14934 - Characterising the global accretion inflow variability for PSR J1023+0038

Cycle: 24, 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) PSR-J1023+0038	STIS/CCD STIS/NUV-MAMA	4	30-May-2017 21:01:33.0	yes

4 Total Orbits Used

ABSTRACT

PSR J1023+0038 is one of the first discovered transitional millisecond pulsars. These systems switch between a low-mass X-ray binary and a radio millisecond pulsar state and link these two source classes, in turn, confirming the pulsar recycling mechanism. Observation of PSR J1023+0038 and other tMSPs shown that this recycling occurs at luminosity levels usually considered as quiescent for other LMXBs. Hence, tMSPs also serve as unique avenues to test low level accretion onto neutron star surface, and interaction between accretion inflow and the pulsar magnetosphere. This low-level accretion regime has remained highly stable for the last 3.75 yr as evidenced by steady X-ray light curves characterised by `low' and `high' modes and rapid switches between the two. Recently, we have also seen similar moding behaviour at longer wavelengths including UV and optical. This is very intriguing as the X-ray moding originates in an inner accretion flow closer to the neutron star and constrained within the light cylinder. Whereas, UV variability is thought to emanate from colder, outer parts of the accretion disk. We request HST/NUV coverage to complement our XMM-Newton observation in order to search and characterise lags between and X-ray and UV emission. This simultaneity will allow us to probe two distinct regions of the system that seem to share a common variability. Ultimately we aim to understand what controls the accretion flow and state transitions in tMSPs.

OBSERVING DESCRIPTION

We aim to observe PSR J1023+0038 with HST in any one of the observation windows scheduled by XMM-Newton. This visit will consist of 4 consecutive HST orbits (spanning $\sim$ 22.8 ks) during which we will carry out time-resolved NUV TIME-TAG spectroscopy with the STIS/NUV-MAMA/G230L instrument/grating combination. We will use the 2376 \AA setting for all of these observations to achieve continuous wavelength coverage between 1570 \AA and 3180 \AA, with the 52 - 0.2 slit. The TIME-TAG mode of STIS will provide a maximum time resolution of 125 μs, fast enough to capture with great detail the mode changing (as shown in Fig. 2) as well as search for variability on the dynamical time-scale within the accretion disk and NS pulse period.

There are no safety concerns for the STIS detectors. In the NUV, our existing HST data as well as Swift/UVOT monitoring observations (taken in the current high state) show that the system is nowhere near bright enough to threaten detector damage. We will use an imaging target acquisition with Mirror B as the best compromise between efficiency and instrument safety. With this set-up, a 3s ACQ/IMAGE target acquisition exposure with the CCD and the 50 CCD aperture yields S/N $\sim$ 30, and the count rate in the brightest pixel never exceeds ~8 c/s, well below the bright object limit.

Coordinated Observations

Our observations require strict simultaneity between HST and XMM-Newton observatories. Our 24 ks XMM-Newton observations are scheduled for early June 2017. We have requested for these XMM-Newton observations with EPIC-MOS1/2 in small window mode and EPIC-pn in fast timing mode, using the thin filter. The existing EPIC-pn lightcurves shows that MSP is easily detectable even in the event of strong background flaring due to the high source count rate ($\sim$ 3 cnts s^{-1} on an average).

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Visit

Proposal 14934, Visit 01, implementation Wed May 31 01:01:34 GMT 2017

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 13-JUN-2017:13:39:30 AND 13-JUN-2017:20:19:30

Fixed Targets

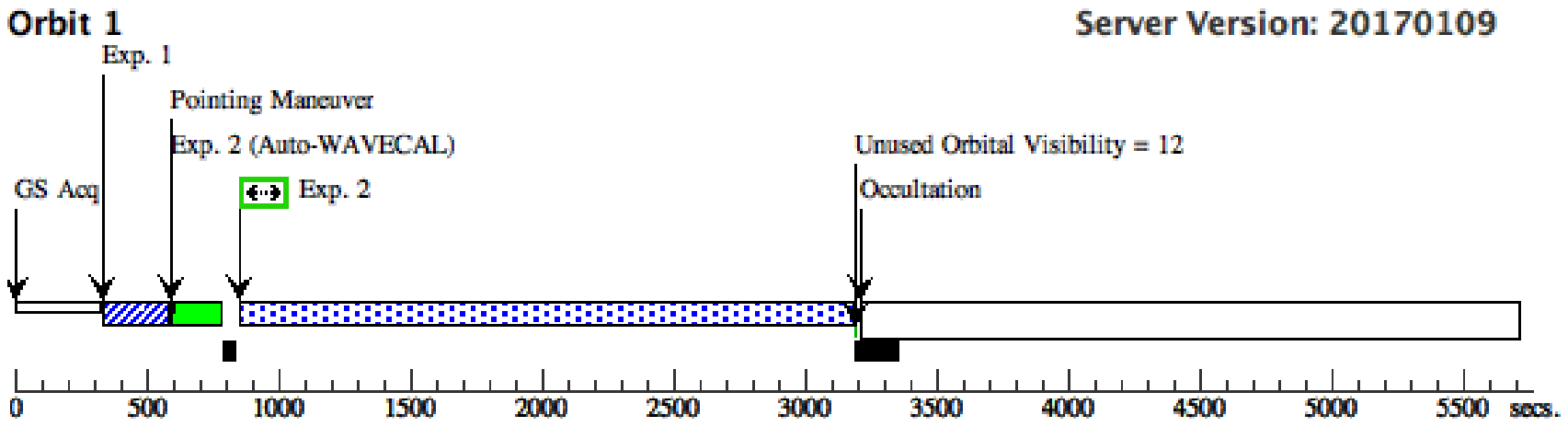
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	PSR-J1023+0038	RA: 10 23 47.6800 (155.9486667d) Dec: +00 38 41.30 (.64481d) Equinox: J2000		V=17.31+/-0.3 Swift/UVOT UVW2 = 18.1+/-0.5, UMW1=18.0+/-0.2 (errors are standard deviation due to variability)	Reference Frame: ICRS

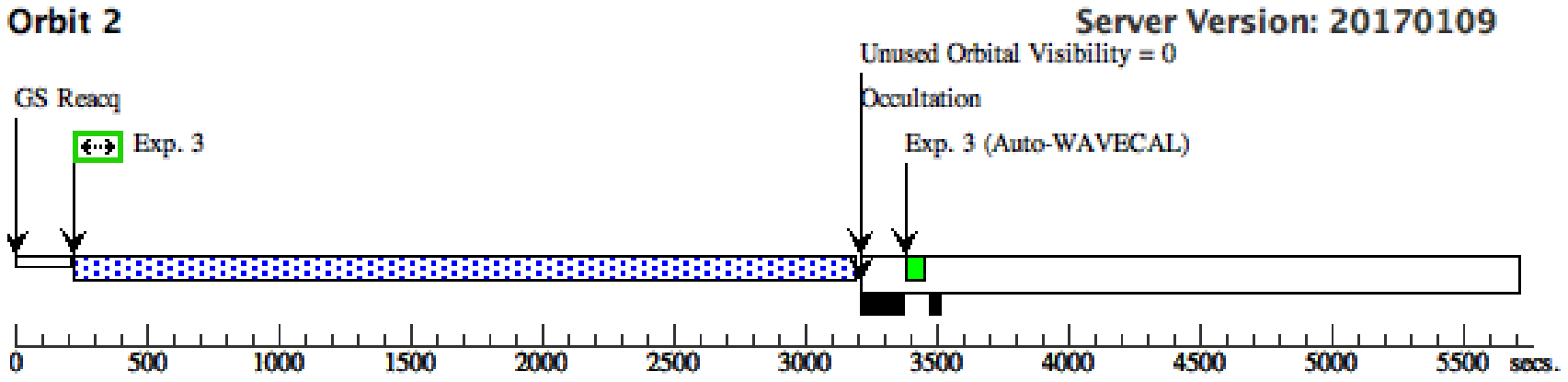
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

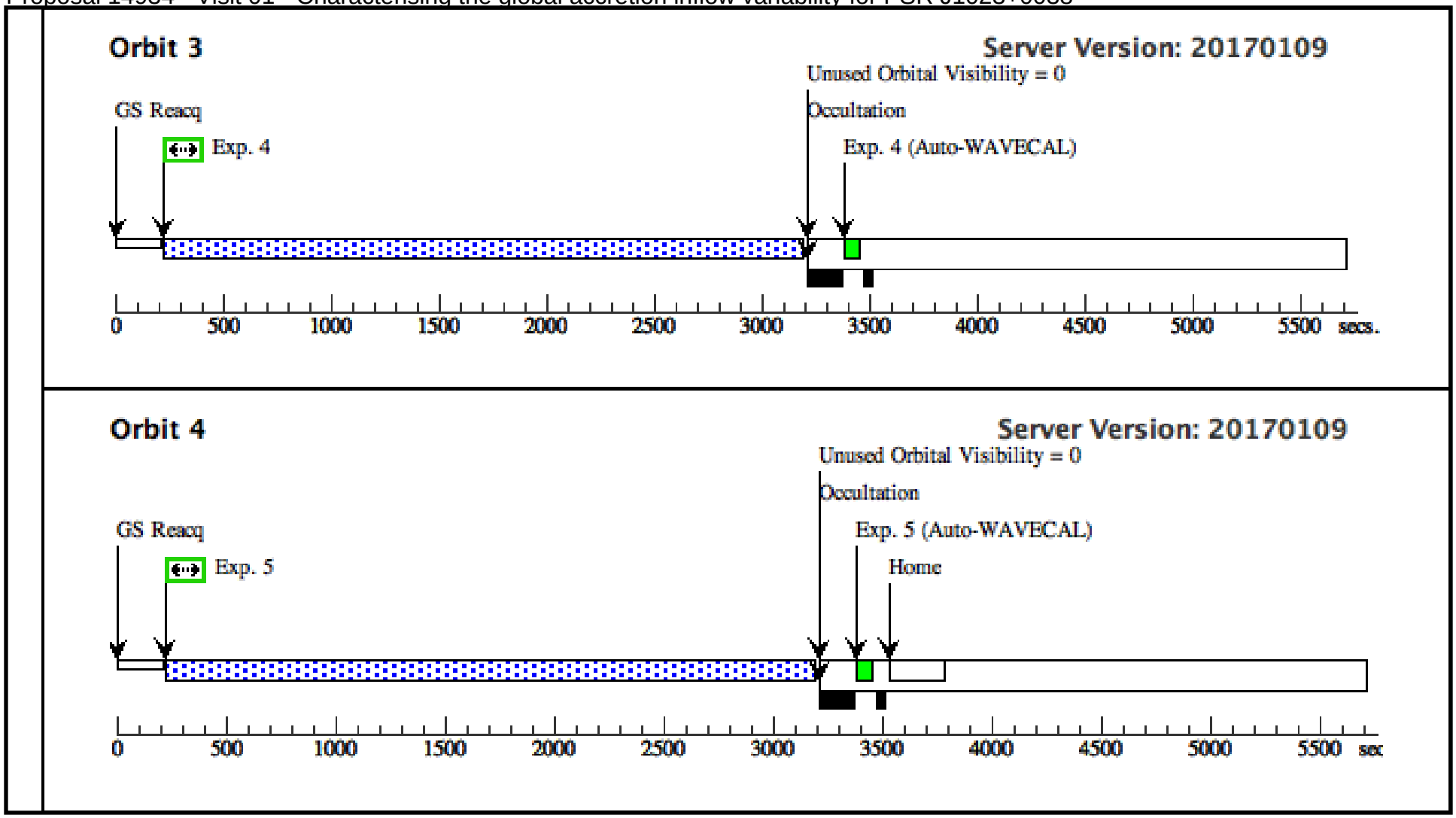
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.996078)	(1) PSR-J1023+0038	STIS/CCD, ACQ, 50CCD	MIRROR				1 Secs (1 Secs)	
								[==>]	***[1]***
2	(STIS.sp.994995)	(1) PSR-J1023+0038	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1500			2000 Secs (2317 Secs)	
								[==>2317.0 Secs]	***[1]***
3	(STIS.sp.994995)	(1) PSR-J1023+0038	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1500			2000 Secs (2960 Secs)	
								[==>2960.0 Secs]	***[2]***
4	(STIS.sp.994995)	(1) PSR-J1023+0038	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1500			2000 Secs (2960 Secs)	
								[==>2960.0 Secs]	***[3]***
5	(STIS.sp.994995)	(1) PSR-J1023+0038	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1500			2000 Secs (2960 Secs)	
								[==>2960.0 Secs]	***[4]***

Orbit Structure






Orbit 3
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GS Reacq
Occultation
Exp. 4
Exp. 4 (Auto-WAVECAL)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.
Orbit 4
Server Version: 20170109
Unused Orbital Visibility = 0
Occultation
GS Reacq
Exp. 5 (Auto-WAVECAL)
Exp. 5
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec