14927 - First Transmission Spectrum of a Cold, Water-Cloud Gas Giant Planet

Cycle: 24, Proposal Category: GO/DD

(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) KEPLER-16	WFC3/IR	6	27-Apr-2017 21:02:54.0	yes

6 Total Orbits Used

ABSTRACT

Here we propose to measure the first transmission spectrum of a cold, water-cloud gas giant planet. While previous efforts focus on planets much warmer than Earth, the Kepler mission has provided us a handful of transiting giant planets that receive Earth-like insolation. These cold gas giants are important targets to characterize because (1) water condenses out in their atmosphere, which leaves distinct and observable methane features; and (2) they are analogs to both the temperate worlds to be observed by JWST and the long-period exoplanets to be imaged by WFIRST. We identify the planet Kepler-16 b to be the pathfinder target in this category. With an average insolation of half Earth's value, Kepler-16 b should have a water cloud deck at 0.4-1.0 bar, below the region probed by transmission spectroscopy. Due to orbital precession, only two more transit events of Kepler-16 b will be available for HST observations, one in Cycle 24 and the other in Cycle 25. Limited orientation of HST prevents the use of spatial

scanning for the very last transit in Cycle 25, thereby decreasing HST's duty cycle and producing low-SNR measurements. The transit in Cycle 24 is thus practically the last transit that can be observed with sufficiently high precision. We request Director's Discretionary Time to observe this transit with WFC3 and obtain a transmission spectrum at 1.1-1.7 micron. The transmission spectrum can detect methane at 3.5-sigma significance. The project will demonstrate transmission spectroscopy as an effective technique to characterize the atmosphere of cold, water-cloud gas giants, and prepare community studies of similar planets as targets for JWST.

OBSERVING DESCRIPTION

We will measure the first transmission spectrum of a cold, water-cloud gas giant planet with Hubble/WFC3 and the G141 grism (1.1-1.7 um).

The times we provide here are for the start of the entire sequence of 6 orbits to fully sample the entire transit: 1 transit to allow HST to thermally settle and the remainding 5 orbits to sample the in- and out-of-transit portions of the lightcurve (2.5 orbits each). Thus, the times we provide here are for the start of the entire sequence of 6 orbits.

Kepler-16 b, due to its orbital precession, will no longer transit the primary star after January 2018. The full dynamic solution of the 227-day orbit of Kepler-16 b indicates that the planet transits in Jun 2017, and this is the only possibility to obtain its transmission spectrum.

We will use the spatial scan mode with the 256GRISM, NSAMP=15, SPARS=10, and a scan rate of 0.097"/sec to produce an exposure time of 103.13 seconds and a 10" scan length (76 pixels).

Visit

Proposal 14927, K16 G141 (01), implementation Fri Apr 28 01:03:02 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 100D TO 200 D; ORIENT 300D TO 360 D; BETWEEN 09-JUN-2017:11:16:21 AND 09-JUN-2017:12:50:44

Comments: WFC3 G141 IR transit of Kepler-16.

The 6 orbits must be scheduled continuously to fully sample the transit of the planet.

As the host star is relatively bright (H-mag = 0.14), we will use the spatial scanning method to collect more photons without saturating the detector.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	KEPLER-16	RA: 19 16 18.1750 (289.0757292d) Dec: +51 45 26.76 (51.75743d) Equinox: J2000	Proper Motion RA: 13.8 mas/yr Proper Motion Dec: -45.4 mas/yr Epoch of Position: 2000.0	V=(?) J 9.815 [0.023], H 9.14 [0.03], K 8.996 [0.022]	Reference Frame: SIMBAD

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

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Wavecal	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG null,-7	Sequence 1-3 Non-Int in K16 G141 (01)	0.55563 Secs (0.556 Secs) *[==>]*	***[1]***
2	Field Spectra	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=2; SAMP-SEQ=RAPID	POS TARG null,-7	Sequence 1-3 Non-Int in K16 G141 (01)	0.55563 Secs X 4 (2.223 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***
3		(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Round trip	Sequence 1-3 Non-Int in K16 G141 (01)	103.128633 Secs X 10 (2062.573 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]* *[==>(Copy 10, Forward)]* *[==>(Copy 10, Reverse)]*	***[1]***

	4	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Round trip	Sequence 4-5 Non-Int in K16 G141 (01)	103.128633 Secs X 10 (2062.573 Secs)	
								[==>(Copy 1, Forward)] *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]* *[==>(Copy 10, Forward)]* *[==>(Copy 10, Reverse)]*	***[2]***
	5	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Forward	Sequence 4-5 Non-Int in K16 G141 (01)	103.128633 Secs (103.129 Secs)	
								[==>]	***[2]***

	6	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Round trip	Sequence 6-7 Non-Int in K16 G141 (01)	103.128633 Secs X 10 (2062.573 Secs)	
								[==>(Copy 1, Forward)] *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]* *[==>(Copy 10, Forward)]* *[==>(Copy 10, Reverse)]*	***[3]***
	7	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Forward	Sequence 6-7 Non-Int in K16 G141 (01)	103.128633 Secs (103.129 Secs)	
								[==>]	***[3]***

	8	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Round trip	Sequence 8-9 Non-Int in K16 G141 (01)	103.128633 Secs X 10 (2062.573 Secs)	
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	9	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Forward	Sequence 8-9 Non-Int in K16 G141 (01)	103.128633 Secs (103.129 Secs)	
								[==>]	***[4]***

	10	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Round trip	Sequence 10-11 Non-Int in K16 G141 (01)	103.128633 Secs X 10 (2062.573 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]* *[==>(Copy 10, Forward)]* *[==>(Copy 10, Reverse)]*	***[5]***
	11	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Forward	Sequence 10-11 Non-Int in K16 G141 (01)	103.128633 Secs (103.129 Secs) *[==>]*	***[5]***

	12	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Round trip	Sequence 12-13 Non-Int in K16 G141 (01)	103.128633 Secs X 10 (2062.573 Secs)	
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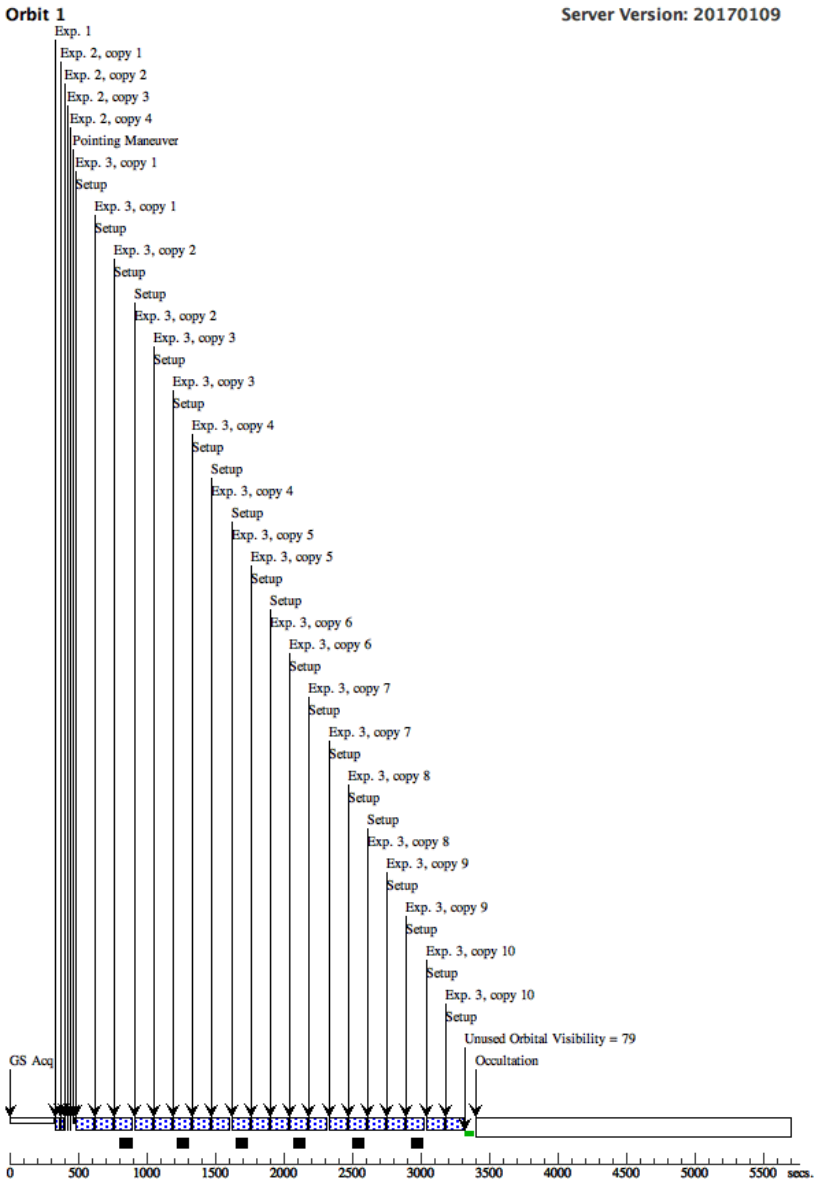
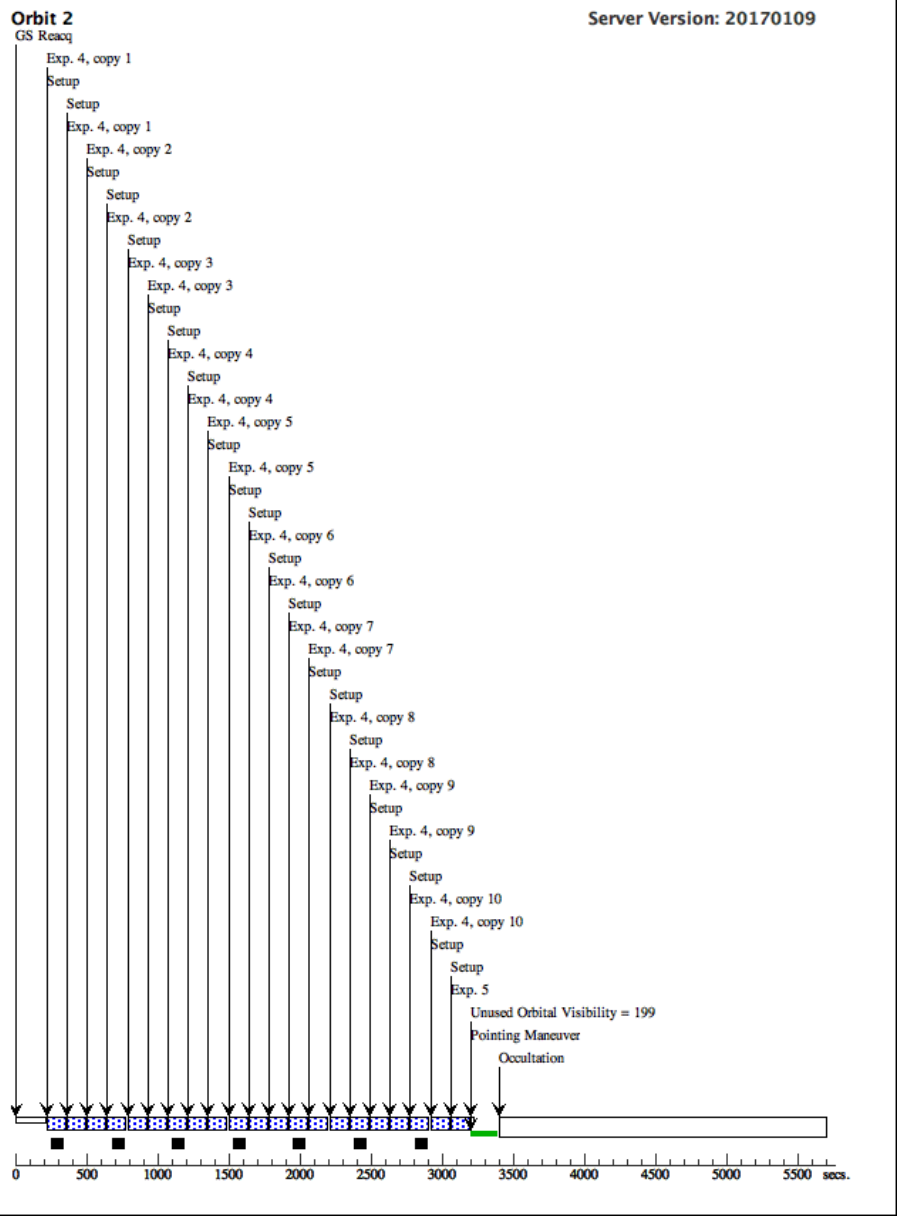
	13	(1) KEPLER-16	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS10	POS TARG null,-7; SPATIAL SCAN 0.097,90.0 Degrees,Forward	Sequence 12-13 Non-Int in K16 G141 (01)	103.128633 Secs (103.129 Secs)	
								[==>]	***[6]***

Orbit Structure

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Orbit 3
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Exp. 8, copy 9
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Exp. 8, copy 10
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Exp. 9
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Pointing Maneuver
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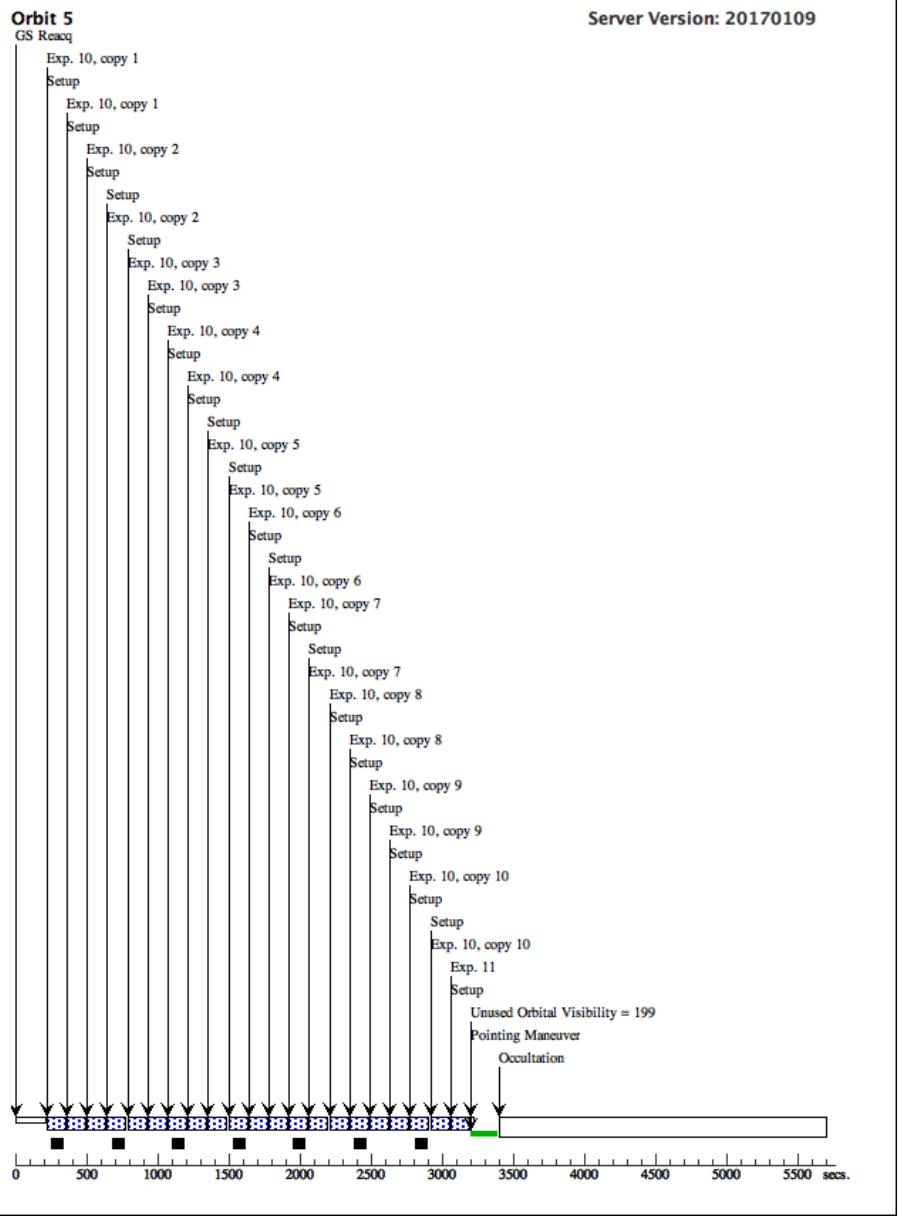
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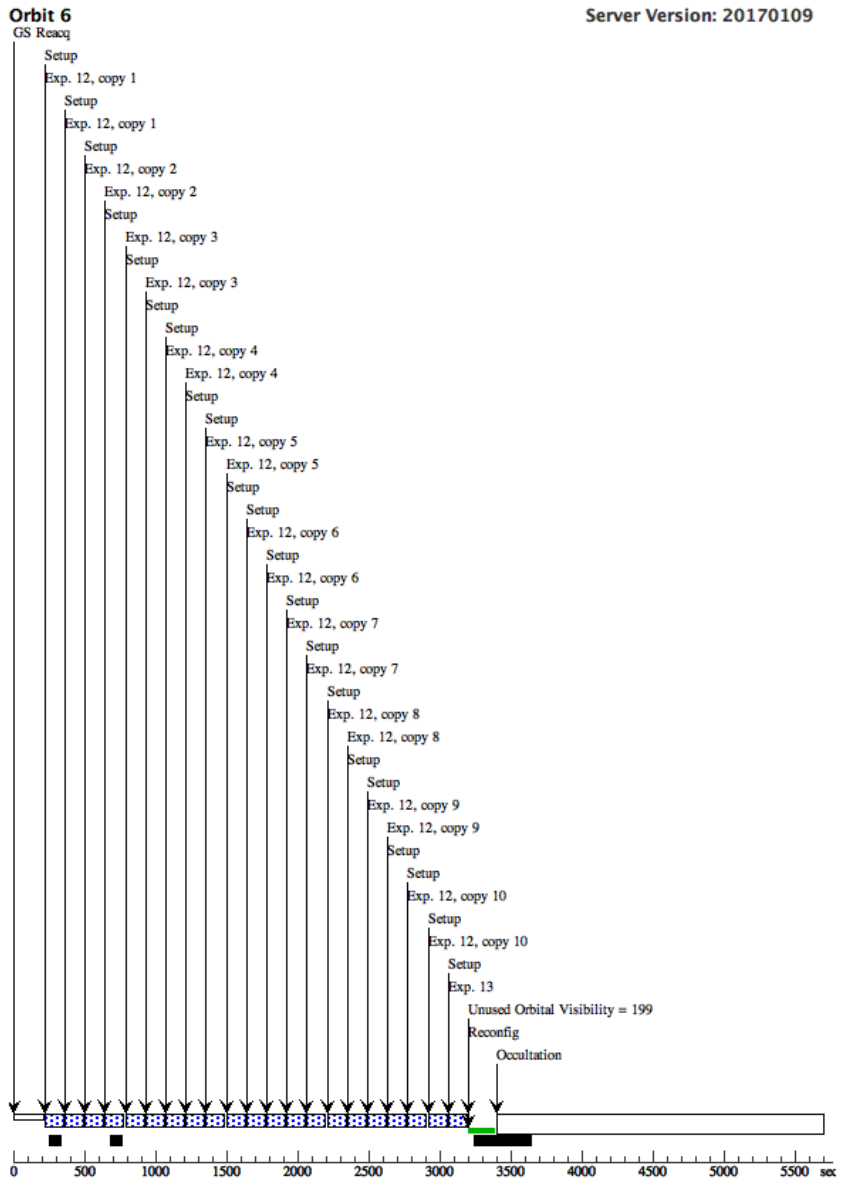
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Exp. 13
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Reconfig
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