



Technical Instrument Report WFPC2 2008-01

PSF characterization for the HST One-Gyro mode test

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ABSTRACT

We have analyzed the WFPC2 data taken during the on-orbit one gyro test which occurred January 29-31, 2008. This program was designed to investigate whether one-gyro guiding would degrade WFPC2 image quality. Science data obtained in one-gyro mode are essentially indistinguishable from those obtained in two-gyro mode.

Introduction

On-orbit tests of the HST one-gyro fine guiding mode and its impact on science instrument performance were carried out in January 2008. More than 160 images were taken with WFPC2 during the test. All results from these tests indicate that there is no degradation in the quality of science data obtained in one-gyro mode compared to two-gyro mode.

The WFPC2/PC point spread function (PSF) shape and stability tests consisted of multiple exposures of two rich star clusters observed with the F555W filter within the calibration program 11077. Sequences of 10, 100, and 400 second exposures were obtained to check for dependencies of the PSF shape on exposure duration and timing within orbits. Observations using $V \approx 13$, and $V \approx 14$ magnitude guide stars allowed for a check of the PSF width dependence on the guide star magnitude.

Program 11077 included two set of observations, Visits A1 and B1-B6 were taken in the standard 2-gyro mode to set a baseline. Visits C1 and D1-D6 were taken during the one-

gyro test. Table 1 lists the target observed and the guide star brightness used during the test.

Target	RA (2000)	Dec (2000)	Guide Star Brightness	Number of Images
NGC 5904	15 18 28.14	+02 07 9.80	V \approx 14	28
NGC 6341	17 17 7.05	+43 17 58.25	V \approx 13 and 14	140

Table 1. Détails of program 11077

The structure of the visits and the data analysis for 11077 resembled very closely those for the original two-gyro test (Sembach et al. 2005). For this test only the PC frame was used. The severe undersampling of the PSF in the WF chips makes the PSF less sensitive to jitter variations.

For each image, the FWHM of the PSF for stars with S/N > 10 was calculated by fitting a gaussian profile to the stellar light profile for each image. This typically resulted in tens to hundreds of measurements per image depending on the number and brightness of the stars. All of the measurements in each image were averaged to produce a mean PSF for the observations.

Figure 1 shows the distribution of these average PSF FWHM measurements in units of PC pixels (\sim 0.46 milli-arcseconds). The distribution does not take into account differences in target, exposure time, or guide star brightness. The average widths for the 1-gyro (1.65 ± 0.14) and 2-gyro (1.67 ± 0.16) dataset are remarkably similar, indicating no obvious degradation in performance.

The 2-gyro data shows a slightly broader distribution than the 1-gyro data. This is mainly due to the fact that the baseline 2-gyro data were acquired in a period of 24 hours while the 1-gyro data were all taken within 10 hours. Breathing and small focus changes between orbits are likely responsible for the larger variation seen in the 2-gyro dataset.

Figure 2 allows a qualitative comparison of the PSF of a star of of NGC 6341 in a 10 second image taken under 2-gyro and 1-gyro operation. Again, no degradation is visible.

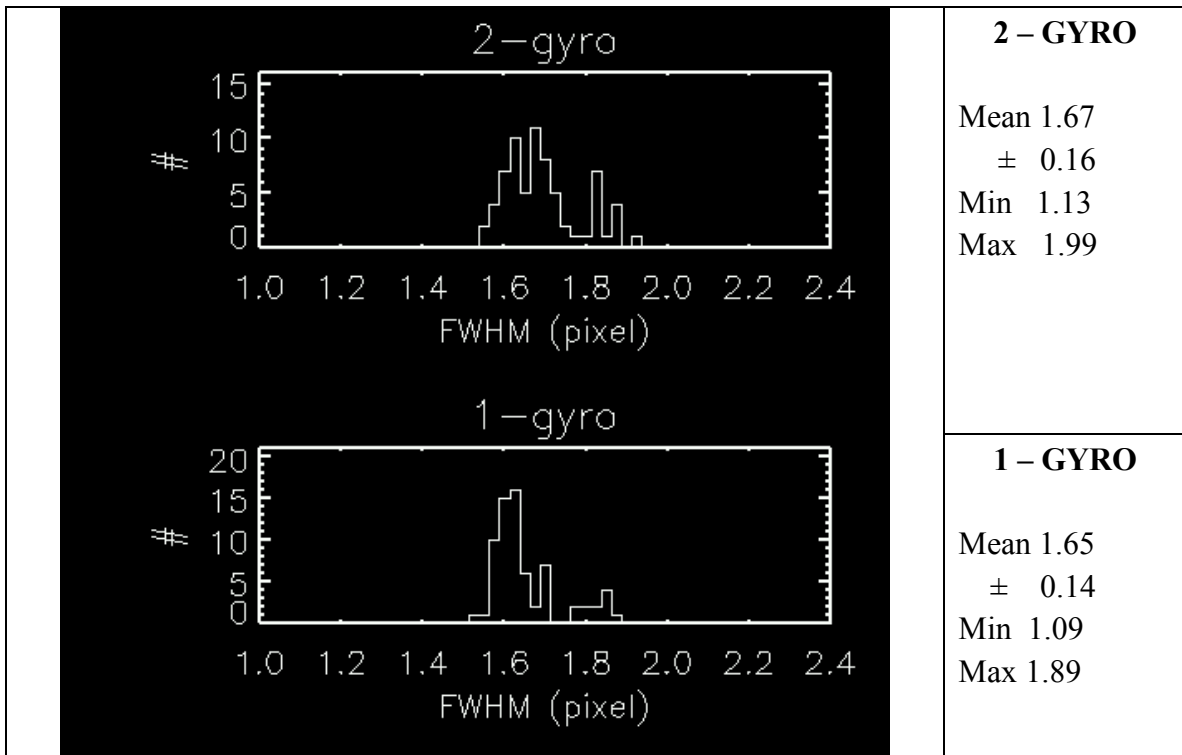


Figure 1. Combined distribution of the FWHM in PC pixels for all the observations of NGC 6341 and NGC 5904 in the two sets of data.

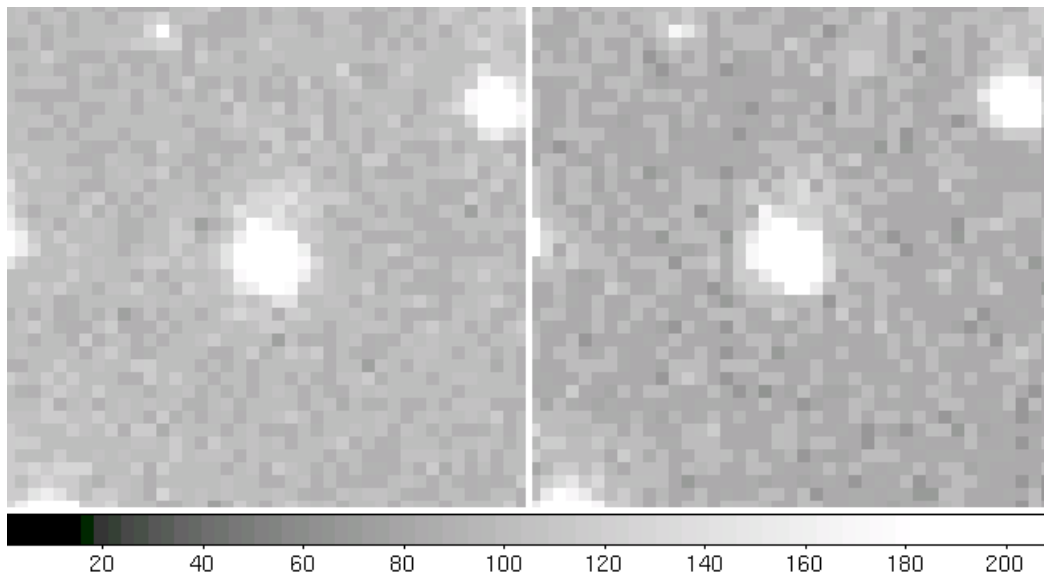


Figure 2: Comparison of a point source PSF under 2-gyro (left) and 1-gyro (right) operation.

The FWHM distributions shown in Figure 1 show multiple structures which be due to differences related to the guide star brightness, exposure time, or position of the target. The numerous observations of the rich cluster NGC 6341 are optimal for studying the relation between the PSF FWHM and the exposure time or guide star brightness.

In Table 2 we have grouped the NGC 6341 observations under 1-gyro and 2-gyro operation according to the exposure duration and the brightness of the guide star.

There are no apparent differences in PSF widths for exposures taken with bright guide stars versus those obtained with faint guide stars. However, there are small changes in the PSF width due to the exposure duration, indicating that longer exposures may have slightly larger PSF widths than shorter exposures. Figure 3 shows the distribution of the PSF FWHM for NGC6341 for the three different exposure times, regardless of the brightness of the guide stars. Such differences were also noted during the original 2-gyro on orbit verification test with the ACS/HRC (Sembach et al. 2005).

	Guide Star Brightness (Mag)			
	V=12.91		V=13.86	
10 sec	FWHM	σ	FWHM	σ
1 - gyro	1.63	0.01	1.62	0.01
2 - gyro	1.65	0.01	1.67	0.01
100 sec	FWHM	σ	FWHM	σ
1 - gyro	1.71	0.01	1.69	0.01
2 - gyro	1.70	0.01	1.70	0.01
400 sec	FWHM	σ	FWHM	σ
1 - gyro	1.82	0.02	1.82	0.03
2 - gyro	1.85	0.04	1.86	0.03
Average	FWHM	σ	FWHM	σ
1 - gyro	1.68	0.01	1.68	0.02
2 - gyro	1.70	0.02	1.72	0.02

Table 2: Average PSF FWHM for observations of NGC 6341 alone. The measurements have been grouped for similar exposure time and guide star brightness.

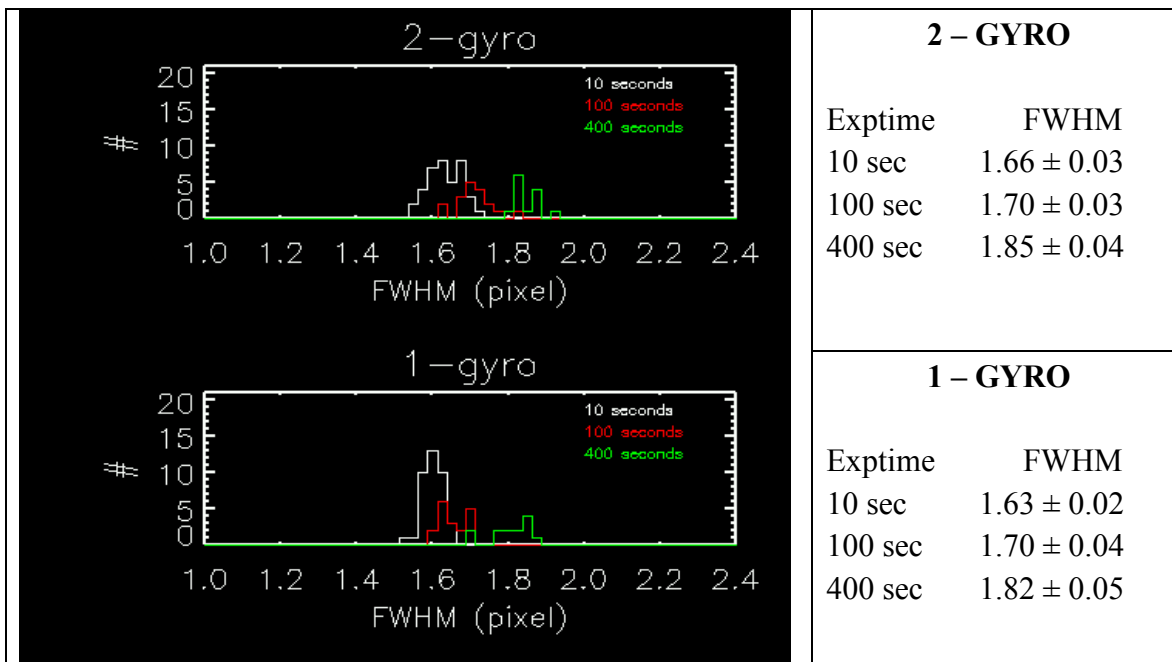


Figure 3 : Distribution of the FWHM for observations of NGC 6341.

Finally, when we look at the variation of the PSF width with position on the sky, we find that the average PSF in NGC 5904 data is systematically smaller than in NGC 6341, but there is no dependency on the gyro guiding configuration. A similar result was found for the clusters observed during the previous 2-gyro on-orbit test.

Target	1 Gyro	2 Gyro
NGC 5904	1.41 ± 0.04	1.46 ± 0.07
NGC 6341	1.68 ± 0.01	1.71 ± 0.01

Table 3 : Average PSF FWHM for the two star clusters

Conclusions

We have analyzed the WFPC2 data of two globular clusters taken in one-gyro mode and compared them with a baseline of identical observations in 2-gyro mode. The science

data obtained in one-gyro mode are essentially indistinguishable from those obtained in two-gyro mode. There is no evidence to suggest that the quality of the science data obtained in 1-gyro mode is any worse than in 2-gyro mode.

Acknowledgements

We would like to thank Vera Platais for helping in the conversion of the IRAF script originally written for the ACS/HRC 2-gyro test so that it could be used with to WFPC2 data.

References

Sembach, K. et al. in “2005 HST Calibration Workshop” , eds. A. Koekemoer, P. Goudfrooij, and L. Dressel, STSci 2005, 357.

APPENDIX – Log of the observations

Table 4. 2-Gyro dataset

EXPOSURE	DATASET	TARGET	EXPTIME	CCDGAIN	FILTER	DATE	TIME
A1-001#001	ua5da101m	NGC5904	10.0	15	F555W	1/25/2008	18:54:17
A1-001#002	ua5da102m	NGC5904	10.0	15	F555W	1/25/2008	18:56:17
A1-001#003	ua5da103m	NGC5904	10.0	15	F555W	1/25/2008	18:58:17
A1-001#004	ua5da104m	NGC5904	10.0	15	F555W	1/25/2008	19:00:17
A1-001#005	ua5da105m	NGC5904	10.0	15	F555W	1/25/2008	19:02:17
A1-002#001	ua5da106m	NGC5904	100.0	15	F555W	1/25/2008	19:04:17
A1-002#002	ua5da107m	NGC5904	100.0	15	F555W	1/25/2008	19:10:17
A1-002#003	ua5da108m	NGC5904	100.0	15	F555W	1/25/2008	19:13:17
A1-003#001	ua5da109m	NGC5904	400.0	15	F555W	1/25/2008	19:16:17
A1-003#002	ua5da10am	NGC5904	400.0	15	F555W	1/25/2008	19:27:17
A1-004#001	ua5da10bm	NGC5904	10.0	15	F555W	1/25/2008	19:35:17
A1-004#002	ua5da10cm	NGC5904	10.0	15	F555W	1/25/2008	19:37:17
B1-001#001	ua5db101m	NGC6341	10.0	15	F555W	1/25/2008	23:52:17
B1-001#002	ua5db102m	NGC6341	10.0	15	F555W	1/25/2008	23:54:17
B1-001#003	ua5db103m	NGC6341	10.0	15	F555W	1/25/2008	23:56:17
B1-001#004	ua5db104m	NGC6341	10.0	15	F555W	1/25/2008	23:58:17
B1-001#005	ua5db105m	NGC6341	10.0	15	F555W	1/26/2008	0:00:17
B1-002#001	ua5db106m	NGC6341	100.0	15	F555W	1/26/2008	0:02:17
B1-002#002	ua5db107m	NGC6341	100.0	15	F555W	1/26/2008	0:08:17
B1-002#003	ua5db108m	NGC6341	100.0	15	F555W	1/26/2008	0:11:17
B1-003#001	ua5db109m	NGC6341	400.0	15	F555W	1/26/2008	0:14:17
B1-003#002	ua5db10am	NGC6341	400.0	15	F555W	1/26/2008	0:25:17
B1-004#001	ua5db10bm	NGC6341	10.0	15	F555W	1/26/2008	0:33:17
B1-004#002	ua5db10cm	NGC6341	10.0	15	F555W	1/26/2008	0:35:17
B2-001#001	ua5db201m	NGC6341	10.0	15	F555W	1/25/2008	20:41:17
B2-001#002	ua5db202m	NGC6341	10.0	15	F555W	1/25/2008	20:43:17
B2-002	ua5db203m	NGC6341	100.0	15	F555W	1/25/2008	20:45:17
B2-002	ua5db204m	NGC6341	100.0	15	F555W	1/25/2008	20:51:17
B2-003	ua5db205m	NGC6341	400.0	15	F555W	1/25/2008	20:57:17
B2-003	ua5db206m	NGC6341	400.0	15	F555W	1/25/2008	21:08:17
B2-004	ua5db207m	NGC6341	10.0	15	F555W	1/25/2008	21:19:17
B2-004	ua5db208m	NGC6341	10.0	15	F555W	1/25/2008	21:24:17
B2-005	ua5db209m	NGC6341	100.0	15	F555W	1/25/2008	22:16:17
B2-005	ua5db20am	NGC6341	100.0	15	F555W	1/25/2008	22:22:17
B2-006	ua5db20bm	NGC6341	10.0	15	F555W	1/25/2008	22:28:17
B2-006	ua5db20cm	NGC6341	10.0	15	F555W	1/25/2008	22:33:17
B2-006	ua5db20dm	NGC6341	10.0	15	F555W	1/25/2008	22:38:17
B2-006	ua5db20em	NGC6341	10.0	15	F555W	1/25/2008	22:43:17
B2-007	ua5db20fm	NGC6341	400.0	15	F555W	1/25/2008	22:48:17
B2-008	ua5db20gm	NGC6341	100.0	15	F555W	1/25/2008	22:56:17
B2-009	ua5db20hm	NGC6341	10.0	15	F555W	1/25/2008	22:59:17
B3-001#001	ua5db301m	NGC6341	10.0	15	F555W	1/26/2008	3:03:17
B3-001#002	ua5db302m	NGC6341	10.0	15	F555W	1/26/2008	3:05:17
B3-001#003	ua5db303m	NGC6341	10.0	15	F555W	1/26/2008	3:07:17
B3-001#004	ua5db304m	NGC6341	10.0	15	F555W	1/26/2008	3:09:17

B3-001#005	ua5db305m	NGC6341	10.0	15	F555W	1/26/2008	3:11:17
B3-002#001	ua5db306m	NGC6341	100.0	15	F555W	1/26/2008	3:13:17
B3-002#002	ua5db307m	NGC6341	100.0	15	F555W	1/26/2008	3:19:17
B3-002#003	ua5db308m	NGC6341	100.0	15	F555W	1/26/2008	3:22:17
B3-003#001	ua5db309m	NGC6341	400.0	15	F555W	1/26/2008	3:25:17
B3-003#002	ua5db30am	NGC6341	400.0	15	F555W	1/26/2008	3:36:17
B3-004#001	ua5db30bm	NGC6341	10.0	15	F555W	1/26/2008	3:44:17
B3-004#002	ua5db30cm	NGC6341	10.0	15	F555W	1/26/2008	3:46:17
B4-001#001	ua5db401m	NGC6341	10.0	15	F555W	1/26/2008	1:27:17
B4-001#002	ua5db402m	NGC6341	10.0	15	F555W	1/26/2008	1:29:17
B4-002	ua5db403m	NGC6341	100.0	15	F555W	1/26/2008	1:31:17
B4-002	ua5db404m	NGC6341	100.0	15	F555W	1/26/2008	1:37:17
B4-003	ua5db405m	NGC6341	400.0	15	F555W	1/26/2008	1:43:17
B4-003	ua5db406m	NGC6341	400.0	15	F555W	1/26/2008	1:54:17
B4-004	ua5db407m	NGC6341	10.0	15	F555W	1/26/2008	2:05:17
B4-004	ua5db408m	NGC6341	10.0	15	F555W	1/26/2008	2:10:17
B5-001#001	ua5db501m	NGC6341	10.0	15	F555W	1/26/2008	23:50:17
B5-001#002	ua5db502m	NGC6341	10.0	15	F555W	1/26/2008	23:52:17
B5-001#003	ua5db503m	NGC6341	10.0	15	F555W	1/26/2008	23:54:17
B5-001#004	ua5db504m	NGC6341	10.0	15	F555W	1/26/2008	23:56:17
B5-001#005	ua5db505m	NGC6341	10.0	15	F555W	1/26/2008	23:58:17
B5-002#001	ua5db506m	NGC6341	100.0	15	F555W	1/27/2008	0:00:17
B5-002#002	ua5db507m	NGC6341	100.0	15	F555W	1/27/2008	0:06:17
B5-002#003	ua5db508m	NGC6341	100.0	15	F555W	1/27/2008	0:09:17
B5-003#001	ua5db509m	NGC6341	400.0	15	F555W	1/27/2008	0:12:17
B5-003#002	ua5db50am	NGC6341	400.0	15	F555W	1/27/2008	0:23:17
B5-004#001	ua5db50bm	NGC6341	10.0	15	F555W	1/27/2008	0:31:17
B5-004#002	ua5db50cm	NGC6341	10.0	15	F555W	1/27/2008	0:33:17
B6-001#001	ua5db601m	NGC6341	10.0	15	F555W	1/26/2008	4:40:17
B6-001#002	ua5db602m	NGC6341	10.0	15	F555W	1/26/2008	4:42:17
B6-002	ua5db603m	NGC6341	100.0	15	F555W	1/26/2008	4:44:17
B6-002	ua5db604m	NGC6341	100.0	15	F555W	1/26/2008	4:50:17
B6-003	ua5db605m	NGC6341	400.0	15	F555W	1/26/2008	4:56:17
B6-003	ua5db606m	NGC6341	400.0	15	F555W	1/26/2008	5:07:17
B6-004	ua5db607m	NGC6341	10.0	15	F555W	1/26/2008	5:18:17
B6-004	ua5db608m	NGC6341	10.0	15	F555W	1/26/2008	5:23:17

Table 5. 1-Gyro dataset

EXPOSURE	DATASET	TARGET	EXPTIME	CCDGAIN	FILTER	DATE	TIME
C1-001#001	ua5dc101m	NGC5904	10.0	15	F555W	1/29/2008	22:01:17
C1-001#002	ua5dc102m	NGC5904	10.0	15	F555W	1/29/2008	22:03:17
C1-001#003	ua5dc103m	NGC5904	10.0	15	F555W	1/29/2008	22:05:17
C1-001#004	ua5dc104m	NGC5904	10.0	15	F555W	1/29/2008	22:07:17
C1-001#005	ua5dc105m	NGC5904	10.0	15	F555W	1/29/2008	22:09:17
C1-002#001	ua5dc106m	NGC5904	100.0	15	F555W	1/29/2008	22:11:17
C1-002#002	ua5dc107m	NGC5904	100.0	15	F555W	1/29/2008	22:17:17
C1-002#003	ua5dc108m	NGC5904	100.0	15	F555W	1/29/2008	22:20:17
C1-003#001	ua5dc109m	NGC5904	400.0	15	F555W	1/29/2008	22:23:17
C1-003#002	ua5dc10am	NGC5904	400.0	15	F555W	1/29/2008	22:34:17
C1-004#001	ua5dc10bm	NGC5904	10.0	15	F555W	1/29/2008	22:42:17
C1-004#002	ua5dc10cm	NGC5904	10.0	15	F555W	1/29/2008	22:44:17
D1-001#001	ua5dd101m	NGC6341	10.0	15	F555W	1/29/2008	23:44:17
D1-001#002	ua5dd102m	NGC6341	10.0	15	F555W	1/29/2008	23:46:17
D1-001#003	ua5dd103m	NGC6341	10.0	15	F555W	1/29/2008	23:48:17
D1-001#004	ua5dd104m	NGC6341	10.0	15	F555W	1/29/2008	23:50:17
D1-001#005	ua5dd105m	NGC6341	10.0	15	F555W	1/29/2008	23:52:17
D1-002#001	ua5dd106m	NGC6341	100.0	15	F555W	1/29/2008	23:54:17
D1-002#002	ua5dd107m	NGC6341	100.0	15	F555W	1/30/2008	0:00:17
D1-002#003	ua5dd108m	NGC6341	100.0	15	F555W	1/30/2008	0:03:17
D1-003#001	ua5dd109m	NGC6341	400.0	15	F555W	1/30/2008	0:06:17
D1-003#002	ua5dd10am	NGC6341	400.0	15	F555W	1/30/2008	0:17:17
D1-004#001	ua5dd10bm	NGC6341	10.0	15	F555W	1/30/2008	0:25:17
D1-004#002	ua5dd10cm	NGC6341	10.0	15	F555W	1/30/2008	0:27:17
D2-001#001	ua5dd201m	NGC6341	10.0	15	F555W	1/30/2008	1:21:17
D2-001#002	ua5dd202m	NGC6341	10.0	15	F555W	1/30/2008	1:23:17
D2-002	ua5dd203m	NGC6341	100.0	15	F555W	1/30/2008	1:25:17
D2-002	ua5dd204m	NGC6341	100.0	15	F555W	1/30/2008	1:31:17
D2-003	ua5dd205m	NGC6341	400.0	15	F555W	1/30/2008	1:37:17
D2-003	ua5dd206m	NGC6341	400.0	15	F555W	1/30/2008	1:48:17
D2-004	ua5dd207m	NGC6341	10.0	15	F555W	1/30/2008	1:59:17
D2-004	ua5dd208m	NGC6341	10.0	15	F555W	1/30/2008	2:04:17
D2-005	ua5dd209m	NGC6341	100.0	15	F555W	1/30/2008	2:57:17
D2-005	ua5dd20am	NGC6341	100.0	15	F555W	1/30/2008	3:03:17
D2-006	ua5dd20bm	NGC6341	10.0	15	F555W	1/30/2008	3:09:17
D2-006	ua5dd20cm	NGC6341	10.0	15	F555W	1/30/2008	3:14:17
D2-006	ua5dd20dm	NGC6341	10.0	15	F555W	1/30/2008	3:19:17
D2-006	ua5dd20em	NGC6341	10.0	15	F555W	1/30/2008	3:24:17
D2-007	ua5dd20fm	NGC6341	10.0	15	F555W	1/30/2008	3:29:17
D2-008	ua5dd20gm	NGC6341	100.0	15	F555W	1/30/2008	3:31:17
D2-009	ua5dd20hm	NGC6341	400.0	15	F555W	1/30/2008	3:34:17
D3-001#001	ua5dd301m	NGC6341	10.0	15	F555W	1/30/2008	4:32:17
D3-001#002	ua5dd302m	NGC6341	10.0	15	F555W	1/30/2008	4:34:17
D3-001#003	ua5dd303m	NGC6341	10.0	15	F555W	1/30/2008	4:36:17
D3-001#004	ua5dd304m	NGC6341	10.0	15	F555W	1/30/2008	4:38:17
D3-001#005	ua5dd305m	NGC6341	10.0	15	F555W	1/30/2008	4:40:17
D3-002#001	ua5dd306m	NGC6341	100.0	15	F555W	1/30/2008	4:42:17

D3-002#002	ua5dd307m	NGC6341	100.0	15	F555W	1/30/2008	4:48:17
D3-002#003	ua5dd308m	NGC6341	100.0	15	F555W	1/30/2008	4:51:17
D3-003#001	ua5dd309m	NGC6341	10.0	15	F555W	1/30/2008	4:54:17
D3-003#002	ua5dd30am	NGC6341	10.0	15	F555W	1/30/2008	4:56:17
D3-004#001	ua5dd30bm	NGC6341	400.0	15	F555W	1/30/2008	4:58:17
D3-004#002	ua5dd30cm	NGC6341	400.0	15	F555W	1/30/2008	5:09:17
D4-001#001	ua5dd401m	NGC6341	10.0	15	F555W	1/30/2008	6:08:17
D4-001#002	ua5dd402m	NGC6341	10.0	15	F555W	1/30/2008	6:10:17
D4-002	ua5dd403m	NGC6341	100.0	15	F555W	1/30/2008	6:12:17
D4-002	ua5dd404m	NGC6341	100.0	15	F555W	1/30/2008	6:18:17
D4-003	ua5dd405m	NGC6341	400.0	15	F555W	1/30/2008	6:24:17
D4-003	ua5dd406m	NGC6341	400.0	15	F555W	1/30/2008	6:35:17
D4-004	ua5dd407m	NGC6341	10.0	15	F555W	1/30/2008	6:46:17
D4-004	ua5dd408m	NGC6341	10.0	15	F555W	1/30/2008	6:51:17
D5-001#001	ua5dd501m	NGC6341	10.0	15	F555W	1/30/2008	7:44:17
D5-001#002	ua5dd502m	NGC6341	10.0	15	F555W	1/30/2008	7:46:17
D5-001#003	ua5dd503m	NGC6341	10.0	15	F555W	1/30/2008	7:48:17
D5-001#004	ua5dd504m	NGC6341	10.0	15	F555W	1/30/2008	7:50:17
D5-001#005	ua5dd505m	NGC6341	10.0	15	F555W	1/30/2008	7:52:17
D5-002#001	ua5dd506m	NGC6341	100.0	15	F555W	1/30/2008	7:54:17
D5-002#002	ua5dd507m	NGC6341	100.0	15	F555W	1/30/2008	8:00:17
D5-002#003	ua5dd508m	NGC6341	100.0	15	F555W	1/30/2008	8:03:17
D5-003#001	ua5dd509m	NGC6341	400.0	15	F555W	1/30/2008	8:06:17
D5-003#002	ua5dd50am	NGC6341	400.0	15	F555W	1/30/2008	8:17:17
D5-004#001	ua5dd50bm	NGC6341	10.0	15	F555W	1/30/2008	8:25:17
D5-004#002	ua5dd50cm	NGC6341	10.0	15	F555W	1/30/2008	8:27:17
D6-001#001	ua5dd601m	NGC6341	10.0	15	F555W	1/30/2008	9:20:17
D6-001#002	ua5dd602m	NGC6341	10.0	15	F555W	1/30/2008	9:22:17
D6-002	ua5dd603m	NGC6341	100.0	15	F555W	1/30/2008	9:24:17
D6-002	ua5dd604m	NGC6341	100.0	15	F555W	1/30/2008	9:30:17
D6-003	ua5dd605m	NGC6341	400.0	15	F555W	1/30/2008	9:36:17
D6-003	ua5dd606m	NGC6341	400.0	15	F555W	1/30/2008	9:47:17
D6-004	ua5dd607m	NGC6341	10.0	15	F555W	1/30/2008	9:58:17
D6-004	ua5dd608m	NGC6341	10.0	15	F555W	1/30/2008	10:03:17