

WFPC Observed PSF Image Library

S. Baggett¹ and J. MacKenty¹

Abstract

Wide Field Planetary Camera (WFPC) point spread functions (PSFs) are briefly discussed and the contents of the WFPC PSF Image Library are described. Details of the processing and extraction of PSF images from WFPC observations are given and the header format is presented. The filter and chip coverage are summarized along with a description of the original data used as a source for the PSFs. A complete list of all PSFs in the Library is included in the Appendix.

I. Introduction

With the current spherical aberration, PSF images for the WFPC have become an essential element in the deconvolution of WFPC data. The *HST* PSF is known to have a sharp 0.1 arcsec radius core which contains only about 15 percent of the energy, while the remaining 85 percent is contained within broad wings which extend out to about 4 arcseconds. In addition, the WFPC PSF is 1) position dependent due to camera vignetting, 2) wavelength dependent due to diffraction effects, and, 3) dependent on the telescope's focus position (see Burrows et al., 1991). Thus, one would ideally like to obtain observed PSFs in a gridwork of positions on each chip, for all filters used and close in time to the observations requiring deconvolution. Longer exposures are required for sufficient signal to noise in the wings, however shorter exposures are needed to avoid having the sharp core of the PSF saturate the cameras. For these reasons, model PSFs will generally be required in addition to the available observed PSFs. For producing model PSFs, the STScI Telescope Image Modelling Package or TIM (Burrows and Hasan, 1993; and this volume) is available, however, it was not specifically designed for computing deconvolution PSFs and is fairly slow. Another software package, Tiny Tim (Krist, 1993), was developed for generating model PSFs and may be obtained from STEIS.

Any of the extracted PSF images in the library may be retrieved directly from DMF in the same manner as other *HST* data (see archive manual in STEIS documents directory or email archive@stsci.edu); note that the archive class should be specified as CDB and extension as R7*. PSFs may also be requested from the STScI User Support Branch (USB) following the same procedures used for requesting calibration data.

1. Space Telescope Science Institute, Baltimore, MD 21218

This report presents a description of the growing contents of the STSci Library of observed WFPC PSFs; updated versions of the tables in this report will be maintained in the STEIS WFPC PSF Memo. The processing and extraction procedure used to obtain the PSF images for the library and the header format of the PSF images are described in §II. The filter and chip coverage of the Library images are presented in §II, followed by a summary of the data from which the PSFs are obtained. Finally, the Appendix contains tables of all PSF names along with filter used, position on chip, original observation name and date, exposure time, target name, and spectral type.

II. Library Images

Processing and Extraction

As an aid in the deconvolution of WFPC observations, a library of WFPC point spread function (PSF) images has been established in the STSCI Calibration Database (CDB). Rather than storing entire WFPC datasets which already reside in the *HST* archives, the library consists of smaller, typically 256x256, sub-sections centered on the PSF star if possible.

In preparation for PSF extraction, the original WFPC datasets were retrieved from DMF and reprocessed with the most up to date reference files (note that cosmic rays have not been removed and deltaflat corrections have not been applied). For images taken in a relatively non-standard way (for example, obtaining PSFs on multiple chips without reading out each time), it was also necessary to properly set the science data file's preflash-related keywords (PREFCORR, PREFFILE, PREFDFIL, SHUTTER) before re-calibrating, since the initial pipeline processing is unaware of the multiple exposures and erroneously sets PREFCORR to NO. The shutter in place during the preflash was derived using the IRAF task 'ENGEXTR' on the associated extracted engineering files (.X0H/.X0D); the values of the W06X135B and W06X136B mnemonics (SHUTOPNB and SHUTOPNA, respectively) indicate the shutter in place at the end of the exposure.

Header Keywords

The headers of the extracted PSF images contain information listed in the tables in the Appendix (and in the STEIS memo) as well as keywords for the camera, mode, origin, exposure time, modified Julian date, calibration flag and flatfield filename if the image was calibrated, PSFSCALE (divisor used to normalize the image), observation mode for use with SYNPHOT, a reference spectrum, and the secondary mirror actuator positions. The actuator position keywords were populated using the results presented in the OTA Instrument Science Report #7 (Burrows, 1992).

Table 1: PSF Image Header

keyword	sample value	description
GROUPS	T	group image?
GCOUNT	1	number of groups
PCOUNT	12	number of group keywords
PSIZE	512	number of bits allowed for all the group parameters
DATAMIN	-8.25279	minimum of all pixels
DATAMAX	1574.536	maximum of all pixels
CRVAL1	122.7054583333	right ascension of reference pixel (deg)
CRPIX1	111.	x-coordinate of reference pixel
CD1_1	1.125227E-5	partial of RA with respect to x
CTYPE1	'RA--TAN'	
CD1_2	4.800087E-6	partial of RA with respect to y
CRVAL2	74.96597222222	declination of reference pixel (deg)
CRPIX2	164.	y coordinate of reference pixel
CD2_2	-1.125227E-5	partial of declination with respect to y
CTYPE2	'DEC--TAN'	
CD2_1	4.800085E-6	partial of declination with respect to x
FILTNAM1	F785LP	first ST ScI filter name
FILTNAM2	"	second ST ScI filter name
CAMERA	PC	WF or PC
MODE	FULL	full or area
DETECTOR	6	1-4 for WF, 5-8 for PC
ROOTNAME	W15E100T	rootname of observation containing psf image
DATA_FIL	D9F15215W.R7H	name of psf image file
TARGNAME	BD+75D325	target
ORIGIN	HST	date source e.g., 'HST', 'TIM', or other
SPECTRAL	O5p	spectral type of source, if known
EXPTIME	0.8	exposure time in seconds
DATE_OBS	13/08/93	UT date (E.G. 28 Jan 1991)
MJD	49212.	modified Julian date (= JD-2400000.5)
XCORNER	362	x pixel of (1,1) corner in psf image
YCORNER	249	y pixel (1,1) corner in psf image
XCENTER	490.	x coordinate of psf center on chip
YCENTER	377.	y coordinate of psf center on chip
CALIBRAT	T	has this image been calibrated? (flat, etc)
FLATFILE	lclSc1916444w.r6h	name of flatfield used
PSFSCALE	1.	divisor used to normalize psf, otherwise 1
OBSMODE	PC,6,F,DN,F785LP	obsmode for synphot (e.g., WF,4,F,DN,F555W)
REFSPEC	"	ref spectrum (CRCALSPEC:AGK_81D266_002.TAB)
ACTUAT25	-1468	position of secondary mirror actuator 25
ACTUAT26	1306	position of secondary mirror actuator 26
ACTUAT27	-833	position of secondary mirror actuator 27
ACTUAT28	1023	position of secondary mirror actuator 28
ACTUAT29	-857	position of secondary mirror actuator 29
ACTUAT30	851	position of secondary mirror actuator 30

General Characteristics

Specific PSF image names are listed in the Appendix; this section presents the filter and spatial coverage of the Library contents. Table 3 summarizes the number and type of PSF images available from the PSF Library, sorted by filter and detector.

Table 2: Statistics on PSF Image Filters

filter	PC 5	PC 6	PC 7	PC 8	WF 1	WF 2	WF 3	WF 4
F230W	1	22	1	1		25		
F284W	1	30	1	1	1	33	1	1
F336W	3	41	4	1	2	34	1	1
F439W	1	35	1	1	1	33	1	1
F487N		17						
F502N		5						
F547M	1	5						
F555W	64	118	68	36	1	58	1	1
F588N		5						
F673N		5						
F702W	3	8	1	3	1	2	1	1
F718M	1	5						
F785LP	64	111	70	38	1	58	1	1
F889N	2	24	2		1	6	1	1

NOTE: there is one PSF, in P6 only, for each of the following filters: F368M, F375M, F437N, F413M, F469N, F492M, F517N, F569W, F656N, F658N, F606W, F622W, F631N, F664N, F648M, F675W, F725LP, F791W, F814W, F850LP, F875M, F1042M, F1083N.

The plots below illustrate the spatial coverage achieved for PC 5-8 and WF 2.

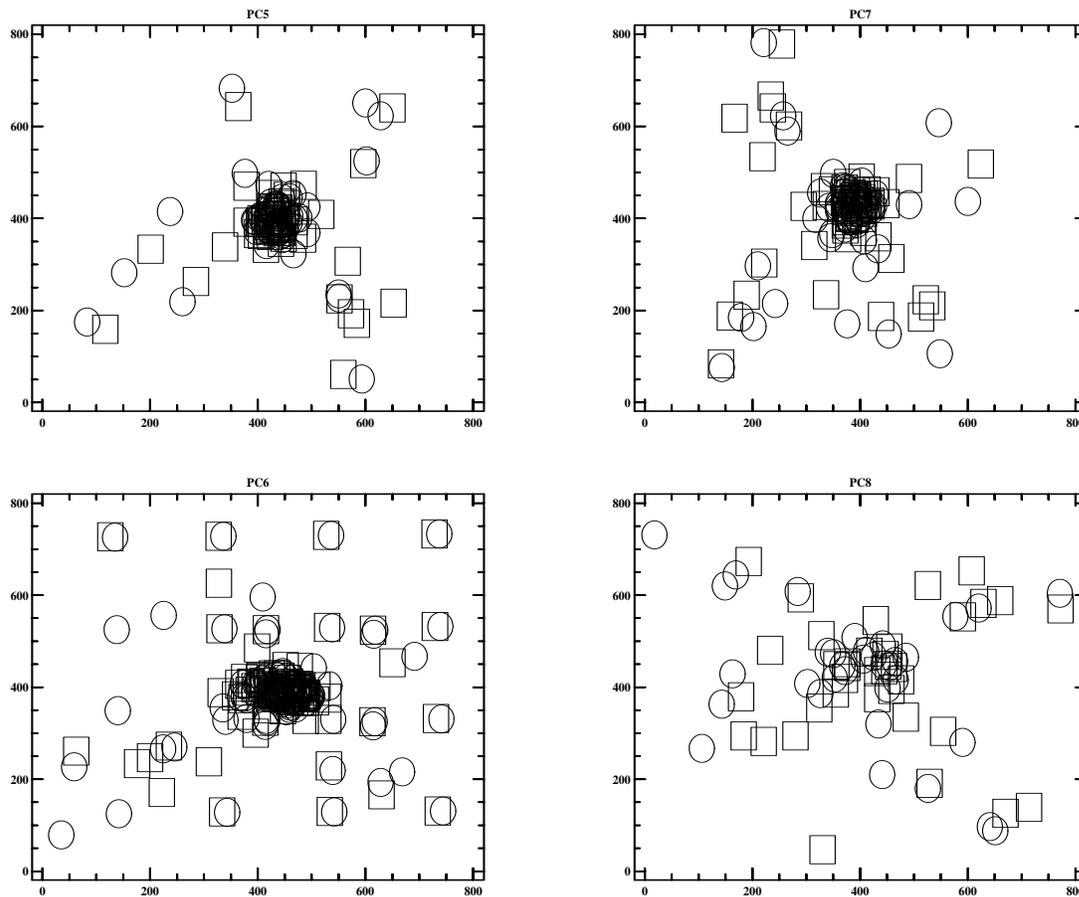


Figure 1: PSF coverage on PC chips. F555W PSFs are indicated with circles, F785LP PSFs with boxes.

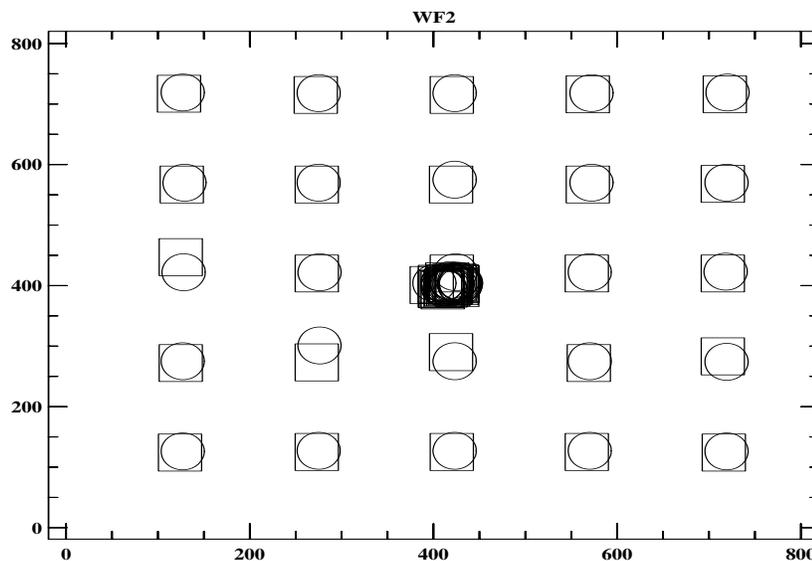


Figure 2: PSF Coverage on WF2 Chip. F555W PSFs are indicated with circles, F785LP PSFs with boxes.

Sources of PSFs

Data from a variety of proposals are used as sources for the PSF images; they are summarized in the table below.

Table 3: Proposals from which PSF Data Has Been Obtained

prop	proposal title	description of observations
3230	PC PSF and Focus Monitoring	PC 5 - 8 F555W and F785LP variety of targets/spectral types one-two stars imaged ~once/week
3241	Mapping Position Dependence of WFPC PSF	WF 2 with F555W, F785LP PC 6 with F336W, F413M, F439W, F487N, F502N, F547M, F555W, F588N, F673N, F718M, F785LP, and F889N two targets: HD151406(F0) and HD144470(B1)
4809	PSF Calibration Proposal	WF 1-4 and PC 5-8 F336W, F555W, F702W, F785LP, and F889N variety of targets/spectral types (chosen from proposals 3230 and 3241)
5025 4207 2877	Photometric Calibration Monitor	WF 2 and PC 6, executed ~once per month F230W, F284W, F336W, F439W, F555W, and F785LP target is UV standard (usually BD+75D325; when unavailable, alternates BD+28D4211 or A+81D266 are used)
4785 5269	Interchip Photometric Calibration	WF 1-4 in F336W, F284W, F439W, F555W, F702W, F785LP, F1042M PC 6 in most WFPC filters (33) PC 5,7,8 in subset (11) of the PC 6 filters executed Fall 1993 target: UV standard BD+75D325
4739	Single Chip UV Calibration	executed once after Aug 1993 decontamination WF2, PC6 : F194W, F230W, F284W target: UV standard BD+75D325
2875	QE Calibration	executed once after Feb 1992 decontamination WF2, PC6 F336W, F439W, F555W, F791W, F702W, F785LP, F889N, F1042M target: UV standard BD+75D325

Notes to table:

3230 - All of the Prop 3230 data has been ingested into the library. This includes the initial delivery as made to STSCI by the WFPC Instrument Definition Team (~100), as well as all observations obtained since then (~340). One or two stars were imaged roughly once per week in PC 5-8, usually 0.11 second exposures taken with F555W and 0.23 second exposures taken with F785LP. Note that 0.11 second exposures may be of limited usefulness due to obscuration of the light beam by the shutter blade (for additional details and discussion of these PSF observations, see the Final OV/SV Report (WFPC IDT, 1992)).

3241 - All of the PSF images from the OTA Calibration Proposal (#3241) 'Mapping the Position Dependence of the WFPC PSF' have been ingested into the Library. The PC 6 observations were taken through a variety of filters (F336W, F413M, F439W, F487N, F502N, F547M, F555W, F588N, F673N, F718M, F785LP, and F889N). Spatial coverage was obtained by imaging the star in 4x4 grids across the chip (F487N and F889N) and in 2x2 grids on the chip for the other filters. The WF 2 observations, taken in F555W and F785LP, imaged the target star in 5x5 grids across the chip.

4809 - All PSF images from the 'PSF Calibration Proposal' obtained so far have been extracted and archived into the library. Images from this proposal are being taken on all four chips, for a subset of filters (F336W, F555W, F702W, F785LP, and F889N). In addition, some spatial coverage is obtained via 2x2 grids of PSF images, taken in these same five filters, in P6 and W2 (see also ISR 92-13, PSF Calibration Plan, S.Baggett and J.MacKenty; note however, that not all observations planned may be taken by the time of the servicing mission).

5025/4207/2877 - Current PSF library installations will include data from the WFPC Cycle 1, Cycle 2, Cycle 3 'Photometric Calibration Monitor' proposals (#2877, #4207, #5025 respectively). These programs obtain WF 2 and PC 6 observations of a UV flux standard about once a month, in F230W, F284W, F336W, F439W, F555W, and F785LP; the PSF memo on STEIS will continue to be updated as necessary to reflect the growing contents of the PSF library.

4785/5269 - The 'WFPC Cycle 2 Interchip Photometric Calibration Proposal' will be taking exposures of usual UV standard BD+75D325 in a variety of popular filters (F284W, F336W, F439W, F555W, F702W, F785LP, and F1042M) for all WF and PC chips as well as exposures in PC6 in most other filters. Many of the images are already in the library; as the final observations are obtained, they will be processed and extracted in the same manner and archived into the library.

4739/2875 - Data from the Single Chip UV Calibration and QE Calibration proposals, which were executed once after the 1993 and 1992 decontamination procedures respectively, will be added to the Library in the near future.

We thank C. Ritchie for providing calibrated images of the Proposal 4785/5269 data.

References

- Baggett, S. M., and MacKenty, J. W., WFPC PSF Image Library Memo, copies available on STEIS.
- Burrows, Christopher, OTA Instrument Science Report #7, "HST Focus and Collimation", Feb 20, 1992.
- Burrows, Christopher, and Hasan, Hashima, Tim Users Manual (Version 30, November 11, 1993).
- Burrows, Christopher J., Holtzman, Jon A., Faber, S.M., Bely, Pierre Y., Hasan, Hashima, Lynds, C.R., and Schroeder, Daniel, ApJ 369, L21, 1991.
- Krist, John, The Tiny Tim User's Manual (Version 2.4, August 1993).
- WFPC IDT, Final Orbital/Science Verification Report, Faber et al., Feb. 1992.

Appendix - Image Names

The tables in this Appendix, one for each detector, summarize the contents of the library at the time of writing; the PSF memo on STEIS will continue to be updated with new deliveries. The information provided in the tables consists of

d : detector (WF=1-4, PC=5-8)

filter : filter name

data_file : rootname of the extracted PSF image (extension .r7h and .r7d)

date_obs : date of the observation (dd/mm/yy)

rootname : name of the original dataset from which PSF was extracted

targname : name of the observed star if known

exp : exposure time (sec)

sp : spectral type of the star (U for unknown)

xc : x pixel of PSF peak in original chip coordinates

yc : y pixel of PSF peak in original chip coordinates

peak : maximum counts in peak of PSF (DN)

All of these keywords except 'peak' are also contained in the individual PSF image headers.