



17222 - WD Periastron Passage in the R Aqr System: Zooming on the New Ejecta and Jet

Cycle: 30, 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) V-R-AQR	WFC3/UVIS	6	05-Jul-2022 09:01:12.0	yes

6 Total Orbits Used

ABSTRACT

We propose HST observations of the R Aqr symbiotic binary system, jointly with Chandra and VLA, as a follow up on the 2020 and 2021 archival observations which show dramatic changes within 1" from the central binary resulting from the enhanced accretion during the recent periastron

passage of the white dwarf (WD) accretor. These phenomena are observable in R Aqr only about twice a century, with the next periastron expected in about 40 years. Our goal is to carry out a timely high-angular resolution multi-wavelength study of this event by zooming in on the central 3" radius circumbinary region. This will allow us to determine the spatial/spectral evolution of the distribution and the characteristics of the new ejecta and jet, and to gain a unique insight into jet formation and early propagation in symbiotic and other accretion-powered systems.

OBSERVING DESCRIPTION

We request a total of 6 orbits, in 1 visit (if not possible, then in two visits within a couple of weeks from each other). The HST high-angular resolution in the spectral regions (filters) that we selected is critical for achieving the science goals of this project. It is very important to have the images at different filters obtained close in time because the R Aqr outburst and jet structures are evolving rapidly. To avoid spatial/spectral confusion of the information in the lines and the continuum we would prefer that the observations are carried in one visit.

We prefer that the observations are scheduled during late Autumn 2022 to Spring 2023 when the Mira is in the vicinity of (or at) its optical minimum. The primary should have a magnitude of V less than 10.5 mag based on the 2020, 2021 and 2022 light curves. This period around minimum starts roughly 15-Nov-2022 and goes through late-June/mid-July 2023 during which time the target visibility becomes very good. The emission from R Aqr is variable, and we will be monitoring closely the light curve and spectra using ground based photometry/spectroscopy. Depending on when the observations are scheduled, we may need to adjust the exposures accordingly - in the time frame of about a month before the actual observations.

We plan to carry out HST WFC3/UVIS imaging of R Aqr using the 4-point dither mode in several filters. This approach will allow us to reach 0.025"/pixel, and will also assist in cosmic ray removal. Combining the dithered images will result in improvement of the sampling of the PSF and will allow us to further enhance the (nominal 0.04") resolution using deconvolution techniques such as Richardson-Lucy or EMC2 reaching 0.025". This will nearly double the number of pixels covering the regions of interest. We also plan several long exposures to image the fainter outer lobes and determine their morphology and evolution when compared to the archival HST observations in the past decade.

Most of the selected filters were used in the 2020 and 2021 archival observations, and will allow direct comparison and study of the dynamical evolution and proper motions of individual structures (inner jet, knots and blobs). The images obtained in the spectral lines will provide information on the ionization state, temperature, and density of the gas. The [CII] line will help determine the (dust) extinction and it is sensitive to carbonaceous grain-depletion. The [Ne IV] line is a good indicator of emission from a high temperature material in the system and its surrounding environment. The F343N filter will provide the [NeV] line intensity, which will indicate whether temperatures significantly higher than 10^5 K are present. The

Proposal 17222 (STScI Edit Number: 1, Created: Tuesday, July 5, 2022 at 8:01:14 AM Eastern Standard Time) - Overview

Mg II λ 2800 Å line has a resonant scattering component and will provide information on the ionization state of the gas. The [OII] λ 3726 Å line is a density indicator. Furthermore, the [OII] λ 3726 Å/CII] λ 2326 Å ratio is a good indicator of temperature and density characteristics of the gas. The [SII] λ 6731 Å/H α ratio will allow us to identify shocked vs. ionized gas emission. The [O III] 4363 Å/5007 Å ratio gives the temperature which further constrains the shock speed and the ionizing spectrum. The F658N filter will provide an estimate the [NII] emission and also allow us to calculate the [S II]/[N II] ratio. The ratio would be suppressed in the inner regions of R Aqr, providing a density diagnostics. The H α /H β ratio will map the reddening along the jet and counter-jet, and perpendicularly to the jet (e.g., orbital plane).

The exposure times are based on the online WFC3 ETC calculations as verified by the 2021 WFC3 observations of R Aqr. We optimize the efficiency of the observing time by using subarray readouts (1024x1024 readout) to minimize the overheads, while still providing a $\geq 40'' \times 40''$ field of view. Our observations include some flash exposure in order to partially remediate the effects of charge-transfer inefficiency due to the age of the detector. The Phase II proposal was generated using the latest APT based on the desired exposure times to avoid saturation and on the use of dither patterns, and makes the most efficient use of the observing time.

In the event a reduced gyro mode will need to be used for this proposal, it will not have any significant impact as long as the target is in the HST field-of-regard when the observations need to be taken in order to catch this time-sensitive behavior of the target since we have no roll constraints for our observations.

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Tue Jul 05 13:01:14 GMT 2022

Visit	Proposal 17222, Visit 01, implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 15-NOV-2022:00:00:00 AND 01-JUL-2023:00:00:00					
Diagnostics	(Exposure 16 (Pattern 2, Exps 16-16 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with WFC3 quad filters to avoid placing the target on the vignetted part of the field of view or moving it to another quadrant.					
	(Exposure 17 (Pattern 2, Exps 17-17 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with WFC3 quad filters to avoid placing the target on the vignetted part of the field of view or moving it to another quadrant.					
	(Exposure 19 (Pattern 2, Exps 19-19 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with WFC3 quad filters to avoid placing the target on the vignetted part of the field of view or moving it to another quadrant.					
Patterns	#	Primary Pattern	Secondary Pattern	Exposures		
	(2)	Pattern Type=SPIRAL Purpose=DITHER Number Of Points=4 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.86 Angle Between Sides= Center Pattern=false		(1-4), (6-8), (9-13), (16), (17), (19)	
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	V-R-AQR	RA: 23 43 49.4634 (355.9560975d) Dec: -15 17 4.18 (-15.28449d) Equinox: J2000		V=10+/-3.0	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[ACCRETION DISK, INTERACTING BINARY, JET, SYMBIOTIC STAR]						

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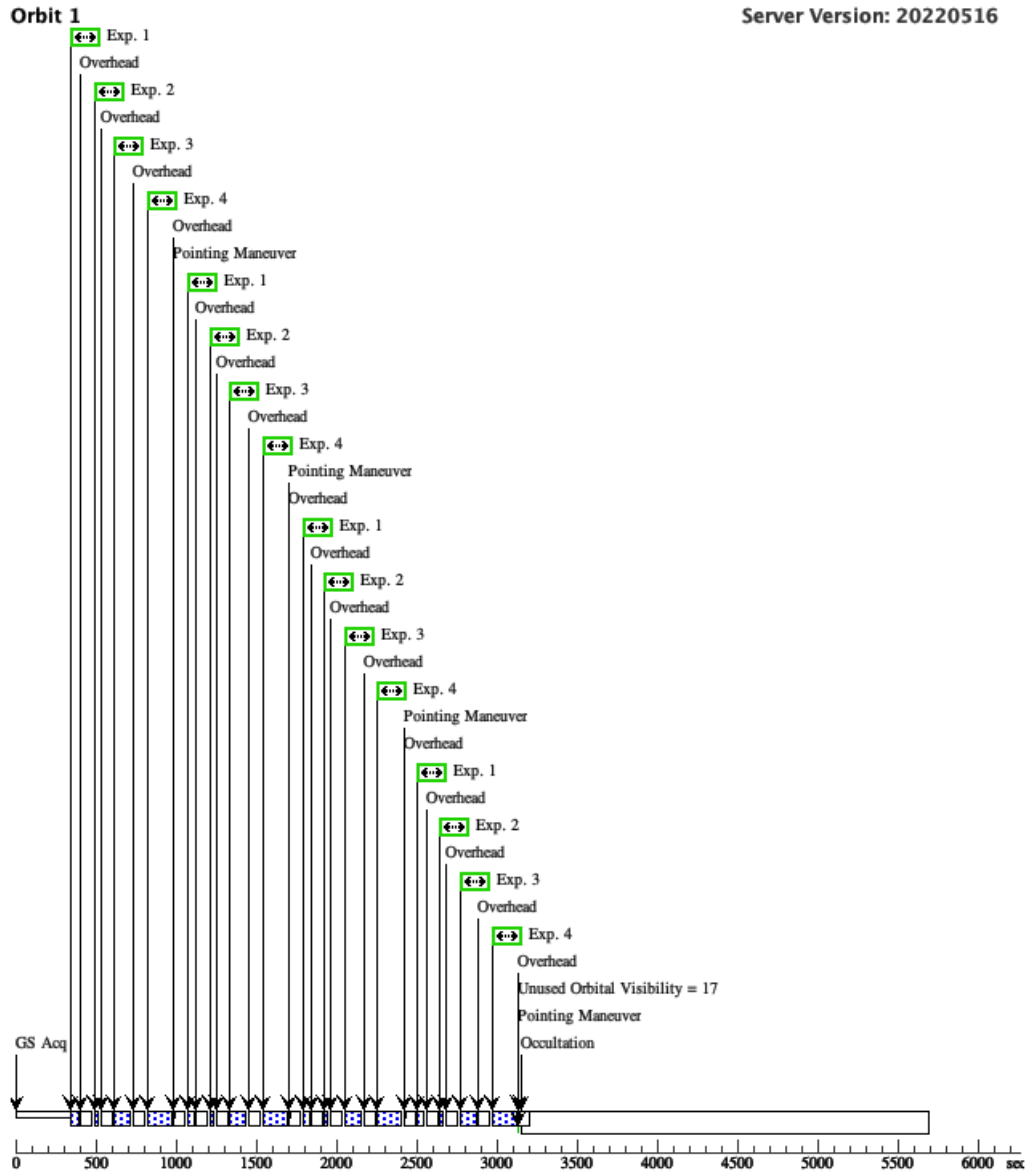
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
Exposures	1	(WFC3UVI S.im.780074)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F502N	FLASH=20	GS ACQ SCENARI O BASE1B3	Pattern 2, Exps 1-4 i n Visit 01 (2)	15 Secs (60 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(WFC3UVI S.im.780074)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F547M	FLASH=20		Pattern 2, Exps 1-4 i n Visit 01 (2)	2 Secs (8 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	3	(WFC3UVI S.im.832643)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F373N	FLASH=20		Pattern 2, Exps 1-4 i n Visit 01 (2)	85 Secs (340 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	4	(WFC3UVI S.im.832644)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	FLASH=20		Pattern 2, Exps 1-4 i n Visit 01 (2)	120 Secs (480 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	5	(WFC3UVI S.im.780074)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F373N	FLASH=20			500 Secs X 2 (1000 Secs) [==>(Copy 1)] [==>(Copy 2)]	[2]
	6	(WFC3UVI S.im.172036 2)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F487N	FLASH=20		Pattern 2, Exps 6-8 i n Visit 01 (2)	15 Secs (60 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[2]
	7	(WFC3UVI S.im.172036 6)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F343N	FLASH=20		Pattern 2, Exps 6-8 i n Visit 01 (2)	90 Secs (360 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[2] [3]
	8	(WFC3UVI S.im.780078)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F656N	FLASH=20		Pattern 2, Exps 6-8 i n Visit 01 (2)	5 Secs (20 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[2] [3]
	9	(WFC3UVI S.im.780079)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F763M	FLASH=20		Pattern 2, Exps 9-13 in Visit 01 (2)	5 Secs (20 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[3] [4]

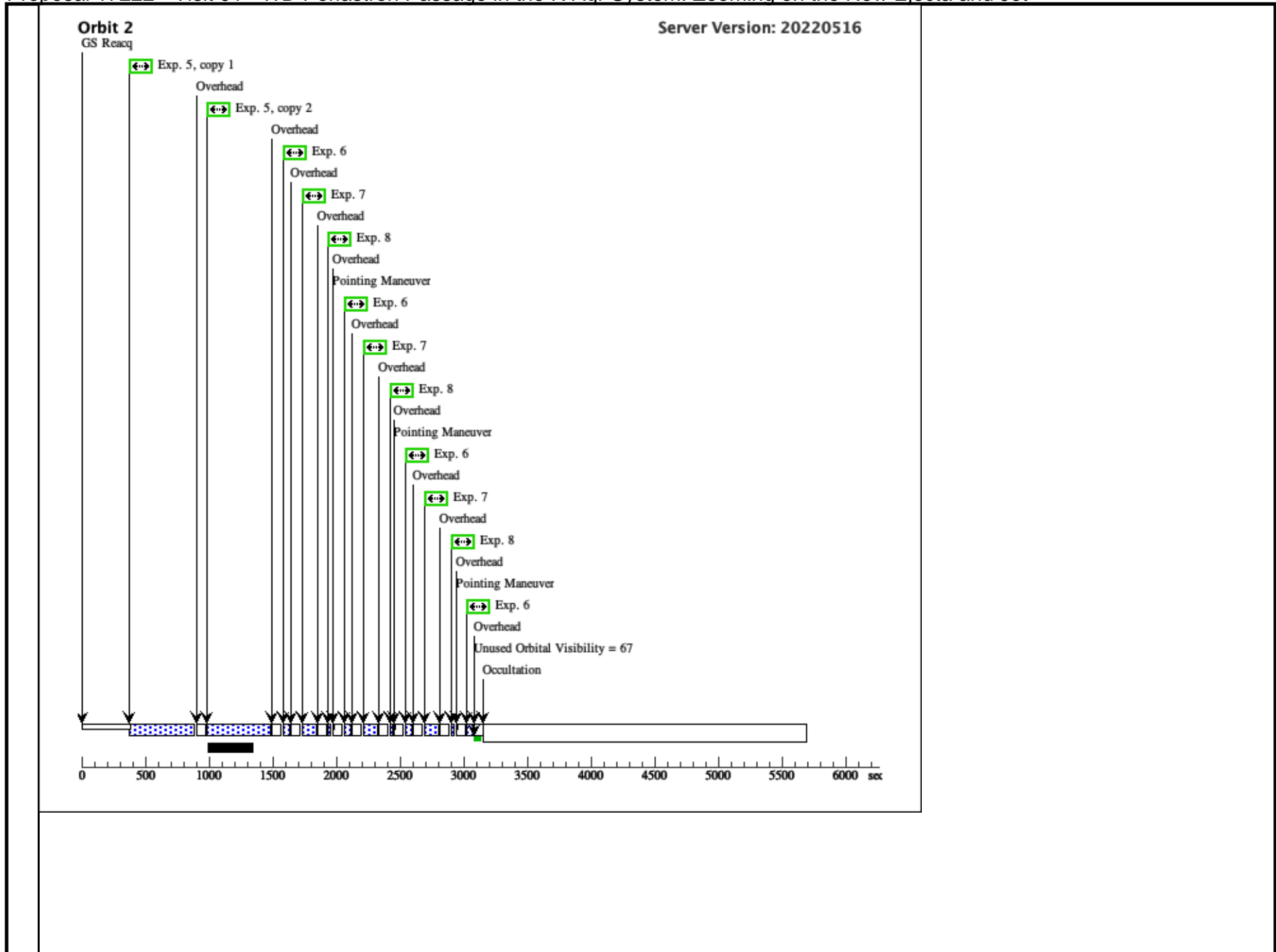
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10	(WFC3UVI S.im.780075)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	FLASH=20	Pattern 2, Exps 9-13 in Visit 01 (2)	10 Secs (40 Secs)	
							[==>(Pattern 1)]	[3]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	[4]
11	(WFC3UVI S.im.780140)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F275W	FLASH=20	Pattern 2, Exps 9-13 in Visit 01 (2)	200 Secs (800 Secs)	
							[==>(Pattern 1)]	[3]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	[4]
12	(WFC3UVI S.im.780140)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F658N	FLASH=20	Pattern 2, Exps 9-13 in Visit 01 (2)	5 Secs (20 Secs)	
							[==>(Pattern 1)]	[3]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	[4]
13	(WFC3UVI S.im.780079)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F673N	FLASH=20	Pattern 2, Exps 9-13 in Visit 01 (2)	5 Secs (20 Secs)	
							[==>(Pattern 1)]	[3]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	[4]
14	(WFC3UVI S.im.780074)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F502N	FLASH=20		700 Secs X 2 (1400 Secs)	
							[==>(Copy 1)]	[4]
							[==>(Copy 2)]	
15	(WFC3UVI S.im.780074)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	FLASH=20		180 Secs X 2 (360 Secs)	
							[==>(Copy 1)]	[4]
							[==>(Copy 2)]	[5]
16	(WFC3UVI S.im.780080)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ232N	FLASH=20	Pattern 2, Exps 16-16 in Visit 01 (2)	145 Secs (580 Secs)	
							[==>(Pattern 1)]	[5]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	
17	(WFC3UVI S.im.780080)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ243N	FLASH=20	Pattern 2, Exps 17-17 in Visit 01 (2)	130 Secs (520 Secs)	
							[==>(Pattern 1)]	[5]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	
18	(WFC3UVI S.im.780074)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F656N	FLASH=20		450 Secs X 2 (900 Secs)	
							[==>(Copy 1)]	[6]
							[==>(Copy 2)]	
19	(WFC3UVI S.im.780080)	(1) V-R-AQR	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ437N	FLASH=20	GS ACQ SCENARI O BASE1B3	Pattern 2, Exps 19-19 in Visit 01 (2)	90 Secs (360 Secs)
							[==>(Pattern 1)]	[6]
							[==>(Pattern 2)]	
							[==>(Pattern 3)]	
							[==>(Pattern 4)]	

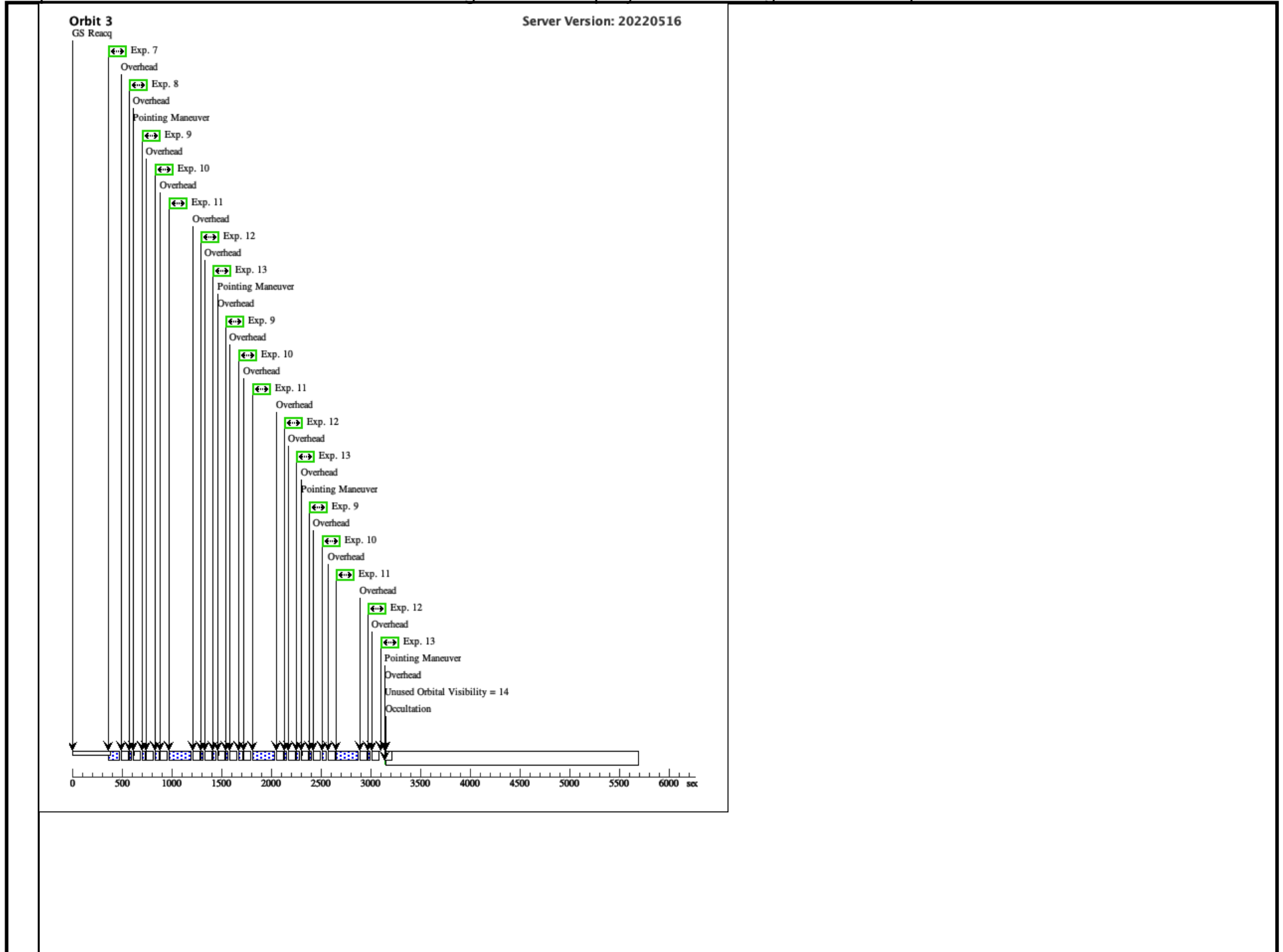
Orbit Structure

Server Version: 20220516





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Orbit 4

GS Reacq

