Large Synoptic Survey Telescope

The Design of the LSST Camera

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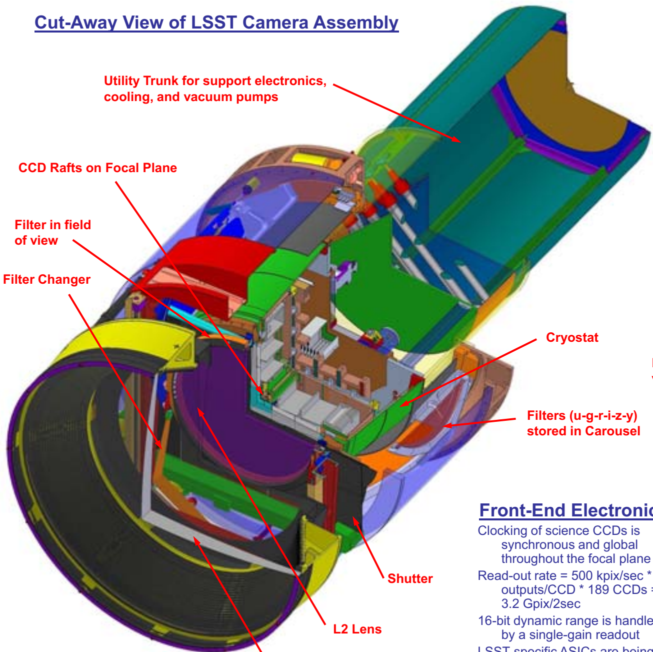
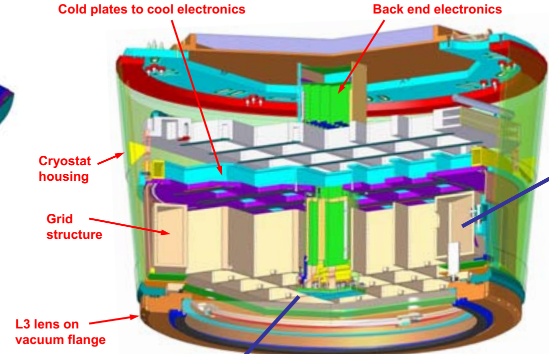
The LSST camera contains a 3.2-gigapixel focal plane array comprised of 189 4K x 4K CCD sensors with 10 micron pixels. The sensors are deep-depletion, back-illuminated devices with a highly segmented architecture that enables the entire array to be read out in 2 seconds. The detectors are grouped in identical 3 × 3 arrays called "rafts." Each raft includes dedicated front-end and back-end electronics boards, which fit within the footprint of its sensors, thus forming a 144-megapixel camera on its own. The rafts and associated electronics are mounted on a silicon carbide grid inside a cryostat. The grid also contains four sets of guide sensors and wavefront sensors at the edge of the field. The entrance window to the cryostat is the third of three refractive lenses. The other two lenses are mounted in the front of the camera body. The camera body also contains a mechanical shutter and a filter exchange system holding five large optical filters, any of which can be inserted into the camera field of view for a given exposure. A sixth optical filter will also be fabricated and can replace any of the five filters during a daytime access. Details of the LSST camera conceptual design are shown below.

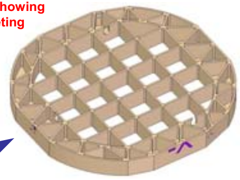
Cut-Away View of LSST Camera Assembly



Cut-Away View of Cryostat

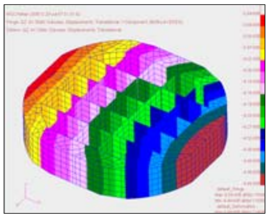


Grid section showing internal gusseting



Grid Structure

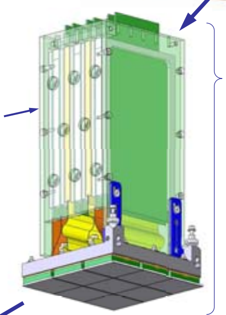
- Supports 21 Rafts and 4 corner Rafts with Guider and Wavefront sensors
- Manufactured from fiber-reinforced SiC for low expansion, high conductivity, high modulus of elasticity, and fracture toughness
- Gravity-induced out-of-plane deflection < 1 micron



Grid Distortion—Zenith-Pointed

Focal Plane Array

- Comprised of 189 4K x 4K CCD's, each with 16 output channels
- 3200 video channels, total
- Sensors organized into 21 identical rafts of 3 x 3 sensors
- Required flatness across focal plane: 10 microns



Raft Tower

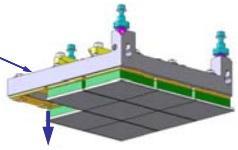
- Sensors are organized into identical Rafts of 3 x 3 sensors
- 144 channels/raft
- A Raft Tower is an autonomous object and can function as a complete camera
- Electronics fit in the "shadow" of the sensors on a Raft

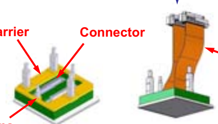
Front-End Electronics

- Clocking of science CCDs is synchronous and global throughout the focal plane
- Read-out rate = 500 kpix/sec * 16 outputs/CCD * 189 CCDs = 3.2 Gpix/2sec
- 16-bit dynamic range is handled by a single-gain readout
- LSST-specific ASICs are being developed to handle analog front-end functions

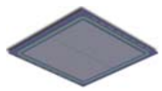
Raft

- 3 x 3 array of 16 M-pixel CCD sensors
- Rigid, low-expansion structural support—SiC or Invar
- Kinematically supported off Grid
- Required flatness across Raft: 6.5 microns





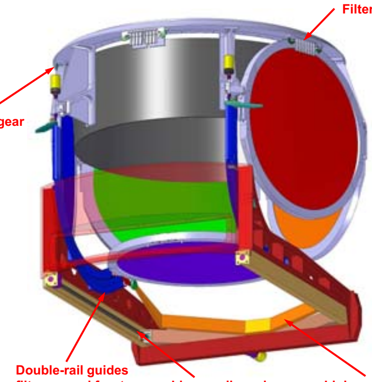
Sensor Package



Sensor

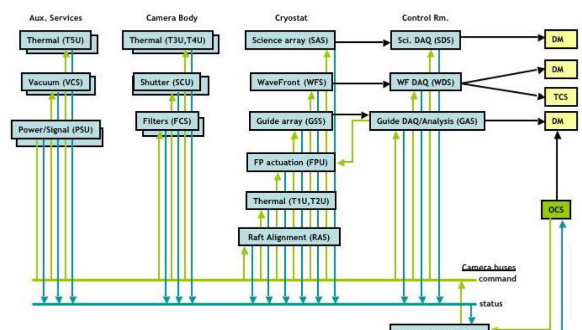
- 4K x 4K CCD sensors
- 2 contiguous imaging areas 2K x 4K
- 2 sec readout at 500 kHz → ~1M pixels per output
- Fill factor must approach unity, which favors a fairly large area footprint of ~16 cm²
- 500 pixels/segment for blooming control of bright stars
- Required flatness across sensor: 5 microns

Multi-port 4K x 4K CCD

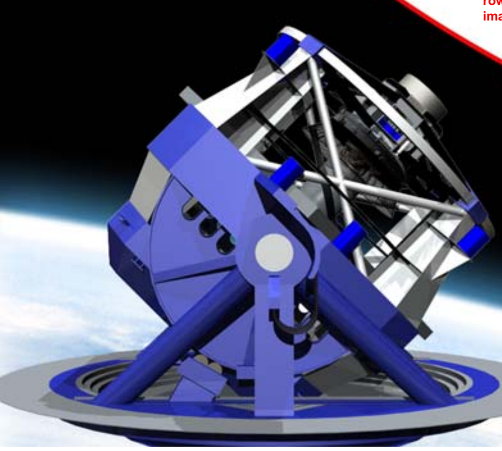


Filters and Exchange System

- 5 filters stored on-board
- 60 second exchange time
- Carousel holds filters in clean storage
- Double-rail auto changer pulls filter from storage carousel and moves it on-line
- System integrates with a manual load-lock changer to allow for clean swap-out of a 6th filter during the day



Camera Control System Schematic



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