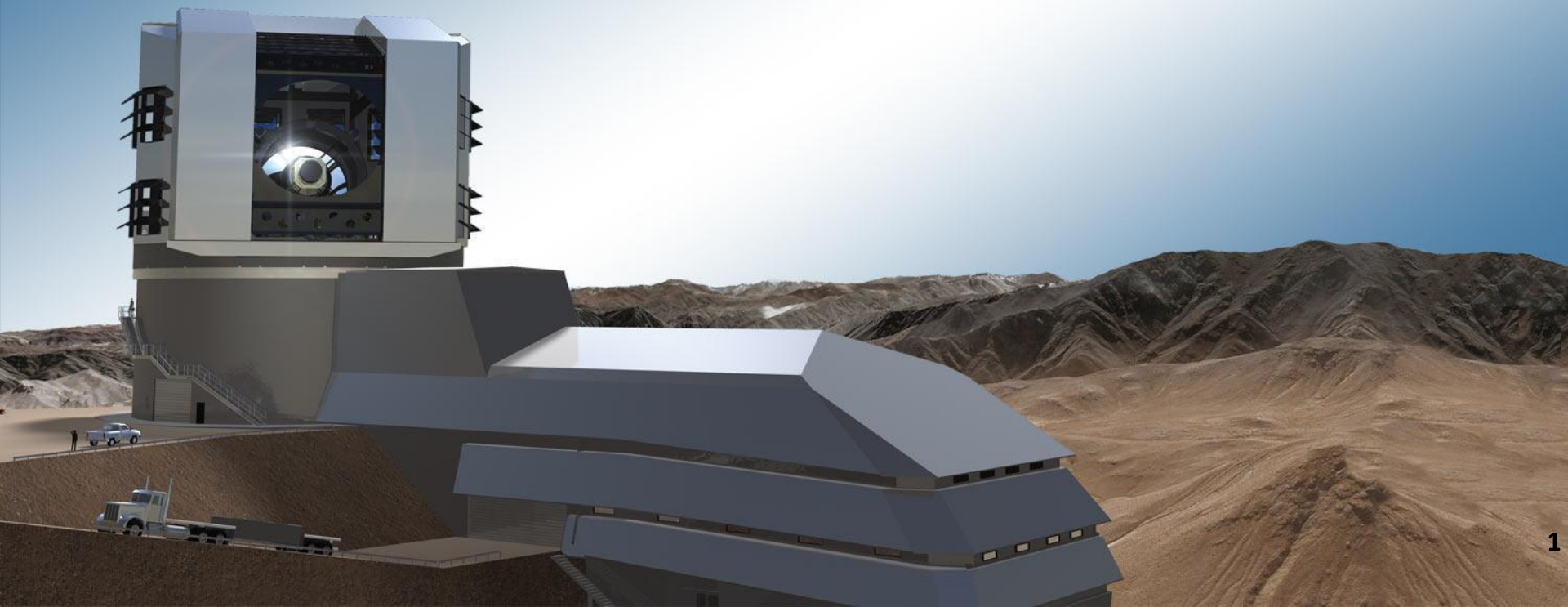




Deferred Charge and Serial Traps

Adam Snyder
LSST PCW 8/13/2019



Effects dependent on number of transfers:

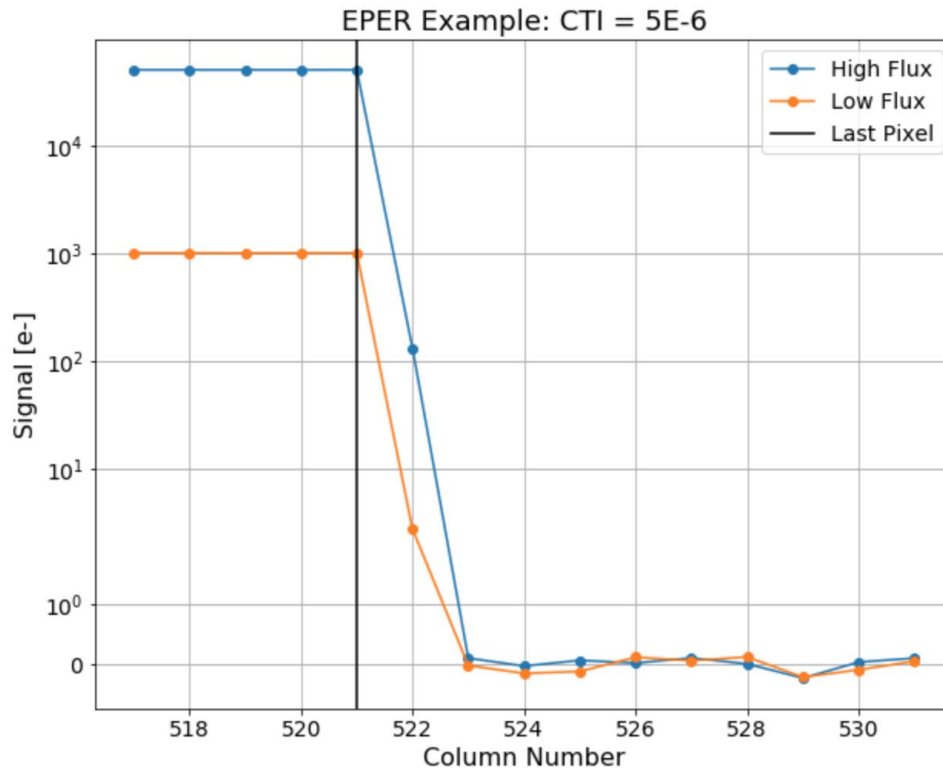
- Transfer due to self-induced drift, fringing fields, and diffusion
- Uniformly distributed single electron traps
 - Bulk traps
 - Radiation-induced traps

Effects independent on number of transfers:

