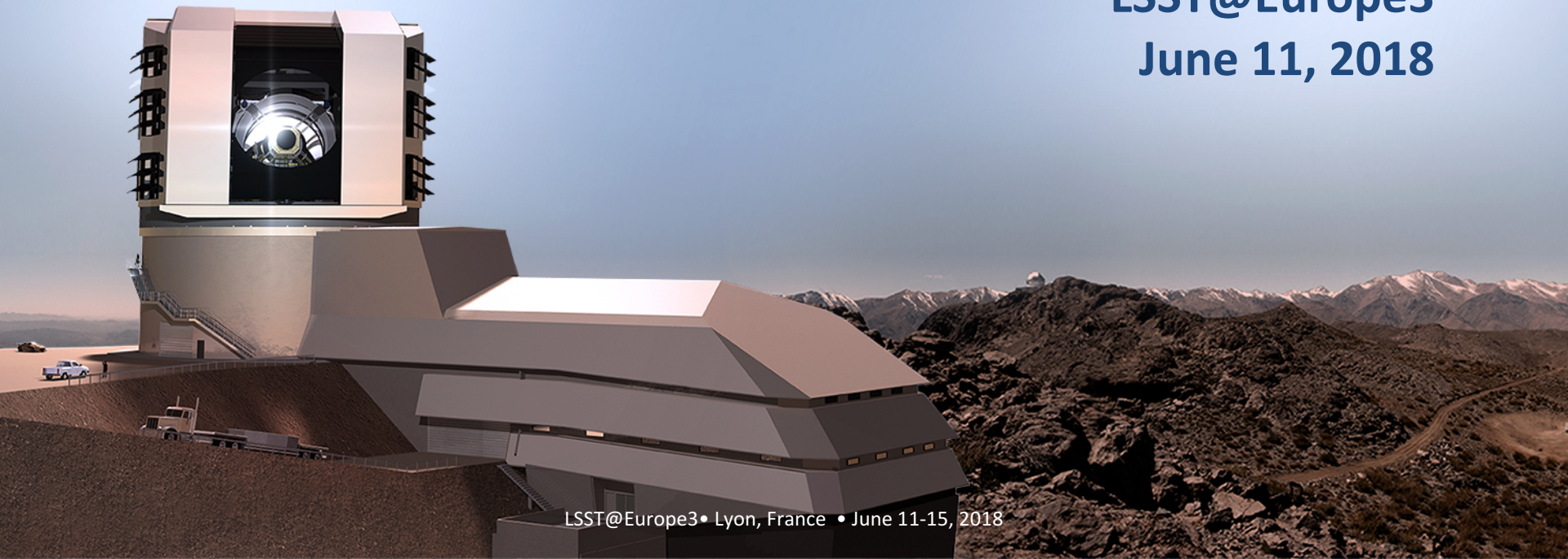




LSST Calibration System Status

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LSST@Europe3
June 11, 2018



LSST Science and the need for high-quality calibration

- The relative photometric repeatability requirement is **5 mmag (0.5%)** in the ***gri*** filters and **7.5 mmag (~0.7%)** in the ***uzy*** filters, for bright unresolved point sources under a wide range of observing conditions
 - high-fidelity determination of supernovae redshifts
 - photometric metallicity determination of stars
 - photometric redshift determination of galaxies
- Meeting these requirements mandates a detailed understanding of the ***systematic*** error introduced by the system
 - E.g. transmission variation as a function of FoV, vignetting, detector response, atmospheric transmission variations etc.

This presentation is a status update to the suite of hardware being built by the Telescope and Site group to characterize these effects on the summit.

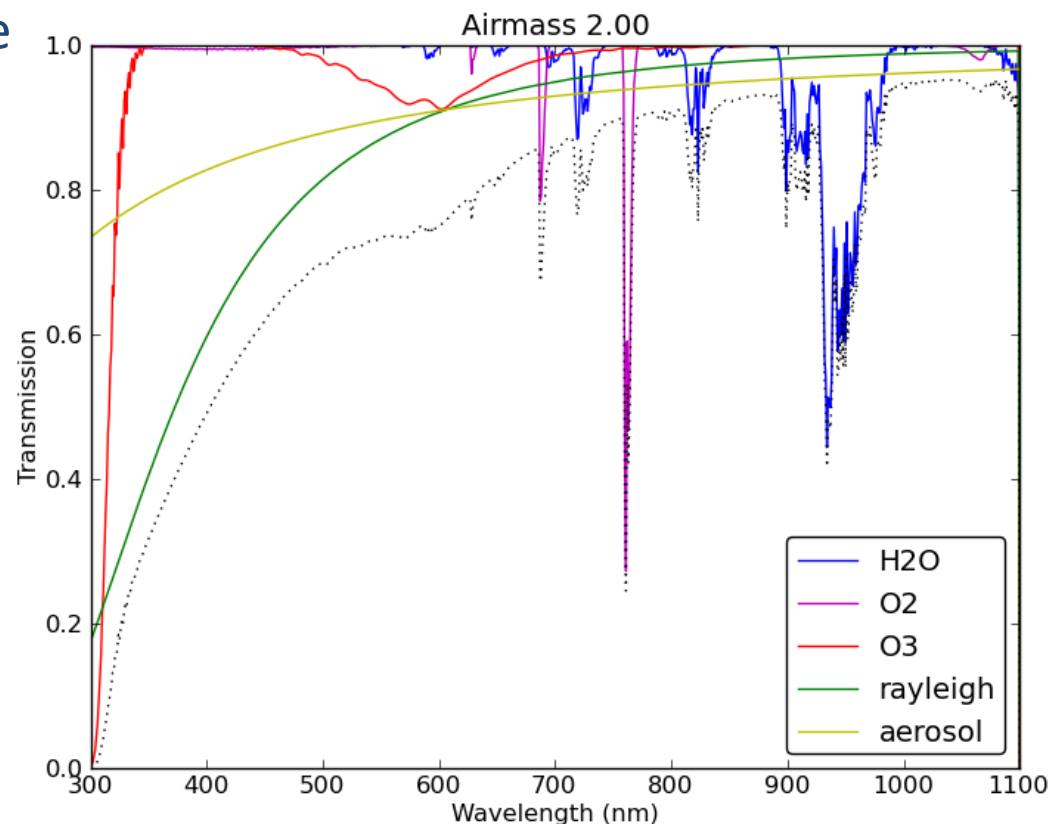
Work carried out in close collaboration with DM (R. Lupton), Camera (C. Stubbs), and SE (C. Claver) teams



Photo by Fabian Collao, August 2017



- Atmospheric spectrum can be broken down into 5 primary components
 - “high” resolution features
 - **Water** and Oxygen
 - “low” resolution features
 - Ozone
 - Rayleigh Scattering
 - **Aerosols**
- Plan to obtain spectra of bright stars during LSST observations to measure the atmospheric transmission
 - Uses an Scheduler analogous to the main telescope
 - Tiago Ribeiro designing this!

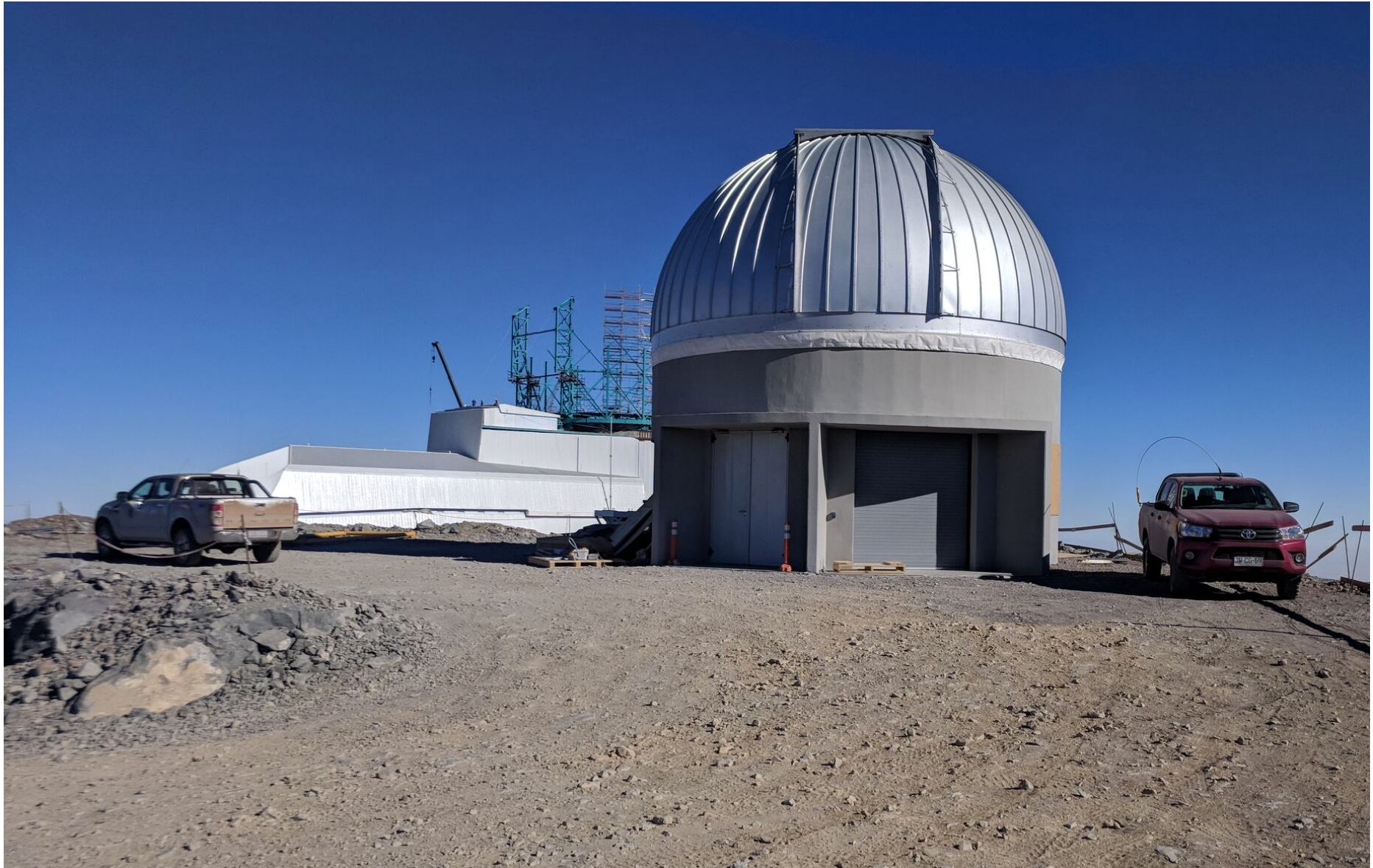


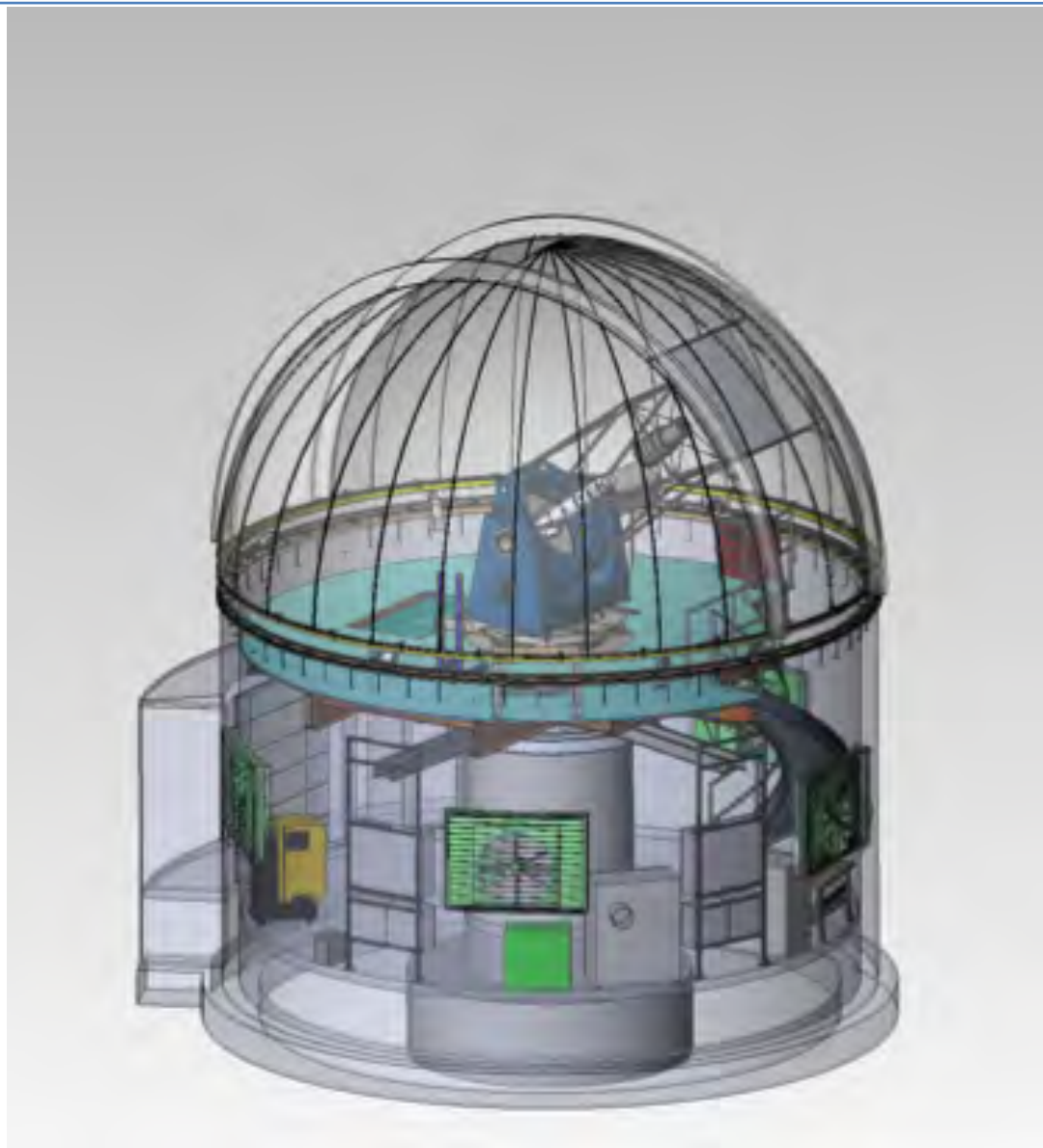
Spectral resolution = 150 at 900 nm

Wavelength range from 350-1000nm

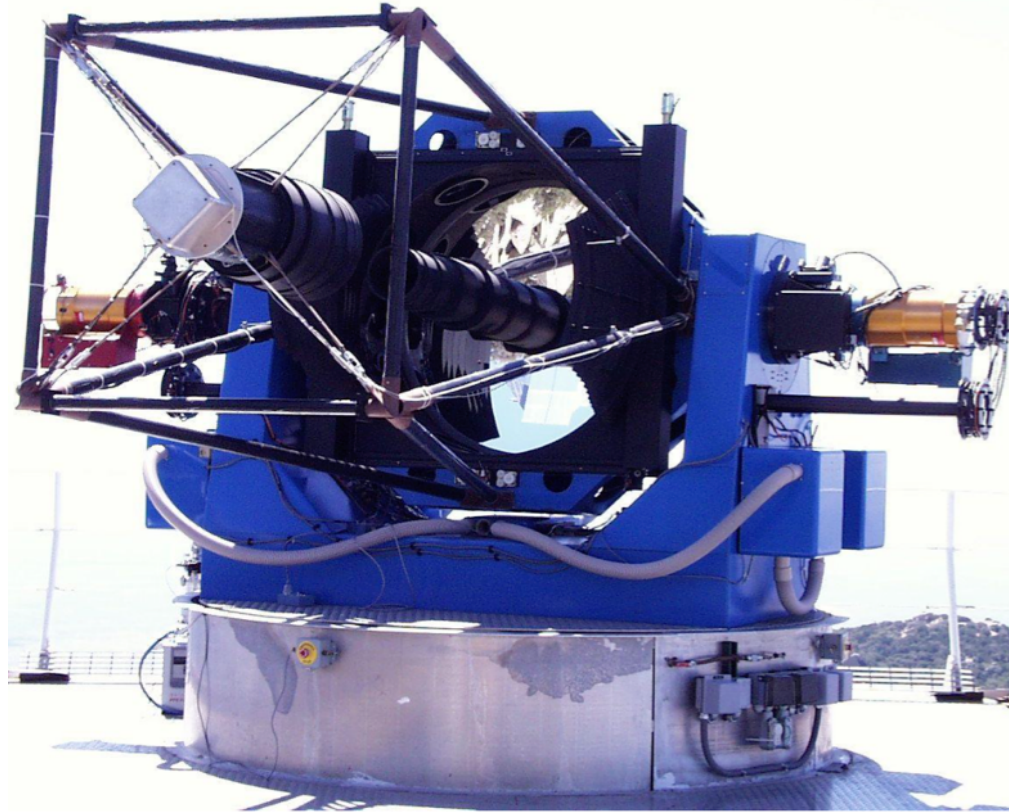
SNR ~ 20 per nm

Requires more dispersion in the **red** than the blue!





- Edgar J. Smith Telescope (aka Calypso) donated to LSST
 - 1.2m diameter
 - f/18
 - Two instrument ports
- Refurbishment started nearly 2 years ago in Tucson by Astronomical Consultants and Equipment (ACE)
- Mount control system being developed by NOAO-South

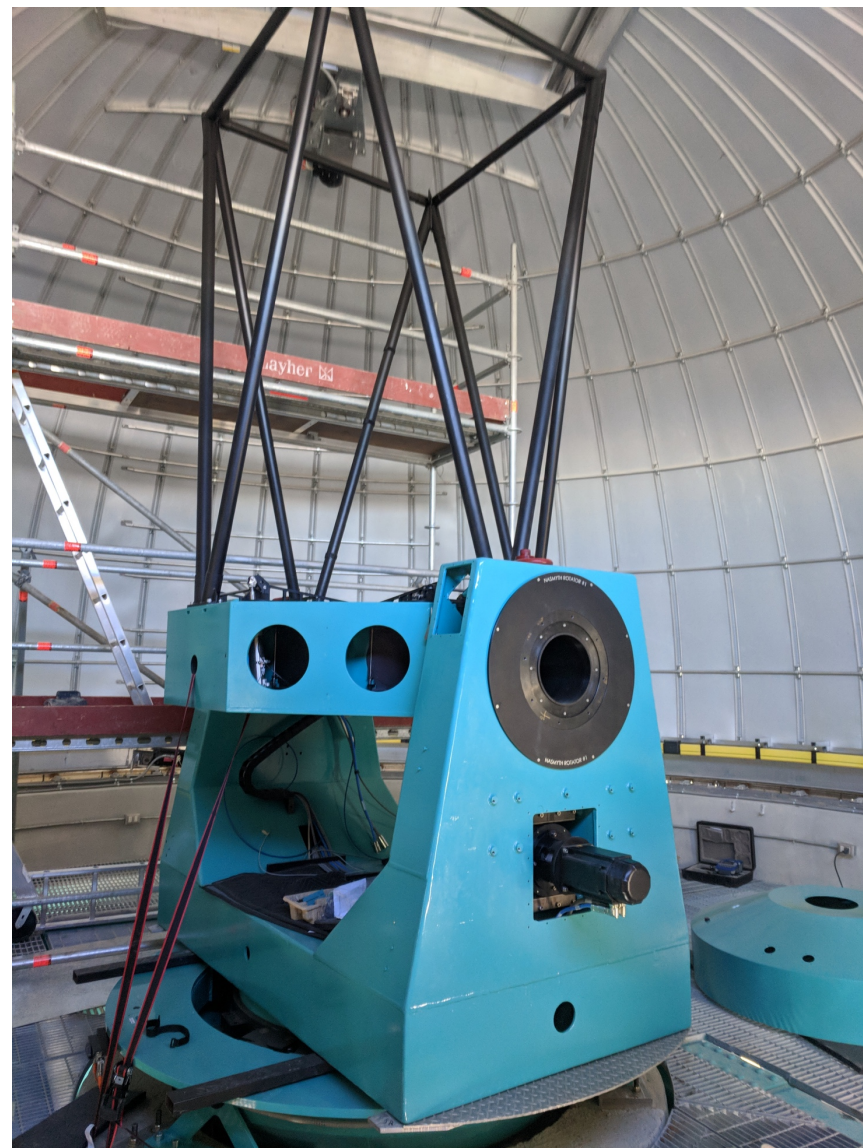
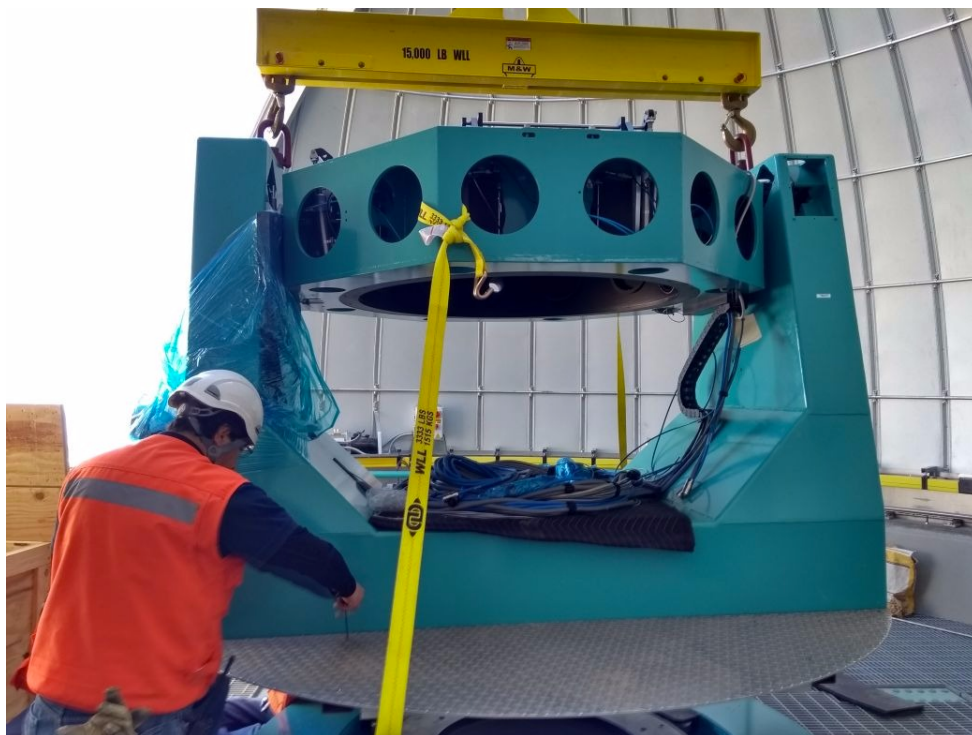




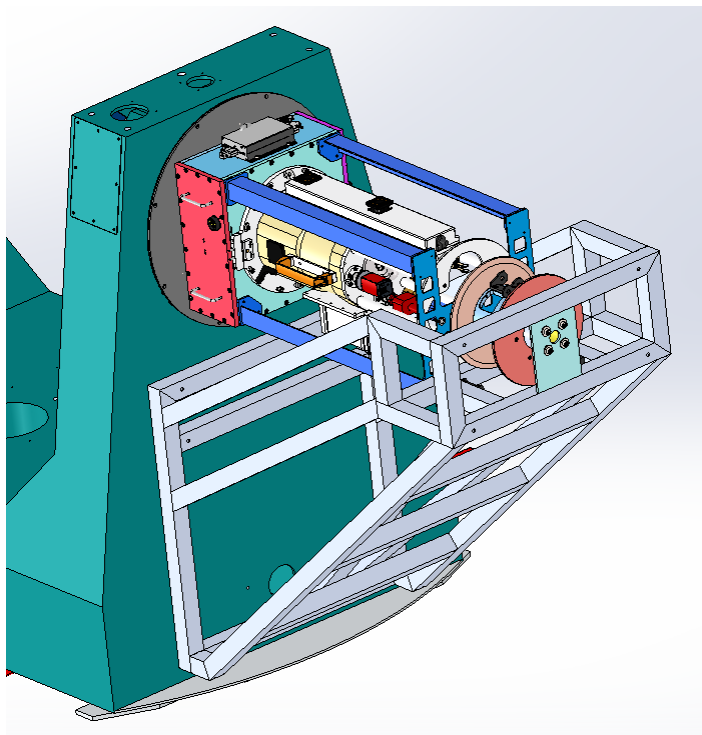




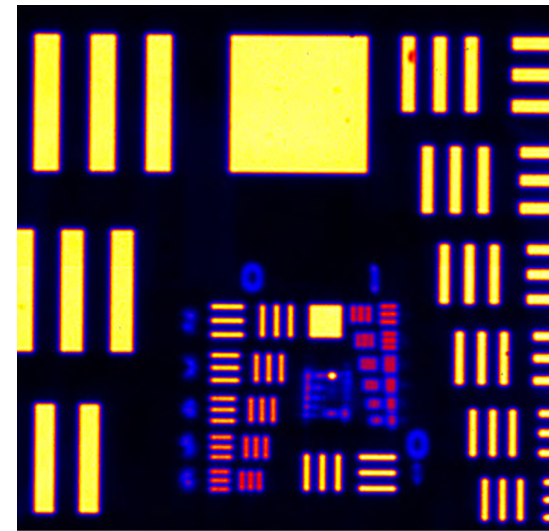
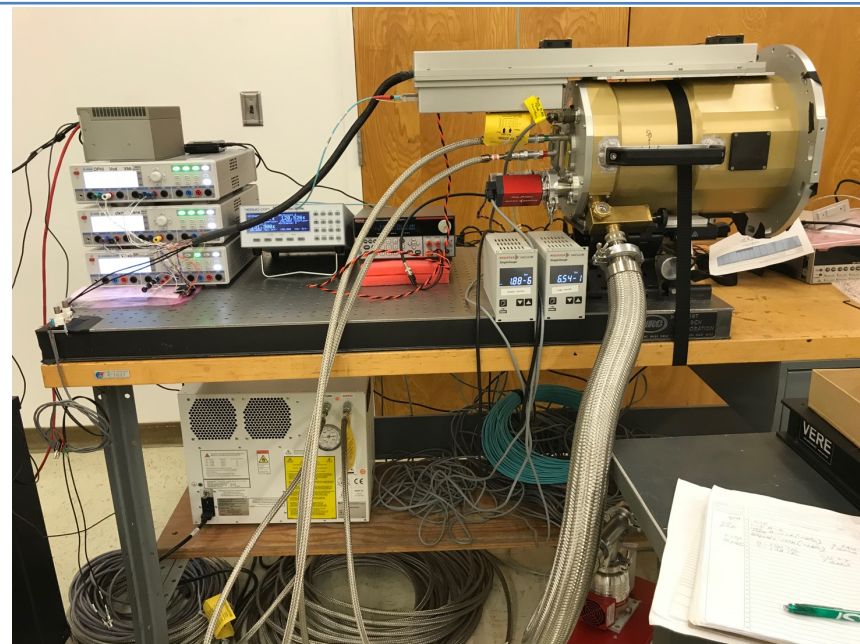
- Telescope now assembled in Chile
- Dome completion expected in July
- First light scheduled for February 2019
 - First Spectrograph data March 2019



- Imager and Slitless spectrograph which supports multiple gratings (3) and filters (3)
 - Baseline design(s) use Ronchi gratings
 - Grating in use depends on seeing conditions
 - Marc Moniez et al studying a holographic grating design



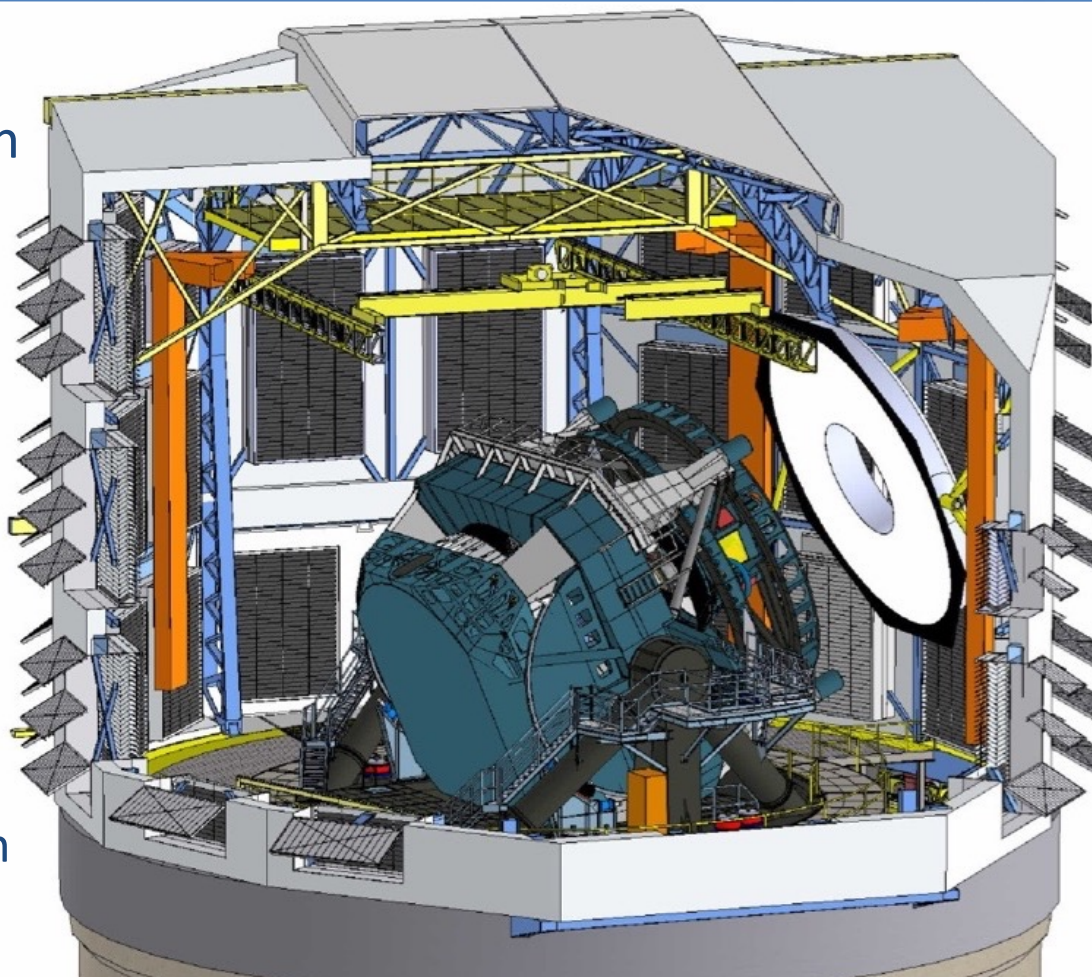
- AT Spectrograph Sensor and Readout System was designed and built at Harvard University (Stubbs et al)
 - *Uses an LSST sensor and corner-raft readout electronics*
- Delivered to Tucson May 2nd and is soon to be integrated with the OCS
- The Auxiliary CCS and DAQ system is online and running in the server room
- DMCS from NCSA has been received



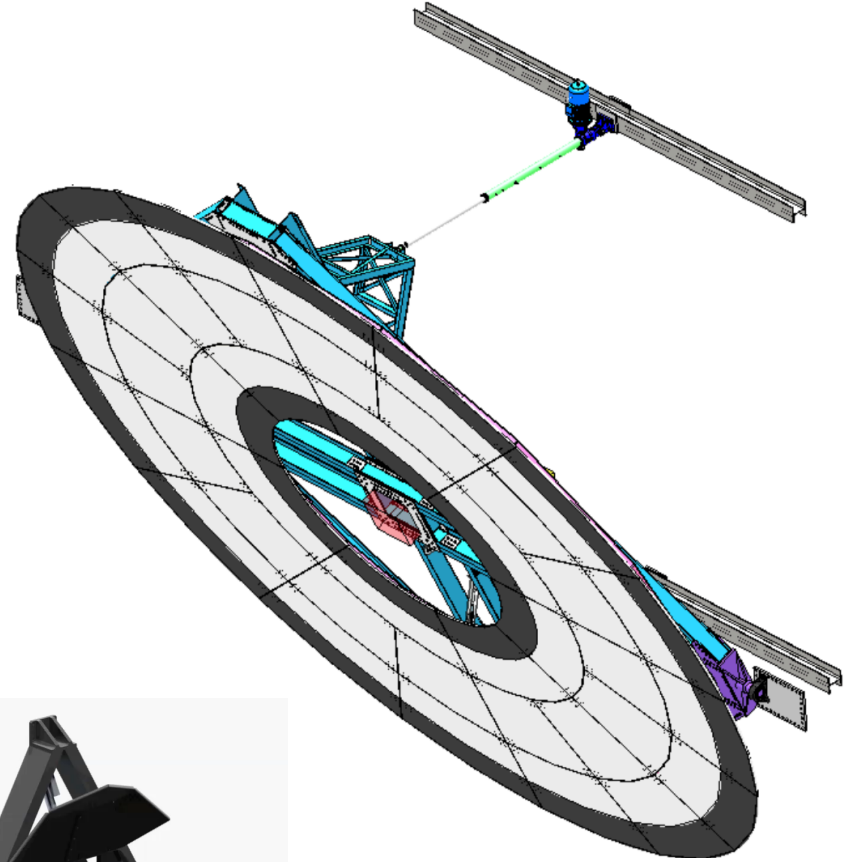
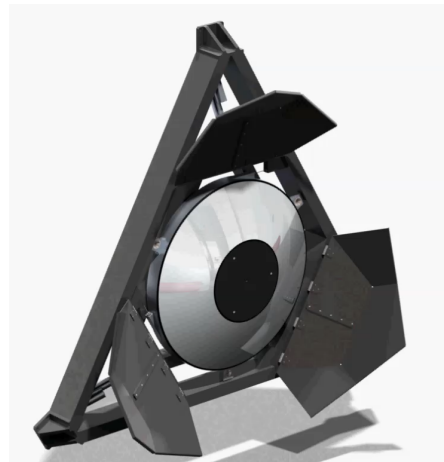
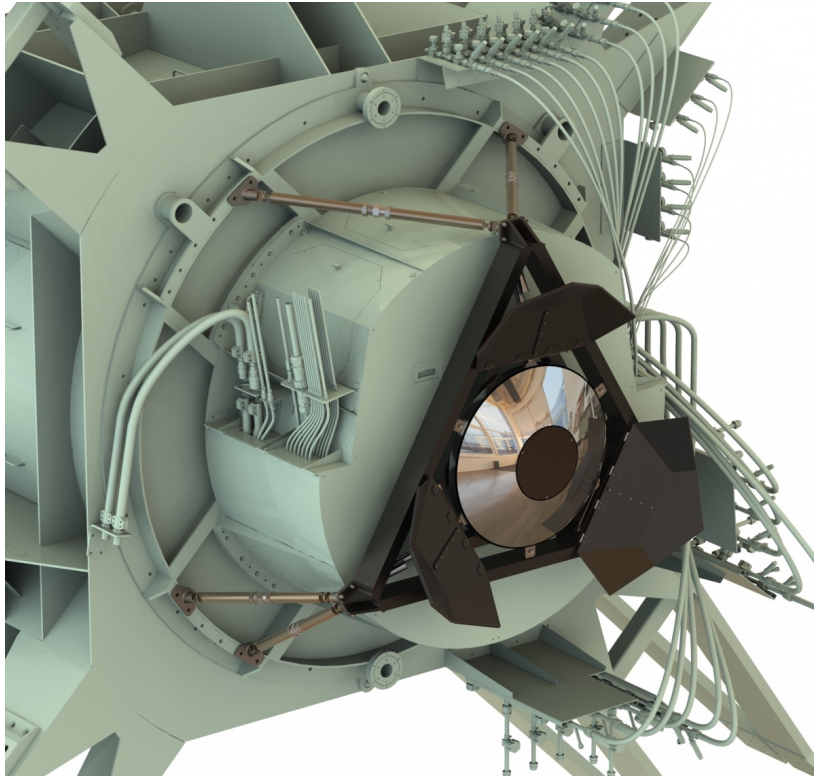
What about the main telescope?



- Designed to determine the spectral transmission function of the telescope and instrument
 - Flat field Screen
 - Narrowband (Laser) illumination
 - Broadband (LED) illumination
 - Collimated Beam Projector
 - Narrowband (Laser) illumination
 - Illumination characterization system
 - NIST calibrated photodiodes
 - Fiber fed spectrographs



- Calibration Screen being designed and fabricated by EIE (dome vendor)
 - Also doing the CBP and laser platforms
- Reflector to begin fabrication this summer

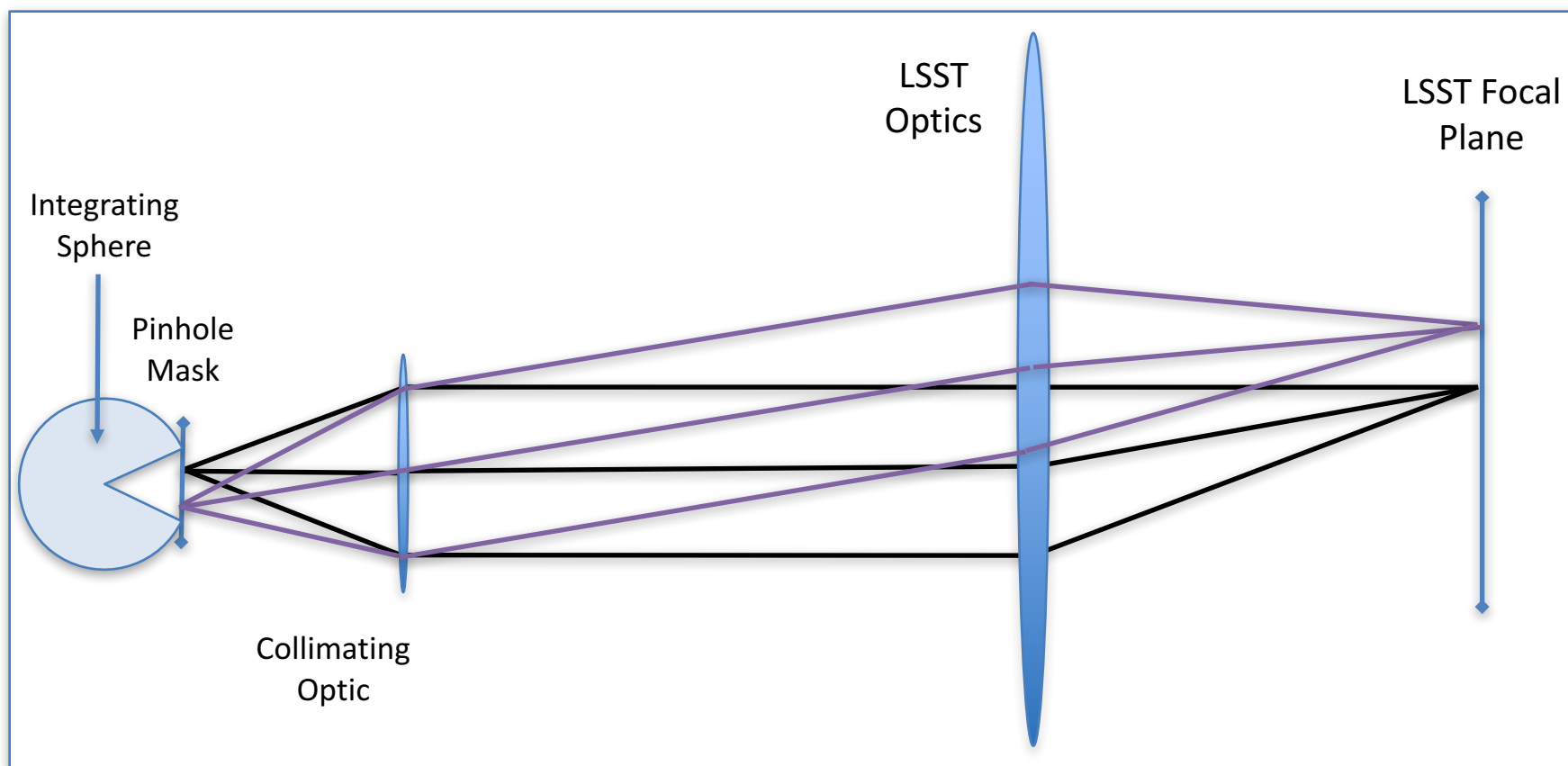




Collimated Beam Projector (CBP)

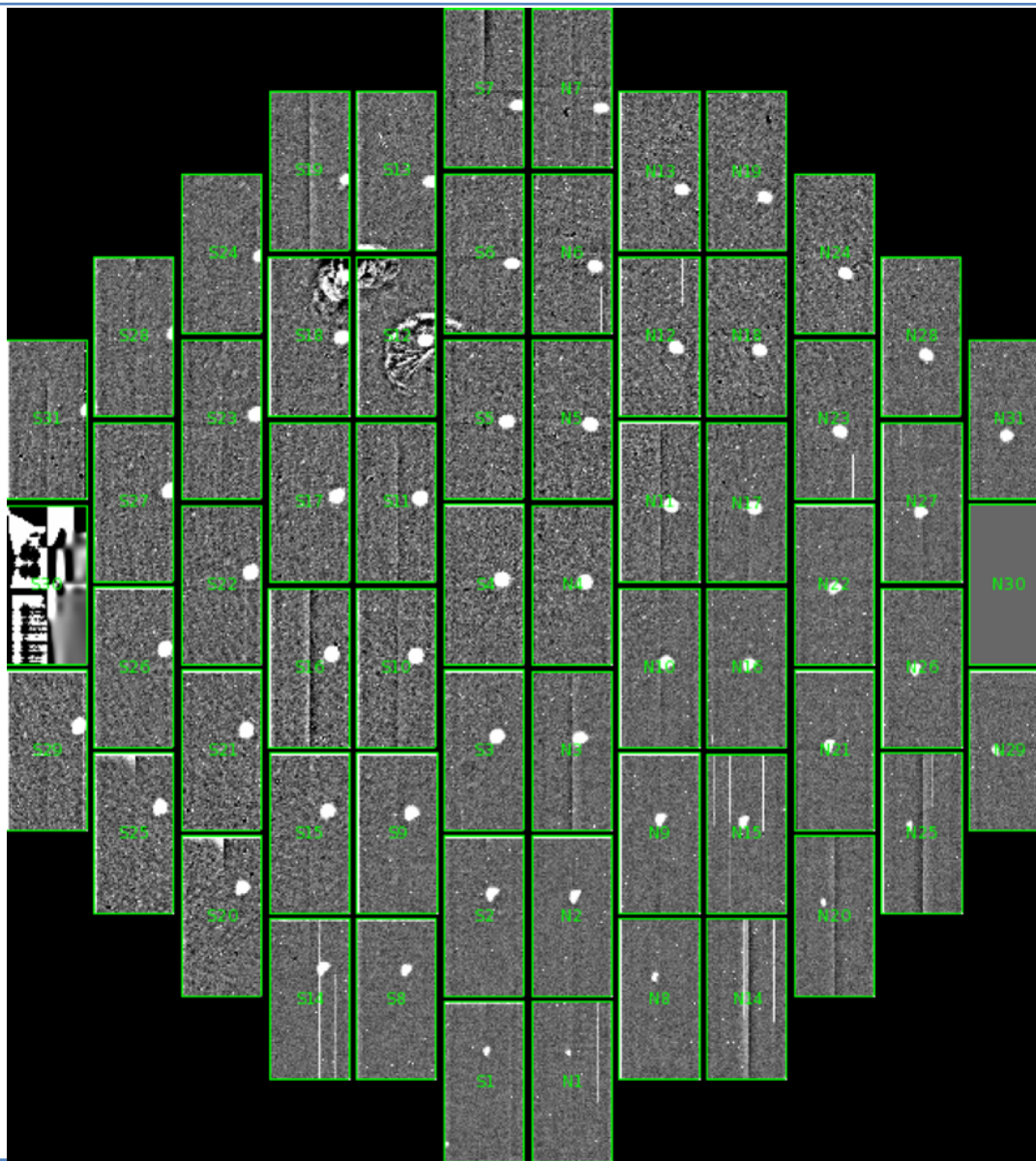


- Collimated 25cm diameter beam to measure transmission as a function of field position, pupil/spatial position, and wavelength
- Spatial mask(s) in the CBP are projected to the telescope which re-images it on the LSST focal plane



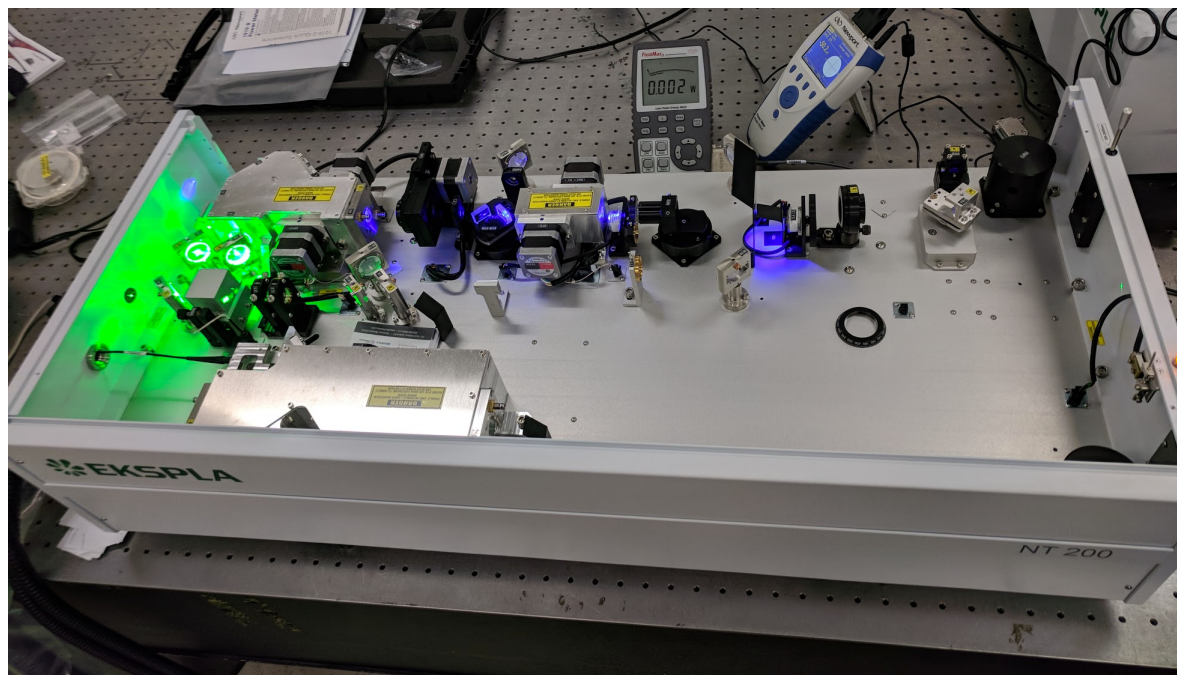


Collimated Beam Projector (CBP)

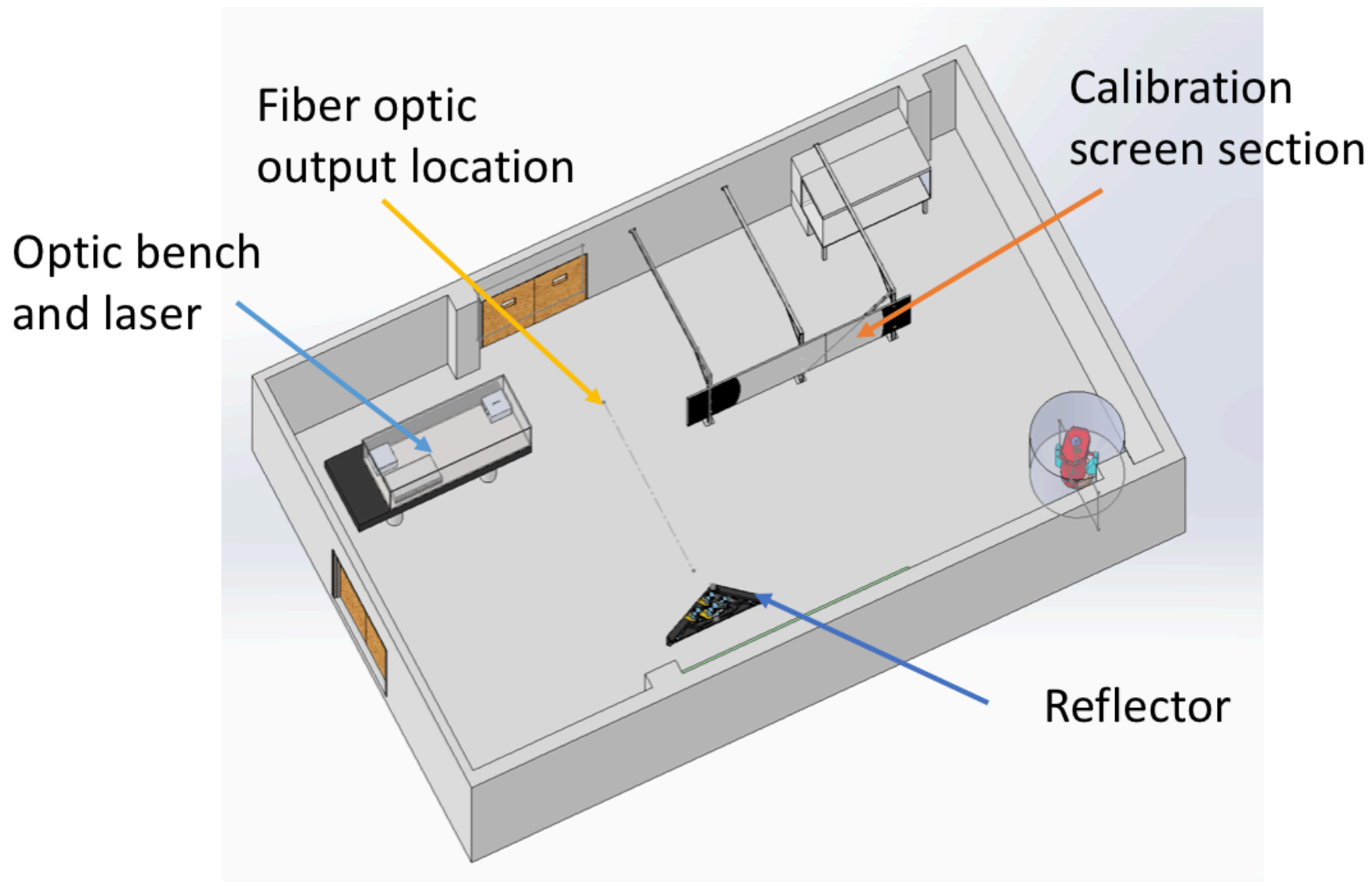


Couglin et al 2016
Ingraham et al 2016
Mondrik et al 2018?

- CBP is now completed and awaiting our approval to ship to Tucson
- Air cooled Ekspla NT242 Tunable Laser has been delivered to Tucson
- Majority of illumination characterization hardware is in-hand



***Lab Integration and
Test starts in August !***



- Auxiliary Telescope now installed. Mount control system development is on-going.
 - First light early next year
- Spectrograph system undergoing multiple integration and commissioning activities in Tucson, AZ
 - From simulating a night of observations, to archiving the data at NCSA
- Main Telescope calibration systems also undergoing integration
 - CBP ready to ship, Laser in-hand
 - Will begin testing (with a telescope that is TBD) in the fall
 - Calibration Screen contract finalized and being designed
 - Illumination optic about to be fabricated