



18348 - Watching a rare massive binary mass loss in real time in NaSt1

Cycle: 34, 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) LS-IV-+00-5	WFC3/UVIS	1	03-Aug-2026 17:00:40.0	yes

1 Total Orbits Used

ABSTRACT

Massive stellar evolution has profound effects on galaxy evolution. Massive stars provide the first chemical enrichment via their mass loss and their different types of supernovae. Their explosive deaths provide stellar feedback governing star formation, is a key uncertainty in galaxy evolution modeling. Binary-induced mass loss is likely the primary mechanism through which massive stars lose mass. Yet, it is poorly understood because massive stars undergoing binary mass loss are extremely rare. We propose to obtain narrowband images of NaSt1, one such rare Galactic post mass transfer massive binary systems to capture the expansion of its known spatially resolved circumstellar medium, and distinguish between eruptive and stable mass loss. The CSM around NaSt1 was imaged by HST in 2013, showing an extended nitrogen-enriched nebula with a radius of around 1000 AU. Recent spectroscopic observations from 2025 measured the CSM expansion speed to 31 km/s, which put the age of the nebula to only about 150

yrs. Provided the time gap of 14 years between the previous HST observation and Cycle 34, a detectable (~ 1 pixel) proper motion of the CSM is expected in the new image. Space-based image quality is key to resolving any asymmetry arising in the CSM expansion, in particular to determine whether the speed is roughly the same across the nebula as expected in steady mass loss, or grows outward as expected in eruptive mass loss.

OBSERVING DESCRIPTION

We request to repeat observations of NaSt1 in the same manner as in the 2013 observations (PID 13034; PI Mauerhan); thus, the description of observations is based on the public information from that program. Images in two narrow band filters are required: F658N to detect the [N II] emission from the extended nebula and F645N to detect the continuum from the scattered light from the central star (Fig. 3 in the proposal). We will perform the same image subtraction to remove the stellar contribution and isolate the CSM. To mitigate the CTE issue and minimize overhead we request the 1Kx1K subarray (UVIS2-C1K1C-SUB), and FLASH = 12. (The SUB subarray is selected to put the nebula in the middle of the subarray, instead of at the corner for the -CTE subarray). To prevent saturation and improve spatial sampling, we request the 5-point subpixel WFC3-UVIS-DITHER-LINE dither pattern, with 176-sec exposure time each, totaling 880 sec of exposure in each filter. We verified the raw data from 2013 that the central star did not saturate the detector. We did not repeat the ETC calculation since this setup has proven to work and even though the source is variable, the amplitude is only 0.13 mag in the R band (Lau et al, 2021). Since the nebula is well resolved and only fills a small fraction of the field of view, we do not restrict the position angle of the telescope. We are performing source subtraction using the F645N data, so the diffraction spikes orientation is not concerning either. Fig. 3 shows that the subtraction can effectively remove them. We verified using Phase II tools that observations fit within one orbit.

Proposal 18348 - Visit 01 - Watching a rare massive binary mass loss in real time in NaSt1

Visit	Proposal 18348, Visit 01										Mon Aug 03 21:00:41 GMT 2026		
	Diagnostic Status: Warning												
	Scientific Instruments: WFC3/UVIS												
	Special Requirements: (none)												
Diagnostics	(Exposure 1 (Pattern 1, Exps 1-1 in Visit 01)) 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 Visit 01)) 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 Coordinate Frame=POS-TARG Pattern Orientation=46.84 Purpose=DITHER Angle Between Sides= Number Of Points=5 Center Pattern=false Point Spacing=0.145 Line Spacing=										(1), (2)	
Fixed Targets	#	Name		Target Coordinates		Targ. Coord. Corrections			Fluxes		Miscellaneous		
	(1)	LS-IV-+00-5		RA: 18 52 17.5478 (283.0731158d) Dec: +00 59 44.30 (.99564d) Equinox: J2000		Proper Motion RA: -0.255 mas/yr Proper Motion Dec: -0.6379999376804335 mas/yr Parallax: 3.332E-4" Epoch of Position: 2000			V=15.4		Reference Frame: ICRS		
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.												
	SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM. Category=STAR Description=[CIRCUMSTELLAR MATTER, EMISSION LINE NEBULA, EMISSION LINE STAR, INTERACTING BINARY]												
Exposures	#	Label	Target	Config,Mode,Aperture		Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1		(1) LS-IV-+00-5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB		F645N	FLASH=12		Pattern 1, Exps 1-1 i n Visit 01 (1)	176 Secs (880 Secs)		[1]	
										[==>172.0 Secs (Pattern 1)]			
										[==>177.0 Secs (Pattern 2)]			
									[==>177.0 Secs (Pattern 3)]				
									[==>177.0 Secs (Pattern 4)]				
									[==>177.0 Secs (Pattern 5)]				
2		(1) LS-IV-+00-5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB		F658N	FLASH=12		Pattern 1, Exps 2-2 i n Visit 01 (1)	176 Secs (885 Secs)		[1]		
									[==>177.0 Secs (Pattern 1)]				
									[==>177.0 Secs (Pattern 2)]				
									[==>177.0 Secs (Pattern 3)]				
									[==>177.0 Secs (Pattern 4)]				
									[==>177.0 Secs (Pattern 5)]				

