



## 11586 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Cycle: 17, Proposal Category: GO

(Availability Mode: SUPPORTED)

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Aaron Dotter (PI)</b>	<b>University of Victoria</b>	<b>dotter@uvic.ca</b>
Dr. Ata Sarajedini (CoI) (AdminUSPI)	University of Florida	ata@astro.ufl.edu

### VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) PYXIS	ACS/WFC	2	28-Oct-2009 21:34:09.0	yes
02	(2) RUPRECHT106	ACS/WFC	2	28-Oct-2009 21:34:17.0	yes
03	(3) IC4499	ACS/WFC	2	28-Oct-2009 21:34:27.0	yes
04	(5) NGC6426	ACS/WFC	2	28-Oct-2009 21:34:35.0	yes
05	(6) NGC7006	ACS/WFC	2	28-Oct-2009 21:34:42.0	yes
06	(4) PALOMAR15	ACS/WFC	5	28-Oct-2009 21:35:00.0	yes

15 Total Orbits Used

### ABSTRACT

We propose to obtain deep ACS-WFC images of six globular clusters (five of which have no previous HST photometry) that reside in the Galactic halo, where the second parameter effect is most pronounced. These globular clusters are among the least studied in the Galaxy and yet, from the

perspective of the second parameter phenomenon, the most intriguing.

With the best available CMDs only reaching the vicinity of the main sequence turn off at present, the unique sensitivity and resolution of ACS-WFC will yield ages of unprecedented precision for these clusters. These data will provide us with new insight into the stellar populations present in the outer Galactic halo and the nature of the second parameter. The second parameter plays a critical role in our understanding of the formation and evolution of the Galaxy and the proposed observations will shed new light on this problem and these exceptional clusters.

### **OBSERVING DESCRIPTION**

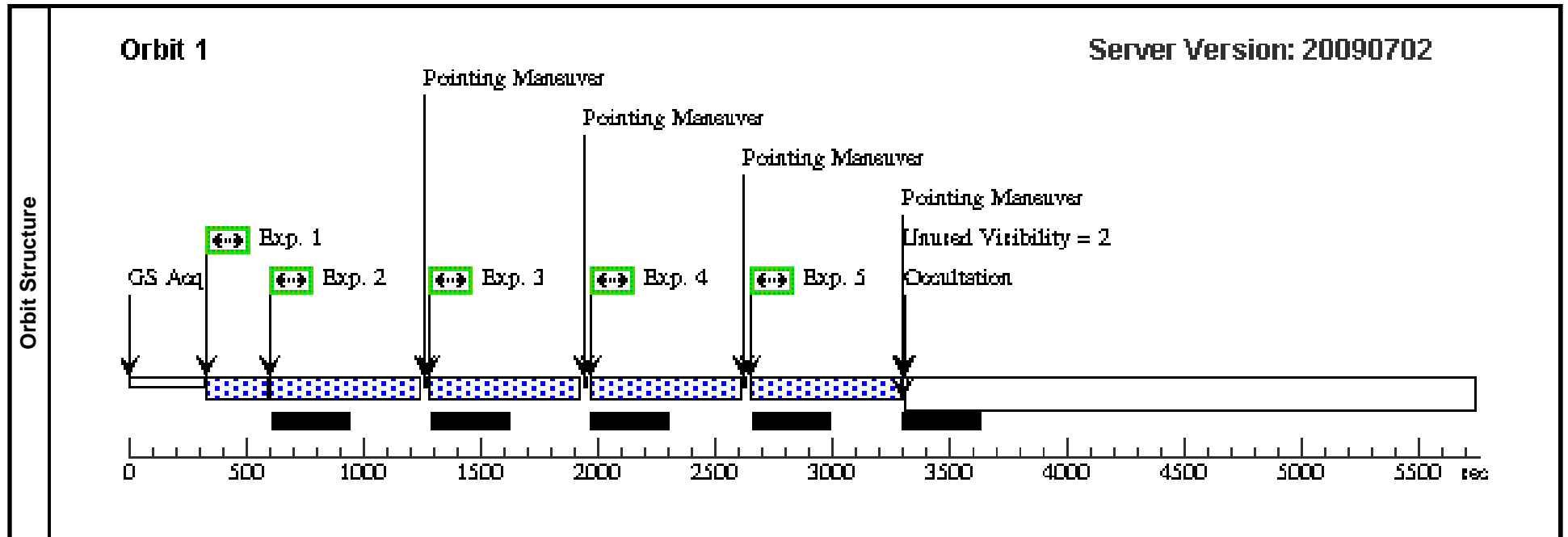
We propose to image the central regions of six Galactic globular clusters using the ACS-WFC in the F606W and F814W filters. Our aim is to reach the un-evolved main sequence for the first time in any of these clusters. We wish to achieve a minimum of  $S/N=10$  in both bands at a  $M_V=8$ , roughly 4 magnitudes below the MSTO. This will allow important, direct comparisons with the CMDs of inner halo GCs from GO-10775 ("The ACS Survey of Galactic Globular Clusters"). We have used the ACS ETC to estimate exposure times adopting a K2V ( $T_{\text{eff}}=4750$  K,  $\log g=4.5$ ) synthetic spectrum which is consistent with  $M_V=8$  in the  $[Fe/H] = -1.5$  isochrones of Dotter et al. (2007). ETC calculations were performed individually for each cluster by adding  $M_V=8$  to the distance modulus and reddening from Harris (1996) and using the resulting apparent V magnitude as normalization. Average levels of background light and other noise were assumed.

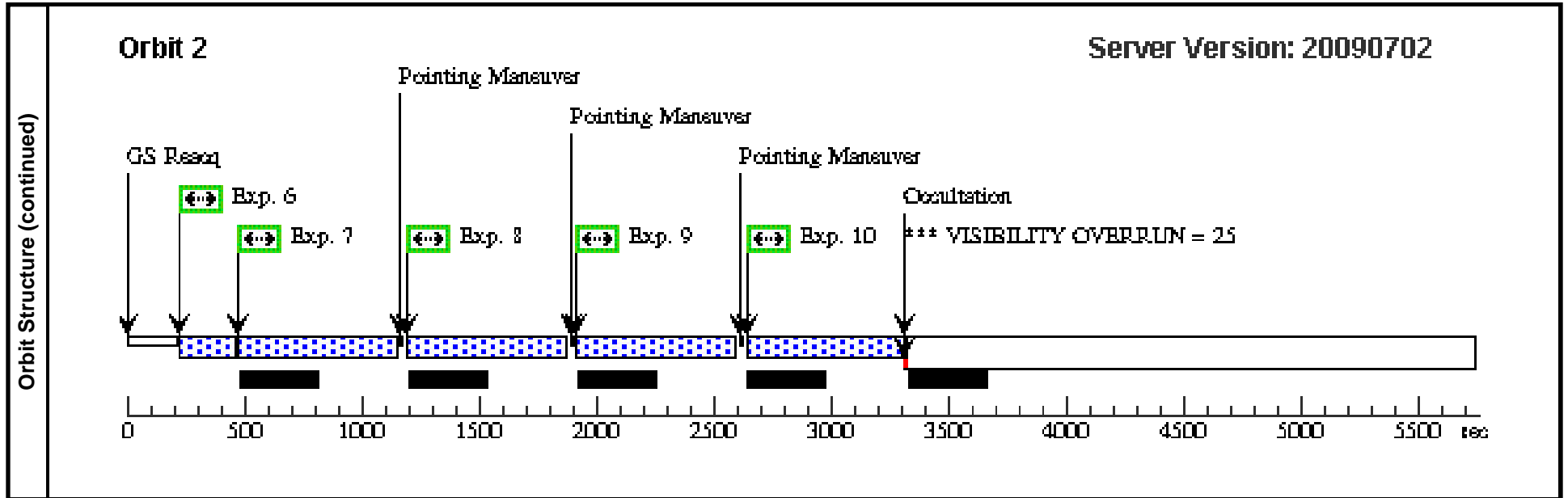
Our plan is to observe five of the six clusters using 1 orbit per filter, with four long exposures of 500-600s, depending on visibility, and one short exposure at ~10% of the length of the long exposures. Dithers have been placed between each of the long exposures. The faintest and most reddened cluster in our sample, Palomar 15, requires more substantial exposure time to achieve the same depth in the CMD. We have therefore planned on 5 orbits for this cluster, 3 in F814W and 2 in F606W. The exposure times are analogous to the other five clusters. Based on these estimates our total orbit budget is 15.

Proposal 11586 - Visit 01 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Thu Oct 29 01:35:09 GMT 2009

<b>Visit</b>	<b>Proposal 11586, Visit 01, completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: ACS/WFC Special Requirements: (none) <i>Comments: Pyxis</i>									
	(Visit 01) Warning (Orbit Planner): VISIBILITY OVERRUN									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(1)	PYXIS	RA: 09 07 57.8000 (136.9908333d) Dec: -37 13 17.00 (-37.22139d) Equinox: J2000		V=12.9	Reference Frame: ICRS				
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>										
<b>Exposures</b>	<b>#</b>	<b>Label</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time/[Actual Dur.]</b>	<b>Orbit</b>
	1	Pyx 606 short	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		50 Secs	
									[==>]	[1]
	2	Pyx 606 long 1	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		517 Secs	
									[==>]	[1]
	3	Pyx 606 long 2	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4		517 Secs	
									[==>]	[1]
	4	Pyx 606 long 3	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F606W				517 Secs	
									[==>]	[1]
	5	Pyx 606 long 4	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F606W			POS TARG 4,-4	517 Secs	
								[==>]	[1]	
6	Pyx 814 short	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F814W			POS TARG -8,8	55 Secs		
								[==>]	[2]	
7	Pyx 814 long 1	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F814W			POS TARG -8,8	557 Secs		
								[==>]	[2]	
8	Pyx 814 long 2	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F814W			POS TARG -4,4	557 Secs		
								[==>]	[2]	
9	Pyx 814 long 3	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F814W				557 Secs		
								[==>]	[2]	
10	Pyx 814 long 4	(1) PYXIS	ACS/WFC, ACCUM, WFCENTER	F814W			POS TARG 4,-4	557 Secs		
								[==>]	[2]	

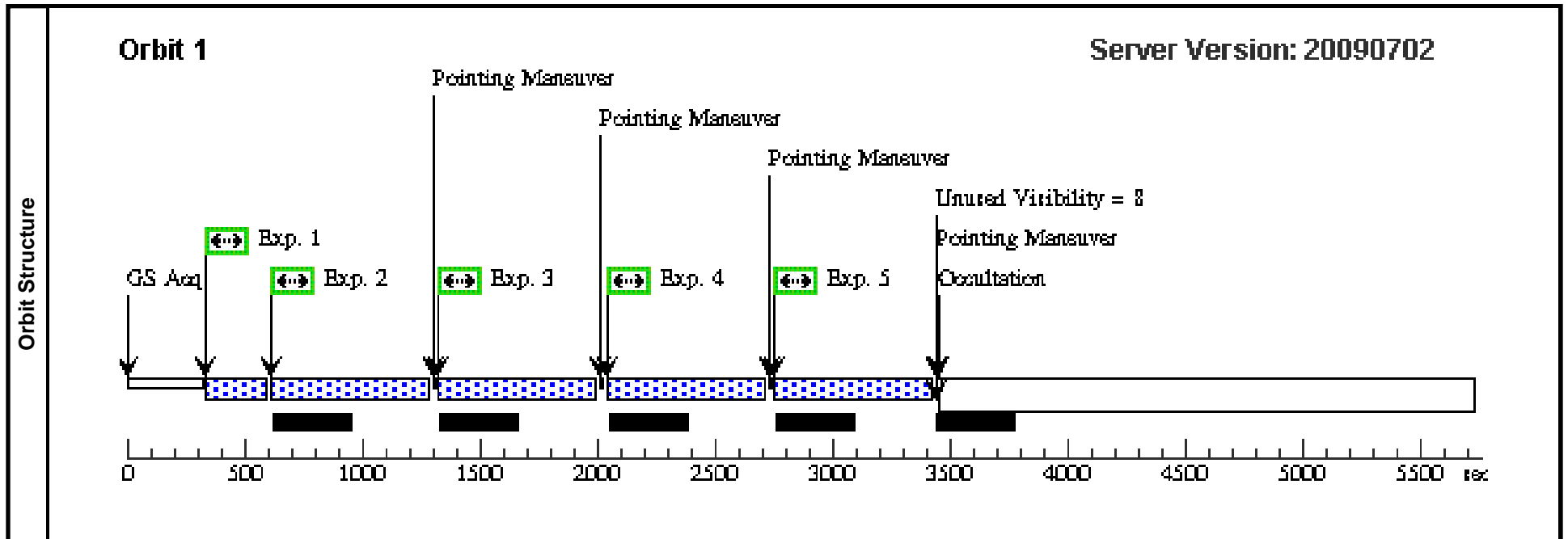


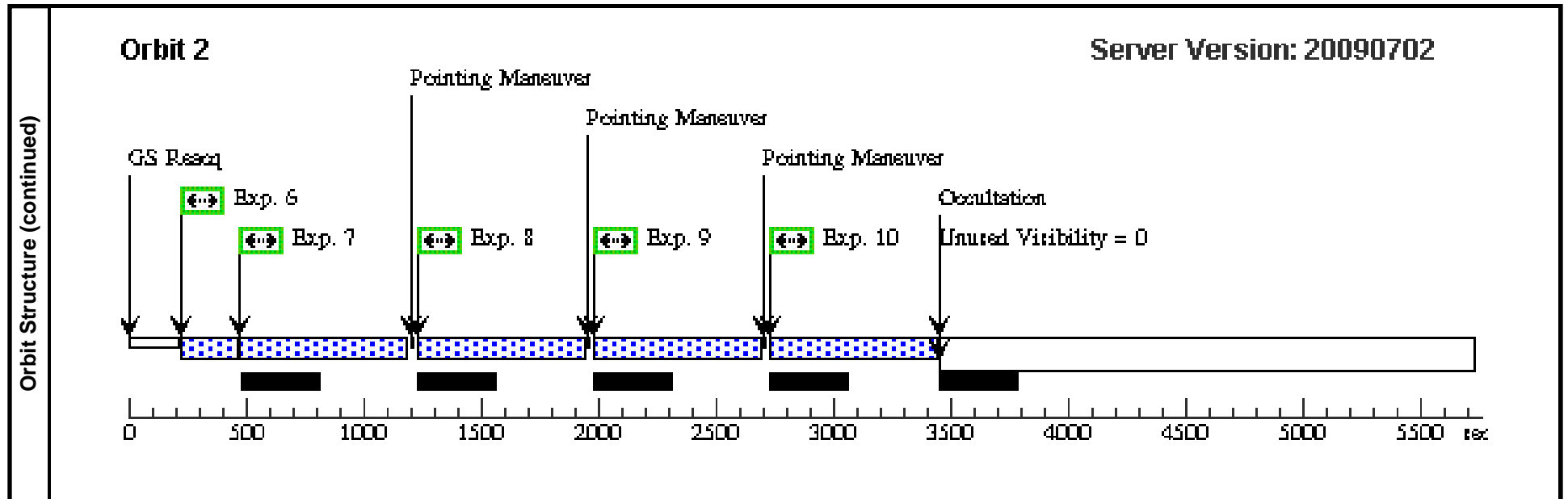


Proposal 11586 - Visit 02 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Thu Oct 29 01:35:10 GMT 2009

Visit	<b>Proposal 11586, Visit 02, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/WFC Special Requirements: (none) Comments: Ruprecht 106									
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	(2)	RUPRECHT106	RA: 12 38 40.2000 (189.6675000d) Dec: -51 09 1.00 (-51.15028d) Equinox: J2000		V=10.90	Reference Frame: ICRS				
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Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	Rup 606 short	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		55 Secs [==>]	[1]
	2	Rup 606 long 1	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		550 Secs [==>]	[1]
	3	Rup 606 long 2	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4		550 Secs [==>]	[1]
	4	Rup 606 long 3	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F606W				550 Secs [==>]	[1]
	5	Rup 606 long 4	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG 4,-4		550 Secs [==>]	[1]
	6	Rup 814 short	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		60 Secs [==>]	[2]
	7	Rup 814 long 1	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		586 Secs [==>]	[2]
	8	Rup 814 long 2	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -4,4		585 Secs [==>]	[2]
	9	Rup 814 long 3	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F814W				585 Secs [==>]	[2]
	10	Rup 814 long 4	(2) RUPRECHT106	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG 4,-4		585 Secs [==>]	[2]



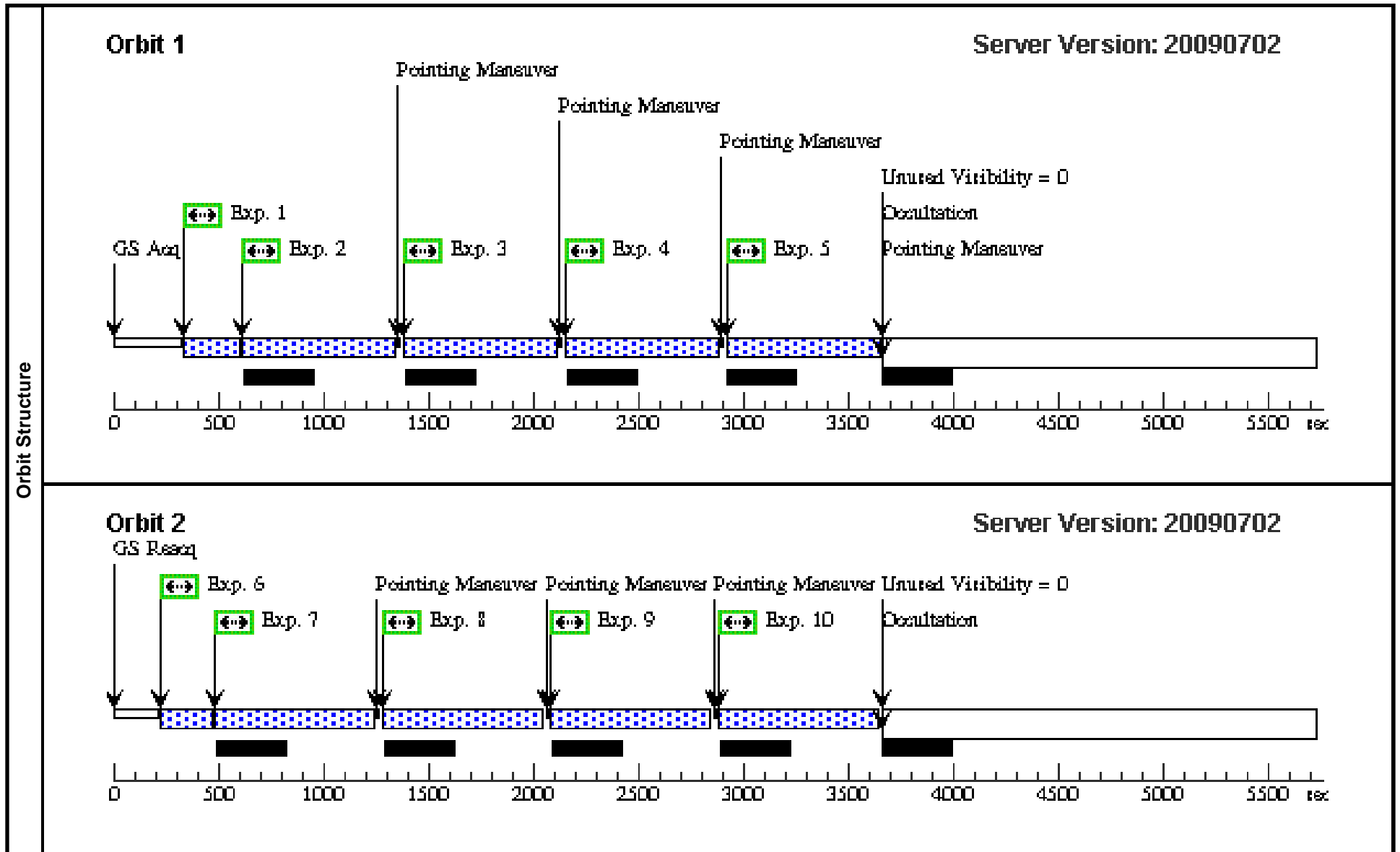




Proposal 11586 - Visit 03 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Thu Oct 29 01:35:11 GMT 2009

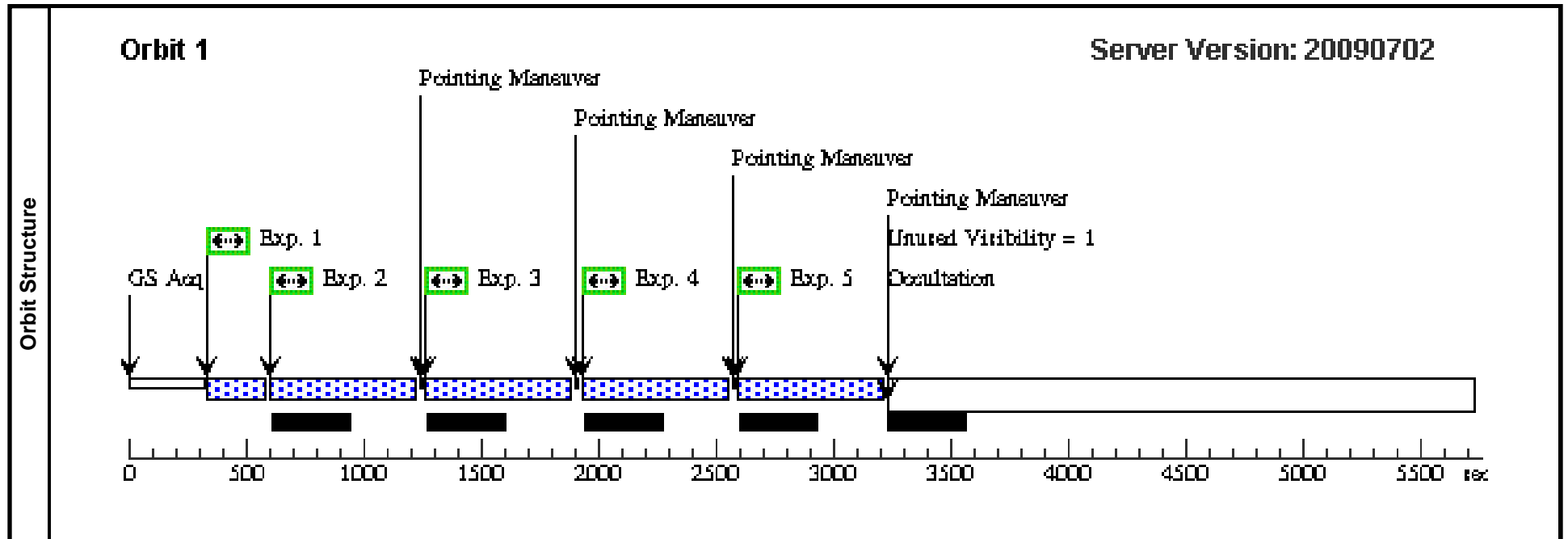
Visit	<b>Proposal 11586, Visit 03, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/WFC Special Requirements: (none) Comments: IC 4499																																																																																																																							
	Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(3)</td> <td>IC4499</td> <td>RA: 15 00 18.5700 (225.0773750d) Dec: -82 12 49.60 (-82.21378d) Equinox: J2000</td> <td></td> <td>V=9.76</td> <td>Reference Frame: ICRS</td> </tr> <tr> <td colspan="6">Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</td> </tr> </tbody> </table>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(3)	IC4499	RA: 15 00 18.5700 (225.0773750d) Dec: -82 12 49.60 (-82.21378d) Equinox: J2000		V=9.76	Reference Frame: ICRS	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.																																																																																																
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#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit																																																																																																															
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2	4499 606 lo ng 1	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		603 Secs [==>]	[1]																																																																																																															
3	4499 606 lo ng 2	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4		603 Secs [==>]	[1]																																																																																																															
4	4499 606 lo ng 3	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F606W				603 Secs [==>]	[1]																																																																																																															
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6	4499 814 sh ort	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		65 Secs [==>]	[2]																																																																																																															
7	4499 814 lo ng 1	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		637 Secs [==>]	[2]																																																																																																															
8	4499 814 lo ng 2	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -4,4		636 Secs [==>]	[2]																																																																																																															
9	4499 814 lo ng 3	(3) IC4499	ACS/WFC, ACCUM, WFCENTER	F814W				636 Secs [==>]	[2]																																																																																																															
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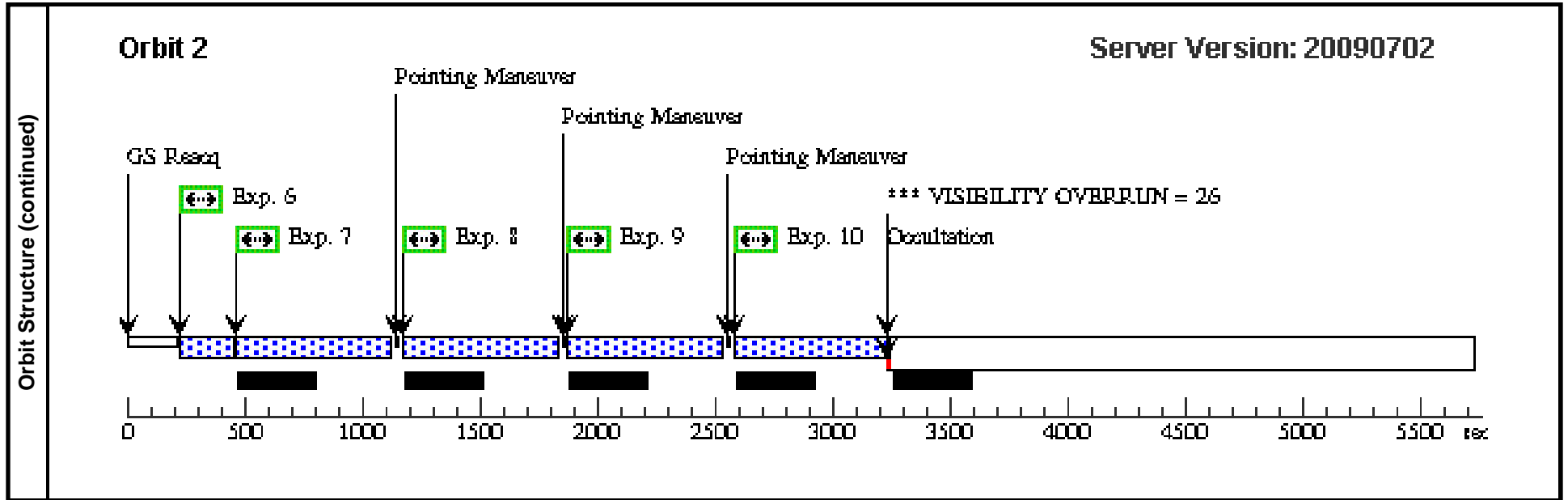


Proposal 11586 - Visit 04 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Thu Oct 29 01:35:11 GMT 2009

<b>Visit</b>	<b>Proposal 11586, Visit 04, completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: ACS/WFC Special Requirements: (none) <i>Comments: NGC 6426</i>									
	(Visit 04) Warning (Orbit Planner): VISIBILITY OVERRUN									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(5)	NGC6426	RA: 17 44 54.7000 (266.2279167d) Dec: +03 10 13.00 (3.17028d) Equinox: J2000		V=11.01	Reference Frame: ICRS				
<b>Exposures</b>	<b>#</b>	<b>Label</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time/[Actual Dur.]</b>	<b>Orbit</b>
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	2	6426 606 lo ng 1	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		500 Secs [==>]	[1]
	3	6426 606 lo ng 2	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4		500 Secs [==>]	[1]
	4	6426 606 lo ng 3	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F606W				500 Secs [==>]	[1]
	5	6426 606 lo ng 4	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG 4,-4		500 Secs [==>]	[1]
	6	6426 814 sh ort	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		50 Secs [==>]	[2]
	7	6426 814 lo ng 1	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		540 Secs [==>]	[2]
	8	6426 814 lo ng 2	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -4,4		540 Secs [==>]	[2]
	9	6426 814 lo ng 3	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F814W				540 Secs [==>]	[2]
	10	6426 814 lo ng 4	(5) NGC6426	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG 4,-4		540 Secs [==>]	[2]

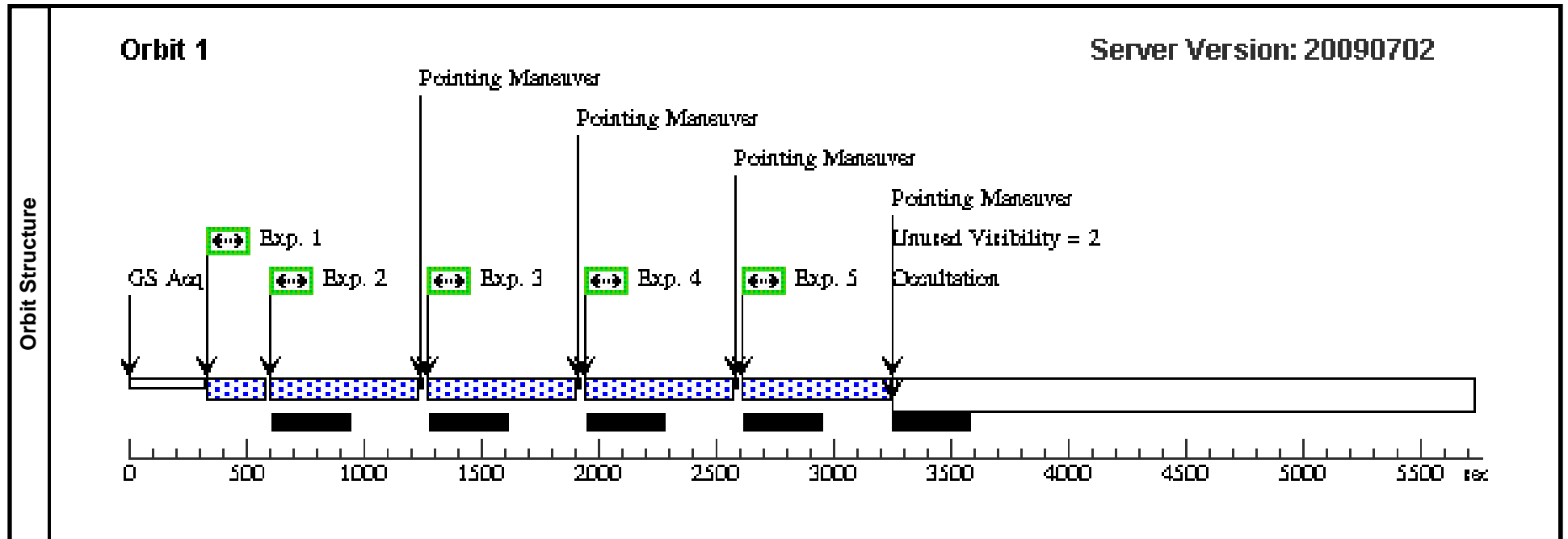


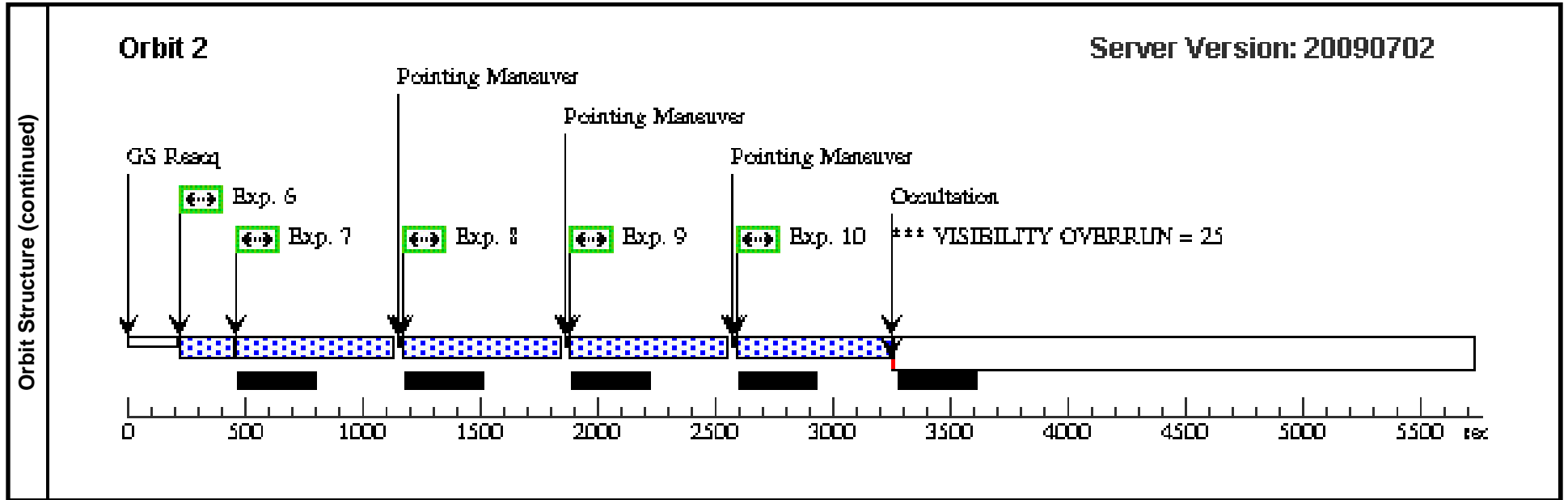


Proposal 11586 - Visit 05 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Thu Oct 29 01:35:12 GMT 2009

<b>Visit</b>	<b>Proposal 11586, Visit 05, completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: ACS/WFC Special Requirements: (none) Comments: NGC 7006									
	(Visit 05) Warning (Orbit Planner): VISIBILITY OVERRUN									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(6)	NGC7006	RA: 21 01 29.4300 (315.3726250d) Dec: +16 11 14.40 (16.18733d) Equinox: J2000		V=10.56	Reference Frame: ICRS				
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.										
<b>Exposures</b>	<b>#</b>	<b>Label</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time/[Actual Dur.]</b>	<b>Orbit</b>
	1	7006 606 sh ort	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		45 Secs [==>]	[1]
	2	7006 606 lo ng 1	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8		505 Secs [==>]	[1]
	3	7006 606 lo ng 2	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4		505 Secs [==>]	[1]
	4	7006 606 lo ng 3	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F606W				505 Secs [==>]	[1]
	5	7006 606 lo ng 4	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG 4,-4		505 Secs [==>]	[1]
	6	7006 814 sh ort	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		50 Secs [==>]	[2]
	7	7006 814 lo ng 1	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8		545 Secs [==>]	[2]
	8	7006 814 lo ng 2	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -4,4		545 Secs [==>]	[2]
	9	7006 814 lo ng 3	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F814W				545 Secs [==>]	[2]
10	7006 814 lo ng 4	(6) NGC7006	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG 4,-4		545 Secs [==>]	[2]	







Proposal 11586 - Visit 06 - Exceptional Galactic Halo Globular Clusters and the Second Parameter

Thu Oct 29 01:35:13 GMT 2009

<b>Visit</b>	<b>Proposal 11586, Visit 06, completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: ACS/WFC Special Requirements: (none) <i>Comments: Palomar 15</i>																																																																																																																												
	<b>Diagnosics</b> (Visit 06) Warning (Orbit Planner): VISIBILITY OVERRUN (Visit 06) Warning (Orbit Planner): VISIBILITY OVERRUN (Visit 06) Warning (Orbit Planner): VISIBILITY OVERRUN																																																																																																																												
<b>Fixed Targets</b>	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(4)</td> <td>PALOMAR15</td> <td>RA: 16 59 51.0000 (254.9625000d) Dec: -00 32 18.00 (-.53833d) Equinox: J2000</td> <td></td> <td>V=14.0</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(4)	PALOMAR15	RA: 16 59 51.0000 (254.9625000d) Dec: -00 32 18.00 (-.53833d) Equinox: J2000		V=14.0	Reference Frame: ICRS	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>																																																																																																															
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#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
Exposures (continued)	12	Pal15 814 lo ng 9	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -8,8	525 Secs [==>]	[3]
	13	Pal15 814 lo ng 10	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG -4,4	525 Secs [==>]	[3]
	14	Pal15 814 lo ng 11	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F814W			525 Secs [==>]	[3]
	15	Pal15 814 lo ng 12	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F814W		POS TARG 4,-4	525 Secs [==>]	[3]
	16	Pal15 606 sh ort 1	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8	10 Secs [==>]	[4]
	17	Pal15 606 lo ng 1	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8	550 Secs [==>]	[4]
	18	Pal15 606 lo ng 2	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4	550 Secs [==>]	[4]
	19	Pal15 606 lo ng 3	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W			550 Secs [==>]	[4]
	20	Pal15 606 lo ng 4	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG 4,-4	550 Secs [==>]	[4]
	21	Pal15 606 sh ort 2	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8	65 Secs [==>]	[5]
	22	Pal15 606 lo ng 5	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -8,8	550 Secs [==>]	[5]
	23	Pal15 606 lo ng 6	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG -4,4	550 Secs [==>]	[5]
	24	Pal15 606 lo ng 7	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W			550 Secs [==>]	[5]
	25	Pal15 606 lo ng 8	(4) PALOMAR15	ACS/WFC, ACCUM, WFCENTER	F606W		POS TARG 4,-4	550 Secs [==>]	[5]

