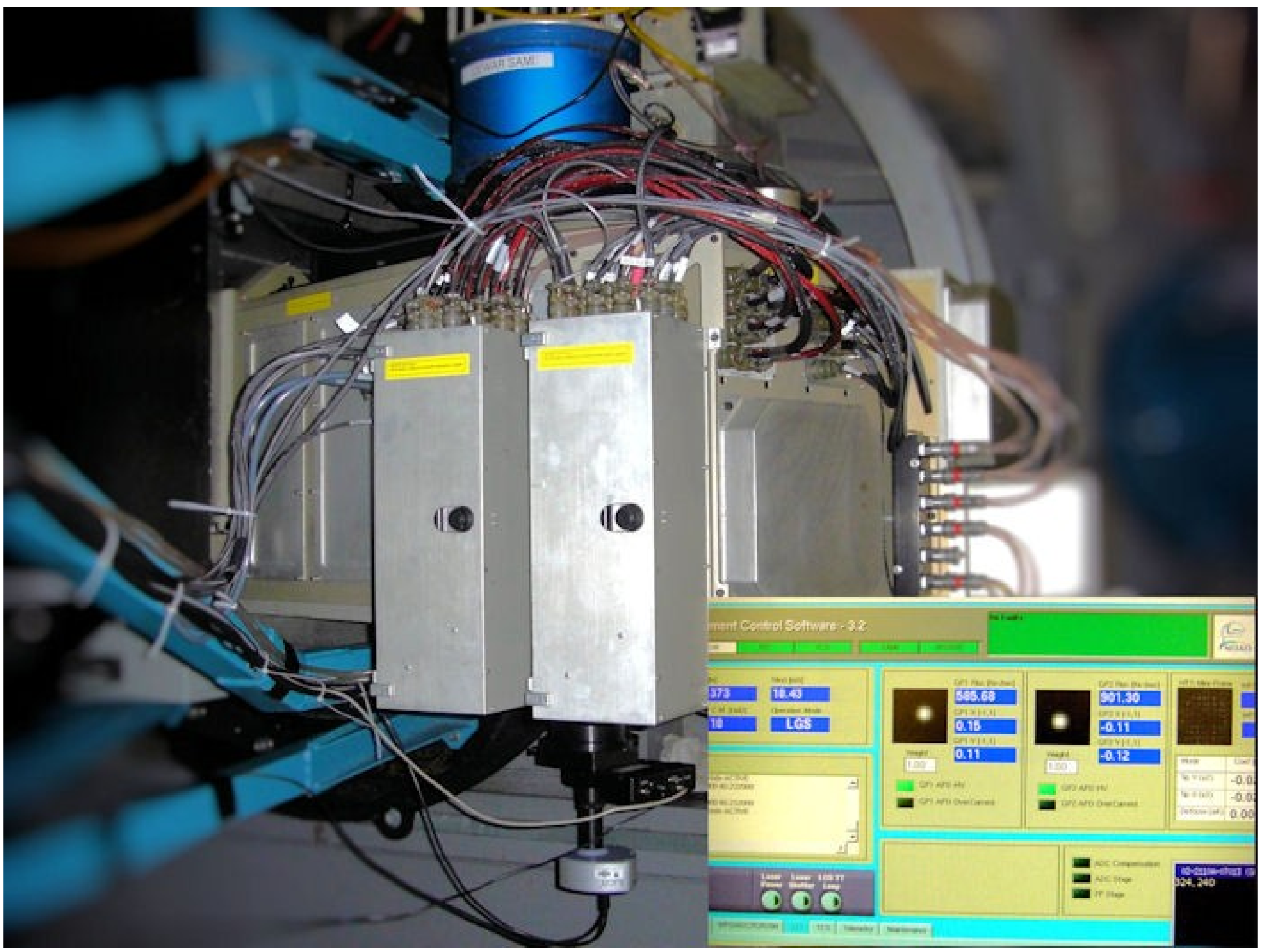
SAM Maintenance Manual

Version 2.1

Last update: August 18, 2016



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The instrument web site, part of the SOAR web space, is located at
http://www.ctio.noao.edu/soar/content/about-sam
Technical information is located in the protected intranet space. To access this information, login as
user: **sam_guest**
password: **s@m8734**

1 Mechanical maintenance

1.1 Removal and installation of the SAM AOM

The installation procedure is described in SDN-SAM-AD-02-3215 (DocDB 773-v1: SAM Installation Manual). Removal is done in the inverse order. Brief sequence is as follows:

- Disconnect SAM from all external cables, glycol lines, and optical fibers. Remove SAMI dewar.
- Set the Nasmyth rotator to the 270° angle (SAM points up) and fix it with pin.
- Attach SAM to the crane.
- Remove the bolts connecting SAM to the ISB. The instrument is in a vertical position, “sitting” on the ISB and secured by the crane.
- Lift SAM with the crane and lower it on its handling cart, which should be set ready on the dome floor. The cart is secured by two diagonal rods.
- Tilt SAM to horizontal position using the mechanism of its cart, then detach the tilting mechanism from the main body of the cart, which rests on its 4 wheels.
- Remove electronics from the SAM rack (each module separately).
- Balance the Nasmyth rotator.

SAM mass: **294kg** without dewar, **330kg** with dewar.

1.2 Removal of SAMI

SAMI has to be removed to get access to some elements inside SAM, e.g. TurSim. This operation takes about 30 min and is done best by two people. Here are the steps to follow.

- Set Nasmyth rotator to a position angle about 30° for convenient access to SAMI from the platform.
- Power down the SAM electronic boxes (motor control)
- Disconnect the dewar (use ground plug on its connector to protect the CCD) and remove the dewar. The dewar is bolted using eight #10-24 Socket Head Cap Screws. Remove the SAMI Leach controller and its power supply.
- Remove SAMI shutter and filter wheel following established procedures

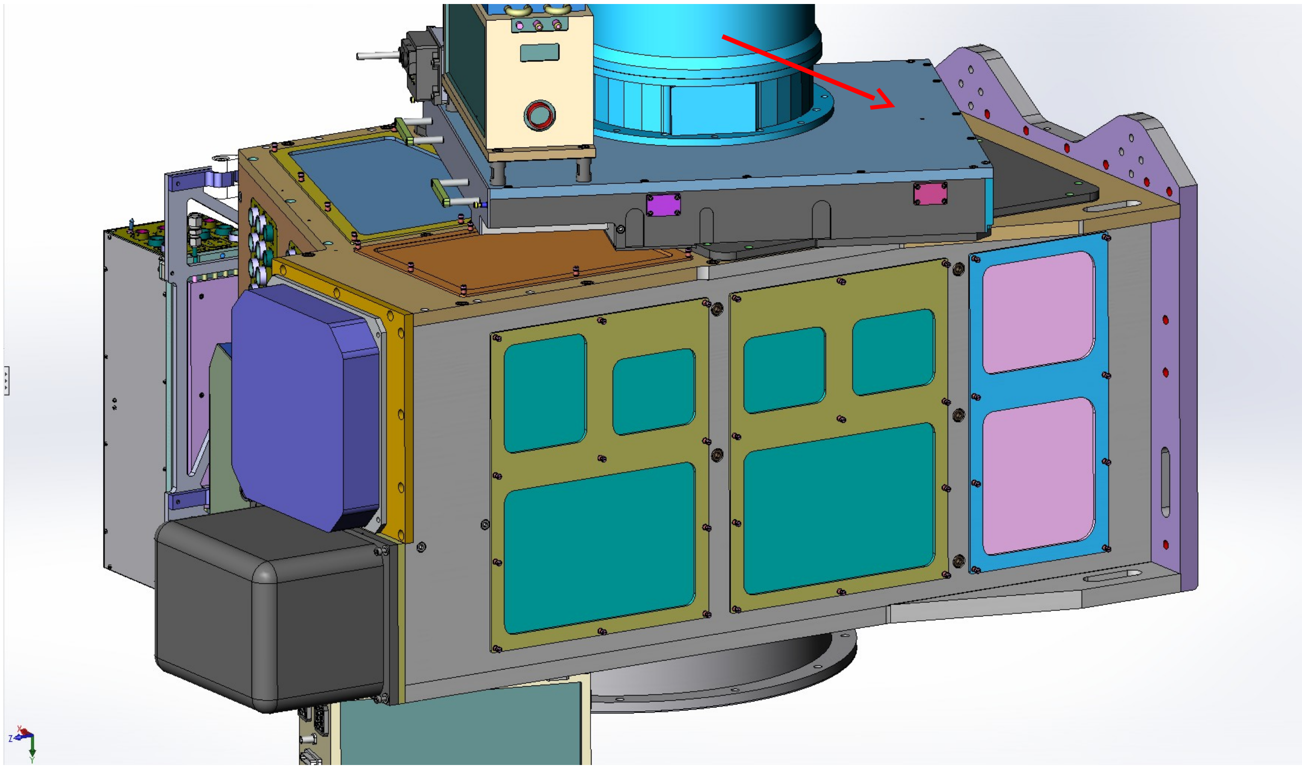

Figure 1.1. SAMI dewar, Leach controller, and housing.

To get access to TurSim, remove SAMI as described above and continue with the following steps:

1. Remove SAMI housing by removing the eleven M10 bolts that fasten SAMI to the main SAM housing.

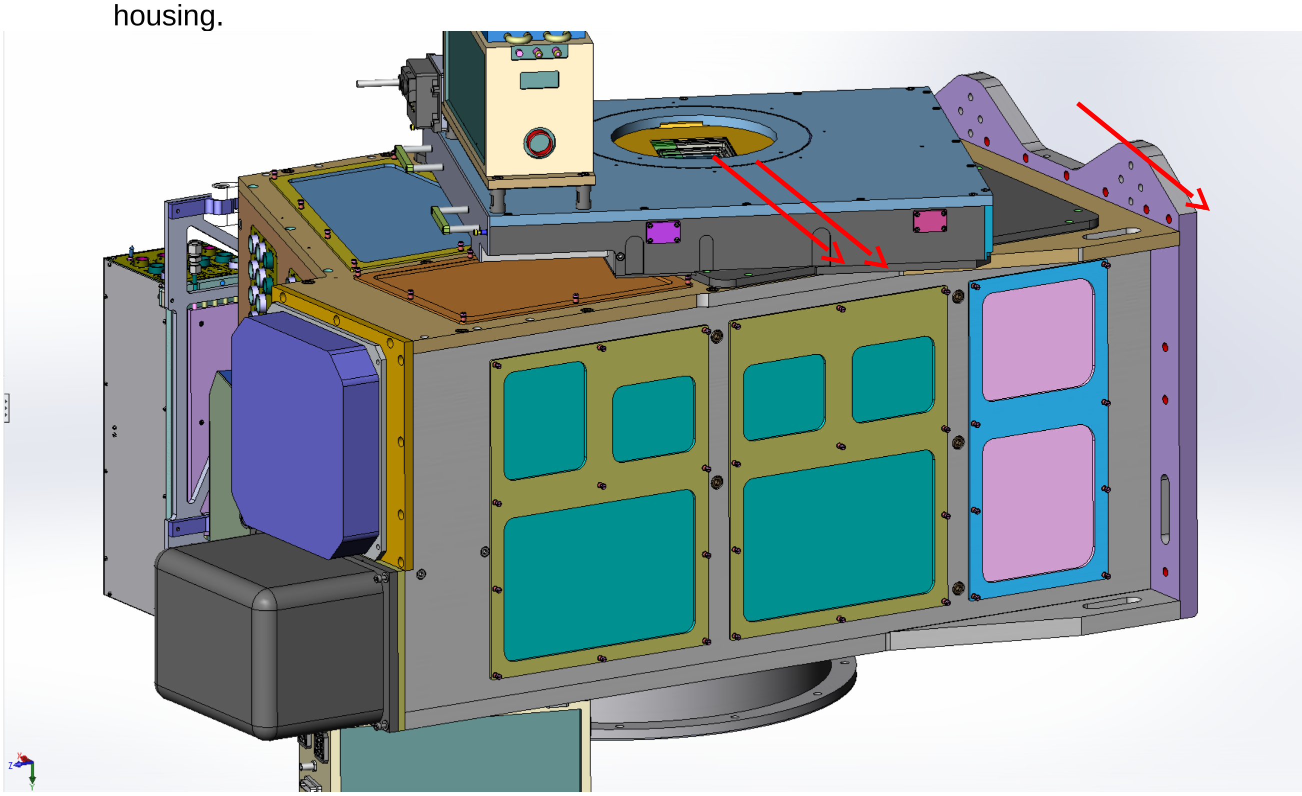

Figure 1.2. Removal of the shutter.

2. Remove the housing top cover shown in Fig. 1.3. The cover has thumbscrews so no tool is needed for this operation.

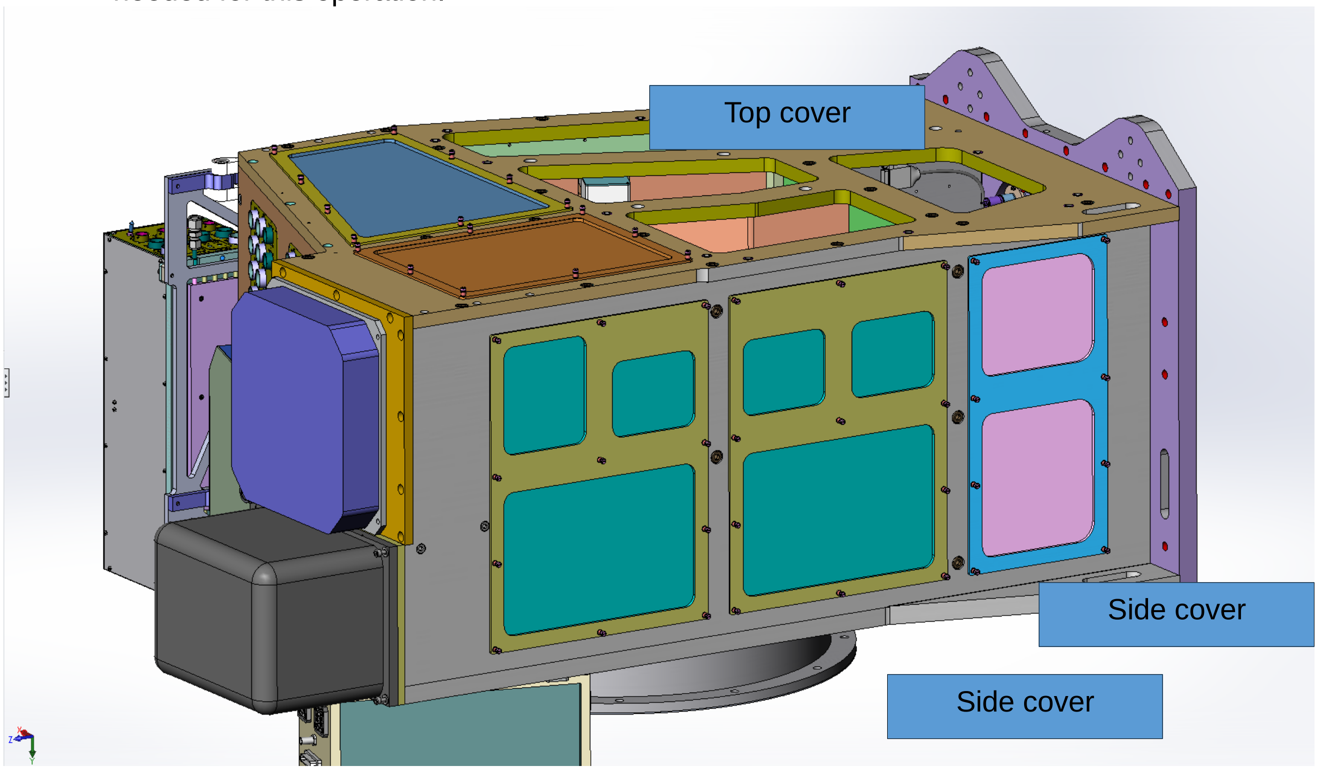

Figure 1.3. Removal of the SAM top cover and side covers.

3. Remove the housing side covers indicated in Fig. 1.3. The covers have thumbscrews so no tool is needed for this operation.

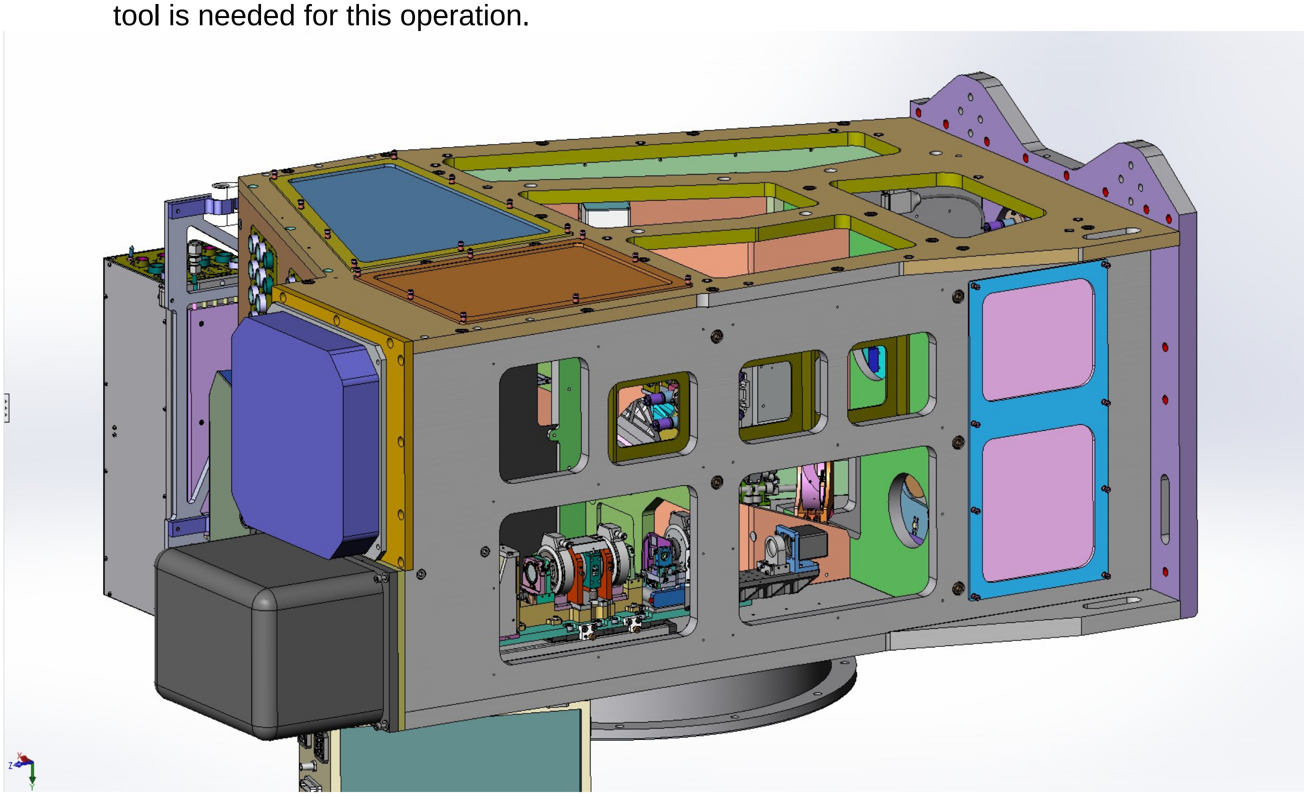

Figure 1.4. TurSim inside SAM.

4. Cover OAP1 with its white Delrin cover.
5. Making sure all power is off, disconnect the TurSim motor control cables shown in Fig. 1.4. These are inside the instrument.

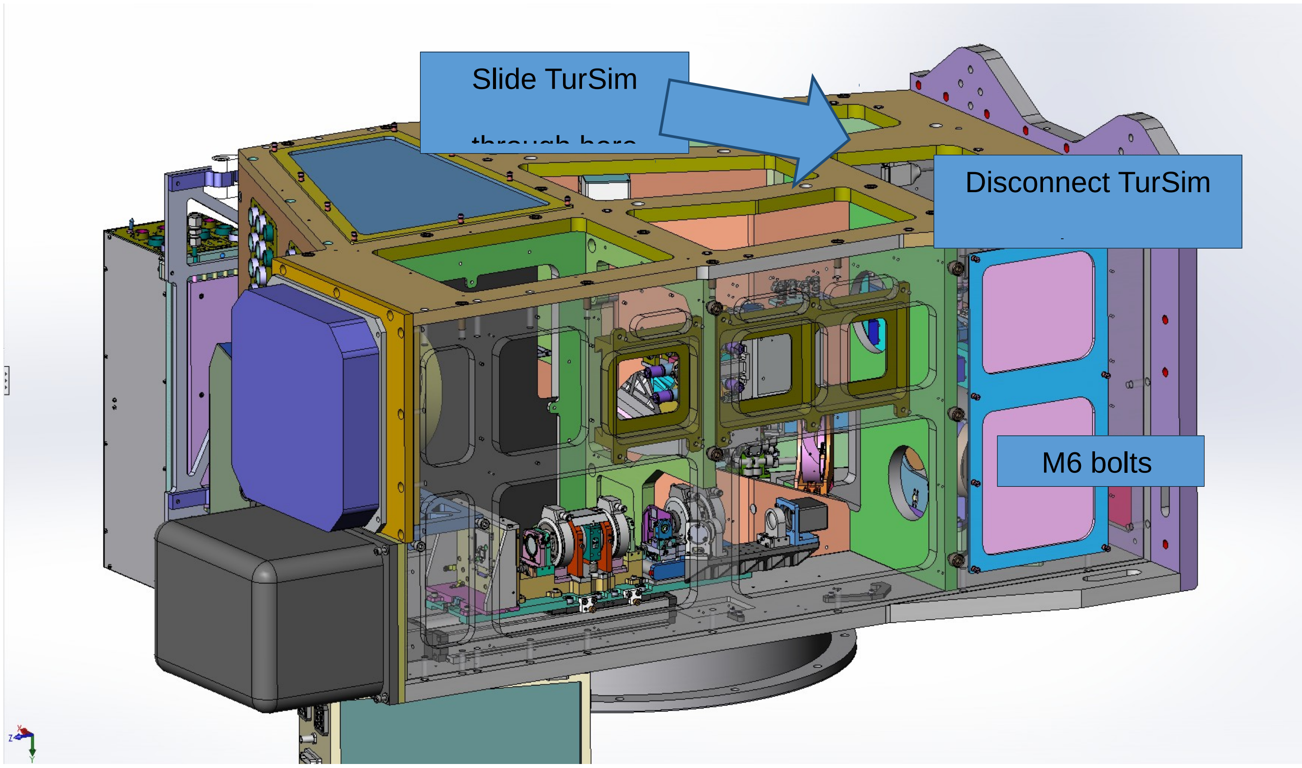

Figure 1.5. Removal of TurSim.

6. Remove the ten M6 bolts that fasten TurSim. The bolts are inside the instrument and not very easy to access. Be aware that you need to hold TurSim after undoing the screws. BE CAREFUL NOT TO TOUCH THE OFF AXIS PARABOLOID MIRROR (OAP1). Even though it is covered, it is fragile!
7. Slide TurSim through the top cover hole shown in Figure 1.5.

Removal of the SAMI shutter is described in the document

DOCDB **666-v1**	**SAM shutter Installation Procedure**

1.3 Access to the laser and the LLT

The laser rack with the power supply and chiller is located on the telescope fork (IR-side) and is accessed from the scissor lift. See SAM-AD-02 3214. The laser box is located on the SOAR tube truss and accessed from the boom lift.

The LLT is bolted behind the SOAR secondary mirror. It is accessed from the scissor lift with the SOAR in horizontal position (elevation < 2°).

1.4 Removal and installation of the LLT

See the description of the LLT mechanical design in the SAM-AD-02-3212. Chapter 8 of that document covers interface between LLT and SOAR and the installation procedure.

The LLT is installed at SOAR fully assembled, with its enclosure. During installation, the SOAR is in the horizontal position, so the gravity is directed in +Y. Two lower M6 screws are placed at B and C, respectively, and two screws at A. The LLT is held by hands, then it slides on the screws in +Y (big yellow arrow in Fig. 1.6) to its nominal position. The lateral position is defined by the lower screws B and C (M6), all other holes being slightly over-sized. After LLT is installed, the remaining 2 screws are placed at B and C and all 6 screws are tightened.

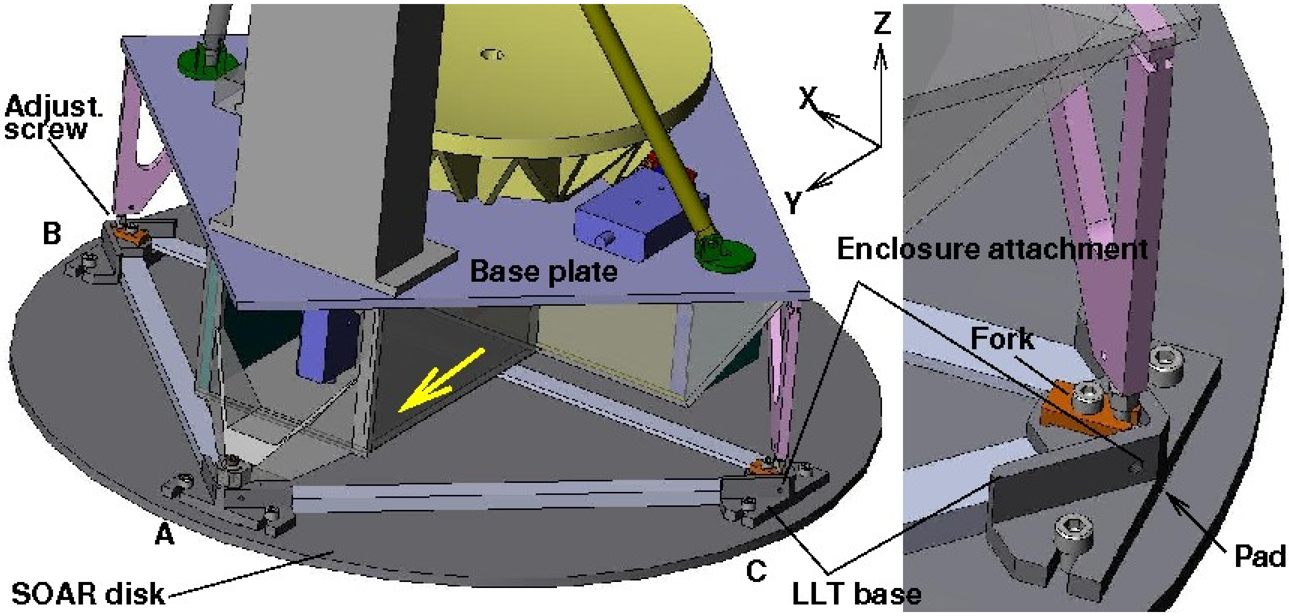

Figure 1.6: Details of the LLT interface to SOAR.

The lower part of the LLT enclosure can be easily removed for maintenance and alignment, without removing the complete enclosure. To do this, release the 4 “fingers” that fix the lower part (Allen screws M2.5) and turn them to release the lower enclosure. Unfasten the Velcro bands on top and bottom and remove the two halves of the lower enclosure. Installation – in the reverse order.

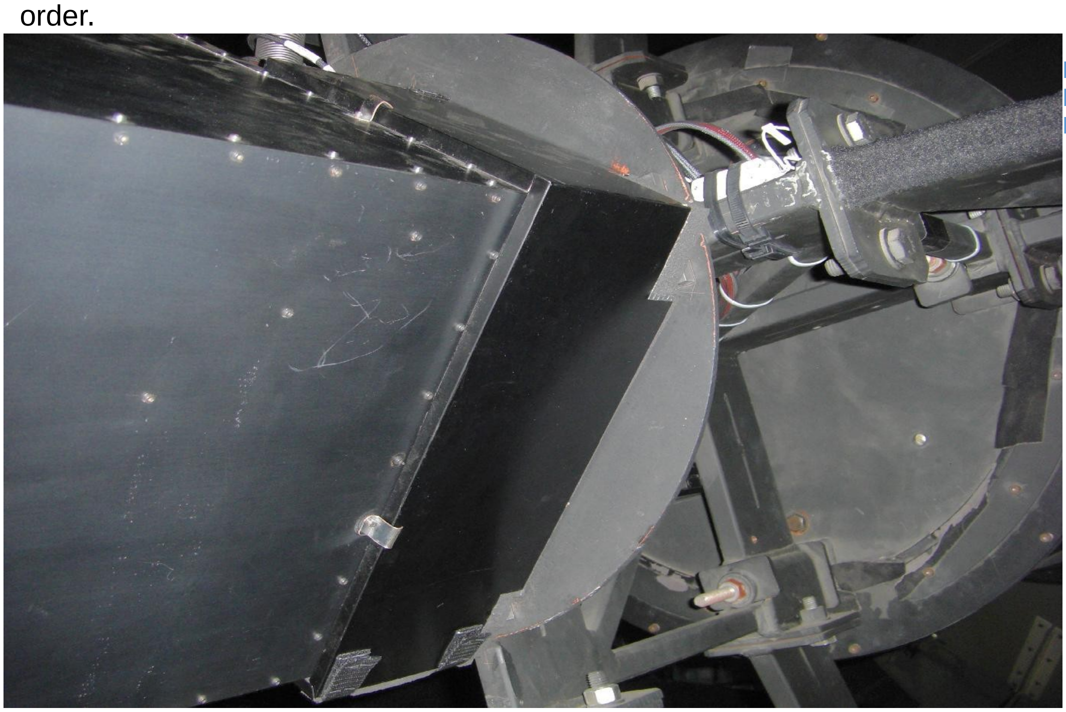

Figure 1.7. Removable lower enclosure of the LLT.

2 Optical maintenance

2.1 Cleaning

2.1.1 SAM main module (AOM)

- With the SAM AOM horizontal (rotator at zero), dismount SAMI and gain access to DM, SAMI fold, dichroic, WFS fold, and collimator.
-open the two covers left on the SAMI side and gain access to OAP1 and OAP2 and the WFS train.
-open lateral covers on the outer side (platform), insert a vacuum cleaner hose.
-open the two external lateral covers on the inner side (Nasmyth rotator) to have side access to the LGS WFS train (acq. camera, laser range-gate, SH unit)
-dismount the HR camera (or other visitor instrument) to access the VI fold.
-with dry-air (or N2 gas) gun through the SAMI side, blow on OAP1 and OAP2, on DM, on Dichroic, SAMI fold and on all the WFS optics. At the same time, suck the air-borne dust produced with the vacuum cleaner hose inserted through the platform side of SAM (see Fig. 2.1).

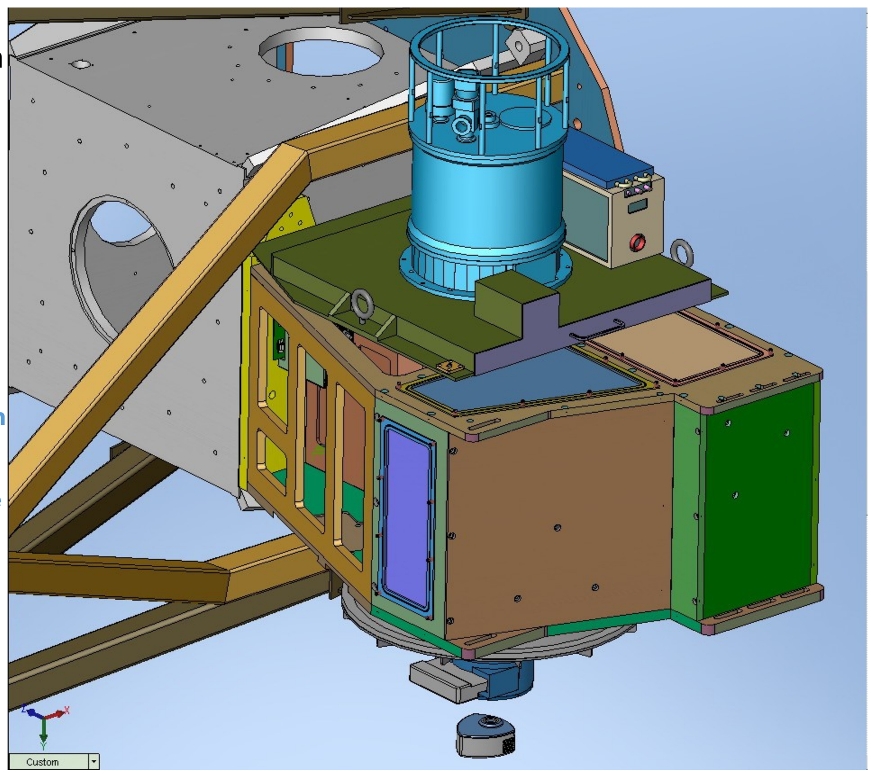

Fig. 2.1 shows the SAM mounted on corresponding port of the optical-ISB Nasmyth . It also shows the SAM covers (or the holes where covers go).

- with dry-air (or N2 gas) gun through the VI side, blow on the VI fold while sucking the air-borne dust produced with the vacuum cleaner hose positioned appropriately.
-If the surfaces (mainly OAP1, OAP2, SAMI fold and VI fold) continue to be dusty, stained or “foggy”, apply the same semi-dry wash done to telescope mirrors (ACTR-xxx).
-Note: **do not dry-wash or touch** in any way the following components: DM, Dichroic, WFS fold, WFS collimator and LGS WFS. These components should only be dusted off with N2 gas air-gun.
-This complete cleaning should be done once per year.

-SAMI filters: should be checked and dusted off with dry air or N2 gas, during the SAM cleaning at least once a year (and also whenever a filter change occurs). Done by Optics during SAM cleaning or ObsSup during filter changes.

2.1.2 LLT cleaning

-LLT housing shutter: dust off with dry air once per 3 months during the monthly top-ring cleaning by Soarops.
-LLT M1 and M2 dust-off with N2 gas gun and then semi-dry wash using the CTIO prescription (ACRT-xxx), once a year by Optics and Soarops.
-LLT M3 and M4 dust off with N2 gas gun once a year by optics and Soarops.
-Laser Box window. Remove laser box to beam propagation tube flexible connector and inspect and then dust off the window with N2 gas gun also once a year during the LLT systems cleaning, by optics and Soarops.

2.2 Alignment between SAM and the SOAR pupil

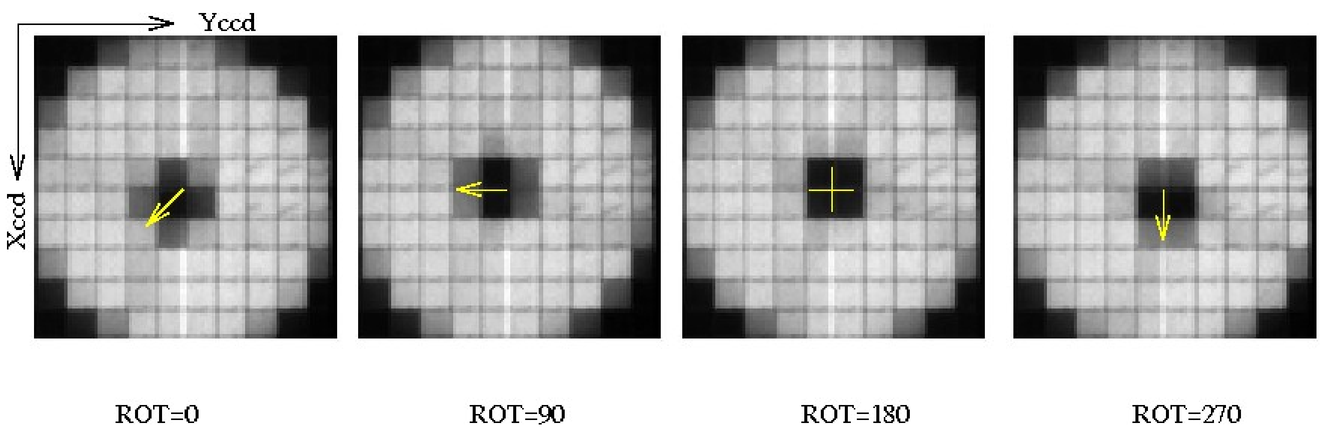

Figure 2.2: Misalignment between SOAR pupil and SAM WFS. Data from Nov. 18, 2010 (SDN 7116). The images of sky in the WFS are oriented as displayed in the ICSoft and RTSoft GUIs. The yellow arrows show pupil displacement at different angles of the Nasmith rotator.

The SAM pupil, defined by the image of the DM, must coincide with the SOAR pupil at all orientations of the Nasmith rotator. This is achieved in two steps. First, the mechanical axis of the rotator must point at the center of the SOAR pupil. This adjustment is done independently of SAM by tuning the angles of the SOAR tertiary mirror. Second, the SAM optical axis has to be co-aligned with the rotator axis, hence with the pupil. This was achieved during SAM installation in November 2010 by adjusting the angle of the SAM M4 mirror inside the ISB.

The pupil alignment is checked by taking images of the daytime sky through the SAM WFS (little light goes through the WFS, so image cubes have to be saved and processed to see the pupil clearly). The displacement of the pupil and its radius are determined from these images using the IDL program fluxmod.pro. The pupil displacement at all rotator angles must be less than 0.2 of the sub-aperture diameter (0.08 m projected on the primary mirror). See

[SDN 7116](#) and [SDN 7133](#) for more details.

In the case of any change in the SOAR optics (M3 angle, re-aluminization, etc.) or ISB optics (M4 angle or position), the pupil alignment in SAM must be checked and, if needed, corrected.

The M3 offset angle can be adjusted using the M3 Web interface as shown in Fig. 2.3, and modifying the EL and AZ offset values manually (top-left in Fig. 2.3). The current values are 16.0 in EL and 0.0 in AZ. Once these values have been adjusted, it is necessary to hard code them in the M3 cRIO FPGA Labview code (R. Cantarutti), so the M3 Control system boots up with the new offset values (consult Mike Warner).

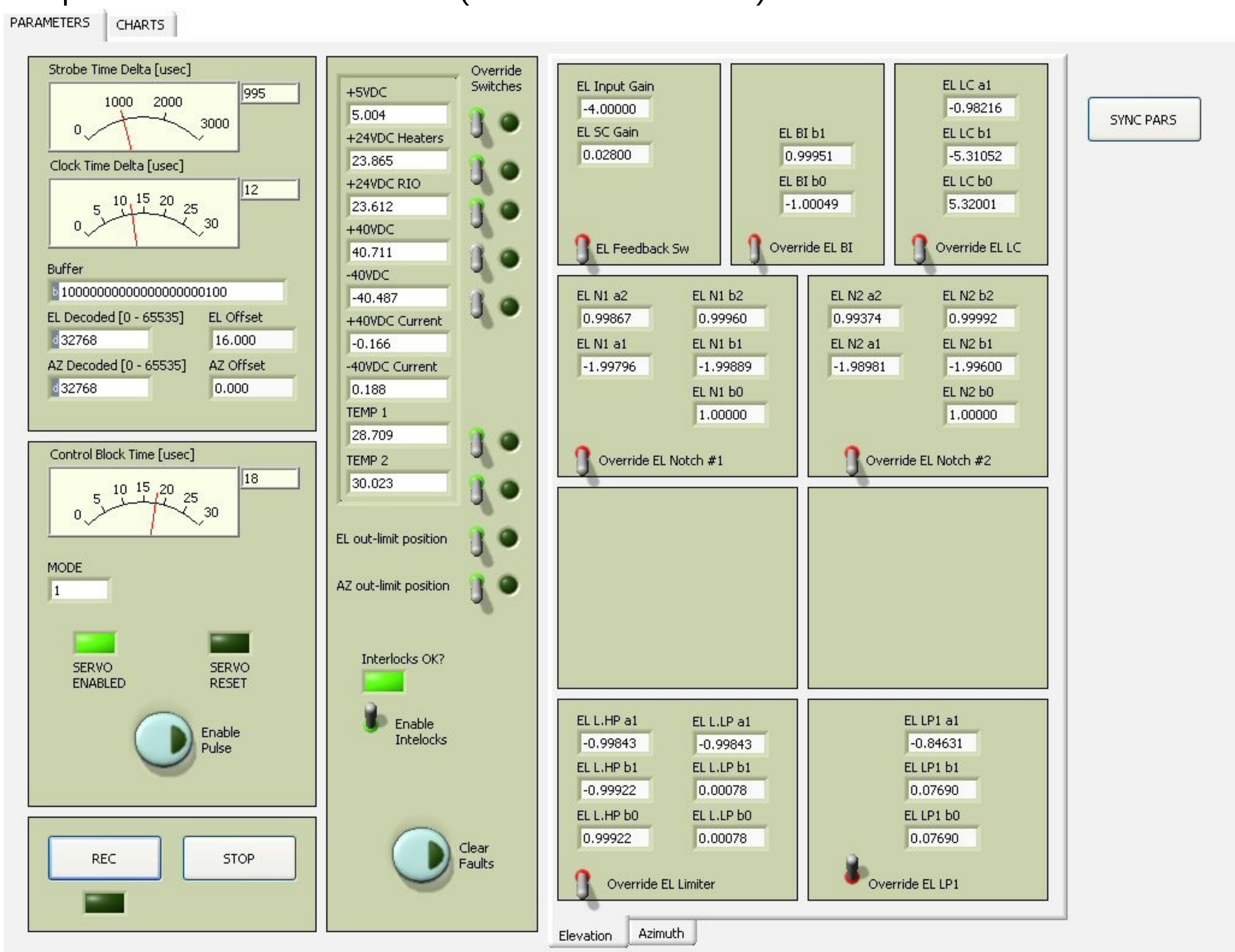

Figure 2.3. Service page of the SOAR M3.

2.3 Optical quality of the SAM AOM

The quality of the SAM optics has been extensively tested during its integration, see [SAM-AD-02-7101](#). In particular, the Strehl ratio of a point source in the guide probe, observed with HRCam, was measured to be 63%. Degradation of the optical quality can occur as a result of the mis-alignment (unlikely) or a change of the DM shape (possible).

To check the internal optical quality, do the following. Switch on the DM driver, flatten the DM and leave it with these voltages for 0.5h-1h to eliminate the creep ("soak"). Determine the new flat DM with TurSim and apply it to the DM (the Nasmith rotator must be at angle 0, otherwise the DM flexure will not be properly corrected at other angles). Retract the TurSim arm. Using HRCam (or SAMI), take images of the point source in the guide probe GP1 located at the center (use the Center-Probe script from the GP1 menu). Adjust the GP1 focus to get the sharpest image and record the image. Also take defocused images (donuts) by offsetting the GP1 focus by ±5 mm from its best position, for further analysis of the residual aberration.

2.4 Quality check of the laser system

2.4.1 Laser beam size and shape

-Install Beam profiler (Beamage-CCD23, Gentec EO) in beam-profiler port on laser-box, Fig.2.4. (see also SAM-AD-02-2310, page6).
-move Beam sampling unit to position IN (use the SAM laser control GUI)
-Turn on laser and measure beam profile and shape.
-If power needs to be checked, then override the laser box opening safety interlock and in manual mode open box and dismount the laser dump2 and mount the power meter head there instead. Turn on the laser and measure (355nm Laser Safety Goggles must be used).

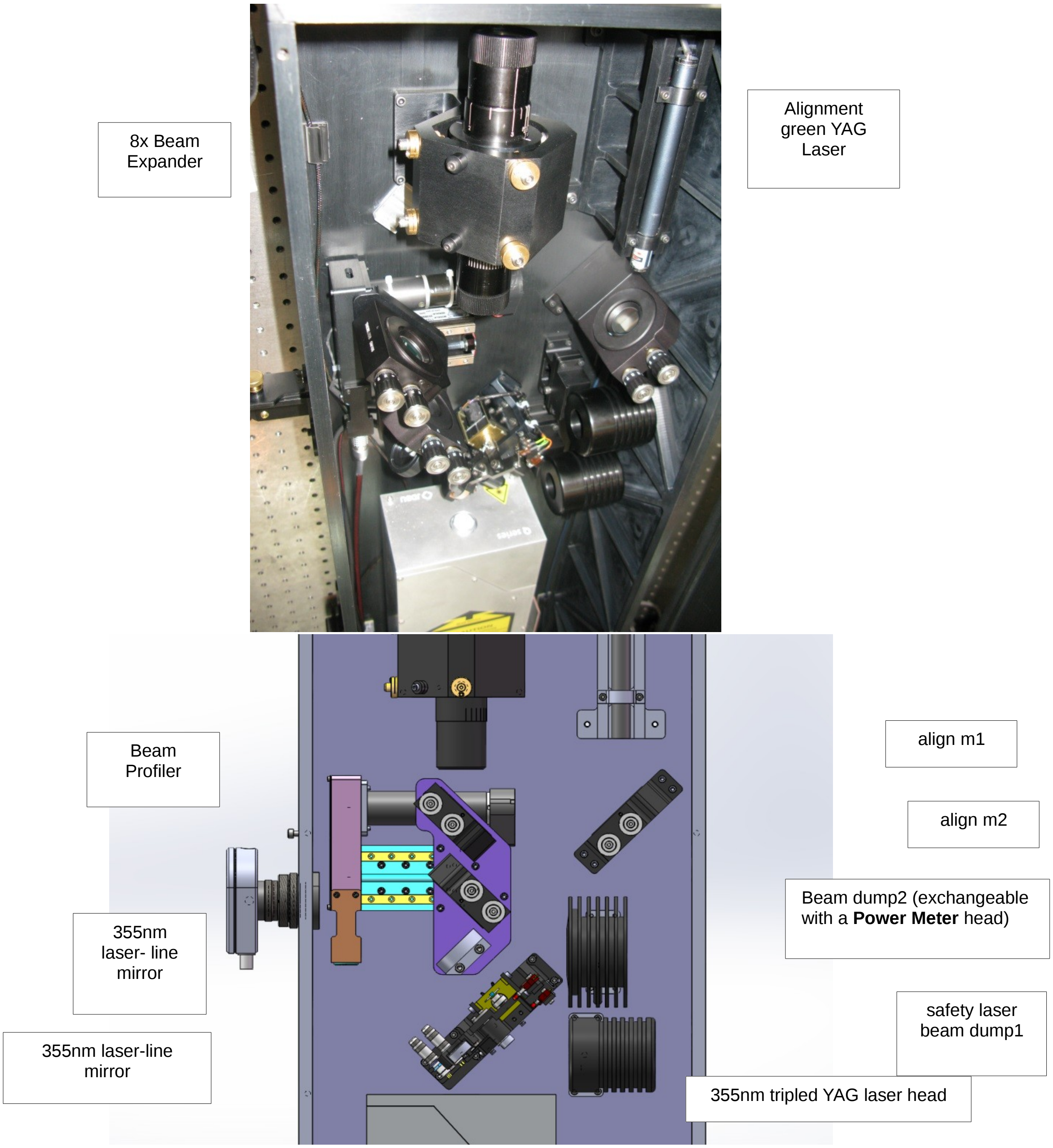

Figure 2.4. As built components of the LGS Laser-box.

2.5 Co-alignment of the laser beam with SOAR

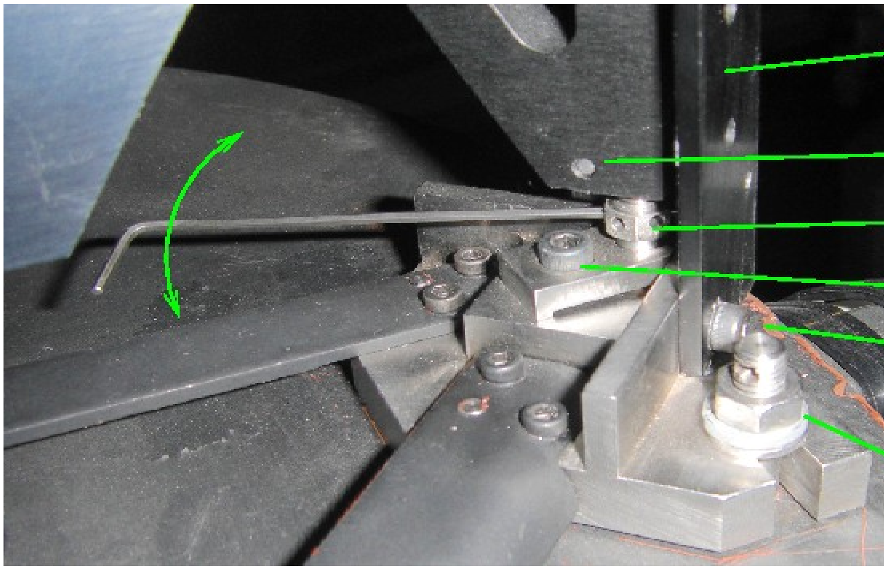

Figure 2.5: Alignment of the LLT optical axis. The screw #2 (right) is shown, with a tool (Allen key) inserted to turn it.

The geometry of the LLT is described briefly in its guide, LLTguide.pdf. The direction of the laser beam emitted by the LLT must coincide with the SOAR optical axis. The remotely controlled adjustment range of the LLT is small, about ±60arcsec. LLT axis must be adjusted mechanically to be near the center of this range. The adjustment is achieved by turning the alignment screws #1 (left if you look into the LLT) and #2 (Fig. 2.5). To access these screws, remove the lower part of the LLT enclosure. Loosen the M3 clamp and the M4 fork screws, turn the alignment screw by inserting a thin rod (e.g. a 1.5-mm Allen key) into its 2-mm holes, then tighten the M3 clamp and the M4 fork.

Each turn of the alignment screw by 60° moves the LLT axis by 150″ (2.5″ per degree of screw rotation). Let dAZ and dEL be the telescope offsets needed to center a star in the LLT (AZ positive to the East), in arcseconds To correct, turn screw #1 by (-dAZ,-dEL)/2.5 degrees (positive when extending the screw and hence lowering the LLT axis). Similarly, turn screw #2 by (+dAZ, -dEL)/2.5. For example, if LLT points up, above the SOAR axis, dEL will be negative (lower the telescope to capture the star in LLT), and the angle to turn the screws will be positive (extend the screws, lower the LLT axis).

The LLT alignment is stable in time, provided there are no changes in the SOAR optics. Adjustment is needed when the settings of the SOAR M2 Hexapod are changed, or after other major changes.

The offset between SOAR and LLT is measured by pointing a star brighter than V=4mag and centering it in SOAR. Note the star's equatorial coordinates as displayed by the TCS. Then acquire the star image in the LLT-ATP camera by offsetting the telescope (use spiral search in the SOAR-TCS hand-paddle, step 30″, time step 20s). Center the star in the LLT by SOAR movements. Note the new coordinates and the **sidereal time.** Use the IDL script offset.pro (edit it by inserting the correct coordinates and sidereal time) to calculate dAZ, dEL, and the required motion of the LLT adjustment screws.

