WFC3 Updates

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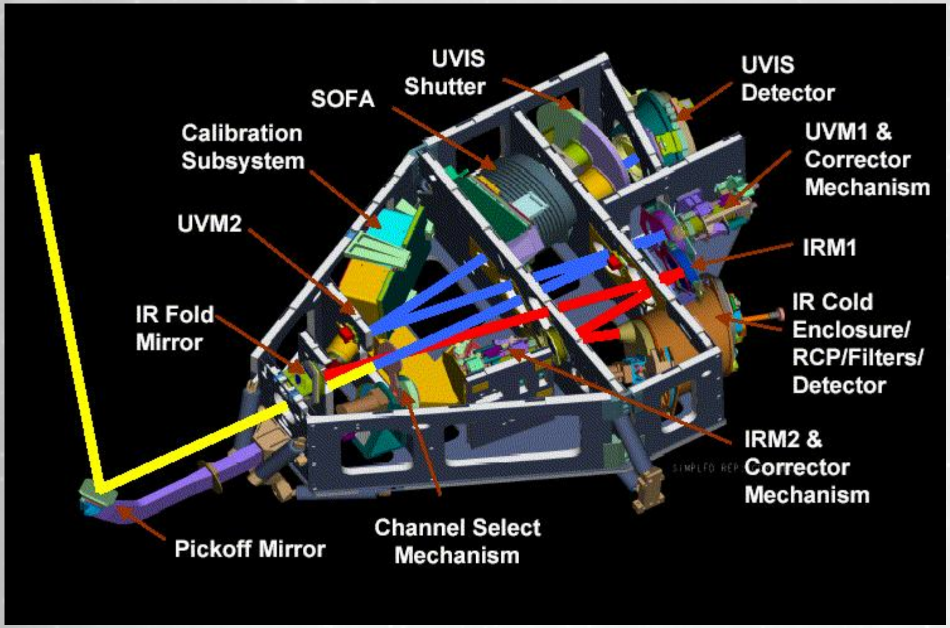
MAST Users Group Meeting

January 14-15, 2016

WFC3



The WFC3 consists of two channels one operating in the optical/ultraviolet and one in the near-infrared.

WFC3 is capable of direct, high-resolution imaging over the entire wavelength range from 200 to 1700 nm.

- A new version of the calibration pipeline should be available to the observes in the spring
- An updated model of persistence is now available. IR data will be reprocessed with the new model when the new pipeline goes live.

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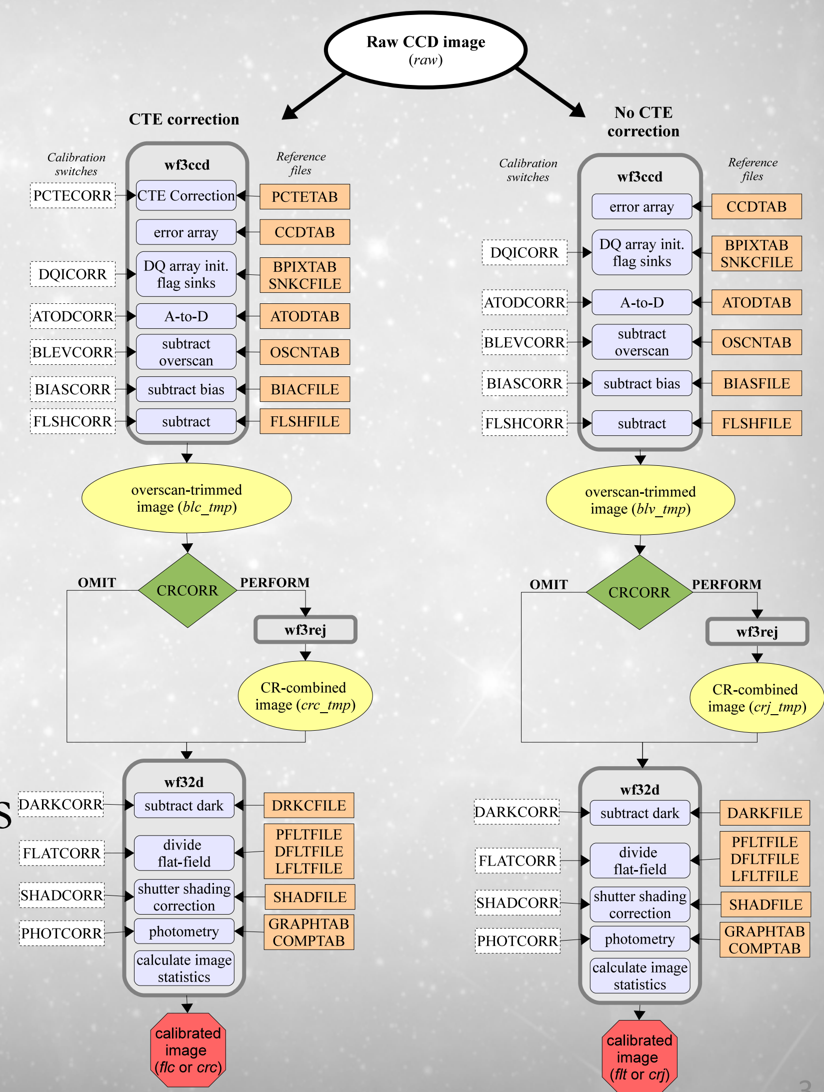
CALWF3 version 3.3

(UVIS 2.0)

- New data processing pipeline for WFC3/UVIS -> higher photometric and astrometric precision.
  - Improved flatfields (especially UV)
  - Improved super darks
  - Chip dependent photometric zero points
  - Pixel based CTE correction



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CALWF3 version 3.3

In version 3.3 each CCD is processed independently

New keywords have been added to the headers of the calibrated images

Photometry Header Keywords

PHOTFLAM = Inverse sensitivity for UVIS1 (= PHTFLAM1)

PHTFLAM1 = inverse sensitivity for UVIS1 + filter

PHTFLAM2 = inverse sensitivity for UVIS2 + filter

PHTRATIO = PHTFLAM2/PHTFLAM1

Photometry Calibration Switches and default values

PHOTCORR = PERFORM. - PHTRATIO is calculated and keyword are populated in the header

FLUXCORR = PERFORM. - UVIS2 is scaled to UVIS1

The New IMPHTAB has 5 extensions:

	Col 1	Col 2	Col 3	Col 4	Col 5	Comments
EXT 1	OBSMODE	DATACOL	PHOTFLAM	PEDIGREE	DESCRIP	*inverse sensitivity for UVIS1*
EXT 2	OBSMODE	DATACOL	PHOTPLAM	PEDIGREE	DESCRIP	*filter pivot wavelength*
EXT 3	OBSMODE	DATACOL	PHOTBW	PEDIGREE	DESCRIP	*filter bandwidth*
EXT 4	OBSMODE	DATACOL	PHTFLAM1	PEDIGREE	DESCRIP	*UVIS1 inverse sensitivity*
EXT 5	OBSMODE	DATACOL	PHTFLAM2	PEDIGREE	DESCRIP	*UVIS2 inverse sensitivity*
FORMAT	CH*40	CH*12	D (25.16g)	CH*30	CH*110	

Photometry Header Keywords

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PHTFLAM1 = inverse sensitivity for UVIS1 + filter

PHTFLAM2 = inverse sensitivity for UVIS2 + filter

PHTRATIO = PHTFLAM2/PHTFLAM1

Photometry Calibration Switches and default values

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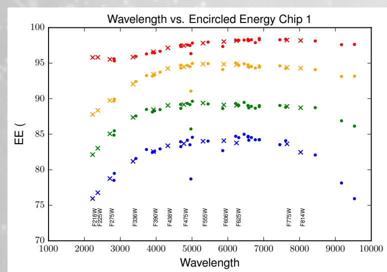
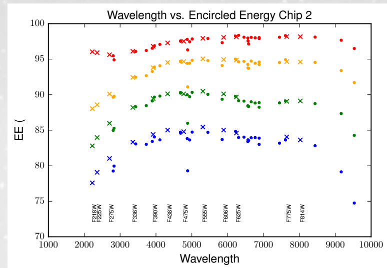
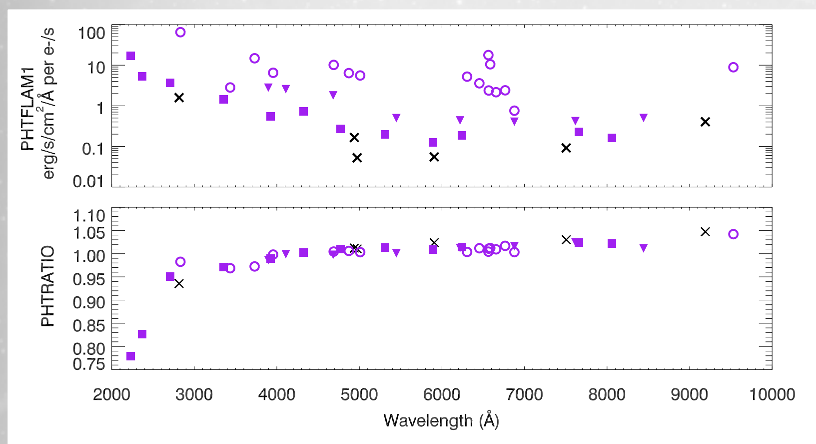
Chip Dependent Photometry







The new zeropoints are 3.5% (~0.03 mag) brighter than the 2012 values., and accurate to ~1%.

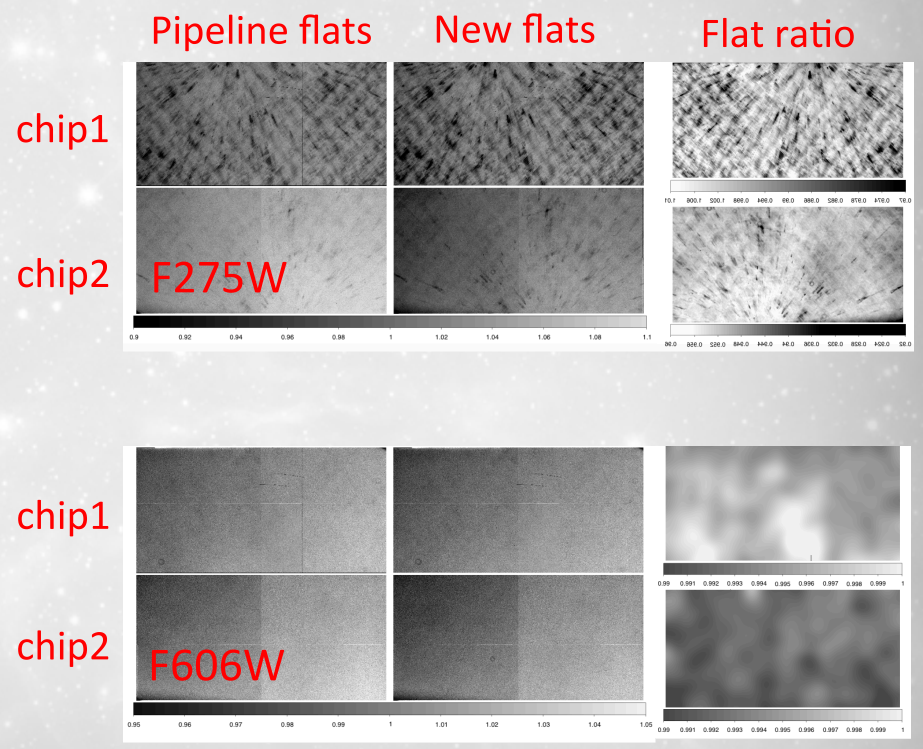
- Encircled energy (EE) and photometric zeropoints (ZPs) are derived from GD71, GD153, GD191B2B in all 42 full-frame filters over a six years timeline.
- Observations for each CCD were combined with AstroDrizzle
- Each CCD+filter has its own ZP.

  UVIS1+filter ≠UVIS2+filter

  (Quad filters are not affected by this change)
- The EE per chip was measured between R=1 to 75 pixels (We used the Hartig 2009 model at R>35 pixel)s.
- ZPs (=inverse of the filter's sensitivity) were determined at r=10 pixels (=0.3962 arcsec) using the WD models in CALSPEC.

New UVIS flafields

- WFC3 flats combined ground-based pixel-to-pixel flats to a space derived mid- and low-frequency (L) correction
- The new correction is computed from CTE-corrected images.
- The LP-flats are independently normalized to the median value for each chip – No QE effects in the flats
- UV flats (F218W, F225W, F275W, F280N) now include temperature correction.



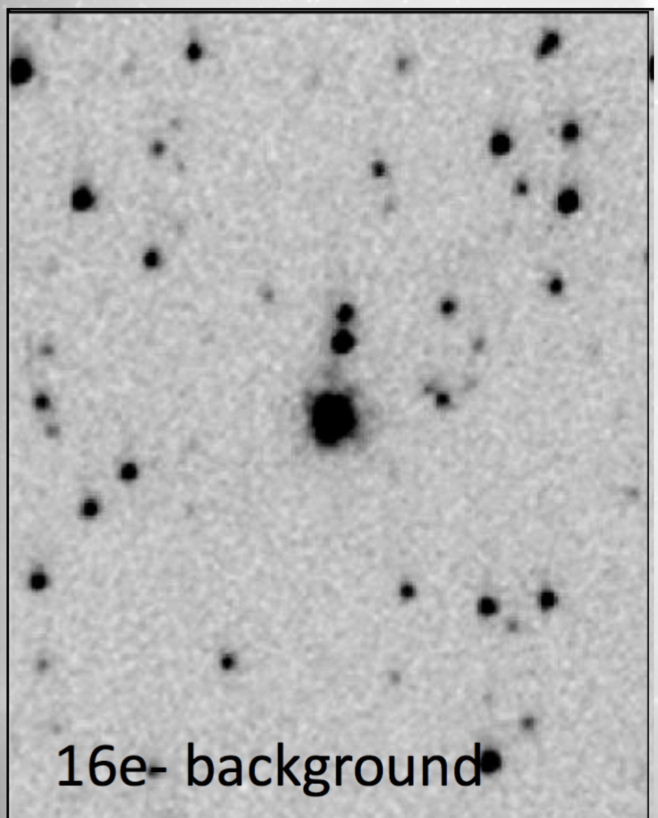
Photometric residuals across the FoV reduced from 3% to 0.5%

Improved Darks

Current pipeline	New release	Improvement
Superdarks (*_drk.fits) are not corrected for CTE	Superdarks (*_drc.fits) <u>are</u> corrected for CTE	Reduction of the background signal due to CTE losses from CRs and hot pixels.
Generated using darks frame taken from 4 non-overlapping days.	Generated using a 'sliding' 4-day window.	Darks are generated daily; More accurate characterization of the hot pixels.
All non-not pixels (dark current<54 e^-/hr) are set to the frame's median value.	Each non-hot pixel is set to the pixel's 'masterdark' value (~100 frames)	More accurate measurement of the true dark current across the detector.

Pixel Based CTE Correction

The radiation environment of HST's low-earth orbit damages CCDs, generating hot pixels, increasing dark current, and decreasing CTE.



Hot pixels in dark frames are used to empirically model CTE losses on a pixel-by-pixel basis. In practice:

1) A range of warm pixels (WPs) is identified in long darks with various level of post-flash.
2) Scale WP levels to estimate expected levels in short darks.
3) Measure surviving WP counts in short darks.
4) Track losses as function of WP size and bkgd.
5) Fit a comprehensive forward model to this data.
6) Invert to obtain correction for science images.
7) The model is applied to science images to restore charge to its original location.

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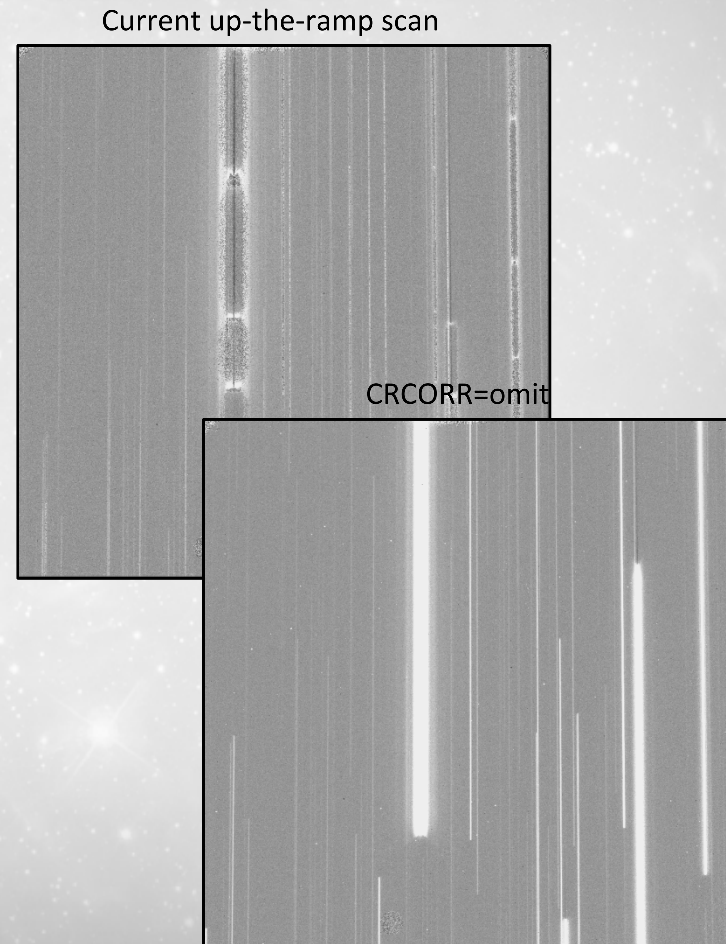
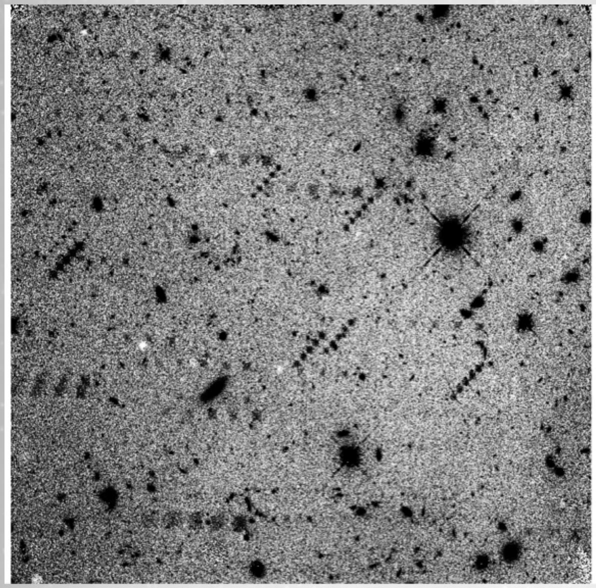
IR Spatial Scan

- 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



IR persistence



- Persistence in IR images is the afterglow of previous saturated exposures.
- Old estimates of persistence were based solely on degree of saturation in past exposure and time elapsed since saturation.
- The new model takes into account also the dependence on the exposure time of the earlier image.

Each IR exposure is processed through the persistence software by the WFC3 team. Persistence masks and persistence-corrected images are sent to the archive and are available for download ~ 5-10 days after the observing date.
https://archive.stsci.edu/prepds/persist/search.php

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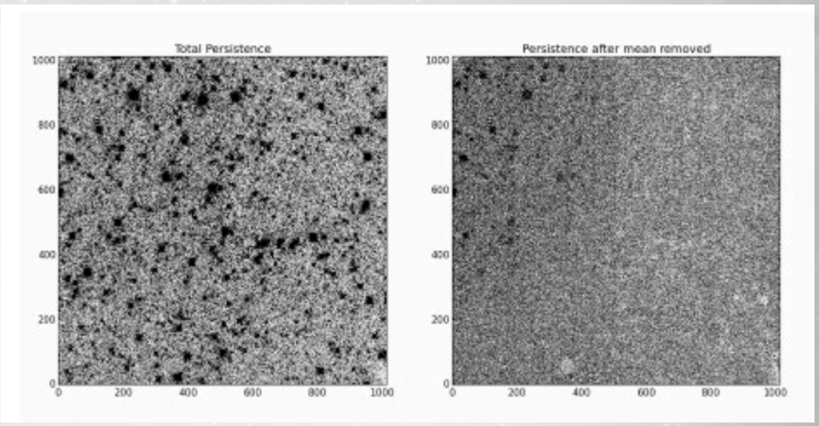
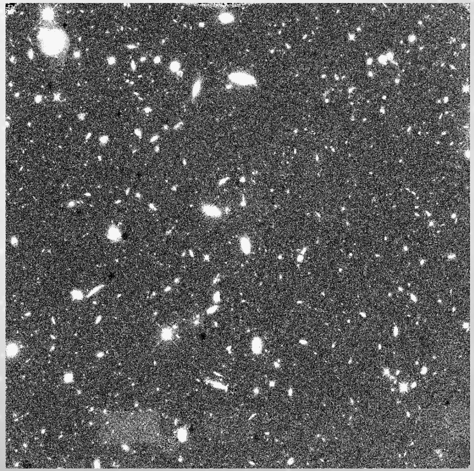
Model Limitations

- The current model assumes a uniform persistence response, while we have evidence that the amount of persistence changes across the detector – We are collecting new data to address this aspect



- The model cannot predict the amount of persistence left by sources that are illuminating portions of the detector that are not read out (i.e. subarrays)



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Summary

- A new version of the calibration pipeline will likely be released in the spring. It will include
  - CTE correction
  - Improved flats and darks
  - Independent treatment of UVIS 2 chips
- We have an improved model for persistence
- We plan to further improve the model
- Persistence corrected files can be downloaded from the archive few days after the observations