13822 - iPTF13bvn: First identification of the progenitor of a Type Ib supernova

Cycle: 22, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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) IPTF13BVN	WFC3/UVIS	3	19-Sep-2014 21:03:51.0	yes
02	(1) IPTF13BVN	ACS/WFC	1	19-Sep-2014 21:03:52.0	yes

4 Total Orbits Used

ABSTRACT

iPTF13bvn may provide the first conclusive answer to the long-standing question of the nature of hydrogen-deficient supernova (SN) progenitors. The detection of a pre-explosion object in archival images at the SN site led at first to the proposal of a Wolf-Rayet progenitor. However, our hydrodynamical modeling of the SN light curves indicated a much lower progenitor mass, and we proposed an interacting binary system as the progenitor. The proposed HST observations will allow us to verify the disappearance of the pre-explosion object and, most importantly, they will test the binary progenitor scenario through the detection in the UV of a hot companion star. If confirmed, this will be the first firm identification of the progenitor of a hydrogen-deficient SN. These observations will be the deepest available of the host galaxy (NGC 5806) in the requested bands, so they will have high archival value. We have requested that these observations are coordinated with those of program GO-13684.

OBSERVING DESCRIPTION

We will obtain deep imaging in two bands of the location of supernova (SN) iPTF13bvn in order to characterize its progenitor system. The observations include one UV band (F225W at WFC3/UVIS), and one optical bands (F814W at ACS/WFC). The UV imaging will allow us to search for the proposed hot companion star of the binary progenitor system. This program will be coordinated with program GO-13684 that will obtain similar imaging of the same field using the F438W and F555W filters with WFC3/UVIS.

The optical imaging will reproduce available pre-explosion imaging from 2005 and will help to characterize the surrounding stellar population, estimate extinction and monitor the evolution of the fading SN. Using four orbits (three in UV and one in optical), we will integrate during nearly 8900 seconds in F225W, and ~2300 s in F814W. According to ETC runs, these exposure times will reach detection limits (Vega magnitudes) of F225W~27 mag, and F814W~28 mag, with S/N~3. This is enough to probe the properties of the proposed companion star, and to detect the disappearance of the exploding (primary) star.

In order to avoid confusion with flux from the SN itself, we requested that the observations are carried out after May 15, 2015 (with visibility constraints, this actually implies after June 10). At that stage the contribution from the SN is expected to be small but non-negligible. However, as pointed out in out Phase I proposal, the SN colors are expected to be much redder than those of the hot companion star, which will allow us to provide a robust detection.

The WFC3/UVIS imaging in F225W were divided into three integrations, one per orbit, using a linear dither pattern to ensure covering the chip gap and cleaning cosmic rays and bad pixels, as well as improving the psf sampling. There is no need to avoid droplets using larger dither steps because we do not require <1% photometric accuracy. The pointing was centered at the nucleus of the host galaxy (NGC 5806) and the UVIS-CENTER

aperture was chosen. With that, we can obtain full coverage of the host galaxy for future reference. According to the BOT, the FOV is free of dangerously bright objects. Each exposure requires a post-flash lamp of 5 e-/pix to increase the background level to ~12 e-/pix and so to mitigate CTE losses. The F225W observations were placed in the first visit of this program because they are critical to our science goals.

Optical imaging with ACS/WFC and the F814W filter were divided into three dithered integrations. They span one orbit that was placed in visit 2. The full detector is used and the pointing is centered at the host-galaxy nucleus to obtain a complete image of the galaxy. With the requested individual integration times, the optical observations require no post-flash lamp. Some objects in the FOV are bright enough to saturate (15 objects according to the BOT), but they are all located far from the SN and in the outskirts of the galaxy.

UV and optical observations were split into separate visits to improve schedulability. However, it would be preferable to have both of them carried out at similar times in order to obtain accurate colors and monitor the SN evolution. That is why we added the loose constraint that visit 2 (optical) is conducted within one month of visit 1 (UV). For the same reason, it would also be ideal to schedule this program within one month of program GO-13684.

Visit

Proposal 13822, UV (01), implementation Sat Sep 20 01:03:54 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: AFTER 15-MAY-2015:00:00:00

Comments: This is the critical visit since it contains the UV observations that will serve to search for the companion of the progenitor of iPTF13bvn.
This visit comprises three orbits, each with one exposure in the F225W band using WFC3/UVIS. We require that the SN has faded enough when these observations are done, so we have placed a loose constraint of scheduling this visit after May 15, 2015. We would like to have this visit executed within one month of the observations of program GO-13684 in order to obtain accurate colors.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-GAP-LINE	Coordinate Frame=POS-TARG		(1)
	Purpose=MOSAIC	Pattern Orientation=85.759		
	Number Of Points=3	Angle Between Sides=		
	Point Spacing=2.414	Center Pattern=true		
	Line Spacing=			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	IPTF13BVN	RA: 15 00 0.6900 (225.0028750d)		V=26.5+/-0.5	Reference Frame: SIMBAD
		Dec: +01 53 27.90 (1.89108d)			
		Equinox: J2000			

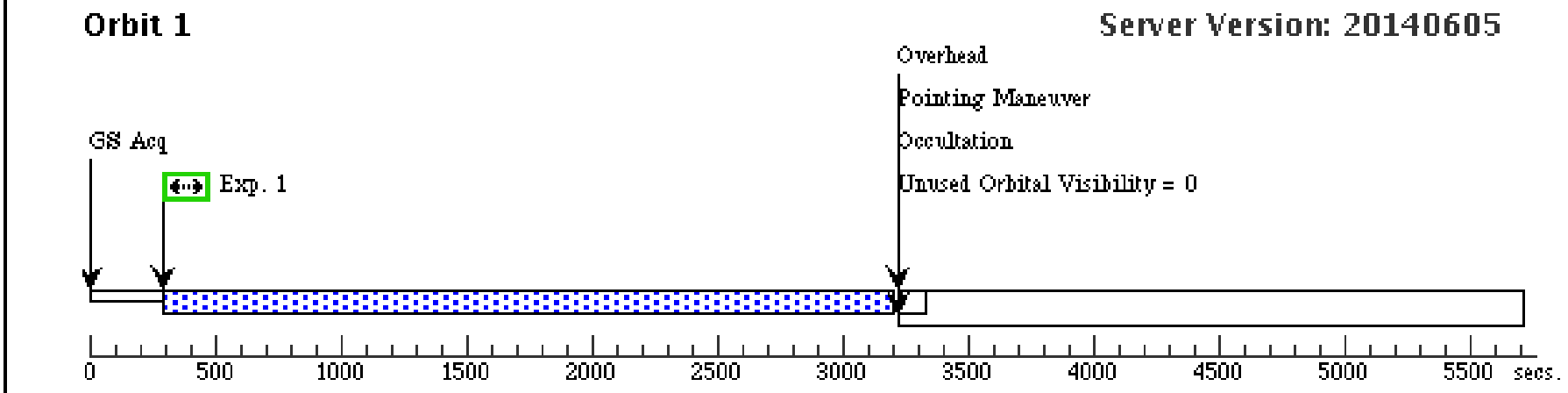
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

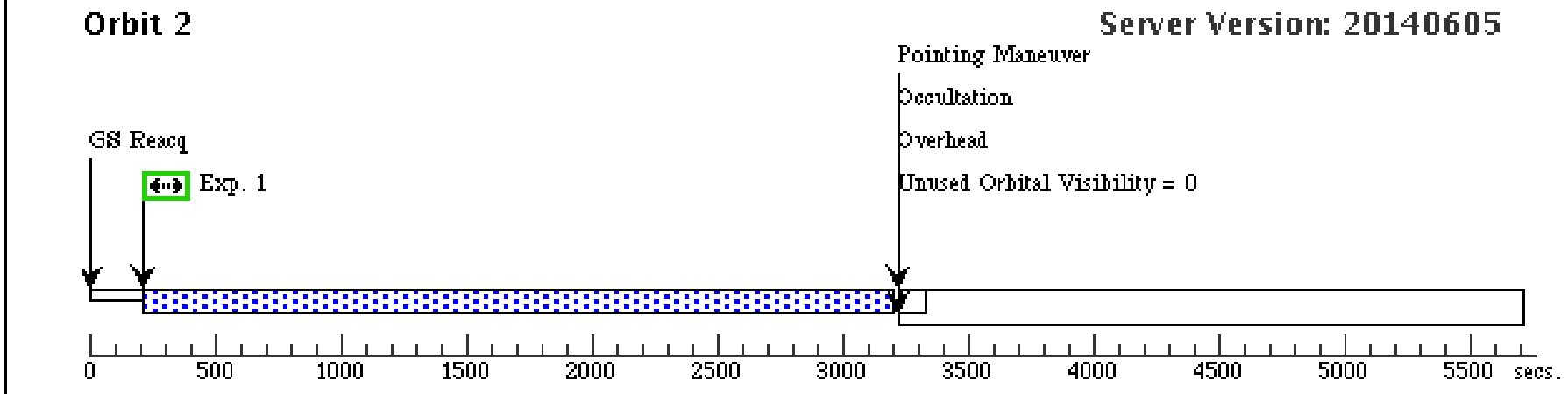
Exposures

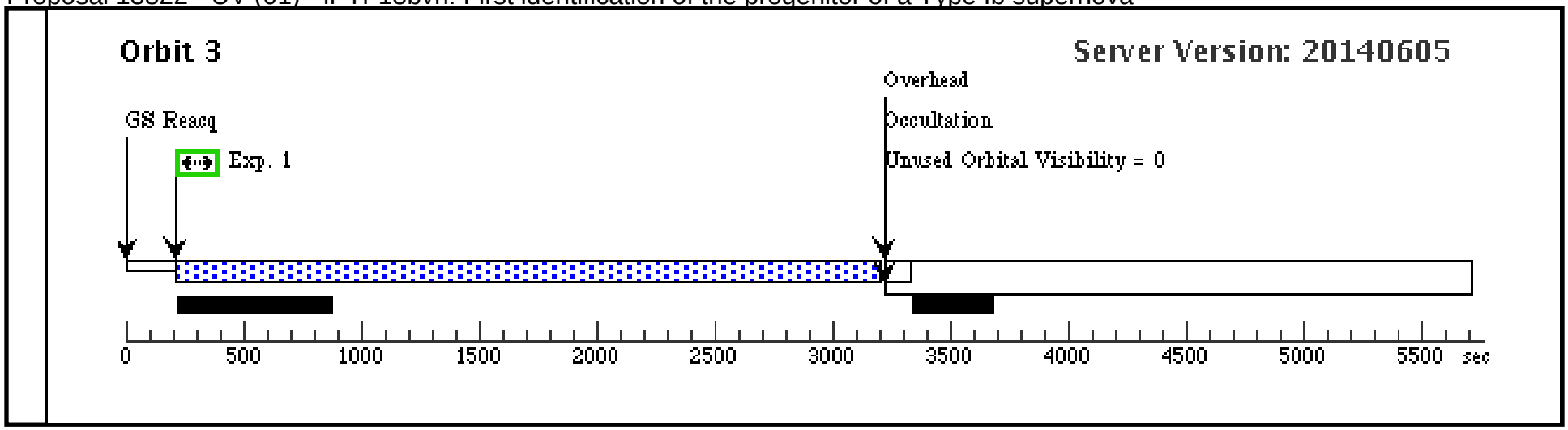
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F225W	(1) IPTF13BVN	WFC3/UVIS, ACCUM, UVIS-CENTER	F225W	FLASH=5		Pattern 2, Exps 1-1 in UV (01) (2)	2300 Secs (8865 Secs)	
								[==>2881.0 Secs (Pattern 1)]	***[1]***
								[==>2992.0 Secs (Pattern 2)]	***[2]***
								[==>2992.0 Secs (Pattern 3)]	***[3]***

Comments: We will obtain the F225W exposures with a three-point dither pattern to cover the chip gap and to avoid bad pixels/columns and cosmic rays. Each exposure requires a post-flash lamp of 5e/pix to increase the backgroud level to ~12e/pix and so to mitigate CTE losses. The Aperture was chosen as UVIS-CENTER and the coordinates are those of the nucleus of NGC 5806. This provides complete coverage of the galaxy in the FOV.

Orbit Structure



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2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13822, Optical (02), implementation Sat Sep 20 01:03:54 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: AFTER 01 BY 0 D TO 30 D

Comments: This visit contains the optical reference imaging with filter F814W that will help determine if the object seen prior to the SN explosion has disappeared.
In order to obtain reliable UV-optical colors, we require that visit 2 is carried out within one month of visit 1.
This visit includes one orbit with three dithered exposures in the F814W band using WFC3/UVIS.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	Pattern Type=ACS-WFC-DITHER-LINE Purpose=DITHER Number Of Points=3 Point Spacing=3.011 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.28 Angle Between Sides= Center Pattern=false		(1)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	IPTF13BVN	RA: 15 00 0.6900 (225.0028750d) Dec: +01 53 27.90 (1.89108d) Equinox: J2000		V=26.5+/-0.5	Reference Frame: SIMBAD

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

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F814W	(1) IPTF13BVN	ACS/WFC, ACCUM, WFC	F814W			Pattern 3, Exps 1-1 in Optical (02) (3)	782 Secs (2345 Secs) *[==>781.0 Secs (Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***

Comments: We will obtain the F814W exposures with a three-point dither pattern to avoid bad pixels/columns and cosmic rays. No post-flash exposure is required. The complete detector is used and the pointing is centered at the nucleus of the host galaxy in order to obtain full coverage of the galaxy.

Orbit Structure