LSST Telescope Design

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Large Synoptic Survey Telescope

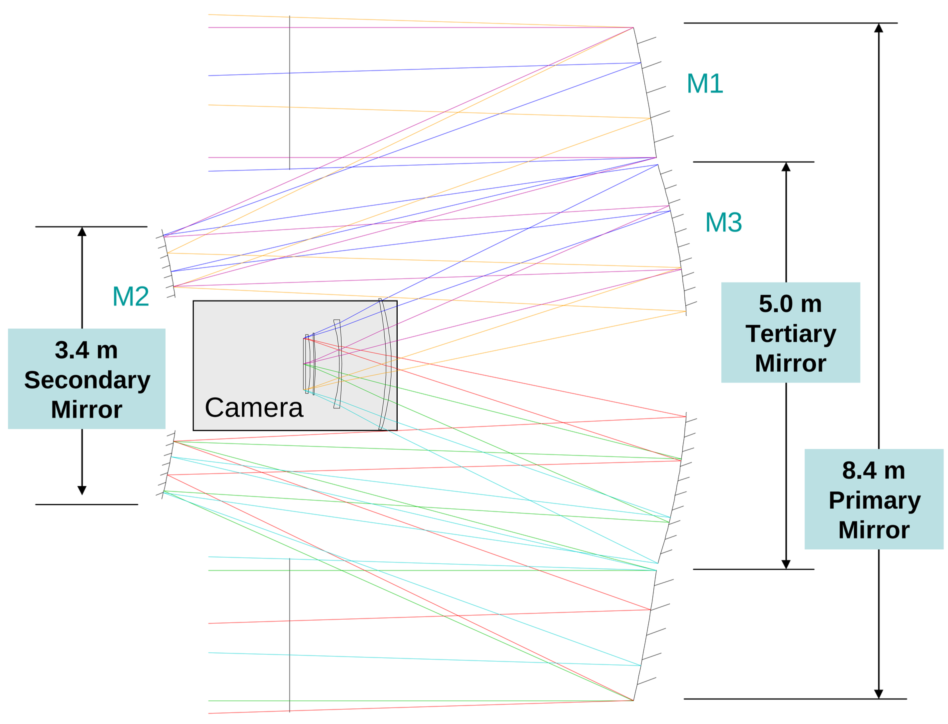
Abstract

The proposed Large Synoptic Survey Telescope (LSST) has an 8.4 meter aperture with a 3.5 degree diameter field of view and must meet the challenging cadence requirements necessary to perform the LSST survey mission. The telescope optical system is based on a Paul-Baker three element design with a single captured focus for the dedicated instrument. The large mirrors, 8.4 m diameter primary, 3.4 m secondary, and 5.0 m tertiary, and the large 64 cm diameter focal plane camera are supported by a rigid steel structure with active control of alignment and mirror support. Analysis has demonstrated that wavefront information taken at multiple field positions within the focal plane can be used unambiguously to control the alignment of all components and the optical figures of the three large mirrors. A significant challenge for the telescope design is the slew and settle requirement of 3.5 degrees in 5 seconds with subsequent moves every 30 seconds. Previous structural and thermal studies have demonstrated telescope design feasibility. The structure has been designed to exhibit a first structural mode of nearly 10 hz. fully loaded with the optical system, the camera, and anticipated parasitic masses in place. The LSST telescope development continues in concert with the parallel development of all other aspects of the LSST Project.

LSST Optical System

The optical system for the LSST is a modified Paul Baker three element Design [(1)]. The design features an 8.4 meter diameter primary mirror, a 3.4 meter diameter secondary that feeds nearly collimated light to a 5 meter diameter tertiary mirror. The three reflecting surfaces produce a spherical image at the camera interface. The camera includes three refractive lens that flatten the field to a 64 cm diameter focal plane

- Design Provides: $A\,\Omega = 318\ m^2deg^2$
  3.5 ° FOV with <0.20 arcsec FWHM images
- Analysis shows mirror structures are within state of the art in manufacturing and control

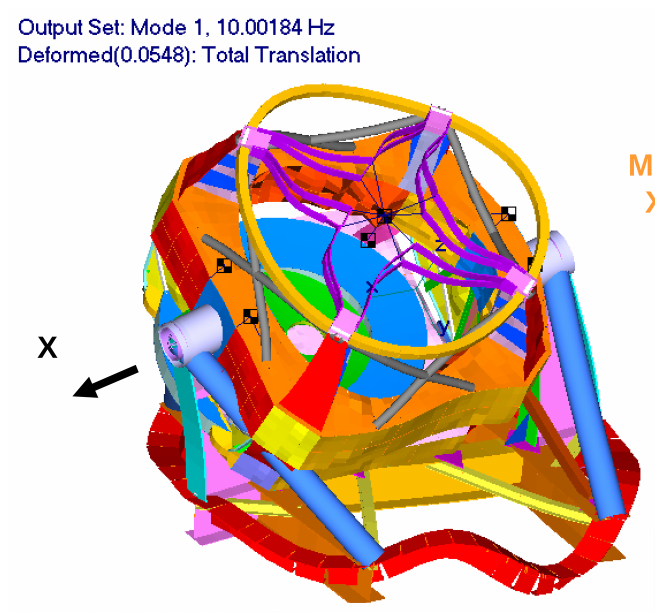


(1) See LSST Optical Design Poster in this AAS Session by L.Sepalla et. al.

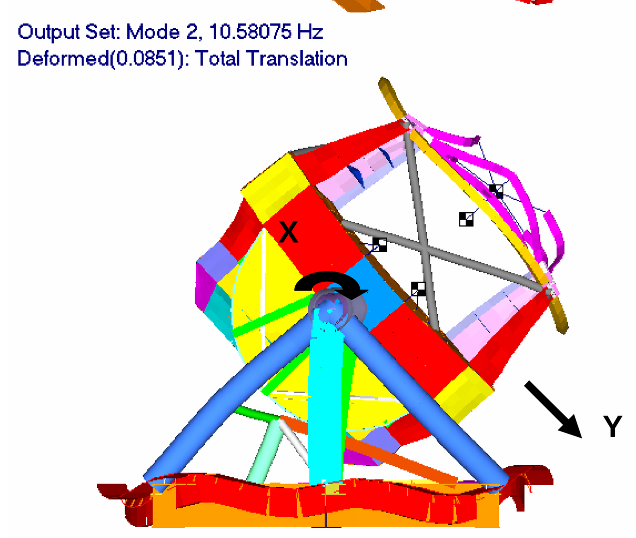
Telescope Structure

Performing the LSST survey demands telescope re-pointing on a 30 second cadence. The nominal operation scenario is to take 2 ten second exposures on a single field and then move to the next field. To minimize overhead the telescope must slew and settle on the next field, usually roughly 3.5 degrees away, in 5 seconds. This highly dynamic operating scenario and short settling time drives the telescope to a stiff high natural frequency pointing and support system.

- Analysis of a baseline structure demonstrated 10 Hz first mode capability
- Development continues maintaining ~10 Hz performance



Mode 1: 10.0 Hz
X-Translation

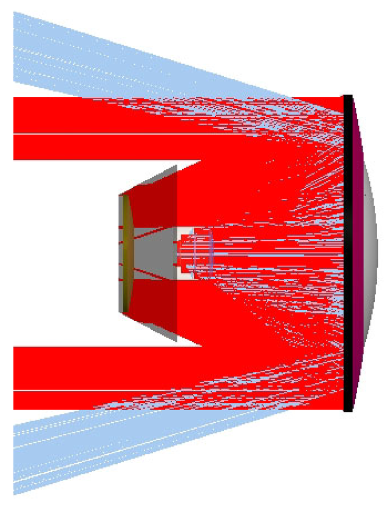


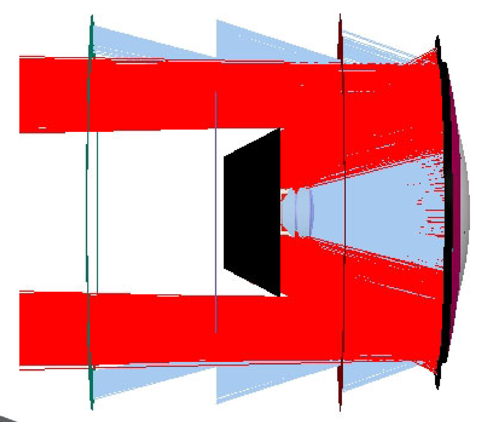
Mode 2: 10.5 Hz
X-Rotation
Y-Translation

LSST Short Tube Design		
Vibration Characteristics		
#	**Hertz**	**Mode**
1	10.0	Elevation Assembly X Translation
2	10.5	Elevation Assembly X Rot, Y Trans
3	13.5	PM Y Trans, TEA Z Trans
4	14.9	PM Y Trans, TEA Z Trans
5	16.3	PM Y Rotation
6	17.5	Azimuth Ring Vibration
7	17.9	Azimuth Ring Vibration
8	18.0	PM X Rot, TEA Z Trans
9	18.6	Azimuth Ring Vibration
10	18.6	Azimuth Ring Vibration

Baffling/Stray Light

Primary out of field reflections can be shielded from the focal plane with a simple set of three baffles. The first baffle is a combination of the telescope structure elevation ring and a small ring supported just above it. The second baffle is provided by the M2 support ring and the third baffle is a ring supported 1.5 meters beyond the M2 support ring.

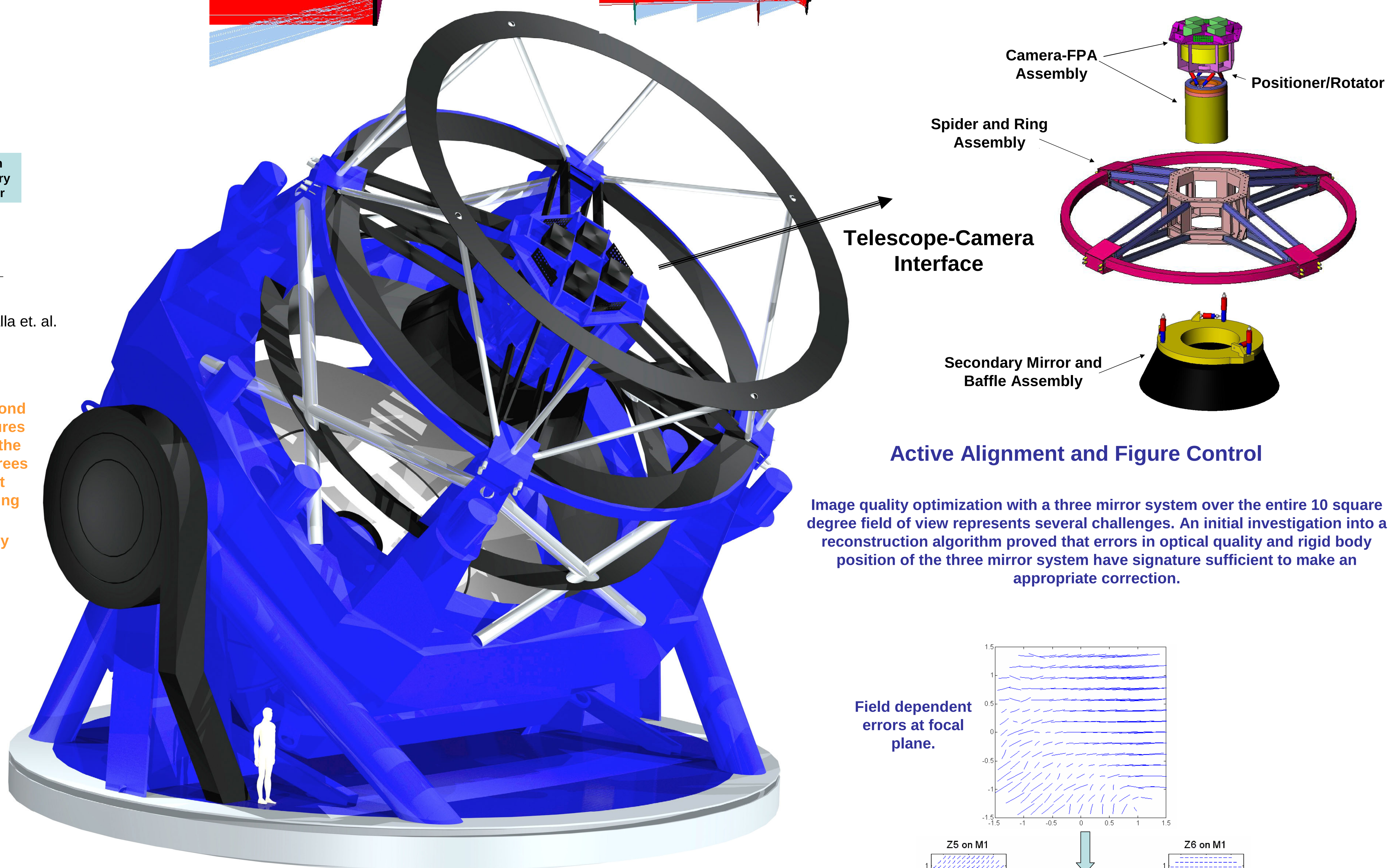




Primary Mirror Ordered

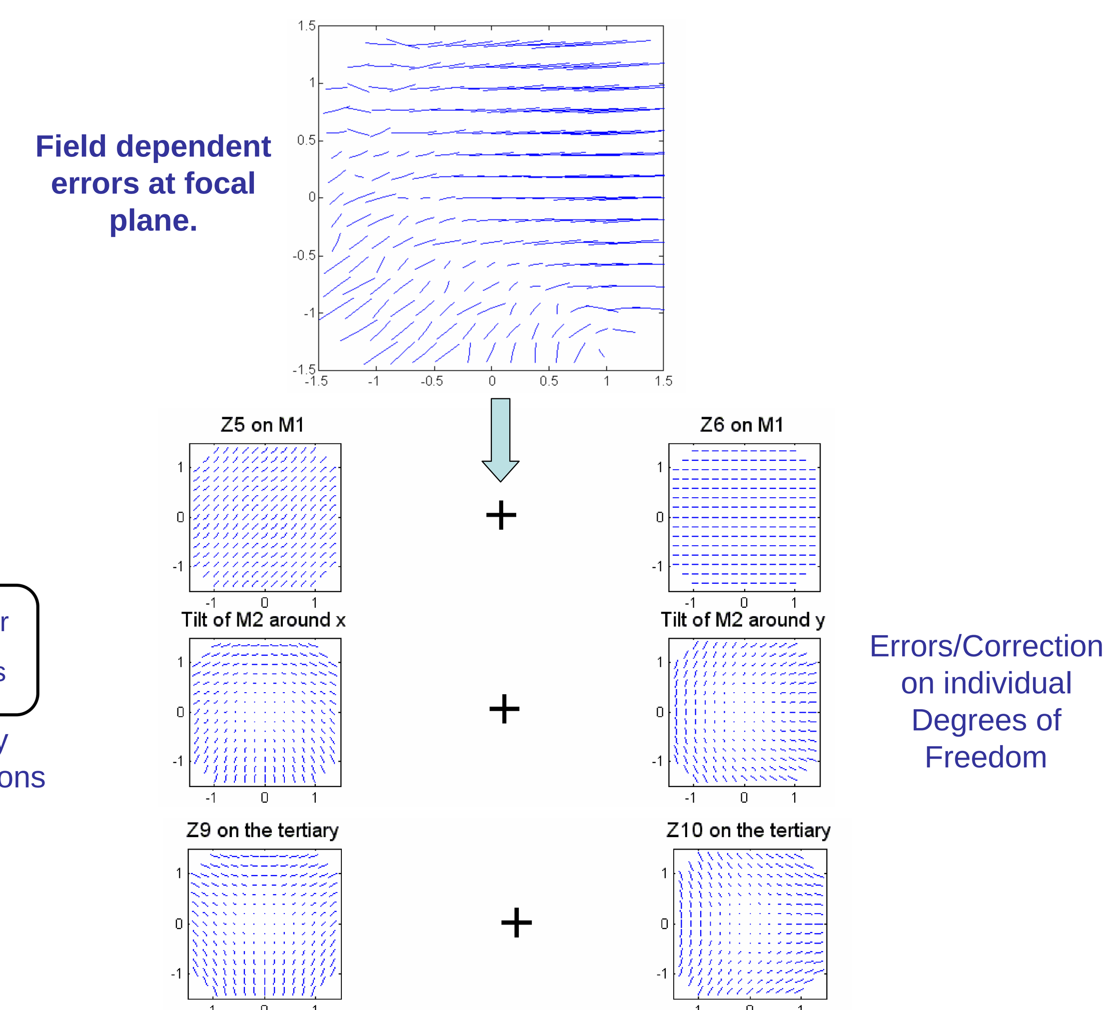
With the generous donation from Mr. Richard Caris LSST has ordered the primary mirror from the University of Arizona Steward Mirror Lab. The mirror design will be based on the successful 8.4 m LBT mirrors but will feature a much larger Center hole to accommodate the 5 meter diameter tertiary mirror.

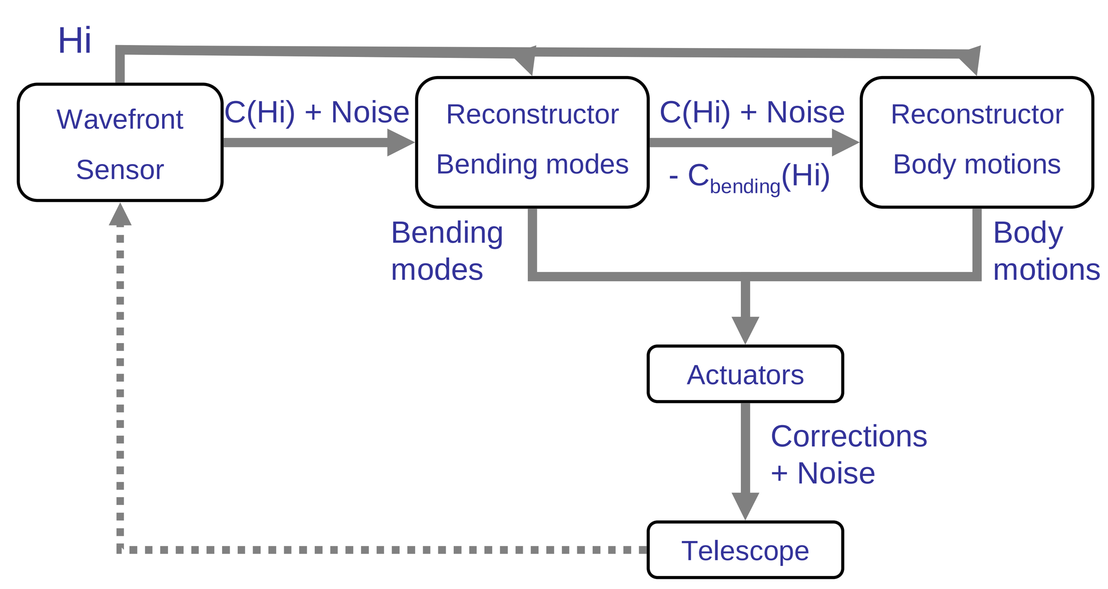
8.4 M LBT Mirror Shown



Active Alignment and Figure Control

Image quality optimization with a three mirror system over the entire 10 square degree field of view represents several challenges. An initial investigation into a reconstruction algorithm proved that errors in optical quality and rigid body position of the three mirror system have signature sufficient to make an appropriate correction.





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