# 15834 - UV Spectroscopic Signatures from Type Ibn Supernovae Strongly Interacting with a Circumstellar Medium

Cycle: 27, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

**INVESTIGATORS**


| *Name* | *Institution* | *E-Mail* |
|---|---|---|
| **Dr. Ori Dosovitz Fox (PI) (Contact)** | **Space Telescope Science Institute** | **ofox@stsci.edu** |
| Dr. Jennifer Andrews (CoI) | University of Arizona | jandrews@as.arizona.edu |
| Dr. Thomas G Brink (CoI) | University of California - Berkeley | tgbrink@berkeley.edu |
| Dr. Peter J. Brown (CoI) | Texas A & M University | pbrown@physics.tamu.edu |
| Dr. Roger A. Chevalier (CoI) | The University of Virginia | rac5x@virginia.edu |
| Dr. Geoffrey C. Clayton (CoI) | Louisiana State University and A & M College | gclayton@fenway.phys.lsu.edu |
| Prof. Alex V. Filippenko (CoI) | University of California - Berkeley | alex@astro.berkeley.edu |
| Prof. Claes Fransson (CoI) (ESA Member) | Stockholm University | claes@astro.su.se |
| Dr. Jose Groh (CoI) (ESA Member) | University of Dublin, Trinity College | jose.groh@tcd.ie |
| Dr. Griffin Hosseinzadeh (CoI) | Harvard University | griffin.hosseinzadeh@cfa.harvard.edu |
| Dr. Patrick Kelly (CoI) | University of Minnesota - Twin Cities | plkelly@umn.edu |
| Dr. Jon Mauerhan (CoI) | The Aerospace Corporation | jon.c.mauerhan@aero.org |
| Dr. Adam Miller (CoI) | Northwestern University | amiller@northwestern.edu |
| Dr. Nathan Smith (CoI) | University of Arizona | nathans@as.arizona.edu |
| Dr. Tamas Szalai (CoI) (ESA Member) | University of Szeged | szaszi@titan.physx.u-szeged.hu |
| Dr. Schuyler D. Van Dyk (CoI) | California Institute of Technology | vandyk@ipac.caltech.edu |
| Dr. WeiKang Zheng (CoI) | University of California - Berkeley | weikang@berkeley.edu |

**VISITS**

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (2) AT2020NXT | STIS/CCD<br>STIS/NUV-MAMA | 1 | 16-Jul-2020 19:00:26.0 | yes |
| 02 | (2) AT2020NXT | STIS/CCD<br>STIS/FUV-MAMA | 1 | 16-Jul-2020 19:00:27.0 | yes |
| 03 | (2) AT2020NXT | STIS/CCD<br>STIS/FUV-MAMA | 1 | 16-Jul-2020 19:00:27.0 | yes |
| 04 | (2) AT2020NXT | STIS/CCD<br>STIS/NUV-MAMA | 1 | 16-Jul-2020 19:00:28.0 | yes |
| 05 | (2) AT2020NXT | STIS/CCD<br>STIS/NUV-MAMA | 1 | 16-Jul-2020 19:00:29.0 | yes |
| 06 | (2) AT2020NXT | STIS/CCD<br>STIS/NUV-MAMA | 1 | 16-Jul-2020 19:00:29.0 | yes |

6 Total Orbits Used

**ABSTRACT**

Type Ibn supernovae (SNe Ibn) are a rare (<1%) core-collapse SN subclass that exhibits hydrogen-poor (e.g., stripped-envelope Type Ib) spectra dominated by narrow helium features that arise from a slow-moving, pre-existing, dense circumstellar medium (CSM). Compared to other SN subclasses, the light curves tend to be brighter and rise/decline faster. These unique properties leave a number of outstanding unknowns, such as progenitor system and powering mechanism. Increasing the intrigue, SNe Ibn are now linked to an even lesser well-known set of explosions known as Fast Blue Optical Transients (FBOTs), which have been suggested to harbor tidal disruption events and/or magnetars. The UV offers an opportunity to determine the true nature of the SN Ibn subclass given its sensitivity to spectral line diagnostics that can constrain the progenitor mass-loss history and CNO processing. Yet given the low rates and fast decline of SNe Ibn (and FBOTs), UV spectroscopy is limited to just two SNe Ibn (and zero FBOTs), and these spectra are of limited use because they (a) do not extend into the far-UV and (b) are either low-resolution or low signal-to-noise ratio. Here we propose a disruptive ToO with HST/STIS to obtain 2 epochs of UV spectra of a SN Ibn within 250 Mpc. This program will not only distinguish between the Type Ibn progenitors and powering mechanisms, but will also provide clues about the nature of FBOTs. Coinciding with Cycle 27's UV Initiative, this program opens up new phase space in our study of the progenitor and explosion characteristics of the SN Ibn

subclass.

