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Peltier repairs at Narrabri in 2018 February

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Abstract

The Peltier thermoelectric modules were replaced in the starboard scattering detector. The port detector modules were tested and confirmed operational. The water-coolant pump was found to have failed. A position encoder failed during the site visit, and temporary repairs were completed allowing normal operation. Replacements for both the pump and encoder will be sent from Birmingham.

Contents

1 Introduction

Steven Hale visited Narrabri from 2018 January 31 to February 14. The most recent previous visit was in 2015 October where repairs to the temperature control systems were made, including a new temperature drive cable, new air conditioner, and new water coolant pump [1].

The purpose of this visit was to investigate recurring problems with detector temperature stabilisation. Section 2 discusses the Peltier thermoelectric modules in the detectors, and Section 3 goes on to include problems with the water coolant pump. Finally, Section 4 details problems with the mount RA position encoder that was not present before the site visit.

2 Peltier Repair

The Peltier thermoelectric modules were replaced in the starboard scattering detector. The port detector modules were tested and confirmed operational. The temperature stabilisation has limited effect while the water-cooling loop is not operational due to a pump failure, discussed in the next section.

The scattering detectors installed in Spectrometer-G "Genghis" at Narrabri are described in BTR-047 [2]. The standard photodiode is typically a Centronic OSD100-5T [3], however at the time the instrument was commissioned these were unavailable and were substituted by Centronic OSD100-6 (RS stock number 303-674). The Series 5T diode has much better temperature dependence but slightly lower quantum efficiency. The temperature dependence of the Series 6 diode is quite poor, and when the detector thermal control is not operational the data are significantly degraded. Since both photodiode models are the same mechanical package, the OSD100-6 diodes should have been replaced with the OSD100-5T 20 years ago as soon as they became available, but this has never been done. On the next site visit these could be changed to improve the low-frequency stability. A small gain increase may be required to compensate for the lower quantum efficiency. The amplifier currently uses a 47 MΩ gain resistor at the transimpedance stage. The similar scattering detectors in Spectrometer-J "Jabba" fitted with the OSD100-5T diodes use 100 MΩ transimpedance gain resistors.

3 Water Coolant Pump

The water pump at Narrabri was replaced shortly after the previous site visit in 2015 October [1]. Mike Hill installed the new pump but unfortunately it still did not work. On 2015 November 18 it was determined that the shaft of the motor has worn and it no longer turned the pump. A new motor was ordered on 2015 November 19, but while waiting for delivery John Wilson was able to make a modification to repair the existing motor shaft and this was installed on 2015 November 23. The new motor was kept as a spare.

On this visit the pump was found to have already failed again. The failure was not obvious since the motor appeared to be running as expected, and the in-line water-pressure meter is broken indicating flow pressure when there is none. The spare motor is still available, but there is no spare pump and so this could not be replaced during the site visit. The water-coolant pump used in Narrabri is a brass rotary vane type made by Procon and supplied by Grainger in the USA, part number 6XE83 with model number 111A100F11AA 250. The driving motor is made by Marathon Motors and also supplied by Grainger, part number 5U257 with manufacturer model number 5KH33GNA444X. A new pump will be ordered and sent from Birmingham.

Without the water loop operational, the spectrometer becomes too warm during the day and the detector thermal stabilisation becomes overwhelmed. This has been exacerbating the detector thermal control problems. The detector setpoints have been temporarily increased from 22 °C to 32 °C, and the interference filter from 38 °C to 43 °C, in order to allow operation at high chassis temperatures. The standard temperature setpoints should be restored once the water loop is operational.

The water tank has a sensor to disable to pump in the event of a low water-level being detected. The sensor is powered using a 12 V wall-brick type PSU. After turning this PSU off and on several times while testing the pump, the PSU failed. The PSU was removed and replaced with a similar 12 V wall supply.

4 Encoder Problems

During the work on the scattering detectors, the mount controller was switched off to prevent the mount moving. After the work was completed and power returned to the mount controller,

the RA position encoder was found to have failed. Some water damage and corrosion was found in the d-connector of the encoder cable, but removing the connector and re-terminating the cable did not solve the problem.

The fault was eventually located as a failed LED. The position encoder is an optical device with 5 UV LEDs illuminating 10 sensors through a Gray-code filter wheel. The 5 LEDs are connected in series with an LM78L configured as a constant-current supply. This means when one LED fails all the LEDs are unpowered. The failed LED was identified and removed, and the LED illuminating the two least-significant bits was used to replace the failed LED. This worked, resulting in an 8-bit encoder rather than the usual 10-bit precision. The low-precision encoder was moved to the dome azimuth, where typically the lowest two bits are already disconnected to prevent the dome from hunting for position during overrun when stopping. The old full-precision dome azimuth encoder was moved to the mount RA axis.

Within the time it took to re-install the device, a second LED failed and it was not possible to operate with four missing bits. Some basic testing indicated that the encoder could operate with any light source illuminating the Gray-code filter wheel. There appeared to be little, if any, wavelength dependence and so UV LEDs were unlikely to be required. The second failed LED was identified and replaced with a simple, common, red LED. Some adjustment was required to ensure the red LED was aligned and correctly illuminating the filter wheel, but once installed worked completely normally.

The final configuration was three standard UV LEDs, one red LED, and one missing LED, resulting in 8-bits of precision on the dome azimuth axis. A new encoder will be sent out to replace the repaired device.

References

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[2] Lines, R. and Miller, B. A. Scattered-Light Detector Manual. *BiSON Technical Report Series,* Number 47, High-Resolution Optical-Spectroscopy Group, University of Birmingham, UK, 1996. [page 2]

[3] Centronic. General Purpose Silicon Sensors (Series 5T). Datasheet Series 5, Centronic, Centronic House, King Henry's Drive, Croydon, CR9 0BG, 2017. URL `http://www.centronic.co.uk/get/5a3fdbfe-ef10-4c8e-9447-f60e6023730b.pdf/general-purpose-detector-series-5t-data-sheet`. [page 2]