

# WFPC2 Cycle 12 Calibration Plan

---

A. Koekemoer, I. Heyer, G. Brammer, V. Kozhurina-Platais,  
J. Rhoads, and B. Whitmore  
November 10, 2003

---

## ABSTRACT

*The WFPC2 Cycle 12 Calibration Program, extending from October 1, 2003 to September 30, 2004 will continue to monitor the health of WFPC2, using the standard suite of calibrations, as well as some special / Close-Out programs to characterize other aspects of the instrument. One significant recent change in the routine monitors concerns the length of time between decontaminations. Since Cycle 11, this period has been increased from 28 days to 49 days because data from the last few Cycles indicate that the contamination rate has been decreasing. Close-Out programs include a characterization of the UV geometric distortion, checks of narrow-band and linear ramp filters, as well as an effort to cross-calibrate WFPC2, ACS and WFC3 photometry. Because there are significantly fewer primary WFPC2 science observations in Cycle 12, the calibration plan has been significantly scaled back, but without sacrificing the quality of data required to calibrate the instrument. For Cycle 12, a total of 25 external orbits will be used, compared to 40 in Cycle 11.*

---

## 1. Introduction

Until Cycle 10, WFPC2 was the most heavily used instrument on HST (~40-60% of the total of ~3000 orbits available for science in a given Cycle), with much of the observing being carried out in prime mode. Since the installation of the Advanced Camera for Surveys (ACS) in Cycle 11, there has been a dramatic change in the usage pattern for WFPC2. The instrument is still used quite heavily by the community (~800 - 1200 orbits / Cycle), though somewhat less than before, but the main difference is that now almost all the WFPC2 observing is carried out in parallel mode. Thus, almost 40% of prime HST science orbits during Cycles 11 and 12 have WFPC2 observations of parallel targets, while

the number of prime WFPC2 science observations have decreased to ~5% and 2% of the total time in each of Cycles 11 and 12 respectively, as demonstrated in Table 1.

**Table 1: WFPC2 Science Program Usage During Cycles 10 - 12**

WFPC2 Science Program Usage	Cycle 10	Cycle 11	Cycle 12
Primary Orbits	1080	153	56
Coordinated Parallel Orbits	40	200	381
Pure Parallel Orbits	300	500	844

In addition to the change in emphasis by the community from prime to parallel observing, there has also been a change in emphasis on the types of WFPC2 science programs that are carried out by the community. Specifically, WFPC2 remains competitive with ACS in the following three areas:

- A comparatively broad selection of filters in a total of 48 optical elements, consisting of 18 narrow-band and medium-band filters, 23 broad-band and long-pass filters, as well as 2 quad filters (each giving 4 different narrow-band wavelengths on the 4 WFPC2 chips), one polarizing filter, and 4 linear ramp filters (LRFs).
- A relatively high discovery efficiency in the near-UV (essentially the product of the instrument area and its UV throughput); while the ACS/HRC is ~3-4 times more sensitive than WFPC2 in the 2000-3500Å wavelength range (i.e. shortwards of the blue cutoff of ACS/WFC), the area of WFPC2 is ~30 times larger than the ACS/HRC.
- A long history of on-orbit performance (10 years as of December 2003) and well-characterized behavior, making WFPC2 suitable for long-term monitoring studies of objects that are variable in their photometric or astrometric properties.

Thus, the majority of Cycle 12 science programs making use of WFPC2 in prime mode consist of either narrow-band filter observations, or the continuation of long-term monitoring programs. On the other hand, WFPC2 parallel science tends to consist mostly of observations through a subset of the broad-band filters, often in the near-UV.

Considering both the reduced observing time for WFPC2 in Cycle 12, as well as the change in its usage patterns, this has necessitated a change in the calibration strategy for the instrument during this Cycle. The principal emphasis of routine calibration continues to be two-fold:

- Monitor and maintain the basic health and safety of the instrument in all its modes.
- Maintain the required calibration accuracies for science modes used in Cycle 12, while also streamlining the calibration process to remove unnecessary observations of modes that are not used during this Cycle.

In addition, during Cycles 11 and 12 we have begun implementation of a class of special Close-Out Calibration Programs, taking into account community input to carry out programs that will increase the value of the WFPC2 archival scientific legacy. In Cycle 12, these include the following programs:

- Photometric cross-calibration with other instruments and systems, in particular ACS and SDSS, by observing a range of different photometric standards through the widest possible range of WFPC2 filters.
- Improving our knowledge of the astrometric distortion of WFPC2 in the UV, by carrying out observations on our standard astrometric field  $\omega$  Centauri using the near-UV F255W filter.
- Improving characterization of the long-term stability of the narrow-band / LRF filter set, by observing an emission-line source in a range of narrow-band filters, by themselves and crossed with LRFs. This will enable verification of the constancy of the central wavelength of the narrow-band filter, as well as providing a check on its throughput.

These changes to the calibration philosophy are reflected in the orbit allocations for the Cycle 12 calibration programs, as shown in Table 2. The number of external orbits for routine monitoring programs are reduced compared with previous Cycles, with the dominant remaining components being the verification of UV throughput before and after decontaminations, as well as a number of routine CTE and photometric monitoring exposures. Likewise, the internal orbit allocation is reduced somewhat to account for the fact that we are no longer calibrating filter modes that are not used for science during this Cycle. However, the special / Close-Out programs remain at a level of ~50% of the entire external orbit allocation budget, reflecting our emphasis on carrying out these programs that are needed to provide final calibration data to enhance the long-term archival legacy of the instrument.

The total time allocated for Cycle 12 calibrations is 25 external orbits (compared to 40 orbits in Cycle 11), and 1681 internal/occultation orbits. This allocation spans October 1, 2003 to September 30, 2004. As always, about 10% of the total external orbit time allocation has been set aside for calibration issues that arise during Cycle 12, amounting to 2 external orbits (included in the total budget of 25 external orbits).

**Table 2: WFPC2 Calibration Program Orbit Allocations During Cycles 10 - 12**

WFPC2 Calibration Program Usage	Cycle 10		Cycle 11		Cycle 12	
	Ext.	Int.	Ext.	Int.	Ext.	Int.
Monitors: Decons, darks, internal flats	23	2242	19	2170	12	1677
Special / Close-Out Programs	32	52	17	1	11	4
Reserve (Unexpected Items)	6		3		2	
<b>Total</b>	<b>61</b>	<b>2294</b>	<b>40</b>	<b>2171</b>	<b>25</b>	<b>1681</b>

## 2. Detailed Description of Cycle 12 Calibration Programs

### *Routine Monitors*

For most of WFPC2's operational lifetime (except during Servicing Mission Observatory Verification periods), decontaminations were done every 28 days to anneal hot pixels and remove contaminants that accumulate over time on the cold CCD windows. During this procedure, the CCDs are warmed to about +22° C, from the operating temperature of -88° C. The removal of contaminants improves throughput in UV filters, and as a result, the 28 day decontamination Cycle was implemented to ensure that UV throughput never drops below 70%. Recent UV photometric data has indicated that the contamination rate is decreasing with time (see *ISR-WFPC2-2002-07, Updated Contamination Rates for WFPC2 UV Filters* by McMaster & Whitmore), allowing the interval between decontaminations to be safely increased to 49 days, as implemented in Cycle 11. This 49 day period is sufficient to ensure that the throughput decrease does not fall below 70%, and in addition, is optimally compatible with other timescales within the scheduling system. As a result, routine monitors tied to decontaminations, such as the photometric monitor of standard star GRW+70D5824, and internal monitors (darks, internal flat fields, Kspots, and biases) occur less frequently. Other calibrations done once a Cycle, that are tied to decontaminations, will occur as they have in past Cycles. These are the UV throughput checks (GRW+70D5824 observed with UV filters), VISFLAT sweeps, and UVFLATs.

Five darks with CLOCKS=OFF and one dark with CLOCKS=ON, each with 30 minute exposure times, continue to execute every week. These darks will be used, along with darks taken before and after the decontaminations, to create dark reference files and hot pixel lists. Three 1000 second darks will be taken each day, on a non-interference basis, to be archived for use by users who need hot pixel information closer to the time of their observations.

The Internal Monitor program will continue to take biases and internal flats each week to monitor the health of WFPC2. INTFLAT and VISFLAT sweeps, linearity tests, and checks for filter rotation anomalies, will be taken as in previous Cycles. These observations will be used to monitor countrate linearity over time, create a backup database of flat fields, and continue monitoring a positioning anomaly in the filter wheel rotation (see *ISR-WFPC2-2002-04: An Analysis of WFPC2 Filter Positional Anomalies*, and *TIR-WFPC2-2002-06: Predicting Photometry Errors due to Linear Ramp Filter Offsets*, both by Gonzaga et al.).

Earthflat observations continue to be taken, but in reduced numbers compared to previous Cycles. This is the result of a recent detailed study of flat fields (see *ISR-WFPC2-2002-02: Updated WFPC2 Flatfield Reference Files for 1995 - 2001*, by Koekemoer, et al.), which not only provided updated flatfields for all the filters but also showed that the

dominant time evolution of flatfields does not depend significantly on color but rather is almost completely independent of the filters. Therefore, visible Earthflats in Cycle 12 will make use of the F502N filter only, to continue tracking the time-dependent effects. The separate program of UV Earthflats will continue, in order to provide measurements of any possible long-term flatfield changes in the UV resulting from the apparent permanent decrease in the contamination rate. Any measured changes in both the visible and UV will be used to produce updated flatfield reference files.

The CTE Monitoring program continues CTE monitors from previous Cycles with observations of a field in Omega Centauri. Observations will also be taken in the 2x2 binning mode to see if this technique reduces CTE effects; this test could also be potentially useful for ACS observations. Another new component of this program is a better characterization of the long-vs.-short anomaly. High signal-to-noise observations will be taken in an uncrowded field, to test the hypothesis that the long-vs.-short effect may only be applicable to very crowded fields.

As in past Cycles, the Photometric Monitoring program will continue to verify photometric stability in filters that are not routinely monitored, but in use during Cycle 12, with observations of the standard star GRW+70D5824 in all four chips. Data from this and previous Cycles will also be used to update photometric zeropoints used in Synphot.

### *Special / Close-Out Programs*

In Cycle 12 there are a total of three special Close-Out Calibration programs that will execute, which are aimed at providing specific observations to increase the scientific value of the WFPC2 archival legacy: a UV astrometric solution; photometric cross-calibration with other instruments, and narrow-band/LRF wavelength characterization.

The UV Astrometric Characterization program is aimed to address the fact that the WFPC2 geometric distortion is expected to be strongest in the UV, yet has been measured empirically only in the F300W, F555W and F814W filters. Thus the aim of this program is to observe a rich field in Omega Centauri at F255W, to enable a complete astrometric solution to be empirically determined in the most commonly used UV broad-band filter. This will also supplement previous observations of sparser clusters at F160BW, F170W and F185W that yield plate scale measurements but are insufficient to enable a full-field geometric distortion solution to be obtained.

Another special Close-Out program in Cycle 12 is the WFPC2 Photometric Cross-Calibration. This is aimed at directly tying the WFPC2 photometry to other commonly used systems, by observing a range of spectrophotometric standards used by STIS, ACS, and WFC3, as well as the Sloan standard star (BD+17D4708), spanning a range of colors, using a wide range of commonly-used WFPC2 filters. These observations will produce a valuable tie-in between WFPC2, ACS, and Sloan filter photometric systems, as well as providing additional independent verifications of the WFPC2 filter system zeropoints.

Finally, a program is being carried out to characterize the wavelength properties of a selection of WFPC2 narrow-band filters and LRFs. This is aimed at addressing possible long-term changes in these filters that may have occurred due to annealing / shrinkage of the thin films over the life of the instrument. The program contains observations of internal flats and external emission-line targets, obtained in narrow-band filters and LRFs (by themselves and crossed with one another). In addition to characterizing the central wavelength, the program also provides a check on the throughput calibration of these filters.

### **3. Conclusion**

The WFPC2 Cycle 12 Calibration Program is aimed at continuing to meet the changing needs of the community by providing on-going essential health and safety monitoring, as well as close-out calibration and cross-instrument calibration with ACS and other photometric systems.

The Instruments Division at STScI is also continuing to lay out plans for further WFPC2 Close-Out work, making sure that all major aspects of WFPC2 are well-characterized, and this will continue to remain a major component of WFPC2 calibration until the instrument is decommissioned. A summary of the Cycle 12 calibration program can be found in Appendix A, and a detailed description of each program in Appendix B. Comment from the community are welcome on this calibration plan, along with suggestions for future Cycles, and closure calibration issues, and can be sent via email to *help@stsci.edu*.

## Appendix A: WFPC2 Cycle 12 Calibration Plan

ID	Proposal Title	Frequency	Estimated Time (orbits)		Scheduling Required	Products	Accuracy Required	Notes
			“External”	“Internal”				
<b>Routine Monitoring Programs</b>								
10067	WFPC2 Decons & Associated Observations	Decons every 49d	8	124	every 49d	CDBS, IHB, Synphot, WWW reports	1-2%	Decons, photometric monitor, internals, UV throughput, VISFLATS and UVFLATS.
10068	Standard Darks	weekly, except decon week		264	every 7 days, except decon week	CDBS	1 e-/hr	CDBS updates and weekly WWW hot pixel lists.
10069 - 10071	Supplemental Darks	0-3/day		1095	every day		n/a	For archive only, no analysis. Useful for calibrating WFPC2 parallels.
10072	Internal Monitor	weekly, except decon week		44	every 7 days, except decon week	CDBS	0.8e-/pix	BIAS, INTFLATS in F555W for gain and throughput stability measurements.
10073	Visible Earth Flats	continuous		50	mid-to-late	CDBS	0.3%	Reduce to 1 filter (time dependence only).
10074	UV Earth Flats	continuous		20	mid-to-late	CDBS	0.3%	
10075	INTFLAT & VISFLAT Sweeps, Filter Rotation Monitor	1/cycle		80	mid-cycle	TIR	0.3%	Flats in all the filters used in Cycle 12, both gain settings / shutters.
10076	CTE Monitor	1/cycle	2		mid-to-late	ISR	0.03 mag	Continue CTE monitor.
10077	Photometric Monitor	1/cycle	2		mid-cycle	ISR	1-2%	GRW+70D5824 in filter/chip combinations used for science in Cycle 12.
<b>Special / Close-Out Calibration Programs</b>								
10078	Photometric Cross-Calibration	once	6		mid-cycle	ISR, Synphot	1%	Cross-instrument calibration using standards from ACS, STIS and WFC3.
10079	UV Astrometric Characterization	once	3	1	mid-cycle	ISR	0.05''	$\omega$ Cen observations in the UV.
10080	Narrow-band / LRF Characterization	once	2	3	mid-to-late	ISR, Synphot	1-2%	Check wavelength stability; observe emission-line source with narrow-band, LRFs
	~10% reserve		2					Placeholder for unexpected items.
<b>TOTAL TIME (including all executions)</b>			<b>25</b>	<b>1681</b>				

## **Appendix B**

The following pages contain a detailed summary and justification for each Cycle 12 calibration program. The Phase 2 versions of these programs can be accessed at:

*[http://www.stsci.edu/hst/scheduling/program\\_information](http://www.stsci.edu/hst/scheduling/program_information)*

## Proposal ID 10067: WFPC2 Cycle 12 Decontaminations and Associated Observations

### Plan

**Purpose** WFPC2 Decons every 49 days. Other programs tied to Decons are also included: photometric stability check, pre- and post-Decon internals, UV throughput checks, internal VISFLAT sweeps, and internal UVFLAT checks.

**Description** *Decontamination:* UV-blocking contaminants removed and hot pixels annealed by warming the CCDs to +22° C for 6 hours.

*Internals:* INTFLATs, biases, darks & Kspots, before/after Decons.

*Photometric Monitor:* GRW+70D5824 is observed either before or after each Decon, rotating the chips: (1) F170W in all chips to monitor for UV contamination; (2) As many as possible of F218W, F255W, F336W will be observed within 1 orbit in a different chip each time.

*UV Throughput:* Observations in F122M, F185W, F343N, F375N, F390N added to each photometric monitor. Used to verify that the UV spectral response curve is unchanged.

*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.

*VISFLAT mini-sweep:* Taken before and after a Decon, once during the Cycle. VISFLATs will also be taken with a ramp filter, one at each gain, to be done at the post-Decon visit, to provide a check of the A-to-D correction. The F336W ratio of VISFLAT to UVFLAT provides a diagnostic of the UV flatfield degradation & ties the UVFLAT and VISFLAT flatfield patterns.

**Fraction** 100%

**GO/GTO**

**Programs Supported**

**Resources** Total of 8 external and 124 internal orbits. Request covers 8

**Required:** Decons, through Sep 2004. External orbits needed: 8 orbits for photometric & UV monitoring, 2 internal orbits for VISFLAT sweep, 2 for UVFLATs, and 120 internal orbits for darks, biases, Kspots, and INTFLAT monitors.

## Plan

**Products** SYNPHOT, CDBS, Instr. Handbook, TIPS meetings, WWW reports, TIR, ISR; new UV flatfields if changes are detected.

**Accuracy Goals** *Photometry*: less than 2% discrepancy between results, 1% rms expected.

*UV throughput*: better than 3% accuracy.

*Flatfields*: temporal variations monitored at 1% level. Gain ratios: stable to better than 0.1%.

*UVFLATs*: 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%.

**Scheduling & Special Requirements** Upon request, all timing requirements hard-coded via special requirements. Cycle 12 proposal to begin after Cycle 11 August, 2003, Decon cycle.

*Decons*: every 49 days.

*Photometry*: Observations 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.

*UVFLATs*: Due to timing requirements, each visit covers a 2-hour time span - one visibility period and two occultation periods.

To prevent excessive degradation of the UV & VIS lamps, the SU durations for each UVFLAT or VISFLAT visit should be kept as follows: 2h 15m use of Cal Module (UV & VIS lamps), then 9h 45m off -- this keeps usage of cal channel within CARD of 3h on/ 12h off).

## Proposal ID 10068: WFPC2 Cycle 12 Standard Darks

### Plan

**Purpose** Measure dark current & identify 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** 264 internal orbits.

**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** Require  $\sim 1$  e-/hr (single-pixel rms) accuracy for most science applications. Expected accuracy in a typical superdark is 0.05 e-/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.

**Goals** are in Decon proposal. As requested, timing requirements have

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

## Proposal ID 10069 - 10071: WFPC2 Cycle 12 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** 1095 internal orbits.

**Required:**

**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. Requires multiple proposal IDs due to large number of visits (1 dark/visit to maximize scheduling flexibility). If data volume becomes an issue, supplemental darks may be dropped.

## Proposal ID 10072: WFPC2 Cycle 12 Internal Monitor

### Plan

**Purpose** This calibration proposal is the Cycle 12 routine internal monitor for WFPC2, to be run weekly to monitor the health of the cameras. A variety of internal exposures are obtained in order to provide a monitor of the integrity of the CCD camera electronics in both bays (gain 7 and gain 15), a test for quantum efficiency of the CCDs, and a monitor for possible buildup of contaminants on the CCD windows.

**Description** The internal observations consist of:

at gain=7: 4 biases, 2 F555W INTFLATs

at gain=15: 4 biases, 2 F555W INTFLATs

The entire set should be run once a week. This proposal should not be run during Decon weeks as the Decon proposal contains the necessary internal images for those weeks. Each visit should be somewhat evenly spaced, i.e. they should be scheduled about 1 week +/- 2 days apart.

**Fraction** 100%

**GO/GTO**

**Programs  
Supported**

**Resources** 44 internal orbits.

**Required:**

**Observation**

**Products** CDBS (superbias created annually).

**Accuracy** 0.8 e-/pix for superbias reference file.

**Goals**

**Scheduling&** every 7 days (except during Decon); no special requirements.

**Special  
Requirements**

## Proposal ID 10073: WFPC2 Cycle 12 Visible 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.

**Description** Observations of the bright Earth (Earthcals) are obtained in F502N to monitor time-dependence of flatfield features.

In Cycle 12, we are reducing the observations to F502N only (previous Cycles have carried out this program using F375N, F656N, and F953N, in addition to F502N and a range of other narrow-band filters). A recent detailed study of earthflats (Koekemoer et al. 2002) showed that there is no significant time evolution in the color dependence of the flatfield; instead, the dominant time evolution of flatfields is independent of filter. Therefore, in order to mitigate pressures on the available observing time for Cycle 12, we will monitor the flatfield time evolution using only F502N.

**Fraction** 100%

**GO/GTO**

**Programs  
Supported**

**Resources** 50 occultation periods (internal orbits).

**Required:  
Observation**

**Products** New flatfields generated and delivered to CDBS if changes detected. (Most recent update was delivered to CDBS in early 2002.)

**Accuracy** The single-pixel signal-to-noise ratio expected in the flatfield is  
**Goals** 0.3%.

**Scheduling &  
Special  
Requirements** None.

## **Proposal ID 10074: WFPC2 Cycle 12 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.

**Description** Earth streak-flats are taken in the UV filter F255W, in order to measure time dependence of the flatfield due to changes in the camera geometry, as well as any possible long-term changes in the UV flatfield from permanent evaporation of contaminants.

**Fraction** ~10%

**GO/GTO**

**Programs  
Supported**

**Resources** 20 occultation periods (internal orbits).

**Required:**

**Observation**

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

**Accuracy** 3-10%.

**Goals**

**Scheduling &  
Special  
Requirements**

## **Proposal ID 10075: WFPC2 Cycle 12 INTFLAT and VISFLAT Sweeps, and Filter Rotation Monitor**

### **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 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. As in Cycle 11, we plan to continue taking extra VISFLAT, INTFLAT, and Earthflat exposures to test the repeatability of filter wheel rotation.

**Description** This proposal contains the INTFLAT filter sweep, linearity and filter rotation tests.

*Linearity test:* flatfields are taken with F555W at a variety of exposure times, using shutters A & B, and gains 7 & 15. 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:* VISFLATs, INTFLATs, and Earthflats will be taken to test the repeatability of the filter wheel positioning. A problem is known to exist in several filters.

**Fraction** 100%

**GO/GTO**

**Programs  
Supported**

**Resources  
Required:  
Observation** 80 internal orbits (including earthflat occultation periods).

**Products** TIR, ISR

**Accuracy** 0.3%

**Goals**

**Scheduling &  
Special  
Requirements** once per cycle; no special requirements

## Proposal ID 10076: WFPC2 Cycle 12 CTE Monitor

### Plan

**Purpose** Monitor CTE during Cycle 12; test whether 2X2 binning affects CTE (may be relevant for ACS) and perform a high S/N long-vs.-short test in an uncrowded field.

**Description** Obtain observations of Omega Cen (NGC 5139) to track changes in the CTE (charge transfer efficiency) in WFPC2. A continuation of proposals in earlier Cycles (7629, 8447, and 8821, 9254, 9591), the principal observations will be at gains 7 and 15, in F814W and F555W. The same pointing is used on WF2 and WF4. The relative orientation of the chips then results in stars at the bottom of one chip falling near the top of the other chip, hence providing a measurement of the CTE loss. We will make similar observations using 2X2 binning. This may reduce CTE loss since the largest loss is to the adjoining pixel, which gets included in the 2X2 bin in 50% of the cases. This may be relevant for future instruments (ACS, WFC3). We will also obtain a high S/N measurement of the long-vs.-short anomaly for uncrowded fields by taking 10 X 10s exposures in Omega Cen, in order to test the recent finding that the long-vs.-short problem is only relevant for crowded fields.

**Fraction** 30 - 50%

**GO/GTO**

**Programs  
Supported**

**Resources** 2 external orbits.

**Required:**

**Observation**

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

**Accuracy** 0.03 magnitudes for the majority (90%) of cases.

**Goals**

**Scheduling &** Schedule about 1 year after the Cycle 11 CTE program.

**Special  
Requirements**

## Proposal ID 10077: WFPC2 Cycle 12 Photometric Monitor

### 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 chips will be made using filters that are not routinely monitored but are still used in Cycle 12. 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** 2 external orbits.
- Required:**
- Observation**
- Products** ISR, Synphot update.
- Accuracy** 1-2% photometry.
- Goals**
- Scheduling & Special Requirements** Execute within 7 days of Decon. To simplify scheduling process, timing requirements are hard-coded via special requirements. Execute mid-cycle.

## Proposal ID 10078: WFPC2 Cycle 12 Close-Out Photometric Cross-Calibration

### Plan

**Purpose** This is a close-out calibration proposal aimed at providing photometric zeropoint cross-calibration between the commonly-used WFPC2 filter sets and those used for ACS and eventually WFC3.

**Description** Observations of several spectrophotometric standards used by other instruments (STIS, ACS, WFC3), including BD+174708 (ACS/SDSS primary standard), GD71 and G191B2B (white dwarfs, which are the primary spectrophotometric standards for STIS), and VB8 and 2M0036+18 (M and L dwarfs respectively, which will have absolute spectrophotometry measured and will become the primary standards for cross-instrument calibration in red filters). In addition, the ACS “standard cluster” 47 Tuc is observed to provide field dependence of photometric color terms across the WFPC2 chips, and provide further tie-ins with the ACS photometric system.

The plan is to spend 1 orbit on each target, exposing only on WF3 for the stars and using single read-out mode to minimize overheads, thereby cycling through as many of the WFPC2 standard broad-band and medium-band filters as possible: F160BW, F170W, F185W, F218W, F522W, F300W, F336W, F380W, F439W, F410M, F450W, F467M, F547M, F555W, F569W, F606W, F622W, F675W, F702W, F785LP, F791W, F814W, F850LP, F1042M. Depending upon the exposure times needed for each target, some of the less commonly-used filters may be dropped if the required exposure times become excessive. Images should be taken within 7 days after a Decon, to minimize any contamination effects.

**Fraction** 100%

**GO/GTO**

**Programs**

**Supported**

**Resources** 6 external orbits.

**Required:**

**Observation**

**Products** ISR, Synphot update.

**Accuracy** 1%

**Goals**

**Scheduling &**

**Special**

**Requirements**

## **Proposal ID 10079: WFPC2 Cycle 12 Close-Out UV Astrometric Characterization**

### **Plan**

**Purpose** Enable a full astrometric solution to be determined empirically in the UV.

**Description** This program consists of 2 orbits for observing Omega Cen in the F255W filter, to provide data for obtaining a full geometric distortion solution in the UV. This will complement the previously determined solutions at F300W, F555W and F814W, and by supplementing previous observations at F160BW, F170W, F185W will also allow a much more reliable extrapolation to shorter wavelengths where obtaining sufficient data is no longer feasible.

In addition, one external orbit is used to observe Omega Cen at F555W, to allow a direct tie-in to the previously measured distortion solution and also provide the annual long-term monitoring of the time dependence of the geometric solution.

Finally, one internal orbit is used for Kelsall spot images which provide an independent measure of the extent by which the camera heads have moved with respect to one another.

**Fraction** 20%

**GO/GTO**

**Programs Supported**

**Resources** 3 external orbits, 1 internal orbit.

**Required:**

**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 &** Schedule in mid-cycle, about 1 year after the equivalent Cycle

**Special** 11 program.

**Requirements**

## **Proposal ID 10080: WFPC2 Cycle 12 Close-Out Narrow-Band/LRF Characterization**

### **Plan**

**Purpose** This proposal is aimed at measuring the wavelength stability of the LRFs, which may have changed over time due to annealing/shrinkage of the thin films.

**Description** On-orbit VISFLATS taken through the LRFs crossed with narrow-band filters to constrain the LRF wavelength calibration, as well as uncrossed LRF VISFLAT exposures to constrain the transverse (cross-wavelength) placement of the LRFs.

External observations of a planetary nebula (2 orbits) to provide an absolute test of the LRF wavelength calibration.

**Fraction** 20%

**GO/GTO**

**Programs**

**Supported**

**Resources** 2 external orbits, 3 internal orbits.

**Required:**

**Observation**

**Products** TIPS, ISR, Synphot, Instrument Handbook

**Accuracy** 1-2%

**Goals**

**Scheduling &**

**Special**

**Requirements**