10537 - Caught in the Act with HST -- Active Jet Sculpting in the Young Preplanetary Nebulae IRAS 22036+5306

Cycle: 14, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Raghvendra Sahai (PI)	**Jet Propulsion Laboratory**	
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Dr. Carmen Sanchez Contreras (CoI)	California Institute of Technology	
Dr. Mark Claussen (CoI)	Associated Universities, Inc.	

VISITS

Visit	*Targets*	*Configurations*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) IRAS22036+5306	ACS/HRC	4	20-Jun-2005 13:39:09.0	yes
02	(1) IRAS22036+5306	WFPC2	1	20-Jun-2005 13:39:15.0	yes

5 Total Orbits Used

ABSTRACT

We have discovered an extended, highly-structured and bipolar nebula surrounding the post-AGB object IRAS22036+5306 (I22036), in a Cycle 10 WFPC2 imaging survey of very young pre-planetary nebulae (PPNs). Young PPNs like I22036, objects in rapid transition between the AGB and Planetary Nebulae (PN) phases, retain direct signatures, in the spatial character of their outflows, of the physical mechanisms which transform slowly expanding, round circumstellar AGB envelopes into highly aspherical PNs with fast-expanding

elongated lobes along one or more axes. I22036 shows intriguing evidence for the presence of jets in the HST images, and VLA A-array maps show OH maser emission in a linear structure along the nebular axis. Our ground-based echelle H-alpha spectra show high-velocity blue-shifted absorption in a very broad (~2000 km/s) line profile, and mm-wave CO J=1-0 interferometric data show a bipolar molecular outflow.

There are very few young PPNs like I22036 which show clear morphological & kinematical evidence of the presence of jets and their working surfaces, making it unquestionably a key object for understanding how jets can sculpt out bipolar lobes in a progenitor AGB star wind. Using ground-based long-slit spectroscopy with the Keck/ESI, we have partially spatially resolved the H-alpha emission in this object. We now propose to image I22036 in F658N, F631N, F606W and F814W in order to identify accurately the location and structure of the shocked gas, and its relation to the jets and their working surfaces. An important goal is to determine whether we can characterise the forward and reverse shocks near the heads of the knotty jets. The proposed HST imaging will help us to understand the spatio-kinematic structure of the outflowing gas in the bipolar lobes, and allow us to study the relationships between the important dynamical components of this nebula. Supporting ground-based observations such as Zeeman measurements of polarised OH masers with the VLBA to search for magnetic fields in I22036 are being pursued for testing magnetic-collimation models for jets in PPNs.

OBSERVING DESCRIPTION

We will obtain deep 4-point dithered observations with the HRC on ACS through the broad-band F606W \& F814W, and the narrow-band F658N filter. Our goal is to make a significant improvement in sensitivity over the previous SNAPshot imaging observations, where we used relatively short exposure times (typically 8-10 minutes).
So we will now use total integration times of about $\sim$2400 sec (1 orbit) each for F606W \& F814W, which will provide a significant improvement over the previous data. We will use F606W images to subtract the continuum from the emission line filter images.

The longest exposure time (about 5000 sec) will be used for the F658N imaging, which will contain both scattered (continuum+Hα) photons, and local Hα emission. This

will provide a signal-to-noise ratio (S/N)$>$60 in the Hα line wings (at $\pm$1000\kms) towards the nebular center and S/N$>$20 towards the lobes. These S/N ratios have been estimated from the intensity of the Hα line in one pixel (0.3$"$) of our ESI long-slit spectrum (slit width=0.5$"$, Figure 2) towards the nebular center and towards the lobes and assuming that the Hα brightness distribution is roughly uniform within a region with size $<$0.3$"$x0.3$"$. We would like to be able to separate the scattered Hα emission from the local emission, either through appropriate differencing or ratioing. We recognize that this may not provide a precise quantitative measurement of the Hα intensity because of imperfect removal of the scattered light due to variable circumstellar extinction, but that does not affect the main goal of the proposal, namely to delineate the regions of active shocks in these nebulae.

We will also image the OI 6300A emission, which is most likely to be only local emission and not scattered, with WFPC2 through the F631N filter. The exposure time with such a filter will be about 2400\,s with the wide field (WFC) camera mode, which will provide S/N in the line wings (up to $\pm$500\kms) of S/N$>$20 towards the center and S/N$>$7 in the lobes. This S/N has been estimated by taking into account that the OI line is a factor of $\sim$4-5 weaker than Hα (from our Keck+ESI spectrum).

Visit

Proposal 10537, Visit 01 Mon Jun 20 17:39:17 GMT 2005

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

Special Requirements: PCS MODE FINE; SCHED 30%

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=false		(1-4)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	IRAS22036+5306	RA: 22 05 30.2800 (331.3761667d) Dec: +53 21 32.70 (53.35908d) Equinox: J2000 Plate Id: (?)		V=16.4	Coordinate Source: HST_IMAGE

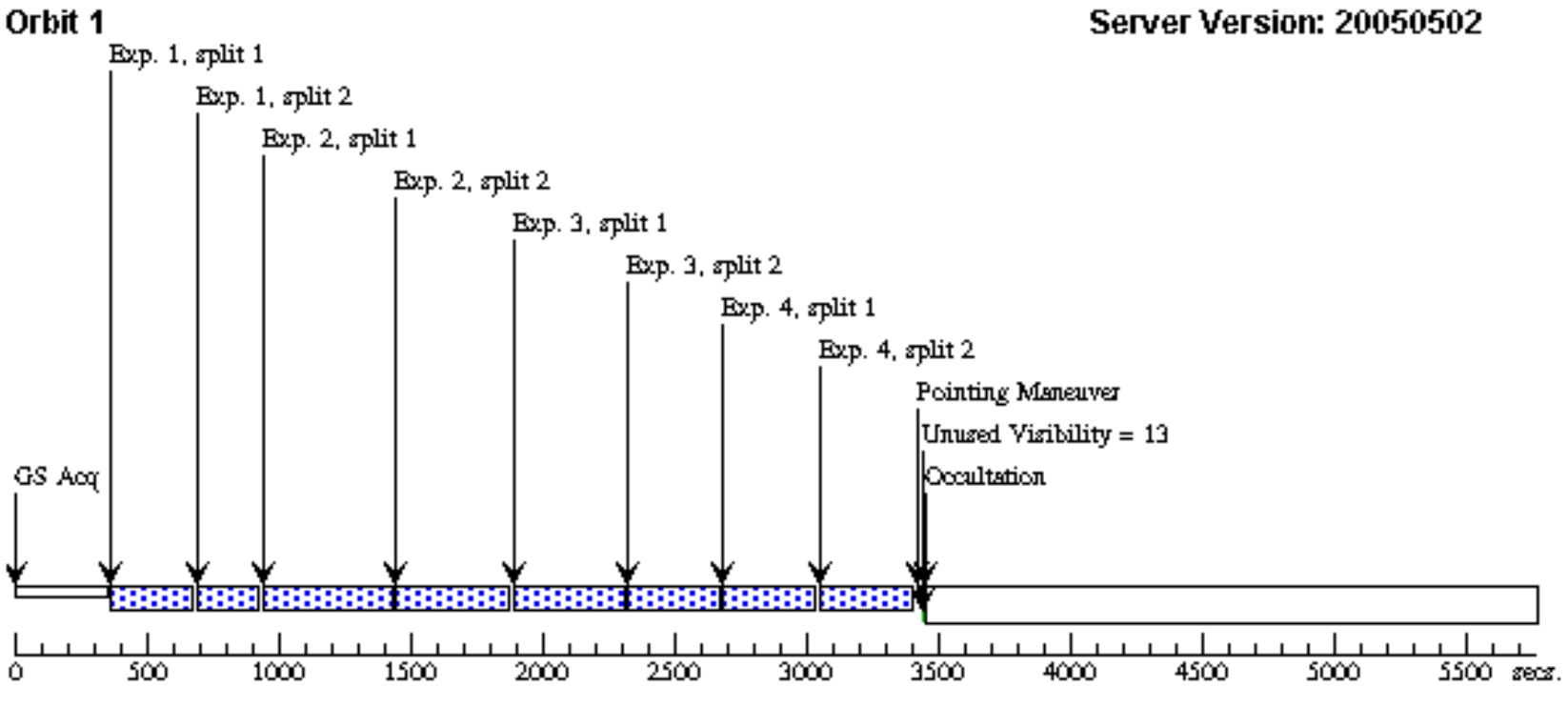
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) IRAS22036+5306	ACS/HRC, ACCUM, HRC	F606W			Pattern 1-4 (1)	400.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]*	***[1]***
								[==>(Pattern 2, Split 1)] *[==>(Pattern 2, Split 2)]*	***[2]***
								[==>(Pattern 3, Split 1)] *[==>(Pattern 3, Split 2)]*	***[3]***
								[==>(Pattern 4, Split 1)] *[==>(Pattern 4, Split 2)]*	***[4]***
2		(1) IRAS22036+5306	ACS/HRC, ACCUM, HRC	F814W			Pattern 1-4 (1)	800.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]*	***[1]***
								[==>(Pattern 2, Split 1)] *[==>(Pattern 2, Split 2)]*	***[2]***
								[==>(Pattern 3, Split 1)] *[==>(Pattern 3, Split 2)]*	***[3]***
								[==>(Pattern 4, Split 1)] *[==>(Pattern 4, Split 2)]*	***[4]***

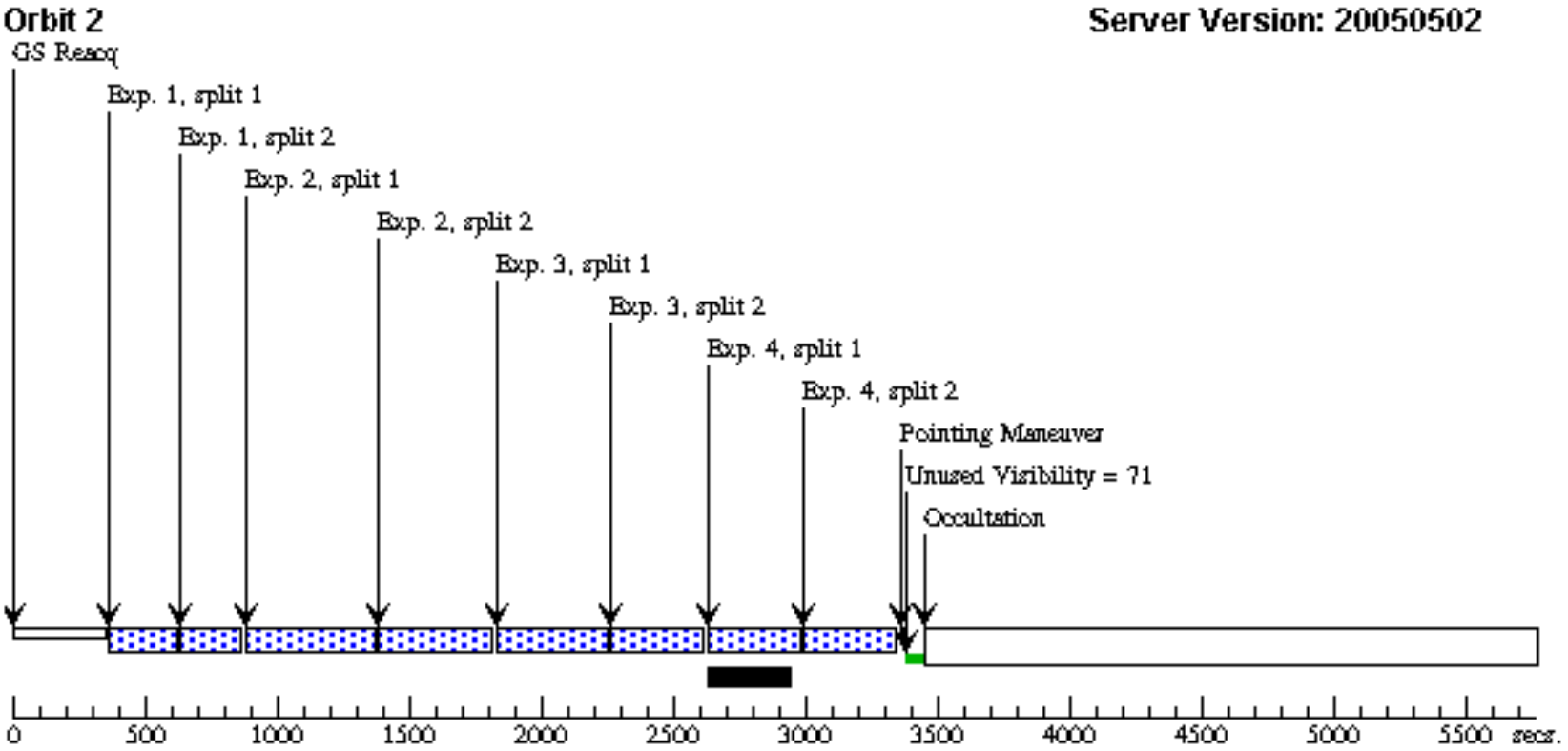
Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
3		(1) IRAS22036+5306	ACS/HRC, ACCUM, HRC	F658N			Pattern 1-4 (1)	638.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]*	***[1]***
								[==>(Pattern 2, Split 1)] *[==>(Pattern 2, Split 2)]*	***[2]***
								[==>(Pattern 3, Split 1)] *[==>(Pattern 3, Split 2)]*	***[3]***
								[==>(Pattern 4, Split 1)] *[==>(Pattern 4, Split 2)]*	***[4]***
4		(1) IRAS22036+5306	ACS/HRC, ACCUM, HRC	F658N			Pattern 1-4 (1)	638.0 Secs	
								[==>(Pattern 1, Split 1)] *[==>(Pattern 1, Split 2)]*	***[1]***
								[==>(Pattern 2, Split 1)] *[==>(Pattern 2, Split 2)]*	***[2]***
								[==>(Pattern 3, Split 1)] *[==>(Pattern 3, Split 2)]*	***[3]***
								[==>(Pattern 4, Split 1)] *[==>(Pattern 4, Split 2)]*	***[4]***

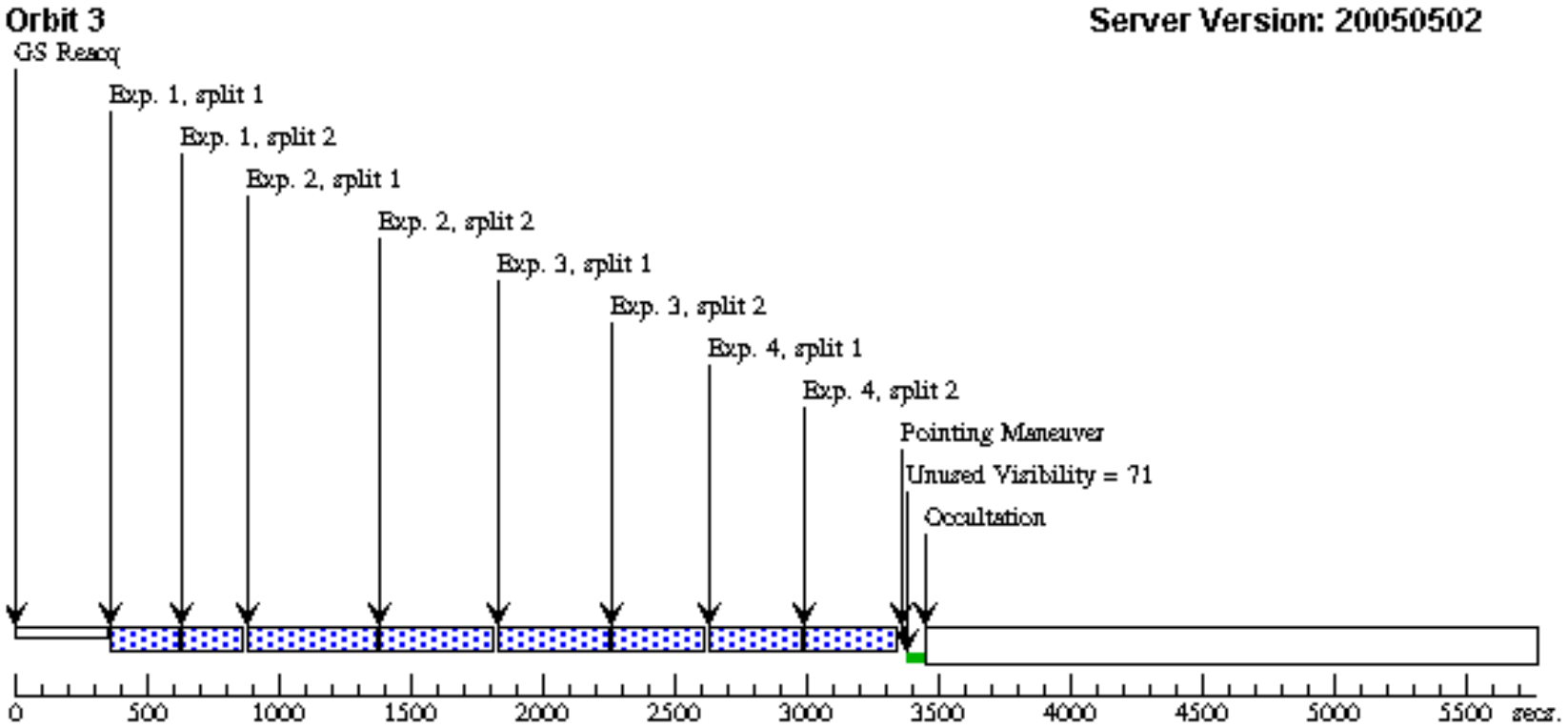
Orbit Structure



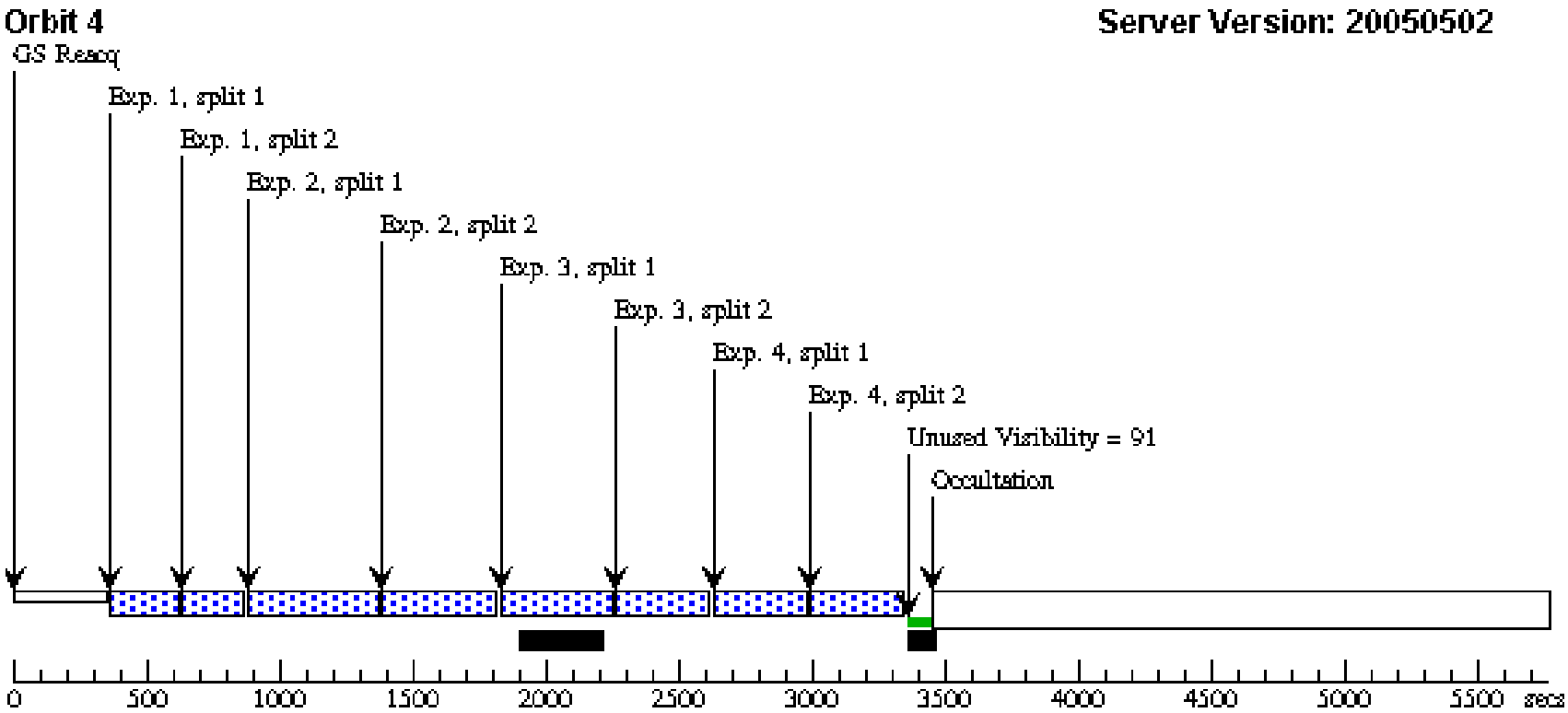
Orbit Structure (continued)



Orbit Structure (continued)



Orbit Structure (continued)



Visit

Proposal 10537, Visit 02 Mon Jun 20 17:39:22 GMT 2005

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Patterns

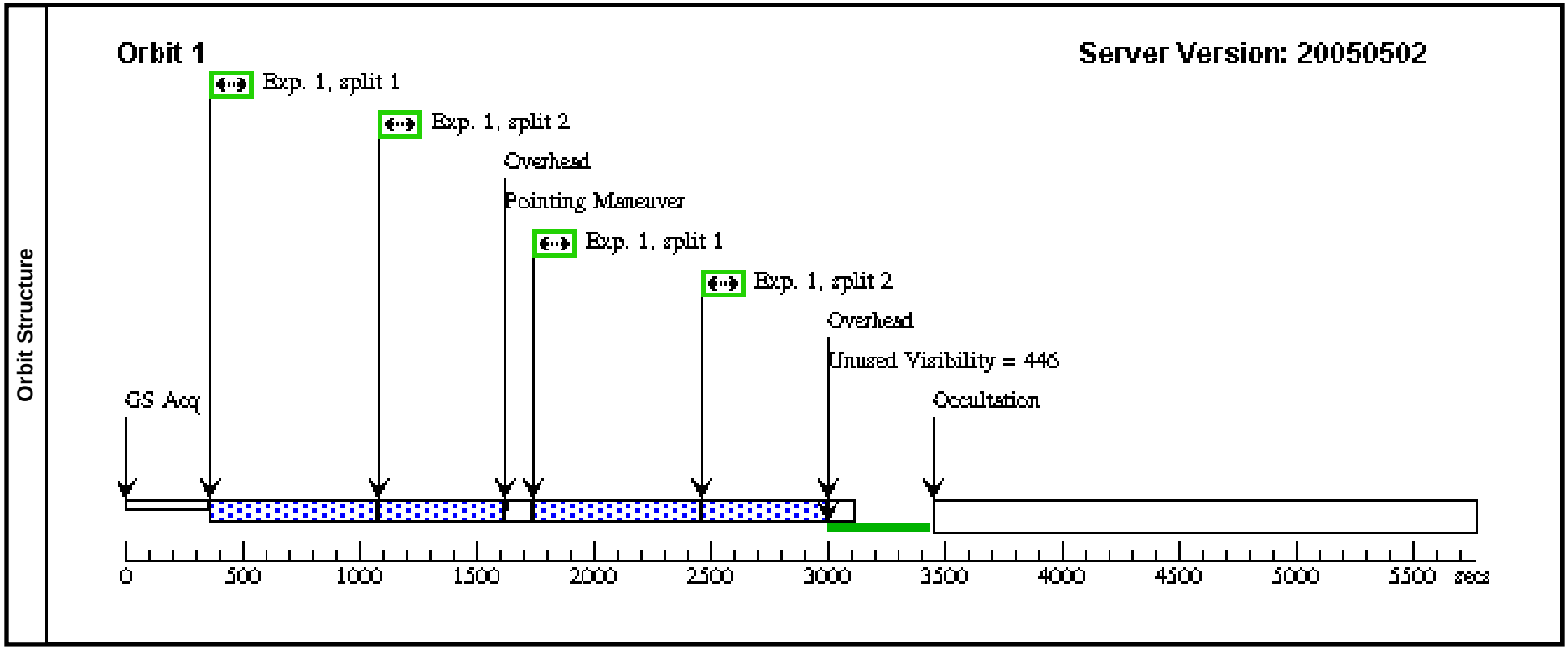
#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFPC2-LINE	Coordinate Frame=POS-TARG		(1)
	Purpose=DITHER	Pattern Orientation=45		
	Number Of Points=2	Angle Between Sides=		
	Point Spacing=0.354	Center Pattern=false		
	Line Spacing=			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	IRAS22036+5306	RA: 22 05 30.2800 (331.3761667d) Dec: +53 21 32.70 (53.35908d) Equinox: J2000 Plate Id: (?)		V=16.4	Coordinate Source: HST_IMAGE

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) IRAS22036+5306	WFPC2, IMAGE, PC1	F631N	CR-SPLIT=0.5; CLOCKS=YES		Pattern 1-1 (2)	500.0 Secs *[==>500.0 Secs (Pattern 1, Split 1)]* *[==>500.0 Secs (Pattern 1, Split 2)]* *[==>500.0 Secs (Pattern 2, Split 1)]* *[==>500.0 Secs (Pattern 2, Split 2)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20050502
Exp. 1, split 1
Exp. 1, split 2
Overhead
Pointing Maneuver
Exp. 1, split 1
Exp. 1, split 2
Overhead
Unused Visibility = 446
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs