SAC8 Peltier Cooled B&W Astro-Camera

by Suk Lee click to email author

The Ultimate Hot-Rodded Webcam?

Well, webcam fans, this is probably the ultimate hot-rodded webcam. The SAC8 is the top-of-the-line astrocamera from SAC-Imaging, and features an aluminum body, active Peltier cooling and very high claimed sensitivity.

Unlike the previously reviewed SAC7, the SAC8 is a black and white camera and comes bundled with the same software suite of COAA AstroVideo and FitsX. We've already seen that the non-cooled SAC7 is a nice introductory DSO camera, how superior is the SAC8 for $150 more than the SAC7?

What's in the box?

Clearly, we're moving up in complexity. The SAC8 comes with (clockwise from top left):

- Camera body
- Extension USB cable
- Parallel cable to connect the camera to the power supply/control box
- Mini CD-ROM
- Power supply/control box with captive USB, power, and parallel port cables

As supplied the SAC8 is astrophotography ready, but the camera does not have a built-in IR block filter,

which can be bought separately if desired. (only necessary for tri-color imaging)

The manual is on the CD-ROM, but the pictures do not match the supplied hardware. However, it's easy to sort out what is what.

Unlike the air-cooled SAC7, the Peltier cooled SAC8 requires a fairly hefty 12V @ 3.5 amp power supply. For the review I used a Kendrick 33 amp-hour battery pack, making sure the charge was above 12V.

SAC8 camera body

The SAC8 body is a nice aluminum casing with a built-in T-thread and 1.25" nosepiece. On the back is the parallel port (to be connected to the power supply/control box, not your computer), and a switch to control the cooling fan.


The parallel port on the camera body doesn't have the usual female screw connectors for the parallel cable, so it kept falling off. You'll have to tape or rubber-band the cable to the camera body. Ditto for the control box.

The fan control switch only seemed to work on the "low" setting.

AstroVideo – Initial tryout with terrestrial images

Acquainting yourself with the SAC8 and AstroVideo is easiest in the daytime where you have a bright stationary object. Select a terrestrial object far away enough from your scope that you can reach focus and select an object that has a bright glint on it. A reflection off of a street lamp, for example, is perfect. Focus with your eyepiece then remove the eyepiece and insert the SAC8. They likely will not be parfocal so expect to have to refocus. The purpose of selecting an object with a bright glint is to be able to see something to focus on.

Plug in the camera to the control box, start up AstroVideo and set up the camera. Do not connect the parallel port yet. You have 3 choices of drivers, select TWAIN device:
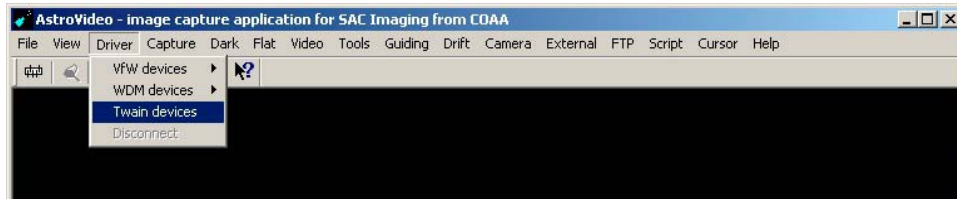
You'll get the following popup, select the SAC8:
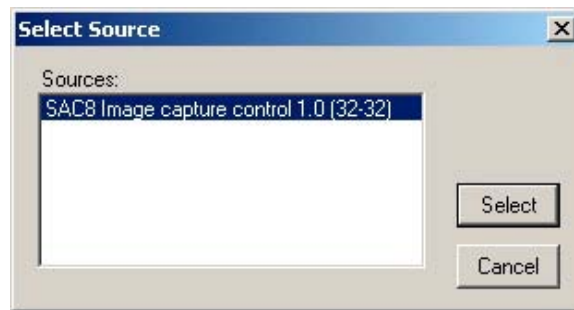
Unlike the SAC7, the video window does not immediately go live. You have to pull up a video preview window. Select View -> Video Preview and you'll get the following live window:
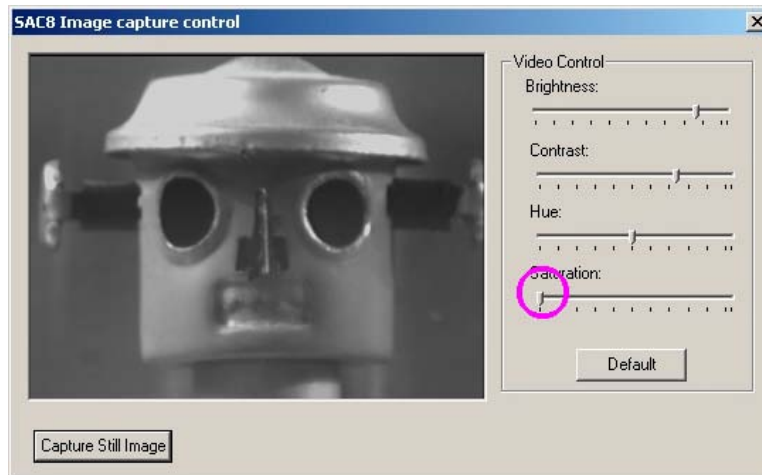

As described in the manual set "Saturation" all the way to 0 since this is a B&W camera – anything other than 0 will inject noise into the picture.

The "Capture Still Image" button doesn't do anything; the next step is to set up long exposure image capture.

The manual insists on setting the parallel port to "ECP" mode, but as with the SAC7, the only way to get an image with the parallel cable connected was to set my parallel port to "EPP" mode. Having set the parallel port up, set up the video preview window mode again and plug in the parallel port cable. If

everything is working right, the picture shouldn't change. If it disappears, you've got a parallel port problem. Assuming your parallel port connection is OK, click on Camera -> Setup long exposure control which brings up the following:
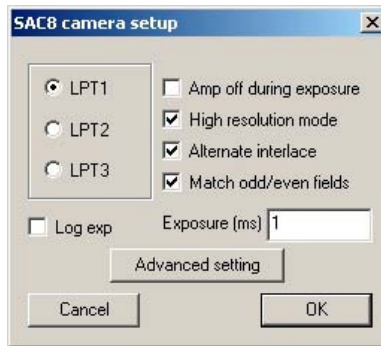

Make sure "High resolution mode" is selected in order to get a 640x480 image. I found that selecting "Alternate interlace" and "Match odd/even fields" gave the smoothest image without scanning lines. You also set the exposure on this popup. As I'd already fiddled around, I knew that a minimum exposure of 1 ms (don't know if it's actually 1 ms) would be sufficient to capture the robot.

Next, setup up the image capture by clicking on Capture -> Setup:
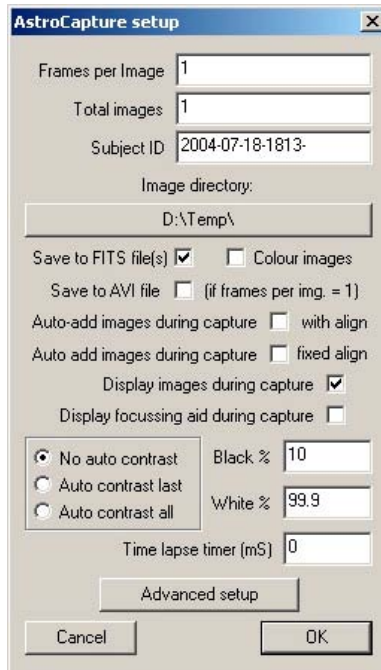
Make sure the program is set to "Save to FITS file(s)" is selected. Now click on Capture -> Start and AstroVideo will capture a long exposure (short in this case!) image and save the file per the setup above:
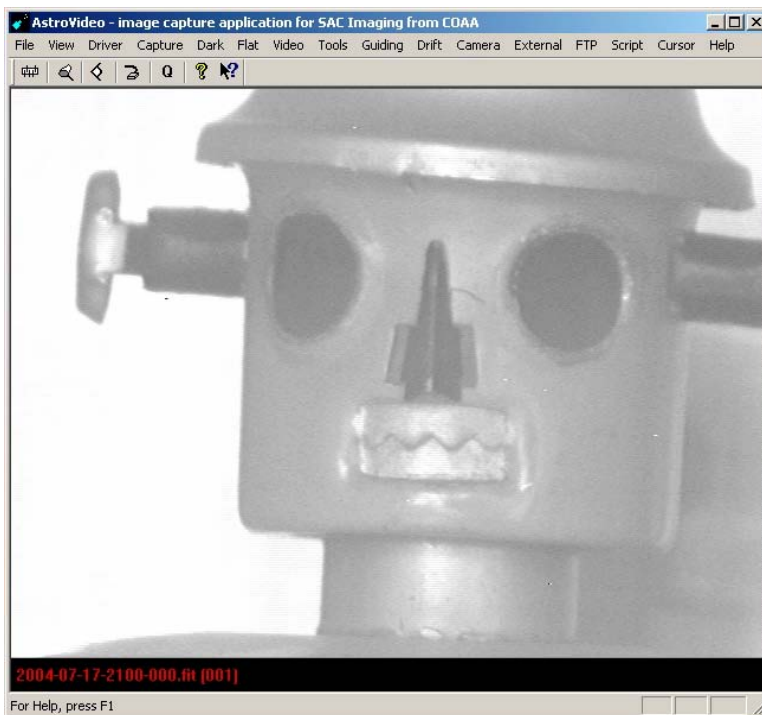

Nice! A bright and smooth image from a single exposure – without stacking. This was taken at night, in a dimly lit portion of my kitchen. The following is a pretty good visual approximation of how dimly the robot toy was lit, so this is definitely a sensitive camera (the cooler was off since this was such a short exposure).
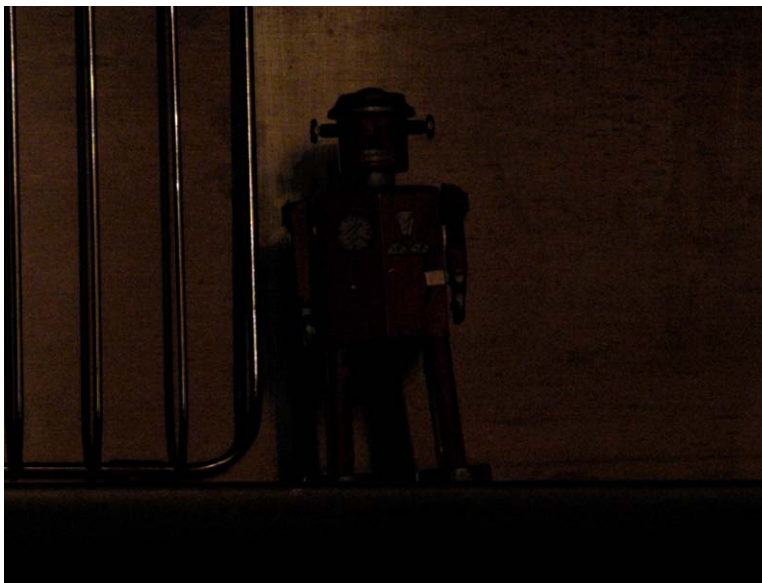
Dark Current Evaluation

In order to determine how well the thermo-electric cooler works, I made a sequence of dark images at 1, 2, 4, 16, 30, 60, 120 and 240 seconds exposure, with the cooler off and on. For comparison I also made the same set of exposures with an SBIG ST2000 temperature controlled CCD camera, again with the cooler off and on. The chart below shows the results.

Dark Current vs Exposure
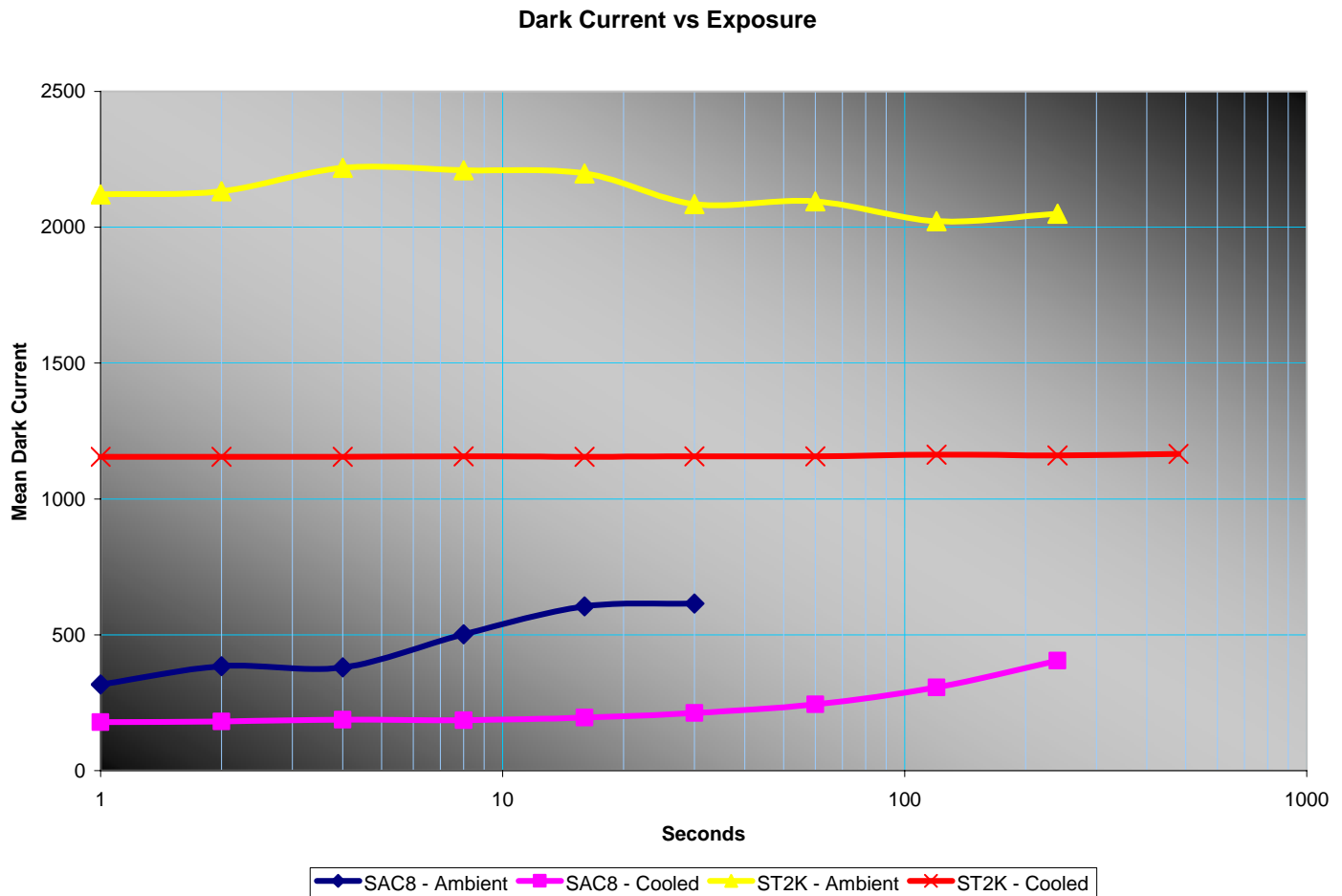
The top two traces are the ST2000 and the bottom are the SAC8. The difference in scale is due to various gain factors, so they can't be compared directly. The interesting thing is to observe the shape of the curves and what they imply.

The dark blue trace is the SAC8 with the cooler and fan turned off. The ambient temperature was around 65F dropping to 60F. Between exposures I waited at least the length of the previous exposure to allow the CCD to cool off. You can see that dark current starts to accumulate as exposure lengthens (the gain on the control box was set to the mid-point).

The lower purple trace shows the effect of turning on the cooler and fan: very good performance reducing dark current. In fact, the fact that the plot stays flat up to around 60 seconds exposure shows that very little dark current is accumulating; you're just mainly getting offset from bias and

readout noise. Just as important, the curve is smooth and monotonic with increasing exposure, implying that if you take a dark shortly after you take an image, you'll get a repeatable amount of dark, and therefore will be able to successfully remove the dark current from your image, even though the camera is not temperature controlled.

Odds and Ends…

The SAC8 was tested on my usual rig of Mewlon250/AP900/STV/Megrez80. A couple of slight oddities showed up in initial testing.
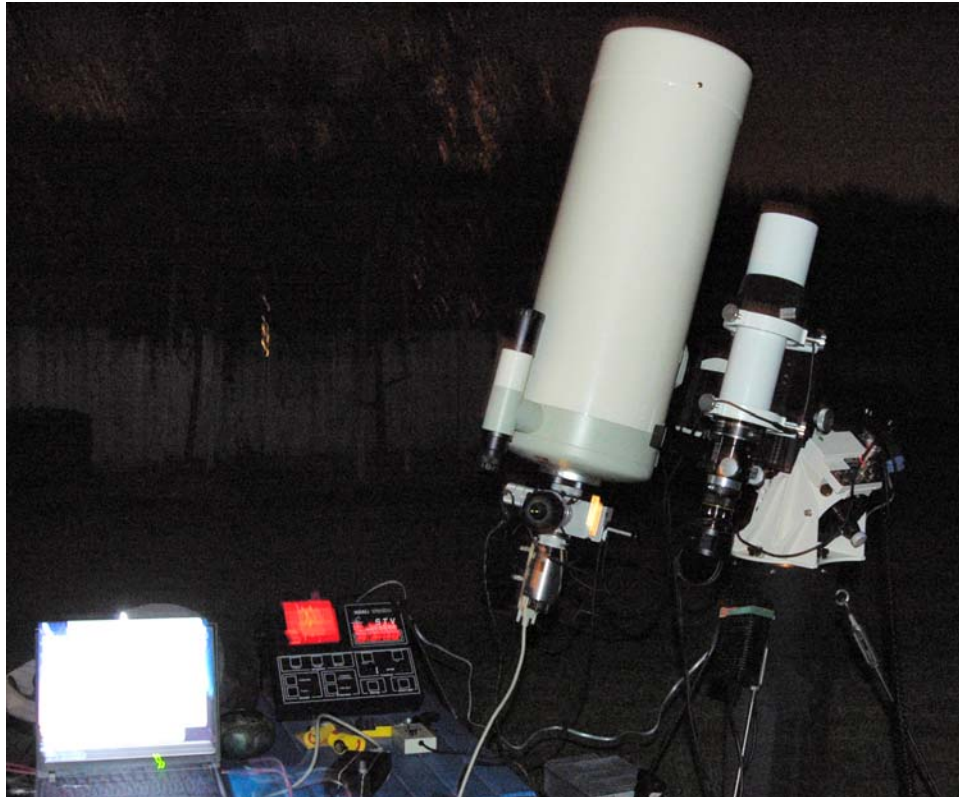

First off, AstroVideo outputs 32-bit FITS files rather than 16-bit which is more standard. The 32-bit output is probably more of an indication of the internal arithmetic word length AstroVideo uses rather than anything with the camera DACs – there are no 32-bit output cameras… The 32-bit FITS file is a bit inconvenient since most applications only read 16-bit FITS files (FITS Liberator for Photoshop and MaximDL are exceptions). Fortunately, SAC Imaging includes an application called FitsX which can read 32-bit and convert to 16-bit.

Also, while there's a gain pot on the control box, there's no mention of it in the manual, except for a paragraph in the FAQ discussing how to determine whether it's doing anything. I played with it and got these results:

| Min | Middle | Max |
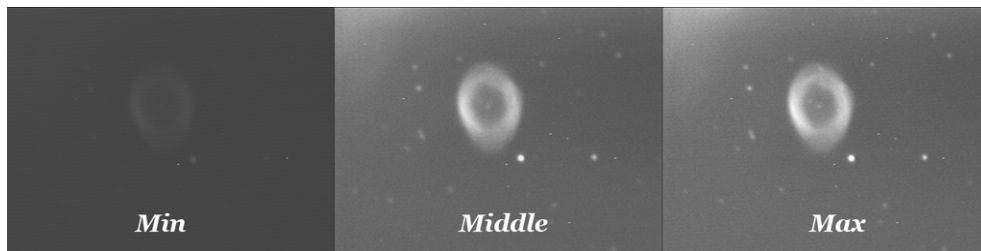
In going from the mid-point of the pot's range to the maximum gain setting, there's no appreciable increase in signal, but noise increases, so I did all imaging with the pot set to the middle position.

Finally, after mounting the SAC8 on my Mewlon250, I was surprised to find that no matter what I did, star images were ovals. ?!?!!! Turns out the fan was resonanting with the telescope vibrating the camera/telescope assembly:

Fan off, same star, it's a double!

Fan on, little oval!
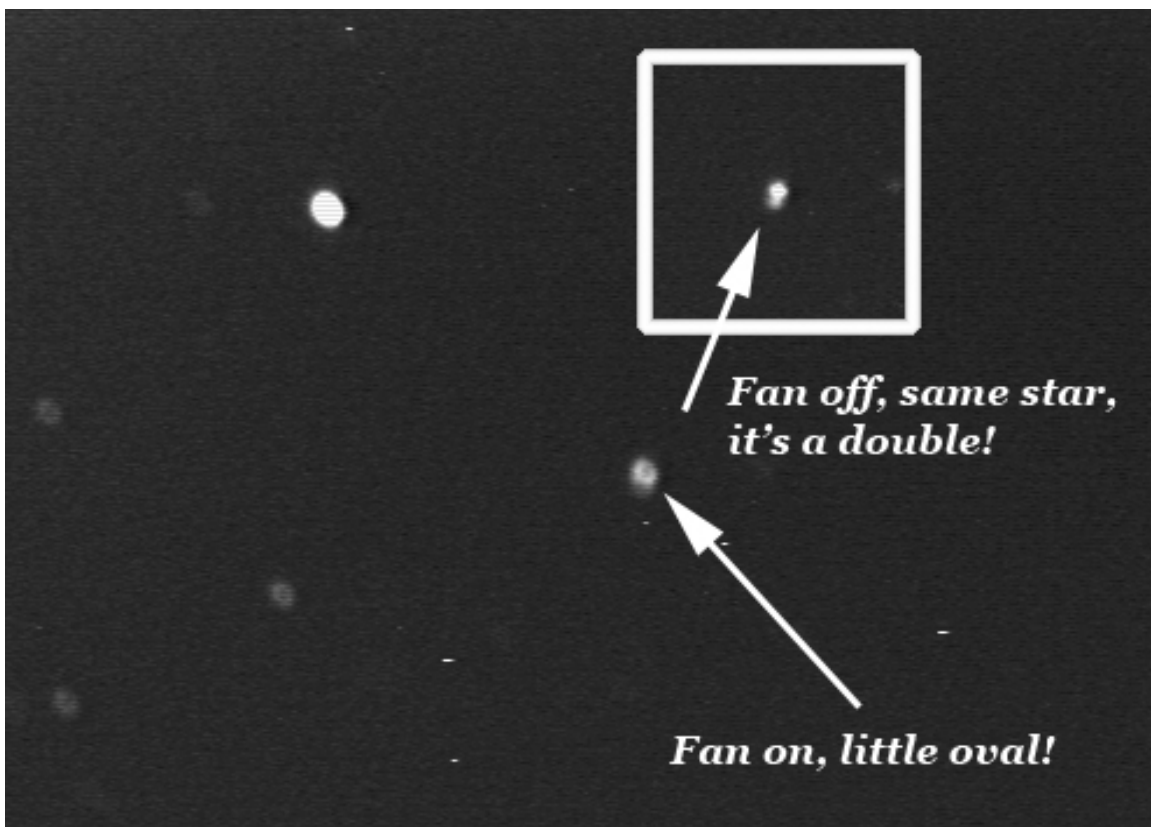
The resonance will be a function of your particular scope/camera combination, but if you get ovals, turn off the fan. I did all subsequent imaging with the fan turned off. I probably lost a little cooling capacity, but as the following images show, the camera worked fine nonetheless.

Sensitivity – M57

First test was M57. Here's a raw FITS file showing a 30 second exposure, no dark processing or stacking, and linear histogram (no stretch):

After capturing 8 images, I captured 8 dark frames to get rid of the amp glow and hot pixels. Here's the 8 frame master dark created by MaximDL:

I used MaximDL to calibrate (dark frame correction) each of the 8 shots of M57, then CCDSoft to align the calibrated images and averaged together, displayed with no histogram stretching or curving:
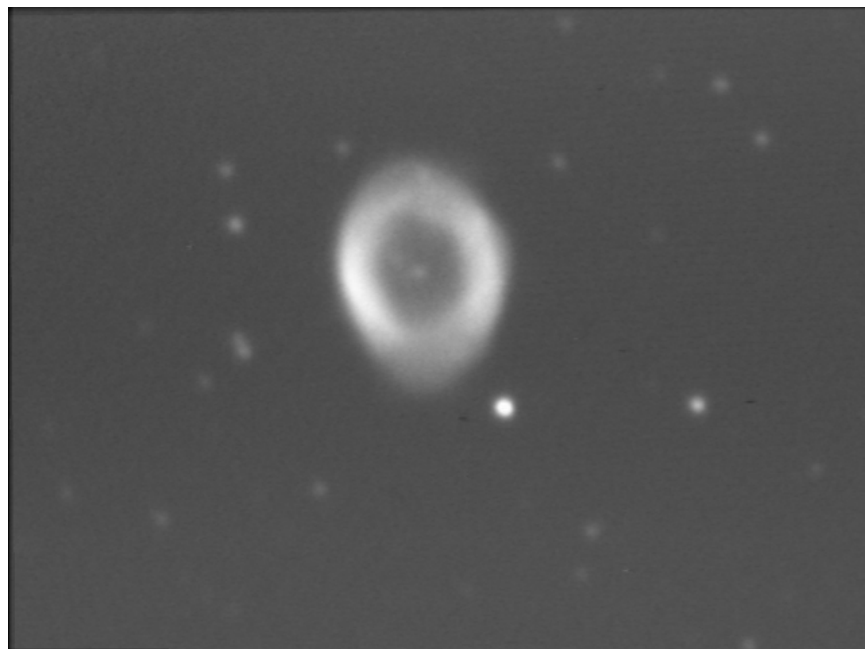
8 exposures of 30 seconds each, averaged together, taken at F12 through a 10" scope. A very nice, smooth, result. This was taken on a night of relatively poor seeing, with better seeing the stars would have been tighter and there would have been a bit more detail in the ring itself.

Here's a comparison shot taken with an SBIG ST2000 cooled astro-camera. Same 8 exposures of 30 seconds each, but cooled to -15C. Similarly processed as above.
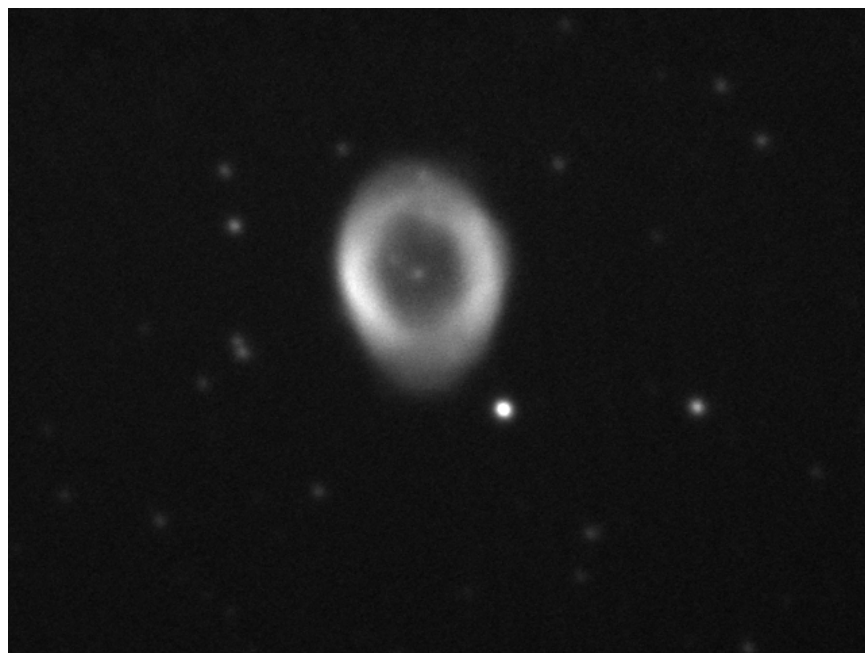
Differences in overall brightness and background blackness are due to slight differences in processing. Looking at the surrounding field stars, you can see that virtually the same depth of image has been captured by both cameras. The ST2k is not the most sensitive CCD camera out there, but for bright DSOs, the SAC8 is as sensitive as SAC Imaging's claims.
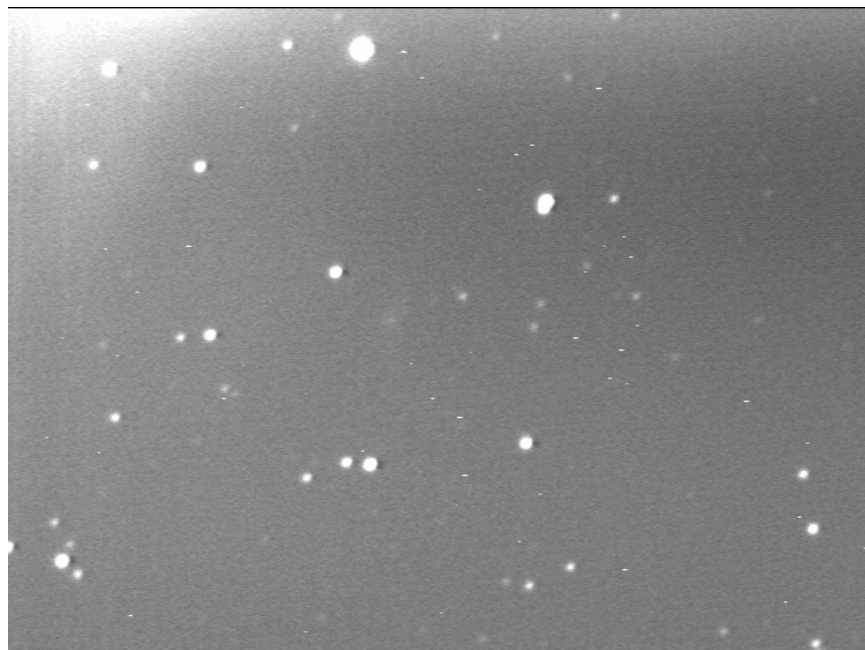
Sensitivity – IC1296

Very near M57 is a much more challenging object, a lovely two-arm spiral galaxy:
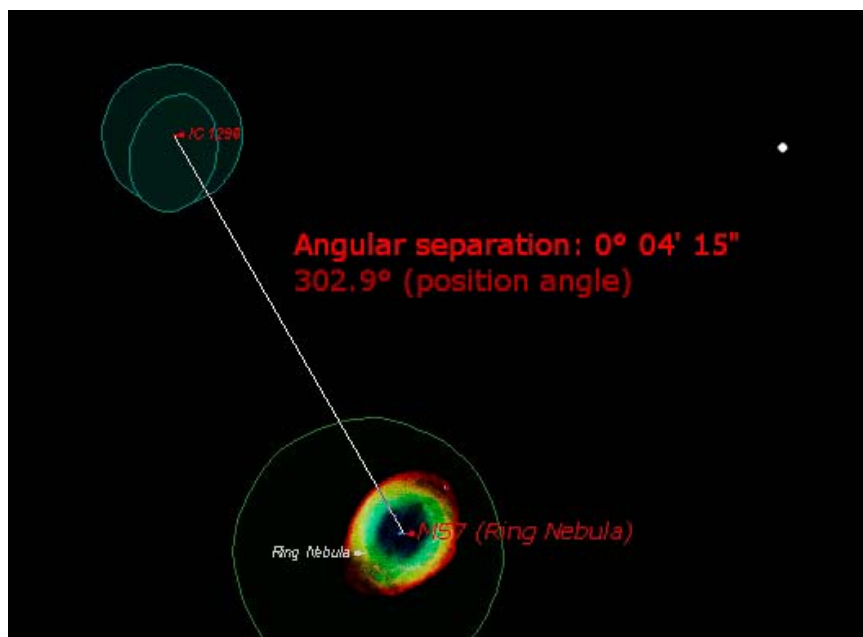
After trying a number of exposures, I found that a 1 minute exposure gave the best balance between image acquisition and amplifier glow noise.

Here's a single 1 minute exposure, no histogram stretch:

The core of IC1296 can be seen as the faint dot just left of center. I took 35 exposures of 1 minute each, calibrated the images with eight 1-minute dark frames in MaximDL, and aligned and summed (as opposed to averaging) to get the following (raw image with no histogram stretch):
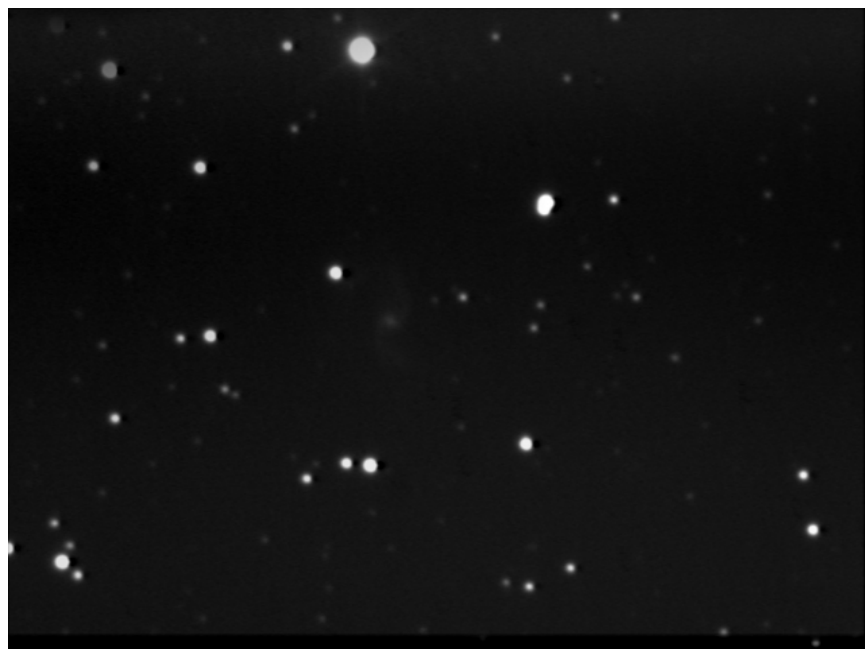

Finally, I used FITS Liberator and Photoshop to strongly process the image to bring up the faint arms (some manual Photoshop work was also done to minimize the banding artifacts brought up by the

strong image processing - the odd black right edges on some of the stars is an artifact of processing that can be eliminated with further effort)):

IC1296 is listed as a 15th magnitude object. However, that luminosity is summed over the whole of the galaxy, so the arms are very much fainter than that. Again, here's a comparison with the cooled ST2k. This time, since the ST2k is capable of much longer imaging before noise becomes a problem, I took the same 35 minute total exposure, but as 7 shots of 5 minutes rather than 35 shots of 1 minute. Again, slight differences in post-processing cause some image differences, but overall, the results are quite similar.
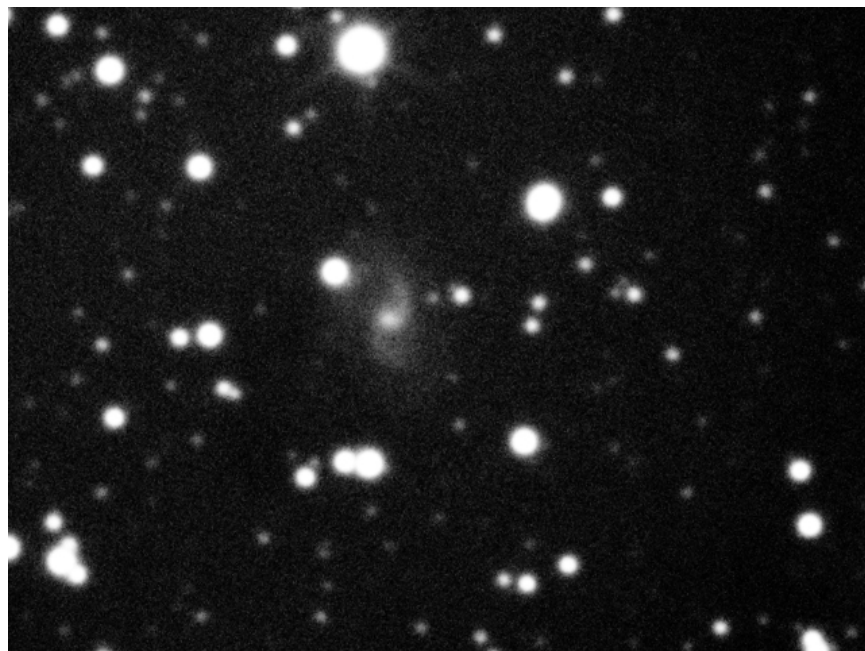
The biggest notable difference (star sizes are dissimilar because of differences in seeing) is that the noise level in the ST2k is much more uniform due to its more expensive custom designed electronics. So, no hand processing to even out the background was necessary. The bottom line though, is that the SAC8 is clearly capable of real DSO imaging.

Summary

Pros

- Very complete product package – comes with everything you need
- Small CCD size lends itself to good DSO imaging scale with short refractors
- Real DSO capability once you get the hang of stacking – can image faint galaxies
- CCD generates less shot noise than other CCD cameras, making post-processing easier
- Terrific price/performance ratio

Cons

- Mechanical connectors need a bit more attention
- Fan can cause vibration problems
- Noise is not uniform when image is highly stretched – requires more post-processing effort
- Small CCD size leads to very high magnifications with typical SCT focal lengths – need to use a 0.33x reducer

At the beginning of the review, I raised the question, is this the Ultimate Hod-Rodded Webcam? I think the answer is definitely YES. It clearly competes with a much more expensive astro CCD camera in terms of short-exposure sensitivity, and, with a little post-processing expertise, can provide satisfying images of truly dim DSO objects.

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