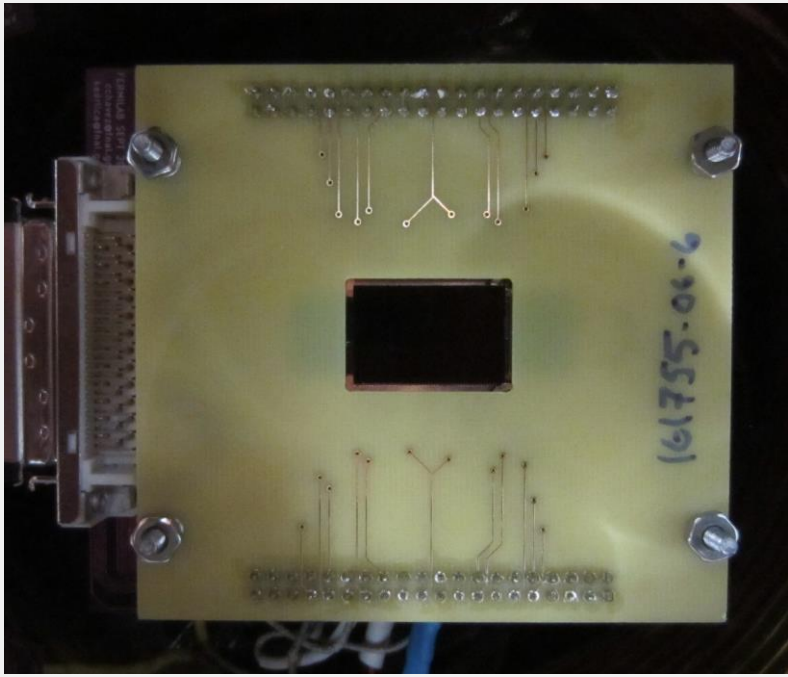
Skipper CCDs for Cosmological Applications



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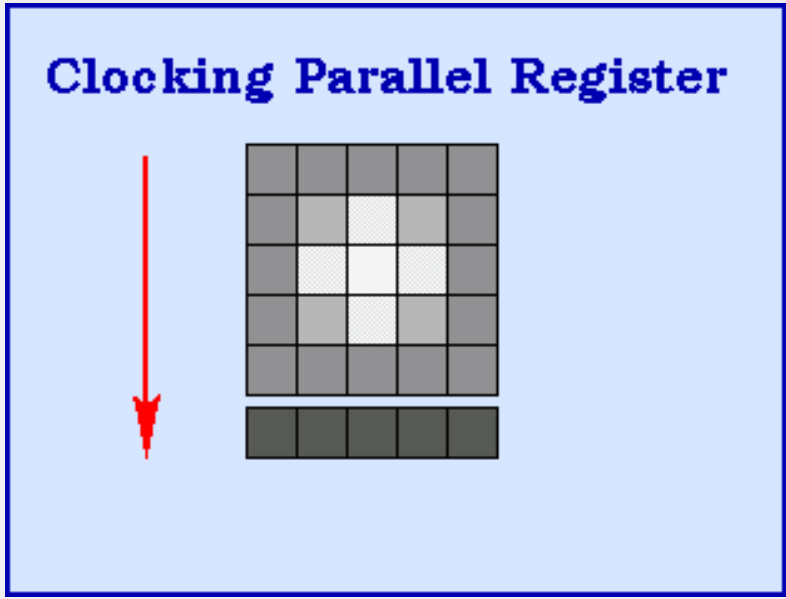
2020 Illinois URM Physics Workshop
November 17, 2020

Fermilab

THE UNIVERSITY OF CHICAGO

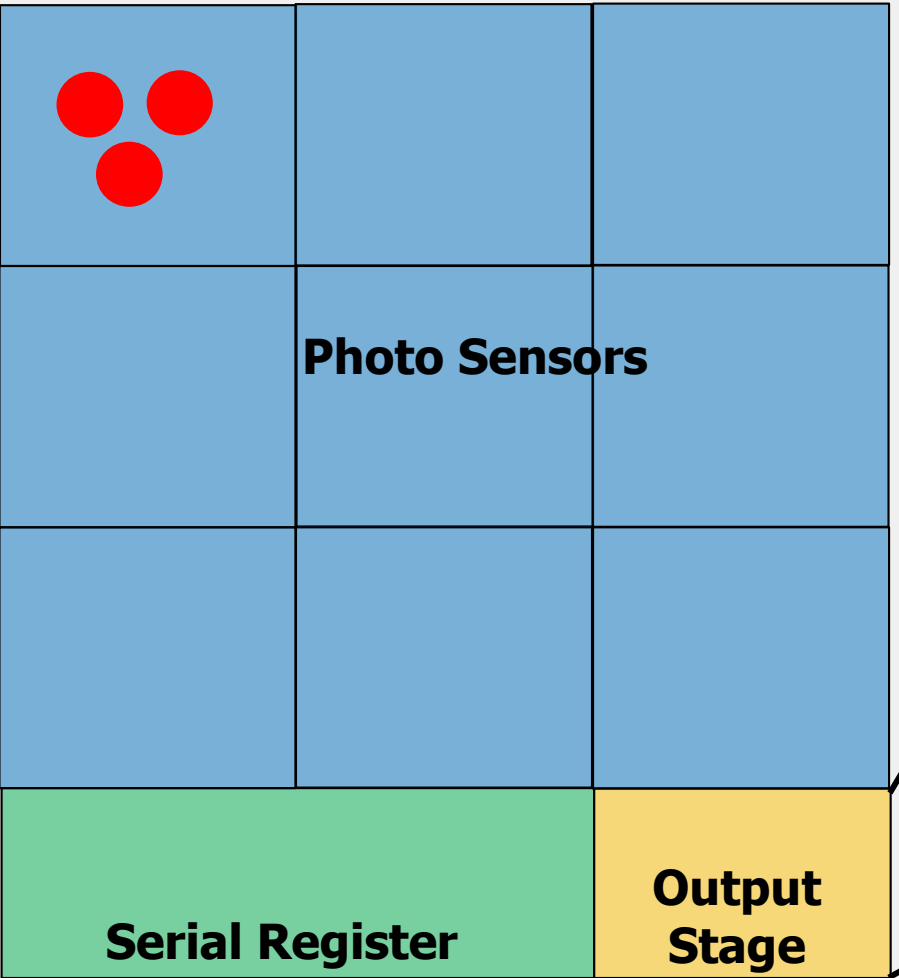
The Skipper CCD

- Charged-coupled devices (CCDs) rely on the photoelectric effect to absorb photons and produce charges (electron-hole pairs) [1].
- Cosmic surveys aim to understand the fundamental physics that governs dark matter.
- To better understand the dark sector, we need to measure fainter and more distant astronomical systems [2].
- Electronic readout noise limit precision measurements $(\sim 2e^{-}\mathrm{rms/pix})$ [3]

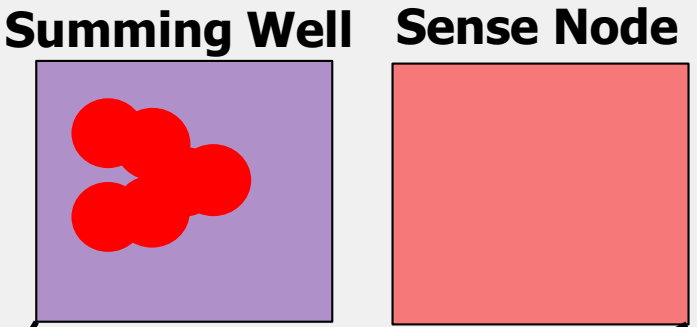


[1] Amelio, G. F., et al. Bell Syst. Tech. J. 49, 593-600 (1970). [2] Ethan, O. N., et al arXiv:1904.10000 (2019).[3] Holland, S. E. et al. IEEE Transactions on Electron Devices 50, 225-238 (2003).

The Skipper CCD

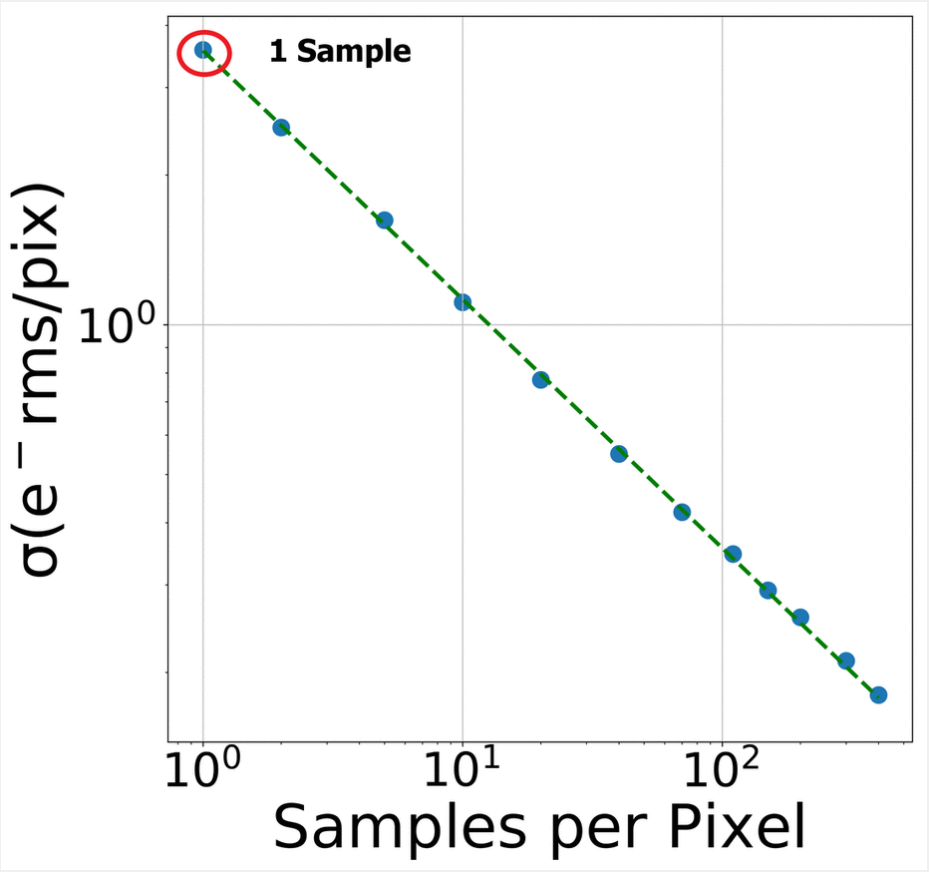


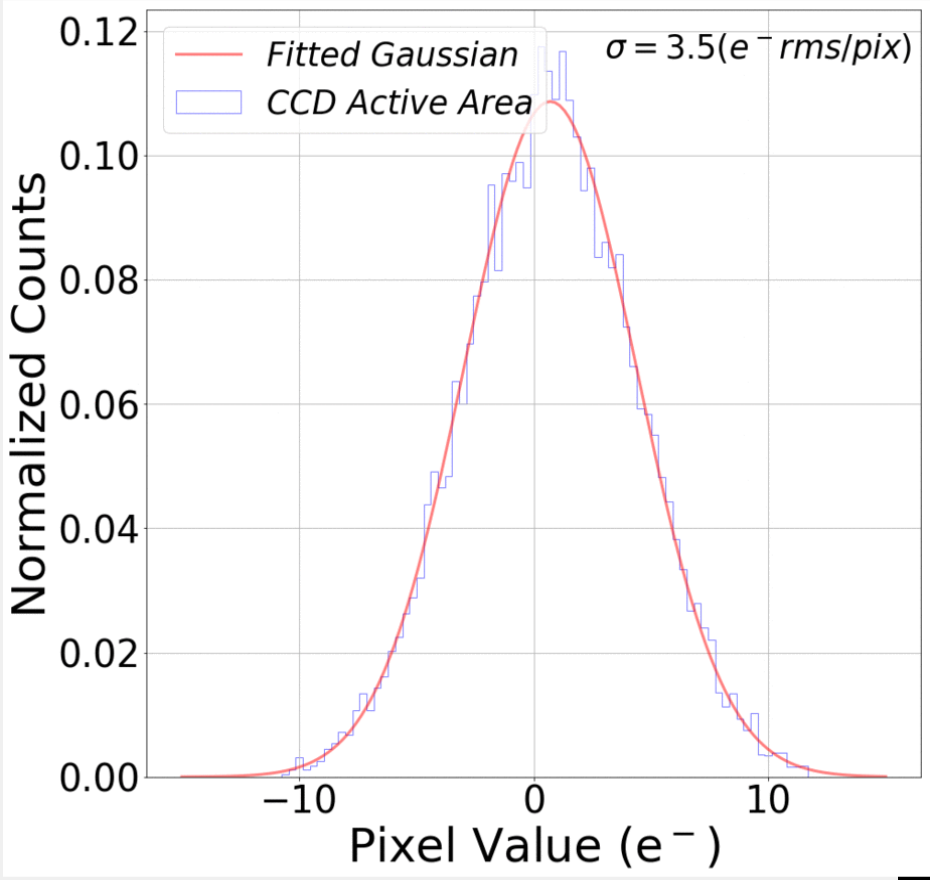
Skipper use a floating gate output + small-capacitance sense node to perform independent, non-destructive measurements of the charge in each pixel $(< 0.04 e^{-} rms/pix)$ [4].



[4] Cancelo, G., et al. arXiv:2004.07599 (2020)

Readout Noise Results



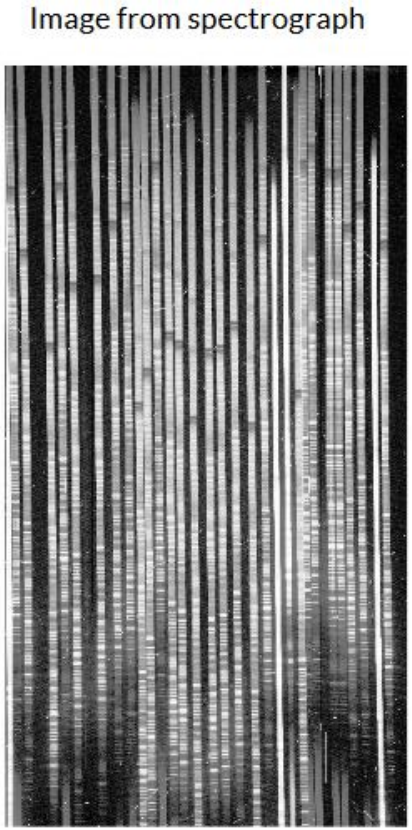


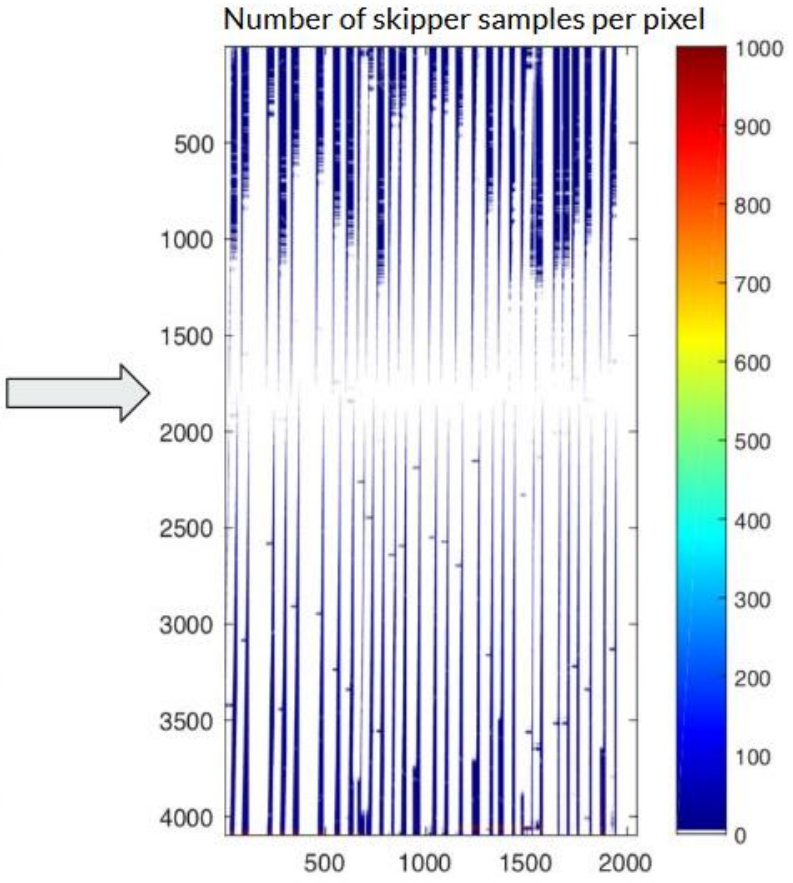
$$\sigma_{400} = 0.18\ e^-$$

Applications

Spectroscopy:

- Regions of interest in the spectrograph are known a priori.
- Faster readout
- Observations of faint objects in the low-signal-to-noise, low-background regime (stellar systems)





Future Goals

- Laboratory and on-sky tests of spectrographs
- New CCD fabrication and testing