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The Grand Opening of the Las Campanas Zoo

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The Grand Opening of the Las Campanas Zoo

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Abstract

The zoo software is installed in Las Campanas on a new computer. The instruments are cleaned, the alignment checked, and all other electronics re-calibrated.

1 Introduction

Brek Miller and Steven Hale visited Las Campanas from 2005 November 29 to December 15 in order to replace the computer and to check on the condition of the two instruments.

There were no known problems with either of the two spectrometers. Our goals for this trip were to replace the computer and to ensure the high quality of the data for the coming Chilean summer.

2 New Zoo

The installation of the zoo software went smoothly. Like Carnarvon, Narrabri, and Mount Wilson, the new data-acquisition system is based on a PCI-1753 96-channel digital I/O card. We need some way to connect the station electronics to this new card. Up until now, we have made simple, multi-purpose DIO splitter boards to get easy access to the DIO lines. We have also made sets of custom cables to connect these DIO lines to the appropriate signals in the station electronics.

For this trip, we tried a new approach: We built a more-complicated DIO splitter board [1] and purchased three pre-made 37-pin straight-through-wired D-connector cables. With the new arrangement, the routing of DIO lines to station signals is done on the DIO splitter board, not in a large array of complicated wye cables.

The whole thing is now much more neat, tidy, and professional looking. Our hesitation at switching to this new method centered around a fear that it would be too difficult to reconfigure the connections on site if that were to become necessary. While it is easy to rewire a D-connector to fix a mistake, changing tracks on a PCB is more difficult. Special care was taken in the design of the new DIO splitter board to make such changes easier. All of the signals are brought out to vias making it easier to connect wires to them; none of the tracks are hidden under components making it easier to cut them.

As it turned out, not a single modification was necessary. The board was perfect!

Like all other zoo openings, things started with a grand reorganization in the dome. Once again we built a timber rack and moved all of the electronics to it. Four cables were too short; three of them had to be remade.

We did not remake the weather cable because the top end of it is wired directly to the weatherproof Buccaneer connectors on the side of the dome. The team who first set-up the Las Campanas station made things tidy by routing the weather cable through the plastic conduit that leads to the relay box. We cut the cable near the middle, pulled each end out through the conduit, put D-connectors on each end, and reconnected the cable. It was then long enough.

The two dome-encoder cables were also routed through the plastic conduit making it difficult to move them to the new timber rack. Worse still, they were made using grey cable with 7/0.1-mm conductors. That is too small. In fact, this cable had already broken in the umbilical where it flexes regularly. Patricio Pinto had hacked the cable to pieces to remove the bad section and soldered things back together to get the dome working again. To put everything right, we completely replaced both encoder cables with black-sheathed cable containing 7/0.2-mm conductors.

After the cables were extended, the rest of the zoo installation went smoothly, for the most part. Some resistors needed to be changed on Interface Module 3 and the Autoguider Module. These changes were known about in advance and are described elsewhere [1]. The only real hiccup came with the Clive Scalers; this problem is described below.

3 Scalers

Most of the systems made the transition to the zoo with little effort. However, the Clive Scalers were the exception. We found periodic glitches in the data stream.

After closer investigation, we were able to work out that every once in a while, a five-digit decimal counter chip would return "A" as the last digit instead of a number from "0" to "9". It wasn't always the same counter chip; but it was always the last digit that was wrong.

The counter chips are read using four digital logic lines; thus there are sixteen possible combinations of outputs. These are interpreted as a four-bit binary pattern. The counter chips are meant to output decimal digits and are never supposed to output the binary patterns for the numbers between ten and fifteen. However, some of them were sometimes reporting "ten" as the last digit. We were unable to work out what the digit was supposed to be.

We changed various resistors and capacitors on the scaler control module in an effort to give the counter chips more time to set-up the data on their output lines; but none of it helped or made any difference. We noticed that the all of the counter chips that were glitching were manufactured by Motorola.

After Clive McLeod designed and built the first set of scalers, he order a large supply of Motorola counter chips — enough to make scalers for all of the stations. When the Clive Scalers were deployed to Las Campanas [2] in 1993 October, there were problems with the input from the transmission monitor V/F: The counter chips were not fast enough to “see” the short pulses.

Clive checked through the data sheets and found that the Motorola counter chips were indeed specified as being slower than the Philips counter chips that he had used in the prototype. Clive bought replacement Philips chips; but that left us with a large stock of slower Motorola chips.

Each counter in the Clive Scalers is made up of two five-digit counter chips. The chip that holds the five least-significant digits counts very quickly while the chip that holds the five most-significant digits counts very slowly, or, in many cases, not at all. So Clive used Philips chips in the least-significant places and Motorola chips in the most-significant places on all new counter modules. The Las Campanas counters are of mixed vintage. The first three counter cards are for Hannibal and were installed [2] in 1993 October. The three counter cards for Ivan and one counter card for the Automated Stellar Photometer were installed [3] in 1994 November.

We found that all of the glitches were occurring on Motorola counter chips. There were eight spare Philips counter chips in the dome. We used those to upgrade two of the counter cards. The last remaining counter card with Motorola chips in the least-significant spaces was swapped to a position where it deals with transmission monitor data.

Why didn’t we notice this problem before the zoo? Because QSOOSY covered it up. QSOOSY used to check for the “invalid” digit values “A” to “F” and would change them to zeros. This only ever affected the least-significant digit; so the the problem went unseen.

Table 1: Gate Signal Connections

EOLM Control Module	*Scaler Inputs Module*
Scaler Reset	Read
rR	Gate 1
rL	Gate 2
ℓR	Gate 3
ℓL	Gate 4

4 Temperature Monitor

The Las Campanas Temperature Monitor was installed on this trip. The temperature monitor is basically a 16-channel, 16-bit analog-to-digital converter. It contains some amplifiers so that it can read temperatures from four LM35 temperature-sensing ICs. The other twelve channels are configured to read pure voltages.

There is no separate manual for the Las Campanas Temperature Monitor, instead you should look at BTR-254, which is the manual for the Carnarvon Temperature Monitor. The two units are nearly identical. The only difference is in the internal wiring. The Carnarvon Temperature Monitor is internally configured for fourteen voltage channels and two LM35 channels while the Las Campanas Temperature Monitor is configured for twelve voltage channels and four LM35 channels.

Table 2: Temperature Monitor Channels

Channel Number	*Name Displayed in the Squid*	*Description*
1	spback	Ambient (thermocouple at back of Hannibal)
2	spec	Hannibal baseplate
3	h_if	Hannibal interference filter
4	h_oven	Hannibal oven bottom
5	h_top	Hannibal oven top
6	h_star	Hannibal starboard detector
7	h_port	Hannibal port detector
8	sun	Sun monitor
9	i_if	Ivan interference filter
10	i_star	Ivan starboard detector
11	i_port	Ivan port detector
12	i_oven	Ivan oven
13	amb	Ambient (LM35 behind mount)
14	room	Control room
15	tank	Water tank

The sixteen channels in Las Campanas are assigned as shown in Table 2.

5 Autoguider Scans

We performed two autoguider scans in order to check the alignment of the mount. The results of the right-ascension scan are shown in Figures 1 and 2. It looks like Hannibal is centered when the right-ascension micrometer is set to 4.3 mm while Ivan is centered at 4.5 mm. The autoguider telescope is 500 mm long, so the angular offset between the two spectrometers is:

$$\theta = \frac{0.2\,\mathrm{mm}}{500\,\mathrm{mm}} = 0.00040\,\mathrm{rad} = 0\overset{\circ}{.}0229 = 1\overset{\prime}{.}374.$$

After that scan, we set the micrometer to 4.4 mm hoping that this would be in the middle. But it looked like this now favored Ivan, so we nudged the micrometer back to 4.3 mm. Incidentally, the micrometer was set at 4.2 mm before we began the scans.

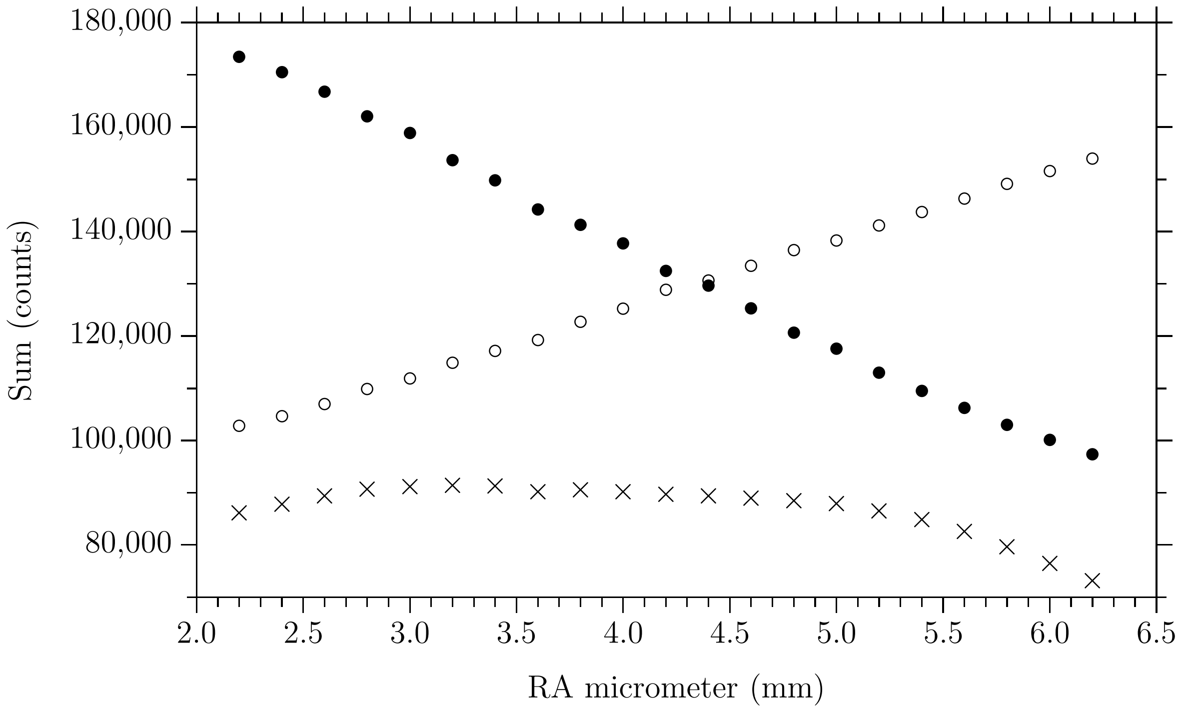

Figure 1: Hannibal sums from an right-ascension autoguider scan. The plot shows how the starboard sum (●), port sum (○), and transmitted sum (×) varied. The transmission monitor data has been multiplied by two. This scan was done with the declination micrometer set at 1.6 mm.

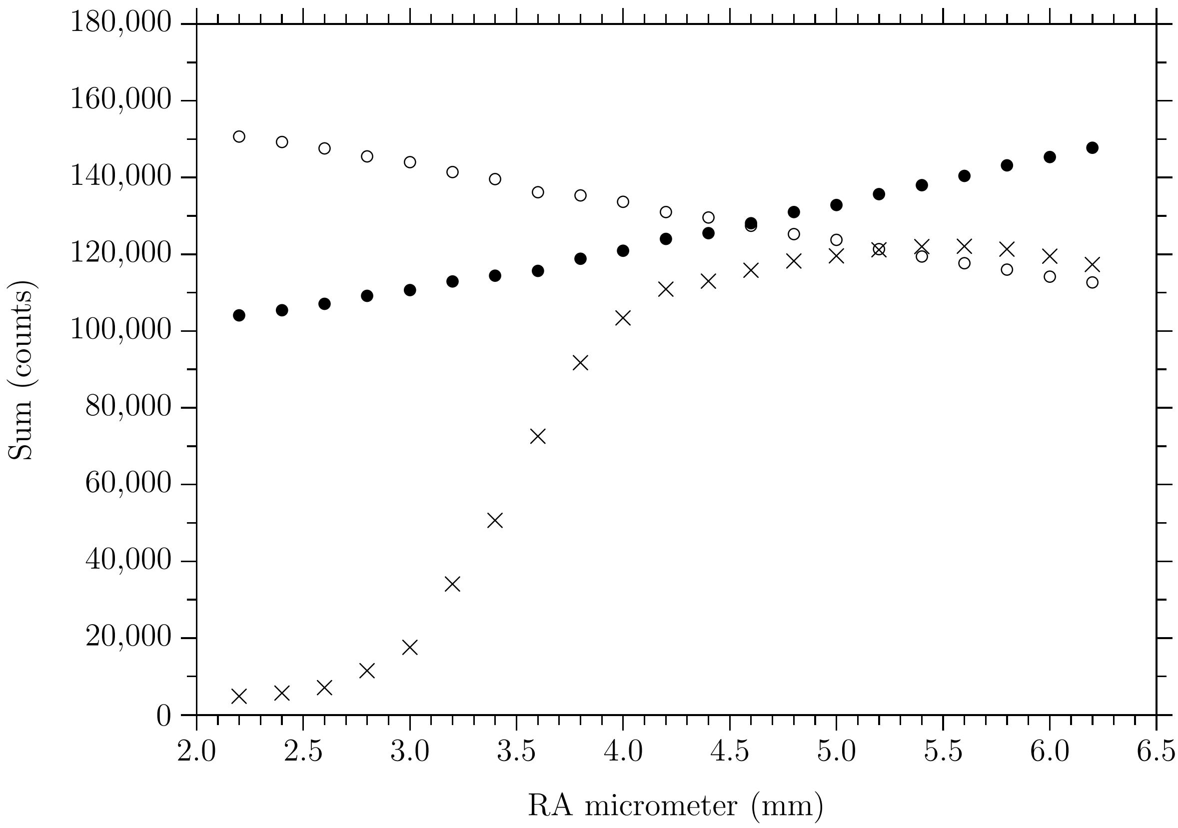

Figure 2: Ivan sums from an right-ascension autoguider scan. The plot shows how the starboard sum (●), port sum (○), and transmitted sum (×) varied. The transmission monitor data has been multiplied by ten. This scan was done with the declination micrometer set at 1.6 mm.

