HIRES CCD Upgrade User Notes

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The old Tektronix TK2048 CCD has been replaced by a 3-chip mosaic of MIT-LL CCD's. We are still characterizing the new detector, with some parameters still to be determined, or temporary. Rather than commit things to a web page at this point we are providing these user notes to upcoming observers. In what follows, the three chips of the mosaic are referred to as "red", "green", and "blue".
Each chip is 2048 X 4096 with 15 micron pixels.

1) Gains:
The blue, green, and red chips have low gains of 1.9, 2.2, and 2.2 e-/ADU respectively. The blue, green, and red chips have high gains of 0.78, 0.86, and 0.84 e-/ADU respectively. Low gain is the default mode. High gain value has been used on sky only a few times so far.

2) Read noise:
The blue, green, and red chips have readout noise of 2.8, 3.1, and 3.1 e- respectively, in low gain mode. The blue, green, and red chips have readout noise of 2.6, 2.6, and 2.9 e- respectively, in high gain mode.

3) Linearity:
These chips are not as linear as many observers may be used to so some caution is in order. Departures from linearity at about the half a percent level are present at signal levels of 39,800, 37,900, and 38,400 ADU for the blue, green, and red chips in low gain mode. Departures from linearity worsen with increasing signal levels and reach of order 5 percent by the time signal levels of order 50,000 ADU are reached.

4) Dark current:
Dark currents are roughly 3.8 4.4, and 2.2 e-/hour for the blue, green, and red chips respectively in low gain mode. In high gain, these are 5.5, 7.7, and 4.2 e-/hour.

5) Bias levels:
Bias levels are 972, 982, and 898 ADU for the blue, green, and red chips in low gain mode. They are 937, 954, and 747 ADU respectively in high gain mode.

6) Quantum efficiency.
The QE of this detector is improved at all wavelengths. Plots showing the QE improvement with respect to the old detector and in an absolute sense are available on the HIRES web pages.

7) Cosmetics and scattered light:
There are several blocked rows. There is also a hair on the red CCD near the left edge. The green CCD also has a peppering of low sensitivity pixels, visible upon careful visual inspection of longslit flat fields. These seem to flat field out okay though. Our old

friend the “meteor” is still there, usually running right thru the middle at a 45-degree angle. A deeper reconnaissance panning thru the intensity scales will reveal a faint shadowy image of the centrally obstructing dewar, complete with its 4 support vanes.

8) Readout speed:

The default readout speed is “fast”. Other speeds have not been tested and observers are discouraged from using them. To the best of our knowledge the other speeds do not offer significant advantages.

9) Changes to available deckers:
With the possibility of higher resolution using 0.4 arcsec slits (see below) the A-decker plate used with the adjustable slit jaws is no longer available. In its place we offer a decker plate with the aforementioned 0.4 arcsec slits.

10) Gaps between chips:
The gaps between the chips run roughly parallel to echelle orders. It is possible to lose small sections of spectrum to the gaps so some care is necessary during setup. Each gap is of order 100 microns (i.e. about 6 or 7 pixels).

11) Binning:
There are some tradeoffs to be considered with regard to binning. The more one bins, the faster the readout. Readout times are now (roughly) 60, 45, and 30 sec for 1x1, 2x1, and 3x1 binning. Conversely, the less one bins the fewer counts per binned pixel and less chance of pushing signal levels into the non-linear regime. Pixels are about 0.12 arcsec in the spatial direction now. On nights of good seeing, binning by 3 may result in just barely sampling the seeing profile.

12) Echelle simulator still a work in progress:
The gaps shown on the simulator may not accurately predict whether you will lose some spectrum. Exercise caution. The simulator is currently, roughly correct but has two bugs. There is a sign flip in echelle angle needed to move the spectrum towards longer or shorter wavelengths. There is also a flip in the direction of increasing pixel number in the cross-dispersion direction. Rather than expend limited resources fixing these problems in a downloadable version, we are in the process of creating a web based version. The first iteration on this effort is now available.

13) Incomplete readout:
These chips are more susceptible to incomplete readout (or persistence, or florescence) than many CCD observers may be used to. We advise you to avoid pushing exposures to near the saturation limit. If you do, you may want to take a number of “clearing exposures” before taking a spectrum you really care about. Recall that this advice extends to any lamp spectra you may take as well. It is easy to saturate on the very bright Argon lines at long wavelengths. A filter in front of the lamp unit such as the NG3 or BG38 may help. It is possible that this phenomenon may be visible even after

exposures that are well below saturation. Ask your support astronomer for the latest recipe to deal with this problem.

14) Very low level additional signal:
A few times during a previous observing run "bands" of slightly higher background signal or read noise were observed. The level was extremely low, on the order of one or two electrons but seemed real. Those pushing the low S/N envelope should be aware of this.

15) Spectrograph focus:
Focus varies slightly across the format. Standard camera focus is about -40,000 +/- 10,000 units (CAFRAW) and can be fine-tuned to your heart's desire, but the standard setting of will work perfectly well for most users. Collimator focus is auto-adjusted by the XHIRES gui. If you want the very best focus, optimized for one particular chip of the three, please contact Grant Hill for advice on how to achieve this.

16) Increase in spectral coverage and filter choice:
The spectrum spanned by the mosaic when using the visible cross disperser is larger than 1 octave (factor of two). Although spectral coverage is thus increased considerably, the free spectral range does exceed the size of the detector longward of about 6000 Angstroms. For very red settings, it is possible to have incomplete coverage still. Filters are required to block light from 2nd order in the red. You can easily see the second order light coming in up at the red end if not blocked. A series of cut-on filters in the filter1 wheel behind the slit is available for order blocking.
2nd order light is not only confined to orders between the red echelle orders, but also occurs on top of the red echelle orders.

The UV cross disperser provides complete spectral coverage in first order between 3000 Angstroms and 6000 Angstroms. No order sorting filters are needed in the wheel behind the slit for such a setup, but depending on the setting chosen, one may wish to block ThAr lines shortward of 3000 Angstroms with a filter in the lamp beam.

17) Improved resolution:
A new set of 0.4 arcsec wide deckers has been installed (decker E1 thru E4). It is available on the hires gui. A plot is available on the HIRES news page showing what Th/Ar profiles look like with this new decker compared to the 0.574 arcsec decker. The plot also shows that resolution with the 0.574 arcsec decker has improved by 10 or 15 percent. The improvement is in part because pixels are now 15 microns, but also because the new detector has improved charge diffusion characteristics.

18) Two different Th/Ar lamps:
There are two different comparison lamps. They have slightly different illumination patterns on the slit, with ThAr2 providing more uniform illumination along the longer slits. They also have a different mixture of gases. ThAr1 has some neon in it, so that it produces weak neon lines near 6000 A and slightly less strong argon lines in the very far red. ThAr2 has little or no neon, and produces stronger argon lines in the very far red.

19) Atmospheric Refraction:

With the extremely high QE of the new detector in the near UV, we are seeing increasing numbers of observers push down to 3000 Angstroms. The existing suite of decker lengths is not optimal. To avoid order overlap at the very shortest wavelengths, observers may choose the 3.5 arcsec long decker. However one must recall that the separation between 3000 Angstrom light and 6000 Angstrom light in the elevation direction exceeds 2 arcsecs for airmasses greater than about 1.5. If possible work at higher airmass, use a blue filter in front of the TV guider, and use the rotator in vertical mode. If using a 3.5 arcsec long decker, consider displacing the target slightly from slit center toward higher elevation.