

# WFPC2 Cycle 10 Calibration Plan

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## ABSTRACT

*This report presents the details of the WFPC2 programs planned to maintain and improve the instrument calibration during Cycle 10. The standard suite of calibrations will be continued, including those used to monitor the health of the instrument as well as the programs to collect data for calibration reference files. In addition, several new proposals will be implemented: a measurement of the effect of CTE on astrometry, a characterization of the PSF wings, a calibration check of the clocks ON mode, and a test of the methane quad filter throughput. The total spacecraft time required for the Cycle 10 plan is 61 external orbits and 2294 occultation periods. This estimate does not include any calibrations associated with the next servicing mission (SM 3b), currently scheduled for Nov 2001; those plans will be presented separately.*

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## 1. Introduction

As in previous cycles, the Cycle 10 calibration program is aimed at maintaining the calibration of WFPC2 via the internal and external monitoring programs as well as performing several new tests. A short overview is provided in Table 1; the entire program is estimated to require 61 external orbits (including several extra orbits to allow for smooth transitions between Cycles, and a ~10% reserve for unanticipated items) and 2294 internal or occultation periods. In past cycles, very little if any, of the reserve has been needed.

### *Monitors*

The decontaminations (decons) will continue to be performed on a monthly basis, to remove the UV contaminants and anneal hot pixels. Internal and external observations are taken before and after the decons, to verify the procedure's success and assess the UV throughput status; also included are 1-2 observations every decon, taken to monitor focus (PC, F555W). In addition to the decon, the health and performance of the cameras will be tracked via weekly internal exposures (biases, darks, flats, kspots) and Earth flats; these

images will also be used to generate the necessary pipeline reference files. As in cycle 9, additional intflats will be taken as part of the internal monitor, to continue accumulating archival images which can be used to generate a preflash calibration. The standard visflat sweep will be expanded to include a check for slight filter rotational offsets such as the one found in FR533N (ISR 01-04, Gonzaga et al.).

**Table 1: Summary of WFPC2 Orbits Required for Cycle 10 Calibrations**

| proposal type           | external orbits | internal (occultations) |
|-------------------------|-----------------|-------------------------|
| monitors                | 23              | 2242                    |
| special (continuations) | 12              | 2                       |
| special (new)           | 20              | 50                      |
| reserve                 | 6               | --                      |
| total                   | 61              | 2294                    |

*Continuations of Special Programs*

The CTE and astrometric monitors, as well as the photometric characterization, will be continued through Cycle 10. The CTE monitor, as before, will entail observations of  $\omega$  Cen at 6 month intervals, to allow tracking of changes in CTE losses. Imaging is done in F814W and F555W, at a variety of preflash levels (20 to 1000  $e^-$ ). An extension of 8813, the astrometric monitor will also be repeated, in order to continue measuring any shifts in the relative positions of the chips or changes in the astrometric solution at the sub-pixel level. Past data have shown that shifts of up to 1 pixel may have occurred since mid-1994 (Casertano et al., in prep). Finally, the photometric check will be done once during Cycle 10, to verify the zeropoints and contamination rates in filters that are not routinely monitored or observed as part of the UV throughput check. Last cycle, observations were limited to PC1 and WF3; this cycle, all four chips will be checked.

*New Special Programs*

Four new programs are planned for Cycle 10: a test of the astrometric effects of CTE, a characterization of the PSF wings (“super-PSF”), a check of the clocks ON mode, and a verification of the methane quad filter.

While the photometric effects of CTE have been well studied, and correction algorithms have been developed, very little is known quantitatively about the astrometric effects of CTE. Riess (2000; ISR 00-04) has shown that extended sources suffer some degree of distortion due to CTE, indicating that the astrometry of sources must also be affected. For example, it is quite possible that the relative separation of a faint source from a bright source will depend on all the factors that influence CTE -- namely position

on the detector, observing epoch, brightness in electrons, and image background. This proposal attempts to quantify these effects by measuring (1) the relative separation of a bright source vs. a faint target at different positions on the PC1 CCD, and (2) the relative motion of a source on the CCD compared to very precise slews performed with the FGSs.

The aim of the “super-PSF” proposal will be to provide deep images of the WFPC2 PSF in several broadband filters, in order to investigate the 2-dimensional structure in the PSF wings and characterize the change in structure with varying focus and with target color. Within a radius of  $\sim 2''$ , the TinyTim software package provides an excellent model of the HST point spread function, giving users the ability to match object color, telescope focus, and chip position for a range of filters. Beyond this radius, however, the models are inadequate, largely due to scattering by the WFPC2 detector and the majority of the empirical PSFs currently in the online library are not deep enough to provide good signal-to-noise in the PSF wings. The proposed “super-PSF” program will obtain highly saturated images of a standard star. The resulting deep observations of the PSF wings will be blended together with PSF cores from TinyTim models, using software currently under development at STScI. Additional new tasks under development will perform 2-dimensional fitting and subtraction of the blended PSF from science images.

Finally, two short 1-orbit programs are planned. The first will provide a verification of the clocks ON mode and is expected to serve as the closure calibration for this mode. A serials clocks ON photometric check was initially performed in Dec. 1994 and a subset of filters were rechecked in Nov. 2000. The Cycle 10 external orbit will be used to observe a standard star in as many of the most frequently used filters and apertures not covered by prior observations. The requested occultation periods will be used to obtain sufficient clocks ON darks to allow for the generation of a superdark. The second short program will provide a check of the methane filter. The extended wings of the filter transmission curve appear to vary across the field of view (Karkoshka, priv. comm.), which can have a major effect on the planetary observations of methane bands. The observations proposed will allow the magnitude and direction of the effect to be quantified.

As always, observers are welcome to suggest new calibrations or comment on the plans presented (email [help@stsci.edu](mailto:help@stsci.edu)). Calibration Outsourcing proposals may also be submitted as part of the Cycle 11 GO program; the Cycle 10 call for outsourcing proposals is online at [http://www.stsci.edu/instruments/wfpc2/wfpc2\\_out.html](http://www.stsci.edu/instruments/wfpc2/wfpc2_out.html)

## **2. Format**

Table 1 summarizes the Cycle 10 calibration programs for WFPC2; the remainder of this report contains details for each proposal. The proposal pages are intentionally in landscape format, to facilitate reporting of the results at the end of Cycle 10. Phase II versions of the proposals can be viewed at <http://www.stsci.edu/public/propinfo.html>.

# WFPC2 Cycle 10 Calibration Plan

| ID  | Proposal Title                         | Frequency    | Estimated Time (orbits)                   |             | Scheduling Required | Products                        | Accuracy Required      | Notes  |
|---|--|--------------|---|-------------|---------------------|---------------------------------|------------------------|--|
|   |  |              | “External”                                | “Internal”  |                     |                                 |                        |  |
| <b>Routine Monitoring Programs</b>                  |  |              |   |             |                     |                                 |                        |  |
| 8932-8934   | WFPC2 Decons & Associated Observations | 1-2/4 wks    | 19 photmon<br>2 UV thru.put<br>2 UV flats | 82          | every 28 d          | CDBS, IHB, Synphot, WWW reports | 1-2%                   | Decons, phot. & focus monitor, internals, UV throughput, visflats and uvflats.     |
| 8935  | Standard Darks                         | weekly       |   | 318         | every 7 d           | CDBS                            | 1 e <sup>-</sup> /hr   | Also for WWW hot pixel lists.  |
| 8936-8938   | Supplemental Darks                     | 0-3/day      |   | 1095        | every day           |                                 | n/a                    | For archive only, no analysis.   |
| 8939  | Internal Monitor                       | weekly       |   | 76          | every 7 d           | CDBS                            | 0.8e <sup>-</sup> /pix | Incl. intflats for preflash.   |
| 8940  | Earth Flats                            | continuous   |   | 210         | mid to late         | CDBS                            | 0.3%                   |  |
| 8941  | UV Earth Flats                         | continuous   |   | 400         | early to mid        | CDBS                            | 3-10%                  | Outsourcing candidate.   |
| 8942  | Intflat & Visflat Sweeps               | 1/cycle      |   | 61          | mid-cycle           | TIR                             | 0.3%                   | Incl. filter rotation offset check.  |
| <b>Special Calibration Programs - Continuations</b> |  |              |   |             |                     |                                 |                        |  |
| 9253  | Astrometric Monitor                    | 2/cycle      | 2   | 2           | early & late        | ISR, STSDAS                     | 0.05”                  | ω Cen as well as K-spots.  |
| 9254  | CTE Photometric Monitor                | 2 x 3 orbits | 6   |             | mid & late          | ISR                             | 0.01 mag               | Continuation of monitors.  |
| 9251  | Photometric Characterization           | 1            | 4   |             | mid-cycle           | ISR, Synphot                    | 2-3%                   | All four chips.  |
| <b>Special Calibration Programs - New</b>           |  |              |   |             |                     |                                 |                        |  |
| 9255  | Astrometric Effects of CTE             | 1            | 12  |             | late                | ISR                             | 1-2 mas                | Target kept on 1 chip.   |
| 9257  | Super-PSF                              | 1            | 6   |             | mid-cycle           | CDBS, STSDAS, ISR               | 10%                    | PSF wing characterization.   |
| 9252  | Clocks ON Verification                 | 1            | 1   | 50          | early               | ISR, Synphot                    | 2-3%                   | Closure calibration.   |
| 9256  | Methane Quad Filter Check              | 1            | 1   |             | mid-cycle           | Synphot, ISR                    | 5%                     | Test of transmission curve across aperture (GO suggestion). Outsourcing candidate. |
|   | ~10% reserve                           |              | 6   |             |                     |                                 |                        | Placeholder for unexpected items.  |
| <b>TOTAL TIME (including all executions)</b>        |  |              | <b>61</b>                                 | <b>2294</b> |                     |                                 |                        |  |

# Proposal ID : WFPC2 Cycle 8932-8934: WFPC2 Decontaminations and Associated Observations

## Plan

**Purpose** Monthly WFPC2 decons. Other programs tied to decons are also included: photometric stability check, focus monitor, pre- and post-decon internals, UV throughput checks, visflat sweep, and internal UV flat check.

**Description** *Decontamination:* UV-blocking contaminants removed and hot pixels annealed by warming the CCDs to +20C for 6 hours.  
*Internals:* intflats, biases, darks & kspots, before/after decons.  
*Photometric Monitor:* GRW+70d5824 is observed after each decon and before every other decon: (1) F170W in all chips to monitor for UV contamination. (2) As many as possible of F160BW, F218W, F255W, F336W, F439W, F555W, F814W will be observed in a different chip each month.  
*Focus Monitor:* two PC, F555W observations of GRW+70d5824 will be taken during every photometric monitoring orbit (one at orbit start, one near orbit end).  
*UV Throughput:* PC & WF3 UV observations in most UV filters, popular UV filters in all chips, to verify that the UV spectral response curve is unchanged. In addition, two PC, F555W observations will be included as an extra focus monitor.  
*Internal UV flatfields:* obtained with the CAL channel's UV lamp using the filters F122M, F170W, F160BW, F185W, & F336W. The uvflats are used to monitor UV flatfield stability and the stability of the F160BW filter by using F170W as the control. The F336W ratio of visflat to uvflat provides a diagnostic of the UV flatfield degradation & ties the uvflat and visflat flatfield patterns. Two supplemental dark frames must be obtained immediately after each use of the lamp to check for possible after-images.

**Fraction** 100%  
**GO/GTO**  
**Programs**  
**Supported**

## Plan

- Resources** Total of 23 external and 82 internal orbits. Request covers 12
- Required:** decons, through Aug 2002. External orbits needed:
- Observation** 19 orbits for photometric monitoring,  
2 orbits for UV throughput,  
2 orbits for UV flats monitor (non-pointed, but displaces WFPC2 science because of timing requirements) plus occultation periods before and after each orbit,  
2 internal orbits for visflat sweep and  
80 internal orbits for intflat monitoring.
- Products** SYNPHOT, CDBS, Instr. Handbook, TIPS meetings, WWW reports, TIR, ISR; new UV flatfields if changes are detected.
- Accuracy** *Photometry*: less than 2% discrepancy between results, 1% rms expected. *Focus measurement*: 1.5 micron accuracy with a goal of 1 mic. *UV throughput*: better than 3%. *Flatfield*: temporal variations monitored at 1% level. *Gain ratios*: stable to better than 0.1%. *UV flats*: About 2-8% pixel-to-pixel expected (filter dependent). *Visflats*: stable to better than 1% in overall level and spatial variations (after correcting for lamp degradation). Contamination effects should be < 1%.
- Goals**
- Scheduling & Special Requirements** Upon request, all timing requirements hardcoded via special requirements. Cycle 10 proposal to begin after Cycle 9 program (8825) ends in Sep.
- Decons*: every 4 weeks. *Photometry*: Observations are tied to within +/- 1 week of decons. *Darks*: around decon, these are taken NON-INT to prevent residual image problems.
- Visflat* sweep must be done with minimum number of lamp cycles to prevent further degradation of the lamp.
- UV flats*: To prevent excessive degradation of the UV lamp while minimizing polymerization of contaminants, the SU duration for each uvflat visit should be kept the same as that in cycle 8 (prop. 8449). Due to timing requirements, each visit covers a 2-hour time span--one visibility period and two occultation periods; other instruments can be used during this period.

## Proposal ID 8935: WFPC2 Cycle 10 Standard Darks

### Plan

**Purpose** Measure dark current & identify of hot pixels.

**Description** Six 1800s exp/week with the shutter closed, five with clocks off, one with clocks on. This frequency is required due to the high formation rate of new hot pixels (several tens/CCD/day). Five darks per week are required for cosmic ray rejection, counterbalancing losses due to residual images, & improving the noise of individual measurements. Sometimes, no usable darks are available for a given week due to residual images, resulting in a longer-than-usual gap in the hot pixel lists, but in a decon week, information on hot pixels that became hot and then annealed would be lost irretrievably. As a result, pre-decon darks (see Decon proposal) are executed NON-INT and at least 30 min after any WFPC2 activity.

**Fraction** 90%

**GO/GTO**

**Programs  
Supported**

**Resources** 318 internal orbits (occultation periods).

**Required:  
Observation**

**Products** Weekly darks delivered to CDBS and monthly tables of hot pixels on the WWW. Superdarks for use in generating pipeline dark reference files.

**Accuracy  
Goals** Require  $\sim 1 \text{ e}^-/\text{hr}$  (single-pixel rms) accuracy for most science applications. Expected accuracy in a typical superdark is  $0.05 \text{ e}^-/\text{hour}$  for normal pixels. The need for regular darks is driven by systematic effects, such as dark glow (a spatially and temporally variable component of dark signal) and hot pixels, which cause errors that may exceed these limits significantly.

**Scheduling &  
Special  
Requirements** These darks are *not* run during decon weeks; decon week darks are in decon proposal. As requested, timing requirements have been hardcoded via special requirements.

## Proposal ID 8936 -8938: WFPC2 Cycle 10 Supplemental Darks

### Plan

**Purpose** Images will allow for frequent monitoring of hot pixels.

**Description** This program is designed to provide up to three short (1000s) darks per day, to be used primarily for the identification of hot pixels. Shorter darks are used so that the observations can fit into almost any occultation period, making automatic scheduling feasible. These supplemental darks are low priority, and should be taken only when there is no other requirement for that specific occultation period. This program complements the higher priority Standard Darks proposal that has longer individual observations for producing high-quality pipeline darks and superdarks. Hot pixels are often a cause of concern for relatively short science programs, since they can mimic stars or mask key features of the observations: about 400 new hot pixels/CCD are formed between executions of the Standard Darks program. The supplemental darks are available to the GO community from the archive; there is no plan to use them in our standard analysis and products.

**Fraction** 30%

**GO/GTO**

**Programs**

**Supported**

**Resources** Total of 1095 internal orbits (occultation periods), which allows

**Required:** for a maximum of 3 darks per day.

**Observation**

**Products** None, though some daily darks may occasionally be used for hot pixel lists if standard darks were lost.

**Accuracy** For archive only, no STScI analysis provided.

**Goals**

**Scheduling& Special Requirements** Scheduled at low priority, non-interference basis, maximum of 3/day. Will require multiple proposal IDs due to large number of visits (1 dark/visit to maximize scheduling flexibility).

## Proposal ID 8939: WFPC2 Cycle 10 Internal Monitor

### Plan

- Purpose** Verify the short-term instrument stability at both gain settings and provide intflats for calibrating preflashed observations.
- Description** Each set of internal observations consists of 8 biases (4 at each gain) and 4 intflats (2 at each gain). The entire set should be run once per week, except for decon weeks, on a non-interference basis. During the decon week, intflats in F502N will be taken, with each shutter blade and at a variety of exposure times to test for linearity. The F502N filter is likely to be the recommended filter for preflashing observations.
- Fraction** 100%
- GO/GTO**
- Programs Supported**
- Resources** 76 internal orbits (occultation periods); 46 will be needed for the usual monitor while 30 will be required for the new F502N
- Required:** intflat monitoring.
- Observation**
- Products** Superbiases delivered annually to CDBS; TIPS reports on possible buildup of contaminants on the CCD windows (worms) as well as gain ratio stability, based on intflats. A Technical Instrument Report will be issued if significant changes occur. Preflash correction images may be generated.
- Accuracy** Approximately 120 bias frames are used for each superbias
- Goals** pipeline reference file, generated once a year; accuracy is required to be better than 1.5 e-/pixel, and is expected to be 0.8 e-/pixel.
- Scheduling & Special Requirements** Regular internals to be scheduled on non-decon weeks, F502N intflats during decon weeks though they are not linked to the decon itself. As requested, timing requirements have been hard-coded via special requirements.

## Proposal ID 8940: WFPC2 Cycle 10 Earth Flats

### Plan

**Purpose** Monitor flatfield stability. This proposal obtains sequences of Earth streak flats to construct high quality flat fields for the WFPC2 filter set. These flat fields will allow mapping of the OTA illumination pattern and will be used in conjunction with previous internal and external flats to generate new pipeline superflats. These Earth flats will complement the Earth flat data obtained during SMOV and Cycles 4-9.

**Description** Observations of the bright Earth (Earthcals) are obtained in a variety of filters. Approximately 200 exposures in each of four narrowband filters (F375N, F502N, F656N, F953N) are required, as well as about 50 exposures in other filters (F160BW, F336W, F343N, F390N, F437N, F469N, F487N, F631N, F658N, F673N -- the F160BW filter is included to provide pinhole information).

**Fraction** 100%

**GO/GTO**

**Programs**

**Supported**

**Resources** 210 internal orbits (occultation periods).

**Required:**

**Observation**

**Products** New flatfields generated and delivered to CDBS if changes detected.

**Accuracy** The single-pixel signal-to-noise ratio expected in the flatfield is

**Goals** 0.3%.

**Scheduling&** None.

**Special**

**Requirements**

## Proposal ID 8941: WFPC2 Cycle 10 UV Earth Flats

### Plan

**Purpose** Monitor flatfield stability. This proposal obtains sequences of Earth streak flats to improve the quality of pipeline flat fields for the WFPC2 UV filter set. These Earth flats will complement the UV Earth flat data obtained during Cycles 8-9.

**Description** Earth streak-flats are taken in UV filters (F170W, F185W, F218W, F255W, F300W, F336W, and F343N). Those UV filters with significant redleak will also be observed crossed with selected broadband filters (F450W, F606W, F675W, and F814W), in order to assess and remove the redleak contribution. Earth flats required: 100 for each of the 7 UV filters plus 20 with each of the crossed filter sets (16 combinations). The entire proposal should be done within 7 months, with the observations evenly distributed over that period of time. The observations are divided into 10 batches, with each batch done 21 days apart.

**Fraction** ~10%

**GO/GTO**

**Programs**

**Supported**

**Resources** 400 occultation periods.

**Required:**

**Observation**

**Products** Updated flatfields for pipeline via CDBS.

**Accuracy** 3-10%. Outsourcing candidate.

**Goals**

**Scheduling&** None.

**Special**

**Requirements**

## Proposal ID 8942: WFPC2 Cycle 10 Intflat Sweeps and Linearity Test

### Plan

**Purpose** Using intflat observations, this WFPC2 proposal is designed to monitor the pixel-to-pixel flatfield response and provide a linearity check. The intflat sequences, to be done once during the year, are similar to those from the Cycle 9 program 8817. The images will provide a backup database in the event of complete failure of the visflat lamp as well as allow monitoring of the gain ratios. The sweep is a complete set of internal flats, cycling through both shutter blades and both gains. The linearity test consists of a series of intflats in F555W, in each gain and each shutter. New this cycle will be extra visflat exposures to test the repeatability of filter wheel motions.

**Description** *Intflat sweep* -- flatfields are obtained with a variety of filters (F336W, F439W, F547M, F555W, F569W, F606W, F622W, F631N, F502N, F656N, F675W, F673N, F702W, F785LP, F814W, F1042M) using shutters A and B, and gains 7 and 15; the BLADE optional parameter is used throughout. A smaller set is obtained only at gain 7 using any shutter blade (F160BW, F300W, F380W, F390N, F410M, F437N, F450W, F469N, F487N, F467M, F588N, F658N, F791W, F850LP, F953N).

*Linearity test* -- flatfields are taken with F555W at a variety of exposure times, using shutters A & B, and gains 7 & 15. In addition, a set is done with clocks ON (only gain 7, shutter B; gain 7 shutter A set was taken during Cycle 9). Since the intflats have significant spatial structure, any non-linearity will appear as a non-uniform ratio of intflats with different exposure times.

*Filter rotation check* -- 10 visits of visflats will be taken to test the repeatability of the filter wheel positioning. A problem is known to exist in FR533N; other filters will be used, to determine whether the problem is limited to the one filter or is present in other filters/wheels.

**Fraction** 100%  
**GO/GTO**  
**Programs**  
**Supported**

## Plan

- Resources** 61 internal orbits (occultation periods) - 21 for the regularly  
**Required:** intflats and estimated 40 for the 10 visflat visits (135 min each).
- Observation**
- Products** TIPS. TIR/ISR if any significant variations are observed or if any new filter problems are noted.
- Accuracy** *Intflats:* Stable to better than 1%. (intflats will provide a baseline comparison of intflat vs visflat (taken in decon proposal) if the CAL channel system fails.)
- Goals**
- Scheduling& Special Requirements** Intflat sweeps should be scheduled within a 2-week period. To minimize filter wheel motions, each filter will be cycled through the two shutters and two gains. Each visit will contain just a few filters, in order to allow flexibility in scheduling, however, the sweep intflats should be done over as short a time period as possible (2 weeks) and in the same month as the visflats. Visflats, as well as the small monthly intflat sets (5 broadband filters), which must be tied to a decon, will be included in the Cycle 10 decon proposals. Upon request, to facilitate implementation and scheduling, these timing requirements are hardcoded via special requirements.

## Proposal ID 9253: WFPC2 Cycle 10 Astrometric Monitor

### Plan

**Purpose** Verify relative positions of WFPC2 chips with respect to one another.

**Description** The positions of the WFPC2 chips with respect to each other appear to be shifting slowly (by about 1 pixel, since 1994). The rich field in  $\omega$  Cen (same positions as cycle 9 proposal 8813) is observed with large shifts (35'') in F555W only, every ~six months. This will allow tracking of the shifts in the relative positions of the chips or changes in the astrometric solution at the sub-pixel level. Kelsall spot images will be taken in conjunction with each execution.

**Fraction** <20%.

**GO/GTO**

**Programs**

**Supported**

**Resources** 2 pointed orbits and 2 occultation periods need for this pro-

**Required:** gram, each separated by 6 months.

**Observation**

**Products** TIPS reports, ISR, update of chip positions in PDB and of geometric solution in STSDAS tasks metric and wmosaic if significant changes are found.

**Accuracy** At least 0.01'' in relative shifts; 0.05'' or better for absolute.

**Goals**

**Scheduling&**

**Special**

**Requirements**

## Proposal ID 9254: WFPC2 Cycle 10 CTE Photometric Monitor

### Plan

**Purpose** Monitor CTE changes during Cycle 10.

**Description** Obtain observations of  $\omega$  Cen (NGC 5139) to continue tracking changes in the CTE (charge transfer efficiency) losses in WFPC2. A continuation of proposals in earlier cycles (7629, 8447, and 8821), the principal observations will be at gain 7, in F814W and F555W, taken with and without a variety of preflash (background) levels (20 to 1000  $e^-$ ). The same pointing is used at WF2 and WF4; along with the relative orientation of the chips, this results in stars at the bottom of one chip falling near the top of the other chip.

**Fraction** 30 - 50%

**GO/GTO**

**Programs**

**Supported**

**Resources** 6 orbits (3 orbits spaced 6 months apart).

**Required:**

**Observation**

**Products** ISR and updates to published CTE correction formulae.

**Accuracy** 0.01 magnitudes.

**Goals**

**Scheduling&** For each monitoring visit, observations will be done in single

**Special** guide star mode.

**Requirements**

## Proposal ID 9251: WFPC2 Cycle 10 Photometric Characterization

### Plan

**Purpose** Provide a check of the zeropoints and contamination rates in non-standard WFPC2 filters.

**Description** Observations of the standard star GRW+70D5824 in all four chipes will be made using filters that are not routinely monitored (F380W, F410M, F450W, F467M, F547M, F569W, F606W, F622W, F702W, F785LP, F791W, F850LP, and F1042M). Images should be taken within 7 days after a decon, to minimize any contamination effects. Results from this program will be compared with archival data from earlier cycles.

**Fraction** 100%

**GO/GTO**

**Programs**

**Supported**

**Resources** 4 orbits.

**Required:**

**Observation**

**Products** ISR, SYNPHOT update if necessary.

**Accuracy** 2-3% photometry.

**Goals**

**Scheduling& Special Requirements** Execute within 7 days of decon. Upon request, to facilitate implementation and scheduling, these timing requirements are hardcoded via special requirements.

# Proposal ID 9255: WFPC2 Cycle 10 Astrometric Effects of CTE

## Plan

**Purpose** This proposal attempts to quantify the astrometric effects of CTE by measuring (1) the relative separation of a bright source vs. a faint target at different positions on the PC1 CCD, and (2) the relative motion of a source on the CCD compared to very precise slews performed with the FGSs. These tests will be conducted for point and extended targets at several different intensity levels.

**Description** While the photometric effects of CTE have been well studied, and correction algorithms have been developed, very little is known about the astrometric effects of CTE. Riess (2000; WFPC2 ISR 00-04) has shown that extended sources suffer some degree of distortion due to CTE, indicating that the astrometry of sources must also be affected. E.g., the relative separation of a faint source from a bright source may depend on all the factors that influence CTE (position on detector, observing epoch, brightness in electrons, and image background).

Targets will be observed in PC, 2x2 grid, 20" on a side, in the first orbit; the second orbit is a repeat with a small pointing offset (dither of  $N+1/2$  PC pixels). The 2-orbit sequence will be done at different background light levels, using exposures from 100s in F450W to 1200s in F622W, repeated three times for two targets (total ~12 orbits).

Targets will be the dense star field in  $\omega$  Cen, and a field of faint galaxies (from extended target CTE proposal 8456). Both fields in both targets will be chosen to have a bright star surrounded by fainter objects. While most of the test is performed on the PC, the WFC CCDs will also be important, as they can provide a sanity check on the motions made with the FGSs. The motions on the WFC CCDs will be a smaller number of pixels, and hence less subject to CTE variations. (Though the larger WFC pixels will make astrometry more difficult). Hence some care should be taken to have stars available on the WFC CCDs, though PC1 is the detector of primary interest.

## Plan

**Fraction** 10-20%.  
**GO/GTO**  
**Programs**  
**Supported**

**Resources** 12 orbits.  
**Required:**  
**Observation**

**Products** ISR.

**Accuracy** The relative separations of the faint targets from the bright star will be measured with millarcsecond accuracy as a function of target position on the CCD and background level. The measured sizes of the large slews (~20") will also be compared to the sizes of commanded slews as a function of background intensity. It will be necessary to correct for image scale effects (i.e. geometric distortion) with care to insure that optical and CTE effects do not become confused.

**Goals**

**Scheduling &**  
**Special**  
**Requirements**

## Proposal ID 9257: WFPC2 Cycle 10 Super-PSF

### Plan

**Purpose** Obtain deep images of the WFPC2 PSF in several broadband filters in order to investigate the 2-dimensional structure in the PSF wings and characterize the change in structure with varying focus and target color.

**Description** This program will provide deep observations of the PSF wings by obtaining highly saturated images which are stepped in exposure time, allowing the creation of a "Super-PSF". STScI is currently developing software that will be able to accurately blend these larger-scale empirical PSF wings together with model PSF cores from TinyTim. The new software will then perform 2-dimensional fitting and subtraction of the blended PSF from science images. The deep images proposed here are crucial for the new software to be effective: the majority of PSFs in the library have poor S/N in the wings and the TinyTim models, while excellent for PSF cores, are inadequate beyond  $\sim 2''$ , primarily due to scattering by the WFPC2 detectors.

Since the shape and width of the PSF varies over time due to the change in telescope focus, the observations are split into 3 visits, 2 orbits each. The majority of archival programs which would benefit from these observations have placed the target on the PC chip, therefore, the PC1-FIX aperture will be used. Targets will be an A0V and a G0V star (TBD), to allow characterization of the color dependence of the PSF. Each star will be observed for an entire orbit, cycling through several broadband filters (F450W, F606W, F702W and F814W), 2 images per filter, at low and high saturation levels.

**Fraction** ~10%.

**GO/GTO  
Programs  
Supported**

**Resources** 6 orbits.

**Required:  
Observation**

## **Plan**

**Products** Accurate empirical PSFs to be derived for PSF fitting photometry, intended for use with STSDAS software currently under development. Observed PSFs and blended PSFs to be archived in on-line PSF library in CDBS. ISR.

**Accuracy** Enable PSF subtraction with ~10% residuals at ~2".

**Goals**

**Scheduling &  
Special  
Requirements**

## Proposal ID 9252: WFPC2 Cycle 10 Clocks ON Verification

### Plan

**Purpose** Closure calibration for clocks ON mode.

**Description** This proposal will provide a check of the existing photometric and dark calibration for the clocks ON mode. An initial analysis was performed on photometric data taken Dec 1994; additional standard star observations using a small number of filters were taken and checked in Nov 2000. The Cycle 10 external orbit will be used to observe a standard star in as many of the most frequently used filters and apertures not covered by prior observations. The results will be compared with clocks OFF data, in order to determine whether any significant differences exist between the two modes (none are expected). The new images will serve as a final verification of the calibration of this mode.

The requested occultation periods will be used to obtain sufficient clocks ON darks over a time span of a few months to allow for generation of a clocks ON superdark.

**Fraction** ~8%.

**GO/GTO**

**Programs**

**Supported**

**Resources** 1 external orbit; 50 occultation periods for darks.

**Required:**

**Observation**

**Products** SYNPHOT update; new clocks ON superdark and reference files, if necessary. ISR.

**Accuracy** Photometric accuracy 2-3%. Expected accuracy in resulting superdark ~0.08 e-/hour for normal pixels.

**Goals**

**Scheduling& Special Requirements** These darks can be executed as time permits, over a period of several months. To minimize impact to scheduling, they will be requested for early in the cycle, before the visible Earth flats begin.

# Proposal ID 9256: WFPC2 Cycle 10 Methane Quad Filter Check

## Plan

**Purpose** Verify FQCH4N-D methane filter characteristics.

**Description** Based on results from Jupiter and Uranus archival WFPC2 data, the extended wings of the methane filter transmission curve appear to vary across the field of view (Karkoshka, priv. comm.). While this is unimportant for objects with flat spectra, it can have a major impact on photometry of objects with methane bands, where a significant fraction of photons comes from the wings. To provide data to check the methane filter, a set of eight 40-sec Saturn images will be taken in a 3x3 grid around the FQCH4W3 methane quad filter aperture (one of the 9 positions falls outside of the filter). The magnitude and direction of the effect will be quantified by comparing results from the rings of Saturn (flat spectrum) to results from Saturn itself (deep methane band spectrum).

**Fraction GO/GTO** This program would benefit all FQCH4N-D archival observations (~1% of external images in the archive).

**Programs Supported**

**Resources** 1 external orbit.

**Required: Observation**

**Products** Outsourcing candidate. Expected product would be an updated filter transmission curve, to be installed in SYNPHOT and an ISR, if the project is not outsourced.

**Accuracy** 5%

**Goals**

**Scheduling & Special Requirements**