



14169 - Measuring the absolute H₂O abundance of WASP-39b's atmosphere

Cycle: 23, Proposal Category: GO

(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) GSC-04980-00761	WFC3/IR	5	22-Dec-2015 21:12:34.0	yes

5 Total Orbits Used

ABSTRACT

Over the past few years, observations of close-in giant planet atmospheres using WFC3's spectroscopic capabilities have played a pivotal role in the NIR characterization of these worlds. We propose to build upon this success by measuring H₂O in the atmosphere of the warm Saturn-mass exoplanet WASP-39b. Our previous optical STIS observations have revealed that WASP-39b has a cloud and haze-free atmosphere, implying that a strong H₂O signal will be detectable. Combined with the scattering signature due to H₂ that we have measured at shorter wavelengths, our detection will enable us to determine the absolute H₂O abundance of the atmosphere. This information is extremely valuable, as it helps to constrain the

formation and evolutionary history of the planet, such as the composition of the primordial accretion disk and the planet's location within that disk. Very few H₂O abundance measurements for transiting exoplanets are currently available, fewer in which the interpretation is not hindered by clouds or hazes. As such, with a clear atmosphere WASP-39b is uniquely placed to provide an important constraint on its atmospheric chemical abundances.

OBSERVING DESCRIPTION

We will use WFC3/IR spectroscopic grism G102 to observe WASP-39 from 0.8 - 1.15 microns over one transit event, with a visit consisting of five consecutive HST orbits. Three orbits will be used to determine the baseline flux, one before and one after transit, while one or two occur during the transit event. We will repeat our successful observing strategies for WFC3 in which we have now perfected very high S/N transit observations in the NIR using spatial scan mode (GO 12473 - Wakeford et al. 2013; Sing et al. 2013; Sing, Wakeford et al. 2015.).

During spatial scan mode the telescope is slowly slewed in the cross-dispersion direction while the camera is exposing. This causes the spectra to become spread over a large pixel area of the detector, providing very high S/N levels and vastly improved duty cycles. Spatial scan mode can result in a ten-fold increase in the number of photons per exposure while considerably reducing overheads. This also increases the time of saturation of the brightest pixels, and allows for longer exposure times (McCullough 2011). We also have no roll restrictions, which further eases scheduling. Using the visit planner in APT, we find that WASP-39 has very long yearly observable windows spread throughout the year.

For each visit with WFC3 we will use the same observing strategy as our Cycle-19 large program GO-12473, which uses spatial scanning mode to dramatically decrease observational overheads and obtain vastly higher S/N levels.

Using WFC3 G141 grism we will observe WASP-39b using spatial scan mode obtaining spectra from 1.1 - 1.7 microns. To reach precisions similar to that of previous HST observations we would require exposure times around 120 seconds spreading the light over around 20 pixels with a scan rate of around 0.2 pixels per second, similar to that of XO-1 (V mag = 11.2) and WASP-31 (V mag = 11.7), which are slightly brighter than WASP-39 (V mag = 12.1). This will allow us to achieve S/N levels of around 1300 per exposure when binned up to 4 pixels with roughly 50 in transit exposures with overheads. Using a 256x256 subarray we will avoid systematics observed in the 512x512 subarray (e.g. WASP-17 Mandell, et al., 2013, GJ 1214 Berta et al., 2012), which have time dependent effects on the detector response and persistent ramp-like effects on the data (Swain et al. 2012). Using spatial scan mode instead of stare mode we will also be able to increase the number of observed photons without reaching the non-linearity limit of the detector.

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Wed Dec 23 02:12:38 GMT 2015

Visit	Proposal 14169, WFC3 IR WASP-39 (01), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR Special Requirements: Period 4.0552782194 D AND ZERO-PHASE HJD2455829.6029470935 <i>Comments: transit of WASP-39b, it is essential that the 5 orbits be scheduled in a continuous block</i>																								
	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>GSC-04980-00761</td> <td>RA: 14 29 18.4080 (217.3267000d)</td> <td>Proper Motion RA: -12.8 mas/yr</td> <td>V=12.09</td> <td>Reference Frame: SIMBAD</td> </tr> <tr> <td></td> <td>Alt Name1: WASP-39</td> <td>Dec: -03 26 40.17 (-3.44449d)</td> <td>Proper Motion Dec: 2.3 mas/yr</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>Equinox: J2000</td> <td>Epoch of Position: 2000</td> <td></td> <td></td> </tr> </tbody> </table> <i>Comments: This object was generated by the target selector and retrieved from the SIMBAD database.</i>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	GSC-04980-00761	RA: 14 29 18.4080 (217.3267000d)	Proper Motion RA: -12.8 mas/yr	V=12.09	Reference Frame: SIMBAD		Alt Name1: WASP-39	Dec: -03 26 40.17 (-3.44449d)	Proper Motion Dec: 2.3 mas/yr					Equinox: J2000	Epoch of Position: 2000	
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#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	WASP-39 WFC3, phase constrained (WFC3IR.i m.719998)	(1) GSC-04980-0076 1	WFC3/IR, MULTIACCUM, GRISM256	F139M	SAMP-SEQ=RAPID ; NSAMP=3	PHASE 0.9531 TO 0 .9570		0.833445 Secs (0.833 Secs) [==>]	[1]
<i>Comments: Direct image for wavelength calibration. Phase constrained so transit occurs in orbit 3-4 between 2nd and 3rd contact.</i>									

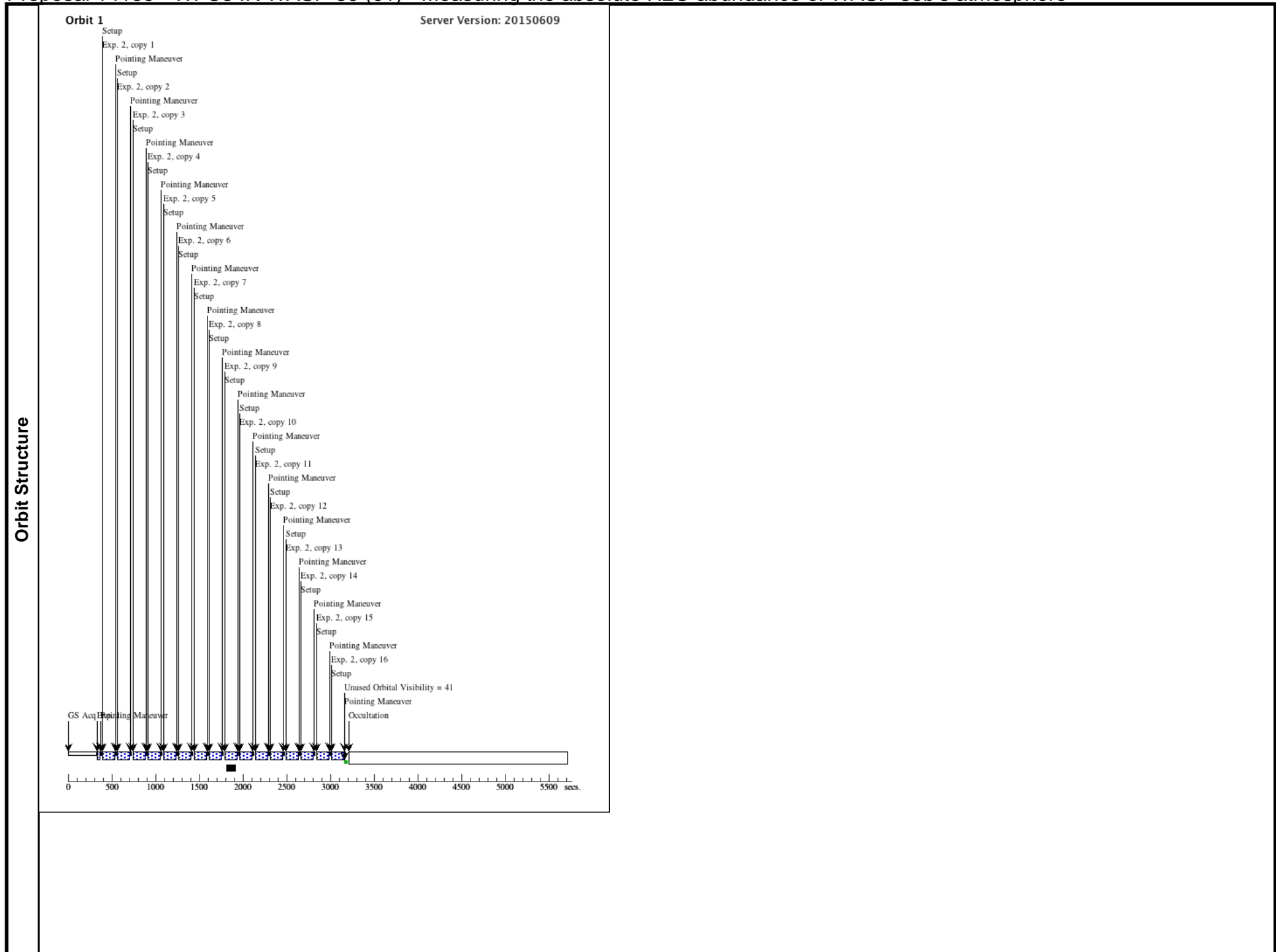
Exposures

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	<p>[==>(Copy 34)] [==>(Copy 35)] [==>(Copy 36)] [==>(Copy 37)] [==>(Copy 38)] [==>(Copy 39)] [==>(Copy 40)] [==>(Copy 41)] [==>(Copy 42)] [==>(Copy 43)] [==>(Copy 44)] [==>(Copy 45)] [==>(Copy 46)] [==>(Copy 47)] [==>(Copy 48)] [==>(Copy 49)] [==>(Copy 50)]</p>	<p>[3]</p>
	<p>[==>(Copy 51)] [==>(Copy 52)] [==>(Copy 53)] [==>(Copy 54)] [==>(Copy 55)] [==>(Copy 56)] [==>(Copy 57)] [==>(Copy 58)] [==>(Copy 59)] [==>(Copy 60)] [==>(Copy 61)] [==>(Copy 62)] [==>(Copy 63)] [==>(Copy 64)] [==>(Copy 65)] [==>(Copy 66)] [==>(Copy 67)]</p>	<p>[4]</p>

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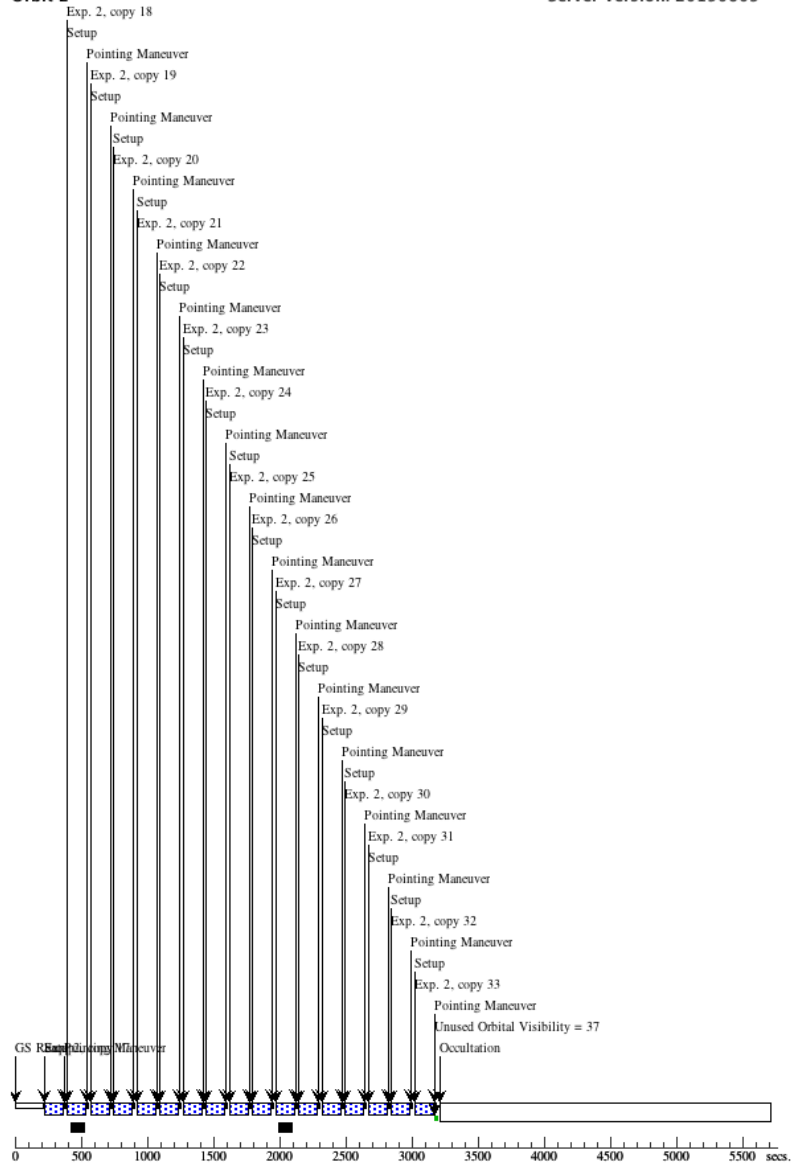
	[==>(Copy 68)] [==>(Copy 69)] [==>(Copy 70)] [==>(Copy 71)] [==>(Copy 72)] [==>(Copy 73)] [==>(Copy 74)] [==>(Copy 75)] [==>(Copy 76)] [==>(Copy 77)] [==>(Copy 78)] [==>(Copy 79)] [==>(Copy 80)] [==>(Copy 81)] [==>(Copy 82)] [==>(Copy 83)] [==>(Copy 84)]	[5]
<i>Comments: SPATIAL SCAN. Count level/pixel is estimated to be 19,444 DN from the ETC, following ISR WFC3-2012-08, with a scan rate of 0.025"/sec covering a total of ~2.8".</i>		



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Orbit 2

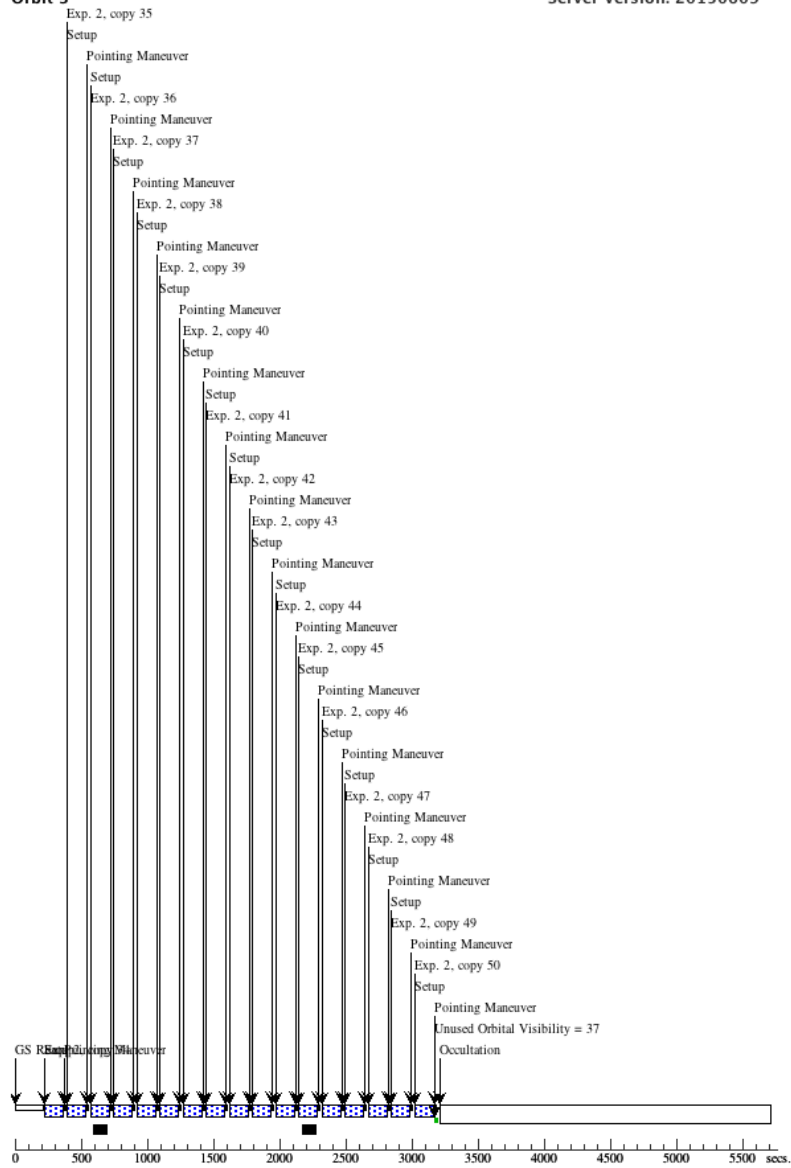
Server Version: 20150609



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Orbit 3

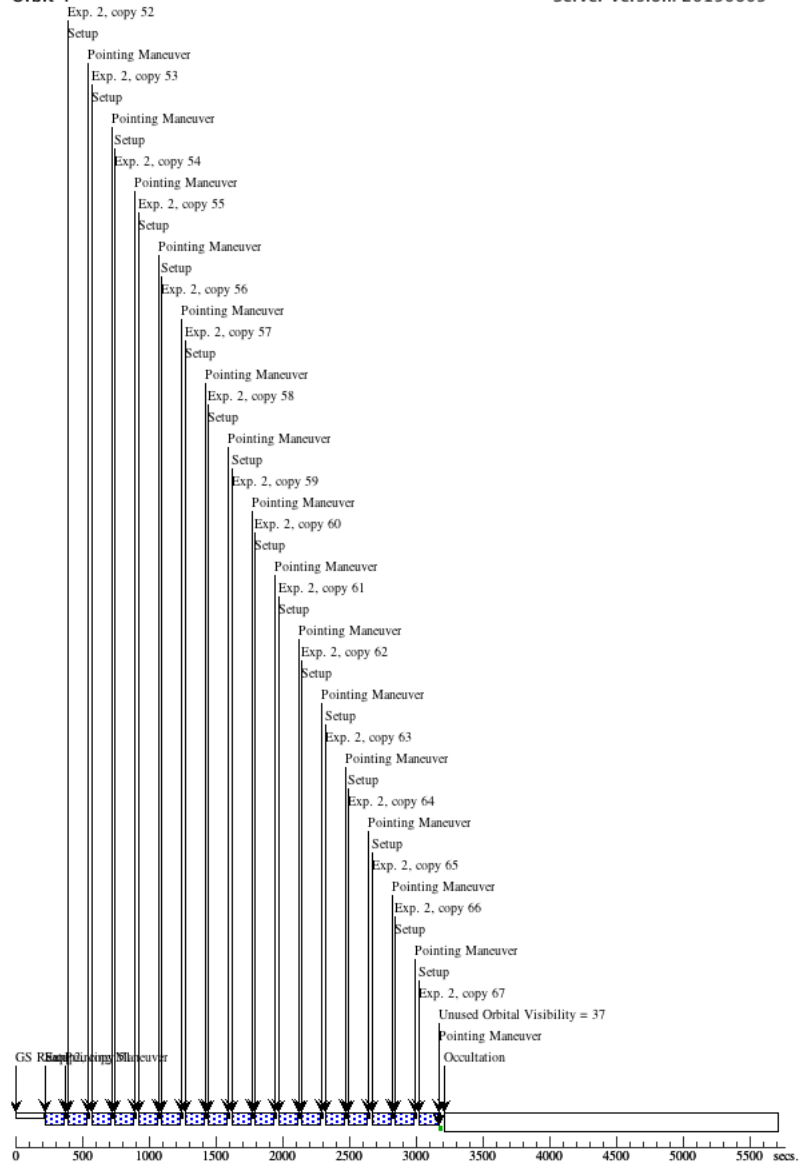
Server Version: 20150609



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Orbit 4

Server Version: 20150609



Proposal 14169 - WFC3 IR WASP-39 (01) - Measuring the absolute H2O abundance of WASP-39b's atmosphere

