



# 10555 - A Search for Satellites Around Kuiper Belt Objects Which Exhibit High Angular Momentum

Cycle: 14, Proposal Category: GO  
(Availability Mode: SUPPORTED)

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Scott S. Sheppard (PI)</b>	<b>Carnegie Institution of Washington</b>	
Dr. Keith S. Noll (CoI)	Space Telescope Science Institute	

## VISITS

<i>Visit</i>	<i>Targets</i>	<i>Configurations</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(2) 20000	ACS/HRC	1	05-Jul-2005 21:43:43.0	yes
02	(1) 32929	ACS/HRC	1	05-Jul-2005 21:43:49.0	yes
03	(3) 2001QG298	ACS/HRC	1	05-Jul-2005 21:43:54.0	yes
04	(4) 47932	ACS/HRC	1	05-Jul-2005 21:43:58.0	yes

4 Total Orbits Used

## ABSTRACT

We propose to use the HST to search for satellites around Kuiper Belt Objects which have large amplitude, fast rotational light curves. Large main belt asteroids with similar light curve characteristics have been found to have near an 80 percent companion rate. This is over an order of magnitude more than the companion rate of main belt asteroids in general. The satellites were probably formed during the process which imparted the high angular momentum on the primary object. To date five Kuiper Belt objects exhibit high angular momentum through their rotational light curves.

## Proposal 10555 - Overview

Two of them have been observed with STIS on the HST and one was found to be a binary. We request three orbits with HST/ACS in order to obtain deep high resolution images of the other three Kuiper Belt objects that have large amplitudes and fast rotations. In addition, we request one orbit to reobserve the other KBO which didn't have a satellite detection in order to obtain deeper and better resolution images than the first observations. Finding binaries is important not only to understand the processes which created the high angular momentum of the primary but also in determining the bulk densities and collisional histories of the objects.

### **OBSERVING DESCRIPTION**

Our targets are KBOs which have high angular momenta and have similar sizes as the main belt asteroids of comparable characteristics. We also need to observe similar sized satellites in the Kuiper belt as those found around the main belt asteroids. The main belt asteroids satellites are around 10 to 15 km in diameter. We need to reach a magnitude of about 28 to be able to detect a KBO this size in the Kuiper belt assuming a low to moderate albedo. ACS/HRC can reach a signal to noise of about 5 with optimal PSF fitting at 28th magnitude in about 2400 seconds.

As mentioned at the end of the Science Justification we request time to observe 4 KBOs to search for companions. Three of the KBOs have not been observed by HST while KBO 2000 GN171 was observed once before with HST/STIS to about 27th magnitude. The targets in our sample have V-band magnitudes between  $20 < V < 23$ . PSF fitting will be used to search for satellites of each KBO observed.

Each KBO will need to be imaged several times during one visit with dithers between exposures to take out cosmic rays and chip defects.

The KBOs are non-sidereally moving objects which have maximum motions of about 4 arcseconds per hour as seen from the Earth at opposition.

## Proposal 10555 - Overview

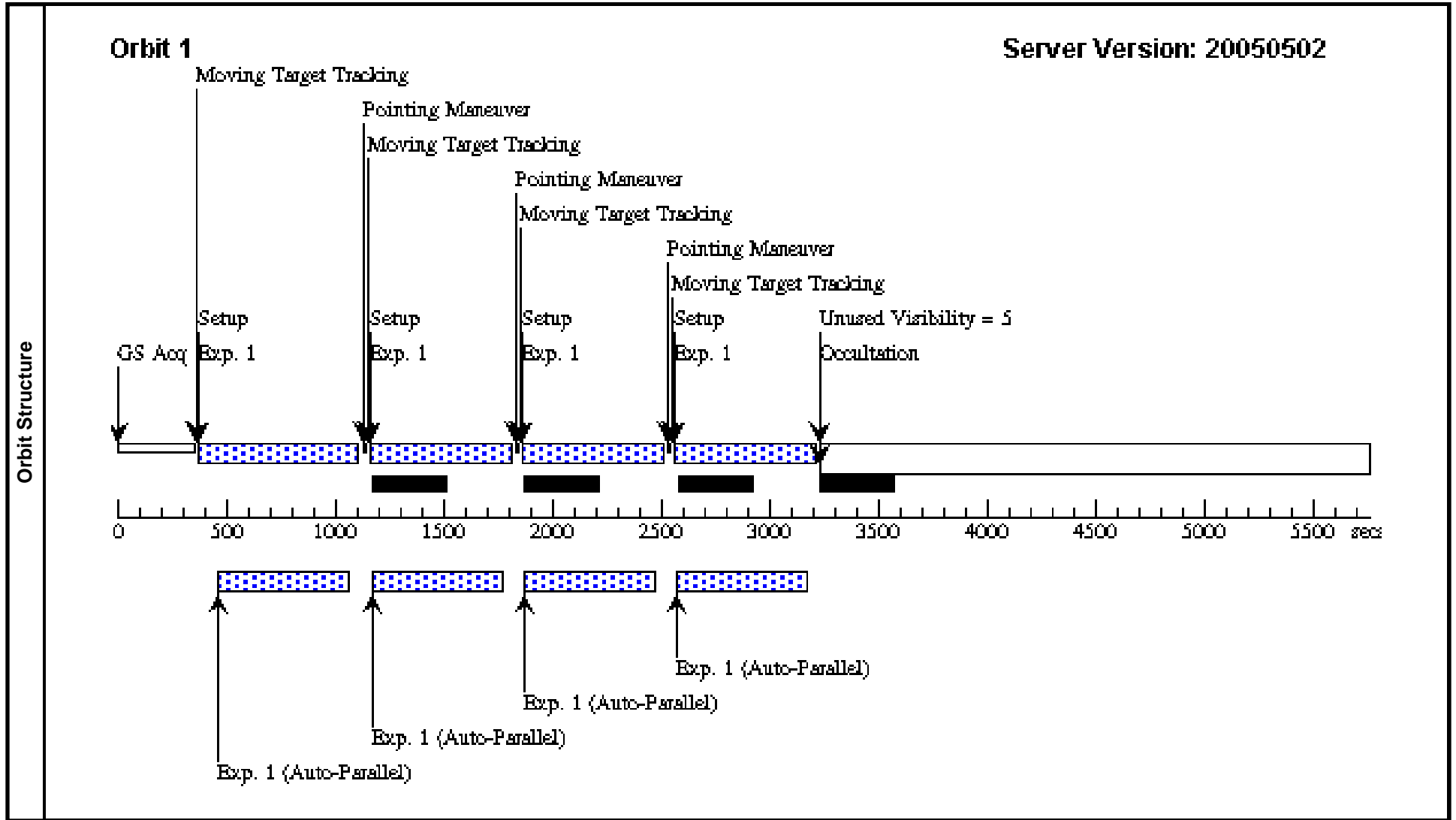
They are near the ecliptic plane. Slight zodiacal light and Earth shine should not be a problem. We will use the Broad V F606W filter for observations. Standard guide star acquisition will take 6 minutes for an object. The ACS/HRC overhead is 2.5 minutes for the first exposure and 1 minute for each additional exposure. We require dithering between exposures and this will add an additional 30 seconds per exposure. We will use tracking to move at the nonsidereal rates of the object while imaging.

Four 600 second images will be taken of each KBO in order to remove noise from cosmic rays and chip defects. With overheads this is  $6 \text{ min} + 2.5 \text{ min} + (3 \times 1 \text{ min}) + (3 \times 0.5 \text{ min}) + (4 \times 10 \text{ min}) = 53$  minutes per object. Since each of our objects will be visible for about 55 minutes per orbit we require one orbit per object to reach the sensitivity we desire. Thus we request 4 orbits with HST/ACS/HRC.

Proposal 10555 - Visit 01 - A Search for Satellites Around Kuiper Belt Objects Which Exhibit High Angular Momentum

Wed Jul 06 01:44:01 GMT 2005

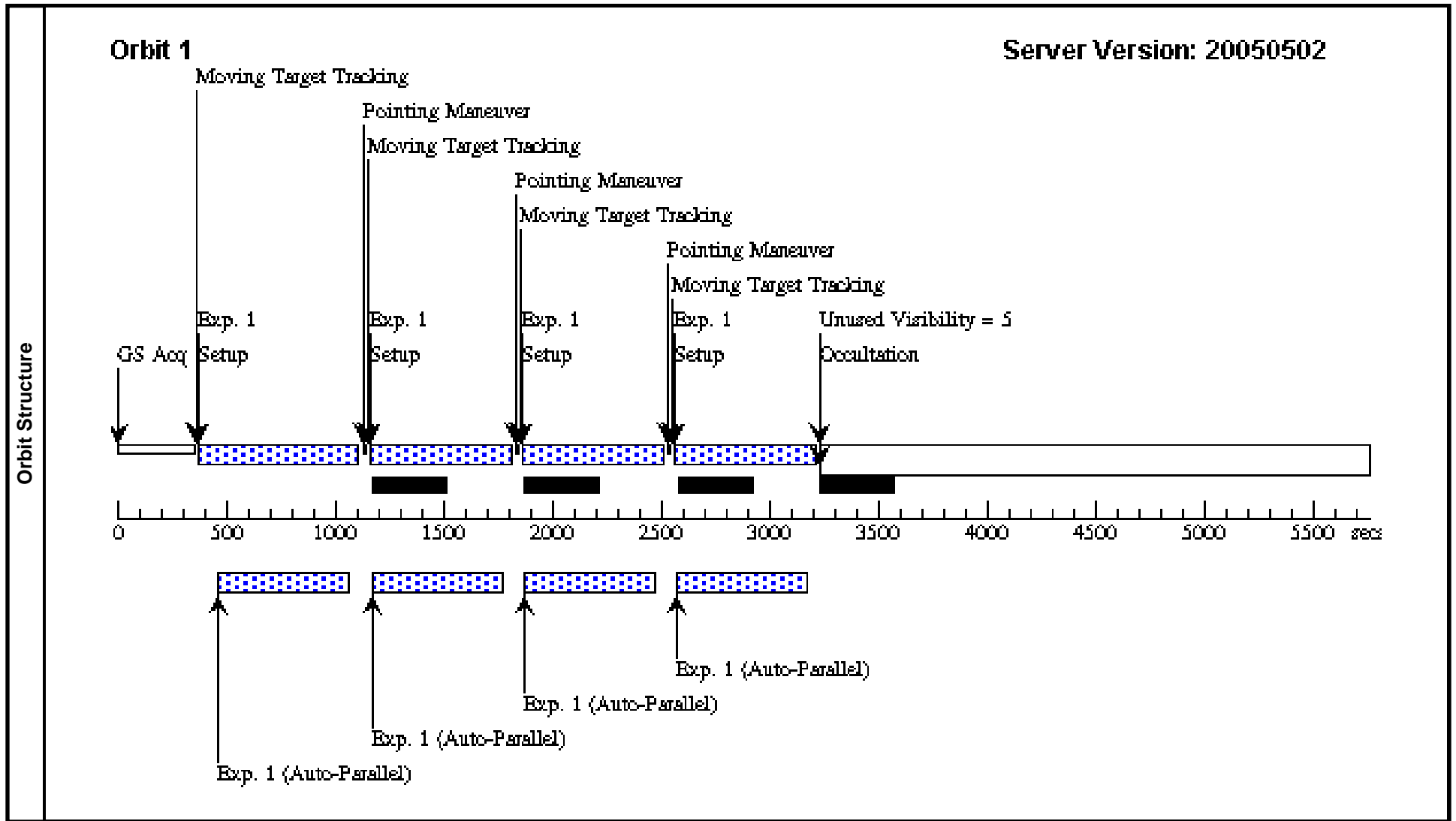
<b>Visit</b>	<b>Proposal 10555, Visit 01</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/HRC Special Requirements: (none)									
	<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>				<b>Secondary Pattern</b>			
(1)		Pattern Type=ACS-HRC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2 Line Spacing=0.098		Coordinate Frame=POS-TARG Pattern Orientation=19.9 Angle Between Sides=63.5 Center Pattern=false						(1)
<b>Solar System Targets</b>	<b>#</b>	<b>Name</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Window</b>				
	(2)	20000	TYPE=ASTEROID,A=43.0698299,E=0.05 L1015,I=17.16869,O=97.3006,W=270.1739 L,M=91.84985,EQUINOX=J2000,EPOCH =30-JAN-2005:00:00:00				A_VEL 20000 FROM HUBBLE GT 0.0000417  <i>Comments: We want to observe the Kuiper Belt Object when its parallax motion allows it to at least move 3 pixels during one orbit (or 2400 seconds). This will allow us to determine which object is the Kuiper Belt object and any possible satellites versus what are stationary background objects. We attempt to put this constraint in below using the "Observing Windows" section limiting the minimum angular velocity. Also, if this severely limits our viewing or observing chances than this angular velocity limit may be removed.</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	1	(2) 20000	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO		Pattern 1-1 (1)	620.0 Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
<i>Comments: We want four images per object for one orbit (to remove cosmic rays and bad pixels). Right now we put 620 seconds per image, but this integration per image may be reduced by up to 10% if needed to fit a smaller observation window.</i>										



Proposal 10555 - Visit 02 - A Search for Satellites Around Kuiper Belt Objects Which Exhibit High Angular Momentum

Wed Jul 06 01:44:01 GMT 2005

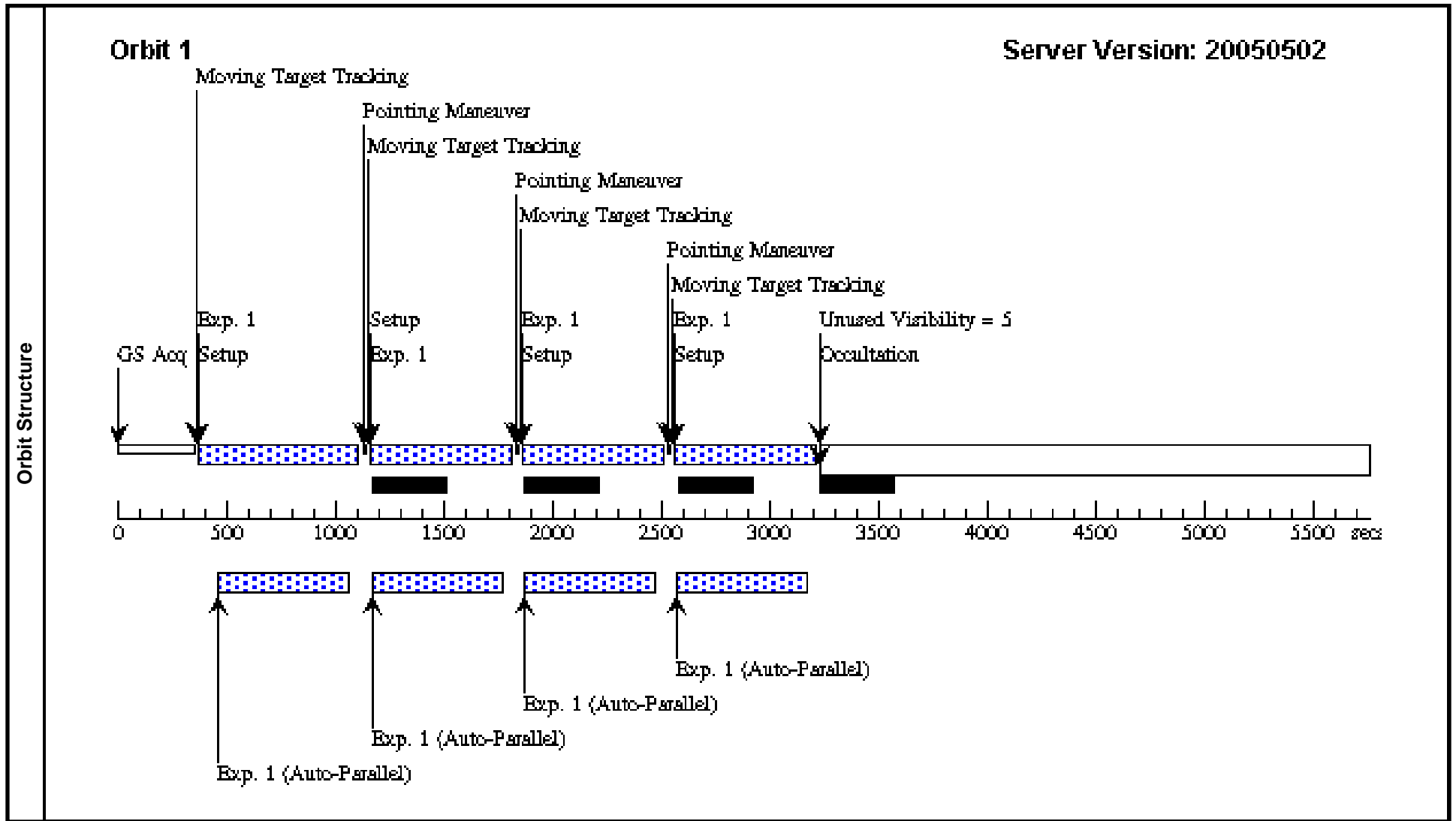
<b>Visit</b>	<b>Proposal 10555, Visit 02</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/HRC Special Requirements: (none)										
	<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>				<b>Secondary Pattern</b>				<b>Exposures</b>
(1)		Pattern Type=ACS-HRC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2 Line Spacing=0.098	Coordinate Frame=POS-TARG Pattern Orientation=19.9 Angle Between Sides=63.5 Center Pattern=false					(1)			
<b>Solar System Targets</b>	<b>#</b>	<b>Name</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Window</b>					
	(1)	32929	TYPE=ASTEROID,A=39.4641155,E=0.25 99466,I=4.84603,O=342.11102,W=25.2157 3,M=358.02996,EQUINOX=J2000,EPOC H=30-JAN-2005:00:00:00				A_VEL 32929 FROM HUBBLE GT 0.0000417				
<i>Comments: We want to observe the Kuiper Belt Object when its parallax motion allows it to at least move 3 pixels during one orbit (or 2400 seconds). This will allow us to determine which object is the Kuiper Belt object and any possible satellites versus what are stationary background objects. We attempt to put this constraint in below using the "Observing Windows" section limiting the minimum angular velocity. Also, if this severely limits when we can make our observations than this angular velocity limit can be removed.</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	1	(1) 32929	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO		Pattern 1-1 (1)	620.0 Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]		[1]
<i>Comments: We want four images per object for one orbit (to remove cosmic rays and bad pixels). Right now we put 620 seconds per image, but this integration per image may be reduced by up to 10% if needed to fit a smaller observation window.</i>											



