15454 - Ultraviolet Spectroscopy of the Black Hole Transient MAXI J1820+070

Cycle: 25, 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	(1) MAXI-J1820+070	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	5	14-Jun-2018 22:00:25.0	yes
02	(1) MAXI-J1820+070	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	5	14-Jun-2018 22:00:30.0	yes

10 Total Orbits Used

ABSTRACT

On March 11, MAXI/GSC detected a new X-ray transient, MAXI J1820+070. Since then, the system has become one of the brightest and least reddened black-hole X-ray binaries ever seen and is currently the target of an extensive multi-wavelength campaign. However, there is one critical gap in this campaign: the ultraviolet band. Here, we propose to rectify this omission by obtaining two epochs of FUV and NUV spectroscopy of the system with HST/STIS.

Remarkably, even though MAXI~J1820+070 is already UV bright, it still appears to be in the so-called ``hard'' state at the moment. This presents us with the unique opportunity to obtain the first-ever hard-state UV observations of any BH binary. This, in turn, will allow us to use the most sensitive disk wind signatures -- which are located in the UV band -- to test for the presence of a disk wind in both the hard and soft states. We therefore propose to obtain two epochs, one scheduled as early as possible to catch the system in the hard state, the other scheduled roughly 1 month later, to catch the system in the soft state.

In addition to the search for disk wind signatures, our data will also be critical for reconstructing the disk SED, allow us to search for stochastic and (quasi-)periodic variability and inter-band time-lags, yield abundance estimates that will tell us the evolutionary history of the system and provide a direct estimate of the reddening and extinction towards the source.

OBSERVING DESCRIPTION

We will visit V404 Cyg three times with HST. The first and third visit will each consist of 5 consecutive HST orbits, during which we will carry out time-resolved far-UV spectroscopy with the COS/G140L instrument/grating combination. We will use the 1105 A setting for all of these observations to achieve continuous wavelength coverage between 1121 A and 2148 A. The TIME-TAG mode of COS will provide sufficient time resolution to capture variability on the dynamical time-scale within the accretion disk. COS is preferred to STIS in the far-UV despite due to its much higher sensitivity in this waveband.

The second visit will consist of 2 consecutive HST orbits, during which we will obtain time-resolved near-UV spectroscopy with the STIS/NUV-MAMA/G230L instruments/detector/grating combination. This gives continuous wavelength coverage between 1570 A and 3180 A, again at a time resolution sufficient to resolve fast flickering.

Recent near-UV photometry obtained by Swift/UVOT shows that F_lambda,NUV ~ 1-5 x 1e-16 erg/cm^2/ s/A. (Motta et al. 2015b), where the near-UV measurement corresponds to the UVW1 or UVW2 filters, which have central wavelength of 2600 A and 1900 A, respectively. Since the intrinsic

SED is likely to be blue, but subject to considerable reddening, far-UV and near-UV fluxes will probably be comparable. Based on these numbers, and allowing for overheads, we then estimate that 10 HST orbits of far-UV spectroscopy will yield a combined spectrum with S/N ~ 5-15 per resolution element at 1500 A. Similarly, our 2 orbits of near-UV spectroscopy will yield a combined spectrum with S/N ~ 5-15 per resolution element at 2800 A.

There are no safety concerns for the COS or STIS detectors. In the near-UV, the existing Swift/UVOT observations show that the system is nowhere near bright enough to threaten detector damage. No empirical data exists so far in the far-UV, but even the most extreme plausible extrapolation from the near-UV to the far-UV -- assuming that both near-UV and far-UV emission lie on the Rayleigh-Jeans tail of the disk spectrum (F_lambda ~ lambda^{-4}) -- yields local and global count rates that remain well below the bright object limits.

We will use an imaging target acquisition with Mirror B as the best compromise between efficiency and instrument safety. With this set-up, a 1 min ACQ/IMAGE target acquisition exposure yields S/N ~ 30-60 depending on the detailed SED shape, and the count rate in the brightest pixel never exceeds 8 c/s, well below the bright object limit.

The observations should ideally take place as soon as possible, in order to ensure that we catch the system before it decays too much.

We also request that the near-UV visit should take place between the two far-UV visits and that all three visits should take place as close in time as possible. This will allow us to construct a near-simultaneous global SED.

Several of us are leaders/members of ongoing monitoring campaigns at other wavelengths, so we can rely on existing/approved programs to obtain (near-)simultaneous coverage across the entire frequency range. In order to facilitate the scheduling of the HST program, we are not requesting any of these auxiliary observations to be formally linked to the HST observations. Instead, we will simply make a best effort to achieve obtain the widest possible range of auxiliary observations as close as possible to the time of the HST observations.

We finally note that, given the strong variability currently seen at all wavelengths and on all time-scales (e.g. Ferrigno et al. 2015; Motte et al. 2015ab; Hynes et al. 2015; Hardy et al. 2015; Tetarenko et al. 2015), it is impossible to predict with certainty whether the system is likely to be detectable in the far-UV in early July. We are therefore happy to work with STScI to mitigate the risk of a non-detection. For example, it may be possible to implement a ``dead-man's switch'', whereby the HST observations will only be executed if Swift/UVOT near-UV photometry closer to the HST scheduling window indicates a significant likelihood of success.

Proposal 15454 - Visit 01 - Ultraviolet Spectroscopy of the Black Hole Transient MAXI J1820+070

Visit

Proposal 15454, Visit 01, completed — Fri Jun 15 02:00:31 GMT 2018

Diagnostic Status: Warning

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

Special Requirements: SCHED 100%

Diagnostics

(Visit 01) Warning (Orbit Planner): STIS TIME-TAG EXPOSURE GENERATES HEAVY DATA VOLUME

Fixed Targets

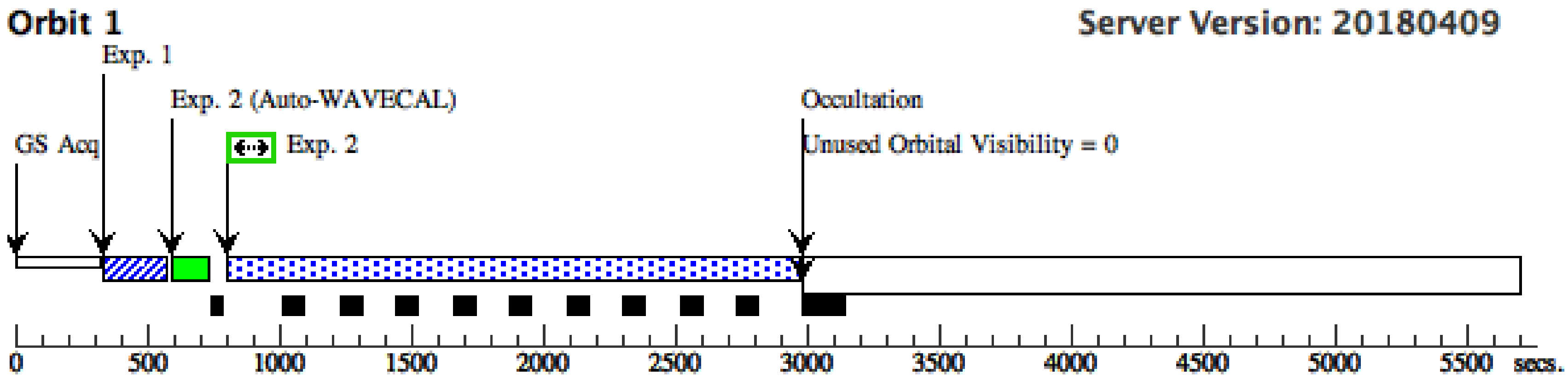
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	MAXI-J1820+070	RA: 18 20 21.9400 (275.0914167d) Dec: +07 11 7.24 (7.18534d) Equinox: J2000	Proper Motion RA: 0 mas/yr Proper Motion Dec: 0 mas/yr Epoch of Position: 2018	V=12	Reference Frame: ICRS

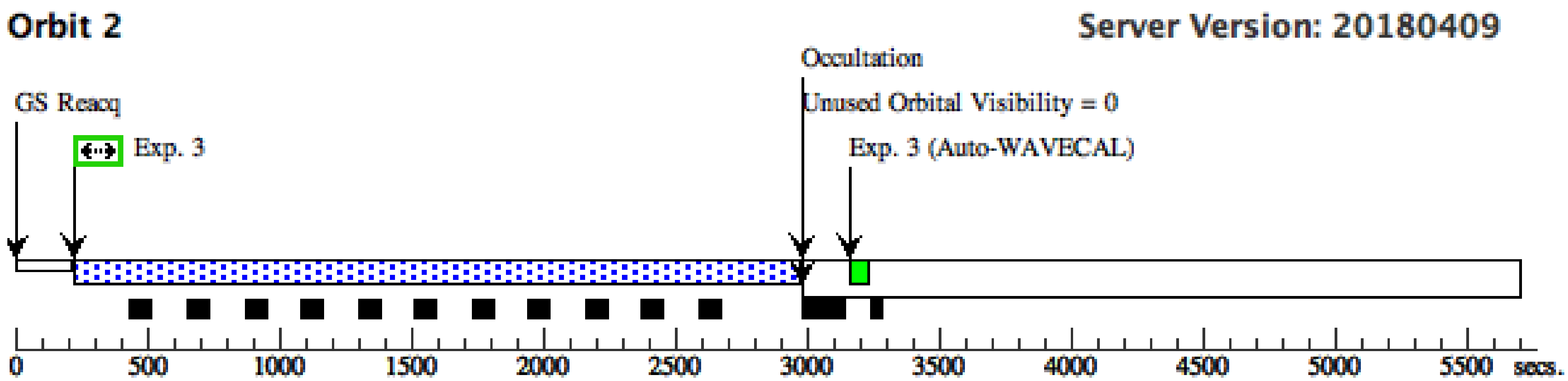
Comments:
Category=STAR
Description=[ACCRETION DISK, WIND, X-RAY NOVAE, X-RAY TRANSIENT]
Extended=NO

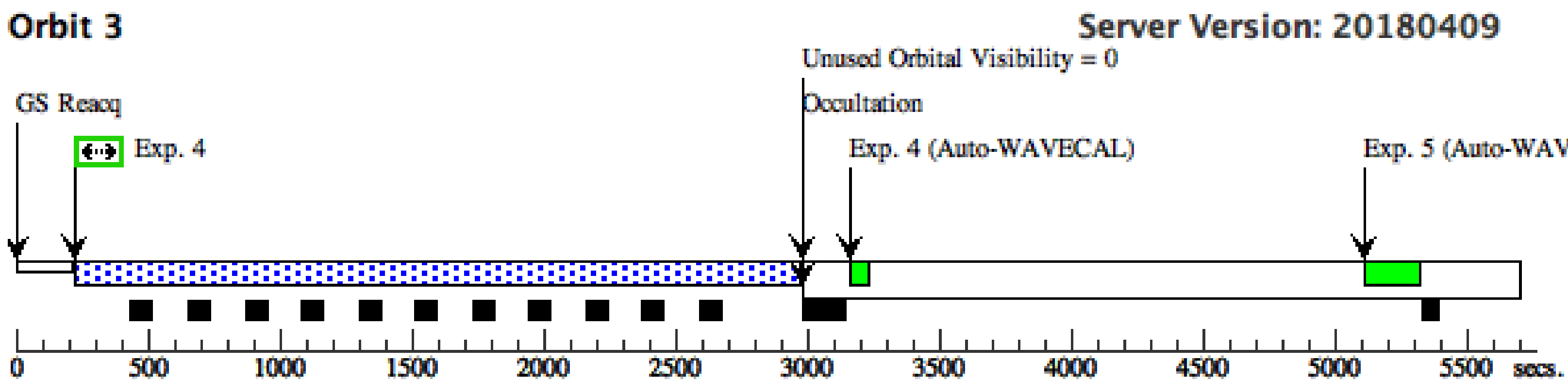
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) MAXI-J1820+070	STIS/CCD, ACQ, 50CCD	MIRROR				0.1 Secs (0.1 Secs) *[==>]*	***[1]***
2	UV-1 (STIS.sp.1156121)	(1) MAXI-J1820+070	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=215			3000 Secs (2151 Secs) *[==>2151.0 Secs]*	***[1]***
3	UV-1 (STIS.sp.1156121)	(1) MAXI-J1820+070	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=215			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[2]***
4	UV-1 (STIS.sp.1156121)	(1) MAXI-J1820+070	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=215			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[3]***
5	UV-1 (STIS.sp.1156123)	(1) MAXI-J1820+070	STIS/NUV-MAMA, TIME-TAG, 0.2X0.2	E230M 1978 A	BUFFER-TIME=150			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[4]***
6	UV-1 (STIS.sp.1156124)	(1) MAXI-J1820+070	STIS/NUV-MAMA, TIME-TAG, 0.2X0.2	E230M 2707 A	BUFFER-TIME=100			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[5]***

Orbit Structure



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GS Reacq
Exp. 4
Occultation
Exp. 4 (Auto-WAVECAL)
Exp. 5 (Auto-WAVECAL)
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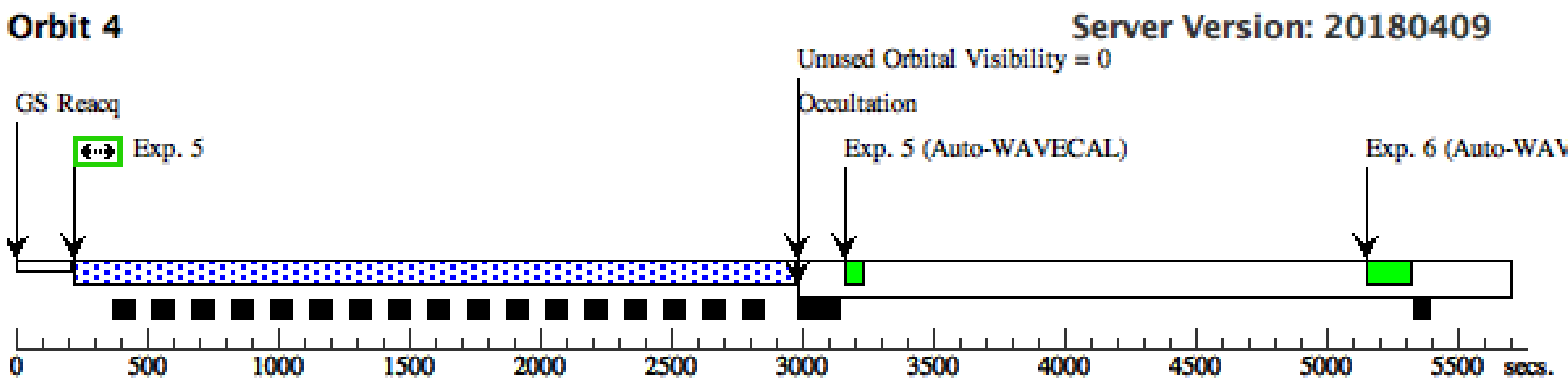
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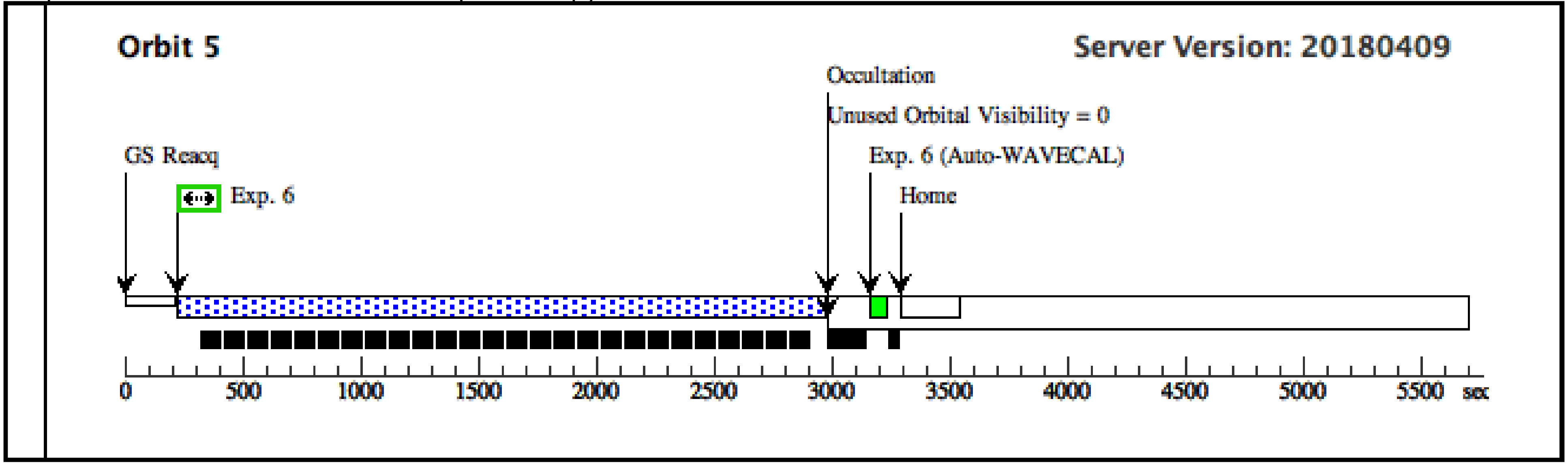
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Occultation
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Exp. 6
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500
1000
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2000
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sec

Proposal 15454 - Visit 02 - Ultraviolet Spectroscopy of the Black Hole Transient MAXI J1820+070

Visit

Proposal 15454, Visit 02, implementation — Fri Jun 15 02:00:32 GMT 2018

Diagnostic Status: Warning

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

Special Requirements: SCHED 100%

Diagnostics

(Visit 02) Warning (Orbit Planner): STIS TIME-TAG EXPOSURE GENERATES HEAVY DATA VOLUME

Fixed Targets

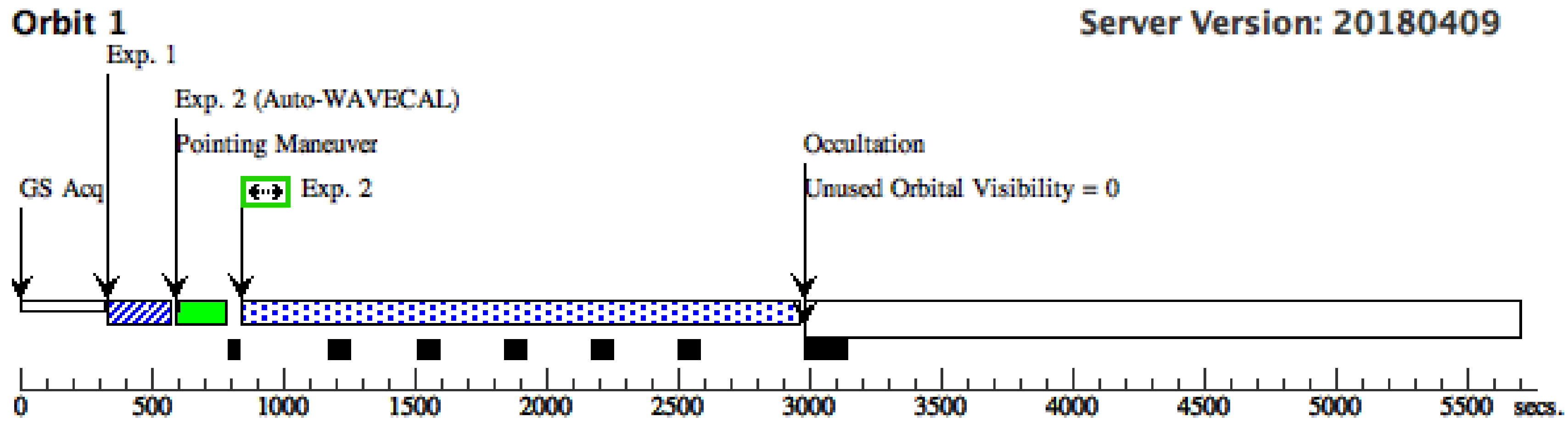
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	MAXI-J1820+070	RA: 18 20 21.9400 (275.0914167d) Dec: +07 11 7.24 (7.18534d) Equinox: J2000	Proper Motion RA: 0 mas/yr Proper Motion Dec: 0 mas/yr Epoch of Position: 2018	V=12	Reference Frame: ICRS

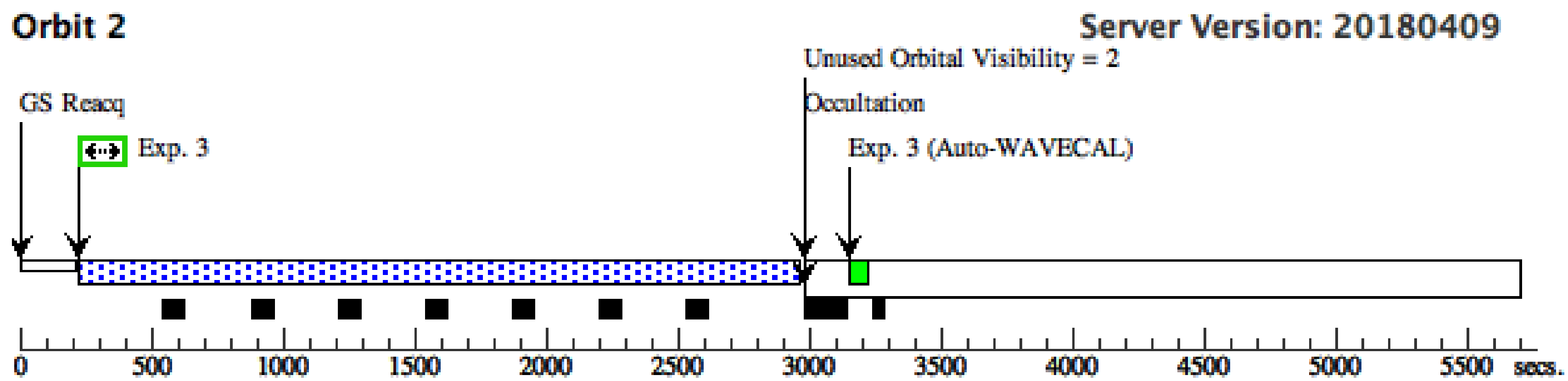
Comments:
Category=STAR
Description=[ACCRETION DISK, WIND, X-RAY NOVAE, X-RAY TRANSIENT]
Extended=NO

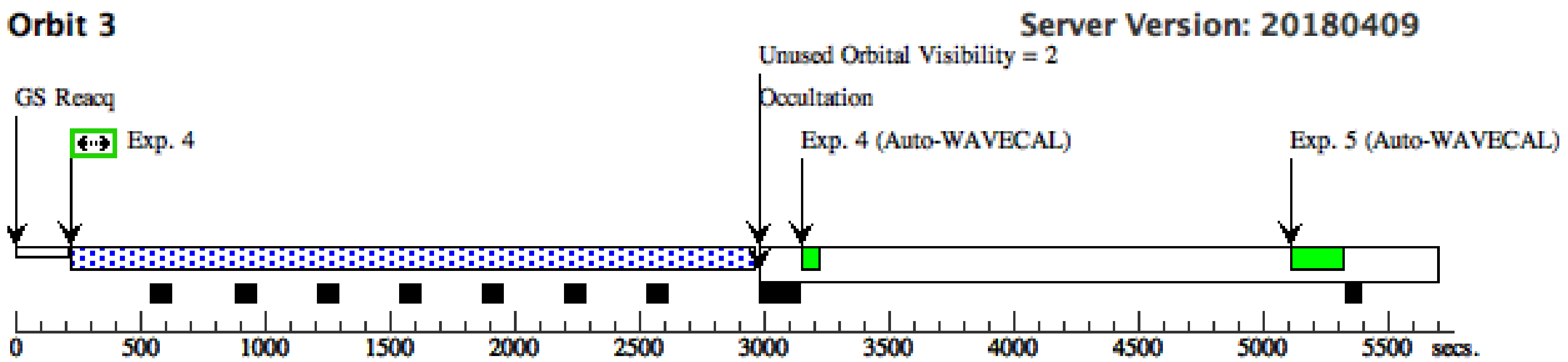
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) MAXI-J1820+070	STIS/CCD, ACQ, 50CCD	MIRROR				0.1 Secs (0.1 Secs) *[==>]*	***[1]***
2	UV-1 (STIS.sp.1168809)	(1) MAXI-J1820+070	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=330			3000 Secs (2105 Secs) *[==>2105.0 Secs]*	***[1]***
3	UV-1 (STIS.sp.1168809)	(1) MAXI-J1820+070	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=330			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[2]***
4	UV-1 (STIS.sp.1168809)	(1) MAXI-J1820+070	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=330			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[3]***
5	UV-1 (STIS.sp.1168819)	(1) MAXI-J1820+070	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=300			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[4]***
6	UV-1 (STIS.sp.1168819)	(1) MAXI-J1820+070	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=300			3000 Secs (2730 Secs) *[==>2730.0 Secs]*	***[5]***

Orbit Structure



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GS Reacq
Occultation
Exp. 4
Exp. 4 (Auto-WAVECAL)
Exp. 5 (Auto-WAVECAL)
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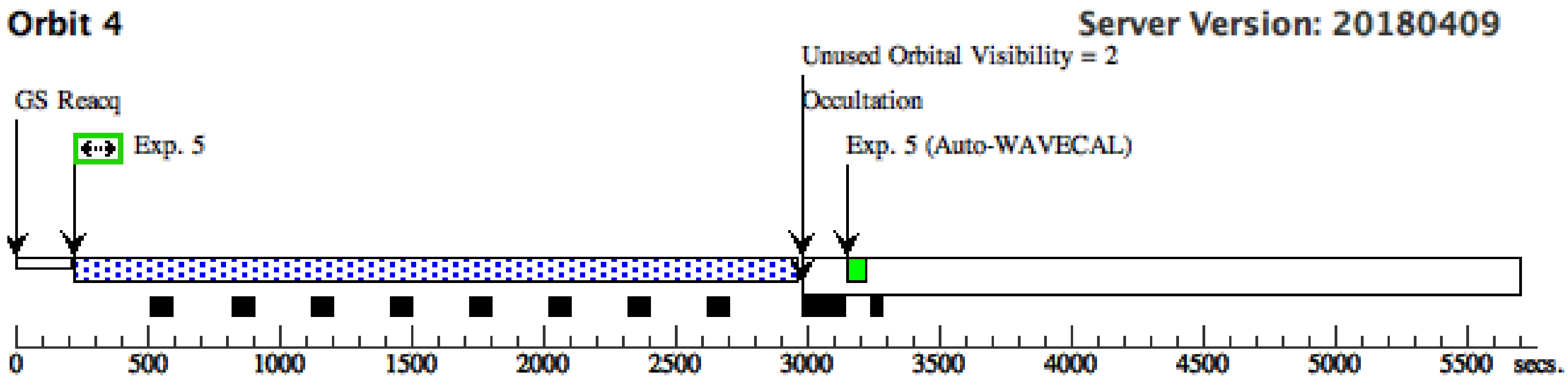
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Occultation
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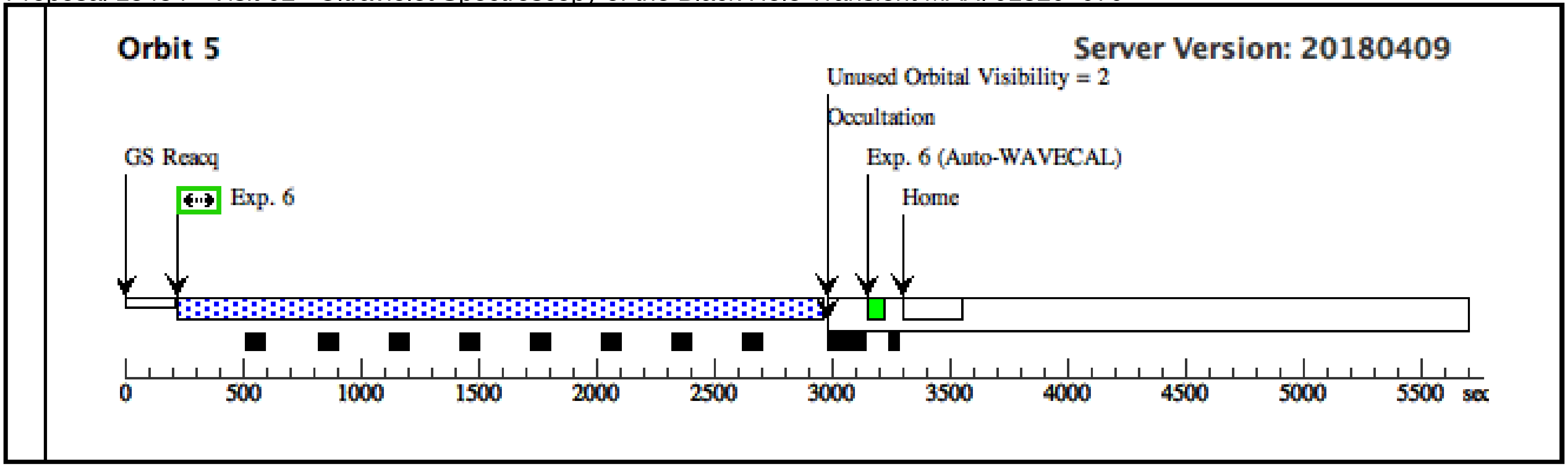
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Unused Orbital Visibility = 2
Occultation
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Exp. 6
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