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TECHNICAL REPORT NO. 360

The Installation of a Digital Autoguider and Tiger Counters in Narrabri in 2013 April

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Abstract

A digital autoguider (the "mount controller") was installed. New "Tiger" counters replaced the existing, broken, scaler system.

1   Introduction

Steven Hale and Guy Davies visited Narrabri from April 7 to April 30. We installed a new digital autoguider — our third mount controller — on this trip.

We also replaced the old computer, the broken scaler system, the cloud detector, and removed the redundant modules from the crate.

2   New Autoguider

We upgraded the autoguider and mount control system on this visit. The following items were changed:

1. Four modules in the main electronics crate were replaced by the mount controller [1]. These four modules are now no longer needed; they are the autoguider module, the RA and DEC stepper modules, and the mount encoder module.

2. The RA and DEC stepper motors were replaced.

3. The cabling to the motors, limit switches, and the autoguider telescopes was replaced.

The following items were not changed:

1. The autoguider telescopes,

2. The encoders and cables,

3. The mount limit switches.

Motors: Installing the new stepper motors was the most difficult part of the replacement. The new motors were chosen so that they were physically similar in size to the stepper motors we use elsewhere.

The mount in Narrabri is similar to the one in Las Campanas, but there are some small, undocumented, differences. Motor mounts were made in Birmingham by Barry Jackson, but we could not be absolutely sure they would fit. The brackets were very close to providing correct alignment of the motor and mount shafts. The brackets were machined for us by "Tuffy" in Narrabri to allow correct placement, and to increase the clearance slightly between the brackets and the mount.

Unfortunately, on the Dec motor the actual motor itself was hitting the mount centre box. The only solution to this was to file a chamfered edge onto the mount itself to provide enough clearance.

Guider Head: The autoguider telescope was not replaced. A new wye-cable was made in order to branch out the coarse and fine guider signals from the MIL connector to two D-connectors. The wiring of the guider quadrants was not known in advance, and had to be determined by connecting the signals through some breadboard and watching to see what the guider did given a range of error signals.

The resulting wiring configuration is the same as the guider in Carnarvon.

Limits: The limit switches on the mount in Narrabri are very nice. There are four switches on each axis, and they are adjustable to allow the trip position to be set. The microswitches themselves were not replaced, but new cabling was installed and the switches adjusted to work correctly with the new mount controller — this was required since we can now measure four switches on each axis.

Gain: The photodiode gain for the fine guider was increased by changing the gain headers inside the mount controller. A value of $1.8\,\mathrm{k\Omega}$ was determined to be suitable — this placed the output from the diode at midrange on the ADC when the mount was on finelock. No adjustment to the feedback capacitor was required since the gain is still quite low and the signal does not oscillate.

The alignment of the coarse guider was adjusted to match the fine guider. This was done by looking at the values from each quadrant when the mount was on finelock.

Once everything was set, the guider thresholds were set on the computer to define when the switching takes place from seeking, to coarse guiding, and to fine lock.

3   Tiger Counters

Prior to this site visit, something had happened that damaged the counters. It appeared that the framing was inconsistent and roughly every other four-second count would result in the digits being read out on the wrong channels. Mike in Narrabri had done his best to try to solve the problem, but had not been successful. This is not surprising given the poor documentation available on the old wire wrap systems.

The counter modules were replaced with one of our new counter units designed by Tony Taylor. The installation proved to be straightforward, with only a few cables having to be rerouted. The trigger levels for the counter channels had to be reduced slightly to allow for a lower than normal pulse voltage from the detectors. The trigger was initially set at 2.5 V in order to be midrange on the logic scale. The trigger was reduced to 1.7 V to allow consistent triggering from the detectors.

4   Computer

The computer in Narrabri was ten years old. It was running Fedora Core 5 and had one hard disk that had already failed.

A new computer was installed on this visit. The case took quite a battering from the DHL "delivery" service. But luckily no permanent damage was inflicted, and the computer still worked.

Two different hard disk manufacturers were selected. We have had lots of trouble with Seagate disks, so only one Seagate disk was installed — the other being a Western Digital.

The computer was configured with a fresh installation of Fedora 14. This is still two years out of date, but the device drivers for the DIO card need to be updated and do not work with any kernel after that shipped with Fedora 14.

5   Tuning

5.1   Guider Alignment Scans

Four autoguider scans were performed. Both axes were scanned with the potassium cell cold, and then again with the cell hot. The results from the cold scan are shown in figures 1 and 2. The results from the hot scan are shown in figures 3 and 4.

Initially the RA micrometer was set to 9.1 mm and the Dec micrometer set to 8.5 mm. The scans show the ideal alignment to be at RA 9.0 mm and Dec 8.5 mm.

We believe we haven't changed the spectrometer or telescope alignment. Since the weather was not really cooperating and we had lots of other work to do, we did not do any further guider scans.

5.2   PCD Calibration

Both the Pockels cell drivers were calibrated following the change to the Tiger counters.

The EOLM output from the Tiger counters is different from the old gate module. With our new PCD units calibration would not have been necessary since they are logic controlled. However, the old "Richard Lines" PCD drivers are basically just big amplifiers and so the calibration is dependent on the voltage from the gate module.
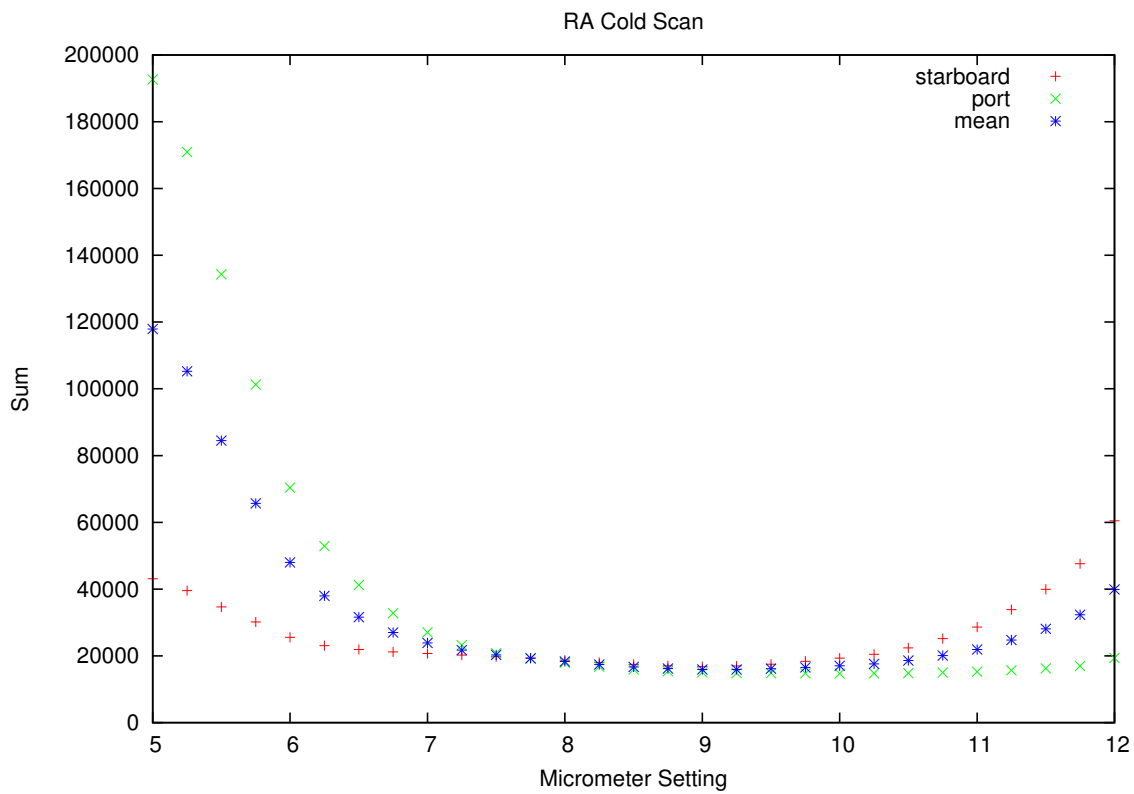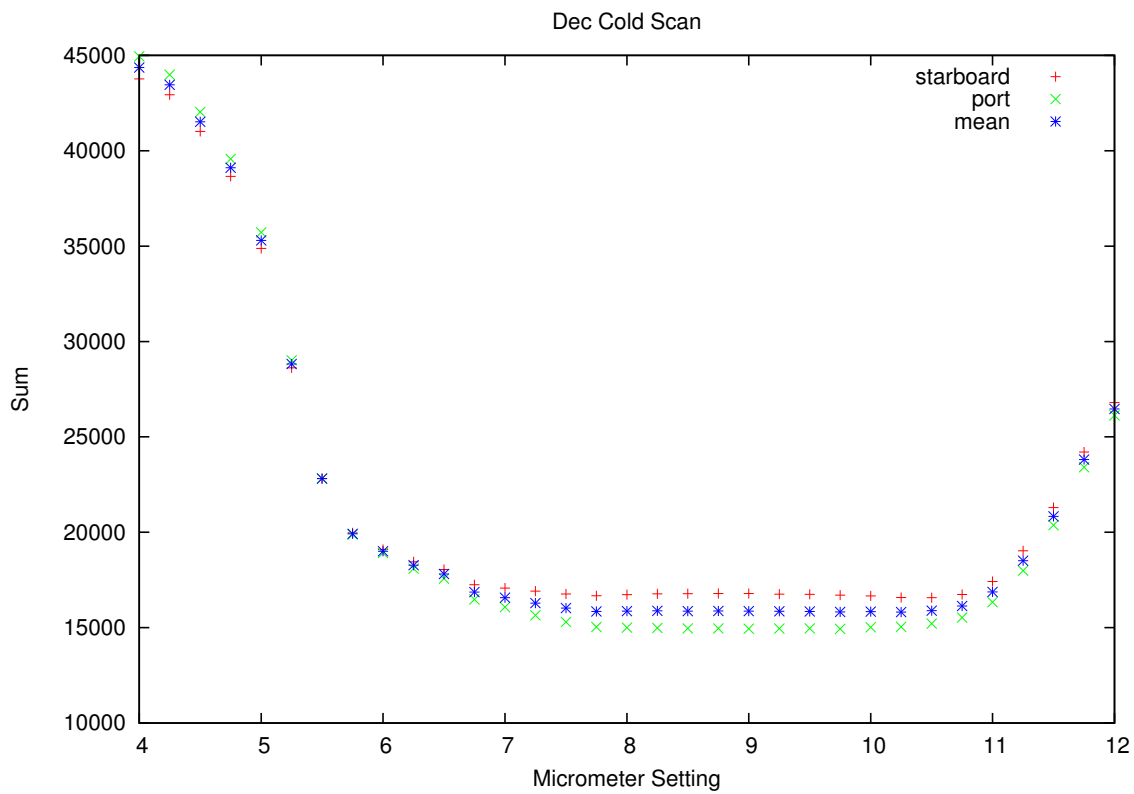
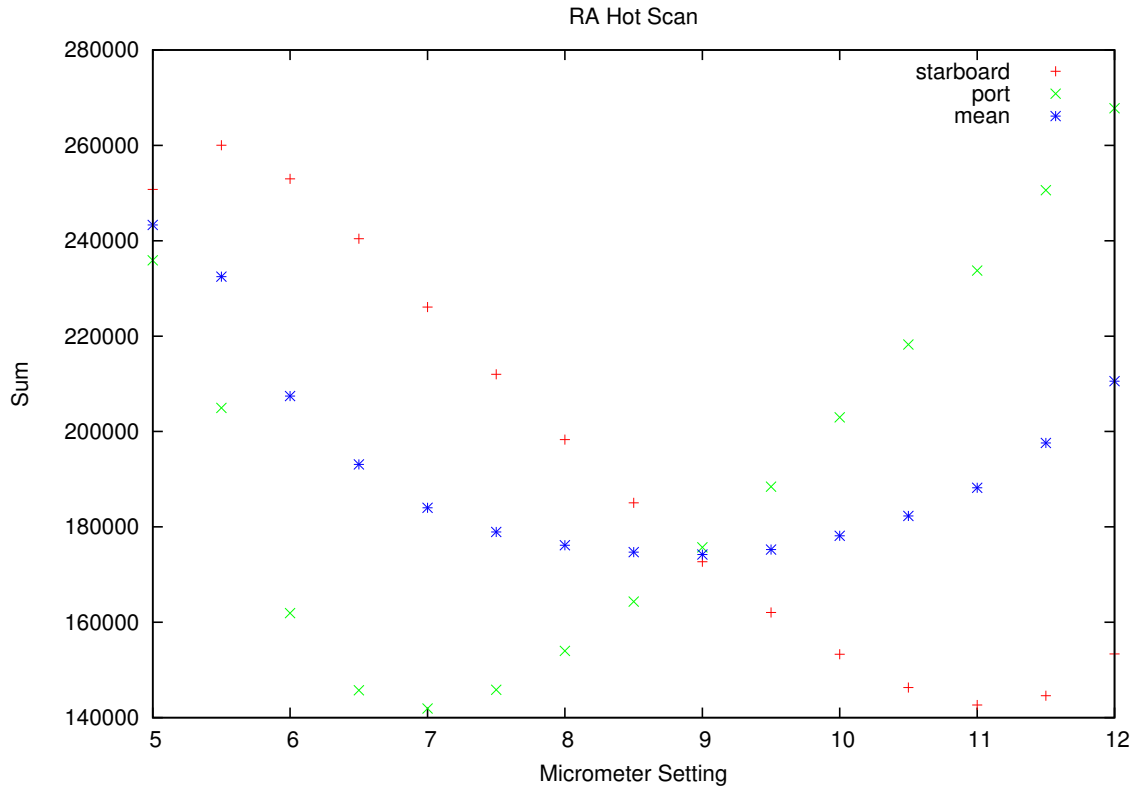**Figure 1**: RA Cold.

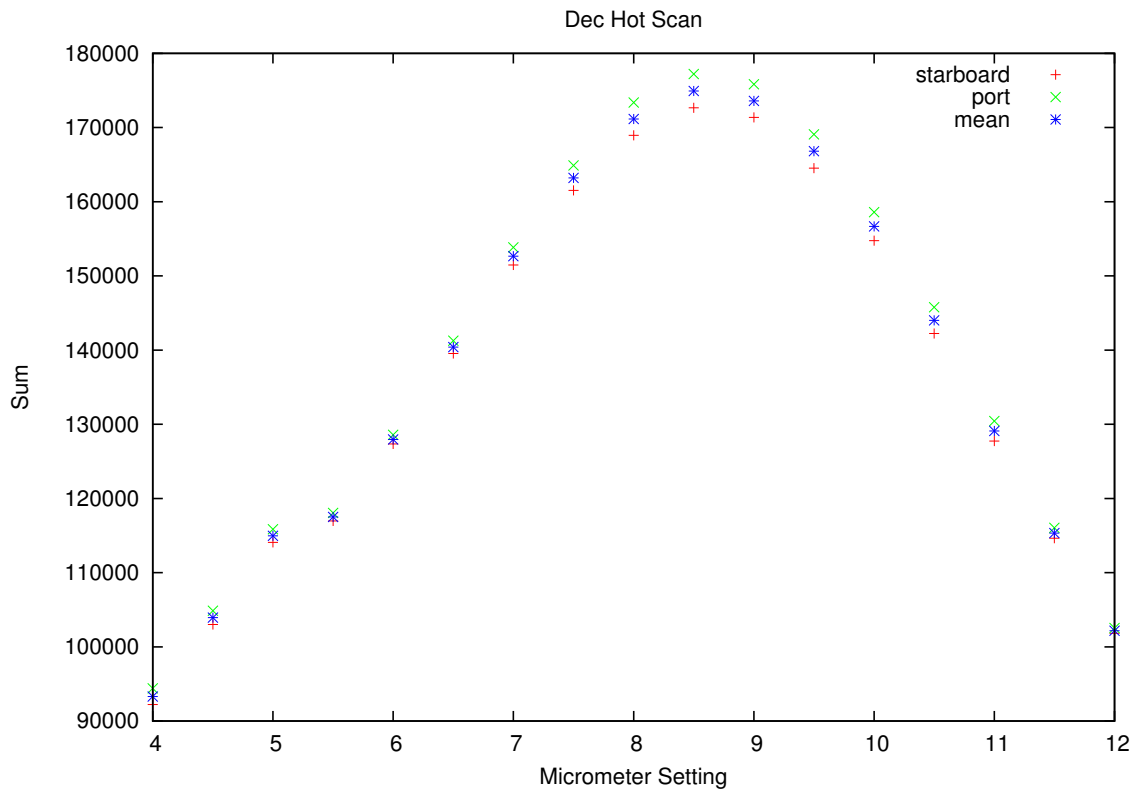**Figure 2**: Dec Cold.

Figure 3: RA Hot.

Figure 4: Dec Hot.

The delta-B was disconnected and the magnetic Pockels cell removed. The driver was scanned over the full range while looking at the velocity ratio output from the detectors. The results are in figure 5. The initial setting was "230", the new scan suggests the best setting is "260" and so the velocity driver was adjusted to the new optimum.

Calibrating the magnetic Pockels cell is slightly more tricky. The magnetic Pockels cell was replaced, and the velocity Pockels cell removed. The magnetic Pockels cell was then moved behind the polariser into the velocity position. The scan was then repeated using the magnetic cell and driver. The results are in figure 6. The initial setting was "250", the new scan suggests the best setting is "300" and so the magnetic driver was adjusted to the new optimum.

All optical components were then moved back to their original positions.
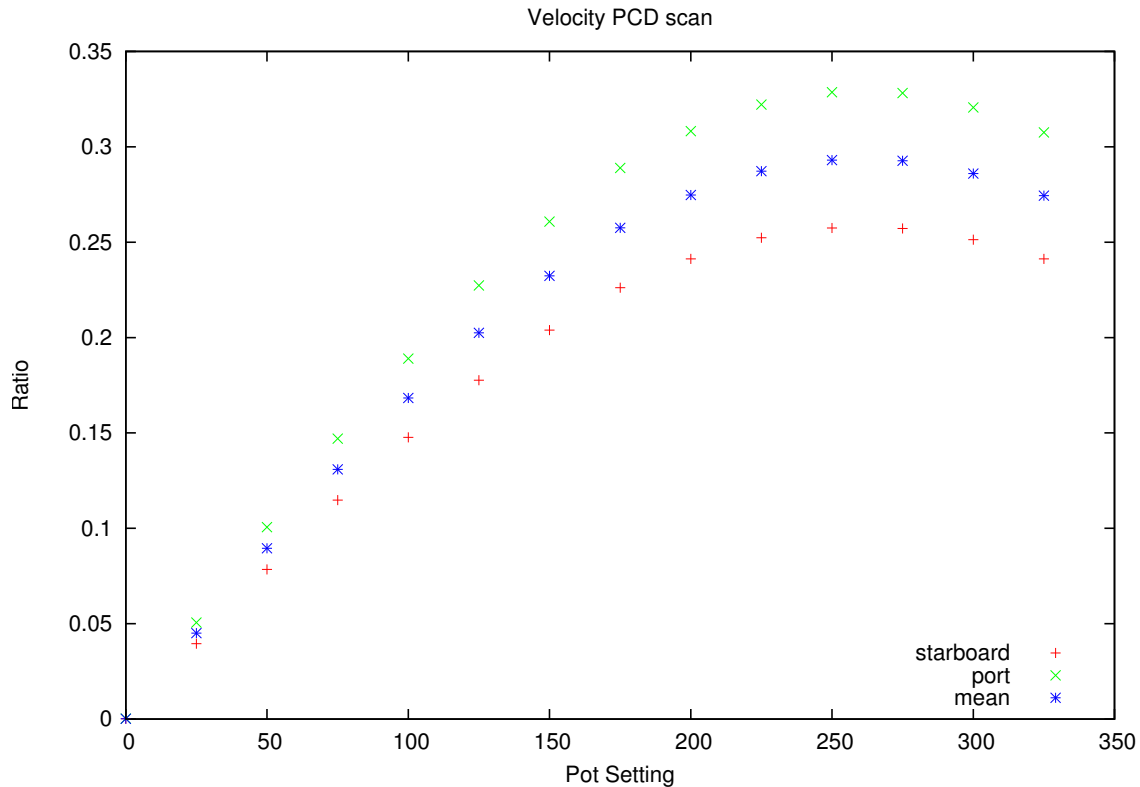
Figure 5: Velocity PCD scan.

5.3 Oven Temperature Scan

The potassium cell was slowly scanned over a range of temperatures. The results are in figure 7. Initially the oven was set to 113 C. The temperature scan shows 115.5 C to be correct, and so the temperature setpoint was updated.

5.4 Interference Filter Scan

The interference filter was slowly scanned over a range of temperatures. There does not appear to be a strong correlation between temperature and filter characteristics — nothing could be determined from the scan. The temperature setpoint was left at the existing 38 C.
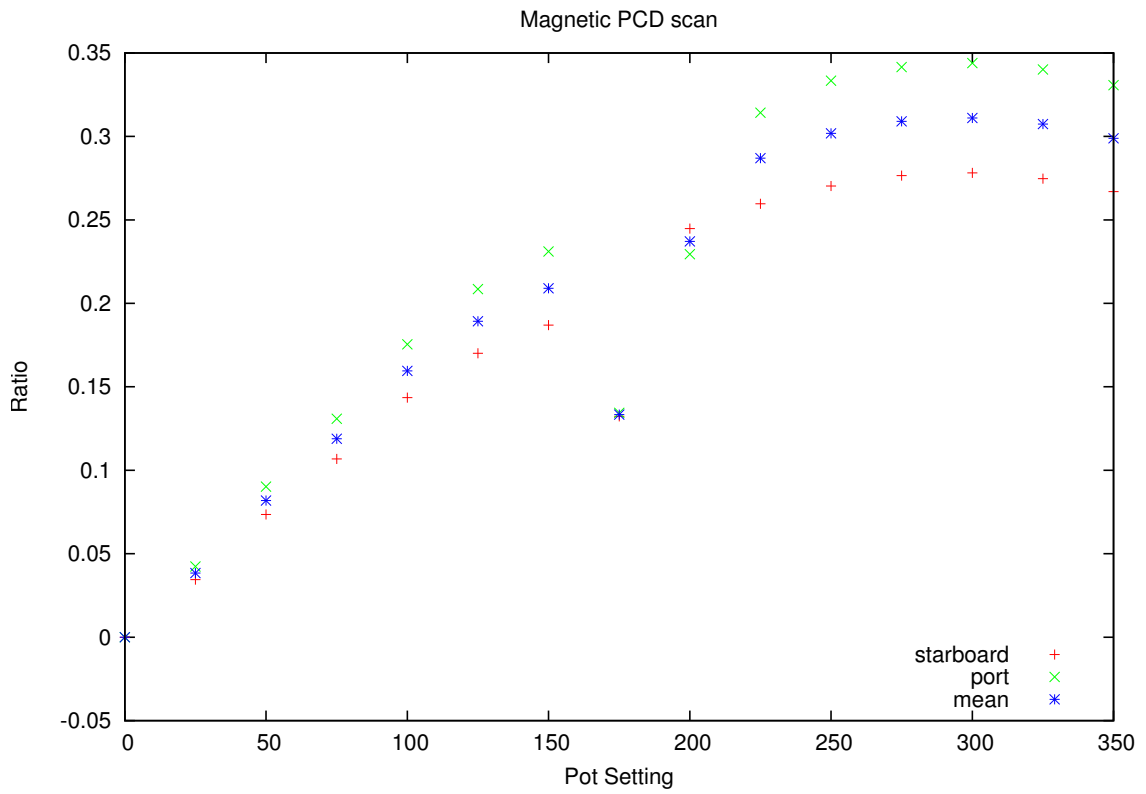
Figure 6: Magnetic PCD scan.

Figure 7: Oven Temperature Scan

5.5 Coarse Filter Cleaned

The front filter was cleaned, providing a noticeable increase in counts.

6 Shutter Problem

There was an intermittent problem with the shutter. Occasionally the shutter would not drive up. After a long, variable, delay the shutter would eventually move to the correct position.

The fault was difficult to trace. It was eventually tracked down to a high-resistance connection between the logic UP line and the connections board in the relay box. The delay was due to the high resistance - the shutter module wo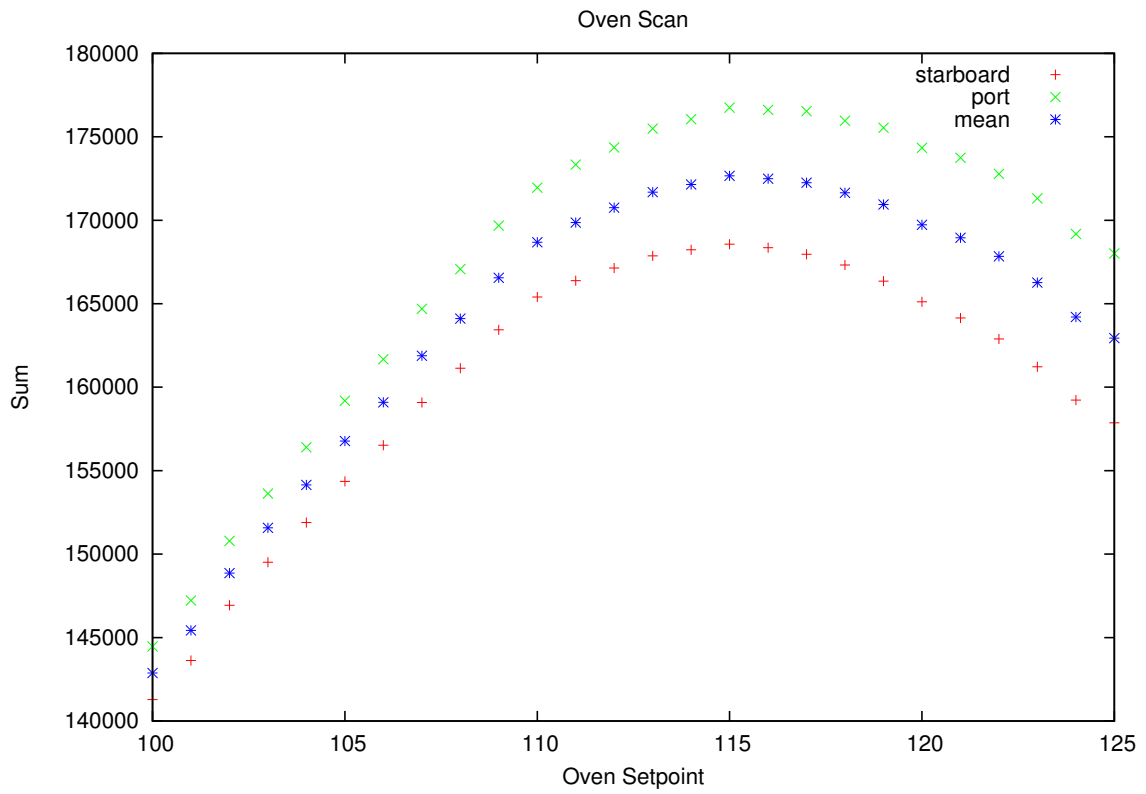uld switch the UP line to tell the shutter to drive UP, but the high-resistance meant it took a long time for the line to actually change state and trip the solid-state relay.

The direction control lines from the shutter and dome modules connect to PCBs in the relay box that have test buttons for driving the shutter and dome. It was the screw terminal on the shutter PCB that caused the problem. This PCB was removed, and the control lines connected directly to the appropriate relays. It worked. The problem was solved.

Unfortunately when reassembling everything, the LED board that indicates the states of the relays fell out of position and applied mains voltage to the shutter control lines. It seems hard to believe that the LED display board actually carried mains voltages as opposed to monitoring the low-voltage logic levels. It is harder still to believe that this board was only wedged into place and not fixed properly.

Sending mains voltages down a logic control line does not do the attached hardware much good. It went with quite a bang. Several ICs in the weather module were damaged, along with burnt tracks on interface module three. The tracks were rebuilt with wire, and the damaged ICs located and replaced with spares. Luckily everything came back to life.

The only permanent damage was to the DIO card in the computer. Several channels are now "stuck" either on or off. The list below shows the results of a write-and-compare test of the card.

```
Port 0A: write=>00000000<, read=>00100000<
Port 0A: write=>11111111<, read=>11111111<
Port 0A: write=>10101010<, read=>10101010<
Port 0A: write=>01010101<, read=>01110101<
Port 0A: write=>00000000<, read=>00100000<

Port 0B: write=>00000000<, read=>00100000<
Port 0B: write=>11111111<, read=>11111111<
Port 0B: write=>10101010<, read=>10101010<
Port 0B: write=>01010101<, read=>01110101<
Port 0B: write=>00000000<, read=>00100000<

Port 0C: write=>00000000<, read=>00100000<
Port 0C: write=>11111111<, read=>01111111<
```

```
Port 0C: write=>10101010<, read=>00101010<
Port 0C: write=>01010101<, read=>01110101<
Port 0C: write=>00000000<, read=>00100000<

Port 1A: write=>00000000<, read=>00100000<
Port 1A: write=>11111111<, read=>11111111<
Port 1A: write=>10101010<, read=>10101010<
Port 1A: write=>01010101<, read=>01110101<
Port 1A: write=>00000000<, read=>00100000<

Port 1B: write=>00000000<, read=>00100000<
Port 1B: write=>11111111<, read=>11111111<
Port 1B: write=>10101010<, read=>10101010<
Port 1B: write=>01010101<, read=>01110101<
Port 1B: write=>00000000<, read=>00100000<

Port 1C: write=>00000000<, read=>11111111<
Port 1C: write=>11111111<, read=>11111111<
Port 1C: write=>10101010<, read=>11111111<
Port 1C: write=>01010101<, read=>11111111<
Port 1C: write=>00000000<, read=>11111111<

Port 2A: write=>00000000<, read=>00100000<
Port 2A: write=>11111111<, read=>11111111<
Port 2A: write=>10101010<, read=>10101010<
Port 2A: write=>01010101<, read=>01110101<
Port 2A: write=>00000000<, read=>00100000<

Port 2B: write=>00000000<, read=>00100000<
Port 2B: write=>11111111<, read=>11111111<
Port 2B: write=>10101010<, read=>10101010<
Port 2B: write=>01010101<, read=>01110101<
Port 2B: write=>00000000<, read=>00100000<

Port 2C: write=>00000000<, read=>00100000<
Port 2C: write=>11111111<, read=>11111111<
Port 2C: write=>10101010<, read=>10101010<
Port 2C: write=>01010101<, read=>01110101<
Port 2C: write=>00000000<, read=>00100000<

Port 3A: write=>00000000<, read=>00100000<
Port 3A: write=>11111111<, read=>11111111<
Port 3A: write=>10101010<, read=>10101010<
Port 3A: write=>01010101<, read=>01110101<
Port 3A: write=>00000000<, read=>00100000<

Port 3B: write=>00000000<, read=>00100000<
Port 3B: write=>11111111<, read=>11111111<
Port 3B: write=>10101010<, read=>10101010<
Port 3B: write=>01010101<, read=>01110101<
Port 3B: write=>00000000<, read=>00100000<
```

```
Port 3C: write=>00000000<, read=>00100000<
Port 3C: write=>11111111<, read=>11111111<
Port 3C: write=>10101010<, read=>10101010<
Port 3C: write=>01010101<, read=>01110101<
Port 3C: write=>00000000<, read=>00100000<
```

A new DIO card was sourced directly from Advantech in Australia. The new card is a "BE" version of our original "PCI-1753". The information printed on the card itself says "PCI-1753-BE Rev:B1". There are no major changes to the design /emdash it is a drop-in replacement for our original card. The main update appears to be some switches to enable the address of the card to be set. We left it set to the default, which matched the card that was removed. The broken card was brought back to Birmingham. It still has many functioning channels and can be used for testing.

Both LED status boards were removed from the relay box to ensure the same thing does not happen again.

7 V/F Pinout

The only modules remaining in the main crate are the dome controller and the power supply for the detector V/F converters. If we install a new dome controller, and replace the V/F power supply we can remove the old main crate completely. No more wire wrap!

The MIL connector that provides power to the detectors has ten pins. Only three of them provide power. Pin C shows $+5\,\mathrm{V}$, pin G shows $-20\,\mathrm{V}$, pin H shows $+20\,\mathrm{V}$, and pin J is ground.

It is not clear if all three voltage rails are required. The $+5\,\mathrm{V}$ rail is provided by a L7805 regulator. The two other rails come directly from the main crate unregulated supply.

References

[1] Ian Barnes and Brek A. Miller. The Mount Controller: A digital autoguider for Carnarvon. *BISON Technical Report Series,* Number 349, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, January 2012.