JULY 19, 2020

FLI CAMERAS:
KELPER SCMOS
CARBON/PROLINE/MICROLINE CCD

ASCOM DRIVERS

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Conventions

The following conventions are used in this manual:

🗒 This icon denotes a note that contains an important information.

Bold — **Bold** text denotes the User Interface items in the software (clickable, for example, menu items, dialog box buttons etc.).

Italic — *Italic* text denotes emphasis, cross-references, or an introduction to a key concept. Italic text can also denote a text that that the user must enter.

Contents

Chapter 1 Introduction

This chapter describes the Windows environment for the ASCOM driver software.

About the FLI ASCOM driver

The FLI ASCOM driver gives you the ability to use the FLI cameras to acquire images and preview video.

Note The cameras may operate at frame rates, depending on camera settings. Please refer to the FLI website for the details.

Windows Environment

This release of FLI ASCOM drivers supports the following software for Windows 7 and above:

- ASCOM Platform 6.2 and above
- Microsoft .NET Framework 4 Client or .NET Framework 4 Full Installation or later
- Windows 8 and later the .NET Framework 3.5 option must be enabled in Control Panel / Programs and Features / Turn Windows Features On and Off
- Visual C++ 2019 redistributable libraries (for FLI dll files)

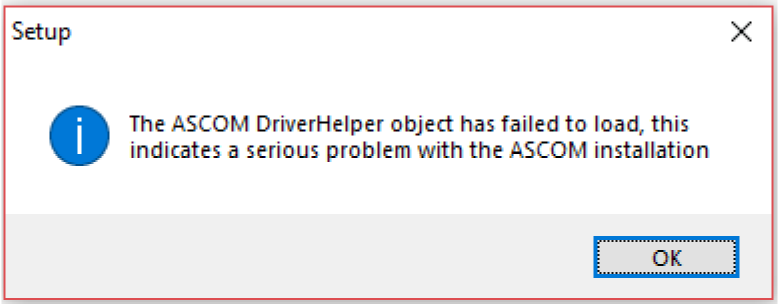
The FLI Driver requires Visual C++ 2019 libraries. The installer will provide these if they are not already present on your PC.

Chapter 2 FLI ASCOM Driver Installation

This chapter contains the installation notes for the FLI cameras ASCOM driver.

Installation

Start **FLI-ASCOM-Setup-Compact-v.6.X.exe** from Windows Explorer. The installer will perform a check for the current ASCOM platform version. On some ASCOM installations the setup may fail to determine the ASCOM Platform version showing the following dialog box (followed by other dialogs):



The ASCOM DriverHelper object has failed to load, this indicates a serious problem with the ASCOM installation

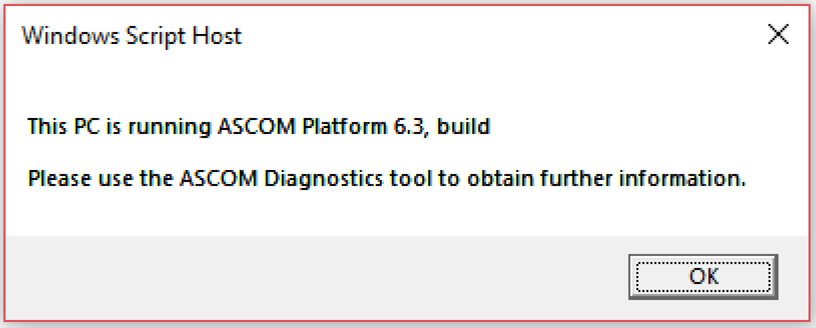
Figure 2-1. The setup fails to determine the ASCOM version.

In this case start the **FLI-ASCOM-Setup-Compact-v.6.X.exe** file. This setup will ***not perform*** any ASCOM Platform version checking prior the driver installation.

Note If using this installation please be sure that the ASCOM Platform version is 6.2 or above. To check the current ASCOM Platform version please run

```
C:\Program Files (x86)\Common Files\ASCOM\ShowPlatformVersion.vbs
```

This should give a dialog box like the following

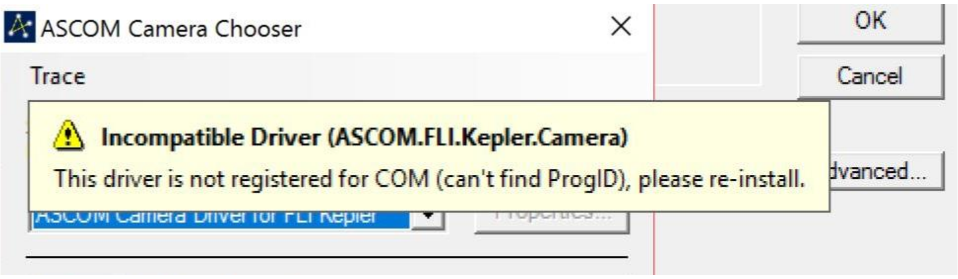


This PC is running ASCOM Platform 6.3, build

Please use the ASCOM Diagnostics tool to obtain further information.

FLI ASCOM Driver Update

After the installation of a new FLI ASCOM Driver over the existing version the following error can appear:



Incompatible Driver (ASCOM.FLI.Kepler.Camera)

This driver is not registered for COM (can't find ProgID), please re-install.

Figure 2-1. The setup fails to properly register the ASCOM driver.

This error can appear in one of the following cases:

- A program that uses ASCOM, such as MaximDL etc., is still opened.
- A program that uses ASCOM, such as MaximDL etc., was closed but did not shut down properly. It is still blocking the ASCOM drivers preventing from the update. The blocking program can be found in the Windows Task Manager.
- The FLI Camera Server is not closed. Note that FLI Camera Server will NOT close itself after closing MaximDL. The user must close it manually.

After these checks the user can try to re-install the ASCOM driver.

The installer will try to un-install the previous version. However, in some cases when you install the same driver for the 2nd time, it can happen that some files are not correctly removed.

In this case it is advised manually removing the following files in the folder

```
C:\Program Files (x86)\Common Files\ASCOM\Camera
```

- ASCOM.FLI.Camera.dll
- FitsUtilities.dll
- FLI.CameraServer.exe
- FLI.Server.Contracts.dll
- FLISharp.dll
- libfli****.dll files

After all the above steps the FLI ASCOM driver can be reinstalled again.

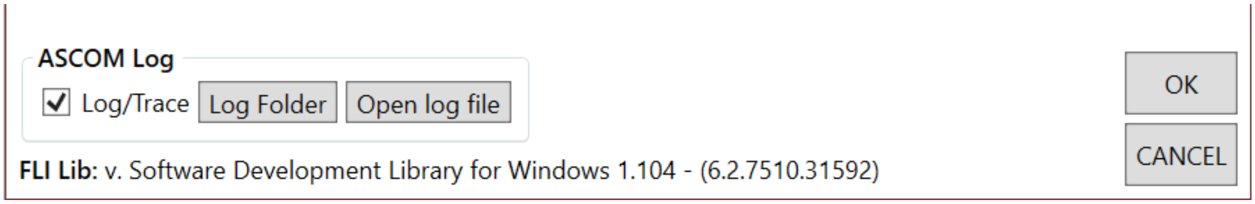
ASCOM Drivers destination folder

All ASCOM camera drivers are installed to the following location:

C:\Program Files (x86)\Common Files\ASCOM\Camera

Chapter 3 Logging the FLI ASCOM driver

Each FLI Settings dialog has a group box that allows to enable or disable the Log Trace information. It could be useful to set the check box “**Log/Trace**” which will enable the tracing of the debug information. The log files (see Note below) can be used to communicate with the FLI support when ASCOM driver encounter problems.



ASCOM Log

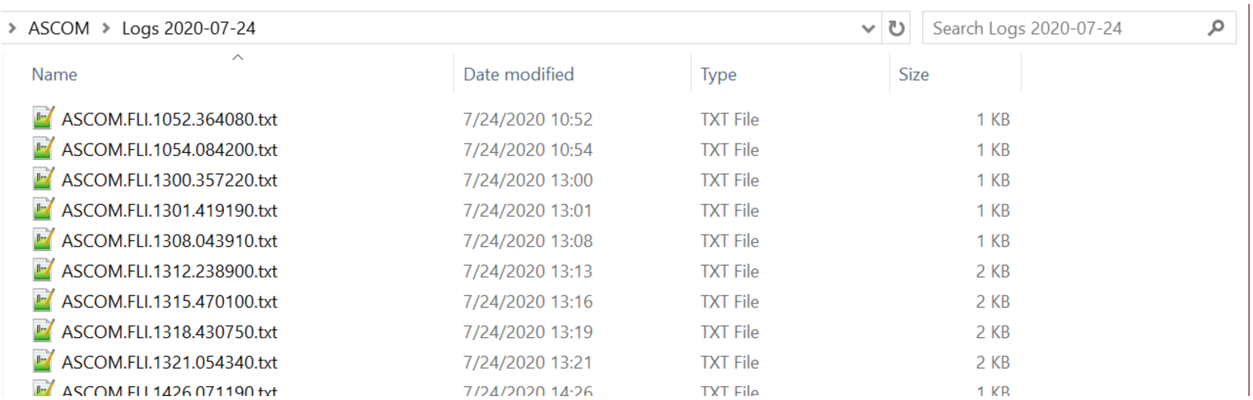
☑ Log/Trace

FLI Lib: v. Software Development Library for Windows 1.104 - (6.2.7510.31592)

Figure 3-1. The bottom area of each FLI ASCOM Driver Settings dialog.

For convenience, the Settings dialog contains 2 buttons:

- “**Log Folder**” button will open Windows Explorer and set it to the current ASCOM log folder
- “**Open log file**” button will open the current ASCOM log file in the default Windows text viewer (Notepad etc.)



Name	Date modified	Type	Size
ASCOM.FLI.1052.364080.txt	7/24/2020 10:52	TXT File	1 KB
ASCOM.FLI.1054.084200.txt	7/24/2020 10:54	TXT File	1 KB
ASCOM.FLI.1300.357220.txt	7/24/2020 13:00	TXT File	1 KB
ASCOM.FLI.1301.419190.txt	7/24/2020 13:01	TXT File	1 KB
ASCOM.FLI.1308.043910.txt	7/24/2020 13:08	TXT File	1 KB
ASCOM.FLI.1312.238900.txt	7/24/2020 13:13	TXT File	2 KB
ASCOM.FLI.1315.470100.txt	7/24/2020 13:16	TXT File	2 KB
ASCOM.FLI.1318.430750.txt	7/24/2020 13:19	TXT File	2 KB
ASCOM.FLI.1321.054340.txt	7/24/2020 13:21	TXT File	2 KB
ASCOM.FLI.1426.071190.txt	7/24/2020 14:26	TXT File	1 KB

Figure 3-2. The current ASCOM Driver logs folder.

The bottom of the dialog shows the current driver version (1.104 on the screenshot below) of the FLI library which can be useful when communicating with the FLI tech support.

Note If the ASCOM log files (if Log/Trace is enabled, see above) can be found in the following directory:

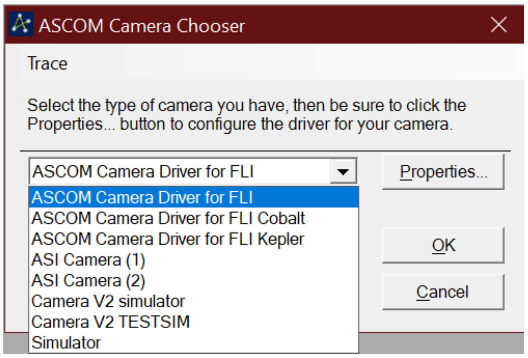
C:\Users\<*USER NAME…*>\ Documents\ASCOM\Logs *YYYY-MM-DD*

Where ***<USER NAME…>*** is the current Windows user name and the ***YYYY-MM-DD*** is the date when the ASCOM driver created log files.

Chapter 4 FLI ML/PL Camera Settings

This chapter contains the notes for the FLI MicroLine/ProLine CCD cameras settings.

The “**ASCOM Camera Driver for FLI**” must be selected in the ASCOM Camera chooser dialog:



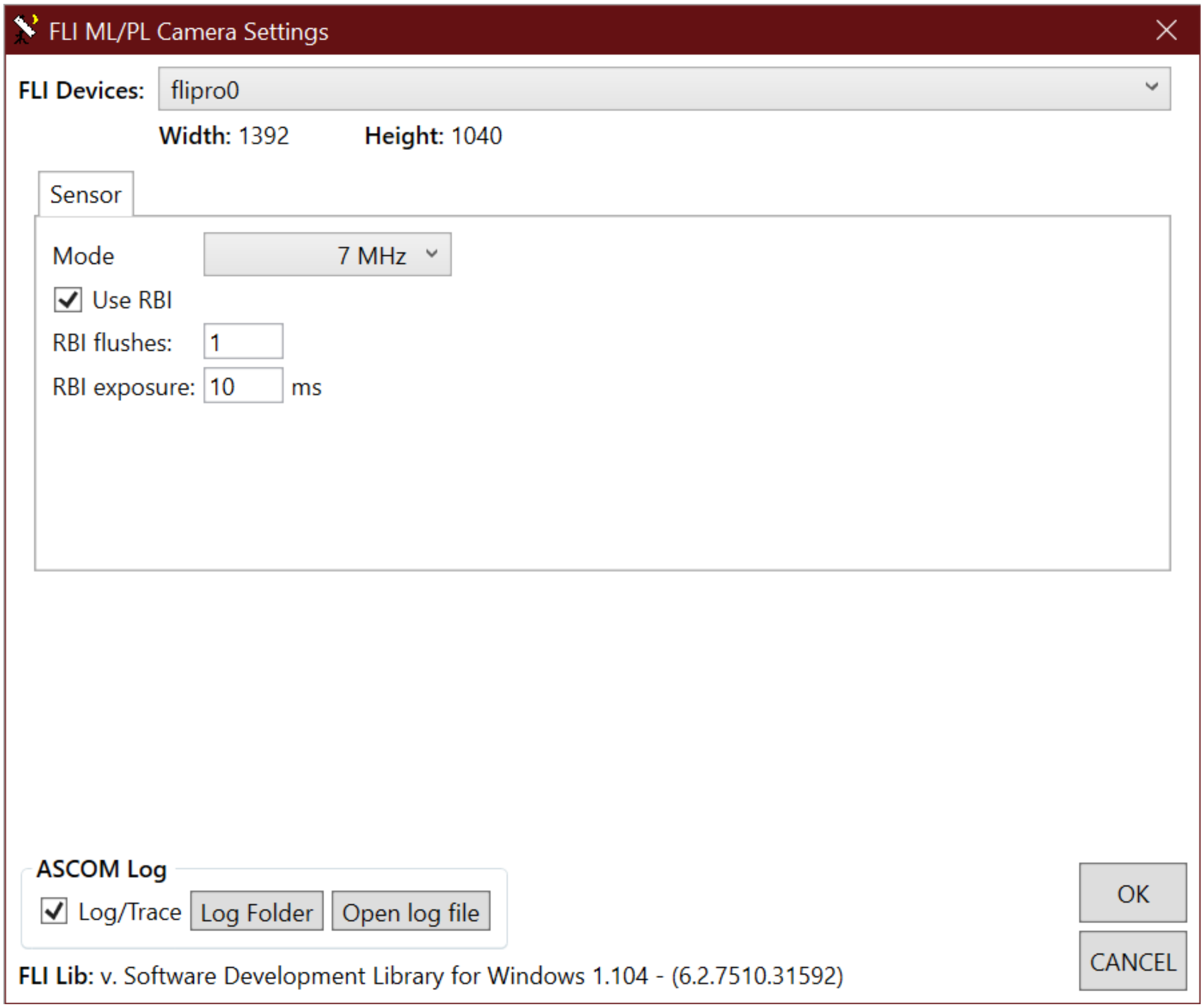
Select the type of camera you have, then be sure to click the Properties... button to configure the driver for your camera.

ASCOM Camera Driver for FLI

Sensor tab

In the **Sensor** tab the following options are available:

- Camera mode selection. Depends on the ML/PL camera model
- Setup the Residual Bulk Image (RBI) Flood-Flush procedure



FLI Devices: flipro0

Width: 1392 **Height:** 1040

Mode 7 MHz

☑ Use RBI

RBI flushes: 1

RBI exposure: 10 ms

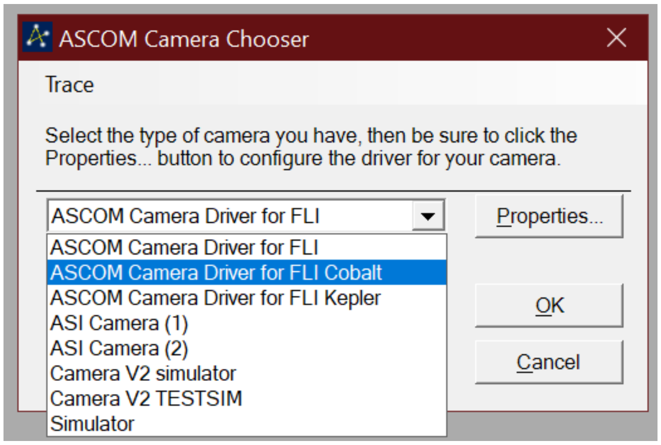
☑ Log/Trace

FLI Lib: v. Software Development Library for Windows 1.104 - (6.2.7510.31592)

Chapter 5 FLI Cobalt Camera Settings

This chapter contains the notes for the FLI Cobalt (DC230-42, DC230-84, DC4320) CCD cameras settings.

The "**ASCOM Camera Driver for FLI Cobalt**" must be selected in the ASCOM Camera chooser dialog:

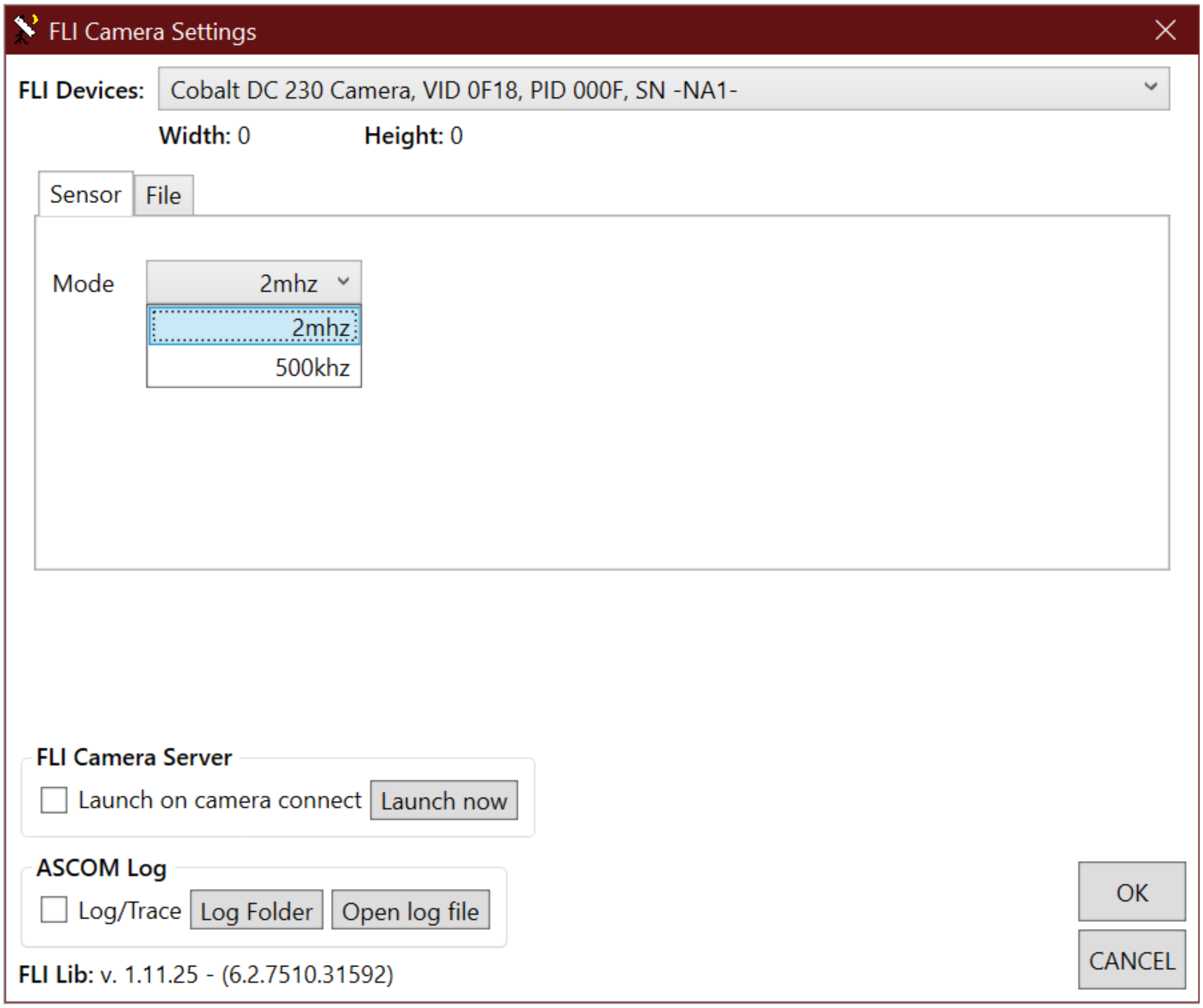

ASCOM Camera Chooser
Trace
ASCOM Camera Driver for FLI
Properties...
ASCOM Camera Driver for FLI
ASCOM Camera Driver for FLI Cobalt
ASCOM Camera Driver for FLI Kepler
ASI Camera (1)
ASI Camera (2)
Camera V2 simulator
Camera V2 TESTSIM
Simulator
OK
Cancel

Select the type of camera you have, then be sure to click the Properties... button to configure the driver for your camera.

Sensor tab

In the **Sensor** tab the following options are available:

- Camera mode selection. Depends on the Cobalt camera model



FLI Camera Settings

FLI Devices: Cobalt DC 230 Camera, VID 0F18, PID 000F, SN -NA1-

Width: 0 **Height:** 0

Mode 2mhz

FLI Camera Server

□ Launch on camera connect

ASCOM Log

□ Log/Trace

FLI Lib: v. 1.11.25 - (6.2.7510.31592)

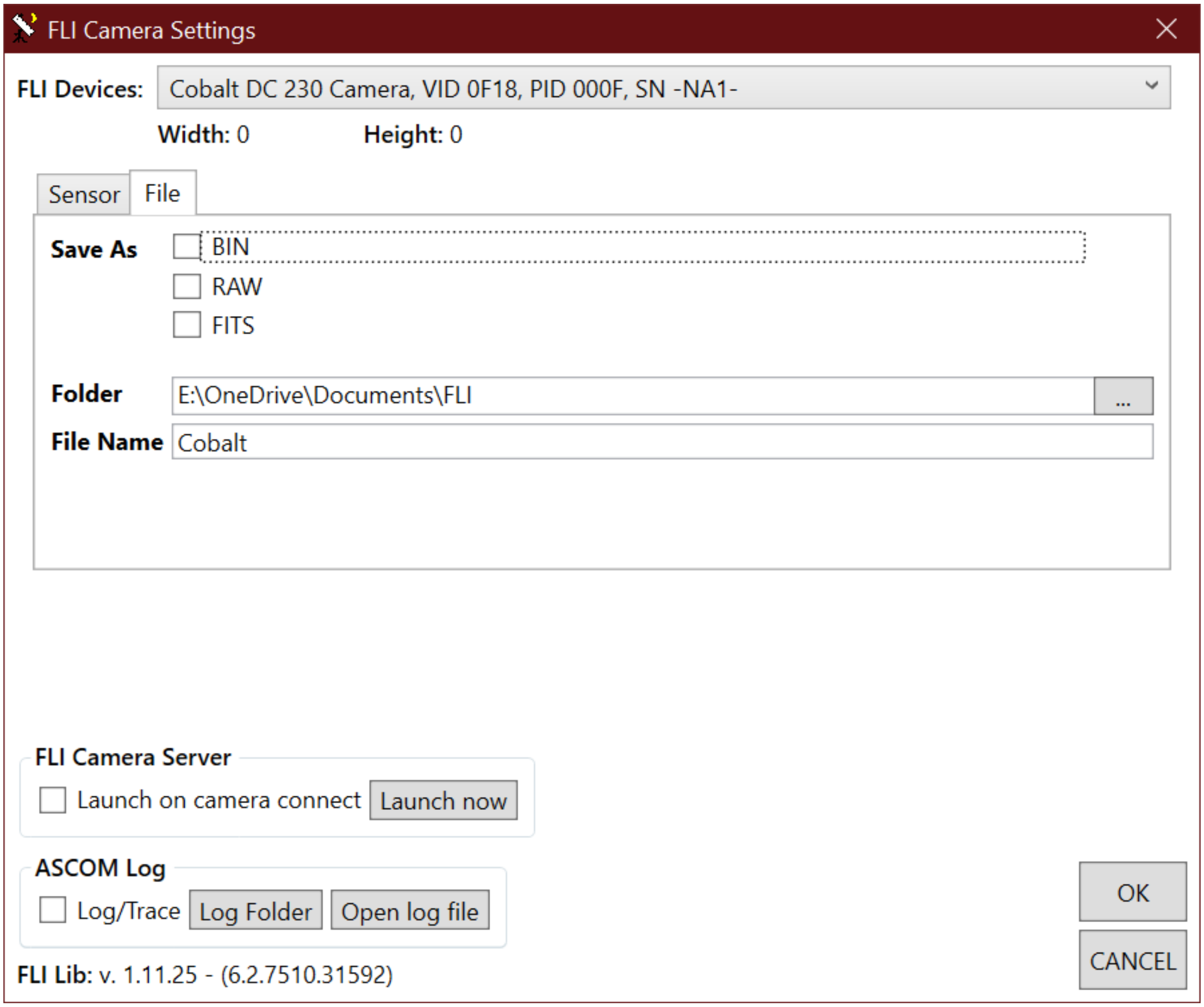
File tab

In the **Files** tab the user can control the format(s) that should be used to store the acquired frames on the disk:

- **RAW/FITS/BIN** – the file formats that are currently available for saving by the ASCOM driver. The RAW format is the frame data as it comes from the camera (with the metadata header). The BIN file format is for the binary frame data in the unsigned short (16 bit) pixel format. FITS is for the “Flexible Image Transport System”

- **Folder** – the folder where all the files will be stored. Can be changed by pressing the “**…**” button

- **File Name** – the text that will be added to each frame file name. All saved frames will start with this text.



FLI Camera Settings

FLI Devices: Cobalt DC 230 Camera, VID 0F18, PID 000F, SN -NA1-

Width: 0 **Height:** 0

Save As □ BIN □ RAW □ FITS

Folder E:\OneDrive\Documents\FLI

File Name Cobalt

FLI Camera Server

□ Launch on camera connect

ASCOM Log

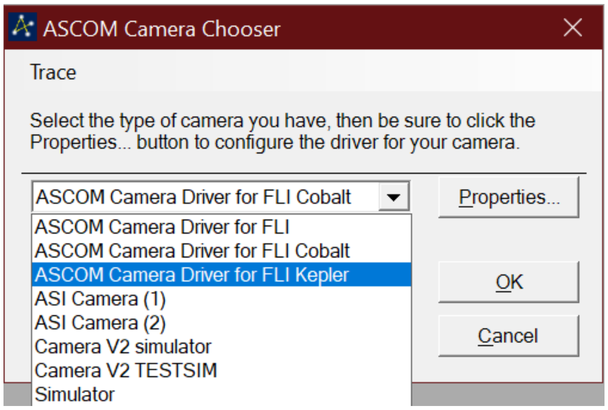
□ Log/Trace

FLI Lib: v. 1.11.25 - (6.2.7510.31592)

Chapter 6 FLI Kepler Camera Settings

This chapter contains the notes for the FLI Kepler sCMOS cameras settings.

The "**ASCOM Camera Driver for FLI Kepler**" must be selected in the ASCOM Camera chooser dialog:



Select the type of camera you have, then be sure to click the Properties... button to configure the driver for your camera.

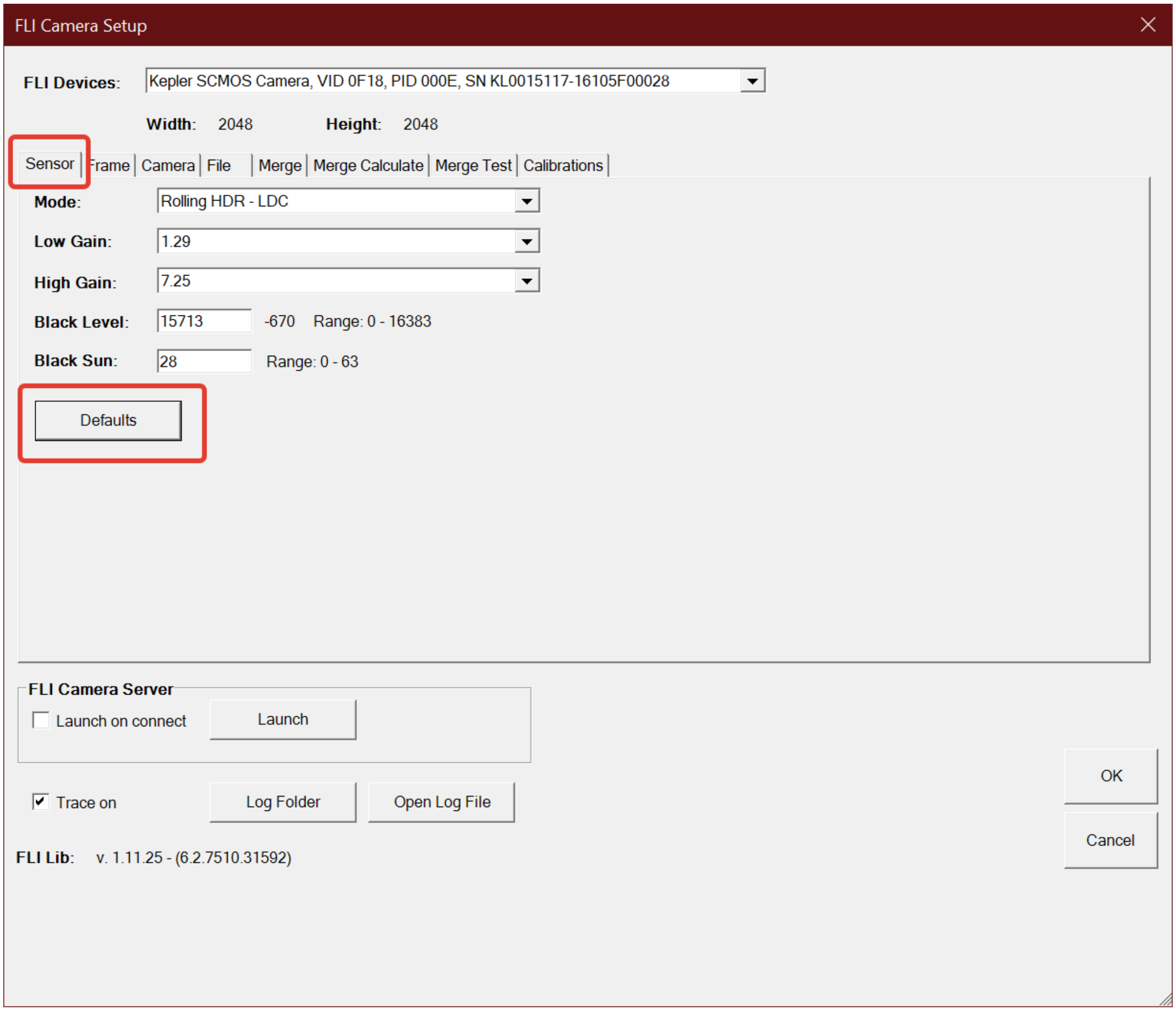
ASCOM Camera Driver for FLI Cobalt

- ASCOM Camera Driver for FLI
- ASCOM Camera Driver for FLI Cobalt
- ASCOM Camera Driver for FLI Kepler
- ASI Camera (1)
- ASI Camera (2)
- Camera V2 simulator
- Camera V2 TESTSIM
- Simulator

Sensor tab

In the **Sensor** tab the following options are available:

- Camera mode selection. Depends on the camera model. The list of available modes can include LDR (low dynamic range) and HDR (high dynamic range)
- The gain value(s) for corresponding channels. In the case when the LDR mode is selected, only the Low Gain value will be used by the ASCOM driver
- The black level and the black sun values



FLI Devices: Kepler SCMOS Camera, VID 0F18, PID 000E, SN KL0015117-16105F00028

Width: 2048 **Height:** 2048

Mode: Rolling HDR - LDC

Low Gain: 1.29

High Gain: 7.25

Black Level: 15713 -670 Range: 0 - 16383

Black Sun: 28 Range: 0 - 63

□ Launch on connect

☑ Trace on

FLI Lib: v. 1.11.25 - (6.2.7510.31592)

- enable/disable the Log/Trace (see below)
- enable/disable the FLI camera server external control program.

NOTE: It is recommended to use the "**Defaults**" button to restore the default Black Level and Black Sun values.

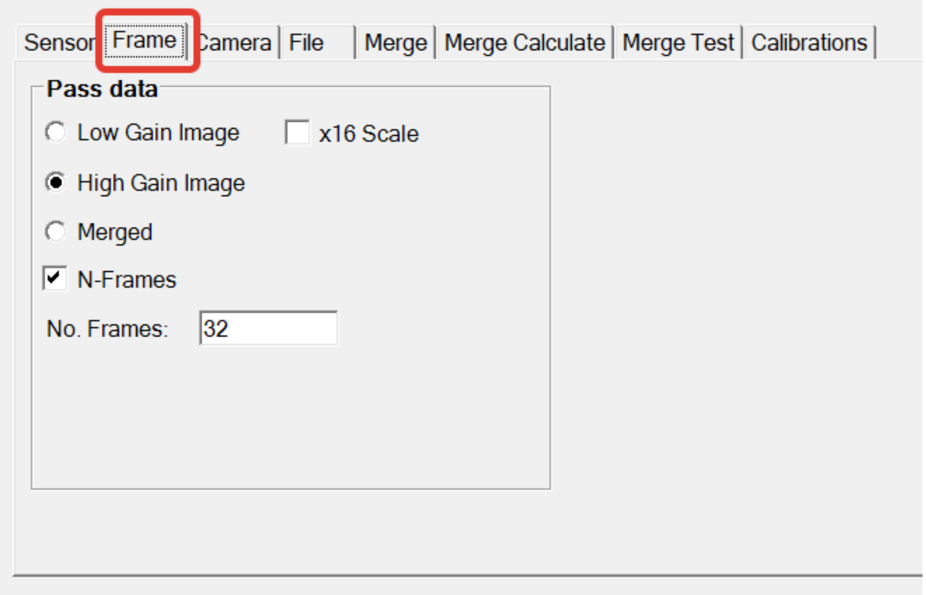
Frame tab

In the **Frame** tab the user can control which channel will be used for the final frame composition:

- Low Gain Image – only the low gain channel will contribute to the final frame. If the current mode is HDR then the high gain channel data will be ignored
- High Gain Image – only the low gain channel will contribute to the final frame. If the current mode is HDR then the low gain channel data will be ignored
- Merged Image – both the low and the high gain channels will contribute to the final frame as a merged image

- Scale factor of 16 can be applied for Low or High Gain channel. Each channel has 12 bits; multiplying each pixel value by 16 will map the data from [0-4095] grayscale range to [0-65520] range. Has no effect on the merged image.

- **N-Frames** mode allows to acquire a specified number (defined by the **No. Frames** text box value) of frames and integrate them into a single final frame. In this case the exposure time of each frame will be scaled by 1/N so that the total exposure will be equal to the exposure time, specified by the user. Only HDR channel will be used for the frame acquisition so that the Low- and High- gain channels merging will be avoided. **NOTE**: the total exposure of N-frames with 1/N exposures each can be longer than exposing a single frame because the system needs to transfer N-frames instead of a single frame.



Pass data

○ Low Gain Image □ x16 Scale

● High Gain Image

○ Merged

☑ N-Frames

No. Frames: 32

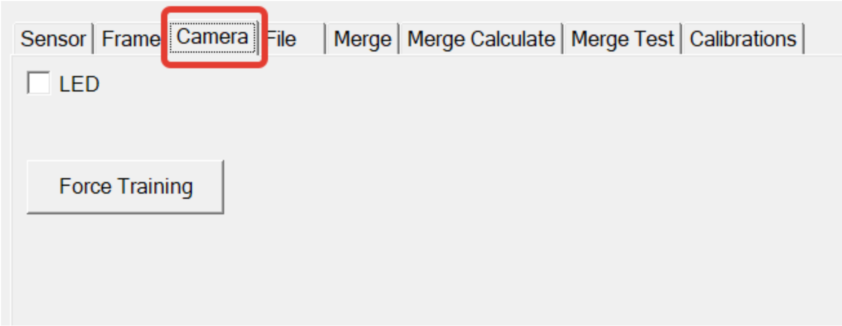
NOTE: these switches are not available if the mode selected in the **Sensor** tab is not one

Camera tab

In the **Camera** tab the user can control:

- The camera LED: controls the operation of the internal LED and can be enabled or disabled

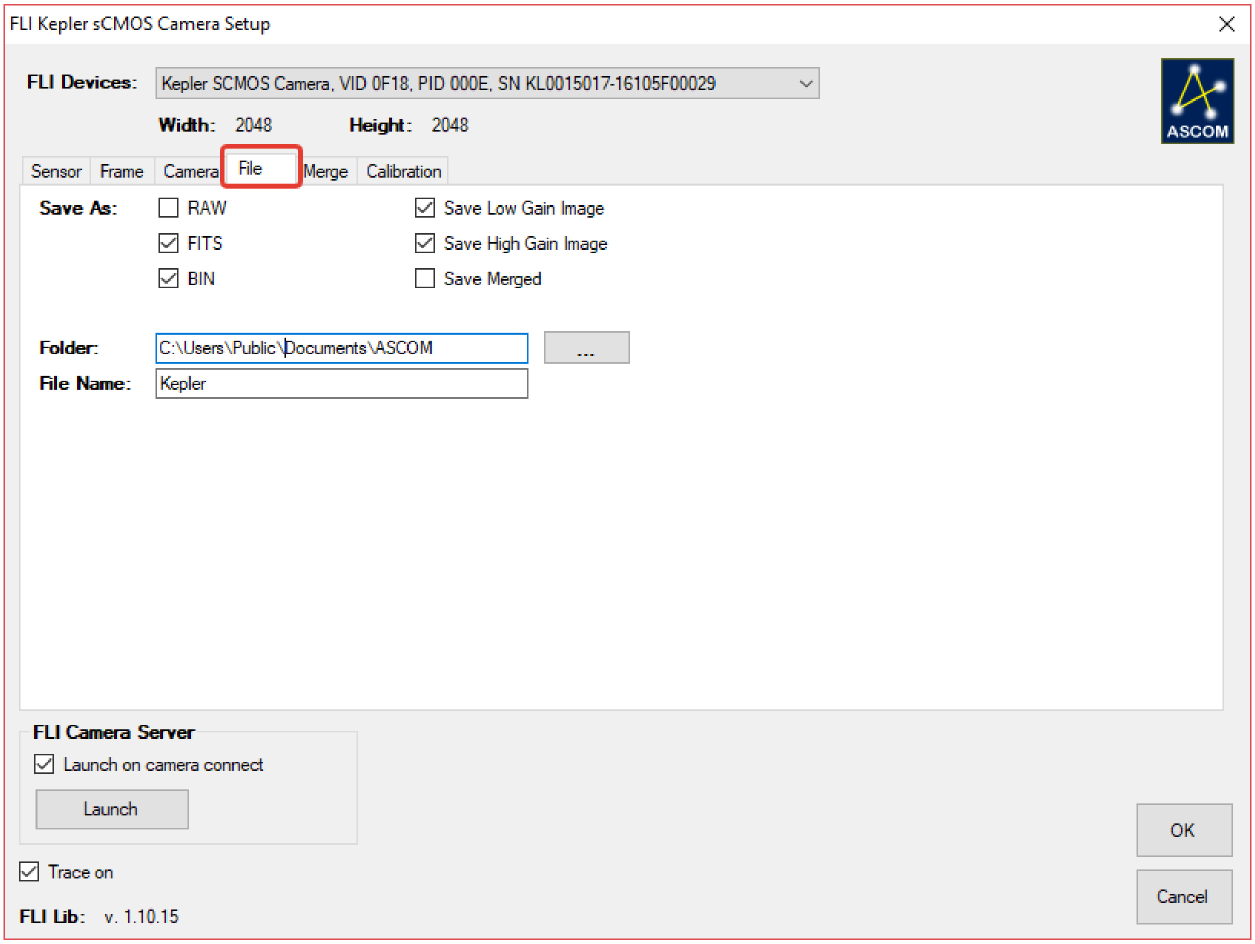
- Force Training – the sensor training at the current temperature.



File tab

In the **Files** tab the user can control the channel(s) and format(s) that should be used to store the acquired frames on the disk:

- **RAW/FITS/BIN** – the file formats that are currently available for saving by the ASCOM driver. The RAW format is the frame data as it comes from the camera (with the metadata header, packed). The BIN file format is for the binary unpacked frame data in the unsigned short (16 bit) pixel format. FITS is for the "Flexible Image Transport System"
- **Save Low/High Gain Image/Merged** – shows which channel(s) will be stored in the selected file formats
- **Folder** – the folder where all the files will be stored. Can be changed by pressing the "**…**" button
- **File Name** – the text that will be added to each frame file name. All saved frames will start with this text.



FLI Kepler sCMOS Camera Setup

FLI Devices: Kepler SCMOS Camera, VID 0F18, PID 000E, SN KL0015017-16105F00029

Width: 2048 **Height:** 2048

Save As:

☐ RAW

☑ FITS

☑ BIN

☑ Save Low Gain Image

☑ Save High Gain Image

☐ Save Merged

Folder: C:\Users\Public\Documents\ASCOM

File Name: Kepler

FLI Camera Server

☑ Launch on camera connect

☑ Trace on

FLI Lib: v. 1.10.15

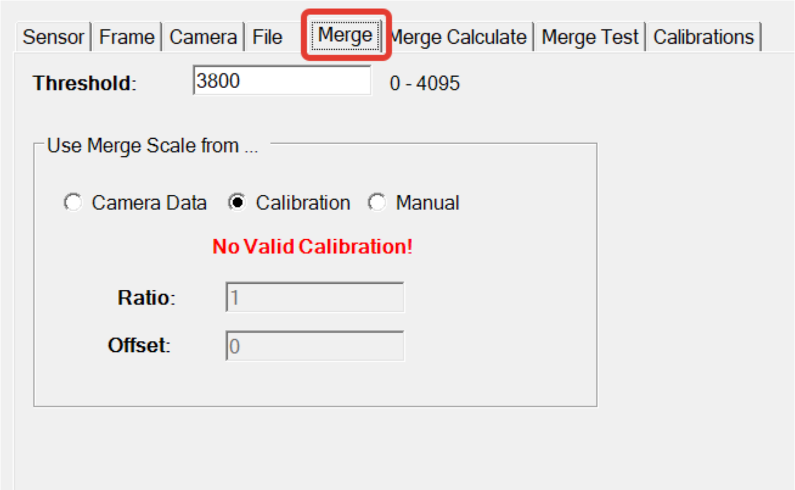
NOTE: the file format check boxes are ignored if none of the **Save …** is selected.

Merge tab

In the **Merge** tab the user can control the threshold for the merging operation:

- **Threshold** – during merging of the low and high gain channels the threshold value will be used to check if the pixel is close to be or completely oversaturated. The default value is 3800.

- **Use Merge Scale from**… - allows the user to control the source of the merge scale (ratio between low- and high-gain channels) and the offset. The available options are: (i) **Camera Data** – the coefficients will be read from the non-volatile camera memory; (ii) **Calibration** – the coefficients will be taken from the user manual calibration (see the "**Merge Calculate**" tab description); (iii) **Manual** – the user can manually enter the coefficients.



Threshold: 3800 0 - 4095

Use Merge Scale from ...

○ Camera Data ● Calibration ○ Manual

No Valid Calibration!

Ratio: 1

Offset: 0

Merge Calculate and Merge Test tabs

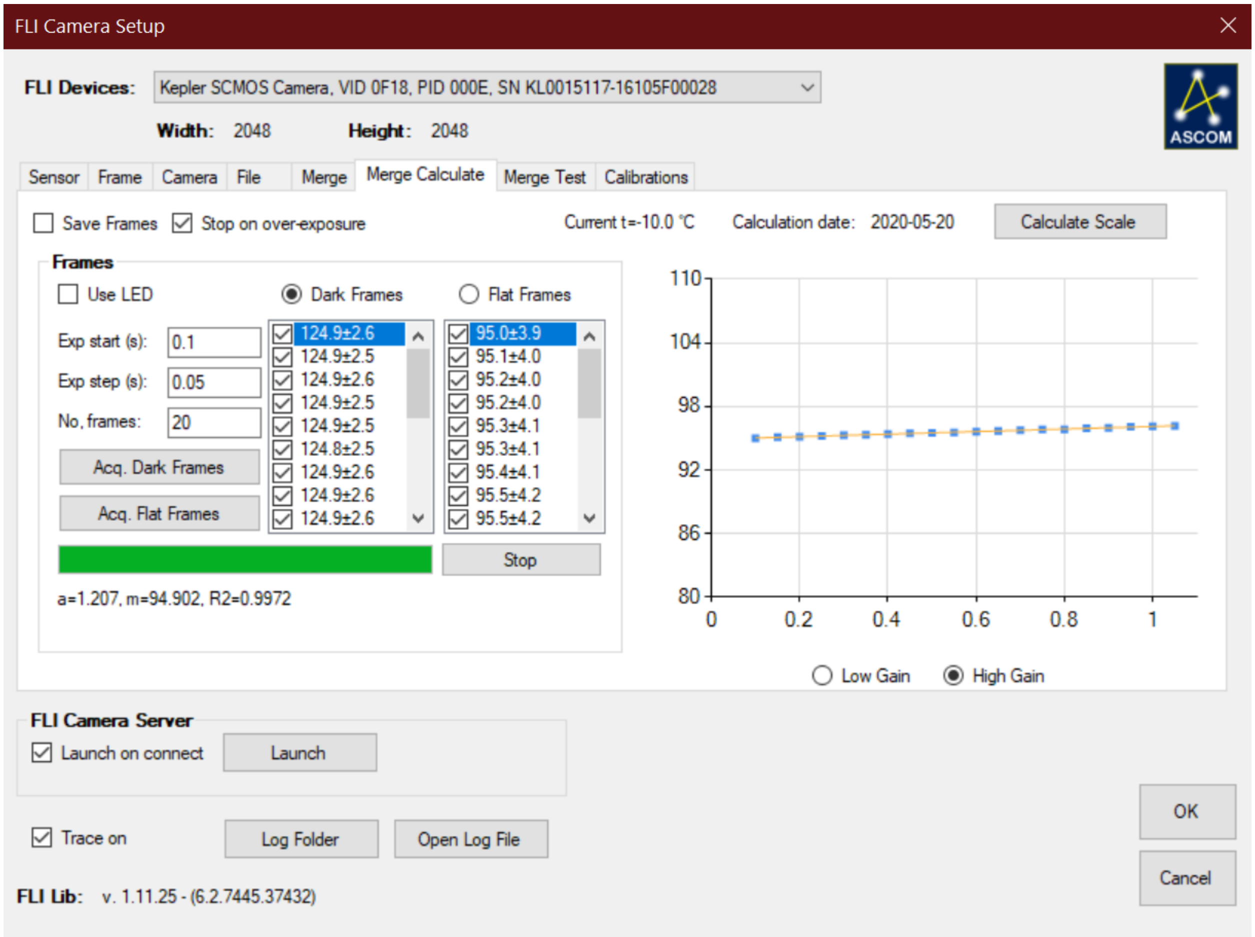
These tabs are described in the following chapters.

Chapter 7 FLI Camera Merge Calculate

This chapter contains the notes for the FLI Kepler sCMOS camera estimation of the merge coefficients.

Merge Calculate tab

When the FLI Kepler sCMOS camera operates in any High Dynamic Range modes, the acquisition contains 2 channels with Low and High gain images. These channels can be merged into a single channel. In the scenario, when the High gain image is completely oversaturated (e.g. when the **Merge Threshold** value in the Merge tab is 3800, all pixels with values above 3800 will be considered as oversaturated), then there is no suitable information available in the High gain image for merging. The final frame will be composed using only the Low gain image data. However, the Low gain image should be correctly scaled. The scale factor is not known and must be calibrated by the user using the following UI of the ASCOM FLI Kepler setup dialog:



FLI Camera Setup

FLI Devices: Kepler SCMOS Camera, VID 0F18, PID 000E, SN KL0015117-16105F00028

Width: 2048 **Height:** 2048

□ Save Frames ☑ Stop on over-exposure

Current t=-10.0 °C

Calculation date: 2020-05-20

Frames

□ Use LED

● Dark Frames ○ Flat Frames

Exp start (s): 0.1

Exp step (s): 0.05

No. frames: 20

Dark Frames	Flat Frames
☑ 124.9±2.6	☑ 95.0±3.9
☑ 124.9±2.5	☑ 95.1±4.0
☑ 124.9±2.6	☑ 95.2±4.0
☑ 124.9±2.5	☑ 95.3±4.1
☑ 124.9±2.5	☑ 95.3±4.1
☑ 124.8±2.5	☑ 95.4±4.1
☑ 124.9±2.6	☑ 95.5±4.2
☑ 124.9±2.6	☑ 95.5±4.2

a=1.207, m=94.902, R2=0.9972

○ Low Gain ● High Gain

FLI Camera Server

☑ Launch on connect

☑ Trace on

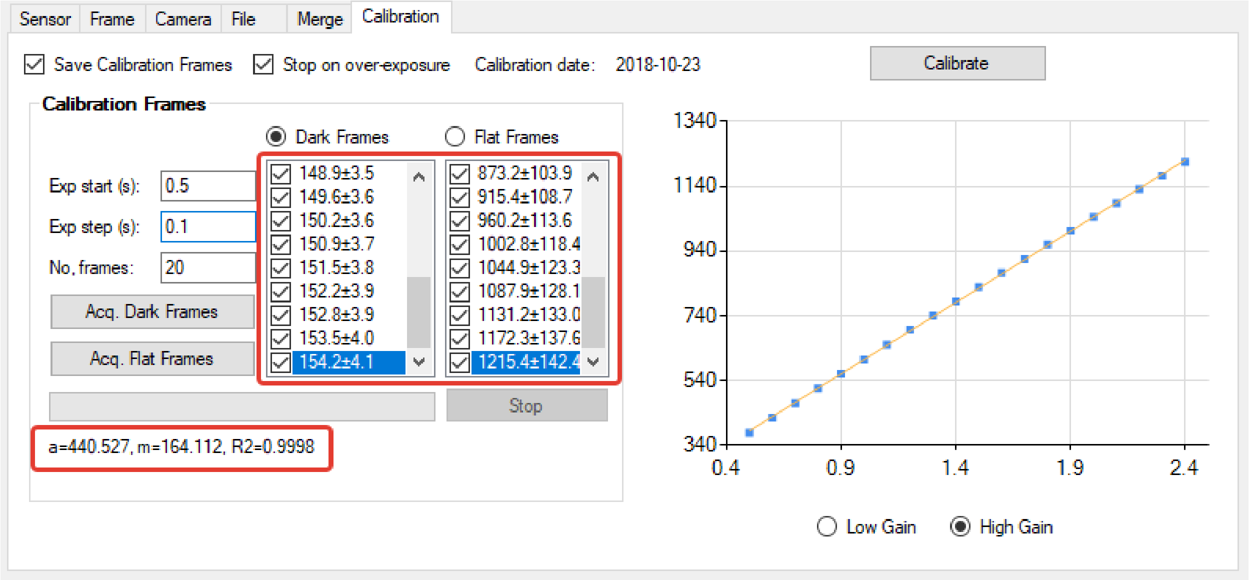
FLI Lib: v. 1.11.25 - (6.2.7445.37432)

The idea behind the calibration is to evaluate the ration between the intensities in the Low and High gain channels using the data from exposure series of dark and flat frames.

The procedure can be described as follows:

- Cover the camera objective. If the camera has a shutter it will be closed automatically
- Set the appropriate acquisition parameters: the starting exposure (for example, 0.5 s), the exposure step (0.1 s) and the total number of dark frames to collect (for example, 20)
- Press **Acq. Dark Frames** button. Wait for completion.
- Open the camera objective and set the illumination. If the camera has a shutter it will be opened automatically
- Set the appropriate acquisition parameters: the starting exposure (for example, 0.5 s), the exposure step (0.1 s) and the total number of flat frames to collect (for example, 20)
- Press **Acq. Flat Frames** button. Wait for completion
- Inspect the statistics and press **Calculate** button.

The program will automatically collect the frames and output the statistics for the Low and High gain channels in the following manner:



☑ Save Calibration Frames ☑ Stop on over-exposure Calibration date: 2018-10-23

● Dark Frames ○ Flat Frames

Exp start (s): 0.5
Exp step (s): 0.1
No. frames: 20

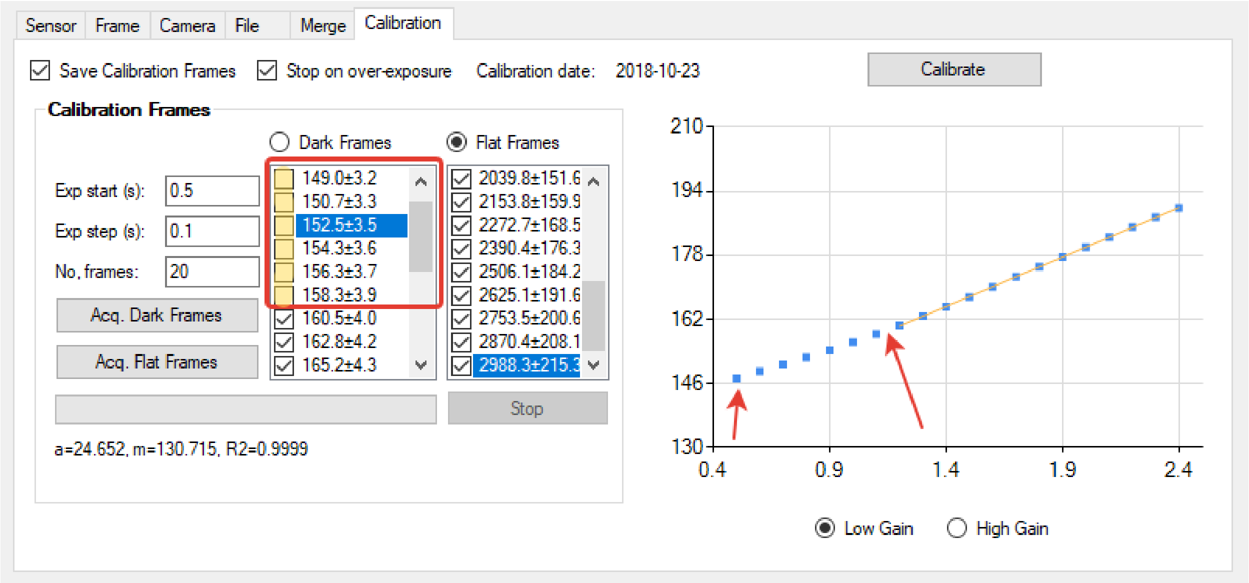
Dark Frames	Flat Frames
☑ 148.9±3.5	☑ 873.2±103.9
☑ 149.6±3.6	☑ 915.4±108.7
☑ 150.2±3.6	☑ 960.2±113.6
☑ 150.9±3.7	☑ 1002.8±118.4
☑ 151.5±3.8	☑ 1044.9±123.3
☑ 152.2±3.9	☑ 1087.9±128.1
☑ 152.8±3.9	☑ 1131.2±133.0
☑ 153.5±4.0	☑ 1172.3±137.6
☑ 154.2±4.1	☑ 1215.4±142.4

a=440.527, m=164.112, R2=0.9998

○ Low Gain ● High Gain

The left and right columns show the average values (± std. dev.) for the Low and High gain images, respectively. The chart on the right shows the visual representation of the average values for the selected channel (can be changed by selecting either **Low Gain** or **High Gain** radio button under the chart). The line equation with the slope (**a**), the interception (**m**) and the **R2** is shown on the bottom left.

If some data points fall off the line, they can be unchecked (yellow marking in the left column). The unchecking will eliminate these points from the linearity test.



☑ Save Calibration Frames ☑ Stop on over-exposure Calibration date: 2018-10-23

Calibration Frames

○ Dark Frames ● Flat Frames

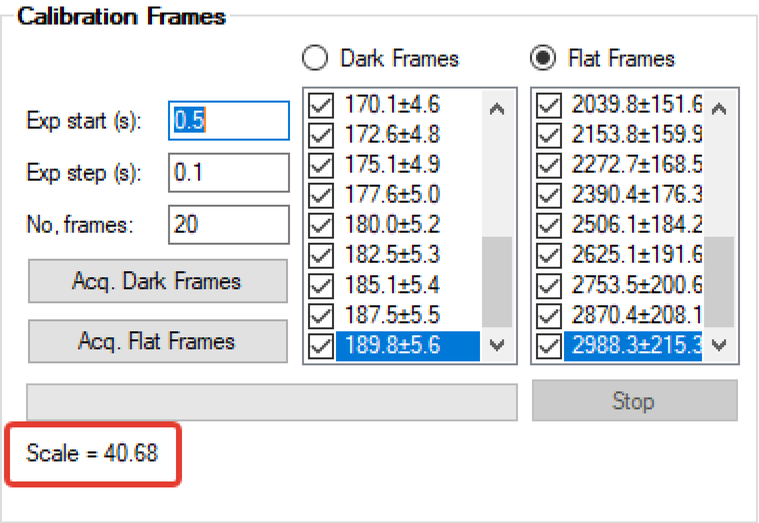
Exp start (s): 0.5
Exp step (s): 0.1
No. frames: 20

Dark Frames	Flat Frames
□ 149.0±3.2	☑ 2039.8±151.6
□ 150.7±3.3	☑ 2153.8±159.9
□ 152.5±3.5	☑ 2272.7±168.5
□ 154.3±3.6	☑ 2390.4±176.3
□ 156.3±3.7	☑ 2506.1±184.2
□ 158.3±3.9	☑ 2625.1±191.6
☑ 160.5±4.0	☑ 2753.5±200.6
☑ 162.8±4.2	☑ 2870.4±208.1
☑ 165.2±4.3	☑ 2988.3±215.3

a=24.652, m=130.715, R2=0.9999

● Low Gain ○ High Gain

If the calculation of the scale factor was successful, it will be shown in the bottom left corner:



Calibration Frames

○ Dark Frames ● Flat Frames

Exp start (s): 0.5
Exp step (s): 0.1
No. frames: 20

Dark Frames	Flat Frames
☑ 170.1±4.6	☑ 2039.8±151.6
☑ 172.6±4.8	☑ 2153.8±159.9
☑ 175.1±4.9	☑ 2272.7±168.5
☑ 177.6±5.0	☑ 2390.4±176.3
☑ 180.0±5.2	☑ 2506.1±184.2
☑ 182.5±5.3	☑ 2625.1±191.6
☑ 185.1±5.4	☑ 2753.5±200.6
☑ 187.5±5.5	☑ 2870.4±208.1
☑ 189.8±5.6	☑ 2988.3±215.3

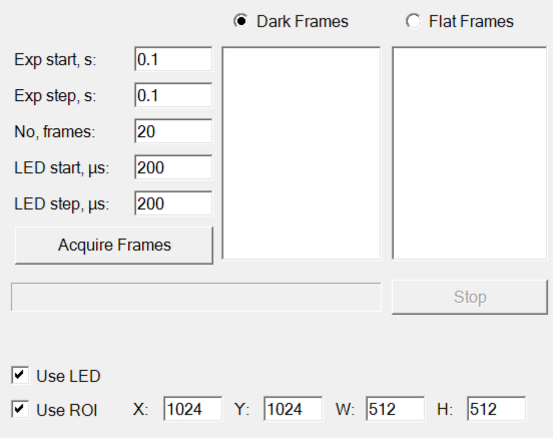
Scale = 40.68

After the successful calculation of the scale factor, the calibration will be stored in the special file and will be used by the ASCOM driver during merging stage.

The user can do the merge calculation using one of the following options:

- a regular light frame with progressive exposure times, defined by **Exp start**, **Exp step** and **No. frames** parameters
- covered sensor using LED flashes. **Use LED** must be checked in this case.

An ROI can be used to calculate frame averages. This is useful if the sensor is evenly exposed only at a certain part.



● Dark Frames ○ Flat Frames

Exp start, s: 0.1

Exp step, s: 0.1

No, frames: 20

LED start, µs: 200

LED step, µs: 200

☑ Use LED

☑ Use ROI X: 1024 Y: 1024 W: 512 H: 512

ASCOM Calibration destination folder

All ASCOM files will be stored (if enabled) to the following default folder (can be changed by the user):

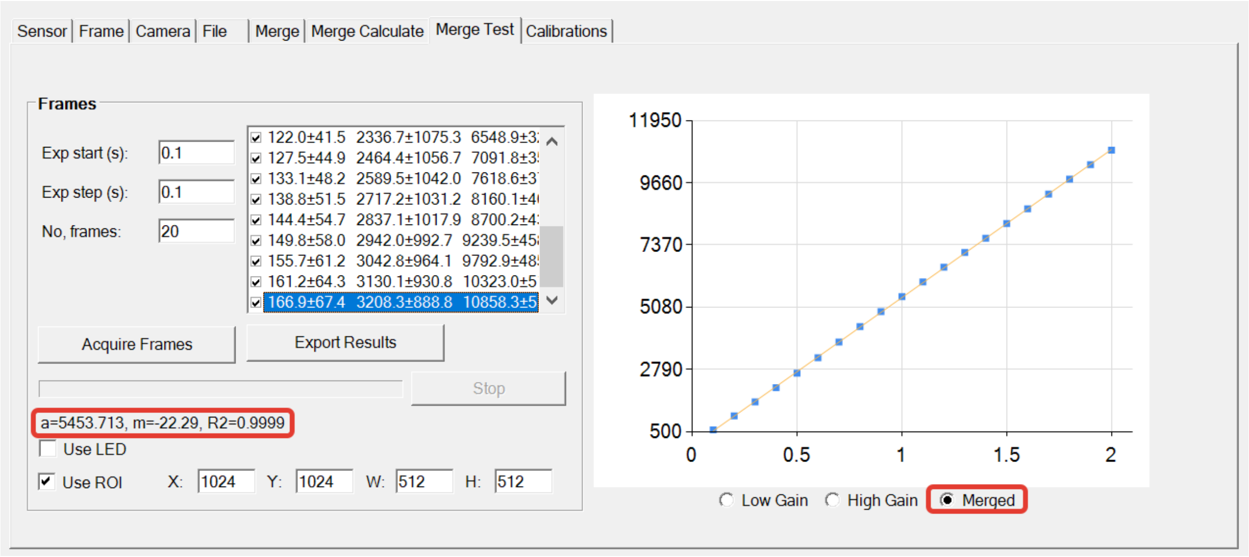
C:\Program Files (x86)\Common Files\ASCOM\Camera\Calibrate

Chapter 8 FLI Camera Calibration Testing

This chapter contains the notes for the FLI Kepler sCMOS camera merge coefficients testing calculated in the previous chapter.

Merge Test tab

The Merge Test tab is designed to test the exposure-series linearity of the Merge Calculate coefficients that are selected on the **Merge** tab (see previous chapters).



Exp start (s): 0.1

Exp step (s): 0.1

No, frames: 20

```
☑ 122.0±41.5  2336.7±1075.3  6548.9±3:
☑ 127.5±44.9  2464.4±1056.7  7091.8±3!
☑ 133.1±48.2  2589.5±1042.0  7618.6±3
☑ 138.8±51.5  2717.2±1031.2  8160.1±4
☑ 144.4±54.7  2837.1±1017.9  8700.2±4:
☑ 149.8±58.0  2942.0±992.7  9239.5±45
☑ 155.7±61.2  3042.8±964.1  9792.9±48!
☑ 161.2±64.3  3130.1±930.8  10323.0±5
☑ 166.9±67.4  3208.3±888.8  10858.3±5
```

a=5453.713, m=-22.29, R2=0.9999

□ Use LED

☑ Use ROI X: 1024 Y: 1024 W: 512 H: 512

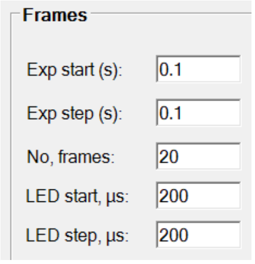
The results can be exported (**Export Results** button) into a .CSV file.

It is possible to specify an ROI for the calculation of the frame average. The **Use ROI** checkbox should be marked in this case.

The merge test can be used by acquiring:

- a regular light frame with progressive exposure times, defined by **Exp start**, **Exp step** and **No. frames** parameters
- covered sensor using LED flashes. **Use LED** must be checked in this case.

The LED flashing exposure times (in ***micro-seconds***!) can be controlled by an extra set of edit boxes when **Use LED** is checked:



Frames

Exp start (s): 0.1

Exp step (s): 0.1

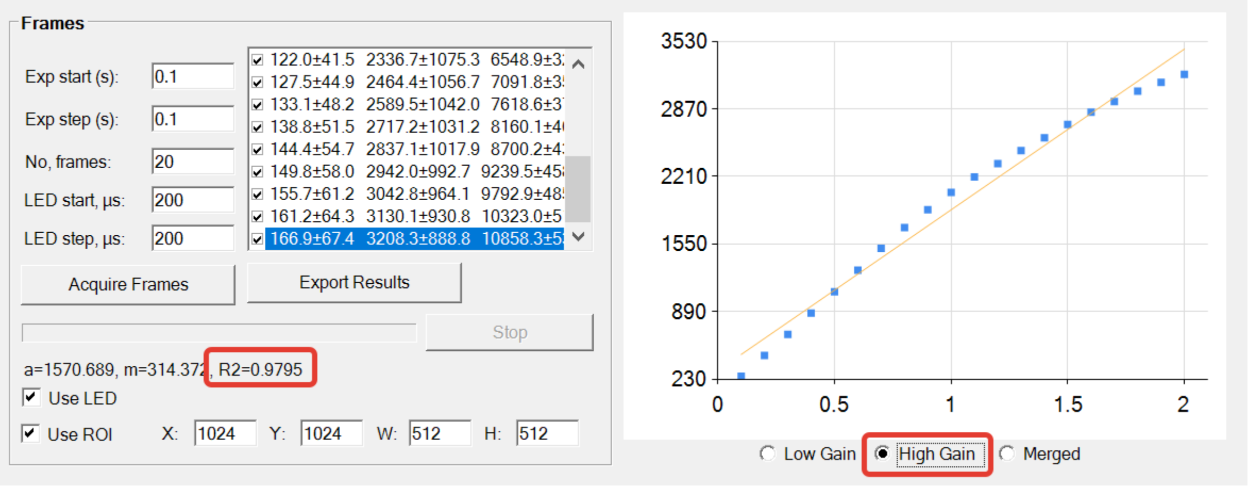
No, frames: 20

LED start, µs: 200

LED step, µs: 200

Important Notes:

The High gain channel can show a non-linear dependency of the frame averages against the linearly increasing exposure time. This can be explained by the over-saturation of the high-gain channel pixels that occurs after certain exposure time.



Frames

Exp start (s): 0.1

Exp step (s): 0.1

No, frames: 20

LED start, µs: 200

LED step, µs: 200

```
☑ 122.0±41.5  2336.7±1075.3  6548.9±3
☑ 127.5±44.9  2464.4±1056.7  7091.8±3
☑ 133.1±48.2  2589.5±1042.0  7618.6±3
☑ 138.8±51.5  2717.2±1031.2  8160.1±4
☑ 144.4±54.7  2837.1±1017.9  8700.2±4
☑ 149.8±58.0  2942.0±992.7  9239.5±45
☑ 155.7±61.2  3042.8±964.1  9792.9±48
☑ 161.2±64.3  3130.1±930.8  10323.0±5
☑ 166.9±67.4  3208.3±888.8  10858.3±5
```

a=1570.689, m=314.372, R2=0.9795

☑ Use LED

☑ Use ROI X: 1024 Y: 1024 W: 512 H: 512

○ Low Gain ● High Gain ○ Merged

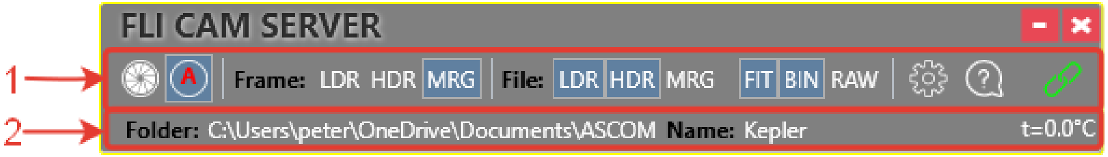
The Merged channel can show a non-linear dependency of the frame averages against the exposure time. This can occur when even the low-gain channel pixels over-saturate at extremely high exposure times or if the test light source is too bright.

Chapter 9 FLI Camera Server

This chapter contains the notes on the "**FLI Camera Server**" program. This software is designed to access the most frequently used settings of the ASCOM driver in real-time. The program designed in a form of a toolbar and stays on-top of all other programs.

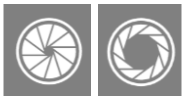
Functionality

The basic functionality of the FLI camera can control some features of the ASCOM driver using two parts of the User Interface as it is shown on the screen shot below:



Folder: C:\Users\peter\OneDrive\Documents\ASCOM Name: Kepler t=0.0°C

The following table gives a brief description of the "**FLI Camera Server**" main toolbar functionality:

Function	Toolbar button	Description
Shutter Open/Close		Opens or closes the camera shutter, if present. The button image reflects the status of the shutter.
ASCOM shutter control	A	The ASCOM driver control of the shutter: automatic (ON) or manual (OFF)
Readout channel	LDR HDR MRG	The channel that will be passed by ASCOM to the 3rd party software: • Low gain (LDR) • High gain (HDR) • Merged image (MRG) •
Save channel	LDR HDR MRG	The channel that will be saved by ASCOM in the storage folder: • Low gain (LDR) • High gain (HDR) • Merged image (MRG) •

File save as …	FIT BIN RAW	The file format(s) that will be used to save the selected channels: • FITS file • BIN data • RAW (FLI buffer)
Settings	⚙	Other ASCOM settings can be accessed
About…	?	About the FLI Camera Server
Camera connection	🔗 🔗	Camera is connected (green) or disconnected (red).
Storage folder	Toolbar #2	Sets the current Windows directory for the storage of the frame data.
File name for saving	Toolbar #2	Sets the base filename. See explanation in the main text.

The FLI Camera server can control

Automatic ASCOM driver shutter control follows the following rules:

- ***Light frame***: the shutter opens on the frame acquisition start and closes at the acquisition end
- ***Dark frame***: the shutter closes on the frame acquisition start and is kept closed at the acquisition end.

If for some reason the default ASCOM shutter control is not enough, the "**FLI Camera Server**" program can be used to prevent the ASCOM driver automatically using the shutter (manual mode). The program communicates with the ASCOM driver and updates the camera state (**Connected** or **Disconnected**) and the status of the camera shutter (**Opened** or **Closed**). Depending on the current shutter state, the program will change the button text to **Close**/**Open**.

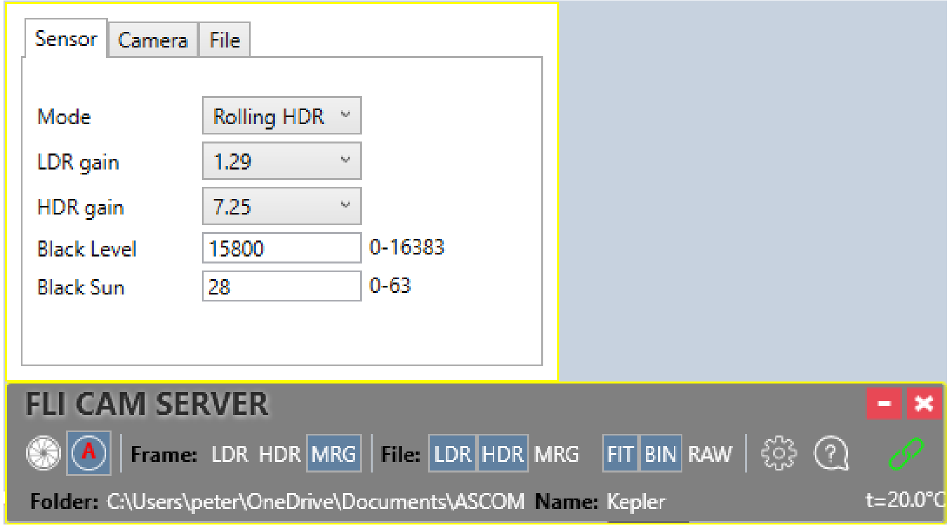
The final file name for saving will be constructed by the ASCOM driver in the following way:

<base-file-name>_1s_1x1_t=0_231057_577-high.fits
where:

- **<base-file-name>** is specified by the user in the Toolbar #2;
- **1s** – the exposure time (here: 1 second)
- **1x1** – the frame binning (here: 1x1)

- t=0 – the temperature (here: 0ºC)
- 231057_577 – the time stamp
- high – the channel type (can be **high**, **low**, **merged**)
- **fits** – the file extension (can be **fits**, **raw** or **bin**).

The settings panel can be opened from the main toolbar by pressing the **Settings** button:



Mode: Rolling HDR
LDR gain: 1.29
HDR gain: 7.25
Black Level: 15800 0-16383
Black Sun: 28 0-63

Folder: C:\Users\peter\OneDrive\Documents\ASCOM Name: Kepler
t=20.0°C

The panel provides the access to some settings of the FLI Kepler cameras that do not need to be accessed frequently.

The "**FLI Camera Server**" program can be launched from the Kepler sCMOS camera settings dialog and can be set to startup automatically when the camera is initialized.

FLI Camera Server installation folder

All ASCOM camera drivers are installed to the following location:

C:\Program Files (x86)\Common Files\ASCOM\Camera

The "**FLI Camera Server**" program will be installed into the same folder during the main FLI ASCOM driver installation.

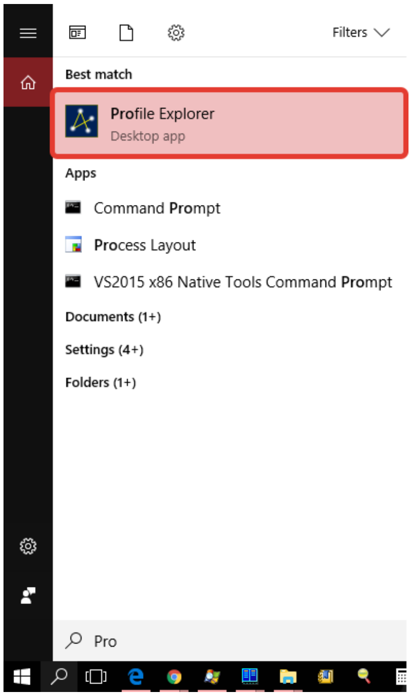
Chapter 10 Configuration profile explorer

This chapter contains the notes related to the ASCOM configuration profile explorer. It visualizes the profile store and allows editing of individual values by presenting the store as a hierarchical folder structure.

Profile Explorer

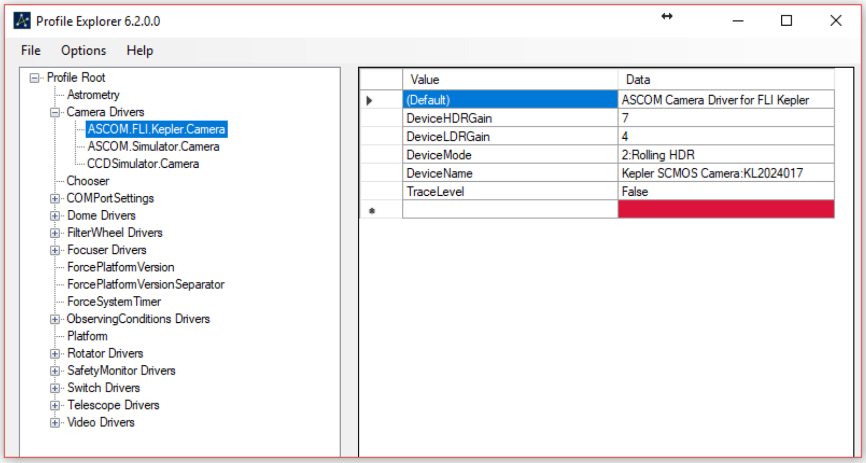
All camera settings can be viewed/modified using the ASCOM Profile Explorer. Profile Explorer is installed to the **Start Menu\ASCOM Platform\Tools** folder.

Alternatively, the user can start the "Profile Explorer" from the Windows task bar by typing "**Pro…**":



The profile settings for the driver can be found under

Profile Root → Camera Drivers → ASCOM.FLI.Kepler.Camera:



	Value	Data
▶	(Default)	ASCOM Camera Driver for FLI Kepler
	DeviceHDRGain	7
	DeviceLDRGain	4
	DeviceMode	2:Rolling HDR
	DeviceName	Kepler SCMOS Camera:KL2024017
	TraceLevel	False
*		

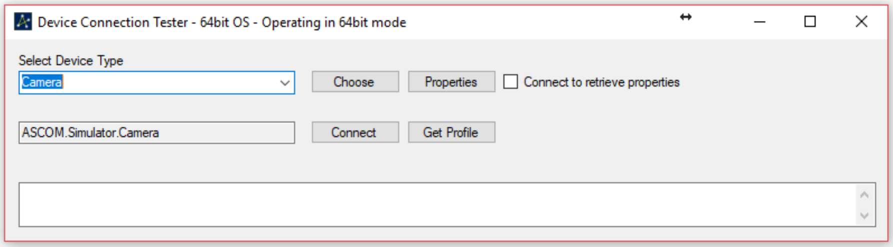
Note If the ASCOM Profile Explorer is executed after the ASCOM FLI Driver installation but before the first run of any application that can configure the FLI Driver ASCOM, then the profile values/data will be empty.

Note Please refer to the ASCOM Platform Help on further description of the Profile Explorer.

Chapter 11 Testing the ASCOM FLI Driver installation

Start the **ASCOM Device Connection Tester** that is a part of the standard ASCOM Platform installation. The location of the Device tester depends on the Windows (32/64 bits) and can be either at
C:\Program Files (x86)\ASCOM\Platform 6\Tools\DriverConnect32
or at
C:\Program Files (x86)\ASCOM\Platform 6\Tools\DriverConnect64

The following dialog will appear:



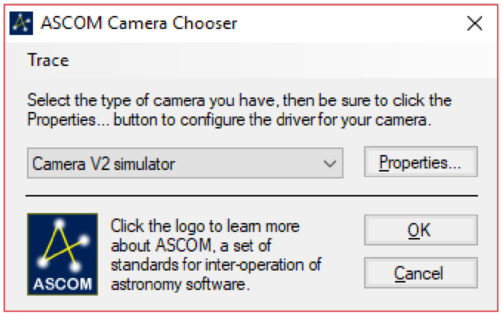
Device Connection Tester - 64bit OS - Operating in 64bit mode

Select Device Type: Camera

ASCOM.Simulator.Camera

Under **Select Device Type** choose **Camera** and press **Choose** button.

The following dialog will be shown:



ASCOM Camera Chooser

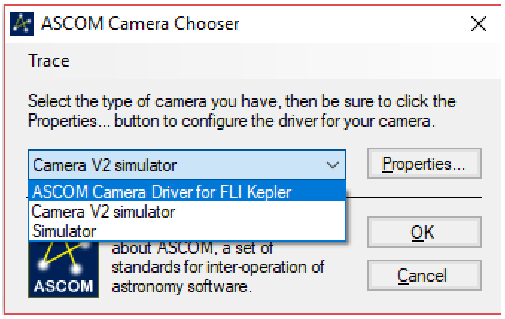
Trace

Select the type of camera you have, then be sure to click the Properties... button to configure the driver for your camera.

Camera V2 simulator

Click the logo to learn more about ASCOM, a set of standards for inter-operation of astronomy software.

Select ASCOM Camera Driver for FLI Kepler.



ASCOM Camera Chooser

Trace

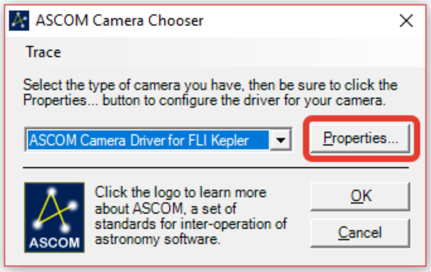
Select the type of camera you have, then be sure to click the Properties... button to configure the driver for your camera.

Camera V2 simulator

ASCOM Camera Driver for FLI Kepler
Camera V2 simulator
Simulator

about ASCOM, a set of standards for inter-operation of astronomy software.

Press **Properties** button.



ASCOM Camera Chooser

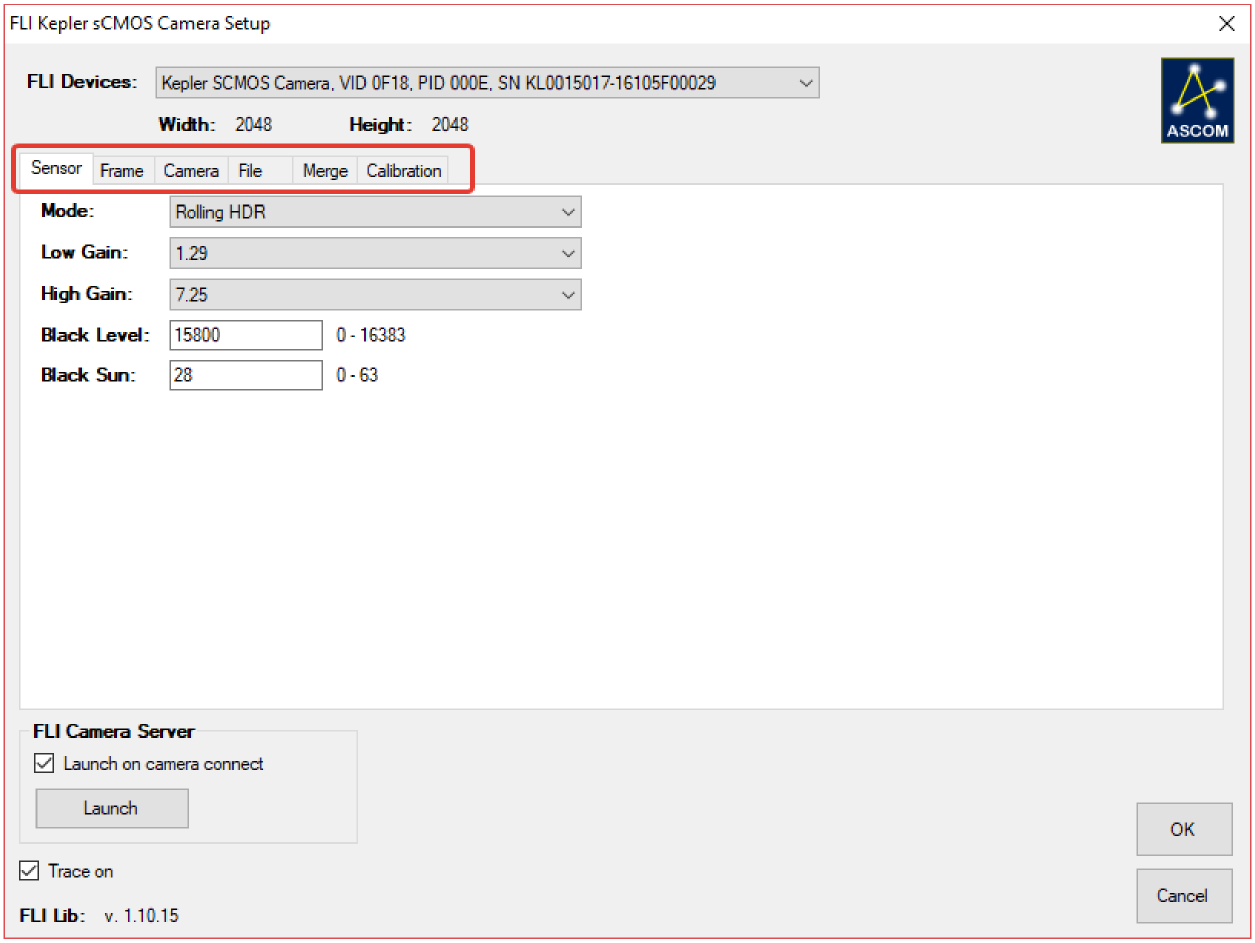
Trace

Select the type of camera you have, then be sure to click the Properties... button to configure the driver for your camera.

