# Cycle 24 STIS Final Calibration Plan

STIS Team

# Cycle 24 Instrument Usage Statistics Based on Approved Programs

- STIS orbits comprise ~27.6% of all GO prime orbits in Cycle 24

| Instruments | Prime Orbits Usage | SNAP Orbit Usage |
|---|---|---|
| ACS | 13.9% | 25.4% |
| COS | 20.5% | 16.8% |
| STIS | 27.6% | 0.0% |
| WFC3 | 37.9% | 57.7% |
| FGS | 0.0% | 0% |

# STIS Cycle 24 Usage Statistics for each Configuration/Mode

| Configuration/Mode | Percentage of STIS Prime Exposure Time | | Percentage of STIS SNAP Exposure Time | |
|---|---|---|---|---|
| | C23 | C24 | C23 | C24 |
| **CCD** | **24.1%** | **31.1%** | **100%** | **--** |
| CCD/Imaging | 0.7% | 1.1% | -- | -- |
| CCD/Spectroscopy | 23.4% | 30.0% | 100% | -- |
| **MAMA/FUV** | **35.7%** | **41.3%** | **--** | **--** |
| FUV/Imaging | 11.0% | 14.3% | --- | -- |
| FUV/Spectroscopy | 24.7% | 27.0% | -- | -- |
| **MAMA/NUV** | **40.2%** | **27.6%** | **--** | **--** |
| NUV/Imaging | 0.8% | 0.1% | --- | -- |
| NUV/Spectroscopy | 39.2% | 27.5% | -- | -- |

# STIS Cycle 24 Usage Statistics for each Grating/Mirror Combination

| Configuration/Mode | Grating/Mirror | Percentage of STIS Prime science Exposure Time | | Percentage of STIS SNAP science Exposure Time | |
|---|---|---|---|---|---|
| | | C23 | C24 | C23 | C24 |
| STIS/CCD | G230LB | 7.9% | 0.1% | 59.7% | -- |
| (31.1%) | G230MB | -- | -- | --- | -- |
| | G430L | 6.4% | 19.6% | 15.7% | -- |
| | G430M | 0.4% | 0.2% | --- | -- |
| | G750L | 7.6% | 8.1% | 24.6% | -- |
| | G750M | 1.3% | 2.0% | --- | -- |
| | MIRROR/CORON | 0.7% | 1.1% | -- | -- |
| STIS/MAMA-FUV | E140H | 7.7% | 2.0% | --- | -- |
| (41.3%) | E140M | 4.4% | 7.1% | --- | -- |
| | G140L | 7.3% | 8.2% | -- | -- |
| | G140M | 5.3% | 9.7% | -- | -- |
| | MIRROR | 11.0% | 14.3% | --- | -- |
| STIS/MAMA-NUV | E230H | 14.8% | 9.4% | -- | -- |
| (27.6%) | E230M | 7.4% | 10.5% | --- | -- |
| | G230L | 17.2% | 7.7% | -- | -- |
| | MIRROR | 0.8% | 0.1% | --- | -- |

# STIS Calibration and Monitor Orbits Approved by Cycle

| | # of Programs | External Orbits | Parallel Orbits | Internal Orbits | Total Orbits |
|---|---|---|---|---|---|
| **Cycle 17** | 25 | 68 | 0 | 1816 | 1884 |
| **Cycle 18** | 20 | 22 | 0 | 1370 | 1392 |
| **Cycle 19** | 18 | 21 | 0 | 1418 | 1439 |
| **Cycle 20** | 20 | 21 | 0 | 1391 | 1412 |
| **Cycle 21** | 20 | 21 | 0 | 1392 | 1413 |
| **Cycle 22** | 19 | 21 | 0 | 1387 | 1408 |
| **Cycle 23** | 22 | 31 | 1 | 1380 | 1416 |
| **Cycle 24** | 17* + 4 | 21 + 5 | 3# | 1345 + 10 | 1369 + 15 |

* Includes approved early submission programs only
# 3 parallel orbits are requested by COS Team
Requesting additional programs/orbits indicated in red

# STIS Cycle 24 Calibration and Monitoring Orbits Requested

| Prop. ID | Title | External | External Parallel | Internal | Frequency (orbits x repeats) | Cycle 23 Allocation |
|---|---|---|---|---|---|---|
| **CCD Monitors** | | | | | | |
| | STIS CCD Performance Monitor | | | 14 | 2x7 | 14 |
| | STIS CCD Dark Monitor | | | 730 | 2x242 + 1x246 | 732 |
| | STIS CCD Bias and Read Noise Monitor | | | 369 | 1x182 + 1x183+1x4 | 370 |
| | STIS CCD Hot Pixel Annealing | | | 39* | 3x13 | 39 |
| | STIS CCD Spectroscopic Flat-Field Monitor | | | 19 | 1x10 +9 | 19 |
| | STIS CCD Imaging Flat-Field Monitor | | | 4 | 1x4 | 4 |
| | STIS CCD Spectroscopic Dispersion Solution Monitor | | | 3 | 3x1 | 3 |
| | STIS CCD Sparse Field CTE | | | 50 | 50x1 | 50 |
| | STIS CCD Full Field Sensitivity | 1 | | 0 | 1x1 | 17 |
| | STIS Slit Wheel Repeatability | | | 1 | 1x1 | 1 |
| | STIS CCD Spectroscopic Sensitivity Monitor | 5 | | | L 1x3, M 2x1 | 5 |
| **MAMA Monitors** | | | | | | |
| | STIS MAMA Spectroscopic Dispersion Solution Monitor | | | 7 | 7x1 | 7 |
| | STIS MAMA Full Field Sensitivity | 3 | | | 1x3 | 3 |
| | STIS MAMA Spectroscopic Sensitivity and Focus Monitor / COS Observations of Geocoronal Lyα Emission | 12 | 3 | | 1x3/L, 1x1/M, 2x4/E | 12 |
| | STIS FUV MAMA Dark Monitor | | | 54 | 6x9 | 54 |
| | STIS NUV MAMA Dark Monitor | | | 52 | 2x26 | 52 |
| | STIS MAMA FUV Flat-Field Monitor | | | 11* | 1x11 | 11 |
| | STIS MAMA Fold Distribution | | | 2 | 2x1 | 2 |
| **Special program** | | | | | | |
| | Monitoring the 3 Primary WD Standard Stars | 5 | | | 5x1 | - |
| **Contingency programs** | | | | | | |
| | STIS MAMA Anomalous Recovery | | | (6) | | (6) |
| | STIS Focus Parallel Measurements◆ | (1) | (1) | | 1x1 | 1 |
| **TOTAL** | **Cycle 24 orbit request** | **26 + (1)** | **3 + (1)** | **1355 + (6)** | | **Ext: 31 +1 Int: 1380+(6)** |

* Internal parallel orbits > 1800s.

( ) Indicates contingency orbits not included in Cycle 24 request.

Routine program being discussed today

Red means new

◆Requesting Cy 23 special program become contingency program in Cy 24

# Cycle 24 STIS Calibration Plan

STIS Team

6/2/2016

# STIS Calibration and Monitor Orbits Approved by Cycle

| | # of Programs | External Orbits | Parallel Orbits | Internal Orbits | Total Orbits |
|---|---|---|---|---|---|
| **Cycle 17** | 25 | 68 | 0 | 1816 | 1884 |
| **Cycle 18** | 20 | 22 | 0 | 1370 | 1392 |
| **Cycle 19** | 18 | 21 | 0 | 1418 | 1439 |
| **Cycle 20** | 20 | 21 | 0 | 1391 | 1412 |
| **Cycle 21** | 20 | 21 | 0 | 1392 | 1413 |
| **Cycle 22** | 19 | 21 | 0 | 1387 | 1408 |
| **Cycle 23** | 22 | 31 | 1 | 1380 | 1416 |
| **Cycle 24** | 18* | 22 | 4# | 1345 | 1371 |

* Includes early submission programs only
# 3 parallel orbits are requested by COS Team

# STIS Cycle 24 Calibration and Monitoring Orbits Requested

| Prop. ID | Title | External | External Parallel | Internal | Frequency (orbits x repeats) | Cycle 23 Allocation |
|---|---|---|---|---|---|---|
| **CCD Monitors** | | | | | | |
| | STIS CCD Performance Monitor | | | 14 | 2x7 | 14 |
| | STIS CCD Dark Monitor | | | 730 | 2x242 + 1x246 | 732 |
| | STIS CCD Bias and Read Noise Monitor | | | 369 | 1x182 + 1x183+1x4 | 370 |
| | STIS CCD Hot Pixel Annealing | | | 39* | 3x13 | 39 |
| | STIS CCD Spectroscopic Flat-Field Monitor | | | 19 | 1x10 +9 | 19 |
| | STIS CCD Imaging Flat-Field Monitor | | | 4 | 1x4 | 4 |
| | STIS CCD Spectroscopic Dispersion Solution Monitor | | | TBD | TBD | 3 |
| | STIS CCD Sparse Field CTE | | | 50 | 50x1 | 50 |
| | STIS CCD Full Field Sensitivity | 1 | | 0 | 1x1 | 17 |
| | STIS Slit Wheel Repeatability | | | 1 | 1x1 | 1 |
| | STIS CCD Spectroscopic Sensitivity Monitor | 5 | | | L 1x3, M 2x1 | 5 |
| | STIS Focus Parallel Measurements◆ | 1 | 1 | | 1x1 | 1 |
| **MAMA Monitors** | | | | | | |
| | STIS MAMA Spectroscopic Dispersion Solution Monitor | | | TBD | TBD | 7 |
| | STIS MAMA Full Field Sensitivity | 3 | | | 1x3 | 3 |
| | STIS MAMA Spectroscopic Sensitivity and Focus Monitor / COS Observations of Geocoronal Lyα Emission | 12 | 3 | | 1x3/L, 1x1/M, 2x4/E | 12 |
| | STIS FUV MAMA Dark Monitor | | | 54 | 6x9 | 54 |
| | STIS NUV MAMA Dark Monitor | | | 52 | 2x26 | 52 |
| | STIS MAMA FUV Flat-Field Monitor | | | 11* | 1x11 | 11 |
| | STIS MAMA Fold Distribution | | | 2 | 2x1 | 2 |
| **Contingency program** | | | | | | |
| | STIS MAMA Anomalous Recovery | | | (6) | | (6) |
| **TOTAL** | **Cycle 24 orbit request** | **22** | **4** | **1345 + (6)** | | **Ext: 31 +1 Int: 1380+(6)** |

* Internal parallel orbits > 1800s.

Green means "executing on alternating cycle only"

( ) Indicates contingency orbits not included in Cycle 24 request.

◆Requesting Cy 23 special program become regular program

Blue: change from last cycle

TBD: Phase Is to be submitted later

# STIS Cycle 24 Calibration: Changes from Cycle 23

- CCD Dark Monitor program will be split into three programs instead of two for manageability.
- CCD Dark Monitor and Bias and Read Noise Monitor have orbits reduced because of no leap day.
- CCD Full Field Sensitivity program is reduced by 16 internal orbits that were needed for CTI testing in Cy 23.
- Requesting to add Focus Parallel Measurements as a regular calibration program to be repeated every cycle.
- MAMA Spectroscopic Sensitivity program will execute one fewer parallel orbit for COS airglow observations, as requested by COS team.

# STIS Cycle 24 Calibration Programs to be Submitted Later

- The performance of the STIS calibration lamps is under current investigation. Efforts are being made to assure that the accuracy of the wavelength calibration for all spectroscopic modes is maintained as the calibration lamps continue to fade. The following regular calibration programs will be submitted later, pending the results of this work:
  - STIS CCD Spectroscopic Dispersion Solution Monitor
  - STIS MAMA Spectroscopic Dispersion Solution Monitor

# STIS/CCD Programs

**Note: STIS Cycle 24 Phase Is Include Cycle 23 Usage Statistics**

# CCD Performance Monitor
# PI: Allyssa Riley

| | |
|---|---|
| **Purpose** | To measure the baseline performance of the CCD detector. |
| **Description** | This program monitors the performance of the CCD detector on orbit for amplifier D only. Bias and flat field exposures are taken to measure read noise, CTE (EPER test), spurious charge, and gain values with full frame observations. Bias exposures are also taken in sub-array readouts to check the bias level for ACQ and ACQ/PEAK observations. All orbits < 1800s |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time. |
| **Resources Required: Observations** | 14 internal orbits performed in 2 groups of 7 |
| **Resources Required: Analysis** | 2 FTE weeks for analysis and documentation. |
| **Products** | Possible update of the gain, bias level, and read noise values in ccdtab. This also provides a relative measure of CTI via the extended pixel edge response test. Possible flight software updates of table CCDBiasSubtractionValue. Summary in the end of cycle ISR and updates to the STIS monitor webpages. |
| **Accuracy Goals** | Read noise good to +/- 0.3 ADU, gain error < 0.08 ADU |
| **Scheduling & Special Requirements** | Visits occur every 6 months in Mar and Sept. |
| **Changes from Cycle 23** | No changes |

# CCD Dark Monitor (Parts 1, 2 and 3)
# PI: Allyssa Riley

| | |
|---|---|
| **Purpose** | Monitor dark current for the STIS CCD. |
| **Description** | Routine monitoring with Amp D and GAIN = 1: obtain 2 visits |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time |
| **Resources Required: Observations** | 242 (part 1) + 242 (part 2) + 246 (part 3) internal orbits <1800s. |
| **Resources Required: Analysis** | 6 FTE weeks; Retrieve and construct superdarks. These superdarks are compared to previous superdarks and the image statistics are checked to see if there are any anomalous statistical deviations. CTI analysis based on short darks is performed. |
| **Products** | Weekly CDBS reference files (superdarks) and a summary in the end of cycle ISR and update of the monitor webpage. |
| **Accuracy Goals** | Superdark rms < 0.012 e-/s and S/N > 1.0 per pixel in superdarks. |
| **Scheduling & Special Requirements** | Two orbits each day. |
| **Changes from Cycle 23** | This program has been split into 3 parts to make the proposal size more manageable. |

# CCD Bias and Read Noise Monitor (Parts 1 & 2)
# PI: Allyssa Riley

| | |
|---|---|
| **Purpose** | Monitor the bias in the 1x1 bin settings at gain=1, and 1x1 at gain = 4, to build up high S/N superbiases and track the evolution of hot columns. Also GAIN=1 and GAIN=4, 1x1 biases through AMPS A and C to use in combination with biases taken through AMP D for monitoring of the read noise |
| **Description** | Take full frame bias exposures in the 1x1 bin settings at GAIN = 1, and at GAIN = 4 with nominal AMP D. Take full frame biases through AMPs A and C in GAIN = 1 and 4 as well for performing read noise monitoring. All exposures are internal and fit in occultation orbits. In addition to routine monitoring, during one month we use 4 additional internal orbits of GAIN = 1, AMP A biases in support of absolute CTI measurements. |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time |
| **Resources Required: Observations** | 182 (part 1) + 183 (part 2) internal orbits + 4 (CTI) internal orbits <1800s |
| **Resources Required: Analysis** | 2 FTE weeks. Retrieve and construct superbiases. These are compared to previous superbiases and the image statistics are checked to see if there are any anomalous deviations. Biases with AMPS A and C allow for monitoring of the read noise. |
| **Products** | Weekly CDBS reference files (superbiases) and a summary in the end of cycle ISR |
| **Accuracy Goals** | Superbiases RMS < 0.95 e- at GAIN = 1 1x1 and RMS < 1.13 e- at GAIN = 4 1x1, S/N > 1 per pixel. |
| **Scheduling & Special Requirements** | One orbit per day for the routine monitor. The additional bias for AMP A should be taken the same month as AMP A darks for CTI analysis |
| **Changes from Cycle 23** | One fewer internal orbit than Cycle 23 so as not to account for a leap day. |

# STIS CCD Hot Pixel Annealing
# PI: Allyssa Riley

| | |
|---|---|
| **Purpose** | To anneal hot pixels and the effectiveness of the CCD hot pixel annealing is assessed by measuring the dark current behavior before and after annealing. |
| **Description** | The characteristics of the CCD will first be defined by a series of bias, dark and flat-field exposures taken before the anneal. The CCD Thermoelectric cooler will be turned off to allow the CCD detector temperature to rise from ~ -80 C to +5 C. The CCD will be left in the uncooled state for approximately 12 hours. At the end of this period the Thermoelectric cooler is turned back on and the CCD is cooled to its normal operating temperature. Since the CCD on Side-2 does not have thermistor, a 4 hour period, at a minimum, is necessary to<br>ensure that the CCD is cool and stable. After the CCD has stabilized, bias, dark and flat-field images will be repeated to check for changes in the CCD characteristics. The flat-field exposures will permit evaluation of any window contamination acquired during the annealing period. Pure parallel mode. |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time. |
| **Resources Required: Observations** | 39 internal orbits and all orbits >1800s. |
| **Resources Required: Analysis** | 2 FTE weeks. By comparing the number of hot pixels before and after the anneal, we see if the hot pixels decrease and estimate the number of hot pixels that persist after the process. |
| **Products** | Hot pixel growth rate, median dark count rate, and a summary in the end of cycle ISR |
| **Accuracy Goals** | Measure the growth rate of hot pixels to within 1% if possible |
| **Scheduling & Special Requirements** | Pure parallel mode exposures. Anneals will execute every 4$^{th}$ week using 3 orbits. |
| **Changes from Cycle 23** | No changes. |

# STIS CCD Spectroscopic Flat-Field Monitor
# PI: Molly Peeples

| | |
|---|---|
| **Purpose** | Obtain medium resolution grating flats to determine the pixel-to-pixel variation for spectroscopic observations and produce the cycle 24 reference p-flat (M and L modes). |
| **Description** | We use the tungsten lamp and the G430M grating to determine the pixel-to-pixel variation of the STIS CCD in spectroscopic mode. The flat exposures are taken with the 50CCD and 52x2 apertures at 5 offset positions in order to map -with a sufficient SNR- the whole sensitive area of the detector. The expected signal is ≥1.4E6 ADU/pixels; while the expected accuracy will be ≤1.5%. All orbits are less < 1800 s. |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time. |
| **Resources Required: Observations** | 19 internal orbits <1800s |
| **Resources Required: Analysis** | 2.5 weeks FTE |
| **Products** | Reference files, summary in end of cycle ISR and ISR as applicable |
| **Accuracy Goals** | ≤1.5% flat field accuracy |
| **Scheduling & Special Requirements** | 9 orbits with G430M/5612 & 50CCD spread across the cycle; 1 visit every ~40 days<br>10 orbits with the G430M/5612 & 52x2 |
| **Changes from Cycle 22** | No changes |

