SM3B Orbital Verification Plan for STIS

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## Overview of STIS Proposals for SMOV3B

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**Orbit Notes:** C=CCD, M=MAMA, I=Internal, E=External, R/T=Real Time
These targets are suitable for STIS02, STIS04, and STIS05.

Targets 1, 2, 3, 5, and 7 cover all possible BEA dates.

Targets 1, 2, 5, and 7 will be observed before SM3B as part of STIS00.

Targets 4 and 6 are too bright for STIS05 (End of BEA Test).
STIS01: CCD Functional

- **Requirements:**
  - J.10.4.5.1.1 (Minifunctional tests shall be executed)
  - J.10.4.5.1.2 (Ability of the TEC shall be tested)
  - J.10.4.5.4.1.1 (Measure noise without NCS operating)

- **Description:** Measure CCD read noise from multiple bias frames in standard science modes: Amp=D, Gain={1,4}, Binning={1x1,2x2}. Verify that CCD achieves –83 C.

- **Dependencies:** Before NCC turn-on.

- **Duration:** 6 internal CCD orbits.

- **Data:** 24 MBytes.

- **Analysis:** Build difference images from bias frame pairs. Get read noise from Gaussian fit to histogram of data values in difference images. CCD temperature from telemetry.
STIS02: Image Quality

- **Requirements:**
  - J.10.4.5.3.1 (Measure focus and aperture throughput)
  - J.10.4.5.3.5.2 (Measure image quality with/without NCC)

- **Description:** Measure STIS/OTA focus from \[\text{OII}\] image. Map PSF width with G230LB spectra through small aperture stepped in cross pattern across point source.

- **Dependencies:** After STIS01. Before and after NCC turn-on.

- **Duration:** 3 external CCD orbits per iteration. 2 iterations.

- **Data:** 9 MBytes per iteration.

- **Analysis:** Phase retrieval of \[\text{OII}\] image. Measure relative aperture throughput versus aperture offset. Compare results with nominal behavior. Analog of STIS bimonthly monitoring program, perhaps with a different target.
Requirements:
- J.10.4.5.4.1 (Track dark rate variations with temperature)

Description: Measure MAMA dark rates at temperatures not available during normal operation. Improve phosphorescence model in anticipation of cooler operating temperatures with ASCS after SM4.

Dependencies: First MAMA proposal to execute. May be skipped. MAMA high voltage may not be turned on until at least 4 days after release (J.10.4.5.1.1).

Duration: 2 internal MAMA orbits per iteration. 3 iterations on successive SAA-free passages.

Data: 32 MBytes per iteration.

STIS04: Jitter Test

- **Requirements:**
  - J.10.4.5.3.5.2 (Measure image quality with/without NCC)

- **Description:** Image a point source with the FUV-MAMA in TIMETAG mode to search for image jitter at frequencies from 0.1 to 100 Hz. Expect 100 counts/sec from point source. Use filter to minimize geocoronal Ly-α background.

- **Dependencies:** Before and after NCC turn-on. Nominally follows STIS03. MAMA high voltage may not be turned on until at least 4 days after release (J.10.4.5.1.1).

- **Duration:** 2 external MAMA orbits per iteration. 2 iterations.

- **Data:** 16 MBytes per iteration.

- **Analysis:** Bin data into 0.05 second intervals. Measure X and Y centroids for each interval. Calculate power spectra of centroids versus time. Compare with Monte Carlo simulations. STIS00 will demonstrate feasibility prior to SM3B.
**STIS05: End of BEA Test**

- **Requirements:** SMOV operational constraint.

- **Description:** Measure FUV sensitivity with a G140L spectrum of a flux standard visible during BEA. Use a large aperture. Performance consistent with pre-SM3B sensitivity will trigger the end of BEA.

- **Dependencies:** First measurement should be at least 7 days after release to allow for decontamination. Prerequisite for leaving BEA.

- **Duration:** 1 external MAMA orbit. Repeat if necessary.

- **Data:** 16 MBytes.

- **Analysis:** Compare measured sensitivity with nominal performance. Analysis will require 2 days. 4 new standards will be observed in STIS00 to accommodate any BEA period.
STIS06: Contamination Monitor

- **Requirements:**
  - J.10.4.5.1.6.2 (Sensitivity shall be monitored periodically)

- **Description:** Monitor sensitivity with spectra of the same flux standard (GRW+70D5824) used in STIS bi-monthly sensitivity monitoring. Use a large aperture.

- **Dependencies:** Begin program in first week after leaving BEA. Normal science may execute in parallel.

- **Duration:** 2 external MAMA and CCD orbits. Repeat weekly for 6 weeks.

- **Data:** 32 MBytes per iteration.

- **Analysis:** Compare measured sensitivity with nominal performance. Analysis will require 2 days after each iteration.
STIS07: CCD Biases

- **Requirements:**
  - J.10.4.5.4.1 (Read noise shall be monitored periodically)
  - J.10.4.5.4.1.1 (Measure noise with NCC operating)

- **Description:** Measure CCD read noise from multiple bias frames in standard science modes: Amp=D, Gain={1,4}, Binning={1x1,1x2,2x1,2x2}.

- **Dependencies:** Prerequisite for transition to normal science operation with CCD. If possible, begin prior to STIS04.

- **Duration:** 1 internal CCD orbit. Repeat daily. Transition to analogous calibration program when normal science begins.

- **Data:** 40 MBytes per iteration.

- **Analysis:** Include darks in normal pipeline processing of science (and SMOV, if possible) images. Compare with noise measured in STIS03 (CCD Functional) obtained with NCC off.
STIS08: CCD Darks

- **Requirements:**
  - J.10.4.5.4.1 (Dark rate shall be monitored periodically)

- **Description:** Dark frames will be obtained daily, as during normal science operations, to track hot pixel evolution.

- **Dependencies:** Prerequisite for transition to normal science operation with CCD. If possible, begin prior to STIS02 (Image Quality) to facilitate SMOV program.

- **Duration:** 1 internal CCD orbit. Repeat daily. Transition to analogous calibration program when normal science begins.

- **Data:** 6 MBytes per iteration.

- **Analysis:** Include darks in normal pipeline processing of science (and SMOV, if possible) images.
STIS09: MAMA Darks

**Requirements:**
- J.10.4.5.4.1 (Dark rate shall be monitored periodically)

**Description:** MAMA dark frames will be obtained weekly, as during normal science operations, to track evolution.

**Dependencies:** Prerequisite for transition to normal science operation with MAMA detectors. If possible, begin when STIS03 (MAMA Dark vs. Temp.) to continue monitoring of dark rate as a function of temperature.

**Duration:** 2 internal MAMA orbits. Repeat weekly. Transition to analogous calibration program when normal science begins.

**Data:** 8 MBytes per iteration.

**Analysis:** Include darks in normal pipeline processing of science (and SMOV, if possible) images.
STIS00: Pre-SM Calibration

- **Requirements**: Required for successful execution of STIS04 (Jitter Test) and STIS05 (End of BEA Test).

- **Description**: Prior to SM3B, perform 1 iteration of STIS04 on any suitable target, and perform STIS05 on 4 new flux standards required to accommodate BEA at any time of year.

- **Dependencies**: Prerequisite for execution of STIS04 and STIS05 during SMOV3B.

- **Duration**: 2+4 external MAMA orbits prior to SMOV3B.

- **Data**: (80 Mbytes prior to SM3B).

- **Analysis**: See descriptions of STIS04 and STIS05.
STIS20: Corrector Alignment

- **Requirements:**
  - J.10.4.5.3.1 (If throughput is significantly substandard, the STIS corrector may be adjusted).

- **Description:** If an adjustment of the STIS corrector is needed, obtain images of a point source while stepping through corrector positions. Use phase retrieval to determine best focus. Set corrector at best focus.

- **Dependencies:** Contingency.

- **Duration:** External CCD orbits. Real time commanding.

- **Data:** (44 Mbytes per iteration).

- **Analysis:** Phase retrieval of images obtained during focus sweep will be used to determine the best focus. Analogous to the SM2 program used initially to position the corrector.
Dependencies on Timely Analysis

- **NCC Turn-on** may occur once STIS01 (CCD Functional), STIS02 (Image Quality), and STIS04 (Jitter Test) have executed. There is no need to wait for analysis results.

- **End of BEA** cannot occur until data from STIS05 (End of BEA Test) have been analyzed. Analysis will require 2 days.

- **Beginning of Normal Science** cannot occur until data from both iterations of STIS02 (Image Quality) and STIS04 (Jitter Test) have been analyzed, and noise measures from STIS01 (CCD Functional) and STIS07 (CCD Biases) have been compared. Analysis may require up to 4 days.

- **Beginning of Normal Science** may occur once STIS08 (CCD Darks) and STIS09 (MAMA Darks) begin, even if analysis is incomplete.

- In general, STIS SMOV3B programs execute in sequence, but do not depend on analysis of preceding programs.
J.10.4.5.2.1 - Determine location of STIS reference aperture with respect to FGS reference frame.

- Target acquisition and peakup in STIS02 (Image Quality) are adequate to test whether STIS moves in SM3B.
- In SMOV3A, measurements of a rich astrometric field showed no motion of STIS with respect to existing frame.
- STIS is not expected to move in SM3B.

J.10.4.5.3.2 - For each optical element and detector, compare location of slit image with pre-SM3B values.

- This requirement was predicated on the assumption that the STIK would be installed in SM3B, potentially deforming the optical bench.
- Abnormal offsets are plausible only if the STIK is installed.