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Repairs to Jabba at Carnarvon in 2016 March

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Abstract

The signal to noise performance of spectrometer-J (Jabba) has been deteriorating since it was installed in 2009 July. The fault was identified as being a failed Schott KG4 short-pass infra-red filter. Since KG4 has been discontinued and no spares are available, it was decided to simply remove the filter and run with only the Schott RG9 coarse red pre-filter installed. Additional work identified a failed rain detector which was removed and returned to Birmingham, with a replacement to be shipped out as soon as possible. The batteries in the UPS were also replaced.

1 Introduction

Steven Hale visited Carnarvon from March 5 to 21. The previous visit was in 2015 February [1]. Jabba was removed from Carnarvon in 2006 November [2] following storm damage in 2005 May [3]. The spectrometer was returned to Carnarvon after significant repairs in 2009 July [4]. Performance was initially very good, but the sensitivity and total counts have been slowly deteriorating [5]. The aim of this site visit was to investigate the cause of the low sensitivity and low counts.

Additionally, the rain detector has been continuing to experience false alarms during the day, and also indicating rain permanently throughout the night. This is despite the detector being replaced in 2015 February [1]. A potential fault on the weather module itself was scheduled for investigation.

2 Low Counts

The noise level from Jabba has been slowly increasing [5] ever since the spectrometer was re-installed in Carnarvon in 2009 July [4]. This increase in noise was caused by a gradual decrease in light throughput. The fault was expected to be found in one or both Pockel's cells, which tend to become slightly opaque when they are damaged. Certainly the fault must be before the two scattering cells, since both cells were affected equally.

All four scattering detectors, both cell ovens, and both Pockel's cells were removed from the spectrometer. Some slight damage was found towards the very edge of the magnetic Pockel's

cell glass, but this should be outside of the beam diameter and so not part of the optical path. No other problems were found. A spare Pockel's cell was temporarily installed in the velocity position, and as expected there was no improvement. All of these components were verified as being in acceptable condition.

The interference filter was removed from the front of the spectrometer in order to view the beam through all the optics. At the point where the beam is focused inside the first cell oven (actually, incorrectly, slightly in front of the vapour cell) it was possible to observe significant vignetting of the beam. But not an alignment error vignetting the edge of the beam, instead random structure across the beam itself. The front filter mount was removed from Jabba. This consists of a long-pass deep red Schott RG9 filter, and a short-pass Schott KG4 infra-red filter. The KG4 was visibly damaged with a slightly opaque structure etched into an area of the filter. The beam was inspected again with only the RG9 re-installed, and confirmed to be uniform. The faulty component was confirmed to be the KG4 filter.

Schott KG4 has been discontinued and is no longer available. Two smaller pieces of KG4 were recovered from the decommissioned 2DGM instrument that is still installed on the mount in Carnarvon, but these were also showing similar degradation. It was decided to run the instrument with only the red RG9 filter. Schott RG9 does have an infra-red cut-off — the KG4 is used only to improve the infra-red rejection and so act as a heat-filter. Both filters are only coarse wavelength selection. The fine wavelength selection is performed by a 15 Å interference filter. There is of course concern that with the reduced heat-protection the interference filter might suffer reduced thermal stability, or worse become damaged. The damage to the KG4 is unlikely to be radiation induced since the damage pattern extends well outside the area of the beam at the point it passes through the filter. The damage must be caused by some other environmental issue, such as possibly the high-humidity and salty air in Carnarvon. Carnarvon is a coastal town only 5 km from the ocean. It is expected that the interference filter will be able to maintain its performance without the additional pre-filter.

Once everything was reassembled, the counts and sensitivity from Jabba immediately returned to 2009 levels. The counts are in fact 25 % higher since KG4 does have some absorption at 770 nm. This should provide a further reduction in noise level. If no problems are experienced, then it may be worth removing the KG4 filters from all other spectrometers and taking advantage of this increase in throughput.

Unfortunately this work seems to have created a large step in the data from the forward cell in the afternoon. This should be investigated on the next site visit. Possibly something has become loose inside the cell oven.

3 Optimisation

The initial auto-guider micrometer settings were 5.0 mm in RA and 1.25 mm in declination, determined on the site visit in 2011 September [6]. A scan was performed in RA and dec with the cell ovens cold. The results are shown in Figures 1 and 2. The best position is found where the cold counts are minimised. The intensity increases at the sides of the cell due to direct reflection from the glass walls. This means that the ideal position is in the middle of the two intensity peaks.

The best alignment in RA was determined to be at 5.0 mm in agreement with the initial setting. The dec micrometer was changed from 1.25 mm to 1.5 mm, but there is really not much difference between the two positions.

The power level of the velocity Pockel's cell was checked. The results are shown in Figure 3. The driver setting was initially at 250 units on the dial. This was increased slightly to 260 units. The magnetic Pockel's cell was not checked, since this requires the velocity cell to be removed, and the magnetic cell moved to the velocity position. This can not be done inside Jabba without also removing the linear polariser between the two cells, and so after the initial polariser alignment it was considered more important to avoid disturbing the polariser position again. The shape setting on both cell drivers is set at 300 units, and this was not changed.

A temperature scan of both ovens was also performed, but high level hazy cloud caused the results to be inconclusive. The temperatures of both cells remain at 115 °C oven-top and 100 °C oven-bottom. Coarse adjustment during work on the cells indicates this is likely to still be the ideal temperature. A temperature scan during better weather can be performed from Birmingham.

The hot-to-cold ratio is approximately 5.2 for the forward cell, but for the aft cell between 1.7 and 2.6 depending on the detector. The aft cell is poorer due to high cold counts. It is not clear why the cold counts should be much higher than the forward cell, there is nothing obvious that would cause an increase in non-resonantly scattered light. There is little that can be done while Jabba is upside-down on the mount. It will likely be necessary to test Jabba on a bench with a test light source to investigate the problem further.

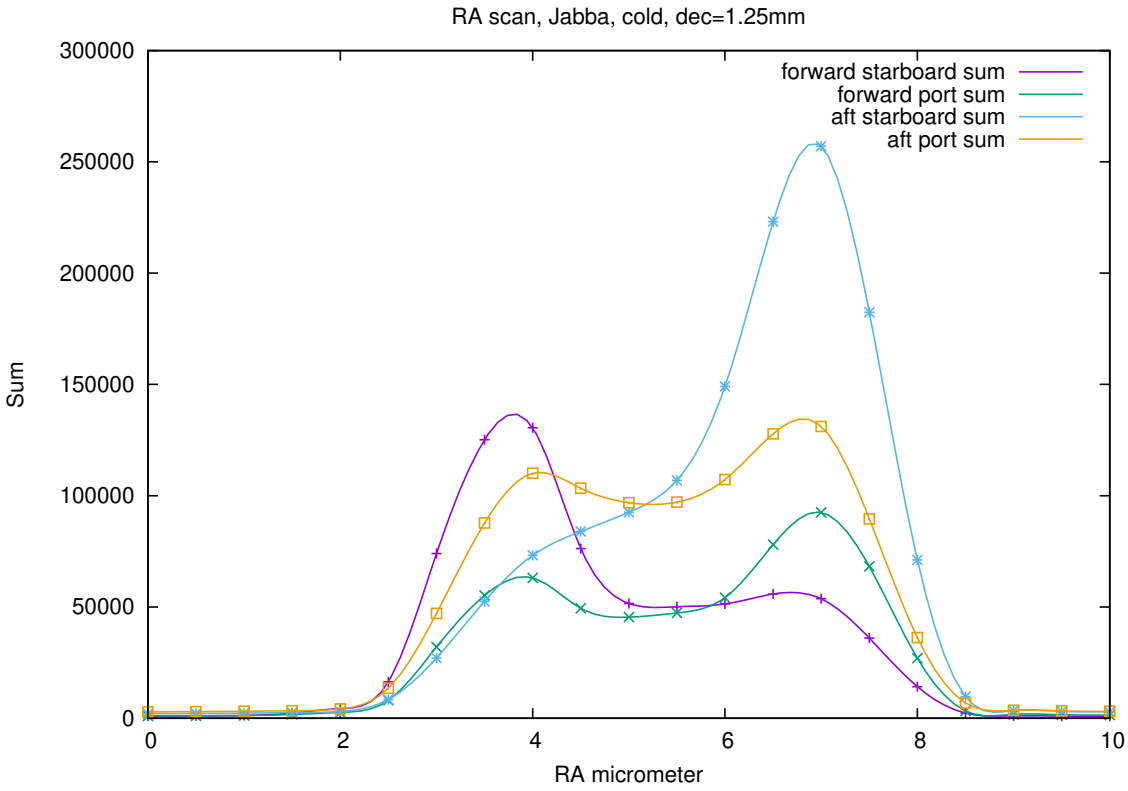

Figure 1: RA Cold Sum

4 Rain Detector

There have been ongoing problems with the rain detector. It has been producing several false alarms during the day, and this fault was investigated in 2015 February [1]. The rain detector was replaced, and this seemed to help initially but did not cure the problem completely. The

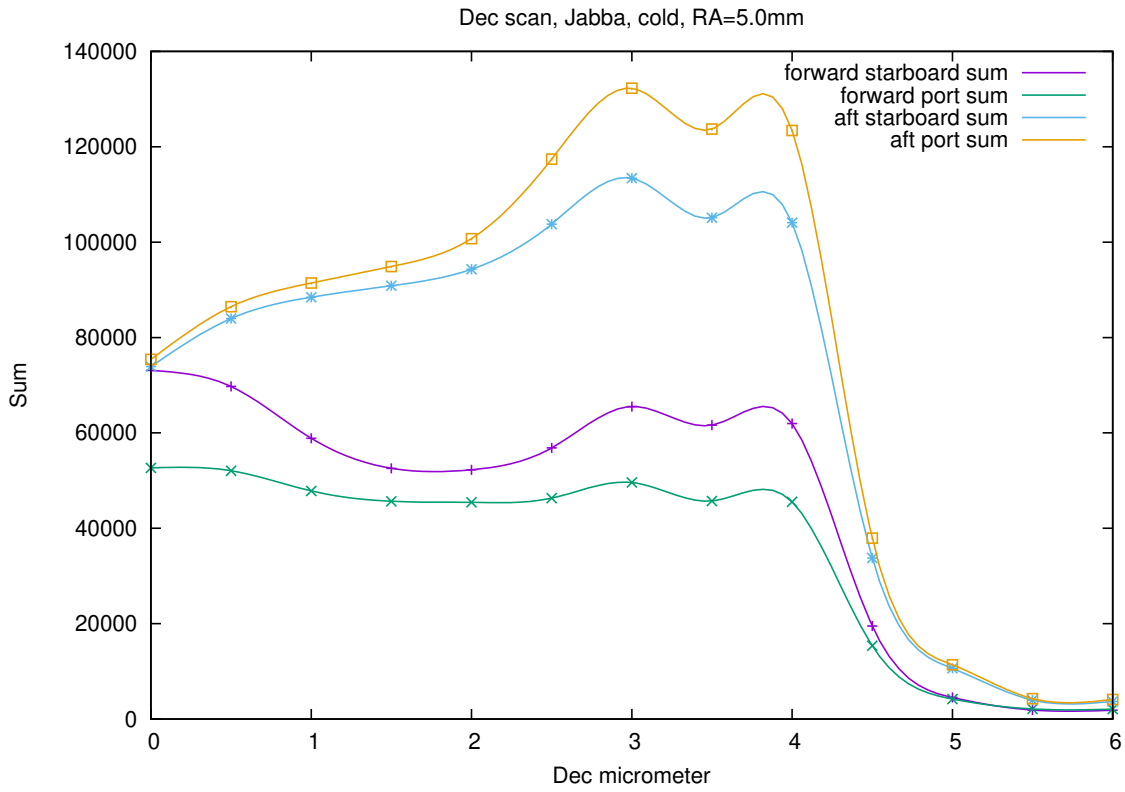

Figure 2: Dec Cold Sum

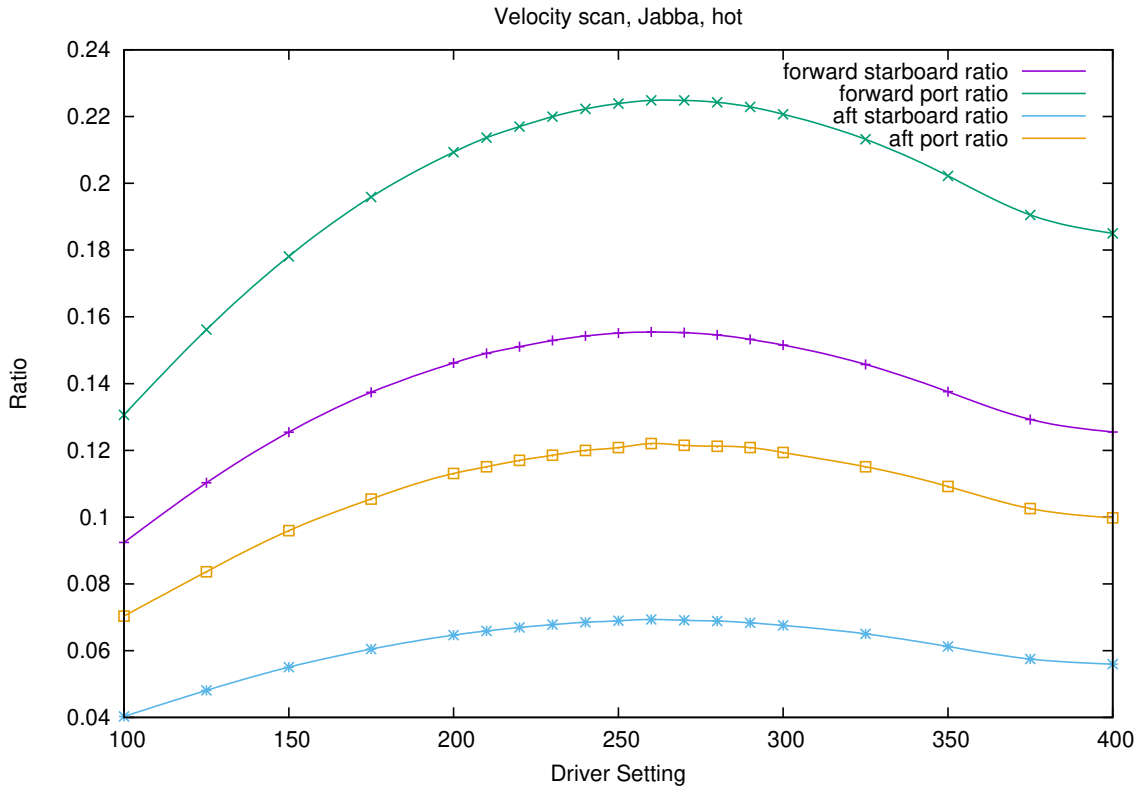

Figure 3: Velocity Pockel's Cell Scan

fault has become progressively worse, to the point where the sensor indicates rain permanently over night and does not clear until around two hours after sunrise.

Since the sensor is reasonably new, a problem with the weather cable or the module itself was suspected. The cabling for the weather arm was last worked on in 2007 February, and the wiring for the rain detector is shown in Figure 4 of BTR282 [2]. However that diagram contains a mistake, there is no violet wire the DRD-11A is only a 7-wire device. The diagram from Sutherland by Brek Miller in BTR314 [7], Figure 7, is correct. The new rain detector is wired as in BTR314 [7]. Prior to this visit, a complete new weather cable was assembled and shipped out. It was installed by Les Bateman on 2015 November 30, but unfortunately it did not help.

On this visit the module was inspected, as recommended in the previous trip report [1]. The inverter modification required by the DRD-11A sensor was removed along with all the old solder. Some general grime was cleaned from the board that was potentially causing some unintended connectivity or capacitance. The inverter and pull-down resistor was refitted, and the module re-installed in the rack. No improvement was found. The detector was tested and found to be unable to detector water at all. Unfortunately, it is not known whether this was the case before the work on the weather module. The weather module was tested by manually grounding the rain signal line, and it successfully indicated rain proving the module was operating correctly. Worse still, the rain sensor continued to indicate rain overnight despite being unable to actually detect water. It seems unlikely that another DRD-11A has failed so soon, but all tests indicate a fault with the detector itself.

The faulty detector was removed and returned to Birmingham. Bench testing confirmed the fault, and a new detector will be shipped out to Carnarvon. Whilst the detector is removed, the cloud sensor has been configured to aggressively close the dome in cloudy conditions. Hopefully this will be sufficient to protect against rain. The only alternative would have been to leave the dome permanently closed.

5 UPS

There are two UPS units in Carnarvon. One is a small 650VA APC Back-UPS which powers the computer, and the second is a larger 1500VA Digitech that is used to close the dome. Both were tested and found to be non-operational in the event of a power failure.

The larger unit has two internal batteries, one of which was found to be low voltage and likely faulty. It was decided to retire the smaller UPS and replace both the batteries in the larger Digitech. The reason there are two separate units for the dome and the computer is to split the load and hopefully allow the UPS to last longer before failure. This does not appear to be the case and simply results in more replacement batteries being required.

Two batteries were ordered from the local computer shop in Carnarvon *Leading Edge Computers*, now trading as a *Betta Home Living* franchise. The batteries were installed and allowed to charge overnight before testing. With just the computer running the front panel indicates 10 % load. With the shutter also driving down it indicates 60 % load, so we are well within capacity. After almost fully closing the dome, the UPS indicates 77 % capacity remaining, and once the motor stops (removing most of the load) this goes up to 90 % remaining. Only one full-closure was tested on battery power. There appears more than sufficient capacity to close the dome several times on a single charge, and this meets the expected performance level of other sites.

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