



14716 - DDO 68: A flea with smaller fleas that on him prey

Cycle: 24, 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) UGC-5340	WFC3/UVIS	3	29-Jul-2016 15:01:21.0	yes
02	(1) UGC-5340	WFC3/UVIS	3	29-Jul-2016 15:01:23.0	yes
03	(1) UGC-5340	WFC3/UVIS	2	29-Jul-2016 15:01:24.0	yes
04	(1) UGC-5340	WFC3/UVIS	2	29-Jul-2016 15:01:25.0	yes

10 Total Orbits Used

ABSTRACT

With the Large Binocular Cameras on the LBT, we have recently discovered a stellar stream apparently connected to DDO 68, one of the most metal-poor and isolated star-forming dwarf galaxies, with a stellar mass of only 10^8 solar masses. Here we propose HST/WFC3 follow-up imaging of the stream to accurately measure, map and characterize its individual stars, in order to: a) constrain its precise distance through the red giant branch tip, and confirm its physical association with DDO 68; and b) infer the evolution of its stellar population. At DDO 68's distance of about 12 Mpc, only HST can resolve the stream into individual stars.

We have previously obtained ACS imaging of DDO 68. Those data, which only capture a small portion of the stream, provide tentative evidence that it is indeed at the distance of the galaxy. We also used the previous ACS data to derive DDO 68's star formation history, and combined the results with new N-body simulations which reproduce both DDO 68's distorted morphology and the position of the stream. This analysis suggests that DDO 68 has cannibalized a ten times smaller companion.

Our proposed observations will image the full extent of the stream, and are critical for not only understanding the true nature of this structure, but may also enable us to trace it further, beyond the extent apparent in the LBT data. DDO 68 will be the least massive dwarf galaxy with direct evidence for accretion of a satellite thus far if confirmed with the proposed observations. This study will be extremely important to test the self-similarity of the hierarchical galaxy formation process at all scales.

OBSERVING DESCRIPTION

At the DDO 68's distance of ~ 12.6 Mpc, corresponding to a distance modulus of $(m-M)_0 \sim 30.51$ (Sacchi et al 2016), the tip of the Red Giant Branch (RGB) is detected at $I \sim 26.4$. The same distance is assumed for our targeted stellar stream apparently connected to DDO 68. In order to derive a robust determination of the stream's distance and stellar population properties, we require to detect an RGB star with a $S/N \sim 5$ at ~ 1 mag below the RGB tip. This corresponds to a red giant star with $I=27.4$ and $V=28.7$ in Johnson-Cousins (conservatively assuming that the reddest RGB stars have $V-I \sim 1.3$ at the metallicity of DDO 68). The WFC3 ETC provides an exposure time of $\sim 12,000$ sec in F606W and $\sim 12,000$ sec in F814W to reach a $S/N \sim 5$ within a circular aperture of 4 pixel radius ($0.016''$, $\sim 2 \times \text{FWHM}$).

For each filter, the total exposure time will be split into two separate visits lasting respectively 2 and 3 orbits, for a total of 10 orbits for the entire program. Each visit will be organized into 8 sub-exposures executed with a primary dither pattern WFC3_UVIS_GAP_LINE to fill the gap between

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the chips, plus a secondary pattern WFC3_UVIS_DITHER_BOX to improve the PSF sampling (and get rid of cosmic rays, and hot/bad pixels). Within the longer 3 orbit visits, we added two short ~300 s exposures, executed with a WFC3_UVIS_DITHER_LINE pattern (with a point spacing ~ 4.8 ", or ~ 120 pixels) in order to get photometry of bright objects saturated in the long exposures.

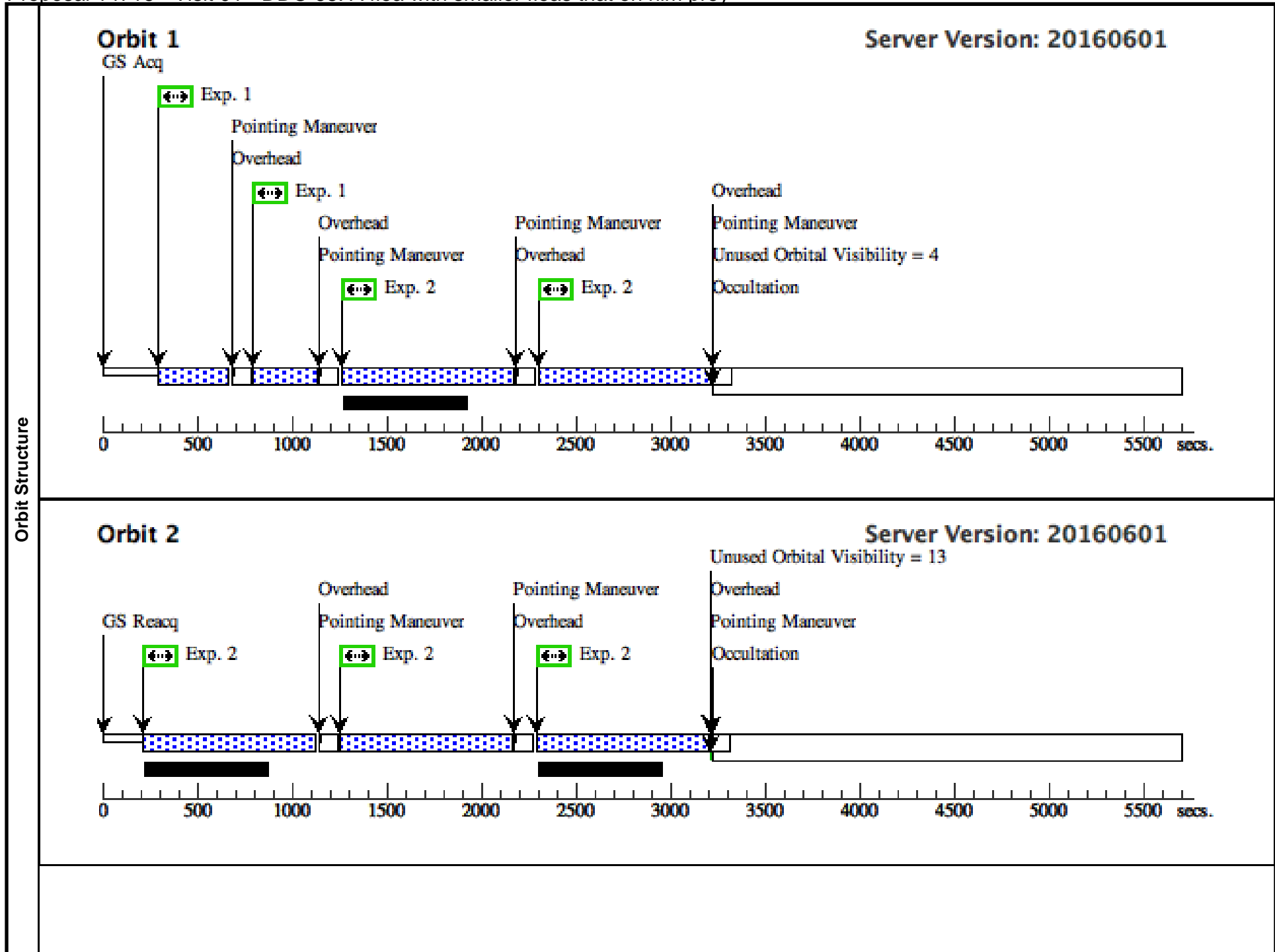
The targeted stellar stream has a projected size of ~20" x 80" on the LBT images. We require a specific orient for our observations in order to place the whole stream within one of the two WFC3 chips, avoiding the gap between the two detectors. The selected orient also maximizes the overlap with the portion of the LEGUS UV data lacking coverage in V and I. We require that the 4 visits will be all executed with the same position and same orient.

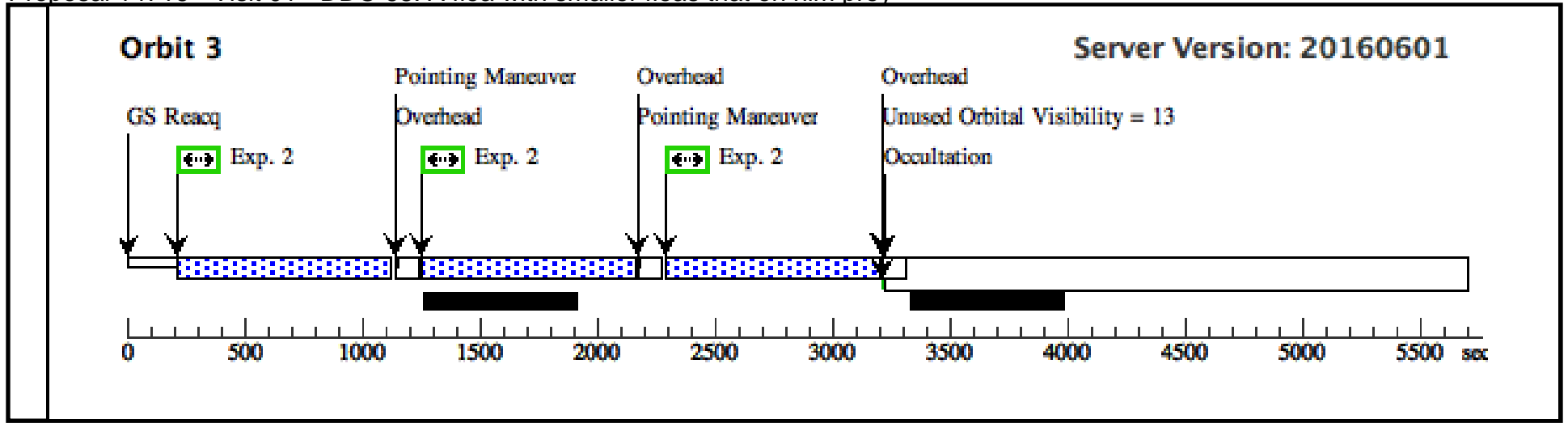
We also require that all 10 orbits are taken within 2 weeks of each other. Carbon stars are an important component of color-magnitude diagrams, and many of these stars are long-period variables. Having all observations made within a two week window will reduce the effect of the long-term variability of the carbon stars on their inferred positions in the color-magnitude diagrams.

Proposal 14716 - Visit 01 - DDO 68: A flea with smaller fleas that on him prey

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Visit	Proposal 14716, Visit 01 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 276D TO 276 D									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=OTHER Number Of Points=2 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false	(2)				
	(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=OTHER Number Of Points=2 Point Spacing=4.828 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	UGC-5340	RA: 09 56 53.6700 (149.2236250d) Dec: +28 49 42.30 (28.82842d) Equinox: J2000		V=20	Reference Frame: ICRS				
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) UGC-5340	WFC3/UVIS, ACCUM, UVIS	F606W			Pattern 2, Exps 1-1 in Visit 01 (2)	340 Secs (680 Secs)	
									[=>(Pattern 1)]	[1]
									[=>(Pattern 2)]	
	2		(1) UGC-5340	WFC3/UVIS, ACCUM, UVIS	F606W			Pattern 1, Exps 2-2 in Visit 01 (1)	910 Secs (7280 Secs)	
									[=>(Pattern 1,1)]	[1]
								[=>(Pattern 1,2)]		
								[=>(Pattern 1,3)]		
								[=>(Pattern 1,4)]	[2]	
								[=>(Pattern 2,1)]		
								[=>(Pattern 2,2)]		
								[=>(Pattern 2,3)]	[3]	
								[=>(Pattern 2,4)]		

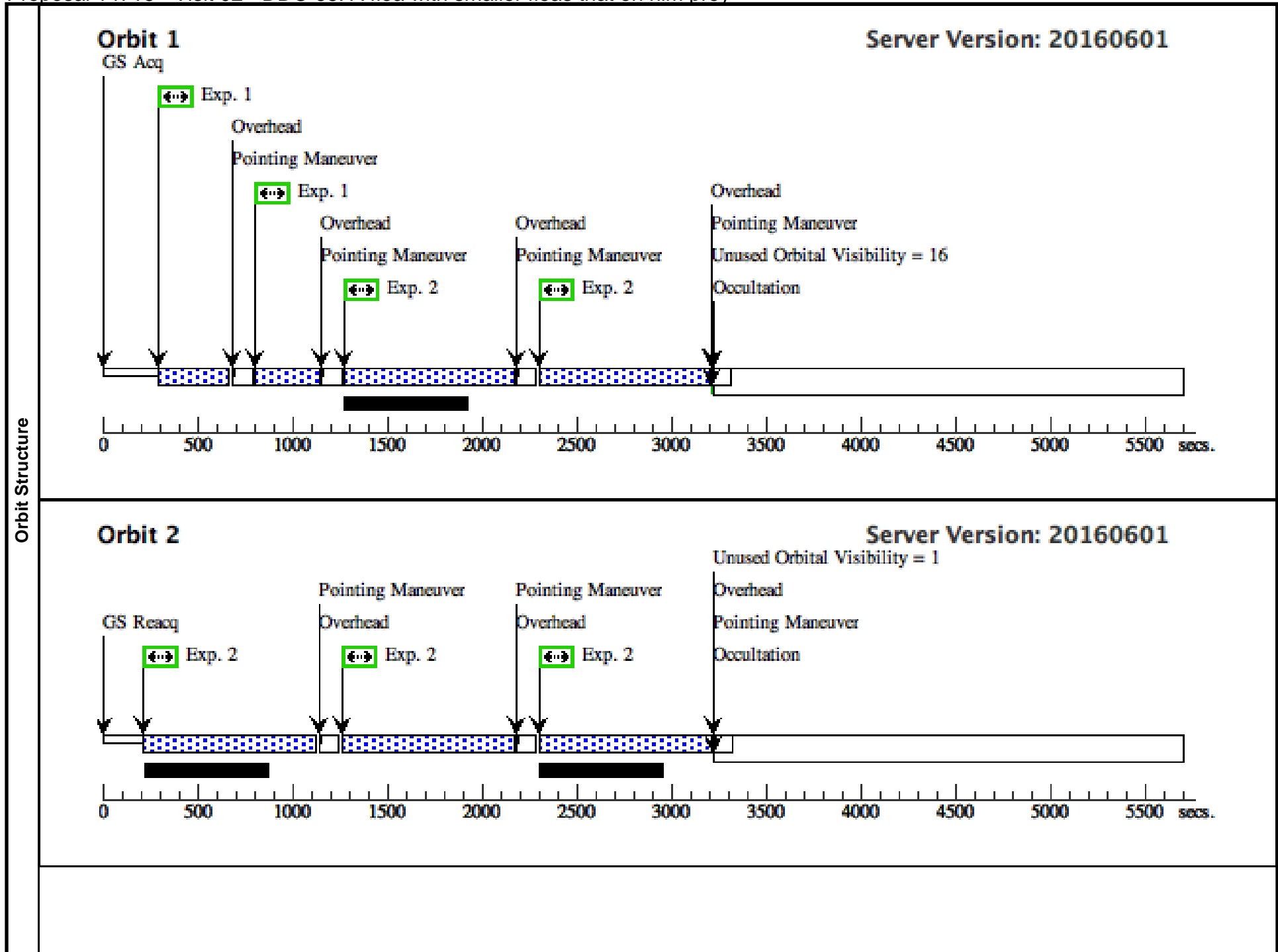


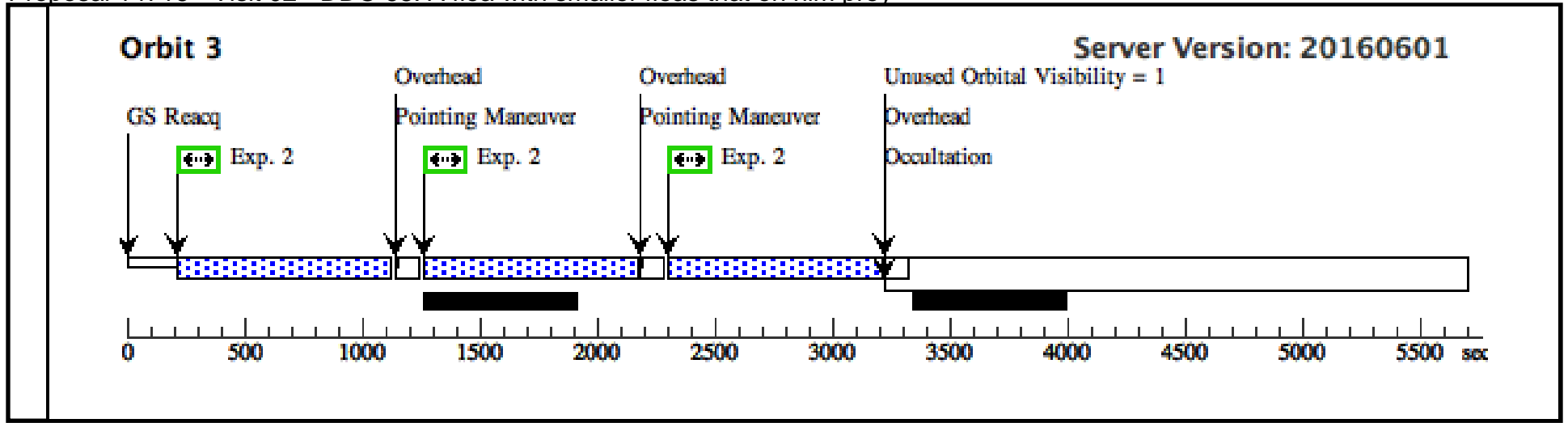


Proposal 14716 - Visit 02 - DDO 68: A flea with smaller fleas that on him prey

Fri Jul 29 19:01:26 GMT 2016

Visit	Proposal 14716, Visit 02 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: SAME ORIENT AS 01									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=OTHER Number Of Points=2 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false	(2)			
	(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=OTHER Number Of Points=2 Point Spacing=4.828 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	UGC-5340	RA: 09 56 53.6700 (149.2236250d) Dec: +28 49 42.30 (28.82842d) Equinox: J2000		V=20	Reference Frame: ICRS				
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) UGC-5340	WFC3/UVIS, ACCUM, UVIS	F814W	FLASH=4		Pattern 2, Exps 1-1 i n Visit 02 (2)	340 Secs (680 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[1]
	2		(1) UGC-5340	WFC3/UVIS, ACCUM, UVIS	F814W			Pattern 1, Exps 2-2 i n Visit 02 (1)	900 Secs (7284 Secs) [=>(Pattern 1,1)] [=>(Pattern 1,2)]	[1]
									[=>914.0 Secs (Pattern 1,3)]	
									[=>914.0 Secs (Pattern 1,4)]	[2]
									[=>914.0 Secs (Pattern 2,1)]	
								[=>914.0 Secs (Pattern 2,2)]		
								[=>914.0 Secs (Pattern 2,3)]	[3]	
								[=>914.0 Secs (Pattern 2,4)]		

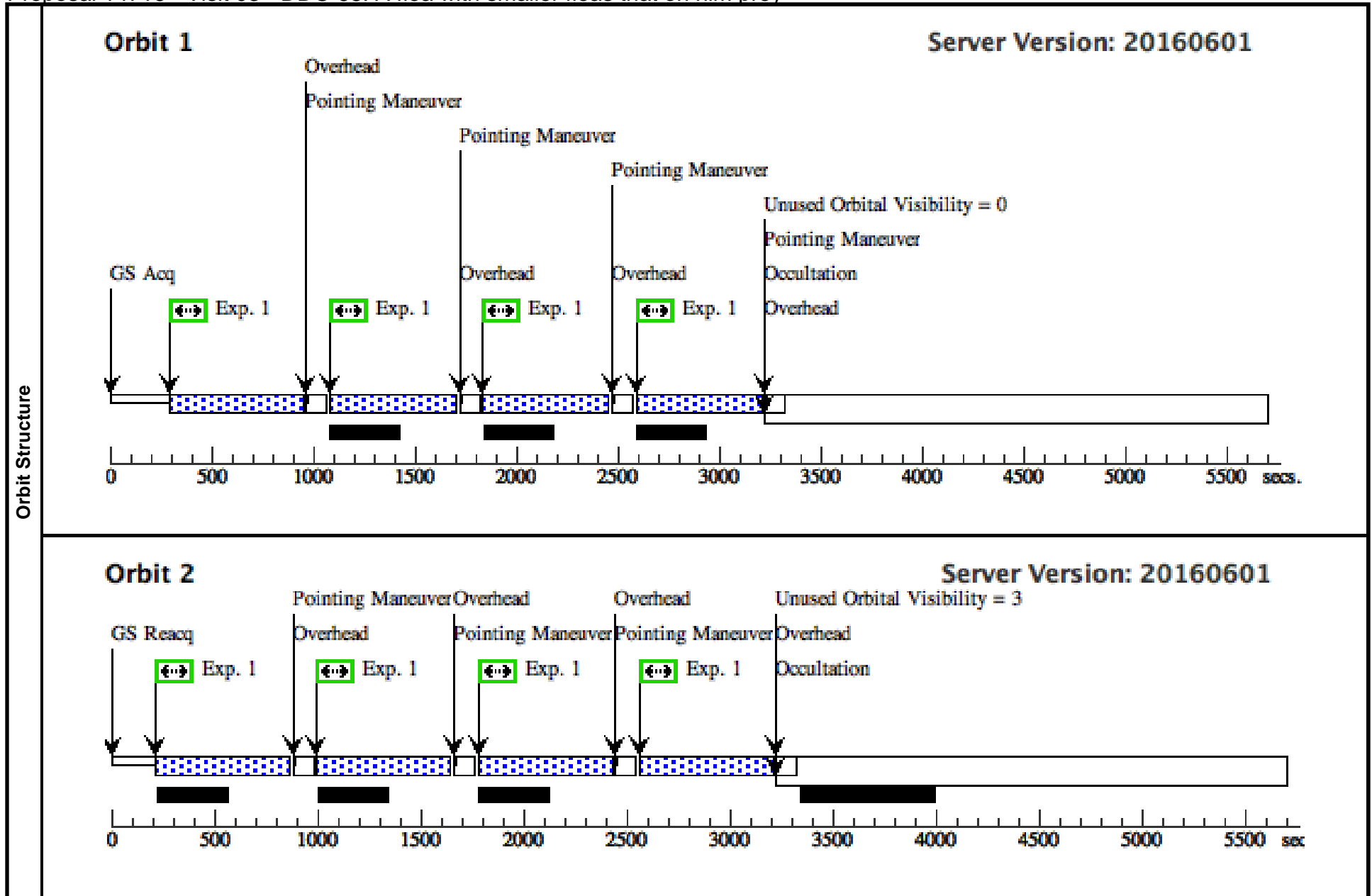




Proposal 14716 - Visit 03 - DDO 68: A flea with smaller fleas that on him prey

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Visit	Proposal 14716, Visit 03 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: SAME ORIENT AS 01									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=OTHER Number Of Points=2 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	(1)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	UGC-5340	RA: 09 56 53.6700 (149.2236250d) Dec: +28 49 42.30 (28.82842d) Equinox: J2000		V=20	Reference Frame: ICRS				
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) UGC-5340	WFC3/UVIS, ACCUM, UVIS	F606W				Pattern 1, Exps 1-1 i n Visit 03 (1)	600 Secs (5116 Secs) [==>626.0 Secs (Pattern 1,1)] [==>626.0 Secs (Pattern 1,2)] [==>626.0 Secs (Pattern 1,3)] [==>626.0 Secs (Pattern 1,4)] [==>653.0 Secs (Pattern 2,1)] [==>653.0 Secs (Pattern 2,2)] [==>653.0 Secs (Pattern 2,3)] [==>653.0 Secs (Pattern 2,4)]



Proposal 14716 - Visit 04 - DDO 68: A flea with smaller fleas that on him prey

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Visit	Proposal 14716, Visit 04 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: SAME ORIENT AS 01									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=OTHER Number Of Points=2 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	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)	UGC-5340	RA: 09 56 53.6700 (149.2236250d) Dec: +28 49 42.30 (28.82842d) Equinox: J2000		V=20	Reference Frame: ICRS				
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) UGC-5340	WFC3/UVIS, ACCUM, UVIS	F814W				Pattern 1, Exps 1-1 i n Visit 04 (1)	600 Secs (5116 Secs) [==>626.0 Secs (Pattern 1,1)] [==>626.0 Secs (Pattern 1,2)] [==>626.0 Secs (Pattern 1,3)] [==>626.0 Secs (Pattern 1,4)] [==>653.0 Secs (Pattern 2,1)] [==>653.0 Secs (Pattern 2,2)] [==>653.0 Secs (Pattern 2,3)] [==>653.0 Secs (Pattern 2,4)]

