WFC3 Cycle 31
Calibration Monitoring

J. Mack, S. Baggett & the WFC3 Team
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WFC3 Cycle 31 Calibration

External orbits = 62
Internal orbits = 1525

Category	ID	PI	Program Title	Ext	Int
UVIS CCD	17345	*Baggett*	WFC3 UVIS Anneal	0	79
UVIS CCD	17346	*Khandrika*	WFC3 UVIS Bowtie Monitor	0	132
UVIS CCD	17347-17349	*Pidgeon*	WFC3 UVIS CCD Daily Monitor (Darks & Biases)	0	642
UVIS CCD	17350	*Rivera*	WFC3 UVIS CCD Unflashed (CTE) Monitor	0	130
UVIS CCD	17351	*Martlin*	WFC3 UVIS Post-flash Monitor	0	60
UVIS CCD	17352	*Kuhn*	WFC3 UVIS CCD Gain Stability	0	18
CTE	17353	*Khandrika*	WFC3 UVIS CTI Monitor (EPER)	0	12
CTE	17354	*Kuhn*	WFC3 UVIS CTE Monitor (Star Cluster)	8	0
CTE	17355	*O'Connor*	WFC3 Characterization of UVIS Traps with Charge Injection	0	36
CTE	17356	*Anderson*	WFC3 UVIS CTE Internal Monitor	0	15
IR Detector	17357	*Dauphin*	WFC3 IR Dark Monitor	0	97
IR Detector	17358	*Green*	WFC3 IR Linearity Monitor	0	10
IR Detector	17359	*Huynh*	WFC3 IR Gain Monitor	0	16

Category	ID	PI	Program Title	Ext	Int
Photometry	17360	*Huynh*	WFC3 UVIS Shutter Monitoring	0	2
Photometry	17361	*Calamida*	WFC3 UVIS & IR Photometry	20	0
Photometry	17362	*Marinelli*	WFC3 UVIS Time Dependent Sensitivity	12	0
Photometry	17363	*Bajaj*	WFC3 IR Time-Dependent Sensitivity: Clusters	3	0
Photometry	17586	*Som*	**WFC3 IR Time-Dependent Sensitivity: Spatial Scans ****	2	0
Focus	17364	*Dressel*	HST Cycle 31 Focus & Optical Monitor	6	0
Grisms	17365	*Som*	WFC3 IR Grism Wavelength Calibration	1	0
Grisms	17366	*Som*	WFC3 IR Grism Flux/Trace Calibration	3	0
Grisms	17367	*Pagul*	WFC3 UVIS Grism Wavelength Calibration	1	0
Flats	17368	*Kuhn*	WFC3 UVIS Pixel-to-Pixel QE Variations via Internal Flats	0	45
Flats	17369	*Khandrika*	WFC3 UVIS Internal Flats	0	13
Flats	17370	*Green*	WFC3 IR Internal Flats	0	18
Flats	17371	*Dauphin*	WFC3 CSM Monitor with Earth Flats	0	200
Astrom	17372	*Martlin*	WFC3 Astrometric Scale Monitoring	6	0

** Non- monitor CAL

WFC3 Cycle 30 Calibration

External orbits = 65
Internal orbits = 1525

Category	ID	PI	Program Title	Ext	Int
UVIS CCD	16967	*Baggett*	WFC3 UVIS Anneal	0	79
UVIS CCD	17002	*Khandrika*	WFC3 UVIS Bowtie Monitor	0	132
UVIS CCD	17003-17005	*Pidgeon*	WFC3 UVIS CCD Daily Monitor (Darks & Biases)	0	642
UVIS CCD	17006	*Pidgeon*	WFC3 UVIS CCD Unflashed (CTE) Monitor	0	130
UVIS CCD	16982	*Martlin*	WFC3 UVIS Post-flash Monitor	0	60
UVIS CCD	17007	*Kuhn*	WFC3 UVIS CCD Gain Stability	0	18
CTE	17008	*Khandrika*	WFC3 UVIS CTI Monitor (EPER)	0	12
CTE	17009	*Kuhn*	WFC3 UVIS CTE Monitor (Star Cluster)	8	0
CTE	17010	*Marinelli*	WFC3 Characterization of UVIS Traps with Charge Injection	0	36
CTE	17259	*Anderson*	WFC3 UVIS CTE Internal Monitor	0	15
CTE	17262	*Anderson*	**WFC3 UVIS Faint-Source CTE Characterization ****	1	0
IR Detector	17011	*Dauphin*	WFC3 IR Dark Monitor	0	97
IR Detector	17012	*Green*	WFC3 IR Linearity Monitor	0	10
IR Detector	17013	*Khandrika*	WFC3 IR Gain Monitor	0	16

Category	ID	PI	Program Title	Ext	Int
Photometry	17014	*Sahu*	WFC3 UVIS Shutter Monitoring	0	2
Photometry	17265	McCullough	**WFC3 UVIS Shutter Timing Jitter ****	1	0
Photometry	17015	*Calamida*	WFC3 UVIS & IR Photometry	20	0
Photometry	17016	*Calamida*	WFC3 UVIS Time Dependent Sensitivity	12	0
Photometry	17260	*Bajaj*	WFC3 IR Time-Dependent Sensitivity: Clusters	3	0
Photometry	17261	*Som*	**WFC3 IR Time-Dependent Sensitivity: Scans ****	2	0
Photometry	17271	*Bajaj*	**WFC3 UVIS Deep PSFs ****	5	0
Focus	17258	*Dressel*	HST Cycle 30 Focus & Optical Monitor	6	0
Grisms	17017	*Som*	WFC3 IR Grism Wavelength Calibration	1	0
Grisms	17018	*Som*	WFC3 IR Grism Flux/Trace Calibration	3	0
Grisms	n/a	*Som*	WFC3 UVIS Grism Wavelength Calibration (every 2 years)	0	0
Flats	17019	*Kuhn*	WFC3 UVIS Pixel-to-Pixel QE Variations via Internal Flats	0	45
Flats	17020	*Khandrika*	WFC3 UVIS Internal Flats	0	13
Flats	17021	*Green*	WFC3 IR Internal Flats	0	18
Flats	17022	*Dauphin*	WFC3 CSM Monitor with Earth Flats	0	200
Astrom	17023	*Martlin*	WFC3 Astrometric Scale Monitoring	6	0

** Non- monitor CAL

WFC3 Calibration Orbit Request by Cycle

Cycle	Type		External (e)	Internal (i)
31	Monitor		60	1525
	Delta : Fall 2023		**2**	**0**
		Total	62	1525
30	Monitor		50	1510
	New Monitors		9	15
	Delta : Fall 2022		6	0
		Total	65	1525
29	Monitor		51	1509
	Delta: Fall 2021		8	10
		Total	59	1519
28	Monitor		48	1509
	Delta : Fall 2020		6	24
	Delta : Spring 2021		9	0
		Total	63	1533

Cycle 31 Delta
- IR TDS Scans = 2e

Cycle 30 New Monitor
- Focus = 6e
- CTE Internals = 15i
- IR TDS Clusters = 3e

Cycle 30 Delta
- IR TDS Scans = 2e
- Deep UVIS PSFs = 2e
- Shutter Timing Jitter = 1e
- Faint Source CTE = 1e

Cycle 29 Delta
- IR Time-Dep (Clusters) = 5e
- CTE Pinning = 10i
- CTE Photom/Astrom = 2e
- CTE Resolved Sources = 1e

Cycle 28 Delta
- IR Grism Flux Calibration = 2e
- IR Time-Dep (Scans) = 2e
- UVIS Background Check = 24i
- UVIS External CTE = 2e
- Photometry = 1e
- IR Time-Dep (Clusters) = 2e
- Focus = 6e

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

UVIS CCDs

Same as the previous cycle

Monitor the health and stability of UVIS channel via the following calibration:

- Perform an anneal of the detector every month
  79 internal = 6 orbits/anneal * 13 anneals + 1 IR dark contingency
- Mitigate hysteresis (bowtie) by conditioning the detector via a series of unsaturated and saturated internal flats
  132 internal = 122 orbits (1 every 3 days) + 10 contingency for SIC&DH lockups
- Perform daily monitoring of the CCDs using a series of dark & biases. Provide updated darks & hot pixel maps
  642 internal = 91 four-day cycles * 7 orbits/cycle = 637 internal orbits + 5 contingency
- Assess how well post-flash is mitigating CTE losses with time using a series of unflashed darks
  130 internal = 10 orbits/anneal * 13 anneals
- Monitor the stability of the post-flash LED with time
  60 internal = 12 iterations * 3 orbits (pattern + brightness checks) + 12 (ref_files) + 12 contingency
- Verify the gain stability in all 4 UVIS quadrants for each binning mode using internal flats over a range of exposures
  18 internal = 9 orbits * 2 epochs

WFC3/UVIS Anneal

Orbits	External: 0 Internal: 79
PI, Co-I's	Baggett, Khandrika, Kuhn, Pidgeon, Rivera
Purpose	Perform regular anneal procedures to 1) repair hot pixels and 2) acquire internal exposures to assess the anneal's effectiveness as well as produce reference files for the calibration pipeline.
Description	WFC3 anneals are performed every 28 days, a cadence which optimally interleaves the WFC3 procedure with those from other instruments. Internal biases as well as darks are taken before and after each procedure to provide a check of bias level, read noise, global dark current, and hot pixel population. A bowtie visit is acquired immediately after each anneal to provide a hysteresis-neutralizing image as well as verify that any hysteresis present has been successfully quenched. In the prior cycle, WFC3 anneals have been performed keeping the IR detector cold (IRTEMP=COLD). This cycle, one iteration may be executed according to the original anneal procedure commanding that includes a partial warming of the IR detector; for this case, one post-anneal IR dark will be needed.
Resources: Observations	79 total = (13 iterations * 6 orbits/iteration) + 1 orbit. Each iteration requires 6 orbits (2 before/2 after each anneal for biases/darks + 1 orbit for the anneal itself + 1 orbit for the attached post-anneal bowtie visit). Seamless continuity across the cycle boundary requires 13 anneals. One orbit for 1 IR dark to be taken *only* in the event an original anneal procedure (warming the IR detector) is performed.
Resources: Analysis	Supports 100% of UVIS programs
Products	Quicklook monitoring plots and tables: read noise, dark current, hot pixels. Data used for daily superdarks (CTE-corrected and un-CTE-corrected), pixel history analysis with monthly bad pixel table deliveries as well as yearly superbiases for calibration pipeline.
Accuracy Goals	Readnoise to <1% ; dark reference files ~2e-/hr rms; bias reference files <1e- rms.
Prior Results, ISRs	Quicklook monitoring plots; Superbias reference file (ISR 2023-03); UVIS pixel history (ISR 2018-15); read noise (ISR 2017-17)
Prior Cycle IDs	12343, 12687, 13071, 13554, 14000, 14366, 14529, 14978, 15567, 15712, 16414, 16564, 16967 (cy30)

WFC3/UVIS Anneal

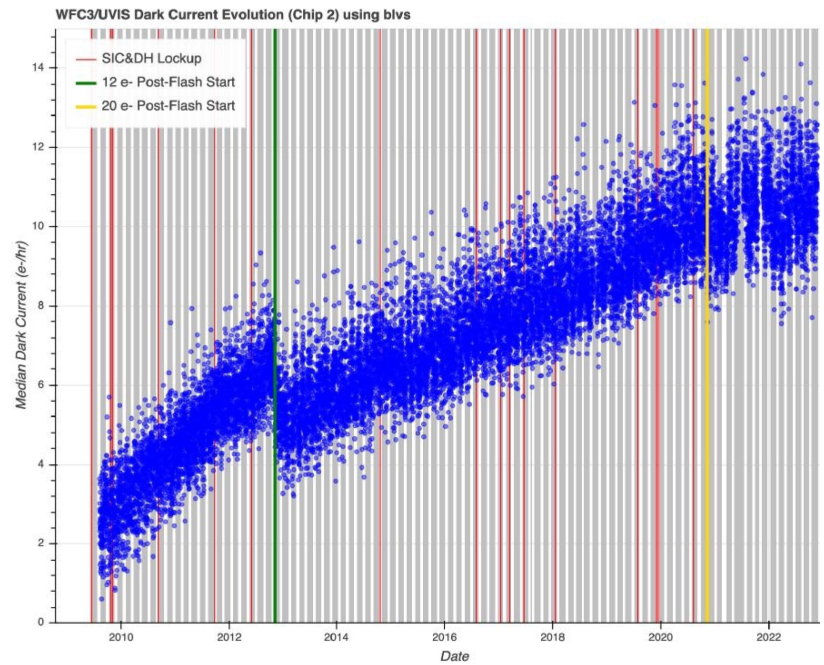
Reference files for CRDS

- BIASFILE
- DARKFILE, DRKCFILE
- BPIXTAB

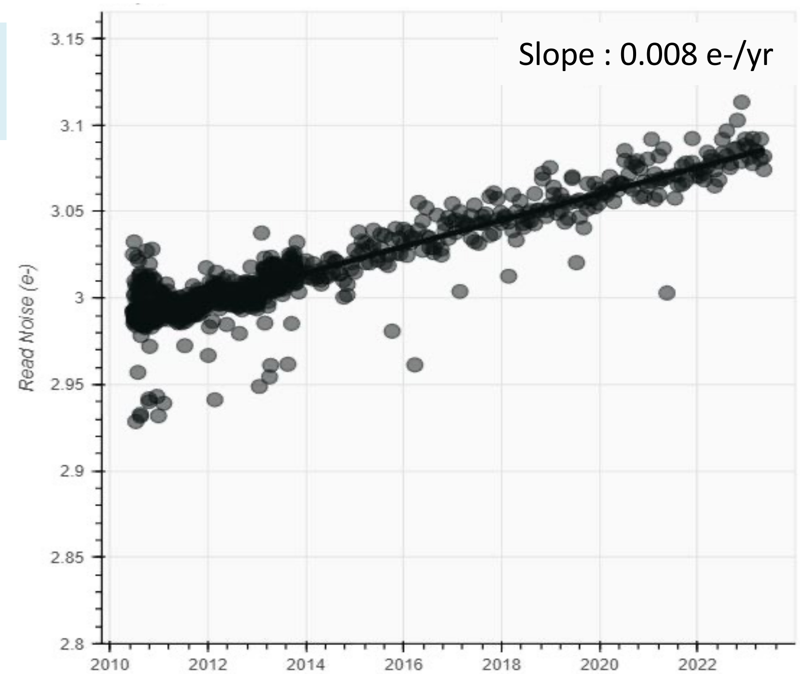
Bad Pixel Table: DQ Flags

FLAG Value	Data Quality Condition	
	UVIS	IR
0	OK	OK
1	Reed-Solomon decoding error	Reed-Solomon decoding error
2	Data replaced by fill value	Data replaced by fill value
4	Bad detector pixel	Bad detector pixel
8	(unused)	Unstable in zero-read
16	Hot pixel	Hot pixel
32	Unstable pixel	Unstable pixel
64	Warm pixel	(Obsolete: Warm pixel)
128	Bad pixel in bias	Bad reference pixel
256	Full- well saturation	Full-well saturation
512	Bad or uncertain flat value	Bad or uncertain flat value
1024	Charge trap (sink pixel)	(unused)
2048	A-to-D saturation	Signal in zero-read
4096	Cosmic ray detected by AstroDrizzle	Cosmic ray detected by AstroDrizzle
8192	Cosmic ray detected during CR-SPLIT or REPEAT-OBS combination	Cosmic ray detected during up-the-ramp fitting

UVIS2 dark vs Year



Amp B Read Noise vs Year



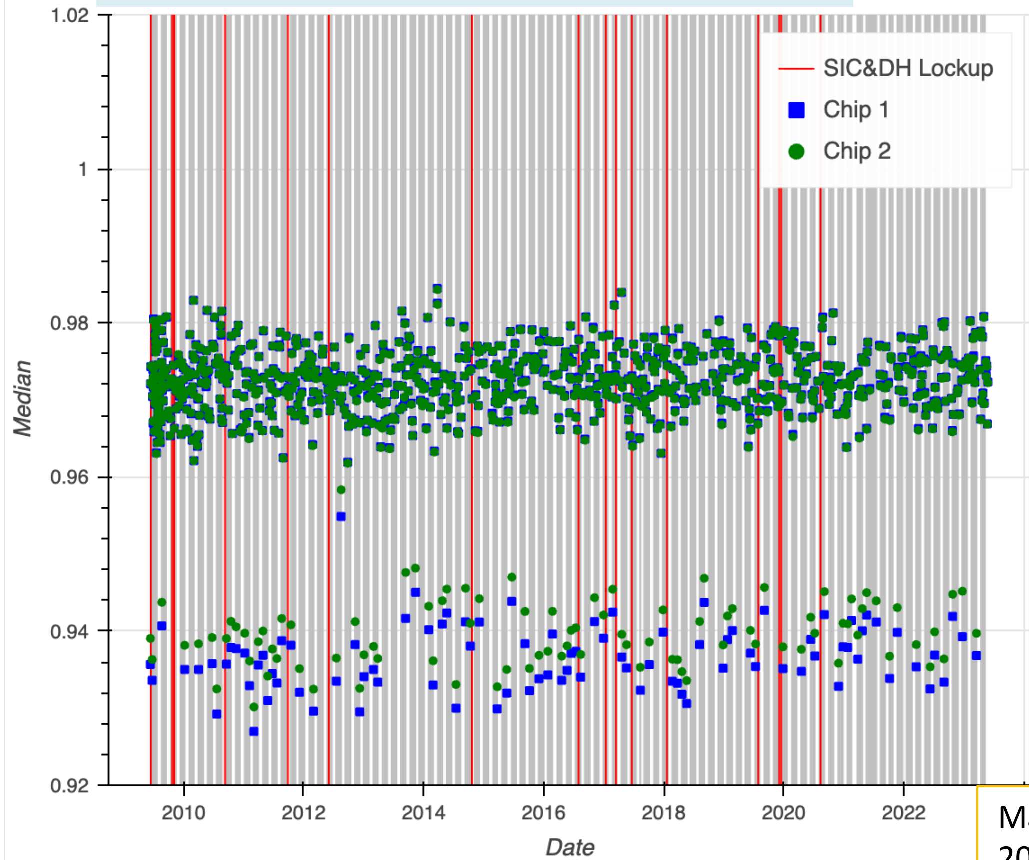
https://wfc3ql.stsci.edu/automated_outputs/cal_uvis_make_darks
https://wfc3ql.stsci.edu/automated_outputs/cal_uvis_make_readnoise

UVIS Bowtie Monitor

Orbits	External:0 Internal: 132
PI, Co-I's	Khandrika, Pidgeon, Baggett
Purpose	Condition UVIS detector for science observing. During TV internal flat testing, it was discovered that the UVIS detector exhibits occasional low-level (~1%) quantum efficiency offsets (i.e. hysteresis) across both chips, an effect dubbed 'bowtie' due to its unique shape in the image ratios. The ground tests revealed that hysteresis can be negated by overexposing the detector by several times the full well. This multi-cycle monitoring program was developed to detect and mitigate UVIS hysteresis on orbit.
Description	Each visit acquires a set of three 3X3 binned internal Tungsten flats. These include (1) an unsaturated image to check for hysteresis features, (2) a saturated 'QE pinning' exposure to fill traps and mitigate QE offsets, and (3) an additional unsaturated image to assess the hysteresis removal efficiency. The F475X filter was selected for (1) its high throughput, (2) its bandpass (<700nm), which is known to mitigate hysteresis and (3) its status as a low-priority filter for science observations.
Resources: Observations	365/3 days= 122 orbits + 10 extra for SIC&DH lockups Three internal flats every 3 days using the F475X filter.
Resources: Analysis	Supports 100% of UVIS programs; Analysis includes inspecting unsaturated frames and image ratios, identifying trends in image ratios over time, quantifying the efficiency of the neutralizing exposure, and investigating anomalies. Investigate shutter 'strobe effect.'
Products	Bowtie data is used for high-cadence monitoring of the relative gain Plots for tracking the bowtie with time (ratio of the first to the third image in a set)
Accuracy Goals	Track bowtie ratio (im1/im3) versus time to 1% rms
Prior Results, ISRs	TIR 2023-01 (Shutter Blade Analysis) – uses bowtie intflats (ratios amp A/D & B/C to monitor shutter) ISR 2018-11 (UVIS Shutter-induced Vibration). ISR 2017-08 (Relative Gain) ISR 2013-09 (Bowtie), ISR 2009-24 (Bowtie)
Prior Cycle IDs	12344, 12688, 13072, 13555, 14001, 14367, 14530, 14979, 15568, 15713, 16393, 16565, 17002 (Cycle 30)

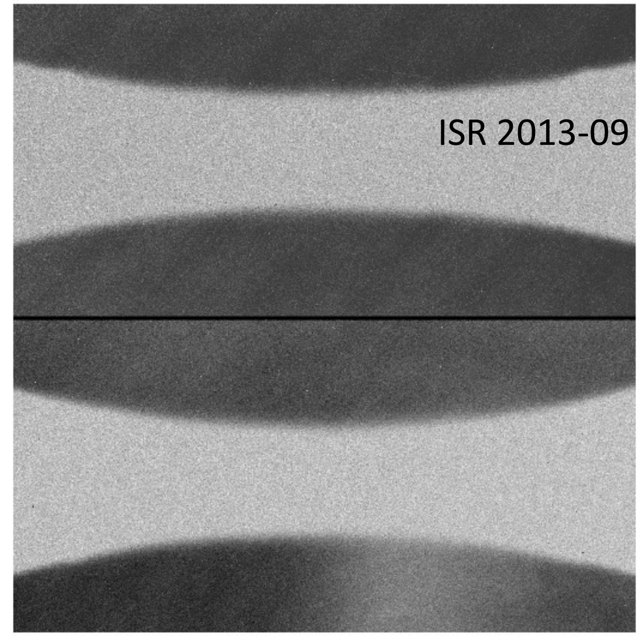
UVIS Bowtie Monitor

Bowtie Ratio (Image 1 to Image 3) - Shutter A

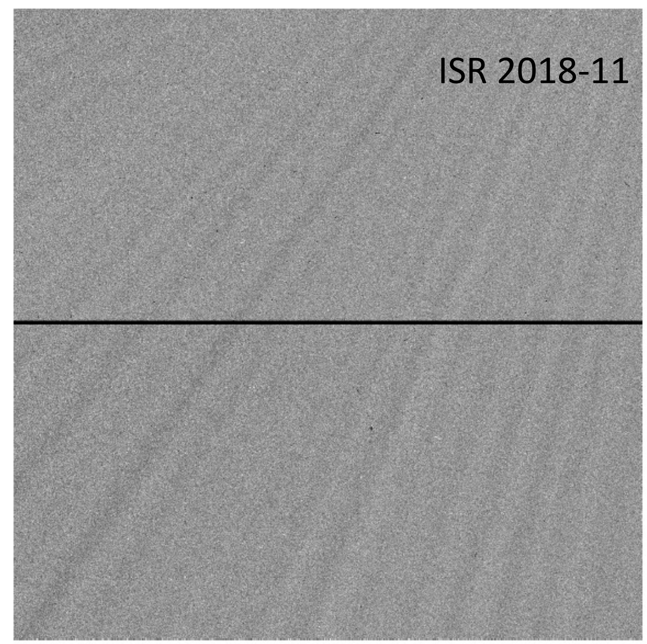


May 2023

Bowtie effect (im1/im3), ± 5%



Shutter strobe effect, ± 0.25% (variation in blade speed)



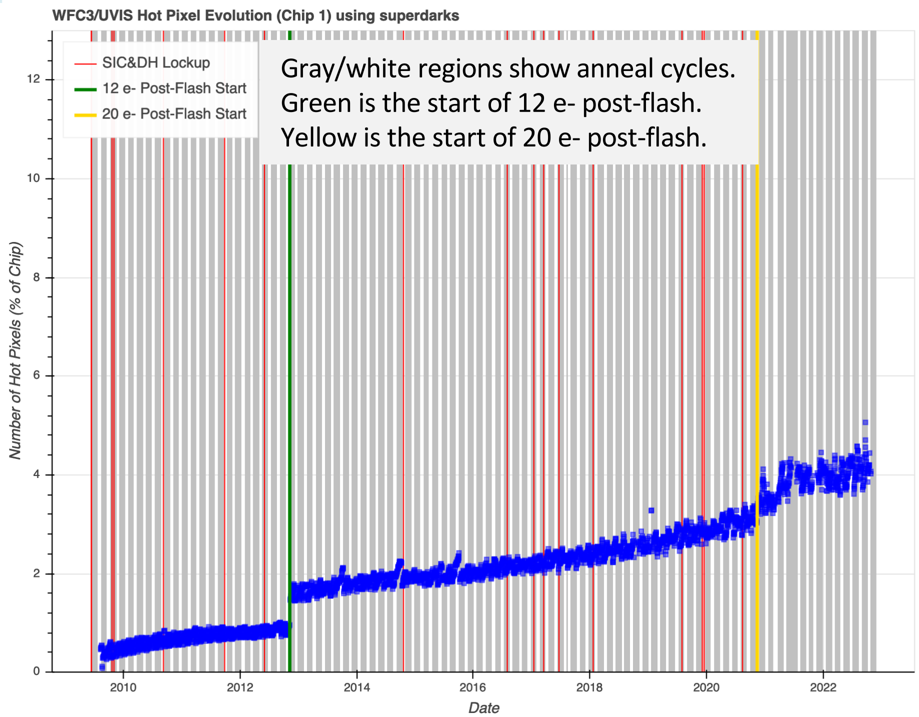
https://wfc3ql.stsci.edu/automated_outputs/cal_uvis_make_bowtie

UVIS CCD Daily Monitor

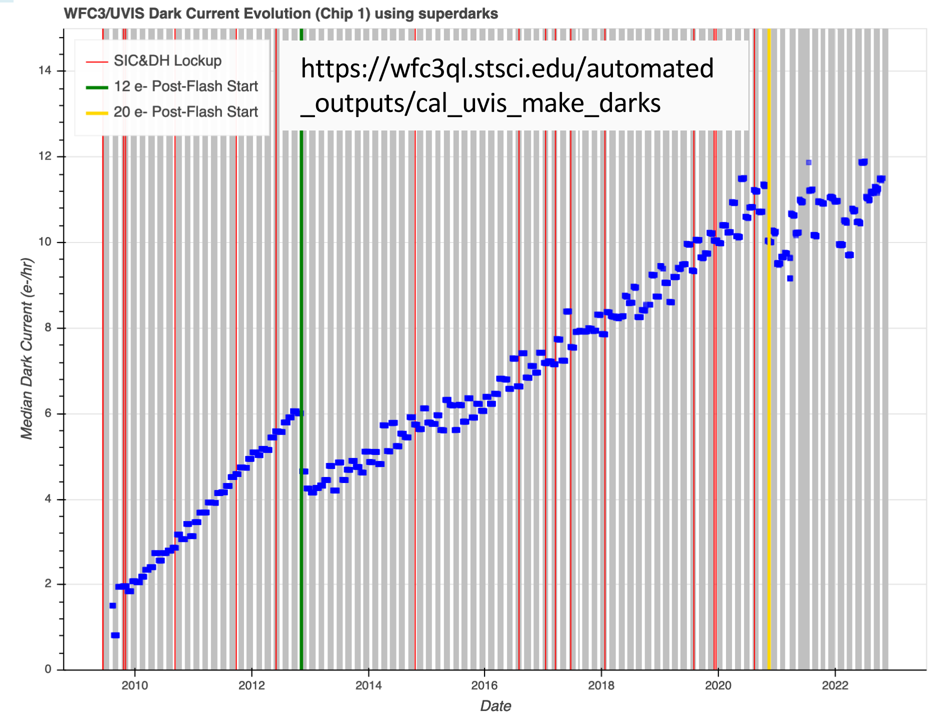
Orbits	External: 0 Internal: 642
PI, Co-I's	Pidgeon, Kuhn, Rivera
Purpose	Continue to monitor the behavior of the UVIS CCDs with a daily set of bias and/or dark frames. These data will be used to generate bias and dark reference files for CRDS. These reference files are used to calibrate all WFC3/UVIS images.
Description	The internals are acquired using a pattern of single-orbit visits repeated every 4 days (see below). All darks are 900 seconds in duration and all exposures are post-flashed. A small number of un-flashed darks are requested in a separate proposal. ***Day 1*** *= 2 visits: one with 2 biases, one with 2 darks.* ***Day 2*** *= 2 visits: each with 2 darks* ***Day 3*** *= 1 visit: 2 darks.* ***Day 4*** *= 2 visits: each with 2 darks.* All non-Day1-Visit-darks use "no-move" darks (i.e. TARGNAME=DARK-NM) in which the CSM is not moved to the IR position and a narrow-band filter configuration is employed to reduce any scattered light. Since Day1-Visit1 visits start with biases, and thus the CSM is in the IR position, these darks do not have to be "no-move" nor does a narrow filter have to be employed. Several different filters are used in order to distribute usage across multiple wheels to avoid overuse of any one.
Resources: Observations	642 orbits = (91 four-day cycles * 7 orbits/cycle) + 5 contingency orbits
Resources: Analysis	Supports 100% of UVIS programs
Products	Reference files: dark (*drk.fits, *dkc.fits) and bias (*bia.fits)
Accuracy Goals	Dark reference files: ~3 e-/hr rms; Bias reference files: <1 e- rms
Prior Results, ISRs	ISR 2023-03: UVIS Superbias; ISR 2019-08: Periodicity in the WFC3/UVIS Bias Overscan ISR 2018-15: UVIS pixel stability from darks; ISR 2017-23: Bias Reference Files Analysis ISR 2014-04, ISR 2016-08 (darks), ISR 2015-13 (read noise)
Prior Cycle IDs	12342, 12689, 13073, 13556, 14002/03/04, 14368/69/70, 14531/32/33, 14980/81/82, 15569/70,71, 15714/15/16, 16394/95/96, 16566/67/68, 17003/04/05 (Cycle 30)

UVIS CCD Daily Monitor

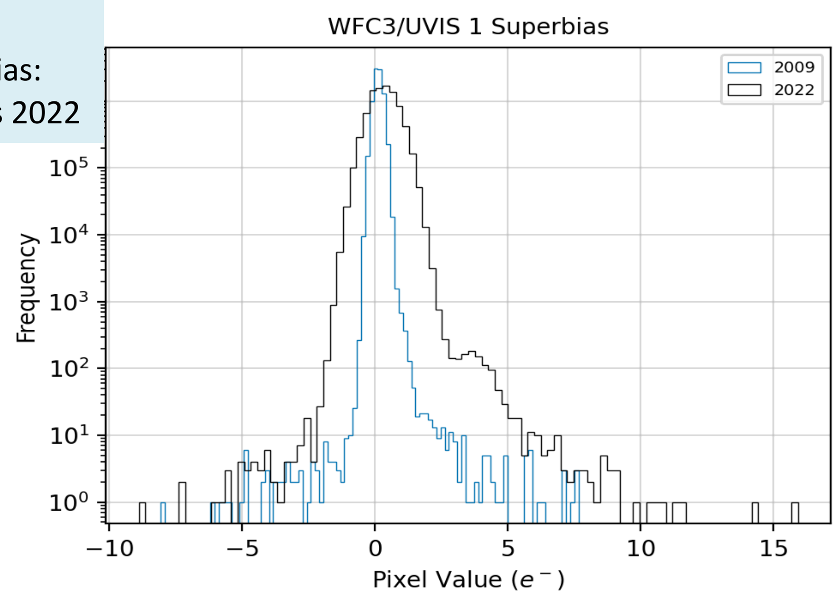
UVIS1 Hot Pixel Growth (% of chip) vs Date



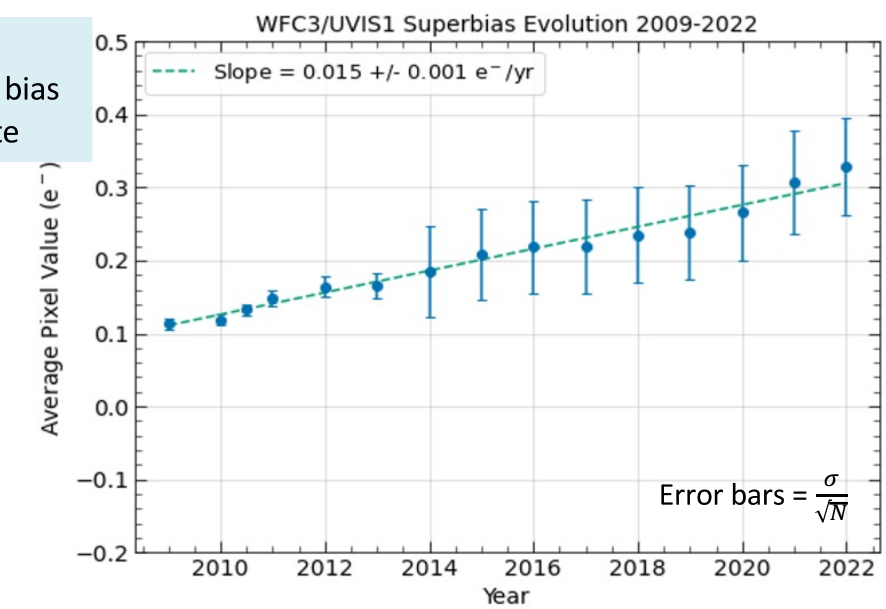
UVIS1 Median Dark current (e^-/hr) vs Date



UVIS1 Superbias: 2009 vs 2022



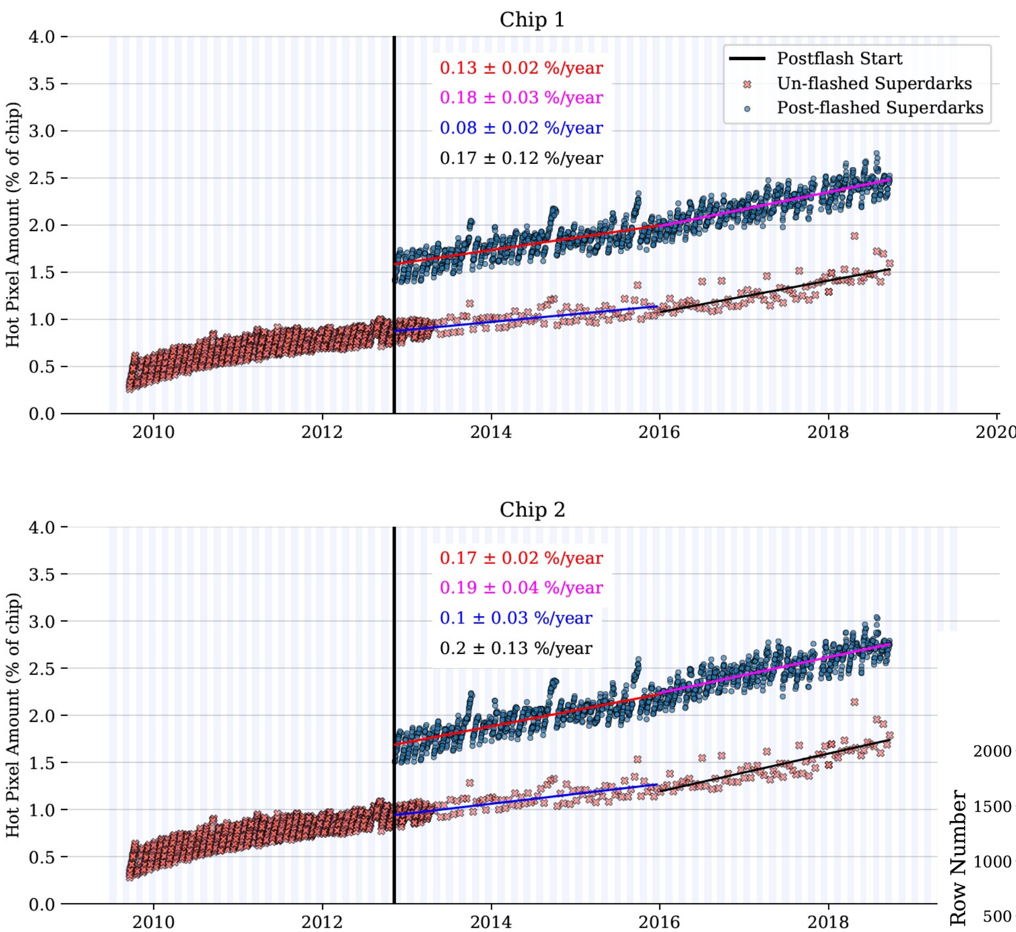
UVIS1 mean bias vs Date



UVIS Un-flashed (CTE) Monitor

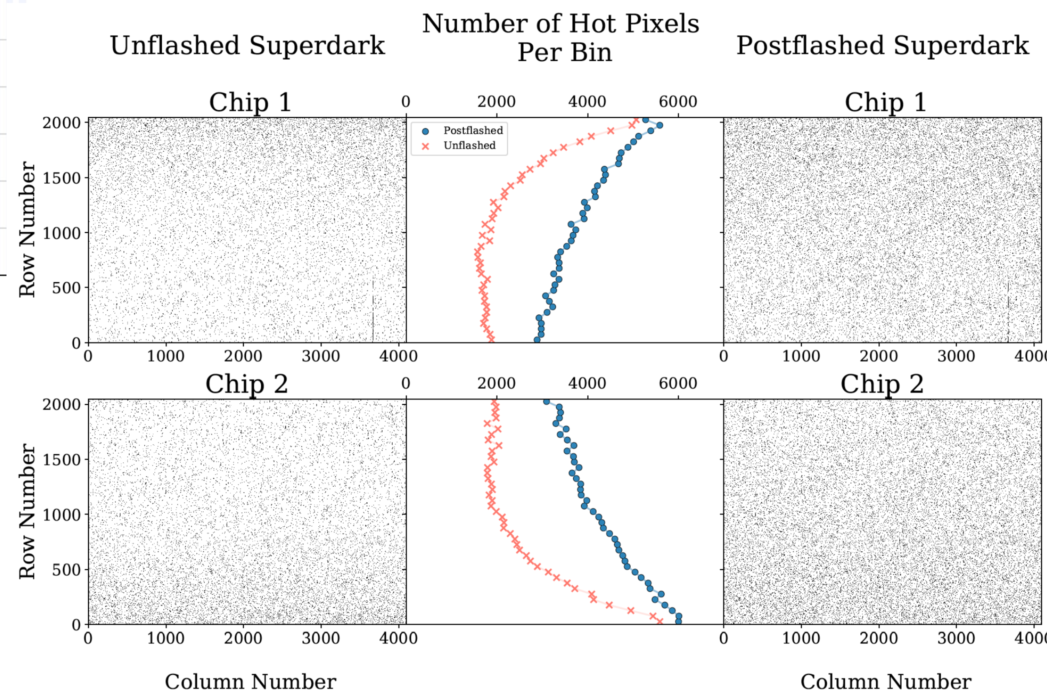
Orbits	External: 0 Internal: 130
PI, Co-I's	Rivera, Pidgeon, Khandrika
Purpose	Obtain un-flashed darks to monitor how well the post-flash is mitigating CTE and to measure the growth of hot pixels observed in exposures with low background
Description	Temporal changes in CTE losses and the efficacy of the post-flash mode are monitored by a series of WFC3/UVIS darks (with no post-flash) taken before and after the monthly UVIS anneal. A large number of internals are taken as part of a daily monitor of warm/hot pixel growth and read noise, however they are all post-flashed. Thus, a small number of un-flashed internals are required to monitor the changes in CTE losses over with time. When used conjunction with the post-flashed internals, the un-flashed internals allow for an assessment of how well the post-flash is mitigating the CTE losses.
Resources: Observations	130 orbits = 13 anneals * 10 orbits per anneal = 5 orbits pre-anneal + 5 post-anneal (where each orbit consists of a single 900s dark)
Resources: Analysis	Supports 100% of UVIS programs, but provides the most value for data taken with low backgrounds
Products	Validation that post-flash is effectively mitigating CTE losses
Accuracy Goals	Track hot pixel fraction versus time to 0.5% rms. Quantify the fractional dependence on detector position compared to those detected in flashed darks
Prior Results, ISRs	ISR 2019-10: 'Post-flashed superdarks contain at least 50% more hot pixels, and had 2 e-/hr lower dark current for each anneal cycle'
Prior Cycle IDs	13559, 14005, 14371, 14534, 14983, 15572, 15717, 16397, 16569, 17006 (Cycle 30)

UVIS Un-flashed (CTE) Monitor



Hot Pixel Evolution in Post-flashed Superdarks and their Un-flashed equivalents

Hot pixel detection at each row (comparison between Post-flashed and Un-flashed)



ISR 2019-10

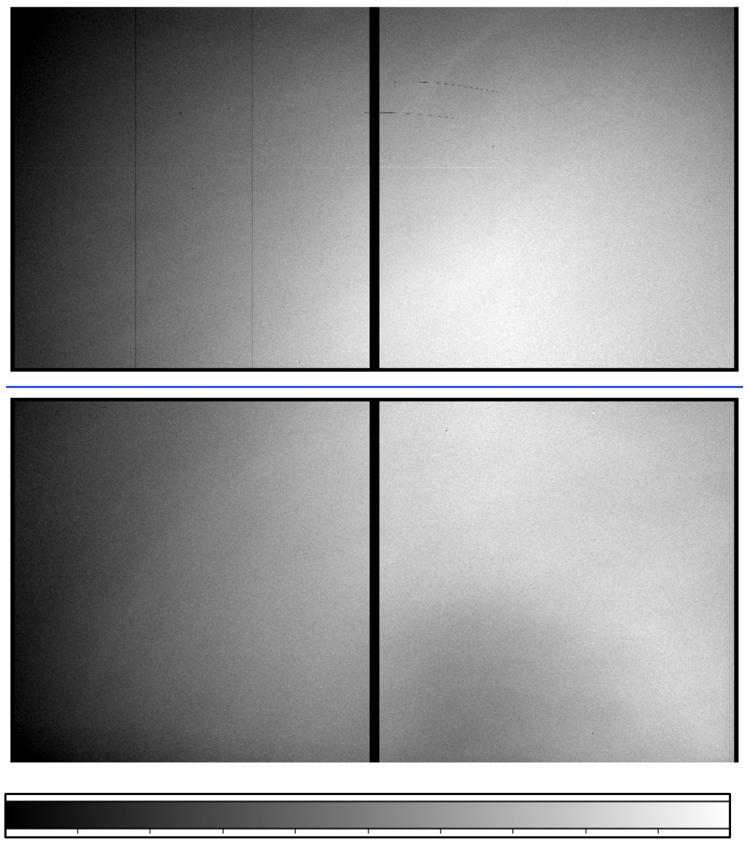
UVIS Post-Flash Monitor

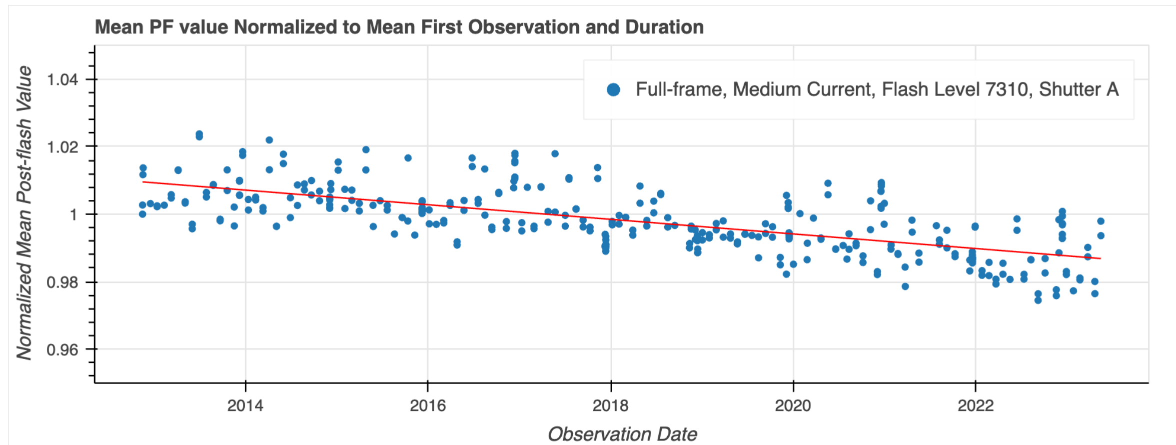
Orbits	External: 0 Internal: 60
PI, Co-I's	Martlin, Khandrika, Green
Purpose	Monitor the flux and illumination pattern of the post-flash LED over time via short dark exposures. The data are used to also create a series of post-flash reference files for the calibration pipeline.
Description	Most observers with low-background (< 20 e-) data are now using the post-flash mode in WFC3/UVIS. We propose to continue the monthly monitoring of the lamp characteristics plus sufficient orbits to allow new generation of post-flash CRDS reference files to be created in the future. Each iteration of the monitor needs 3 orbits – two obtain high S/N flashed full-frames for both shutter blades to check for pattern changes. One obtains a 1k x 1k subarray taken at a variety of post-flash levels to check on the brightness stability of the lamp. For the new reference files, 12 orbits are needed. Furthermore, in the event the LED illumination pattern changes more rapidly than expected 12 more orbits would be needed – if the pattern stays stable then they will not be needed.
Resources: Observations	60 orbits = 36+12+12 =3 orbits/month*12 months (brightness & pattern checks) +12 (new reference file) +12 (contingency)
Resources: Analysis	100% of UVIS programs PI to analyze subarray data @12e, Co-I to analyze long & medium current (used to make reffiles)
Products	Yearly post-flash reference files FLSHFILE = (*fls.fits), Post-flash lookup table for APT
Accuracy Goals	Lamp stability to 0.1 %/year $\pm$ 0.5% rms. Shutter stability to 0.1%
Prior Results, ISRs	ISR 2023-01 (FLS reference, lamp stability), ISR 2017-13 (FLS reference files), ISR 2017-03 (lamp stability) ISR 2013-12 (flash calibration), ISR 2003-01 (flash vs charge injection to mitigate CTE)
Prior Cycle IDs	13078, 13560 (shutter requirement), 14006, 14372, 14535, 14984, 15573, 15718, 16398, 16570, 16982 (cy30)

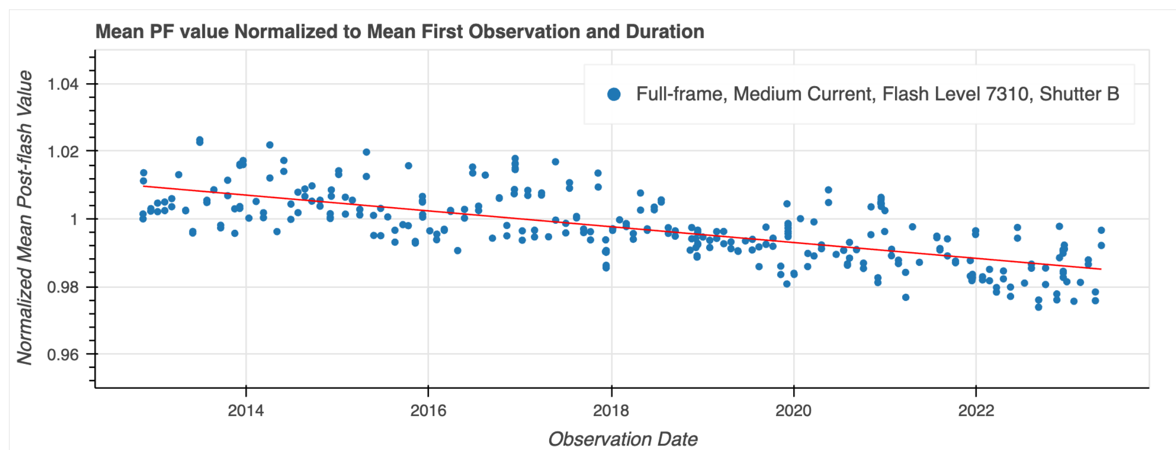
UVIS Post-Flash Monitor

FLSHFILE Reference File:
Shutter A, Medium current

Post-Flash LED Lamp Stability:
Normalized mean post-flash vs time based on high S/N PF frames
Top: Shutter A; Bottom: Shutter B







ISR 2017-13

ISR 2023-01

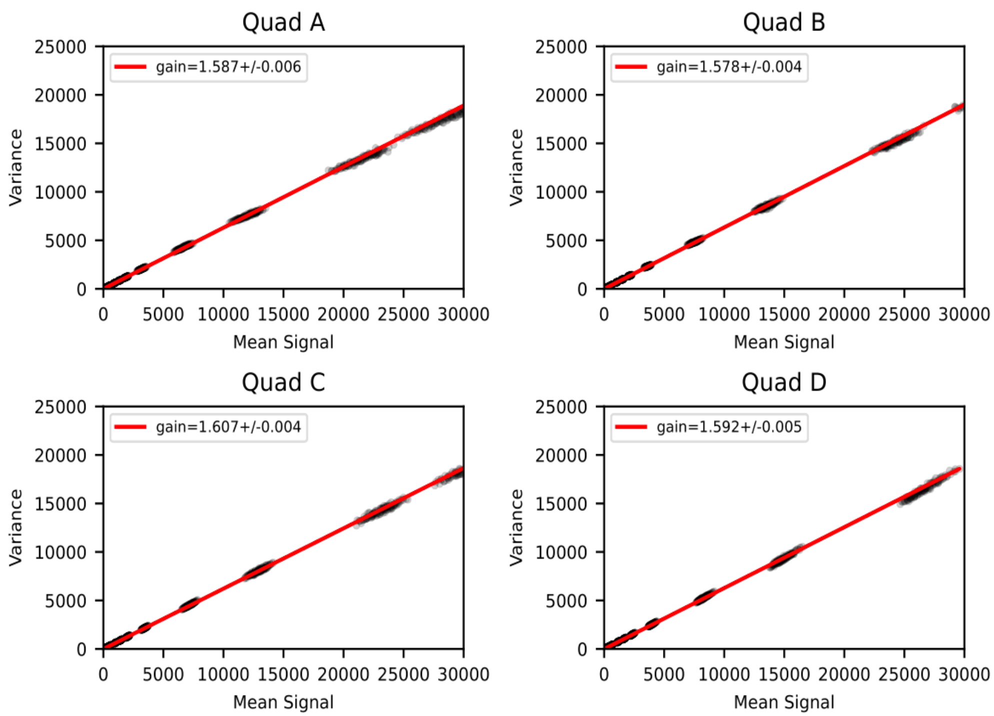
UVIS Gain Stability

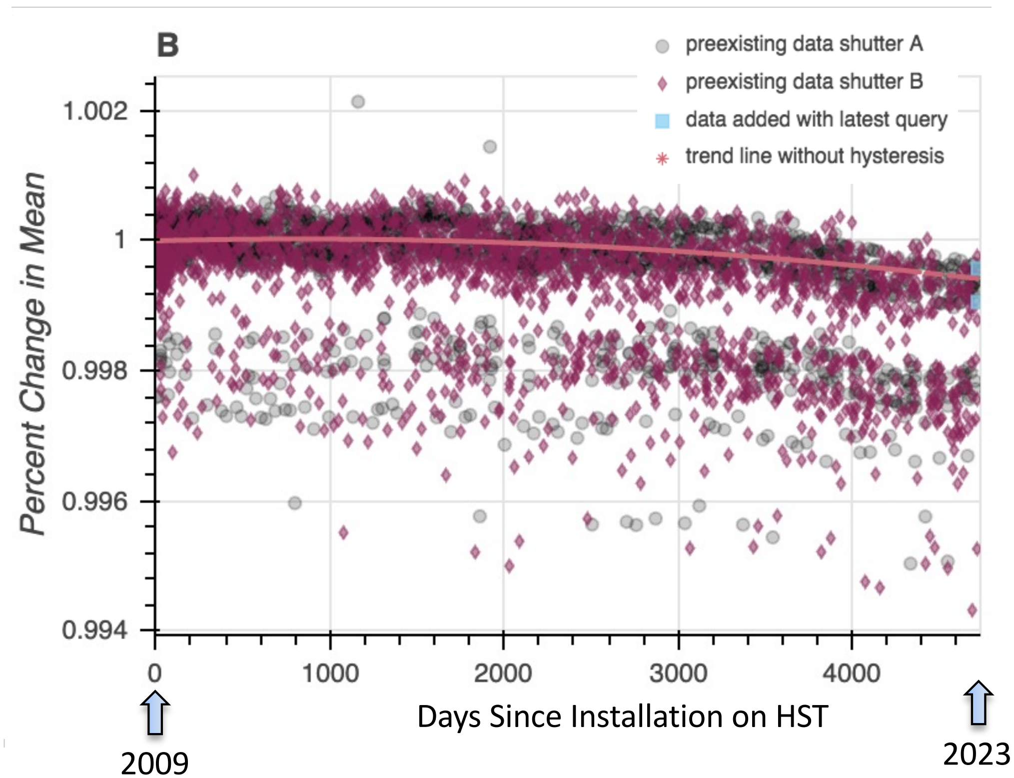
Orbits	External: 0 Internal: 18
PI, Co-I's	Kuhn, Huynh, Khandrika
Purpose	Monitor the absolute gain for the nominal detector setting.
Description	Observations consist of 8 pairs of full-frame binned (2x2 and 3x3) and un-binned internal flats at nominal gain. Two epochs, 9 orbits each, are request to be taken ~6 months apart. Six of these orbits will be for sampling the unbinned mode in order to increase the sampling at the lower signal levels.
Resources: Observations	18 orbits = 2 epochs * 9 orbits per epoch Each epoch has 6 full-frame internal flatfields, and 3 binned exposures (2x2 and 3x3) taken in the F645N filter with the tungsten lamp, with varying exposure times.
Resources: Analysis	Supports 100% of UVIS programs Analysis using the standard mean-variance technique. Reduce any difference in the calibrated images across amplifiers for binned proposals. Reduction software requires removal of IRAF dependencies (linear fitting)
Products	Monitoring the health & safety of the instrument
Accuracy Goals	Measure gain to < 1% and track gain stability to < 0.1%
Prior Results, ISRs	ISR 2022-08: (Cy26-29) ISR 2018-17: (Cy24, Cy25), 2017-08: Relative Gain ISR 2016-13: (Cy23): within ~1-2% of Cy22. ISR 2016-09, ISR 2015-05, ISR 2014-05, ISR 2013-02, ISR 2011-13, ISR 2009-29
Prior Cycle IDs	11906, 12346, 12690, 13168, 13561, 14007, 14373 (Cycle 23 ISR) 14536 (Cy24 within 1% of cy23), 14985, 15574, 15719, 16399, 16571, 17007 (Cycle 30)

UVIS Gain Stability

Mean Signal (DN) vs Variance

Gain Ratio Stability (amp B/A) vs Time (days)
derived from Bowtie frames





ISR 2022-08
Cycle 29 Epoch 2 1x1 binning

https://wfc3ql.stsci.edu/automated_outputs/cal_uvis_make_gain
https://wfc3ql.stsci.edu/automated_outputs/cal_uvis_make_bowtie

CTE Characterization and Calibration

Same as the previous cycle

GOs have been able to mitigate CTE losses using post-flash (PF), starting in 2012 (Cycle 20). To support these efforts we request the following regular calibration monitor programs:

- Monitor CTE via Extended Pixel Edge Response (**EPER**) using internal lamp flats + short darks
  12 internal orbits = 2 orbits/epoch * 6 epochs
- Observe **stellar fields** characterized by different crowding (NGC104 and OmegaCen) with various PF levels to calibrate the photometric and astrometric CTI corrections.
  8 external orbits = 3 orbits/epoch * 2 epochs (NGC104) + 2 orbits/epoch * 1 epoch (OmegaCen)
- Use **charge-injected bias** to monitor the length of the CTE trails. This information will be used as an input for the CTE algorithm.
  36 internal orbits = 1 orbit every ~10 days
- Check the recommended **post-flash** level by acquiring long darks with a range background levels
  15 internal orbits

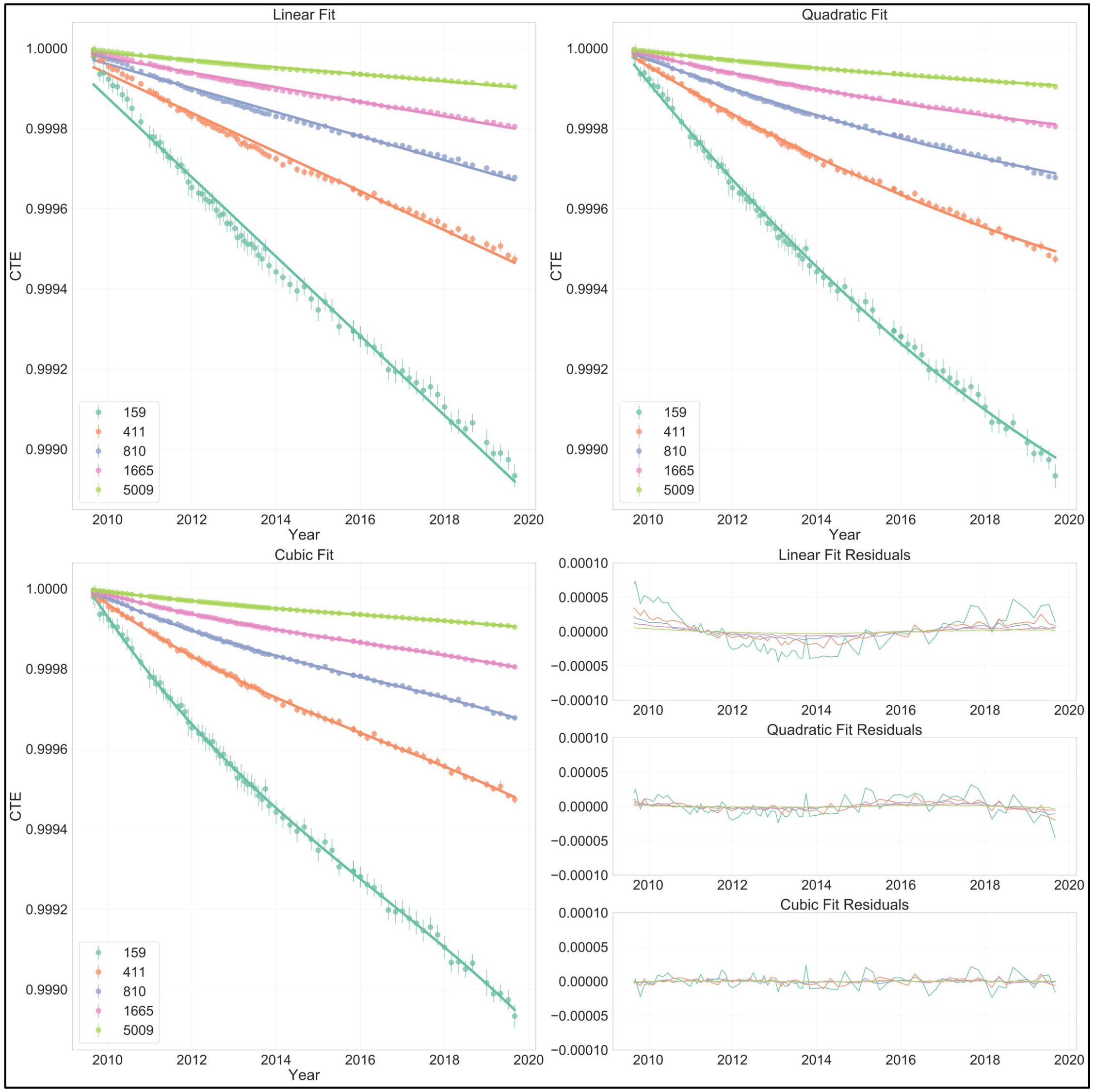
WFC3/UVIS CTI Monitor (EPER)

Orbits	External: 0 Internal: 12
PI, Co-I's	Khandrika, O'Connor
Purpose	(1) Measure the UVIS CCD Charge Transfer Inefficiency (CTI) using the Extended Pixel Edge Response (EPER) method. (2) Assess CTE losses over time in a continuation of the multi-cycle CTE monitor.
Description	12 internal orbits (2 every other month) are used to assess the profiles of excess charge in the extended pixel region of the special EPER readout format and monitor the CTI of WFC3/UVIS. Each visit-pair obtains internal lamp flat field at a variety of illumination levels as well as two short dark exposures to be used as a bias measurement. A visit-pair is taken approximately every 9 weeks over the span of a year.
Resources: Observations	12 orbits = 6 epochs, each consisting of a 2 visit (orbit) pair Visit 1 = 1 dark+ 2 tungsten flats (F390M), Visit 2 = 1 dark+ 1 tungsten flats (F390W) + 2 tungsten flats (F438W).
Resources: Analysis	Supports 100% of UVIS observations, especially faint, low background targets Analysis of the extended overscan in comparison to science pixels in the EPER readout mode. Rewriting reduction software (currently in IDL) and tracking changes since 2016
Products	Monitoring the health of the instrument; Comparison with external CTE calibration data
Accuracy Goals	Quantify decline in EPER CTE at the 4^{th} decimal place and fit models to predict future decline
Prior Results, ISRs	ISR 2020-06: WFC3/UVIS EPER CTE 2009 – 2020 (Shows periodicity anti-correlated to solar activity.) ISR 2016-10: WFC3/UVIS EPER CTE 2009-2016 (CTE degradation appears to be quadratic and is settling with time); ISR 2013-03, ISR 2011-17, ISR 2009-10, ISR 2007-13
Prior Cycle IDs	11924, 12347, 12691, 13082, 13565, 14011, 14377 (Cy23) = in 2016 ISR 14540, 14989, 15575, 15720, 16400, 16572, 17008 (Cy30)

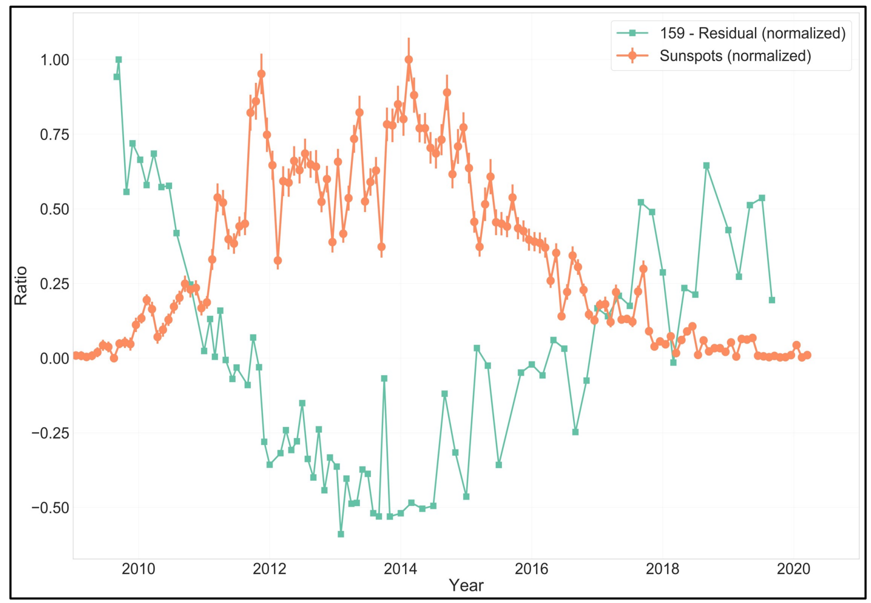
WFC3/UVIS CTI Monitor (EPER)

Top Left: Decline of EPER CTE as a function of illumination level (electrons) with **linear** fits to the data. Top right: **Quadratic** fit. Bottom Left: **Cubic** fit. Bottom Right: Residuals of each fit

ISR 2020-06



Sunspot activity versus time, compared to the residuals of the 160 e− illumination level.
Both the sunspot data and the residuals are normalized to their respective maximum values

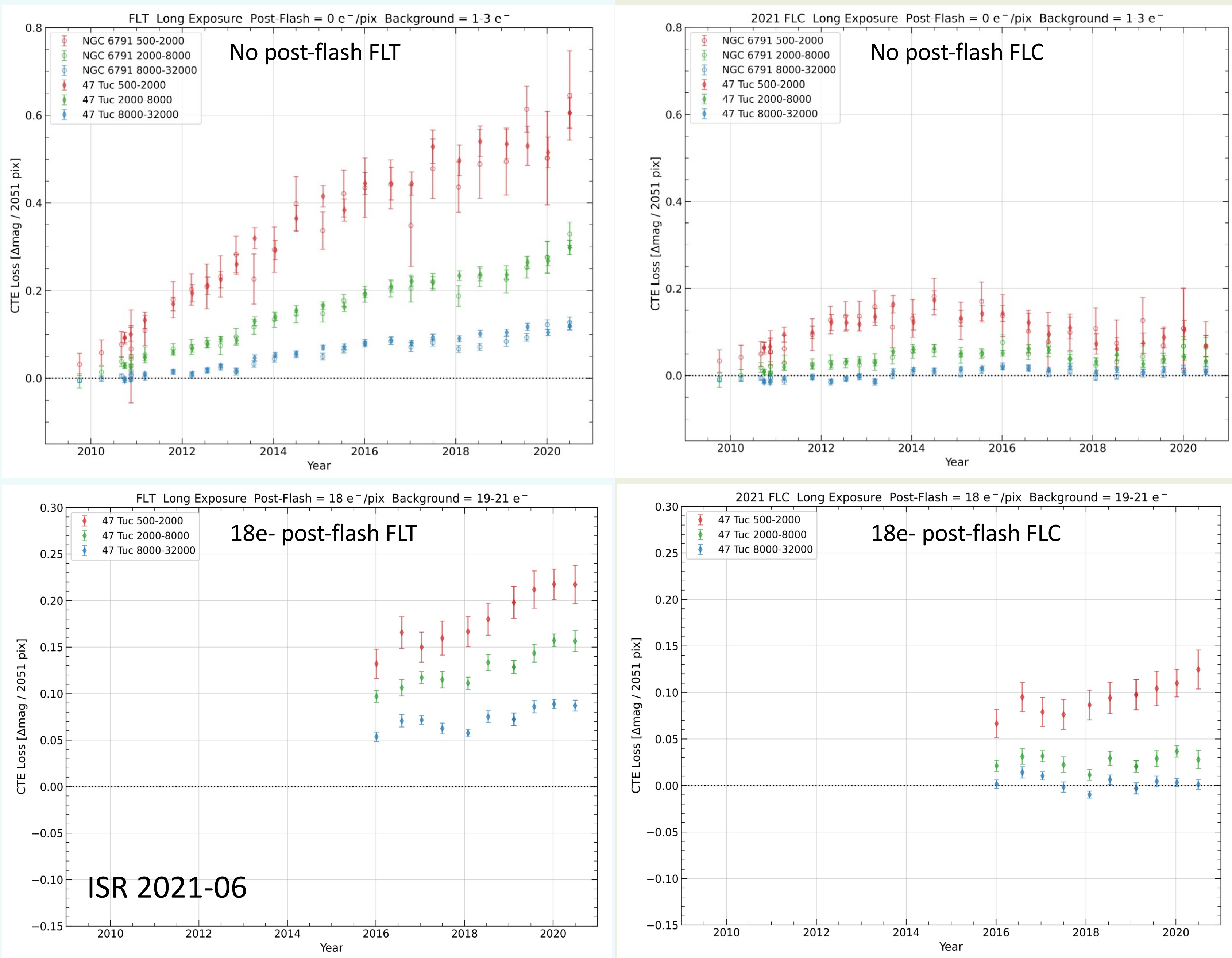


WFC3/UVIS External CTE Monitor: Star Clusters

Orbits	External: 8 Internal: 0
PI, Co-I's	Kuhn, Bajaj, Anderson, Baggett
Purpose	Monitor CTE degradation as a function of epoch and source/observation parameters. Calibrate photometric corrections. Provide data to test and monitor the pixel-based CTE model.
Description	We continue (from Cy20), using post-flash to sample background levels and monitor the efficacy of the post-flash model for CTE mitigation. Exposures of NGC 104 and Omega Cen in F502N (~zero background) will monitor the maximum CTE in different field densities. (In Cycle 28, Omega Cen replaced NGC 6791 which is deemed too sparse. The former has more stars, particularly at the faint end, which would improve the CTE measurements). Long exposures, dithered by ~2000 pixels in Y, will measure absolute CTE. We sample various background levels to test whether the currently recommended level of 20 e-/pix still provides the best compromise between background noise and CTE losses. The data are also used to test the effectiveness of the pixel-based CTE correction.
Resources: Observations	8 orbits = 4 orbits (Omega Cen) at two epochs + 4 orbits (NGC104) at two epochs Images are acquired in the F502N filter at eight different non-zero (i.e. post-flash) background levels
Resources: Analysis	Supports 100% of UVIS programs Analyze how the photometry of point sources within star clusters changes at different detector orientations. Test for over/under corrections of pixel-based CTE correction in *flc files.
Products	CTE coefficients. Test efficacy of pixel-based CTE correction, test of recommended background level. Some of the data is/has been used to create and improve the hst1pass software and table-based CTE corrections.
Accuracy Goals	Validate pixel-based correction to ~5% (no flash) and ~2% (with flash). Validate the recommended flash level to ± 3e-.
Prior Results, ISRs	ISR 2022-05: 'One-Pass HST Photometry with hst1pass', ISR 2021-13: 'Table-Based CTE Corrections for flt-Format WFC3/UVIS', ISR 2021-09: 'Updating the WFC3/UVIS CTE Model and Mitigation Strategies' ISR 2021-06: 'New FLC External CTE Monitoring 2009 – 2020'; ISR 2021-03: 'CTE Monitor through 2020' ISR 2020-08: 'Strategies for Mitigation of CTE Losses'
Prior Cycle IDs	12379, 12692, 13083, 13566, 14012, 14378, 14541, 14881 (bulge, non-monitor), 14990, 15576, 15721, 16401, 16441, (omega cen, non-monitor), 16862 (omega cen, non-monitor), 16573, 17009 (cy30)

WFC3/UVIS External CTE Monitor: Star Clusters

dMag vs Date (FLT, No CTE-corr) | dMag vs Date (FLC, v2.0 pixel-based CTE-corr)



WFC3/UVIS External CTE Monitor: Star Clusters

ISR 2021-13

Photometry: dmag vs mag

No table-based corr | With table-based

Astrometry: dy (pix) vs mag

No table-based corr | With table-based

Sky 4e-

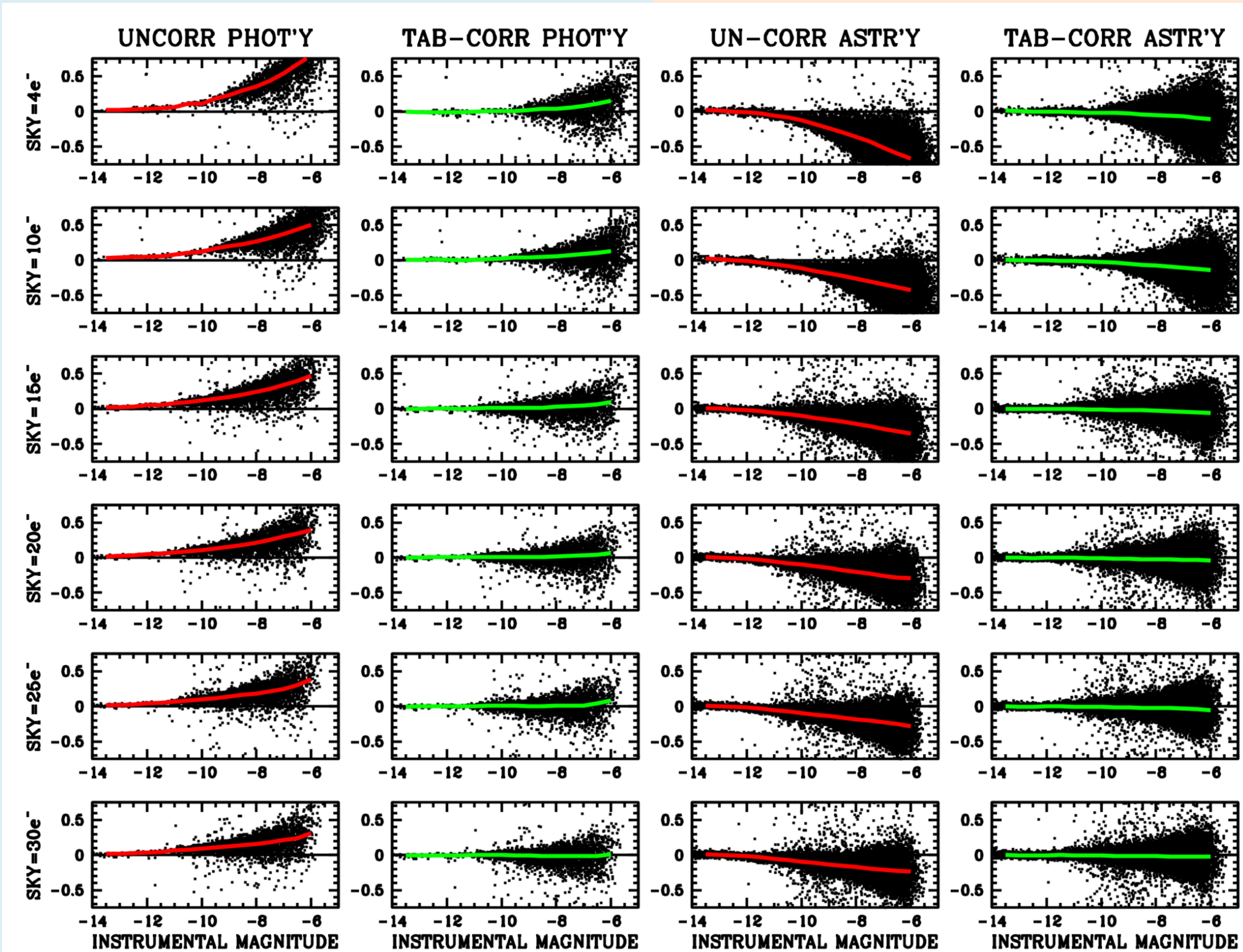
Sky 10e-

Sky 15e-

Sky 20e-

Sky 25e-

Sky 30e



UVIS Traps with Charge Injection

Orbits	External:0 Internal: 36
PI, Co-I's	O'Connor, Marinelli, Khandrika
Purpose	This program is designed to monitor the UVIS trap growth via charge-injected biases
Description	The charge transfer efficiency (CTE) of the WFC3/UVIS channel continues to decline as damage from radiation accumulates. One method to mitigate the impact of CTE losses is to apply a pixel-based CTE correction algorithm the images after they are acquired. An algorithm such as this requires a detailed knowledge of the traps, which capture and release charge during the image readouts. This program will identify and characterize the traps responsible for the charge losses, map their distributions across the chips, and monitor their growth over time.
Resources: Observations	36 orbits = 1 orbit of 'line 25' charge injected biases every 10 days To aid the schedulers, each visit will have a 5 day window to be executed.
Resources: Analysis	0% of GO programs currently use CI, but it is a useful way to monitor the CCD degradation. PI will utilize pixel history code developed by Bourque & Anderson.
Products	Alternate method of tracking the growth of charge traps across the detector.
Accuracy Goals	Mean residual signal in CI rows to ~2 e- rms
Prior Results, ISRs	ISR 2011-02: WFC3/UVIS Charge Injection Behavior: Results of an Initial Test (Bushouse)
Prior Cycle IDs	Program ID: 12348 (ISR 2011), 12693, 13084, 13569, 14013, 14379,14542, 14991, 15577, 15722, 16402, 16574, 17010 (cycle 30)

CTE Internal Monitor

Orbits	External: 0 Internal: 15
PI, Co-I's	Anderson, Kuhn, Baggett
Purpose	Regularly monitor the recommended post-flash level by acquiring long darks with a range of background levels. Since CTE effects increase over time, these tests must be done every year.
Description	Understanding CTE losses in Hubble's CCDs has been a learning experience. First, we studied standard long darks and measured losses by adding up the flux in the trails. Next, we took short and long darks to probe the small-packet end directly, since trails behind faint warm pixels (WPs) are hard to quantify. This worked well for the smallest packets (i.e., those containing fewer than 30 electrons), but the faint WPs were hard to study on higher backgrounds (see **Figure 1**). In Cycle 29, we devised a pilot supplemental Cal program that took a set of long 900s darks with various levels of post-flash. **Figure 2** shows that the new strategy gets much better sampling of the loss curves for WPs of various intensities. In Cycle 30, we optimized the strategy, probing a wider range of backgrounds. **Figure 3** shows the success of this strategy. This strategy will be used to pin the model as well as a regular internal CTE monitor, as CTE losses can be directly observed in background-diverse WP data.
Resources: Observations	15 internal orbits. The standard set of UVIS dark monitor observations probes backgrounds of 0e and 20e. We will use these observations as a baseline for exploring other backgrounds, including 30 additional levels: 3e, 4e, 5e, 6e, 9e, 12e, 16e, 20e, 25e, 30e, 40e, 50e, 65e, 80e, 100e, 125e, 150e, 200e, 275e, 450e, 700e, 1000e, 1500e, 2500e, 3500e, 6500e, 9000e, 2000e, 5000e, 14000e, 20000e, 30000e. We can take two background levels per orbit, so it will take 15 orbits to complete this 30-exposure program.
Resources: Analysis	Compare against and improve the pixel-based model
Products	New recommendations on trade-offs between background and mitigation; new constraints on model.
Accuracy	Assess CTE losses at better than the 10% level.
Prior ISRs	ISR 2021-09: Updating the WFC3/UVIS CTE model; ISR 2020-08: Strategies for Mitigation of CTE Losses
Prior Cycle IDs	Cy30: 17259, Cy29: 16861, Cy28: 16440, Cy27: 16029, Cy24: 14880

CTE Internal Monitor

BEFORE: Sparse data! We need better sampling of losses-vs-bkgd

NOW: very well sampled WP-vs-bkgd trends!

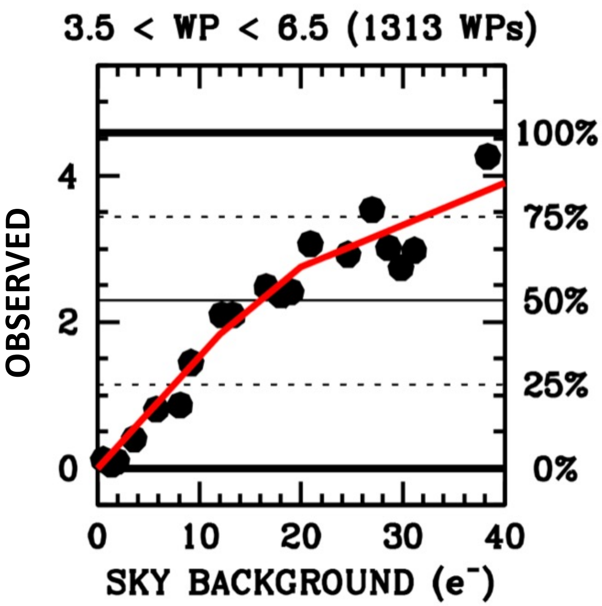


Figure 1: Surviving fractions of faint WPs (ISR 2021-09)

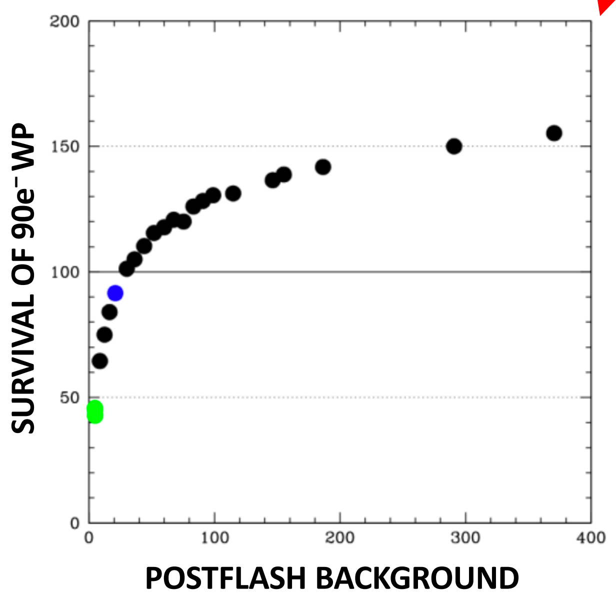


Figure 2: Results from previous Cy29 (Cal-16861). WPs with 90e in 20s darks. Clear trend of losses. Need better sky + WP sampling.

INTERESTING TURN-OVER!

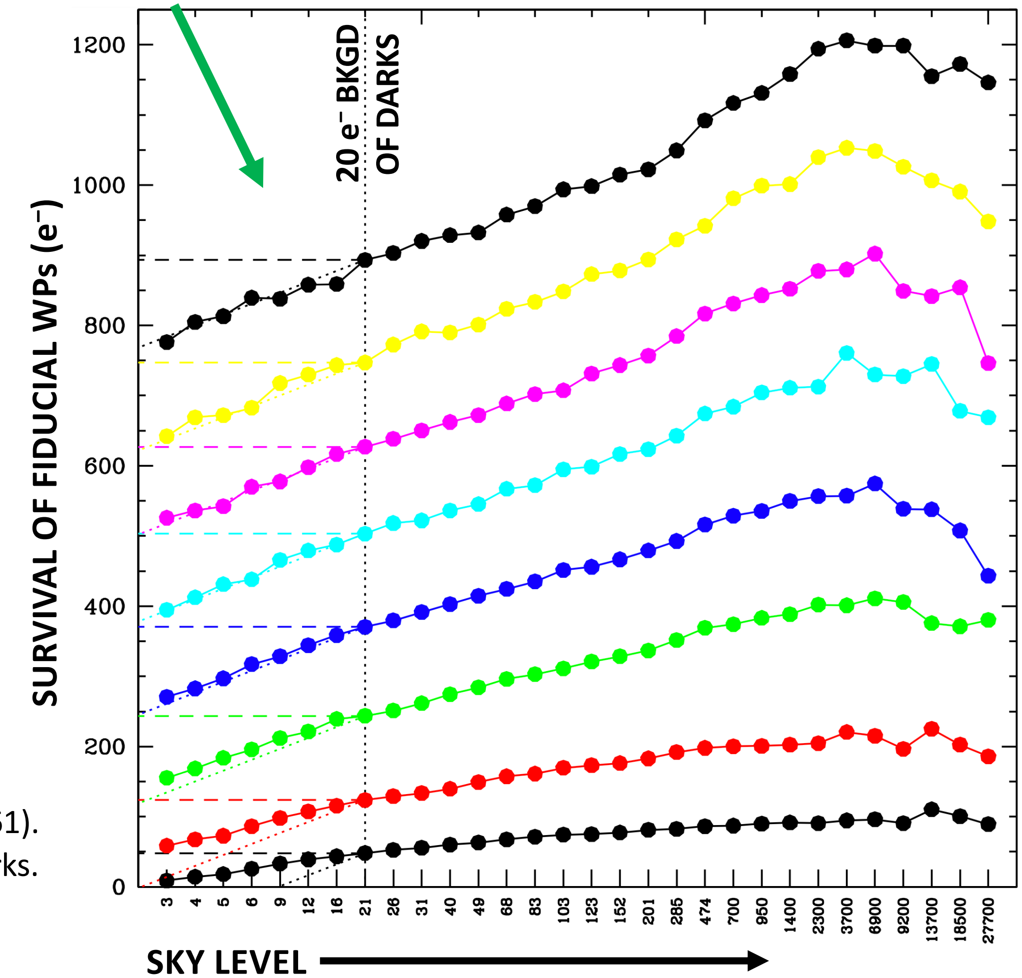


Figure 3: Early reduction of CAL-17259 data. We can follow the loss curves for a wide range of WPs from backgrounds of ~30,000 e⁻ to very low. This will be compared with the forward model in order to better pin the pixel-based model.

IR Detector

Same as the previous cycle

Monitor the health and stability of IR channel and verify the non-linearity correction:

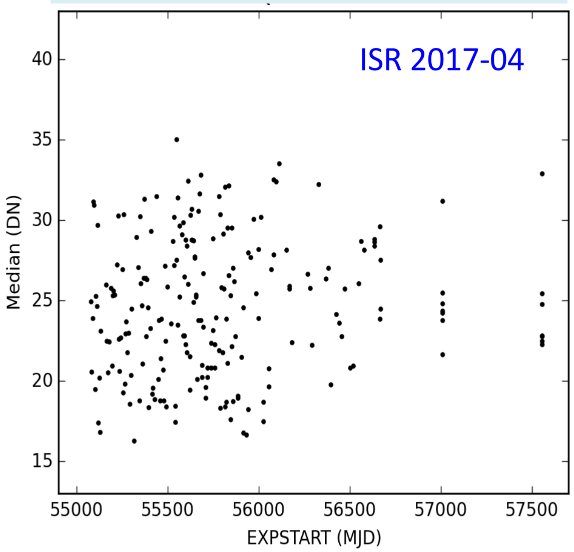
- Obtain IR darks. The number of orbits is dictated by observing modes most-requested by GOs.
  97 internal orbits = 26 orbits (SPARS200, every 2 weeks) + 71 orbits (other samp-seq/apertures)
- Monitor the IR non-linearity by obtaining saturated internal flats
  10 internal orbits = 10 orbits in F127M (half SPARS25, half SPARS10) * 1 epoch/year
- Verify the stability of the IR channel gain via a series of lamp flats
  16 internal orbits = 8 orbits * 2 epochs/year

IR Dark Monitor

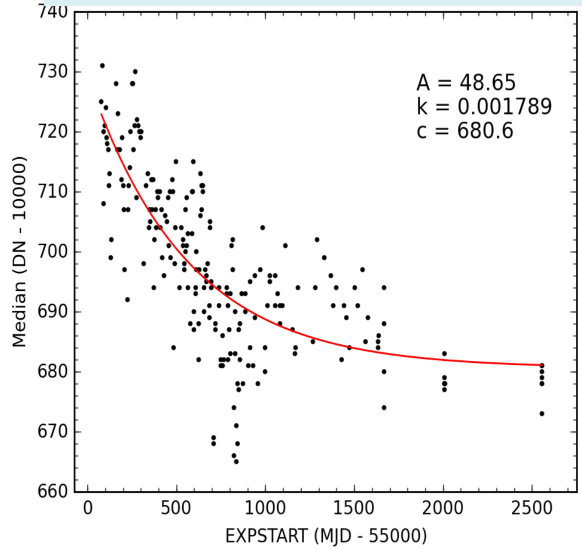
Orbits	External: 0 Internal: 97
PI, Co-I's	Dauphin, Green, Marinelli
Purpose	This program acquires a variety of WFC3/IR darks to support the removal and study of dark current. SPARS200 dark observations are periodically obtained to monitor trends in the bad pixels (hot, unstable, or dead), zeroth read level, and dark current. The remaining orbits collect dark ramps for generating stacked IR dark calibration files for use by the MAST pipeline.
Description	Full-frame and subarray dark images will be collected using each sample sequence. The total number of images collected over the course of the cycle for a given mode is based on the total number of input ramps used in the current superdark for that mode and the popularity of that mode in external science observations. The IR dark current has remained nearly unchanged since launch (ISR 2017-04) which allows for more relaxed scheduling constraints compared to older WFC3/IR dark monitor programs. With the exception of the SPARS200/Full-Frame hot-pixel monitoring observations (~every 2 weeks), the observations have no set scheduling parameters.
Resources: Observations	97 total orbits: 26 orbits of SPARS200 every 2 weeks + 71 orbits spread amongst the other 23 sample sequence/subarray combinations (weighted by usage, with each observed at least 2x/yr and up to 40x/yr) An 1800-sec, non-interruptible hold precedes the observations to protect from persistence.
Resources: Analysis	Supports 100% of IR programs Dark Analysis and BPIXTAB by the PI. Bias levels monitored by QL.
Products	Updated IR dark calibration files (One DARKFILE per cycle for each SAMP-SEQ) and cycle-dependent IR bad pixel table (contains flags for unstable pixels, hot pixels, bad in 0^{th} read). Updated MDRIZTAB parameter file for AstroDrizzle
Accuracy Goals	Median dark rate ~0.05 e-/s ± 0.03 e-/s rms. Reference pixel signal to ~50 DN rms
Prior Results, ISRs	ISR 2022-01: Bad Pixel Tables, ISR 2019-04: Time-dependent Superdarks, ISR 2019-03: Time-dependent Bad Pixel Tables, ISR 2017-24: A Predictive WFC3/IR Dark Current Model ISR 2017-04 (study of dark current variation, zeroth read levels, reference pixels), ISR 2014-06 (updated dark reference files), ISR 2012-11 (dark current stability).
Prior Cycle IDs	11929, 12349, 12695, 13077, 13562, 14008, 14374, 14537, 14986, 15578, 15723, 16403, 16575, 17011

IR Dark Monitor

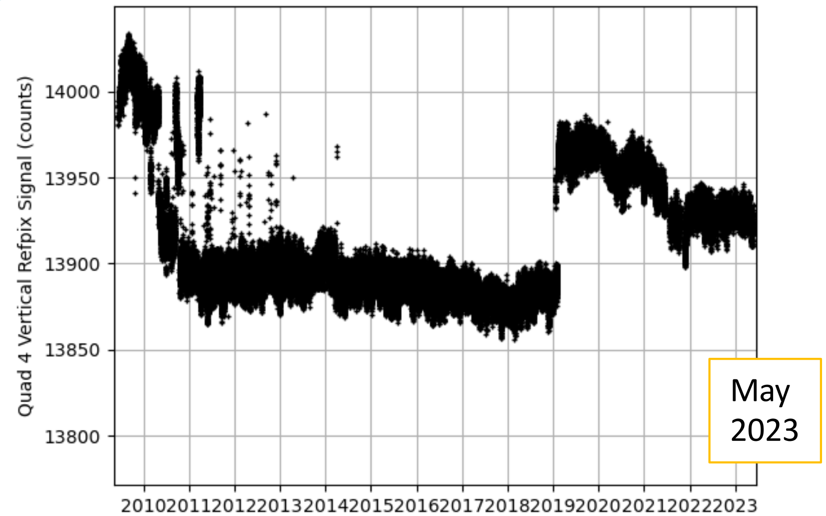
Median IR dark vs date (quad4)



The 0^{th} read level vs date (quad4)

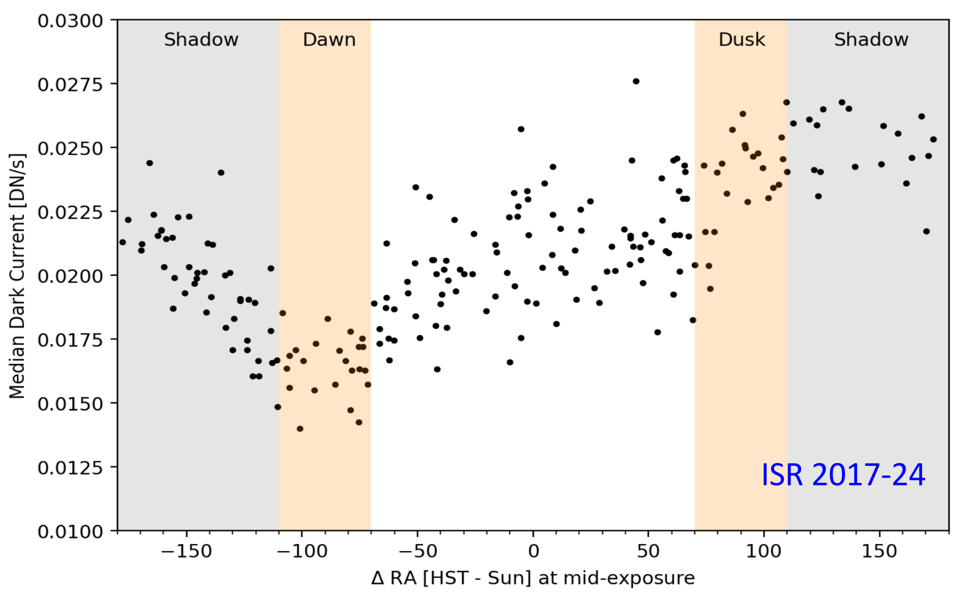


Reference pixel signal vs date (quad4)

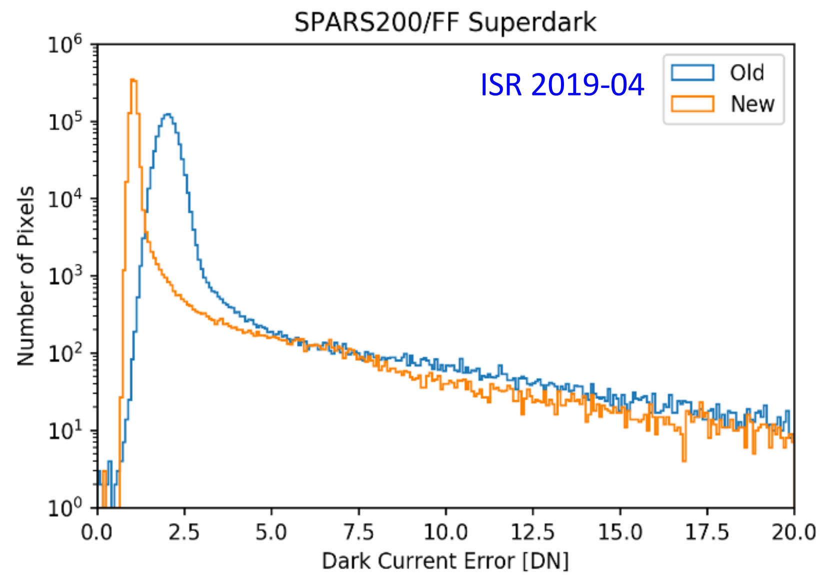


https://wfc3ql.stsci.edu/automated_outputs/cal_ir_make_bias_plots

Correlation of median dark current with the HST day/night cycle via WFC3 telemetry. Range= 0.015-0.025 DN/s



The mean dark error and its dispersion are reduced ~2-3x in the 2019 dark compared to prior (ISR 2014-06) calibration.

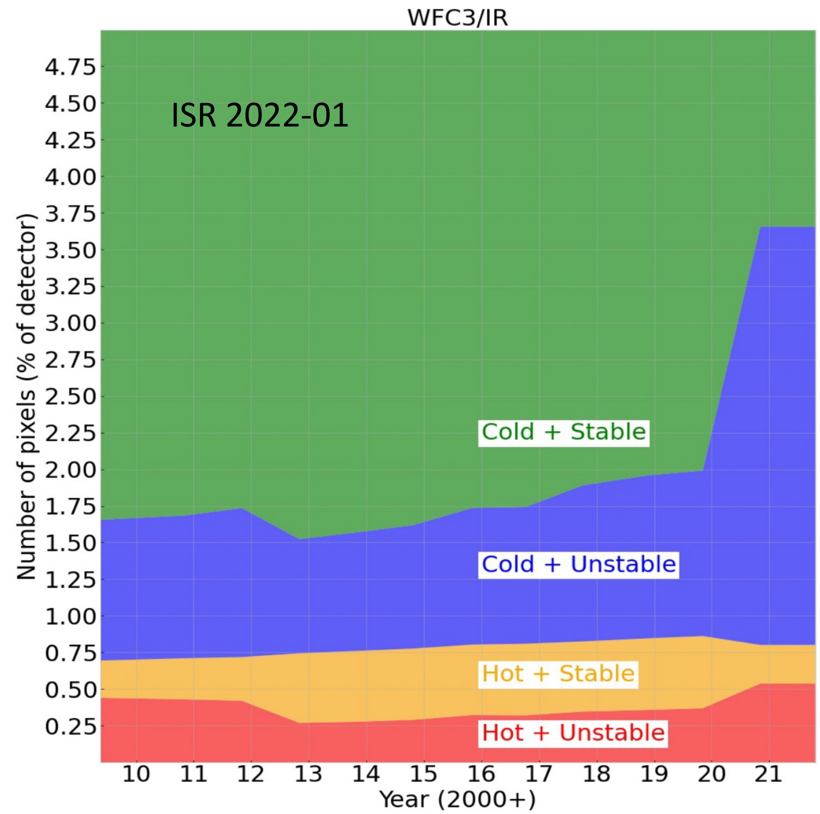


IR Dark Monitor

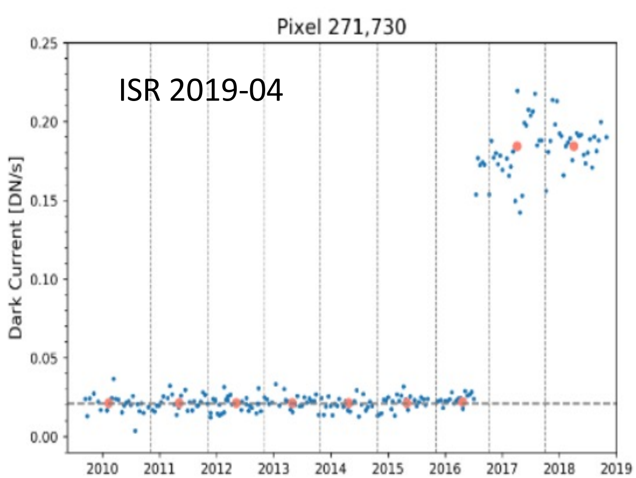
IR pixel stability through Cycle 28.

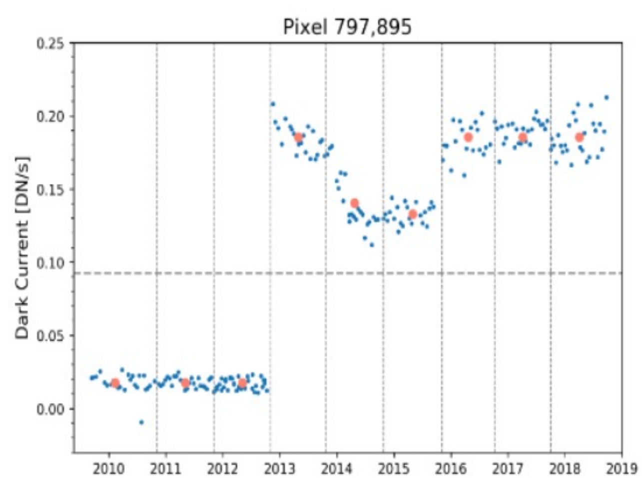
Each layer is stacked, so absolute percentages are aggregated and total to 100%.

The y-axis caps at 5%, meaning that over 95% of pixels are cold and stable (i.e. good).

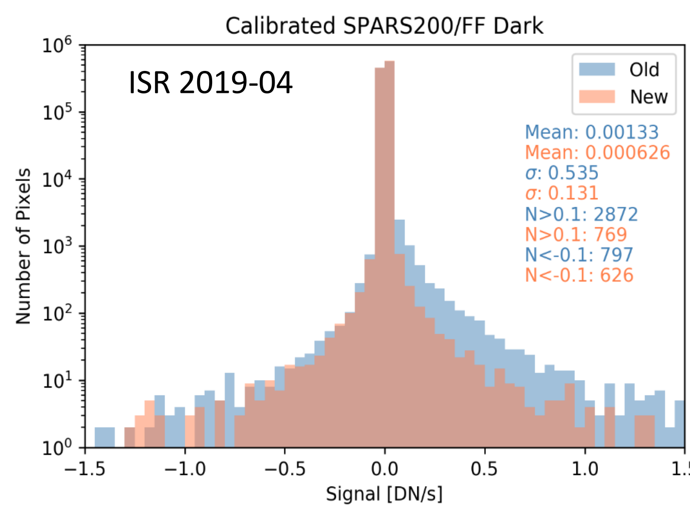


Pixel history for two pixels with superdark values determined for each cycle (orange). Dashed line compares with a simple full-stack superdark.





Single dark exposure calibrated with old vs new (Cy25) superdark

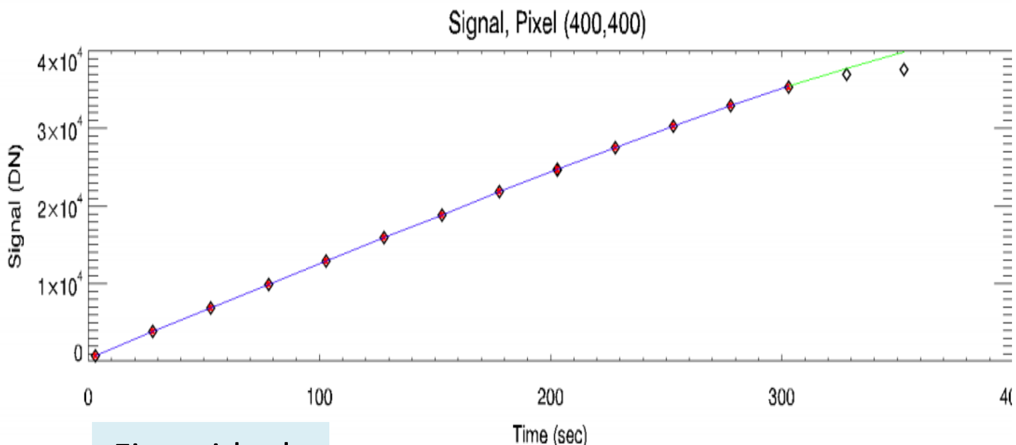


IR Linearity Monitor

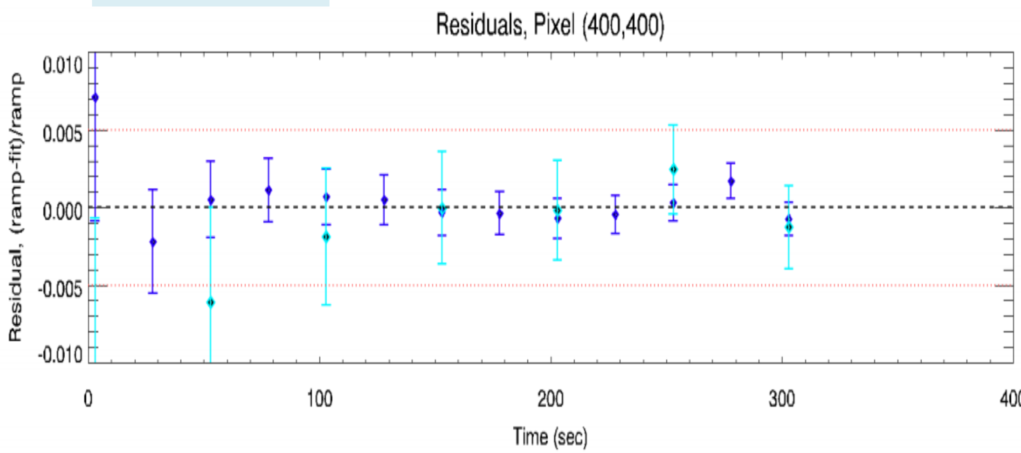
Orbits	External: Internal: 10
PI, Co-I's	Green, Bajaj
Purpose	Monitor the non-linearity of the WFC3/IR detector and track the stability over time
Description	HgCdTe detectors suffer from a non-linear response to incident flux. The calibration pipeline corrects for the effects of non-linearity. This monitor uses flat field ramps to characterize the non-linearity of each detector pixel.
Resources: Observations	10 internal orbits, once per year. Visits are identical in structure and consist of a dark observation followed by two internal flats using the Tungsten lamp through F126N (half SPARS10, half SPARS50) and F127M (half SPARS25, half SPARS10). The initial narrow band flat is used to ensure that the lamp is warm and stable in preparation for the F127M exposure, but not so bright to cause persistence. A trailing dark is obtained after the F127M flat to measure the persistence decay rate.
Resources: Analysis	Supports 100% of IR programs. For each pixel, a polynomial for the full ramp vs. time. The parameters of the appropriate fit are used to define an 'ideal' linear signal rate, and subsequently a measure of fractional linearity for each read. Another curve fit to the measured linearity and signal of each read with tunable parameters is used to find a correction for the non-linear response.
Products	NLINFILE reference file (*lin.fits)
Accuracy Goals	Photometry for long vs short exposures to <0.5% over a range of flux values
Prior Results, ISRs	ISR 2022-07, 'WFC3/IR Photometric Stability Stellar Cluster Study' (Long-term sensitivity changes in the IR channel), ISR 2014-17, 'Updated Non-linearity Calibration method for WFC3/IR'
Prior Cycle IDs	(47Tuc+Internals) Programs: 11931, 12352, 12696, 13079, 13563 Internals only (Cy22+): 14009, 14375, 14538, 14987, 15579, 15724, 16404, 16576, 17012 (cy30)

IR Linearity Monitor

Polynomial fit to signal vs time for a single detector pixel (red points)

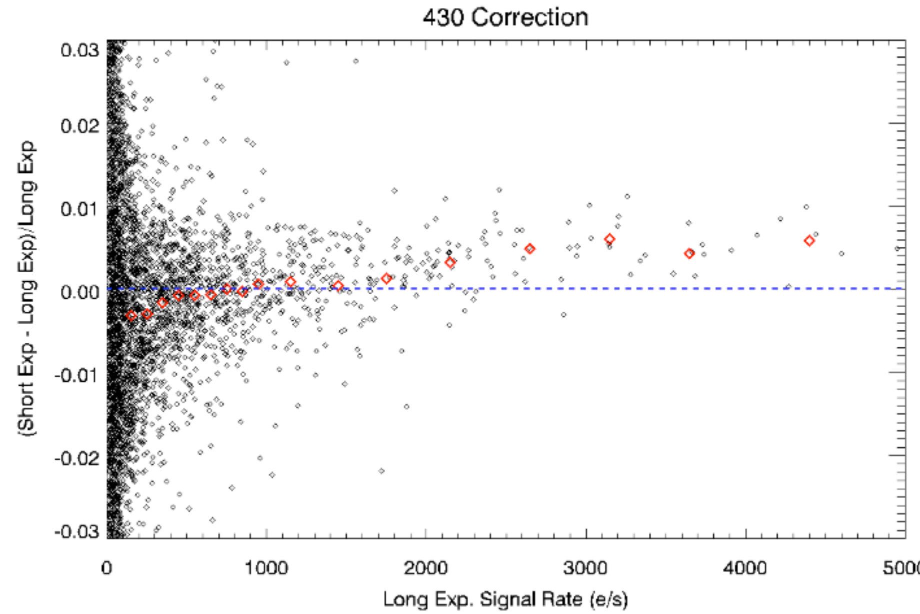


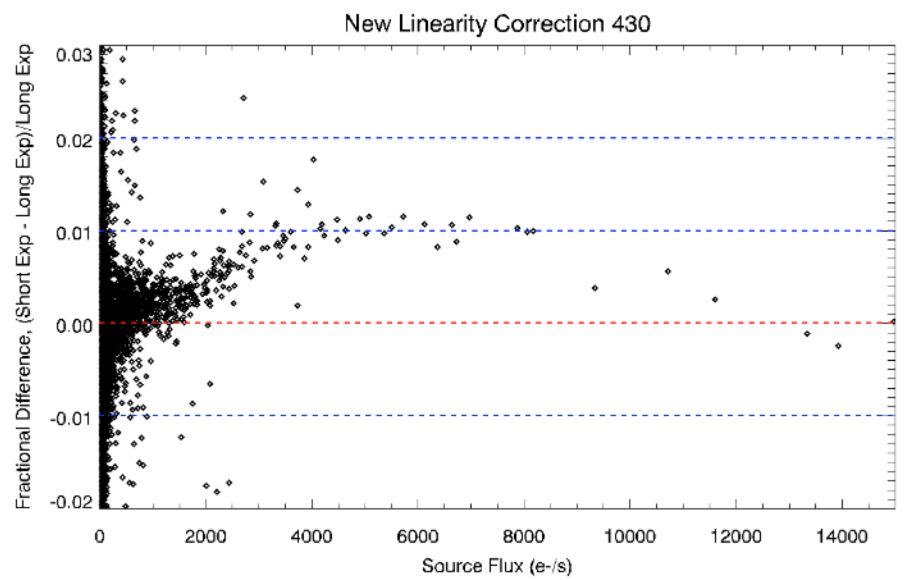
Fit residuals



ISR 2014-17

Validation with 47 Tuc





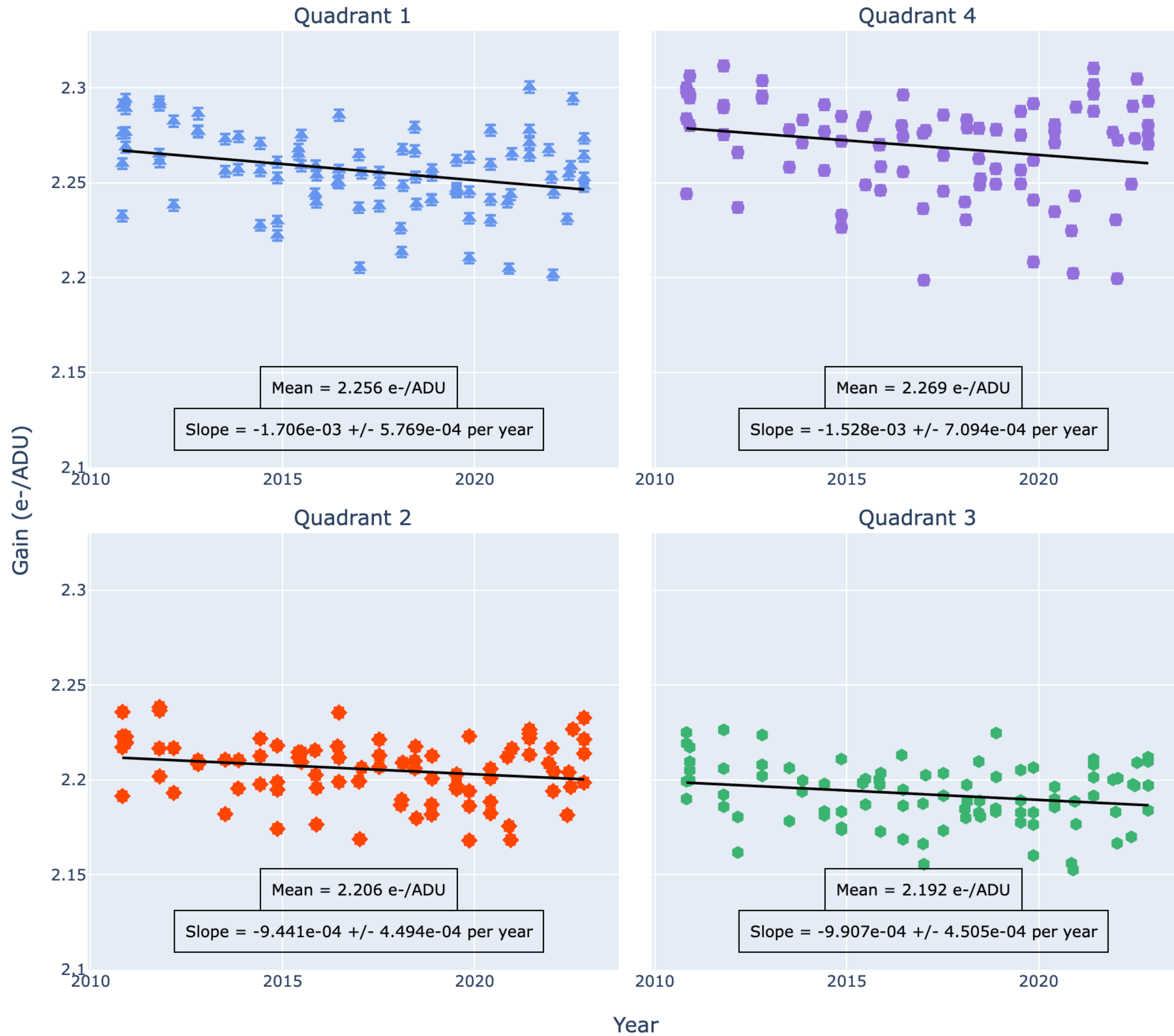
IR Gain Monitor

Orbits	External: Internal: 16
PI, Co-I's	Huynh, Khandrika, Green
Purpose	Measure the gain in four quadrants of the IR detector twice a year.
Description	Gain, the scaling relation between analog digital units (ADU) and photoelectrons, is a fundamental detector parameter. Gain can be measured using the mean-variance method on pairs of internal flats. For each quadrant of the ramp pairs, the mean-variance method is used to calculate the gain.
Resources: Observations	16 internal orbits, 8 in the summer and 8 in the winter. Each visit is identical and begins with a dark, allowing the BLANK to move into position before the lamp is turned on. The Tungsten lamp is turned on, and while the lamp warms a short warm up flat is taken through F126N to ensure a linear signal hits the detector for the duration of the long flat. Next, the long flat field ramp to be used in the gain measurement is taken. Finally, a trailing dark is taken to monitor persistence. Pairs of ramps are observed within 24 hours.
Resources: Analysis	Supports 100% of IR programs. Existing IDL software calculates the gain in each quadrant using the mean-variance method.
Products	Measurements of the gain and scatter in gain measurements for each epoch of observations. Quicklook monitoring plots are regularly updated.
Accuracy Goals	Measure gain to < 1% and track gain stability to <0.1%
Prior Results, ISRs	ISR 2015-14: WFC3 IR Gain from 2010 to 2015 (cycles 17-22)
Prior Cycle IDs	11930, 12350, 12697, 13080, 13564, 14010, 14376, 14539, 14988, 15580, 15725, 16405, 16577, 17013 (cy30)

IR Gain Monitor

IR Gain vs Date (2010 - Nov 2022)

The IR gain is calculated via the mean-variance method for each ramp pair and plotted vs MJD.



Quick Look Monitor- Updated to use plotly, providing the reader with interactive access to plots

https://wfc3ql.stsci.edu/automated_outputs/cal_ir_gain

WFC3 Photometric Performance

Same as the previous cycle

The following monitoring programs are designed to check the stability of the UVIS and IR photometric calibration:

- Monitor the accuracy of the shutter mechanism
  2 internal orbits
- Monitor the UVIS throughput with wavelength using scanned observations of CALSPEC standards
  12 external orbits = 2 white dwarfs (5x/yr), 1 G-star (2x/yr)
- Monitor the stability of the zeropoints for both UVIS and IR detectors using CALSPEC standards
  20 external orbits=
  IR: 4 orbits = 3 white dwarfs & 1 G-star (1x/yr)
  UVIS: 16 orbits = 3 white dwarfs (1-2x/chip/yr); 1 G-star & 1 A-star (1x/chip/yr)
- Monitor changes in the IR sensitivity using uncrowded regions in stellar clusters
  3 external orbits = M4 (2x/yr) + 47Tuc (1x/yr)
- Monitor changes in the IR sensitivity using scanned observations of an open cluster
  2 external orbits = M35 (2x/yr)

UVIS Shutter Monitoring

Orbits	External: 0 Internal: 2
PI, Co-I's	Huynh, Baggett, Calamida
Purpose	Monitor the performance of the UVIS shutter blades. The specific objectives are: (i) compare the photometric behavior of both shutter blades, for short vs long exposures (ii) check for any shutter shading effects
Description	Internal flats in F555W and F814W in each of the 4 amps will be used to monitor the repeatability and any shutter shading effects. We will continue to monitor the photometric behavior of blades A and B separately. Internal flats from the bowtie monitoring program provide an additional check of the shutter repeatability. External orbits are no longer required for this program; standard star observations from Cycles 23 & 24 show no noticeable difference in the performance of the shutter compared to SMOV.
Resources: Observations	2 internal orbits with the tungsten lamp on each of the 4 amplifiers in two filters.
Resources: Analysis	Supports 100% of UVIS programs. Internal tungsten lamp exposures will be used to check if count levels are consistent as expected from different exposure times and for both A and B blades.
Products	If the shutter shading is found to be significant, or if the performance of the 2 shutters is found to be different, this would require delivery a new reference file (e.g. SHADFILE) to correct for the behavior.
Accuracy Goals	Cross-calibrate shutters A and B to 0.2%. Monitor the stability to 0.1%
Prior Results, ISRs	The tungsten lamp output is continuing to decline. The counts from A and B are consistent for 1 and 17 sec exposures. For the 0.48 sec exposures, the results are ambiguous since the lamp is still brightening during the first exposure. Shutter shading effects have not substantially changed in the past 12 years. TIR: TIR 2023-01 (UVIS Shutter Blade Analysis) ISRs: 2018-11 (Shutter-induced Vibration), 2015-12 (Shutter Characterization), 2014-09 (Blade Side "A" for Short Exposures), 2009-25 (Shutter Shading)
Prior Cycle IDs	11427, 14019, 14383, 14882, 15397, 15584, 15726, 16406, 16578, 17014 (cy30)

UVIS Shutter Monitoring

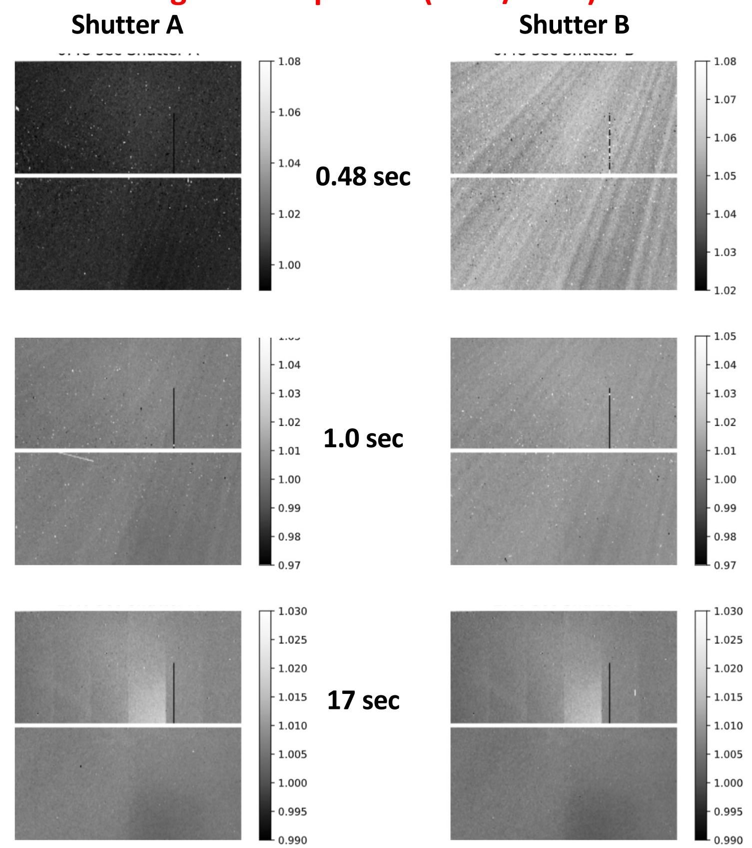
TIR WFC3 2023-01: Internal Lamp exposures

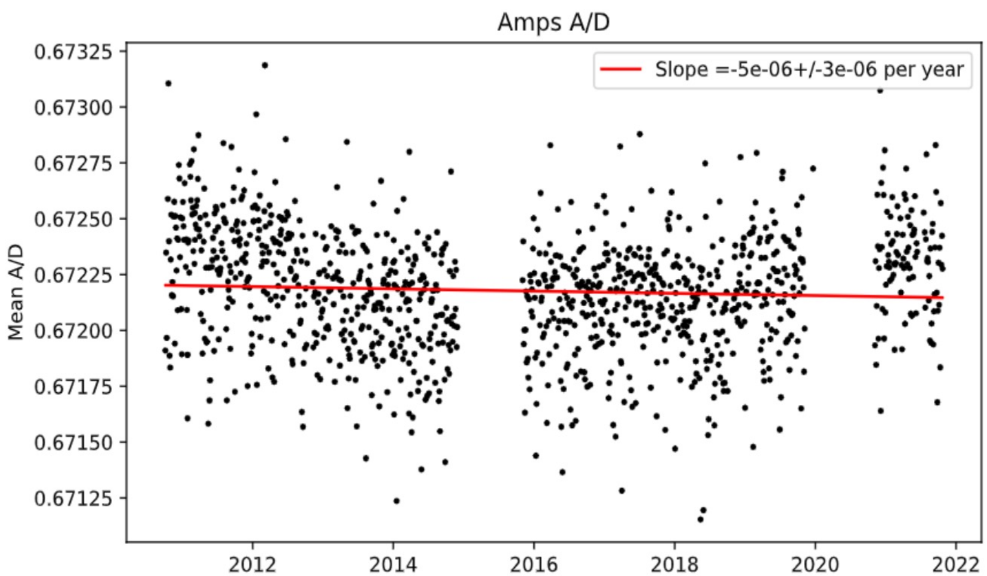
Count ratios observed in SMOV and **Cycle 30** remain constant for all 4 amplifiers (identified artifacts are other known detector effects), demonstrating that there is little to no change in the shutter shading compared to SMOV testing. The tungsten lamp continues to degrade overtime, with the percent decrease being consistent with other tests performed in **ISR 2021-15.**

TIR WFC3 2023-01: Bowtie Monitor

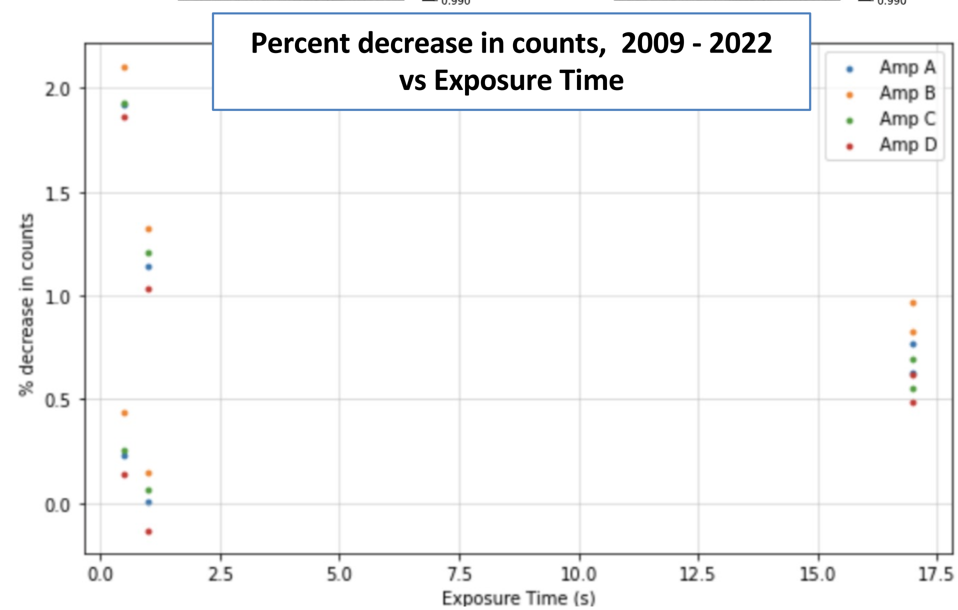
No measurable variation in the A/D and B/C flux ratios is found over the WFC3 lifetime, confirming the shutter is stable to ~0.1%.

Tungsten Lamp Ratio (2009/2022)





2009 - 2022



WFC3 UVIS and IR Photometry

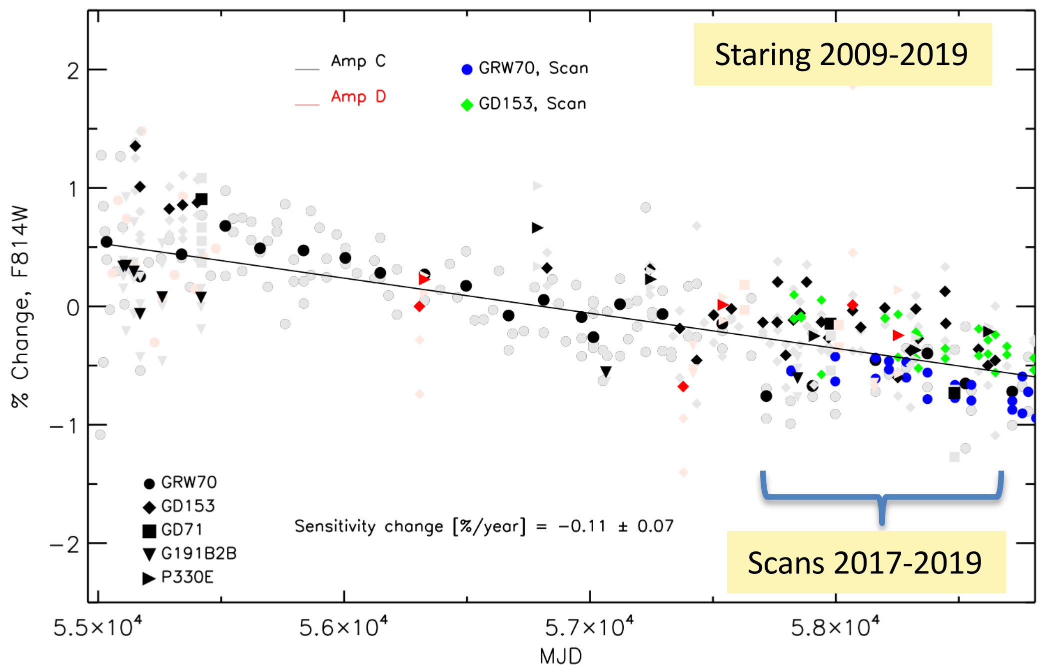
Orbits	External: 20 Internal: 0
PI, Co-I's	Calamida, Bajaj, Mack, Pidgeon, Marinelli
Purpose	Monitor the photometric throughput and stability with staring mode observations. Compute inverse sensitivities, EE's, and any color terms for all UVIS & IR filters as a function of time, detector position, and wavelength.
Description	***IR:*** Three white dwarf standards (**GD153, GD71, GRW+70D5824**) and a G-star (**P330E**) in all IR imaging filters. ***UVIS:*** The same four flux standards (for cross-calibration) in a subset of filters in the corner subarrays. In Cy26, GRW+70 replaced G191B2B, which is too bright in many filters and which has not been used for IR calibration since Cy19. This target allows for better synergy with the UVIS scanned data, which observes GD153 and GRW+70. An A-type star (**TYC-4212-455-1**) is observed to better constrain any color terms.
Resources: Observations	**IR**: 4 orbits = 4 stars * 1 epoch/star * 1 orbit/epoch to sample <u>all</u> filters **UVIS**: 8 orbits = 4 stars * 1 epoch/star * 2 chips * 1 orbit/chip/epoch (same as pre-Cy27 phot monitor) + 6 orbits = 2 stars * (2 epochs GRW*2 chips, 1 epoch GD153 * 2chips) (staring subset from contam monitor) + 2 orbits= A-star * 2 epochs/star (TYC-4212-455-1 for color terms)
Resources: Analysis	Supports 100% of UVIS & IR programs. The UVIS photometry reduction pipeline is capable of handling either FLC or DRC files (see TIR 2022-02).
Products	IMPHTTAB reference file which populates time-dependent photometry keywords in the image headers; Encircled Energy tables; Synthetic photometry tables for use with the ETC and synphot
Accuracy Goals	Track stability to < ~0.1%/yr. Improve UVIS accuracy to 1% absolute w.r.t. STIS (current relative photometry is ~0.5%) Improve IR photometric accuracy to 1% absolute w.r.t. STIS (current relative photometry is ~1%.)
Prior Results, ISRs	**UVIS**: TIR 2022-02: UVIS Photometry Pipeline; ISR 2022-02: UVIS EE; ISR 2021-04: Time-dependent Zeropoints, ISR 2018-08: UV Color terms, ISR 2018-02: Comparing ACS/WFC & WFC3/UVIS **IR :** ISR 2022-07: IR TDS in clusters**,** ISR 2021-05: IR TDS via Scans, 2020-10: IR Zpts, ISR 2020-05: IR TDS; ISR 2019-07: IR repeatability, ISR 2019-01: Count-rate Nonlinearity, 2009-37: EE
Prior Cycle IDs	11450 (UVIS), 11451 (IR), 11903 (UVIS), 11926 (IR), 12334, 12699, 13089, 13575, 14021, 14384, 14870 (IR), 14871, 14883, 14992, 15399 (UVIS color terms), 15582, 16030, 16415, 16579, 17015 (cy30)

ISR 2021-04

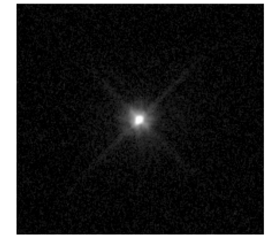
Relative photometry of five CALSPEC standards vs date (MJD)

- FLC's: grey
- DRC's: black, amp C
  red, amp D
- Scans: blue, GRW70
  green, GD153

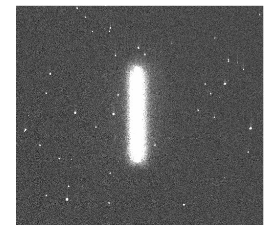
UVIS2 F814W Sensitivity Loss



UVIS Staring 2009-2020



UVIS Scans 2017-2021

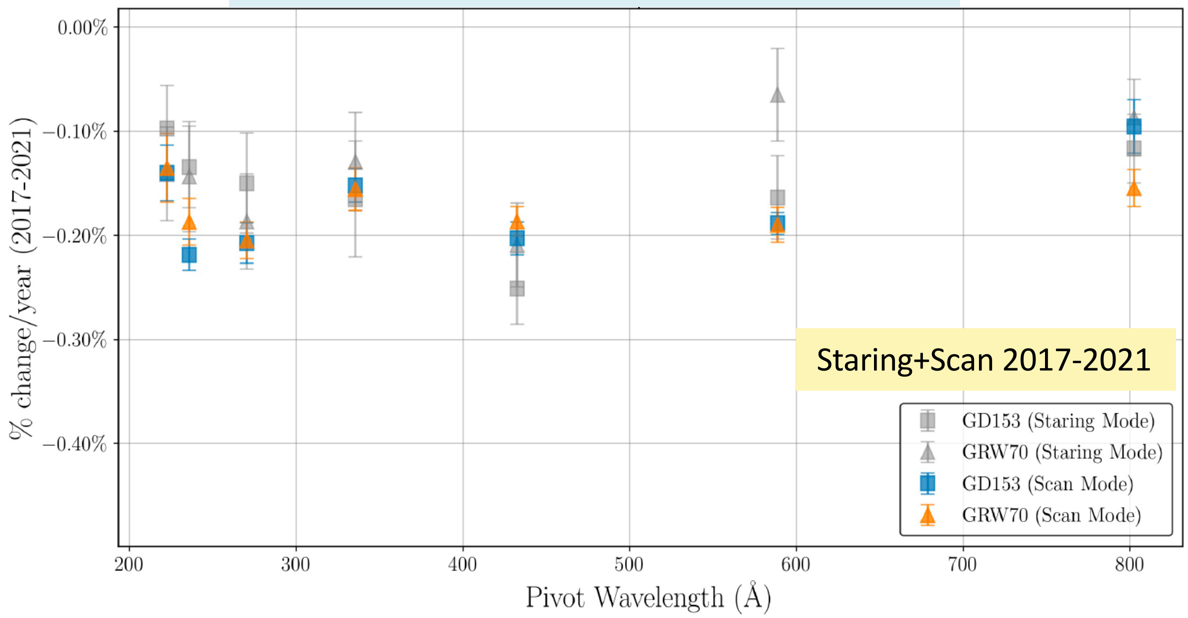


ISR 2022-04

Slope (% change per year) versus filter wavelength

- Staring: Grey
- Scans: Blue,Orange

UVIS2 Sensitivity Loss vs Wavelength



IR staring mode photometry

Monitoring of CALSPEC flux standards over 11 years shows **no evidence** of a sensitivity loss over time (ISR 2020-10), but the data are limited by systematic errors ± 1%.

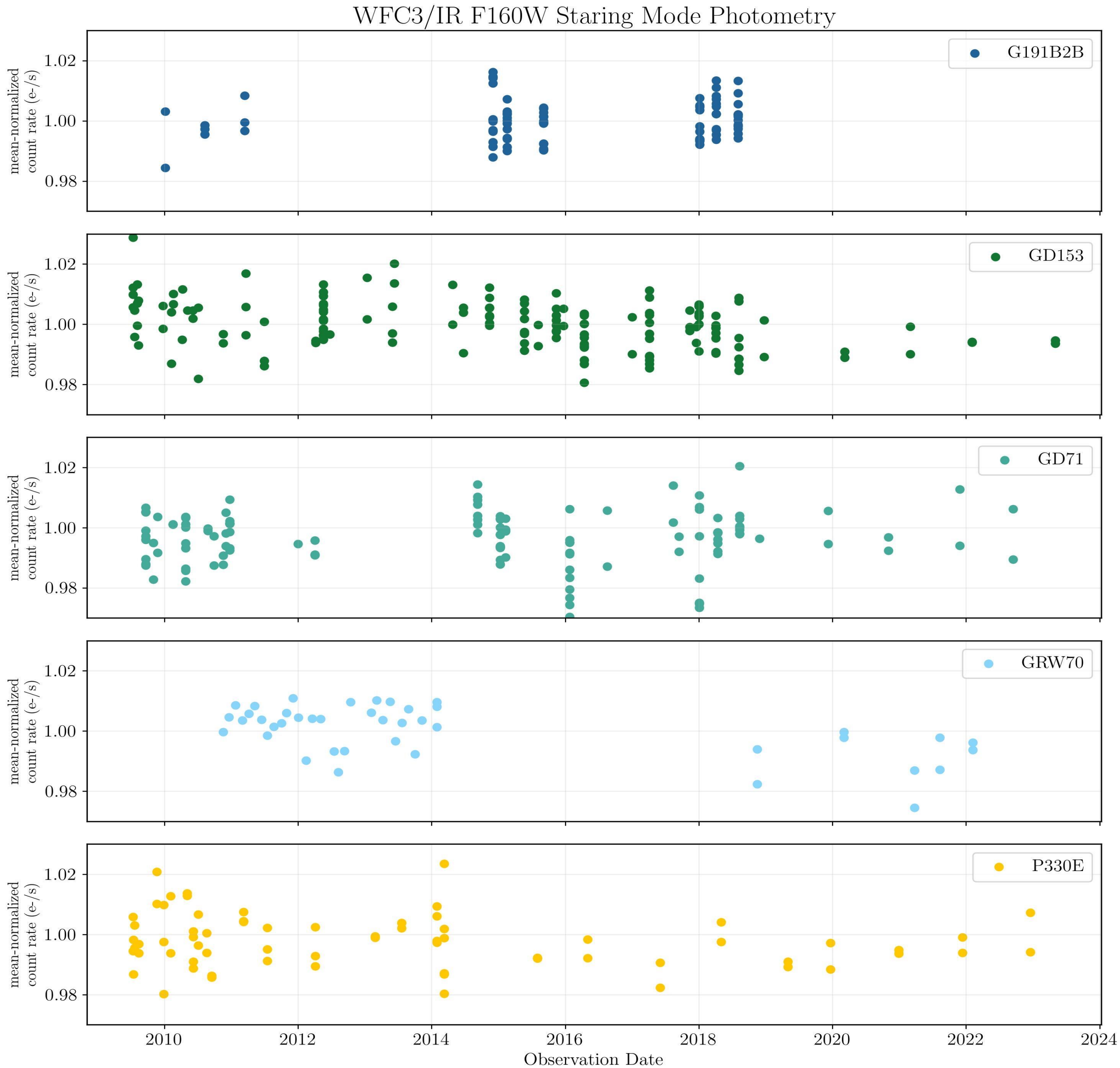
These data are ideal for computing the photometric zpts, but not for tracking relative changes

Additional IR Monitoring:

Star cluster photometry in sparse regions of M4 and NGC 104 shows losses of ~0.1 % per year (ISR 2022-07, see slide 44).

These losses are consistent with those from repeated, **scanned observations of M35** (ISR 2021-05).

F160W Relative Photometry of 5 CALSPEC flux standards

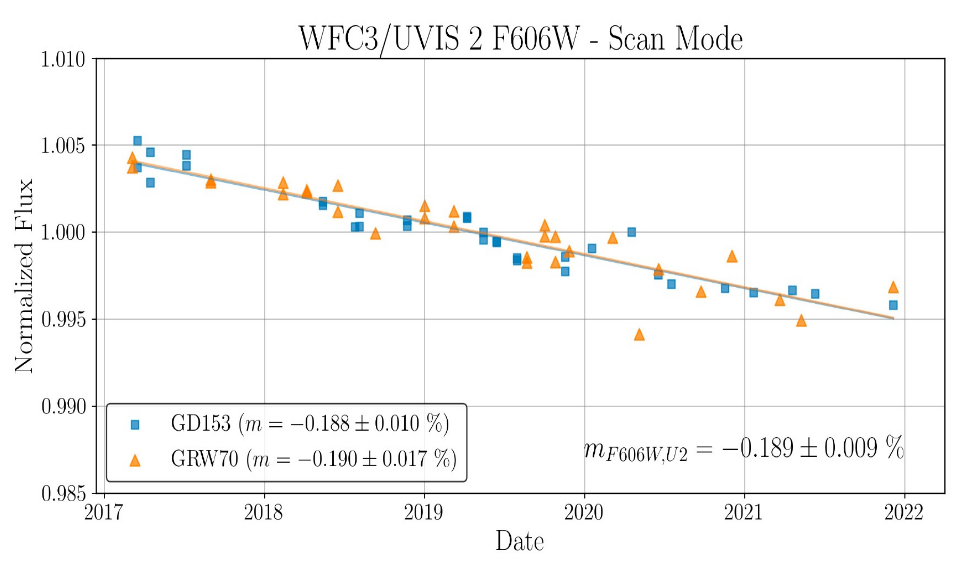


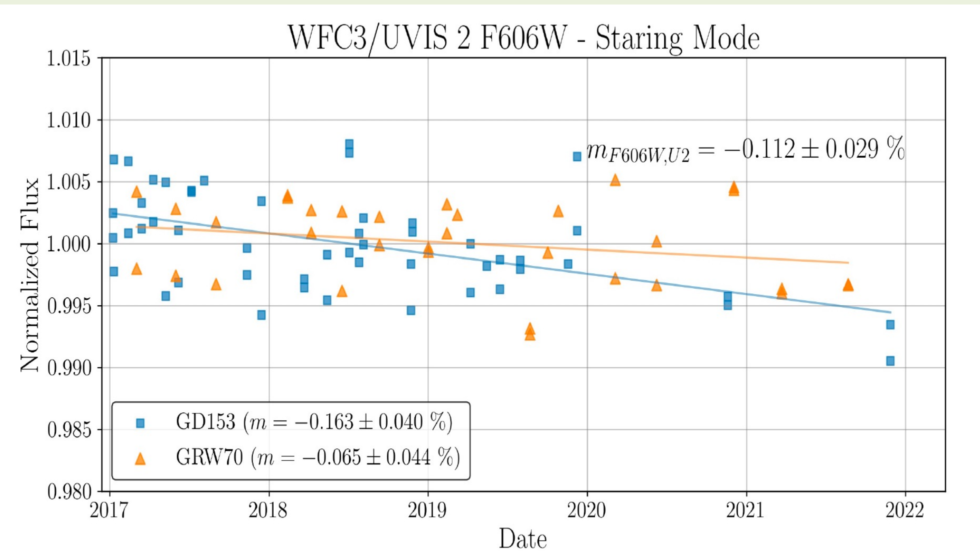
UVIS Time-Dependent Sensitivity

Orbits	External: 12 Internal: 0
PI, Co-I's	Marinelli, Calamida, Baggett, Mack
Purpose	Monitor relative changes in the UVIS photometric throughput using scanned observations. Traditionally, this program looks for the presence of contaminants on the optics via the flux of standard stars as a function of time and wavelength. Additional filters have been added to monitor sensitivity losses at longer wavelengths. In Cy27, staring mode data from program were moved to the Photometry Monitor for improved efficiency.
Description	Each visit obtains scanned subarray observations of HST standards in both amps A and C through a subset of filters. The white dwarf GRW+70D5824 has been used for past monitors and will be continued. A second white dwarf (GD153) was added in Cycle 23 with equal weight. This target has an added benefit of being schedulable throughout the year in 1-Gyro mode. P330E was added in Cy27 to look for any color effects. Given the greater precision of scanned mode *(~2-5x improved over staring mode),* we will test whether these data can be used for computing photometric zeropoints or if they are better suited for relative photometry.
Resources: Observations	12 orbits, scans only = 10 orbits for two white dwarfs (GRW+70, GD153) @ 5x/yr + 2 orbits for a G-star (P330E) @ 2x/yr
Resources: Analysis	Supports 100% of UVIS programs. Software in the WFC3 internal github repository will be used for photometry. These will be compared with the much longer baseline of staring mode data.
Products	While no UVIS contamination of has been detected, long-term sensitivity losses are present in all filters. The IMPHTTAB reference file populates time-dependent photometry keywords in the image headers.
Accuracy Goals	Track temporal stability to < ~0.1%/yr (the r.m.s. repeatability)
Prior Results, ISRs	ISR 2023-02: 'Testing Aperture Corrections for WFC3/UVIS Spatial Scans', ISR 2022-04: 'Monitoring WFC3/UVIS Photometric Sensitivity with Spatial Scans', ISR 2021-04, 2017-21, 2017-15, 2014-20.;
Prior Cycle IDs	11426, 11907, 12333, 12698, 13088, 13574, 14018, 14382, ← (Staring mode only) Cy24=14815 (staring)+14878 (scans), Cy25=15398 (staring/scans), Cy26=15583 (staring/scans), Scans only → Cy27 =16021, Cy28=16416 , Cy29= 16580, Cy30=17016

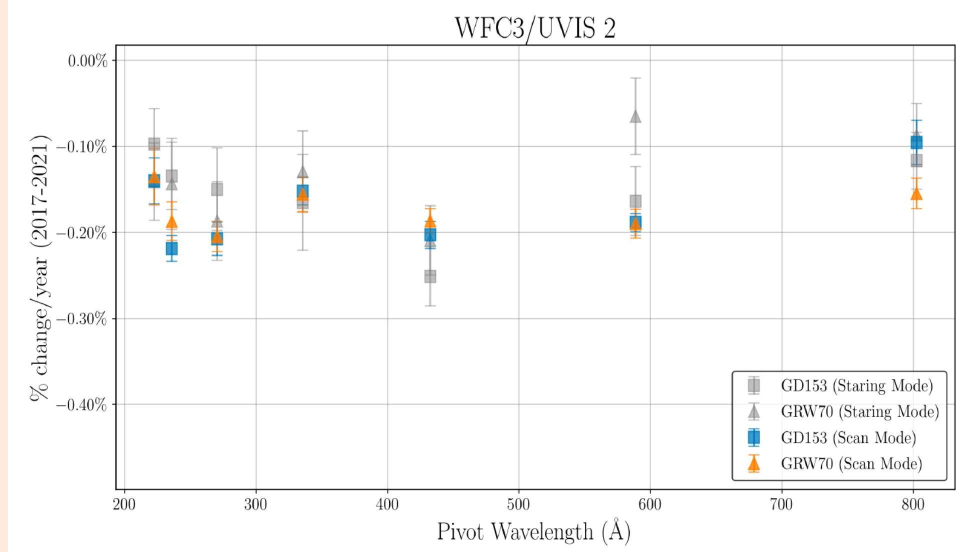
UVIS Time-Dependent Sensitivity

- Relative Flux for Scans (top) and Staring (bottom)
  ISR 2022-04

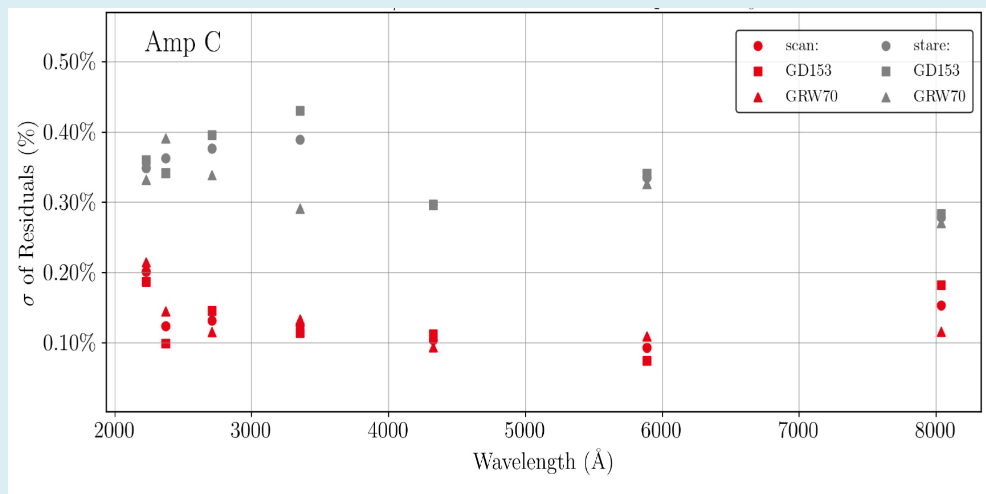




- Percent loss per year vs wavelength for scan/stare
- Slopes derived for the two methods are consistent



- Repeatability is ~0.1% (scans) vs ~0.3% (staring)
- 1-sigma scatter is 2-5x better with scans



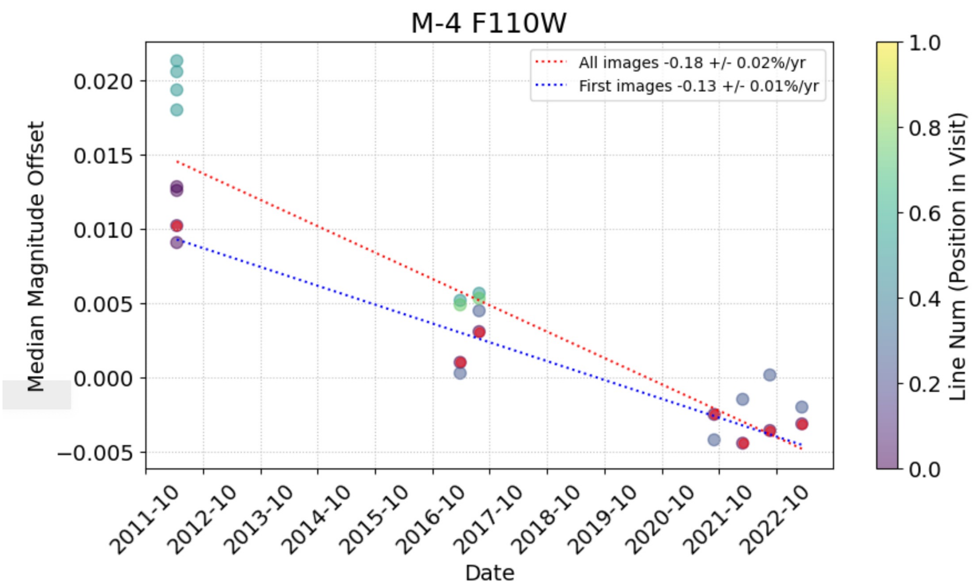
WFC3/IR Time-Dependent Sensitivity in Staring Mode (Clusters)

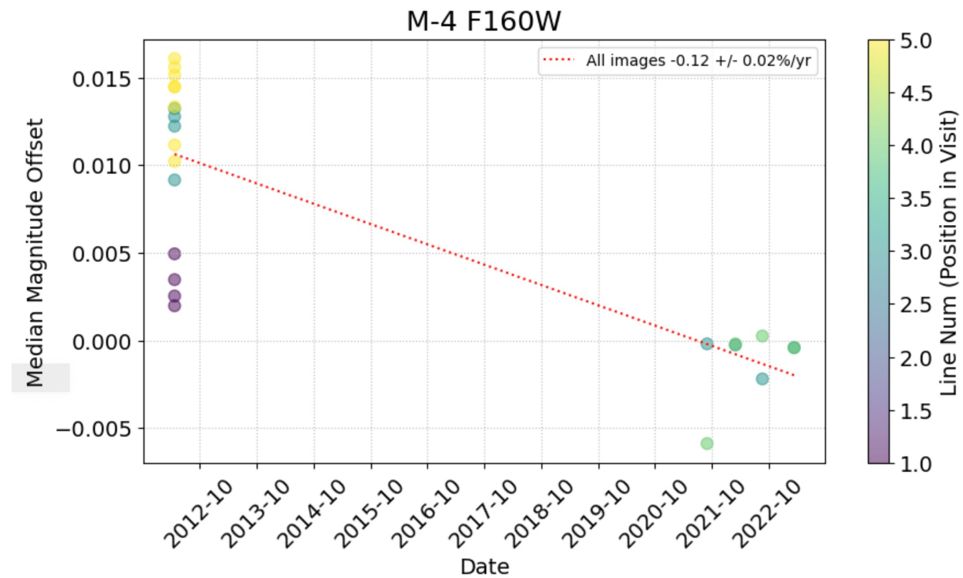
Orbits	External: 3 Internal: 0
PI, Co-I's	Bajaj, Calamida, Mack, Som
Purpose	Test for sensitivity losses in the IR detector by leveraging prior observations of stellar clusters.
Description	A variety targets/techniques result in range of IR sensitivity loss estimates. For example, the IR grism flux monitor suggests losses of 0.12 $\pm$0.01 % yr $^{-1}$ (G102) and 0.06 $\pm$0.01 % yr $^{-1}$ (G141). The IR photometric monitor, however, show no evidence of any loss in the IR imaging filters, but the repeatability is limited by systematic errors of $\pm$ 1%. Scanned images of M35 show marginal losses 0.06 $\pm$0.01% yr $^{-1}$ in F140W, but these data have a large scatter which may be related to detector preconditioning. Cluster observations allow for the measurement of many more stars, and we repeat prior observations of two uncrowded stellar fields in the clusters M4 and NGC104. Recent analysis of these data suggest losses of 0.13 $\pm$0.01 % yr $^{-1}$ in F110W (M4) and 0.10 $\pm$0.05 % yr $^{-1}$ in F160W (NGC104).
Resources: Observations	3 orbits - 2 targets; *One cluster observed 2x/year and the other cluster 1x/year (will start swapping Cycle 32)* Target 1: **M4**: 1 visit (orbit) in F110W & F160W to follow the pending (Fall 2023) visit by 12 months; Target 2: **NGC 104**: 2 visits (six months apart) in F160W. We repeat prior observing strategies (filter, samp_seq, exposure time, dither pattern) to minimize systematic errors and mitigate self-persistence.
Resources: Analysis	Analysis using software tools already developed by the PI for prior data
Products	IMPHTTAB reference file & synphot tables; Time-dependent keywords to be implemented in FY24
Accuracy Goals	Characterize TDS losses of ~1% over the WFC3 lifetime to <0.5% accuracy Systematic errors are up to 1% across visits, so multiple visits & targets are required.
Prior Results	ISR 2022-07, WFC3/IR Photometric Stability Stellar Cluster Study; ISR 2020-10: Updated WFC3/IR Photometric Calibration; ISR 2021-05: Scanned Photometry of M35; ISR 2020-05: WFC3 IR Sensitivity over Time; ISR 2019-07: IR photometric repeatability, 2019AJ...157...229B: CALSPEC WFC3 Infrared Grism Spectrophotometry
Prior IDs	Cycle 30: CAL-17260 (**M4, NGC 104**) ; Cycle 29 CAL-16864 (**M4, NGC 104, Omega Cen**); Prior **M4**: GO-12602, GO-14725, CAL-16512; Prior **NGC 104**: 'IR Linearity Monitor' CAL-11931, 12352, 12696, 13079, 13563

M4 Cluster

F110W fit using 'All images' in visit -0.18 ± 0.02%/yr
'First images' in visit -0.13 ± 0.02%/yr

F160W fit for 'All images' is -0.12 +/- 0.02%/yr, but these follow F110W in the visit and may suffer from self-persistence

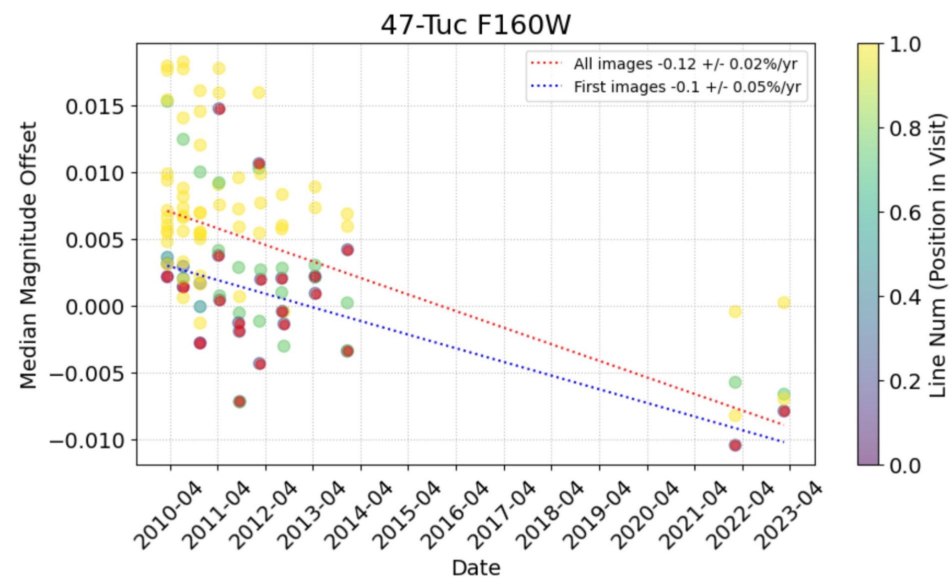




NGC 104

F160W fit (All images): -0.12 ± 0.02 % yr^{-1}
(First images): -0.10 ± 0.04 % yr^{-1}

Purple points mark the 'First image' in visit
Other colors are affected by self-persistence



ISR 2022-07

WFC3/IR Time-Dependent Sensitivity: Spatial Scans

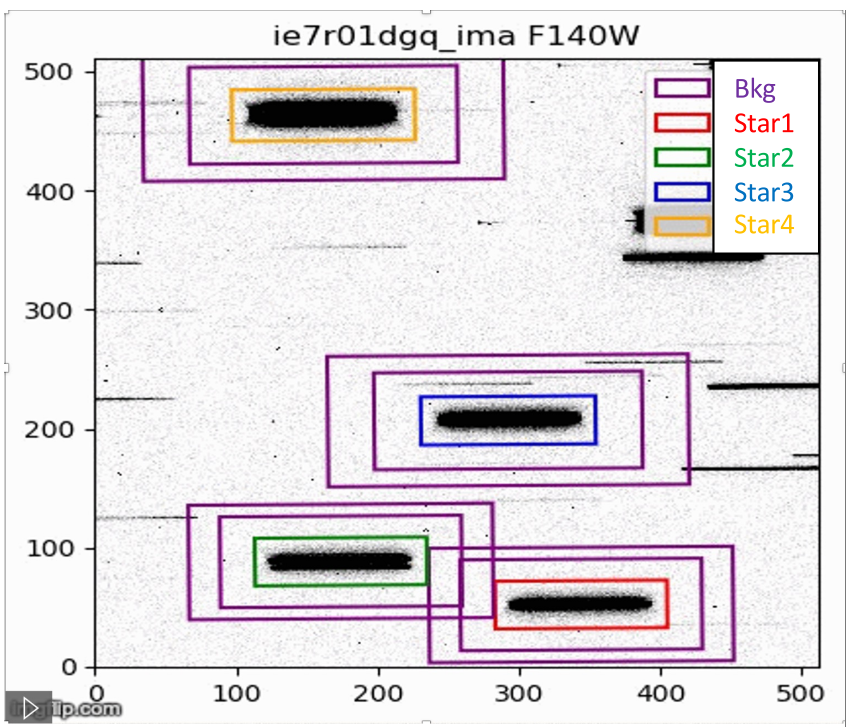
Orbits	External: 2 Internal: 0
PI, Co-I's	Som, Bajaj, Mack
Purpose	Monitor sensitivity losses using scanned observations of M35 in the F140W and F098M filters acquired over several years. Supplement parallel efforts to monitor the IR sensitivity using CALSPEC white dwarf standards and stellar clusters.
Description	Scanned images of M35 show that IR photometry is repeatable to ~0.2% within a visit and ~1% across visits, compared to ~2% in staring mode. Revisiting the same M35 field over time will allow us to monitor any time-dependent losses in sensitivity. Rather than scanning a single star, the M35 field provides multiple sources, and this field has been observed twice in cycles 27, 29 & 30 . The latest results show a losses of $0.060 \pm 0.007\%\ yr^{-1}$ in F140W, consistent with G141 results $0.061 \pm 0.007\ \%\ yr^{-1}$. This is consistent with losses measured from stellar clusters observations (F110W; $0.12 \pm 0.02\ \%\ yr^{-1}$ and F160W; $0.06 \pm 0.03\ \%\ yr^{-1}$).
Resources: Observations	2 orbits taken 3 months apart (Jan 2024 and Mar 2024) at the same orientation in order to sample the same pixels and minimize flat field errors. Repeated observations are taken with large dithers to estimate the flat field accuracy.
Resources: Analysis	FTE estimate ~3 weeks (<0.1 FTE); Analysis by the PI using existing software for scanned data. Future analysis includes measuring the flux along the scan to look for pixel phase effects.
Products	IMPHTTAB (Image Photometry Table) for WFC3/IR and new SYNPHOT filter throughput curves
Accuracy Goals	Characterize TDS losses of ~1-2% over the WFC3 lifetime to ~0.1% accuracy; Systematic errors across visits are up to 1% so multiple visits are required. These include the effects of detector preconditioning, pixel phase errors, and flat fields errors for the dithered exposures.
Prior Results, ISRs	Som et al., ISR 2021-05: 'Photometric Repeatability and Sensitivity Evolution of WFC3/IR' Bohlin et al. 2019AJ....157..229B, 'CALSPEC: WFC3 Infrared Grism Spectrophotometry' Bajaj, ISR 2019-07, 'WFC3/IR Photometric Repeatability'
Prior Cycle IDs	CAL-17261, 16439 & 16031 in Cycles 27, 28 & 30: 'WFC3 IR Time-dependent Sensitivity' CAL-14020 in Cycle 22: 'WFC3 Photometric Repeatability'

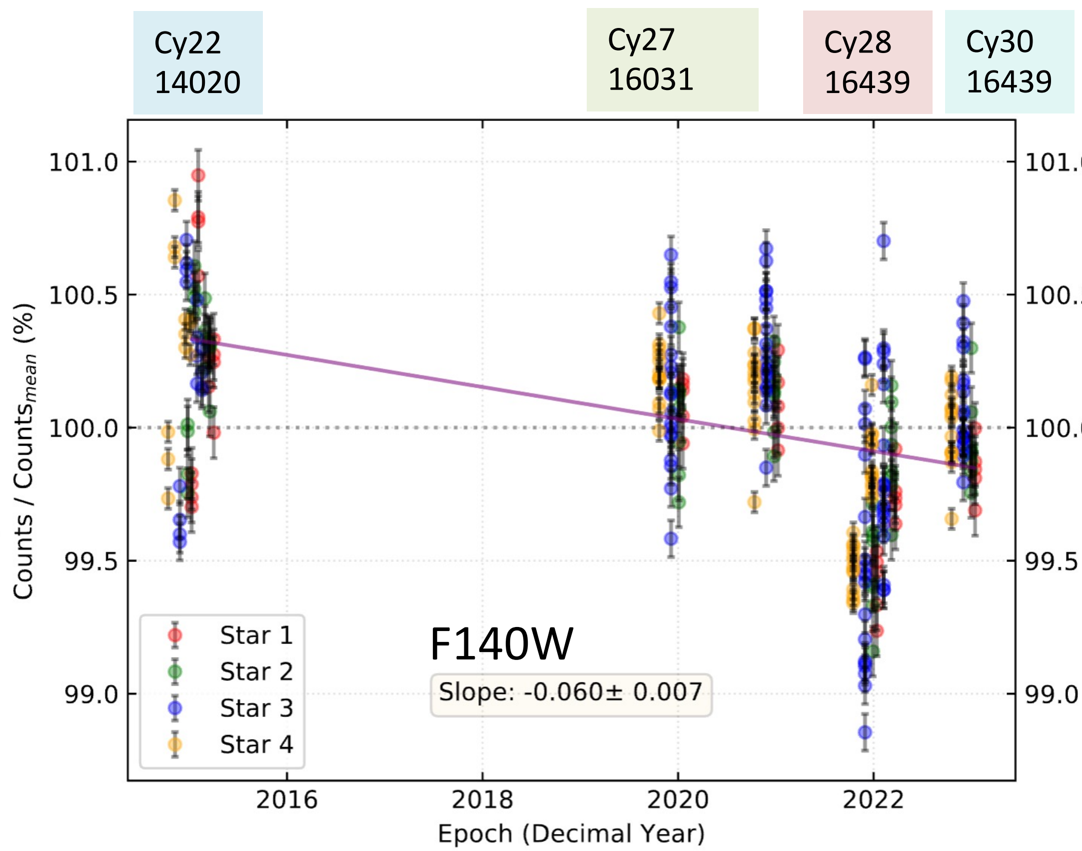
IR Scans of bright (V~13) stars in **M35**

- Photometry of 4 stars in four repeated visits in 2015 varies by ~0.2% within a visit and ~0.8% between visits
- Losses are significant compared to the estimated error and similar to those observed with the grisms.

TDS Method	Slope	Time Baseline
F140W Scans	-0.060+/-0.007 % yr^{-1}	(8 years)
G141	-0.061+/-0.007 % yr^{-1}	(14 years)
F098M Scans	-0.158+/-0.021 % yr^{-1}	(4 years)
G102	-0.116+/-0.008 % yr^{-1}	(14 years)

Som et al., ISR 2023 *in prep* & ISR 2021-05





WFC3 Focus Calibration

Same as the previous cycle

The traditional CAL/OTA monitor was converted to a CAL/WFC3 monitor in Cy30. This program is designed to:

- Monitor the OTA focal length in order to maintain HST focus within science tolerances
- Determine any focus offsets between the HST imagers

6 external orbits = 1 orbit per visit * 6 visits (non-contiguous)

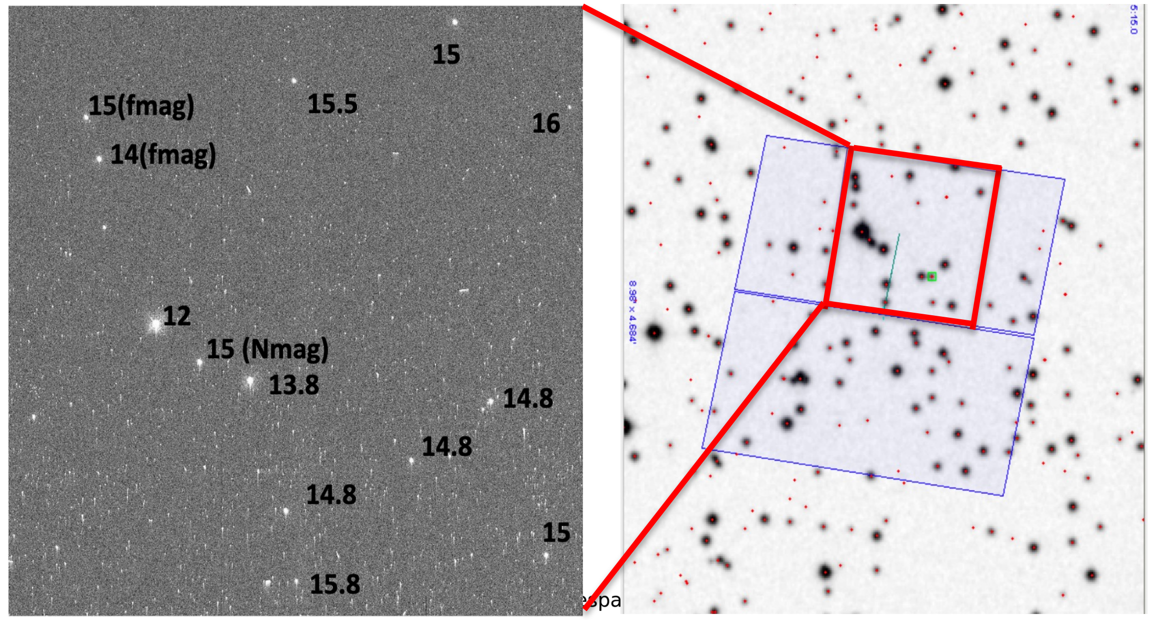
HST Cycle 31 Focus & Optical Monitor

Orbits	External: 6 Internal: 0
PI, Co-I's	Dressel, Rivera, Anderson, Lallo
Purpose	Utilize WFC3/UVIS and ACS/WFC in parallel to observe stellar cluster members with multiple exposures over an orbit. Phase retrieval performed on the PSF in each image will be used to measure focus, with the ability to explore apparent coma, astigmatism, and other changes in WFC3. Goals: 1.) monitor the OTA focal length for the purposes of maintaining focus within science tolerances, 2.) determine focus offsets between the imagers and identify any science instrument (SI)-specific focus behavior and dependencies.
Description	This bi-monthly program uses the WFC3/UVIS filter F410M to take shallow subarray exposures of the sparse open cluster NGC188. Full frame ACS/WFC exposures in F502N are made in parallel. Phase retrieval (PR) is performed on the stellar images to measure the focus of each exposure in equivalent secondary mirror despace. These focus measurements are used to track the evolution of the focus over months and years and to inform whether a focus adjustment is required.
Resources: Observations	6 external orbits, 1 orbit every ~2 months with WFC3/UVIS and ACS/WFC in parallel for con-focality check. The use of WFC3 subarrays allows for more exposures during the orbit.
Resources: Analysis	Uses standard PR techniques to determine of the amount of defocus aberration present in images acquired with both science instruments
Products	Since deployment, the HST OTA has shrunk by ~150 microns, resulting in over 20 compensating Secondary Mirror (SM) adjustments away from the Primary Mirror to maintain good focus to the SI's. This program provides the observations to determine when an SM adjustment is required.
Accuracy Goals	Measure and track the mean despace to within +/-1 micron for both detectors
Prior Results, ISRs	Numerous focus reports are available on 'Hubble's Focus and PSF' webpage: https://www.stsci.edu/hst/instrumentation/focus-and-pointing/focus
Prior Cycle IDs	CAL-WFC3: 17258, CAL-OTA: 16827, 16475, 16050, 15620, 15001, 14866, 14451

HST Cycle 31 Focus & Optical Monitor

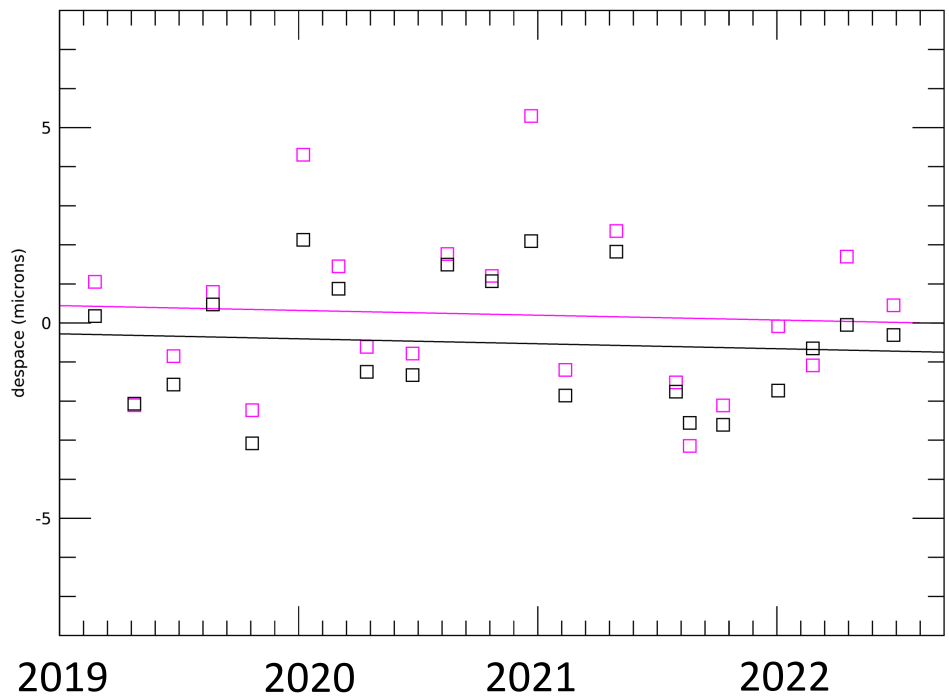
CAL/OTA field: NGC 188

F410M (228 s)
1024x1024 Subarray
V-mag as noted



Despace (microns) vs Date

UVIS - magenta
ACS - black



WFC3 Grism Spectroscopy

Same as the previous cycle,
with the exception of 1 orbit in the UVIS grism done every 2 years

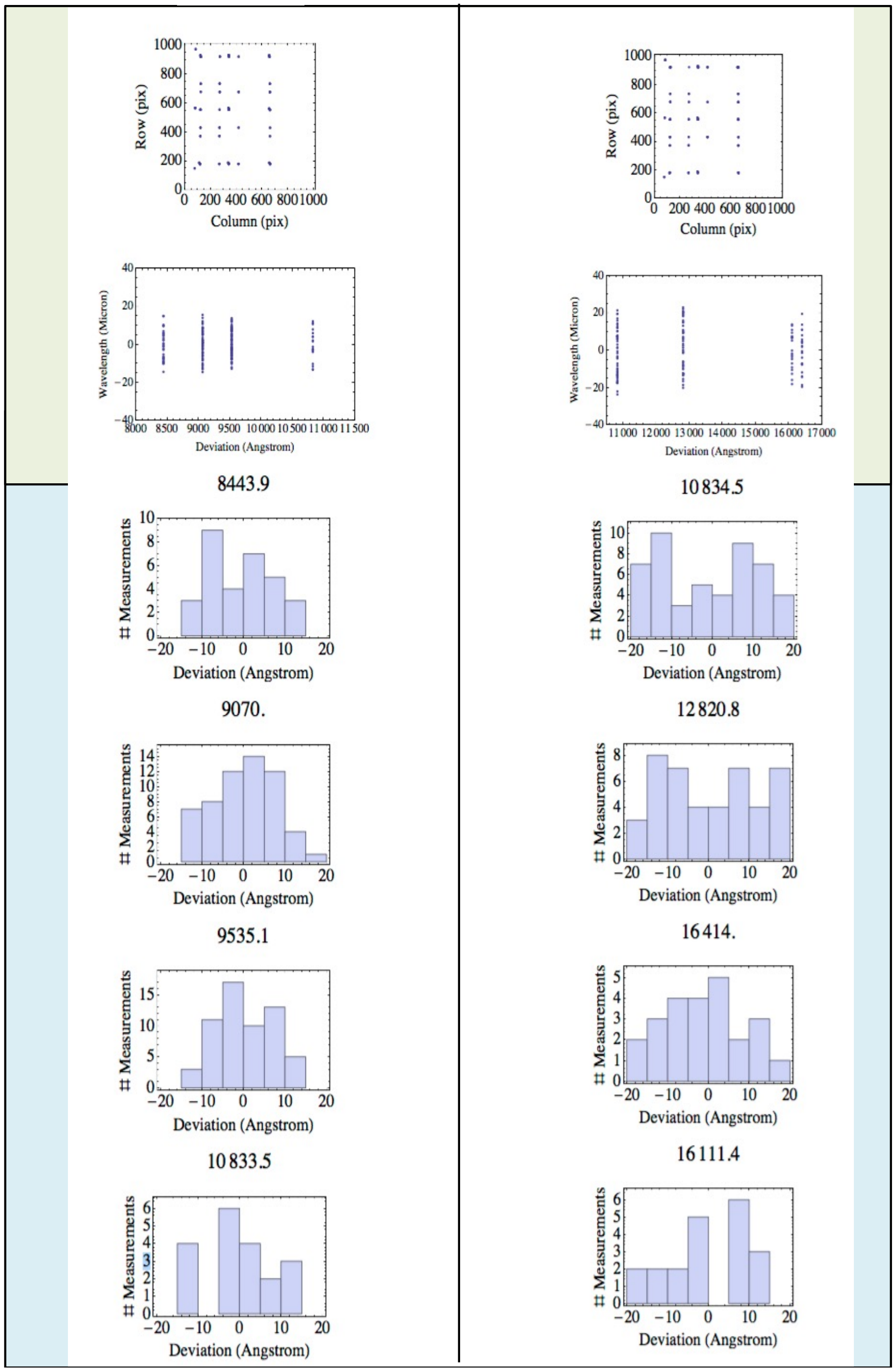
- Monitor and improve the wavelength calibration for both IR grisms
  1 orbit
- Monitor and improve the flux calibration and trace for both IR grisms
  3 orbits (same as last cycle)
- Monitor the wavelength stability of the UVIS grism in both chips.
  1 orbit (every other year; last done in Cycle 29)

WFC3 IR Grism Wavelength Calibration & Stability

Orbits	External: 1 Internal: 0
PI, Co-I's	Som, Pidgeon
Purpose	Verify the temporal stability of the wavelength dispersion for the G102 and G141 grisms
Description	Grism G102 and G141 observations of VY2-2 will be obtained and reduced to verify that the dispersion of these grisms is not changing.
Resources: Observations	1 orbit = 1 pointing at the center of the field per grism
Resources: Analysis	Supports 30% of IR programs (grisms) Automated reduction using custom internal software.
Products	New aXe configuration files, as needed
Accuracy Goals	10 Å for G102; 20 Å for G141
Prior Results, ISRs	hstaXe Cookbook: https://github.com/spacetelescope/hstaxe ISR 2018-13: Linear Reconstruction of Grism Spectroscopy ISR 2017-01: A More Generalized Coordinate Transformation Approach for Grisms ISR 2016-15: Trace and Wavelength Calibrations of the WFC3 G102 and G141 IR Grisms ISR 2015-10: IR Grism Wavelength Solutions Using the Zero Order Image as the Reference Point
Prior Cycle IDs	12356, 12703, 13093, 13580, 14023, 14385, 14543, 14543, 14993, 15586, 15727, 16407, 16582, 17017 (cy30)

WFC3 IR Grism Wavelength Calibration & Stability

G102 G141



The location at which emission lines were extracted and measured (using the latest trace calibration)

The difference between the fitted model of the wavelength dispersion and the fiducial wavelengths of the lines which were detected and measured.

Histogram of the fit residuals, over the entire field of view, for each emission line measured:

G102:		G141:	
O I	(8,443.9 A)	He I	(10,834.5 A)
[S III]	(9,070.0 A)	He I	(12,820.8 A)
[S III]	(9,535.1 A)	H I Br12	(16,414.0 A)
He I	(10,833.5 A)	H I Br13	(16,111.4 A)

ISR 2016-15

WFC3 IR Grism Flux/Trace Calibration & Stability

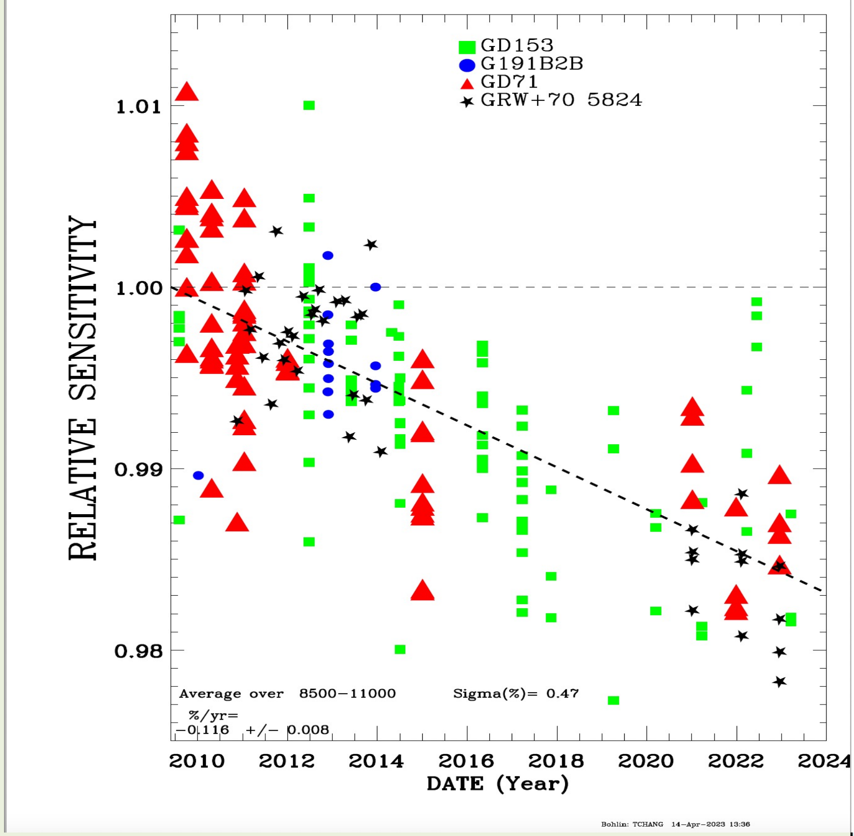
Orbits	External: 3 Internal: 0
PI, Co-I's	Som, Pidgeon
Purpose	Monitor the time-dependent sensitivity (TDS) for both IR grisms via annual measurements of spectrophotometric standard white dwarf stars. Verify the temporal stability of trace solution.
Description	The original flux monitor observed GD71 and GD153 at a range of detector positions but was reduced to a single orbit of GD153 based on the stability of the initial calibration. Using a longer time baseline, a decrease in sensitivity of ~0.1% per year has been measured. In Cycle 28, GRW+70 5824 was added to this monitor (and GD71 resumed) to more accurately characterize the time-dependent losses.
Resources: Observations	3 orbits (1 orbit/star for three WD standards in both grisms). Observations are taken at 3 positions near the center of the detector with postargs (-20, 0) (-20, +15) (-20, -15)
Resources: Analysis	ABSCAL code by Bohlin will be used for analysis
Products	Time-dependent sensitivity corrections for the GO community using grisms. Synthetic photometry tables for use with synphot and hstaXe
Accuracy Goals	Characterize TDS losses to accuracy <0.1%.
Prior Results, ISRs	hstaXe Cookbook: hstaXe Cookbook: https://github.com/spacetelescope/hstaxe ISR 2020-04: 'Dispersed IR background in G102, G141' (3 components= Zodi +He +Scatter) Bohlin & Deustua, 2019AJ....157..229B, 'CALSPEC: WFC3 Infrared Grism Spectrophotometry' ISR 2016-15: Trace and Wavelength Calibrations of the WFC3 G102 and G141 IR Grisms
Prior Cycle IDs	**GD71**: 11936, 12357,12702, **GD153**: 13092, 13579, **GD71:** 14024, **GD153:** 14386, 14544, 14994, 15587, **GD153+GD71+GRW:** 15728, 16408, 16583, 17018 (cy30)

WFC3 IR Grism Flux/Trace Calibration & Stability

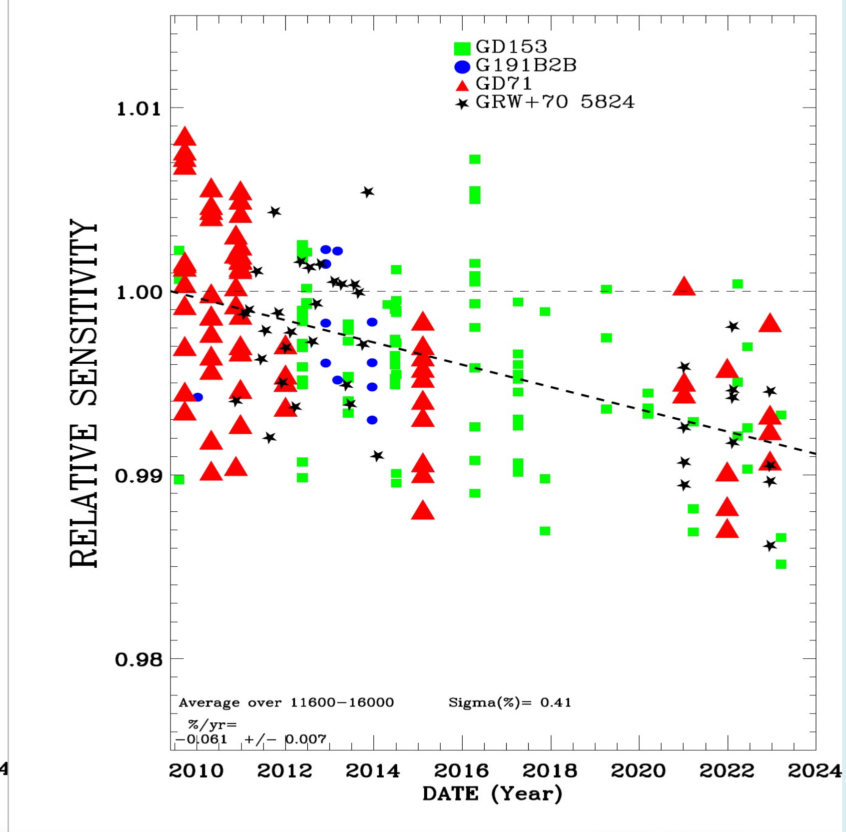
- Grisms on WFC3 are extremely popular
- Precision IR SEDs are critical for CALSPEC / support for future IR missions (JWST, Roman)
- Sensitivity losses are seen in G102, G141 archival standard star data (Som & Bohlin 2023, in prep.)

- Grism flux monitor in Cycle 27 observed **GD153** (green), once per year
- Approval in Cycle 28 to add **GD71** (red), **GRW+70D5824** (black) for a total of 3 orbits
- These three WDs are also observed in the 'Photometry Monitor' for IR filters

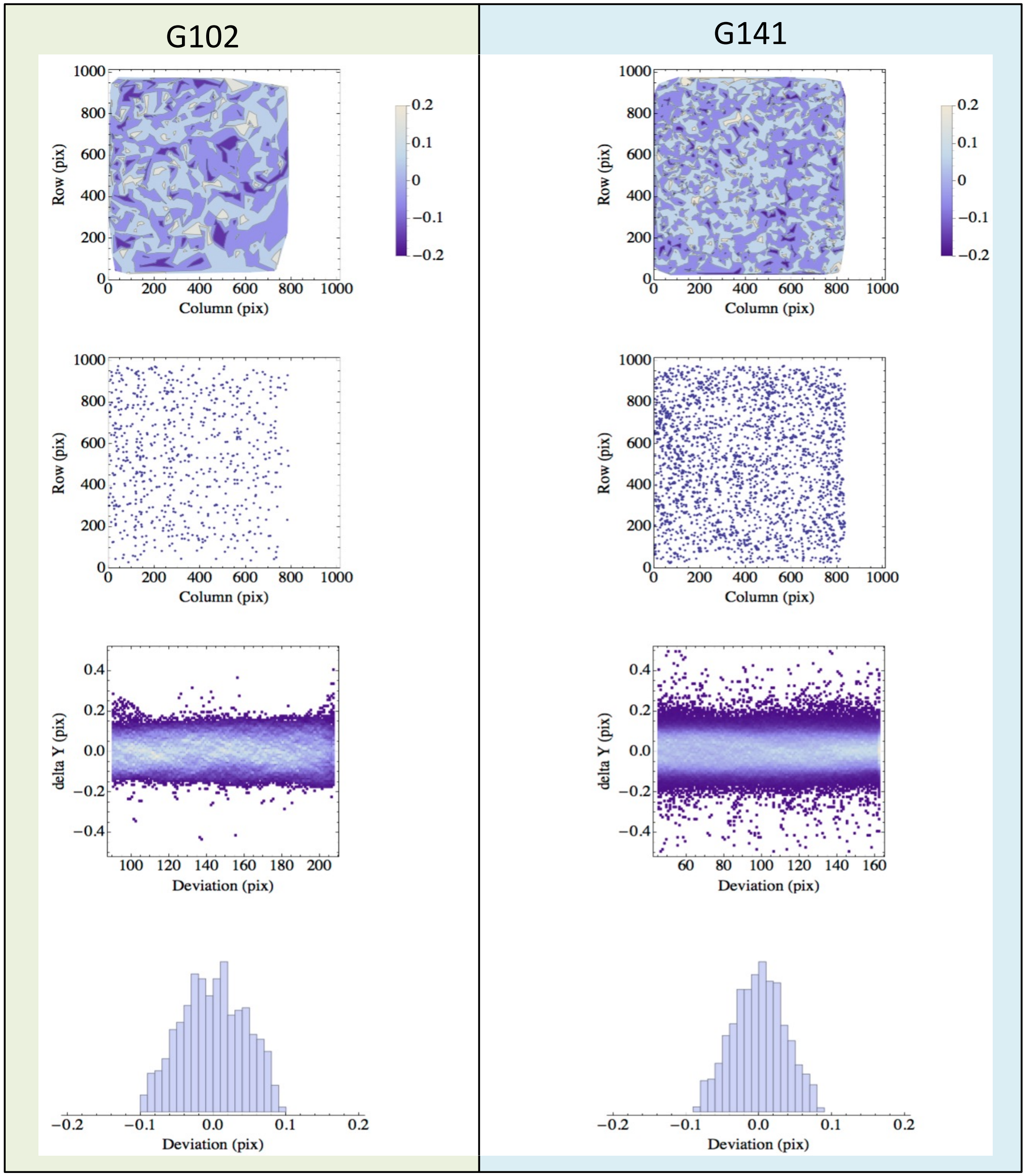
G102 = -0.12+/-0.01 % yr^{-1}



G141 = -0.06+/-0.01 % yr^{-1}



WFC3 IR Grism Flux/Trace Calibration & Stability



ISR 2016-15

The 2D residual plots between the measurements and the trace models.

The object positions at which measurements were obtained.

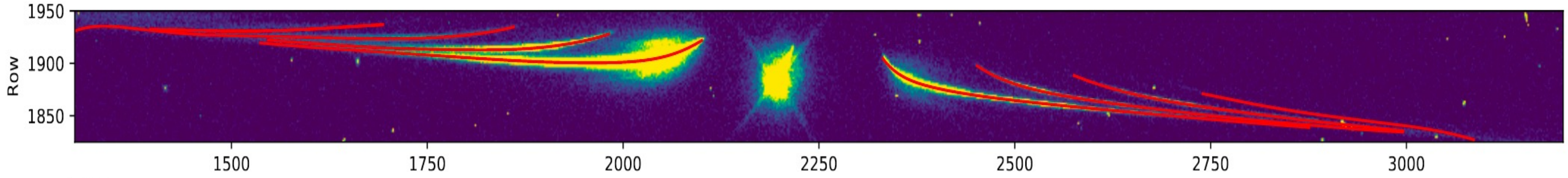
The residuals of all measurements as a function of ‘S’ along the trace.

The average error in the trace positions over the entire field of view.

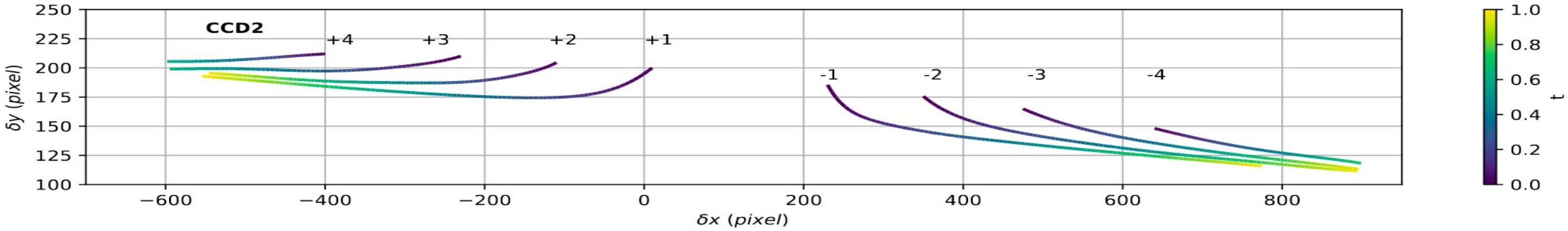
UVIS Grism Wavelength Calibration

Orbits	External: 1 Internal: 0 (This program executes every other cycle due to limited G280 usage)
PI, Co-I's	Pagul, Som, Pidgeon, Kuhn
Purpose	Monitor and refine the UVIS wavelength calibration, as necessary. This calibration will improve our ability to process archived data as well as support current and future UVIS spectroscopic programs.
Description	Grism G280 spectra of WR-14 will be obtained to verify that the dispersion of this grism is not changing. (The flux calibration uses GD71.) One orbit is requested for monitoring every other cycle. The last observations were acquired in Cycle 27 to refine both the flux and wavelength calibration by sampling more detector positions.
Resources: Observations	1 orbit = 4 pointings (2 per CHIP). Two (2) positions on each CHIP will repeat the previously observed position (critical as they show +1 and -1 orders) and verify the stability of this mode.
Resources: Analysis	Supports 2% of UVIS programs (G280 filter)
Products	Configuration files for use with HSTaxe, recently updated in ISR 2020-09
Accuracy Goals	Establish the stability of the UVIS wavelength calibration to ~1 pixel (resolution element).
Prior Results, ISRs	hstaXe Cookbook: https://github.com/spacetelescope/hstaxe ISR 2020-09: 'Updated Calibration of the G280 Grism'; ISR 2017-20: 'Trace and Wavelength Calibrations of the UVIS G280 +1/-1 Grism Orders'; ISR 2011-18: 'Contam Monitoring with G280', ISR 2009-01: 'Ground calibration'
Prior Cycle IDs	Wavelength Cal: 16581 (**cy29**, 1 orbit), 16022 (**cy27**, 4 orbits), 15588 (cy26, 1 orbit), 14995 (cy25, 1 orbit), 14545 (cy24, 1 orbit), 14387 (cy23, 1 orbit), 14025 (cy22, 2 orbits), 13578 (cy21, 2 orbits), 13091 (cy20, 2 orbits), 12705 (cy19, 3 orbits), 12359 (cy18, 4 orbits), 11935 (cy17, 1 orbit) Flux Calibration: 16023 (**cy27**, 5 orbits), 14026 (cy22, 2 orbits), 13577 (cy21, 2 orbits), 13090 (cy20, 20 orbits), 12704 (cy19, 4 orbits), 11934 (cy17, 1 orbit)

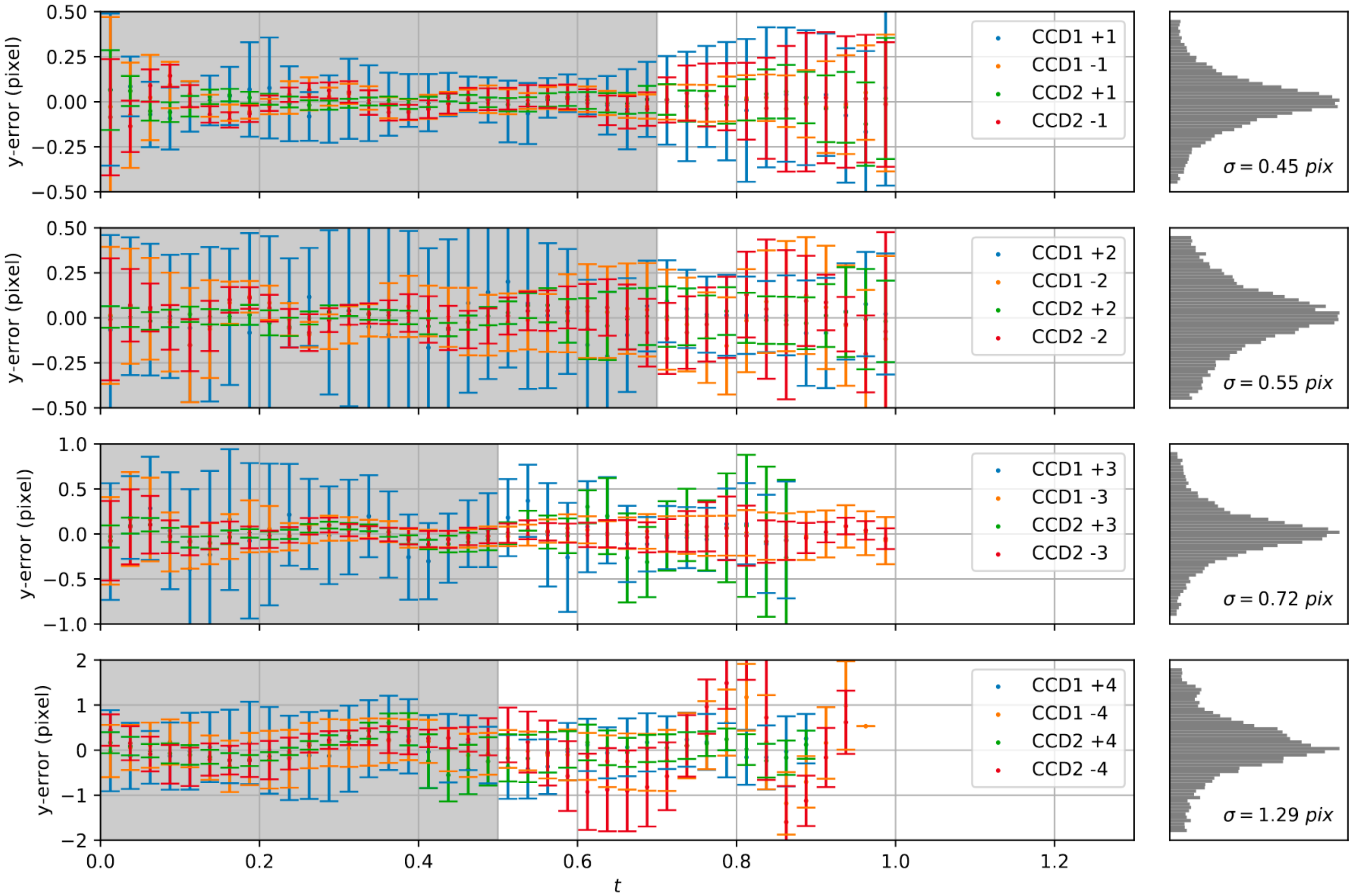
G280 Wavelength Calibration



G280 spectrum with significant overlap in the spectral orders



Trace at the center of CCD2



Left: Fit residuals of the spectral trace for the ±1, ±2, ±3, ±4 orders vs ‘t’, a free parameter in the 2-D polynomial fits.

Shaded regions show where there is no overlap with any other spectral order.

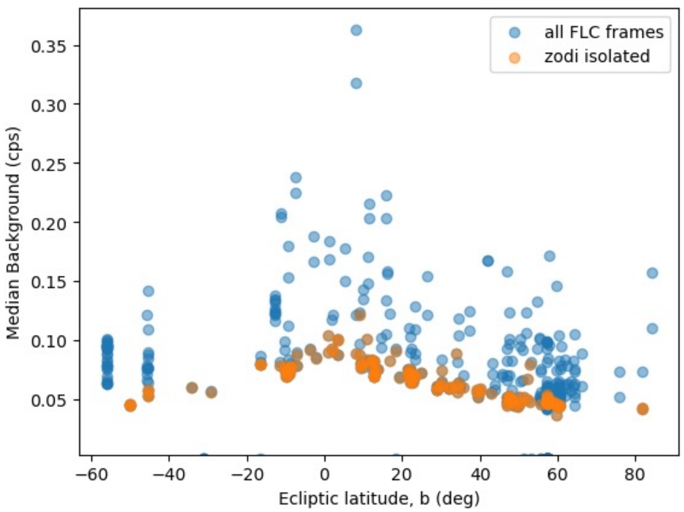
Field dispersions for the ±1 orders are accurate to fraction of a pixel and to ~0.5 pix for the ±2 orders.

Right: Histograms of the residuals.

ISR 2020-09

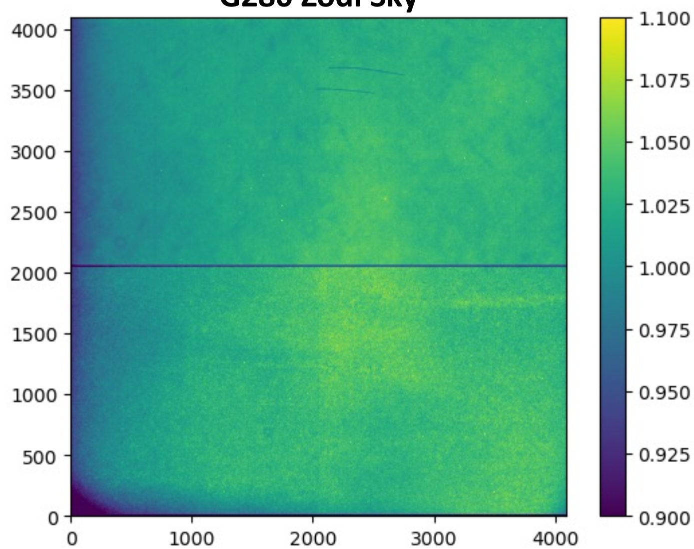
Preliminary Results: New G280 master sky for use with the UVIS HSTaXe notebook

Selection of frames stacked to generate zodi sky



We isolate the zodiacal light contribution by minimizing other contaminating sources, that is, we consider frames taken in the Earth's shadow (*sun altitude < 0 deg*), outside of the galactic plane *(|galactic latitude| > 20 deg*), and with a large angular separation between the source and the moon/sun (*moon angle > 20 deg; sun angle > 75 deg*).

G280 Zodi Sky

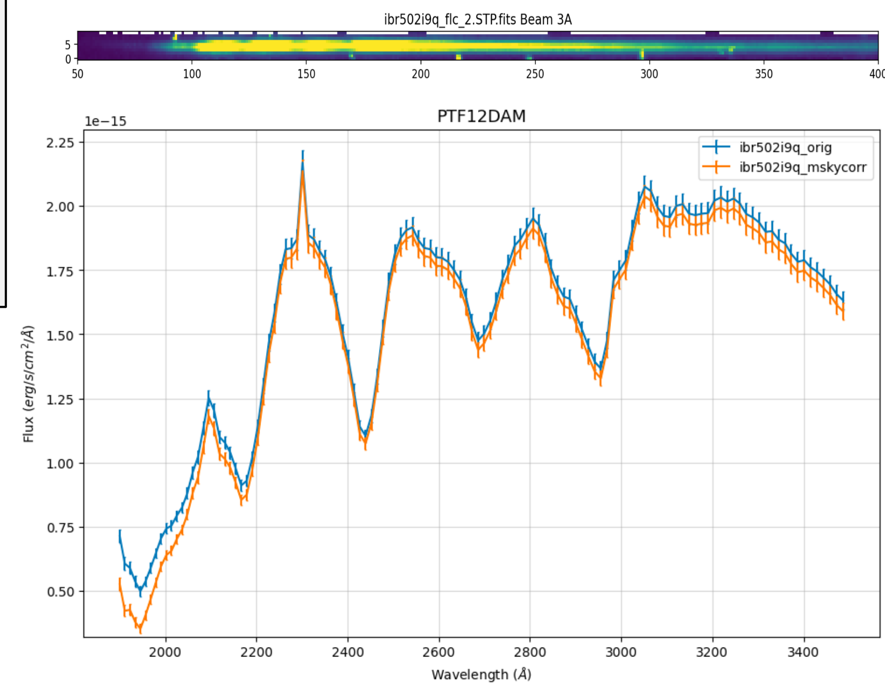


Final zodi sky stack: note both the 'flare' and cross hatch patterns: features that are present in the overlapping broadband flat field images, including the direct image filter, F300X, as well as F250LP.

Ongoing work will determine if there is a spectral component, especially for large Earth limb angles. So far, no clear spectral features from Earth's atmosphere have been detected

Pagul, private communication

Sample spectral extraction using G280 zodi sky



Using HSTaXe UVIS extraction notebook to compare spectra with and without the master zodi sky model.

HSTaXE repo for WFC3
HSTaXE UVIS cookbook

Flatfield Calibration

Same as the previous cycle

- Monitor a population of UVIS pixels with anomalous low QE values

  45 internal orbits = 1 orbit*6 epochs (UV) + 3 orbits*13 epochs (VIS)

- Monitor the health of the UVIS filters via internal flats

  13 internal orbits = 3 orbits * 1 epoch (D_2, all UV filters)
  + 8 orbits * 1 epoch (Tungsten, all VIS filters)
  + 1 orbit * 2 epochs (Tungsten, subset VIS filters)

- Monitor the health of the IR filters via internal flats

  18 internal orbits = 6 orbits *2 exposures * 1 epoch (all filters)
  + 1 orbit *3 exposures * 2 epochs (broadband filters)

- Monitor the health of the CSM by observing the bright earth

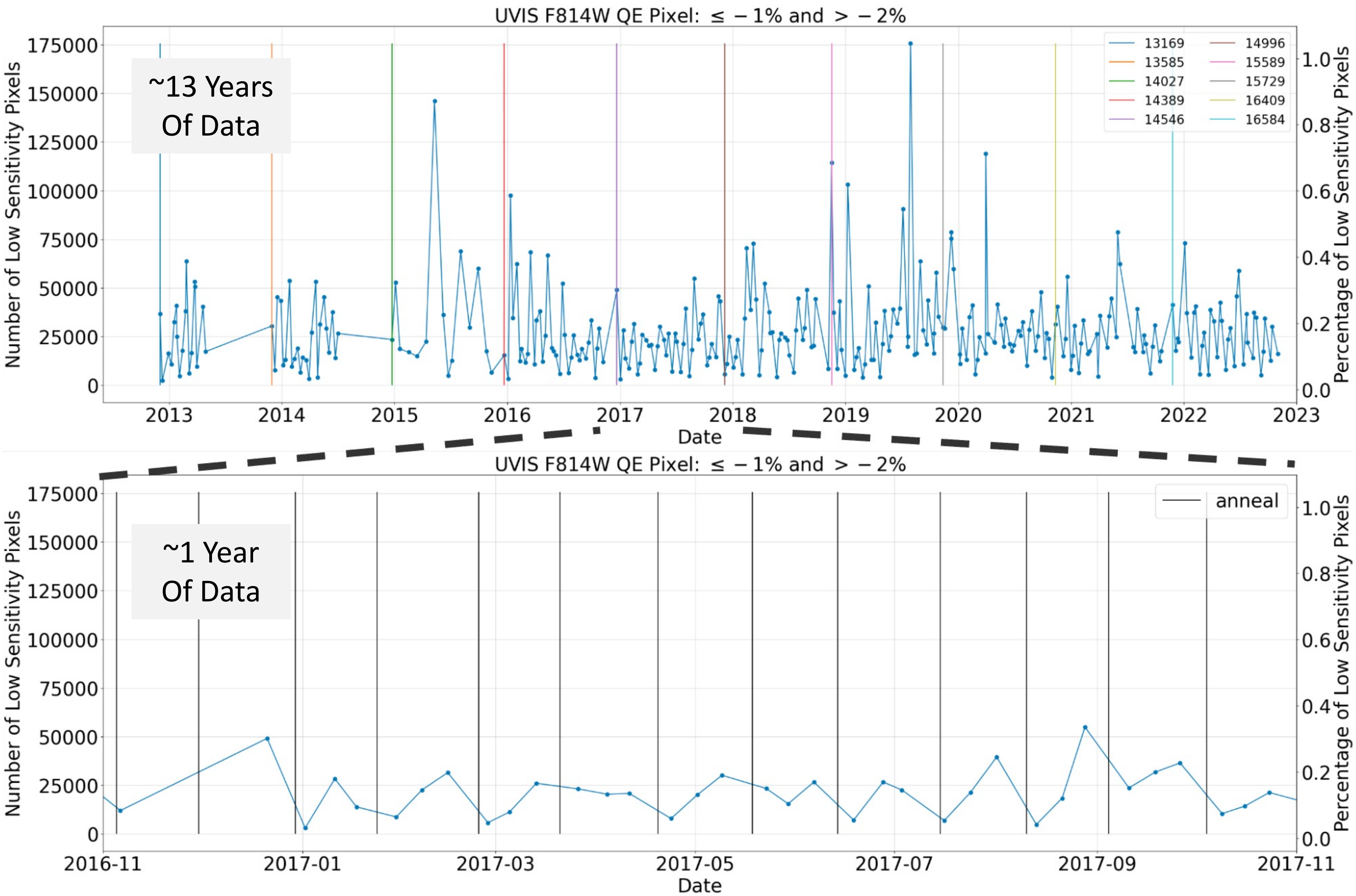
  200 internal orbits = At least one flat every time the CSM is moved.
  (Typical cadence is 1-2x/week)

WFC3 UVIS Pixel-to-Pixel QE Variations via Internal Flats Monitor

Orbits	External: 0 Internal: 45
PI, Co-I's	Kuhn, Dauphin, Martlin
Purpose	To track the population of pixels that exhibit anomalous QE variations between anneals.
Description	This program monitors the randomly distributed population of pixels that exhibit anomalous QE variations between anneals, characterized by a sensitivity loss that is more pronounced in the blue than in the red. This population is unique for each anneal cycle and exhibits clustering in the UV. Internal flats are taken to monitor this population in the UV and Visible wavelengths.
Resources: Observations	45 internal orbits: UV = 1 orbit*6 epochs, VIS= 3 orbits*13 epochs For the UV, 6 orbits with the D2 lamp are taken in F225W and F336W, 1 orbit every other month in the week before the anneal. UV orbits require non-int sequences to minimize cycling of the D2 lamp. For the Visible filters, 3 orbits each anneal cycle (a week before the anneal, midway between anneals, and just after the anneal) are taken with the Tungsten lamp in F438W, F645N and F814W.
Resources: Analysis	Supports 100% of UVIS programs
Products	Maps of the population of anomalous pixels between anneals. Written reports
Accuracy Goals	Track populations of low sensitivity pixels that vary by <-1%, <-2%, and <-4% for each filter
Prior Results, ISRs	ISR 2023-xx, in prep. (Dauphin et al.) ISR 2014-18: Pixel-to-Pixel Flat Field Changes in WFC3/UVIS
Prior Cycle IDs	13169, 13585 (ISR-2014), 14027, 14389, 14546, 14996, 15589, 15729, 16409, 16584, 17019 (cy30)

WFC3 UVIS Pixel-to-Pixel QE Variations via Internal Flats Monitor

Low sensitivity pixel population [-1%,-2%) in F814W as a function of time.
Top: Vertical colored show cycle boundaries
Bottom: Vertical black lines show UVIS anneal dates



Dauphin et al, ISR in prep.

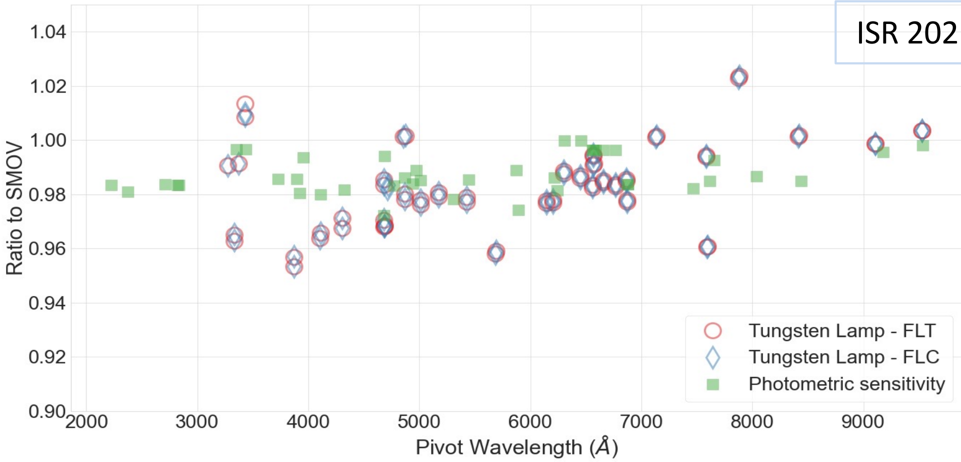
UVIS Internal Flats

Orbits	External: 0 Internal: 13
PI, Co-I's	Khandrika, Kuhn
Purpose	Monitor the stability of the UVIS pixel-to-pixel sensitivity in all filters by obtaining internal flat fields with the tungsten and deuterium lamps
Description	We will acquire internal flats in all UVIS filters in order to monitor the stability of the pixel-to-pixel response as well as the flux output of the internal lamps
Resources: Observations	13 orbits = 3*(D_2) + 8*(Tungsten_all) + 2*(Tungsten_subset) This consists of 3 orbits with the D2 lamp for the filters F218W, F200LP, F225W, F275W, F280N, F300X, F336W, F343N, F373N, F390M, F390W, F395N, FQ232N, FQ243N, FQ378N, and FQ387N. Eight orbits with the Tungsten lamp will acquire the remaining 46 filters. Observations in the 4 filters, F390W, F438W, F606W, and F814W, with the Tungsten lamp will be repeated 2 times over the cycle for a total of 2 orbits.
Resources: Analysis	Supports 100% of UVIS programs, but no products are delivered. Check for stability in the pixel-to-pixel response. Search for prominent new features in each UVIS filters by comparing internal flats acquired over time. Track the flux output of the calibration lamps
Products	Written reports
Accuracy Goals	Look for systematic changes exceeding 1%, after accounting for lamp decay
Prior Results, ISRs	ISR 2021-16: WFC3/UVIS: Deuterium Lamp and Filter Performance 2009-2021 ISR 2021-15: WFC3/UVIS Tungsten Lamp and Filter Performance 2009-2021 ISR 2010-03: WFC3 SMOV Proposal 11432: UVIS Internal Flats
Prior Cycle IDs	11432 11914, 12337, 12711, 13097, 13586, 14028, 14390, 14547, 14997, 15590, 15730, 16410, 16585, 17020 (cy30)

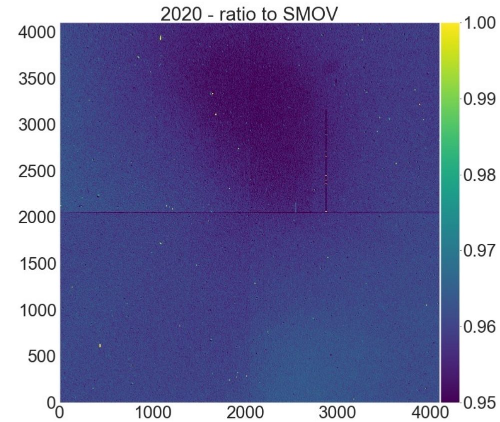
UVIS Internal Flats

2020-to-SMOV count rate Ratio vs Pivot Wavelength for:
1.) Tungsten Lamp (blue, red), 2. CALSPEC standards (green)

ISR 2021-15

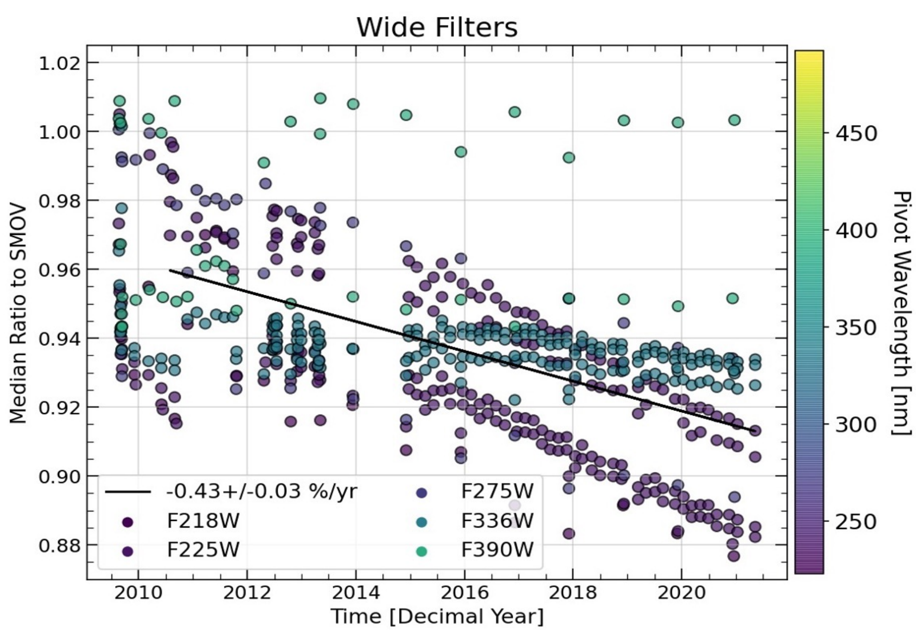


Tungsten Ratio (F390W): 2020-to-SMOV
--> NEW Artifact: "Bowling Pin"

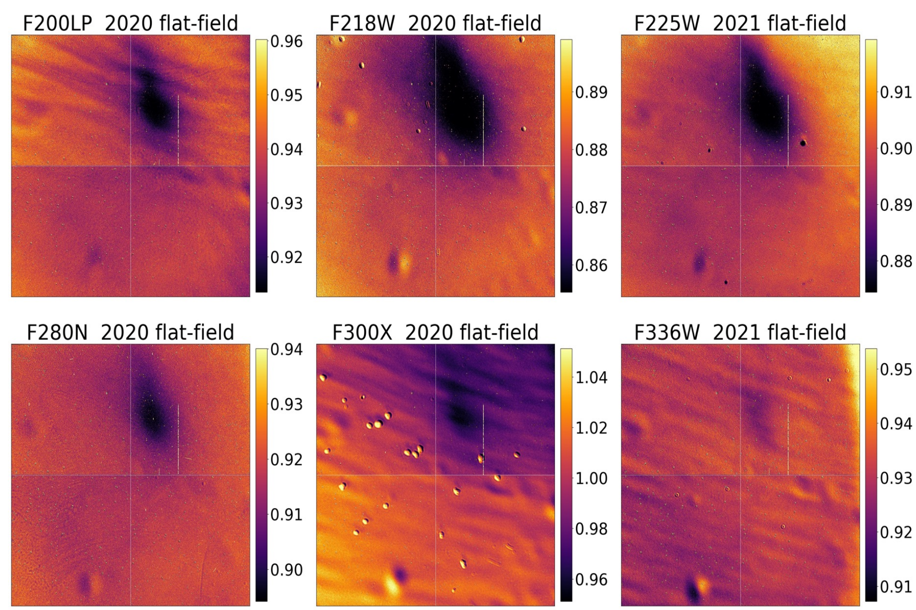


Deuterium lamp: Relative count rate vs time

ISR 2021-15



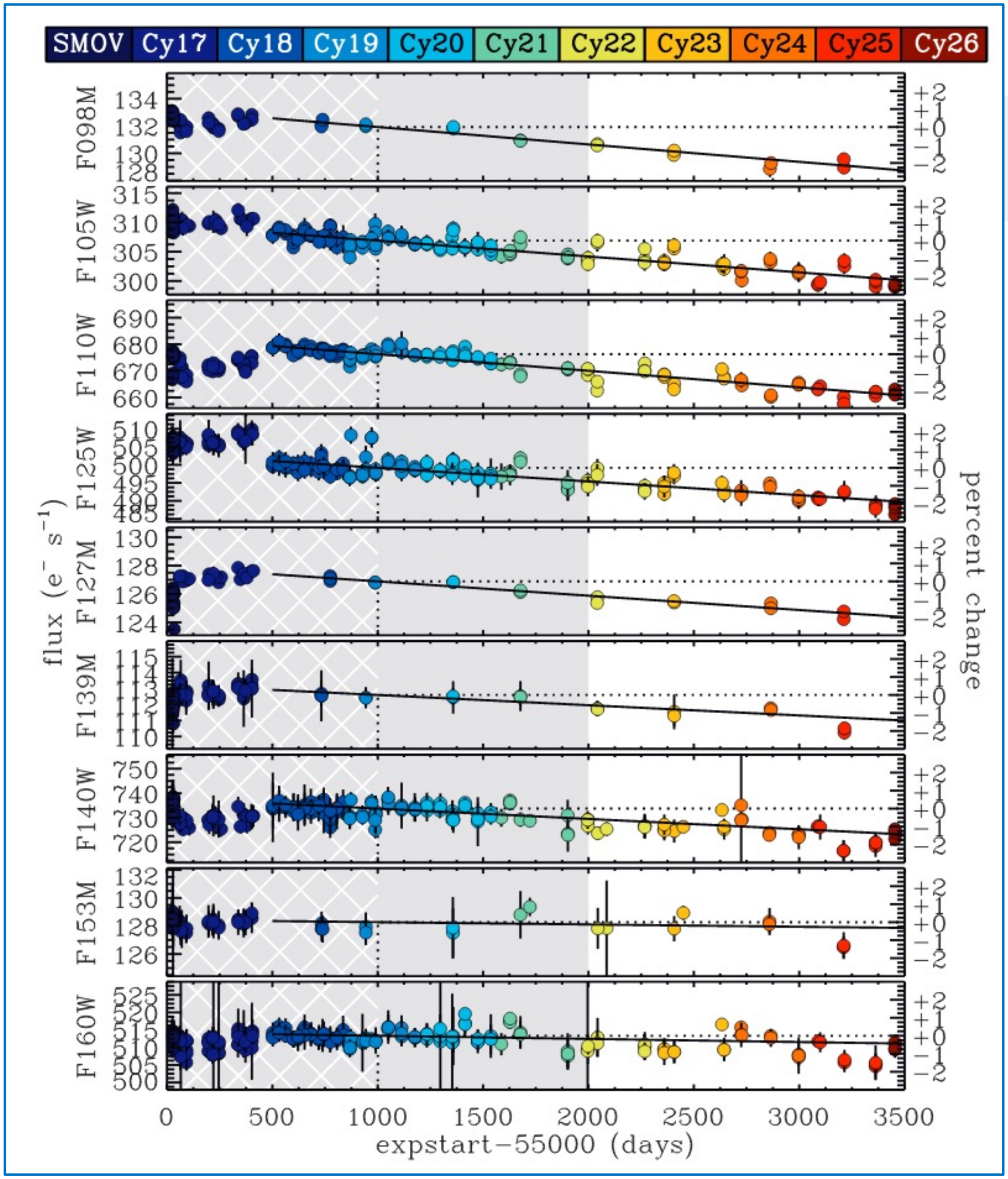
Deuterium Ratio: 2020-to-SMOV
--> Bowling pin also visible here)



IR Internal Flats

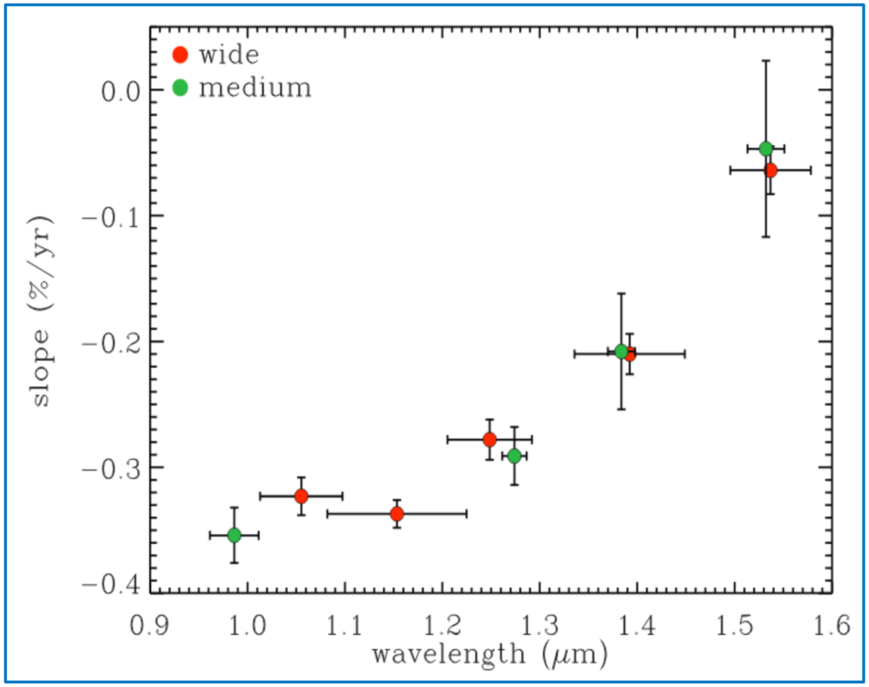
Orbits	External:0 Internal: 18
PI, Co-I's	Green, Khandrika, Kuhn
Purpose	Monitor the stability of the IR pixel-to-pixel sensitivity in all filters by obtaining internal flat fields with the tungsten lamp.
Description	In this program, we study the stability and structure of the IR channel flat field images through all filter elements. Flats will be monitored, to capture any temporal trends in the flat fields and delta flats produced. High signal observations will provide a map of the pixel-to-pixel flat field structure, as well as identify the positions of any dust particles. This version contains a full set of IR filter exposures once in the middle of the cycle. In addition we will acquire 3 exposures in each of the 2 broadband filters F105W, F110W, F125W, F140W, and F160W twice during the cycle.
Resources: Observations	18 internals = (6 orbits*2 exposures)_all filters + (3 orbits *2exposures) Sample the full set of IR filters once in the middle of the cycle. This requires 6 orbits* 2 exp= 12 orbits. Sample a subset of broadband filters (F105W, F110W, F125W, F140W, and F160W) to monitor those flats 2 times during the cycle (early and near the end). This requires another 6 orbits = (2 epochs x 3 exposures). If time permits, obtain a short dark before the intflat to mitigate persistence.
Resources: Analysis	Supports 100% IR programs.
Products	Monitor the stability of the pixel-to-pixel response and track the decay of the calibration lamps. Use these data to update BPIXTABs (dead, unstable pixels) last modified in 2022
Accuracy Goals	Look for systematic changes exceeding 1%, after accounting for lamp decay
Prior Results, ISRs	ISR 2022-01: Cold and Unstable Pixels in WFC3/IR; 'Median dark current up by 6.5%' ISR 2019-06: IR Internal flats; 'The tungsten lamp is becoming redder with time. We find no strong evidence for changes in the pixel-to-pixel sensitivities.' ISR 2019-03: Time-dependent Bad Pixel Tables, ISR 2015-11, ISR 2013-04, ISR 2009-42
Prior Cycle IDs	11433, 11915, 12338, 12712, 13098, 13587, 14029 ← 2015 ISR includes data through Cy22. 14391, 14548, 14998, 15591 ←2019 ISR includes this more recent data. 15731 (Cy27), 16411 (cy28), 16586, 17021 (cy30)

IR Internal Flats



Mode count rate vs. time. A steady decline is seen since Cy18 (MJD=56,000)

ISR 2019-06



Slope of the mode count rate (%/yr) vs. wavelength. The trend is consistent with a reddening of the tungsten lamp as the filament vaporizes over time and coats the inner surface of the lamp.

WFC3 CSM Monitor with Earth Flats

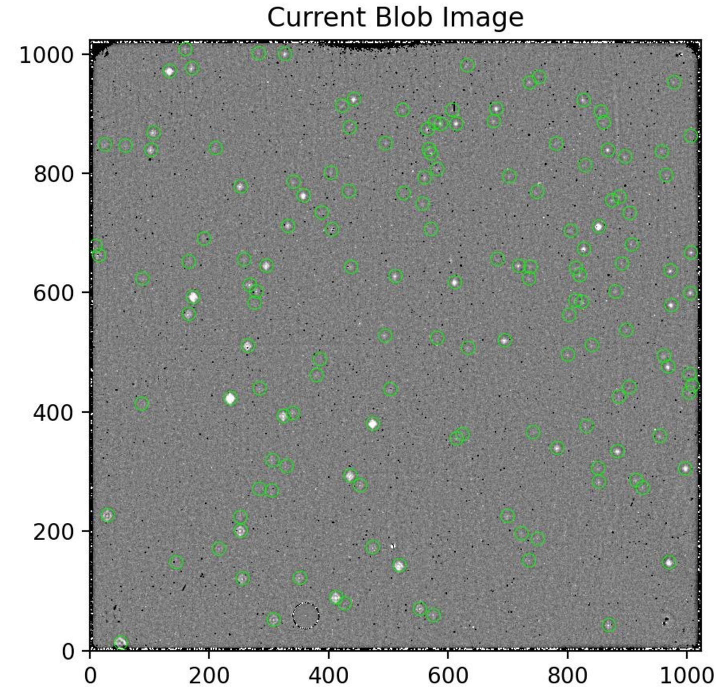
Orbits	External: 0 Internal: 200
PI, Co-I's	Dauphin, Green
Purpose	Monitor the CSM angle and new blob appearances using earth flats.
Description	Take quick (~100 s) F153M exposures looking down at the dark Earth to use airglow as a uniform glowing screen. Use these images to detect new blobs and use the positions to track the CSM angle over time.
Resources: Observations	200 orbits: F153M, SPARS25, NSAMP=5 Typical cadence is 1-2x/week, but gaps are expected when either the CSM doesn't move or when the schedule is over-constrained.
Resources: Analysis	Supports 100% of IR programs Monitoring to be carried out by the PI and Quicklook Team. Updates to the monitoring software/blob ISR to be completed by the PI. New reference files as new blobs appear.
Products	DQ flags (BPIXTAB strong blob flags), DFLTFILE (blob flats & DQ flags for strong and weak blobs), "CSM offsets table" for GSFC, Machine Learning Model (GitHub repo: spacetelescope/deepwfc3)
Accuracy Goals	Identify new blobs within 1 day of receipt of Earth flat. (Typical cadence is 1-2 flats per week)
Prior Results, ISRs	ISR 2021-10: WFC3/IR Blob Flats ISR 2021-08: WFC3 IR Blob Classification with Machine Learning ISR 2018-06: WFC3/IR Blob Monitoring ← ISR updated regularly to include any new blobs TIR 2019-01: Blob Monitoring: An End-to-End Jupyter Notebook Workflow ISR 2017-16: Possible Overlaps Between Blobs, Grism Apertures, and Dithers ISR 2015-06: (Impact of blobs on WFC3/IR photometry) ISR 2014-21 (Time-dependent blob flags/monitoring) ISR 2012-15 (Blob monitoring/color), ISR 2010-06 (Blob monitoring/origin)
Prior Cycle IDs	14392,14549, 14999, 15592, 15732, 16412, 16587, 17022 (cy30)

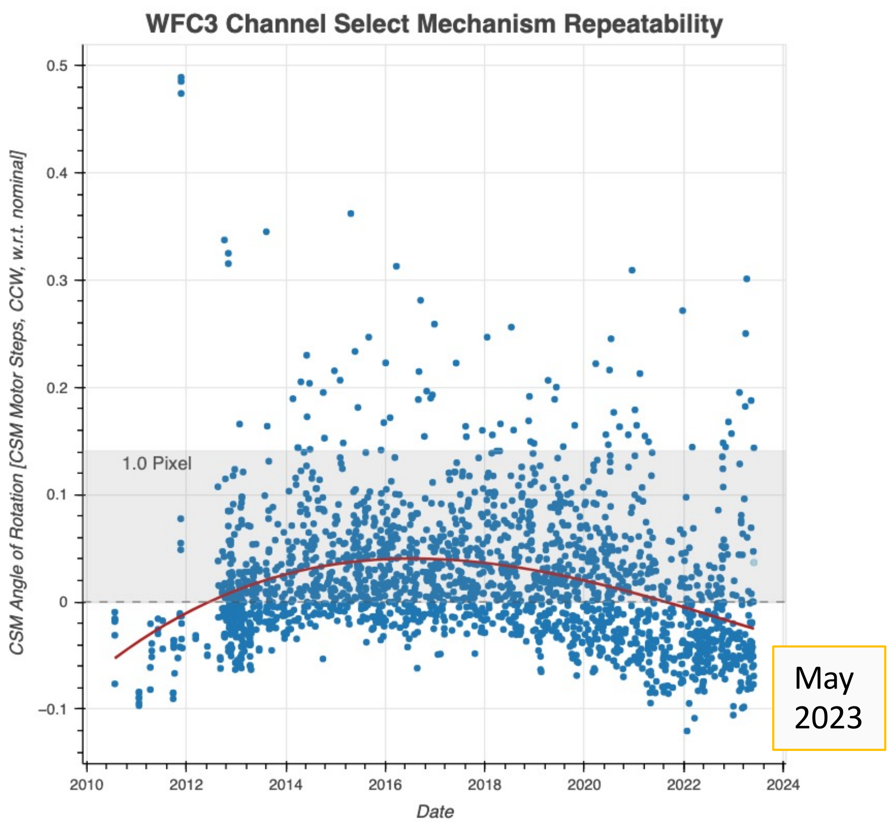
WFC3 CSM Monitor with Earth Flats

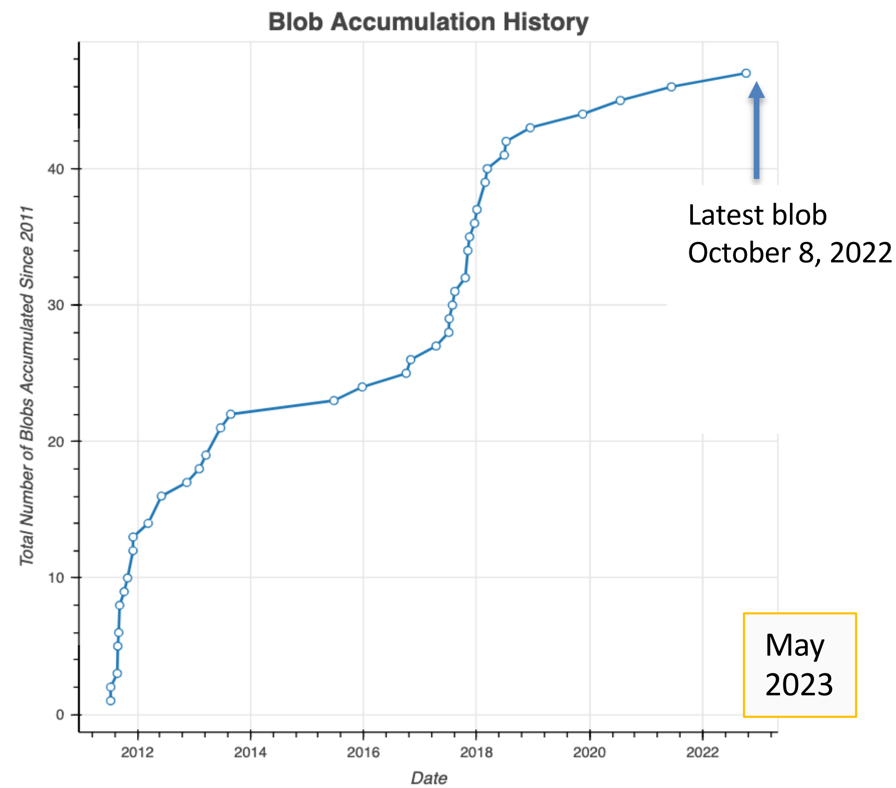
New blobs are identified using the most recent dark earth flat (i.e. the “blob image”, right)

The positions of these blobs are used to measure the CSM angle of rotation, which is used to ensure the CSM is operating as expected.

https://wfc3ql.stsci.edu/automated_outputs/cal_ir_check_csm
https://github.com/spacetelescope/wfc3-ir-bad-pixels/blob/master/blob_monitoring.ipynb
https://github.com/spacetelescope/deepwfc3/tree/master/projects/ir_blob







Astrometric Calibration

Same as the previous cycle

- Monitor the temporal stability of the plate-scale in WFC3 UVIS & IR detectors

  6 internal orbits = 1 exposure *3 epochs (UVIS, F606W)
  + 1 exposure *3 epochs (IR, F160W)

WFC3 Astrometric Scale monitoring

Orbits	External: 6 Internal: 0
PI, Co-I's	Martlin, O'Connor, Bajaj
Purpose	Continue monitoring the stability of the WFC3 UVIS and IR plate scale over time.
Description	The standard astrometric catalog in the vicinity of the Omega Cen globular cluster has been used to examine the geometric distortion of UVIS and IR as a function of wavelength in multi-cycle calibration programs over the lifetime of WFC3. All observations from these programs have been reduced and provided the multi-wavelength distortion in UVIS and IR. The geometric distortion coefficients implemented in the IDCTAB format are used in the HST pipeline to correct for ~7% distortion in WFC3 images down to <1%. Observations of Omega Cen taken in F606W (UVIS) and F160W (IR) during the last 11 years (>30 epochs in total) are used to look for any time dependency in the plate scale of the two detectors.
Resources: Observations	6 orbits: 3 epochs each in F606W UVIS and F160W IR. Observations of Omega Cen will be observed with the same pointing in each detector, but with 3 different OTA roll-angles per orbit over 3 epochs in December, March, and June.
Resources: Analysis	Supports 100% of UVIS & IR programs; Measure accurate X & Y positions on drizzled images from each detector and solve 6-parameter transformation w.r.t. the Standard Astrometric Catalog or/and GAIA to calculate the linear terms for analysis of any time-dependency.
Products	IDCTAB, NPOLFILE, D2IMFILE reference files Calibration of the geometric distortion (skew and scale parameters) with time. If needed, provide empirical linear time dependent corrections, similar to the ACS/WFC time-dependent skew (see ACS ISR 2015-06).
Accuracy Goals	Reduce uncertainty in the scale to 2 mas if there is any time-dependent distortion.
Prior Results, ISRs	**ISR 2021-07**, Accuracy of the WFC3 Standard Astrometric Catalog w.r.t. Gaia EDR3; **ISR 2019-09**: Comparison of UVIS Distortion to GAIA DR2; **ISR 2018-10**: Updates to UVIS Filter-Dependent and Geometric Distortions**; ISR 2018-09**: IR Time Dependency of Linear Geometric Distortion; **ISR 2018-01**: Accuracy of the HST Standard Astrometric Catalogs with respect to Gaia; **ISR 2014-12**: Astrometric Correction for UVIS Filter-Dependency; **ISR 2015-02**: Standard Astrometric Catalog and Stability of UVIS Distortions; **ISR 2012-07**: UVIS and IR Multi-Wavelength Distortion; **ISR 2012-03:** UVIS and IR Time Dependency of Linear Geometric Distortion
Prior Cycle IDs	11911, 11928, 12094, 12353, 12714, 13100, 13570, 14031, 14393, 14550, 15000, 15593, 15733, 16413, 16588, 17023 (cy30)

WFC3 Astrometric Scale monitoring

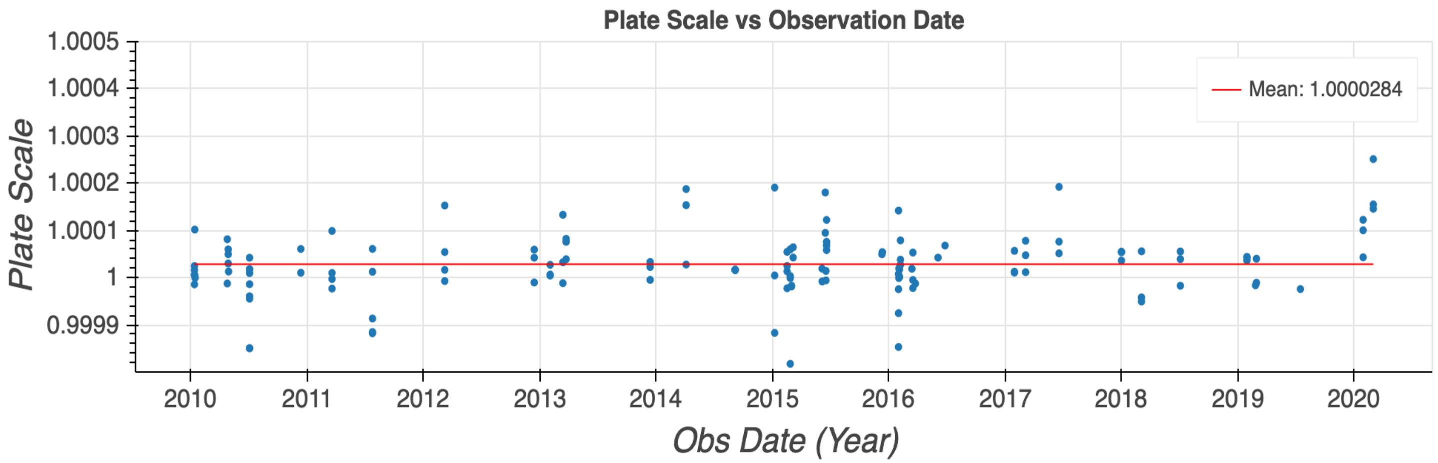
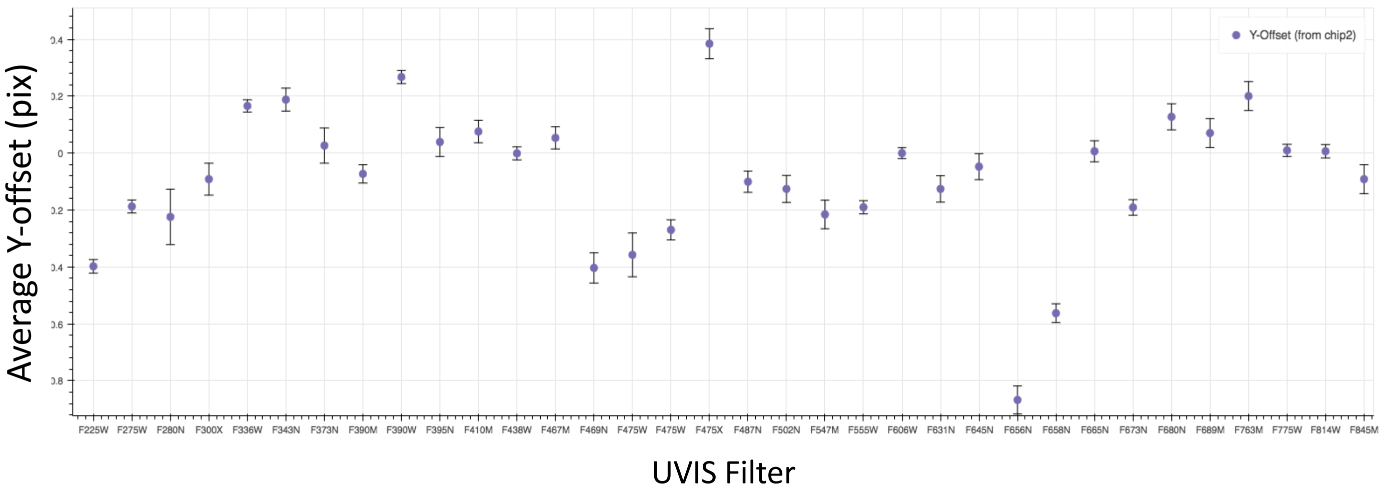
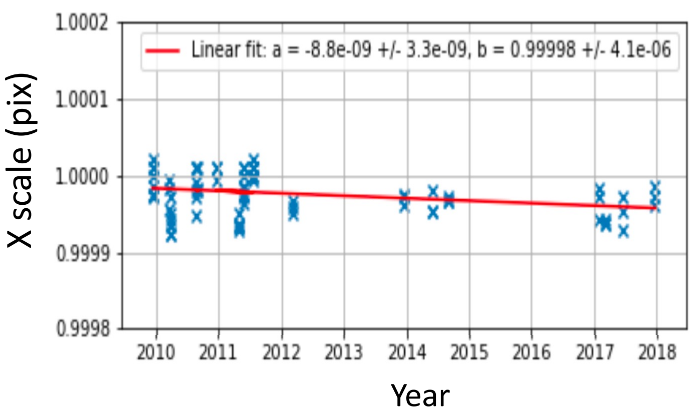


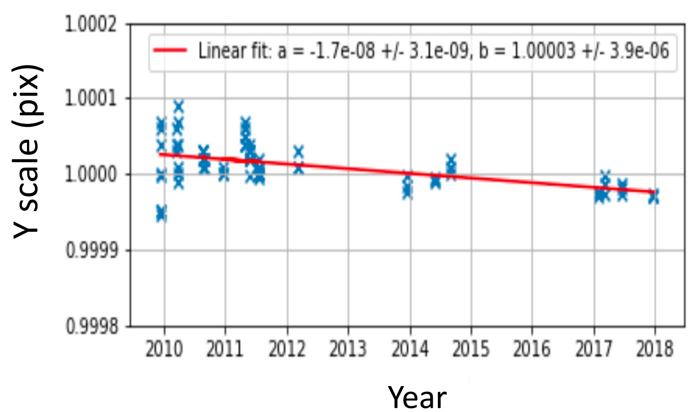
Plate Scale vs time
ISR 2021-07

Based on the linear transformation between Gaia eDR3 and each individual UVIS image.



UVIS filter wedge offsets:
Y-offset (pix) vs
Wavelength
ISR 2018-10





IR plate scale vs time
ISR 2018-09