Coarse adjustment of LLT and SOAR can be done during daytime using a periscope (see

SDN 7118). After the two light sources are brought to coincidence, move the LLT axis upwards by ~ 90″ to compensate for the horizontal position of SOAR during this alignment (outside the active optics range).

2.6 Filter wheels

The filters will be dusted off with dry-air or N2 gas gun during filter changes by ObsSup staff (as done with filters). During the SAM main module cleaning, the SAMI filters will be dismounted and cleaned using drag-and-wipe with Ethanol if dusting off is not enough to clean them (stained or stuck dust).

3 Detector maintenance

3.1 Dewar vacuum

Instrument Telemetry is already in place. If vacuum gauge is repaired and left turned on it could be automatically read/stored - this includes possible alarms. Check the detector status at
http://ctiop8.ctio.noao.edu:8000/InstMon.html

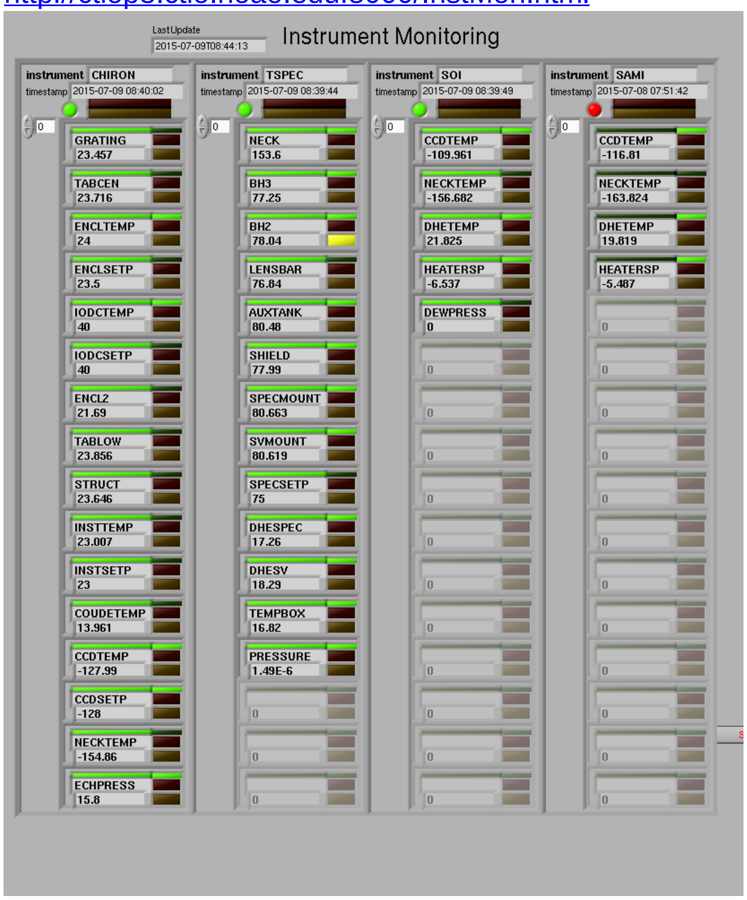

Figure 3.1. Detector monitoring tool on the web.

3.2 Leach controllers

See SAM-AD-02-5372 by R.Cantarutti/M.Bonati
Instrument Telemetry coming from the Leach controllers is already in place, including database storage, alarms and remote monitoring via web page (data every 10 minutes). The important point is that the controller should not be turned off in order to get telemetry.

3.3 CCD maintenance/periodic check

As part of the observatory-wide Detector Quality control project, there should be a periodic checking of the basic CCD parameters: gain, linearity and noise. The period and method of checking (possibly some automatic tasks started manually) is TBD, but in principle once a month could be reasonable.

4 Electronics and laser

See SAM-AD-02-5382 and SAM-AD-02-5210 by E.Mondaca for main electronic box and PXI+DAC.

4.1 Deformable mirror and interaction matrix

The health of the DM and its driver is checked by measuring the interaction matrix and comparing it with previously measured matrices. Any change of response (either global or of a single electrode) will be detected. Follow the procedure for measuring Imat, as described in the § 3.2 of the RTSoft User Manual (also DocDB 581-v1). Then use the IDL program imatcomp.pro. The relative difference between Imats reported by this program should not exceed 0.2.

4.2 Laser power and coolant

The laser optical power, measured by the internal sensor after a 30-min warm-up, must be no less than 7 W.

The laser coolant is a 15% Glycol solution in distilled water with the Chloramine additive (see https://www.optishield.net/Chloramine_Additive.php), concentration 1 g per gallon. To change the coolant, do the following:

- Clean the reservoir of the laser chiller.
- Purge the coolant lines to the laser head.
- Re-fill with clean coolant.

See further instructions on filling in the Laser Chiller Manual at SAM/electronics/laser/Q_Series_Chiller_ Manual _revC

Check coolant **before each run** and change the glycol/water mix **once per year**.

4.3. Glycol in SAM

-Check the coolant **before each run** and change the glycol/water mix **once per year,** jointly with coolant change in the Optical Nasmith system.

5. Computer system maintenance

1. RTSOFT: not critical, but it might be desirable to clean the directory containing old WFS bias fits files, IMAT fits files, flat DM files, etc. The logrotate service take care of log files management.

2. ICSOFT: the logrotate service take care of log files management.
3. AOMSOFT: check the /home/aom/logs directory once a year.
4. LMSOFT: check the /home/slgm/logs directory once a year.
5. SLCHSFOT: check /home/slch/APPROOT directory once a year.

Not mandatory, run the fsck command on all systems once every six months to check hard disk integrity. Not mandatory, check repository copy of the software against working copy and update repository if necessary every 6 months.

Appendix A: Table of SAM periodic maintenance tasks

The table lists periodic maintenance tasks defined in this document. The responsibility is defined as SOAR operational support (SOAR-ops), CTIO optical engineer (Opt.Eng.), or SAM instrument scientist (SAM-Sci)

Table 1: SAM periodic maintenance tasks

N	Task	Sect.	Periodicity	Responsibility
1	LLT dust cleaning	2.1.2	3 months	SOAR-ops
2	LLT mirror wash	2.1.2	1 year	Opt.Eng.
3	SAM AOM cleaning	2.1.1	1 year	Opt.Eng.
4	DM control	4.1	Each run	SAM-Sci.
5	SAMI CCD check	3.3	TBD	Electr.Eng
6	Laser coolant check	4.2	Each run	SOAR-ops
7	SAM coolant check	4.3	Each run	SOAR-ops
8	Computers check	5.0	1 year	SAM-Sci

The Checklist Table, to be filled for each SAM run, can be found in the SAM Memo.

Appendix B: SAM Maintenance Calendar

The calendar is to be updated at each maintenance operation by entering its date, next date, and the name of the person who did the maintenance.

Task, Manual Section	**Period**	**Respons.**	**Last date**	**Next date**	**Who did**
LLT dust cleaning (2.1.2)	3 months	SOAR-ops			
LLT mirrors wash (2.1.2)	1 year	Opt.Eng.			
SAM AOM cleaning (2.1.1)	1 year	Opt.Eng.			
SAMI CCD check (3.3)	TBD	Electr.Eng			
SAM coolant replacement (4.3)	1 year	SOAR-ops			
Laser coolant replacement (4.2)	1 year	SOAR-ops			
Computers check (5.0)	1 year	SAM-Sci			

Last update: ____