



13714 - Tracing Hot Plasma in the RY Tau Jet

Cycle: 22, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Stephen L. Skinner (PI) (Contact)	University of Colorado at Boulder	stephen.skinner@colorado.edu
Dr. Marc Audard (CoI) (ESA Member)	Observatoire de Geneve	marc.audard@unige.ch
Prof. Manuel Guedel (CoI) (ESA Member)	University of Vienna	manuel.guedel@univie.ac.at
Dr. Peter Christian Schneider (CoI) (ESA Member)	Universitat Hamburg, Hamburger Sternwarte	cschneider@hs.uni-hamburg.de

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) RYTAU	STIS/CCD STIS/FUV-MAMA	5	08-Sep-2014 21:07:12.0	yes
02	(1) RYTAU	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	3	08-Sep-2014 21:07:15.0	yes

8 Total Orbits Used

ABSTRACT

The accreting T Tauri star RY Tau drives a spectacular bipolar jet whose blueshifted component is traced optically at separations of 1.3" - 30" from the star. Optical studies probe cool jet plasma ($T \sim 1e4$ K) but evidence for much hotter plasma ($T \sim 1e5 - 1e6$ K)

is seen in UV spectral lines and Chandra X-ray images. We propose to obtain STIS UV spectra of RY Tau with the slit aligned along the jet. HST's high spatial resolution and UV spectral line diagnostics will determine the spatial extent and properties of the hot plasma in the inner jet and will test jet-heating models. Only HST provides the capabilities needed to study conditions in the hot dense plasma in the physically important inner jet where launching and collimation occur.

OBSERVING DESCRIPTION

Observations: We will obtain 1st-order STIS/MAMA UV grating spectra of the RY Tau jet with the 52" x 0.2" slit, which is well-matched to the jet dimensions. The brightest knots lie within 15" of the star (Fig. 1) and the jet width is FWHM = 0.2" - 0.3" (AA09). We request G140L (2 orbits), G140M (5 orbits), and G230L (1 orbit) gratings. G140L and G230L will provide complete spectral coverage of the FUV and NUV including several important emission lines as specified below. The higher spectral resolution of G140M (1523 - 1577 Ang.) will fully resolve the C IV doublet at 1548.2/1550.7 Ang. G140M will provide accurate measurements of jet velocity (resolution $\Delta V = 25 \text{ km s}^{-1}$) and will allow any weak contribution from fluorescent H2 lines to be discerned (Fig. 6). STIS is clearly preferred over COS since STIS provides spatially-resolved spectra along the jet.

Stellar Parameters: RY Tau is a F8-G1 TTS with $T_{\text{eff}} = 5945 \text{ K}$ (C04) and variable $V = 10.3 \pm 0.9 \text{ mag}$. The most recent AAVSO photometry in April 2014 give a range $V = 10.5 - 11$. Target MAMA brightness limits are not exceeded. The extinction toward the disked star is $A_V = 2.2 \pm 0.2 \text{ mag}$ (C04) but may well be lower toward the jet offset from the star. No companion has yet been found (e.g. Leinert et al. 1993; Pott et al. 2010). Observed (absorbed) UV continuum flux densities are $F_{\text{cont}}(1760 \text{ Ang.}) = 1.9\text{e-}15$ and $F_{\text{cont}}(1958 \text{ Ang.}) = 2.07\text{e-}15 \text{ ergs cm}^{-2} \text{ s}^{-1} \text{ Ang.}^{-1}$ (Valenti et al. 2000 [V00]; C04).

Previous STIS G140L/230L observations with the slit nearly perpendicular to the jet (Fig. 5; C04) give observed (absorbed) line fluxes in units of 10^{-14} ergs cm^{-2} s^{-1} : C IV = 5.93; Si III] = 7.70; C III] = 5.37. ETC predicts S/N = 35 - 50 for G140L/230L in these lines.

Sensitivity: Allowing for overheads (Sec. 6.4 of the Primer), we estimate usable exposures of 13080 s (G140M), 4800 s (G140L), and 2040 s (G230L). Our requested exposures (orbits) are driven by the need to obtain adequate sensitivity and SNR in faint emission lines for flux measurement and line analysis. As a benchmark, we use the C IV flux detected in the DG Tau jet during a 14 ksec STIS G140M slit observation (S13). The observed (absorbed) jet flux is $F_{1548+1551} = 2.0 \times 10^{-14}$ erg cm^{-2} s^{-1} at offsets of 0.15" - 0.3" from the star, of which 2/3 comes from the 1548 Ang. line (Fig. 6-left). Continuum emission in the jet is expected to be very low (Fig. 6-left). Assuming a similar C IV flux for RY Tau's jet, the ETC predicts SNR = 10 in C IV for G140M (Fig. 6-right) and SNR = 30 for G140L. G140L will reach a line detection threshold (SNR = 10) at C IV for absorbed line fluxes 10 times lower than that measured for DG Tau's jet. For G230L, ETC predicts an absorbed line flux detection threshold of $F_{\text{line}} (3.0-3.6) \times 10^{-15}$ erg cm^{-2} s^{-1} for Si III] (1892 Ang.) and C III] (1909 Ang.), more than an order of magnitude fainter than the stellar line fluxes.

UV Line Diagnostics: The most important spectral lines for diagnosing physical conditions in the jet will be the C IV doublet at 1548/1551 (G140L, G140M) and the optically thin Si III] 1892 and C III] 1909 lines (G230L). The C IV line traces hotter plasma. The flux ratio of the Si III] and C III] lines provides density information and can diagnose higher densities ($n_e = 10^{10} \text{ cm}^{-3}$) that are present in shock regions near the star (Lamzin 2000b; GV07). Other useful G140L lines are: Si IV 1394/1403, He II 1640 (tracers of intermediate-T plasma), C III 1176 and Si III 1206 (densities; C04).

Special Requirements

Since our primary goal is to study emission from the jet, we require that the 52" x 0.2" slit be oriented along the jet axis, so PA APER = 114 deg. or PA APER = 294 deg. is requested. These

Proposal 13714 (STScI Edit Number: 1, Created: Monday, September 8, 2014 8:07:17 PM EST) - Overview

values correspond to ORIENT = 159.35 deg. and ORIENT = 339.35 deg.. The Visit Planner shows that the observations are schedulable in Cycle 22 at ORIENT = 159.35 deg. The first available window occurs from 28 Nov. - 6 Dec. 2014 and a second window on similar dates in 2015.

Proposal 13714 - RY Tau G140M (01) - Tracing Hot Plasma in the RY Tau Jet

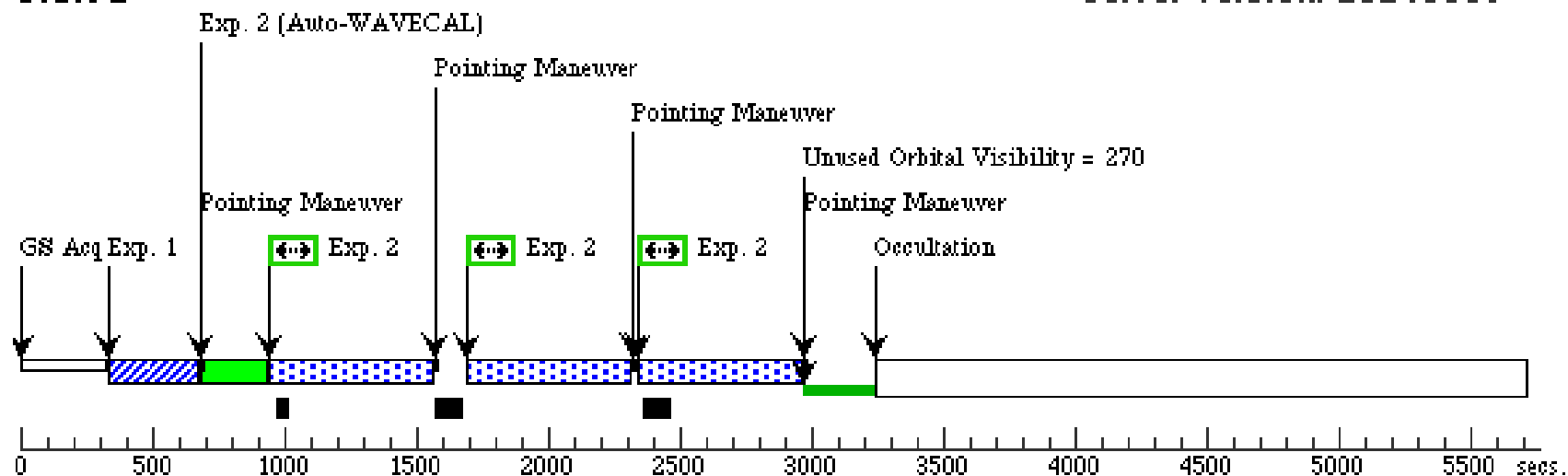
Visit	Proposal 13714, RY Tau G140M (01), implementation			Tue Sep 09 01:07:17 GMT 2014		
	Diagnostic Status: No Diagnostics					
	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA					
	Special Requirements: SCHED 30%; ORIENT 157.8D TO 160.9 D; ORIENT 337.8D TO 340.9 D; GROUP 01,02 WITHIN 30D					
	Comments: Visit schedulability is very sensitive to science target exposure times. Exposure times have been set to allow scheduling in either Nov. 2014 or Nov. 2015. Ref. Email discussion between S. Skinner and Miranda Link on 7-14-2014.					
Patterns	#	Primary Pattern	Secondary Pattern	Exposures		
	(1)	Pattern Type=STIS-ALONG-SLIT Purpose=DITHER Number Of Points=3 Point Spacing=0.275 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=90.0 Angle Between Sides= Center Pattern=false		(2), (3), (4), (5), (6)		
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	RYTAU	RA: 04 21 57.4100 (65.4892083d) Dec: +28 26 35.57 (28.44321d) Equinox: J2000 Comments: Variable star. AAVSO gives V magnitudes in range V = 9.6 - 11.2 from April 2013 - April 2014. During the same period, B ranged from B = 10.75 - 12.1. Most recent AAVSO values in April 2014 are V = 10.8 +- 0.2 and B = 11.8 +- 0.2. During the period 1983 - 2004 the range was V = 9.3 - 11.6 (Ref. Ismailov & Adygezalade 2012). Colors are: U-B = +0.48, B-V = +1.03 (Herbig and Bell catalog). U-B = +0.49, B-V = +1.11 (Schegerer et al. 2008). Field star search: A search of GSCv2.3.2 with the HEASARC Browse utility using a circular search region of radius 30 arcsecs centered on RY Tau returns only one object: RY Tau. A search of the USNO B1 catalog using the same search region returns 7 objects of which RY Tau is the brightest (B1 = 11.34) and the second brightest is USNO 1184-0061103 (B1 = 16.69, offset 16.6 arcsec from RY Tau).		V=10.3+/-1.0	Reference Frame: ICRS

Proposal 13714 - RY Tau G140M (01) - Tracing Hot Plasma in the RY Tau Jet

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(STIS.ta.620 918)	(1) RYTAU	STIS/CCD, ACQ, F28X50OII	MIRROR				20. Secs (20 Secs)	
									[==>]	[1]
	2	(STIS.sp.62 1510)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1550 A			Pattern 1, Exps 2-2 i n RY Tau G140M (0 1) (1)	600 Secs (1800 Secs)	
									[==>(Pattern 1)]	
									[==>(Pattern 2)]	[1]
									[==>(Pattern 3)]	
	3	(STIS.sp.62 1548)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1550 A			Pattern 1, Exps 3-3 i n RY Tau G140M (0 1) (1)	815 Secs (2445 Secs)	
									[==>(Pattern 1)]	
									[==>(Pattern 2)]	[2]
									[==>(Pattern 3)]	
	4	(STIS.sp.62 1549)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1550 A			Pattern 1, Exps 4-4 i n RY Tau G140M (0 1) (1)	815 Secs (2445 Secs)	
									[==>(Pattern 1)]	
									[==>(Pattern 2)]	[3]
									[==>(Pattern 3)]	
	5	(STIS.sp.62 1549)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1550 A			Pattern 1, Exps 5-5 i n RY Tau G140M (0 1) (1)	815 Secs (2445 Secs)	
									[==>(Pattern 1)]	
									[==>(Pattern 2)]	[4]
									[==>(Pattern 3)]	
	6	(STIS.sp.62 1549)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2	G140M 1550 A			Pattern 1, Exps 6-6 i n RY Tau G140M (0 1) (1)	815 Secs (2445 Secs)	
									[==>(Pattern 1)]	
									[==>(Pattern 2)]	[5]
									[==>(Pattern 3)]	

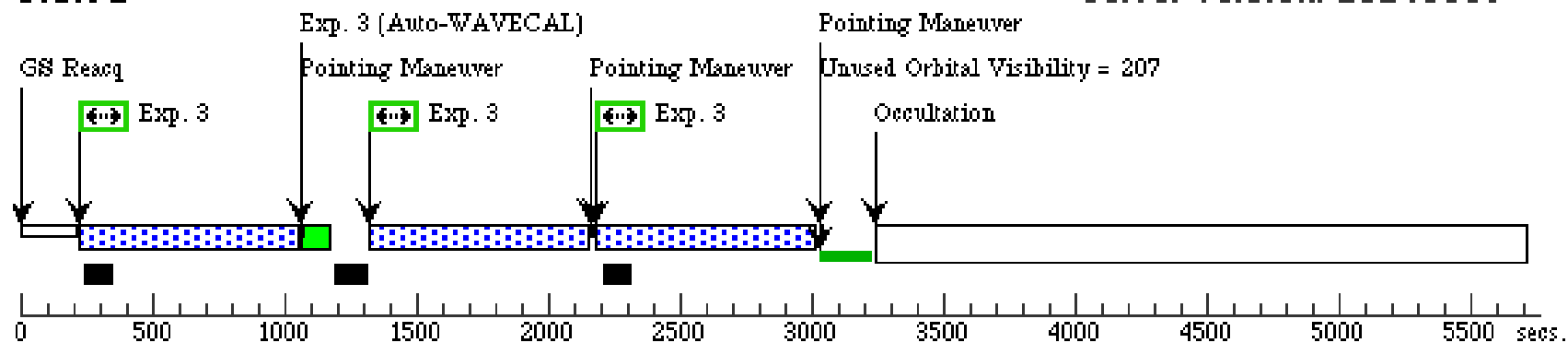
Orbit 1

Server Version: 20140605



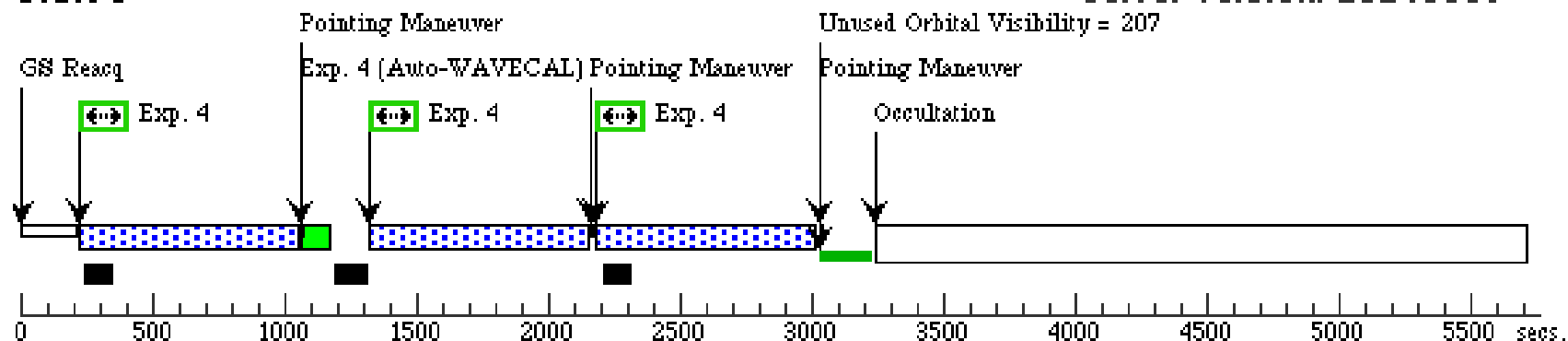
Orbit 2

Server Version: 20140605



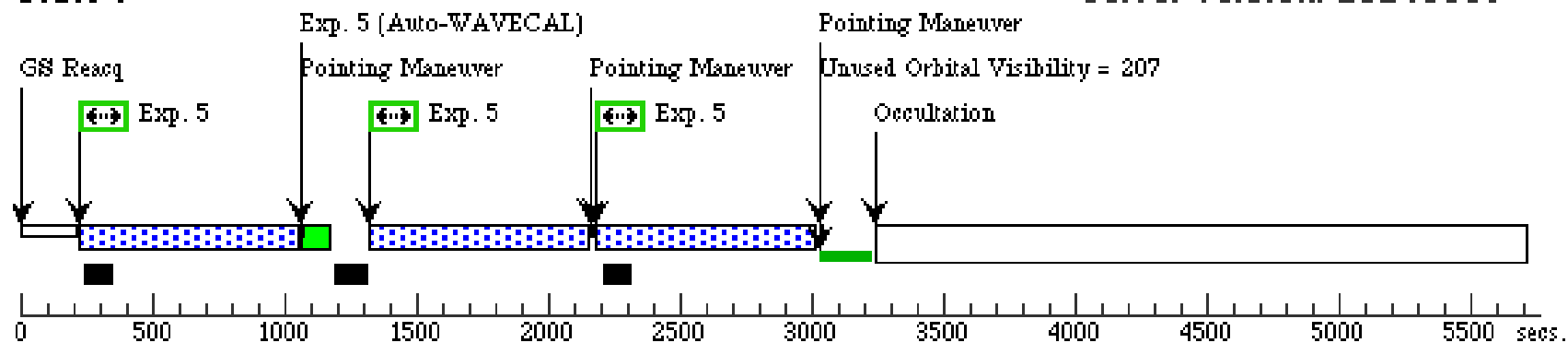
Orbit 3

Server Version: 20140605



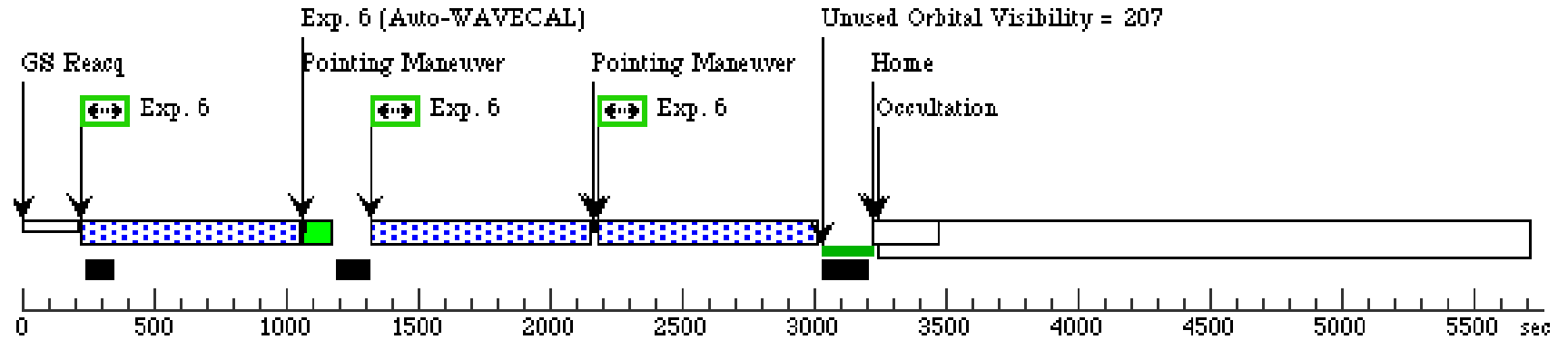
Orbit 4

Server Version: 20140605



Orbit 5

Server Version: 20140605

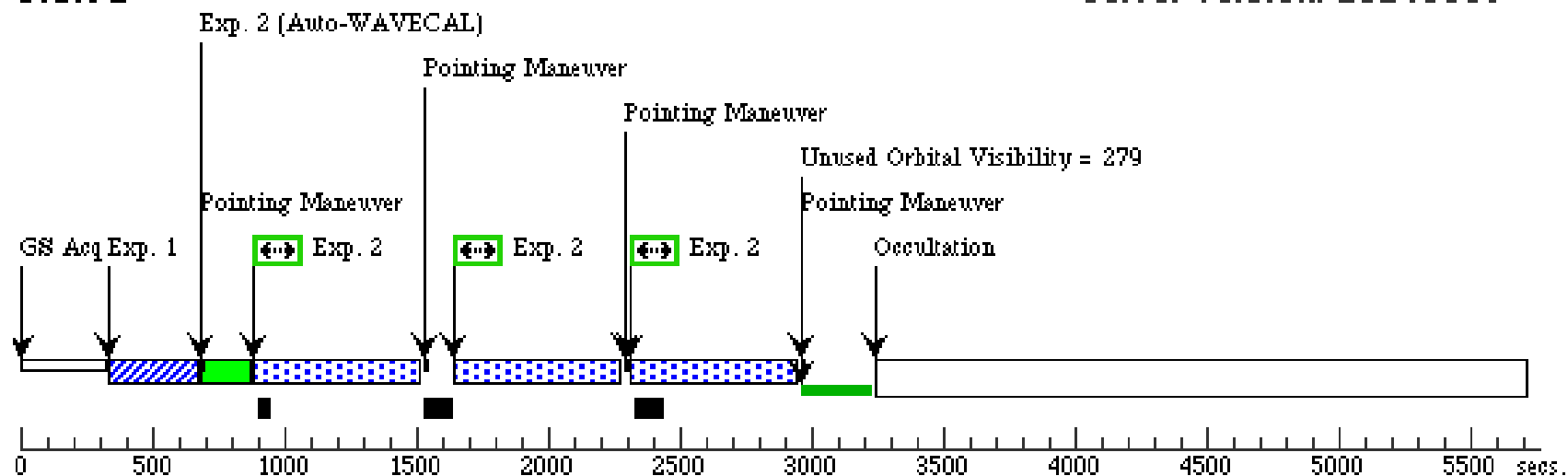


Proposal 13714 - RY Tau G140L G230L (02) - Tracing Hot Plasma in the RY Tau Jet

Visit	Proposal 13714, RY Tau G140L_G230L (02), implementation										Tue Sep 09 01:07:18 GMT 2014			
	Diagnostic Status: No Diagnostics													
	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA, STIS/NUV-MAMA													
	Special Requirements: SCHED 30%; ORIENT 157.8D TO 160.9 D; ORIENT 337.8D TO 340.9 D													
	Comments: Visit schedulability is very sensitive to science target exposure times. Exposure times have been set to allow scheduling in either Nov. 2014 or Nov. 2015. Ref. Email discussion between S. Skinner and Miranda Link on 7-14-2014.													
Patterns	#	Primary Pattern					Secondary Pattern					Exposures		
	(1)	Pattern Type=STIS-ALONG-SLIT Coordinate Frame=POS-TARG Purpose=DITHER Pattern Orientation=90.0 Number Of Points=3 Angle Between Sides= Point Spacing=0.275 Center Pattern=false Line Spacing=										(2), (3), (4)		
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous					
	(1)	RYTAU	RA: 04 21 57.4100 (65.4892083d) Dec: +28 26 35.57 (28.44321d) Equinox: J2000				V=10.3+/-1.0		Reference Frame: ICRS					
Comments: Variable star. AAVSO gives V magnitudes in range V = 9.6 - 11.2 from April 2013 - April 2014. During the same period, B ranged from B = 10.75 - 12.1. Most recent AAVSO values in April 2014 are V = 10.8 +- 0.2 and B = 11.8 +- 0.2. During the period 1983 - 2004 the range was V = 9.3 - 11.6 (Ref. Ismailov & Adygezalzade 2012). Colors are: U-B = +0.48, B-V = +1.03 (Herbig and Bell catalog). U-B = +0.49, B-V = +1.11 (Schegerer et al. 2008). Field star search: A search of GSCv2.3.2 with the HEASARC Browse utility using a circular search region of radius 30 arcsecs centered on RY Tau returns only one object: RY Tau. A search of the USNO B1 catalog using the same search region returns 7 objects of which RY Tau is the brightest (B1 = 11.34) and the second brightest is USNO 1184-0061103 (B1 = 16.69, offset 16.6 arcsec from RY Tau).														
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture		Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit		
	1	(STIS.ta.620 918)	(1) RYTAU	STIS/CCD, ACQ, F28X500II		MIRROR				20. Secs (20 Secs)				
										[==>]		[1]		
	2	(STIS.sp.62 1550)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2		G140L 1425 A			Pattern 1, Exps 2-2 in RY Tau G140L_G230L (02) (1)	620 Secs (1860 Secs)				
										[==>(Pattern 1)]				
										[==>(Pattern 2)]		[1]		
										[==>(Pattern 3)]				
	Comments: ETC simulation uses archived STIS G140L spectrum as input spectrum (dataset O5EX01020).													
	3	(STIS.sp.62 1551)	(1) RYTAU	STIS/FUV-MAMA, ACCUM, 52X0.2		G140L 1425 A			Pattern 1, Exps 3-3 in RY Tau G140L_G230L (02) (1)	820 Secs (2460 Secs)				
										[==>(Pattern 1)]				
									[==>(Pattern 2)]		[2]			
									[==>(Pattern 3)]					
Comments: ETC simulation uses archived STIS G140L spectrum as input spectrum (dataset O5EX01020).														
4	(STIS.sp.62 1553)	(1) RYTAU	STIS/NUV-MAMA, ACCUM, 52X0.2		G230L 2376 A			Pattern 1, Exps 4-4 in RY Tau G140L_G230L (02) (1)	850 Secs (2550 Secs)					
									[==>(Pattern 1)]					
									[==>(Pattern 2)]		[3]			
									[==>(Pattern 3)]					
Comments: ETC simulation uses archived STIS G230L spectrum as input spectrum (dataset O5EX01010).														

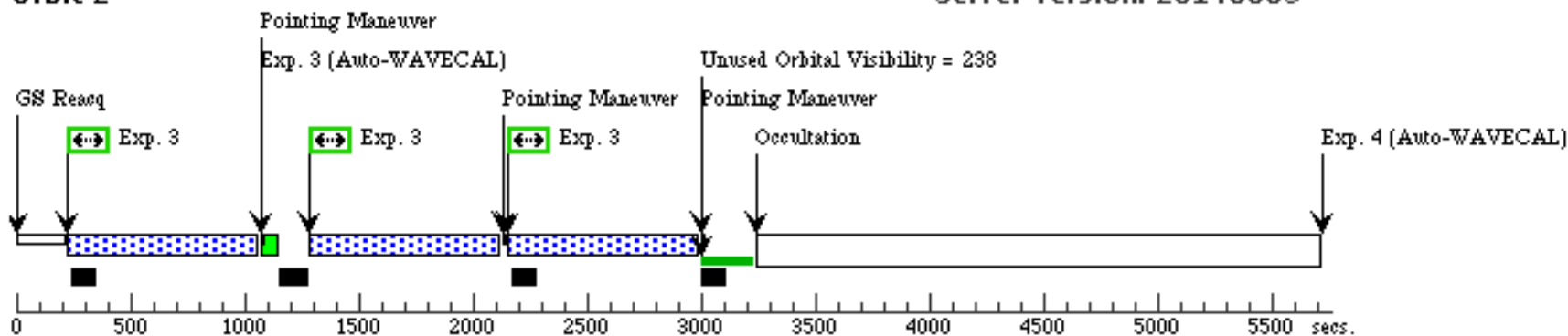
Orbit 1

Server Version: 20140605



Orbit 2

Server Version: 20140605



Orbit 3

Server Version: 20140605

