



13460 - The Remarkable Ultraviolet Spectrum of Mrk 231

Cycle: 21, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) MRK-231	COS/FUV COS/NUV	6	30-Sep-2013 21:48:43.0	yes
02	(1) MRK-231	STIS/CCD STIS/NUV-MAMA	1	30-Sep-2013 21:49:05.0	yes

7 Total Orbits Used

ABSTRACT

In recent years, Mrk 231, the nearest quasar, has become the archetype of quasar feedback in action. A powerful galactic-scale wind with outflow velocity > 1000 km/sec and mass outflow rate > 400 Msun/yr has been discovered by members of our team in the optical as well as in the far-infrared (Herschel) and mm-wave (IRAM). This object was recently observed by our team with COS. The FUV spectrum of Mrk 231 is truly remarkable: Ly-alpha is in emission, faint, very broad (>10000 km/s), and highly blueshifted (-3500 km/sec). Equally remarkable are the absence of broad absorption

line (BAL) features and the slowly declining FUV continuum at shorter wavelengths. Both of these results are unexpected because Mrk 231 is a well-known FeLoBAL QSO and is very dusty. This suggests that the observed Ly-alpha emission is produced in the outflowing BAL cloud system, while the Balmer lines arise primarily from the standard broad emission line region (BELR) seen through the dusty ($A_V \sim 7$ mag.) broad absorption line region (BALR). At present, two simple geometries - spherical and disk - may explain these data. Better measurements over the full suite of BALs in the UV are needed to better constrain these geometric models and allow us to do a quantitative analysis of the ionization, total column density, and ultimately kinetic energy of the outflow seen in the visible. We request 7 orbits to observe Mrk 231 in the FUV with COS and in the NUV with STIS. This modest investment will help us understand arguably one of the most important objects in the local universe, and shed light on the long-standing issues of the BELR geometry (disk vs wind) and outflowing BALR structure and energetics.

OBSERVING DESCRIPTION

We requested and were allocated 7 orbits to observe one target, Mrk 231. This program is thus relatively straightforward. This target was observed by our group in Cycle 19 using COS/G130M. We now wish to revisit this object using COS/G140L (5 + 1 orbits) and STIS/G230L (1 orbit). The first 5 orbits of COS/G140L are centered at 1280 Å, while the other COS orbit is centered at 1105 Å to get redshifted Ly-alpha region (which is in the gap at 1280 Å). The STIS orbit will cover the NUV range.

In the first COS orbit, we use ACQ/IMAGE to obtain a NUV image of this target. Next we use ACQ/PEAKXD and ACQ/PEAKD to center the target within the COS aperture. For STIS, we use Config = STIS/CCD, Mode = ACQ, Spectral Element = MIRROR to do the centering on the 0.2 x 50" slit. We use F28X50OII to center on the blue part of the spectrum, rather than the green or red, and thus minimize possible (but unlikely for this QSO) centroid shifts between the NUV and optical positions. The exposure time for the STIS target acquisition is based on $f_{\lambda}(3900 \text{ Å}) = 1e-14 \text{ erg/s/cm/cm/cm/Å}$ measured from our own ground-based spectrum (Veilleux et al. 2013, ApJ, 764, 15)

All of the COS observations are done in TIME-TAG mode. This temporal sampling will allow us to exclude poor quality data and get improved thermal correction and background removal. Our target exposures are split into four segments of 415 seconds (first orbit) or 665 seconds using FP_POS = ALL. This observing strategy is adopted to reduce the fixed pattern noise. In all cases, the requested exposure time of these four segments / orbit is shorter than 2/3 of the real buffer time derived from ETC, so we set buffer-time = 415 or 665 seconds. The STIS exposures are also split into four segments of equal length (473 seconds to take maximum use of the visibility).

Proposal 13460 - Visit 01 - The Remarkable Ultraviolet Spectrum of Mrk 231

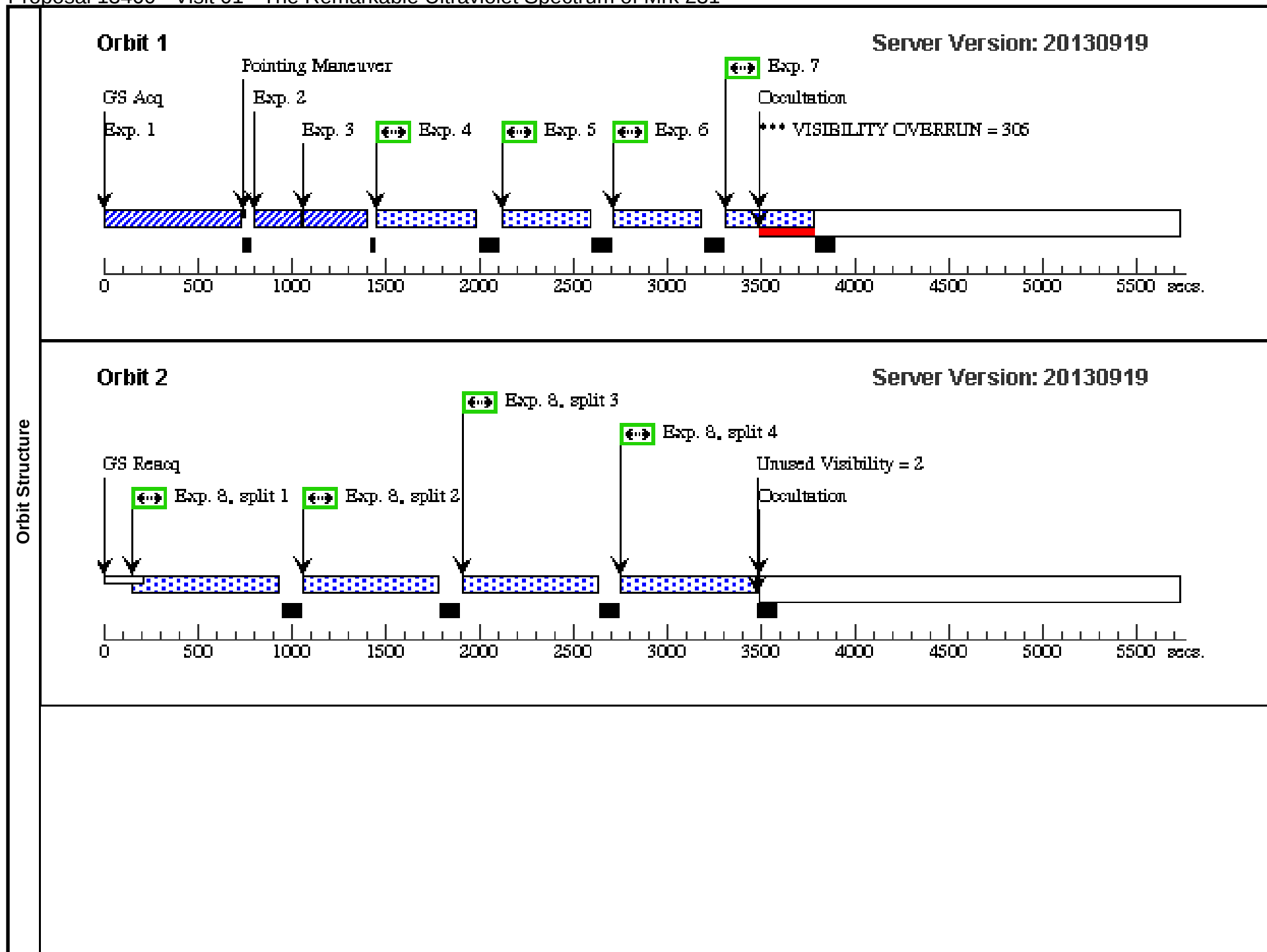
Visit	Proposal 13460, Visit 01, implementation Tue Oct 01 01:49:13 GMT 2013				
	Diagnostic Status: Warning Scientific Instruments: COS/NUV, COS/FUV Special Requirements: (none)				
Diagnostics	(Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS (Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS (Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS (Visit 01) Warning (Orbit Planner): VISIBILITY OVERRUN (Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(1)	MRK-231	RA: 12 56 14.1110 (194.0587958d) Dec: +56 52 24.70 (56.87353d) Equinox: J2000	Redshift: 0.0422	V=13.84 1.5E-15 erg/s/cm/cm at 1310 A (measured from our Cycle 19 CO S data)
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					

Proposal 13460 - Visit 01 - The Remarkable Ultraviolet Spectrum of Mrk 231

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(cos.im.510406)	(1) MRK-231	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				150 Secs (150 Secs)	
									[==>]	[1]
	2	(cos.sa.510431)	(1) MRK-231	COS/FUV, ACQ/PEAKXD, PSA	G140L 1280 A	SEGMENT=BOTH			39 Secs (39 Secs)	
									[==>]	[1]
	3	(cos.sa.510431)	(1) MRK-231	COS/FUV, ACQ/PEAKD, PSA	G140L 1280 A	CENTER=DEF; NUM-POS=5; STEP-SIZE=0.9			39 Secs (39 Secs)	
									[==>]	[1]
	4	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=41 5; FLASH=YES; FP-POS=1			415 Secs (415 Secs)	
									[==>]	[1]
	5	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=41 5; FLASH=YES; FP-POS=2			415 Secs (415 Secs)	
									[==>]	[1]
	6	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=41 5; FLASH=YES; FP-POS=3			415 Secs (415 Secs)	
									[==>]	[1]
	7	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=41 5; FLASH=YES; FP-POS=4			415 Secs (415 Secs)	
									[==>]	[1]
	8	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=66 5; FLASH=YES; FP-POS=ALL			665 Secs (2660 Secs)	
									[==>(Split 1)]	[2]
									[==>(Split 2)]	
									[==>(Split 3)]	
									[==>(Split 4)]	
	9	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=66 5; FLASH=YES; FP-POS=ALL			665 Secs (2660 Secs)	
									[==>(Split 1)]	[3]
									[==>(Split 2)]	
									[==>(Split 3)]	
									[==>(Split 4)]	
	10	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=66 5; FLASH=YES; FP-POS=ALL			665 Secs (2660 Secs)	
									[==>(Split 1)]	[4]
									[==>(Split 2)]	
									[==>(Split 3)]	
									[==>(Split 4)]	
	11	(cos.sp.510392)	(1) MRK-231	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=66 5; FLASH=YES; FP-POS=ALL			665 Secs (2660 Secs)	
									[==>(Split 1)]	[5]
									[==>(Split 2)]	
									[==>(Split 3)]	
									[==>(Split 4)]	

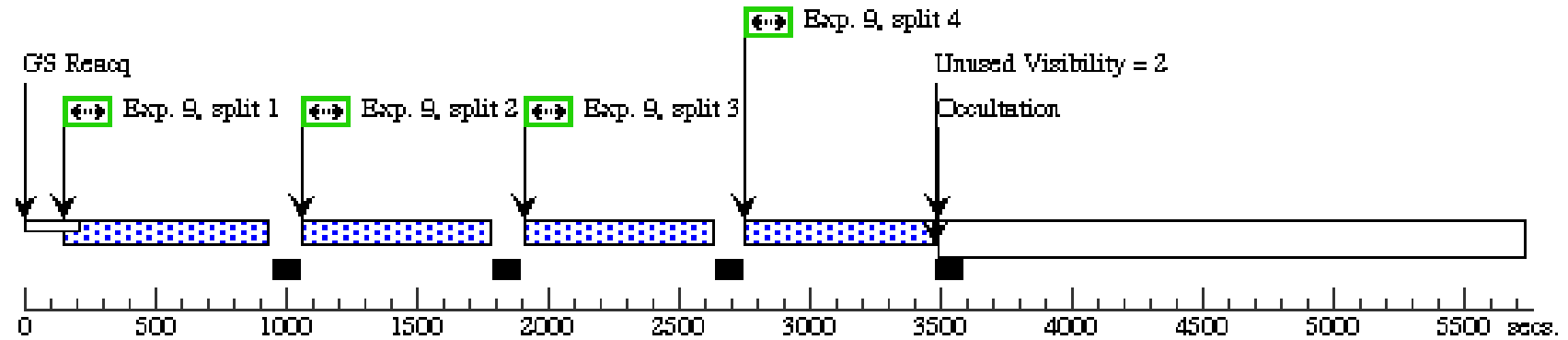
Proposal 13460 - Visit 01 - The Remarkable Ultraviolet Spectrum of Mrk 231

	12	(cos.sp.5103 (1) MRK-231 93)	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=66 5; FLASH=YES; FP-POS=ALL	665 Secs (2660 Secs)	[6]
						[==>(Split 1)]	
						[==>(Split 2)]	
						[==>(Split 3)]	
						[==>(Split 4)]	



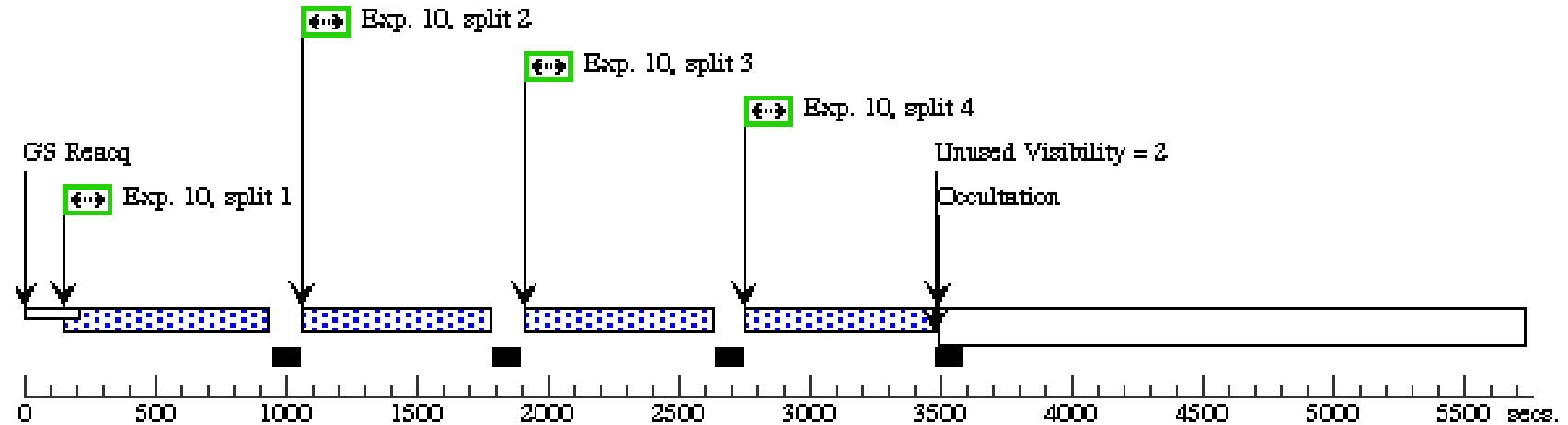
Orbit 3

Server Version: 20130919



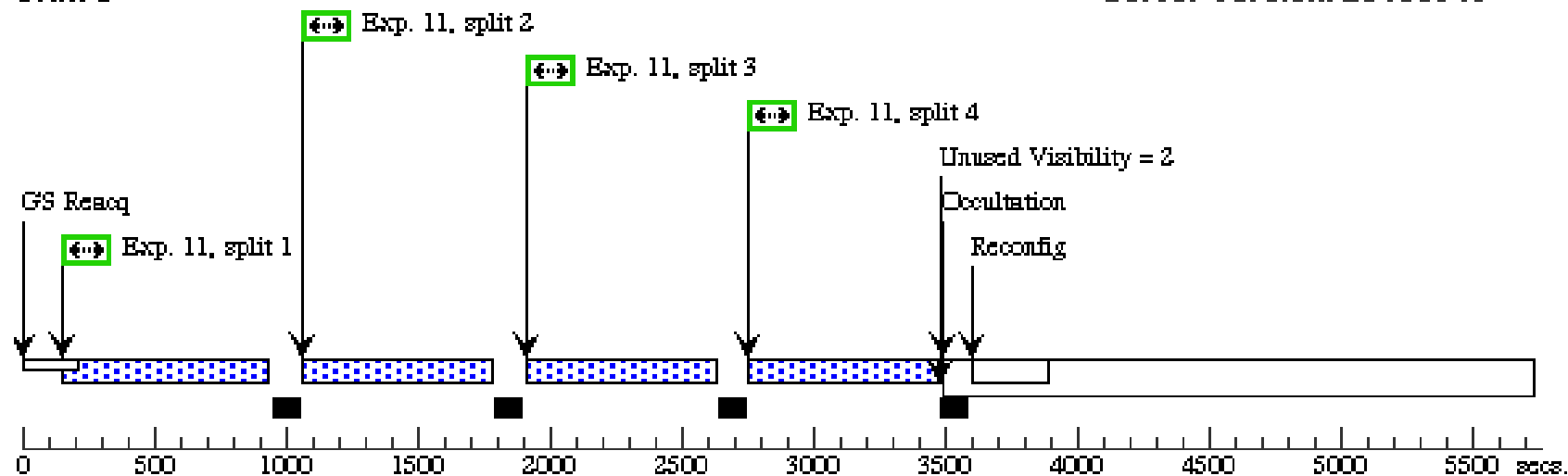
Orbit 4

Server Version: 20130919



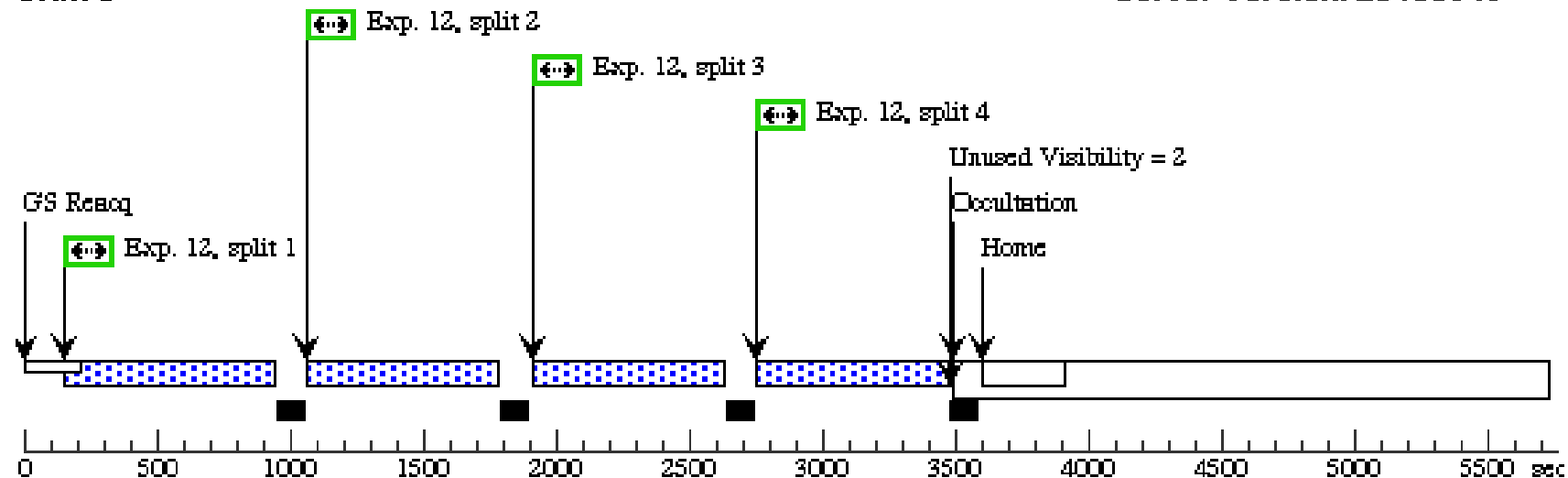
Orbit 5

Server Version: 20130919



Orbit 6

Server Version: 20130919



Proposal 13460 - Visit 02 - The Remarkable Ultraviolet Spectrum of Mrk 231

Visit	Proposal 13460, Visit 02, implementation										Tue Oct 01 01:49:18 GMT 2013
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: STIS/CCD, STIS/NUV-MAMA										
	Special Requirements: (none)										
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(1)	MRK-231	RA: 12 56 14.1110 (194.0587958d) Dec: +56 52 24.70 (56.87353d) Equinox: J2000		Redshift: 0.0422		V=13.84 1.5E-15 erg/s/cm/cm at 1310 A (measured from our Cycle 19 CO S data)		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.513 502)	(1) MRK-231	STIS/CCD, ACQ, F28X500II	MIRROR	ACQTYPE=POINT			22 Secs (22 Secs)		
									[==>]		[1]
	Comments: Exposure time was estimated using $f_{\lambda}(3900\text{ A}) = 1e-14\text{ erg/s/cm/cm/A}$ measured from our own ground-based spectrum (Veilleux et al. 2013, ApJ, 764, 15)										
	2	(stis.sp.5103 95)	(1) MRK-231	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=47 3			473 Secs (473 Secs)		
									[==>]		[1]
	3	(stis.sp.5103 95)	(1) MRK-231	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=47 3			473 Secs (473 Secs)		
									[==>]		[1]
	4	(stis.sp.5103 95)	(1) MRK-231	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=47 3			473 Secs (473 Secs)		
									[==>]		[1]
5	(stis.sp.5103 95)	(1) MRK-231	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=47 3			473 Secs (473 Secs)			
								[==>]		[1]	
Orbit Structure	Orbit 1										
	Server Version: 20130919										