16271 - A new window on the UV SED of star-forming galaxies: direct measurements of ionizing spectra in the Lyman continuum

Cycle: 28, 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) J0232+0025	COS/FUV COS/NUV	5	12-Jun-2020 15:00:27.0	yes
02	(2) J0837+4512	COS/FUV COS/NUV	5	12-Jun-2020 15:00:28.0	yes
03	(3) J0901+5111	COS/FUV COS/NUV	5	12-Jun-2020 15:00:29.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(4) J1252+5237	COS/FUV COS/NUV	5	12-Jun-2020 15:00:29.0	yes
05	(5) J1358+4611	COS/FUV COS/NUV	5	12-Jun-2020 15:00:30.0	yes
06	(6) J1450+3913	COS/FUV COS/NUV	5	12-Jun-2020 15:00:31.0	yes

30 Total Orbits Used

ABSTRACT

The Lyman continuum (LyC = hydrogen-ionizing radiation at wavelengths < 912 Ang) of galaxies plays a fundamental role in determining the physical and observational properties of the ISM and IGM, including cosmic reionization. Yet it is basically inaccessible to direct observations, and one therefore heavily relies on theoretical, yet untested predictions from synthesis models. Furthermore the ionizing spectra differ significantly between different models, with important implications on widely used emission line diagnostics and other observables. We here propose to observe for the first time the shape of the ionizing continuum of several star-forming galaxies shortward of (from ~600 to 912 Angstroem) and across the Lyman break. This can be achieved with COS by targeting LyC emitters at z~0.6-0.8. The observations will measure for the first time stellar and nebular emission features in the LyC, and thus provide the first direct constraints for stellar population models in this spectral range. The proposed observations will provide unique insight on the hardness of the ionizing spectra of star-forming galaxies, with numerous possible implications on our understanding of the emission line properties of distant galaxies, sources of cosmic reionization, emission line diagnostics, and related topics.

OBSERVING DESCRIPTION

We propose to observe for the first time the shape of the ionizing continuum of several star-forming galaxies shortward of the Lyman break (between ~ 600 - 912 A). This is feasible in z ~ 0.6 - 0.8 galaxies with a significant escape of LyC radiation. To achieve this goal we have selected six z ~ 0.6 - 0.8 galaxies such that their UV spectra from 610 - 680 A to 1100 - 1200 A rest-frame can be observed with a single setting with the G140L grism in a spectral range where COS is efficient. The targets have been selected from the latest SDSS release using the same criteria as Izotov and collaborators, namely (1) compact or unresolved (size < 2.5") star-forming galaxies with (2) strong emission lines (EW(Hbeta) ~ 100 - 200 A), and (3) a high ratio [O iii]/[O ii]> 3 - 4. This method has so far shown a success rate of 100% in finding LyC emitters. We have also verified that the targets show Mg ii 2796,2808 strongly in emission, which is an additional indication that these galaxies should be LyC emitters (Henry et al. 2018). And we have

verified that the emission line ratios of our galaxies are compatible with photoionization by stars, not AGN (using different line ratios, line widths etc.). The targets have also GALEX near-UV magnitudes, metallicities, low extinction, and other properties comparable to those of the strong LyC emitters discovered by Izotov et al. (2018ab). The large EW(Hbeta) shows that the UV emission must be dominated by young (< 6 Myr) massive stars, as also found for the sources of Izotov et al. (2018b). All these findings show that our sources are ideal targets to study for the first time the SED in the Lyman continuum. We propose to target 6 galaxies to gather these unique observations. Observing several galaxies is important since neither their flux in the Lyman continuum nor the exact shape can be predicted precisely. Indeed, variations in the intrinsic SED are expected and measuring them is among the main objectives of the proposal. Spectra of several sources may also be needed to avoid possible contamination by intervening low-z Lyman Limit systems, which could render part of the SED at < 912 A unusable. For all these reasons we propose a small sample of galaxies for this pilot study. We have verified that our targets are sufficiently faint to satisfy safety conditions for observing with the COS (see Target Summary) and that there are no sources brighter than the COS safety limits in proximity (within circle of 43" diameter) of our targets. We will obtain NUV acquisition images of the targets with the standard Mirror A and the AQN/IMAGE mode, with exposures of ~ 1500 seconds to reach a S/N ~ 20 within a 9x9 pixel box centered on the brightest part of the galaxy. We have used the GALEX NUV magnitudes to estimate the S/N. The angular galaxy radius is chosen to be 0.2", inside which most of the galaxy light is concentrated. The total time for acquisition is up to 120s+2x1500s = 3120s per object (HST Primer manual), i.e. one orbit. The acquisition image will allow us to analyse the UV morphology of the sources. The COS will be used in combination with the low-resolution G140L grating centered at 800 A to measure the LyC. The required number of orbits for each object is calculated so as to detect the LyC at the level above 3sigma with a 400-pixel binning of the data at the observed wavelength 912x(1+z). For the LyC flux we have assumed the mimimum value corresponding to an escape fraction of 5 %, and the intrinsic LyC flux density is obtained from the relation I(Hbeta)/I(912) ~ 9 A (Izotov et al. 2016b), where I(Hbeta) is the extinction-corrected flux of the Hbeta emission line. We have also done simulations of the expected observations using the synthetic spectra to confirm that a sufficient S/N can be obtained over the entire wavelength range of interest. The extinction of the targets, measured from the Balmer decrement is very low (E(B-V) ~ 0 - 0.07). All the available data (including combination of COS spectra, GALEX photometry and SED) will be used to model and correct for selective extinction. It is difficult to foresee the selective extinction in this spectral range. For each target 1 orbit is needed for acquisition, and 4 orbits for the spectrum with the low-resolution G140L grating, i.e. 5 orbits in total. We therefore request a total of 30 orbits for 6 objects.
Our observations do not require constraints on the HST orientation. Therefore, operating HST in reduced gyro mode would likely affect our program a little, slightly increasing the time for acquisition and slightly reducing the time for science observations.

Visit

Proposal 16271, J0232+0025 (01) Fri Jun 12 19:00:32 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J0232+0025	RA: 02 32 29.5100 (38.1229583d) Dec: +00 25 4.22 (.41784d) Equinox: J2000	Redshift: 0.7641	V=21.33+/-0.10 FUV=22.40+/-0.14, NUV=20.94+/-0.05, F(900)=8.3e-17 erg/s/cm2/A - expected intrinsic flux of the Lyman continuum.	Reference Frame: ICRS

Comments:
Category=GALAXY
Description=[DWARF COMPACT, STARBURST]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	J0232+0025 ACQ (COS.ta.1445221)	(1) J0232+0025	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1338.0 Secs (1338 Secs)	
								[==>]	***[1]***
2	J0232+0025 G140L (COS.sp.1445228)	(1) J0232+0025	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=9500.0; FLASH=YES; FP-POS=ALL; SEGMENT=A			1500 Secs (10742 Secs)	
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								[==>2686.0 Secs (Split 2)]	***[3]***
								[==>2686.0 Secs (Split 3)]	***[4]***
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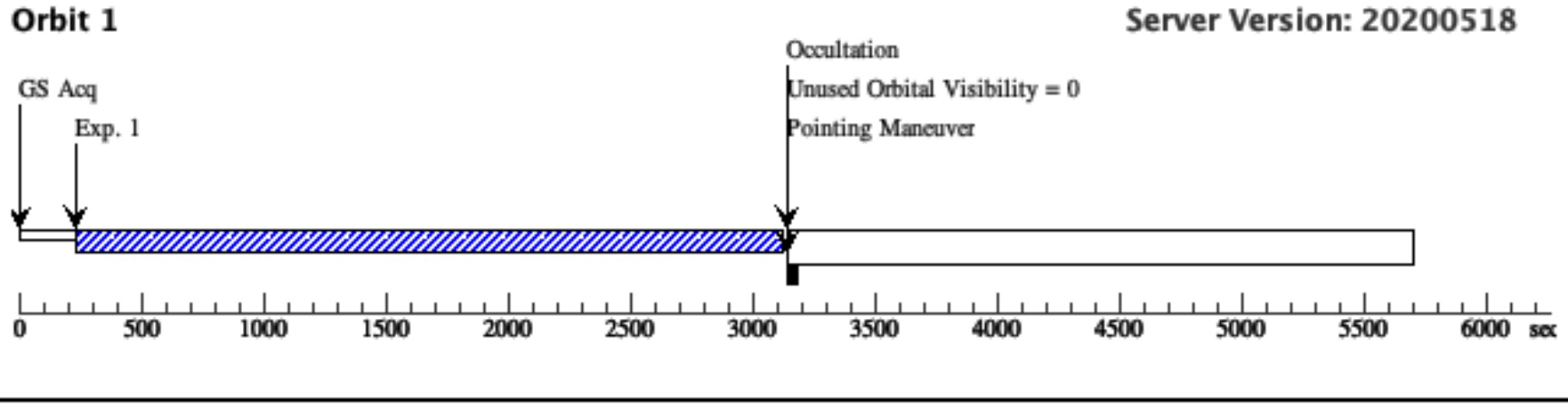
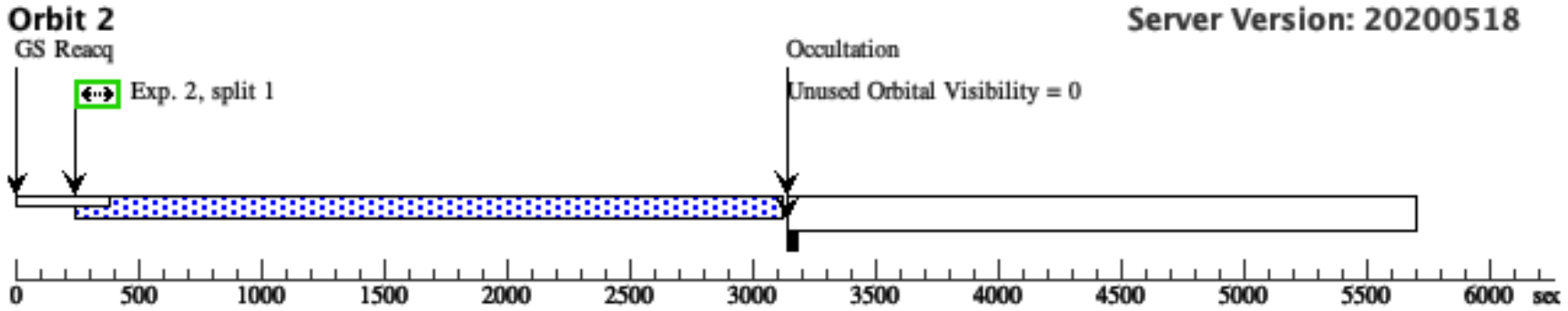
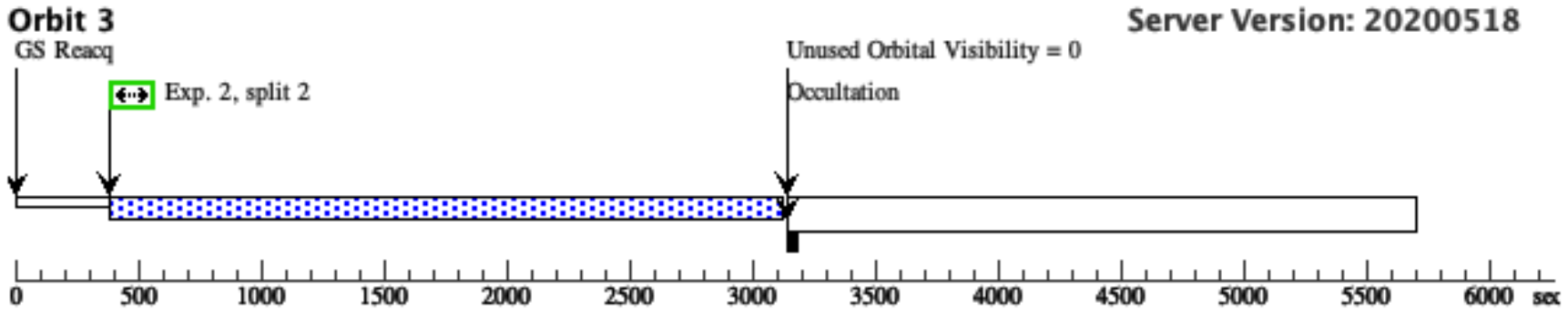
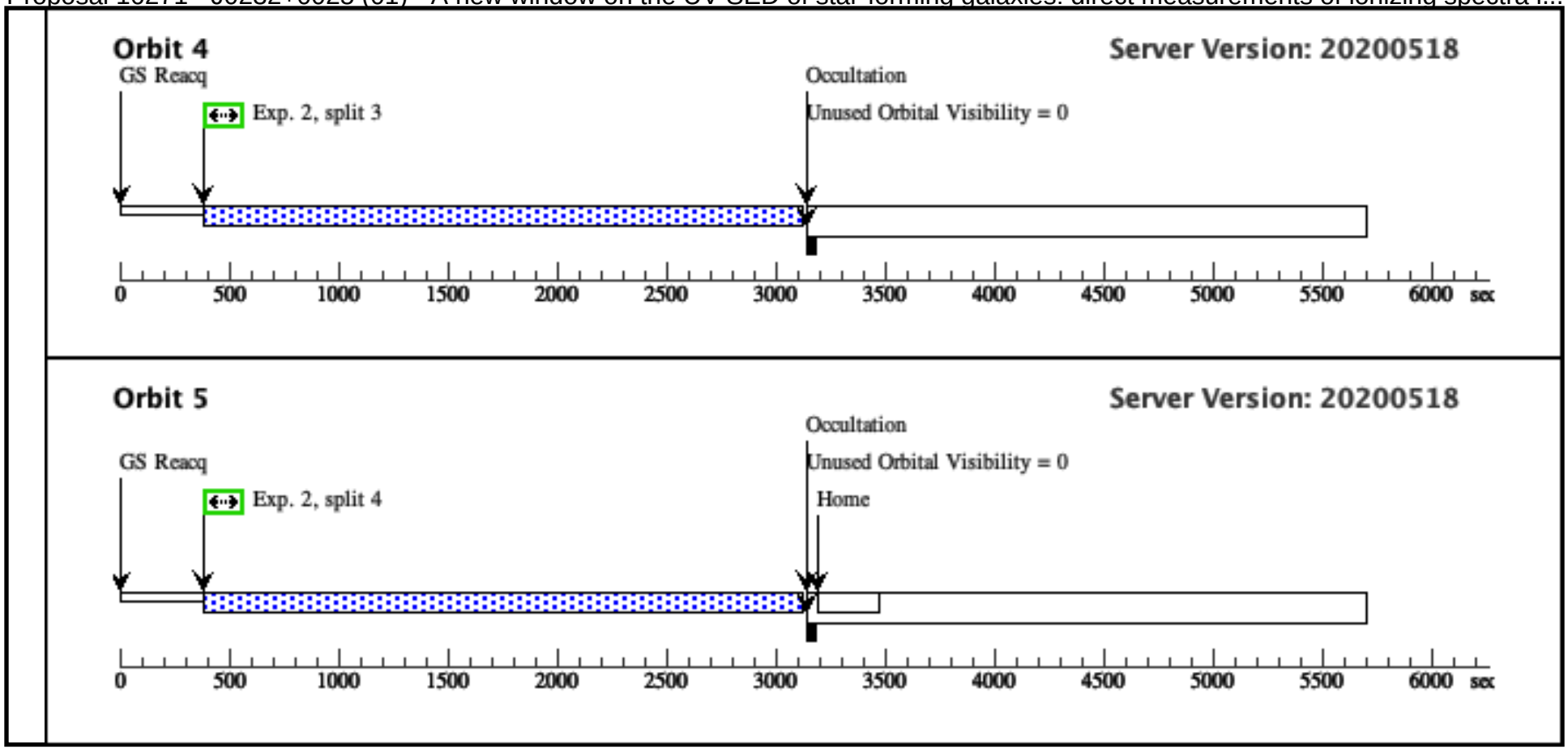
Orbit Structure





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sec
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Server Version: 20200518
GS Reacq
Exp. 2, split 4
Occultation
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Home
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500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16271, J0837+4512 (02) Fri Jun 12 19:00:32 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	J0837+4512	RA: 08 37 58.6900 (129.4945417d) Dec: +45 12 33.30 (45.20925d) Equinox: J2000	Redshift: 0.7816	V=21.65+/-0.10 FUV=24.24+/-0.25, NUV=21.75+/-0.07, F(900)=9.0e-17 erg/s/cm2/A - expected intrinsic flux of the Lyman continuum.	Reference Frame: ICRS

Comments:
Category=GALAXY
Description=[DWARF COMPACT, STARBURST]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	J0837+4512 ACQ (COS.ta.1445222)	(2) J0837+4512	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1409.0 Secs (1409 Secs)	
								[==>]	***[1]***
2	J0837+4512 G140L (COS.sp.1445228)	(2) J0837+4512	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=9500.0; FLASH=YES; FP-POS=ALL; SEGMENT=A			1500.0 Secs (11314 Secs)	
								[==>2827.0 Secs (Split 1)]	***[2]***
								[==>2829.0 Secs (Split 2)]	***[3]***
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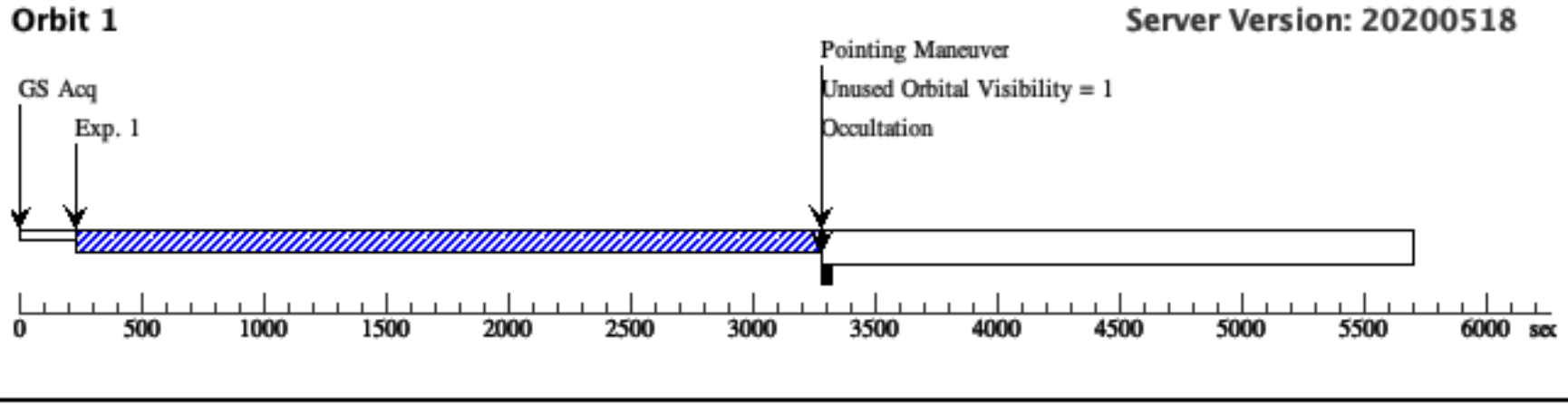
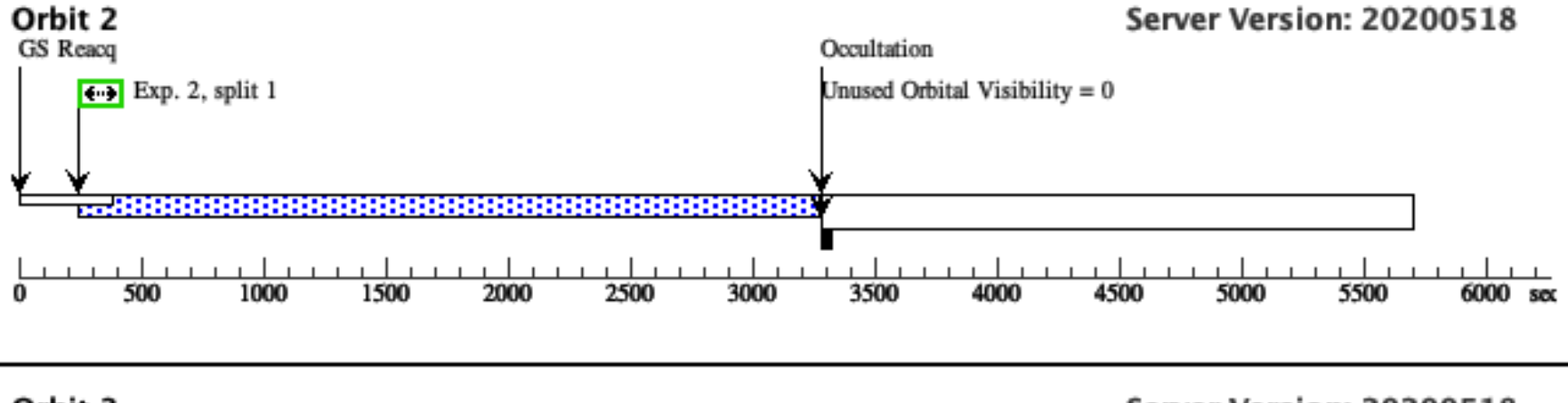
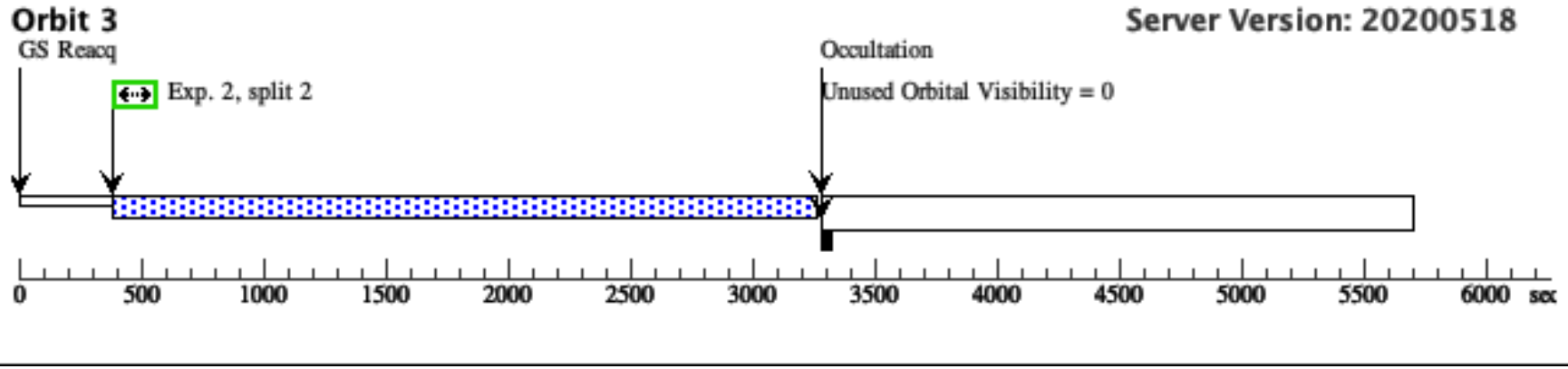
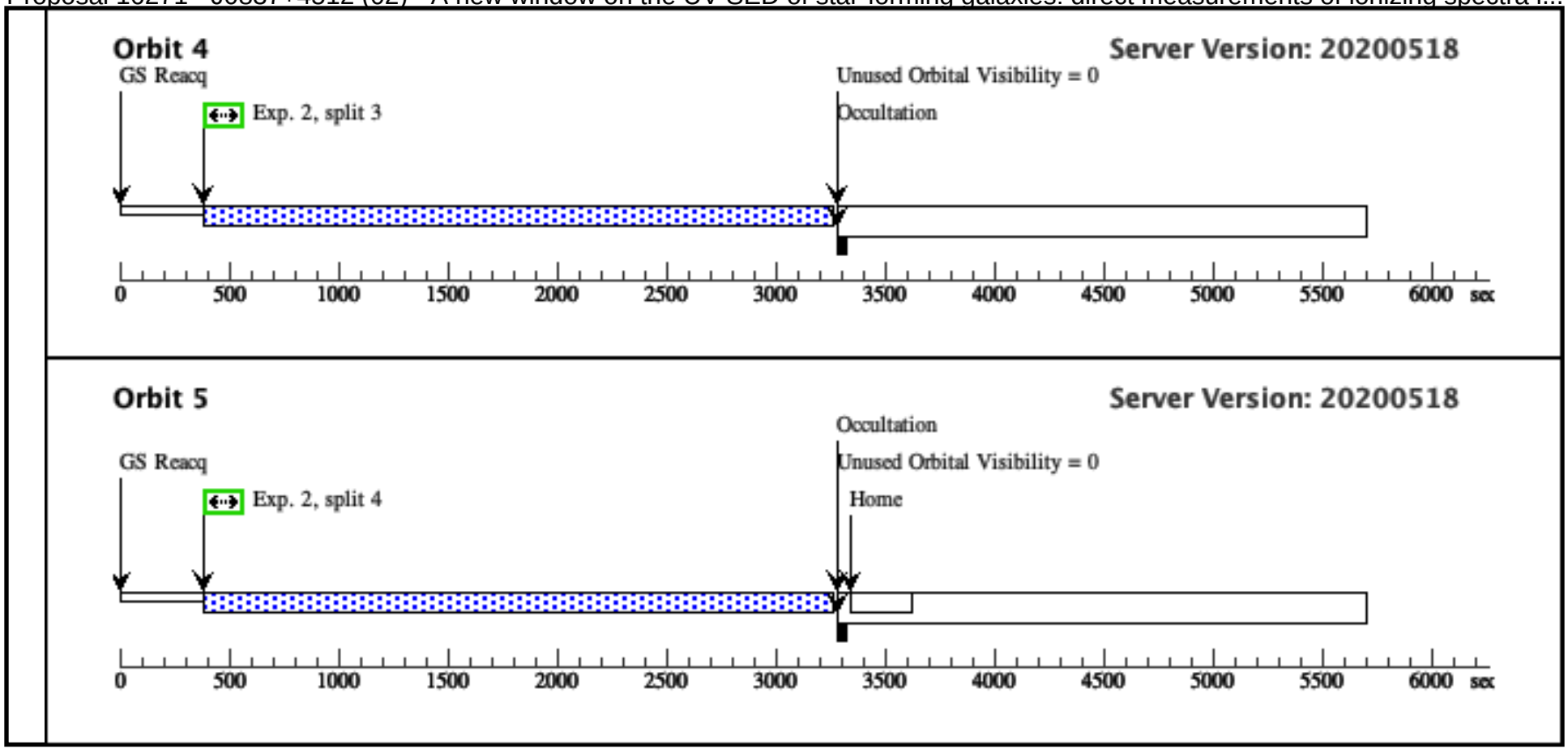
Orbit Structure





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5000
5500
6000
sec
Orbit 5
Server Version: 20200518
Occultation
GS Reacq
Unused Orbital Visibility = 0
Exp. 2, split 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16271, J0901+5111 (03) Fri Jun 12 19:00:32 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	J0901+5111	RA: 09 01 38.2800 (135.4095000d) Dec: +51 11 46.57 (51.19627d) Equinox: J2000	Redshift: 0.6374	V=21.66+/-0.10 FUV=22.15+/-0.53, NUV=22.16+/-0.35, F(900)=8.2e-17 erg/s/cm2/A - expected intrinsic flux of the Lyman continuum.	Reference Frame: ICRS

Comments:
Category=GALAXY
Description=[DWARF COMPACT, STARBURST]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	J0901+5111 ACQ (COS.ta.1445222)	(3) J0901+5111	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1433.0 Secs (1433 Secs)	
								[==>]	***[1]***
2	J0901+5111 G140L (COS.sp.1445228)	(3) J0901+5111	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=9500.0; FLASH=YES; FP-POS=ALL; SEGMENT=A			1500.0 Secs (11506 Secs)	
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								[==>2877.0 Secs (Split 2)]	***[3]***
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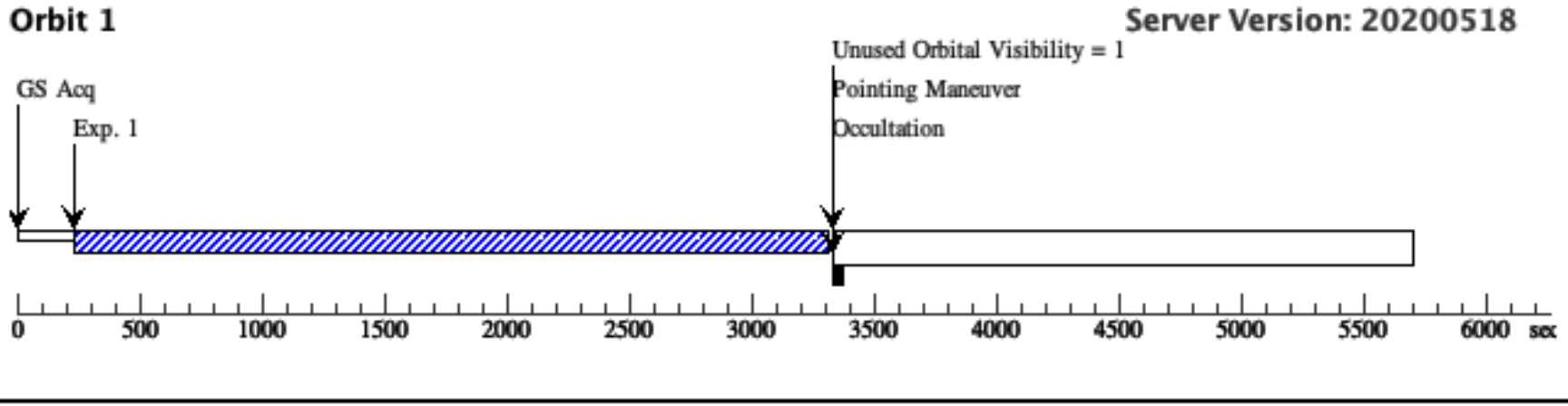
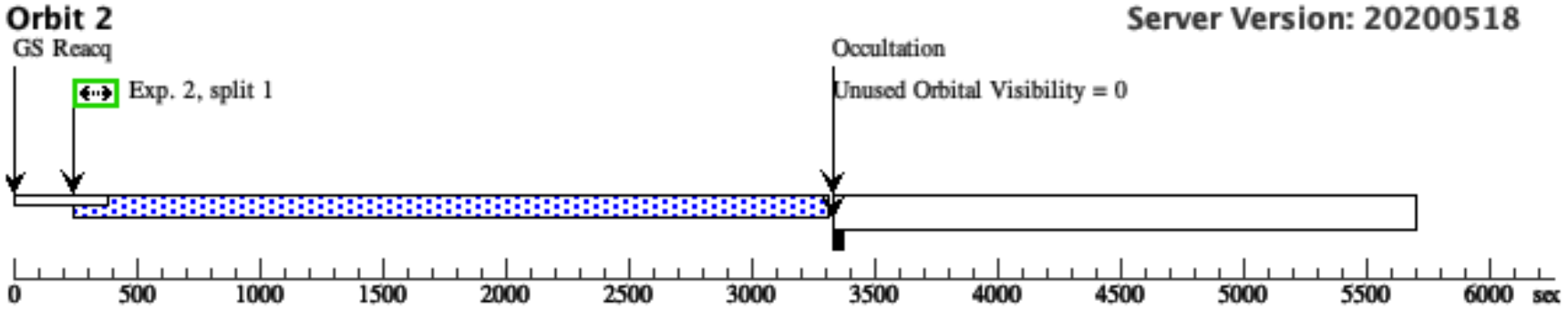
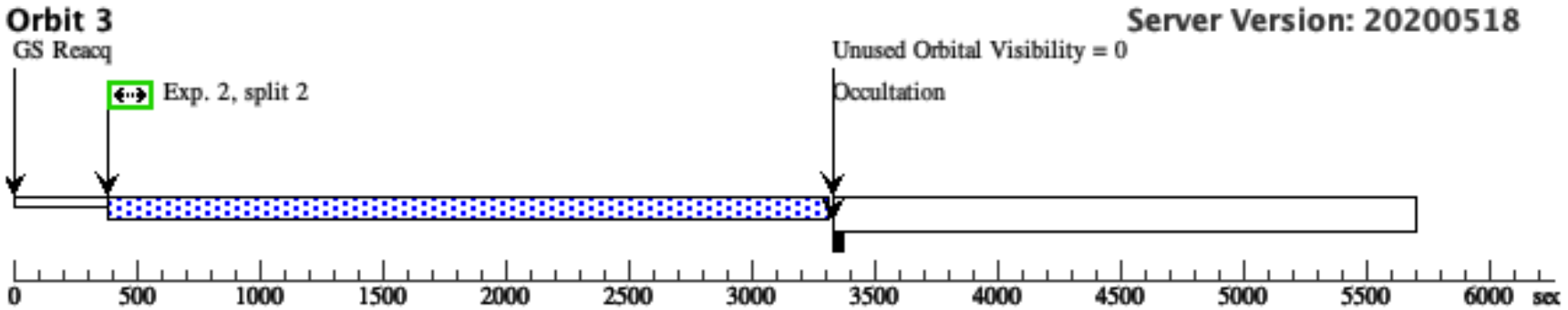
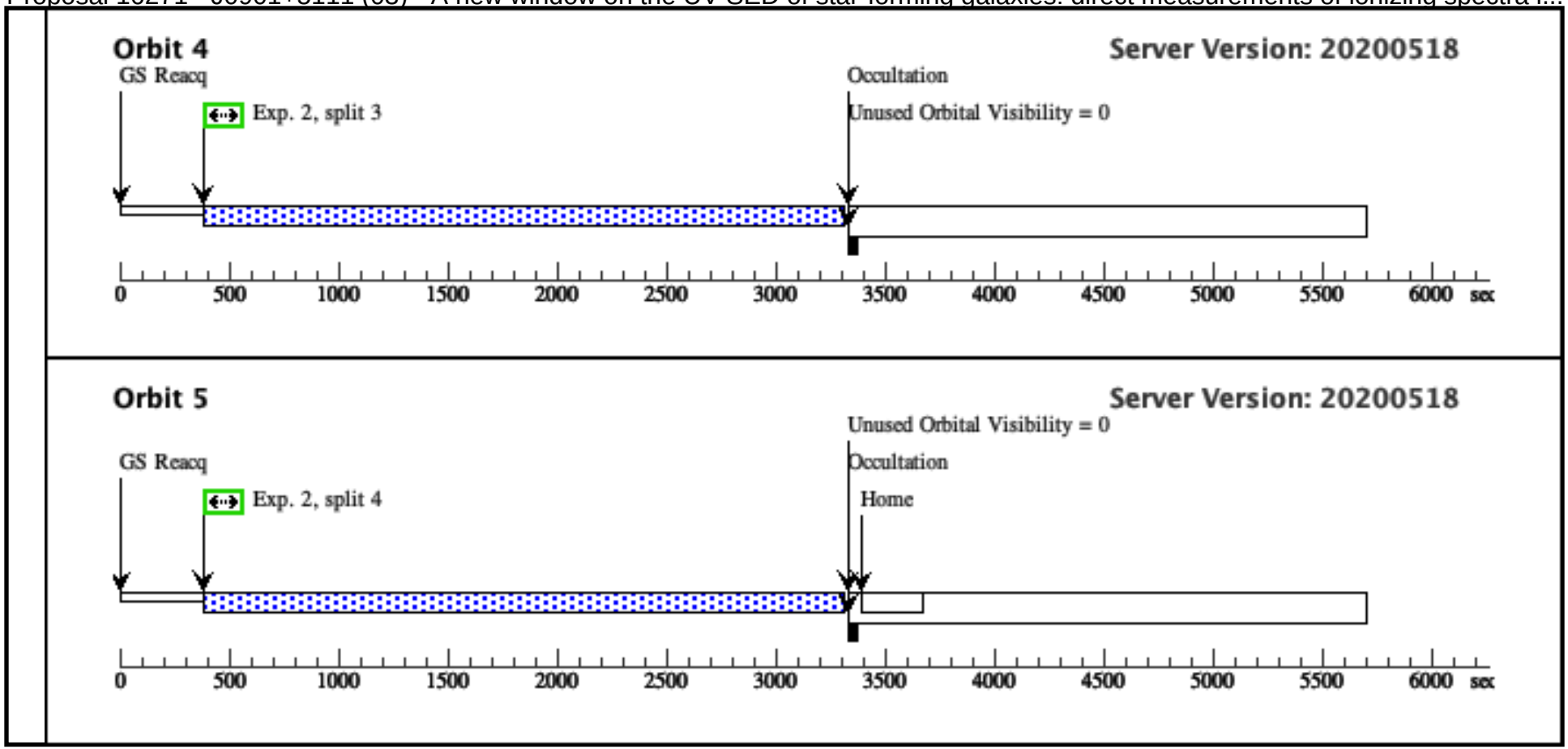
Orbit Structure





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Orbit 5
Server Version: 20200518
Unused Orbital Visibility = 0
GS Reacq
Exp. 2, split 4
Occultation
Home
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500
1000
1500
2000
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5500
6000
sec

Visit

Proposal 16271, J1252+5237 (04) Fri Jun 12 19:00:32 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

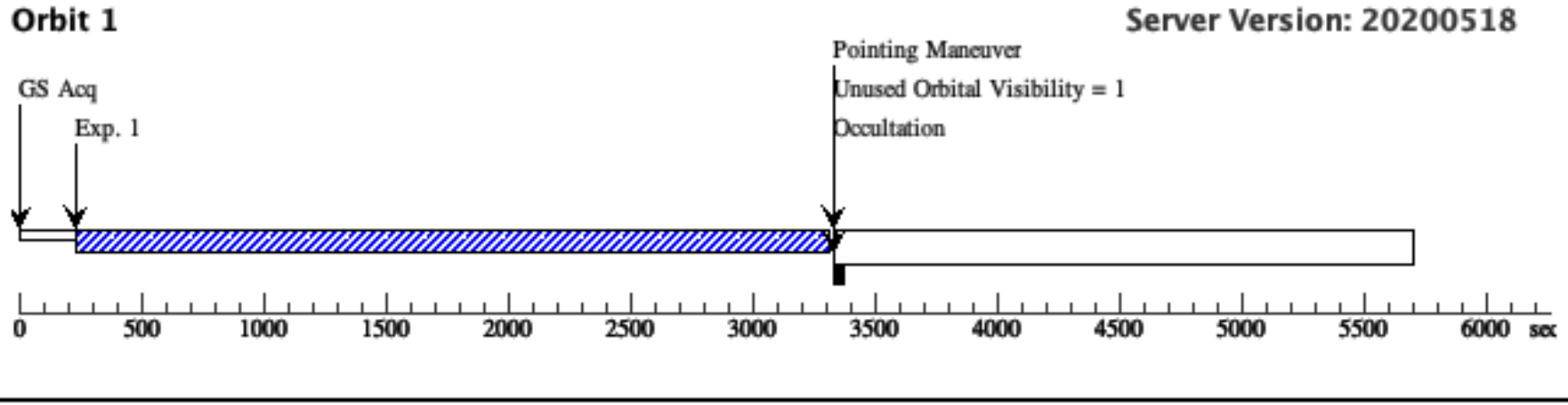
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	J1252+5237	RA: 12 52 31.3900 (193.1307917d) Dec: +52 37 16.42 (52.62123d) Equinox: J2000	Redshift: 0.6225	V=21.87+/-0.10 NUV=21.77+/-0.14, F(900)=7.2e-17 erg/s/cm2/A - expected intrinsic flux of the Lyman continuum.	Reference Frame: ICRS

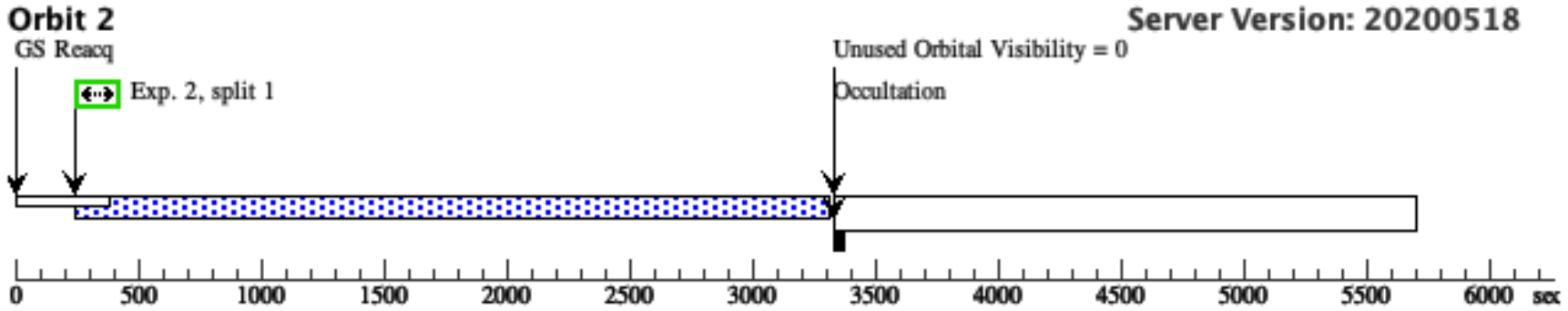
Comments:
Category=GALAXY
Description=[DWARF COMPACT, STARBURST]
Extended=NO

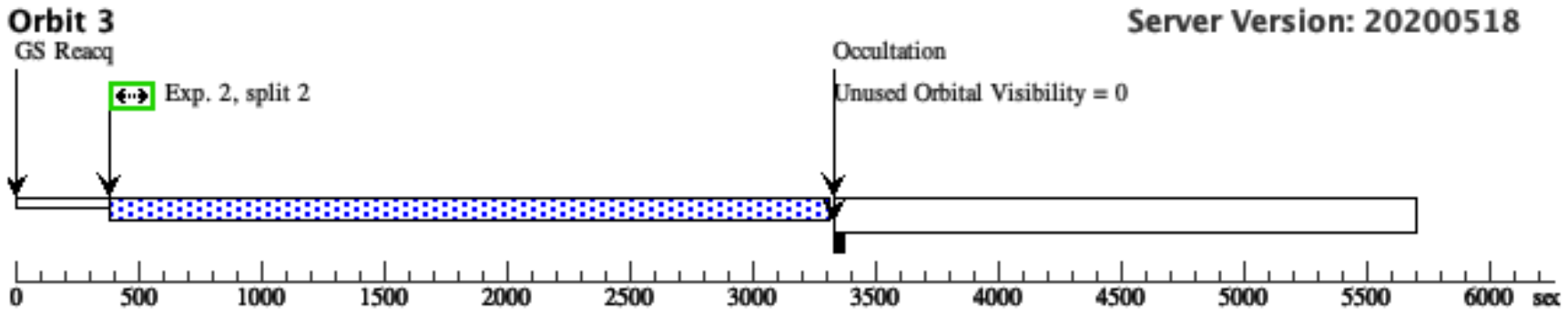
Exposures

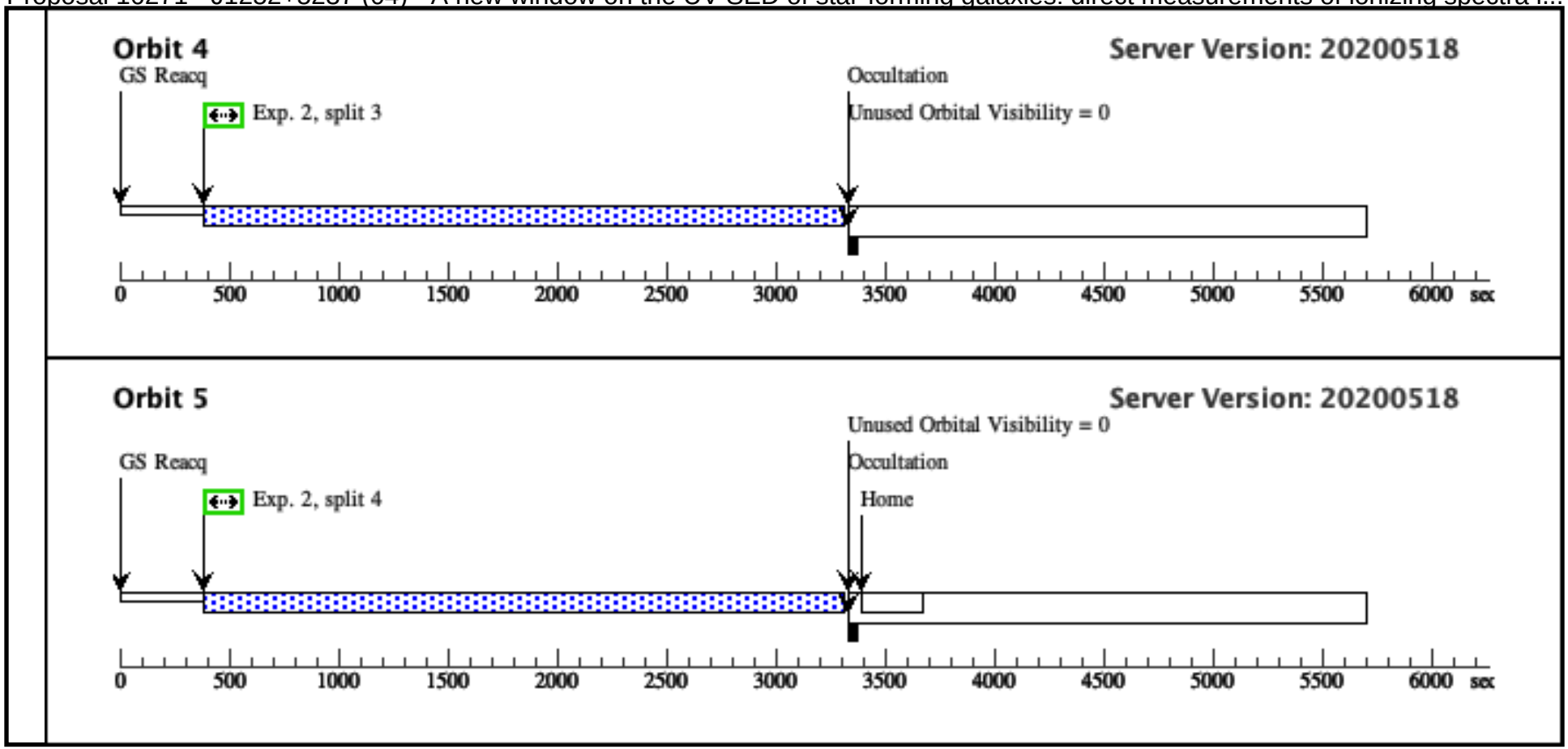
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	J1252+5237 ACQ (COS.ta.1445224)	(4) J1252+5237	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1433.0 Secs (1433 Secs)	
								[==>]	***[1]***
2	J1252+5237 G140L (COS.sp.1445228)	(4) J1252+5237	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=9500.0; FLASH=YES; FP-POS=ALL; SEGMENT=A			1500.0 Secs (11506 Secs)	
								[==>2875.0 Secs (Split 1)]	***[2]***
								[==>2877.0 Secs (Split 2)]	***[3]***
								[==>2877.0 Secs (Split 3)]	***[4]***
								[==>2877.0 Secs (Split 4)]	***[5]***

Orbit Structure





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sec
Orbit 5
Server Version: 20200518
Unused Orbital Visibility = 0
GS Reacq
Exp. 2, split 4
Occultation
Home
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500
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1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16271, J1358+4611 (05) Fri Jun 12 19:00:32 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	J1358+4611	RA: 13 58 6.7400 (209.5280833d) Dec: +46 11 43.19 (46.19533d) Equinox: J2000	Redshift: 0.6195	V=21.44+/-0.10 FUV=22.90+/-0.24, NUV=21.29+/-0.09, F(900)=11.6e-17 erg/s/cm2/A - expected intrinsic flux of the Ly man continuum.	Reference Frame: ICRS

Comments:
Category=GALAXY
Description=[DWARF COMPACT, STARBURST]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	J1358+4611 ACQ (COS.ta.1445225)	(5) J1358+4611	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1409.0 Secs (1409 Secs)	
								[==>]	***[1]***
2	J1358+4611 G140L (COS.sp.1445228)	(5) J1358+4611	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=9500.0; FLASH=YES; FP-POS=ALL; SEGMENT=A			1500.0 Secs (11314 Secs)	
								[==>2827.0 Secs (Split 1)]	***[2]***
								[==>2829.0 Secs (Split 2)]	***[3]***
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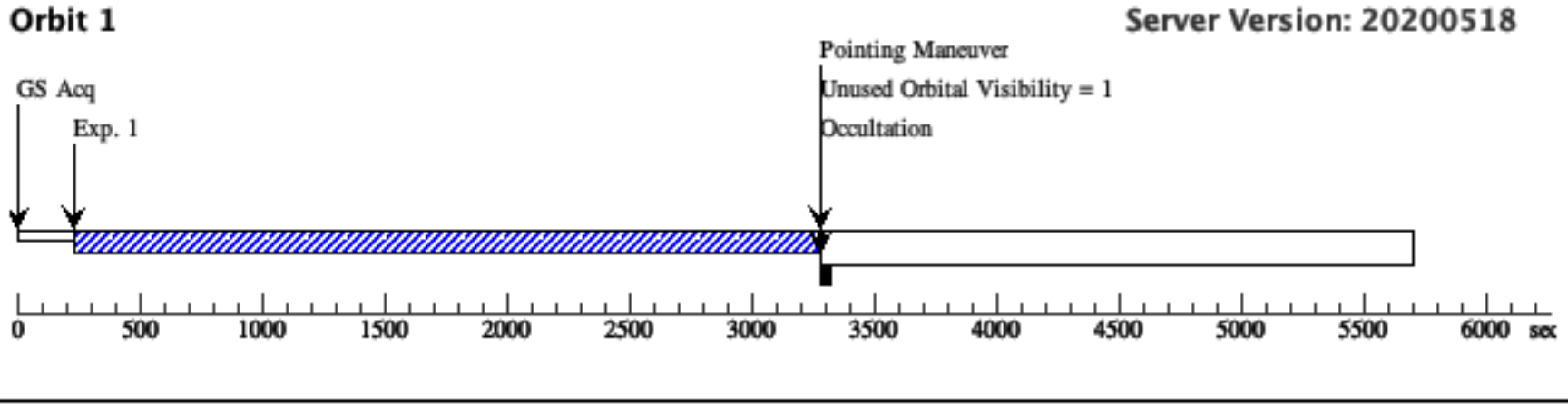
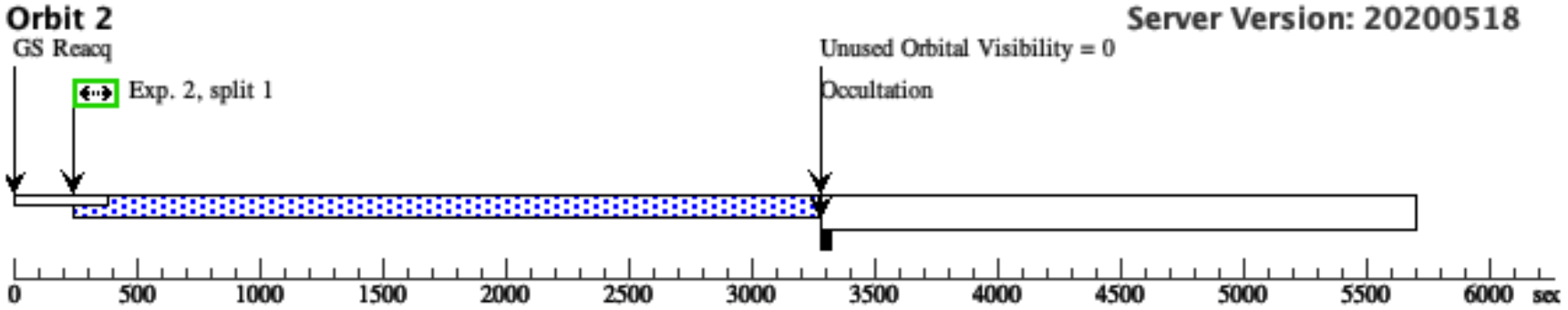
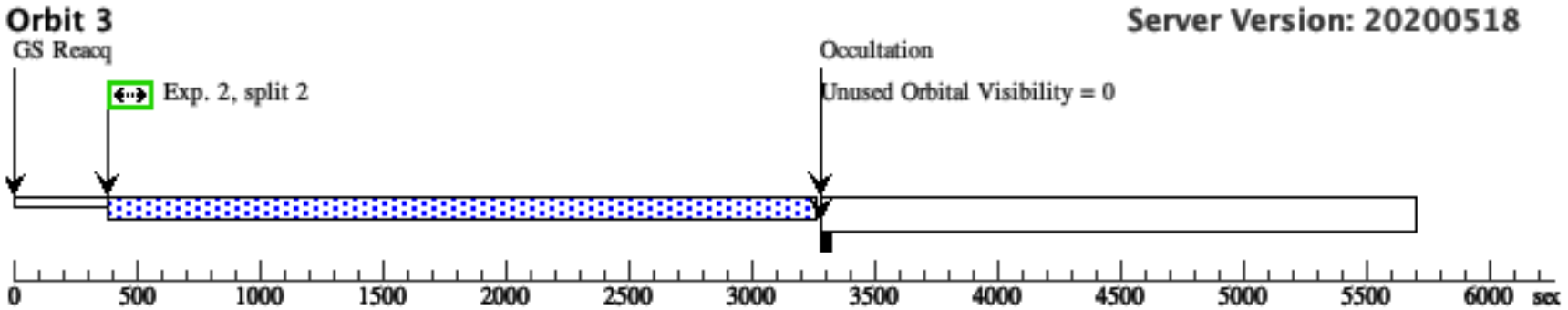
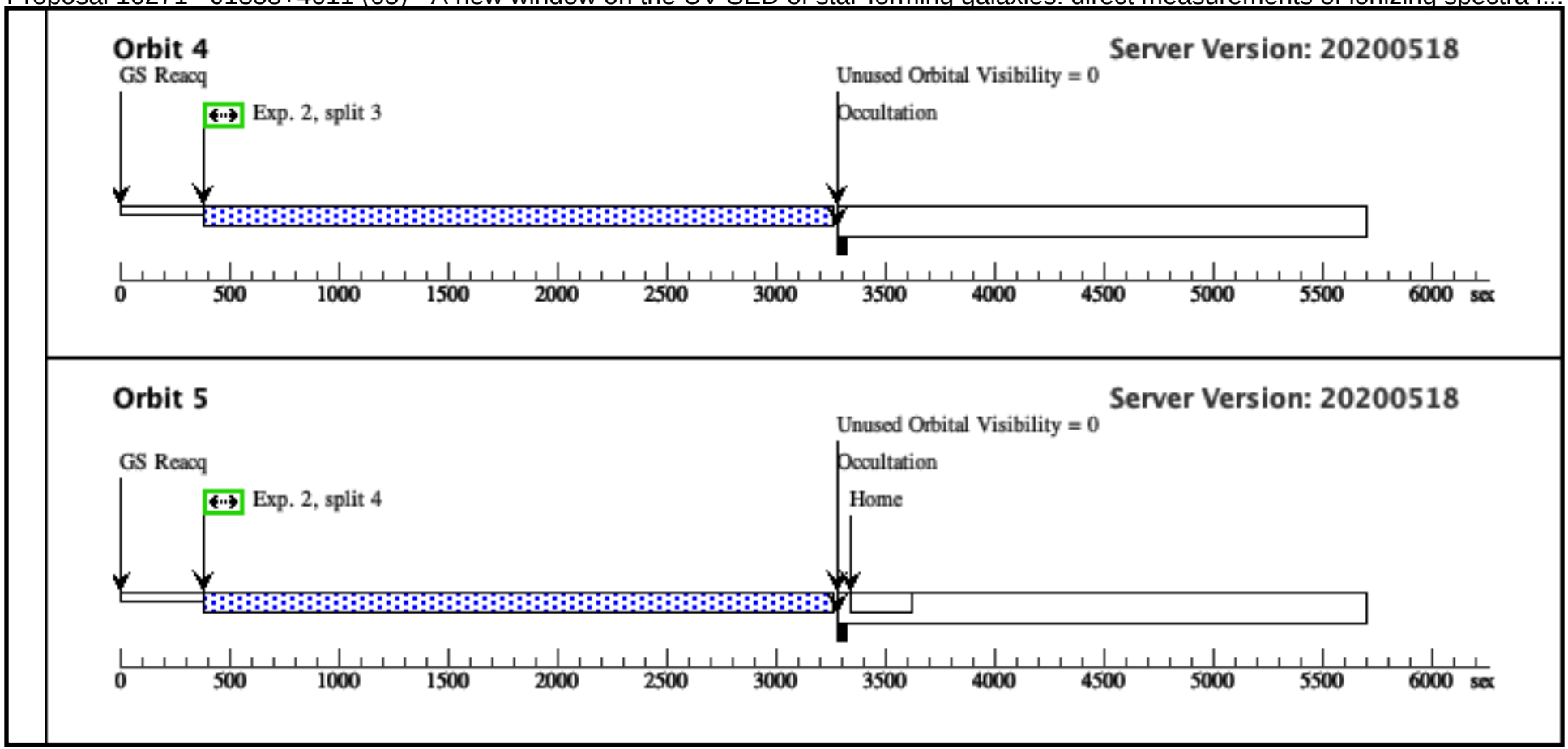
								[==>2829.0 Secs (Split 4)]	***[5]***

Orbit Structure








Orbit 4
Server Version: 20200518
GS Reacq
Exp. 2, split 3
Unused Orbital Visibility = 0
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec
Orbit 5
Server Version: 20200518
GS Reacq
Exp. 2, split 4
Unused Orbital Visibility = 0
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16271, J1450+3913 (06) Fri Jun 12 19:00:32 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

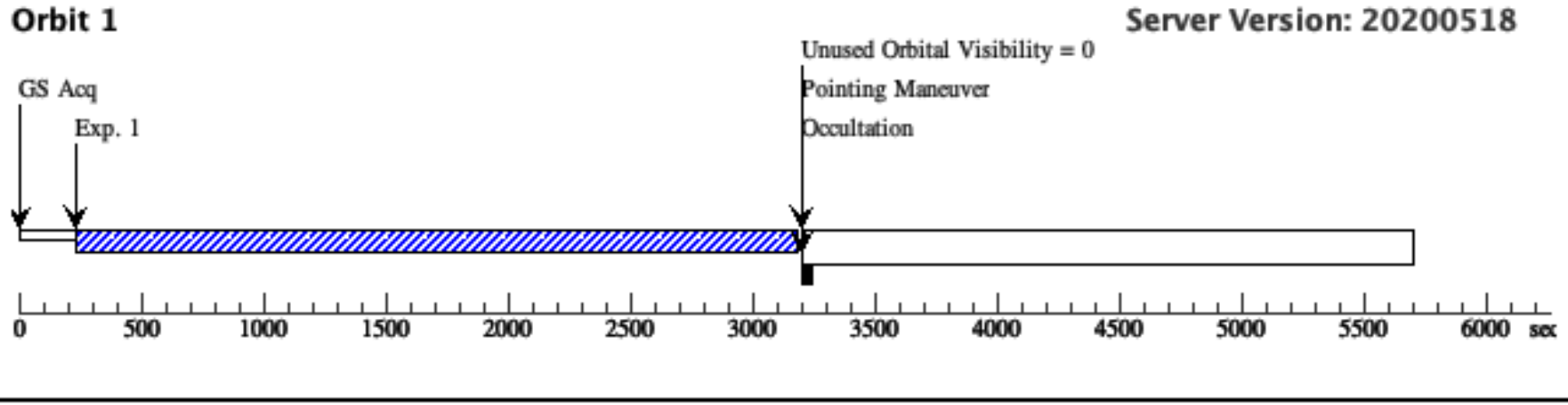
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	J1450+3913	RA: 14 50 29.8900 (222.6245417d) Dec: +39 13 21.84 (39.22273d) Equinox: J2000	Redshift: 0.6145	V=21.38+/-0.10 NUV=21.34+/-0.23, F(900)=10.9e-17 erg/s/cm2/A - expected intrinsic flux of the Ly man continuum.	Reference Frame: ICRS

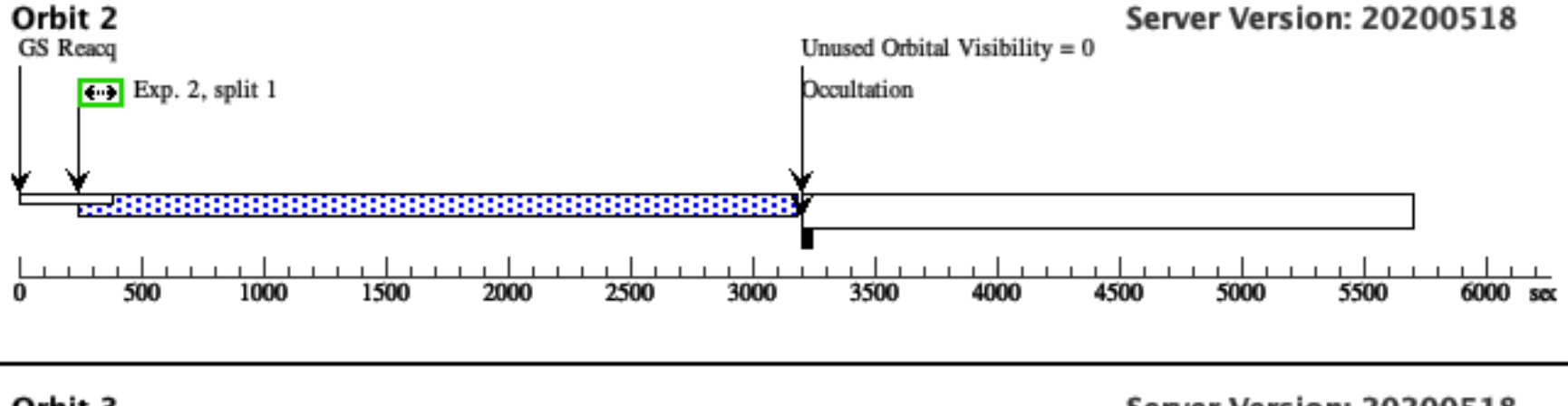
Comments:
Category=GALAXY
Description=[DWARF COMPACT, STARBURST]
Extended=NO

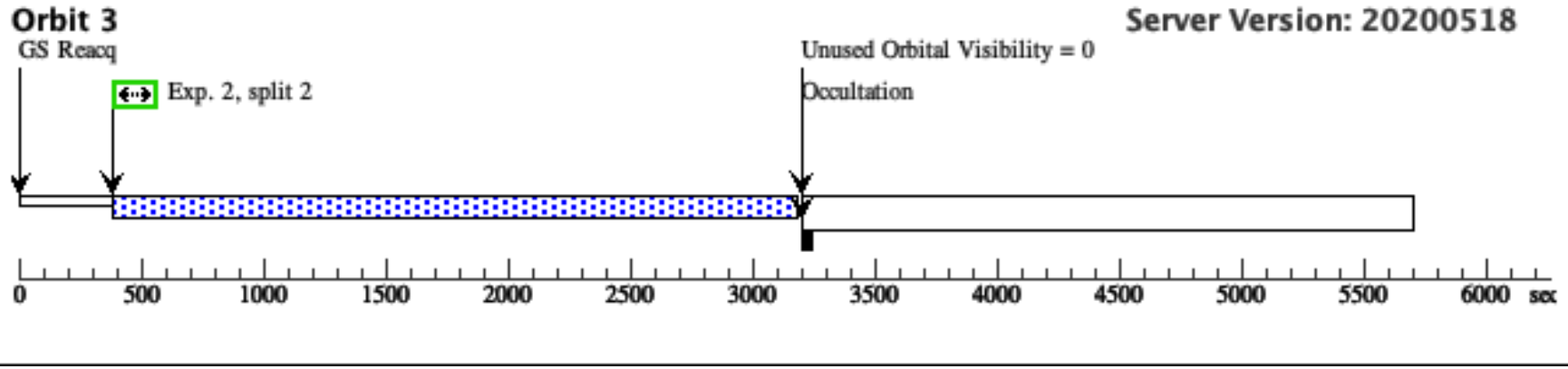
Exposures

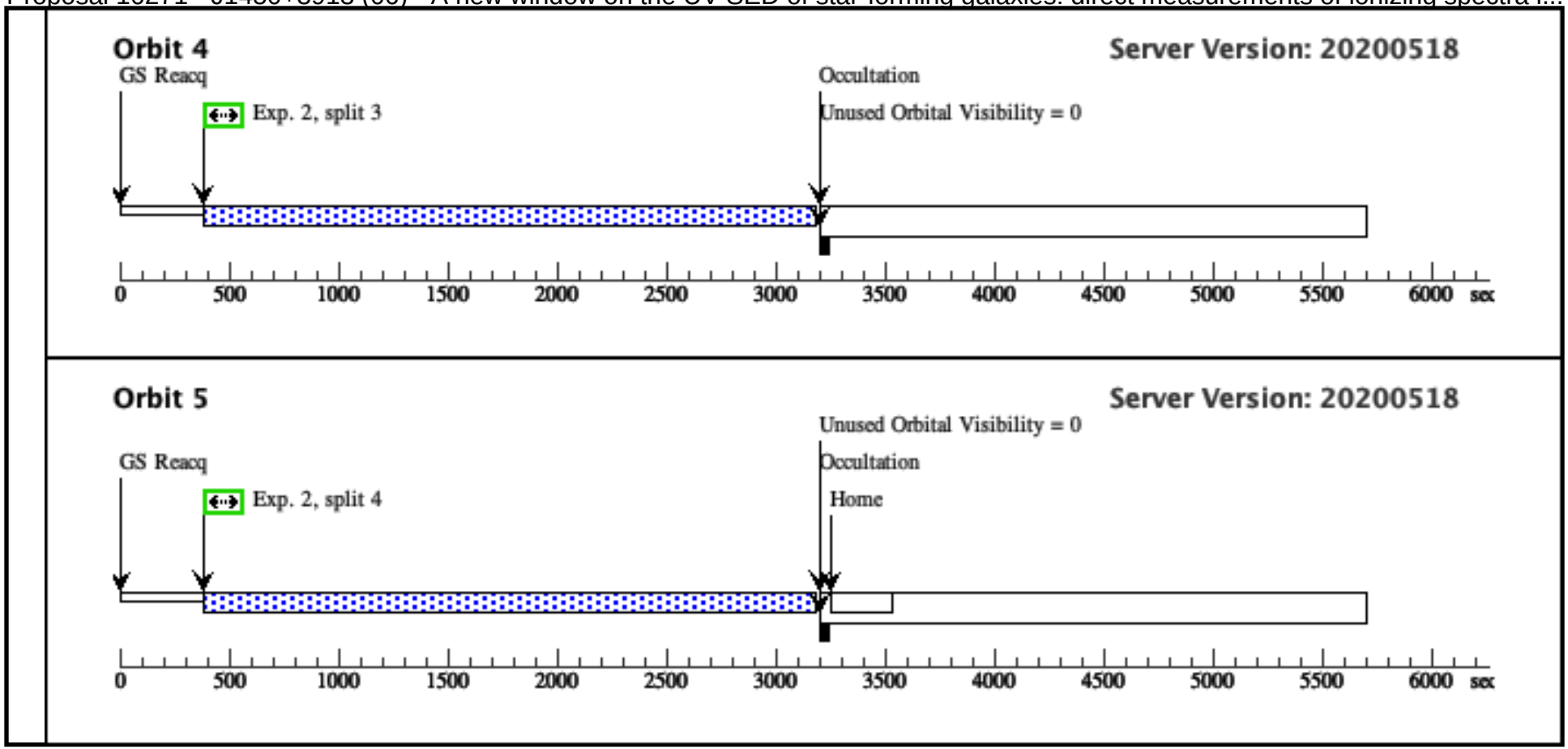
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	J1450+3913 ACQ (COS.ta.1445226)	(6) J1450+3913	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1367.0 Secs (1367 Secs)	
								[==>]	***[1]***
2	J1450+3913 G140L (COS.sp.1445228)	(6) J1450+3913	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=9500.0; FLASH=YES; FP-POS=ALL; SEGMENT=A			1500.0 Secs (10974 Secs)	
								[==>2742.0 Secs (Split 1)]	***[2]***
								[==>2744.0 Secs (Split 2)]	***[3]***
								[==>2744.0 Secs (Split 3)]	***[4]***
								[==>2744.0 Secs (Split 4)]	***[5]***

Orbit Structure








Orbit 4
Server Version: 20200518
GS Reacq
Exp. 2, split 3
Occultation
Unused Orbital Visibility = 0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec
Orbit 5
Server Version: 20200518
Unused Orbital Visibility = 0
GS Reacq
Exp. 2, split 4
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec