NeutronOptics FLIR (Point Grey) Camera Operation

NeutronOptics x-ray or neutron cameras can be supplied with an optional FLIR (Point Grey) IMX249 CMOS or similar detector when high frame rates are required (up to 41 fps). The normal maximum exposure of the IMX249 detector with USB3 is 4 seconds (32 seconds for the GigE version); CMOS dark current noise is higher requiring shorter exposures, but SharpCap can reduce these limitations.

The IMX249 is a slower frame-rate version of the IMX174, and currently the best Sony CMOS detector for low-light imaging. It is a relatively large sensor, with big pixels favouring light capture, with high Quantum Efficiency (QE) The USB3 camera is powered by a USB cable up to 25m long, and the GigE version by a PoE GigE cable. Note the optional cooling fins on the FLIR camera to limit temperature (and dark current) by air cooling, and the carbon fibre window for the x-ray version..

- **Sensor Type:** Pregius CMOS IMX249
- **Resolution:** 1920 x 1200
- **Image size:** 11.25x7.03 mm (Type 1/1.2")
- **Pixel Size:** 5.86 x 5.86 µm
- **Quantum Efficiency:** ~80%
- **Full well capacity:** >30,000 electrons
- **A/D Readout:** 12 bit scaled to 16-bit
- **Readout Noise:** ~7 e-
- **Dark current** (~1 e-/pixel/sec @ 45°C)
- **Peltier Cooling:** uncooled
- **Frame Rate:** 41 fps with <5m USB3
- **Binning:** Software binning post capture
- **Mount:** C-mount
- **Trigger Signals:** Software trigger
- **Interface:** USB 3.1 or PoE GigE
- **Power:** power over USB or ethernet
- **Maximum Exposure Length:** 4s or 32s
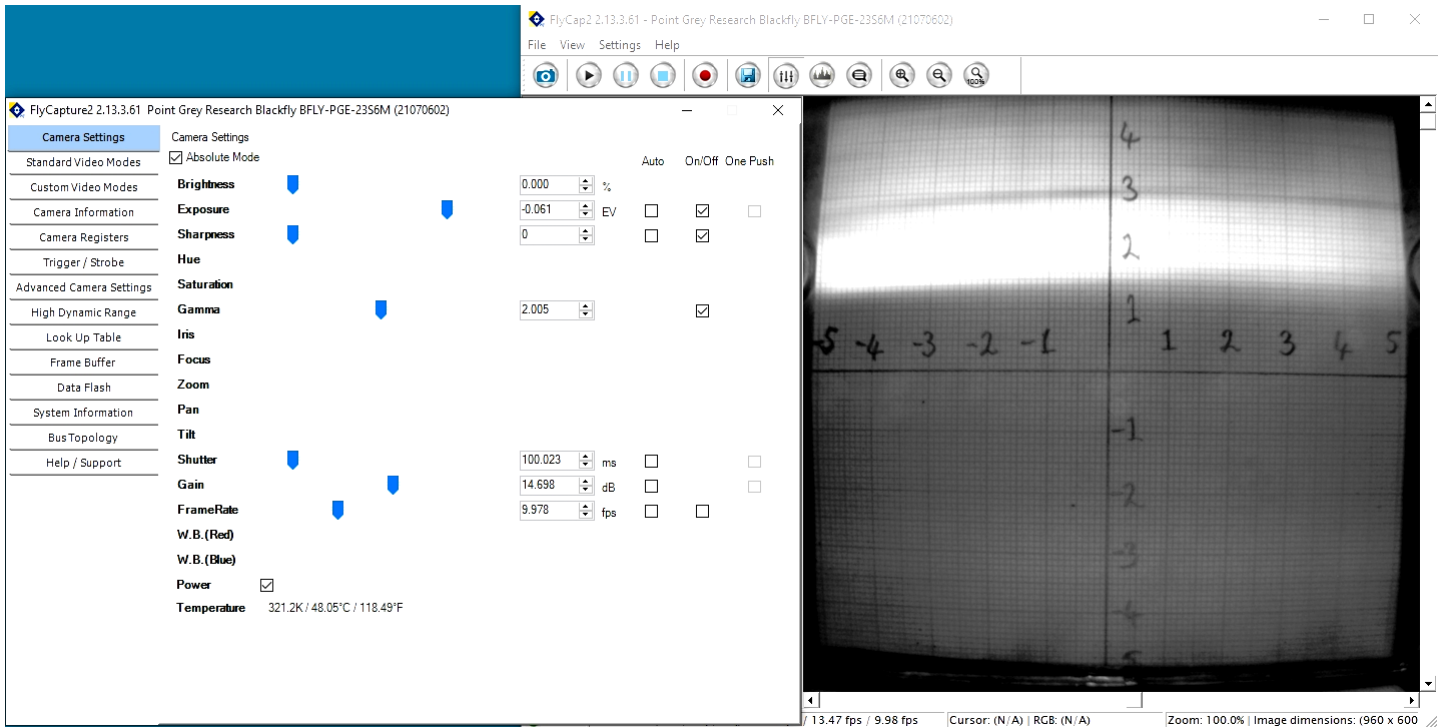- **SDK:** FLIR FlyCapture C++ SDK

* **Very high frame rates (41 fps) are only possible with short USB3 cables (5.0m)**.
But rates of 9 fps (IMX249) can be obtained even with 10+ metre amplified USB2 extension cables.

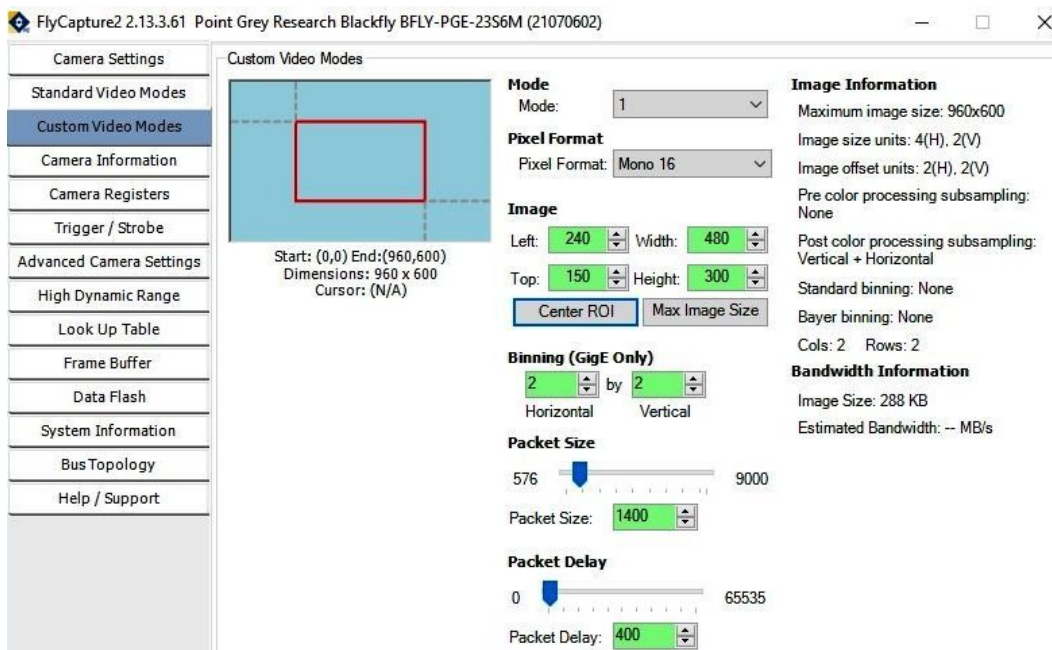## Install the Driver and FlyCapture software

- Click on the **FlyCap2Viewer** from the DVD (The 32-bit x86 version is more compatible)
- **FlyCap2Viewer** installs camera drivers for USB and/or GigE cameras
- You can optionally assign a FLIR ethernet camera to a static persistent IP number
- Assign a static IP number if you also use the computer for internet, or if you have other problems

FLIR Point Grey FlyCap2 for Camera Control and Acquisition

FlyCap2 was designed for high frame rate and video capture in daylight and contains additional features you won't need for slower x-ray or neutron imaging. The camera will be automatically recognised when plugged in. FlyCap2 is designed to control multiple cameras simultaneously. A window will open displaying the image using default exposure, gain etc. as shown to the left below.
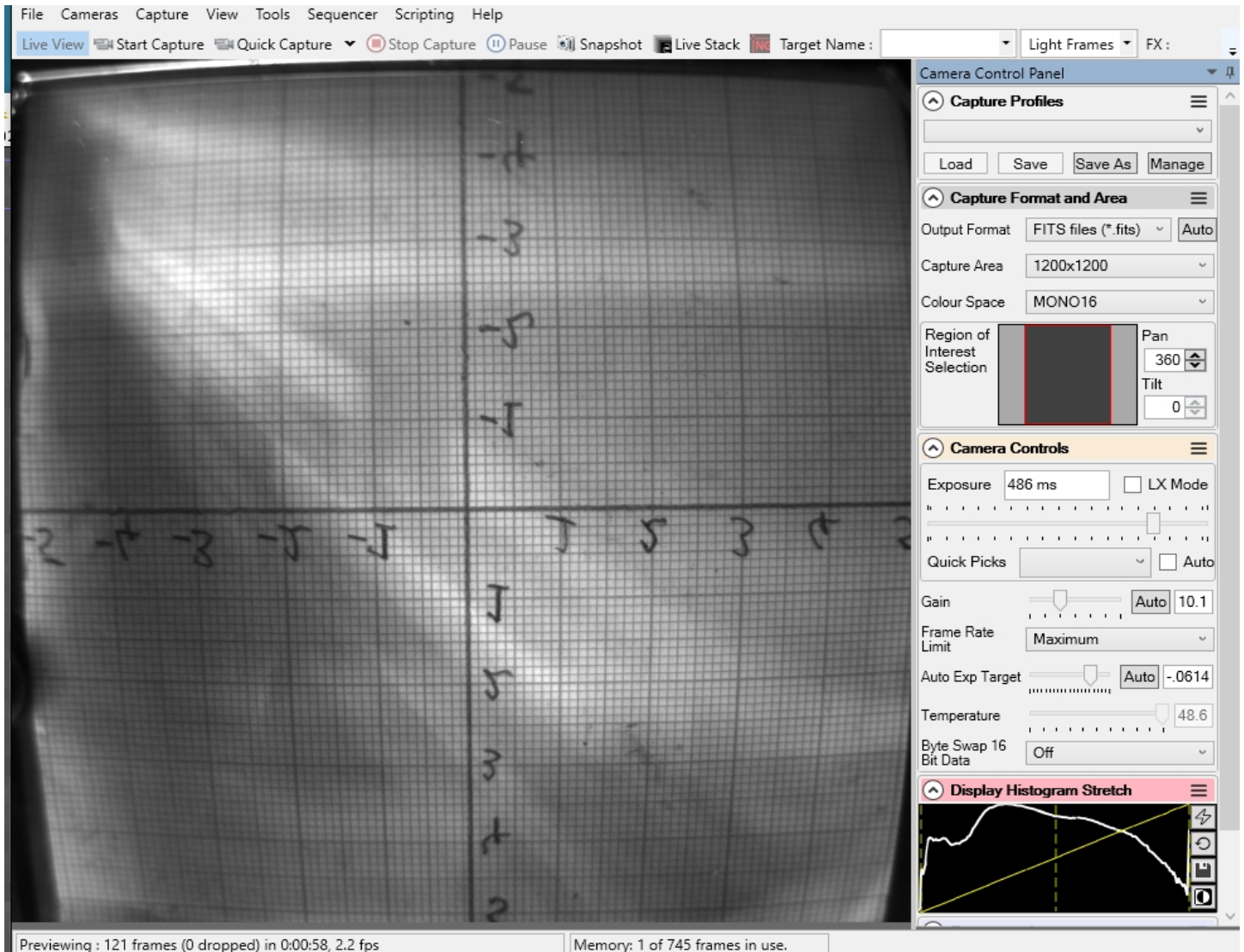

To change these, click the "**Settings**" menu and "**Toggle Camera Control Dialogue**" to open the control window (insert above). Uncheck **Shutter, Gain** and **FrameRate**. Also switch the **FrameRate "Off"**. You can now increase the Shutter (Exposure) to a maximum of 4 seconds (USB model). You can increase the **gain** from **"0.0"** but this will also increase noise in the image. Increasing the **Intensity**, **Exposure**, **Sharpness** and **Gamma** only changes the display, not the saved image.

In the Settings window, click on "**Custom Video Modes**" and select "**Mode 1**" and **"Mono16"** rather than **"Mode 0"** with **"Mono8"**. You can restrict the image to a **"region of interest"** to increase frame rate. You can only apply "**binning**" to increase intensity at the expense of resolution if you have a GigE camera, but you can do binning off-line in imageJ. **Binning of 2x2** is recommended with this high resolution detector. Finally, In "**Settings/Advanced Camera Settings**" toggle "**Mirror Image**".

Recommended SharpCap Viewer

Instead of FlyCap, you can use SharpCap4 (also on the DVD), which was designed for low-light imaging by amateur astronomers, with more complete controls, including many you will not need for x-ray or neutron imaging. Prefer the 32-bit version for compatibility. You must **first install and run FlyCap2** (above) to install the drivers and **set Mono16** and eventually binning with the GigE camera. The camera will be automatically recognised if it is plugged in, and you just need to choose it from the "Cameras" menu. A window will open with the image and camera controls on the right. You can arrange the order of controls by dragging the 3-line icon. An exhaustive SharpCap User Manual is available, but the instructions below may be sufficient to start with.
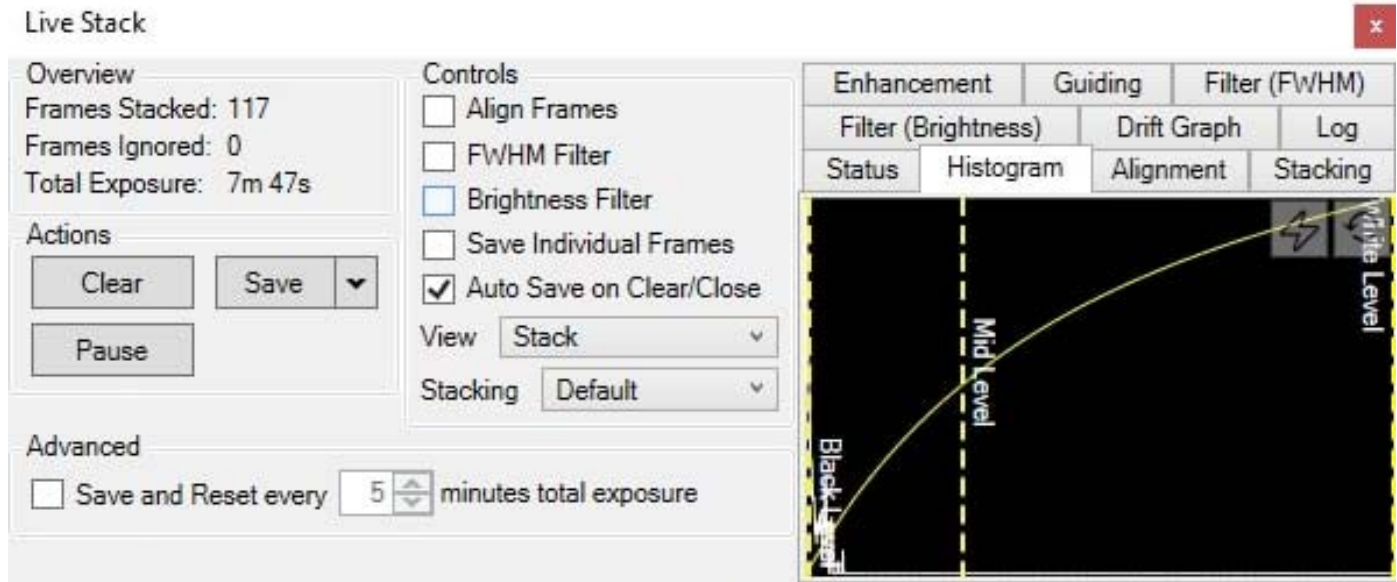

Zoom the image with Ctrl-mouse-scroll or the zoom selection at the top right. Set **"Capture Format"** to TIFF or FITS, Capture Area e.g.1200x1200, and Mono16. In the **"Camera Controls"** set the Exposure (toggle LX mode for long exposures), set the Gain to zero (or increase it, at the expense of noise) and read the sensor temperature. Toggle **Byte Swap OFF** (or ON) to obtain a curve in the Display Histogram. The top rightmost icon allows you to use Edge Detection and other focussing aids. You can drag the vertical line in the **"Display Histogram"** to stretch the intensity display to emphasise lower intensities. Focussing may be best when the Display Histogram curve maximises.

Click "**Snapshot**" to save a single image frame, or "**Livestack**" to sum several (see below)..

In menu **"File/Settings"** check auto connect and restore, and format AVI and FITS. Choose where and how files are saved. **Tip:** set a **"Default Profile"** to open with those settings on start-up.
The camera settings are in a hidden file called **_autosave (camera name).ini** which can be found in:
C:\Users\<your windows user name>\AppData\Roaming\SharpCap\CaptureProfiles
You can delete this file and it will be created again next time you exit SharpCap

Stacking short exposures in SharpCap

An interesting feature of SharpCap is real-time stacking of a series of short exposures. This allows you to judge when you have sufficient intensity (and to overcome the maximum exposure limit of the FLIR camera). Click on the **"Live Stack"** icon above the image display to open this stacking window. You can drag this window so that it does not cover the image. Switch off **"Align Frames"** which refers to alignment based on stars. Most of the controls to the right are also for astronomers; only the live histogram is useful, but normally you might save the summed stack as a 32-bit image and filter noise from it with imageJ.

You can also use imageJ to stack a series of short exposures, which allows filtering of noise from the individual images before averaging. For very short exposures this may be better than averaging first and then filtering. Use the SharpCap menu **Capture/Start_Capture** then enter the number of images to be saved. After capturing those images, use the ImageJ menu **File/Import/Image_Sequence**, open the first image, and then OK to import all images in that directory into a displayed stack. Use **Image/Adjust/Brightness-Contrast** to examine the noise, and apply **Process/Noise/De-speckle** to all images. You may need to **De-speckle** twice. Finally sum or average the stack using **Image/Stacks/Z-Projection**.

For long stacked exposures you may see a diffuse background patch due to amplifier glow. Depending on the speed of your computer, frames may be dropped for frame rates >8 fps.

FireCapture Imaging Software

FireCapture is another image capture application developed for amateur astronomy that you might also use for neutron and x-ray imaging with our FLIR (Point Grey) camera. FLIR has not yet developed an ASCOM driver for their cameras.

Hints on getting Optimal Performance

- The center of the image will not correspond exactly to the centre of the window
- Use a capture area of e.g. 1200x1200 if you have a square FOV e.g. 100x100mm
- The exposure time depends of course on the intensity of your beam
- Exposure time and frame rate can be controlled separately for short exposures
- Use "Process/Noise/De-speckle" in ImageJ to remove noisy pixels from saved files

For the latest information, please check our web site http://neutronoptics.com/software.html