# STIS CCD Imaging Flat-Field Monitor
# PI: John Debes

| | |
|---|---|
| **Purpose** | Purpose: Collect high SNR white light imaging flats (aperture=50CCD) for monitoring purposes and to create a new reference p-flat for chronographic (and imaging) observations. |
| **Description** | Once every 3 months, obtain a series of imaging CCD flats using the MIRROR and the unfiltered 50CCD aperture. The 3 months cadence will allow us to keep monitoring possible (but unlikely) variations across the cycle; while the combined observations will allow us to obtain an average signal ~620000 ADU/pix (similarly to the past cycles) and create a high accuracy (~1%) imaging p-flat. The remaining time in each orbit/visit will be used to monitor the stability of the CORON aperture due to the MSM limited reproducibility. |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time. |
| **Resources Required: Observations** | 4 internal orbits |
| **Resources Required: Analysis** | 4 weeks FTE |
| **Products** | Reference p-flat and TIR or ISR as relevant. |
| **Accuracy Goals** | ~1% flat field accuracy |
| **Scheduling & Special Requirements** | 1 orbit every 3 months. |
| **Changes from Cycle 23** | None. |

# CCD Sparse Field CTE Internal
# Sean Lockwood

| | |
|---|---|
| **Purpose** | Re-establish an accurate correction for parallel register CTE losses that can be used for direct analysis of science data with negligible background. Do measurements for one gain setting (GAIN=4), alternating with GAIN=1 every-other-cycle. |
| **Description** | The sparse field CTE will be measured via internal calibration lamp observations taken through narrow slits. Using the onboard tungsten lamp, narrow slit images are projected at different positions on the detector. At each position a series of exposures is taken alternating between the 'A' and 'C' amplifiers for readout. The further the charge needs to be shifted to be read out, the more charge it will lose. For the parallel CTE measurement, the test will use the the cross disperser slits: 0.05x31NDB and 0.05x31NDA. In order to test the effects of different bias voltages the whole series of exposures are executed once for GAIN=4 and once for GAIN=1 every-other cycle; this process requires a total of 50 orbits per cycle which includes various sets of biases. For the CTE pixel based correction, the test requires 8 orbits for darks read out with amplifier A. |
| **Fraction GO/GTO Programs Supported** | 24% of STIS total exposure time (cycle 23) |
| **Resources Required: Observations** | 50 internal visits<br>(7/50 visits will exceed the 1800 s limit by ~100 s in order to capture the full sequence of exposures required for best analysis.) |
| **Resources Required: Analysis** | 3 FTE weeks |
| **Products** | Determine slope for time dependent empirical flux correction of CTE,<br>possible update of ccdtab reference file,<br>and a summary in the end of cycle ISR. |
| **Accuracy Goals** | 1% |
| **Scheduling & Special Requirements** | Schedule between 01 November 2016 and 01 January 2017.<br>Visits should execute in order. |
| **Changes from Cycle 23** | Data taken for gain=4 instead of gain=1; alternates every cycle. |

# STIS CCD Full-Field Sensitivity
# PI: John Debes

| | |
|---|---|
| **Purpose** | To monitor CCD sensitivity over the whole field of view. |
| **Description** | Measure a photometric standard star field in Omega Cen in 50CCD annually to monitor CCD sensitivity over the whole field of view. Keep the spacecraft orientation within a suitable range (+/- 5 degrees) to keep the same stars in the same part of the CCD for every measurement. This test will give a direct transformation of the 50CCD magnitudes to the Johnson-Cousins system for red sources. These transformations should be accurate to 1%. The stability of these transformations will be measured to the sub-percent level. These observations also provide a check of the astrometric and PSF stability of the instrument over its full field of view. All external orbits > 1800s. |
| **Fraction GO/GTO Programs Supported** | 24% |
| **Resources Required: Observations** | 1 external |
| **Resources Required: Analysis** | 1 FTE week |
| **Products** | Summary in the end of cycle ISR |
| **Accuracy Goals** | 1% |
| **Scheduling & Special Requirements** | ORIENT 310.0D TO 310.0 D; BETWEEN 15-JAN-2017:00:00:00 AND 20-MAR-2017:00:00:00 |
| **Changes from Cycle 23** | Deletion of 16 internal orbits to create dark and bias observations in Amp A used for testing of CTI in Cycle 23. |

# STIS Slit Wheel Repeatability
# PI: TalaWanda Monroe

| | |
|---|---|
| **Purpose** | To test the repeatability of slit wheel motions. |
| **Description** | A sequence of lamp spectra taken using grating G230MB and the three smallest long slits 52X0.1, 52X0.2, and 52X0.05. |
| **Fraction GO/GTO Programs Supported** | 100% |
| **Resources Required: Observations** | 1 internal orbit (24 exposures, ~40 minutes total) once per year |
| **Resources Required: Analysis** | 2 FTE days |
| **Products** | The average and maximum shifts observed in the dispersion and the spatial direction. Summary in end of cycle ISR |
| **Accuracy Goals** | Shifts should be smaller than 0.5 pixels. |
| **Scheduling & Special Requirements** | Between Nov 01-2016 and Jan 31 2017 |
| **Changes from Cycle 23** | No changes |

# STIS CCD Spectroscopic Sensitivity Monitor
# PI: TalaWanda Monroe

| | |
|---|---|
| **Purpose** | Monitor the spectroscopic sensitivity of the STIS CCD using both low- and medium-resolution gratings to reveal contamination issues that may affect the spectroscopic throughput. |
| **Description** | This program will monitor the STIS CCD spectroscopic sensitivity using a high-declination spectroscopic calibration star (AGK+81D266). The results will be compared to previous observations to detect trends. The L modes will be observed at the nominal and E1 positions every four months with one orbit per visit. The M modes will be observed at the nominal and E1 positions as well, once per year with two orbits per visit. |
| **Fraction GO/GTO Programs Supported** | 24%, Cycle 23 |
| **Resources Required: Observations** | 5 external orbits |
| **Resources Required: Analysis** | 7 FTE weeks: 3 FTE weeks for sensitivity analysis, 2 weeks for ISR, 2 FTE weeks for CTE correction verification |
| **Products** | Updated STIS TDSTAB file, an ISR on STIS sensitivity monitoring, summary in end of cycle ISR |
| **Accuracy Goals** | Minimum signal to noise of 50 per resolution element at the least sensitive wavelength. |
| **Scheduling & Special Requirements** | 1 orbit every 4 months for L modes. 2 orbits/year for M modes. |
| **Changes from Cycle 23** | No changes |

# STIS Focus Parallel Measurements
## Charles Proffitt

| | |
|---|---|
| **Purpose** | To determine the focus offset between the STIS OII filter and that of WFC3/UVIS and ACS/WFC. This will allow any long term secular changes in the relative focus of the three instruments to be determined. |
| **Description** | A UV bright star will be observed with STIS F28X50OII while parallel observations are done of rich star fields in 47 Tuc using WFC3 F410M and ACS F502N. This prime/parallel grouping is repeated 4 times for STIS+WFC3 using a small dither pattern. During two of these iterations there is also time to include a parallel ACS F502N image. Phase retrieval analysis should allow measurement of the relative focus of the three instruments independent of any uncertainties in the breathing model. |
| **Fraction GO/GTO Programs Supported** | 100% of STIS external observations are affected by the focus |
| **Resources Required: Observations** | 1 external orbit, 1 parallel orbit |
| **Resources Required: Analysis** | Estimate 2 FTE weeks |
| **Products** | A measurement of the focus offset between STIS and ACS and WFC3. Possible recommendations for adjustments to the STIS corrector. |
| **Accuracy Goals** | < 1 micron of equivalent secondary despace |
| **Scheduling & Special Requirements** | The ORIENT requirement of 255 to match previous iterations of this setup and ensure that the same stars are viewed in WFC3 and ACS will force execution of this program to occur between 26-May-2017 and 13-Jul-2017. |
| **Changes from Cycle 23** | None |

# STIS/MAMA Programs

# STIS MAMA Full-Field Sensitivity
# PI: John Debes

| | |
|---|---|
| **Purpose** | To monitor the sensitivity of the FUV-MAMA and NUV-MAMA over the full field |
| **Description** | By observing the globular cluster NGC6681 once every year at roughly the same orientation, we will monitor the full-field sensitivity of the MAMA detectors and their astrometric and PSF stability. These observations will be used to look for contamination, throughput changes, or formation of color centers in the photocathode and window that might be missed by spectroscopic monitoring or difficult to interpret in flat-fielding. Although this test is done using MAMA imaging modes, the confirmation of detector stability and uniformity provided by this monitor is important for spectroscopic observations as well. All orbits > 1800s. |
| **Fraction GO/GTO Programs Supported** | 76% of STIS prime exposure time |
| **Resources Required: Observations** | 3 external orbits |
| **Resources Required: Analysis** | 1 FTE week |
| **Products** | Summary in the end of cycle ISR |
| **Accuracy Goals** | 1% |
| **Scheduling & Special Requirements** | Should roughly match most common orient from previous observations. ORIENT 260.0D TO 266.0 D; BEFORE 16-JUN-2017:00:00:00 |
| **Changes from Cycle 23** | No Changes |

# STIS MAMA Spectroscopic Sensitivity & Focus Monitor / COS Observations of Geocoronal Lyα Emission

## PI: TalaWanda Monroe

| | |
|---|---|
| **Purpose** | Monitor the sensitivity of each STIS MAMA grating mode to detect any changes due to contamination or other effects, and monitor the STIS focus in spectroscopic and imaging modes. |
| **Description** | - SENSITIVITY: Obtain exposures in each of the two low-resolution MAMA spectroscopic modes every 4 months, in each of the 2 medium-resolution modes once a year, and in each of the 5 echelle modes every 3 months, using unique calibration standards for each mode (L: GRW+70D5824, M: AGK+81D266, E: BD+28D4211), and compare the results to the first observations to detect any trends.<br>- FOCUS: For this cycle we will continue to monitor the STIS focus (small aperture throughput as a function of UV wavelength) by including a direct comparison between the G230LB 0.1X0.09 and 52x2 throughput, as well as a narrow band OII CCD image during each L-Mode visit. We will continue to also include an OII image with the M-mode visit.<br>- AIRGLOW: COS/FUV airglow spectra will be obtained in parallel before move to LP4. |
| **Fraction GO/GTO Programs Supported** | Focus monitor: 100% of STIS exposures- Sensitivity monitor: 76% of STIS exposures- Airglow parallel: 45% COS exposures (Cycle 23) |
| **Resources Required: Observations** | 12 external orbits, 3 parallel COS orbits |
| **Resources Required: Analysis** | 6.5 FTE weeks: 3 FTE weeks for sensitivity analysis, 2 weeks for ISR, 1.5 for focus. No COS analysis planned. |
| **Products** | Updated STIS TDSTAB file and ISRs on STIS sensitivity monitoring and focus monitoring. Summary in the end of cycle ISR. |
| **Accuracy Goals** | Minimum signal to noise of 50 per resolution element at the least sensitive wavelength. 10% for focus changes. |
| **Scheduling & Special Requirements** | Visits need to be approximately equally spaced throughout the cycle. |
| **Changes from Cycle 23** | One fewer parallel COS visit. |

# STIS FUV MAMA Dark Monitor
## Sean Lockwood

| | |
|---|---|
| **Purpose** | Monitor the behavior of the dark current in the FUV MAMA detector,<br>provide data for dark count corrections for faint object observations,<br>and also provide a check on the health of the detector |
| **Description** | Every six weeks a set of six exposures of 1300s is taken with the FUV MAMA with the shutter closed. The exposures are evenly spread over a six-hour SAA-free period. |
| **Fraction GO/GTO Programs Supported** | 36% (cycle 23) |
| **Resources Required: Observations** | 54 internal visits |
| **Resources Required: Analysis** | 2 FTE |
| **Products** | Dark current images and temperature-dependent formula for applying to an individual observation. Update to monitoring webpage. |
| **Accuracy Goals** | 1% |
| **Scheduling & Special Requirements** | Groups of visits spaced apart ~every 6 weeks<br>SAA free |
| **Changes from Cycle 23** | None |

# STIS NUV MAMA Dark Monitor
## Sean Lockwood

| | |
|---|---|
| **Purpose** | Monitor the behavior of the dark current in the NUV MAMA detector,<br>provide data for dark count corrections for faint object observations,<br>and also provide a check on the health of the detector |
| **Description** | Every two weeks a set of two 1300 s exposures is taken with the NUV MAMA with the shutter closed. The exposures are taken separated by six hours within an SAA-free period. This separates long and short term temporal effects. |
| **Fraction GO/GTO Programs Supported** | 40% (cycle 23) |
| **Resources Required: Observations** | 52 internal visits |
| **Resources Required: Analysis** | 2 FTE |
| **Products** | Dark reference files and tables modeling time and temperature dependence of dark rates. Update to monitoring webpage. |
| **Accuracy Goals** | 1% |
| **Scheduling & Special Requirements** | Pairs of visits spaced apart every 2 weeks<br>SAA free |
| **Changes from Cycle 23** | None |

# STIS FUV MAMA Flat-Field Monitor
# PI: Molly Peeples

| | |
|---|---|
| **Purpose** | This program is aimed at obtaining FUV-MAMA flat-field observations to create new p-flats with a SNR of ~100 per (low resolution) pixel. The flats are obtained with the Krypton lamp and the MR grating G140M, similar to the cycle 17 and 18 programs. However the exact instrument setup (slit width and central wavelength) might change depending on the desired count level (which will be close to the internally allowed global rate limit). |
| **Description** | Past experience and observations have shown that ~11 visits are sufficient to create a cumulative image with ~2500 counts/pixel (high resolution mode, equivalent to ~10000 count/pixel in low resolution mode). We will start taking exposures with the setup G140M/52x0.1/1470 as in cycles 18, 20, and 22 programs. We will move to G140M/52x0.1/1420 if/when the global rate has decreased below 180000-190000 counts/sec (maximum allowed is ~280000 counts/sec). On the basis of past experience exposures will be at least 4740 sec long. Hence, all orbits exceed the 1800 s execution time. Different visits will have different slit offsets in order to illuminate the pixels which are normally shadowed by the slit bars. |
| **Fraction GO/GTO Programs Supported** | 36% of STIS total exposure time. |
| **Resources Required: Observations** | 11 internal orbits and all orbits > 1800s. |
| **Resources Required: Analysis** | 4 FTE weeks |
| **Products** | This cycle p-flat is for monitoring purposes. The achievable SNR is limited by the Poisson noise. If applicable a new reference p-flat will be created combining cycle 17, 18, 20, 22, and 24 FUV flats. ISR as applicable. |
| **Accuracy Goals** | 1.0%: Accuracy is per low-res pixel (2x2 high-res pixels). |
| **Scheduling & Special Requirements** | Similar to the NUV flat program, the observations are executed on alternate cycles, to save lamp lifetime. |
| **Changes from Cycle 23** | None. This program is run on even-numbered cycles. |

# STIS MAMA Fold Distribution
# PI: Thomas Wheeler

| | |
|---|---|
| **Purpose** | The fold analysis provides a measurement of the distribution of charge cloud sizes incident upon the anode providing some measure of changes in the pulse-height distribution of the MCP and, therefore, MCP gain. |
| **Description** | While globally illuminating the detector with a flat field, the valid event (VE) rate counter is monitored, while various combinations of row and column folds are selected. |
| **Fraction GO/GTO Programs Supported** | 76% of STIS prime orbits |
| **Resources Required: Observations** | 2 internal orbits |
| **Resources Required: Analysis** | 0.5 FTE day. |
| **Products** | The results will be sent to the STIS Team and V. Argabright of Ball Aerospace. |
| **Accuracy Goals** | N/A |
| **Scheduling & Special Requirements** | This proposal is executed annually. |
| **Changes from Cycle 23** | No changes. |

# Contingency Programs

# STIS MAMA Recovery from Anomalous Shutdown
# PI: Thomas Wheeler

| | |
|---|---|
| **Purpose** | Safe and orderly recovery of either MAMA detector from an anomalous shutdown. |
| **Description** | The recovery procedure consists of three separate tests (i.e. visits) to check the MAMA's health after an anomalous shutdown. Each must be successfully completed before proceeding onto the next. They are: (1) signal processing electronics check, (2) slow, intermediate voltage high-voltage ramp-up, and (3) ramp-up to full operating voltage. |
| **Fraction GO/GTO Programs Supported** | 76% of STIS prime orbits |
| **Resources Required: Observations** | 6 internal orbits |
| **Resources Required: Analysis** | If activated, 0.5 FTE day per test. |
| **Products** | For tests 1-3, only a Go/No-Go to proceed will be given. |
| **Accuracy Goals** | N/A |
| **Scheduling & Special Requirements** | This is a contingency proposal activated only in the event of an anomalous shutdown. This proposal is usually followed by the STIS MAMA Fold Distribution proposal. |
| **Changes from Cycle 23** | No changes |

# Cycle 23 Usage Statistics

# STIS Cycle 24 Phase Is Include Cycle 23 Usage Statistics

| Configuration/Mode | Percentage of STIS Prime Exposure Time | | Percentage of STIS SNAP Exposure Time | |
|---|---|---|---|---|
| | C22 | C23 | C22 | C23 |
| **CCD** | **26.4%** | **24.1%** | **100%** | **100%** |
| CCD/Imaging | 8.5% | 0.7% | -- | -- |
| CCD/Spectroscopy | 17.9% | 23.4% | 100% | 100% |
| **MAMA/FUV** | **42.1%** | **35.7%** | **--** | **--** |
| FUV/Imaging | 1.5% | 11.0% | --- | -- |
| FUV/Spectroscopy | 40.6% | 24.7% | -- | -- |
| **MAMA/NUV** | **31.5%** | **40.2%** | **--** | **--** |
| NUV/Imaging | 0.2% | 0.8% | --- | -- |
| NUV/Spectroscopy | 31.3% | 39.2% | -- | -- |

# STIS Cycle 23 Usage Statistics for each Grating/Mirror Combination

| Configuration/Mode | Grating/Mirror | Percentage of STIS Prime science Exposure Time | | Percentage of STIS SNAP science Exposure Time | |
|---|---|---|---|---|---|
| | | C22 | C23 | C22 | C23 |
| STIS/CCD | G230LB | 3.4% | 7.9% | --- | 59.7 |
| (24.1%) | G230MB | 0.03% | -- | --- | -- |
| | G430L | 1.9% | 6.4% | 52.1% | 15.7% |
| | G430M | 1.7% | 0.4% | --- | -- |
| | G750L | 9.4% | 7.6% | 47.9% | 24.6% |
| | G750M | 1.5% | 1.3% | --- | -- |
| | MIRROR/CORON | 8.5% | 0.7% | -- | -- |
| STIS/MAMA-FUV | E140H | 4.2% | 7.7% | --- | -- |
| (35.7%) | E140M | 12.6% | 4.4% | --- | -- |
| | G140L | 17.4% | 7.3% | -- | -- |
| | G140M | 6.4% | 5.3% | -- | -- |
| | MIRROR | 1.5% | 11.0% | --- | -- |
| STIS/MAMA-NUV | E230H | 0.7% | 14.8% | -- | -- |
| (40.2%) | E230M | 13.1% | 7.4% | --- | -- |
| | G230L | 17.4% | 17.2% | -- | -- |
| | MIRROR | 0.2% | 0.8% | --- | -- |

