The Large Synoptic Survey Telescope Commissioning Camera

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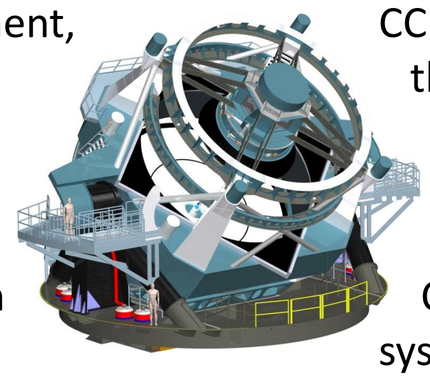
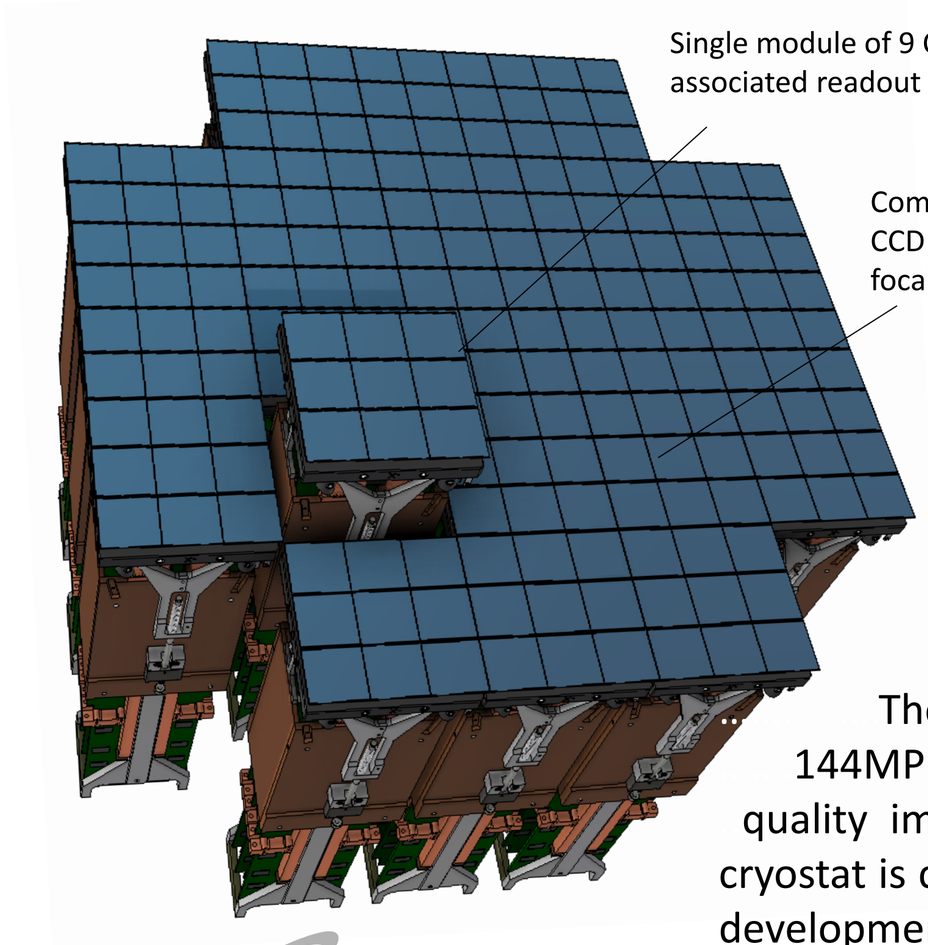
Background:

The Large Synoptic Survey Telescope (LSST) will be an 8m-class, fast cadence, all-sky survey telescope and is noted for its likely impact on dark matter and dark energy science among other things. While the telescope's optical design employs a unique three-mirror modified Paul-Baker arrangement, the integrated camera (LSSTCam) represents a significant technological challenge itself: The focal plane will be populated with the world's largest visible light CCD array at 63cm in diameter and 2.4GP in resolution, which when illuminated with the telescope's extremely fast f/1.2 optical beam, imposes a flatness requirement on the modular sensor array of +/-15um across the mosaic, which must also be cooled to -95°C. The camera's optics establish similarly impressive landmarks: The first lens in the three-element corrector will be the largest imaging lens ever produced (1.55m).



Introduction:

The commissioning phase of the LSST will begin in 2020 with the completed LSST Camera ready for integration 9 months later. In the interim a **commissioning camera (ComCam)** will be deployed with a 9 CCD subset of the science focal plane to perform early telescope alignment and commissioning tasks, complete engineering first light, and possibly produce early usable science data. The cryostat with the 9 CCD module which it contains is the bulk of the ComCam instrument; a self contained test camera which emulates the mechanical and thermal environment of LSSTCam allowing operation and readout of .7deg^2 worth of science focal plane as though the complete camera were present. This cryostat was designed for the sensor and electronics development effort at Brookhaven National Laboratory and several more will be produced in addition to ComCam for production testing and ancillary efforts at other institutions in the project.

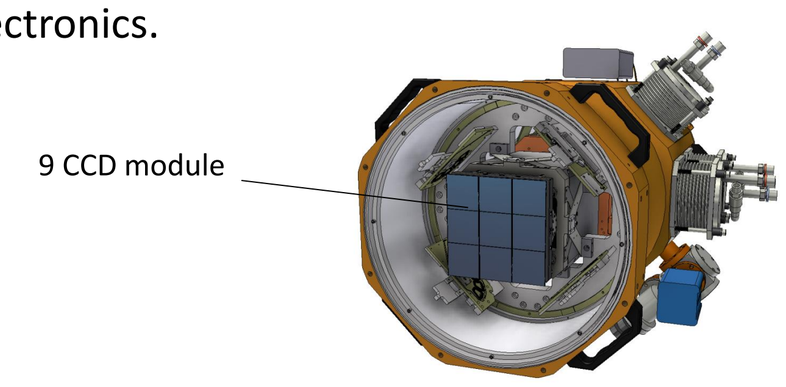


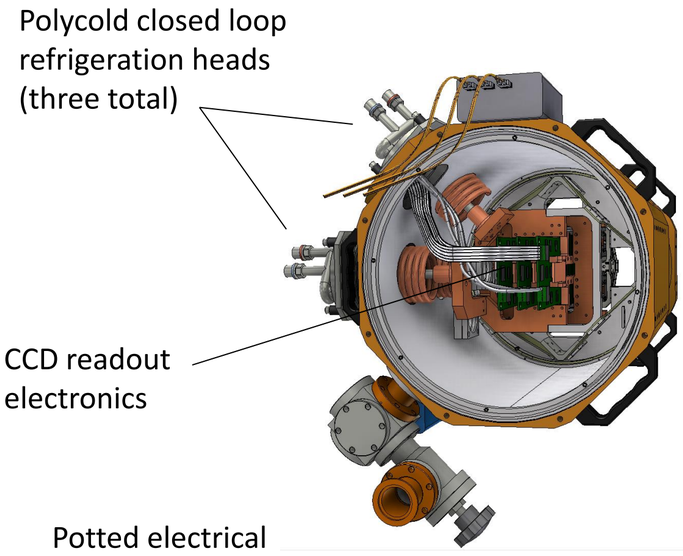
Emulating LSSTCam:

Twenty-one CCD/electronics modules comprise the complete focal plane array within LSSTCam. Within ComCam, one such module will be supported in a surrogate environment that provides the needed mechanical and thermal support, which is divided into two distinct zones. The mechanical interface for the 9-CCD baseplate of a CCD/electronics module is three kinematic spheres attached to a low thermal expansion support frame. By virtue of the CCD/electronics module design the CCD baseplate is mechanically decoupled from the electronics crate, which in addition to holding the CCD readout electronics provides the thermal conduction path from the CCDs via flexible thermal straps to the cryogenic refrigeration system. A separate higher power thermal path and refrigeration system exists for cooling the electronics.

Thermal environment:

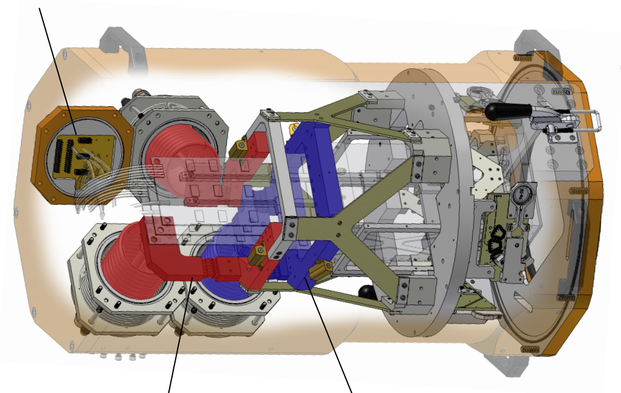
We use Polycold closed-loop refrigeration systems to cool both thermal zones. Two units running the highest thermal capacity refrigeration blend with a combined peak heat removal capacity of 100W are dedicated to cooling the electronics, as shown below by the red-shaded region. The CCDs are cooled to -95°C by a lower temperature cooling blend using one Polycold unit, as shown by the blue-shaded region.





Optical & Electrical:

A three-element correcting optic and filter changer have been designed by NOAO to transform the cryostat described here into a commissioning camera capable of the full science imaging performance of the LSSTCam on the scale of 9 CCDs. A full aperture shutter will also be incorporated along with a dummy mass to simulate the load of LSSTCam.



A custom potted PCB is used to feed the high speed data and power connections out of vacuum using the native LSST cabling. In external optical transition module creates the optical data link needed for the longer-range high fidelity data link to the control and readout computers.

Summary:

The LSST commissioning camera is a self-contained 144MP astronomical camera capable of LSST science-quality imaging on a smaller plate scale. A copy of the cryostat is currently in use for science sensor and electronics development. In addition to its life as ComCam, several additional copies will be produced for use in various incarnations throughout the LSST project.

Cryostat in LSST sensor testing lab

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