16508 - Confirming a Failed Supernova Candidate in M51

Cycle: 28, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Jacob Jencson (PI) (Contact)	**University of Arizona**	**jjencson@email.arizona.edu**
Prof. David J. Sand (CoI) (AdminUSPI)	University of Arizona	dave.j.sand@gmail.com
Prof. Jay Strader (CoI)	Michigan State University	straderj@msu.edu
Dr. Nathan Smith (CoI)	University of Arizona	nathans@as.arizona.edu
Dr. Jennifer Andrews (CoI)	NOIRLab - Gemini North (HI)	jandrews@gemini.edu
Jeniveve Pearson (CoI)	University of Arizona	jenivevepearson@email.arizona.edu
Dr. Stefano Valenti (CoI)	University of California - Davis	stfn.valenti@gmail.com

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) M51DS1	ACS/WFC	1	17-May-2021 09:00:15.0	yes
02	(1) M51DS1	ACS/WFC	1	17-May-2021 09:00:15.0	yes
04	(1) M51DS1	WFC3/IR	1	17-May-2021 09:00:16.0	yes
54	(1) M51DS1	WFC3/IR	1	17-May-2021 09:00:18.0	yes

4 Total Orbits Used

ABSTRACT

We request three orbits of ACS (F606W, F814W) and WFC3 IR (F110W, F160W) imaging at the location of a red supergiant star in M51 that has vanished, potentially as a 'failed supernova' that directly collapsed into a black hole. There is mounting evidence, both observational and theoretical,

that 10-30% of core collapses do not yield a supernova explosion, but only one viable candidate for such a 'failed supernova' event has been observed thus far. Here, we have discovered a new, strong candidate for the disappearance of a luminous star in M51 which has been detected dozens of times with HST through late 2017. The star had the characteristics of a 25-30 M_sun red supergiant before it faded from view (>2.0 mag) in 2019 in a crowded region of a spiral arm. Deep HST multi-band imaging in the next few months will confirm the nature of the vanished star and rule out possible alternatives, such as a dust-obscured star. These observations will also constrain any fading remnant emission that may be associated with fallback accretion or an associated dust shell; depending on the results, this will be a prime target for further HST and JWST monitoring in future cycles. HST is the only currently available facility with the resolution and sensitivity, especially in the near-IR, necessary to perform this test. Confirmation of a second strong case for a 'failed supernova' will have broad consequences, not only for verifying this channel of stellar death, but for our understanding of stellar remnants, chemical enrichment, and ultimately models of black hole formation.

OBSERVING DESCRIPTION

Our primary science goal is to determine the nature of the fading source M51-DS1. To accomplish this we require three orbits total to observe in the optical (F606W, F814W) and near-infrared (F110W, F160W). The optical data (two orbits) will be with ACS/WFC, and the near-infrared (one orbit) with WFC3/IR.

We split up our observations into three separate visits of one orbit each.

For both the ACS and WFC3 observations, we use a standard four-point dither box for each orbit, with sub-pixel dithers in order to get closer to the native resolution of ACS.

Visit

Proposal 16508, M51DS1_F606W (01), completed Mon May 17 13:00:18 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false		(1)

Fixed Targets

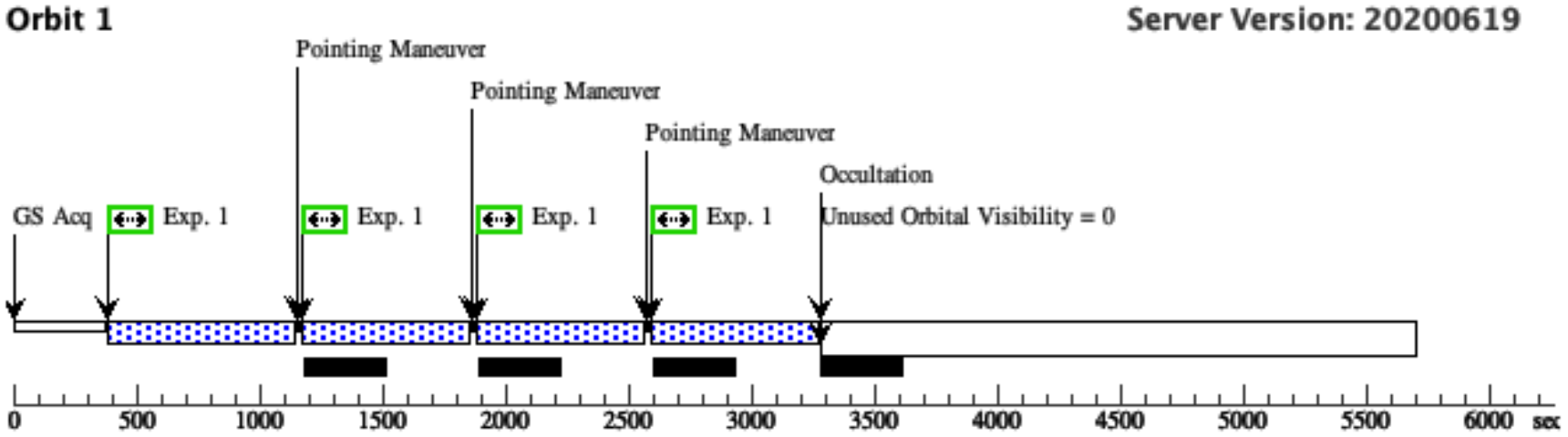
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M51DS1	RA: 13 29 56.1600 (202.4840000d) Dec: +47 11 47.83 (47.19662d) Equinox: J2000		V=24.0	Reference Frame: ICRS

Comments:
Category=STAR
Description=[CIRCUMSTELLAR MATTER, SUPERGIANT O]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) M51DS1	ACS/WFC, ACCUM, WFC1	F606W			Pattern 1, Exps 1-1 in M51DS1_F606W (01) (1)	400 Secs (2208 Secs) *[==>552.0 Secs (Pattern 1)]* *[==>552.0 Secs (Pattern 2)]* *[==>552.0 Secs (Pattern 3)]* *[==>552.0 Secs (Pattern 4)]*	*[1]*

Orbit Structure



Visit

Proposal 16508, M51DS1_F814W (02), completed Mon May 17 13:00:18 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false		(1)

Fixed Targets

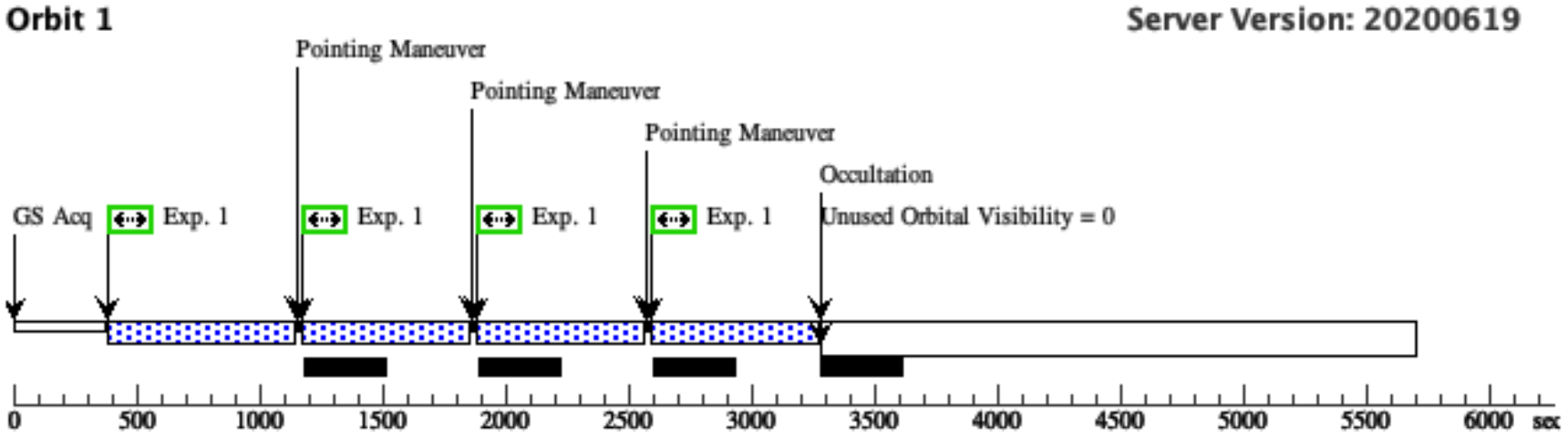
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M51DS1	RA: 13 29 56.1600 (202.4840000d) Dec: +47 11 47.83 (47.19662d) Equinox: J2000		V=24.0	Reference Frame: ICRS

Comments:
Category=STAR
Description=[CIRCUMSTELLAR MATTER, SUPERGIANT O]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) M51DS1	ACS/WFC, ACCUM, WFC1	F814W			Pattern 1, Exps 1-1 in M51DS1_F814W (02) (1)	400 Secs (2208 Secs) *[==>552.0 Secs (Pattern 1)]* *[==>552.0 Secs (Pattern 2)]* *[==>552.0 Secs (Pattern 3)]* *[==>552.0 Secs (Pattern 4)]*	*[1]*

Orbit Structure



Visit

Proposal 16508, M51DS1_IR (04), failed Mon May 17 13:00:18 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1), (2)

Fixed Targets

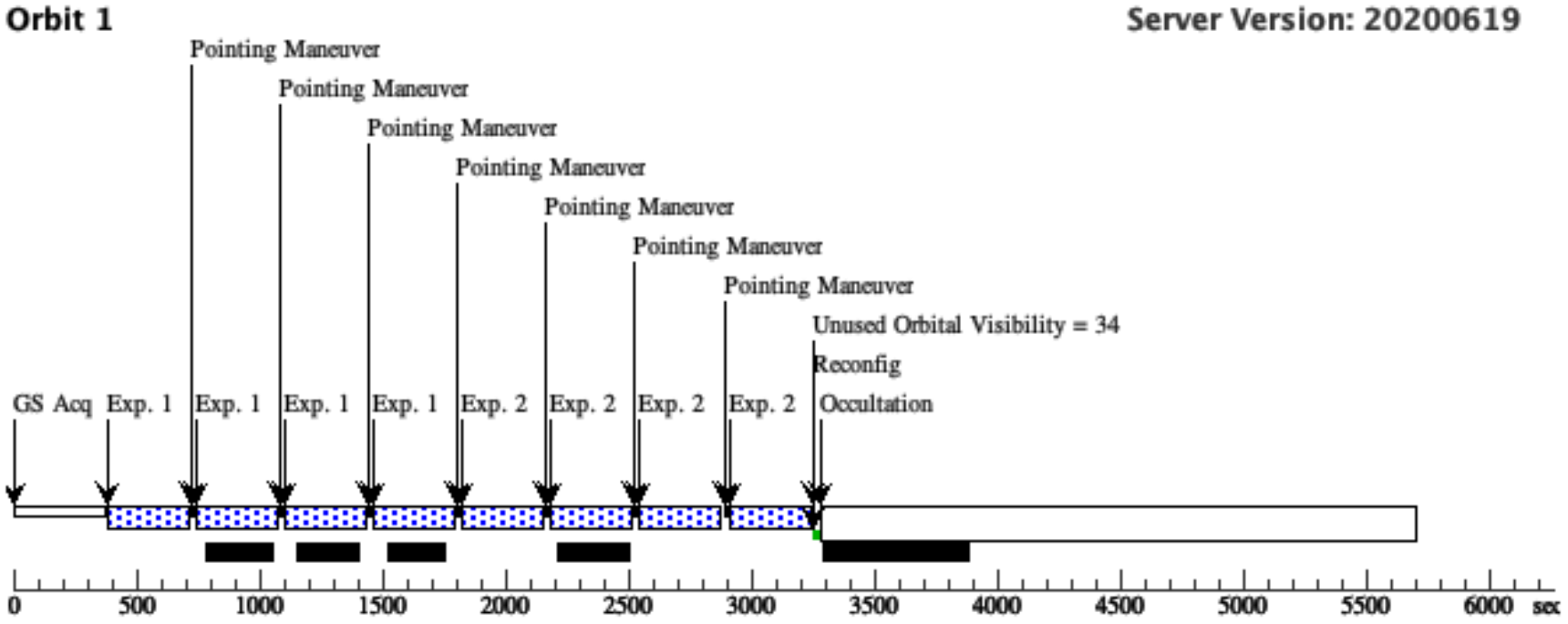
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M51DS1	RA: 13 29 56.1600 (202.4840000d) Dec: +47 11 47.83 (47.19662d) Equinox: J2000		V=24.0	Reference Frame: ICRS

Comments:
Category=STAR
Description=[CIRCUMSTELLAR MATTER, SUPERGIANT O]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F110W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=9; SAMP-SEQ=STEP100		Pattern 3, Exps 1-1 in M51DS1_IR (04) (3)	299.231323 Secs (1196.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2	F160W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=STEP100		Pattern 3, Exps 2-2 in M51DS1_IR (04) (3)	299.231323 Secs (1196.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 16508, M51DS1_IR (54), implementation Mon May 17 13:00:18 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Comments: HOPR repeat of visit 04

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M51DS1	RA: 13 29 56.1600 (202.4840000d) Dec: +47 11 47.83 (47.19662d) Equinox: J2000		V=24.0	Reference Frame: ICRS

Comments:
Category=STAR
Description=[CIRCUMSTELLAR MATTER, SUPERGIANT O]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F160W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG 0.000,0.000	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
2	F160W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG 0.542,0.182	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
3	F110W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG 0.000,0.000	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
4	F110W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG 0.542,0.182	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
5	F110W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG 0.339,0.485	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
6	F110W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG -0.203,0.303	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
7	F160W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG 0.339,0.485	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*
8	F160W	(1) M51DS1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=STEP100	POS TARG -0.203,0.303	Sequence 1-8 Non-Int in M51DS1_IR (54)	299.231323 Secs (299.231 Secs) *[==>]*	*[1]*

Orbit Structure