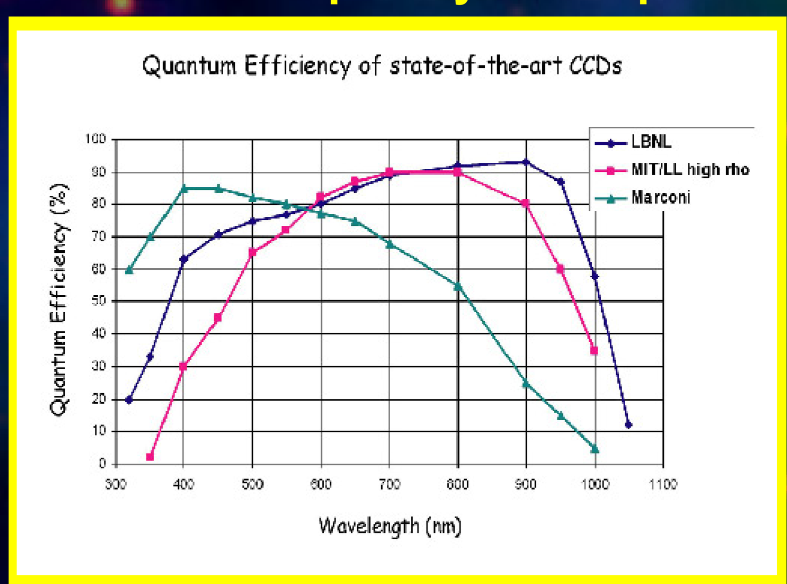
Supernova/Acceleration Probe: GigaCAM - A Billion Pixel Imager

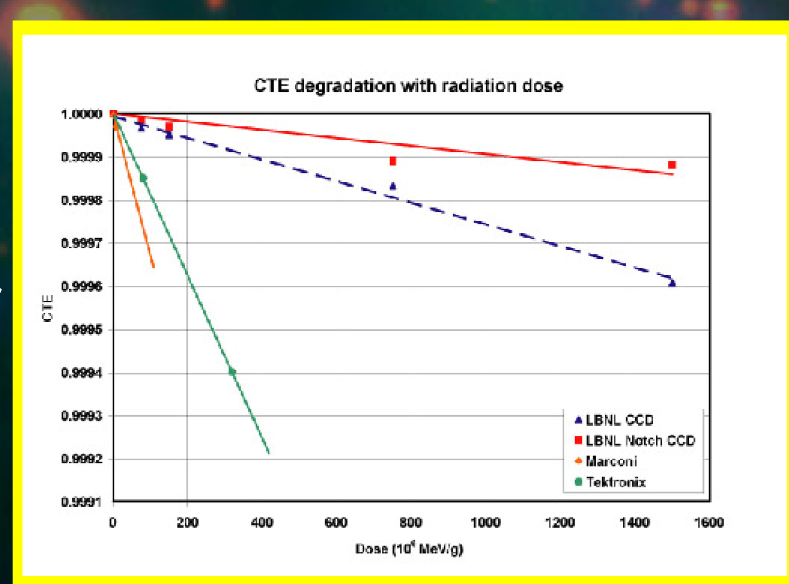
http://snap.lbl.gov

The SNAP Collaboration

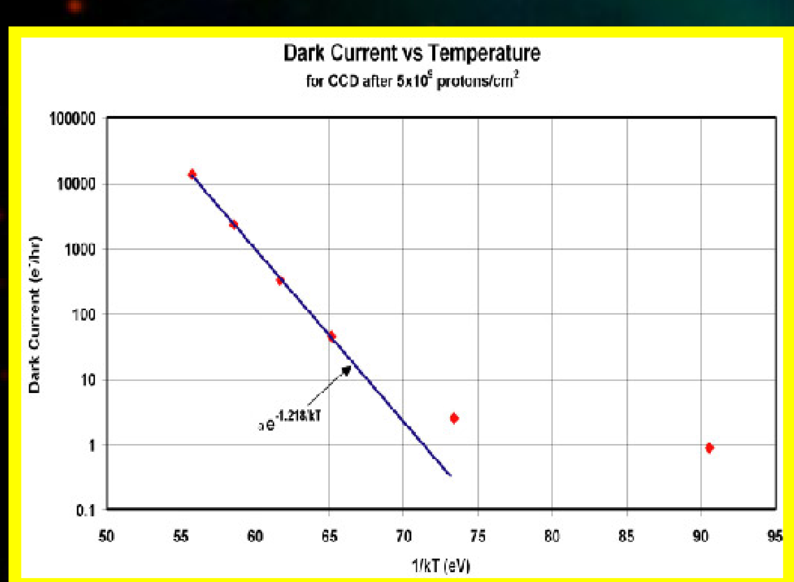
Performance of the LBNL CCD Developed by the Supernova Cosmology Project



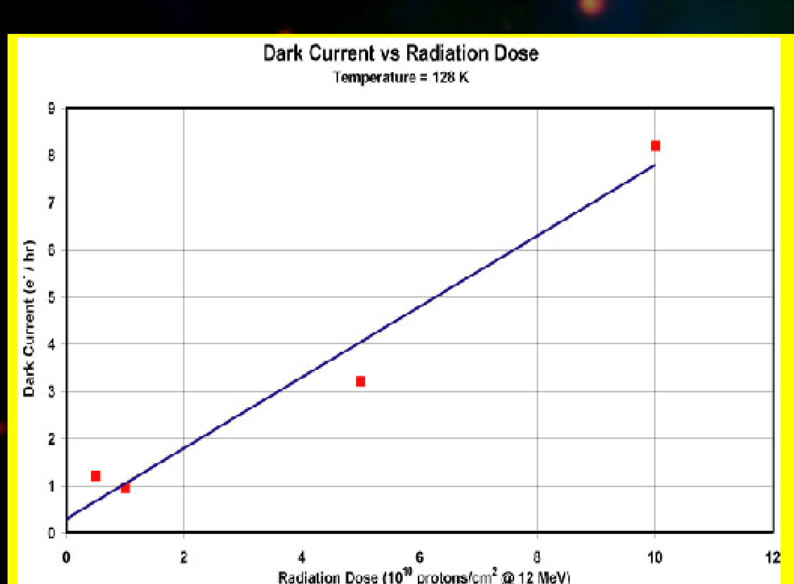
Comparison of quantum efficiency measurements for potential Keck Observatory upgrades, including a LBNL fully-depleted CCD (Belentic, Stover and Taylor, Jan. 2001).



Radiation damage degrades charge transfer efficiency. Measurements show only a small loss of CCD CTE for NIEL doses expected for the lifetime of the SNAP mission (10 MeV/g) as compared to other detectors.



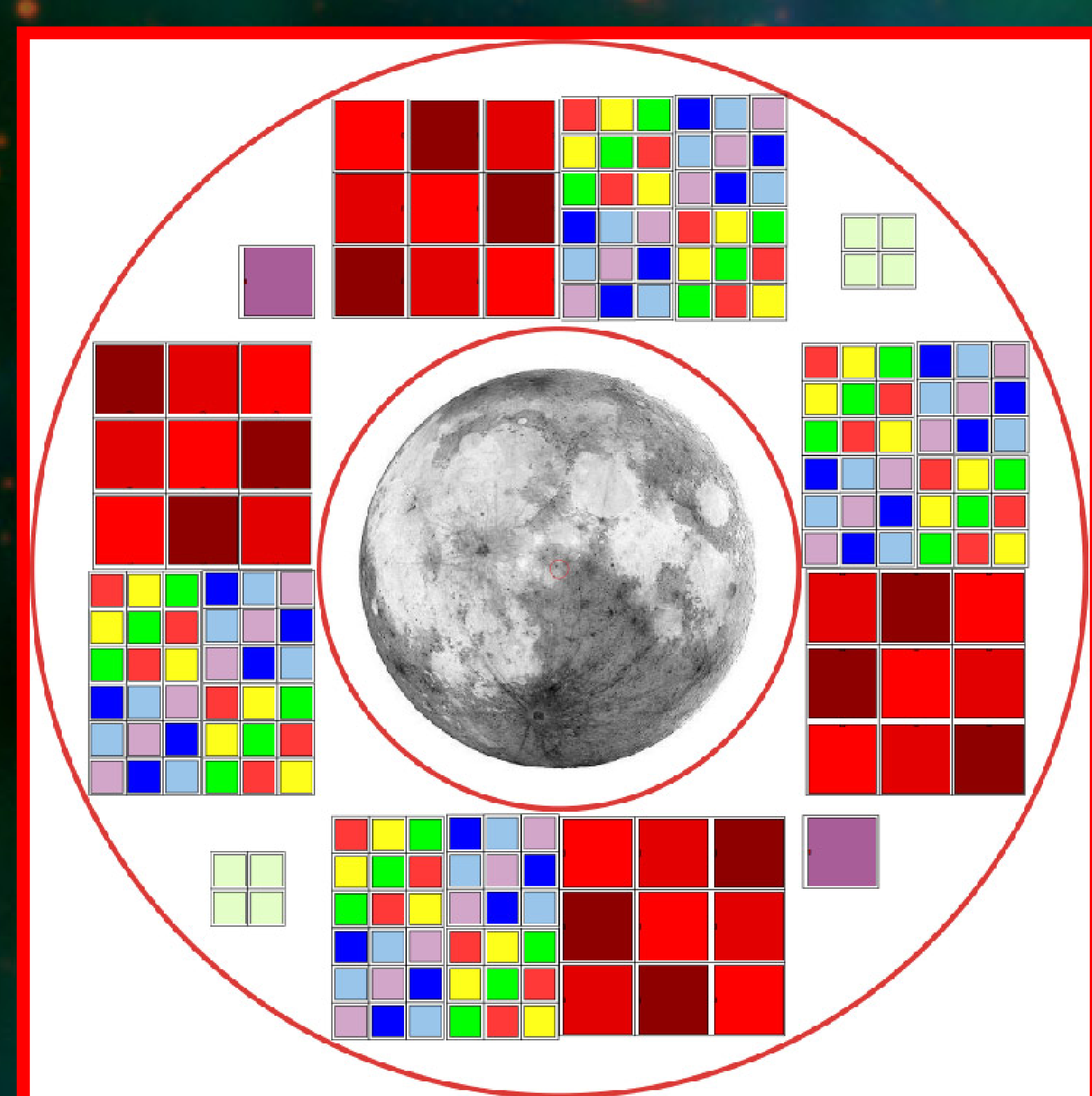
The figure shows the typical exponential increase of dark current with temperature, as well as the low temperature limit. The fit gives the expected Si bandgap, so no new dark current sources are developing.



The measured increase of dark current with radiation dose at 128 K is shown for a one hour dark exposure. The minimum read noise of the CCDs is 2e-. Therefore, dark current of less than 4 e- per exposure has little impact on the CCD performance. Even after the highest irradiation dose, 30 minute exposures meet that benchmark.

The LBNL CCD in Action

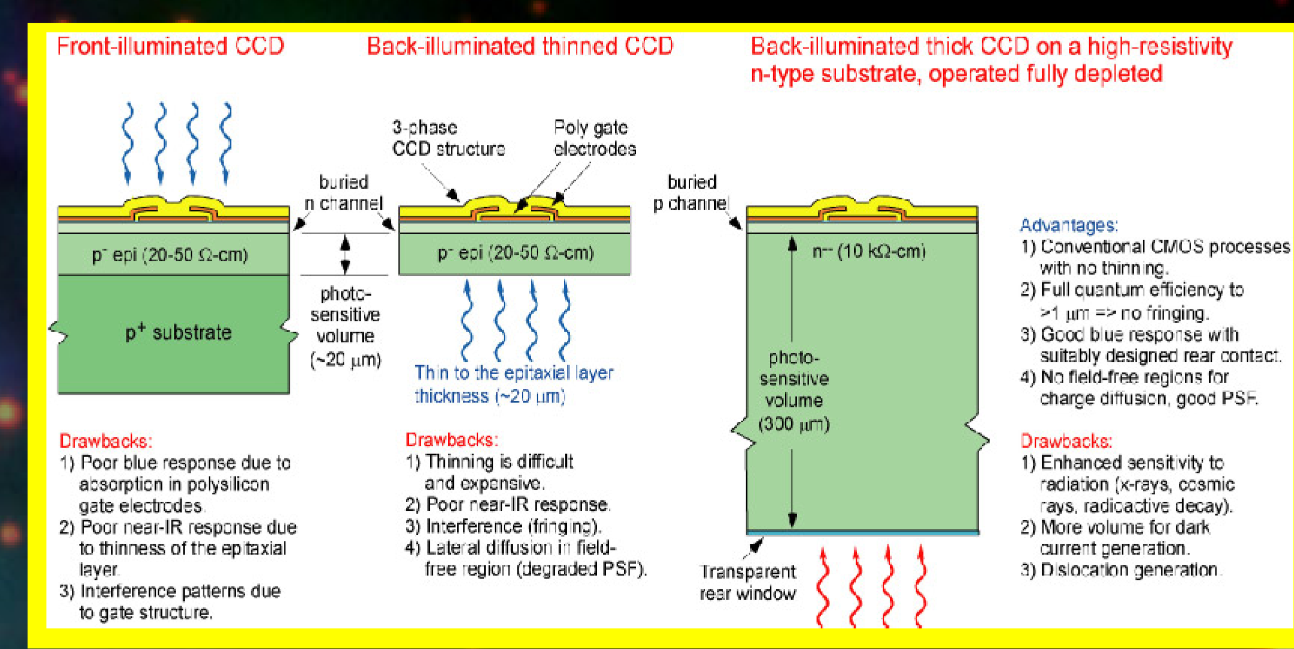
This false color image of the Dumbell Nebula was taken by the 3.5-meter WIYN telescope using the new LBNL CCDs . The image was assembled from images taken through narrow-band filters centered roughly on the Hα (blue) and S III (953.2 nm) emission lines (green), and an intermediate-band filter centered at 1.02 microns that includes emission form He II at 1012.4 nm (red). The background stars, dimmed by foregroud dust, clearly show through in the 1 μm filter image. Courtesy NOAO/AURA/NSF. Copyright WIYN Consortium, Inc.

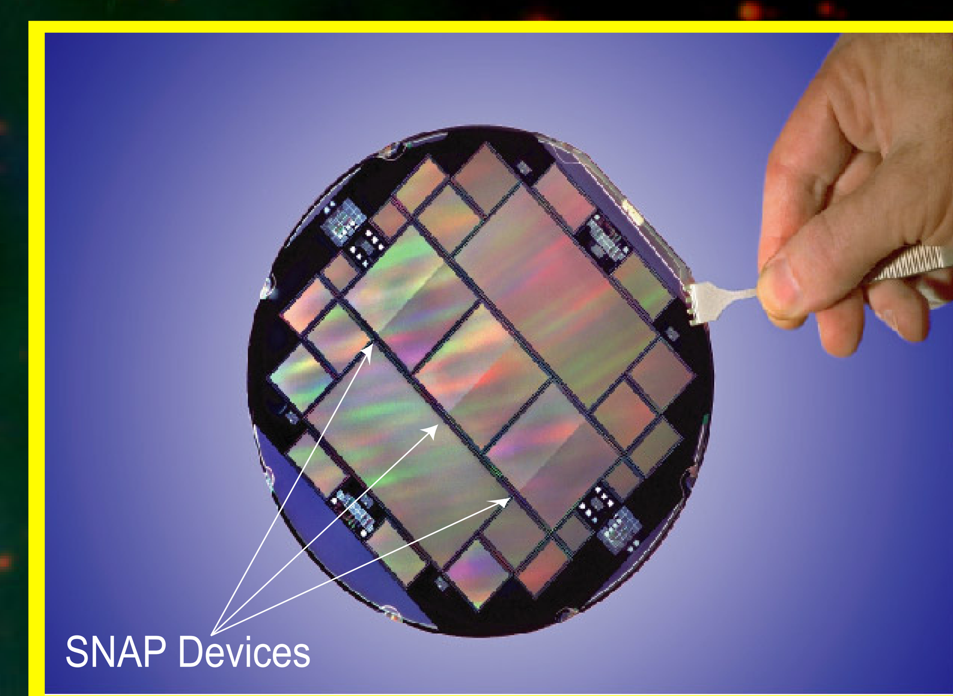


GigaCAM: The SNAP Focal Plane

A key technological innovation in the SNAP instrumentation is a large one billion pixel camera: GigaCAM, the largest and most sensitive astronomical imager ever. The GigaCAM incorporates 144, 1620 x 1620 10.5 μm pixel CCDs and 36+2, 2048 x 2048 18 μm HgCdTe devices. High accuracy multimand photometry is achieved utilizing 10 fixed filters, from 350 -- 1700 nm, on a fixed focal plane. The camera's inner angular radius is 6.0 mrad and the outer radius is 13.0 mrad. In linear dimensions the inner radius is 129.120 mm and the outer radius is 283.564 mm.

Typical CCD Technologies vs. The LBNL CCD Developed by the Supernova Cosmology Project

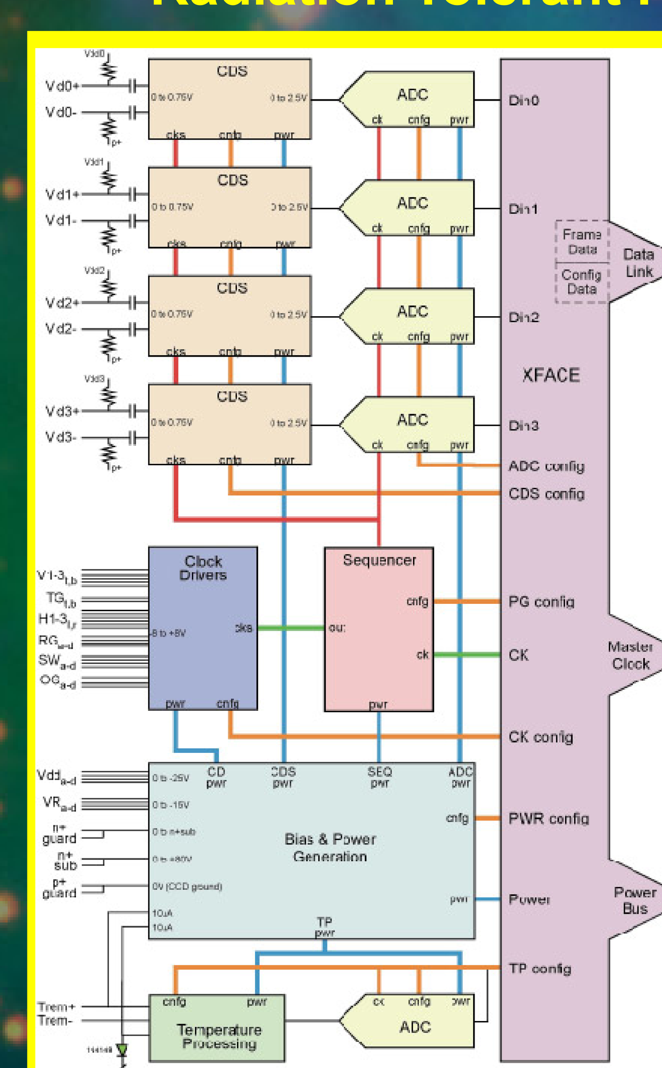




Industrialization of Technology

The LBNL CCD technlogy, layout and recipe were transferred to a commercial foundry. Three candidate SNAP devices, 2880 x 2880 10.5 μm pixels and four corner readout are shown on a processed 150 mm (6 in.) wafer.

Radiation Tolerant Readout Electronics



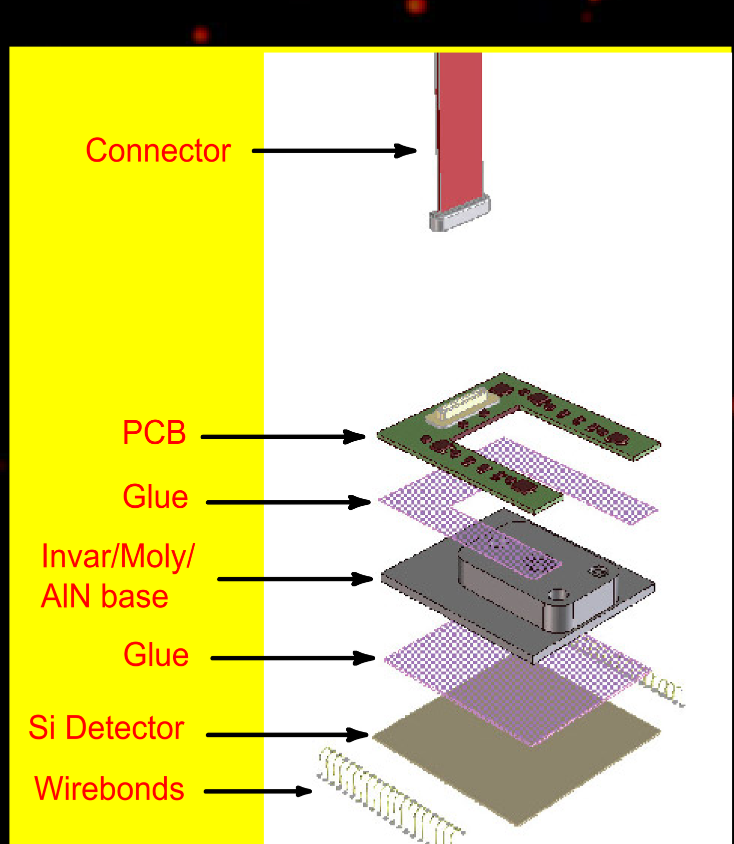
CDS -- Dual ramp correlated double sampler with programmable gain receiver and ADC output buffer used to achieve required readnoise.

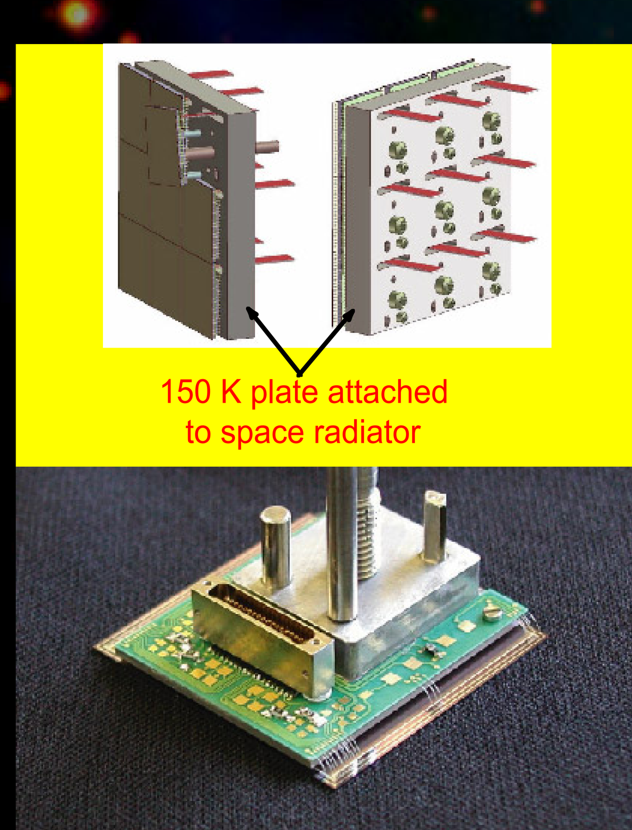
ADC -- 16-bit, 100 kHz equivalent conversion rate per CCD (could be a single muxed 400 kHz unit).

Sequencer -- Clock pattern generator supporting modes of operation: erase, expose, readout, idle.

Clock Drivers -- Programmable amplitude and rise/fall times. Supports 4-corner or 2-corner readout.

Bias and Power Generation -- Provide switched, programmable large voltages for CCD and local power.





CCD Mosaic Packaging

Left Panel: The CCD Packaging supports the CCD while connecting it to the cold plate. The 300 μm thick CCD is four-side abuttable enabling very large mosaics. The packaging incorporates built-in mechanical precision, access to bonding pads, local electronics, a cable connector, low background radiation materials and low chemical reactivity with Si. *Top Right Panel:* With precision CCD modules, precision baseplate, and adequate clearances designed in, the focal plane assembly is "plug and play." *Bottom Right Panel:* 2k x 2k packaging prototype.

GigaCAM Integration