Large Synoptic Survey Telescope

Design Overview of the LSST Camera

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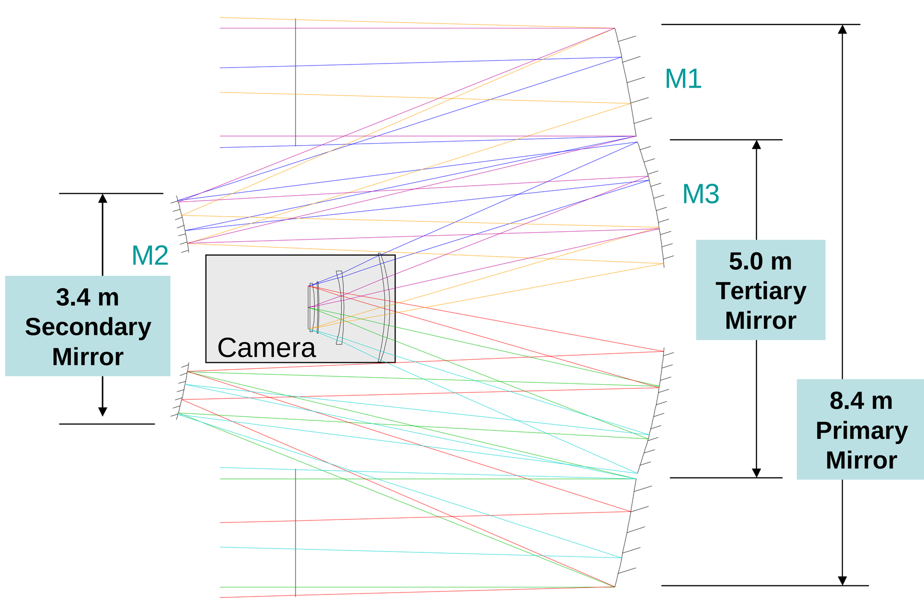
The Large Synoptic Survey Telescope will be a large aperture, large field-of-view ground-based telescope operating in the visible band. It is designed to provide a synoptic survey of a major fraction of the sky in five color bands, on timescales ranging from minutes to days. The database generated by the LSST will be amenable to a wide variety of scientific analyses, ranging from searches for moving bodies in the solar system to the mapping of the dark matter distribution as a function of redshift through weak lensing. (See Tyson et al. poster for science overview and Stubbs et al. poster for project overview.)

The LSST camera will be the largest digital camera ever built. As such, its design presents a number of challenges. The field of view will be 3.5 degrees in diameter and will be sampled by a 3 billion pixel array of sensors. The entire array must be readout in under 2 s, which leads to demanding constraints on the sensor architecture and the readout electronics. In addition, given the fast optical beam (f 1.2), the build tolerances on the assembly and alignment of the focal plane are tight. The camera incorporates three very large refractive lenses, and an array of five large filters.

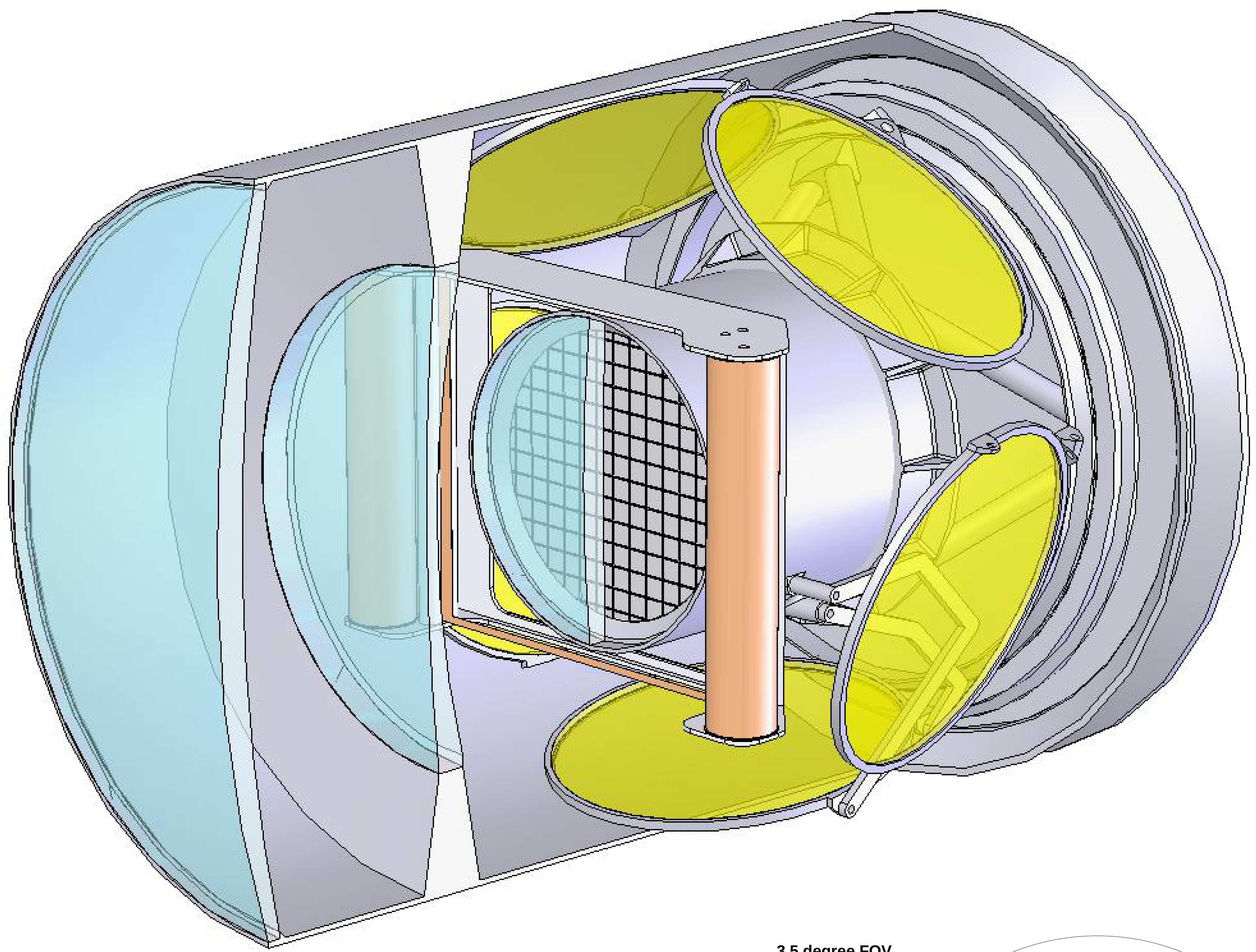
We present an overview of the overall camera design, with an emphasis on key aspects of our development program. Parallel posters will discuss the details of the sensor development (O'Connor et al.) and of the opto-mechanical subsystems (Hale et al.)

CAMERA CHALLENGES

- **Sensor requirements:**
  - **10 μm pixel size**
  - **Pixel full-well > 90,000 e⁻**
  - **Low noise (< 5 e⁻ rms), fast (< 2 sec) readout (→ < –60 C)**
  - **High QE 400 – 1000 nm**
  - **All of above exist, but not simultaneously in one detector**
- **Focal plane position precision of order +/- 5 μm**
- **Large number of sensors, integrated electronics, high fill factor**
  - **Difficult to implement without sacrificing serviceability**
- **Large diameter filter coatings**
- **Constrained volume (camera in beam)**
  - **Makes shutter, filter exchange mechanisms challenging**
- **Constrained power dissipation to ambient**
  - **To limit thermal gradients in optical beam**
  - **Requires conductive cooling with low vibration**

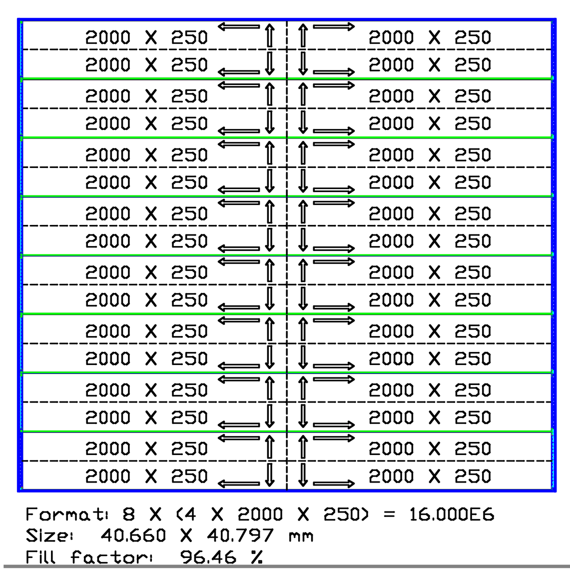


LSST optical design, illustrating the location of the camera in the beam.

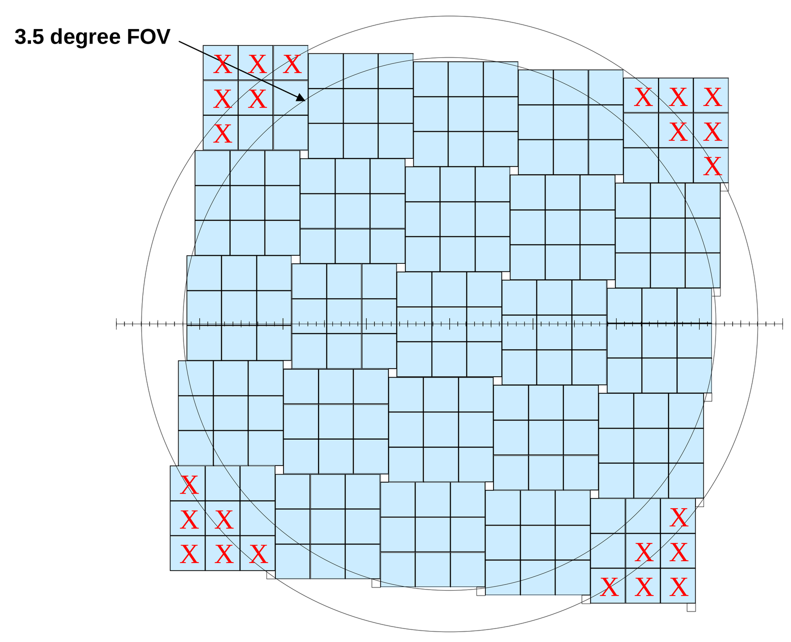


DOE PARTICIPATION IN LSST

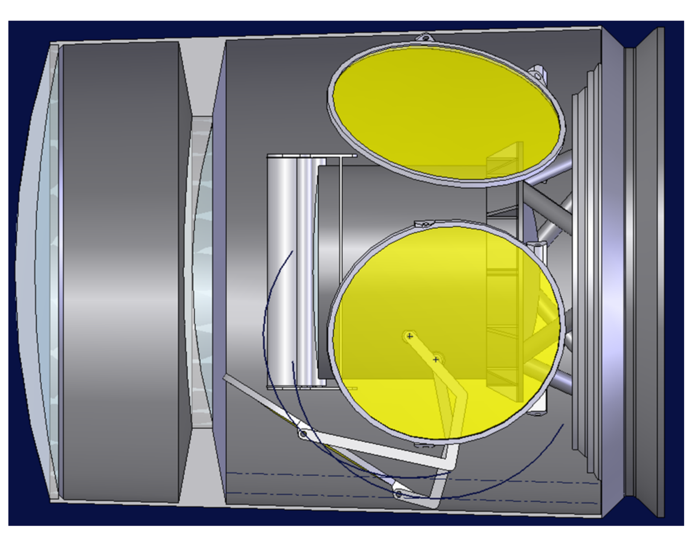
- **A collaboration of DOE-funded institutions has been formed to pursue participation in LSST. This collaboration has been working closely with the LSST Corporation under the coordination of the LSST Director and Project Manager.**
- **The proposed DOE "deliverables" include the LSST camera system and contributions to the DAQ, the software, system modeling and operations.**
- **SLAC will lead the development of the camera, with significant contributions coming from BNL, LLNL, and DOE-funded university groups (e.g. Harvard, UIUC).**



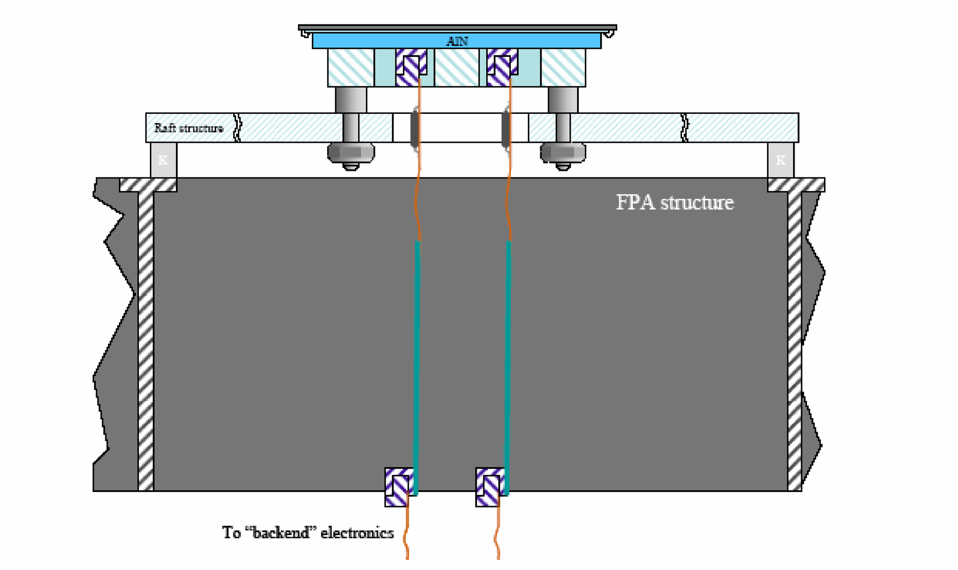
Design concept for a CCD sensor. It is highly segmented to enable fast readout at low noise.



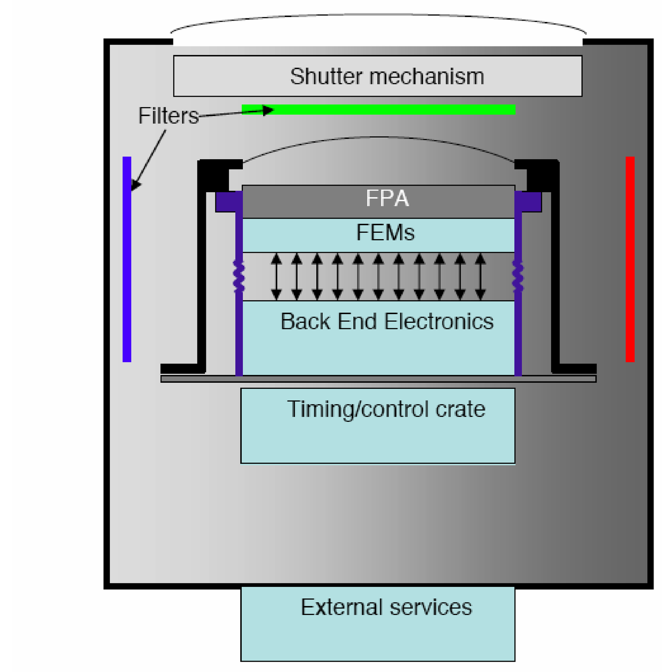
Possible layout of the rafts on the focal plane. The gaps at the corners are potential locations for wavefront sensors.



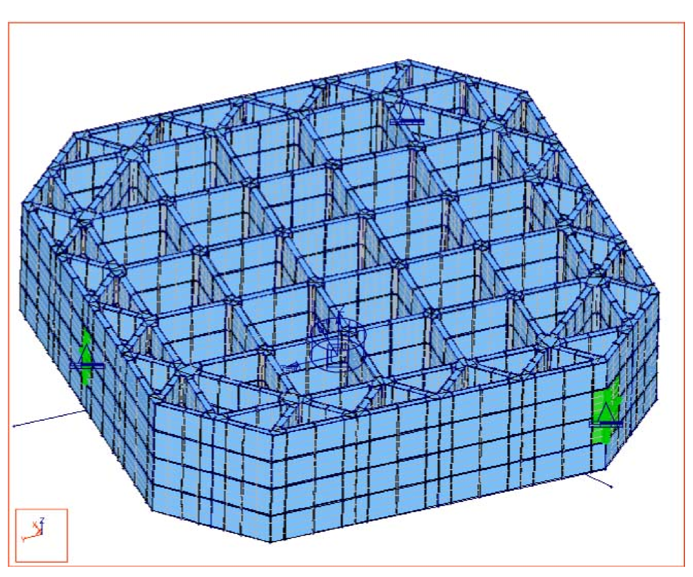
Mechanical layout of camera. There are 5 filters present at any one time, mounted on a carousel and inserted via a two-arm mechanism.



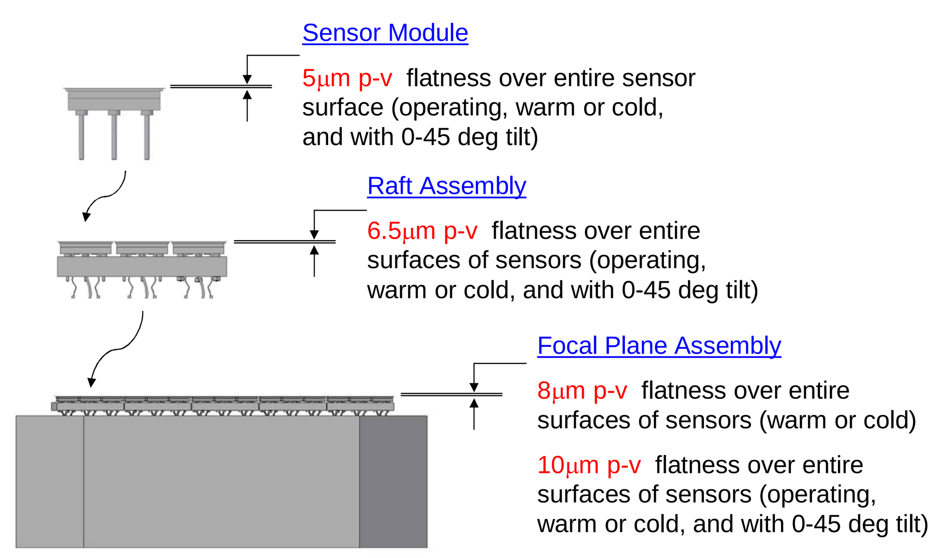
Sensor mounting concept. Packaged sensors are aligned on "rafts" which are then positioned on the FPA structure.



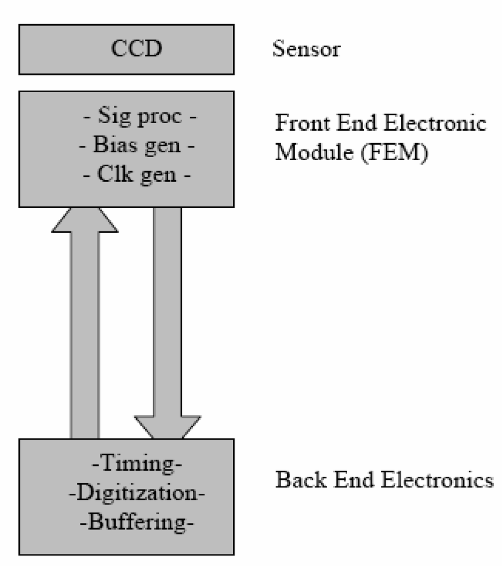
Distribution of camera electronics.

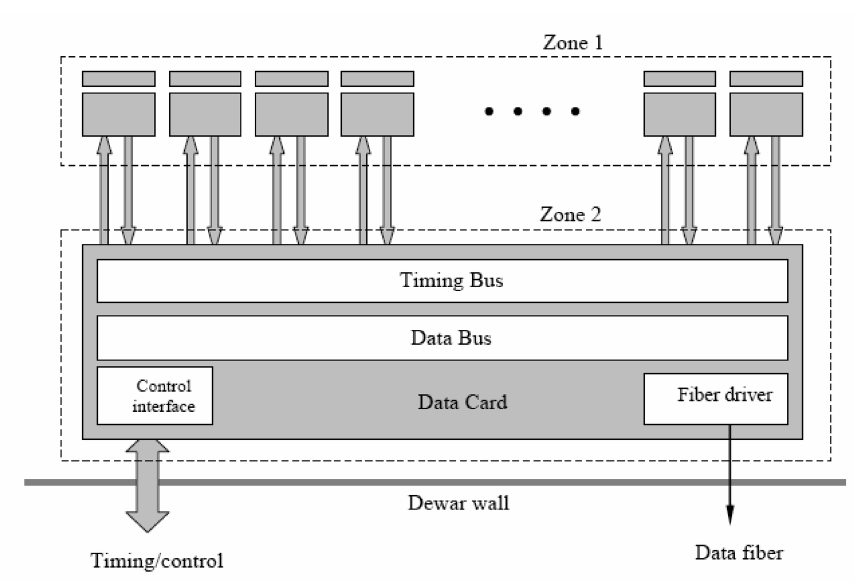


Integrating structure for the focal plane array.



Tolerance allocation for the alignment of the focal plane array.





Readout architecture for a single sensor *(left)* and for groups of sensor modules *(right).*

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