



18413 - Catching Carbon Outflow: A New FUV Probe of Escaping Exoplanet Atmospheres

Cycle: 34, Proposal Category: GO
(Availability Mode: SUPPORTED)

INVESTIGATORS

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Dr. Joshua D. Lothringer (CoI)	Space Telescope Science Institute

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) HD-209458	COS/FUV COS/NUV	2	17-Aug-2026 16:00:43.0	yes
02	(1) HD-209458	COS/FUV COS/NUV	5	17-Aug-2026 16:00:44.0	yes
03	(1) HD-209458	COS/FUV COS/NUV	2	17-Aug-2026 16:00:44.0	yes
04	(1) HD-209458	COS/FUV COS/NUV	5	17-Aug-2026 16:00:45.0	yes

14 Total Orbits Used

ABSTRACT

Atmospheric escape driven by stellar high energy irradiation is a primary driver of exoplanet evolution and composition. Direct measurements of escaping gas traditionally rely on Lyman alpha, the metastable He I triplet, and a handful of UV metal lines; each tracer faces observational or interpretive limits. Expanding the set of robust spectral diagnostics is therefore critical to break model degeneracies and to measure mass loss, composition, and ionization structure across a wider range of systems. Theoretical models identify C III 977.02 as a particularly strong FUV line that forms at large radii in hydrodynamic outflows; for canonical hot Jupiters, models predict an in transit C III depth of ~39%. Our program aims to validate C III as a practical tracer of hydrodynamic escape: a detection would open a new FUV window on carbon loss and atmospheric evolution, while a non detection will place meaningful constraints on mass loss, ionization, and model assumptions.

OBSERVING DESCRIPTION

We will observe HD 209458b in four visits using COS/FUV with the G140L grating centered at 1280 Angstroms. This setting simultaneously covers our diagnostic line, C III 977.02 Angstroms (segment B, 900-1165 Angstroms), and stellar continuum/context lines (segment A, 1280-2391 Angstroms) used to monitor activity. We use a single FP-POS setting within each visit to preserve a consistent solution across the exposures being co-added, which is required given the low S/N expected on the C III line. The FP-POS value differs between the Baseline and Transit visits in order to balance the cumulative FP-POS usage across the program, per COS IHB guidance (Sec. 5.8).

Two of the four visits are 5-orbit Transit visits, scheduled to cover the transit of HD 209458b ($P \sim 3.52$ days), capturing ingress, mid-transit, egress, and immediate pre/post-transit baseline. The other two visits are 2-orbit Baseline visits, used to independently characterize short-term stellar variability outside of transit. The phase constraints for the program are set on the acquisition (ACQ) exposure of each Baseline visit: Baseline 1 is constrained to occur 12 hours from its associated transit, and Baseline 2 is further offset from Baseline 1 by one additional HST orbit (~ 45 minutes). This extra offset between the two baseline visits maximizes our phase coverage of out-of-transit stellar variability across the two epochs, rather than sampling the same relative phase twice.

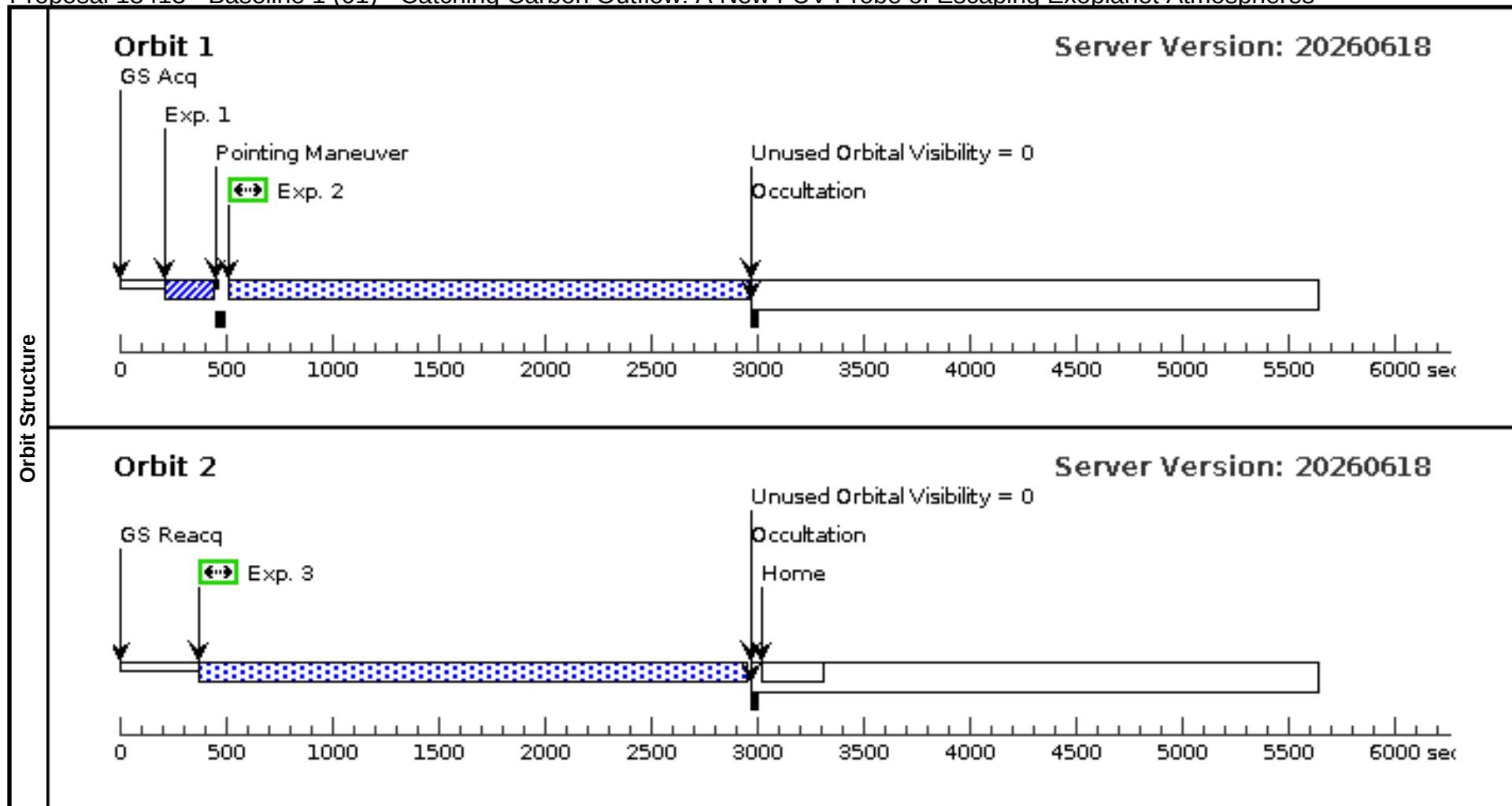
The four visits are organized into two independent epochs, each pairing one Baseline visit with one Transit visit (Baseline 1/Transit 1 and Baseline 2/Transit 2), in order to test repeatability of any detected signal and to guard against a single-epoch signal driven by stellar activity or instrumental systematics.

All science exposures use TIME-TAG mode at the PSA aperture with 2000 s integrations, allowing us to bin the data into finer sub-exposures for a precise C III time series. Each visit begins with a COS/NUV MIRRORA acquisition at the BOA aperture.

There are multiple opportunities to schedule these phase-constrained visits between April 2027 and September 2027.

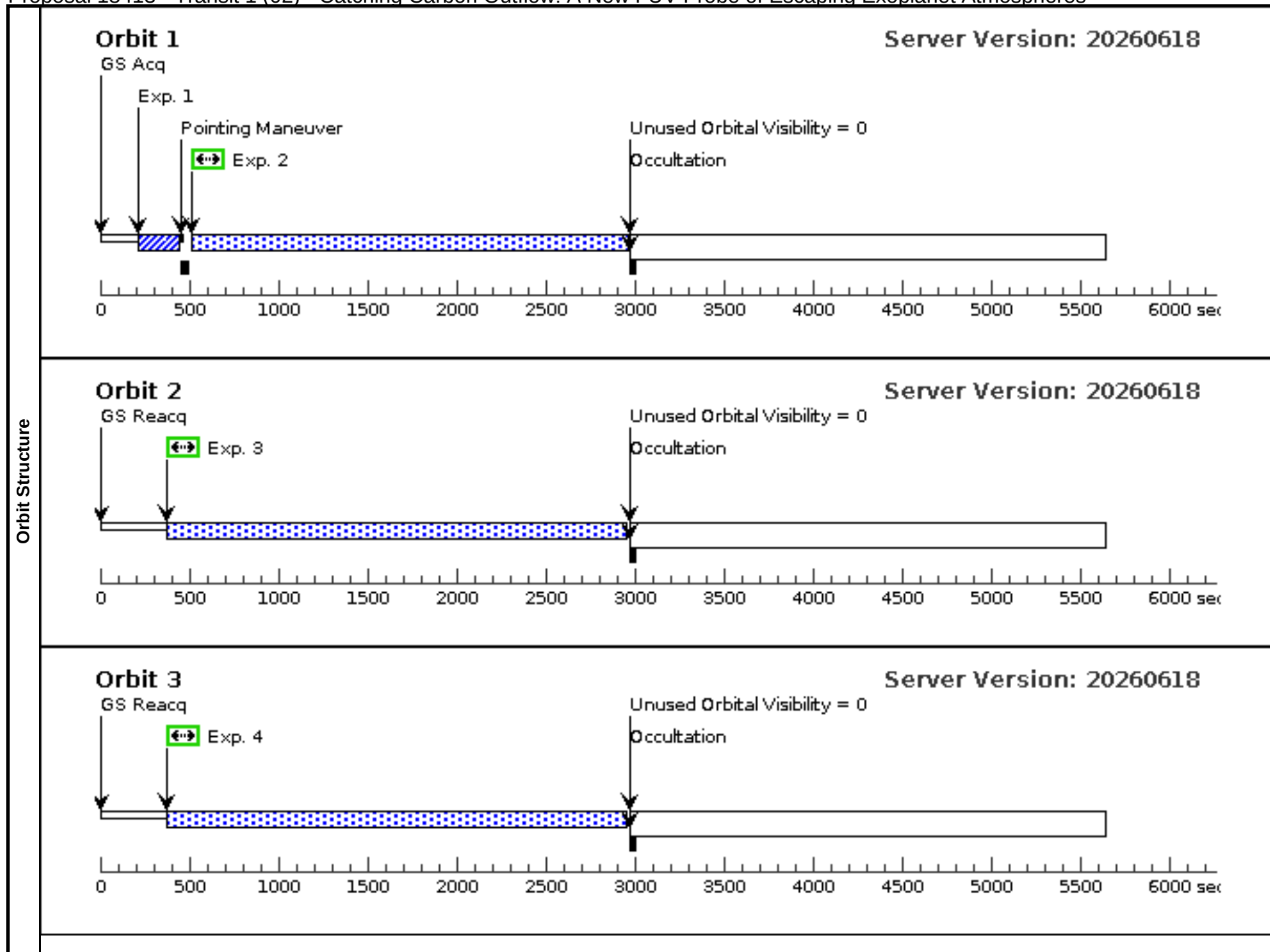
Proposal 18413 - Baseline 1 (01) - Catching Carbon Outflow: A New FUV Probe of Escaping Exoplanet Atmospheres

Visit	Proposal 18413, Baseline 1 (01)							Mon Aug 17 20:00:46 GMT 2026		
	Diagnostic Status: Warning									
	Scientific Instruments: COS/FUV, COS/NUV									
	Special Requirements: Period 3.52474859 D AND ZERO-PHASE HJD2451659.93742									
Diagnostics	(Baseline 1 (01)) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions at a given COS cenwave (or 2 positions for certain exception cases). See extended explanation in the diagnostic browser.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	HD-209458	RA: 22 03 10.7727 (330.7948863d) Dec: +18 53 3.55 (18.88432d) Equinox: J2000	Proper Motion RA: 29.766 mas/yr Proper Motion Dec: -17.976 mas/yr Parallax: 0.0207694" Epoch of Position: 2000	V=7.63	Reference Frame: ICRS				
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.									
	Category=EXT-STAR Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV] Extended=NO									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	ACQ (COS.ta.236 4750)	(1) HD-209458	COS/NUV, ACQ/IMAGE, BOA	MIRRORA		PHASE 0.80114420 96451291 TO 0.8129 653837240063		2 Secs (2 Secs) [==>]	[1]
	2	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=3; LIFETIME-POS=L P11			2000 Secs (2261 Secs) [==>2261.0 Secs]	[1]
	3	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=4; LIFETIME-POS=L P11			2000 Secs (2532 Secs) [==>2532.0 Secs]	[2]



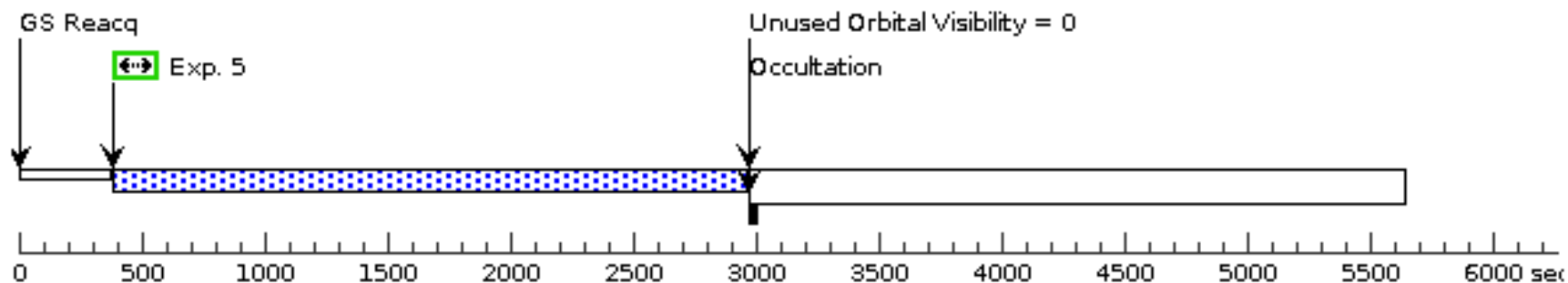
Proposal 18413 - Transit 1 (02) - Catching Carbon Outflow: A New FUV Probe of Escaping Exoplanet Atmospheres

Visit	Proposal 18413, Transit 1 (02)										Mon Aug 17 20:00:46 GMT 2026	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: COS/FUV, COS/NUV											
	Special Requirements: AFTER 01 BY 11.5 H TO 12.5 H											
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(1)	HD-209458	RA: 22 03 10.7727 (330.7948863d)		Proper Motion RA: 29.766 mas/yr		V=7.63		Reference Frame: ICRS			
			Dec: +18 53 3.55 (18.88432d)		Proper Motion Dec: -17.976 mas/yr							
			Equinox: J2000		Parallax: 0.0207694"							
					Epoch of Position: 2000							
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.											
	Category=EXT-STAR											
	Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV]											
	Extended=NO											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1	ACQ (COS.ta.236 4750)	(1) HD-209458	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				2 Secs (2 Secs)			
									[==>]		[1]	
	2	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000;			2000 Secs (2261 Secs)			
						FP-POS=1;			[==>2261.0 Secs]		[1]	
						LIFETIME-POS=L P11						
	3	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000;			2000 Secs (2532 Secs)			
						LIFETIME-POS=L P11;			[==>2532.0 Secs]		[2]	
						FP-POS=2						
	4	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000;			2000 Secs (2532 Secs)			
						FP-POS=3;			[==>2532.0 Secs]		[3]	
						LIFETIME-POS=L P11						
5	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000;			2000 Secs (2532 Secs)				
					LIFETIME-POS=L P11;			[==>2532.0 Secs]		[4]		
					FP-POS=3							
6	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000;			2000 Secs (2532 Secs)				
					FP-POS=4;			[==>2532.0 Secs]		[5]		
					LIFETIME-POS=L P11							



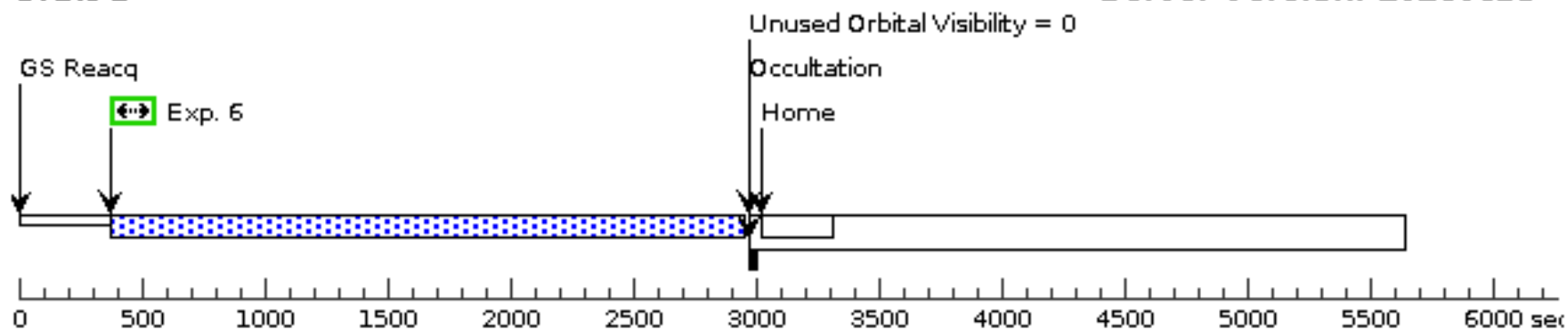
Orbit 4

Server Version: 20260618



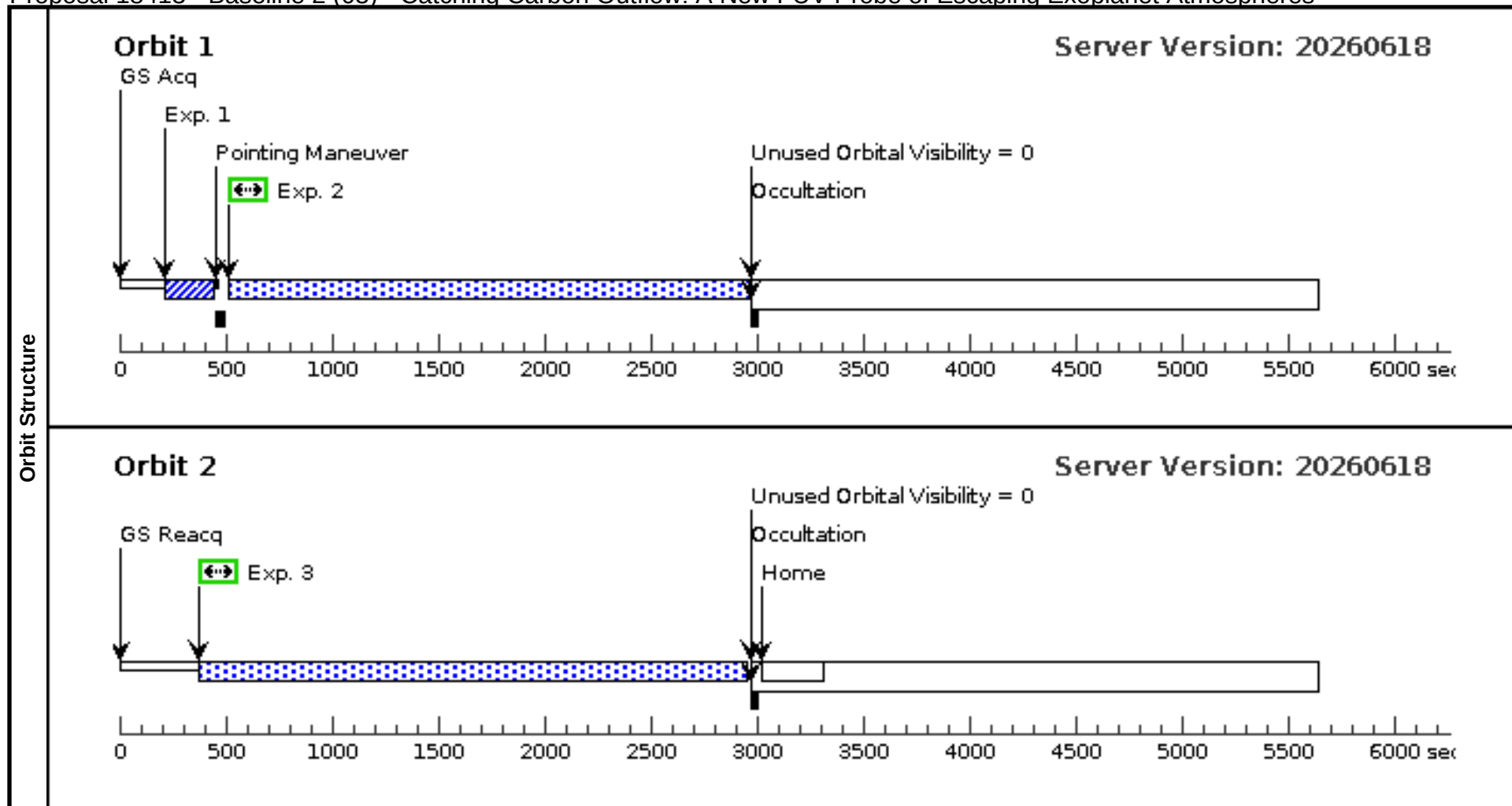
Orbit 5

Server Version: 20260618



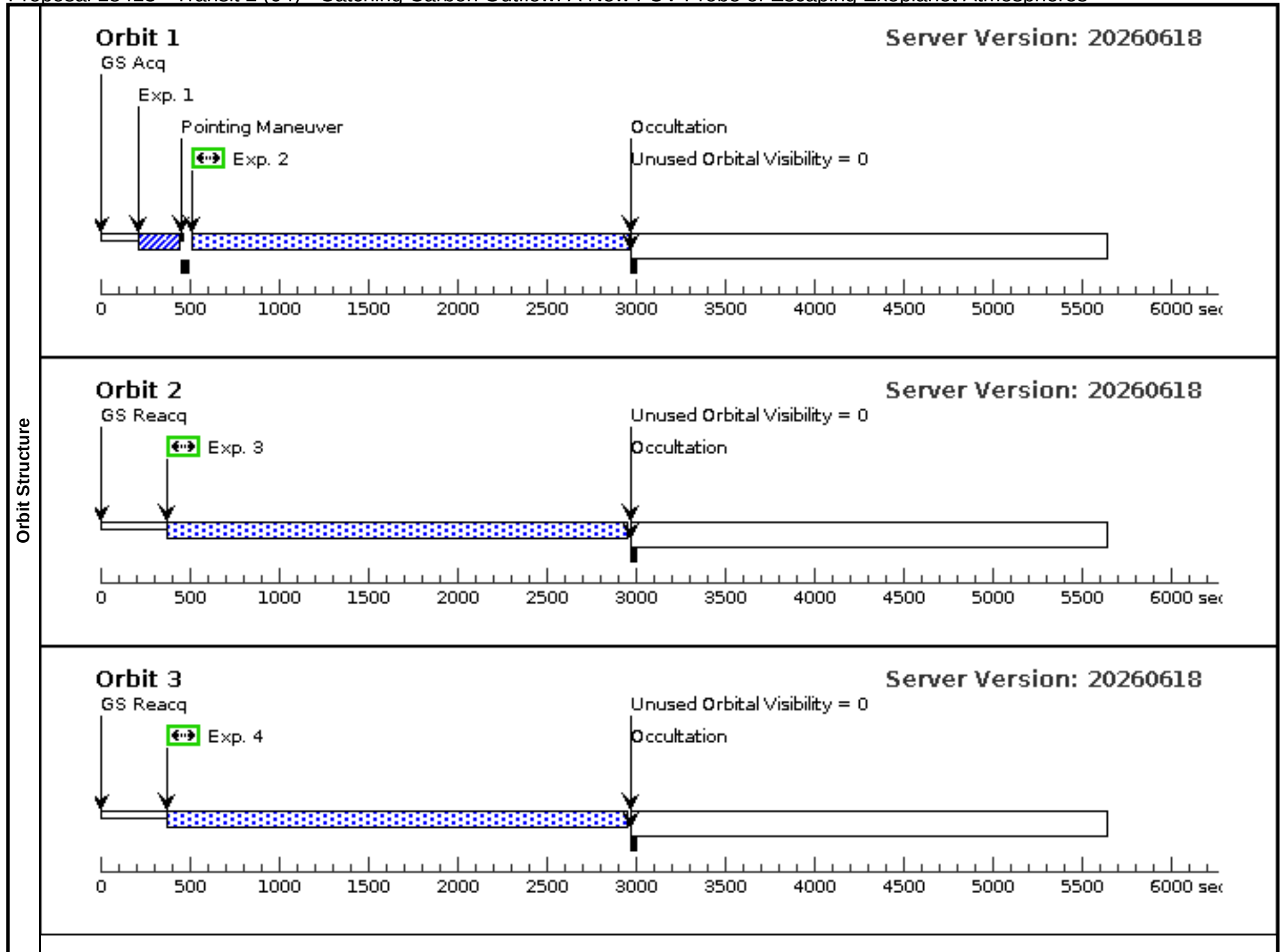
Proposal 18413 - Baseline 2 (03) - Catching Carbon Outflow: A New FUV Probe of Escaping Exoplanet Atmospheres

Visit	Proposal 18413, Baseline 2 (03)								Mon Aug 17 20:00:46 GMT 2026	
	Diagnostic Status: Warning									
	Scientific Instruments: COS/FUV, COS/NUV									
	Special Requirements: Period 3.52474859 D AND ZERO-PHASE HJD2451659.93742									
Diagnostics	(Baseline 2 (03)) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions at a given COS cenwave (or 2 positions for certain exception cases). See extended explanation in the diagnostic browser.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	HD-209458	RA: 22 03 10.7727 (330.7948863d) Dec: +18 53 3.55 (18.88432d) Equinox: J2000	Proper Motion RA: 29.766 mas/yr Proper Motion Dec: -17.976 mas/yr Parallax: 0.0207694" Epoch of Position: 2000	V=7.63	Reference Frame: ICRS				
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.									
	Category=EXT-STAR Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV] Extended=NO									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	ACQ (COS.ta.236 4750)	(1) HD-209458	COS/NUV, ACQ/IMAGE, BOA	MIRRORA		PHASE 0.81001009 0204287 TO 0.82183 12642831641		2 Secs (2 Secs) [==>]	[1]
	2	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=3; LIFETIME-POS=L P11			2000 Secs (2261 Secs) [==>2261.0 Secs]	[1]
	3	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=4; LIFETIME-POS=L P11			2000 Secs (2532 Secs) [==>2532.0 Secs]	[2]



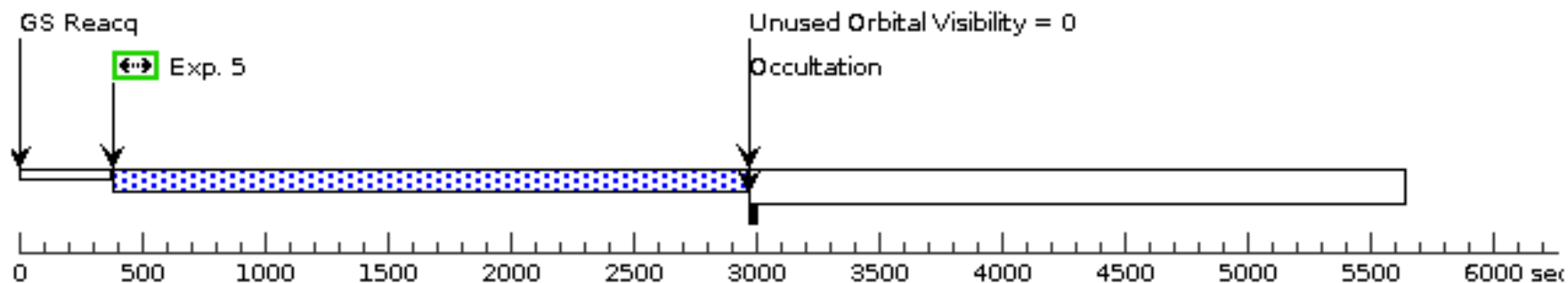
Proposal 18413 - Transit 2 (04) - Catching Carbon Outflow: A New FUV Probe of Escaping Exoplanet Atmospheres

Visit	Proposal 18413, Transit 2 (04)								Mon Aug 17 20:00:46 GMT 2026	
	Diagnostic Status: No Diagnostics									
	Scientific Instruments: COS/FUV, COS/NUV									
	Special Requirements: AFTER 03 BY 11.5 H TO 12.5 H									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	HD-209458	RA: 22 03 10.7727 (330.7948863d) Dec: +18 53 3.55 (18.88432d) Equinox: J2000	Proper Motion RA: 29.766 mas/yr Proper Motion Dec: -17.976 mas/yr Parallax: 0.0207694" Epoch of Position: 2000	V=7.63	Reference Frame: ICRS				
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.									
	Category=EXT-STAR									
	Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV] Extended=NO									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	ACQ (COS.ta.236 4750)	(1) HD-209458	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				2 Secs (2 Secs) [==>]	[1]
	2	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=1; LIFETIME-POS=L P11			2000 Secs (2261 Secs) [==>2261.0 Secs]	[1]
	3	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=2; LIFETIME-POS=L P11			2000 Secs (2532 Secs) [==>2532.0 Secs]	[2]
	4	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=3; LIFETIME-POS=L P11			2000 Secs (2532 Secs) [==>2532.0 Secs]	[3]
	5	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=3; LIFETIME-POS=L P11			2000 Secs (2532 Secs) [==>2532.0 Secs]	[4]
	6	SCI (COS.sp.229 0758)	(1) HD-209458	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=12 000; FP-POS=4; LIFETIME-POS=L P11			2000 Secs (2532 Secs) [==>2532.0 Secs]	[5]



Orbit 4

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Orbit 5

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