17532 - High-Velocity Cloud Complex M: Precise Constraints on the Conditions, Abundance Patterns and Dust Content, and the Physics of Circumgalactic Gas in the Disk-Halo Interface

Cycle: 31, Proposal Category: GO

(Availability Mode: AVAILABLE)

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) BD+38-2182 WAVE	STIS/CCD STIS/FUV-MAMA	2	07-Jun-2024 16:01:09.0	yes
02	(2) MRK-421	STIS/CCD STIS/FUV-MAMA	2	07-Jun-2024 16:01:10.0	yes
03	(2) MRK-421	STIS/CCD STIS/FUV-MAMA	2	07-Jun-2024 16:01:11.0	yes
04	(2) MRK-421	STIS/CCD STIS/FUV-MAMA	2	07-Jun-2024 16:01:11.0	yes

8 Total Orbits Used

ABSTRACT

The Milky Way high-velocity cloud (HVC) Complex M offers several advantages for investigation of gas physics in the disk-halo interface of the Galactic circumgalactic medium (CGM). First, there are three UV-bright objects that are in the direction of Complex M that are closely spaced in the sky: two stars (HD93521 and BD+38d2182) and an extragalactic AGN (MRK421) that constrain the location of the gas: absorption lines at the velocity of the HVC are not detected in the spectrum of the closest object (HD93521, Gaia distance = 1.2 kpc), but the HVC is detected in absorption toward the more distant star (BD+38d2182, Gaia distance = 3.8 kpc) and the extragalactic sightline. The targets are at high latitudes, so the gas is constrained to be at z-heights > 1.1 kpc. Second, the targets are extremely bright, so they can be observed with the highest-resolution STIS E140H grating with good S/N. Third, the close projected spacing constrains the transverse dimensions of the gas clouds. We propose to use new STIS E140H observations of BD+38d2182 and MRK421, combined with archival HD93521 spectra to study CGM gas physics in this important region. With these data we will: (1) constrain the dimensions and kinematics of the HVC, (2) constrain the line-broadening mechanism, (3) derive the physical conditions in the HVC as well as the lower-velocity IVCs, (4) constrain important gas-physics time scales, (5) study abundance and dust-depletion patterns, and (6) investigate the ionization and origin of the highly-ionized gas including non-equilibrium and interface models.

OBSERVING DESCRIPTION

The targets have been safely observed previously with COS or STIS, but not with the E140H mode that we require. These are very bright targets, which enables our use of the E140H grating. However, we have used the STIS exposure-time calculator to check whether the targets exceed the bright-object limits in this STIS mode, and we find that these objects can be safely observed without endangering the instrument. Our goal is to obtain STIS E140H spectra that are as good as those used by Tripp (2022) so that we can carry out a similar analysis, and we want to cover a wavelength range that includes the O I, N I, S II, C II, C II*, C IV, Si II, Si III, Si IV, and Ni II lines at the highest spectral resolution. To do this we will need to be able to detect individual components with equivalent widths as weak as 6 mA . For BD+38 2182, this is straightforward. Using the fluxes recorded in the archival STIS E140M observation of BD+38 2182, we find that a one-orbit observation with the E140H grating tilt at lambda(cen) = 1271 and a one-orbit observation with the grating tilt at lambda(cen) = 1453 A will provide this signal-to-noise per resolution element or better. For MRK421 we are faced with a more expensive program because this target is fainter. Therefore to achieve our goals while using the telescope as efficiently as possible, for MRK421 we will follow the procedure successfully employed by Tripp (2022): we will obtain one STIS E140H spectrum with good S/N that will provide a high-resolution template for the component structure of the low-ionization stages (based on O I, S II, and Si II) and a separate template for the higher ionization stages (based on Si IV). This STIS E140H spectrum will be obtained with the

lambda(cen) = 1343 A grating tilt so that all of these species are recorded at the highest spectral resolution. For the MRK421 E140H spectrum, we find that we require an exposure time of 9100 seconds for our weakest line, and we request 4 orbits for this observation including overheads. We will also obtain a STIS E140M observation of MRK421, which will add coverage of N I, Si III, C IV, Fe II, Al II, and several additional lines of Si II, Ni II, and C I. Again based on STIS ETC calculation for the addtional important lines, we request a 2-orbit observation of MRK421 with the E140M grating. To avoid possible problems arising from STIS focus issues (Proffit et al. 2017), we will use the 0.2$" \times 0.2"$ aperture for both the E140H and the E140M observations.

IMPACT OF REDUCED-GYRO OBSERVING: Based on the reports presented to the Space Telescope Users Committee, we expect that reduced-gyro observing would have only very minor impacts on this program. The increased target acquisition times would likely have negligible effect: the targets are very bright and the acq times are already very short, so increase of acquistion times by a ~2 minutes would have a very small impact on the final S/N of the spectra. The observations are: (1) not time-critical, (2) not coordinated with another observatory, and (3) not constrained to require certain orientations. The program does not require any of the special observing modes that would be impacted by reduced-gyro telescope operation. Therefore this study is a robust program for HST in any situation that requires <3 gyros.

Visit

Proposal 17532, BD38_visit1 (01), implementation Fri Jun 07 20:01:12 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

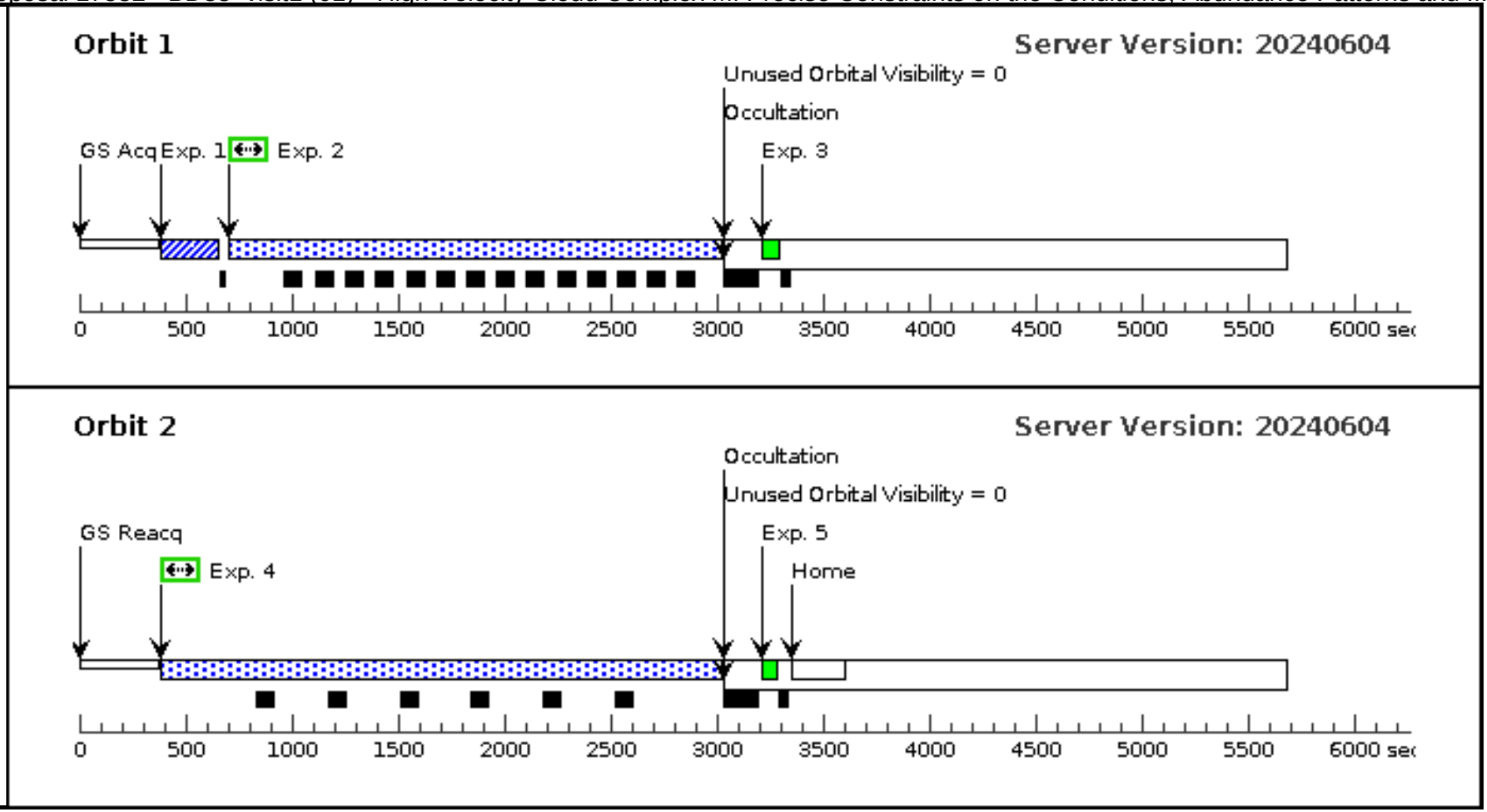
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BD+38-2182	RA: 10 49 12.9127 (162.3038029d) Dec: +38 00 14.85 (38.00413d) Equinox: J2000	Proper Motion RA: -4.1998409840398205E-4 sec of time/yr Proper Motion Dec: 0.0018700000000000001 arcsec/yr Epoch of Position: 2015.5	V=11.2+/-0.1 B-V=-0.18, Flambda(1254) = 3.8e-12, Flambda(1403) = 2.0e-12	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[B3-B5 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.188 8736)	(1) BD+38-2182	STIS/CCD, ACQ, F28X50OII	MIRROR	ACQTYPE=POINT			4.0 Secs (4 Secs)	
								[==>]	***[1]***
Comments: Target is very bright, so use the F28X50OII filter. With a Kurucz model for a B3V star and V = 11.19, the STIS acquisition ETC indicates that the time to saturation is 71 seconds with this filter, so there should be plenty of buffer between the exposure time and the saturation time.									
2	(STIS.sp.18 88745)	(1) BD+38-2182	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1271 A	BUFFER-TIME=142.0; WAVECAL=NO			2258.0 Secs (2181 Secs)	
								[==>2181.0 Secs]	***[1]***
3		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1271 A				30.0 Secs (30 Secs)	
								[==>]	***[1]***
4	(STIS.sp.18 88749)	(1) BD+38-2182	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1453 A	BUFFER-TIME=336.0			2636.0 Secs (2508 Secs)	
								[==>2508.0 Secs]	***[2]***
5		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1453 A				*[==>]*	***[2]***

Orbit Structure



Visit

Proposal 17532, MRK421_H_visit1 (02), implementation Fri Jun 07 20:01:12 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

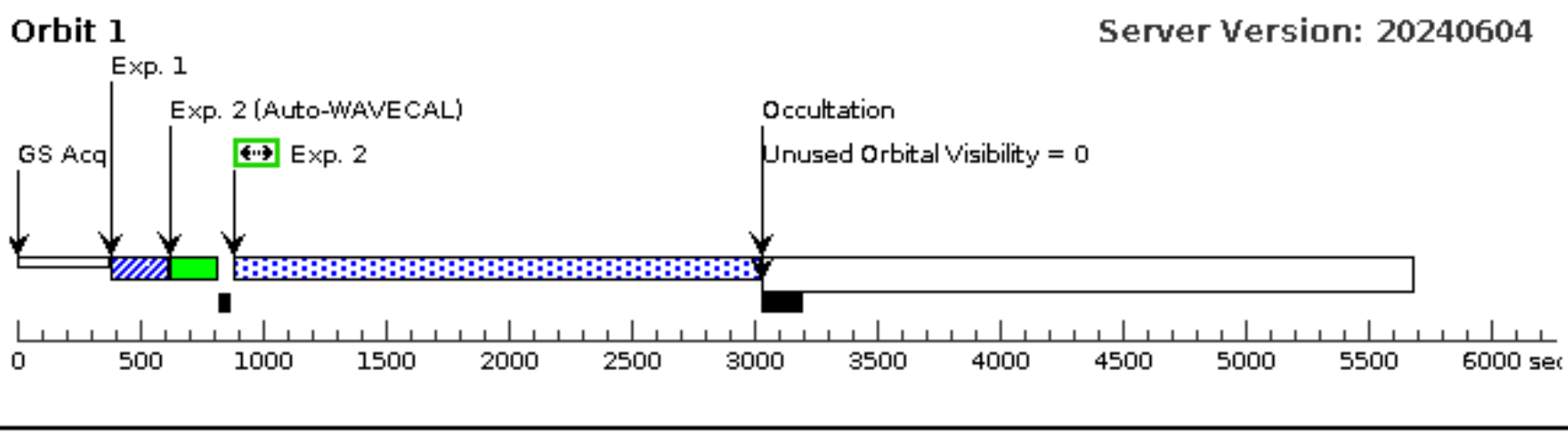
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	MRK-421	RA: 11 04 27.3141 (166.1138088d) Dec: +38 12 31.80 (38.20883d) Equinox: J2000	Proper Motion RA: -9.502458734744213E-6 sec of time/yr Proper Motion Dec: 3.9E-5 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.03	V=12.9+/-0.4 B = 13.5, Flambda(1254) = 2.0e-13, Flambda(1549) = 1.3e-13	Reference Frame: ICRS

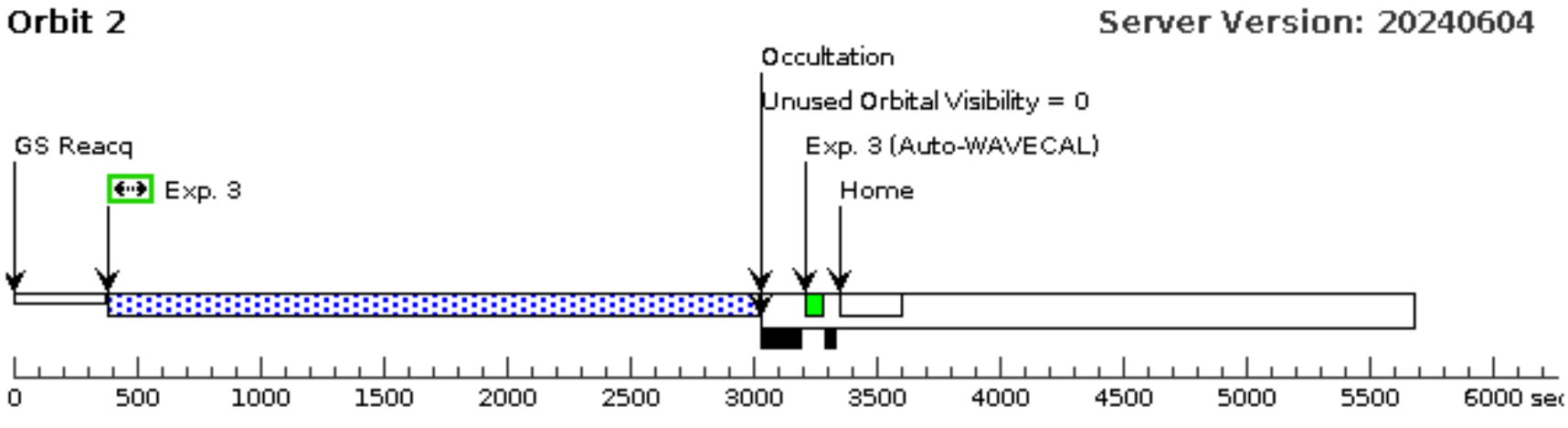
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[BL LAC]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1888805)	(2) MRK-421	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.2 Secs (0.2 Secs)	
								[==>]	***[1]***
Comments: MRK421 is somewhat variable. Used V = 13.3 (historical average) to calculate acquisition exposure time, but we also checked that the brightest magnitude observed (V = 12.87) would not saturate the CCD with this exposure time.									
2	(STIS.sp.1888806)	(2) MRK-421	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1343 A	BUFFER-TIME=2047.0			2205 Secs (2128 Secs)	
								[==>2128.0 Secs]	***[1]***
3	(STIS.sp.1888806)	(2) MRK-421	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1343 A	BUFFER-TIME=2047.0			2757 Secs (2629 Secs)	
								[==>2629.0 Secs]	***[2]***

Orbit Structure





Visit

Proposal 17532, MRK421_H_visit2 (03), implementation Fri Jun 07 20:01:12 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

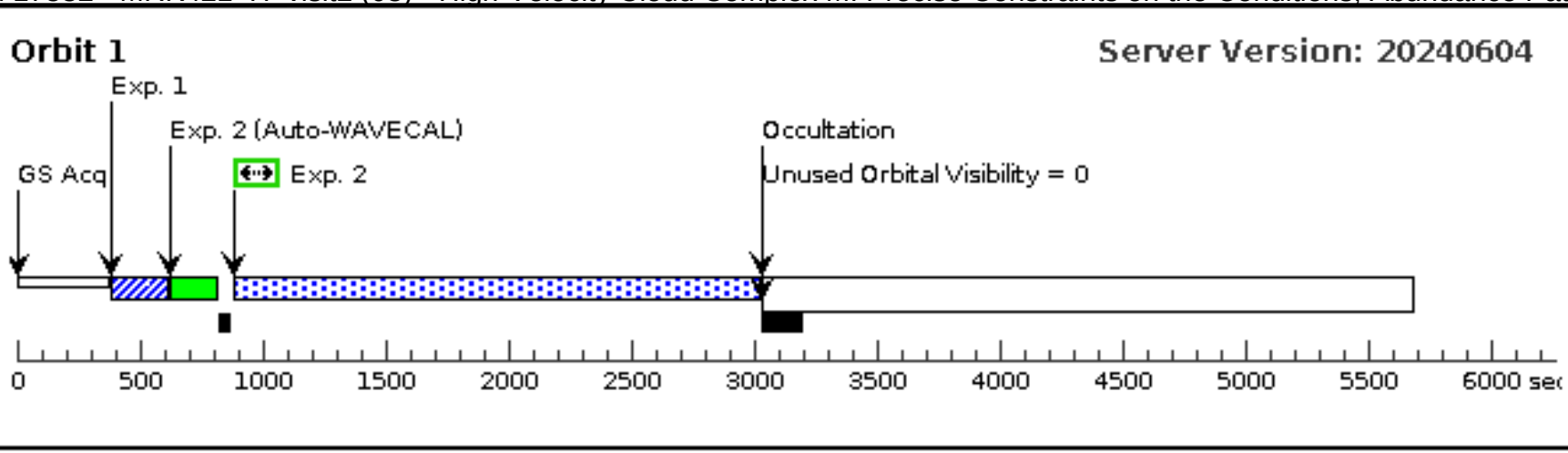
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	MRK-421	RA: 11 04 27.3141 (166.1138088d) Dec: +38 12 31.80 (38.20883d) Equinox: J2000	Proper Motion RA: -9.502458734744213E-6 sec of time/yr Proper Motion Dec: 3.9E-5 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.03	V=12.9+/-0.4 B = 13.5, Flambda(1254) = 2.0e-13, Flambda(1549) = 1.3e-13	Reference Frame: ICRS

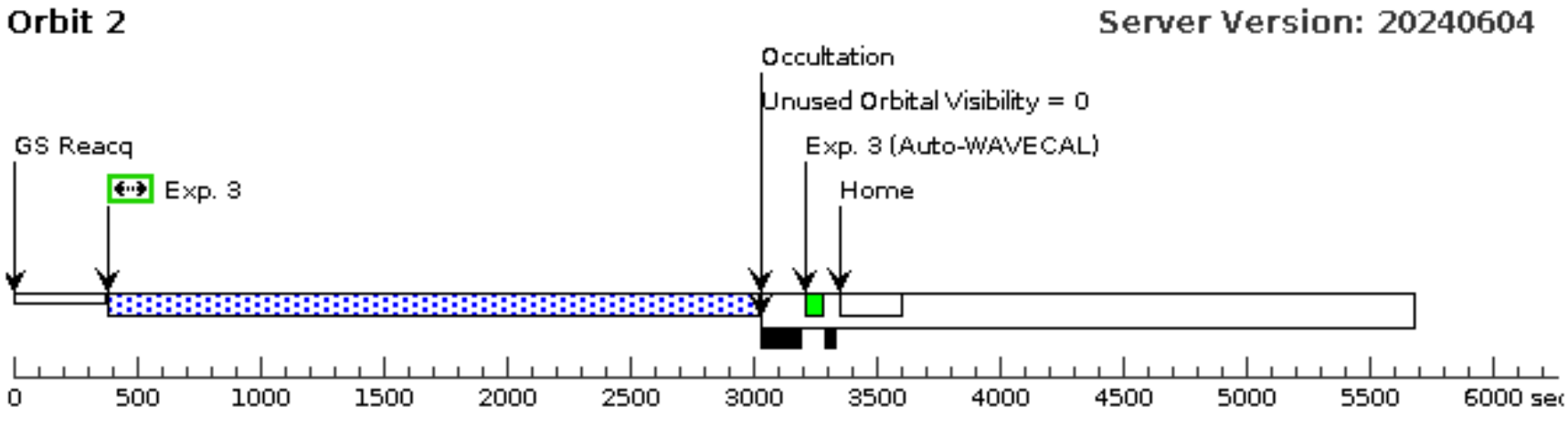
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[BL LAC]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1888805)	(2) MRK-421	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.2 Secs (0.2 Secs)	
								[==>]	***[1]***
Comments: MRK421 is somewhat variable. Used V = 13.3 (historical average) to calculate acquisition exposure time, but we also checked that the brightest magnitude observed (V = 12.87) would not saturate the CCD with this exposure time.									
2	(STIS.sp.1888806)	(2) MRK-421	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1343 A	BUFFER-TIME=2047.0			2205 Secs (2128 Secs)	
								[==>2128.0 Secs]	***[1]***
3	(STIS.sp.1888806)	(2) MRK-421	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1343 A	BUFFER-TIME=2047.0			2757 Secs (2629 Secs)	
								[==>2629.0 Secs]	***[2]***

Orbit Structure





Visit

Proposal 17532, MRK421_M_visit (04), implementation Fri Jun 07 20:01:12 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	MRK-421	RA: 11 04 27.3141 (166.1138088d) Dec: +38 12 31.80 (38.20883d) Equinox: J2000	Proper Motion RA: -9.502458734744213E-6 sec of time/yr Proper Motion Dec: 3.9E-5 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.03	V=12.9+/-0.4 B = 13.5, Flambda(1254) = 2.0e-13, Flambda(1549) = 1.3e-13	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[BL LAC]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1888805)	(2) MRK-421	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.2 Secs (0.2 Secs)	
								[==>]	***[1]***
Comments: MRK421 is somewhat variable. Used V = 13.3 (historical average) to calculate acquisition exposure time, but we also checked that the brightest magnitude observed (V = 12.87) would not saturate the CCD with this exposure time.									
2	(STIS.sp.1888808)	(2) MRK-421	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=1299.			2255 Secs (2178 Secs)	
								[==>2178.0 Secs]	***[1]***
3	(STIS.sp.1888808)	(2) MRK-421	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=1299.			2757 Secs (2629 Secs)	
								[==>2629.0 Secs]	***[2]***

Orbit Structure