15250 - Resolving the Multiphase ISM of an Elliptical Galaxy at z~0.4

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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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) HE0047-1756A	COS/FUV COS/NUV	3	05-Dec-2018 19:01:33.0	yes
02	(1) HE0047-1756A	COS/FUV COS/NUV	4	05-Dec-2018 19:01:35.0	yes
03	(1) HE0047-1756A	COS/FUV COS/NUV	4	05-Dec-2018 19:01:37.0	yes

11 Total Orbits Used

ABSTRACT

Nearly 40% of elliptical galaxies are found to contain cool gas but exhibit no on-going star formation, indicating that some feedback mechanisms are at work. While AGN feedback is commonly thought to be responsible for quenching star formation in massive halos, recent work has reiterated the importance of feedback from old stellar populations, including Type Ia supernovae (SNe Ia). In Zahedy et al. (2016), we reported detections of strong

MgII absorption with rest-frame absorption equivalent width of Wr~4 Ang at two locations separated by 8 kpc in projected distance in the ISM of a z=0.408 massive elliptical. The most striking finding is a uniform, super-solar Fe/Mg ratio across a large line-of-sight velocity range of ~700 km/s. The observed super-solar Fe/Mg ratio suggests a large contribution of SNe Ia (>20%) in chemical enrichment. Follow-up low-resolution FUV spectroscopy with HST/STIS allowed us to measure a neutral hydrogen column density of log N(HI)~19.5 and metallicity of ~1/3 solar for both absorbers. Remarkably, the STIS spectra also revealed additional strong absorption features (Wr>1 Ang) that are consistent in wavelength with CII, CIII, NII, NIII, and OVI absorption lines, indicating the presence of a complex, multiphase ISM in this elliptical. Here we propose to use COS with the G130M and G160M gratings to spectrally resolve these low- to high-ionization lines in one absorber. The proposed high-resolution COS spectra will allow us to constrain both the column densities and velocity profiles of individual ions, providing a unique opportunity to resolve the thermal state and ionization condition in the ISM of an intermediate-redshift elliptical galaxy.

OBSERVING DESCRIPTION

We will obtain high-resolution (R~17000) FUV spectra of the brighter image of the doubly lensed QSO HE0047-1756, using COS and the G130M and G160M gratings. The primary goal of the proposed FUV spectroscopic observations is to spectrally resolve both low- and high-ionization metal absorption in the ISM of the lensing galaxy, a massive elliptical galaxy at z~0.4.

Exposure Time Estimation:

We aim to reach a signal-to-noise ratio (S/N) level that will allow us to resolve individual components within a strong absorption system. Based on our previous experience with COS data as well as simulated COS spectra, we find that a signal-to-noise ratio of S/N > 10 is sufficient for reaching the goal. From GALEX observations of the HE0047-1756 field, the estimated FUV magnitude of the brighter image of this lensed QSO, HE0047-1756A, is AB(FUV) = 18.7. Using the latest version of the COS exposure time calculator (v25.2) with the FOS QSO spectral template redshifted to z_em = 1.676 and scaled to the FUV magnitude of HE 0047-1756A, we estimate that the total exposure times required to reach the targeted mean S/N ~ 10 are 4 orbits for G130M and 7 orbits for G160M.

Observing Strategy:

The observations will be performed in three separate HST visits, each 3-4 orbits long. COS with the G130M and G160M gratings provide sufficient resolution (FWHM ~ 20 km/s) to resolve the low- and high-ionization absorption lines of this system into distinct kinematic components. For G130M, we will use two central wavelength settings, C1291 (both A and B segments) and C1327 (with the B segment turned off). For G160M, we will use four central wavelength settings, C1577, C1589, C1600, and C1611, in order to reach a uniform S/N over the full spectral range.

Furthermore, to reduce the effects of fixed pattern noise in the resulting spectra, we will use multiple FP-POS offsets for each central wavelength setting (two positions for C1291 and C1611, and four positions for the remaining central wavelength settings).

Onboard target acquisition of the QSO will be performed in the first orbit of each visit, by obtaining an NUV image in ACQ/IMAGE mode. Additional ACQ/SEARCH mode acquisition is not necessary, because the coordinates of the target are known to better than 0.25". The estimated GALEX NUV magnitudes of the target QSO image is AB(NUV)=17.8. The Bright Object Tool indicates that MIRROR B is needed in the ACQ/IMAGE mode in order to avoid exceeding the brightness limit. Using the COS Target Acquisition ETC, we find that to obtain a S/N=40 in the acquisition image, a 100s exposure is necessary using MIRROR B. To reduce potential confusion caused by light from the fainter QSO image B (1.4" away from the target), we impose an ORIENT constraints of 125/305 degrees (with an allowed range of +/-45 degrees), in order to maximize the distance between the two QSO images in the cross-dispersion direction.

Visit

Proposal 15250, Visit 01, implementation Thu Dec 06 00:01:37 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: ORIENT 80D TO 170 D; ORIENT 260D TO 350 D

Comments: There are two nearby targets to HE0047A that need to aligned in the cross-dispersion (XD) so that the PSA/MIRRORB target acquisition (TA) will not co-add the light from the multiple targets and MIRRORB spots causing potential confusion during the TA. This XD alignment will also disperse the light from the three targets above or below the prime spectrum. This will allow custom extraction of all sources for cross-contamination analysis.

The targets are approximately aligned along the ORIENT=305/125 angle. We allow a range of +/- 45 degrees, so our Orient requirements are:
260 < ORIENT < 350 OR 80 < ORIENT < 170

There is no requirement for a common alignment between the visits.

Diagnostics

(Visit 01) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

Fixed Targets

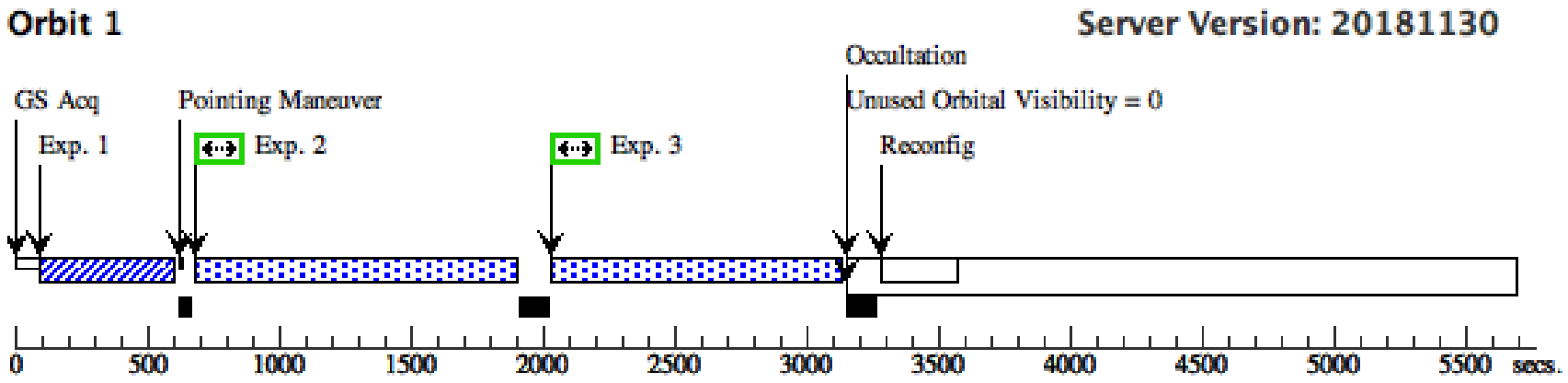
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HE0047-1756A	RA: 00 50 27.8050 (12.6158542d) Dec: -17 40 9.02 (-17.66917d) Equinox: J2000	Redshift: 1.676	V=17.57 GALEX FUV (AB)=18.7, GALEX NUV(AB) = 17.8	Reference Frame: ICRS

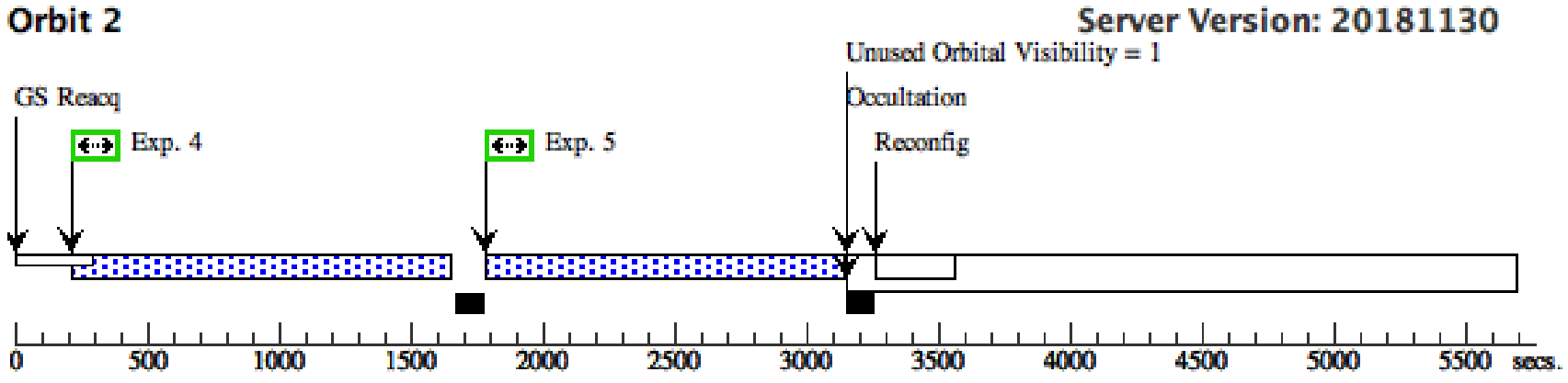
Comments:
Category=EXT-MEDIUM
Description=[ABSORPTION LINE SYSTEM - EXTRAGALACTIC, BULGE, DARK CLOUD, HALO, HI CLOUD]
Extended=NO

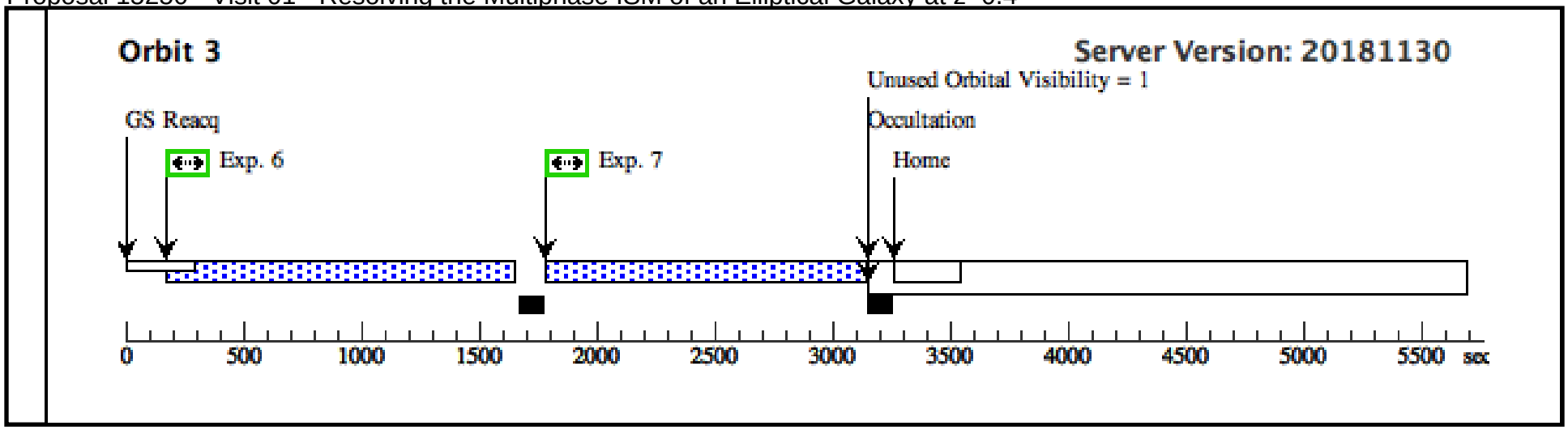
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1005330)	(1) HE0047-1756A	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				110 Secs (110 Secs) *[==>]*	***[1]***
2	(COS.sp.1005331)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=1024; SEGMENT=BOTH; FLASH=YES			1050 Secs (1050 Secs) *[==>]*	***[1]***
3	(COS.sp.1005331)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=1024; SEGMENT=BOTH; FLASH=YES			1050 Secs (1050 Secs) *[==>]*	***[1]***
4	(COS.sp.1005225)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1327 A	FLASH=YES; SEGMENT=A; FP-POS=1; BUFFER-TIME=1312			1304 Secs (1304 Secs) *[==>]*	***[2]***
5	(COS.sp.1005225)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1327 A	FLASH=YES; SEGMENT=A; FP-POS=2; BUFFER-TIME=1312			1304 Secs (1304 Secs) *[==>]*	***[2]***
6	(COS.sp.1006801)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FLASH=YES; BUFFER-TIME=1311; FP-POS=1; SEGMENT=BOTH			1303 Secs (1303 Secs) *[==>]*	***[3]***
7	(COS.sp.1006801)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FLASH=YES; BUFFER-TIME=1311; FP-POS=2; SEGMENT=BOTH			1303 Secs (1303 Secs) *[==>]*	***[3]***

Orbit Structure



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Visit

Proposal 15250, Visit 02, implementation Thu Dec 06 00:01:37 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: ORIENT 80D TO 170 D; ORIENT 260D TO 350 D

Comments: There are two nearby targets to HE0047A that need to aligned in the cross-dispersion (XD) so that the PSA/MIRRORB target acquisition (TA) will not co-add the light from the multiple targets and MIRRORB spots causing potential confusion during the TA. This XD alignment will also disperse the light from the three targets above or below the prime spectrum. This will allow custom extraction of all sources for cross-contamination analysis.

The targets are approximately aligned along the ORIENT=305/125 angle. We allow a range of +/- 45 degrees, so our Orient requirements are:
260 < ORIENT < 350 OR 80 < ORIENT < 170

There is no requirement for a common alignment between the visits.

Diagnostics

(Visit 02) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

Fixed Targets

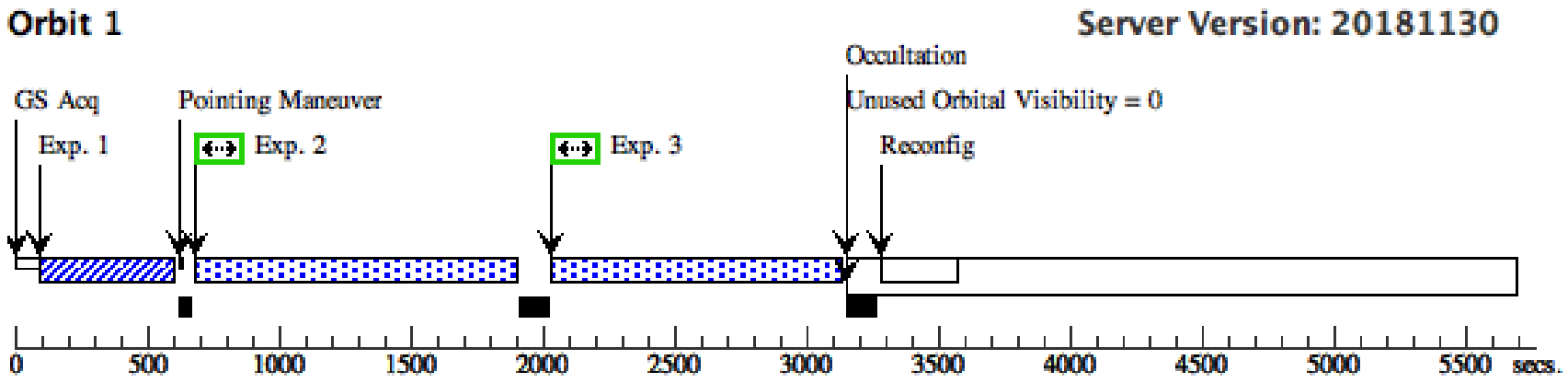
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HE0047-1756A	RA: 00 50 27.8050 (12.6158542d) Dec: -17 40 9.02 (-17.66917d) Equinox: J2000	Redshift: 1.676	V=17.57 GALEX FUV (AB)=18.7, GALEX NUV(AB) = 17.8	Reference Frame: ICRS

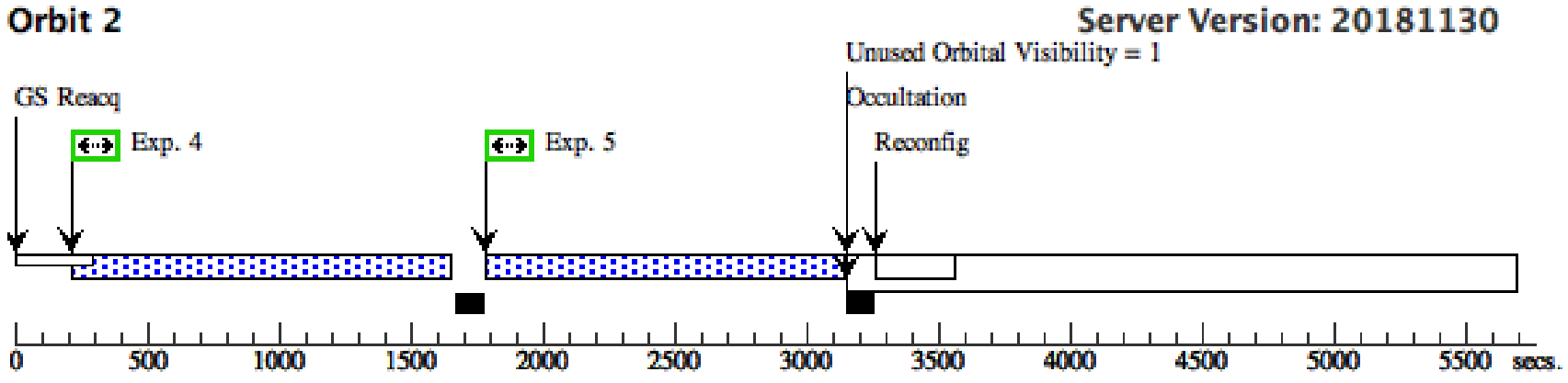
Comments:
Category=EXT-MEDIUM
Description=[ABSORPTION LINE SYSTEM - EXTRAGALACTIC, BULGE, DARK CLOUD, HALO, HI CLOUD]
Extended=NO

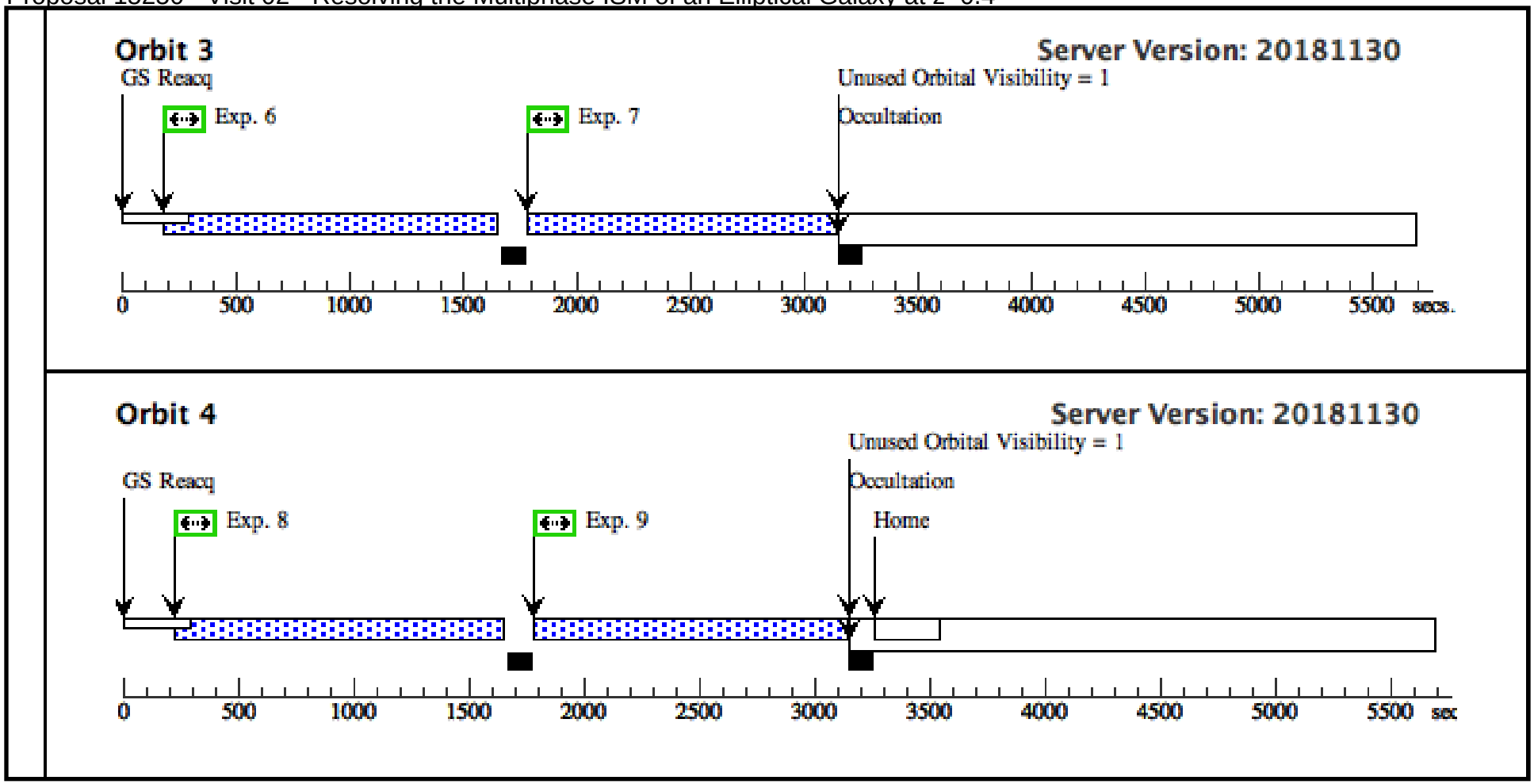
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1005330)	(1) HE0047-1756A	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				110 Secs (110 Secs) *[==>]*	***[1]***
2	(COS.sp.1005331)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=1024; SEGMENT=BOTH; FLASH=YES			1050 Secs (1050 Secs) *[==>]*	***[1]***
3	(COS.sp.1005331)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=1024; SEGMENT=BOTH; FLASH=YES			1050 Secs (1050 Secs) *[==>]*	***[1]***
4	(COS.sp.1005225)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1327 A	FLASH=YES; SEGMENT=A; FP-POS=3; BUFFER-TIME=1312			1304 Secs (1304 Secs) *[==>]*	***[2]***
5	(COS.sp.1005225)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G130M 1327 A	FLASH=YES; SEGMENT=A; FP-POS=4; BUFFER-TIME=1312			1304 Secs (1304 Secs) *[==>]*	***[2]***
6	(COS.sp.1006805)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FLASH=YES; BUFFER-TIME=1311; FP-POS=2; SEGMENT=BOTH			1303 Secs (1303 Secs) *[==>]*	***[3]***
7	(COS.sp.1006805)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FLASH=YES; BUFFER-TIME=1311; FP-POS=4; SEGMENT=BOTH			1303 Secs (1303 Secs) *[==>]*	***[3]***
8	(COS.sp.1006808)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FLASH=YES; BUFFER-TIME=1312; FP-POS=3; SEGMENT=BOTH			1304 Secs (1304 Secs) *[==>]*	***[4]***
9	(COS.sp.1006808)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FLASH=YES; BUFFER-TIME=1312; FP-POS=4; SEGMENT=BOTH			1304 Secs (1304 Secs) *[==>]*	***[4]***

Orbit Structure



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Visit

Proposal 15250, Visit 03, implementation Thu Dec 06 00:01:38 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: ORIENT 80D TO 170 D; ORIENT 260D TO 350 D

Comments: There are two nearby targets to HE0047A that need to aligned in the cross-dispersion (XD) so that the PSA/MIRRORB target acquisition (TA) will not co-add the light from the multiple targets and MIRRORB spots causing potential confusion during the TA. This XD alignment will also disperse the light from the three targets above or below the prime spectrum. This will allow custom extraction of all sources for cross-contamination analysis.

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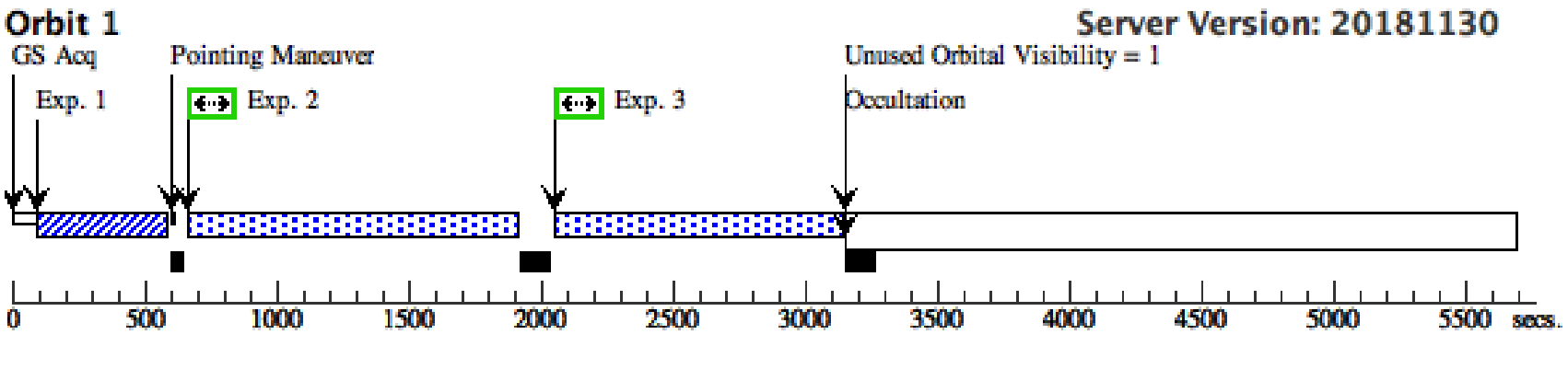
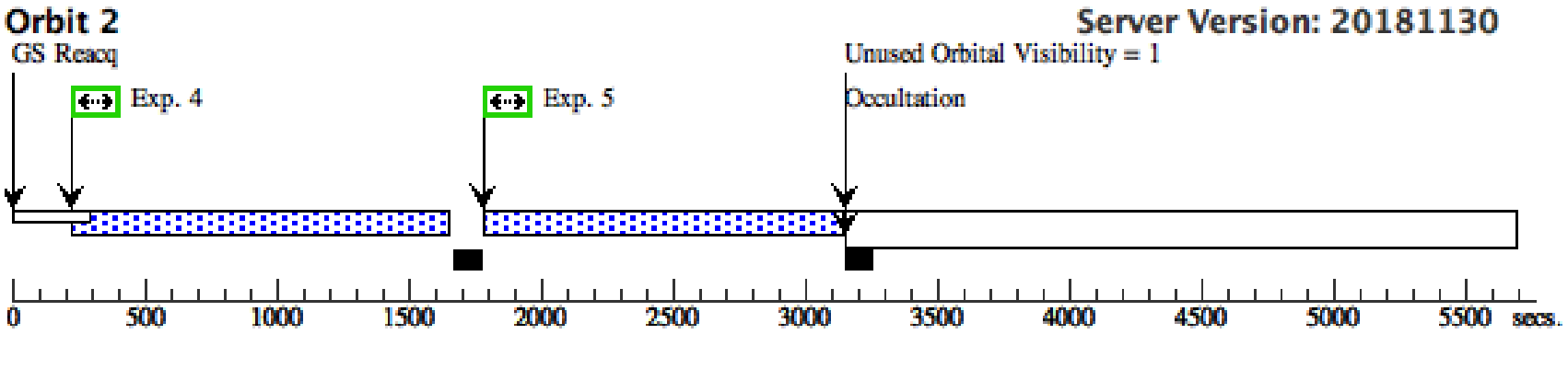
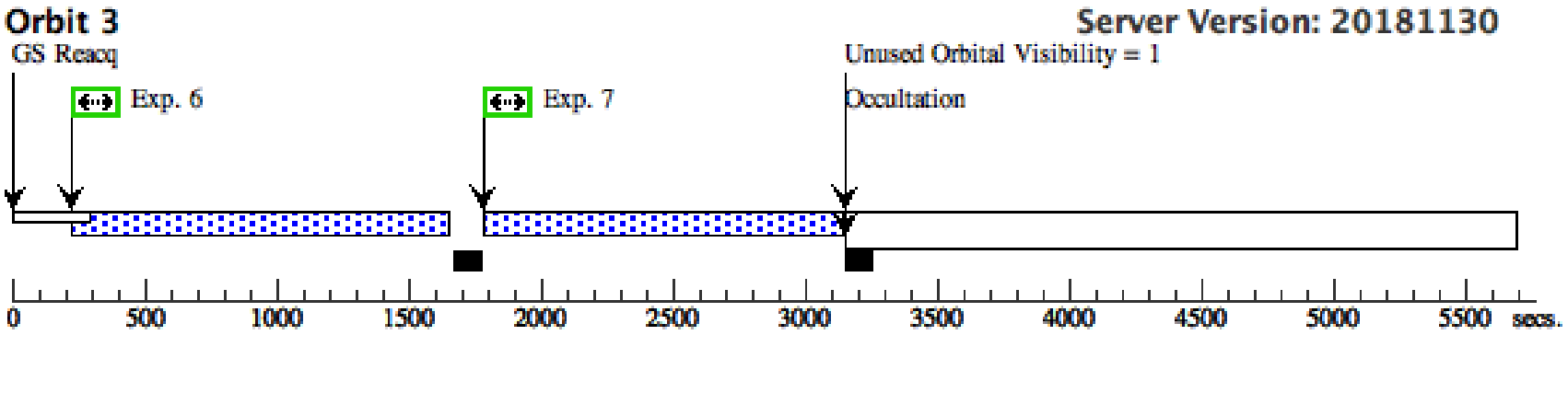
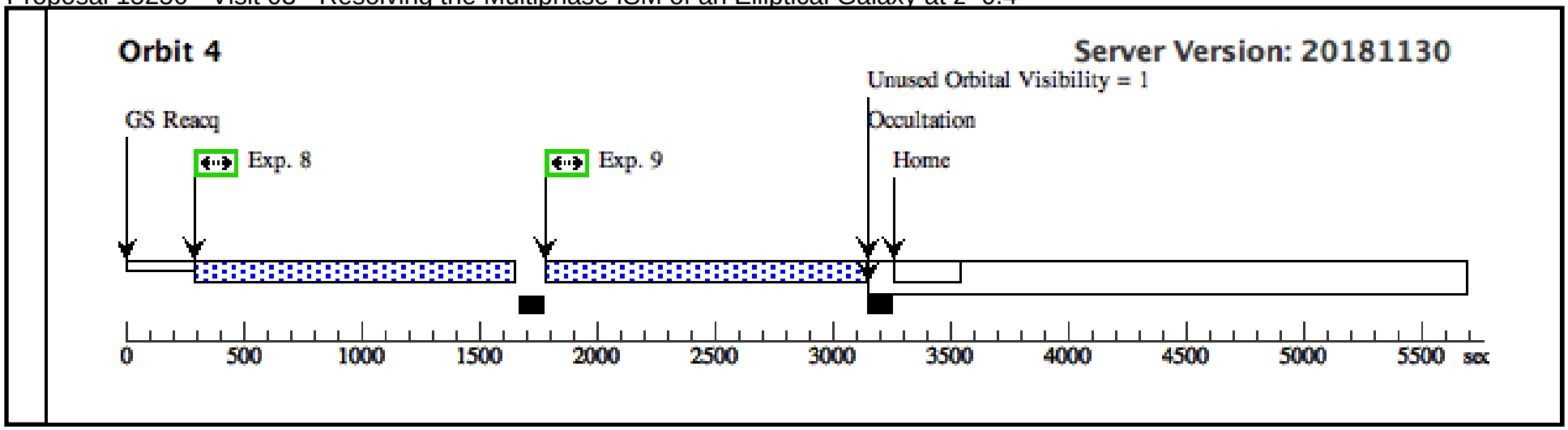
1	(COS.ta.1005330)	(1) HE0047-1756A	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				100 Secs (100 Secs) *[==>]*	***[1]***
2	(COS.sp.1006842)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FLASH=YES; SEGMENT=BOTH; FP-POS=1; BUFFER-TIME=10 12			1038 Secs (1038 Secs) *[==>]*	***[1]***
3	(COS.sp.1006842)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FLASH=YES; SEGMENT=BOTH; FP-POS=2; BUFFER-TIME=10 12			1038 Secs (1038 Secs) *[==>]*	***[1]***
4	(COS.sp.1006801)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FLASH=YES; SEGMENT=BOTH; FP-POS=3; BUFFER-TIME=13 12			1304 Secs (1304 Secs) *[==>]*	***[2]***
5	(COS.sp.1006801)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FLASH=YES; SEGMENT=BOTH; FP-POS=4; BUFFER-TIME=13 12			1304 Secs (1304 Secs) *[==>]*	***[2]***
6	(COS.sp.1006844)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1600 A	FLASH=YES; SEGMENT=BOTH; FP-POS=1; BUFFER-TIME=13 12			1304 Secs (1304 Secs) *[==>]*	***[3]***
7	(COS.sp.1006844)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1600 A	FLASH=YES; SEGMENT=BOTH; FP-POS=2; BUFFER-TIME=13 12			1304 Secs (1304 Secs) *[==>]*	***[3]***
8	(COS.sp.1006844)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1600 A	FLASH=YES; SEGMENT=BOTH; FP-POS=3; BUFFER-TIME=13 12			1304 Secs (1304 Secs) *[==>]*	***[4]***
9	(COS.sp.1006844)	(1) HE0047-1756A	COS/FUV, TIME-TAG, PSA	G160M 1600 A	FLASH=YES; SEGMENT=BOTH; FP-POS=4; BUFFER-TIME=13 12			1304 Secs (1304 Secs) *[==>]*	***[4]***

Orbit Structure





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