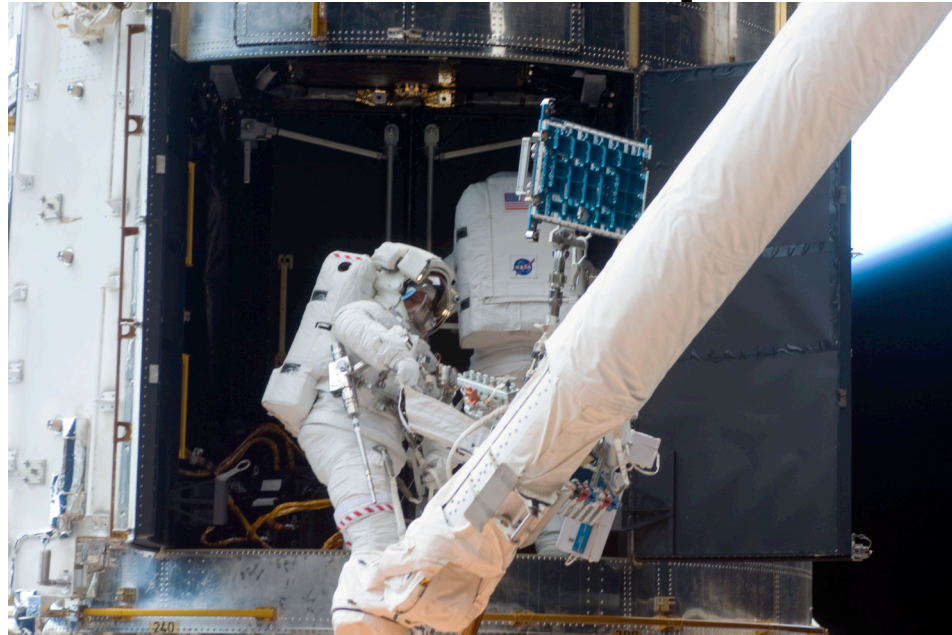


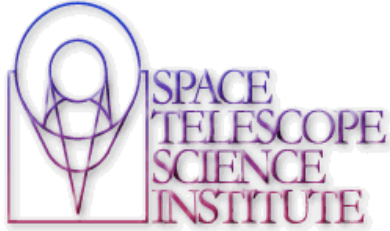
STIS Update

Charles R. Proffitt

STIS Repair

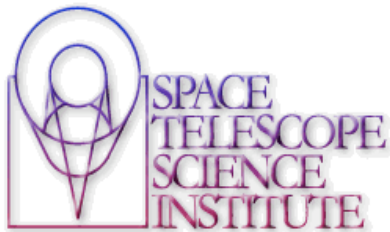


- On May 17, 2009 during EVA #4 of SM4, astronauts Mike Massimino & Michael Good, successfully replaced the failed STIS LVPS-2 card, and restored STIS to operations after $\sim 4\frac{3}{4}$ years of inactivity.



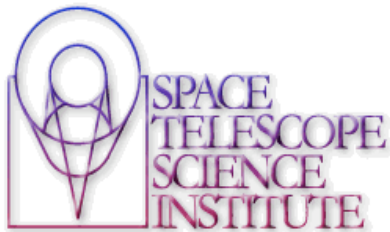
Outline

- STIS SMOV Overview
- STIS Post-repair Performance
 - Detectors
 - Alignment
 - Throughputs
- Calibration Program
 - Significant forthcoming calibrations
- Changes for cycle 18



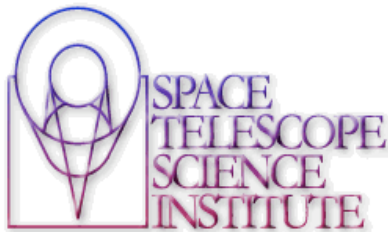
STIS SMOV

- STIS SMOV plan:
 - Goal was to verify ability of STIS to do science
 - Many time consuming calibrations deferred to Cy 17
 - Originally expected to complete in ~ 6 weeks
- CCD recovery, initial observations and initial FUV MAMA recovery were nominal
- Two anomalies then caused substantial delays
 - SIC&DH suspended on June 15
 - Hang of STIS MAMA Interface Electronics on July 6
- STIS CCD ERO June 29, GO Science July 1
- First STIS MAMA GO Science 15 Aug, 2009



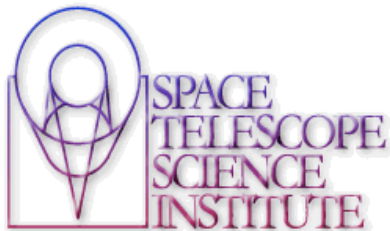
STIS & the SI C&DH

- During SI C&DH anomaly, loss of a timing signal causes all SIs to “reset” to boot mode
 - Forces all HV power supplies off
 - Cannot command SIs until SI C&DH reset
- STIS has extra vulnerability due to MCE (MAMA Control Electronics) resets caused by optical isolator problems
 - Any time MAMA LVPSs are on, a partial cosmic ray reset could ramp up HV to disallowed values
 - Normally STIS control section computer monitors MCE and forces full reset to zero HV in event of a partial reset
 - STIS MAMA LVPS normally turned off during all SAA passages
 - Both these protections go away during a SI C&DH hang
 - If LVPS on throughout SAA passages, about 1 in 1000 chance per day of damaging or destroying a MAMA detector



STIS vulnerabilities to SI C&DH anomalies

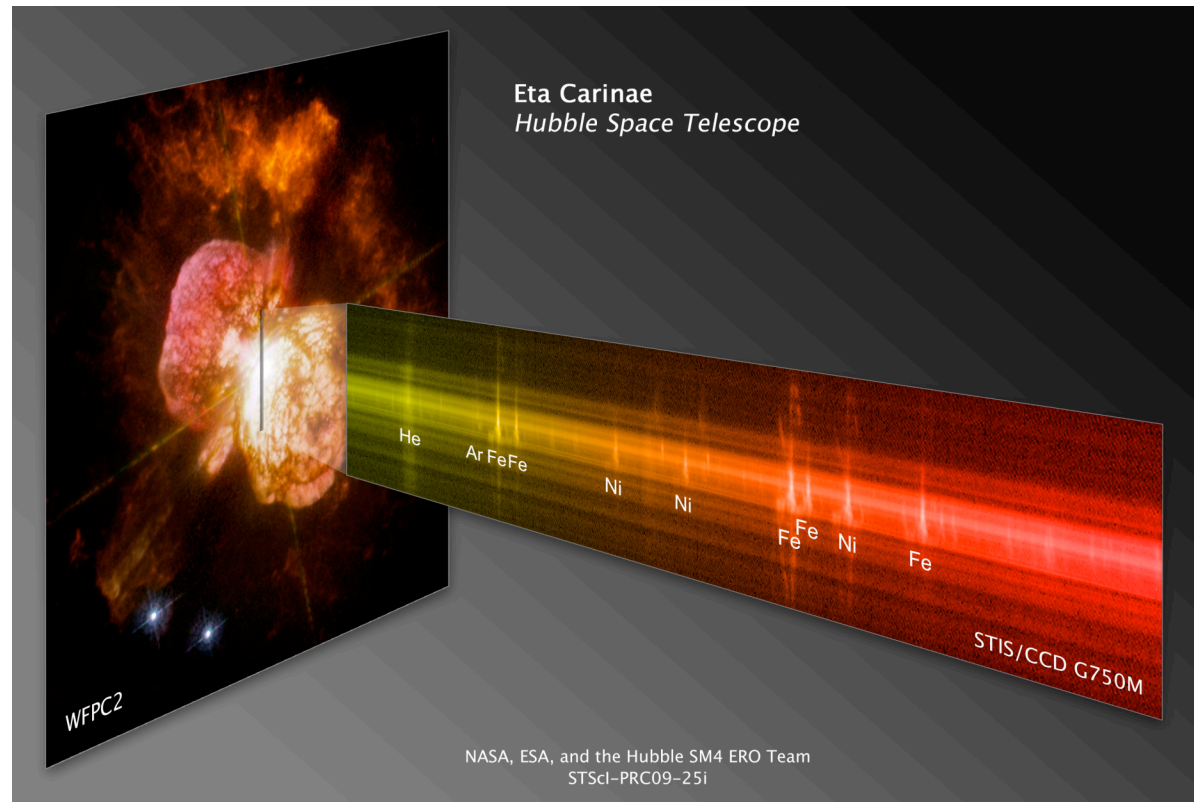
- After SI C&DH recovery, STIS is safed ASAP to turn off MAMA LVPSs, reducing exposure to MCE resets
 - No available mechanism to shut off LVPS before SI C&DH recovery
- Currently, the policy is keep STIS MAMA LVPSs powered outside SAA to minimize thermal swings; cycle off only in SAA
- Considering changing policy to only power a given LVPS if that MAMA is being used that week
 - Advantages
 - Can reduce exposure to SI C&DH anomaly by factor of two or three
 - Less cycling of relays and power supplies
 - Disadvantages
 - Keeping detector cold when not used will lead to a substantially higher equilibrium NUV MAMA dark current (~ 2 to 3X) during use
 - Less scheduling flexibility
 - Fewer MAMA SNAP opportunities
 - Any change in this policy has been deferred to allow NUV MAMA to remain warm to mitigate its larger than expected dark current



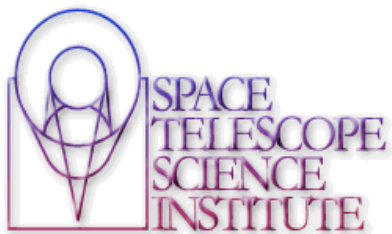
STIS MIE Suspend

- On July 6, 2009, during a CCD target ACQ, the MAMA Interface Electronics (MIE) failed to respond to a request for the coarse time, causing STIS to suspend
- On July 9 & 10, recovery attempts failed when attempting to dump MIE memory caused additional instrument suspend events
 - MIE dumps had succeeded earlier in SMOV
- Conclusions
 - Original suspend was probably due to a single event upset in the MIE electronics that disabled the processor
 - Similar event previously seen in SBC MIE
 - Rebooting MIE solves problem
 - MIE dump failure similar to those of July 9/10 had occurred in 1997
 - Suspect there is timing issue with the design that can occasionally interfere with required interrupts that are necessary to let the NSSC computer know that STIS is still alive
 - Will avoid using MIE2RAM macro in future

STIS ERO Observations

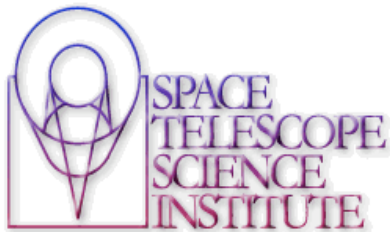


- STIS ERO observations of η Car on 29 June, 2009 marked the return of high spatial resolution long slit spectroscopy to HST
- First STIS MAMA GO Science executed on 15 Aug, 2009



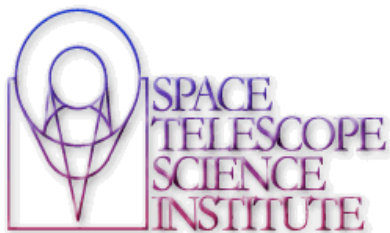
STIS Performance after SM4

Changes since 2004



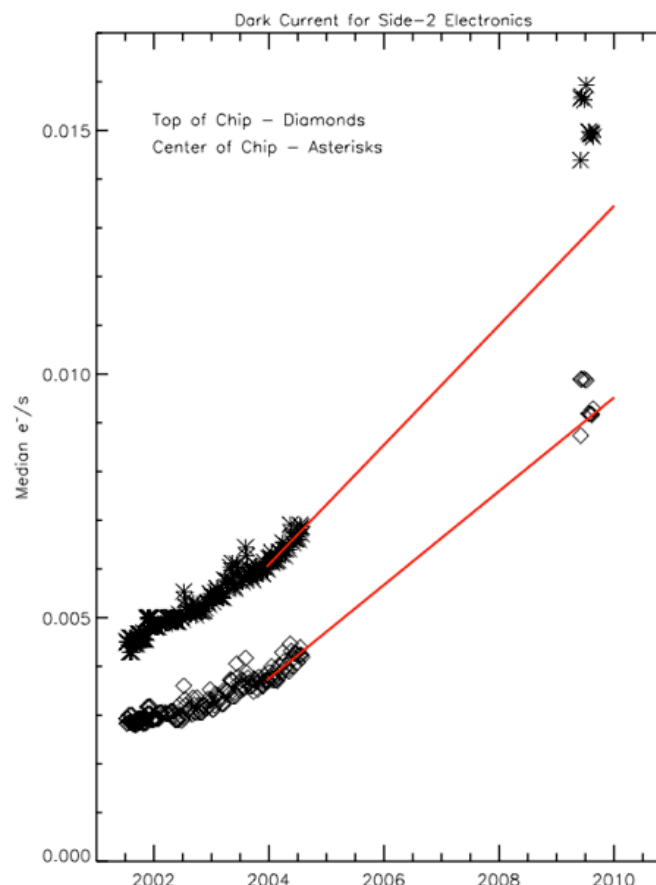
STIS after SM4 CCD Detector

- CCD detector continued to accumulate radiation damage between 2004 and 2009
 - Increased dark current
 - More hot pixels
 - Continued loss of Charge Transfer Efficiency
- Slight increase in read noise (0.2 - 0.3 DN)
 - Coherent pattern noise introduced with side-2 switch unchanged
- Amp B now has problem in transferring data to output (bit slip) and will no longer be used
 - GO science has always used amp D
 - B/D amp pair used for CTE tests, will now use A/C
- Higher aft-shroud temperatures and lack of closed loop T control on side-2 mean CCD detector temperature now significantly higher

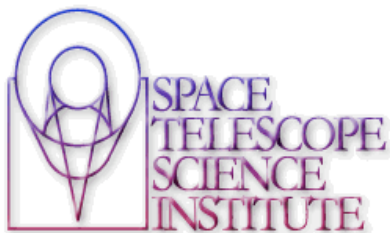


STIS CCD dark current

- Dark current increases with time
 - Too soon to measure slope of post-SM4 dark trend over time
- Increases $\sim 7\%$ /degree of housing temperature
 - OCCDHT averaged ~ 17 C in 2001, ~ 22 C recently
- CCD dark current varies across detector
 - $\sim 63\%$ lower dark current close to readout
 - Another reason to use the E1 positions for faint targets which put the spectrum closer to the readout register



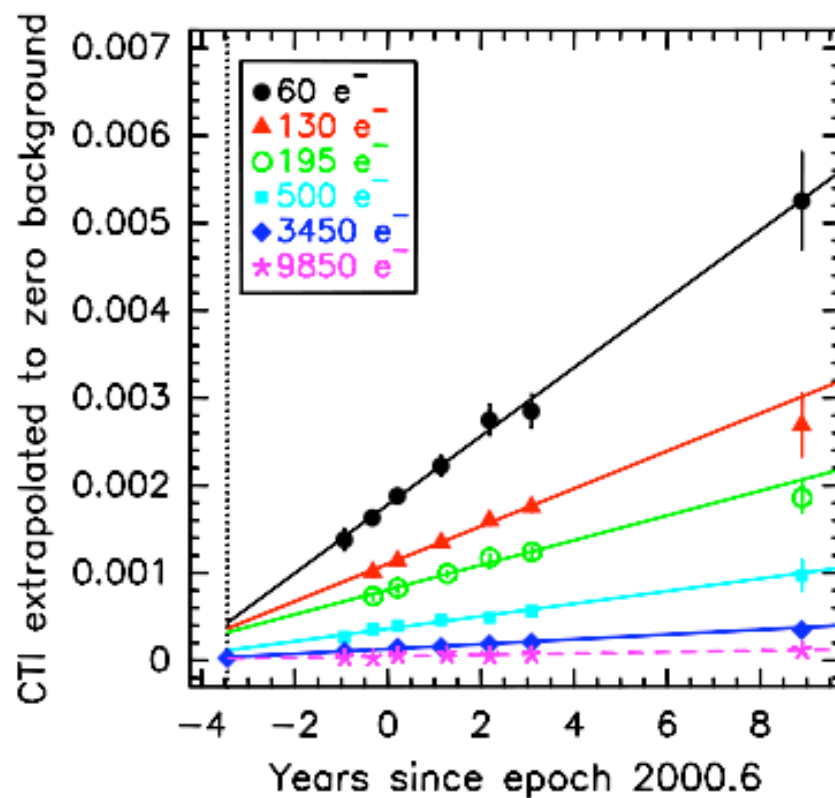
- Dark current at center and near the readout for STIS CCD with side-2 electronics. All results are scaled to a CCD housing temperature of 22 C.

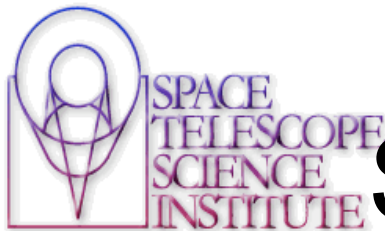


STIS CCD CTE

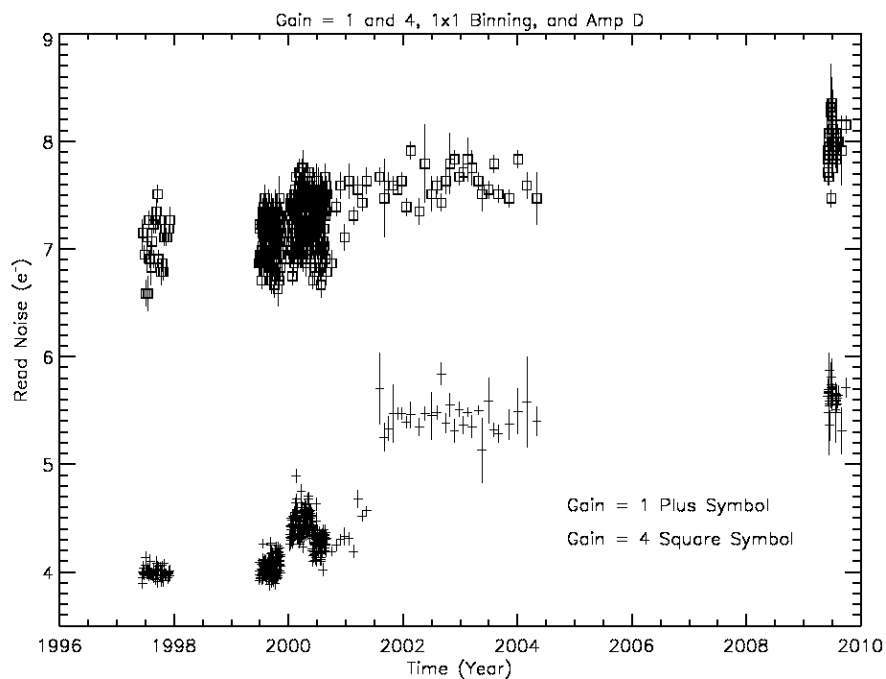
Charge transfer inefficiency (CTI = 1- CTE) extrapolated to zero background as a function of observation date for various values source signal levels is shown at right.

Post SM4 results are consistent with a linear extrapolation of previous trends.





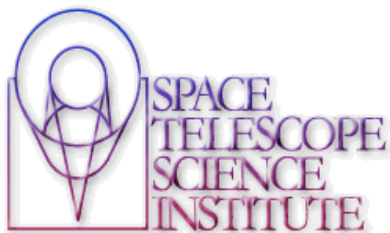
STIS CCD Read-noise



The STIS read-noise has slightly increased.

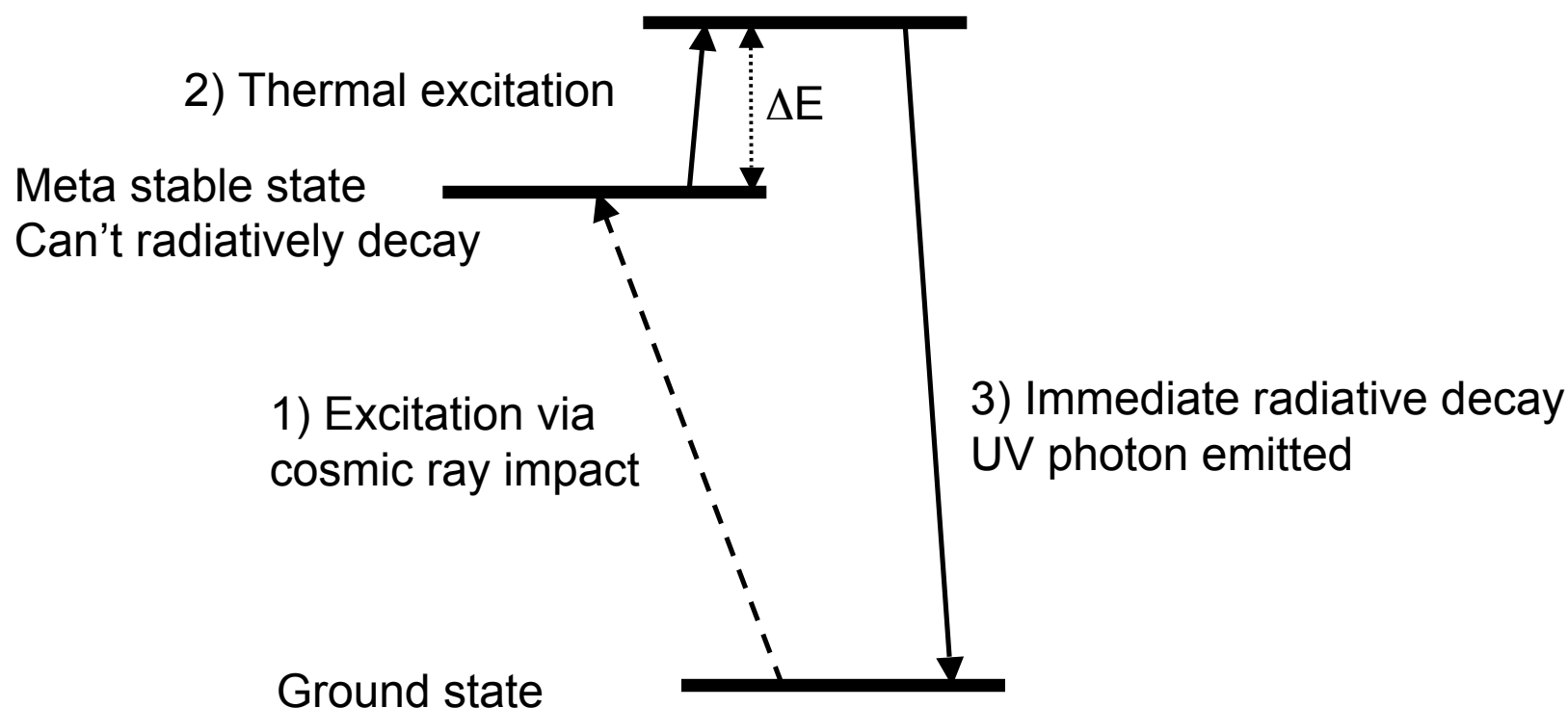
In 2004, read-noise was about
5.4 e^- for CCDGAIN=1 and
7.7 e^- for CCDGAIN=4

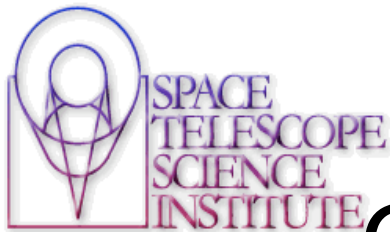
In 2009, this has become
5.6 e^- for CCDGAIN=1 and
8.0 e^- for CCDGAIN=4



NUV MAMA Window Phosphorescence

- NUV MAMA dark current dominated by de-excitation of meta-stable states in window.
 - Cosmic ray impacts during SAA populate these states

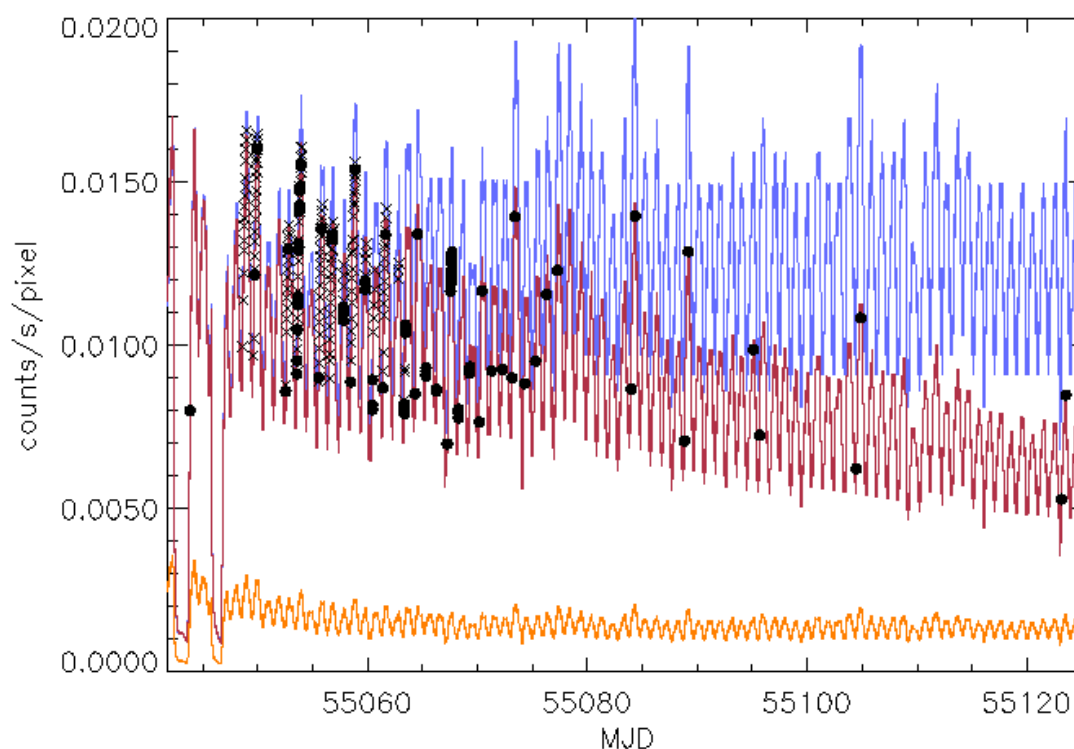




STIS NUV MAMA Dark Current (Pre-SM4 model)

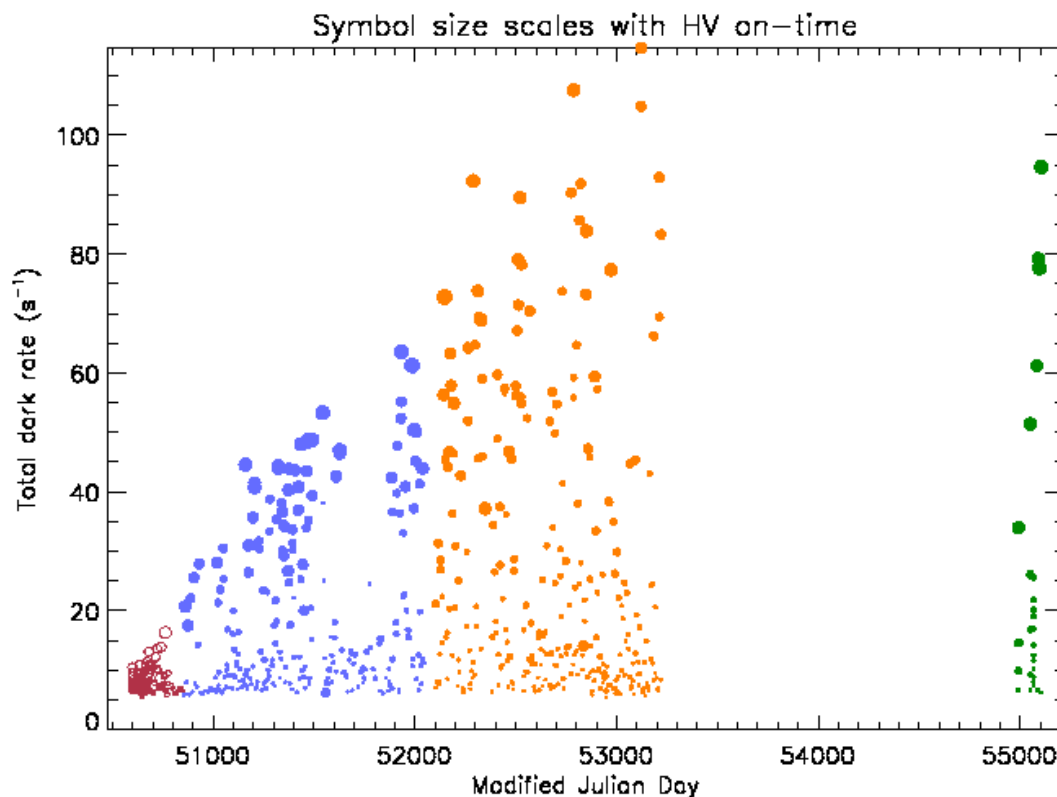
- Dark rate depends on both on number of such states that are occupied and the probability of de-excitation
 - Dark rate $\sim N_{\text{ex}} e^{-(\Delta E/(kT))}$
 - $dN_{\text{ex}}/dt = \Gamma (N_{\text{tot}} - N_{\text{ex}}) - [A e^{-(\Delta E/(kT))}] N_{\text{ex}}$
 - N_{tot} is the number of metastable states
 - N_{ex} is the number of those states currently populated
 - Γ is rate at which cosmic rays populate empty states
 - $A e^{-(\Delta E/(kT))}$ is the probability a trapped state will de-excite due to thermal transition to an unstable state
- Tube temperature varies primarily with LVPS (low voltage power supply) cycling (HV has small effect)
 - Daily cycling around SAAs causes daily T and dark cycling
- When tube kept cold, number of excited states build up
 - Causes temporary increase in dark current after warmup

NUV MAMA Dark rate

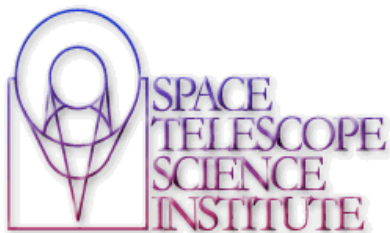


- **Orange curve** shows prediction of pre-SM4 dark current model
 - Short term fluctuations are due to daily temperature cycling
- Symbols show STIS NUV MAMA dark current measurements
- **Pre-SM4 prediction** + $Ae^{-(\Delta E/kT)}e^{-(t/\tau)}$, with $\tau = 100$ days (red) and $\tau = \infty$ (blue)
- If current trend holds, will return to expected range by start of Cycle 18

FUV MAMA Dark Rate

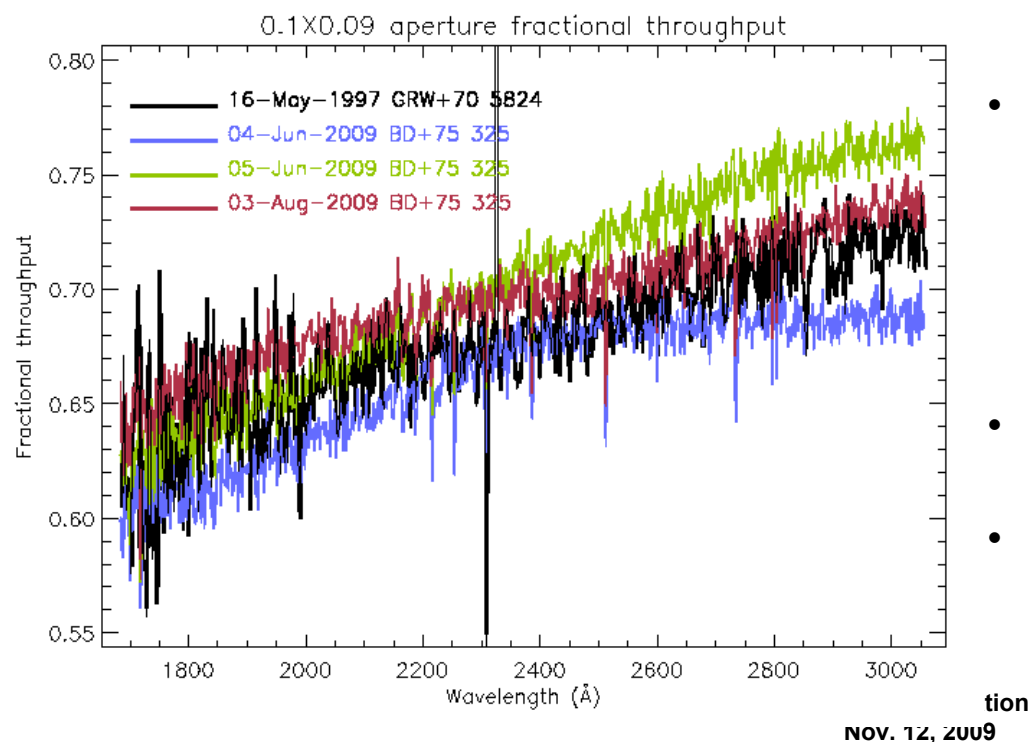


- FUV MAMA dark current is lowest immediately after HV turn-on and increases as a function of turn-on time. Initial dark rate after SM4, was lower than during 2004, but this has increased to a comparable level.



Focus & Alignment

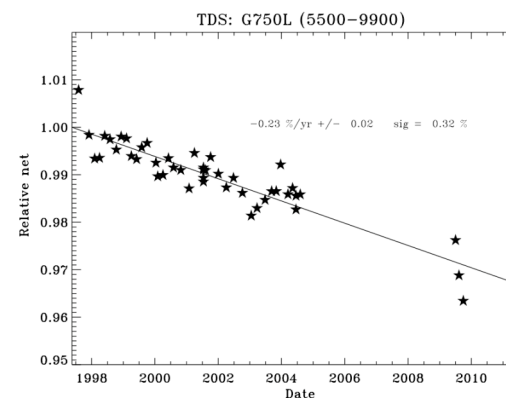
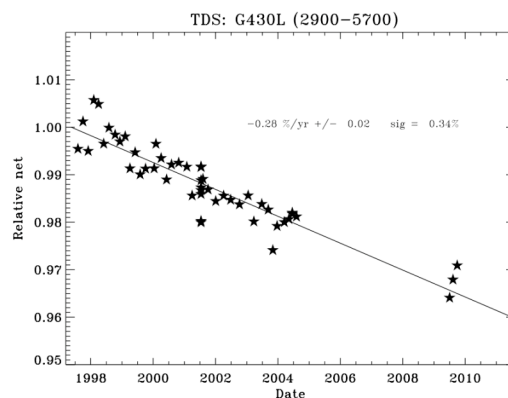
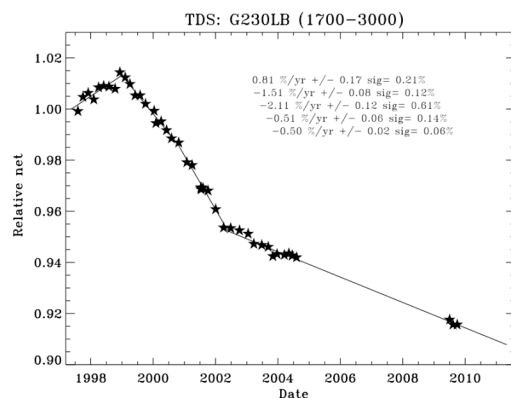
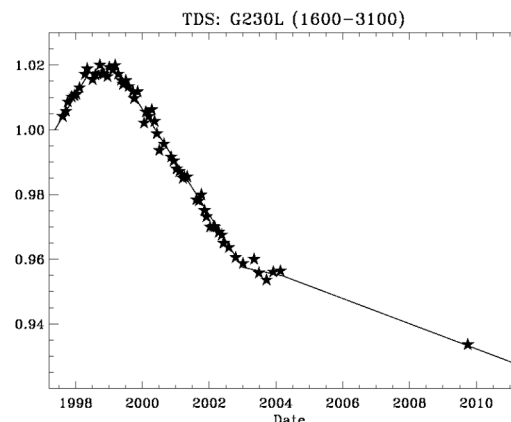
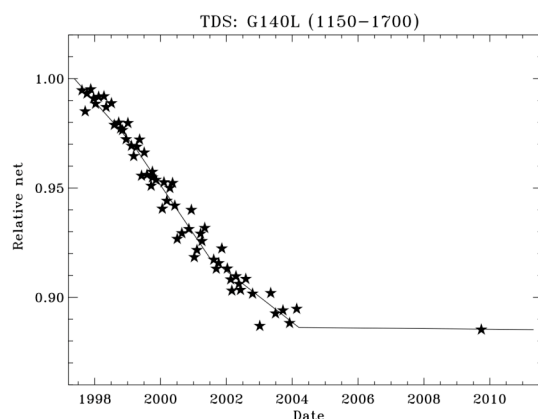
- STIS-to-FGS Alignment within 0.25" of expected value, well within tolerances required for standard ACQ procedures and comparable to GSC2 catalogue uncertainties
- Cal lamp exposures show internal grating alignments unchanged
- Small aperture throughputs and narrow band images show focus unchanged



- The ratios of the small 0.1x0.09 to large aperture (52x2 or 50CCD) net count rates as measured with deep G230LB ACCUM spectra are compared for data from 1997 (black) and 2009 SMOV (color).
- Throughput variations seen typical of expected breathing changes
- No apparent degradation of STIS throughput caused by 20 July move of HST secondary

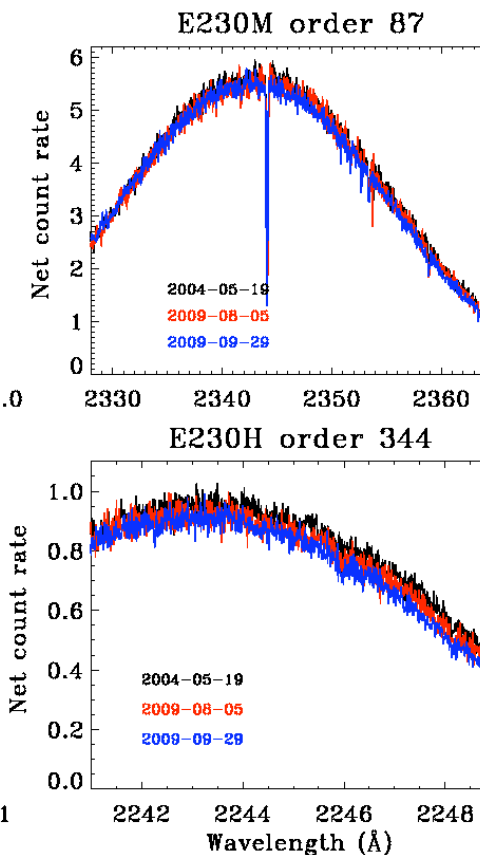
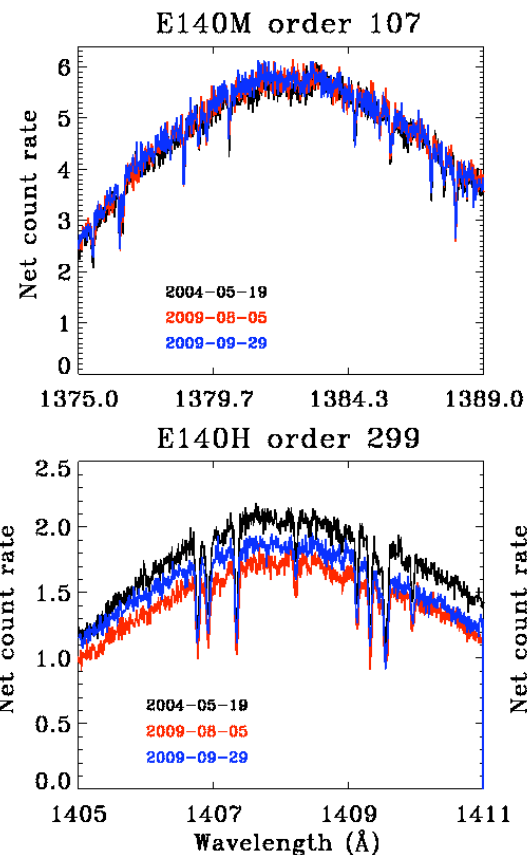
Sensitivity Changes

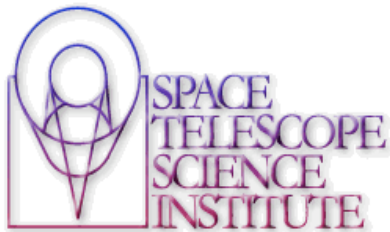
- Most STIS sensitivity declines close to, or less than, a simple extrapolation of 2004 trends.
- The average changes from throughputs at launch are shown for STIS L-mode



Echelle modes

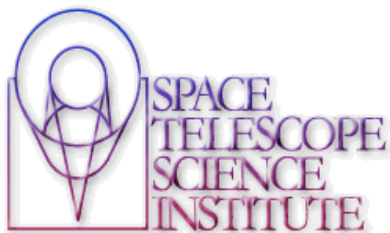
- Sensitivity monitor observations show 3 out of 4 echelle gratings show differences no larger than the expected throughput variations of 0.2×0.2 aperture
- E140H is systematically low by 10-20%. Cause still being investigated.





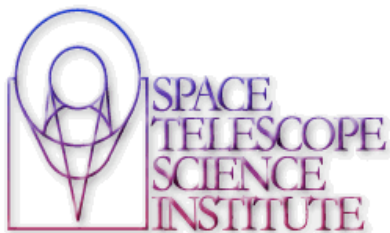
STIS Cycle 17 Calibration Plans

- Includes standard programs for monitoring
 - Throughputs
 - Dark rates
 - CCD detector performance (biases, read-noise, CTE)
- Pending high priority calibrations not done during SMOV include:
 - Pixel-to-pixel flat fields for all detectors
 - Re-measurement of all echelle `CENWAVE` settings using WD standard G191 B2B
 - Needed to monitor blaze functions shifts and zeropoints



Policy Changes for Cycle 18

- Changes to modes allowed for STIS MAMA parallel and SNAP observations
 - STIS MAMA imaging and PRISM modes may no longer be proposed as coordinated parallel or SNAP observations
 - All other MAMA spectroscopic modes may continue to be used in fixed target coordinated parallel and SNAP observations
- Rationale for changes
 - These modes have rarely been requested as SNAPs or parallels
 - Bright object screening for these very sensitive modes is highly labor intensive for STScI
 - The execution rate for MAMA SNAPs is extremely low
 - Rescheduling of coordinated parallel observations requires additional parallel fields to be screened at the new orient
 - In the NUV, WFC3 UVIS UV filters are a better choice for many observations and don't have bright object concerns



IHB & ETC Updates

- IHB is being updated to discuss the changes in Instrument Performance presented here.
- However, most tables and figures for S/N calculations, BOP limits, limiting magnitudes, etc. will not be updated from the values that had been projected for cycle 17.
- ETC updated with new time-dependent sensitivity changes and best estimate of dark currents for Cycle 18.
 - For the NUV MAMA we adopted a rather pessimistic dark rate of 0.005 counts/s/pixel.