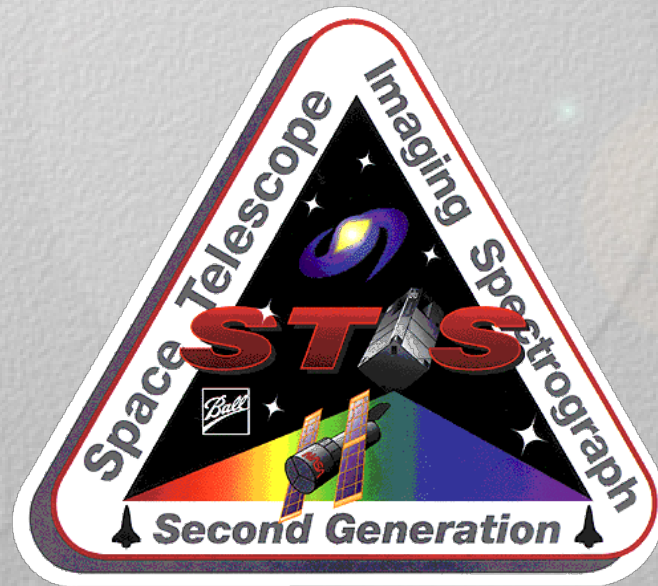


STIS 1ST Order Spectroscopic Point Source Flux Calibration

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STIS 1st Order Flux Calibration

- Overview of fundamental flux calibration
- Aperture and position dependent effects
 - ◆ Vignetting along slit
 - ◆ Aperture-grating throughput variations
 - ◆ Miscentering in the aperture
- Implementation of new corrections in CALSTIS and OTFR pipeline.



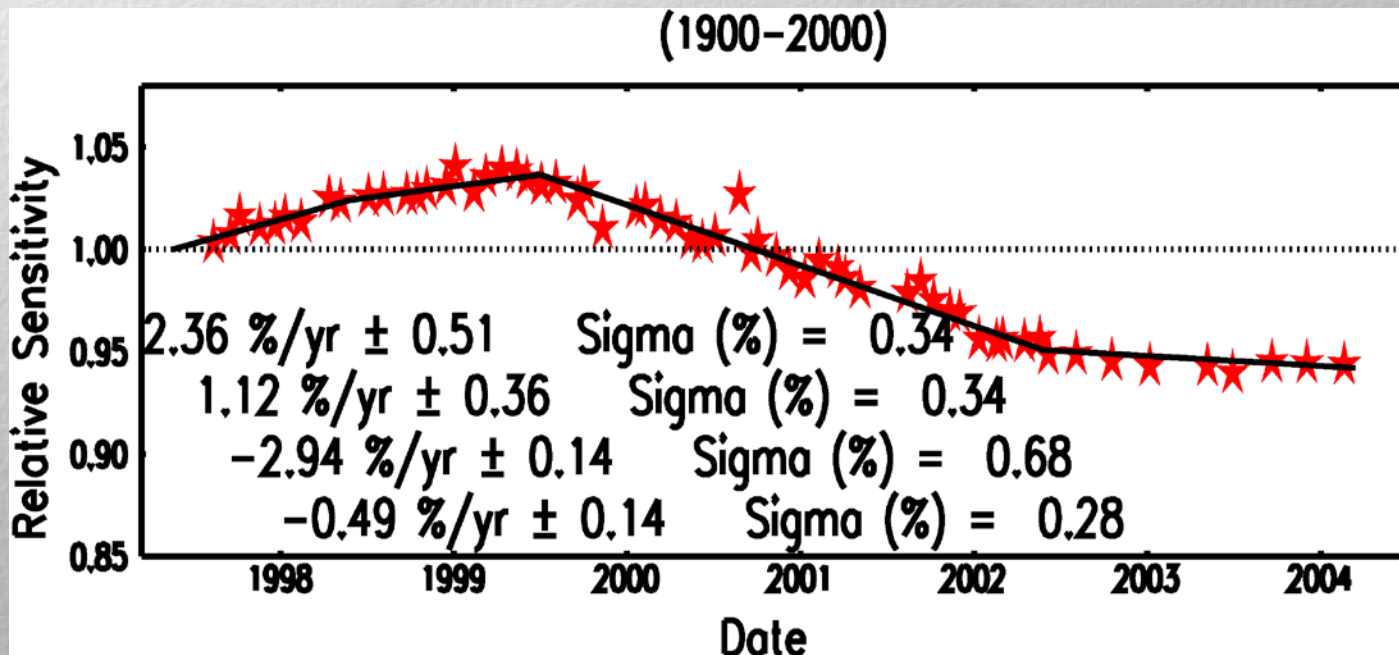
Basis of Flux Calibration

- Primary flux calibrators DA white dwarfs (Bohlin 2000, AJ 120, 437). Assume NLTE spectra calculated by Hubeny (Barstow et al. 2003, MNRAS, 344, 562)
- Primary calibration observations are L Mode with 52X2 aperture (Bohlin 2002 HST Cal Wksp, 115); Limited G*M mode data.
- **Aims for 1% - 2% accuracy for *L modes when observed with 52X2***
- Time dependent sensitivity (TDS) and charge transfer inefficiency (CTI) corrections applied.



Time Dependence of Sensitivity

- TDS monitored with secondary standards.
- Sensitivity varies with time and λ .
- Flattening of sensitivity decline in early 2002.



Sample λ bin from G230L Sensitivity Monitor



Accuracy of Flux Calibration

- Models of WD fluxes good to $\sim 1\%$
- Repeatability of STIS L modes at central 52X2 aperture position better than 1%
- Some issues with how to treat charge transfer inefficiency (CTI) at long wavelengths (typical uncertainty $\sim 1\%$, 5% for very faint sources; see following talk by Goudfrooij).
- What about other apertures & positions?



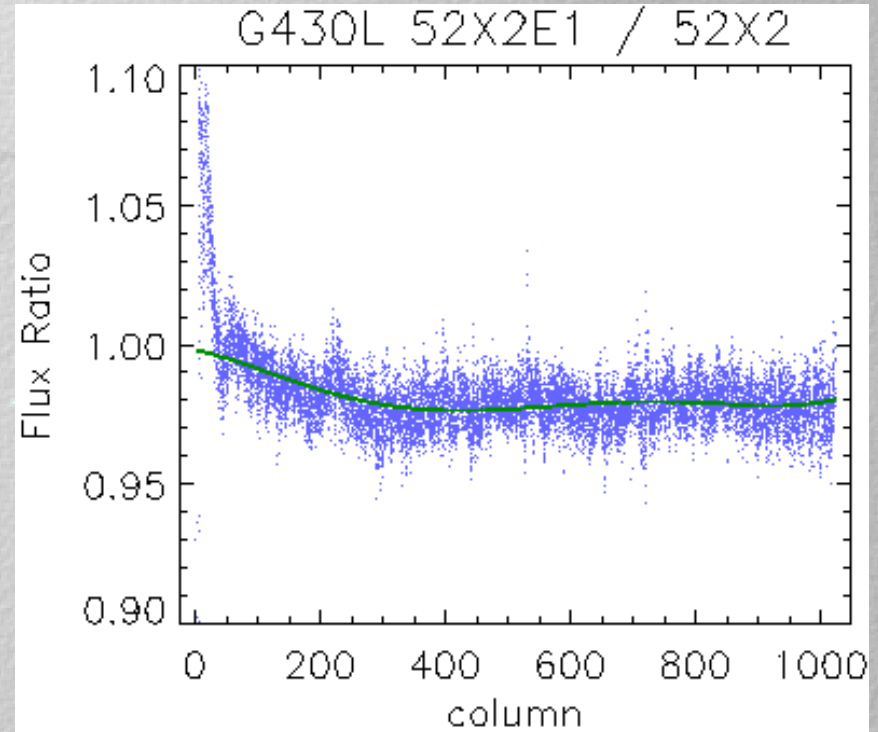
Calibration of Other Apertures

- Primary calibration done near row 512 with 52X2 aperture, but
 - ◆ Targets can be anywhere along slit.
 - ◆ For CCD E1 positions at row 900 defined to reduce CTI.
 - ◆ Aperture throughputs vs λ , aren't as simple as was assumed.
 - ◆ Breathing and mis-centering can cause flux losses for small apertures.



Sensitivity variations along slit

- After Apr 2002 CCD sensitivity monitor at both center & E1
- Other data sets dithered stars up & down slit
- Used to define LFLATs which correct flt image
- Implemented for G140L in 2002, and for G230LB, G430L, & G750L soon

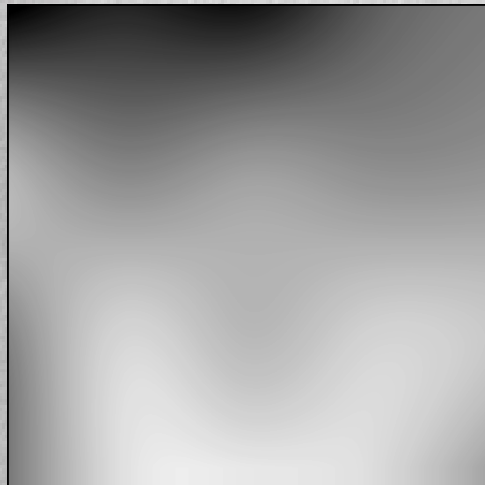
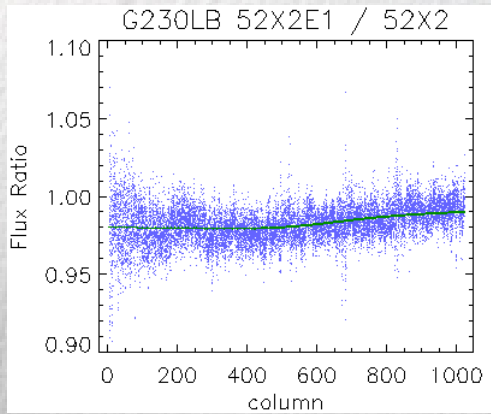




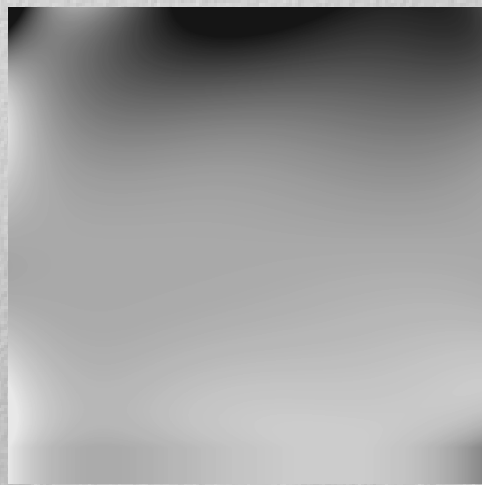
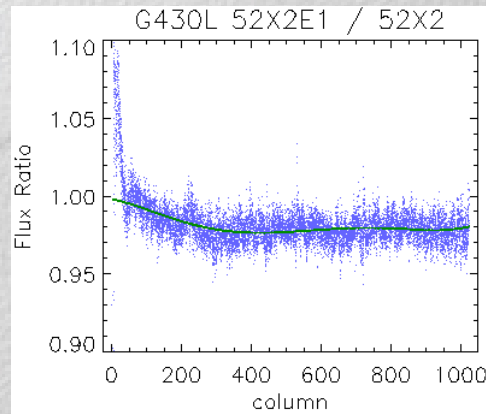
Vignetting of CCD L Modes

Sensitivity monitor data gives high S/N measure at E1

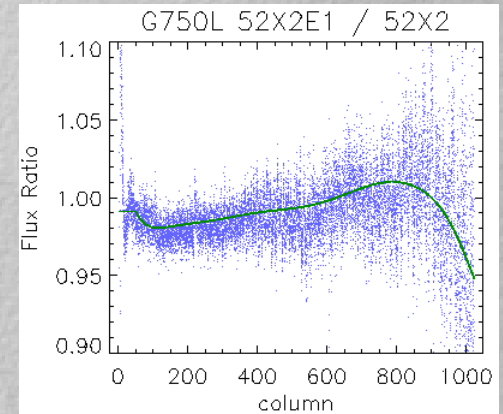
G230LB



G430L



G750L

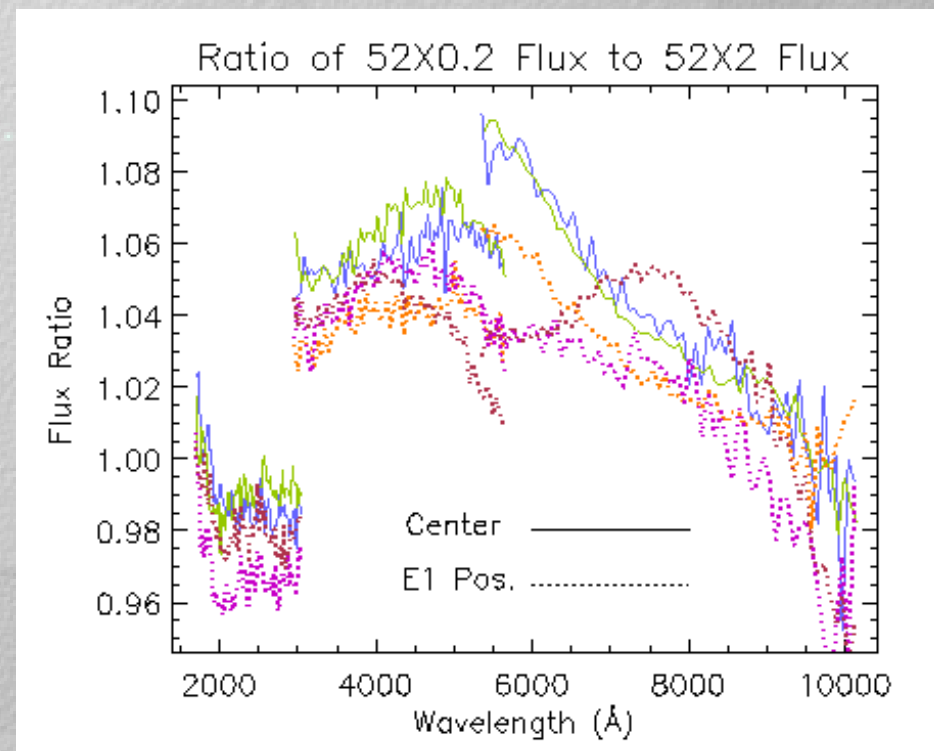


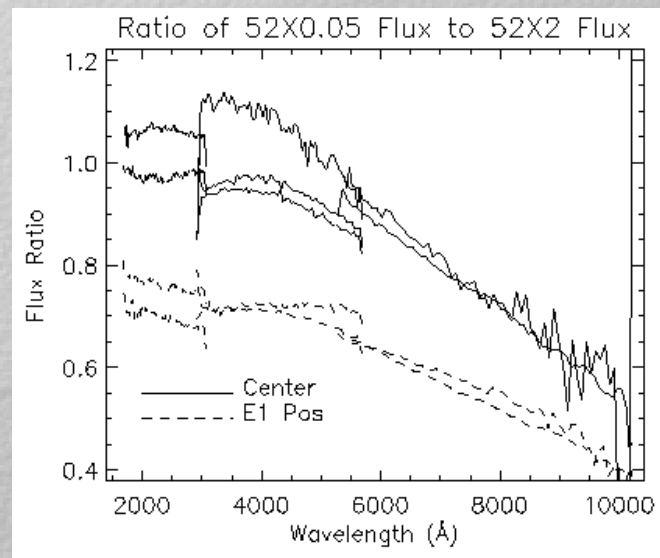
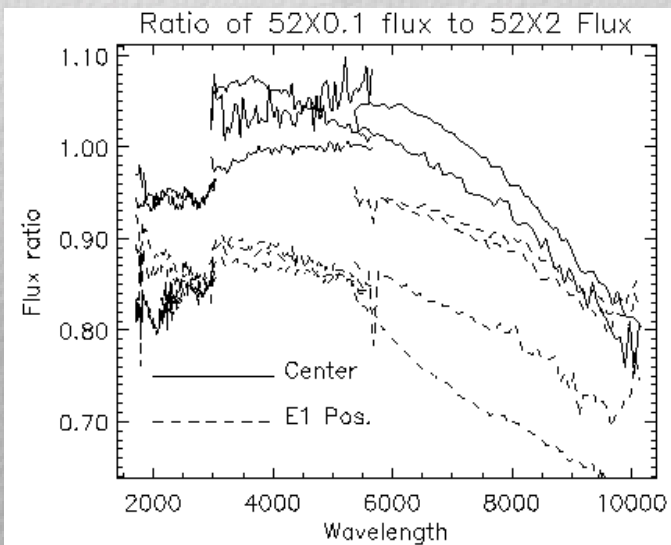
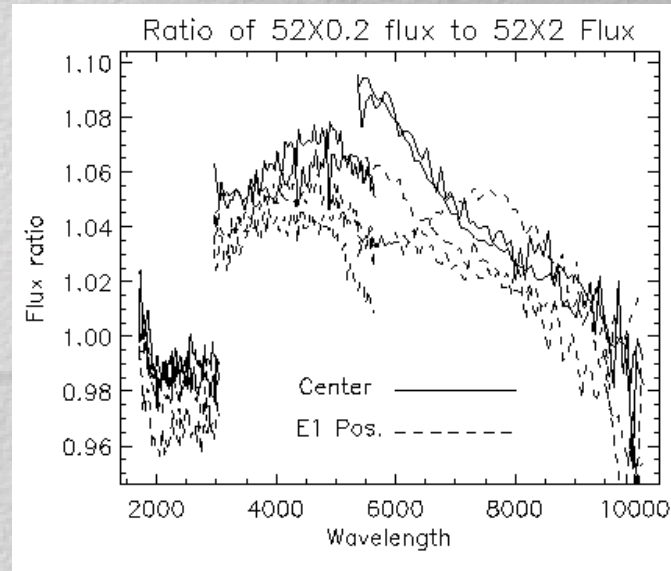
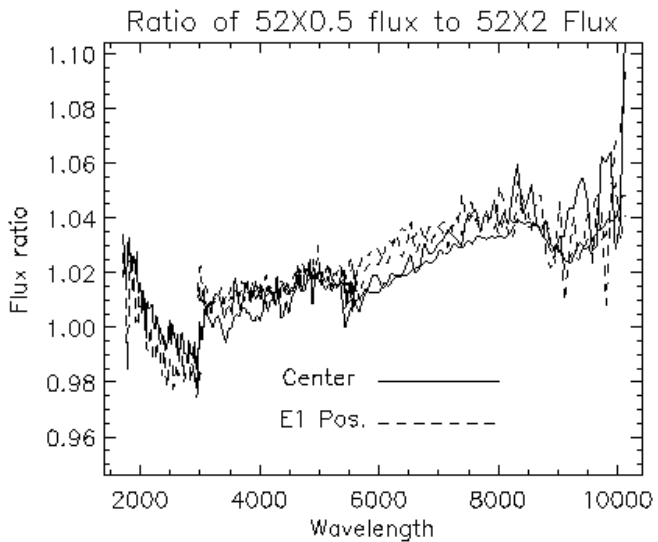


Relative Aperture Throughputs

Flux offsets in small apertures originally assumed smaller than breathing, but a more careful comparison shows ...

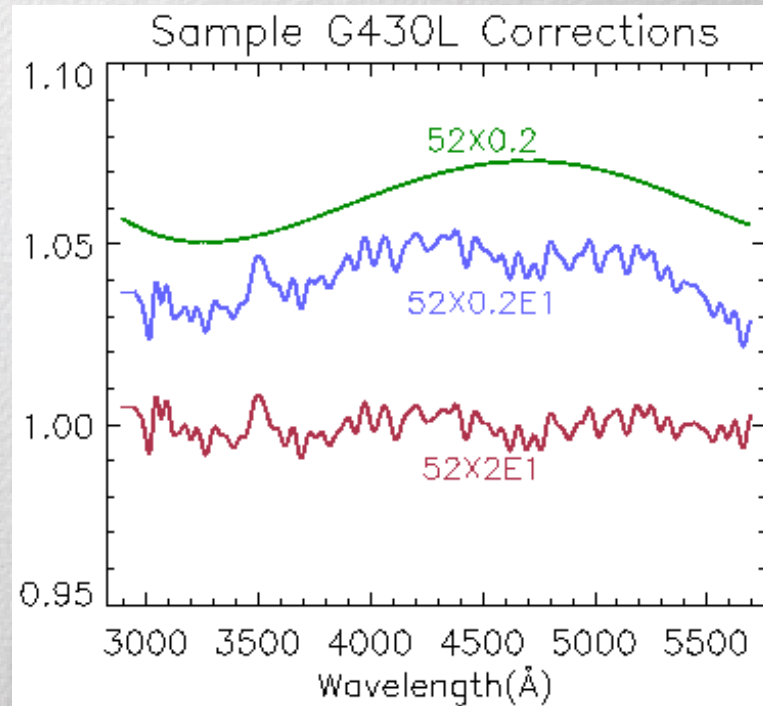
- *Flux offsets are repeatable*
- *Clear discontinuities between gratings*
- *May be related to extra G430L & G750L Lyot stops*
- *Should fix this in calibration*







Grating-Aperture Corrections

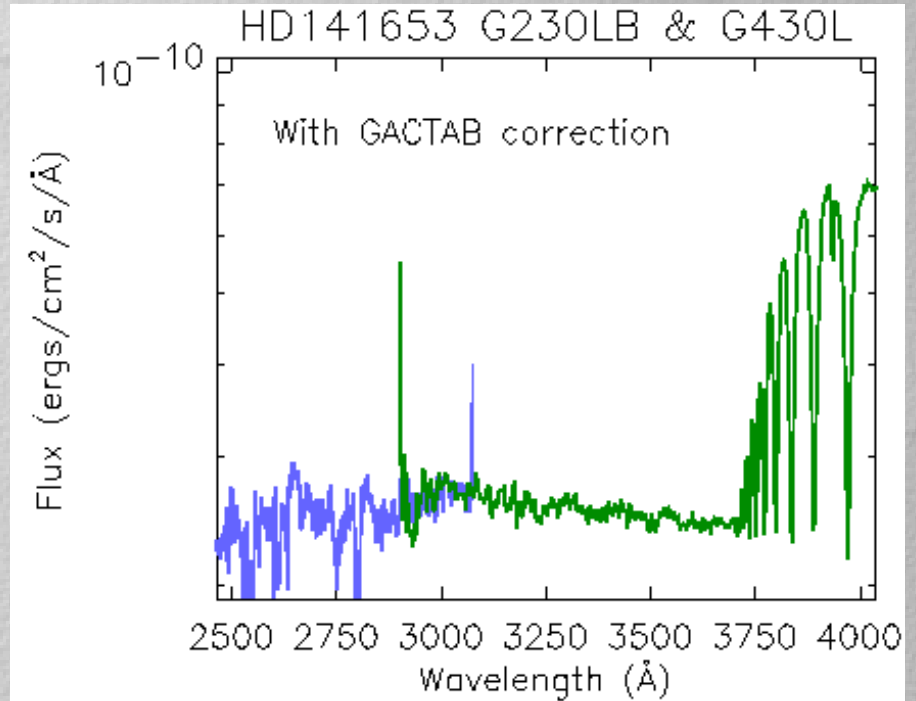
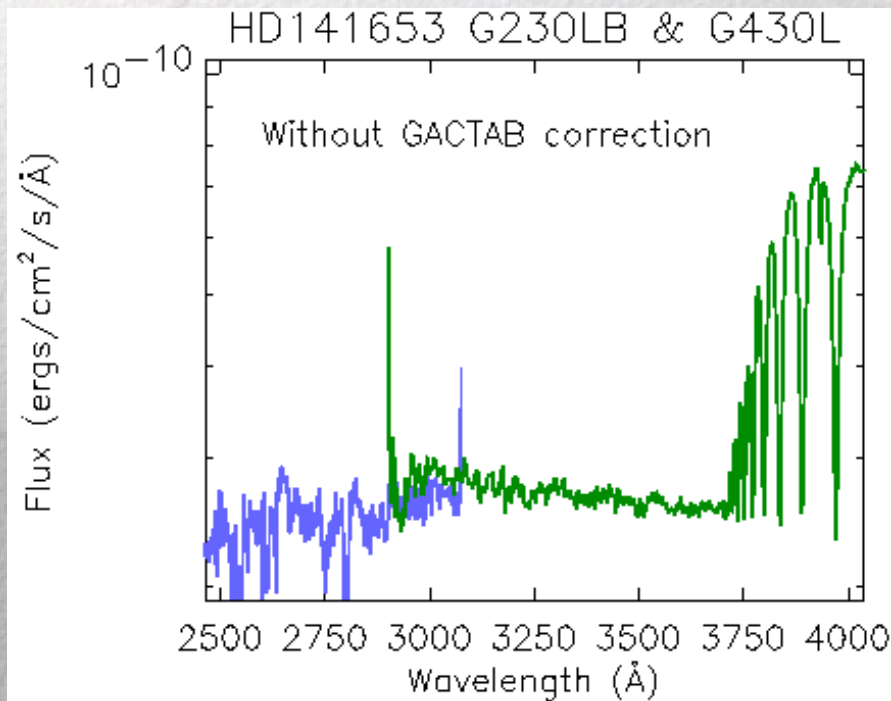


- Small scale structure at E1 in GAC vector
- Effects of Lyot stop in GAC vector
- Low order vignetting done by LFLAT
- Even after LFLAT, small E1 apertures have lower throughput than at center



Correction for 52x0.2

Datasets o68m01010 & o68m01060

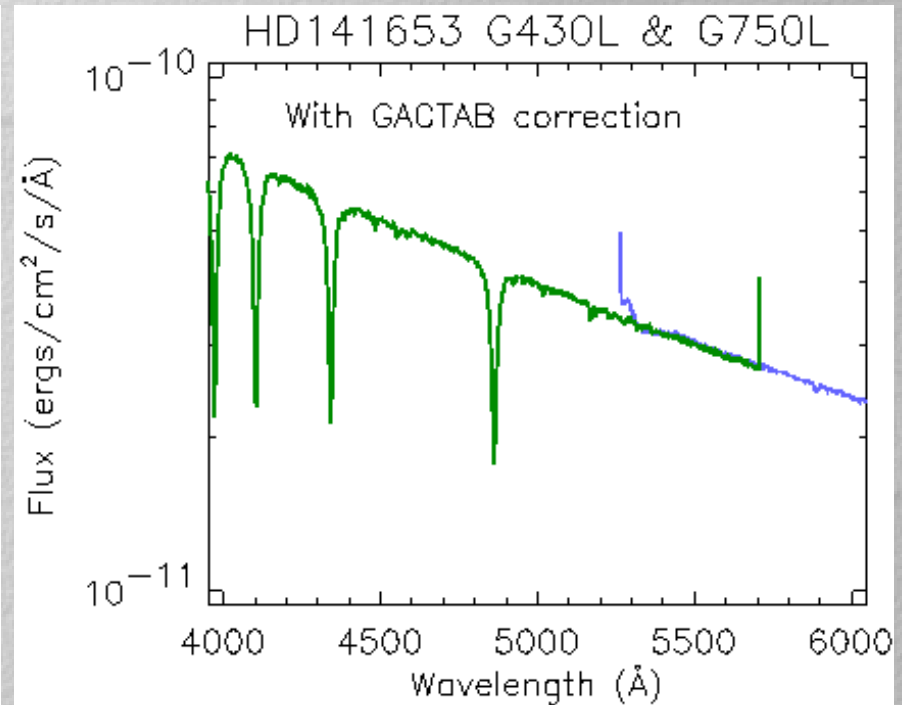
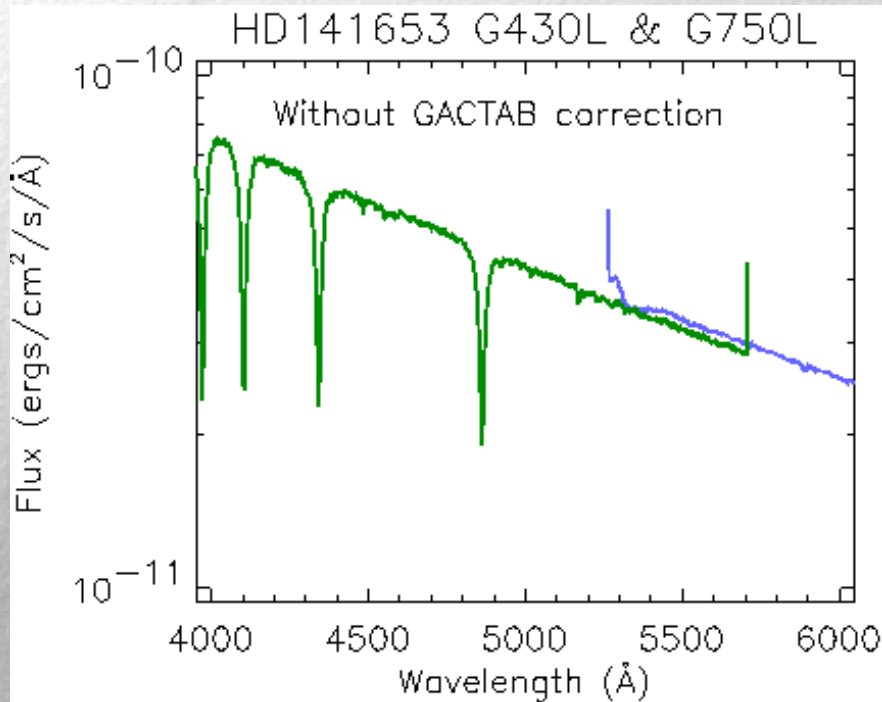


Overlap between G230LB and G430L 52X0.2



Correction for 52x0.2

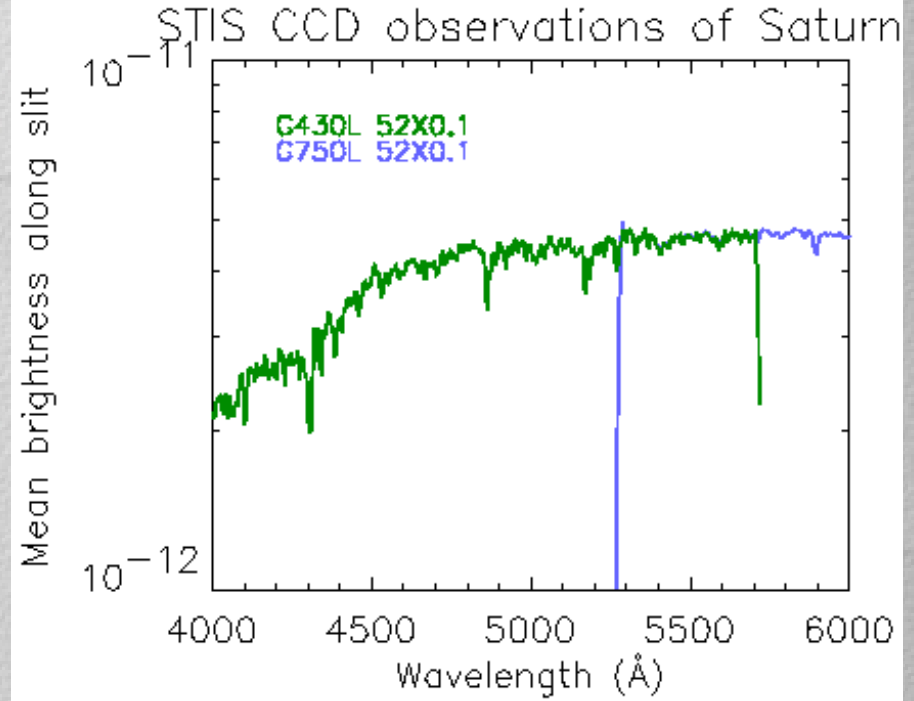
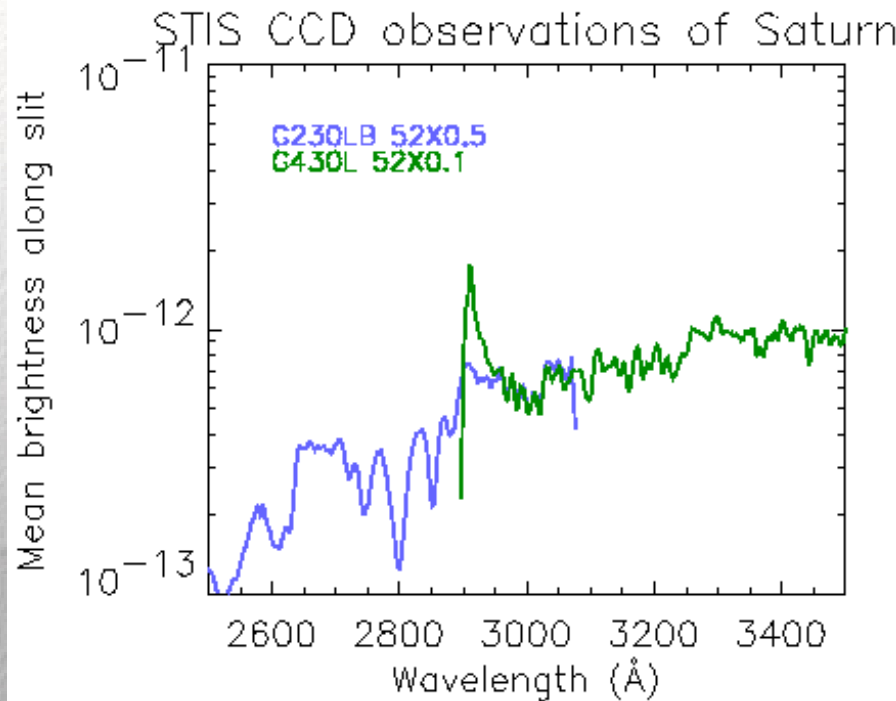
Datasets o68m01060 & o68m010c0



- Overlap between G430L and G750L - 52X0.2
- In practice effect of miscentering on G750L is often as large as 52x0.2 GAC correction.



Extended source small aperture fluxes



- Extended sources \gg slit (e.g., Saturn) have no discontinuities between gratings.
- Don't need GAC correction for extended sources.

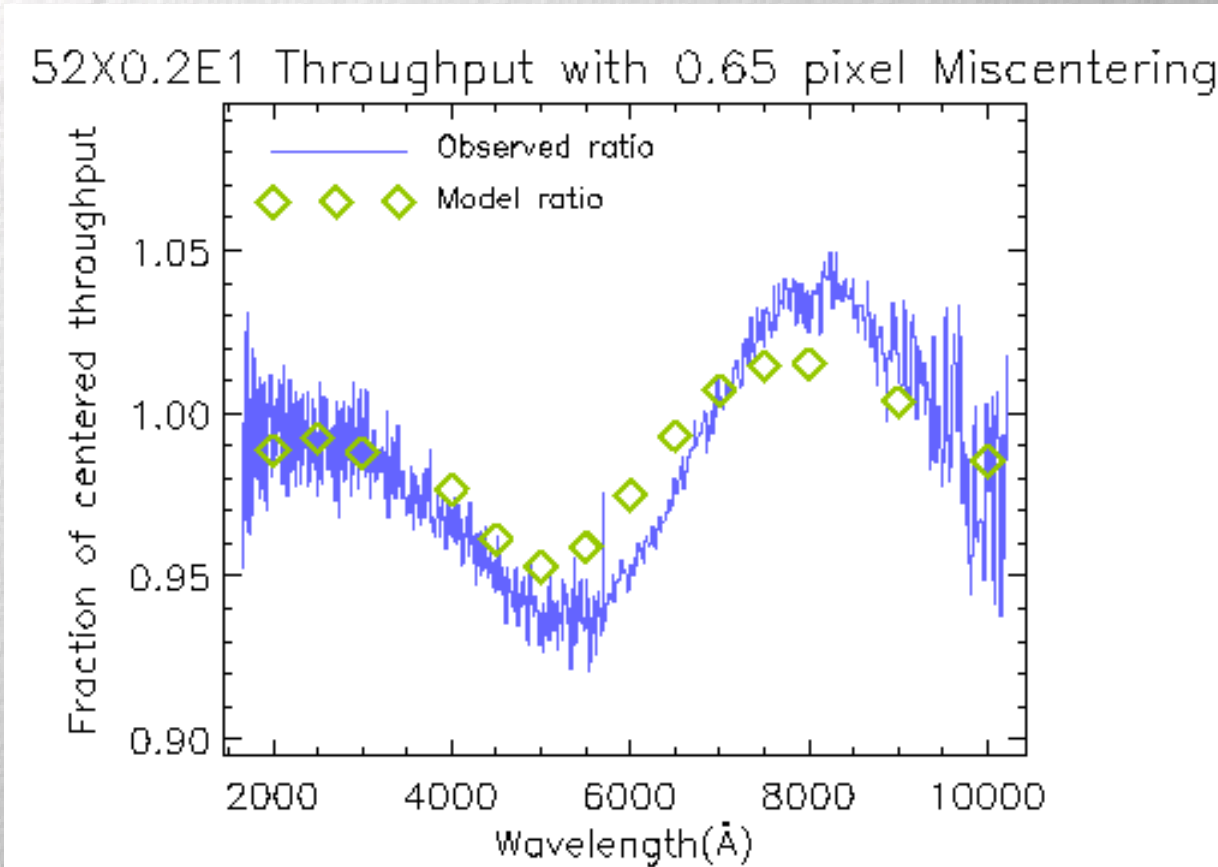


Effect of Aperture Miscentering

- Original E1 positions defined $\sim 2/3$ pixel off slit centers, SIAF file fixed in Sept 2003.
- Calibration data at 52X0.2E1 mostly done with ACQ/Peaks in a smaller aperture.
- Some calibration data deliberately offset by $2/3$ pixel to estimate effect...



Flux Change from 2/3 Pixel Offset



- Measured throughput changes resembles simple model (tiny tim PSFs + mask) with 1st Airy ring near edges of aperture.



Installation of Corrections

- OTFR implementation, and new reference files available 11/29/05 (estimated)
 - ◆ LFLAT files for CCD L modes
 - ◆ New reference file Grating-aperture Correction Table – GACTAB
 - ◆ No attempt to correct for aperture miscentering in OTFR
 - ◆ Correction for temperature dependent sensitivity changes ($< 1\%$) added to TDS
- Required code changes included with CALSTIS 2.19 in STSDAS 3.4 (early November 2004).
- Final CTI/TDS adjustments next year.



Remaining Issues

- Small aperture throughputs for other modes (e.g., G140L/G230L) under review
- Limited data to measure G^*M throughput and vignetting, esp. given many CENWAVEs.
- Final CTI and TDS corrections pending.
- No pipeline fix for 2/3 pixel miscentering.
- G230LB/MB zero order scattered light
- Generally meet goal of 2% accuracy and 1% repeatability for 52X2.
- For 52X0.2, 2% repeatability possible in principle, but without peakup 5% in practice.