



## The Slim Lodestar or Ultrastar USB CCD Option

NeutronOptics x-ray or neutron cameras can be supplied with an optional slim CCD unit, with either 752x580 (lodestar) or 1392x1040 (ultrastar) pixels. The slim CCD has far higher 16-bit intensity resolution compared to only 8-bits from the original "video" CCD. This CCD unit cannot be Peltier cooled, and is connected to a Windows computer via a single USB-2 cable used both to [control the camera](#) and collect the image. Amplified 10m cable extensions can be supplied.

The [mini i-Cam](#) is the simplest form of this camera. The following instructions apply, but first remove the O-ring holding the carbon window and scintillators to check the focus of the camera using the focussing grid with ambient light. Select one scintillator and cover it with the C-window and O-ring. Thinner scintillators give higher resolution but lower intensity: the neutron scintillator is yellow.



- **Sensor Type:** Interline EXView [ICX829ALA](#) or [ICX825ALA](#)
- **Image size:** Diagonal 8 mm (Type 1/2") or 11 mm (type 2/3")
- **Resolution:** 752 x 580 or 1392x1040
- **Pixel Size:** 8.6 x 8.3  $\mu\text{m}$  or 6.45 x 6.45  $\mu\text{m}$

### Common features:

- **Binning:** from 2x2 to 8x8 (improved intensity & read-out )
- **High sensitivity** (QE>75% at 500-600nm), low smear
- **Low dark current** (<0.1 e/s ambient), anti-blooming
- **Full well capacity:** >50,000 electrons (dynamic range)
- **ADC:** 16 bit grey scale, optional filtering and distortion
- **Readout Noise:** 10 e- typical
- **Readout Time:** ~0.15s
- **Interface:** USB 2.0 High Speed with 10-20m USB cables
- **Power:** 12v DC 0.8A, for EU, UK, US/Japan, AU/CN
- **Maximum Exposure Length:** Unlimited
- **CCD Unit:** 32mm diameter, 72mm height, 50g weight
- **Lens Coupling:** CS-mount
- **SDK:** C++, VB Wrapper, .net Wrapper, ImageJ, LabView

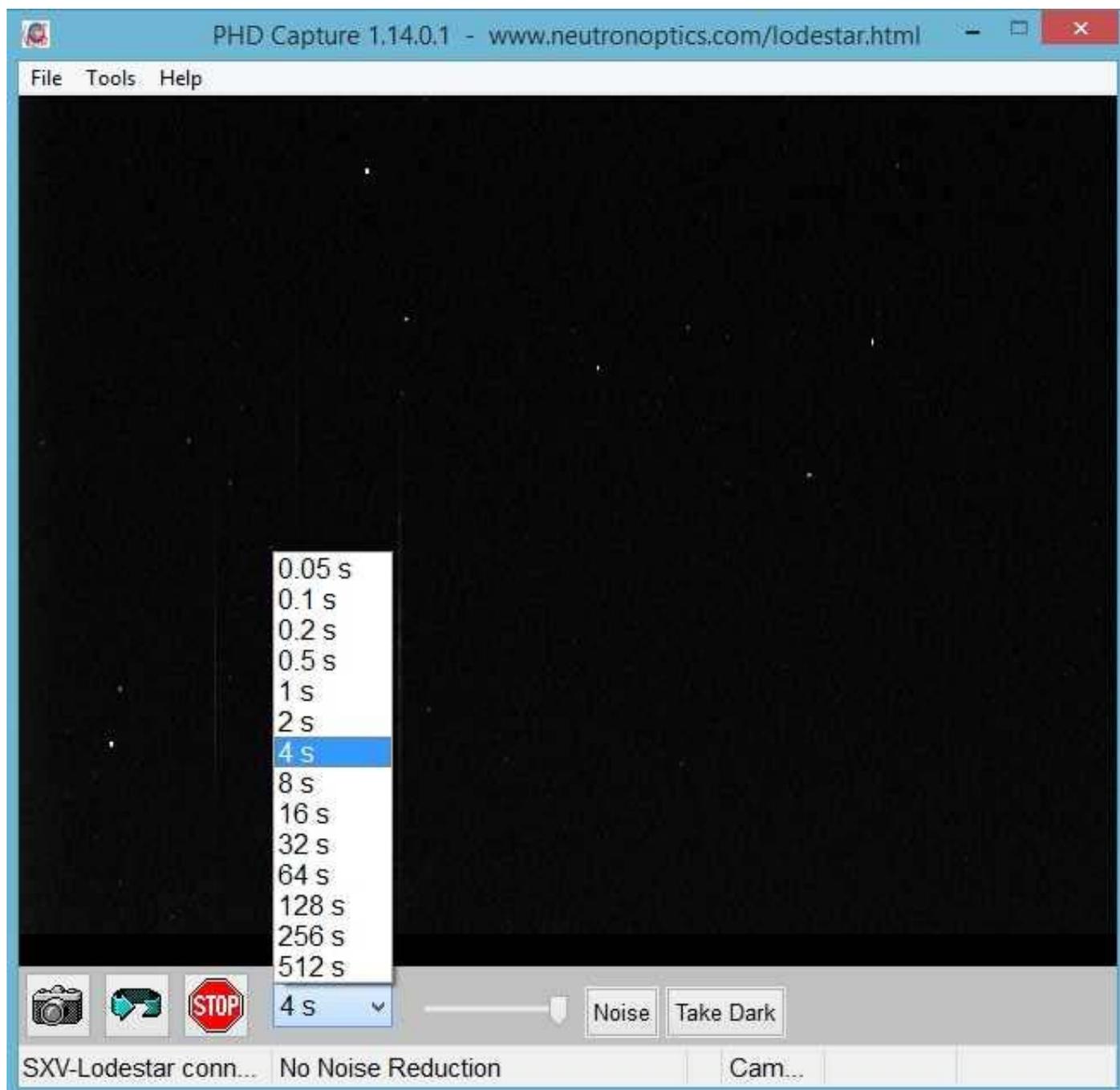
## Install the Driver and Artemis Capture software

1. Browse the CD & launch "Install Drivers.exe" for your 32-bit or 64-bit system
2. Connect the camera to a USB port on your computer
3. The computer should automatically search for and install the driver
4. The Windows Device Manager should now show a Starlight Xpress CCD

## PHD for Simple Real-time Imaging with the Slim Lodestar USB Camera

If you just want to see your sample in the beam, with cyclic exposures of from 0.05s to 512s, you can install this simple free application for which you just click the Loop/Stop buttons after selecting the camera. The 16-bit image is updated in real time, and you can save it then open it with [ImageJ](#) to remove noisy pixels and enhance it in other ways.

- Download and install the free [PHD Guiding](#) application.
- Download our [custom PHD.exe](#) to overwrite PHD.exe in the PHDGuiding folder.
- Launch our custom PHD.exe to display the image and controls.



- Click the camera icon and select the SXV Lodestar Slim CCD camera
- Click the LOOP icon to start exposing for the selected time
- Click STOP to stop the loop at the end of the current acquisition (wait for it)
- File/Save Image saves the 16-bit image
- The slider changes display contrast
- Try the 3x3 median Noise filter
- Try Take Dark background subtraction
- Open the saved images using ImageJ

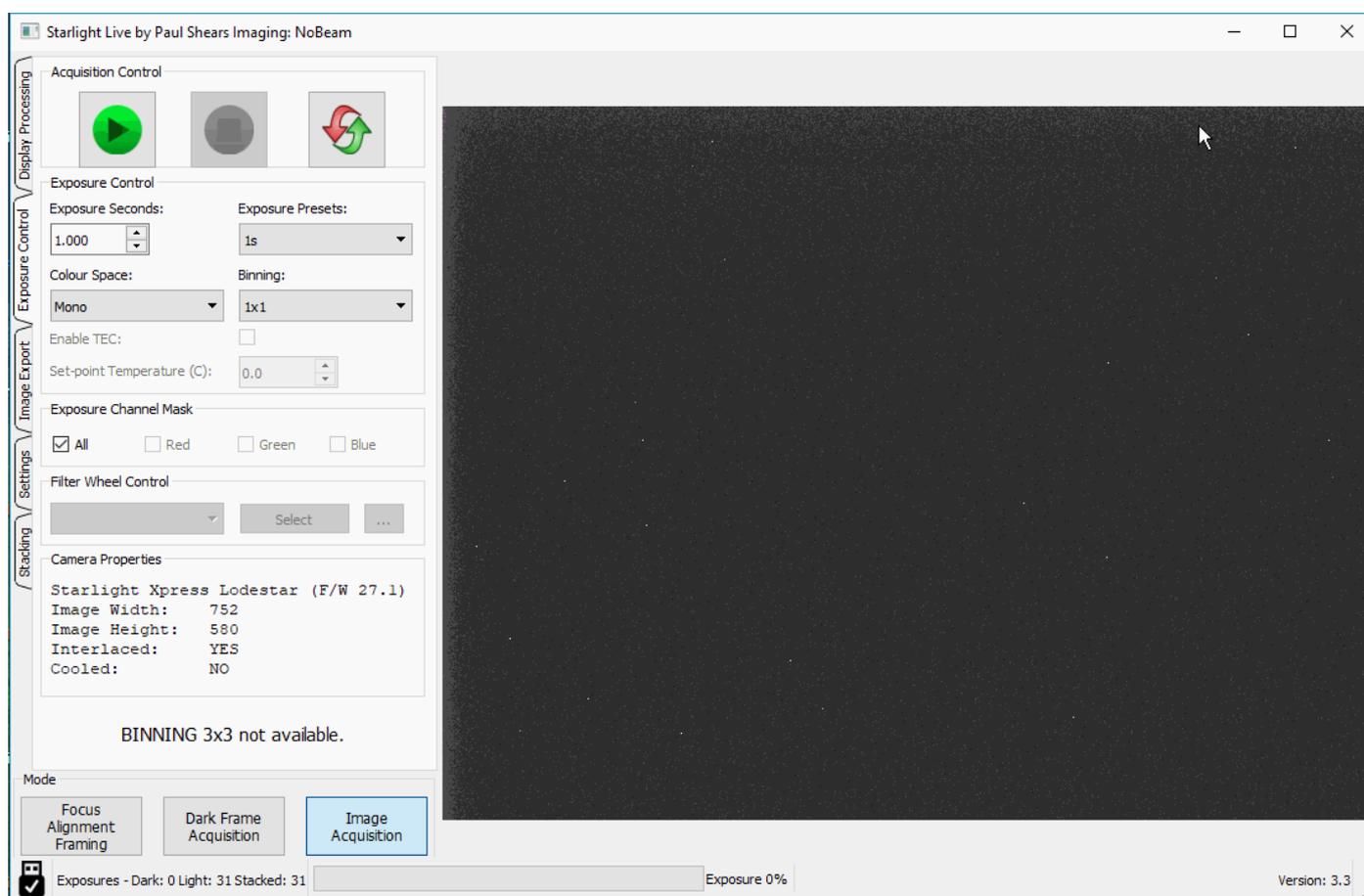
Use the [ASCOM](#) driver for sharper images, better noise reduction, and hardware binning, which will increase intensity at the expense of resolution. You should also install the [ASCOM Platform 6](#) environment. The ASCOM driver is installed in C:\Program Files\Common Files\ASCOM\Camera and you can use *Control Panel/Programs* or the *ASCOM Profile Explorer* to remove it.

In the ASCOM camera chooser, select "Starlight Xpress Lodestar or Ultrastar Guider", click on "Properties" and un-select all options. Click on "Noise" to filter out hot pixels (see Hints below).

## Starlight Live Image Capture with the Slim USB Camera

Starlight Live automatically collects a series of images, and can sum them in real time. The 16-bit images can be opened with [ImageJ](#) to remove noisy pixels and de-interlace.

- Download and install the [Starlight Live](#) camera capture application.
- For Macintosh systems, use the [OSX version](#) of Starlight Live.
- Launch Starlight Live to automatically connect to the Lodestar/Ultrastar camera.

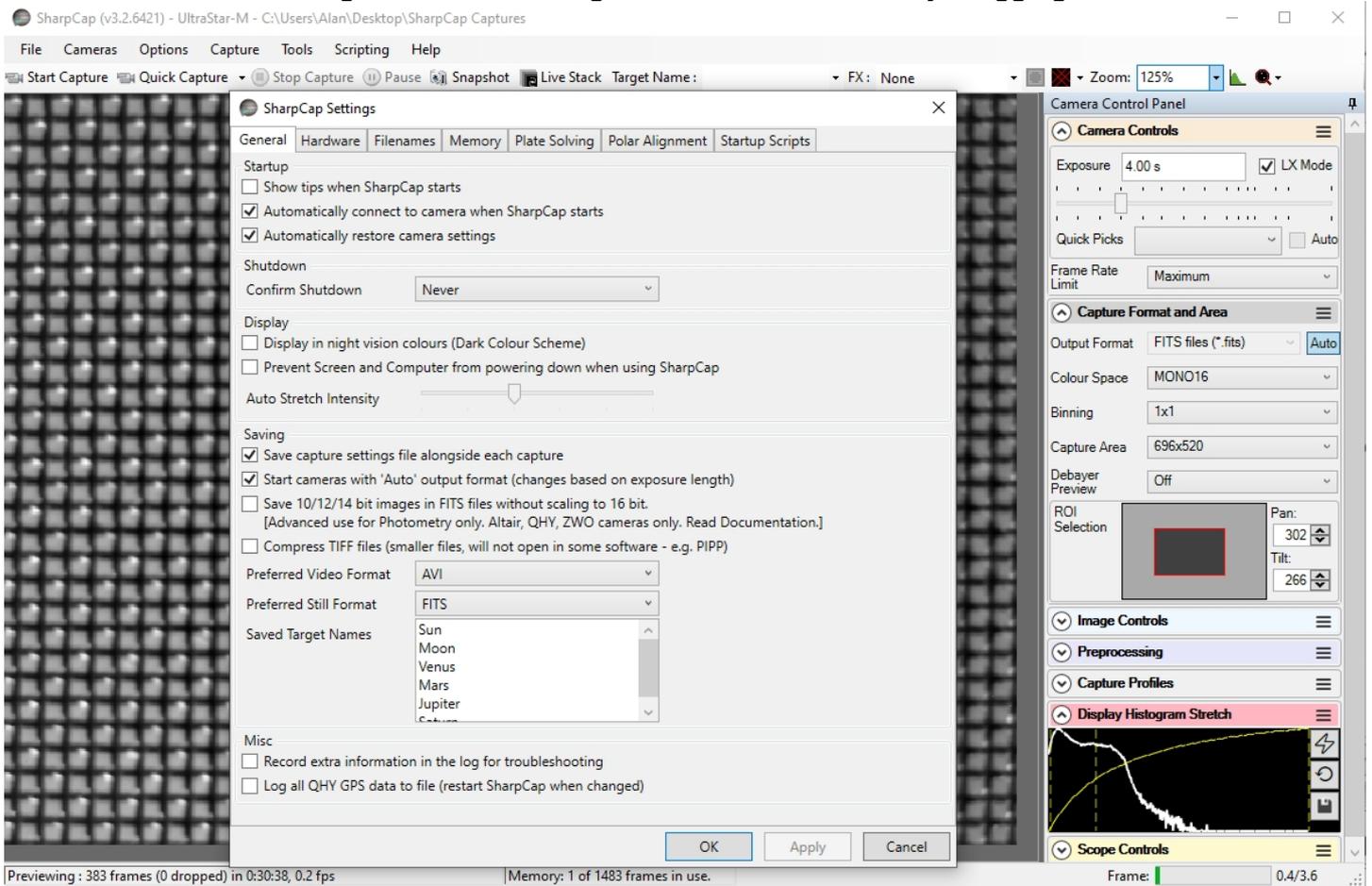


- The **Exposure Control** tab enters the **Exposure in Seconds**  
The **Green/Red buttons** Start/Stop a series of images. The **Arrow button** resets
- The **Stacking** tab sums the images live  
Set **Max Pixel Displacement = 0** (this is useful only for astronomical imaging)  
Set **Filter to Median 3x3** to filter out noise (or filter noise later with imageJ).
- In the **Display** tab; bracket the intensity between the **Dark and White Levels**).
- The **Image Export** tab is used to save FITS images

Real time stacking of a series of short exposures is an important advantage of Starlight Live. It allows you to see the intensity accumulating with time, and judge when to stop the exposure.

# SharpCap 3.2 Camera Control and Acquisition

[SharpCap](#) 3.2 was also designed for amateur astronomers and contains additional features that you will not need for x-ray or neutron imaging. 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.

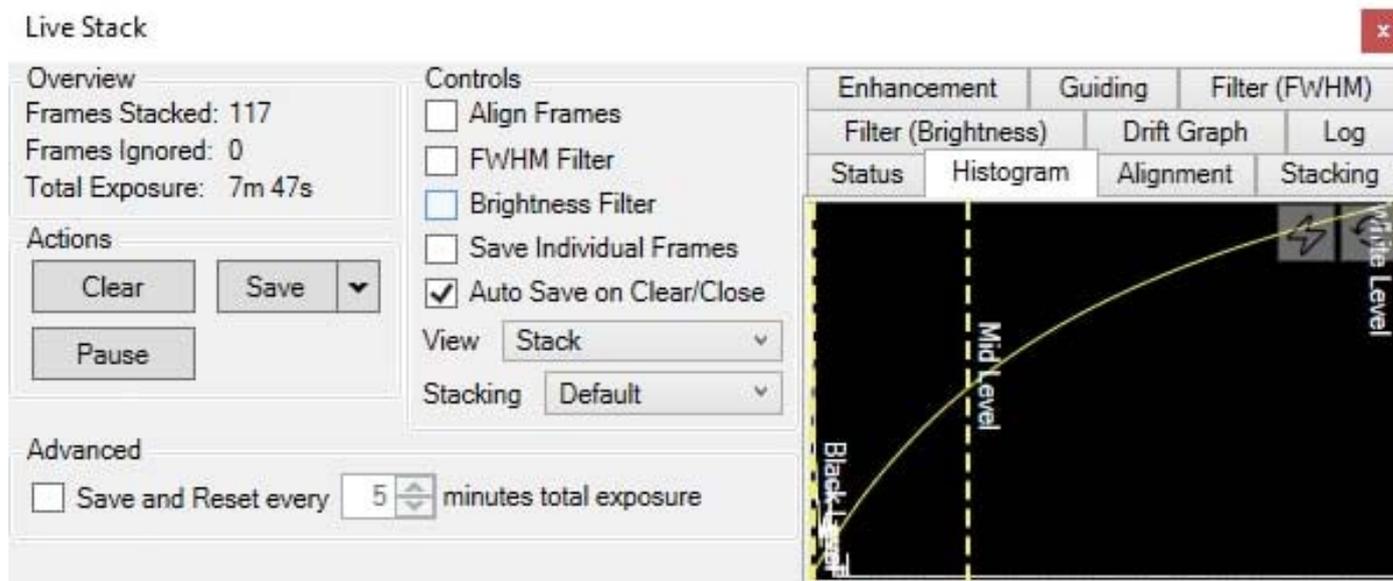


In the Camera Controls you can set the Exposure (toggle LX mode for long exposures), the Gain (higher gains also increase noise) and you can read the sensor temperature. In the **Capture Format**, select TIFF or FITS and Mono16. To speed up readout, select a reduced **Capture Area**, and drag the rectangle to the **Region of Interest**. You can also drag the vertical line in the **Display Histogram** to stretch the intensity display.

## Stacking short exposures in SharpCap 3.2

An important advantage of SharpCap is real-time stacking of a series of short exposures, which allows you to judge when you have accumulated sufficient intensity. 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 point stars. Most of the controls to the right are also for astronomers; only the live histogram is useful, but normally you would 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.



## ASCOM Camera Control and Treatment with ImageJ

[ImageJ](#) is recommended for image analysis. ImageJ will open the raw [FITS](#) files, then remove noise, modify contrast and other properties, and save them in various formats. More importantly, it will allow you to measure intensity profiles and display your data in ways that will make it more meaningful.

If you install the [ASCOM Platform 6](#) environment, and the [sxASCOM camera driver](#), you can control the camera directly using [ImageJ for ASCOM](#). This has advantages in that sequentially acquired images, eg for tomography, are opened directly in ImageJ.

You can even [simultaneously acquire images from two cameras](#) and stitch them together.

When installing the [sxASCOM camera driver](#), choose to install a "Starlight Xpress Standalone Guide Camera", then choose a "Starlight Xpress LodeStar Guide Camera" (or Ultrastar). There is no need to install ASCOM drivers for the other cameras.

After choosing the "Starlight Xpress LodeStar/Ultrastar" Guider" in the [ASCOM chooser](#), click "Properties" and unselect every option, but choose "Double Exposure Short".

## Hints on getting Optimal Performance

- The exposure time depends of course on the intensity of your beam
- 2x2 binning will give x4 the intensity and faster readout, but halve resolution
- Use the "Process/Noise/De-speckle" filter in [ImageJ](#) to remove noisy pixels
- The slim Lodestar (not Ultrastar) CCD is interlaced to obtain very fast readout
- If this appears to be a problem, try the [ImageJ](#) de-interlace filter
- Copy the [de-interlace](#) filter [Deinterlace .class](#) to ImageJ\plugins & apply it
- But de-speckle the raw image first, before de-interlacing or blurring
- "Gaussian blur" from Options/Execute makes it difficult to remove noisy pixels
- The center of the image doesn't correspond to the centre of the window because the CCD chip is not centred to better than 0.5mm in its housing

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

## The mini-iCam Neutron or X-ray camera

The scintillator and carbon fibre window can easily be exchanged, depending on whether x-rays or neutrons are to be imaged. Either a Pb-glass plate protects the CCD from radiation damage in the straight-through configuration, or a 90-degree mirror takes the CCD out of the direct beam.

**Do not expose the CCD to radiation.** Use the wire grid to adjust focussing if necessary.

The individual parts can be unscrewed. **The lens is fragile**, so hold it at its base to unscrew from the mirror, but at its top to unscrew from CCD. **Do not force any of the screws.** Thin x-ray scintillators give higher resolution but less intensity; the black coated x-ray scintillator has the highest resolution. **The yellow neutron scintillator (if supplied) is fragile.**

