Call for Proposals and Phase I Proposal Instructions

Cycle 9

GO/SNAP/AR deadline: 9/10/99 8:00 pm EDT
E/PO deadline: 1/28/00 8:00 pm EST
How to get help:

1. Visit the STScI’s Web site:
   http://www.stsci.edu

2. Send e-mail to help@stsci.edu, or call 1-800-544-8125 (the Help Desk).
   From outside the United States, call 1-410-338-1082.

This document has been edited by Letizia Stanghellini, of the Science Program Selection Office (SPSO).

Every effort has been made to ensure this Call for Proposals is free of errors. Proposers should bring any perceived inconsistencies or concerns to the attention of SPSO (send email to help@stsci.edu), for correction and clarification.

SPSO is responsible for the process of selecting the HST science program, which includes preparing Calls for Proposals, organizing proposal reviews, and developing associated policies. SPSO staff includes astronomers Meg Urry (Office Head), Letizia Stanghellini, and Roeland van der Marel, and Technical Manager Brett Blacker.
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CHAPTER 1: Introduction

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1.1 OVERVIEW

This document invites proposals for participation in the ninth round (“Cycle 9”) of the General Observer (GO), Snapshot (SNAP), and funded Archival Research (AR) programs of the Hubble Space Telescope (HST). The telescope and its instruments were built under the auspices of the National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA), and management of HST’s scientific program has been assigned to the Space Telescope Science Institute (STScI).

HST is a 2.4-m telescope that was carried into orbit on April 24, 1990, aboard the orbiter Discovery. The first HST servicing mission, carried out by the Endeavour astronauts in December 1993, improved its optical performance via the Corrective Optics Space Telescope Axial Replacement (COSTAR) and Wide Field Planetary Camera 2 (WFPC2). The second HST servicing mission (SM2), carried out by the Discovery astronauts in February 1997, replaced the Goddard High Resolution Spectrograph (GHRS) and the Faint Object Spectrograph (FOS) with two new science instruments: the Space Telescope Imaging Spectrograph (STIS), and the Near Infrared Camera and Multi-Object Spectrometer (NICMOS). A new Solid-State Recorder (SSR) and a refurbished analog tape recorder were installed, providing much improved data storage capabilities; and a refurbished Fine Guidance Sensor, FGS1R, with improved optics and resulting greater sensitivity replaced FGS-1. The instruments remaining in operation after the second servicing mission are the WFPC2, the Faint Object Camera (FOC), and the astrometric Fine Guidance Sensor (FGS-3). FOC was not offered for observations in Cycle 8, and will also not be offered in Cycle 9. The principal capabilities of the present HST observatory include high-resolution ultraviolet and optical imaging, and a broad range of spectroscopic capabilities over these wavelength domains. NICMOS reached cryogen exhaustion in January, 1999.

The next two servicing missions are planned to further improve the performance of HST: servicing mission 3A (SM3A) is planned for October 14, 1999, and includes the installation of a new FGS2R and replacement of all 6 rate-sensing gyroscopes, along with several other spacecraft components. Servicing mission 3B (SM3B) is currently planned for December 1, 2000. During SM3B the Advanced Camera for Surveys (ACS) will replace FOC, and NICMOS will resume operations after a new cryo-cooling system is installed.

Part I of this Call for Proposals (CP) summarizes the policies and procedures for proposing Cycle 9 HST observations and for requesting funding to support research on archival HST data. Part II provides an overview of HST’s current technical capabilities. Further detailed information about the telescope and each Scientific Instrument (SI) is provided.
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on-line, as described in § 1.3. Part III of this document is the Phase I Proposal Instructions, including detailed instructions for obtaining the proposal templates, preparing and submitting them electronically.

It is very important that all proposers, including those who proposed in previous cycles, read this document carefully. Proposers should particularly note the following features of Cycle 9:

- The Cycle 9 Call for Proposals (CP) is an electronic Document. Proposers should refer to the electronic version of the CP at the release date (June 11, 1999) for policies and procedures. Neither the Call for Proposals nor the Instrument Handbooks will be mailed to Libraries.
- Cycle 9 observing will commence nominally in July 2000, and have a duration of approximately one year.
- Cycle 9 observing proposals may request use of FGS, STIS, and WFPC2.
- Proposal submission for Cycle 9 is entirely electronic.
- Archival proposers do not need to submit a detailed budget in Phase I.
- The Cycle 9 Telescope Allocation Committee (TAC) will give special consideration to Large programs, awarding up to 1000 orbits to these programs.
- The Cycle 9 proposals should include, in the Scientific Justification, the importance of the program to astronomy in general.
- Review panels will span a broader range of science than in previous cycles, so proposers should consider writing the scientific justification for a broader audience.
- In Cycle 9 there is the new opportunity for joint HST-Chandra proposals (see § 2.1.7).
- Cycle 9 continues the opportunity for U.S. GO/SNAP/AR researchers to submit Education/Public Outreach (E/PO) proposals (APPENDIX I). Grants under this program will be awarded only to successful GO/SNAP/AR proposers.

The Cycle 9 deadline for GO/SNAP/AR proposals is Friday, September 10, 1999 8:00pm EDT.

The Cycle 9 deadline for E/PO proposals is Friday, January 28, 2000, 8:00pm EST.

Late proposals will not be considered.

1.2 GETTING STARTED

It is important that all proposers read the entire Call for Proposals in order to understand the policies and procedures for preparing and submitting observing programs, and to gain an overview of the HST and its capabilities.

GO proposals must contain a summary of the proposed observing program, including the targets that are to be observed and their celestial coordinates, and the desired instrument modes and filters or dispersers. In addition, a calculation of the number of spacecraft orbits needed to accomplish the observing program must be carried out and summarized in the proposal. Thus it is important that proposers consult technical documentation about the capabilities and sensitivities of the instrument(s) that will be used to obtain the observations. Where necessary, proposers should discuss their requirements with appropriate
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STScI experts, by contacts provided via the STScI Help Desk at help@stsci.edu before submitting their proposals.

1.3 TECHNICAL DOCUMENTATION

The current set of Instrument Handbooks that should be used by proposers is now available on the Web. Users should refer to the latest Web versions of the Handbooks in the preparation of their proposals. Older versions should not be used. Current versions of the Handbooks of SIs offered in Cycle 9 are:


Current versions of the (Mini) Handbooks for SIs to be offered in the future are the ACS Instrument Mini-Handbook (June 1999) and the NICMOS Instrument Handbook (Version 3, June 1999). These handbooks are available for comparison only, as these SIs are not offered at the moment.

Of particular relevance for HST observing proposals are the Instrument Web pages which, besides providing access to electronic versions of the Instrument Handbooks, contain the Web tools for estimating instrument count rates and exposure times. These tools also provide warnings about target count rates that exceed any linearity or safety limits. The Web address for current, past, and future SIs is:

http://www.stsci.edu/instruments/

An HST Data Handbook is available, describing the data that are produced by each of the current SIs. In addition, a guide to the Space Telescope Science Data Analysis Software is available (STSDAS, see also §7.3):


For Archival Researchers, a manual is available which describes how to gain access to the HST Data Archive through StarView. The Archive Manual is listed here, together with the SIs not offered for observations in Cycle 9, also of interest for archival proposers:


More information on the Archived HST Data can be found in § 8.1, and at:

http://archive.stsci.edu/hst/

Information for E/PO proposals is contained in APPENDIX I:

Proposers are informed that, starting with Cycle 9, paper documentation will not be available for distribution. Proposers unable to download the Web (PDF) documents locally may contact the STScI Help Desk at help@stsci.edu.
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Proposals will be selected for General Observer (GO), Snapshot (SNAP), and funded Archival Research (AR) programs through a competitive peer-review process. A portion of the observing time has been allocated for Guaranteed Time Observers (GTOs). It is also possible to submit requests at any time for Director’s Discretionary (DD) time for extremely urgent, unforeseen observations. In addition, U.S. proposers are strongly encouraged to submit Education/Public Outreach (E/PO) proposals associated with their approved GO, SNAP, and AR proposals (APPENDIX I). Note the different deadlines for GO/SNAP/AR (September 10, 1999) and for the E/PO (January 28, 2000) proposals.

2.1 GENERAL OBSERVER PROPOSALS

2.1.1 Scope of General Observer Proposals

General Observer (GO) proposals aim to advance astrophysical knowledge through HST observations, and may request any scientifically justified amount of observing time. In past cycles the Space Telescope Advisory Committee (STAC) advised that the best scientific use of the HST required a mix of programs of different sizes, and that in particular “Large programs” should be encouraged. The TAC (see § 6.2.2) will monitor the overall distribution to ensure that a reasonable number of programs of all sizes is selected.

2.1.2 Large Programs (> 99 Orbits)

Large programs are those requiring 100 or more orbits, and should be strongly justified, well-thought-out proposals that would lead to clear advance in our understanding. Large programs must utilize the unique capabilities of HST to address important scientific questions in a comprehensive approach which is not possible in smaller time allocations. The
Large programs will be evaluated for scientific merit by the TAC, which will have a large number of orbits to award independent of panel allocation for Regular proposals. A Large program may extend beyond the current proposing cycle, if scientifically justified.

The STAC was confident that at least three Large programs would be ranked sufficiently highly to be awarded time each cycle, with at least 10-20% of the GO time devoted to such programs in the steady state. The STAC did not identify particular Large program topics to be targeted, primarily because it did not wish to restrict the creativity of the community in formulating imaginative new projects. In compliance with these expectations, about 10% of Cycle 8 orbits were allocated to Major programs (defined as larger than 60 orbits, see the Cycle 8 Call for Proposals). A step forward will be attempted in Cycle 9, in which the TAC will have up to ~1000 orbits to award to Large programs, with the goal of implementing several programs in the 200-300 orbit range.

Proposers are strongly encouraged to develop competitive Large proposals. Naturally, scientific excellence is a requirement for all HST programs, and the orbit allotment to Large programs is still subject to the science selection review.

Selection of a Large program for implementation does not rule out acceptance of smaller projects to do similar science, although target duplication and overall program balance may be considered.

### 2.1.3 Regular Programs (< 100 Orbits)

In Cycle 9 we do not distinguish among Small and Medium proposals, redefining all programs requesting less than 100 orbits as “Regular programs”. Regular programs will be reviewed by the expert panels. In order to encourage the acceptance of sizable proposals by the panels, we will implement a progressive orbit “subsidy” for each proposal in this category, with orbits in the subsidy coming from outside the panel allotment. The algorithm for the subsidy will be finalized after the Phase I deadline, with the goal of creating an acceptance rate of the submitted scientific programs independent of their size. Therefore, proposers can request the number of orbits needed to achieve their science goals without worrying about the effect on probability of success.

### 2.1.4 Surveys

Survey programs are those that, while well-justified with a clear scientific program, also produce large, uniform databases having significant archival value, and suitable for the use of other members of the astrophysics community.

Surveys can be of any type - Large, Regular, Snapshot - and they should be flagged by selecting the keyword SURVEY as one of the scientific keywords (see § 15, Step 4. Add up all the orbits).

Proposers are advised that a commitment to waive part or all of the proprietary period will be considered positively in selecting such programs.

### 2.1.5 Long-Term Programs

GO programs will normally be completed within the current scheduling cycle. However, long-term programs (i.e., observing programs having a duration of more than one cycle) may also be accepted.

Long-term programs require a long time baseline, but not necessarily a large total number of spacecraft orbits, in order to achieve their scientific goals. Typical examples of such projects might be astrometric observations or long-term monitoring of variable stars, or
active galactic nuclei. *Proposals for long-term status should be limited to cases where such status is clearly required to optimize the scientific return of the project.* The scientific necessity for an allocation of time extending beyond Cycle 9 should be presented in detail.

Long-term programs may be approved for durations of up to three observing cycles. New long-term proposals should describe the entire requested program and should provide a cycle-by-cycle breakdown of the number of orbits requested. However, the observation summary table in the proposal should specify only the visits for Cycle 9, not the proposed visits for future cycles. A Cycle 9 long-term proposal is not allowed to request the use of instruments other than those presently offered. Large programs may request continuation in Cycles 10 and 11, if scientifically compelling and well justified.

The Cycle 9 TAC can award limited amounts of time in Cycles 10 and 11, where the scientific justification is compelling, *with no re-submission of proposals in those cycles.*

Note that no continuation proposal is required from GOs who had Cycle 9 time approved in Cycles 7 or 8.

**2.1.6 Target-of-Opportunity Proposals**

Targets-of-opportunity (TOO) are astronomical objects undergoing unexpected or unpredictable transient phenomena. They include objects that can be identified before the onset of such phenomena (e.g., dwarf novae, eclipsing variable stars, etc.), and objects that cannot be identified in advance (e.g., novae, supernovae, gamma ray bursts, newly discovered comets, etc.). For such proposals it may not be possible to include a list of specific objects; instead, the proposer may specify “generic targets”. The proposal should present a detailed plan of observations that will be implemented if the specified event occurs; it should also provide an estimate of the probability of occurrence of the specified event during the observing cycle.

Because of the heavy impact that TOO observations have on the short- and medium-term *HST* schedule, the number of rapid TOO programs (i.e., 3 weeks turn-around or shorter) will be limited to approximately 6 in Cycle 9. The Principal Investigator (PI) should include as part of the proposal the required turn-around time and, if that time is short, strong justification of the same.

TOO proposals will be peer reviewed through the normal procedures. An accepted program will be executed only in the event that the specified phenomenon actually occurs, and *it will be the responsibility of the GO to inform STScI of the occurrence of the phenomenon.* If the event does not occur during the observing cycle, the program will be deactivated at the end of the cycle. No carry-over of the TOO unused time will be allowed.

Accepted programs will require submission of a Phase II proposal (see § 6.4) before the event occurs. If there is uncertainty in the filter, exposure time, or other exposure parameters, the Phase II proposal should include a selection of pre-planned contingencies from which the observer will make a selection. When notifying STScI of the appearance of the target of opportunity, the GO must provide an accurate target position.

A review of the completed proposal will be made to assure the safety of the observations, to verify that the program complies with the original observing-time allocation and scientific objectives, and to identify execution opportunities. Note that TOO proposals that utilize the STIS MAMA detectors need to pass bright object checking before they can be scheduled. For rapid turn-around proposals, where the target may be varying in intensity, a strategy will need to be developed to ensure the safety of the TOO observations. A
description of how the proposer plans to deal with this issue should be provided in the Special Requirements section of the proposal. After approval by the Director of a request to activate a TOO observation, the schedule of observations will be replanned to contain the new observations. The time necessary to conduct these activities will vary with the particular circumstances, but the minimum response time will be roughly 2–5 days, and this will be achievable only if all details of the proposal (except the target position) are available in advance. If the program requires submission of a new, detailed Phase II proposal, then the response time will be substantially longer.

In the event of a sudden phenomenon of a nature that could not have been anticipated, for which it is felt that HST observations should be initiated on an urgent basis, a request for Director’s Discretionary time may be submitted (see § 2.5). In this case, proposers should follow the instructions therein.

2.1.7 Joint HST-Chandra Proposals

Proposers whose observations are fundamentally of multiwavelength nature requiring both HST and the Chandra X-ray Observatory (formerly AXAF) can submit a single proposal, requesting time on both Observatories, to either the present HST Cycle 9 or the Chandra Cycle 2 review. Chandra Cycle 2 is expected to run between August 2000 through July 2001, based on launch in July 1999. This enables proposers to avoid the “double jeopardy” of submitting proposals to two separate reviews. By agreement with the Chandra X-ray Center (CXC), STScI will be able to award up to 400 kiloseconds of Chandra observing time, and similarly the CXC will be able to award up to 100 orbits of HST time (note that both Chandra and HST allocate, for this opportunity, about one week of observing time), to very highly rated proposals. The only criterion above and beyond the usual review criteria is that both sets of data are required to meet the scientific goals.

Proposers wishing to exercise this option should send their proposals to the observatory that represents the prime science. While there is multiwavelength expertise in the review panels for both observatories, typically the HST panels will be stronger in IR/optical/UV science and the Chandra panels in X-ray science. Technical feasibility is the responsibility of the observer, who may want to consult the CXC. Any observations that prove unfeasible or impossible to schedule may not be done.

Proposers must include technical information about the Chandra observations, as described in § 15, item #17. Information on Chandra can be found on the Web at:

http://asc.harvard.edu

2.2 Snapshot Proposals

In the process of optimizing the HST observing schedule, the scheduling algorithm occasionally finds short time intervals during which it is impossible to schedule any exposures from the pool of accepted programs. In order to utilize these intervals for scientific observations, STScI has developed the capability to take short exposures (“snapshots”) on objects selected from a large list of candidates.

Snapshot observations are placed on the schedule only after the observing sequence has been determined for the higher-priority targets. In the HST schedule the distribution of gaps suitable for snap observations is broad and flat between 20 and 45 minutes. However, this distribution depends on the primary observation schedule, the operating characteristics of the instruments, and on other factors; it is therefore not predictable at the time of
Proposal Categories

program submission. Past experience shows that there are roughly ten opportunities each week for snapshot exposures.

Astronomers are invited to propose scientific programs which can be carried out based on observations of a set of such snapshot exposures. Proposers are advised that a commitment to waive part, or all, of the proprietary period will be included in the selection criteria for such programs. Snapshot proposers should consider the following guidelines:

• A snapshot proposal aims at observing a series of targets. In Phase I, we ask proposers to define the size of the program (i.e., the number of targets) and to unambiguously identify their targets (e.g., reference to target lists in papers, or detailed description of target characteristics). Proposers should also provide at this stage a typical example of a snapshot exposure, including the observing mode, exposure time, filter, and required acquisition mode. We do not ask for a complete coordinate list in Phase I.
• Each snapshot consisting of, e.g., guide-star acquisition, target acquisition, exposure, and readout, should require no more than 45 minutes total. We note here that, although the gap size distribution indicates that larger snapshots are feasible, snapshots with shorter (< 25 minutes) target visibility periods are more flexible to schedule.
• The observations should be as straightforward as possible, with a minimum of filter or grating motions.
• Each snapshot is considered as a separate target, with no link to any other snapshot even if taken on the same source with the same or different observing setup (e.g., different filters). Repeated observations of a given target are not guaranteed.
• Snapshot proposals should specifically identify the requested proprietary data-rights period for the exposures, for consideration and allocation by the peer reviewers.
• Spectroscopic STIS MAMA snapshots are allowed.
• STIS MAMA imaging snapshots are allowed, but the total number of such targets accepted will not exceed one hundred, due to bright object checking requirements.

Note that moving target snapshot programs that are not time critical are acceptable in Cycle 9, as they should require the same implementation effort as fixed target snap programs. Also note that all STIS MAMA snapshots are executed under FGS control (fine guiding), and that moving target snapshots using the MAMA detectors are NOT permitted.

Snapshot proposers should be aware that snapshot time allocations are not guaranteed. The number of observations actually executed will depend on the availability of appropriate schedule gaps, therefore only a fraction of the sample targets may actually be observed. Typical completion rates are far less than 70% and there is no commitment to obtain any completion factor for snapshot programs.

Due to the nature of snapshot programs, it is not possible to assign priorities to the targets to be observed.

If a snapshot exposure fails during execution it will not be repeated.

2.3 Archival Research Proposals

Completed HST observations, including both GO and GTO data (see § 2.6), become available to the community upon expiration of their proprietary periods. The data are archived at STScI and are available for analysis by interested scientists through direct
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retrieval (which is free and does not involve financial support) or the HST Archival Research (AR) program (which provides financial support for the analysis of the data). A copy of the HST Archive is also maintained at the Space Telescope - European Coordinating Facility (ST-ECF) in Garching, to which European requests should normally be addressed. The Canadian Astronomy Data Centre (CADC) also maintains a copy of HST science data (only), and is the preferred source for Canadian astronomers. See § 8.1 for an overview of the Data Archive, and for details of the procedures for accessing archival HST data.

Funding for U.S. astronomers to support the analysis of archival data is expected to be available during Cycle 9. Proposals for funded Archival Research may be submitted only by scientists affiliated with U.S. institutions. Proposals for AR funding during Cycle 9 will be considered at the same time, and by the same reviewers, as proposals for observing time for Cycle 9, and the deadline for submission is the same for all proposals. The review of AR proposals will be based on scientific merit and other appropriate criteria, as discussed in § 6.2.3.

The data must be already residing in the Archive and released from proprietary rights, or to be released by the time of the funding allocation (approximately February 2000). Researchers proposing an AR program that will also utilize data from other NASA centers should submit their AR proposal to STScI if the majority of the program involves HST archival data and its analysis. Conversely, requests for support of AR programs utilizing data primarily from other missions should follow the guidelines in the appropriate NASA Research Announcements.

Cycle 9 proposers are informed of data available from the Archival Pure Parallel Program, described in § 3.2 and on the Web at

http://archive.stsci.edu/hst/parallels

In addition, observation of the Hubble Deep Field South (HDF-S) was completed in November 1998, and the data are available for Cycle 9 Archival Research proposals. Detailed information regarding the HDF and HDF-S is available on the Web at


and


Proposals for funded AR should be submitted on the special AR proposal form by electronic mail. If the AR proposal is approved, a detailed budget will be requested from the U.S. PIs and all U.S. Co-Is. Instructions for preparing AR proposals are given in § 17.2. For AR proposals submitted by non-U.S. PIs with U.S. Co-Investigators (Co-Is) who request funding, one of the U.S. Co-Is should be designated as administratively responsible for STScI funding.

Scientific programs that require funding for both Archival Research and new observations should be submitted as two separate proposals, one requesting funding for the Archival Research, and the other proposing the new observations. The proposals should refer to each other so that the reviewers will be aware of both components of the proposed project.

2.4 EDUCATION/ PUBLIC OUTREACH PROPOSALS

The NASA Office of Space Science (OSS) has developed a comprehensive approach for making education at all levels (with a particular emphasis on pre-college education) and
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the enhancement of public understanding of space science integral parts of all of its mis-

sions and research programs.

In line with these NASA OSS policies, STScI is announcing the opportunity for U.S. PIs
to submit E/PO proposals in conjunction with an approved HST proposal (see APPENDIX I: for details). E/PO proposals should not be submitted with GO/SNAP/AR
proposals, but only after the notification from STScI that a GO/SNAP/AR program has
been accepted for implementation.

2.5 DIRECTOR’S DISCRETIONARY PROPOSALS

Up to 10% of the available HST observing time may be reserved for Director’s Discretion-
ary (DD) allocation.

A proposal for DD time might be appropriate in cases where a truly unexpected transient
phenomenon occurs or when developments since the last proposal cycle make a time-crit-
icical observation necessary. Under no circumstances should a request for DD time be used
to resubmit all or part of a proposal that was rejected by the normal peer review process.
Transient phenomena that could have been foreseen should have been proposed as a TOO
within the regular cycle.

The Director will usually seek advice on the scientific merit and technical feasibility of
such requests from STScI staff and outside specialists before taking action. The primary
criteria for acceptance are extremely high scientific merit and a strong demonstration of
the urgency of the observations. Very few non-time-critical DD proposals are approved; in
general, the proposers are encouraged to resubmit their programs for the next peer review
cycle.

The HST observing schedule is determined several weeks in advance of the actual obser-
vations. Although it is technically feasible to interrupt the schedule and initiate observa-
tions of a new target, short-notice interruptions place very severe demands on the planning
and scheduling process, decrease overall observing efficiency, delay other programs, and
are therefore restricted. Hence, requests for DD time must be extremely well justified and,
if at all possible, submitted at least three months before the date of the requested observa-
tions. Proposals for observations already covered under the Target-of-Opportunity cate-
gory will generally not be acceptable. In view of the long lead times, it will in many cases
be more appropriate to submit a proposal through the normal GO procedure (e.g., as a Tar-
get-of-Opportunity program) than to request DD time. In the case that a DD time proposal
with a short turn-around is accepted, the PI or his/her deputy is required to be reachable by
STScI personnel on a 24 hour basis between the submission and the implementation of the
program, for Phase II preparation.

Observations obtained as part of a DD program generally do not have a proprietary period,
and are made available immediately to the astronomical community. However, DD pro-
posers may request and justify longer proprietary periods in their proposals.

Scientists wishing to request DD time should do so by using the DD Submission Template
on the Web at the following URL:

http://www.stsci.edu/ftp/proposer/dd.html

If you do not have access to a Web browser, then you may inquire about DD procedures
from the STScI Help Desk.
2.6 GUARANTEED TIME OBSERVERS PROGRAMS

The National Aeronautics and Space Administration has awarded a portion of the observing time during the first three years of HST operations following SM2, to scientists involved in the development of the new instruments. Similarly, GTO time will be allocated after SM3B to scientists involved in the development of ACS.
CHAPTER 3: HST Observation Types

In this Chapter...

3.1 Primary Observations on page 3-19
  3.1.1 Overview on page 3-19
  3.1.2 Time-Critical Observations on page 3-19
  3.1.3 Real-Time Observations on page 3-20

3.2 Parallel Observations on page 3-20

3.1 PRIMARY OBSERVATIONS

3.1.1 Overview

Primary observations are defined as those that determine the telescope pointing and orientation. Since all of the SIs are located at fixed positions in the telescope focal plane, it is possible simultaneously to observe with one or more instruments in addition to the primary instrument; those additional observations are named parallel observations (§ 3.2).

3.1.2 Time-Critical Observations

Proposals may request that HST observations be made at a specific date and time, or within a range of specific dates. Examples of time-critical observations for which such requests would be appropriate include, but are not limited to, the following: (1) astrometric observations; (2) observations of specific phases of binary or pulsating stars; (3) monitoring of variable stars or galactic nuclei; (4) imaging of surface features on rotating solar-system bodies; (5) observations that require a specific telescope orientation (since the orientation is fixed by the date of observation, as discussed in Part II); (6) observations that must coincide with simultaneous ground-based or other space-based experiments; (7) observations in support of planetary missions; and (8) observations required to be repeated at some time interval.

Time-critical events that occur over short time intervals compared to the orbital period of HST (such as eclipses of very short-period binary stars) introduce an additional complication because it will not be known to sufficient accuracy, until a few weeks in advance, where HST will be in its orbit at the time of the event, and hence whether it will occur above or below the spacecraft’s horizon (see § 12.3). Proposals to observe such events can therefore be accepted only conditionally.

Because of the constraints that time-critical observations impose on the HST scheduling system, the scientific justification for such requests should be presented in detail in the observing proposal.
3.1.3 Real-Time Observations

A limited capability is available for real-time interactions during HST observing. Interactive target acquisitions (§ 13.2), late ephemeris improvements, and real-time analysis for science purposes are permitted in real-time.

The usual purpose of a real-time interaction will be to carry out an interactive target acquisition, either with the same SI to be used for the scientific observations, or with a camera SI followed by an offset to the required SI (see the Instrument Handbooks for technical details). This type of pointing improvement is required when the target must be positioned more accurately than can be done with the guide stars alone (typically about 1”), and when there is no on-board mechanism available to accomplish that task, or when early acquisition techniques cannot be used.

Small maneuvers without target acquisition are typically used to improve the telescope pointing without requiring an observation to measure the target location. The need for this type of improved pointing arises most often for solar-system targets, because of uncertainties in the target’s ephemeris, and because the HST orbital decay causes changes in the times of observations after the planning and telescope scheduling have been completed. In general, the size of all real-time maneuvers is limited by the requirement that the same pair of guide stars be used to accomplish all such pointings, usually less than 1 arcmin.

Real-time analysis may be requested for either science data or engineering telemetry associated with an observation for reasons other than target acquisition. The scientific necessity of seeing the data immediately must be fully justified in the proposal.

Availability of the Tracking and Data Relay Satellite System and other constraints limit the number of real-time interactions to a few per week. Real-time observations generally require additional operational overheads, and thus reduce observing efficiency. However, some scientific programs require this activity for success and it should be requested for them. In those cases, the scientific and operational justification for such interactions should be presented clearly in the observing proposal because real-time interactions are a limited resource. Furthermore, failure of one of the SSA transmitters in 1998 reduces the opportunity to schedule real-time contacts and generally precludes two contacts in a single orbit. This transmitter is likely to be replaced in the next servicing mission.

Real-time observations will generally require the GO’s presence at STScI during the exposures. STScI personnel will be present to assist the GO, and to execute the command requests.

3.2 Parallel Observations

Parallel observations provide a mechanism for increasing the productivity of the HST observatory. Parallel observations are observations made with one or more additional SIs while another SI is carrying out a primary observation. Depending on whether a parallel observation is or is not related to any specific primary observation, it is defined as coordinated parallel or pure parallel, respectively. Parallel observations are made solely on a basis of non-interference with the associated primary observations.

Since each SI samples a different portion of the HST focal plane (see Figure 11.1: ), an SI used in parallel mode will normally be pointing at a “random” area of sky several minutes of arc away from the primary target. Thus parallel observations are usually of a survey nature. However, many HST targets lie within extended objects such as star clusters or galaxies, making it possible to conduct parallel observations of nearby portions of, or even specific targets within, these objects.
HST Observation Types

Following the recommendations of the Cycle 7 HST Time Allocation Committee, an HST Archival Pure Parallel Program was begun at the start of the Cycle 7 GO observing era (June 1997), and it is ongoing. This program seeks to maximize the scientific return from HST to the community, by taking parallel data with STIS and WFPC2, whenever these instruments are not prime. The data are non-proprietary and are placed immediately into the HST Archive. The Archival Pure Parallel observing programs are designed with the intent of building consistent and coherent datasets for the HST Archive. A detailed description of the HST Archival Pure Parallel Program can be found on the Web at http://archive.stsci.edu/hst/parallels.

Parallel observations of the following types may be proposed:

1. **Pure parallel observations.** In this case, a proposal is submitted for parallel observations that are unrelated to any specific primary observations. Proposals for such programs may involve either specific or generic targets; however, the latter are more common. Proposers must justify how the proposed program is different from or significantly enhances the existing HST Pure Parallel Program. Appropriate scheduling opportunities for such observations will be identified by STScI.

2. **Coordinated parallel observations.** In this case, the GO requests use of two or more SIs simultaneously, typically in order to observe several adjacent targets or regions within an extended object. Proposals for coordinated parallel observations should present a description of a coherent scientific program that clearly requires simultaneous usage of multiple SIs. The effective aperture locations of the SIs are listed in Table 11.2: and shown in Figure 11.1: .

Technical discussions of parallel observations are given in the *Instrument Handbooks*. Proposers are not allowed to add, in Phase II, coordinated parallel observations not included in the Phase I proposal.

Parallel observations are not permitted to interfere significantly with primary observations; this restriction applies both to concurrent and subsequent observations. Some examples of this policy are the following:

- The parallel observation will not be made if its inclusion would shorten the primary observation.
- Parallel observations will have lower priority on stored command capacity and on telemetry data volume.

The WFPC2 and STIS CCD modes may be used for pure parallel programs in any combination of primary and parallel instruments. The STIS MAMAs and the FGS may be used together with any other instrument for coordinated parallel observations (within the same proposal) with a specified orientation, but not for pure parallel observations.

The spacecraft computers automatically correct the telescope pointing of the primary observing aperture for the effect of differential velocity aberration. This means that image shifts at the parallel aperture of 10 to 20 mas can occur during parallel exposures. The effect of the shift can be minimized by using the SI with the lower spatial resolution for the parallel exposure.
CHAPTER 4: Proposal Submission

In this Chapter...

4.1 Who May Submit on page 4-22
4.2 Endorsements on page 4-22
4.3 Funding of U.S. Observers and Archival Researchers on page 4-23
4.4 Proposal Confidentiality on page 4-23

4.1 WHO MAY SUBMIT

Proposals for *HST* observing time may be submitted by scientists of any nationality or affiliation, and may request use of any of the available SIs offered in Cycle 9. Each proposal must identify a single individual who will act as PI, but should also list all Co-Is who will be involved in the analysis of the data. The PI will be responsible for the scientific and administrative conduct of the project, and will be the formal contact for all communications with STScI. All proposals will be reviewed without regard to the nationalities or affiliations of the proposers.

An agreement between NASA and ESA states that a minimum of 15% of *HST* observing time (on average over the lifetime of the *HST* project) will be allocated to scientists from ESA member states. It is anticipated that this requirement will continue to be satisfied via the normal selection process, as it has been in previous cycles. In order to monitor the allocation to scientists from ESA member states, STScI requests that each PI and Co-I whose affiliation is with an ESA member-state institution be identified as such in the list of investigators contained in the proposal.

4.2 ENDORSEMENTS

Endorsement signatures are not required for Phase I observing proposals (unless required by the regulations of the proposing institution); such endorsements will be requested in Phase II from successful GOs only.

Proposals for observing time from *student PIs* will be considered. Each such proposal should be accompanied by a written statement from the student's faculty advisor certifying (1) that the student is qualified to conduct the observing program and data analysis; and (2) that the student is in good academic standing. This letter from the advisor should be sent by the deadline to SPSO, c/o Graduate Student Submission, either by paper, e-mail or fax (see APPENDIX A: for address). If the research is part of a doctoral thesis, the proposal should so indicate. (The faculty advisor’s statement is not required in cases where a student is listed in the proposal only as a Co-I.) Students should, however, be particularly aware of the inherent uncertainties of space-based research and of the possible impact of delays upon their educational progress.
4.3 **FUNDING OF U.S. OBSERVERS AND ARCHIVAL RESEARCHERS**

Subject to availability of funds from NASA, STScI will provide financial support for scientists affiliated with U.S. institutions. Detailed policies that apply to such funding are discussed in Appendix B of this document. Successful GO and AR proposers will be requested to provide the Budget Forms as part of their Phase II submissions.

For proposals submitted by non-U.S. PIs with U.S. Co-Is who request funding, one of the U.S. Co-Is should be designated as administratively responsible for STScI funding, and should collect and submit the budget forms for all of the U.S. Co-Is in Phase II.

Proposers from ESA member states should note that ESA does not fund HST research programs. Therefore, successful ESA member-state proposers should seek any necessary resources from their respective home institutions or national funding agencies. ESA observers do, however, have access to the data-analysis facilities and technical support of the staff of the ST-ECF (see Appendix A).

4.4 **PROPOSAL CONFIDENTIALITY**

Proposals submitted to STScI will be kept confidential to the maximum extent consistent with the review process described in § 6.2. However, all Phase II information for accepted programs including PI and Co-I names, project titles, abstracts, description of observations, special scheduling requirements, and details of all targets and exposures, will be accessible to the public.
CHAPTER 5: Policy Summary

5.1 Duplications of Observations on page 5-24
5.2 Data Rights on page 5-25
5.3 Use of the Continuous Viewing Zone on page 5-25
5.4 Unschedulable or Infeasible Programs on page 5-26
5.5 Special Calibrations on page 5-26
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5.7 Publication of HST Results on page 5-28

5.1 Duplications of Observations

This subsection discusses several aspects of observations that may duplicate other observations already obtained with HST, or that are currently in the pool of accepted HST programs. An observation is defined as duplicating a previous one if it is on the same astronomical target or field, with the same or similar instrument, a similar instrument mode, similar sensitivity, similar spectral resolution, and a similar spectral range.

It is the responsibility of proposers to check their proposed observations against the catalog of previously executed or accepted programs, and, if any duplications exist, to identify and justify them in the Phase I proposal.

Any case of unjustified duplication that may come to the attention of the peer reviewers could lead to rejection during the Phase I deliberations. A final systematic computer-aided check for duplications of previous observations is carried out in Phase II, and duplicate observations will be rejected. The duplication check is done against the Data Archive (which includes previously accepted programs) and the GTO program.

Under NASA policy, the GTO programs (see § 2.6) are protected against contemporaneous acquisition by the GOs of duplicate observations. Proposed GO observations that are judged to infringe upon this protection will be disallowed. However, the duplication protection is as specifically defined above; entire classes of objects or broad scientific programs are not protected. The GTOs are entitled to revise their programs after each cycle of GO selection, but they in turn may not duplicate the previously approved GO programs. GTOs may not modify their programs in the time interval between the publication of the GTO/GO catalog in each cycle and the final submission of the Phase II GO programs selected for that cycle. The protection of each observation is in force throughout its proprietary data-rights period (see § 5.2), and then expires.

A catalog of all past and planned GO and GTO observing programs is available on the Web, or it can be examined interactively using StarView (see § 8.1).
Prospective GOs should examine the catalog and exposure lists carefully before submitting their proposals, to ensure that they have not duplicated these programs. If there are duplications, they must be identified and justified strongly as meeting significantly different and compelling scientific objectives.

Without specific TAC recommendation to retain such exposures, STScI will remove or restrict them during the duplication checks that are made in Phase II. In these cases, no compensatory observing time will be allowed and the associated observing time will be removed from the allocation.

Snapshot targets may not duplicate approved GO or GTO programs in the same cycle. Following selection, investigators will define the target samples and may be called upon to assist in the elimination of target duplications. Duplicate observations will be disallowed.

SNAP targets can not duplicate earlier SNAP targets if the earlier program is still active, even if the target has not been observed yet.

It may occasionally happen that a proposer requests an acquisition image that is already contained in a GTO program, which would be protected according to the NASA policies outlined above; if an early-acquisition image is determined to be in conflict with a protected GTO image, the GO-requested image may still be permitted, but may only be used for acquisition purposes.

**5.2 DATA RIGHTS**

GOs and GTOs have exclusive access to their scientific data during a proprietary period. Normally this period is the 12 months following the date on which the data, for each target, are archived and made available to the investigator after routine data processing (§7.2). At the end of the proprietary period, data are available for analysis by any interested scientist through the HST Archive (see §2.3 and §8.1).

Proprietary periods longer than 12 months may on rare occasions be appropriate for long-term programs (defined in §2.1.5 as programs whose observations extend over more than one cycle) if there is a need to have most or all of the data available before any significant scientific results can be obtained. Since a proprietary period longer than 12 months is not supported by the related keyword on the proposal cover page, requests for data-rights extensions beyond 12 months must be made in the proposal scientific justification, and will be subject to the initial panel/TAC review.

Proposers who wish to request a proprietary period shorter than one year, or to waive their proprietary rights, should specify it in the cover page of their proposals. Because of the potential benefit to the community at large, particularly in the case of large projects, snapshots, or surveys, proposers are asked to give this possibility serious consideration.

**5.3 USE OF THE CONTINUOUS VIEWING ZONE**

Observations of targets that lie in the Continuous Viewing Zone (CVZ) (see §12.1 and APPENDIX G) have been shown to be more than twice as efficient as the ensemble of non-CVZ observations; hence observers are encouraged to request the CVZ when possible, in order to maximize the scientific return and efficiency of their observations. The
allocation of spacecraft orbits allows proposers to evaluate straightforwardly the efficiency gains realized through observations made in the CVZ. It will often be found that use of the CVZ will allow a significant increase in the possible exposure time during a given number of spacecraft orbits, and hence its exploitation is to the proposer’s advantage. Proposers should also be aware that it is not possible to use the Shadow time (SHD) and Low-sky (LOW) special requirements in the CVZ (see §16.2, step 2), and that special timing requirements are not generally compatible with CVZ observations. Hence, observations requiring low background should not be proposed for execution in the CVZ.

In previous cycles, observations in the CVZ were requested by observers in Phase I and were approved or disallowed by the TAC or panels. Proposers using the CVZ had a margin of risk in the cases in which their programs were unschedulable in the CVZ. We have changed the CVZ policy.

In Cycle 9, proposers should use CVZ visibility in their orbit estimates where possible, and STScI will make every effort to schedule the observations in this optimal way. Because CVZ opportunities are limited, however, it may be necessary to schedule the observations using standard orbit visibility (i.e., more orbits), especially for large numbers of CVZ orbits and/or additional scheduling constraints.

Proposers should be aware that all programs approved in Phase I are conditional upon technical review, which is based on variables unknown at the time of program selection, and that rescheduling CVZ proposals by using standard orbit visibility may prove impossible (see also §5.4).

5.4 UNSCHEDULED OR INFEASIBLE PROGRAMS

Successful proposers should be aware that the actual execution of their observations may, in some cases, prove impossible. Possible reasons include the following: (1) the accepted observation could be found extremely difficult for technical reasons or infeasible only after receipt of the Phase II information; (2) the observing mode or instrument selected may not be operational; or (3) it might be found that suitable guide stars do not exist. Therefore,

all observations are accepted for the HST program with the understanding that there can be no guarantee that the observations will actually be obtained.

Target-of-opportunity and time-critical observations can be particularly complex to plan and execute, and will be completed only to the extent that circumstances allow. Proposers should contact the STScI Help Desk if they have questions about whether an observation is feasible. Furthermore, observations are scheduled to optimize the overall HST efficiency. STScI will not contemplate requests to advance the scheduling of individual programs based on other considerations.

5.5 SPECIAL CALIBRATIONS

Data from HST observations are normally provided to the GO after application of full calibrations. The calibration and engineering test programs can use up to 10% of the avail-
able orbits with HST. In order to obtain quality calibrations for a broad range of observing modes, yet stay within the available calibration time, only a restricted set - the supported modes - may be calibrated. Use of available but unsupported modes is allowed to enable potentially unique and important science observations, but is discouraged except where driven by scientific need. Observations taken using available but unsupported modes which fail, due to the use of the unsupported mode, will not be repeated. Use of available but unsupported modes should be justified in the Special Requirements section of the proposal. See the individual Instrument Handbooks for more details. Any required calibration observations for these modes must be included in the request for observing time and the data reduction will be the responsibility of the observer.

The Instrument Handbooks contain details on the standard calibrations. Any special calibration need not met by the advertised standard calibration program is the responsibility of the proposer and requires a direct request for additional observing time in the Phase I submission. Proposers must estimate the time required for any special calibration from the information given in the Instrument Handbooks. The STScI Help Desk can provide assistance on this when needed, but requests for such assistance must be received at least 14 days before the Phase I deadline.

In the cases in which special calibrations require orbits in addition to those requested for science acquisition, proposers are asked to enter these requests in the Observation Summary (see § 15, item #13).

Data flagged as having been acquired for calibration purposes will normally be made non-proprietary. All HST data may be accessed and analyzed by appropriate Instrument Scientists to assess instrument performance and to develop calibrations. If proprietary data are used in this way strict confidentiality is maintained.

5.6 FAILED OBSERVATIONS

HST observations fail at the rate of a few percent. Some of these failures result from occasional guide stars that cannot be acquired, or from an instrument anomaly, or the telescope happening to be in a suspended mode when a particular observation was scheduled. Such failures that are obviously beyond the proposer’s control are usually rescheduled for an automatic repeat; when this is the case, the proposer will receive a notice to this effect from the Observation Support/Post-Observation Data Processing Unified System (OPUS). A smaller fraction of failures do not have a clear cause, and may not be evident from our internal reviews of data quality. If you believe your observation has failed or is seriously degraded, then you may request a repeat by filing a Hubble Observation Problem Report (HOPR). The HOPR must be filed within 90 days after the observations are taken (the short time limit is imposed in order for us to learn about, and thus correct if possible, subtle problems). It is standard policy that for sets of observations to be repeated, the proposer should be willing to have the degraded/failed observations be made public. In cases where the failure resulted from proposer error, say incorrect coordinates, a repeat will not be granted. In cases where the failure was a result of incorrect instrument performance, or incorrect information provided by the Institute, a repeat will usually be granted. A 90% completion rule also usually applies, such that if the observer has obtained more than 90% of the planned observations and the missing data are not uniquely important, then a repeat is not normally granted.
5.7 **Publication of HST Results**

It is expected that the results of *HST* observations and Archival Research will be published in the scientific literature. All publications based on *HST* data must carry the following footnote (with the phrase in brackets included in the case of Archival Research):

“Based on observations made with the NASA/ESA Hubble Space Telescope, obtained [from the data Archive] at the Space Telescope Science Institute, which is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5-26555. These observations are associated with proposal(s) ID [###]”

If the research was supported by a grant from STScI, the publication should also carry the following acknowledgment at the end of the text:

“Support for this work was provided by NASA through grant number [###] from the Space Telescope Science Institute, which is operated by AURA, Inc., under NASA contract NAS 5-26555.”

One preprint or reprint of each refereed publication based on *HST* research must be sent to the following address:

Librarian  
Space Telescope Science Institute  
3700 San Martin Dr.  
Baltimore, MD 21218 USA

In addition, one preprint of each publication based on *HST* research should be sent to the following address:

Dr. David Leckrone  
*HST* Senior Scientist  
Code 440  
Goddard Space Flight Center  
Greenbelt, MD 20771 USA

This advance information is important for planning and evaluation of the scientific operation of the *HST* mission. We also remind *HST* observers that they have a responsibility to share interesting results of their *HST* investigations with the public at large. The Office of Public Outreach of STScI is available to help observers use their *HST* data for public information and education purposes. Proposers can find guidelines and examples of these activities in the Web page:

CHAPTER 6: Proposal Evaluation, Selection, and Implementation

In this Chapter...

6.1 Technical Review on page 6-29
6.2 Scientific Review on page 6-30
   6.2.1 Review Panels on page 6-30
   6.2.2 Telescope Allocation Committee on page 6-30
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6.3 Allocation of HST Observing Time on page 6-31
6.4 Phase II Procedures on page 6-32

The process by which HST proposals will be reviewed and selected for implementation is described in this section. Prospective observers will find it useful to have an understanding of this process as they prepare their proposals.

The review of proposals for use of the Hubble Space Telescope (HST) is managed by the Space Telescope Science Institute (STScI) and carried out in two phases. In Phase I, proposers submit a scientific justification and observation summary for peer review. The Telescope Allocation Committee (TAC) and panels recommend a list of programs to the STScI Director for preliminary approval and implementation. During Phase II, proposers whose observing projects have been recommended provide complete details of their proposed observations, to allow STScI to conduct a full technical feasibility review of the programs, and a cross-proposal exposure duplication test to search for similar exposures among current HST programs. Up-to-date Exposure Catalogs are made available to proposers prior to the Phase I deadline in order to avoid duplication-related problems during the Phase II implementation and review. Upon final approval by the Director, the Phase II information is then used to schedule and obtain the actual observations.

“Phase I” refers to the process from proposal preparation and submission through the peer-review selection and Director’s approval. “Phase II” refers to the detailed program preparations (including specifications of the actual HST exposures in complete detail) that are subsequently carried out by the GOs who have been approved for observing time. Programs are not fully accepted until the Phase II has been submitted and the conflict checking and feasibility reviews are completed.

6.1 Technical Review

The technical review of the proposals by STScI personnel is currently done after Phase II submission (see § 6.4). This is carried out by a careful reading of the proposal by STScI staff members who look for particularly complex, or human and technical resource-intensive observations, or those requiring the use of limited resources (such as real-time acquisitions or TOO programs).
6.2 Scientific Review

The evaluation of the scientific merit of proposals is accomplished via peer review. Proposals are ranked according to a well-defined set of criteria (§ 6.2.3) by scientists chosen from the international astronomical community, in order that a final recommended HST program may be transmitted to the STScI Director.

6.2.1 Review Panels

In Cycle 9 Regular programs (§ 2.1.3) will be considered in detail by very broad expert panels, each spanning several scientific categories (§ 15). Along with the usual criteria for success (§ 6.2.3), these expert panels will consider the significance of the proposed program to astronomy. Proposers should consider framing their scientific justification in terms appropriate for a panel with broad expertise.

Each review panel will approve proposals up to their allocated number of orbits. In contrast with previous cycles, the orbits allocated by the panels to Regular programs will generally not require TAC approval (they will of course be subject to the Director’s approval); scientific balance will be determined within each panel rather than by the TAC. The panels will also be able to forward their comments on Large programs (§ 2.1.2) to the TAC for their final consideration.

6.2.2 Telescope Allocation Committee

The primary responsibility of the TAC in Cycle 9 will be to review the Large proposals (§ 2.1.2). Up to 1000 orbits will be allocated by the TAC to excellent Large programs. The TAC will also be the final arbiter of other extra-ordinary or cross-panel issues arising in the panel review. The TAC will be composed of panel chairs and other members of the international scientific community.

6.2.3 Selection Criteria

The peer reviewers will be advised to generally accept or reject proposals as they are and minimize orbit/object trimming. Therefore it is very important to justify both the selection and number of targets, and the number of orbits requested. Unjustified requests of time may result in rejection of the entire proposal.

The review panels and TAC will base their evaluations of HST observing proposals on the following criteria:

- The scientific merit of the proposed project, the importance of its contribution to the advancement of scientific knowledge.
- The general importance to astronomy of the proposed program.

Note that the importance to astronomy must be explicitly stated in the scientific justification of all Cycle 9 proposals.

- The rationale for target selection (both type and number of objects).
- The technical feasibility and likelihood of success of the project (a quantitative estimate of expected results and needed accuracy of the data should be provided).
Proposal Evaluation, Selection, and Implementation

• The requirement for the unique capabilities of HST in order to achieve the scientific goals of the program (e.g., evidence that the project cannot be accomplished with a reasonable use of ground-based telescopes, irrespective of their accessibility to the proposer).
• Evidence that the project has already been pursued to the limits of ground-based and/or other space-based techniques.
• Evidence of collaborative and coordinated effort to maximize the scientific return from the observational program, especially for large projects.
• The demands made on HST and STScI resources, including the efficiency with which telescope time will be used.
• For snapshot, pure parallel, and survey proposals in particular, the optional commitment of the proposers to waive part or all of the proprietary period.

In the evaluation of Large proposals the panels and TAC will use the following additional criteria:
• Evidence that a plan exists for assembling a coherent database that will be adequate for addressing all of the purposes of the program.
• Evidence that the proposers possess sufficient expertise to assure a thorough analysis of the database.
• Evidence that the work of the proposers will be coordinated effectively, even though a large team may, in some cases, be required for the proper analysis of the data.
• Evidence that the observational database will be obtained in such a way that it will be useful to the maximum possible extent for purposes beyond the immediate goals of the large project.

The most important evaluation criteria for Archival Research proposals will be:
• The scientific merit of the proposed project and the importance of its contribution to the advancement of scientific knowledge.
• The improvement or addition of scientific knowledge with respect to the previous original use of the data. In particular, strong justification must be given to reanalyze data with the same science goal as that originally proposed.
• Evidence that the proposers possess sufficient expertise and resources to assure a thorough analysis of the database.
• The demands made on STScI resources, including funding and technical assistance.

6.3 ALLOCATION OF HST OBSERVING TIME

Based on TAC and panel recommendations, the STScI Director will make the final allocation of observing time. The time recommended by the TAC and panels and approved by the Director will be in units of “orbits.” Directions and examples for calculating the required number of orbits are given in §16.1 and APPENDIX H; they take into account the actual on-target exposure time, plus the overhead time spent acquiring guide stars and placing the targets in the desired instrument apertures, reacquiring guide stars after Earth occultation, preparing the instruments for the observations, and reading out the data.

All proposers will receive electronic notification of the outcome of the selection process. It is anticipated that the panels and TAC will meet approximately two months after the proposal submission deadline, and that notification of the Phase I outcome will be sent shortly thereafter.
6.4 PHASE II PROCEDURES

The information supplied by observers in their Phase I proposal forms enables the scientific and preliminary technical review of the project, but is not detailed enough for flight implementation and scheduling of the observations. Successful GO/SNAP observers will be asked to submit additional detailed “Phase II” observation specifications so that their programs can be placed on the observing schedule for execution. The Phase II submission deadline will be approximately eight weeks after notification of the TAC outcome.

Failure to submit the Phase II by the required deadline will result in the loss of time allocation.

Detailed budgets (U.S. GO, SNAP, and AR) will be requested for submission with the Phase II material. PIs are notified of the results of review of their submitted Phase II budgets approximately 3 months after the Phase II deadline.

For complex or difficult programs, observers may visit STScI before the Phase II deadline. U.S. GOs may incur pre-award travel costs to support such visits, and financial support for such visits, where appropriate, may be included in the Phase II budget and in a preparatory funding request. However, it should be noted that all pre-award expenditures are incurred at the risk of the PI and that all funding is contingent upon the availability of funds from NASA at the time the award is made.
CHAPTER 7: Data Processing and Analysis

In this Chapter...

7.1 Program Coordinator and Contact Scientist Support on page 7-33
7.2 Routine Scientific Data Processing on page 7-33
7.3 Space Telescope Science Data Analysis System on page 7-34

This Chapter outlines the sources of technical/scientific support that STScI provides to assist GOs with analysis of their data. It also briefly describes the routine processing applied to all HST data and the data products that observers will receive.

7.1 PROGRAM COORDINATOR AND CONTACT SCIENTIST SUPPORT

Cycle 9 programs will be assigned a Program Coordinator (PC), whose role is to help the observer deliver a Phase II proposal which is syntactically correct and will schedule successfully on the telescope. Selected programs (e.g., those with first-time PIs, those using complicated observing strategies) will also be assigned a Contact Scientist (CS), whose role is to provide advice on observing strategies which will ensure the scientific objectives of the program will be carried out, and to answer specific questions about instrument performance; those observers not automatically assigned a CS may request one. The CS will be an Instrument Scientist involved in the calibration and characterization of the primary instrument used in the observer’s program. Of course, observers with any question about HST can contact the STScI Help Desk, whether or not they have been assigned a CS.

New GOs may find a short (2-3 day) post-observation visit to STScI useful for the purpose of learning how to deal with their data.

7.2 ROUTINE SCIENTIFIC DATA PROCESSING

Scientific data are routed from HST to the Tracking and Data Relay Satellite System (TDRSS), through the TDRSS ground station at White Sands, New Mexico, to the Data Distribution Facility (DDF) at Goddard Space Flight Center in Greenbelt, Maryland, and finally to STScI. At STScI the production pipeline of OPUS provides standard processing for data editing, calibration, and product generation. These functions, performed automatically, include the following:

• Reformat and edit data from spacecraft packet format to images and spectra.
• Perform standard calibrations (flat fields, wavelength calibrations, background subtraction, etc.) with currently available calibration files.
Data Processing and Analysis

- Produce standard data output products (FITS tapes of raw and calibrated images, standard plots, OMS [jitter and performance flags] files, PDQ [Procedural Data Quality Assessment] files, etc.).

The data are stored in the Hubble Data Archive after processing by OPUS, and they become available to other researchers after expiration of the proprietary period. Any further processing or scientific analysis is the responsibility of the GO. If requested in the Phase II proposal, one tape copy (usually 8 mm Exabyte or DAT tape) of the raw and processed data is made and sent to the PI or his/her designee. The PIs may also request electronic access to the data for themselves or anyone else. This access can be obtained by sending e-mail to: archive@stsci.edu.

Access must be specifically requested for each proposal. As described below, STScI provides assistance with data analysis and Archive access, either by e-mail or telephone, or during GO visits to Baltimore.

7.3 SPACE TELESCOPE SCIENCE DATA ANALYSIS SYSTEM

STSDAS is a set of tools and support software used to calibrate and analyze HST data. A companion package, TABLES, is a set of tools for creating and manipulating tabular data, reading and writing FITS images and tables, and creating customized graphics. STSDAS and TABLES are layered onto the Image Reduction and Analysis Facility (IRAF) software from the National Optical Astronomy Observatories (NOAO); one must be running IRAF in order to run STSDAS and TABLES.

We expect to support STSDAS and TABLES on the following platforms:

- Solaris/SunOS
- Digital Unix (formerly OSF/1 and soon to be True64)
- HP-UX
- SGI IRIX
- IBM AIX
- PCs running Redhat or Slackware Linux

Support is contingent on a suitable version of IRAF being available for the platform. We will not support all platforms that IRAF supports, as we are dropping support of OpenVMS, Ultrix, and FreeBSD for PCs.

STSDAS and TABLES provide a large range of data-analysis tools, including the following:

- Calibration of HST data
- Synthetic photometry
- Interactive curve fitting and surface photometry
- Image restoration
- Fourier analysis
- Table creation and manipulation
- FITS image and table I/O
- Graphics tasks tailored to HST data

The STSDAS calibration software is the same as used in the OPUS pipeline. HST observers can, therefore, recalibrate their data, examine intermediate calibration steps, and re-run
the pipeline using different calibration switch settings and reference data. STSDAS includes the software needed to generate new versions of calibration reference data and calibration parameters. STSDAS also provides tools for on-site users to access the Calibration Data Base and the Data Archive.

Observers should use up-to-date software, especially if it is used for analysis of positions from HST imaging data. Current software is backward compatible with all HST archival data. However, use of software with old release dates (e.g., pre-1994 for analysis of WFPC2 data) could return spurious results. The current release of STSDAS (version 2.1, December 1998) is available for downloading from the Web at:

http://ra.stsci.edu/STSDAS.html

Questions about STSDAS may be addressed to help@stsci.edu.
Facilities for Archival Research

CHAPTER 8: Facilities for Archival Research

In this Chapter...

8.1 The STScI Data Archive Catalog: Browsing and Duplication Checking
8.2 Archival Research Support

Policies for submitting requests for archival HST data, and for proposing funded Archival Research (AR), were discussed in § 2.3. The following subsections give an overview of the Archive facilities available at STScI and methods for accessing them. Further information is given in the HST Archive Manual (§ 1.3).

All science and calibration data, along with a large fraction of the engineering data, are placed in the Hubble Data Archive. As of May 1, 1999, the Archive contained approximately 6.3 Terabytes of data. About 5 Gbytes of new data are archived each day. Over half the Archive (in byte volume) is science data. Most of the data in the Archive are public and may be retrieved by any user. Check the archive home page http://archive.stsci.edu for the most recent listing of user services.

8.1 The STScI Data Archive Catalog: Browsing and Duplication Checking

The STScI Data Archive is the primary storage and distribution point for science, calibration, and engineering data from the Hubble Space Telescope. The heart of the Archive is the Data Archive and Distribution Service (DADS). DADS is the collection of optical disks on which the data are stored, the databases which comprise the Archive catalog, and the hardware and software that support the ingest and distribution of HST data.

Interested applicants may browse the Archive catalog through the Web or by using a special user interface, StarView. The Web interface is available at http://archive.stsci.edu/hst/ and provides a fast means for doing simple searches for data existing in the Archive. Through the Web interface, the user can retrieve data as well as the corresponding calibration and observatory monitoring files. Forms for Web-based duplication checking of single targets can be found at http://archive.stsci.edu/hst/duplication_checking

The ability to check lists of targets for duplications by existing or planned HST observations is a planned feature, to be available by July 1999.
Facilities for Archival Research

StarView is an X-Windows interface suitable for more sophisticated searches of the Archive. StarView provides a wide variety of search screens, including screens to review the calibration of observations and to search the text of HST observing proposal abstracts. StarView allows the user to create custom queries, and to cross-correlate lists of targets with HST pointings. Search results may be displayed in single-record or in table formats, and may be saved to a file.

StarView can be easily installed on most computers. Compiled versions of StarView are available for most versions of SunOS, Solaris, Digital UNIX for Alpha, and OpenVMS for VAX and Alpha. The software may be downloaded via anonymous ftp from archive.stsci.edu in pub/starview/, or through the Web at http://archive.stsci.edu/hst/distributed_starview.html

In both the Web interface and StarView, preview images or spectra are available for most public observations. Both interfaces also offer integrated access to the Digitized Sky Survey, and both allow the user to access SIMBAD (Set of Identifications, Measurements, and Bibliography for Astronomical Data) or NED (NASA/IPAC Extragalactic Database) to look up the coordinates of an object by name.

An alternative way of searching the archive, and for target duplication checking, is to download and examine the Archived Exposure Catalog (AEC) and the Planned Archive Exposure Catalog (PAEC). AEC and PAEC are sets of flat ASCII files containing summary information about exposures, including the target name, position, instrument mode, and the date on which the data became (or will become) public. The AEC and the PAEC may be examined by any text editor or used as a local database of HST observations and planned observations. The AEC and PAEC are updated monthly, and are available via anonymous ftp from archive.stsci.edu in pub/catalogs, or through the Web at http://archive.stsci.edu/hst/aec.html http://archive.stsci.edu/hst/paec.html

STScI maintains an “Archive Hotseat”, archive@stsci.edu, or 410-338-4547, which operates during normal office hours (EST). Any archive-related questions, problems, or comments should be referred to the Hotseat.

8.2 Archival Research Support

Users may retrieve any public data or the proprietary data which they have been authorized to access. PIs can request authorization for themselves or collaborators by sending e-mail to archive@stsci.edu. All Archive users should register via the Web at:http://archive.stsci.edu/registration.html

After finding suitable datasets in the Web interface or StarView and marking them for retrieval, initiate the retrieval process by pressing the “Retrieve marked datasets” button in either interface. Users have the option of sending the data to the staging area, from which they may retrieve them via anonymous ftp, or they can have the data delivered over the Internet directly to a disk on the users’ home computer; finally, users may request data on tape. The tape option is recommended for users whose network bandwidth or available disk space is limited. Proprietary data must be retrieved either directly or to tape (8mm or Exabyte) mailed directly to the PI or his/her designee.

Datasets selected from the AEC may be retrieved by creating a file list of the desired data set names and uploading it to either StarView or the Web interface. See the Archive Manual or contact the Archive Hotseat for more information.
Facilities for Archival Research

STScI provides limited assistance in the reduction and analysis of archived data. Most PIs will find that they are able to obtain sufficient advice through the Help Desk. New HST users may consider a short visit to STScI to get help on the implementation of their programs. Visits can be arranged through the Help Desk. Although a Contact Scientist is not usually assigned to a funded AR program, STScI will do so upon request; the CS will serve as a single point of contact to help resolve calibration and data analysis issues. However, proposers should plan to conduct the bulk of their archival research at their home institutions, and should request funds accordingly. Limited resources preclude extensive assistance in the reduction and analysis of data obtained by non-funded archival researchers.
Part II. The Hubble Space Telescope

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CHAPTER 9: System Overview

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9.1 Telescope Description

As shown in Figure 9.1, HST’s SIs are mounted in bays behind the primary mirror. The Wide Field Planetary Camera 2 occupies one of the radial bays, with an attached 45 degree pickoff mirror that allows it to receive the on-axis beam. Three SIs (Faint Object Camera, Near Infrared Camera and Multi-Object Spectrometer, and Space Telescope Imaging Spectrograph) are mounted in the axial bays and receive images several arc-minutes off-axis.

HST receives electrical power from two solar arrays, which are turned (and the spacecraft rolled about its optical axis) so that the panels face the incident sunlight. During the 1993 servicing mission the astronauts installed new solar arrays, which have significantly reduced the thermally induced vibrations that the old arrays were producing. Nickel-hydrogen batteries provide power during orbital night. The two high-gain antennas shown in Figure 9.1 provide communications with the ground (via the Tracking and Data Relay Satellite System). Power, control, and communications functions are carried out by the Support Systems Module (SSM), which encircles the primary mirror.

During the servicing mission in December 1993, the astronauts installed COSTAR in the fourth axial bay (in place of the High Speed Photometer). COSTAR deployed corrective reflecting optics in the optical paths in front of the FOC, GHRS, and FOS, thus removing the effects of the primary mirror’s spherical aberration. In addition WF/PC was replaced by the WFPC2, which contains internal optics to correct the spherical aberration.

The Fine Guidance Sensors (FGSs) occupy the other three radial bays and receive light 10–14 arcminutes off-axis. Since at most two FGSs are required to guide the telescope, it is possible to conduct astrometric observations with a third FGS. Their performance is unaffected by the installation of COSTAR.

The second servicing mission replaced FOS and GHRS by STIS and NICMOS, and also has replaced several additional pieces of equipment. One of the FGSs (FGS-1) has been replaced with an enhanced FGS, called FGS1R. The new FGS1R has an adjustable folding flat mirror which is commandable from the ground and enables the realignment in the FGS optical path, and thus lessen the effects of spherical aberration. As a result, FGS1R significantly exceeds FGS-3 in astrometric performance. A solid state recorder (SSR) has replaced ESTR-1, and provides a factor of 10 greater on-board data storage volume. It also provides increased flexibility in scheduling HST observations, reducing the coupling with the TDRSS system.
System Overview

Figure 9.1: The Hubble Space Telescope. Major components are labelled, and definitions of V1, V2, V3 spacecraft axes are indicated. Note that, although FOC and NICMOS are on the telescope, they are not offered for observations in Cycle 9.

At the time of writing, there are three other planned servicing missions: SM3A is scheduled for October 14, 1999. During SM3A the astronauts will install a new FGS, replace all 6 rate-sensing gyroscopes, and also they will install a new spacecraft computer, a backup solid state reader, and other spacecraft components. During SM3B, scheduled to occur on December 1, 2000, the Advanced Camera for Surveys (ACS) will be installed, replacing the FOC. A mechanical cooling system is planned for installation which, if successful, will allow further use of the NICMOS. Enhanced thermal control for the axial instruments will be provided with the installation of an aft-shroud cooling system. In addition, a number of repairs and replacements to the spacecraft equipment will be made. A third servicing mission (SM4) will install the Cosmic Origins Spectrograph (COS) and the Wide Field Camera 3 (WFC3).

9.2 HST Maneuvering and Pointing

In principle, HST is free to roll about its optical axis. However, this freedom is limited by the need to keep sunlight shining on the solar arrays, and by a thermal design that assumes that the Sun always heats the same side of the telescope.
To discuss *HST* pointing, it is useful to define a coordinate system that is fixed to the telescope. This system consists of three orthogonal axes: V1, V2, and V3. V1 lies along the optical axis, V2 is parallel to the solar-array rotation axis, and V3 is perpendicular to the solar-array axis (see Figure 9.1). Power and thermal constraints are satisfied when the telescope is oriented such that the Sun is in the half-plane defined by the V1 axis and the positive V3 axis. The orientation that optimizes the solar-array positioning with respect to the Sun is called the “nominal orientation.”

It should be noted that the nominal orientation angle required for a particular observation depends on the location of the target and the *date of the observation*. Observations of the same target made at different times will, in general, be made at different orientations.

Some departures from nominal orientation are permitted during *HST* observing (e.g., if a specific orientation is required at a specific date, or if the same orientation is required for observations made at different times). Off nominal roll is defined as the angle about the V1 axis between a given orientation and nominal orientation. Off nominal rolls are restricted to approximately 5 degrees when the sun angle is between 50 degrees and 90 degrees, <30 degrees when the sun angle is between 90 degrees and 178 degrees and is unlimited at anti-sun pointings of 178 degrees to 180 degrees (note that in order to achieve an anti-sun pointing of 178-180 degrees the target must lie in or near the plane of the sun’s orbit).

*HST* utilizes electrically driven reaction wheels to perform all maneuvering required for guide-star acquisition and pointing control. A separate set of rate gyroscopes is used to provide attitude information to the pointing control system.

The slew rate is limited to approximately 6 degrees per minute of time. Thus, about one hour is needed to go full circle in pitch, yaw, or roll. Upon arrival at a new target, up to 5 additional minutes must be allowed for the FGSs to acquire a new pair of guide stars. As a result, large maneuvers are costly in time and are generally scheduled for periods of Earth occultation or crossing of the South Atlantic Anomaly (see §12.2).

The telescope does not generally observe targets that lie within 50 degrees of the Sun, 15.5 degrees of any illuminated portion of the Earth, 7.6 degrees of the dark limb of the Earth, or 9 degrees within the Moon.

There are exceptions to these rules for *HST* pointing. For example, the bright Earth is a useful flat-field calibration source. However, there are onboard safety features that cannot be overridden. The most important of these is that the aperture door shown in Figure 9.1 will close automatically whenever *HST* is pointed within 35 degrees of the Sun, in order to prevent direct sunlight from reaching the optics and focal plane.

Objects in the inner solar system, such as Venus or comets near perihelion, are unfortunately difficult or impossible to observe with *HST*, because of the 50 degree solar limit. When the scientific justification is compelling, observations of Venus and time-critical observations of other solar-system objects lying between 46 degrees and 50 degrees of the Sun may be carried out (this capability was successfully demonstrated in Cycle 4).

### 9.3 Data Storage and Transmission

The *HST* observing schedule is constructed at STScI and command loads are forwarded to the Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, where the Space Telescope Operations Control Center (STOCC) is located. Communication with the spacecraft is via the Tracking and Data Relay Satellite System (TDRSS), which consists of a set of satellites in geosynchronous orbit.
System Overview

The TDRSS network supports many spacecraft in addition to HST. Therefore, use of the network, either to send commands or return data, must be scheduled. Because of limited TDRSS availability, command sequences for HST observations are normally uplinked periodically and stored in the onboard computers. HST then executes the observations automatically.

It is possible for observers at STScI to interact in real-time with HST for specific purposes, such as certain target acquisitions. In practice, real-time interactions are difficult to schedule (see §3.1.3). During normal operations, fewer than 25 real-time interactions have been required in each of the past two years.

HST currently uses a large capacity Solid State Recorder to store scientific data before transmission to the ground. Except when real-time access is required, most HST observations are stored to the SSR and read back to the ground several hours later. Some scientific programs requiring very high data-acquisition rates cannot be accommodated, because the SIs would generate more data than either the links or ground system could handle.
CHAPTER 10: Telescope Performance

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10.3 Observing Time Availability on page 10-45

10.1 Optical Performance

Because the primary mirror has about one-half wave of spherical aberration, the Optical Telescope Assembly (OTA) did not achieve its design performance until after the December 1993 servicing mission. From this time on, SI detectors (FGSs excluded) have viewed a corrected beam, either via COSTAR in the past or internal optics on current cycle SIs. Table 10.1: gives a summary of general OTA characteristics, independent of SIs.

Table 10.1: HST Optical Characteristics and Performance

<table>
<thead>
<tr>
<th>Design</th>
<th>Ritchey-Chretien Cassegrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture</td>
<td>2.4 m</td>
</tr>
<tr>
<td>Wavelength Coverage</td>
<td>From 1100 Å (MgF₂ limited)</td>
</tr>
<tr>
<td></td>
<td>To ~3 microns (self-emission limited)</td>
</tr>
<tr>
<td>Focal Ratio</td>
<td>f/24</td>
</tr>
<tr>
<td>Plate Scale (on axis)</td>
<td>3.58 arcsec/mm</td>
</tr>
<tr>
<td>PSF FWHM at 5000 Å</td>
<td>0.043 arcsec</td>
</tr>
<tr>
<td>Encircled Energy within 0.1&quot; at 5000 Å</td>
<td>87% (60%-80% at detectors)</td>
</tr>
</tbody>
</table>

Because each SI has unique characteristics, the actual encircled energy will differ from instrument to instrument and may also vary with observing techniques. For instrument specific Point Spread Function (PSF) characteristics over various wavelength ranges, please consult the Instrument Handbooks. The TinyTim software, developed at STScI and at ST-ECF, is available for detailed simulations of HST images which agree well with observation. This software can be downloaded from the Web site:

http://www.stsci.edu/ftp/software/tinytim
10.2 GUIDING PERFORMANCE

*HST*’s Pointing Control System (PCS) has two principal hardware components. Rate gyroes are the guidance sensors for large maneuvers and high-frequency (> 1 Hz) pointing control. At lower frequencies, the optical Fine Guidance Sensors (FGSs) provide for pointing stability, as well as for precision maneuvers such as moving-target tracking and offsets and spatial scans.

Each of the three FGSs covers a 90 degree sector in the outer portion of the *HST* field of view (FOV), as shown in Figure 11.1. Optics within the FGS, using precision motor-encoder combinations, select a 5" x 5" region of sky into an $x$, $y$ interferometer system. Once an FGS is locked onto a star, the motor-encoders are driven to track the interference fringe of the guide star. The encoder positions are used by the PCS software to update the current telescope attitude and correct the pointing.

The FGSs have two guiding modes: Fine Lock and Coarse Track. Fine Lock was designed to keep telescope jitter below 0.007" rms, which is now routinely achieved. A drift of up to 0.05" may occur over a timescale of 12 hours and is attributed to thermal effects as the spacecraft and FGSs are heated or cooled. Observers planning extended observations in 0.1" or smaller STIS slits should execute a target peak up maneuver every 4 orbits.

Coarse Track is now believed to cause degradation in mechanical bearings in the FGSs, and accordingly is no longer available as a guiding mode.

Guide-star acquisition times are typically 6 minutes. Reacquisitions following interruptions due to Earth occultations take about 5 minutes. It is also possible to take observations (primarily WFPC2 or STIS CCD “snapshot” exposures) without guide stars, using only gyro pointing control. The absolute pointing accuracy using gyroes is about 14" (one sigma). The pointing drifts at a rate typically of 1.4 +/- 0.7 mas/sec, but it can be somewhat larger depending on the slew history of *HST*.

An option to be considered is provided by single FGS guide star acquisition, where the translational motion of the *HST* is controlled by the FGS finelock on a guide star and the roll motion is left to gyro control. A gyro drift will therefore be present in the pointing performance, however the drift is of order 1.5 mas/sec around the dominant guide star and so introduces a much smaller translational drift into the pointing. Note however that gyro drift can build up through occultations.

10.3 OBSERVING TIME AVAILABILITY

*HST*’s “observing efficiency” is defined as the fraction of the total time that is devoted to acquiring guide stars, acquiring astronomical targets, and exposing on them.

The main factors that limit the observing efficiency are (1) the low spacecraft orbit, with resulting frequent Earth occultation of most targets; (2) interruptions by passages through the South Atlantic Anomaly; (3) the relatively slow slew rate; and (4) the performance of the scheduling algorithm.

During Cycle 9, it is anticipated that the observing efficiency will be about 50%. Of the usable spacecraft time, about 80% is allocated to scientific observations, with the remainder devoted to calibration and engineering observations (10%), and DD programs and repeats of failed observations (also 10%).
SM3A, occurring during Cycle 8, and SM3B will have an additional impact on the total number of available orbits for science observations.

The procedure for estimating (and minimizing) the number of spacecraft orbits required for a given set of exposures is provided in § 16.1. In addition to the on-target exposure time, the procedure takes into account target visibility durations, time required for guide-star acquisitions and reacquisitions and for target acquisitions, and instrument overheads and readout times.
In this Chapter...

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11.5 Bright-Object Constraints on page 11-52

The following Scientific Instruments will be available for Cycle 9 proposals:

- Fine Guidance Sensors (FGS)
- Space Telescope Imaging Spectrograph (STIS)
- Wide Field Planetary Camera 2 (WFPC2)

All of the SIs are mounted at the HST focal plane, so that all except the WFPC2 receive light that is slightly off-axis. A schematic diagram of the telescope focal plane is given in Figure 11.1:.

The following subsections contain brief descriptions of the SIs offered in Cycle 9, while details on the instrument parameters are found in APPENDIX C: , and examples of programs are in APPENDIX H: . After examining Table 11.1: (a)–(e), prospective proposers should read these descriptions in order to determine which SIs are likely to be most suitable for their programs. Revised or updated Instrument Handbooks, which discuss the SIs in detail, are available from STScI as described in § 1.3. The Instrument Handbooks must be consulted before actual preparation of observing proposals. In addition, exposure time calculators for WFPC2 and STIS can be found on the Web instrument pages to assist in the estimation of exposure times.

Data from the following SIs, which were removed from HST during the December 1993 servicing mission (WF/PC, HSP), or in February 1997 (FOS, GHRS), or which will be still on board of HST for parts of Cycle 9, but not offered for observations (FOC, NICMOS), are now available only in archival form:

- Wide Field Planetary Camera 1 (WF/PC)
- High Speed Photometer (HSP)
- Faint Object Spectrograph (FOS)
- Goddard High Resolution Spectrograph (GHRS)
- Faint Object Camera (FOC)
- Near Infrared Camera and Multi-Object Spectrometer (NICMOS)

Overviews of the capabilities of these five instruments are provided in APPENDIX D: , which should be consulted by persons interested in proposing for Archival Research fund-
Scientific Instrument Overview

The following Table 11.1: describes the capabilities of the SIs that will be available on HST during Cycle 9. Note that for some applications more than one instrument can accomplish a given task, but not necessarily with equal quality or speed. This table is provided as an overview. There may be small differences between these numbers and those in the Instrument Handbooks: the Instrument Handbooks numbers should take precedence.

Table 11.1: HST Instrument Capabilities

(a) Direct Imaging

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WFPC23</td>
<td>150 x 150</td>
<td>0.10</td>
<td>1200–11,000</td>
<td>28.0</td>
</tr>
<tr>
<td></td>
<td>35 x 35</td>
<td>0.0455</td>
<td>1200–11,000</td>
<td>27.7</td>
</tr>
<tr>
<td>STIS</td>
<td>52 x 52</td>
<td>0.05</td>
<td>2500–11,000</td>
<td>28.5</td>
</tr>
<tr>
<td></td>
<td>25 x 25</td>
<td>0.024</td>
<td>1650–3100</td>
<td>24.8</td>
</tr>
<tr>
<td></td>
<td>25 x 25</td>
<td>0.024</td>
<td>1150–1700</td>
<td>24.4</td>
</tr>
</tbody>
</table>

(b) Slit Spectroscopy

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>STIS5</td>
<td>optical 52&quot;x (0.05-2)&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UV first order (25-28)&quot;x (0.05-2)&quot;</td>
<td></td>
<td>Echelles ~100,000</td>
<td>11.8–13.0</td>
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<tr>
<td></td>
<td>UV echelle (0.1-0.2)&quot;x (0.025 -0.2)&quot;</td>
<td></td>
<td>~30,000</td>
<td>12.7-15.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prism ~150</td>
<td>22.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>First order ~8000</td>
<td>15.2–16.1-19.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>~700</td>
<td>18.6–20.1-22.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(c) Slitless Spectroscopy

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WFPC26</td>
<td>0.1</td>
<td>~100</td>
<td>3700–9800</td>
<td>25</td>
</tr>
<tr>
<td>STIS6</td>
<td>0.05</td>
<td>~700–8000</td>
<td>2000–11,000</td>
<td>See slit</td>
</tr>
<tr>
<td></td>
<td>0.024</td>
<td>~700–8000</td>
<td>1150–3100</td>
<td>spectroscopy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>above</td>
</tr>
</tbody>
</table>
Scientific Instrument Overview

(d) Positional Astrometry

<table>
<thead>
<tr>
<th>SI</th>
<th>Field of View</th>
<th>Precision (per observation)</th>
<th>Wavelength Range (Å)</th>
<th>Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGS1R</td>
<td>69 sq arcmin</td>
<td>1-2 mas 3 mas</td>
<td>4700–7100</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;17.0</td>
</tr>
<tr>
<td>FGS-3</td>
<td>69 sq arcmin</td>
<td>1-2 mas 3 mas</td>
<td>4700–7100</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;17.5</td>
</tr>
</tbody>
</table>

(e) Binary Star Resolution and Measurements

<table>
<thead>
<tr>
<th>SI</th>
<th>Field of View</th>
<th>Separation [mas]</th>
<th>Accuracy [mas]</th>
<th>Delta Magnitude (max)</th>
<th>Primary Star Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGS1R</td>
<td>aperture center 5x5° IFOV</td>
<td>8</td>
<td>1</td>
<td>0.6</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>1</td>
<td>1.0</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>1</td>
<td>1.0</td>
<td>&lt;15.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>1</td>
<td>2.5</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>1</td>
<td>4.0</td>
<td>&lt;15.0</td>
</tr>
<tr>
<td>FGS3</td>
<td></td>
<td>20</td>
<td>1-2</td>
<td>1.0</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>1-2</td>
<td>1.0</td>
<td>&lt;14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
<td>1-2</td>
<td>2.0</td>
<td>&lt;16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
<td>1-2</td>
<td>3.2</td>
<td>&lt;14.5</td>
</tr>
</tbody>
</table>

Notes to Tables 11.1 (a)–(e):

1 WFPC2 has polarimetric imaging capabilities. STIS has coronographic capabilities.

2 Limiting V magnitude for an unreddened A0 V star in order to achieve a S/N ratio of 5 in an exposure time of 1 hour assuming low-background conditions (low-sky). The limiting magnitude in imaging in the visual is strongly affected by the sky background; under normal observing conditions, the limiting magnitude can be about 0.5 brighter than listed here. Please note that low-sky conditions limit flexibility in scheduling, and are not compatible with CVZ. Single entries refer to wavelengths near the center of the indicated wavelength range. STIS direct imaging entries assume use of a clear filter for the CCD and the quartz filter for the UV (for sky suppression). For STIS spectroscopy to achieve the specified S/N per wavelength pixel with a 0.5” slit, multiple values are given corresponding to 1300, 2800, and 6000Å respectively (if in range).

3 The WFPC2 has four CCD chips that are exposed simultaneously. Three are “wide-field” chips, each covering a 75” x 75” field and arranged in an “L” shape, and the fourth is a “planetary” chip covering a 35” x 35” field.

4 The resolving power is lambda/resolution, for STIS it is $\lambda/2\Delta\lambda$ where $\Delta\lambda$ is the dispersion scale in Angstroms/pixel.
5The 25 or 28" first order slits are for the MAMA detectors, the 52" slit is for the CCD. The R ~150 entry for the prism on the near-UV MAMA is given for 2300Å. More accurate and up to date values for spectroscopic limiting magnitudes can be found in the STIS Instrument Handbook.

6All STIS modes can be operated in a slitless manner by replacing the slit by a clear aperture. WFPC2 has a capability of obtaining low-resolution “spectra” by placing a target successively at various locations in the WFPC2 linear ramp filter. STIS also has a PRISM for use in the UV.

11.1 FINE GUIDANCE SENSORS

As a science instrument, FGS offers accurate relative astrometry and high spatial resolution. In Position mode it measures the relative positions of objects in its 69 square arc minute FOV with a per observation precision of about 1 mas. In Transfer mode the FGS 5” x 5” instantaneous field of view is scanned across an object to obtain an interferogram with high spatial resolution (conceptually equivalent to an imaging device that samples an object’s point spread function with 1 mas pixels).

In either mode the FGS yields 40hz photometry with a relative precision of about 1 milli-magnitude. Objects over a dynamic range of 3 < V < 17 can be observed.

Position mode observing is used to determine the relative parallax, proper motion, and reflex motion of single stars and binary systems. Multi-epoch programs have resulted in measurements accurate to about 0.5 mas or less. Transfer mode observing is used to measure the angular size of extended objects or to resolve binary systems and measure the separation, position angle, and relative brightness of its components. FGS1R can resolve close binary systems with angular separations of only 8 mas and magnitude differences of less than 1.0. Systems with magnitude differences as large as 4 can be resolved provided the separation of the stars is larger than about 30 mas.

11.2 SPACE TELESCOPE IMAGING SPECTROGRAPH

STIS uses two-dimensional detectors operating from the ultraviolet to the near infrared (1150–11,000 Å) in support of a broad range of spectroscopic capabilities. STIS can be used to obtain spatially resolved, long-slit (or slitless) spectroscopy of the 1150–10,300 Å range at low to medium spectral resolutions of R ~ 500 to 17,000 with first-order gratings. Echelle spectroscopy at medium and high (R ~ 30,000 and 110,000) resolutions covering broad spectral ranges of Δλ ~ 800 or 200 Å, respectively, is available in the ultraviolet (1150–3100Å). STIS can also be used for deep optical and solar-blind ultraviolet imaging.

The three 1024 x 1024 pixel detectors supporting spectroscopy and imaging applications are:

- A solar-blind CsI (FUV) Multi-Anode Microchannel Array (MAMA) with 0.024” pixels, a nominal 25” x 25” FOV operating from 1150 to 1700 Å.
- A Cs2Te (NUV) MAMA with 0.024” pixels and a nominal 25” x 25” FOV operating from 1600 to 3100 Å.
- A CCD with 0.05” pixels, covering a 52” x 52” FOV operating from ~2000 to 11,000 Å.

The MAMA detectors support time resolutions down to 125 micro-sec in TIME-TAG mode, and the CCD can be cycled in ~20 sec with use of small subarrays. The CCD also
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provides visible-light, and the MAMA ultraviolet-light, coronographic spectroscopy. Coronographic CCD imaging is also supported.

11.3 Wide Field Planetary Camera 2

The WFPC2 is designed to provide digital imaging over a wide field of view. It has three “wide-field” charge-coupled devices (CCDs), and one high-resolution (or “planetary”) CCD. Each CCD covers 800 x 800 pixels and is sensitive from 1200 to 11,000 Å. All four CCDs are exposed simultaneously, with the target of interest being placed as desired within the FOV.

The three Wide Field Camera (WFC) CCDs are arranged in an “L”-shaped FOV whose long side projects to 2.5’, with a projected pixel size of 0.10”. The Planetary Camera (PC) CCD has a FOV of 35” x 35”, and a projected pixel size of 0.0455”. A variety of filters may be inserted into the optical path. Polarimetry may be performed by placing a polarizer into the beam. A ramp filter exists that effectively allows one to image a ~10” region in an arbitrary 1.3% bandpass at any wavelength between 3700 and 9800 Å, by appropriately positioning the target within the FOV.

The WFC configuration provides the largest imaging FOV available on HST, but under-samples the cores of stellar images; the PC configuration samples the images better, over its smaller FOV.

Table 11.2: Nominal Effective Relative Aperture Location

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Aperture</th>
<th>U2</th>
<th>U3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGS</td>
<td>FGS1R</td>
<td>−726</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>FGS-2</td>
<td>0</td>
<td>726</td>
</tr>
<tr>
<td></td>
<td>FGS-3</td>
<td>726</td>
<td>0</td>
</tr>
<tr>
<td>STIS</td>
<td>PC</td>
<td>214</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>WF2</td>
<td>−2</td>
<td>+30</td>
</tr>
<tr>
<td></td>
<td>WF3</td>
<td>51</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>WF4</td>
<td>−55</td>
<td>−48</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>WFPC2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11.4 The HST Field of View

Figure 11.1: shows the layout of the instrument entrance apertures in the telescope focal plane, as projected onto the sky. The Instrument Handbooks should be consulted for details of each instrument’s aperture sizes and orientations. The figure shows the physical locations of the WFPC2, STIS, and FGS apertures in the focal plane.

We define two new axes in Figure 11.1: , U2 and U3, which are fixed in the focal plane as projected onto the sky. At nominal roll (see § 10.2 ), the U3 axis points toward the anti-Sun.

Table 11.2: lists the relative effective locations of the SI apertures; the U2, U3 coordinate system of Figure 11.1: is used, and the linear dimensions have been converted to arcsec-
Scientific Instrument Overview

onds using a plate scale of 3.58 arcsec/mm. The locations of the apertures listed in Table 11.2: are accurate to about +/- 1 arcsec.

Figure 11.1: The HST field of view. FOC and NICMOS are not offered in Cycle9.

11.5 Bright-Object Constraints

Some of the SIs must be protected against over-illumination; these constraints are discussed below. Observations that violate these constraints should not be proposed. Note however that there may be non-linearity, saturation, or residual-image effects that set in at substantially fainter limits than the safety limits discussed below; the Instrument Handbooks should be consulted for details. In Phase II, it is the responsibility of the GO to ensure that no targets violate the bright-object constraints.

1. FGS. Objects as bright as V=3.0 may be observed if the 5-mag neutral-density filter (F5ND) is used. Observations on all objects brighter than V=8.0 should be performed with this filter. There is a hardware limitation which prevents the FGS target acquisition from succeeding for any target brighter than V=8.0 (3.0 with F5ND).

2. STIS. No safety-related brightness limits for the CCD. The STIS MAMA detectors can be damaged by excessive levels of illumination and are therefore protected by hardware safety mechanisms. In order to avoid triggering these safety mechanisms, absolute limits on the brightest targets which can be observed by STIS will be enforced by proposal screening. It is the GO’s responsibility to provide accurate information to facilitate this process. It is STScI policy that observations lost due to
MAMA bright object violations will not be repeated. MAMA bright object limits are mode dependent. The specific count rate observing limits and example magnitude screening limits for astronomical objects observed in the most commonly used modes are in the STIS Instrument Handbook. In addition, the STIS Exposure Time Calculator on the STIS Web page can be used to determine if a particular instrument/target combination exceeds the screening limit.

3. **WFPC2.** No safety-related brightness limits.
CHAPTER 12: Orbital Constraints

In this Chapter...

12.1 Target Viewing Times and Continuous Viewing Zones on page 12-54
12.2 South Atlantic Anomaly on page 12-54
12.3 Spacecraft Position in Orbit on page 12-55
12.4 Orient on page 12-55

HST is in a relatively low orbit. The low orbit imposes a number of constraints upon scientific programs, which will be discussed in the following subsections.

12.1 TARGET VIEWING TIMES AND CONTINUOUS VIEWING ZONES

As seen from HST, targets in most of the sky are occulted by the Earth for varying lengths of time during each 96-min orbit. Targets lying in the orbital plane are occulted for the longest interval, about 36 min per orbit. However, this is a purely geometric limit and does not include the additional time lost due to Earth-limb avoidance limits (see §9.2), guide-star acquisition or re-acquisition, instrument setup, and South Atlantic Anomaly avoidance (see §12.2). These orbital occultations are analogous to the diurnal cycle for ground-based observing and impose the most serious constraint limiting the efficiency of most HST observations.

The length of target occultation decreases with angle from the spacecraft orbital plane. Targets lying within 24 degrees of the orbital poles are not geometrically occulted at all during the HST orbit. However, the size of the resulting “Continuous Viewing Zones” (CVZs) is substantially reduced by the Earth-limb avoidance angles. Note also that scattered Earth light may be significant when HST observes near the bright earth-limb.

Since the HST orbital poles lie 28.5 degrees from the celestial poles, any target located in two declination bands near +/- 61.5 degrees may be in the CVZ at some time during the 56-day HST precessional cycle. Some regions in these declination bands can be unusable during the part of the year when the sun is too close to the region. Depending upon HST orbit and the target position, there may be one to 10 CVZ window durations ranging from one orbit up to 7 days. However, passages through the SAA will restrict the longest uninterrupted observation to about 5-6 orbits (see below).

12.2 SOUTH ATLANTIC ANOMALY

Above South America and the South Atlantic Ocean lies a lower extension of the Van Allen radiation belts called the South Atlantic Anomaly (SAA). No astronomical or calibration observations are possible during passages of the spacecraft through the SAA because of the high background induced in the detectors. As the HST orbit precesses and the earth rotates, some time during the day the southern part of the HST orbit will intersect
Orbital Constraints

the SAA. Thus for about 7-9 contiguous orbits, the HST will pass through the SAA causing observing activities to be interrupted for about 20 to 25 minutes each orbit. This will be followed by 8-10 hours (5-6 orbits) of no SAA interruption. Therefore daily SAA passages limit the longest possible uninterrupted exposures, even in the CVZs, to 5 or 6 orbits.

12.3 SPACECRAFT POSITION IN ORBIT

Because HST’s orbit is low, atmospheric drag is significant. Moreover, the amount of drag varies, depending on the orientation of the telescope and the density of the atmosphere, which depends on the level of solar activity. The main manifestation of this effect is that it is difficult to predict in advance where HST will be in its orbit at a given time. The position error may be as large as 30 km within two days of a determination of the position of the spacecraft in its orbit. A predicted position 44 days in the future may be up to ~4000 km (95% confidence level) in error.

This positional uncertainty affects observers of time-critical phenomena, since the target could be behind the Earth at the time of the event. In the worst case, it will not be known if a given event will be observable until a few days before the event.

12.4 ORIENT

In order to assist observers in determining when a particular spacecraft orientation (ORIENT) is feasible, it should be recalled that HST must always be oriented such that sunlight falls on the solar panels (see § 9.2 ). At a given date, there is an optimum orientation of the telescope, from which only relatively small deviations are permitted.

Allowable deviations from nominal roll are discussed in § 9.2 . HST will normally not be allowed to point closer than 50° from the Sun when the telescope is in daylight. In terms of the angle $\beta$ (angular distance between target and antisolar point), no restrictions will be violated if $\beta \leq 130^\circ$. Also note that, in order for an observation to be feasible, there must be a suitable guide star in at least one of the two FGSs used for pointing.

Information on how to calculate $\beta$ is found in the Web page:

http://www.stsci.edu/observatory/tools/roll_entry.cgi
CHAPTER 13: Guide Stars and Target Acquisition

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13.1 Guide Stars on page 13-56
13.2 Target Acquisitions on page 13-56
   13.2.1 Target Acquisition without the Ground System on page 13-57
   13.2.2 Target Acquisition with the Ground System on page 13-57
13.3 Solar-System Targets on page 13-57
   13.3.1 Tracking Capabilities on page 13-58
13.4 Offsets and Spatial Scans on page 13-58

As described in § 10.2, HST uses guide stars located at the edge of its field of view. Unlike ground-based telescopes, however, HST uses two guide stars in order to control the pitch, yaw, and roll axes of the telescope. It is also possible to control the telescope pointing in pitch and yaw with one guide star, with the rate gyros controlling the roll angle. In that configuration, the telescope orientation may slowly roll about the axis defined by the direction to the star. The guide star(s) are selected in advance by STScI for each observation.

13.1 GUIDE STARS

Selection of guide stars (GSs) is carried out by the Guide Star Selection System (GSSS) at STScI. The required whole-sky coverage made it necessary for STScI to assemble a collection of survey plates as the basis for construction of a catalog of GS candidates. For the northern hemisphere (for which proper motions have now outdated the Palomar Sky Atlas), a special “Quick-V” survey was conducted for STScI with the 1.2-m Schmidt telescope at Palomar Observatory. The equatorial region and the southern hemisphere are covered by the SERC-J survey and its equatorial extension.

The Guide Star Catalog (GSC), which resulted from the digitization and analysis of the plate collection contains information, including coordinates and magnitudes, on about 18 million objects to 14.5 mag. Version 1.1 of the Guide Star Catalog (distributed on CD-ROM and on the STScI Web site) is used for HST operations. The use of Version 1.2 is not supported at this time.

13.2 TARGET ACQUISITIONS

Target acquisition is the method used to assure that the target is in the field of view of the requested aperture to the level of accuracy required by the science. There are several dis-
tinct methods of target acquisition; each has a different approach and different accuracy, and will take different amounts of time and resources to complete. The level of accuracy required depends on the size of the aperture to be used to acquire the science data and on the nature of the scientific program.

13.2.1 Target Acquisition without the Ground System

*Blind acquisition* means that guide stars are acquired and the FGSs are used for pointing control. The pointing is accurate to the guide star position uncertainty, which is about 1".

*Onboard acquisition* means that software onboard the spacecraft specific to the science instrument in use will be used to center the fiducial point onto the target. Onboard target acquisitions will be needed for all STIS spectroscopic observations (except slitless). The WFPC2 does not have onboard acquisition capabilities. For specific information on methods and expected pointing accuracies, see the *Instrument Handbook* for the instrument to be used.

*Early acquisition* means using an image taken on an earlier visit to provide improved target coordinates for use with subsequent visits.

13.2.2 Target Acquisition with the Ground System

Target acquisitions that cannot be accomplished reliably or efficiently via one of the above methods may still be possible by transmitting relevant data to STScI, analyzing them to determine the needed pointing corrections, and then providing those corrections to the telescope. This description covers two kinds of activities, the “interactive acquisition” and the “reuse target offset”, both of which are described briefly here.

*Interactive acquisition*, or *real-time target acquisition*, uses the ground system software to calculate the small angle maneuver to move the aperture onto the target. This method is available for all science instruments except the astrometry FGS. High data rate TDRSS links are required at the time the data are read out to transmit the data to the ground, and at a subsequent time to re-point the telescope before the science observations. This procedure adds a constraint to the scheduling. The GO, or a designated representative, must be present at STScI at the time of the acquisition. The acquisition data, usually an image, are analyzed by OPUS (Observatory Support/ Post-Observation Data Processing Unified System) personnel to compute the image coordinates and centering slew for the target identified by the GO.

*Reuse target offset* means using an offset slew derived from an onboard acquisition, or an image done on a previous visit, to reduce the amount of time required for subsequent visits to the same target. The data from the initial visit are analyzed by OPUS personnel to provide the offset slew to be repeated for subsequent visits. All subsequent visits to the target must use the same guide stars as the initial visit, which limits the time span of all visits to a few weeks. There are additional instrument-specific requirements. The GO is advised to contact the STScI Help Desk if this capability is required. Justification for the use of this capability must be included in the Phase I proposal.

13.3 Solar-System Targets

Objects within the solar system have apparent motions with respect to the fixed stars. *HST* has the capability to point at and track moving targets, including planets, their satellites, and surface features on them, with sub-arcsecond accuracy. However, there are a variety of
practical limitations on the use of these capabilities that must be considered before addressing the feasibility of any particular investigation.

Two specific aspects of solar-system observations are discussed below: the initial acquisition of a moving target, and the subsequent tracking of the target during the scientific observations. Only an overview of the current moving-target capabilities is given here. Phase I proposers are encouraged to consult the STScI Help Desk for more detailed information.

13.3.1 Tracking Capabilities

_HST_ is capable of tracking moving targets with the same precision achieved for fixed targets. This is accomplished by maintaining FGS Fine Lock on guide stars, and driving the FGS star sensors in the appropriate path, thus moving _HST_ so as to track the target. Tracking under FGS control is technically possible for apparent target motions up to 5 arcsec/s. In practice, however, this technique becomes infeasible for targets moving more than a few tenths of an arcsec/s. It is currently possible to begin observations under FGS control and then switch over to gyros when the guide stars have moved out of the FGS field of view. If sufficient guide stars are available, it is possible to “hand off” from one pair to another, but this will typically incur an additional pointing error of about 0.3”.

Targets moving too fast for FGS control, but slower than 7.8 arcsec/s, can be observed under gyro control, with a loss in precision that depends on the length of the observation.

The track for a moving target is derived from its orbital elements. Orbital elements for all of the planets and their satellites are available at STScI. For other objects, the GO must provide orbital elements for the target in Phase II.

13.4 Offsets and Spatial Scans

Offsets (using the same guide stars and performed under the same guide star acquisition) can be performed to an accuracy of about +/-0.02” for the larger slews. The size of the offset is limited by the requirement that both guide stars remain within the respective FOVs of their FGSs. Offsets within single detectors (most common type) can be performed to within +/- 0.003”. Offsets that continue across separate visits (including visits executed with the same guide stars) will typically have an accuracy of ~0.3”.

It is also possible to obtain data while _HST_ scans across a small region of the sky. In all cases the region scanned must be a parallelogram (or a single scan line). Two types of “spatial scans” (i.e., raster scans) may be requested:

- **Continuous scan.** In this case, data are continually obtained while the telescope is in motion.
- **Dwell scan.** In this case, the telescope stops its motion periodically during the scan, and data are obtained only when the telescope is not in motion.

The possible scan area is limited by the requirement that the same guide stars is used throughout the scan, and the maximum possible scan rate for continuous scans is 1 arcsec/s. Continuous spatial scan lines cannot be interrupted and must therefore be completed within one orbital target-visibility period. Spatial scans requiring more than 45 minutes of spacecraft time should be avoided.

Note that spatial scans are not available for STIS observations.
Part III. Phase I
Instructions

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CHAPTER 14: How to Submit a Phase I HST Proposal

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14.1 PROPOSAL SUBMISSION

Cycle 9 Observing and Archival Research proposals should be submitted electronically. One filled-in LaTeX template file, and one PostScript/PDF file for each proposal should be send to the following Internet address:

newprop@stsci.edu

The deadline for submission is September 10, 1999, 8:00pm EDT.

We urge applicants to submit their electronic versions well before the deadline, to avoid possible last-minute hardware or overloading problems, or network delays/outages.

The maximum total number of pages is 10 for Regular and 13 for Large proposals. Archival Research proposals have the same page limit as Regular proposals. These totals include no more than 3 (or 6 for Large proposals) pages of text for the scientific justification, plus up to 2 additional pages for figures and references. The font size should not be smaller than 12pt. Note however that target lists longer than 1 page, and the list of previously approved HST programs, are not counted against the total page limit. Student Principal Investigators should send a certification letter from their faculty advisor, as described in §4.2.

The proposer sends via electronic mail both the filled-in LaTeX proposal template and the PostScript/PDF file output from LaTeX (which can incorporate any desired monochrome figures). For large PostScript/PDF files, an ftp area is available.

In Cycle 9 Budget Forms are not required in Phase I for GO, SNAP, or AR proposals.

Budget forms will be requested in Phase II from successful U.S. observers only.
14.2 PREPARATION AND SUBMISSION INSTRUCTIONS

This subsection discusses general procedures for proposal preparation and submission. Specific instructions for filling out the electronic proposal template can be found respectively in §§ 15 and 17.1 for observing and archival proposals.

The computer software used in the review and feasibility analysis of proposed HST observations can interpret the proposal information only if it is in the correct format. It is therefore essential that the proposal template be filled out carefully, accurately, completely, and in accordance with the instructions.

Step-by-step Instructions

1. Obtain the Template and Style Files.

To obtain electronic copies of the LaTeX template files and the style files, please send an e-mail message to newprop@stsci.edu containing the words “request templates” in the subject line. Proposers will receive the following files by automatic “return e-mail”:
   • the Phase I Observing Proposal Template file obstemplate.tex and the Archival Research Proposal Template file artemplate.tex,
   • the style file phase1.sty which includes the supertabular files,
   • an example of a completed observing template file in obsexample.tex.

2. Fill out the Template File

Fill out the appropriate Proposal Template file using any text editor on the proposer’s local computer. Instructions can be found in the template itself, and in §§ 15 and 17.1 respectively for observing and archival proposals.

3. Prepare a Paper Copy of the Proposal

This step is optional, and for your own convenience. For most proposers, the easiest way to produce a paper copy of the proposal is to run LaTeX and then print the formatted proposal. If you are not familiar with LaTeX, please check with your system manager for how to run it on your system, and how to use PostScript encapsulation for any figures. The STScI Help Desk may also be contacted for assistance with any questions or problems. Rather than completing the LaTeX template version, some proposers may prefer to use different word processing software to produce a paper copy of the proposal.

4. Send the Template File Electronically - “LaTeX Submission”

Send the completed Phase I proposal LaTeX template file to STScI by e-mail to newprop@stsci.edu before the deadline. This is the first step of the submission. After this, you need to submit a PostScript/PDF version of your proposal.

5. Send the formatted version of your Proposal to STScI - “PostScript/PDF Submission”

To send a formatted version, you can either send a PostScript/PDF file via e-mail (5a), or a PostScript/PDF file via ftp (5b). Please select ONE of these options.
5a. PostScript/PDF Submission via e-mail
Send one PostScript/PDF file, with figures included, to STScI by e-mail to newprop@stsci.edu before the deadline. All figures must be encapsulated into the PostScript/PDF file (i.e., send only ONE PostScript/PDF file). Color figures will be printed on grey scales. Please set the \texttt{formattedsubmission} keyword in the \LaTeX{} template to “EMAIL”.

5b. PostScript/PDF Submission via ftp
If your PostScript/PDF file contains large figures some e-mail facilities may lead to truncation or corruption of the file. If you think this may be a problem for your submission, your PostScript/PDF file should be transferred to STScI via ftp rather than by e-mail. We have assigned a high security area for this purpose, and although you can put your files there, only the appropriate STScI staff can retrieve them. If you wish to use this option, please refer to the instructions given on-line at \url{http://www.stsci.edu/ftp/proposer/cycle9/ftp_instructions} or contact the STScI Help Desk. Do NOT put the \LaTeX{} template in the ftp area. Please set the \texttt{formattedsubmission} keyword in the \LaTeX{} template to “FTP”.

6. Acknowledgments
Proposers will receive an acknowledgment of their e-mail transmission immediately after it is received at STScI; due to network problems, especially in the immediate vicinity of the deadline, the acknowledgment messages may be delayed. Proposers are kindly requested not to re-submit their proposals without checking with STScI or waiting at least 2-3 hours, to avoid multiple submission of the same proposal. If no acknowledgment is received within a few days, proposers should contact the STScI Help Desk. For PostScript/PDF submissions, a separate acknowledgment will be sent after printing of the file. Again, if no second acknowledgment is received within a week, PostScript/PDF submitters should contact the STScI Help Desk at help@stsci.edu.
CHAPTER 15: Instructions for Filling out HST Observing Proposal Forms

This Chapter provides guidelines for filling out the observing proposal forms. Instructions on how to fill out the observing proposal forms are also given in the LaTex template. Archival Researchers should refer to § 17.1 where complete instructions for the AR proposal forms are provided.

Proposers should observe the following general instructions and conventions when filling out the forms:

• All proposals for HST observations must be submitted on current Cycle 9 versions of the appropriate STScI forms; the forms provided for previous proposal cycles must not be used.
• A detailed budget will be required for GOs in Phase II. Budget Forms will be provided to GOs after the review and approval of proposals for Cycle 9.
• Page limits must be strictly observed. All proposals are limited to 10 pages for Regular and 13 pages for Large proposals total. Target lists longer than 1 page and the list of previously approved HST programs (item #19 below) are not counted against this total.

◆ How to Fill out a Cycle 9 Observing Proposal Form

#1—Please supply a concise TITLE for your proposal. The title should be no longer than 2 printed lines. Please use mixed case, not all capital letters.

#2—Specify the appropriate PROPOSAL CATEGORY. Valid entries here are one (and only one) of the following:

GO—General Observer proposal
SNAP—Snapshot proposal

#3—Select the SCIENTIFIC CATEGORY you deem appropriate for the proposed project. Please note that some of the categories have changed with respect to previous cycles. You may find that your proposal could fit equally well in several categories, however we request that you carefully follow our category descriptions when making your choice, and select one and only one category. Unlike previous cycles, in Cycle 9 the scientific categories do not correspond to specific review-panels. Broader panels will be constituted by suitably grouping the following categories, with the goal of optimizing the scientific program selection.
Instructions for Filling out HST Observing Proposal Forms

**SCIENTIFIC CATEGORIES:**

**SOLAR SYSTEM:** this category refers to all objects belonging to the solar system (except the Sun and Mercury), such as planets, comets, minor planets, asteroids, planetary satellites, etc.

**STAR FORMATION:** This category refers to forming and newly-formed stars, and the material surrounding them. It includes studies of proto-planetary disks, extra-solar planets, early evolution, pre-main sequence stars, T-Tauri stars, HH objects, FU Orionis stars.

**COOL STARS:** This category refers to stars with effective temperatures less than about 10,000 K. It includes subdwarfs, subgiants, giants, supergiants, AGB stars, pulsating/variable stars, brown dwarfs, stellar activity (coronas/flares), atmospheres, chromospheres, mass loss, abundances.

**HOT STARS:** This category refers to stars which spend a significant fraction of their observable lives at an effective temperature higher than about 10,000 K. It includes OB stars, neutron stars, white dwarfs, Wolf-Rayet stars, blue stragglers, central stars of PN, variable hot stars, luminous blue variables, hot subdwarfs, supernovae, pulsars, X-ray binaries, CVs.

**ISM AND CIRCUMSTELLAR MATTER:** This category includes the general properties of the diffuse medium within the Galaxy and nearby galaxies: planetary nebulae, nova shells, supernova remnants, stellar jets (except star formation), winds and outflows, HII regions, giant molecular clouds, diffuse and translucent clouds, ionized gas in the halo, diffuse gas observed in emission or absorption, dust, dust extinction properties, dark clouds, deuterium abundance.

** STELLAR POPULATIONS:** This category refers to resolved stellar populations in globular clusters, open clusters or (OB) associations, and in the Milky Way and other Local Group and nearby galaxies. Included are studies of color-magnitude diagrams, luminosity functions, initial-mass functions, internal dynamics and proper motions.

**GALAXIES:** This category addresses the galaxies in the Hubble sequence as well as galaxy mergers and interactions, starburst galaxies, IR-bright galaxies, dwarf galaxies and low-surface brightness galaxies. It includes studies of galaxy structure, morphology and dynamics, and studies of the unresolved stellar populations and globular clusters populations of galaxies.

**AGN/QUASARS:** This category addresses active galaxies and quasars, and includes both studies of the active phenomena themselves, and of the properties of the host galaxies that harbor AGNs and quasars. The definition of AGN is to be interpreted broadly, and contains, e.g., Seyfert galaxies, BL Lac objects, radio galaxies, blazars, and LINERS.

**QUASAR ABSORPTION LINES AND IGM:** This category addresses the physical properties and evolution of absorption line systems detected along the line of sight to quasars and of other diffuse IGM. It includes not only spectroscopy, but also, e.g., imaging of damped Ly-alpha systems.

**COSMOLOGY:** This category includes the following topics: structure and properties of clusters and groups of galaxies; strong and weak gravitational lensing; studies of galaxy evolution through observations of galaxies at intermediate and high redshifts (including e.g., the Hubble Deep Fields); cosmology in general; the structure of the universe as a whole; and cosmological parameters and the extra-galactic distance scale.

#4—Select as many KEYWORDS as necessary to describe the scientific goal(s) of the proposal, with a minimum of one and a maximum of five. Keywords must be taken from
Instructions for Filling out HST Observing Proposal Forms

the list below. The keyword “SURVEY” must be selected to flag survey proposals (see § 2.1.4). Use all capital letters, and do not modify these Keywords.

KEYWORDS

GENERIC

ABSORPTION LINES
ASTROMETRY
CHEMICAL ABUNDANCES
DYNAMICS
DUST
EMISSION LINES
EVOLUTION
MULTIWAVELENGTH STUDY
SURVEY
VARIABILITY

SOLAR SYSTEM

ASTEROIDS
COMETS
EXOSPHERIC ATMOSPHERES
KUIPER BELT OBJECTS
PLANETARY ATMOSPHERES
PLANETARY PLASMAS
PLANETARY SATELLITES
RINGS AROUND PLANETS
SUPPORT OF NASA PLANETARY MISSIONS
SURFACES OF PLANETS/MOONS/OTHER

GALACTIC

ATMOSPHERES AND CHROMOSPHERES
CENTRAL STARS OF PLANETARY NEBULAE
CLUSTER BINARY STARS AND BLUE STRAGGLERS
DETACHED BINARIES
ECLIPSING BINARIES
ERUPTIVE BINARY STARS AND CATAclySMIC VARIABLES
EXTRA-SOLAR PLANETS
GALACTIC BULGE
GALACTIC CENTER
GALACTIC DISK
GALACTIC HALO
GIANTS AND AGB STARS
HERBIG-HARO OBJECTS
LOW-MASS AND COOL STARS
MAIN SEQUENCE STARS
Instructions for Filling out HST Observing Proposal Forms

MASSIVE STARS
NEUTRON STARS AND PULSARS
NOVA SHELLS
PECULIAR BINARY STARS
OLD FIELD STARS
OPEN STAR CLUSTERS
PLANETARY NEBULAE
PROTO-PLANETARY DISKS
PROTO-PLANETARY NEBULAE
STAR COUNTS
STELLAR ACTIVITY
STELLAR EVOLUTION AND MODELS
SUBDWARFS
SUPERNova REMNANTS
T TaurI STARS
UV-BRIGHT STARS
VARIABLE AND PULSATING STARS
VERY LOW MASS STARS AND BROWN DWARFS
WHITE DWARFS
WINDS/OUTFLOWS/MASS-LOSS
WOLF-RAYET STARS
X-RAY BINARIES
YOUNG STARS AND PROTOSTELLAR OBJECTS

GALACTIC OR EXTRA-GALACTIC

ACCRETION DISKS
BLACK HOLES
DARK MATTER
GLOBULAR CLUSTERS
H II REGIONS
INTERSTELLAR AND INTERGALACTIC MEDIUM
JETS
MICROLENSING
MOLECULAR CLOUDS
STAR FORMATION
RESOLVED STELLAR POPULATIONS

EXTRA-GALACTIC

AGN PHYSICS
BAL QUASARS
BL LAC OBJECTS AND BLAZARS
CLUSTERS OF GALAXIES
COOLING FLOWS
COSMOLOGICAL PARAMETERS AND DISTANCE SCALE
DAMPED LYMAN-ALPHA ABSORPTION SYSTEMS
DWARF GALAXIES
ELLIPtical GALAXIES
Instructions for Filling out HST Observing Proposal Forms

#5—Identify the mode of submission for the PostScript/PDF proposal (e-mail or ftp). You may provide information on PostScript/PDF contact by filling out pscontactemail with an e-mail address. This address will be used in addition to the e-mail address provided by the PI section below when acknowledging your PostScript/PDF submission.

#6—Enter the name, institutional affiliation, complete address, telephone, electronic mail, and ESA member-state affiliation (if appropriate) of the PI. There must be one and only one PI for each proposal.

#7—Identify which Scientific Instrument(s) will be used in the project. The allowable choices are one or more of the following: FGS, STIS, WFPC2.

#8—In the case of GO observing proposals, enter the total number of orbits requested for primary observations and parallel observations. The values must be calculated as described in §16.1. For long-term projects, provide a year-by-year breakdown of the orbits requested. For SNAP observing proposals, specify the total number of targets requested.
Instructions for Filling out HST Observing Proposal Forms

#9—If you wish to change the default proprietary period (12 months) for all observations in the program, enter either 0, 3, or 6 (months). See § 5.2 on Data Rights.

#10—Provide a concise abstract describing the proposed observations. The abstract must fit on the first page of the printed proposal: typically this will be no more than 20 lines, 80 characters per line. Include the main scientific goals and justify the necessity of HST data.

#11—List the names, institutional affiliations, e-mail addresses, and countries of all Co-Is. Also indicate whether each Co-I is affiliated with the ESA or with an ESA member-state institution.

#12—Joint HST-Chandra Observations

Proposers applying for joint HST-Chandra Observations (see § 2.1.7) should mark this flag, following the directions on the Template. Proposers should specify whether they were awarded time in Chandra (previously AXAF) Cycle 1 period, and any other constraint on the Chandra observations, in item #17 below.

#13—Observation Summary (OS)

—The OS accommodates observations of (a) fixed targets (i.e., all targets outside the solar system whose positions can be defined by specific celestial coordinates), (b) generic targets (i.e., targets defined by certain general properties, rather than by specific coordinates), and (c) solar-system targets (i.e., moving targets).

—For long-term programs (see § 2.1.5), include only visits requested for Cycle 9.

—All visits and exposures for a given target that use the same instrument and mode may be summarized using a single OS line.

—Special calibration exposures on internal sources and calibration exposures using the Earth, or external astronomical calibration targets, should be indicated here. Both special and external calibrations should be listed as separate lines on the OS, with the appropriate number of orbits where applicable. The need for calibrations should be also described in Item #15—Description of the Observations—of the proposal form.

—For SNAP proposals, the OS should be filled out with a typical example of a snapshot exposure (less than one orbit), including spectral element, etc. A complete description of the target list should be provided in the scientific justification (see §2.2).

—For each row of the OS, the following information must be provided:

1. TARGET NAME

Targets should be named using the conventions recommended in APPENDIX E, and the adopted naming should be used consistently throughout the proposal.

2. TARGET RA AND DEC (J2000)

Supply the coordinates for fixed targets only. For generic targets use a very short text description either of the target location (e.g., HIGH-GALACTIC LATITUDE FIELD) or of the target itself.

It is important to note that the HST SIs may have very small apertures and fields of view. Target-acquisition apertures in some cases are only a few seconds of arc in size. It will be the successful proposer’s responsibility in Phase II to provide coordinates accurate to about 1” for all approved targets which require onboard acquisition. Proposers can use the extraction available on-line to obtain this accuracy in Phase II. For Phase I, however, target positions with accuracies better than 1’ are sufficient for the TAC and panel review (except in crowded fields where the identity of the target may be in question).
3. TARGET MAGNITUDE

Supply the apparent total magnitude in the V passband for the entire target (galaxy, planet, etc.), if known. This information is used only for scientific review, not for exposure-time calculations.

Note that some observing modes of STIS have limits on the brightness of the objects that can be observed safely. For more information, refer to § 11.2 and the STIS Instrument Handbook.

4. Scientific Instrument Configuration and Operating Mode

Enter the SI configuration first, and then the operating mode. The allowable options for each SI can be found in APPENDIX C:

5. SPECTRAL ELEMENT(S) (AND CENTRAL WAVELENGTH IF STIS)

All of the desired spectral element(s) (i.e., filters and gratings) should be entered (see APPENDIX C: for the allowable options). Several different spectral elements for different exposures may be included on the same OS exposure line, each separated by a comma (e.g., F555W,F656N). If more than one element is required for the same exposure, then join the elements with a + (e.g., F255W+POL45). If a STIS grating is used, then list in parentheses (immediately following the spectral element listing) the central wavelength in angstroms for the exposures defined on the given line (e.g., G430M (4781, 4961)).

6. APERTURE

For STIS proposals only, all the desired apertures should be entered (see APPENDIX C: for the allowable options). Several different apertures from different exposures may be included on the same OS exposure line, each separated with a comma (e.g., 52X0.1, 52X0.2).

7. TOTAL NUMBER OF ORBITS

Specify the total number of orbits (i.e., the sum of the orbits for all of the exposures from all target visits requested) (see § 16.1).

8. SPECIAL REQUIREMENT FLAGS

Enter the flags listed in the Table below, where applicable. These seven options are the only allowable entries. Note that, although Low-sky observations were possible in previous cycles as well, the Flag for the observation summary LOW is a novelty of Cycle 9.

Table 15.1: Flags for the Observation Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVZ</td>
<td>Continuous Viewing Zone observations (see § 5.3).</td>
</tr>
<tr>
<td>DUP</td>
<td>Observations which duplicate previous or upcoming GO and/or GTO exposures. See Item #18—Justify Duplications, and § 5.1.</td>
</tr>
<tr>
<td>SHD</td>
<td>Shadow Time observations (see § 16.2 step 2).</td>
</tr>
<tr>
<td>LOW</td>
<td>Low-sky observations (see § 16.2 step 2).</td>
</tr>
<tr>
<td>PPAR</td>
<td>Parallel observations. All of the exposures specified on this OS line are to be done in pure (PPAR) or coordinated (CPAR) parallel mode. List them both, if needed (see § 3.2).</td>
</tr>
<tr>
<td>CPAR</td>
<td>Target-of-Opportunity observations (see § 2.1.6).</td>
</tr>
</tbody>
</table>
Instructions for Filling out HST Observing Proposal Forms

#14—Scientific Justification

This section should include a balanced discussion of both background information and the program’s goals and significance to astronomy (see § 6.2.3), and should include a description on how your proposed program will contribute to the general astronomical knowledge.

Note that this is novel to Cycle 9, and it is a strict requirement. For SNAP proposals, the scientific justification should also describe the nature of the target sample; for SNAP and Surveys proposals, the potential use of the proposed database to the astronomical community should be clear (see § 2.2 and § 2.1.4).

The description of the scientific justification should be no more than 3 pages for Regular programs and no more than 6 pages for Large programs (see § 2.1 for definitions). Note that this is different than in previous cycles. An additional two pages, in either case, will be allowed for (optional) figures, tables and references.

For the individual items below (#15–18) there are no specific page limits; however, the total proposal page limits of 10 pages for Regular and 13 pages for Large proposals must be observed (without counting the information provided in item #19, and target lists longer than 1 page).

#15—Description of the Observations

Provide a short description of the proposed observations. Explain the amount of exposure time and number of orbits requested (e.g., number of objects, examples of exposure-time calculations and orbit estimations for some typical observations, etc.). You should summarize your STIS target acquisition strategy and durations. List any non-standard calibration requirements (see § 5.5) for the proposed observations here. Proposers should estimate the additional number of orbits required for these special calibrations (if any), and list them in the OS (item # 13 above). Snapshot and Survey proposals should specifically identify the requested proprietary data-rights period for the exposures. Long-term projects should provide summary information for the entire project, along with a cycle-by-cycle breakdown of the requested spacecraft orbits, including previously allocated time.

#16—Special Requirements

Justify any special scheduling requirements for early acquisitions, real-time, shadow time, Low-sky, time-critical, CVZ, target-of-opportunity (TOO), and non-SAA impacted observations. For TOO objects, indicate their probability of occurrence during Cycle 9, and how soon HST must begin observing them after occurrence. Note that the earliest HST can begin TOO observations is 2–5 days after notification, and that the available number of TOO observations with less than 3 weeks turnaround is limited. STIS MAMA observations can only be scheduled in non-SAA impacted orbits.

#17—Supporting/Coordinated Observations

Describe plans for conducting coordinated and/or supporting observations with other facilities, and if these observations put constraints on the scheduling of HST observations, such as, simultaneous or coordinated observations with other spacecraft or ground-based campaigns, or at a fixed time.

Proposers requesting joint HST-Chandra observations (see § 2.1.7) must provide a paragraph of technical justification for the Chandra portion of their program. This paragraph must include: the choice of instrument (and grating, if used), the exposure mode and chip selection (ACIS) or instrument configuration (HRC), the requested exposure time, justifi-
Instructions for Filling out HST Observing Proposal Forms

Justification for the exposure time, target count rate(s) and assumptions made in its determination, information about nearby bright sources which may lie in the field of view, a demonstration that telemetry limits will not be violated, and a description of how pile-up effects will be minimized (ACIS only).

Proposers can get all the relevant information at:
http://asc.harvard.edu

The primary document is the Cycle 1 Proposers Guide, which is available under the “User Documents” link. Questions can also be sent to the Chandra Help Desk link at the bottom of the above Web page.

Full specification of approved observations (via the RPS form) will be requested during the Chandra Cycle 2 period, at which time a detailed feasibility check will be made.

#18—Justify Duplications

Justify, on a target-by-target basis, any possible or potential duplication with previously accepted GO or GTO observing programs (see § 5.1). Use the DUP (Duplicate Observation) flag in the OS to identify the duplicated observations. Duplicate observations that are not justified and found in Phase II may be disallowed.

#19—Previous HST Programs

The following material is not included in the page count for length limits. List proposal number and status of the data (especially publications) for each accepted GO/SNAP/AR proposal of the PI (e.g., GO-4975 - 24 Orbits - Ap.J. 441, 672, 1995). Identify allocations of resources related to the proposal. Unpublished data from early cycles should be explained. A significant publication record will be regarded by Panels and TAC as a strong plus. GTO programs and publications may be included at the PI’s discretion.
CHAPTER 16: Orbit Estimates

In this Chapter...

16.1 Visits on page 16-72
16.2 Detailed Orbit Calculation on page 16-73

An HST orbit normally contains 52 - 60 minutes (depending on the declination of the target) of useful observing time - the “visibility period”. Some fraction of this time must be used for various overheads. The exact amount of overhead time is determined by several different factors. This section describes a simple way of determining the number of orbits required for your proposal, taking all these factors into account. Before we explain how this is done we first need to define the concept of a visit.

16.1 Visits

A visit is an exposure or series of consecutive exposures, with overheads, on a given target, and may consist of the following parts:

1. guide-star acquisition (to point HST at the target)
2. target acquisition (to place the target in an instrument aperture)
3. science exposure(s) (to obtain the data)
4. instrument overheads (to set up the instrument and read out the data)
5. instrument calibrations/overheads (if more than standard calibration is required)

If the visit lasts more than one orbit, it will continue with the following for each subsequent orbit:

6. guide-star re-acquisition (to keep HST pointed and locked after earth occultation)
7. science exposure(s)
8. instrument overheads
9. instrument calibrations/overheads

Thus, a typical visit for a spectroscopic observation (for the cameras, a target acquisition is usually not required) may look schematically like the following:

Table 16.1: Schematic Visit for Spectroscopic Observations

|---------|-----------|-------------|--------------|----------|--------------|----------|--------------|
Orbit Estimates

Note that some portion of the overheads may occur before the science exposure, but for the purposes of this calculation the overheads are all assumed to follow. A new visit is required whenever a new set of guide stars must be acquired. Thus, whenever the following occurs, a new visit must be defined:

- A change in target position of greater than 2’. Note that solar-system objects that move more than 2’ during the observations may not necessarily require a new visit.
- Repeated, periodic, or other time-separated observations with an interval between exposures such that one or more empty visibility periods would otherwise be required (e.g., to obtain an image of an object every 30 days for 5 times, or to obtain a spectrum of an object at phases 0.0, 0.3, 0.6). No visit should contain empty visibility periods.
- Required changes in spacecraft roll orientation.
- A change in instrument (e.g., WFPC2 to STIS), except that coordinated primary and parallel observations are contained within the same visit. The switching of primary instruments requires a change of guide stars.

The maximum duration for a single visit is generally limited by the number of consecutive South Atlantic Anomaly (SAA)-free orbits (5 - 6 orbits); for shorter visits the impact of the SAA can be eliminated or minimized by careful scheduling (to place the SAA in the portion of the orbit when the target is occulted). Visits longer than 5 orbits must be broken into separate smaller visits, each with their own guide star and target acquisitions, and will be scheduled at least a day apart. If you feel that this does not apply to your program, please contact the STScI Help Desk. For STIS programs containing both CCD and MAMA science (excluding target acquisition) exposures, in which there are more than 30 minutes of science observing time using the CCD at a single target position (inclusive of overheads), and for which that target is observed for more than a single orbit, you must split the exposures into visits which separate the CCD science exposures from the MAMA exposures. If you believe your science requires CCD and MAMA science exposures in the same visit (e.g., variability monitoring programs), you should provide an explanation in the Special Requirements section of the proposal. For astrometric observations using the FGS, each individual set (consisting of target object and reference objects) may be obtained in one visit if there is no telescope motion made during the sequence.

16.2 Detailed Orbit Calculation

◆ Step 1. Define your Observations and Group them into Visits

The first step in determining the number of orbits is to define the observations (instrument, mode, disperser, number of exposures, and exposure time) you need to execute on each target to accomplish your scientific objectives. Exposure time calculations are available on the STScI Web site. You will then need to group your observations into separate visits following the rules given above.

◆ Step 2. Determine the Visibility Period

The second step is for you to determine the “visibility period” for each target, which is defined as the amount of unocculted time per orbit (i.e., the amount of time per orbit dur-
Orbit Estimates

ing which observations can be made). This is done by using Table 16.2: below, which gives the visibility period as a function of target declination; values are also provided for moving targets, and for observations requiring SHD, LOW, or CVZ observing conditions.

LOW (Low-sky): If the noise in your measurement will be dominated by zodiacal light, then you may wish to use the Low-sky scheduling restriction, which will assure that the sky background is within 30% of the yearly minimum for your target. This is achieved by restricting an observation to times that minimize both Zodiacal Light and Earthshine scattered by the OTA. The Zodiacal Light is minimized with a seasonal restriction, and the Earthshine is minimized by reducing the orbital visibility of the target by approximately 15% (the exact reduction depends on declination as shown in Table 16.2: ). If the Low-sky restriction is not used, for example, the Zodiacal Light background for low-ecliptic latitude targets can be as much as four times greater than the minimum value. Earthshine at the standard limb avoidance angle (20 degrees) exceeds the Zodiacal minimum by a similar factor. Use the orbital visibility given in the last column of Table 16.2: when computing the required number of orbits. The Low-sky restriction should be requested in Phase I.

SHD (Shadow time): This refers to observing when HST is in Earth shadow, which can be useful for reducing the geocoronal Lyman alpha background. If you require low continuum background, use the Low-sky Special Requirement described above. If you require shadow time for your observations, then you have 25 minutes in which to obtain your science exposures regardless of target declination. Note that you may perform guide-star acquisitions/re-acquisitions, as well as end-of-orbit overheads, outside the narrower shadow time window.

MT (Moving Targets): These objects are generally in or near the ecliptic plane, so the visibility period will be ~ 53 minutes. Do not enter a flag on the OS for this condition.

CVZ (Continuous Viewing Zone): The CVZ includes the parts of the sky where the telescope can point continuously for the entire orbit(s) without being occulted by the Earth (see §§ 5.3, 12.1 ). If you can utilize CVZ time for your observations, then the visibility period is 96 minutes per orbit for 5-6 orbits, beyond which time SAA interference will limit the visibility to ~70 minutes per orbit for the next 7-9 orbits. It may be to the proposer’s advantage to select CVZ targets if possible, since the long visibility period of 96 minutes per orbit will allow a factor of two competitive advantage in terms of required resource charge (orbits) to perform the same science observations relative to non-CVZ targets. However, in practice the utility of CVZ observations could be reduced because the special requirements SHD and LOW are inconsistent with CVZ observations. While the brightness of the scattered Earthshine background during CVZ observations is not greater than during non-CVZ observations (since the same bright limb avoidance angle is used), the duration of high background can be considerably greater since the line of sight can graze the bright earth-limb avoidance zone during CVZ observations. Also, it may not be possible to schedule observations that require special timing as CVZ targets. Observation sets that will use Phase II Special Requirements: ORIENT, ON HOLD (for targets-of-opportunity), AFTER, BEFORE, BETWEEN, or PHASE restrictions should therefore adopt the non-CVZ target visibility period for resource estimation.
Table 16.2: Orbital Visibility

<table>
<thead>
<tr>
<th>Declination</th>
<th>Visibility [minutes]</th>
<th>Low-sky Visibility [minutes]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 18</td>
<td>52</td>
<td>47</td>
</tr>
<tr>
<td>18 – 33</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>33 – 43</td>
<td>54</td>
<td>48</td>
</tr>
<tr>
<td>43 – 48</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>48 – 53</td>
<td>56</td>
<td>45</td>
</tr>
<tr>
<td>53 – 58</td>
<td>57</td>
<td>45</td>
</tr>
<tr>
<td>58 – 63</td>
<td>56</td>
<td>46</td>
</tr>
<tr>
<td>63 – 68</td>
<td>57</td>
<td>45</td>
</tr>
<tr>
<td>68 – 73</td>
<td>58</td>
<td>43</td>
</tr>
<tr>
<td>73 – 88</td>
<td>59</td>
<td>42</td>
</tr>
<tr>
<td>88 – 90</td>
<td>60</td>
<td>41</td>
</tr>
</tbody>
</table>

See text for the following:

- Shadow time 25
- MT 53
- CVZ 96

Step 3. Map out the Orbits in each Visit

The third step is to fit science exposures and necessary overheads into the visibility period of each orbit, for all the visits required. The better you can pack your orbits, the more efficient your proposal will be.

Step 3.1 Guide Star Acquisitions

For all observations, a guide-star acquisition is required, which takes 6 minutes. At the beginning of subsequent orbits in a multi-orbit visit, a shorter guide-star re-acquisition is required, which takes 5 minutes. For CVZ observations in which the visibility period is 96 minutes, guide-star re-acquisitions are not required; however, if your CVZ observation extends into SAA-impacted orbits, then guide-star re-acquisitions are required for those orbits. If you are obtaining very short exposures with the WFPC2 or STIS (in a Snapshot proposal) and wish to utilize the gyro guiding mode, then use of guide stars is not required, and the observation has no acquisition. Otherwise SNAP observations are obtained with single FGS guide which requires 5 minutes for acquisition.

Step 3.2 Target Acquisitions

Following the guide-star acquisition, a target acquisition may be required, depending on the instrument used.

FGS, WFPC2: For the FGS, observations are done following a standard Spiral Search location sequence. Most WFPC2 observations also do not require a target acquisition.
Orbit Estimates

However, if you require precise positioning of the target (accuracy better than 1–2") with the cameras, you will need an interactive acquisition (see § 13.2.2 and the Instrument Handbooks).

**STIS:** Following the initial guide star acquisition for your visit, the target location in the aperture plane will be known to an accuracy of 1 to 2". For science observations taken through spectroscopic slits which are less than 3" in either dimension and for imaging observations taken using one of the coronagraphic apertures, you will need to use an on-board STIS target acquisition and possibly an acquisition peakup exposure to center your target. STIS target acquisitions employ the CCD camera to image the target’s field directly and onboard flight software processes the image to locate the position of the target.

Acquisitions: STIS target acquisition exposures (MODE=ACQ) always use the CCD, one of the filtered or unfiltered apertures for CCD imaging and a mirror as the optical element in the grating wheel. Acquisition exposures center your target in the slit or behind a coronagraphic bar to an accuracy of 0.01" for point sources. For a DIFFUSE source, the accuracy depends on the size of the target, and can be as large as 0.1". A typical STIS target acquisition exposure takes 6 minutes. However, if you are acquiring a very faint target (V>21, where the exposure time on the target is not negligible), you should add 4*exposure time to the overhead. For diffuse targets see §§ 8 and 9 of the STIS Instrument Handboo.

Peakups: Additionally, an acquisition peakup exposure (MODE=ACQ/PEAKUP) must be taken following the target acquisition exposure to refine the target centering of point or point-like sources in slits less than 0.2" wide (or tall). Peakup exposures use a science slit or coronagraphic aperture and are taken with the CCD as the detector and with either a mirror or a spectroscopic element in the grating wheel. The typical centering accuracy following a peakup sequence is 5% of the slit dimension. Typical STIS imaging point source peakups (V<21) will take ~6 minutes.

**Early Acquisitions:** Early Acquisitions are simply science images obtained in visit 1, followed by science images/spectra obtained in visit 2 (scheduled at a later time).

**Interactive Acquisition:** If you require an interactive acquisition, treat the image obtained as a science exposure (see below), then add 30 minutes for the real-time contact (which may overlap the occultation interval at the end of an orbit). If you feel you need to utilize this capability, please consult the Instrument Handbooks and contact the STScI Help Desk; you will also have to justify the need for this type of acquisition in your proposal as this is a limited resource.

**Step 3.3 Science Exposures and Instrument Overheads**

Following the target acquisition, you should place the science exposures in the orbit. The time allocation for these exposures consists of two parts—the exposure time and the instrument overhead. The exposure times were determined in Step 1, while the instrument overheads are given in Table 16.3: below for each instrument operating mode.

**FGS:** Details of FGS observing strategies may be found in the FGS Instrument Handbook. The POSITION Mode (POS) overhead estimates provided in Table 16.3: are simplified and generalized. We have found many instances where the exposure time in Phase II can be reduced somewhat since actual data acquisition time is folded into some of the overhead activities. STScI Contact Scientists will work with the GO in refining exposure times for Phase II submission.

The TRANSFER Mode (TRANS) exposure times for different number of scans are reported in Table 16.4: .
**Orbit Estimates**

**STIS:** Some differences will be found between the overhead times presented here in Table 16.3: and those discussed in § 9 of the STIS Instrument Handbook. While both times are based on the same data, the times presented here are a simplified version of those presented in the handbook. The STIS examples found in APPENDIX H: use the simplified method presented here in the Call for Proposals. For long multi-orbit or more complex programs, please consult § 9 of the STIS Instrument Handbook directly.

When calculating STIS MAMA overhead times, we refer to spectroscopy and imaging. STIS MAMA spectroscopy are those observations obtained with either the NUV or FUV MAMA detector and a grating, while STIS MAMA imaging are those observations with the NUV or FUV MAMA and a mirror in place.

The overhead times are presented as those required per exposure or the overhead times required for a subsequent exposure with no change from the previous exposure. This means that the two exposures are taken with the same aperture and grating in place and that the same wavelength is specified. The exposure times can be different between the two exposures. If you are in doubt about whether or not you would need to make a change, please assume a change for these Phase I estimates to avoid an orbit allocation shortfall later.

**WFPC2:** Note that all WFPC2 images with exposure times longer than 10 minutes will be split (by default in the ratio 0.5+\/- 0.2) to allow for cosmic-ray subtraction (CR-SPLIT). These should be counted as a single exposure with an overhead of 5 min when mapping out your observations, (this time accounts for the fact that there are two exposures). If you have exposures shorter than 10 minutes, or do not wish to split your exposures, then use the NO CR-SPLIT overhead time. All exposures with the Linear Ramp Filters (LRF) require an additional 2 minutes of overhead due to repositioning of the telescope. In order to allow for more efficient scheduling of WFPC2 observations (in SAA-impacted orbits), a 1 minute “efficiency” overhead per orbit is required; see the WFPC2 handbook update for details.

When placing the science observations into the visit, it is important to note that WFPC2 exposures cannot be paused across orbits. This means that if you have 20 minutes left in an orbit, you can only insert an exposure that takes 20 minutes or less (including overhead). If you wish to obtain a 30 minute exposure, then you can either put it all into the next orbit, or you can specify, e.g., a 20 minute exposure in the first orbit, and a second exposure of 10 minutes in the next orbit (and thus include two exposure overheads).

A number of WFPC2 users have employed dithering, or small spatial displacements, to allow better removal of chip defects and the reconstruction of sub-pixel resolution. During Phase II the user will be given access to “canned” dithering routines, which will avoid many of the tricky details involved in planning spatial scans. The overhead for dithering, however, can be noticeable, about 1 minute for each move. The advantages, disadvantages, and overhead associated with dithering are discussed in more detail in the WFPC2 handbook.
### Table 16.3: Instrument Overheads

<table>
<thead>
<tr>
<th>SI</th>
<th>Mode</th>
<th>Time [minutes]</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFPC2</td>
<td>IMAGE</td>
<td>3</td>
<td>NO CR-SPLIT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>CR-SPLIT (2 exposures)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>LRF exposures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Efficiency (each orbit)</td>
</tr>
<tr>
<td>STIS</td>
<td>CCD ACCUM</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAMA-spectro.</td>
<td>1</td>
<td>if no change from previous exposure</td>
</tr>
<tr>
<td></td>
<td>MAMA-imaging</td>
<td>8</td>
<td>if no change from previous exposure</td>
</tr>
<tr>
<td></td>
<td>ACQ</td>
<td>1</td>
<td>if no change from previous exposure</td>
</tr>
<tr>
<td></td>
<td>ACQ/PEAK</td>
<td>6</td>
<td>add 4 x acq. exp. time for faint targets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>add 4 x acq. exp. time for faint targets</td>
</tr>
<tr>
<td>FGS</td>
<td>POS(^a)</td>
<td>4</td>
<td>Instrument Setup, per orbit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Instrument Shutdown, per orbit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>V &lt; 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>14 &lt; V &lt; 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>15 &lt; V &lt; 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>16 &lt; V &lt; 16.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>V &gt; 16.5</td>
</tr>
<tr>
<td></td>
<td>TRANS(^b)</td>
<td>~1</td>
<td>target acquisition, any V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2</td>
<td>overhead per scan, any V</td>
</tr>
</tbody>
</table>

\(^a\)The POS overheads reported here are simplified (see text).

\(^b\)The TRANS overhead includes \~1 m for target acquisition and \~12 s per scan. It is thus dependent on the number of scans obtained during a target visibility period. The total overhead is 1 m + 12 s times the number of scans.

### Table 16.4: TRANSFER mode exposure times

<table>
<thead>
<tr>
<th>V</th>
<th>Exp. times (without overheads) [s]</th>
<th>Assuming:</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-12</td>
<td>400</td>
<td>10 scans</td>
</tr>
<tr>
<td>13-14</td>
<td>800</td>
<td>20 scans</td>
</tr>
<tr>
<td>15</td>
<td>1200</td>
<td>30 scans</td>
</tr>
<tr>
<td>16</td>
<td>2400</td>
<td>60 scans</td>
</tr>
</tbody>
</table>

**Moving Targets:** The onboard tracking command that is used for moving-target observations does not allow an observation (exposure plus overhead) to be longer than 33 minutes. The result is that long exposures must be split into two or more shorter exposures with separate instrument overheads for each piece.

**Small Angle Maneuvers:** These are changes in telescope pointing of less than 2’. If you are offsetting by 1’–2’, add 1 minute of overhead.
Orbit Estimates

Spatial Scans: Spatial scan timing is very dependent on the type and size of the scan. A general rule of thumb that can be used to estimate the orbit time overheads associated with spatial scans is to add

\[(\text{Number of Steps} - 1) \times \text{Small Angle Maneuver time}\]

to the exposure time and overheads where SAM_time is defined as follows:

Table 16.5: Small Angle Maneuver time

<table>
<thead>
<tr>
<th>step-size</th>
<th>SAM_time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0” &lt; step-size &lt; 1”</td>
<td>10 seconds</td>
</tr>
<tr>
<td>1” &lt; step-size &lt; 10”</td>
<td>0.5 minutes</td>
</tr>
<tr>
<td>10” &lt; step-size &lt; 1’</td>
<td>1 minute</td>
</tr>
</tbody>
</table>

For example, if your exposure time + overhead/exposure is 4 minutes per exposure and you’re planning a 4 point scan with 5” between points, you would allow 17.5 minutes for the total duration of the sequence:

total exposure time with associated overhead= 16 minutes

total scan overhead= 1.5 minutes \([4-1) \times 0.5]\)

More precise spatial scan timing information is only available by using the Phase II Remote Proposal Submission software (RPS2). Contact the STScI Help Desk if you are a new HST user and need instructions for accessing the RPS2 software. Note that spatial scans are not supported with the FGS nor with STIS.

Reuse Target Offset: For those programs with multiple visits to the same target within a three-week period (start to finish), you may be able to utilize the “reuse target offset” function. Please contact the STScI Help Desk if you feel your program can benefit from this capability. If reuse target offset is appropriate for your program, you should only include the target acquisition sequence in the initial visit; the subsequent visits should start with your science exposures.

Parallel Observations: These are treated just like primary observations. Although the primary program will be responsible for performing the guide-star acquisitions and target acquisitions, the time for these overheads must still be considered in mapping parallel exposures.

For coordinated parallel observations, where you know the visit structure of the prime observations, the mapping of parallels should be straightforward. For pure parallel observations, where you may not know the prime target declinations, you should use one of the following to determine the visibility period:

1. The minimum allowable visibility period based on the target selection criteria converted to a declination range (e.g., if the generic requirement calls for \(\delta > 80^\circ\), use 59 minutes)

or

2. if you cannot do the above, map out the exposures (plus overheads) you wish to obtain in an orbit for any legal visibility period (52–60 minutes). If you choose this method, you may need to decrease your exposure times when you are matched with the prime observation if it has a lesser visibility period than you selected; you will be contacted by STScI if a reduction is required.

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◆ Step 4. Add up all the orbits

Once all the visits are defined, simply add the number of orbits in each visit, and insert the number of orbits for each target/instrument combination into the proposal template. Note that only whole orbits can be requested, and only whole orbits will be allocated. (The reason for this limitation is that the combined overhead for slew, guide star acquisition, and other overheads makes it very unlikely that an unused portion of a visibility period can be effectively used by another science program.)

Note that Snapshot proposals (see § 2.2) will most likely take less than one orbit per observation. Proposers should make certain that each of their SNAP exposures (with overheads) requires less than one visibility period. In particular, in past cycles the gaps suitable for SNAP observations were in the range of 20-45 minutes.
CHAPTER 17: Instructions for Archival Research Proposals

In this Chapter...

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17.2 How to Fill Out Archival Research Templates on page 17-81
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17.1 OPPORTUNITY FOR HST ARCHIVAL RESEARCH

Completed HST observations whose proprietary periods have expired are available to the community through the HST Archival Research Program. Funding may also be available for U.S. astronomers to support the analysis of such data. This section describes how to prepare and submit AR proposals for cases where funding is requested. See § 2.3 for a discussion of the policies and procedures relevant to the HST AR Program. Consult § 8.1 and the HST Archive Manual for more detailed information about the HST Archive and for instructions on how to request archival data when funding is not requested. Additional Archive information and a registration form are available from the Web at http://www.stsci.edu/archive.html

17.2 HOW TO FILL OUT ARCHIVAL RESEARCH TEMPLATES

AR proposals should be submitted using the appropriate Cycle 9 AR Proposal LaTeX Template. The Proposal LaTeX template “ARtemplate.tex” and associated style file can be obtained by sending an e-mail message to newprop@stsci.edu containing the words “request templates” in the subject lines. Proposers will receive the relevant files by automatic “return e-mail”.

Proposals must contain all of the items in the template:

#1. TITLE: Please supply a concise title for your proposal. The title should be no longer than 2 printed lines. Please use mixed cases, not all capital letters.

#2. SCIENTIFIC CATEGORY: Select the most appropriate scientific category among those listed in § 15 (Step 3. Map out the Orbits in each Visit).

#3—Select as many KEYWORDS as necessary to describe the scientific goal(s) of the proposal, with a minimum of one and a maximum of five. Keywords must be taken from the list in § 15 (Step 4. Add up all the orbits). Use all capital letters, do not modify the Keywords.

#4—Identify the mode of submission for the PostScript/PDF proposal (e-mail or ftp). You may provide information on PostScript/PDF contact by filling out pscontactemail with an
Instructions for Archival Research Proposals

#5. PRINCIPAL INVESTIGATOR: Identify the PI. Give full postal address, and also e-mail address (if available), and ESA member-state affiliation (if appropriate).

#6. TOTAL BUDGET REQUEST: Please enter a U.S. dollar figure for your total budget request in the cover page.

#7. ABSTRACT: The text of your abstract may not exceed 20 printed lines.

#8. CO-INVESTIGATORS: List the names, institutional affiliations, e-mail addresses, and countries of all Co-Is. Also indicate whether each Co-I is affiliated with the ESA or with an ESA member-state institution.

#9. SCIENTIFIC JUSTIFICATION: Present the scientific justification for the proposed program, including i) its goals and expected significance to astronomy; ii) the improvement or addition of knowledge with respect to the previous use of the data (see § 2.3 and § 6.2.3). Do not exceed 3 pages of text. Up to 2 additional pages may be used for figures, references and tables.

#10. DATA ANALYSIS PLAN: Provide a detailed data analysis plan for how your team will accomplish its science goals, including an estimate of the total number of data sets that will be analyzed, available resources, individual responsibilities where appropriate, and how the analysis will allow you to achieve your scientific objectives.

#11. BUDGET NARRATIVE: describe concisely (in words rather than numbers) what the requested funds, if awarded, will support.

#12. PREVIOUS HST PROGRAMS: The following material is not included in the page count for length limits. List proposal number and status of the data (especially publications) for each accepted GO/SNAP/AR proposal of the PI (e.g., GO-4975 - 24 Orbits - Ap.J. 441, 672, 1995). Unpublished data from early cycles should be explained. A significant publication record will be regarded by Panels as a strong plus.

Maximum total number of pages is 10. This includes no more than 3 pages of text for the scientific justification, plus up to 2 additional pages for figures and references. Font size should not be smaller than 12pt.

17.3 PROPOSAL SUBMISSION

In Cycle 9, the procedures for GO/SNAP and AR submissions have been unified. AR proposals should be submitted in electronic format. For each proposal, you must send the completed LaTeX template file and the PostScript/PDF file to STScI by e-mail to new-prop@stsci.edu, as explained in § 14.2.
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APPENDIX A: STScI, ST-ECF, and CADC Contacts

◆ A.1 Space Telescope Science Institute

Mail: 3700 San Martin Drive, Baltimore, Maryland 21218

Telephone: Listed extensions should be dialed after prefix 410-338 (from US)

Department: Name, e-mail, and Extension:

STScI Help Desk help@stsci.edu (1082) (toll free U.S. number: 1-800-544-8125)

SPSO Head: Meg Urry cmu@stsci.edu (4593) Technical Manager: Brett Blacker blacker@stsci.edu (1281)

Director’s Office Director: Steven Beckwith svwb@stsci.edu (4710) Deputy Director: Michael G. Hauser hauser@stsci.edu (4730) Assoc. Director for Science Programs: F. Duccio Macchetto macchetto@stsci.edu (4790)

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Science Support Division Head: Brad Whitmore whitmore@stsci.edu (4743)

Grants Administration Office Branch Chief: Ray Beaser beaser@stsci.edu (4200)
A.2 Space Telescope European Coordinating Facility

The ST-ECF provides HST information to European astronomers.

**Mail:**
Space Telescope-European Coordinating Facility
European Southern Observatory
Karl-Schwarzschild-Strasse 2
D-85748 Garching bei München
Germany

**Telephone:** +49-89-320-06-291
**FAX:** +49-89-320-06-480
**Electronic Mail:** stdesk@eso.org

Details of the activities and support available are summarized via the ST-ECF Web page: http://ecf.hq.eso.org/

The ST-ECF Newsletter, although aimed principally at European HST users, includes articles of general interest to the HST community. To receive the Newsletter, send full name and postal address to stdesk@eso.org.

A.3 Canadian Astronomy Data Centre

Canadian proposers may obtain assistance from the Canadian Astronomy Data Centre (CADC).

**Mail:** CADC/DAO
5071 W. Saanich Rd.
Victoria, B.C. V8X 4M6
Canada

**Telephone:** 604-363-0025
**Electronic Mail:** cadc@dao.nrc.ca
APPENDIX B: Funding Policies

It is anticipated that funds will be made available to STScI by NASA for the direct support of Cycle 9 HST research by U.S. scientists. This Appendix discusses the general conditions under which such funding will be awarded.

◆ B.1 Eligibility for STScI Grant Funds

Funding from STScI may be requested by scientists who are (1) United States citizens residing in the U.S., or abroad if salary and support are being paid by a U.S. institution; (2) U.S. permanent residents and foreign-national scientists working in and funded by U.S. institutions in the U.S.; or (3) U.S. Co-Investigators (Co-Is) on observing projects with non-U.S. Principal Investigators (PIs).

Proposals for funding will be accepted from Universities and other nonprofit research institutions, private for-profit organizations, Federal employees, STScI employees, and unaffiliated scientists. For-profit organizations should note that profit is not an allowable cost for GO/SNAP/AR grants.

STScI encourages collaboration by scientists from different institutions in order to make the best use of HST observing time and STScI financial support. Where multiple organizations are involved, it is normally required that the proposal be submitted by only one institution, with one scientist designated as PI with full responsibility for the scientific and administrative organization of the project. The proposal should clearly describe the role of the other institutions and the proposed managerial arrangements. STScI will award funding to the designated PI institution and to the Co-I institutions. In special circumstances, a single grant may be awarded to the PI institution, which will provide Co-I funding through sub-grants or subcontracts.

When a U.S. PI obtains grant funds from STScI for a project involving non-U.S. Co-Is, no funding may flow through the U.S. PI to the non-U.S. Co-Is.

U.S. Co-Is requesting funds for a proposal submitted by a non-U.S. PI are required to submit the Phase II budget forms through one of the Co-I institutions. Approved funding will be awarded by STScI directly to the Co-I institutions.

◆ B.2 Allowable Costs

Support may be requested for the acquisition, calibration, analysis, and publication of HST data, and related costs.

The following costs are allowable:

1. Salaries and wages. Salary support for project investigators is allowable, provided it is consistent with the policies of the institution assuming responsibility for the grant.

STScI funds may not be used to pay more than a person’s full-time salary or to pay more than an individual’s hourly rate. Also, an individual may not be reimbursed for consulting or other work in addition to a regular full-time institutional salary covering the same period of employment. For faculty members in academic institutions, STScI funding will normally be limited to no more than two months of summer-salary support. Exceptions for released time during the academic year may be permitted in special circumstances, but such costs must be fully justified in the proposal.
Released time for project investigators working in non-academic institutions is allowable, provided the compensation requested is reasonable and consistent with each employee’s regular full-time salary or rate of compensation.

It is assumed that most scientists will be affiliated with, and apply to STScI through, institutions that will make substantial support available for project activities (e.g., computer facilities, collaboration with other scientists, students, or research assistants). Salary support may be requested for unaffiliated scientists, but must be justified in the proposal, preferably in terms of the scientist’s salary while most recently affiliated with an institution, or the salary that would be received if the scientist were currently employed on a full-time basis rather than working on the HST project.

2. Research assistance. Reasonable costs for graduate students, post-doctoral associates, data aides, and secretarial and technical support for the analysis of HST data are allowable. For post-doctoral associates and other professionals, each position should be listed with the number of months, percentage of time that will be spent on the project, and rate of pay (hourly, monthly, or annual). For graduate students and secretarial, clerical, and technical staff, only the total number of persons and the total amount of salaries per year in each category are required. All such salaries must be in accordance with the standard policies of the institution assuming responsibility for the project.

3. Fringe benefits. If an institution’s usual accounting practices provide that its contributions to employee “benefits” (Social Security, retirement, etc.) be treated as direct costs, STScI funds may be requested for all applicable fringe benefits.

4. Publication costs. Reasonable costs for publication of research results obtained from the analysis of HST data are allowable.

5. Travel. Transportation and subsistence costs for project personnel to obtain, analyze, and disseminate direct results of HST observations are allowable, provided such costs have been justified in the proposal and fully detailed in the budget. Such costs must be in accordance with the written travel policies of the institution assuming responsibility for the project. In lieu of an institutional travel policy, the Federal Travel Regulations may be used for guidance.

6. Computer services. The costs of computer time and software for the analysis of HST data are allowable. Details of the services and software that will be used must be fully described and justified in the proposal.

7. Permanent equipment. The purchase of permanent equipment (items costing over $5000), including computers or related hardware, will be approved in special circumstances, and a detailed justification must be provided in the budget narrative. If such equipment is requested, the proposal must certify that the equipment is not otherwise available to project personnel, and/or that the cost of renting the equipment (or usage charges) would exceed the purchase price. Institutions are encouraged to provide at least half of the purchase price of any item costing more than $10,000. Unless stated to the contrary in the Grant Award Document, title to and all responsibility for equipment purchased...
with grant funds will be vested in the grantee institution, provided that the grantee uses the equipment for the authorized activities of the project and provided that the grantee agrees to transfer title to the equipment to the designee of STScI or NASA if a request for such transfer should be made within 120 days after the completion of the project. However, if the grantee organization has provided at least half of the purchase price of the equipment, STScI will vest title to such equipment in the grantee institution. Normally, the purchase of equipment will not be approved in grants to unaffiliated individuals or for-profit organizations. A detailed list of equipment purchased with grant funds must be provided with the required final financial report at the end of the grant period.

8. Materials and supplies. Materials and supplies directly related to the analysis of HST data are allowable, provided such costs are not already reimbursed through indirect costs.

9. Funds to support ground-based observations. Funding for preparatory observations is allowable for the acquisition of astrometric data to obtain accurate target positions for an observer’s approved HST program. Ground-based observations that are clearly essential to the interpretation of HST observations are also allowable. A description and justification of the planned observations must be provided in the Budget Narrative Form submitted in Phase II. The total cost of the ground-based observations must be only a small portion of the overall budget to analyze HST data.

10. Indirect costs (IDCs). Indirect costs are allowable, provided that the IDC rate used in the budget is based on a Negotiation Agreement with the Federal Government. STScI will exclude from the indirect cost base all subcontracts and subgrants in excess of $10,000. Should funding be approved for the project, the grantee will be requested to submit one copy of the Federal IDC Negotiation Agreement to the STScI Grants Administration Branch.

For institutions without a negotiated rate, STScI may allow a charge of 10% of direct costs, less items that would distort this base, such as major equipment purchases. However, the charge must not exceed $5,000 and documentation must be available to support the amount charged. Alternatively, such institutions may show such expenses as direct costs to the project, provided documentation will be maintained to verify such costs. Unaffiliated scientists should not use an indirect cost rate; instead, all administrative costs should be shown as direct costs of the project.

◆ B.3 Budget Submission

Questions concerning funding policies and the budget forms should be directed to the STScI Grants Administration Office.

◆ B.4 Preparatory Funding

GOs may request early funding of their programs if necessary to prepare for the receipt of HST data. Proposers may request up to 25% of the funds for their programs to be awarded prior to the start of the Cycle 9 observing schedule. Preparatory funding may be requested when the budget is submitted in Phase II. Note that the preparatory funds are part of the overall funding allocated for the program, not additional funds.
◆ **B.5 Grant Period**

It is anticipated that STScI will award funding for periods of one to two years, depending on the nature and complexity of the project, to complete the analysis of the current cycle’s observations. If the requested support is for more than one year, funding for the project will be on an annual basis, with additional funding for each subsequent grant year awarded after a favorable review of an annual performance report that will be required.

Long-term projects that are approved for more than one cycle of observations will be funded on an annual basis. Long-term programs approved in Cycle 7 require an annual continuation proposal. A budget for the analysis of current cycle observations must be submitted with an estimate of the funding requirements for subsequent cycles. Funding for subsequent cycles will be provided through an amendment to an existing STScI grant.

◆ **B.6 Award of Funds**

Shortly before the start of Cycle 9, each PI will receive notification from the Director concerning the specific funding allocation for their GO program. It is anticipated that requests for preparatory funding will be awarded prior to the start of Cycle 9. Additional funding up to the approved funding allocation will be awarded after the receipt of observational data for each GO program.

◆ **B.7 Educational Supplements**

Scientific initiatives with Education and Public Outreach purposes can be funded through the Education/Public Outreach proposals, to be submitted in conjunction with a parent GO/SNAP/AR research proposal (see APPENDIX I: for details).
APPENDIX C: Scientific Instrument Parameters

◆ C.1. Fine Guidance Sensors (FGS)
Instrument: FGS
Configuration: FGS
Mode: POS, TRANS

Table C.1.1: Spectral Elements for FGS

<table>
<thead>
<tr>
<th>Name</th>
<th>Comments</th>
<th>Effective Wavelength [Å]</th>
<th>Full Width at Half Maximum [Å]</th>
</tr>
</thead>
<tbody>
<tr>
<td>F583W</td>
<td>Clear filter</td>
<td>5830</td>
<td>2340</td>
</tr>
<tr>
<td>F5ND</td>
<td>Neutral Density (5 mag)</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td>F605W</td>
<td>Astrometry Clear filter</td>
<td>6050</td>
<td>1900</td>
</tr>
<tr>
<td>F550W</td>
<td>Yellow filter</td>
<td>5500</td>
<td>750</td>
</tr>
<tr>
<td>PUPIL</td>
<td>2/3 Pupil stop</td>
<td>5830</td>
<td>2340</td>
</tr>
</tbody>
</table>

◆ C.2. Space Telescope Imaging Spectrograph (STIS)
Instrument: STIS
Configuration: STIS/FUV, STIS/NUV, STIS/CCD
Mode: ACCUM, TIMETAG
### Table C.2.1: STIS Spectroscopy - CCD

<table>
<thead>
<tr>
<th>Name</th>
<th>Tilts</th>
<th>Central Wavelength [Å]</th>
<th>Å per exposure</th>
<th>Resolving Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>G750L</td>
<td>Prime</td>
<td>7751</td>
<td>5030</td>
<td>~750</td>
</tr>
<tr>
<td>G750M</td>
<td>Prime</td>
<td>5734,6252,6768,7283,7795,8311,8825,9336,9851</td>
<td>570</td>
<td>~7000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>6094,6581,8561,9286,9806</td>
<td>570</td>
<td>~7000</td>
</tr>
<tr>
<td>G430L</td>
<td>Prime</td>
<td>4300</td>
<td>2800</td>
<td>~750</td>
</tr>
<tr>
<td>G430M</td>
<td>Prime</td>
<td>3165,3423,3680,3936,4194,4451,4706,4961,5216,5471</td>
<td>286</td>
<td>~7000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>3305,3843,4781,5093</td>
<td>286</td>
<td>~7000</td>
</tr>
<tr>
<td>G230LB</td>
<td>Prime</td>
<td>2375</td>
<td>1380</td>
<td>~750</td>
</tr>
<tr>
<td>G230MB</td>
<td>Prime</td>
<td>1713,1854,1995,2135,2276,2416,2557,2697,2836,2976,3115</td>
<td>155</td>
<td>~7000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>2794</td>
<td>155</td>
<td>~7000</td>
</tr>
</tbody>
</table>

### Table C.2.2: STIS Spectroscopy - NUV-MAMA

<table>
<thead>
<tr>
<th>Name</th>
<th>Tilts</th>
<th>Central Wavelength [Å]</th>
<th>Å per exposure</th>
<th>Resolving Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>G230L</td>
<td>Prime</td>
<td>2376</td>
<td>1610</td>
<td>~700</td>
</tr>
<tr>
<td>G230M</td>
<td>Prime</td>
<td>1687,1769,1851,1933,2014,2095,2176,2257,2338,2419,2499,2579,2659,2739,2818,2898,2977,3055</td>
<td>90</td>
<td>~13,000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>1884,2600,2800,2828</td>
<td>90</td>
<td>~13,000</td>
</tr>
<tr>
<td>E230M</td>
<td>Prime</td>
<td>1978,2707</td>
<td>~800</td>
<td>~30,000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>2124,2269,2415,2561</td>
<td>~800</td>
<td>~30,000</td>
</tr>
<tr>
<td>E230H</td>
<td>Prime</td>
<td>1763,2013,2263,2513,2762,3012</td>
<td>~267</td>
<td>~110,000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>1813,1863,1913,1963,2063,2113,2163,2213,2313,2363,2413,2463,2563,2613,2663,2713,2812,2862,2912,2962</td>
<td>~267</td>
<td>~110,000</td>
</tr>
<tr>
<td>PRISM</td>
<td>Prime</td>
<td>1200</td>
<td>1950</td>
<td>~100</td>
</tr>
<tr>
<td>Name</td>
<td>Tilts</td>
<td>Central Wavelength (Å)</td>
<td>Å per exposure</td>
<td>Resolving Power</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>------------------------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>G140L</td>
<td>Prime</td>
<td>1425</td>
<td>620</td>
<td>~1000</td>
</tr>
<tr>
<td>G140M</td>
<td>Prime</td>
<td>1173,1222,1272,1321,1371,1420,1470,1518,1567,1616,1665,1714</td>
<td>55</td>
<td>~13,000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>1218,1387,1400,1540,1550,1640</td>
<td>55</td>
<td>~13,000</td>
</tr>
<tr>
<td>E140M</td>
<td>Prime</td>
<td>1425</td>
<td>620</td>
<td>~45,000</td>
</tr>
<tr>
<td>E140H</td>
<td>Prime</td>
<td>1234,1416,1598</td>
<td>~210</td>
<td>~110,000</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>1271,1307,1343,1380,1453,1489,1526,1562</td>
<td>~210</td>
<td>~110,000</td>
</tr>
</tbody>
</table>
Table C.2.4: STIS Imaging

<table>
<thead>
<tr>
<th>Name</th>
<th>Filter</th>
<th>Cent. Wavelength [Å]</th>
<th>FWHM [Å]</th>
<th>Detector</th>
</tr>
</thead>
<tbody>
<tr>
<td>50CCD</td>
<td>clear</td>
<td>5850</td>
<td>4410</td>
<td>CCD</td>
</tr>
<tr>
<td>F28X50LP</td>
<td>optical longpass</td>
<td>7230</td>
<td>2720</td>
<td>CCD</td>
</tr>
<tr>
<td>F28X50OIII</td>
<td>[O III]</td>
<td>5007</td>
<td>5</td>
<td>CCD</td>
</tr>
<tr>
<td>F28X50OII</td>
<td>[OII]</td>
<td>3740</td>
<td>80</td>
<td>CCD</td>
</tr>
<tr>
<td>25MAMA (NUV)</td>
<td>clear</td>
<td>2220</td>
<td>1200</td>
<td>NUV</td>
</tr>
<tr>
<td>25MAMA (FUV)</td>
<td>clear</td>
<td>1370</td>
<td>320</td>
<td>FUV</td>
</tr>
<tr>
<td>F25QTZ (NUV)</td>
<td>UV near longpass</td>
<td>2320</td>
<td>1010</td>
<td>NUV</td>
</tr>
<tr>
<td>F25QTZ (FUV)</td>
<td>UV near longpass</td>
<td>1590</td>
<td>220</td>
<td>FUV</td>
</tr>
<tr>
<td>F25SRF2 (NUV)</td>
<td>UV far longpass</td>
<td>2270</td>
<td>1110</td>
<td>NUV</td>
</tr>
<tr>
<td>F25SRF2 (FUV)</td>
<td>UV far longpass</td>
<td>1480</td>
<td>280</td>
<td>FUV</td>
</tr>
<tr>
<td>F25MgII</td>
<td>Mg II</td>
<td>2800</td>
<td>70</td>
<td>NUV</td>
</tr>
<tr>
<td>F25CN270</td>
<td>continuum near 2700 Å(^a)</td>
<td>2700</td>
<td>350</td>
<td>NUV</td>
</tr>
<tr>
<td>F25CIII</td>
<td>C III</td>
<td>1909</td>
<td>70</td>
<td>NUV</td>
</tr>
<tr>
<td>F25CN182</td>
<td>continuum near 1800 Å</td>
<td>1820</td>
<td>350</td>
<td>NUV</td>
</tr>
<tr>
<td>F25LYA</td>
<td>Lyman alpha</td>
<td>1216</td>
<td>85</td>
<td>FUV</td>
</tr>
<tr>
<td>F25NDQ1(^b)</td>
<td>neutral density, ND=10(^{-1})</td>
<td>1150-11000</td>
<td></td>
<td>CCD/NUV/FUV</td>
</tr>
<tr>
<td>F25NDQ2(^b)</td>
<td>neutral density, ND=10(^{-2})</td>
<td>1150-11000</td>
<td></td>
<td>CCD/NUV/FUV</td>
</tr>
<tr>
<td>F25NDQ3(^b)</td>
<td>neutral density, ND=10(^{-3})</td>
<td>1150-11000</td>
<td></td>
<td>CCD/NUV/FUV</td>
</tr>
<tr>
<td>F25NDQ4(^b)</td>
<td>neutral density, ND=10(^{-4})</td>
<td>1150-11000</td>
<td></td>
<td>CCD/NUV/FUV</td>
</tr>
<tr>
<td>F25ND3</td>
<td>neutral density, ND=10(^{-3})</td>
<td>1150-11000</td>
<td></td>
<td>CCD/NUV/FUV</td>
</tr>
<tr>
<td>F25ND5</td>
<td>neutral density, ND=10(^{-5})</td>
<td>1150-11000</td>
<td></td>
<td>CCD/NUV/FUV</td>
</tr>
</tbody>
</table>

\(^a\) filter has a substantial red leak

\(^b\) quad filter (see Instrument Handbook)
Table C.2.5: STIS CCD Imaging with the Coronograph

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEDGEA1.0</td>
<td>wedge A in coronographic aperture; width=1.0”</td>
</tr>
<tr>
<td>WEDGEA1.8</td>
<td>wedge A in coronographic aperture; width=1.8”</td>
</tr>
<tr>
<td>WEDGEA2.0</td>
<td>wedge A in coronographic aperture; width=2.0”</td>
</tr>
<tr>
<td>WEDGEA2.5</td>
<td>wedge A in coronographic aperture; width=2.5”</td>
</tr>
<tr>
<td>WEDGEA2.8</td>
<td>wedge A in coronographic aperture; width=2.8”</td>
</tr>
<tr>
<td>WEDGEB1.0</td>
<td>wedge B in coronographic aperture; width=1.0”</td>
</tr>
<tr>
<td>WEDGEB1.8</td>
<td>wedge B in coronographic aperture; width=1.8”</td>
</tr>
<tr>
<td>WEDGEB2.0</td>
<td>wedge B in coronographic aperture; width=2.0”</td>
</tr>
<tr>
<td>WEDGEB2.5</td>
<td>wedge B in coronographic aperture; width=2.5”</td>
</tr>
<tr>
<td>WEDGEB2.8</td>
<td>wedge B in coronographic aperture; width=2.8”</td>
</tr>
<tr>
<td>BAR10</td>
<td>bar in coronographic aperture; 10.0”x3.0”</td>
</tr>
</tbody>
</table>

Table C.2.6: Supported Spectroscopic Apertures for STIS ¹

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2X0.06</td>
<td>echelle slit</td>
</tr>
<tr>
<td>0.2X0.09</td>
<td>echelle slit</td>
</tr>
<tr>
<td>0.2X0.2</td>
<td>echelle slit</td>
</tr>
<tr>
<td>6X0.2</td>
<td>echelle slit</td>
</tr>
<tr>
<td>0.2X0.2 FP (A-E)</td>
<td>fpsplit echelle slit</td>
</tr>
<tr>
<td>0.2X0.06 FP (A-E)</td>
<td>fpsplit echelle slit</td>
</tr>
<tr>
<td>0.1X0.03</td>
<td>echelle slit</td>
</tr>
<tr>
<td>52X0.05</td>
<td>first order slit</td>
</tr>
<tr>
<td>52X0.1</td>
<td>first order slit</td>
</tr>
<tr>
<td>52X0.2</td>
<td>first order slit</td>
</tr>
<tr>
<td>52X0.5</td>
<td>first order slit</td>
</tr>
<tr>
<td>52X2</td>
<td>first order slit</td>
</tr>
<tr>
<td>52X0.2F1</td>
<td>first order slit; fiducial=0.5”</td>
</tr>
<tr>
<td>0.2X0.05ND</td>
<td>neutral density echelle slit</td>
</tr>
<tr>
<td>0.3X0.05ND</td>
<td>neutral density echelle slit</td>
</tr>
</tbody>
</table>

¹ The first order modes can also be used slitless, or with blocking filters.
In addition to the supported apertures in Table C.2.6, there are also many available (but unsupported) apertures that can be used if necessary; see the Instrument Handbook for the complete list. The need for the available apertures should be addressed in the Special Requirements section of the proposal.

◆ **C.3. Wide Field Planetary Camera 2 (WFPC2)**

Instrument: WFPC2
Configuration: WFPC2
Mode: IMAGE

<table>
<thead>
<tr>
<th>Name</th>
<th>Wheel</th>
<th>Description</th>
<th>Central Wavelength [Å]</th>
<th>Effective Width [Å]</th>
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</thead>
<tbody>
<tr>
<td>F122M</td>
<td>1</td>
<td>H Ly - Alpha (Red Leak)</td>
<td>1420</td>
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<td>F130LP</td>
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<td>CaF(_2) Blocker (zero focus shift)</td>
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<td>4776</td>
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<td>F160AW(^a)</td>
<td>1</td>
<td>Sodium filter A</td>
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<td>F160BW(^a)</td>
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<td>Suprasil Blocker (zero focus shift)</td>
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<td>F170W</td>
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<td>F300W</td>
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<td>“Wide U”</td>
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<td>F336W</td>
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<td>“WFPC2 U”, “Strömgren u”</td>
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<tr>
<td>F343N</td>
<td>5</td>
<td>Ne V</td>
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<td>CN</td>
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<td>He II</td>
<td>4694</td>
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<td>F487N</td>
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<td>H Beta</td>
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<td>[O III]</td>
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<td>“WFPC2 V”</td>
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<td>1226</td>
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<tr>
<td>F569W</td>
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<td>F555W is generally preferred</td>
<td>5614</td>
<td>966</td>
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<tr>
<td>F588N</td>
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<td>He I &amp; Na I</td>
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<tr>
<td>F606W</td>
<td>10</td>
<td>“Wide V”</td>
<td>5935</td>
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<td>F622W</td>
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The F160BW filter is superior to the F160AW filter. If you feel you need to use the F160AW filter, please contact help@stsci.edu.

<table>
<thead>
<tr>
<th>Name</th>
<th>Wheel</th>
<th>Description</th>
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<td>F658N</td>
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<td>[S II]</td>
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<td>F675W</td>
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<td>“WFPC2 R”</td>
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<td>F702W</td>
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<td>“Wide R”</td>
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<td>F791W</td>
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<td>F1042M</td>
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**Quadrant Filters**

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<tr>
<td>FQUVN</td>
<td>11</td>
<td>Redshifted [O II]</td>
<td>3765–3992</td>
<td>63 (avg.)</td>
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<tr>
<td>FQCH4N</td>
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<td>Methane Bands (Jewel Quad)</td>
<td>5433–8929</td>
<td>49 (avg.)</td>
</tr>
<tr>
<td>POLQ</td>
<td>11</td>
<td>Polarizer (0, 45, 90, 135) - zero focus shift</td>
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**Linear Ramp Filters**

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<tbody>
<tr>
<td>LRF</td>
<td>12</td>
<td>Linear ramp filter set</td>
<td>3710–9762</td>
<td>1.3% CW</td>
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</table>

* The F160BW filter is superior to the F160AW filter. If you feel you need to use the F160AW filter, please contact help@stsci.edu.
<table>
<thead>
<tr>
<th>Spectral Element</th>
<th>Aperture</th>
<th>Central Wavelength [Å]</th>
<th>Effective Width [Å]</th>
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<td>F160BN15</td>
<td>F160BN15</td>
<td>1600</td>
<td>900</td>
<td>on CCD WF3</td>
</tr>
<tr>
<td>FQUVN</td>
<td>WF2</td>
<td>3992</td>
<td>64</td>
<td>nominal rotation</td>
</tr>
<tr>
<td>FQUVN</td>
<td>WF3</td>
<td>3913</td>
<td>59</td>
<td>nominal rotation</td>
</tr>
<tr>
<td>FQUVN</td>
<td>WF4</td>
<td>3830</td>
<td>57</td>
<td>nominal rotation</td>
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<tr>
<td>FQUVN33</td>
<td>FQUVN33</td>
<td>3765</td>
<td>73</td>
<td>–33 degree rotation, on CCD WF2</td>
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<tr>
<td>FQCH4N</td>
<td>FQCH4W2</td>
<td>5433</td>
<td>38</td>
<td>nominal rotation, on CCD WF2</td>
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<td>FQCH4N</td>
<td>FQCH4W3</td>
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<td>64</td>
<td>nominal rotation, on CCD WF3</td>
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<tr>
<td>FQCH4N</td>
<td>FQCH4W4</td>
<td>7274</td>
<td>51</td>
<td>nominal rotation, on CCD WF4</td>
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<td>FQCH4N33</td>
<td>FQCH4N33</td>
<td>6193</td>
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<td>FQCH4N15</td>
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<td>–15 degree rotation, on CCD PC1</td>
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<td>FQCH4P15</td>
<td>FQCH4P15</td>
<td>8929</td>
<td>64</td>
<td>+15 degree rotation, on CCD PC1</td>
</tr>
<tr>
<td>POLQ</td>
<td>PC1</td>
<td></td>
<td></td>
<td>pol. angle 135 degrees; POS TARG +8, +8 recommended to avoid cross-talk</td>
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<tr>
<td>POLQ</td>
<td>WF2</td>
<td></td>
<td></td>
<td>pol. angle 0 degrees</td>
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<tr>
<td>POLQ</td>
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<td>WF4</td>
<td></td>
<td></td>
<td>pol. angle 90 degrees</td>
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<td>POLQN33</td>
<td>POLQN33</td>
<td></td>
<td></td>
<td>pol. angle 102 degrees, on CCD WF2</td>
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<tr>
<td>POLQP15</td>
<td>POLQP15W</td>
<td></td>
<td></td>
<td>pol. angle 15 degrees, on CCD WF2</td>
</tr>
<tr>
<td>POLQP15</td>
<td>POLQP15P</td>
<td></td>
<td></td>
<td>pol. angle 15 degrees, on CCD PC1; not recommended: clear FOV only 3 arcsec</td>
</tr>
<tr>
<td>POLQN18</td>
<td>POLQN18</td>
<td></td>
<td></td>
<td>pol. angle 117 degrees, on CCD WF2</td>
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</table>
APPENDIX D: Scientific Instruments not offered in Cycle 9

The following subsections describe the four instruments that were removed from HST during the servicing missions and the two instruments still on board the HST but not currently offered for observations in Cycle 9. The information may be of use to persons proposing AR. Further details for any of the instruments mentioned below may be found through consulting the most recent Instrument Handbooks and the HST Data Handbook as presented in § 1.3. Web pages are maintained for the WF/PC, HSP, GHRS, FOS, FOC and NICMOS and will be updated to facilitate AR. Assistance may also be obtained from the STScI Help Desk.

◆ D.1 Wide Field Planetary Camera 1 (WF/PC)

The WF/PC had two configurations; in both, the FOV was covered by a mosaic of four charge-coupled devices (CCDs). Each CCD had 800 × 800 pixels and was sensitive from 1150 to 11,000 Å. However, internal contaminants on the camera optics limited normal operation to the range from 2840 to 11,000 Å.

In the Wide Field Camera (low-resolution) configuration, the FOV was 2′.6 × 2′.6, with a pixel size of 0″.10. In the Planetary Camera (high-resolution) configuration, the FOV was 1′.1 × 1′.1, and the pixel size was 0″.043. A variety of filters was available. The WF/PC received about 40% of the observing time on HST in Cycles 1–3, with a large and diverse range of science observations resulting. All WF/PC data was adversely affected by the existence of spherical aberration. Unique and valuable data exists in the archive, but in terms of photometric accuracy, and especially image quality, data taken with the WFPC2 from Cycle 4 and on is superior.

◆ D.2 High Speed Photometer (HSP)

The HSP was designed to take advantage of the lack of atmospheric scintillation for a telescope in orbit, as well as to provide good ultraviolet performance. Integrations as short as 10 μs were possible, over a broad wavelength range (1200 to 8000 Å), and polarimetry was also possible. Observations were carried out through aperture diameters of 1′′.0 with the visual and ultraviolet detectors, and 0″.65 with the polarimetry detector.

HSP had a large variety of fixed aperture/filter combinations distributed in the focal plane; selection was accomplished by moving the telescope so as to place the target in the desired aperture behind the desired filter.

The HSP detectors were four image-dissector tubes and one photomultiplier tube. A variety of ultraviolet and visual filters and polarizers was available. The HSP was used for only a relatively small fraction (5%) of HST observing in Cycles 1–3; the HSP science program was among the more severely compromised by spherical aberration. Only limited instrument expertise is available at STScI in support of HSP AR. The extremely high

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speed with which some HSP data was acquired make these still unique for either past, current or planned HST capabilities.

◆ **D.3 Faint Object Spectrograph (FOS)**

The FOS performed low and moderate resolution spectroscopy (R ~ 250 and 1300) in the wavelength range 1150 to 8500 Å. A variety of apertures of different sizes and shapes were available which could optimize throughput and spectral or spatial resolution. Ultraviolet linear and circular spectropolarimetric capability was also present.

Two gratings and a prism were available in the low resolution mode and six gratings were available in the R = 1300 mode to cover the entire spectral range. The photon-counting detectors were two 512-element Digicons, one which operated from 1150 to 5500 Å (FOS/BLUE), and the other from 1620 to 8500 Å (FOS/RED).

Most FOS data were acquired in accumulation and rapid-readout modes; periodic and image modes were only occasionally employed. Time resolutions as short as 30 msec were feasible. The electron image was magnetically stepped through a programmed pattern during the observations which provided for oversampling, compensation for sensitivity variations along the Digicon array, sky measures, and/or measurement of orthogonally polarized spectra. Normally data were read out in intervals that were short compared to the exposure time.

The FOS received about 20–25% of the total HST observing time over Cycles 1–6, carrying out a large and diverse range of science topics. Due to the polarimetric and large dynamic range capabilities a substantial fraction of these data will remain unique.

◆ **D.4 Goddard High Resolution Spectrograph (GHRS)**

The GHRS used two, 500-element digicon detectors providing sensitivity from 1100 to 1900 Å (Side 1—solar blind) and 1150 to 3200 Å (Side 2). The GHRS provided photon-noise limited data if an observing strategy was undertaken to map out photocathode response irregularities with the FP-SPLIT option. Signal-to-noise ratios of 100 or more were routinely achieved, and upwards of 1000 on occasion.

The GHRS modes include a first order grating covering 1100–1900 Å at R ~ 2,500 (285 Å bandpass), four first order holographic gratings with very low scattered light covering 1150–3200 Å at R ~ 25,000 (27–45 Å bandpass), and cross-dispersed echelles at R ~80,000 over 1150–3200 Å (6–15 Å bandpass).

The GHRS had two apertures: the 2.0” Large Science Aperture, and 0.25” Small Science Aperture; post-COSTAR the aperture projections were reduced to 1.74” and 0.22” respectively. The small aperture projected to one resolution element, thus even pre-COSTAR data taken with this retained the designed spectral resolution, albeit at reduced throughput.

Some data were acquired at time resolutions as short as 50 milli-seconds in a Rapid Readout mode. Most observations were acquired in accumulation mode which provided for oversampling, compensation for sensitivity variations along the Digicon array, and simultaneous monitoring of detector backgrounds. Routine observations of the on-board Pt-Ne emission line lamp provide data with well calibrated wavelengths.

The GHRS received about 20–25% of the total HST observing time over Cycles 1–6, with a large and diverse range of high quality science observations resulting. Due to the high
signal-to-noise and large dynamic range capabilities in the far ultraviolet, much of this data will remain unique.

◆ **D.5 Faint Object Camera (FOC)**

The FOC was designed to provide high-resolution images of small fields. The FOC consists of two independent optical relays that magnify the input beam by a factor of four (f/96) and two (f/48). A variety of filters, prisms (for slitless spectroscopy), and polarizers could be placed in the optical beam. The f/48 relay also has a longslit spectrograph. The FOC photocathodes limited the wavelength range from 1200 to 6000 Angstroms.

When corrected by COSTAR the field of view and pixel size of the f/96 camera are 7" x 7" (512 x 512 format) and 0.014" x 0.014", respectively; a field of 14" x 14" could be used with the 512 x 1024 pixel format and a rectangular pixel size of 0.028" x 0.014". Without COSTAR in the beam, the corresponding parameters for the f/96 camera are: 11" x 11" field of view in the 512 x 512 format, pixel size 0.0223" x 0.0223" and full-format field of 22" x 22" with 0.0446" x 0.0223" pixels. The corresponding values for the (little used) f/48 camera are twice those of the f/96 camera.

The f/96 camera was the primary FOC imaging workhorse; high voltage instability problems limited the use of the f/48 relay to mainly long-slit spectroscopic data after the installation of COSTAR.

Most of the FOC data in the archive are unique because the spatial resolution of the FOC is greater than that of any current (or planned) HST instrument. Also, the UV sensitivity was significantly higher than WFPC2, but less than STIS, although a larger variety of filters was available. Finally, the polarizers in the f/96 relay have very low instrumental polarization and excellent polarizing efficiencies.

◆ **D.6 Near Infrared Camera and Multi-Object Spectrometer (NICMOS)**

The NICMOS provided HST’s only infrared capability. The three 256 x 256 pixel cameras of NICMOS are designed to provide diffraction limited sampling to 1.0 micron (Camera 1), 1.75 micron (Camera 2), and offer via Camera 3 a relatively large field of view. The short wavelength response at 0.8 micron is set by the HgCdTe detector array, while a 2.6 micron cutoff was selected as the longest usable wavelength given HST’s warm optics.

The cryogen in the dewar was exhausted in January 1999. It is expected that with the installation of the NICMOS Cooling System (NCS) in SM3b, the instrument will provide an infrared capability for several years.

Each camera carries 19 independent optical elements providing a wide range of filter options. Cameras 1 and 2 have polarimetric filters, Camera 2 has a 0.3 arcsec radius coronographic spot and optimized cold mask, that provides coronographic imaging. Camera 3 has three separate grisms providing slitless spectroscopy over the full NICMOS wavelength range. A variety of standard dithering and chopping (for background and sky mapping) sequences are available.
APPENDIX E: Target Naming Conventions

Target names are used to provide unique designations for the targets throughout the proposal. These names will generally also be used in Phase II, in the HST observing schedule, and ultimately to designate targets in the HST data archives. Prospective proposers and Archival researchers will use these names to determine whether HST has observed a particular object. This facility will be most useful if consistent naming conventions are used for targets.

The following convention should be followed in naming targets:

Each time a distinct telescope pointing is requested, a new target name should be defined. For example, for several pointings within a galaxy, one might define target names like NGC4486-NUC, NGC4486-JET, NGC4486-POS1, and NGC4486-POS2.

◆ E.1. Catalog Name

The preferred order for catalogs to be used for the designation of various classes of objects is provided below. It is arranged in order of decreasing priority. If a target is not contained in these catalogs, then other catalog designations may be used (e.g., IRC or IRAS Catalog numbers, 4U X-ray Catalog designation, Villanova White-Dwarf Catalog number, etc.).

The use of positional catalogs (SAO, Boss, GC, AGK3, FK4, etc.) is discouraged. For uncataloged targets, see below.

Stars

• Henry Draper Catalog number (e.g., HD140283). HDE numbers are discouraged, except in the Magellanic Clouds.
• Durchmusterung number (BD, CD, or CPD). In the southern hemisphere, adopt the convention of using CD north of –52 and CPD south of that limit (e.g., BD+30D3639, CD–42D1462).
• General Catalog of Variable Stars designation, if one exists (e.g., RR–LYR, SS–CYG).

Star Clusters and Nebulae

• New General Catalog (NGC) number (e.g., NGC6397, NGC7027).
• Index Catalog (IC) number (e.g., IC418).
• For planetary nebulae, the Perek-Kohoutek designation (e.g., PK208+33D).
• For H II regions, the Sharpless Catalog number (e.g., S106).

Galaxies and Clusters of Galaxies

• NGC number (e.g., NGC4536).
• IC number (e.g., IC724).
• Uppsala Catalog number (e.g., UGC11810).
• For clusters of galaxies, the Abell Catalog number (e.g., ABELL2029).
Quasars and Active Galaxies

• The name defined in the compilation by Veron-Cetty and Veron (ESO Scientific Report No. 18, 1998) should be used (e.g., 3C273). The Veron-Cetty and Veron Catalog can be found at:

◆ E.2 Uncataloged Targets

Objects that have not been catalogued or named should be assigned one of the following designsations:

• Isolated objects should be designated by a code name (the allowed codes are STAR, NEB, GAL, STAR-CLUS, GAL-CLUS, QSO, SKY, FIELD, and OBJ), followed by a hyphen and the object’s J2000 equatorial coordinates, if possible, rounded to minutes of time and minutes of arc (e.g., for an optical binary star at J2000 coordinates $\alpha = 1^h 34^m 28^s$ and $\delta = -15^\circ 31'12''$, the designations would be STAR-0134-1531A and STAR-0134-1531B).

• Uncataloged objects within star clusters, nebulae, or galaxies should be designated by the name of the parent body followed by a hyphen and a type designation of the object (e.g., for a star cluster within NGC 224, the designation would be NGC224-STARCLUS).

• Known objects within nebulae or galaxies may also be designated by the name of the parent object followed by a hyphen and an identifier of the target object. The identifier should be brief, but informative (e.g., the jet in NGC 4486 could be designated NGC4486-JET). Other examples are: NGCS139-ROA24, LMC-R136A, ABELL30-CENSTAR, NGC205-NUC.

◆ E.3 External Calibration Targets

The name of a target that is being observed only as a calibration standard for other observations should be designated by appending the code –CAL to the target name (e.g., BD28D4211-CAL). Both external and internal calibration targets (e.g., WAVE, INTFLAT) and calibrations using the Earth should be included in the OS, and described in Item #15—Description of the Observations—of the proposal form.
APPENDIX F: Astronomical Symbols Available for Use in the Proposal Templates

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tr>
<td>\halpha Ha</td>
<td>30\arcsec 30''</td>
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<tr>
<td>\hbeta H\beta</td>
<td>0\fd5 0.5</td>
</tr>
<tr>
<td>\hgamma H\gamma</td>
<td>0.4</td>
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<tr>
<td>\lya Ly\alpha</td>
<td>0.6</td>
</tr>
<tr>
<td>\lyb Ly\beta</td>
<td>0.6</td>
</tr>
<tr>
<td>\mum \mu</td>
<td>0.6</td>
</tr>
<tr>
<td>\mv M\nu</td>
<td>0.6</td>
</tr>
<tr>
<td>\ubvr UBVR</td>
<td>0.06</td>
</tr>
<tr>
<td>\ub U-B</td>
<td>0.4</td>
</tr>
<tr>
<td>\bv B-V</td>
<td>\onehalf 1/2</td>
</tr>
<tr>
<td>\vr V-R</td>
<td>\onethird 1/3</td>
</tr>
<tr>
<td>\ur U-R</td>
<td>\twothirds 2/3</td>
</tr>
<tr>
<td>\ion{O}{3} O III</td>
<td>\onequarter 1/4</td>
</tr>
<tr>
<td>3.6\micron 3.6\mu m</td>
<td>\threequarters 3/4</td>
</tr>
<tr>
<td>25\kms 25 \text{km s}^{-1}</td>
<td>\slantfrac{22}{7} 22/7</td>
</tr>
<tr>
<td>\peryr yr^{-1}</td>
<td>\squig ~</td>
</tr>
<tr>
<td>M\subsun M_\odot</td>
<td>\lessim \leq</td>
</tr>
<tr>
<td>\sun \odot</td>
<td>\gtrsim \geq</td>
</tr>
<tr>
<td>\earth \oplus</td>
<td>\la \leq</td>
</tr>
<tr>
<td>\sq \oplus</td>
<td>\ga \geq</td>
</tr>
<tr>
<td>90\deg 90^\circ</td>
<td>\nodata \ldots</td>
</tr>
<tr>
<td>16\aqdeg 16\deg^2</td>
<td></td>
</tr>
</tbody>
</table>
This Appendix provides the Web link to the Tables to be used for CVZ observations (see § 12.1). Included are three tables for each of northern and southern declinations for the 12-month period July 01, 2000- July 01, 2001, including:

• The maximum duration in orbits of any single CVZ window;
• The total duration in orbits of all CVZ opportunities for targets at the specified RA and Declination; and
• The total number of CVZ windows.

The CVZ Tables can be found at the following Web address:
http://www.stsci.edu/ftp/proposer/cycle9/CVZ_Tables.html

An automatic estimate of the three relevant times above can be obtained directly by supplying the target coordinates in the above Web page as well.

Proposers should be aware that near the “wings” of the CVZ area (i.e., where there is only one CVZ window), the actual availability of CVZ observing will depend in detail on the geometry of the HST orbit during Cycle 9.
APPENDIX H: Examples

This Appendix contains example orbit calculations for each of the SIs offered in Cycle 9. These examples can be used to help lay out the exposures and overheads needed to calculate the number of orbits required. Detailed instructions for how to make the calculations are provided in §16.2.

◆ H.1 Example with Fine Guidance Sensors

Targets: Binary01, ref1, ref2, ref3, ref4, ref5 (ref2, ref3: V=14.6, all other targets: V<14.0)
Declination: +23 degrees
Visibility: 53 minutes

Table H.1.1: Exposure Example with FGS

<table>
<thead>
<tr>
<th>Mode</th>
<th>Aperture</th>
<th>Spectral Element</th>
<th>Number of Exposures</th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>POS</td>
<td>PRIME</td>
<td>F583W</td>
<td>8</td>
<td>10 s / target</td>
</tr>
<tr>
<td>POS</td>
<td>PRIME</td>
<td>F583W</td>
<td>2</td>
<td>40 s / target (ref2, ref3)</td>
</tr>
<tr>
<td>TRANS</td>
<td>PRIME</td>
<td>F583W</td>
<td>1</td>
<td>~ 800 s (20 scans)</td>
</tr>
</tbody>
</table>

Table H.1.2: Overheads for the FGS Example

<table>
<thead>
<tr>
<th>Overheads</th>
<th>Overhead Time</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS ACQ</td>
<td>6 m</td>
<td>once per visit</td>
</tr>
<tr>
<td>Instrument Setup</td>
<td>4 m</td>
<td>once per orbit</td>
</tr>
<tr>
<td>POS</td>
<td>1 m</td>
<td>per exposure, V&lt;14</td>
</tr>
<tr>
<td>POS</td>
<td>2 m</td>
<td>per exposure, 14&lt;V&lt;15</td>
</tr>
<tr>
<td>TRANS ACQ</td>
<td>~1 m</td>
<td>per exposure</td>
</tr>
<tr>
<td>TRANS</td>
<td>~12 s</td>
<td>per scan</td>
</tr>
<tr>
<td>Instrument Shutdown</td>
<td>~3 m</td>
<td>once per orbit</td>
</tr>
</tbody>
</table>
Table H.1.3: Time Estimator Example for FGS

<table>
<thead>
<tr>
<th>Activity</th>
<th>Target</th>
<th>Mode</th>
<th>Exposure time</th>
<th>Duration [m] with overheads</th>
<th>Elapsed time [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS ACQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ins. Setup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>Binary01</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>11.2</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>Binary01</td>
<td>TRANS</td>
<td>800 s</td>
<td>18.3</td>
<td>29.5</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>Binary01</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>30.7</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>ref5</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>31.9</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>ref3</td>
<td>POS</td>
<td>40 s</td>
<td>2.7</td>
<td>34.6</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>ref4</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>35.8</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>Binary01</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>37</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>ref5</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>38.2</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>ref1</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>39.4</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>ref2</td>
<td>POS</td>
<td>40 s</td>
<td>2.7</td>
<td>42.1</td>
</tr>
<tr>
<td>ACQ/Obs</td>
<td>Binary01</td>
<td>POS</td>
<td>10 s</td>
<td>1.2</td>
<td>43.3</td>
</tr>
<tr>
<td>Ins. Shutdown</td>
<td></td>
<td></td>
<td>3 m</td>
<td>3</td>
<td>46.3</td>
</tr>
<tr>
<td>Unused</td>
<td></td>
<td></td>
<td>6.7</td>
<td>6.7</td>
<td>53</td>
</tr>
</tbody>
</table>
H.2 Example with Space Telescope Imaging Spectrograph

Target: NGC 2727
Declination: +15 degrees
Visibility: 52 minutes

Table H.2.1: Exposure Example with STIS

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Mode</th>
<th>Aperture</th>
<th>Element</th>
<th>Num Exp</th>
<th>Exp Time [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>STIS/CCD</td>
<td>ACQ</td>
<td>F28X50LP</td>
<td>MIRROR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STIS/CCD</td>
<td>ACQ/PEAK</td>
<td>52X0.1</td>
<td>MIRROR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STIS/CCD</td>
<td>ACCUM</td>
<td>F28X50OII</td>
<td>MIRROR</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>STIS/NUV</td>
<td>ACCUM</td>
<td>F25QTZ</td>
<td>MIRROR</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>STIS/NUV</td>
<td>ACCUM</td>
<td>52X0.1</td>
<td>G230L</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>STIS/FUV</td>
<td>ACCUM</td>
<td>52X0.1</td>
<td>G140L</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>STIS/FUV</td>
<td>ACCUM</td>
<td>52X0.1</td>
<td>G140M</td>
<td>2</td>
<td>19</td>
</tr>
</tbody>
</table>

Table H.2.2: Overheads for the STIS Example

<table>
<thead>
<tr>
<th>Overheads</th>
<th>Overhead Time [m]</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS ACQ</td>
<td>6</td>
<td>first orbit on new target</td>
</tr>
<tr>
<td>GS Re-ACQ</td>
<td>5</td>
<td>per orbit after first orbit</td>
</tr>
<tr>
<td>ACQ</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>ACQ/PEAK</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>CCD ACCUM</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>MAMA-spectro.</td>
<td>8</td>
<td>1m if no change from previous exposure</td>
</tr>
<tr>
<td>MAMA-imaging</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
### Table H.2.3: Time Estimator Example for STIS

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration [m]</th>
<th>Elapsed Time [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orbit 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS ACQ</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>ACQ</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>ACQ/PEAK</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>F28X500HII</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Overhead</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>F25QTZ</td>
<td>22</td>
<td>47</td>
</tr>
<tr>
<td>Overhead</td>
<td>5</td>
<td>52</td>
</tr>
<tr>
<td><strong>Orbit 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS Re-ACQ</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>G230L</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Overhead</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>G140L</td>
<td>17</td>
<td>44</td>
</tr>
<tr>
<td>Overhead</td>
<td>8</td>
<td>52</td>
</tr>
<tr>
<td><strong>Orbit 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS Re-ACQ</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>G140M</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Overhead</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>G140M</td>
<td>19</td>
<td>51</td>
</tr>
<tr>
<td>Overhead</td>
<td>1</td>
<td>52</td>
</tr>
</tbody>
</table>
H.3 Example with Wide Field Planetary Camera 2

Target: Q1623+268
Declination: +27 degrees
Visibility: 54 minutes

Table H.3.1: Exposure Example with WFPC2

<table>
<thead>
<tr>
<th>Mode</th>
<th>Aperture</th>
<th>Element</th>
<th>Num Exp</th>
<th>Exp Time [m]</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>image</td>
<td>WFALL</td>
<td>F814W</td>
<td>1</td>
<td>40</td>
<td>CR-SPLIT</td>
</tr>
<tr>
<td>image</td>
<td>WFALL</td>
<td>F450W</td>
<td>1</td>
<td>43</td>
<td>CR-SPLIT</td>
</tr>
<tr>
<td>image</td>
<td>WFALL</td>
<td>F555W</td>
<td>4</td>
<td>7</td>
<td>Box pattern dither</td>
</tr>
</tbody>
</table>

Table H.3.2: Overheads for the WFPC2 Example

<table>
<thead>
<tr>
<th>Overheads</th>
<th>Overhead Time [m]</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS ACQ</td>
<td>6</td>
<td>first orbit on new target</td>
</tr>
<tr>
<td>GS Re-ACQ</td>
<td>5</td>
<td>per orbit after first orbit</td>
</tr>
<tr>
<td>Exposure &lt;=600s</td>
<td>3</td>
<td>per exposure assuming default (no CR-SPLIT)</td>
</tr>
<tr>
<td>Exposure &gt;600s</td>
<td>5</td>
<td>per exposure assuming default CR-SPLIT</td>
</tr>
<tr>
<td>Target offsets</td>
<td>1</td>
<td>per small target offset inside FOV</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1</td>
<td>per orbit</td>
</tr>
</tbody>
</table>
Table H.3.3: Time Estimator Example for WFPC2

<table>
<thead>
<tr>
<th>Activity</th>
<th>Exposure Time [m]</th>
<th>Elapsed Time [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orbit 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS ACQ</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>F814W</td>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>Exp Overhead</td>
<td>5</td>
<td>51</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1</td>
<td>52</td>
</tr>
<tr>
<td>Unused</td>
<td>2</td>
<td>54</td>
</tr>
<tr>
<td><strong>Orbit 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS Re-ACQ</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>F450W</td>
<td>43</td>
<td>48</td>
</tr>
<tr>
<td>Exp Overhead</td>
<td>5</td>
<td>53</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1</td>
<td>54</td>
</tr>
<tr>
<td><strong>Orbit 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS Re-ACQ</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>F555W</td>
<td>4x7</td>
<td>33</td>
</tr>
<tr>
<td>Exp Overhead</td>
<td>4x3</td>
<td>45</td>
</tr>
<tr>
<td>Offset Overhead</td>
<td>3x1</td>
<td>48</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1</td>
<td>49</td>
</tr>
<tr>
<td>Unused</td>
<td>5</td>
<td>54</td>
</tr>
</tbody>
</table>
APPENDIX I: Education/Public Outreach Proposals

I.1. Scope of Program

The NASA Office of Space Science (OSS) has developed a comprehensive approach for making education at all levels (with a particular emphasis on pre-college education) and the enhancement of public understanding of space science integral parts of all of its missions and research programs. The two key documents that establish the basic policies and guide all OSS Education and Outreach activities are a strategic plan entitled Partners in Education: A Strategy for Integrating Education and Public Outreach Into NASA’s Space Science Programs (March 1995) and an implementation plan entitled Implementing the Office of Space Science (OSS) Education/Public Outreach Strategy (October 1996). Both may be obtained either from the World Wide Web selecting “Education and Public Outreach” from the menu on the OSS homepage at http://www.hq.nasa.gov/office/oss/ or from Dr. Jeffrey Rosendhal, Code S, Office of Space Science, NASA Headquarters, Washington, DC 20546-0001, USA.

Principal Investigators on any OSS NASA Research Announcement (NRA) are strongly encouraged to submit Education/Public Outreach (E/PO) proposals. Note that the E/PO proposals are solicited only in conjunction with a “parent” research proposal, and the proposed activities should have some degree of intellectual linkage with the objectives of that parent research proposal and/or the science expertise of its Principal Investigator (PI).

In line with these NASA OSS policies, STScI is announcing the opportunity for successful U.S. General Observers and Archival Researchers to submit E/PO proposals in conjunction with their accepted HST Cycle 9 proposals. Up to $10K per year may be proposed for an E/PO program, and the E/PO proposals will be funded using an amount not to exceed 2% of the currently available HST Cycle 9 GO/SNAP/AR budget. Awarded GO/SNAP/AR proposers from the same institution may collaborate to build a larger E/PO effort. The combined proposals must have a single Principal Investigator (PI) designed for the E/PO proposal with a demonstration of the role that PI will have in the E/PO effort. Any E/PO proposal which is a collaboration of GO/SNAP/AR proposals can link a maximum of five (5) awards at $10,000 each, for up to $50,000. Further requirement information for the E/PO Call for Proposals can be found on the Web site at URL: http://cycle-epo.stsci.edu

E/PO proposals will be due approximately six weeks after the notification to proposers, and will be evaluated (see criteria below) by appropriate scientific, education, and outreach personnel. The evaluation of E/PO proposals will be conducted in an independent review, and the results will be provided to the STScI Director for final selection.

In general, the broad evaluation criteria against which a proposed E/PO activity will be considered are:

• The quality, scope, and realism of the proposed E/PO program;
• The establishment of effective, long-duration partnerships with institutions and/or personnel in the fields of educational and/or public outreach as the basis for and an integral element of the proposed E/PO program;
• The linkage of the proposed E/PO task with HST science and NASA education programs and activities, and its compliance with NASA and OSS guidance;
• The potential of the proposed E/PO activity to have a “multiplier effect” (e.g., prospects for broad dissemination or replication of an E/PO product);
• For proposals dealing with formal education, the degree to which the proposed E/PO effort promotes nationally recognized and endorsed education reform efforts and/or reform efforts at the state or local levels;
• The adequacy of plans for evaluating the effectiveness and impact of the proposed education/outrach activity;
• The degree to which the proposed E/PO effort contributes to the training of, involvement in, and broad understanding of science and technology by underserved and/or underutilized groups;
• The prospects for building on, taking advantage of, and leveraging existing and/or ancillary resources beyond those directly requested in the proposal;
• The capability and commitment of the proposer to carry out the proposed E/PO program; and
• The adequacy and realism of the proposed budget (including any additional resources outside those requested from NASA).

Note that originality of the proposed effort is not a criterion. Rather, NASA OSS policy seeks assurance that the PI is committed to carrying out a meaningful, effective, credible, and appropriate E/PO activity.

◆ 1.2. Assistance for the Preparation of E/PO Proposals

To directly aid space science personnel in identifying and developing high quality E/PO opportunities, and establishing partnerships between the space science and E/PO communities, NASA OSS has established a national space science education/outreach infrastructure. The purpose of this infrastructure is to provide the coordination, background, linkages, and services needed for a vital national, coordinated, long-term E/PO program. Of particular interest to proposers to this Research Announcement are two elements of this system (which is described in more detail in the OSS education/outreach implementation plan referred to above).

Four OSS science theme oriented “E/PO Forums” have been established to help orchestrate and organize in a comprehensive way the education/outreach aspects of OSS space science missions and research programs and provide ready access to relevant E/PO programs and products to both the space science and education communities. See http://origins.stsci.edu/ for the Origins Education Forum information that serves as the host OSS Forum for the HST mission.

Five regional E/PO “Broker/Facilitators” have also been selected to search out and establish high leverage opportunities, arrange alliances between educators and OSS-supported scientists, and help scientists turn results from space science missions and programs into educationally-appropriate activities to be disseminated nationally and regionally.

Prospective proposers are strongly encouraged to make use of these infrastructure resources to help identify suitable E/PO opportunities and arrange appropriate alliances. Points of contact and addresses for all of these E/PO Forums and Broker/Facilitators may
be found by opening Education and Public Outreach from the menu of the OSS homepage at
http://www.hq.nasa.gov/office/oss/

◆ 1.3. Programmatic Information

The guidelines for the preparation and submission of the E/PO component of a research proposal submitted in response to this HST Cycle 9 Call for Proposals are listed below.

E/PO proposals are to be submitted electronically by uploading its text to the secure Web site at URL
http://cycle-epo.stsci.edu

This site will provide complete instructions for accomplishing this activity using a wide variety of formats. Proposers without access to the Web or who experience difficulty in using this site may contact the Space Telescope Science Institute by e-mail at hstcycle_epo@stsci.edu, or FAX at (410) 338 4579 for assistance. The submission deadline for E/PO proposals is Friday, January 28, 2000, 8:00 pm EST, that is, approximately six weeks after proposers are notified of the outcome of their GO/SNAP/AR proposals.

The E/PO proposal must contain the same title and PI list as the Phase I GO/SNAP/AR parent proposal.

The body of an E/PO proposal should be restricted to five printed pages at no less than 10 point type and include the following information: a brief abstract of the proposed program; an expanded description of the objectives and planned activities; a description of the intended involvement of the PI of the “parent” research proposal, as well as that of any additional personnel who are proposed to be responsible for the E/PO effort and/or the respective institutional responsibilities if a partnership is proposed; and a brief statement and explanation of the total requested E/PO budget.

A separate budget form is needed for E/PO proposals. For E/PO proposals associated with HST GO proposals, detailed budgets will be requested during the Phase II process for accepted proposals only.

Questions about an E/PO program associated with this Call for Proposals may be directed to:

Dr. Anne Kinney
Outreach Science Content Manager
Office of Public Outreach
Space Telescope Science Institute
3700 San Martin Drive
Baltimore, MD 21218
Telephone: (410) 338-4831
hstcycle_epo@stsci.edu.

Finally, attention is also called to the Initiative to Develop Education through Astronomy and Space Science (IDEAS) program administered by the Space Telescope Science Institute on behalf of OSS. This program, which currently selects proposals yearly, provides awards of up to $10K (with a few up to $40K) to enhance and encourage the participation of space scientists in E/PO activities. Annual solicitations for the IDEAS program are typ-
ically released in July with proposals due in October. The IDEAS program is open to any space scientist based in the U.S. regardless of whether or not they hold a research grant from NASA OSS. e-mail inquiries about IDEAS may be directed to: ideas@stsci.edu.

The current request for proposals is posted on the Web at http://ideas.stsci.edu

Inquiries also may be addressed to:
  IDEAS Program
  Office of Public Outreach
  Space Telescope Science Institute
  3700 San Martin Drive
  Baltimore, MD 21218
### APPENDIX J: Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AEC</td>
<td>Archived Exposures Catalog</td>
</tr>
<tr>
<td>AR</td>
<td>Archival Research</td>
</tr>
<tr>
<td>AURA</td>
<td>Association of Universities for Research in Astronomy, Inc.</td>
</tr>
<tr>
<td>CADC</td>
<td>Canadian Astronomy Data Centre</td>
</tr>
<tr>
<td>COSTAR</td>
<td>Corrective Optics Space Telescope Axial Replacement</td>
</tr>
<tr>
<td>CPAR</td>
<td>Coordinated Parallel Observation</td>
</tr>
<tr>
<td>CS</td>
<td>Contact Scientist</td>
</tr>
<tr>
<td>CVZ</td>
<td>Continuous Viewing Zone</td>
</tr>
<tr>
<td>CCD</td>
<td>Charge-Coupled Device</td>
</tr>
<tr>
<td>Co-I</td>
<td>Co-Investigator</td>
</tr>
<tr>
<td>DADS</td>
<td>Data Archive and Distribution System</td>
</tr>
<tr>
<td>DD</td>
<td>Director’s Discretionary</td>
</tr>
<tr>
<td>DUP</td>
<td>Duplicate Observation</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>E/PO</td>
<td>Education/Public Outreach</td>
</tr>
<tr>
<td>FGS</td>
<td>Fine Guidance Sensor</td>
</tr>
<tr>
<td>FITS</td>
<td>Flexible Image Transport System</td>
</tr>
<tr>
<td>FOC</td>
<td>Faint Object Camera</td>
</tr>
<tr>
<td>FOV</td>
<td>Field of View</td>
</tr>
<tr>
<td>FOS</td>
<td>Faint Object Spectrograph</td>
</tr>
<tr>
<td>ftp</td>
<td>File Transport Protocol</td>
</tr>
<tr>
<td>FUV</td>
<td>Far Ultraviolet</td>
</tr>
<tr>
<td>GHRS</td>
<td>Goddard High Resolution Spectrograph</td>
</tr>
<tr>
<td>GO</td>
<td>General Observer</td>
</tr>
<tr>
<td>GS</td>
<td>Guide Star</td>
</tr>
<tr>
<td>GSC</td>
<td>Guide Star Catalog</td>
</tr>
<tr>
<td>GSFC</td>
<td>Goddard Space Flight Center</td>
</tr>
</tbody>
</table>
### Instructions for Archival Research Proposals

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSSS</td>
<td>Guide Star Selection System</td>
</tr>
<tr>
<td>GTO</td>
<td>Guaranteed Time Observer</td>
</tr>
<tr>
<td>HSP</td>
<td>High Speed Photometer</td>
</tr>
<tr>
<td>HST</td>
<td><em>Hubble Space Telescope</em></td>
</tr>
<tr>
<td>IDC</td>
<td>Indirect Cost</td>
</tr>
<tr>
<td>IDEAS</td>
<td>Initiative to Develop Education through Astronomy and Space Science</td>
</tr>
<tr>
<td>IRAF</td>
<td>Image Reduction and Analysis Facility</td>
</tr>
<tr>
<td>LOW</td>
<td>Low-sky observations flag</td>
</tr>
<tr>
<td>LRF</td>
<td>Linear Ramp Filters</td>
</tr>
<tr>
<td>MAMA</td>
<td>Multi-Anode, Microchannel Array</td>
</tr>
<tr>
<td>MT</td>
<td>Moving Target</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NED</td>
<td>NASA/IPAC Extragalactic Database</td>
</tr>
<tr>
<td>NICMOS</td>
<td>Near Infrared Camera and Multi-Object Spectrometer</td>
</tr>
<tr>
<td>NOAO</td>
<td>National Optical Astronomy Observatories</td>
</tr>
<tr>
<td>NUV</td>
<td>Near Ultraviolet</td>
</tr>
<tr>
<td>OPUS</td>
<td>Observation Support/Post-Observation Data Processing Unified System</td>
</tr>
<tr>
<td>OS</td>
<td>Observation Summary</td>
</tr>
<tr>
<td>OTA</td>
<td>Optical Telescope Assembly</td>
</tr>
<tr>
<td>PC</td>
<td>Program Coordinator</td>
</tr>
<tr>
<td>PCS</td>
<td>Pointing Control System</td>
</tr>
<tr>
<td>PI</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>PPAR</td>
<td>Pure Parallel Observation</td>
</tr>
<tr>
<td>PRESTO</td>
<td>Project to Re-Engineer Space Telescope Observing</td>
</tr>
<tr>
<td>PSF</td>
<td>Point-Spread Function</td>
</tr>
<tr>
<td>RPS2</td>
<td>Remote Proposal Submission Software (2nd generation)</td>
</tr>
<tr>
<td>SAA</td>
<td>South Atlantic Anomaly</td>
</tr>
<tr>
<td>SHD</td>
<td>Shadow Time</td>
</tr>
<tr>
<td>SI</td>
<td>Scientific Instrument</td>
</tr>
<tr>
<td>SIMBAD</td>
<td>Set of Identifications, Measurements, and Bibliography for Astronomical Data</td>
</tr>
<tr>
<td>SM2</td>
<td>Second <em>HST</em> Servicing Mission, carried out in February 1997</td>
</tr>
</tbody>
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# Instructions for Archival Research Proposals

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>SM3(a and b)</td>
<td>Third <em>HST</em> Servicing Missions</td>
</tr>
<tr>
<td>SPSO</td>
<td>Science Program Selection Office</td>
</tr>
<tr>
<td>SSM</td>
<td>Support Systems Module</td>
</tr>
<tr>
<td>ST-ECF</td>
<td>European Coordinating Facility for Space Telescope</td>
</tr>
<tr>
<td>STAC</td>
<td>Space Telescope Advisory Committee</td>
</tr>
<tr>
<td>STOCC</td>
<td>Space Telescope Operations Control Center</td>
</tr>
<tr>
<td>STIS</td>
<td>Space Telescope Imaging Spectrograph</td>
</tr>
<tr>
<td>STScI</td>
<td>Space Telescope Science Institute</td>
</tr>
<tr>
<td>STSDAS</td>
<td>Space Telescope Science Data Analysis Software</td>
</tr>
<tr>
<td>TAC</td>
<td>Telescope Allocation Committee</td>
</tr>
<tr>
<td>TDRSS</td>
<td>Tracking and Data Relay Satellite System</td>
</tr>
<tr>
<td>TOO</td>
<td>Target-of-Opportunity</td>
</tr>
<tr>
<td>URL</td>
<td>Universal Resource Locator</td>
</tr>
<tr>
<td>WFC</td>
<td>Wide Field Camera</td>
</tr>
<tr>
<td>WF/PC</td>
<td>Wide Field Planetary Camera 1</td>
</tr>
<tr>
<td>WFPC2</td>
<td>Wide Field Planetary Camera 2</td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web</td>
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