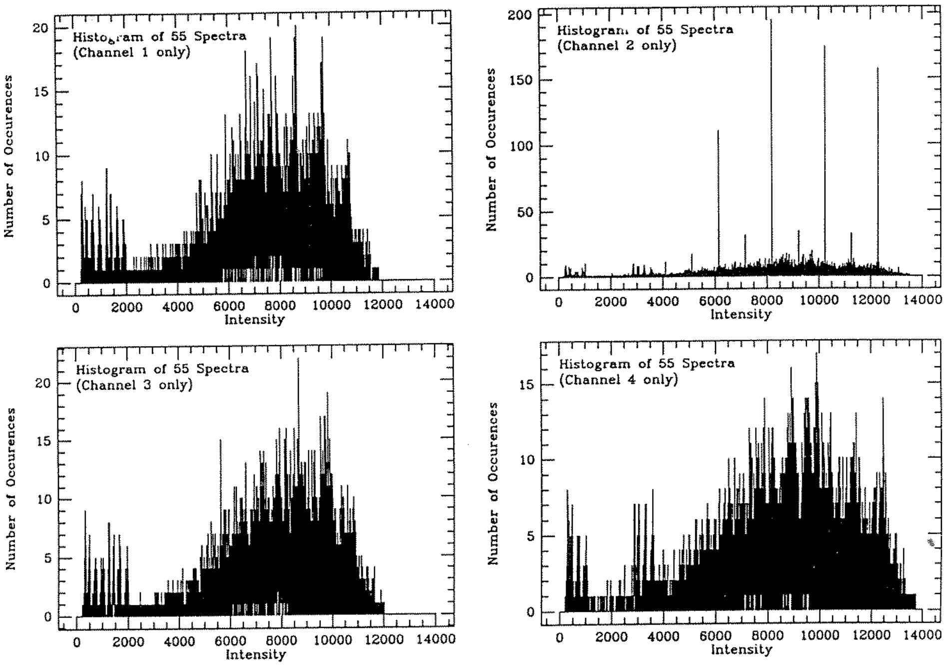

Figure 7: Histograms for each of the four separate channels of raw data from the Reticon before it was repaired. Although only the ADC for channel 2 was actually defective, the other three channels show the same non-linearity at a very low level.

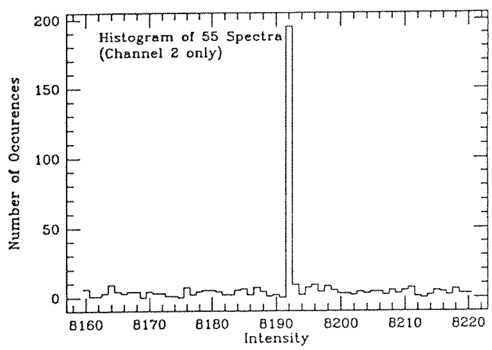

Figure 8: Detail of the histogram of channel 2 given in Figure 7, showing how the next lower intensity level just below the spike has no counts.

Figure 7 shows histograms of intensity values for each of the four channels generated from 55 'raw' spectra taken with the CFHT system before repair. Although you can see small spikes for the other three channels, the large spikes in channel two are the most obvious. Figure 8 shows more detail in the region of the large spike at ADC level 8192, where you can see that there are no values at all at 8191. The analogy with the simulation in Figure 6 is quite striking.

Despite our success in curing the problem there seems to be no way to recover the mis-converted data in the original spectra. For most scientific programs a mean of the neighboring channel 1 and channel 3 values (after correction for baseline and amplification factor) is a satisfactory substitute for a delinquent value in channel 2. For further advice please contact one of the authors.

It is interesting to note that none of the ADCs are immune to this non-linearity problem, which must ultimately set a limit to spectrophotometric precision at high signal-to-noise levels.

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First Lab and Sky Tests of the Low Noise 1024^2 FORD/SAIC CCD

A 1024x1024 CCD array, with 18 micron pixels was acquired on loan from the Scientific Applications International Corporation (SAIC). This imager, manufactured at the Ford Aerospace foundry, employs a 3-phase, buried-channel technology. With a low read noise, excellent CTE and QE response normal for a thick CCD, the SAIC device is a very attractive CCD. Extensive lab tests were performed to optimize the chip behavior, as well as 2 nights of PF observing.

The first lab tests showed immediately a non linear response in several vertical "bar regions" on the left side of the detector, at signals above 20000 e^-. This behavior was confirmed by flat field exposures taken on the telescope dome through broad band filters, where the departure from linearity was seen at even lower levels of 12000 e^- in the I band. This behavior is believed to be wavelength dependent. A compromise between the full well capacity and the gain setting (final = 2.4 e^-/ADCU) lead to a read out noise of 6.4 e^- for a useful data range of 54000 e^- (the respective best values were 5.7 and 100000 e^- resp.).

Cosmetically, 4 bad columns are present (some are a set of several bad columns), either hot or cold, and are spread out across the device. Up to 300 traps can be detected across the CCD, and consist of several connected pixels that appear to have a lower QE by 5 to 30%. Due to this property, these areas are corrected nicely by basic flat fielding techniques, leaving a nearly clean image. The on-sky behavior is quite good with very little bleeding from saturated star cores, with a 4.2 x 4.2 $arcmin^2$ field of view. The read out noise was measured as 8.3 e^- on the telescope due to an unexpected pick up noise in the power supply that was eliminated latter. The QE compares to our smaller Ford device PHX1, except for the reduced UV-blue response since the device is not Metachrome II coated, and a higher QE in the far red (I band).

In conclusion, this chip is very promising for low light level applications, although great care would have to be taken to avoid placing crucial objects or spectral features on bad columns or QE deficient "traps", nor to exceed 12000-15000 e^- on the non-linear regions. For these reasons, this chip is not yet to be released for general use. Discussions with the SAIC corporation are in progress to exchange that device with a similar one of better grade within a few months.

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