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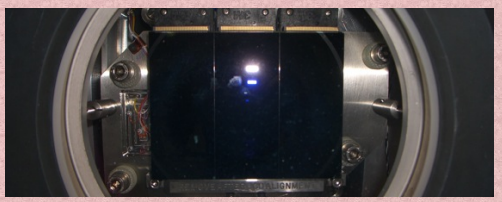

Newly populated e2v GMOS-N focal plane inside the dewar

GMOS

Gemini North Multi-Object Spectrograph (GMOS-N) Interim CCDs Upgrade: Commissioning Results II

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Abstract

The GMOS-N instrument was upgraded with new e2v deep-depletion devices in November 2011. The new detectors extend and improve the sensitivity at both ends of the optical spectrum by factors of up to 1.45 in the blue and > 2 longward of 850 nm. These CCDs, being deep-depletion devices, are significantly thicker than the original CCDs and produce spectral images affected much less by fringing. This provides a significantly improved sky subtraction at long wavelengths, which is dominated by a dense population of atmospheric emission lines. We present commissioning results including detector characteristics, spectroscopic throughputs, cosmic ray rates, nod & shuffle dark features, and spectral PSFs.

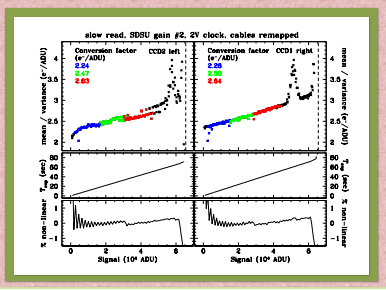

Figure 2: Photon transfer curves for CCD2 left and CCD1 right amps. When unbinned, all amps can exceed full well as evidenced when the conversion factor goes highly nonlinear. Even in this regime the detector remains linear to <1% as seen in the lower panel. The sawtooth pattern arises from the unequal travel times of the GMOS blade shutter in consecutive exposures. The split variance evidenced by the CCD2 left amp is not understood but is not believed to have a noticeable influence on science data. Only this amp continues to exhibit this odd behavior after the cable remap work.

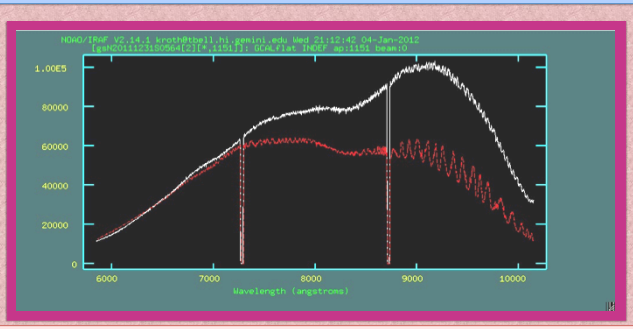

Figure 1: Identical GCAL spectral flats taken with the new e2vDD detectors compared to the original EEV CCDs (in red). The spectra are scaled to match flux at 675 nm as expected from the relative QE curves to account for possible fluctuations in the Qtz Halogen bulb brightness. This figure also nicely demonstrates the difference in fringing at long wavelengths.

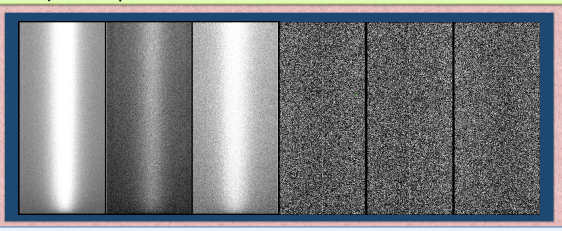

Figure 3: Bias image from the EEV (left) compared to the e2v DD devices (right). The new detectors show no evidence of the smooth variation in counts across the detector. However, there is a 2 pixel wide column of slightly elevated counts in the middle of each detector, and so bias subtraction (after overscan correction) is still recommended. A high signal-to-noise bias image is available:

http://www.gemini.edu/sciops/instruments/gmos/calibration/example-cal-data/bias-images

Table 1: Comparison of key detector characteristics measured before and after the CD upgrade. Where the values for the three CCDs in the detector array (or the two amps per detector) differ significantly three (six) values are indicated. **The most up-to-date values, as well as information on other readout modes, can be found at the following link:**

http://www.gemini.edu/sciops/instruments/gmos/imaging/detector-array

	e2v Deep Depletion	Original EEV
Pixel Scale (arcsec/pixel) [5.5'x5.5' FOV]	0.0729	0.0728
Gain conversion factor (e^-/ADU) (low gain)	2.31 / 2.24 / 2.25	2.04 / 2.32 / 2.19
Readout noise (e^-) (slow readout)	3.4 : 3.2 / 3.2 / 3.4	3.5 / 3.3 / 3.0
Fringing @ 900 nm*	3%	7%
Full well (ke$^-$)**	110	150 / 100 / 150
Non-linearity**	< 1%	< 1%
Bias level***	1180 : 1060 / 920 : 1100 / 1190 : 1110	750 / 630 / 390
Cosmic Ray Rate (hits/sec)****	20	5

*See Figure 1 **See Figure 2 ***See Figure 3 ****See Figure 4

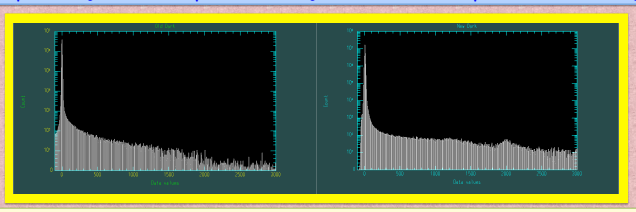

Figure 4: Histogram of cosmic ray hits on identical configuration darks taken with the original EEV detectors (left) and the new e2v DD CCDs (right). Since the new detectors are almost twice as thick as the original CCDs it is expected that they are more susceptible to cosmic rays. We find a much higher incidence of high count rate events, and recommend a maximum exposure time of 40 minutes for these devices.

Detector characterization is ongoing, updates can be found on the GMOS webpages: http://www.gemini.edu/sciops/instruments/gmos/