14794 - Planetary Nebulae in the Open Clusters of M31

Cycle: 24, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
02	(3) M31-B458-D049	WFC3/UVIS	1	11-Jul-2018 15:18:02.0	yes
03	(4) M31-SK044A	WFC3/UVIS	1	11-Jul-2018 15:18:03.0	yes
04	(1) M31-B477-OFFSET (2) M31-B477-D075-PN CCDFLAT	STIS/CCD	2	11-Jul-2018 15:18:05.0	yes
05	(1) M31-B477-OFFSET (2) M31-B477-D075-PN	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	11-Jul-2018 15:18:06.0	yes

6 Total Orbits Used

ABSTRACT

Most planetary nebulae (PNe) are field objects. Precious little is known about their progenitor stars' properties and how they relate to those of the PN. The lone exceptions are the very rare

cases where a PN is a member of an open star cluster. Then one can determine the ages, masses, and compositions of the progenitors, providing direct tests of stellar-evolution theory.

We have recently discovered three PNe belonging to open clusters in M31, the Andromeda Galaxy. Here we propose a set of HST follow-up investigations.

For the PN in the M31 cluster B477-D075, we know its precise location, and there are excellent photometric data (from the M31 PHAT project) that establish the host cluster's age (350 Myr) and the mass of the PN progenitor star (3.35 Msun). We will use STIS spectroscopy in the UV and optical to measure He, CNO, and alpha-process abundances in the nebula, based on emission-line fluxes and a photoionization code. Our primary aim is to compare the measured abundances with predictions of post-AGB evolution theory. In particular, "hot-bottom burning" is expected to produce enhanced He/H and N/O abundances when the progenitor star is sufficiently massive, but it is uncertain whether this occurs at masses as low as ~3 Msun, or requires masses of at least ~5 Msun. Thus our observations will provide key new constraints on AGB evolution of intermediate-mass stars.

For two other M31 clusters, B458-D049 and SK044A, whose integrated-light spectra show that a PN is present, we will use WFC3 with an [O III] filter to verify the presence of the PNe, and determine their precise astrometric locations. We will then follow up with STIS spectroscopy in a future HST Cycle.

OBSERVING DESCRIPTION

This program has 3 targets. For one of the targets we will obtain long-slit spectra with STIS. For the other two, we will obtain direct images with WFC3.

1. STIS: The target is a planetary nebula in the M31 open cluster B477-D075. Since the PN itself is very faint, we do an acquisition on a nearby, brighter star. We have measured the offset from this star to the PN using narrow-band ACS

images that show both the star and the PN. Following the acquisition and offset maneuver, we use 4 HST orbits to obtain STIS spectra with the low-resolution gratings. We dither along the slit for these observations.

2. WFC3: For the open clusters B458-D049 and SK044A, each of which is known from ground-based integrated spectra to contain a PN, we will obtain direct images in order to precisely locate the PN (for follow-up STIS spectroscopy in a future cycle). We will obtain a narrow-band F502N image ([O III]), along with a broad-band V (F555W) image. Image subtraction will clearly identify the PN. We will also obtain images in I (F814W) in order to obtain an improved color-magnitude diagram for each cluster.

Visit

Proposal 14794, WFC3-M31-B458 (02), implementation Wed Jul 11 19:18:07 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-3 in WFC3-M31-B458 (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 1-3 in WFC3-M31-B458 (02))) 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 1-3 in WFC3-M31-B458 (02))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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=true		(1-3)

Fixed Targets

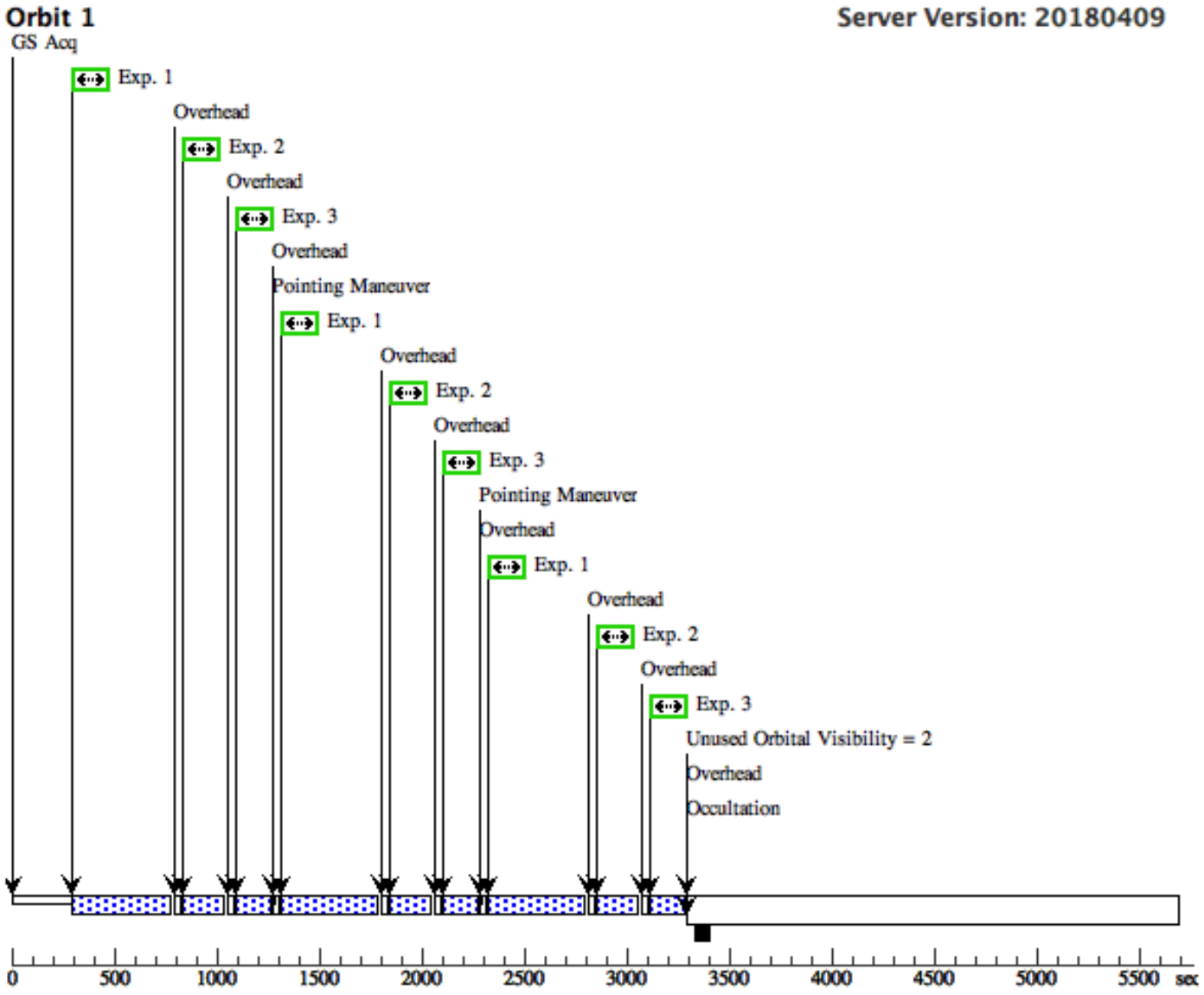
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	M31-B458-D049	RA: 00 41 44.5900 (10.4357917d) Dec: +40 51 22.90 (40.85636d) Equinox: J2000		V=25	Reference Frame: ICRS

Comments:
Category=STELLAR CLUSTER
Description=[EMISSION LINE NEBULA, OPEN CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) M31-B458-D049	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F502N	CR-SPLIT=NO; FLASH=8		Pattern 1, Exps 1-3 in WFC3-M31-B458 (02) (1)	450 Secs (1350 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(3) M31-B458-D049	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F555W	CR-SPLIT=NO; FLASH=6		Pattern 1, Exps 1-3 in WFC3-M31-B458 (02) (1)	175 Secs (525 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
3		(3) M31-B458-D049	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	CR-SPLIT=NO		Pattern 1, Exps 1-3 in WFC3-M31-B458 (02) (1)	150 Secs (450 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***

Orbit Structure



Visit

Proposal 14794, WFC3-M31-SK044A (03), implementation Wed Jul 11 19:18:07 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-3 in WFC3-M31-SK044A (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 1-3 in WFC3-M31-SK044A (03))) 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 1-3 in WFC3-M31-SK044A (03))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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=true		(1-3)

Fixed Targets

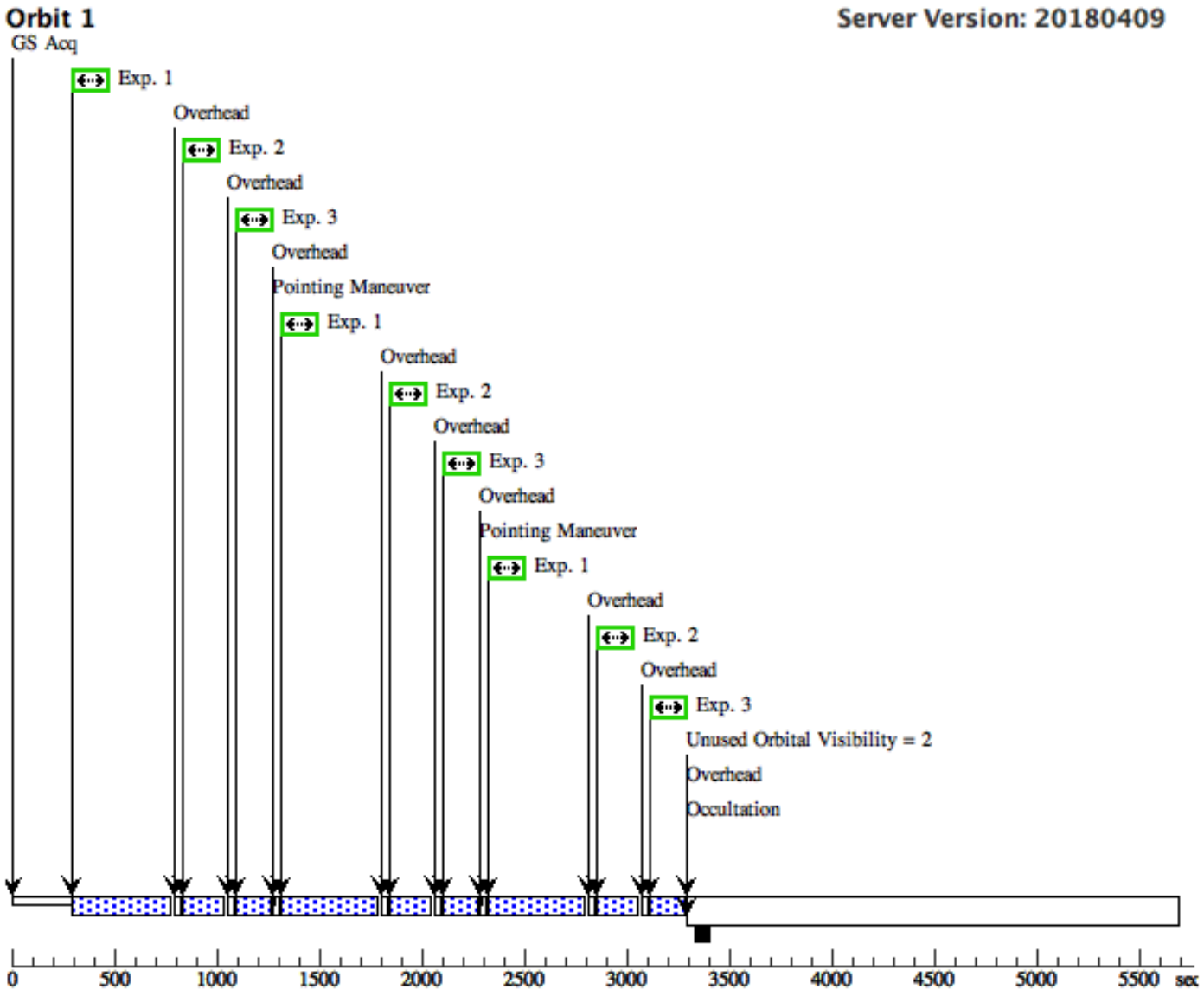
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	M31-SK044A	RA: 00 42 6.3200 (10.5263333d) Dec: +40 53 16.60 (40.88794d) Equinox: J2000		V=26.1	Reference Frame: ICRS

Comments:
Category=STELLAR CLUSTER
Description=[EMISSION LINE NEBULA, OPEN CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(4) M31-SK044A	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F502N	CR-SPLIT=NO; FLASH=8		Pattern 1, Exps 1-3 in WFC3-M31-SK044A (03) (1)	450 Secs (1350 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(4) M31-SK044A	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F555W	CR-SPLIT=NO; FLASH=6		Pattern 1, Exps 1-3 in WFC3-M31-SK044A (03) (1)	175 Secs (525 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
3		(4) M31-SK044A	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	CR-SPLIT=NO		Pattern 1, Exps 1-3 in WFC3-M31-SK044A (03) (1)	150 Secs (450 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***

Orbit Structure



Visit

Proposal 14794, STIS-CCD-M31-B477-PN (04) Wed Jul 11 19:18:07 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: STIS/CCD

Special Requirements: (none)

Diagnostics

(STIS-CCD-M31-B477-PN (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(2)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=3	Angle Between Sides=		
	Point Spacing=0.40624	Center Pattern=true		
	Line Spacing=			
(3)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(4)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=4	Angle Between Sides=		
	Point Spacing=0.40624	Center Pattern=true		
	Line Spacing=			

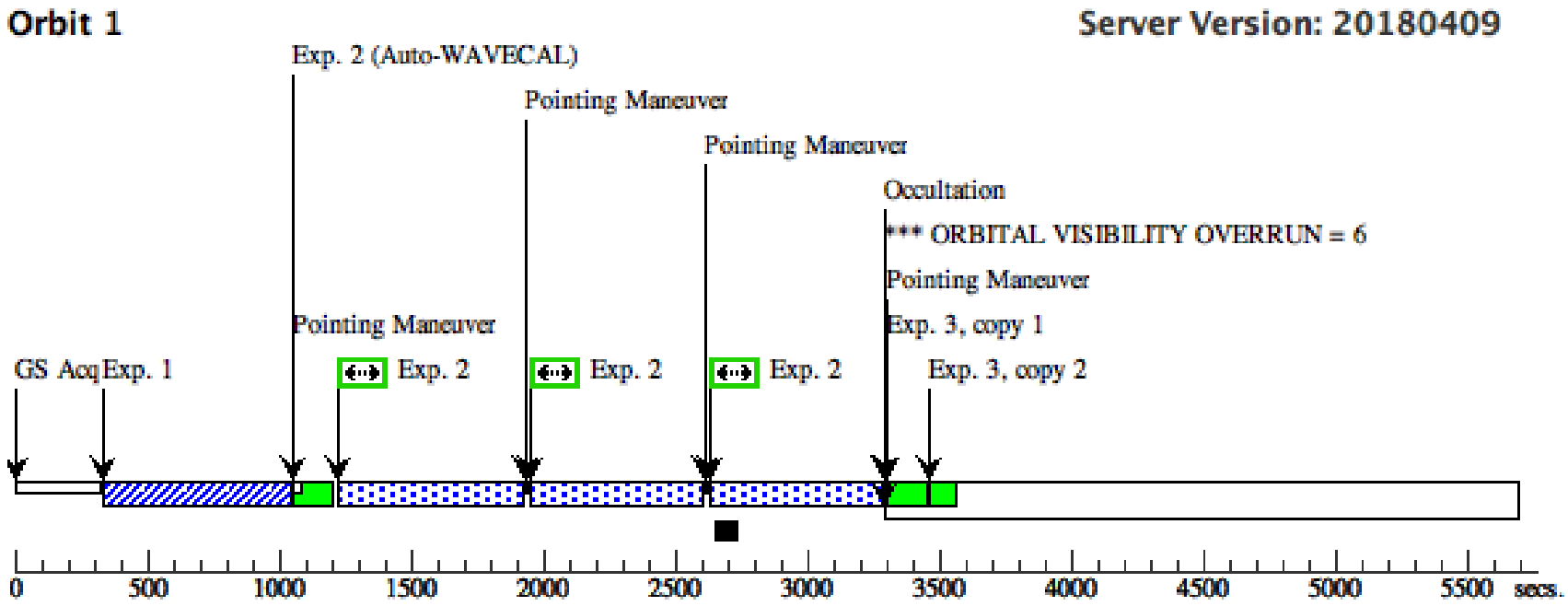
Fixed Targets

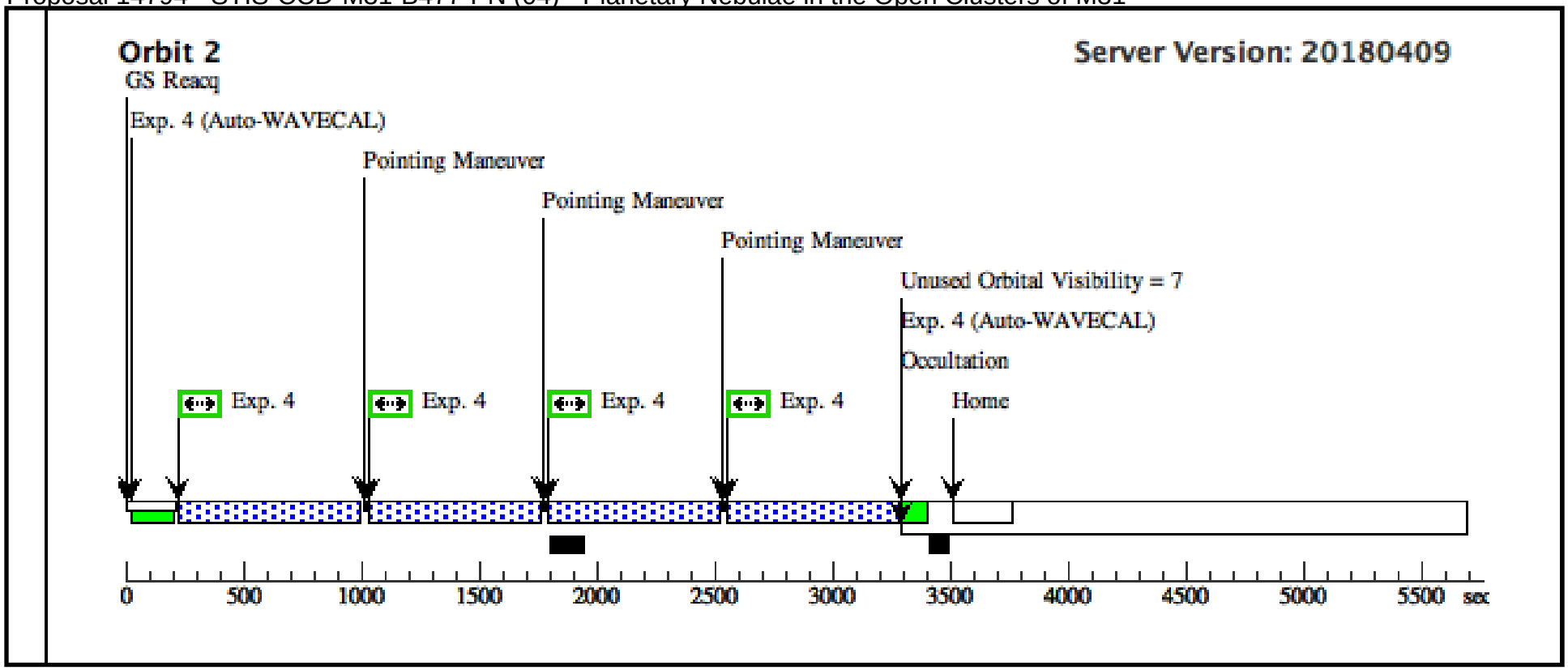
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M31-B477-OFFSET	RA: 00 45 8.2954 (11.2845642d)		V=22	Reference Frame: ICRS
		Dec: +41 39 48.39 (41.66344d)			
		Equinox: J2000			
Comments: *Category=UNIDENTIFIED* *Description=[OPTICAL EMITTER]*					
(2)	M31-B477-D075-PN	Offset from M31-B477-OFFSET		V=22	Offset Position (M31-B477-D075-PN)
		RA Offset: 0.11 Secs			
		Dec Offset: -9.969 Arcsec			
Comments: *Category=EXT-MEDIUM* *Description=[EJECTA, EMISSION LINE NEBULA, PLANETARY NEBULA]*					

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Offset star acq	(1) M31-B477-OFFSET	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			120 Secs (120 Secs) *[==>]*	 ***[1]***
2	G750L	(2) M31-B477-D075-PN	STIS/CCD, ACCUM, 52X0.5E1	G750L 7751 A	CR-SPLIT=NO; GAIN=1		Pattern 2, Exps 2-2 in STIS-CCD-M31-B477-PN (04) (2)	615 Secs (1845 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[1]***
3	Fringe flat	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[1]***
4	G430L	(2) M31-B477-D075-PN	STIS/CCD, ACCUM, 52X0.5E1	G430L 4300 A	CR-SPLIT=NO; GAIN=1		Pattern 3, Exps 4-4 in STIS-CCD-M31-B477-PN (04) (3)	690 Secs (2760 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[2]***

Orbit Structure

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Occultation
Exp. 4
Exp. 4
Exp. 4
Exp. 4
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1500
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3000
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Visit

Proposal 14794, STIS-MAMA-M31-B477-PN (05) Wed Jul 11 19:18:08 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA

Special Requirements: (none)

Diagnostics

(STIS-MAMA-M31-B477-PN (05)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(STIS-MAMA-M31-B477-PN (05)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(G230L (05.002)) Warning (Form): Sensitive exposures should have an ETC run number provided.

(G140L (05.003)) Warning (Form): Sensitive exposures should have an ETC run number provided.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(2), (3)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=2	Angle Between Sides=		
	Point Spacing=0.3952	Center Pattern=true		
	Line Spacing=			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M31-B477-OFFSET	RA: 00 45 8.2954 (11.2845642d) Dec: +41 39 48.39 (41.66344d) Equinox: J2000		V=22	Reference Frame: ICRS
Comments: *Category=UNIDENTIFIED* *Description=[OPTICAL EMITTER]*					
(2)	M31-B477-D075-PN	Offset from M31-B477-OFFSET RA Offset: 0.11 Secs Dec Offset: -9.969 Arcsec		V=22	Offset Position (M31-B477-D075-PN)
Comments: *Category=EXT-MEDIUM* *Description=[EJECTA, EMISSION LINE NEBULA, PLANETARY NEBULA]*					

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Offset star acq	(1) M31-B477-OFFSET	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			75 Secs (75 Secs) *[==>]*	*[1]*
2	G230L	(2) M31-B477-D075-PN	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A			Pattern 4, Exps 2-2 in STIS-MAMA-M31-B477-PN (05) (4)	1430 Secs (2006 Secs) *[==>1003.0 Secs (Pattern 1)]* *[==>1003.0 Secs (Pattern 2)]*	*[1]*
3	G140L	(2) M31-B477-D075-PN	STIS/FUV-MAMA, ACCUM, 52X0.5D1	G140L 1425 A			Pattern 4, Exps 3-3 in STIS-MAMA-M31-B477-PN (05) (4)	1435 Secs (2870 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	*[2]*

Orbit Structure