**WFC3 UVIS Detector Performance**

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**Abstract**

The Wide Field Camera 3 (WFC3) is a fourth-generation imaging instrument installed on the Hubble Space Telescope (HST) during Servicing Mission 4 (SM4) in May 2009. WFC3 has two observational channels, UV/visible (UVIS) and infrared (IR); both have been performing well on-orbit. Since installation, the WFC3 team has been diligent in monitoring the performance of both detectors. The UVIS channel consists of two e2v, backside illuminated, 2k×4k CCDs arranged in a 2x1 mosaic. We present results from some of the monitoring programs used to check various aspects of the UVIS detector. We discuss the growth trend of hot pixels and the efficacy of regular anneals in controlling the hot pixel population. We detail a pixel population with lowered-sensitivity that evolves during the time between anneals, and is largely reset by each anneal procedure. We discuss the stability of the post-flash LED lamp, used and recommended for CTE mitigation in observations with less than 12 e-/pixel backgrounds. Finally, we summarize long-term photometric trends of the UVIS detector, as well as the absolute gain measurement, used as a proxy for the on-orbit evolution of the UVIS channel.

**Post-Flash**

The post-flash image file (FLSFILE) is utilized to calibrate observations that have taken advantage of the post-flash feature for CTE mitigation.

- Monitoring of post-flash LED shows no evidence of long-term variations
- ~5% variation between shutter blades A and B
- LED flash pattern ±20% variation across FOV
- Count rates for different flash levels are stable
- Illumination pattern is stable

The figure above shows the median count rate as a function of flash level for both shutter blades A and B over cycle 20* (PID 13078) and cycle 21** (PID 13560). The count rate from cycle 20 through cycle 21 for both shutters is stable across all flash levels.

*observation dates range 11/2012-11/2013
**observation dates range 12/2013-10/2014

**Gain Stability**

- Gain values for nominal setting of 1.5 e-/DN are stable through early cycle 22 compared to previous measurements (errors ~0.01 e-/DN)

The table below shows the absolute gain values since Thermal Vac 3 (TV3, ground testing in 2008/2009) through December 2014.

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<tr>
<th>Quadrant</th>
<th>Cy22 Dec</th>
<th>Cy21 Dec</th>
<th>Cy20 Cy20 Dec</th>
<th>Cy19</th>
<th>Cy18</th>
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**Photometric Trends**

- Causes for these photometric trends are currently unknown but are being investigated by the WFC3 Team

Table: Throughput change (percent per year) for subset of UVIS filters for amplifiers A and C. Throughput change varies with filter and have formal errors of < 0.001.

**Hot Pixel Trends**

- Long-term growth of hot pixels is currently ~100 pixels per chip per day (after post-flash start)
- ~3.3% of pixels in each chip are hot pixels (above 54 e-/h)
- Monthly anneals erase 20-30% of hot pixel population

The figure to the left shows the hot pixel populations for chip 1. Time periods between anneals are represented by the gray/white regions. The green line represents the start of post-flashing the darks used to measure the hot pixel population. Prior to post-flashing, many hot pixels were undetectable due to CTE losses; now they survive the readout and are detected as hot.

**Information and Resources**

For more information see WFC3 Instrument Science Reports: [http://www.stsci.edu/hst/wfc3/documents/ISRs/]
- WFC3 ISR 2014-18: Pixel-to-Pixel Flat Field Changes in WFC3/UVIS
- WFC3 ISR 2014-05: WFC3 Cycle 20 Proposal 13168: UVIS Gain
- WFC3 ISR 2014-04: WFC3 Cycle19 & 20 Dark Calibration
- WFC3 ISR 2013-12: WFC3 Post-Flash Calibration

For additional questions contact help@stsci.edu

**Low Sensitivity Pixels**

During the time between anneals a population of pixels with lowered sensitivity develops.

- **General Population Characteristics**
  - Average sensitivity deficit of ~1-2%
  - Most pixels are reset (~90%) after each anneal
  - Almost exclusively a different set of pixels between each anneal
  - Wavelength dependent
  - UV filters are affected the most (i.e. more pixels affected, larger sensitivity drop, tend to be 2-3 pixels in size)
  - Best mitigation option is to dither

On average the sensitivity deficit is 2 times greater in F438W than in F814W. The green line shows the 1:1 ratio of F438W and F814W. If there were no wavelength dependence, the population would be fit by this line.

- **Low sensitivity population shows no significant increase from Cycle 20 to Cycle 21.**

The figures to the right show the normalized low sensitivity pixel populations (~2% deviation from median) in F438W (bottom) and F814W (top) over the course of Cycle 20 and Cycle 21. The vertical lines represent the monthly anneals. Both filters show ~90% of low sensitivity pixels reset after the annealing process.