10807 - The knotty jet of He 2-90: An ideal laboratory for studying the formation and propagation of jets in dying stars

Cycle: 15, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HE2-90	WFPC2	1	22-Mar-2007 21:11:04.0	yes
02	(1) HE2-90	WFPC2	3	22-Mar-2007 21:11:11.0	yes
03	(1) HE2-90	WFPC2	1	22-Mar-2007 21:11:18.0	yes

5 Total Orbits Used

ABSTRACT

Previous WFPC2 observations have led to the serendipitous discovery of an extended, highly-collimated, ``pulsed'' bipolar jet emanating from a compact planetary nebula, He 2-90. Subsequently, an average proper motion of the knots in the jet was measured, which together with radial velocities, enabled us to characterise the basic physical properties of the jet. The knotty jet in He 2-90 resembles other prominent examples of pulsed jets in young stellar objects or symbiotic stars, but is probably by far the best example yet of a non-relativistic, symmetric, jet in a ``clean'' astrophysical environment.

The formation (acceleration and collimation) of jets is not fully understood, specially in the case of jets in dying stars. We now propose to re-image He 2-90 with WFPC2 and exploit the factor 3.5 longer time
baseline now available from the first-epoch observations in September 1999, in order to measure the proper motion of individual knots in the jet with unprecedented accuracy. These data will enable us to characterise the ejection history of the source, specially deviations from a constant period (latter is related to the binary period of the system), e.g., due to instabilities in the accretion mechanism. We will also be able to test if the ejection mechanism is symmetric: any deviation in the ejection history of the knots in the opposing jet beams, will indicate a magnetic field structure and/or the accretion disk which is not symmetric across the equatorial plane. We will also carry out deep imaging with the ACS/WFC camera in order to determine the shapes/sizes of a large number of knots. The shapes/sizes of the knots, and changes with distance from the source probe the strength of the magnetic field inside the jet. HRC imaging of the central source and jet on sub-arcsecond scales will be carried out to probe the magnetic field close to the jet source, and deviations from linearity in the jet-beam which may result from instabilities in the magnetic field. These data will allow us to significantly improve our existing 2-dimensional MHD model of the He2-90 jet, and/or provide impetus for new 3-dimensional models.

OBSERVING DESCRIPTION

WFPC2 imaging:
The image will be obtained with the Planetary Camera. The jet in He 2-90 was detected with a H-Alpha snapshot exposure (18 min in total) with the F656N filter (Sahai & Nyman 2000), a second epoch H-Alpha image with WFPC2 with the F656N filter to look for proper motion used a slightly higher exposure time of 20 min (Sahai et al. 2002). We would like to obtain now a third epoch H-Alpha images for a more accurate velocity mapping in this line. The image should be at least as deep, so we propose a total integration time of 35 min in this line (to roughly account for the slow degradation of the WFPC2 camera). The velocity mapping of the knots and determining the ejection history of the jet source is an important component of our study. We propose imaging with the H-Alpha filter to have comparable data from all three epochs.
We thus need 1 orbit for the WPFC2 imaging.

ACS / WFC imaging:
The WFC imaging will be used to search and resolve knots which are more distant to the jet source than those detected in the former WFPC2

imaging campaigns. The H-Alpha+[NII] filter F658N will be used. Ground based images have shown that the extent of the jet is about 4000, knots can be seen to a distance of 2500 (Fig.1); more distant knots can be expected. Sahai & Nyman (2000) found that the intensity of the knots decreases with r^-gamma and gamma = 2.2. The intensity of knot e' at about 7 " was measured to 7.5 x10^-15 erg/s/cm^2, so the distant knot i' at 14" is expected to have an intensity of about 1.6 x 10^-15 erg/s/cm^2. We propose to use a total integration time of 120 min, in order to determine the shape/structure of sufficiently distant knots. With a 120 min exposure, we can detect knot i' with a S/N ratio of about 20; observations with a S/N ratio of 10 can be done to an intensity value of 6 x10^-16 erg/s/cm^2, corresponding to a distance of about 19". These values have been derived using the ACS exposure time calculator.
Assuming the periodical behavior of the jet ejection, the number of detected knots will increase by a factor of two. The intensity of the most distant detected knot is still high enough to resolve the shape of this knot, and therefore to reach the scientific goal of this campaign. Detailed investigations of the shapes of the knots will be used to determine the strength of the magnetic field inside the jet.
We thus need 3 orbits for the WFC imaging.

ACS / HRC imaging:
The HRC imaging will be used to resolve the innermost knots close to the central source and to measure the contrast in intensity between the knots and the inter-knot jet material. This contrast is expected to decrease with decreasing radius and can be used the estimate the strength of the magnetic field close to the jet source. We propose a total integration time of 40 min. The intensity of a knot at 100 is expected to be 5.5 x 10^-13 erg/s/cm^2, the S/N ratio is then 120, which is adequate for determining the knot to inter-knot intensity ratio accurately as well as characterise any deviations from non-linearity in the jet beam.
We thus need 1 orbit for the HRC imaging.

All imaging will include short to correct for saturation in long exposures, dithering and cosmic-ray splitting to obtain the highest quality images.

Visit

Proposal 10807, Visit 01, completed Fri Mar 23 01:11:21 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: PCS MODE FINE; ORIENT 157.5D TO 167.5 D; ORIENT 337.5D TO 347.5 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFPC2-BOX	Coordinate Frame=POS-TARG		(3)
	Purpose=DITHER	Pattern Orientation=26.6		
	Number Of Points=4	Angle Between Sides=143.1		
	Point Spacing=0.559	Center Pattern=true		
	Line Spacing=0.559			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HE2-90	RA: 13 09 36.2500 (197.4010417d) Dec: -61 19 36.00 (-61.32667d) Equinox: J2000		V=13.0	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) HE2-90	WFPC2, IMAGE, PC1-FIX	F656N				5.0 Secs X 2	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[1]***
2		(1) HE2-90	WFPC2, IMAGE, PC1-FIX	F656N				60.0 Secs	
								[==>]	***[1]***
3		(1) HE2-90	WFPC2, IMAGE, PC1-FIX	F656N	CLOCKS=YES		Pattern 3-3 (1)	300.0 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Visit

Proposal 10807, Visit 02, scheduling Fri Mar 23 01:11:23 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: ORIENT 265.5D TO 274.5 D; ORIENT 85.5D TO 94.5 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFPC2-BOX	Coordinate Frame=POS-TARG		(1)
	Purpose=DITHER	Pattern Orientation=26.6		
	Number Of Points=4	Angle Between Sides=143.1		
	Point Spacing=0.559	Center Pattern=true		
	Line Spacing=0.559			

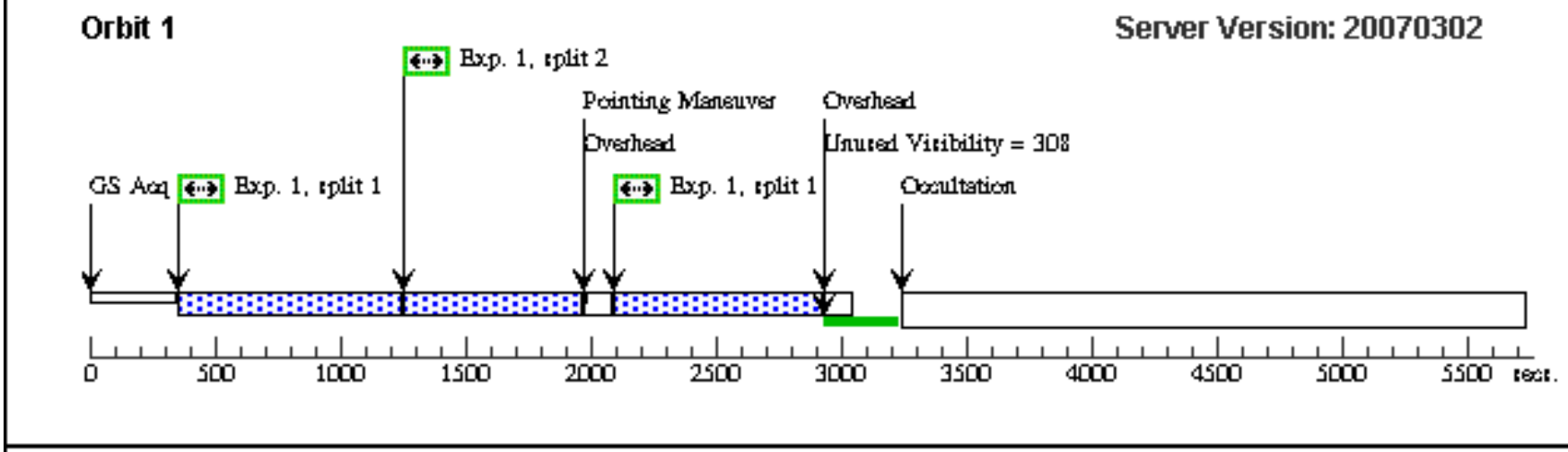
Fixed Targets

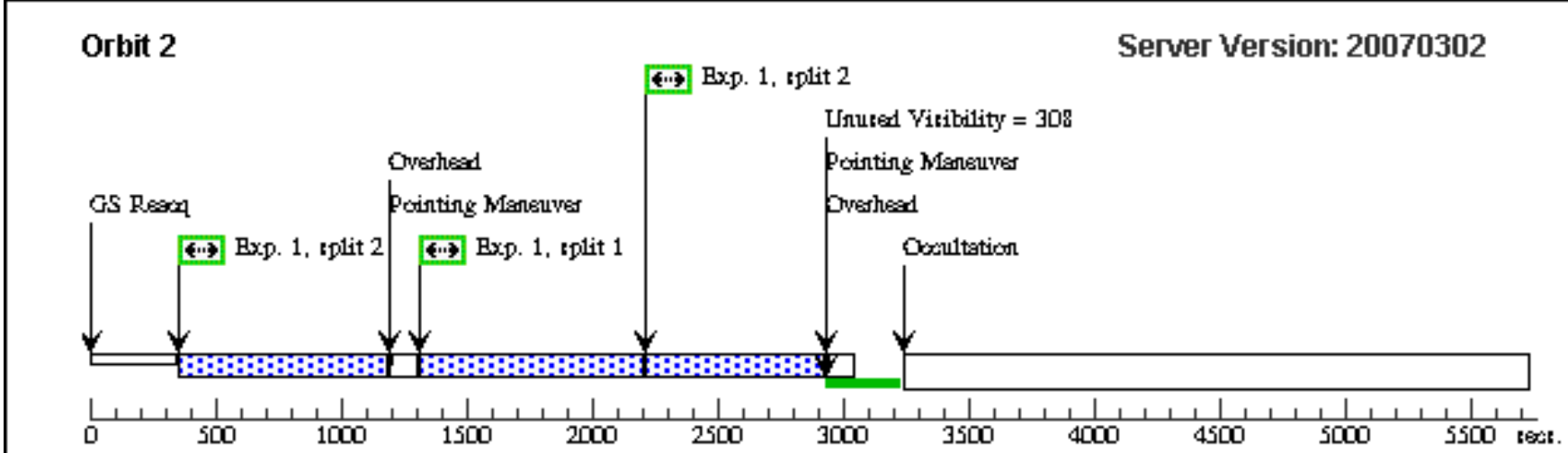
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HE2-90	RA: 13 09 36.2500 (197.4010417d)		V=13.0	Reference Frame: ICRS
		Dec: -61 19 36.00 (-61.32667d)			
		Equinox: J2000			

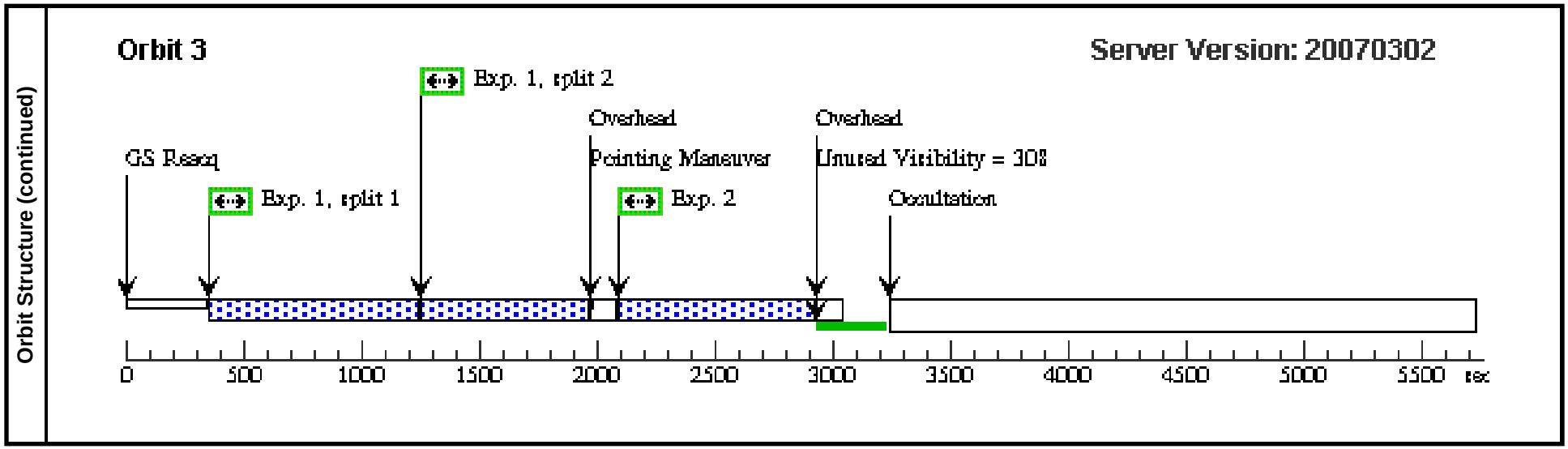
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) HE2-90	WFPC2, IMAGE, WF3-FIX	F658N	CLOCKS=YES		Pattern 1-1 (1)	1400.0 Secs	
								[==>(Pattern 1, Split 1)]	
								[==>(Pattern 1, Split 2)]	***[1]***
								[==>(Pattern 2, Split 1)]	
								[==>(Pattern 2, Split 2)]	
								[==>(Pattern 3, Split 1)]	***[2]***
								[==>(Pattern 3, Split 2)]	
								[==>(Pattern 4, Split 1)]	***[3]***
								[==>(Pattern 4, Split 2)]	
2		(1) HE2-90	WFPC2, IMAGE, WF3-FIX	F658N	CLOCKS=YES;			700.0 Secs	
					CR-SPLIT=NO			*[==>]*	***[3]***

Orbit Structure






Orbit Structure (continued)
Orbit 3
Server Version: 20070302
Exp. 1, split 2
Overhead
Pointing Maneuver
Overhead
Unused Visibility = 30%
GS Reacq
Exp. 1, split 1
Exp. 2
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 10807, Visit 03, scheduling Fri Mar 23 01:11:25 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: ORIENT 85.5D TO 94.5 D; ORIENT 265.5D TO 274.5 D

Patterns

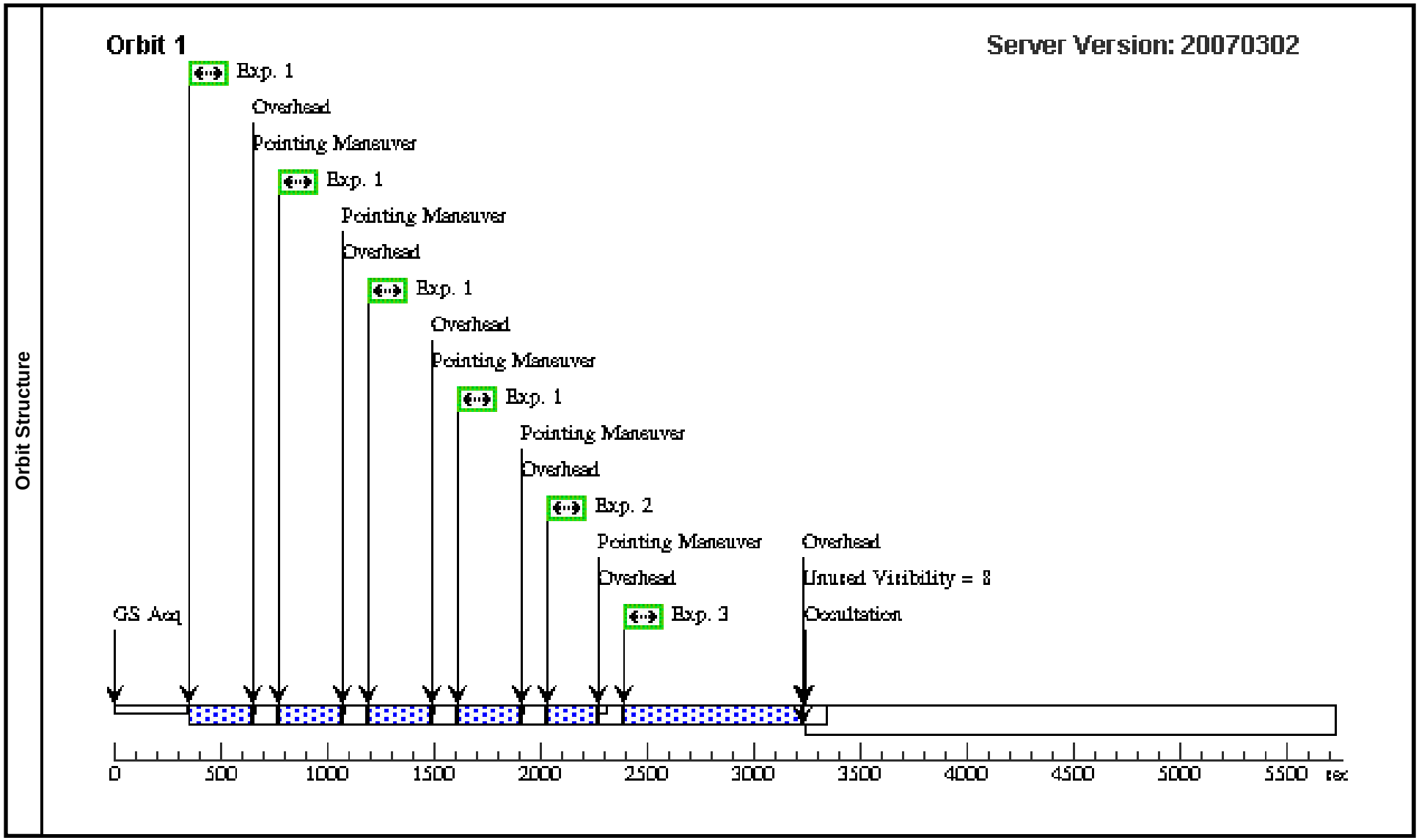
#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFPC2-BOX	Coordinate Frame=POS-TARG		(1)
	Purpose=DITHER	Pattern Orientation=26.6		
	Number Of Points=4	Angle Between Sides=143.1		
	Point Spacing=0.559	Center Pattern=true		
	Line Spacing=0.559			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HE2-90	RA: 13 09 36.2500 (197.4010417d)		V=13.0	Reference Frame: ICRS
		Dec: -61 19 36.00 (-61.32667d)			
		Equinox: J2000			

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) HE2-90	WFPC2, IMAGE, PC1-FIX	F658N	CLOCKS=YES		Pattern 1-1 (1)	120.0 Secs	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
2		(1) HE2-90	WFPC2, IMAGE, PC1-FIX	F658N	CLOCKS=YES			100.0 Secs	
								[==>]	***[1]***
3		(1) HE2-90	WFPC2, IMAGE, WF3-FIX	F658N	CLOCKS=YES;			700.0 Secs	
					CR-SPLIT=NO			*[==>]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20070302
Exp. 1
Overhead
Pointing Maneuver
Exp. 1
Pointing Maneuver
Overhead
Exp. 1
Overhead
Pointing Maneuver
Exp. 1
Pointing Maneuver
Overhead
Exp. 2
Pointing Maneuver
Overhead
Exp. 3
Overhead
Unused Vitibility = 8
Occultation
GS Acq
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec