User Information Report UIR-2007-004

All About Survey Programs

Information, Rules and Guidelines for Proposers and Observers

Bill Workman, Ian Jordan, George Chapman
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ABSTRACT

This UIR describes Survey programs and their origin, discusses basic statistics on Survey target characteristics and scheduling opportunites, and details the rules and procedures that proposers and observers need to follow when submitting their Phase II program or when requesting changes to their program.

1 Introduction

Beginning in Cycle 16, in an effort to maintain maximum science productivity of the Hubble Space Telescope, STScI introduced a new category of GO program called the Survey Program. This new program category is targeted toward HST orbits currently being used by a subset of SNAPshot programs. The SNAPshot category was designed to take advantage of unused scheduling opportunities by defining and executing sets of observations based on a random distribution of science targets and shorter viewing durations. The Survey program aims to ensure that those same (and possibly more) orbits are used more efficiently by eliminating the characteristic statistical uncertainty of SNAP programs execution. However, in exchange for an HST orbit allocation *guarantee*, there need to be limits on the definitions of such programs.

The following sections provide background information for the Survey Program as well as a list of characteristics and restrictions to guide the design of a SNAP program.

2 Why Survey Programs?

Throughout the history of SNAP program execution, STScI has regularly received inquiries from SNAP observers about the execution rate of their SNAP programs and what can be done to improve the completion percentage of their programs. Over the years a variety of changes to the scheduling process have been implemented. In response to the most recent inquiries, the suggestion of this new category of program was raised. The concept suggests that there may be a way to provide opportunity for certain flavors of programs, which are currently accepted and executed as SNAPs, to be allocated a specific amount of HST time just like Regular GO programs. The benefit to the observer is the assurance that a specific number of targets and HST orbits would be scheduled for execution. This would be a great benefit for current SNAP programs whose designs rely heavily on the reliability of the statistical scheduling rates to achieve the minimum completion percentage necessary to accomplish the science goals of the program. Survey programs will be judged side-by-side with the Regular GO programs, for which there is also an expectation of completing the entire program. Likewise, accepted Survey Program data are granted the same proprietary rights as Regular GO programs.

Survey programs also help us to increase overall HST science productivity above that provided by SNAP programs. By structuring Survey visits for a specific range of target viewing durations and using the Long Range Planning tools to assign plan windows, a larger number of HST orbits can be utilized more efficiently.

3 Defining Survey Programs

Survey observations must be designed to schedule in a specific subset of HST orbits separate from those used for standard GO programs. The characteristics of the selected orbits satisfy two goals; first, they support scheduling of a certain fraction of HST observations that are currently implemented as SNAP programs. Secondly, they are understood well enough to be candidate orbits for pre-planning. To schedule Survey observations in these HST orbits, they must have the following characteristics and restrictions:

- Survey program visit durations (including guide star acquistion and instrument overheads) are restricted to between 40 and 48 minutes. See Section 4 for further explanation.
- The Survey Program category is designed to optimize the use of the SAA impacted part of the day. Therefore, it is desireable that these programs use science instrument modes that can be used in SAA impacted orbits. See Sections 4 and 5 more explanation.
- No Special Requirements are permitted for Survey visits.
- Target selection and visit durations:
  - Survey targets should be well distributed on the sky, particularly in right ascension, to help reduce scheduling conflicts.
  - Survey visit durations are limited to 2 orbits because there are few opportunities for multi-orbit Survey visits in the SAA on the days that they will be scheduled.
  - STScI currently estimates that between 200 and 250 HST orbits will be *allocated* for Survey programs in Cycle 17. The number is subject to revision based on further target viewing analysis.
- Survey programs follow the rules of standard GO programs with respect to failure repeats and completion guarantees.

4 Why the lower and upper limits on Survey visit duration?

SNAP programs were introduced to fill orbits not being scheduled by standard GO visits, which have minimum viewing durations of ~52 minutes. The history of SNAP program execution shows that their median visit duration is 40 minutes and that less than 10% of executed visits have durations greater than 50 minutes. Additionally, recent target viewing studies using a 2500 point sky grid reveal that there are few HST orbits available in the 50+ minute range that are not already being used by regular GO visits. The evidence indicates that this viewing range is better utilized by programs using the default GO visit structures. Therefore, it makes sense to set the upper bound of Survey visit durations to a value that is lower than this standard default.

The sky grid study also shows that there are significant scheduling opportunities in the 40 to 48 minute range that cannot be utilized by current standard GO programs because their visit durations are too long. Figure 1 documents the known variation in the HST scheduling rate that exists due to the impact of the South Atlantic Anomaly (SAA) region during the 48 day HST-Sun synodic period. By focusing on available viewing durations at the low scheduling phases of this cycle, the potential exists to not only guarantee a fixed number of orbits for survey programs, but also to increase the total number of HST orbits being scheduled overall. While some of these orbits are currently being used by SNAP visits, the sky study indicates that more scheduling gains can be achieved by explicitly designing and planning observations for these times. Survey programs are defined to take advantage of these under-utilized orbits.

5 Which HST orbits are available for Survey Programs?

Other Phase I articles discuss the limitations of operating in certain science modes when HST passes in or near the SAA. For operating modes that must avoid any orbit that intersects the SAA, like ACS/SBC and certain NICMOS activitites, at least half of the 15 HST orbits each day are unusable. However, these orbits can be used with operating modes like the ACS CCDs if the science activities are constructed

appropriately. The problem is that the net available time for science in these SAA-impacted orbits is usually much shorter than non-impacted orbits. The amount of time available depends on HST's target pointing and roll attitude, and what day of year the observation is executed. Target viewing time is reduced anywhere from 0 to 75% of that available for the same target during non-SAA impacted orbits. When the SAA event occurs completely within a target occultation event, the SAA is said to be *hidden* during target occultation. These zero-impact orbits are used by standard GO visits. However, there are many SAA-impacted orbits that are not zero impact for standard GO programs.

Figure 1 shows how the scheduling rate for standard GO programs varies according to the phase of HST-Sun synodic precession period. The chart shows that the HST scheduling rate for standard GO programs is significantly reduced for roughly half of this 48 day period. Studies show that this reduced rate is directly attributable to HST orbit plane, Sun and science target alignments that are non optimal for SAA hiding. This means that there are many SAA impacted orbits that are not being used for standard GO science because there simply is not enough time for *full visit* science in those orbits. While some orbits are being used by SNAP observations, there is no guarantee that they are are being used to maximum efficiency. Additionally, the SNAP pool cannot ensure that the most number of these orbits are being utilized. Since Survey programs are structured and planned for reduced science viewing durations, they have the most potential to maximize the number and efficient use of these reduced target visibility orbits. The reduced visit duration limit for Survey programs also opens up a larger area of the sky from which targets can be selected for observation in these orbits.

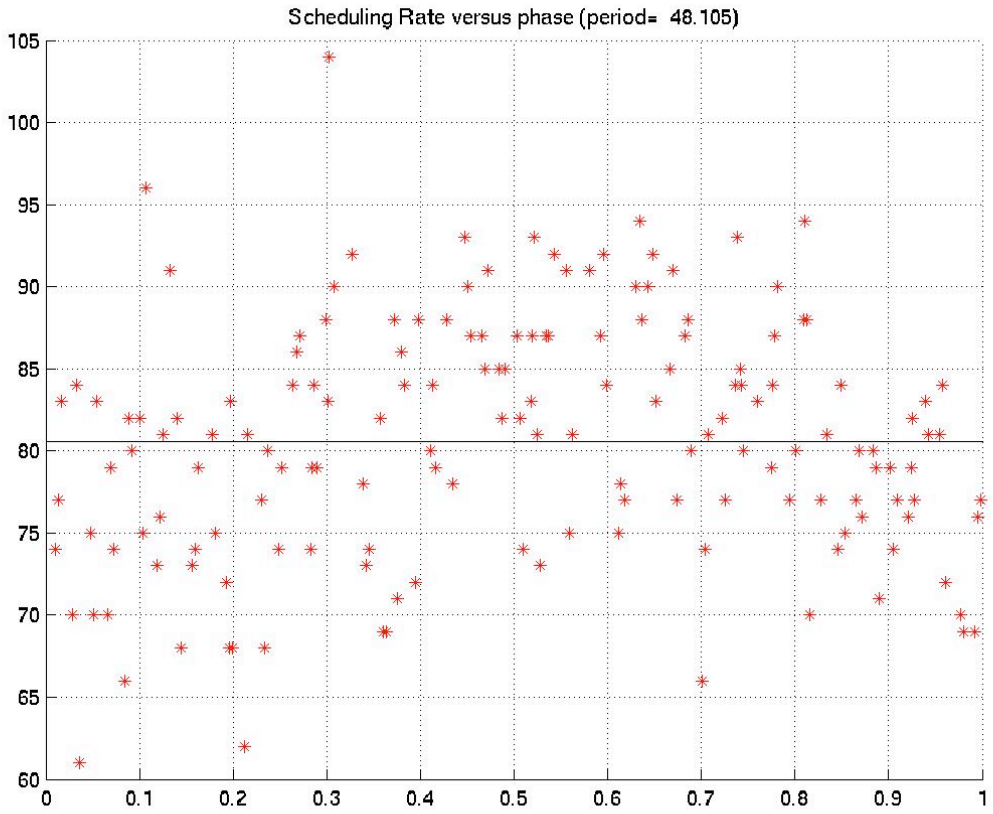

Figure 1: 3-Gyro Scheduling as a Function of the HST Sun-synodic Phase

6 How many HST orbits are available for Survey Programs and which targets can be used?

The HST-Sun synodic periodicity combines with the known contraints on target viewing to restrict the number of HST orbits and days available for observing Survey targets each cycle. Our studies reveal some important facts about 48-minute scheduling opportunities:

- There will be ~9.5 HST-Sun *epochs* in Cycle 17 which should provide at least 200 orbits for Survey observations.
- While each epoch is ~48 days long, there are at most 24 days each epoch with this viewing duration. This limits the number of HST orbits that can be used for a given target and time range. Why only half of the epoch?
  - Recall that Survey programs are designed to fill orbits that are not currently being used by standard GO visits.
  - 48 minute visits have the most opportunities in the low scheduling rate half of the 48 day HST-Sun cycle.
- While the trend is less obvious in 3-gyro mode when compare to 2-gyro mode, the number of days and orbits per day is declination dependent. Targets that lie further north on the sky have more usable days and orbits. In other words, target availability is not symmetric about the celestial equator. Rather, it steadily increases from the South celestial pole toward the North celestial pole.
- Adjacent targets that are separated by ~24 degrees in right ascension will schedule optimally with respect to the SAA on different orbits of the day; i.e. – SAA *hiding* (during target occultation) occurs on different orbits for adjacent targets that have this approximate separation. Therefore, it is possible to schedule more Survey observations each day (e.g. 2 vs 1) given an appropriate distribution of targets.
- As with standard GO programs, clumping of target observations in a HST-Sun half-epoch can lead to scheduling conflicts and ultimately a delay in visit execution.

So what does this mean for Survey program target selection?

In general it means that there are limits on the number of HST orbits available for individual regions of the sky. Therefore, a well constructed Survey program will include a target list that:

1. is well spaced in Right Ascension.
2. is weighted toward higher northern declination targets for programs that require multiple orbit visits (maximum of 2 orbits per visit).
3. provides a sufficient number of alternate targets so that there are options for resolving orbit scheduling conflicts between Survey programs; i.e. - between 1.5 and 3 times the number needed to satisfy the science goals of the program.

7 Final Comments

Survey programs give you the opportunity to obtain a preallocated number of observations in this visit duration range. In addition, it has the potential to increase the overall scheduling efficiency of HST and thereby provide more science opportunities for the astronomy community as a whole. We will continue to explore ways to use and improve all classes of HST programs to achieve desired science goals while increasing the overall productivity of HST. If you have ideas, please communicate with us. E-mail may be sent to help@stsci.edu.