# 13648 - Uncovering the Putative B-Star Binary Companion of the SN 1993J Progenitor

Cycle: 22, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

**INVESTIGATORS**



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|---|---|---|
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**VISITS**

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (1) SN-1993J | WFC3/UVIS | 2 | 31-Jul-2014 21:01:02.0 | yes |
| 02 | (1) SN-1993J | ACS/SBC | 1 | 31-Jul-2014 21:01:03.0 | yes |

3 Total Orbits Used

**ABSTRACT**

The stripped-envelope Type IIb supernova (SN IIb) is a unique subclass of core-collapse explosions that result when a massive star loses most, but not all, of its outer envelope. Theoretical models suggest progenitor systems consist of low-mass stars that lose their envelopes during mass transfer to a binary companion, which becomes UV bright in the process. Although four stripped-envelope supernovae have progenitor stars identified in pre-explosion images, not a single progenitor companion star has been directly detected to date. In other words, the Type IIb progenitor system remains observationally unconfirmed. The nearby Type IIb SN 1993J in M81, at a distance of only 3.6 Mpc, offers one of the best opportunities to detect the putative companion and test the progenitor model. Indeed, evidence has been mounting over the past decade for a hot companion, but the dominating SN flux and contamination from nearby stars has made a confirmation difficult. In 2012, our team obtained HST/COS spectra and detected a far-UV (FUV) excess flux consistent with a hot B-star. This spectrum, however, is limited by a low signal-to-noise ratio and poor spatial resolution. Now that the SN has sufficiently faded, we propose FUV and NUV imaging of SN 1993J and the surrounding stars to disentangle the source of the FUV excess flux once and for all. Coinciding with Cycle 22's UV initiative, we can shed light on the binary nature of Type IIb progenitors in just 3 orbits.

**OBSERVING DESCRIPTION**

WFC3:

- Use the C512C subarray
  - Near amp C
    - mitigate CTE
    - low flat field gradient
  - 512 pix = 20 arcsec - plenty of room to dither and get all of surrounding stars
  - short readout --> get almost all of our planned exposure time
  - amp C has ~20 droplet, but we arent going to worry about the droplets
  - Don't have to use POSTARGs to put target near amplifier
- EXPTIME (actual/ planned):
  - F218W - 3000s/3000s
  - F275 - 2260s/2300s
  - F336W - 640s/700s
- FLASH = 9

- Based on 12531 observations, background is ~2.5, we want 12 e-/pix --> FLASH of 9 e-/pix

- 1 WFC3 visit:
  - putting all WFC3 observations in one 2 orbit visit. We want everything relatively close in time anyways, why not?
- 4 pt box dither
  - sub pixel dither to maximize PSF sampling and therefore spatial sampling
  - remove CR and hot pixels

ACS:

- ETC Calc for binary companion: http://etc.stsci.edu/etc/results/ACS.im.573826/
- F140LP - remove airglow lines
- EXPTIME (actual/planned) = 3150s/3000s
- Use SBC aperture

## Visit

**Proposal 13648, wfc3 box subarray (01), implementation** Fri Aug 01 01:01:04 GMT 2014

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

*Comments: Y POS-TARG = -4 for the WFC3 exposures to mitigate CTE while staying > 5 arcsec away from chip edge to avoid flat field artifacts*

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (5) | Pattern Type=WFC3-UVIS-DITHER-BOX<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=0.173<br>Line Spacing=0.112 | Coordinate Frame=POS-TARG<br>Pattern Orientation=23.884<br>Angle Between Sides=81.785<br>Center Pattern=false | | (1), (2), (3) |

## Fixed Targets

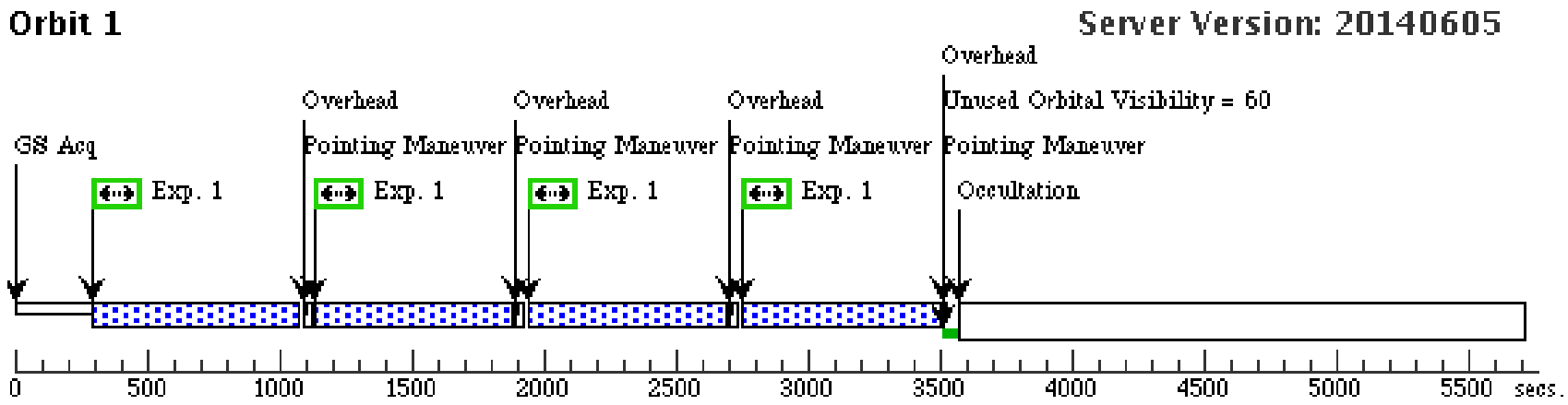
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | SN-1993J | RA: 09 55 24.9500 (148.8539583d)<br>Dec: +69 01 13.40 (69.02039d)<br>Equinox: J2000 | | V=22.9 | Reference Frame: NED |

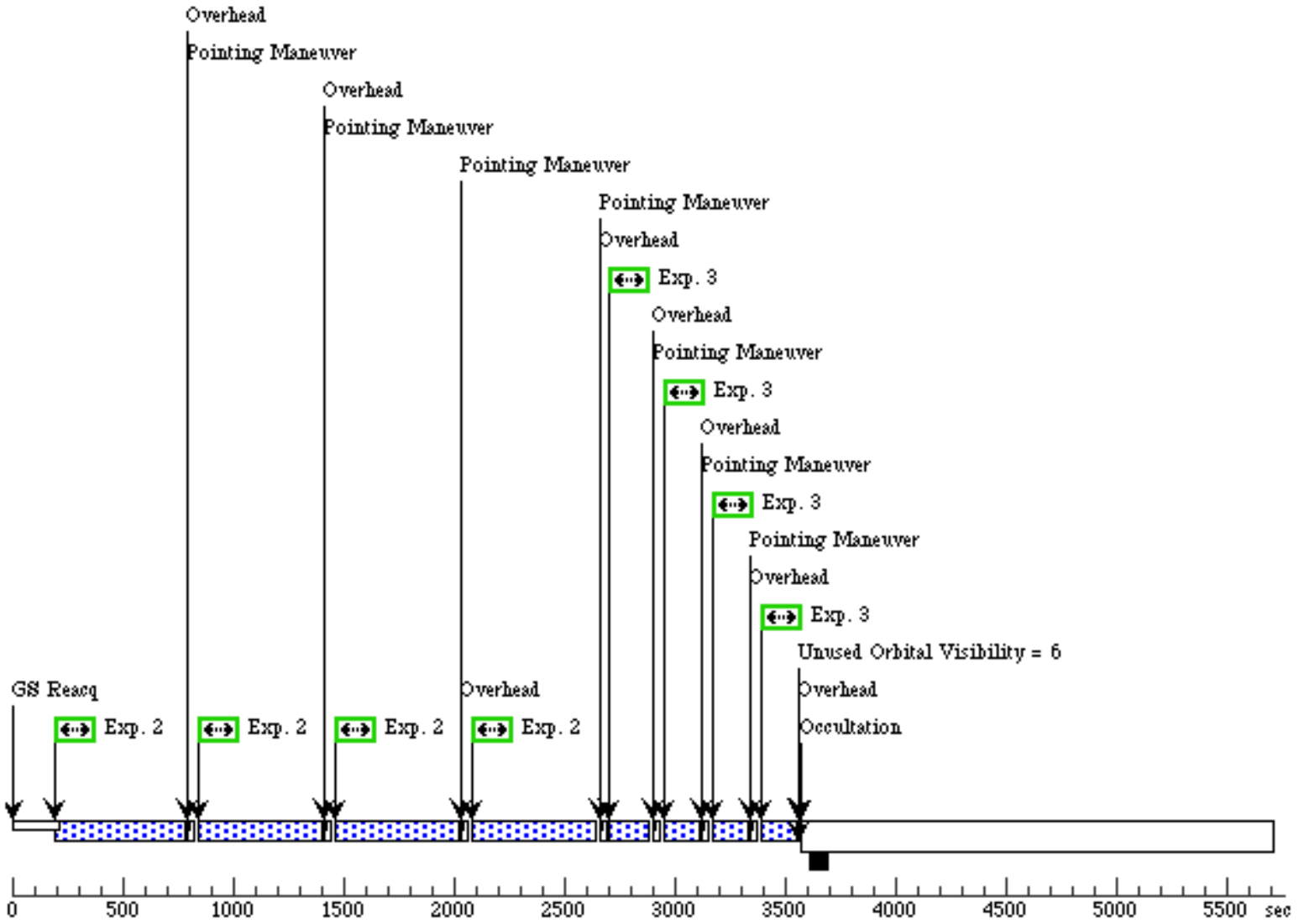
*Comments: This object was generated by the targetselector and retrieved from the NED database.*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F218W | (1) SN-1993J | WFC3/UVIS, ACCUM, UVIS2-C512C-SUB | F218W | FLASH=12 | POS TARG null,-4 | Pattern 5, Exps 1-1 in wfc3 box subarray (01) (5) | 750 Secs (3000 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]*<br>*[==>(Pattern 4)]* | ***[1]*** |
| 2 | F275W | (1) SN-1993J | WFC3/UVIS, ACCUM, UVIS2-C512C-SUB | F275W | FLASH=12 | POS TARG null,-4 | Pattern 5, Exps 2-2 in wfc3 box subarray (01) (5) | 565 Secs (2260 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]*<br>*[==>(Pattern 4)]* | ***[2]*** |
| 3 | F336W | (1) SN-1993J | WFC3/UVIS, ACCUM, UVIS2-C512C-SUB | F336W | FLASH=12 | POS TARG null,-4 | Pattern 5, Exps 3-3 in wfc3 box subarray (01) (5) | 160 Secs (640 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]*<br>*[==>(Pattern 4)]* | ***[2]*** |

Orbit Structure




Orbit 2
Server Version: 20140605
Overhead
Pointing Maneuver
Overhead
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Overhead
Exp. 3
Overhead
Pointing Maneuver
Exp. 3
Overhead
Pointing Maneuver
Exp. 3
Pointing Maneuver
Overhead
Exp. 3
Unused Orbital Visibility = 6
Overhead
Occultation
GS Reacq
Exp. 2
Exp. 2
Exp. 2
Overhead
Exp. 2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 13648, ACS/SBC (02), implementation** Fri Aug 01 01:01:04 GMT 2014

**Diagnostic Status: No Diagnostics**

Scientific Instruments: ACS/SBC

Special Requirements: GROUP 02,01 WITHIN 30D

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | SN-1993J | RA: 09 55 24.9500 (148.8539583d)<br>Dec: +69 01 13.40 (69.02039d)<br>Equinox: J2000 | | V=22.9 | Reference Frame: NED |

*Comments: This object was generated by the targetselector and retrieved from the NED database.*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (ACS.im.573826) | (1) SN-1993J | ACS/SBC, ACCUM, SBC | F140LP | | | | 3150 Secs (3150 Secs)<br>*[==>]* | *[1]* |

## Orbit Structure