



14487 - Light Echoes and the Progenitor of SN 2016adj in Cen A

Cycle: 23, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
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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) SN2016ADJ	WFC3/UVIS	2	01-Mar-2016 21:04:32.0	yes
02	(1) SN2016ADJ	WFC3/UVIS	1	01-Mar-2016 21:04:35.0	yes
03	(1) SN2016ADJ	WFC3/UVIS	1	01-Mar-2016 21:04:36.0	yes

4 Total Orbits Used

ABSTRACT

Supernova (SN) 2016adj is the fifth closest SN to be discovered during the lifetime of HST. This event offers us a rich variety of rare and unique opportunities, including: (1) identifying the progenitor; (2) mapping the three-dimensional structure and chemical composition of the progenitor's circumstellar and the host galaxy's interstellar environments; (3) testing models of stellar mass loss and high-mass stellar evolution; and (4) measuring the distance to the host galaxy, Cen A. The progenitor field of the SN has been observed from the near-UV to the near-IR with WFC3, which will immediately allow us to accomplish the first science goal by identifying the progenitor (or establishing its upper limits) once a new image with the SN present is taken. Preliminary analyses of early-time spectra of SN 2016adj indicate its light is being extinguished by at least $A(V)=2-4$ magnitudes, meaning it is buried deep within the dust lane of Cen A. Echoes of the SN light off of this dust will allow us to produce high-resolution, three-dimensional maps of the structure and composition of the dust in and around the line-of-sight to the SN, which we will use (as explained in this

proposal) to accomplish science goals (2)-(4) listed above. Please note that since echoes pass through a given point in space only once, data are permanently lost for each epoch that is not observed. While we will propose for continued observations in the Cycle 24 call for proposals, most of the science we propose cannot be achieved if the observations in this proposal are not taken before Cycle 24 begins.

OBSERVING DESCRIPTION

This observing campaign is to search for light echoes of SN 2016adj off of pre-existing circumstellar and interstellar matter. The field in which SN 2016adj exploded was observed by WFC3 UVIS as part of GO-11360 in the following filters (and exposure times): F438W (1605 s), F547M (1250 s), and F814W (1240 s). These pre-explosion images allow us to perform an optimal observing strategy of duplicating previous observations, and then using PSF-matched difference-imaging techniques specifically adapted to HST images, which subtract off all sources of constant flux to reveal extended, low surface-brightness echo features. For this proposal, we will continue to use this combination of WFC3/UVIS filters. In particular, the F547M filter is free from most bright emission lines that can contribute contaminating sources of noise when looking for light echoes.

For the first epoch, we do not know the brightness of the SN, so a long exposure may saturate. As such, we will take long exposures in the 3 filters, and medium and short exposures in F547M. As we have done with past programs, for maximum spatial resolution, we will take all exposures using a four-point dither box with sub-pixel offsets to allow drizzling to higher resolution. Images in F814W and F438W were taken on 22 Feb 2016 as part of GO-14115 (PI. Van Dyk). Examination of the counts show that the SN is especially bright in the F814W filter, reaching the full-well capacity within 10 sec. The supernova is expected to be ~25% fainter when our first observation is to be taken. We have planned for short exposures in F547M and F814W to image the SN without saturating it, and longer exposures to look for faint surface-brightness features around it. For short integrations, we have looked at background counts in other images from 2010, and added post-FLASH to reach 12-13 e/pix. Longer integrations do not need the post flash. There is need for short integrations in F438W because the SN is already quite faint and will only become fainter with time.

The supernova is located very close to a bright foreground (field) star, and we need to keep its diffraction spikes from crossing the location of the SN. Based on the roll-angle of the telescope on 22 Feb 2016, the spikes will cross the supernova if the ORIENTAT is between 180-205 degrees. We have therefore added ORIENT constraints to keep the ORIENTAT either below 180 or greater than 205, as follows. The header from icvy01aiqflt.fits (GO-14415) lists PA_V3= 129.6 and ORIENTAT=174.14, which we interpret as meaning the angle U3= 309.6 or about 310 degrees. This implies the roll angle of the telescope must be either $U3 < 315$ or $U3 > 340$ when taking data. We have put these ORIENT constraints into the first visit.

