15852 - Testing IMF variation in elliptical galaxies using chromospheric activity of M dwarfs

Cycle: 27, 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) NGC-1407 (5) NGC-1407-STAR	COS/FUV COS/NUV	2	12-Sep-2019 14:00:33.0	yes
02	(1) NGC-1407 (5) NGC-1407-STAR	COS/FUV COS/NUV	2	12-Sep-2019 14:00:35.0	yes
03	(3) NGC-2695-STAR (4) NGC-2695	COS/FUV COS/NUV	2	12-Sep-2019 14:00:36.0	yes
04	(3) NGC-2695-STAR (4) NGC-2695	COS/FUV COS/NUV	2	12-Sep-2019 14:00:37.0	yes

8 Total Orbits Used

ABSTRACT

The question whether the stellar initial mass function (IMF) is universal is still unresolved. Perhaps the most persistent claims for IMF variation have come from studies of the centers of elliptical galaxies: several lines of evidence suggest that the IMF is bottom-heavy in those regions compared to the IMF of the Milky Way. Here we propose to test this by searching for the far UV emission lines associated with chromospheric activity on the surfaces of stars. By observing two galaxies with very similar properties but different claimed IMFs we will do a differential experiment: we expect to see UV lines in NGC1407, which has been claimed to have an excess of M dwarfs of a factor of 10, but not in the control galaxy NGC2695. An analysis of the H+K line region of the two galaxies is consistent with this hypothesis but not conclusive. This proposal has risk: the strengths of UV features in M dwarfs in elliptical galaxies have never been measured, and we may detect nothing in both galaxies. However, a detection of the UV lines could provide very strong evidence for IMF variation (if the lines are seen in NGC1407 but not in NGC2695) or against it (if the lines are equally strong in both galaxies).

OBSERVING DESCRIPTION

The goal of the program is to search for UV emission lines in two early-type galaxies: NGC1407 and NGC2695.

The program is split into 4 visits of 2 orbits each:

visit 1: NGC1407
orbit 1: acquisition on offset star + blind offset + direct image on target + G130M exposure at 1291 Ang at FP-POS 3
orbit 2: G130M exposure at 1291 Ang at FP-POS 4

visit 2: NGC1407
orbit 1: acquisition on offset star + blind offset + direct image on target + G160M exposure at 1533 Ang at FP-POS 1-4 (4 splits)
orbit 2: G160M exposure at 1533 Ang at FP-POS 1-4 (4 splits)

visit 3: like visit 1, but for NGC 2695
visit 4: like visit 2, but for NGC 2695

Brightness of the galaxies

The program aims to measure faint UV lines, but for the direct imaging and also for the expected continuum emission in the spectra it is important to have an approximate estimate of the magnitudes. These were determined from GALEX FUV and NUV data. The total AB magnitude in the central 2.5" diameter aperture is AB~21.1 for NGC1407 and AB~21.9 for NGC2695. The FUV-NUV color is ~0 for both galaxies (i.e. the spectrum is roughly flat in Fnu).
The average brightness per square arcsec, which is needed in the ETC, is 22.8 for NGC1407 and 23.6 for NGC2695. We are not near bright source limits (even if it is assumed that the galaxies are point sources within the 2.5" aperture).

Brightness of the lines

These were estimated to be ~1e-15; this is discussed in the Phase 1 proposal. We are not near bright limits.

Acquisition

Offset stars are used for both targets, as they are too faint for a direct acquisition. The magnitudes of the stars were measured from GALEX NUV images; the AB magnitudes at 2300 Angstrom are 20.46 for the NGC1407 star and 17.16 for the NGC2695 star. For NGC1407 MIRRORA is used. For NGC2695 the star is too bright for MIRRORA, and MIRRORB is used. Exposure times were determined with the ETC, using a S/N=50 criterion. This gave exposure times of ~1.5 minutes for both.

The coordinates of the offset stars were obtained from Gaia DR2 and are extremely accurate.
The offsets to the galaxies were determined from DECALS imaging and, as a cross-check, 2MASS imaging. They are accurate to ~0.2".

Direct images on target

After slewing to the science targets a short (300s) imaging exposure will be obtained to verify the location of the galaxy. As we do not know the

exact brightness distribution of the galaxies on sub-arcsec scales it is difficult to estimate what, exactly, the S/N ratio will be. We assume that the AB magnitude within a 0.4" radius aperture is about ~22.5 mag. In 300s this gives a S/N ratio within this aperture of 20, sufficient to determine whether it is properly centered (and whether it is there!). If the light is more spread out, the S/N ratio will be lower, and if it is more peaked, the S/N ratio will be higher, but in either case we should be able to see both galaxies quite clearly if we are in the right place. Following section 6.1 in the Instrument Handbook, FLASH=YES was selected to track the drift of the OSMs.
This additional 300s image in each visit was approved by the TTRB.

Wavelength settings

We use only a single setting for G130M (1291) and a single setting for G160M (1533). With these settings all important UV lines are away from gaps. If we added a wavelength setting to cover the gaps one or more lines would get half the exposure time, and we would not gain anything from the added wavelength coverage (as there are no lines in the gaps).

FP-POS settings

In the context of COS2025 we can only use FP-POS 3 and FP-POS 4 with the G130M/1291 setting. I simply used position 3 for the first exposure, and position 4 for the second. If there is any reason to do finer splits (that is, subexposures within each exposure, going back and forth between 3 and 4) then we can do that. However, it does not seem anything would be gained, and it would lead to some added overhead.

With the G160M/1533 setting we can use all FP-POS settings, and we do. Each exposure is split into 4 subexposures with all 4 settings.

Visit

Proposal 15852, Visit 01, implementation Thu Sep 12 18:00:38 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Exposure 3 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

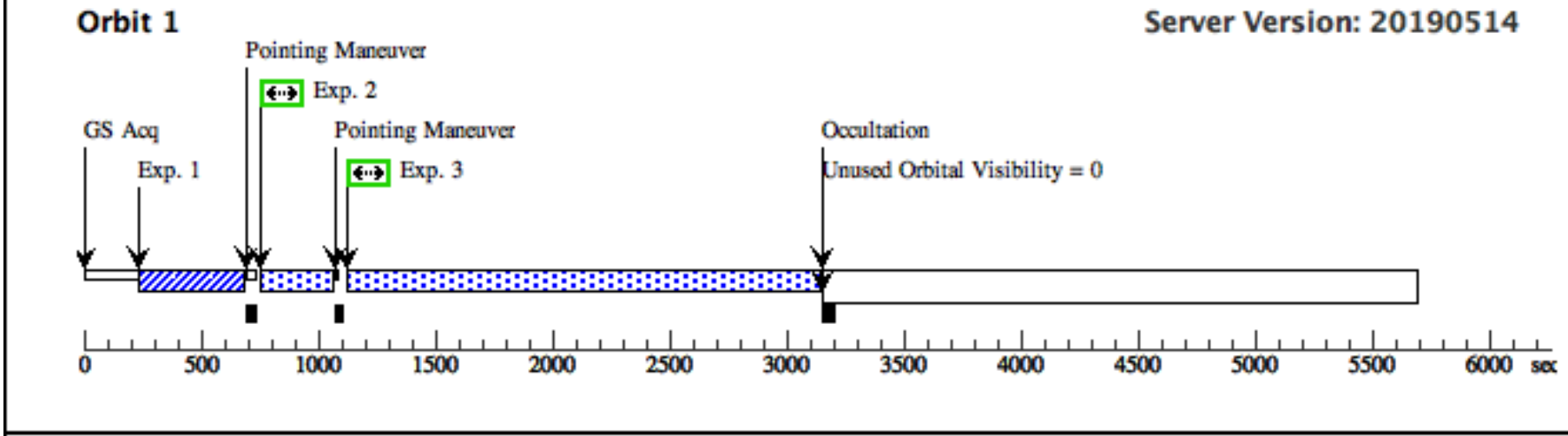
Fixed Targets

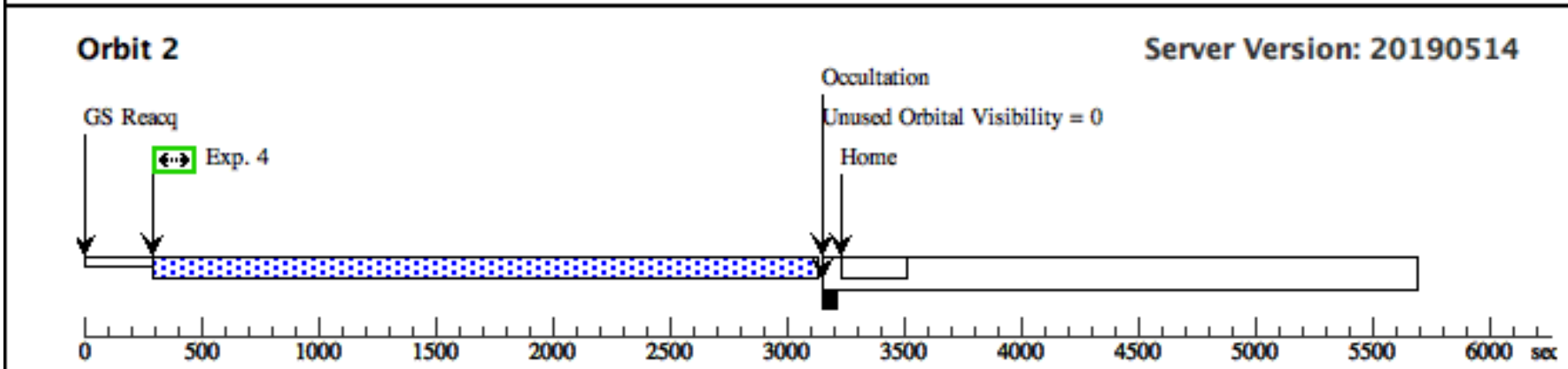
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-1407	Offset from NGC-1407-STAR RA Offset: -0.0192 Degrees Dec Offset: -7.48E-4 Degrees		V=10	Offset Position (NGC-1407)
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=GALAXY* *Description=[ELLIPTICAL]* *Extended=YES*					
(5)	NGC-1407-STAR	RA: 03 40 16.4640 (55.0686000d) Dec: -18 34 45.54 (-18.57932d) Equinox: J2000	Proper Motion RA: 16.9 mas/yr Proper Motion Dec: 12.9 mas/yr Parallax: 0.00115" Epoch of Position: 2000	V=15.0 20.46 (GALEX NUV)	Reference Frame: ICRS
Comments: This is the position of the offset star. Position from Gaia DR2 database. The offset from this star to NGC1407 is 65.6 arcsec West, and 2.7 arcsec South. *Category=STAR* *Description=[UNDESIGNATED]* *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.im.1375743)	(5) NGC-1407-STAR	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				114 Secs (114 Secs) *[==>]*	***[1]***
2	(COS.im.1378016)	(1) NGC-1407	COS/NUV, TIME-TAG, PSA	MIRRORA	BUFFER-TIME=1667; FLASH=YES			300 Secs (300 Secs) *[==>]*	***[1]***
3	(COS.sp.1372384)	(1) NGC-1407	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5254; FLASH=YES; FP-POS=3; SEGMENT=BOTH			1600 Secs (1848 Secs) *[==>1848.0 Secs]*	***[1]***
4	(COS.sp.1372397)	(1) NGC-1407	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5254; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2000 Secs (2790 Secs) *[==>2790.0 Secs]*	***[2]***

Orbit Structure





Visit

Proposal 15852, Visit 02, implementation Thu Sep 12 18:00:38 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Exposure 3 (Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

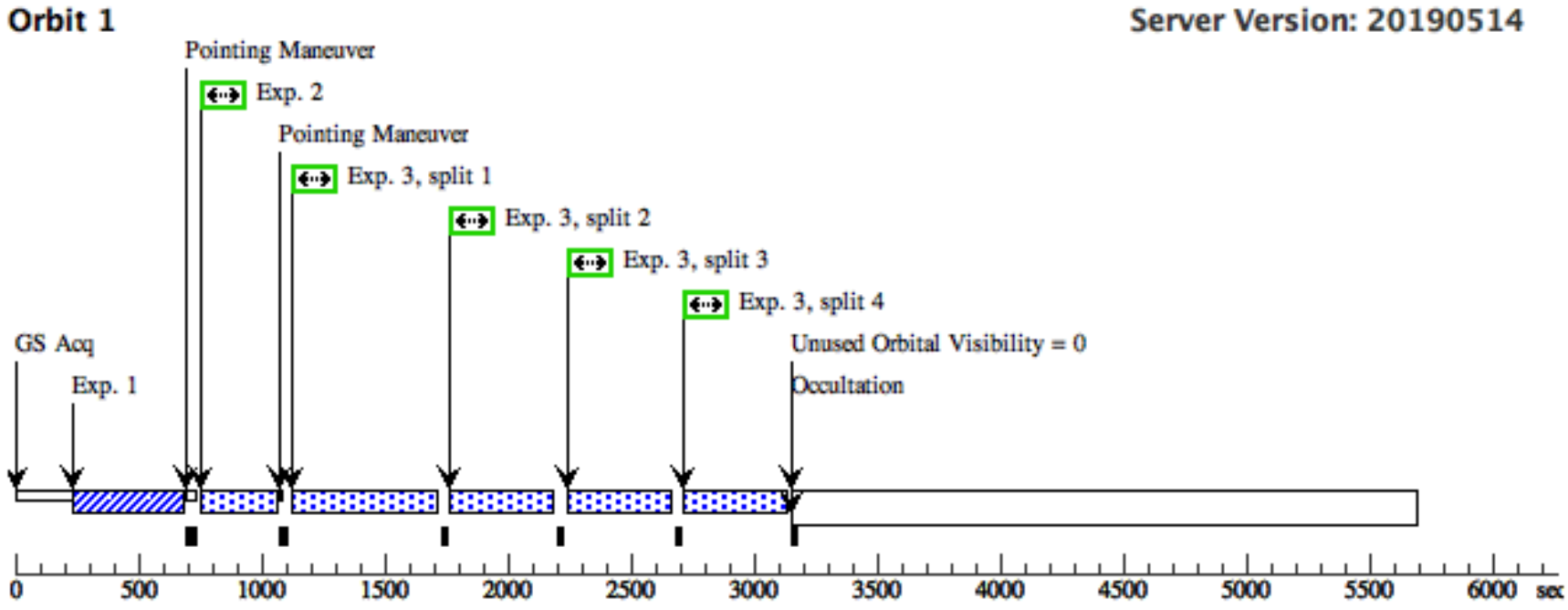
Fixed Targets

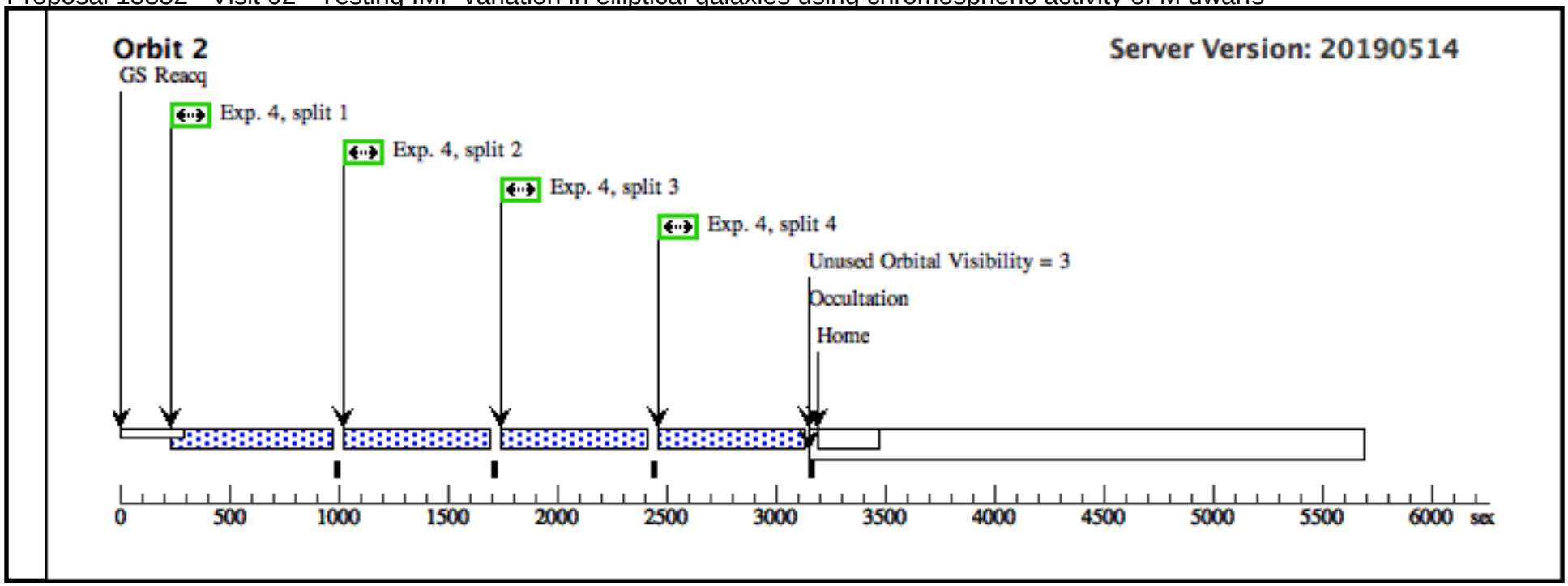
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-1407	Offset from NGC-1407-STAR RA Offset: -0.0192 Degrees Dec Offset: -7.48E-4 Degrees		V=10	Offset Position (NGC-1407)
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=GALAXY* *Description=[ELLIPTICAL]* *Extended=YES*					
(5)	NGC-1407-STAR	RA: 03 40 16.4640 (55.0686000d) Dec: -18 34 45.54 (-18.57932d) Equinox: J2000	Proper Motion RA: 16.9 mas/yr Proper Motion Dec: 12.9 mas/yr Parallax: 0.00115" Epoch of Position: 2000	V=15.0 20.46 (GALEX NUV)	Reference Frame: ICRS
Comments: This is the position of the offset star. Position from Gaia DR2 database. The offset from this star to NGC1407 is 65.6 arcsec West, and 2.7 arcsec South. *Category=STAR* *Description=[UNDESIGNATED]* *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.im.1375743)	(5) NGC-1407-STAR	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				114 Secs (114 Secs) *[==>]*	 ***[1]***
2	(COS.im.1378016)	(1) NGC-1407	COS/NUV, TIME-TAG, PSA	MIRRORA	BUFFER-TIME=1667; FLASH=YES			300 Secs (300 Secs) *[==>]*	 ***[1]***
3	(COS.sp.1372439)	(1) NGC-1407	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=20119; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			350 Secs (1480 Secs) *[==>370.0 Secs (Split 1)]* *[==>370.0 Secs (Split 2)]* *[==>370.0 Secs (Split 3)]* *[==>370.0 Secs (Split 4)]*	 ***[1]***
4	(COS.sp.1372440)	(1) NGC-1407	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=20119; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			600 Secs (2472 Secs) *[==>618.0 Secs (Split 1)]* *[==>618.0 Secs (Split 2)]* *[==>618.0 Secs (Split 3)]* *[==>618.0 Secs (Split 4)]*	 ***[2]***

Orbit Structure




Orbit 2
Server Version: 20190514
GS Reacq
Exp. 4, split 1
Exp. 4, split 2
Exp. 4, split 3
Exp. 4, split 4
Unused Orbital Visibility = 3
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 15852, Visit 03, implementation Thu Sep 12 18:00:38 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Exposure 3 (Visit 03)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Visit 03)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

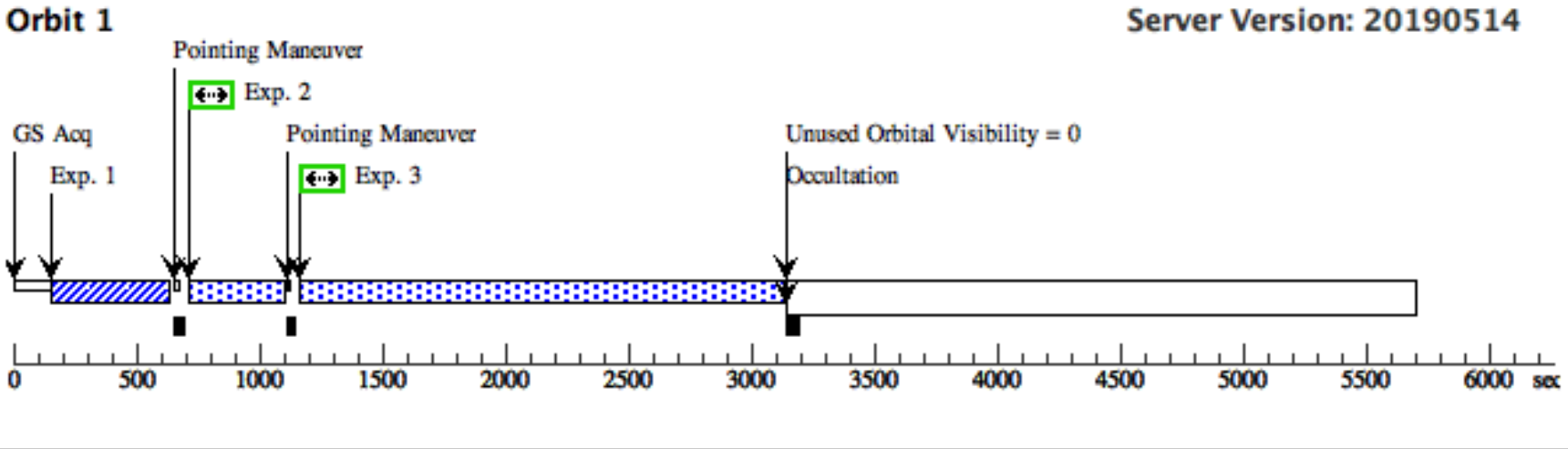
Fixed Targets

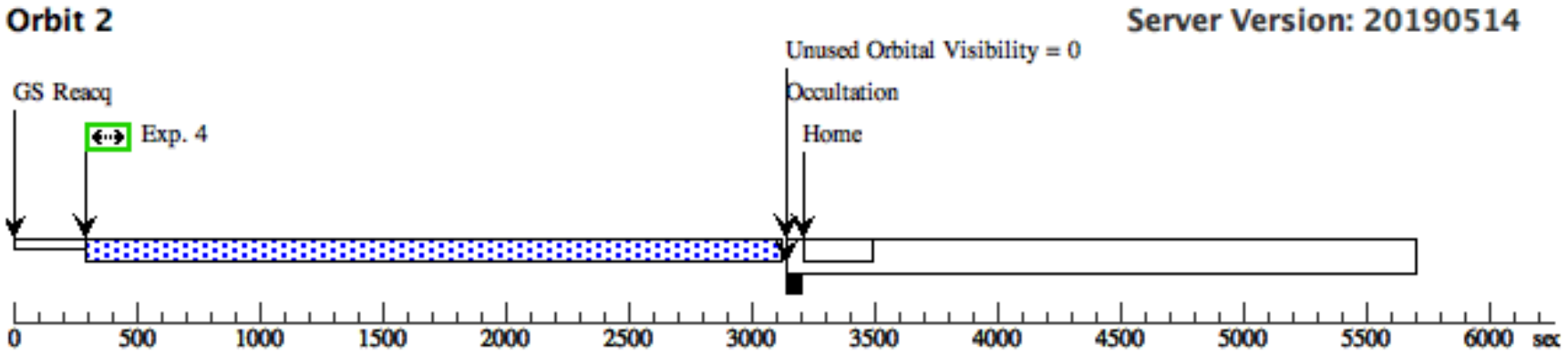
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	NGC-2695-STAR	RA: 08 54 28.6740 (133.6194750d) Dec: -03 04 1.33 (-3.06704d) Equinox: J2000	Proper Motion RA: -2.2 mas/yr Proper Motion Dec: 0.4 mas/yr Parallax: 0.0006" Epoch of Position: 2000	V=14.3 17.16 (GALEX NUV)	Reference Frame: ICRS
Comments: This is the position of the offset star. Position from Gaia DR2 database. The offset from this star to NGC2695 is 24.0 arcsec West, and 0.4 arcsec North. *Category=STAR* *Description=[UNDESIGNATED]* *Extended=NO*					
(4)	NGC-2695	Offset from NGC-2695-STAR RA Offset: -0.00667 Degrees Dec Offset: 1.08E-4 Degrees		V=12	Offset Position (NGC-2695)
Comments: The target is 24.0 arcsec West and 0.4 arcsec North of NGC-2695-STAR *Category=GALAXY* *Description=[ELLIPTICAL]* *Extended=YES*					

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.im.1375738)	(3) NGC-2695-STAR	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				94 Secs (94 Secs) *[==>]*	 ***[1]***
2	(COS.im.1378016)	(4) NGC-2695	COS/NUV, TIME-TAG, PSA	MIRRORA	BUFFER-TIME=1667; FLASH=YES			300 Secs (300 Secs) *[==>]*	 ***[1]***
3	(COS.sp.1372442)	(4) NGC-2695	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5328; FLASH=YES; FP-POS=3; SEGMENT=BOTH			1700 Secs (1797 Secs) *[==>1797.0 Secs]*	 ***[1]***
4	(COS.sp.1372443)	(4) NGC-2695	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=5328; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2000 Secs (2776 Secs) *[==>2776.0 Secs]*	 ***[2]***

Orbit Structure





Visit

Proposal 15852, Visit 04, implementation Thu Sep 12 18:00:38 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Visit 04) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Exposure 3 (Visit 04)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Visit 04)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

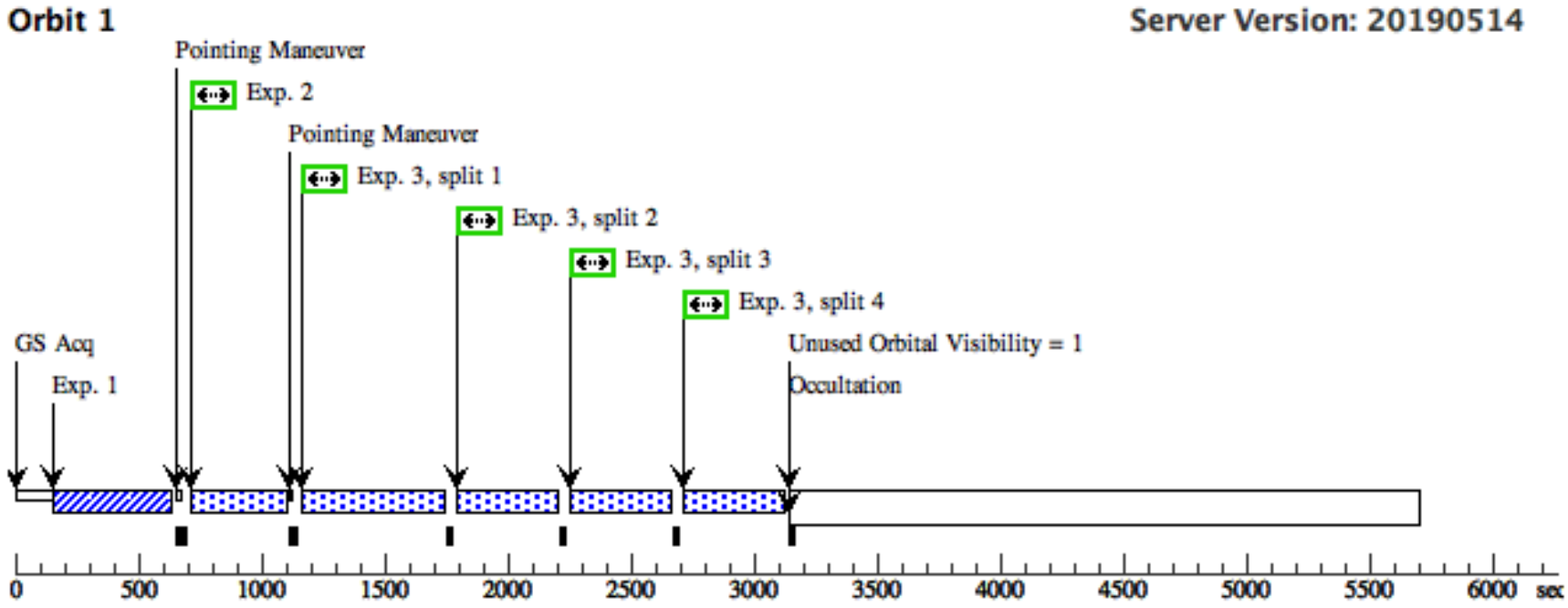
Fixed Targets

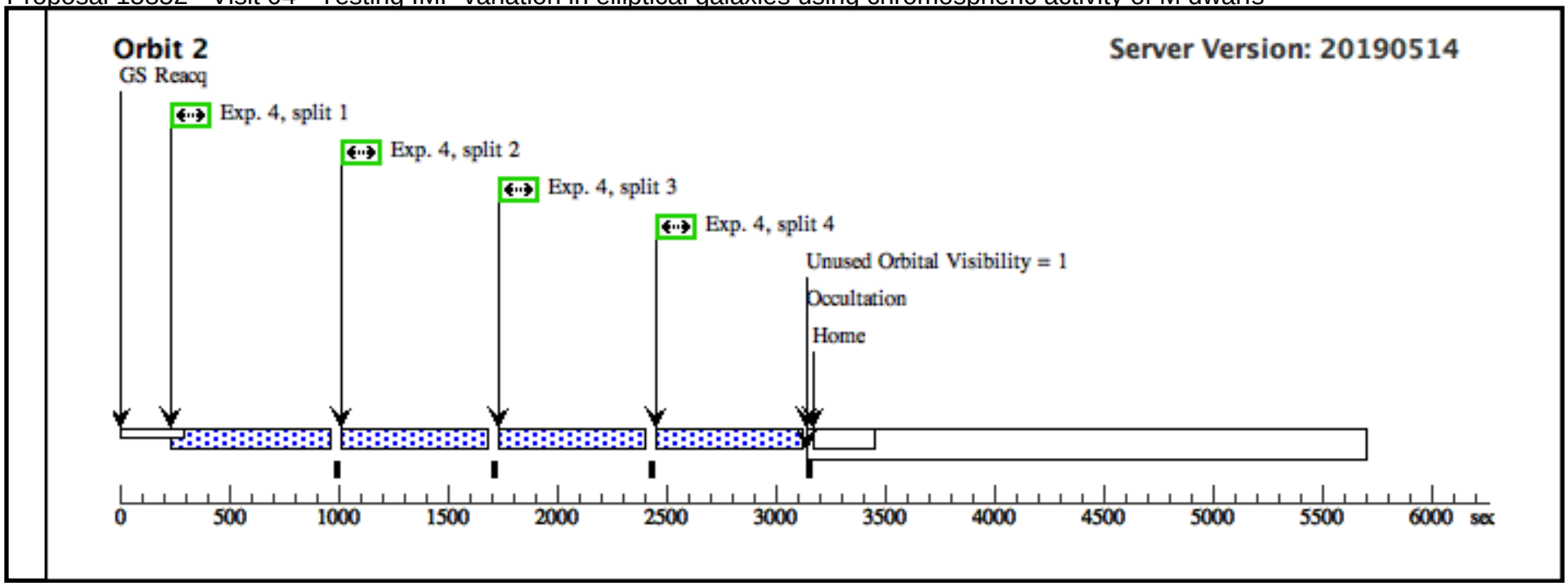
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	NGC-2695-STAR	RA: 08 54 28.6740 (133.6194750d) Dec: -03 04 1.33 (-3.06704d) Equinox: J2000	Proper Motion RA: -2.2 mas/yr Proper Motion Dec: 0.4 mas/yr Parallax: 0.0006" Epoch of Position: 2000	V=14.3 17.16 (GALEX NUV)	Reference Frame: ICRS
Comments: This is the position of the offset star. Position from Gaia DR2 database. The offset from this star to NGC2695 is 24.0 arcsec West, and 0.4 arcsec North. *Category=STAR* *Description=[UNDESIGNATED]* *Extended=NO*					
(4)	NGC-2695	Offset from NGC-2695-STAR RA Offset: -0.00667 Degrees Dec Offset: 1.08E-4 Degrees		V=12	Offset Position (NGC-2695)
Comments: The target is 24.0 arcsec West and 0.4 arcsec North of NGC-2695-STAR *Category=GALAXY* *Description=[ELLIPTICAL]* *Extended=YES*					

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.im.1375738)	(3) NGC-2695-STAR	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				94 Secs (94 Secs) *[==>]*	***[1]***
2	(COS.im.1378016)	(4) NGC-2695	COS/NUV, TIME-TAG, PSA	MIRRORA	BUFFER-TIME=1667; FLASH=YES			300 Secs (300 Secs) *[==>]*	***[1]***
3	(COS.sp.1372445)	(4) NGC-2695	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=20784; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			350 Secs (1428 Secs) *[==>357.0 Secs (Split 1)]* *[==>357.0 Secs (Split 2)]* *[==>357.0 Secs (Split 3)]* *[==>357.0 Secs (Split 4)]*	***[1]***
4	(COS.sp.1372446)	(4) NGC-2695	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=20784; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			600 Secs (2460 Secs) *[==>615.0 Secs (Split 1)]* *[==>615.0 Secs (Split 2)]* *[==>615.0 Secs (Split 3)]* *[==>615.0 Secs (Split 4)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20190514
GS Reacq
Exp. 4, split 1
Exp. 4, split 2
Exp. 4, split 3
Exp. 4, split 4
Unused Orbital Visibility = 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec