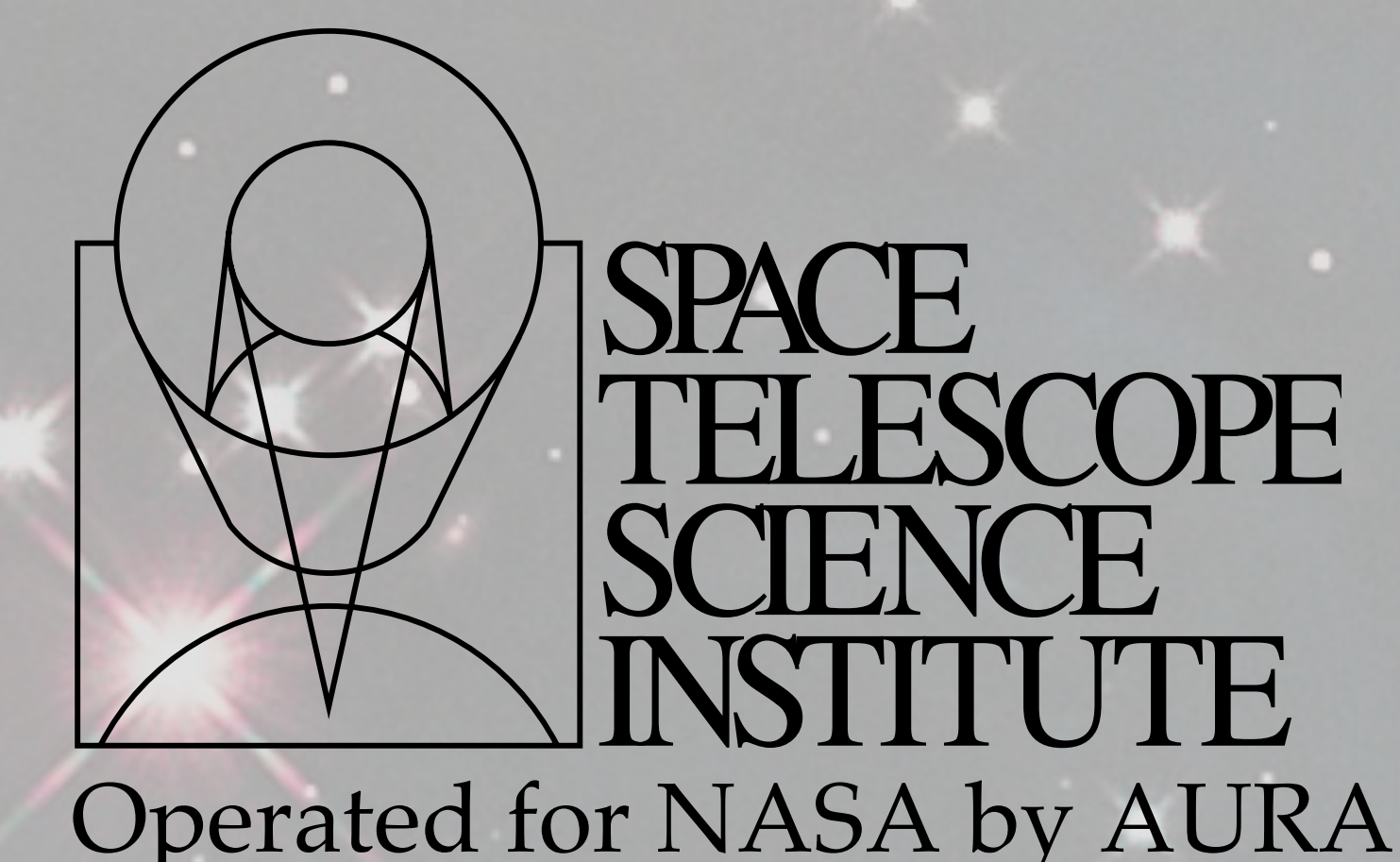


# HST WFC3: UVIS Dark Calibration

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Poster 122.04



## ABSTRACT

Wide Field Camera 3 (WFC3), a fourth-generation imaging instrument on board the Hubble Space Telescope (HST), has exhibited excellent performance since its installation during Servicing Mission 4 in May 2009. The UVIS detector, comprised of two e2v CCDs, is one of two channels available on WFC3 and is named for its ultraviolet and visible light sensitivity. We present the various procedures and results of the WFC3/UVIS dark calibration, which monitors the health and stability of the UVIS detector, provides characterization of hot pixels and dark current, and produces calibration files to be used as a correction for dark current in science images. We describe the long-term growth of hot pixels and the impacts that UVIS Charge Transfer Efficiency (CTE) losses, post-flashing, and proximity to the readout amplifiers have on the population. We also discuss the evolution of the median dark current, which has been slowly increasing since the start of the mission and is currently  $\sim 6$  e-/hr/pix, averaged across each chip. We outline the current algorithm for creating UVIS dark calibration files, which includes aggressive cosmic ray masking, image combination, and hot pixel flagging. Calibration products are available to the user community, typically 3-5 days after initial processing, through the Calibration Database System (CDBS). Finally, we discuss various improvements to the calibration and monitoring procedures. UVIS dark monitoring will continue throughout and beyond HST's current proposal cycle.

## UVIS CHANNEL

- Two 2k x 4k e2v thinned, back-illuminated CCDs at -83C
- Chips separated by  $\sim 35$  pix or  $\sim 1.4''$
- Field of View:  $160'' \times 160''$ , covering 200-1000 nm
- Standard Readout: full-frame via 4 amps
- Readnoise:  $\sim 3$  e-; Gain:  $\sim 1.6$  e-/DN; Full well: 63 – 72k e-
- Optional binning or subarray readouts
- *Post-flash available for CTE loss mitigation; highly recommended for low-signal sources on low backgrounds*

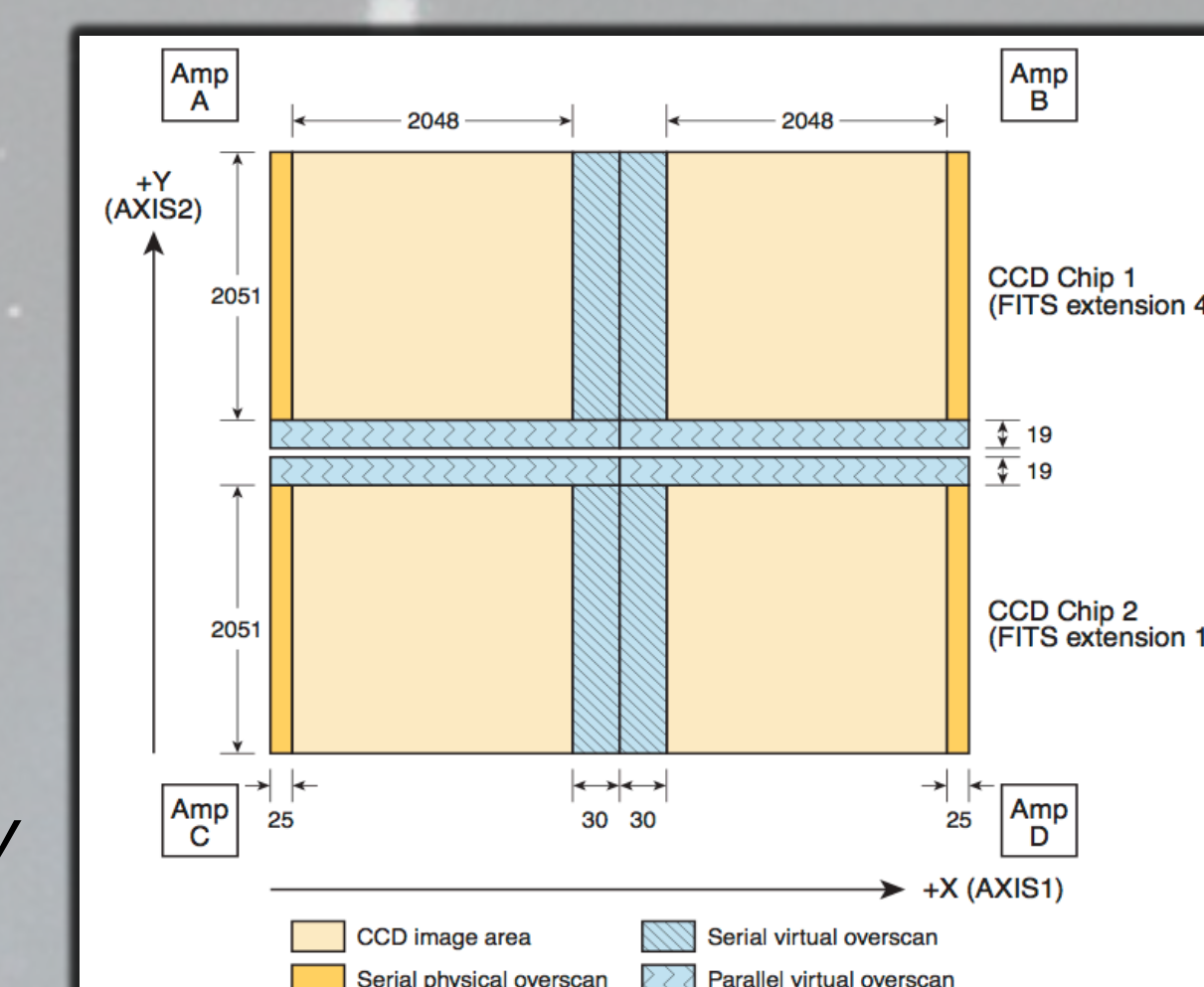


Figure 3 – CCD readout configuration

## HOT PIXELS AND DARK CURRENT

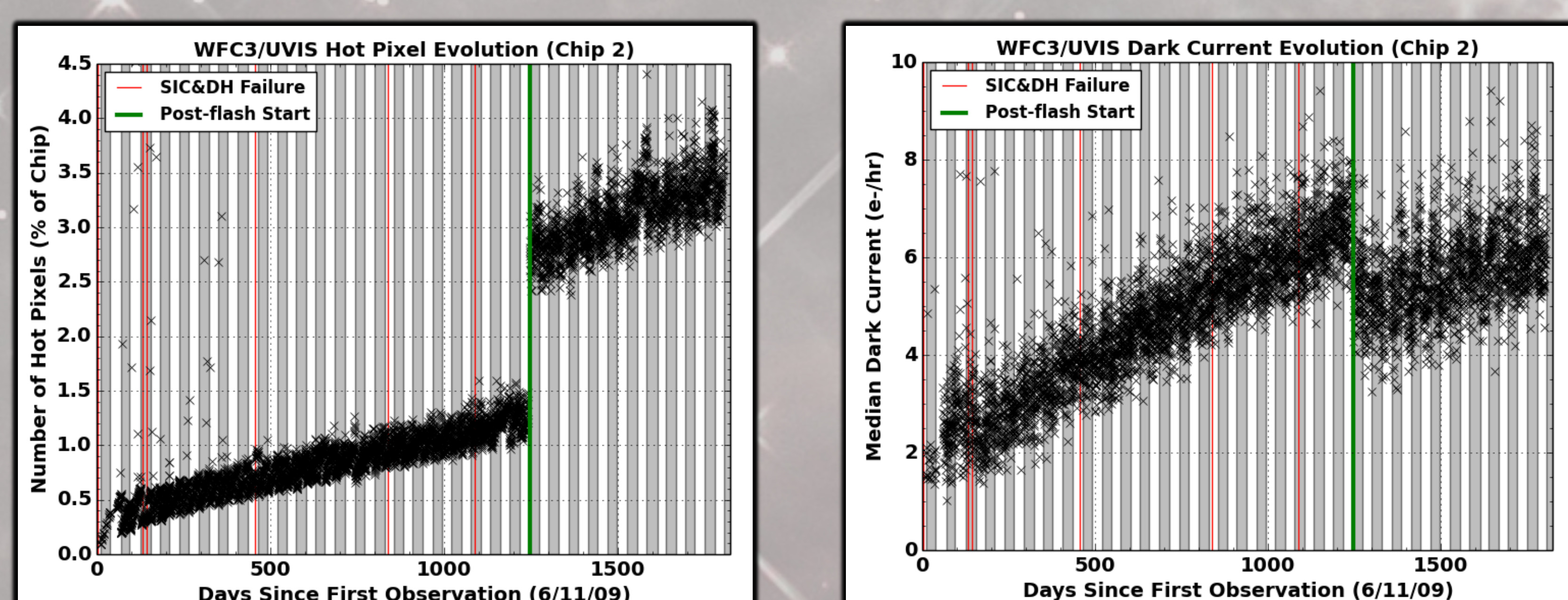


Figure 1 – Percentage of hot pixels ( $>54$  e-/hr) (left) and median dark current (right) versus time for Chip 2 (Amps C & D). About 1000 new hot pixels above the 54 e-/hr threshold appear every day, currently occupying  $\sim 3.3\%$  of each chip. Each month, the UVIS detector is warmed to  $+20$ C, erasing 20-30% of the hot pixels. Long-term growth in hot pixels is currently  $\sim 35$ /chip/day. Median dark current increases  $\sim 1.4$  e-/hr/year/pix and is currently  $\sim 6$  e-/hr/pix. Monthly anneal intervals are represented by gray/white regions.

## CHARGE TRANSFER EFFICIENCY AND POST-FLASH

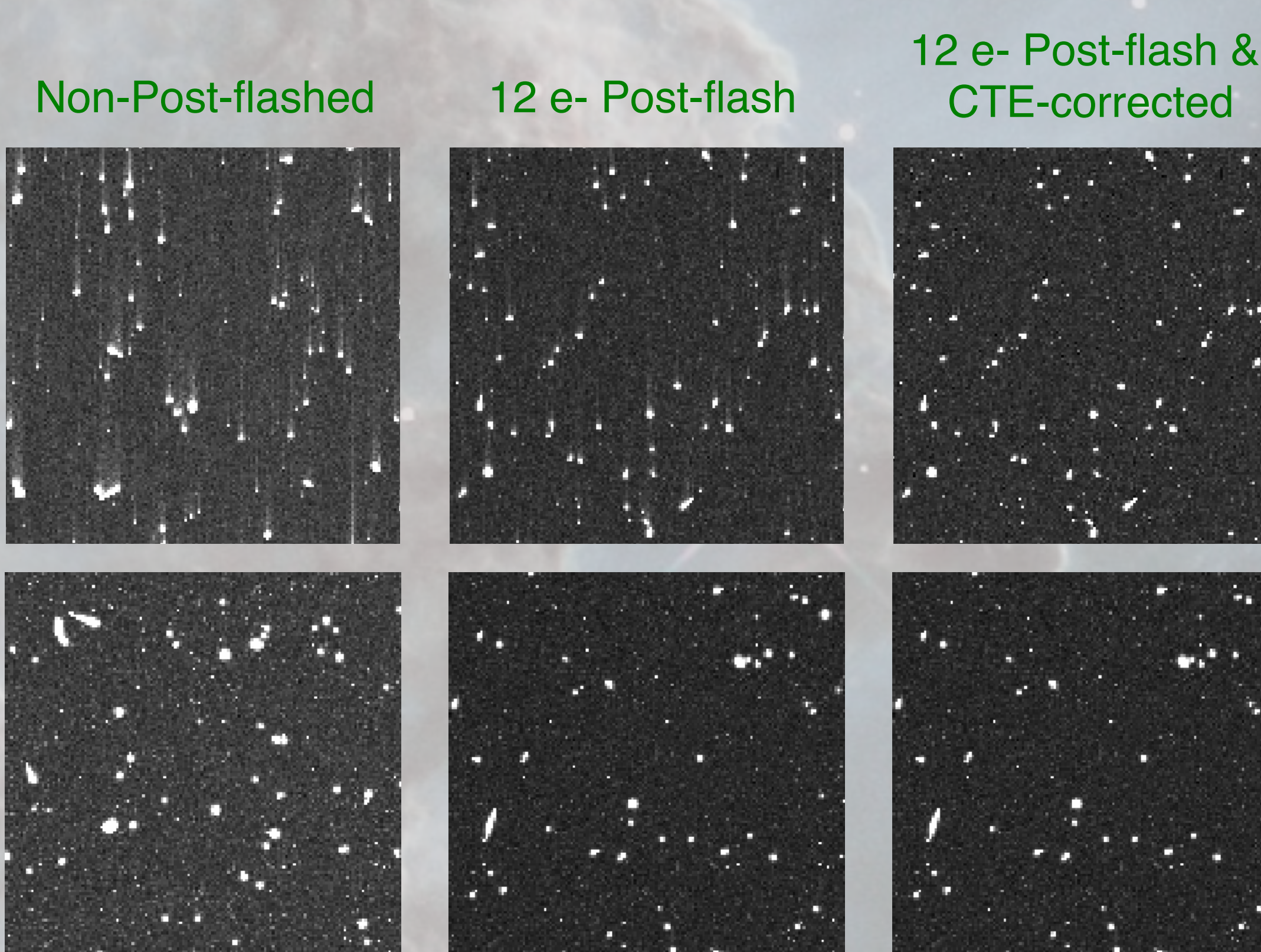


Figure 4 – 150x150 pixel regions of 900s darks located close (bottom panels) and far (top panels) from the readout amplifier in quadrant C for non-post-flashed (left), post-flashed (center) and post-flashed & CTE-corrected (right) darks.

*Post-flashing the detector mitigates CTE.* Hot pixels and cosmic rays in WFC3 darks contain extended trails caused by CTE losses. Since the 11/08/2012 UVIS anneal (day 1246 in Figure 1), darks have been post-flashed, i.e. a background of 12 e-/pix is introduced to each image. Post-flashing preserves faint signal in pixels far from the amps that otherwise would have been undetectable due to the CTE losses. The suppression of CTE trails by the post-flash improves the detection of hot pixels and allows for a more accurate measure of the dark current level. *CTE can be further mitigated by the WFC3 CTE Correction Software*, which is a stand-alone routine that performs pixel-based CTE corrections.

## FUTURE IMPROVEMENTS

We aim to incorporate additional steps in generating UVIS dark reference files that will improve the overall quality of the final product. These changes include:

- *Setting pixels below the 54 e-/hr threshold to an anneal-cycle averaged value* - Instead of setting pixels to the frame's median value (see purple box in Figure 2), using an anneal-cycle average reflects a more accurate measurement of the true dark current.
- *Creating reference files for each day* - The 4-day reference files will be generated using a sliding 4-day window rather than the current non-overlapping 4-day windows. I.e., instead of  $\sim 2$  new 4-day reference files per week, there will be a new 4-day reference file each day. This will yield a more accurate measure of the hot pixels surrounding the observation.
- *Performing CTE corrections on RAW darks* - this will mitigate any background signal introduced by CTE effects.

## DARK REFERENCE FILES

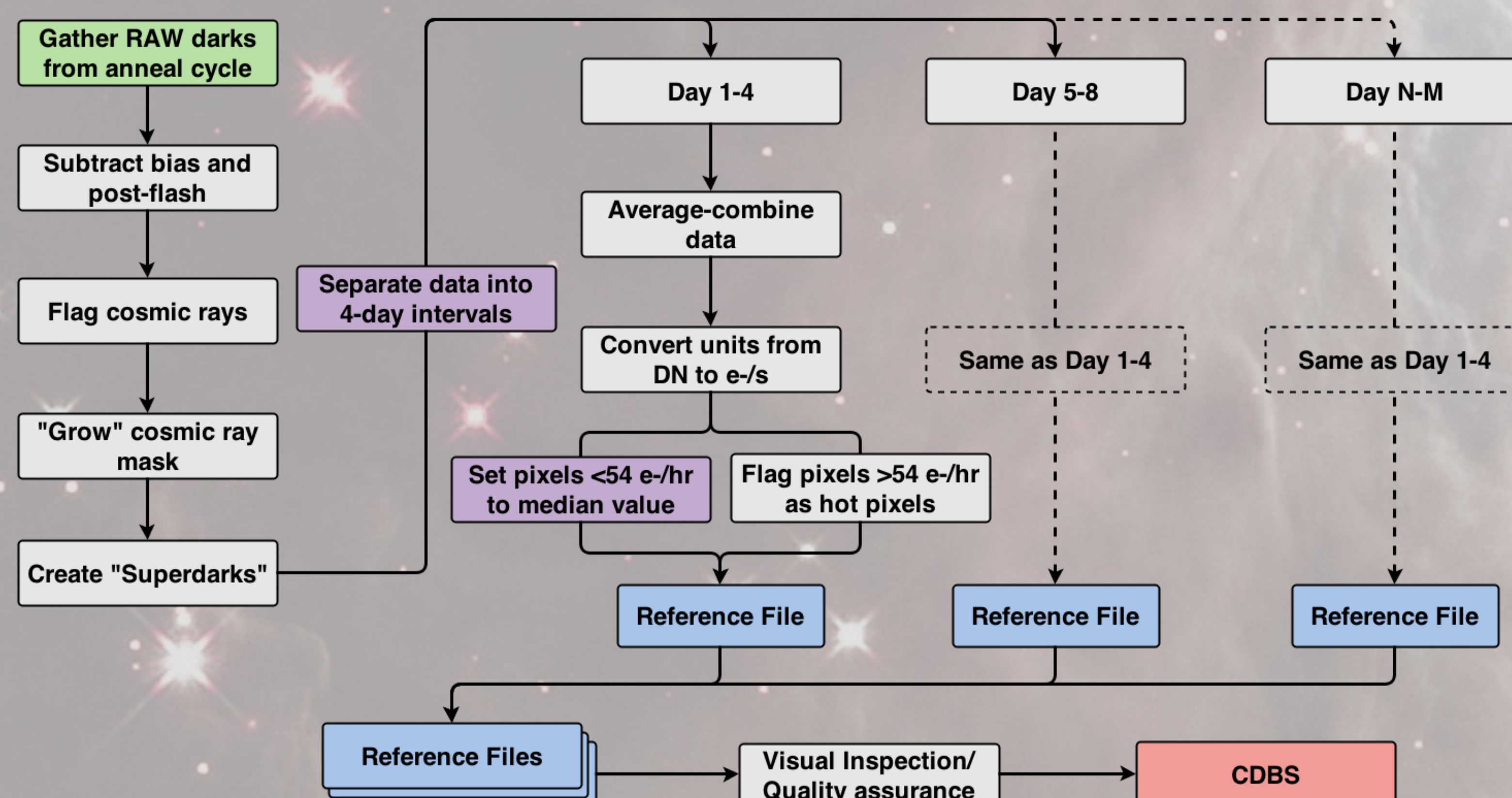


Figure 2 – An outline of the procedure for UVIS dark reference file generation. Reference files are comprised of 4-day stacks of 900s dark frames, which are acquired daily through the UVIS CCD daily Monitor and UVIS Anneal calibration programs. Reference files are available through the Calibration Database System (CDBS).

## REFERENCES AND ADDITIONAL INFORMATION

- WFC3 Main Page: [www.stsci.edu/hst/wfc3](http://www.stsci.edu/hst/wfc3)
- STScI Help Desk: [help@stsci.edu](mailto:help@stsci.edu)
- WFC3 Instrument Handbook: [http://www.stsci.edu/hst/wfc3/documents/handbooks/currentIHB/wfc3\\_ihb.pdf](http://www.stsci.edu/hst/wfc3/documents/handbooks/currentIHB/wfc3_ihb.pdf)
- UVIS Performance Monitoring: [http://www.stsci.edu/hst/wfc3/ins\\_performance/monitoring/](http://www.stsci.edu/hst/wfc3/ins_performance/monitoring/)
- UVIS dark reference files are available at <http://www.stsci.edu/hst/observatory/cdbs/>
- CTE in WFC3/UVIS and CTE correction software: [http://www.stsci.edu/hst/wfc3/ins\\_performance/CTE/](http://www.stsci.edu/hst/wfc3/ins_performance/CTE/)
- WFC3 Cycle 19 & 20 Dark Calibration: Part I, J. Biretta and M. Bourque, WFC3 ISR 2014-04, April 2014
- Related Posters ([http://www.stsci.edu/hst/wfc3/documents/meeting\\_posters/aas224/](http://www.stsci.edu/hst/wfc3/documents/meeting_posters/aas224/)):
  - WFC3: Improvements to WFC3 UVIS Photometric Calibration; Catherine Gosmeyer (Poster 122.03)
  - WFC3/UVIS Charge-Transfer-Efficiency Losses: Mitigation and Correction; Jay Anderson (Poster 122.05)
  - WFC3: News Regarding IR Backgrounds, Spatial Scans, and Cycle 22 Phase 2 Advice; John MacKenty (Poster 122.06)