17729 - Decoding Reionization Era using UV and IR spectral features

Cycle: 32, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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Dr. Joris Witstok (CoI) (ESA Member)	Cosmic Dawn Center, Niels Bohr Institute

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC-2366	COS/FUV COS/NUV	4	18-Jun-2025 10:00:15.0	yes
02	(2) UM461	COS/FUV COS/NUV	3	18-Jun-2025 10:00:17.0	yes
03	(2) UM461	COS/NUV	4	18-Jun-2025 10:00:18.0	yes
04	(3) NGC-4861	COS/FUV COS/NUV	4	18-Jun-2025 10:00:19.0	yes
13	(2) UM461	COS/NUV	4	18-Jun-2025 10:00:20.0	yes

19 Total Orbits Used

ABSTRACT

JWST and ALMA are revolutionizing the study of reionization-era galaxies by providing spectra of galaxies in the ultraviolet+optical and far infrared (FIR), respectively. Hence, it is urgent and crucial to establish a local reference sample of high-redshift "analog" galaxies covering UV, optical, and FIR. The UV and FIR carbon spectral features are seen in both low and high redshift galaxies with extreme properties. We build this proposal upon a multiwavelength pilot study of a reionization-era analog galaxy, Pox 186, showing extreme FIR [OIII]88/[CII]158 and high equivalent width of CIII]1909; and request HST/COS medium resolution FUV and NUV spectroscopy for three dwarf galaxies with high [OIII]/[CII] (>2) line ratios and high equivalent widths of [OIII]5007+Hbeta (>200 Angstrom) - the properties commonly observed in high-redshift galaxies. The requested COS/UV spectroscopy of these three galaxies will thereby double a sample of three Herschel dwarf galaxies with existing multiwavelength data and will allow us to characterize the properties of the pristine interstellar medium, massive stars, and infer parameters such as escape fraction of Lyman continuum and production efficiency of ionizing photons in a sample of reionization era analogs. These data will hence present a complete multiwavelength local reference sample and templates for rest-frame UV, optical, and FIR spectroscopy of early galaxies accessible by JWST and ALMA, and is a unique opportunity to decode puzzles of the reionization era.

OBSERVING DESCRIPTION

We propose to obtain high-quality (S/N >10) HST/COS spectra of three dwarf galaxies, which are potential local analogs of high-z (6~7) galaxies. We aim to detect the important nebular and stellar features ubiquitous at high-z such as CIV1548, 1550, He II 1640, OIII]1661, 1666 and CIII]1907, 1909 by using G160M and G185M to cover the wavelength range of (~1434-1796 A and ~1720-2027 A, respectively. The medium resolution COS gratings,

G160M and G185M have sufficient spectral resolution required to resolve the CIV, OIII] and CIII] doublets mentioned above and will also be beneficial to resolve any broadening of the CIII] line profile. The existing UV spectroscopy (IUE, FOS) suffers from various issues (low S/N, insufficient wavelength coverage) as described in the sample selection. We prefer COS to STIS because of its higher sensitivity and better spectral resolution required for detecting and resolving various emission features. Two of the three targets are extended, which might affect the overall flux calibrations. However, this will not be a problem for most of our analysis which would be based on normalized spectra. We used the COS/ETC online tool to estimate the exposure times for target acquisition and spectroscopic observations of the three galaxies as described below: All our targets have GALEX images available. We estimated GALEX/FUV magnitudes for all point sources while GALEX/FUV surface brightness in the case of the extended source and then used them for normalization of a flat continuum source while estimating exposure time for Target acquisition via PSA and a recommended S/N=20. We will use Mirror A as recommended for NGC4861 while Mirror B for the other two targets that are too bright to observe with Mirror A. For spectroscopic observations, we used previously acquired spectra (IUE, FOS and G140L given in Table 1) within the COS/ETC to achieve a S/N>10 in emission lines of interest, i.e. CIII]1909 for G185M and CIV or OIII] for G185M. For UM461, no spectrum is currently available, so we assumed a flat continuum and normalized by GALEX/FUV surface brightness for extended source. For estimating the

number of orbits, we assumed a conservative HST orbital time of 54 minutes, which excludes overheads related to guide-star re-acquisition and FP-POS split. The above method resulted in 15 orbits for observing three targets, comprising 6 orbits with G160M and 9 orbits with G185M. All proposed targets are safe to observe with HST/COS as no warnings (local or global) of violations are reported by the ETC. We will split the COS/UV spectroscopic observations within four FP-POS, which will serve various purposes, including an improved S/N. The G160M and G185M have dispersions of 73.4 and 103 mA resolution elements, respectively. We will fit the narrow Milky Way (MW) absorption features to estimate the approximate spectral resolution and then use them to bin the reduced and extracted one-dimensional spectra for achieving higher S/N. Our sample consists of nearby galaxies, which means COS aperture will cover spatial scales ranging from stellar clusters in galaxies to sub kiloparsec consisting of several HII regions, which will allow us to also study the effect of spatial scales in our analysis. If OIII] 1667 overlaps with the MW's Al II 1670 line, we will predict the strength of OIII] 1666 using the intrinsic emission line ratio of OIII] 1660, 1666 doublet. In total, we request 15 HST/COS orbits to acquire FUV and NUV spectra covering several emission lines within three galaxies, which show IR and optical properties similar to the EoR galaxies.

Visit

Proposal 17729, NGC-2366 (01), scheduling Wed Jun 18 14:00:21 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(NGC-2366 (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

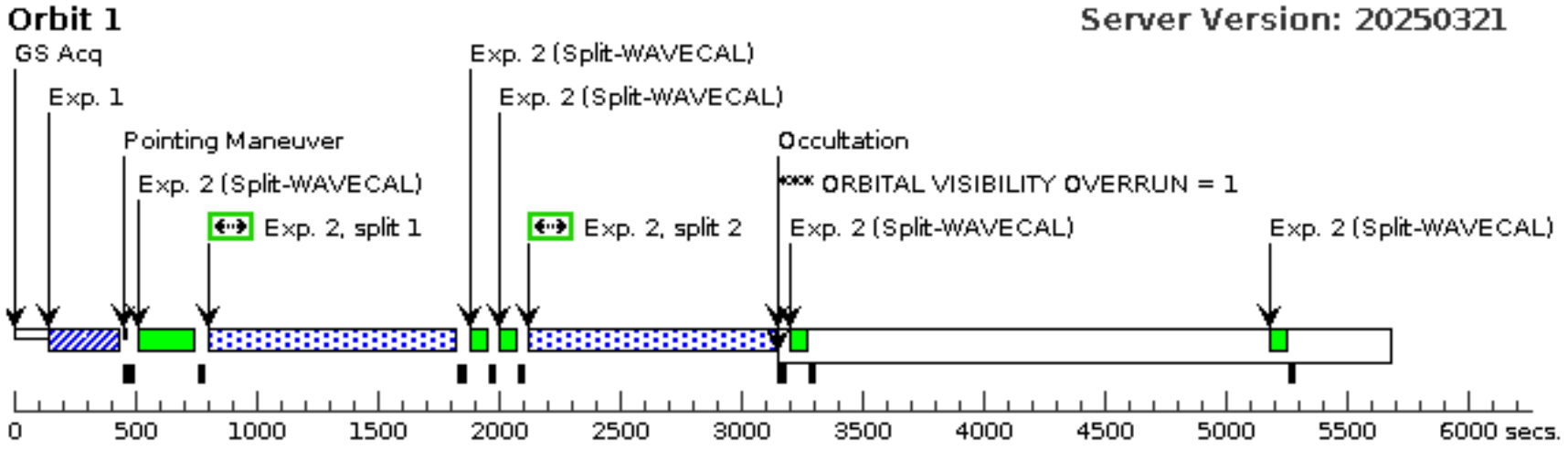
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-2366	RA: 07 28 42.6803 (112.1778346d) Dec: +69 11 21.98 (69.18944d) Equinox: J2000		V=11.39	Reference Frame: ICRS

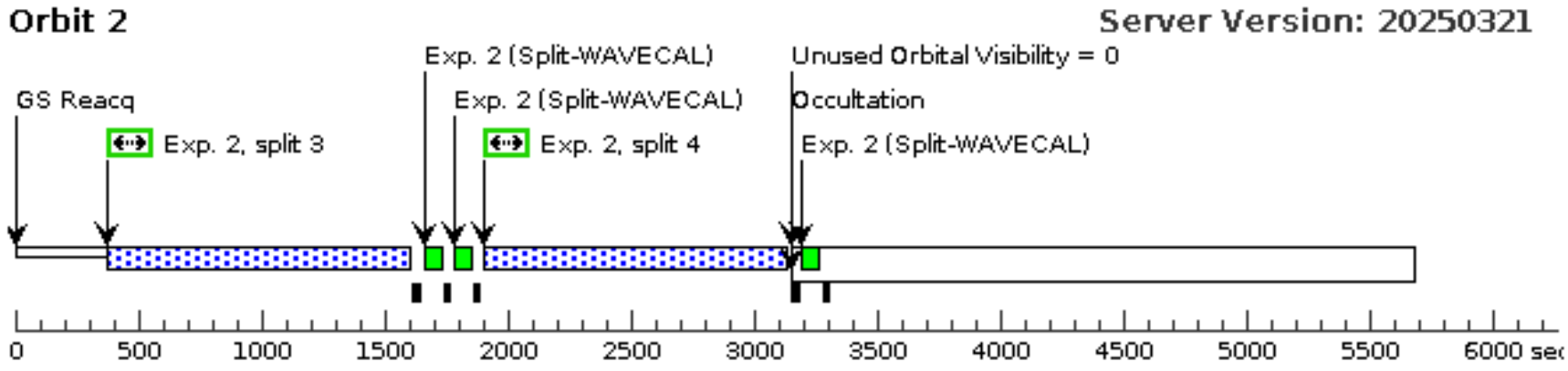
Comments:
Category=GALAXY
Description=[STAR FORMING REGION]
Extended=NO

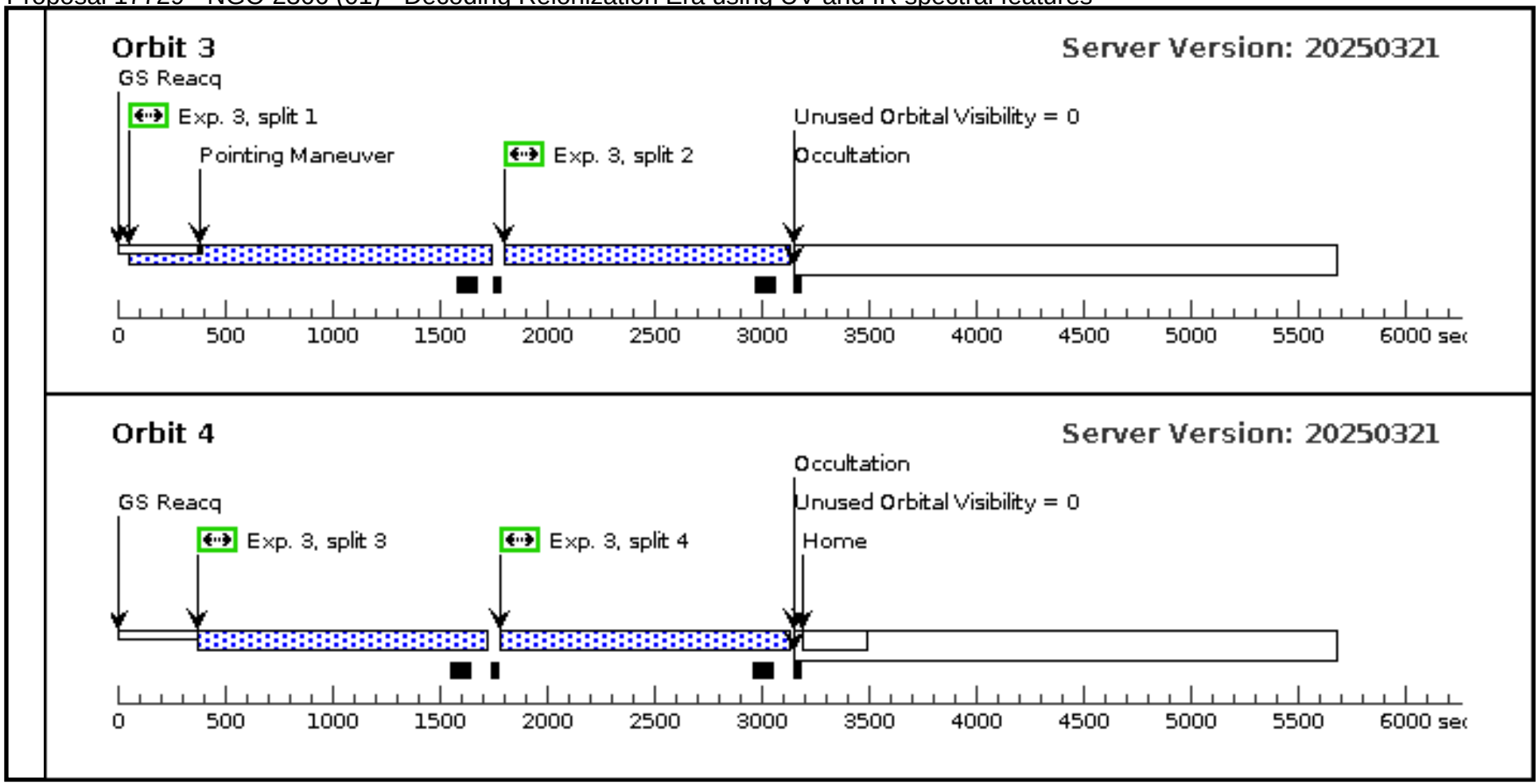
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq/Image (1505783)	(1) NGC-2366	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				2 Secs (2 Secs)	
								[==>]	***[1]***
2	COS/FUV (1923251)	(1) NGC-2366	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=ALL; BUFFER-TIME=8668			695 Secs (4294 Secs)	
								[==>968.0 Secs (Split 1)] *[==>967.0 Secs (Split 2)]*	***[1]***
								[==>1179.0 Secs (Split 3)] *[==>1180.0 Secs (Split 4)]*	***[2]***
3	COS/NUV (1923260)	(1) NGC-2366	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1172; FP-POS=ALL; FLASH=YES			600 Secs (5302 Secs)	
								[==>1318.0 Secs (Split 1)] *[==>1318.0 Secs (Split 2)]*	***[3]***
								[==>1333.0 Secs (Split 3)] *[==>1333.0 Secs (Split 4)]*	***[4]***

Orbit Structure



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GS Reacq
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Pointing Maneuver
Exp. 3, split 2
Unused Orbital Visibility = 0
Occultation
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3500
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4500
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5500
6000 sec
Orbit 4
Server Version: 20250321
Occultation
GS Reacq
Unused Orbital Visibility = 0
Exp. 3, split 3
Exp. 3, split 4
Home
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500
1000
1500
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2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17729, UM461 (02), implementation Wed Jun 18 14:00:21 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

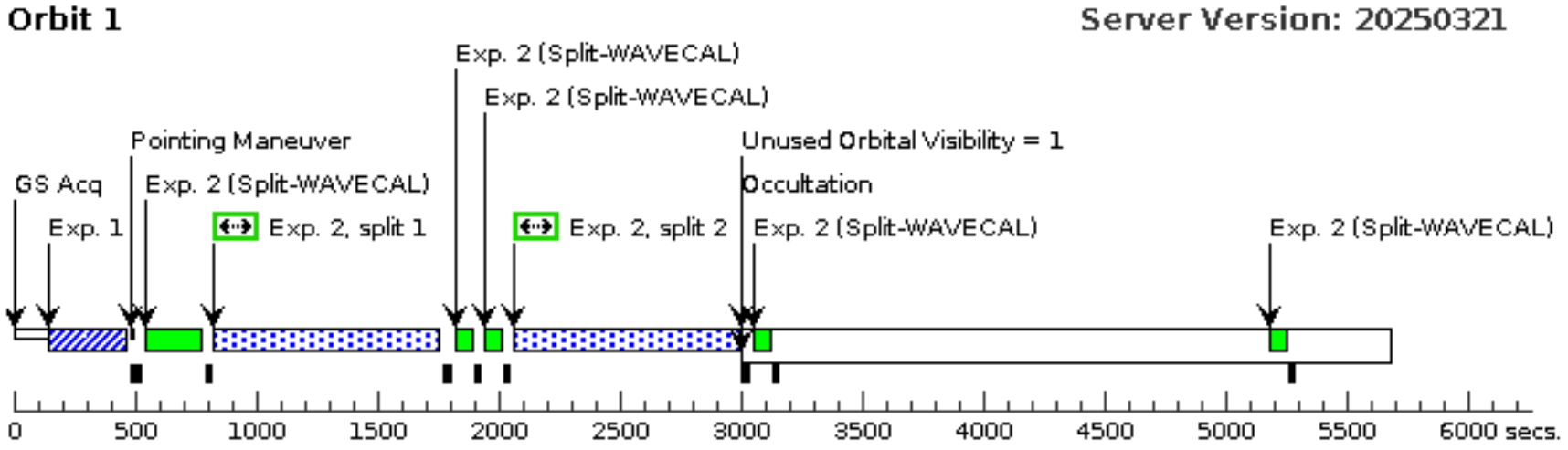
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	UM461	RA: 11 51 33.3534 (177.8889725d) Dec: -02 22 21.89 (-2.37275d) Equinox: J2000		V=17.717+/-0.060	Reference Frame: ICRS

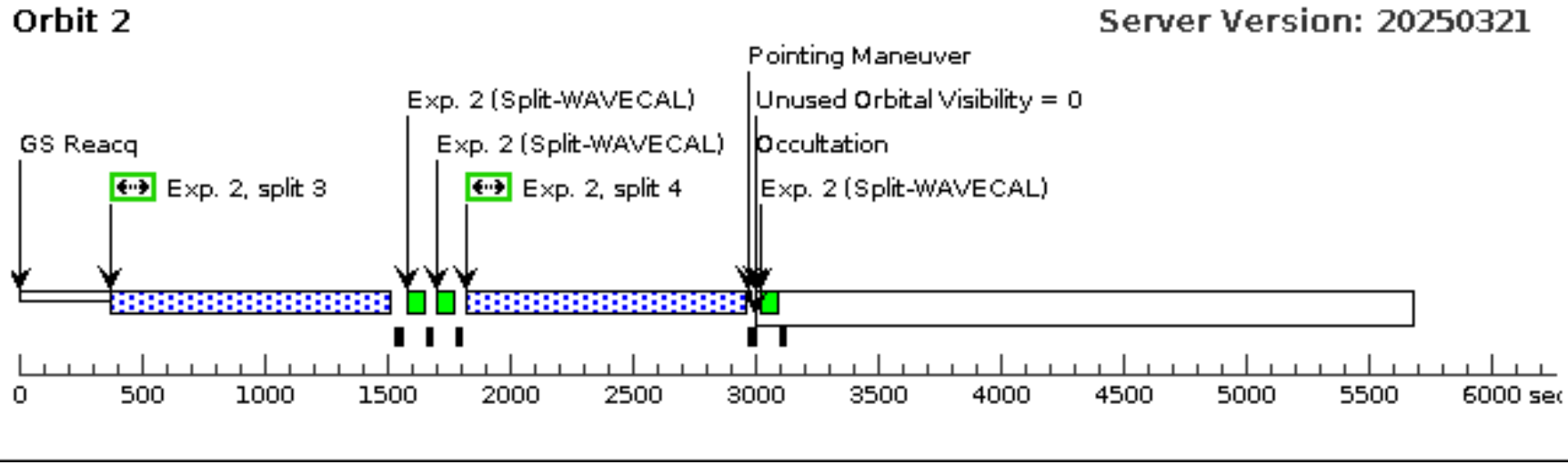
Comments:
Category=GALAXY
Description=[STAR FORMING REGION]
Extended=NO

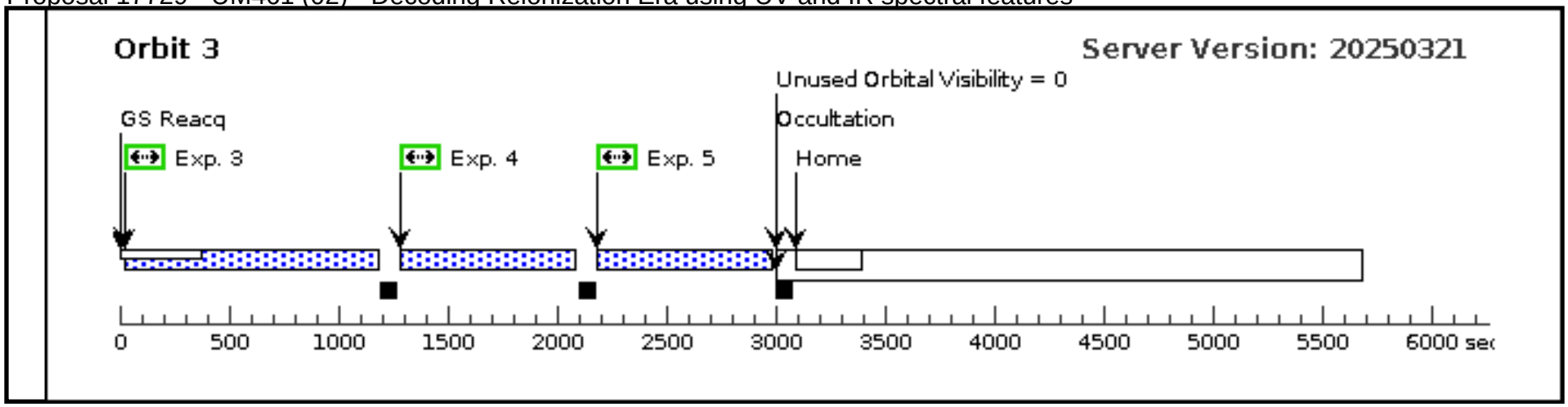
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq/Image (1505917)	(2) UM461	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARIO BASE1O3		16 Secs (16 Secs) *[==>]*	***[1]***
2	COS/FUV (1923311)	(2) UM461	COS/FUV, TIME-TAG, PSA	G160M 1623 A	BUFFER-TIME=7471; FP-POS=ALL			1129 Secs (3944 Secs) *[==>880.0 Secs (Split 1)]* *[==>879.0 Secs (Split 2)]* *[==>1093.0 Secs (Split 3)]* *[==>1092.0 Secs (Split 4)]*	***[1]*** ***[2]***
3	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=1; FLASH=YES			1129 Secs (788 Secs) *[==>788.0 Secs]*	***[3]***
4	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=2; FLASH=YES			1129 Secs (788 Secs) *[==>788.0 Secs]*	***[3]***
5	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=3; FLASH=YES			1129 Secs (788 Secs) *[==>788.0 Secs]*	***[3]***

Orbit Structure



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Server Version: 20250321
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 3
Exp. 4
Exp. 5
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Visit

Proposal 17729, UM461 (03), failed

Wed Jun 18 14:00:21 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV

Special Requirements: (none)

Fixed Targets

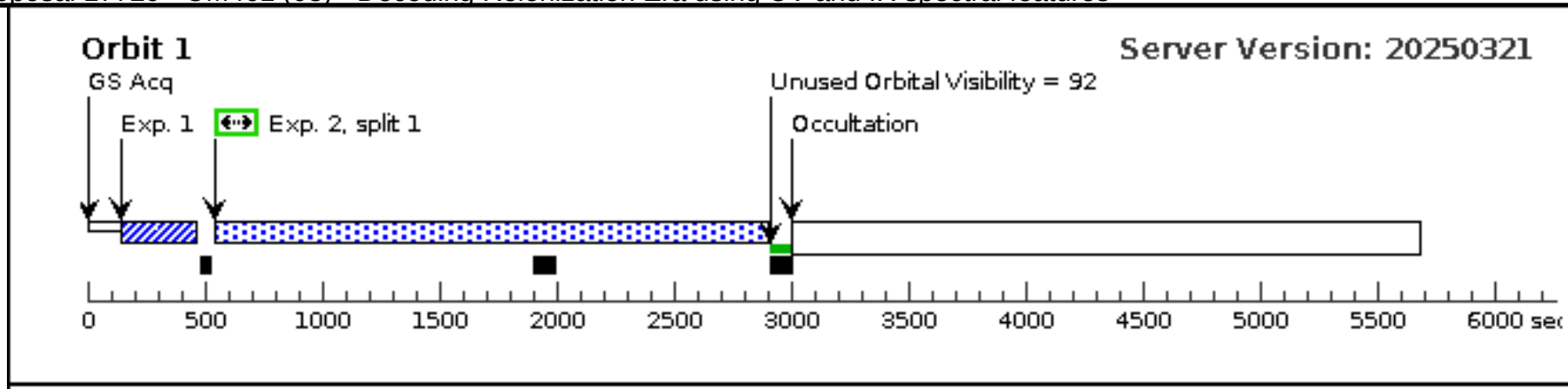
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	UM461	RA: 11 51 33.3534 (177.8889725d) Dec: -02 22 21.89 (-2.37275d) Equinox: J2000		V=17.717+/-0.060	Reference Frame: ICRS

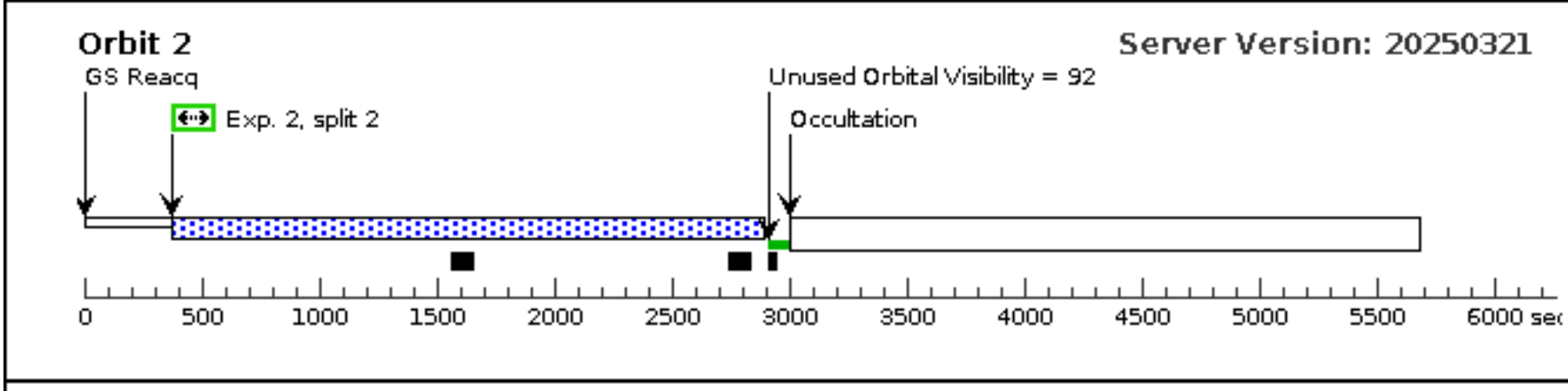
Comments:
Category=GALAXY
Description=[STAR FORMING REGION]
Extended=NO

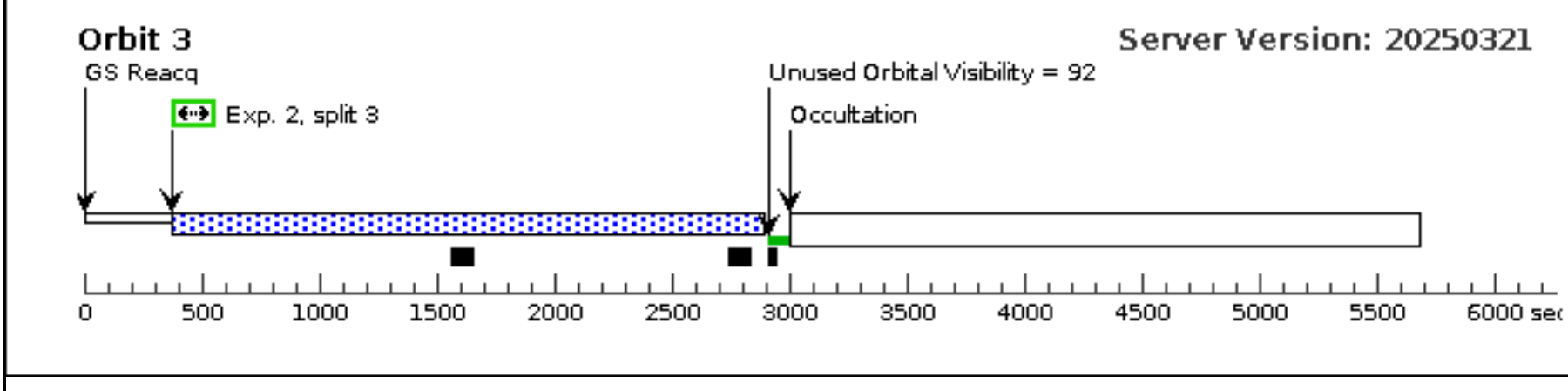
Exposures

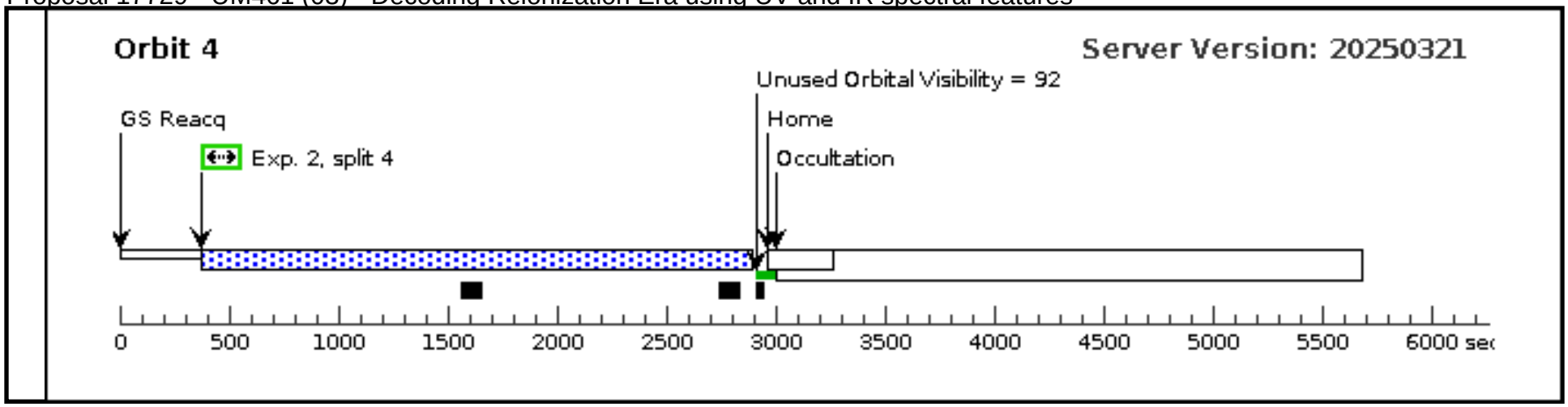
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq/Image (1505917)	(2) UM461	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARIO BASE1O3		16 Secs (16 Secs)	
								[==>]	***[1]***
2	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=ALL; FLASH=YES			1129 Secs (9680 Secs)	
								[==>2162.0 Secs (Split 1)]	***[1]***
								[==>2506 Secs (Split 2)]	***[2]***
								[==>2506 Secs (Split 3)]	***[3]***
								[==>2506.0 Secs (Split 4)]	***[4]***

Orbit Structure








Orbit 4
Server Version: 20250321
Unused Orbital Visibility = 92
GS Reacq
Exp. 2, split 4
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Occultation
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Visit

Proposal 17729, NGC-4861 (04), scheduling Wed Jun 18 14:00:21 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(NGC-4861 (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS/FUV (04.002)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

Fixed Targets

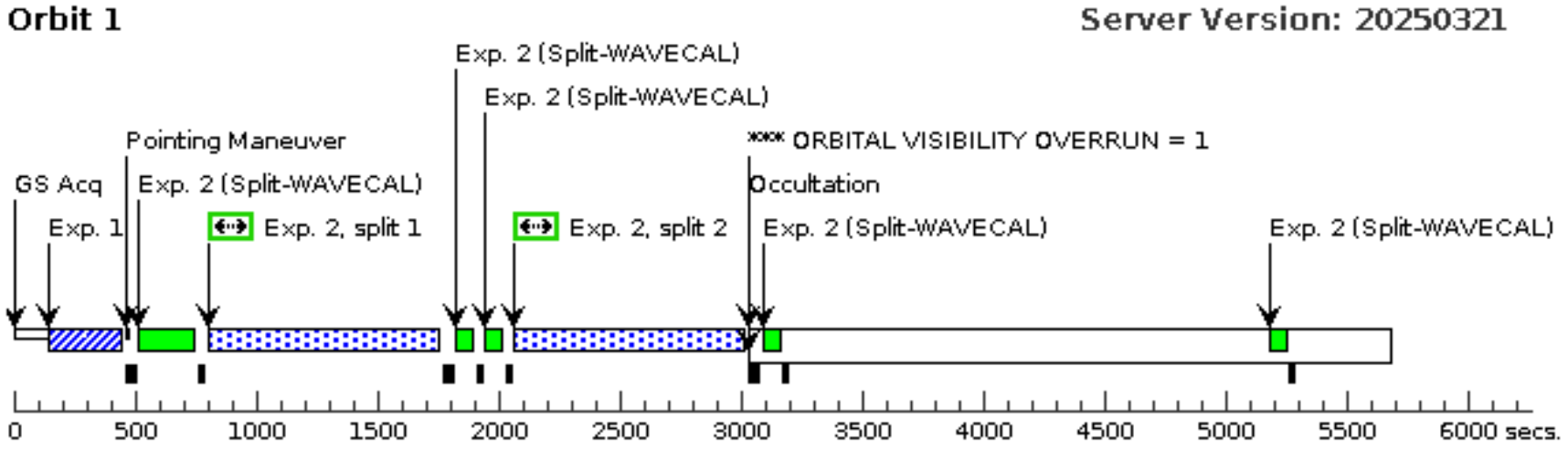
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	NGC-4861	RA: 12 59 0.2300 (194.7509583d) Dec: +34 50 43.50 (34.84542d) Equinox: J2000		V=12.32	Reference Frame: ICRS

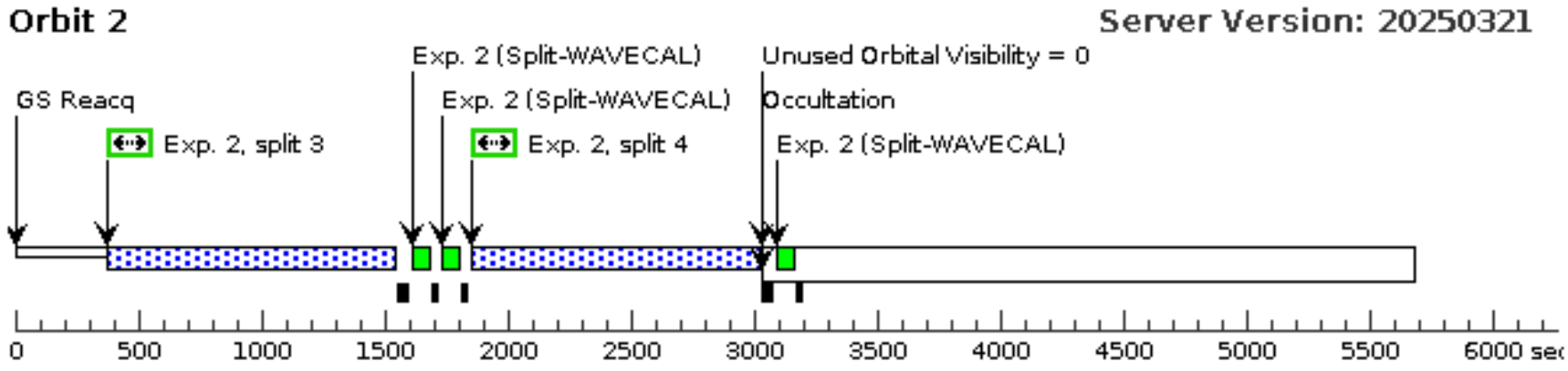
Comments:
Category=GALAXY
Description=[STAR FORMING REGION]
Extended=YES

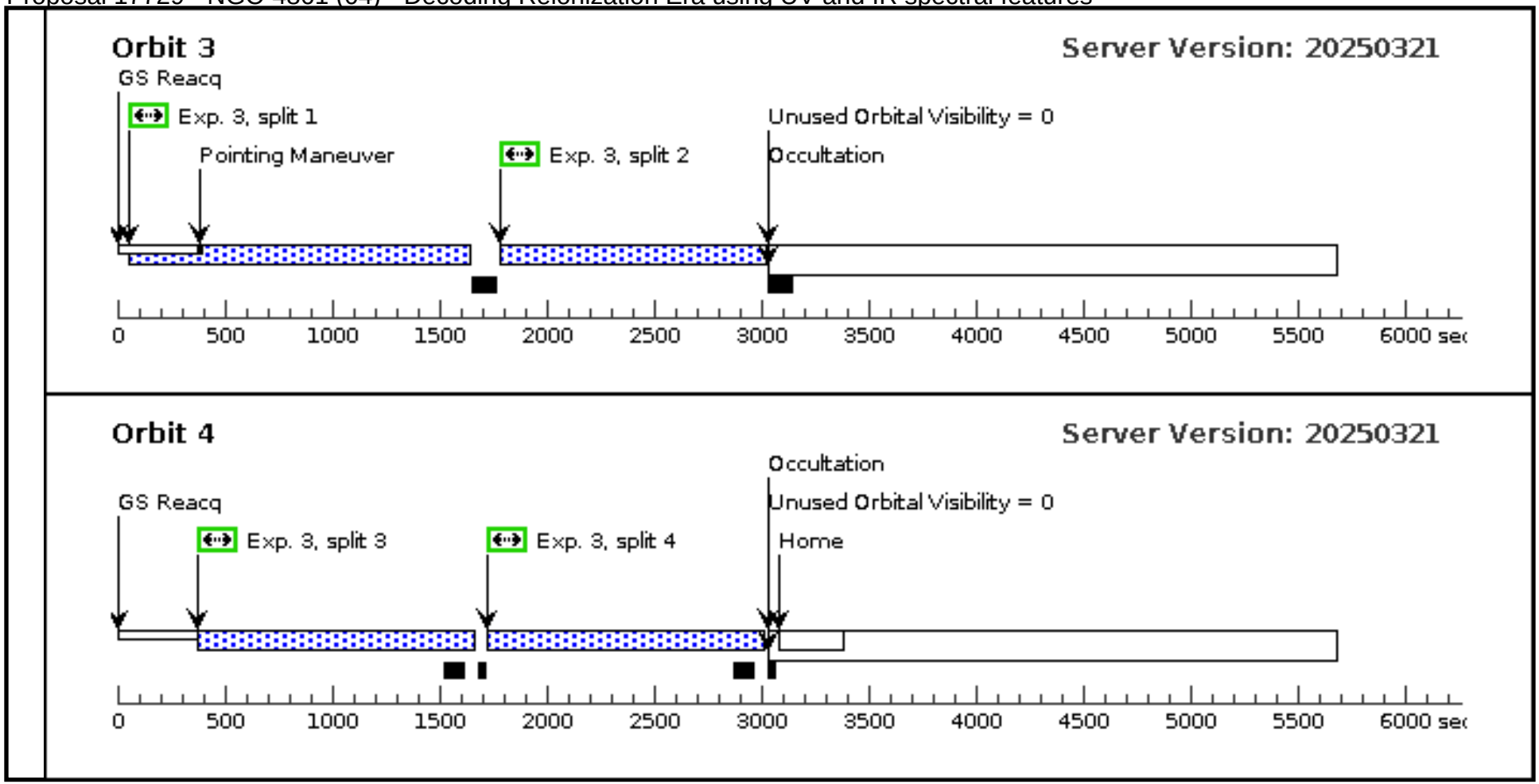
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq/Image (1506012)	(3) NGC-4861	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				3.5 Secs (3.5 Secs)	
								[==>]	***[1]***
2	COS/FUV (1923297)	(3) NGC-4861	COS/FUV, TIME-TAG, PSA	G160M 1623 A	BUFFER-TIME=3796; FP-POS=ALL			374 Secs (4038 Secs)	
								[==>903.0 Secs (Split 1)] *[==>902.0 Secs (Split 2)]*	***[1]***
								[==>1116.0 Secs (Split 3)] *[==>1117.0 Secs (Split 4)]*	***[2]***
3	COS/NUV (1923308)	(3) NGC-4861	COS/NUV, TIME-TAG, PSA	G185M 1921 A	BUFFER-TIME=1140; FLASH=YES; FP-POS=ALL			900 Secs (4992 Secs)	
								[==>1222.0 Secs (Split 1)] *[==>1221.0 Secs (Split 2)]*	***[3]***
								[==>1274.0 Secs (Split 3)] *[==>1275.0 Secs (Split 4)]*	***[4]***

Orbit Structure






Orbit 3
Server Version: 20250321
GS Reacq
Exp. 3, split 1
Pointing Maneuver
Exp. 3, split 2
Unused Orbital Visibility = 0
Occultation
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Orbit 4
Server Version: 20250321
Occultation
GS Reacq
Unused Orbital Visibility = 0
Exp. 3, split 3
Exp. 3, split 4
Home
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5000
5500
6000 sec

Visit

Proposal 17729, UM461 (13) Wed Jun 18 14:00:22 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/NUV

Special Requirements: (none)

Diagnostics

(UM461 (13)) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

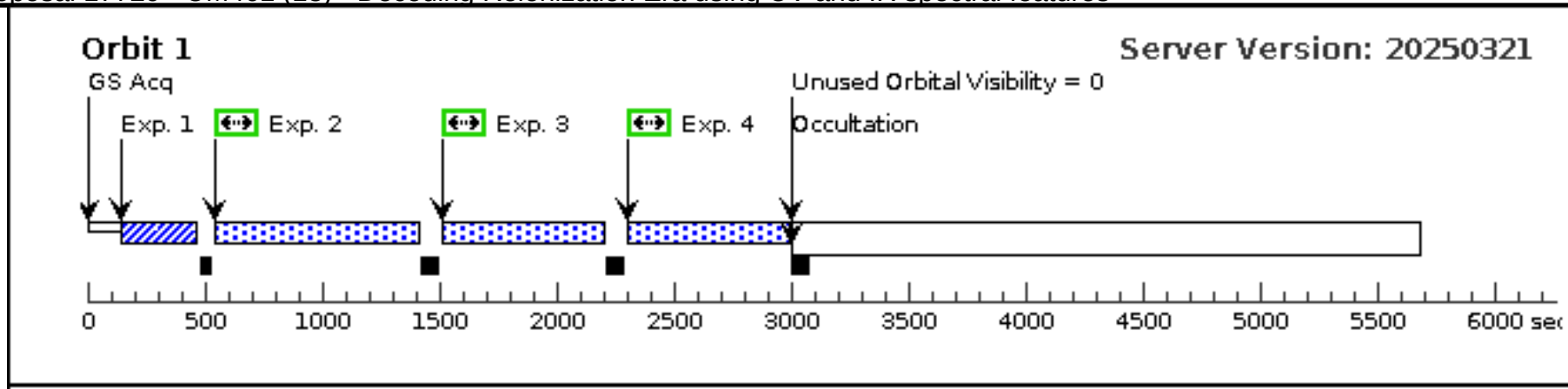
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	UM461	RA: 11 51 33.3534 (177.8889725d) Dec: -02 22 21.89 (-2.37275d) Equinox: J2000		V=17.717+/-0.060	Reference Frame: ICRS

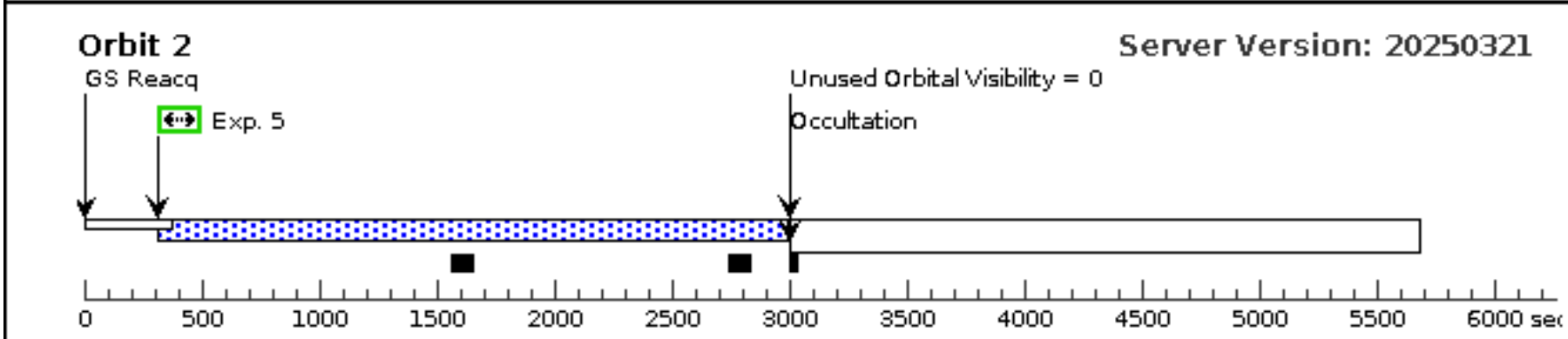
Comments:
Category=GALAXY
Description=[STAR FORMING REGION]
Extended=NO

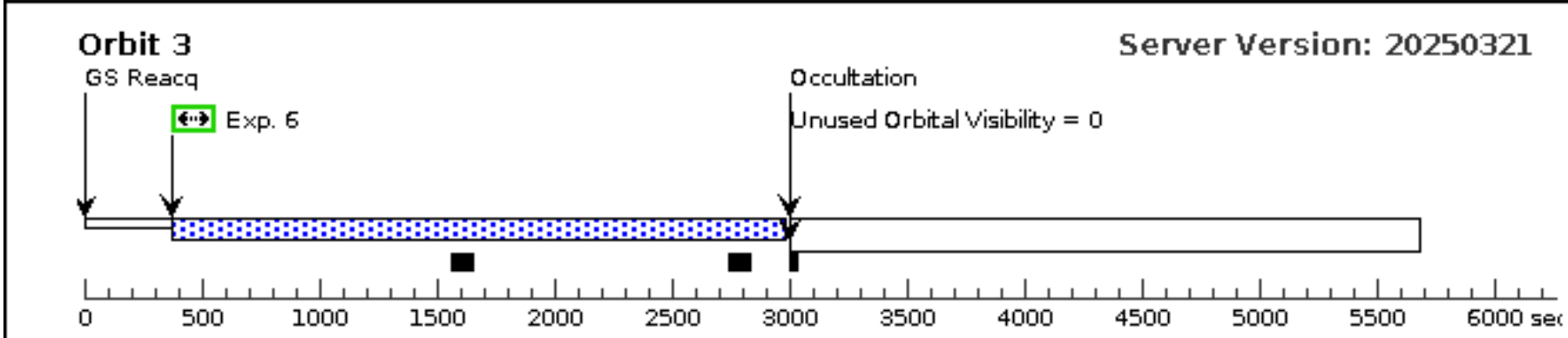
Exposures

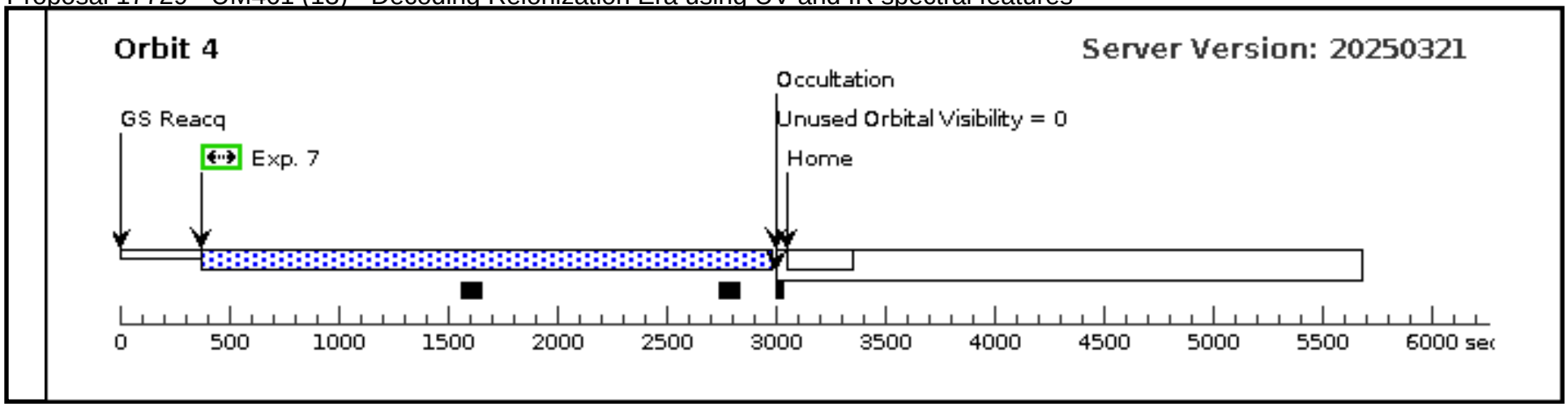
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq/Image (1505917)	(2) UM461	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARIO BASE1O3		16 Secs (16 Secs) *[==>]*	***[1]***
2	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=1; FLASH=YES			1129 Secs (674 Secs) *[==>674.0 Secs]*	***[1]***
3	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=2; FLASH=YES			1129 Secs (674 Secs) *[==>674.0 Secs]*	***[1]***
4	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=3; FLASH=YES			1129 Secs (674 Secs) *[==>674.0 Secs]*	***[1]***
5	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=1; FLASH=YES			1129 Secs (2598 Secs) *[==>2598.0 Secs]*	***[2]***
6	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=2; FLASH=YES			1129 Secs (2598 Secs) *[==>2598.0 Secs]*	***[3]***
7	COS/NUV (1923313)	(2) UM461	COS/NUV, TIME-TAG, PSA	G185M 1900 A	BUFFER-TIME=1183; FP-POS=3; FLASH=YES			1129 Secs (2598 Secs) *[==>2598.0 Secs]*	***[4]***

Orbit Structure








Orbit 4
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Occultation
GS Reacq
Unused Orbital Visibility = 0
Exp. 7
Home
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4500
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5500
6000 sec