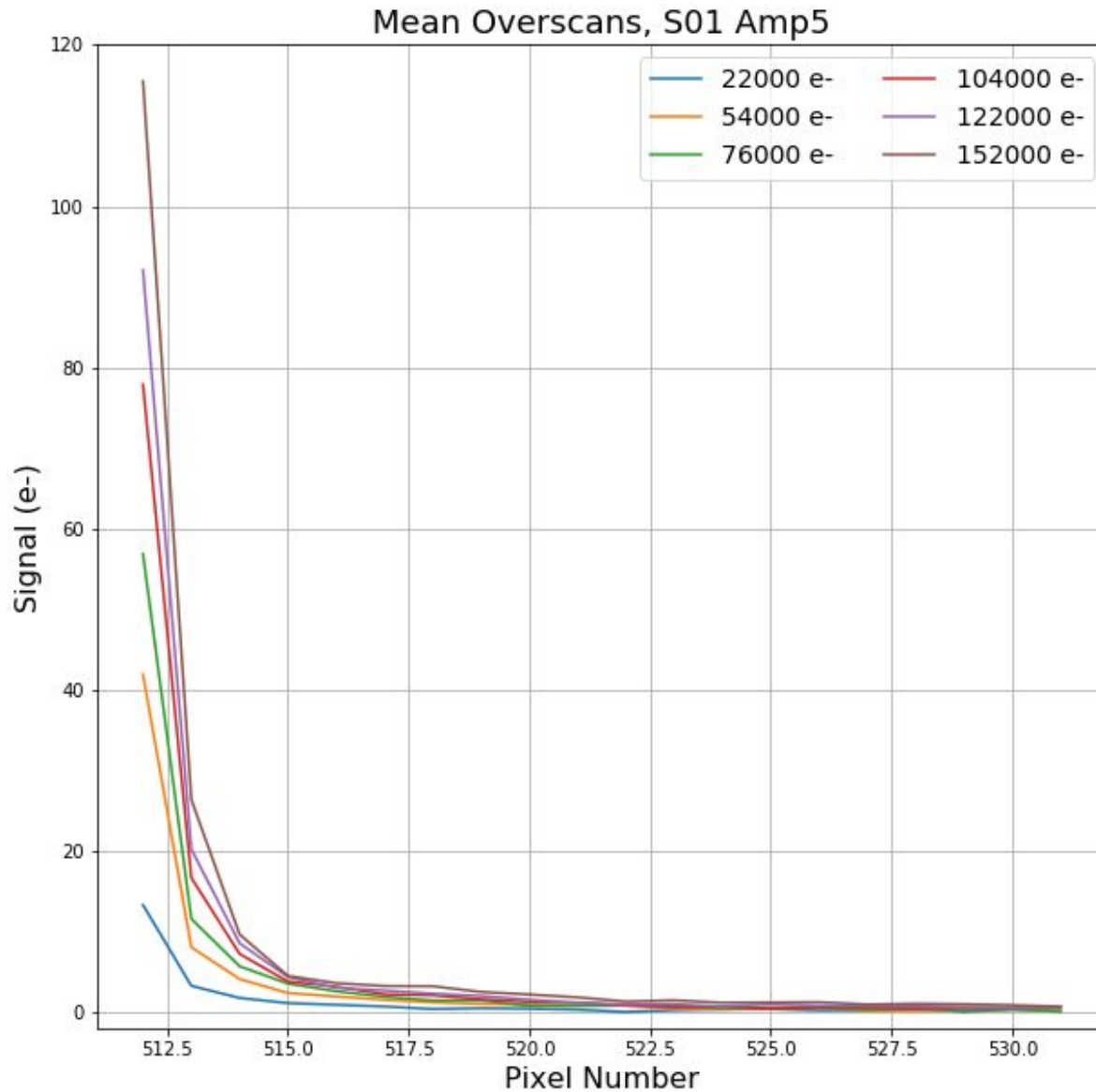
- Design traps - fixed charge loss of up to $O(100)$ e-
- Process traps - fixed charge loss of $O(10)$ e-
- Electronic effects
 - Drifting bias offset
 - Incomplete reset of the sense node

Charge Transfer Inefficiency (CTI) - ratio of electrons not transferred between two pixels, to the total electrons before the transfer.

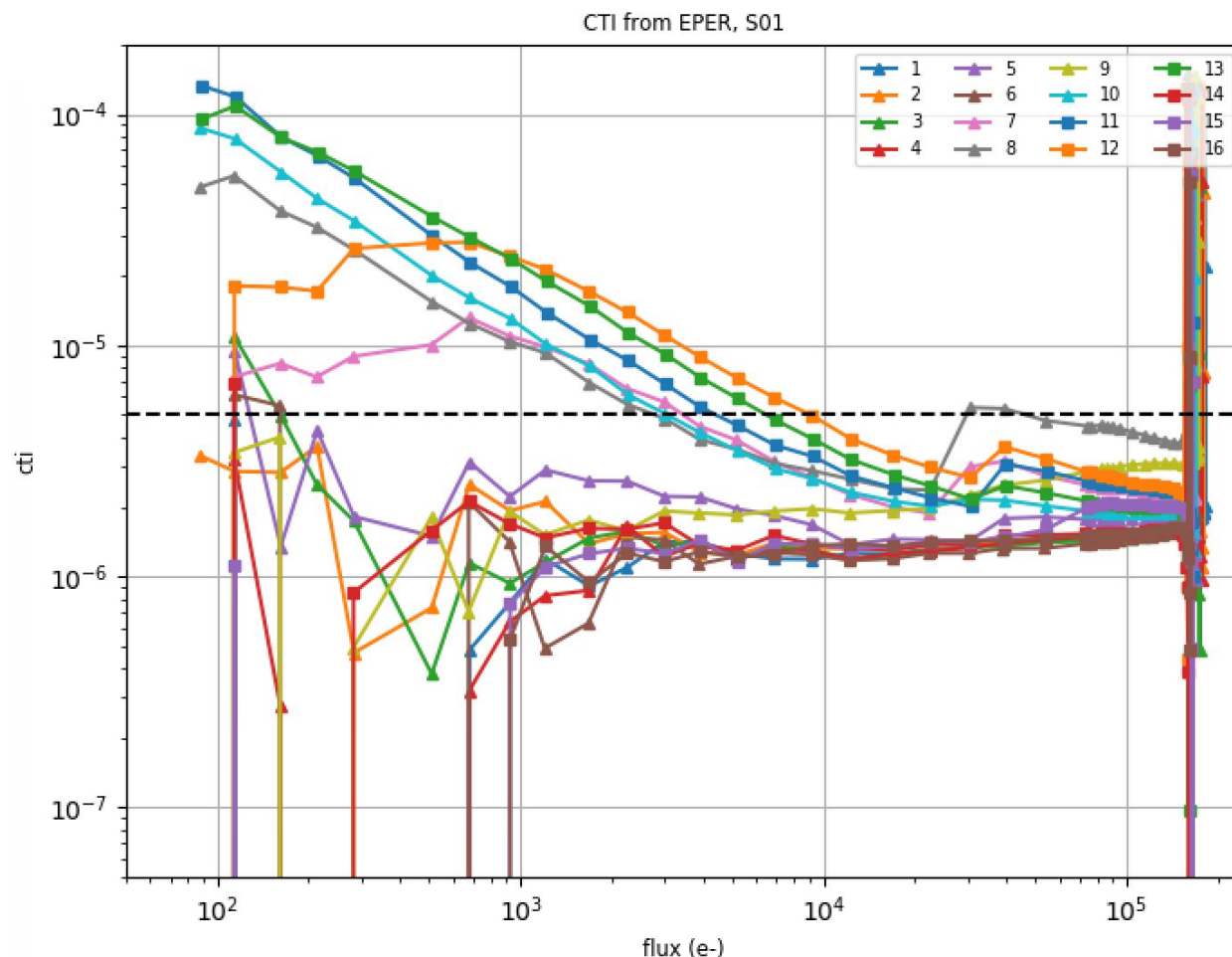
Extended Pixel Edge Response (EPER) - measurement of deferred charge in the overscan pixel region, after a flat field image.



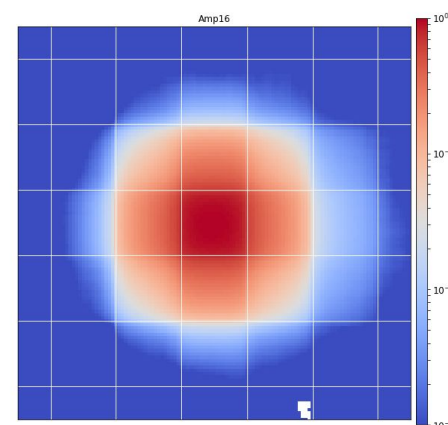
$$CTI = \frac{S_{\text{overscan}}}{N_T S_{\text{lastpixel}}}$$



At high fluxes, deferred charge signal measured in overscan traces.



Aggregated Fe55 Profile:



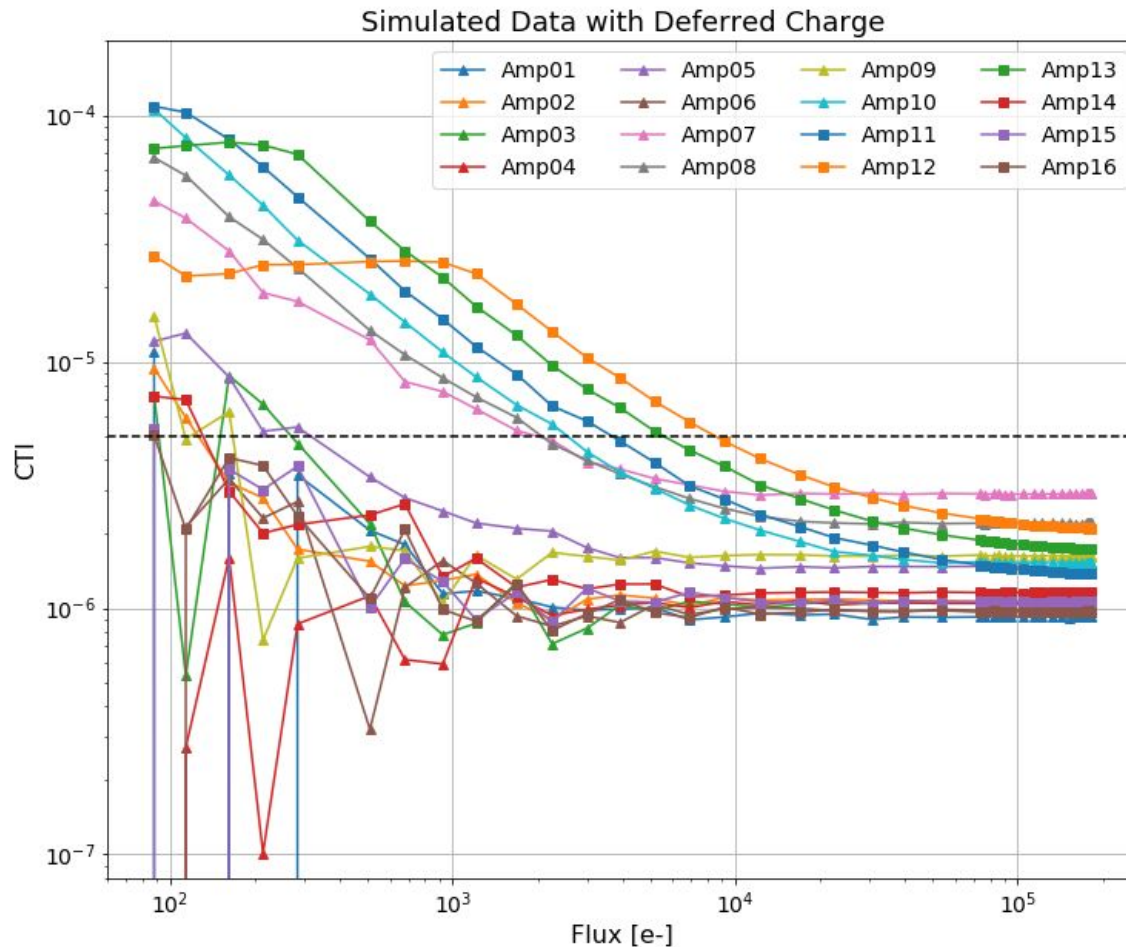
At low fluxes, significant deferred charge is measured in several CCD amplifier segments.

Can this effect be modeled/simulated/corrected?

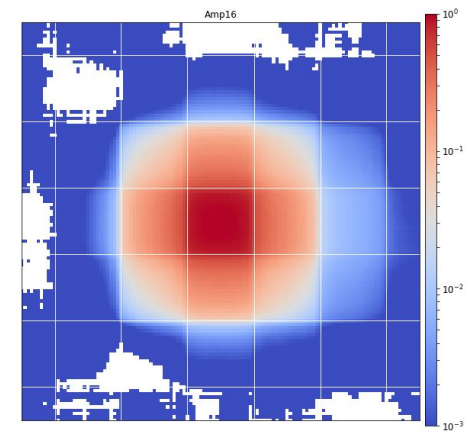
CTI Correction (R. Massey 2009)

- True Image = I
- Image after readout = $I + \delta$ (A)
- Image after additional readout = $I + 2\delta + \delta^2$ (B)
- (A) + (A) - (B) = $I - \delta^2$ (C)
- After additional readout = $I + \delta - \delta^2 - \delta^3$ (D)
- (A) + (C) - (D) = $I + \delta^3$ (E)

Additional considerations needed for noise correlations introduced by repeated simulated serial transfers.



