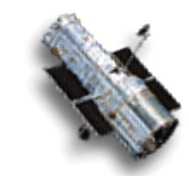
COS + STIS Update

Cristina Oliveira

COS/FUV Wavelength Calibration



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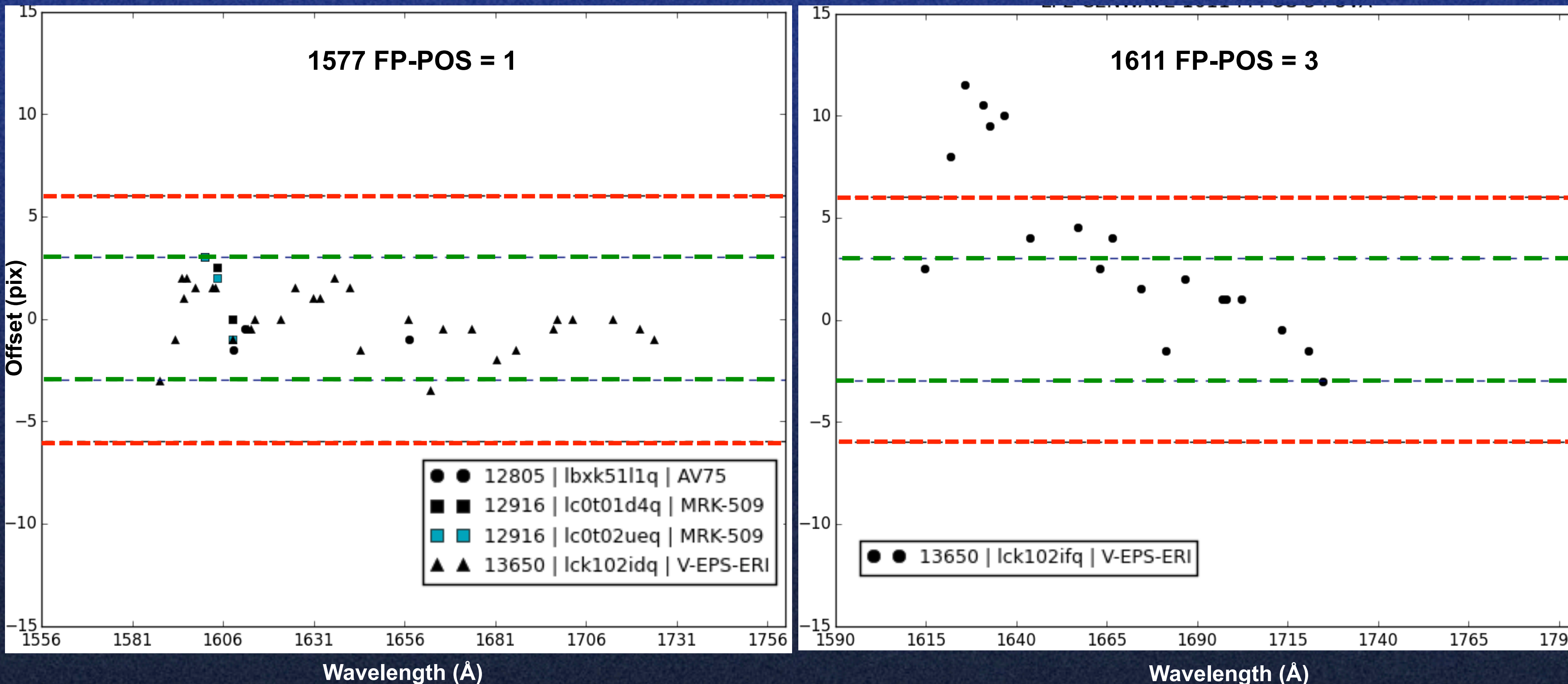
Cross-Correlation Offsets
G160M LP2 - FUVA



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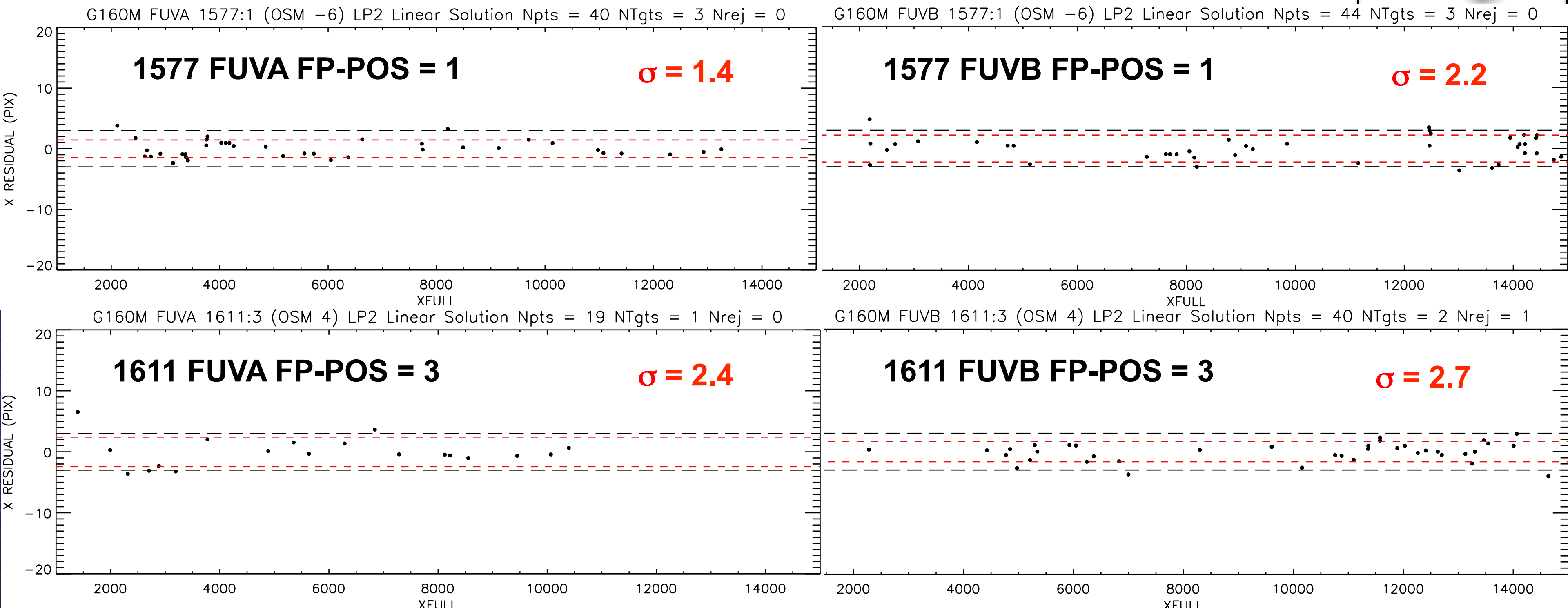
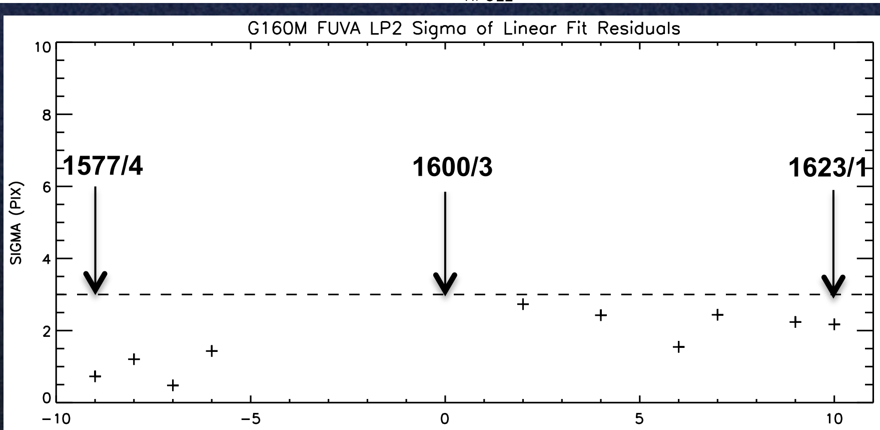
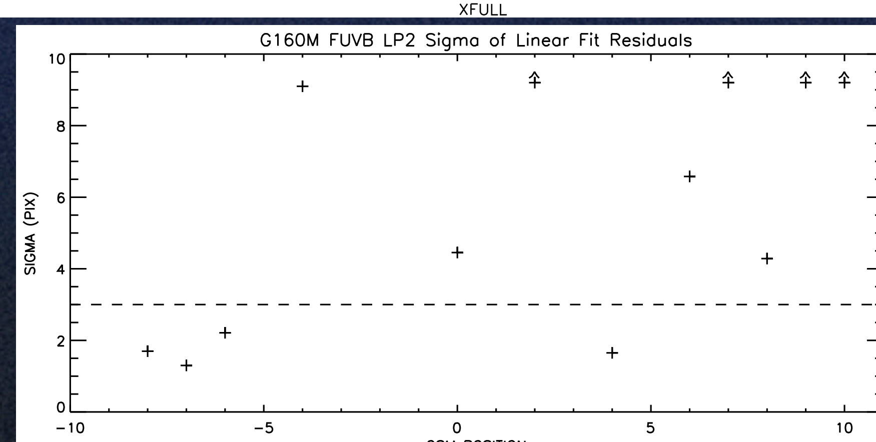
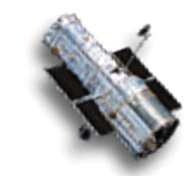
Preliminary Dispersion Solutions G160M/LP2

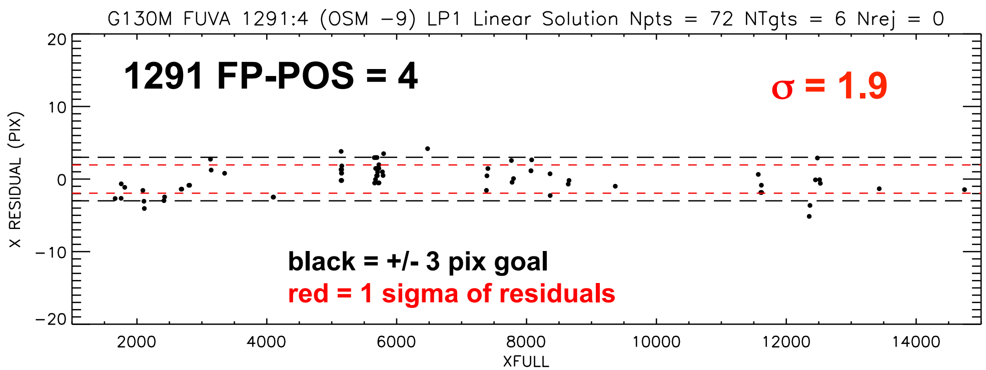


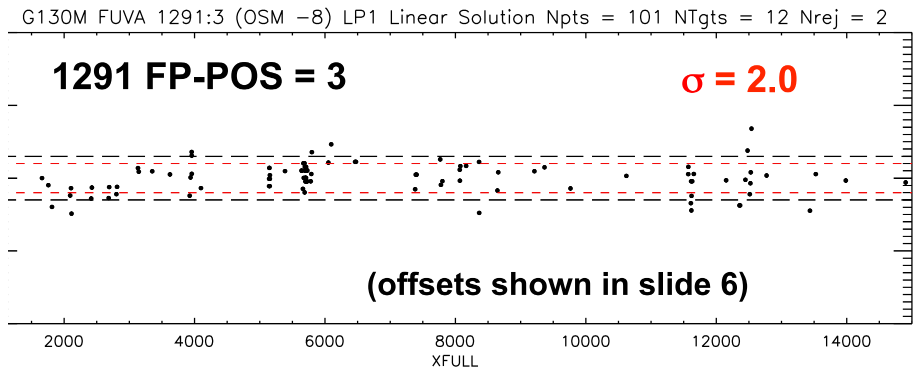


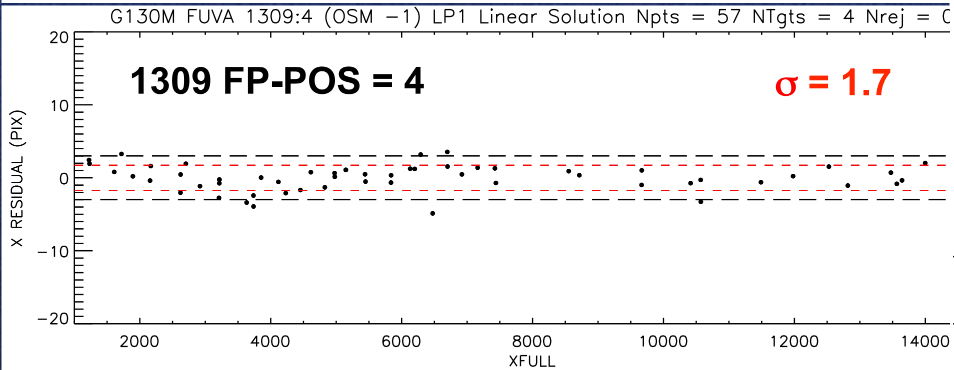


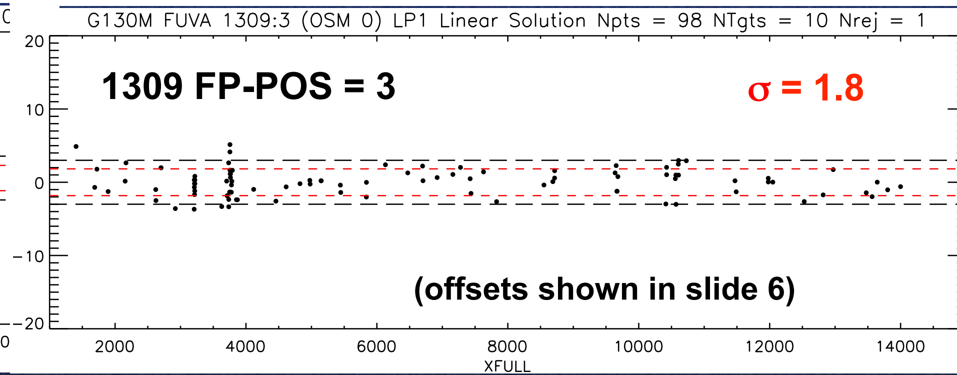
Preliminary Dispersion Solutions G130M/FUVA/LP1

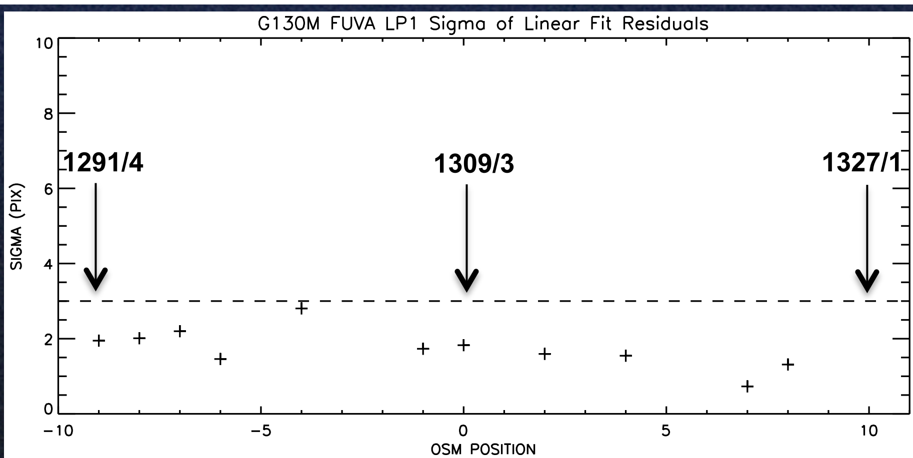


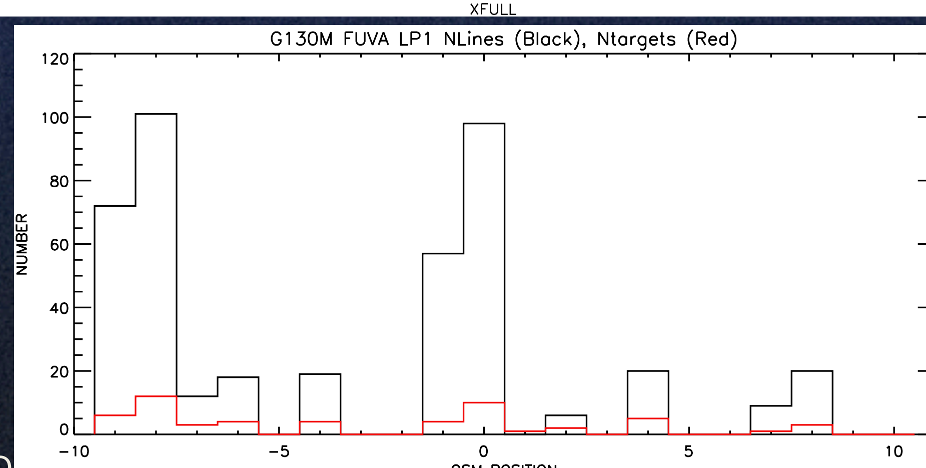




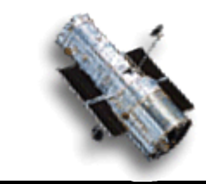








Detector Walk



- Detector walk is the dependence of the calculated photon position on the pulse height (see e.g. Sahnow et al., 2011, SPIE proceedings, Vol 8859)
- Affects both the dispersion (x-walk) and cross-dispersion (y-walk) directions
- Figures in next slide are “interesting” examples of x-walk in the COS/FUV detector
  - x-walk is worse in some localized areas
- COS pipeline
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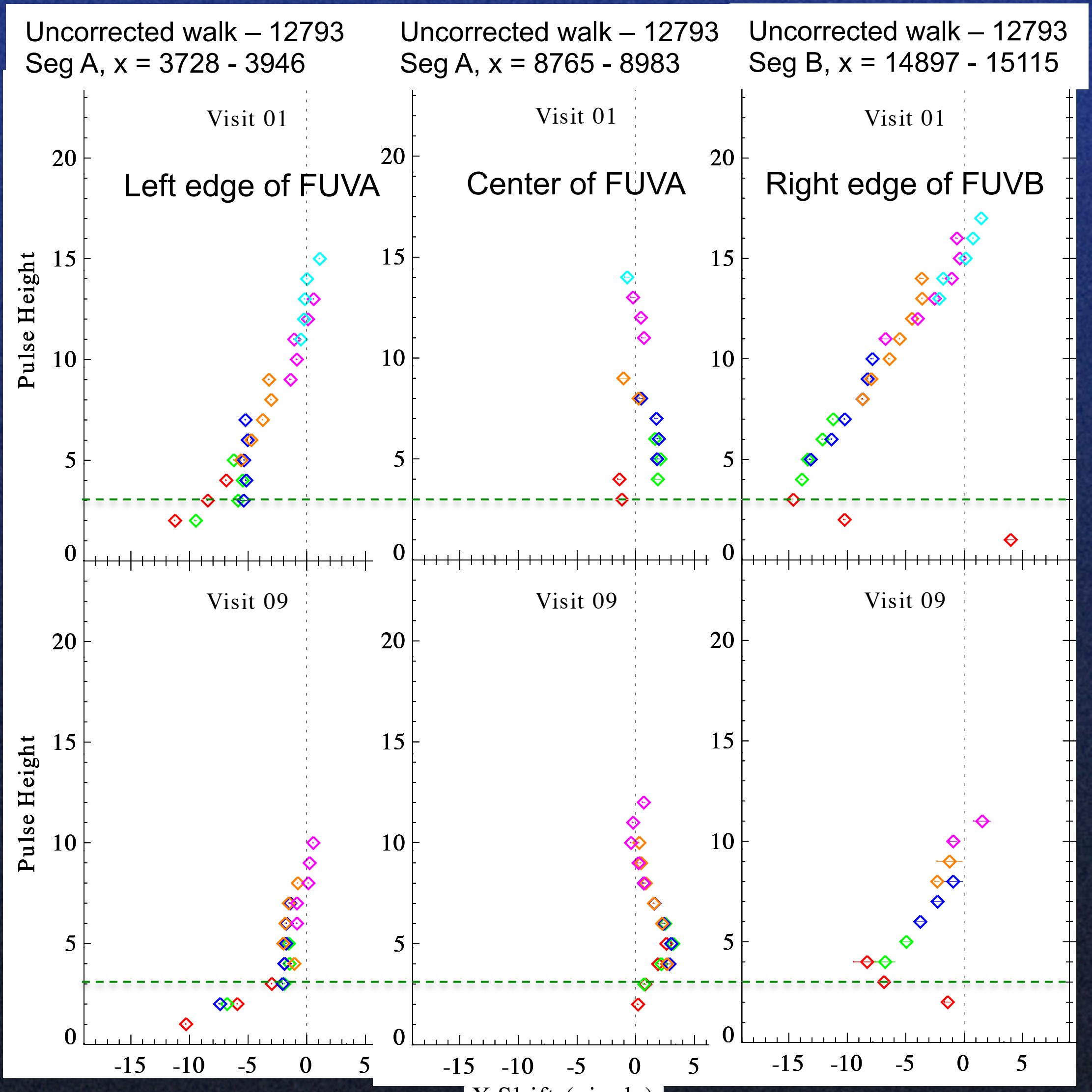
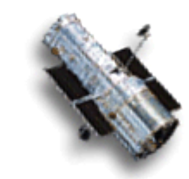
Walk Correction



- Analyzing lamp data taken at different HV to evaluate x- and y-walk
  - Want to determine how the registration of events on the detector varies depending on the PHA
  - Affects both the dispersion (x) and cross-dispersion directions (y)
  - COS pipeline contains currently a y-walk correction only, that will be revisited in this work. Higher priority is to tackle the x-walk
  - x-walk varies in detector and in some areas can be up to ~6 pix, over the PHA range used in normal operations (PHA > 3, marked by green dashed line)
  - Edges of the detector are worse

Updating Dispersion Solutions Ongoing Work



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- Identify datasets where TA uncertainty is minimal and use those datasets to derive zero-point of wavelength solution

- Use AGN dataset compiled by B. Wakker and C. Danforth in addition to other datasets to test new dispersion solutions
  - Current wavelength dispersion reference file can support up to n=3 polynomial
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- Investigate if difference between LP1 and LP2 dispersion coefficients is significant – both with models and from data

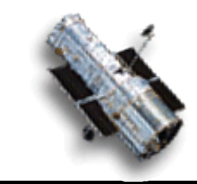
- Explore ray-trace models and see if can explain discrepancy between models and new coefficients by adjusting the focus in the models
  - If so, might be able to use ray-trace models coefficients for settings for which we have no overlapping COS + STIS data

- Release updated dispersion coefficients for most used settings in early 2016 and full set by ~ Summer 2016

- To improve dispersion solutions beyond +/- 3 pix (and to that level in some localized regions) will need to improve x-walk and geometric distortion corrections

BACK-UP SLIDES

COS/FUV Wavelength Calibration



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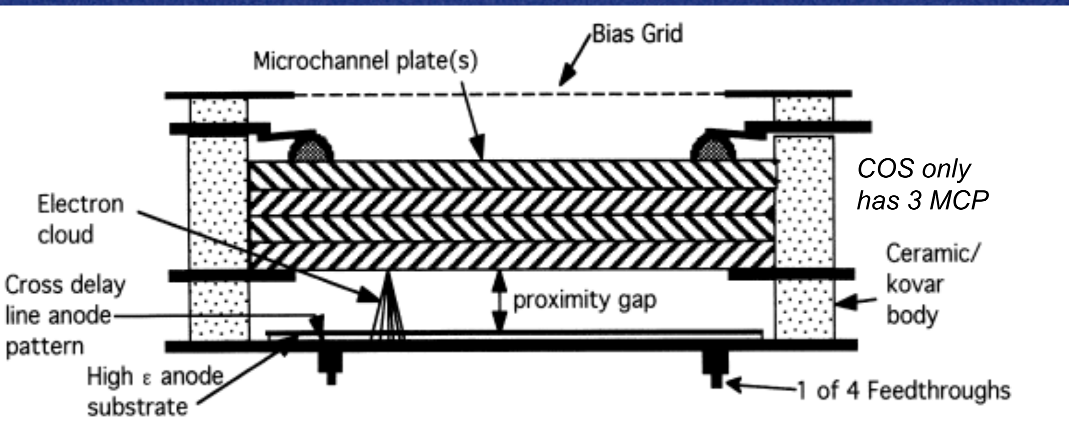
COS/FUV Detector

COS/FUV detectors are analog – signal is digitized at the end. No physical pixels.



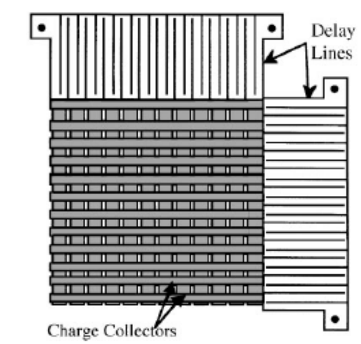
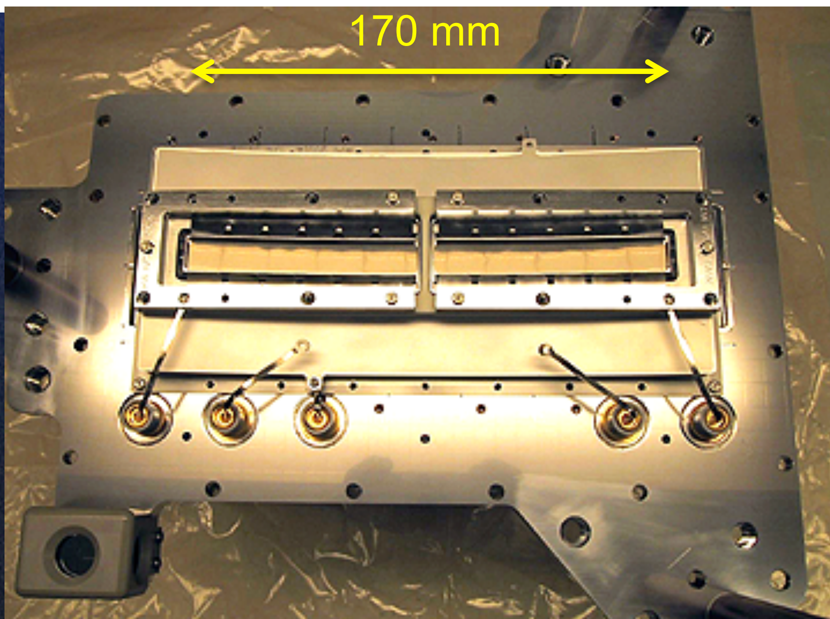
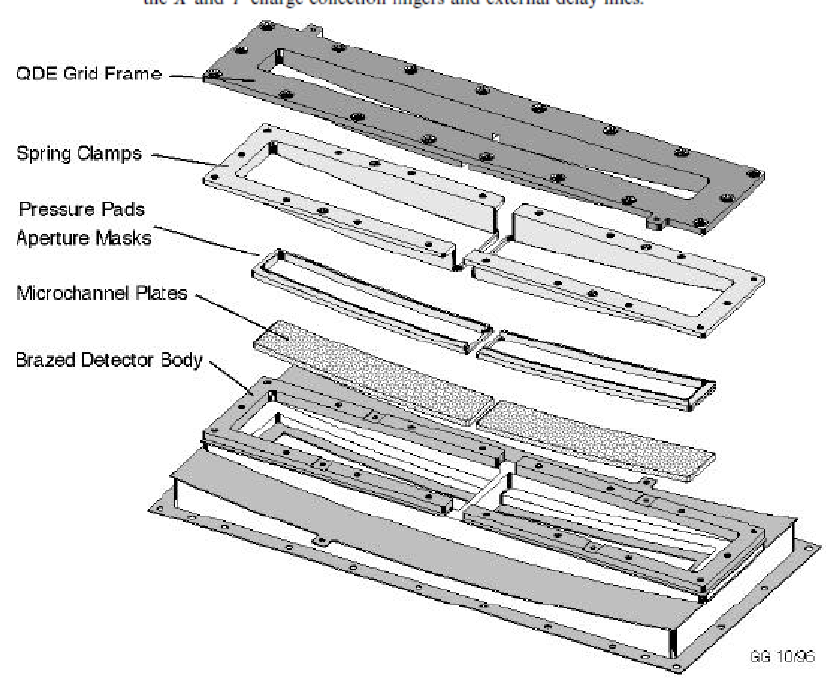
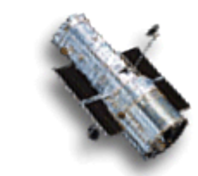


Fig. 2. Schematic view of a crossed delay anode design showing the X and Y charge collection fingers and external delay lines.





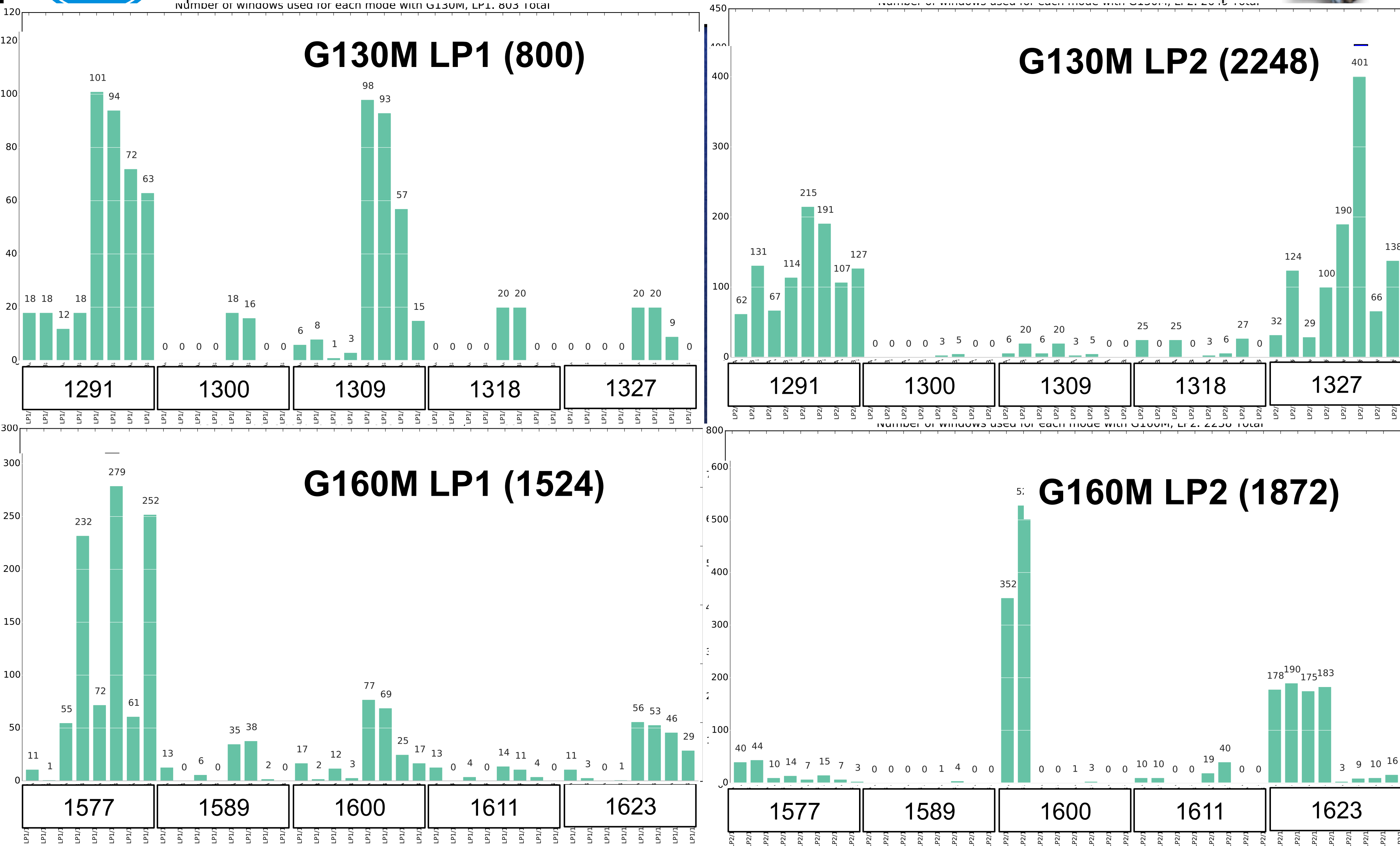
COS/FUV Wavelength Calibration: Using STIS as Reference



- Effort is focused on improving the G130M and G160M dispersion solutions
  - These are the gratings used by most of the people that need an improved λ solution
  - Current dispersion solutions used by CalCOS are linear, we are investigating linear and quadratic fits

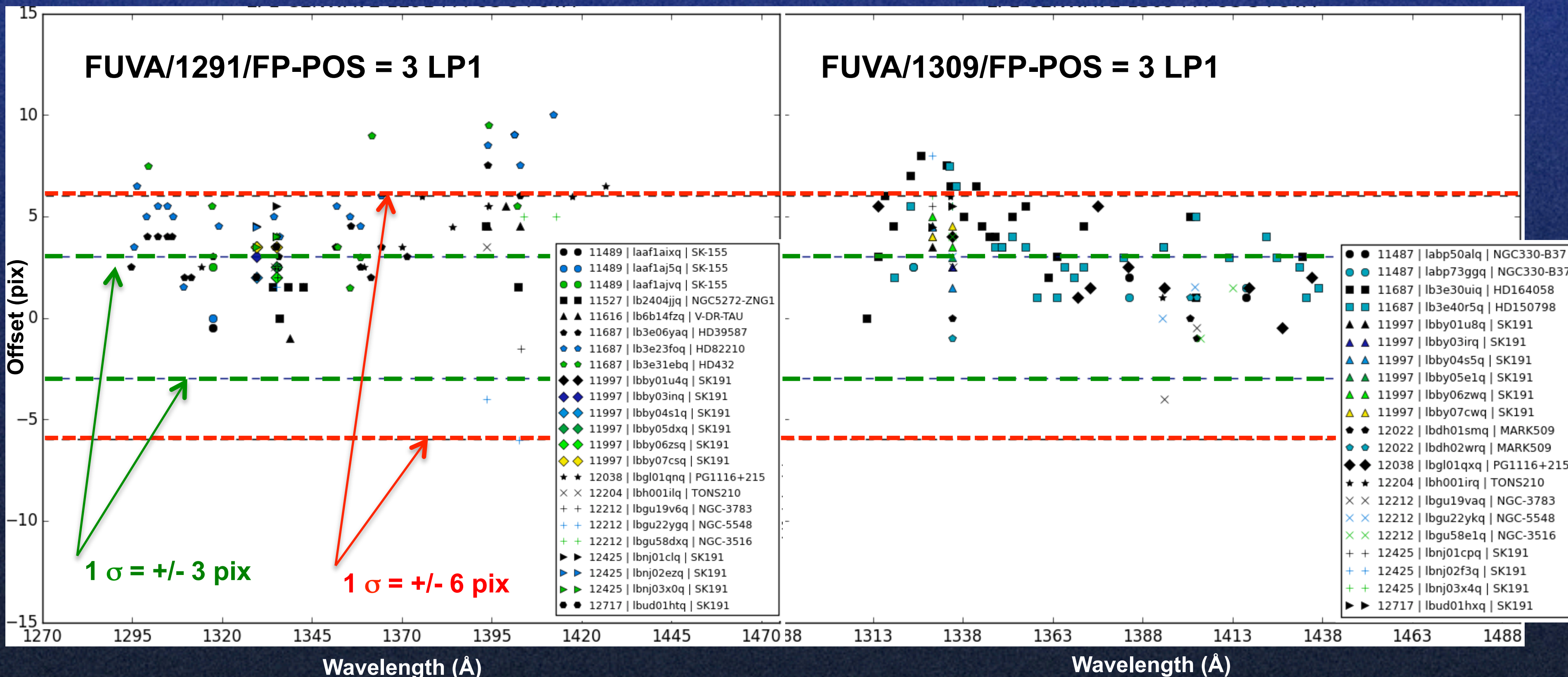
- Have 25 targets that have COS (G130M, G160M) and STIS (E140H, E140M, E230H, E230M) data
  - STIS wavelength accuracy is at least 0.5 km/s (H gratings) and 1.5 km/s (M gratings)
  - For each target, wavelength windows with emission/absorption features were carefully selected, with the goal of maximizing wavelength coverage, while avoiding variable stellar wind lines and regions of airglow in the COS/FUV data (~640 unique windows)
  - For which window, the COS and STIS data are cross-correlated so that a shift can be determined (~7300 COS windows used)
  - Lines at the edge of detector are discarded, and DQ values are taken into account
  - Lifetime positions (LP), cenwaves, and FP-POS are being kept separate at this point
  - For some targets the TA strategy might not be optimal for this purpose – zero point of the wavelength scale will be affected, but valuable information can still be extracted from the data
    - Targets with best-centering TA will be used to bootstrap settings where zero-point might not be accurate, can be expanded to targets without STIS data

Distribution of Cross-Correlation Windows per Setting



order of histogram is A/1, B/1, A/2, B/2, left to right.

Cross-Correlation Offsets



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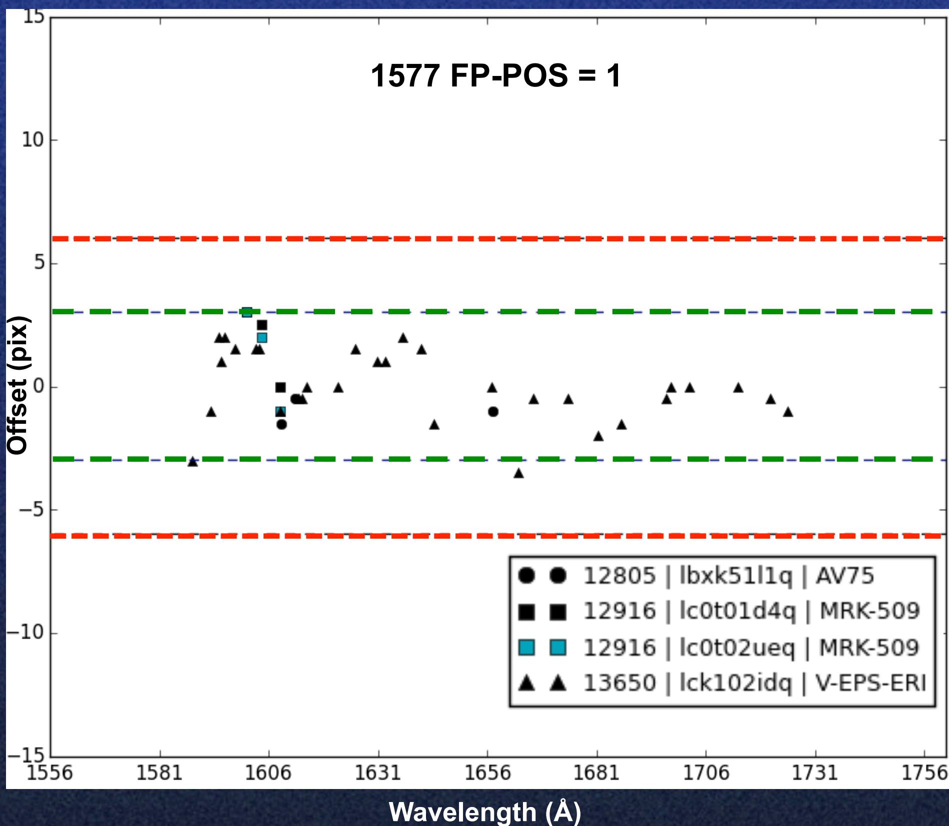

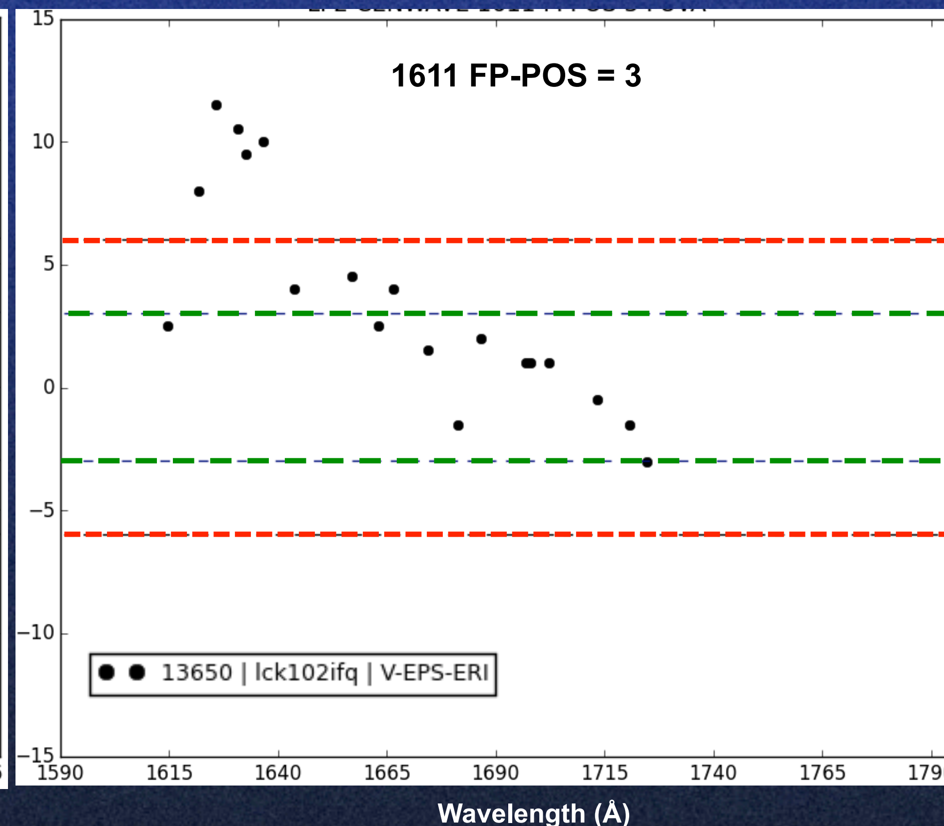

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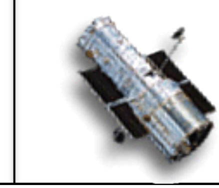

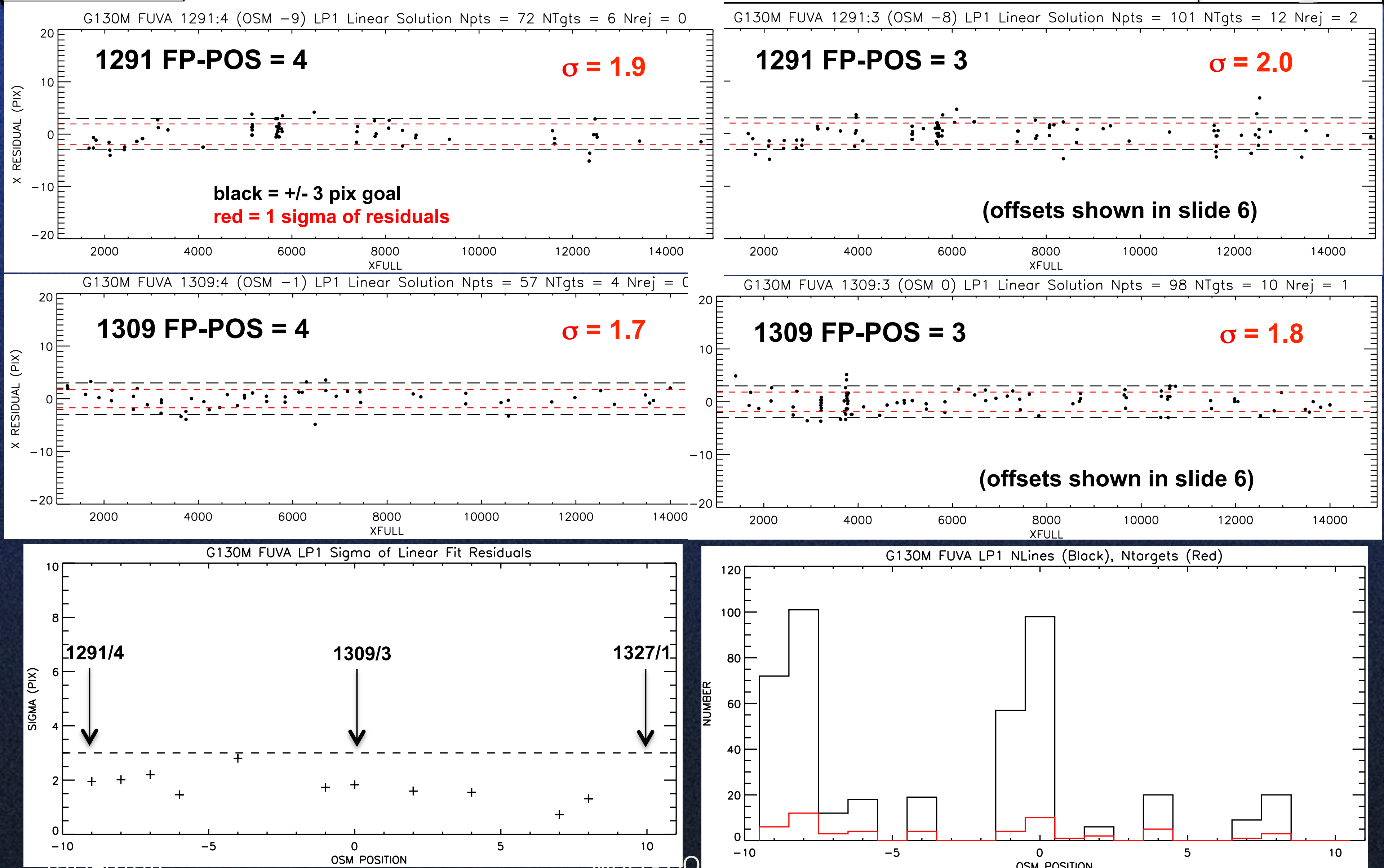

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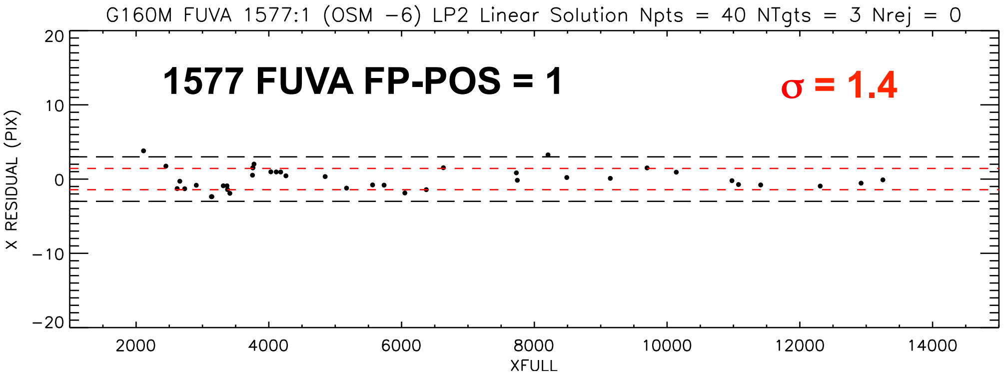
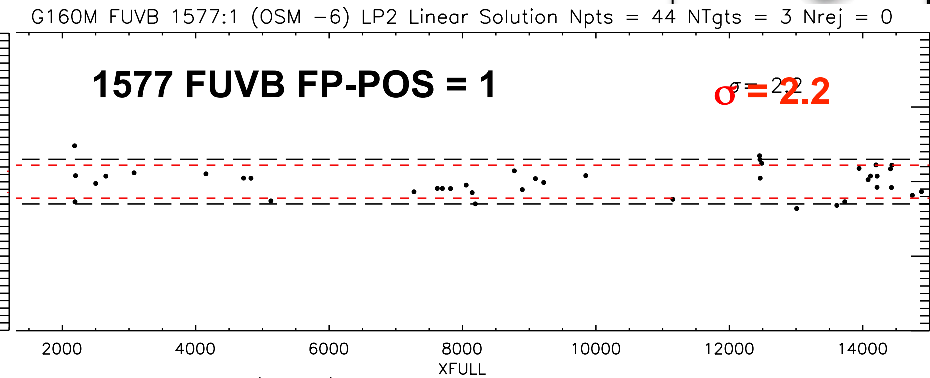
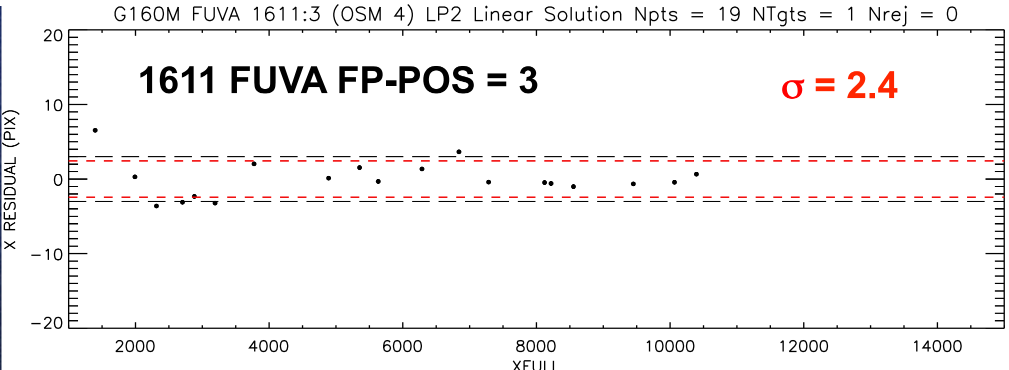
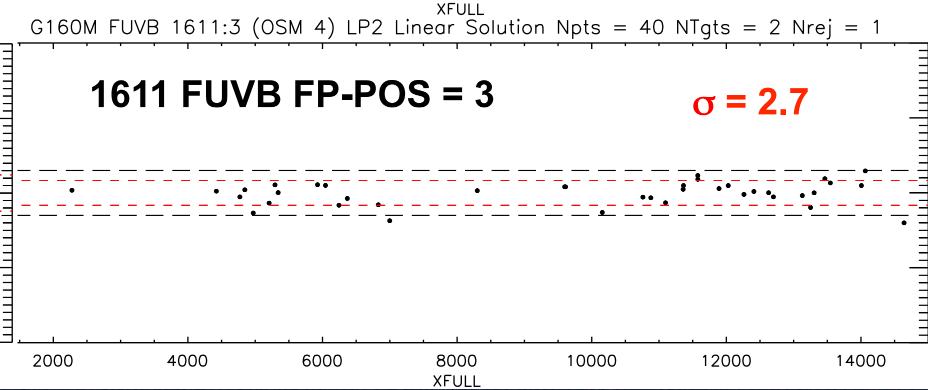
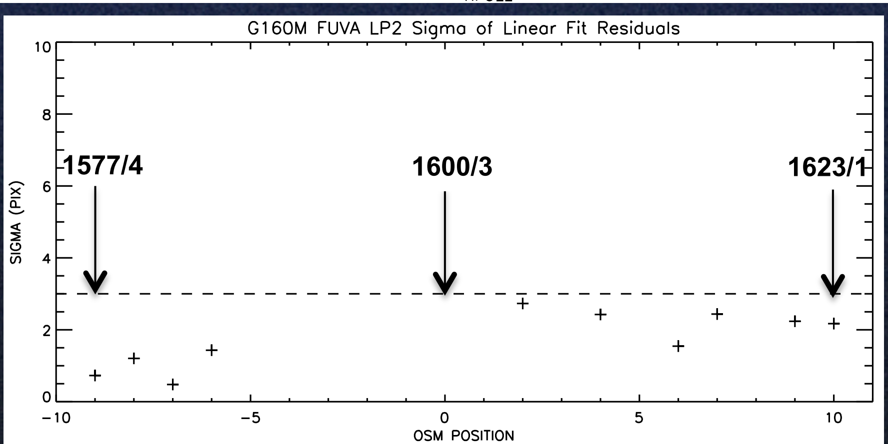
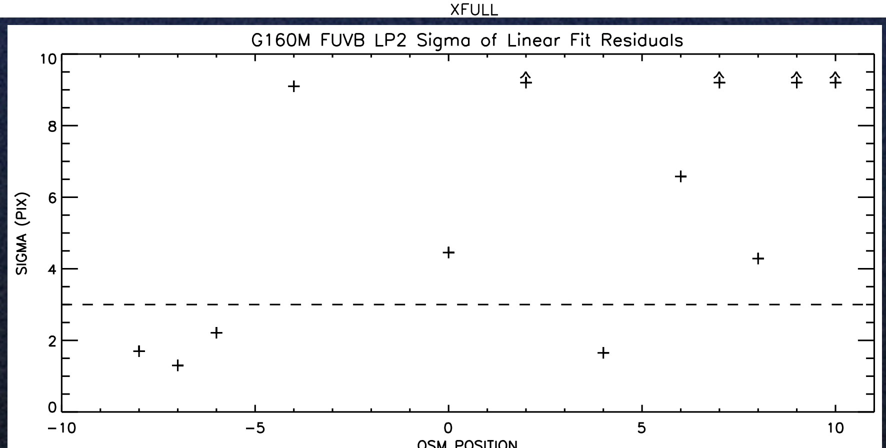




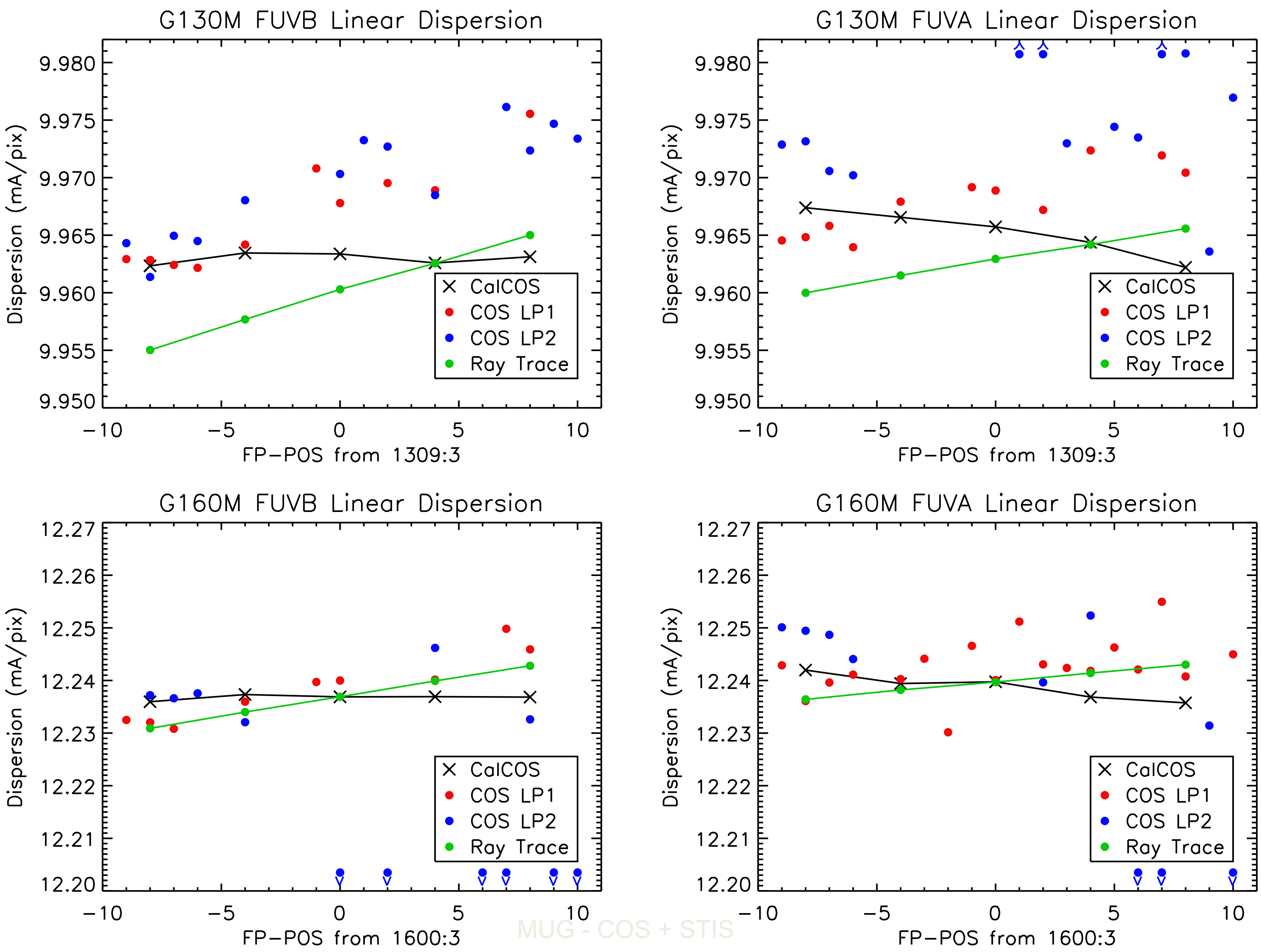




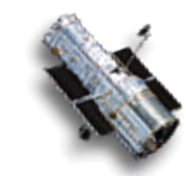


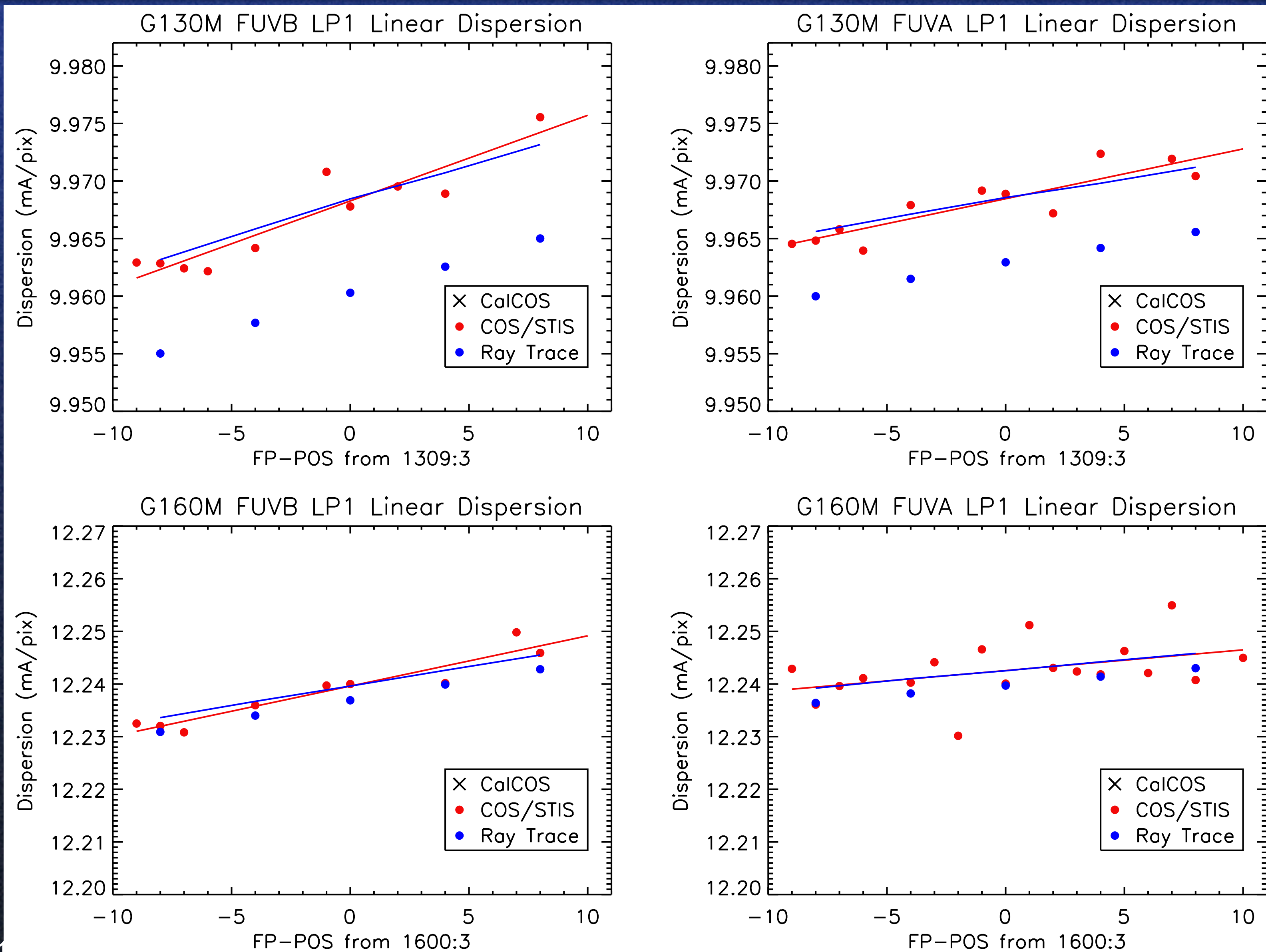


What about Ray Trace Models?



Matching COS/STIS Results and Ray Trace Models





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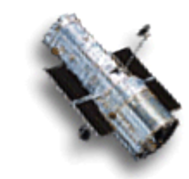

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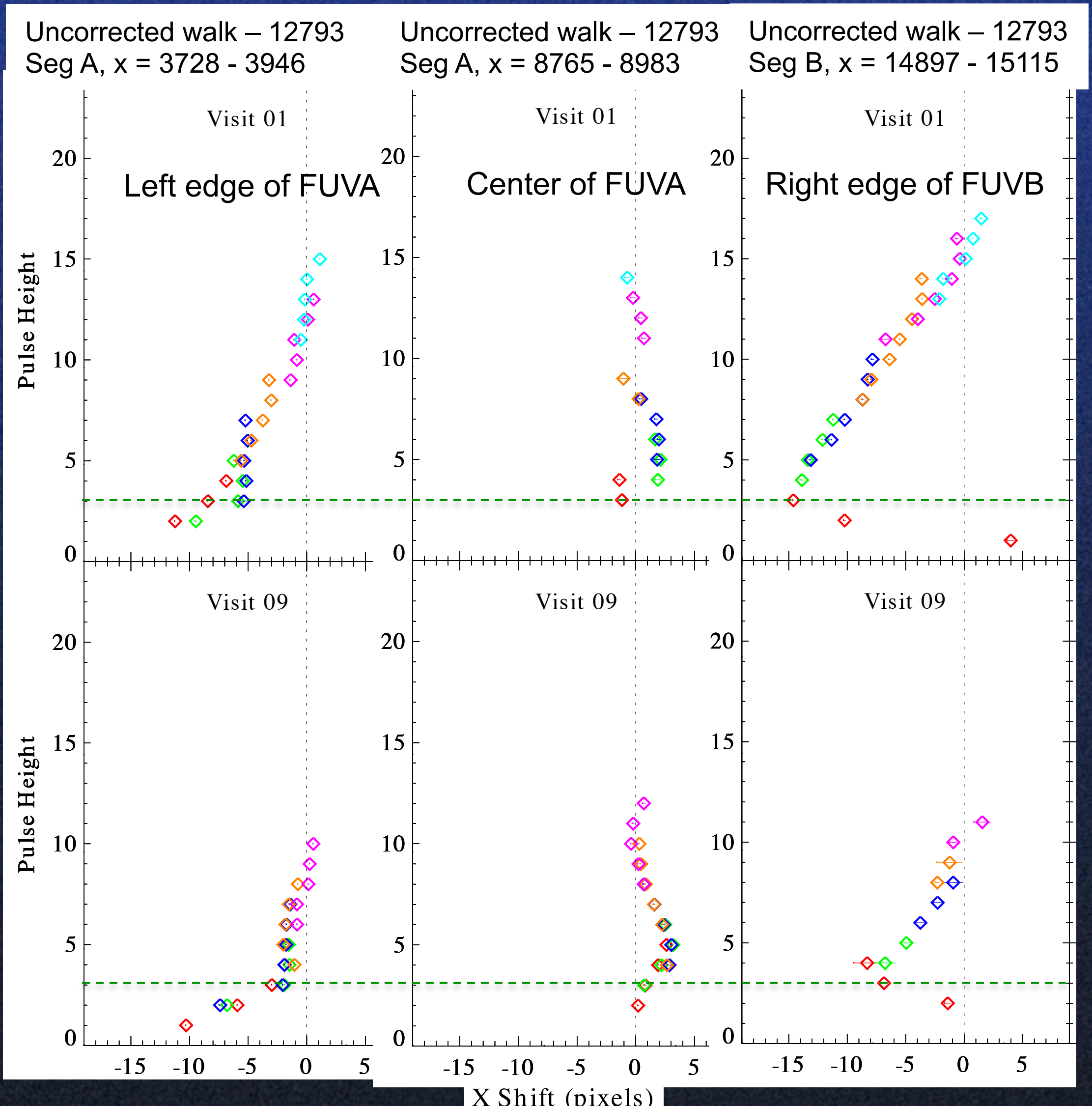
Walk Correction



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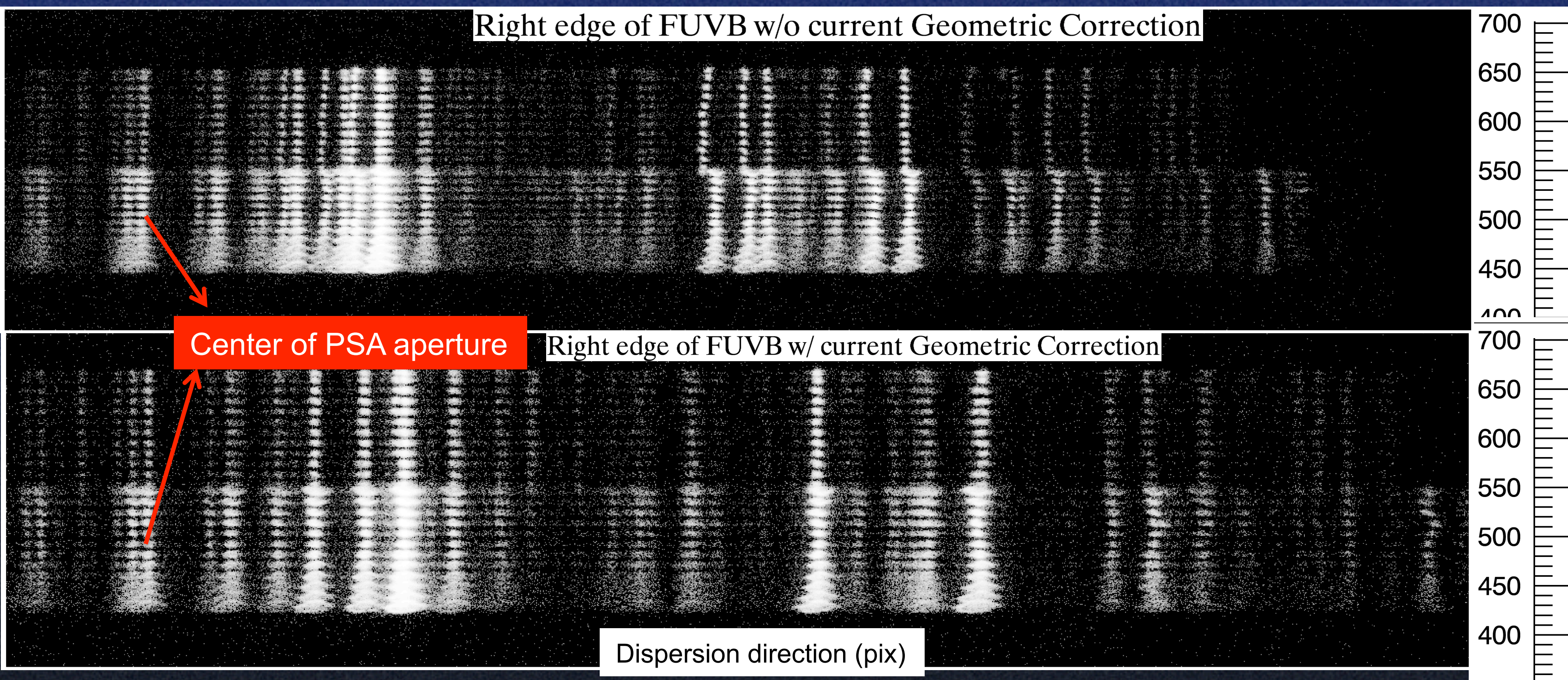
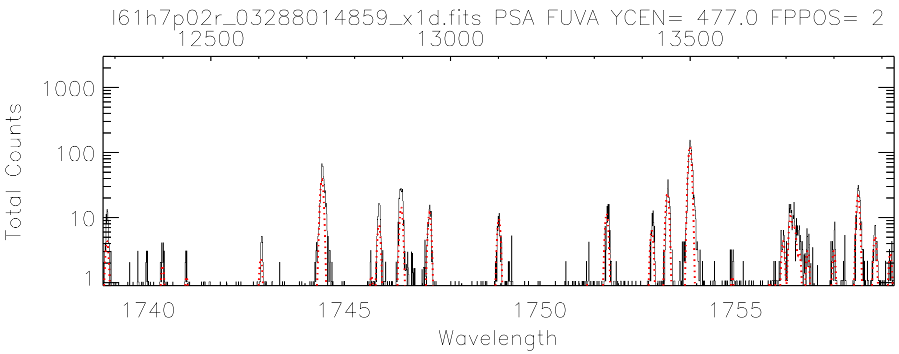
  - Edges of the detector are worse

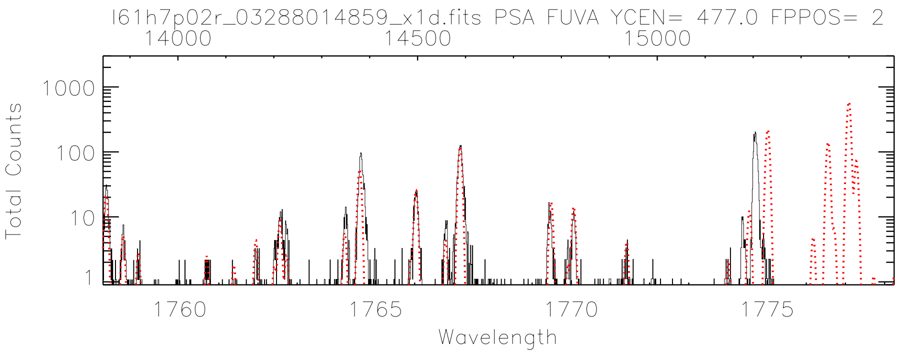
Geometric Distortion Correction

- Have processed through CalCOS the TV03 data used to determine geometric distortion correction to assess how well it does
  - Have a lamp line every 30 to ~ 200 pixels, so can only probe on those scales
  - Determined that 87% of the lines are within 3 pix of expected position (by fitting centroid of line)
  - Edge effects are very noticeable even in geometrically corrected data
- Figures show geometrically uncorrected (top) and corrected (bottom) data

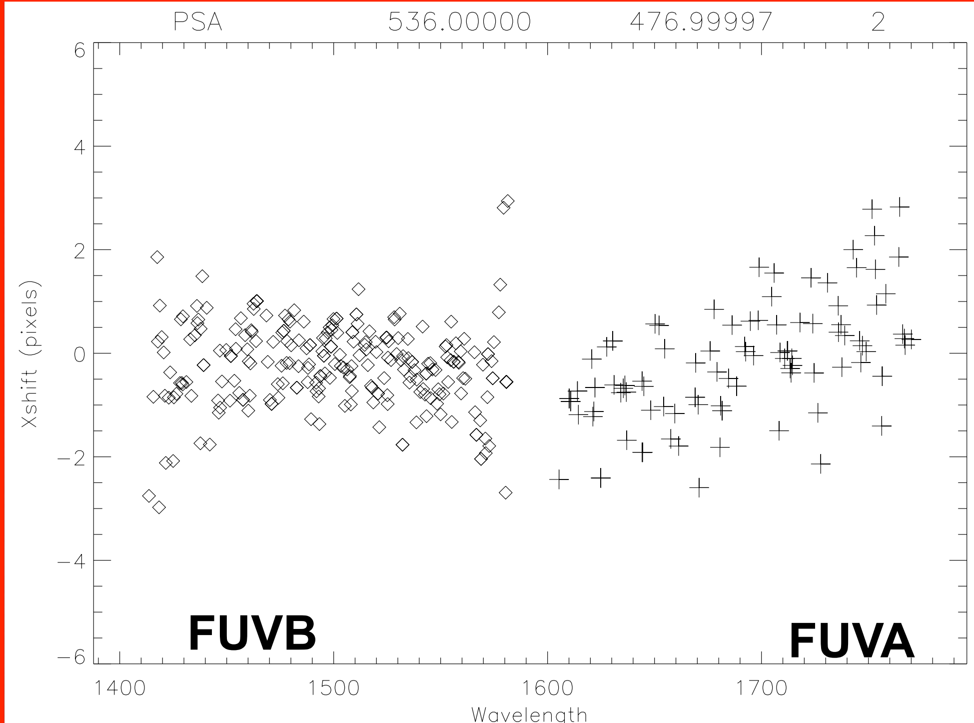


Matching NIST PtNe Line Atlas to Geometric Distortion TV03 Data





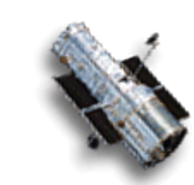
- Goal is to further improve geometric distortion correction
- NIST atlas is convolved with Gaussian LSF, line intensity is scaled to match COS
- Offsets between simulated (red line) and observed (black line) spectra are determined by cross-correlation



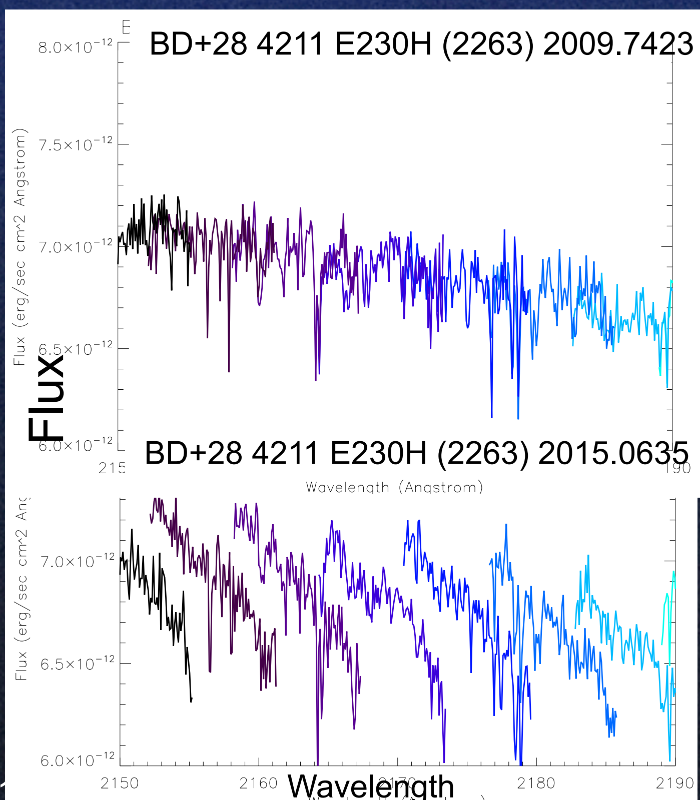
- Measured offsets shown for spectra obtained close to LP1 (TV location ~1.2” above LP1)
- Preliminary measurements indicate that most offsets are within ~ +/-2 pix

=> Geometric correction residuals not a huge factor in wavelength dispersion uncertainties

STIS Echelle Blaze Function (I)

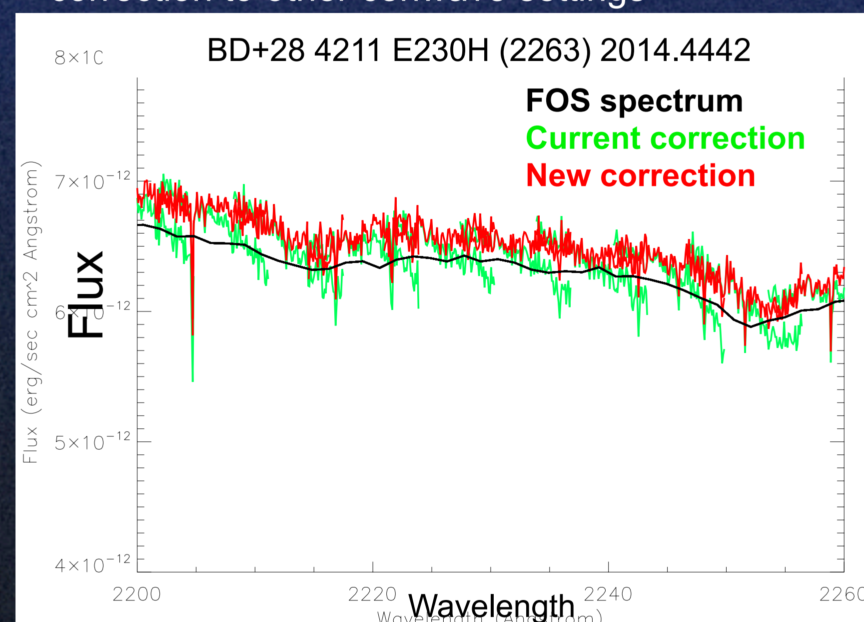


- Blaze function characterizes grating efficiency along each spectral order
  - Spatial component: due to changes in location of spectrum on detector, due to mechanism non-repeatability
  - Temporal component: due to shifts in angle of grating grooves (epoxy?, contamination?)
  - Localized flux calibration errors up to 10-15%



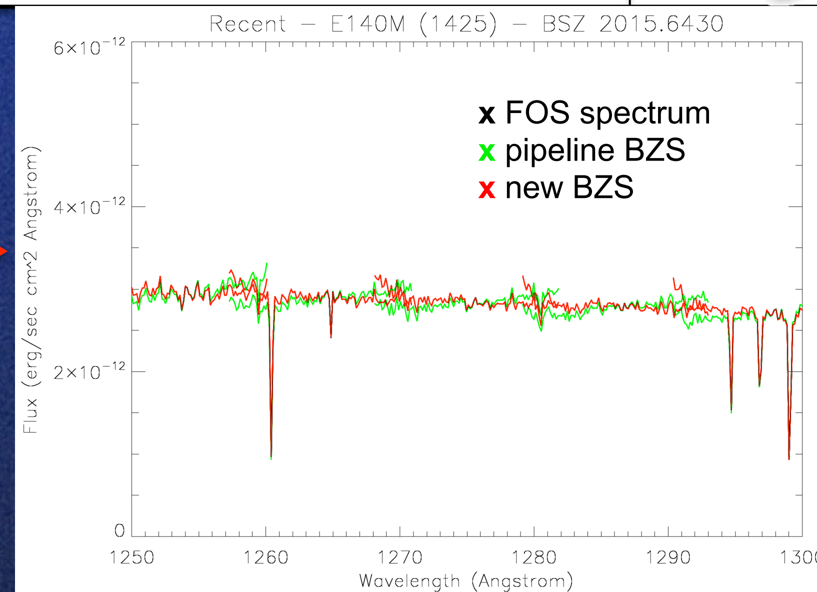
Analysis uses data from sensitivity monitoring programs:

- E140H (1416), E140M (1425), E230H (2263), and E230M (1978, 2707).
- Significant improvement has been achieved for E140H and E140M
- For E230M, the echelle blaze function shift was not as pronounced and the current version of ref. file does a good job
- For E230H, there is significant improvement for monitored 2263 setting; difficulty in extending correction to other cenwave settings

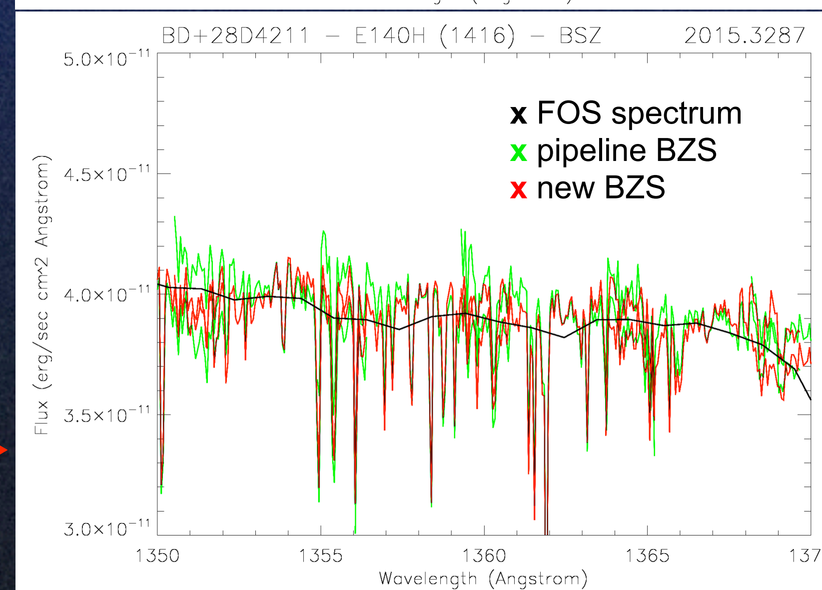


STIS Echelle Blaze Function (II)

- Preparing new pipeline reference files for E140H, E140M, and E230M
- Correction introduces some artifacts on some E140H/E140M orders, which need to be investigated prior to delivery
  - May be related to extrapolating blaze function beyond initial measurements
  - Evaluating whether reference file modifications might fix this
  - Alternatively, could flag extrapolated regions as bad, but this would require a CalSTIS code change
- After finalizing other gratings will consider a wider range of data to determine E230H corrections as a function of CENWAVE

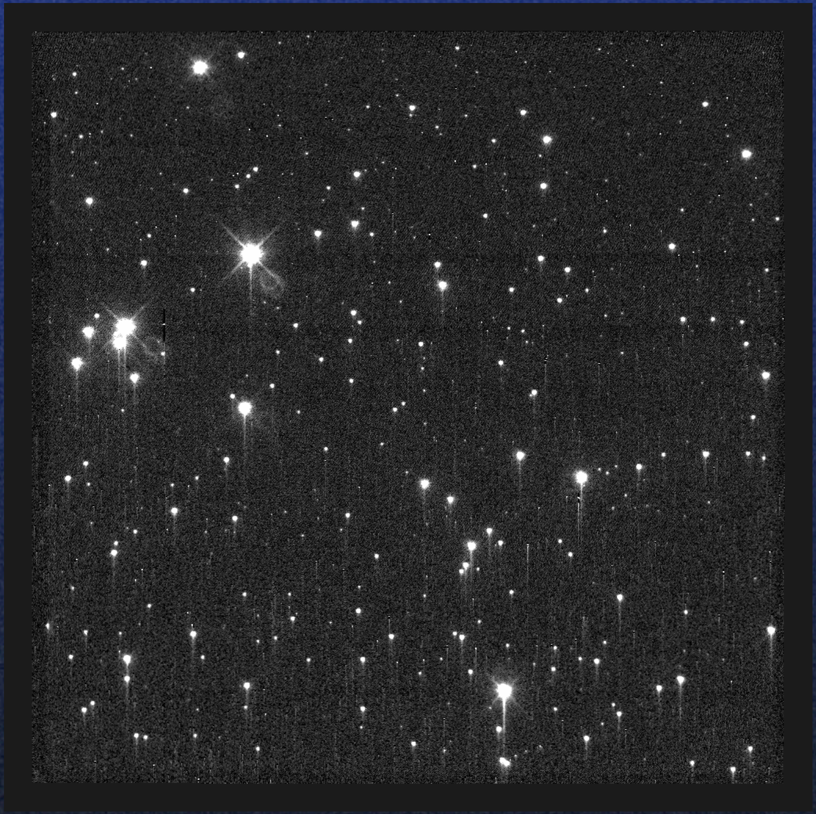


Section of E140H shows some improvement with new correction added (red curve), but significant discrepancies between orders remain



STIS CCD Pixel Based CTE Correction

- COS/STIS released new stand-alone pixel based CTE correction for STIS/CCD
  - Using scripts derived from ACS pipeline correction work
  - Tool includes correction of darks & recalibration
  - Tool and cookbook released in September 2015



http://www.stsci.edu/hst/stis/software/analyzing/scripts/pixel_based_CTI