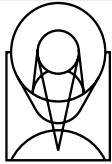


Cycle 14 WFPC2 Calibration Plan

Overall Goals:

- Monitor & maintain WFPC2 health & safety.
- Maintain required calibration accuracies for science modes used in Cycle 14.
- Implement Close-Out calibrations to increase the value of the WFPC2 scientific legacy.



Recent History of WFPC2 Usage

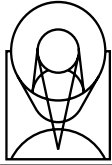
- Cycles 12 - 14: WFPC2 prime science orbits relatively low.
- Parallel observing remains dominant mode for WFPC2 science.

WFPC2 Science Program Usage	Cycle 11	Cycle 12	Cycle 13	Cycle 14
Primary Orbits	153	56	21	50
Coordinated Parallel Orbits	200	381	890	307
Pure Parallel Orbits	500	844		

WFPC2 Calibration Program Usage	Cycle 11		Cycle 12		Cycle 13		Cycle 14	
	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.
Monitors: decons, darks, internals, flats, photometry, CTE	19	2170	12	1677	13	582	11	552
Special / Close-Out Calibrations	17	1	13	4	2		6	
Reserve (Unexpected Items)	3		2		2		2	
Total	40	2171	25	1681	17	582	19	552

WFPC2 Cycle 14 Calibration Plan Summary

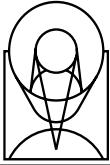
ID	Proposal Title (PI)	Frequency	Estimated Time (orbits)		Scheduling Required	Resources Required (FTE)	Products	Accuracy Required	Notes
			“External”	“Internal”					
10744	WFPC2 Decons & Associated Observations (Biretta)	Decons every ~60d	6	94	every ~60d	0.2	CDBS, Inst Hbk, Synphot, WWW reports	1-2%	Decons, photometric monitor, internals, UV throughput, VISFLATS and UVFLATS.
10748	Standard Darks (Kozhurina-Platais)	weekly, except decon week		264	once every 7 days, except decon wk.	0.2	CDBS	1 e-/hr	CDBS updates and weekly WWW hot pixel lists.
10745	Internal Monitor (Biretta)	weekly, except decon week		44	once every 7 days, except decon week	0.1	CDBS	0.8e-/pix	BIAS, INTFLATS in F555W for gain and throughput stability measurements
10749	Visible Earth Flats (Gonzaga)	continuous		50	mid-to-late	0.1	CDBS	0.3%	F502N only (time dependence only)
10750	UV Earth Flats (Gonzaga)	continuous		20	mid-to-late	0.1	CDBS	0.3%	F255W only
10751	INTFLAT & VISFLAT Sweeps, Filter Rotation Monitor (Gonzaga)	1/cycle		80	mid-cycle	0.1	TIR	0.3%	Flats in all the filters, both gain settings & both shutters.
10746	CTE Monitor (Biretta)	1/cycle	2 + 2		mid-to-late	0.2-0.3	ISR	0.03 mag	Continue CTE monitor + Close Out
10747	Photometric Monitor + Close-Out (Biretta)	1/cycle	3 + 4		mid-cycle	0.2	ISR, Synphot	1%	GRW+70d5824 in filter/chip combinations used for science in Cycle 14 + Close Out
	~10% reserve		2						Placeholder for unexpected items.
TOTAL TIME (including all executions)			19	552					



Cycle 14 WFPC2 Calibration Programs

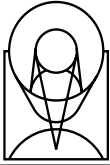
WFPC2 Cycle 14 Decontaminations (ID=10744; PI=Biretta)

- In Cycle 12 & 13 we had 8 Decons at 49 day intervals, with 4 pre-Decon and 4 Post-Decon monitors. Each monitor had F170W in all 4 chips, and an additional 9 UV & blue filters cycling among the different chips.
- Cycle 14:
 - Increase interval between decons from 49 days to 60 days to improve two-gyro scheduling of the monitor observations.
 - Hence only 6 decons and 6 monitors charged to Cycle 14.
 - Follow previous strategy to cycle through chips for UV filters; but 2 monitors in the 8-part rotation will trail into future Cycle 15 calibration.
- Total cost: 6 external orbits, 94 internal orbits



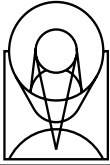
WFPC2 Cycle 14 Standard Darks (ID=10748; PI=Kozhurina-Platais)

- Six 1800s exposures / week (5 with clocks off, one with clocks on; note that WFPC2 GOs are using both modes in Cycle 14)
- Used to generate weekly darks for CDBS (specifically the hot pixels, to be added to the superdark), plus weekly hot pixel tables for the web.
- Not scheduled during Decon weeks (those are taken care of by the Decon proposal, obtaining darks soon after each Decon)
- Need for regular weekly darks is driven by temporal changes on this timescale for hot pixel growth
- Total cost: 264 internal exposures



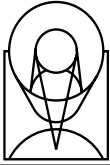
WFPC2 Cycle 14 Internal Monitor (ID=10745; PI=Biretta)

- Aim to monitor the health of the camera electronics, including gain stability, bias level, and throughput verification.
- Scheduled once / week, except for weeks containing a Decon visit (which are taken care of by the Decon proposal)
- Each visit contains 4 BIAS frames and 2 INTFLAT exposures at both Gain=7 and Gain=15
- Provides data for annual superbias in CDBS
- Total cost: 44 internal orbits



WFPC2 Cycle14 Visible & UV Earth Flats (ID=10749&10750; PI=Gonzaga)

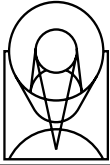
- During previous cycles, the earthflat programs have monitored the time dependence of flatfield changes in a range of different narrow-band filters (primarily F375N, F502N, F656N, F953N), as well as 8 additional narrow-band filters.
- An extensive study by Koekemoer et al. 2001 showed that there is no significant color-dependent change in the flatfields - the time-dependent changes are predominantly monochromatic. Furthermore, the large-scale changes are generally less than ~0.5-1% (small-scale spots are somewhat higher, up to a few percent)
- Therefore, in Cycle 12&13 we have monitored the Earthflats only in the primary Earthflat filter, F502N, and the primary UV filter F255W (to monitor potential UV throughput changes across the field related to contaminants)
- Cycle 14: continue monitoring only in F502N and F255W



WFPC2 Cycle14 INTFLAT & VISFLAT Sweeps, Filter Rotation Monitor

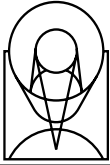
(ID=10751; PI=Gonzaga)

- Monitor WFPC2 pixel-to-pixel flatfield response by obtaining INTFLAT and VISFLAT exposures in F555W.
- Monitor WFPC2 linearity using a series of INTFLAT exposures in F555W at a variety of exposure times, both gains, and using both shutters A & B; any non-linearity would appear as non-uniform ratio of INTFLATS with different exposure times
- Obtain a range of INTFLAT exposures in the entire standard optical filter set (31 filters). Obtain a series of VISFLAT and EARTHFLAT exposures in the 4 linear ramp filters (by themselves for VISFLATS, and crossed with appropriate narrow-band filters for the Earthflats), to provide a check of the repeatability of the filter wheel positioning for these filters.
- Total cost: 80 internal orbits (includes earthflat occultations)
- *Execute INTFLATs only during ACS anneals to avoid scattered light.*



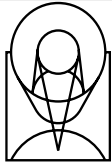
WFPC2 Cycle 14 CTE Monitor (ID=10746; PI=Biretta)

- Continue monitoring CTE degradation; better characterize the long-vs-short anomaly.
- To be executed once in cycle.
- Same structure as before for monitors: Omega Cen in F814W and F555W, in WF2 & WF4, gain 7 and some gain 15.
- High S/N Long vs. Short test for uncrowded field is included. Recent indications are that the long vs. short effect is primarily relevant for very crowded fields. A higher S/N set of observations, i.e. with 10 repeats for the 10s exposures, are needed to determine whether the long vs. short effect is zero for uncrowded fields.
- There is recent evidence for differing amounts of CTE in different detectors. As a close-out activity, we include 2 additional orbits to allow direct measurement of the CTE in WF2 and WF4, rather than merely obtaining their average.
- Total cost: 2 + 2 external orbits.



WFPC2 Cycle 14 Photometric Monitor + Close-Out (ID=10747; PI=Biretta)

- Observe the WFPC2 standard star GRW+70d5824 in a range of filter/chip combinations that are used in Cycle 14 (3 orbits).
- Include additional filter/chip combinations from standard photometric set that are not explicitly requested by GOs.
- Include additional filters not calibrated in recent Cycles as a Close-Out activity (4 orbits).
- Goal is to verify stability to 1-2%, and update the photometric zeropoints in SYNPHOT, if necessary.
- To be compared to baseline observations to identify any time dependencies.
- Total cost: 3 + 4 external orbits



Cycle 13 Calibration Status / Completion

ID	Proposal Title (PI)	Frequency	Estimated Time (orbits)		Completed	Notes
			"External"	"Internal"		
10356	WFPC2 Decons & Associated Observations (Heyer)	Decons every ~60d	8	124	67%	Decons, photometric monitor, internals, UV throughput, VISFLATS, UVFLATS. Runs through 10 Oct 2005. Throughput plots on WWW.
10359	Standard Darks (Kozhurina-Platais)	weekly, except decon week		264	68%	Runs through 28 Nov 2005. Weekly darks delivered to CDBS.
10360	Internal Monitor (Biretta)	weekly, except decon week		44	80%	BIAS, F555W INTFLATS. Runs through 30 Oct 2005.
10361	Visible Earth Flats (Gonzaga)	continuous		50	100%	
10362	UV Earth Flats (Gonzaga)	continuous		20	100%	
10363	INTFLAT & VISFLAT Sweeps, Filter Rotation Monitor (Gonzaga)	1/cycle		80	100%	
10364	CTE Monitor (Heyer)	1/cycle	2		100%	
10365	Photometric Monitor (Heyer)	1/cycle	3		(Scheduled for 8/2005)	GRW+70d5824 in various filter/chip combinations.
10366	Photometric Cross-Calibration (Biretta)	once	2		100%	T-dwarf star in a range of WFPC2 filters, for ACS & WFC3 cross-calibration.

Proposal ID 10744: WFPC2 Cycle 14 Decontaminations and Assoc. Obs.

Plan

- Purpose** WFPC2 decons. Other programs tied to decons are also included: photometric stability check, focus monitor, pre- and post-decon internals, 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. Increase interval to ~60 days to improve two-gyro scheduling.
- Internals:* intflats, biases, darks & kspots, before/after decons.
- Photometric Monitor & UV Throughput:* GRW+70d5824 is observed alternately before or after each decon: (1) F170W in all chips to monitor far UV contamination. (2) As many as possible of F122M, F185W, F218W, F255W, F300W, F336W, F343N, F375N, F390N, and F555W will be observed within 1 orbit in a different chip each decon; 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 flat field 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 flat field degradation & ties the uvflat and visflat flat field 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 flat field degradation & ties the UVFLAT and VISFLAT flat field patterns.
- Fraction GO/GTO Programs Supported** 100%
- Resources Required:** Total of 6 external and 94 internal orbits. Request covers 6 decons, through Sep 2006. External orbits needed: 6 orbits for photometric & UV monitoring, 2 internal orbits for visflat sweep, 2 for UVFlats, and 90 internal orbits for darks, biases, kspots, and intflat monitors.
- Resources Required:** 0.3 FTE
- Analysis**
- Products** SYNPHOT, CDBS, Instr. Handbook, TIPS meetings, WWW reports, TIR, ISR; new UV flatfields if changes are detected.

Plan

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

UV throughput: better than 3%.

Flatfields: 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%.

Scheduling & Special Requirements Upon request, all timing requirements hard-coded via special requirements. Cycle 14 proposal to begin after Cycle 13 August, 2005, decon cycle.???

Decons: every ~60 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.

UV flats: 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 10748: WFPC2 Cycle 14 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

Resources 0.2 FTE

Required:

Analysis

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 ~ 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

Scheduling& These darks are not run during decon weeks; decon week darks

Special are in decon proposal. As requested, timing requirements have

Requirements been hard-coded via special requirements.

Proposal ID 10745: WFPC2 Cycle 14 Internal Monitor

Plan

Purpose This calibration proposal is the Cycle 14 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 in 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 (except on decon weeks), on a non-interference basis. This proposal should not be run during Decon weeks as the decon proposal will contain 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

Resources 0.1 FTE

Required:

Analysis

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 10749: WFPC2 Cycle 14 Vis Earth Flats

Plan

Purpose Monitor flat field 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 flat-field features.

In Cycle 14, propose to continue monitoring only F502N (as was done in Cycles 12 & 13; prior to Cycle 12, all 12 narrow-band filters have been used). A detailed study of earthflats (Koekemoer 2001) showed that there was no time evolution in the color dependence of flatfields, i.e. the time evolution of flatfields is monochromatic.

Fraction 100%

GO/GTO

**Programs
Supported**

Resources 50 occultation periods (“internal orbits”).

Required:

Observation

Resources 0.1 FTE

Required:

Analysis

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 10750: WFPC2 Cycle 14 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 flatfield due to changes in the camera geometry as well as any possible long-term changes from permanent evaporation of contaminants.

Fraction ~10%

GO/GTO

Programs

Supported

Resources 20 occultation periods (“internal orbits”).

Required:

Observation

Resources 0.1 FTE

Required:

Analysis

Products Updated flatfields for pipeline via CDBS.

Accuracy 3-10%.

Goals

Scheduling&

Special

Requirements

Proposal ID 10751: WFPC2 Cycle 14 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 to take extra VISFLAT, INTFLAT, and Earthflat exposures to test the repeatability of filter wheel motions.

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 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: 80 “internal” orbits and occultation periods (for earth flats).

Observation

Resources Required: 0.1 FTE

Analysis

Products TIR, ISR

Accuracy 0.3%

Goals

Scheduling & Special Requirements once per cycle; schedule INTFLATs only during ACS anneals to avoid scattered light

Proposal ID 10746: WFPC2 Cycle 14 CTE Monitor

Plan

Purpose Measure CTE during Cycle 14; 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, 10364), 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 average CTE loss between these chips. 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. Finally, as a close-out activity, we include two additional orbits to allow individual measurement of the CTE in WF2 and WF4. This will allow confirmation of whether WF4 has substantially less CTE than the other chips, and whether there are in fact chip-to-chip variations in CTE.

Fraction 40 - 60%

GO/GTO

Programs

Supported

Resources 2 + 2 external orbits.

Required:

Observation

Resources 0.2 FTE

Required:

Analysis

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 13 CTE program.

Special

Requirements

Proposal ID 10747: WFPC2 Cycle 14 Photometric Monitor & Close-Out

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 chip/filter combinations used in Cycle 14. Additional observations in all chips for standard photometric filters. The chip/filter combinations are PC1 & WF3: F218W, F255W, F336W, F439W, F450W, F467M, F469N, F487N, F547M, F555W, F606W, F631N, F656N, F673N, F791W, F814W, F953N, F1042M, and FQCH4N15; WF2 & WF4: F439W, F450W, F555W, F606W, F814W (3 orbits). Additional filters which have not been calibrated in recent Cycles are included as a close-out activity (4 orbits); performing these calibrations now will allow repeat of any failed observations prior to WFPC2 de-orbit. All 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 3 + 4 external orbits.

Required:

Observation

Resources 0.2 FTE

Required:

Analysis

Products ISR, SYNPHOT update.

Accuracy 2-3% photometry.

Goals

Scheduling& Execute within 7 days of Decon. To simplify scheduling process,

Special process, timing requirements are hard-coded via special requirements.

Requirements Execute mid-cycle.