LSST Telescope Design Developments

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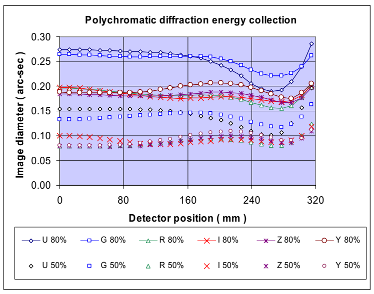
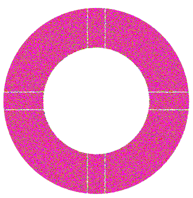
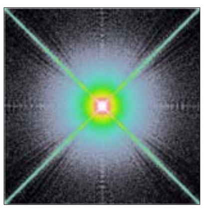
Large Synoptic Survey Telescope

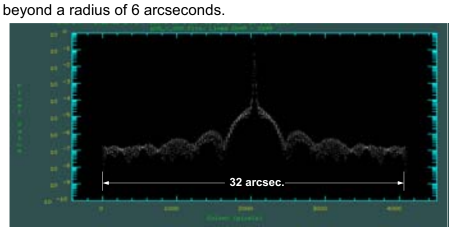
The proposed Large Synoptic Survey Telescope (LSST) has an 8.4 meter aperture with a 3.5 degree diameter field of view and must meet the challenging cadence requirements necessary to perform the LSST survey mission. Several advances have been made in the concept design of the telescope. The telescope 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 convex secondary, and 5.0 m tertiary feeding a 3 element refractive corrector produces a large 65 cm diameter focal plane. These elements are supported by a rigid steel structure with active alignment mechanisms on each element for position maintenance and correction. The optical design has been optimized and the primary and tertiary mirror surfaces are now specified to be fabricated into a single monolithic mirror blank. We analyze wavefront information within the focal plane to control the optical figures of the three powered reflective surfaces and their alignments. An active rigid body alignment system concept has been developed using laser tracker technology to reduce the computation load on wavefront sensing. The LSST telescope development continues in concert with the parallel development of all aspects of the entire LSST Project.







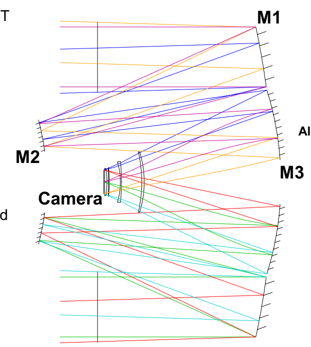
Diffraction PSF: The support of the LSST secondary and instrument assembly is done by 8×50mm thick structural vanes resulting in the pupil geometry shown (above left). The crossectional area of the vanes is a very small percentage of the 6.7m effective clear aperture collecting area. A stretched logarithmically scaled on-axis pure diffraction r-band image (upper right) shows complex image structure at extremely low levels. A logarithmic crossectional cut through the image along the diffraction spike (below) shows that the relative diffraction intensity is >10^6 below the peak beyond a radius of 6 arcseconds.



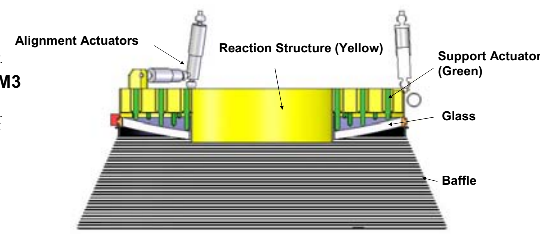
Optical Design: The optical design for the LSST is a highly optimized compact three-mirror telescope system (see Liang *et* al., poster #26.20) feeding a large refractive corrector producing a 3.5 degree field of view covering a 64 cm diameter flat focal plane (left). The LSST telescope consists of three aspheric mirrors; an 8.4-m primary (M1), a 3.4-m convex secondary (M2), and a 5.0-m tertiary (M3).

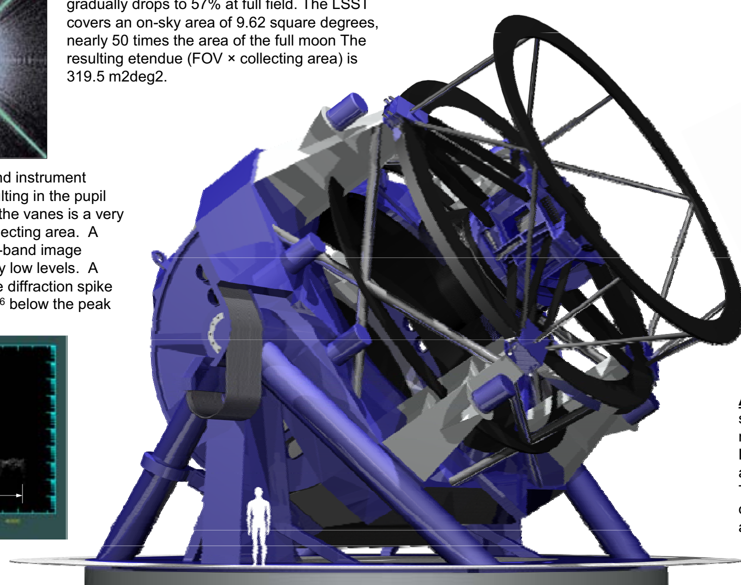
The LSST optical performance is superb. The image quality as measured by the 80% encircled energy image is better than 0.3 arcseconds for all spectral bands (ugrizY); for the rizY spectral bands, the 80% encircled energy is ~0.2 arcseconds or better (see figure at left).

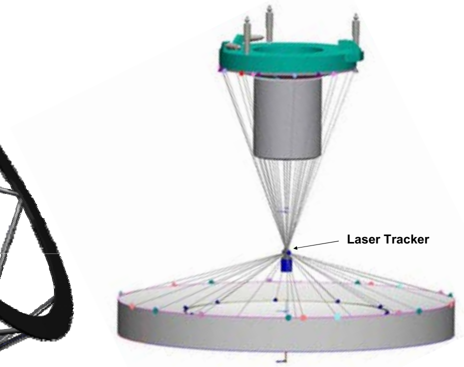
The throughput of the LSST is 62.55% on-axis out to a field radius of 0.7 degrees, and then gradually drops to 57% at full field. The LSST covers an on-sky area of 9.62 square degrees, nearly 50 times the area of the full moon The resulting etendue (FOV × collecting area) is 319.5 m2deg2.



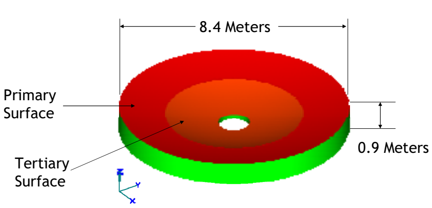
Secondary Mirror Design (below) is a 100 mm meniscus glass substrate supported by 102 axial and 6 lateral actuators. Alternate materials and lightweighted structured mirrors are also being considered.

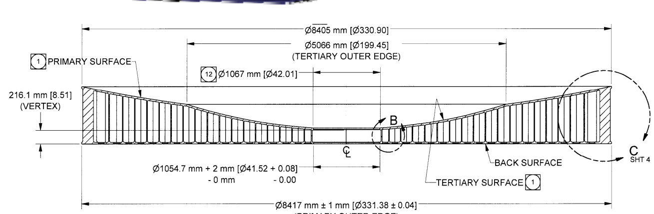


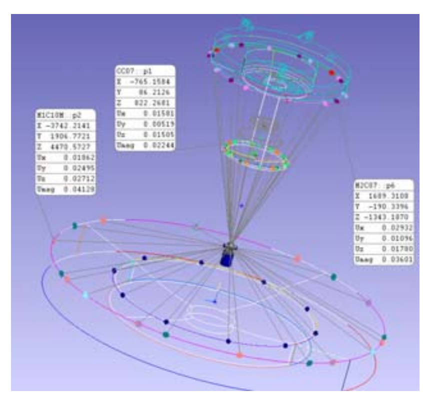




Active Alignment: The challenge of operational alignment of this system is being addressed by focal plane wavefront sensors and a rigid body alignment system (see Gressler *et al*., poster #26.21). The LSST will extend the laser tracker system intended for integration alignment to also function in real time to maintain rigid body position. The cadence of the observations and the desire to reduce the number of dedicated exposure for wavefront sensing motivates this redundant alignment system.







M1-M3 Monolith: LSST has adopted a monolithic mirror design for the primary and tertiary surfaces. Due to the contiguous position of the Tertiary surface with respect to the Primary surface, both can be figured into a single substrate. The mirror will be cast in the normal Steward Observatory process and the Tertiary will be formed by grinding out the excess cast material. Testing these surfaces together will be a challenge but the monolithic mirror is considered a significant operation advantage and within the state of the art today.

The LSST research and development effort is funded in part by the National Science Foundation under Scientific Program Order No. 9 (AST-0551161) through Cooperative Agreement AST-0132798.
Additional funding comes from private donations, in-kind support at Department of Energy laboratories and other LSSTC Institutional Members.

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