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Jabba is Returned to Carnarvon in 2009 July

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Abstract

We visited Carnarvon from July 1 to 17. We put Jabba back on the mount. We also upgraded the computer from Fedora Core 5 to Fedora 10.

1 Introduction

Barry, Ian, and Brek removed [1] Jabba from the mount in 2006 November. We spent two and a half years refitting the spectrometer. It was ready to go back to Carnarvon.

2 Jabba

We put Jabba back on the mount and connected all of the electronics. It works well.

2.1 Selecting the Position for Jabba

Les Schultz and David helped us put Jabba on the mount. Then Les helped us put Jabba on the mount again. Then again. It took us three tries to get it right. Let us explain why.

Before putting Jabba on the mount, we noticed that the forward two holes on the left and right edges of the center box have been drilled out and tapped to M8. We don't know why. All of the other holes are still M6, like they should be.

Jabba has never had 8-mm holes in its baseplate. So we assumed that these front M8 holes were not to be used. The holes in Jabba's baseplate are 350 mm and 500 mm from the aft edge. The holes in the center box are 50 mm apart in the direction towards the sun. (They are 57 mm apart in the direction transverse to the sun; but that isn't important for this story.) Avoiding the M8 holes in the center box; there is only one place to which Jabba can be fastened. And that is where we put it.

We found that we were unable to balance the mount properly. We examined some old photographs and concluded that Jabba used to be perhaps 50 mm further forward. We examined the baseplate of Jabba and looked for the old holes. There is some evidence that they were 250 mm and 350 mm from the aft edge. If the old 250-mm holes were to go where we put the new 350-mm holes, Jabba would be 100 mm further forward and there would be no need to use the M8 holes. So where should Jabba go? Should it go 50 mm or 100 mm further forward. The evidence was conflicting. Brek guessed 100 mm.

Les helped us move Jabba 100 mm further forward. We drilled out the 500-mm holes to 8.5 mm and used some M8 bolts that we found. They are not countersunk. This is not ideal; but at least Jabba won't fall off the mount.

We tried balancing the mount. It is close; but it wanted a little bit of weight on the back of the 2DGM. However, there was no way to put any weight there (see the next section).

There was another problem with this position for Jabba: it was not possible to get the forward detectors in and out without disassembling them. The front magnet was blocked by the yoke regardless of where the mount was moved in declination.

So we moved Jabba, again. This time we moved it back 50 mm to the intermediate position. It looks like the holes really were at 350 mm and 500 mm from the aft edge and that some M8 holes were used. But we cannot work out how Jabba used to be attached like this.

2.2 Balancing Jabba

Balancing Jabba was more difficult than we had expected it to be. We didn't have photographs showing the old positions of the counterweights. It was a mistake not to take such photographs when we removed Jabba.

Brek has now looked back through older photographs and he has found some prints from 2002 December showing where the counterweights used to be. The positions that we chose on this trip are slightly different. We're not sure which choice is better. We will now describe the counterweight situation in some detail. This information will be useful in the future to anyone who wants to try to rebalance the mount. However, for the casual reader, this next section will be uninteresting and may be skipped.

Keep in mind that while we were trying to balance the mount, we were not completely sure that we had Jabba back in its original position. We were always haunted by the thought that it might not be possible to balance the mount in this configuration.

The first thing that you need to know about the Carnarvon counterweights is that there were only three places where they could be attached; and we didn't notice one of those places at first because the old holes had been covered. It will be easier if we describe these three locations (plus one decoy) in detail.

1. **Front of the 2DGM.** Thinking back to the time when Jabba was on the mount, we tried to remember where the counterweights were. But there was only one place that came to mind. This place was the front of the 2DGM. At first glance, this was also the only obvious place to put counterweights.

   The 2DGM is a tube-and-bulkhead design just like Jabba. The tubes are not used as cooling pipes though and there were four 3/8 BSW studs screwed into the front of the tubes. 3/8 BSW is close to M10. These studs held an aluminum heat shield (painted white) and several sheets of lead flashing, each of which had four holes meticulously cut in it — one hole for each of the four apertures on the front of the 2DGM. There was another aluminum plate behind the lead making a sandwich of sorts.

In the end, we did not choose to put these counterweights back on. Though they are still in the dome and can be used again if necessary. We'll describe how we compensated for this missing weight later.

2. **Back of the 2DGM.** There were four M8 studs sticking out of the back of the four tubes on 2DGM. It looked like someone had tried to put counterweights here at some point. But M8 studs are far too small for the tubes. We examined them closely and found they were held in with silicone sealant! They aren't suitable for counterweights and we didn't put any here.

3. **Front of Mark V.** There are two M8 studs sticking out the front of Mark V just below the aperture. They were hidden behind the heat shield so we didn't notice them at first. We put one counterweight here. The old photograph shows that there was a counterweight here before. There is room for only one counterweight behind the heat shield. If more weight is needed here, holes will need to be drilled in the heat shield and longer studs put in.

4. **Back of Mark V.** While trying to balance the mount, we felt that it would be useful to have some weight at the back of Mark V. But there was no obvious place to put it. We removed Mark V's cover and we removed the PMTAmp from the back of spectrometer. This revealed some old holes that were in exactly the right places for counterweights.

   We removed Jabba on the same trip that we installed the PMTAmp. When we removed Jabba, we must have removed the counterweights and then put the PMTAmp over the holes. On this trip, we attached two counterweights to the back of Mark V and then attached the PMTAmp to the counterweights.

In summary, we placed one weight on the front of Mark V, two on the back of Mark V, and none on the front of the 2DGM. This seemed to balance declination pretty well. The old photographs show one weight on the front of Mark V, two on the back of Mark V, and the sheets of lead on the front of the 2DGM. The weight on the back of Mark V may have been sticking out farther from the spectrometer to compensate for the weight on the front of the 2DGM.

Although declination was well balanced, right ascension was not. We found that the mount fell towards zero hour angle. The force at sunrise and sunset was far too great — the mount was jumping teeth on the gears. We tried putting the extra weight on the front of the 2DGM. This fixed the right-ascension balance but messed up declination. Instead of the 2DGM weights, we bought eight new dive weights and put two new M8 studs on the yoke, one on each side. We put four dive weights on each stud. Weight placed directly on the yoke does not affect declination balance; but it does alter the right-ascension balance. We think the mount is now pretty well balanced in both right ascension and declination.

2.3 The Use of Ropes

There is one last thing about the mounting of Jabba that we think we should mention. We needed help getting Jabba on the mount. But the two of us managed to unpack Jabba and get it up onto the observing platform all by ourselves. And we did it quite easily too.

Back in Birmingham we used to let Barry Jackson take all the weight while doing this job. He practically carried the spectrometer up and down the ladder single handedly. Neither of us had any hope of doing that.

But we found another way. We tied a rope around the front of Jabba. Brek stood at the top of the ladder and pulled the front up step by step. Ian held the back of the spectrometer. This worked far better than we could have ever hoped.

The spectrometer is not too heavy for two people to lift. The problem is that on the ladder there is nowhere to stand in order to get in a good position to lift the spectrometer without being in the way. The rope solves this problem. One person can stand comfortably at the top of the ladder and the other person can stand comfortably on the floor below.

The rope was also very useful while we were putting the spectrometer on the mount. While doing this, you must lock the gears apart; otherwise the mount will slip and this risks damaging the gears. However, with the old counterweights removed, the mount is very off balance and won't stay where you put it. We tied the rope to the back of the 2DGM and looped it around the dome. This held the mount in place while we positioned Jabba and put the bolts in. The whole operation was much easier than we feared. It's a good thing too; because we did this job three times!

2.4 Detector Sensitivity

The sensitivity in the port data is higher than that in starboard. The same is true for the aft cell: port is more sensitive than starboard. One might have expected the situation to be reversed in the aft cell. For example, we expect the offsets in the data to go in opposite directions when we compare forward to aft. Forward port has a slight positive offset with respect to forward starboard; but aft starboard has a slight positive offset with respect to aft port.

Brek guessed that the differing sensitivities might be due to the detector aperture. He changed its position on the starboard detector, but that only made things worse. So he moved the aperture back to its original position.

We don't know what is causing the difference in sensitivities. It doesn't seem to affect the high-frequency performance. If the sensitivities were to become too low, the data would become noisy. But the power spectrum doesn't show any signs of excessive noise in either detector. We'll have to live with this difference for now. Maybe someone else will be able to come up with some ideas. Out of interest, we note that Klaus, the other two-magnet spectrometer, also shows a difference in sensitivity between the two detectors. Though the difference isn't as great.

2.5 Water Loop

We connected the water loop to Jabba on July 9. We bought some 8-mm, clear tubing from Mitre 10. They didn't have any reinforced tubing at that size.

The 8-mm tubing fit perfectly on the pipes on Mark V. Jabba's pipes, on the other hand, are sized for 1/4-inch hose. There was already quite a lot of black tape wrapped around the pipes. This made it possible to attach the 8-mm tube directly to Jabba.

Currently, there is 12-mm, clear, reinforced hose attached to the pump downstairs. One of the hoses upstairs is coupled to 8-mm surgical tubing which is then attached to Mark V. The other 12-mm hose upstairs couples to 1/4-inch hose, which couples to 8-mm surgical tubing, which connects to Jabba.

We turned the water loop on with Jabba in the shade and no temperature controllers active. The temperature of the forward starboard detector, which had been rising all morning, dropped from 28°C to 23°C. The water in the tank was 20.1°C.

2.6 Future Work

Everything is working in Carnarvon. The temperature controllers and the counters can now be reconfigured from Birmingham. We made no effort to find optimal values for the settings for any of these devices while we were in Carnarvon. We should now begin the process of tuning the system from here.

3 Jabba Alignment

Brek Miller and Guy Davies spent some time in Birmingham working with the lens alignment in Jabba. They tried using a laser; but didn't get much useful work done with it. They tried removing the interference filter and pointing the instrument at the sun. You can see the beam when you do this. They aligned the lenses by looking at the beam. Then Brek did some autoguider scans but found that the results were not optimal.

So, still in Birmingham, Brek tried a different method of aligning the lenses. He set all the lens mounts to be centered in the bulkheads. He used a mirror to get a better view and in some cases counted threads on the grub screws that support the discs on which the lenses are mounted. He had to fiddle with the position of the ovens slightly. He used the mirror to look up the beam line into the magnet to see where the oven should go. After all of this, Brek did some more autoguider scans. The results were surprisingly good.

This line-things-up-by-eye-until-they-look-straight approach seems very unprofessional and is somehow unsatisfying; but Brek found that it produced the best results.

After unpacking Jabba in Carnarvon but before taking it upstairs, we checked the positions of all of the lenses. One was slightly loose. We fixed its position and re-tightened it. After that, we made no further adjustments to the lenses.

We made several autoguider scans; the results are shown in Figures 1 to 6. It appears that Jabba's internal alignment is still quite good.

After roughly pointing Jabba at the sun and getting it working, it was clear that Mark V was no longer working properly. The cold declination scan shown in Figure 1 shows why. Jabba is pointing at the sun when the autoguider is roughly at the center of its travel in declination. But for Mark V, this is way off. In fact, it is off by about 1°. Mark V needs the autoguider to be set near the edge of its travel.

Brek remembers helping Darren Lewis align Mark V and Jabba. On one occasion, they needed some very thin shim plates. On another occasion, no shims at all were required.

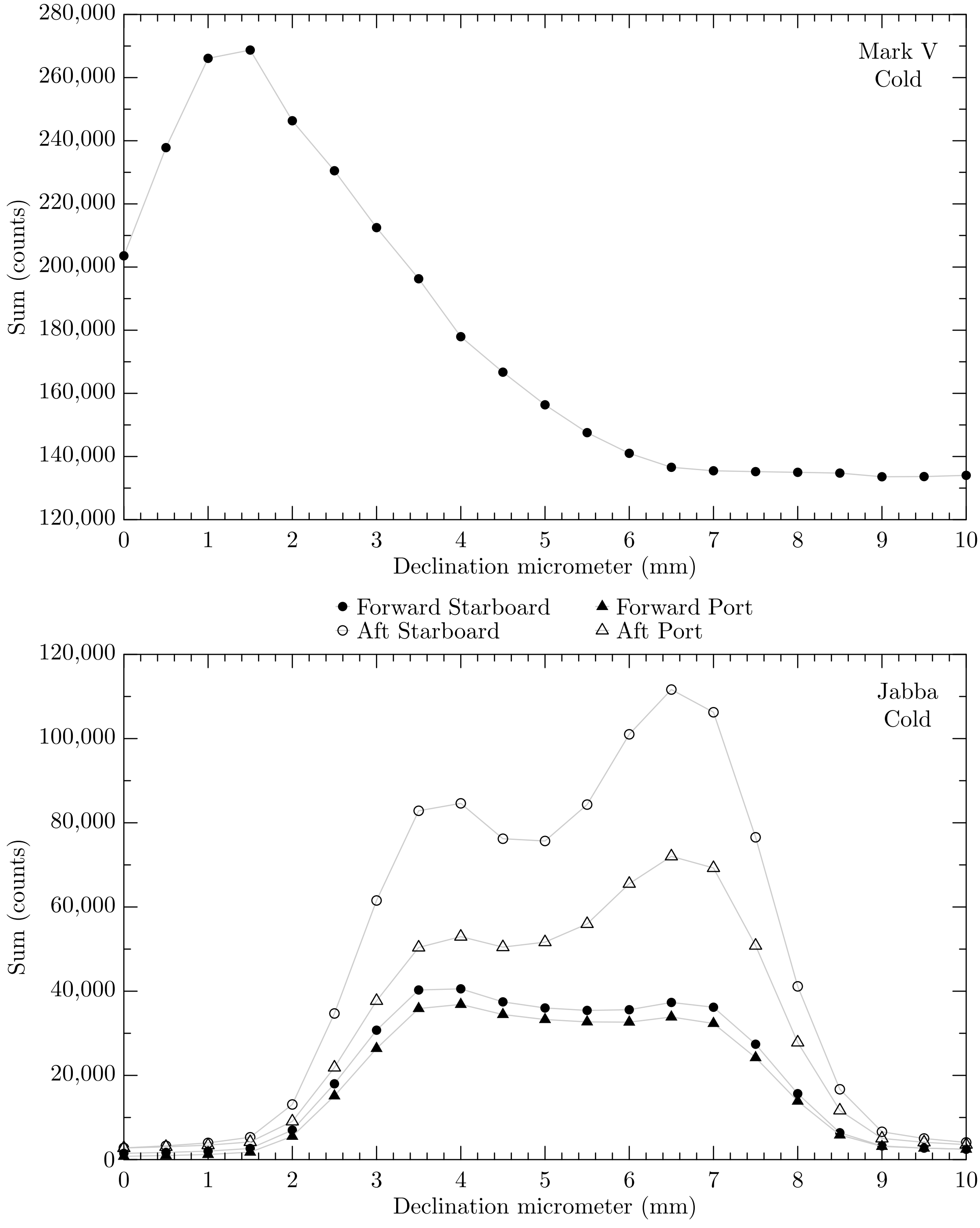


Figure 1: Cold declination scan made at 2009 July 11 02:10 UTC before Jabba was shimmed.

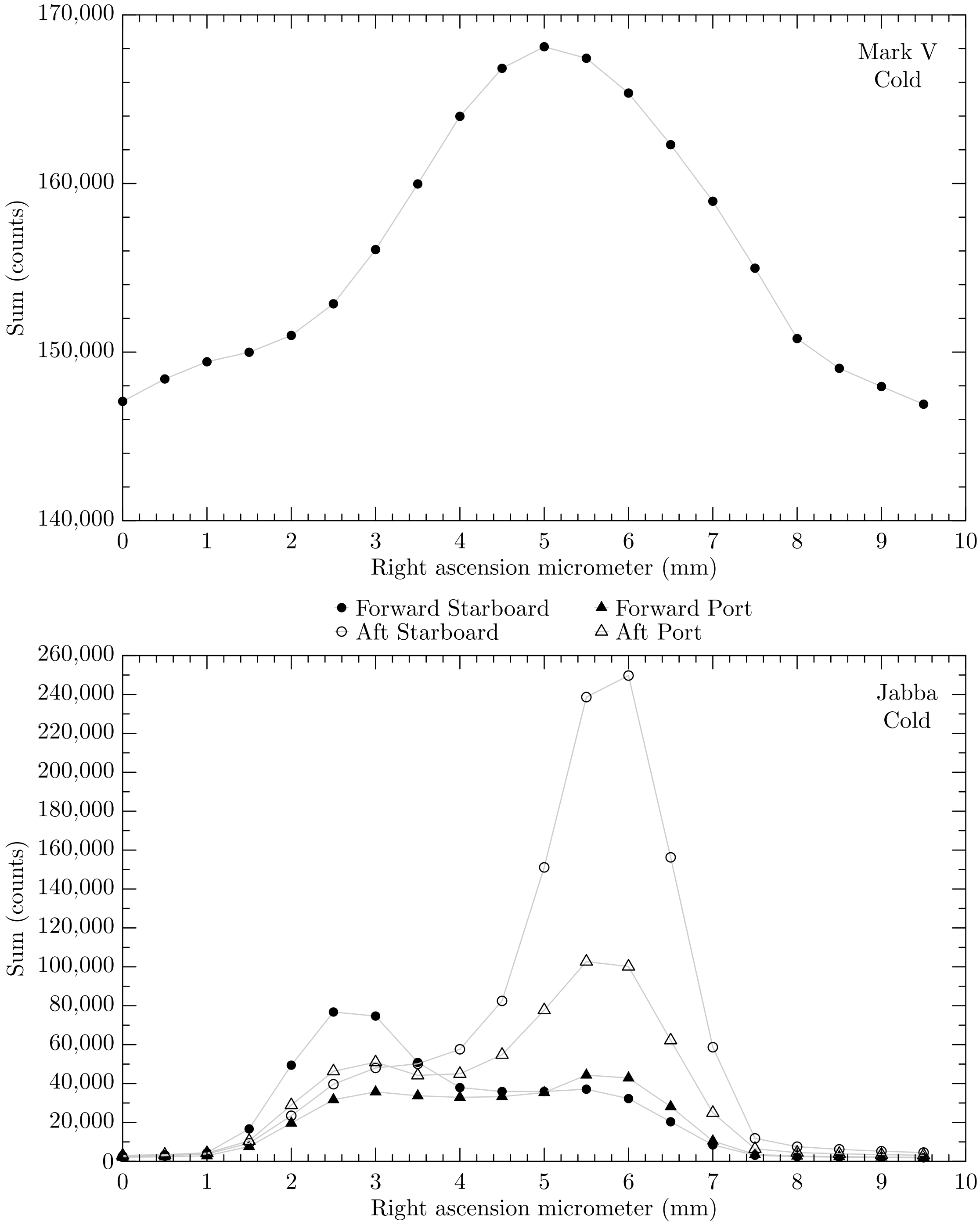
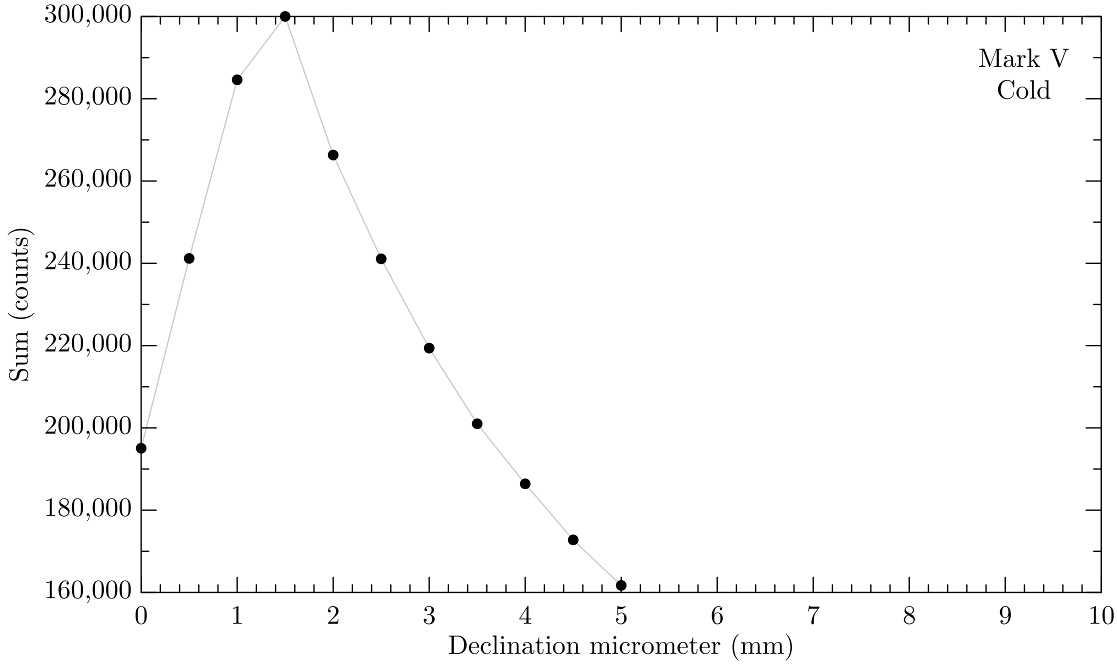


Figure 2: Cold right ascension scan made at 2009 July 11 03:10 UTC before Jabba was shimmed.



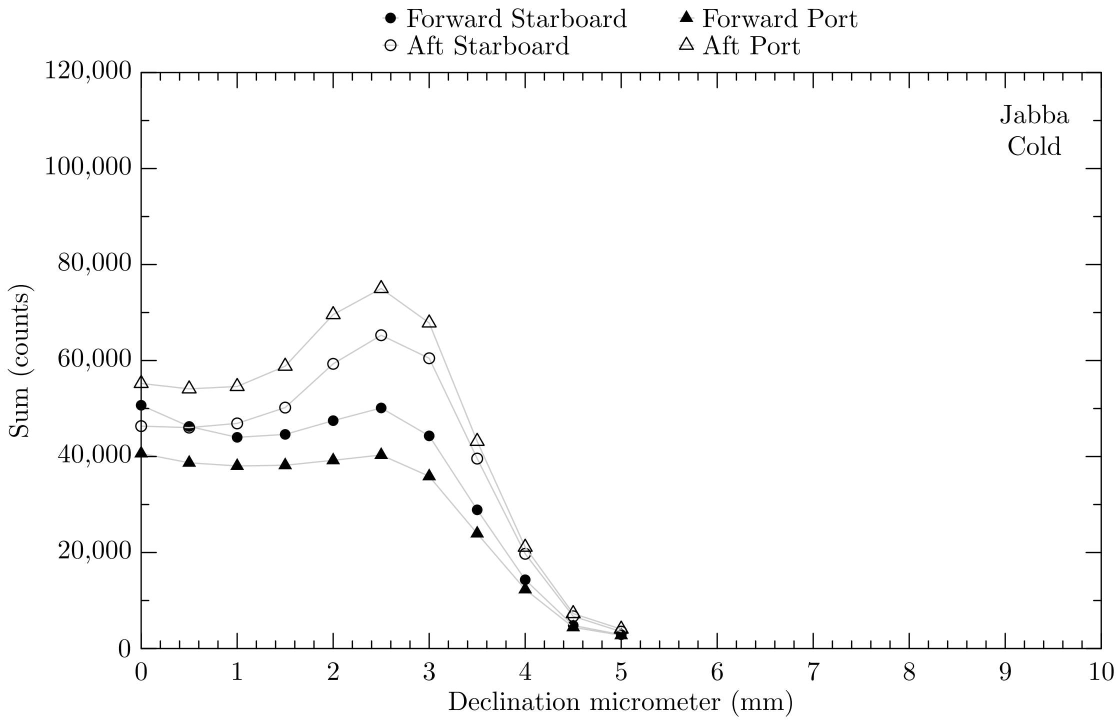


Figure 3: Cold declination scan made at 2009 July 14 05:06 UTC after Jabba was shimmed.

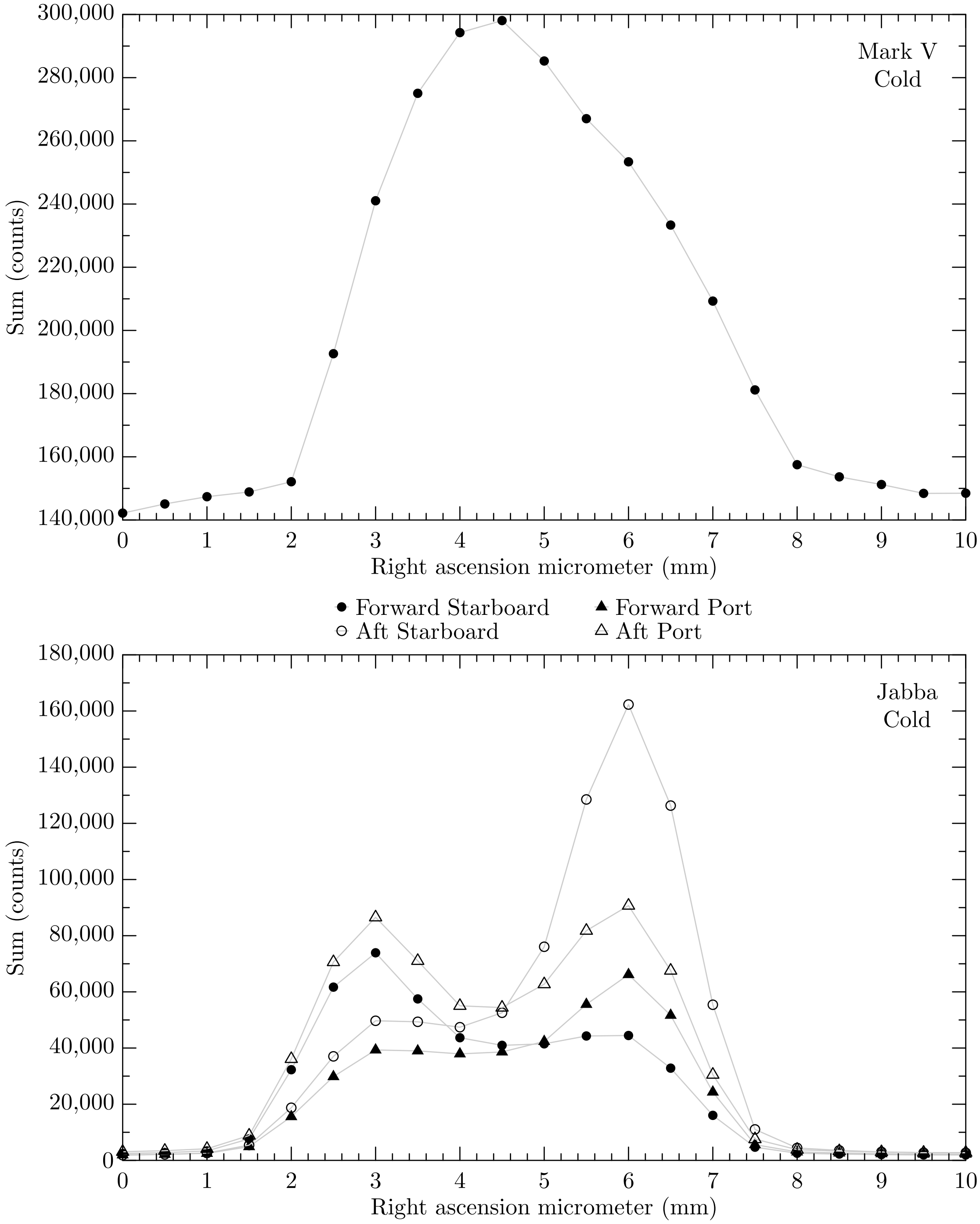


Figure 4: Cold right ascension scan made at 2009 July 14 05:30 UTC after Jabba was shimmed.

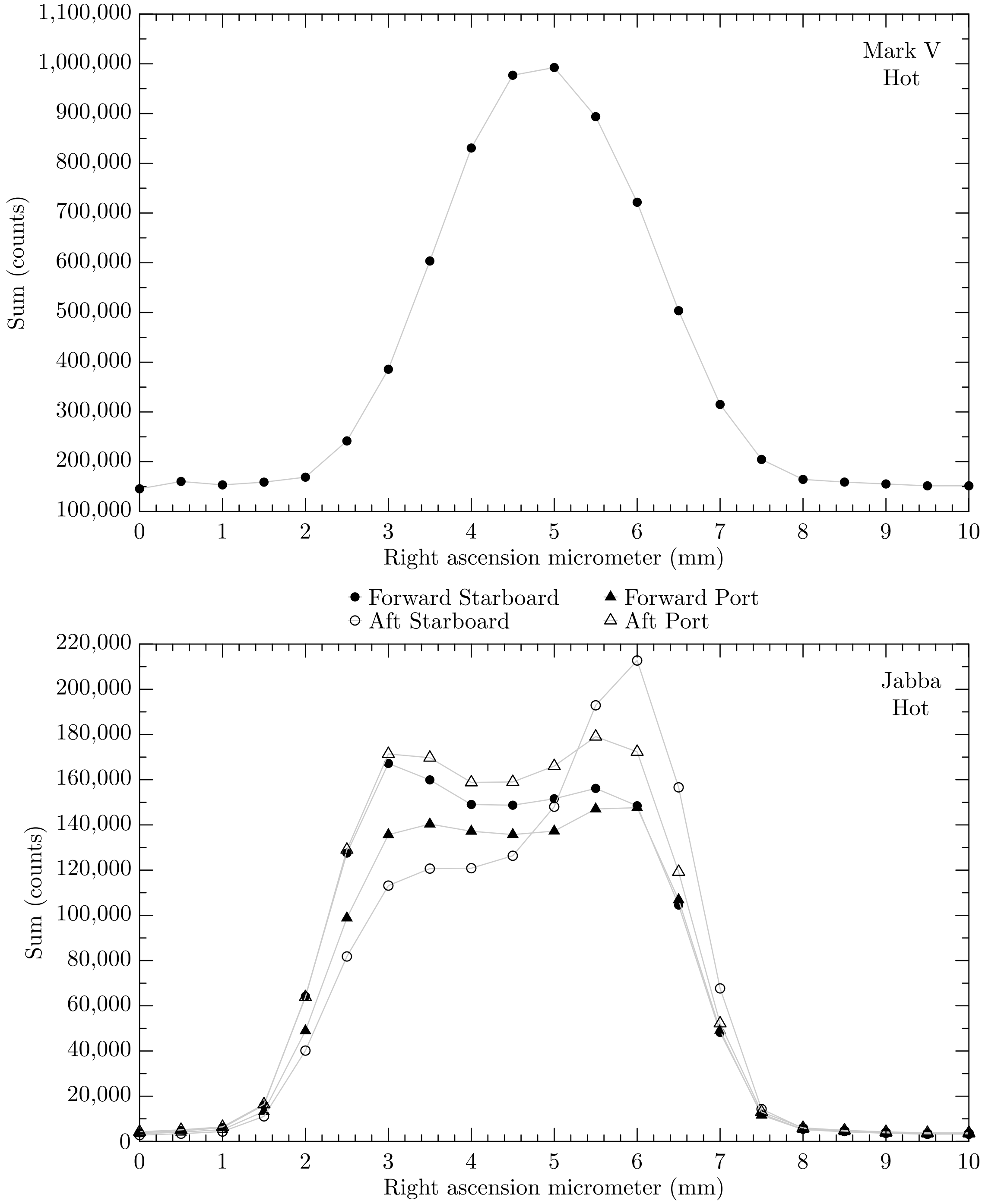


Figure 5: Hot right ascension scan made at 2009 July 14 06:18 UTC after Jabba was shimmed.

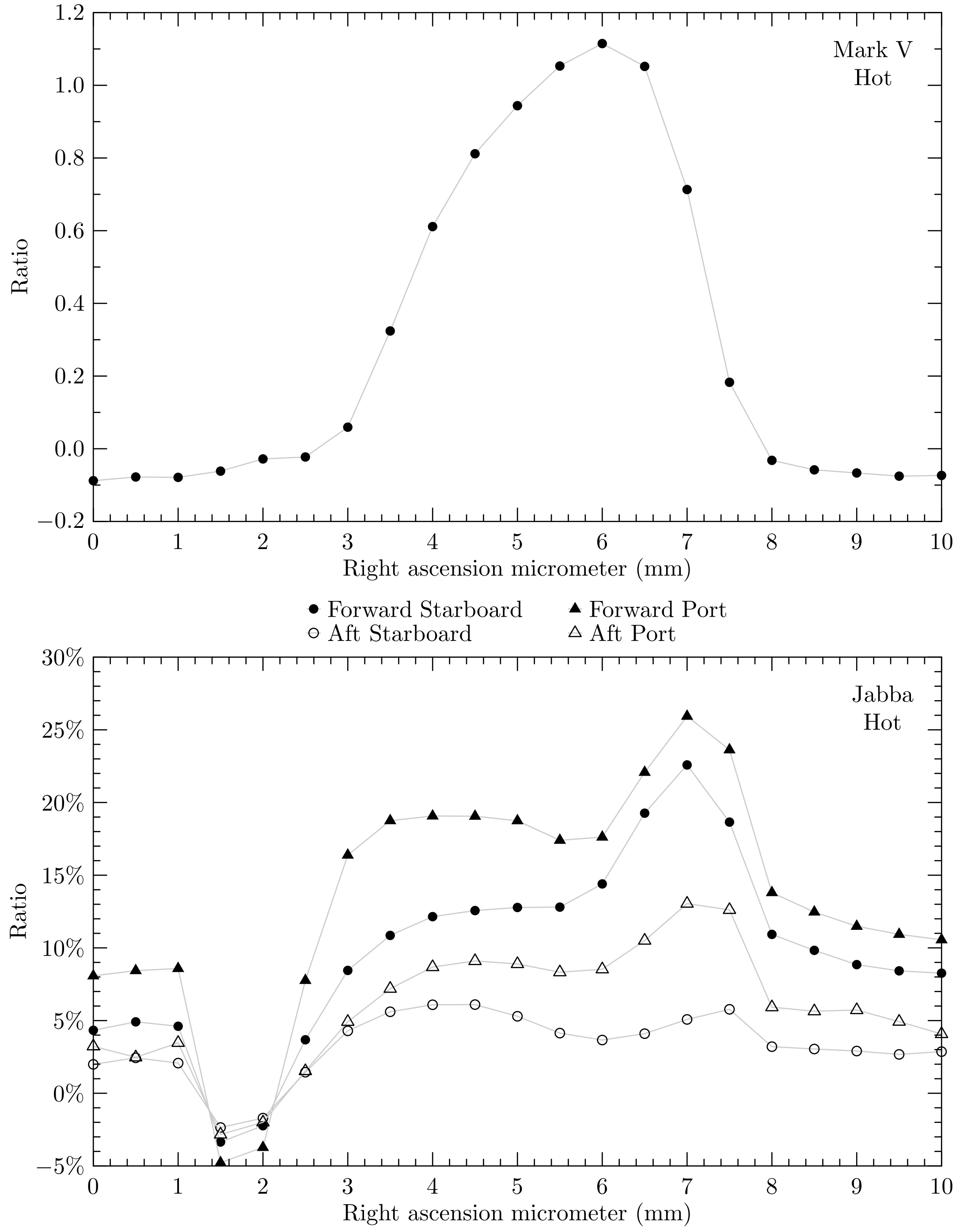


Figure 6: Hot right ascension scan made at 2009 July 14 06:18 UTC after Jabba was shimmed.

A 5-mm shim plate is required in order to tilt Jabba by 1°. That's quite large. We had no shims that size; but we did find a 5-mm aluminum plate. We took it to Arkco Engineering and a nice man cut a strip for us on his guillotine.

Figure 3 shows the results from a declination scan made after Jabba was shimmed. Notice how the two instruments are now aligned with each other; though many of the Jabba's features are lost off the end of the autoguider travel.

One degree is a large alignment error. Why are the two instruments so far out? Brek has an idea. He thinks that Jabba is well aligned and that Mark V is off by one degree. We had a look inside Mark V and didn't find anything wrong. However, it did look like the telescope was off center on the second bulkhead. It was not adjustable. This is how Joe Litherland attached it [2] back in 1993. Brek thinks that Joe adjusted the telescope so that the beam passed through the cell. But he didn't worry about whether or not the beam was parallel to the baseplate. After all, the autoguider would be used to compensate. Brek thinks this is why the autoguider needs to be near the end of its travel in declination in order to get the beam to go through Mark V properly.

It is possible that when Darren Lewis put Jabba on the mount, he didn't alter the autoguider settings. Instead, he adjusted Jabba's lenses to get the beam to go through the spectrometer. He must have moved some of the lenses off center in order to compensate for the 1° pointing error. Perhaps this compromise contributed to the footprint.

Figures 3 and 4 show the autoguider scans done with the oven cold after the shim plated was added. We chose 4.5 mm for the right ascension micrometer and 1.25 mm for the declination micrometer.

We then heated the ovens and did one more right-ascension scan. The sums are shown in Figure 5 and the ratios are shown in Figure 6. The graphs in this figure give you some idea of the sensitivity of the instrument. To convert micrometer settings into angles you need to know that the distance from the declination micrometer to the telescope pivot point is 215 mm. That means that about 3.75 mm corresponds to 1°. We didn't measure the position of the right-ascension micrometer; it was slightly closer to the pivot point. Perhaps the distance is 200 mm. The forward starboard ratio seems to be slightly more sensitive to pointing errors. The ratio changed from 12.15% to 12.78% as the right-ascension micrometer changed from 4 mm to 5 mm. If we assume our standard inverse sensitivity of $3000\,\mathrm{m\,s^{-1}}$, we estimate the pointing sensitivity to be:

$$(3000\,\mathrm{m\,s^{-1}})\,(0.1278-0.1215)\left(\frac{200\,\mathrm{mm}}{5\,\mathrm{mm}-4\,\mathrm{mm}}\right)\left(\frac{\pi}{180^\circ}\right)\left(\frac{1^\circ}{60'}\right)\left(\frac{1'}{60''}\right)=0.018\,\mathrm{m\,s^{-1}/arcsec}.$$

4 Computer

We upgraded the computer from Fedora Core 5 to Fedora 10.

We have tried something different with this installation. We have put / and */home* on separate partitions. This is now the recommended way to install Linux. The idea is that you can install the next version of Fedora on / without overwriting */home*. Some day we will see if this works.

We replaced the power supply in the computer. The old one was making a funny sound. We bought the new power supply at a new shop in Carnarvon called Gascoyne Photographics and Computer Services Pty. Ltd. It is located on Robinson Street about half way back to the Carnarvon Central Apartments.

5 Pockels Cells

The velocity Pockels cell is L14. The magnetic Pockels cell is L13. We sent four SHV cables to Carnarvon. However, when we got there, we found that one of the cables had only one SHV connector on it. We left the magnetic Pockels cell disconnected. We will send a pair of cables to Les Schultz later. He can connect this for us.

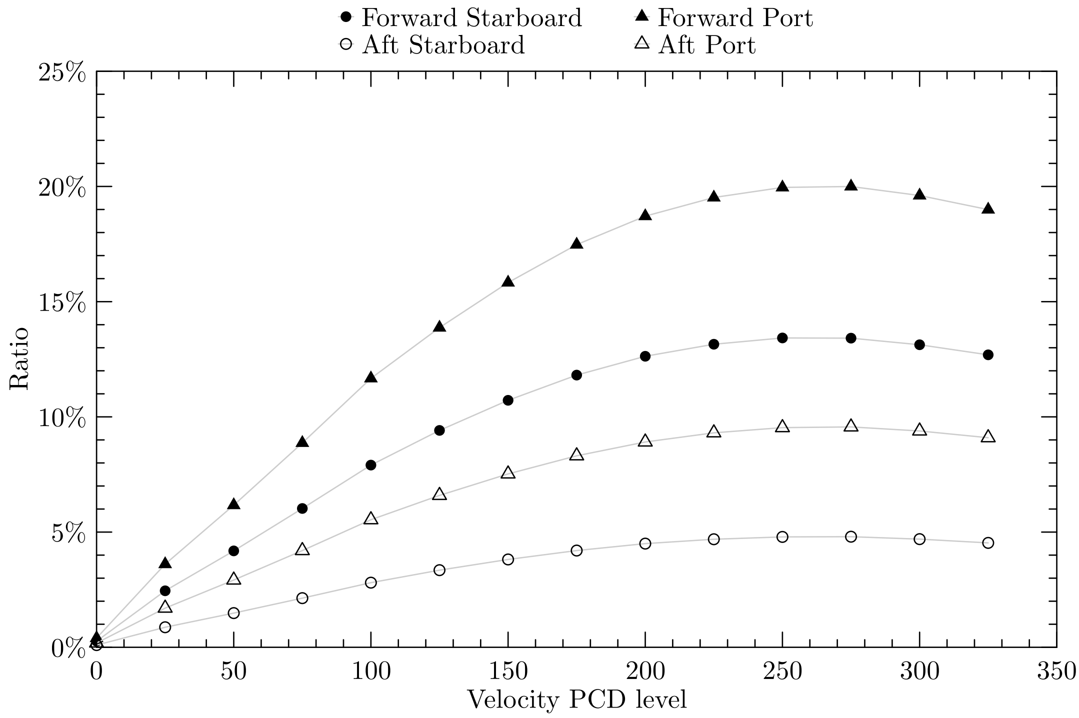


Figure 7: Velocity Pockels-cell driver scan made at 2009 July 11 06:30 UTC.

The optimum setting for the velocity Pockels-cell driver level is 250. The 10-turn knob is on at the wrong angle and is difficult to read. It should be replaced.

6 Shutter Down Limit Switch

At the start of the visit, we noticed that the computer thought that the shutter was on the down limit all the time.

The shutter down limit switch does not affect the operation of the dome; it is only used so that the computer knows when the shutter is all the way down.

The limit switch was pretty badly corroded and so we changed it. However, once a lot of the corrosion was removed, we found that the switch was working fine. We think that the problem may have been with the cable. We replaced both the switch and cable. The wiring diagram for the shutter down limit switch is shown in Figure 8.

7 Blind Open Sensor

While we were looking for the problem with the shutter down limit switch, we noticed that the cable to the blind open sensor was also damaged. We decided that this sensor should be re-wired.

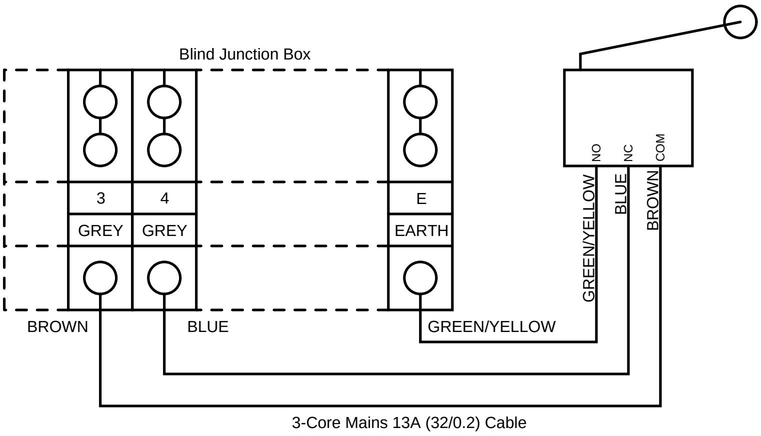


Figure 8: The dome down limit switch wiring.

Originally, this reed-switch sensor was soldered directly to the cable that fed into the blind junction box. We decided to use a terminal block instead of solder; this makes changing the switch much simpler.

The wiring diagram for the new wiring is given in Figure 9.

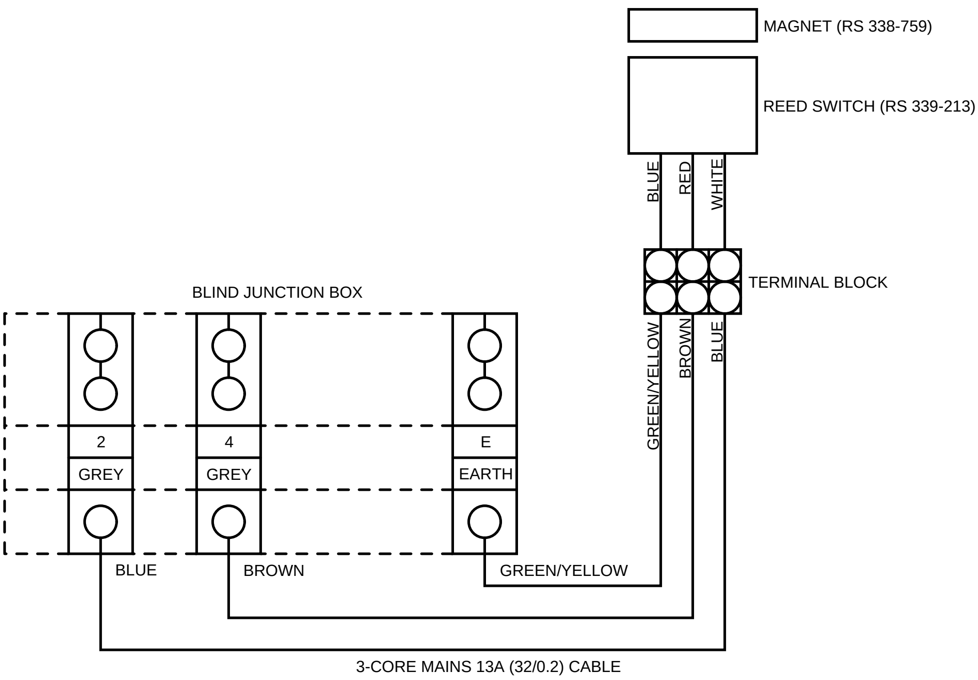


Figure 9: The blind open sensor wiring.

8 Telephone

For about a month's time, we had had some minor problems with the DSL broadband connection. Our IP address had been changing a couple of times each day. While we were in Carnarvon, we observed that the DSL modem occasionally lost contact with Big Pond. When it reconnects, it gets assigned a different IP address.

During this visit, our telephone line developed a fault. We no longer got a dial tone; though the DSL still worked. We reported the problem to Telstra and they sent an engineer. When he arrived, we traced the problem to the cable between our dome and the caretaker's building. An animal, perhaps a mouse, had chewed through the cable just outside the caretaker's building. The Telstra engineer and Brek crawled through the tunnel to the point where the cable was broken. The engineer replaced the section of cable from this point up to the connections panel in the building. Now our telephone and broadband connection work well.

The Telstra engineer thinks that the mouse chewed through the insulation exposing the copper wire causing it to start to corrode. Then the cable got wet in the rain that we had on this trip. That caused the copper to corrode more and finally break. The broken wire prevented our telephone from working. But the DSL modem, which works at high frequencies, saw this as a small capacitor and continued to work.

References

[1] Ian Barnes, Brek A. Miller, and Barry Jackson. The removal of Jabba from Carnarvon in 2006 November. *BISON Technical Report Series,* Number 282, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, February 2007.

[2] Joe Litherland. Repairs to the Carnarvon solar spectrometer. *BISON Technical Report Series,* Number 19, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, January 1994.