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

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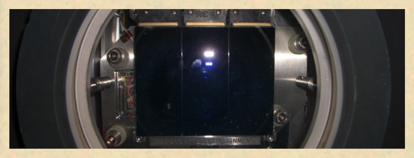

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GMOS

Abstract

The Gemini GMOS-North CCDs are undergoing a succession of upgrades to improve sensitivity, particularly in the red. In late fall 2011, the original GMOS-N E2V CCDs were replaced with deep depletion E2V devices. The array consists of three 2048x4608 CCD chips in the same layout as the original CCDs, having enhanced blue and red response. The improvement in QE is > 25% at 400nm and > 75% at 900nm, with sensitivity extending redward of 950nm. In addition, fringing is much less than with the original CCDs. Other properties, including noise characteristics, pixel scale, and readout time are similar to the original CCDs. We present a comparison of imaging obtained with the original and deep depletion E2V CCDs, highlighting the realized gains in increased red sensitivity and reduced fringing.

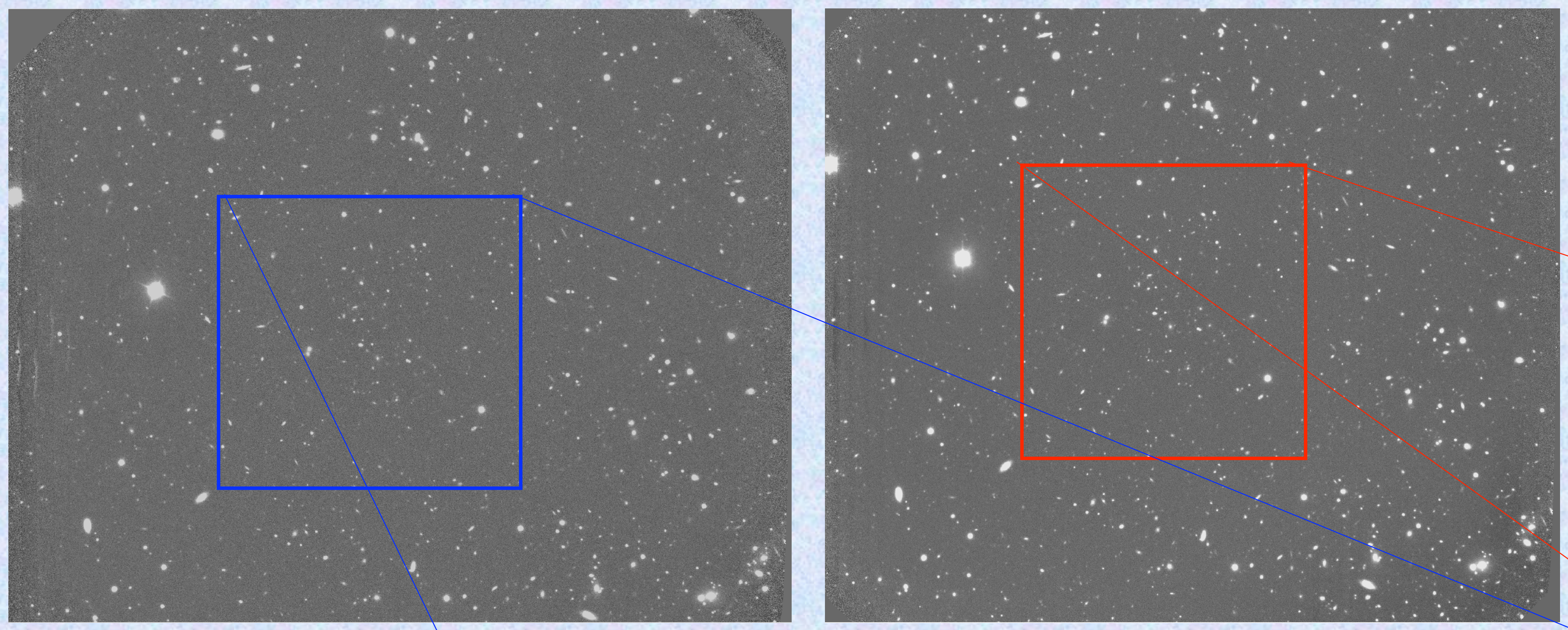


Fig. 1. Before and after images taken of a field centered on the distant galaxy cluster RXJ0848.6+4453 at z = 1.27. The field of view covers 5.5 x 5.6 arcmin for both, with the same pixel scale. Images were taken under the same observing conditions. Left: GMOS image taken with the original E2V CCDs. Total integration time of the combined z' image is 60min, taken with seeing FWHM = 0.55 arcsec. Right: GMOS image observed with the new deep depletion E2V CCDs. Total integration time is 55min with FWHM = 0.52 arcsec.

By eye, more objects are apparent in the image taken with the new CCDs. This image goes deeper due to both the increased sensitivity at these wavelengths and to the long-pass z' filter used here, which was previously cut off at the red end by the CCD sensitivity cut-off around 1000nm. The new CCDs extend to redder wavelengths, ~1050nm

Fig. 2 A close-up of the central region of the images in Fig 1. The field of view is 2.3 x 2.3 arcmin.

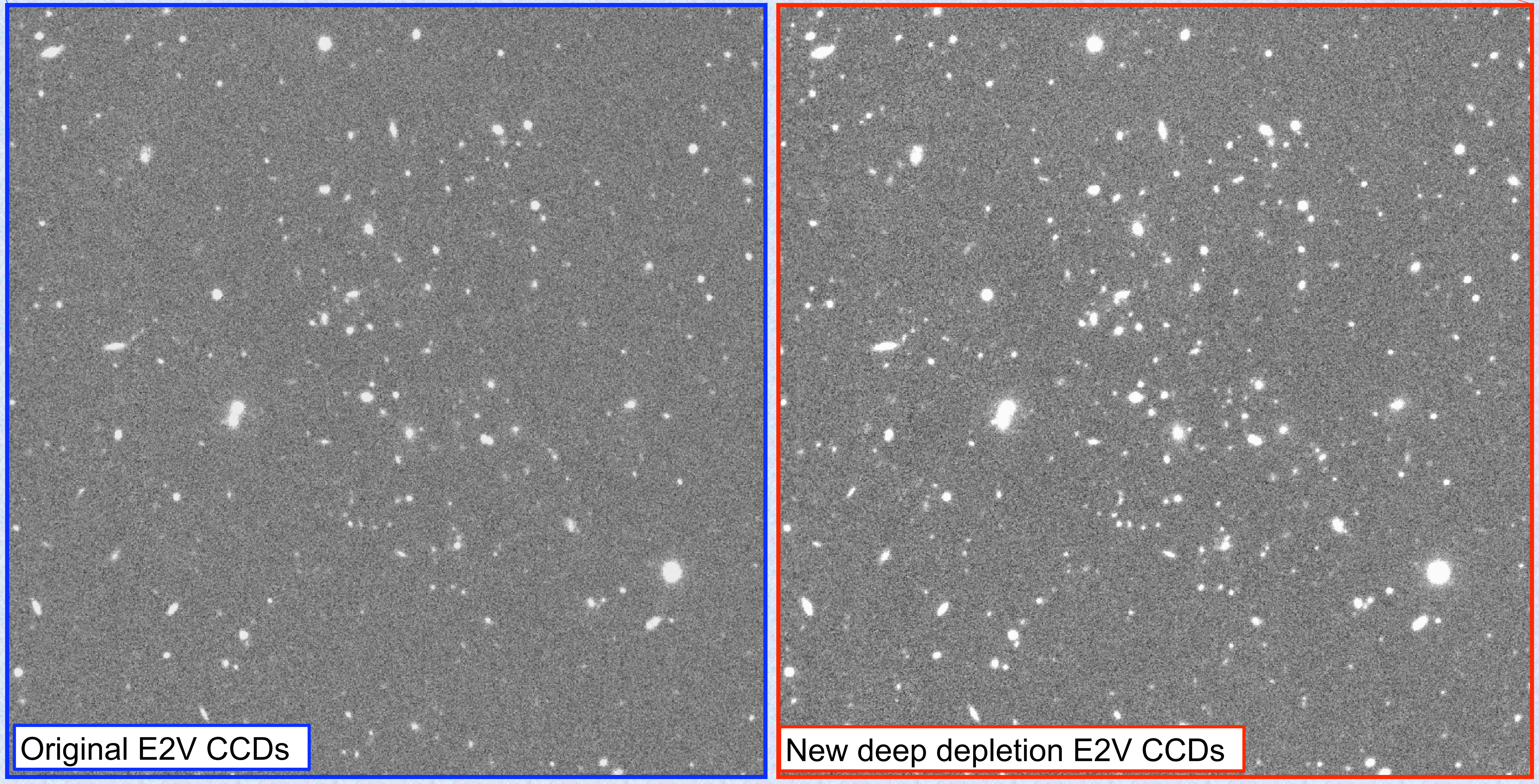
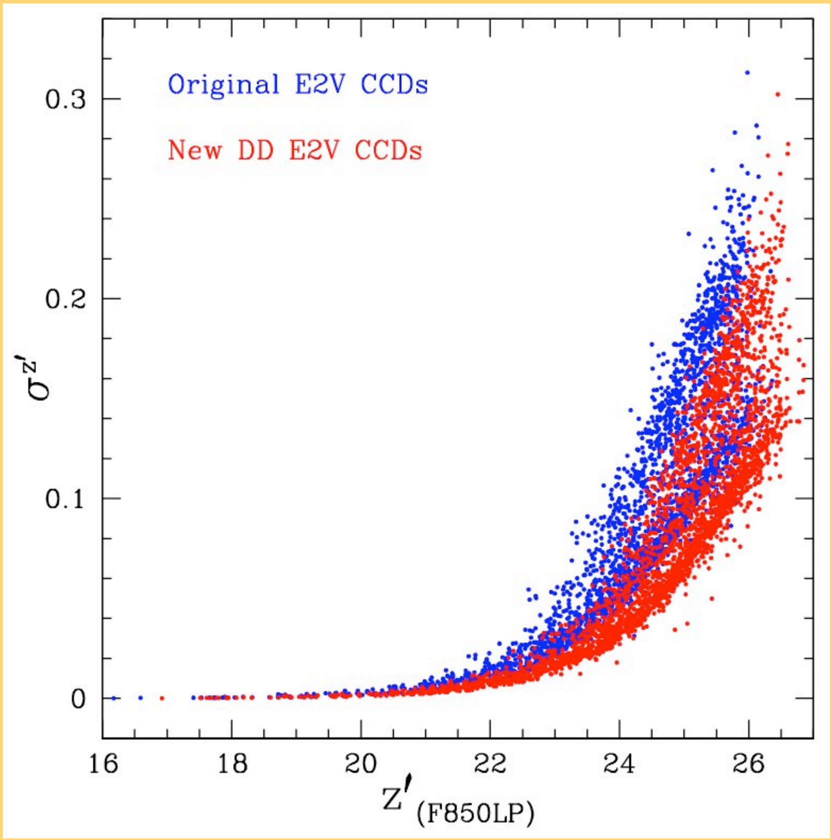


Fig 3. Source Extractor detections from each image in Fig. 1. Plotted are the measured total magnitude, calibrated to the HST/ACS F850LP system, vs. measurement uncertainty. Blue points are detections from imaging with the original E2V CCDs, red points are detections from the new deep depletion E2V CCDs. The bifurcation for each set of detections is due to the deeper detection limit for point sources. We find that for the same total integrations, and in similar conditions, we reach ~ 0.5 mag deeper with the new CCDs.



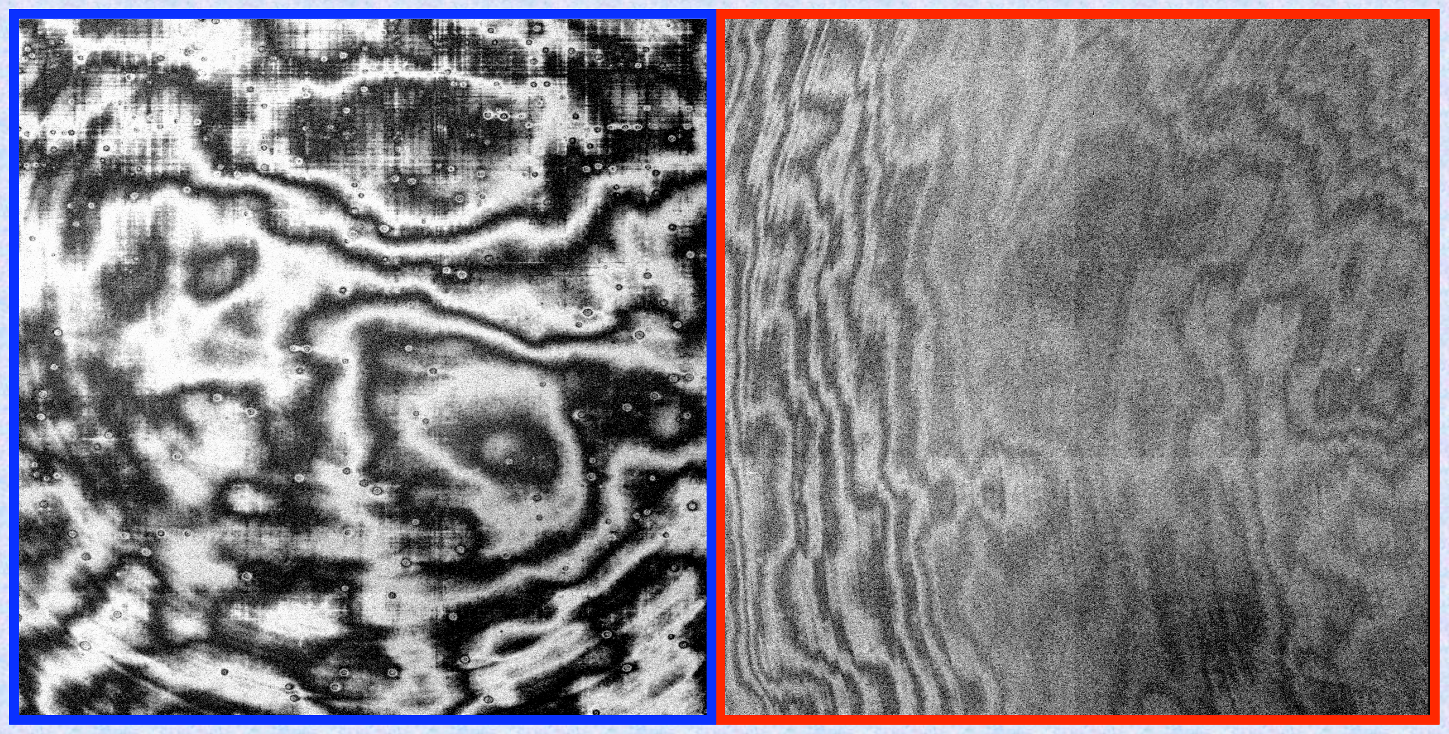


Fig 4. Section of z'-band fringe frames for the two different CCD arrays, displayed with the same stretch. Left: A 2 x 2.2 arcmin sized region from the center of the array taken with the original E2V array. The fringing is at the level of 2.1% of the background (average peak to peak). Right: The same region taken with the new deep depletion CCDs. The fringes are at the level of 0.4% of the background.

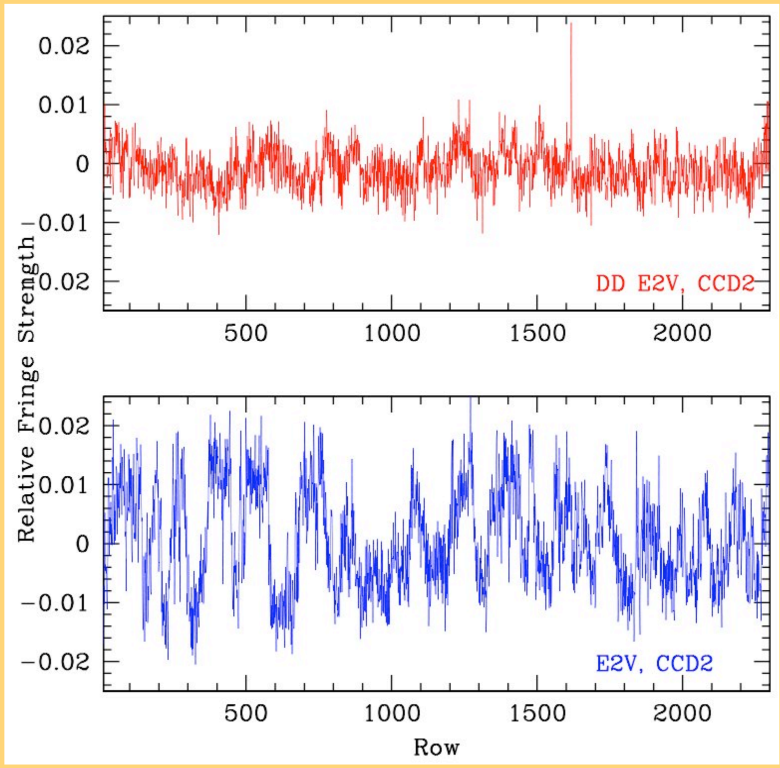


Fig 5. Vertical cut through the central CCD of the array (CCD2) in a z'-band fringe frame. This shows fringe strengths as a fraction of the background counts. Overall, z'-band fringe strengths in the new E2V CCDs are about a factor of ~7 weaker than in the old CCD array.

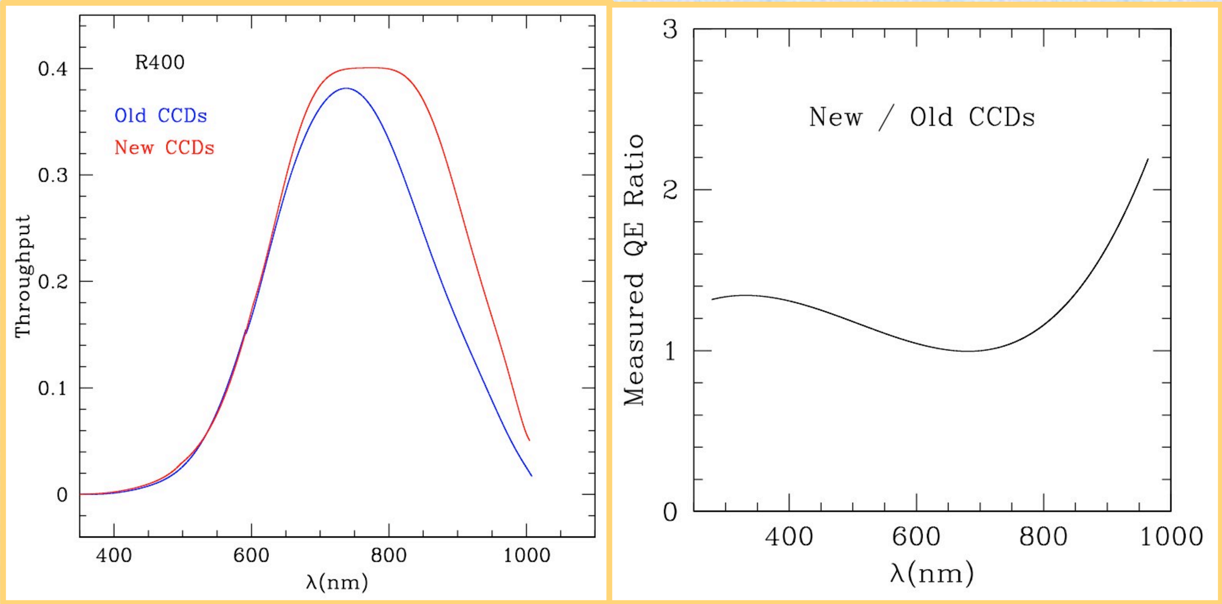
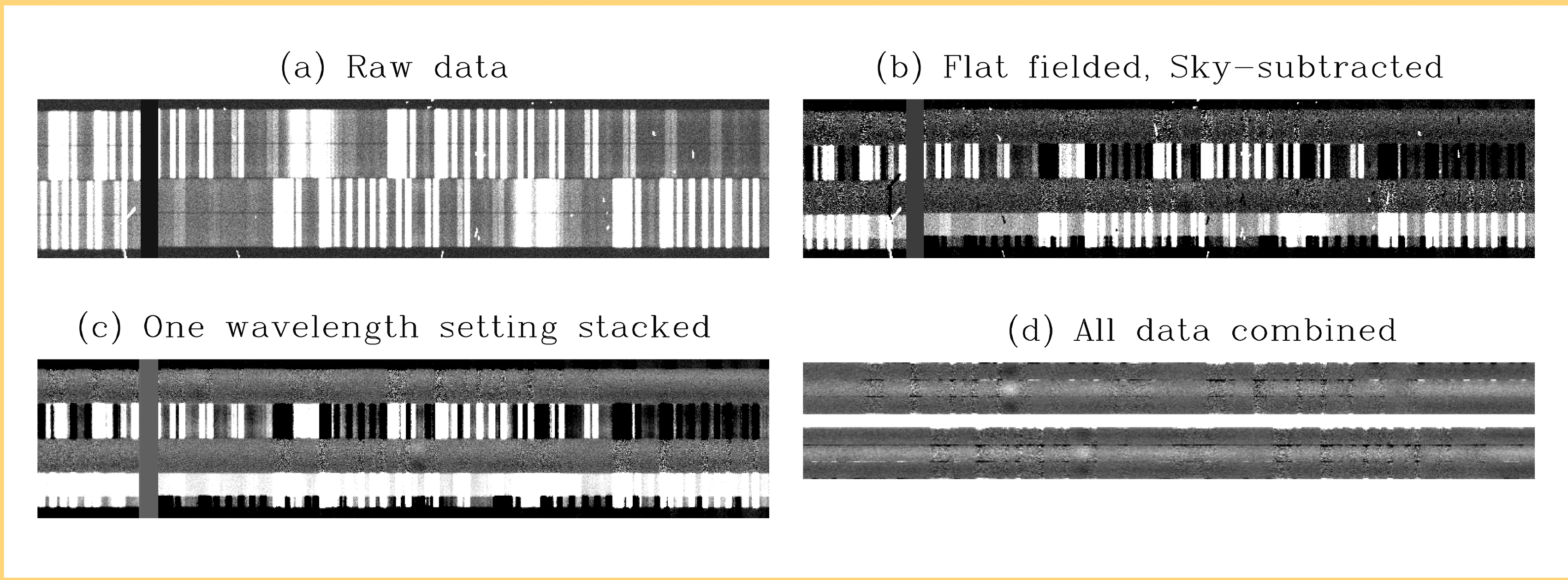


Fig 6. Left: Preliminary comparison of spectral throughput for the two sets of CCDs using the R400 grating, based on observations of spectrophotometric standard stars taken in photometric conditions with a wide slit. Right: ratio between the QEs of the new and old CCDs, measured from ratios of flat fields taken with the same setup for both sets of CCDs.

Fig 7. Data reduction steps for nod and shuffle spectroscopic observations. These were challenging observations of faint, z'_{F850LP} = 22-24.5 mag galaxies. Virtually nothing is seen in individual frames. Faint spectra are visible in the final processed, combined image.



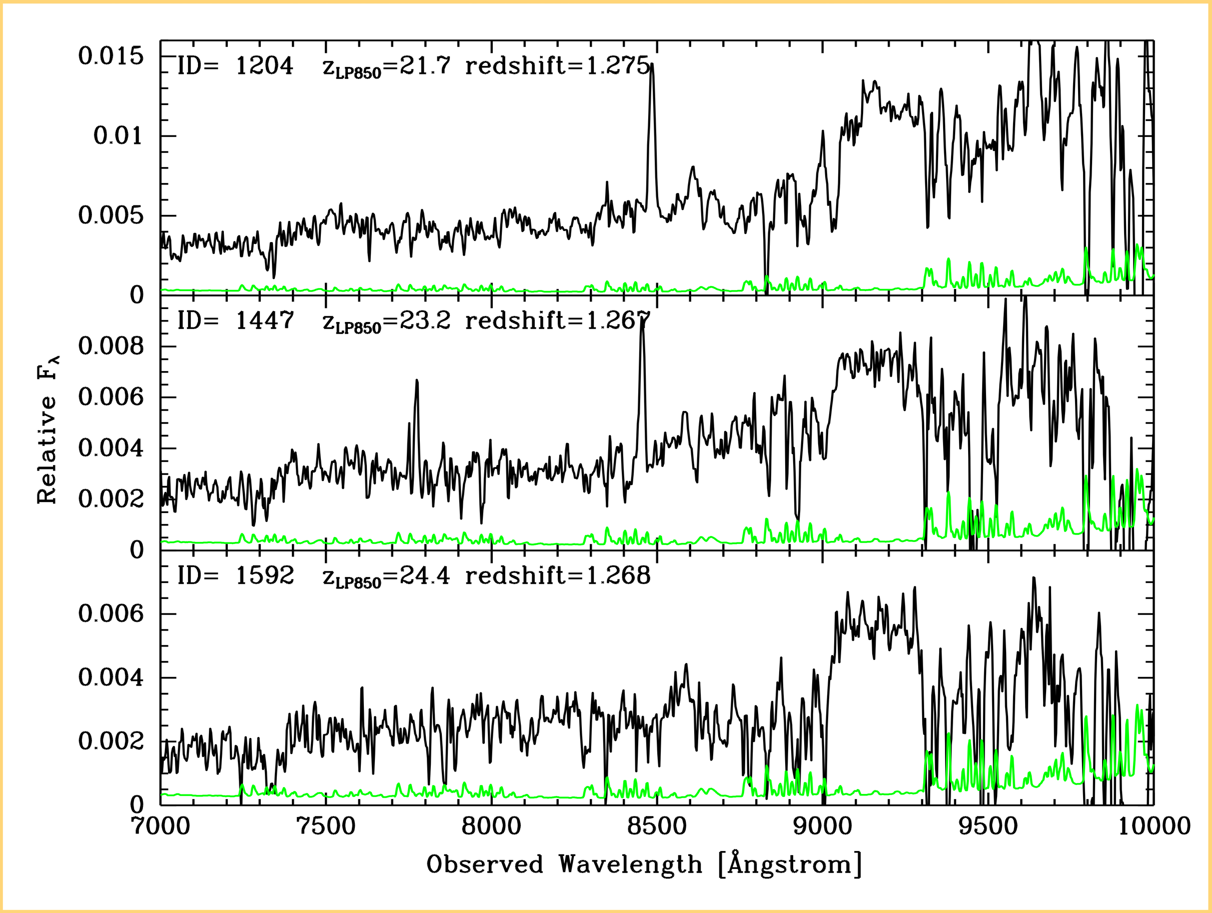


Fig 8. Spectra for 3 galaxies in RXJ0848.6+4453 observed with the new deep depletion E2V CCDs. Observations are 10.5h open shutter nod-and-shuffle, using the R400 grating and 1" slit width. Average seeing was 0.55".

These observations demonstrate use of the new CCDs in the far red and test the reduction software. Wavelength coverage this far red was previously unfeasible with GMOS-N. Data reduction scripts are currently being refined to improve sky subtraction in the far red.