WFPC2 Cycle 7 Closure Report

S. Baggett, J. Biretta, S. Casertano, S. Gonzaga, I. Heyer, M. McMaster, C. O'Dea, A. Schultz, B. Whitmore, M. Wiggs
December 23, 1999

ABSTRACT

This report describes in detail the WFPC2 observations used to maintain and improve the quality of WFPC2 calibrations during Cycle 7 and their status as of October 1999. Also included are the WFPC2 programs executed during the NIC3 Campaign in 1998 and summaries of the Cycle 6 proposal analyses completed since the writing of the Cycle 6 Closure report.

1. Overview

As discussed in the Cycle 7 Calibration Plan for WFPC2 (ISR 97-06, Casertano et al.), the major goals of the calibration program during Cycle 7 were to verify the stability of the instrument and to continue pursuing the remaining issues limiting the photometric accuracy. Cycle 7, at about 24 months long (June 1997 to June 1999), was longer than previous cycles. The original plan called for a norminal 1 year Cycle, however, this was later extended because 1) the Servicing Mission verifications in early 1997 required more orbits than originally estimated and 2), the NICMOS observing program was accelerated in order to complete as many observations as possible before the cryogen ran out (this included nearly 1000 extra orbits accepted during a special call for NICMOS proposals in 1997). For WFPC2, the increased Cycle length translated to an increase in emphasis on the monitoring proposals, which were of course extended as necessary to provide coverage throughout the entire term of Cycle 7 and a smooth transition into the Cycle 8.

Monitoring Programs

As in previous Cycles, the monitoring program revolved around the monthly decontamination (decon) procedures used to remove contaminants from the CCD windows and to anneal hot pixels (proposal 7619). Each decon was flanked by the Photometric Monitoring program (7618), consisting of observations of the standard white dwarf GRW+70d5824 which provided regular measurements of the photometric throughput, the contamination state of the CCD windows, the PSF properties at a variety of wavelengths, and the OTA focus. Regular internal observations were also used for monitoring: weekly darks (7619, 7620, 7621, 7712, 7713), to produce dark reference files and hot pixel lists; weekly biases, INTFLATs, and K-spots (7619, 7622, 7623) as a check of the camera's optics, electronics chain, and the pixel-to-pixel response in the visible and to produce bias reference files; Earth flats (7625), to map any changes in the flatfields; and UV flats (7624) to monitor the pixel-to-pixel response in the UV.

Most of the internal programs were continuations from previous Cycles; however, in response to behaviour noted in the instrument during previous cycles, two new monitors were implemented in Cycle 7. The first was the set of Supplemental Darks (7621, 7712, 7713; multiple proposals were required for ease in implementation and scheduling). The supplemental darks are short, 1000 sec darks taken daily on a low-priority, non-interference basis, up to 3 darks per day, intended as an aid in identifying hot pixels. The other new monitoring program was the Astrometric Monitor program (7627), to allow tracking of the WFPC2 chip positions in the focal plane: previous measurements revealed that a gradual shift of ~1 pixel total has occurred since early 1994.

Special Programs

Three special calibration programs were planned for Cycle 7: two to help improve the photometric accuracy of WFPC2 and one to help expand the PSF library holdings. The Photometric Characterization (7628) repeated some of the previous cycle's NGC 2100 imaging, to check for temporal changes in the zeropoints, and included new observations of NGC2419 to expand the coverage to bright red giants. In addition, the usual filter sweep was performed using the primary white dwarf standard GRW+70d5824 and the field standards in ω Cen. The second special calibration program was the CTE Characterization (7630); these data were taken to provide a complete set of observations with which to explore the parameter space of the 'long vs short' anomaly (stars appear fainter in shorter exposures) and refine the flux and background-level dependent aperture corrections. Finally, the PSF Characterization program (7629) obtained observations of ω Cen in the "wide UBVR" filters (F300W, F450W, F606W, F702W) and I filter (F814W); these filters are frequently used for their high throughput but are not as well characterized as the standard UBVR set (F336W, F439W, F555W, F675W).

Cycle 6 Carry-Overs and NIC3-Campaign WFPC2 Programs

We also take this opportunity to close out the remaining Cycle 6 programs that had not been completed at the time of the Cycle 6 Closure Report (ISR 98-01, Baggett et al.) and to include the WFPC2 calibration programs implemented as a result of the NIC3 observing campaign in 1998; the programs are summarized in Table 2. Results from those proposals are presented here, if possible, under their Cycle 7 counterpart proposals (e.g., Earth Flat results from Cycle 6 are included in the Earth Flat results from Cycle 7). The Cycle 6 carry-overs include the Visflat Monitor (6906, results are included with 7623 Internal Flats), the Earth Flats (7909, results included with 7625 Cycle 7 Earth Flats) program, the Photometric Transformation (6935, results included with 7628 Photometric Characterization), the UV Throughput (6936), the PSF Characterization (6938, results are included with 7629 Cycle 7 PSF Characterization, the Post-NIC3 Campaign Focus Check (7925, results included with 7618 Photometric Monitoring), and the Long Decons (8049, results included with 7619 Decontaminations).

2. Format of this document

Table 1 presents a summary of the Cycle 7 calibration proposals; Table 2 presents a summary of the Cycle 6 carry-overs and the WFPC2 programs run during the NIC3 campaign in 1998. The tables include proposal titles and numbers, frequency with which the program was executed, estimated resources (actual external orbits used included in brackets), any products of the analysis, accuracy of the results, and general notes. The remainder of this document consists of detailed descriptions of each calibration program in a standard format, designed for ease in viewing electronically as well as on paper. For each program, the left side of the page ("Plan") contains the original description of the planned observations, their purpose and expected results; the right side of the page ("Results") describes any modifications to the Plan, details on the execution, actual resources used (as obtained from PRESTO statistics), results achieved, a timeline of activity, and plans for any future continuation of the program. If the program is not complete, an estimate is given of the resources that will be necessary for completion. Finally, a detailed bibliography is provided, listing any new documents since the last closure report as well as pointers to items of general interest.

Table 1: Summary of Cycle 7 Calibration Programs.

ID	Proposal Title	Frequency	Estimated Time (orbits)		Products	Accuracy	Notes
			"External"	"Internal"			
			Routine Monitoring Programs				
7618	Photometric Monitoring	1-2/4 weeks	36 [39]		SYNPHOT	1-2%	Done. Also used as focus monitor.
7619	Decontamination	1/4 weeks		288	CDBS	n/a	Done. Used together with darks, internals.
7620	Standard Darks	weekly		360	CDBS,WWW	1 e^-/hr	Done. Also hot pixel lists on WWW.
7621+	Supplemental Darks	weekly		2016		n/a	Done. Data archived; no analysis provided.
7622	Internal Monitor	2/4 weeks		72	CDBS, TIR	0.8 e^-/pix	Done. New superbias reference files.
7623	Internal Flats	1/4 weeks		75	TIR	0.3%	Done. Mostly INTFLATs.
7624	UV Flat Field Monitor	2/cycle	4	8		2-8%	Done. Data obtained before and after decons.
7625	Earth Flats	continuous		155	CDBS	0.3%	Done.
7626	UV Throughput	2/cycle	4		SYNPHOT	3-10%	In progress.
7627	Astrometric Monitor	2/cycle	2	2	TIPS, TIR	0.05''	In progress. Also included K-spots
			Special Calibration Programs				
7628	Photometric Characteriz.	1	10		ISR	2-5%	In progress.
7629	PSF Characterization	1	5		WWW	10%	Done. Filters F300W, F450W, F606W, F702W, F814W.
7630	CTE Characterization	1	14 [13]		ISR	0.01 mag	Done.
7631	Polarization proposal	1	4		WWW,ISR	3-5%	Placeholder; later withdrawn in favor of Cycle 8 program 8053.
7929	CTE Monitoring	4	4		ISR, PASP	0.02 mag	Done. Measure changes in CTE ramp
8054	LRF Calibration	1	10 [12]		ISR	3-5%	In progress. Test LRF stability
8053	Supplemental Earth Flats	1		155	CDBS	0.3%	In pogress. Flats for end of cycle; results included as part of 7625.
	TOTAL TIME (including all executions)		93 [97]	3131	***Assumes Cycle 7 length of 96 weeks (22 months)***		

Orbits listed in Estimated Time column are orbits requested and used; a [] marks cases where the actual number (bracketed) differed from the estimate.

Table 2: Summary of Carry-Over Cycle 6 and WFPC2 NIC3 Campaign Programs.

ID	Proposal Title	Frequency	Estimated Time (orbits)		Products	Accuracy	Notes
			“External”	“Internal”			
Cycle 6 Proposals							
6906	Visflat Monitor	2/4 weeks		62	ISR	0.3%	Done. Included in results for 7623 (Internal Flats)
6909	Earth Flats	continuous		155	CDBS	0.3%	Done. Included in results for 7625 (Cycle 7 Earth Flats).
6935	Photometric Transform.	2	12		ISR	2-5%	In progress. Included in results for 7628 (Photometric Characterization).
6938	PSF Characterization	1	7		CDBS	10%	Done. Included in results for 7629 (Cycle 7 PSF Characterization).
6939	Linear Ramp Filters	1	6		CDBS	3%	Withdrawn in favor of 8054 (Cycle 7 LRF Calibration).
6940	Polarizers	1	4		CDBS	3-5%	Program deferred to Cycle 8 (8053).
6941	Astrometry Verification	1	4		STSDAS	0.01’’	In progress. Included in results for 7627 (Cycle 7 Astrometric Monitor).
WFPC2 Calibrations during NIC3 Campaign							
7925	Post-NIC2 Campaign Focus Check	1	1		WWW	1 micron RMS	Done. Included in results for 7618 (Photometric Monitor).
8049	Long WFPC2 Decons	1		56	CDBS	n/a	Done. Included in results for 7619 (Decontamination proposal).

Proposal ID 7618: WFPC2 Cycle 7: Photometric Monitor

	Plan		Results
Purpose	Regular external check of instrumental stability. Based on Cycle 6 program 6902.	**Modifications**	Three extra orbits were added to allow for special monitoring done during the NIC3 campaign in June 1998.
Description	Standard star GRW+70d5824 is observed before and after a decontamination (decon) using three different strategies: (1) F170W in all four chips to monitor contamination in the far UV; (2) F439W, F555W, F814W on the PC to monitor focus; (3) F160BW, F218W, F255W, F300W, F336W, F439W, F555W, F675W, F814W in a different chip each month. Observations are taken after each decon and before every other decon, resulting in 36 orbits for 24 decon cycles.	**Execution**	No problems. Due to changing target visibility windows during the year, occasional exposures had to be trimmed to maintain single-orbit visits.
Prog. Supported	100%	**Time-line**	Executed roughly every 28 days
Resources	36 pointed orbits (assumes 24 decon cycles in Cycle 7)	**Resources Used**	39 orbits.
Products	Instrument Handbook, reports at monthly TIPS meetings, WWW (sensitivity trends); updates in UV sensitivity variation used in SYNPHOT.	**Products**	Photometric monitoring results (see Figure 1) were presented in the WFPC2 Handbook, at TIPS meetings, and on WWW. The data were also used in Longterm Photometric Stability study ISR 98-03 (Baggett & Gonzaga) and in focus monitoring (Lallo).
Accuracy Goals	Overall discrepancies between the results of this test need to be measured to better than 2% and are expected to be less than 1% rms. This has been the case in Cycles 4 through 6. The point of the test is to measure this variation. Focus measurements have an expected accuracy of 1.5 micron, and a goal of 1 micron; the uncertainty in the focus determination is dominated by external factors, such as OTA breathing.	**Accuracy Achieved**	The standard star countrates have remained stable to about 1%. Longterm photometric monitoring (ISR 98-03, Baggett & Gonzaga) found that typical fluctuations are ~2% or less peak to peak over 4 years in filters longwards of and including F336W. At the same time, the UV throughput has gradually evolved, with post-decon countrates increasing in some filters (e.g., 12% in F160BW+PC and ~9% in F170W+PC), while decreasing in other filters (e.g., ~3% in F255W+PC; see Figure 2). In addition, contaminant growth rates have slowed slightly for some UV filters (e.g., ~1%/day to 0.5%/day in F160BW on PC). In general, data taken with filters redward of F336W do not require a contamination correction based on day since decon however, they may require a small zeropoint correction. The Observatory WWW pages present the focus monitoring results (see also Figure 4, below); ~1 micron RMS of secondary mirror motion is typically achieved (Lallo).
Special Requirements	Needs to be scheduled shortly before and after decontaminations (up to 5 days).	**Continuation Plans**	Similiar monitoring will continue into Cycle 8.

Figure 1. Photometric monitoring results for PC1 and WF3, from Feb. 1994 through Sep. 99, taken from WWW photometric monitoring memo (Gonzaga et al.,). Note the restoration to “normal” throughput in the UV after each decon as well as the gradual longterm trends.

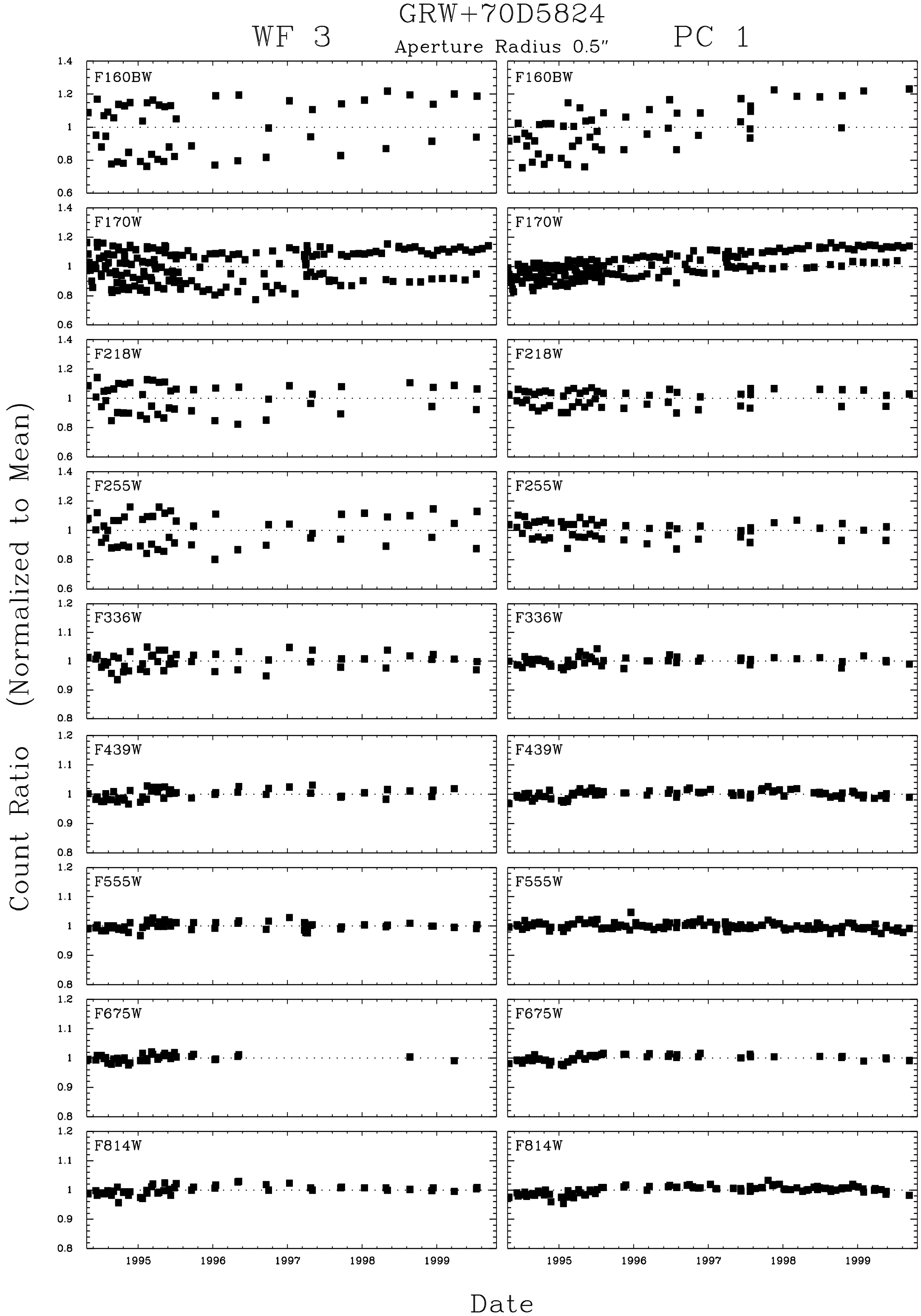


Figure 2. Contamination-corrected normalized countrates for PC and WF2 as a function of Modified Julian Date (1994-1998), illustrating the longterm photometric changes in WFPC2 (figure from Longterm Photometric Stability study ISR 98-03 (Baggett & Gonzaga). The cause of the discontinuity (near Feb 1995, MJD 49750) remains elusive.

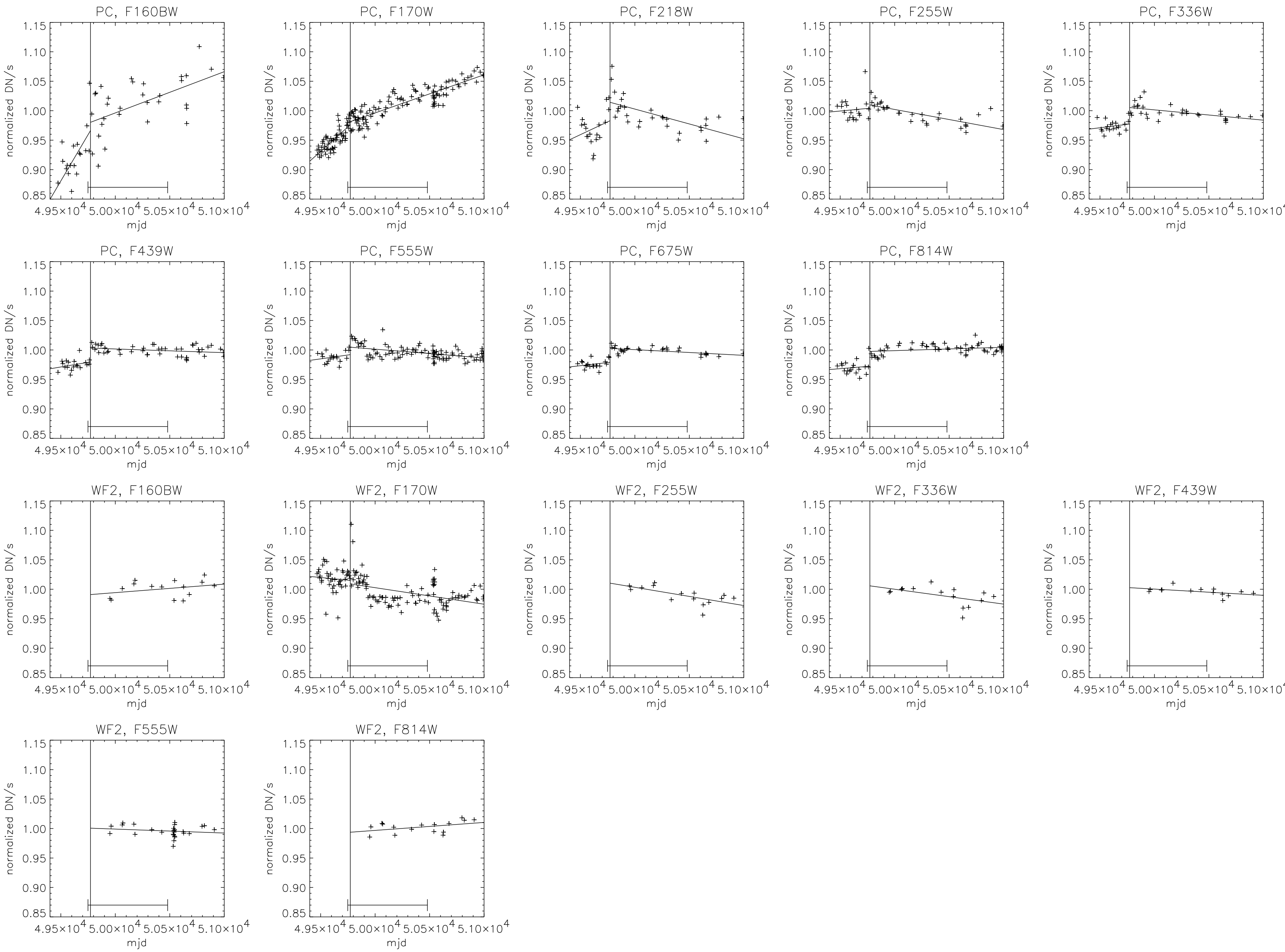
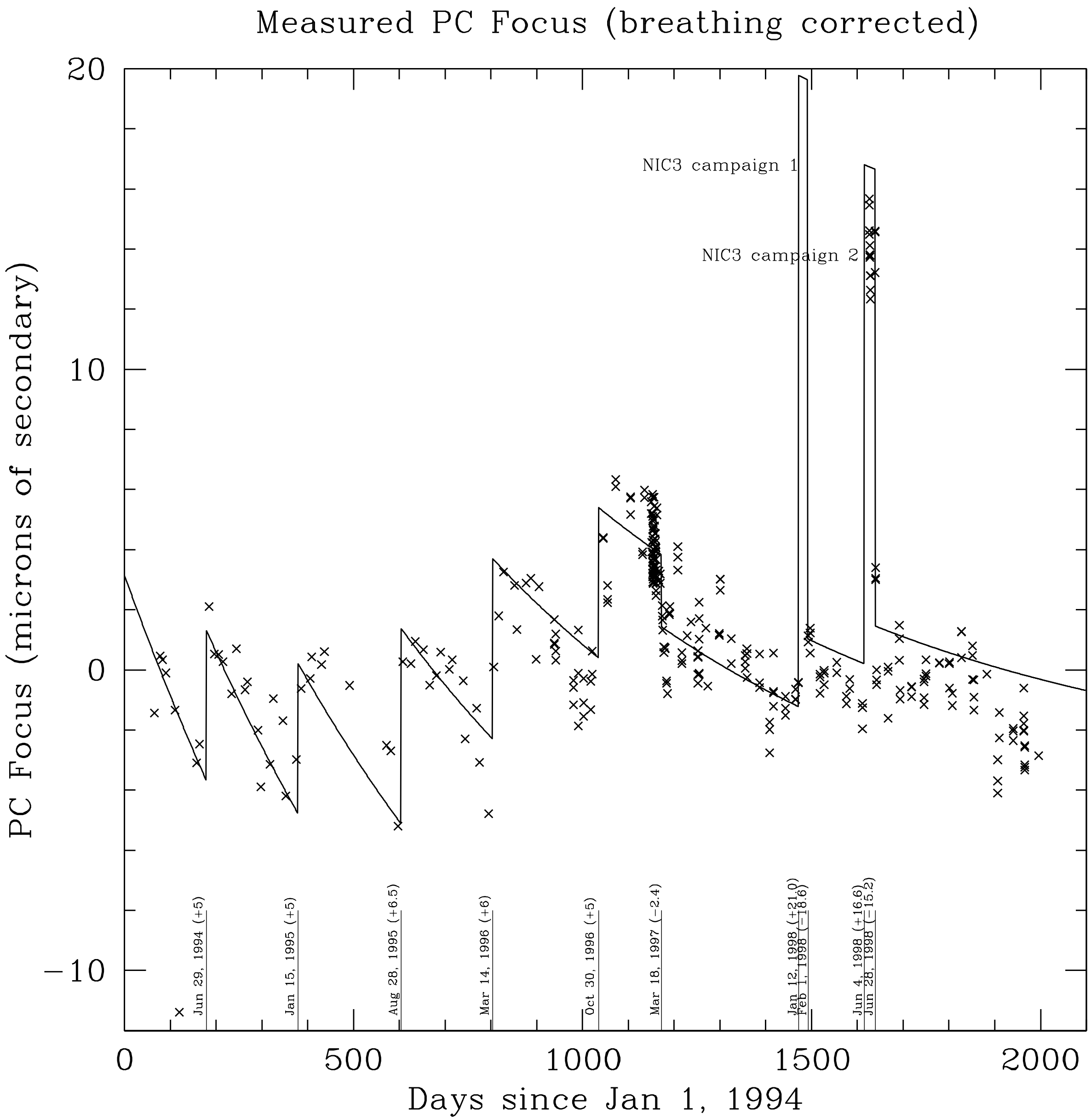


Figure 3. History of the PC focus since Jan 1994. The focus values have been corrected for breathing (single-orbit timescale) effects using the Hershey model; superimposed on the data are the secondary mirror moves and the best fit exponential (figure taken from Observatory WWW pages (Lallo)).



Proposal ID 7619: WFPC2 Cycle 7 Decontamination (includes results from 8049 Long Decons during NIC3 Campaign)

Plan

Purpose UV blocking contaminants are removed, and hot pixels cured, by warming the CCDs to +20C for six hours.

Description The decontamination (decon) itself is implemented via the DECON mode, in which the TECs are turned off and the CCD and heatpipe heaters are turned on to warm the detectors and window surfaces. Keeping WFPC2 warm for ~6 hours has been shown in previous Cycles to be sufficient to remove the contaminants and anneal many hot pixels.; continuation of 6-hour decons is anticipated for Cycle 7.
The observations taken before and after each decon consist of: 4 biases (2 at each gain), 4 INTFLATs (2 at each gain), 2 K-spots (both gain 15, one short and one long, optimized for PC and WF), and 5 darks (gain 7, clocks off). To minimize time-dependent effects, each set of internals will be grouped within 2 days and performed no more than 1 day before the decon and no later that 12 hours after the decon. To prevent irretrievable loss of the critical pre-decon hot pixel status information, the darks will be executed as a non-interruptible sequence at least 30 minutes after any other WFPC2 activity.

Prog. Supported 100%

Resources 288 internal (assumes 24 decon cycles in Cycle 7)

Products Those obtained from use of darks, biases and other intenals (see Proposals 7620 and 7622).

Accuracy Goals Objective is to insure that the contaminants are periodically removed from the CCD window. Biases, darks and other internals taken with this proposal are used in generating reference files (see Proposals 7620 and 7622).

Special Requirements Requires scheduling at 4 week intervals. Dark frames taken before decons must be protected from residual images.

Results

Modifications None.

Execution Routine decons were successfully performed once every ~28 days.
Due to SMOV in 1997 and the NIC3 campaign in 1998, not all requested internal orbits were needed.

In June 1998, the secondary mirror was moved to bring NIC3 into focus, a NIC3 Observing “Campaign”. The mirror move of course resulted in moving WFPC2 out of focus, so no WFPC2 science programs were scheduled during the campaign. This opportunity was used to test whether very long decons (four decons, each 24 hours at +22C, proposal 8049) would reduce the CTE effects - it did not (Casertano, priv.comm.; also see results from CTE monitor 7929, which was run a few weeks after the NIC3 campaign’s end).

Time-line See Table 3 below.

Resources Used 168 internal orbits (not all internal exposures needed).

Products Dark reference files for pipeline (Wiggs et al.); hotpixel lists for WWW (Wiggs & Casertano); updates to WFPC2 History File on WWW (Baggett & Wiggs).

Accuracy Achieved N/A. Periodic removal of contaminants and annealing of hot pixels was successful. Table 3 below lists all decon procedures done to date. Figure 1 in Photometric Monitoring proposal (7618) section illustrates the restoration to nominal throughput after each decon.

Continuation Plans The 4 week decon schedule will be continued in Cycle 8.

Table 3. WFPC2 Decontamination Dates and Parameters, taken from the WFPC2 History Memo on the WWW (maintained by Baggett and Wiggs). Column labeled ‘t’ is length of time chips are kept warm; time given reflects the cooldown start time, cameras are ready for science ~3.5 hours later.

date	MJD	t	date	MJD	t	date	MJD	t	date	MJD	t[a]
1994			17 Oct 09:43	50007.4053		21 Mar 03:35	50528.1494	6	Aug 21 12:23	51046.5161	6
Feb 22 11:37	49405.4840	6	15 Nov 08:53	50036.3706		05 Apr 08:50	50543.3681	6	Sep 15 02:18	51071.0963	6
Mar 24 11:08	49435.4639	6	14 Dec 07:03	50065.2929		25 Apr 23:00	50563.9583	6	Oct 14 02:39	51100.1104	6
Apr 24 00:49	49466.0340	6	1996			15 May 20:18	50583.8460	6	Nov 10 05:01	51127.2090	6
May 23 15:00	49495.6250	5.5	11 Jan 23:24	50093.9750	6	07 Jun 13:06	50606.5461	6	Dec 08 14:19	51155.5969	6
Jun 13 11:02	49516.4597	12	11 Feb 00:30	50124.0208	6	24 Jun 11:04	50623.4612	6	Dec 31 03:29	51178.1453	6
Jul 10 11:40	49543.4861	12	10 Mar 00:21	50152.0147	6	24 Jul 18:42	50653.7795	6	1999		
Jul 28 07:12	49561.3000	12	02 Apr 00:16	50175.0111	6	20 Aug 02:17	50680.0952	6	Jan 28 01:06	51206.0458	6
Aug 27 09:46	49591.4069	12	04 May 17:09	50207.7146	6	17 Sep 17:24	50708.7256	6	Feb 23 22:43	51232.9471	6
Sep 25 00:46	49620.0319	12	28 May 06:16	50231.2614	6	13 Oct 18:00	50734.7506	6	Mar 25 20:15	51262.8441	6
Oct 21 00:41	49646.0285	12	22 Jun 22:15	50256.9277	6	14 Nov 05:19	50766.2217	6	Apr 20 23:47	51288.9910	6
Nov 19 17:29	49675.7285	6	28 Jul 13:34	50292.5653	6	10 Dec 09:40	50792.4027	6	May 19 08:28	51317.3528	6
Dec 18 06:00	49704.2500	6	23 Aug 10:10	50318.4242	6	1998			Jun 16 07:07	51345.2965	6
1995			18 Sep 16:25	50344.6840	6	Jan 08 00:03	50821.0025	6	Jul 14 04:07	51373.1715	6
13 Jan 16:14	49730.6764	6	18 Oct 07:46	50374.3236	6	Feb 01 19:15	50821.0025	6	Aug 10 04:00	51400.1667	6
12 Feb 01:54	49760.0792	6	12 Nov 09:40	50399.4031	6	Mar 06 09:18	50878.3877	6	Sep 9 01:27	51430.0604	6
11 Mar 14:30	49787.6042	6	15 Dec 00:00	50432.0417	8	Mar 31 12:54	50903.5376	6	Oct 5 15:27	51456.6437	6
8 Apr 10:29	49815.4368	6	19 Dec 12:33	50436.5229	6	May 02 12:26	50935.5186	6	Nov 3 06:51	51485.2854	6
7 May 01:13	49844.0507	6	1997			Jun 07 21:01	50971.8757	24			
2 Jun 18:30	49870.7708	6	07 Jan 23:41	50455.9875	6	Jun 09 23:59	50973.9993	24			
27 Jun 20:00	49895.8333	6	09 Feb 00:00	50488.0006	6	Jun 12 08:01	50975.3340	24			
30 Jul 08:50	49928.3681	6	23 Feb 19:08	50502.7978	6	Jun 25 06:59	50989.2910	24			
27 Aug 05:43	49956.2382	6	27 Feb 06:31	50506.2721	6	Jun 28 14:06	50992.5881	6			
22 Sep 03:40	49982.1528	6	04 Mar 10:16	50511.4278	6	Jul 22 18:56	51016.7889	6			

Proposal ID 7620: WFPC2 Cycle 7 Standard Darks

Plan

Purpose Measure dark current on individual pixels and identify hot pixels at frequent intervals.

Description Every week, five 1800s exposures are taken with the shutter closed. The length of the exposures is chosen to fit within an occultation period. The weekly frequency is required because of the high formation rate of new hot pixels (several tens per CCD per day). Five darks a week are required for cosmic ray rejection, to counterbalance losses due to residual images, and to improve the noise of individual measurements. Even with these measures, some weeks no usable darks will be available because of residual images. Normally this results only in a longer-than-usual gap in the hot pixel lists, but in a decontamination week, information on pixels that became hot and then annealed would be lost irretrievably. For this reason, pre-decon darks are to be executed NON-INT and at least 30 minutes after any WFPC2 activity (see Proposal 7619). Normal darks do not need to be protected in this fashion.

Prog. Supported 90%

Resources 360 internal orbits (occultation periods)

Products Weekly dark frames delivered to CDBS and monthly tables of hot pixels on the Web.

Accuracy Goals The required accuracy for darks is about 1 e^-/hour (single-pixel rms) for the vast majority of science applications. The expected accuracy in a typical superdark is 0.7 e^-/hour for normal pixels. The need for regular dark frames 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.

Special Req's None.

Results

Modifications More internal orbits were required than initially requested, due to the extension of Cycle 7.

Execution No problems, proposal executed as planned.

Note that additional information on hot pixels can be obtained from the dark frames taken via the Supplemental Darks program (7621, 7712, 7713). The supplemental darks are archived only and not used to generate dark reference files.

Time-line 5 darks/week.

Resources Used 438 occultation periods.

Products Reference files delivered to CDBS roughly every week (Wiggs et al.), accessible via Starview or WWW Reference File listing. WWW hotpixel lists are maintained as well. (Wiggs et al.).

Accuracy Achieved The typical superdark accuracy is ~0.7 e^-/hour.
The low-level dark current has been steadily increasing: over ~5 years, the dark current in the chip centers has increased by a factor of ~2.2 in the WF chips and ~1.3 in PC (TIR 98-03; Baggett et al.). The increase is included in the reference files; the dark current remains a small portion of the total image noise.
An additional change noted is an increase in the number of permanent hot pixels (Casertano, priv.comm.). Over the two years since the previous super-dark, the number of permanent hotpixels has increased by a factor ~2.5 at all intensity levels - though these permanently hot pixels still represent only a very small fraction (~0.2%) of the total pixels. These permanent hot pixels are likely caused by radiation damage to the detector pixels.

Cont. Plans Cycle 8 to continue the 5 darks/week.

Proposal ID 7621, 7712, 7713: WFPC2 Cycle 7 Supplemental Darks

	Plan		Results
Purpose	Obtain very frequent monitoring of hot pixels.	**Modifications**	None.
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 observations can fit into almost any occultation period, making automatic scheduling feasible. Supplemental darks will be taken at low priority, and only when there is no other requirement for that specific occultation period. This program is complementary with 7620, Standard Darks, whose longer individual observations are better suited to produce high-quality pipeline darks and superdarks, and are also carried out at higher priority. Note that hot pixels are often a cause of concern for relatively short science programs, since they can mimic or mask key features of the observations, and about 400 new hot pixels per CCD are formed between executions of the Standard Darks program (7620). These observations will be made available as a service to the GO community, and there is no plan to use them in our standard analysis and products. This program is only feasible starting in Cycle 7, thanks to the Solid State Recorder.	**Execution**	No problems. These darks are rated as low priority, to be taken on a non-interference basis as time allows. However, generally the schedule allowed for all 3 supplemental darks to be taken each day.
Prog. Supported	30%	**Time-line**	Three darks per day if possible.
Resources	2016 internal orbits (occultation periods) maximum, depending on availability of suitable opportunities; program runs in no-interference, low-priority mode. The proposal will be designed to obtain up to 3 darks per day over Cycle 7, provided there are no other scheduling conflicts.	**Resources Used**	1957 internal orbits.
Products	None.	**Products**	There is no plan to use these darks in the standard WFPC2 analysis tasks or products. Data are taken and archived, available to the user community via Starview.
Accuracy Goals	N/A	**Accuracy**	N/A
Special Requirements	Must be designed to allow automatic scheduling at low priority. Three program IDs required due to large number of visits (one dark per visit).	**Continuation Plans**	Cycle 8 to continue the daily darks program.

Proposal ID 7622: WFPC2 Cycle 7 Internal Monitor

Plan

Purpose Verification of short-term instrument stability for both gain settings.

Description The internal observations will consist 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. This proposal is similar to the Cycle 6 Internal Monitor (6905).

Prog. Supported 100%

Resources 72 internal orbits (occultation periods)

Products Superbiases delivered yearly 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.

Accuracy Goals Approximately 120 bias frames will be used for each superbias pipeline reference file, generated once per year; accuracy is required to be better than 1.5 e^-/pix, expected to be 0.8 e^-/pix.

Special Requirements None.

Results

Modifications None.

Execution No problems.
Due to SMOV in 1997 and the NIC3 campaign in 1998, not all requested internal orbits were needed.

Time-line Every week except decon weeks.

Resources Used 69 internal orbits.

Products Results were presented at TIPS meetings. Updated bias files have been installed in CDBS (Gonzaga et al.), accessible via Starview or WWW Reference File listing. No significant differences were found between the old and new biases.

Accuracy Achieved Sets of 120 bias frames are used to generate reference files; the resulting accuracy is ~0.5 e^-/pixel (Properties of WFPC2 Biases, (O'Dea et al., ISR 97-04). Statistics of recent biases are given in the table below.

Continuation Plans Similar weekly monitoring will continue in Cycle 8.

Table 4. Statistics (in DN) of recent superbias files; pedigree column lists epoch of bias frames used in the superbias.

name	gain	PC		WF2		WF3		WF4		pedigree
of superbias reference file		**mean**	**stddev**	**mean**	**stddev**	**mean**	**stddev**	**mean**	**steddev**	**dates of bias frames used to generate reference files**
i2i1201qu	7	0.343	0.128	0.313	0.154	0.295	0.134	0.318	0.146	31/07/96-30/11/97
i9817383u	7	0.347	0.149	0.327	0.254	0.314	0.494	0.344	0.306	01/12/97-13/08/98
j9a1612mu	7	0.345	0.141	0.336	0.267	0.330	0.533	0.351	0.388	29/08/98-21/08/99
i2h1025iu	15	0.176	0.075	0.160	0.085	0.149	0.079	0.169	0.090	22/08/96-30/11/97
j3f1747qu	15	0.183	0.084	0.163	0.131	0.168	0.087	0.185	0.161	01/12/97-13/08/98
j9a1612nu	15	0.188	0.081	0.162	0.137	0.154	0.267	0.181	0.205	29/08/98-21/08/99

Proposal ID 7623: WFPC2 Cycle 7 Internal Flats

Plan

Purpose Monitor the pixel to pixel flatfield response and the VISFLAT lamp degradation as well as detect any possible changes due to contamination. This program is a combination and continuation of the Cycle 6 VISFLAT and INTFLAT Monitor proposals (6906, 6907, respectively).

Description This proposal contains an INTFLAT filter sweep, a VISFLAT mini-sweep, linearity tests, and monitoring images. Monitoring is carried out by taking INTFLATs with the photometric filter set after each decon. The VISFLAT mini-sweeps (before and after decon, twice during the cycle) will include the photometric filter set at gain 7, plus the linear ramp filter FR533N at both gains to test the camera linearity. The INTFLAT sweep, taken within a two-week period, includes almost all filters, some with both blades and gains. The linearity test will be done at both gains and blades using F555W, and an additional set with one blade and gain with clocks on.

Prog. Supported 100%

Resources 75 internal orbits (occultation periods)

Products TIPS report, Technical Instrument Report if any significant variations are observed.

Results

Modifications None.

Execution No problems.

Due to SMOV in 1997 and the NIC3 campaign in 1998, not all internal orbits were needed.

Time-line Continuous; sweeps done Sep 97, Mar 98, Jun 98, Jan 99.

Resources Used 51 internal orbits.

Products Results have been presented at TIPS meetings as well as in ISR 99-01 Internal Flatfield Monitoring (O'Dea, Mutchler, & Wiggs) and in TIR 98-02 Analysis of Excess Charge in WFPC2 Overscans (Mutchler, O'Dea, & Biretta).

	Plan		Results
Accuracy Goals	Assuming Cycle 7 results will be similar to those from previous cycles, the VISFLATs should be stable to better than 1%, both in overall level and spatial variations (after correcting for lamp degradation), and contamination effects should be < 1%. For the INTFLATs, the signal-to-noise ratio per pixel is estimated to be similar to the VISFLATs, but the spatial variations in the illumination pattern are much larger. However, the INTFLATs will provide a baseline comparison of INTFLAT vs VISFLAT, in the event of a complete failure of the CAL channel system. Temporal variations in the flatfields can be monitored at the 1% level. Gain ratios should be stable to better than 0.1%.	**Accuracy Achieved**	A detailed comparison of VISFLATs and INTFLATs taken from 1994 to 1998 has been presented in ISR 99-01 Internal Flatfield Monitoring II. Stability of the Lamps, Flats and Gains (O'Dea, Mutchler, & Wiggs). The analysis showed that 1) the VISFLAT lamp continues to degrade (see Figure 4 below), 2) the INTFLAT lamps are quite stable, having increased in output by only 1.3% in 4 years, 3) the relative gain ratios are stable in WF2 and WF4, although there is a steady 0.3 % drift in the WF3 gain ratio, and a jump in the PC ratio of 0.7% during the servicing mission, 4) the pixel-to-pixel response of the chips is very stable, 5) there are a few small variations in the VISFLAT fields (donuts and blemishes) due to dust on optical surfaces either moving or appearing. The effects of contamination (location of "worms") are stable with time. The VISFLAT data were also used in an effort to further understand charge trapping effects in the WFPC2 CCDs (TIR 98-02, Mutchler, O'Dea, & Biretta). A significant signal above the nominal bias level was found in the VISFLAT overscan columns, a signal which decays to zero over several pixels. The amount of overscan charge appears independent of image counts (at least at high count levels), which is consistent with it being due to CTE traps in the serial register though other causes can not be ruled out. The amount of excess charge has also been increasing slowly with time (doubling since installation of WFPC2, see Figure 5), possibly due to long-term radiation damage in the CCD .
Special Requirements	The observations, especially VISFLATs, should be scheduled into a minimum of lamp cycles in order to help preserve the lamp's lifetime. To minimize filter wheel usage during the INTFLAT portion of the proposal, 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 INTFLAT sweep should be completed over a time span of no more than two weeks.	**Continuation Plans**	Overall, the results from the VISFLATs and INTFLATs are in good agreement. If the VISFLAT lamps become unusable, the INTFLAT lamps would provide useful diagnostics of all properties except possibly for the stability of the flat fields on large scales which is affected by the variations in the Carley bulbs.

Figure 4. VISFLAT lamp intensity as a function of cumulative lamp cycles (from ISR 99-01 (O'Dea et al.))

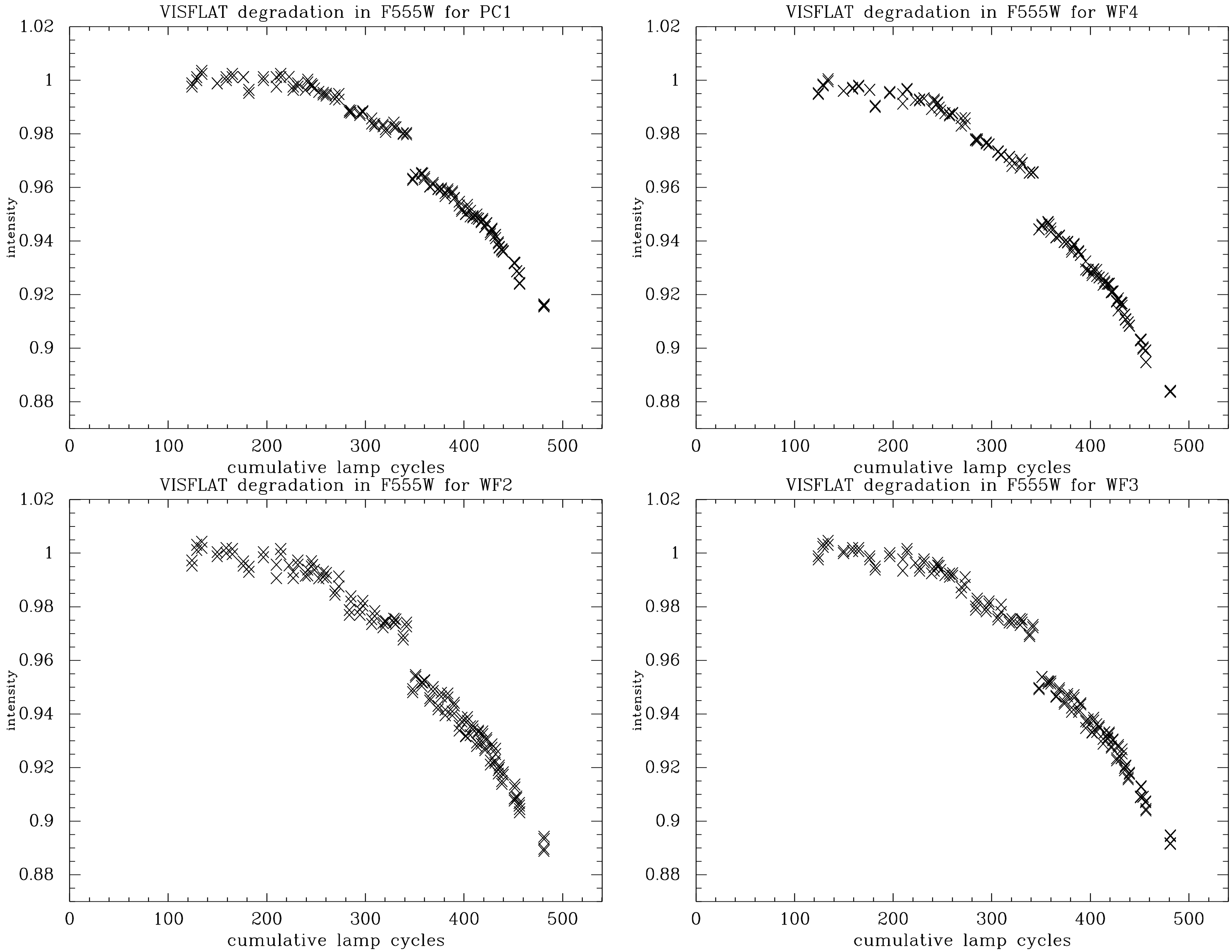
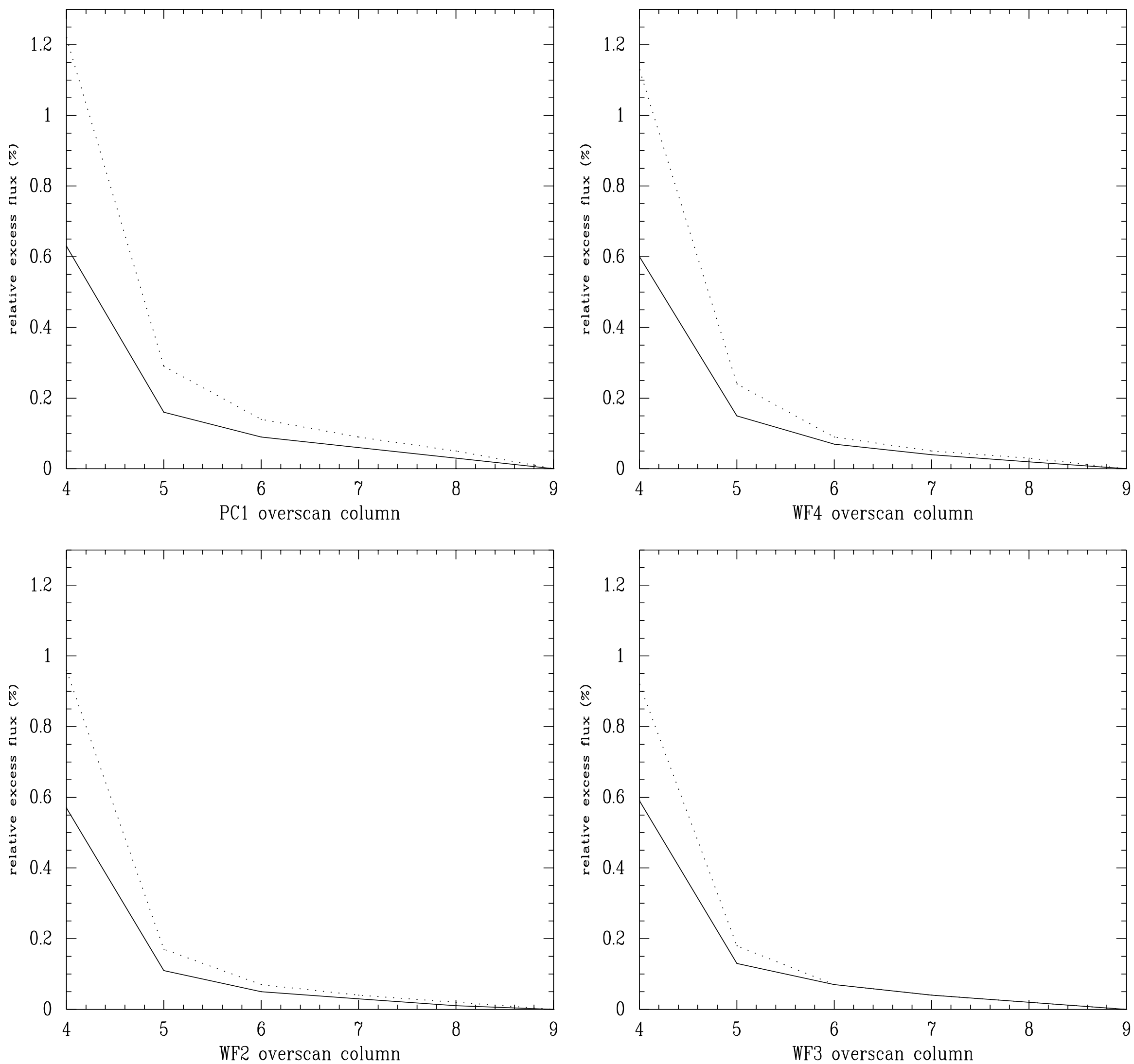


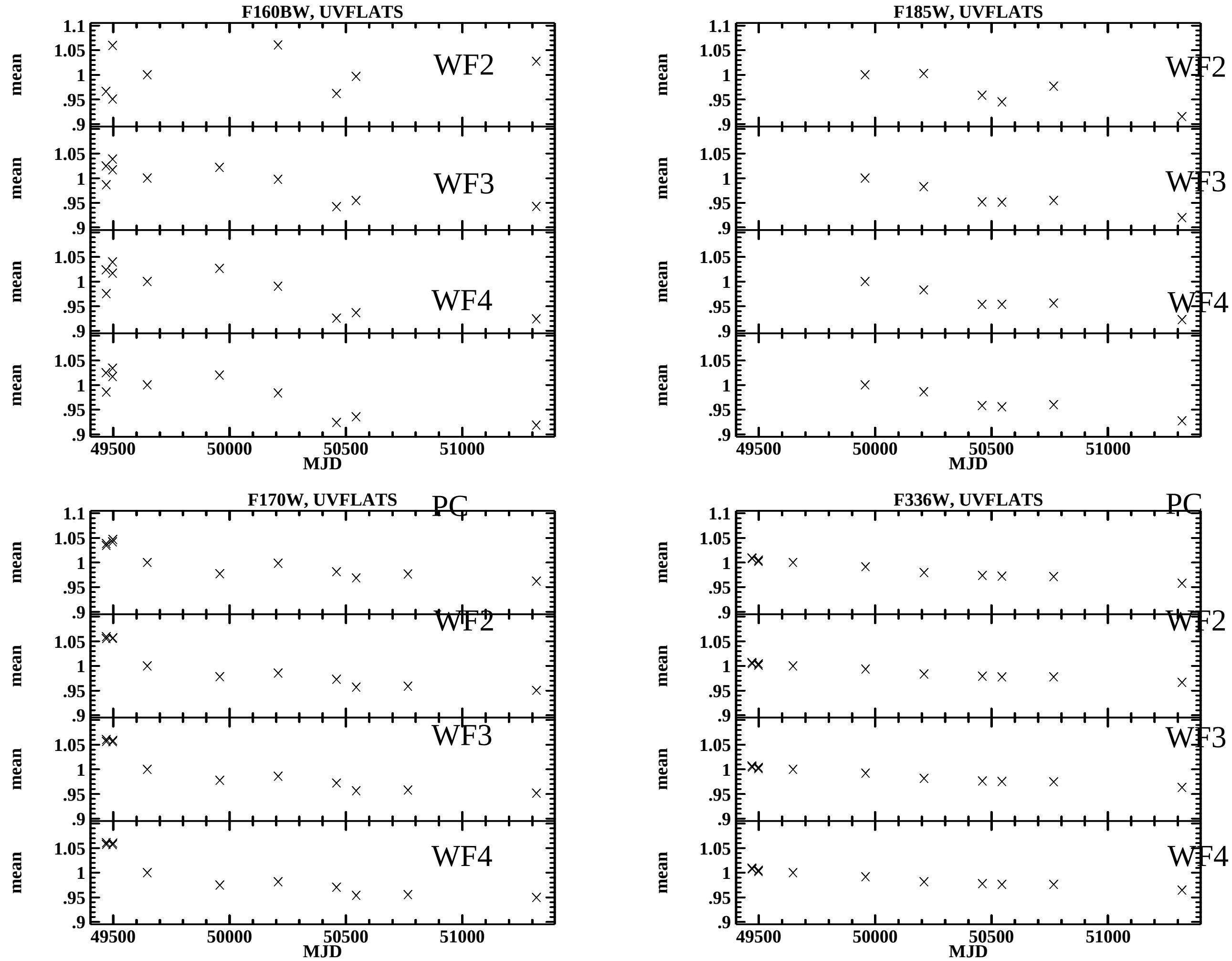
Figure 5. Excess overscan flux as a percentage of the incident flux for all four WFPC2 CCDs. Data from both 1994 (solid line) and 1998 (dashed line) are plotted to illustrate that the amount of deferred charge found in the WFPC2 overscans is increasing over time (from TIR 98-02, Mutchler, O'Dea, & Biretta; a paper copy of the report is available upon request to help@stsci.edu).



Proposal ID 7624: WFPC2 Cycle 7 UV Flat Field Monitor

Plan		Results	
Purpose	Monitor the stability of UV flat field.	**Modifications**	None.
Description	UV flat fields obtained with the CAL channel's ultraviolet lamp (UVFLAT) will be used to monitor the UV flat field stability and the stability of the Woods filter (F160BW) by using F170W as the control. The F336W ratio of VISFLAT (Cycle 6 proposal 6906) to UVFLAT will provide a diagnostic of the UV flat field degradation and tie the UVFLAT and VISFLAT flat field patterns together. Two dark frames are obtained immediately after each use of the lamp, in order to check for possible after-images.	**Execution**	UV flatfields were taken in F122M, F170W, F160BW, F185W, and F336W.
Prog. Supported	10%	**Time-line**	Nov 97, May 99.
Resources	4 orbits (non-pointed, but displaces WFPC2 science due to timing requirements), plus 8 occultation periods before and after.	**Resources Used**	4 orbits.
Products	New UV flat fields if changes are detected.	**Products**	Results reported at TIPS meeting.
Accuracy Goals	About 2-8% pixel-to-pixel expected (depending on filter).	**Accuracy Achieved**	The UV flats have been used to track the lamp degradation (see Figure 6); pixel-to-pixel scatter is roughly as expected: 2-3% for F336W, 2-4% in F170W, 6-10% in F185W, and ~10-20% in F160BW.
Special Requirements	Uses the limited-life UV lamp. To prevent excessive degradation of the lamp, SU duration for each UVFLAT visit are the same as those used in Cycles 5 and 6 (6191, 6908). Because of timing requirements, the observations cannot be taken entirely during occultation; each visit covers a 2-hour time span, thus one visibility period and two occultation periods (other instruments can be used during this period). To be executed twice during Cycle 7, after a decontamination.	**Continuation Plans**	Cycle 8 to continue the UV lamp monitoring.

Figure 6. UV flat field statistics from April 1994 to June 1999, in four filters for the four cameras (Baggett). Countrates are averages of the central 300x300 pixels, normalized to the October 1994 set of UV flats (F185W images are normalized to Aug 1995 data due to lack of F185W data in Oct 1994). UV flats taken more than 10 days after a decon procedure are not included.



Proposal ID 7625: Cycle 7 Earth Flats (includes results from 6909: Cyc6 Earth Flats, 8053: Cyc7 Supplemental Earth Flats)

Plan

Purpose Monitor flat field stability.

Description As in the Cycle 6 program 6909, sets of 200 Earth-streak flats are taken to construct high quality narrow-band flat fields with the filters F160BW, F375N, F502N, F656N and F953N. Of these 200 perhaps 50 will be at a suitable exposure level for destreaking. The resulting Earth superflats map the OTA illumination pattern and will be combined with SLTV data (and calibration channel data in case of variation) for the WFPC2 filter set to generate a set of superflats capable of removing both the OTA illumination and pixel-to-pixel variations in the flat fields. The general plans of Cycles 5 and 6 are repeated.

Prog. Supported 100%

Resources 155 internal orbits (and 155 each for 6909 and 8053).

Products New flat fields to CDBS if changes detected.

Accuracy Goals Large-scale flat field variations can be tracked to about 0.3%.

Special Requirements None.

Results

Modifications More Earth flats were required than initially requested due to the extension of Cycle 7.

Execution Cycle 7 Earth flat program 7625 was extended with proposal 8053, in order to have flats for the last 6 months of Cycle 7. The extra proposal was necessary because the duration of Cycle 7 was extended (see Introduction) and the original 7625 would not have provided sufficient coverage to verify the flat field stability and provide a monitor of the typical low-level temporal variations seen over the course of a year.

Time-line Mar-Jul 1999 (program 8053), Sep 97-May 98 (program 7625), Aug 96-Jun 97 (program 6909)

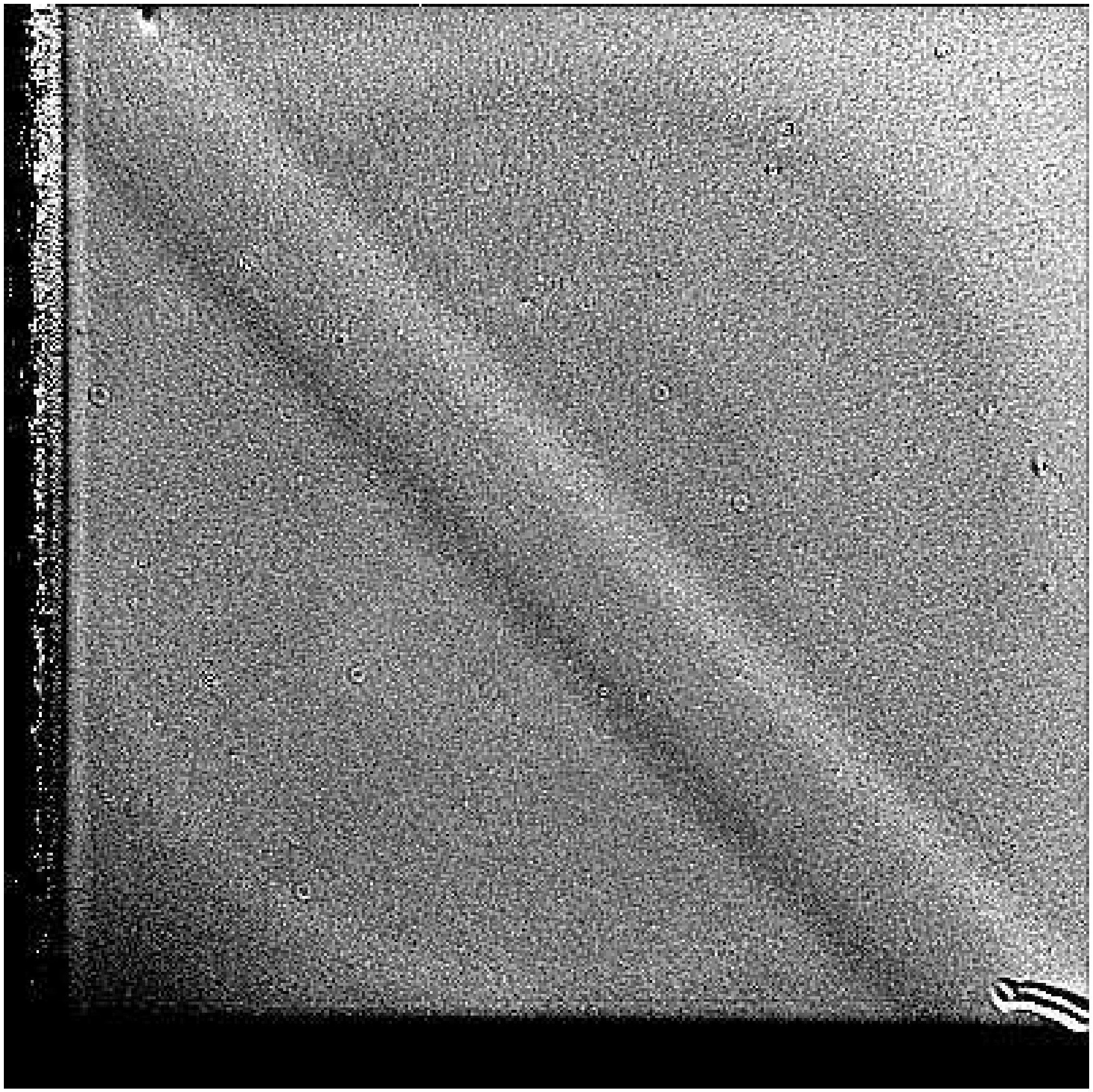
Resources Used 234 internal orbits each for 8053 and 7625, 224 for 6909.

Products

Accuracy Achieved Most changes in the flatfields can be ascribed to small shifts in the optical alignment (~1 pixel), which result in apparent motions of the dust spots & camera obscurations relative to the pixel grid. The largest changes, ~12% in amplitude, occur on WF4 in pairs of previously-seen bright and dark dust spots a few pixels in size, though all four cameras have such spots (~2 dozen per camera) at a smaller level (~4%). All CCDs also exhibit changes, at ~0.5% level, in the pattern of broad diagonal bars (40 pixels wide) crossing the CCDs. The changes in the diagonal bars are attributed to shifts in the alignment of the OTA spider and WFPC2 repeater spiders; the figure below is a ratio image of new vs old flats for F502N in WF4. The only other notable change in the flat field is the appearance of 3 new dust spots on the WF2 field flattener lens.
Work is currently underway to update the flatfield CDBS files to account for these changes.

Continuation Plans Cycle 8 to continue the earth flat monitoring.

Figure 7. A ratio image of the new and old F502N flat field for WF4. The change in the diagonal bar is at the ~0.5% level while the dust spots have changed by ~4%.



Proposal ID 7626: WFPC2 Cycle 7 UV Throughput

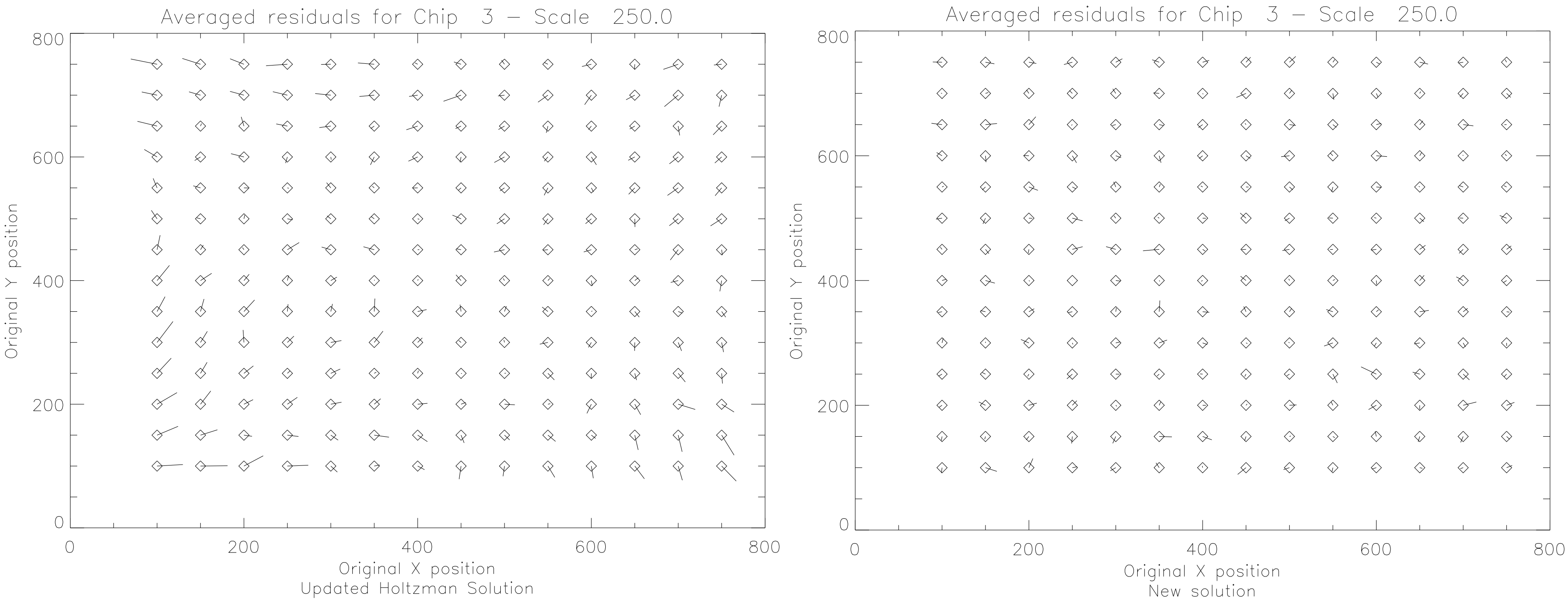
	Plan		Results
Purpose	Verify throughput for all UV filters. Loosely based on the Cycle 5 and 6 UV throughput proposal (6186, 6936).	**Modifications**	None.
Description	GRW+70d5824 will be observed shortly before and after a DECON through all the UV filters in PC and WF3. Observations should be taken roughly mid-way through the cycle.	**Execution**	As planned.
Prog. Supported	10%	**Time-line**	Oct 1998.
Resources	4 pointed orbits	**Resources Used**	4 orbits.
Products	TIPS, SYNPHOT update if necessary, Technical Report to document any changes if necessary.	**Products**	Photometry has been completed; analysis is still in progress.
Accuracy Goals	The UV throughput will be measured to better than 3%.	**Accuracy Achieved**	
Special Requirements	Timing requirements with respect to decontaminations.	**Continuation Plans**	UV filters will be spot-checked in Cycle 8.

Proposal ID 7627: WFPC2 Cycle 7 Astrometric Monitor (includes results from 6941: Cycle 6 Astrometric Monitor)

	Plan		Results
Purpose	Verify relative positions of WFPC2 chips with respect to one another. Repeats parts of Cycle 6 proposal 6942 twice during Cycle 7.	**Modifications**	None.
Description	The rich field in ω Cen used for the Astrometry Verification (6942) is observed with large shifts (35’’) in F555W only, at two different times during Cycle 7. This will indicate whether there are shifts in the relative positions of the chips or changes in the astrometric solution at the subpixel level. Kelsall spot images will be taken in conjunction with each execution. The K-spots data and some external data indicate that shifts of up to 1 pixel may have occurred since mid-1994.	**Execution**	No problems.
Prog. Supported	20%	**Time-line**	April and September 1998.
Resources	2 pointed orbits and 2 occultation periods	**Resources Used**	2 orbits.
Products	TIPS, Technical Instrument Report; update of chip positions in PDB and of geometric solution in STSDAS task metric if any changes are found.	**Products**	The geometric distortion in each chip, as measured from this data as well as from data taken for Cycle 6 proposal 6941, remains stable. Distortions amount to typically a few tenths of a pixel in each chip center up to a few pixels at the edges of each chip (0.008" to 0.100" in PC and 0.020-0.3" in WFC. An improved plate solution with new distortion coefficients will be available in the near future; the figure below compares the Holtzman solution (PASP **107**, 156) and the new solution by Casertano. The positions of the chips with respect to each other continues to shift slowly (~1 pixel total since early 1994). Any inter-chip position errors will affect the STSDAS WFPC2 tasks metric and wmosaic; these tasks, which currently contain the distortion fits presented in ISR 95-02 The Geometric Distortion in WFPC2 (Gilmozzi et al.), will be updated in a future version of STSDAS.
Accuracy Goals	At least 0.1’’ in the relative shifts, with a goal of 0.02-0.05’’.	**Accuracy Achieved**	Accuracy for relative astrometry is very good: better than 0.005" in one chip and ~0.1" for targets on different chips. Absolute accuracy is typically ~0.5"- 1.0", limited of course by the uncertainties in the guide star positions and in the FGS to WFPC2 transformation.

Plan		Results	
Special Requirements	None	**Continuation Plans**	Astrometric monitoring to be maintained in Cycle 8.

Figure 8. Distortions over the WF3 field-of-view; left plot shows the residuals from the Holtzman solution (PASP **107**, 156), right plot illustrates the new Casertano solution. Error vectors are in PC pixels, magnified by a factor of 250 (1 tick is 9mas).



Proposal ID 7628: WFPC2 Cycle 7 Photometric Characterization and 6935: WFPC2 Cycle 6 Photometric Transformation

	Plan		Results
Purpose	(1) Determine whether any changes in the zeropoint, or in the spatial dependence of the zeropoint or contamination, have occured; (2) include another globular cluster (NGC 2419) in order to extend the parameter space for determinations of photometric transformation. Combines and continues Cycle 6 proposals 6934, 6935.	**Modifications**	None.
Description	Observations of the primary photometric standard GRW+70d5824 will be compared against baseline observations. The cluster fields in ω Cen and NGC 2100 will be compared to previously obtained data in order to test for spatial variations in the throughput. Most broad-band and intermediate-width filters, including the far UV set for NGC 2100 (very young, many blue stars). A contamination test using UV filters will also be performed for NGC 2100. New observations of the Galactic globular cluster NGC 2419 will be compared with good ground-based photometry; this cluster is very distant (100 kpc) and will provide a large color spread on giant branch and HB.	**Execution**	No problems.
Prog. Supported	30%	**Time-line**	Mar, May, Jun 1999 for NGC2419, GRW+70d5824, and ω Cen, respectively. NGC2100 done in Sep-Oct 1998.
Resources	10 pointed orbits	**Resources Used**	10 orbits.
Products	ISR; SYNPHOT updates if necessary.	**Products**	
Accuracy Goals	Photometric stability expected to be better than 2%. Photometric transformations to be defined to 2-5%, depending on filter; most of the error derives from limited knowledge of the transformations between ground-based and WFPC2 photometric systems.	**Accuracy Achieved**	The analysis of these 2 proposals is still in progress.
Special Requirements	Specific orientations will be required to match previous cycles or optimize overlap with ground-based data. All observations should be executed shortly after decontamination, except for the pre-decon visit in the contamination test.	**Continuation Plans**	Photometric characterization to be spot-checked in Cycle 8.

Proposal ID 7629: WFPC2 Cycle 7 PSF Characterization

	Plan		Results
Purpose	Provide a subsampled PSF over the full field to allow PSF fitting photometry and to test PSF subtraction as well as dithering techniques. Based on Cycle 6 program 6938.	**Modifications**	None.
Description	Measure PSF over full field in often-used, high-throughput filters in order to update the TIM and TINYTIM models and to allow accurate empirical PSFs to be derived for PSF fitting photometry. Repeat F814W from earlier Cycles, to provide a continuing baseline, and replace the other filters with F300W, F450W, F606W and F702W (often used because of their high throughput but are not as well characterized as the standard photometric set F336W, F439W, F555W, and F675W). These observations will also be useful to test PSF subtraction and dithering techniques at various locations on the CCD chips. With one orbit per filter, 4x4 a spatial scan with stepsize of 0.025” is performed; this gives a critically sampled PSF over most of the visible range and will allow a check for sub-pixel phase effects on the integrated photometry. This program uses the same specially chosen field in ω Cen as the Cycle 5 proposal 6193.	**Execution**	No problems.
Prog. Supported	15%	**Time-line**	Images were taken in early June 1999.
Resources	5 pointed orbits	**Resources Used**	5 orbits.
Products	PSF library (WWW)	**Products**	Nearly 1000 PSFs have been extracted from the individual frames of the 7629 data and installed in the WFPC2 Observed PSF Library (see Table below for a snapshot of contents). Dithering the images to obtain subsampled PSFs for the library is still in pogress.
Accuracy Goals	Provides measurement of pixel phase effect on photometry (sub-pixel QE variations exist). Tens of well exposed stars in each chip will each be measured 16 times per filter at different pixel phase. The proposal therefore provides, in principle, a high S/N, critically-sampled PSF ; the result will be largely limited by breathing variations in focus. It is difficult to predict the PSF accuracy; if breathing is less than 5 microns peak-to-peak, the resulting PSFs should be good to about 10% in each pixel. In addition, the test gives a direct measurement of sub-pixel phase effects on photometry, which should be measured to better than 1%.	**Accuracy Achieved**	In progress.

Plan	
Special Requirements	Needs same pointing and orientation as Cycle 5 observations for proposal 6193.

Results	
Continuation Plans	Cycle 8 PSF proposal will spot-check two of the five filters used here. If resources allow, critically-sampled PSFs will be generated and installed into the library as well.

Table 5. Contents of WFPC2 Observed PSF Library as of October 1999.

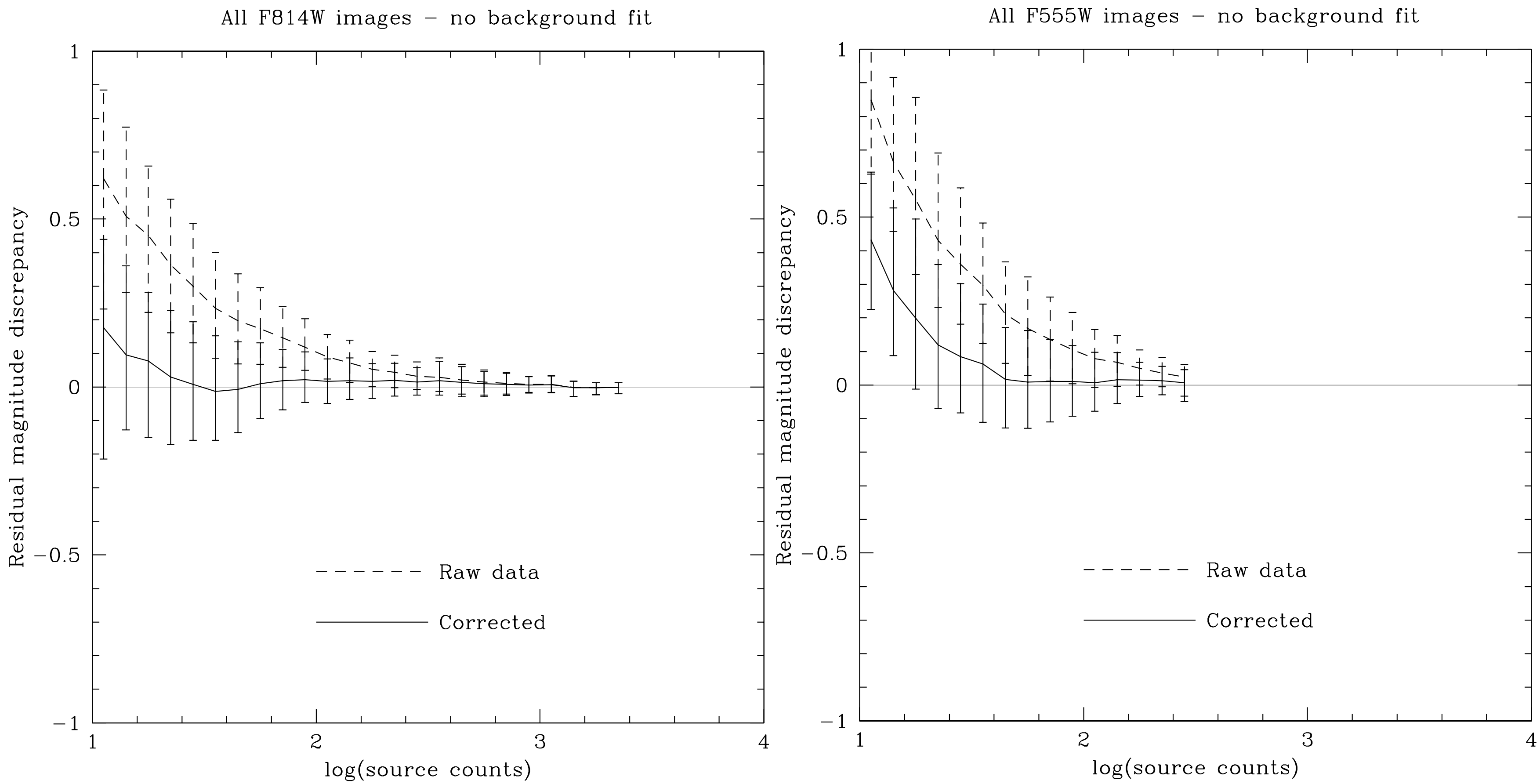
filter	pc	wf2	wf3	wf4	filter	pc	wf2	wf3	wf4	filter	pc	wf2	wf3	wf4
F160BW	10	9	7	5	F439W	83	131	149	114	F675W	77	49	87	50
F170W	37	42	40	33	F450W	7	55	55	60	F702W	35	56	73	45
F218W	8	3	6	--	F467M	2	3	7	1	F785LP	23	24	34	23
F255W	9	15	14	5	F547W	11	17	31	11	F791W	1	--	--	--
F300W	36	38	52	49	F555W	141	141	192	130	F814W	269	350	448	351
F336W	50	90	95	55	F569W	13	18	22	11	F850LP	1	--	4	--
F380W	2	3	14	--	F606W	92	87	141	100	F1042M	3	6	3	--
F410M	2	1	9	--	F622W	1	--	1	--					

Proposal ID 7630: WFPC2 Cycle 7 CTE Characterization

	Plan		Results
Purpose	Conduct a thorough examination of the variation in photometric zeropoint as a function of exposure length, background (via preflash), and position in the chip. Include spot checks for the dependence of zeropoint variations on filter, order of exposures, and camera shifts (CTE ramp).	**Modifications**	None.
Description	A well-studied field in the globular cluster NGC 2419 will be observed through F814W with a combination of exposure times (10, 40, 100, 300, 1000s) and preflash levels (0, 5, 10, 100, and 1000 e^-). Completes Cycle 6 proposal 6937, which was shortened substantially because of servicing mission constraints. Will also include several observations in reverse order (to test for hysteresis), in F555W and F300W (filter dependence), and after a pointing shift (to test for x, y dependence), as well as a series of equal-length exposures to test the effect of noiseless preflash. This proposal should improve substantially our understanding of CTE and of the long vs. short anomaly.	**Execution**	Nominal.
Prog. Supported	30%	**Time-line**	November 1997.
Resources	14 pointed orbits	**Resources Used**	13 orbits.
Products	ISR, paper; if appropriate, a special task to correct the CTE effect will be generated.	**Products**	ISR 98-02 The Long vs Short Anomaly in WFPC2 Images (Casertano & Mutchler) provides a full report on the proposal 7630 data analysis, including a straightforward formula for correcting pointsource photometry for the long vs short effect (for CTE corrections, see results of 7929 CTE Monitor). The correction works well for targets with 30 counts or more, where the magnitude measurements have smaller uncertainties (see Figure 9). A better correction could be forced for objects with <30 counts, however, that causes an undesirable overcorrection in the range 100-400 counts.
Accuracy Goals	The reported short vs. long exposure effect is ~0.05 mag. We want to determine it to better than 0.02 mag, with a goal of 0.01 mag.	**Accuracy Achieved**	The analysis of this dataset (ISR 98-02, Casertano & Mutchler) found that the long vs short anomaly depends only upon the total counts in the aperture, i.e., the effect is independent of exposure time, position on the chip (after CTE correction is applied), and wavelength (F555W and F814W affected in a similar fashion). The are hints of a weak dependence on background, but the effect is not statistically significant.

Plan		Results	
Special Requirements	Observations should be made at the same position and roll angle as the NGC 2419 exposures in proposals GO 5481 and CAL 6937.	**Continuation Plans**	

Figure 9. Residual magnitude discrepancies as a function of total source counts in F814W and F555W, with and without the correction developed for the long versus short anomaly (taken from ISR 98-02, Casertano & Mutchler).



Proposal ID 7929: WFPC2 Cycle 7 CTE Monitor

	Plan		Results
Purpose	Monitor variations in CTE ramp for bright and faint targets.	**Modifications**	The last execution of 7929, originally set for Aug 1999, was instead rolled into the Cycle 8 CTE Monitor proposal (8447). The one remaining orbit in 7929 has been credited to the Cycle 8 CTE Monitor proposal.
Description	Analysis of Cycle 6 CTE data shows that the CTE ramp depends strongly on stellar magnitude and background, and that its amplitude varies in time for faint stars. However, most measurements have been taken so far under slightly different conditions from one another. This program will take four one-orbit measurements of the CTE at four month intervals, under the same conditions as the best data taken so far. It will provide an accurate and efficient tracer of changes in the CTE ramp, and show to what extent WFPC2 remains a photometric instrument for faint objects. Observations of the standard field in NGC 5139 will be taken at the same roll angle, but centered in each of the WF chips in turn, thus reversing the x and y positions of each star. No preflash test is included.	**Execution**	
Prog. Supported	50%	**Time-line**	Mar and Aug 1998, Feb 1999
Resources	4 pointed orbits	**Resources Used**	3 orbits.
Products	ISR.	**Products**	WWW memo on the "Time Dependence of the Charge Transfer Efficiency" (Whitmore), Whitmore et al. (PASP **111**,1559, Dec 1999), and the June 1999 AAS poster paper on CTE (Heyer et al.). All three are available on the WFPC2 Documentation page.

Plan

Accuracy Goals The measurements will enable tracking of the CTE ramp with an accuracy requirement of 0.02 mag, and a goal of 0.01 mag.

Special Requirements Requires three slightly different pointings within same orbit; may require drop to gyros if no guide star is available for all three pointings.

Results

Accuracy Achieved The results of the analysis are discussed completely in the Whitmore et al. (PASP **111**,1559, Dec 1999); the primary results can be summarized as follows. The CTE loss is the same on all three WF chips (and PC, as well as can be determined); however, due to the lower background on PC, the CTE effect is generally larger on PC. While the primary CTE loss occurs along the Y-axis, there also appears to be a weak CTE effect along the X-axis. The CTE effect shows a strong time dependence; in the worst case (faint stars on faint backgrounds), the CTE loss has increased from ~3% in early 1994 to ~40% in Feb 1999 (see Figure 10; see also June 1999 AAS poster paper on CTE (Heyer et al.). Note, however, that most WFPC2 exposures are much longer than the short calibration images, resulting in higher background which significantly reduces the CTE loss and minimizes the CTE problem for most science exposures.

A set of formulae, using the X, Y position and brightness of the star, the background level, and the time of observation, have been developed to correct for the CTE loss when performing aperture photometry and are given in the Whitmore et al. (PASP **111**,1559, Dec 1999).

Continuation Plans CTE monitoring will continue into Cycle 8 but with modified exposure sequences, based upon the results from this proposal and feedback from the user community.

Figure 10. The percent CTE loss over 800 pixels versus the star brightness in counts, for a variety of filters (noted in upper left of each plot), using 2-pixel apertures. Note the trend of higher CTE loss for fainter targets at all wavelengths as well as the tendency for mid-range wavelengths to have the lowest CTE loss (~4% in F555W and F606W) while the longer and shorter wavelengths have larger CTE loss (figure taken from Whitmore et al. (PASP **111**,1559, Dec 1999).

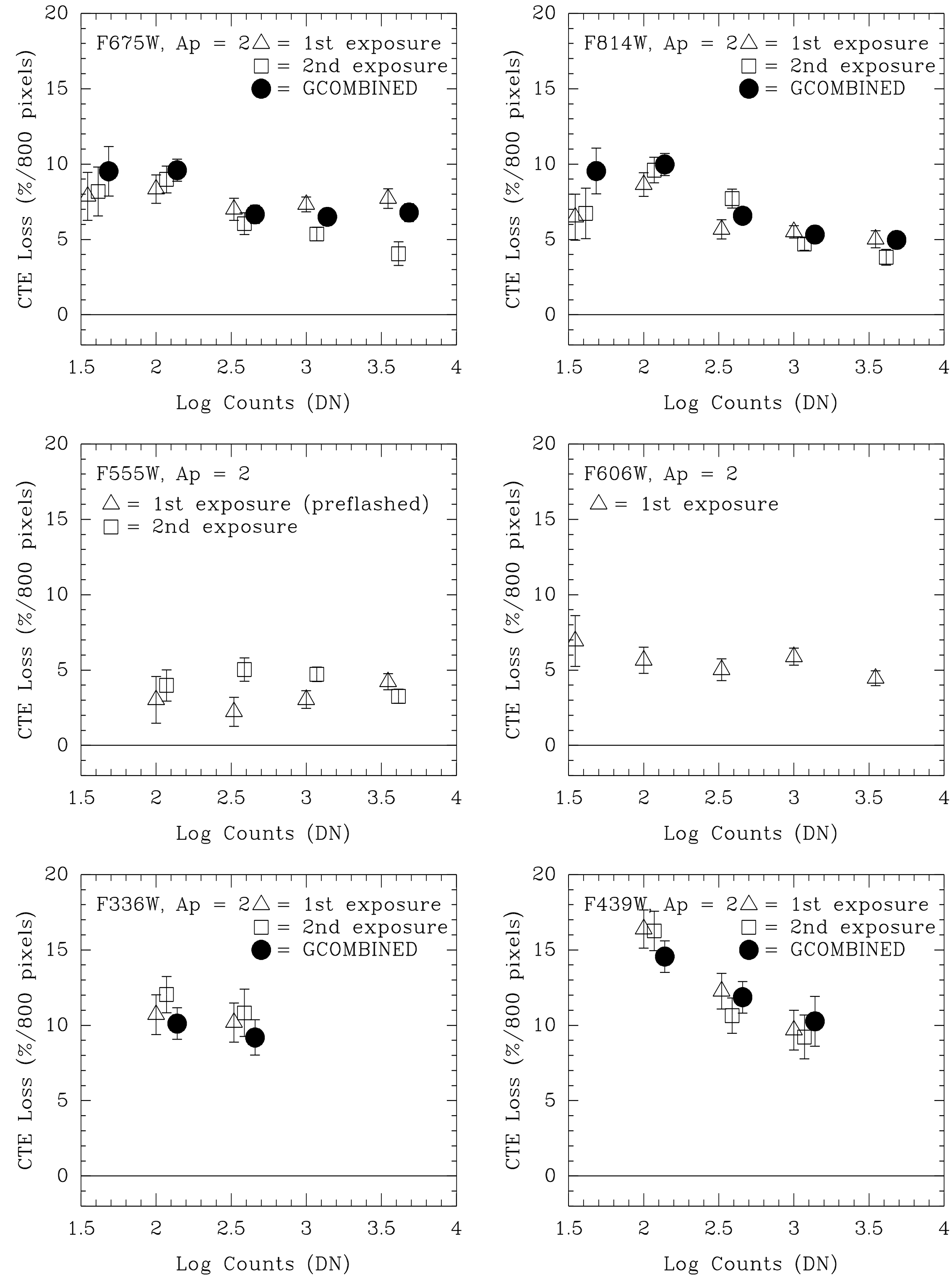
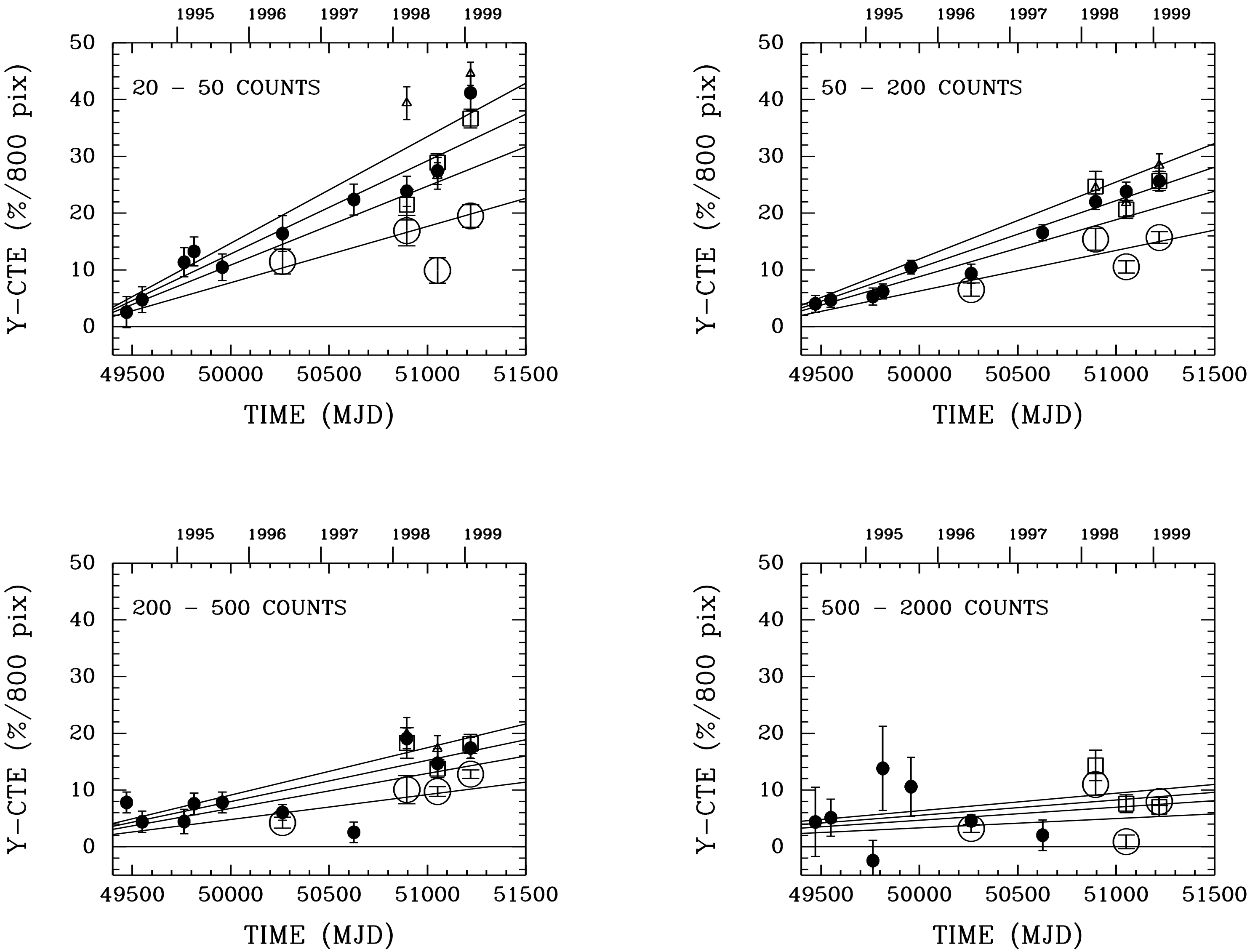


Figure 11. The Y-CTE loss as a function of time for four different target brightness ranges (figure taken from Whitmore et al. (PASP **111**,1559, Dec 1999)). Triangles are for F439W (background=0.03DN), squares are for F555W (background=0.05DN), filled circles are for 14 sec exposures with F814W (background=0.1DN) and open circles are for 100 sec exposures with F814W (background=0.38DN). Smaller symbols are for observations with less background and the lines are from predictions as given in Whitmore et al. (PASP **111**,1559, Dec 1999).



Proposal ID 8054 WFPC2 Cycle 7 LRF Calibration

Plan

Purpose Complete the analysis of LRF properties: throughput and wavelength scale.

Description The primary spectrophotometric standard GRW+70d5824 will be observed at several locations on the three most used Linear Ramp Filters to verify its throughput as a function of wavelength. In addition, exposures of the Orion Nebula at two different pointings will be used to verify the wavelength calibration of the LRF at the wavelengths of major nebular lines. Previous executions of the LRF calibration have demonstrated a throughput 7% lower than the expectations based on laboratory filter tracings, with a scatter of 10% rms. The series of observations of GRW+70d5824 will: 1) measure the temporal stability of the difference between measured and predicted throughput; 2) demonstrate whether the scatter is due to measurement errors or to intrinsic variations in the filter; 3) complete the wavelength coverage (some of the observations from previous programs were lost); and 4) and provide more closely spaced points in the most often used ramp filter. The observations of the Orion Nebula, at two carefully optimized pointings, will provide a direct test of the wavelength calibration and vignetting of the LRF at the wavelengths of Hα, Hβ, [OIII], [NII] and [SII].

Prog. Supported 7%

Resources 10 pointed orbits

Products ISR, new SYNPHOT tables.

Accuracy Goals Measure throughput to 5%, wavelength position to about 5-10 pixels.

Special Requirements Requires spatial scans.

Results

Modifications None.

Execution The standard star observations are of limited usefulness due to a proposal error. The Cycle 8 proposal will be used to revisit the standard star.

Time-line June-July 1999.

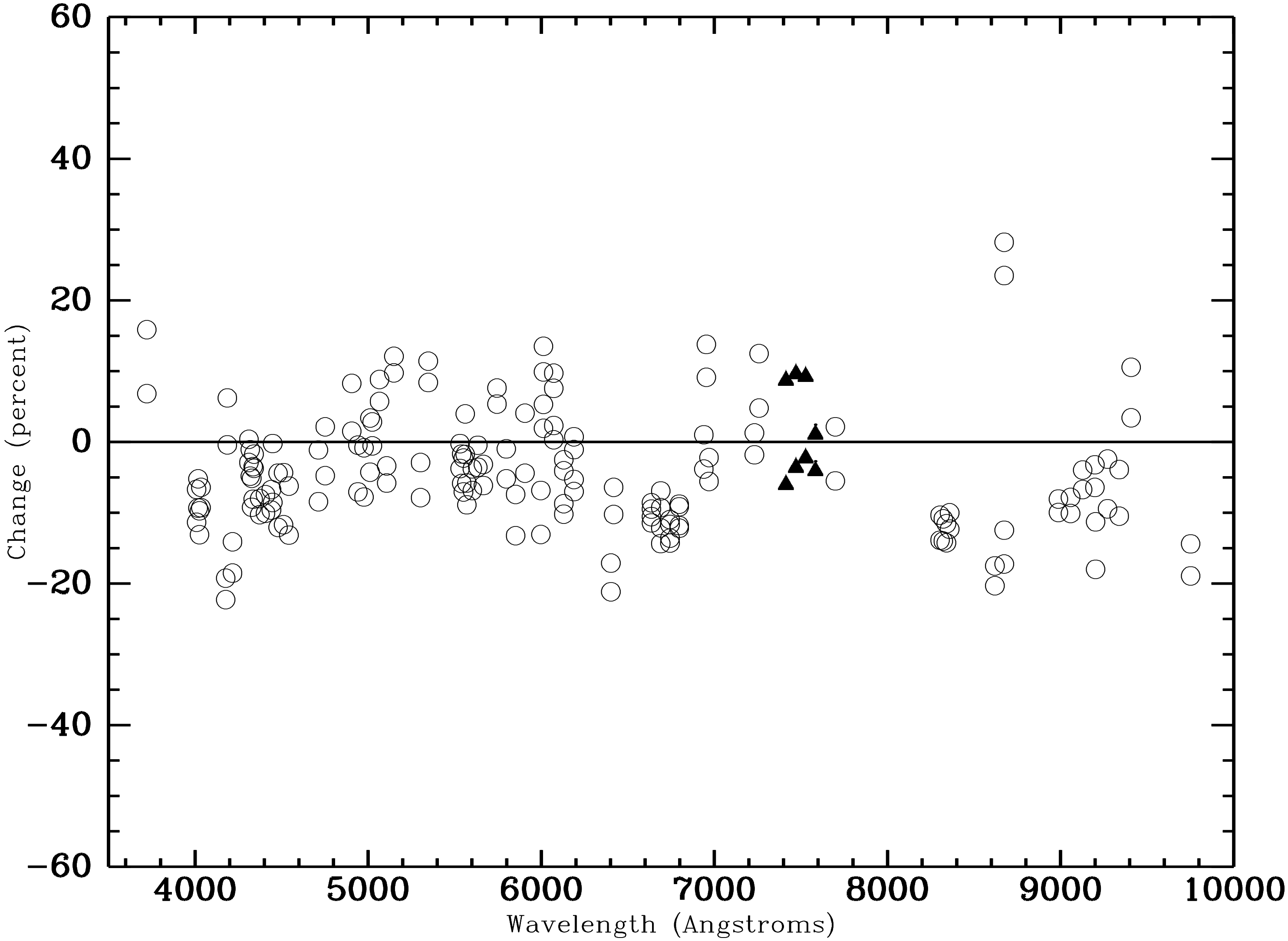
Resources Used 12 orbits.

Products

Accuracy Achieved Analysis of the Orion images is still in progress. Results from Cycle 6 showed ~1% agreement between the ground-based calibration and the on-orbit data, though there was also ~7.5% RMS scatter between individual data points, as yet not completely understood (see Figure below; O'Dea & McMaster).

Continuation Plans Cycle 8 calibration plans will depend upon results from Cycle 7 proposal.

Figure 12. Linear ramp filter results compared to SYNPHOT predictions (O'Dea and McMaster); circles represent Cycle 6 data, triangles Cycle 7 data. Change shown along y-axis is ((observed countrate/synphot prediction)-1)*100.



References

General Documents

Site Map of WFPC2 WWW pages

- WFPC2 Advisories page
- WFPC2 Documentation page
- WFPC2 Software Tools
- WFPC2 User Support
- Frequently Asked Questions
- WFPC2 Clearinghouse

The WFPC2 Instrument Handbook
The HST Data Handbook
The 1997 HST Calibration Workshop
STAN, the Space Telescope Analysis Newsletter
Proposals in Phase II format, page maintained by PRESTO
WFPC2 PSF page

New ISRs and other reports since the last closure report

Charge-Transfer Efficiency of WFPC2, PASP **111**,1559, Dec 1999, Whitmore, Heyer, and Casertano.
99-02: *WFPC2 Cycle 8 Calibration Plan*, Baggett, Casertano, Biretta, Gonzaga, & WFPC2 Group.
99-01: *Internal Flat Field Monitoring II. Stability of the Lamps, Flats, and Gains*, O'Dea, Mutchler, & Wiggs.
98-04: *The Drizzling Cookbook*, Gonzaga, Biretta, Wiggs, Hsu, T.E.Smith, L.Bergeron, & WFPC2 Group.
98-03: *WFPC2 Long-Term Photometric Stability*, Baggett & Gonzaga.
98-02: *The Long vs. Short Anomaly in WFPC2 Images*, Casertano & Mutchler.
98-01: *WFPC2 Cycle 6 Calibration Closure Report*, Baggett, Casertano, & WFPC2 Group.

Internal reports

TIR WFPC2 99-01: *WFPC2 Aperture Photometry Corrections as a Function of Chip Position*, Gonzaga, O'Dea, & Whitmore.
TIR WFPC2 98-04: *Addendum to TIR 98-04*, Biretta & Baggett.
TIR WFPC2 98-04: *Proposed Modification to the WFPC2 SAA Avoidance Contour*, Biretta & Baggett.
TIR WFPC2 98-03: *WFPC2 Dark Current Evolution*, Baggett, Casertano, & Wiggs.
TIR WFPC2 98-02: *Analysis of the Excess Charge in WFPC2 Overscans*, Mutchler, O'Dea, & Biretta.
TIR WFPC2 98-01: *Time Dependence of the CTE on the WFPC2*, Whitmore.

For paper copies of any documents listed here, please contact help@stsci.edu.