



13632 - Seasonal Dependence of the Escape of Martian Water

Cycle: 21, Proposal Category: GO/DD

(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-ACS (2) SKY-NEAR-MARS	ACS/SBC	2	09-May-2014 00:50:20.0	yes
02	(3) MARS-STIS	STIS/FUV-MAMA	1	09-May-2014 00:50:36.0	yes

3 Total Orbits Used

ABSTRACT

This proposal is to obtain ACS/SBC images and STIS spectra of the extended H Ly alpha and O 1304 emissions from H and O atoms in the atmosphere of Mars to study seasonal changes in the escape rate of H and O atoms, and thereby water. Prior HST observations have revealed a surprising rapid change in the H escape rate in late martian summer following a global dust storm, and have shown that STIS spectra can easily detect superthermal O atoms. The relative degree of influence of seasons and dust storms on the H density and escape flux are not known, and little is

known about variations in the hot O density and escape rate. The timing of these observations is key to these scientific goals. Mars is now approaching the Sun, HST can observe Mars over a wide range of seasons from April - Nov 2014, and HST will not be able to observe Mars again until after the prime mission of MAVEN. These observations will provide strong support for the NASA MAVEN mission, scheduled to arrive at Mars in Sept. 2014. This proposal is for a single visit of 3 HST orbits in late spring 2014 to establish the baseline conditions when Mars is far from the Sun.

OBSERVING DESCRIPTION

We propose to obtain ACS SBC UV images and STIS G140L spectra of Mars to measure the distribution of exospheric hydrogen and oxygen via the extended H Ly alpha and OI 1304 emissions. 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.

For the OI 1304 emission the STIS G140L with 52x0.5 arc sec aperture will be used to spectrally separate the different emissions with imaging along the slit. From prior spectra, there is sufficient sensitivity found to detect the hot O emission to an altitude above 1000 km in a single HST orbit. We request one visit of 3 orbits to set the level of emission when Mars is far from the Sun.

The ACS/SBC clear (F115) images will be taken during the portion of the HST orbit when HST is in shadow, and filtered (F140) images when HST is in sunlight, to minimize the geocoronal background brightness at Ly alpha. In the 2007 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, 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 the 2007 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 (ACS and STIS) and 1 on the sky background (ACS).

In more detail, in GO program 11170 we obtained ACS SBC images of H Ly alpha emission from the hydrogen corona in three visits near solar minimum in Fall 2007. The image is the scaled difference between F115LP and F140LP images to remove the reflected solar continuum from the disc of Mars, and the disk portion has been replaced by a scaled FUV image. Above ~200 km altitude the emission is purely H Ly alpha. It is important to obtain time-series images of the geocoronal sky background close in time to the martian images to accurately subtract the background emission, as was done with these data. In Figure 1b one can see from the intensity traces that the emission steadily decreased, maintaining a shape consistent with a single ~300 K H population but decreasing in intensity by more than 30 % over 4 weeks' time. The model profiles correspond to H fluxes by Jean's escape of 2.6 , 2.1 , and $1.8 \times 10^8 \text{ cm}^{-2}\text{-sec}^{-1}$. The same general decrease in martian Ly alpha emission was detected by SPICAM from within the atmosphere in coordinated observations. We note that better fits are obtained to the ACS profiles with a lower temperature plus a hot component. This requires a detailed comparison with an exosphere / radiative transfer model, work which is ongoing.

HST is the only facility that has the UV sensitivity and angular resolution necessary for these observations. While the SPICAM instrument on Mars Express can also measure Ly alpha, its location in an orbit within the martian H corona and operational constraints do not permit mapping of the extended emission. The same constraints will apply to MAVEN, whose apoapse distance will be ~ 4000 km. We will schedule coordinated SPICAM observations of the limb altitude profile of the Ly alpha emissions from inside the atmosphere (J.-L. Bertaux), for comparison and cross-calibration of the H distribution measurements. However, the SPICAM instrument now responds intermittently to commands, and may or may not be available for new observations. If data are forthcoming, this will aid the modeling effort to derive the distribution of H atoms with altitude and local time, and confirm any long-term trends in the coronal emission.

The count rates for ACS SBC clear (F115) imaging of Mars from GO 11170 range from 5000 - 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 that bright object protection and counting rate limits will not hinder the observations. Count rates with STIS G140L are much lower than with ACS SBC, and well below the maximum allowed.

Proposal 13632 - Mars-ACS (01) - Seasonal Dependence of the Escape of Martian Water

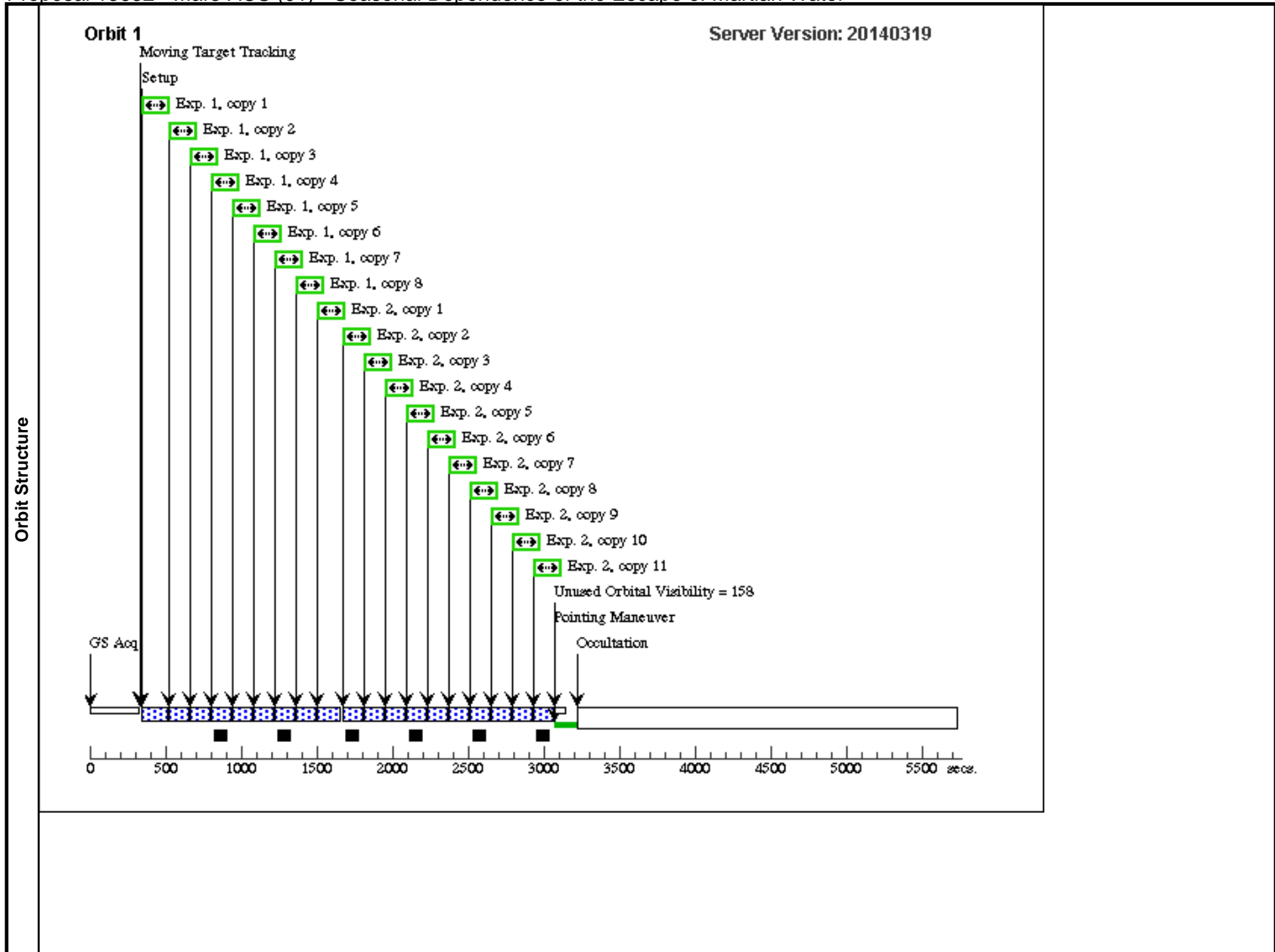
Fri May 09 04:50:45 GMT 2014

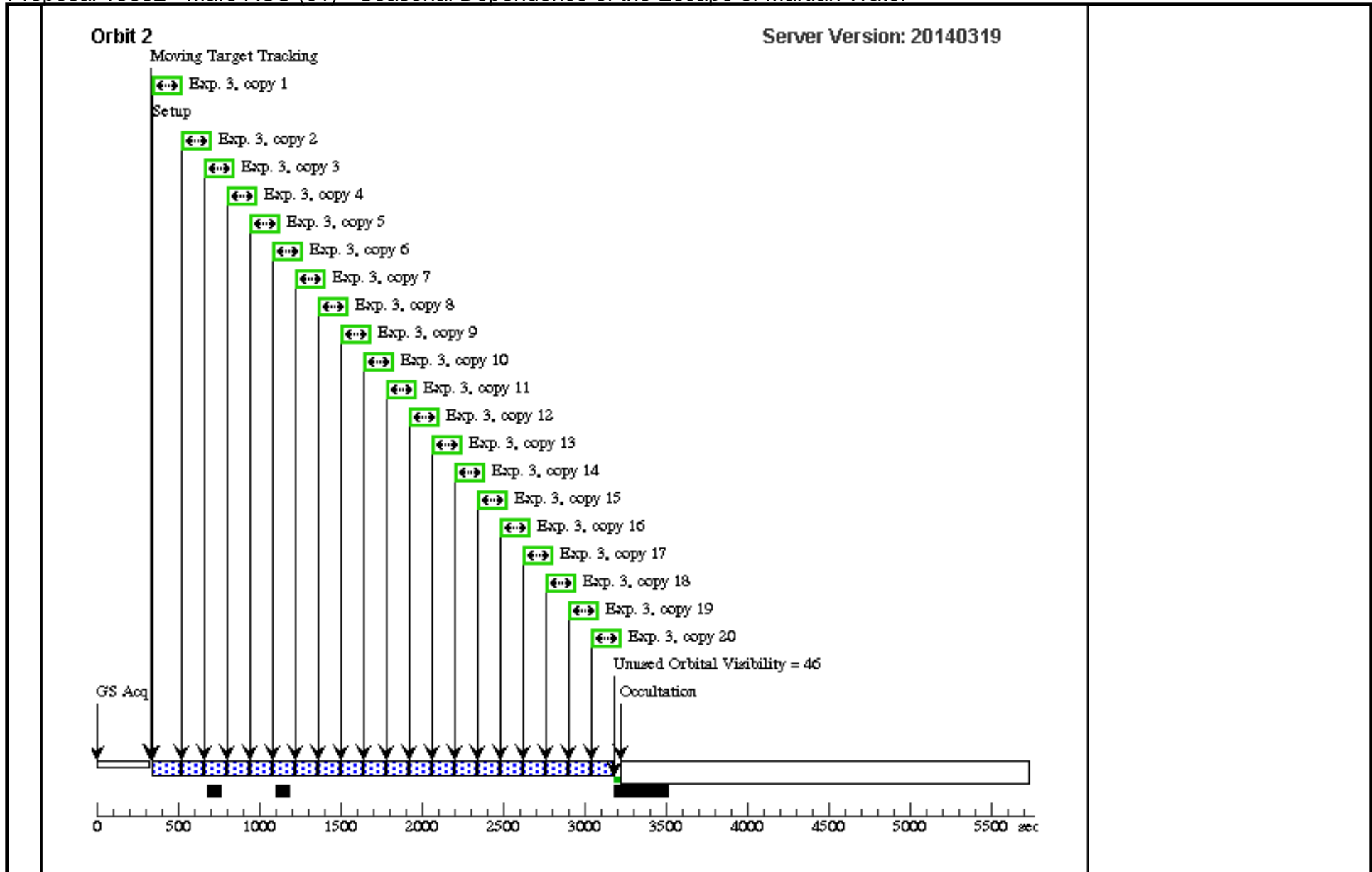
Visit	Proposal 13632, Mars-ACS (01), implementation Diagnostic Status: Warning Scientific Instruments: ACS/SBC Special Requirements: ORIENT 93D TO 95 D; BEFORE 01-JUN-2014:00:00:00					
	(Exposure 1 (Mars-ACS (01))) Warning (Form): Sensitive exposures should have an ETC run number provided. (Exposure 2 (Mars-ACS (01))) Warning (Form): Sensitive exposures should have an ETC run number provided. (Exposure 3 (Mars-ACS (01))) Warning (Form): Sensitive exposures should have an ETC run number provided.					
Diagnosics						
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window
	(1)	MARS-ACS	STD=MARS	TYPE=POS_ANGLE,RAD=13,ANG=325,REF=NORTH		EARTH
	<i>Comments: H and O emission UV count rates are described in the text</i>					
(2)	SKY-NEAR-MARS	STD=MARS	TYPE=POS_ANGLE,RAD=295,ANG=0,REF=NORTH		EARTH	
<i>Comments: just sky background Ly alpha emission</i>						

Proposal 13632 - Mars-ACS (01) - Seasonal Dependence of the Escape of Martian Water

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1) MARS-ACS		ACS/SBC, ACCUM, SBC-FIX	F140LP				100 Secs X 8 (800 Secs)	[1]
								[==>(Copy 1)]	
								[==>(Copy 2)]	
2	(1) MARS-ACS		ACS/SBC, ACCUM, SBC-FIX	F115LP				100 Secs X 11 (1100 Secs)	[1]
								[==>(Copy 1)]	
								[==>(Copy 2)]	
3	(2) SKY-NEAR-MA RS		ACS/SBC, ACCUM, SBC-FIX	F115LP		NEW OBSET FULL ACQ		100 Secs X 20 (2000 Secs)	[2]
								[==>(Copy 1)]	
								[==>(Copy 2)]	

Exposures





Proposal 13632 - Mars-STIS (02) - Seasonal Dependence of the Escape of Martian Water

Fri May 09 04:50:48 GMT 2014

Visit	Proposal 13632, Mars-STIS (02), scheduling Diagnostic Status: Warning Scientific Instruments: STIS/FUV-MAMA Special Requirements: ORIENT 130D TO 136 D; BEFORE 01-JUN-2014:00:00:00
	(Mars-STIS (02)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (Exposure 1 (Mars-STIS (02))) Warning (Form): Sensitive exposures should have an ETC run number provided.

Diagnosics	(Mars-STIS (02)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (Exposure 1 (Mars-STIS (02))) Warning (Form): Sensitive exposures should have an ETC run number provided.
	(Exposure 1 (Mars-STIS (02))) Warning (Form): Sensitive exposures should have an ETC run number provided.

Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
	(3)	MARS-STIS	STD=MARS				

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(3) MARS-STIS		STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140L 1425 A	BUFFER-TIME=30 00				2450 Secs (2450 Secs) [==>]

