HSC23V
Multispectral Imaging System Software

User Guide

Table of Contents

Chapter 1 Introduction

1.1 Intended Use

Multispectral Imaging System Software is designed to be used with Thorlabs instruments, such as:

- **HSC23V**: Multispectral Imaging System

Many GUI features are common to all instruments while some are device specific. This document will cover the common functionalities, and the device-specific customizations are described in the respective instrument manual.

Chapter 2 Software Setup

2.1 Requirements

The minimum system requirements for running Multispectral Imaging System Software are listed below.

Minimum Hardware Requirements

- Monitor Resolution: 800 x 600 pixels
- Processor (CPU): Intel Core i5 or AMD Athlon II
- Memory (RAM): 8 GB
- Hard Drive: 2 GB of Available Disk Space
- Interface: High-Speed USB 3.0 Connector, Type A

Software Requirements

The Multispectral Imaging System Software is compatible with the following operating systems.

- Windows® 10 (64-bit)
- Windows® 11

For operation of the HSC23V Multispectral Imaging System by the Multispectral Imaging System Software, Microsoft .NET Framework version 4.7.2 or higher is required and is included with the installation package.

Note: Do not connect the instrument to your PC before the software has been completely installed.

2.2 Software Installation

If the instrument is shipped with a laptop, all required drivers and software are pre-installed. If you wish to install the software on another computer or need to re-install the software, please download the installer from Thorlabs' website by:

- Navigating to the link on the card supplied in the Accessories envelope, or
- Software tab on the HSC23V Multispectral Imaging System webpage

The installation package will install all the necessary software and drivers for the instrument. A single computer can control several instrument types simply by installing the different installers after one another. A prompt may appear asking for "Elevated mode" or "Administrator mode;" please ask your system administrator if you do not have administrator privileges.

Figure 1 Software Setup Screen

2.3 Connecting to the PC

After the software installation has finished, you can connect the instrument to an available USB port on the PC. **Use only the USB 3.0 Type-A to Micro-B cable that is included with the instrument**, as quality can differ between producers. If a replacement cable is required, you can find a replacement (CABU31) on the Thorlabs website.

After connecting the instrument to the PC, the operating system will load the appropriate USB drivers. Please wait for this procedure to finish before doing anything else.

2.4 Starting the Application

After the software is installed and the instrument is connected to the PC, the application controlling the instrument may be started. The Multispectral Imaging System software can be found by clicking the "Start" button and then "Thorlabs" (or "Programs" → "Thorlabs" → "FilterWheel" depending on your Windows® version) and clicking on the application icon named "FilterWheel".

When the Multispectral Imaging System application starts, it will automatically detect all compatible cameras connected to the PC. If more than one camera is detected, a list of available devices will be displayed. Click the desired camera entry and click "OK".

During program operation, a list of all available devices can be seen by pressing the "Connect" button or the menu item "Connect" under the File menu.

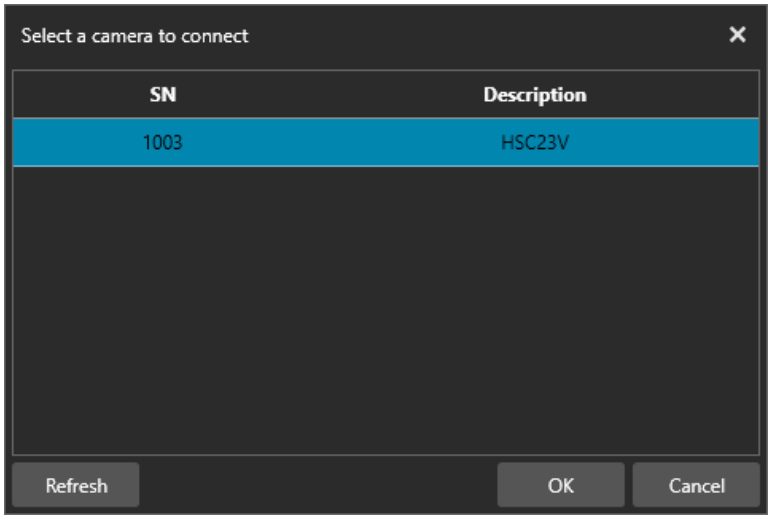


Figure 2 Select Camera

Chapter 3 Operation

3.1 Interface Overview

When the Multispectral Imaging System software starts, the main window is composed of six areas:

- Main Menu: Contains the command buttons.
- Setup and Acquisition Controls: Provides access to the setup and acquisition settings of the software.
- Image Area: This area displays the current image collected by the instrument.
- Plot Controls Bar: This area selects visualization plots for the current image.
- Filter Thumbnails: This area displays the most recent image for each filter wheel position.
- Status Bar: Shows information and status as appropriate.

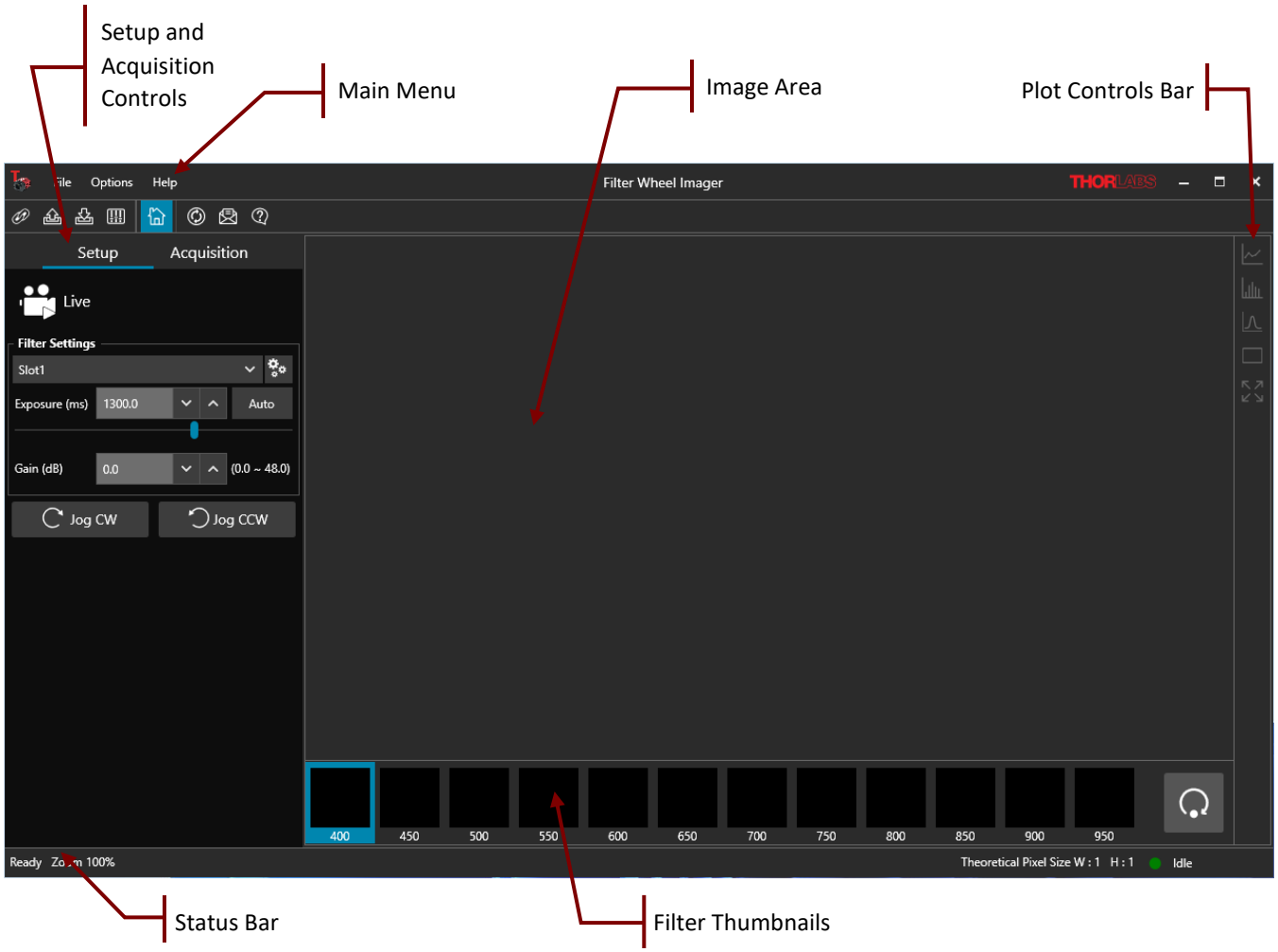


Figure 3 Layout of the Main Window of the Multispectral Imaging System Software at Startup (when a HSC23V Instrument is Connected)

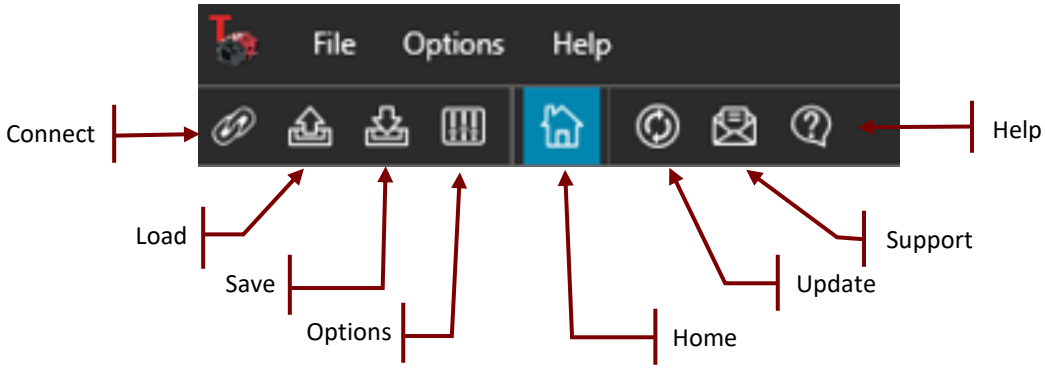


Figure 4 Layout of the Main Menu

3.2 Acquiring Data

Images are acquired from the connected device and processed according to the current settings. Prior to proceeding, ensure that the field of view of the imaging system is illuminated with sufficient and even intensity from an appropriate light source. The HSC23V CMOS sensor automatically compensates for dark current; there is no explicit feature in the software.