Proposal 10555 - Visit 03 - A Search for Satellites Around Kuiper Belt Objects Which Exhibit High Angular Momentum

Wed Jul 06 01:44:02 GMT 2005

<b>Visit</b>	<b>Proposal 10555, Visit 03</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/HRC Special Requirements: (none)										
	<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>				<b>Secondary Pattern</b>				<b>Exposures</b>
(1)		Pattern Type=ACS-HRC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2 Line Spacing=0.098		Coordinate Frame=POS-TARG Pattern Orientation=19.9 Angle Between Sides=63.5 Center Pattern=false						(1)	
<b>Solar System Targets</b>	<b>#</b>	<b>Name</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Window</b>					
	(3)	2001QG298	TYPE=ASTEROID,A=39.1843938,E=0.19 15167,I=6.50351,O=162.57295,W=211.507 66,M=349.88454,EQUINOX=J2000,EPOC H=30-JAN-2005:00:00:00			A_VEL 2001QG298 FROM HUBBLE GT 0.0000417					
<i>Comments: We want to observe the Kuiper Belt Object when its parallax motion allows it to at least move 3 pixels during one orbit (or 2400 seconds). This will allow us to determine which object is the Kuiper Belt object and any possible satellites versus what are stationary background objects. We attempt to put this constraint in below using the "Observing Windows" section limiting the minimum angular velocity. Also, if this severely limits our viewing or observing chances than this angular velocity limit may be removed.</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	1	(3) 2001QG298	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO		Pattern 1-1 (1)	620.0 Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]		[1]
<i>Comments: We want four images per object for one orbit (to remove cosmic rays and bad pixels). Right now we put 620 seconds per image, but this integration per image may be reduced by up to 10% if needed to fit a smaller observation window.</i>											



Proposal 10555 - Visit 04 - A Search for Satellites Around Kuiper Belt Objects Which Exhibit High Angular Momentum

Wed Jul 06 01:44:03 GMT 2005

<b>Visit</b>	<b>Proposal 10555, Visit 04</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: ACS/HRC Special Requirements: (none)										
	<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>				<b>Secondary Pattern</b>				<b>Exposures</b>
(1)		Pattern Type=ACS-HRC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2 Line Spacing=0.098				Coordinate Frame=POS-TARG Pattern Orientation=19.9 Angle Between Sides=63.5 Center Pattern=false				(1)	
<b>Solar System Targets</b>	<b>#</b>	<b>Name</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Window</b>					
	(4)	47932	TYPE=ASTEROID,A=39.6896218,E=0.28 69864,I=10.79551,O=26.09245,W=194.658 42,M=353.11502,EQUINOX=J2000,EPOC H=30-JAN-2005:00:00:00				A_VEL 47932 FROM HUBBLE GT 0.0000417				
<i>Comments: We want to observe the Kuiper Belt Object when its parallax motion allows it to at least move 3 pixels during one orbit (or 2400 seconds). This will allow us to determine which object is the Kuiper Belt object and any possible satellites versus what are stationary background objects. We attempt to put this constraint in below using the "Observing Windows" section limiting the minimum angular velocity. Also, if this severely limits our viewing or observing chances than this angular velocity limit may be removed.</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	1	(4) 47932	ACS/HRC, ACCUM, HRC	F606W	CR-SPLIT=NO		Pattern 1-1 (1)	620.0 Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]		[1]
<i>Comments: We want four images per object for one orbit (to remove cosmic rays and bad pixels). Right now we put 620 seconds per image, but this integration per image may be reduced by up to 10% if needed to fit a smaller observation window.</i>											