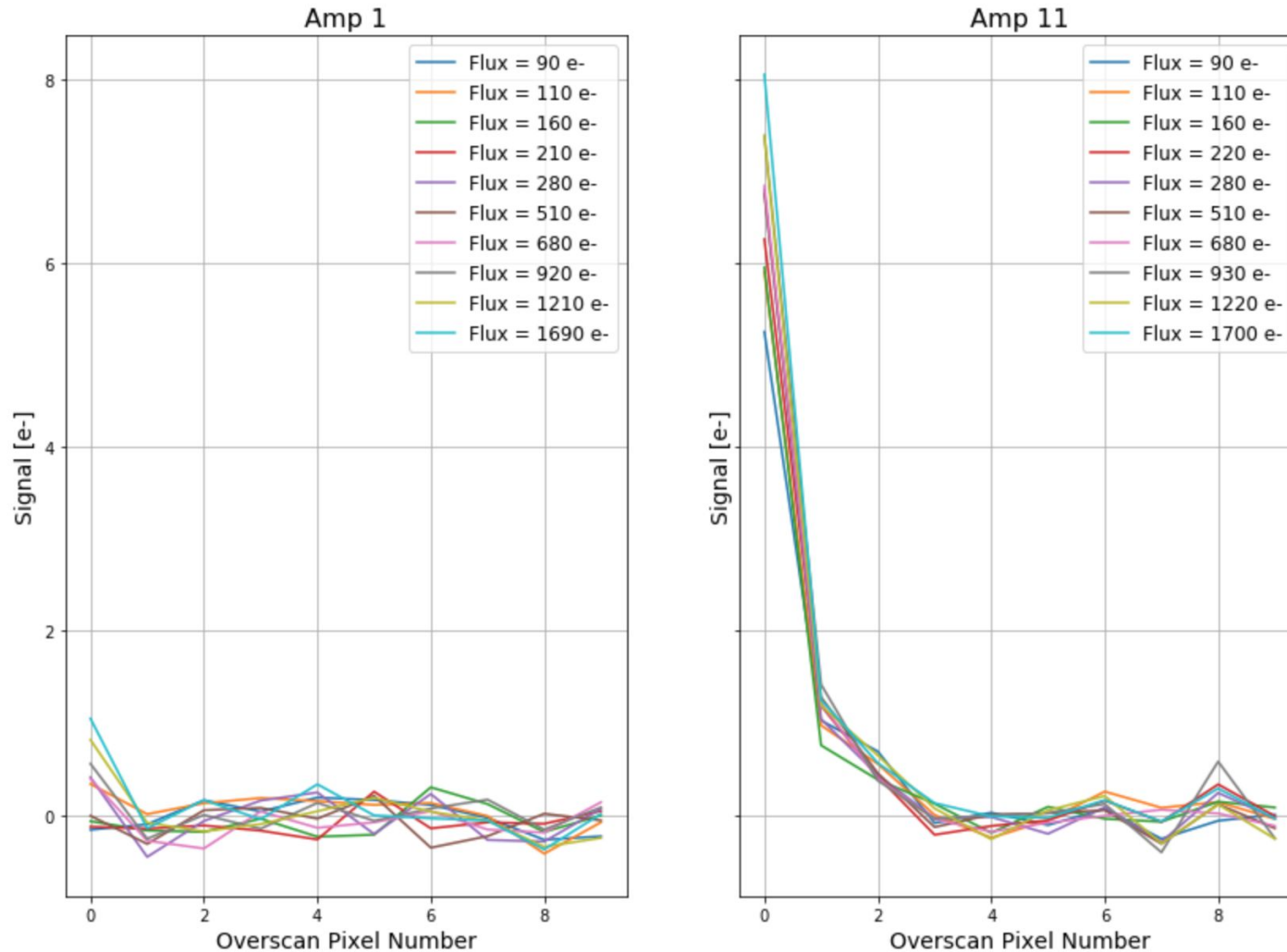
Aggregated Fe55 Profile:



