OSG Cycle6 Calibration Plan

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ABSTRACT

This report summarizes the Observatory Support Group calibration plans for cycle 6. The plan consists of routine and special calibration programs with a total required spacescraft time of 30 orbits. A description of the scientific motivation and requirements for each individual program is given.

1. Introduction

The Observatory Support Group (OSG) centralizes and coordinates calibration programs that run across instruments or are essential for the operation of HST as an observatory. Note that these should not be confused with the engineering -level observatory calibrations that are performed as well. The OSG cycle 6 calibrations can be divided into two separated classes, the routine and the special calibrations.

The routine calibration programs are designed to monitor aspects of the HST performance like the focal plane stability. Typically, observations are repeated at various times during each cycle. The special calibration programs are designed to (1) cover calibration issues that affect more than one instrument, e.g. establishment of absolute standards, or (2) to re-assess HST operational constraints like the impact of background light at low limb angle.

This document explains in detail the scientific justification of each of the planned calibration programs as well as the requirements, accuracy and final products. This information is available on the OSG WEB pages (http://www.stsci.edu/ftp/instrument_news/Observatory/cycle6.html). Also available on the OSG WEB page is a general overview of the HST cycle 6 calibration plan and the links to the specific calibration plans of each instrument.

Proposal 6961/2: OSG Cycle 6: Focal Plane Stability Monitor

Plan

Purpose: To monitor the positions of the science instrument target apertures, referenced to a WFPC2 fiducial and the FGS V2V3 vehicle frame. The purpose of the program is to detect and delineate sources of focal plane evolution, support accurate and reliable target acquisition, assess pointing performance and develop operational strategy for new instruments.

Description: At various times in the 8 months when M35 is available, each SI acquires a target in the M35 cluster, chosen so that in parallel, several cluster stars are imaged in WFPC2. The same pair of guide stars is used for each spring orientation and another pair for each fall orientation. The M35 cluster astrometry is known to approximately 25 mas. By including all instruments in the test we aim to distinguish between movements of individual instruments and that of the FGS V2V3 system. The results of the measurements are also used to evaluate the accuracy of the FGS-FGS rotation matrices. We propose to make one measurement in the fall of 1996, one in the spring before the servicing mission. The duration of the test may need to be extended from 4 orbits to 5 or 6 because of the lack of an engineering tape recorder and the need to have direct line of sight viewing to TDRS. An early cycle 7 post-SMOV observation is being planned to include the new SIs.

Fraction of GO Programs Supported: 100%

Resources:

   Observation: 6 orbits per pre-SMOV visits. Total 12 orbits.

   Analysis: Analysis of the observations will take approximately 0.3 FTE over one year.

Special Requirements: Specific orientations to within 0.1 degrees. Test performed as SEQ No GAP. Engineering telemetry mode H, and specific TDRS contacts to assure guide star data.

Accuracy: given the catalog accuracy of 25 mas it is reasonable to expect to be able to detect shifts a small as 50 mas. Due to uncertainties in defining positions in the apertures, the FGS/FGS alignment errors, and instrument detector motions, the limits of our precision are in the range 60 to 100 mas. The accuracy requirement is 0.1 arcsec and the accuracy goal is 0.05 arcsec.

Products: Trend analysis of focal plane stability. Indication of when to update instrument apertures and FGS alignment matrices. Methods for efficient target acquisition scenarios for new instruments. Trouble shooting.

Proposal 6925: FOS Spectra of Solar Analogs

Plan

Purpose: Establish NICMOS standards as HST spectrophotometric standards

Description: We request FOS observations of three selected solar analog stars to obtain an accurate absolute spectrophotometry of faint red stars in the 2200A to 8400A wavelength range. These selected stars will be the primary standards for the absolute calibration of the near-infrared camera (NICMOS). The FOS spectra will be used in evaluating the accuracy of the method and assumptions behind the absolute calibration of NICMOS. The IDT proposed calibration is based on broad band photometry of these stars, which defines the absolute flux by assuming that the intrinsic spectra are identical to the solar spectrum. A detailed analysis of the differences in the spectral features and energy distribution of the selected G stars with respect to the reference spectrum of the Sun will be performed.

So far, all HST standards are blue hot stars, or white dwarfs with colors B-V < -0.1. The four selected G stars will then be established as new HST standards and added to the current sample of HST absolute calibration standards. These new faint red (B-V ~ +0.65) G stars are needed in the calibration of the WFPC2 in order to measure broadband calibration differences for precisely known flux distributions for red stars, as well as the for blue stars that are currently used. Future HST spectrographs (STIS) can also make use of these red faint HST standards to measure levels of grating scattered parasitic light.

Each star will be observed twice to reduce the statistical uncertainty in the FOS repeatability from visit to visit.

Fraction of GO Programs Supported: all future NICMOS programs.

Resources:

Observation: 18 orbits: 3 orbits per target (1 for adquisition, 1 for G270H, 1 for rest of gratings) x 3 targets x 2 times.

Analysis: 0.2 FTE including data reduction and analysis as well as delivery of final product and documentation.

Special Requirements: observations to be scheduled between June and October 1996. Analysis finished by January 1997 before NICMOS is in place.

Accuracy: Final accuracy in the absolute flux depends on the pointing accuracy, temporal changes in the flat fields, and scattering effects in the ultraviolet. A similar program for the white dwarf standard stars gave a final accuracy of 2% for the absolute flux of these stars. For the solar analogs the requirement will be to have a final abolute flux with an uncertainty of 3\% in the optical, and 10\% in the ultraviolet. The goals would be to have a 2\% uncertainty in the optical and 5\% in the UV.

Products: The final absolute flux calibrated spectra of the stars will be included in the CALSPEC directory of HST calibration standards. An instrument science report explaining the results will also be issued.

Proposal 6963: OTA Calibration at Low Limb Angle

Plan

Purpose: Justify reduction of bright earth constraints to increase target viewing time and extend the declination bands of the continuous viewing zone regions. Verify the extent of variation in earth albedo, that the variation of diffuse earth and zodiacal light background in the focal plane is small, and that the UV background (non-Lyman-alpha atmospheric glow) is small at low limb angle. Calibrate the SEAM model at low limb angle up to the non-thermal background limited NIR.

Description: Schedule a set of one or more 1-minute F606W or F814W WFPC exposures on gyroscope pointing control upon termination of data taking prior to occultation over the sun-lit earth. To obtain coverage of the bright limb angle range 15.5 - 20.0 degrees at small solar-zenith angle, the constraint will be adjusted to 15.5 degrees and placement on a flight calendar will be limited to long visibility intervals for which the day/night terminator is far from the field-of-view. The least possible limb angle variation is thereby guaranteed for an adequately illuminated earth limb. Progress in scheduling fifty observations will be monitored and the constraint adjusted if necessary to provide adequate distribution in limb and solar-zenith angle.

Observations needed to support NICMOS SMOV shall be identified and scheduled so that model calibration in the NIR can be completed by December 1996.

The results of the analysis - measurement of background flux and variation across the image - will be used to determine the variation in earth albedo and to determine the optimized and worst case model calibration. Existing FOS data at large limb angle (D. Elkin was a co-I) from the HDF program will be used to justify extrapolation to the UV at low limb angle to the extent possible.

Fraction of GO Programs Supported: 15% - 20%

Resources:

   Observation: One-minute exposure duration, scheduled in sets of one or more prior to occultation on a no impact basis.

   Analysis: Analysis of the observations including software development are expected to take 0.3 - 0.5 FTE

Special Requirements: Gyroscope PCS control. The bright earth constraint shall be set to 15.5 degrees with the capability to adjust if necessary during the program. Schedule only when visibility duration is long and terminator is away from the field-of-view. Engineering telemetry mode H

Accuracy: A factor of 2 for the data spread and calibration, but typically within 20%. A 3-sigma worst case calibration accuracy.

Products: Model validation, determination of acceptable constraint reductions and recommendations for planning and scheduling

Table 1: OSG Cycle 6 Calibration Plan

ID	Proposal Title	Frequency	Estimated Time (orbits)		Required Resources (FTE)	Products	Accuracy
			"External"	"Internal"			
Routine Monitoring Programs							
6961 & 6962	Focal Plane Stability Monitor	2 visits cycle 6	12		0.3	Trend analysis	0.1 arcsec
Special Calibration Programs							
6925	FOS Spectra of Solar Analogs	2 visits per target	18		0.2	Calspec	3%
6963	OTA Calibration at Low Limb Angle	50 exposures		50 exposures	0.3-0.5	revised CVZ limits	
TOTAL TIME (including all executions)			30		0.8-1.0		