



# 12950 - A Deep, Near-UV Probe of the Faint Cataclysmic Variable Population of 47 Tucanae

Cycle: 20, 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) 47TUCANAE ANY	ACS/WFC WFC3/UVIS	4	11-Jul-2013 11:22:25.0	yes
02	(1) 47TUCANAE ANY	ACS/WFC WFC3/UVIS	4	11-Jul-2013 11:23:12.0	yes

8 Total Orbits Used

## ABSTRACT

Dense globular clusters are rich sites for the production of interacting binaries, such as cataclysmic variables (CVs), millisecond radio pulsars (MSPs), and double WD systems. Previous HST WFPC2 and Chandra X-ray observations have identified 22 CVs in 47 Tuc with  $M_V < 10$ . The unprecedented near-UV sensitivity, field of view, and resolution of the WFC3, in combination with subarcsecond Chandra positions, will allow us to probe the faint CV population down to  $M_V = 11.6$ , identifying a large population of CVs at very low mass-transfer rates. The distribution of CV mass transfer rates inferred will constrain models of CV evolution and dynamical formation. We will also survey the population of helium-core WDs, another window into binary evolution.

## OBSERVING DESCRIPTION

Our goal is to reach  $U \sim 24.8$  in both F390W and F300X, sensitive to faint blue CVs. In this dense cluster core, we use 4x4 dithering to improve our spatial resolution, resulting in target exposure times of 3881 s in F390W and 14256 s in F300X, leading to 8 orbits. We actually achieve 4656 s in F390W, and 14736 s in F300X.

We schedule our program in two visits, since no visit should be more than 5 orbits. Each visit starts with one orbit of F390W (4 exps of  $\sim 580$  s, considering guide star acq), then 3 orbits of F300X (4 exps of 608 s each, considering shorter re-acq). Each orbit steps through a WFC3 DITHER-BOX pattern. The 3rd and 4th orbits are offset by (1.446", 2.926") and (-1.446", -2.926") to ensure that all parts of the chip gap get 2/3 coverage in F300X in each visit, and the 1st orbit of the 2nd visit is offset to ensure that the chip gap is covered in F390W.

We set up our dithers as POS-TARGS (following details in the document WFC3-2010-09.pdf) to allow inclusion of parallel ACS WFC exposures (patterns can't be used since we don't use the same parallel ACS parameters for all WFC3 pointings in an orbit). Dumping two WFC3 exposures takes longer than a single WFC3 exposure, so can only be done at the end of an orbit. Since ACS must be dumped after each exposure, only the last two WFC3 exposures per orbit can have long ( $\sim 500$  s) ACS parallels, while the first two WFC3 exposures can have short ( $\sim 200$  s) parallels (allowing immediate buffer dump). This gives us sixteen ACS exposures per visit, which we divide into 3 short F438W, 3 short F625W (one only 65 s to correct saturated stars), 2 short F658N, and 8 long F658N exposures. We find that we reach  $R \sim 23.9$  in H-alpha,  $R \sim 24.5$  in B, and 25 in R. Since the ACS fields are two half-mass radii from the center, their crowding will not be severe, so we do not attempt detailed subpixel dithering, though our WFC3 dithering will be sufficient for hot pixel and bad column cleaning.

We place no restrictions on the timing of the two visits, so the two WFC3 visits may be at different roll angles, and the two parallel ACS fields may overlap, or be two separate fields. We choose WFC3-CENTER and place the target point at the Goldsbury (2011) center of 47 Tuc.

**ADDITIONAL COMMENTS**

We choose a 10-photon post-flash to ensure that our F300X exposures have sufficient signal to avoid the worst CTE degradation. Existing WFC3/UVIS F390W exposures show that these exposures will easily attain sufficient electrons/pixel. We are willing to add post-flash electrons to our H-alpha ACS exposures.

Proposal 12950 - Visit 01 - A Deep, Near-UV Probe of the Faint Cataclysmic Variable Population of 47 Tucanae

<b>Visit</b>	<b>Proposal 12950, Visit 01, implementation</b> <span style="float: right;">Thu Jul 11 15:23:32 GMT 2013</span> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/UVIS, ACS/WFC Special Requirements: SCHED 100%					
	<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>
	(1)	47TUCANAE Alt Name1: NGC104	RA: 00 24 5.7100 (6.0237917d) Dec: -72 04 52.70 (-72.08131d) Equinox: J2000		V=3.95 Resolved target. Faintest target CVs U=24.8.	Reference Frame: ICRS

Proposal 12950 - Visit 01 - A Deep, Near-UV Probe of the Faint Cataclysmic Variable Population of 47 Tucanae

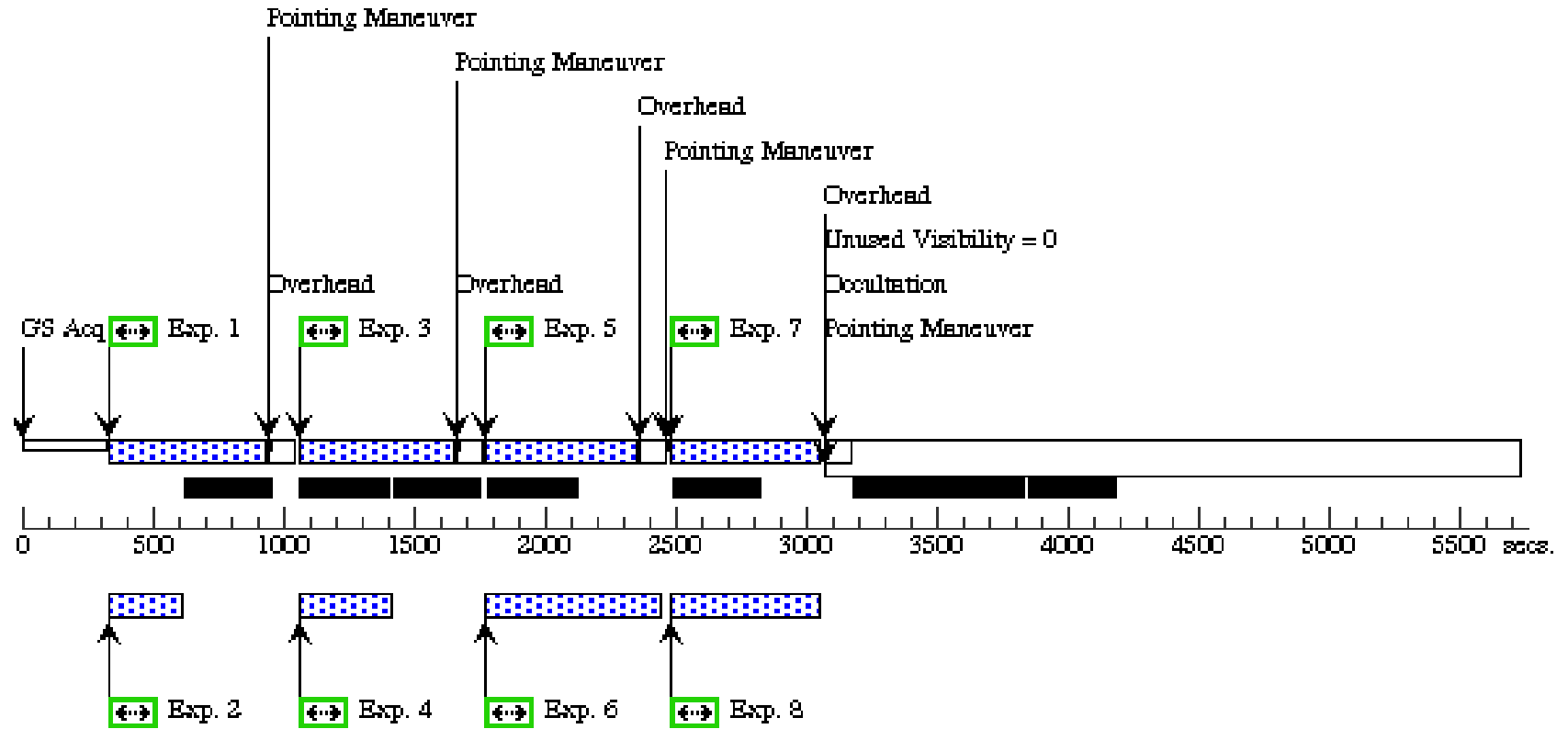
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
Exposures	1	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 0,null	Prime + Parallel Group 1-2 in Visit 01	567 Secs (567 Secs)	[1]
								[==>]		
	2	R short	ANY	ACS/WFC, ACCUM, WFC	F625W	FLASH=20		Prime + Parallel Group 1-2 in Visit 01	65 Secs (65 Secs)	[1]
									[==>65.0 Secs ]	
	3	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 0.15848, 0.070175	Prime + Parallel Group 3-4 in Visit 01	590 Secs (590 Secs)	[1]
									[==>]	
	4	R	ANY	ACS/WFC, ACCUM, WFC	F625W	FLASH=10		Prime + Parallel Group 3-4 in Visit 01	223 Secs (223 Secs)	[1]
									[==>223.0 Secs ]	
	5	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 0.09905, 0.16492	Prime + Parallel Group 5-6 in Visit 01	578 Secs (578 Secs)	[1]
									[==>]	
	6	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 5-6 in Visit 01	515 Secs (509 Secs)	[1]
									[==>509.0 Secs ]	
	7	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG -0.0594 3,0.094745	Prime + Parallel Group 7-8 in Visit 01	577 Secs (577 Secs)	[1]
									[==>]	
	8	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 7-8 in Visit 01	445 Secs (445 Secs)	[1]
									[==>]	
	9	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 0,0	Prime + Parallel Group 9-10 in Visit 01	604 Secs (604 Secs)	[2]
									[==>]	
	10	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 9-10 in Visit 01	271 Secs (251 Secs)	[2]
									[==>251.0 Secs ]	
	11	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 0.15848, 0.070175	Prime + Parallel Group 11-12 in Visit 01	604 Secs (604 Secs)	[2]
									[==>]	
12	B	ANY	ACS/WFC, ACCUM, WFC	F435W	FLASH=20		Prime + Parallel Group 11-12 in Visit 01	196 Secs (176 Secs)	[2]	
								[==>176.0 Secs ]		
13	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 0.09905, 0.16492	Prime + Parallel Group 13-14 in Visit 01	604 Secs (604 Secs)	[2]	
								[==>]		
14	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 13-14 in Visit 01	528 Secs (524 Secs)	[2]	
								[==>524.0 Secs ]		
15	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -0.0594 3,0.094745	Prime + Parallel Group 15-16 in Visit 01	604 Secs (604 Secs)	[2]	
								[==>]		
16	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 15-16 in Visit 01	472 Secs (472 Secs)	[2]	
								[==>]		
17	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.446,2. 926	Prime + Parallel Group 17-18 in Visit 01	614 Secs (609 Secs)	[3]	
								[==>609.0 Secs ]		
18	B	ANY	ACS/WFC, ACCUM, WFC	F435W	FLASH=20		Prime + Parallel Group 17-18 in Visit 01	206 Secs (200 Secs)	[3]	
								[==>200.0 Secs ]		
19	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.60448, 2.99618	Prime + Parallel Group 19-20 in Visit 01	613 Secs (609 Secs)	[3]	
								[==>609.0 Secs ]		
20	B	ANY	ACS/WFC, ACCUM, WFC	F435W	FLASH=20		Prime + Parallel Group 19-20 in Visit 01	255 Secs (250 Secs)	[3]	
								[==>250.0 Secs ]		
21	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.54505, 3.09092	Prime + Parallel Group 21-22 in Visit 01	614 Secs (609 Secs)	[3]	
								[==>609.0 Secs ]		
22	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 21-22 in Visit 01	533 Secs (529 Secs)	[3]	
								[==>529.0 Secs ]		

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23	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.38657, 3.02075	Prime + Parallel Group 23-24 in Visit 01	614 Secs (609 Secs) [==>609.0 Secs ]	[3]
24	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 23-24 in Visit 01	488 Secs (477 Secs) [==>477.0 Secs ]	[3]
25	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.446,-2.926	Prime + Parallel Group 25-26 in Visit 01	614 Secs (609 Secs) [==>609.0 Secs ]	[4]
26	R	ANY	ACS/WFC, ACCUM, WFC	F625W	FLASH=10		Prime + Parallel Group 25-26 in Visit 01	223 Secs (218 Secs) [==>218.0 Secs ]	[4]
27	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.2875 2,-2.85583	Prime + Parallel Group 27-28 in Visit 01	613 Secs (609 Secs) [==>609.0 Secs ]	[4]
28	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 27-28 in Visit 01	223 Secs (218 Secs) [==>218.0 Secs ]	[4]
29	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.3469 5,-2.76108	Prime + Parallel Group 29-30 in Visit 01	614 Secs (609 Secs) [==>609.0 Secs ]	[4]
30	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 29-30 in Visit 01	584 Secs (580 Secs) [==>580.0 Secs ]	[4]
31	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.5054 3,-2.83126	Prime + Parallel Group 31-32 in Visit 01	614 Secs (609 Secs) [==>609.0 Secs ]	[4]
32	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 31-32 in Visit 01	488 Secs (466 Secs) [==>466.0 Secs ]	[4]

**Orbit 1**

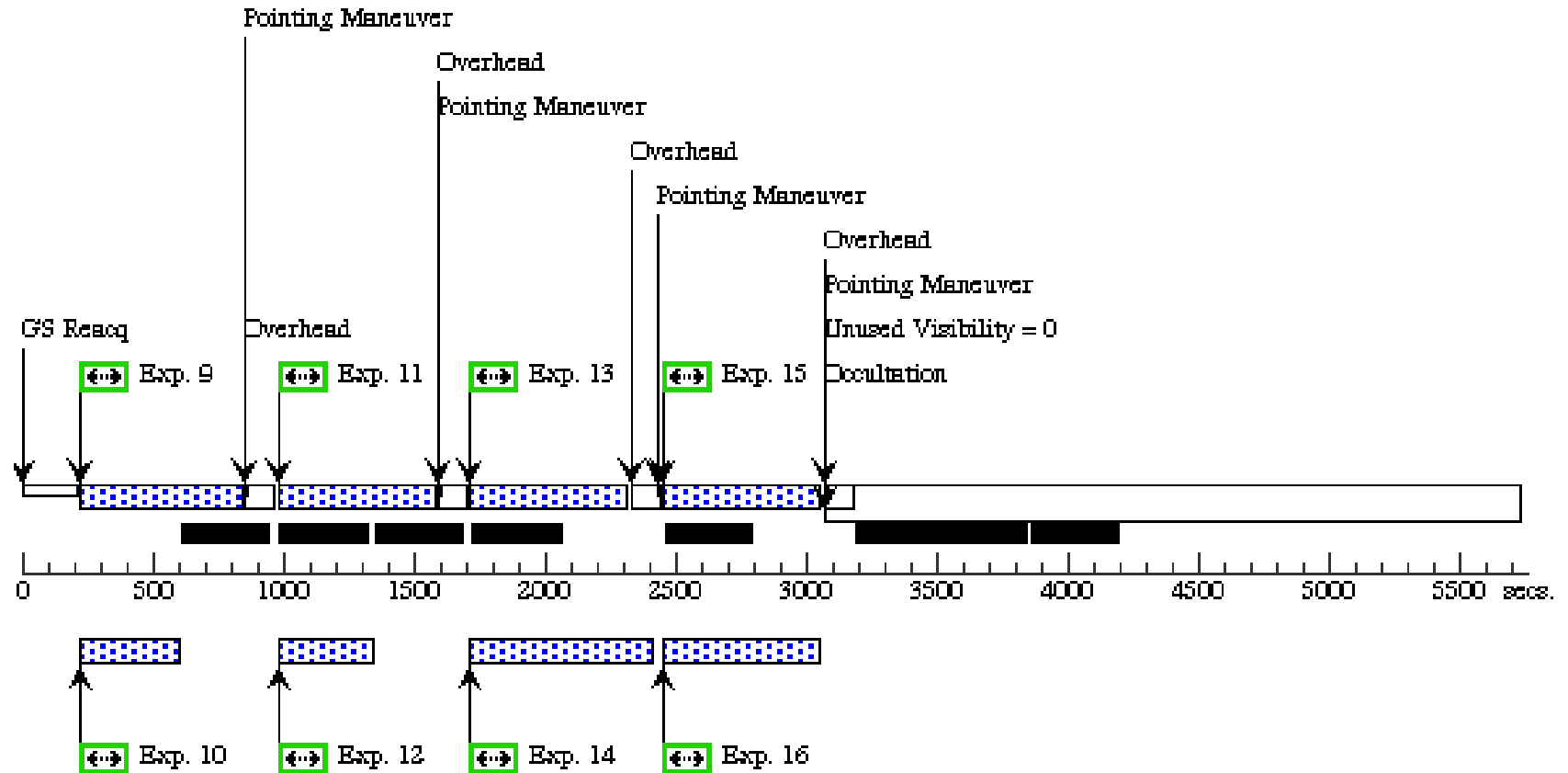
Server Version: 20130502



Orbit Structure

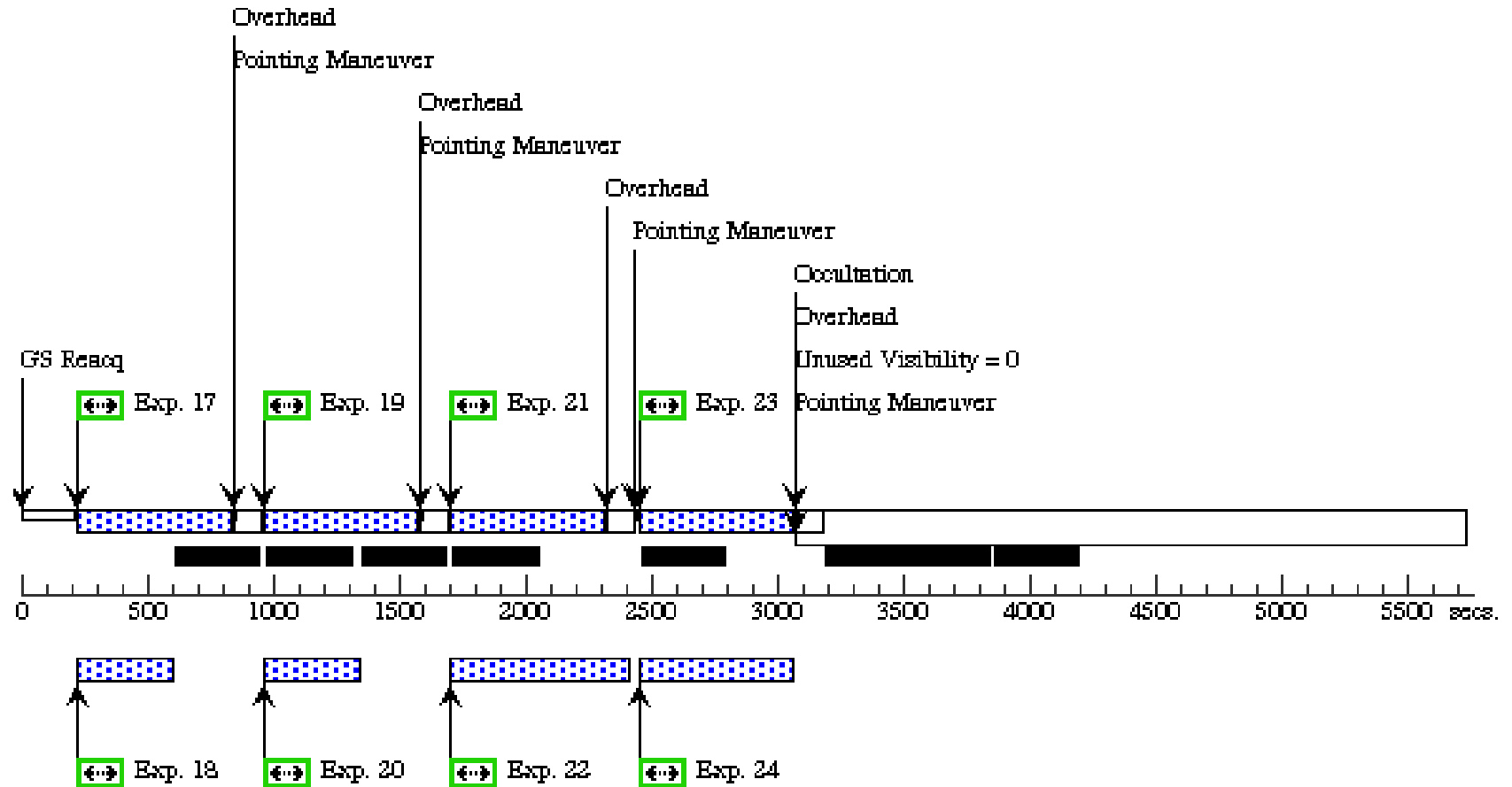
Orbit 2

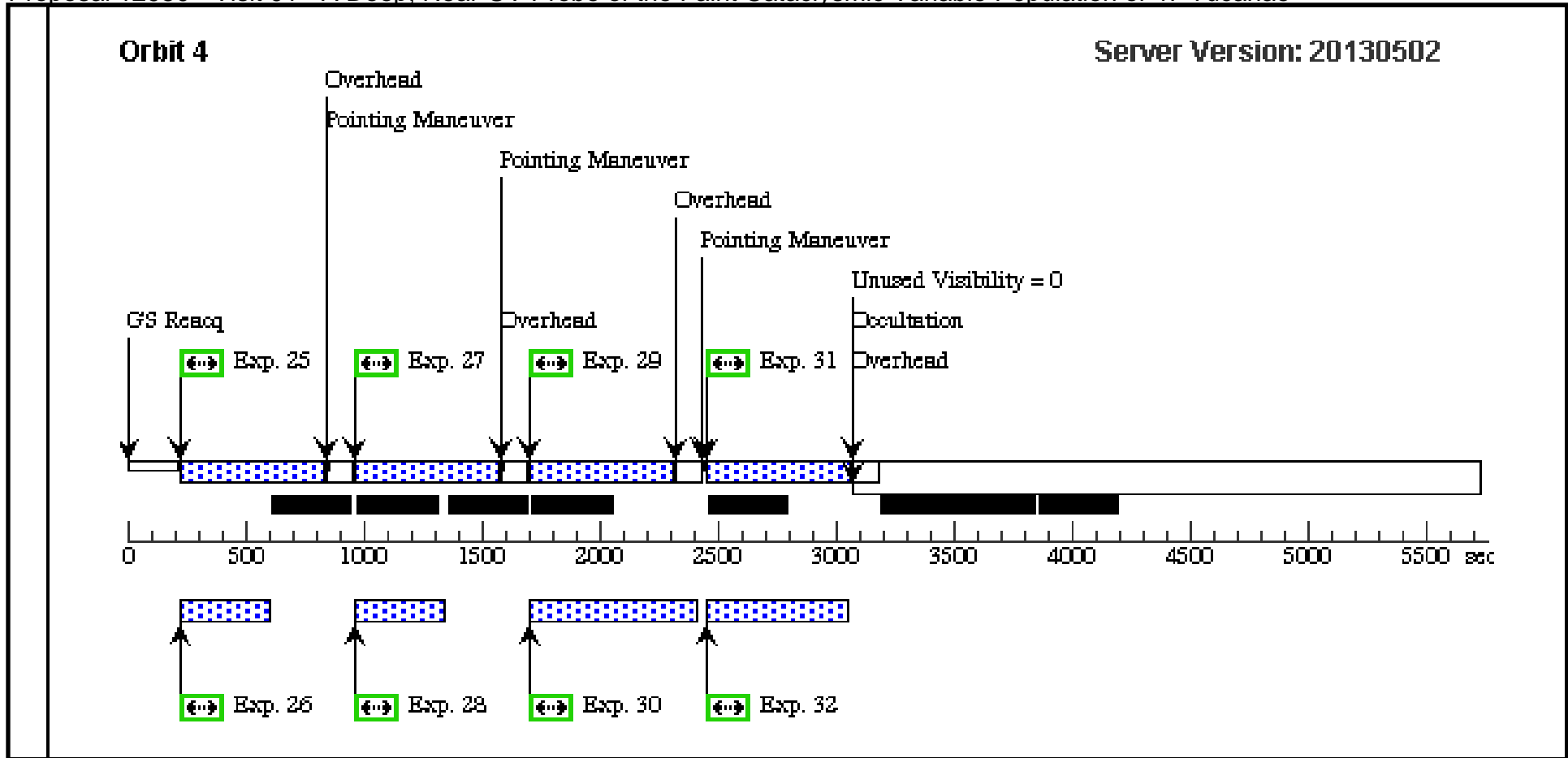
Server Version: 20130502



Orbit 3

Server Version: 20130502





Proposal 12950 - Visit 02 - A Deep, Near-UV Probe of the Faint Cataclysmic Variable Population of 47 Tucanae

<b>Visit</b>	<b>Proposal 12950, Visit 02, implementation</b> <span style="float: right;">Thu Jul 11 15:23:38 GMT 2013</span> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/UVIS, ACS/WFC Special Requirements: SCHED 100%					
	<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>
	(1)	47TUCANAE Alt Name1: NGC104	RA: 00 24 5.7100 (6.0237917d) Dec: -72 04 52.70 (-72.08131d) Equinox: J2000		V=3.95 Resolved target. Faintest target CVs U=24.8.	Reference Frame: ICRS

Proposal 12950 - Visit 02 - A Deep, Near-UV Probe of the Faint Cataclysmic Variable Population of 47 Tucanae

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
Exposures	1	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 1.446,2.926	Prime + Parallel Group 1-2 in Visit 02	573 Secs (573 Secs)	[1]
								[==>]		
	2	R short	ANY	ACS/WFC, ACCUM, WFC	F625W	FLASH=20		Prime + Parallel Group 1-2 in Visit 02	65 Secs (65 Secs)	[1]
									[==>65.0 Secs ]	
	3	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 1.60448,2.99618	Prime + Parallel Group 3-4 in Visit 02	584 Secs (584 Secs)	[1]
									[==>]	
	4	R	ANY	ACS/WFC, ACCUM, WFC	F625W	FLASH=10		Prime + Parallel Group 3-4 in Visit 02	223 Secs (218 Secs)	[1]
									[==>218.0 Secs ]	
	5	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 1.54505,3.09092	Prime + Parallel Group 5-6 in Visit 02	578 Secs (578 Secs)	[1]
									[==>]	
	6	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 5-6 in Visit 02	515 Secs (509 Secs)	[1]
									[==>509.0 Secs ]	
	7	C	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F390W		POS TARG 1.38657,3.02075	Prime + Parallel Group 7-8 in Visit 02	577 Secs (577 Secs)	[1]
									[==>]	
	8	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 7-8 in Visit 02	445 Secs (445 Secs)	[1]
									[==>]	
	9	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 0,0	Prime + Parallel Group 9-10 in Visit 02	604 Secs (604 Secs)	[2]
									[==>]	
	10	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 9-10 in Visit 02	271 Secs (267 Secs)	[2]
									[==>267.0 Secs ]	
	11	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 0.15848,0.070175	Prime + Parallel Group 11-12 in Visit 02	604 Secs (604 Secs)	[2]
									[==>]	
12	B	ANY	ACS/WFC, ACCUM, WFC	F435W	FLASH=20		Prime + Parallel Group 11-12 in Visit 02	196 Secs (192 Secs)	[2]	
								[==>192.0 Secs ]		
13	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 0.09905,0.16492	Prime + Parallel Group 13-14 in Visit 02	604 Secs (604 Secs)	[2]	
								[==>]		
14	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 13-14 in Visit 02	528 Secs (524 Secs)	[2]	
								[==>524.0 Secs ]		
15	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -0.05943,0.094745	Prime + Parallel Group 15-16 in Visit 02	604 Secs (604 Secs)	[2]	
								[==>]		
16	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 15-16 in Visit 02	472 Secs (472 Secs)	[2]	
								[==>]		
17	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.446,2.926	Prime + Parallel Group 17-18 in Visit 02	614 Secs (609 Secs)	[3]	
								[==>609.0 Secs ]		
18	B	ANY	ACS/WFC, ACCUM, WFC	F435W	FLASH=20		Prime + Parallel Group 17-18 in Visit 02	206 Secs (196 Secs)	[3]	
								[==>196.0 Secs ]		
19	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.60448,2.99618	Prime + Parallel Group 19-20 in Visit 02	613 Secs (609 Secs)	[3]	
								[==>609.0 Secs ]		
20	B	ANY	ACS/WFC, ACCUM, WFC	F435W	FLASH=20		Prime + Parallel Group 19-20 in Visit 02	255 Secs (251 Secs)	[3]	
								[==>251.0 Secs ]		
21	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.54505,3.09092	Prime + Parallel Group 21-22 in Visit 02	614 Secs (609 Secs)	[3]	
								[==>609.0 Secs ]		
22	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Group 21-22 in Visit 02	533 Secs (529 Secs)	[3]	
								[==>529.0 Secs ]		

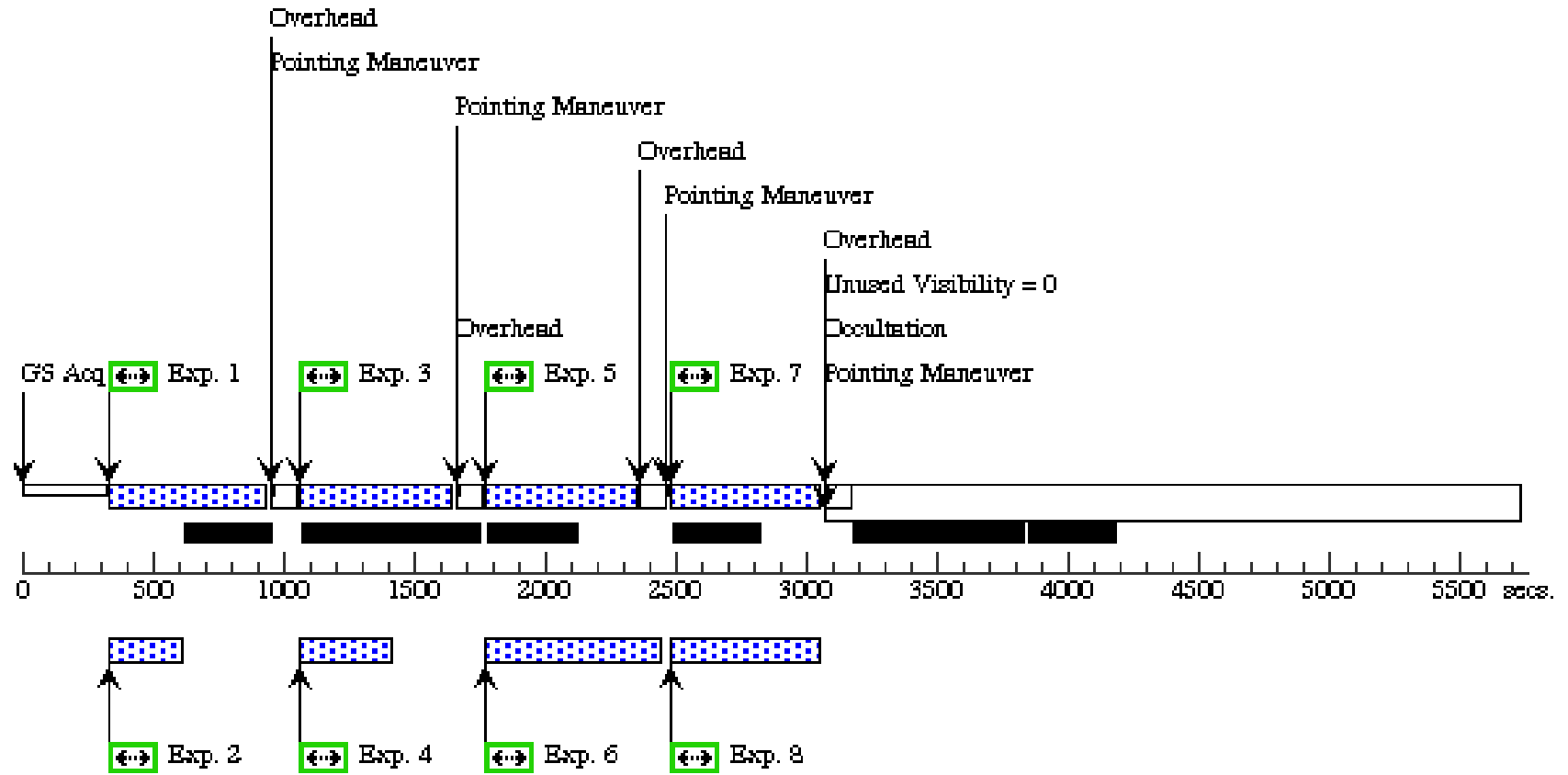
Proposal 12950 - Visit 02 - A Deep, Near-UV Probe of the Faint Cataclysmic Variable Population of 47 Tucanae

23	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG 1.38657, 3.02075	Prime + Parallel Gro up 23-24 in Visit 02	614 Secs (609 Secs) [==>609.0 Secs ]	[3]
24	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Gro up 23-24 in Visit 02	488 Secs (477 Secs) [==>477.0 Secs ]	[3]
25	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.446,- 2.926	Prime + Parallel Gro up 25-26 in Visit 02	614 Secs (609 Secs) [==>609.0 Secs ]	[4]
26	R	ANY	ACS/WFC, ACCUM, WFC	F625W	FLASH=10		Prime + Parallel Gro up 25-26 in Visit 02	223 Secs (219 Secs) [==>219.0 Secs ]	[4]
27	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.2875 2,-2.85583	Prime + Parallel Gro up 27-28 in Visit 02	613 Secs (609 Secs) [==>609.0 Secs ]	[4]
28	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Gro up 27-28 in Visit 02	223 Secs (219 Secs) [==>219.0 Secs ]	[4]
29	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.3469 5,-2.76108	Prime + Parallel Gro up 29-30 in Visit 02	614 Secs (609 Secs) [==>609.0 Secs ]	[4]
30	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Gro up 29-30 in Visit 02	584 Secs (580 Secs) [==>580.0 Secs ]	[4]
31	NUV	(1) 47TUCANAE	WFC3/UVIS, ACCUM, UVIS-CENTER	F300X	FLASH=10	POS TARG -1.5054 3,-2.83126	Prime + Parallel Gro up 31-32 in Visit 02	614 Secs (609 Secs) [==>609.0 Secs ]	[4]
32	H-alpha	ANY	ACS/WFC, ACCUM, WFC	F658N	FLASH=20		Prime + Parallel Gro up 31-32 in Visit 02	488 Secs (477 Secs) [==>477.0 Secs ]	[4]

Orbit 1

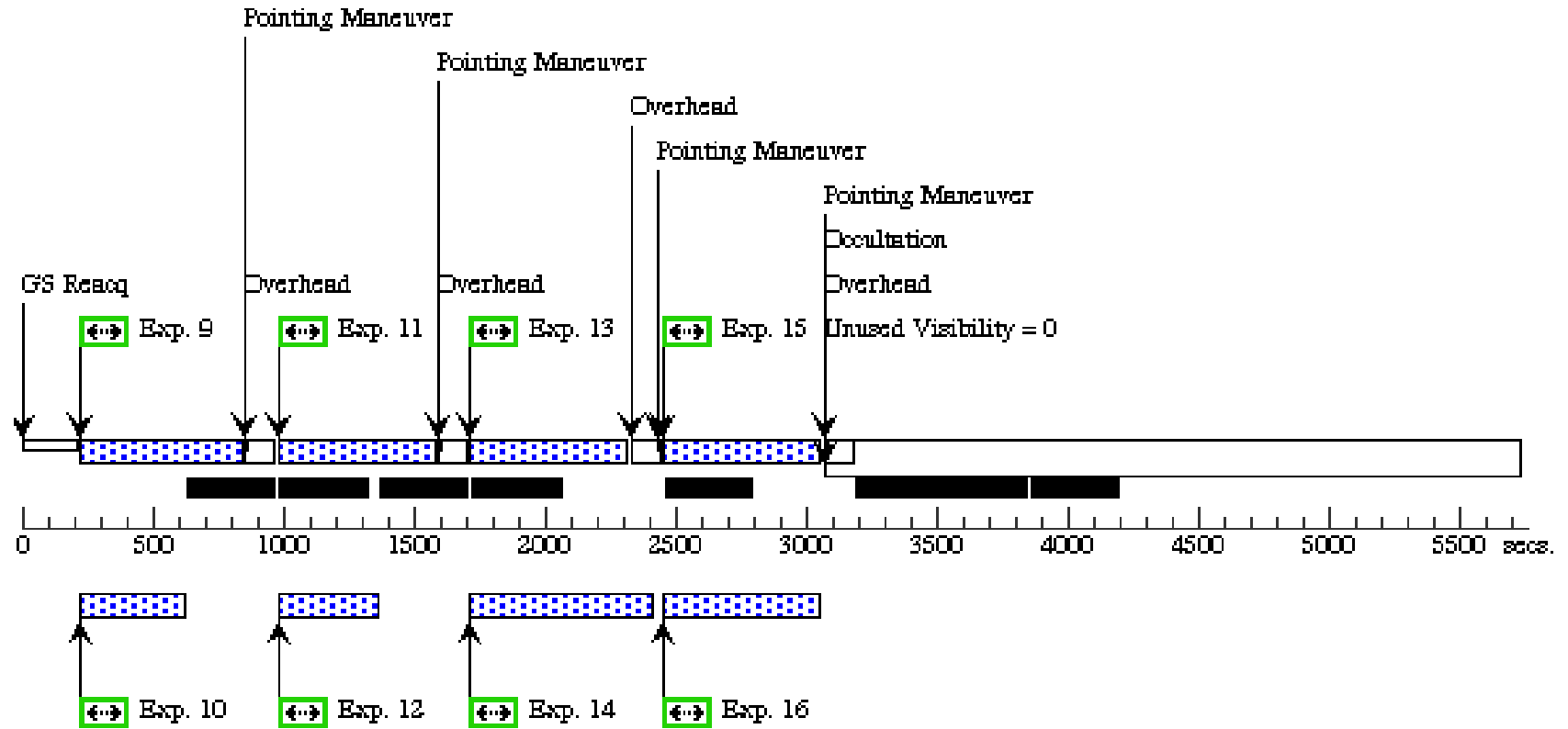
Server Version: 20130502

Orbit Structure



Orbit 2

Server Version: 20130502



Orbit 3

Server Version: 20130502

