



Status Report on Wide Field Camera 3

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Highlights of WFC3 Activities Since Last STUC Meeting



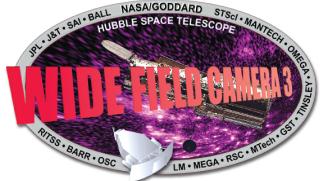
- WFC3 has been fully integrated – with all flight closeouts – with the final flight detectors (UVIS-1' and IR-4) installed – our best CCDs and by far the best IR FPA
- WFC3 has successfully completed acoustic and EMI testing
- WFC3 has successfully completed VEST/SMGT testing
- WFC3 has completed the bulk of the Thermal/Vac-3 test and science calibration program, with excellent results overall
- The flight spare UVIS detector, UVIS-3, has been completed and delivered to GSFC (a high quality IR spare is also in hand)
- STScI completed the necessary materials in support of the Cycle 17 Call: Handbook, up-to-date ETC, Instrument Science Reports
- Will elaborate on the highlights of T/V-3 as well as the issues it has uncovered below



Resolution of Issues Identified in T/V-2



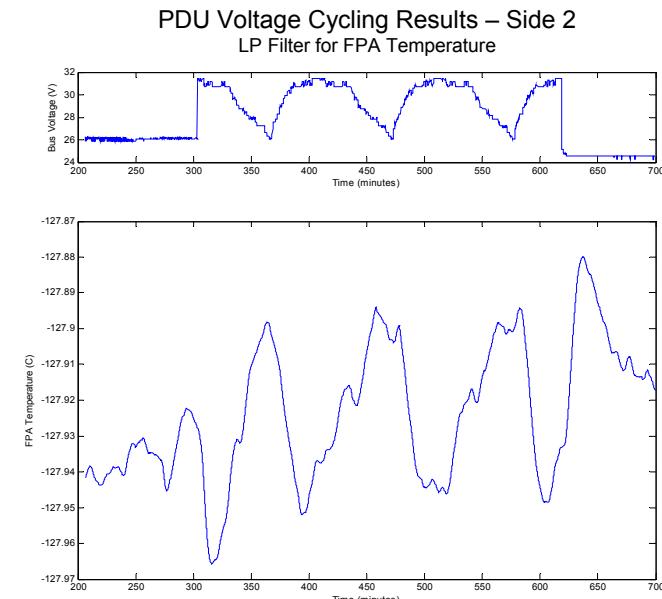
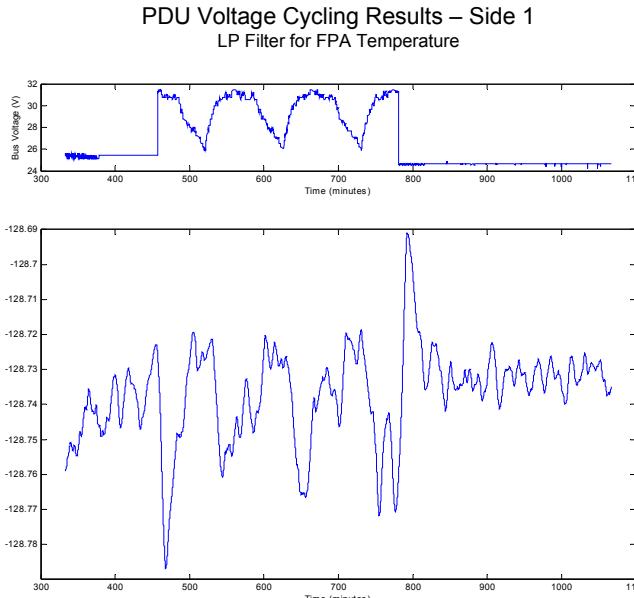
- IR FPA temperature control – had been very poor
 - Now within specification on both electronics sides, details below
- Calibration subsystem
 - Failed tungsten lamps replaced by robust new custom build from Carley Lamps; all four bulbs are working great through thermal-vac
 - D2 lamp still shows intermittent delayed firings (minutes of delay); not a significant issue if behavior remains stable
- Glint in UVIS detector package
 - Resolved in both flight (UVIS-1') and spare (UVIS-3) assemblies with a judiciously placed baffle
- IR throughput degradation/variation during T/V-2
 - Resolved as GSE issue; delightfully **high** and **stable** during T/V-3



IR FPA Temperature Control Now Meets Specification



- Control loop gains improved, electronic coupling to other circuits reduced
- Specification is 100mK stability: Side 1 now achieves ~50mK; Side 2 now achieves ~70mK (vs. 1.7K at start of T/V-2)
- PDU voltage cycling is the dominant perturber; orbital thermal cycling shows negligible effect
- Effect on steady-state dark is negligible with IR-4 FPA; ~10e- level transient effects seen over 6 min intervals – should be calibratable





T/V-3 Alignment Results Show Both Flight Detectors Properly Positioned



- Both detectors are within tolerance in all 6 degrees of freedom, in particular the critical detector tilt angles

UVIS-1' Alignment Summary		
	9 Mar '08 (Cold Op)	Tolerance
$\Theta_x (^{\circ})$	-0.096	± 0.20
$\Theta_y (^{\circ})$	0.046	± 0.20
$\Theta_z (^{\circ})$	0.050	± 0.500
X (mm)	-0.124	± 0.300
Y (mm)	-0.116	± 0.300
Z (mm)	-0.619	± 0.850

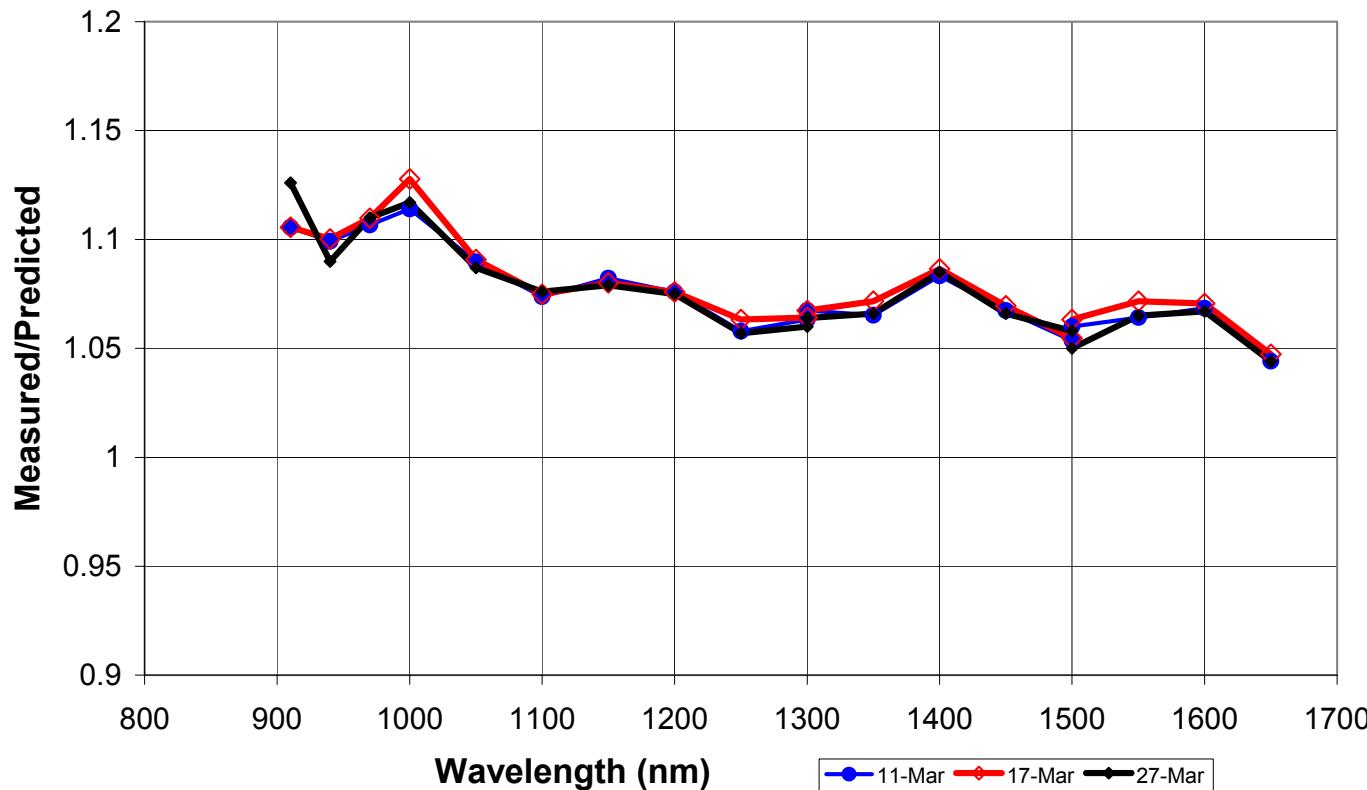
IR-4 Alignment Summary		
	10 Mar '08 (Cold Op)	Tolerance
$\Theta_x (^{\circ})$	0.088	± 0.30
$\Theta_y (^{\circ})$	0.062	± 0.30
$\Theta_z (^{\circ})$	-0.028	± 1.00
X (mm)	0.111	± 0.180
Y (mm)	0.042	± 0.180
Z (mm)	-0.153	± 0.20



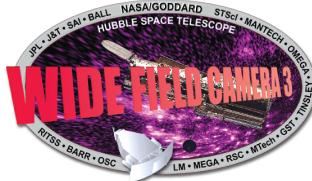
IR Throughput Measurements are High and Stable in T/V-3



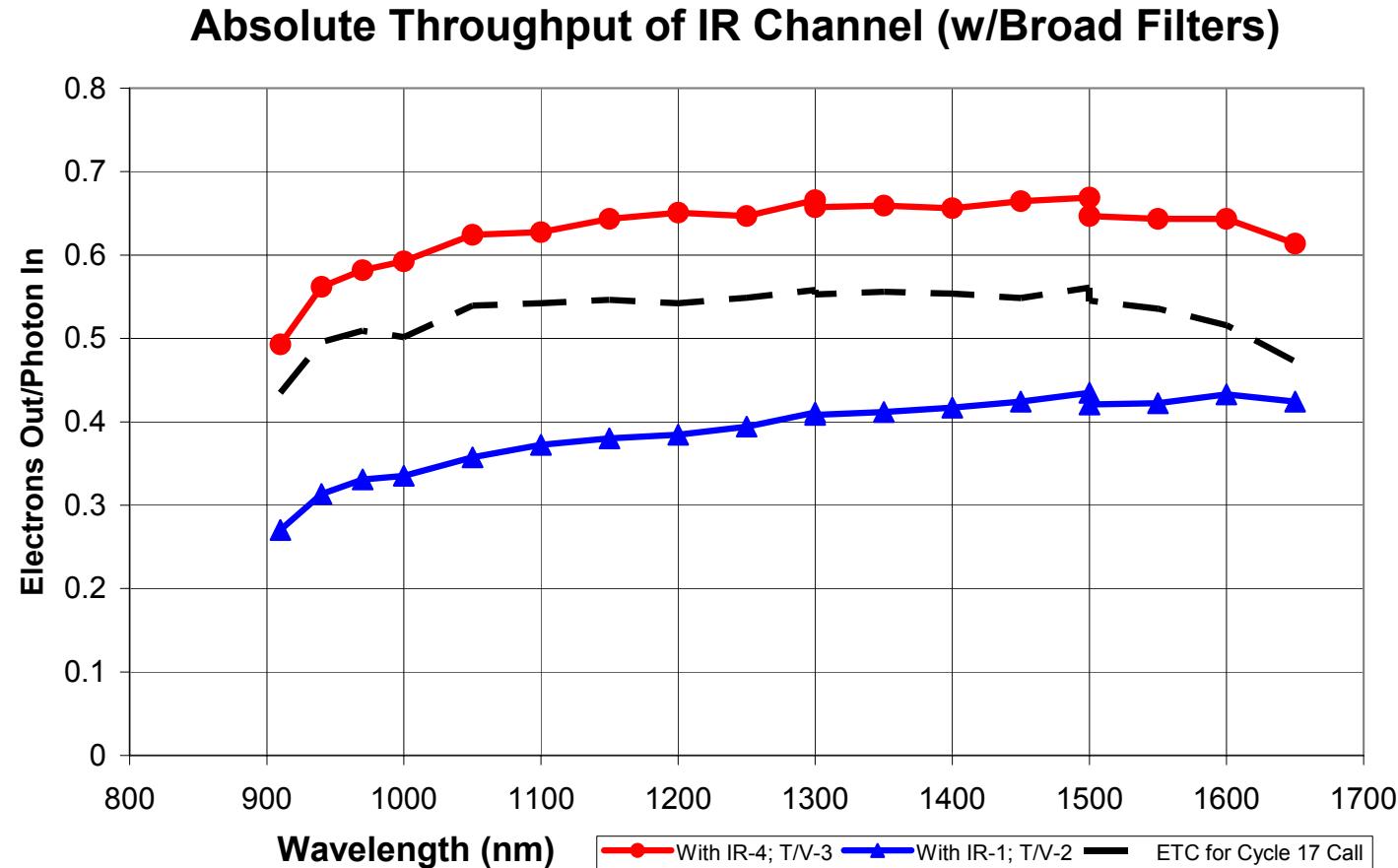
End-to-End Throughput with IR-4 vs. Component Predictions



- Agreement at the 5-10% level is very reasonable (two calibrations against NIST; two gain calibrations; all the optics)
- No sign of optics throughput deficit suggested by earlier T/V runs with their less reliable test methodology



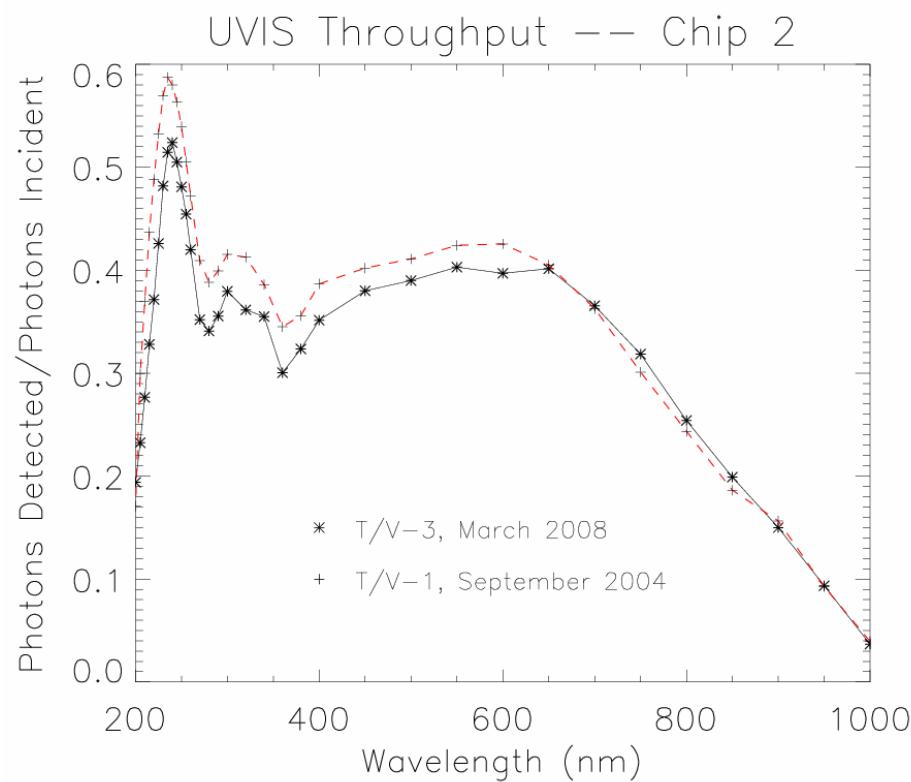
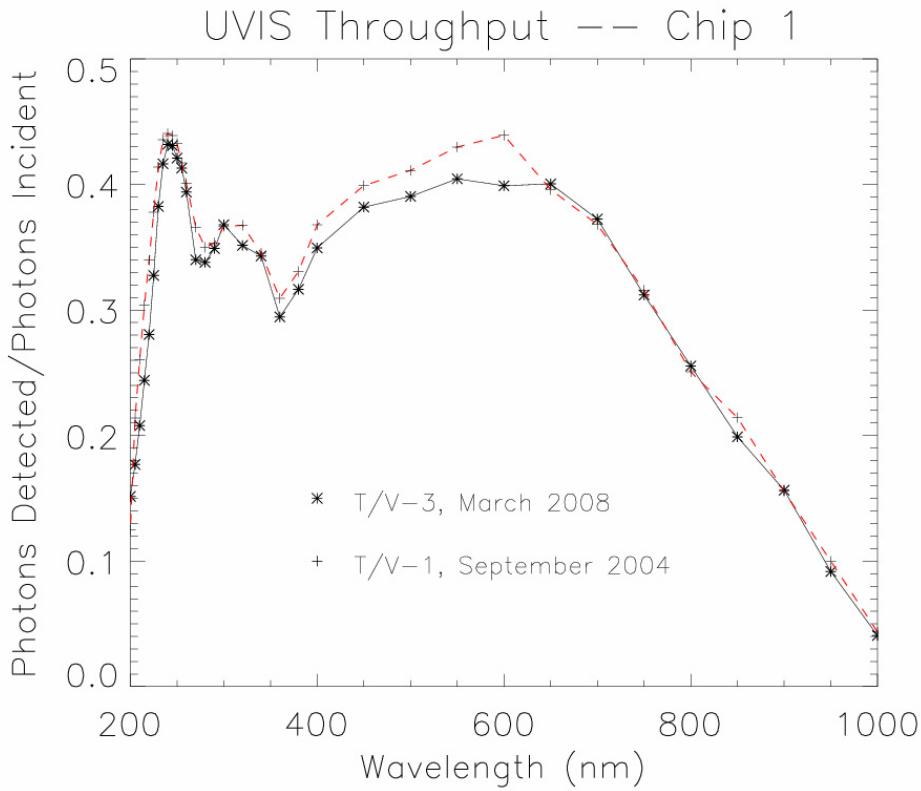
IR Throughput in T/V-3 Higher Than Promised in Cycle 17 Call



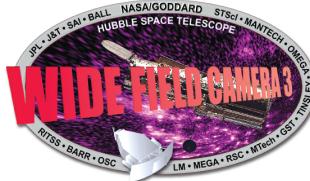
- Best current estimate indicates WFC3 IR channel should deliver higher throughput than promised to observers in Cycle 17 call



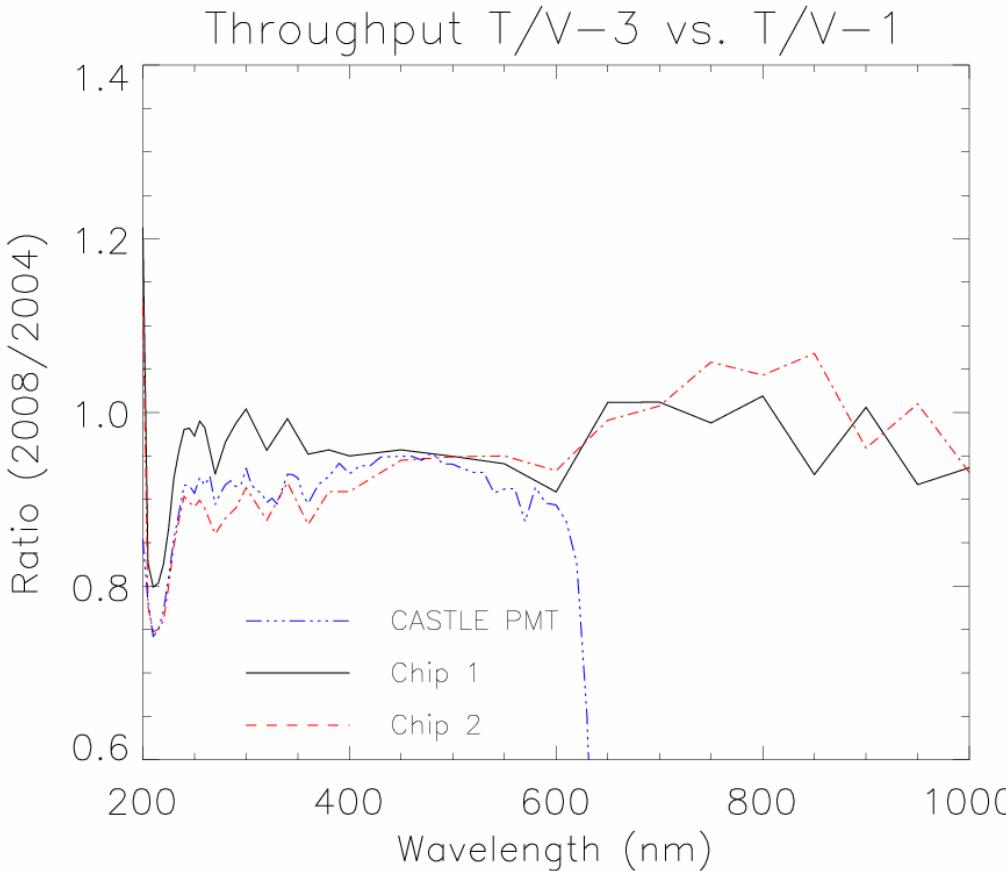
UVIS Throughput in T/V-3



- T/V-3 UVIS throughput results are in reasonable agreement with results from T/V-1 (same CCDs in rebuilt assembly)

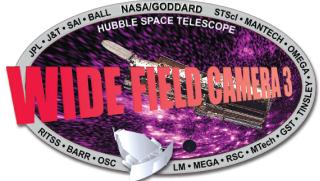


Final UVIS Throughput Calibration Requires Additional Work



- Apparent change since T/V-1 largely attributable to claimed calibration change in transfer standard (reference) detector
 - Either both WFC3 and reference changed identically, or (more likely) neither changed
 - Requires careful post-facto calibration of reference after T/V-3

- Even if the more recent calibration is correct, users will have more signal in NUV than Cycle 17 ETC predicted – ETC did not take credit for quantum yield effect in NUV, so more electrons are actually produced (by $340/\lambda[\text{nm}]$); we also have new data indicating quantum yield correction has been over-estimated.



Flight Detector Read Noise and Dark Current



UVIS Detector

- Read noise: 3.0-3.2 e- rms (vs. spec of 4, goal of 3)
- Dark current: <1 e-/pix/hr at -83C

IR Detector

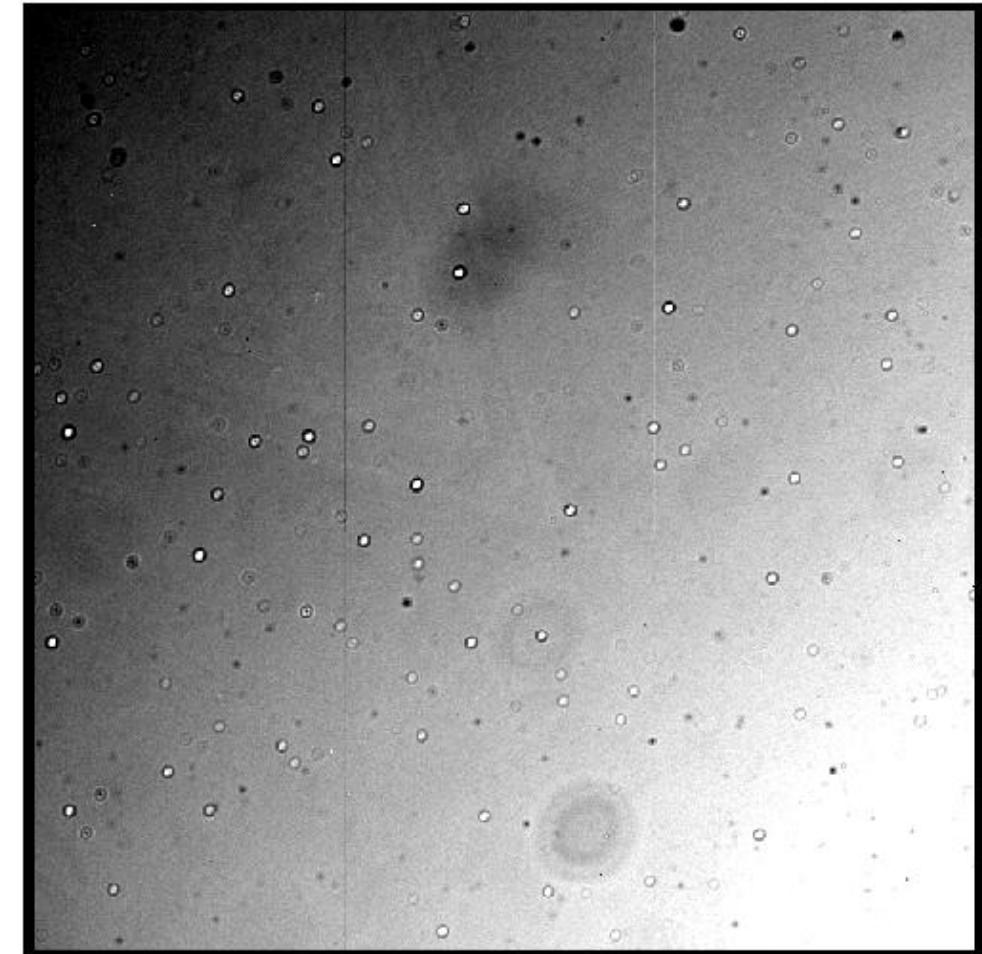
- Read noise: 20-21e- rms CDS; 13-14 e- rms fitting 16 reads up the ramp
- Dark current: ~0.045 e-/pix/sec with BLANK in place; varies slightly with filter as thermal emission of filter trades off against transmission of thermal emission from warmer optics upstream



UVIS-1' Flats Show a New Population of Lensing Spots



- Most of the “bright-core” flat field features are new, acquired in acceptance testing of UVIS-1’ after its TEC/cable/glint shield rework
- The bright cores are thought to result from the refractive/diffractive effects of droplet residue on the outer surface of the vacuum window
- They are more worrisome than the simple opaque particle shadows because the bright cores and surrounding rings indicate that there is some deflection of rays en route to the detector, not just blockage
- This makes the problem not just a flat-fielding problem, but at some level a deconvolution problem
- Our calibration tests indicate that the scientific impact of these features will in fact be quite small



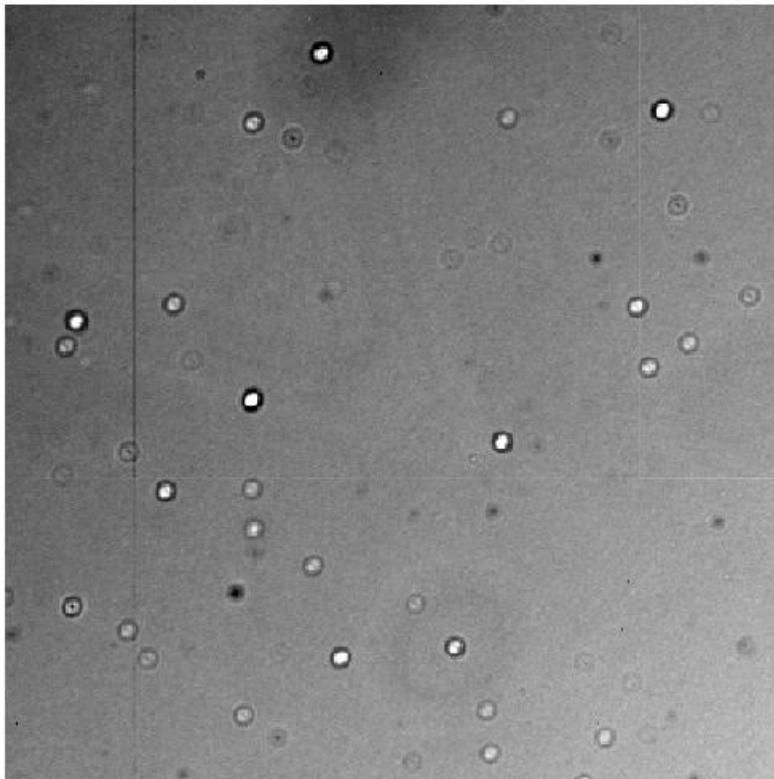
Internal Flat in the Most Affected Quadrant,
Through the F438W Filter



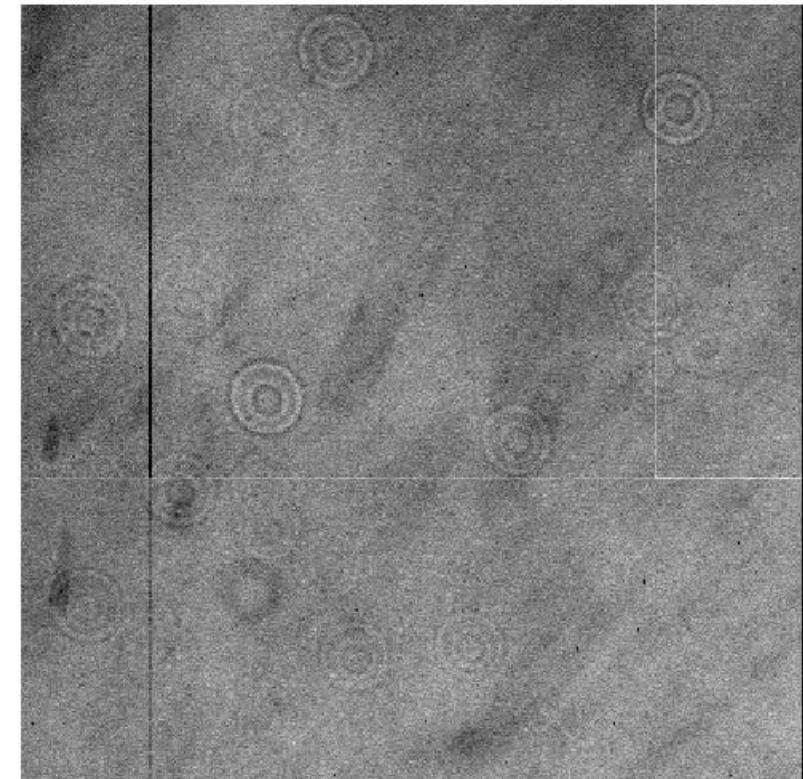
Internal vs. External Flats



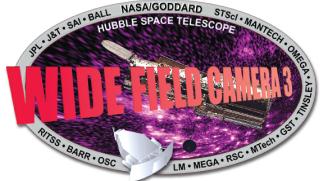
- The intensities of all window features are greatly reduced in external flats (representative of the f/# of the science beam); the internal cal beam is much more highly collimated.



Internal flat in F438W, 1000 x 1000 pixel section



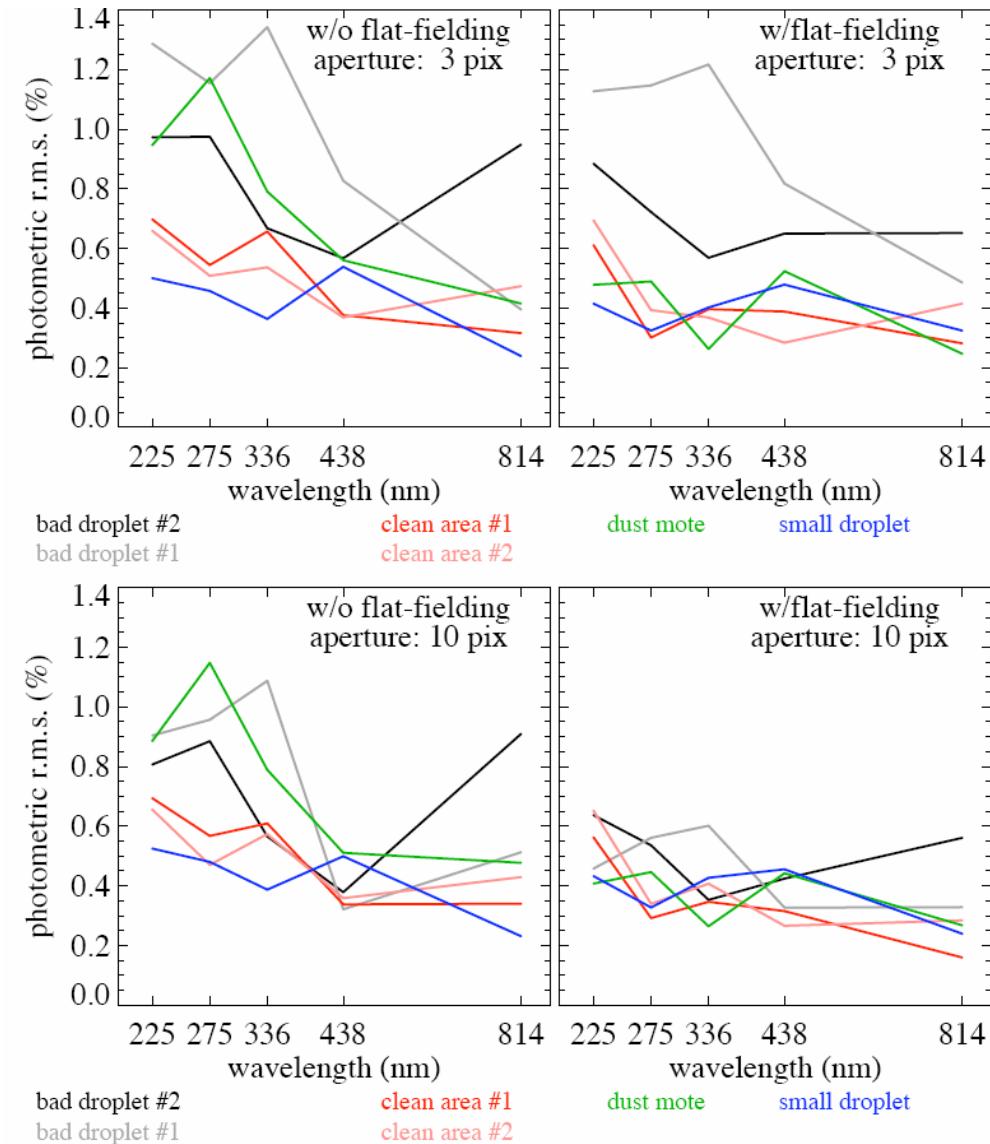
External flat in same region; contrast is now reduced to ~+/-0.5% or less



Photometric Accuracy Is Affected Slightly; Still Within Specification

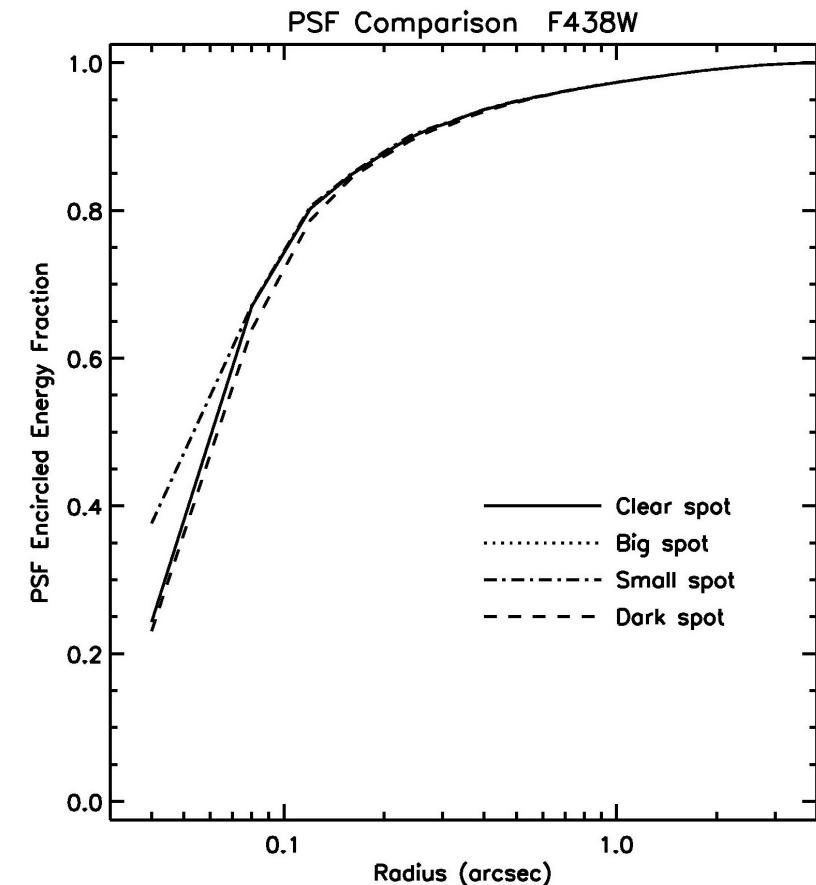
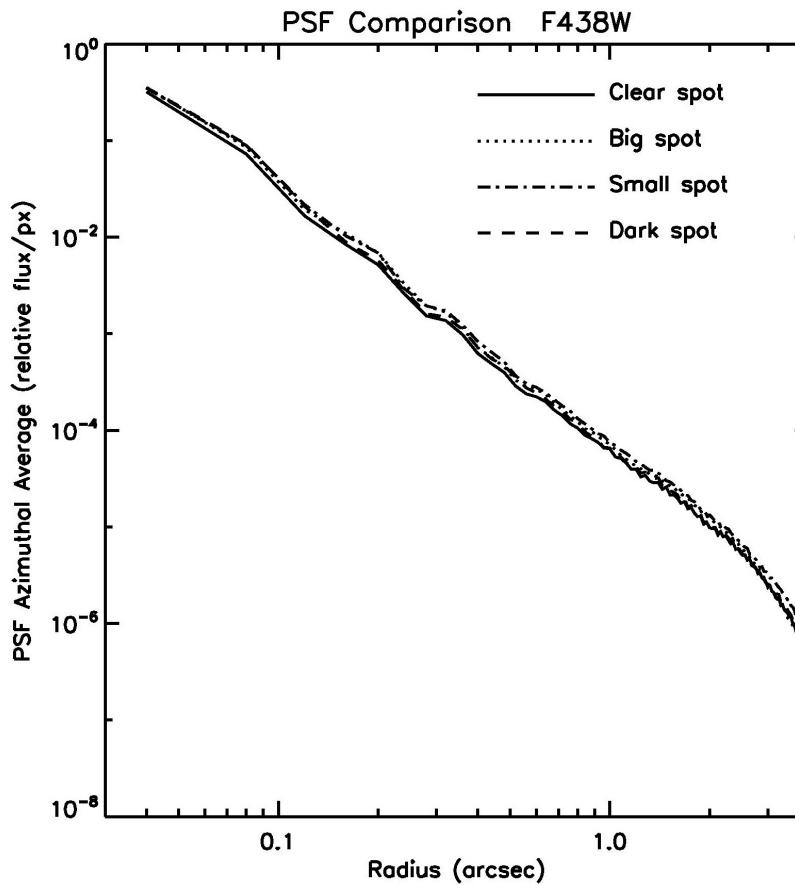


- We have assessed the effects of the spots on photometric accuracy by scanning a simulated point source in different regions of the detector
- In the vicinity of the worst spot features (a minority of the population), analysis by Tom Brown shows that small aperture photometry is measurably affected, but remains within spec (1% VIS, 2% UV)
- With 10 pixel radius extractions, even the strongest features show very small effects
- Typical dithering strategies will further mitigate the impact

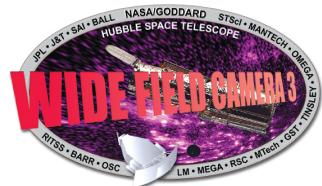




UVIS1' PSF Comparison F438W



- Similarly, deep PSF/encircled energy analyses by George Hartig show negligible, in-spec differences in wings – near-field features at the 0.2% level typically seen near large spot features; George’s deep EE curves confirm the photometric outliers – effects can be spotted in the 0.1-0.4 arcsec radius annulus

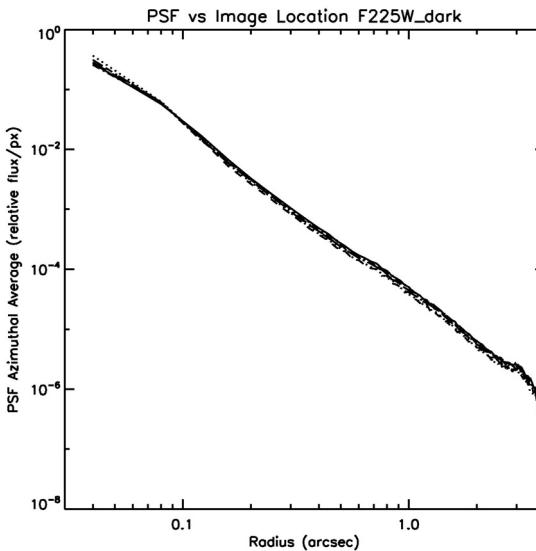


UV AzAvg PSF on Flat-Field Features Show Negligible Differences

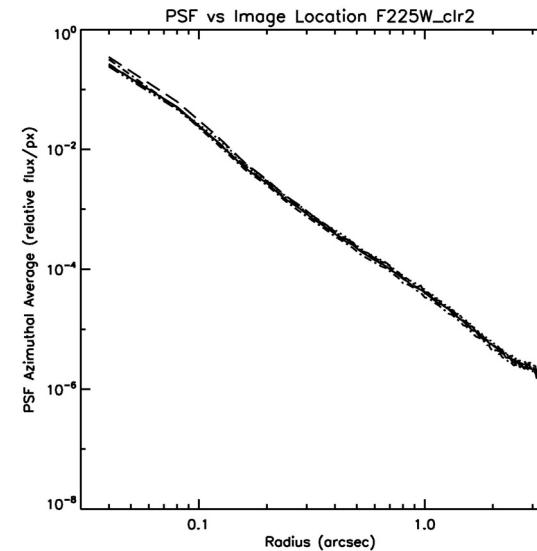


F225W

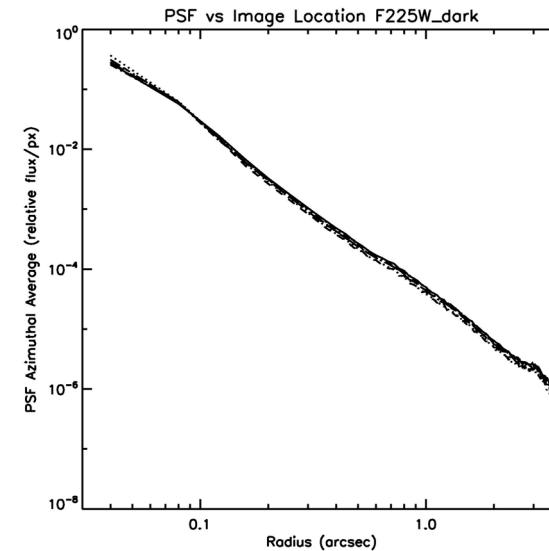
dark



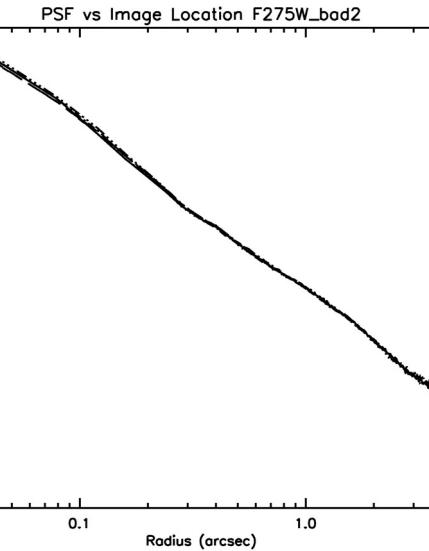
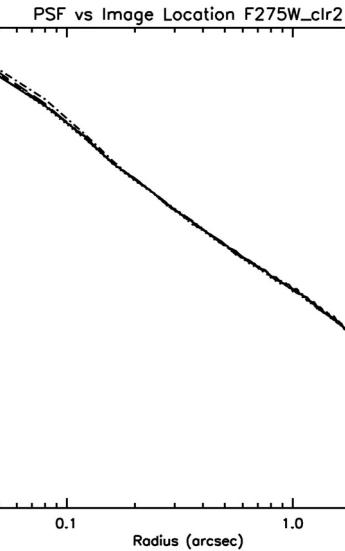
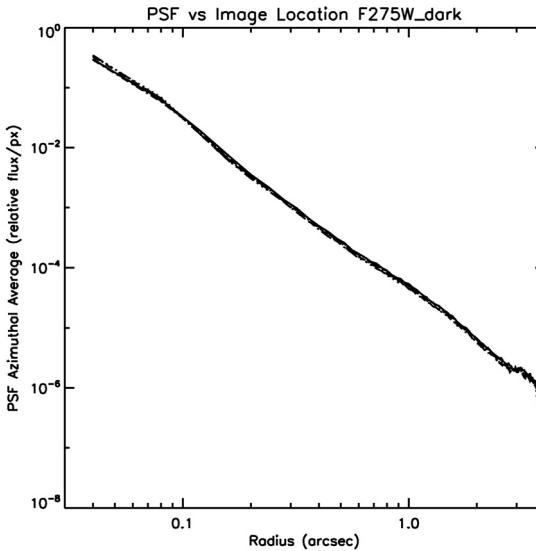
clear2



bad2



F275W

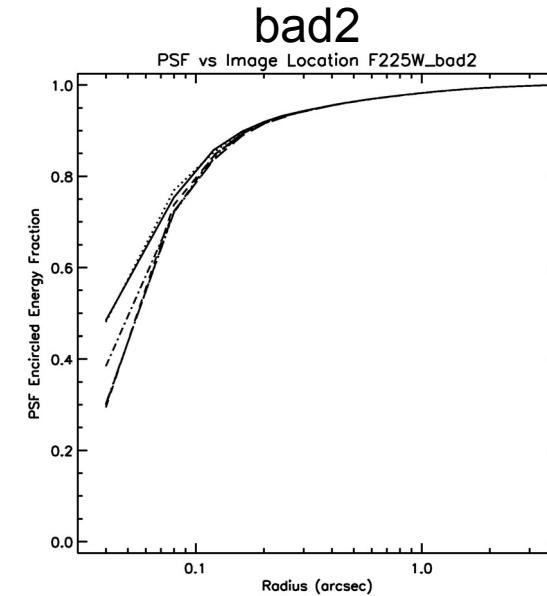
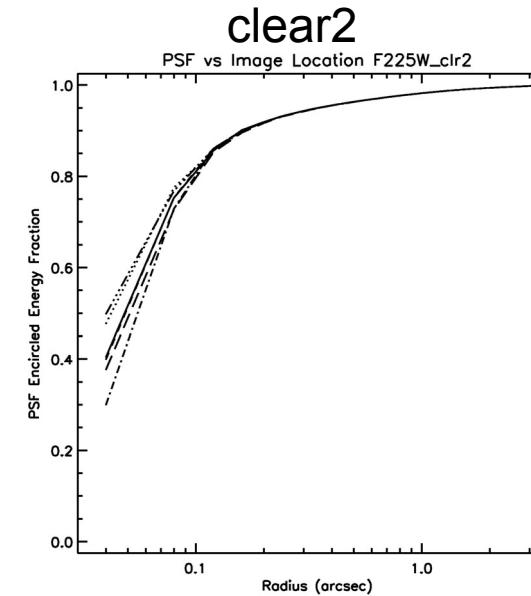
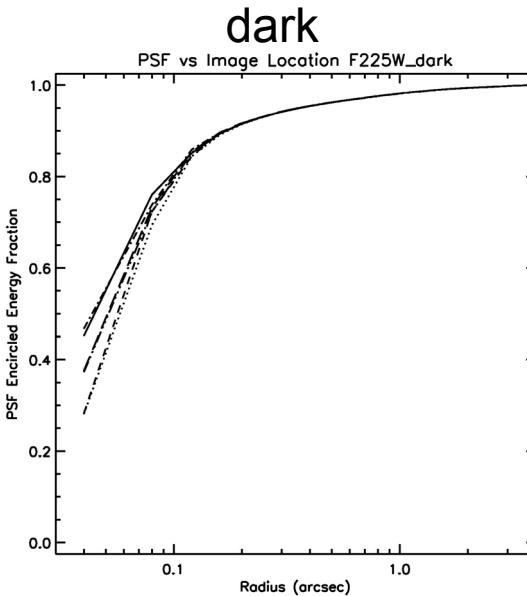




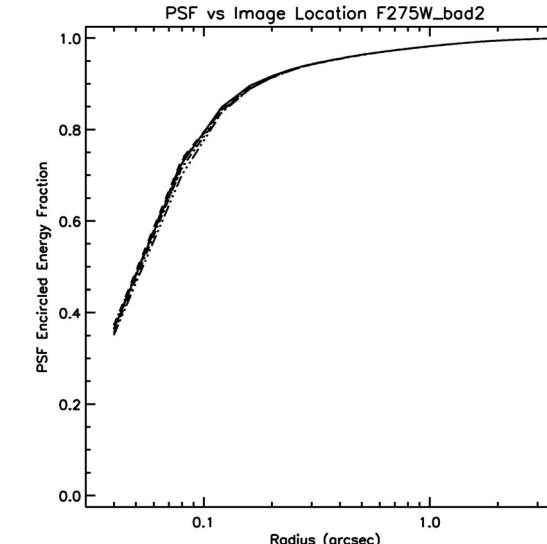
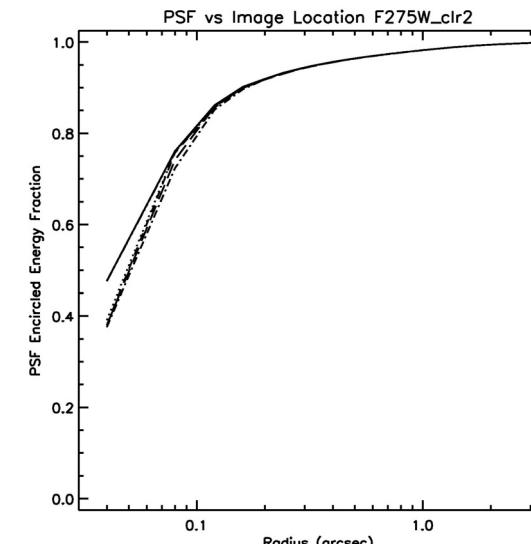
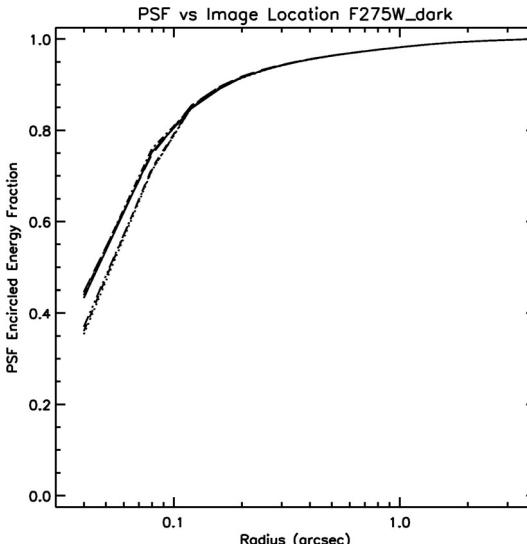
UV PSF Encircled Energy Curves on Flat Field Features Also Show Little Difference



F225W



F275W

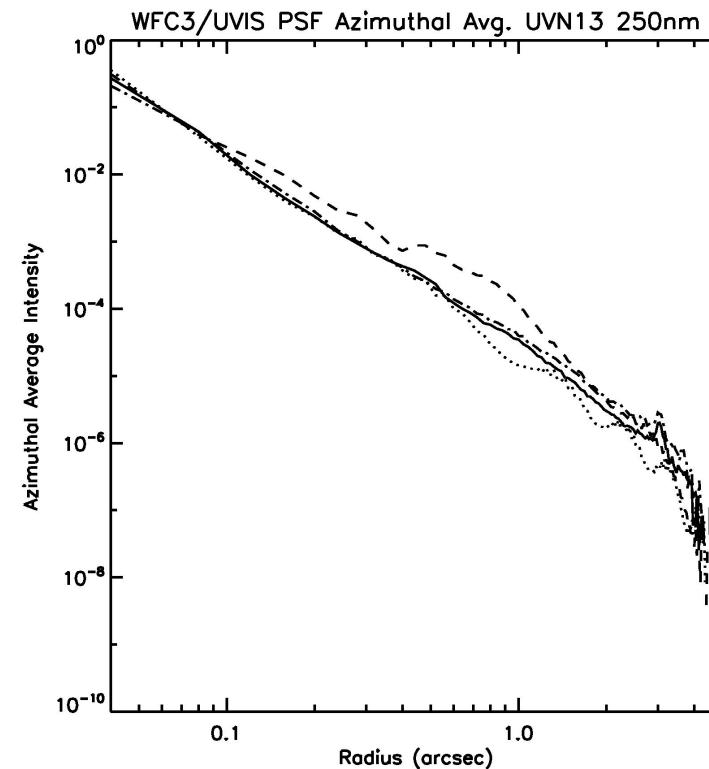
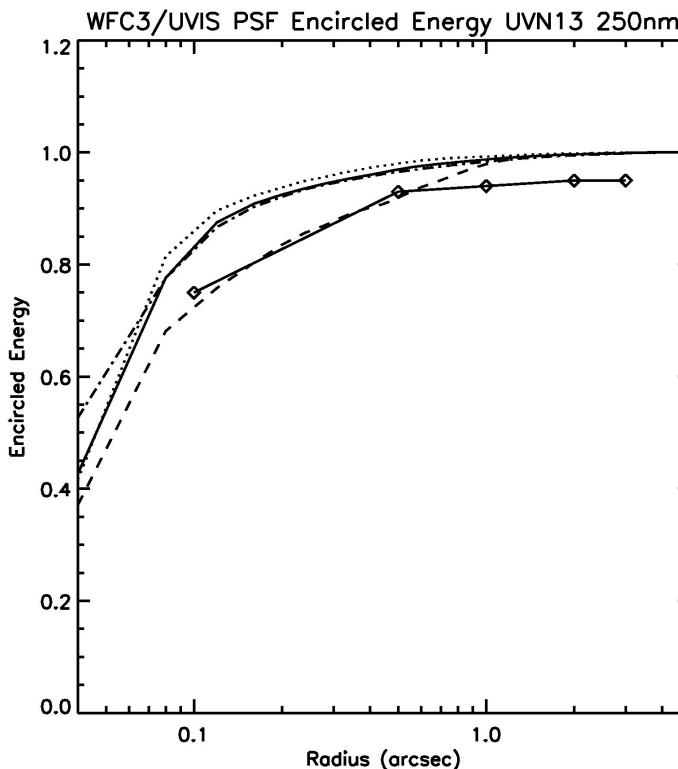




UVIS PSFs at 250 nm Agree Well in T/V-1 vs. T/V-3



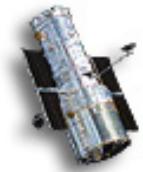
- UV PSF is not just the same over the field now; it also has not significantly degraded since TV1 measurement with UVIS-1 detector, before rebuild



Solid: OS meas TV1 Dot-Dash: OS meas TV3 Dotted: OS model Dashed: OTA+WFC3 model Diamonds: Original Spec at 250 nm – since lowered in recognition of OTA mid-frequency scatter effects in the NUV



Current Intention Is To Fly As Is



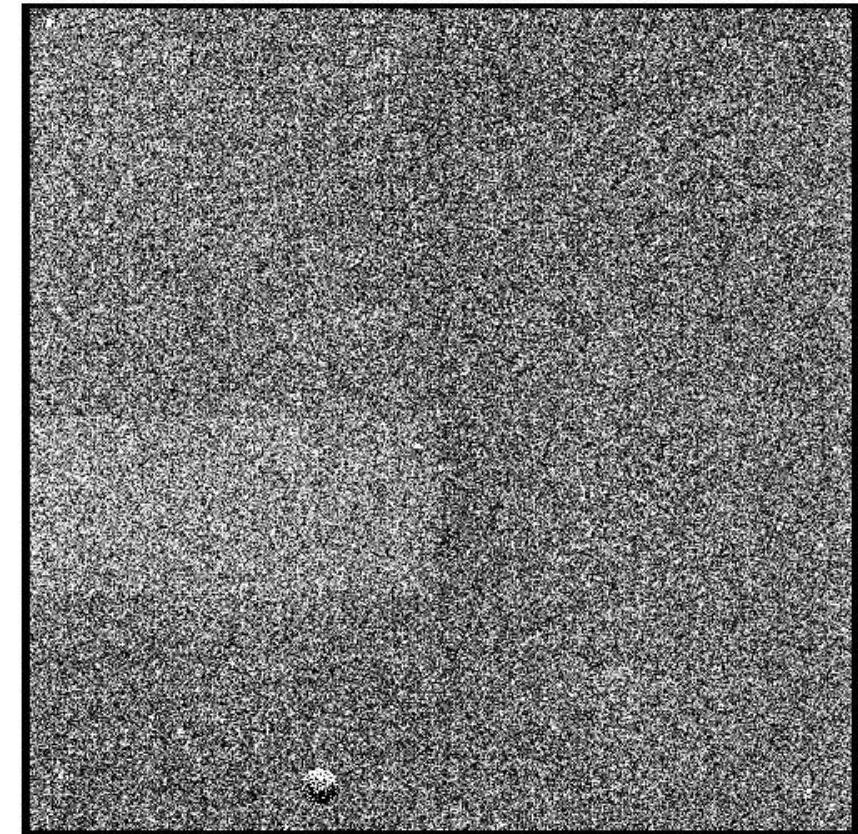
- We believe the window could be successfully cleaned, eliminating the bulk of the offending features
- The issue is access to the detector – would entail weeks of highly invasive rework to a fully-buttoned up instrument (general handling, ESD, contamination) and then an extensive re-qualification program (acoustic, EMI, thermal-vac); with *likely* launch slip, there would be time to do this *if no serious problems were encountered*
- The judgment of the local science team, the HST Project, and the WFC3 Science Oversight Committee, is that the science impact is sufficiently small that this level of rework and risk is not justified
- SOC resolution bottom line, based on their assessment of science performance impact: “*We recommend that NO invasive measures be taken to remove the material from the flight housing now in the WFC3 instrument.*” Their resolution calls for appropriate documentation and information to be distributed to community, which we of course will do



Banded Bias Offsets in IR Readouts

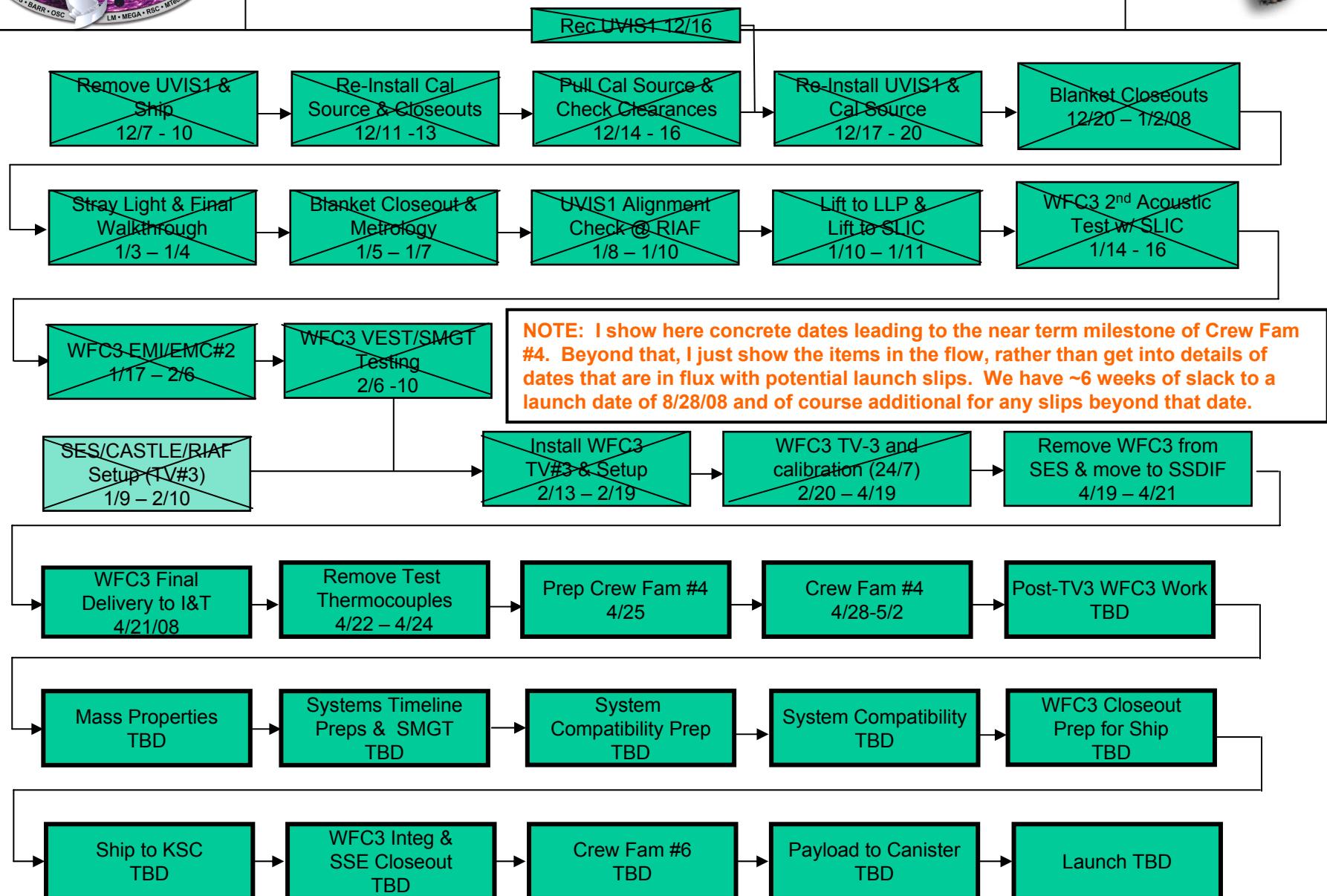


- Low-level bias shift ($\sim 2.5\text{DN}$) is seen intermittently in lower left quadrant of readout; effect is tracked by the reference pixels in those rows
- Frequency was $\sim 1/30$ reads; dropped to $\sim 1/400$ reads
- Only seen with Side 1 electronics
- Lack of dependence on gain setting (same shift in DN) indicates fault is on a DEB board that is side-specific
- No examples in over 1500 readouts on Side 2
- If no insights are developed from off-line testing of non-flight electronics, will fly like this with recommendation to start flight ops on Side 2





WFC3 Schedule (December 2007-Launch)





Conclusion

- WFC3 is nearing the end of a comprehensive, successful integration and test program after a long development program
- Some noteworthy statistics:
 - >160 calibration SMS's run so far in T/V-3
 - Over 8,000 images obtained in T/V-3 (>57,000 in the WFC3 archive)
 - In the past 15 months, WFC3 has been operated for >3600 hrs; this represents 33% of total clock time for that interval
- WFC3 is very close to launch readiness for SM4 – and for supporting the exciting program proposed for it in Cycle 17 and beyond