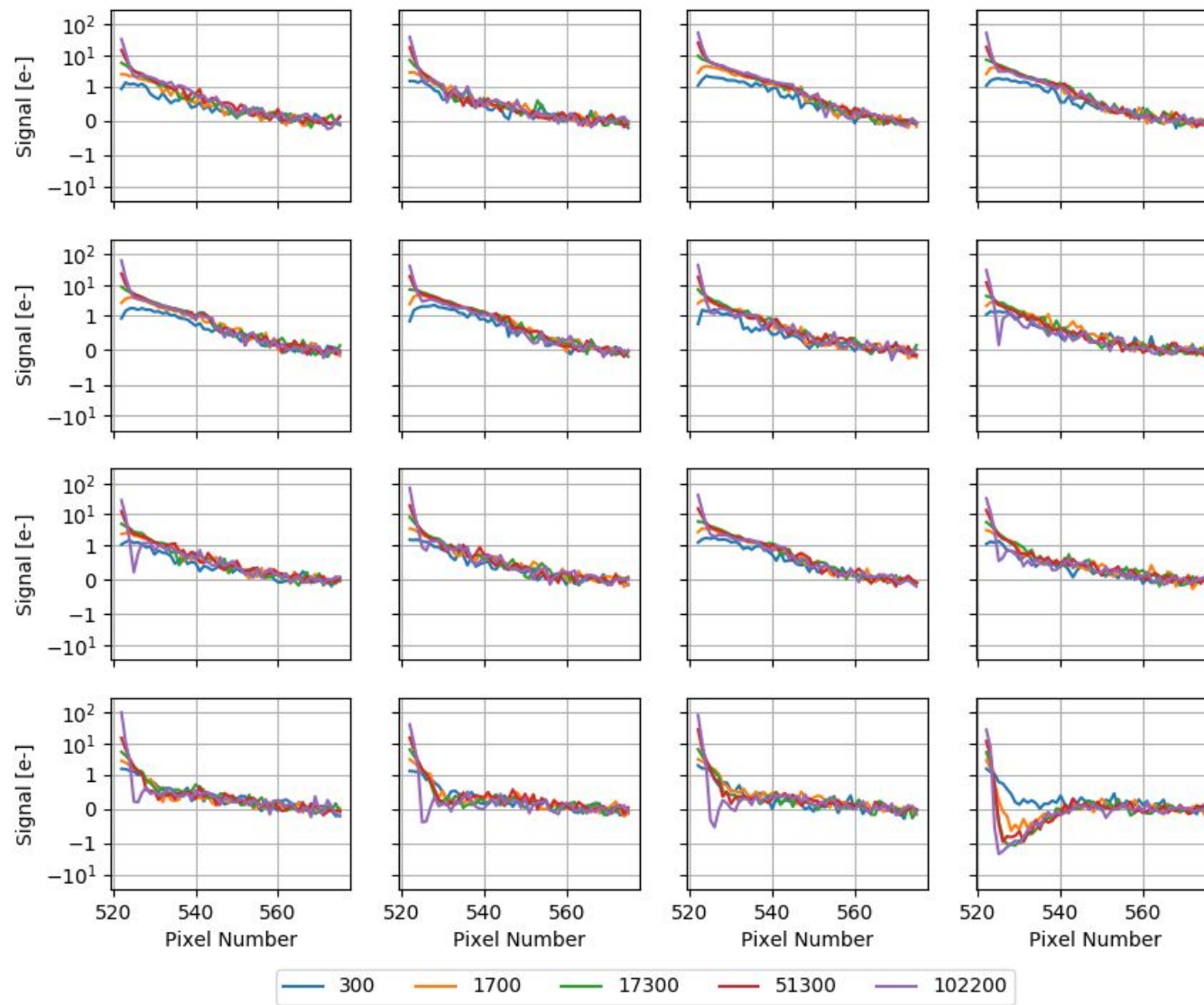
Simulate images with serial readout including:

- Pixel-to-pixel percentage charge inefficiency
- Serial register trapping (MCMC determined trap parameters)

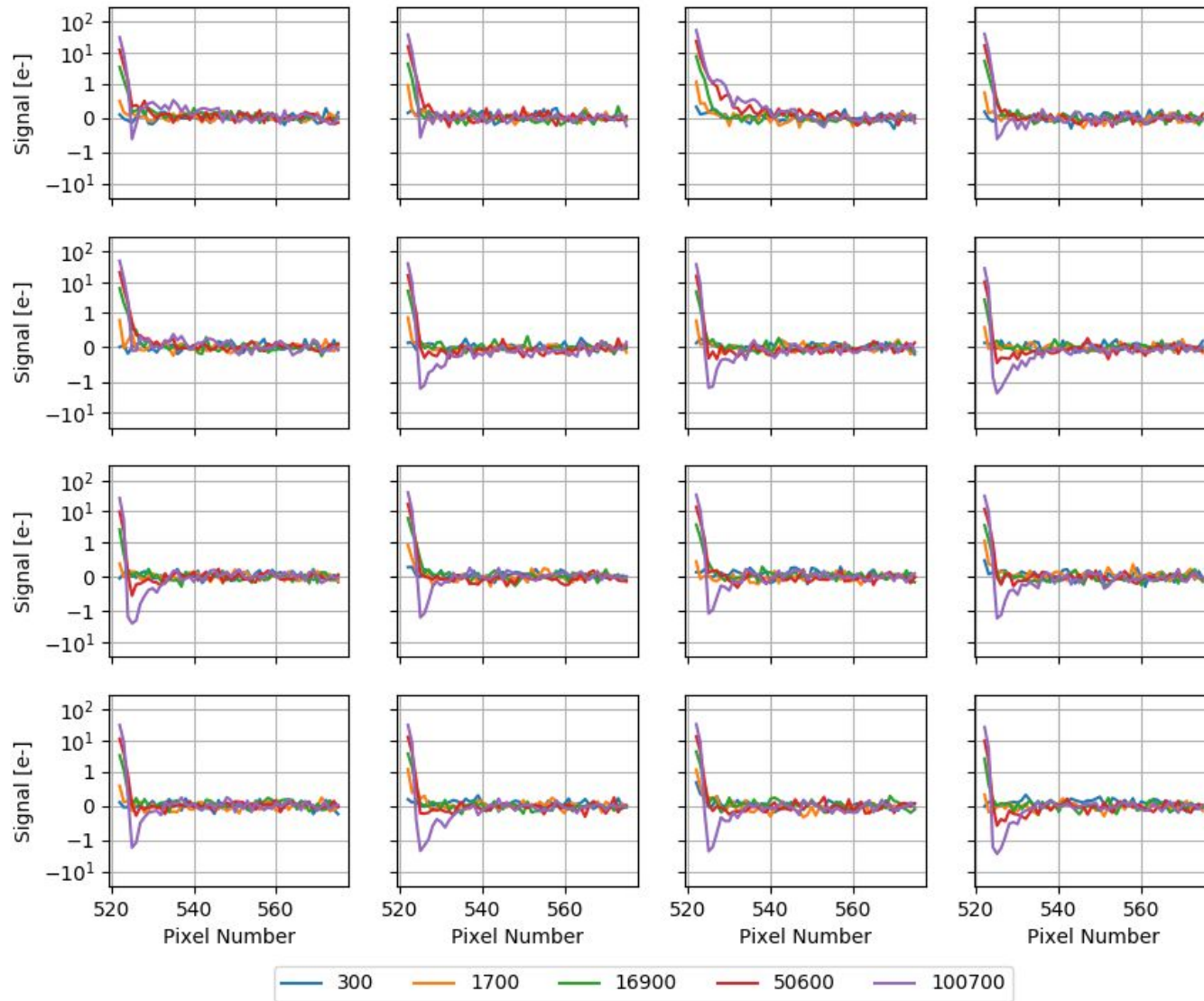
Back-Up Slides



Comparison of two amplifiers, showing large CTI discrepancies at low flux.



Deferred charge signal initially seen in overscan traces.



Adjusting reset gate voltage removes signal (but negative bounce remains).