Procedure to Collimate the SDSS 2.5m Secondary Mirror

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Cautionary Notes

- Only people trained by observatory staff may execute this procedure.
- The alignment telescope is delicate and extremely expensive; treat it carefully.

Equipment Required

- Alignment telescope: a small but heavy telescope about 6" in diameter stored in an orange case. It is kept in Jon Davis' office.
- "Manhole cover" and associated shoulder screws and pins: the fixture used to mount the alignment telescope to the 2.5m instrument rotator. It is stored in a special case in the plugging support building.

Initial State of Telescope

- All instruments removed (excluding the spectrographs) and safely stowed.
- Spectrograph corrector removed and safely stowed.

Notes

- VMS/DCL command ($ prompt) are indicated by a leading $. You need not type the $.
- TCC commands are listed as such. If you have a $ prompt and want to issue a TCC command you must start the TCC using `$ telrun`. If you are in the TCC and want to issue a VMS/DCL command, exit the TCC using `exit` or ^z.

- Commands within text (rather than on their own line) are shown in double quotes. Don't type the quotes.
- If you have the monitor space, consider using two TCC logins, one for VMS/DCL level commands and one for TCC commands. This is especially helpful while moving mirrors with setmir, as the TCC window will show you how long each move will take.
- ^z means control-z; similarly for ^\, etc.

Procedure

Set Up The Measurement Apparatus

1. Confirm that the M2 actuators are homed with TCC command `"mir status sec"`. If any are not homed you will see a warning message `W Text="Cannot compute SecOrient; not all axes homed"`.

2. If any M2 actuators are not homed, home them as described in the TCC Operator's Manual, section on homing mirrors.

3. Set the secondary mirror to its nominal centered position, orientation 0 0 0 0 0:
    - `$ setmir`
    - tell setmir to move the secondary mirror to orientation 0 0 0 0 0
    - keep setmir running; you'll use it while taking measurements
4. Install the wagon wheel:
    1. Set the altitude of the telescope to 6 degrees using MCP Menu.

    2. Bolt the wagon wheel to the rotator using shoulder bolts. Leave it slightly loose so you can reposition it.

    3. Find the correct set of holes (A,B,C or D) for the pins. Each set of holes puts the pins at a slightly different radius, which is needed as the correct radius varies with temperature. Find the outermost set of holes that will accept the pins and leave very little slop. Be sure to insert all three pins in the **same** lettered hole, else the wagon wheel will not be centered.

    4. Insert shims between the pins and the rotator. You'll probably want 0.002-0.004" of shim. Find the largest shims that will just hold themselves in.

    5. Tighten the shoulder bolts to hold the wagon wheel in place.
5. Install the alignment telescope in the wagon wheel. Be careful; the alignment telescope is a $20,000 item. Orient the telescope so that the focus knob can be turned through the large hole in the wagon wheel.

6. Install the light bulb in the alignment telescope and plug it in.

7. Adjust the focus of the crosshairs of the alignment telescope by rotating the eyepiece.

8. Adjust the focus of the alignment telescope until the dimple in the center of M2 is in focus (by turning the knurled focus wheel).

9. Align the alignment telescope:
    1. Start by aiming the crosshairs at the top of the dimple on the secondary. Typically this is close to the correct position.

    2. Record the position of the alignment telescope's crosshairs on the secondary mirror's dimple (e.g. by making a sketch).

    3. Turn the instrument rotator 90 degrees (using the Menu interface).

    4. Repeat the above two steps until you have measured at 4 rotator angles, each 90 degrees apart.

    5. The four points of the crosshairs on the M2 dimple should be symmetrically arrayed about a central point. Determine the position of this central point.

    6. Tilt the alignment telescope to center the crosshairs on this central point.

    7. Repeat the sequence above until the crosshairs do not move with respect to the M2 dimple when the rotator is turned.

Measure Collimation

This procedure requires two people: one to look through the eyepiece, the other to move the secondary mirror (using setmir) and change the altitude of the telescope (using MCP Menu).

1. Set the telescope to an altitude of 10 degrees.

2. Adjust the mirror until it is collimated:
    1. Adjust the xy translation of the secondary mirror until the crosshairs are centered on the M2 dimple.

    2. Change the focus of the alignment telescope to bring the illuminated crosshairs into focus (the M2 dimple will no longer be in focus). Note:

you **must** have the bulb in the alignment telescope lit to generate the illuminated crosshairs.

    3. Adjust the xy tilt of the secondary mirror until the illuminated crosshairs are centered on the main crosshairs.

    4. If you had to change the tilt significantly, measure translation again.

3. Record the collimated tilt and translation of the mirror.

4. Change the altitude of the telescope to 85 degrees (being careful to protect people and the alignment telescope) and record the collimated translation and tilt at this altitude.

5. If the secondary mirror cannot be moved into collimation at both 10 and 85 degrees, adjust the secondary cage as required (by rotating the turnbuckles for the rods that attach up the secondary cage to the secondary truss) to center the mirror better.

6. Continue measuring collimation vs altitude until you have data at all of the following altitudes: 85, 70, 50, 30, 10 (or some similar set of values).

7. Move the telescope up to 85 degrees and back down to 10 degrees. This is intended to relax the mirror in case there is some hysteresis.

8. Take a second set of measurements of collimation vs. altitude.

Fit and Apply Collimation Data

1. Fit measured y translation to the following formula:
   `y(alt) = Co + Csin * sin(alt) + Ccos * cos(alt)`
   One way to do the fitting is to use the Igor worksheet "Fit Collimation Coef vs Alt".

2. The other parameters should be sufficiently constant over the range of altitude that their average value can be used (in other words, only `Co` is of interest for those parameters). If this is false, try to figure out what is wrong. Then, if necessary, go ahead and fit them to the same model.

3. Edit the file `tinst:default.dat` on the TCC to apply the new collimation coefficients. The desired parameters are SecPistCoef, SecXTiltCoef, SecYTiltCoef, SecXTransCoef and SecYTransCoef. The existing comments should indicate exactly where the data belongs; if the comments are missing or

seem inadequate, use the TCC command "`show block inst`" to obtain the official comments.

Document History

2003-06-16 R. Owen: first release