# Cycle 23 Instrument Usage Statistics Based on Approved Programs

- STIS orbits comprise ~14.3% of all GO prime orbits in Cycle 23

| Instruments | Prime Orbits Usage | SNAP Orbit Usage |
|---|---|---|
| ACS | 15.7% | 11.7% |
| COS | 18.0% | 7.3% |
| STIS | 14.3% | 6.7% |
| WFC3 | 52.0% | 74.3% |
| FGS | <0.01% | 0.0% |

# Cycle 24 STIS Special Calibration Program Plan

Tala Monroe
&
STIS Team

9/26/2016

# Routine STIS Spectroscopic Dispersion Solution Programs

# STIS CCD Spectroscopic Dispersion Solution Monitor
## PI: Molly Peeples

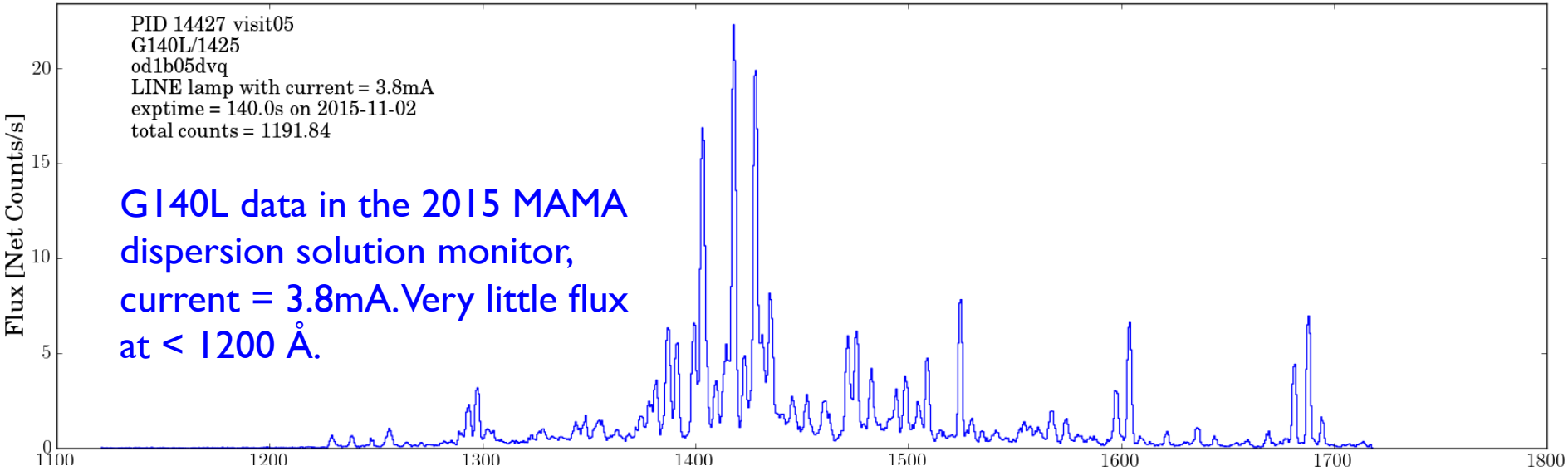
| | |
|---|---|
| **Purpose** | To monitor the wavelength and spatial distortion maps for some configurations of the STIS/CCD. |
| **Description** | Internal wavecals will be obtained with all 6 gratings (G230LB, G230MB, G430L, G430M, G750L, G750M) supported for use with the CCD. All observations will be obtained with the 52x0.1 aperture, which maps to 2 pixels at the CCD. As in previous cycles, the HITM1 lamp will be used, rather than the LINE lamp. The HITM1 lamp has a more favorable spatial illumination pattern, dropping by only a factor of 3 at row 900, relative to the peak brightness at row 420. |
| **Fraction GO/GTO Programs Supported** | 30% of STIS total exposure time. |
| **Resources Required: Observations** | 3 internal orbits |
| **Resources Required: Analysis** | 4 FTE weeks |
| **Products** | Update wavelength dispersion reference file as needed, ISR, and a summary in the end of cycle ISR. |
| **Accuracy Goals** | 0.2 pixels; wavelength accuracy for row 900. Wavelength coefficients are tabulated every 32 rows in the CCD dispersion (_dsp) reference file. Exposure times in this program have typically been chosen to yield a S/N ratio of at least 10 per pixel in row 900 after combining 32 rows. This constraint must be satisfied in the left, middle, and right thirds of the image. Existing HITM1 wavecals were used to estimate exposure times assuming no significant degradation since Cycle 18. |
| **Scheduling & Special Requirements** | These observations are taken once per cycle |
| **Changes from Cycle 23** | No changes. |

# STIS MAMA Spectroscopic Dispersion Solution Monitor
## PI: Molly Peeples

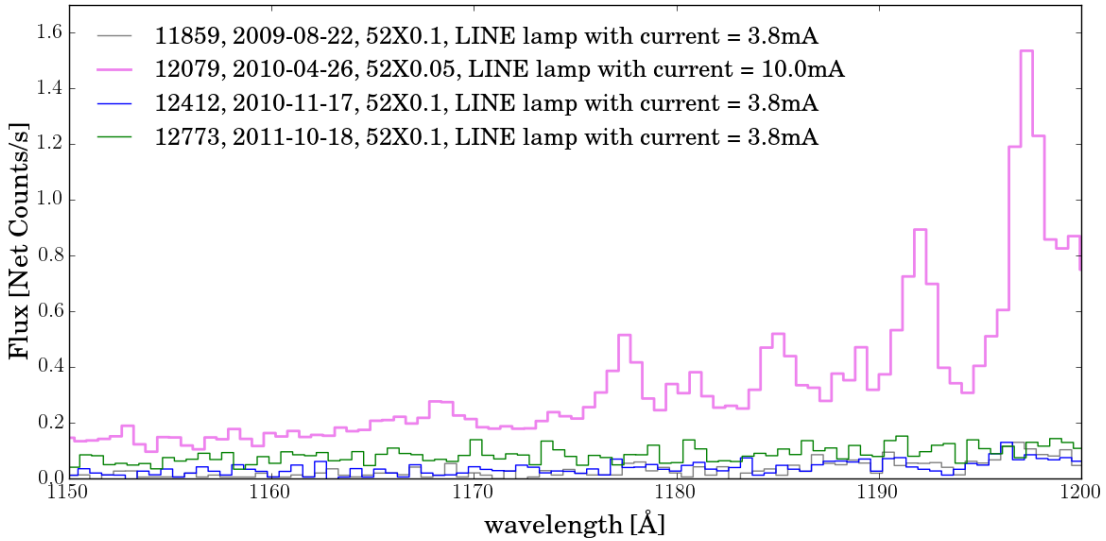
| | |
|---|---|
| **Purpose** | To monitor the wavelength dispersion solutions of some STIS MAMA configurations. |
| **Description** | Internal wavecals will be obtained in all gratings at primary and secondary central wavelengths chosen to cover Cycle 24 use. There is also overlap with choices of configurations used with previous calibration programs which will enable long-term monitoring. This program uses the LINE lamp for a total of approximately 8 hours, typically at a lamp current of 10 mA, consuming about 0.5% of the 15000 mAhour lifetime. Extra-deep wavecals are included for some echelle modes and for some first order modes to ensure detection of weak lines. All orbits < 1800s. |
| **Fraction GO/GTO Programs Supported** | 55% of STIS total exposure time. |
| **Resources Required: Observations** | 7 internal orbits |
| **Resources Required: Analysis** | 4 FTE weeks |
| **Products** | Update wavelength dispersion reference file as needed, ISR, and a summary in the end of cycle ISR. |
| **Accuracy Goals** | 0.1 pixels internal wavelength precision. |
| **Scheduling & Special Requirements** | These observations are taken once per cycle |
| **Changes from Cycle 23** | We will enforce that the medium current of 10mA is used for all modes, as is done for auto wavecals taken by GOs, as opposed to the 3.8mA this program used previously. This will give us both deeper wavecals in the 3 relevant modes as well as allow us to more easily track the fading of the LINE lamp with time. |

# STIS MAMA Spectroscopic Dispersion Solution Monitor
## PI: Molly Peeples

Changing the current from 3.8mA to 10mA: an example with G140L




G140L data in the 2015 MAMA dispersion solution monitor, current = 3.8mA. Very little flux at < 1200 Å.




For fixed aperture, expect ~20x more flux for 3.8mA→10mA with the LINE lamp. With how fast this lamp is fading at bluer wavelengths, this will help us both improve monitoring of both the dispersion solution and the fading of the LINE lamp.

# STIS Special Program

# Monitoring the 3 Primary WD Standard Stars
## Ralph Bohlin

| | |
|---|---|
| **Purpose** | Verify the spectrophotometric stability of the stars observed for the MAMA and CCD spectroscopic sensitivity monitors in the low-resolution gratings, to reveal any intrinsic changes in brightness not caused by sensitivity changes. |
| **Description** | Three hydrogen white dwarfs, G191B2B, GD153, and GD71, will be observed with the L-mode gratings to reveal any variability in observations of GRW+70D5824 and AGK+81D266, which are routinely monitored every 4 months in the L-modes. A lapse of three years in observations of the three standards necessitates a return visit in Cycle 24. All spectroscopic observations rely on TDS corrections derived from observations of GRW+70D5824 and AGK+81D266. Verification of the stability of the monitor stars is crucial for maintaining absolute flux calibration uncertainties. Observations requested: 1 orbit for G191B2B G230LB, G430L, and G750L CCD observations, two orbits each for GD153 and GD71 with G140L and G230L MAMA observations and G230LB, G430L, and G750L CCD observations. |
| **Fraction GO/GTO Programs Supported** | 85% of STIS prime exposures |
| **Resources Required: Observations** | 5 external orbits |
| **Resources Required: Analysis** | 5 FTE weeks: 3 FTE weeks for sensitivity analysis, 2 weeks for ISR |
| **Products** | Increased knowledge of uncertainties in the TDS, verification of the TDS corrections in the TDSTAB, summary in end of cycle ISR |
| **Accuracy Goals** | 1%; Minimum signal to noise of 50 per resolution element at least sensitive wavelength |
| **Scheduling & Special Requirements** | SAA-free orbits; no monthly offset |
| **Changes from Cycle 23** | New program |

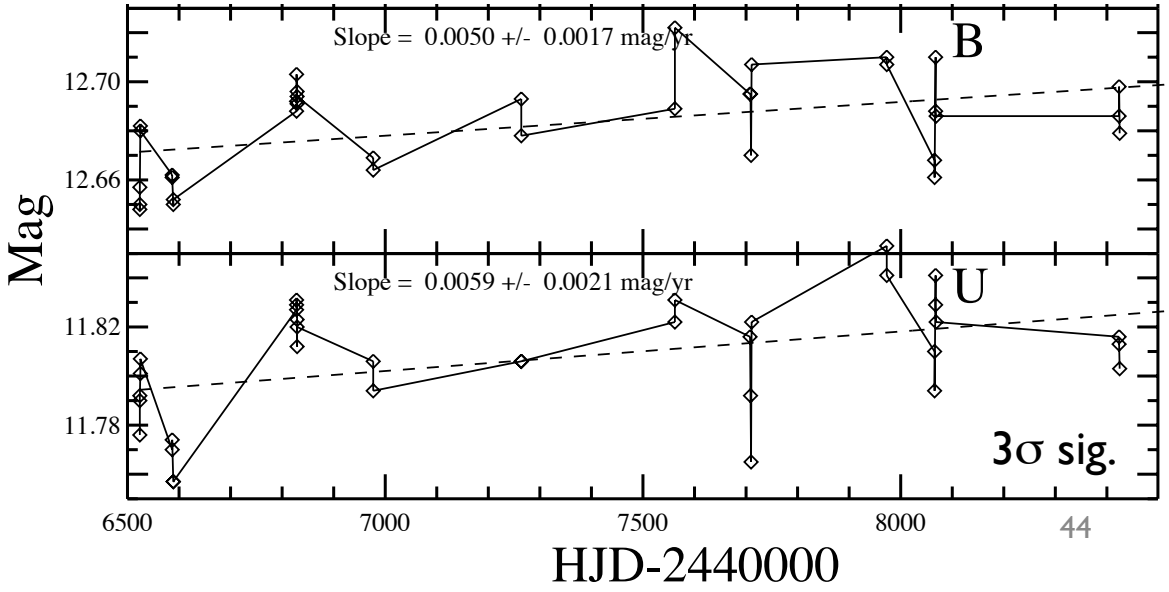
- Fundamental standard stars should be observed to safe-guard against possible variability of the sensitivity monitor stars, GRW+70D5824 and AGK+81D266.

- Historically, STIS observed three standard WD stars, as frequently as every year, but there was a lapse in observations the past three years.

- Brighter G191B2B requires one orbit and can only be observed with the CCD modes G230LB, G430L, and G750L.

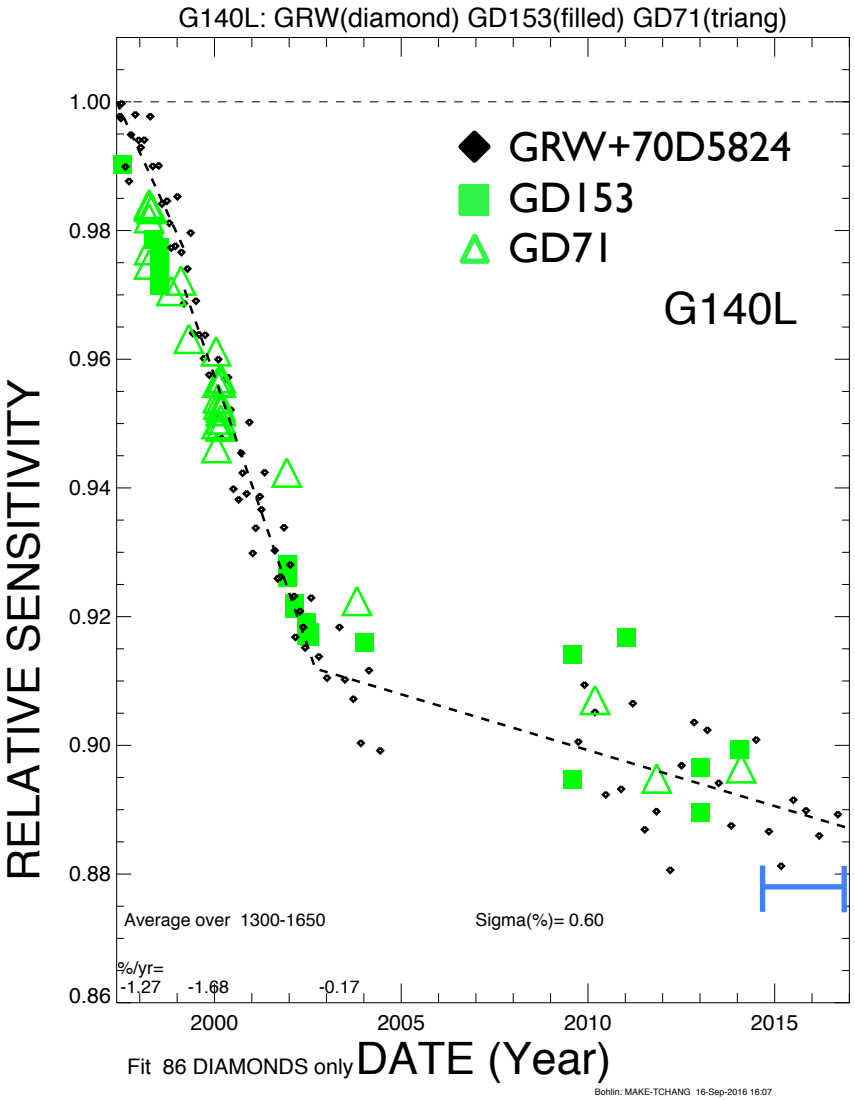
- Fainter WDs GD153 and GD71 will be observed with CCD modes, plus MAMA modes G140L and G230L, and will require two orbits each.

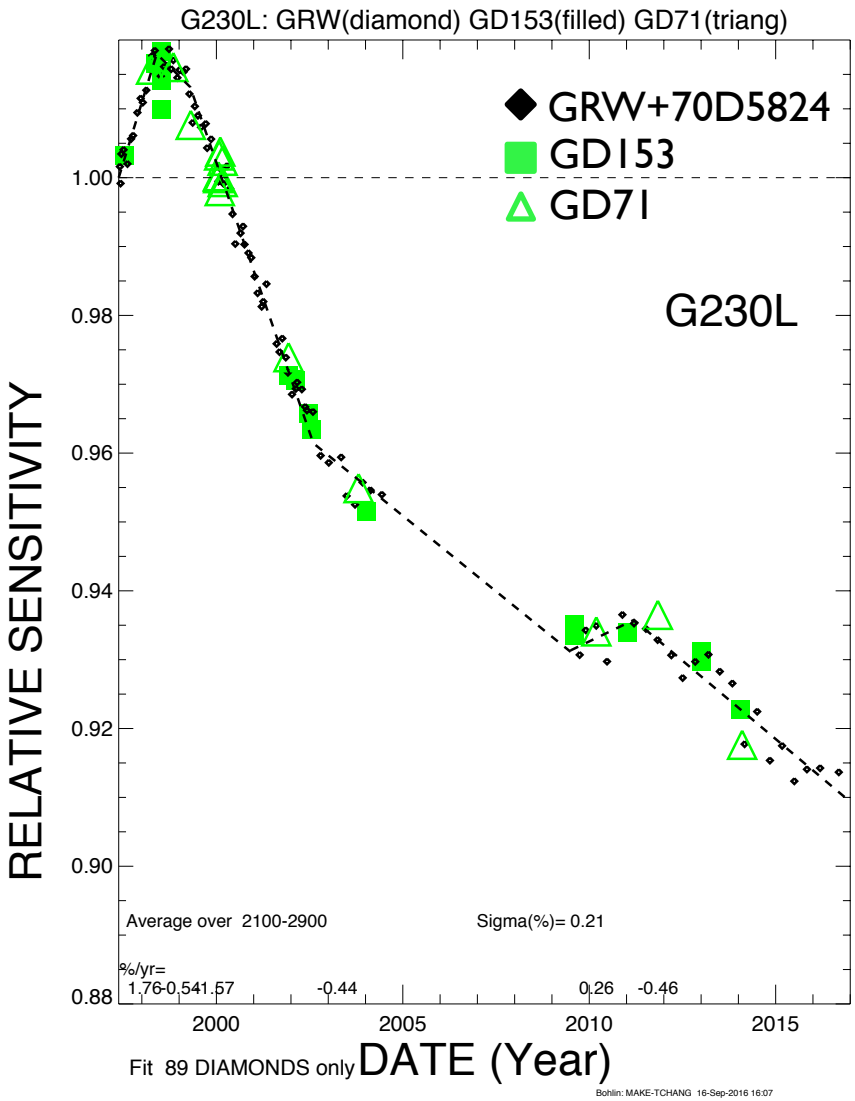
Ground-based photometry hints at possible long-term variability of GRW +70D5824 (Bohlin & Landolt 2015)



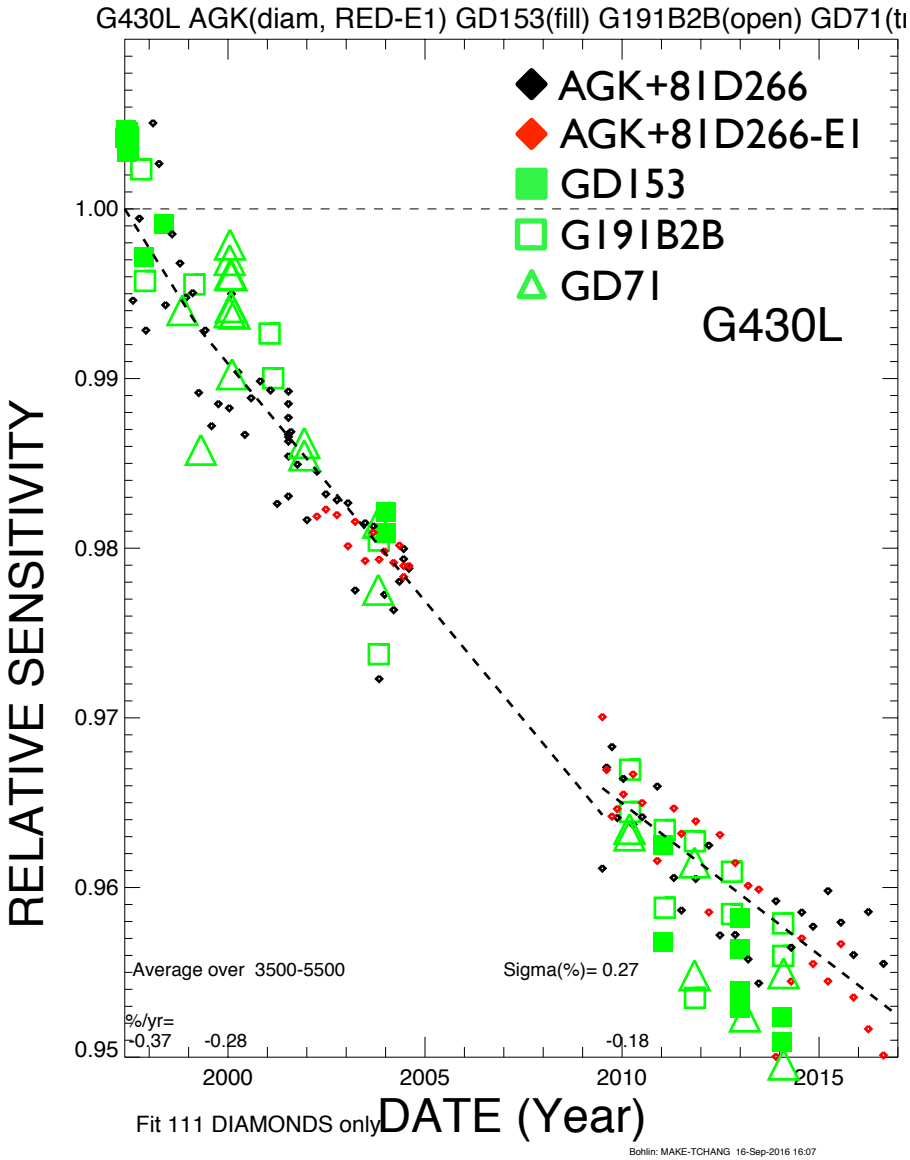
# MAMA Spectroscopic Sensitivity Trends

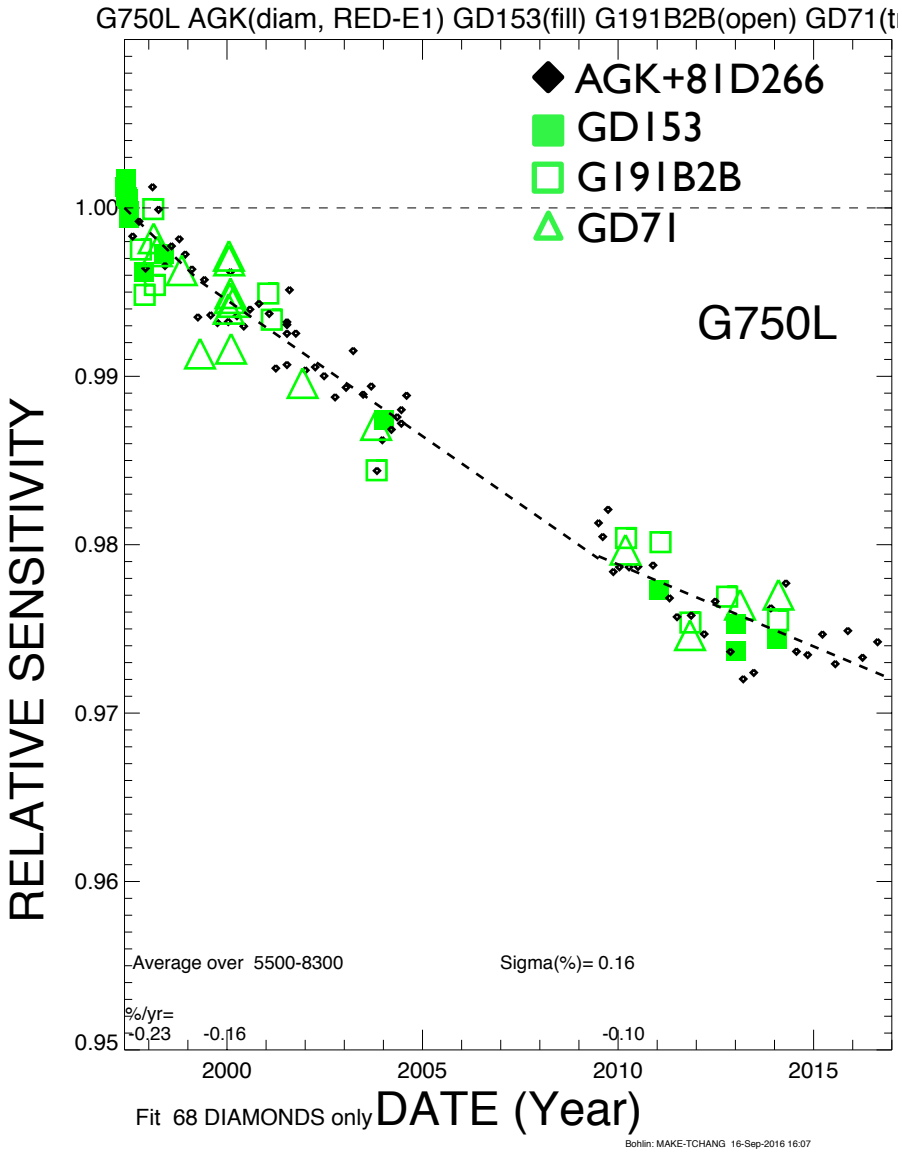
## A lapse of ~3 years has occurred since last observations



# CCD Spectroscopic Sensitivity Trends



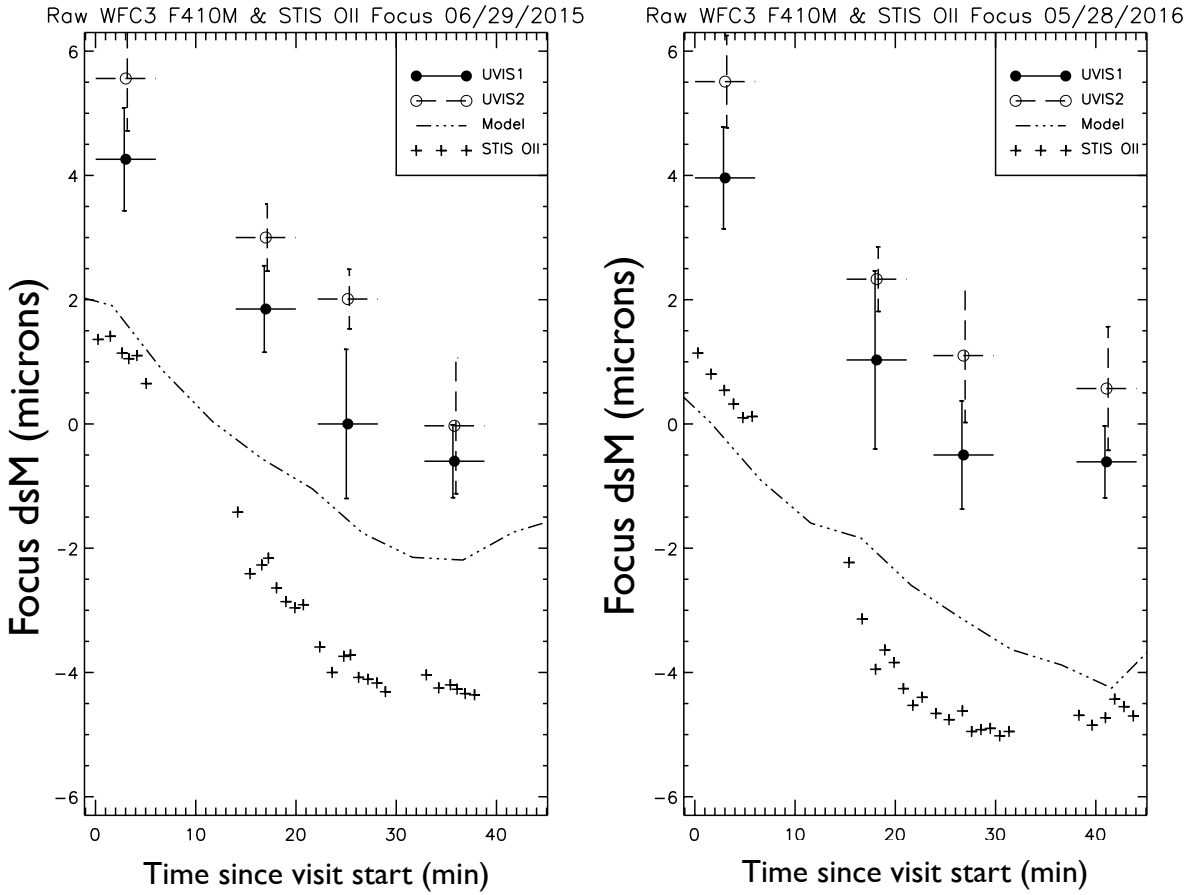



# Contingency Program

# STIS Focus Parallel Measurements
# Charles Proffitt

| | |
|---|---|
| **Purpose** | To determine the focus offset between the STIS OII filter and that of WFC3/UVIS and ACS/WFC. This will allow any long term secular changes in the relative focus of the three instruments to be determined. |
| **Description** | A UV bright star will be observed with STIS F28X50OII while parallel observations are done of rich star fields in 47 Tuc using WFC3 F410M and ACS F502N. This prime/parallel grouping is repeated 4 times for STIS+WFC3 using a small dither pattern. During two of these iterations there is also time to include a parallel ACS F502N image. Phase retrieval analysis should allow measurement of the relative focus of the three instruments independent of any uncertainties in the breathing model. |
| **Fraction GO/GTO Programs Supported** | 100% of STIS external observations are affected by the focus |
| **Resources Required: Observations** | 1 external orbit, 1 parallel orbit |
| **Resources Required: Analysis** | Estimate 2 FTE weeks |
| **Products** | A measurement of the focus offset between STIS and ACS and WFC3. Possible recommendations for adjustments to the STIS corrector. |
| **Accuracy Goals** | < 1 micron of equivalent secondary despace |
| **Scheduling & Special Requirements** | The ORIENT requirement of 255 to match previous iterations of this setup and ensure that the same stars are viewed in WFC3 and ACS will force execution of this program to occur between 26-May-2017 and 13-Jul-2017. |
| **Changes from Cycle 23** | None. Will request to activate program if focus monitor indicates significant focus change. |

# STIS Focus Parallel Measurements




The focus offset between STIS F28X50OII images and other cameras can be used to monitor the stability of the STIS focus over time.

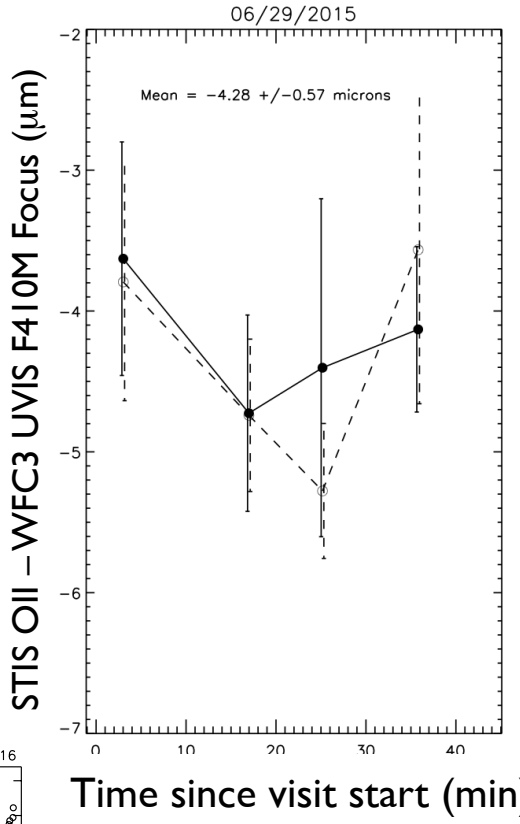
The WFC3 UVIS F410M images of 47 Tuc taken in program 14063 in Cy 22 and 14425 in Cy 23 provide dozens of stars suitable for phase retrieval. The ACS WFC F502N images provide several additional stars.

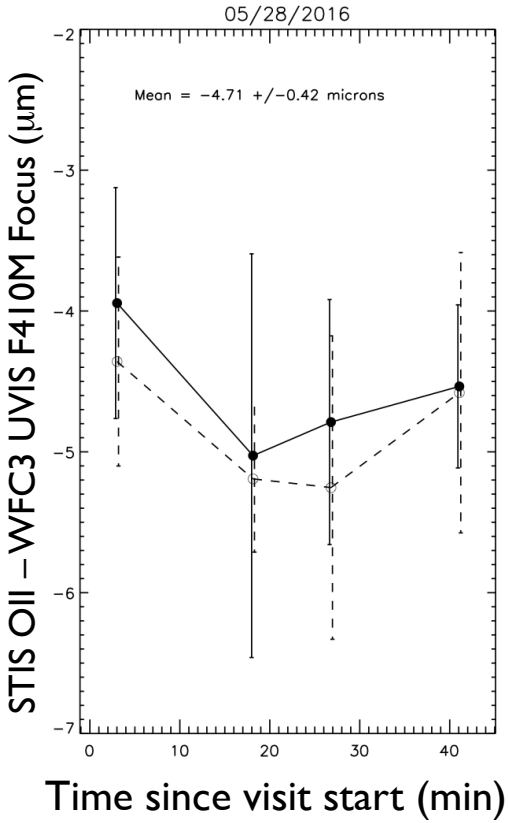
- Visits of 47 Tuc field provide a direct measure of the stability of the STIS focus over time

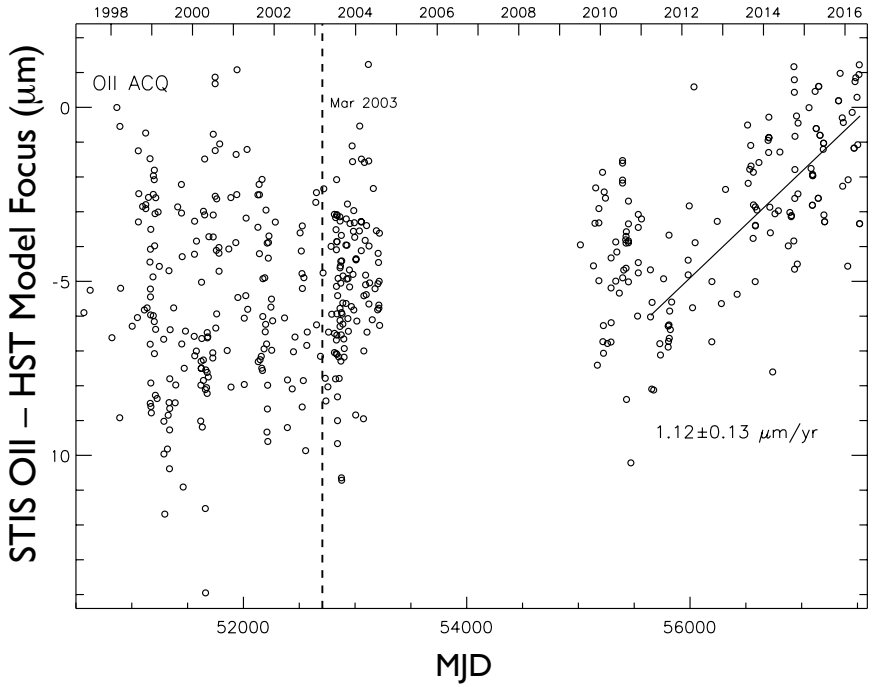
- Repeating the exact pointing and exposures provide a good differential measurement, regardless of any systematic uncertainties

- Taking parallel images with three instruments provides a measurement that is independent of the focus model

Results from Cy 22 and Cy 23 programs indicate the focus difference between STIS OII and WFC3 has been ~constant over the last year.




We will request to activate the program if the focus monitor and GO ACQs indicate a significant focus change.

# Backup Slides

# STIS Sensitivity Accuracies

- Uncertainties specified in STIS IHB.

| Attribute | Accuracy | Limiting Factors |
|---|---|---|
| **CCD Spectroscopic Accuracies** | | |
| Absolute photometry[a] | | Instrument stability<br>Correction of charge transfer efficiency |
| L modes | 5% | Time dependent photometric calibration |
| M modes | 5% | Fringe correction (for λ > 7500 Å) |
| Relative photometry[b] (within an exposure) | | Instrument stability<br>Correction of charge transfer efficiency<br>Time dependent photometric calibration |
| L modes | 2% | Fringe correction (for λ > 7500 Å) |
| M modes | 2% | |
| **MAMA Spectroscopic Accuracies** | | |
| Absolute photometry[c] | | Instrument stability<br>Time dependent photometric calibration |
| L modes | 4% | |
| M modes | 5% | |
| Echelle modes[d] | 8% | |
| Relative photometry (within an exposure)[e] | | Instrument stability<br>Flat fields<br>Echelle modes: |
| L modes | 2% | Blaze shift correction accuracy |
| M modes | 2% | Scattered light subtraction |
| Echelle modes[f] | 5% | |