17596 - Revealing the Powering Mechanisms of Type Icn Supernovae through Late-time Observations

Cycle: 31, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Craig Pellegrino (PI) (Contact)	**The University of Virginia**
Prof. Maryam Modjaz (CoI)	The University of Virginia
Dr. Tyler Pritchard (CoI)	New York University
Kyle Davis (CoI)	University of California - Santa Cruz
Prof. Ryan Foley (CoI)	University of California - Santa Cruz

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) SN2023XGO	WFC3/IR WFC3/UVIS	2	12-Jul-2024 17:00:31.0	yes
03	(1) SN2023XGO	WFC3/UVIS	1	12-Jul-2024 17:00:32.0	yes
02	(1) SN2023XGO	WFC3/IR WFC3/UVIS	2	12-Jul-2024 17:00:32.0	yes

5 Total Orbits Used

ABSTRACT

We propose to obtain two epochs of HST imaging of supernova (SN) 2023xgo, the closest Type Icn SN to date (d = 62 Mpc), between 120 to 300 days after explosion in order to constrain its late-time powering mechanism. Type Icn SNe are a rare but astrophysically-interesting class of transients

powered by interaction with H- and He-poor circumstellar material-- evidence that their uncertain progenitor stars underwent extraordinary mass loss before explosion. A better understanding of their progenitors and mass-loss mechanisms will impact theories of stellar evolution and the formation of gravitational wave sources. Modeling the light curves of these objects has surprisingly revealed that their explosions produce little, if any, radioactive 56Ni. Progenitor scenarios that permit such little 56Ni include the explosion of a massive Wolf-Rayet star undergoing significant fallback accretion, or of an ultra-stripped, lower-mass (<= 12 Msun) star. We request late-time photometric observations in order to differentiate between the proposed progenitor scenarios by estimating the explosive nucleosynthetic yields and by searching for evidence of ongoing interaction with material at larger distances from the progenitor star. These observations will further constrain radioactive decay as a powering mechanism for synthesized 56Ni masses >= 0.001 Msun. The low redshift of SN 2023xgo and its optimal phase throughout Cycle 31 offer the first possibility to observe the late-time light curve of a Type Icn SN to date. These observations will directly probe the progenitor properties of these rare and exotic transients, informing our understanding of the extremes of mass loss in massive stars.

OBSERVING DESCRIPTION

We propose two visits, each comprising of two orbits, to image the nearby supernova SN 2023xgo with the WFC3/UVIS F606W and F814W bands as well as the WFC3/IR F125W and F160W bands. We will use the first orbit in each visit to image SN 2023xgo with WFC3/UVIS in the F606W and F814W filters, and the second orbit in each visit to image SN 2023xgo with WFC3/IR in the F125W and F160W filters.

We request that our first visit be scheduled on 22 March 2024 and our second visit on 20 July 2024. This window fits our criterion of having two visits separated by at most 120 days. During this time frame we expect the brightness of SN 2023xgo to be within our proposed range of V band magnitude 24.0 +/- 2.0. In particular, obtaining our first observation on 22 March is vital as the supernova will not be visible to HST again until mid July. Waiting until that time for our first visit runs the risk that the supernova will be too faint to observe by the second visit.

For each visit, our observation plan is as follows. In our first orbit, we will utilize the WFC3-UVIS-DITHER-LINE pattern with the F606W and F814W filters. We request a total of 1200s of exposure time in F606W and 1432s of exposure time in F814W, each split evenly between two exposures. In our second orbit, we will utilize the WFC3-IR-DITHER-BOX-MIN pattern with the F125W and F160W filters. For each filter, we request a total of ~1312s of exposure time, split evenly into four exposures.

We expect these observations to be unaffected by the possibility of reduced gyro operations during Cycle 31. These observations do not rely on utilizing HST's full field of view, nor on its normal spatial scan speed.

Visit

Proposal 17596, Visit 01, failed Fri Jul 12 21:00:33 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: BETWEEN 12-MAR-2024:00:00:00 AND 20-JUL-2024:00:00:00

Diagnostics

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

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)
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=1.716 Line Spacing=1.095	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(3-4)

Fixed Targets

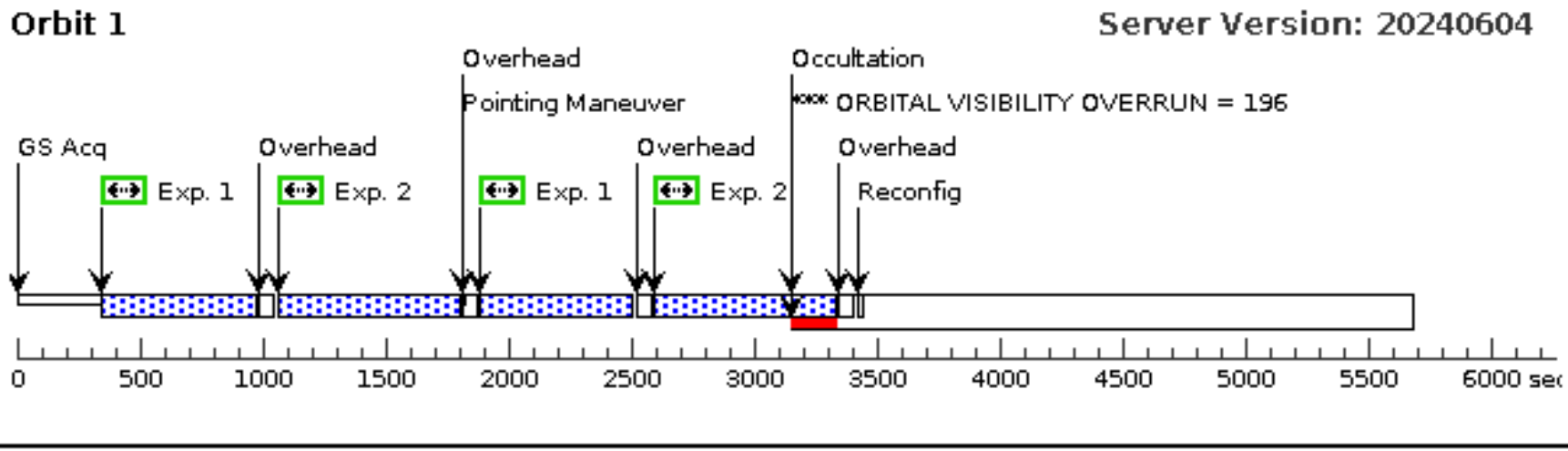
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN2023XGO	RA: 05 04 19.1900 (76.0799583d) Dec: +67 37 21.10 (67.62253d) Equinox: J2000	Redshift: 0.014	V=24.0+/-2.0	Reference Frame: ICRS

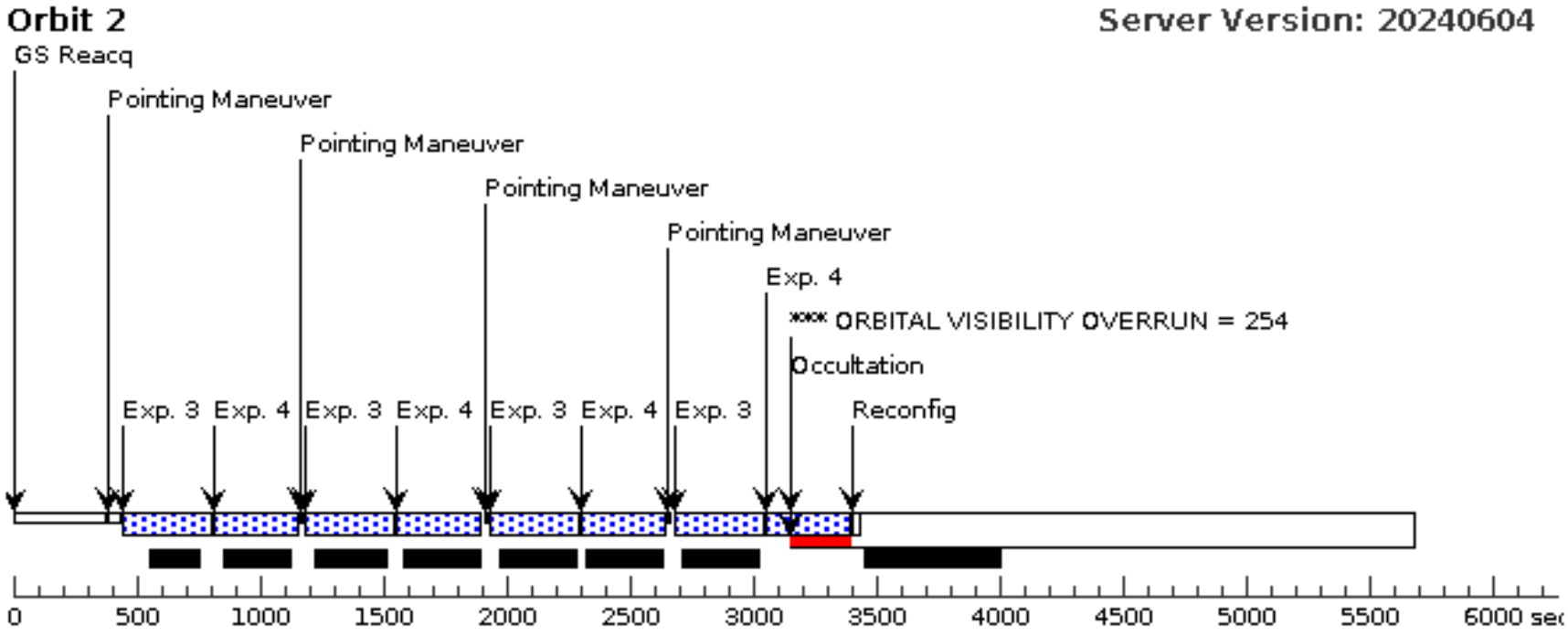
Comments:
Category=EXT-STAR
Description=[EJECTA, SUPERNOVA]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN2023XGO	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W			Pattern 1, Exps 1-2 in Visit 01 (1)	600 Secs (1200 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) SN2023XGO	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W			Pattern 1, Exps 1-2 in Visit 01 (1)	716 Secs (1432 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3		(1) SN2023XGO	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=14; SAMP-SEQ=SPARS25		Pattern 2, Exps 3-4 in Visit 01 (2)	327.938986 Secs (1311.756 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***
4		(1) SN2023XGO	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=14; SAMP-SEQ=SPARS25		Pattern 2, Exps 3-4 in Visit 01 (2)	327.938986 Secs (1311.756 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 17596, Visit 03, implementation Fri Jul 12 21:00:33 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: AFTER_02 BY 30 D TO 60 D

Diagnostics

(Exposure 2 (Pattern 1, Exps 1-2 in Visit 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 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

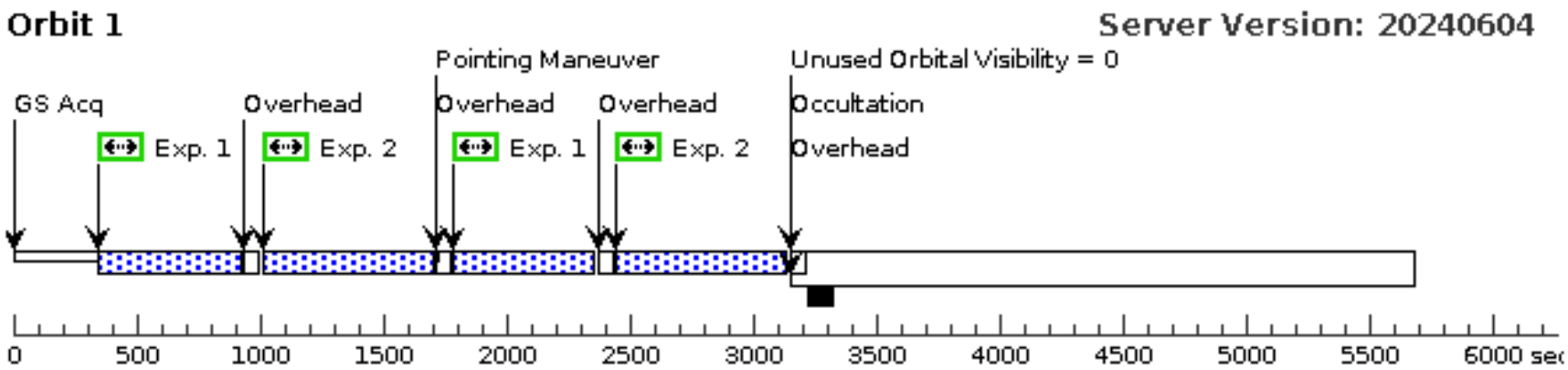
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN2023XGO	RA: 05 04 19.1900 (76.0799583d) Dec: +67 37 21.10 (67.62253d) Equinox: J2000	Redshift: 0.014	V=24.0+/-2.0	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[EJECTA, SUPERNOVA]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN2023XGO	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W			Pattern 1, Exps 1-2 in Visit 03 (1)	600 Secs (1102 Secs) *[==>551.0 Secs (Pattern 1)]* *[==>551.0 Secs (Pattern 2)]*	***[1]***
2		(1) SN2023XGO	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W			Pattern 1, Exps 1-2 in Visit 03 (1)	716 Secs (1334 Secs) *[==>667.0 Secs (Pattern 1)]* *[==>667.0 Secs (Pattern 2)]*	***[1]***

Orbit Structure



Visit

Proposal 17596, Visit 02, implementation Fri Jul 12 21:00:33 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: AFTER_01 BY 30 D TO 120 D

Diagnostics

(Exposure 2 (Pattern 1, Exps 1-2 in Visit 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 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)
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=1.716 Line Spacing=1.095	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(3-4)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN2023XGO	RA: 05 04 19.1900 (76.0799583d) Dec: +67 37 21.10 (67.62253d) Equinox: J2000	Redshift: 0.014	V=24.0+/-2.0	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[EJECTA, SUPERNOVA]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN2023XGO	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W			Pattern 1, Exps 1-2 in Visit 02 (1)	551 Secs (1102 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) SN2023XGO	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W			Pattern 1, Exps 1-2 in Visit 02 (1)	667 Secs (1334 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3		(1) SN2023XGO	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=13; SAMP-SEQ=SPARS25		Pattern 2, Exps 3-4 in Visit 02 (2)	302.938471 Secs (1211.754 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***
4		(1) SN2023XGO	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=SPARS25		Pattern 2, Exps 3-4 in Visit 02 (2)	277.937956 Secs (1111.752 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure