Manual for the
HJST coude solar port cover

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Instrument Scientist
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1 Introduction

The HJST (Harlan J. Smith Telescope) coude spectrograph can be fed from a solar port located on the roof of the coude bulge of the building. The solar port was designed to be manually uncovered and covered for use. After the advent of remote observing, the covering and uncovering has been done manually by observing support staff in coordination with the remote observer. This uncovering and covering function has now been computerized so that the observer alone can do it via the software GUI for the spectrograph, and from ICE software scripts. In emergency situations the cover can be operated manually. The new Solar Port Cover (SPC) was installed and commissioned in January 2021.

2 Operating the Solar Port Cover

The TS2 GUI is shown in figure 1. To open the solar port, the *Open* button is left mouse clicked in the *Solar Port* panel in the upper left of the TS2 GUI. Similarly the SPC is closed via the *Close* button in the *Solar Port* panel. The cover takes 4-5 seconds to both open and close. Sensors detect if the SPC is open or closed, and the measured position is reported by the green indicator lights in the *Solar Port* panel of the GUI.

The SPC is designed for robust operation in wind speeds up to 50 mph. In normal operation the TS server software will determine the wind speed from the Mt Locke weather system. If the weather system is unavailable, or if the weather data is corrupt, the TS GUI will pop up the dialog window shown in figure 2. This dialog window asks the observer to confirm that the wind speed is below 50 mph. A remote observer should call Observing Support staff if there is doubt about the wind speed. The SPC should not be opened in rain, snow, or when it might be icy.

The Solar Port Cover is shown open and closed in figures 3 and 4, respectively.

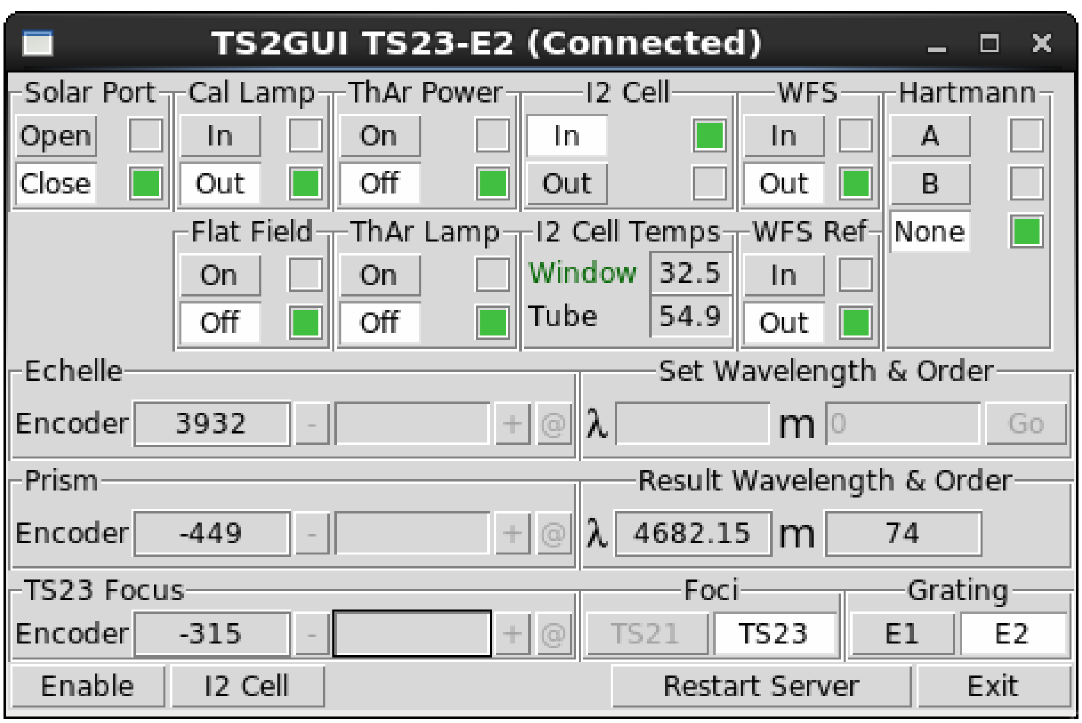

Figure 1: The TS2 GUI is shown. The Solar Port Cover is opened and closed by clicking the buttons in the *Solar Port* panel located at the top left of the Window. The green position indicator lights within the panel report the measured position of the SPC.

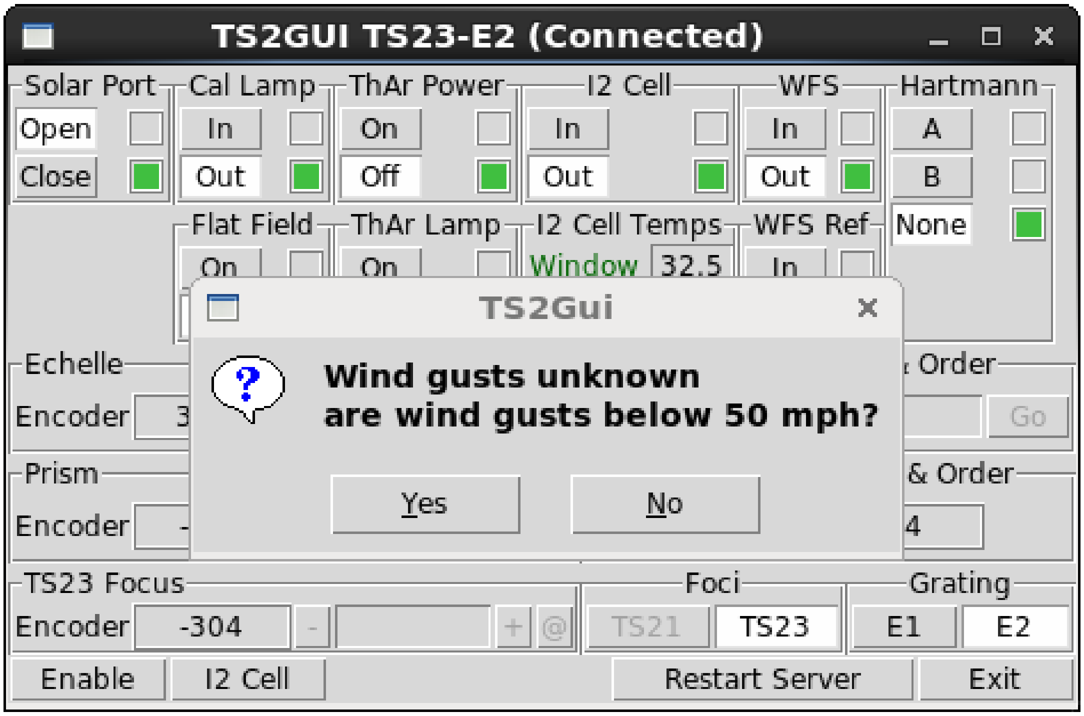

Figure 2: The TS2 GUI is shown presenting the popup window asking the user about the wind speed at the telescope. This popup is presented to the observer if the TS2 server cannot determine the wind speed from the Mt. Locke weather system. The SPC is designed for robust operation in wind speeds up to 50 mph.

Figure 3: the solar port cover is shown in the open position. The ground glass diffuser optic is seen in the circular opening on the right-hand side. The cover drive shaft is spring loaded when open to prevent cover bounce in the wind.

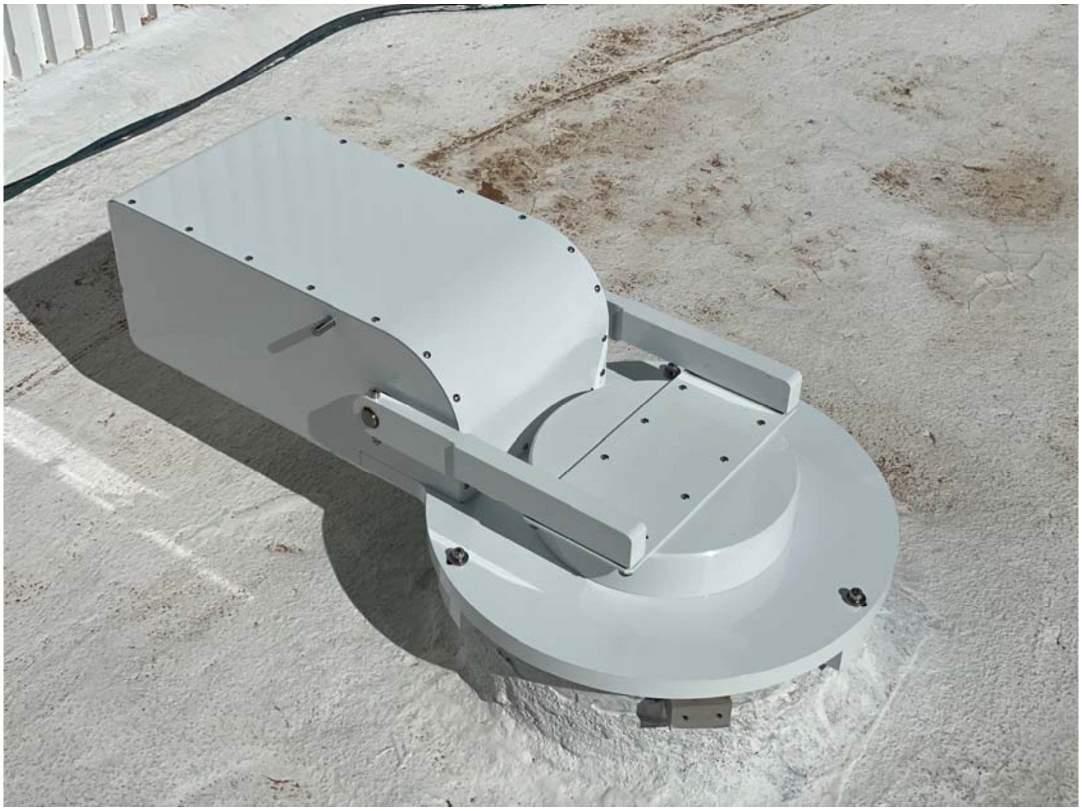

Figure 4: the solar port cover is shown in the closed position. The cover is spring loaded so that it closes flat on the circular base plate, as closing in a cocked position would allow light leakage.

3 Manual operation of the Solar Port Cover

Figures 3 and 4 show that the actual circular cover piece (the cap) is mounted on two side arms. The two side arms are connected to a horizontal drive shaft by shoulder bolts as shown in figure 5. Two nuts are on each shoulder bolt so the nuts lock against themselves, securing the nuts on the bolts.

To manually open or close the cover, the nuts must be removed from the shoulder bolts, and the shoulder bolts pushed fully out of the arms. Then, both side arms should be pushed or pulled symmetrically to actuate the cover. If the arms are not pushed or pulled fairly evenly, the arms can twist relative to each other and potentially strain the spring loaded mount of the actual cover.

There is an anti-seize compound on the shoulder bolts that can make a mess of hands or surfaces that the compound touches.

Figure 5: the shoulder bolt and nuts are seen holding one of the cover side arms to the drive shaft. This shoulder bolt is removed on each of the two arms to manually actuate the cover.

4 ICE script control of the Solar Port Cover

The Solar Port Cover (SPC) can be controlled from the ICE command line and from ICE scripts. The parameter *calibration* in the ICE parameter file *instrpars* is used with the arguments *SPC_open, SPC_close,* and *SPC?.* Examples of ICE command line usage follow

```
instrument calibration=SPC_open
instrument calibration=SPC_close
instrument calibration=SPC?
```

5 Optical properties of the diffuser

The new SPC uses a new entrance window diffuser. Here are its key properties:

- The diffuser window is made from fused silica for high transmission at all wavelengths used by TS1 and TS2. The new diffuser is slightly more efficient that the original diffuser, especially in the UV and violet.
- The diffusion occurs at the underside surface of the window, which was fine ground with *600 grit*. Figure 6 shows the transmission of the diffuser as a function of output beam angle centered upon the direction of a collimated input beam. Note that TS1 and TS2 accept input beam angles of +/- 0.88 degrees. The diffusion angle is intended to be small enough that very little of the light entering the spectrograph comes from reflection off the side of the telescope dome. The light entering the spectrograph primarily comes from within a few degrees of the zenith.

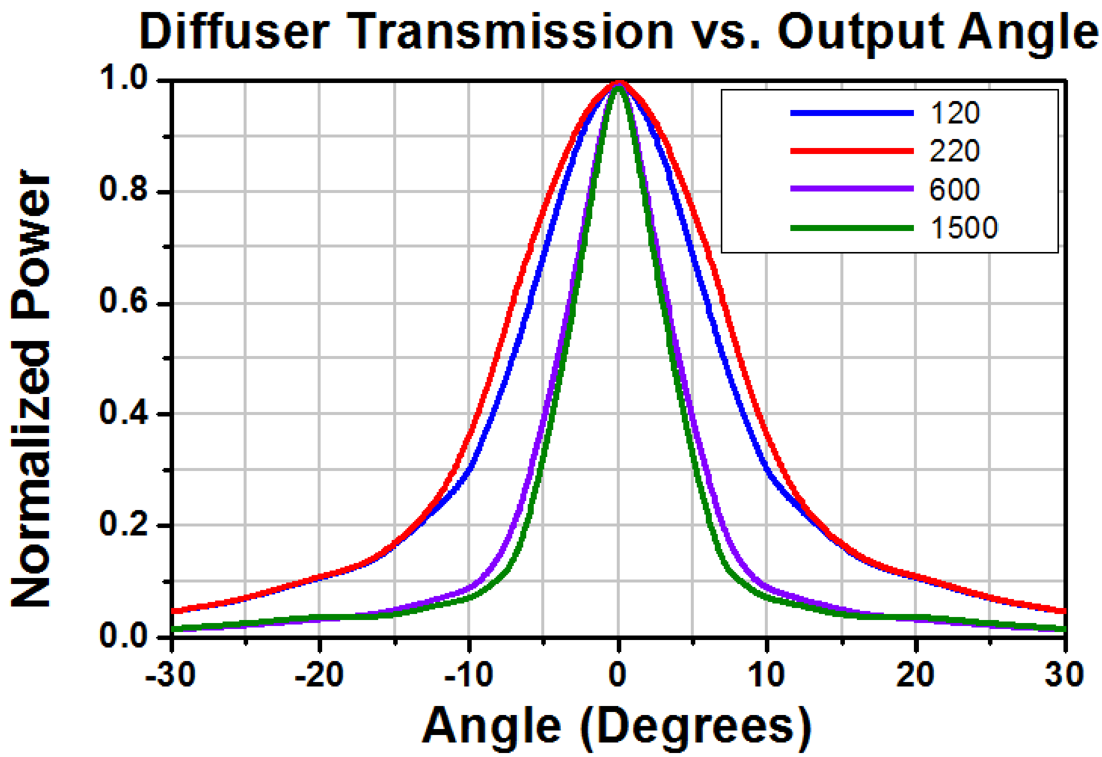

Figure 6: the transmission of the SPC diffuser versus the output beam angle centered upon the direction of a collimated input beam angle. The SPC corresponds to the purple curve.

6 Solar Port Cover engineering

6.1 The mechanical design

The mechanical design was done with Inventor and is in the McDonald Observatory Inventor Vault. This includes the model and all the part drawings.

6.2 The electronic design

All schematics were done with OrCAD, and will be added to the Inventor Vault.

6.3 Control system

The Solar Port Cover control electronics are installed in the 2018 controller that is located on the east wall in the spectrograph ante room. Figure 7 shows the controller and details the SPC subsystems within the controller.

The SPC is fused within the controller (see figure 7 caption). If the SPC stalls for any reason during opening and closing, the *slow-blow* fuse is rated to blow in about 3-5 seconds. The SPC might stall for reasons such as ice preventing it from moving, or an obstruction such as ice or snow preventing the cover from fully closing.

Motion control is via the Galil RIO controller seen in figure 7 left of top center (black box with green custom printed circuit board attached).

The motor drive of the SPC is in the housing that extends to the north side of the SPC assembly. To protect against a lightning strike reaching the controller, the housing parts are all electrically connected to each other, and to the grounded solar port tube extending down into the building.

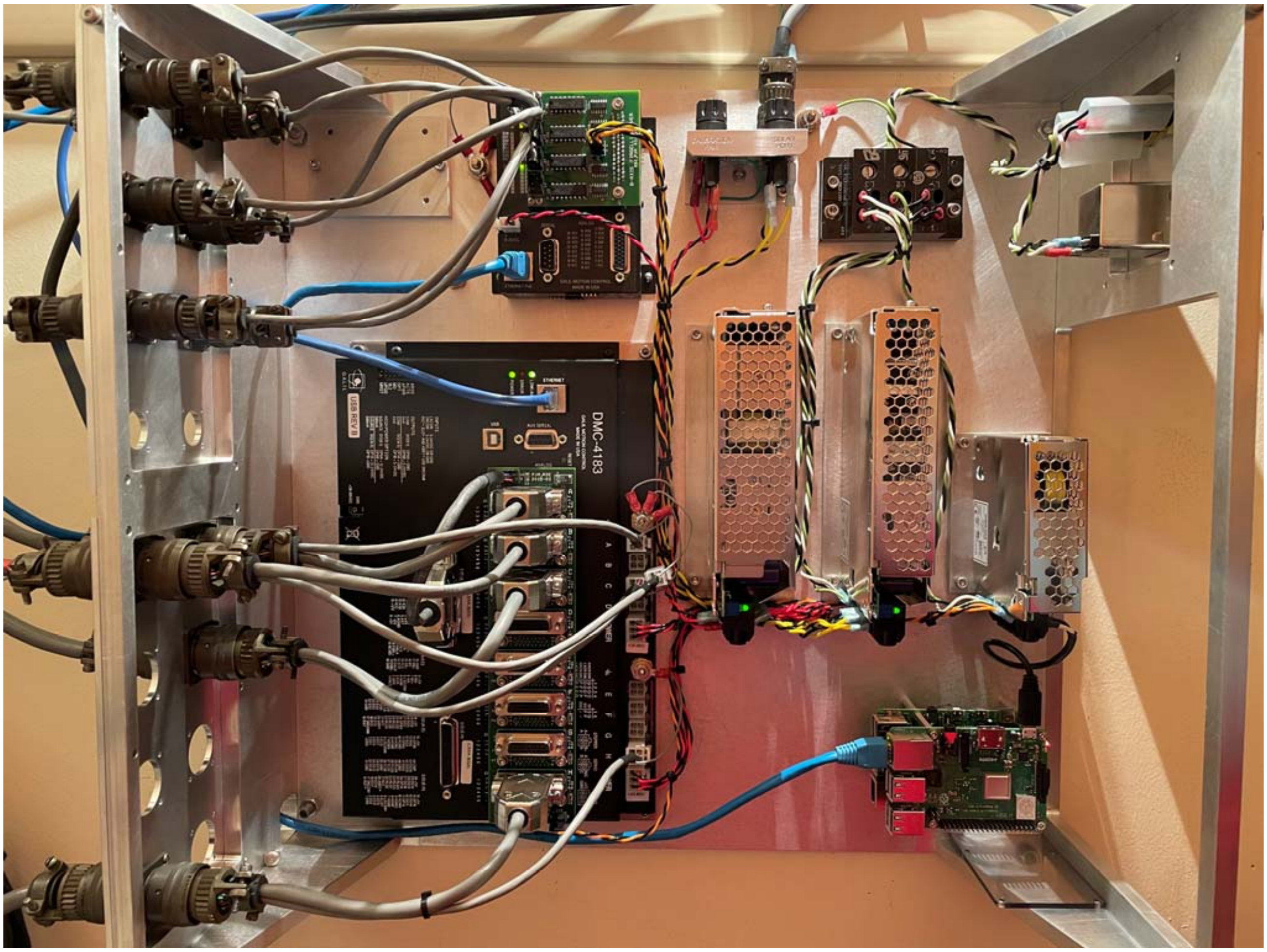

Figure 7: The ‘2018’ motion controller for TS2/2dcoude. The power cable for the SPC is seen leaving the photo at top center, and the *fuse holder* (black) for the SPC power is seen directly in front of the power cable connector. The control cable for the SPC connects to the left side of the controller in the outboard position of the third row of connectors down from the top.

6.4 The Solar Port Cover gasket

The SPC is weather and light sealed to the vertical solar port tube by the gasket on the underside of the SPC assembly shown in figure 8. The gasket is made from 40A durometer, 1/8-inch thick EPDM rubber (McMaster-Carr #8985K54). It is made in two pieces that are super glued together. A metal template shown in figure 9 is used to mark the rubber, and the rubber is cut with scissors. The template and rubber are stored in MacQueen’s locker at the HJST. The EPDM rubber is expected to have a very long lifetime.

Figure 8: The underside of the Solar Port Cover showing the gasket seated in the gasket groove, the electrical connectors, and a vent into the motor housing.

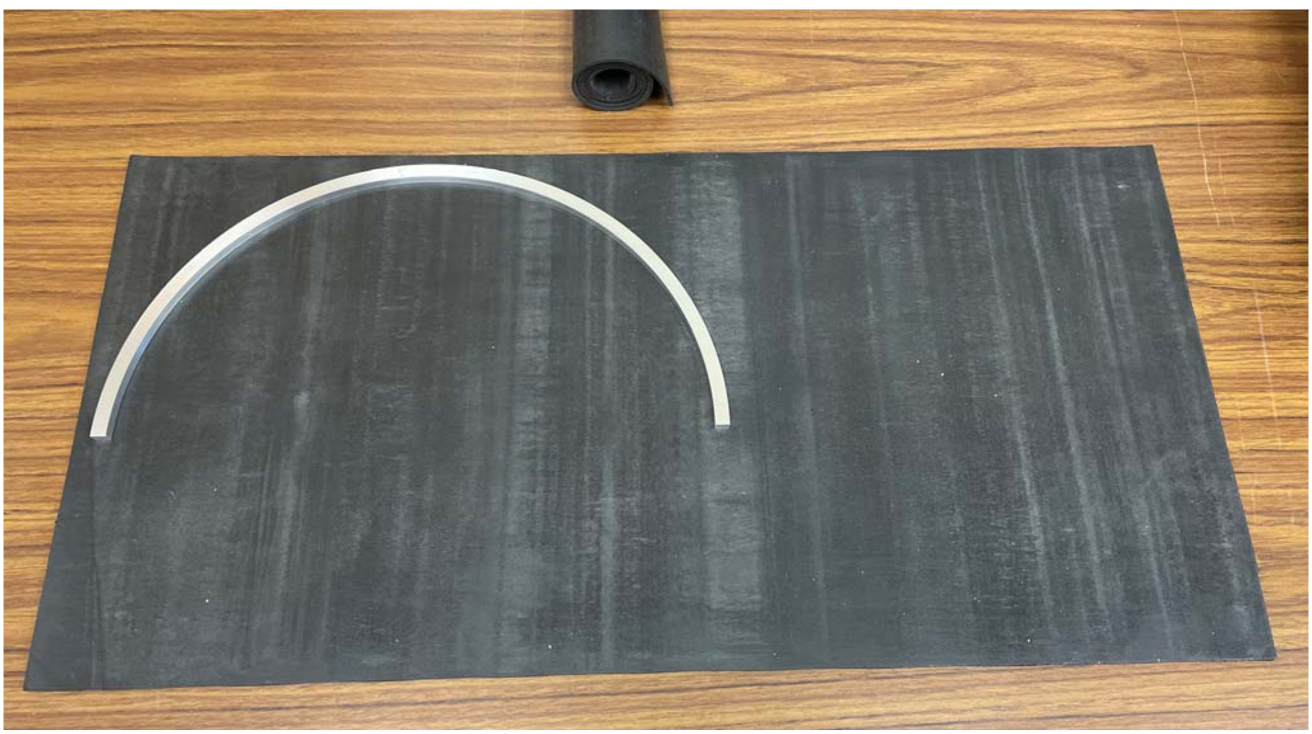

Figure 9: The gasket material and template used in cutting a gasket section.

6.5 The Project Group

The Coude Solar Port Cover was designed and built by the following project group

- Brian South, Mechanical Engineer
- Doug Edmonston, Electronics Technician
- Sam Odoms, Senior Software Engineer
- Gordon Wesley, Mechanical Engineer
- Rupert Ruiz, Machinist
- Johnny Goertz, Machine shop Supervisor
- Phillip MacQueen, Senior Research Scientist