



## 16672 - Ly-alpha emission from the low-z most metal-deficient star-forming galaxies

Cycle: 29, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Yuri I. Izotov (PI) (Contact)</b>	<b>Ukrainian National Academy of Sciences, BITP</b>	<b>yizotov@bitp.kiev.ua</b>
Dr. Natalia G. Guseva (CoI)	Ukrainian National Academy of Sciences, BITP	nguseva@bitp.kiev.ua
Prof. Trinh Xuan Thuan (CoI) (AdminUSPI)	The University of Virginia	txt@virginia.edu
Prof. Klaus J. Fricke (CoI) (ESA Member)	Universitäts-Sternwarte Gottingen	kfricke@gwdg.de
Dr. Gabor Worseck (CoI) (ESA Member)	Universität Potsdam	gworseck@uni-potsdam.de
Prof. Daniel Schaerer (CoI) (ESA Member)	Observatoire de Geneve	daniel.schaerer@unige.ch
Prof. Anne Verhamme (CoI) (ESA Member)	Observatoire de Geneve	anne.verhamme@unige.ch

### 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) J0122+0048	COS/FUV COS/NUV	3	20-Jul-2021 08:00:37.0	yes
02	(2) J0139+1542	COS/FUV COS/NUV	4	20-Jul-2021 08:00:38.0	yes
03	(3) J0811+4730	COS/FUV COS/NUV	4	20-Jul-2021 08:00:39.0	yes
04	(4) J0837+1921	COS/FUV COS/NUV	4	20-Jul-2021 08:00:40.0	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>
05	(5) J1004+3256	COS/FUV COS/NUV	4	20-Jul-2021 08:00:41.0	yes
06	(6) J1206+5007	COS/FUV COS/NUV	4	20-Jul-2021 08:00:42.0	yes
07	(7) J1234+3901	COS/FUV COS/NUV	4	20-Jul-2021 08:00:43.0	yes
08	(8) J1505+3721	COS/FUV COS/NUV	3	20-Jul-2021 08:00:44.0	yes
09	(9) J2229+2725	COS/FUV COS/NUV	4	20-Jul-2021 08:00:45.0	yes

34 Total Orbits Used

## ABSTRACT

Extremely metal-deficient (XMD), compact and low-mass star-forming galaxies (SFGs) at low redshifts are considered to be the likely nearby counterparts of the high- $z$  star-forming dwarf galaxies thought to be responsible for the reionization of the Universe. We propose to observe with the HST/COS a complete sample of the nine most metal-deficient ( $12+\log O/H < 7.25$ ) compact SFGs known in the local universe, to obtain medium-resolution spectra of the Ly-alpha emission line. Only one galaxy with such a low metallicity, I Zw 18, has been studied previously with the HST/COS. These SFGs were selected from the Data Release 16 and earlier releases of the Sloan Digital Sky Survey to be not only XMD, but also to be very compact and to have very young starbursts ( $EW(H\beta) > 100\text{\AA}$ ). Among them one galaxy, J0811+4730 with  $12+\log O/H = 6.98$ , is one of the lowest-metallicity low- $z$  SFG known to date. The Ly-alpha profiles in those medium resolution spectra will be used to indirectly estimate the escape fraction of the Lyman continuum and will provide important insight on the ISM and radiation field of the star-forming regions. Obtaining the rest-UV spectra of these nine XMD SFGs which will serve as templates for the analysis of spectra of high- $z$  dwarf galaxies with active star formation, is thus both urgent and crucial for upcoming studies with the JWST and the largest ground-based facilities.

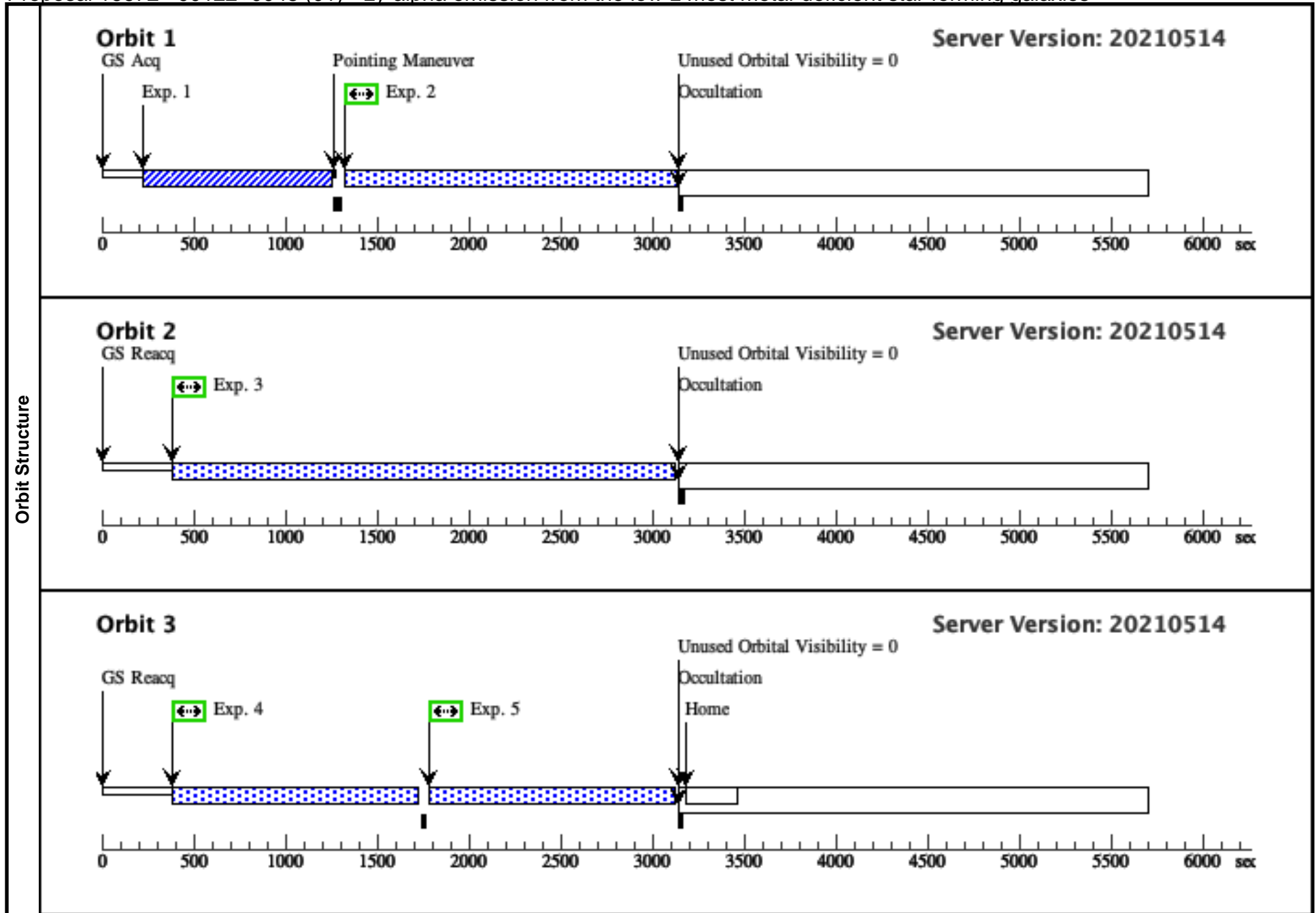
## OBSERVING DESCRIPTION

The galaxies are faint and satisfy safety conditions for observing with the COS. Furthermore, there are no sources brighter than the COS safety limits in circular regions with the diameter of 43 arcsec centered on the selected galaxies. NUV acquisition images of the targets will be obtained with the

## Proposal 16672 (STScI Edit Number: 0, Created: Tuesday, July 20, 2021 at 7:00:45 AM Eastern Standard Time) - Overview

standard Mirror A and the ACQ/IMAGE mode to reach a S/N<sub>20</sub> inside a 9x9 pixel box centered on the brightest part of the galaxy. The adopted GALEX NUV magnitudes were used to estimate exposure times. 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+2x700s=1520s per object (HST Primer manual), or half of orbit. As a bonus, the UV morphology of the selected objects will be studied with these images. For medium-resolution spectroscopy, the COS in combination with the G130M grating will be used to observe the Ly-alpha line. This resolution is required to resolve the Ly-alpha line profile and to measure features such as the velocity separations between different emission peaks which give the best estimate of the LyC escape fraction. The Ly-alpha emission-line profiles in the spectra of the proposed galaxies will be compared to those in LyC leaking galaxies and in Green Pea galaxies. The GALEX FUV magnitude is used to calculate for each object the required number of orbits to obtain a S/N > 5 for the continuum near Ly-alpha line, in the case of a 100-pixel binned spectrum. This S/N would be enough to obtain the Ly-alpha profile with a sufficient accuracy for radiative transfer modeling and for deriving velocity separations between the peaks. For each target, 0.5 orbit for acquisition, and 2.5 or 3.5 orbits for the spectrum with the medium-resolution G130M grating are needed, totalling 3 or 4 orbits per object. A total of 34 orbits for 9 objects is requested.

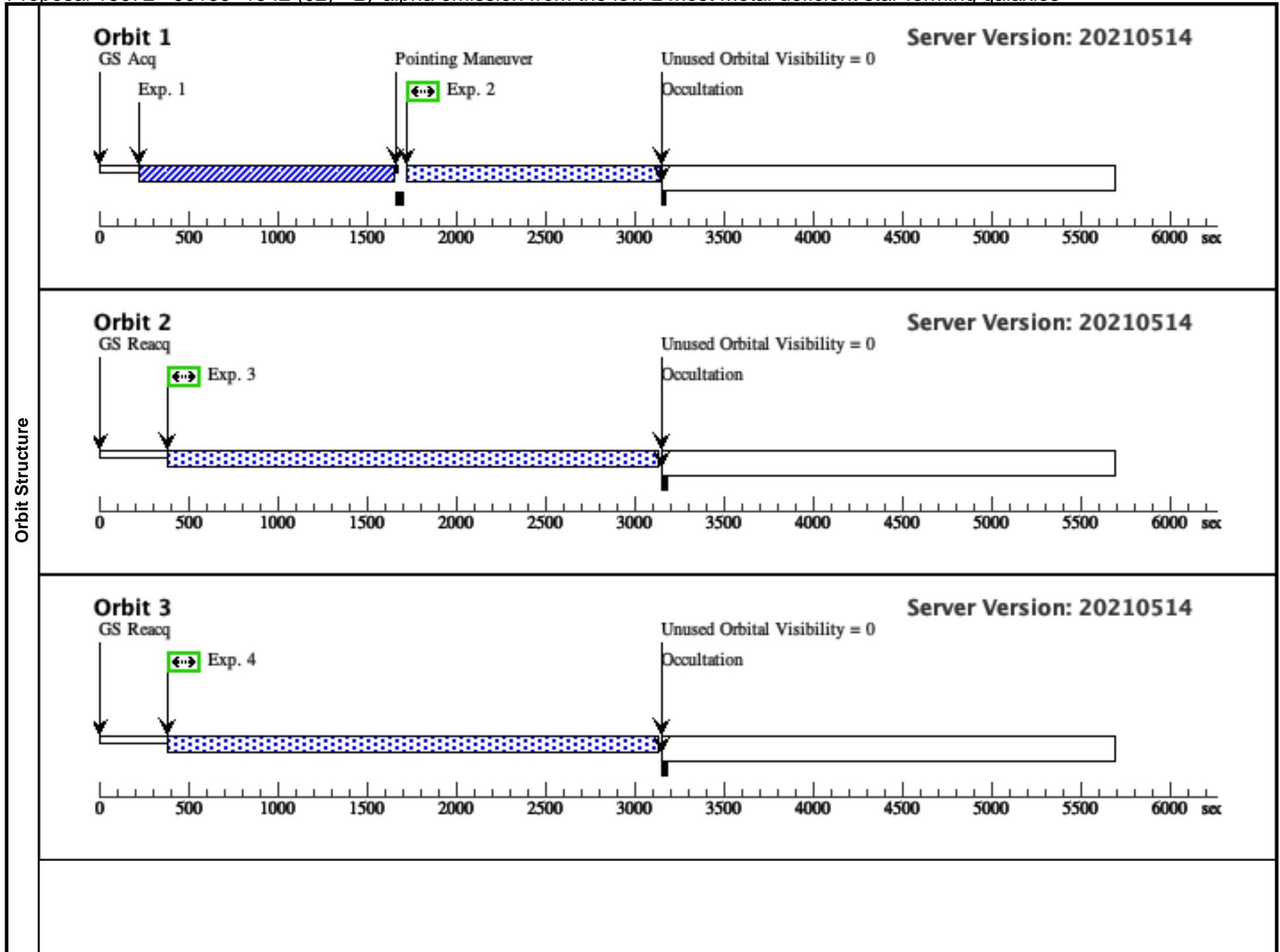


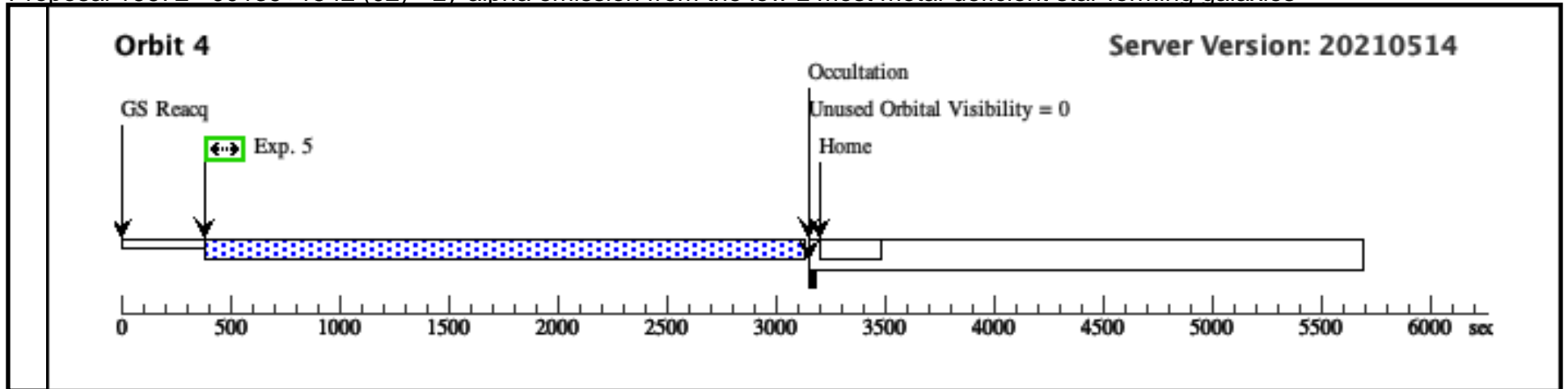


Proposal 16672 - J0139+1542 (02) - Ly-alpha emission from the low-z most metal-deficient star-forming galaxies

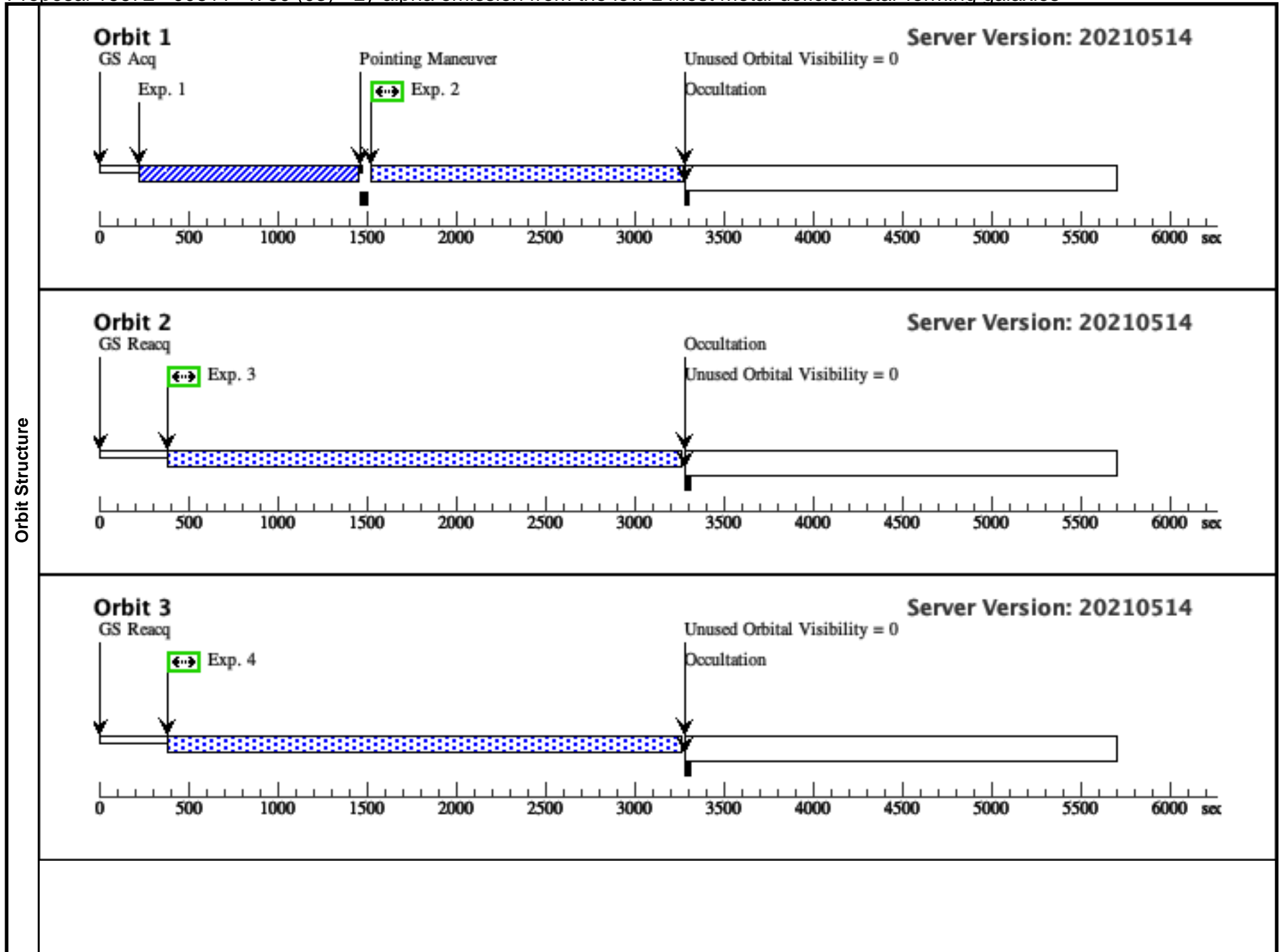
Tue Jul 20 12:00:45 GMT 2021

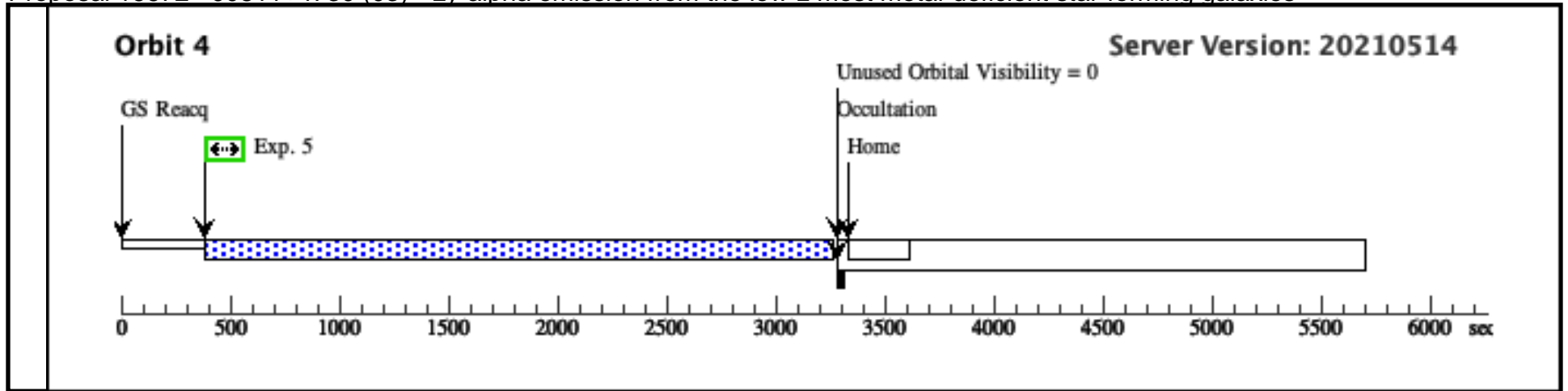
Visit	<b>Proposal 16672, J0139+1542 (02), implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(2)	J0139+1542	RA: 01 39 11.9300 (24.7997083d) Dec: +15 42 41.32 (15.71148d) Equinox: J2000	Redshift: 0.0281	V=21.84+/-0.05 NUV=22.17+/-0.15	Reference Frame: ICRS				
	<i>Comments:</i> 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	J0139+1542 ACQ (COS.ta.152 2145)	(2) J0139+1542	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				600 Secs (600 Secs) [==>]	[1]
	2	J0139+1542 G130M1 (COS.sp.152 2146)	(2) J0139+1542	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=20 000.0; FLASH=YES; FP-POS=1; SEGMENT=BOTH			1000 Secs (1236 Secs) [==>1236.0 Secs ]	[1]
	3	J0139+1542 G130M2 (COS.sp.152 2146)	(2) J0139+1542	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=20 000.0; FLASH=YES; FP-POS=2; SEGMENT=BOTH			1000 Secs (2700 Secs) [==>2700.0 Secs ]	[2]
	4	J0139+1542 G130M3 (COS.sp.152 2146)	(2) J0139+1542	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=20 000.0; FLASH=YES; FP-POS=3; SEGMENT=BOTH			1000 Secs (2700 Secs) [==>2700.0 Secs ]	[3]
	5	J0139+1542 G130M4 (COS.sp.152 2146)	(2) J0139+1542	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=20 000.0; FLASH=YES; FP-POS=4; SEGMENT=BOTH			1000 Secs (2700 Secs) [==>2700.0 Secs ]	[4]



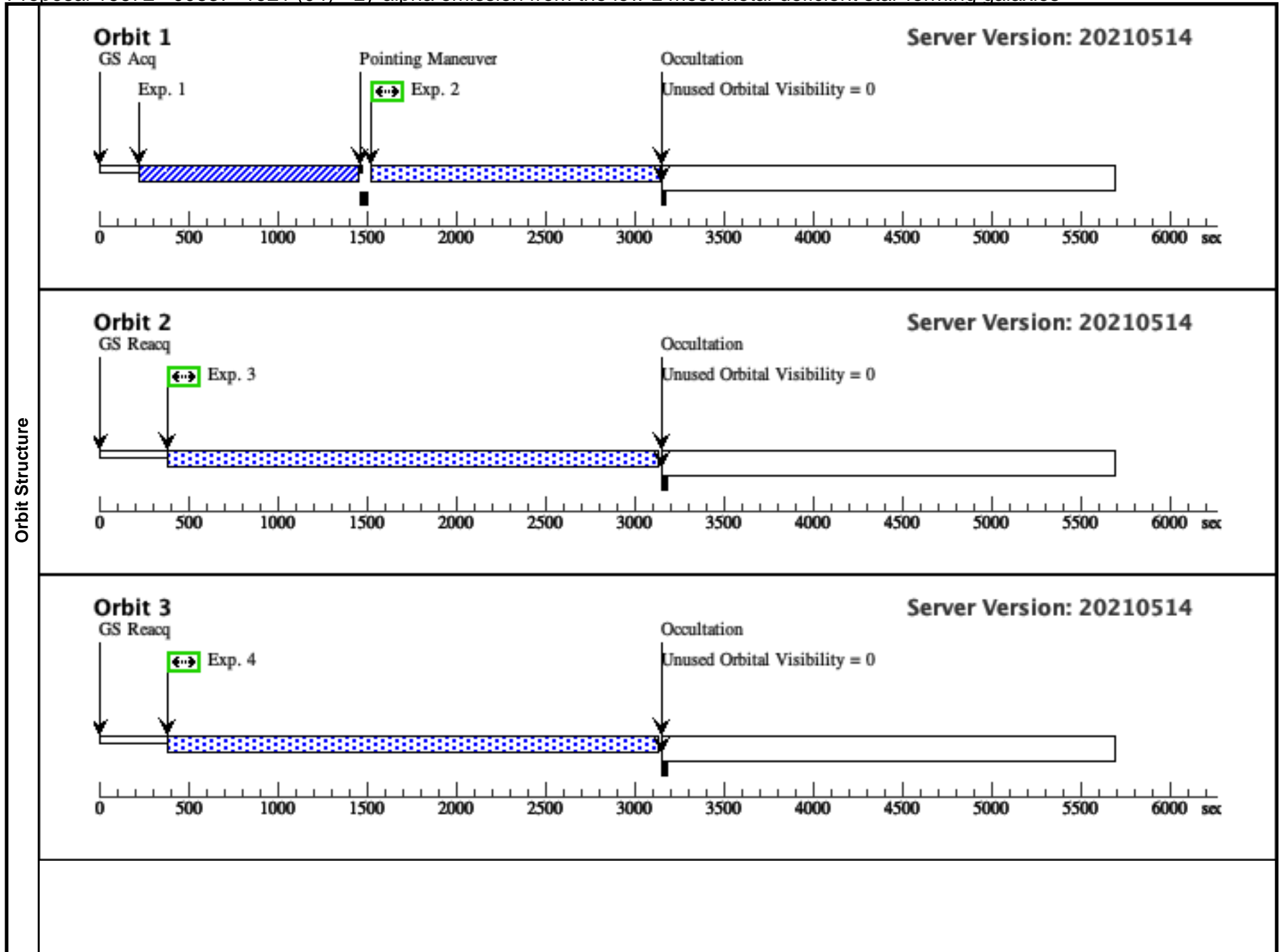


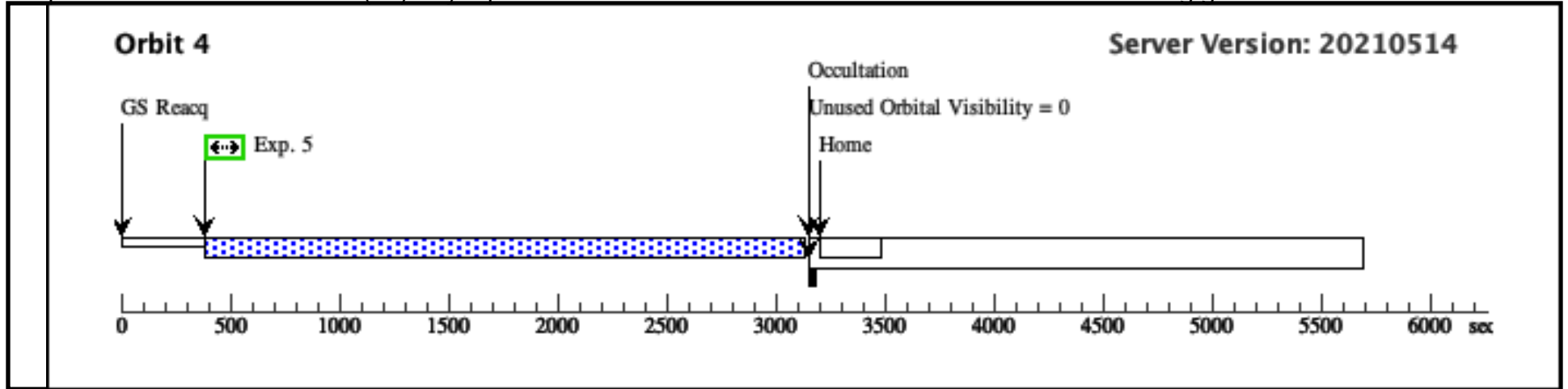




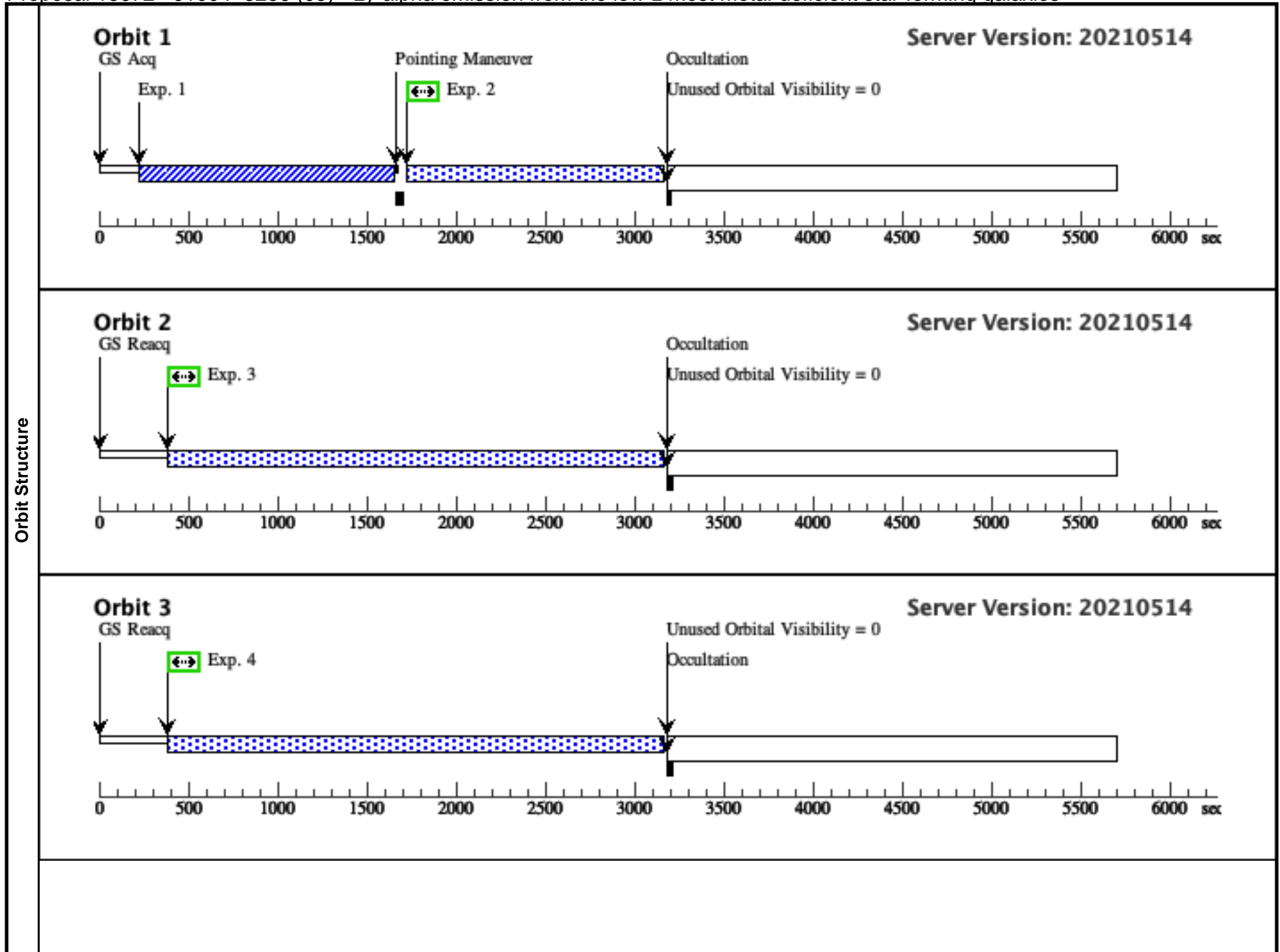


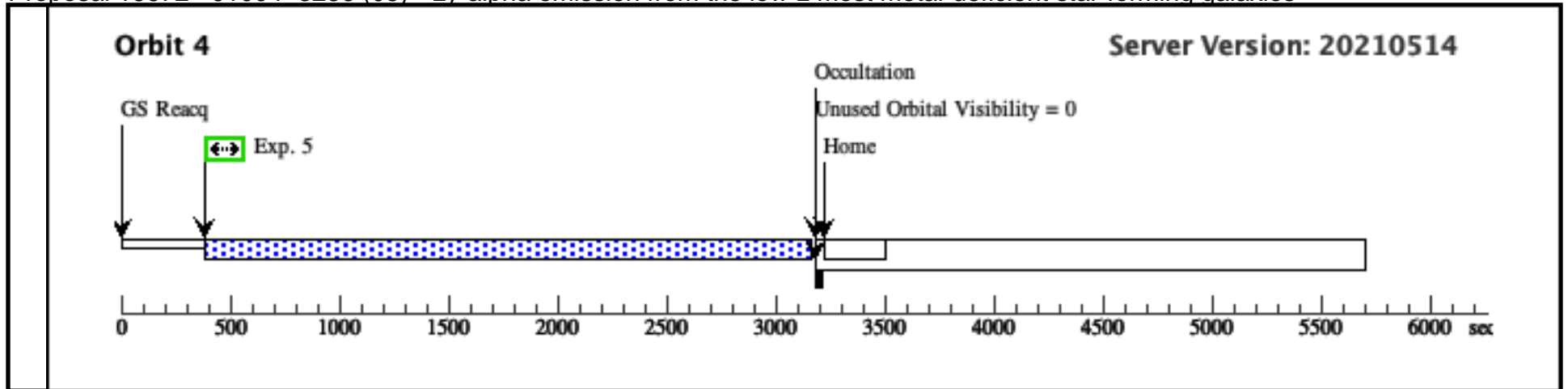




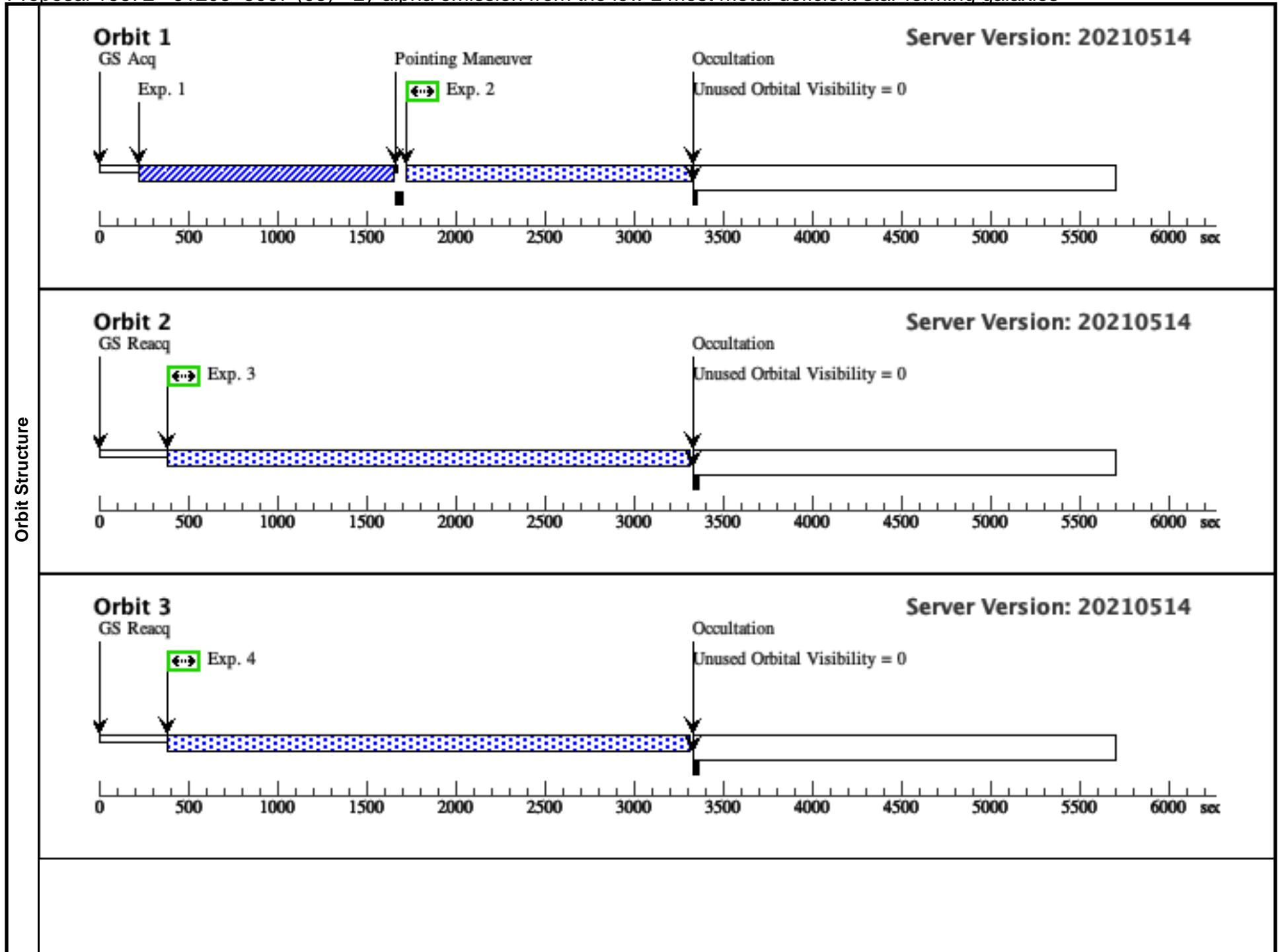


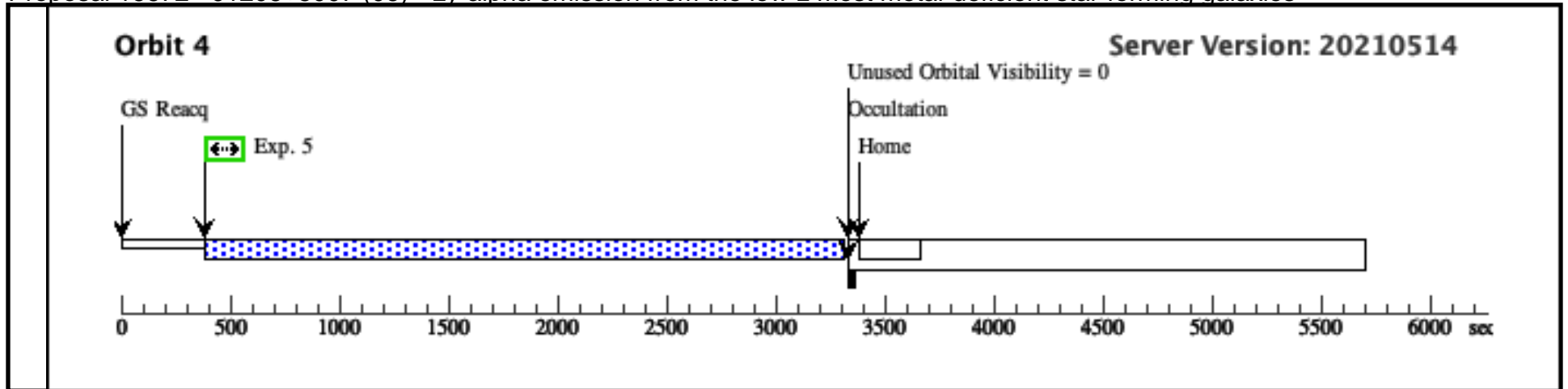








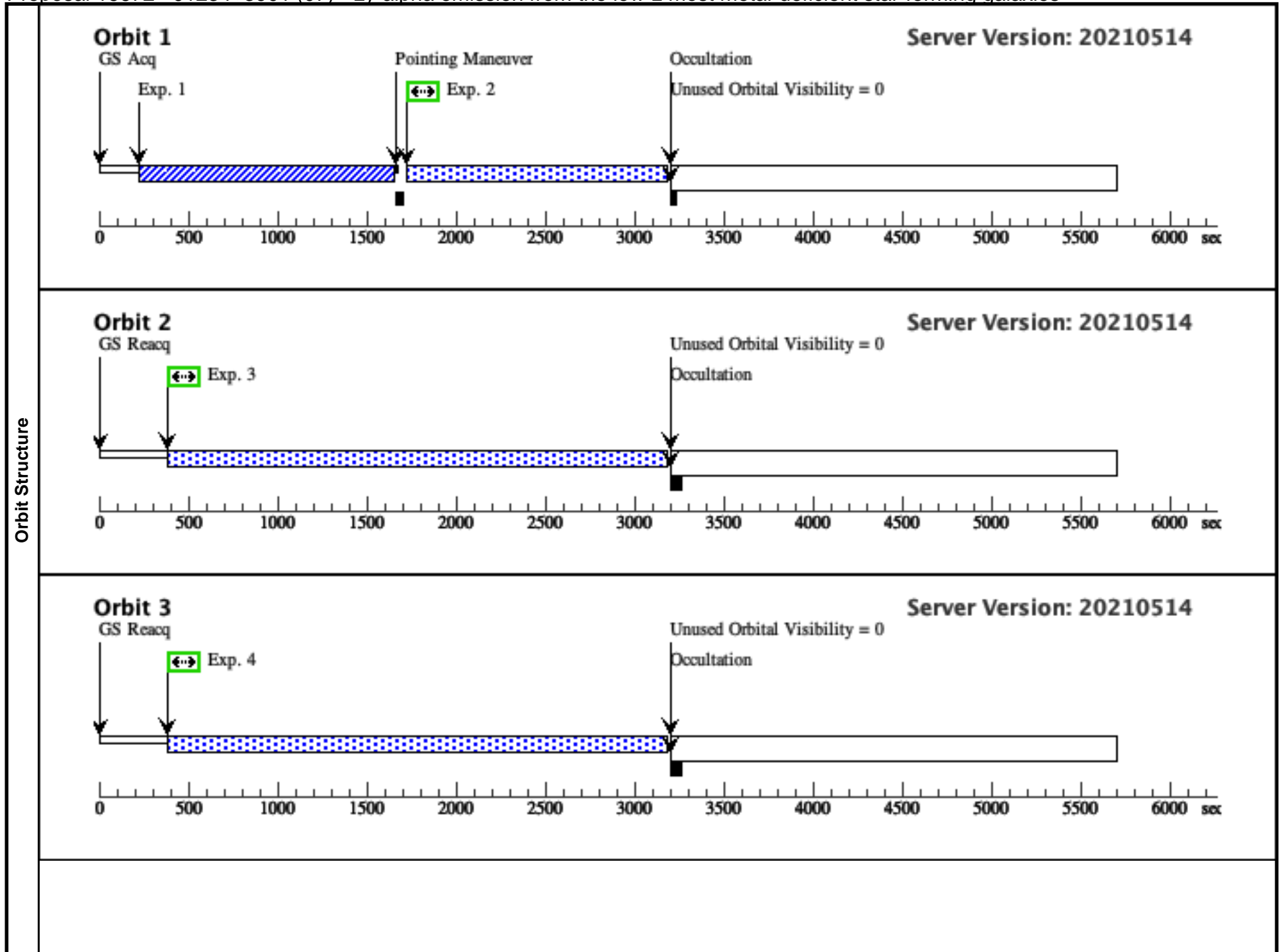


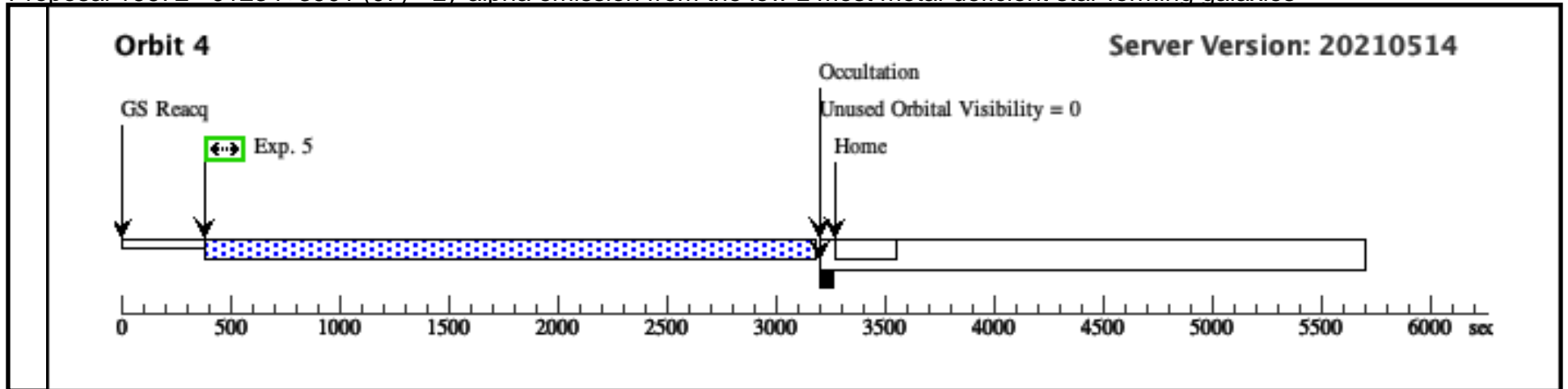


Proposal 16672 - J1234+3901 (07) - Ly-alpha emission from the low-z most metal-deficient star-forming galaxies

Tue Jul 20 12:00:46 GMT 2021

Visit	<b>Proposal 16672, J1234+3901 (07), implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)																					
	Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(7)</td> <td>J1234+3901</td> <td>RA: 12 34 15.7100 (188.5654583d) Dec: +39 01 16.41 (39.02123d) Equinox: J2000</td> <td>Redshift: 0.1329</td> <td>V=21.92+/-0.06 FUV=21.24+/-0.38, NUV=22.17+/-0.57</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> <p> <i>Comments:</i>  <i>Category=GALAXY</i>  <i>Description=[DWARF COMPACT, STARBURST]</i>  <i>Extended=NO</i> </p>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(7)	J1234+3901	RA: 12 34 15.7100 (188.5654583d) Dec: +39 01 16.41 (39.02123d) Equinox: J2000	Redshift: 0.1329	V=21.92+/-0.06 FUV=21.24+/-0.38, NUV=22.17+/-0.57
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous																	
(7)	J1234+3901	RA: 12 34 15.7100 (188.5654583d) Dec: +39 01 16.41 (39.02123d) Equinox: J2000	Redshift: 0.1329	V=21.92+/-0.06 FUV=21.24+/-0.38, NUV=22.17+/-0.57	Reference Frame: ICRS																	
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit												
	1	J1234+3901 ACQ (COS.ta.152 2155)	(7) J1234+3901	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				600 Secs (600 Secs) [==>]	[1]												
	2	J1234+3901 G130M1 (COS.sp.152 2156)	(7) J1234+3901	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=60 00.0; FLASH=YES; FP-POS=1; SEGMENT=A			1000 Secs (1294 Secs) [==>1294.0 Secs ]	[1]												
	3	J1234+3901 G130M2 (COS.sp.152 2156)	(7) J1234+3901	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=60 00.0; FLASH=YES; FP-POS=2; SEGMENT=A			1000 Secs (2744 Secs) [==>2744.0 Secs ]	[2]												
	4	J1234+3901 G130M3 (COS.sp.152 2156)	(7) J1234+3901	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=60 00.0; FLASH=YES; FP-POS=3; SEGMENT=A			1000 Secs (2744 Secs) [==>2744.0 Secs ]	[3]												
	5	J1234+3901 G130M4 (COS.sp.152 2156)	(7) J1234+3901	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=60 00.0; FLASH=YES; FP-POS=4; SEGMENT=A			1000 Secs (2744 Secs) [==>2744.0 Secs ]	[4]												

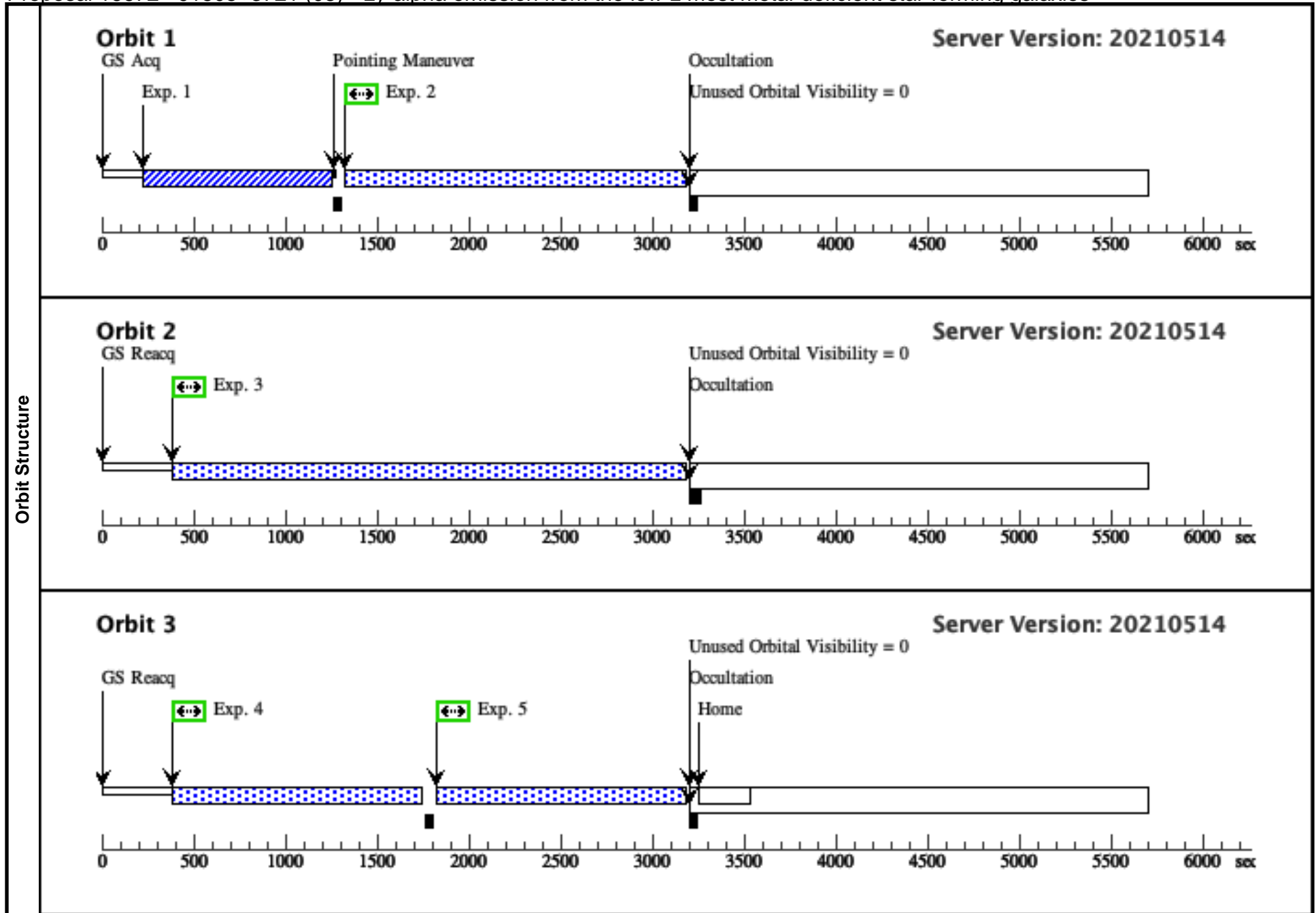




Proposal 16672 - J1505+3721 (08) - Ly-alpha emission from the low-z most metal-deficient star-forming galaxies

Tue Jul 20 12:00:46 GMT 2021

Visit	<b>Proposal 16672, J1505+3721 (08), implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/FUV, COS/NUV Special Requirements: BETWEEN 2022.023 AND 2022.039; BETWEEN 2022.055 AND 2022.215; BETWEEN 2023.023 AND 2023.057; BETWEEN 2023.065 AND 2023.090 Comments: The Ly-alpha line can be affected by the OI airglow emission line. Therefore, the observations should preferentially be taken in orbital shadow to minimize this contamination. We used a table with the orbital visibility to select optimal observing periods with a shadow visibility of more than 25 minutes. These have been implemented with BETWEEN constraints.												
	Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(8)</td> <td>J1505+3721</td> <td>RA: 15 05 8.5800 (226.2857500d) Dec: +37 21 40.22 (37.36117d) Equinox: J2000</td> <td>Redshift: 0.0753</td> <td>V=20.97+/-0.06 FUV=21.54+/-0.32, NUV=21.29+/-0.18</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> Comments: Category=GALAXY Description=[DWARF COMPACT, STARBURST] Extended=NO	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(8)	J1505+3721	RA: 15 05 8.5800 (226.2857500d) Dec: +37 21 40.22 (37.36117d) Equinox: J2000	Redshift: 0.0753	V=20.97+/-0.06 FUV=21.54+/-0.32, NUV=21.29+/-0.18
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous								
(8)	J1505+3721	RA: 15 05 8.5800 (226.2857500d) Dec: +37 21 40.22 (37.36117d) Equinox: J2000	Redshift: 0.0753	V=20.97+/-0.06 FUV=21.54+/-0.32, NUV=21.29+/-0.18	Reference Frame: ICRS								
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit			
	1	J1505+3721 ACQ (COS.ta.152 2158)	(8) J1505+3721	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				400 Secs (400 Secs) [==>]	[1]			
	2	J1505+3721 G130M1 (COS.sp.152 2159)	(8) J1505+3721	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=1; SEGMENT=A			1000 Secs (1694 Secs) [==>1694.0 Secs ]	[1]			
	3	J1505+3721 G130M2 (COS.sp.152 2159)	(8) J1505+3721	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=2; SEGMENT=A			1000 Secs (2744 Secs) [==>2744.0 Secs ]	[2]			
	4	J1505+3721 G130M3 (COS.sp.152 2159)	(8) J1505+3721	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=3; SEGMENT=A			1000 Secs (1310 Secs) [==>1310.0 Secs ]	[3]			
	5	J1505+3721 G130M4 (COS.sp.152 2159)	(8) J1505+3721	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=4; SEGMENT=A			1000 Secs (1310 Secs) [==>1310.0 Secs ]	[3]			



Proposal 16672 - J2229+2725 (09) - Ly-alpha emission from the low-z most metal-deficient star-forming galaxies

Tue Jul 20 12:00:46 GMT 2021

<b>Visit</b>	<b>Proposal 16672, J2229+2725 (09), implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/FUV, COS/NUV Special Requirements: BETWEEN 2021.274 AND 2021.316; BETWEEN 2021.333 AND 2021.342; BETWEEN 2022.167 AND 2022.326 <i>Comments: The Ly-alpha line can be affected by the OI airglow emission line. Therefore, the observations should preferentially be taken in orbital shadow to minimize this contamination. We used a table with the orbital visibility to select optimal observing periods with a shadow visibility of more than 25 minutes. These have been implemented with BETWEEN constraints.</i>									
	<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>			
(9)		J2229+2725	RA: 22 29 33.1900 (337.3882917d) Dec: +27 25 25.60 (27.42378d) Equinox: J2000	Redshift: 0.0762	V=21.47+/-0.06 FUV=21.45+/-0.28, NUV=21.88+/-0.37	Reference Frame: ICRS				
<i>Comments:</i> Category=GALAXY Description=[DWARF COMPACT, STARBURST] Extended=NO										
<b>Exposures</b>	<b>#</b>	<b>Label (ETC Run)</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	J2229+2725 ACQ (COS.ta.152 2160)	(9) J2229+2725	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				500 Secs (500 Secs) [==>]	[1]
	2	J2229+2725 G130M1 (COS.sp.152 2161)	(9) J2229+2725	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=1; SEGMENT=A			1000 Secs (1459 Secs) [==>1459.0 Secs ]	[1]
	3	J2229+2725 G130M2 (COS.sp.152 2161)	(9) J2229+2725	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=2; SEGMENT=A			1000 Secs (2709 Secs) [==>2709.0 Secs ]	[2]
	4	J2229+2725 G130M3 (COS.sp.152 2161)	(9) J2229+2725	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=3; SEGMENT=A			1000 Secs (2709 Secs) [==>2709.0 Secs ]	[3]
	5	J2229+2725 G130M4 (COS.sp.152 2161)	(9) J2229+2725	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=58 50.0; FLASH=YES; FP-POS=4; SEGMENT=A			1000 Secs (2709 Secs) [==>2709.0 Secs ]	[4]

