



## NeutronOptics Basler Ace Camera Operation

NeutronOptics x-ray or neutron cameras can be supplied with an optional BASLER Ace [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 BASLER 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  $\mu\text{m}$
- **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 POI ethernet
- **Maximum Exposure Length:** 4s or 32s
- **SDK:** BASLER Pylon C++ SDK

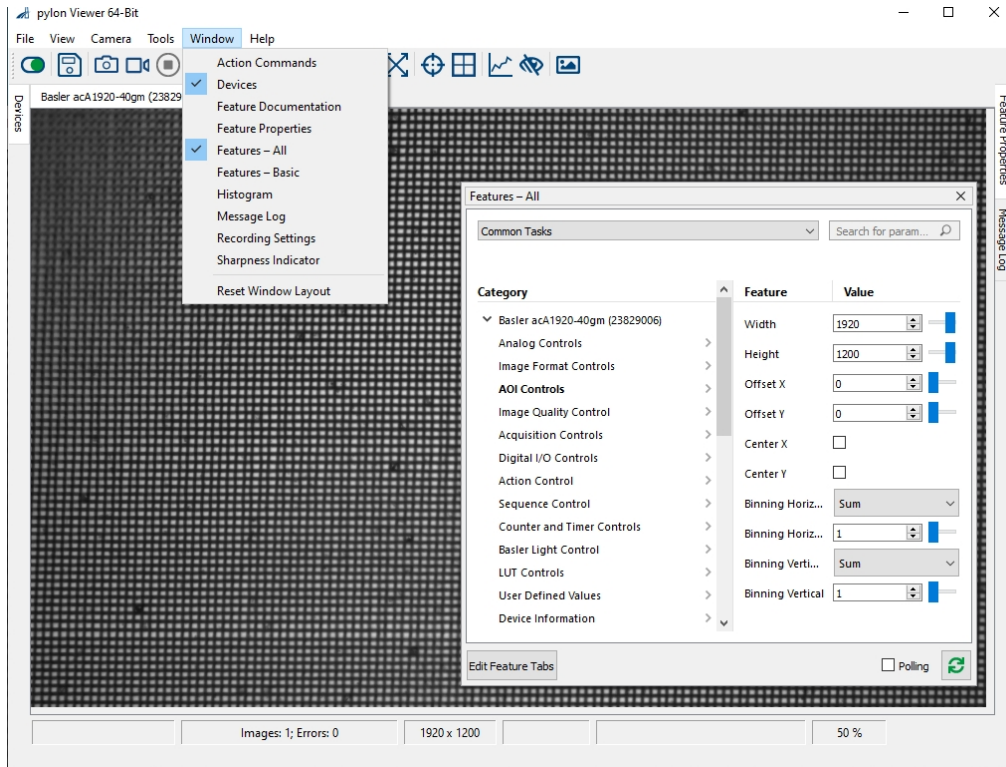
\* **Very high frame rates (41 fps) are only possible with short USB3 cables (5.0m).**  
 But rates of 9 fps (IMX249) can be obtained even with 10+ metre amplified USB2 extension cables.

### Install Pylon6.1.1 with the Basler Camera Driver

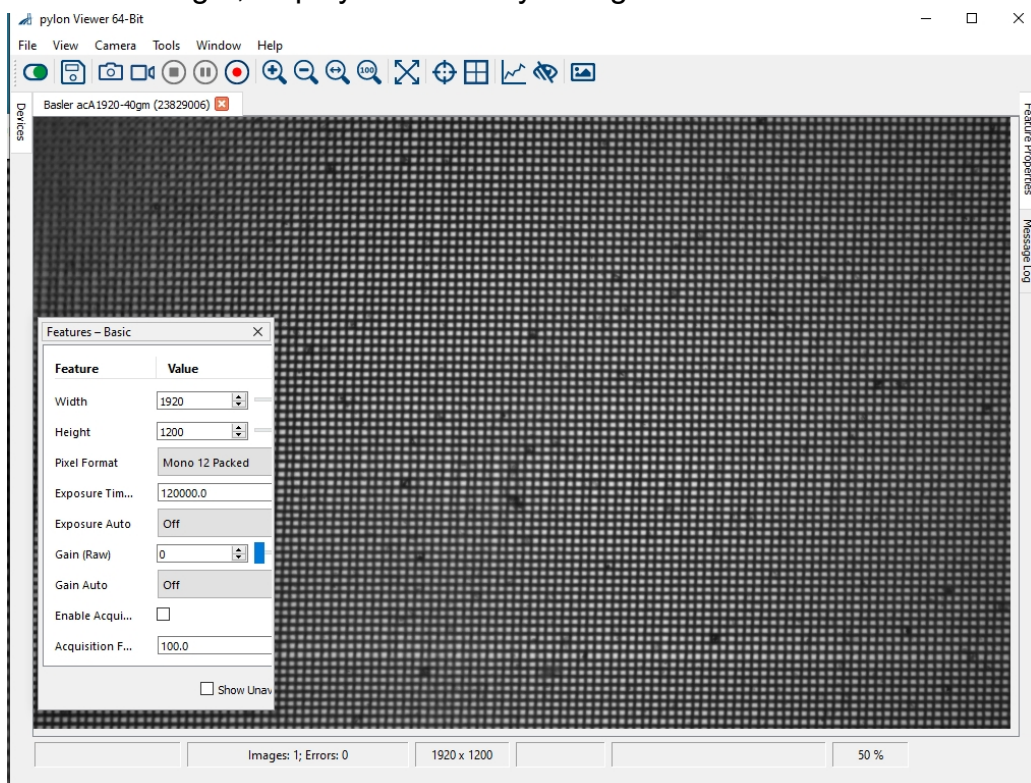
- Download the [pylon 6.1.1](#) Camera Software Suite for Windows (or other systems).
- Click on the installer and choose the "Developer" option then "USB" and/or "GigE".
- More recent versions than 6.1.1 are not compatible with the SharpCap viewer.
- Installing the Pylon Viewer also installs camera drivers for USB and/or GigE cameras

# BASLER Pylon Viewer for Camera Control

The [Pylon Viewer](#) was designed for high frame rate video capture and contains additional features you won't need for slower x-ray or neutron imaging. The camera will be automatically recognised when plugged in. A window will open displaying menus for devices and features; more are available under the "Window" menu. Double-click on the camera in the "Devices" window and set its properties in the "Features" window. Click on the fourth video icon in the header to start a stream of images.

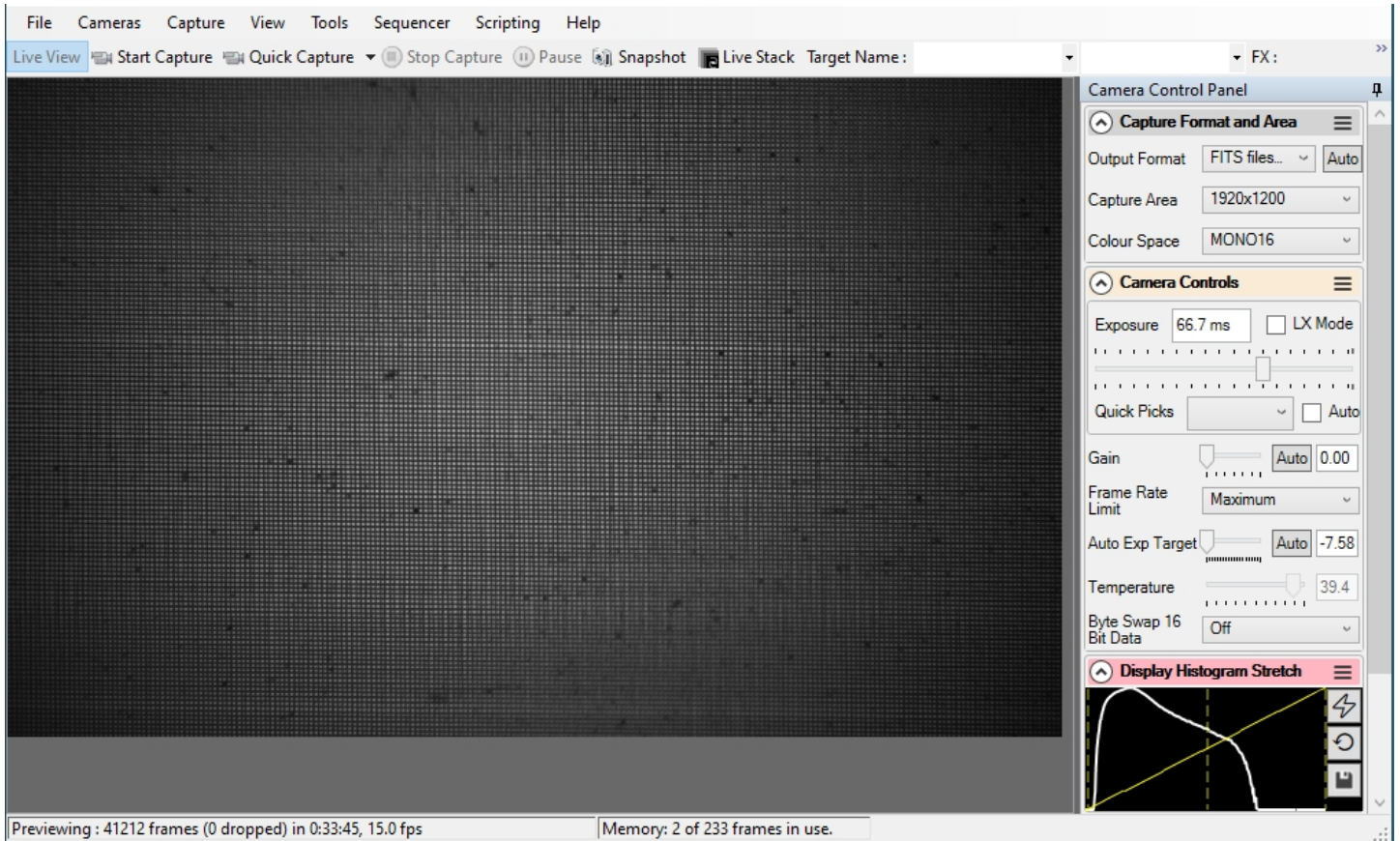


Prefer the "Features-Basic" window (below), which contains all that you will need except possibly "Binning". In particular you can change the region of interest "Width" and "Height", the pixel format (Mono12 packed is best or Mono8 for maximum frame rate), and most importantly the "Exposure Time" (in microseconds). Using "Gain" will increase image brightness, but reduce signal/noise ratio. The icons along the top of the Pylon window represent "On", "Save", Image", "Video" "Stop", "Pause", "Record", "Magnify", "De-magnify" etc. The Cross arrows display the full image, and the remaining icons add a crosshair or target, display the intensity histogram etc. Hover over the icons for details.



## 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 Pylon6.1.1** (above) to install the drivers 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.



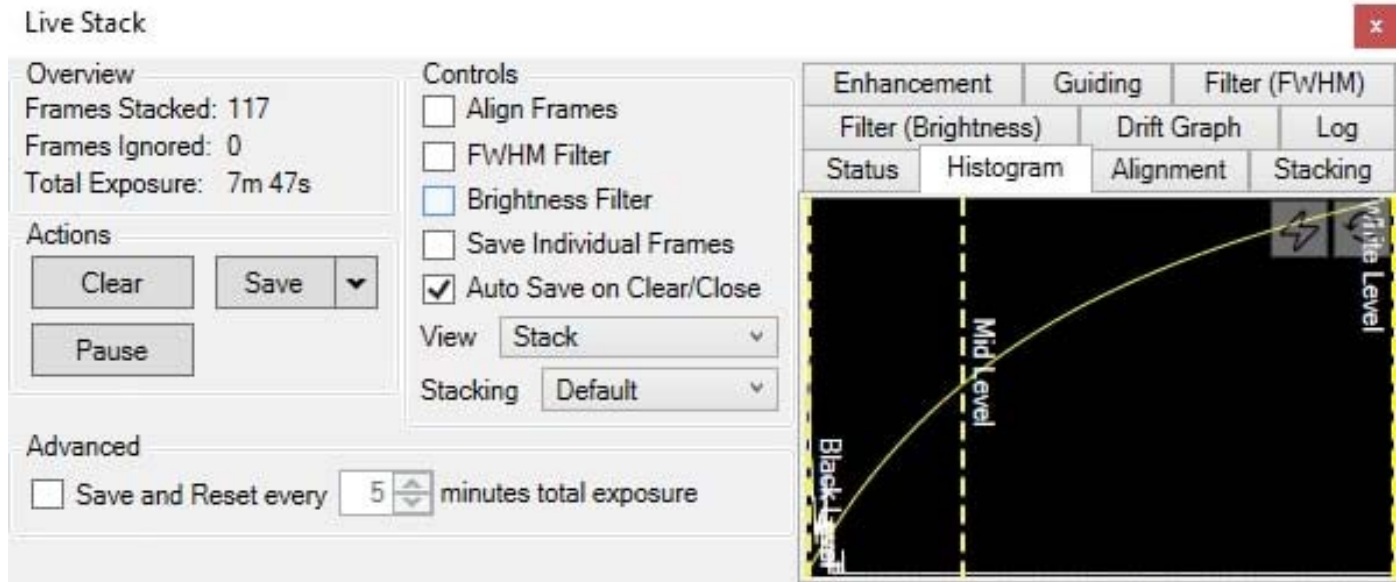
Zoom the image with Ctrl-mouse-scroll or the zoom selection at the top right. Set "**Capture Format**" to TIFF or FITS, Capture Area, and Mono16. In the "**Camera Controls**" set the Exposure (toggle LX mode for long exposures), set the Gain to zero (or increase it, at the expense of noise) and read 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**" (insert) 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 may not correspond to the centre of the window
- because the CCD chip is not centred to better than 0.5mm in its housing
- 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>