17768 - Detecting the UV Accretion Signatures from PDS-70b

Cycle: 32, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Laura Flagg (PI) (Contact)	**The Johns Hopkins University**
Dr. Christopher Michael Johns-Krull (CoI)	Rice University
Dr. Andrea Isella (CoI)	Rice University
Dr. Alycia J. Weinberger (CoI)	Carnegie Institution of Washington
Prof. Ray Jayawardhana (CoI)	The Johns Hopkins University
Dr. James Muzerolle Page (CoI)	Space Telescope Science Institute
Dr. Thanawuth Thanathibodee (CoI)	Chulalongkorn University
Dr. Yifan Zhou (CoI)	The University of Virginia
Dr. Jake Turner (CoI)	Cornell University

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(2) PDS70	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA WFC3/UVIS	5	18-Dec-2024 14:00:48.0	yes
02	(2) PDS70	STIS/CCD STIS/NUV-MAMA	3	18-Dec-2024 14:00:50.0	yes

8 Total Orbits Used

ABSTRACT

Accretion is an essential step in gas giant planet-building and measuring the accretion rate illuminates the nature of planet-disk interactions as well as the timescale for and the process of planet formation. While there are numerous models for how planets may accrete material from the circumstellar disk in which they form, there is little consensus about the specifics given the lack of direct observational evidence. PDS-70b (a ~5 Myr-old giant planet) has had its accretion luminosity measured at H-alpha and in the continuum at 335 nm. However, the accretion rates derived from these measurements range over 2 orders of magnitude. For stars, the most accurate accretion indicators are shortward of 300 nm, as these more directly probe the accretion shock where infalling material impacts the surface. Similar observations of accreting planets are needed to better test whether an analogous process occurs in planet formation.

We propose to observe PDS-70b between 120 nm and 300 nm at low resolution to search for accretion signatures in the UV to better constrain the accretion process on PDS 70b and measure a reliable accretion rate. We will observe PDS-70b at H-alpha both before and after each UV observation so we can calibrate the relationship between accretion signatures at H-alpha versus the UV, as is done for stars. We will also observe PDS-70b at medium resolution from 276 to 285 nm to measure the accretion line profile and constrain the planet's mass, a key quantity needed to reliably measure the accretion rate. These observations will provide some of the first UV observational data of planet accretion and will result in new and important insights into planet formation.

OBSERVING DESCRIPTION

This program aims to detect the UV flux from PDS 70b. The program is broken down into two visits. In one visit (5 orbits), we will acquire low-resolution spectra in order determine the flux from various UV lines and compare that to the planet's H-alpha flux, which we will also measure during that visit. In the other visit (3 orbits), we will acquire medium resolution spectra in order to resolve the line profile.

We can capture both the star's and the planet's UV spectra by aligning the slit from STIS/MAMA at the planet's position angle using the 52 arcsec X0.2 arcsec slit. PDS-70b's apparent separation from its host star is large enough at the moment that the star's and the planet's signals will be spatially separated with STIS/MAMA spectroscopy, as shown in the original proposal. For the H-alpha observations, we will employ a four point dither pattern, as has been shown to work for previous observations of this system with WFC3/UVIS. We will use the same observation strategy as that of GO-17427, which observed this same system. The warning on FLASH level has been ignored based on prior observations of the system (GO-

For the low-resolution visit, after acquisition, we will start with the STIS/MAMA G2230L NUV observations for a partial orbit. We will then move to the STIS/MAMA G140L FUV observations for the remainder of the first orbit plus three full orbits. We finish with the WFC3 observations of H-alpha for an orbit.

For the medium-resolution visit, after acquisition, we will spend the remainder of that orbit plus two full orbits observing the system with STIS/MAMA G230M (central wavelength 2800) NUV.

Visit

Proposal 17768, Low-res (01), implementation Wed Dec 18 19:00:50 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS, STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA

Special Requirements: ORIENT 116D TO 132 D; ORIENT 296D TO 312 D; BETWEEN 03-MAR-2025:00:00:00 AND 05-MAR-2025:23:59:59; BETWEEN 09-MAR-2025:00:00:00 AND 22-MAR-2025:23:59:59

Diagnostics

(WFC3_2 (01.007)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=BOX	Coordinate Frame=POS-TARG		(7)
	Purpose=DITHER	Pattern Orientation=0		
	Number Of Points=4	Angle Between Sides=90		
	Point Spacing=0.02	Center Pattern=false		
	Line Spacing=0.02			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	PDS70	RA: 14 08 10.1540 (212.0423083d)	Proper Motion RA: -29.661 mas/yr	V=12.18+/-0.13	Reference Frame: ICRS
	Alt Name1: CD-408434	Dec: -41 23 52.58 (-41.39794d)	Proper Motion Dec: -23.823 mas/yr	B=13.42 (Simbad); Swift uvw2 (1599-2256 A.) = 1.5e-13 ergs/cm^2/s; uvwI (2253-2946 A.) = 2.7e-13 ergs/cm^2/s (ref. Joyce et al. 2020)	
	Alt Name2: GSC07811-01917	Equinox: J2000	Epoch of Position: 2000		
			Radial Velocity: 3.13 km/sec		

Comments: RA, Dec are from Simbad (referenced to Gaia DR2).
RA, Dec errors, Proper Motion, Radial Velocity are from Gaia DR2.
V mag and uncertainty are from range given in Simbad.
Category=STAR
Description=[EXTRA-SOLAR PLANETARY SYSTEM, K V-IV, T TAURI STAR]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	STIS_ACQ	(2) PDS70	STIS/CCD, ACQ, F28X50LP	MIRROR				.4 Secs (0.4 Secs)	
								[==>]	***[1]***
2	NUV_ (1729877)	(2) PDS70	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=693			460 Secs (460 Secs)	
								[==>]	***[1]***
3	FUV_G140L_exp4 (1729896)	(2) PDS70	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5934			1193 Secs (1193 Secs)	
								[==>]	***[1]***
4	FUV_G140L_exp1 (1729896)	(2) PDS70	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5934			2640 Secs (2640 Secs)	
								[==>]	***[2]***
5	FUV_G140L_exp2 (1729896)	(2) PDS70	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5934			2640 Secs (2640 Secs)	
								[==>]	***[3]***
6	FUV_G140L_exp3 (1729896)	(2) PDS70	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5934			2640 Secs (2640 Secs)	
								[==>]	***[4]***
7	WFC3_2 (1888734)	(2) PDS70	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F656N			Pattern 1, Exps 7-7 in Low-res (01) (1)	59 Secs X 6 (1416 Secs)	
								[==>(Pattern 1, Copy 1)]	***[5]***
								[==>(Pattern 1, Copy 2)]	
								[==>(Pattern 1, Copy 3)]	
								[==>(Pattern 1, Copy 4)]	
								[==>(Pattern 1, Copy 5)]	
								[==>(Pattern 1, Copy 6)]	
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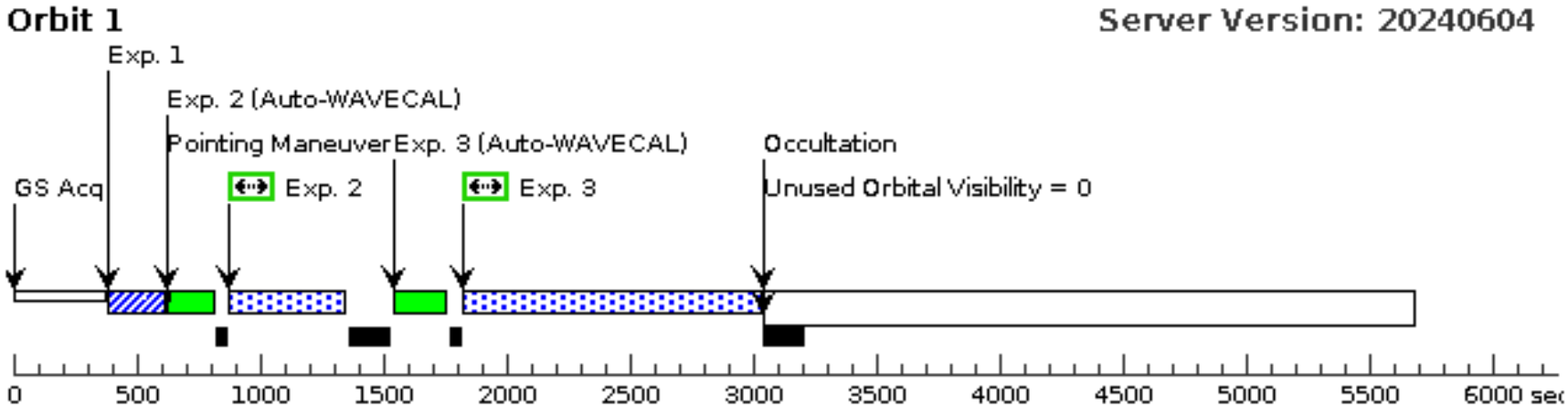
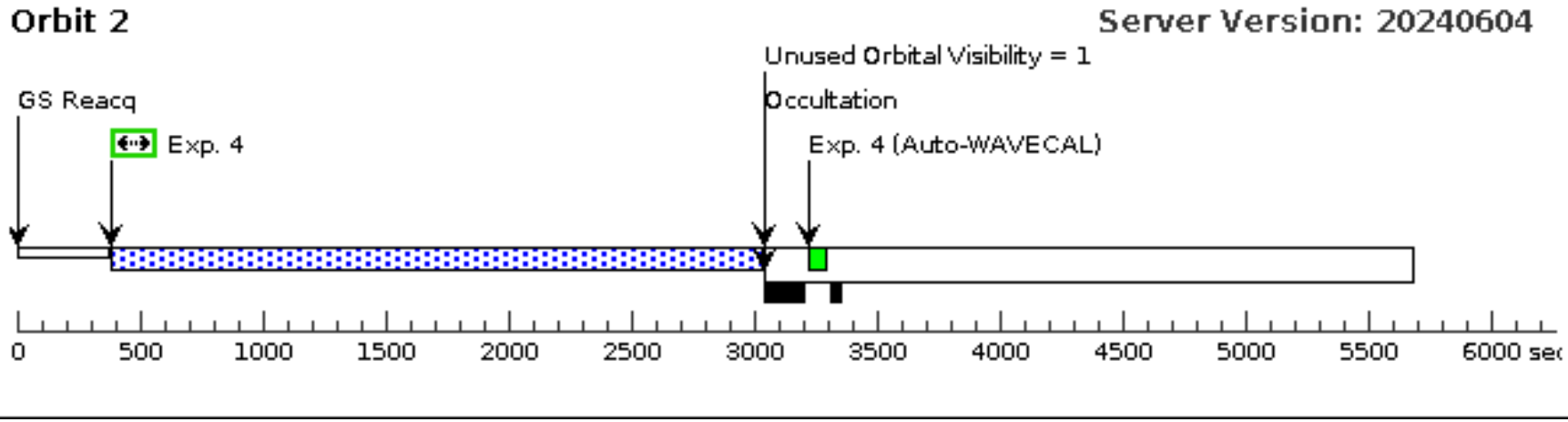
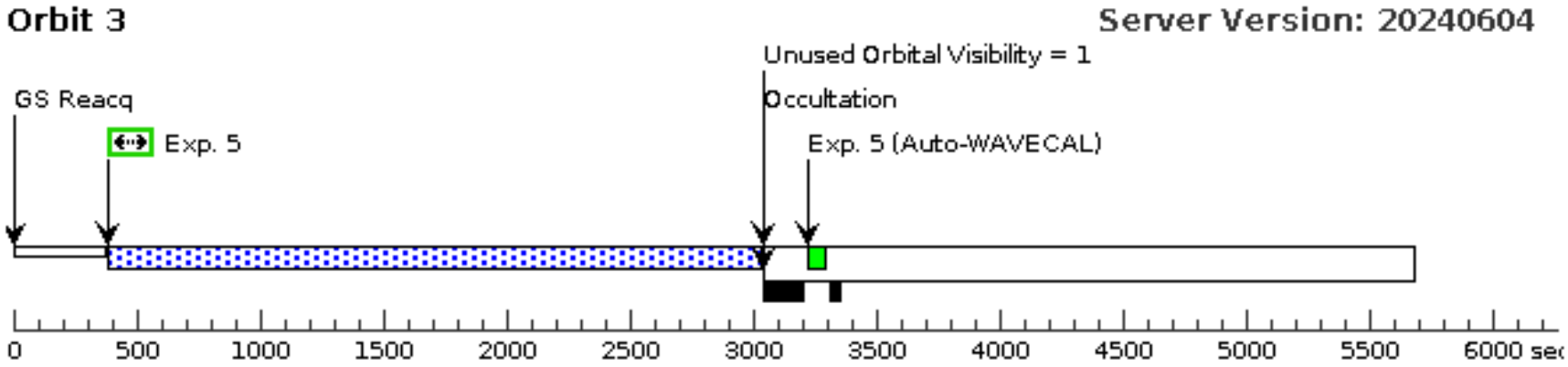
								[==>(Pattern 4, Copy 5)]	
								[==>(Pattern 4, Copy 6)]	

