10851 - Solving the Riddle of the Red Rectangle: Proper Motion Study of a Bipolar Nebula around a Binary

Cycle: 15, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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VISITS

Visit	*Targets*	*Configurations*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HD44179	ACS/HRC	2	10-Jul-2006 21:09:51.0	yes
02	(1) HD44179	ACS/WFC	2	10-Jul-2006 21:10:06.0	yes

4 Total Orbits Used

ABSTRACT

We propose to use ACS to obtain second-epoch, high spatial-resolution images of the nearest Pre-Planetary nebula, the Red Rectangle (RR). The RR is a Rosetta Stone for testing our understanding of binarity in the evolution of AGB stars to bipolar planetary nebulae, because it is a known binary with well determined orbital and circumbinary disk characteristics, and because of its proximity (330-700 pc). Recent analysis of archival STIS data shows evidence for outflow motion of about 100 km/s. Thus, 2nd epoch observations, in combination with those of 8 years ago, will yield a direct detection of proper motion of sharp nebular structures and the overall expansion rate of this nebula. The observations will therefore detect and characterise for the first time, the outflow motions of a (possibly) disk-collimated outflow from an evolved binary shaping a bipolar nebula. Deep

narrow-band imaging of the RR using the HRC and WFC with the F658N filter will be used to trace H-alpha emission in the central and distant parts of RR, as a probe of the shocked gas.

We will run numerical simulations of two currently competing models for shaping the RR, using the FLASH MHD code. This code has been implemented on the JPL supercomputer to study interacting wind processes in the formation of pre-planetary and planetary nebulae. The model predictions of the proper motion vectors will be compared to the observed values, and we will investigate whether tuning of the model parameters is adequate to find fits to the data, or these models have to be abandoned in favor of new ones. This study will help to improve our currently very limited understanding of the role of binarity in the tranformation of AGB stars to planetary nebulae.

OBSERVING DESCRIPTION

We will obtain images in the ACS/WFC camera using the F625W filter, and with comparable exposure times, in order to provide close matches to the images obtained with the WFPC2 PC camera. Since the nebula is very bright, we will use a total exposure time of 600 sec, including short exposures to obtain unsaturated images of the bright central parts (for comparison, the WFPC2 images were obtained with one 0.7 sec and three 40 sec exposures). The images through the Hα+[NII] filter, F658N, will be much longer (about 50 min) - the ground-based Hα data reported in CVBG04 was obtained using the 3.5m NTT with a 1200 sec exposure. Hence, we will use 2 orbits to obtain the WFC images in the F625W and F658N filters, with the bulk of the time being devoted to the F658N image. We will allocate 2 orbits to obtain high-quality HRC images in these two filters, with a similar division of the exposure time between the broad-band and narrow-band filter. All images will be dithered and cosmic-ray split. We have verified that the requested exposure times will produce high signal-to-noise images, using the Exposure Time Calculators, and the observed

intensities from our WFPC2 and ground-based images (for Hα).

Comparison of the WFPC2 and the WFC images to derive proper motions will not be difficult. First, the overall expansion motions from the center can be derived by simply measuring the separation of identical structures on opposite sides of the center of the nebula for each epoch. Secondly, the plethora of well-defined sharp structures in the nebula make it easy to identify well-defined, localised comparison points in the two images for registration and alignment. Expansion motions of PNs from HST images have been succesfully determined using well-tested techniques by several PN researchers (e.g., Hajian, Terzian, Balick), so we do not anticipate any difficult in doing this for the RR.

Visit

Proposal 10851, Visit 01 Tue Jul 11 01:10:09 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

Special Requirements: PCS MODE FINE; ORIENT 90.0D TO 120.0 D; ORIENT 270.0D TO 300.0 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-HRC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.15 Line Spacing=0.098	Coordinate Frame=POS-TARG Pattern Orientation=19.9 Angle Between Sides=63.5 Center Pattern=true		(1-4)
(2)	Pattern Type=ACS-HRC-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.198 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=44.3 Angle Between Sides= Center Pattern=true		(5)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD44179	RA: 06 19 58.2220 (94.9925917d) Dec: -10 38 14.51 (-10.63736d) Equinox: J2000		V=9.3	Reference Frame: ICRS

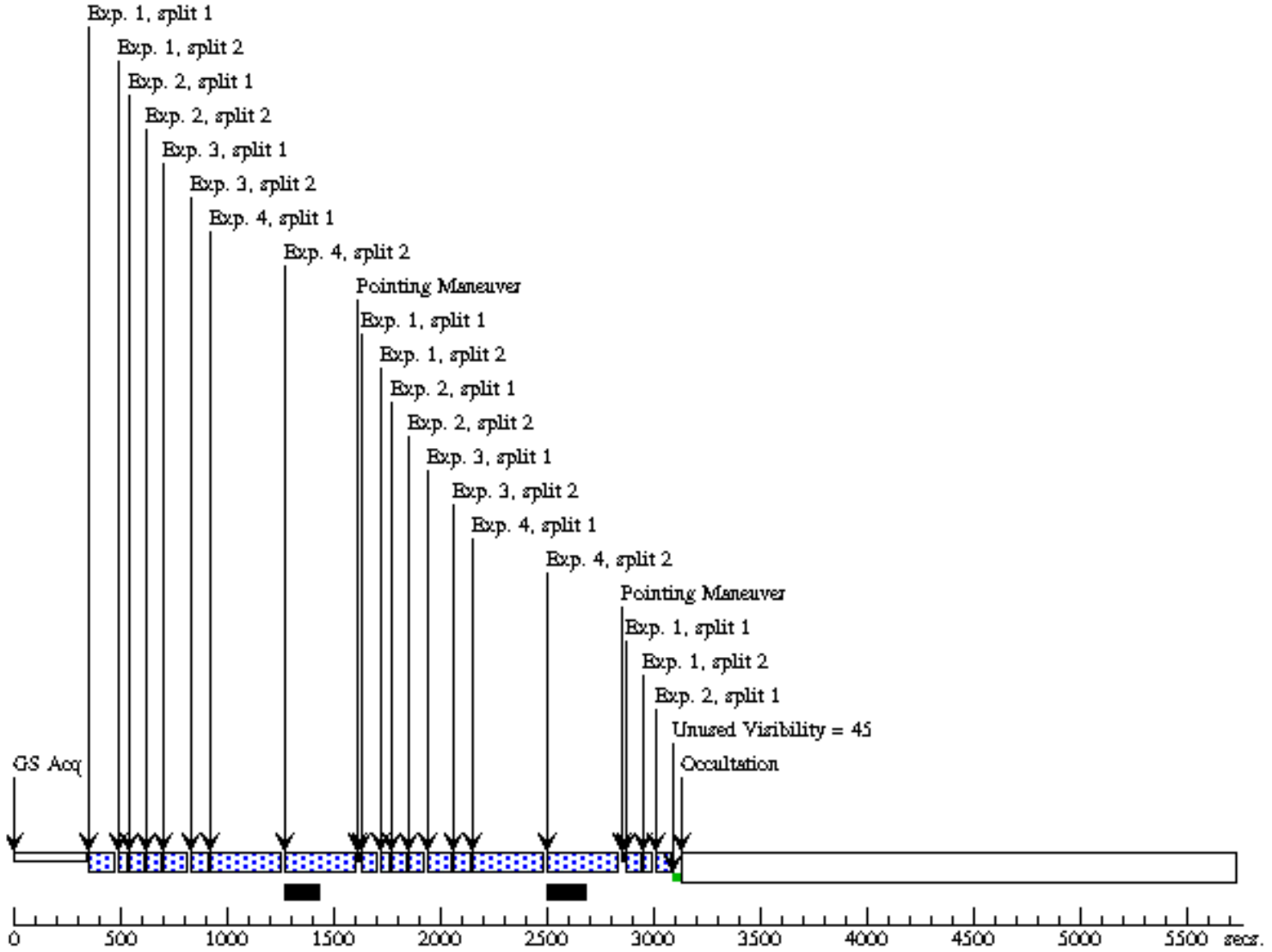
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) HD44179	ACS/HRC, ACCUM, HRC	F625W			Pattern 1-4 (1)	6.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]* *[==>(Pattern 3, Split 2)]*	***[1]***
								[==>(Pattern 4, Split 1)] *[==>(Pattern 4, Split 2)]*	***[2]***

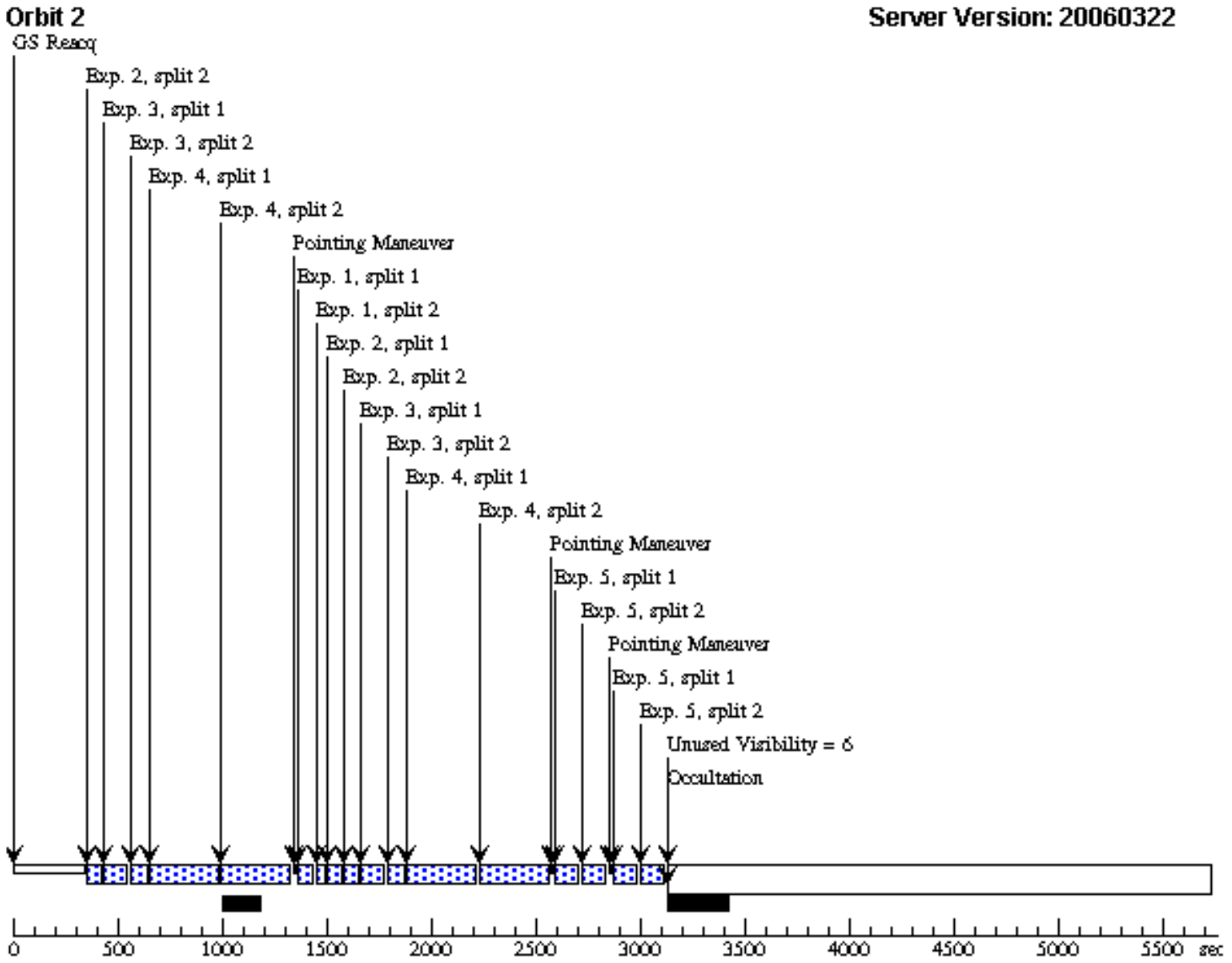
Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
2		(1) HD44179	ACS/HRC, ACCUM, HRC	F625W			Pattern 1-4 (1)	60.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]*	***[1]***
								[==>(Pattern 3, Split 2)] *[==>(Pattern 4, Split 1)]* *[==>(Pattern 4, Split 2)]*	***[2]***
3		(1) HD44179	ACS/HRC, ACCUM, HRC	F658N			Pattern 1-4 (1)	82.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]*	***[1]***
								[==>(Pattern 3, Split 1)] *[==>(Pattern 3, Split 2)]* *[==>(Pattern 4, Split 1)]* *[==>(Pattern 4, Split 2)]*	***[2]***
4		(1) HD44179	ACS/HRC, ACCUM, HRC	F658N			Pattern 1-4 (1)	600.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]*	***[1]***
								[==>(Pattern 3, Split 1)] *[==>(Pattern 3, Split 2)]* *[==>(Pattern 4, Split 1)]* *[==>(Pattern 4, Split 2)]*	***[2]***
5		(1) HD44179	ACS/HRC, ACCUM, HRC	F658N			Pattern 5-5 (2)	154.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]*	***[2]***

Orbit Structure



Orbit Structure (continued)



Visit

Proposal 10851, Visit 02 Tue Jul 11 01:10:12 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: PCS MODE FINE; ORIENT 90.0D TO 120.0 D; ORIENT 270.0D TO 300.0 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	Pattern Type=ACS-WFC-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=3.011 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.3 Angle Between Sides= Center Pattern=false		(6)

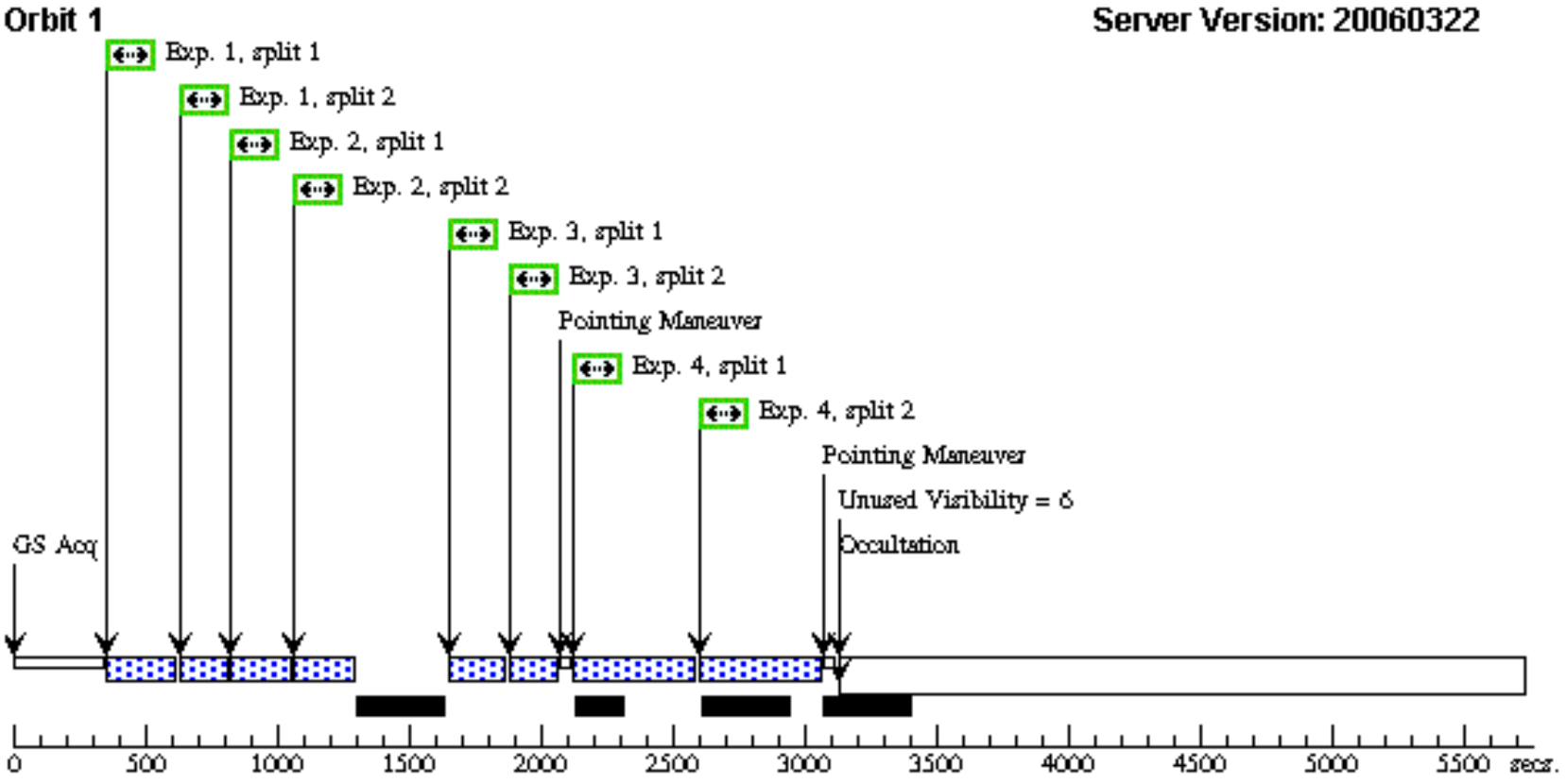
Fixed Targets

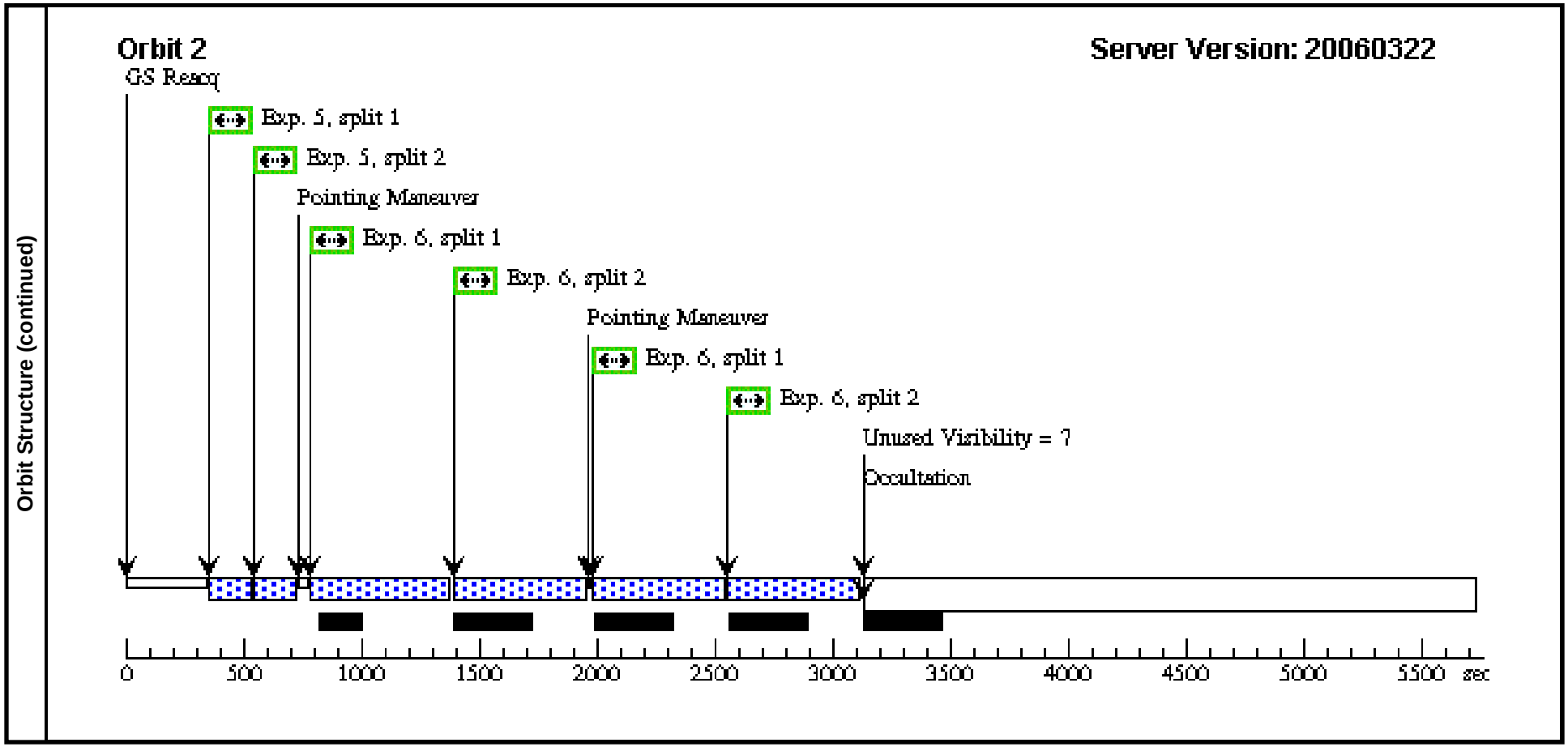
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD44179	RA: 06 19 58.2220 (94.9925917d) Dec: -10 38 14.51 (-10.63736d) Equinox: J2000		V=9.3	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) HD44179	ACS/WFC, ACCUM, WFC1-2K	F658N				6.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***
2		(1) HD44179	ACS/WFC, ACCUM, WFC1-2K	F658N				104.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***
3		(1) HD44179	ACS/WFC, ACCUM, WFC1-2K	F625W				10.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***
4		(1) HD44179	ACS/WFC, ACCUM, WFC	F625W				678.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***
5		(1) HD44179	ACS/WFC, ACCUM, WFC1-2K	F625W				1.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[2]***
6		(1) HD44179	ACS/WFC, ACCUM, WFC	F658N			Pattern 6-6 (3)	870.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]*	***[2]***

Orbit Structure




Orbit Structure (continued)
Orbit 2
Server Version: 20060322
GS Reacq
Exp. 5, split 1
Exp. 5, split 2
Pointing Maneuver
Exp. 6, split 1
Exp. 6, split 2
Pointing Maneuver
Exp. 6, split 1
Exp. 6, split 2
Unused Visibility = 7
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec