16933 - The Origin and Impact of Flares in M Dwarf Systems

Cycle: 29, Proposal Category: GO/DD

(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	(2) WOLF-359	STIS/CCD STIS/FUV-MAMA	3	05-May-2022 10:00:20.0	yes
02	(2) WOLF-359	STIS/CCD STIS/FUV-MAMA	3	05-May-2022 10:00:22.0	yes
03	(2) WOLF-359	STIS/CCD STIS/FUV-MAMA	3	05-May-2022 10:00:23.0	yes

9 Total Orbits Used

ABSTRACT

M dwarf stars are the most abundant stars in the galaxy and have a high frequency of Earth-sized planets, making them the favored targets of upcoming missions to detect and characterize exoplanets. However, these stars are known to exhibit high levels of activity and flaring, which can deplete a planet's atmosphere of water and ozone over time, raising questions about the habitability of planets around these stars. It is clear that there is still much to be learned about M dwarfs, their activity, and the potential habitability of their planetary systems. Monitoring campaigns with simultaneous observations across a broad range of wavelengths are needed in order to determine how stellar flaring emission correlates across the electromagnetic spectrum. Here, we propose to conduct such a campaign using HST STIS for four nearby M dwarfs, spectral analogues of Proxima Cen spanning a range of ages and activity levels. We have already been awarded observing time with ALMA, Swift, NICER, and ground-based optical facilities that will be executed simultaneously between now and October 2022. These HST DDT observations are the only way to add FUV coverage to this campaign. Recent observations of Proxima Cen suggest that UV and millimeter emission trace each other closely during flares, and this proposed study will show whether this is a universal property of mid-M dwarfs regardless of age. By deriving a scaling relation between millimeter and UV emission, we will have a powerful new tool to determine the UV environment of stars and their potential to host habitable planets, and be able to capitalize on existing all-sky cosmology surveys at millimeter and radio wavelengths.

OBSERVING DESCRIPTION

Monitoring campaigns with simultaneous observations across a broad range of wavelengths are needed in order to determine how stellar flaring emission correlates across the electromagnetic spectrum. This new study will show whether the correlation between millimeter and UV emission is a

universal property of mid-M dwarfs regardless of age and activity level.

Wolf 359 is a well-known flare star (Robinson et al. 1995) that was the target of a recent campaign with Kepler/K2, Swift, LCOGT, and radio facilities spanning 20 MHz - 3.1 GHz. Using 1 min cadence, more than 800 flares were detected in 80 days (Quintana, priv. comm.). Compared to Proxima Cen, both stars have similar slopes of their flare frequency distributions, but Wolf 359 has significantly more flares at all energies. ALMA and Chandra time were also awarded for Wolf 359. The combination of the HST UV observations with simultaneous monitoring at millimeter, x-ray, and optical wavelengths will definitively show any correlations between flaring emission at these different wavelengths. By observing for 12 orbits, we should detect >7 large flares and many more small flares from Wolf 359 given its 2x higher flare rate than Proxima Cen.

MAMA safety: We conservatively take the SIMBAD spectral type of M6 and U-band quiescent magnitude of 16.71. A 10^{-4} probability flare would
produce a maximum U-band magnitude increase of -2.8 mag, yielding a peak U-band magnitude of 13.91. With these input values, we find peak line fluxes during a 10 ^{-4} probability flare of 3.1e-13 erg/s/cm^2 (C IV), 1.2e-13 (Si IV), and 3.1e-13 (Ly alpha). When these line fluxes and a 9000 K blackbody associated with the flaring U-band magnitude are run through the ETC, count rate limits for the STIS E140M spectrograph are not violated.

Observing plan: HST STIS E140M grating (0.2 x 0.2 arcsec slit, covering 1150 - 1700 Ang), 3 visits of 4 orbits each
Target acquisition in the STIS/CCD with the F28x50OII aperture at an exposure time of 10 sec.
TIME-TAG mode.

Visit

Proposal 16933, Visit 01, implementation Thu May 05 14:00:24 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: (none)

Comments: UV spectra of Wolf 359
JD 2459700.493056 (May 1 at 23:10) is the approximate start of nightime observing at ALMA. See table below.
The first 13 minuts of the first orbit are acquisitions, so orbit can start at 23:10 and have the spectra be taken after dark.

	sunset	end of astro twilight	airmass 1.5	airmass 2.0	
04/26	*22:11*	*23:23*	*03:47*		
05/08	*22:03*	*23:18*	*03:00*		
05/22	*21:55*	*23:14*	*02:04*		
06/03	*21:54*	*23:14*		*02:15*	**last day for 3 hours of dark above airmass 2*
06/17	*21:53*	*23:13*	*00:21*	*01:20*	
06/30	*21:56*	*23:16*	*23:31*	*00:29*	
07/10	*22:00*	*23:20*		*23:49*	

Fixed Targets

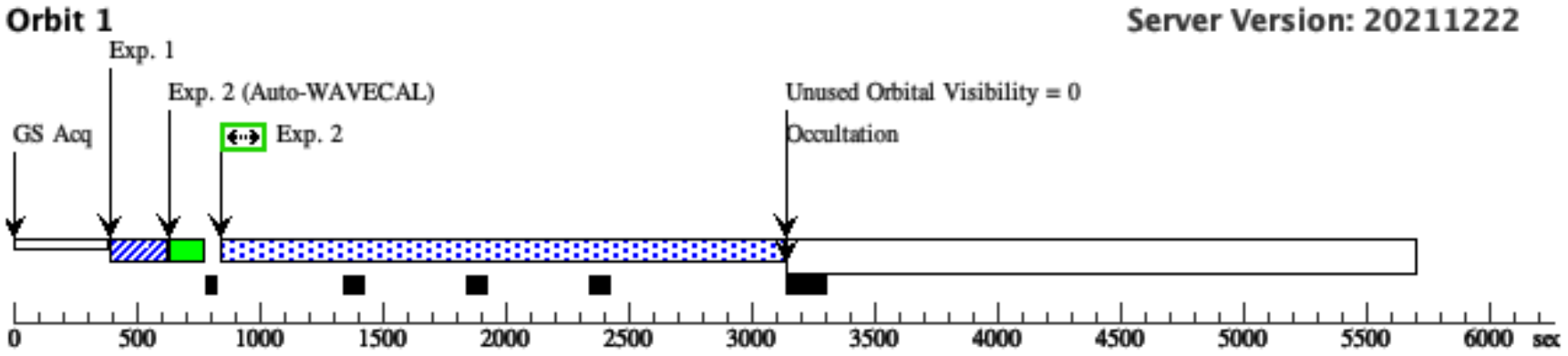
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	WOLF-359 Alt Name1: GJ406	RA: 10 56 24.7675 (164.1031979d) Dec: +07 00 9.82 (7.00273d) Equinox: J2000	Proper Motion RA: -0.25969309 sec of time/yr Proper Motion Dec: -2699.215 mas/yr Parallax: 0.4151794" Epoch of Position: 2016.0	V=13.507 U=16.706	Reference Frame: ICRS

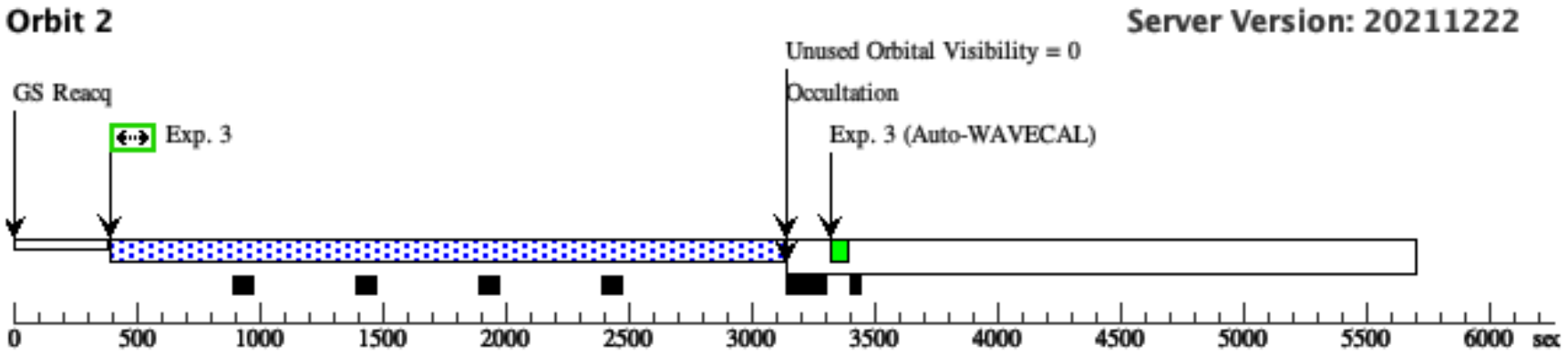
Comments: Gaia EDR3 ICRS Ep=2016.0 coordinates
pmra = pm(EDR3) / 15. / cos(dec) / 1000.
Category=STAR
Description=[EMISSION LINE STAR, IRREGULAR VARIABLE, M V-IV]

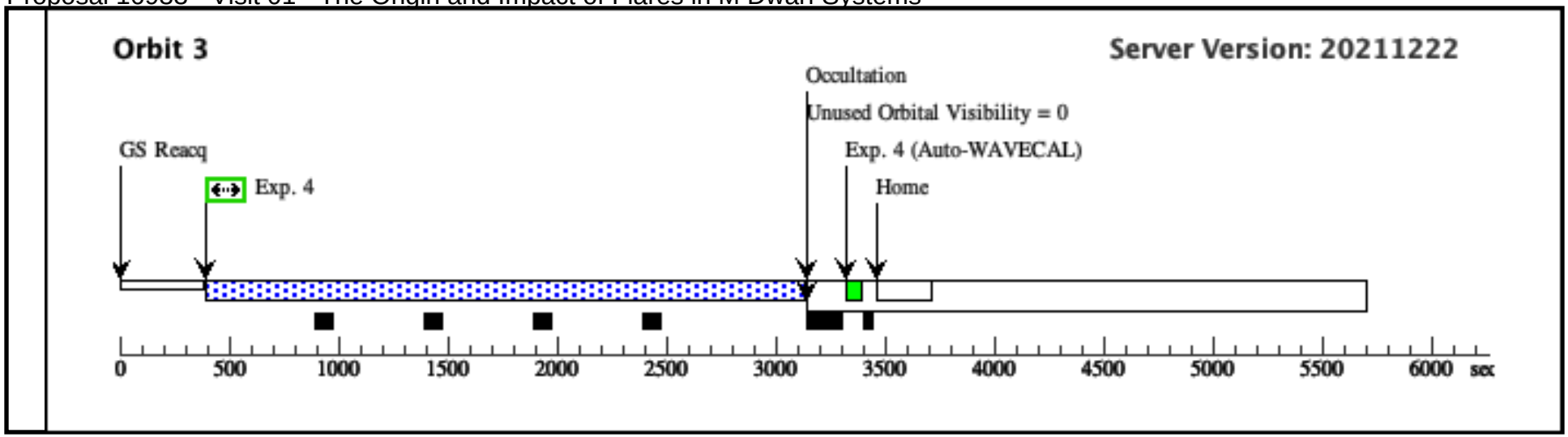
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1744165)	(2) WOLF-359	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.3 Secs (0.3 Secs) *[==>]*	 ***[1]***
	Comments: STIS ETC using F28x50LP, I=9.507 and Phoenix M dwarf Models M5.5 3000K gives S/N~258 in 0.3 s, saturates at 1.88 s								
2	(STIS.sp.1744164)	(2) WOLF-359	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=500			2271 Secs (2271 Secs) *[==>]*	 ***[1]***
	Comments: ETC says S/N=0 on continuum U-band, but that's not really relevant.								
3	(STIS.sp.1744164)	(2) WOLF-359	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=500			2723 Secs (2723 Secs) *[==>]*	 ***[2]***
	Comments: ETC says S/N=0 on continuum U-band, but that's not really relevant.								
4	(STIS.sp.1744164)	(2) WOLF-359	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=500			2723 Secs (2723 Secs) *[==>]*	 ***[3]***
	Comments: ETC says S/N=0 on continuum U-band, but that's not really relevant.								

Orbit Structure






Orbit 3
Server Version: 20211222
Occultation
Unused Orbital Visibility = 0
GS Reacq
Exp. 4 (Auto-WAVECAL)
Exp. 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16933, Visit 02, implementation Thu May 05 14:00:24 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: (none)

Comments: UV spectra of Wolf 359

Fixed Targets

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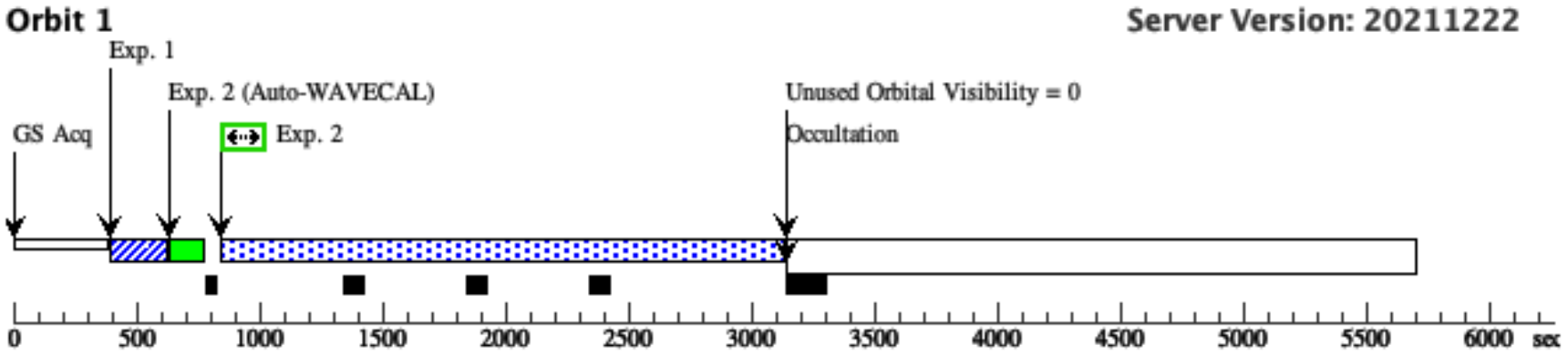
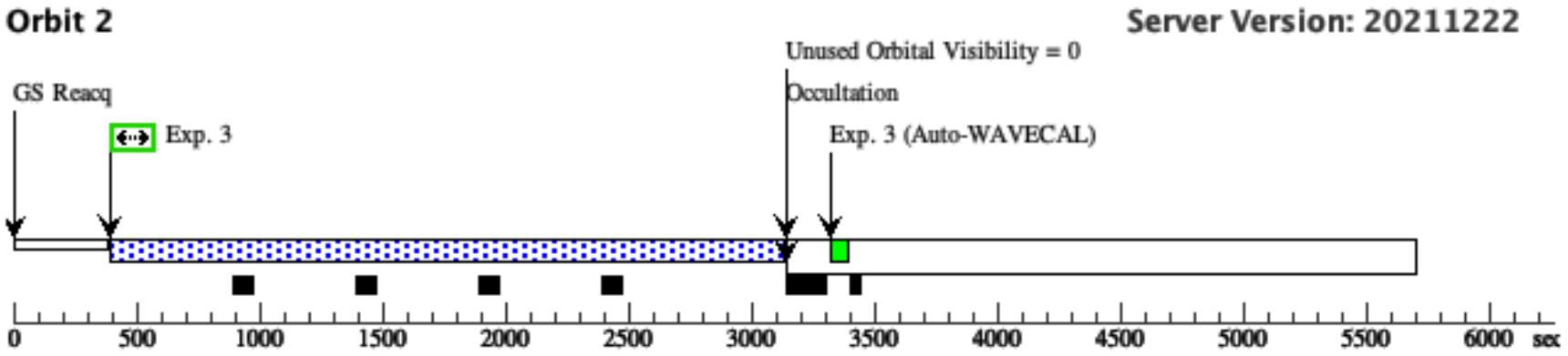
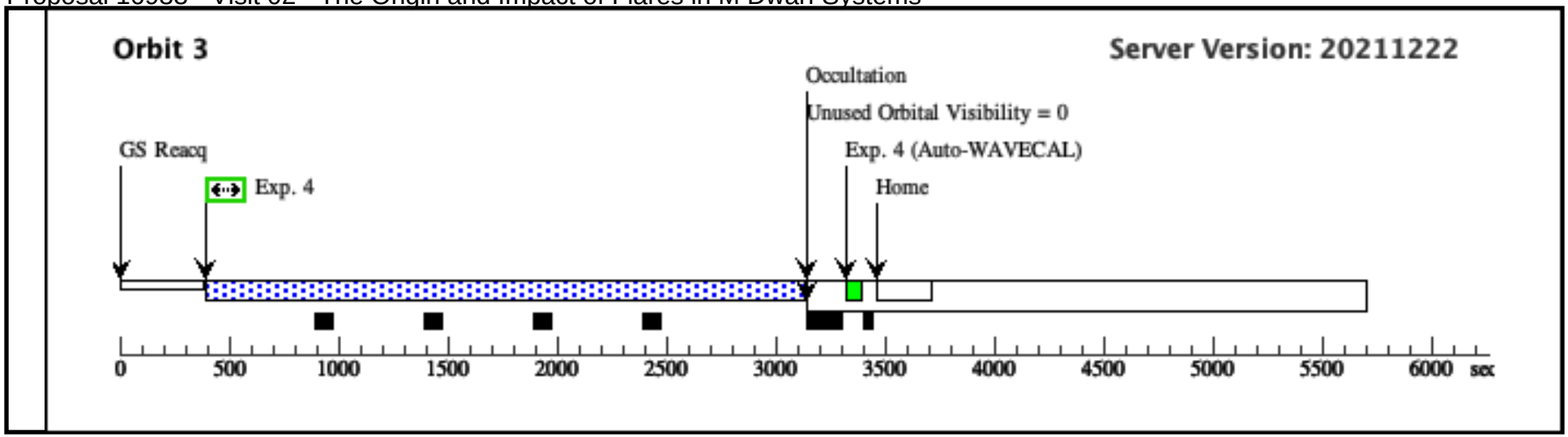
Orbit Structure






Orbit 3
Server Version: 20211222
Occultation
Unused Orbital Visibility = 0
GS Reacq
Exp. 4 (Auto-WAVECAL)
Exp. 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16933, Visit 03, implementation Thu May 05 14:00:24 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: (none)

Comments: UV spectra of Wolf 359

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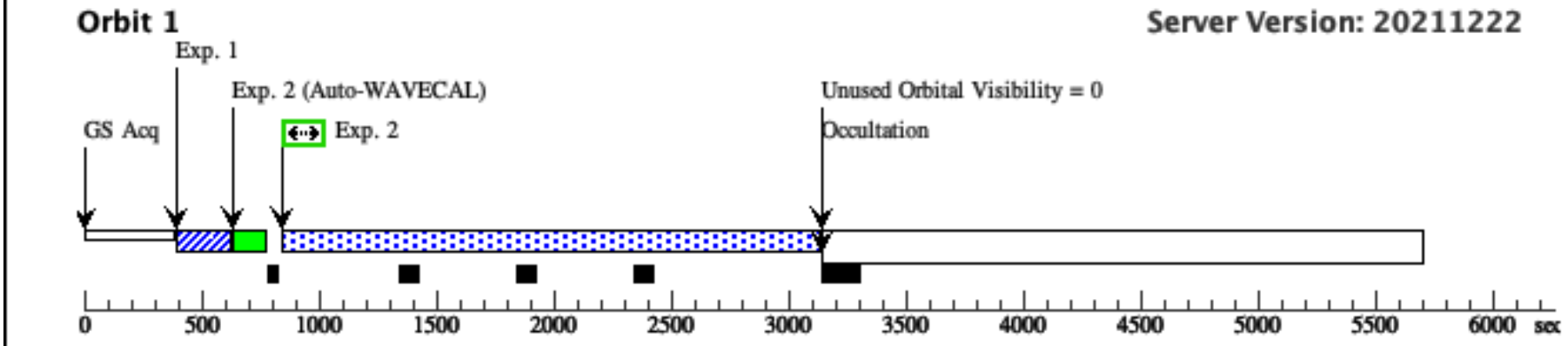
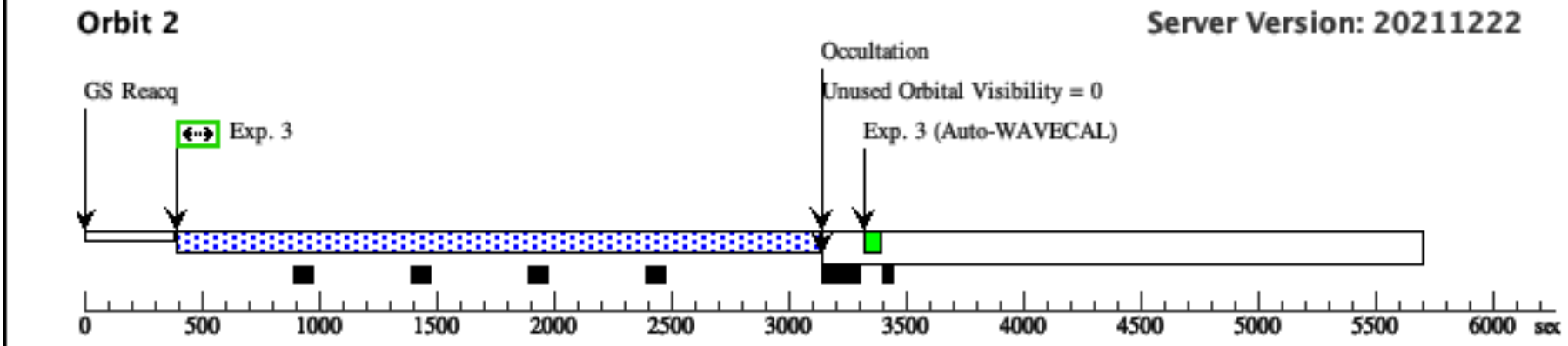
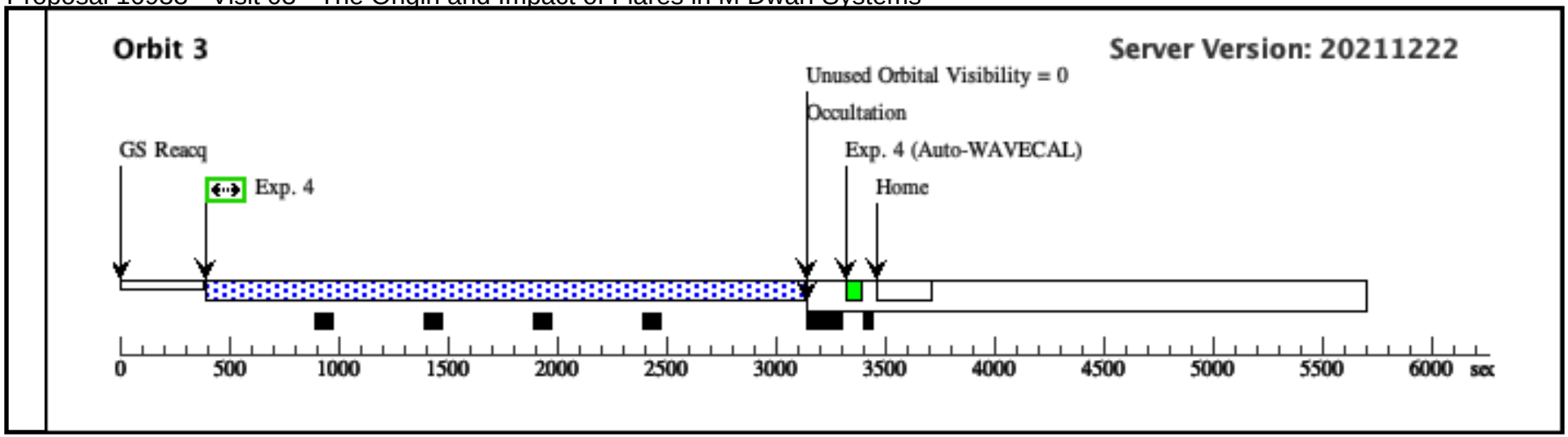
	Comments: ETC says S/N=0 on continuum U-band, but that's not really relevant.								

Orbit Structure






Orbit 3
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Unused Orbital Visibility = 0
Occultation
GS Reacq
Exp. 4
Exp. 4 (Auto-WAVECAL)
Home
0
500
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1500
2000
2500
3000
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4000
4500
5000
5500
6000
sec