10834 - The Shell of the Recurrent Nova T Pyx

Cycle: 15, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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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) T-PYX	WFPC2	1	21-May-2007 19:03:22.0	yes
02	(1) T-PYX	WFPC2	1	21-May-2007 19:03:26.0	yes
03	(1) T-PYX	WFPC2	1	21-May-2007 19:03:28.0	yes
04	(1) T-PYX	WFPC2	1	21-May-2007 19:03:31.0	yes
05	(1) T-PYX	WFPC2	1	21-May-2007 19:03:33.0	yes

5 Total Orbits Used

ABSTRACT

T Pyx is the only known recurrent nova with a shell. This 'shell' is mysterious because it has been resolved into thousands of knots that apparently aren't expanding. We propose to take a deep F658N image of T Pyx during one orbit to serve as a 12 year baseline from the previous HST WFPC2 images in 1994 and 1995. This much longer baseline will allow us to push down the limits on expansion velocities to ~10 km/s and will allow us to measure the lifetimes of the knots. Also, we expect to discover the expanding inner shell from the last eruption in 1966 which should now have

expanded to ~0.9" in radius. Detailed modeling of the observed line fluxes will give the mass of the individual knots and the shells. The details of the expansion velocities, lifetimes, and masses of the knots will determine the nature of the T Pyx shell; with alternatives being a nova shell, a planetary nebula, stalled shocks in a pre-existing shell, or a cloud ionized by the high luminosity and temperature of the white dwarf. If we can separate out the mass ejected during the 1966 eruption, then we can compare it to the total mass accreted between the 1944 and 1966 eruptions (6.0x10^-6 solar mass) so as to determine whether the white dwarf is gaining or losing mass on average. If the white dwarf is gaining mass, then it must inevitably exceed the Chandrasekhar mass and collapse as a Type Ia supernova, and thus recurrent novae would be shown to be an important component of the solution to the Type Ia progenitor problem.

OBSERVING DESCRIPTION

Our proposed observations are simple. We are asking for only one filter (F658N) on this one target. For the highest angular resolution, we will use the PC on WFPC2, and this will duplicate observations from 1994/5 for which we are seeking changes. We will dither by several pixels between exposures to remove cosmetic defects and will use CR-SPLITs.

Our original proposal (as accepted) was to use the ACS, but this is not possible now. So instead of one ACS orbit, we have been granted 5 WFPC2 orbits. This should be adequate. The reason that this should be adequate is that we are seeking changes from the earlier HST observations from 1994/5, and those earlier observations used 8 orbits with WFPC2 and the identical set up. So this second Phase II submission is simple to migrate our earlier observations over to a five-orbit WFPC2 observation.

Our choice of filter is F658N, so as to include both the Halpha and [NII] lines. This choice will maximize our signal. (The 1994/5 HST images taken with filters for the [OII], [OIII], and HeII lines showed that the knots were too faint to be detected.) The shell spectrum in Williams (1982) shows the Halpha and [NII] lines to be substantially overlapping, so observations with the ACS/HRC filter F660N would not be able to well-separate the two lines. We will separate the Halpha and [NII] fluxes from our F658N images on the basis of the line ratio in Williams (1982) as well as from detailed models of the 1994/5 WFPC2 images through the old F658N and F656N filters. As we are now going to be using the same filter as the 1994/5 observations, the need for the separation is minimized, as our primary requirements are to get exact positions and magnitudes for comparison with the old data.

How many orbits are required? For our science tasks, we need to be able to see all the knots detected in 1994 and 1995. The 1994/5 Halpha and [NII] data set from the WFPC2 was made with 8 orbits total. The F658N filter on the ACS/HRC has a peak transmission of 39% versus 11% for the same filter on the WFPC2. The sensitivity (including telescope throughput and the chip quantum efficiency) of the ACS/HRC is just over 50% at [NII], versus about 15% for the WFPC2. This translates into a factor of 11.8 improvement in the speed of collecting the same number of photons. In addition, the ACS/HRC has smaller pixels than the WFPC2 (0.027"/pix versus 0.045"/pix) so the background contribution to a given pixel will be smaller for an unresolved source. In all, the 1994/5 data from 8 orbits should be matched and substantially improved upon with just one orbit of ACS/HRC data. We were originally granted one orbit with the ACS. However, now that the ACS is no longer workiing, we have been granted 5 orbits with the WFPC2. This should be adequate, as our five orbits in 2007 will allow us to see almost all the knots as were detected in the identical configuration in eight orbits in 1994/5.

We are fortunate that the ACS/HRC field of view includes a good bright star 17" south of T Pyx (see Figure 1) for use as a PSF star with plenty of signal. We know that this star will not be saturated because is was far from saturated in the 1994/5 HST data. This star has been measured many times with high accuracy in many filters (including by Arlo Landolt) so we know its absolute flux through the F658N filter to serve as a photometric calibration. This star will also serve to accurately set the astrometric reference frame for comparison with the 1994/5 images. (The image scales and distortions for both the WFPC2 and ACS/HRC are well known, so comparison of the astrometric positions from the two epochs will be straight forward.) The ACS/HRC field of view is 26"x29", so we will have the center position be 5" from T Pyx towards the PSF star so that the entire shell and the PSF star will be included for all orientations of HST. Now, with us using the PC chip of the WFPC2 camera, we are asking to have T Pyx exactly at the optimal center of the PC chip, and in this case the comparison star will be on-chip for all orientations. So we now want T Pyx well centered on the PC chip with no orientation constraints.

The dominant uncertainty in our mass measure will be from the distance - but this distance uncertainty will not affect our determination of whether the white dwarf in T Pyx is gaining or loosing mass. The reason is that both our measures of M_ejecta and dM/dt have the same dependences (i.e., inverse-square) on the distance. So when we evaluate whether M_ejecta<tau_rec*dM/dt, the distance dependencies cancel out and hence our result will be distance independent.

HST is the only telescope that can make the required observations. The reason is that our science requires the resolution of the knots and positional accuracies that are comparable to that of the first-epoch HST observations.

Visit

Proposal 10834, Visit 01, implementation Mon May 21 18:03:35 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Comments: We are after a single image of T Pyx and its shell (taken over 5 orbits) with the WFPC2 and the F658N filter. We will break up each orbit into a pair of exposures (to avoid any problems with cosmetic effects across the shell) and we will use the CR-SPLITs. There are no constraints for timing or orientation.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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=			

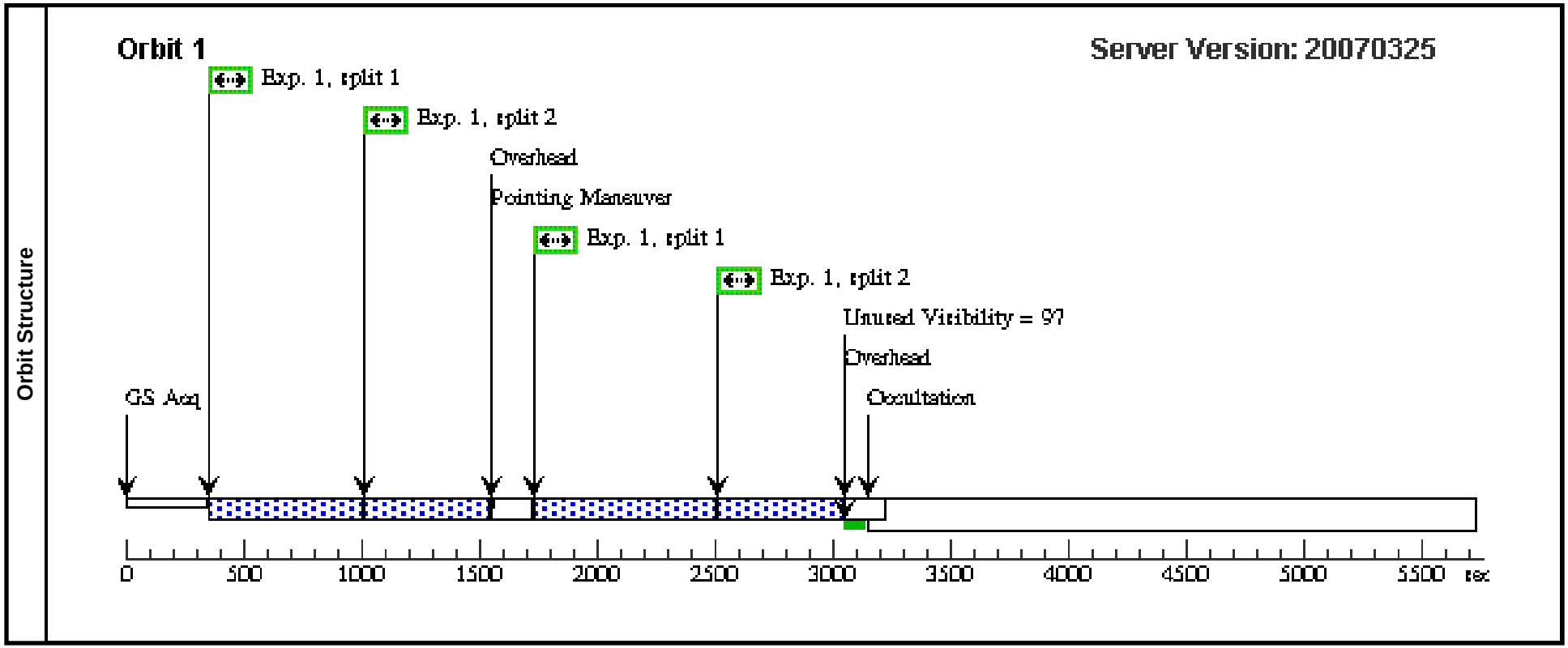
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	T-PYX	RA: 09 04 41.4700 (136.1727917d)		V=15.5+/-0.1	Reference Frame: SIMBAD
		Dec: -32 22 47.00 (-32.37972d)			
		Equinox: J2000			

Comments: We want T Pyx placed at the optimal center of the PC chip. With this, the 'standard' star 17 arc-seconds south of T Pyx will be on-chip for all orientations.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	T Pyx	(1) T-PYX	WFPC2, IMAGE, PC1	F658N			Pattern 1-1 (1)	795.0 Secs	
								[==>400.0 Secs (Pattern 1, Split 1)]	***[1]***
								[==>500.0 Secs (Pattern 1, Split 2)]	
								[==>500.0 Secs (Pattern 2, Split 1)]	
								[==>500.0 Secs (Pattern 2, Split 2)]	


Orbit Structure
Orbit 1
Server Version: 20070325
Exp. 1, split 1
Exp. 1, split 2
Overhead
Pointing Maneuver
Exp. 1, split 1
Exp. 1, split 2
Unused Visibility = 97
Overhead
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 10834, Visit 02 Mon May 21 18:03:35 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Comments: We are after a single image of T Pyx and its shell (taken over 5 orbits) with the WFPC2 and the F658N filter. We will break up each orbit into a pair of exposures (to avoid any problems with cosmetic effects across the shell) and we will use the CR-SPLITs. There are no constraints for timing or orientation.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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)	T-PYX	RA: 09 04 41.4700 (136.1727917d)		V=15.5+/-0.1	Reference Frame: SIMBAD
		Dec: -32 22 47.00 (-32.37972d)			
		Equinox: J2000			

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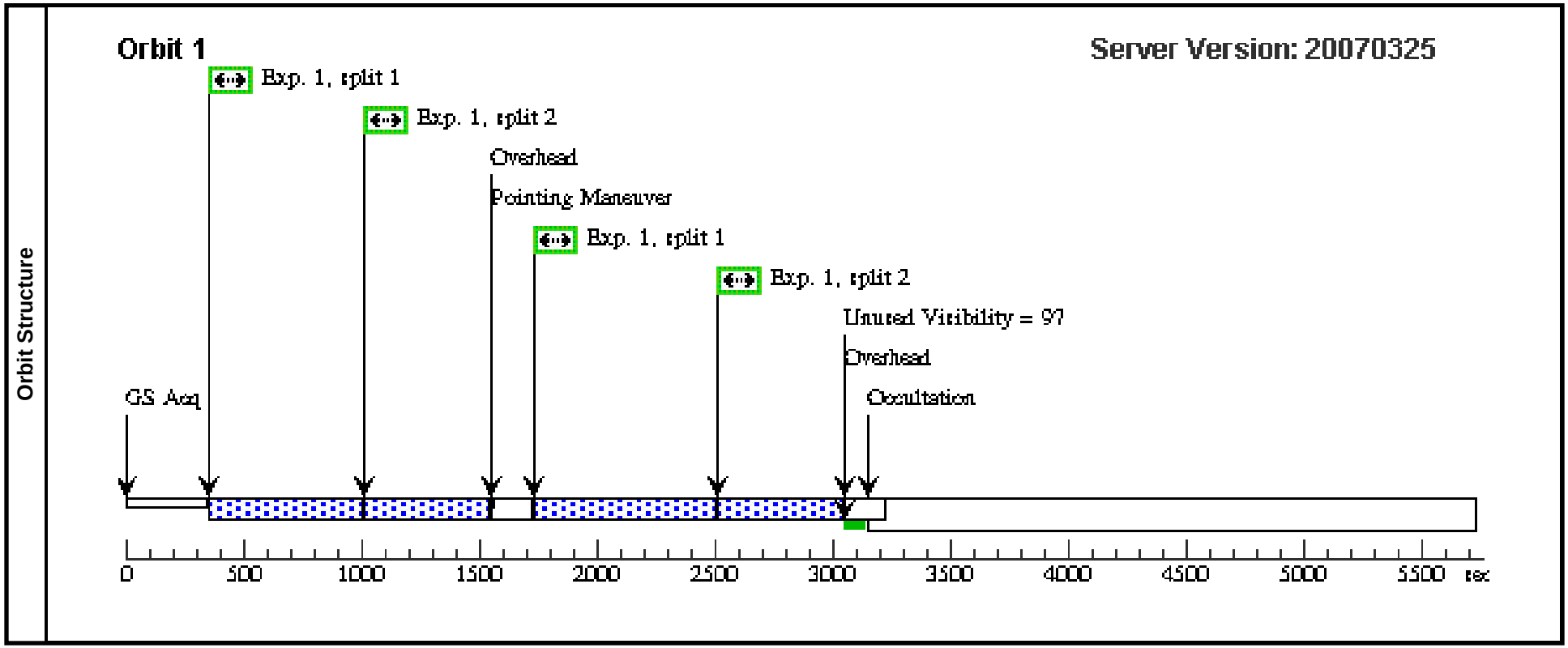
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	T Pyx	(1) T-PYX	WFPC2, IMAGE, PC1	F658N			Pattern 1-1 (1)	795.0 Secs	
								[==>400.0 Secs (Pattern 1, Split 1)]	***[1]***
								[==>500.0 Secs (Pattern 1, Split 2)]	
								[==>500.0 Secs (Pattern 2, Split 1)]	
								[==>500.0 Secs (Pattern 2, Split 2)]	


Orbit Structure
Orbit 1
Server Version: 20070325
Exp. 1, split 1
Exp. 1, split 2
Overhead
Pointing Maneuver
Exp. 1, split 1
Exp. 1, split 2
Unused Visibility = 97
Overhead
Occultation
GS Acq
0
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4500
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sec

Visit

Proposal 10834, Visit 03 Mon May 21 18:03:36 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Comments: We are after a single image of T Pyx and its shell (taken over 5 orbits) with the WFPC2 and the F658N filter. We will break up each orbit into a pair of exposures (to avoid any problems with cosmetic effects across the shell) and we will use the CR-SPLITs. There are no constraints for timing or orientation.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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)	T-PYX	RA: 09 04 41.4700 (136.1727917d)		V=15.5+/-0.1	Reference Frame: SIMBAD
		Dec: -32 22 47.00 (-32.37972d)			
		Equinox: J2000			

Comments: We want T Pyx placed at the optimal center of the PC chip. With this, the 'standard' star 17 arc-seconds south of T Pyx will be on-chip for all orientations.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	T Pyx	(1) T-PYX	WFPC2, IMAGE, PC1	F658N			Pattern 1-1 (1)	795.0 Secs	
								[==>400.0 Secs (Pattern 1, Split 1)]	***[1]***
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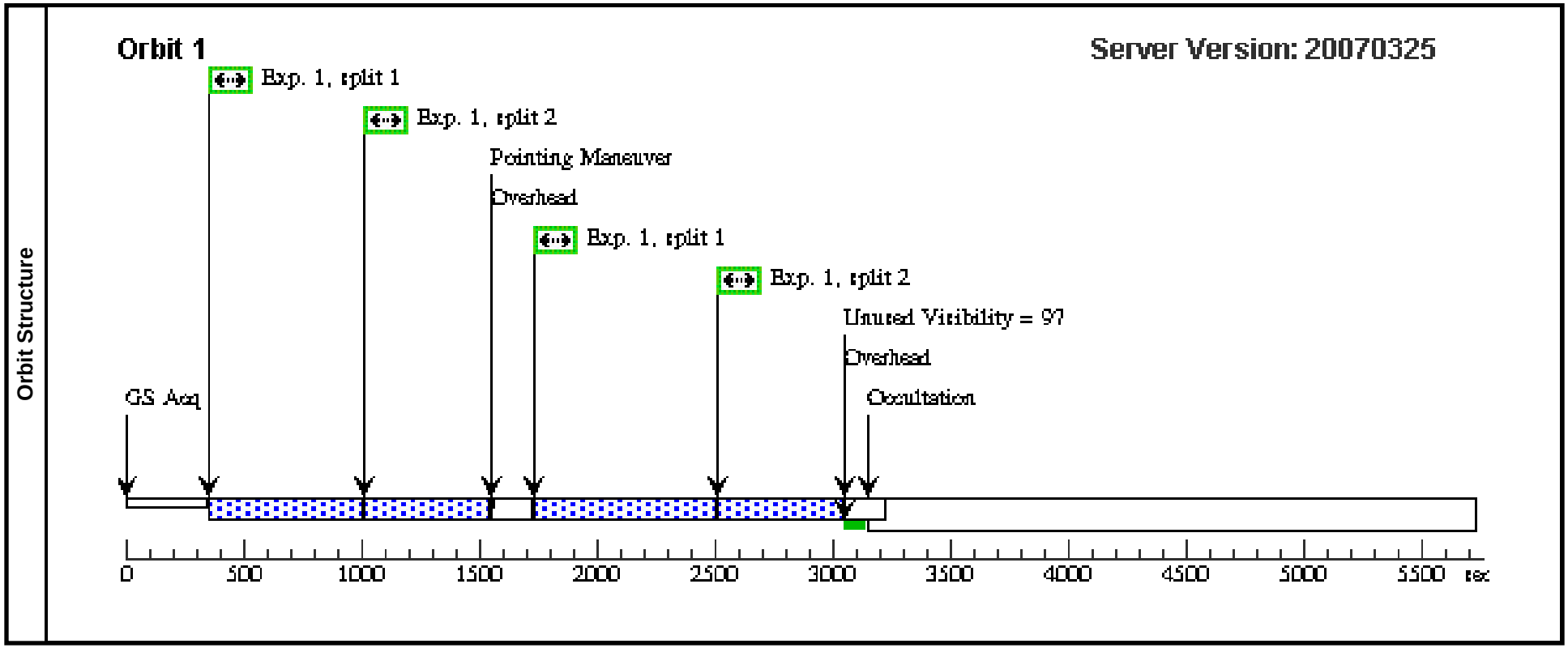
								[==>500.0 Secs (Pattern 2, Split 1)]	
								[==>500.0 Secs (Pattern 2, Split 2)]	


Orbit Structure
Orbit 1
Server Version: 20070325
Exp. 1, split 1
Exp. 1, split 2
Pointing Maneuver
Overhead
Exp. 1, split 1
Exp. 1, split 2
Unused Visibility = 97
Overhead
GS Acq
Occultation
0
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4500
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5500
sec

Visit

Proposal 10834, Visit 04 Mon May 21 18:03:36 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Comments: We are after a single image of T Pyx and its shell (taken over 5 orbits) with the WFPC2 and the F658N filter. We will break up each orbit into a pair of exposures (to avoid any problems with cosmetic effects across the shell) and we will use the CR-SPLITs. There are no constraints for timing or orientation.

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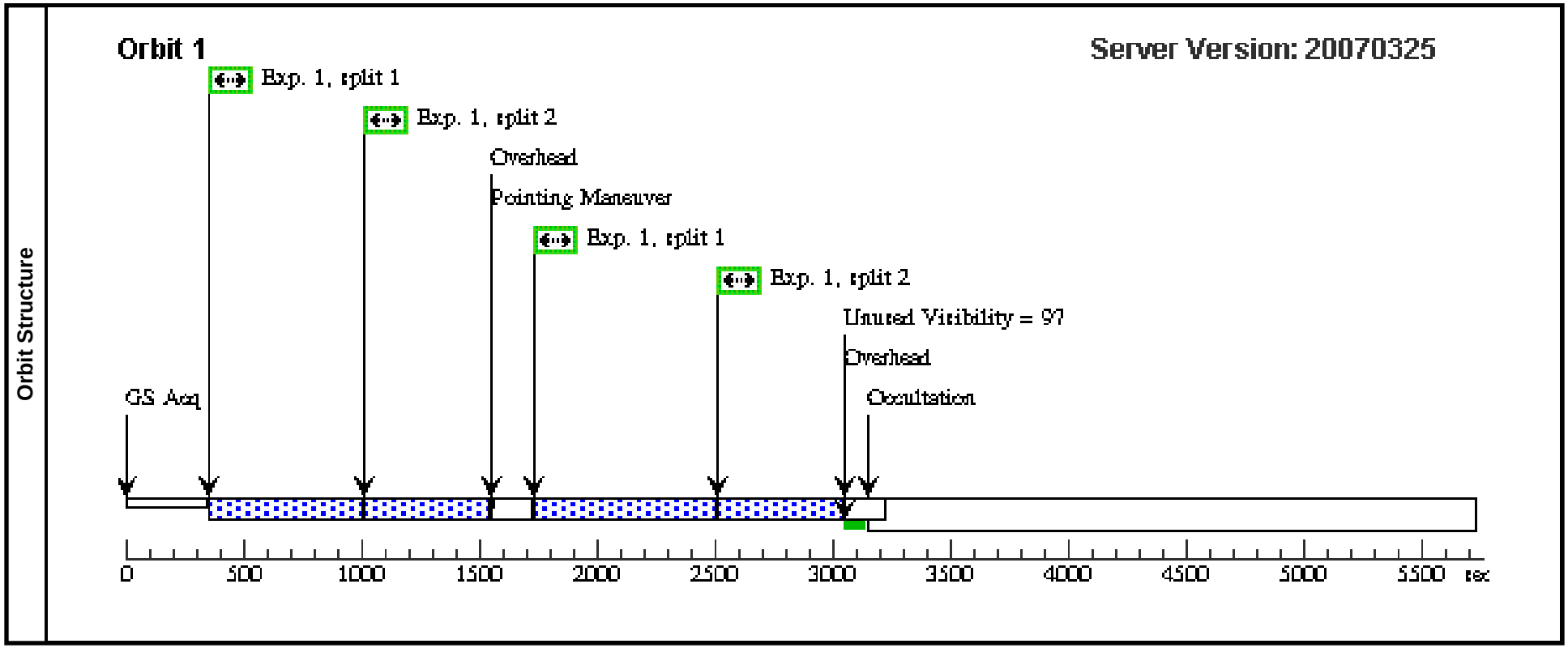
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Unused Visibility = 97
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Visit

Proposal 10834, Visit 05 Mon May 21 18:03:37 GMT 2007

Diagnostic Status: No Diagnostics

Scientific Instruments: WFPC2

Special Requirements: (none)

Comments: We are after a single image of T Pyx and its shell (taken over 5 orbits) with the WFPC2 and the F658N filter. We will break up each orbit into a pair of exposures (to avoid any problems with cosmetic effects across the shell) and we will use the CR-SPLITs. There are no constraints for timing or orientation.

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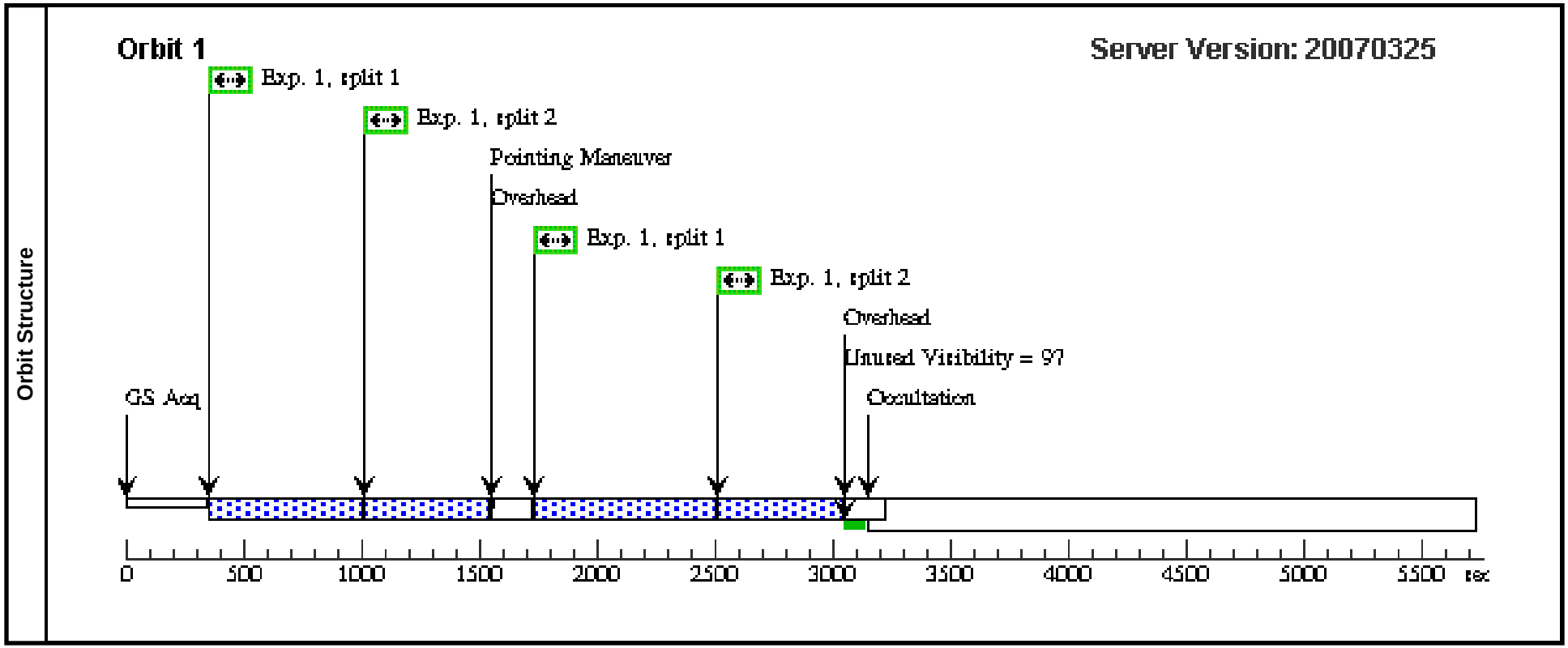
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