SPACE TELESCOPE SCIENCE INSTITUTE

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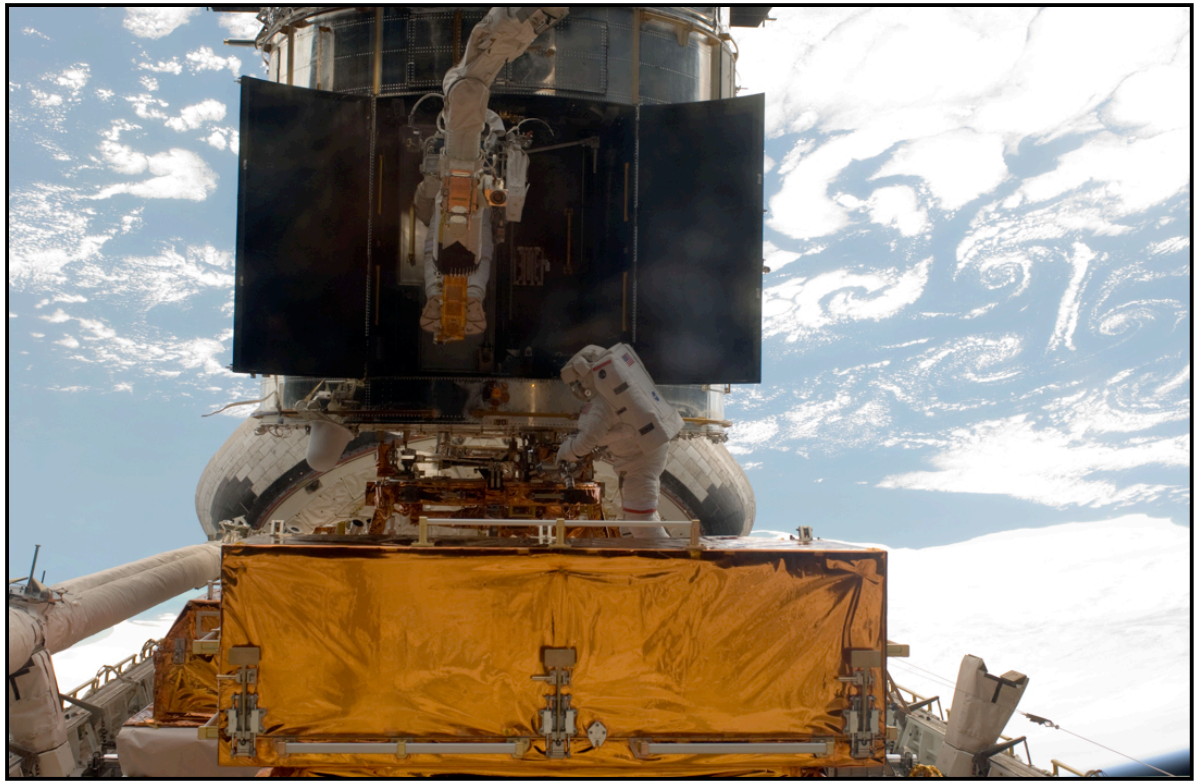
STUC - COS Update

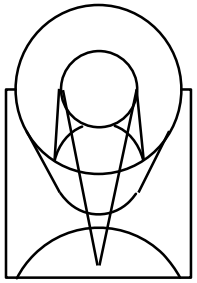
Alessandra Aloisi

12 November 2009

COS Installation



On May 16, 2009 COS was successfully installed on Hubble during EVA 3 of SM4.



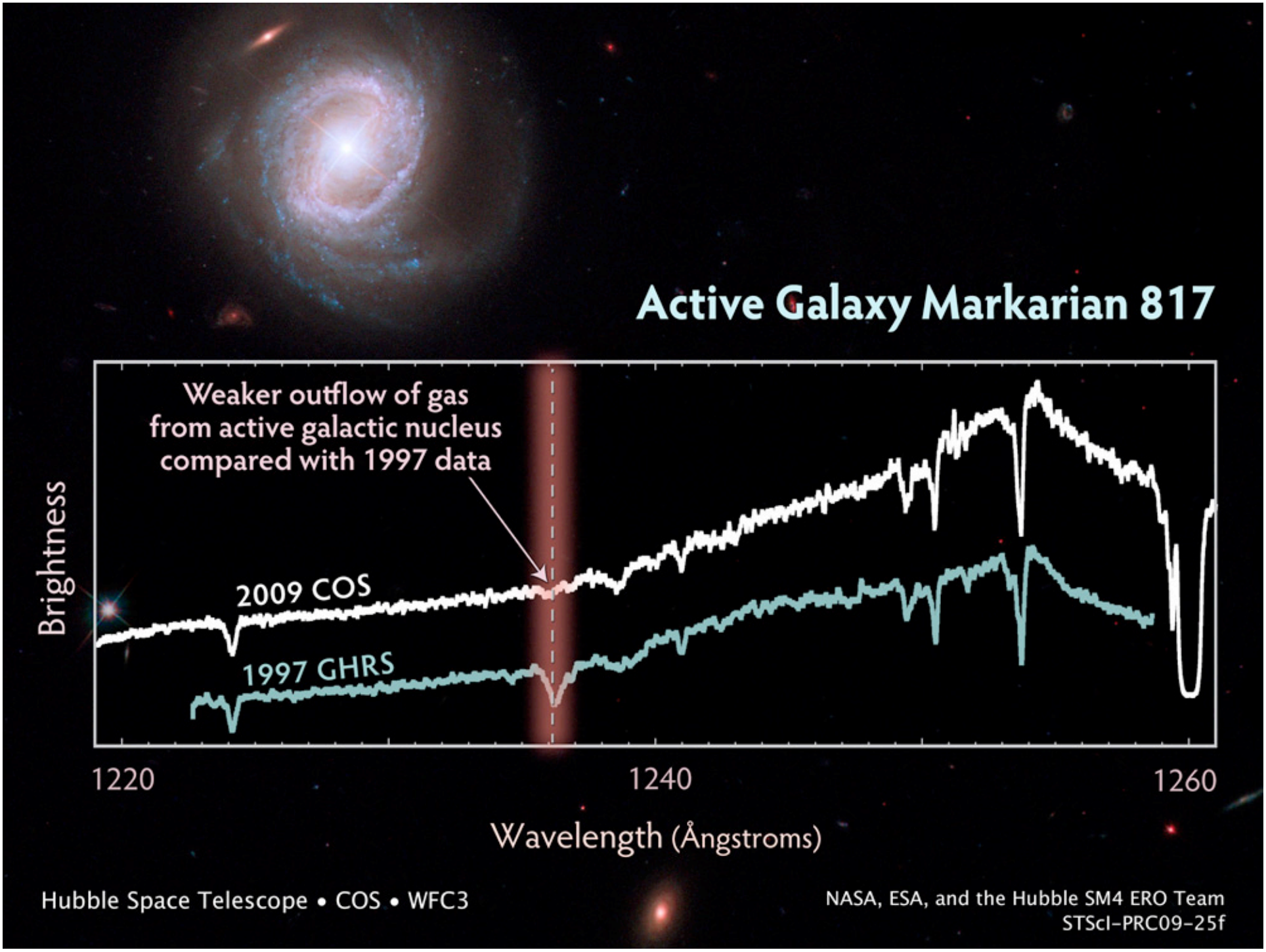
Agenda

- SMOV Overview
- Instrument Performance
- Cycle 17 Calibration Plan
- Cycle 18 User Support

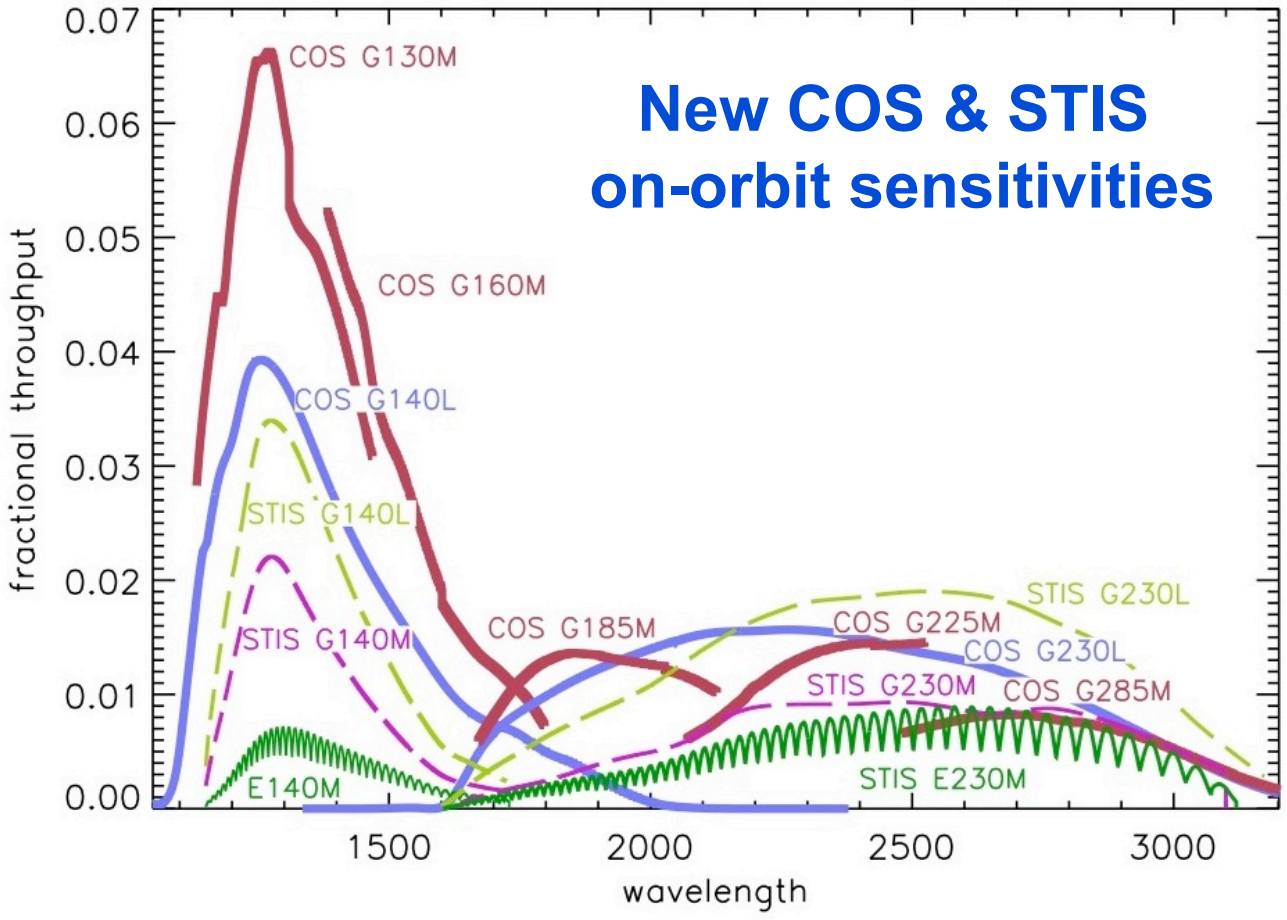
SMOV Overview

- 34 SMOV programs designed to characterize COS on-orbit performance and ability to carry on science program
- SMOV was joint (50-50) effort between STScI COS team and COS IDT
- Completed end of Sep 2009 (~ 3.5 months)
- Nearly 2,800 individual exposures for a total of 156 internal & 259 external SMOV orbits
- First COS ERO data on Aug 2, 2009
- COS released for science on week of Sep 14, 2009

COS is performing as expected!

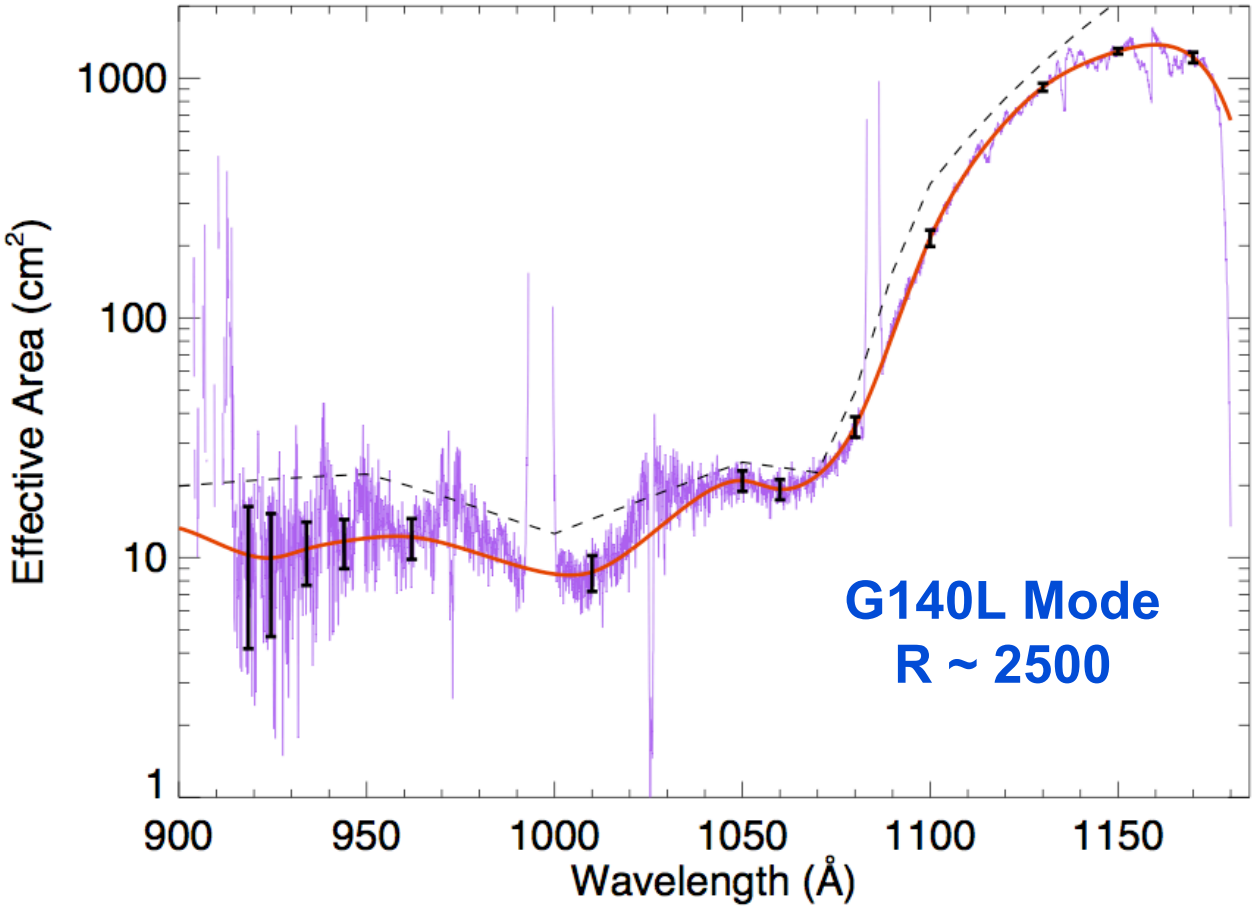

Active Galaxy Markarian 817
Weaker outflow of gas
from active galactic nucleus
compared with 1997 data
2009 COS
1997 GHRS
Brightness
1220
1240
1260
Wavelength (Ångstroms)
Hubble Space Telescope • COS • WFC3
NASA, ESA, and the Hubble SM4 ERO Team
STScI-PRC09-25f

COS Sensitivity



- Superb in FUV
- Comparable to STIS in NUV
- NUV sensitivity in G225M & G285M is as expected at launch from grating degradation
- Within 20% of ground values

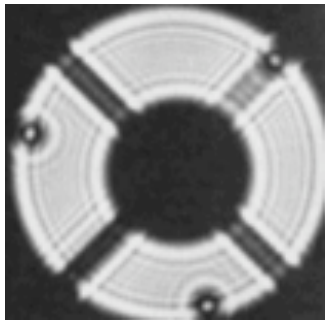
COS has Sensitivity Down to the Lyman Limit



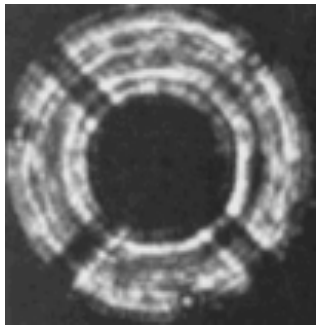
McCandliss et al. 2009, ApJL, submitted

COS LSF

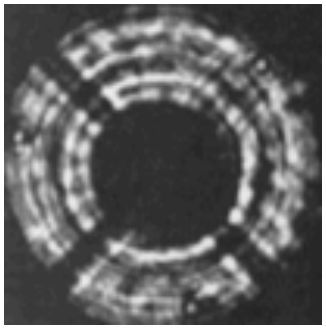
- COS LSF measured on orbit with HST OTA deviates from profile measured on the ground
- inclusion of mid frequency zonal "polishing" wave-front errors (WFE) from OTA provides better fit to on-orbit data



Predicted without WFE



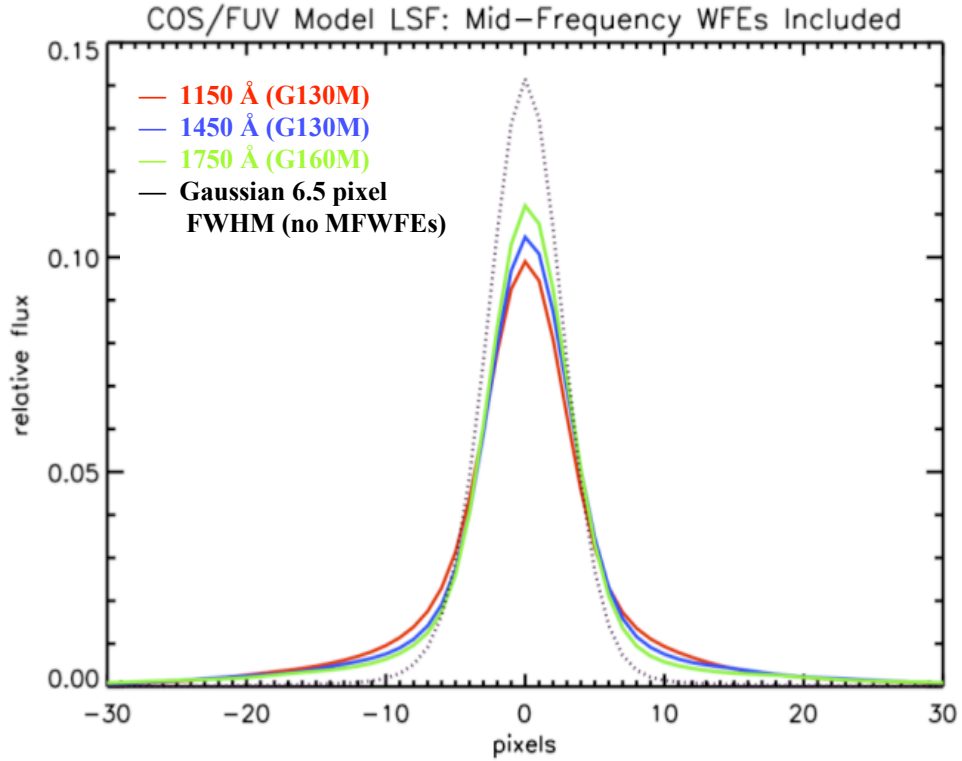
WFPC2 observed



Map of inferred WFE

Krist & Borrows 1995, Applied Optics

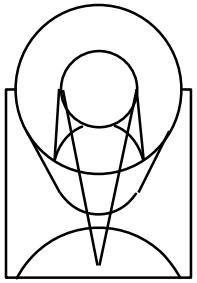
COS FUV LSF



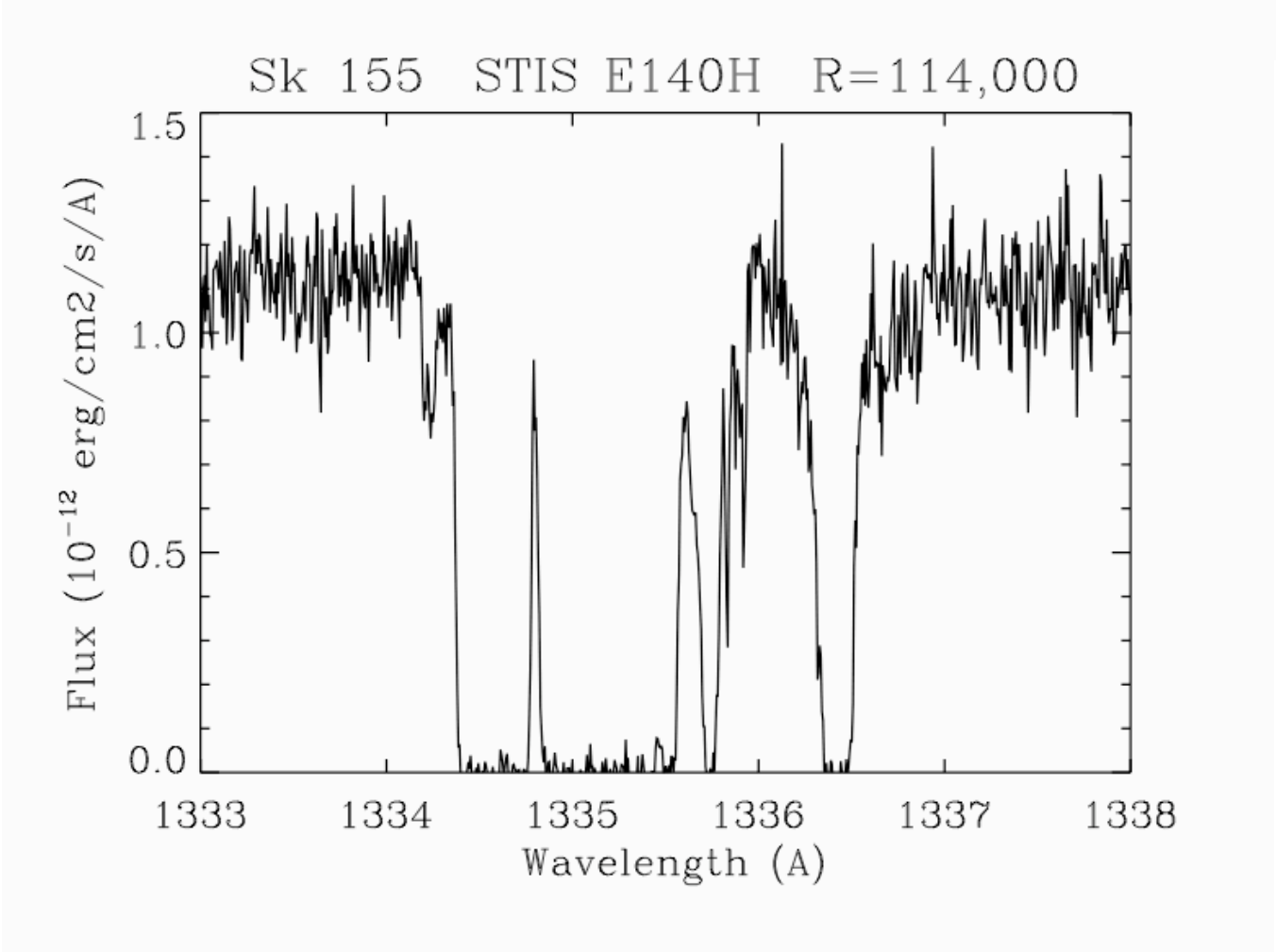
- LSF power is distributed from core to wings due to MFWFEs
- Effect is wavelength dependent, being most extreme in the FUV
- R ~ 16,000 vs 20,000 @ 1300 Å

Ghavamian et al. 2009, COS ISR 2009-01

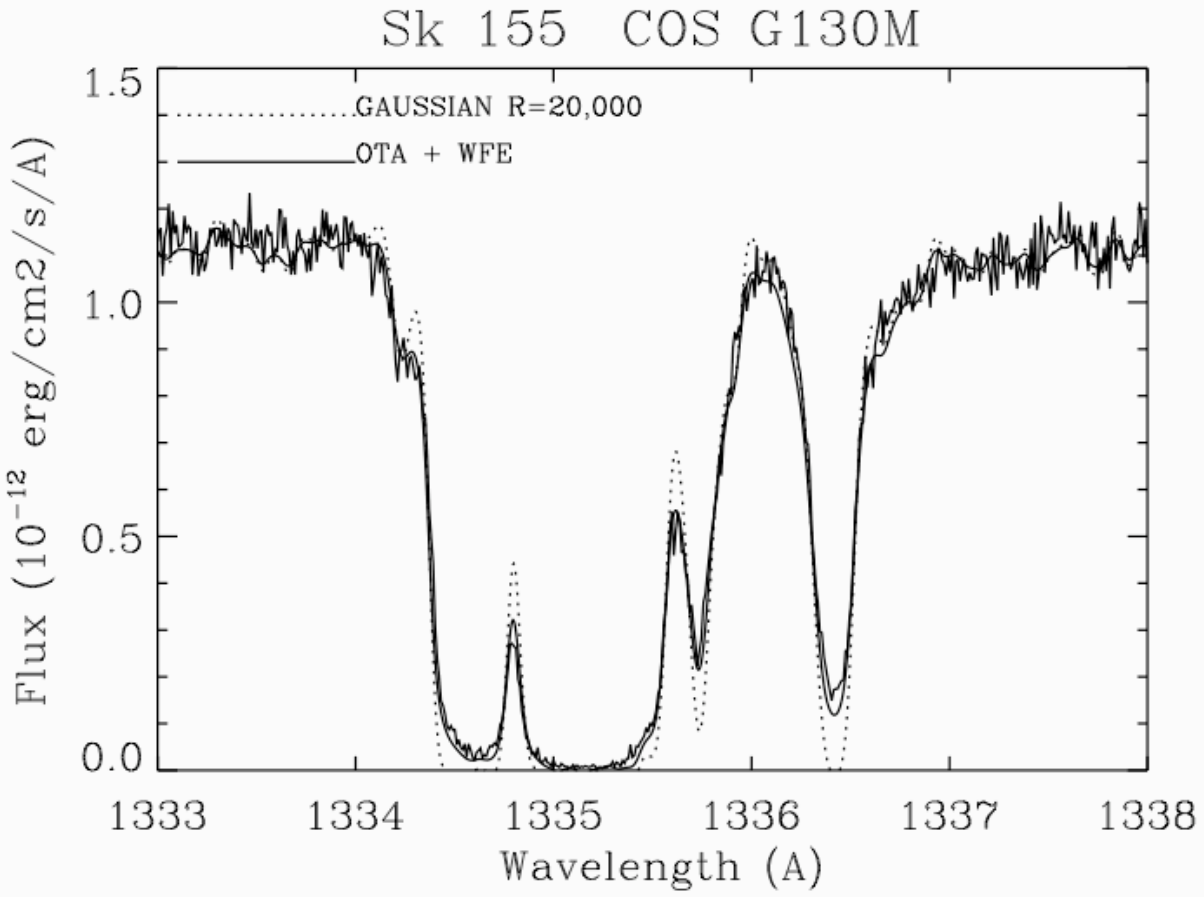
FUV spectral resolution not quite good as expected



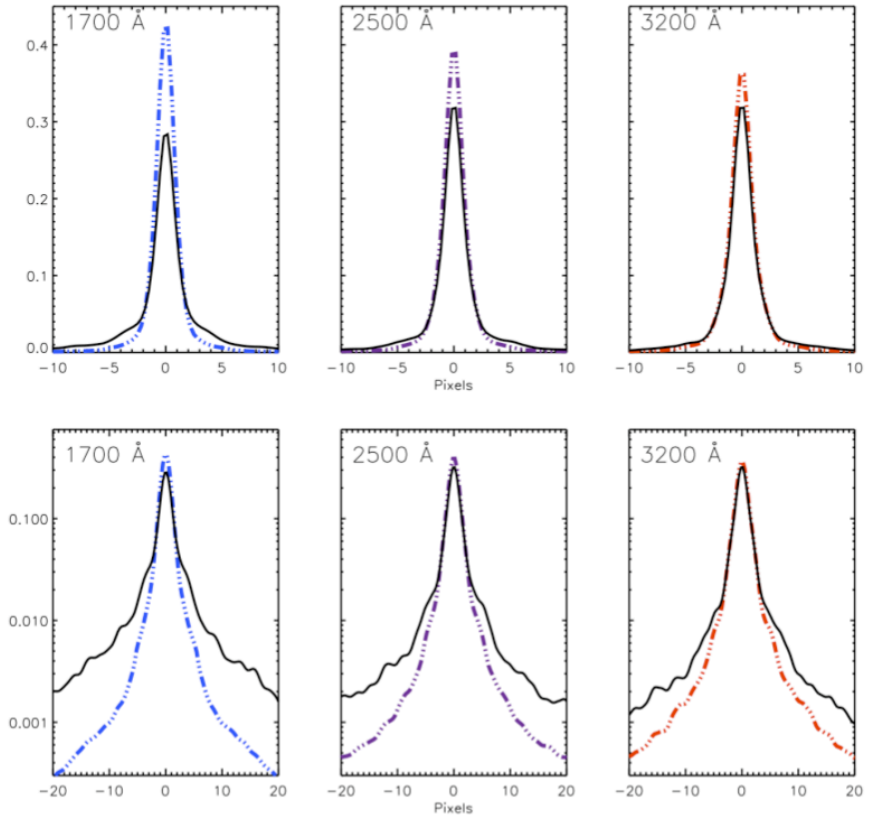
A Spectral Comparison



A Spectral Comparison



COS NUV LSF



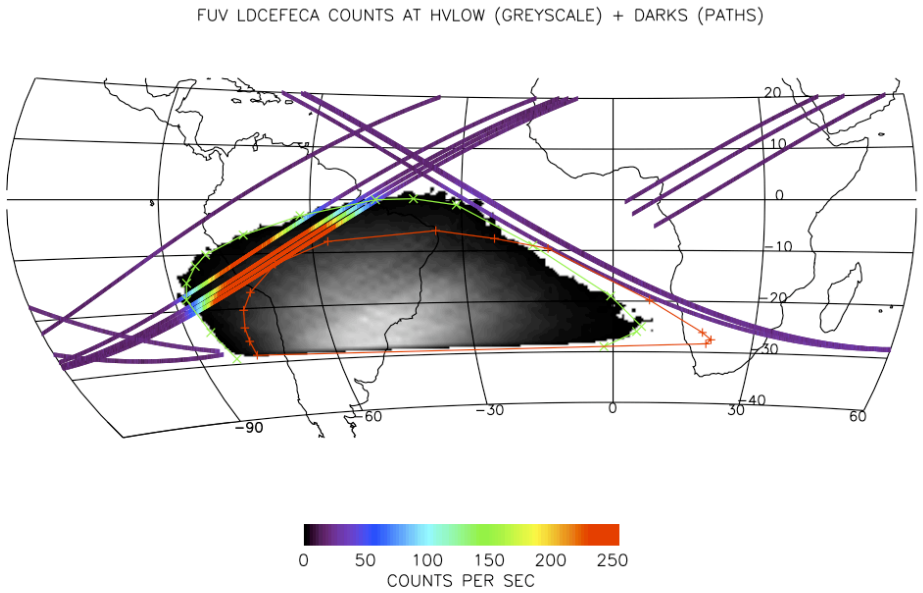
- Contribution of WFE present in NUV
- Almost negligible longward of 2500 Å

Ghavamian et al. 2009, COS ISR 2009-01

NUV spectral resolution at λ > 2500 Å as expected

COS Detector Darks

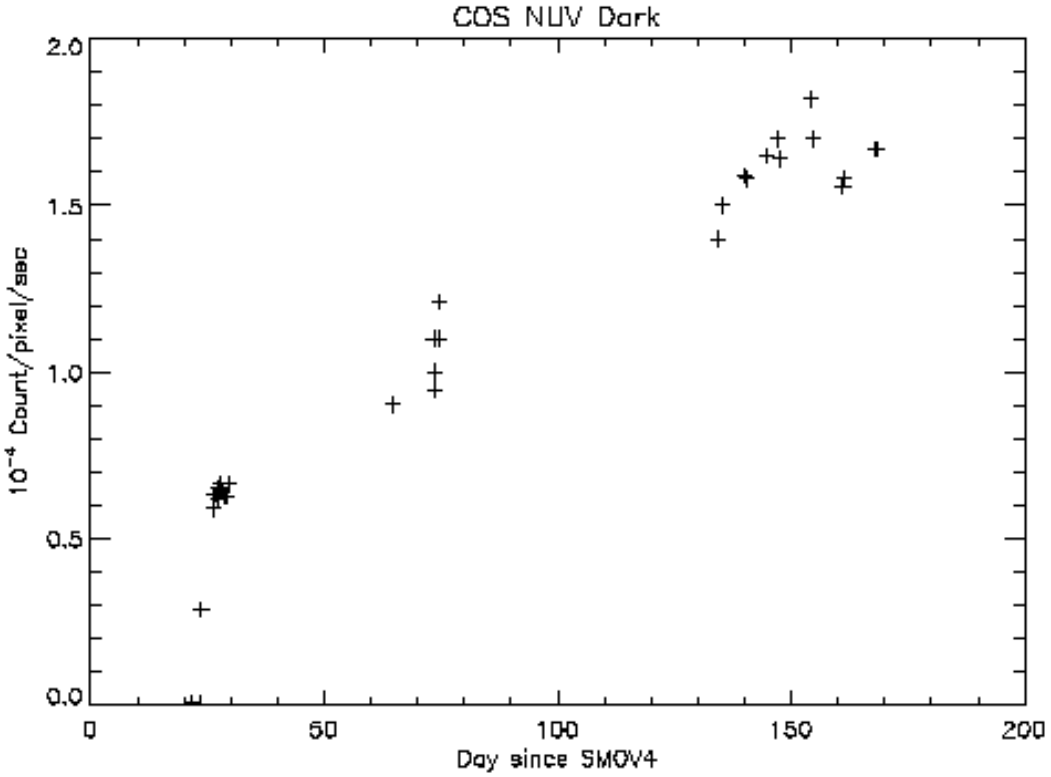
- FUV Dark rate away from the SAA is ~15 counts/sec per segment, which is around prelaunch predictions.
- NUV Dark rate away from the SAA is ~ 65 counts/sec, which is significantly below prelaunch predictions (~225 cts/sec).



- Dark rate near the SAA can be substantially higher, particularly on the western edge
- The SAA model should be modified in order to better reflect the actual count rate distribution with position in the orbit.

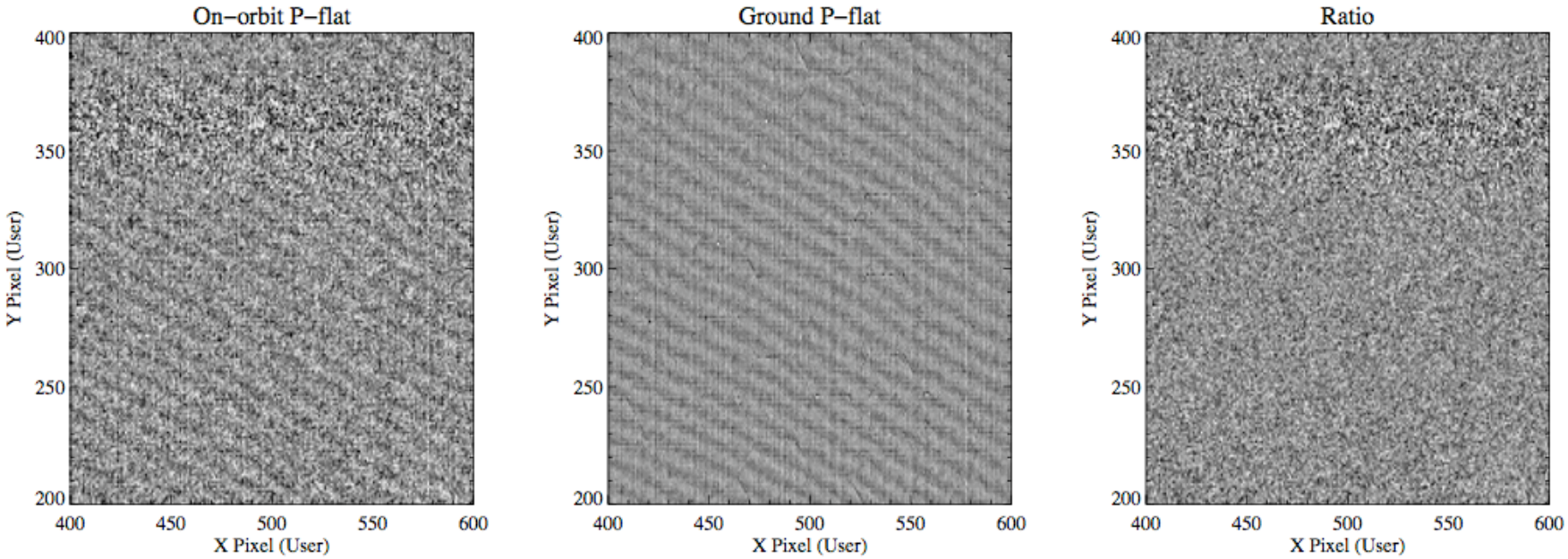
COS NUV Dark Evolution

- Dark count has increased from ~70 cts/sec over entire detector area to showing signs of leveling off ~150 cts/sec in mid Oct 2009
- Possibly increased population of metastable states in detector faceplate
- Remains below initial predictions



COS NUV Flat

- NUV on-orbit flat (internal lamp) confirmed that ground flat (with higher S/N) can be used for flat field calibration
- Vignetting (up to 15-20%) in first 200 pixels on detector as observed on orbit now corrected in flat field
- NUV flat field correction currently applied in CALCOS

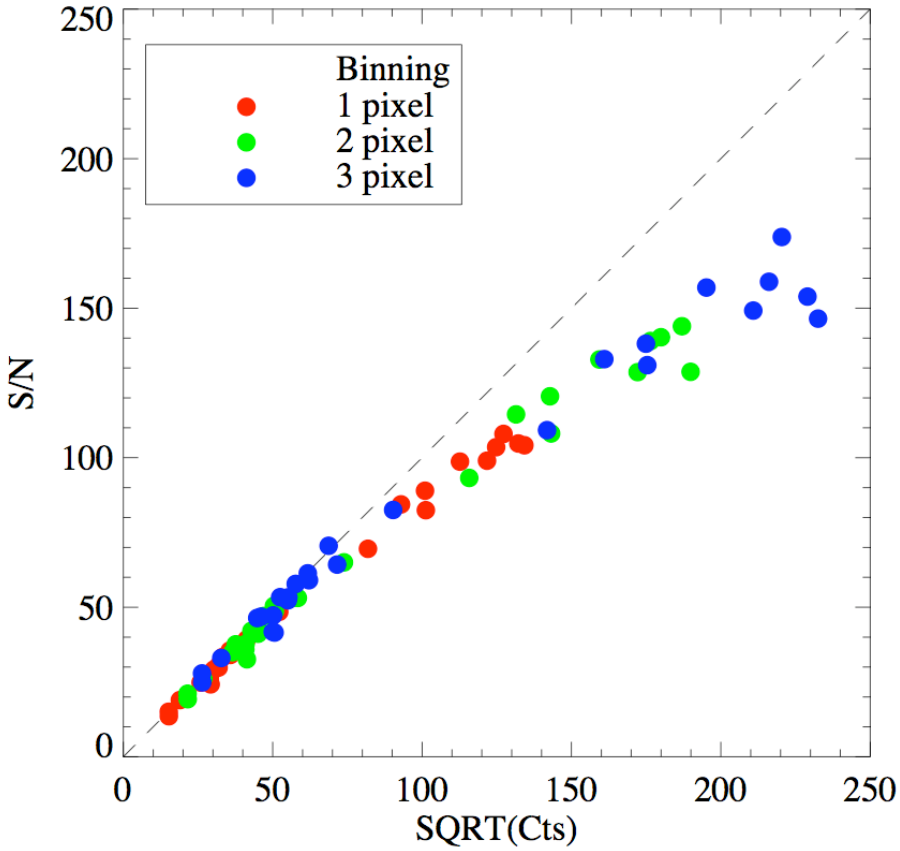


NUV High S/N

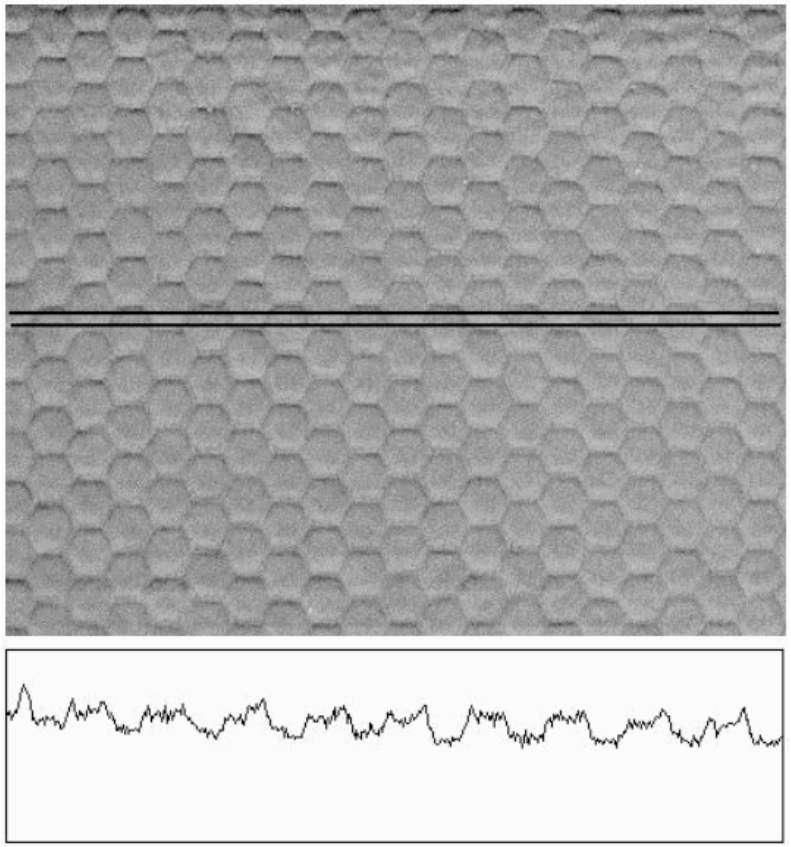
COS can achieve S/N > 30 per 3-pixel resel with single exposure and flat field calibration

COS can achieve S/N >100 per 3-pixel resel with 4 FP-POS positions and flat field calibration

Poisson S/N can be recovered up to ~ 70



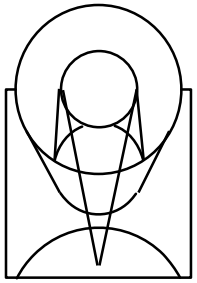
COS FUV Flat



Vallerga et al. 2001, SPIE 4498, 141

FUV flats composed by:

1. Equivalent of "pixel-to pixel" variations in MCP
2. Fixed pattern noise (hexagonal multifiber boundaries) in MCP
3. Grid wires above MCP

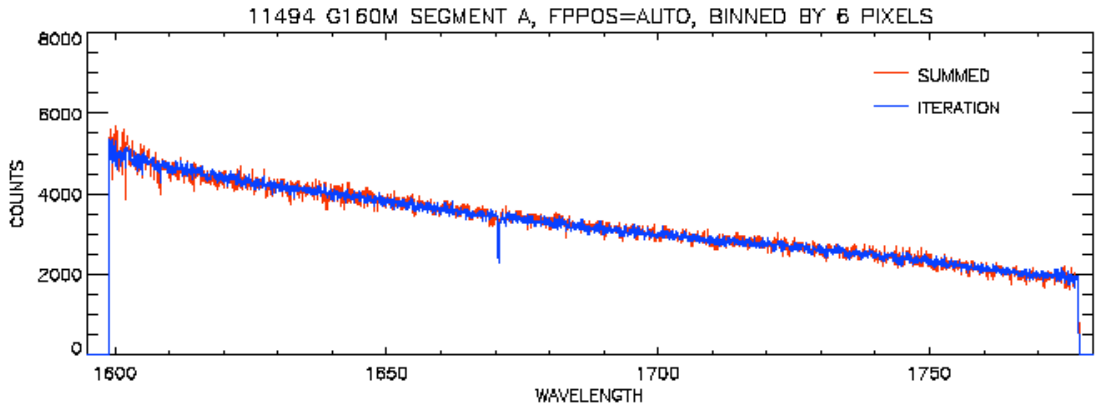


COS FUV Flat (ctd)

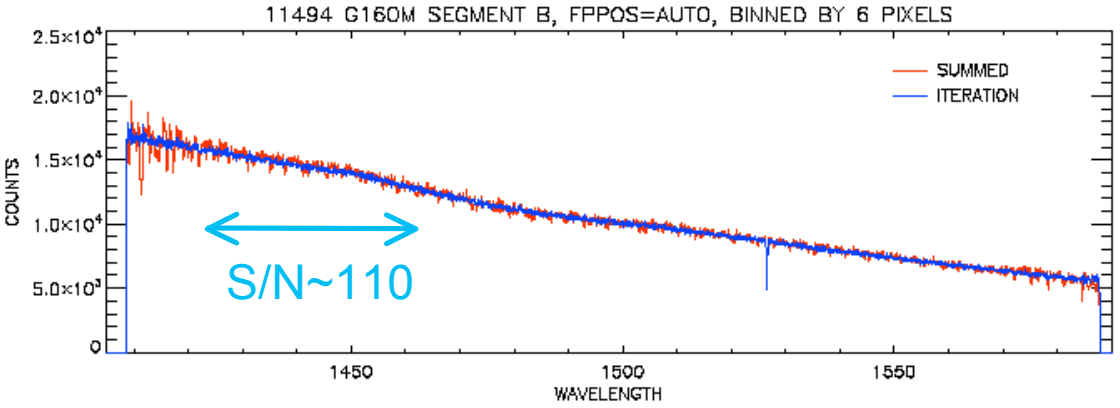
- 2D ground flats (Berkeley + TV03)
  - still to be validated with on-orbit data
  - currently not in use for flat fielding
- Analysis of SMOV data to create 2D flats with observations of external sources still in progress
  - Pulse-height dependence observed
  - Grating dependence observed
- Currently investigating detector walk effect in cross-dispersion direction (~ 3-5 pixels) as cause of apparent pulse-height and grating dependence of 2D flats
- FUV flat field correction currently not applied in CALCOS

FUV High S/N

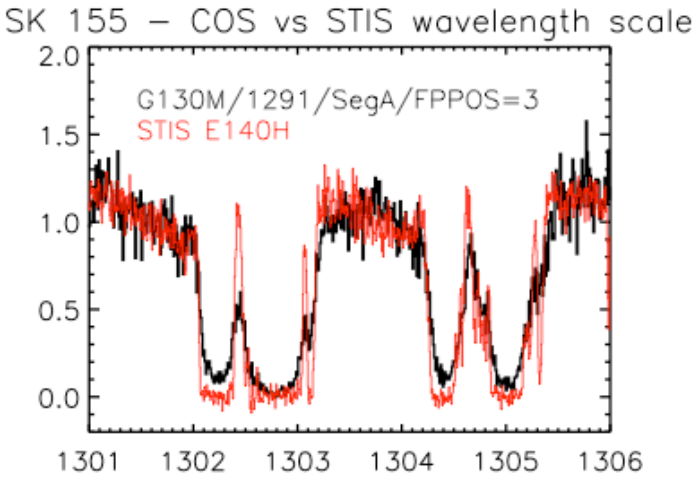
Demonstrated ability to achieve S/N > 30 per 6-pixel resel with different FP-POS positions

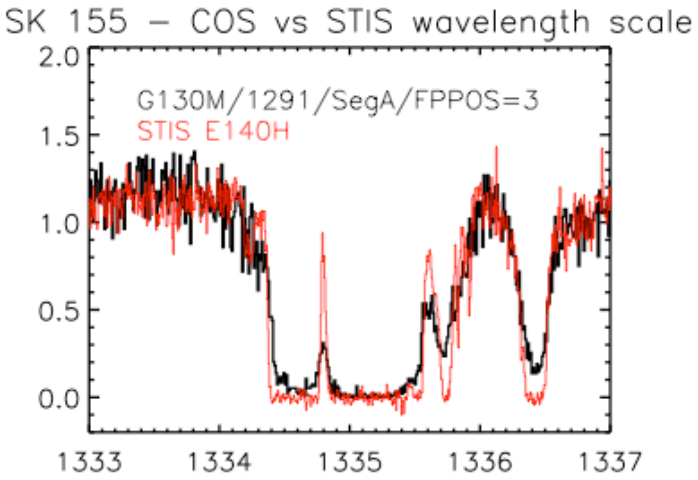


Demonstrated capability to achieve S/N >100 per 6-pixel resel with 4 FP-POS positions and iterative 1D flat fielding technique



COS Wavelength Calibration





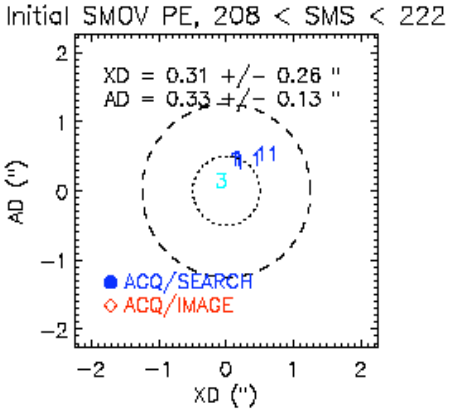
- In the process of measuring on-orbit wavelength zeropoints compared to ground calibration
- Used high-resolution STIS echelle spectra for comparison when possible
- Relative agreement between COS and STIS ~ 1 pixel (0.0010 Å)
- Absolute STIS wavelength accuracy ~ 0.5-1 pixel (0.0056 Å)

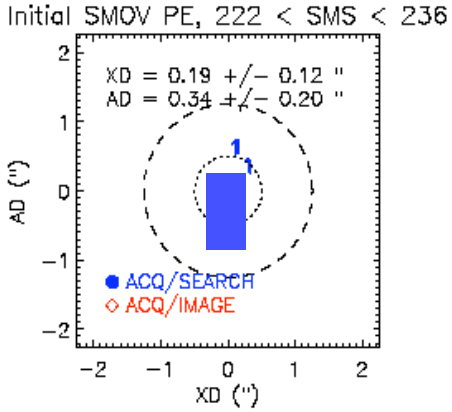
COS Target Acquisition (TA)

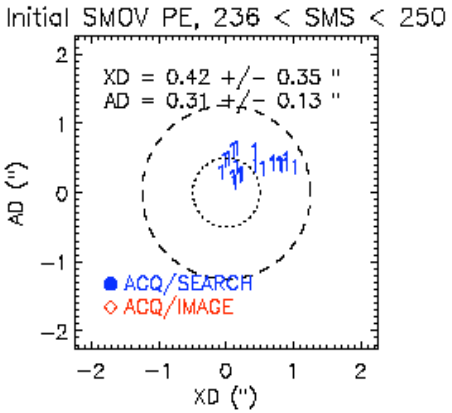
- COS only spectrograph with TA in UV
- All 3 TA methods tested and working as planned:
  - NUV imaging
  - NUV dispersed light
  - FUV dispersed light
- New recommendation of SNR=60 for TA in imaging mode with BOA

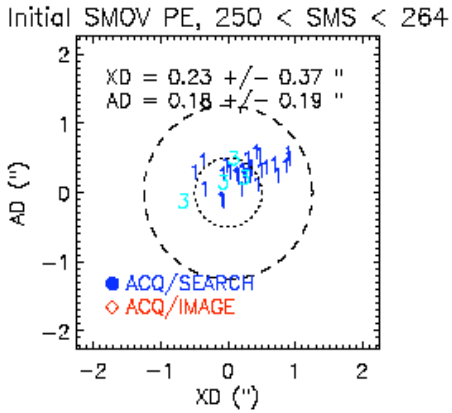
COS Blind Pointing Analysis

- Now including all centering slews in all TA sequences
- Cumulative centroid continues to be at approximately +0.3 arcsec in both along-dispersion (AD) and cross-dispersion (XD) directions; sigma ~0.4 arcsec in both coordinates
- No clear indication of time evolution of centroid









COS Cycle 17 Calibration Plan

- Already includes calibration monitoring programs for:
  - Dark rates
  - Throughputs
  - Internal/external wavelength scale
- Supplemental programs with special calibrations following SMOV to be defined for Jan 2009; these may include:
  - Characterization of FUV G140L segment B sensitivity (900-1150 Å)
  - Focus checks
  - Semi-annual NUV grating efficiency test
  - Additional FUV flat field data

COS Cycle 18 User Support

- Major revision of COS IHB with updates from SMOV analysis results; to be published in Jan 2010
- APT 18.0 updates:
  - Added G140L new central wavelength 1250 setting
  - (new setting avoids zero-order light of 1230 at FP-POS=4)
  - Made G140L central wavelength 1230 setting engineering only
  - Made FP-POS = AUTO engineering only (to avoid confusion between total exposure time and single exposure buffer time)
- ETC 18.0 updates:
  - New sensitivities
  - New wavelength ranges
  - Support of FUV G140L 1230 Segment B (still in the work)