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The WFPC2 PSF Library

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Abstract. We describe the development of the WFPC2 PSF Library. The extraction of observed Point Spread Functions from standard calibration observations, as well as the creation of their associated header files are discussed. We then describe the development of the WWW-based PSF Library Search Tool, and use of the Tool.

1. Introduction

The WFPC2 PSF Library is designed to provide observers with easy access to a selection of observed PSFs, taken in most WFPC2 filters, and in various positions across each chip. Many of the PSFs were extracted from images of the clusters Omega Centauri and M67, which were imaged as part of STScI's ongoing WFPC2 Calibration Observations. These observations provided stellar images of various intensities, saturation levels, and positions across the chips. Only isolated, non-overlapping PSFs were selected.

In the future, we plan to extract PSFs from the calibration observations of the single white dwarf stars A+81D266, BD+75D325, GRW+70D5824, and Feige110, from selected, public GO data, as well as from the remaining observations of the clusters mentioned previously.

2. Generation of the PSFs

The PSF images were extracted from archival, pipeline processed WFPC2 images, with no further processing, and generally no cosmic-ray rejection. To identify PSF candidates, the observations were examined by eye. The PSF stars had to be well separated from other stars and have a peak intensity of no less than 150 DN; there was no imposed upper limit on any star's intensity.

For all stars meeting these simple selection criteria, the IRAF tool imexamine was used to fix the star's position and calculate the peak intensity (a Gaussian fit, in DN). An estimate was made of the background level on the chip, by determining the average within 3 - 20x20 pixel regions, free from cosmic rays. The resulting estimate is given in the BACKGND keyword in the PSF header.

The PSF positions and intensities were used to:

1. Determine the DN value of the peak pixel from image statistics (not the fit from imexamine), and then define the size of the extracted image. For peak intensities less than 3500 DN, the extracted image is 64x64 pixels, centered on the PSF; greater than 3500 DN, the image is 128x128 pixels.

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2. Extract the image sections as separate images with individual headers, comprised of the original WFPC2 header, plus new PSF specific keywords, listed in the table below.

3. Recompute the minimum and maximum data values and the "good" minimum and maximum data values, and update the PSF headers.

Table 1. Keywords added to PSF image headers.

KEYWORD	DEFINITION
ORIGIN	Data Source (HST,TINYTIM, or COMPOSITE)
XCENTER	X coordiante of PSF center on chip
YCENTER	Y coordiante of PSF center on chip
XCORNER	X pixel of (1,1) corner in PSF image
YCORNER	Y pixel of (1,1) corner in PSF image
RA_PSF	RA of PSF star (deg, J2000)
DEC_PSF	DEC of PSF star (deg, J2000)
PEAKINT	Peak intensity at xcenter, ycenter
PEAKFIT	Peak of Gaussian fit
SATURATD	Is PSF saturated? (Y or N)
BACKGND	Background (in DN)
SPECTRAL	Spectral type of source, if known
REFSPEC	Reference spectrum, if known
T306	Secondary mirror temperature (degrees Celsius)
T307	Secondary mirror temperature (degrees Celsius)
T308	Secondary mirror temperature (degrees Celsius)
T309	Secondary mirror temperature (degrees Celsius)
V2_RMS	V2 Axis RMS (milli-arcsec)
V2_P2P	V2 Axis peak to peak (milli-arcsec)
V3_RMS	V3 Axis RMS (milli-arcsec)
V3_P2P	V3 Axis peak to peak (milli-arcsec)
GUIDEACT	Actual guiding mode at end of GS Acquisition
RELFOCUS	Relative focus (in microns)

Any PSF image with saturated pixels (bitflag = 8, in the original calibration image's data quality (.c1h) file), had those pixel values replaced with a value of -100. This will allow users to quickly identify saturated pixels within the PSF.

3. Status of the PSF Library

To date there are 2701 PSF images available in the PSF Library. The table below lists the current distribution of PSFs by filter and chip.

Table 2. Status of the PSF Library by filter and chip.

FILTER	PC	WF2	WF3	WF4
F300W	8	9	14	9
F336W	40	81	86	50
F380W	1	3	3	0
F410M	1	1	1	0
F439W	60	93	122	73
F450W	2	4	1	0
F467M	1	3	3	1
F547M	10	17	26	11
F555W	80	102	132	89
F569W	12	18	20	11
F606W	38	25	50	30
F675W	40	14	18	10
F702W	12	27	18	17
F785LP	22	24	29	23
F814W	218	277	334	277

4. PSF Relative Focus Information

One of the new PSF header keywords provides a value for the relative focus (RELFOCUS). This was done to provide users with a general idea of the focus of HST at the time of the PSF observation. Thus, users can use PSFs at or near the same focus as their own observations.

Presently, nearly half of the PSFs in the Library have RELFOCUS values determined from an average fit of the focus monitoring data based on the "phase-retrieval" method, with no correction for orbit-to-orbit variations in the focus, (known as "breathing"). No breathing correction could be performed because the observations were made prior to July 1995, when temperature data became readily available. The other half of the PSFs were taken after July 1995, and have the "breathing" correction applied to the averaged phase-retrieval focus values. See Instrument Science Report OTA-18 for details on the focus history of HST and the "breathing" correction (Casertano, 1995). The r.m.s. scatter around the average fit is roughly +/- 2 microns, while the scatter for points with the breathing correction applied is close to +/- 1.3 microns.

Within the headers of the PSFs, we have also included the secondary mirror temperatures (T306, T307, T308, and T309 keywords), if known. Thus, if a particular PSF has a value other than 0.00, the breathing correction has been applied.

Also available from the PSF Library Help Page is a table containing the Modified Julian Date (MJD), and the averaged phase-retrieval focus values (with no breathing correction applied), to provide users with an estimate for the focus of their science image.

5. PSF Library Search and Retrieval Tool

In order to make the PSF images easily accessible to WFPC2 users, we opted for a Web-based search and retrieval tool, with the PSF images stored and available on-line. The tool was designed to be as flexible as possible, allowing the user to search for desired PSFs using virtually any combination of criteria. The output of this search can also be sorted according to the user's needs.

There are four basic steps to using the tool:

1. Define a subset of PSFs using qualifiers on the main page.
2. Select for retrieval a subset (or all) PSFs from the tabular output.
3. Request generation of an ftp command file for retrieval of the selected PSFs.
4. Save the command file to local disk, and run it at the user's leisure.

The Tool is accessible at the following WWW address:

www.stsci.edu/ftp/instrument_news/WFPC2/Wfpc2_psf/wfpc2-psf-form.html

The page has an extensive help file as well as a status page, listing the number of PSFs per filter and chip, and also plots showing the X-Y positions of the PSFs on the original images (see Figure 1). The PSF files can be retrieved in either FITS or GEIS formats.

Figure 2 displays a portion of the PSF page, with parameters set to search for all PSFs for filter F547M, in the PC, with any gain, and both serials. There are many other keywords that can be used as qualifiers, such as observation date, exposure time, if the PSF is saturated, peak intensity, X,Y position (with search radius), as well as jitter. The user can sort the output according to any criteria, in this example the output will be sorted by dataset name, detector, and gain. The result of this search is in the "default output" format and is illustrated in Figure 3.

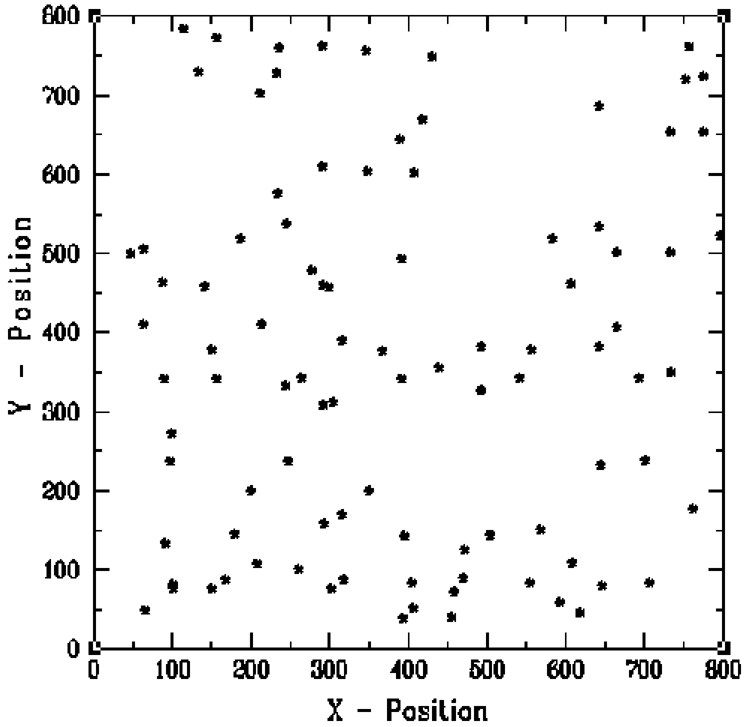

Figure 1. Positions of all PSFs available for F555W on the WF2 chip.

The output page allows the user to preview the PSF image, by "clicking" on the highlighted dataset name. It also allows for the selection of either all or just a few PSFs to be marked for retrieval. The PSFs can then be downloaded to the user's machine in either GEIS or FITS format.

The PSF Library is being continually updated with new PSFs. However, some users may find no appropriate PSFs in the Library. In this case we recommend using archival data, either calibration or public GO data as a source of observed PSFs. Another alternative is to use TinyTim, a program to generate theoretical PSFs. Tiny Tim can be accessed at:

http://scivax.stsci.edu/~krist/tinytim.html

6. Acknowledgements

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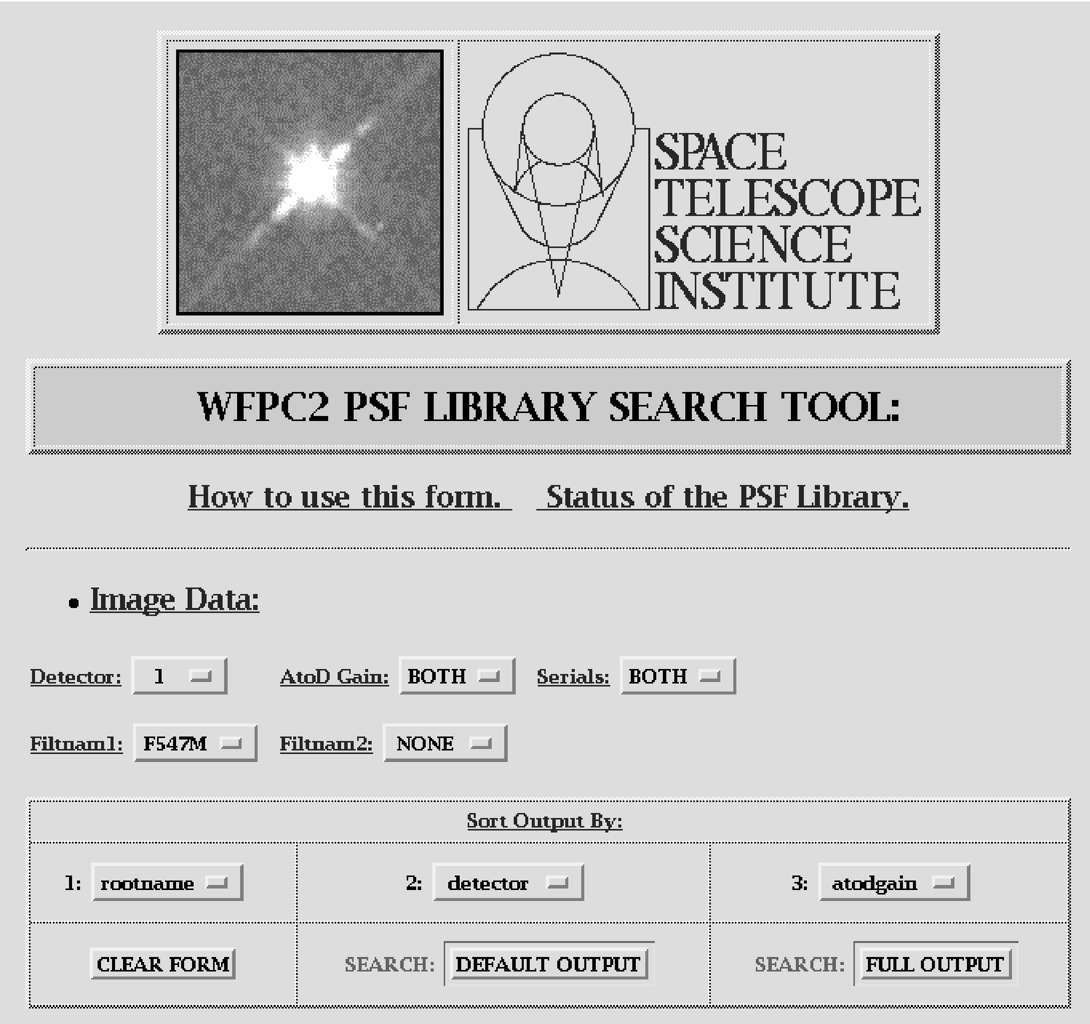
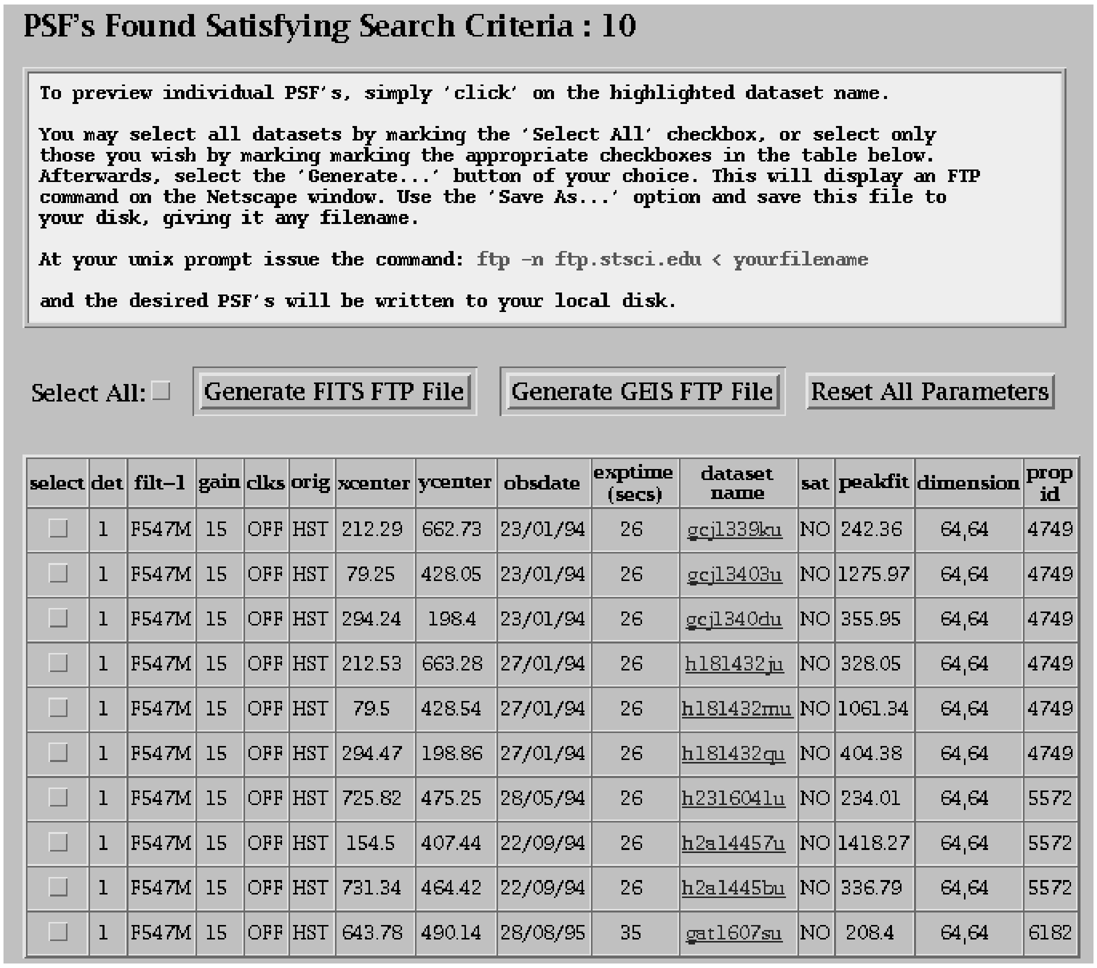


Figure 2. A portion of the WFPC2 PSF Library Web Page.



PSF's Found Satisfying Search Criteria : 10

To preview individual PSF's, simply 'click' on the highlighted dataset name.

You may select all datasets by marking the 'Select All' checkbox, or select only those you wish by marking marking the appropriate checkboxes in the table below. Afterwards, select the 'Generate...' button of your choice. This will display an FTP command on the Netscape window. Use the 'Save As...' option and save this file to your disk, giving it any filename.

At your unix prompt issue the command: ftp -n ftp.stsci.edu < yourfilename

and the desired PSF's will be written to your local disk.

Select All: ☐ Generate FITS FTP File | Generate GEIS FTP File | Reset All Parameters

select	det	filt–1	gain	clks	orig	xcenter	ycenter	obsdate	exptime (secs)	dataset name	sat	peakfit	dimension	prop id
☐	1	F547M	15	OFF	HST	212.29	662.73	23/01/94	26	gcjl339ku	NO	242.36	64,64	4749
☐	1	F547M	15	OFF	HST	79.25	428.05	23/01/94	26	gcjl3403u	NO	1275.97	64,64	4749
☐	1	F547M	15	OFF	HST	294.24	198.4	23/01/94	26	gcjl340du	NO	355.95	64,64	4749
☐	1	F547M	15	OFF	HST	212.53	663.28	27/01/94	26	h181432ju	NO	328.05	64,64	4749
☐	1	F547M	15	OFF	HST	79.5	428.54	27/01/94	26	h181432mu	NO	1061.34	64,64	4749
☐	1	F547M	15	OFF	HST	294.47	198.86	27/01/94	26	h181432qu	NO	404.38	64,64	4749
☐	1	F547M	15	OFF	HST	725.82	475.25	28/05/94	26	h2316041u	NO	234.01	64,64	5572
☐	1	F547M	15	OFF	HST	154.5	407.44	22/09/94	26	h2a14457u	NO	1418.27	64,64	5572
☐	1	F547M	15	OFF	HST	731.34	464.42	22/09/94	26	h2a1445bu	NO	336.79	64,64	5572
☐	1	F547M	15	OFF	HST	643.78	490.14	28/08/95	35	gat1607su	NO	208.4	64,64	6182

Figure 3. Output from a search of the PSF Library.