14916 - Probing methane chemistry in a newly-discovered warm gas giant before JWST

Cycle: 24, Proposal Category: GO

(JWST Initative)

(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) TYC-5530-1795-1	WFC3/IR	5	29-Mar-2017 21:02:09.0	yes

5 Total Orbits Used

ABSTRACT

WASP-107b is a new, relatively cool (~770K) transiting exoplanet that our team confirmed in January 2017. It has a mass lower than Saturn (0.12MJ), a radius almost as large as Jupiter's (0.94RJ), and a bright host star (H ~ 8.6). These properties make it an outstanding target for transmission spectroscopy. With HST, it will be possible to measure a transmission spectrum rivaling the quality of the canonical planets HD 209458b and HD 189733b. Its low equilibrium temperature places WASP-107b well below the predicted transition from hot, CO-dominated exoplanet atmospheres to cooler, CH4 dominated ones. We propose to use WFC3+G102 and WFC+G141 to measure its near-infrared transmission spectrum. This, combined with allocated K2 photometry will allow us to classify WASP-107b as clear or cloudy, and search for evidence of CH4. If such evidence is detected, WASP-107b would become a prime target for JWST Cycle 1, which is why these observations should be made as soon as possible.

OBSERVING DESCRIPTION

Our WFC3 observations will provide a transmission spectrum for the transiting exoplanet WASP-107b across the 0.8-1.1 micron wavelength range. We are targeting the absorption signatures of water and methane.

**Observing strategy:

To construct the transmission spectrum, we require a single transit of WASP-107b to be observed with WFC3 G102. The observations will be made in slitless spectroscopic mode. Our observing setup is very similar to that used in previous successful exoplanet transit programs, such as for the similar-brightness GJ1214 in Program 13021 (PI Bean).

At the start of the HST visit, a standard phase-constrained acquisition image will be taken. The subsequent observing strategy consists of taking repeated exposures for the duration of the transit, plus time before and after the transit to establish the out-of-transit baseline flux.

We will use the forward spatial scanning mode with a scan rate of 0.068 arcsec/sec, using SPARS10 and NSAMP=15. We will read out a subarray size of 256 pixels to reduce overheads. Individual exposure times will be 103.1 sec, resulting in a scan across 7.0 arcsec = 54 pixels per exposure, leaving plenty of room on the detector to estimate the background flux.

Each transit of WASP-107b lasts 165 minutes. We therefore require 5 consecutive HST orbits. The first orbit serves to allow the telescope to

thermally relax into its new pointing position, which is a standard procedure adopted by all HST transiting exoplanet observations. The remaining orbits will provide good phase coverage during transit, and allow for sufficient time (2 HST orbits - one before transit, one after transit) to establish the baseline stellar flux necessary to accurately measure the transit depth. We will obtain 17 science exposures per HST orbit, coming to a total of 34 in-transit and 34 out-of-transit exposures.

We choose not to use bi-directional spatial scanning, e.g. as has been done for GJ1214 in Program 13021 (PI Bean). This is because although bi-directional spatial scanning would allow an additional 2 exposures to be acquired per HST orbit (i.e. 19 per orbit), the instrumental systematics are different for each scan direction, which is likely more of a disadvantage.

**Signal-to-noise estimates:

WASP-107b is a bright target in the conventional sense (V=11.5mag, J=9.4mag). The challenge with exoplanet transmission spectroscopy is to measure subtle changes in the system brightness across different wavelength channels, via variations in the transit depth. We used the HST Exposure Time Calculator with the observational setup described above to calculate a SNR of ~1800 per resolution element per exposure. Note that this flux will be spread over 54 pixel columns due to the spatial scan (see above), so there is no risk of saturation.

Visit

Proposal 14916, WASP-107 WFC3 (01) Thu Mar 30 01:02:13 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 38D TO 186 D; ORIENT 229D TO 358 D; Period 5.721490 D AND ZERO-PHASE HJD2456514.40982

Comments: It is essential that the five HST orbits be scheduled in a contiguous block, free of the SAA. We have defined each HST orbit within a non-interruptible sequence, to ensure that all exposures defined within the sequence are taken during the same HST orbit.

We will use forward spatial scanning mode to avoid saturation on relatively long exposures and increase observing efficiency.

Visit orientation requirements have been defined to avoid spectra from nearby stars overlapping the target spectrum.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	TYC-5530-1795-1	RA: 12 33 32.8480 (188.3868667d)	Proper Motion RA: -96.1 mas/yr	V=11.47	Reference Frame: SIMBAD
		Dec: -10 08 46.14 (-10.14615d)	Proper Motion Dec: -9.6 mas/yr		
		Equinox: J2000	Epoch of Position: 2000.0		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

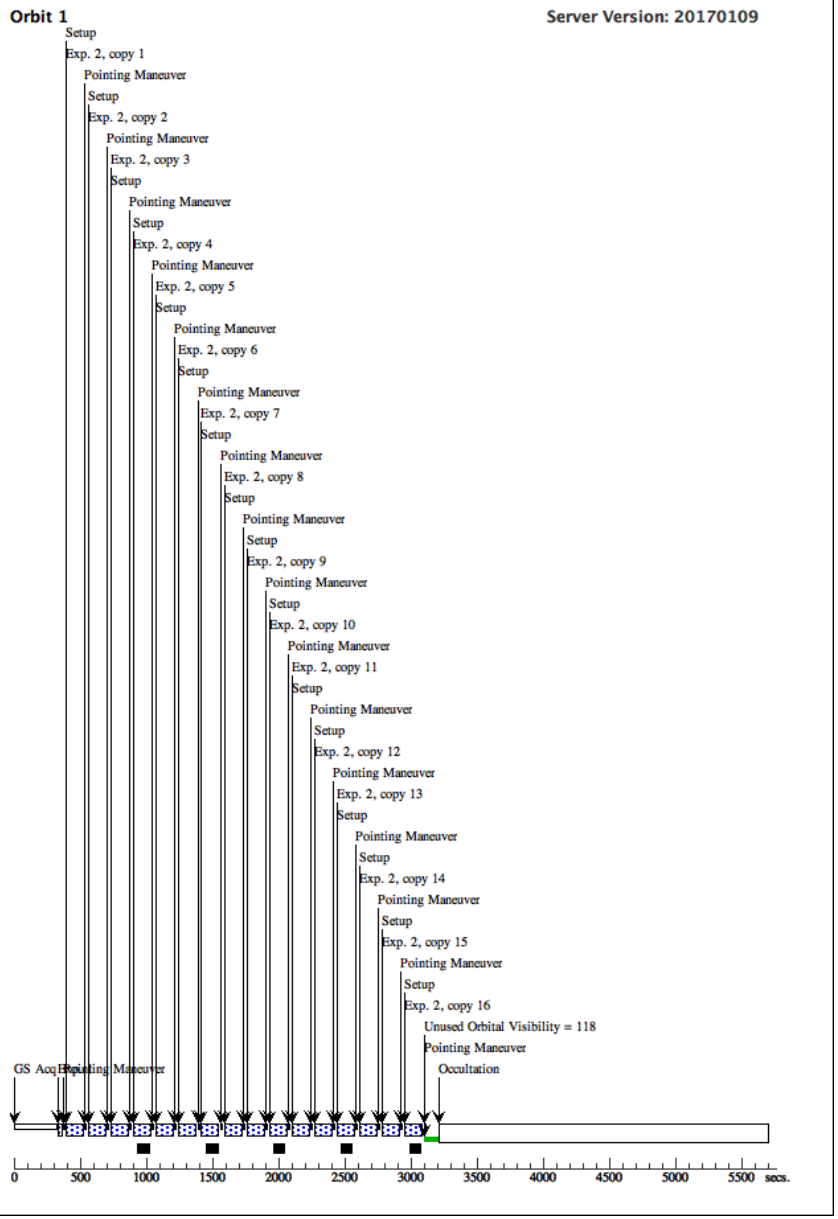
Exposures

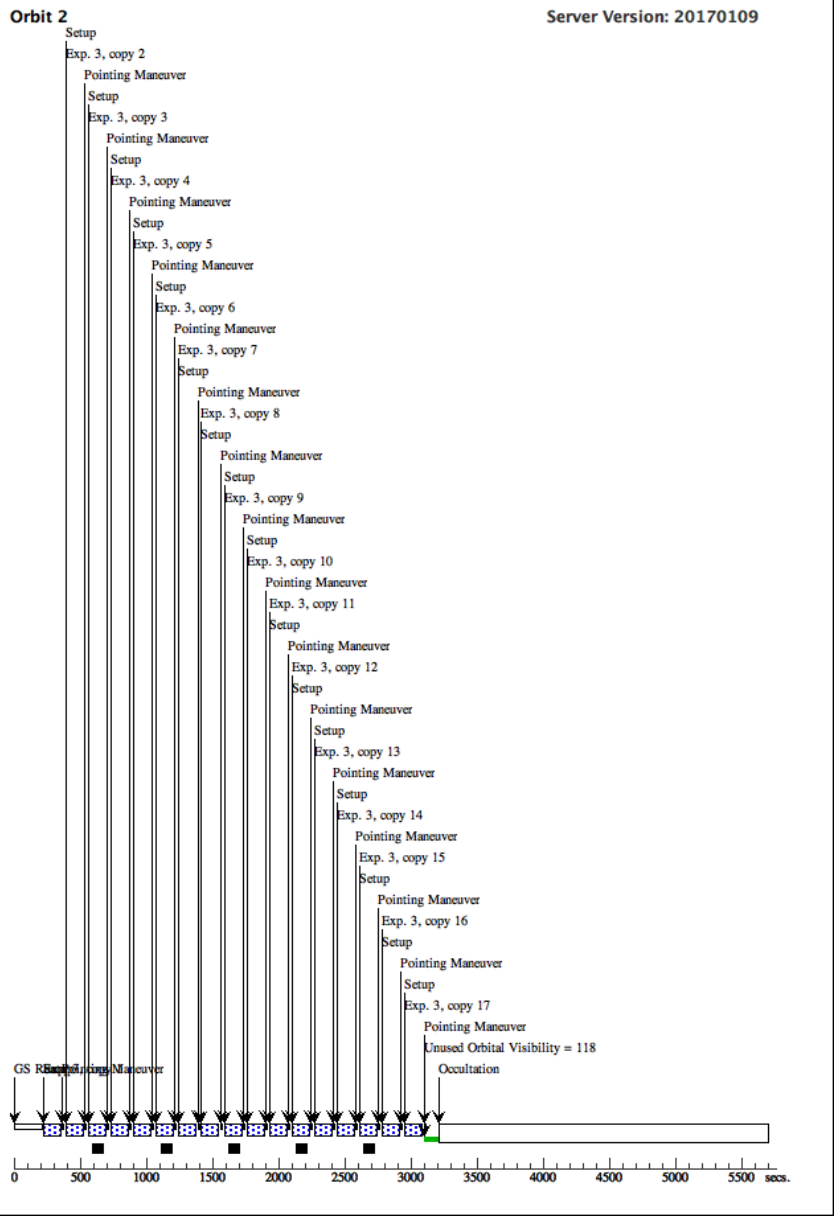
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquisition (WFC3IR.im.920238)	(1) TYC-5530-1795-1	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=3; SAMP-SEQ=RAPID	PHASE 0.9668 TO 0.9729	Sequence 1-2 Non-Int in WASP-107 WFC3 (01)	0.833445 Secs (0.833 Secs) *[==>]*	***[1]***
2	Science 1 (WFC3IR.ss.920186)	(1) TYC-5530-1795-1	WFC3/IR, MULTIACCUM, GRISM256	G102	NSAMP=15; SAMP-SEQ=SPARS10	SPATIAL SCAN 0.068,90.0 Degrees,Forward	Sequence 1-2 Non-Int in WASP-107 WFC3 (01)	103.128633 Secs X 16 (1650.058 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]* *[==>(Copy 11)]* *[==>(Copy 12)]* *[==>(Copy 13)]* *[==>(Copy 14)]* *[==>(Copy 15)]* *[==>(Copy 16)]*	***[1]***
3	Science 2 (WFC3IR.ss.920186)	(1) TYC-5530-1795-1	WFC3/IR, MULTIACCUM, GRISM256	G102	NSAMP=15; SAMP-SEQ=SPARS10	SPATIAL SCAN 0.068,90.0 Degrees,Forward	Sequence 3-3 Non-Int in WASP-107 WFC3 (01)	103.128633 Secs X 17 (1753.187 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]* *[==>(Copy 11)]* *[==>(Copy 12)]* *[==>(Copy 13)]* *[==>(Copy 14)]* *[==>(Copy 15)]* *[==>(Copy 16)]* *[==>(Copy 17)]*	***[2]***

	4	Science 2 (WFC3IR.ss.920186)	(1) TYC-5530-1795-1	WFC3/IR, MULTIACCUM, GRISM256	G102	NSAMP=15; SAMP-SEQ=SPARS10	SPATIAL SCAN 0.0 68,90.0 Degrees,Forward	Sequence 4-4 Non-Int in WASP-107 WFC3 (01)	103.128633 Secs X 17 (1753.187 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]* *[==>(Copy 11)]* *[==>(Copy 12)]* *[==>(Copy 13)]* *[==>(Copy 14)]* *[==>(Copy 15)]* *[==>(Copy 16)]* *[==>(Copy 17)]*	***[3]***
	5	Science 2 (WFC3IR.ss.920186)	(1) TYC-5530-1795-1	WFC3/IR, MULTIACCUM, GRISM256	G102	NSAMP=15; SAMP-SEQ=SPARS10	SPATIAL SCAN 0.0 68,90.0 Degrees,Forward	Sequence 5-5 Non-Int in WASP-107 WFC3 (01)	103.128633 Secs X 17 (1753.187 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]* *[==>(Copy 11)]* *[==>(Copy 12)]* *[==>(Copy 13)]* *[==>(Copy 14)]* *[==>(Copy 15)]* *[==>(Copy 16)]* *[==>(Copy 17)]*	***[4]***

	6	Science 2 (WFC3IR.ss.920186)	(1) TYC-5530-1795-1	WFC3/IR, MULTIACCUM, GRISM256	G102	NSAMP=15; SAMP-SEQ=SPARS10	SPATIAL SCAN 0.068,90.0 Degrees,Forward	Sequence 6-6 Non-Int in WASP-107 WFC3 (01)	103.128633 Secs X 17 (1753.187 Secs)	
									[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]* *[==>(Copy 11)]* *[==>(Copy 12)]* *[==>(Copy 13)]* *[==>(Copy 14)]* *[==>(Copy 15)]* *[==>(Copy 16)]* *[==>(Copy 17)]*	***[5]***

Orbit Structure

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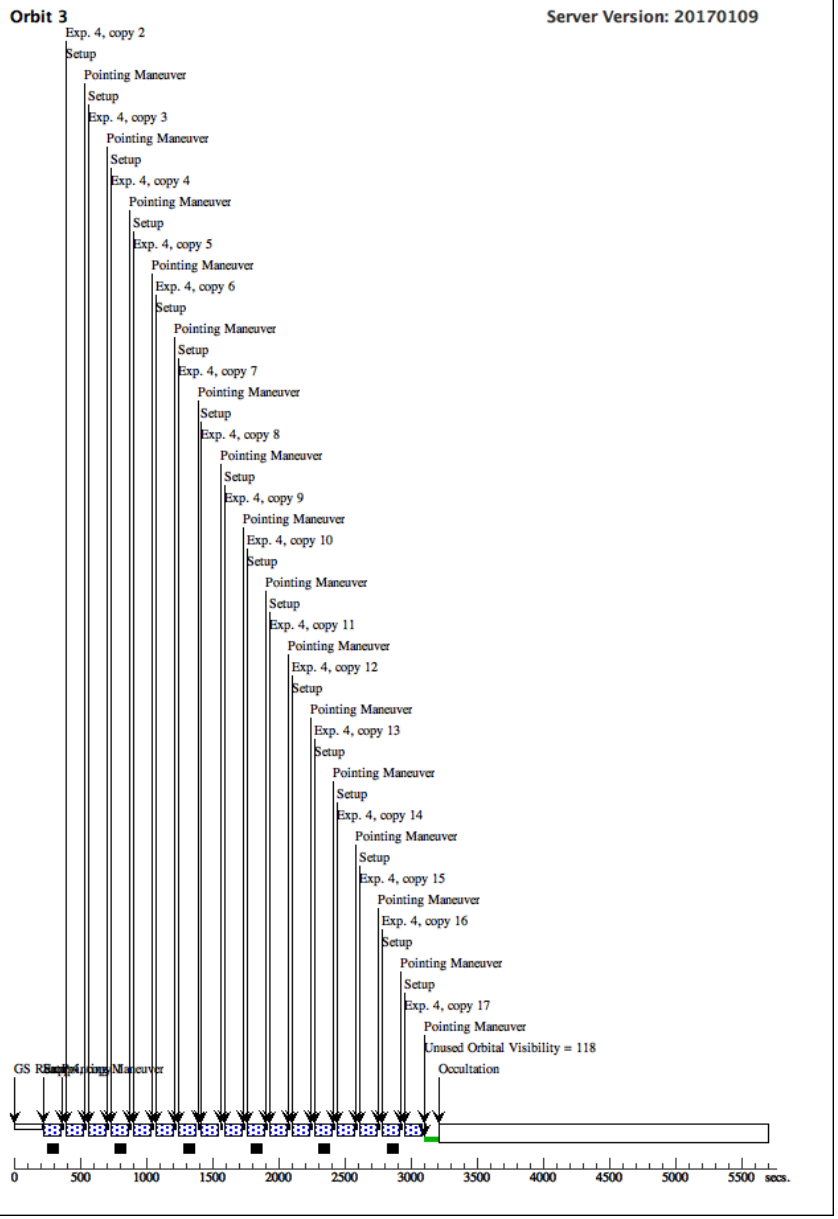
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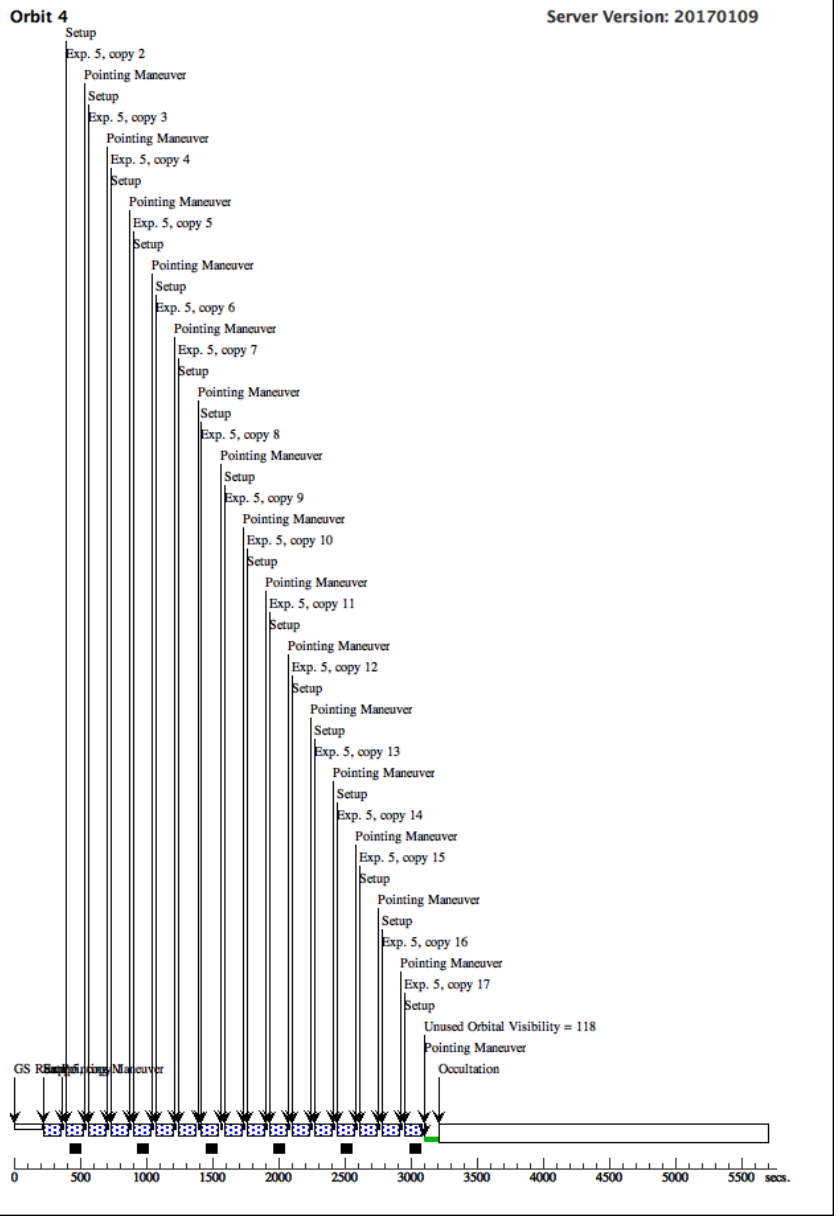
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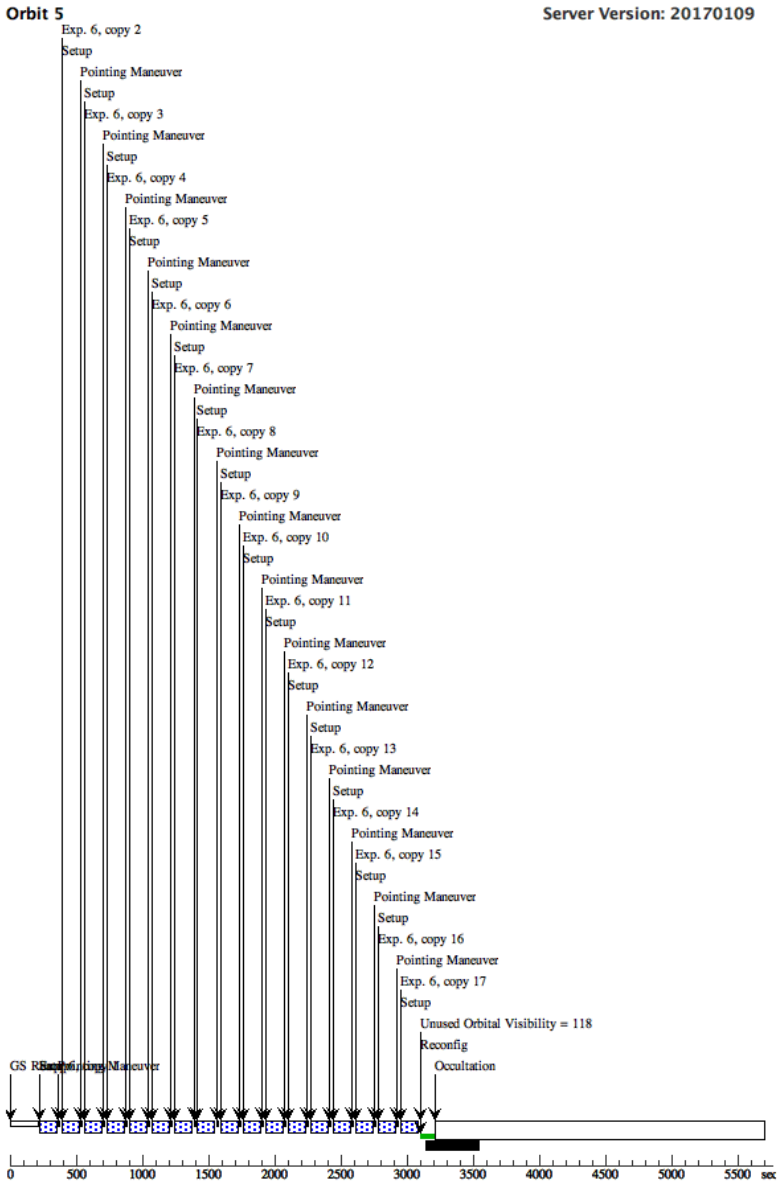
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