



15174 - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:32.0	yes
02	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:33.0	yes

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
03	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:34.0	yes
04	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:35.0	yes
05	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:36.0	yes
06	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:36.0	yes
07	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:37.0	yes
08	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:37.0	yes
57	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:38.0	yes
58	(1) GJ436	COS/FUV COS/NUV	1	23-Jan-2018 16:09:39.0	yes

10 Total Orbits Used

ABSTRACT

Closely-orbiting, massive planets can measurably affect the activity of their host star through tides, magnetic disturbances, or even mass transfer. Observations of these star planet interactions (SPIs) provide a window into stellar and planetary physics that may eventually lead to constraints on planetary magnetic fields. Recently, the MUSCLES Treasury Survey of 11 exoplanet host stars revealed correlations providing the first-ever evidence of SPIs in M dwarf systems. This evidence additionally suggests that N V 1238,1242 Angstrom emission best traces SPIs, a feature that merits further investigation. To this end, we propose an experiment using the M dwarf + hot Neptune system GJ 436 that will also benefit upcoming transit observations. GJ 436 is ideal for an SPI experiment because (1) escaped gas from its known rapidly evaporating hot Neptune could be funneled onto the star and (2) it displays a tentative SPI signal in existing, incomplete N V observations. The proposed experiment will complete these N V observations to constrain a model of modulation in N V flux resulting from a stellar hot spot induced by the planet. The results will provide evidence for or against hot spot SPIs producing the correlations observed in the MUSCLES Survey. Furthermore, the acquired data will

establish a broader FUV baseline to constrain day-timescale variability and facular emission in FUV lines, needed for the interpretation of upcoming transit observations of GJ 436b. For this reason, we waive our proprietary rights to the data. Establishing GJ 436's baseline FUV variability and testing the hot spot hypothesis are only possible through the FUV capabilities of HST.

OBSERVING DESCRIPTION

The proposed observations will sample two timescales to constrain the SPI signal and place a limit on facular flux. Each of two separate four-exposure SPI observation sets will sample a single planetary orbit (2.6 d). These observations will be separated by a significant fraction of the stellar rotation period (39.9 d) to sample changes due to the appearance/occultation of stellar faculae.

The feasibility of observing FUV emission lines from GJ 436b has already been established by the 2015 MUSCLES observations that motivated this proposal. These observations yielded ~5% per orbit precision in N V that is sufficient to meet this program's science goals. Therefore, the driving requirement for these observations is phase coverage. For each of the two sets of four-orbit SPI observations that sample an orbit of GJ 436b

- One orbit should occur within the interval [-3.3, 3.4] of mid-transit of GJ 436b, to sample the hot-spot flux near full.
- One orbit should occur 9.8 h to 5.2 h before mid-transit, to sample intermediate hot- spot flux in the rising phase.
- One orbit should occur 5.6 h to 11.0 h after mid-transit, to sample intermediate hot- spot flux in the declining phase.
- One orbit should occur in the 37.9 h window either >11.9 h before mid-transit or >13.7 h after mid-transit, to sample stellar flux when the hot spot is not on the visible hemisphere.

The slight asymmetry in these numbers is due to the eccentricity, 0.16, of GJ 436b's orbit.

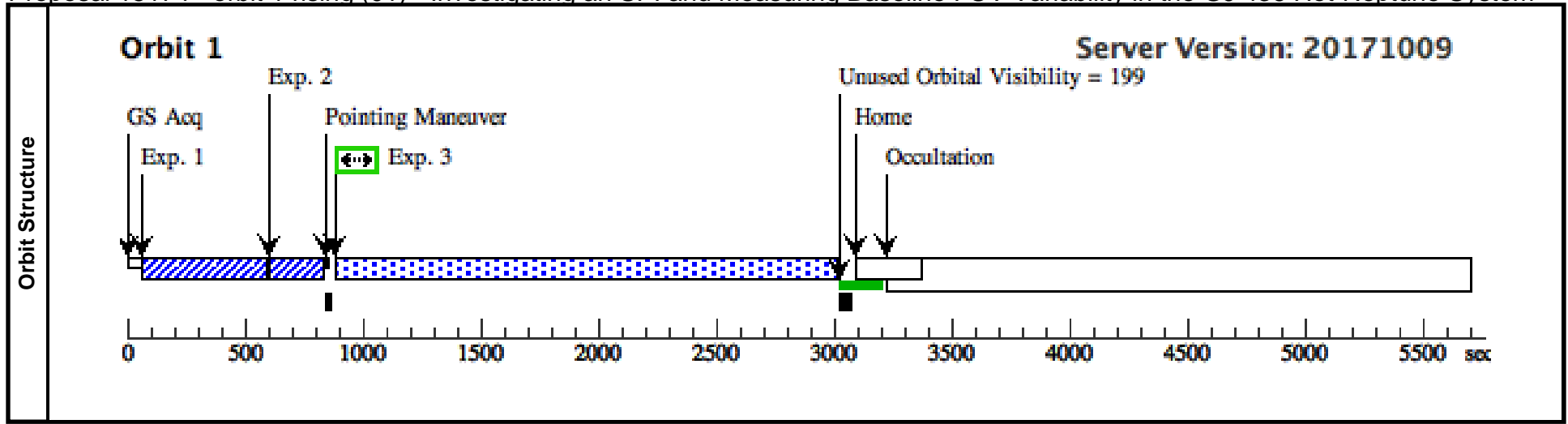
Because the science goals are based on relative photometric measurements of line flux, we will employ a single FPPOS position of the grating to maximize photometric precision. This will ensure that any systematic flat-fielding errors will be identical (or as close as possible) between each exposure, minimizing any impact fixed-pattern noise could have on relative photometric measurements.

Optionally, the observations could be combined with upcoming transit observations of GJ 436b to enhance their scientific return. Three five-orbit visits to GJ 436 are currently scheduled for January and March of 2018 for program 14767 "The Panchromatic Comparative Exoplanetary Treasury Program," PI David Sing. If the two SPI observations are scheduled to coincide with the transit visits, then the SPI orbits can also be used to provide a firmer out-of transit baseline and an estimate of the astrophysical noise that is contemporaneous with the observed transits. This would yield greater confidence in the transit results. Meanwhile, the SPI program will benefit from the increased sampling of the hot-spot flux near peak.

Proposal 15174 - orbit 1 rising (01) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

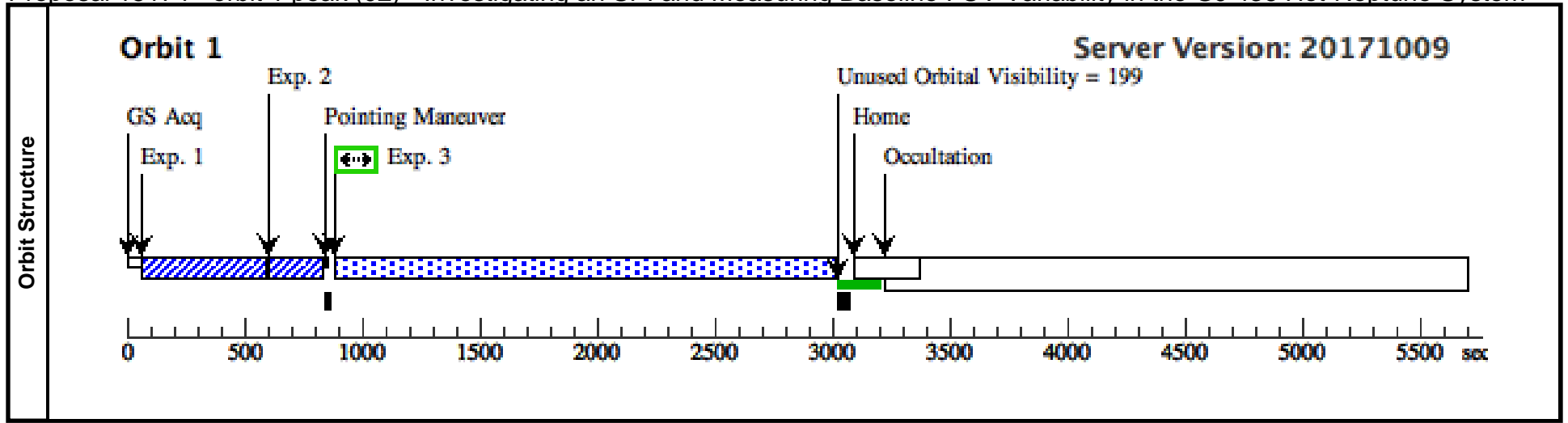
Visit	<p>Proposal 15174, orbit 1 rising (01), completed</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208; GROUP 01,02,03,04 WITHIN 5D</p> <p>Comments: The "orbit" in the label of these visits refers to the orbit of GJ 436b, not HST.</p> <p>If possible, please coordinate observations to occur in tandem with the transit observations of program 14767, which also has two G130M visits scheduled. Visit groups that are coordinated with 14767 can use that programs transit visit in place of the "peak" visit in the visit group. If the two 14767 transit visits occur sequentially, then only one should be conducted in tandem with these observations to preserve the > 20 d spacing between the two visit groups of this program.</p> <p>Will not do acquisition search because GAIA coordinates are extremely accurate. Will not do peakxd or peakd because target count rate is prohibitively low. Wavelength accuracy is not a driving requiremet, so as long as the target is in the aperture all should be well.</p> <p>planet GJ 436b phase during visit: 0.8455203068350099 < PHASE < 0.9175704888725785</p>																																																																				
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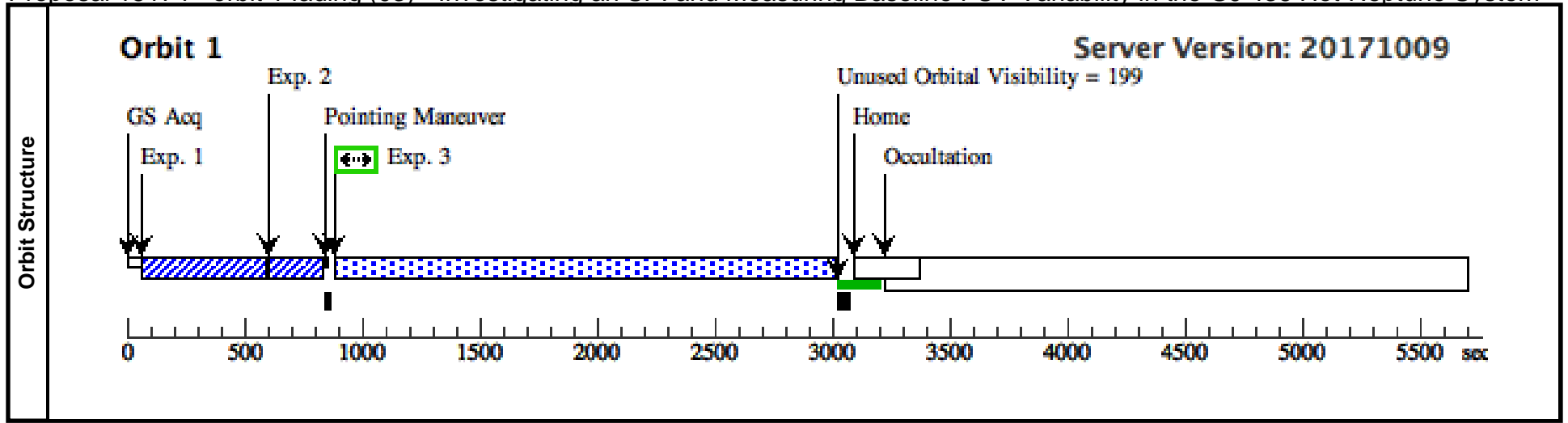
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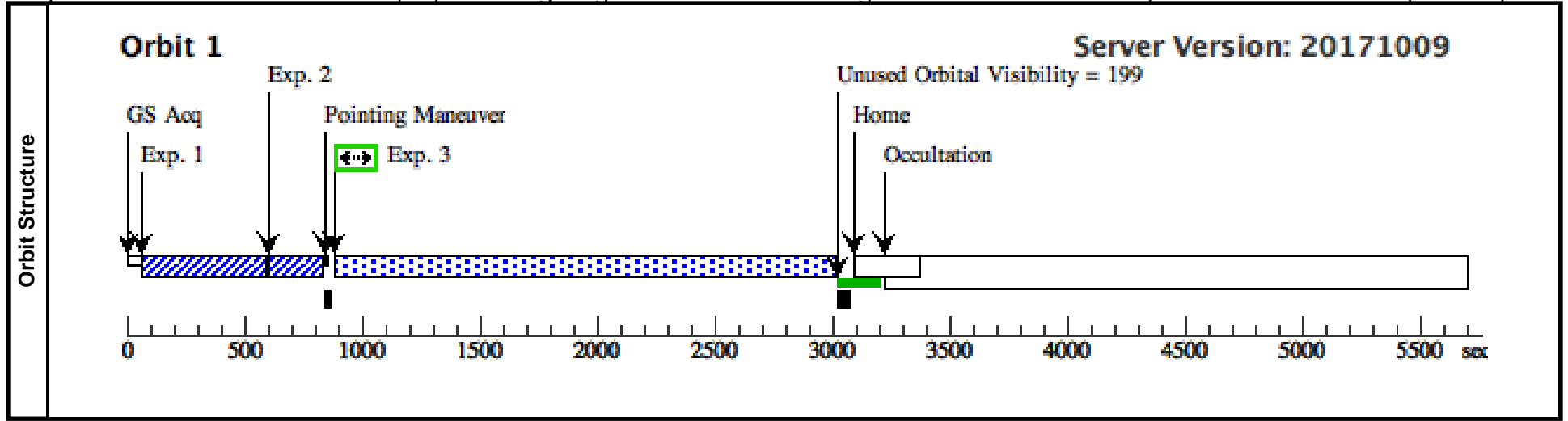
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Proposal 15174 - orbit 1 occulted (04) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

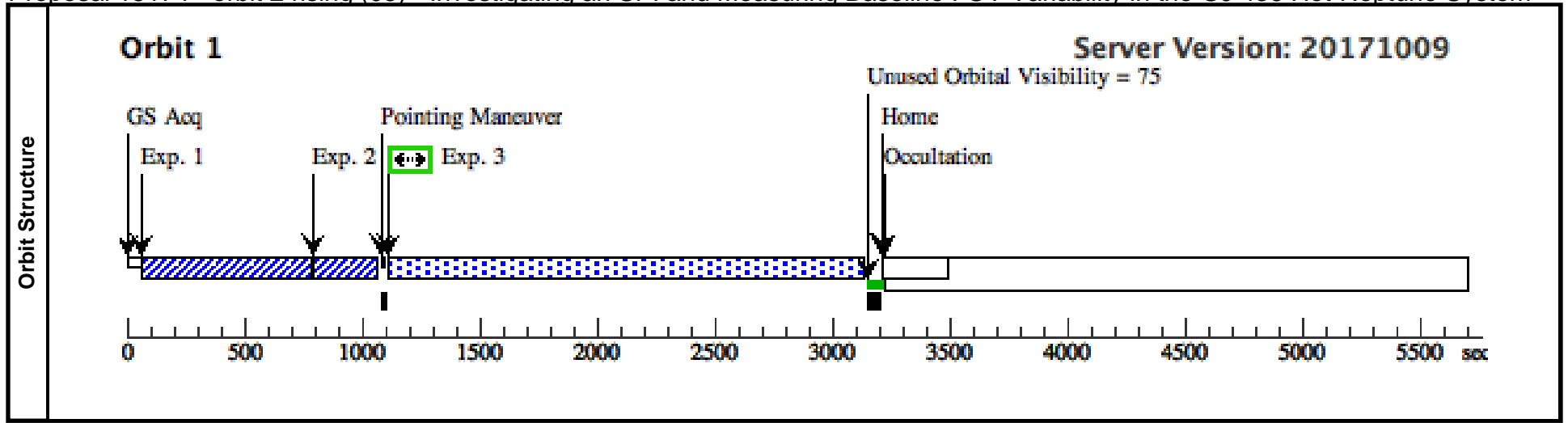
Visit	Proposal 15174, orbit 1 occulted (04), completed Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208 <i>Comments: planet GJ 436b phase during visit: 0.2155416491853716 < PHASE < 0.8119885297114802</i>																																																	
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Proposal 15174 - orbit 2 rising (05) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

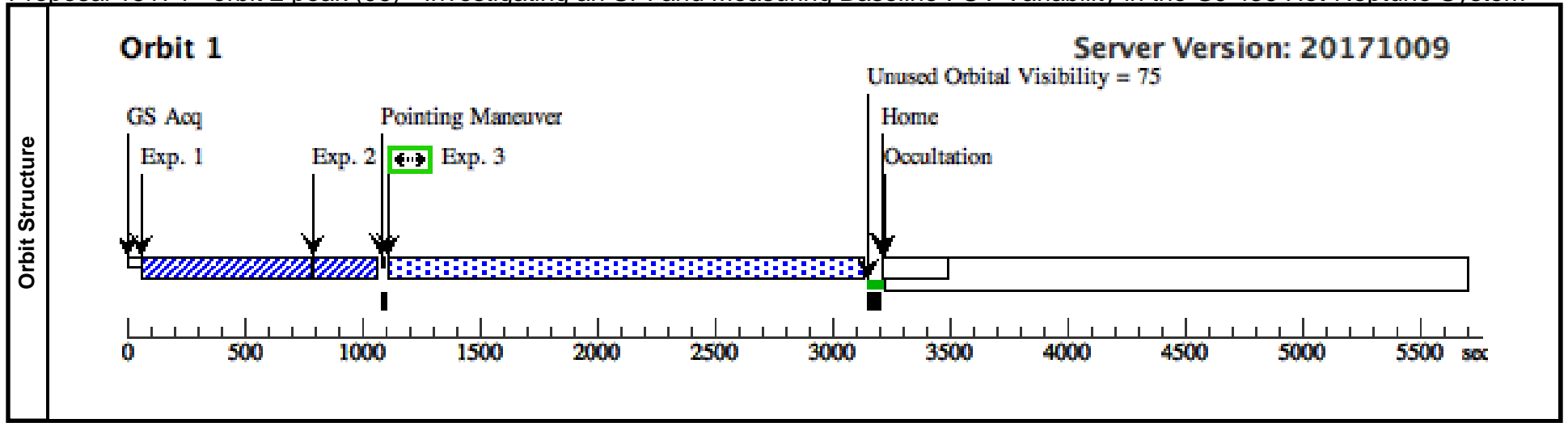
Visit	<p>Proposal 15174, orbit 2 rising (05), completed</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: AFTER 01 BY 20 D TO 10000 D; Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208; GROUP 05,06,07,08 WITHIN 5D</p> <p><i>Comments: planet GJ 436b phase during visit: 0.8455203068350099 < PHASE < 0.9175704888725785</i></p>																																																																					
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Proposal 15174 - orbit 2 peak (06) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

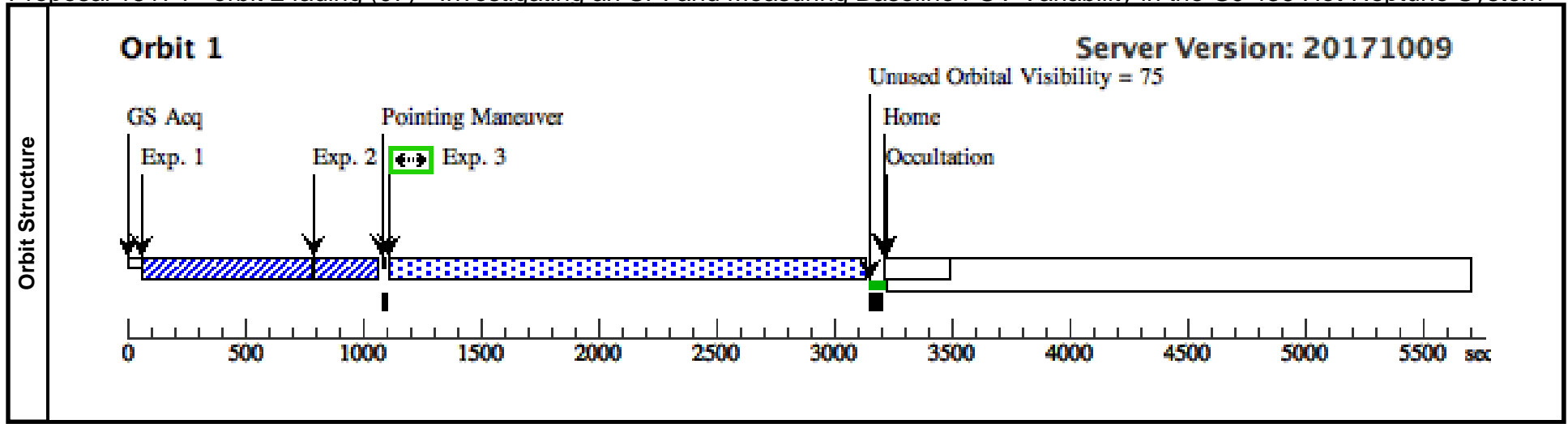
Visit	Proposal 15174, orbit 2 peak (06), completed Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208 <i>Comments: planet GJ 436b phase during visit: 0.9486410507731764 < PHASE < 0.05361732560975</i>																																																																				
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Proposal 15174 - orbit 2 fading (07) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

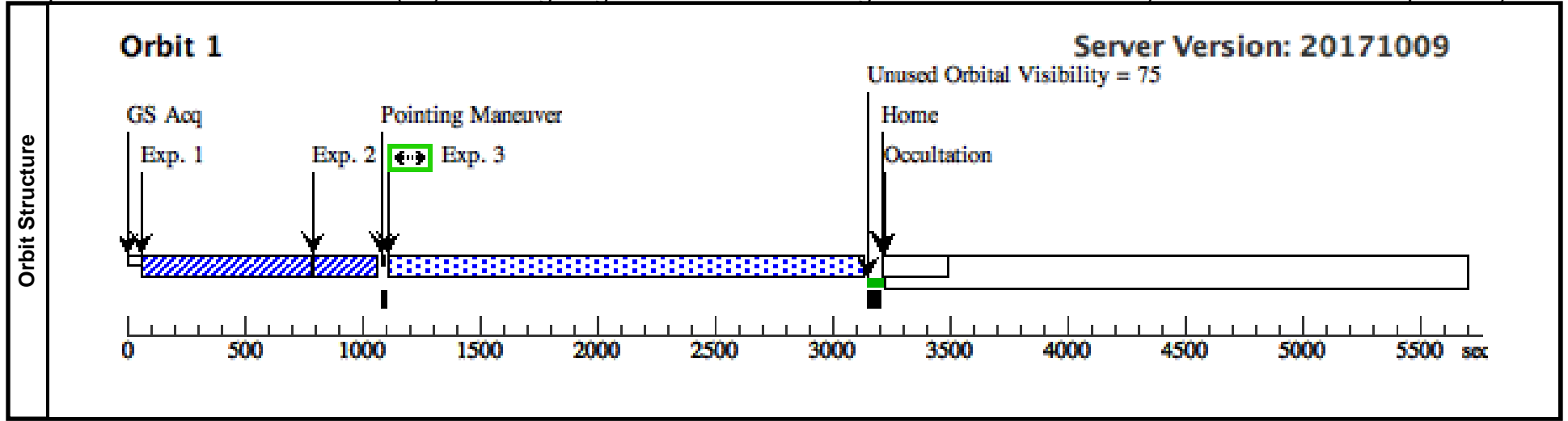
Visit	<p>Proposal 15174, orbit 2 fading (07), failed</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208</p> <p><i>Comments: planet GJ 436b phase during visit: 0.08825406807815696 < PHASE < 0.17396741862295528</i></p>																																																																					
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Proposal 15174 - orbit 2 occulted (08) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

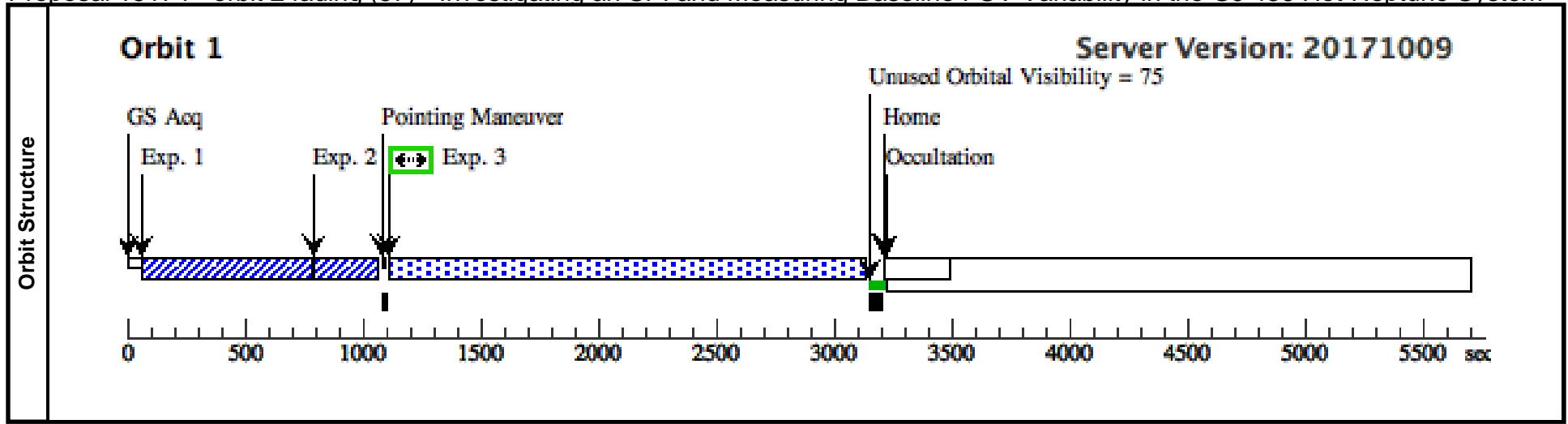
Visit	<p>Proposal 15174, orbit 2 occulted (08), failed</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208</p> <p><i>Comments: planet GJ 436b phase during visit: 0.2155416491853716 < PHASE < 0.8119885297114802</i></p>																																																																					
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Proposal 15174 - orbit 2 fading (57) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

Visit	Proposal 15174, orbit 2 fading (57), implementation Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208 <i>Comments: planet GJ 436b phase during visit: 0.08825406807815696 < PHASE < 0.17396741862295528</i>																																																																				
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Proposal 15174 - orbit 2 occulted (58) - Investigating an SPI and Measuring Baseline FUV Variability in the GJ 436 Hot-Neptune System

Tue Jan 23 21:09:40 GMT 2018

Visit	Proposal 15174, orbit 2 occulted (58), implementation Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 2.6438979 D AND ZERO-PHASE HJD2454865.083208 <i>Comments: planet GJ 436b phase during visit: 0.2155416491853716 < PHASE < 0.8119885297114802</i>																																																																				
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Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>GJ436</td> <td>RA: 11 42 12.0953 (175.5503971d) Dec: +26 42 11.45 (26.70318d) Equinox: J2000</td> <td>Proper Motion RA: 895.196 mas/yr Proper Motion Dec: -813.717 mas/yr Parallax: 0.10258" Epoch of Position: 2015 Radial Velocity: 9.61 km/sec</td> <td>V=10.59</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[M V-IV] Extended=NO</p>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	GJ436	RA: 11 42 12.0953 (175.5503971d) Dec: +26 42 11.45 (26.70318d) Equinox: J2000	Proper Motion RA: 895.196 mas/yr Proper Motion Dec: -813.717 mas/yr Parallax: 0.10258" Epoch of Position: 2015 Radial Velocity: 9.61 km/sec	V=10.59	Reference Frame: ICRS																																															
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