17784 - AT2019krl: Did a star die?

Cycle: 32, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Beth Fitzpatrick (PI) (ESA Member) (Contact)	**University College Dublin**
Dr. Morgan Fraser (CoI) (ESA Member)	University College Dublin

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) AT2019KRL	WFC3/UVIS	1	18-Oct-2024 11:00:17.0	yes
02	(1) AT2019KRL	WFC3/IR	1	18-Oct-2024 11:00:18.0	yes

2 Total Orbits Used

ABSTRACT

AT2019krl is gap transient which exploded in 2019 in M74. Originally classified as an LBV, recent HST observations suggest that it may have dimmed to a luminosity fainter than that of the progenitor. This implies a terminal explosion, i.e., AT2019krl is a peculiarly faint core collapse supernova. AT2019krl would in fact be the faintest core collapse supernova ever observed. To explain such a low luminosity, AT2019krl must be a "failed supernova", the result of the collapse of a massive star to a black hole. This would be the first observational evidence of a "failed supernova", which have been theoretically predicted and are a solution to the "Red Supergiant Problem" (the lack of supernova progenitors above 16 solar masses, despite red supergiants existing with these masses). Unfortunately, AT2019krl was located near the edge of the chip in this recent image, meaning that the apparent dimming may not be genuine. We have conducted an analysis of the magnitudes of other sources in close proximaty to the chip edge and conclude that it is likely that our observations are real and AT2019krl was a "failed supernova". New HST observations at the site of the transient are required for confirmation.

OBSERVING DESCRIPTION

We propose new imaging of AT2019krl to be taken using WFPC3/UVIS with a total exposure time of 1090s in each of the F555W and F814W filters, which will fill one orbit (53 min duration). In addition to this, we wish to obtain 2060s of WFPC3/IR imaging (1030s in each of the F110W and F160W filters), which will also take one orbit. We hence request two orbits of HST time. We wish to at least match the depth of the pre-explosion images covering the site of AT2019krl, which were 780 s in the F555W and F814W filters. Allowing 6 min for guide star acquisition, 0.5 min for filter change, 2.1 min for readout, and 0.5 min for small dithers; we will require 16.4 min for overheads to obtain 2 images in each of the F555W and F814W filters. This leaves 36.6 min of open shutter time, implying 2x545 s exposures per filter. We will use a two-point dither pattern to help remove bad pixels. As our exposures are longer than 339s we do not incur extra overheads associated with dumping the images. These observations will reach a limiting Vega magnitude of 26.8 and 26.1 mag in F555W and F814W respectively. To rule out the possibility that AT2019krl is obsucred by dust, observations in the IR are required. Using DUSTY, we calculate that if AT2019krl is indeed enshrouded in dust, but has comparable luminosity to the progenitor star, then it must have both F110W and F160W magnitudes <24.0. We will reach limiting magnitudes of 25.6 and 24.4 respectively, in these filters with 2x515s exposures over one orbit.

Visit

Proposal 17784, Optical (01), implementation Fri Oct 18 15:00:19 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2)

Fixed Targets

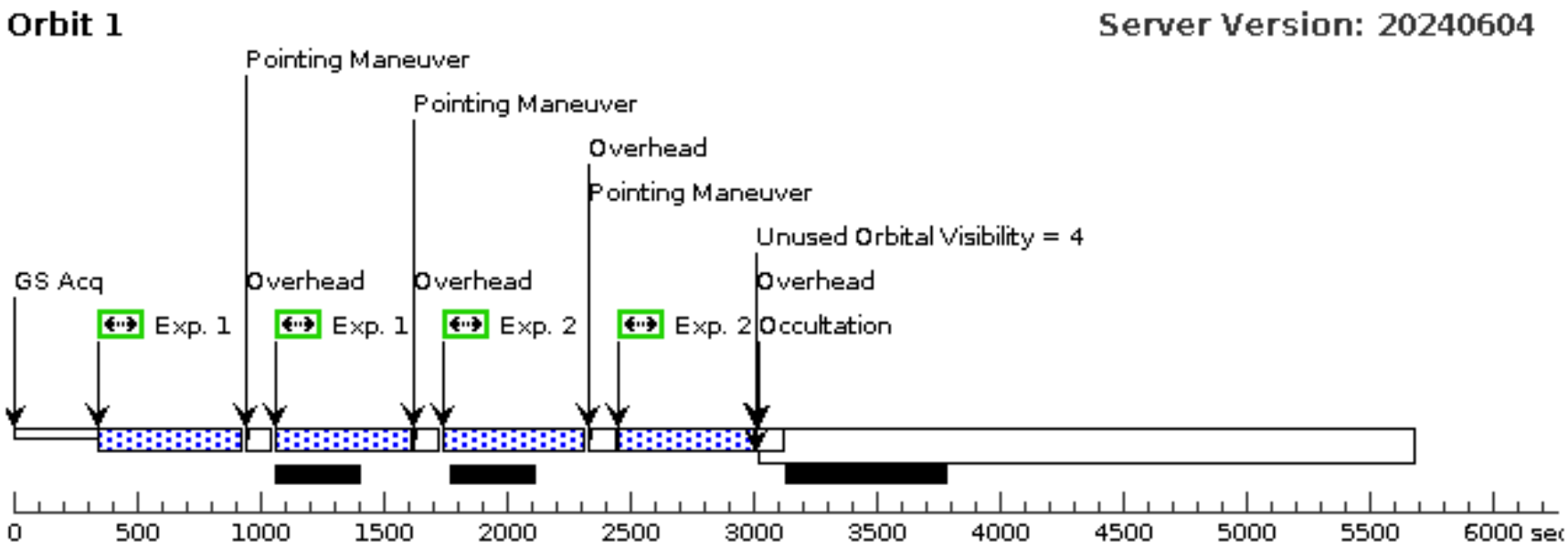
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	AT2019KRL	RA: 01 36 49.6510 (24.2068792d) Dec: +15 46 46.21 (15.77950d) Equinox: J2000	Epoch of Position: 2000	V=24+/-2	Reference Frame: ICRS

Comments: Coordinates updated with values from Transient Name Server.
The magnitude of the target is uncertain and is what we wish to test as part of this proposal. In V we expect it to be between 24-26 mag. In the IR the brightest the target could be is 24th mag. However, even if the source is not observed in the IR, the limiting magnitudes coupled with the optical photometry, will allow us to determine the nature of the target.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F555W	(1) AT2019KRL	WFC3/UVIS, ACCUM, UVIS1-FIX	F555W	FLASH=2		Pattern 1, Exps 1-1 in Optical (01) (1)	555 Secs (1110 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	F814W	(1) AT2019KRL	WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	FLASH=4		Pattern 1, Exps 2-2 in Optical (01) (1)	555 Secs (1110 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***

Orbit Structure



Visit

Proposal 17784, IR (02), implementation Fri Oct 18 15:00:19 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=1.908 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(1), (2), (3)

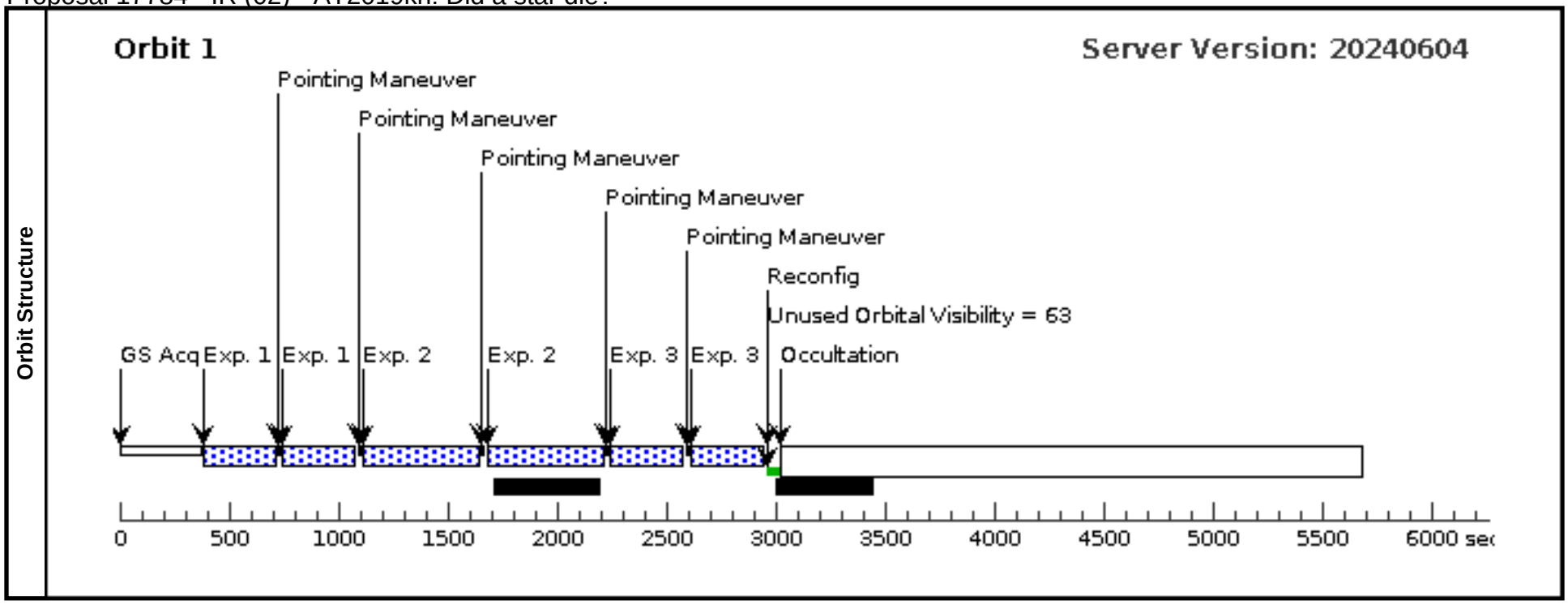
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	AT2019KRL	RA: 01 36 49.6510 (24.2068792d) Dec: +15 46 46.21 (15.77950d) Equinox: J2000	Epoch of Position: 2000	V=24+/-2	Reference Frame: ICRS

Comments: Coordinates updated with values from Transient Name Server.
The magnitude of the target is uncertain and is what we wish to test as part of this proposal. In V we expect it to be between 24-26 mag. In the IR the brightest the target could be is 24th mag. However, even if the source is not observed in the IR, the limiting magnitudes coupled with the optical photometry, will allow us to determine the nature of the target.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F160W	(1) AT2019KRL	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=SPARS50; NSAMP=7		Sequence 1-3 Non-Int in IR (02) Pattern 2, Exps 1-1 in Sequence 1-3 Non-Int in IR (02) (2)	302.934997 Secs (605.87 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	F110W	(1) AT2019KRL	WFC3/IR, MULTIACCUM, IR-FIX	F110W	SAMP-SEQ=SPARS100; NSAMP=6		Sequence 1-3 Non-Int in IR (02) Pattern 2, Exps 2-2 in Sequence 1-3 Non-Int in IR (02) (2)	502.933906 Secs (1005.868 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	F160W	(1) AT2019KRL	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=SPARS50; NSAMP=7		Sequence 1-3 Non-Int in IR (02) Pattern 2, Exps 3-3 in Sequence 1-3 Non-Int in IR (02) (2)	302.934997 Secs (605.87 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***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Orbit 1
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Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Reconfig
Unused Orbital Visibility = 63
GS Acq
Exp. 1
Exp. 1
Exp. 2
Exp. 2
Exp. 3
Exp. 3
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec