# Final report: 4k CCD Camera for SCSU

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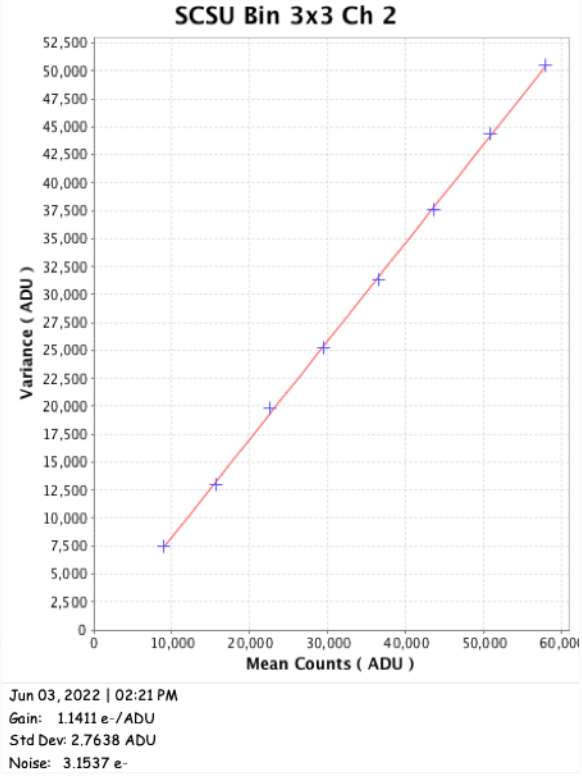
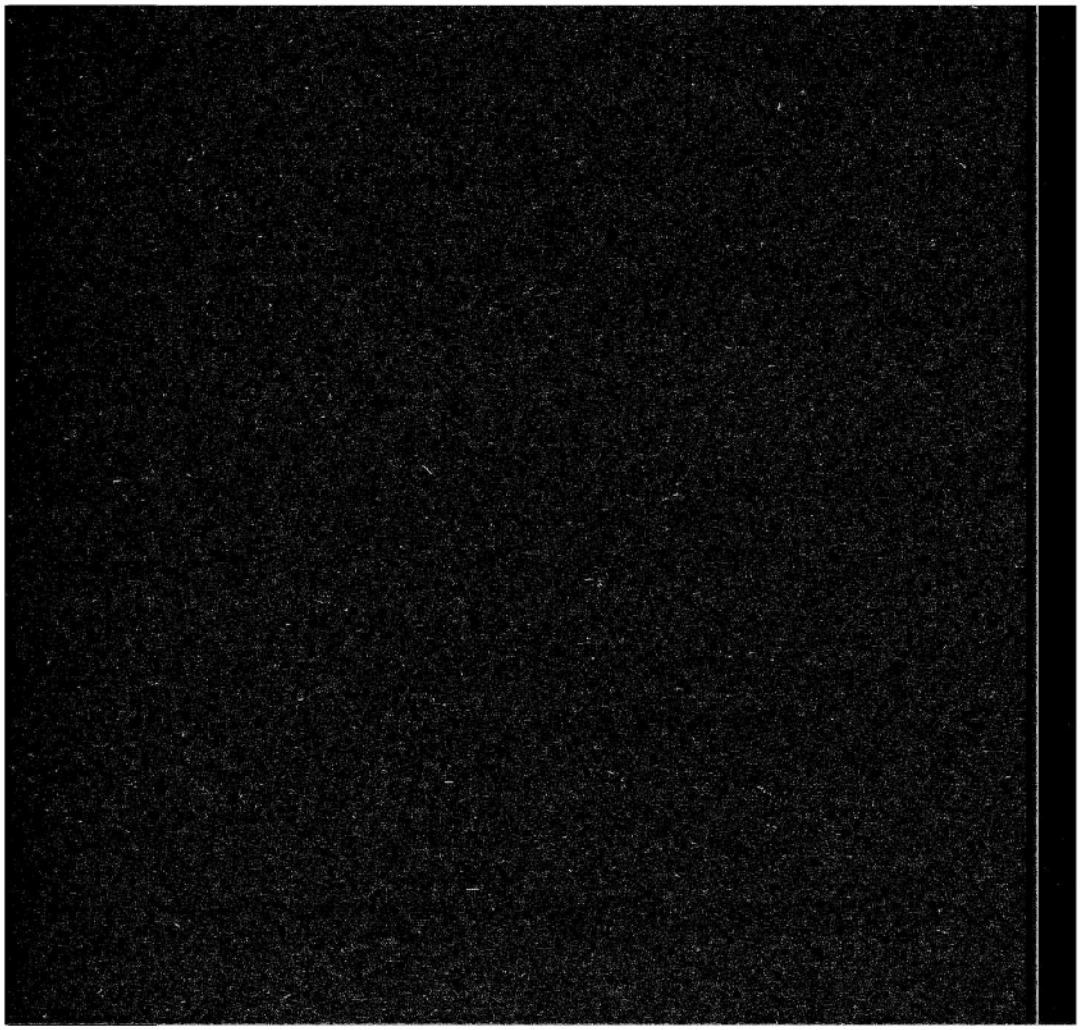
June 6, 2022

This camera uses the Teledyne e2V CCD231-84-1-F21 CCD, consisting of 4096 x 4096 pixels, each 15 microns square. Its serial number is 17352-04-01. The camera's default is to read out from video channel #2 with 3 x 3 binning at normal speed. Other readout modes can be selected, including single channel readout from any of the three remaining channels, quad readout, binning selection, speed selection (slow, normal and fast) and sub-array readout. The following data was all obtained in single channel, 3 x 3 binning mode:

| | Noise e- rms | Gain e-/ADU | Full Well k e- | Readout time seconds |
|---|---|---|---|---|
| Lower Left, channel #0 | 3.25 | 1.24 | 81 | 7.4 |
| Lower Right, channel #1 | 3.19 | 1.21 | 80 | 7.4 |
| Upper Right, channel #2 | 3.15 | 1.14 | 75 | 7.4 |
| Upper Left, channel #3 | 3.35 | 1.34 | 88 | 7.4 |

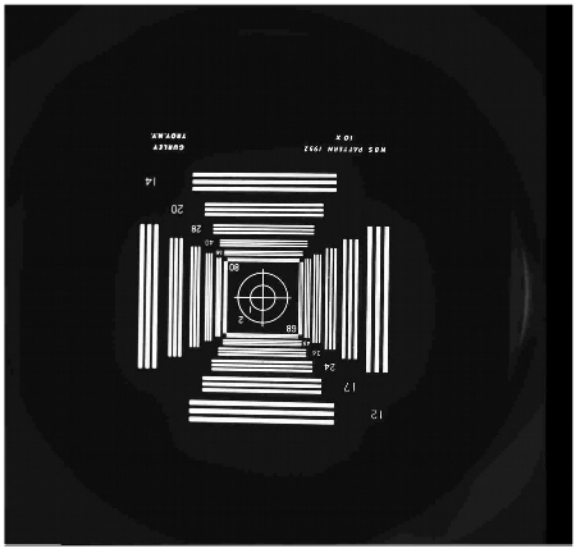


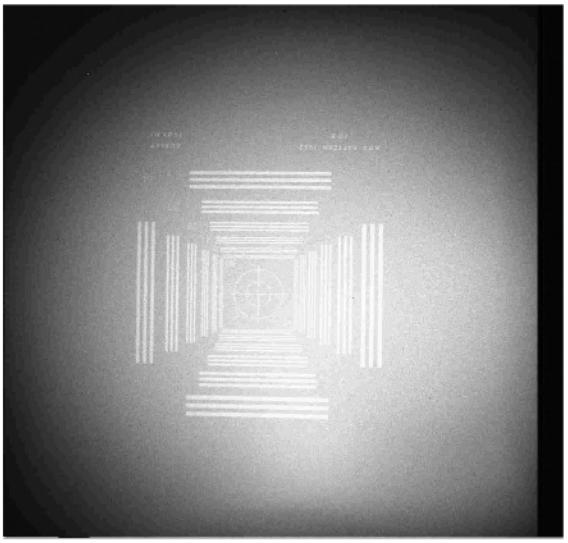
Long exposure time dark frames were obtained in the default readout mode. The CCD was operated at a temperature of -100 C, the recommended temperature for operation in the field. The measured dark current rate is 2.7 e- per pixel per hour, or 30.8 e-/hour per 3 x 3 binned pixels. Cosmic rays are plentiful in this ten minute exposure, and properly shaped. There do not appear to be any hot pixels. The bright vertical line on the right is in the overscan region, and its origin is a mystery.



The default image size for unbinned readout is 4302 cols x 4098 rows. This is normally entered on the Owl Setup window, but does not have to be in this system since these have been hard-coded into the "tim.lod" file that is downloaded. The hard coded software applies the 3 x 3 binning and computes a final image size of 1434 cols x 1366 rows. Note that these hard-coded values may be overwritten by entering image sizes in the Setup window and selecting binning and channel numbers with the windows in the "Supported Configuration" part of the main Owl window. An important constraint is that the final image sizes must both be even numbers, necessitating that the unbinned readout sizes in 3 x 3 binned mode must be evenly divisible by 6 to avoid painful computer crashes.

Images were taken of a test pattern at bright and very faint illumination levels. The bright image has features close to the full well, and the very faint image's are around 50 e-. Excellent image quality is apparent.

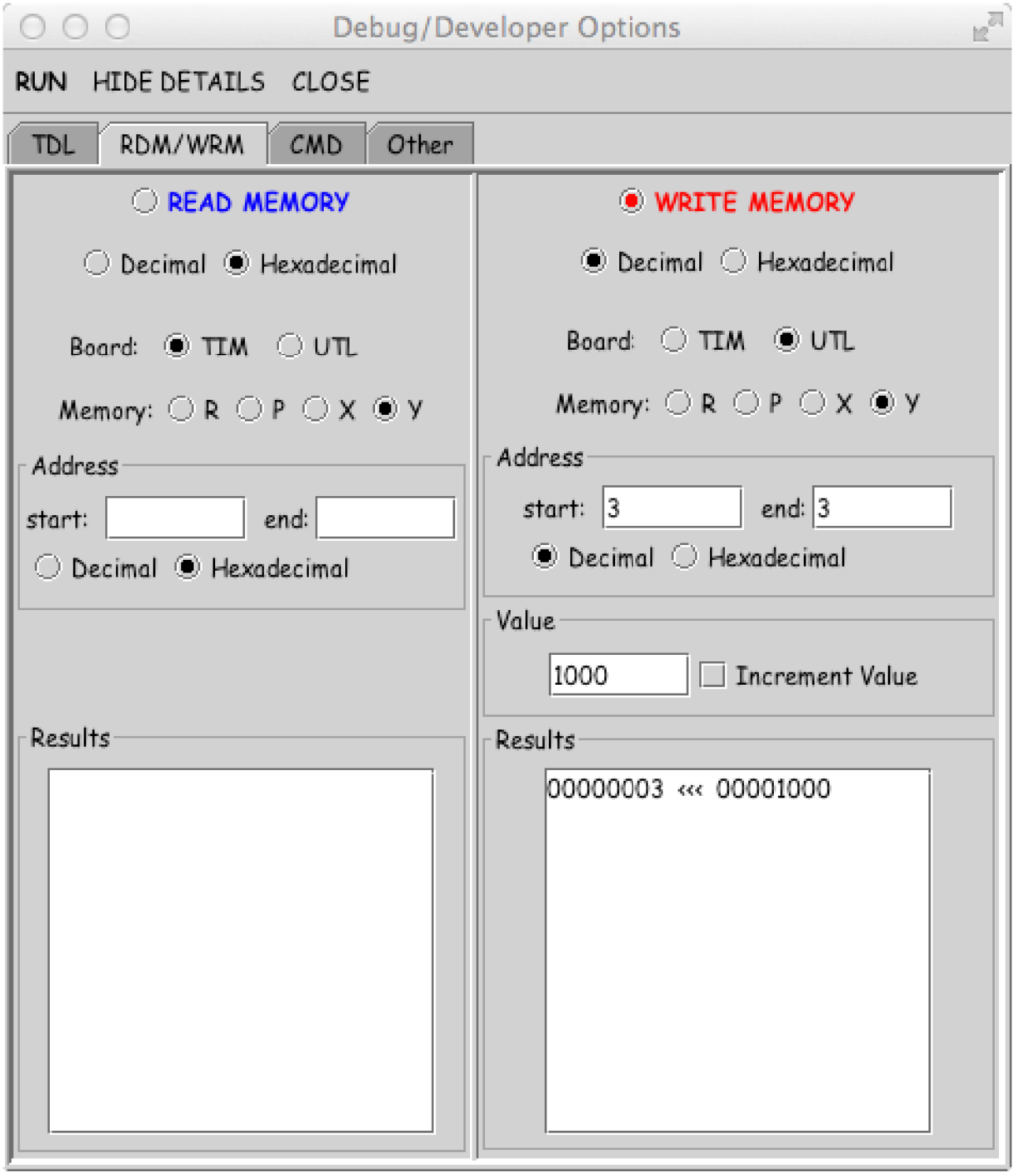


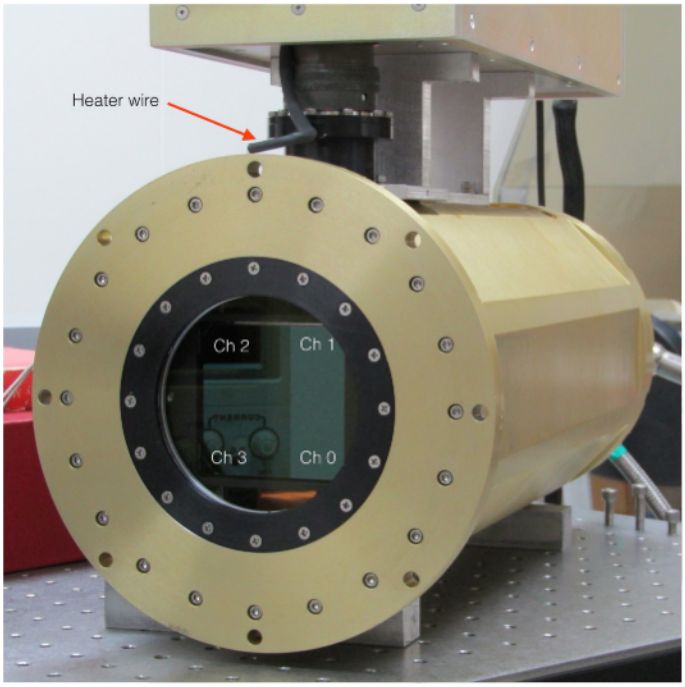


A heater was installed in the window plate to keep the window from forming dew in cold, damp weather. It consists of manganin wire placed in a groove near the bolts that fasten the window plate to the dewar body, sealed with thermally conductive epoxy. The heater voltage is supplied by the utility board, and is programmable as follows:

In the main window of Owl select OPTIONS, Debug ..., RDM/WRM, WRITE MEMORY, Decimal, UTL, Y, Address start = end = 3, Decimal, Value = 0 to 3560, then RUN. The maximum power available is about 10 watts, as follows:

| UTL Y:3 | Voltage volts | Current mA | Power watts |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 100 | 0.34 | 11.6 | 0.006 |
| 1000 | 3.4 | 193 | 0.66 |
| 2000 | 7.0 | 400 | 2.8 |
| 3000 | 11.8 | 606 | 7.1 |
| 3560 | 13.4 | 765 | 10.25 |


Debug/Developer Options
RUN
HIDE DETAILS
CLOSE
TDL
RDM/WRM
CMD
Other
READ MEMORY
Decimal
Hexadecimal
Board:
TIM
UTL
Memory:
R
P
X
Y
Address
start:
end:
Decimal
Hexadecimal
Results
WRITE MEMORY
Decimal
Hexadecimal
Board:
TIM
UTL
Memory:
R
P
X
Y
Address
start:
3
end:
3
Decimal
Hexadecimal
Value
1000
Increment Value
Results
00000003 <<< 00001000




The physical location of the four readouts of the CCD are shown along with the heater wire. The CCD has been rotated 90 degrees counter-clockwise from its its normal orientation where Ch 0 is in the Lower Left place. The heater wire is a bit fragile, so some care should be exercised in handling the dewar.