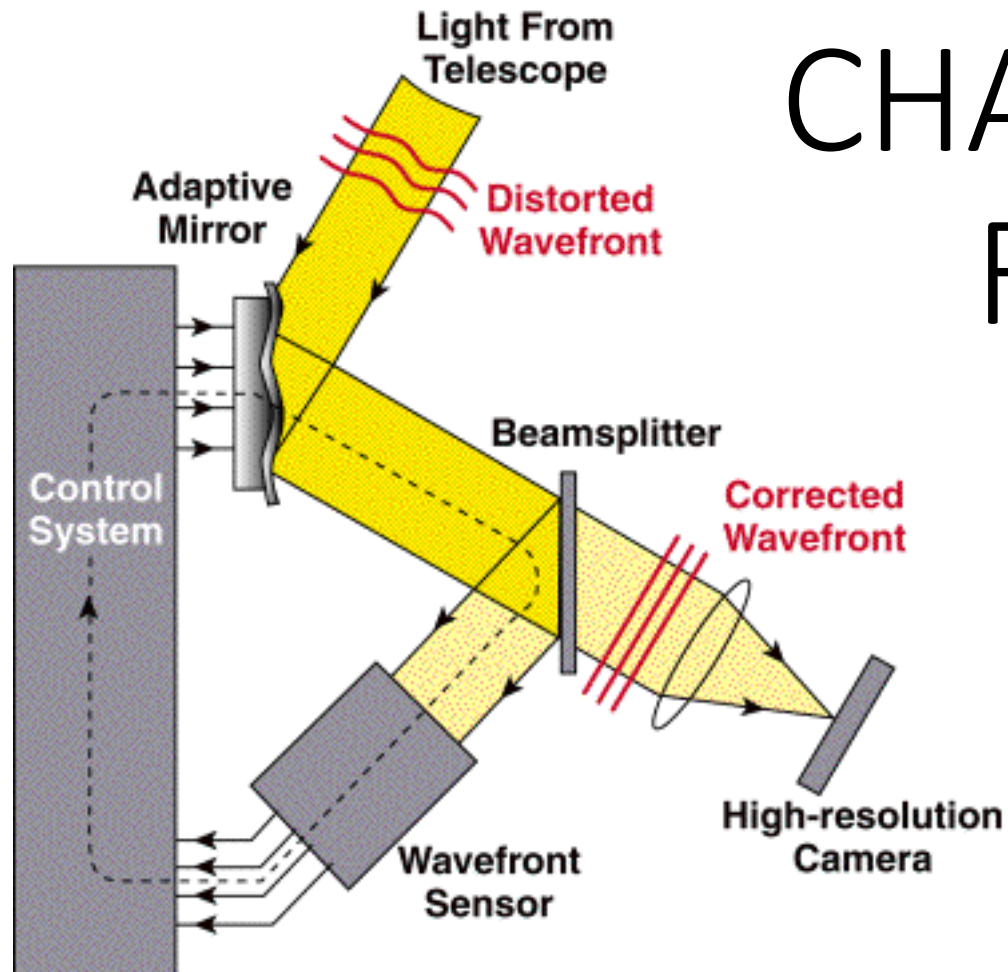
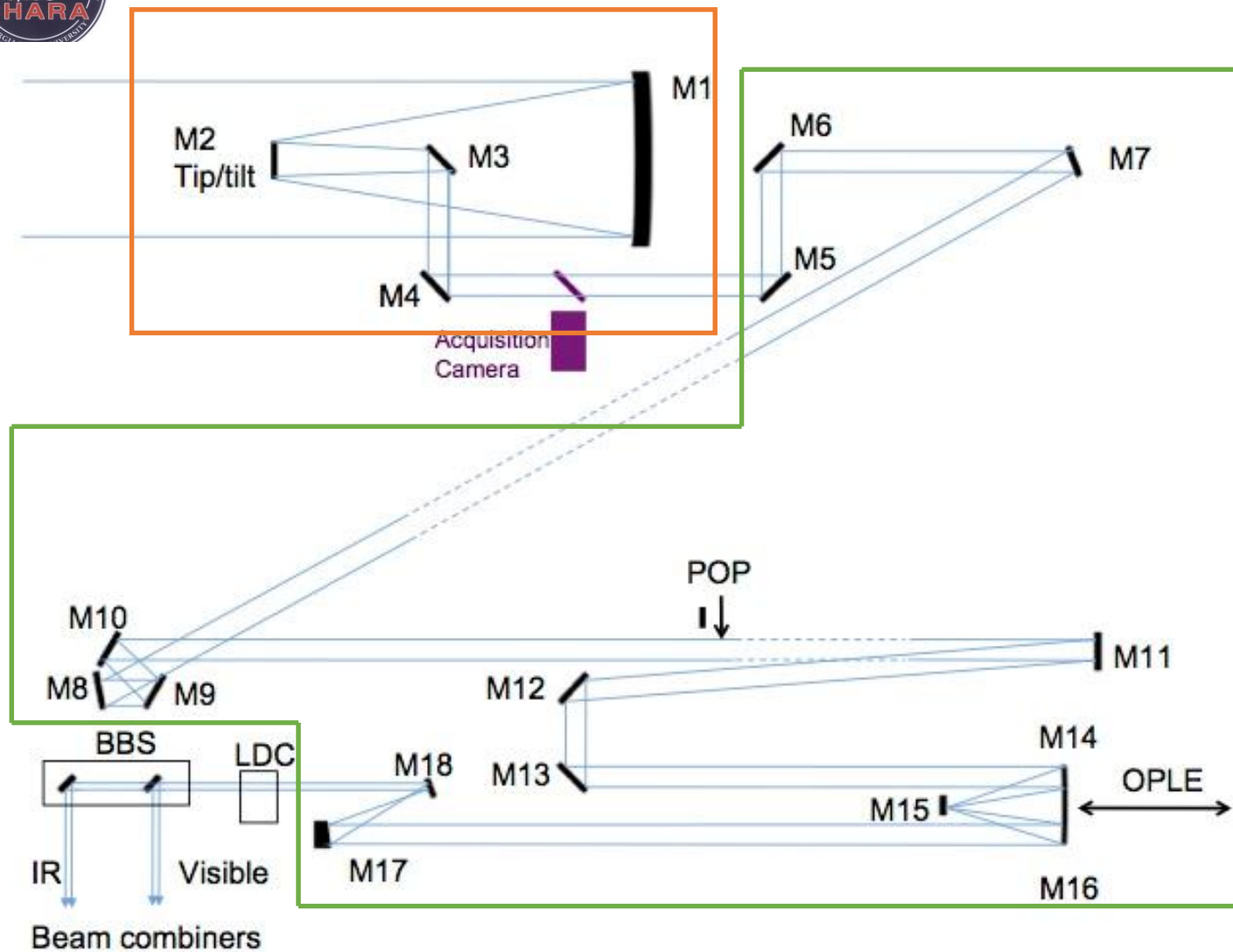


CHARA Adaptive Optics Review & Update

Matt Anderson





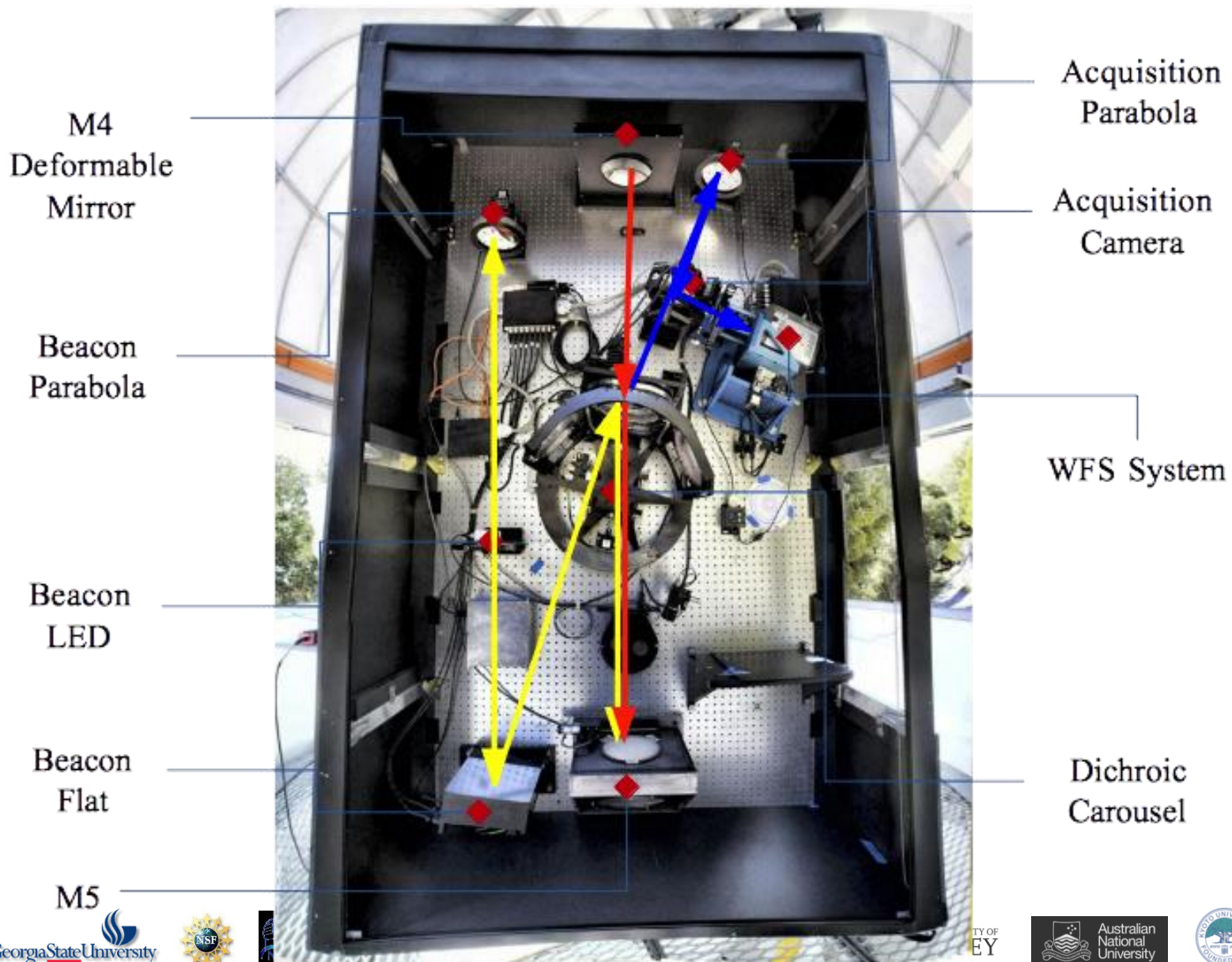
Phase I

Wavefront Sensors at each telescope
Non-common-path AO for lab
(ie. LABAO)

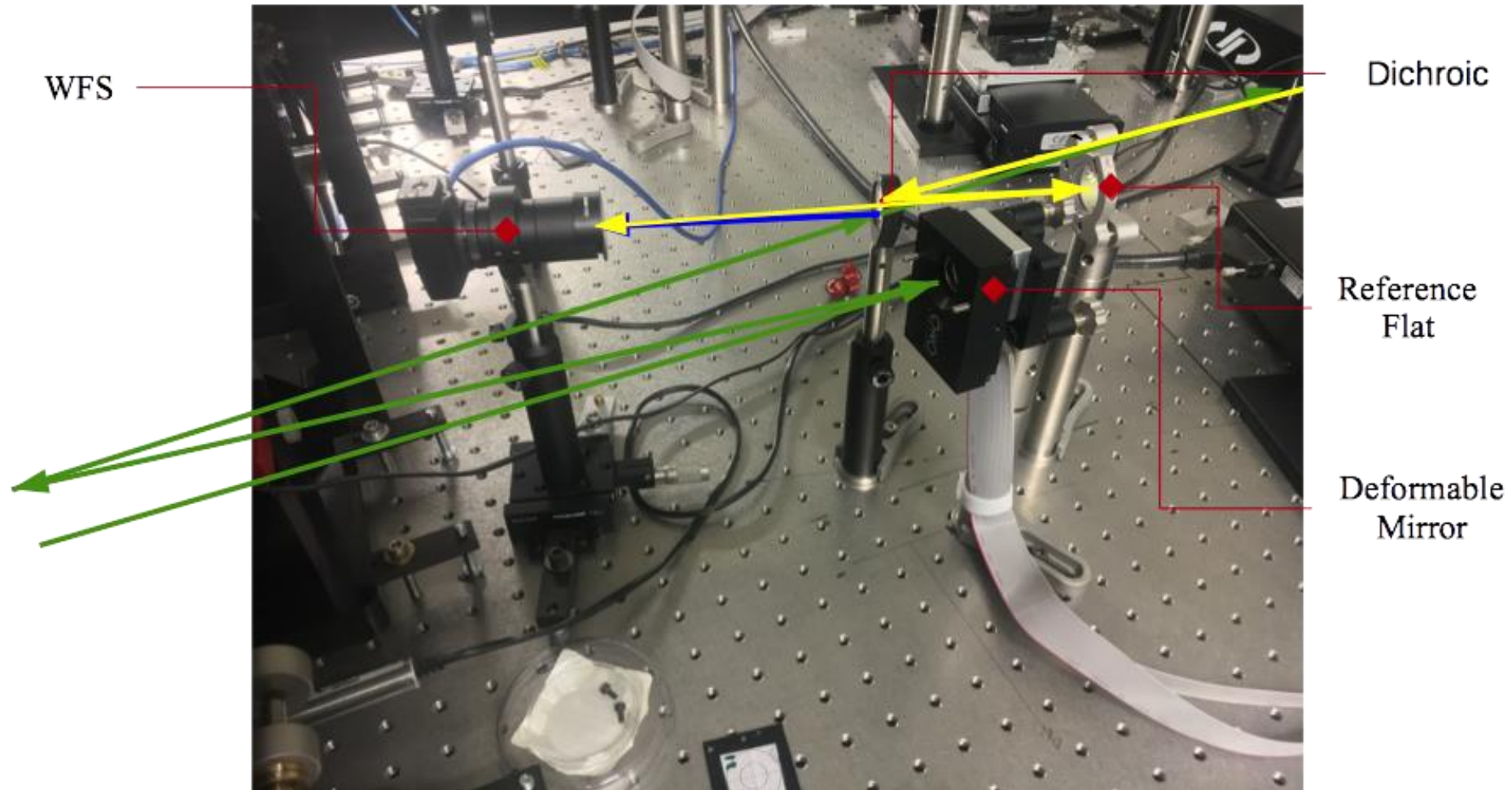
Phase II

Deformable Mirrors for each telescope
Associated mounting and calibration hardware

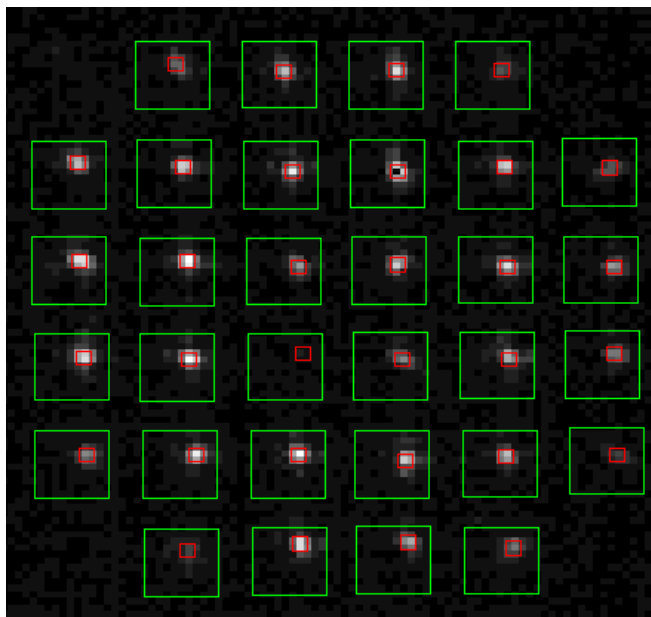
AO at the Telescopes



Lab AO

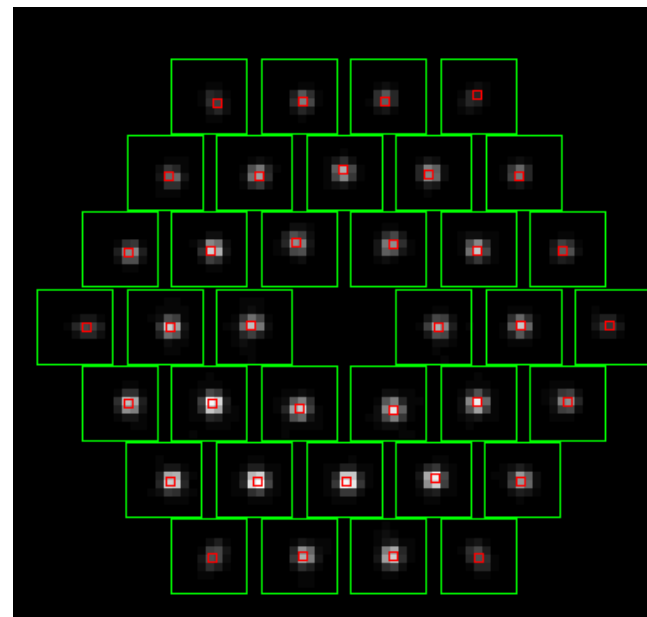


WFS & DM Specifics



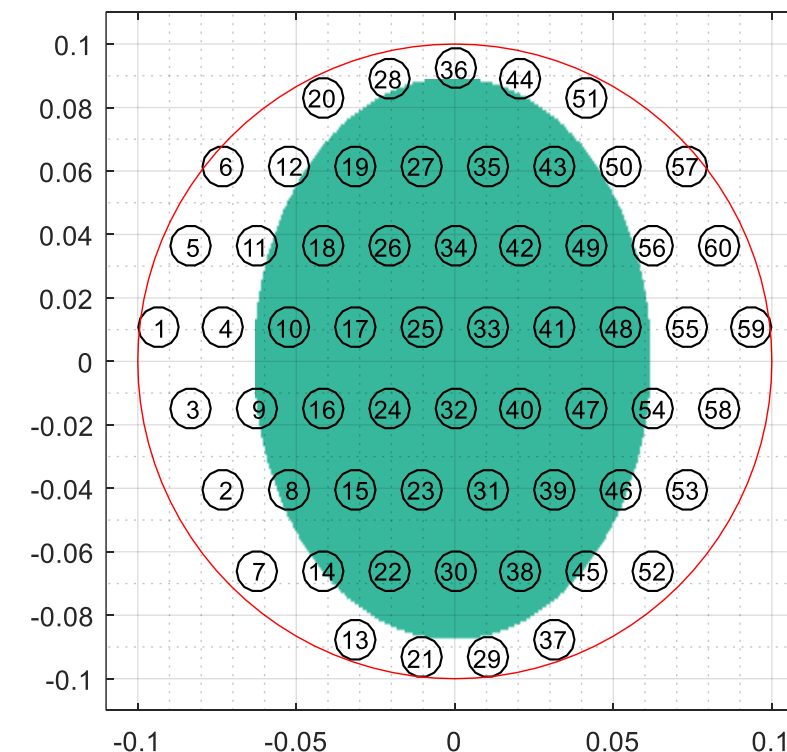
Labao

- Deformable Mirror
 - 37 Actuator OKO
 - 15mm Diameter
 - Max deflection: 9 micron
- Wavefront Sensor
 - 0.15mm pitch



Tao

- Deformable Mirror
 - 60 Actuator ALPAO
 - 125x177mm (Active Area)
 - Max deflection: 29 micron
- Wavefront Sensor
 - 0.11 mm pitch

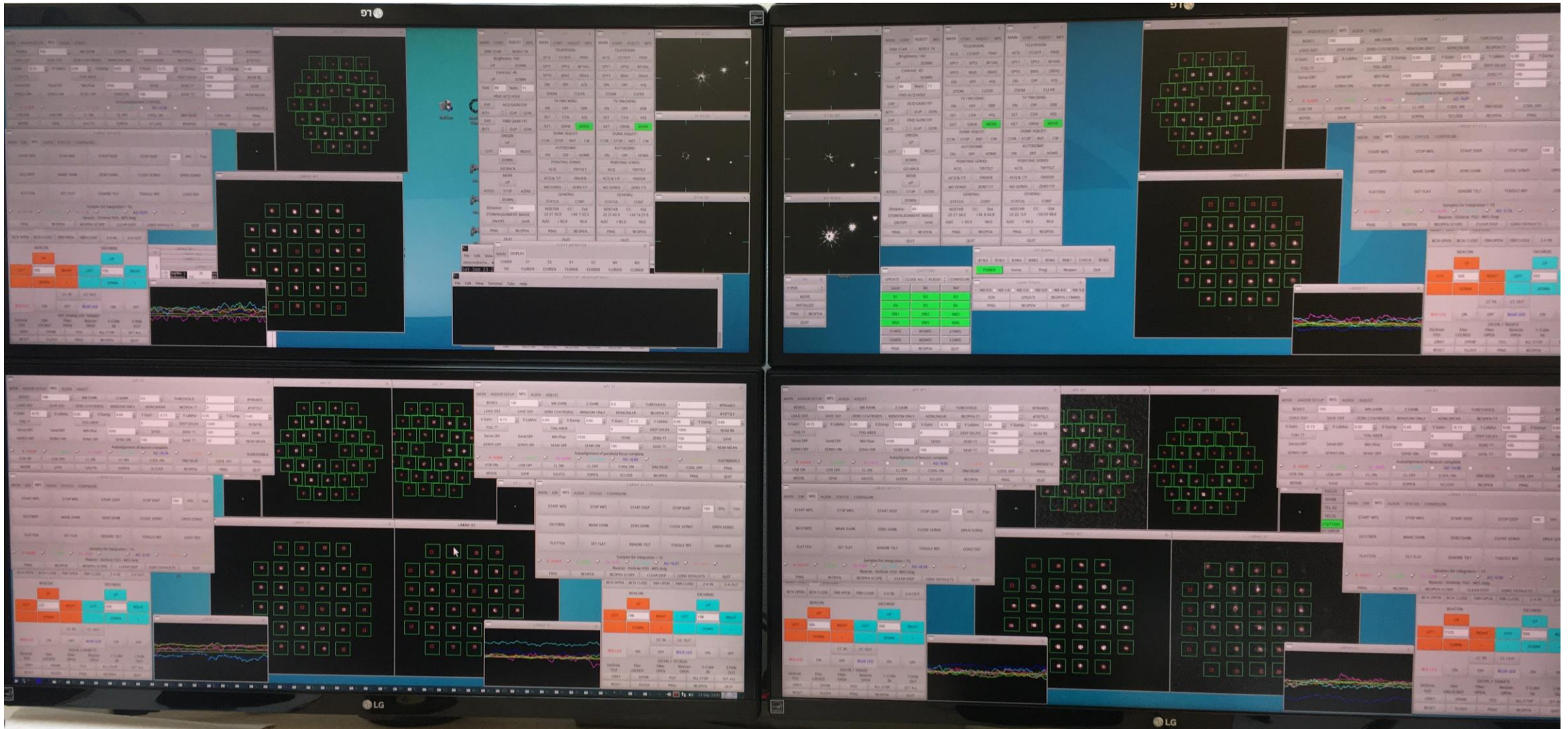




Phase I Status



Phase I Complete

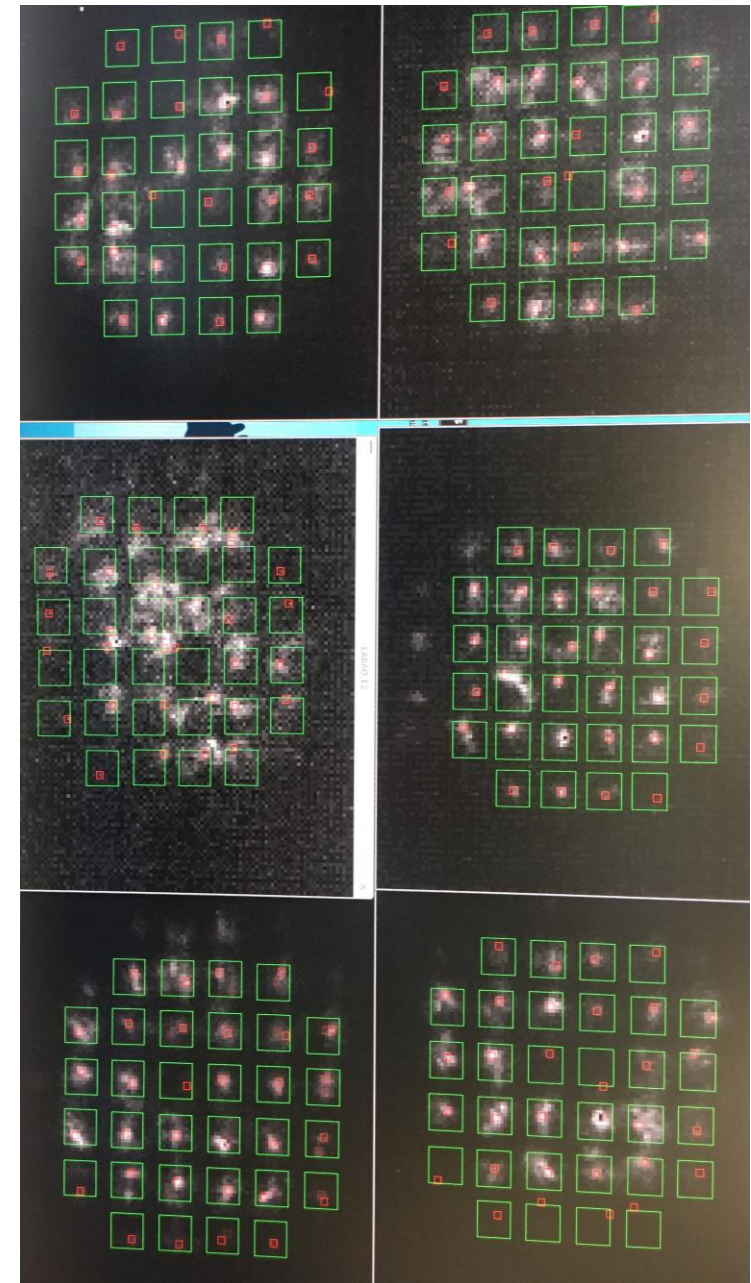


Your Talk Title Here

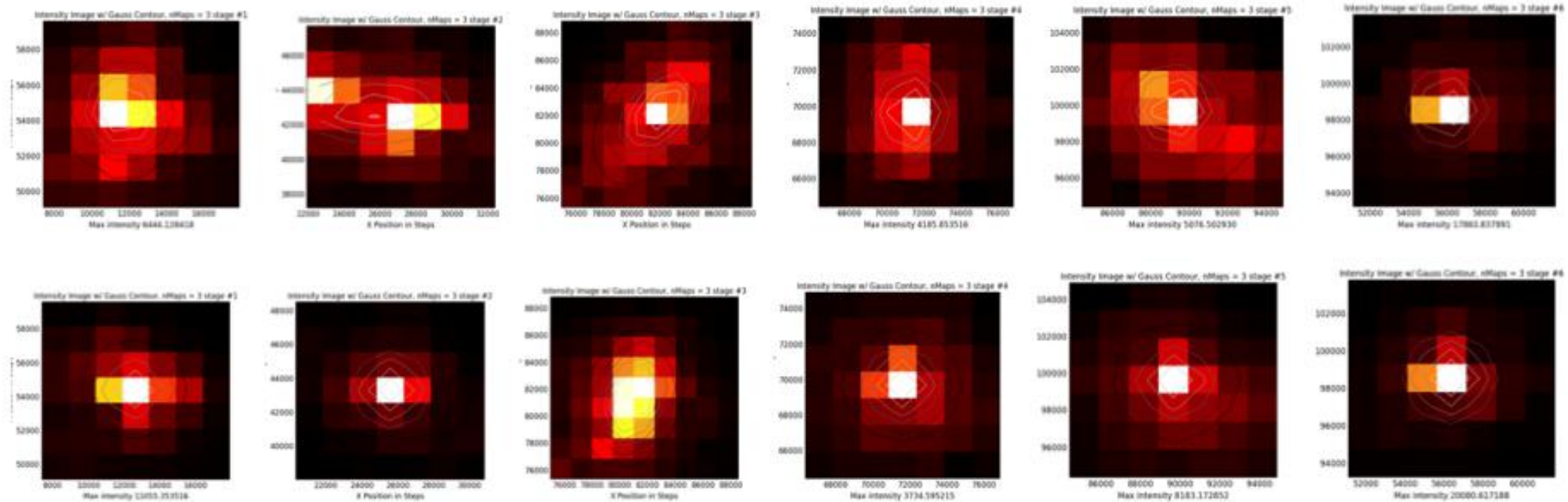


LABAO Current Situation

- Labao used daily for alignment
 - Remote
 - Objective
- Star-Flat Procedure routinely used
 - Flat is measured on nearby bright star ($V < 4$)
 - Data is taken
 - New flat measured when moving to new target
 - Current procedure is on the CHARA wiki
 - [/Operating Procedures/Using Labao with Starlight](#)
 - Good results for MIRCX
 - Poor results for CLIMB
- Star-Flat Procedure reveals static aberration sources



Labao Improvements for MIRCX

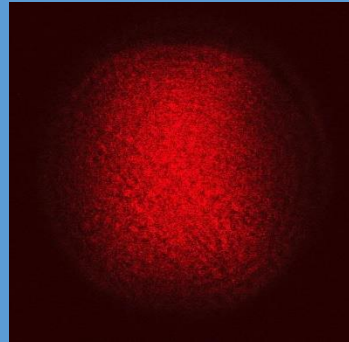


- Closed loop Labao on sky
 - $V < 2.5$
- Correction speed: 40Hz
- Lab tip-tilt guiding
- DM is saturating
 - A reason for optimism!

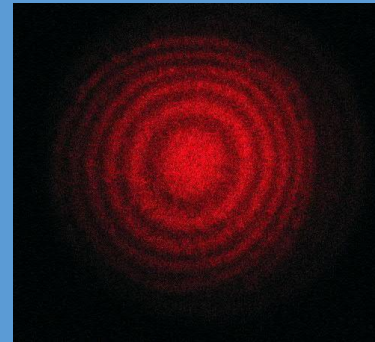
ACTUATOR VOLTAGES vs DM SURFACE

All Lab-DMs were tested with a Michelson setup in the lab before installation J. S. June 2015

Actual wave-fronts reflected from a Lab-DM



0 V applied to all 37 actuators,
~ one fringe across → ~ flat surface



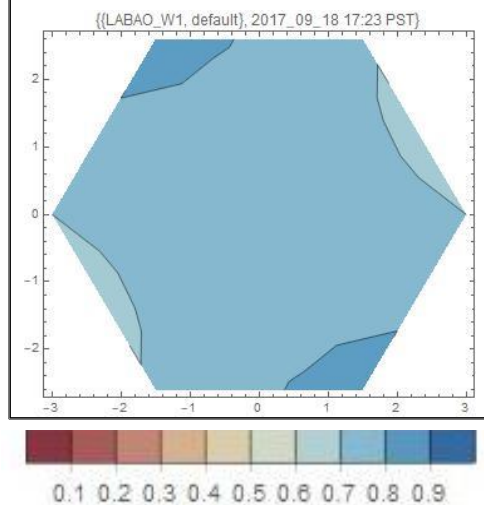
Uniform V applied to all actuators
→ smooth concave surface

The DM actuator response is some monotonic function of the applied voltages. **Sets of applied voltages relate to DM shapes, and in turn relate to the aberrations being corrected.**

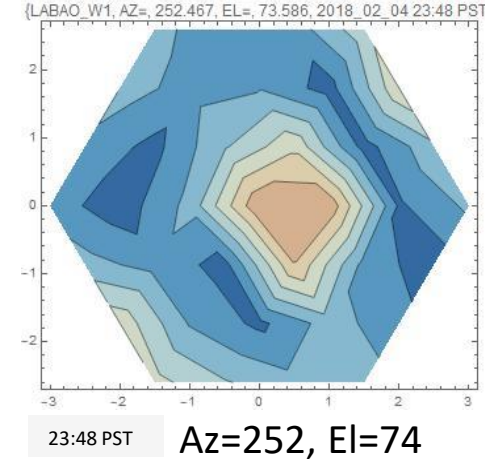
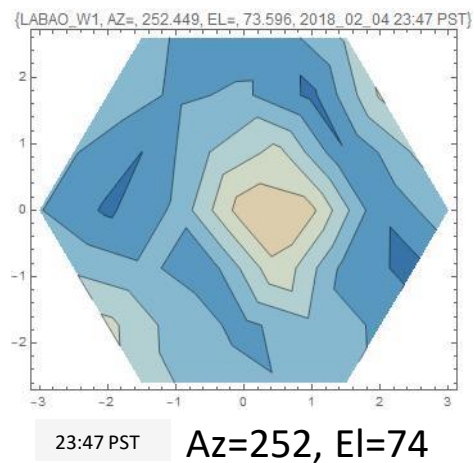
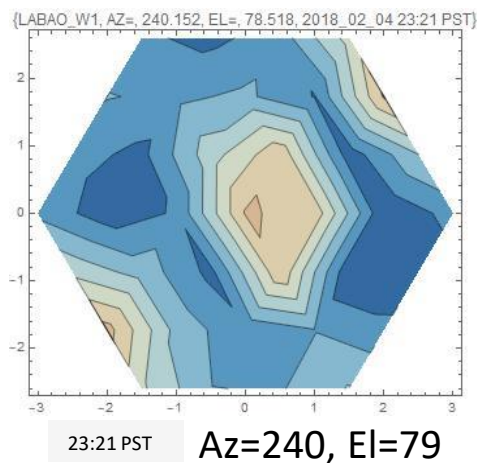
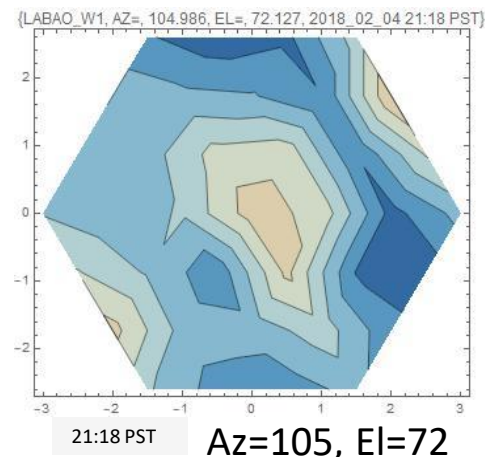
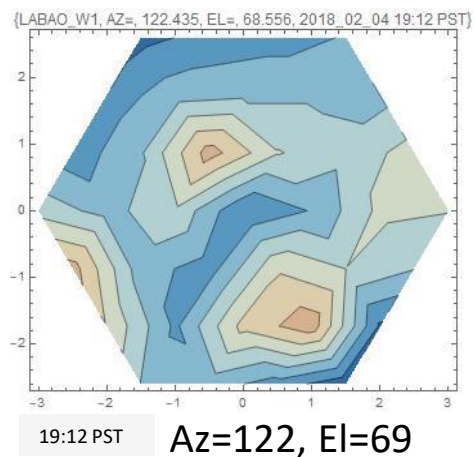
The following contour plots show the **actuator voltages of the default FLAT and Star-FLATs on a single night.**

Applied voltages are scaled from 0 to 1.
Contours shown in 0.1 increments.

W1 Default FLAT



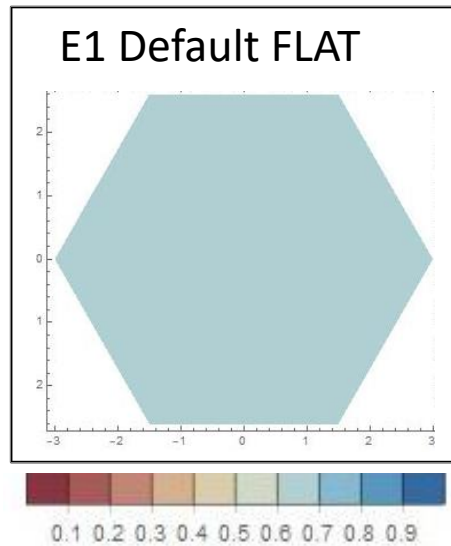
W1 Star-FLATs 2018-02-05 UT



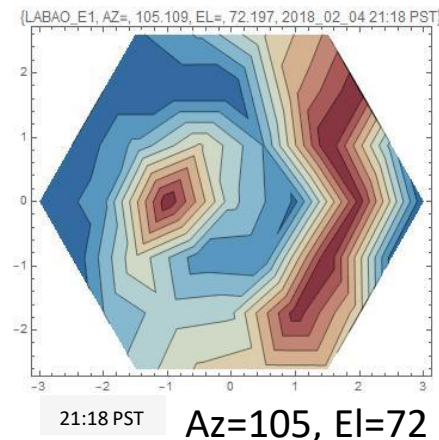
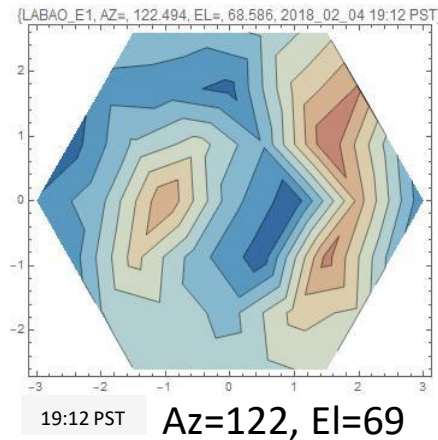
The aberrations being corrected do not seem to rotate on the lab-wfs, and fairly constant throughout the night.

Only the focusing looks a bit off somewhere.

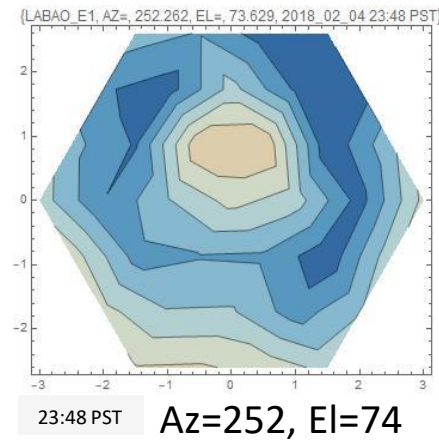
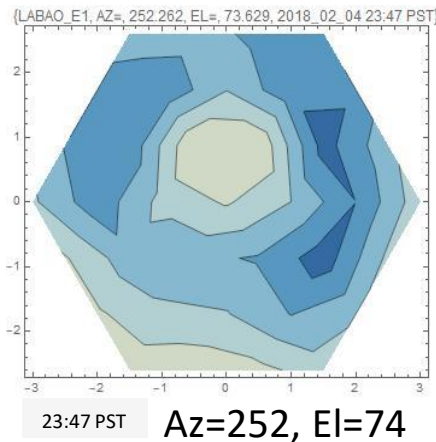
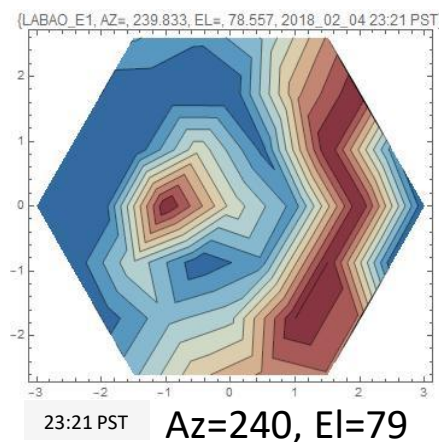
J. S. Febr. 2018



E1 Star-FLATs 2018-02-05 UT

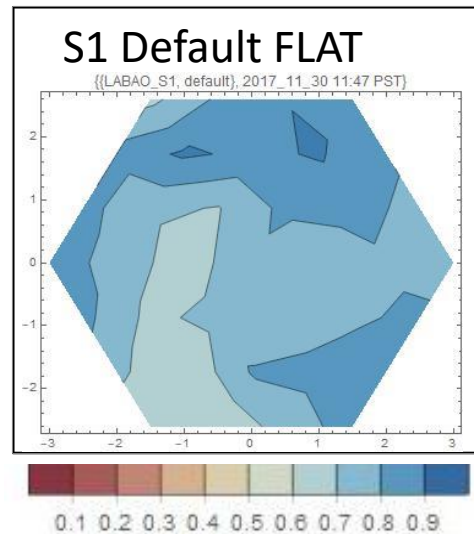


The aberrations being corrected do not seem to rotate on the lab-wfs, no correlation with telescope AZ indicates negligible telescope astigmatism.

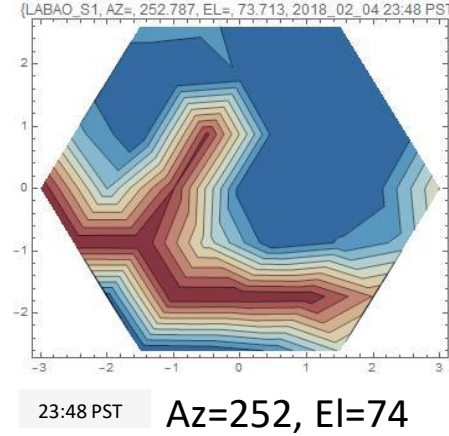
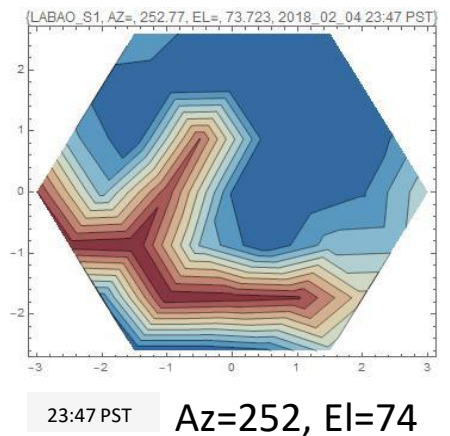
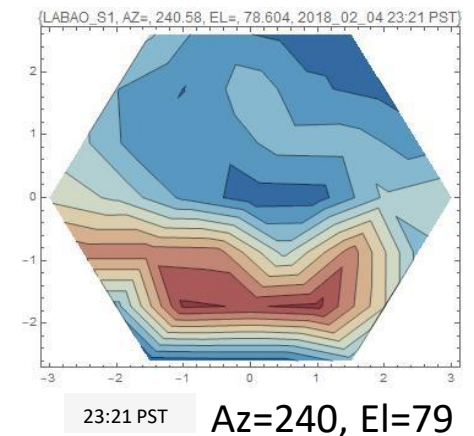
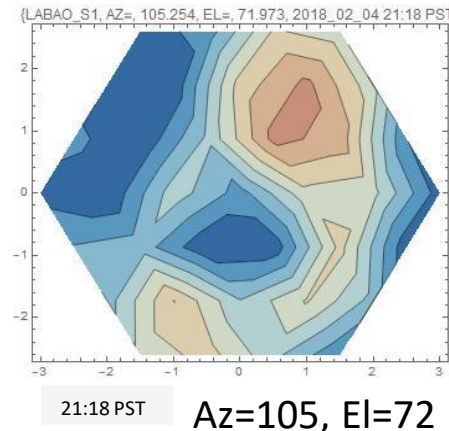
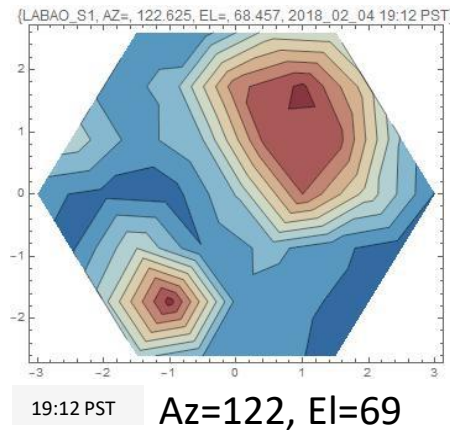


Possible correlation with OPLE cart position. This looks like beam shear at some places, which may be fixed by better OPLE rail alignment.

J. S. Febr. 2018



S1 Star-FLATs 2018-02-05 UT



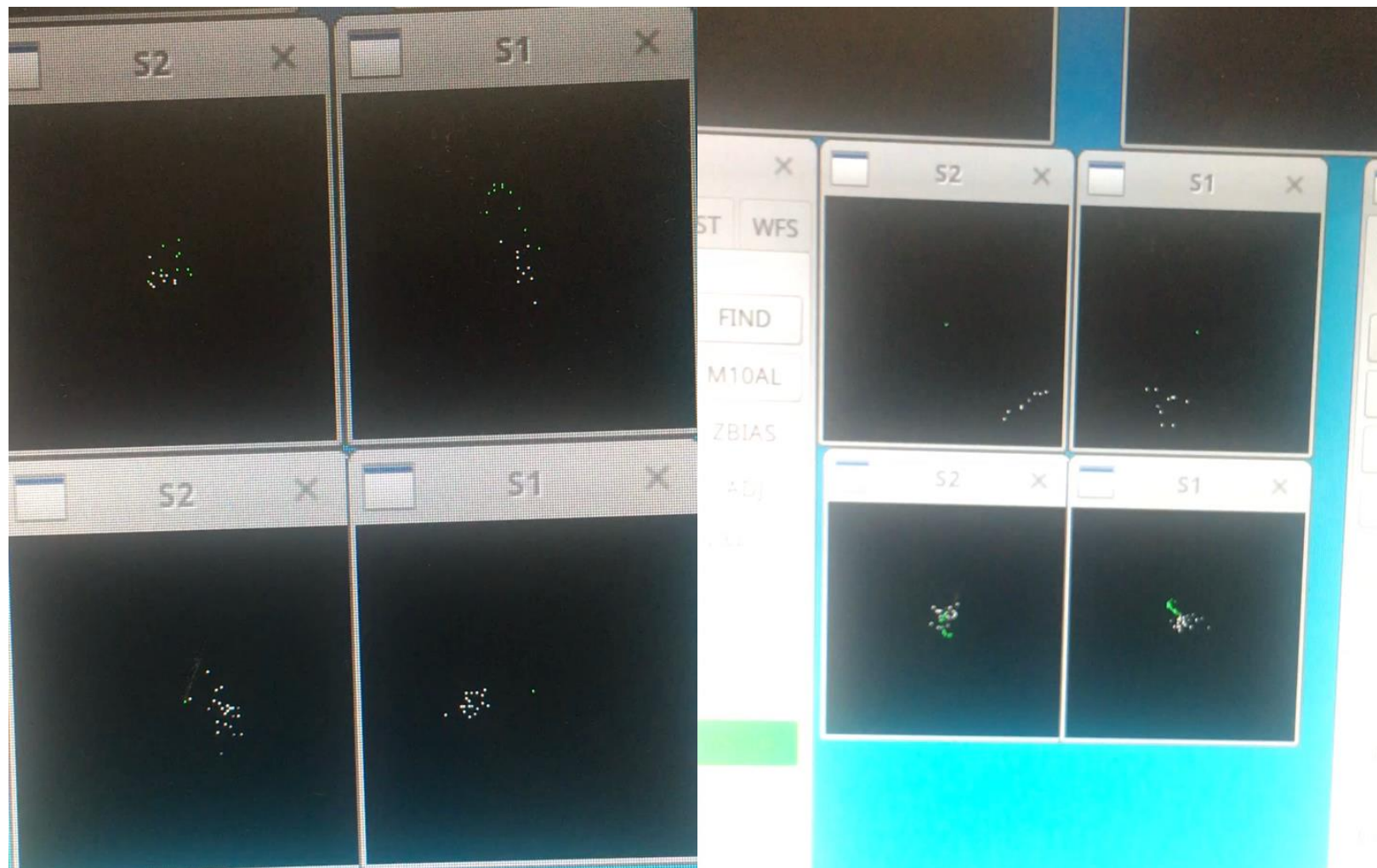
J. S. Febr. 2018

DM corrections seem extreme in all cases, caused probably by multiple problems:

- The extreme ridges may be due to **vignetting** seen by LABAO wfs.
- There could be problems with the LABAO wfs itself, this one was left untouched for the longest time.
- DM shapes seem to rotate with telescope AZ suggesting **telescope astigmatism**.

Telescope Based Tip-Tilt

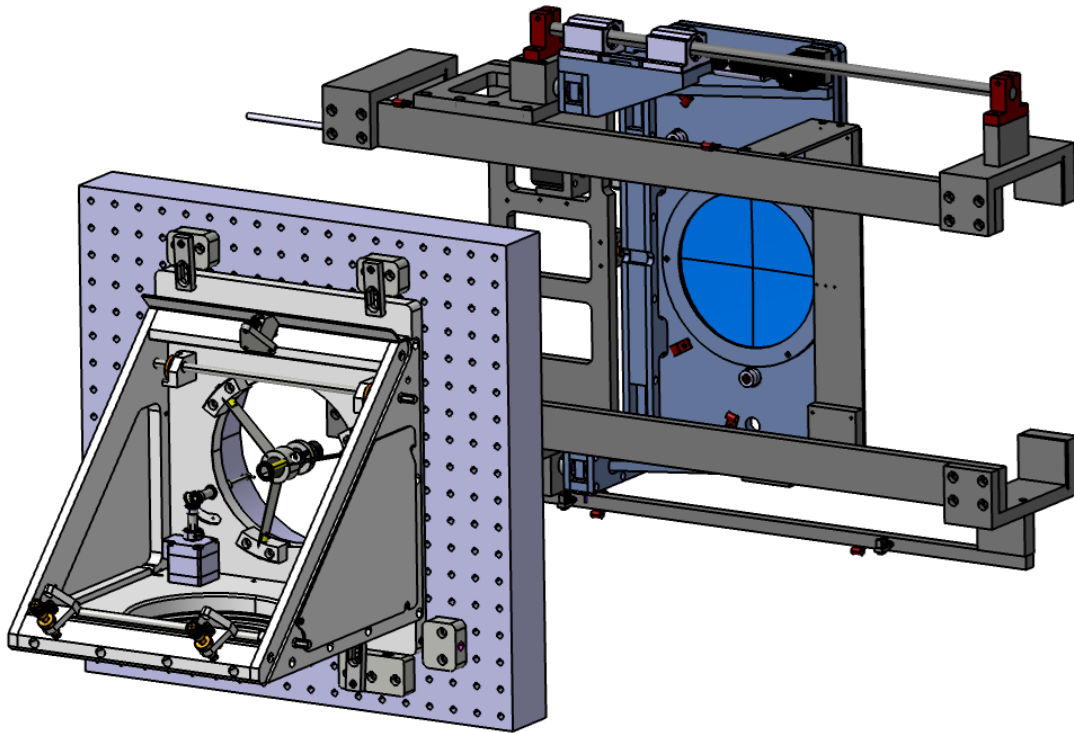
- TWFS Tip-Tilt works
- TWFS offset from lab
 - Auto M7
- Programs can use different Tip-Tilt settings
- Telescope Tip-Tilt has been used to $V \sim 11.5$ (NGC 4151)





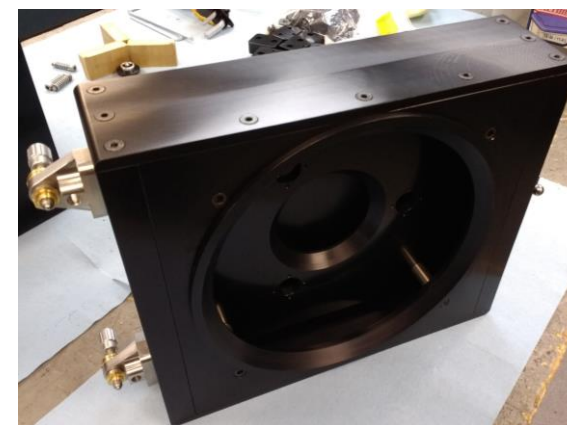
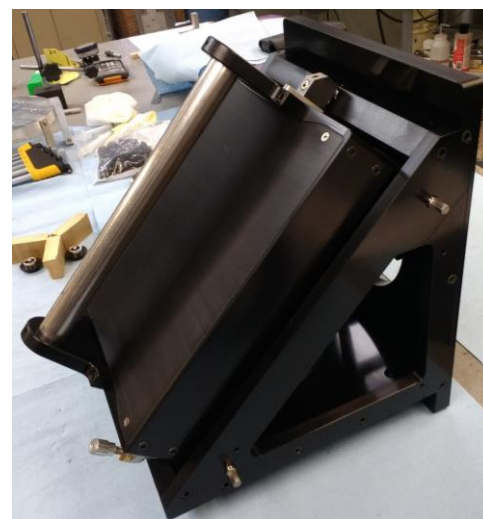
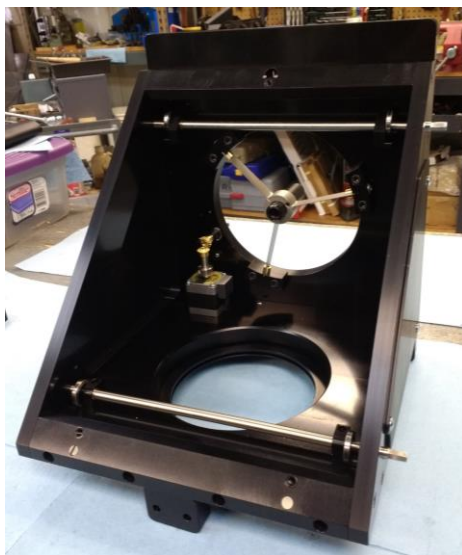
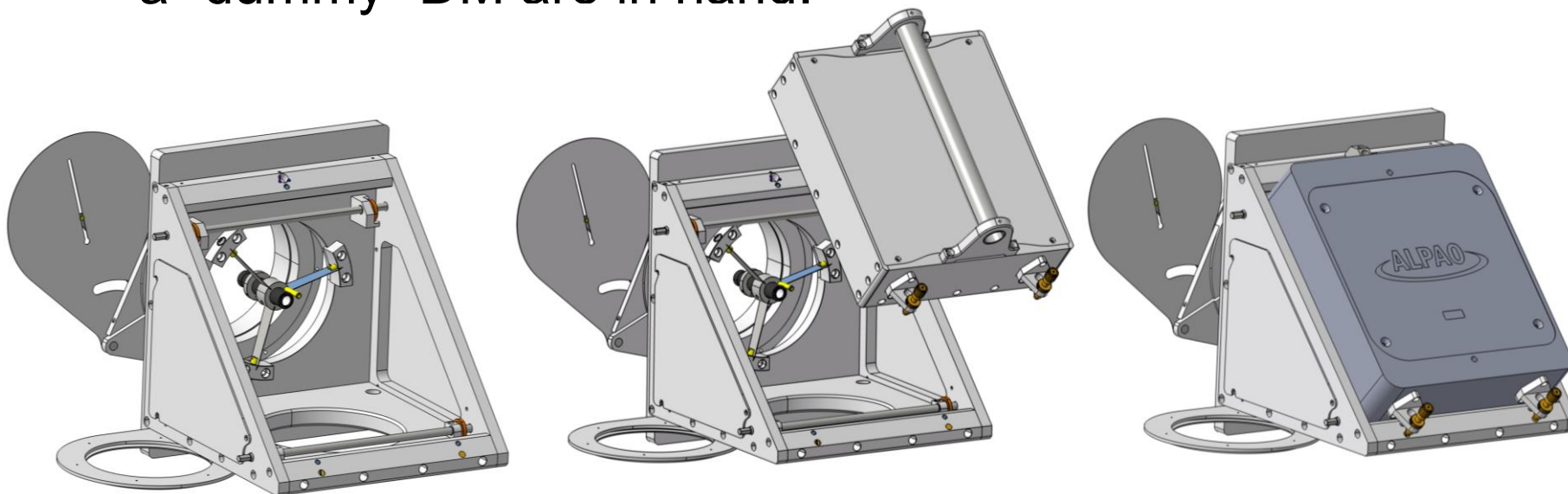
Phase II Status

Phase II Telescope Hardware Changes / Additions



- All telescopes require
 - mounts for the DMs
 - DM calibration light sources
- DM mounts
 - Kinematic adjustments
 - “Dummy DM” flat mirror
- DM calibration light source
 - Fiber fed light source
 - Measure DM reconstructor
 - Kinematic Adjustments
- All other hardware is already in place per Phase I

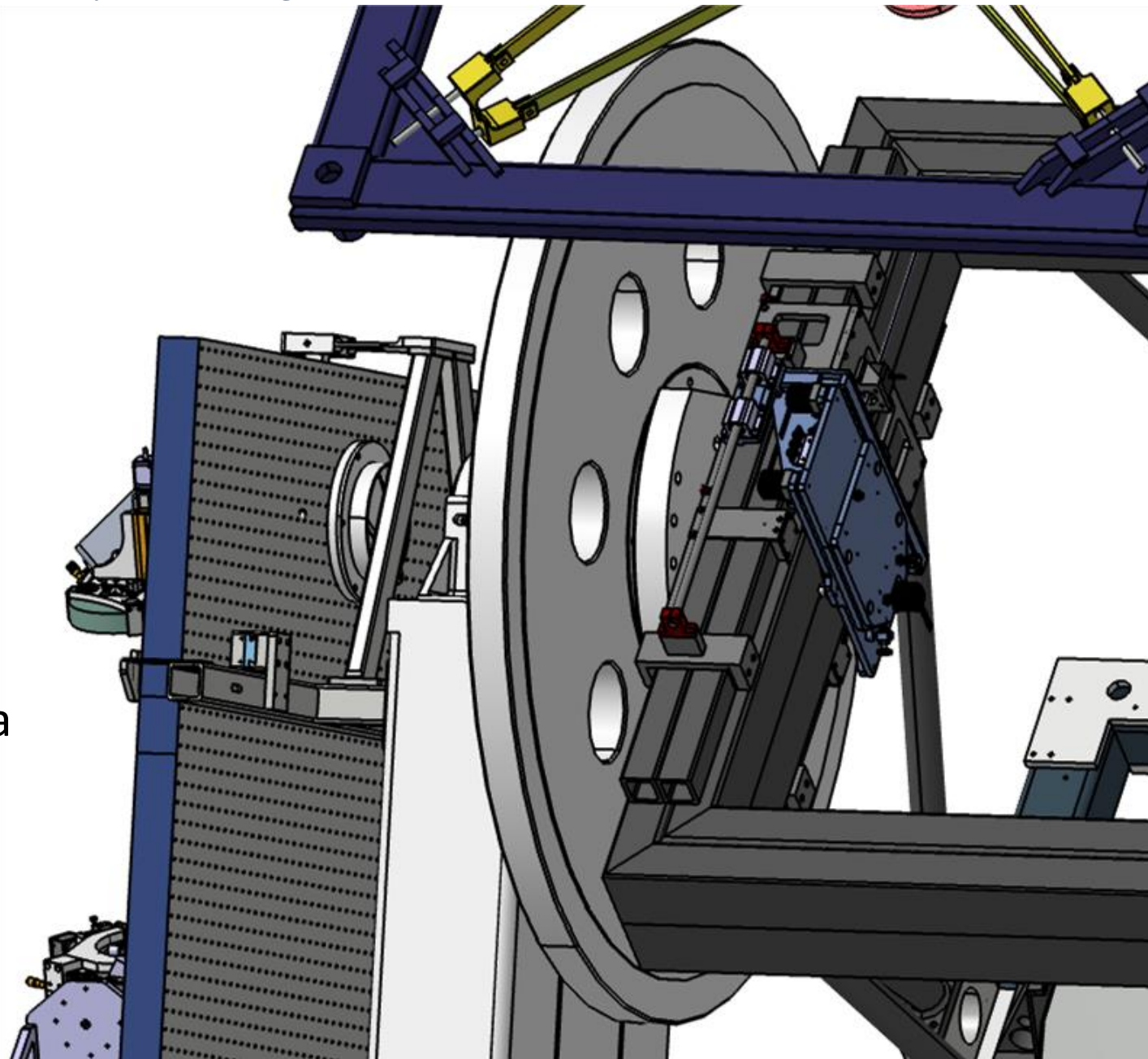
A prototype mount for the DM and a “dummy” DM are in hand.



“dummy” DM

DM Calibration Source

- Clamps to telescope midframe
 - Midframes vary up to 0.25" (6.3 mm)
- Actuators for Tip-Tilt / Focus
- Must clear beam path
 - Linear actuator
 - < 2" (50mm) from midframe
- Prototype has shipped from Atlanta



The first Telescope DM Arrives





Moving Forward

- Prototype DM is onsite
 - Testbed is ready
 - Waiting on software and time
- S2 will be ready for on sky testing with the DM soon
 - M4 Mount being installed
 - Calibration source nearly ready
- E1 is likely the 2nd telescope to get a DM
 - Recoating in May
- Others to follow in schedule dead time
- Ongoing AO engineering time has been integrated into the observing schedule
 - Thursday Nights
 - AO engineering runs
- There is much software development to do
 - GUI Development
 - Automation Development



The Great GUI Problem