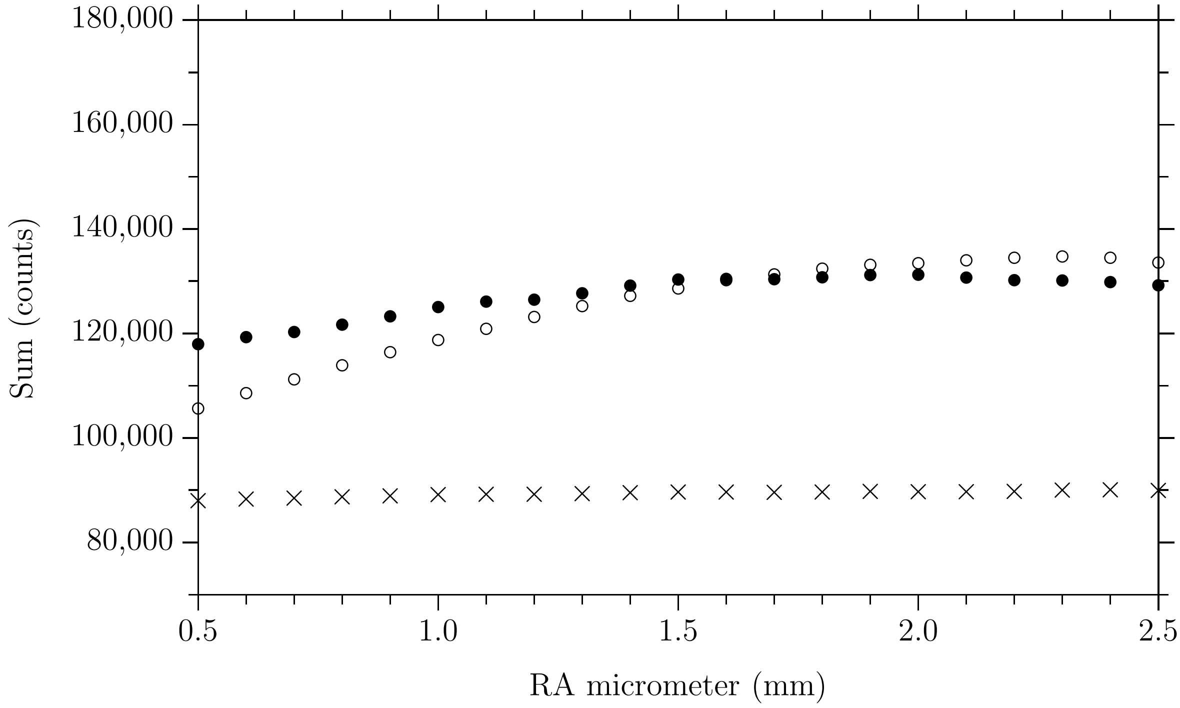

Figure 3: Hannibal sums from an declination autoguider scan. The plot shows how the starboard sum (•), port sum (∘), and transmitted sum (×) varied. The transmission monitor data has been multiplied by two. This scan was done with the declination micrometer set at 4.2 mm.

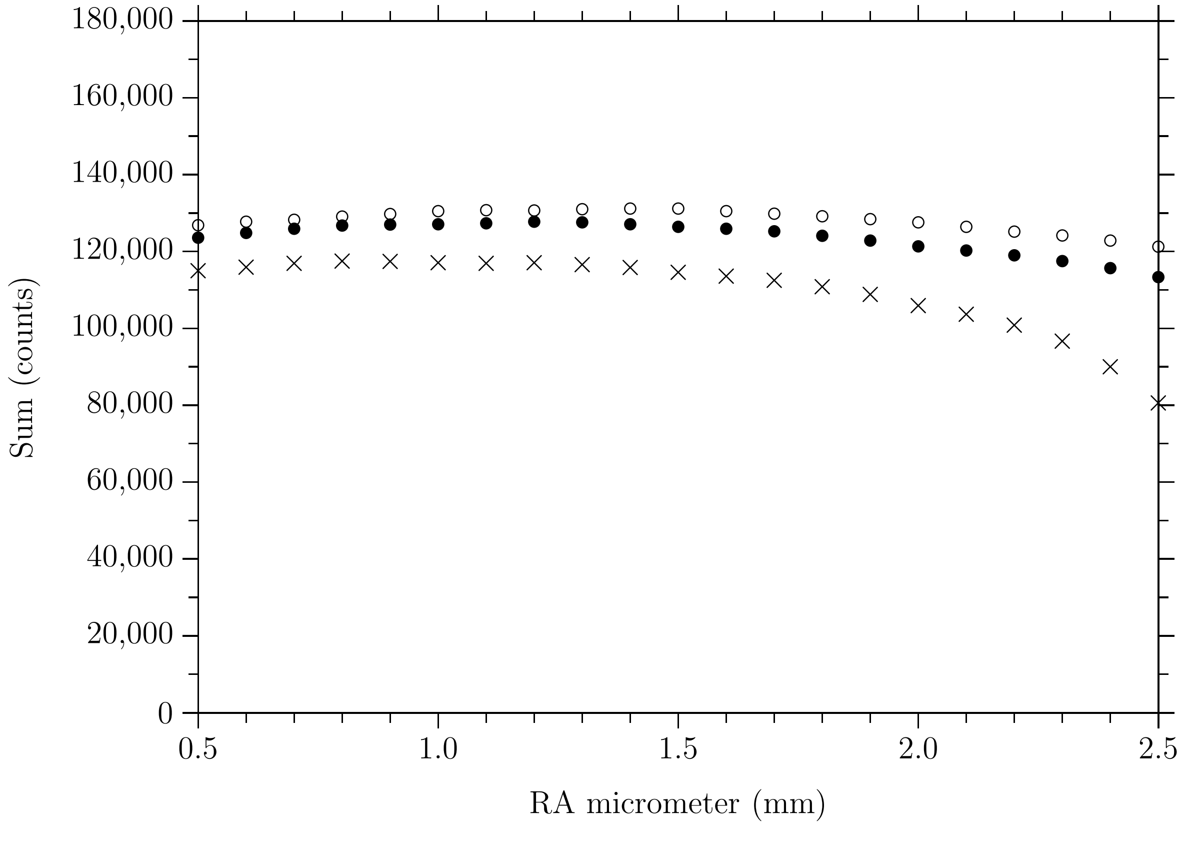

Figure 4: Ivan sums from an declination autoguider scan. The plot shows how the starboard sum (•), port sum (∘), and transmitted sum (×) varied. The transmission monitor data has been multiplied by ten. This scan was done with the declination micrometer set at 4.2 mm.

The results of the declination scan are shown in Figures 3 and 4. It looks like Hannibal wants the declination micrometer set to 2.0 mm while Ivan wants 1.25 mm. We compromised and set it at 1.6 mm. Before the scan, the micrometer was set to 1.4 mm.

The angular difference between the two spectrometers is:

$$\theta = \frac{0.75\,\text{mm}}{500\,\text{mm}} = 0.00150\,\text{rad} = 0^\circ\!.0859 = 5'\!.16.$$

The center box in the mount is 290 mm long. To correct this error, we would need a 0.435-mm-thick shim under the front of Ivan.

6 Spectrometer Performance

We cleaned the front filter of Hannibal and the front lens of Ivan at around December 8 15:00 UT. Table 3 shows the improvements that this made. On December 9 we cooled the ovens and measured the hot-to-cold ratios. The results are shown in Table 4.

Table 3: Results of Filter/Lens Cleaning

	Sum (counts) Before	*Sum (counts) After*	
Hannibal Starboard	97,780	129,327	+32.3%
Hannibal Port	96,350	126,977	+31.8%
Hannibal Transmission	26,665	40,618	+52.3%
Ivan Starboard	85,581	128,634	+50.3%
Ivan Port	87,626	133,365	+52.2%
Ivan Transmission	6,107	11,688	+91.4%

Table 4: Hot-to-Cold Ratios

	Sum (counts) Cold	*Sum (counts) Hot*	*Ratio*
Hannibal Starboard	13,177	132,321	10.0
Hannibal Port	12,032	133,773	11.1
Hannibal Transmission	45,328	44,468	1.0
Ivan Starboard	17,254	107,874	6.3
Ivan Port	19,667	113,715	5.8
Ivan Transmission	11,006	11,113	1.0

7 Anemometer

Upon arrival at Las Campanas we noticed that the anemometer on the dome was not spinning around despite a fairly strong wind. The bearings had seized.

On 2005 December 6 we replaced the bearings and the weather-seals using a Vaisala bearing-kit. It now actually spins round in less than 100 MPH winds.

8 UPS

Shortly before our arrival, Patricio Pinto discovered that our UPS was not working. He replaced some of the batteries and it came back to life.

We reorganized the mains connections to cater for the new placement of the electronics. We moved the UPS, installed some new plug boards, and rewired many of the other plug boards. Right now, only the computer and relay box are connected to the UPS. This minimizes the load on the UPS and we hope that this will improve its performance and extend the life of the batteries.

We fully tested the UPS. The station successfully shuts down during power failures and comes back to life when power is restored. Our tests showed that the UPS has enough power to lower the shutter from its highest position and close the blind, twice. Afterwards it still indicates there is a considerable amount of charge left in its batteries.

9 GPS

A patch to the NTP software is required to get it to work with our Magellan GPS units. We copied this patch from the Narrabri Zoo. By guessing names, we found two NTP servers on the Las Campanas network; they are *ntp1.lco.cl* and *ntp2.lco.cl*. The station computer can now set its clock using any of these three time signal sources.

10 Neslab

Both spectrometers are water cooled. Water from a 210-ℓ tank is pumped around a circuit of hoses and through cooling plates on the bottoms of the spectrometers. The temperature of the water is allowed to drift during the day; however, there is a Neslab CFT-33D Refrigerated Recirculator in the dome that can cool the water if necessary.

The first large water tank was introduced [5] to the Las Campanas system in 1997 November by Richard Lines. Brek Miller added [6] a separate pump, replaced the Neslab water circulator, and added a capillary thermostat to control it in 1999 January.

The filter got clogged with rust on 2001 February 27 and so Las Campanas Observatory staff replaced [7] the metal tank with a plastic one.

When we arrived for this visit, we found that the capillary thermostat was not working. The bulb at the end of the capillary tube that acts as a sensor had broken off; presumably it is on the bottom of the tank. There is a spare capillary thermostat in Las Campanas; however, we decided to allow the computer to control water circulator. As part of the zoo installation, we put a temperature sensor in the water tank. We also used one of the spare solid-state relays meant for the dome and wired it to switch power to the water circulator. We connected the input of this relay to line 3A7 of the DIO card.

A *cron* job (*/etc/cron.hourly/tankcheck*) checks the tank temperature and decides whether to turn the water circulator on or off. There is no manual override switch on the relay box. If you want to turn the water circulator on or off for testing, you can use two small shell scripts: */home/zoo/bin/neslab-on* and */home/zoo/bin/neslab-off*. You must be a keeper in order to use these.

When the computer reboots, the lines on the DIO card float high, it has internal 10-kΩ pull-up resistors. This is enough to activate the relay and turn the water circulator on. After the computer finishes booting, the water circulator turns back off again; but we didn't like this behavior. So we connected a 5-kΩ resistor across the relay inputs. This prevents the water circulator from turning on when the computer reboots.

11 Water Pump

On December 5 we decided to change the water-cooling pump. The current one should have died by now, but it was still running. Nevertheless we have a new (and better) pump to replace it. It is much quieter than the old one, which is nice.

The new pump has a built-in filter system. This kept clogging up with little plastic bits from inside the water tank. On December 4 we drilled a new hole in the tank top in order to insert a temperature probe. When we did this we took great care to catch all swarf with a home-made paper swarf-catching tool. It's a shame previous visitors weren't so diligent. After several filter-cleanings it is now running okay.

12 Network Camera

We installed an Axis 205 Network Camera in the dome. It is mounted next to the shutter and is pointing back at the mount. Its IP address is 200.28.147.214. Because it is behind a firewall, you cannot access the camera directly from Birmingham. Instead, you must either login on the station computer and retrieve an image with:

```
% wget http://200.28.147.214/jpg/image.jpg
```

or set-up a tunnel from Birmingham through the station computer to the camera and then use a web browser locally:

```
% ssh -fN -L 2005:200.28.147.214:80 bison.lco.cl
% firefox http://localhost:2005/
```

13 Water Tap

On December 2 we discovered that the water supply to the dome didn't work. Brek asked the maintenance guy about it, in passing, to see if there was anything they could do about it sometime when they weren't busy. On December 3, a man with a spanner came around to fix it. He turned into two men with an air-compressor. The tap is right by where we were working so we were just getting in the way. We went to play pool.

After a little while we went back to see if they'd finished. We discovered they had turned into three men with an air-compressor and a generator. We went back to continue our tournament. Later, we check again to find they had gone for the night, but left all the equipment — so they hadn't finished yet.

The plumber arrived again on December 4. He augmented the current tools with a pick, shovel, propane tank, and blow-torch. He replaced a section of pipe and now the water works again. At least, that's what we think he did judging by the old pipe outside the dome. We're not entirely sure since his explanation was in Spanish.

14 Foam

On December 7 we cut away some of the insulating foam from both spectrometers because it was fouling on the mount at the extreme ends of the declination travel. The mount can now trip the limit-switches and stops safely when the computer tries to drive the mount too far in one direction.

References

[1] Ian Barnes and Brek A. Miller. Interface C: Another DIO splitter. *BISON Technical Report Series,* Number 262, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, February 2006.

[2] Brek A. Miller. Report on the work done at Las Campanas from 1993 October 24 to 1993 November 11. *BISON Technical Report Series,* Number 18, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, November 1993.

[3] Peter D. Monks, Chris J. Underhill, and George R. Isaak. Two trips to Las Campanas to install a second spectrometer and an automated photometer: 1994 November 12 to December 13 and 1995 March 7 to March 23. *BISON Technical Report Series,* Number 40, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, June 1995.

[4] Ian Barnes, Barry Jackson, Sukhpal S. "Paul" Jagpal, and Brek A. Miller. The Carnarvon Temperature Monitor. *BISON Technical Report Series,* Number 254, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, September 2005.

[5] Richard Lines. A visit to Las Campanas after the lightning strike that destroyed our step-down transformer. *BISON Technical Report Series,* Number 71, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, February 1998.

[6] Brek A. Miller. The installation of a Flojet pump at Las Campanas in 1999 January. *BISON Technical Report Series,* Number 97, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, March 1999.

[7] Brek A. Miller. BiSON operations log for 2001. *BISON Technical Report Series,* Number 178, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, January 2002.