15097 - Imaging the Extended Hot Hydrogen Exosphere at Mars to Determine the Water Escape Rate

Cycle: 25, 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) MARS-EXOSPHERE (3) MARS-EXOSPHERE-OFFSET	ACS/SBC	2	16-Jan-2018 19:01:08.0	yes
51	(1) MARS-EXOSPHERE (3) MARS-EXOSPHERE-OFFSET	ACS/SBC	2	16-Jan-2018 19:01:12.0	yes
02	(1) MARS-EXOSPHERE	ACS/SBC	1	16-Jan-2018 19:01:14.0	yes
03	(1) MARS-EXOSPHERE (3) MARS-EXOSPHERE-OFFSET	ACS/SBC	2	16-Jan-2018 19:01:16.0	yes

7 Total Orbits Used

ABSTRACT

ACS SBC imaging of the extended hydrogen exosphere of Mars is proposed to identify the hot hydrogen population present in the exosphere of Mars. Determining the characteristics of this population and the underlying processes responsible for its production are critical towards constraining the escape flux of H from Mars, which in turn is directly related to the water escape history of Mars. Since the hot atoms appear mainly at high altitudes, these observations will be scheduled when Mars is far from Earth allowing us to image the hot hydrogen atoms at high altitudes where they dominate the population. The altitude coverage by HST will extend beyond 30,000 km or 8.8 Martian radii in this case, which makes it perfect for this study as orbiting spacecraft remain at low altitudes (MAVEN apoapse is ~ 6000 km) and cannot separate hot atoms from the thermal population at those altitudes. The observations will also be carried out when Mars is near aphelion, the atmospheric temperature is low, and the thermal population has a small scale height, allowing the clear characterization of the hot hydrogen layer. Another advantage of conducting this study in this cycle is that the solar activity is near its minimum, allowing us to discriminate between changes in the hot hydrogen population from processes taking place within the atmosphere of Mars and changes due to external drivers like the solar wind, producing this non-thermal population. This proposal is part of the HST UV initiative.

OBSERVING DESCRIPTION

We propose to obtain ACS SBC UV images of Mars to study the characteristics of the non-thermal hydrogen atoms populating the exosphere of Mars. Hydrogen atoms resonantly scatter solar Lyman alpha photons (far-ultraviolet wavelengths) that can be imaged using the ACS detector and a combination if filters onboard the HST. More specifically, each observing run would be a series of clear and filtered images, with the F140LP filter used to image Mars with the Lyman alpha photons blocked and the F115LP (clear) filter which allows the Lyman alpha emission from Mars through to the detector. The scaled difference between the clear and filtered images reveals the Lyman alpha coming from the hydrogen atoms present in the exosphere of Mars. This is very effective in studying the Martian exosphere, as above ~250 km from the Martian surface most of the emission is Lyman alpha.

Sky observations near Mars are critically important to accurately subtract the Lyman alpha emissions coming from the background geocorona and interplanetary hydrogen. The allotted orbits would be divided into a series of 3 visits of 2 orbits each, one observing Mars and one for the sky background, except for the second visit which will consist of one orbit of Mars observations for a total of 5 orbits. However, the second visit would be combined with a complementary calibration proposal visit (#15098) which would conduct the necessary sky observations for it. The three visits would be spaced over a time period of 28 days which would allow us to monitor changes in the hot hydrogen population at Mars over one solar

rotation (28 days) as different regions of the Sun exhibit different solar activity.

HST is the only facility that has the UV sensitivity, necessary angular resolution as well as much larger altitude coverage in order to image the extended hot hydrogen exosphere of Mars. While MAVEN and MEX are capable of measuring the lower exosphere with higher altitude resolution that is fruitful towards studying latitudinal differences, they are not capable of imaging the more energetic hydrogen atoms that reside at the highest reaches of the Martian exosphere. This study will greatly aid in constraining the mechanisms influencing the escape of H from the atmosphere of Mars thereby providing a better estimate of the timeline for the water loss history from Mars.

The ACS/SBC clear (F115LP) images will be taken during the shadow portion of HST's orbit, and the filtered (F140LP) images will be taken when HST is in sunlight to minimize the brightness contributed by the geocoronal H atoms at Lyman alpha. One HST orbit during each observing run will be dedicated towards measuring the background emissions from the interplanetary hydrogen and the geocorona. It is imperative that the background emissions be measured relative to HST's orbital location as experience with past programs has shown that the geocorona is too variable to be modeled with high accuracy for deriving the Lyman alpha emissions from the Martian exosphere. This is very important towards determining the faint emissions from the Martian hydrogen exosphere far from Mars.

The count rates for ACS SBC clear (F115LP) imaging of Mars range from 5000-80000 counts/sec as determined from earlier HST observing campaigns. This count rate is well below the limit of 200,000 counts/sec, and the local count rate limits are also not exceeded. Count rates with F140LP filter are much lower since this filter blocks Lyman alpha emission. The roll angle will be unconstrained for this program. Since Mars moves accross the sky, this generally makes it possible to locate good guide stars within any week-long observing window, and it has been shown in GO 11170, 13794, and 14752 that bright object protection and counting rate limits will not hinder the observations, even when Mars is close to the Sun.

Proposal 15097 - Visit 01 - Imaging the Extended Hot Hydrogen Exosphere at Mars to Determine the Water Escape Rate

Visit

Proposal 15097, Visit 01, failed Wed Jan 17 00:01:18 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: ORIENT 286D TO 294 D; BETWEEN 17-DEC-2017:00:00:00 AND 20-DEC-2017:00:00:00

Comments: Offset Mars disc to one corner of ACS/SBC FOV to image the extended H coronal emission on the sunward side

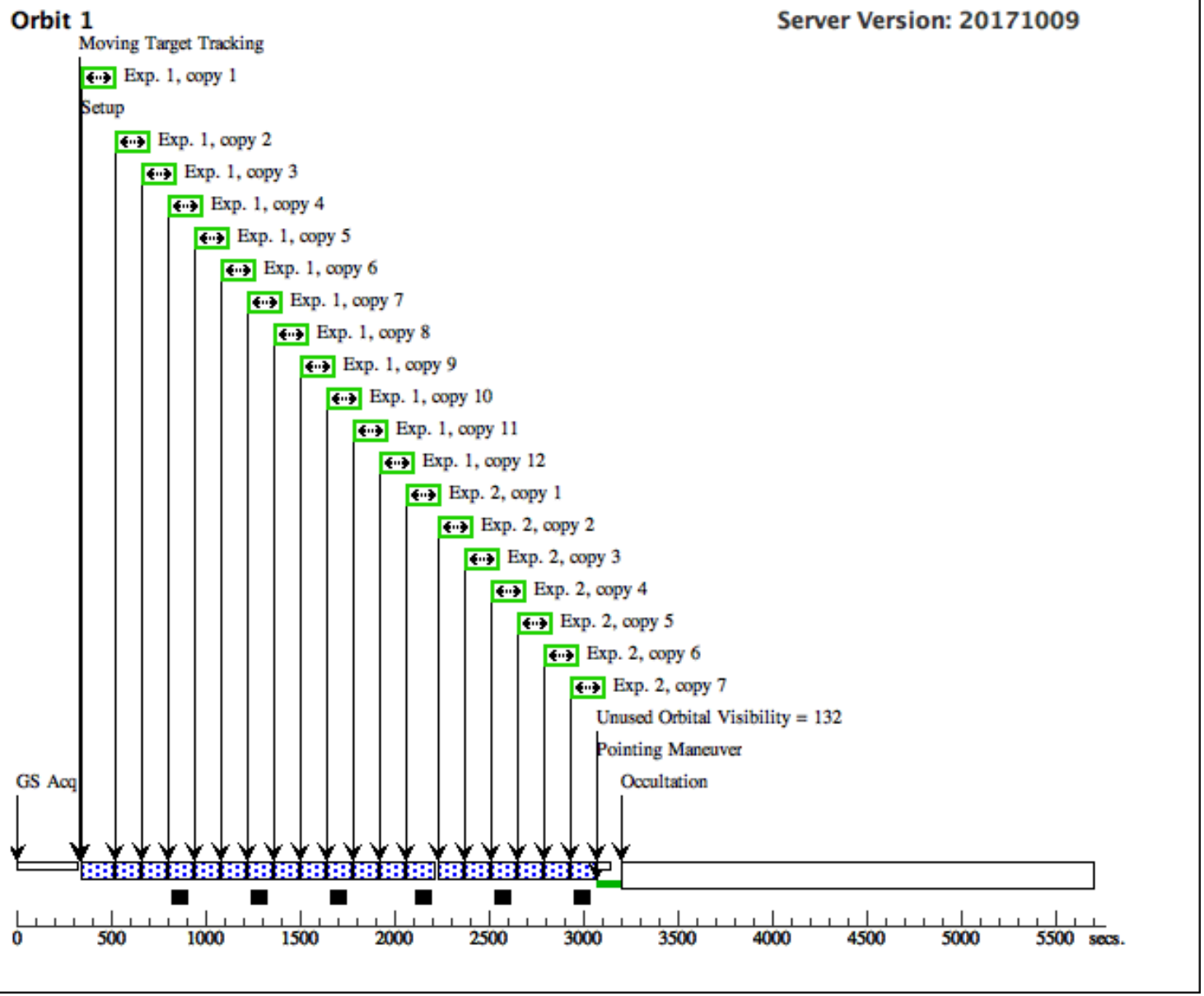
Solar System Targets

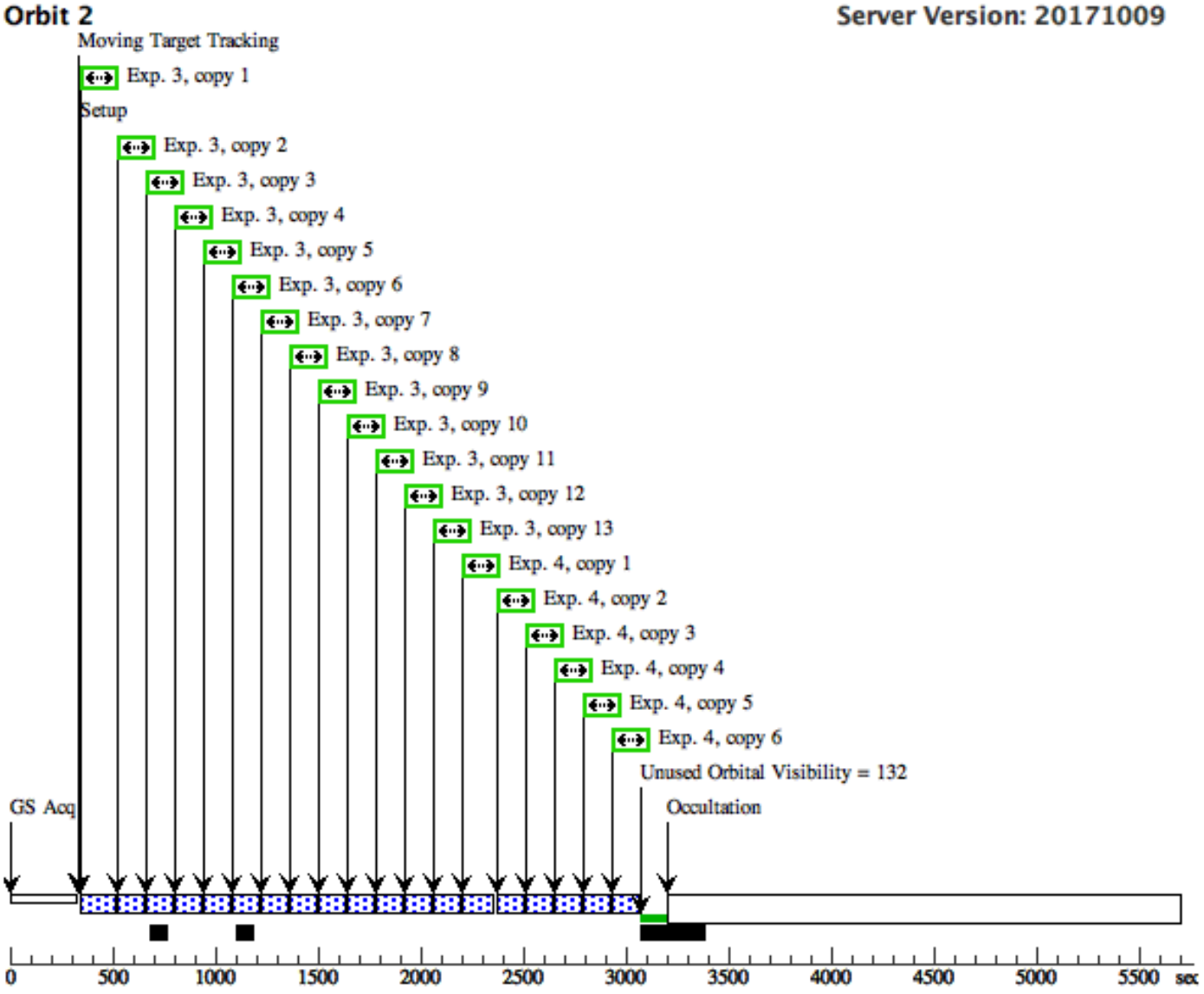
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	MARS-EXOSPHERE	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=172,REF=NORTH			EARTH
(3)	MARS-EXOSPHERE-OFFSET	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH			EARTH

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-EXOSPHERE	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)]*	***[1]***
2	(0)	(1) MARS-EXOSPHERE	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 7 (700 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]*	***[1]***
3	(0)	(3) MARS-EXOSPHERE-OFFSET	ACS/SBC, ACCUM, SBC	F115LP		NEW OBSET FULL ACQ		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]***
4	(0)	(3) MARS-EXOSPHERE-OFFSET	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 6 (600 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]*	***[2]***

Orbit Structure

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Server Version: 20171009
Moving Target Tracking
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Exp. 3, copy 3
Exp. 3, copy 4
Exp. 3, copy 5
Exp. 3, copy 6
Exp. 3, copy 7
Exp. 3, copy 8
Exp. 3, copy 9
Exp. 3, copy 10
Exp. 3, copy 11
Exp. 3, copy 12
Exp. 3, copy 13
Exp. 4, copy 1
Exp. 4, copy 2
Exp. 4, copy 3
Exp. 4, copy 4
Exp. 4, copy 5
Exp. 4, copy 6
Unused Orbital Visibility = 132
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Proposal 15097 - Visit 51 - Imaging the Extended Hot Hydrogen Exosphere at Mars to Determine the Water Escape Rate

Visit

Proposal 15097, Visit 51, implementation Wed Jan 17 00:01:18 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: ORIENT 278D TO 285 D; BETWEEN 09-FEB-2018:00:00:00 AND 11-FEB-2018:00:00:00

Comments: Offset Mars disc to one corner of ACS/SBC FOV to image the extended H coronal emission on the sunward side

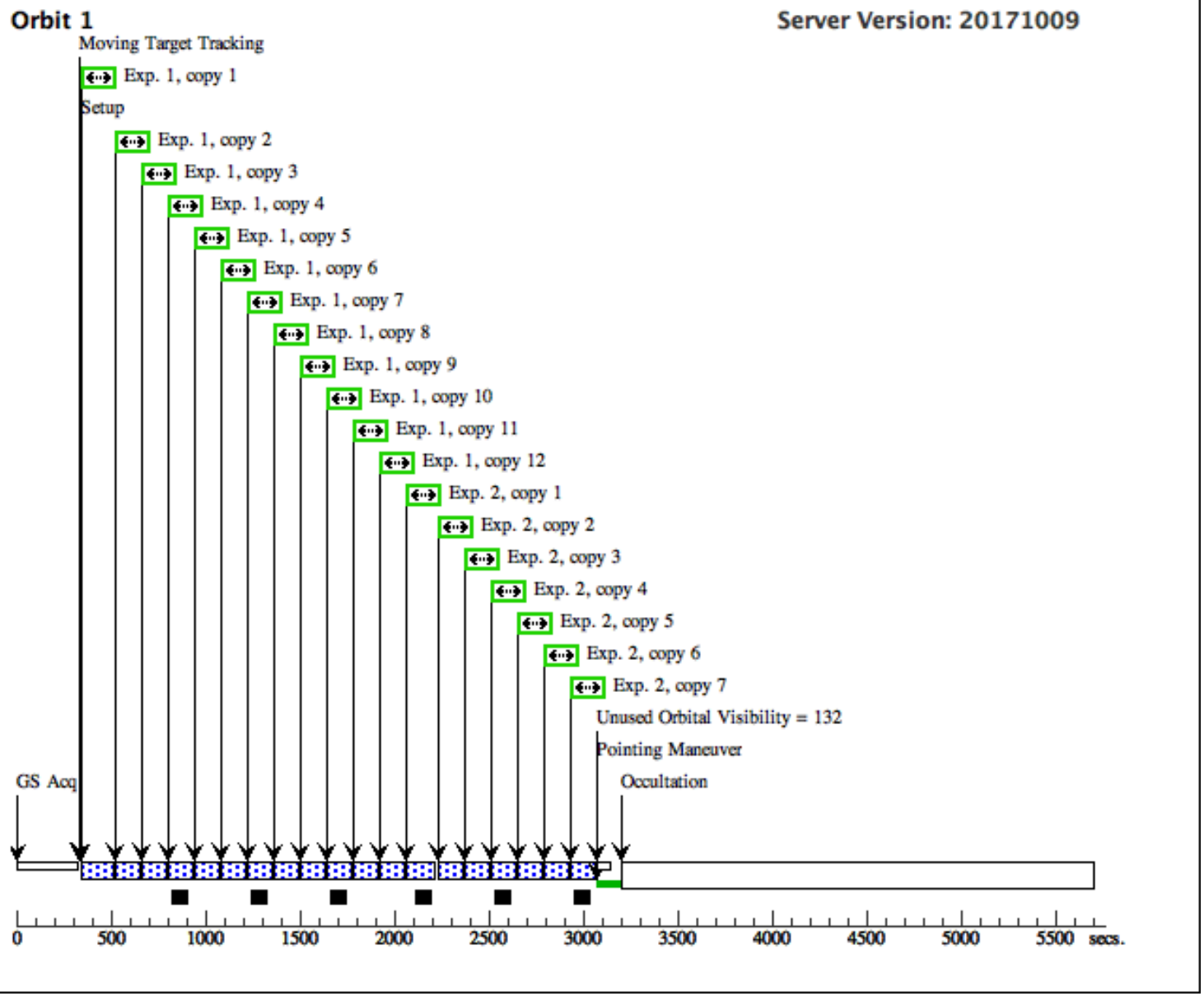
Solar System Targets

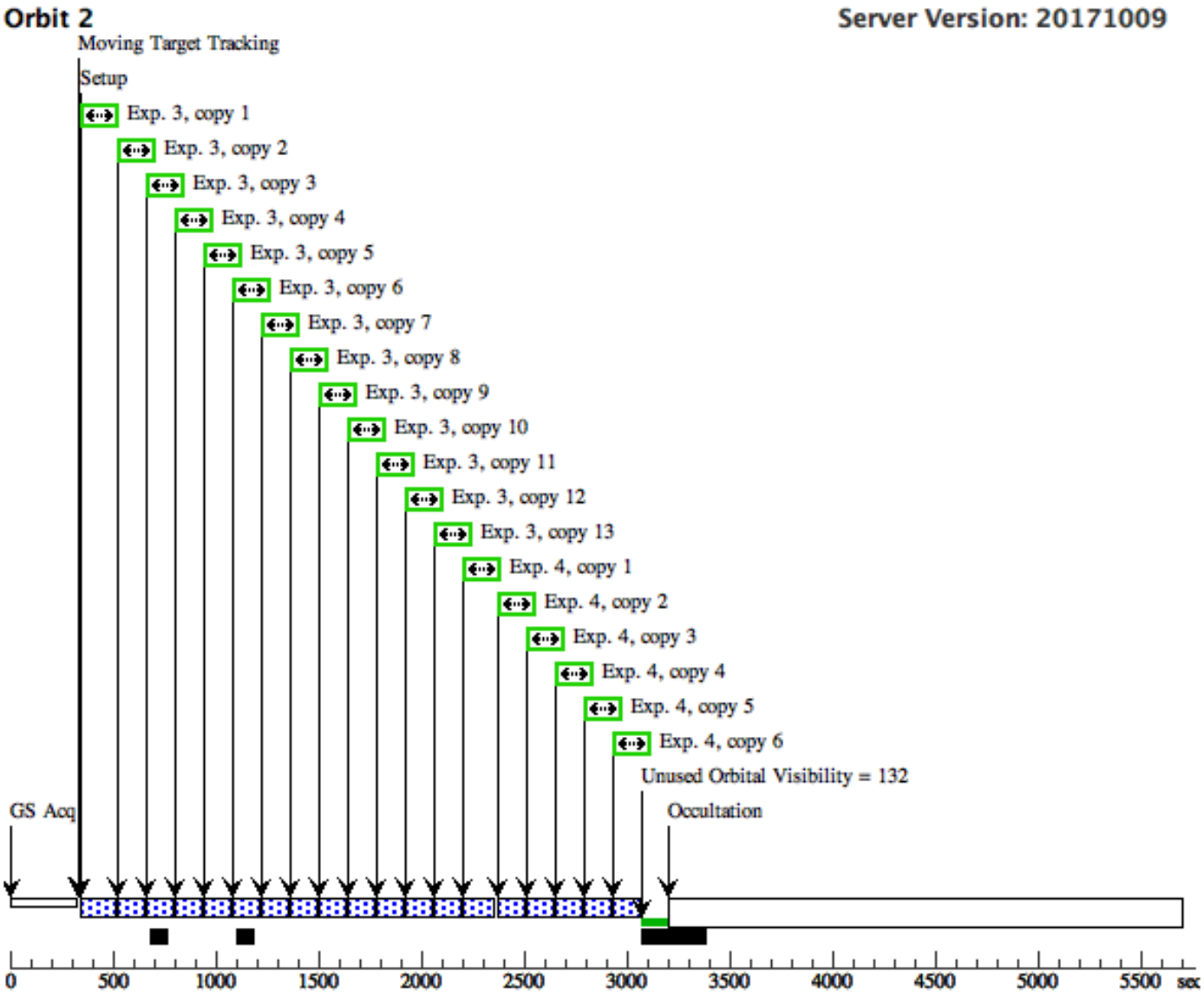
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	MARS-EXOSPHERE	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=172,REF=NORTH			EARTH
(3)	MARS-EXOSPHERE-OFFSET	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH			EARTH

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-EXOSPHERE	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)]*	***[1]***
2	(0)	(1) MARS-EXOSPHERE	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 7 (700 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]*	***[1]***
3	(0)	(3) MARS-EXOSPHERE-OFFSET	ACS/SBC, ACCUM, SBC	F115LP		NEW OBSET FULL ACQ		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]***
4	(0)	(3) MARS-EXOSPHERE-OFFSET	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 6 (600 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20171009
Moving Target Tracking
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Exp. 3, copy 12
Exp. 3, copy 13
Exp. 4, copy 1
Exp. 4, copy 2
Exp. 4, copy 3
Exp. 4, copy 4
Exp. 4, copy 5
Exp. 4, copy 6
Unused Orbital Visibility = 132
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15097, Visit 02, completed Wed Jan 17 00:01:18 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: ORIENT 283D TO 290 D; AFTER 01 BY 13 D TO 15 D

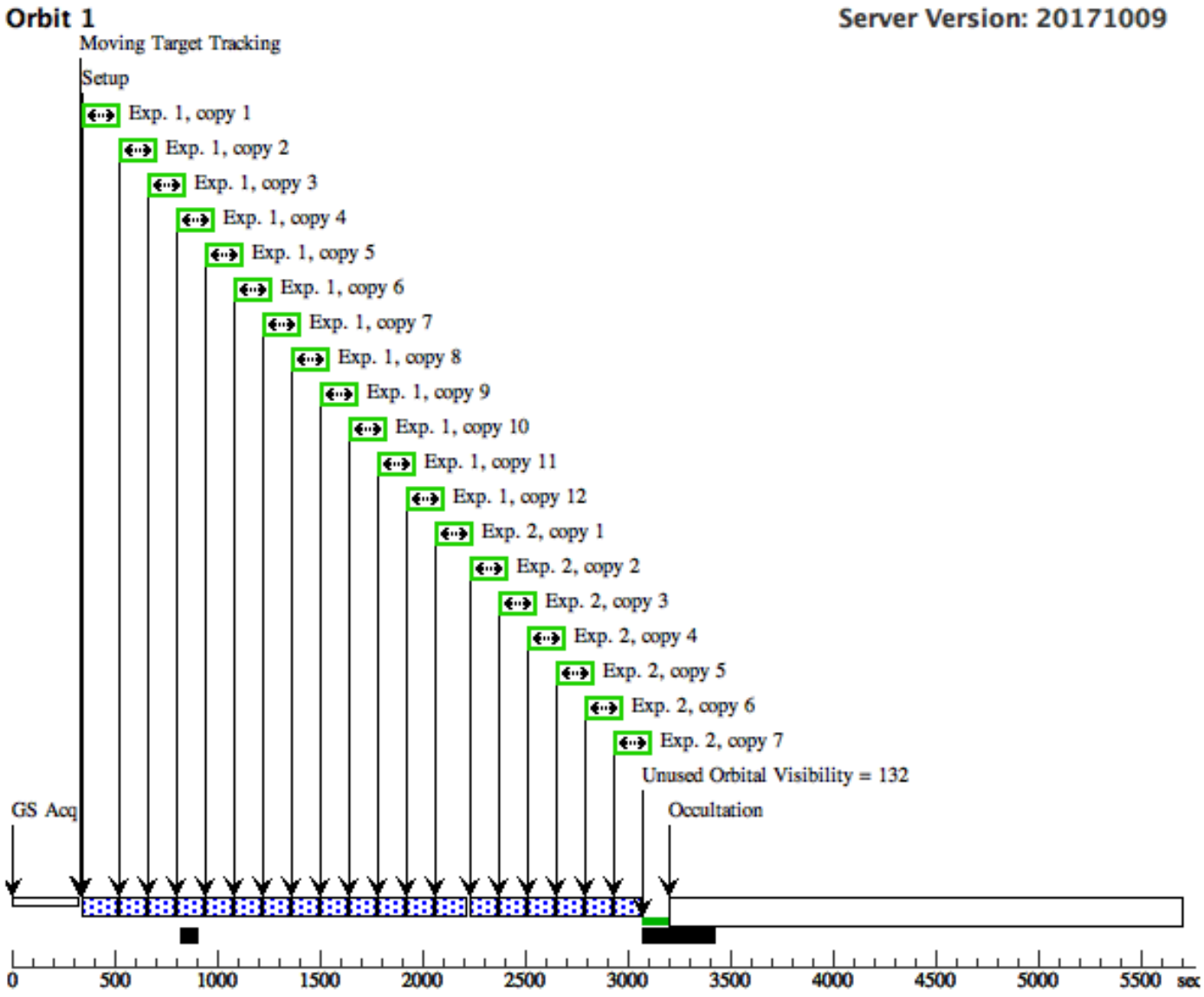
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	MARS-EXOSPHERE	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=172,REF=NORTH			EARTH

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-EXOSPHERE	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 12 (1200 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	
								[==>(Copy 8)]	
								[==>(Copy 9)]	
								[==>(Copy 10)]	
								[==>(Copy 11)]	
								[==>(Copy 12)]	
2	(0)	(1) MARS-EXOSPHERE	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 7 (700 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	

Orbit Structure



Proposal 15097 - Visit 03 - Imaging the Extended Hot Hydrogen Exosphere at Mars to Determine the Water Escape Rate

Visit

Proposal 15097, Visit 03, completed Wed Jan 17 00:01:18 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: ORIENT 281D TO 288 D; AFTER 01 BY 26 D TO 28 D

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	MARS-EXOSPHERE	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=172,REF=NORTH			EARTH
(3)	MARS-EXOSPHERE-OFFSET	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH			EARTH

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-EXOSPHERE	ACS/SBC, ACCUM, SBC	F115LP				100 Secs X 11 (1100 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	
								[==>(Copy 8)]	
								[==>(Copy 9)]	
								[==>(Copy 10)]	
								[==>(Copy 11)]	
2	(0)	(1) MARS-EXOSPHERE	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 8 (800 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	
								[==>(Copy 8)]	
3	(0)	(3) MARS-EXOSPHERE-OFFSET	ACS/SBC, ACCUM, SBC	F115LP		NEW OBSET FULL ACQ		100 Secs X 13 (1300 Secs)	
								[==>(Copy 1)]	***[2]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	
								[==>(Copy 8)]	
								[==>(Copy 9)]	
								[==>(Copy 10)]	
								[==>(Copy 11)]	
								[==>(Copy 12)]	
								[==>(Copy 13)]	
4	(0)	(3) MARS-EXOSPHERE-OFFSET	ACS/SBC, ACCUM, SBC	F140LP				100 Secs X 6 (600 Secs)	
								[==>(Copy 1)]	***[2]***
								[==>(Copy 2)]	
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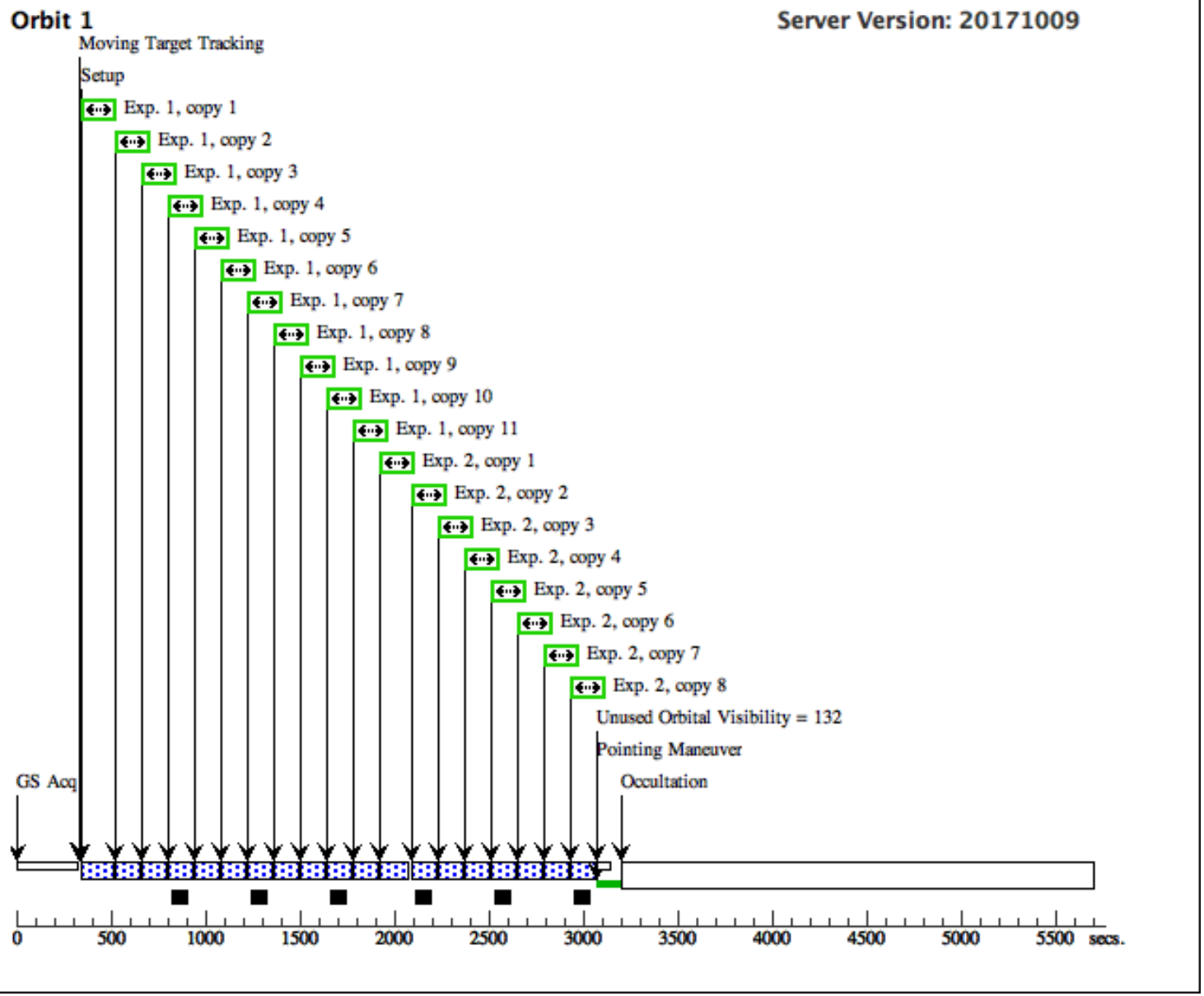
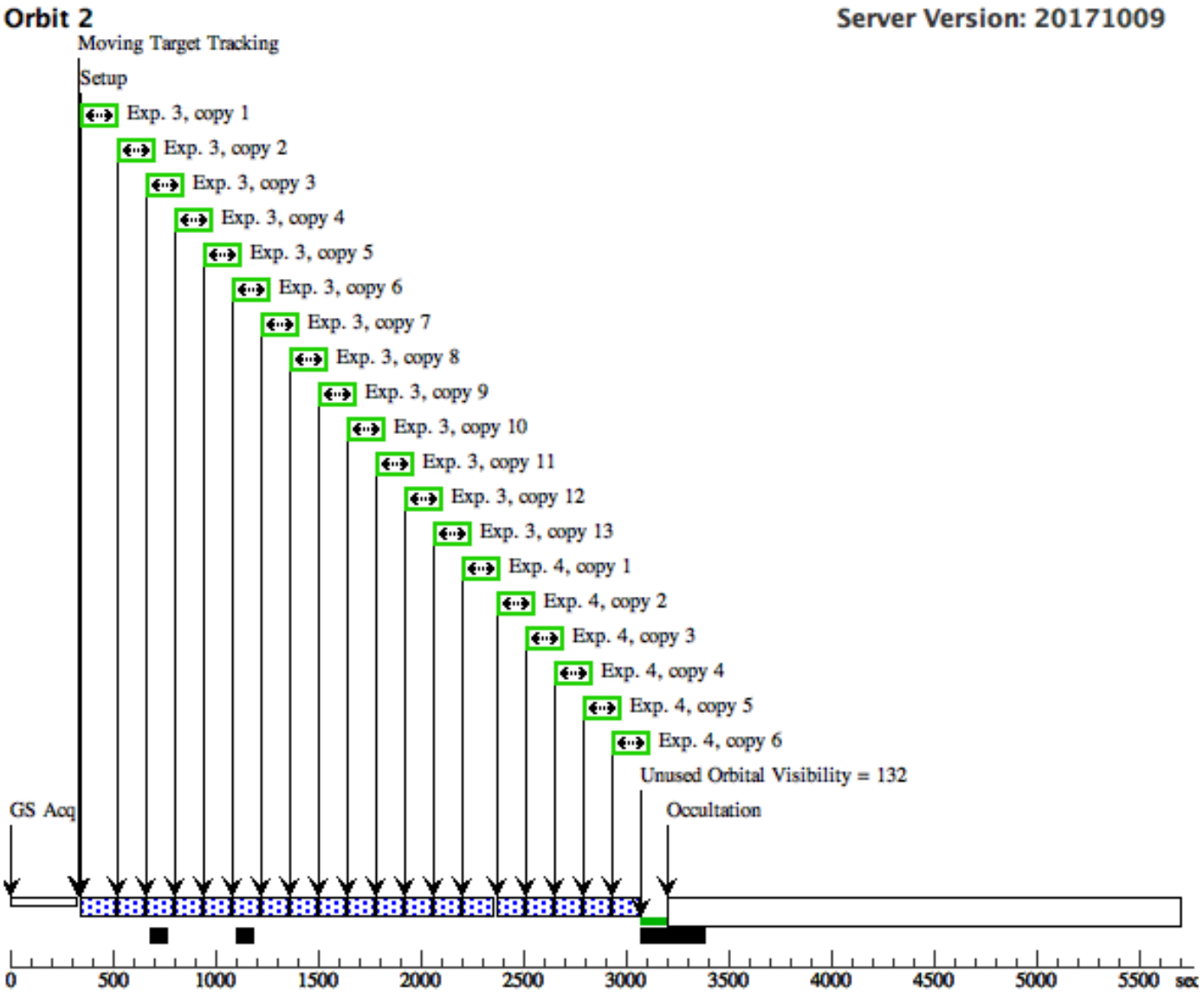
								[==>(Copy 6)]	

Orbit Structure




Orbit 2
Server Version: 20171009
Moving Target Tracking
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Exp. 3, copy 7
Exp. 3, copy 8
Exp. 3, copy 9
Exp. 3, copy 10
Exp. 3, copy 11
Exp. 3, copy 12
Exp. 3, copy 13
Exp. 4, copy 1
Exp. 4, copy 2
Exp. 4, copy 3
Exp. 4, copy 4
Exp. 4, copy 5
Exp. 4, copy 6
Unused Orbital Visibility = 132
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec