



13484 - Structure, Excitation, and Evolution of Shocks: A Multi- Wavelength Study of Herbig-Haro 1/2

Cycle: 21, Proposal Category: GO
(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) HH1-2	WFC3/UVIS	4	03-Sep-2013 21:19:57.0	yes
03	(1) HH1-2	WFC3/UVIS	3	03-Sep-2013 21:20:08.0	yes
04	(1) HH1-2	WFC3/UVIS	2	03-Sep-2013 21:20:14.0	yes

9 Total Orbits Used

ABSTRACT

More than 1000 Herbig-Haro (HH) objects are known today. Among these, HH 1 and HH 2 are taking a special place because they remain the brightest known HH objects in the sky. As such, they have been studied at all wavelengths, from X-rays to the radio continuum, and with all observing techniques. Adding to this their fine bipolar morphology displaying two major bow shocks and a finely collimated jet, it is no surprise that HH 1 and 2 constitute the reference frame against which data on all other HH objects are compared. We propose to observe HH 1/2 with the following narrowband filters (in order of wavelength) offered by WFC3: [Ne IV] 2425, Mg II 2795+2802, [O II] 3726+28, H-beta 4861, [O III]

5007, [O I] 6300, H-alpha 6563, [S II] 6717, and [S II] 6731. These lines probe different shock velocities and physical parameters, hence the analysis of the resulting images allow us to explore a number of scientific questions related to the physical conditions in the shocks, their structure and their kinematics. We have at our disposal the sophisticated adaptive grid code "yguazu" in which the gasdynamic equations are integrated together with a many-species ionization network. This allows us to compute both 2D and full 3D models of HH flows from which we can directly obtain predictions of emission maps in all of the above transitions, aiding the interpretation of the line ratio maps. The resulting study will provide a major step forward in our understanding of the shock physics of outflows from young stars.

Note: We have received permission to change the three quad filters ([Ne IV] 2425, [S II] 6717, [S II] 6731) and instead add 1 orbit to MgII and 1 orbit to [OII] to improve S/N.

OBSERVING DESCRIPTION

HH 1/2 are the two brightest HH objects in the sky, which permits us to study them in these transitions at a much more limited number of orbits than other HH flows. However, our previous HST images have documented that the emission knots span a large range in flux in H alpha and [SII], from the brightest knots to faint diffuse emission at the detection limit. As an example, the S/N ratio in our 1 orbit (3x800 sec) H alpha WFPC2 images for the brightest pixel in HH 2 is 10^4 , and in HH 1 it is $>10^2$. WFC3 has a smaller pixel scale, but a higher throughput, so WFC3 would have a signal that is $((0.04''/\text{pix})/(0.10''/\text{pix}))^2 \times (22\%/11\%) = 0.32$ smaller in an equivalent exposure time. This difference is insignificant compared to the large range of flux ratios from knot to knot, so we retain 1 orbit for the H alpha filter. The Halpha/[SII] ratio is ~ 4.5 for the brightest parts in HH 2, but drops below 1 (with a lowest value of 0.25) over most of the remaining shock regions, while for HH 1 the Halpha/[SII] ratio is ~ 3.5 , and again at or below 1 for the remaining structures of the object. Hence, 1 orbit will provide a similar good S/N ratio as our WFPC2 images. The new, so far unobserved transitions are, based on optical/ultraviolet spectra integrating across much of HH 1/2, from a factor of a few to more than a factor 10 fainter than Halpha, but since they probe very different shock regions, the line ratios change widely across the two objects. Based on the very limited available information, we have decided to also use one orbit for each of these filters, accepting that there may be filters in which only the brighter knots will have sufficient S/N to allow a proper analysis.

We are allocated 9 orbits of WFC3 UVIS imaging for this project and we group the observations into 3 visits. In the first visit we use two orbits in F373N ([OII] 3726/3728) filter, and one orbit each in F502N ([OIII] 5007) and F631N ([OI] 6300). The [OII] orbits use a 4-point dithering in two orbits; the [OIII] and [OI] orbits use a 2-point dithering. In the second visit we use one orbit each for filters F656N (H alpha 6563), F487N (H beta 4861), and F673N ([SII] 6717/6731), each with a 2-point dithering. In the third visit the filter F280N (Mg II 2795/2802) and a 4-point dithering is

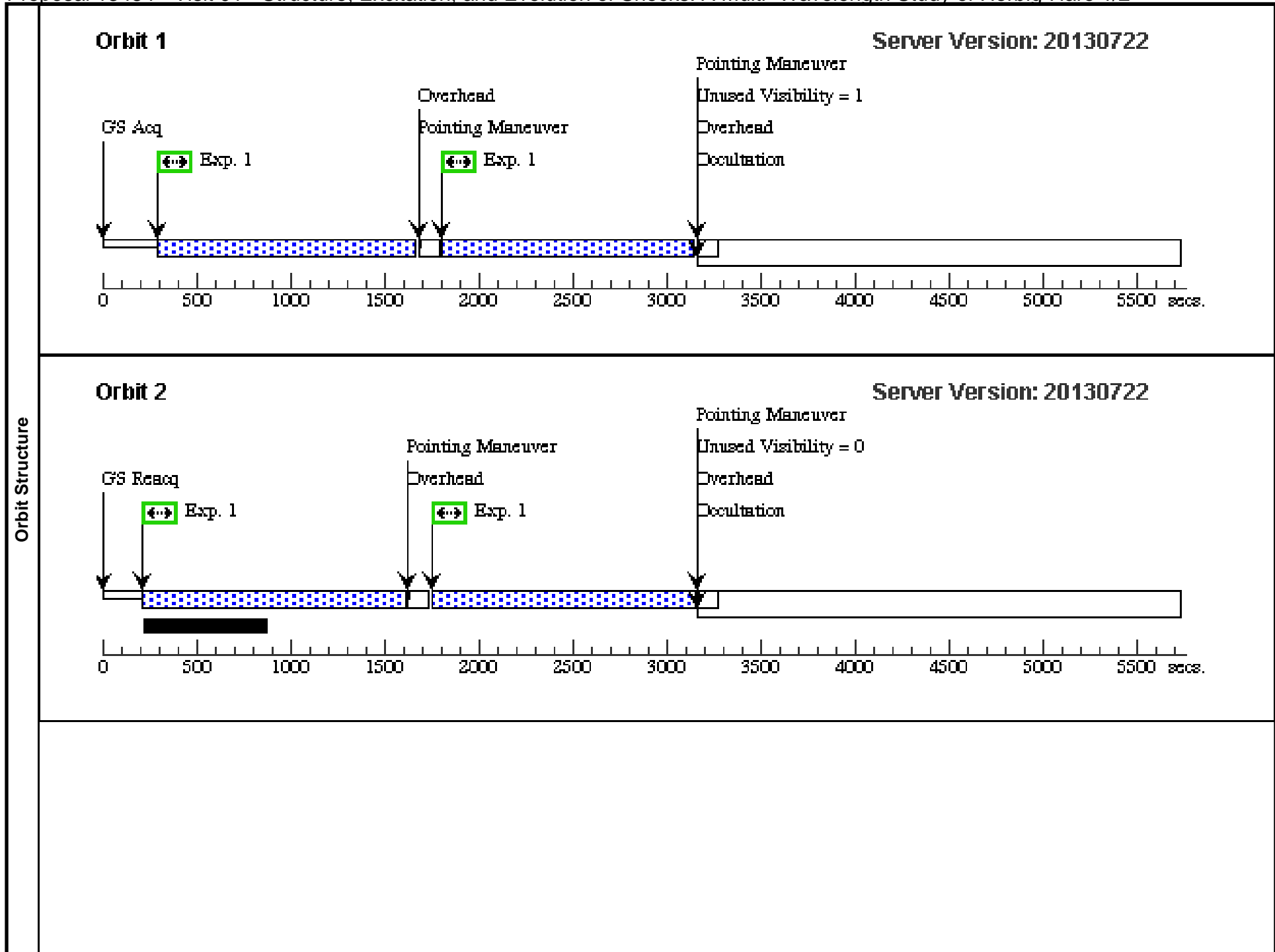
Proposal 13484 (STScI Edit Number: 0, Created: Tuesday, September 3, 2013 8:20:21 PM EST) - Overview

used for two orbits. All observations have the same central pointing. The total extent of the HH 1-2 bipolar flow is 172", matched to the WFC3 diagonal of 229". We would like these 3 visits observed as close together as possible, not exceeding a month in interval. This is important due to the significant tangential motion of the objects, so the closer in time the visits can be made, the better.

Proposal 13484 - Visit 01 - Structure, Excitation, and Evolution of Shocks: A Multi- Wavelength Study of Herbig-Haro 1/2

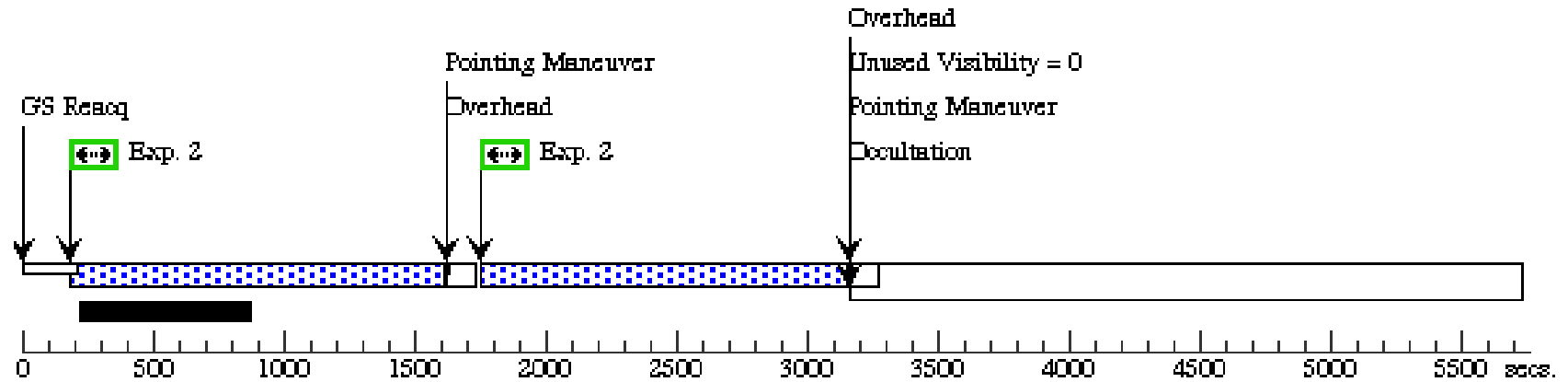
Wed Sep 04 01:20:22 GMT 2013

Visit	Proposal 13484, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: SCHED 50%; ORIENT 225D TO 228.8 D; ORIENT 234D TO 251 D; ORIENT 308D TO 342 D; GROUP 01,03,04 WITHIN 30D									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=DITHER Number Of Points=2 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true		(2), (3)				
	(2)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=3.633 Line Spacing=2.352	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	HH1-2	RA: 05 36 23.3900 (84.0974583d) Dec: -06 46 16.50 (-6.77125d) Equinox: J2000		V=17.38	Reference Frame: ICRS				
<i>Comments: The target Herbig-Haro Object HH 1-2 contains bright knots and diffuse emission. 17.38 is the V-magnitude of the Cohen-Schwartz Star in the field.</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F373-OII	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F373N	FLASH=10		Pattern 2, Exps 1-1 in Visit 01 (2)	1300 Secs (5484 Secs)	
									[==>1343.0 Secs (Pattern 1)]	[1]
									[==>1343.0 Secs (Pattern 2)]	
								[==>1399.0 Secs (Pattern 3)]	[2]	
								[==>1399.0 Secs (Pattern 4)]		
2	F502-OIII	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F502N	FLASH=10		Pattern 1, Exps 2-2 in Visit 01 (1)	1300 Secs (2798 Secs)		
								[==>1399.0 Secs (Pattern 1)]	[3]	
								[==>1399.0 Secs (Pattern 2)]		
3	F631-OI	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F631N	FLASH=10		Pattern 1, Exps 3-3 in Visit 01 (1)	1300 Secs (2798 Secs)		
								[==>1399.0 Secs (Pattern 1)]	[4]	
								[==>1399.0 Secs (Pattern 2)]		



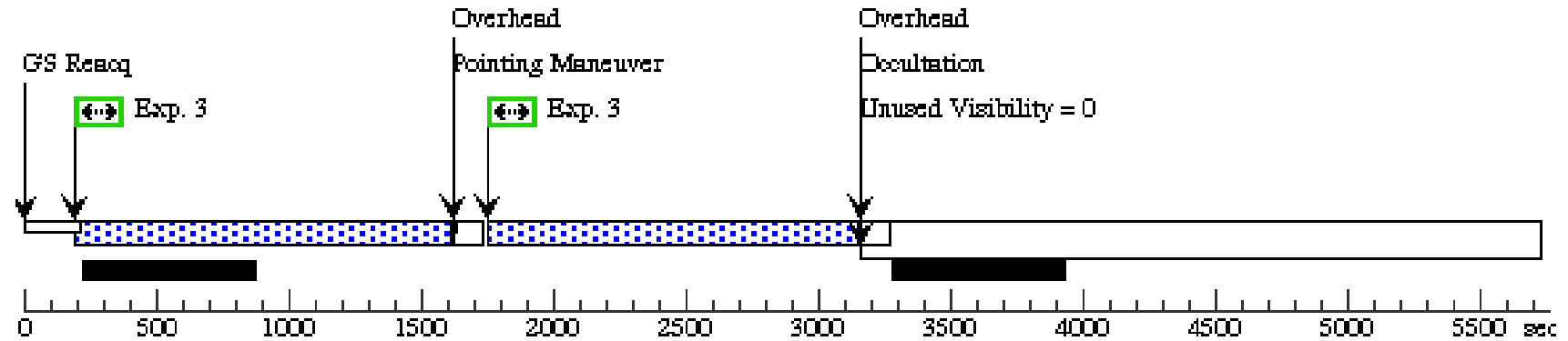
Orbit 3

Server Version: 20130722



Orbit 4

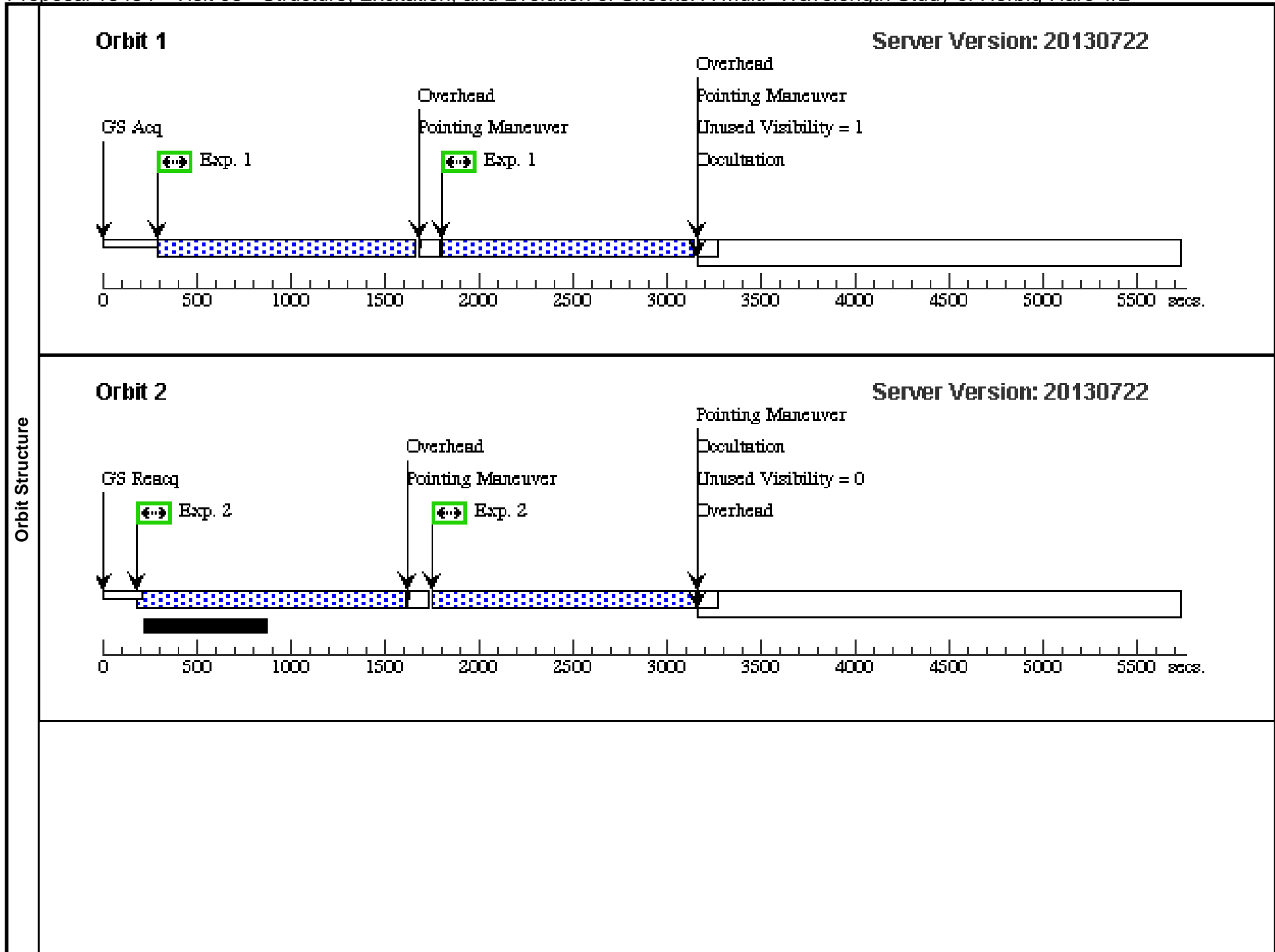
Server Version: 20130722

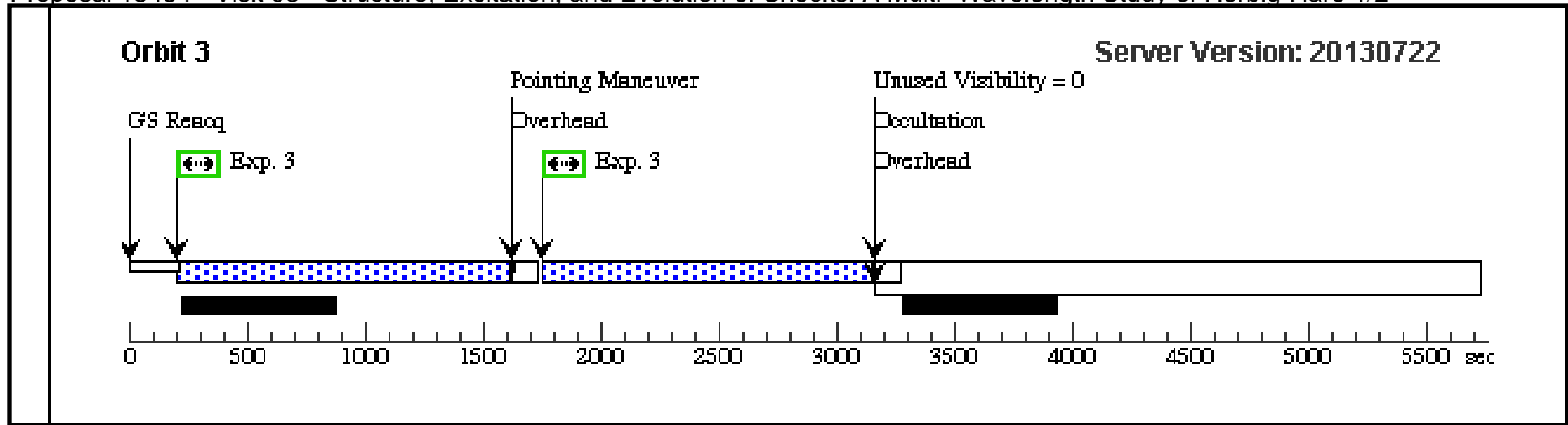


Proposal 13484 - Visit 03 - Structure, Excitation, and Evolution of Shocks: A Multi- Wavelength Study of Herbig-Haro 1/2

Wed Sep 04 01:20:25 GMT 2013

Visit	Proposal 13484, Visit 03, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: SCHED 50%; ORIENT 218D TO 228.8 D; ORIENT 234D TO 253 D; ORIENT 308D TO 342 D; GROUP 03,01,04 WITHIN 30D										
	Patterns	#	Primary Pattern			Secondary Pattern			Exposures		
		(1)	Pattern Type=WFC3-UVIS-GAP-LINE	Coordinate Frame=POS-TARG					(1), (2), (3)		
		Purpose=DITHER	Pattern Orientation=85.759								
		Number Of Points=2	Angle Between Sides=								
		Point Spacing=2.414	Center Pattern=true								
		Line Spacing=									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(1)	HH1-2	RA: 05 36 23.3900 (84.0974583d)				V=17.38		Reference Frame: ICRS		
			Dec: -06 46 16.50 (-6.77125d)								
			Equinox: J2000								
	<i>Comments: The target Herbig-Haro Object HH 1-2 contains bright knots and diffuse emission. 17.38 is the V-magnitude of the Cohen-Schwartz Star in the field.</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	F656-Ha	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F656N	FLASH=10		Pattern 1, Exps 1-1 in Visit 03 (1)	1300 Secs (2686 Secs)		
									[=>1343.0 Secs (Pattern 1)]		[1]
									[=>1343.0 Secs (Pattern 2)]		
	2	F487-Hb	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F487N	FLASH=10		Pattern 1, Exps 2-2 in Visit 03 (1)	1300 Secs (2798 Secs)		
									[=>1399.0 Secs (Pattern 1)]		[2]
									[=>1399.0 Secs (Pattern 2)]		
	3	F673-SII	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F673N	FLASH=10		Pattern 1, Exps 3-3 in Visit 03 (1)	1300 Secs (2798 Secs)		
									[=>1399.0 Secs (Pattern 1)]		[3]
									[=>1399.0 Secs (Pattern 2)]		





Proposal 13484 - Visit 04 - Structure, Excitation, and Evolution of Shocks: A Multi- Wavelength Study of Herbig-Haro 1/2

Wed Sep 04 01:20:27 GMT 2013

Visit	Proposal 13484, Visit 04, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: SCHED 50%: ORIENT 225D TO 228.8 D; ORIENT 234D TO 253 D; ORIENT 308D TO 342 D; GROUP 04,01,03 WITHIN 30D										
	Patterns	#	Primary Pattern				Secondary Pattern			Exposures	
		(2)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=3.633 Line Spacing=2.352	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false						(1)	
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(1)	HH1-2	RA: 05 36 23.3900 (84.0974583d) Dec: -06 46 16.50 (-6.77125d) Equinox: J2000				V=17.38		Reference Frame: ICRS		
	<i>Comments: The target Herbig-Haro Object HH 1-2 contains bright knots and diffuse emission. 17.38 is the V-magnitude of the Cohen-Schwartz Star in the field.</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	F280-MgII	(1) HH1-2	WFC3/UVIS, ACCUM, UVIS-CENTER	F280N	FLASH=10		Pattern 2, Exps 1-1 in Visit 04 (2)	1300 Secs (5484 Secs)		
									[=>1343.0 Secs (Pattern 1)]		[1]
									[=>1343.0 Secs (Pattern 2)]		
									[=>1399.0 Secs (Pattern 3)]		
									[=>1399.0 Secs (Pattern 4)]		[2]