Orbit Structure



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GS Reacq
Exp. 5
Exp. 5 (Auto-WAVECAL)
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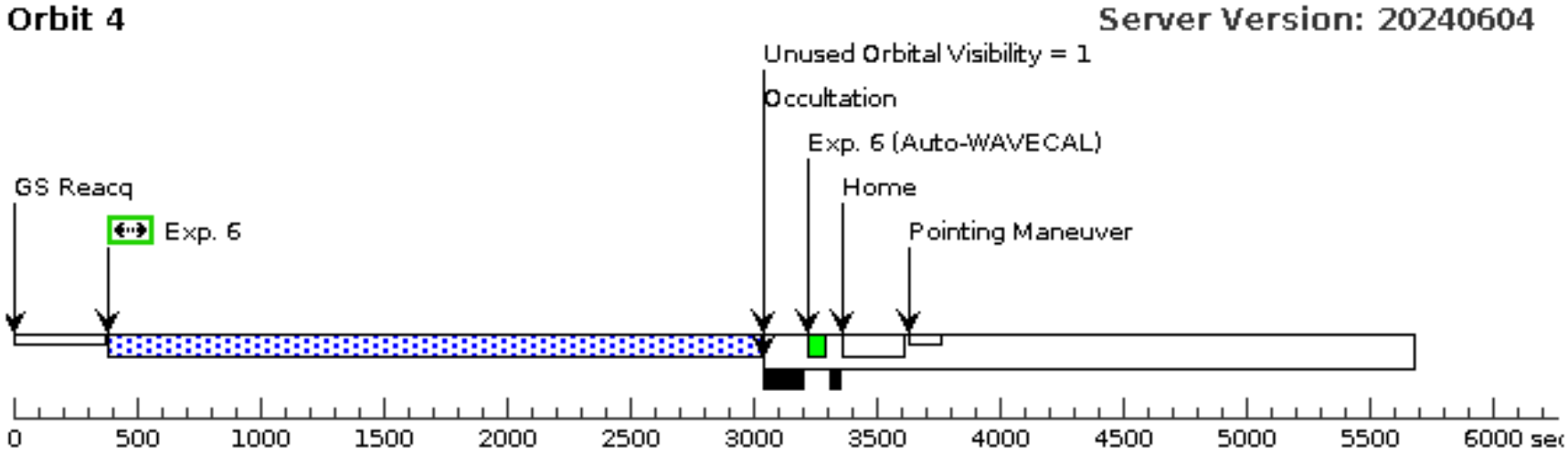
6000 sec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Server Version: 20240604
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Occultation
Exp. 6 (Auto-WAVECAL)
GS Reacq
Exp. 6
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Pointing Maneuver
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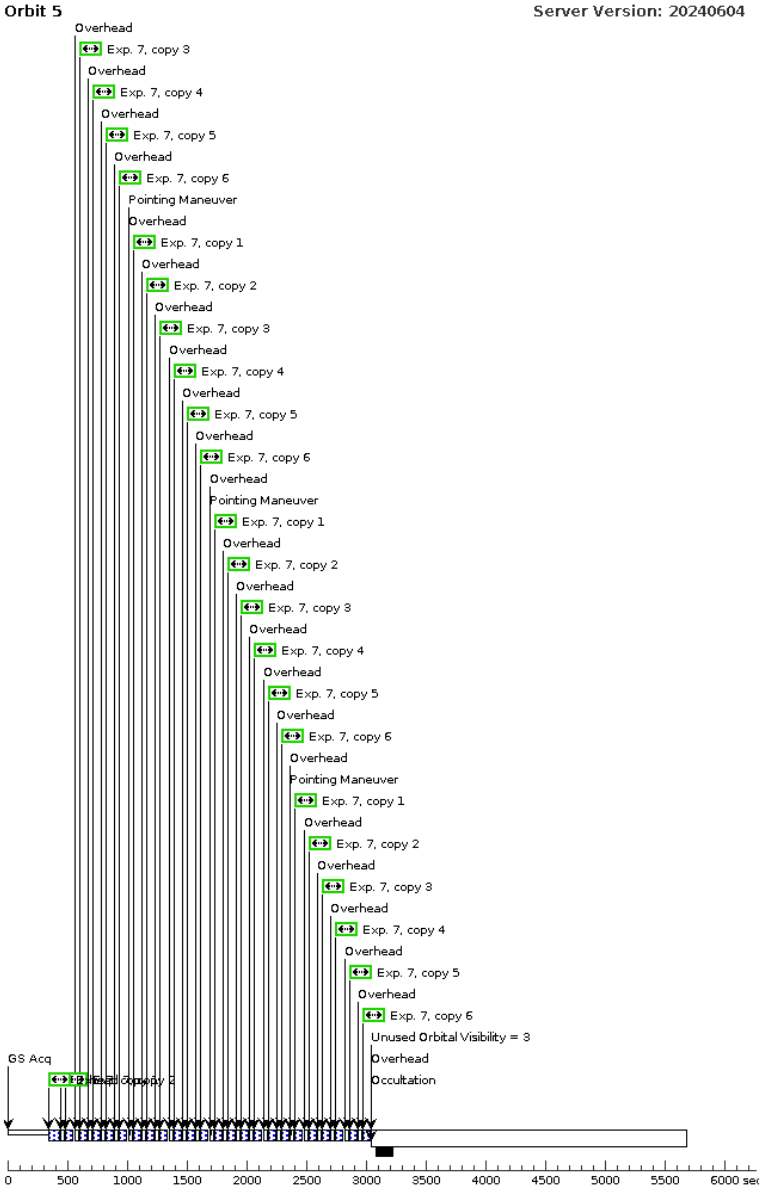
4500
5000
5500
6000 sec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Server Version: 20240604
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Exp. 7, copy 3
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Exp. 7, copy 4
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Exp. 7, copy 5
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Exp. 7, copy 6
Pointing Maneuver
Overhead
Exp. 7, copy 1
Overhead
Exp. 7, copy 2
Overhead
Exp. 7, copy 3
Overhead
Exp. 7, copy 4
Overhead
Exp. 7, copy 5
Overhead
Exp. 7, copy 6
Overhead
Pointing Maneuver
Exp. 7, copy 1
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Exp. 7, copy 2
Overhead
Exp. 7, copy 3
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Exp. 7, copy 4
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Exp. 7, copy 5
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Exp. 7, copy 6
Overhead
Pointing Maneuver
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Overhead
Exp. 7, copy 2
Overhead
Exp. 7, copy 3
Overhead
Exp. 7, copy 4
Overhead
Exp. 7, copy 5
Overhead
Exp. 7, copy 6
Unused Orbital Visibility = 3
Overhead
Occultation
GS Acq
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17768, medium-res (02), implementation Wed Dec 18 19:00:51 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: ORIENT 116D TO 132 D; ORIENT 296D TO 312 D; BETWEEN 03-MAR-2025:00:00:00 AND 05-MAR-2025:23:59:59; BETWEEN 09-MAR-2025:00:00:00 AND 22-MAR-2025:23:59:59

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RA, Dec errors, Proper Motion, Radial Velocity are from Gaia DR2.
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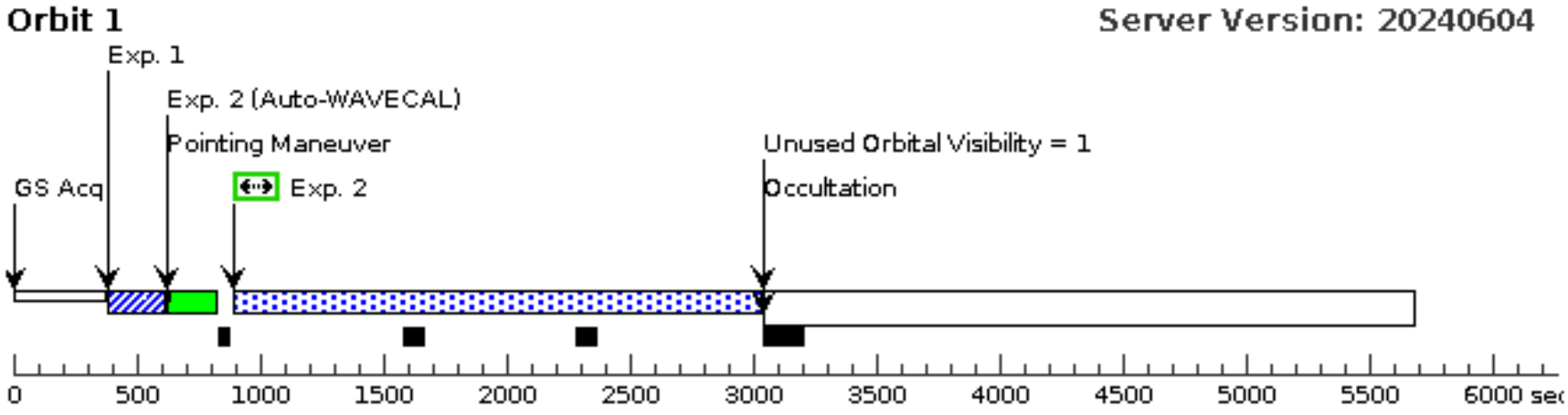
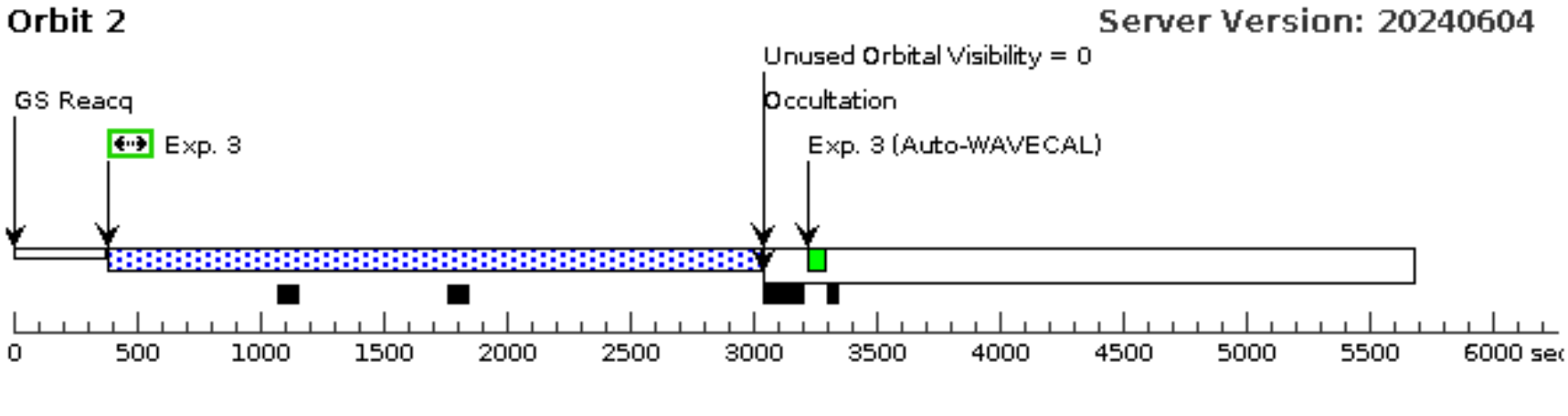
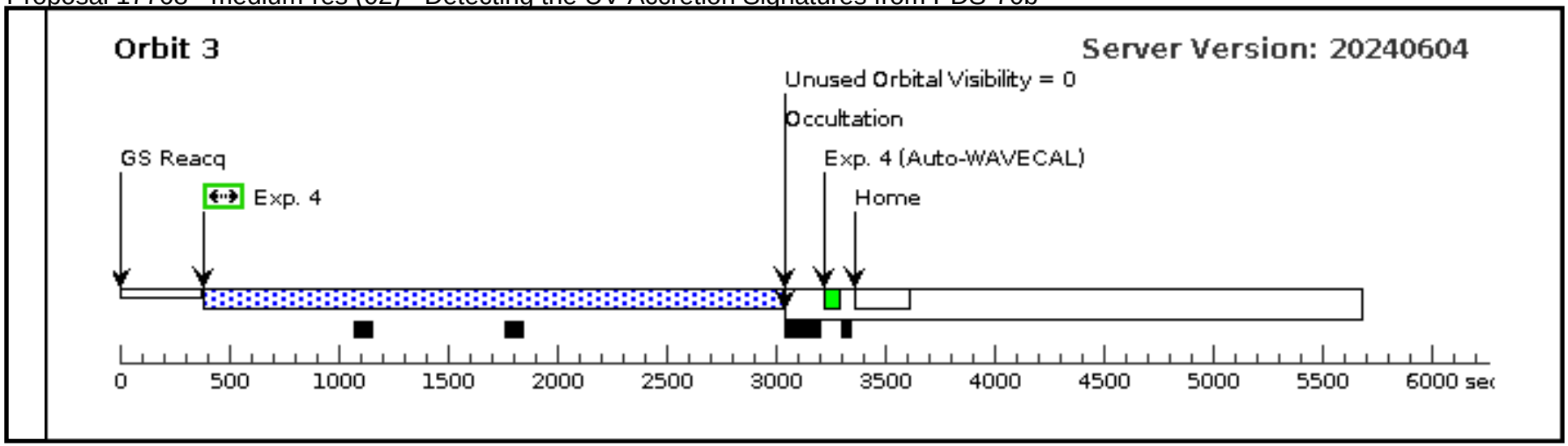
1	STIS_ACQ	(2) PDS70	STIS/CCD, ACQ, F28X50LP	MIRROR				.4 Secs (0.4 Secs) *[==>]*	 ***[1]***
2	NUV_ (1731191)	(2) PDS70	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230M 2800 A	BUFFER-TIME=693			2121 Secs (2121 Secs) *[==>]*	 ***[1]***
3	NUV_ (1731191)	(2) PDS70	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230M 2800 A	BUFFER-TIME=693			2639 Secs (2639 Secs) *[==>]*	 ***[2]***
4	NUV_ (1731191)	(2) PDS70	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230M 2800 A	BUFFER-TIME=693			2639 Secs (2639 Secs) *[==>]*	 ***[3]***

Orbit Structure



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GS Reacq
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Exp. 4 (Auto-WAVECAL)
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4000
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5000
5500
6000 sec