



16917 - Water loss from Mars: Energetic Deuterium and its effects on the D/H ratio

Cycle: 29, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

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) DISK-OF-MARS WAVE	STIS/FUV-MAMA	2	22-Jun-2022 08:00:18.0	yes
02	(2) SKY-NEAR-MARS WAVE	STIS/FUV-MAMA	1	22-Jun-2022 08:00:19.0	yes

3 Total Orbits Used

ABSTRACT

How much water did Mars lose over time? Can it be estimated by looking at the present value of the D/H ratio at Mars? The current picture of martian water escape estimates that Mars has lost ~140 m of global equivalent layer (GEL) of water over its evolution history based on the enhanced D/H ratio of ~4-8 times the value at Earth. Recently completed analysis of D and H Lyman alpha observations obtained by the Mars Atmosphere Volatile Evolution (MAVEN) mission show that the D and H exospheric densities undergo large changes in a short timescale of weeks. The present escape process that would facilitate such fast depletion of the column of D and H is insufficient to account for the magnitude of change observed,

Proposal 16917 (STScI Edit Number: 12, Created: Wednesday, June 22, 2022 at 7:00:19 AM Eastern Standard Time) - Overview raising the likelihood of the presence of an energetic population of D and H created by non-thermal processes. The existence of such a population of H has been recently discovered with HST. The proposed 3-orbit observations with STIS is to discover energetic D atoms in the exosphere of Mars. The discovery and characterization of such a population is key towards determining the total water lost by Mars, and would increase the current estimates by a notable amount. The results from this observation program will also have significant effects towards our understanding of using the D/H metric in determining the total amount of water lost not only from Mars, but from other planetary atmospheres as well. This proposal supports the HST UV initiative.

OBSERVING DESCRIPTION

This program will observe Mars in the far ultraviolet with the STIS spectrograph in conjunction with the E140H echelle grating in order to observe the deuterium Lyman-alpha emission 1215.33 Ang from the martian exosphere. The aim of this program is to detect the energetic deuterium in population at Mars. The E140H grating is required as it is capable of separating the martian D and H Lyman-alpha line which are separated by 0.33 Ang. The STIS Echelle spectrograph has a high resolution of 0.057 Ang using the 0.5 arcsec aperture. This aperture is more than enough to separate the H and D lines at Mars. We will utilize the TIMETAG configuration and the 52 x 0.5 aperture for this observation. The 52 arcsec long aperture is necessary for the observation line as it provides a higher count rate for the extended emission region where the D emission is faint. The success of the proposed science depends on the ability to detect faint D emissions above the limb of the planet. A count rate of 5 counts/sec-kR within the 52 x 0.5 arcsec aperture field of view at Lyman alpha has been well demonstrated in previous HST observations of Mars, Jupiter, and the interplanetary hydrogen in the far-ultraviolet.

Three HST orbits will be utilized for the whole program. These orbits will be executed in July 2022 when the conditions for observing the faint martian D Lyman alpha emission above the limb is ideal. This is because the Mars solar longitude at the time of the observations will be close to 270 degrees when the martian D emission will be at its peak brightness. The Sun-Earth-Mars angle will be close to 77 degrees which means Mars will be more on the night side of Earth and out of HST's solar exclusion zone. This is beneficial because the background Lyman alpha emission from the Earth's hydrogen exosphere will be smaller. This background emission can have intensities > 30 kR on the dayside and intensities < 5 kR on the night side. Mars being more on the night side will reduce the intensity of this background emission. There is no contamination expected from Earth's D Lyman alpha line as the intensity from this line is non-detectable at HST's altitude with the observing line of sight pointed away from the planet.

Out of the three orbits, the first two will point the STIS instrument on the disk of Mars. Mars will be at a distance of ~ 1.18 AU from Earth and will have an angular diameter of ~ 7.9 arcseconds in the sky. The 52x0.5 arcsec slit will easily cover the whole disk of Mars and altitudes up to ~ 7000 km

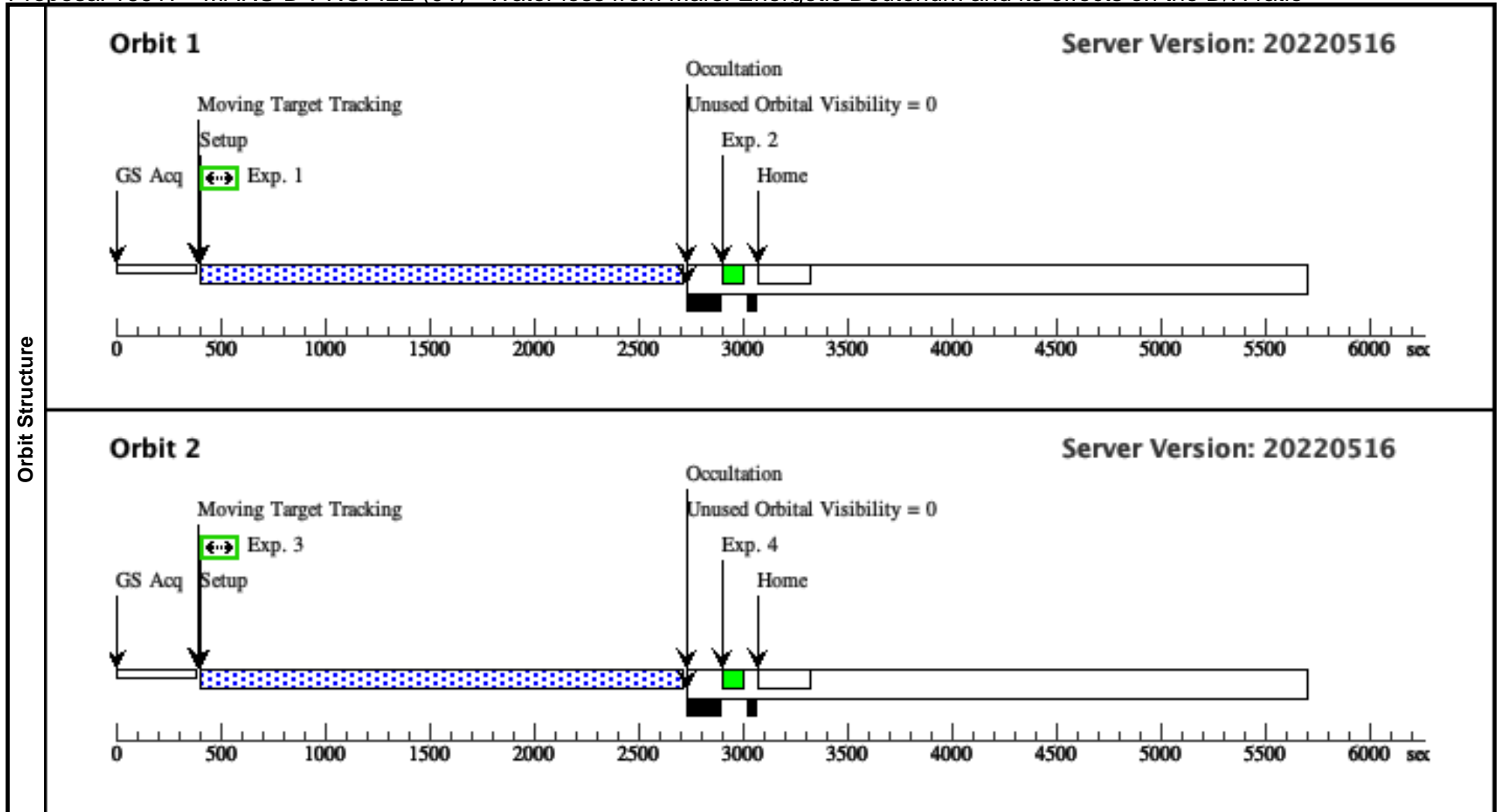
Proposal 16917 (STScI Edit Number: 12, Created: Wednesday, June 22, 2022 at 7:00:19 AM Eastern Standard Time) - Overview
above the limb. The emission from altitudes above the limb is necessary to detect the change in slope from the presence of energetic D atoms. Energetic D is expected to dominate above ~300 km altitude at Mars during southern summer solstice. The D emission intensity is ~800 Rayleighs on the Mars disk for medium solar activity at southern summer solstice. The intensity falls off exponentially with altitude from the limb of the planet and is expected to have intensities <50 R at 300 km. The STIS E140H instrument with the 52x0.5 arcsec slit would get ~600 counts from a 50 R emission for an integration time of 2400 sec.

The third orbit will be used to point STIS 3 arcminute away from Mars in order to measure the background emissions from the geocorona and IPH. Measurement of these background emissions is extremely necessary as this has to be subtracted off from the Mars H Lyman alpha line to get the correct estimate of its intensity due to the overlap between the three lines. The Mars H Lyman alpha line intensity will be used to estimate the D/H ratio from the thermal H atoms dominating the emission from the disk of Mars. This estimate will then be modified to account for the presence of energetic D. This will allow us to better understand the implications of the presence of energetic D on the D/H ratio metric and its usage in determining the total amount of water lost from Mars.

Proposal 16917 - MARS-D-PROFILE (01) - Water loss from Mars: Energetic Deuterium and its effects on the D/H ratio

Wed Jun 22 12:00:19 GMT 2022

Visit	Proposal 16917, MARS-D-PROFILE (01), implementation Diagnostic Status: Warning Scientific Instruments: STIS/FUV-MAMA Special Requirements: ORIENT 246D TO 258 D; AFTER 02 BY 0.9 Orbits TO 1.1 Orbits; BETWEEN 14-JUL-2022:00:00:00 AND 30-JUL-2022:00:00:00; VISIBILITY INTERVAL 45.5 M <i>Comments: This program will look at the disk of Mars and the limb to detect the D emission profile above the limb</i>									
	(MARS-D-PROFILE (01)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS.									
Diagnosics										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	DISK-OF-MARS	STD=MARS				EARTH			
<i>Comments: Description=Exosphere of Mars Extended=YES</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	MARS-OR B-1 (0)	(1) DISK-OF-MARS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=1106; WAVECAL=NO			2211 Secs (2159 Secs) [==>2159.0 Secs]	[1]
	2	WAVECAL 1	WAVE	STIS/FUV-MAMA, ACCUM, 6X0.2	E140H 1234 A				40 Secs (40 Secs) [==>]	[1]
	3	MARS-OR B-2 (0)	(1) DISK-OF-MARS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=1169; WAVECAL=NO	NEW OBSET FULL ACQ		2337 Secs (2159 Secs) [==>2159.0 Secs]	[2]
	4	WAVECAL 2	WAVE	STIS/FUV-MAMA, ACCUM, 6X0.2	E140H 1234 A				40 Secs (40 Secs) [==>]	[2]



Proposal 16917 - MARS-D-PROFILE (02) - Water loss from Mars: Energetic Deuterium and its effects on the D/H ratio

Wed Jun 22 12:00:19 GMT 2022

Visit
Proposal 16917, MARS-D-PROFILE (02), implementation
Diagnostic Status: Warning
 Scientific Instruments: STIS/FUV-MAMA
 Special Requirements: ORIENT 246D TO 258 D; BETWEEN 14-JUL-2022:00:00:00 AND 30-JUL-2022:00:00:00; VISIBILITY INTERVAL 45.5 M
Comments: This program will look at the disk of Mars and the limb to detect the D emission profile above the limb

Diagnostics
 (MARS-D-PROFILE (02)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS.

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	SKY-NEAR-MARS	STD=MARS	TYPE=POS_ANGLE,RAD=300,ANG=0,REF=NORTH			EARTH
<i>Comments: Description=Offset to sky near Mars Extended=YES</i>						

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	SKY-NEAR-MARS-OR B3 (0)	(2) SKY-NEAR-MARS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=1106; WAVECAL=NO			2212 Secs (2159 Secs) [=>2159.0 Secs]	[1]
2	WAVECAL 3	WAVE	STIS/FUV-MAMA, ACCUM, 6X0.2	E140H 1234 A				40 Secs (40 Secs) [=>]	[1]

