to **pass through** and cannot be changed.

Note

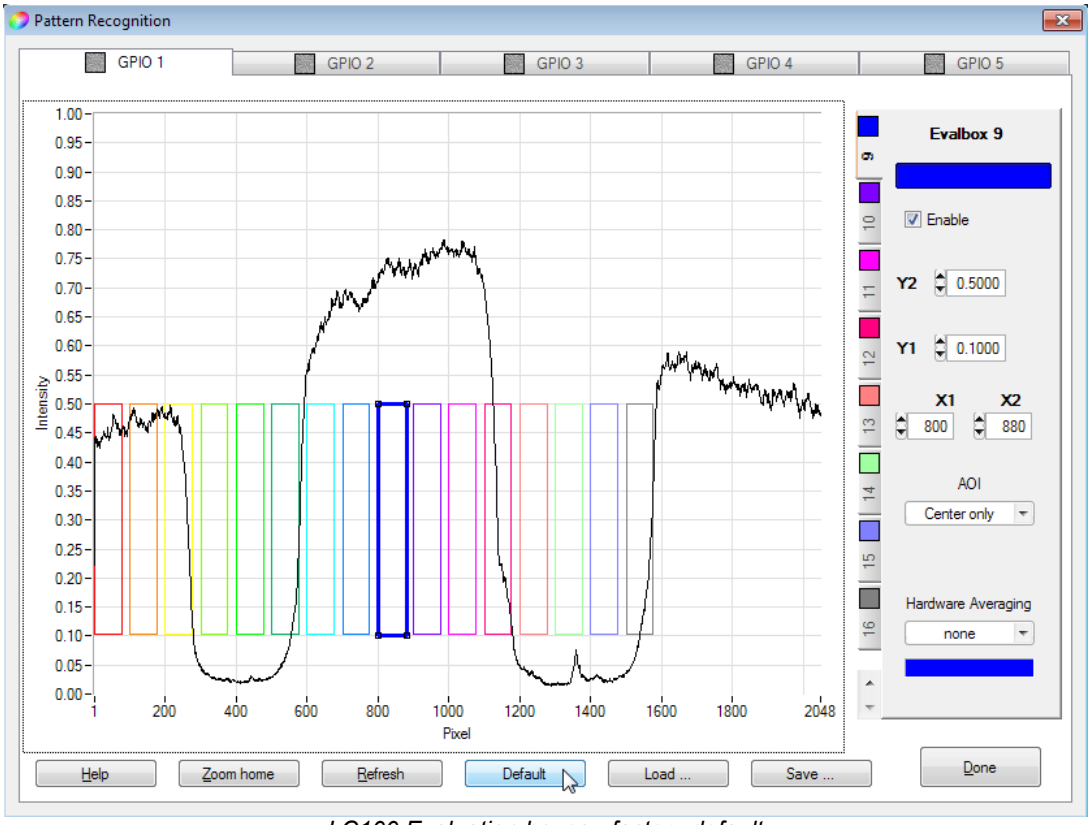
When linking another GPIO output as additional input, the pass through / inverted modes for the linked inputs are independent of the output polarity setting of the appropriate GPIO out. The following diagram illustrates that for the example above 46:



3.22.4 Pattern Recognition

LC100 Pattern Recognition is a powerful tool to evaluate a scan for it's curve shape. By other words, it's possible to observe the intensities detected within certain pixel ranges, compare them with given margins and output the result as a logical signal representing "***TRUE / FALSE***" information.

For this purpose, for ***each GPIO port*** the entire diagram area can be divided into up to 16 areas of interest ("**evaluation boxes**").



LC100 Evaluation boxes - factory default

Each evaluation box is defined by a range of pixel numbers (X1 = start pixel number; X2 = end pixel number) and a range of correlated intensities (Y1 = min. intensity; Y2 = max. intensity), this way forming a rectangle. Evaluation boxes may overlap and can be enabled/disabled independently.

Note

For each GPIO port, different numbers, positions and sizes of the evaluation boxes can be defined.

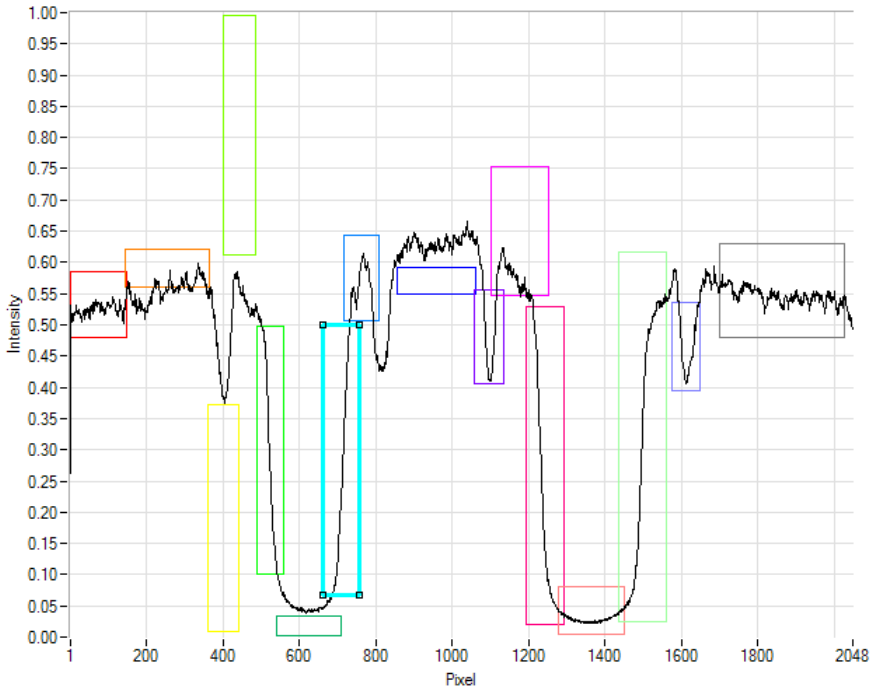
For evaluation, the intensity values in the appropriate area of interest (AOI) are compared with the selected criterion. There are 6 different criteria available. If the intensities match the criterion, the result of evaluation is ***TRUE***, else - ***FALSE***. Detailed explanation please find in section Area Of Interest 51.

This evaluation result is provided via GPIO. In order to use a GPIO for output of evaluation results, it must be configured as an output in evaluation mode - see section GPIO output modes 46. ***TRUE*** leads to output state HI, ***FALSE*** to LO. The GPIO output state can be linked to one ore more AOI. If the result of more than one AOI is linked to a GPIO, all results must be ***TRUE*** in order to generate a ***TRUE*** output signal at the appropriate GPIO (logical AND).

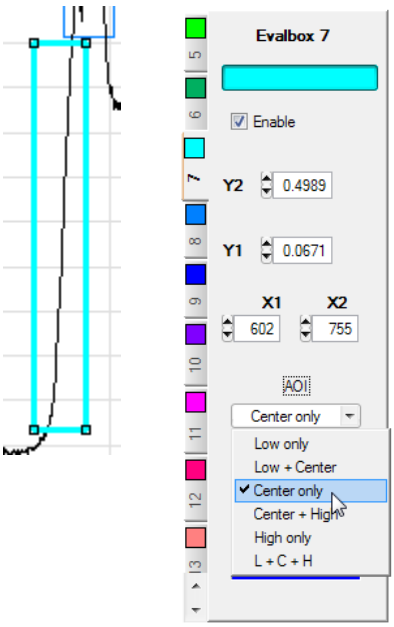
Note

Different GPIO (in evaluation output mode) can be linked to one ore more common evaluation boxes (AOI). In such case, each GPIO evaluates the same evaluation box(es), but the evaluation criteria can be different for each individual GPIO. Please see the example 52 for detailed explanation.

3.22.4.1 Editing an Evaluation Box



Above figure shows a diagram with 16 defined evaluation boxes. To the right of the diagram the evaluation edit box is located.



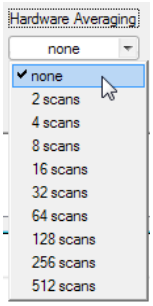
- **Select an eval box**: Click to a vertical tab, stating the number and color of the desired eval box. The tabs can be scrolled to display rested eval boxes. Therefore click to the arrows on the bottom of the tab bar (see position of the mouse pointer in the figure to the left)
- **Enable**: If check this, the appropriate GPIO will consider this evaluation box as activated.
- **Y2, Y1, X1, X2**: here the margins of the evaluation box can entered numerically.
- Alternatively, the margins can be defined using the mouse pointer - just move it to a corner of the evaluation box in the diagram (the mouse pointer changes from to), click and hold left and drag this corner to the desired position.
- The position of the evalbox can be moved over the diagram area - place the mouse pointer inside the evaluation box - the pointer changes to - then click and hold left ( ) and move the eval box to the desired position.

- **AOI**: There are 6 different evaluation criteria available for the AOI (Area Of Interest). If the scan propagation matches the selected criterion, the result of the evaluation in the particular box is TRUE. Details are explained in section Area of Interest 51.

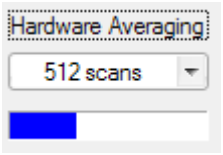
Zooming the diagram area

For a better visibility, the diagram area can be zoomed out. Therefore, move the mouse pointer to a corner of the desired zoom area and press and hold both the Ctrl key and the left mouse button. The cursor changes from to . Drag the zoom area to the desired size. The button "Zoom Home" returns to the view of the entire diagram area.

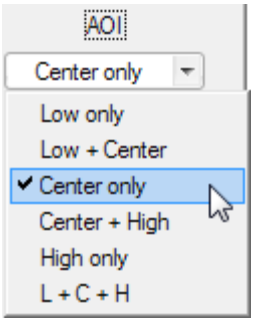
Hardware Averaging



LC100 hardware is able to average the result of an evaluation box prior. This averaging can be extended to up to 512 scans. A progress bar indicates the averaging status:

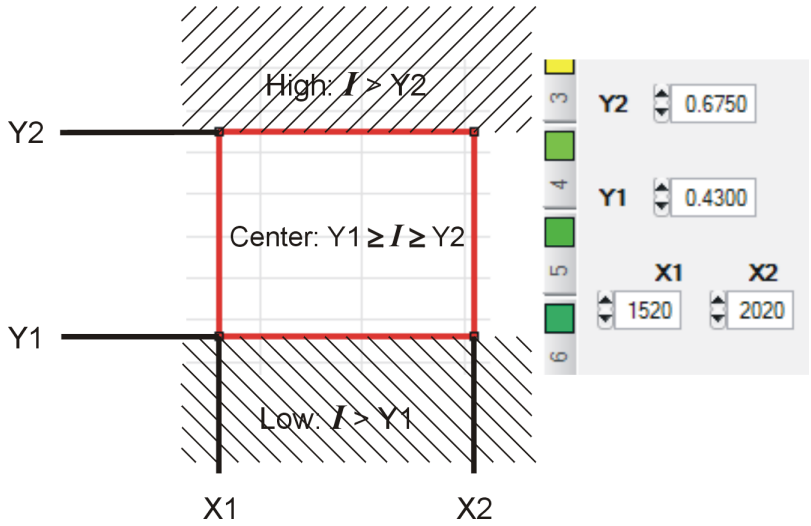


3.22.4.2 Area Of Interest (AOI)



In order to characterize the path of a scan through the evaluation box, for each evaluation box (AOI = Area Of Interest) one out of the 6 available criteria as below can be selected.

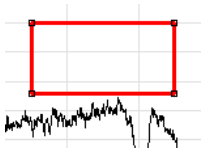
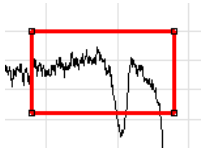
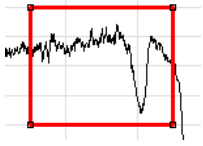
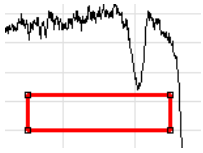
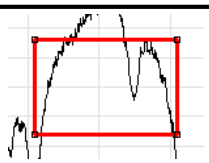
Each criterion describes how the intensity values in the given pixel interval (X1, X2) are related to the given intensity interval (Y1, Y2). The next figure explains these criteria.



- **Low only**: Intensity values of the pixels from X1 to X2 must be less than Y1.
- **Low + Center**: Intensity values must be less than Y2 ***and*** less than Y1
- **Center only**: Intensity values must be higher than Y1 and less than Y2
- **Center + High**: Intensity values must be higher than Y1 ***and*** higher than Y2
- **High only**: Intensity values must not be less than Y2
- **L + C + H**: Intensity values within the pixel interval (X1, X2) must be located in all 3 regions, that means lower than Y1 ***and*** between Y1 and Y2 ***and*** higher than Y2

3.22.4.3 Examples

In this section an overview of the possible deciding criteria for the AOI is given.

Scan propagation through the evaluation box	Results for AOI criteria					
	Low Only	Low + Center	Center only	Center + High	High only	L + C + H
	*TRUE*	*FALSE*	*FALSE*	*FALSE*	*FALSE*	*FALSE*
	*FALSE*	*TRUE*	*FALSE*	*FALSE*	*FALSE*	*FALSE*
	*FALSE*	*FALSE*	*TRUE*	*FALSE*	*FALSE*	*FALSE*
	*FALSE*	*FALSE*	*FALSE*	*TRUE*	*FALSE*	*FALSE*
	*FALSE*	*FALSE*	*FALSE*	*FALSE*	*TRUE*	*FALSE*
	*FALSE*	*FALSE*	*FALSE*	*FALSE*	*FALSE*	*TRUE*

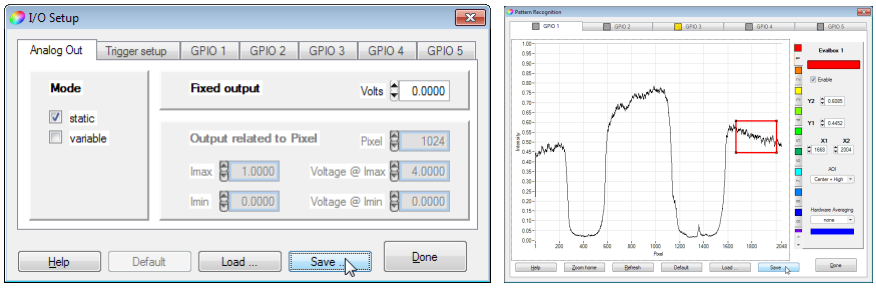
3.22.5 Saving and Loading of I/O Configurations

Save I/O configuration: all settings of analog output 43, trigger 44 and of GPIO 1...5 45, including the settings of pattern recognition 48, will be saved.

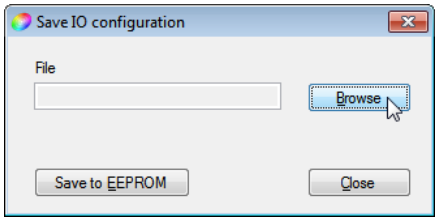
Via the **LOAD** function, previously saved configurations can be re-opened.

Save to File

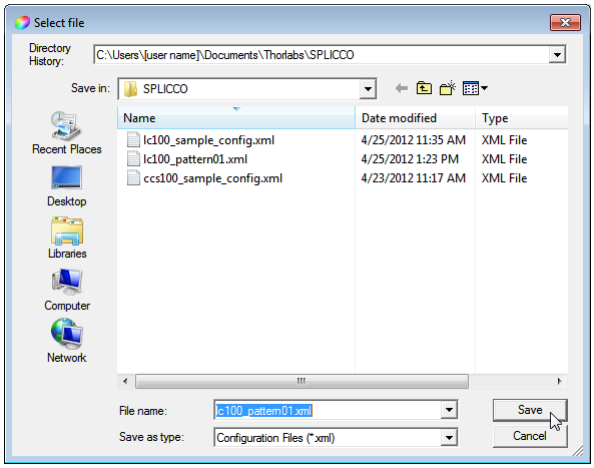
Click to the **Save to File** button in either the Pattern Recognition or I/O Setup panel:



A dialog box for selecting a file name appears:



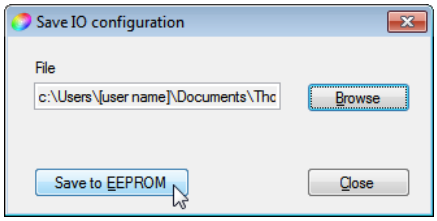
Click to **Browse** in order to enter a file name:



The default directory for configuration files is

- under Windows XP
  C:\Documents and Settings\ [username] \Documents\Thorlabs\SPLICCO
- under Windows Vista / 7
  C:\Users\ [username] \Documents\Thorlabs\SPLICCO

Enter a file name and click **Save** to save the configuration file. The dialog closes and the previous dialog appears:



Click to "**Save to EEPROM**" if the entire I/O configuration needs to be stored to the camera's internal non-volatile memory. In this case, no file name is required. The saved I/O Setup is then available by default upon connect of the camera.

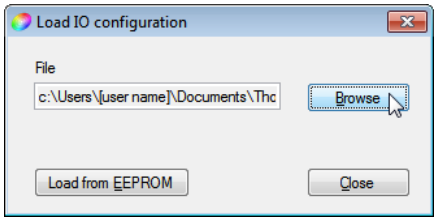
If you don't want to save to EEPROM, click "Close"

Note

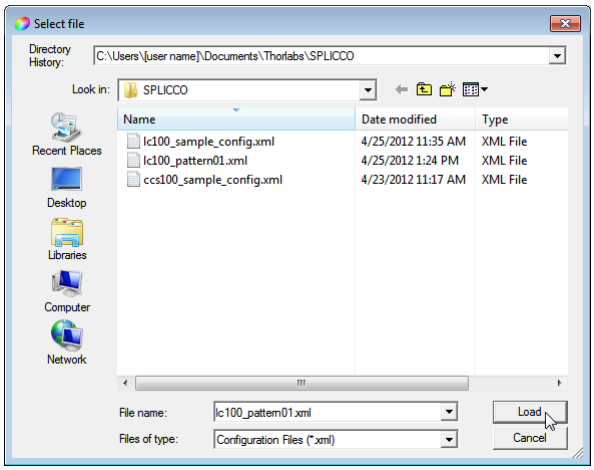
- Current settings for GPIO, analog out, trigger and pattern recognition (configuration of evaluation boxes) are saved automatically when exiting SPLICCO software or just disconnecting the software from the camera, as long as the camera remains physically connected to the USB port of the PC. Once the camera was disconnected physically, upon re-connect the settings of the I/O ports, analog out, trigger and pattern recognition are loaded from the camera's internal EEPROM.
- When saving a configuration file, please make sure not to overwrite an already existing configuration.

Load from File

A previously saved I/O configuration can be re-opened. Click to the **Load from File** button in either Pattern Recognition or Input/Output Configuration panel. A dialog box for selecting a file name appears:



Click to **Browse** in order to select a file name:

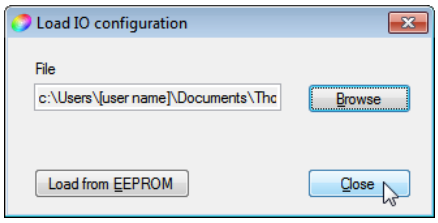


The default directory for configuration files is

- under Windows XP
  C:\Documents and Settings\ [username] \Documents\Thorlabs\SPLICCO

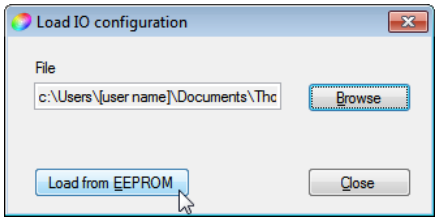
- under Windows Vista / 7
  C:\Users\ [username] \Documents\Thorlabs\SPLICCO

Select the required directory and file name, then click **Load** to load the configuration file. The dialog closes and the previous dialog appears. Click "Close" to finish:



Load from EEPROM

A saved to the LC100 camera I/O configuration can be re-opened. Click to the **Load from File** button in either Pattern Recognition or Input/Output Configuration panel, then in the next dialog "Load from EEPROM":



The configuration will be read out from the camera and displayed in the GUI.

3.22.6 Stand Alone Operation

Owing to the capability of the LC100 Smart Line Camera to save the complete I/O configuration to the internal, non-volatile memory (EEPROM), it can be operated without SPLICCO.

The saved to EEPROM I/O configuration includes:

1. Analog output 43 configuration
2. Trigger mode 33 (and trigger delay 44, if applicable)
3. Flash 45 delay and duration (in case, a GPIO was configured as flash output)
4. All GPIO 45 settings including the according individual evaluation boxes 48

In this operating mode, the LC100 must be powered via the USB interface, e.g. by connecting it to a USB power supply or a PC. The GPIO ports deliver the output signal. This way, the camera can recognize predefined patterns, using GPIO1...GPIO5, and/or the intensity of a certain pixel can be observed via the analog output.

