

# WFC3

20 October 2016

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# CALF3 SUMMARY

WFC3 is operating nominally

## User support

- CS-IS reviews
- CY24

## Completed Studies

- Dragon's Breath
- EPER
- Post-flash monitor
- New IR dither patterns
- IR PSF libraries and QE
- Self-persistence on photometry
- Improved GRISM extractions

## Ongoing Studies

- IR flats
- Fringing
- IR “optimal’ super-darks



# WFC3 CY24 ROUTINE MONITORING

ID	PI	Program Title	Ext	Int	ID	PI	Program Title	Ext	Int		
UVIS CCD	14529	<i>Baggett</i>	UVIS anneal	0	79	14815	<i>Baggett</i>	WFC3/UVIS contam monitor	14	0	Photometry
	14530	<i>Sunnquist</i>	UVIS bowtie monitor	0	130	14882	<i>Sahu</i>	UVIS shutter monitoring	2	1	
	14531	<i>Bourque</i>	UVIS CCD daily monitor (darks & biases)	0	642	14883	<i>Deustua</i>	WFC3 UVIS & IR photometry	11	0	
	14532										
	14533										
	14534	<i>Khandrika</i>	UVIS CCD un-flashed monitor	0	135	14543	<i>Pirzkal</i>	WFC3 IR grisms wavelength calibration	4	0	
IR Detector	14535	<i>Martlin</i>	UVIS post-flash monitor	0	60	14544	<i>Pirzkal</i>	WFC3 IR grisms flux/trace calibration	4	0	Grisms
	14536	<i>Martlin</i>	UVIS CCD gain stability	0	18	14545	<i>Brammer</i>	WFC3 UVIS grism wavelength calibration	1	0	
CTE	14537	<i>Sunnquist</i>	IR dark monitor	0	97						Flats
	14538	<i>Gosmeyer</i>	IR linearity monitor	0	10	14546	<i>Bajaj</i>	UVIS Pixel-to-Pixel QE Variations via Internal Flats	0	51	
	14539	<i>Gosmeyer</i>	IR gain monitor	0	16	14547	<i>Bajaj</i>	UVIS internal flats	0	13	
Astrom	14540	<i>Khandrika</i>	UVIS CTI monitor (EPER)	0	12	14548	<i>Ryan</i>	IR internal flats	0	18	Astrom
	14541	<i>Mack</i>	UVIS CTE monitor (star cluster)	8	0	14549	<i>McCullough</i>	CSM monitor with earth flats	0	200	
	14542	<i>Martlin</i>	Characterization of UVIS traps with CI	0	36	14550	<i>Platais</i>	Astrometry monitoring	6	0	



## CY24 NEW CAL PROGRAMS

ID	PI	Title	Ext	Int
14878	<i>McCullough</i>	UVIS contamination using spatial scans	6	0
14897	<i>Baggett</i>	UVIS sink pixel map update	0	20
14880	<i>Anderson</i>	UVIS CTE Model Re-Characterization	0	15
14881	<i>Anderson</i>	UVIS CTE Pixel-Based Model Evaluation	2	0
		<b>TOTAL</b>	<b>8</b>	<b>35</b>



# QUICKLOOK ACTIVITIES

WFC3 Automation Platform

Unlocked Hold Anomalies Archives Automated Outputs Log Analysis Docs

Unlocked	On Hold	Log Analysis	Today's Status
New unlooked images. <a href="#">View All »</a> <a href="#">View From Start »</a>	Images placed on hold. <a href="#">View All »</a> <a href="#">View From Start »</a>	Missing files and ingest errors. <a href="#">Ingest Logs »</a> <a href="#">Missing File Logs »</a>	Unlooked Images: 0 Images on Hold: 8 Error Folders: 0 Incomplete Folders: 0

### Automated Outputs

These are the daily outputs of the WFC3 Automation Platform.

<b>Bowtie Plots</b> <a href="#">View Plots »</a>	<b>Bias Plots</b> <a href="#">View Plots »</a>	<b>Darks Plots</b> <a href="#">View Plots »</a>	<b>Disk Use Plots</b> <a href="#">View Plots »</a>
<b>UVIS Contam Monitor Plots</b> <a href="#">View Plots »</a>	<b>UVIS EPER CTI Plots</b> <a href="#">View Plots »</a>	<b>UVIS Gain Plots</b> <a href="#">View Plots »</a>	<b>IR Gain Plots</b> <a href="#">View Plots »</a>
<b>CSM Monitor Plots</b> <a href="#">View Plots »</a>	<b>UVIS External CTE Plots</b> <a href="#">View Plots »</a>	<b>IR Bad Actor List</b> <a href="#">View Table »</a>	<b>IR Persistence</b> <a href="#">View Table »</a>

### Database

The web interface to the MySQL database of all WFC3 images.

[Query form »](#)

### Proposal Links

Links to Cal and GO thumbnails by proposal ID.

[Cal proposals »](#) [GO proposals »](#)

### Script Execution Status

Execution status for cron job scripts.

Script	Date Last Executed	Status
cal_ir_make_bad_actor	10-05-2016 16:00	Completed Successfully
cal_ir_make_bias_plots	10-06-2016 08:45	Completed Successfully
cal_ir_make_persistence	10-05-2016 19:00	Completed Successfully
cal_uvvis_make_bowtie	10-06-2016 08:00	Completed Successfully
cal_uvvis_make_ctecorr_darks	10-06-2016 07:00	Completed Successfully

WFC3 Automation Platform

Unlocked Hold Anomalies Archives Automated Outputs Log Analysis Docs

**Dragon's breath**

Example 1 of dragon's breath — UVIS Example 2 of dragon's breath — UVIS Example 3 of dragon's breath — UVIS

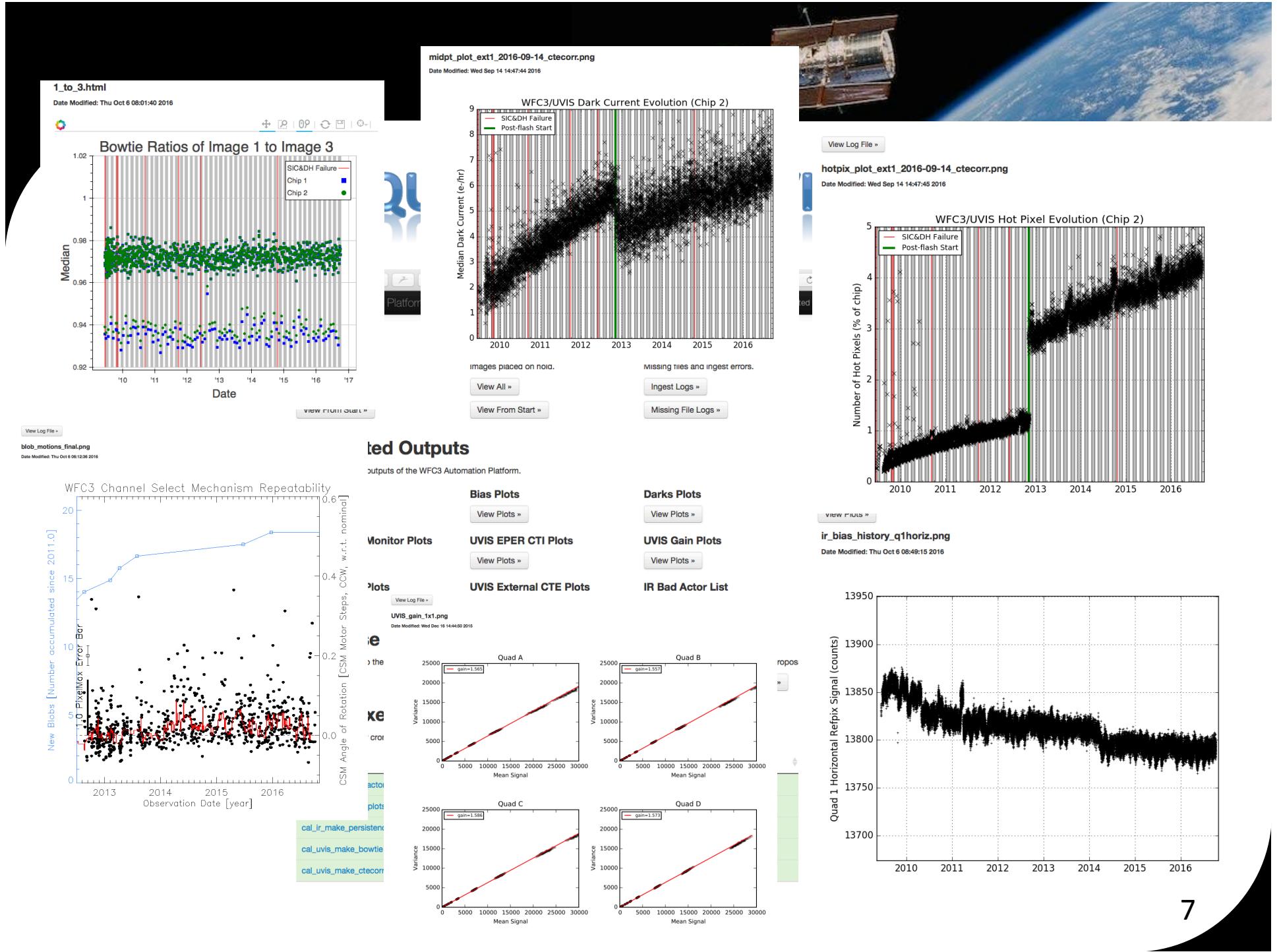
**Earth limb**

Example 1 of Earth shine — IR Example 2 of Earth shine — IR Example 3 of Earth shine — IR

**Excessive saturation**

Example 1 of excessive saturation — IR Example 2 of excessive saturation — UVIS Example 3 of excessive saturation — UVIS

6

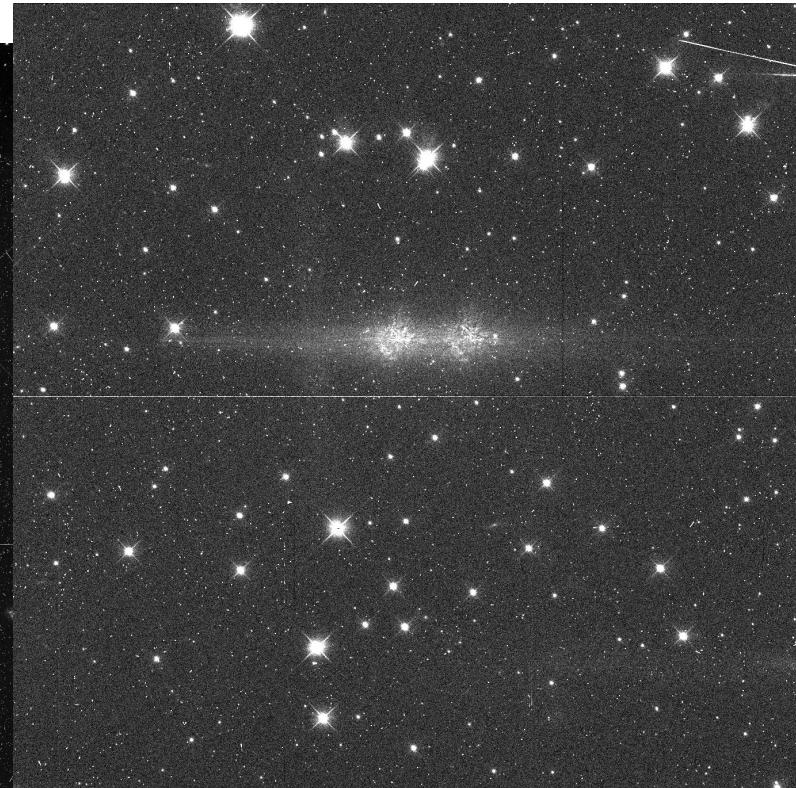
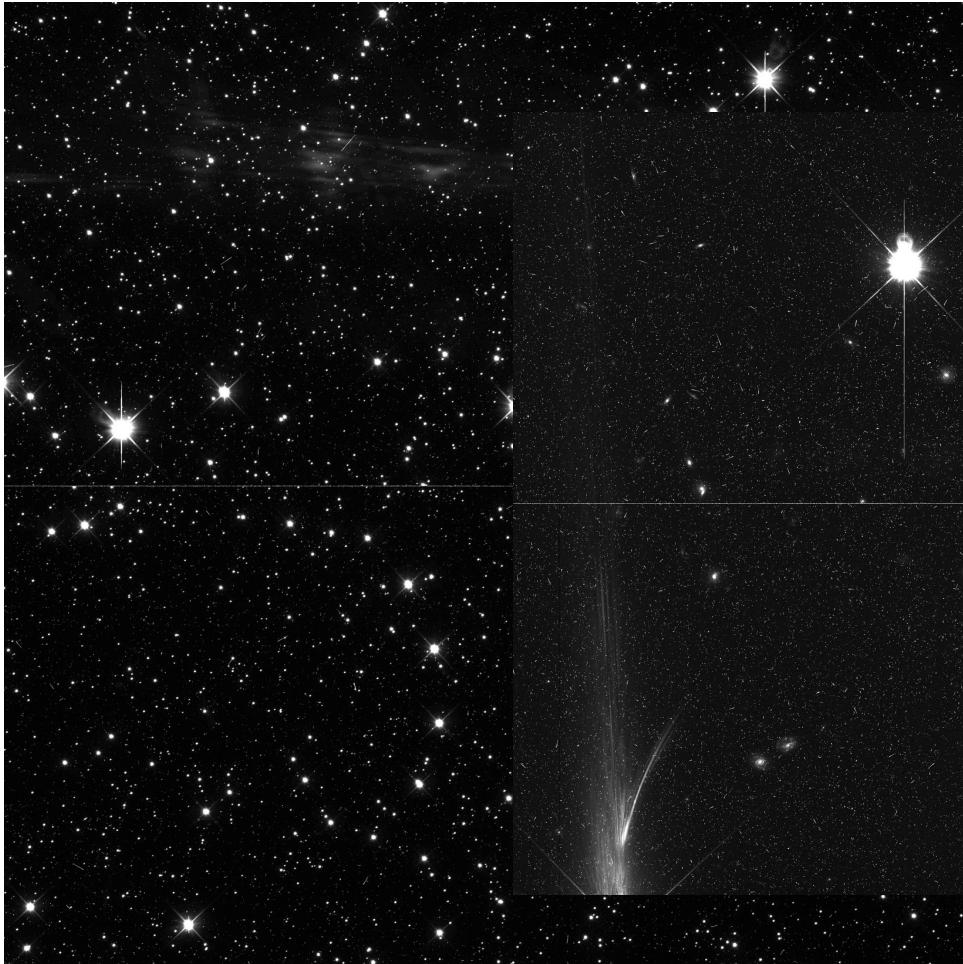




# Completed Studies & Enhancements



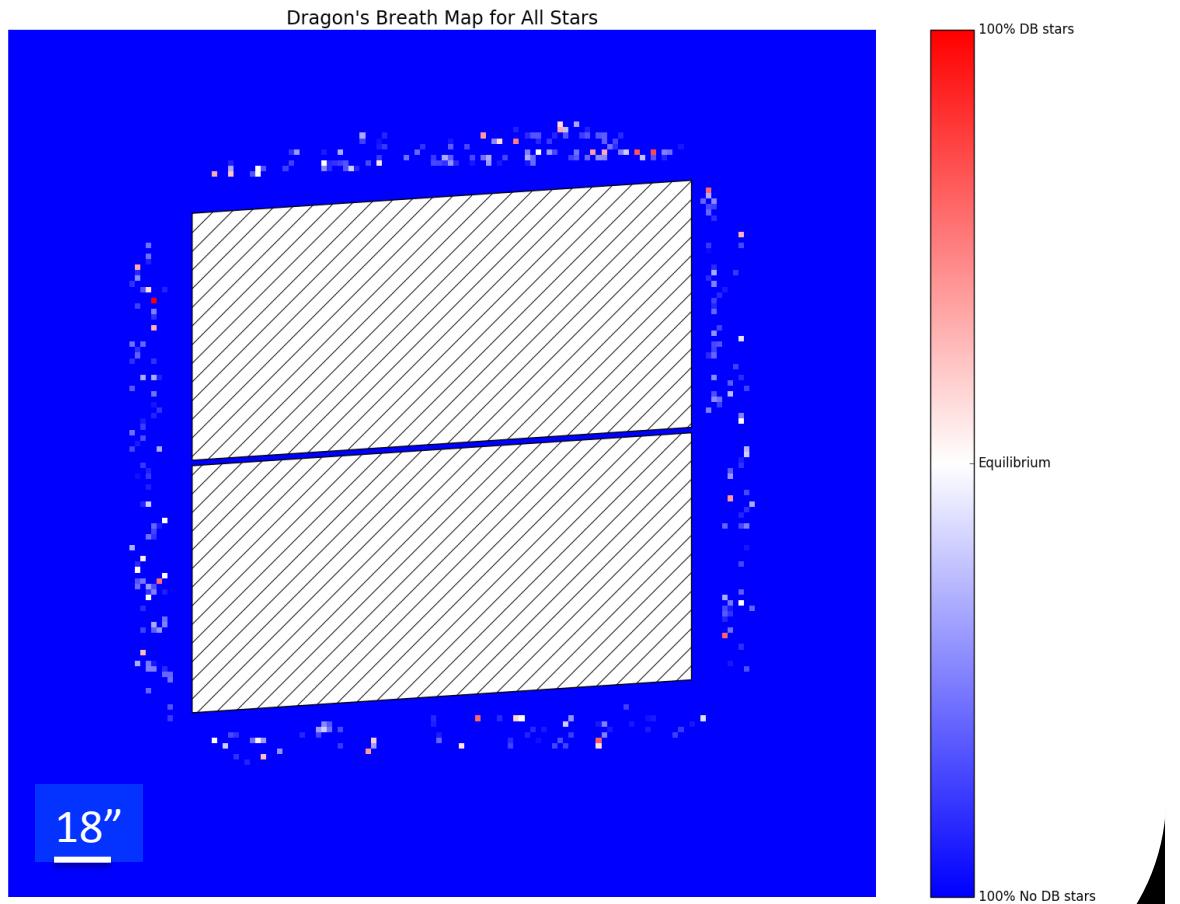
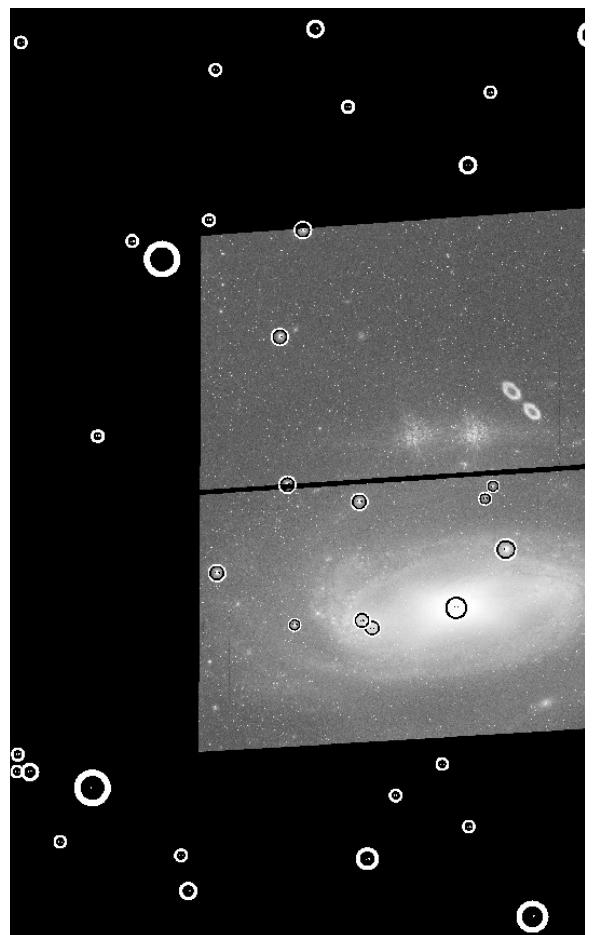
## WFC3/UVIS DRAGON'S BREATH



Larissa Markwardt (SASP 2016), Matthew Bourque & Katie Gosmeyer



# WFC3/UVIS DRAGON'S BREATH

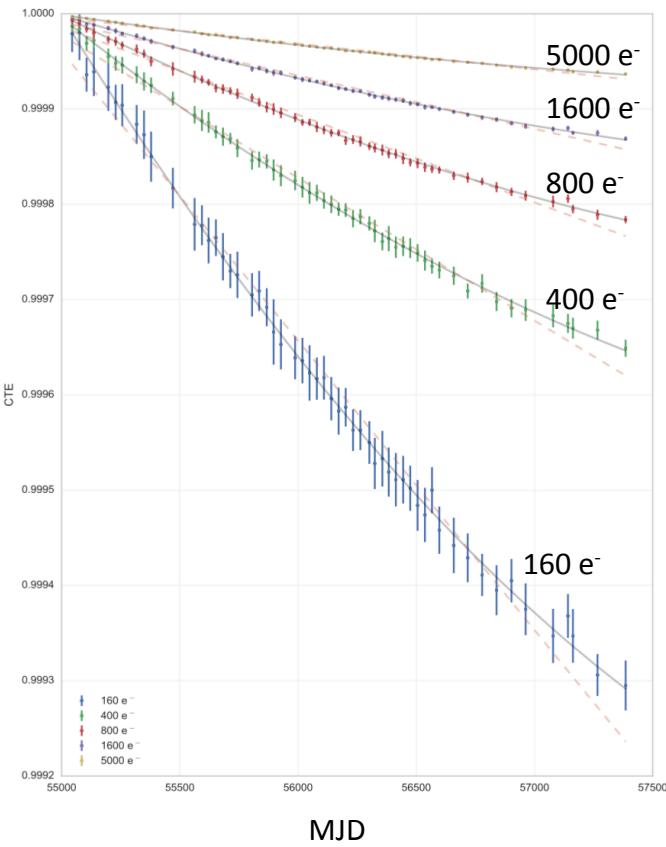


Larissa Markwardt (SASP 2016), Matthew Bourque & Katie Gosmeyer



## EPER CTE AUG 2009 – APR 2016

The Extended Pixel Edge Response (EPER) technique allows the monitoring of charge transfer efficiency (CTE) decline with time.



The EPER CTE decline has been traditionally modeled with a linear least-squares fit.

The decline is non-linear, especially at the lower illumination rates. It is better represented by a quadratic function.

This may indicate that the CTE decline is leveling off or reducing with time.

Harish Khandrika et al. WFC3-ISR 2016-10

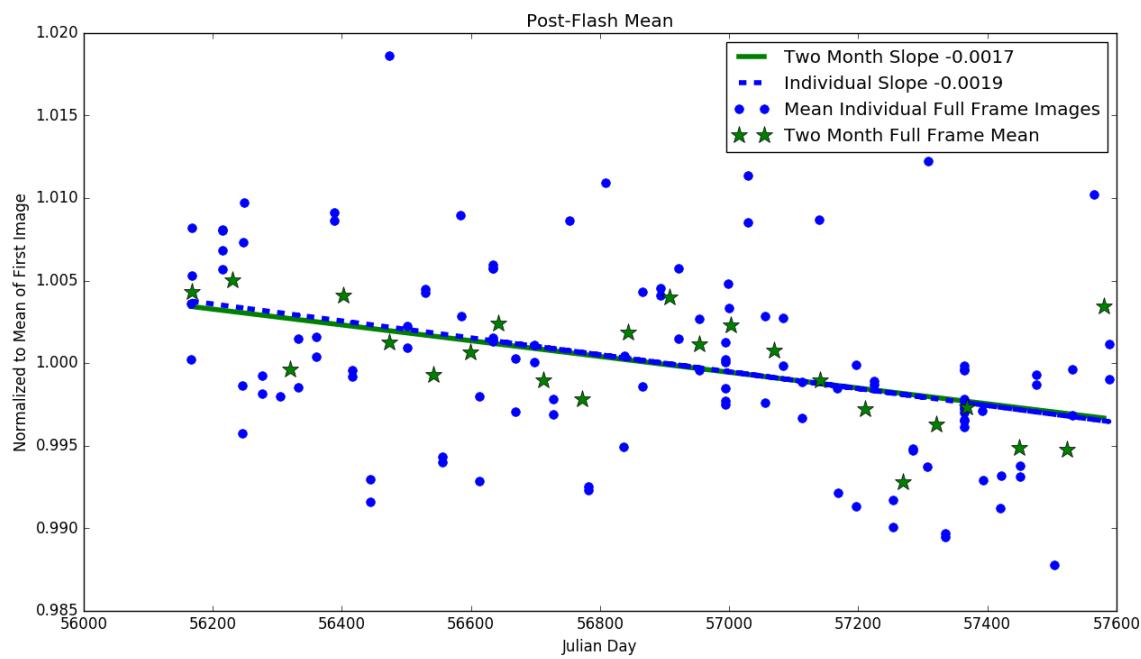


# POST FLASH MONITOR

Post-flash is an effective way to mitigate the effect of the degrading CTE.

The analysis of the post-flashed darks shows a progressive decrease in the LED intensity.

	Low Current	Medium Current	High Current
Hours of use	26.7	7.7	0.003
Number of Images	22430	959	10

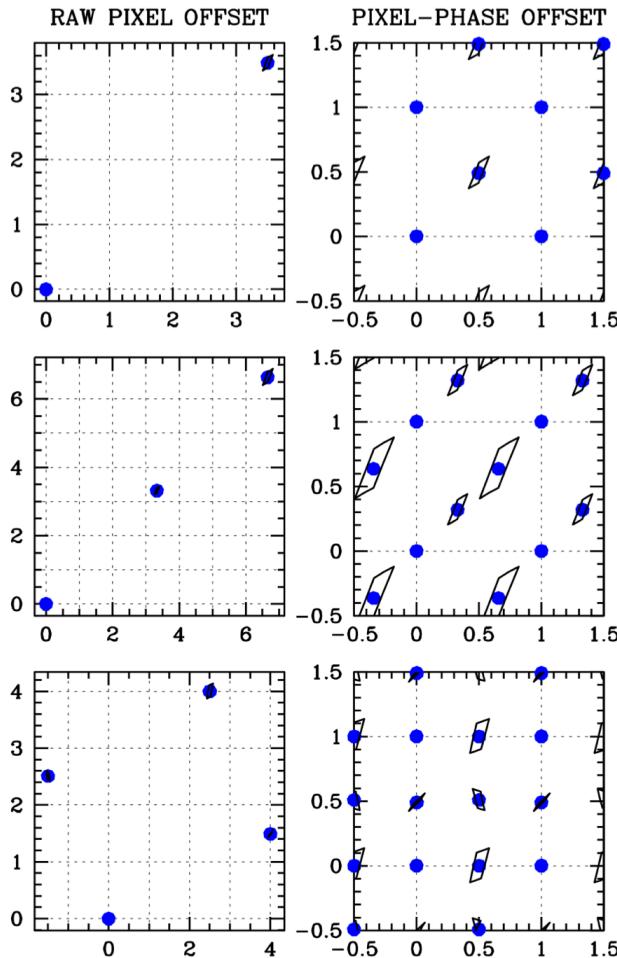


- LED life time of 100,000 hours.
- There is a backup LED on WFC3.

Heather Kurtz



## SUPPLEMENTAL WFC3/IR DITHER PATTERNS

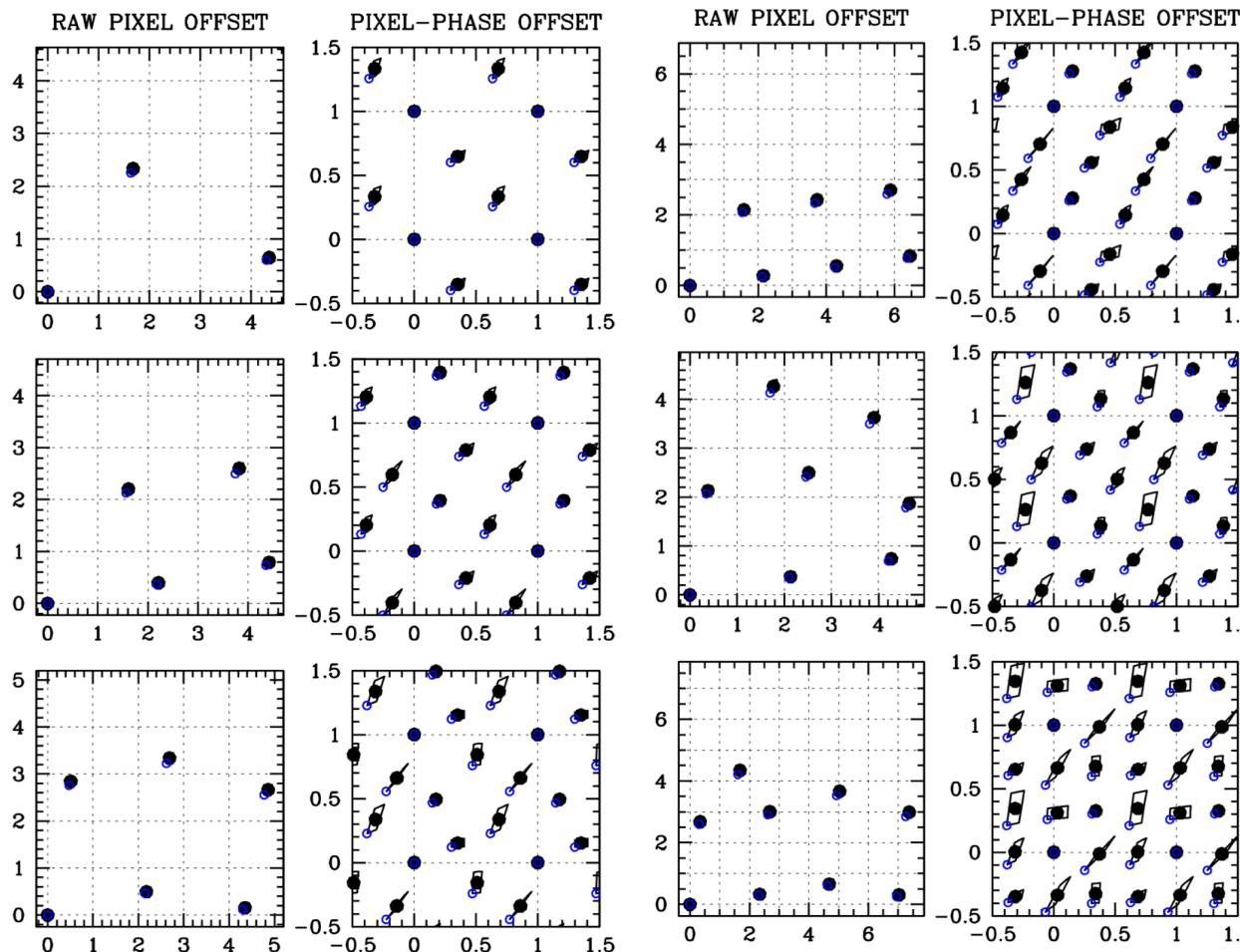


In the handbook we provide instructions for 2, 3 and 4 point dither patterns (with the recommended 3-pt being not optimized for re-sampling the PSF).

Because of the small size of WFC3/IR images it is common for users to acquire more than 4 exposures (pointings) per filter in one orbit.



# SUPPLEMENTAL WFC3/IR DITHER PATTERNS

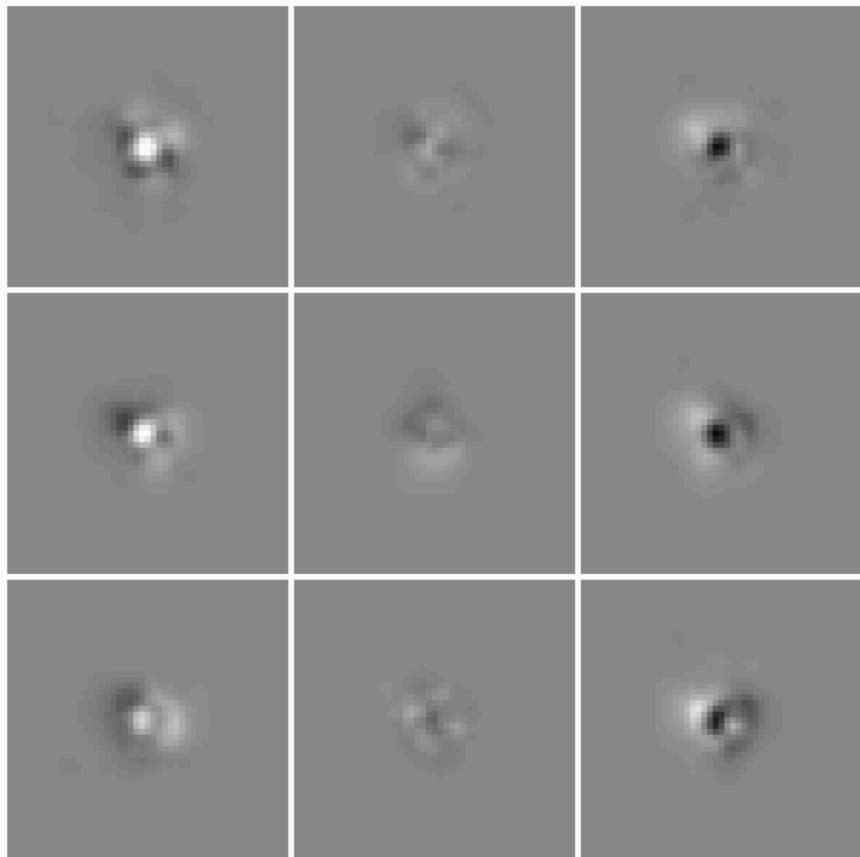


New patterns optimized for the resampling of the PSF now available for 3, 5, 6, 7, 8 and 9 pointings.

Jay Anderson, WFC3-ISR 2016-14



## WFC3/IR PSF LIBRARIES



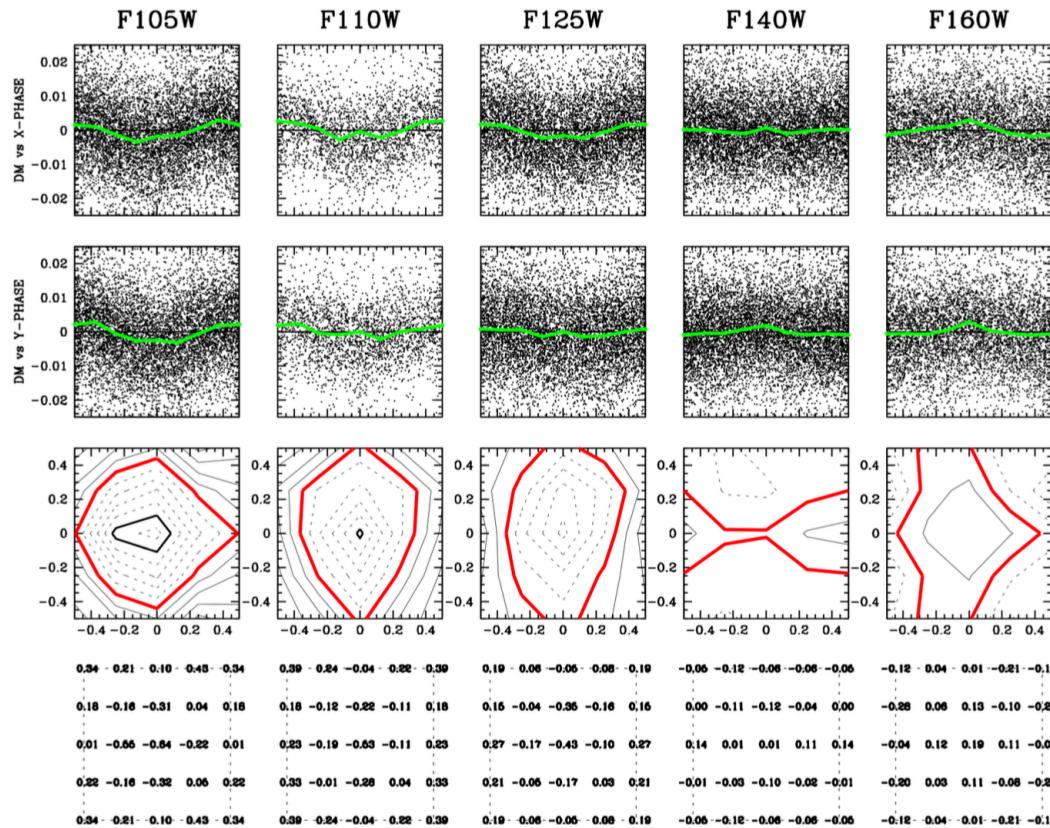
The WFC3/IR PSF is severely undersampled (42% of the flux is in the central pixel vs. the pure 20% of a Gaussian that is Nyquist sampled).

Significant complications in the analysis of point sources and barely resolved objects.

In F105W the shape of the PSF changes across the detector. The PSF has more flux in the central pixel on the right (43%) and less on the left side (39%) of the detector.



# WFC3/IR PSF LIBRARIES



We derived spatially variable PSFs libraries for 5 highly used broadband filters.

The PSF become better-sampled moving towards longer wavelengths.

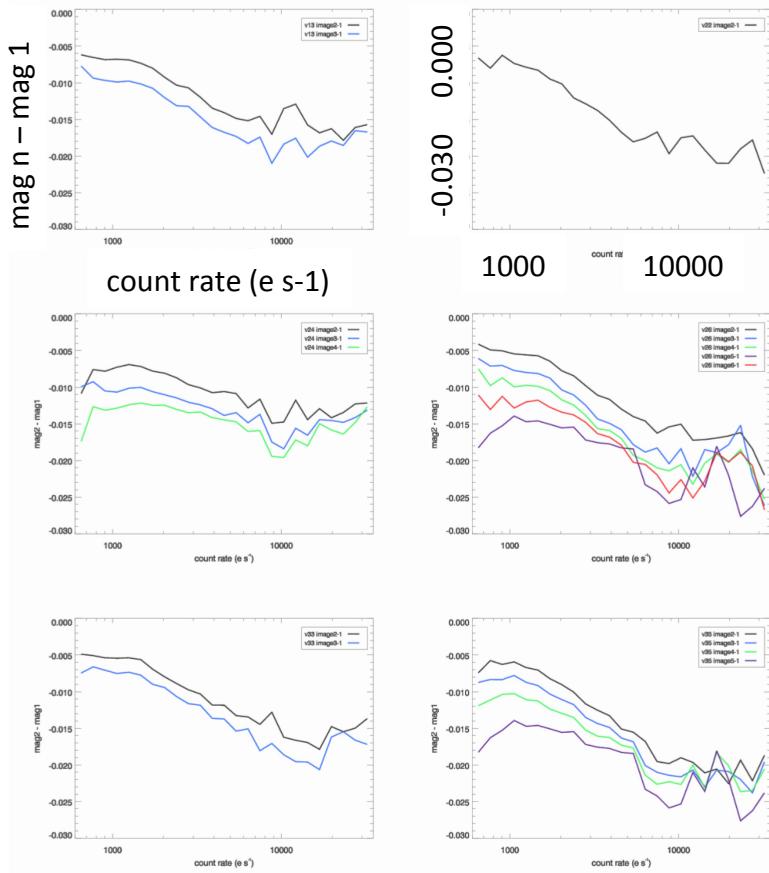
The WFC3/IR detector shows mild QE variations, with the total number counts collected for star depending in the pixel phase.

The center of the pixels is more sensitive to blue light than the rest of the pixel.

New PSF libraries can be downloaded from  
<http://www.stsci.edu/hst/wfc3/analysis/PSF>



# EFFECT OF REPEATED EXPOSURES ON IR PHOTOMETRY



The flux measured in an IR pixel depends on its previous history.

We examined a set of observations where multiple exposures were taken at the same position (no dither).

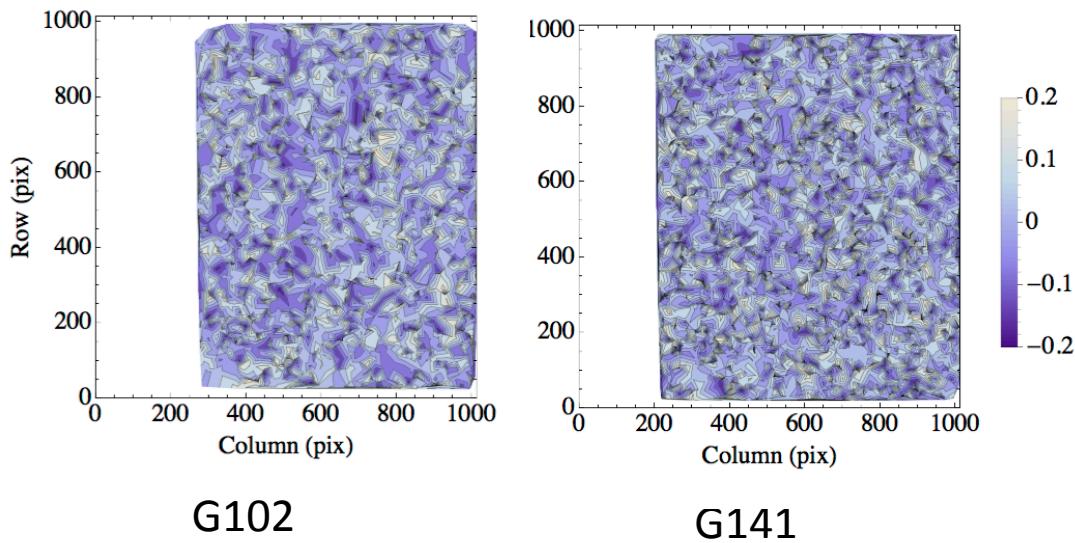
- The flux rises with the number of exposures.
- The flux increase can affect photometry at the level of 0.02-0.04 magnitudes

Knox Long, Sylvia Baggett & Vera Kozhurina-Platais,  
WFC3-ISR 2016-11



# IMPROVED TRACE AND WAVELENGTH CALIBRATIONS FOR G102 AND G141 GRISMS

0 order



The extent of the field of view edges has been determined for both grisms. The FoV extends -22 arcsec (-183 WFC3/IR pixels) to the left and +10 arcsec (+85 pixels) to the right.

The spectral trace, wavelength solution and throughput of G102 and G141 remain stable.

Improved calibration using new reference standard and archival data.

Residuals for the trace calibration:  
+1 order <0.05 pixel,  
-1 order ≈ 0.1 pixel,  
0<sup>th</sup> order < 1 pixel.

Nor Pirzkal, Russell Ryan & Gabe Brammer,  
WFC3-ISR 2016-15



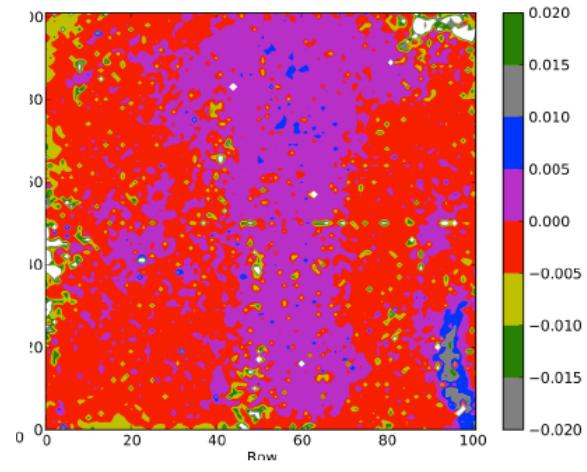
Ongoing studies



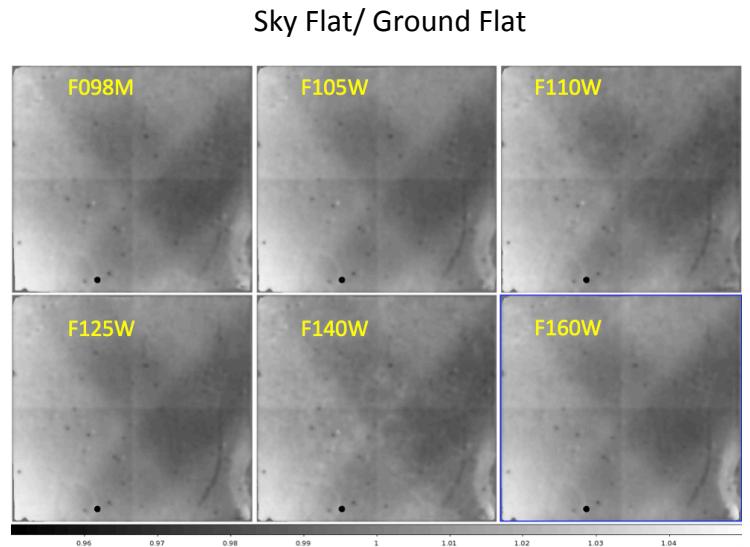
# IR SKY FLATS

Pipeline flats combines  
Ground P-flats \* “Grey” L-flat

- In-flight L-flat are from sky flats using 2009-2010 data.
- Due to limited data we created a ‘grey’ correction by weighting average of all filters.
- Grey L-flat is smoothed before combining with P-flats flats.



Fractional Difference F125W & F160W



ISR WFC3-2011-11  
Color residuals  
i.e. ~2% in the wagon wheel



# FRONTIER FIELDS ABEL 370 PARALLEL

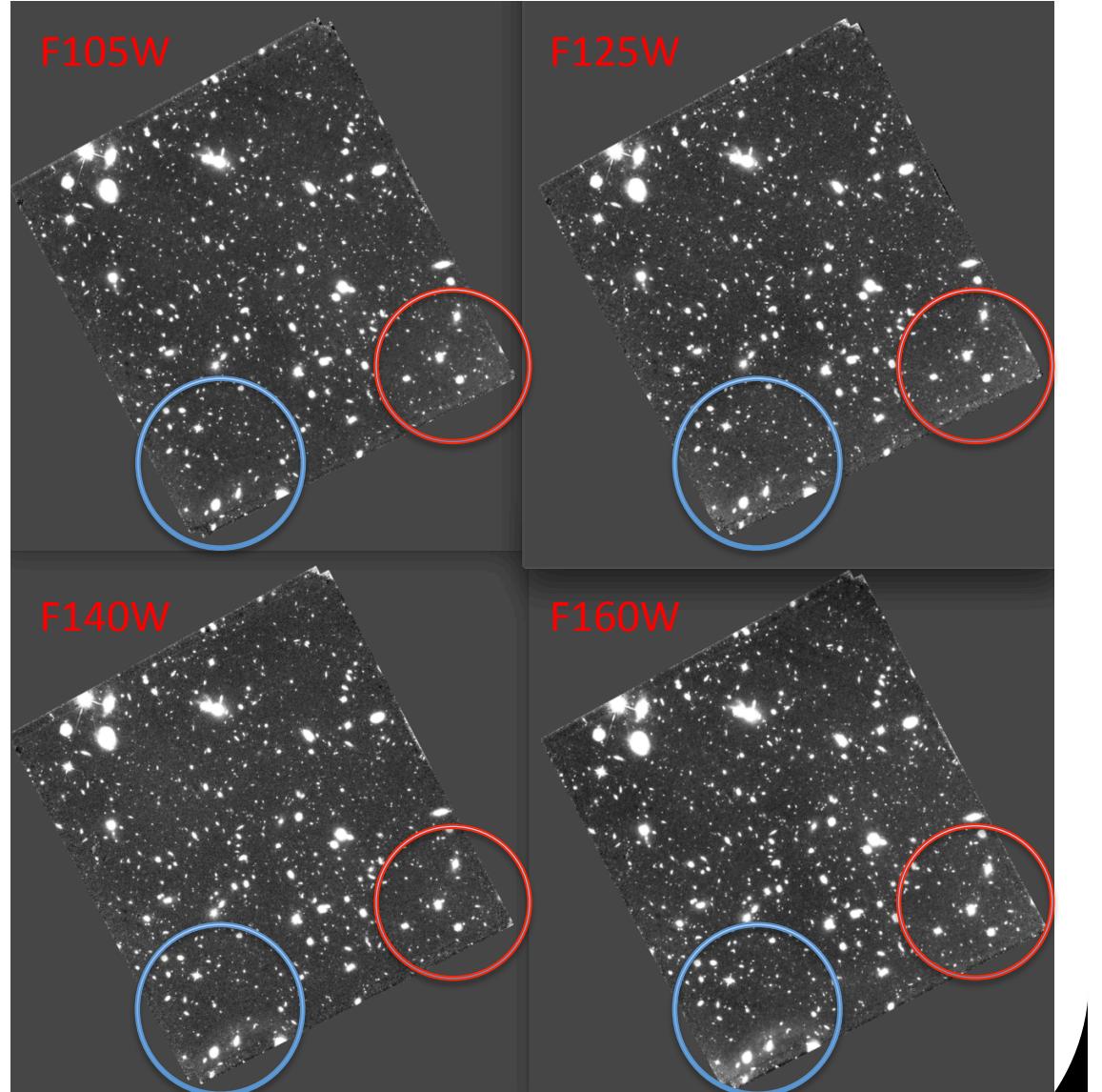
Color-dependent features:

Wagon Wheel

Amp B corner

More data available:  
Filter dependent L-flat correction  
possible.

F160W solution is still ~20% noisier  
than the ground P-flat, smoothed the  
correction.





## IR BLOBS

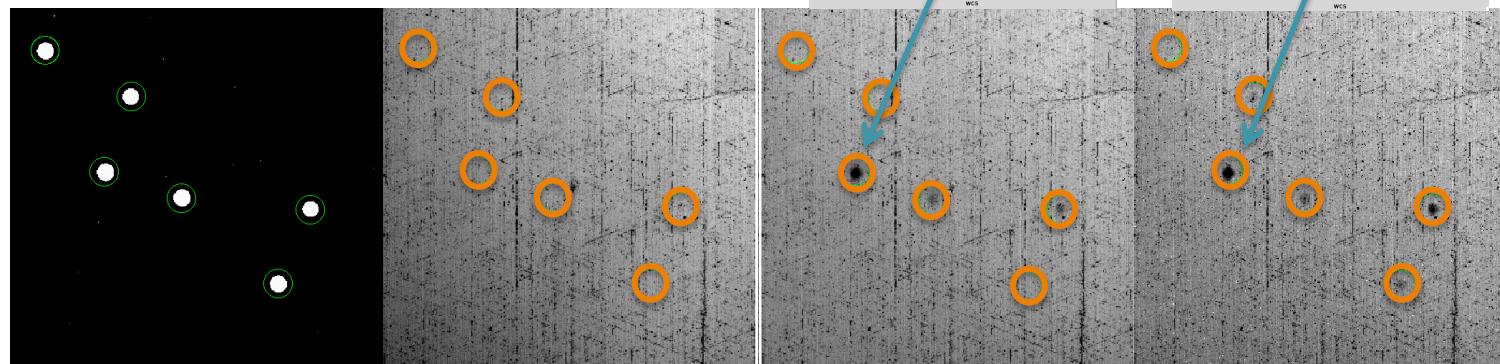
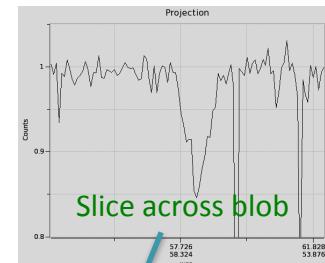
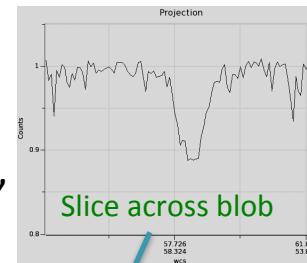
Defocused images of particulates on the CSM reduce the sensitivity of ~10-15% in small regions (IR blobs).  
IR blobs are not in the [ground flats](#); first observed after WFC3 installed. The number increased over time.  
Since Dec 2009, the number of blobs has stabilized and remained ~constant.

Inflight blobs do not move, nor grow in size, nor eventually disappear.

In smoothed “Grey” F-flat correction (currently in the pipeline) blobs are broader with reduced depth

Replaced the smoothed blobs with their unsmoothed values taken from sky flats

Improves data products for data with no “blob-dither”





## FRINGING CORRECTION

- Create fringing model from ground test data
- Use IDL code:
  - Scale fringe model to image
  - Remove fringing
- USE IDL code to Scale fringe model to:
  - Determined bright and dark regions of the fringe model
  - Take the mean of the bright areas minus the mean of the dark
  - Median ratio of image to fringe model
  - Subtract fringe from image

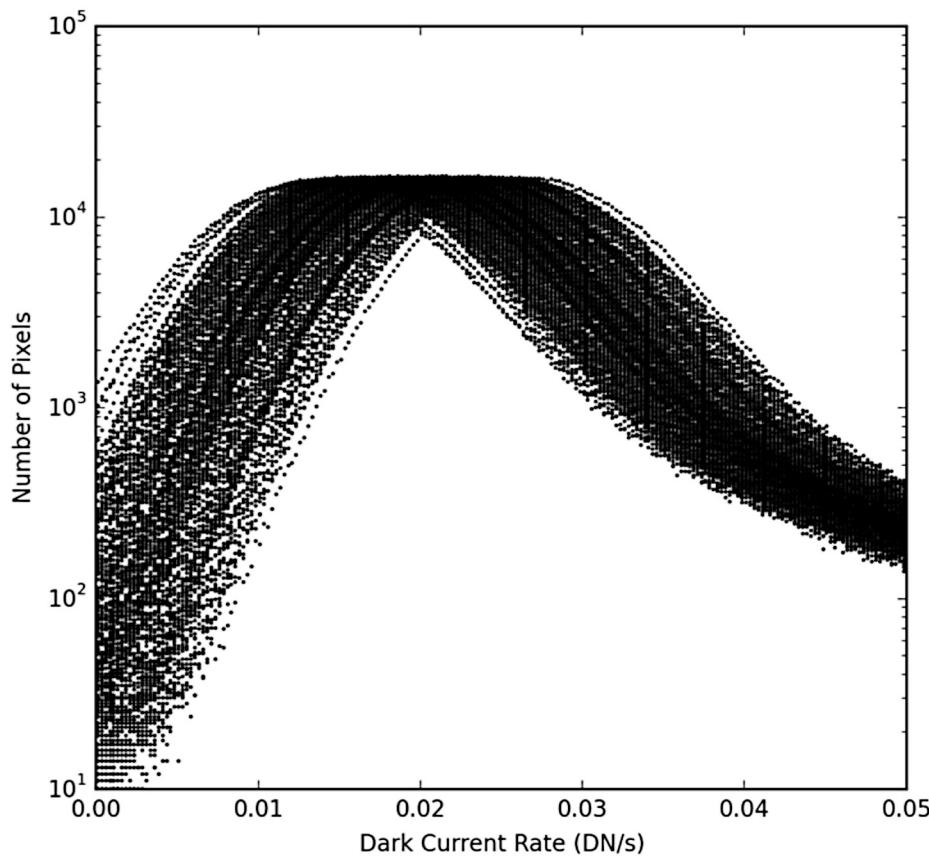


Needs to be tested for more filters and variable backgrounds.

The IDL code will be released to the community via WFC3 webpage.



## WFC3/IR DARK CURRENT

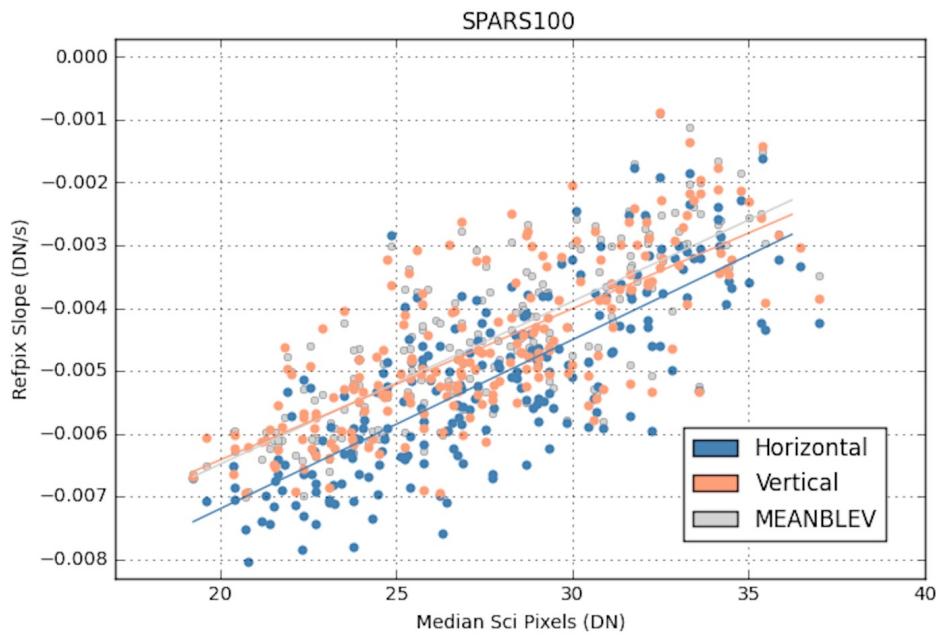


The overall IR dark signal has remained nearly constant since launch. However image-to-image peak dark rates vary by ~0.02 DN/s.

The cause of this variation is unknown, and the current IR superdark generation method incorporates the full range of these darks.



# WFC3 IR DARK CURRENT



For a given 15-read SPARS100 IR dark, the reference pixel signal decreases between  $\sim$ 5-10 DN up the ramp.

The rate of this decrease is related to the median dark signal in the image.

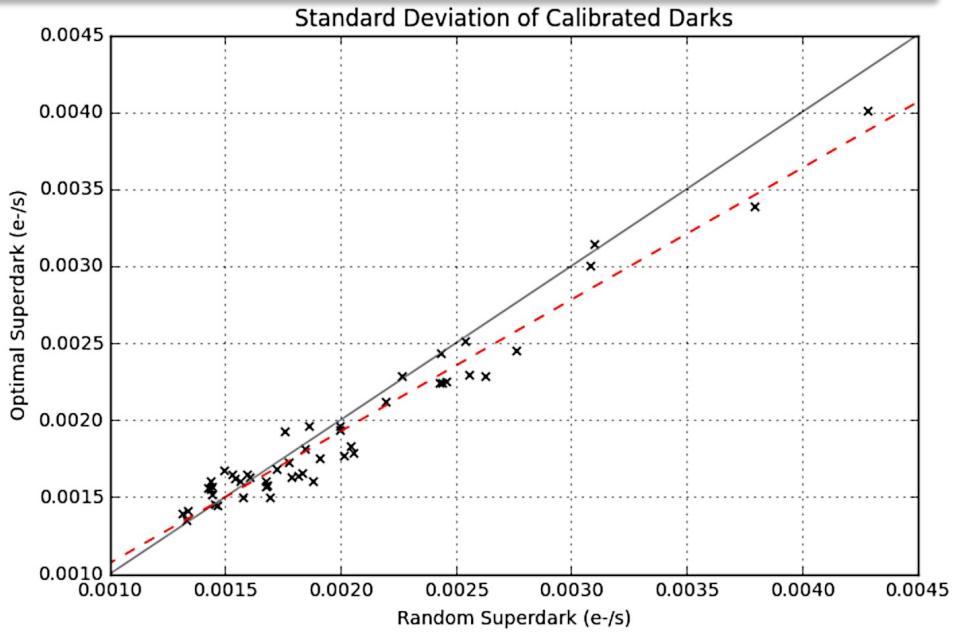
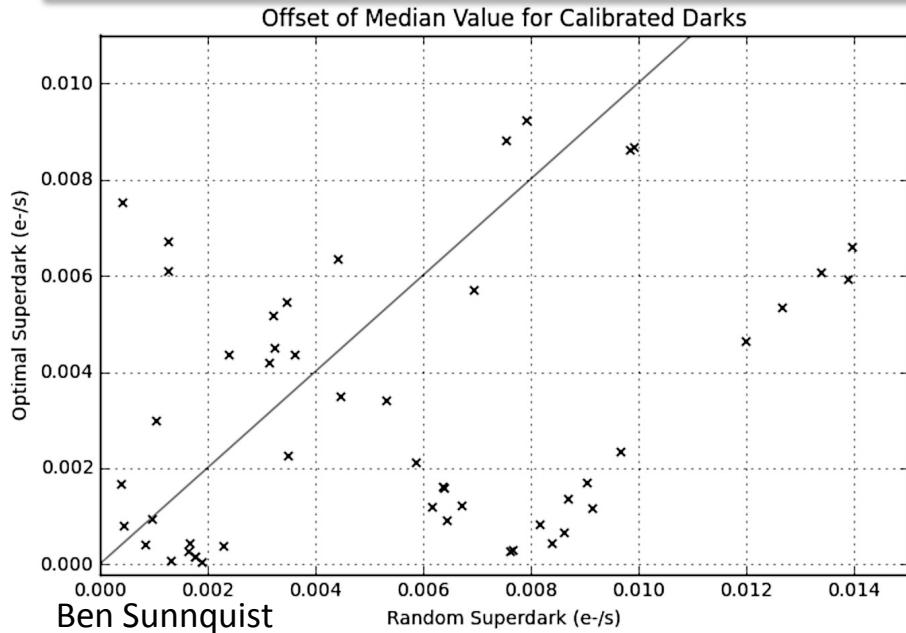
This relationship holds in other tested sample sequences (SPARS200, STEP200) and using only horizontal reference pixels (which aren't affected by signal memory).



## OPTIMAL IR SUPER-DARK

A new, ‘optimal’ superdark based on the previous relationship (and unique to an image’s reference pixel slope) may outperform our current method (called ‘random’ in the plots). Individual IR darks calibrated with this ‘optimal’ superdark generally have lower remaining signal (i.e. peak values closer to zero) and lower standard deviations.

This new superdark generation method is currently being optimized and tested on science images for potential incorporation into the pipeline.





## RECENTLY PUBLISHED ISRS

WFC3 ISR 2016-15: "*Trace and Wavelength Calibrations of the WFC3 G102 and G141 IR Grisms*" Nor Pirzkal, Russell Ryan, and Gabriel Brammer

WFC3 ISR 2016-14: "*Supplemental Dither Patterns for WFC3/IR*" Jay Anderson

WFC3 ISR 2016-13: "*WFC3 Cycle 23 Proposal 14373: UVIS Gain*" Catherine Martlin

WFC3 ISR 2016-12: "*Empirical Models for the WFC3/IR PSF*" Jay Anderson

WFC3 ISR 2016-11: "*The Effect of Repeated Exposures on Measured Fluxes in the WFC3/IR Detector*" Knox Long, Sylvia Baggett, and Vera Kozhurina-Platais

WFC3 ISR 2016-10: "*WFC3/UVIS EPER CTE Cycles Aug 2009 – Apr 2016*" Harish Khandrika, Sylvia Baggett, and Ariel Bowers

WFC3 ISR 2016-07: "*Updated WFC3/UVIS Chip Dependent SYNPHOT/PYSYNPHOT Files*" Susana Deustua