



13047 - The D/H Ratio and Escape of Water from Venus

Cycle: 20, Proposal Category: GO

(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) VENUS (2) VENUS-OFFSET-7D	S/C STIS/FUV-MAMA	1	30-Sep-2013 21:01:08.0	yes
02	(1) VENUS (3) VENUS-OFFSET-6P9D	S/C STIS/FUV-MAMA	1	30-Sep-2013 21:01:17.0	yes
03	(2) VENUS-OFFSET-7D	STIS/FUV-MAMA	1	30-Sep-2013 21:01:22.0	yes
04	(1) VENUS (2) VENUS-OFFSET-7D	S/C STIS/FUV-MAMA	1	30-Sep-2013 21:01:28.0	yes
05	(1) VENUS (2) VENUS-OFFSET-7D	S/C STIS/FUV-MAMA	1	30-Sep-2013 21:01:33.0	yes
06	(2) VENUS-OFFSET-7D	STIS/FUV-MAMA	1	30-Sep-2013 21:01:38.0	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>
10	(4) S8G1000134-TEST	S/C	1	30-Sep-2013 21:01:40.0	yes
11	(5) S8G1000147-TEST	S/C	1	30-Sep-2013 21:01:42.0	yes

8 Total Orbits Used

ABSTRACT

This proposal is to make STIS E140H long aperture observations of Venus near elongation to measure the D and H Ly alpha emissions to determine the D/H ratio in the upper atmosphere, with implications for the historic escape of water into space. It is important to determine the actual D Ly alpha brightness in Venus' upper atmosphere, and also to measure the center-to-limb variation of the H Ly alpha emission, to understand the radiative transfer of these emissions and derive accurate values for the densities of both H and D and thus the D/H ratio. The combination of one long-slit STIS spectrum of Venus and the coordinated sounding rocket data can put to rest uncertainties about the D/H ratio and escape of water that have lingered since Pioneer Venus orbited Venus in the late 1980's.

OBSERVING DESCRIPTION

The next Venus opposition periods are August 15, 2012 at western elongation and November 1, 2013 at eastern elongation. While these bracket either side of cycle 20, we prefer the latter observing period for the line of sight Doppler shift. The requirement is to have a sufficient Doppler shift from the combined line of sight orbital motions of Venus and the Earth to separate the terrestrial and cytherian emissions. We place a limit of 14 km/sec (the spectral resolution of STIS E140H with the 0.5 aperture) to cleanly separate the lines. The detection of D Ly alpha also imposes the requirement that Venus appear blue-shifted with respect to the geocoronal emissions, to prevent the geocoronal H line from overlapping with the Venus D line. Observations in late September 2013 satisfy this criterion (all evening apparitions of Venus are OK).

With the STIS 52 x 0.5 arc sec aperture and 0.057 Angstrom resolution, equal to 14 km/sec velocity resolution, we will just resolve the Venus lines from the geocoronal lines with the Doppler shift from the combined orbital motion near elongation. In addition, we will have sky measurements of the geocoronal H and D lines through the rest of the aperture, providing a higher S/N ratio than in the Venus spectrum for an accurate subtraction. This would give a limiting detection brightness of roughly 100 R at 3 sigma in a 300 sec. observation, limited by a combination of photon counting statistics and the grating scattered light from the H line plus the subtraction of the geocoronal emission. This limiting brightness is factor of 3 below the IUE limit and an order of magnitude lower than theoretical estimates, and thus sufficient to place strong constraints on the D abundance in the upper atmosphere of Venus.

As stated above, the combined goal of this proposal is to detect the D emission and to obtain the intensity profile of the H emission across the Venus disc to help to model the H density with a radiative transfer code. From prior STIS E140H observations we know that we will get 0.4 cts/sec-arcsec² from a 1 kR emission. In a 5 min integration (limited by the technique of observing Venus after it rises but before the Sun rises) covering 8 x 0.5 arc sec of the Venus sunlit disc, we would get a total of 48 counts from a 100 R D Ly alpha emission and 250 counts per 0.2 arc sec resolution element from the 20 kR H Ly alpha emission. We request 2 orbits to observe Venus each visit to build the S/N ratio, plus one orbit for sky background. The combined 600 sec exposure time on Venus is what was obtained in the recent GO 12433. From that program we assume that 5 min observing time can be obtained each orbit, and this should be confirmed by STScI staff. If 600 sec total observing time requires more than 8 orbits, we would restrict the integration time on Venus to this number. The count rate from the D emission would be limited, but the H intensity profile across Venus would be well sampled.

REAL TIME JUSTIFICATION

We will schedule the HST observations with similar observing conditions as NASA sounding rocket 36.261. The observations do not have to be simultaneous for a fruitful comparison of the data, e.g. models can account for differences in geometry and field of view, and we can scale the intensities by the measured solar Ly alpha flux at the times of both observations corrected for the angle between the Earth and Venus. The rocket experiment are expected to have a higher sensitivity to D Ly alpha emission than HST, but much lower angular resolution. The STIS data will have high angular resolution to obtain the spatial profile of H Ly alpha emission across the Venus disc, in addition to the line profile, so that we can model the H abundance with a radiative transfer code.

The Venus Express UV spectrometer (PI J-L. Bertaux, co-I J-Y. Chaufray) observes the dayside H Lyman-alpha emission routinely in limb mode (Chaufray et al. 2012). Dayside limb observations by SPICAV-VEX will be performed at the same time to support HST observations. Paxton et al. (1988) show that disc and limb observations are complementary to study H in the upper atmosphere of Venus. Limb observations are useful to constrain H density above the exobase but are not sensitive to thermospheric H density (Chaufray et al. 2012), while disc observations are mostly sensitive to thermospheric H but not sensitive to exospheric H distribution. Because the thermospheric H density is controlled by escape, only disc observations can provide constraints on H escape. Therefore, SPICAV-VEX and HST observations will be complementary and will be used to derive the full H density profile in the Venusian thermosphere and exosphere.

ADDITIONAL COMMENTS

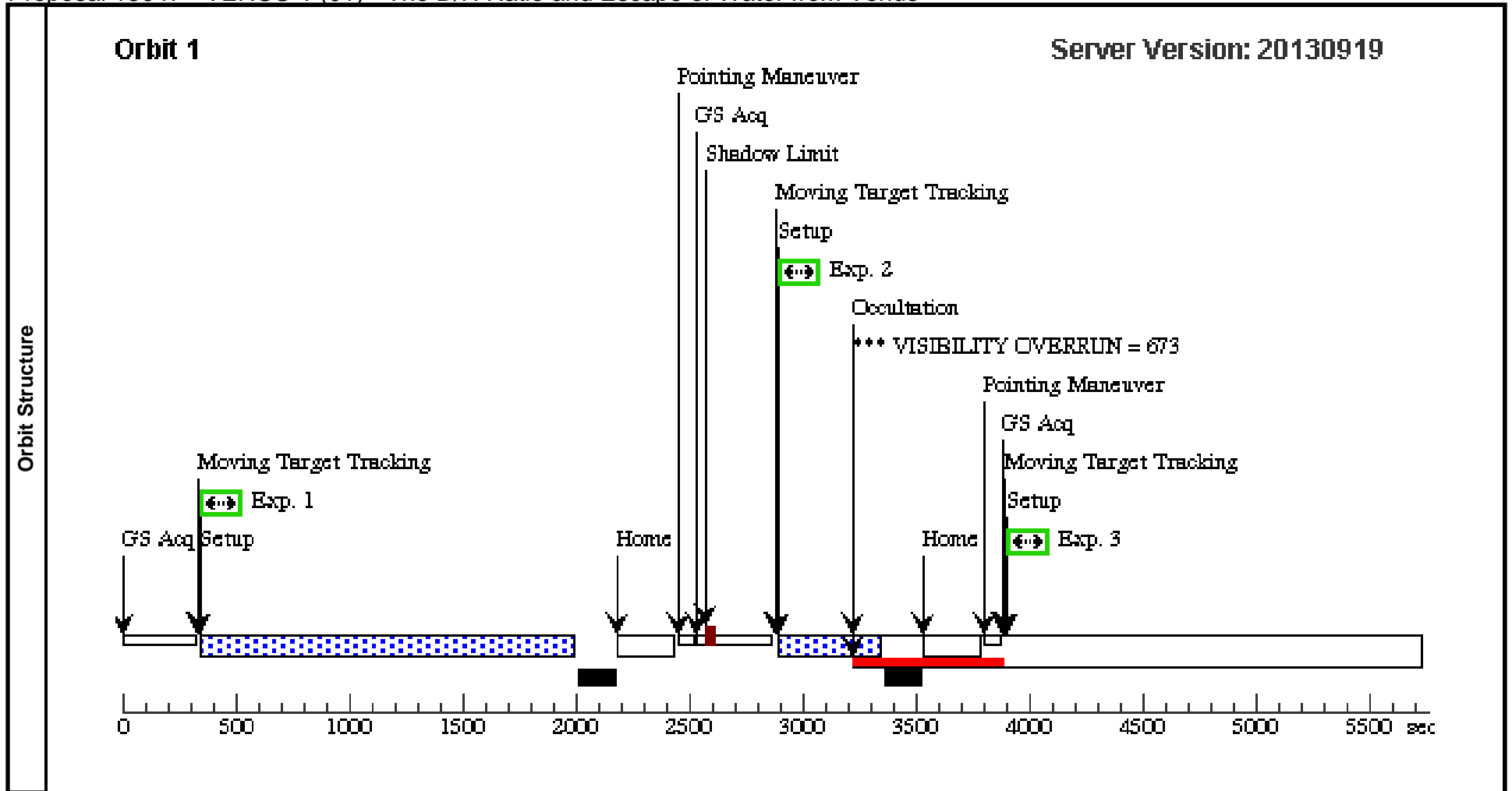
Proposal 13047 (STScI Edit Number: 94, Created: Monday, September 30, 2013 8:01:48 PM EST) - Overview

Observations will be of Venus near eastern elongation. Phase 2 proposal is being entered by PI, not knowing exact conditions at time of observations (HST orbit, etc.). Observations will observe Venus just after sunset, and pointing at Venus must occur from a nearby location just after the sun sets, due to Venus at angle less than 50 deg. from the Sun.

Proposal 13047 - VENUS-1 (01) - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:49 GMT 2013

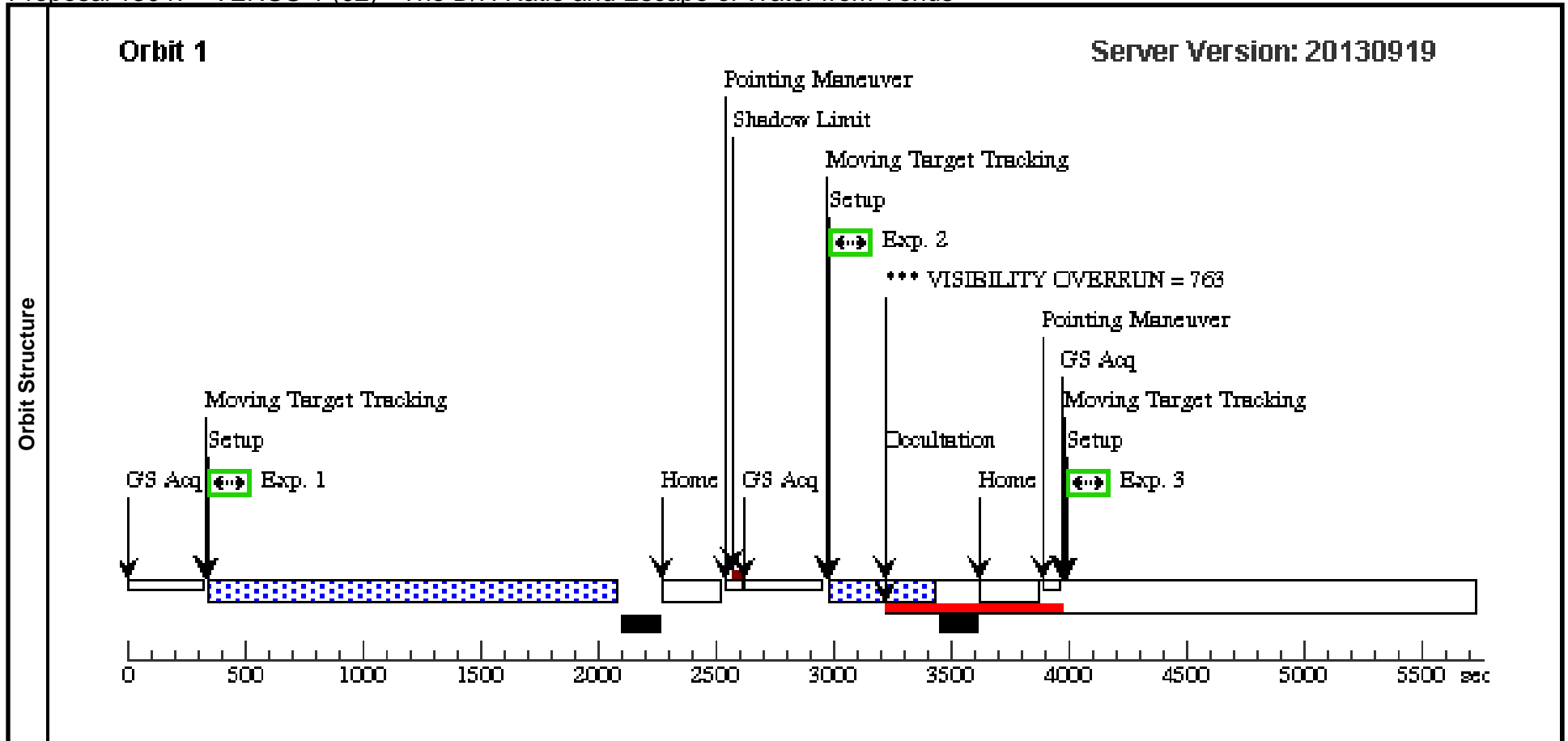
Visit	Proposal 13047, VENUS-1 (01), scheduling Diagnostic Status: Warning Scientific Instruments: S/C, STIS/FUV-MAMA Special Requirements: GROUP 01,02,03 WITHIN 5.5 Orbits										
	Diagnosics (VENUS-1 (01)) Warning (Orbit Planner): VISIBILITY OVERRUN (VENUS-1 (01)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (VENUS-1 (01)) Warning (Orbit Planner): VISIBILITY OVERRUN (Exposure 1 (VENUS-1 (01))) Warning (Form): Sensitive exposures should have an ETC run number provided. (Exposure 2 (VENUS-1 (01))) Warning (Form): Sensitive exposures should have an ETC run number provided.										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(1)	VENUS	STD=VENUS			SEP OF VENUS SUN FROM EARTH GT 46.5D	EARTH				
(2)	VENUS-OFFSET-7D	STD=VENUS		TYPE=POS_ANGLE,RAD=25200,A NG=180,REF=SUN			EARTH				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1		(2) VENUS-OFFSET-7D	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=15 30			1500.0 Secs (1500 Secs) [==>]	[1]	
	<i>Comments: buffer-time estimate based on 52 x 0.2 aperture spectra of Mars and sky near Mars in GO 12538, max. count rate then was 240 cts/sec, for brighter emission from Venus and sky it is assumed count rate may be as high as 1000 cts/sec</i>										
	2		(1) VENUS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=30 0; WAVECAL=NO	SHADOW; GSPAIR S8G100013 4F10000000000F0; GS ACQ SCENARI O SINGLE			300.0 Secs (300 Secs) [==>]	[1]
<i>Comments: buffer-time estimate based on 52 x 0.2 aperture spectra of Mars and sky near Mars in GO 12538, max. count rate then was 240 cts/sec, for brighter emission from Venus and sky it is assumed count rate may be as high as 1000 cts/sec</i>											
3		(2) VENUS-OFFSET-7D	S/C, POINTING, V1			EXP PCS MODE G YRO			1 Secs (1 Secs) [==>]	[1]	



Proposal 13047 - VENUS-1 (02) - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:51 GMT 2013

Visit	Proposal 13047, VENUS-1 (02), scheduling Diagnostic Status: Warning Scientific Instruments: S/C, STIS/FUV-MAMA Special Requirements: (none)									
	(VENUS-1 (02)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (VENUS-1 (02)) Warning (Orbit Planner): VISIBILITY OVERRUN (VENUS-1 (02)) Warning (Orbit Planner): VISIBILITY OVERRUN (Exposure 1 (VENUS-1 (02))) Warning (Form): Sensitive exposures should have an ETC run number provided. (Exposure 2 (VENUS-1 (02))) Warning (Form): Sensitive exposures should have an ETC run number provided.									
Diagnostics										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	VENUS	STD=VENUS			SEP OF VENUS SUN FROM EARTH GT 46.5D	EARTH			
(3)	VENUS-OFFSET-6P9D	STD=VENUS		TYPE=POS_ANGLE,RAD=24840,A NG=180,REF=SUN			EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(3) VENUS-OFFSET-6P9D	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=15 60			1590.0 Secs (1590 Secs) [==>]	[1]
	2		(1) VENUS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=30 0; WAVECAL=NO	SHADOW; GSPAIR S8G100013 4F1000000000F0; GS ACQ SCENARI O SINGLE		300.0 Secs (300 Secs) [==>]	[1]
	3		(3) VENUS-OFFSET-6P9D	S/C, POINTING, V1			EXP PCS MODE G YRO		1 Secs (1 Secs) [==>]	[1]



Proposal 13047 - VENUS-1 (03) - The D/H Ratio and Escape of Water from Venus

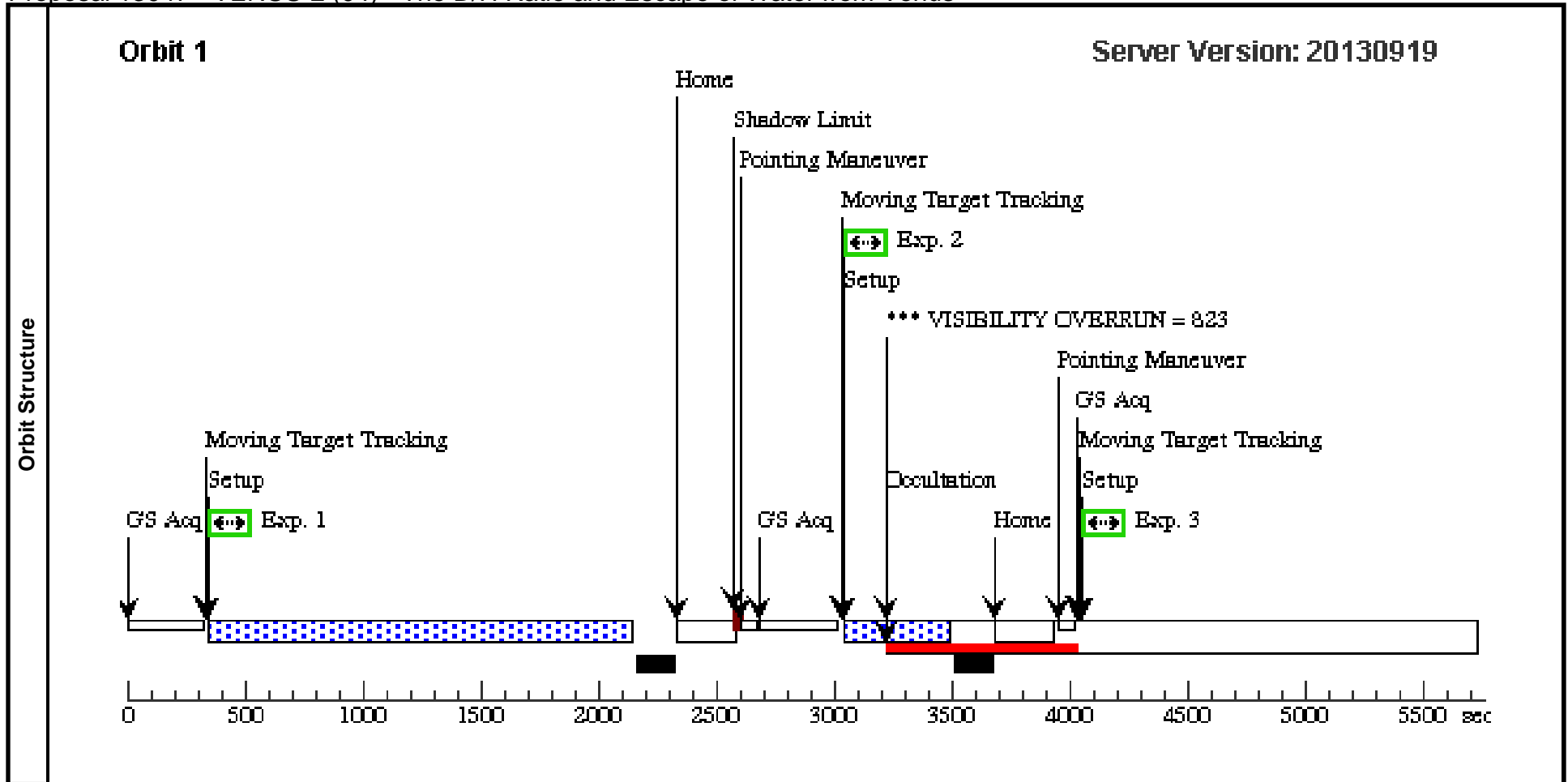
Tue Oct 01 01:01:52 GMT 2013

Visit	Proposal 13047, VENUS-1 (03), scheduling Diagnostic Status: Warning Scientific Instruments: STIS/FUV-MAMA Special Requirements: NOTRACK									
	(VENUS-1 (03)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (Exposure 1 (VENUS-1 (03))) Warning (Form): Sensitive exposures should have an ETC run number provided.									
Diagnosics										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Ephem Center				
	(2)	VENUS-OFFSET-7D	STD=VENUS		TYPE=POS_ANGLE,RAD=25200,A NG=180,REF=SUN		EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(2) VENUS-OFFSET-7D	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=21 60			2100.0 Secs (2100 Secs) [==>]	[1]
Orbit Structure	Orbit 1 Server Version: 20130919									

Proposal 13047 - VENUS-2 (04) - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:53 GMT 2013

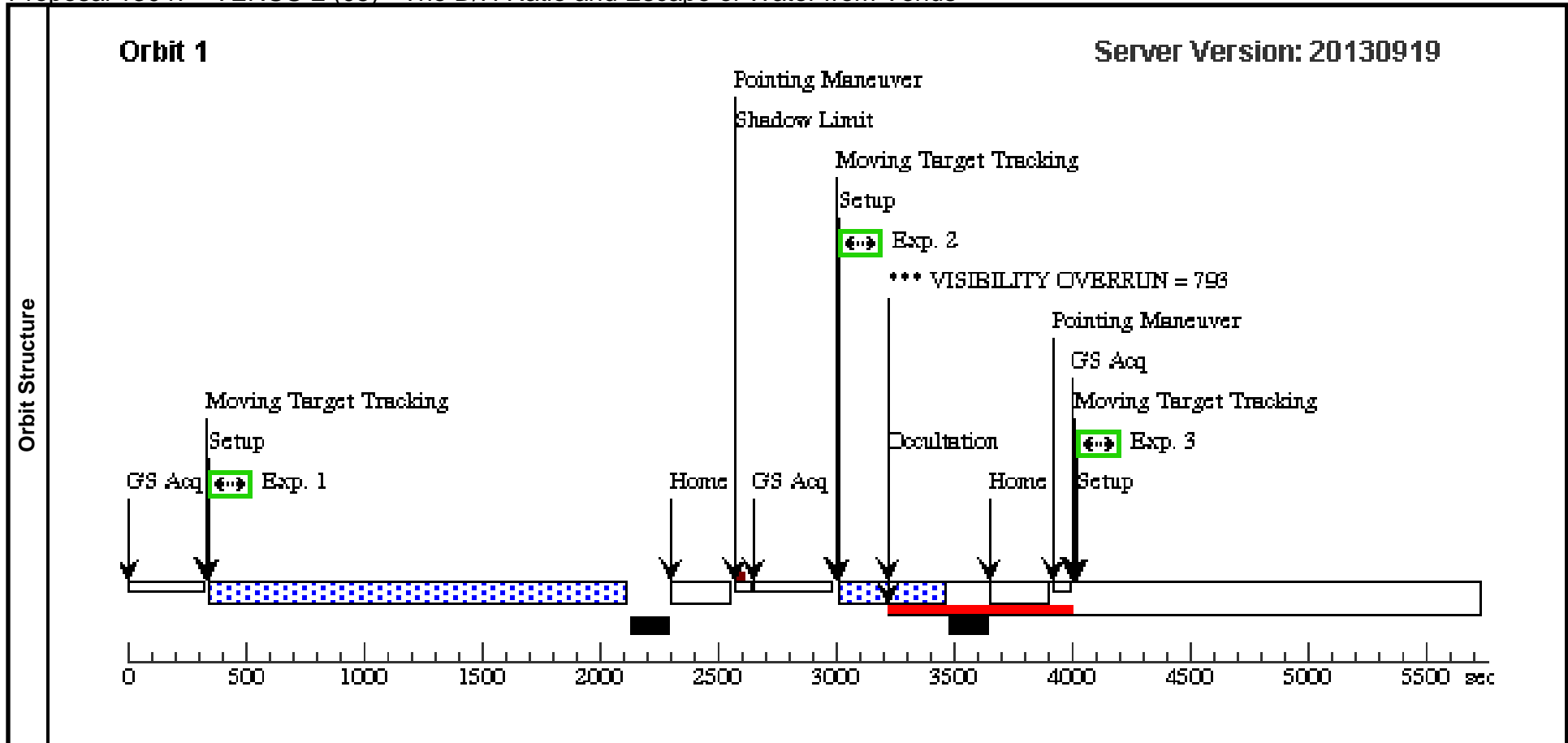
Visit	Proposal 13047, VENUS-2 (04), scheduling Diagnostic Status: Warning Scientific Instruments: S/C, STIS/FUV-MAMA Special Requirements: GROUP 04,05,06 WITHIN 5.5 Orbits										
Diagnostics	(VENUS-2 (04)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (VENUS-2 (04)) Warning (Orbit Planner): VISIBILITY OVERRUN (VENUS-2 (04)) Warning (Orbit Planner): VISIBILITY OVERRUN (Exposure 1 (VENUS-2 (04))) Warning (Form): Sensitive exposures should have an ETC run number provided. (Exposure 2 (VENUS-2 (04))) Warning (Form): Sensitive exposures should have an ETC run number provided.										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(1)	VENUS	STD=VENUS			SEP OF VENUS SUN FROM EARTH GT 46.5D	EARTH				
(2)	VENUS-OFFSET-7D	STD=VENUS		TYPE=POS_ANGLE,RAD=25200,A NG=180,REF=SUN			EARTH				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1		(2) VENUS-OFFSET-7D	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=16 20			1650.0 Secs (1650 Secs) [==>]	[1]	
	Comments: buffer-time estimate based on 52 x 0.2 aperture spectra of Mars and sky near Mars in GO 12538, max. count rate then was 240 cts/sec, for brighter emission from Venus and sky it is assumed count rate may be as high as 1000 cts/sec										
	2		(1) VENUS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=30 0; WAVECAL=NO	SHADOW; GSPAIR S8G100014 7F10000000000F0; GS ACQ SCENARI O SINGLE			300.0 Secs (300 Secs) [==>]	[1]
Comments: buffer-time estimate based on 52 x 0.2 aperture spectra of Mars and sky near Mars in GO 12538, max. count rate then was 240 cts/sec, for brighter emission from Venus and sky it is assumed count rate may be as high as 1000 cts/sec											
3		(2) VENUS-OFFSET-7D	S/C, POINTING, V1			EXP PCS MODE G YRO			1 Secs (1 Secs) [==>]	[1]	



Proposal 13047 - VENUS-2 (05) - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:54 GMT 2013

Visit	Proposal 13047, VENUS-2 (05), scheduling Diagnostic Status: Warning Scientific Instruments: S/C, STIS/FUV-MAMA Special Requirements: (none)									
	(VENUS-2 (05)) Warning (Orbit Planner): VISIBILITY OVERRUN (VENUS-2 (05)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (VENUS-2 (05)) Warning (Orbit Planner): VISIBILITY OVERRUN (Exposure 1 (VENUS-2 (05))) Warning (Form): Sensitive exposures should have an ETC run number provided. (Exposure 2 (VENUS-2 (05))) Warning (Form): Sensitive exposures should have an ETC run number provided.									
Diagnosics										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	VENUS	STD=VENUS			SEP OF VENUS SUN FROM EARTH GT 46.5D	EARTH			
(2)	VENUS-OFFSET-7D	STD=VENUS		TYPE=POS_ANGLE,RAD=25200,A NG=180,REF=SUN			EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(2) VENUS-OFFSET-7D	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=16 20			1620.0 Secs (1620 Secs) [==>]	[1]
	2		(1) VENUS	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=30 0; WAVECAL=NO	SHADOW; GSPAIR S8G100013 4F1000000000F0; GS ACQ SCENARI O SINGLE		300.0 Secs (300 Secs) [==>]	[1]
	3		(2) VENUS-OFFSET-7D	S/C, POINTING, V1			EXP PCS MODE G YRO		1 Secs (1 Secs) [==>]	[1]



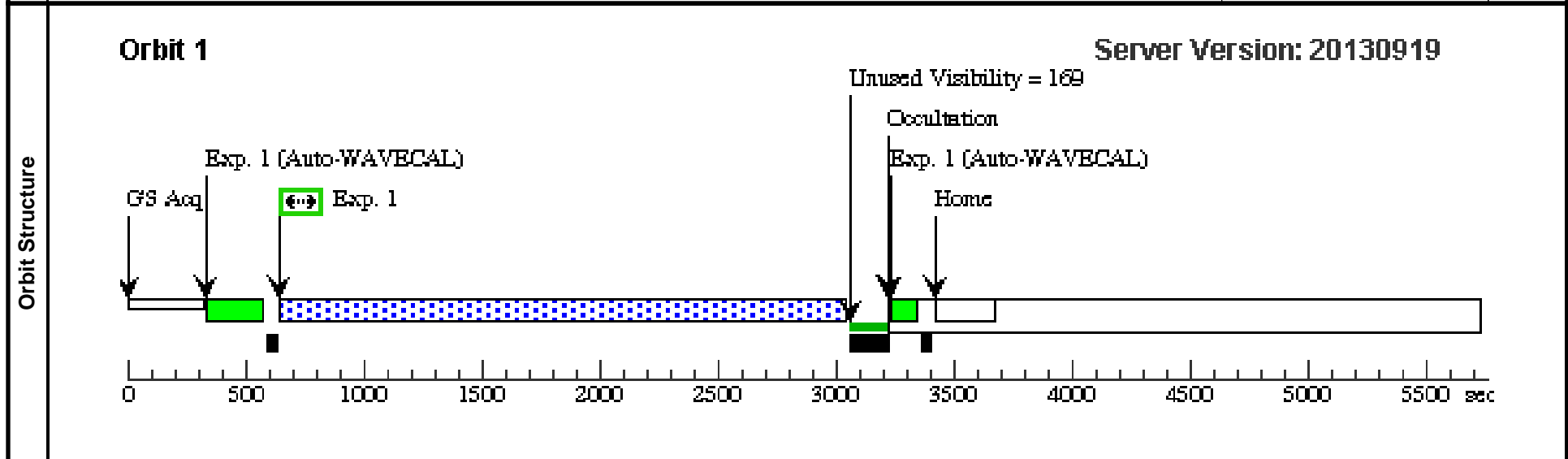
Proposal 13047 - VENUS-2 (06) - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:55 GMT 2013

Visit	Proposal 13047, VENUS-2 (06), scheduling Diagnostic Status: Warning Scientific Instruments: STIS/FUV-MAMA Special Requirements: NOTRACK
	(VENUS-2 (06)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronagraphy with STIS or COS. (Exposure 1 (VENUS-2 (06))) Warning (Form): Sensitive exposures should have an ETC run number provided.

Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
	(2)	VENUS-OFFSET-7D	STD=VENUS	TYPE=POS_ANGLE,RAD=25200,A NG=180,REF=SUN			EARTH

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(2) VENUS-OFFSET-7D	(2) VENUS-OFFSET-7D	STIS/FUV-MAMA, TIME-TAG, 52X0.5	E140H 1234 A	BUFFER-TIME=23 40	NEW OBSET FULL ACQ		2340.0 Secs (2340 Secs) [==>]	[1]



Proposal 13047 - Visit 10 - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:55 GMT 2013

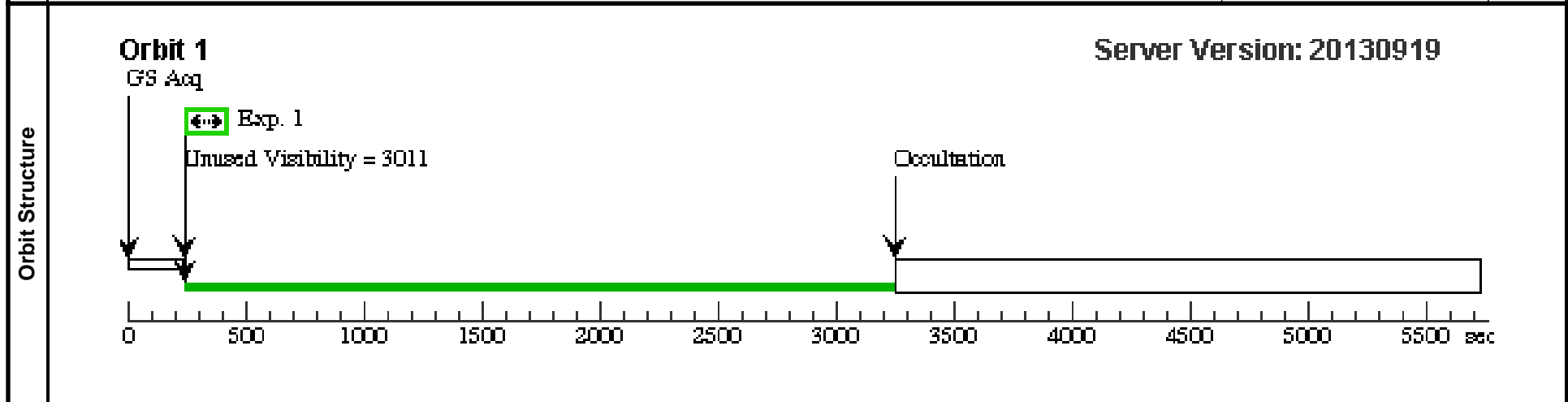
Visit	Proposal 13047, Visit 10, completed				
	Diagnostic Status: No Diagnostics				
	Scientific Instruments: S/C				
	Special Requirements: BEFORE 23-SEP-2013:00:00:00				

Comments: Guide star acquisition test for guide star S8G1000134.

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(4)	S8G1000134-TEST	RA: 17 05 59.4720 (256.4978000d) Dec: -26 16 9.12 (-26.26920d) Equinox: J2000		V=24	Reference Frame: ICRS

Comments: A pointing at which to perform a guide star acquisition test for guide star S8G1000134.

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(4) S8G1000134-TE ST	S/C, POINTING, V1			POS TARG -213.63 02,-224.7858; GSPAIR S8G100013 4F1000000000F0; GS ACQ SCENARI O SINGLE		1 Secs (1 Secs) [==>]	[1]



Proposal 13047 - Visit 11 - The D/H Ratio and Escape of Water from Venus

Tue Oct 01 01:01:56 GMT 2013

Visit	Proposal 13047, Visit 11, completed				
	Diagnostic Status: No Diagnostics				
	Scientific Instruments: S/C				
	Special Requirements: BEFORE 23-SEP-2013:00:00:00				

Comments: Guide star acquisition test for guide star S8G1000147.

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(5)	S8G1000147-TEST	RA: 17 07 11.5200 (256.7980000d) Dec: -26 18 19.80 (-26.30550d) Equinox: J2000		V=24	Reference Frame: ICRS

Comments: A pointing at which to perform a guide star acquisition test for guide star S8G1000147.

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(5) S8G1000147-TE ST	S/C, POINTING, V1			POS TARG -213.63 02,-224.7858; GSPAIR S8G100014 7F1000000000F0; GS ACQ SCENARI O SINGLE		1 Secs (1 Secs) [==>]	[1]

