



14752 - Variability in the Escape of Water from Mars

Cycle: 24, 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) MARS-EXOSPHERE-1 (2) SKY-NEAR-MARS	ACS/SBC	2	09-Nov-2016 11:53:39.0	yes
02	(4) MARS-EXOSPHERE-2 (8) SKY-NEAR-MARS-2	ACS/SBC	2	09-Nov-2016 11:53:42.0	yes
03	(2) SKY-NEAR-MARS (5) MARS-EXOSPHERE-3	ACS/SBC	2	09-Nov-2016 11:53:45.0	yes
04	(2) SKY-NEAR-MARS (6) MARS-EXOSPHERE-4	ACS/SBC	2	09-Nov-2016 11:53:47.0	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>
05	(2) SKY-NEAR-MARS (7) MARS-EXOSPHERE-5	ACS/SBC	2	09-Nov-2016 11:53:50.0	yes

10 Total Orbits Used

ABSTRACT

The present-day escape of water from the atmosphere of Mars must be understood to extrapolate back in time to determine past conditions on the red planet. To be able to perform this extrapolation accurately, we need to determine the factors that control the escape of H and O today. This work is well underway with observations of the martian exosphere by HST and MAVEN. We have established that the H escape rate is highly variable over the course of a martian year (factor of ten), with strong seasonal variations in the exospheric H density, but the controlling factor(s) are not yet well determined. This proposal is to extend this work with HST observations in Fall 2016 during martian southern summer, when both the H escape flux and the dust storm activity are at maximum levels. This period corresponds to a time when the MAVEN IUVS will not be able to measure exospheric H due to its orbital geometry, and it corresponds to the arrival of ExoMars in a high altitude capture orbit where this mission will have a good global view of Mars. The coordinated observations with HST, MAVEN, and ExoMars will allow us to measure short term changes in the lower and upper atmospheres during a key time of the Mars seasons, when the escape flux is highest, Mars is closest to the Sun, and there is the highest level of dust storm activity. We will use the relative timing of atmospheric changes to determine cause and effect leading to the large changes in the escape of water. This proposal supports the HST UV initiative.

OBSERVING DESCRIPTION

We propose to obtain ACS SBC UV images of Mars to measure the distribution of exospheric hydrogen via the extended H Ly alpha emission. The ACS images will be obtained in a series of clear and filtered images, with the F140LP filter used to record the disc emissions with Ly alpha blocked. The scaled difference of the clear and F140LP frames provides the Ly alpha emission. In practice, more than 250 km above the planet limb the only emission is from Ly alpha, while the difference method is needed for the lower atmosphere. Sky observations near Mars are critically important to accurately subtract the background geocoronal and interplanetary emissions. We request five visits of 2 orbits each, for a program total of 10 orbits. The spacing of the needed orbits to determine changes in the H density and escape flux during southern summer is justified in the Scientific Justification. We believe that this is the minimum number of visits needed to discriminate dust storms from slower seasonal changes based on historic storms, and the time period covers the most likely time of year for the emergence of large dust storms as well as the expected peak in H density and escape flux.

These observations will employ the same approach as in cycle 22, using ACS/SBC to image the H Ly alpha emission from the difference of clear and filtered images (F115 - F140). Two orbits per visit have been shown to provide an adequate S/N ratio by co-adding pixels as a function of radial distance. In HST cycle 22 we also observed the O 1304 emission profile across the disc, and found interesting changes in the O density that are now under analysis. However, the MAVEN IUVS instrument can now better detect the hot O than can HST, thus we are not proposing to pursue more O observations with HST. By contrast, HST has a real advantage over MAVEN by observing the whole column of coronal H from outside the atmosphere to high altitudes (15,000-20,000 km). The MAVEN IUVS instrument also observes H Ly alpha, but is limited to observing within the atmosphere below about 6000 km due to the orbital geometry and never measures the sky background level. A cross comparison of the MAVEN and HST data during Fall 2014 found large ambiguities in derived density and temperature when the observations are made within the atmosphere and only at low altitudes. The effects of the velocity distribution of outgoing H atoms and nonthermal effects on the corona become pronounced at altitudes of several martian radii, and high altitudes must be observed to compare with models to accurately derive values for density and temperature.

The ACS/SBC clear (F115) images will be taken during the shadow portion of the HST orbit, and filtered (F140) images when HST is in sunlight, to minimize the geocoronal background brightness at Ly alpha. In the 2014 observations, one orbit each on target and sky provided a signal to noise ratio and accuracy of sky background subtraction that permits detection of the martian corona to the level of 150-200 Rayleighs. To accurately subtract the background geocoronal and interplanetary emissions, however, it is imperative to measure its brightness versus HST orbital location. One HST orbit will be used in each visit for a series of clear images taken several arc min away from Mars, since the field of view near Mars will be filled with coronal emission. Although only the sky background (geocoronal and interplanetary emissions) will be observed, an accurate subtraction is key to determining the brightness of faint emission far from Mars. Experience with past programs has shown that the geocoronal conditions are too highly variable to be modeled with a high accuracy for this subtraction. A side benefit of this will be to build up a Ly alpha flat field of the ACS MAMA, for comparison with the general UV flat field used for calibration. A low order Ly alpha flat field obtained during earlier observations has been delivered to STScI for distribution to the public, and it will be improved by new observations. Each visit will thus consist of 2 orbits observing Mars and the sky background with ACS/SBC. If for any reason the ACS were not available, we would use the STIS UVMAMA with 25MAMA and F25SRF2.

HST is the only facility that has the UV sensitivity and angular resolution needed for these observations. MAVEN IUVS can also measure Ly alpha, and will be used to obtain altitude profiles as long as it can observe the sunlit portion of the exosphere. Its location in an orbit within the martian H corona and operational constraints do not permit mapping of the extended emission. There will be coordinated MAVEN IUVS observations of the

limb altitude profile of the Ly alpha emissions for the period preceding the HST period. The SPICAM instrument on MEX is no longer used in the UV mode.

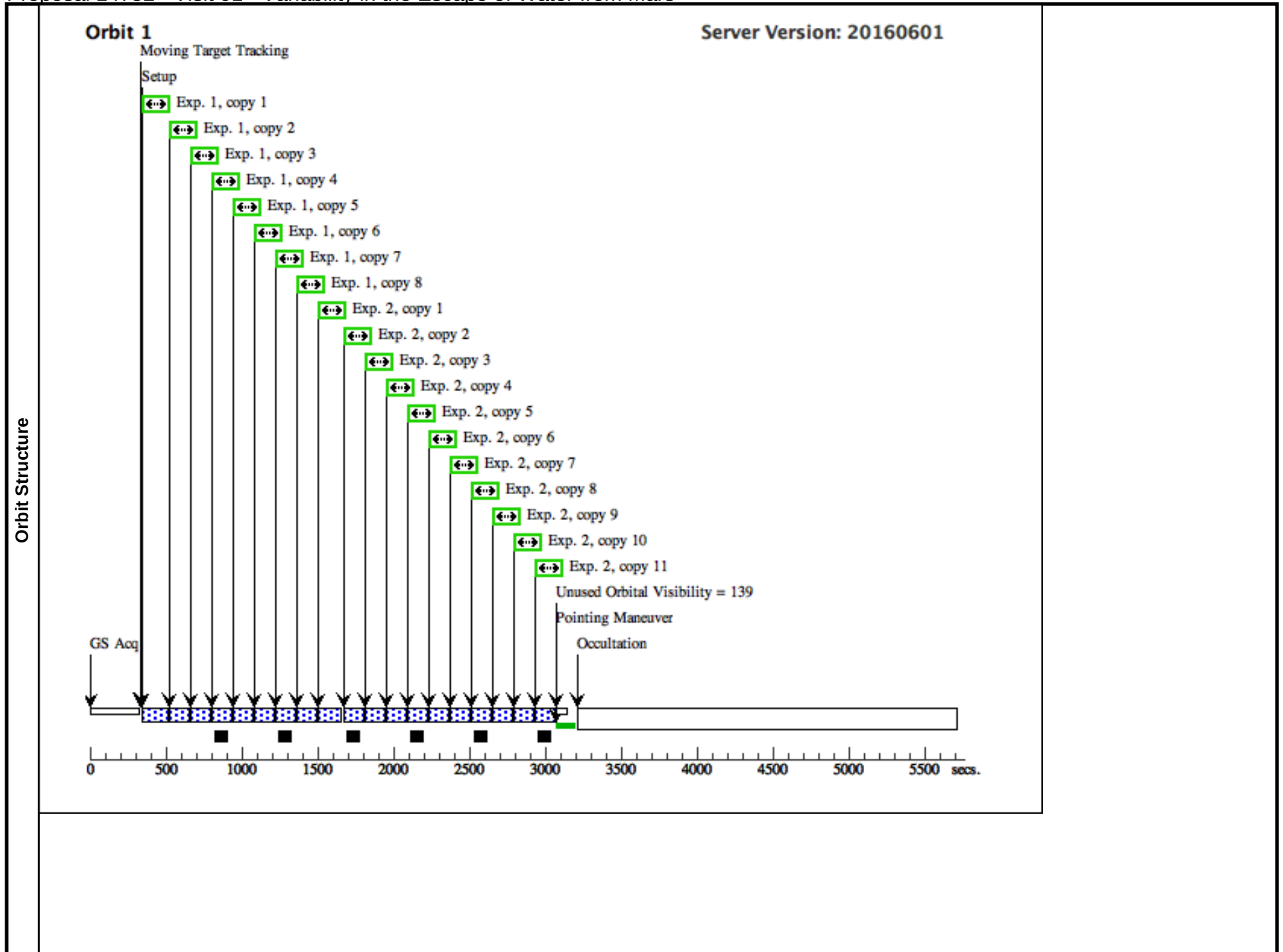
The count rates for ACS SBC clear (F115) imaging of Mars from earlier observations range from 5000 to 40000 counts/sec, well below the limit of 200,000 counts/sec, and the local count rate limits are also not exceeded. Count rates with F140LP are much lower since the Ly alpha emission is blocked. The roll angle will be unconstrained for this program. The fact that Mars moves across the sky generally makes it possible to locate good guide stars within any week-long observing window, and we have shown in GO 11170 and 13794 that bright object protection and counting rate limits will not hinder the observations, even when Mars is close to the Sun.

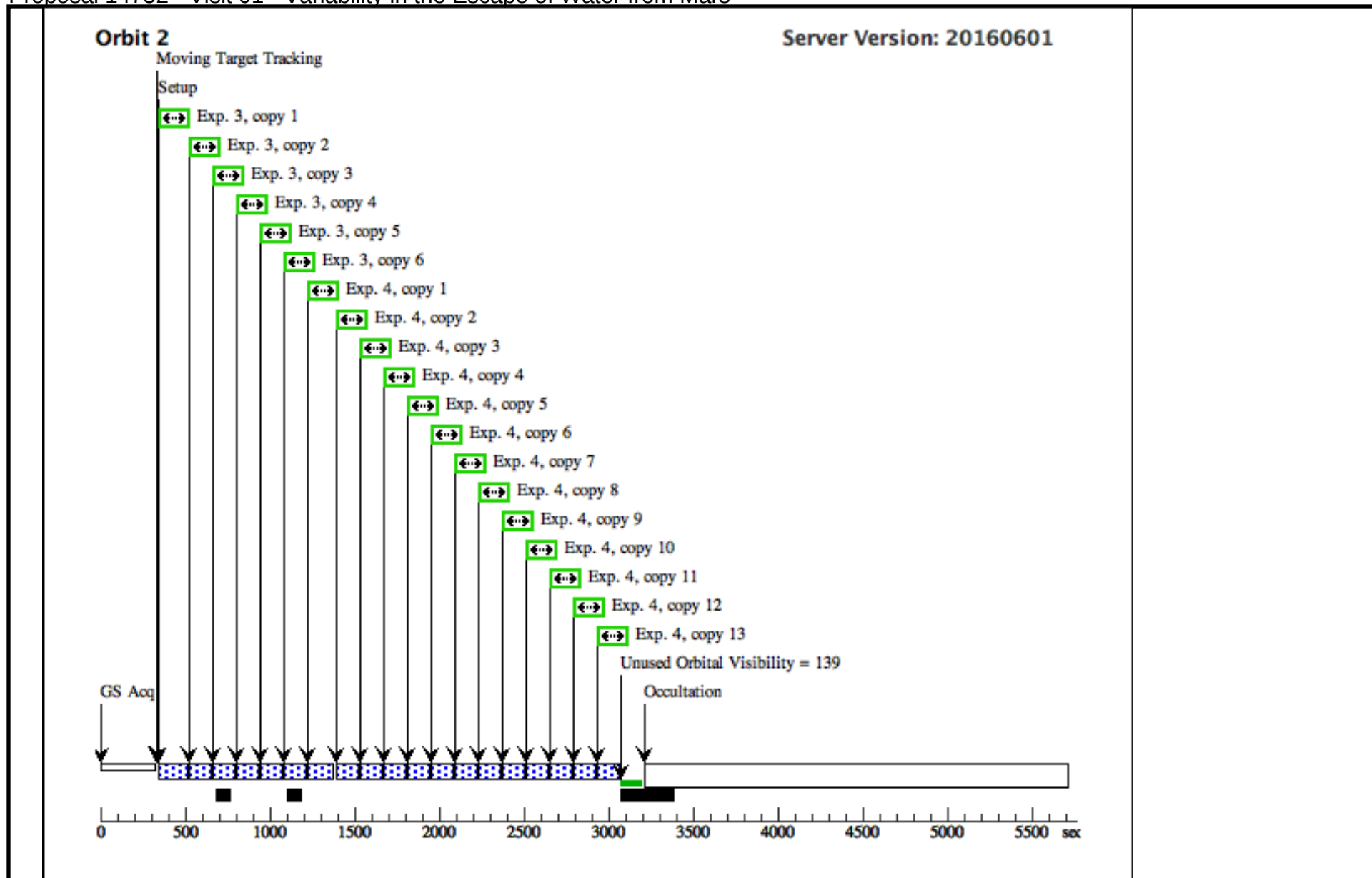
Proposal 14752 - Visit 01 - Variability in the Escape of Water from Mars

Visit	Proposal 14752, Visit 01, completed Wed Nov 09 16:53:52 GMT 2016					
	Diagnostic Status: No Diagnostics Scientific Instruments: ACS/SBC Special Requirements: ORIENT 87D TO 90 D; BETWEEN 20-SEP-2016:00:00:00 AND 22-SEP-2016:00:00:00					
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Ephem Center
	(1)	MARS-EXOSPHERE-1	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=216,REF=NORTH		EARTH
	<i>Comments: Offset Mars disc to corner of ACS/SBC FOV to image H coronal emissions far from the planet in the sunward direction.</i>					
	(2)	SKY-NEAR-MARS	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH		EARTH

Proposal 14752 - Visit 01 - Variability in the Escape of Water from Mars

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(0)	(1) MARS-EXOSPH ERE-1	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 8 (800 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)]	[1]
	2	(0)	(1) MARS-EXOSPH ERE-1	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 11 (1100 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)] [==>(Copy 9)] [==>(Copy 10)] [==>(Copy 11)]	[1]
	3	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F140LP		NEW OBSET FULL ACQ		100 Secs X 6 (600 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)]	[2]
	4	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 13 (1300 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)]	[2]



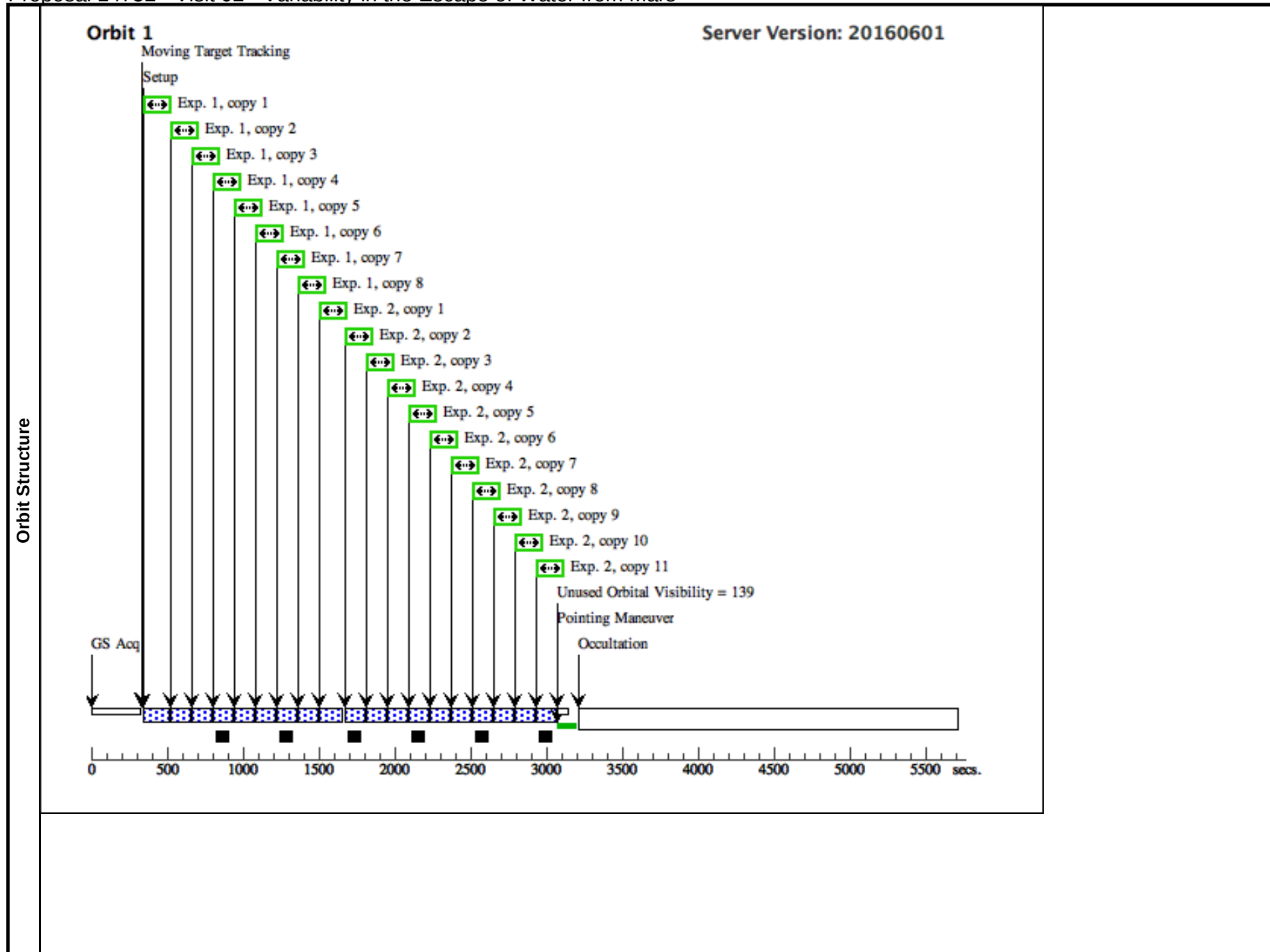


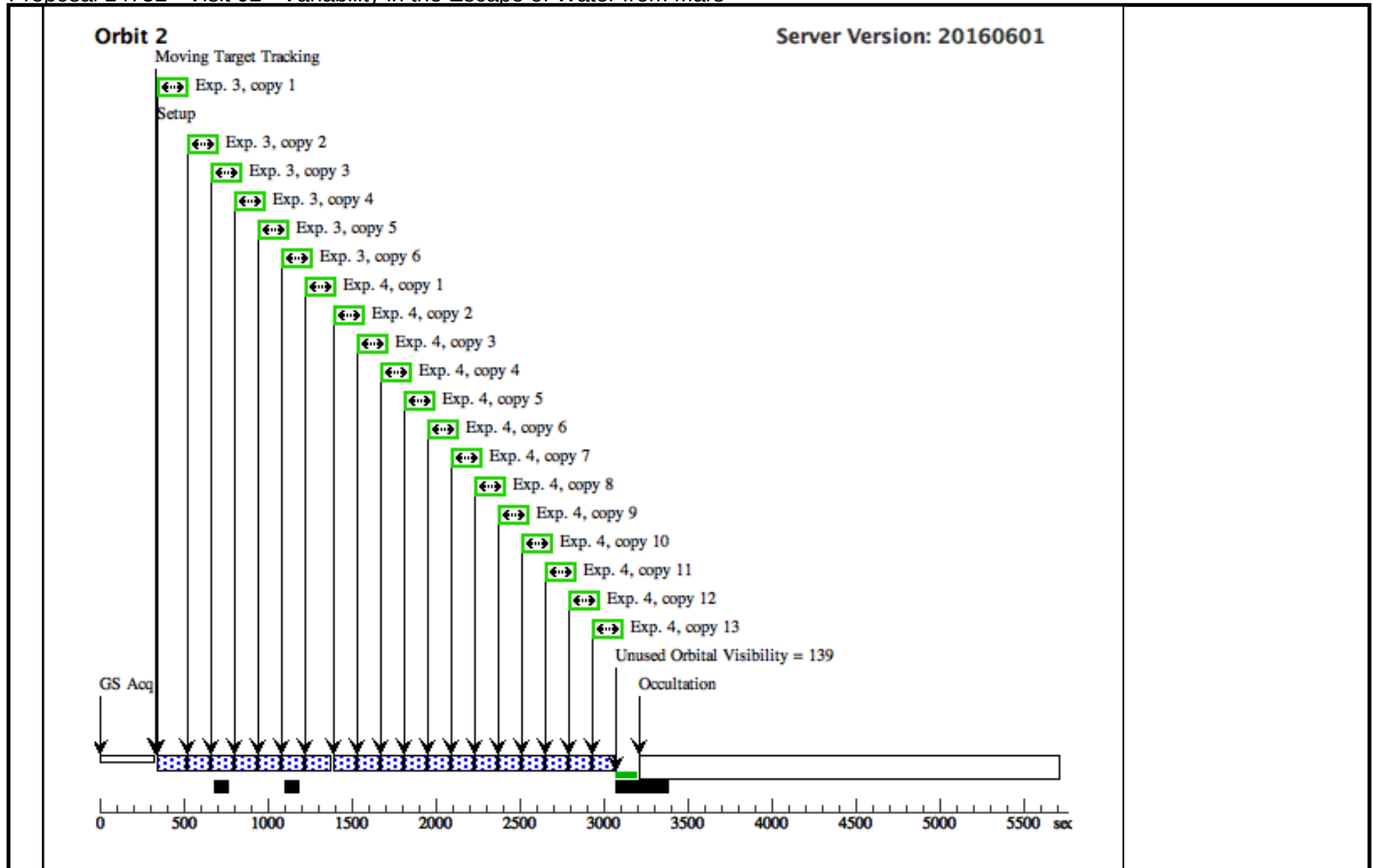
Proposal 14752 - Visit 02 - Variability in the Escape of Water from Mars

Visit	Proposal 14752, Visit 02, completed Wed Nov 09 16:53:52 GMT 2016					
	Diagnostic Status: No Diagnostics Scientific Instruments: ACS/SBC Special Requirements: ORIENT 85D TO 88 D; BETWEEN 20-OCT-2016:00:00:00 AND 22-OCT-2016:00:00:00					
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Ephem Center
	(4)	MARS-EXOSPHERE-2	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=214,REF=NORTH		EARTH
	Comments: Offset Mars disc to corner of ACS/SBC FOV to image H coronal emissions far from the planet in the sunward direction.					
	(8)	SKY-NEAR-MARS-2	STD=MARS	TYPE=POS_ANGLE,RAD=355,ANG=0,REF=NORTH		EARTH

Proposal 14752 - Visit 02 - Variability in the Escape of Water from Mars

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(0)	(4) MARS-EXOSPH ERE-2	ACS/SBC, ACCUM, SBC	F140LP		GS ACQ SCENARI O BASE1B3		100 Secs X 8 (800 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)]	[1]
	2	(0)	(4) MARS-EXOSPH ERE-2	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 11 (1100 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)] [==>(Copy 9)] [==>(Copy 10)] [==>(Copy 11)]	[1]
	3	(0)	(8) SKY-NEAR-MA RS-2	ACS/SBC, ACCUM, SBC	F140LP		NEW OBSET FULL ACQ		100 Secs X 6 (600 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)]	[2]
	4	(0)	(8) SKY-NEAR-MA RS-2	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 13 (1300 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)]	[2]



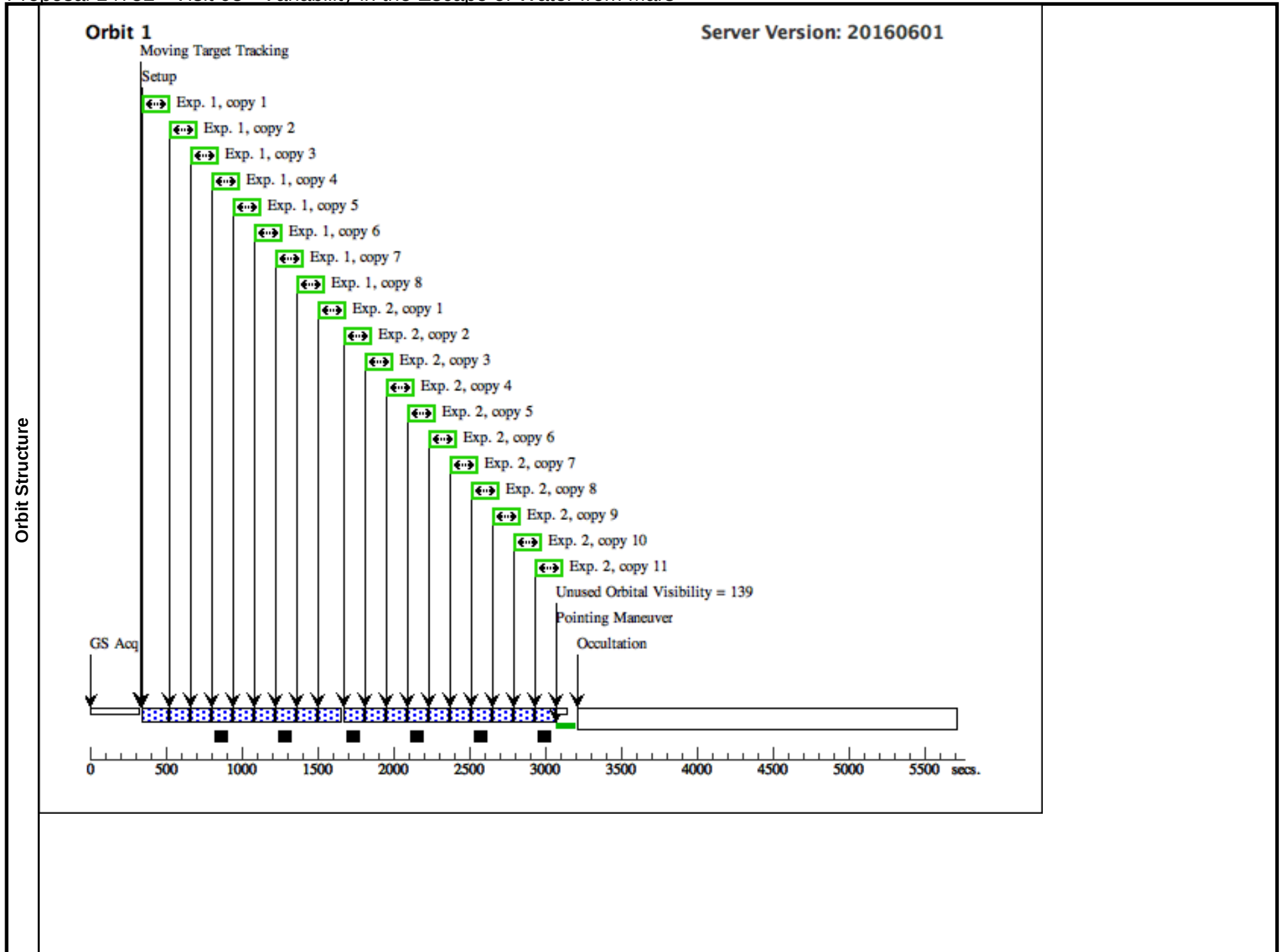


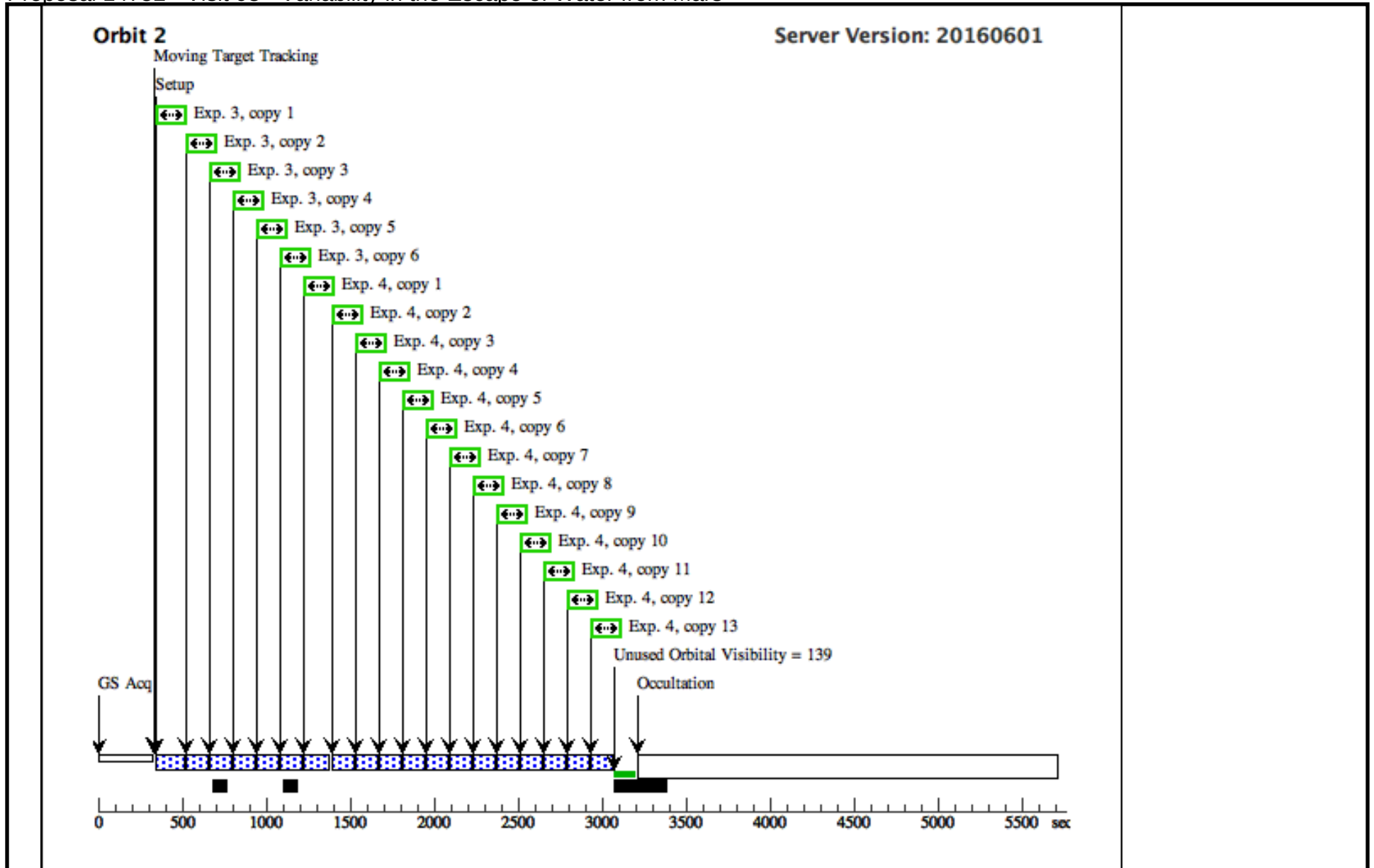
Proposal 14752 - Visit 03 - Variability in the Escape of Water from Mars

Visit	Proposal 14752, Visit 03, scheduling Wed Nov 09 16:53:52 GMT 2016					
	Diagnostic Status: No Diagnostics Scientific Instruments: ACS/SBC Special Requirements: ORIENT 77D TO 80 D; BETWEEN 19-NOV-2016:00:00:00 AND 21-NOV-2016:00:00:00					
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Ephem Center
	(2)	SKY-NEAR-MARS	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH		EARTH
	(5)	MARS-EXOSPHERE-3	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=206,REF=NORTH		EARTH
Comments: Offset Mars disc to corner of ACS/SBC FOV to image H coronal emissions far from the planet in the sunward direction.						

Proposal 14752 - Visit 03 - Variability in the Escape of Water from Mars

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(0)	(5) MARS-EXOSPH ERE-3	ACS/SBC, ACCUM, SBC	F140LP		GS ACQ SCENARI O BASE1B3		100 Secs X 8 (800 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)]	[1]
	2	(0)	(5) MARS-EXOSPH ERE-3	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 11 (1100 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)] [==>(Copy 9)] [==>(Copy 10)] [==>(Copy 11)]	[1]
	3	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F140LP		NEW OBSET FULL ACQ; GS ACQ SCENARI O BASE1B3		100 Secs X 6 (600 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)]	[2]
	4	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 13 (1300 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)]	[2]



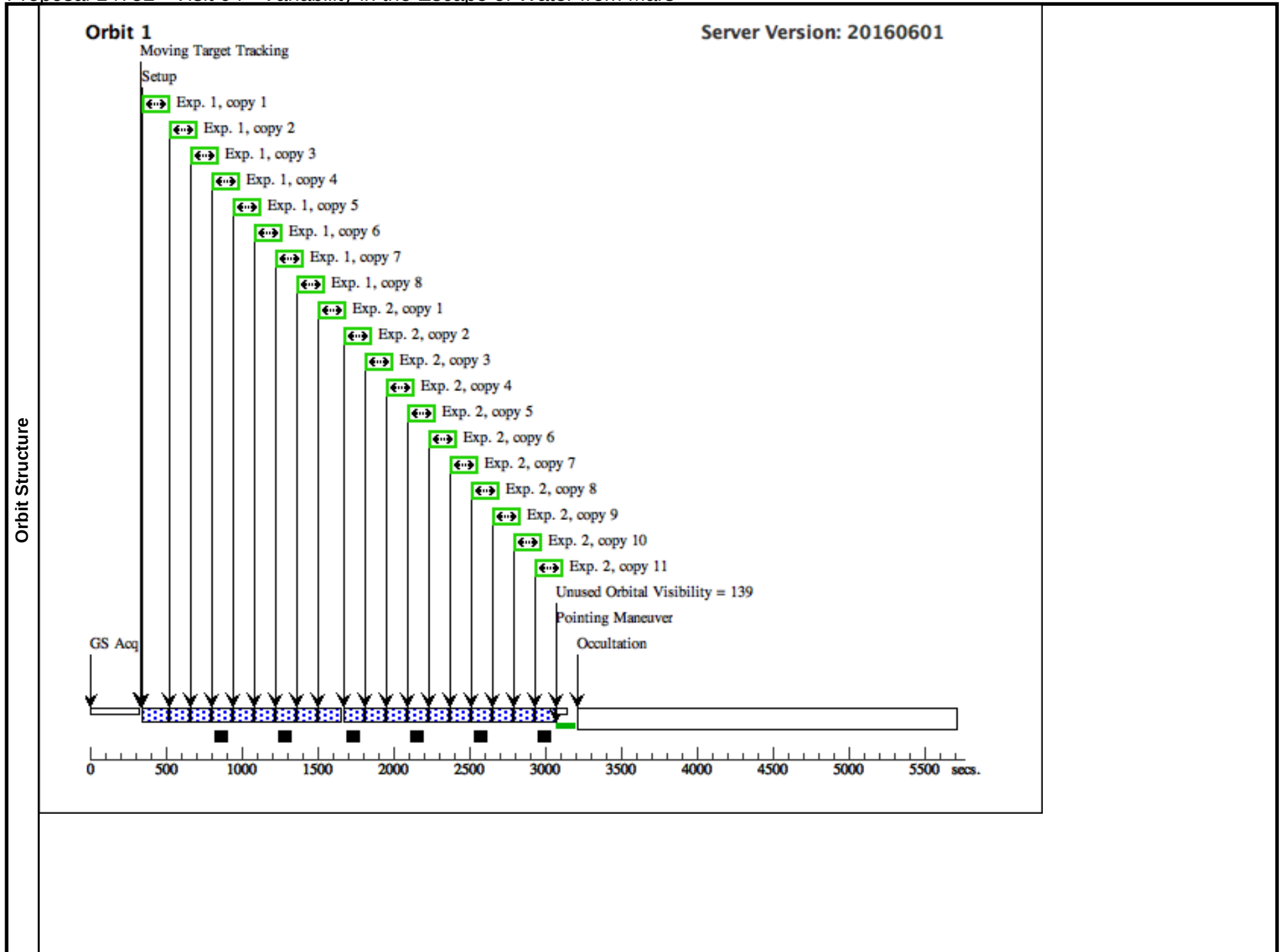


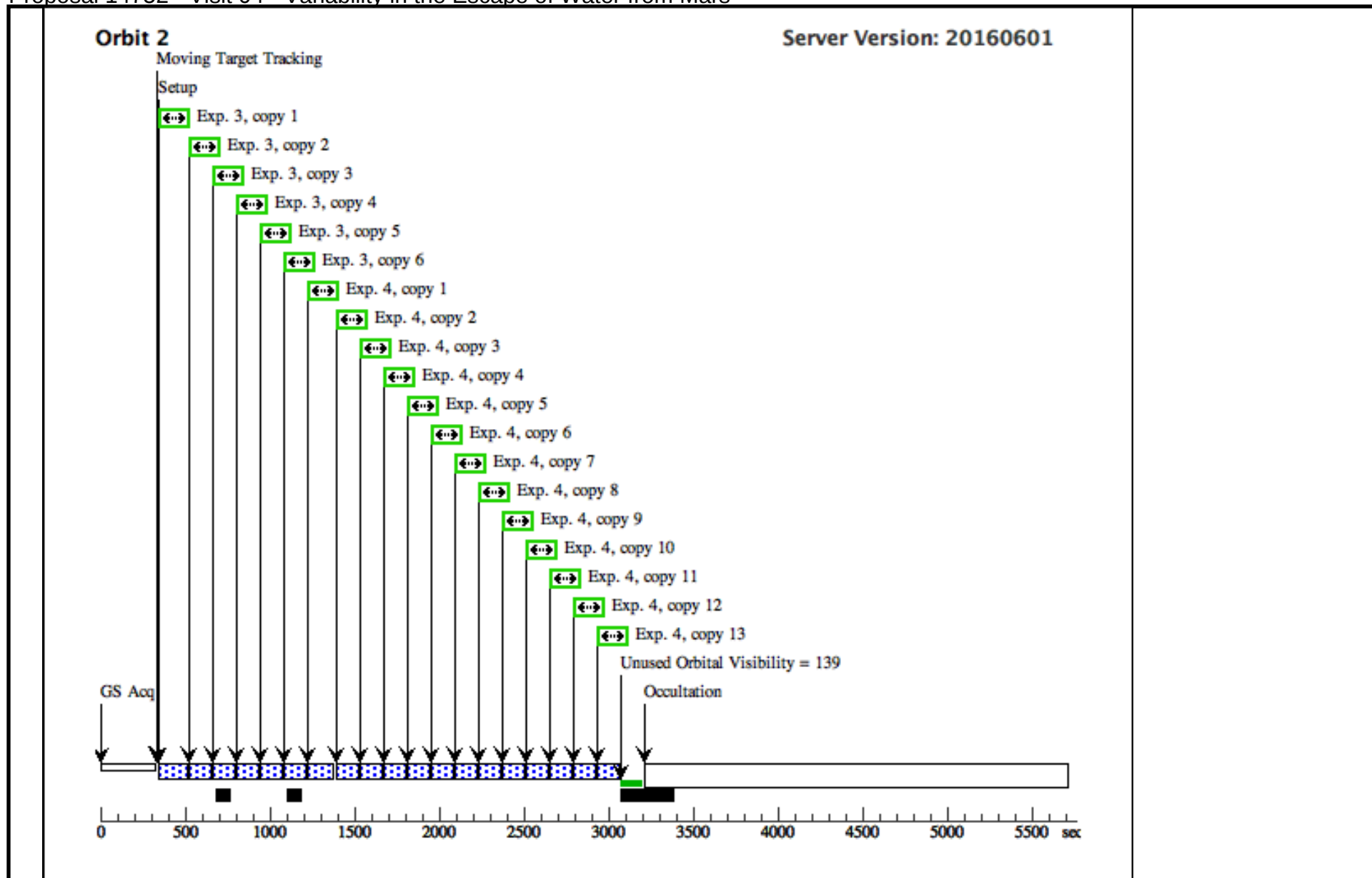
Proposal 14752 - Visit 04 - Variability in the Escape of Water from Mars

Visit	Proposal 14752, Visit 04, scheduling Wed Nov 09 16:53:52 GMT 2016					
	Diagnostic Status: No Diagnostics Scientific Instruments: ACS/SBC Special Requirements: ORIENT 71D TO 74 D; BETWEEN 19-DEC-2016:00:00:00 AND 21-DEC-2016:00:00:00					
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Ephem Center
	(2)	SKY-NEAR-MARS	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH		EARTH
	(6)	MARS-EXOSPHERE-4	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=201,REF=NORTH		EARTH
Comments: Offset Mars disc to corner of ACS/SBC FOV to image H coronal emissions far from the planet in the sunward direction.						

Proposal 14752 - Visit 04 - Variability in the Escape of Water from Mars

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(0)	(6) MARS-EXOSPH ERE-4	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 8 (800 Secs)	
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	2	(0)	(6) MARS-EXOSPH ERE-4	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 11 (1100 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)] [==>(Copy 9)] [==>(Copy 10)] [==>(Copy 11)]	[1]
	3	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F140LP		NEW OBSET FULL ACQ		100 Secs X 6 (600 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)]	[2]
	4	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 13 (1300 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)]	[2]





Proposal 14752 - Visit 05 - Variability in the Escape of Water from Mars

Visit	Proposal 14752, Visit 05, scheduling Diagnostic Status: No Diagnostics Scientific Instruments: ACS/SBC Special Requirements: ORIENT 69D TO 72 D; BETWEEN 18-JAN-2017:00:00:00 AND 20-JAN-2017:00:00:00						Wed Nov 09 16:53:52 GMT 2016
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
	(2)	SKY-NEAR-MARS	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH			EARTH
	(7)	MARS-EXOSPHERE-5	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=197,REF=NORTH			EARTH
Comments: Offset Mars disc to corner of ACS/SBC FOV to image H coronal emissions far from the planet in the sunward direction.							

Proposal 14752 - Visit 05 - Variability in the Escape of Water from Mars

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(0)	(7) MARS-EXOSPH ERE-5	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 8 (800 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)]	[1]
	2	(0)	(7) MARS-EXOSPH ERE-5	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 11 (1100 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)] [==>(Copy 8)] [==>(Copy 9)] [==>(Copy 10)] [==>(Copy 11)]	[1]
	3	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F140LP		NEW OBSET FULL ACQ		100 Secs X 7 (700 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)] [==>(Copy 4)] [==>(Copy 5)] [==>(Copy 6)] [==>(Copy 7)]	[2]
	4	(0)	(2) SKY-NEAR-MA RS	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 12 (1200 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)]	[2]

