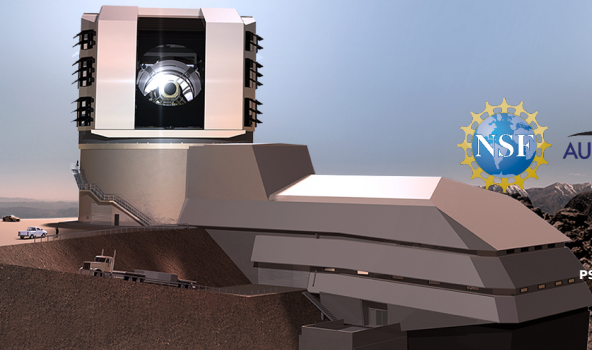
Rubin Observatory

ISR: DM and Camera

Robert Lupton, Princeton University
LSST Pipeline/Calibration Scientist

2020-08-19



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- Camera: Jim Chiang, Aaron Roodman, Seth Digel, Adam Snyder, Yousuke Utsumi, . . .
- ComCam: Brian Stalder, Kevin Reil, . . .
- UC Davis: Craig Lage, Tony Tyson, . . .

Introduction

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E.g. in writing this talk I used Andrés's page https://confluence.lsstcorp.org/display/DM/Sensor+Characterization+and+ISR which is informed by discussions at the SAWG and Camera Verification meetings

Flux levels

$$N_{\text{photon}} = \frac{15.09}{R}\left(\frac{S_\nu}{\mu\text{Jy}}\right)\left(\frac{t}{\text{s}}\right)\left(\frac{A}{m^2}\right)$$

In a 30s Rubin exposure, a 1μ Jy source produces *c.* 3000 counts; 1 ADU/pixel is *c.* 29.1 AB asec^{-2}.

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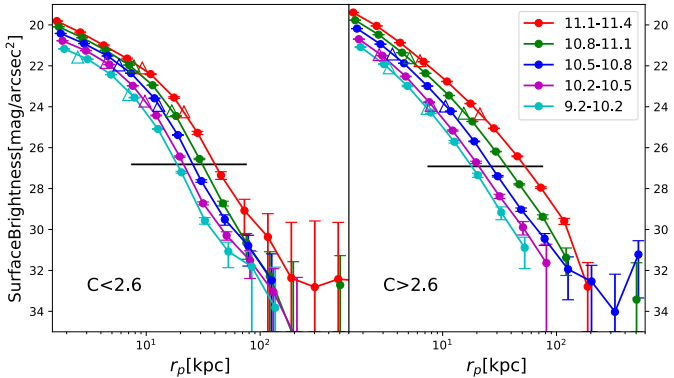

HSC *r*
Wang *et al.* 2019
arXiv:1811.04714

ISR as of 2019-07

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- saturation and suspect pixel masking
- overscan subtraction
- CCD assembly of individual amplifiers
- bias subtraction
- variance image construction
- linearization of nonlinear response
- crosstalk correction
- mask defects, edges, nans, etc.
- brighter-fatter correction
- dark subtraction
- fringe correction
- stray light subtraction
- flat correction
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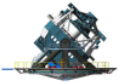

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Bias and Overscan

DM subtracts an overscan-corrected 2-D master bias with mean ~ 0, and an offset estimated from the overscan.

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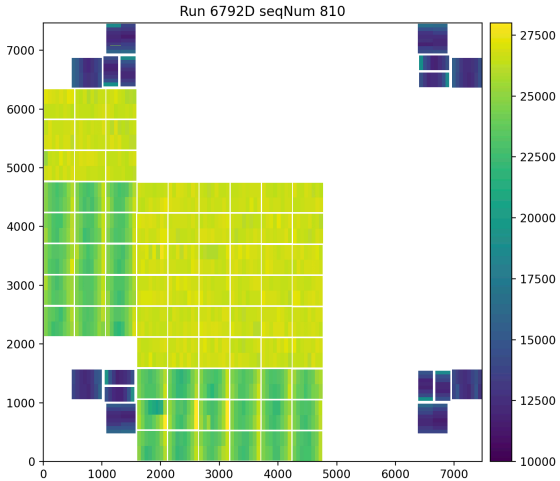
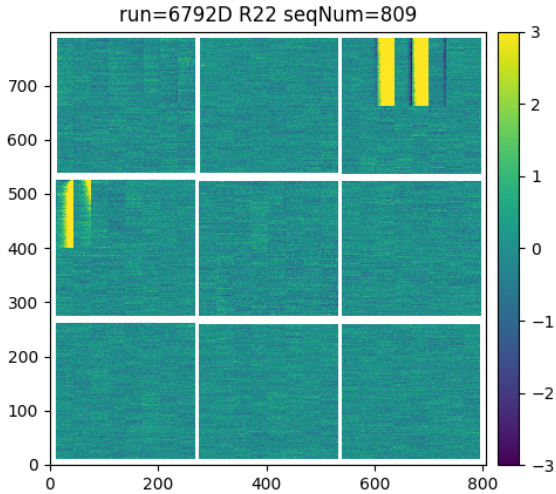


Run 6792D, Raft R22 (bias, oscan per-row)



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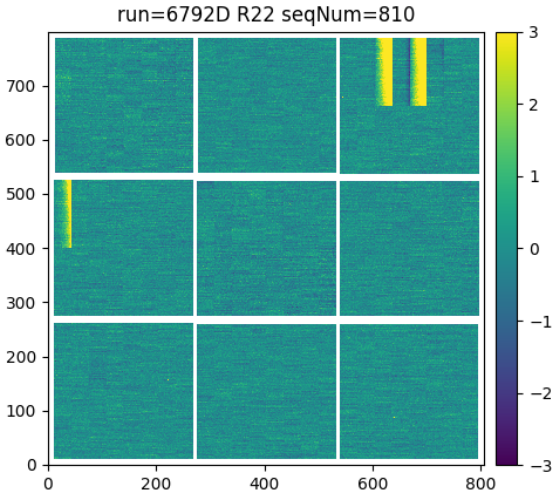

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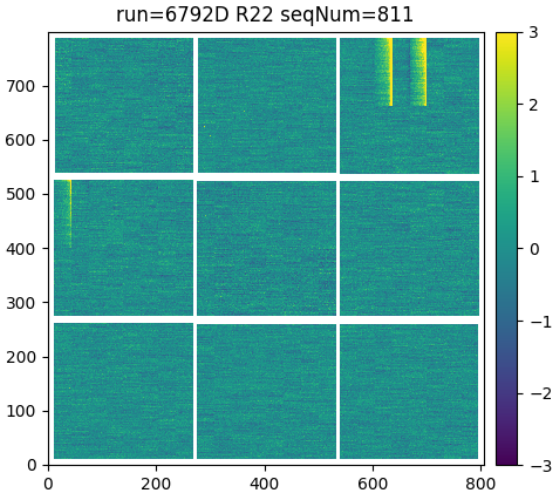

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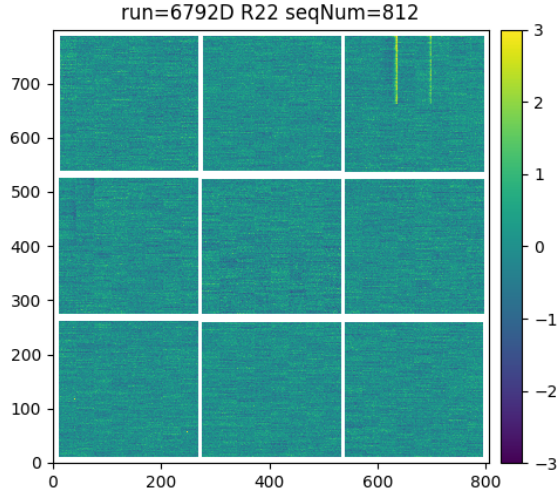

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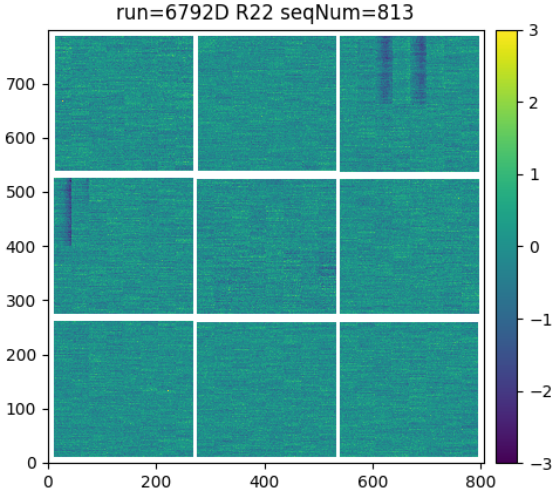

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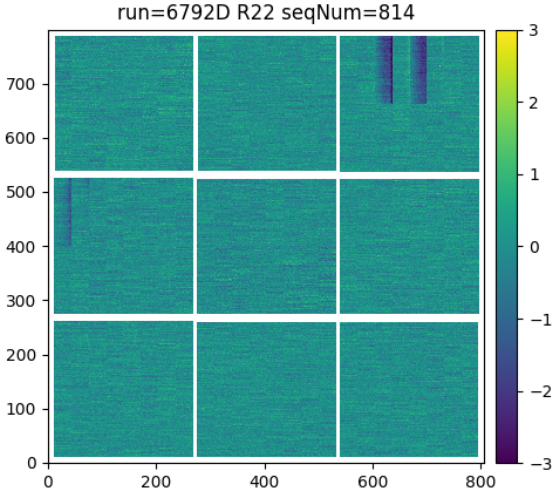

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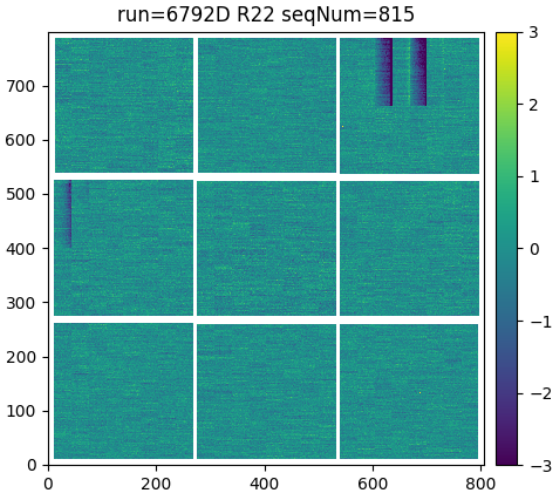

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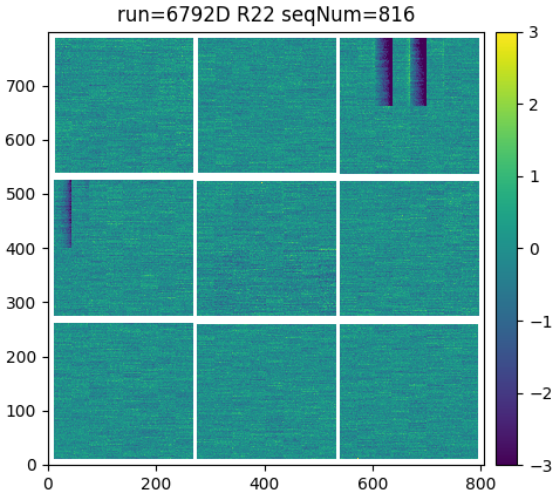

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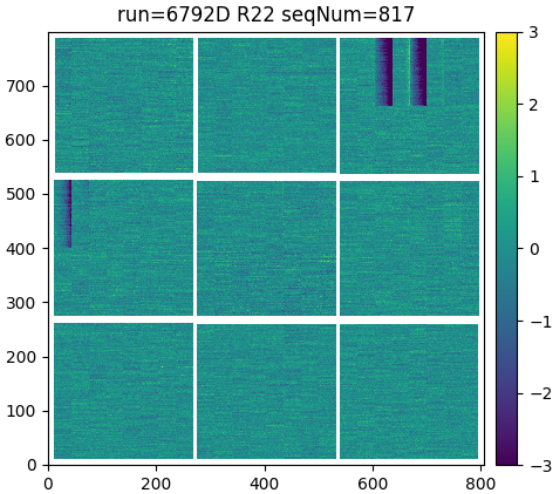

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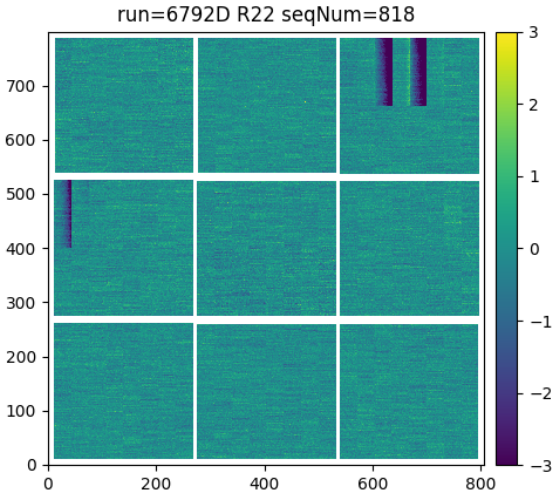

BOT R22 S22 C12 seqNum: 809–818

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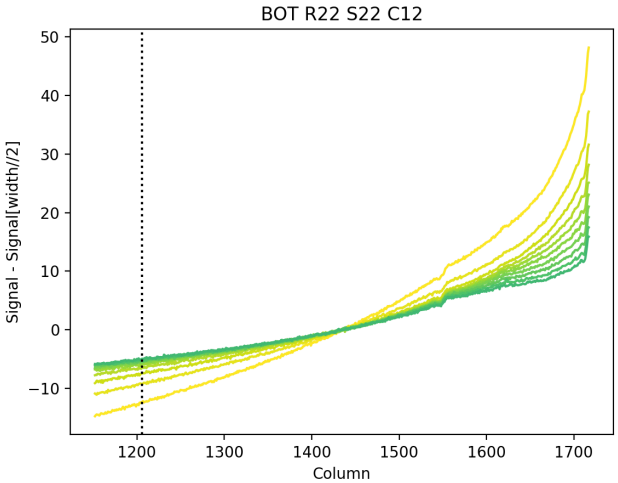

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1. Gain: drift over time and temperature

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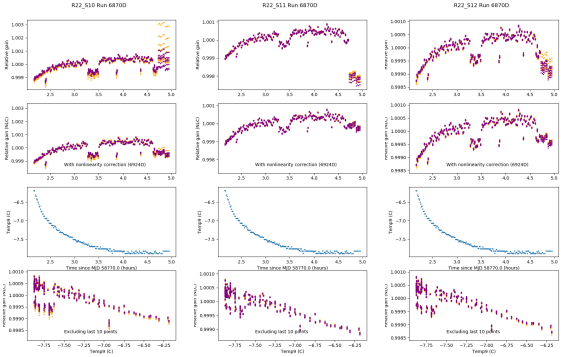

Seth Digel

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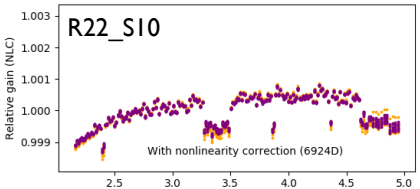

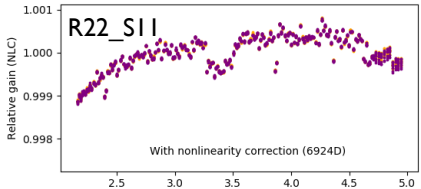

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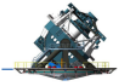

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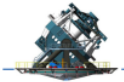
Relative gain drifts between CCDs and (worse) amplifiers is a problem for sky subtraction.



Tearing and Persistence in E2V CCDs

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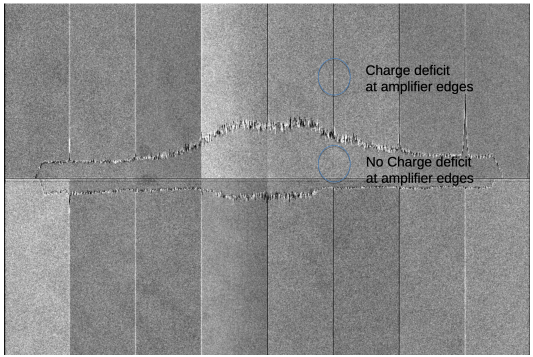

Pierre Antilogus, Claire Juramy, “Running e2v sensor in bipolar”, 2019-07-14

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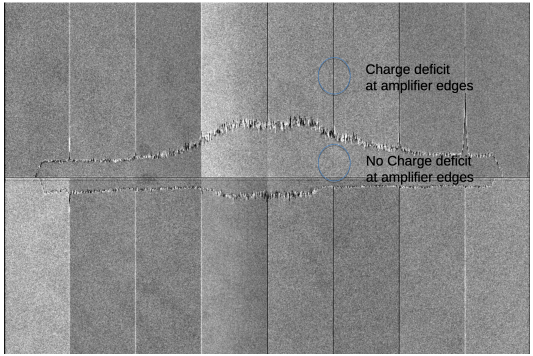

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Tearing is solved by inverting voltages; investigating divisadero

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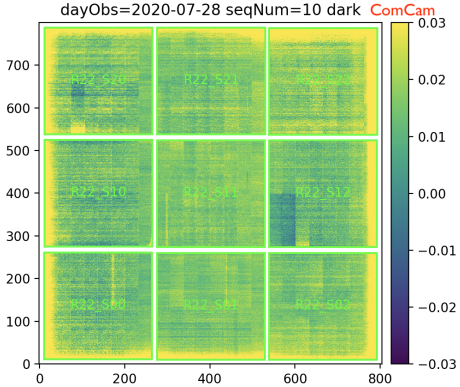

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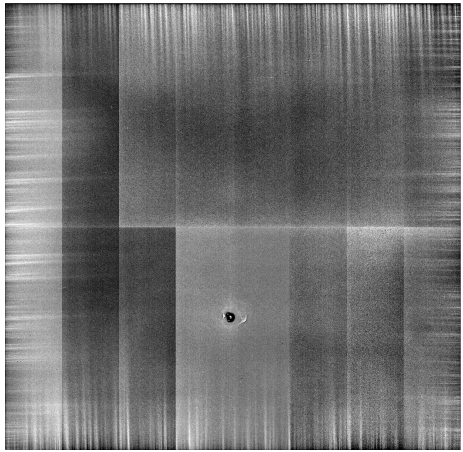
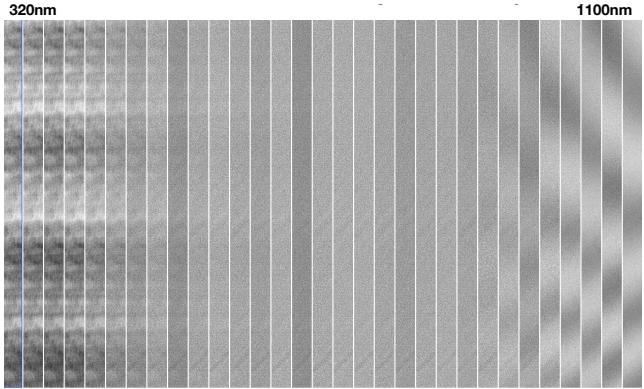
Probably OK if stable

1. Comb-like pattern in the far red ($\lambda > 1\mu m$)



$1.05\mu m$ Yousuke Utsumi, 2019-8-13

1. Flat fields
2. "Annealing" (E2V), "Coffee stains" (ITL)
3. Fringing



E2V

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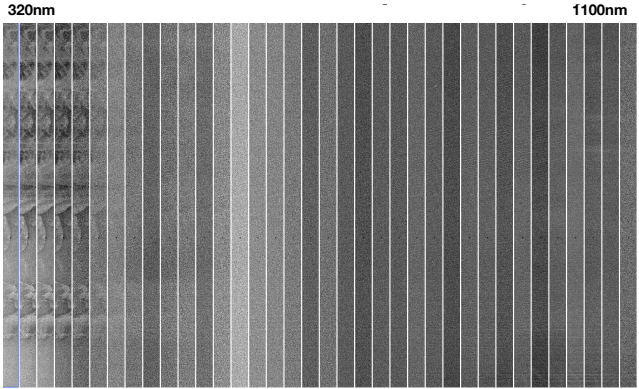

ITL

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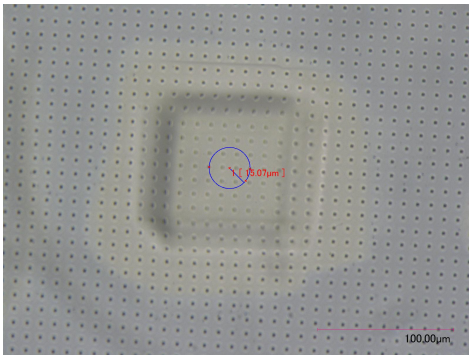

E2V B dots
Craig Lage
arXiv:1911.09577v1.

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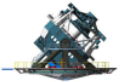

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– Include large-scale effects in WCS
– Think about small-scale effects
– Worry about whether these effects are really static

Charge Transfer [In]Efficiency

1. Serial CTE (and serial traps)
   - Fails specifications (req: CTE = 5e-6 from EPER) for a significant fraction of the ITL amps
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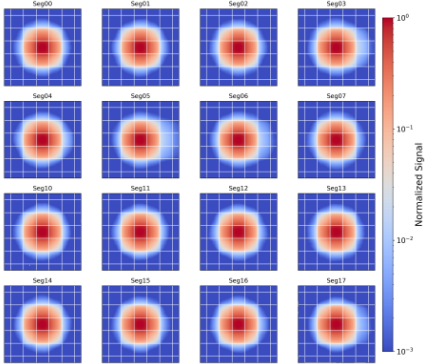

Snyder and Roodman 2020 arXiv:2001.03223

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- Traps holding $\sim$ 10-20 e^- with $\tau \sim 1\mu s$
- Anomalous impedences near the sense node
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Because the readnoise is added *after* the CTE effect, correcting for CTE leads to correlated noise.

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Interpolated/masked along with defects

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Current algorithms correct *c.* 90% of the effect

1. Voltage Testing And Optimization
2. Excessive power dissipation
3. Cross talk (correction matrix)

Video Chain

1. Voltage Testing And Optimization
2. Excessive power dissipation
3. Cross talk (correction matrix)
    - Non-linearity is under study. Steve R.
4. ADC issues
5. Jitter and jitter cleaner
6. Analog overshoot in the signal chain, incomplete reset

What’s the Next Step?

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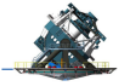
Now seems to be a good time for Rubin subsystems to merge our work on the detectors in a more formal way, leading to permanent integration.

What's the Next Step?

Rubin Observatory

Now seems to be a good time for Rubin subsystems to merge our work on the detectors in a more formal way, leading to permanent integration.

- Take data in Chile using OCS to command comCam
  - Including defined sets of calibration frames
- Transfer data to NCSA using Long Haul Network (LHN) and ingest
- Reduce calibration data, run QA



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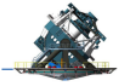

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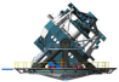

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At the same time, do as much of this as possible with BOT data:

- Take BOT data using CCS to command lsstCam
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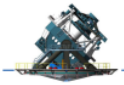
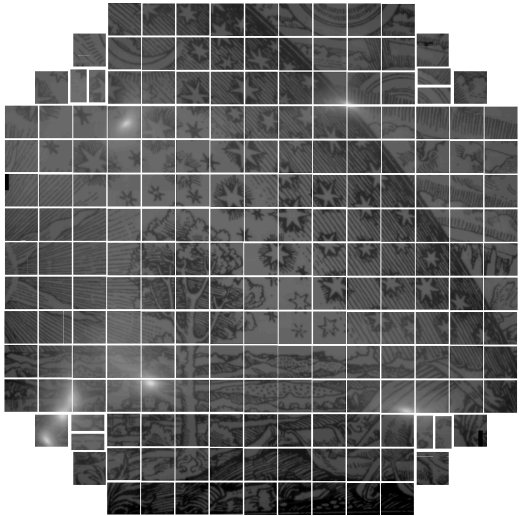
DM's working on this with the camera team.



The End

BOT Run 12478, dayObs=2020-08-18 seqNum=92



BOT Run 12478, dayObs=2020-08-18 seqNum=92