CCD temperature control

CTIO 60 inches Chiron

CHI60HF-4.1

La Serena, November 2009

Contents

Introduction

The goal of this brief report is to summarize the CCD temperature control of the Chiron at the 60 inches telescope, as well as to set a baseline for future comparison. This document does not pretend to be a comprehensive study of the thermal control, but just a quick reference. All the following tests/tunings were done in the electronic lab. In La Serena

The temperature control is being done through an external, commercial temperature controller.

a) instrument**: Lakeshore 325** temperature controller
b) sensor: **silicon diode 1N914** at the detector mount
c) actuator: **Nickel-Chromium resistance wire** installed at the detector mount, driven by a current output of the Lakeshore controller

Figure 1 shows a simple diagram of the control. The input sensor for the control is the silicon diode installed at the mount

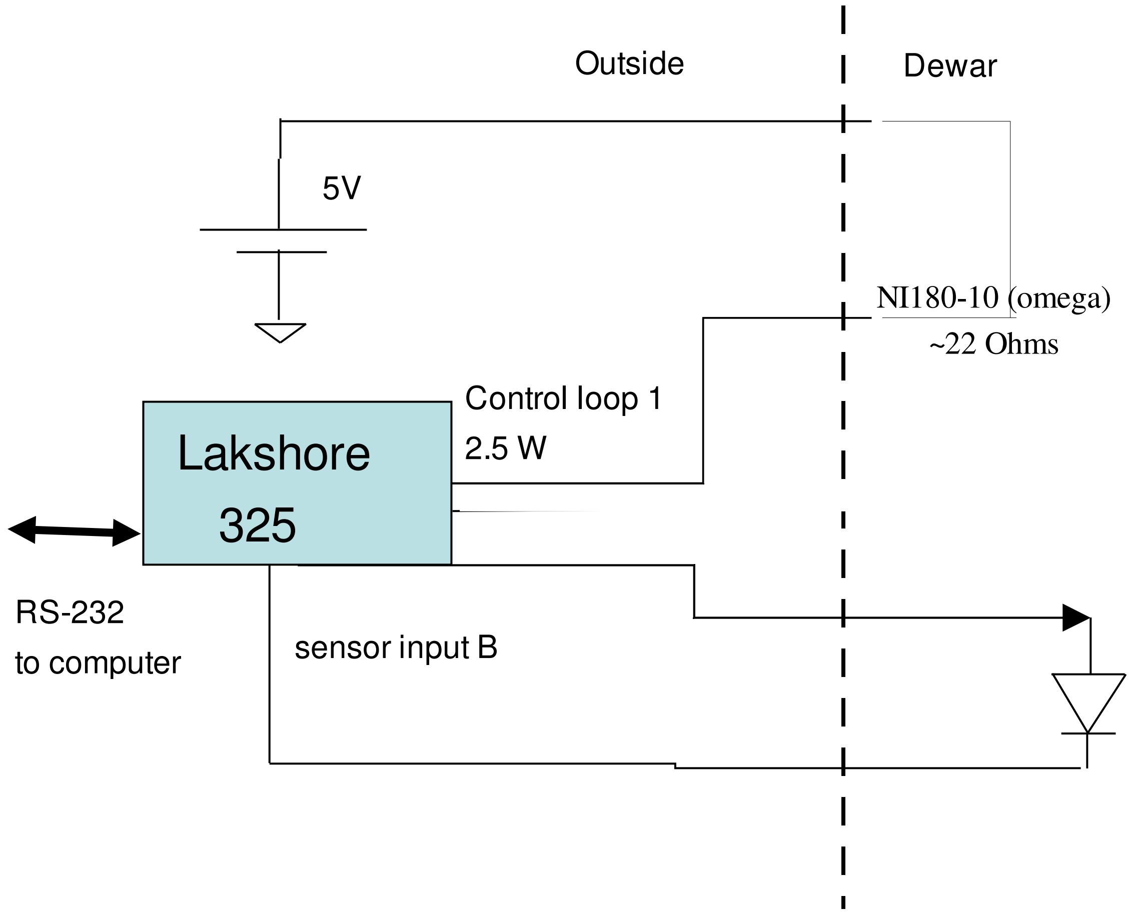

Figure 1: temperature control

Chapter 1: Control: Dynamic response

The Lakeshore 325 implements a PID algorithm for the control loop.
The curve used for the diode was the standard instrument curve **DT-500D,** found to be very consistent with the custom curves used in other instrumentation site.

Figure 2 shows the step response of the closed control loop after the final tuning of the PID parameters. The final values are stated on table 1.

The working temperature was chosen to be close to **-120 C** (173 K) because this is about the usual working temperature of the system. Note that both under and overshoot are reasonably small. The heater power was measured at the Lakeshore side, simply by requesting the % of the maximum power. It is important to note that with the heater load settings for Loop 1 (see ***Appendix A***) the maximum output current is **about 350 mA**, and the maximum power is 2.5 W.

Parameter	**Value**
overshoot	150 mK
undershoot	200 mK
P	800
I	20
D	0

Table 1: PID control response for 1 K step @ 173 K (-120 C)

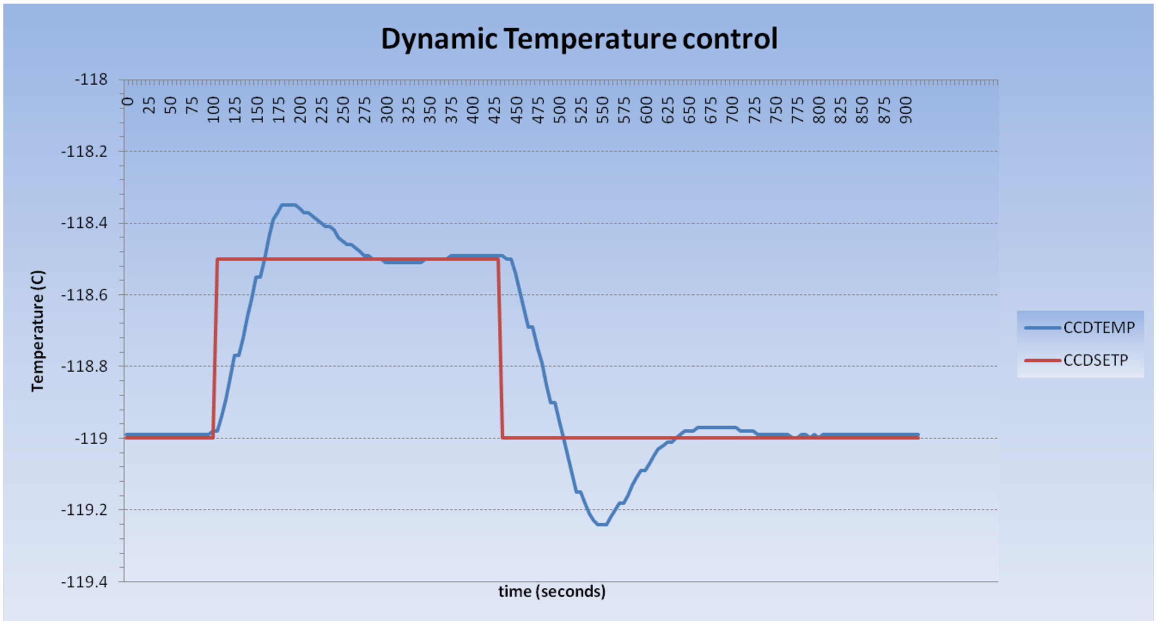

Figure 2: Step response after tuning

Chapter 2.:Control stability

Figure 3 shows the long term control stability. The graph shows a step of 200 mk at -110 C, and then a stable period of about half an hour. Note that the CCD temperature (blue) does not move at all during the stable time period. This is just due to the resolution of the curve. So, this curve is just tell us that the CCD temperature is stable to at least 10 mK.

What is important to note/explain is the apparent offset between the requested setpoint (**-110.00**) and the measured, stable temperature (**-109.99**). This difference is due to the conversion between actual sensor units (volts) and temperature using the conversion curve given. The instrument does the real control using sensor units, so it passes the requested setpoint in temperature to a requested value in volts and closes the loop there. The sensor value is converted back to temperature for the user to see.

Depending on the resolution of the ADC converter, the resolution of the given curve, the way the instrument makes the interpolation/conversion, and the way the instrument do the back conversion (truncation, etc) it is reasonable to expect some "apparent" offset.

For the instrument that will use this control system the precision/stability shown is way better than really required.

Table 2 shows the parameters derived from the graph and the lecture of the Lakeshore screen

Parameter	Value
stability	Better than 10 mK
heater power	66 %

Table 2: Long term stability parameters

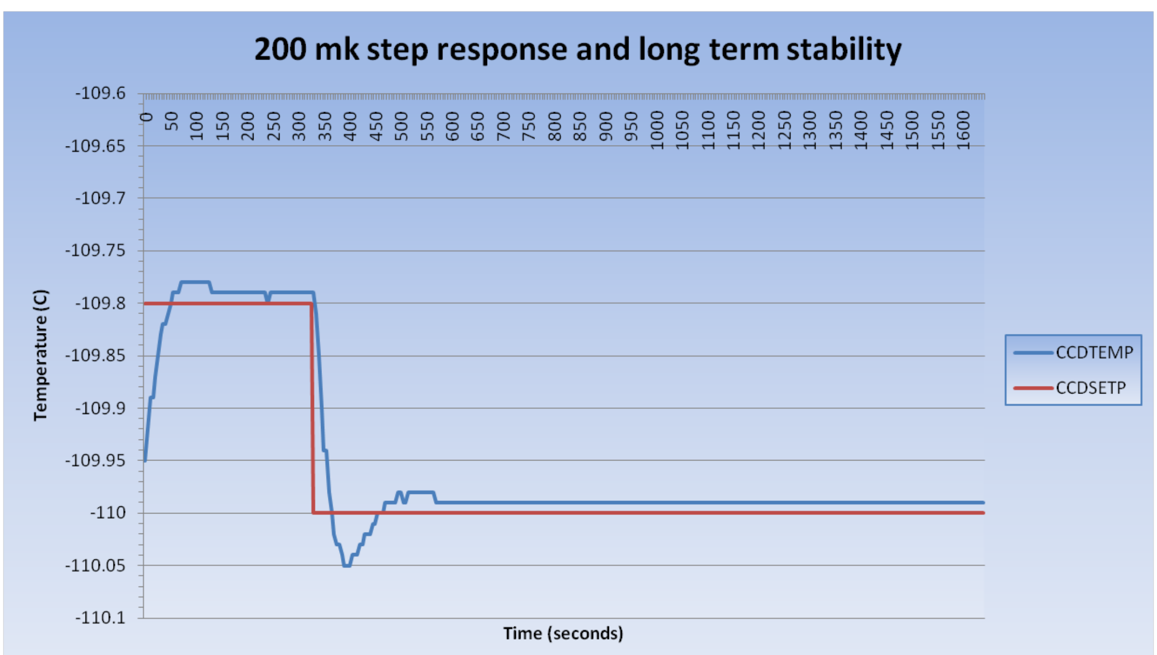

Figure 3: Long term temperature stability

Conclusion / General notes

- The temperature control system of Chiron works in a way suitable for the application
- All the Lakeshore settings are stored in the instrument's non-volatile memory, so there is no need for any parameter upload or handling at startup (power-up). The instrument has no need of any external intervention
- The actual control loop has been set so it also starts when the Lakeshore is powered (See ***Appendix A***)
- The computer that is usually attached to the Lakeshore's serial port is used only to monitor/graph/log the data periodically, but it is not required for the temperature control.

Appendix A: Lakeshore 325 settings

Sensor Input:

***Input Setup* Key**

Input Setup: B
Type: Silicon diode
Curve: DT-500D
Filter: off

Control Loop 1:

***Control Setup* Key**

Input: B
Unit: Celsius
Control Mode: Closed
Power-on: enabled *(control starts when powered)*
Heater load: 25 Ohms
Setpoint ramp: off

Auto Tune Key

Tune mode: manual PID
P=400
I=120
D=0

***Heater Range* Key**

Heater Range: low