Multiple follow-up imaging epochs are necessary to record echoes with the fidelity needed to extract their geometries. Since light-echo morphology

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changes on the timescale set by the effective width of the SN pulse, which for Type Ib and Iib SNe is between 20-40 days, with a maximum of about 60 days for a typical Type II, the SN should be imaged at roughly the same interval. The first visit needs to happen before the Cycle 24 proposal deadline of 08 Apr 2016, with sufficient lead time so that we can use these initial observations to properly plan a comprehensive observing strategy. As such, we have requested the first observation happen before 24 Mar 2016. Originally we applied for 6 orbits, to use in 3 visits of 2 orbits each. With an allocation of only 4 orbits, we have decided that it is more scientifically valuable to image the structure of potential echoes with the 40-60 day cadence to fully cover the period until Cycle 24 starts, than to acquire full color information of the echoes with only two visits. As such, we are going to use one orbit 40-60 days after the first visit (visit 2), and one orbit 40-60 days thereafter (visit 3). These latter two visits will only use F547M and F814W. If, after the first visit in all 3 filters, we discover that echoes are sufficiently faint to require deeper observations, we will ask to revise the 2nd and 3rd visits to use the whole orbit to image in F547M only. There is no reason to expect the diffraction spikes from the nearby star will cross the SN in visits 2 and 3.

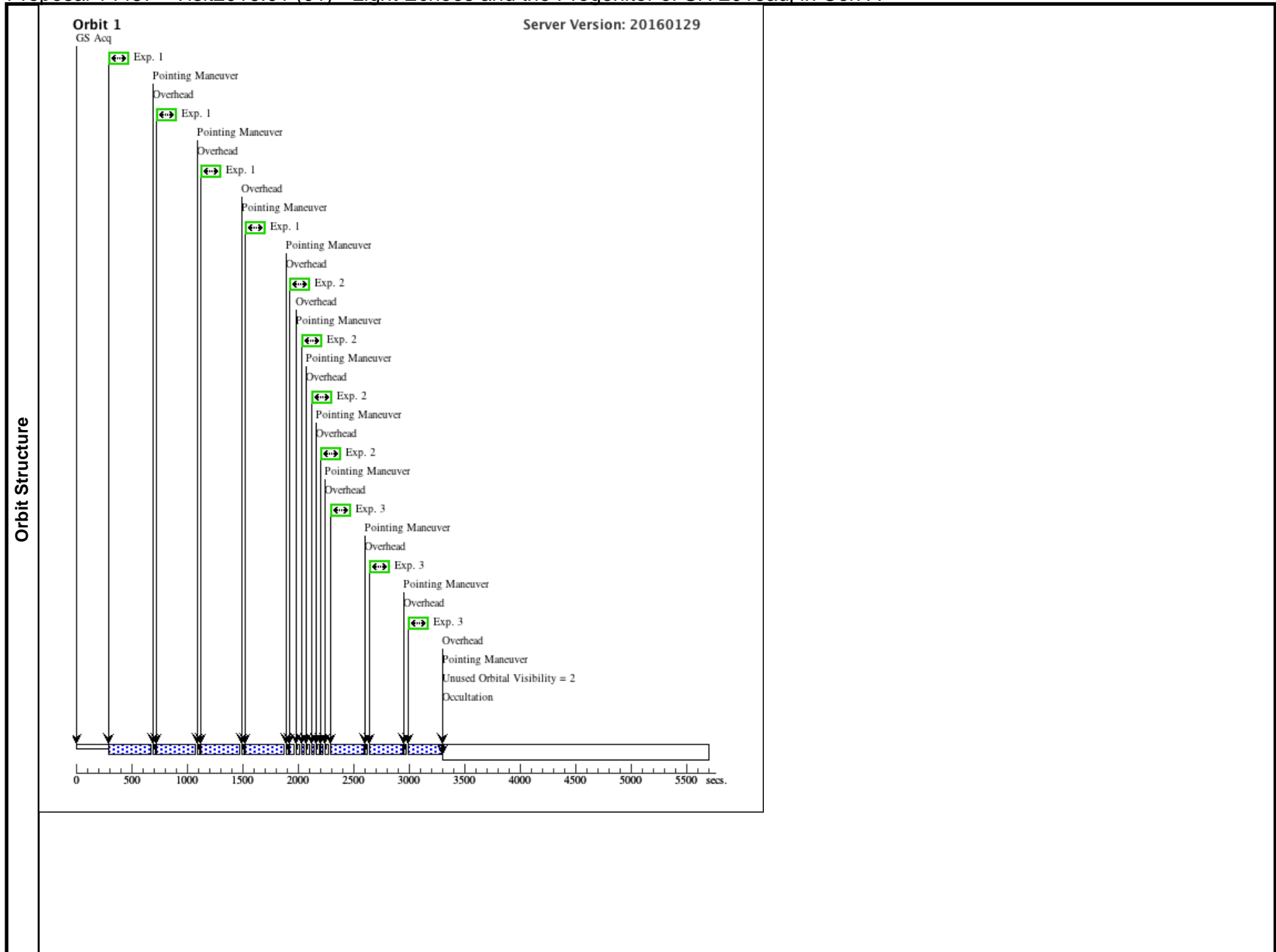
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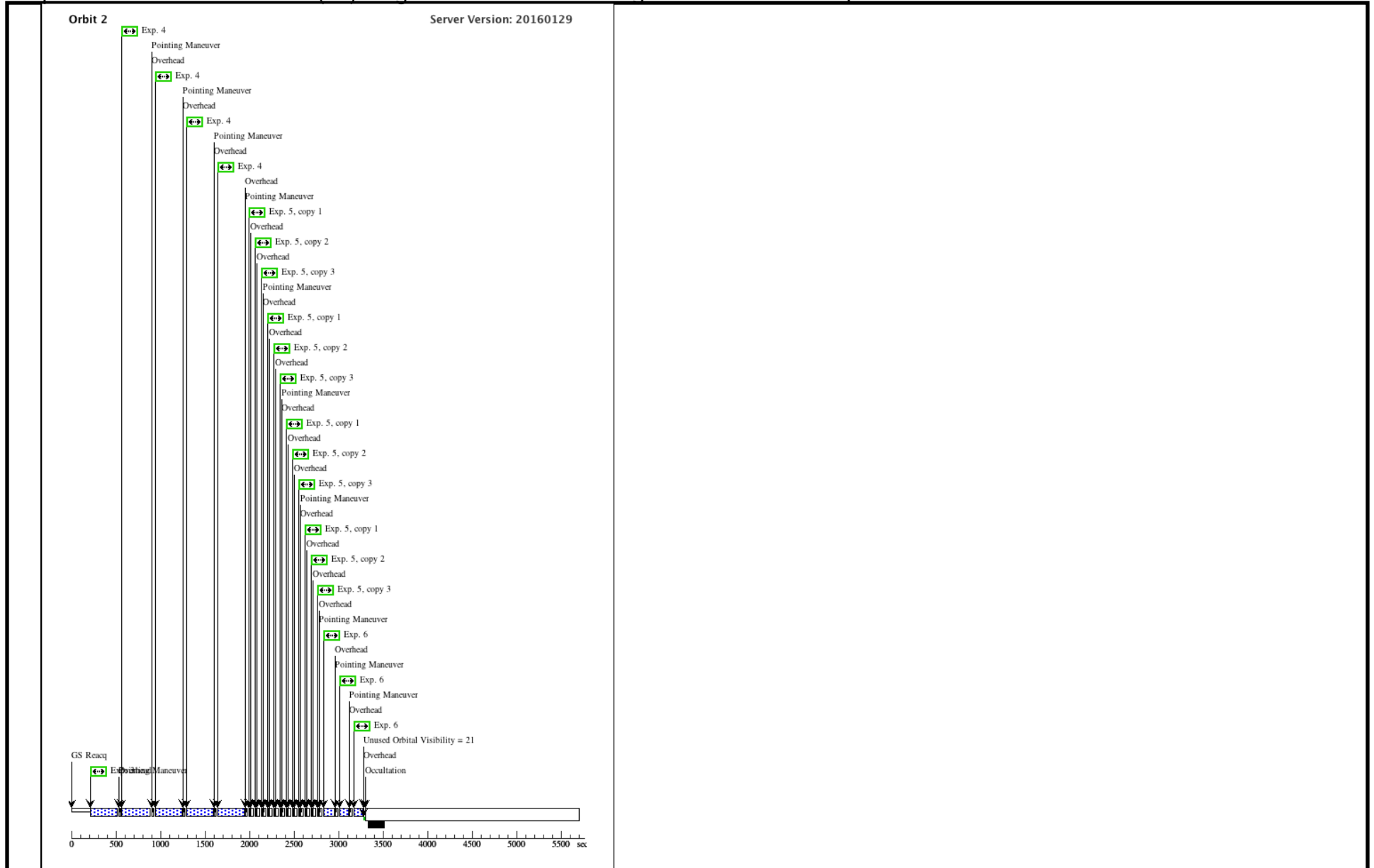
Visit	Proposal 14487, Visit2016.01 (01), implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 300D TO 315 D; ORIENT 340D TO 355 D; BETWEEN 18-MAR-2016:00:00:00 AND 24-MAR-2016:00:00:00					
	(Exposure 1 (Pattern 1, Exps 1-1 in Visit2016.01 (01))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (Exposure 3 (Pattern 1, Exps 3-3 in Visit2016.01 (01))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (Exposure 4 (Pattern 1, Exps 4-4 in Visit2016.01 (01))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (Exposure 5 (Pattern 1, Exps 5-5 in Visit2016.01 (01))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (Exposure 6 (Pattern 2, Exps 6-6 in Visit2016.01 (01))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser					
Diagnosics						
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures	
		(1)	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), (2), (3), (4), (5)	
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false	(6)			
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	SN2016ADJ	RA: 13 25 24.1100 (201.3504583d) Dec: -43 00 57.50 (-43.01597d) Equinox: J2000		V=15+/-1	Reference Frame: ICRS

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#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F438W			Pattern 1, Exps 1-1 in Visit2016.01 (01) (1)	350 Secs (1400 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F547M	FLASH=11		Pattern 1, Exps 2-2 in Visit2016.01 (01) (1)	25 Secs (100 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	3	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F547M			Pattern 1, Exps 3-3 in Visit2016.01 (01) (1)	300 Secs (1200 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1] [2]
	4	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W			Pattern 1, Exps 4-4 in Visit2016.01 (01) (1)	300 Secs (1200 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[2]
	5	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=10		Pattern 1, Exps 5-5 in Visit2016.01 (01) (1)	10 Secs X 3 (120 Secs) [==>(Pattern 1, Copy 1)] [==>(Pattern 1, Copy 2)] [==>(Pattern 1, Copy 3)] [==>(Pattern 2, Copy 1)] [==>(Pattern 2, Copy 2)] [==>(Pattern 2, Copy 3)] [==>(Pattern 3, Copy 1)] [==>(Pattern 3, Copy 2)] [==>(Pattern 3, Copy 3)] [==>(Pattern 4, Copy 1)] [==>(Pattern 4, Copy 2)] [==>(Pattern 4, Copy 3)]	[2]
	6	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F547M	FLASH=6		Pattern 2, Exps 6-6 in Visit2016.01 (01) (2)	100 Secs (300 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	[2]



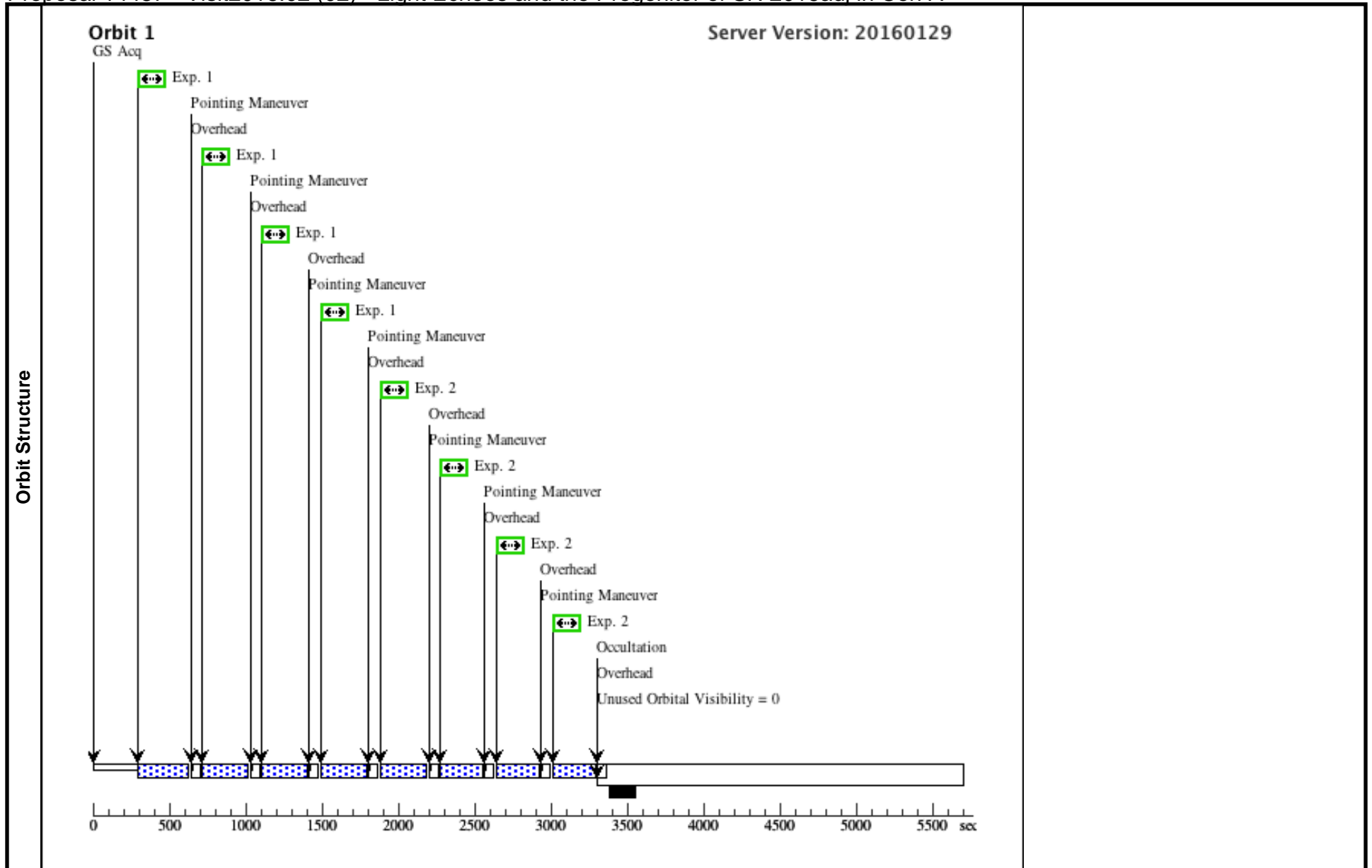
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Proposal 14487 - Visit2016.02 (02) - Light Echoes and the Progenitor of SN 2016adj in Cen A

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Visit	Proposal 14487, Visit2016.02 (02), implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 01 BY 40 D TO 60 D									
	(Exposure 1 (Pattern 1, Exps 1-1 in Visit2016.02 (02))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (Exposure 2 (Pattern 1, Exps 2-2 in Visit2016.02 (02))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser									
Diagnosics										
Patterns	#	Primary Pattern	Secondary Pattern		Exposures					
	(1)	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), (2)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	SN2016ADJ	RA: 13 25 24.1100 (201.3504583d) Dec: -43 00 57.50 (-43.01597d) Equinox: J2000		V=15+/-1	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) SN2016ADJ	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-M1K1C-SUB	F547M			Pattern 1, Exps 1-1 in Visit2016.02 (02) (1)	300 Secs (1200 Secs)	
									[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(1) SN2016ADJ	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-M1K1C-SUB	F814W			Pattern 1, Exps 2-2 in Visit2016.02 (02) (1)	280 Secs (1120 Secs)	
								[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]	



Proposal 14487 - Visit2016.03 (03) - Light Echoes and the Progenitor of SN 2016adj in Cen A

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Visit	Proposal 14487, Visit2016.03 (03), implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 02 BY 40 D TO 60 D									
	(Exposure 1 (Pattern 1, Exps 1-1 in Visit2016.03 (03))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (Exposure 2 (Pattern 1, Exps 2-2 in Visit2016.03 (03))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser									
Diagnos										
Patterns	#	Primary Pattern	Secondary Pattern	Exposures						
	(1)	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), (2)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	SN2016ADJ	RA: 13 25 24.1100 (201.3504583d) Dec: -43 00 57.50 (-43.01597d) Equinox: J2000		V=15+/-1	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) SN2016ADJ	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-M1K1C-SUB	F547M			Pattern 1, Exps 1-1 in Visit2016.03 (03) (1)	300 Secs (1200 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]
	2	(1) SN2016ADJ	(1) SN2016ADJ	WFC3/UVIS, ACCUM, UVIS2-M1K1C-SUB	F814W			Pattern 1, Exps 2-2 in Visit2016.03 (03) (1)	280 Secs (1120 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]

