

LATEST NEWS ON INSTRUMENTATION

FTS Implementation Under the New Data Acquisitions Environment

The night of 6 November 1989 marked the end of an era, as the beginning of the first FTS run to use the new HP 9000 computers. The FTS was the last CFHT instrument to be moved from the HP 1000 computers to the HP 9000's.

The first task in the conversion to the new computers, due to different hardware architectures, was to modify the computer interface to the FTS electronics in such a way that the HP 9000 system could successfully communicate with the FTS. The changes, specified and implemented by Bernt Grundseth, Philippe Papasian, and Mark Barbour, went beyond providing a basic interface. They in fact offloaded the most real-time intensive tasks to a microprocessor, thereby liberating the HP 9000 to perform other higher level tasks, for example, real-time FFT's.

Having already successfully ported several major instruments to the new X Window-based user interface, the software team of John Kerr, Bernt Grundseth, Jon Brewster, and Steve Smith, eagerly faced the challenges of the FTS. The most demanding developments were to occur in the real-time plotting packages and the interactive tools needed by the observer to make critical decisions before starting a scan.

The first run with the new computers was intensive. In addition to Jean-Pierre Maillard, and the support astronomer, Tim Davidge, the system was used by 5 different observing teams in a span of seven nights. Much good data was obtained and the new computers proved to be up to the task of managing the FTS.

It is perhaps appropriate that the HP 1000 computers finish out a decade of service to the software group just as CFHT commences its second decade of operations.

John Kerr

Reticon Fix

After a decade of nearly trouble free operation during which we extolled at meetings the virtues of 1872 Reticons for quality spectrophotometry, we were rather slow to respond to a subtle electronic problem which emerged in the last twelve months with the CFHT system. Observers began to complain about small nicks and spikes which often appeared in flat-fielded spectra, an example is shown in Figure 5. They occur in groups with an 8-point period that cannot be eliminated with the usual 8-point normalization. After inconclusive tests at the telescope the system was returned to UBC

Figure 5: A portion of a Reticon spectrum of an early-type star taken in the near-IR, showing two Pachen lines, several lines of HF super-imposed on the stellar continuum. The large number of positive spikes extending over most of the right-hand side of the spectrum are due to the ADC problem. The data have had a mean baseline subtracted and have been divided by a flat field lamp exposure.

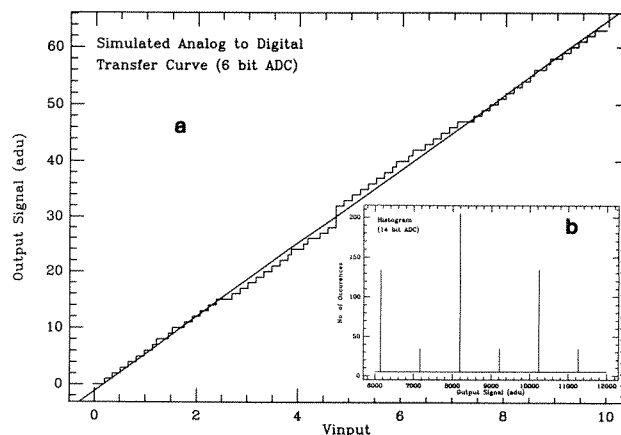
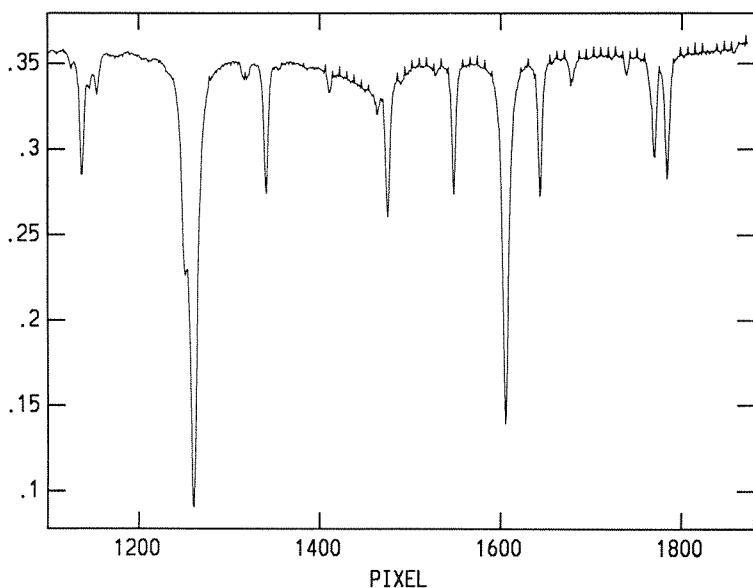


Figure 6: (a) The non-linear step function curve represents a simulated curve for a defective analog-to-digital converter. The straight line of a proper linear transfer curve is shown for reference. (b) The histogram resulting from the defective transfer curve shown in (a), where the input signal is a smooth ramp function.

in August 1989, where the fault was traced to a defective analog-to-digital converter (ADC) in the second channel of the video processing electronics (the 1872 Reticon has four independent outputs).

The ADCs with both the Reticon and CCD detectors use a method of successive approximation to compare the input signal voltage with the various internally established reference voltages that define the bit levels. If one of these internal references is not in a precise binary ratio with its neighbors the ADC output will not be a linear step function. To simulate this we defined a faulty ADC calibration shown in Figure 6a. Figure 6b shows the resulting histogram of output numbers in response to a (noiseless) linear input voltage ramp. The spikes at some numbers and obvious deficits at others are the result of the flawed conversion process.

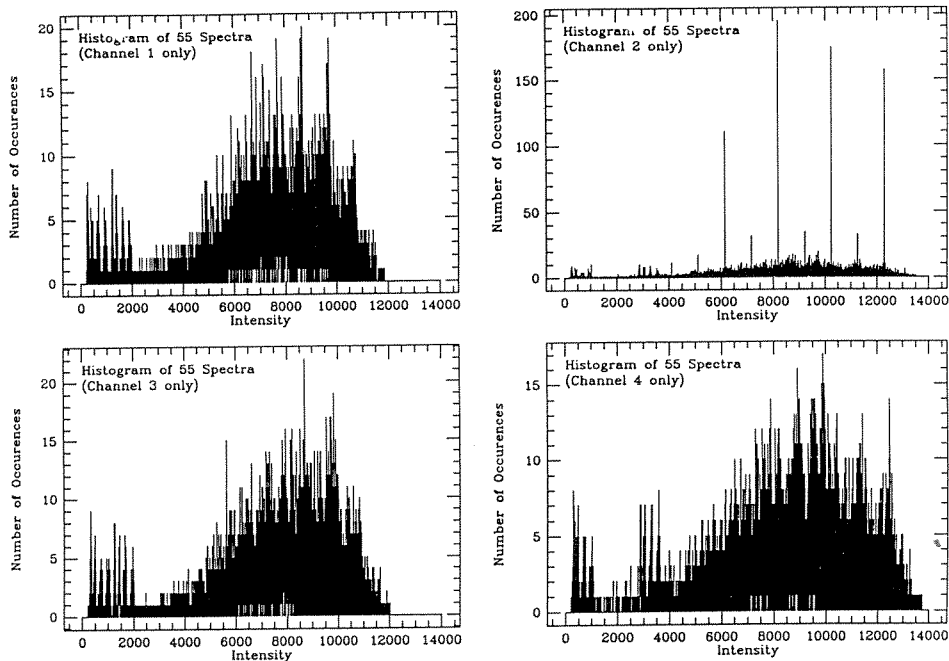


Figure 7: Histograms for each of the four separate channels of raw data from the Reticon before it was repaired. Although only the ADC for channel 2 was actually defective, the other three channels show the same non-linearity at a very low level.

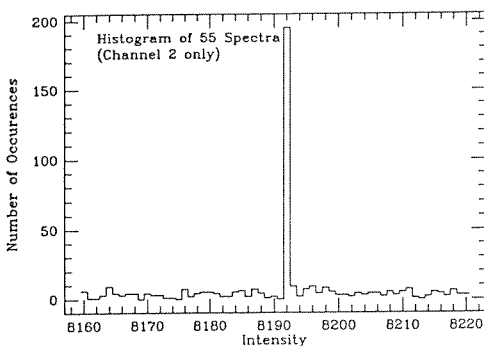


Figure 8: Detail of the histogram of channel 2 given in Figure 7, showing how the next lower intensity level just below the spike has no counts.

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 1024² 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 arcmin² 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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