



STScI

# ACS Instrument Status

(N. Grogin and the ACS Team)



- 1) Highlights of Recent ACS Team Activities
- 2) Cycle 24 ACS CAL Plan
- 3) WFC Long-Term Monitoring Updates
- 4) Recent ACS Calibration Developments:
  - WFC Subarray Overhaul
  - LED Post-flash Luminance Correction
  - Measurements of SBC PSF Wings (to  $\approx 5''$ )
- 5) Additional calibration works-in-progress

# *Recent ACS Team Activities*

- Phase II reviews of *all* Cycle 24 ACS GO/DD/SNAP programs:
  - Reduced Cyc24 usage: WFC = 508 orbits prime + 198 orbits par.; SBC = 48 orbits
  - Current tally, before DD and mid-Cycle additions, is 45 programs using ACS
  - Phasell reviewing is well underway, as of Oct'16
- Revision of ACS Instrument Handbook (for Cycle 25)
  - Revised treatments of WFC geometric distortion, CTE degradation and mitigation
  - Extensive discussion of Cycle 24 changes to WFC subarray modes
  - Incorporating latest developments from last year's calibration updates [ISRs, TIRs]
- Support of DD/SNAP legacy programs for the external community
  - Ongoing support of HST Frontier Fields [just finished the last observations!]
    - Phasell preparation & delivery; 4wk base-line superdarks; rapid ReDCaT deliveries after anneals
    - Quality assurance & pipeline "self-calibration" of HFF ACS imagery
  - "Gap-filler" ultra-SNAP program: ~1' NGC/IC galaxies (for the moment)

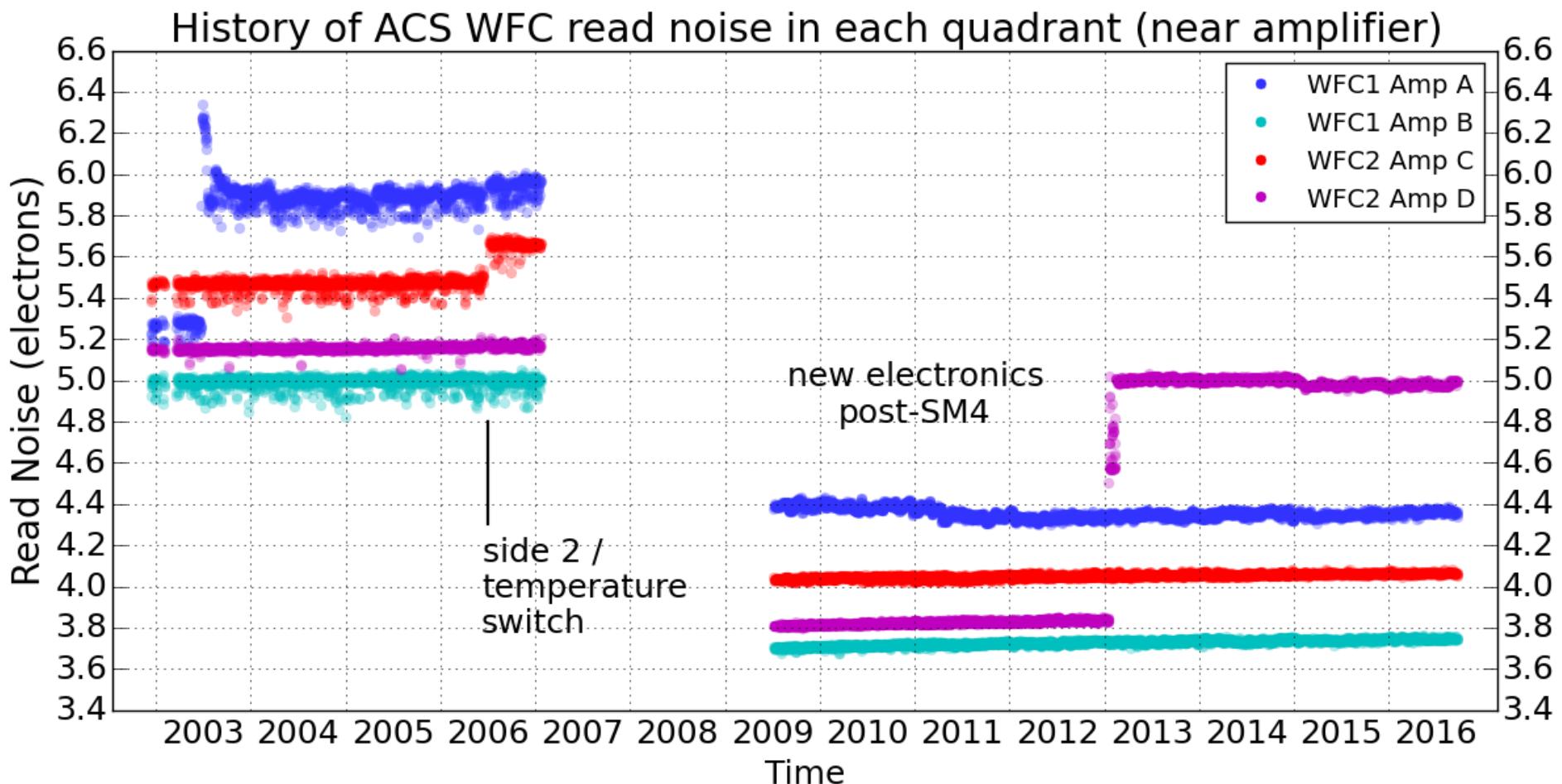
# ACS Cycle 24 Calibration Plan

PI	Proposal Title	Frequency	Time (orbits)		Scheduling Required	Products	Accuracy Required	Notes
			External	Internal				
Golimowski	ACD CCD Daily Monitor	3x/week		624	Periodic	Ref flies		Dark, bias creation
Chiaberge	ACS External CTE Monitor	Yearly	8		3Q 2017	correction formula	1% abs	Monitoring of CTE losses to calibrate correction formula
Chiaberge	ACS Internal CTE Monitor	2x/cycle		12	Nov 16 May 17	Web, cte ref files	10%	CTE EPER test
Golimowski	ACS CCD Hot Pixel Annealing	4-weekly		156	Periodic	Ref		
Avila	ACS UV Contam. Monitor	Yearly	2			Ref, ISR	1%	SBC sensitivity
Coe	ACS CCD Stability Monitor	3x in cycle	4		Nov 16 Mar/Jul 17	Ref files	1%	L-flat, Distortion, Photometry
Borncamp	ACS Internal Flat Fields	2x/cycle		16	~Dec 16 ~Aug 17	Ref, IRS	<1%	Track flat field changes, uses lamp
Avila	ACS SBC darks	Yearly		4			10%	
Bohlin	ACS Photometric Calibration	Yearly	9		Mar 17	ISR, zp, ref files	<1%	Photometric standards; new K-type star added
Wheeler	ACS SBC MAMA Recovery	as needed		4		-	-	After irregular safing
Bellini	WFC Post-flash Calibration	Yearly		1	Mar 17	Ref, ISR	1%	Post-flash ref file
Anderson	Repinning and reformulation of the ACS/WFC CTE model	as needed		12		Model, ISR		Taken within same anneal pd.
Total requested orbits			23	829				

- Cyc24 CAL orbit-cost is significantly reduced from Cyc23 CAL
  - 10 fewer external orbits: mostly SBC-related
  - ~230 fewer internal orbits: mostly subarray biases

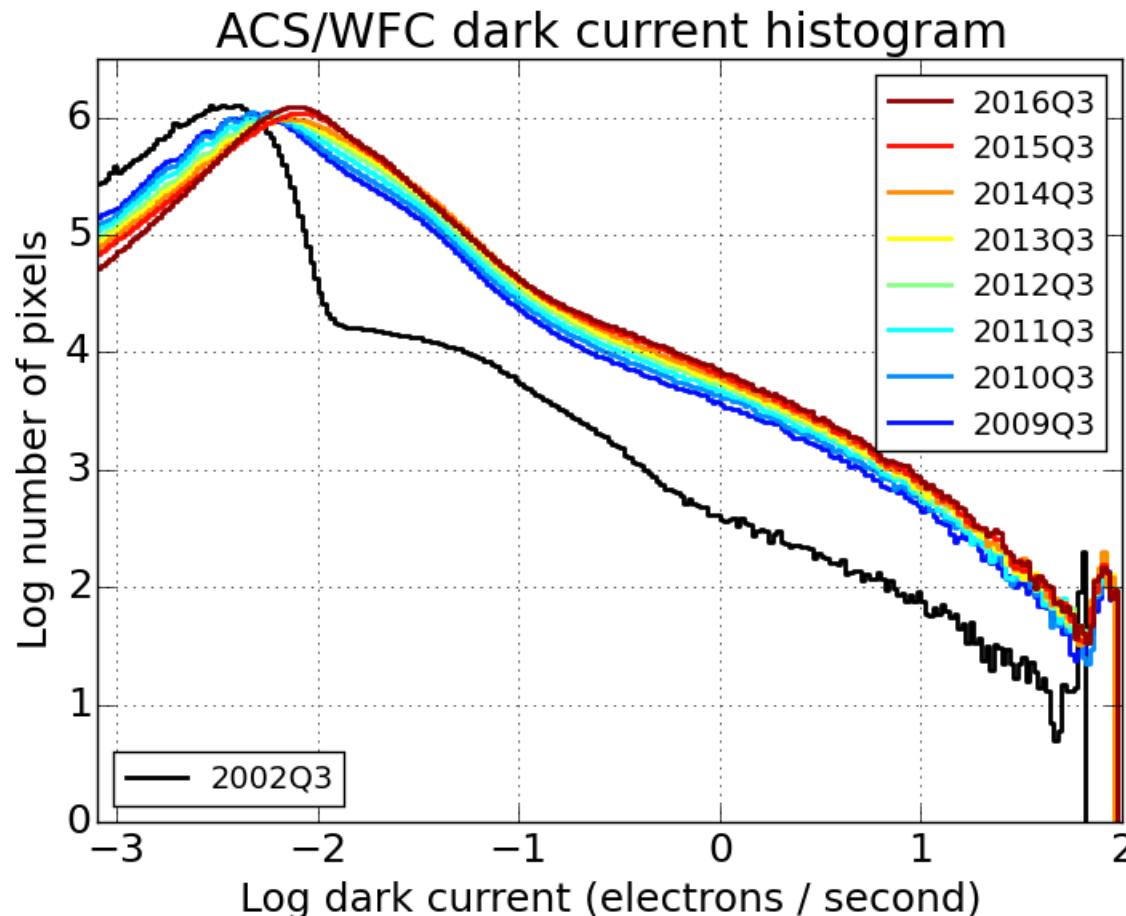
# WFC Read-Noise Monitoring

- All WFC amps' read noise have been stable since Jan'13 anomaly
- Noise levels remain below pre-SM4 values for all amps



# *WFC Dark-Current Monitoring*

- Global dark-current: slowly and steadily worsening with time
- Improved warm-pixel fidelity from CTE-mitigating post-flash

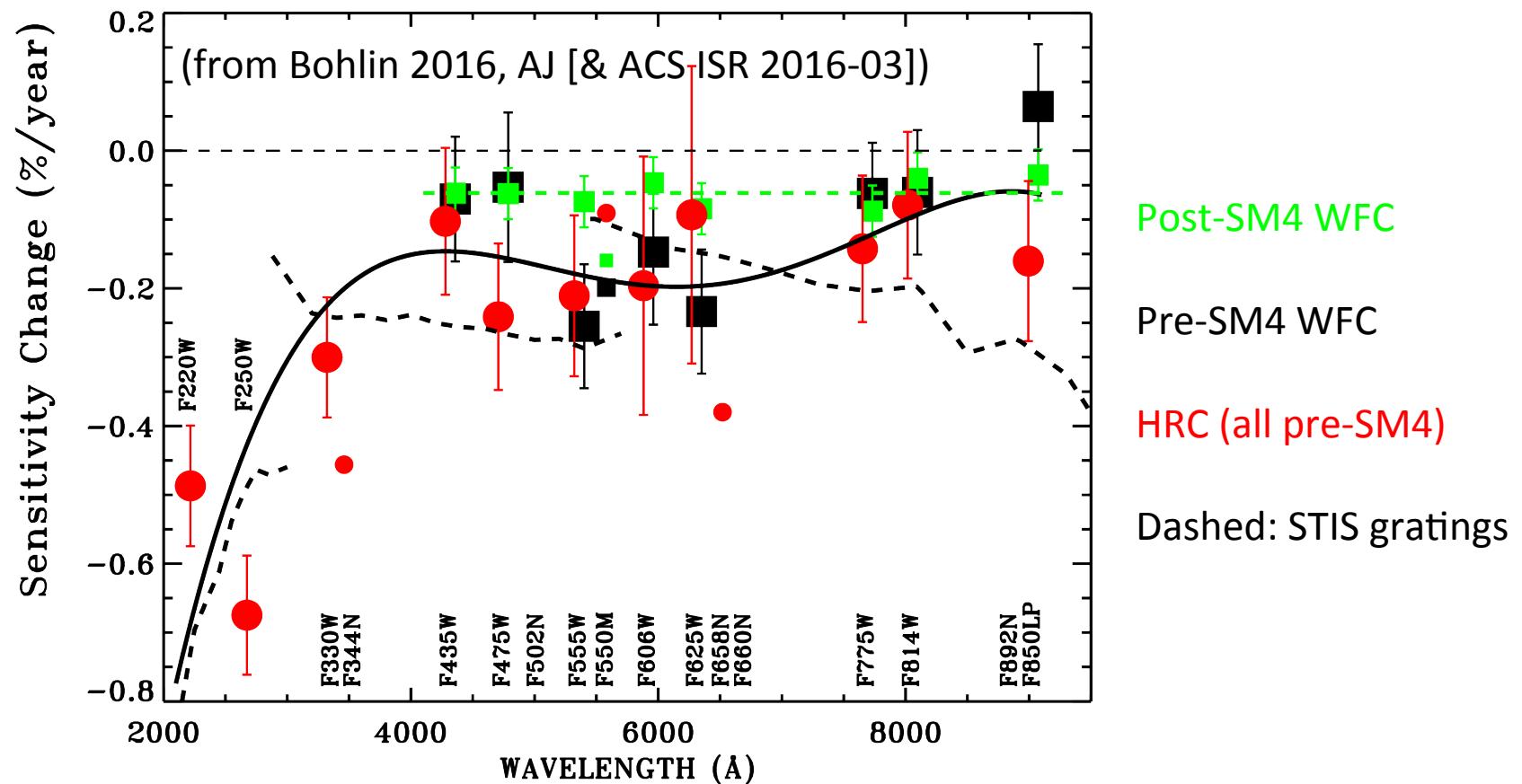


# *WFC Absolute Flux Calibrations. I.*

- Long-term monitoring of spectrophot. stds:
  - External uncertainty for the absolute flux is ~1%, while the internal consistency of the sensitivities in the broadband ACS filters is ~0.3% among the three primary WD flux stds.
  - For stars as cool as K type, the agreement with the CALSPEC standards is within 1% at the WFC1-1K subarray position, which achieves the 1% precision goal for the first time.
  - Revised encircled energies and absolute sensitivities replace seminal results published in Sirianni et al. (2005).
  - Synthetic predictions of WFC & HRC count-rates for the mean of 3 primary WD stds. agree w/ observations to 0.1%.
- (Small) changes made to ACS ETC, ZP webtool

# *WFC Absolute Flux Calibrations. II.*

- Revised post-SM4 WFC sensitivity degradation measurements
  - Largely filter-independent value: -0.061%/yr after SM4. [green dashed line]

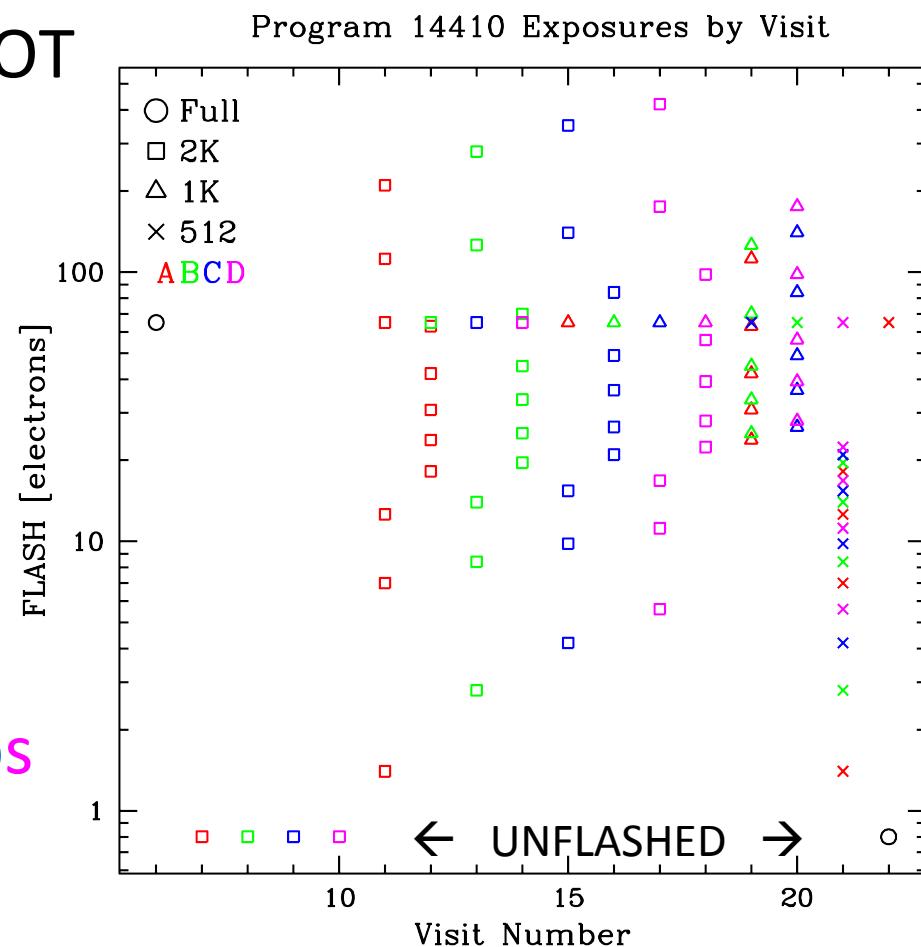


# WFC Subarray Overhaul

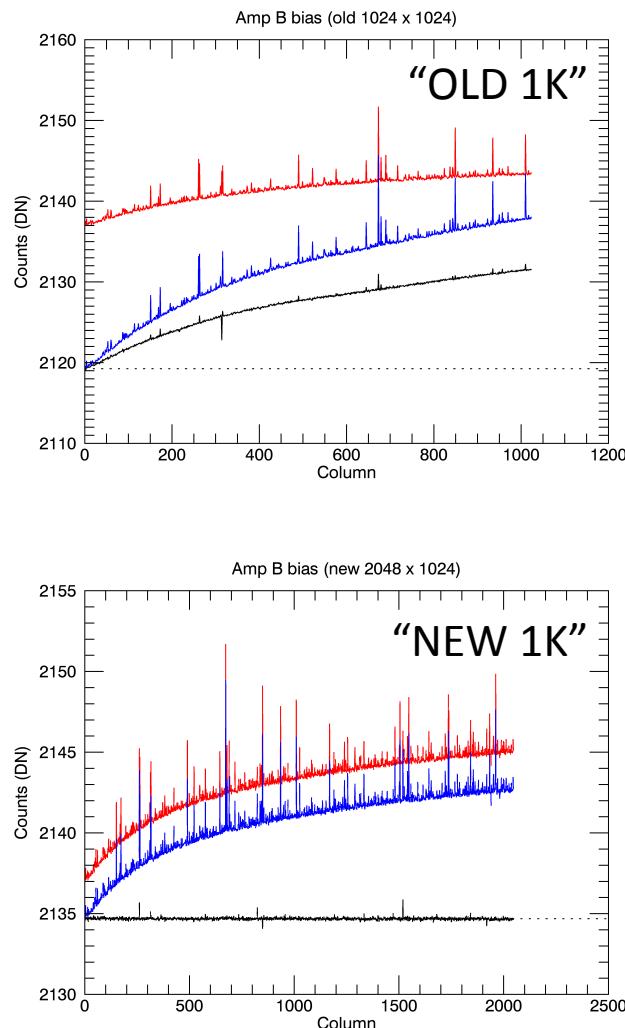
- Calibration headaches for post-SM4 ACS/WFC subarrays:
  - De-biasing post-SM4 subarray images
    - Post-SM4 bias structure varies with readout timing pattern (because of new ASIC & DSI)
    - Readout timing patterns, unchanged since pre-SM4, differ b/w subarrays and full-frame
    - Overhead in calibration orbits (~100 orbits/year) to obtain subarray-mode bias frames
    - Overhead in personnel resources to insure subarray biases are contemporaneous
  - Readout-timing  $\Delta$  makes pixel-based CTE correction inapplicable to non-2K subarrays
  - Readout overheads *longer* than full-frame; <2K columns prevents bias-shift correction
- Solution: Re-define WFC subarray readouts to match full-frame timing
  - Twelve new subarray modes, all with 2K columns: (512,1K,2K) rows; all 4 quadrants
  - Subarray biases no longer needed (excerpt from full-frame); identical CALACS steps
- Implementation/Validation time-table:
  - ✓ GSFC ground-testing (Oct/Nov'15); On-orbit testing (23 Nov'15); OAT (5 Apr'16) recently
  - ✓ Successful FSW installation on 2 May'16; validation program executed 9-10 May'16
  - ✓ *As of OPUS 2016.1 (Aug'16), all new subarray modes are cleanly processed by CALACS*
  - ✓ Former subarray modes transitioned to “available but unsupported” as of Cycle 24
  - ✓ New subarray modes well-documented: ACS IHB for Cycle 24; ACS DHB v8.0; APT

# *Subarray Validation Program*

- Bias-gradient validation
  - Repeat of Nov'15 OOT
  - 5 internal orbits
- CTE validation
  - Same CTE profile?
  - 12 internal orbits
  - FLASH = 0-420e<sup>-</sup>
  - All subarrays & **amps**
  - Analysis in progress



# Old vs. New Subarray Readouts



Curves show the average bias level of 1024 rows in quadrant B for:

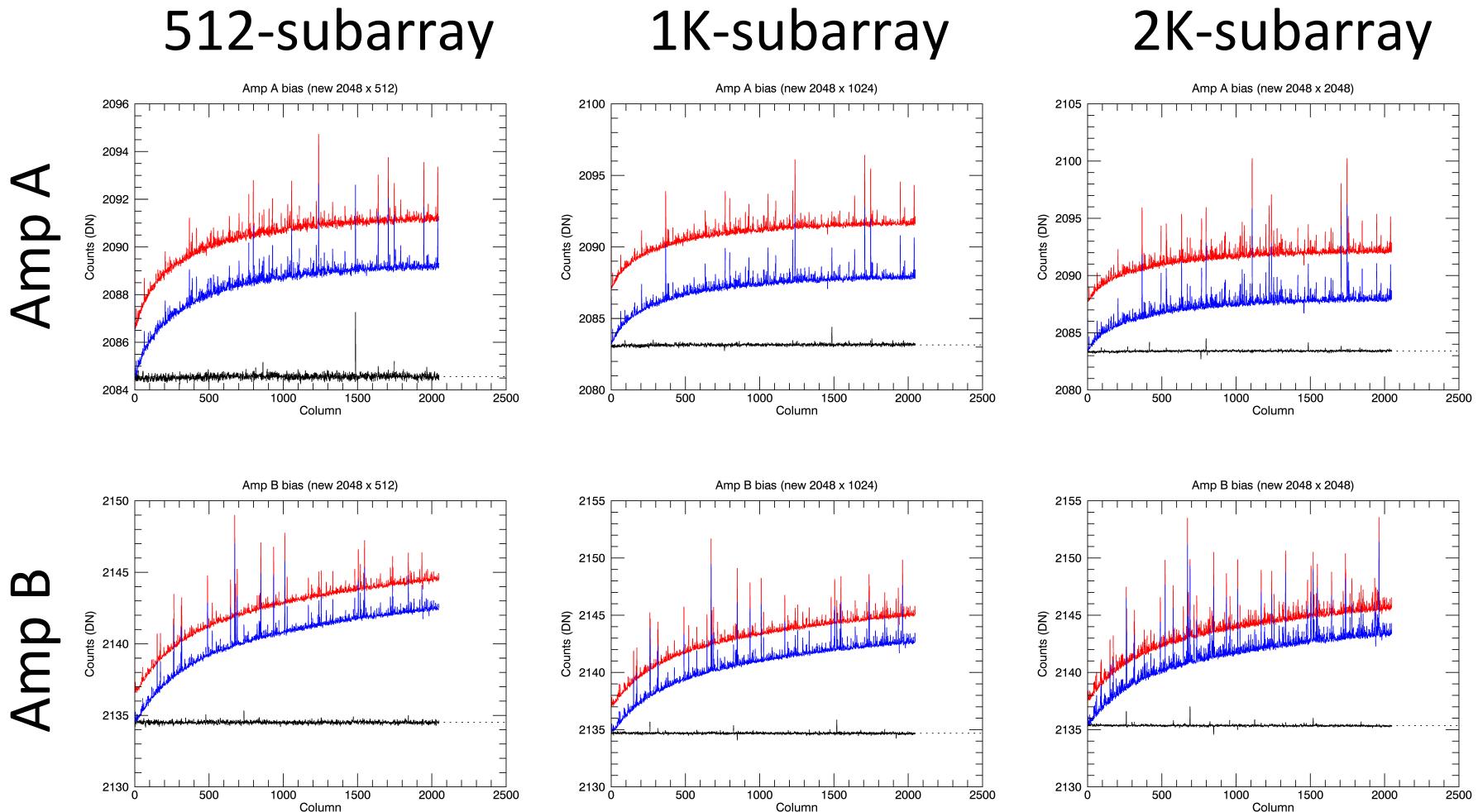
- Blue: 1K×1K (old, top) and 2K×1K (new, bottom) subarrays
- Red: Corresponding regions of full-frame bias
- Black: normalized difference of subarray and full-frame
- Dotted: ideal fat-zero (min. subarray bias value)

## Take-aways:

- Bias gradients in the old 1024×1024 subarray and the corresponding region of full frame differ up to ~13 DN (modulo the fat-zero offset and 1/f noise)
- Bias gradients in the new 2048×1024 subarray and the corresponding region of full frame are *identical* (modulo the fat-zero offset and 1/f noise)
- The following two slides show similar results for all new subarrays (512-, 1K-, and 2K-columns) in all four quadrants

# Subarray Validation: Amps A&B

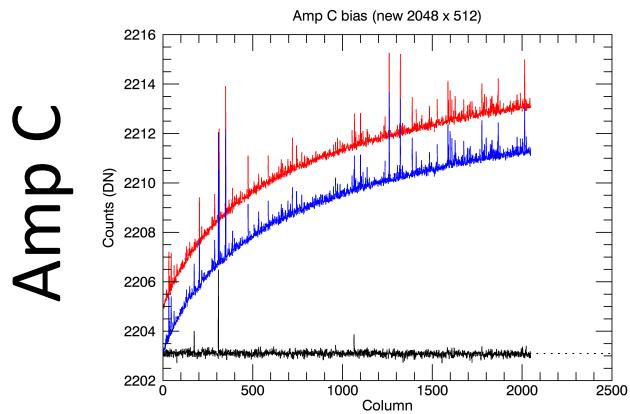
- Bias gradients for **full-frame** vs. **subarray** readouts



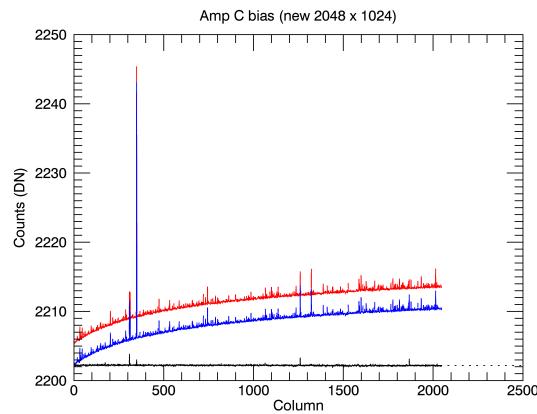
# Subarray Validation: Amps C&D

- Bias gradients for **full-frame** vs. **subarray** readouts

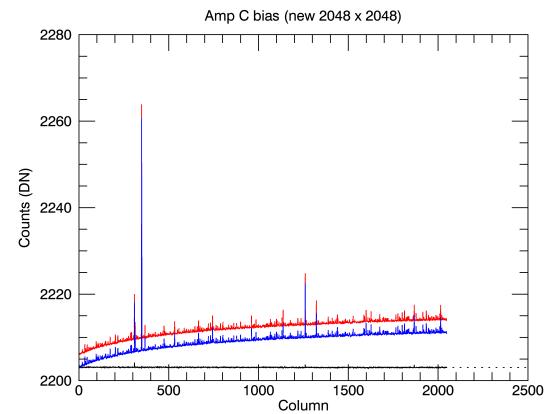
512-subarray



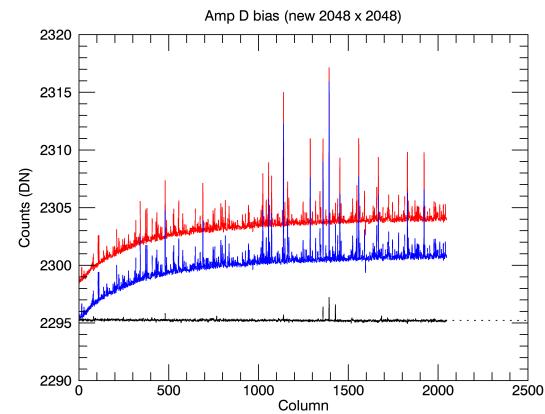
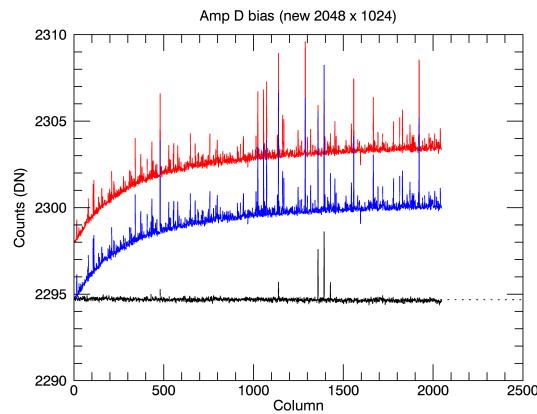
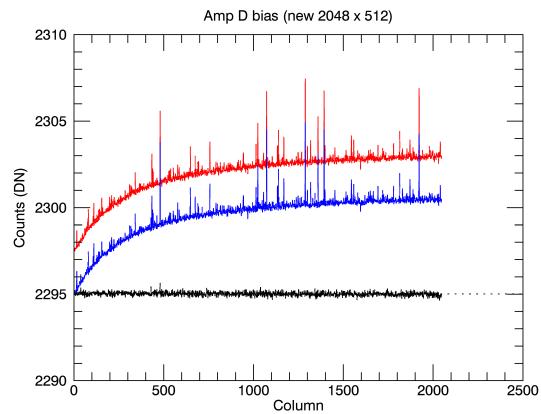
1K-subarray



2K-subarray

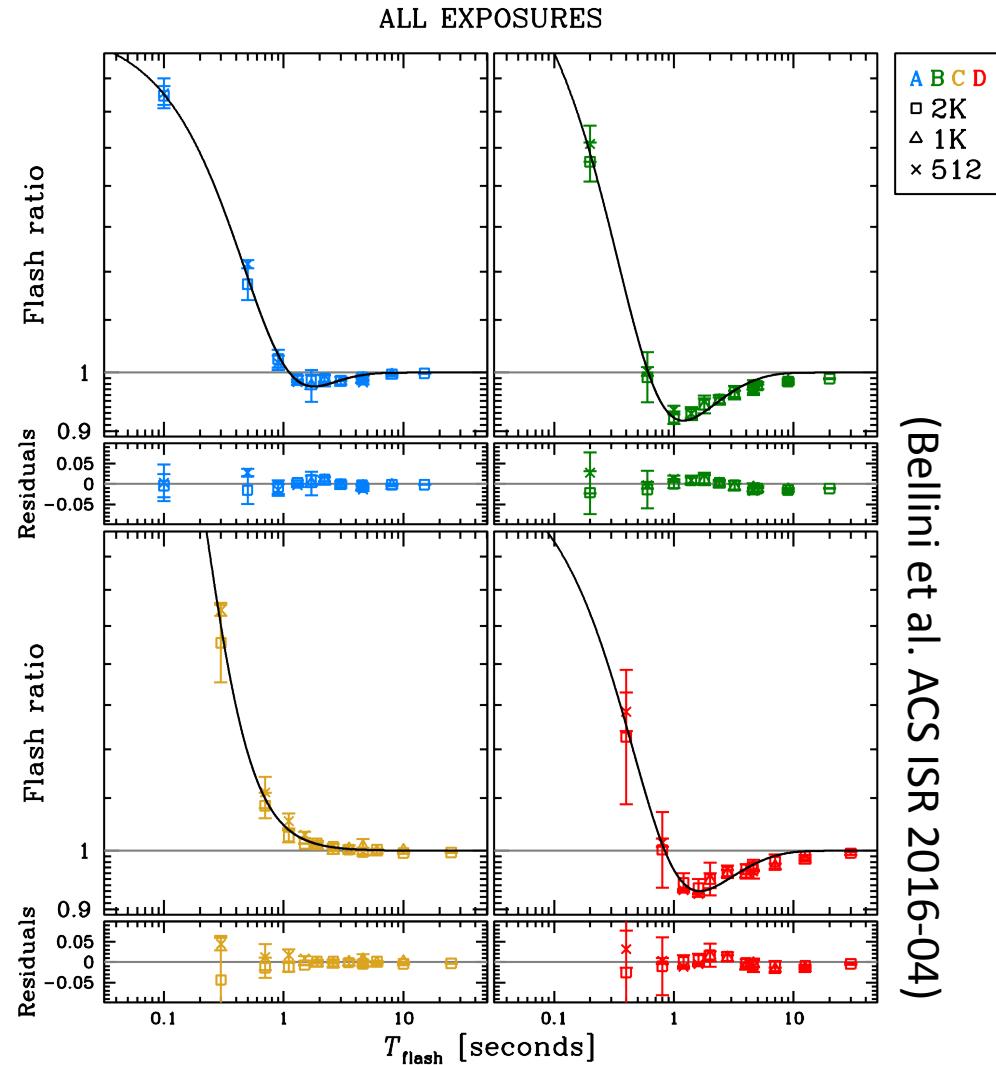


Amp D



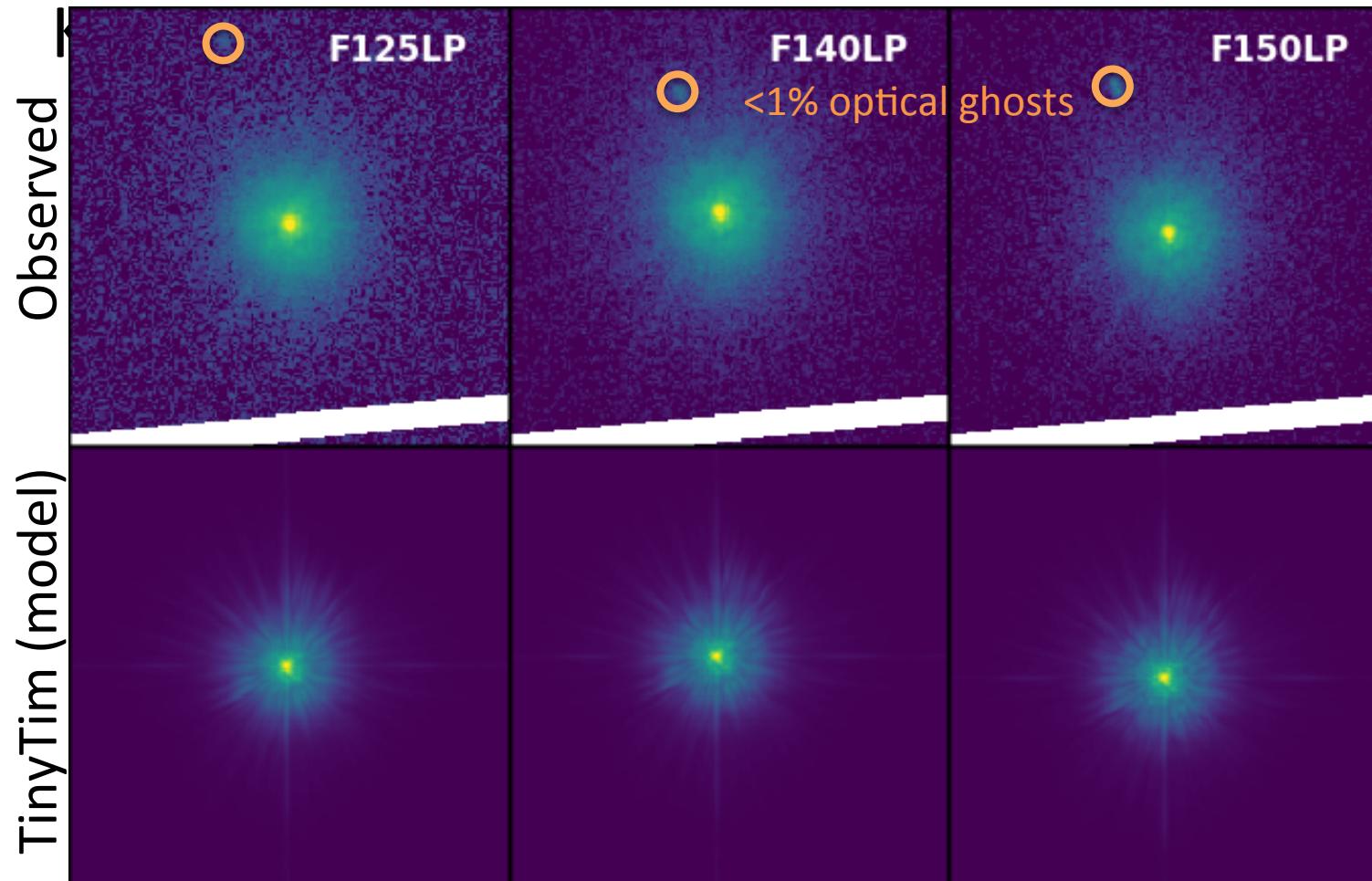
# LED Post-flash Luminance Correction

- Turn-on transient power to LED
- Quadrant-dependent; repeatable
- Deviations  $\leq 10\%$  (from  $14 \text{ e}^-/\text{sec}$ )
- Asymptotes to steady at  $> 10 \text{ sec}$
- Typical use-case durations:
  - Calibration darks: 4.6 sec
  - GO CTE mitigation:  $\approx 1 \text{ sec}$
  - Reference file: 196 sec
- 3-param fit: good to  $\sim 1\%$  (black)
- Correction to CALACS FLASHCORR
- [Year-to-year fading by  $\sim 0.1\%$ ]



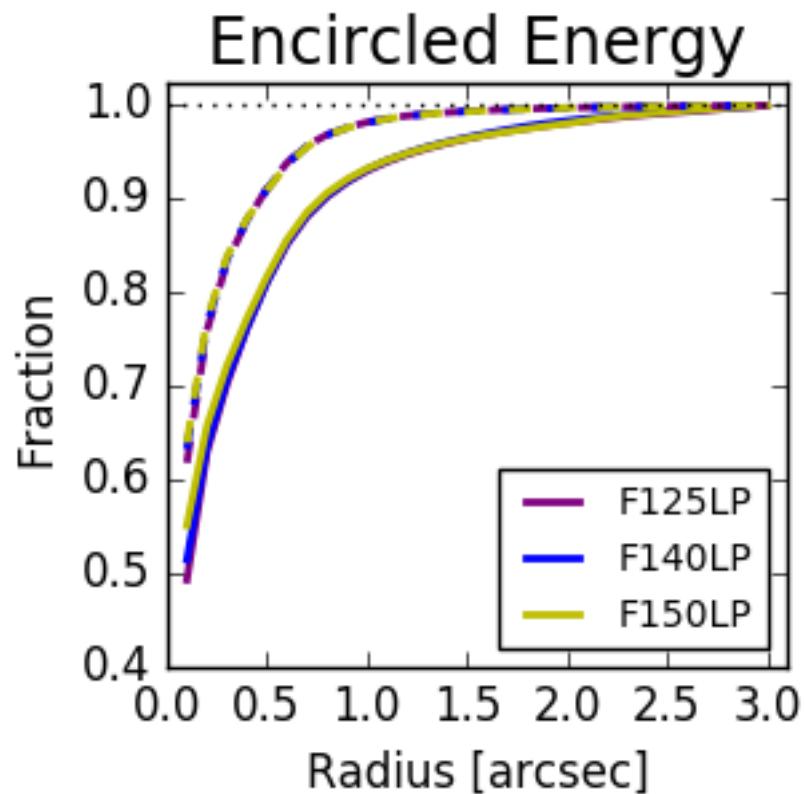
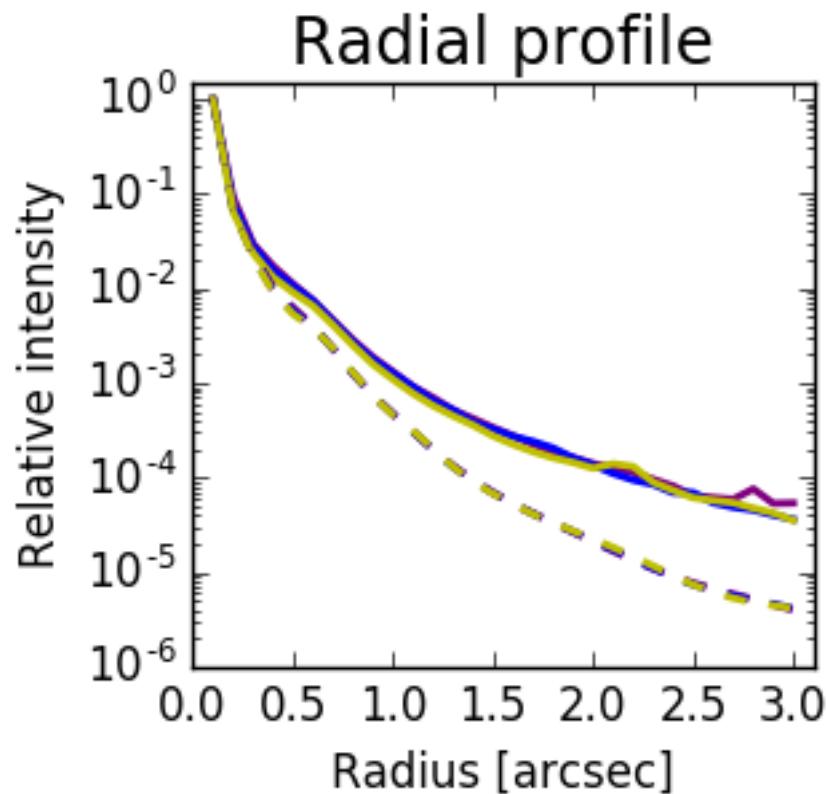
# *Revised SBC Encircled Energies. I.*

- Cyc23 CAL program: isolated WD,  $T_{\text{eff}} = 13390$



# *Revised SBC Encircled Energies. II.*

- SOLID: Observed; DASHED: TinyTim (model)



# *ACS Works-in-Progress (3–6 mos.)*

- Pixel-based CTE correction update
  - All subarrays (new modes *should* match full-frame CTE)
  - Introduce non-linear time dependence (seen also with UVIS)
- “Save the Pixels”: readout dark (superbiases)
  - “Bad columns” from readout dark are often stable
- Refinement of default WFC AstroDrizzle params.
  - Current ‘MDRIZTAB’ can result in stellar core-clipping for DRZ
- Expanded polarimetry calibrations
  - Several new filters: from F435W to F775W, incl. narrow-band
  - Unique capability for optical: high resolution + precision