3.2.1 Finding the Camera

When the software starts it will automatically detect and read the properties of all compatible cameras connected to the computer through USB (refer to Section 2.4). If the program was started before the instrument was connected or powered-on, the software will not be able to find the instrument. In this case, close the software and make sure the instrument is connected to the PC and is powered on before restarting the software.

3.2.2 Swapping the Camera

If two or more cameras are connected to the PC, then the camera may be swapped from within the software. Exit "Live" mode (if appropriate). Click the "Connect" button for menu item "Connect" under the File menu to launch the selection window (see Figure 5). The first alternate camera available will be highlighted automatically; click "OK" to accept the change or "Cancel" to keep the current device.

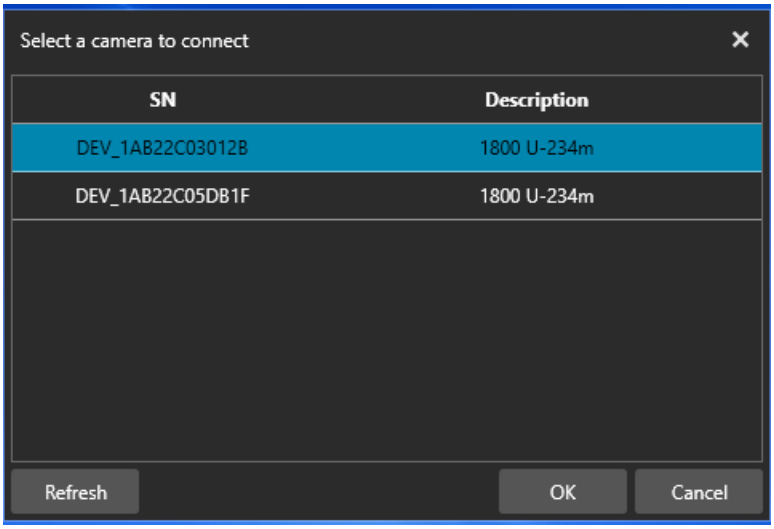


Figure 5 Selecting a Camera (Swapping the Camera)

3.2.3 Loading a Configuration

Instrument configurations are stored in JSON files. A default configuration of the last-known settings is always loaded upon starting the software. Use the "Load" button or menu item "Load" under the File menu to import a specific previously saved configuration.

3.2.4 Optimizing Filter Intensities

Under the Setup tab, click the "Live" button to begin real-time image acquisition. The signal intensity on the camera must be optimized for each filter in the wheel. The "Home" button moves the filter wheel to Slot 1. The filter wheel may be moved to any filter slot by three different methods.

- Use the pull-down list under Filter Settings.

- Use the “Jog CW” (clockwise) or “Jog CCW” (counterclockwise) buttons.
- Click the desired thumbnail at the bottom of the window.

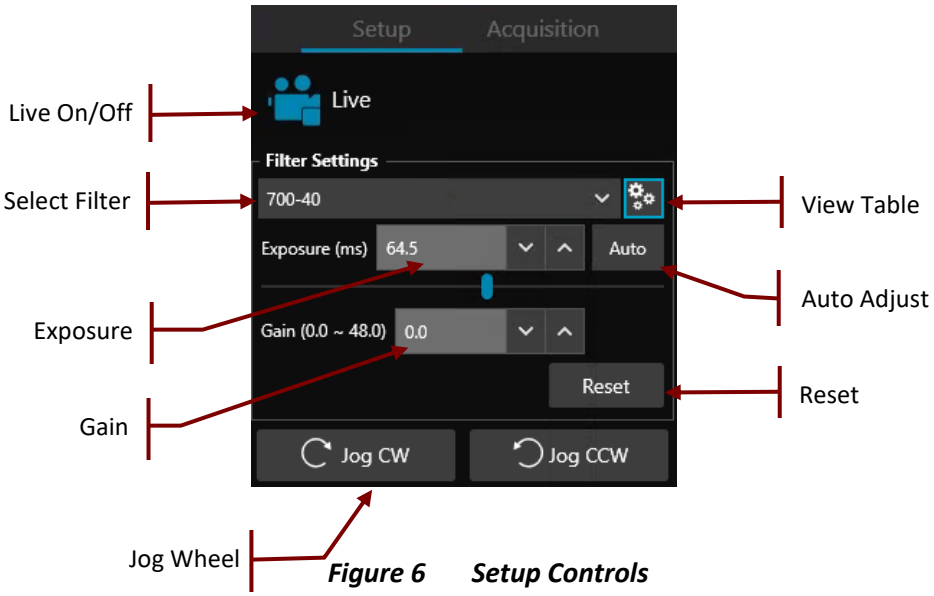


Figure 6 Setup Controls

Use “Exposure” and “Gain” controls to improve the image intensity. Click the “Histogram” button in the Plot Controls Bar to bring up a real-time intensity histogram of the current image (see Section 3.3.2).

- Type directly into the exposure and gain control boxes.
- Increment/decrement by the adjacent arrow buttons.
- Adjust exposure using slider control.
- Adjust exposure using the “Auto” button.
- Click the “Reset” button to restore the exposure and gain to the last saved values.

The gears button will display a summary table of all filter settings and may be used to edit/change any of the following (see Figure 7). Note that the filter name may be changed using Options - Filter Wheel (see Section 4.2).

- Type (Band Pass, Multi-Band, Short Pass, Long Pass, Other)
- Wavelength
- FWHM
- Exposure
- Gain

Click “OK” to keep any changes made in the table or “Cancel” to revert to the original values.

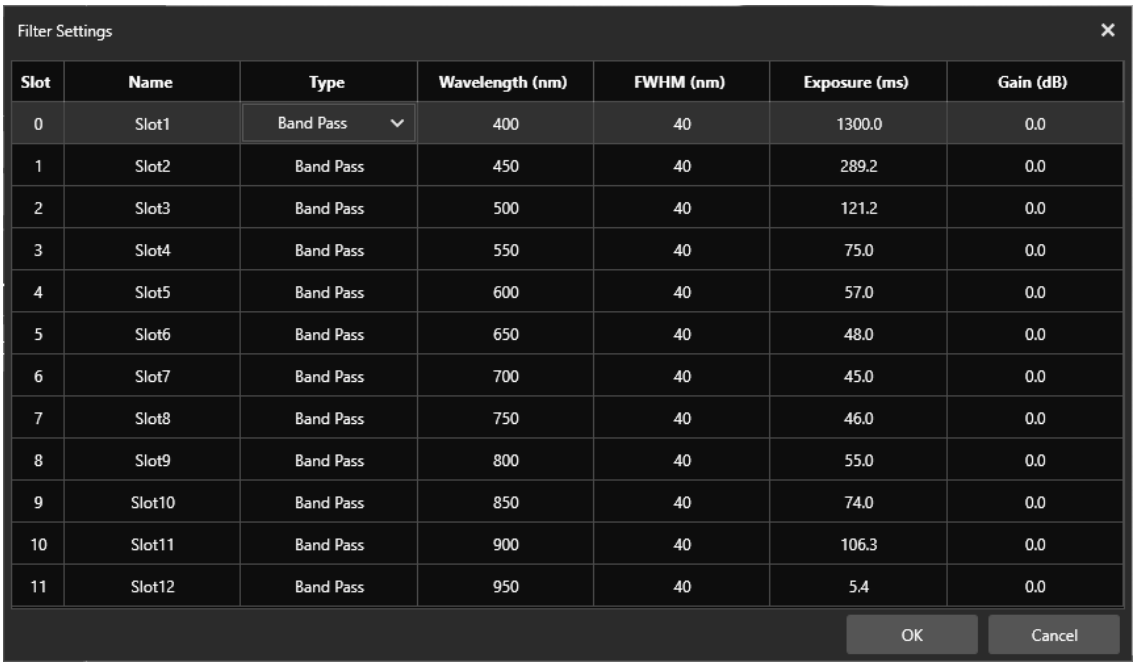


Figure 7 Filter Settings

3.2.5 Saving a Configuration

All configuration changes are immediately written to the default configuration file. Use the “Save” button or menu item “Save” under the File menu to store the current configuration file for later use.

3.2.6 Collecting Data

The Acquisition tab is shown in Figure 8. Images may be collected as “Single” or “Full Stack” by pressing the corresponding button. “Single” collects one image for the current filter wheel position (highlighted thumbnail), while a “Full Stack” collects an image for each filter wheel position beginning with slot 1.

- Storage Settings
    - Storage Path: Click in the text box to manually enter a path or click the ellipsis to browse to a folder location.
    - Prefix: Click in the text box to change the prefix. The prefix and system date/time are used to generate the image stack name (e.g., “stack_Demo_250505102639.tif” or single image name (e.g., “Demo_250505102639.tif”).
- Acquisition Settings
    - Average Frames: Activate by clicking the checkbox. The number of frames indicated are averaged together for each image collected in both “Continuous” and “Total Acquisition” modes.
    - Continuous: Images will be collected in order beginning with slot 1 and continuing through multiple image stacks until the “Full Stack” button is pressed to stop the acquisition. If the “Full Stack” button is pushed during collection of a stack, the user will be prompted to finish the current stack or abort image collection.
    - Total Acquisition: A fixed number of image stacks will be collected as indicated in the accompanying text box.

- Acquisition Delay: The numerical wait time in “Delay Unit” units between image stacks for total acquisition mode.
- Delay Unit: With “Acquisition Delay”, governs the length of time between image stacks. Choices are hours, minutes, and seconds.

- Data Collected: List of image stacks most recently collected. If the list length exceeds the allotted space, a scroll bar/arrows control becomes available.
- Gallery Setup: Collect new images while cycling through filter slots from 1 – 12, but do not save to disk (see Figure 9).

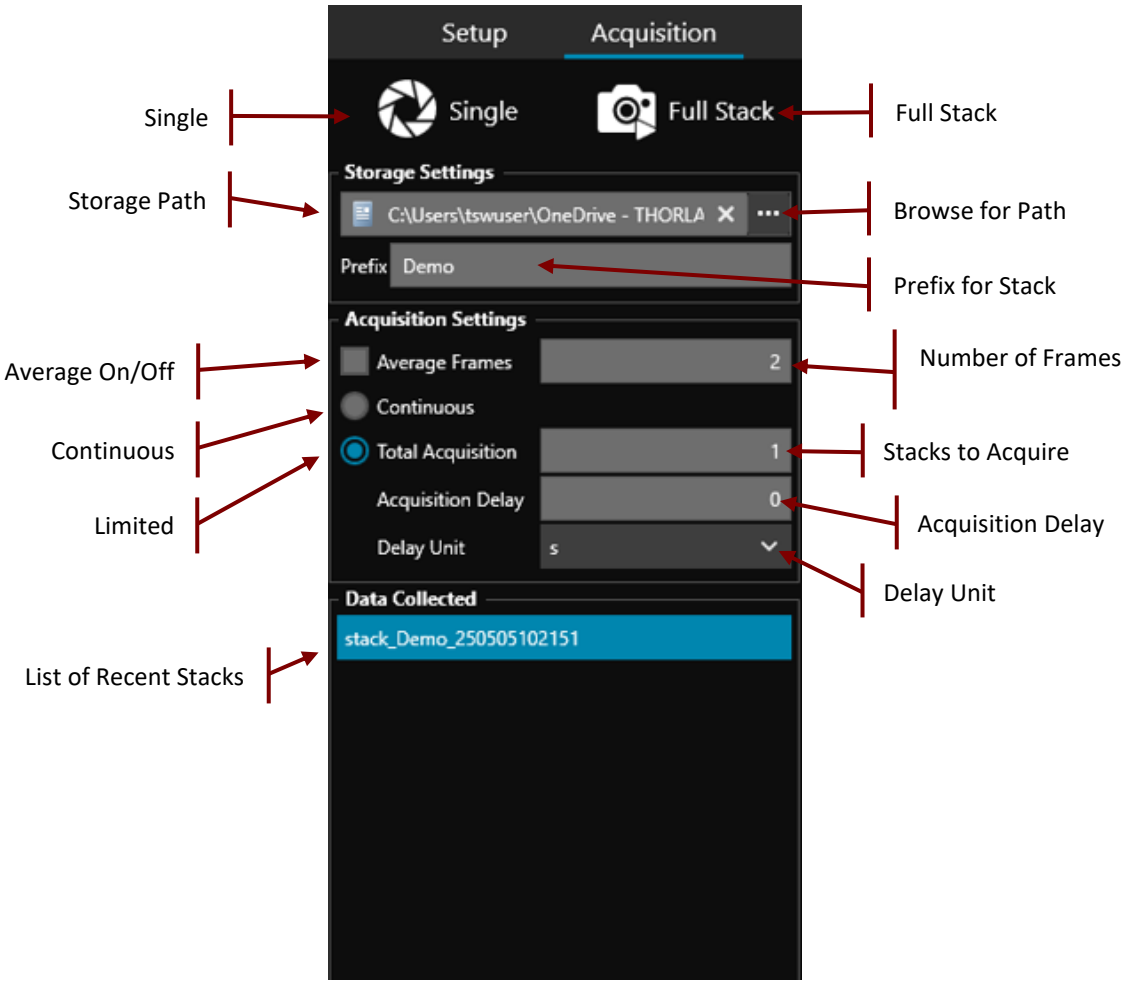


Figure 8 Acquisition Controls

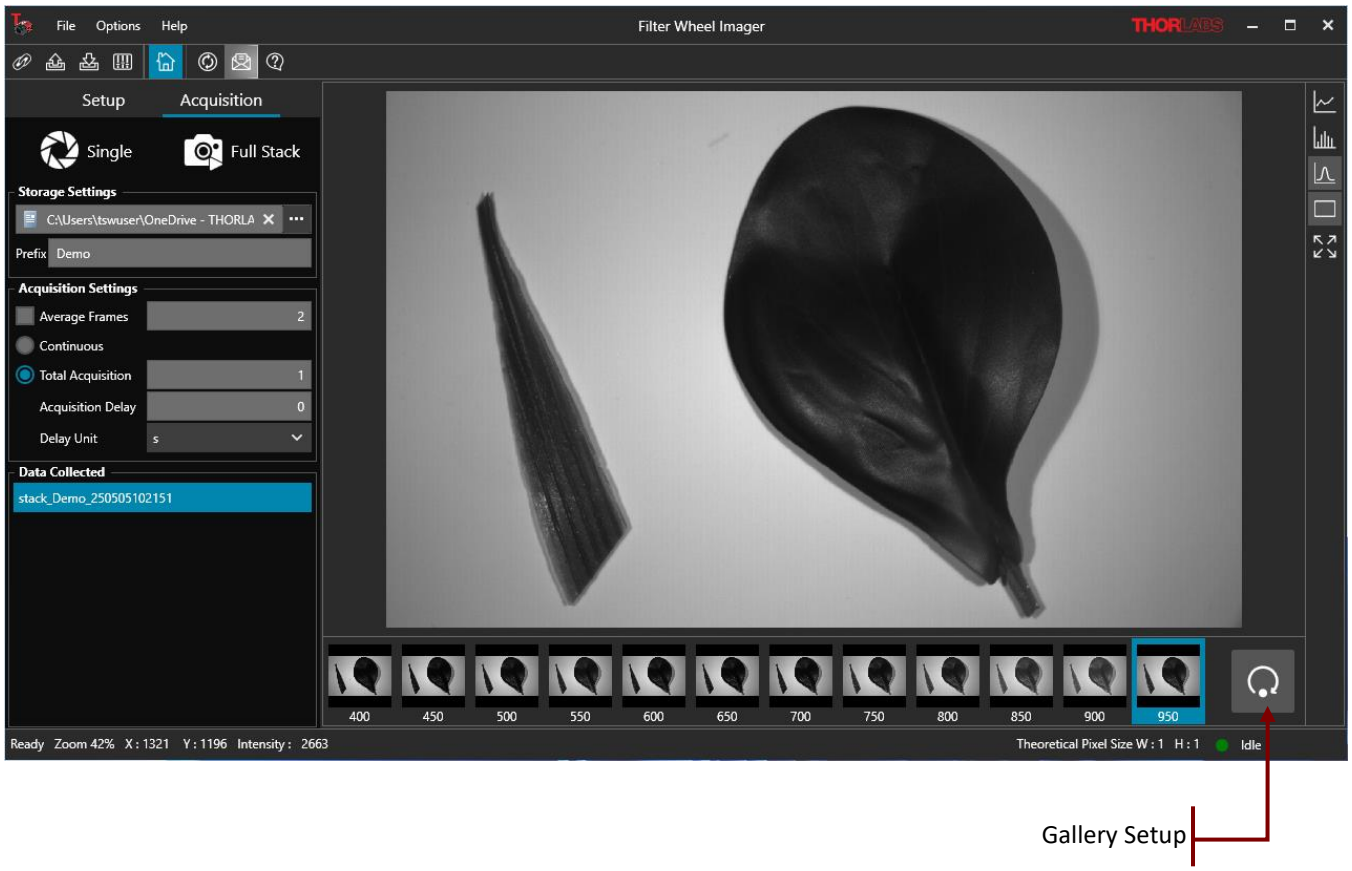


Figure 9 Full Image Stack

3.2.7 Other Features

Right-click anywhere in the image area to bring up an options menu.

- Save as: Click to save the current image as a .tif or .jpg file.

3.3 Plot Bar Controls

The Plot Bar controls become active as soon as Live mode is activated, or any image has been collected and may be used on live or static images. Press the corresponding button on the plot bar to start a plot.

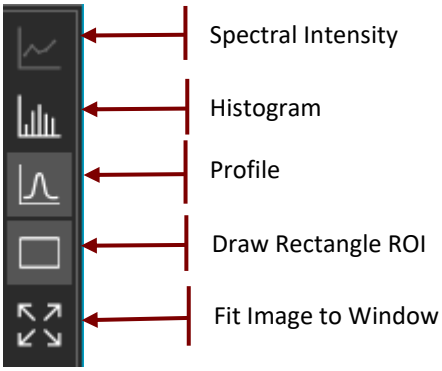


Figure 10 Plot Bar Controls

3.3.1 Spectral Intensity Tool

This feature is active after an image stack has been collected. Click the desired image stack in the "Data Collected" list and then press the "Spectral Intensity" button to display the plot. If no region of interest (ROI) has been selected, this plot will use the average intensity of each image as the corresponding data points (see Figure 11).

- Export Data: Save spectrum data to a .csv file.

Figure 11 Spectral Intensity (Overall Average)

If one or more regions of interest have been created, then this plot will display the average intensity of the highlighted ROI(s) (see Section 3.3.4 and Figure 12). Additional ROIs may be selected while the Spectrum plot is open and will be added to it.

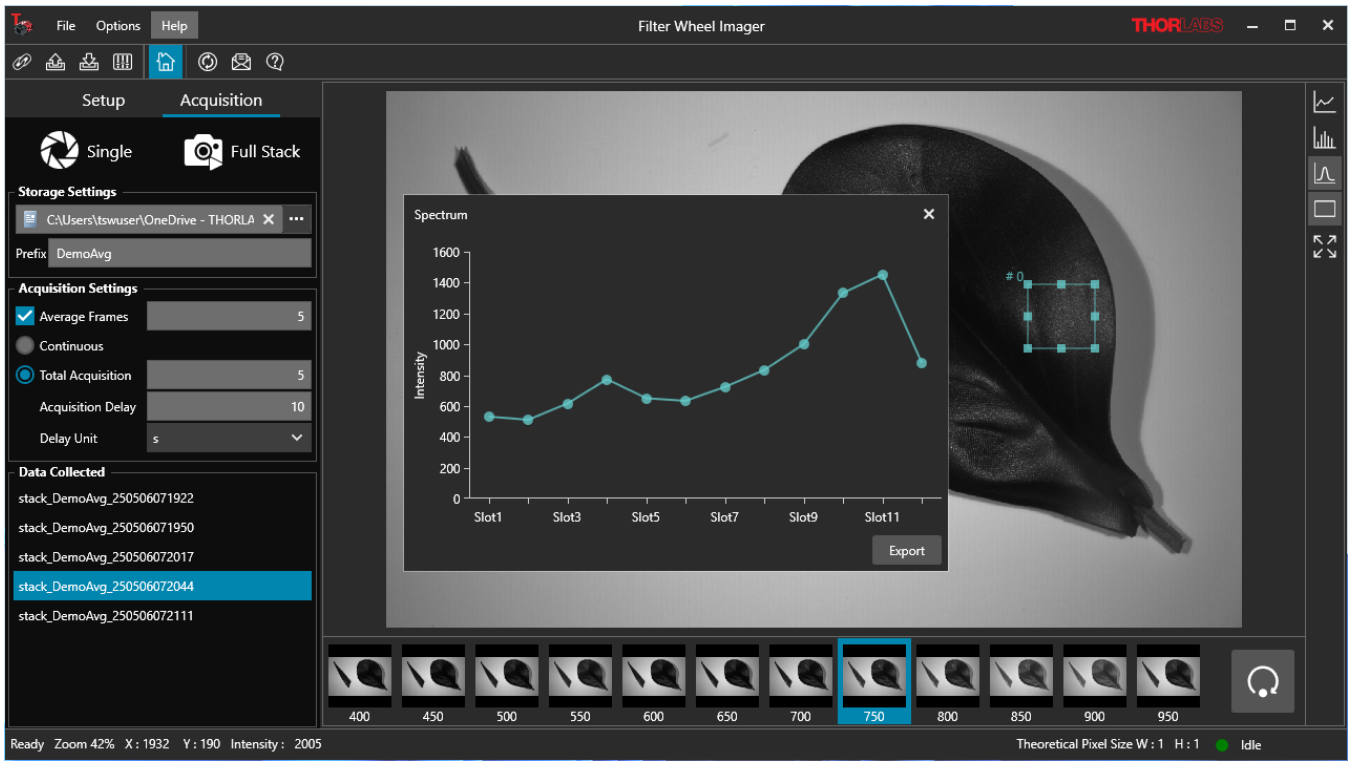


Figure 12 Spectral Intensity (ROI Average)

3.3.2 Intensity Histogram Tool

The Histogram is essential for optimizing light intensity for each filter in “Live” mode. Press the “Histogram” button to open the plot. Intensity bins are represented on the X-axis and pixel counts are represented on the Y-axis. Hover the cursor over a bar on the plot to display the total for that bin.

The Histogram may also be used after an image stack has been collected. While the Histogram is open, click on different slot thumbnails to view data for different filters.

- X-axis Zoom: Slider control to change X-axis view.
- X-axis Limits: Manually enter minimum and maximum values.
- Auto Scale X-axis: Automatic adjustment of minimum and maximum values
- Reset X-axis: Return plot view to original X-axis limits.
- Export Data: Save histogram data to a .csv file.
- Y-axis Log Scale: Check to change Y-axis scale for easier viewing of lower-count bins.

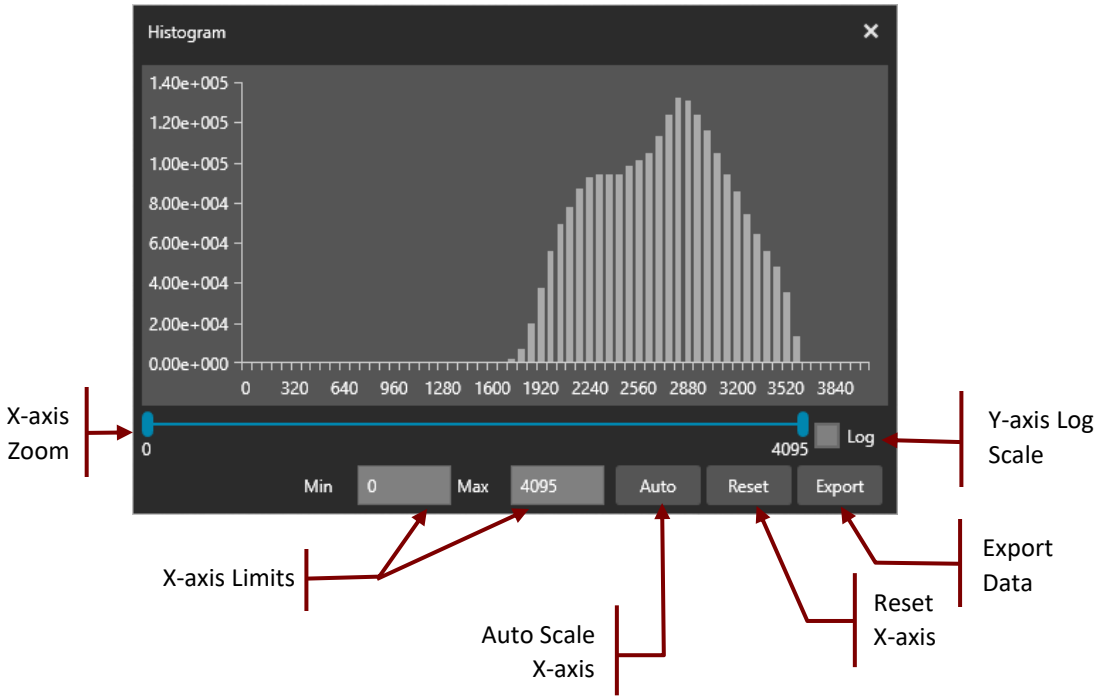


Figure 13 Histogram Controls

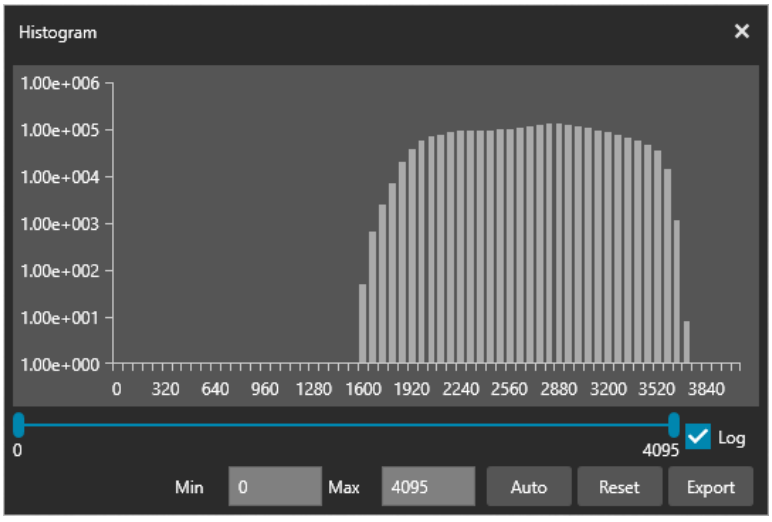


Figure 14 Histogram - Log Scale

3.3.3 Intensity Profile Tool

The “Profile” button changes the cursor icon in the image area. Press and hold the left mouse button while dragging the mouse across the image to draw a straight line. Release the mouse button to end the line. The profile plot for the current filter slot will appear.

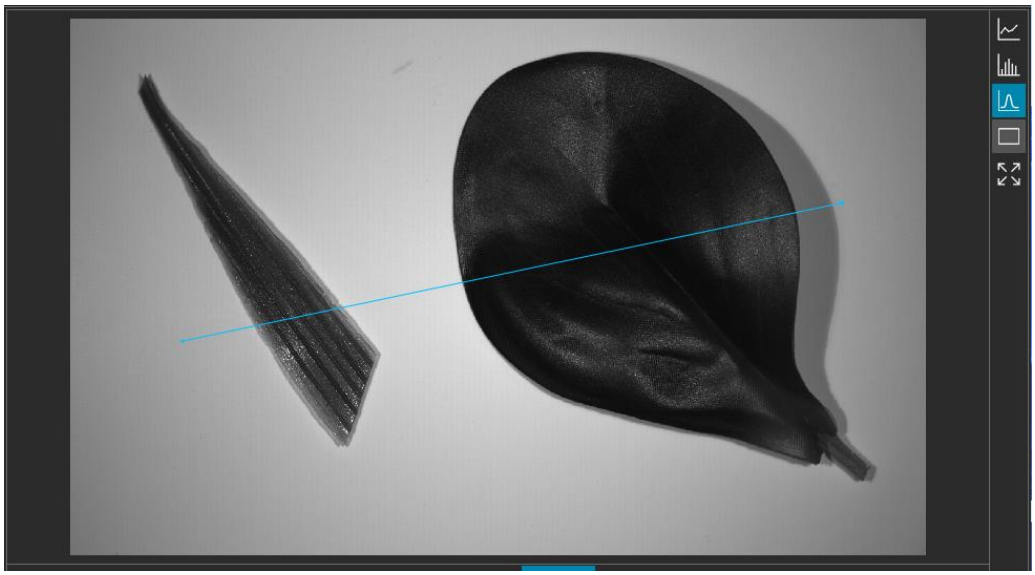


Figure 15 Profile Line

Hovering the mouse over the plotted profile line will display the X and Y coordinates for that point.

Click in the image area to erase the profile line and draw a new one. Once a profile line has been drawn, it is possible to click from thumbnail to thumbnail to view the same profile line for different filters.

- Line Width (Pixel): Enter a value in pixels to change the line width of the profile line. Integer values 1-10 are accepted. All pixels captured by this line will be used to compute the profile intensity plot.
- Export: Save profile data to a .csv file

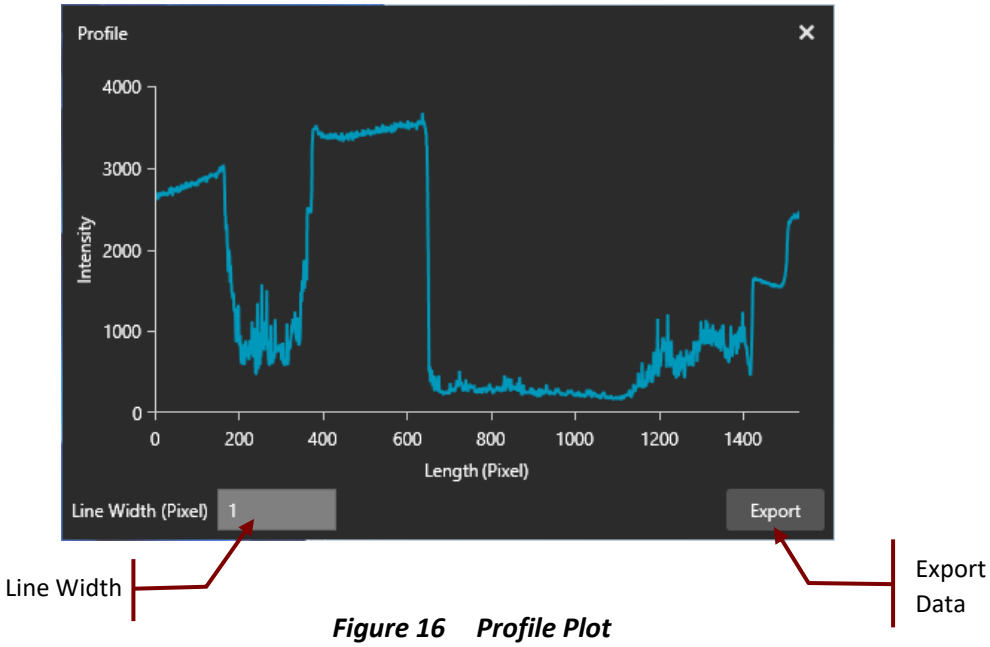


Figure 16 Profile Plot

Close the profile plot to exit the intensity profile tool.

3.3.4 Draw Rectangle ROI Tool

Press the "Draw Rectangle ROI" button to activate the tool. Press and hold the left mouse button and draw a rectangle on the image to capture the desired region of interest. This process may be repeated to select additional regions of interest. To remove a region of interest, click inside the ROI to highlight it and press the delete key. The ROI selection tool is used in conjunction with the "Spectral Intensity" button (Section 3.3.1). There is no limit to the number of ROIs that may be defined.

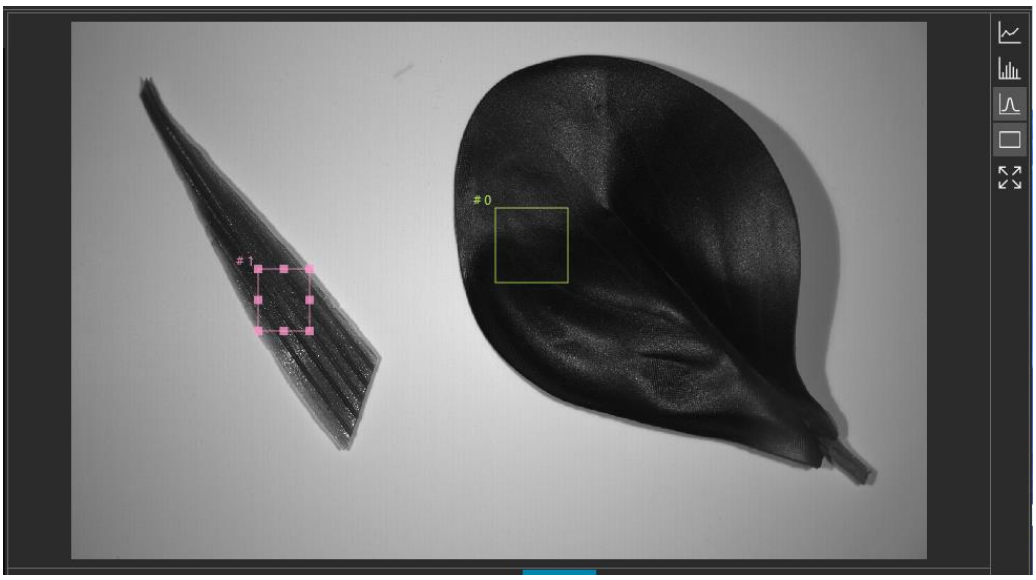


Figure 17 ROI Selection

3.3.5 Fit Image to Window

Press the "Fit Image to Window" button to scale the image to fill the image area, while maintaining the aspect ratio.

3.4 Status Bar

3.4.1 Message Area

Various messages can appear in this area during instrument operation.

- Ready: Indicates instrument is ready on program start.
- Frames per Second: Frames per second (FPS) is the imaging rate at which the camera is operating while in Live mode.
- Capturing: Indicates filter wheel motion (e.g., "Jogging to 400-40.") or current position (e.g., "In slot 400-40.").

3.4.2 Zoom

Zoom value depends on the application window size, use of the "Fit Image to Window" button, and camera binning settings.

3.4.3 Cursor Location

The current cursor position is given in terms of X and Y coordinates (pixels).

3.4.4 Intensity

The intensity of the current filter position at the indicated cursor location is given in detector counts.

3.4.5 Pixel Information

The current theoretical pixel size is listed.

3.4.6 Camera Status

Busy (yellow circle) or idle (green circle) indicates whether the camera is or is not collecting images.

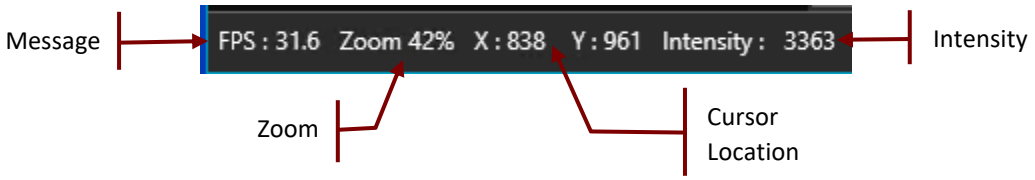


Figure 18 Status Bar (left)

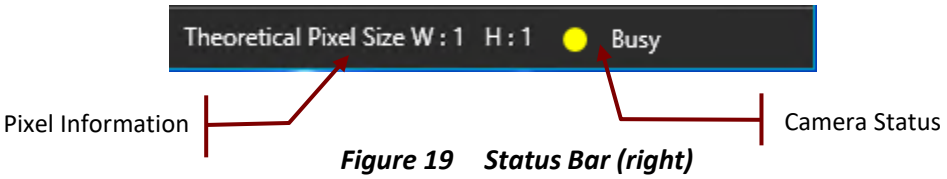


Figure 19 Status Bar (right)

Chapter 4 Options

Pressing the “Options” button or the “Settings” menu item in the Options menu will open the Options dialog. Four categories are available.

4.1 General

- Acquisition File Formats
    - Single Image
        - JPEG
        - TIFF
    - Full Stack
        - OME-TIFF
        - TIFF
- Theoretical Pixel Size
    - Pixel Size: Enter value

- Unit: Choose cm, mm, µm, nm

- Exposure Limit
  - Minimum Exposure Time: Enter value [0 ms lower limit]
  - Maximum Exposure Time: Enter value [10000.0 ms upper limit]

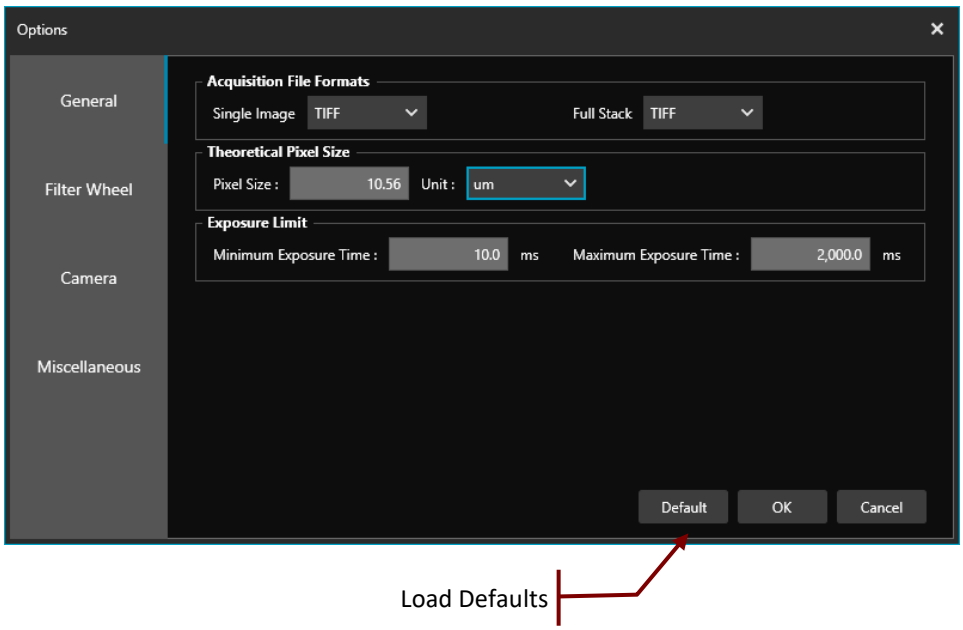


Figure 20 Layout of the General Options

4.2 Filter Wheel

The friendly name of each filter slot and associated image color map (default = grayscale) can be edited from this window. Press the “OK” button to save any changes. Press the “Reset” button to revert to the default name and color setting for each filter. Press the “Cancel” button to leave the settings unchanged.

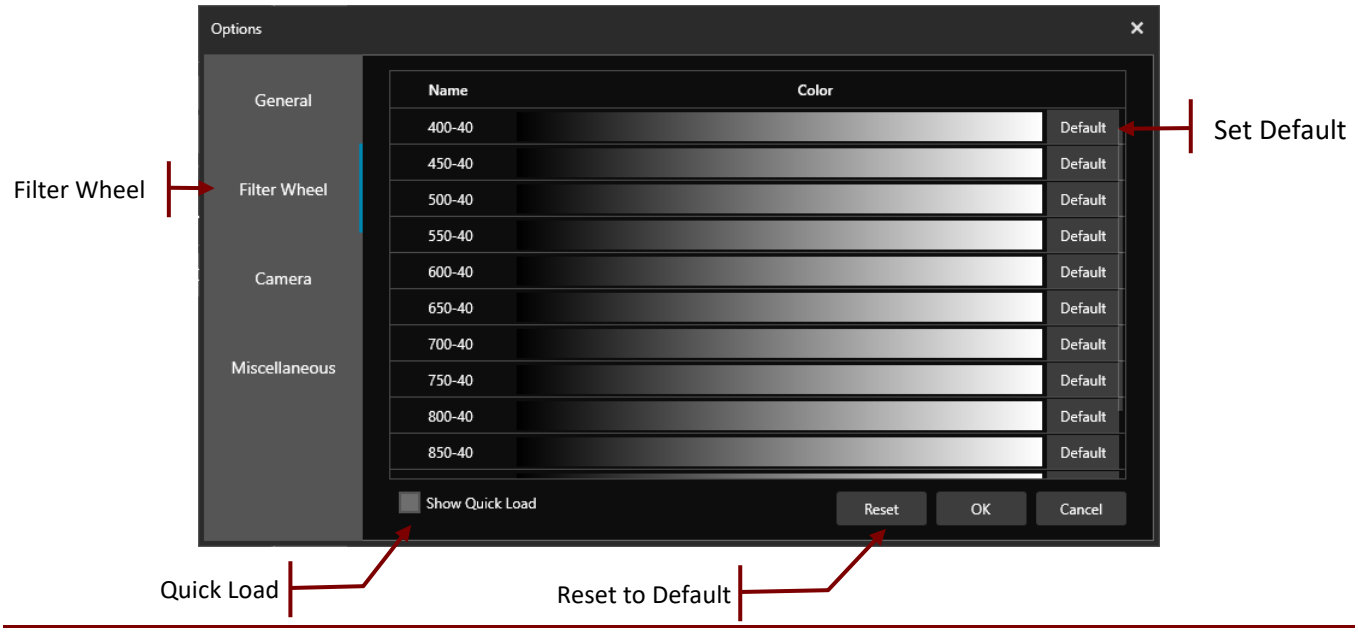


Figure 21 Layout of the Filter Wheel Options

Click a filter name entry to change the friendly name. The color bar to the right of a filter name shows the color scheme on a 0 - 4095 scale to be applied to an image based on the intensity value at each pixel. Click the color bar for a filter to select and then click the down arrow to expand the color palette options. Select a new color or "Advanced" for customization (see Figure 22). Use the "Default" button to the right of each filter color bar to make that name and color the new defaults for that filter.

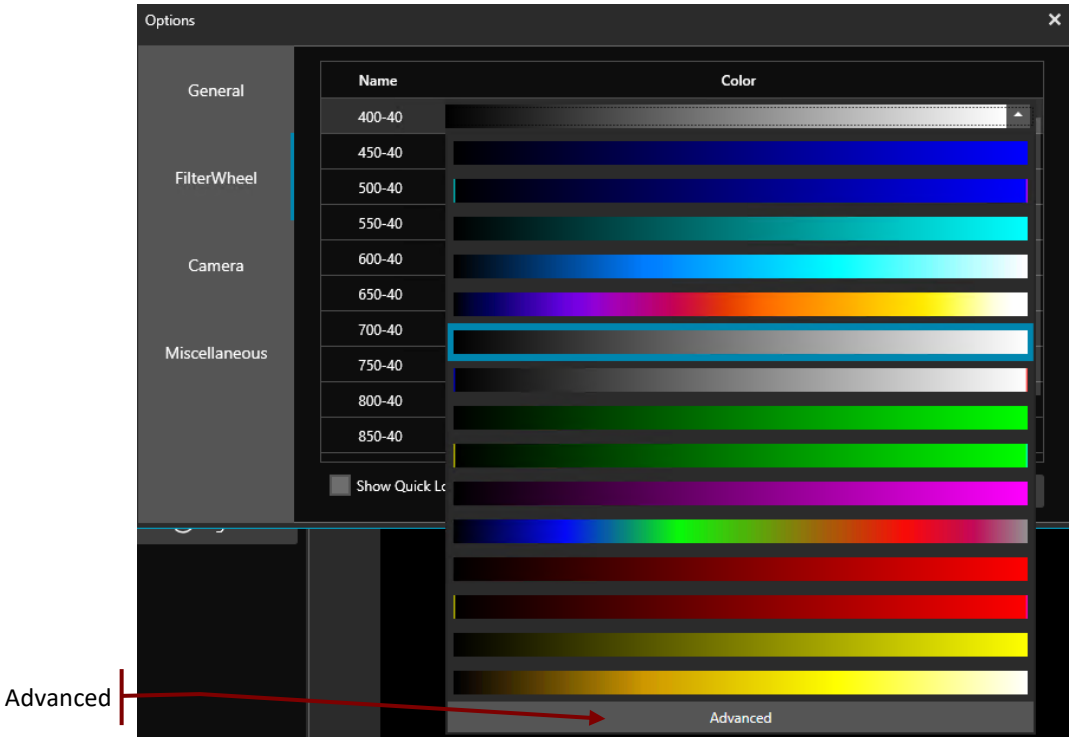


Figure 22 Color Options

The advanced Colormap Editor offers the following means for changing color. Nine colors are used to represent an image based on intensity levels (see Figure 23). If accepted, this new color map will appear at the bottom of the list as seen in Figure 22.

- Handle: Click on a handle to select it. Drag it left or right to change the color.
- Color Bar: Range of colors for this colormap.
- Color Select: Use the pull-down palette to change the color at the selected handle.
- Handle Scroll: Move the scroll bar left or right to change the color at the selected handle.
- Up/Down: Fine adjustments can be made with the up/down arrows or direct entry in the accompanying text box.
- OK: Click to accept colors.
- Cancel: Do not accept colors.

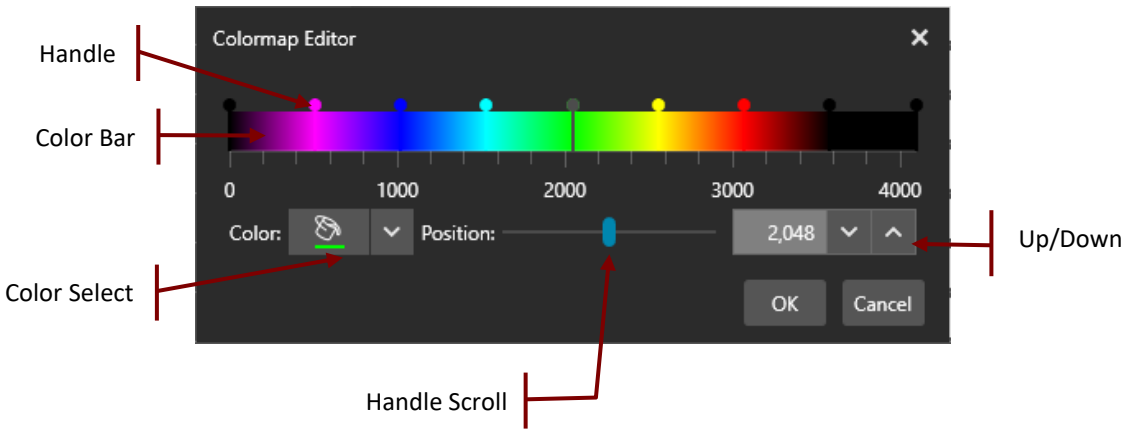


Figure 23 Colormap Editor

Activate "Quick Load" to enable easy replacement of a filter in the filter wheel. Press "OK" to close the Options window. The bottom of the main screen now features the Quick Load "Load" button in the lower left corner (see Figure 24). It is visible on the "Setup" tab and is active when "Live" is off.

Figure 24 Quick Load (Load)

Quick Load Example for Filter 450:

1. Click thumbnail corresponding to the filter that will be replaced (Figure 24).
2. Click "Load". The filter wheel will rotate 180 degrees to bring the selected filter (450) to the filter access port. The button will change to "Ready" and the filter now in front of the camera will be highlighted (750) (Figure 25).
3. Refer to the Multispectral Imaging System User Guide for instructions on filter replacement.
4. After the new filter has been loaded into the filter wheel, click the "Ready" button. The filter wheel will rotate 180 degrees to bring the selected filter (450) back to the camera. The button will change back to "Load" as seen in Figure 24.
5. Repeat steps 1-4 to change additional filters.
6. Edit the filter name, if needed, in the Filter portion of the Options window.

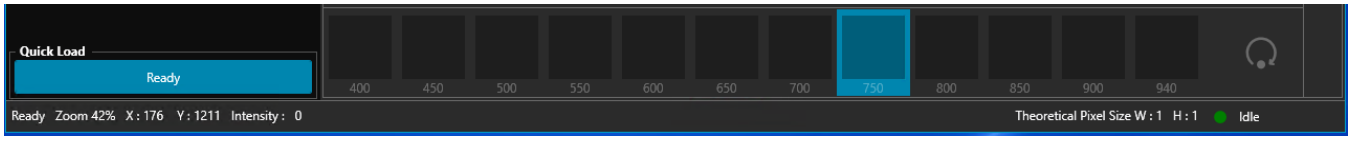


Figure 25 Quick Load (Ready)

4.3 Camera

Various camera settings can be adjusted from this window (see Figure 26). Press the "OK" button to save any changes. Press the "Default" button to revert to the software's default settings. Press the "Cancel" button to leave the settings unchanged. If the instrument is in "Live" mode, then camera settings are disabled.

- General Options
    - Binning: Turn binning on/off [Default=On].
    - Vertical: Bin pixels on the Y axis with possible values 1-8. Values > 1 will decrease the bottom ROI. [Default=1].
    - Horizontal: Bin pixels on the X axis with possible values 1-8. Values > 1 will decrease the right ROI. [Default=1].
    - Correction: Turn correction on/off [Default=On].
    - DPC: Defect pixel correction mode [Default].
    - FPNC: Fixed pattern noise correction mode.
    - ReverseX: Reverses image left to right [Default=Off].
    - ReverseY: Reverses image top to bottom [Default=Off].
- ROI: The camera ROI is the rectangular region on the detector that is used for the images to be collected.
    - Top: Enter value or use arrows to change (minimum = 0).
    - Bottom: Enter value or use arrows to change (maximum = 1216 (HSC23V)).
    - Left: Enter value or use arrows to change (minimum = 0).
    - Right: Enter value or use arrows to change (maximum = 1936 (HSC23V)).
    - Full Frame: Return settings to maximum detector area [Default=maximum area].

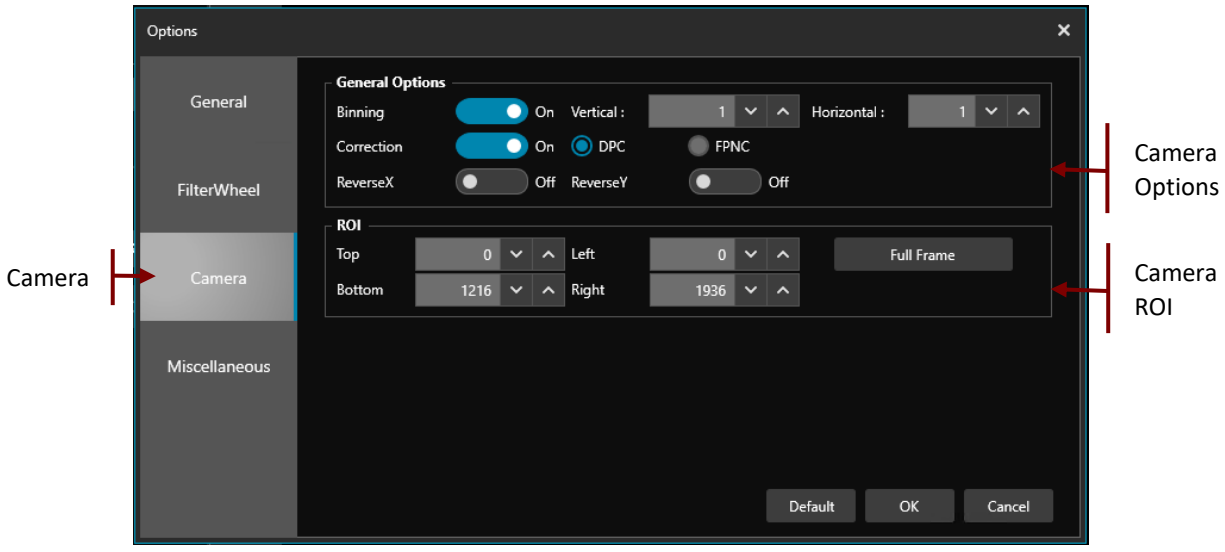


Figure 26 Layout of the Camera Options

4.4 Miscellaneous

This window provides access to the theme and language of the software. Click the desired setting to make an immediate change. “Theme” is also accessible as a menu option under the Options menu. “Language” is also accessible as a menu option under the Options menu.

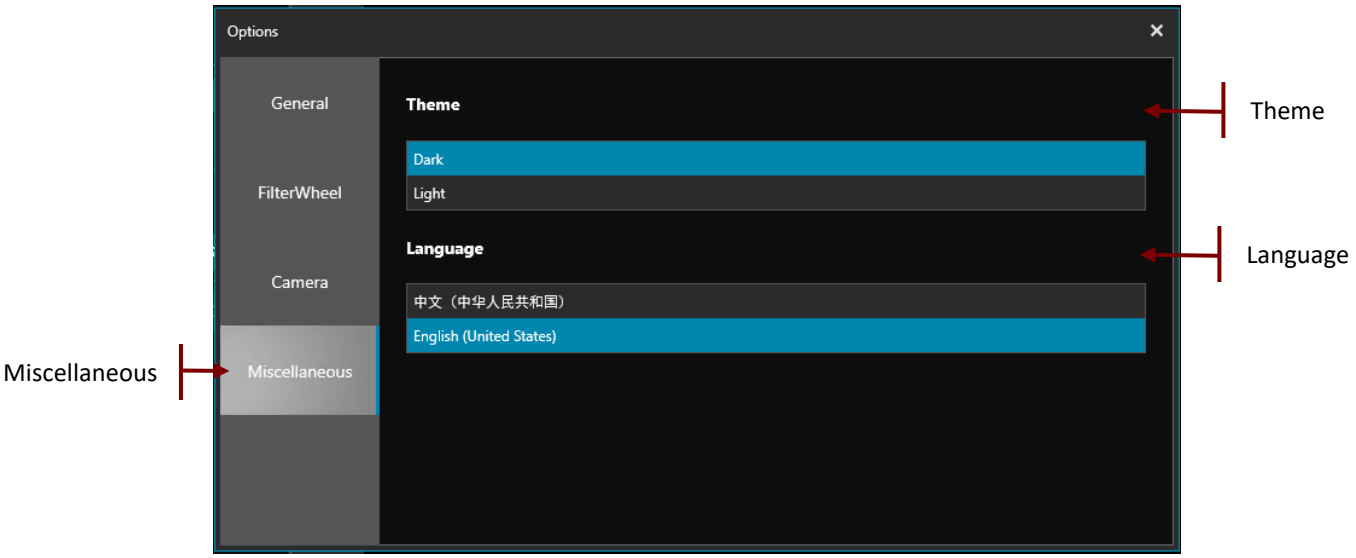


Figure 27 Layout of Miscellaneous Options

Chapter 5 Help

5.1 Update

Press the “Update” button or click the menu item “Update” under the Help menu.

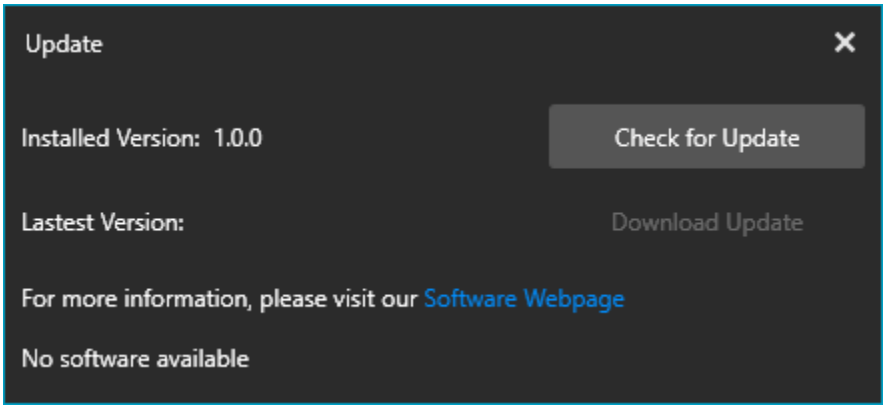


Figure 28 Update

5.2 Support

Click the menu item “Support” under the Help menu to access the error log and request technical support.

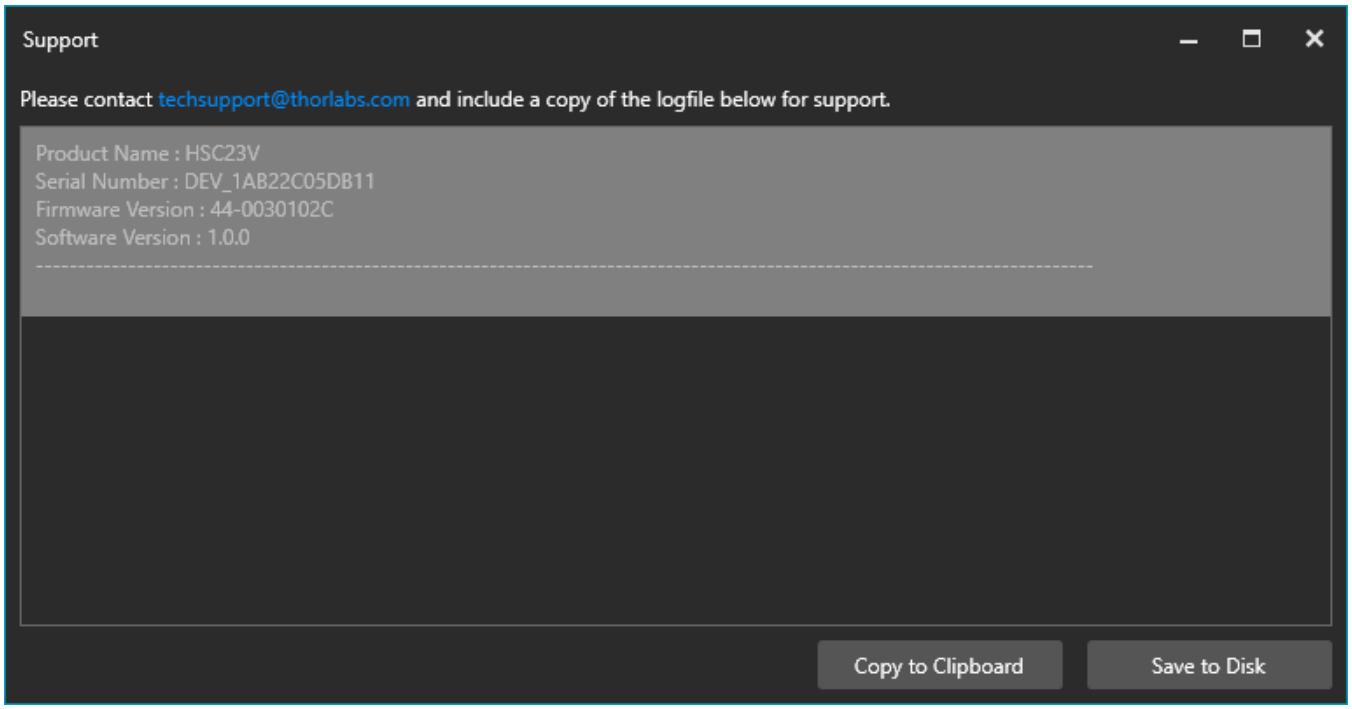


Figure 29 Support

5.3 About

Click the menu item “About” under the Help menu for details regarding instrument components.

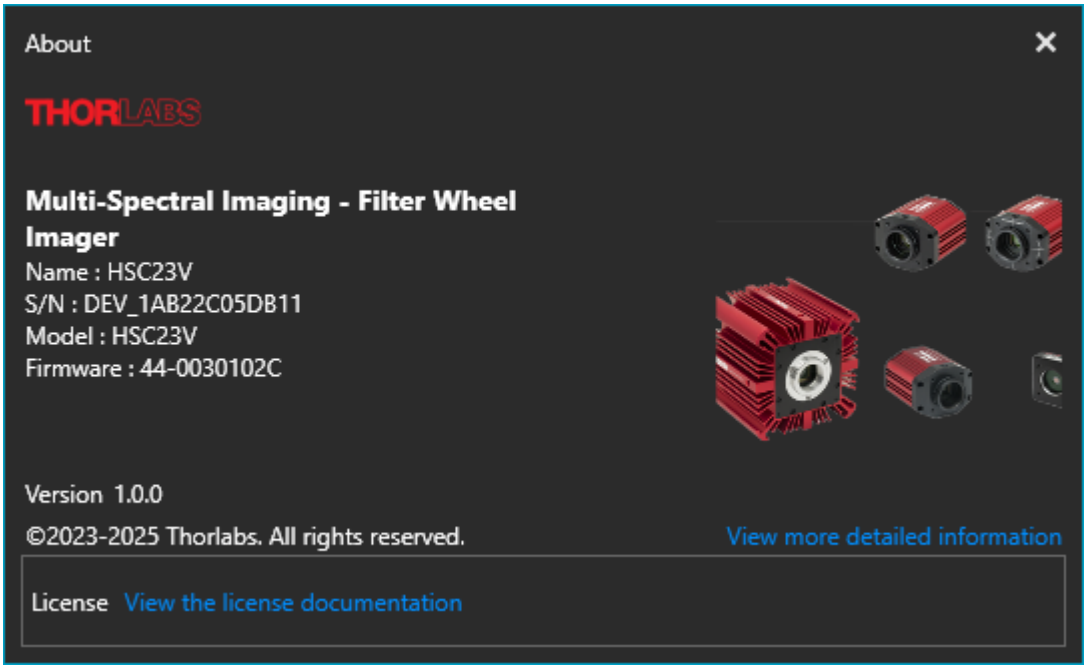
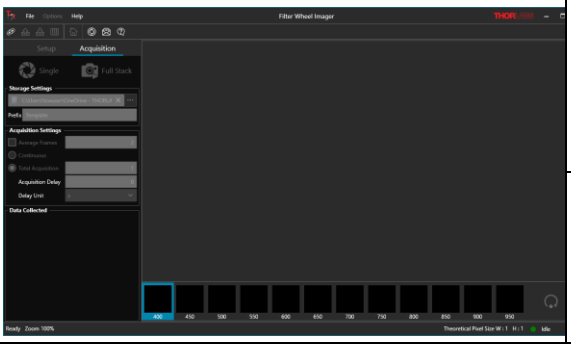
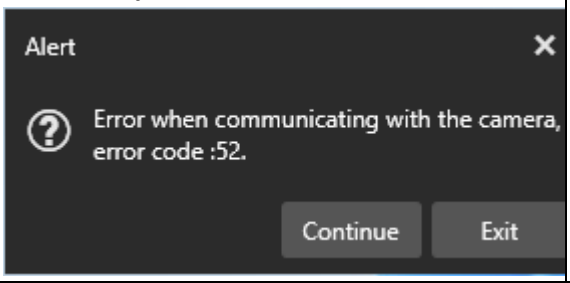
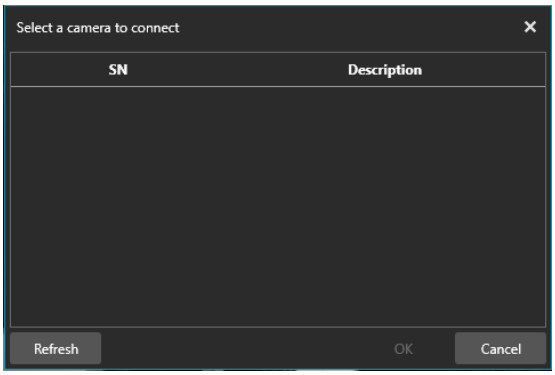
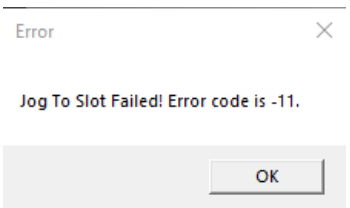
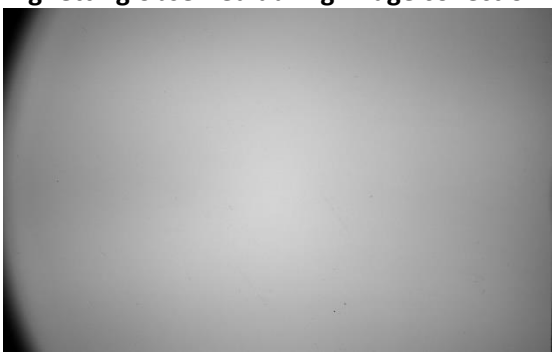


Figure 30 About

Chapter 6 Troubleshooting

Problem	Action
Software Installation Failed	Be sure to have administrative rights on your computer which enables you to install the software. Ask your system administrator to give you such rights or to do the installation.
Software Starts with Inactive Main Screen 	Motor power is off, and USB is not connected. 1. Close software. 2. Connect USB. 3. Restore power to motor. 4. Start software.
	Motor power is on, and USB is not connected. 1. Close software. 2. Connect USB. 3. Start software.
Software Brings up Error 52 Several Seconds into Startup 	USB is connected but motor power is off. 1. Click “Exit” from Alert window. 2. Restore power to motor. 3. Start software. Or 1. Restore power to motor. 2. Click “Continue” from Alert window. 3. Software will operate normally.
‘Select a camera to connect’ Appears Unexpectedly During Normal Operation 	USB cable is loose or has fallen off during operation. 1. Close software. 2. Re-attach USB cable. 3. Start software.
Jog Error Message 	Motor is out of sync with camera. 1. Acknowledge error. 2. Close software. 3. Remove power from motor. 4. Restore power to motor. 5. Start software.

Problem	Action
Filter Wheel Will Not Change Positions	This usually occurs when motor power is off. 1. Close software. 2. Restore power to motor. 3. Start software.
Image is Too Dark	Remove lens cap.
	Check the scene lighting.
	Increase exposure time or gain if necessary.
Image is Too Bright or Washed Out	Check the scene lighting.
	Decrease exposure time or gain if necessary.
Vignetting observed during image collection. 	Vignetting can indicate that the filter wheel is not precisely centered on the D-hub. Consult the HSC23V Multispectral Imaging System User Guide for instructions on adjusting the filter wheel. If wheel adjustment fails to fix the issue, the imaging system may need to have the home position reestablished. Contact **techsupport@thorlabs.com** for assistance.
If All Else Fails	Bring up the error log by clicking the "Support" button or menu item "Support" under the Help menu. Save it to file and attach it to an email to **techsupport@thorlabs.com**.

Chapter 7 Appendix

JSON configuration file example. Each filter slot (numbered 0-11) has a set of parameters; this example has been shortened by omitting filter slots 2-10.


```
[
 {
  "SlotName": "FBH400-40",
  "SlotParameters": {
   "Color": "Gray",
   "Type": 0,
   "Wavelength": 400,
   "FWHM": 40,
   "Setting": {
    "ExposureTime": 24993.131,
```

```
      "IsAutoExposure": false,
      "Gain": 0,
      "IsAutoGain": false
     }
    }
  },
{
   "SlotName": "FBH450-40",
   "SlotParameters": {
     "Color": "Gray",
     "Type": 0,
     "Wavelength": 450,
     "FWHM": 40,
     "Setting": {
       "ExposureTime": 24993.131,
       "IsAutoExposure": false,
       "Gain": 0,
       "IsAutoGain": false
     }
   }
  },
… and so on for filter slots 2-10
  {
   "SlotName": "FBH950-40",
   "SlotParameters": {
     "Color": "Gray",
     "Type": 0,
     "Wavelength": 950,
     "FWHM": 40,
     "Setting": {
       "ExposureTime": 24993.131,
       "IsAutoExposure": false,
       "Gain": 0,
       "IsAutoGain": false
```

```
      }
    }
  }
]
```

Chapter 8 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

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