WFC3: Status and Advice for Cycle 22 Proposers

John W. MacKenty, Sylvia M. Baggett, Susana E. Deustua, Derek Hammer, Janice C. Lee, Peter R. McCullough, Norbert Pirzkal, Vera Kozhurina-Platais, Adam G. Riess, and the WFC3 Team (STScI)

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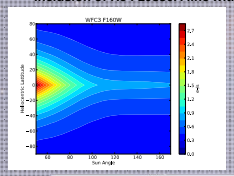
Summary

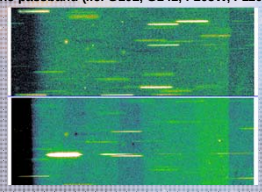
- **WFC3 continues to perform nominally.**
  - Photometric zero points (including UV) are stable to <0.5 % since August 2009
  - Astrometric calibration is stable and dominated by Telescope "breathing"
  - UVIS CCD Detectors CTE declining as expected with radiation damage
  - IR Detector shows essentially zero evolution of its performance in flight
- **Notes to Observers:**
  - UVIS CCD Post-Flash became available in Cycle 20 to reduce CTE effects
    - If background < 12e-, increasing background to 12e- restores the charge transfer performance for faint sources to ~80% of original levels
  - UVIS Shutter Blade selection now available for short exposures
    - Permits observer to obtain best possible PSF (*i.e.* less shutter vibration)
  - IR Background variation has a significant component due to He I 10830Å line
    - Impacts F105W, F110W, G102, and G141 filter&grism passbands

WFC3 Infrared Background Variations

- A key feature of the IR Channel → GRISMS and Wide Filters Zodiacal Background Limited

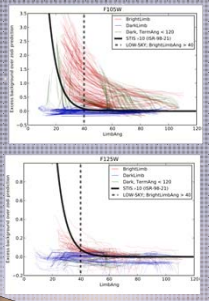
- Nominal Backgrounds: 0.5 to 1.0 e-/s/pixel
  - HOWEVER: brighter (up to 3-5e-/s) and non-uniform backgrounds are observed!
- Caused by:
  - Pointings that traverse zodi cloud (*i.e.* <80° sun angle near ecliptic plane).
  - Long dwells near bright earth limb (*i.e.* CVZ or near CVZ situations).
  - Inclusion of He I 10830Å line with the passband (*i.e.* G102, G141, F105W, F110W).

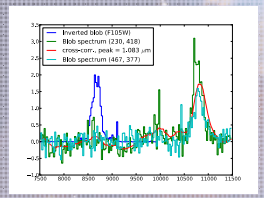




Above: Variation in G141 background seen between two exposures.

Below: He I 10830Å line see in silhouette due to opaque dust particles on CSM mirror.



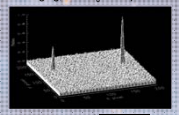


WFC3 Spatial Scans

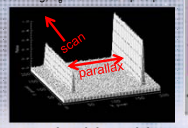
Spatial Scans allow the light from astronomical objects to be trailed across the WFC3 detectors in a predictable and repeatable manner during exposures at rates up to 4.8 arc seconds per second (FGS control) and 7.8 "/s (GYRO control).

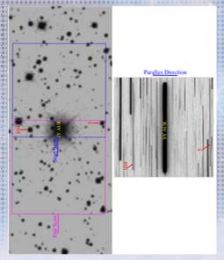
- Enables:
  - Significantly increased S/N observations – especially for infrared spectroscopy of bright sources (*e.g.* exo-planet transits)
  - Higher precision astrometric measurements orthogonal to the scan direction (measurements to <30 micro-arc seconds
  - Opportunity to observe brighter sources (especially with the IR detector– 0th mag possible with Grism in -1 order)
  - Flat field verification and improvement of mid-spatial frequency residuals in near UV CCD flats

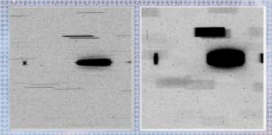
Imaging, PSF σ_s=0.01 pix



Scanning, σ_s=0.01/√N samples pix

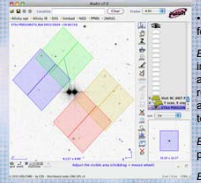






Left: IR Grism Spectra (Stationary and Scan)

Below: Scan spectra of Vega (-2, -1, 0, +1 orders)



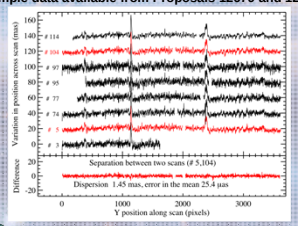
Left: Enhanced Astronomers Proposal Tool (APT) for planning spatial scans.

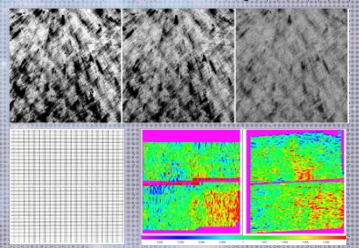
Below: Illustration of future potential of scans to improve UV flat fields. F336W flats at -82C, -49C, and their ratio show 2-3% p-p residuals. Larger residuals are present in the F218W, F225W, F275, and F300W flat for with -82C flight operating temperature flats do not exist.

Bottom Left: Superposition of multiple scans of a pair of bright stars.

Bottom Right: Measured flat residuals.

- Example: High Precision Astrometry for Parallax Measurements
  - Precision of centroiding of bright stars is 0.01 pix (400 µas)
  - Scans over several 1000s pixels → factor of >10 better
  - Exceeds FGS precision and compares favorable with GAIA
  - Spacecraft jitter and astrometric calibration are main factors
    - Differential experiments and multiple reference stars
  - Example data available from Proposals 12679 and 12794





Improved Instrument Calibrations

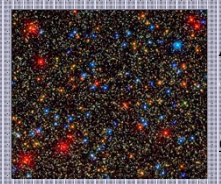
- UVIS Photometry
  - Independent solutions for UVIS CCD detectors coming Feb 2014.
- UVIS Astrometry
  - Two-dimensional corrections for photo-lithographic pattern in place
  - Filter specific corrections being developed in 2014.
- UVIS Darks improved by use of Post-Flash (better discrimination of hot pixels).
- IR Spectroscopy
  - Wavelength calibration in PN IC 5117 removes small offset between Grisms.
- IR Linearity and Persistence
  - Effort in Cycle 21 to understand impacts of charge trapping on precision photometric observations of bright sources.

- Annual WFC3 Calibration Plan documented in WFC3 Instrument Science Reports and summarized in Appendix of WFC3 Instrument Handbook –inputs always welcome!
- Cycle 21 = 98 External and 1907 Internal Orbits

Program Title	Ext. Orbits	Int. Orbits	Program Title	Ext. Orbits	Int. Orbits
UVIS anneal	0	85	IR persistence model tests*	8	8
UVIS bowtie monitor*	0	243	Trapping mitigation in spatial scan observations of exocoster planets*	15	0
UVIS CCD daily monitor*	0	644	WFC3 contamination & stability monitor	10	0
UVIS CCD un-flashed monitor*	0	140	WFC3 UVIS & IR photometry*	18	0
UVIS post-flash monitor	0	60	IR Grism: cross checking sensitivity function of hot and cool star*	1	0
UVIS CCD gain stability	0	18	UVIS Grism: flux calibration*	2	0
IR dark monitor	0	95	UVIS Grism: wavelengths calibration & stability*	2	0
IR linearity monitor	3	9	IR Grisms: flux calibration*	4	0
IR gain monitor	0	16	IR Grisms: wavelengths calibration & stability*	4	0
UVIS CTI monitor (EPER)	0	12	IR Grisms sky characterization*	2	20
UVIS CTE monitor (star cluster)*	6	0	Recalibration of the IR Grism wavelength ZPs*	2	0
CTE characterization with post-flashed darks*	0	15	UV flats via spatial scan*	8	0
Characterization of the charge-level dependence of CTE losses*	0	13	UV flat field validation*	4	0
Characterization of UVIS traps with CI*	0	72	CCD anomalous QE pixels*	0	24
UVIS & IR geometric distortion	6	0	UVIS internal flats	0	15
High precision astrometry*	3	0	IR internal flats	0	18
			CSM monitor with earth flats*	0	400

Abstract

The Hubble Space Telescope's Wide Field Camera 3 provides observers with powerful imaging and slitless spectroscopic capabilities from 200 to 1700 nm. In this paper we present a summary of WFC3's current status and performance characteristics together with highlights of key new information for astronomers developing proposals for future science investigations. Over the past couple of years, observers have made increasing use of WFC3's ability to obtain high precision astrometric and photometric observations. We discuss improvements to the general astrometric calibration and recent advances in techniques for obtaining specialized observations with an astrometric precision better than 30 micro arc seconds. We also report on the photometric recalibration of the UVIS channel which incorporates independent solutions for the two CCD detectors resulting in improved zero points and color terms in the near ultraviolet and on measurements which demonstrate the excellent astrometric and photometric stability of this instrument. Finally, we provide advice for observers to better understand and predict astronomical backgrounds with the aim of improving the sensitivity of deep observations.



Additional Information:

http://www.stsci.edu/hst/wfc3

and

http://www.stsci.edu/hst/wfc3/documents/ISRs

Questions and Support: help@stsci.edu