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Quantum efficiency, reflectivity, and point-spread function characterization of LBNL CCD's

Donald E. Groom, Christopher J. Bebek, Maximilian Fabricius, Jessamyn A. Fairfield, Armin Karcher, Natalie A. Roe, and Jens Steckert
(Lawrence Berkeley National Laboratory, Berkeley CA 94720)

A Quantum Efficiency Machine has been developed at Lawrence Berkeley Lab to measure the quantum efficiency (QE) of the novel CCD's described in other presentations at this Symposium. It is conventional, but with significant innovations. The most important of these is that the reference photodiode (PD) is coplanar with the cold CCD inside the dewar. The PD is on a separate heat sink regulated to the PD calibration temperature. The effects of geometry and reflections from the dewar window are eliminated, and since the PD and the CCD are observed simultaneously, light intensity regulation is not an issue. A ``dark box" provides space between the exit port of the integrating sphere and the CCD dewar, ensuring nearly uniform illumination. It also provides a home for a reflectometer and spot projector.

The measurement of reflectivity (R) is essential for corroborating the QE measurements, since QE \leq 1-R everywhere, and QE = 1-R over much of the spectral region. R does not depend on the CCD readout gain or the calibration accuracy of the reference PD. In our reflectometer the light monitor and the CCD carriage are both moved so that no extra mirrors are introduced.

The intrinsic point-spread function of a CCD is limited by transverse diffusion of the charge carriers as they drift to the potential wells, driven by the electric field produced by the substrate bias potential---hence a bias that is normally several times that needed for total depletion. A precision spot projector fed by the monochromator is installed in the dark box for the measurements. An rms width of 3.7\pm0.2 um is obtained for the 200-um thick SNAP CCD's biased at 115 V, thus meeting the SNAP design goals. The result agrees with simple theory once the electric field dependence of carrier mobility is taken into account.