15699 - Pi Men c: The first confirmed water world?

Cycle: 26, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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) PI-MEN WAVE	STIS/CCD STIS/FUV-MAMA	5	21-Nov-2019 13:00:36.0	yes
02	(1) PI-MEN	COS/FUV COS/NUV	5	21-Nov-2019 13:00:38.0	yes

10 Total Orbits Used

ABSTRACT

Planets with water-dominated bulk compositions are not represented in our Solar System. Their existence will have major implications on the theories of planet formation and evolution. Yet, none of the ~4,000 known exoplanets have been definitely identified as a water world. Pi Men c, TESS's first discovery, probably stands the best chance to confirm the reality of water worlds. This super-Earth is strongly irradiated by its solar-type host star, and its bulk density is consistent with 50-100% by volume in H2O. Only 18 pc away, this bright system is ideal for transmission spectroscopy, especially at FUV wavelengths probing the uppermost atmosphere. Our photochemistry-evaporation models show that the stellar irradiation received by the planet sustains a vigorous atmospheric outflow. If H2O or other heavy molecules are present, they will photodissociate into atoms and form an extended upper atmosphere that can be probed through absorption at resonance lines. In many ways, Pi Men c is an optimal target for such an investigation. We request 10 HST orbits to cover two FUV transits and search for absorption by H I, O I and C II in the planet's upper atmosphere. Detecting these atoms will allow us to assess whether Pi Men c contains abundant H2O or other heavy gases (e.g. CO2 / CO), and will motivate a thorough observing programme in future GO Calls. This insight is unattainable by current facilities operating in the near-infrared. We will support our HST-based findings with comprehensive photochemical modeling of the planet's upper and lower atmospheres.

OBSERVING DESCRIPTION

We will observe two transits of pi Men c with 2 visits. 1 visit will entirely use STIS G140M 52"x0.2" (1222 cenwave; time-tag mode) to prioritize Lyman alpha (1216 Angstroms), and the other will entirely use COS G130M PSA (1222 cenwave; time-tag mode) to prioritize the metal lines. We will also be attempting an airglow subtraction on Lyman alpha in the COS spectra as was recently demonstrated in Bourrier et al. (2018), which would allow us to search for time variability in the planetary Lyman alpha absorption. The visits will each contain 5 consecutive orbits. The transit of pi Men c lasts approximately 3 hours, so the first 2 orbits will cover the pre-transit period, the second 2 orbits will cover the transit, and the final orbit will cover the post-transit period.

Proposal 15699 - STIS visit (01) - Pi Men c: The first confirmed water world?

Visit

Proposal 15699, STIS visit (01), completed Thu Nov 21 18:00:39 GMT 2019

Diagnostic Status: No Diagnostics

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

Special Requirements: Period 6.2678216 D AND ZERO-PHASE HJD2458325.5032199

Comments: As in past programs targeting Ly alpha exoplanet transits with STIS, we keep the instrument settings identical throughout the entire visit. We enabled the available wavecal=no mode to increase the duty cycle of the STIS observations and prevent auto-wave calibration from disrupting the transit time sequence in the STIS visit and preventing instrument setting changes. In addition, we keep an identical setup for the entire visit and do not switch between any settings to further prevent instrument-induced systematic errors in the photometric time series observations. For wavelength calibration, we set a wavelength calibration frame during the Earth occultation at the end of each orbit.

Fixed Targets

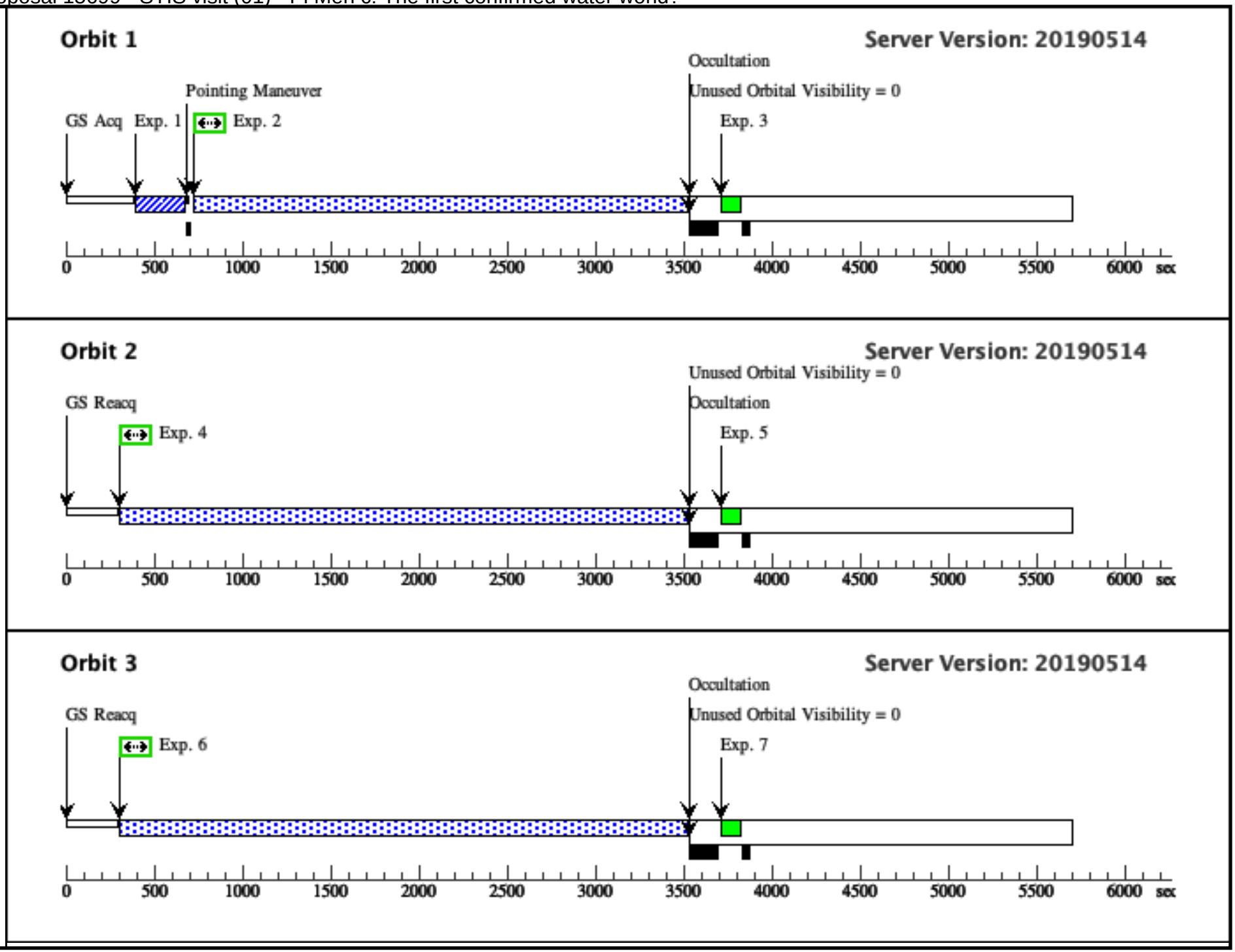
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	PI-MEN	RA: 05 37 9.8851 (84.2911879d) Dec: -80 28 8.83 (-80.46912d) Equinox: J2000	Proper Motion RA: 311.187 mas/yr Proper Motion Dec: 1048.845 mas/yr Parallax: 0.0547052" Epoch of Position: 2000 Radial Velocity: 10.73 km/sec	V=5.67 GALEX FUV = 17.52+/-0.06 mag	Reference Frame: ICRS

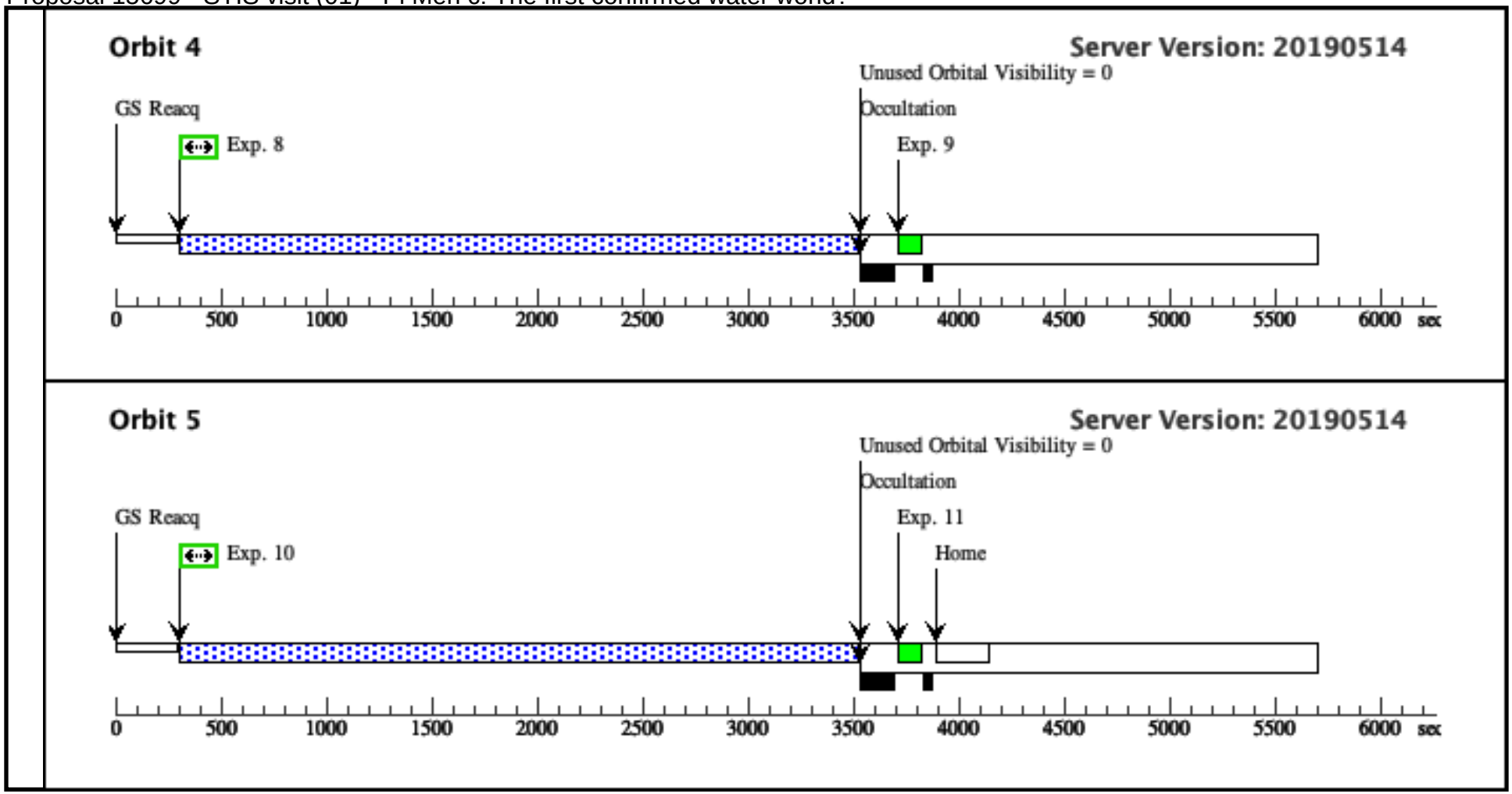
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[EXTRA-SOLAR PLANET, G V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	STIS-ACQ (STIS.ta.1326572)	(1) PI-MEN	STIS/CCD, ACQ, F28X50OIII	MIRROR		PHASE 0.9645 TO 0.9710	Sequence 1-3 Non-Int in STIS visit (01)	1 Secs (1 Secs) *[==>]*	***[1]***
Comments: Acquisition based on the stellar V band magnitude and effective temperature.									
2	STIS-SCIENCE-1 (STIS.sp.1327422)	(1) PI-MEN	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140M 1222 A	BUFFER-TIME=5276; WAVECAL=NO		Sequence 1-3 Non-Int in STIS visit (01)	2704 Secs (2644 Secs) *[==>2644.0 Secs]*	***[1]***
3	STS-WAVECAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1222 A			Sequence 1-3 Non-Int in STIS visit (01)	*[==>]*	***[1]***
4	STIS-SCIENCE-2 (STIS.sp.1327423)	(1) PI-MEN	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140M 1222 A	BUFFER-TIME=5276; WAVECAL=NO		Sequence 4-5 Non-Int in STIS visit (01)	3202 Secs (3202 Secs) *[==>]*	***[2]***
5	STS-WAVECAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1222 A			Sequence 4-5 Non-Int in STIS visit (01)	*[==>]*	***[2]***
6	STIS-SCIENCE-3 (STIS.sp.1327423)	(1) PI-MEN	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140M 1222 A	BUFFER-TIME=5276; WAVECAL=NO		Sequence 6-7 Non-Int in STIS visit (01)	3202 Secs (3202 Secs) *[==>]*	***[3]***
7	STS-WAVECAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1222 A			Sequence 6-7 Non-Int in STIS visit (01)	*[==>]*	***[3]***
8	STIS-SCIENCE-4 (STIS.sp.1327423)	(1) PI-MEN	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140M 1222 A	BUFFER-TIME=5276; WAVECAL=NO		Sequence 8-9 Non-Int in STIS visit (01)	3202 Secs (3202 Secs) *[==>]*	***[4]***
9	STS-WAVECAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1222 A			Sequence 8-9 Non-Int in STIS visit (01)	*[==>]*	***[4]***
10	STIS-SCIENCE-5 (STIS.sp.1327423)	(1) PI-MEN	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140M 1222 A	BUFFER-TIME=5276; WAVECAL=NO		Sequence 10-11 Non-Int in STIS visit (01)	3202 Secs (3202 Secs) *[==>]*	***[5]***
11	STS-WAVECAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1222 A			Sequence 10-11 Non-Int in STIS visit (01)	*[==>]*	***[5]***

Orbit Structure

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Orbit 5
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sec

Visit

Proposal 15699, COS visit (02), implementation Thu Nov 21 18:00:39 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 6.2678216 D AND ZERO-PHASE HJD2458325.5032199

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
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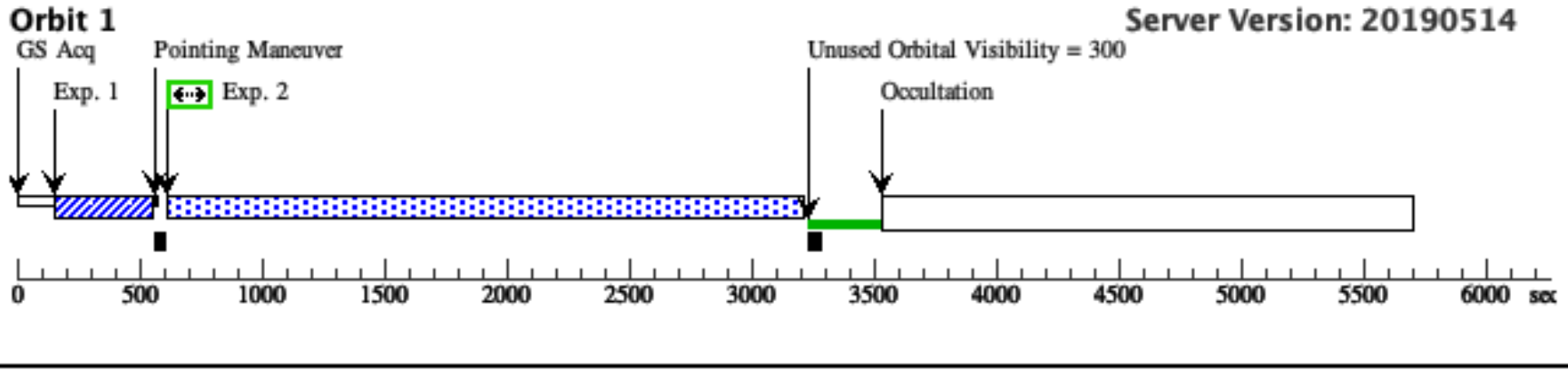
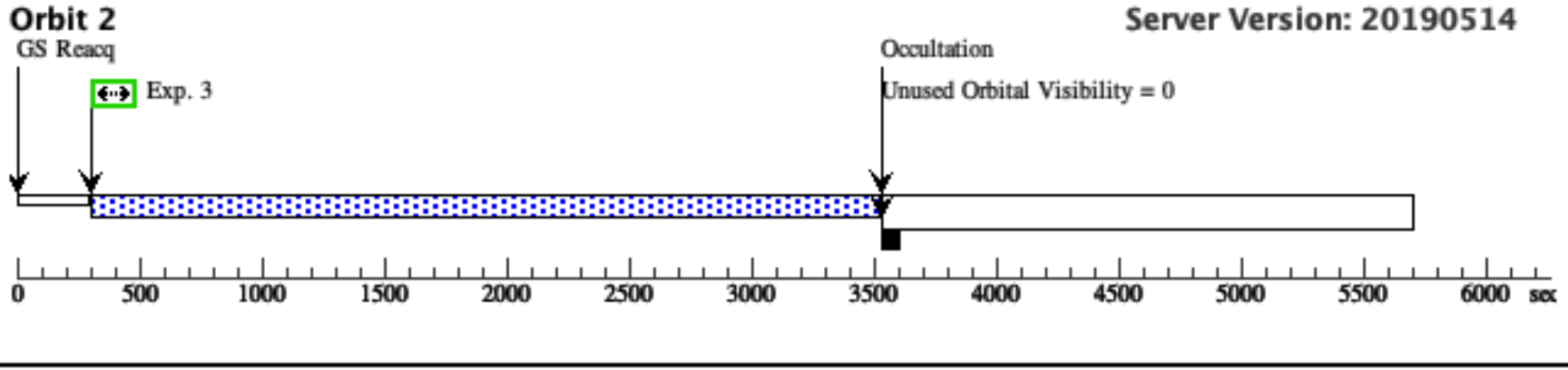
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[EXTRA-SOLAR PLANET, G V-IV]
Extended=NO

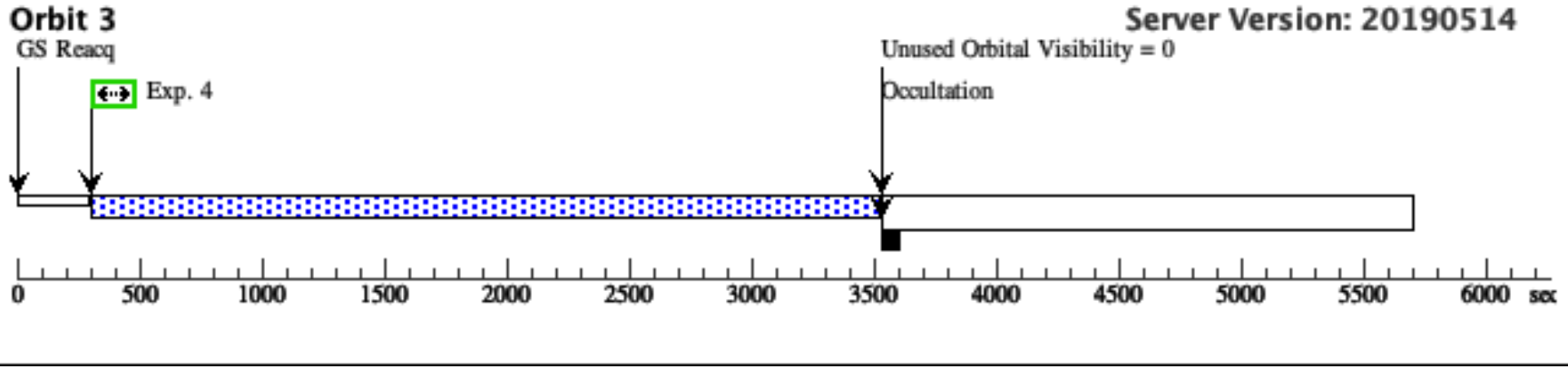
Exposures

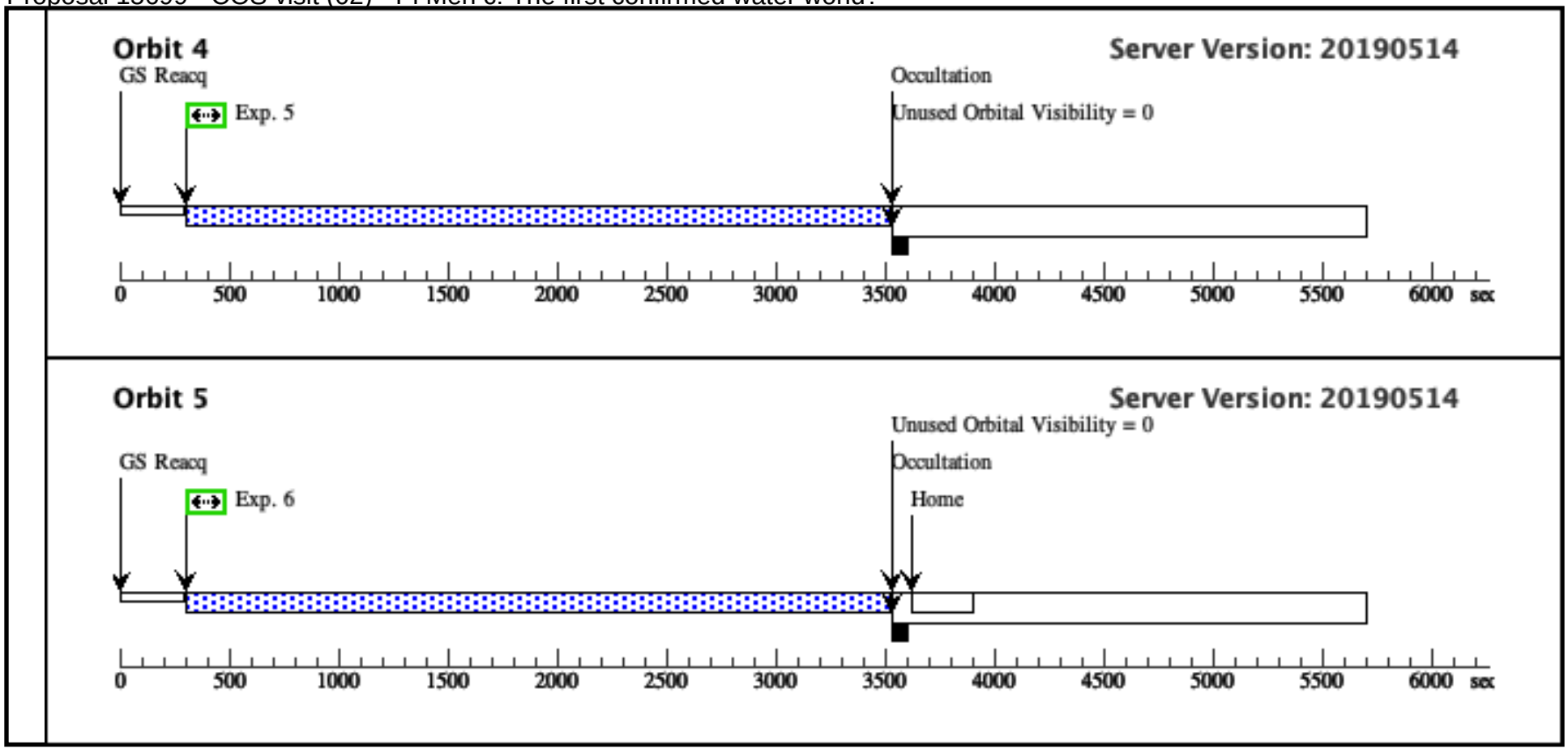
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	COS-ACQ (COS.ta.1326614)	(1) PI-MEN	COS/NUV, ACQ/IMAGE, BOA	MIRRORB		PHASE 0.9640 TO 0.9705	Sequence 1-2 Non-Int in COS visit (02)	47 Secs (47 Secs) *[==>]*	***[1]***
2	COS-SCIENCE-1 (COS.sp.1327424)	(1) PI-MEN	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5527; FP-POS=3; FLASH=YES		Sequence 1-2 Non-Int in COS visit (02)	2842 Secs (2429 Secs) *[==>2429.0 Secs]*	***[1]***
3	COS-SCIENCE-2 (COS.sp.1327425)	(1) PI-MEN	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5527; FLASH=YES; FP-POS=3			3168 Secs (3168 Secs) *[==>]*	***[2]***
4	COS-SCIENCE-3 (COS.sp.1327425)	(1) PI-MEN	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5527; FLASH=YES; FP-POS=3			3168 Secs (3168 Secs) *[==>]*	***[3]***
5	COS-SCIENCE-4 (COS.sp.1327425)	(1) PI-MEN	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5527; FLASH=YES; FP-POS=3			3168 Secs (3168 Secs) *[==>]*	***[4]***
6	COS-SCIENCE-5 (COS.sp.1327425)	(1) PI-MEN	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5527; FLASH=YES; FP-POS=3			1619 Secs (3168 Secs) *[==>3168.0 Secs]*	***[5]***

Orbit Structure





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Exp. 6
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