13361 - Discovering and Characterizing the Young Supernova Remnant Population in M101

Cycle: 21, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(5) M101-ACS5-NEW	WFC3/UVIS	3	24-Jun-2013 22:28:08.0	yes
02	(1) M101-ACS1	WFC3/UVIS	1	24-Jun-2013 22:28:19.0	yes
03	(2) M101-ACS2	WFC3/UVIS	2	24-Jun-2013 22:28:28.0	yes
04	(3) M101-ACS3	WFC3/UVIS	2	24-Jun-2013 22:28:38.0	yes
05	(4) M101-ACS4	WFC3/UVIS	2	24-Jun-2013 22:28:48.0	yes

10 Total Orbits Used

ABSTRACT

Young supernova remnants (SNRs), especially ones like Cas A where heavy elements are still prominent, provide insights into SNe, the stars that produce them, and the galaxies where they reside. Here we propose to leverage and expand on existing Hubble ACS/WFC images of the iconic face-

on spiral M101 by obtaining new [O III] data and [S II] images with WFC3 to identify and characterize the SNR population of M101. Deep H-alpha images of M101 already exist for 4 ACS fields, as does an extremely deep (1 Ms Chandra) X-ray study--important since many SNRs, including ALL of the known ejecta-dominated ones, are strong X-ray sources. While existing data have enabled exploration of SNRs previously identified from the ground, they do not allow identifications of new (and especially young) SNRs. We propose to observe these fields in [O III] (strongest line in ejecta-dominated SNRs) and [S II] (to provide the [S II]/H-alpha ratio diagnostic to distinguish SNRs from photoionized nebulae), plus adding one new field in these lines plus H-alpha. For a modest time investment, all the optical and X-ray diagnostics will be in hand to explore what we expect to be a rich population of young SNRs in the complex inner regions of the galaxy where HST resolution is most needed. Furthermore, ACS images in BVI also exist for these fields, so we will use CMD fitting to constrain the progenitor masses for many of these as we did for the SN 1957D remnant in M83. We will compare to other galaxies, especially M83 where the young SNRs appear to have evolved quickly beyond the ejecta-dominated stage. M101 and M83 differ in mean abundances and star formation rate areal density, providing contrasting conditions.

OBSERVING DESCRIPTION

In this program, we will obtain new [O III] and [S II] emission-line images or four fields in the galaxy M101 for which deep Halpha observations are in the archive (along with BVI broadband data). We will also observe one new field that fills in a hole in the spatial coverage from the existing four fields, and this field will be observed in Halpha as well as [O III] and [S II].

Both WFC3 and ACS have [O III] and Halpha filters and so in principle either could be used for these portions of our program. The WFC3, however, has the F673N filter necessary for obtaining the [S II] measurements we need. Based on the availability of postflash with WFC3 to mitigate CTE, we have decided to take all of the new data requested here with WFC3. The price we pay is a loss of some spatial coverage that we would obtain with the larger ACS field of view, but given that much of our science is driven by faint emission-line sources, we have decided to go with WFC3. In some sense, this will also simplify our data analysis on the back end, since all of the new data will be obtained with the same instrument.

ACS B, V, I broadband data from archived program 9490 (Kuntz, PI) exist for the entire region of interest, and will be used to subtract the existing ACS Halpha data, and allow us to study the stellar component near each SNR. However, rather that attempt to use ACS data to subtract the new WFC3 data, we rwill observe WFC3 F547M continuum images as part of this program. This avoids alignment and PSF variation complications between ACS and WFC3 data. The exception is for one of the ACS fields where, because of time restrictions, we have not added the F547M, and will instead use the ACS data for subtractions. We also get somewhat less integration time in [O III] and [S II] on this field in order to fit into the 10

orbit allocation.

We request modest matching of FoV position angle to the four existing ACS/WFC fields to maximize overlap. We do not require exact matching and assume a +/-10 degree latitude and modulo 180 degrees field rotations to provide significant flexibility in scheduling the new observations. The new field has a preferred orientation to maximize coverage of known SNRs in the region between two of the existing fields, and we allow modulo 90 degrees and +/-10 degrees for scheduling flexibility. In Phase II, we have positioned the WFC3 FOVs within the ACS footprints to cover regions of most interest. Hence, the positions do not agree exactly with those of the archival ACS fields.

A thee-step pattern is used for most of these data, to cover the gap and inprove cosmic ray rejection. (A two-step pattern is used on the one field with shorter exposures.)

POSTFLASH values are set on the exposures, based partly on ETC estimates of background and based partly on our earlier experience with cy19 program 12513 in M83.

Visit

Proposal 13361, New Field (01), implementation Tue Jun 25 02:28:57 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 0D TO 20 D; ORIENT 90D TO 110 D; ORIENT 180D TO 200 D; ORIENT 270D TO 290 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=1.635 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=86.84 Angle Between Sides= Center Pattern=false		(1-4)

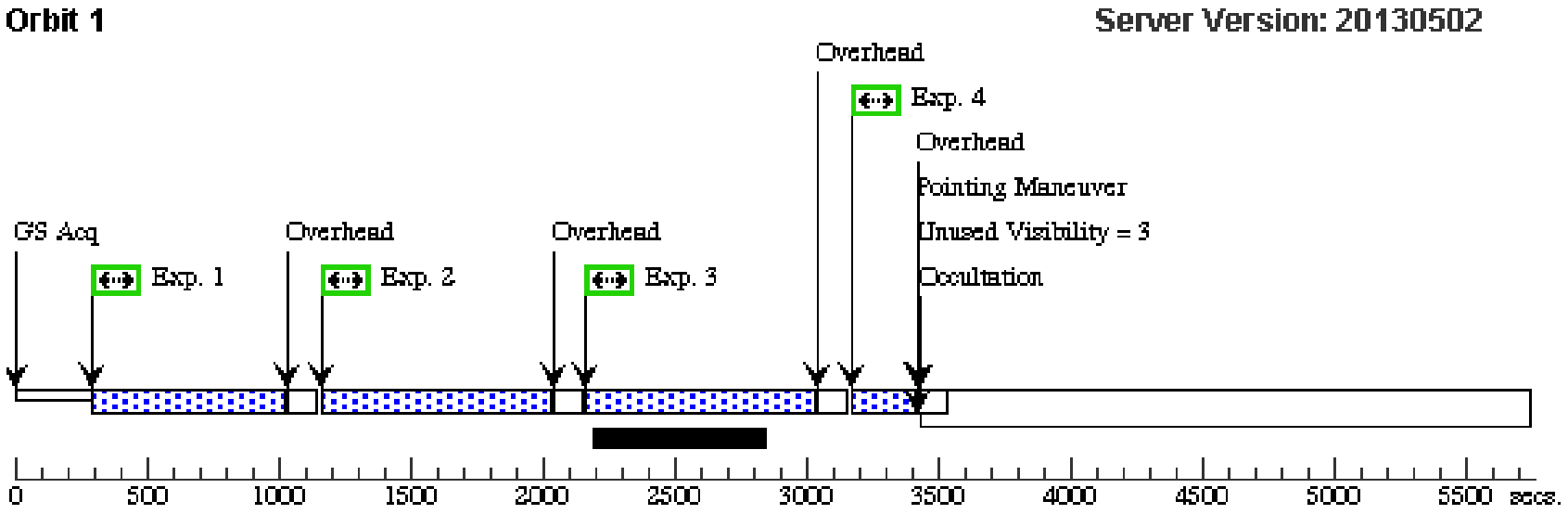
Fixed Targets

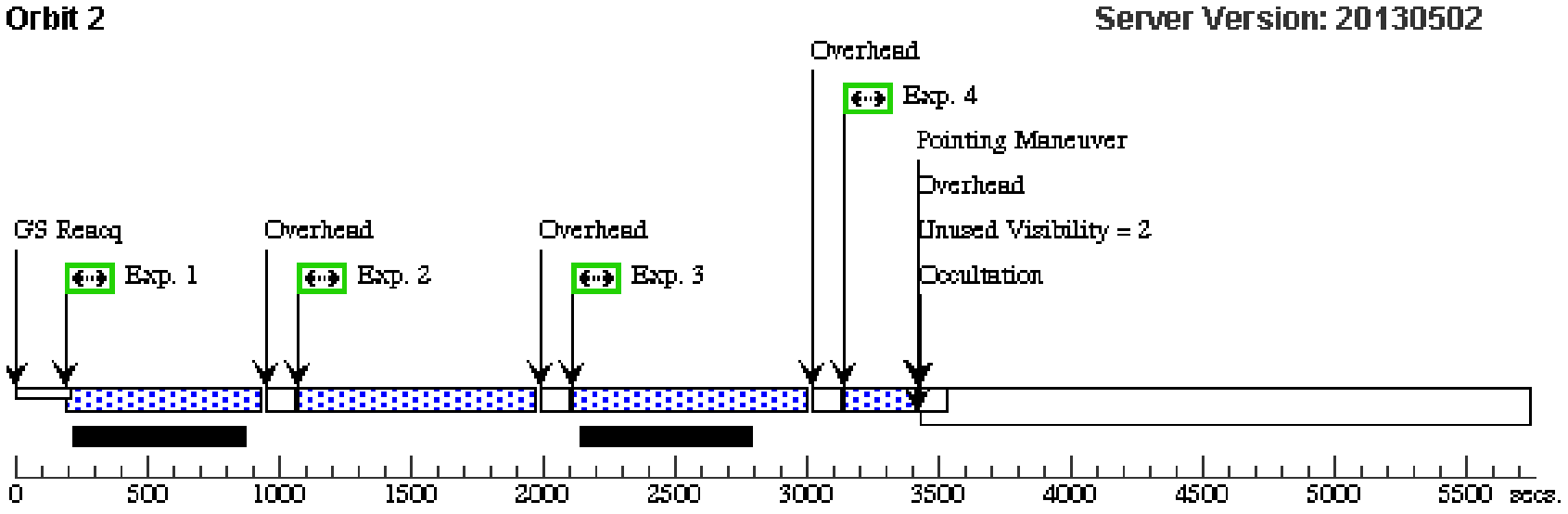
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	M101-ACS5-NEW	RA: 14 03 29.5341 (210.8730588d) Dec: +54 21 43.01 (54.36195d) Equinox: J2000		V=9	Reference Frame: ICRS

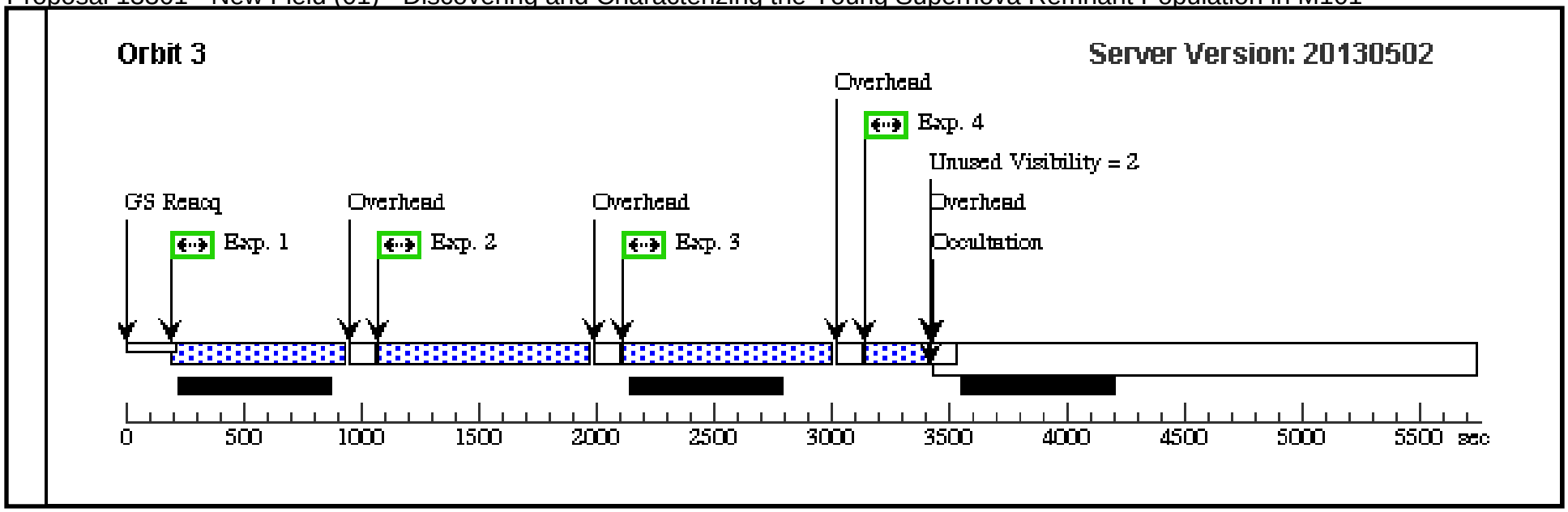
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(5) M101-ACS5-NEW	WFC3/UVIS, ACCUM, UVIS-CENTER	F657N	FLASH=8	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-4 in New Field (01) (1)	700 Secs (2150 Secs)	
								[==>698.0 Secs (Pattern 1)]	***[1]***
								[==>726.0 Secs (Pattern 2)]	***[2]***
								[==>726.0 Secs (Pattern 3)]	***[3]***
2		(5) M101-ACS5-NEW	WFC3/UVIS, ACCUM, UVIS-CENTER	F502N	FLASH=8		Pattern 1, Exps 1-4 in New Field (01) (1)	850 Secs (2600 Secs)	
								[==>848.0 Secs (Pattern 1)]	***[1]***
								[==>876.0 Secs (Pattern 2)]	***[2]***
								[==>876.0 Secs (Pattern 3)]	***[3]***
3		(5) M101-ACS5-NEW	WFC3/UVIS, ACCUM, UVIS-CENTER	F673N	FLASH=8		Pattern 1, Exps 1-4 in New Field (01) (1)	850 Secs (2600 Secs)	
								[==>848.0 Secs (Pattern 1)]	***[1]***
								[==>876.0 Secs (Pattern 2)]	***[2]***
								[==>876.0 Secs (Pattern 3)]	***[3]***
4		(5) M101-ACS5-NEW	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	FLASH=10		Pattern 1, Exps 1-4 in New Field (01) (1)	220 Secs (710 Secs)	
								[==>218.0 Secs (Pattern 1)]	***[1]***
								[==>246.0 Secs (Pattern 2)]	***[2]***
								[==>246.0 Secs (Pattern 3)]	***[3]***

Orbit Structure



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Exp. 2
Overhead
Exp. 3
Overhead
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13361, ACS1 Field (02), implementation Tue Jun 25 02:29:02 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 180D TO 200 D; ORIENT 0D TO 20 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=2.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=86.84 Angle Between Sides= Center Pattern=false		(1-2)

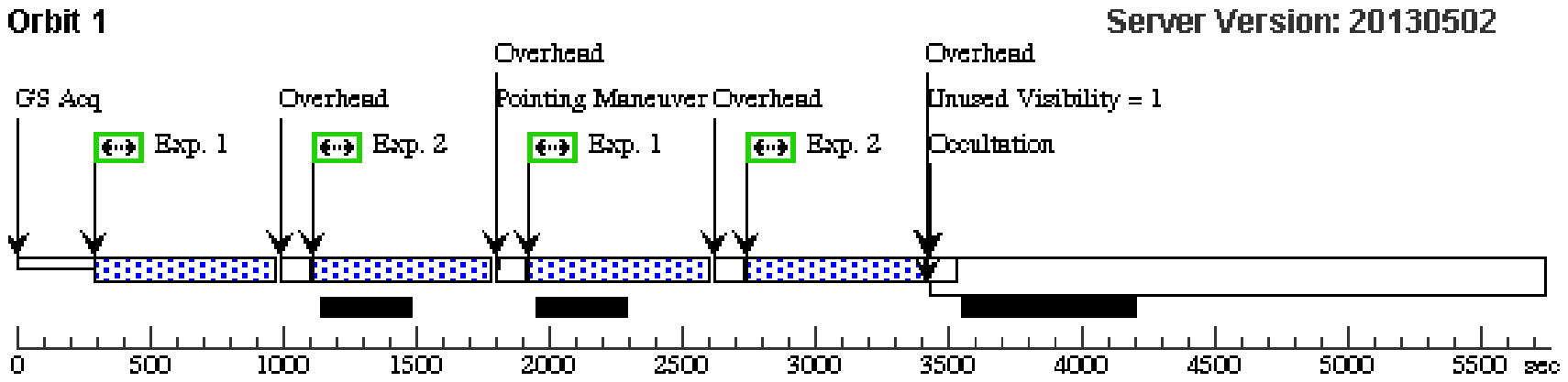
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M101-ACS1	RA: 14 03 40.6229 (210.9192621d) Dec: +54 19 27.36 (54.32427d) Equinox: J2000		V=9	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) M101-ACS1	WFC3/UVIS, ACCUM, UVIS-CENTER	F502N	FLASH=10	GS ACQ SCENARIO BASE1B3	Pattern 2, Exps 1-2 in ACS1 Field (02) (2)	650 Secs (1310 Secs) *[==>655.0 Secs (Pattern 1)]* *[==>655.0 Secs (Pattern 2)]*	*[1]*
2		(1) M101-ACS1	WFC3/UVIS, ACCUM, UVIS-CENTER	F673N	FLASH=10		Pattern 2, Exps 1-2 in ACS1 Field (02) (2)	650 Secs (1310 Secs) *[==>655.0 Secs (Pattern 1)]* *[==>655.0 Secs (Pattern 2)]*	*[1]*

Orbit Structure



Visit

Proposal 13361, ACS2 Field (03), implementation Tue Jun 25 02:29:03 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 180D TO 200 D; ORIENT 0D TO 20 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=1.635 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=86.84 Angle Between Sides= Center Pattern=false		(1-3)

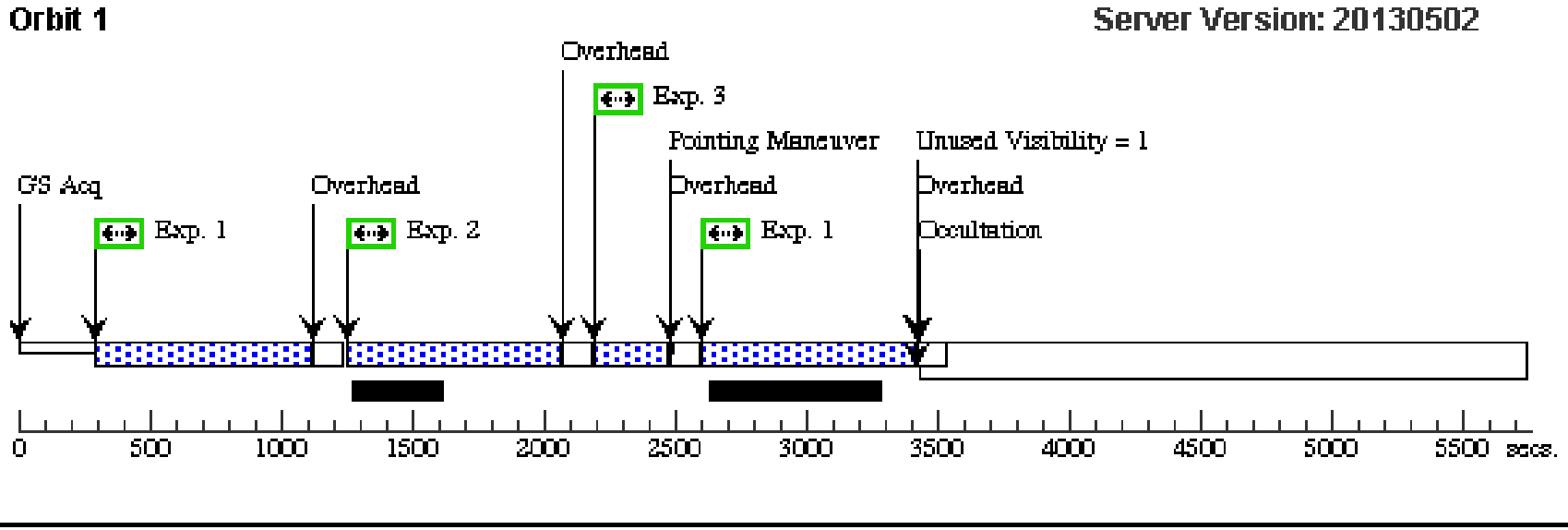
Fixed Targets

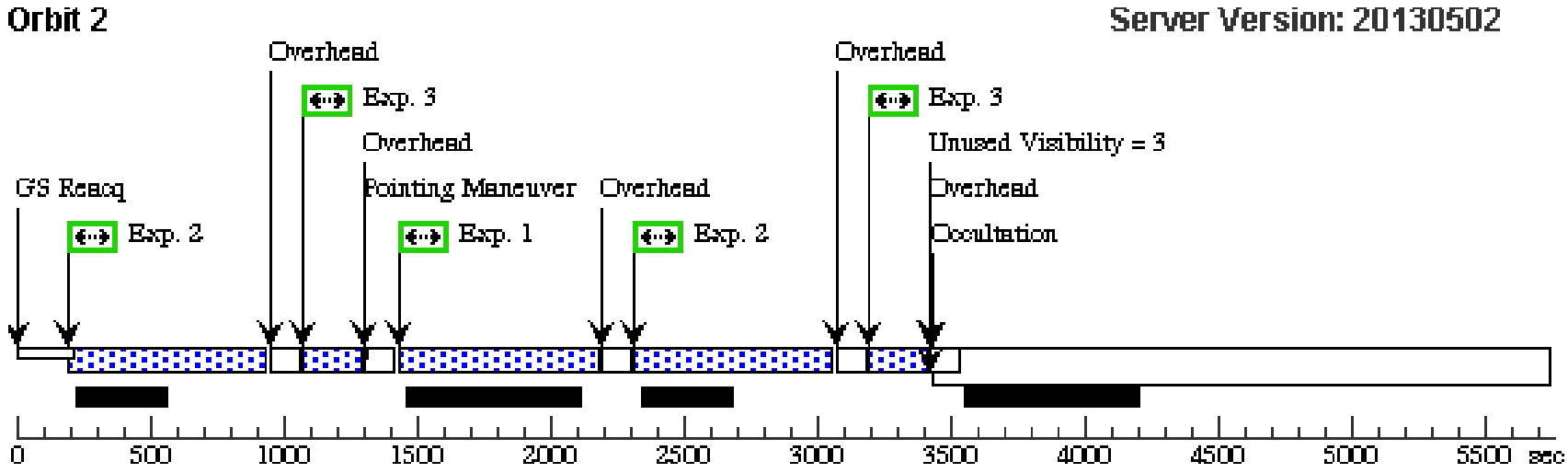
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	M101-ACS2	RA: 14 03 8.8742 (210.7869758d) Dec: +54 21 8.92 (54.35248d) Equinox: J2000		V=9	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) M101-ACS2	WFC3/UVIS, ACCUM, UVIS-FIX	F502N	FLASH=8	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-3 in ACS2 Field (03) (1)	725 Secs (2302 Secs)	
								[==>788.0 Secs (Pattern 1)] *[==>788.0 Secs (Pattern 2)]*	***[1]***
								[==>726.0 Secs (Pattern 3)]	***[2]***
2		(2) M101-ACS2	WFC3/UVIS, ACCUM, UVIS-FIX	F673N	FLASH=8		Pattern 1, Exps 1-3 in ACS2 Field (03) (1)	725 Secs (2240 Secs)	
								[==>788.0 Secs (Pattern 1)]	***[1]***
								[==>726.0 Secs (Pattern 2)] *[==>726.0 Secs (Pattern 3)]*	***[2]***
3		(2) M101-ACS2	WFC3/UVIS, ACCUM, UVIS-FIX	F547M	FLASH=10		Pattern 1, Exps 1-3 in ACS2 Field (03) (1)	190 Secs (635 Secs)	
								[==>253.0 Secs (Pattern 1)]	***[1]***
								[==>191.0 Secs (Pattern 2)] *[==>191.0 Secs (Pattern 3)]*	***[2]***

Orbit Structure





Visit

Proposal 13361, ACS3 Field (04), implementation Tue Jun 25 02:29:06 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 85D TO 105 D; ORIENT 260D TO 280 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=1.635 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=86.84 Angle Between Sides= Center Pattern=false		(1-3)

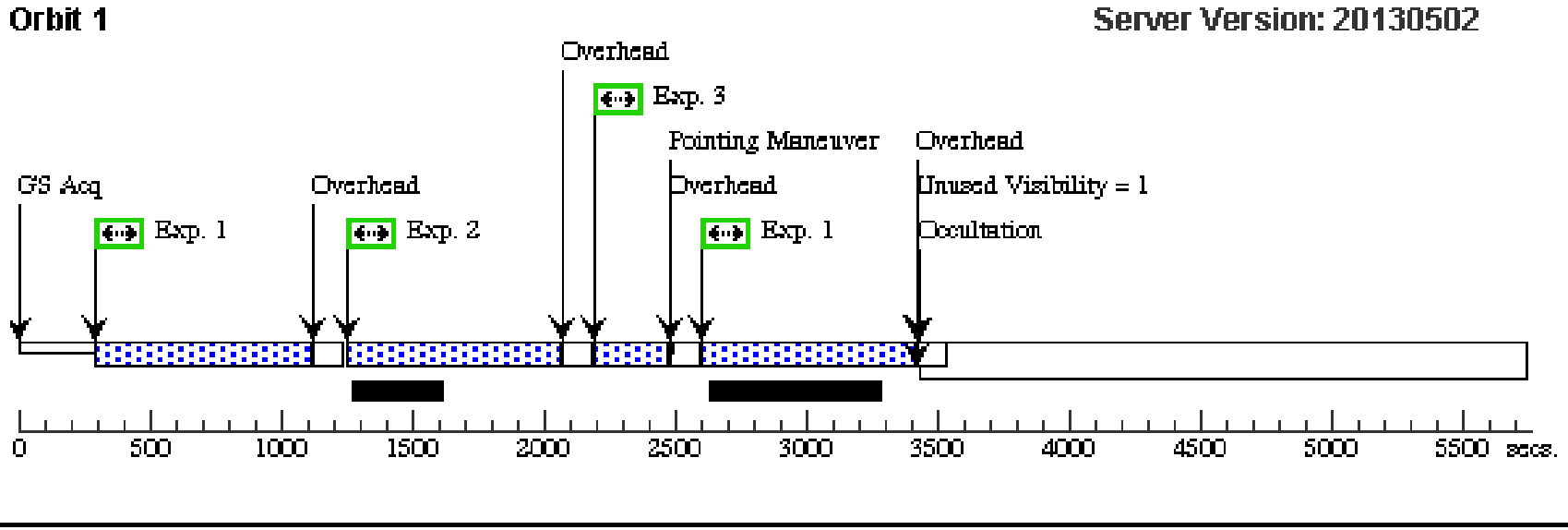
Fixed Targets

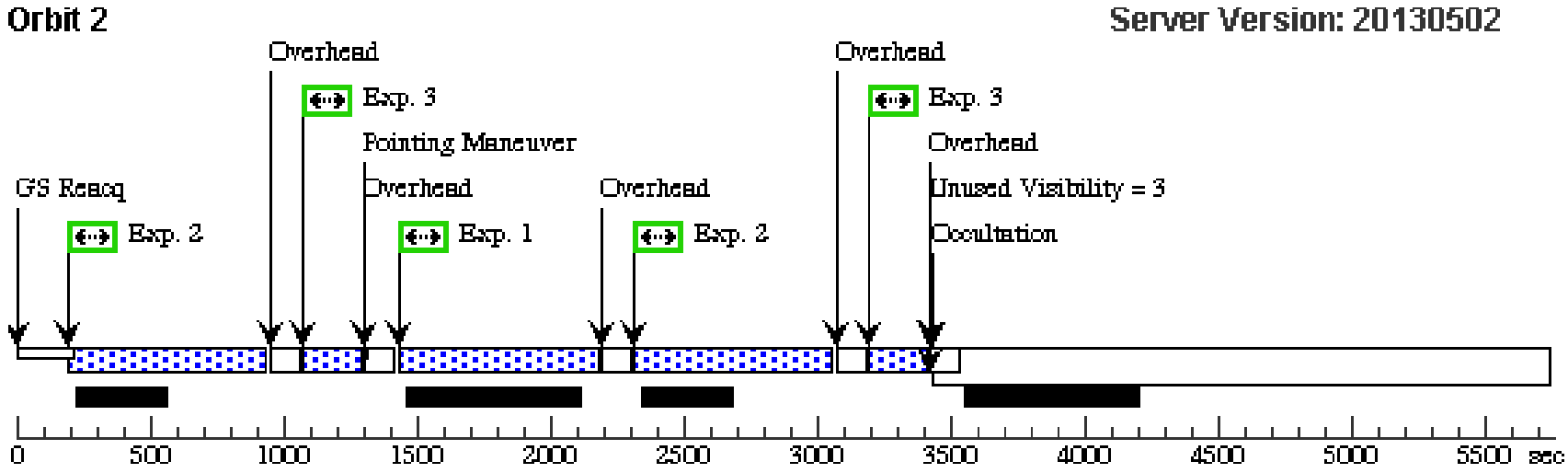
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	M101-ACS3	RA: 14 03 18.7327 (210.8280529d) Dec: +54 24 6.88 (54.40191d) Equinox: J2000		V=9	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) M101-ACS3	WFC3/UVIS, ACCUM, UVIS-CENTER	F502N	FLASH=8	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-3 in ACS3 Field (04) (1)	725 Secs (2302 Secs)	
								[==>788.0 Secs (Pattern 1)] *[==>788.0 Secs (Pattern 2)]*	***[1]***
								[==>726.0 Secs (Pattern 3)]	***[2]***
2		(3) M101-ACS3	WFC3/UVIS, ACCUM, UVIS-CENTER	F673N	FLASH=8		Pattern 1, Exps 1-3 in ACS3 Field (04) (1)	725 Secs (2240 Secs)	
								[==>788.0 Secs (Pattern 1)]	***[1]***
								[==>726.0 Secs (Pattern 2)] *[==>726.0 Secs (Pattern 3)]*	***[2]***
3		(3) M101-ACS3	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	FLASH=10		Pattern 1, Exps 1-3 in ACS3 Field (04) (1)	190 Secs (635 Secs)	
								[==>253.0 Secs (Pattern 1)]	***[1]***
								[==>191.0 Secs (Pattern 2)] *[==>191.0 Secs (Pattern 3)]*	***[2]***

Orbit Structure





Visit

Proposal 13361, ACS4 Field (05), implementation Tue Jun 25 02:29:08 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 260D TO 280 D; ORIENT 85D TO 105 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=1.635 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=86.84 Angle Between Sides= Center Pattern=false		(1-3)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	M101-ACS4	RA: 14 03 20.6220 (210.8359250d) Dec: +54 18 47.74 (54.31326d) Equinox: J2000		V=9	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(4) M101-ACS4	WFC3/UVIS, ACCUM, UVIS-CENTER	F502N	FLASH=8	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-3 in ACS4 Field (05) (1)	725 Secs (2302 Secs)	
								[==>788.0 Secs (Pattern 1)] *[==>788.0 Secs (Pattern 2)]*	***[1]***
								[==>726.0 Secs (Pattern 3)]	***[2]***
2		(4) M101-ACS4	WFC3/UVIS, ACCUM, UVIS-CENTER	F673N	FLASH=8		Pattern 1, Exps 1-3 in ACS4 Field (05) (1)	725 Secs (2240 Secs)	
								[==>788.0 Secs (Pattern 1)]	***[1]***
								[==>726.0 Secs (Pattern 2)] *[==>726.0 Secs (Pattern 3)]*	***[2]***
3		(4) M101-ACS4	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	FLASH=10		Pattern 1, Exps 1-3 in ACS4 Field (05) (1)	190 Secs (635 Secs)	
								[==>253.0 Secs (Pattern 1)]	***[1]***
								[==>191.0 Secs (Pattern 2)] *[==>191.0 Secs (Pattern 3)]*	***[2]***

Orbit Structure