CCD Characterization and Modeling at UC Davis

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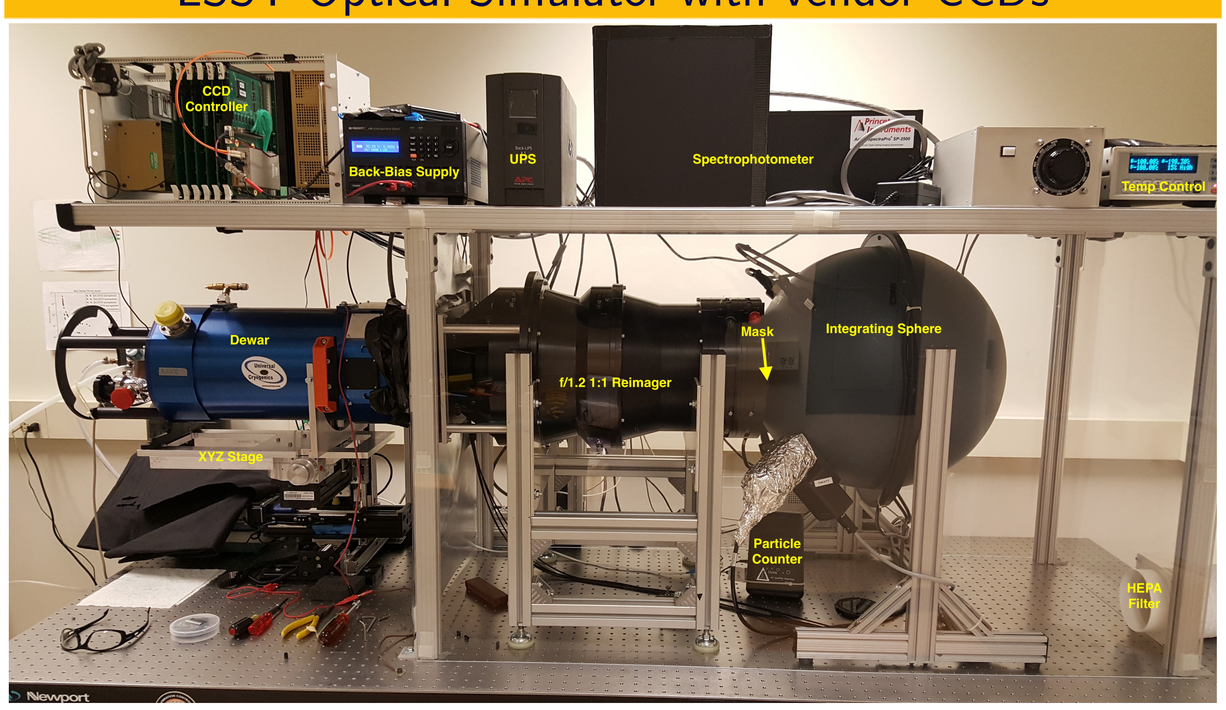
Overview

The LSST Optical Simulator at UC Davis allows us to characterize CCDs from both LSST vendors on a common platform in a variety of ways, as detailed in the accompanying plots.

- **Masks containing artificial stars as well as extended objects have been fabricated and imaged.**
- **Simulation code for simulating the electrical fields and electron paths in the CCDs has been built and calibrated using data from the optical simulator.**

LSST Optical Simulator with vendor CCDs

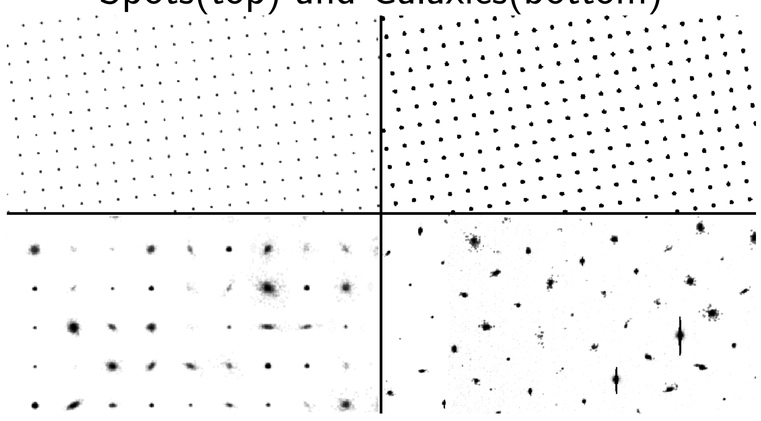


ITL 3800C

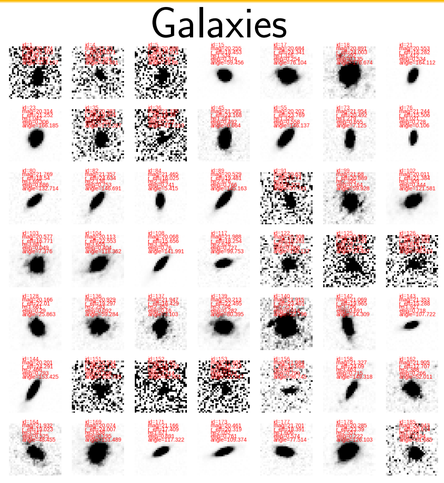
E2V CCD250

Artificial stars and galaxies

Spots(top) and Galaxies(bottom)



Galaxies

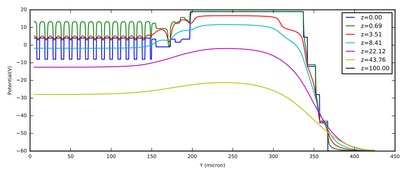


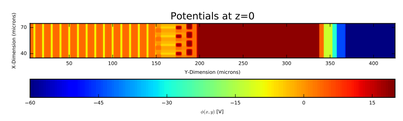
Extended objects are built on the mask with $0.5\mu\mathrm{m}$ "sub-pixels".
400 of these per $10\mu\mathrm{m}$x$10\mu\mathrm{m}$ CCD pixel.
Size, brightness, orientation, and Sersic profiles are varied.

Astrometric shift at CCD edge

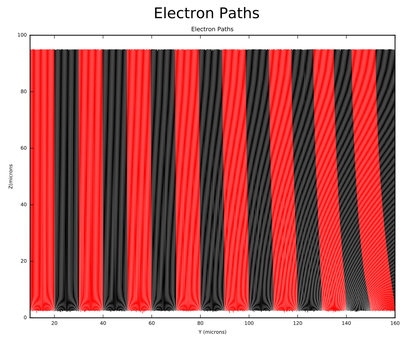
Potentials

Potentials. Grid = 128*1344*320.

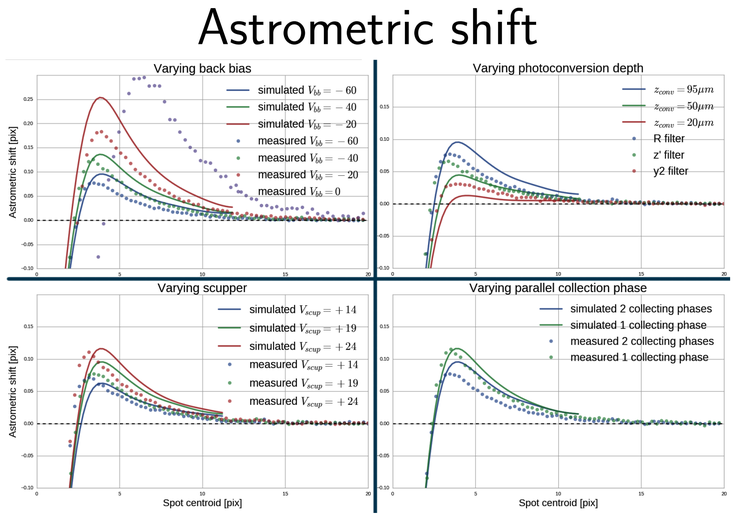




Electron paths



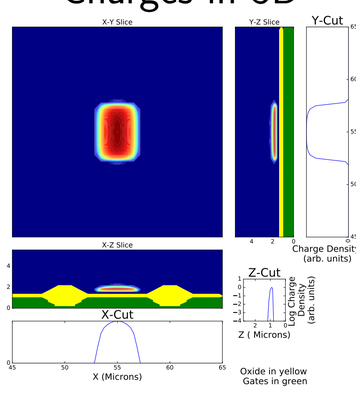
Astrometric shift



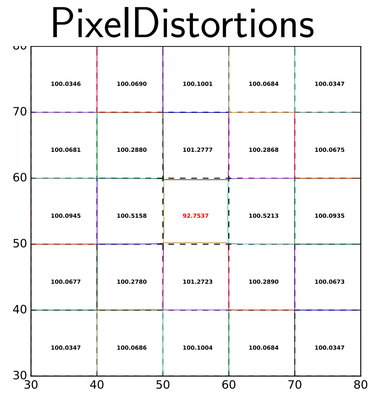
Simulation captures shape, location, and variation with voltages.

Pixel distortions and correlations

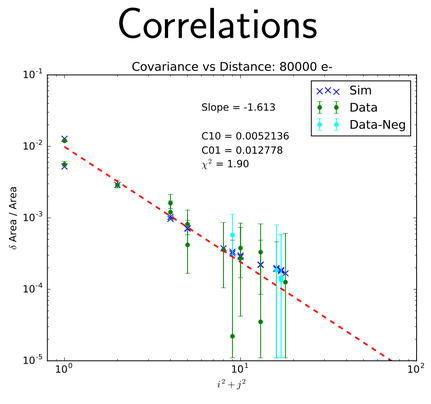
Charges in 3D



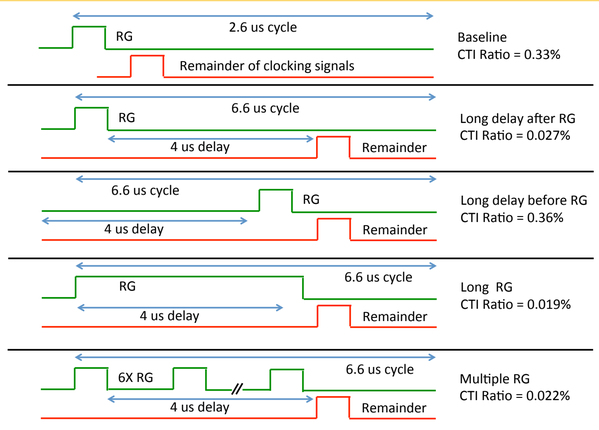
PixelDistortions

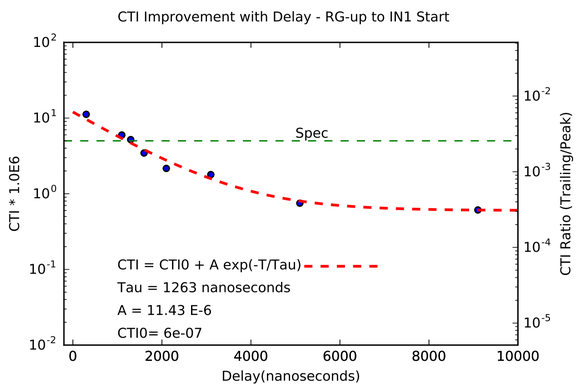


Correlations



Serial CTI improvement with delay (ITL)

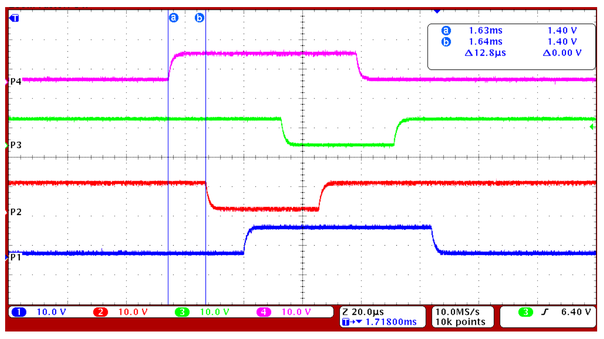




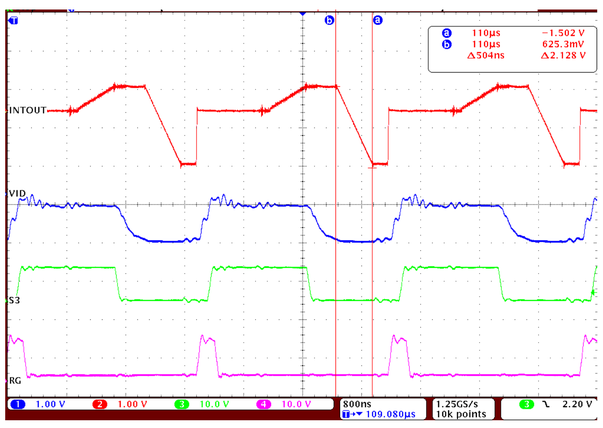
Impact of increasing delay on the serial Charge Transfer Inefficiency(CTI) for the STA3800, as measured using the EPER method.

CCD timing waveforms (E2V)

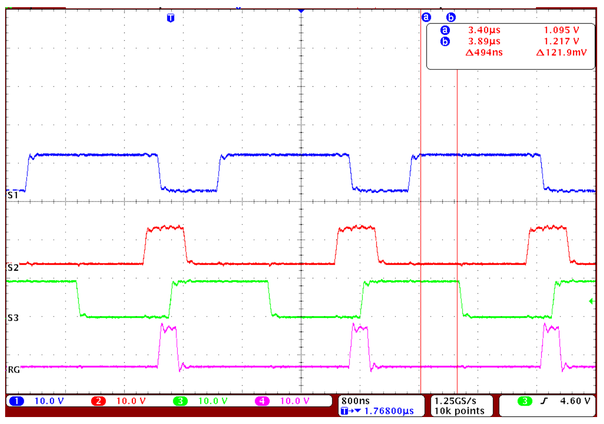
Parallel Clocks



Video



Serial Clocks



Serial cycle time 2.6 μsec.
Flat at 50% full well.
VID is the video signal
INTOUT is the DSI capacitor.

References and Code

References

- Tyson, J.A., et.al., "LSST optical beam simulator", SPIE Conference Series, V 9154, 2014, http://arxiv.org/abs/1411.5667.
- Bradshaw, A.K., et.al., "Mapping charge transport effects in thick CCDs with a dithered array of 40,000 stars", JINST, V10, Apr, 2015.
- Lage, C, et.al., "Measurements and Simulations of the Brighter-Fatter Effect in CCD Sensors", JInst, V12, PC03091, 2017, http://arxiv.org/abs/1703.05823.
- Bradshaw, A.K., et.al., "Characterization of LSST CCDs Using Realistic Images, Before First Light", 2017, http://arxiv.org/abs/1808.00534v1.

Code

- Poisson solution simulator for LSST CCD's, https://github.com/craiglagegit/Poisson_CCD22
- Python based GUI control software for the UC Davis LSST optical simulator, https://github.com/craiglagegit/LSST_GUI
- Code for building masks with simulated stars and galaxies, https://github.com/craiglagegit/MaskCode