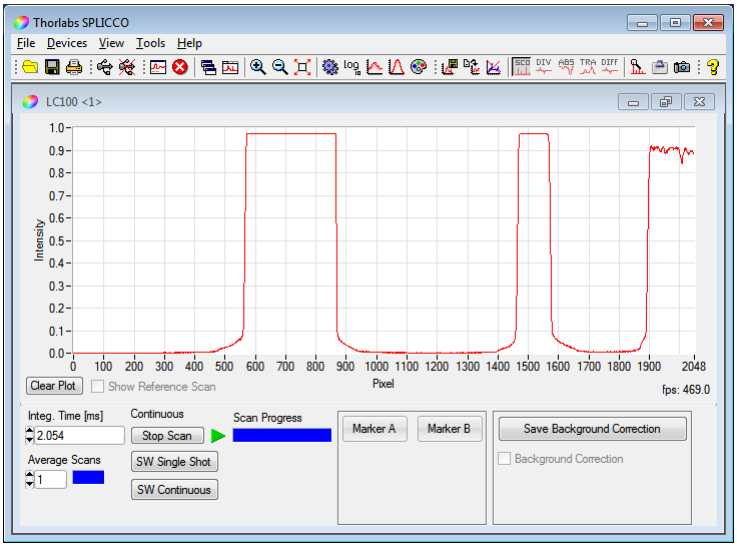
In stand alone operation, the saved trigger function is active as well.

All output signals are provided at the GPIO port connector 72 and can be connected via the included trigger cable (CAB-LC100 72) to peripheral devices.

3.23 Application Note

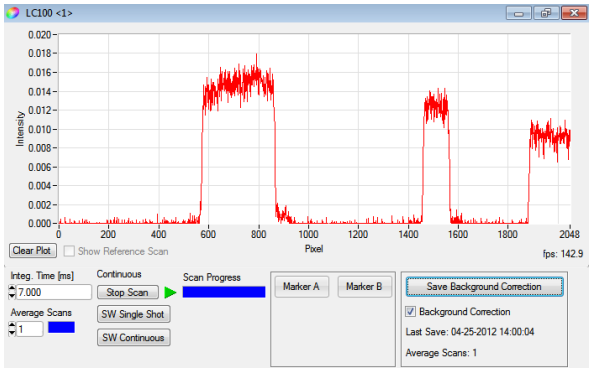
This section hopes to aid the user, by giving tips or hints on how to obtain the best measurements with the Smart Line Camera. It begins with a few general suggestions and finishes by giving a choice of question with solutions.

For a good signal to noise (S/N) ratio, it is recommended to have the spectral data of interest in between 70% and 95% of the intensity scale (0.7 - 0.95). This ensures that the signal is above the background noise, but not overexposed. You can identify an overexposed signal by the increased line width (see: blooming) and a characteristic plateau of the signal maximum.

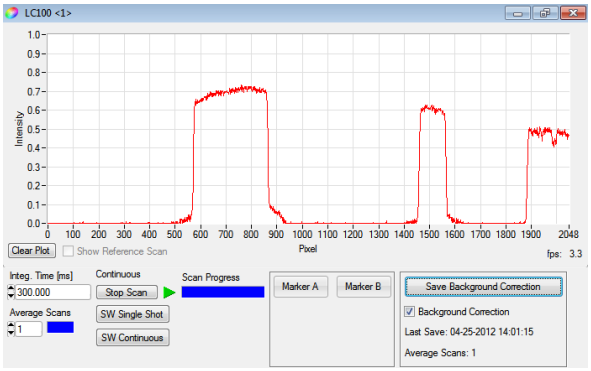


If your signal looks similar to the sample in the above figure, decrease the integration time to get a maximum peak intensity in between 0.9 and 1.0. If your signal is still overexposed at the minimum integration time of 1.054 ms, it is recommended to use neutral density filters or other optical attenuator in front of the light source to decrease its intensity.

If the signal you are evaluating is very small, you can increase the integration time. As shown in the next figures, this way the peak intensity raises from ~ 0.018 (equal to 1.8% of the max. intensity) to about 0.7 (70%), which is a recommended value.

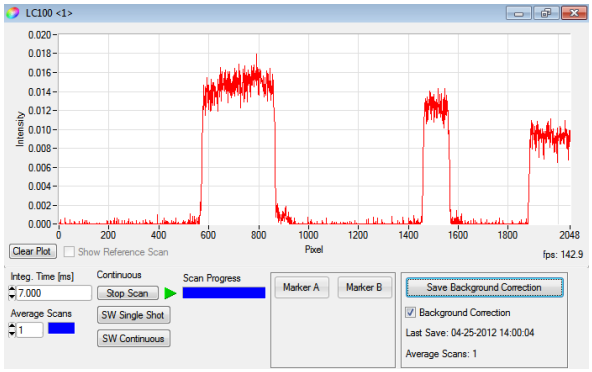


Scan, recorded at 7 ms integration time

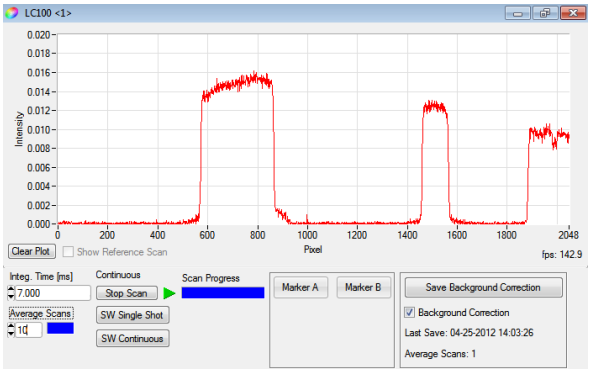


Scan, recorded at 300ms integration time

If you are already at the maximum or if other parameters of your experiment do not permit long exposures, you can also use the averaging function to raise you signal above the noise. The result can be seen in the following figures. Please note, that the intensity is around 0.018 which corresponds to 1.8% of the available intensity scale.



Scan, recorded at 7 ms integration time and 1 average



Scan, recorded at 7ms integration time and 10 averages

Blooming

Blooming is a property owned by all CCD sensors, as used in the LC100. Strongly overexposed pixels tend to discharge neighboring / adjacent pixels, even if they are not illuminated. This can be seen in the scan by an increased pattern width, which could lead to misinterpretations of the signal. You can avoid this effect by decreasing the integration time or using optical attenuators, as described above.

4 Virtual Devices

4.1 What are virtual devices?

SPLICCO offers a special feature named "Virtual devices" which allows to demonstrate the various application features without having a real device connected to the PC.

Those virtual devices can simulate line cameras or spectrometers. The properties of virtual devices can be set and will be stored in a XML file.

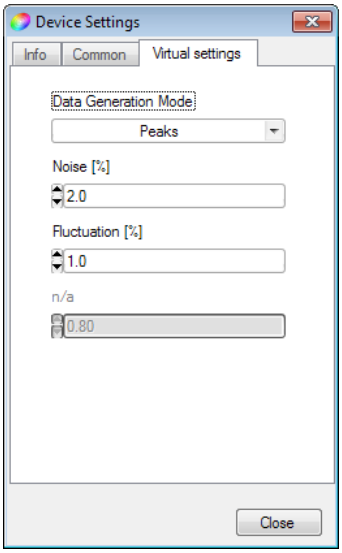
Available parameters:

- device type
- number of pixels
- minimum and maximum wavelength
- manufacturers and instruments name
- serial and revision number
- alias
- lock status

4.2 Configuration of virtual devices

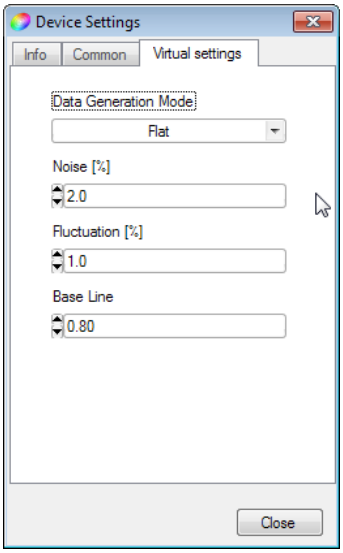
Virtual devices offers some options to manipulate the simulated data. The settings can be changed in Device Settings 31 dialog, tab 'Virtual settings'.

Virtual spectrometer:



If the virtual device simulates a spectrometer the "Data Generation Mode" offers the mode "Peaks" only . Each time you select this mode new peaks will be generated. With the help of the control "Noise" the noise level in % can be changed as well as the fluctuation.

Virtual line camera:



If the virtual device simulates a line camera, the "Data generation mode" offers the modes "Line" and "Curve". The noise level and the fluctuation can be set and the baseline of the measurement and the amplitude of the curve can be changed.

4.3 The virtual devices description file

All virtual devices used by SPLICCO are described by a XML file, which can be modified with a simple text editor, e.g., Notepad. This description file can be found in the installation folder of SPLICCO software:

C:\Program Files\Thorlabs\SPLICCO\CameraDescription.xml

HINT: Make a backup of this file before you modify the original to restore it if needed.

Please close SPLICCO before you edit this file. The changes will become active after SPLICCO is started again.

Each virtual device has the following parameters:

DEVICETYPE	The device type. 0 for a spectrometer, 1 for a virtual line camera.
NUM_PIXELS	The number of pixels. 1 < NUM_PIXELS < 10000
WAVELENGTH_MIN	The minimum wavelength, minimal value should be ≥ 0.
WAVELENGTH_MAX	The maximum wavelength, maximal value should be ≤10000.
MANUFACTURER	The manufacturers name.
INSTRUMENT	The instruments name.
SERIALNUMBER	The virtual devices serial number.
REVISION	The virtual devices revision number.
ALIAS	The virtual devices alias.
LOCKSTATUS	The virtual devices lock status. 0 means unlocked, 1 means locked. The device can only be opened if the lockstatus is 0.

To create a new virtual device for SPLICCO, please open the file "CameraDescription.xml" in the installation folder. A new entry should be formatted in the same way as the original virtual devices. Open the description file, add your device and save it as XML file to above folder.

Note

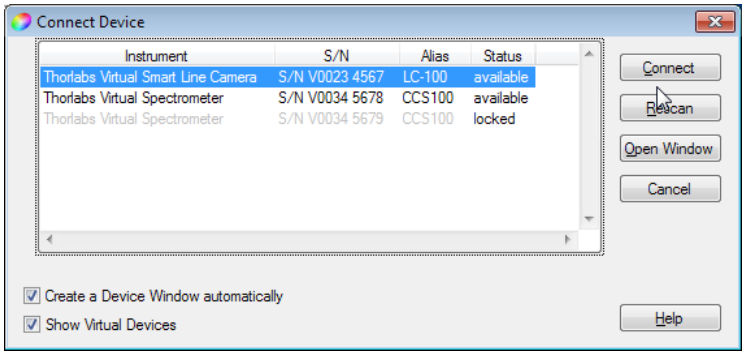
Please make sure that serial numbers are unique.

Example:

The following changes were made; a third device was added in lock state:

```
- <SPLICCO>
  - <CAMERA_1>
      <DEVICETYPE>1</DEVICETYPE>
      <NUM_PIXELS>3000</NUM_PIXELS>
      <WAVELENGTH_MIN>420</WAVELENGTH_MIN>
      <WAVELENGTH_MAX>660</WAVELENGTH_MAX>
      <MANUFACTURER>Thorlabs</MANUFACTURER>
      <INSTRUMENT>Virtual Smart Line Camera</INSTRUMENT>
      <SERIALNUMBER>S/N V0023 4567</SERIALNUMBER>
      <REVISION>1.00</REVISION>
      <ALIAS>LC-100</ALIAS>
      <LOCKSTATUS>0</LOCKSTATUS>
    </CAMERA_1>
  - <CAMERA_2>
      <DEVICETYPE>0</DEVICETYPE>
      <NUM_PIXELS>3000</NUM_PIXELS>
      <WAVELENGTH_MIN>371</WAVELENGTH_MIN>
      <WAVELENGTH_MAX>842</WAVELENGTH_MAX>
      <MANUFACTURER>Thorlabs</MANUFACTURER>
      <INSTRUMENT>Virtual Spectrometer</INSTRUMENT>
      <SERIALNUMBER>S/N V0034 5678</SERIALNUMBER>
      <REVISION>0.90</REVISION>
      <ALIAS>CCS100</ALIAS>
      <LOCKSTATUS>0</LOCKSTATUS>
    </CAMERA_2>
  - <CAMERA_3>
      <DEVICETYPE>0</DEVICETYPE>
      <NUM_PIXELS>3000</NUM_PIXELS>
      <WAVELENGTH_MIN>371</WAVELENGTH_MIN>
      <WAVELENGTH_MAX>842</WAVELENGTH_MAX>
      <MANUFACTURER>Thorlabs</MANUFACTURER>
      <INSTRUMENT>Virtual Spectrometer</INSTRUMENT>
      <SERIALNUMBER>S/N V0034 5679</SERIALNUMBER>
      <REVISION>0.90</REVISION>
      <ALIAS>CCS100</ALIAS>
      <LOCKSTATUS>1</LOCKSTATUS>
    </CAMERA_3>
  </SPLICCO>
```

This leads to the virtual devices dialog as below:



5 Write Your Own Application

In order to write your own application, you need a specific instrument driver and some tools for use in different programming environments. The driver and tools are being installed to your computer during software installation and cannot be found on the installation CD.

In this section the location of drivers and files, required for programming in different environments, are given for installation under Windows XP (32 bit) and Windows 7 (32 and 64 bit)

Note

SPLICCO software and drivers are 32 bit applications. As for this reason, in 32 bit systems, they are installed to

```
C:\Program Files\...
```

while in 64 bit systems - to

```
C:\Program Files (x86)\...
```

In the table below you will find a summary of what files you need for particular programming environments.

Programming environment	Necessary files
C, C++, CVI	*.h (header file) *.lib (static library)
C#	.net wrapper dll
Visual Studio	*.h (header file) *.lib (static library) or .net wrapper dll
LabView	*.fp (function panel) and NI VISA instrument driver Beside that, LabVIEW driver vi's are provided with the *.llb container file

Note

All above environments require also the NI VISA instrument driver dll !

In the next sections the location of above files for all hardware, supported by SPLICCO drivers, is described in detail.

5.1 CCS Series

NI VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Bin\CCS_Series_Drv_32.dll

Note

This instrument driver is required for all development environments!

The source code of this driver can be found in

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries\CCS_Series_Drv.c

Online Help for NI VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries\Manual

NI LabVIEW driver

C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\CCSseries\CCSseries.llb

(LabVIEW container file with driver vi's - "LabVIEW xxxx" stands for actual LabVIEW installation folder.)

Header file

C:\Program Files\IVI Foundation\VISA\WinNT\include\CCS_Series_Drv.h

Static Library

C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\CCS_Series_Drv_32.lib

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries\CCS_Series_Drv_32.lib

Function Panel

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries\CCS_Series_Drv.fp

.net wrapper dll

C:\Program Files\Microsoft.NET\Primary Interop Assemblies\Thorlabs.CCS_Series.dll

Example for C

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries\Examples\C

sample.c - C program how to communicate with a CCS series spectrometer

sample.exe - same, but executable

Example for C#

Solution file:

C:\Program Files\IVI Foundation\VISA\WinNT\ThorlabsCCSseries...
...\Examples\CSharp\CCS100_CSharpDemo.sln

Project file

C:\Program Files\IVI Foundation\VISA\WinNT\ThorlabsCCSseries...
...\Examples\CSharp\CCS100_CSharpDemo\CCS100_CSharpDemo.csproj

Executable sample demo

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries...
...\Examples\CSharp\CCS100_CSharpDemo\bin\Release\CCS100_CSharpDemo.exe

Example for LabView

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs CCSseries\Examples....

...\LabVIEW\CCS Series Sample.llb

5.2 LC100 Smart Line Camera

NI VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Bin\LC100_Drv_32.dll

Note

This instrument driver is required for all development environments!

The source code of this driver can be found in

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\LC100_Drv.c

Online Help for VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\Manual

NI LabVIEW driver

C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\LC100\LC100.llb

(LabVIEW container file with driver vi's - "LabVIEW xxxx" stands for actual LabVIEW installation folder.)

Header file

C:\Program Files\IVI Foundation\VISA\WinNT\include\LC100_Drv.h

Static Library

C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\LC100_Drv_32.lib

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\LC100_Drv_32.lib

Function Panel

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\LC100_Drv.fp

.net wrapper dll

C:\Program Files\Microsoft.NET\Primary Interop Assemblies\Thorlabs.LC100.dll

Example for C

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\Examples\C

sample.c - C program how to communicate with a LC100 Smart Line Camera

sample.exe - same, but executable

Example for C#

Solution file:

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\Examples...

...\CSharp\ LC100_CSharpDemo.sln

Project file

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100...

...\Examples\CSharp\LC100_CSharpDemo\LC100_CSharpDemo.csproj

Executable sample demo

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100...
...\Examples\CSharp\LC100_CSharpDemo\bin\Release\LC100_CSharpDemo.exe

Example for LabView

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC100\Examples...

...\LabVIEW\LC100 Sample Source Distribution.llb

5.3 SPX Series

NI VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Bin\SPX_Drv_32.dll

Note

This instrument driver is required for all development environments!

The source code of this driver can be found in

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs SPx\SPX_Drv.c

Online Help for VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs SPx\Manual

NI LabVIEW driver

C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\SPx\SPX.llb

(LabVIEW container file with driver vi's - "LabVIEW xxxx" stands for actual LabVIEW installation folder.)

Header file

C:\Program Files\IVI Foundation\VISA\WinNT\include\SPX_Drv.h

Static Library

C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\SPX_Drv.lib

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs SPx\SPX_Drv.lib

Function Panel

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs SPx\SPX_Drv.fp

.net wrapper dll

C:\Program Files\Microsoft.NET\Primary Interop Assemblies\Thorlabs.SPx_Drv.dll

Examples for CVI:

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs SPx\Examples\CVI

contains examples in source code and executable

5.4 LC1 Line Camera

NI VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Bin\LC1_Drv_32.dll

Note

This instrument driver is required for all development environments!

The source code of this driver can be found in

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC1\LC1_Drv.c

Online Help for VISA Instrument driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC1\Manual

NI LabVIEW driver

C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\LC1\LC1.llb

(LabVIEW container file with driver vi's - "LabVIEW xxxx" stands for actual LabVIEW installation folder.)

Header file

C:\Program Files\IVI Foundation\VISA\WinNT\include\LC1_Drv.h

Static Library

C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\LC1_Drv.lib

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC1\LC1_Drv.lib

Function Panel

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC1\LC1_Drv.fp

.net wrapper dll

C:\Program Files\Microsoft.NET\Primary Interop Assemblies\Thorlabs.LC1_DRV.dll

Examples for CVI

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC1\Examples\CVI
contains examples in source code and executable

Examples for LabVIEW

C:\Program Files\IVI Foundation\VISA\WinNT\Thorlabs LC1\Examples...
...\Labview\LC1-USBexample.llb

6 Maintenance and Service

6.1 Maintenance

Protect the LC100 smart line camera from adverse weather conditions. The LC100 line camera is not water resistant.

Attention

To avoid damage to the spectrometer, do not expose it to spray, liquids or solvents!

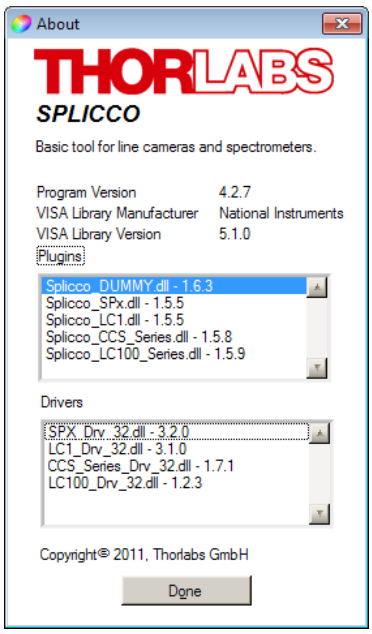
The unit does not need a regular maintenance by the user.

If necessary the unit and the display can be cleaned with a cloth dampened with water.

The LC100 line camera does not contain any modules that could be repaired by the user himself. If a malfunction occurs, the whole unit has to be sent back to *Thorlabs* 76. Do not remove any covers!

6.2 Version Information

The menu entry 'Help -> About' displays all application relevant data: Splicco , VISA and the .dll versions.



In case of a support request, please submit the software version of the application. This will help to locate the error.

Visit Thorlabs website www.thorlabs.com for available updates to download.

6.3 Troubleshooting

SPLICCO software terminates with error message "Software cannot be installed"

- Check if you have administrator privileges on your computer
- For WindowsXP© users: Make sure, Service Pack 3 is installed.

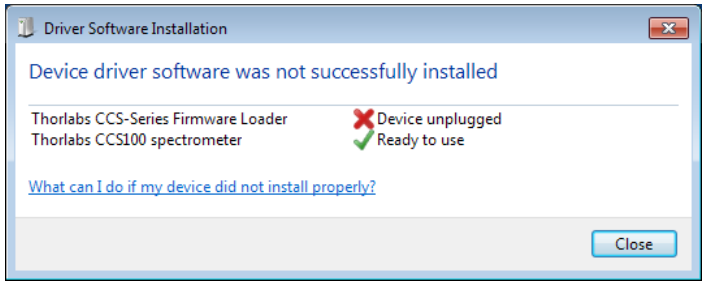
SPLICCO cannot find any devices but the virtual devices :

- Check if VISA runtime 5.1 or higher is installed.
- Make sure that the connected device is made by Thorlabs.
- Try to connect the device to another USB port.

Installation wizard prompts to specify the path of a ".sys" file:

- point wizard to "Windows\System32\drivers"

When connecting a spectrometer, an error message is displayed:



- This error message can be ignored. The reason is that firstly, Windows recognizes a device which requires a firmware download into the device. After finishing the download, the spectrometer reboots and a identifies himself with the exact type. Windows may recognize this reboot as a disconnect and thus, the above error message appears. Don't worry - your device will operate normally.

Measurement is running but the diagram is not updated with new measurement values :

- Look if the device is set to idle mode.
- Maybe you pressed the "Stop" button.
- Set device into "software trigger single shot" mode, trigger once, return to "software trigger continuous" mode
- if in "external trigger single/continuous", check your trigger source or re-arm the trigger

After opening an exported *.csv file with Microsoft Excel, a large number of incorrect numbers are displayed at the Excel sheet :

- The decimal separator in your Microsoft Excel may be set to ',' instead to '.'. The *.csv files generated by this program requires that Excel interprets '.' as the decimal separator.

"Found New Hardware Wizard" finishes with the error "the wizard cannot find the necessary software":

- This error occurs when the installer cannot find SPLICCO installed on your system.
- Install SPLICCO.
- Be sure that your device is configured as a VISA device.
- Check if VISA runtime 5.1 or higher is installed on your system.

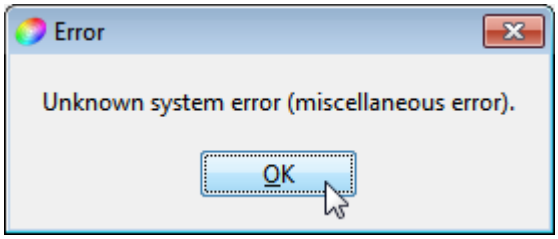
The Intensity of the measured signal does not increase linearly with the integration time:

- The CCD array applies an electronic shutter function, if integration times below 4ms are used. In that case the pixels are sequentially recharged, until the time to the next CCD readout matches the wanted integration time. Unfortunately the manufacturer of the CCD does not guarantee this recharging/resetting of the array to be 100% effective. Therefore it cannot be guaranteed that all photons are ignored, before the actual integration time starts. This might cause peak heights to in- or decrease to a higher degree than the integration time was changed.
- If you want to make relative comparisons of signal heights or areas beneath the curve, try using integration times above 4ms and use the dark current correction (Properties/LC100 settings/ Save dark current correction).

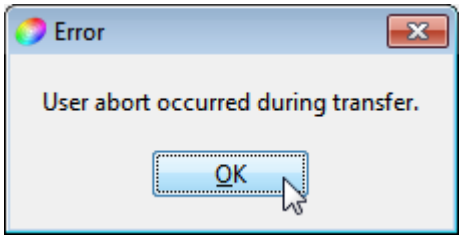
The scan seems to be shifted - the intensity at pixel #0 is displayed at pixel # 512

- This is a synchronization issue between the camera and the software. 512 is the size of the USB buffer. Please change trigger mode or averaging temporarily - this stops the data acquisition and resets the buffer.

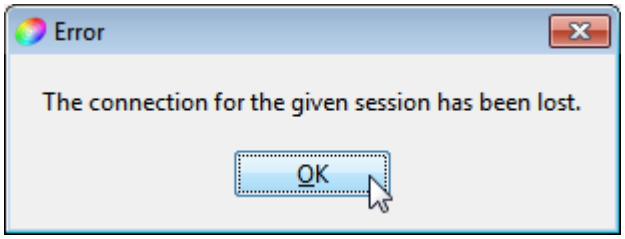
Error messages as below appear



and / or



- Actually, prior to above error messages another panel should have appeared:



- Usually, the reason is a hardware disconnect - the USB cable has been unplugged. Please check.
- If a USB hub is used, it's power supply might have dropped.
- A common USB interface failure might have occurred.
- Possibly, the computer has been turned to Sleep or Hibernate during a running SPLICCO session - after wake up, the session won't be restored.

7 Appendix

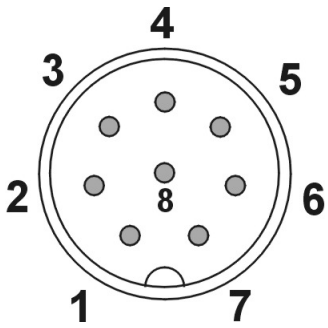
7.1 Technical Data

	LC100
Sensor Specifications	
Detector Range (CCD Chip)	350 - 1100 nm
CCD Pixel Size	14 µm x 56 µm (14 µm pitch)
CCD Sensitivity	240 V / (lx · s)
CCD Dynamic Range [1])	333
CCD Pixel Number	2048
Integration Time	1.054 ms − 50 s
Scan Rate Internal Trigger [2])	Max 900 scans/s
S/N Ratio [3])	≤2000 : 1
External Trigger	
Trigger Input	BNC
Trigger Signal	TTL 5 V and 3.3 V
Trigger Frequency, Scan Rate [2])	Max 450 Hz, 450 Scans/s
Trigger Pulse Length	Min 50 ns
Trigger Delay	4.5 µs
Number of GPIOs	5
GPIO Type	3.3 V TTL
Region of Interests	16
Analog Output	Programmable 0 - 4 V
General Specs	
Interface	Hi-Speed USB2.0 (480 Mbit/s)
Dimensions (L x W x H)	80 mm x 80 mm x 33 mm (3.13" x 3.13" x 1.30")
Weight	<0.4 kg
Operating Temperature Range [4])	0 to 40 °C
Storage Temperature Range	-40 to 70 °C

All technical data are valid at 23 ± 5°C and 45 ± 15% rel. humidity (non condensing)

[1]) ratio of saturation voltage to dark current voltage
[2]) 1.055 ms integration time
[3]) with 10x averaging, depending on integration time; for single shot use CCD dynamic range
[4]) non-condensing

7.1.1 GPIO port connector

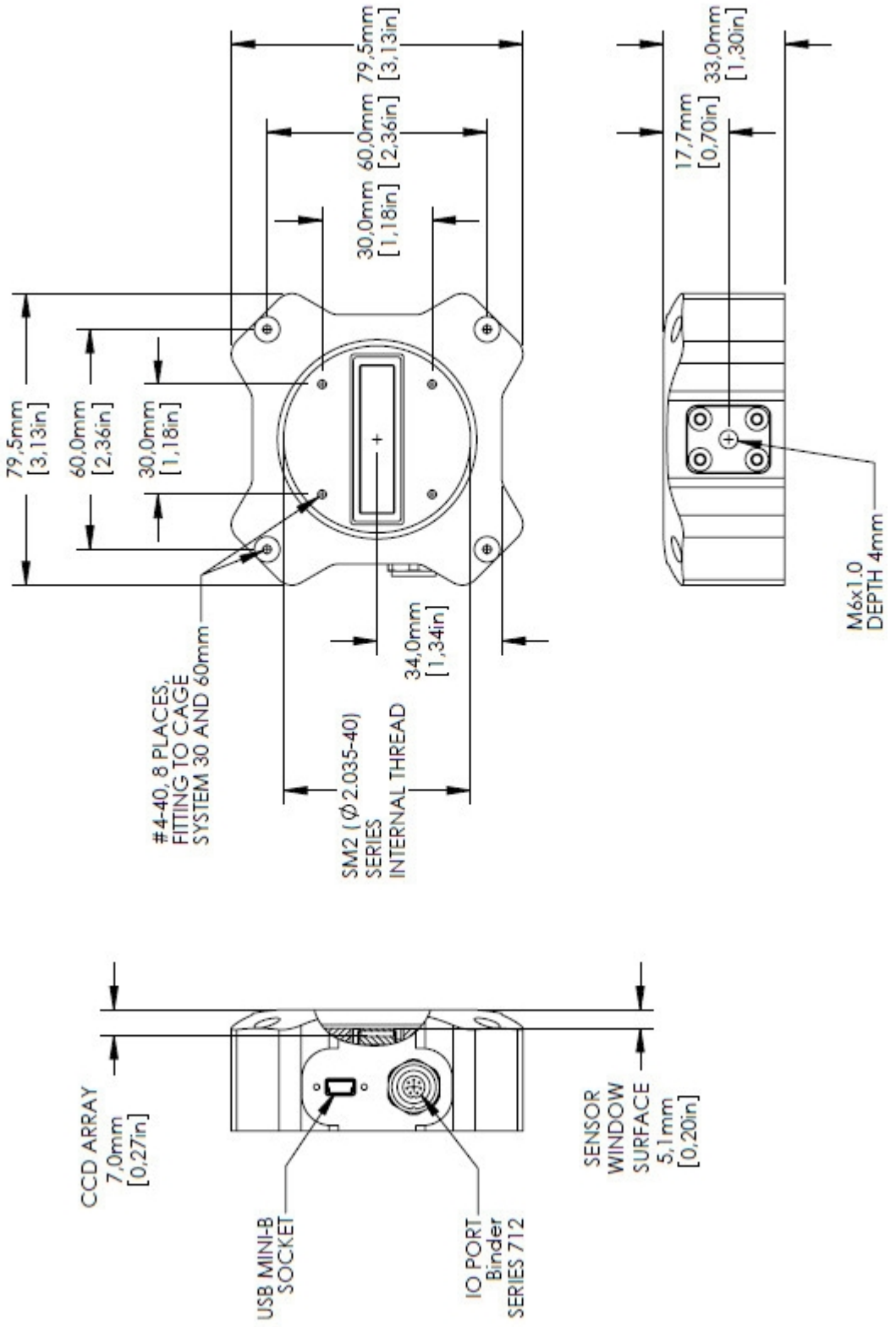


Pin #	Description
1	Trigger Input, LL TTL (max. 3.3V; 0 - 0.4V = LOW, 2.4 - 3.3 V = HIGH)
2	Common GND (Trigger and GPIO)
3	Analog Output, *0 - 4V DC in 4096 increments*, max. current 16mA
4 -8	GPIO ports 1-5, LL TTL

CAB-LC100 Trigger cable
DIN 47100 color code

Pin #	Color	Description
1	BNC plug	Trigger In
2	BNC shield, brown	Trigger Ground
3	green	Analog Out
4	yellow	GPIO1
5	gray	GPIO2
6	pink	GPIO3
7	blue	GPIO4
8	red	GPIO5
	white	n.c. (unused)

7.2 Dimensions



7.3 Certifications and Compliances

Category	Standards or description
EC Declaration of Conformity - EMC	Meets intent of Directive 2004/108/EC [1]) for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:
EN 61326:2006	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions [2,3,4]) and Immunity. [2,3,4])
IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion B)
IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion A)
IEC 61000-4-4	Electrical Fast Transient / Burst immunity (Performance criterion B)
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B [2,3,4]).
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 2006/95/EC [5])
EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use.
UL 61010-1 2nd ed.	Safety requirements for electrical equipment for measurement, control and laboratory use.
CAN/CSA C22.2 No. 61010-1 2nd ed.	Safety requirements for electrical equipment for measurement, control and laboratory use.
IEC 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use.
Equipment Type	Test and measuring
Safety Class	Class I equipment (as defined in IEC 60950-1:2001)

[1]) Replaces 89/336/EEC
[2]) Compliance demonstrated using high-quality shielded interface cables.
[3]) Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.
[4]) Minimum Immunity Test requirement.
[5]) Replaces 73/23/EEC, amended by 93/68/EEC.

7.4 Listings

7.4.1 List of acronyms

The following acronyms and abbreviations are used in this manual:

CCD	Charge-coupled Device
CSV	Comma Separated Values
DLL	Dynamic Link Library
FCC	Federal Communications Commission
GPIO	General Purpose Input/Output
GUI	Graphical User Interface
IEC	International Electrotechical Commission
LL TTL	Low Level TTL
OEM	Orginal Equipment Manufacturer
PC	Personal Computer
PCB	Printed Circuit Board
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment
SPLICCO	Spectrometer and Line camera Control
SW	Software
USB	Universal Serial Bus
VISA	Virtual Instrument Software Architecture
VME	Virtual-8086 Mode Enhancement
VXI	VMEbus eXtensions for Instrumentation
VXIPNP	VMEbus eXtensions for Instrumentation Plug aNd Play
WEEE	Waste Electrical and Electronic Equipment Directive
XML	eXtensible Markup Language

7.4.2 Thorlabs Worldwide Contacts

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Thorlabs 'End of Life' Policy (WEEE)

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabs electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see figure below)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated.

As the WEEE directive applies to self contained operational electrical and electronic products, this “end of life” take back service does not refer to other Thorlabs products, such as:

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB’s, housings etc.).

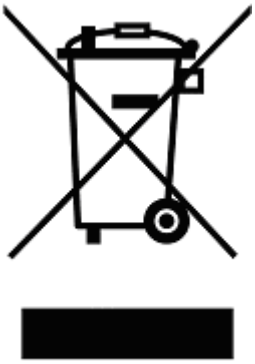
Waste treatment on your own responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS Directive is to reduce the content of toxic substances in electronic products in the future.
The intent of the WEEE Directive is to enforce the recycling of WEEE. A controlled recycling of end-of-life products will thereby avoid negative impacts on the environment.



Crossed out "Wheelie Bin" symbol

Warranty

Thorlabs warrants material and production of the SPLICCO for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs will see to defaults by repair or by exchange if these are entitled to warranty.
For warranty repairs or service the unit must be sent back to Thorlabs. The customer will carry the shipping costs to Thorlabs, in case of warranty repairs Thorlabs will carry the shipping costs back to the customer.
If no warranty repair is applicable the customer also has to carry the costs for back shipment.
In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs warrants the hard- and software determined by Thorlabs for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs is not liable for consequential damages.

Restiction of Warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs reserves the right to change this instruction manual or the technical data of the described unit at any time.

Copyright

Thorlabs GmbH has taken every possible care in preparing this Operation Manual. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this manual is regularly updated and adapted to reflect the current status of the software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.
Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.
Insofar as permitted under statutory regulations, we assume no liability for direct damage, indirect damage or damages suffered by third parties resulting from the purchase of this product. In no event shall any liability exceed the purchase price of the product.
Please note that the content of this User Manual is neither part of any previous or existing agreement, promise, representation or legal relationship, nor an alteration or amendment thereof. All obligations of Thorlabs GmbH result from the respective contract of sale, which also includes the complete and exclusively applicable warranty regulations. These contractual warranty regulations are neither extended nor limited by the information contained in this User Manual. Should you require further information on this product, or encounter specific problems that are not discussed in sufficient detail in the User Manual, please contact your local Thorlabs dealer or system installer.

Status: 2012