ASCOM Camera Driver for FLI Kepler

Click the logo to learn more about ASCOM, a set of standards for inter-operation of astronomy software.

The dialog with the basic FLI Kepler sCMOS camera settings will appear:



FLI Kepler sCMOS Camera Setup

FLI Devices: Kepler SCMOS Camera, VID 0F18, PID 000E, SN KL0015017-16105F00029

Width: 2048 **Height:** 2048

Sensor | Frame | Camera | File | Merge | Calibration

Mode: Rolling HDR

Low Gain: 1.29

High Gain: 7.25

Black Level: 15800 0 - 16383

Black Sun: 28 0 - 63

FLI Camera Server

☑ Launch on camera connect

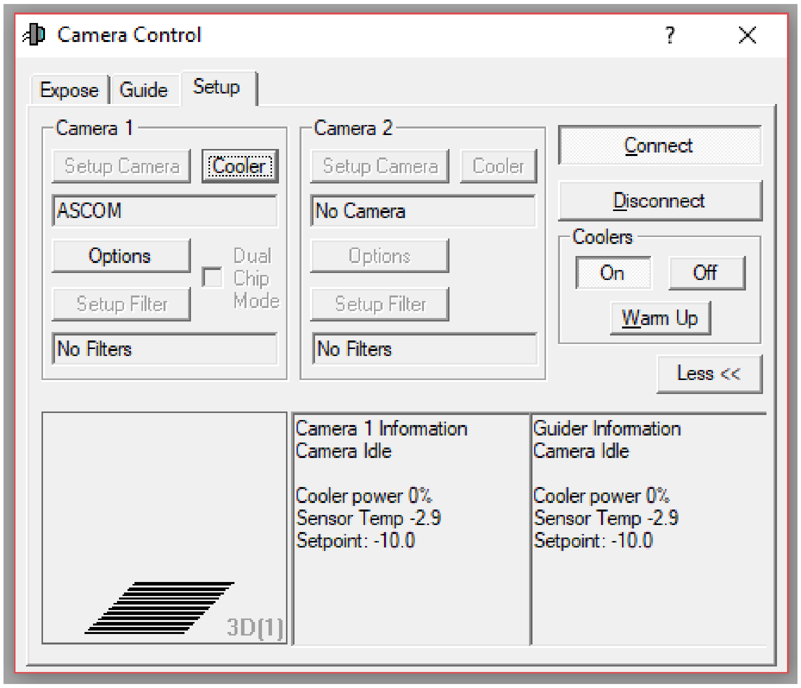
☑ Trace on

FLI Lib: v. 1.10.15

All FLI Kepler camera main settings can be accessed through the set of tabs that are described in detail in the previous chapters.

Chapter 12 Testing in MaxIm DL

In Maxim DL the **Camera Control** dialog box provides the access to the ASCOM drivers:



ASCOM

No Filters

No Camera

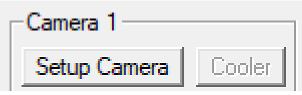
No Filters

```
Camera 1 Information
Camera Idle

Cooler power 0%
Sensor Temp -2.9
Setpoint: -10.0
```

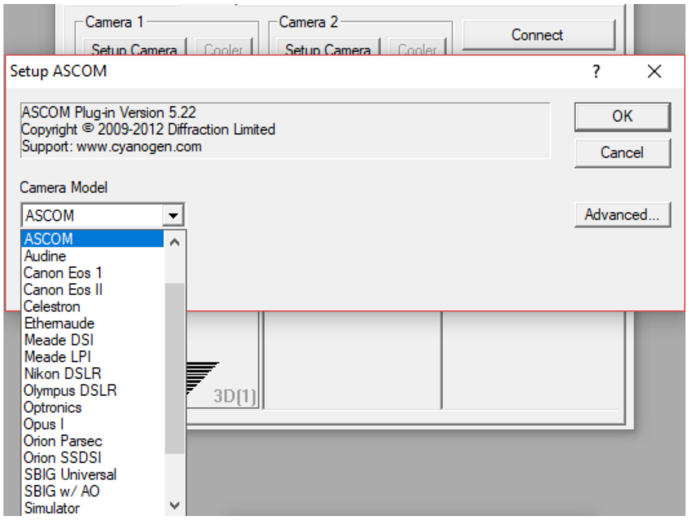
```
Guider Information
Camera Idle

Cooler power 0%
Sensor Temp -2.9
Setpoint: -10.0
```

Press **Disconnect** button to close the connection to the camera.

Once the current camera is disconnected the **Setup Camera** button will become available:



Press the **Setup Camera** button, select **ASCOM** for the **Camera Model** and setup the FLI driver as described above.

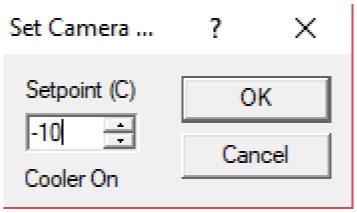


Setup ASCOM

ASCOM Plug-in Version 5.22
Copyright © 2009-2012 Diffraction Limited
Support: www.cyanogen.com

Camera Model: ASCOM

The Cooler settings can be used to set the temperature:

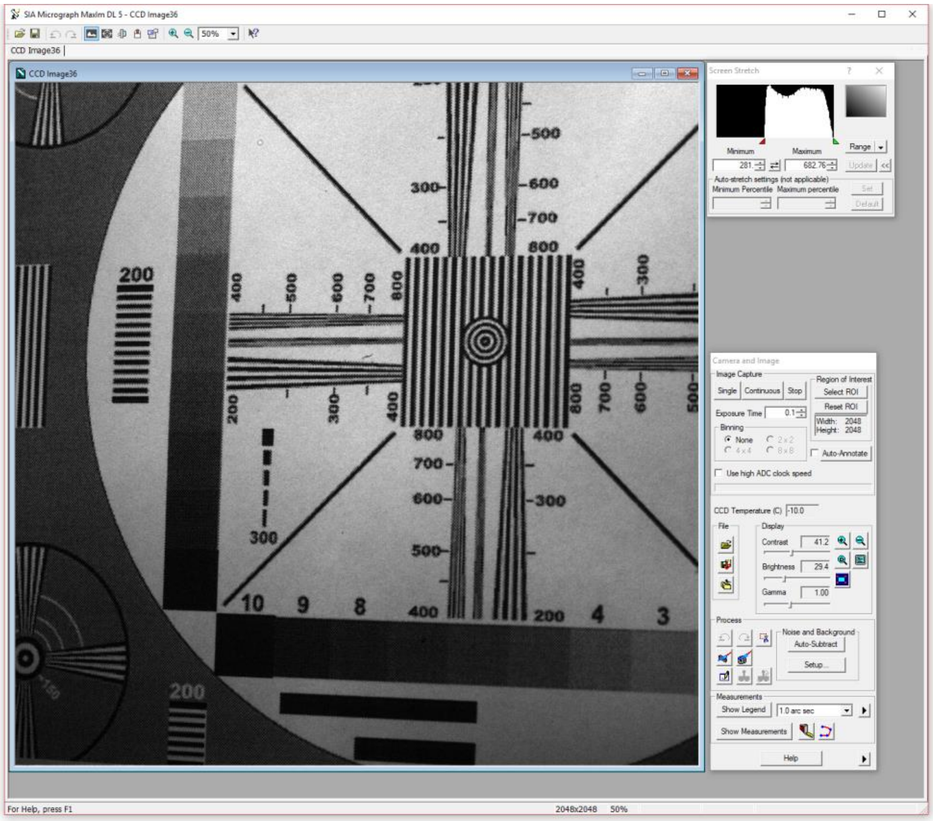


Set Camera ...

Setpoint (C): -10

Cooler On

The LDR mode snapshot. Notice the low values of the histogram range.



SIA Micrograph MaxIm DL 5 - CCD Image36

Screen Stretch: Minimum 281. Maximum 682.76

Auto-stretch settings (not applicable)

Exposure Time 0.1

Binning: ● None

Width: 2048
Height: 2048

☐ Use high ADC clock speed

☐ Auto-Annotate

CCD Temperature (C) -10.0

Contrast 41.2

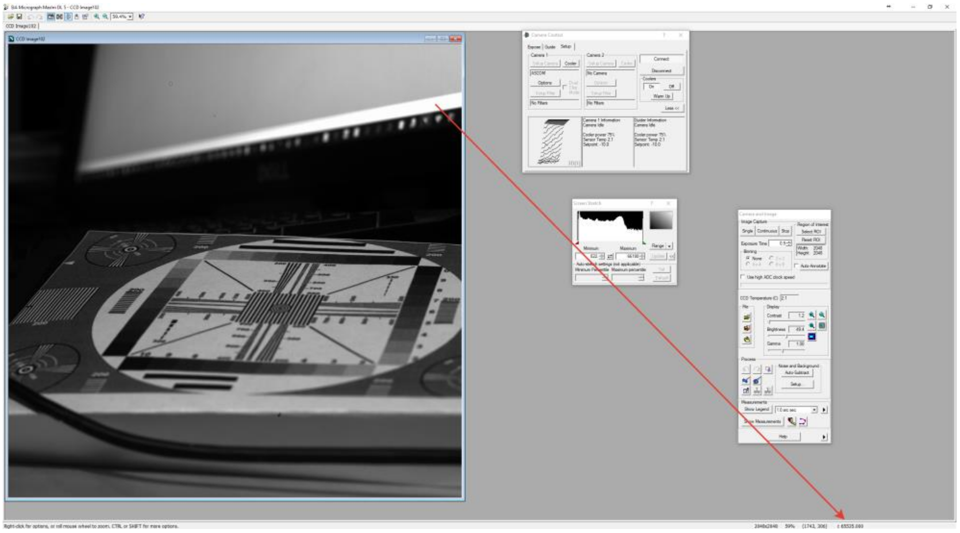
Brightness 29.4

Gamma 1.00

1.0 arc sec

For Help, press F1 2048x2048 50%

The HDR merged mode snapshot. Notice the “white” values of 65535 and the histogram range:



ASCOM

No Camera

No Filters

Camera 1 Information
Camera Idle

Cooler power 75%
Sensor Temp 2.1
Setpoint -10.0

Guider Information
Camera Idle

Cooler power 75%
Sensor Temp 2.1
Setpoint -10.0

Exposure Time 0.5

Width 2048
Height 2048

CCD Temperature (C) 2.1

Contrast 1.2
Brightness 49.4
Gamma 1.00

1.0 arc sec

Right-click for options, or roll mouse wheel to zoom. CTRL or SHIFT for more options.

2048x2048 59% (1743, 306) i 65535.000

Chapter 13 Python programming

To use the ASCOM FLI driver from the Python programming language the following libraries must be installed:

```
# for win32com.client do:
pip install pywin32
# if it did not work try:
pip install pypiwin32
```

In Python’s scientific computing environment, efficient data structures for working with arrays are provided by the NumPy library and it is very convenient use it.

The imports that can be used are

```
import win32com.client               # needed to load COM objects
from win32com.universal import com_error     # for COM exceptions
import numpy as np
import matplotlib.pyplot as plt
import re
import time
```

The following constants can be defined for simplicity:

```
ASCOM_FLI_KEPLER_CAMERA = 'ASCOM.FLI.Kepler.Camera'
ASCOM_FLI_KEPLER_GET_MODE = 'GetMode'
ASCOM_FLI_KEPLER_SET_MODE = 'SetMode'
ASCOM_FLI_KEPLER_GET_MODESLIST = 'GetModesList'
ASCOM_FLI_KEPLER_GET_LOWGAIN = 'GetLowGain'
ASCOM_FLI_KEPLER_SET_LOWGAIN = 'SetLowGain'
ASCOM_FLI_KEPLER_GET_LOWGAINTABLE = 'GetLowGainTable'
ASCOM_FLI_KEPLER_GET_HIGHGAIN = 'GetHighGain'
ASCOM_FLI_KEPLER_SET_HIGHGAIN = 'SetHighGain'
ASCOM_FLI_KEPLER_GET_HIGHGAINTABLE = 'GetHighGainTable'
ASCOM_FLI_KEPLER_GET_BLACKLEVELLOW = 'GetBlackLevelLo'
ASCOM_FLI_KEPLER_GET_BLACKLEVELHIGH = 'GetBlackLevelHi'
ASCOM_FLI_KEPLER_GET_BLACKSUNLOW = 'GetBlackSunLo'
ASCOM_FLI_KEPLER_GET_BLACKSUNHIGH = 'GetBlackSunLo'
```

First, an ASCOM camera object must be created:

```
# get the camera object
cam = win32com.client.Dispatch(ASCOM_FLI_KEPLER_CAMERA)
if not cam.Connected:
    print('Connecting to the camera...')
    cam.Connected = True
    if not cam.Connected:
        print('Unable to connect to the camera')
        exit(-1)
```

At the program exit the camera must be disconnected:

```
print('Disconnecting from the camera...')
cam.Connected = False
```

If there is no camera connected, then the above script will produce the following output:

```
Connecting to the camera...
Unable to connect to the camera.
```

Once the current camera is connected the following script can be used to obtain the camera properties:

```
print('Connected to the camera!')
print('Description: ' + cam.Description)
print('DriverInfo: ' + cam.DriverInfo)
print('DriverVersion: ' + cam.DriverVersion)
print('InterfaceVersion: ' + str(cam.InterfaceVersion))
print('Name: ' + cam.Name)

print('CameraState: ' + str(cam.CameraState))
print('PixelSizeX: ' + str(cam.PixelSizeX))
print('PixelSizeY: ' + str(cam.PixelSizeY))
print('CameraXSize: ' + str(cam.CameraXSize))
print('CameraYSize: ' + str(cam.CameraYSize))
print('NumX: ' + str(cam.NumX))
print('NumY: ' + str(cam.NumY))
print('StartX: ' + str(cam.StartX))
print('StartY: ' + str(cam.StartY))
print('BinX: ' + str(cam.BinX))
print('BinY: ' + str(cam.BinY))
print('MaxBinX: ' + str(cam.MaxBinX))
print('MaxBinY: ' + str(cam.MaxBinX))
print('CCDTemperature: ' + str(cam.CCDTemperature))
print('HeatSinkTemperature: ' + str(cam.HeatSinkTemperature))

print('CanAbortExposure: ' + str(cam.CanAbortExposure))
print('CanAsymmetricBin: ' + str(cam.CanAsymmetricBin))
print('CanGetCoolerPower: ' + str(cam.CanGetCoolerPower))
print('CanPulseGuide: ' + str(cam.CanPulseGuide))
print('CanSetCCDTemperature: ' + str(cam.CanSetCCDTemperature))
print('CanStopExposure: ' + str(cam.CanStopExposure))
print('CanFastReadout: ' + str(cam.CanFastReadout))
print('CoolerOn: ' + str(cam.CoolerOn))
print('CoolerPower: ' + str(cam.CoolerPower))
print('HasShutter: ' + str(cam.HasShutter))
print('ExposureMax: ' + str(cam.ExposureMax))
print('ExposureMin: ' + str(cam.ExposureMin))
```

The above code produces the following output:

```
Connecting to the camera...
Connected to the camera!
Description: ASCOM Camera Driver for FLI Kepler
DriverInfo: ASCOM Camera Driver for FLI Kepler. Version: 6.2
DriverVersion: 6.2
InterfaceVersion: 2
Name: FliPro
CameraState: 0
PixelSizeX: 11.0
PixelSizeY: 11.0
CameraXSize: 2048
CameraYSize: 2048
NumX: 2048
NumY: 2048
StartX: 0
StartY: 0
BinX: 1
BinY: 1
MaxBinX: 1
MaxBinY: 1
```

```
CCDTemperature: 20.0
HeatSinkTemperature: -59.9375
CanAbortExposure: True
CanAsymmetricBin: False
CanGetCoolerPower: True
CanPulseGuide: False
CanSetCCDTemperature: True
CanStopExposure: True
CanFastReadout: True
CoolerOn: False
CoolerPower: 16.0
HasShutter: True
ExposureMax: 3600.0
ExposureMin: 0.0
```

The camera readout modes can be obtained through the ASCOM **ReadoutModes** list:

```
try:
    # ASCOM only supports readout modes if CanFastReadout == False
    if not cam.CanFastReadout:
        print('ReadoutMode: ' + str(cam.ReadoutMode))
        print('ReadoutModes:')
        modes = cam.ReadoutModes
        for i in range(modes.Count):
            print('  #' + str(i) + ' ' + str(modes[i]))
except com_error as error:
    _, msg, exc, _ = error.args
    _, _, msg2, _, _, _ = exc
    print('Oops!  ' + msg + ' ' + msg2)
```

Some of the FLI Kepler camera parameters can be accessed through the ASCOM **SupportedActions** list.

```
actions = cam.SupportedActions
print('Actions: ' + str(actions.Count))
for i in range(actions.Count):
    print('  #' + str(i) + ' -> ' + actions[i])

# ASCOM function: string Action(string ActionName, string ActionParameters)
```

The above code produces the following output:

```
Actions: 20
  #0 -> SetShutter
  #1 -> SetMode
  #2 -> GetMode
  #3 -> GetModesList
  #4 -> GetLowGainTable
  #5 -> GetHighGainTable
  #6 -> SetLowGain
  #7 -> GetLowGain
  #8 -> SetHighGain
  #9 -> GetHighGain
  #10 -> SetBlackLevelLo
  #11 -> SetBlackLevelHi
  #12 -> GetBlackLevelLo
  #13 -> GetBlackLevelHi
  #14 -> SetBlackSunLo
  #15 -> SetBlackSunHi
  #16 -> GetBlackSunLo
  #17 -> GetBlackSunHi
  #18 -> SetFramePassChannel
  #19 -> GetFramePassChannel
```

For, example, the list of modes can be obtained by the following code:

```
modes = cam.Action(ASCOM_FLI_KEPLER_GET_MODESLIST, '')
print('Modes list: ')
print_table(modes, ', index=', ', name=')
print('Current Mode: ' + cam.Action(ASCOM_FLI_KEPLER_GET_MODE, ''))
print('Set Mode: res = ' + cam.Action(ASCOM_FLI_KEPLER_SET_MODE, str(0)))
# check the mode
print('Current Mode: ' + cam.Action(ASCOM_FLI_KEPLER_GET_MODE, ''))

# set to HDR mode
print('Set Mode: res = ' + cam.Action(ASCOM_FLI_KEPLER_SET_MODE, str(2)))
# check the mode again
print('Current Mode: ' + cam.Action(ASCOM_FLI_KEPLER_GET_MODE, ''))
```

with the following result:

```
Modes list:
  #0, index=0, name=Rolling LDR
  #1, index=1, name=Rolling LDR - LDC
  #2, index=2, name=Rolling HDR
  #3, index=3, name=Rolling HDR - LDC
```

For the camera gains:

```
# gains
low_gains = cam.Action(ASCOM_FLI_KEPLER_GET_LOWGAINTABLE, '')
high_gains = cam.Action(ASCOM_FLI_KEPLER_GET_HIGHGAINTABLE, '')
# print('Low Gain Table: ' + low_gains)
# print('High Gain Table: ' + high_gains)
# print tables
print('Low Gain Table:')
print_table(low_gains, ', index=', ', gain=')
print('High Gain Table:')
print_table(high_gains, ', index=', ', gain=')

try:
    # NOTE: in LDR modes settings High gain will throw an exception
    print('Low Gain: ' + cam.Action(ASCOM_FLI_KEPLER_GET_LOWGAIN, ''))
    print('High Gain: ' + cam.Action(ASCOM_FLI_KEPLER_GET_HIGHGAIN, ''))
    # set gains
    print('Low Gain: ' + cam.Action(ASCOM_FLI_KEPLER_SET_LOWGAIN, str(0)))
    print('High Gain: ' + cam.Action(ASCOM_FLI_KEPLER_SET_HIGHGAIN, str(0)))
    # check gains
    print('Low Gain: ' + cam.Action(ASCOM_FLI_KEPLER_GET_LOWGAIN, ''))
    print('High Gain: ' + cam.Action(ASCOM_FLI_KEPLER_GET_HIGHGAIN, ''))
    # set gains back
    print('Low Gain: ' + cam.Action(ASCOM_FLI_KEPLER_SET_LOWGAIN, str(2)))
    print('High Gain: ' + cam.Action(ASCOM_FLI_KEPLER_SET_HIGHGAIN, str(7)))
    # check gains
    print('Low Gain: ' + cam.Action(ASCOM_FLI_KEPLER_GET_LOWGAIN, ''))
    print('High Gain: ' + cam.Action(ASCOM_FLI_KEPLER_GET_HIGHGAIN, ''))
except com_error as error:
    _, msg, exc, _ = error.args
    _, _, msg2, _, _, _ = exc
    print('Oops!  ' + msg + ' ' + msg2)
```

With the following results:

```
Low Gain Table:
  #0, index=0, gain=0.66
  #1, index=4, gain=1.29
  #2, index=1, gain=1.85
  #3, index=2, gain=2.49
  #4, index=3, gain=3.68
  #5, index=5, gain=3.7
  #6, index=6, gain=4.95
  #7, index=7, gain=7.25
High Gain Table:
  #0, index=0, gain=0.66
  #1, index=4, gain=1.29
  #2, index=1, gain=1.85
  #3, index=2, gain=2.49
  #4, index=3, gain=3.68
  #5, index=5, gain=3.7
  #6, index=6, gain=4.95
  #7, index=7, gain=7.25
```

A single frame can be obtained from the camera using the following code:

```
# set the full frame
cam.NumX = cam.CameraXSize
cam.NumY = cam.CameraYSize

# start 1.0s light frame exposure
print('Acquire 1s bright image')
cam.StartExposure(1.0, True)

# wait for the frame to be ready
while not cam.ImageReady:
    print('No image yet...')
    time.sleep(0.2)

# get the camera image
buffer = cam.ImageArray
# print the very first pixel
print('First pixel: ' + str(buffer[0][0]))
```

At this point it is convenient to convert the image data into the NumPy array:

```
image = np.array(buffer)
```

The we can save the above data (4-bit integer numbers) into a file:

```
# make a file
newFile = open("image2.bin", "wb")
# write to the file
newFile.write(image)
```

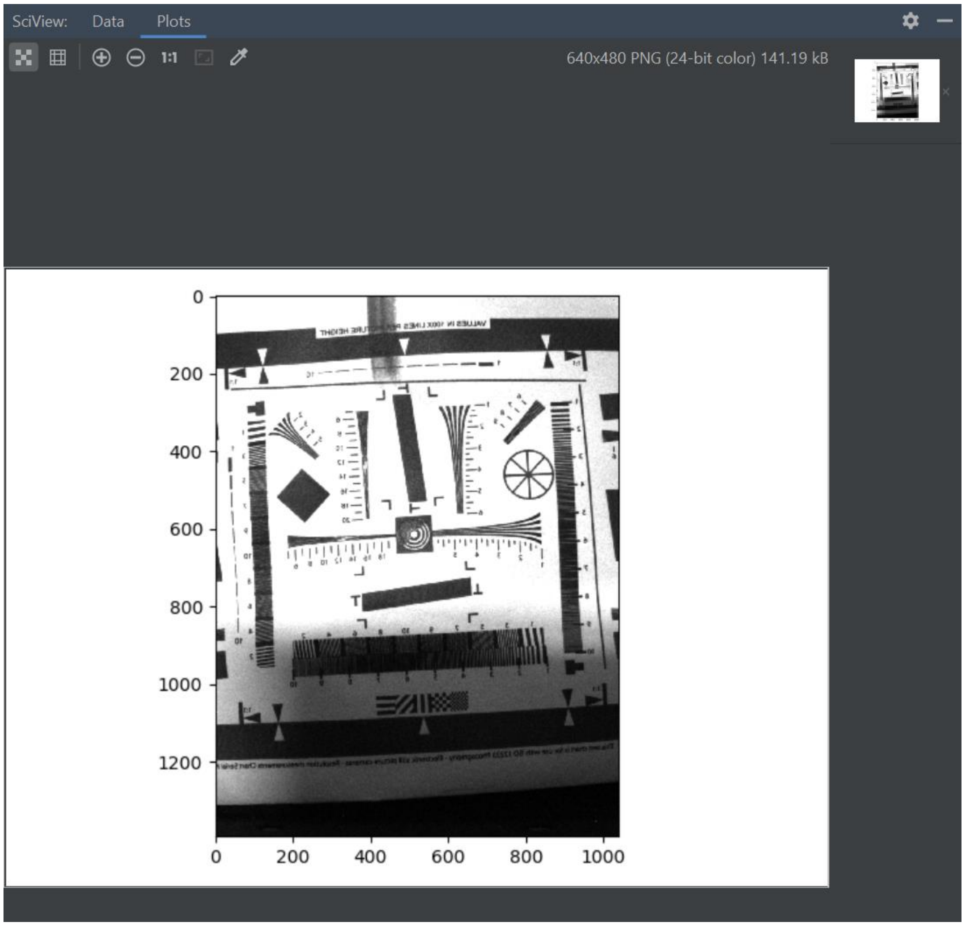
The NumPy array can be created as an unsigned 16-bit integer from the image buffer as:

```
image = np.array(buffer, dtype=np.uint16)
```

Alternatively, we can display the image:

```
plt.imshow(image, cmap='gray', vmin=0, vmax=4096)
plt.show()
```

In the **JetBrains © PyCharm** Python programming environment we can see the image directly in the **SciView** tab:



Actions description

The following table describes all the names and parameters that ASCOM Action function accepts as arguments:

Action name	Action parameter	Description
SetShutter	‘open’ / ‘close’	Opens/Closes the shutter
SetMode	0 … N–1	Sets the mode (N – number of modes in the table returned by **GetModesList**)
GetMode		Gets the current mode
GetModesList		Gets the modes list as a multiline string. Each line has the format of: *<mode name>*;*<mode index>*
GetLowGainTable		Gets the modes list as a multiline string. Each line has the format of: *<gain value>*;*<gain index>*
GetHighGainTable		Same as Low gain table
SetLowGain	0 … N–1	Sets low gain index (N – number of gains in the table returned by **GetLowGainTable**)
GetLowGain		Gets low gain index
SetHighGain	0 … N–1	Sets high gain index (N – number of gains in the table returned by **GetHighGainTable**)
GetHighGain		Gets high gain index
SetBlackLevelLo	0 … 16383	Set the low Black Level
SetBlackLevelHi	0 … 16383	Set the high Black Level
GetBlackLevelLo		Get the low Black Level
GetBlackLevelHi		Get the high Black Level
SetBlackSunLo	0 … 63	Set the low Black Sun
SetBlackSunHi	0 … 63	Set the high Black Sun
GetBlackSunLo		Get the low Black Sun
GetBlackSunHi		Get the high Black Sun
SetFramePassChannel	0 – low, 1 – high, 2 – merged	Set the frame pass channel type
GetFramePassChannel		Get the frame pass channel type