**OBSERVING DESCRIPTION**

We propose to obtain 2 epochs (3 orbits each) of STIS-MAMA spectra of a single Type Ibn supernova. The brightness is really the most important factor, but SNe Ibn can vary in brightness substantially (magnitudes). We offer rough guidelines of a target within 250 Mpc and as close to light-curve maximum as possible (preferably pre-max). The goal is to detect UV signatures that can distinguish between progenitor scenarios. These observations will also trace circumstellar interaction, constrain the progenitor mass loss, and identify late-time heating mechanisms for potential warm dust.

The initial spectrum will be triggered as a *disruptive* ToO, and observations should be scheduled as soon as possible. The second epoch should be obtained again within 10 days (the goal is to maximize the time between the two epochs, so there may be some wiggle room depending on the brightness and evolution timeline of the SN). We will use the data to trace circumstellar interaction, constrain the progenitor mass loss, and measure the CNO processing. Comparisons to other SN and FBOT subclasses will also help distinguish between progenitor systems and central engine powering mechanisms.

The first epoch will include observations in both the G140 and G230L bandpasses.
The second epoch will include observations in only the G230L bandpass.

We choose STIS over COS for several reasons. Most importantly, STIS offers spatially resolved spectra that exploit the intrinsically high resolution of HST over a large spectral range (accommodating both the C III] 1909 Ang and Mg II 2800 Ang lines). The long slit length will allow us to subtract contamination from zodiacal light, earthshine, the host galaxy, and H II regions. STIS also has superior sensitivity to COS in the NUV. While COS is optimized for isolated, faint point sources in the FUV with medium resolution, we would suffer from less wavelength coverage and require more integrations. We would also lose the advantages of the slit described above.

## Visit

**Proposal 15834, STIS-SNIbn1-Epoch1(FUV) (01), implementation** Thu Jul 16 23:00:30 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: ON HOLD ; TOO RESPONSE TIME 2.0D

*Comments: Likely to acquire on bright SN.*

*On Hold Comments: Target-of-Opportunity.*

*The initial spectrum will be triggered as a disruptive ToO, and observations should be scheduled as soon as possible (2-5 days as stated in the CfP). Less than 2 days could be possible since PI Fox works at STScI and has worked on ultra-rapid responses with HST planners in the past.*

*The main goal, however, is to make sure the observations are obtained around peak, which typically happens about 3 days post-discovery.*

## Fixed Targets

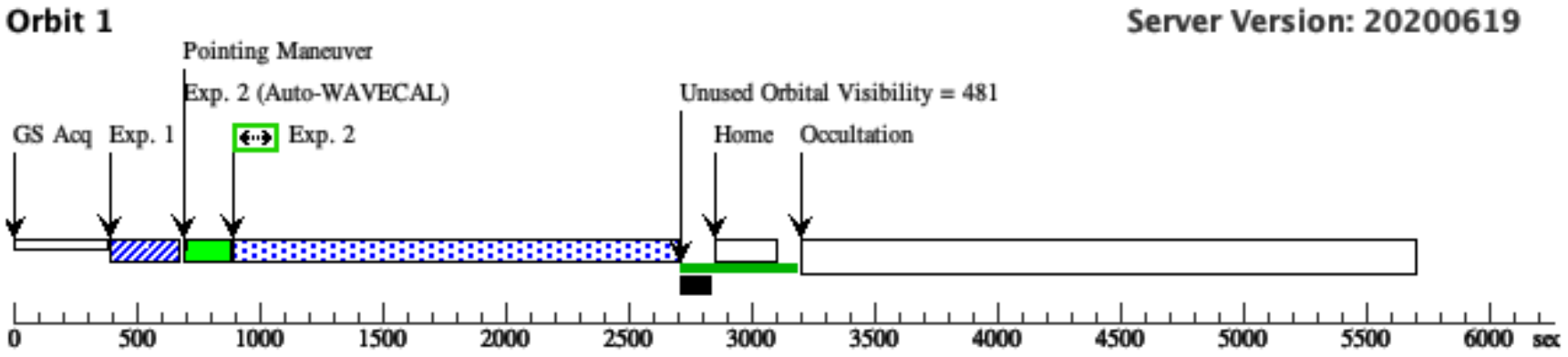
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | AT2020NXT | RA: 22 37 36.2350 (339.4009792d)<br>Dec: +35 00 7.66 (35.00213d)<br>Equinox: J2000 | | V=17 | Reference Frame: ICRS |

*Comments:*
*Category=STAR*
*Description=[SUPERNOVA TYPE IB]*
*Extended=NO*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ACQ (STIS.ta.1406439) | (2) AT2020NXT | STIS/CCD, ACQ, 50CCD | MIRROR | | | | 10 Secs (10 Secs)<br>*[==>]* | *[1]* |
| *Comments: Used 10,000K Blackbody normalized to V=16. SN should be bright during initial acquisition.* | | | | | | | | | |
| 2 | STIS/NUV Exp 1 (STIS.sp.1367898) | (2) AT2020NXT | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A | | | | 2000 Secs (1800 Secs)<br>*[==>1800 Secs ]* | *[1]* |
| *Comments: Assuming a 10,000K Blackbody around peak.* | | | | | | | | | |

## Orbit Structure



## Visit

**Proposal 15834, STIS-SNIbn1-Epoch1(FUV) (02)** Thu Jul 16 23:00:30 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: AFTER 01 BY 0 Orbits TO 1 Orbits; ON HOLD ; TOO RESPONSE TIME 2.0D

*Comments: Likely to acquire on bright SN.*

*On Hold Comments: Target-of-Opportunity.*

*The initial spectrum will be triggered as a disruptive ToO, and observations should be scheduled as soon as possible (2-5 days as stated in the CfP). Less than 2 days could be possible since PI Fox works at STScI and has worked on ultra-rapid responses with HST planners in the past.*

*The main goal, however, is to make sure the observations are obtained around peak, which typically happens about 3 days post-discovery.*

## Fixed Targets

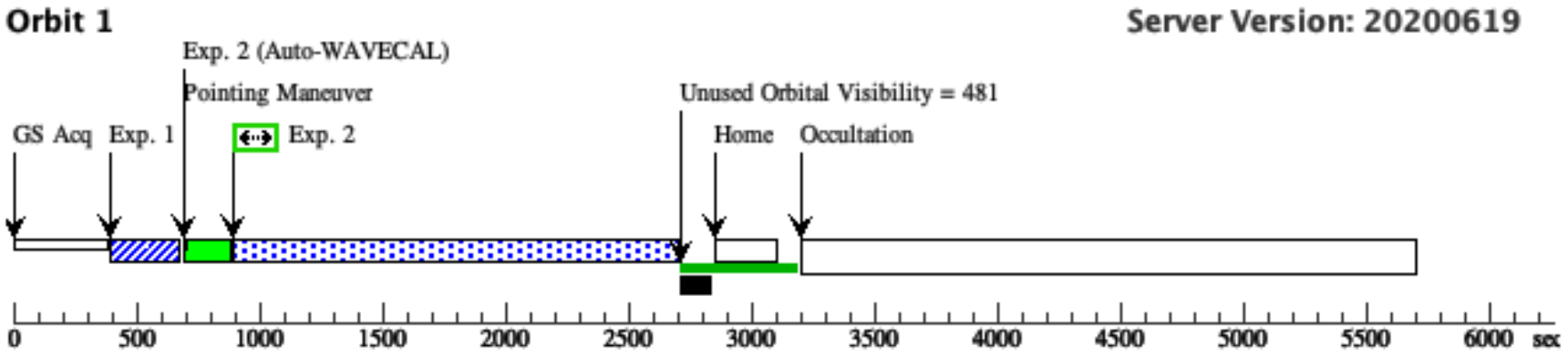
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | AT2020NXT | RA: 22 37 36.2350 (339.4009792d)<br>Dec: +35 00 7.66 (35.00213d)<br>Equinox: J2000 | | V=17 | Reference Frame: ICRS |

*Comments:*
*Category=STAR*
*Description=[SUPERNOVA TYPE IB]*
*Extended=NO*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ACQ (STIS.ta.1406439) | (2) AT2020NXT | STIS/CCD, ACQ, 50CCD | MIRROR | | | | 10 Secs (10 Secs)<br>*[==>]* | *[1]* |
| *Comments: Used 10,000K Blackbody normalized to V=16. SN should be bright during initial acquisition.* | | | | | | | | | |
| 2 | STIS/FUV Exp 1 (STIS.sp.1367897) | (2) AT2020NXT | STIS/FUV-MAMA, ACCUM, 52X0.2D1 | G140L<br>1425 A | | | | 2000 Secs (1800 Secs)<br>*[==>1800 Secs ]* | *[1]* |
| *Comments: Assuming a 10,000K Blackbody around peak.* | | | | | | | | | |

## Orbit Structure



## Visit

**Proposal 15834, STIS-SNIbn1-Epoch1(FUV) (03)** Thu Jul 16 23:00:30 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: AFTER 02 BY 0 Orbits TO 1 Orbits; ON HOLD ; TOO RESPONSE TIME 2.0D

*Comments: Likely to acquire on bright SN.*

*On Hold Comments: Target-of-Opportunity.*

*The initial spectrum will be triggered as a disruptive ToO, and observations should be scheduled as soon as possible (2-5 days as stated in the CfP). Less than 2 days could be possible since PI Fox works at STScI and has worked on ultra-rapid responses with HST planners in the past.*

*The main goal, however, is to make sure the observations are obtained around peak, which typically happens about 3 days post-discovery.*

## Fixed Targets

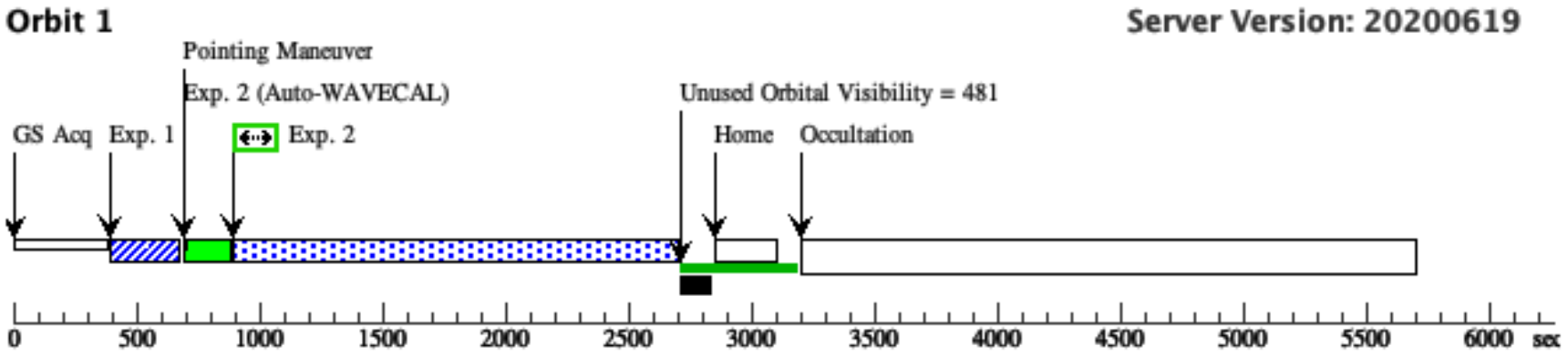
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | AT2020NXT | RA: 22 37 36.2350 (339.4009792d)<br>Dec: +35 00 7.66 (35.00213d)<br>Equinox: J2000 | | V=17 | Reference Frame: ICRS |

*Comments:*
*Category=STAR*
*Description=[SUPERNOVA TYPE IB]*
*Extended=NO*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ACQ (STIS.ta.1406439) | (2) AT2020NXT | STIS/CCD, ACQ, 50CCD | MIRROR | | | | 10 Secs (10 Secs)<br>*[==>]* | *[1]* |
| *Comments: Used 10,000K Blackbody normalized to V=16. SN should be bright during initial acquisition.* | | | | | | | | | |
| 2 | STIS/FUV Exp 2 (STIS.sp.1367897) | (2) AT2020NXT | STIS/FUV-MAMA, ACCUM, 52X0.2D1 | G140L<br>1425 A | | | | 2000 Secs (1800 Secs)<br>*[==>1800 Secs ]* | *[1]* |
| *Comments: Assuming a 10,000K Blackbody around peak.* | | | | | | | | | |

## Orbit Structure



## Visit

**Proposal 15834, STIS-SNIbn1-Epoch2(FUV) (04)** Thu Jul 16 23:00:30 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: AFTER 01 BY 6 D TO 12 D; ON HOLD

*Comments: Likely to acquire on bright SN.*

*On Hold Comments: Target-of-Opportunity.*

*This visit will be scheduled for 6-12 days following the first visit (as specified in the Timing Requirements), ideally aiming for 10 days. But we'd like to have some flexibility with our final submission to account for the brightness and light-curve evolution.*

## Fixed Targets

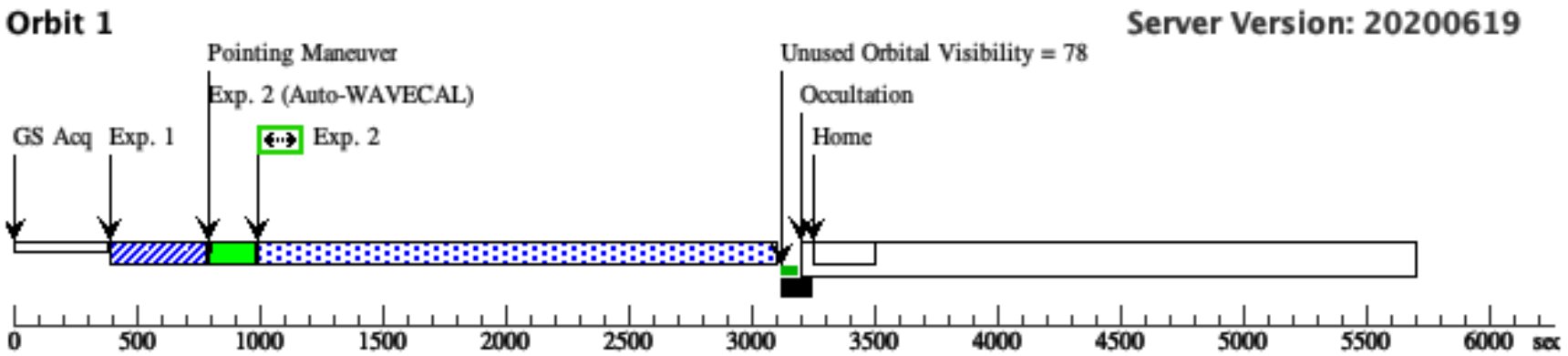
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | AT2020NXT | RA: 22 37 36.2350 (339.4009792d)<br>Dec: +35 00 7.66 (35.00213d)<br>Equinox: J2000 | | V=17 | Reference Frame: ICRS |

*Comments:*
*Category=STAR*
*Description=[SUPERNOVA TYPE IB]*
*Extended=NO*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ACQ (STIS.ta.1406440) | (2) AT2020NXT | STIS/CCD, ACQ, F28X50LP | MIRROR | | | | 40 Secs (40 Secs)<br>*[==>]* | *[1]* |
| | *Comments: Used 10,000K Blackbody normalized to V=16. SN should be bright during initial acquisition.* | | | | | | | | |
| 2 | STIS/NUV Exp 1 (STIS.sp.1367905) | (2) AT2020NXT | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A | | | | 2000 Secs (2100 Secs)<br>*[==>2100.0 Secs ]* | *[1]* |
| | *Comments: Assuming a 7,000K Blackbody around 10 days post-max.* | | | | | | | | |

## Orbit Structure



## Visit

**Proposal 15834, STIS-SNIbn1-Epoch2(FUV) (05)** Thu Jul 16 23:00:30 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: AFTER 04 BY 0 Orbits TO 1 Orbits; ON HOLD

*Comments: Likely to acquire on bright SN.*

*On Hold Comments: Target-of-Opportunity.*

*This visit will be scheduled for 6-12 days following the first visit (as specified in the Timing Requirements), ideally aiming for 10 days. But we'd like to have some flexibility with our final submission to account for the brightness and light-curve evolution.*

## Fixed Targets

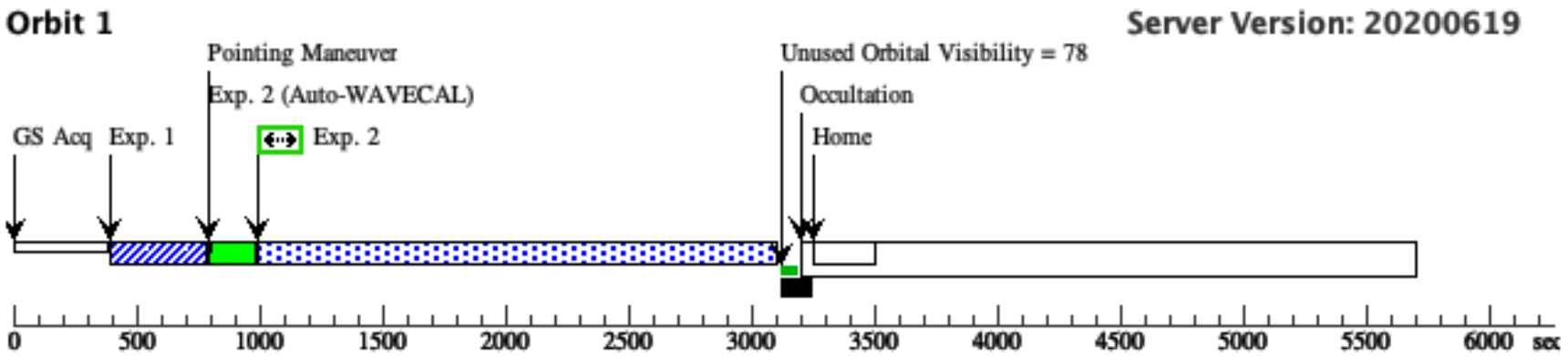
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | AT2020NXT | RA: 22 37 36.2350 (339.4009792d)<br>Dec: +35 00 7.66 (35.00213d)<br>Equinox: J2000 | | V=17 | Reference Frame: ICRS |

*Comments:*
*Category=STAR*
*Description=[SUPERNOVA TYPE IB]*
*Extended=NO*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ACQ (STIS.ta.1406440) | (2) AT2020NXT | STIS/CCD, ACQ, F28X50LP | MIRROR | | | | 40 Secs (40 Secs)<br>*[==>]* | *[1]* |
| | *Comments: Used 10,000K Blackbody normalized to V=16. SN should be bright during initial acquisition.* | | | | | | | | |
| 2 | STIS/NUV Exp 1 (STIS.sp.1367905) | (2) AT2020NXT | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A | | | | 2000 Secs (2100 Secs)<br>*[==>2100.0 Secs ]* | *[1]* |
| | *Comments: Assuming a 7,000K Blackbody around 10 days post-max.* | | | | | | | | |

## Orbit Structure



## Visit

**Proposal 15834, STIS-SNIbn1-Epoch2(FUV) (06)** Thu Jul 16 23:00:30 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: AFTER 05 BY 0 Orbits TO 1 Orbits; ON HOLD

*Comments: Likely to acquire on bright SN.*

*On Hold Comments: Target-of-Opportunity.*

*This visit will be scheduled for 6-12 days following the first visit (as specified in the Timing Requirements), ideally aiming for 10 days. But we'd like to have some flexibility with our final submission to account for the brightness and light-curve evolution.*

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | AT2020NXT | RA: 22 37 36.2350 (339.4009792d)<br>Dec: +35 00 7.66 (35.00213d)<br>Equinox: J2000 | | V=17 | Reference Frame: ICRS |

*Comments:*
*Category=STAR*
*Description=[SUPERNOVA TYPE IB]*
*Extended=NO*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ACQ (STIS.ta.1406440) | (2) AT2020NXT | STIS/CCD, ACQ, F28X50LP | MIRROR | | | | 40 Secs (40 Secs)<br>*[==>]* | *[1]* |
| | *Comments: Used 10,000K Blackbody normalized to V=16. SN should be bright during initial acquisition.* | | | | | | | | |
| 2 | STIS/NUV Exp 1 (STIS.sp.1367905) | (2) AT2020NXT | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A | | | | 2000 Secs (2100 Secs)<br>*[==>2100.0 Secs ]* | *[1]* |
| | *Comments: Assuming a 7,000K Blackbody around 10 days post-max.* | | | | | | | | |

## Orbit Structure