Wide Field Camera 3

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WFC3 Summary

- **WFC3 is operating nominally**

- New Features for Observers in development:
  - UVIS 2.0 Pipeline changes
  - IR Spatial Scan Pipeline Changes
  - IR SPARS5 Sample Sequence

- Completed Studies and Enhancements:
  - CSM tracking and usage control
  - Snowballs history
  - Convenience Apertures
  - Improved tracking of Bad/Worst/Sensitive Actors

- Ongoing Activities:
  - IR Backgrounds
  - Improved Astrometry
  - PSF Library and GRISM Software
UVIS 2.0

• New version of UVIS portions of the CALWF3 pipeline under development
  – Two chip photometric solution
  – CTE correction within the OPUS pipeline
  – Improvements to dark reference files

• Plan to release in Fall 2015 as a single major change
  – Awaiting major infrastructure changes to OPUS
  – Components and reference files currently available to users via www download
Two-chip solution

- Original photometry approach (copied ACS)
  - Zeropoints based on averages over the two chips
  - Flat fields constructed from Omega Cen dithered over two chips
  - Pipeline flats for both chips normalized to area on amp A
- However, different WFC3 chip QE’s create problems
  - Zeropoints require fudge factors in *synphot* tables
  - Astrodrizzle results are not optimal: requires flat image, single ZP
- New approach
  - Determine separate zeropoints for each chip
  - Determine and normalize flat field separately for each chip
  - Finally: scale chip 2 to chip 1 in *calwf3* so zeropoints match
  - Fully backwards compatible (i.e. full set of keywords retained)
- Made available to community via www Dec 2014
  - Full set of reference files (including all Flat Fields)
  - http://www.stsci.edu/hst/wfc3/analysis/uvis_2_chip
CTE correction in pipeline

• Current situation
  – Correction available since mid-2013 as standalone FORTRAN script
    http://www.stsci.edu/hst/wfc3/tools/cte_tools
  – Supports full-frames and majority of subarrays
  – Model and software stable

• Development starting for incorporation into OPUS/calwf3
  – Pipeline to branch into two paths (same conventions as ACS/WFC)
    1) Standard processing as done today, results in raw, flt, drz files
    2) New branch to correct for CTE then perform usual image
       calibrations (dark, flat, etc). Results in rac, flc, drc files.
  – All products, with and without CTE correction, produced and archived
  – Script transitioned to SSB for conversion to C
Improved UVIS superdarks

• Current situation
  – Superdarks generated from non-overlapping 4-day intervals of dark frames, i.e., ~2 superdarks per week
  – Hot pixels identified as those above predefined threshold and set to value determined from the 4-day stack, flagged in DQF
  – Good pixels set to median of all good pixels across the chip

• Improved approach
  – Darks generated daily from sliding 4-day intervals, i.e., ~7 superdarks per week, providing more finely-tuned hot pixel correction for science images
  – Hot pixels identified and set as before
  – Good pixels set individually, using median value for each pixel based on ~1 month of dark frames
  – Update software to use amp-dependent gain values (~0.5 to 1.5% change, depending upon amp)
New IR Features

• OPUS pipeline to be modified to better handle spatial scans
  – Currently ramp fitting creates messy FLT files (will be disabled)
  – Relevant header keywords to be duplicated in FLT from SPT

• A new SAMPLE SEQUENCE is being added for Cycle 23
  – SPARS5 will provide a cadence between RAPID and SPARS10
  – Motivation was orbit packing efficiency for exo-planet transits
CSM moves staying at ~30/week or below.

Plots from G. Chapman
IR Snowballs History

- Snowball: circular object ~2-5 pix in radius that appear instantly between IR reads and saturates the detector – cause uncertain? Radioactivity?
- Good news: stable since SM4!

![Snowball Image](image1)

![Saturation Map](image2)

![Flux Map](image3)

![Snowball Flux Distribution](image4)
Multiple UVIS subarray apertures were introduced in cycle 18 to eliminate the need for user-defined subarrays -- reduced errors and Phase 2 re-work.

- Generally used to enable parallel data dumps of short exposures (< 348 s)
- Some are also ideal for minimizing losses due to CTI
- HOWEVER: some uses want full array plus placing target new amplifier

### Target placement \((x,y)\) near C amp:

<table>
<thead>
<tr>
<th>aperture</th>
<th>x</th>
<th>y</th>
<th>size</th>
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<tbody>
<tr>
<td>UVIS2-C512C-SUB</td>
<td>257.0</td>
<td>257.0</td>
<td>513 x 512</td>
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<tr>
<td>UVIS2-C1K1C-SUB</td>
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<td>512.0</td>
<td>1025 x 1024</td>
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<td>UIVS2-2K2C-SUB</td>
<td>762.0</td>
<td>816.0</td>
<td>2047 x 2050</td>
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<tr>
<td>UVIS-QUAD-SUB (C)</td>
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<td>816.0</td>
<td>2047 x 2050</td>
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</table>

Two new full array apertures with target placement that minimizes CTI losses and avoids the need to guess at POSTARGs

<table>
<thead>
<tr>
<th>aperture</th>
<th>x</th>
<th>y</th>
<th>size</th>
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</thead>
<tbody>
<tr>
<td>UVIS2-257XY-CTE</td>
<td>257.0</td>
<td>257.0</td>
<td>full array</td>
</tr>
<tr>
<td>UVIS2-512XY-CTE</td>
<td>512.0</td>
<td>512.0</td>
<td>full array</td>
</tr>
</tbody>
</table>
IR Persistence

- Monitoring incoming data plus proposal reviews
  - Flag and schedule around: BAD (2 orbit) actors since Cycle 18
  - Now tracking WORST (10 orbit) and Sensitive (high impact) cases

Macs0416 - F160W (PID#13496, Visit 94, exp. 01)

Still not perfect: earth flat overflew a city

These aren’t the scattered light artifacts you are looking for
**IR Backgrounds**

- Prior STUC presentation on discovery of important of He 1.083 micron feature with HST is in daylight
  - Frontier Fields data scheduled successfully to avoid sunlight with impacted filters (i.e. F105W in night; F160W in day)
  - Multiple efforts to communicate this to observers
- Significant for most GRISM observations (lots of structure!)
  - Multi-component models with zodi + He I (+ earth limb) appear promising and are under development
  - Improved tools (pipeline?) for ramp fitting and data editing

Figure X: Sky-subtraction of grism exposures with master sky images. Panel b) represents a trivial grey flat-field correction using the imaging flat-field reference file. The best-fit sky image in panel c) is a composite of zodiacal and He 1.083μm line components; the structure results from overlapping vignettled grism orders.
Improving UVIS Astrometry

- Initial WFC3 requirement: 4 mas (0.1 pixels) for AstroDrizzle is sufficient for most image registration and stacking programs

- Potential to do much better
  - WFC3 very stable internally due to thermal control of optical bench
  - Inclusion of photolithographic mask offsets (2013) → 2 mas
  - Inclusion of filter induced mid-spatial frequencies → 1 mas
    - Done for ~10 UVIS filters with sufficient Omega Cen data
    - Expanding to remaining filters over Cycles 22-23
  - Omega Cen field now has Jay Anderson’s proper motion catalog

- Questions:
  - How to best exploit GAIA?
  - Future applications of Spatial Scanning approach (<30 µas – Riess et al.)
PSF Library and GRISM tools

• **PSF Library**
  – ~10^7 stars “reasonably isolated” with “reasonable S/N” in F606W
  – Expanding to entire set of WFC3 observations
  – First application: improve focus monitoring from ~2 µm to <1µm
    • Provides nearly continuous tracking (rather than monthly monitors with Phase retrieval) with comparable results
    • Outcomes: improved breathing model and (perhaps) more frequent focus adjustments for WFC3/UVIS
  – Exploring methods for making this usefully available –suggestions welcome!

• **Advanced GRISM data reduction algorithms/software**
  – Tool to handle observations at multiple roll angles
  – Forward Modeling methods to extract fainter sources and understand errors
  – Highly synergistic with JWST and WFIRST-AFTA needs
A Study of Focus Variability of the WFC3/UVIS F606W PSF

<table>
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<tr>
<th>Date</th>
<th>Focus Model</th>
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<tbody>
<tr>
<td>17 Mar 2014</td>
<td>3.75 (magenta)</td>
</tr>
<tr>
<td>27 Feb 2012</td>
<td>1.9 (cyan)</td>
</tr>
<tr>
<td>24 May 2013</td>
<td>-2.6 (blue)</td>
</tr>
<tr>
<td>8 Jun 2012</td>
<td>-4.1 (green)</td>
</tr>
<tr>
<td>6 Jun 2012</td>
<td>-7.4 (red)</td>
</tr>
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The colored points represent a few exposures where stars from a given exposure occupy a similar location in the focus space.