GEMINI OBSERVATORY

observing time request summary

Semester: 2025A

Observing Mode: Queue + Standard ToO - AEON/multi-facility

Gemini Reference:

Instruments: GMOS South, GMOS North

Time Awarded: NaN

Thesis: Yes

JWST Synergy: No

Band 3 Acceptable: No

Title: **Exploring Type Ia Supernova Luminosity Bias and Diversity through Spectroscopic Twins**

Principal Investigator: **Henna Abunemeh**
PI institution: University of Illinois at Urbana-Champaign, Department of Astronomy 103 Astronomy Building 1002 West Green Street Urbana IL 61801, USA
PI status: Grad Thesis
PI phone/e-mail: /
Co-Investigators: **Amanda Wasserman (thesis)**: University of Illinois at Urbana-Champaign,
Haille Perkins (thesis): University of Illinois at Urbana-Champaign,
Gautham Narayan: University of Illinois at Urbana-Champaign,

Partner Submission Details *(multiple entries for joint proposals)*

		PI Request		NTAC Recommendation			
Partner	**Lead**	**Time**	**Min**	**Reference**	**Time**	**Min**	**Rank**
USA	Abunemeh	11.40 hr	0.00 hr		NaN	NaN	
	Total Time	*11.40 hr*	*0.00 hr*		*0.00 hr*	*0.00 hr*	

Total Time of Observations

Band	GN	GS
Band 1/2	5.70 hr	5.70 hr
Band 3	0.00 hr	0.00 hr

Abstract

Type Ia supernovae (SNe Ia) are one of the best probes for measuring cosmological distances and the accelerating expansion of the universe, but intrinsic scatter in their luminosities—driven by factors such as progenitor metallicity, ejecta composition, and host galaxy environment—limits their precision as standard candles. Observational studies have revealed correlations between Hubble residuals, spectral features, and environmental properties, emphasizing the need to systematically investigate these influences to improve SNe Ia standardization. Spectroscopic twins—SNe Ia with nearly identical spectra but diverse light-curve properties—offer a unique opportunity to isolate intrinsic physical differences

from environmental and observational effects. Early-phase spectroscopy is critical for capturing the initial conditions that drive SNe Ia diversity, enabling the identification of subtle features and correlations that reduce systematic scatter in cosmological distance measurements. To address these challenges, we propose high-resolution spectroscopic observations with the Gemini Observatory to advance the precision of SNe Ia as cosmological tools and support next-generation surveys such as LSST and Roman.

TAC Category

Stellar Astrophysics, Evolution, Supernovae, Abundances /

Scheduling Constraints

Observation Details (Band 1/2)

Observation	RA	Dec	Brightness	Total Program Partner
Supernova-S-05				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-S-04				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-S-03				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-S-02				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-S-01				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-S-05				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit B480 None 1.0 arcsec slit				
Supernova-S-04				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit B480 None 1.0 arcsec slit				
Supernova-S-03				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any				

Resources: GMOS-S Longslit B480 None 1.0 arcsec slit				
Supernova-N-04				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-S-02				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit B480 None 1.0 arcsec slit				
Supernova-S-01				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-S Longslit B480 None 1.0 arcsec slit				
Supernova-N-05				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit R400 OG515 (> 520 nm) 1.0 arcsec slit				
Supernova-N-03				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit R400 OG515 (> 520 nm) 1.0 arcsec slit				
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Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit B480 None 1.0 arcsec slit				
Supernova-N-04				0.57 hr

				0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit B480 None 1.0 arcsec slit				
Supernova-N-03				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit B480 None 1.0 arcsec slit				
Supernova-N-02				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit B480 None 1.0 arcsec slit				
Supernova-N-01				0.57 hr 0.50 hr 0.07 hr
Conditions: CC 70%/Cirrus, IQ 85%/Poor, SB 80%/Grey, WV Any **Resources:** GMOS-N LongSlit B480 None 1.0 arcsec slit				

Scientific Justification *Limited to 1 page of text plus 2 pages for figures and references.*

Type Ia supernovae (SNe Ia) are powerful tools for studying the accelerating expansion of the universe [15;11]. Their utility arises from the correlation between their luminosity, photometric evolution, light-curve shape, and color, which allow us to make precise distance measurements [13; 12; 14]. However, the standardization of SNe Ia as distance indicators is not perfect. Even when SNe have identical light curves in one photometric band, they can exhibit measurable magnitude-differences in other bands. These variations, collectively known as intrinsic scatter, highlight that objects with otherwise identical light-curve shapes still differ in their overall luminosity due to unaccounted factors. Despite the precision of current correction methods (correcting for light-curve shape and color), SNe Ia distances have an intrinsic scatter of approximately 8% [16; 5]. These discrepancies suggest additional factors such as variations in progenitor metallicity or ejecta composition influence the observed transient event.

The intrinsic scatter propagates to the differences between the measured distance moduli and those predicted by a cosmological model, known as Hubble residuals (HRs). HRs are not solely due to photometric uncertainties and may indicate underlying physical differences among SNe Ia [3; 16]. HRs have been found to correlate with host-galaxy mass [6; 9; 18], while host-galaxy metallicity has been linked to SNe Ia luminosity [4; 2; 10], indicating a connection between the progenitor system and observed supernova characteristics. Correlations between HRs and spectral features, such as the Si II λ6355 velocity (v_{SiII}), point to ejecta properties as a contributor to scatter [17]. These findings call attention to the importance of systematically investigating how environmental factors influence the observed properties of SNe Ia and how spectral features correspond to variations in their underlying systems. Discovering additional parameters linked to this variance could further minimize scatter and significantly improve the precision of SNe Ia as cosmological probes. Studying spectroscopic twins—SNe Ia with nearly identical spectra but differing light curves (Figs. 2 and 3)—provides an approach to isolate intrinsic properties from environmental and observational factors. Comparing twins can reveal subtle trends in spectral features and luminosity variations, offering new calibration parameters to improve distance measurements. Observing these objects at early phases is especially crucial for capturing the initial conditions that shape their diversity and evolution.

Wide-field surveys such as the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) will usher in a new era of supernova discovery, detecting up to 1000 SNe per night. However, LSST's low cadence will lead to light curves with restricted sampling, limiting the ability to fully characterize the diversity of SNe Ia without complementary spectroscopy. Despite LSST's low cadence, young SNe Ia can be identified by leveraging real-time alerts, machine learning classifiers, and cross-survey data. Additionally, our team will utilize experience gained from ongoing analyses of data from public alerts and proprietary sources, such as the Young Supernova Experiment (YSE) [1], to refine light-curve construction and classification techniques.

High-resolution spectroscopic observations are essential for uncovering subtle features that contribute to intrinsic scatter, improving distance calibration, and reducing systematic uncertainties, thereby improving LSST's ability to constrain dark energy properties- while also enhancing our understanding of SNe Ia progenitor systems, explosion physics, and environmental influences, contributing to a more complete picture of these objects. These observations provide crucial insights into the physical variations among SNe Ia, their dependence on host galaxy environments, and correlations between spectral features, Hubble residuals, and luminosity variations. Gemini's spectroscopy offers the resolution and sensitivity needed to investigate these variations in detail, enabling the identification of spectroscopic twins and increasing the sample available for analysis. This expanded sample will facilitate the identification of new correlations that improve SNe Ia standardization. By addressing these key questions, Gemini observations will prepare the scientific community to maximize the potential of LSST and other next-generation surveys, enabling advancements in cosmology.

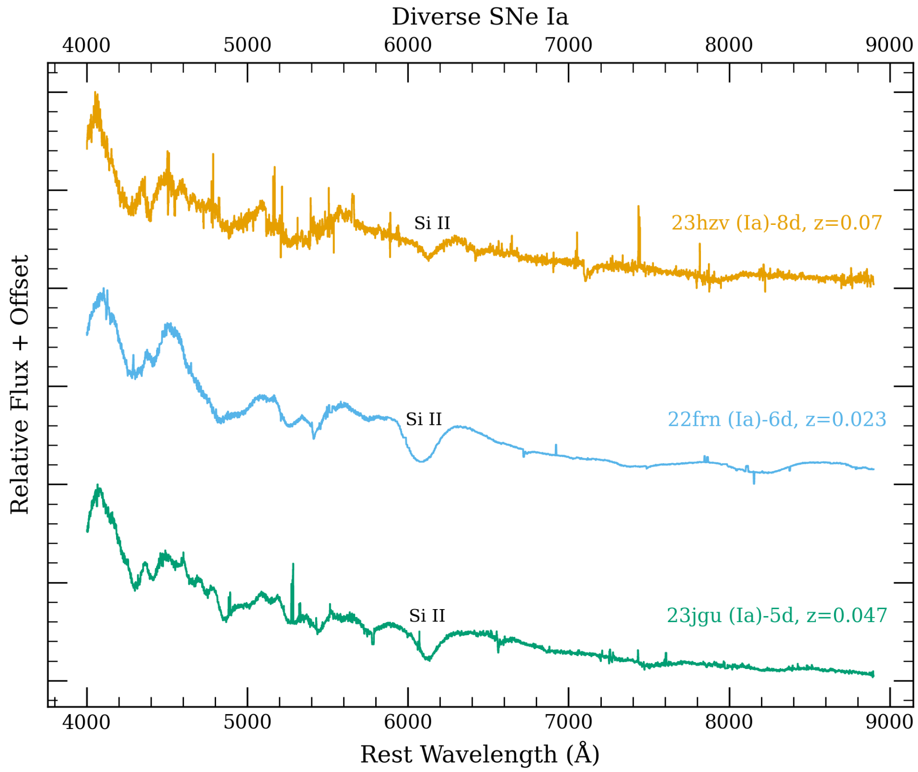


Figure 1: Spectra of Type Ia supernovae acquired with GMOS at Gemini Observatory (private communication), with timing listed as days relative to peak brightness. While all objects are classified as SNe Ia, the spectra demonstrate diversity in their features despite their similar luminosity and classification. SN2022frn, shown here, is later identified as a spectroscopic twin to SN2022yuw in Figs. 2 and 3.

References

[1] Aleo et al., 2022, arXiv:2211.07128

[2] Childress M., et al., 2013b, ApJ, 770, 108

[3] Conley A., et al., 2011, ApJS, 192, 1

[4] D'Andrea C. B., et al., 2011, ApJ, 743, 172

[5] Jones D. O., et al., 2019, ApJ, 881, 19

[6] Kelly P. L., et al., 2010, ApJ, 715, 743

[7] Kessler R., et al., 2009a, PASP, 121, 1028

[8] Kessler R., Scolnic D., 2017, ApJ, 836, 56

[9] Lampeitl H., et al., 2010, ApJ, 722, 566

[10] Pan Y. C., et al., 2014, MNRAS, 438, 1391

[11] Perlmutter S., et al., 1999, ApJ, 517, 565

[12] Phillips M. M., 1993, ApJ, 413, L105

[13] Pskovskii I. P., 1977, Soviet Ast., 21, 675

[14] Riess A. G., et al., 1996, ApJ, 473, 88

[15] Riess A. G., et al., 1998, AJ, 116, 1009

[16] Scolnic D. M., et al., 2018, ApJ, 859, 101

[17] Siebert M. R., et al., 2020, MNRAS, 493, 5713

[18] Sullivan M., et al., 2010, MNRAS, 406, 782

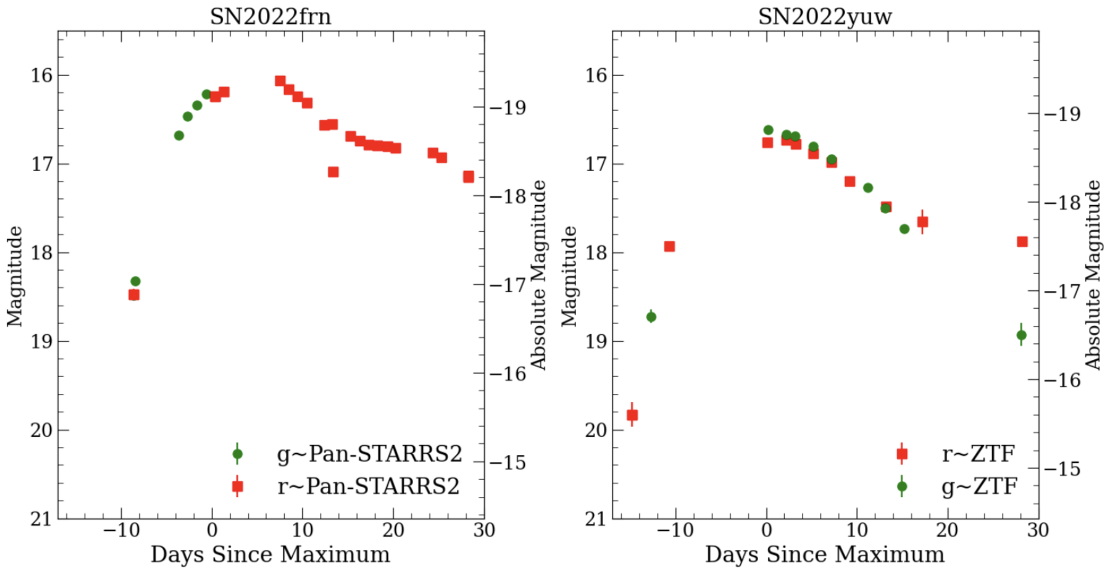


Figure 2: Light curve for SN2022frn and SN2022yuw, both type Ia SNe. The data for SN2022yuw is from ZTF where the g-band observations are shown in green, r-band observations shown in red. The data for SN2022frn is from Pan-STARRS GPC2 where the g-band observations are shown in green, r-band observations shown in red. Both light curves exhibit different shapes and do not provide enough information to the nature of each SNe.

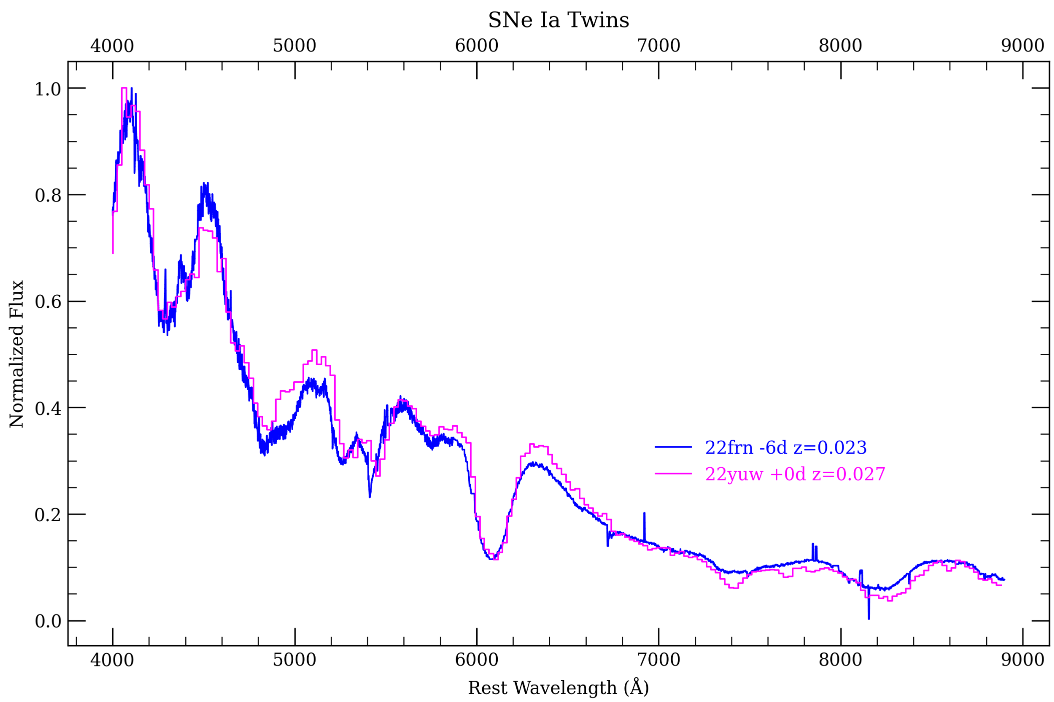


Figure 3: Spectra for SN2022frn and SN2022yuw with timing listed as days relative to peak. SN2022yuw spectra acquired from TNS. Despite the differences in their respective light curves (shown in in Fig 2), it is evident that the observations were taken with comparable magnitudes for each object, despite their difference in peak they are still spectroscopically similar. Observing SNe Ia at similar magnitude, despite phase differences, allows us to isolate intrinsic spectral features and identify correlations between light-curve variations and spectral similarities, improving our understanding of their diversity and reducing systematic scatter.

Experimental Design *Limited to 1 page of text*

YSE utilizes the Pan-STARRS telescopes– PS1 since 2020 and PS2 since spring 2022 to survey $\sim$1,512 deg^2 at a time with a 3-day cadence, out of which we have access to DECam data spanning $\sim$300 deg^2. YSE finds scores of SNe within 2 days of explosion by itself. Through public resources and partnerships, our team has access to major transient survey data streams, including ATLAS, *Gaia*, PSST, and ZTF. The team also ingests all data reported to the TNS, including ASAS-SN, DLT40 and amateur discoveries. This combination is critical for triggering on the *best* young transients and guarding against weather loss. Additionally, the combined data set results in significantly higher cadence than any individual survey, typically $<$2 days across the Northern sky and $<$1 day in the region also surveyed with DECam. This cadence is *essential for identifying transients when they are hours old and sending young and nearby SNe to Gemini.* Objects that are especially likely to be within a day of explosion from privately obtained DECam and PS2 data will be immediately sent to Gemini-North/South (with the choice of N or S dependent on declination of the target), using the AEON system where possible.

Technical Description *Limited to 1 page of text*

We will trigger optical spectroscopy with Gemini/GMOS targeting SN candidates with magnitudes in the range $19 \lesssim r \lesssim 21$ mag, detected by either DECam or Pan-STARRS. This program can equally balance requests between Gemini-N and Gemini-S. All of our sources will be rising, and will be brighter than this when we acquire spectra. We therefore adopt $r \approx 20.5$ mag as the faint limit of our program. We aim to cover the Si II λ6355 feature, whose blue (red) edge will be redshifted to roughly 6300 (8000) Å for our lowest- (highest-) z targets. Our observations will use either the B480 or R400 (with the OG515 order-blocking filter) for targets, with the choice of grating tailored to each target's estimated redshift to optimize coverage of Si II λ6355and other critical spectral features. To mitigate chip gaps in the GMOS detectors, we will use two slightly different grating angles for each target. Each configuration will include 2x600s exposures. Given 960s for acquisition, 4x24s for readout and 90s for the grating change, our total request per spectrum is 1 hour for both configurations. While exposure time calculations are accounted for in both setups, the ITC processes each configuration independently, leading to the 960-second acquisition time being counted twice.

For targets at the faint limit magnitude of $g \sim 20.5$, our observations will achieve a S/N = 3 per pixel in even relatively poor conditions (IQ85, CC70, WV100, SB80). These conditions are sufficient for detecting faint supernova features under typical Hawaiian skies. This S/N level enables reliable classification, redshift determination, and the study of spectral line velocities and their correlation with light-curve properties. Supernova features are broad, spanning more than 100 Å. As a result, the signal-to-noise ratio for certain measurements can be greatly increased by binning the spectrum. Whenever feasible, we will align the slit with the parallactic angle, which is crucial for analyzing line ratios and achieving accurate relative spectrophotometry. Given the faintness of these sources, smaller aperture telescopes are insufficient for obtaining the required data quality, except for brighter objects. For this program, Gemini will only be triggered for targets that are faint and observed early, providing critical spectroscopic information to complement existing samples and fill the sparsely explored regime of early-phase observations. This approach allows us to address key questions about SN physics that remain underrepresented in current spectroscopic data sets.

While the observing conditions indicated are approximate, we stress that our observations do not need to occur in photometric conditions. Prior programs have demonstrated that this configuration works well for obtaining publication-quality SN spectra. We request equal amounts of Gemini North and Gemini South time, as both facilities are extremely useful for obtaining PS1, PS2, and ZTF SNe in the North and DECam SNe in the South. We are flexible if shifting time between North and South makes scheduling easier for Gemini Observatory staff. Sources brighter than ∼19 mag will be observed with a combination of other spectroscopic resources to which our team has access.

We request a total of 5.7 hours (5 objects) on Gemini North and 5.7 hours on Gemini South including overheads for a total of 11.4 hours. We request a minimum amount of time of 6.84 hours, 3.42 hours on Gemini North and 3.42 hours on Gemini South, to allow us to observe three objects in the north and three in the south.

Band 3 Plan *Limited to 1/2 page of text*

Not requesting Band 3.

Classical Backup Program *Limited to 1/2 page of text*

This is not a classical request.

Justify Target Duplications

The proposed targets will be new transient events, and will not be duplicate observations.

ITC Examples

Gemini Integration Time Calculator
GMOS-N - 2025A.1.1.1

Click here for help with the results page.
Read noise: 4.14 e-/pix
Dark current: 8.3E-4 e-/s/pix
software aperture extent along slit = 1.95 arcsec
fraction of source flux in aperture = 0.53
derived image size(FWHM) for a point source = 1.39 arcsec

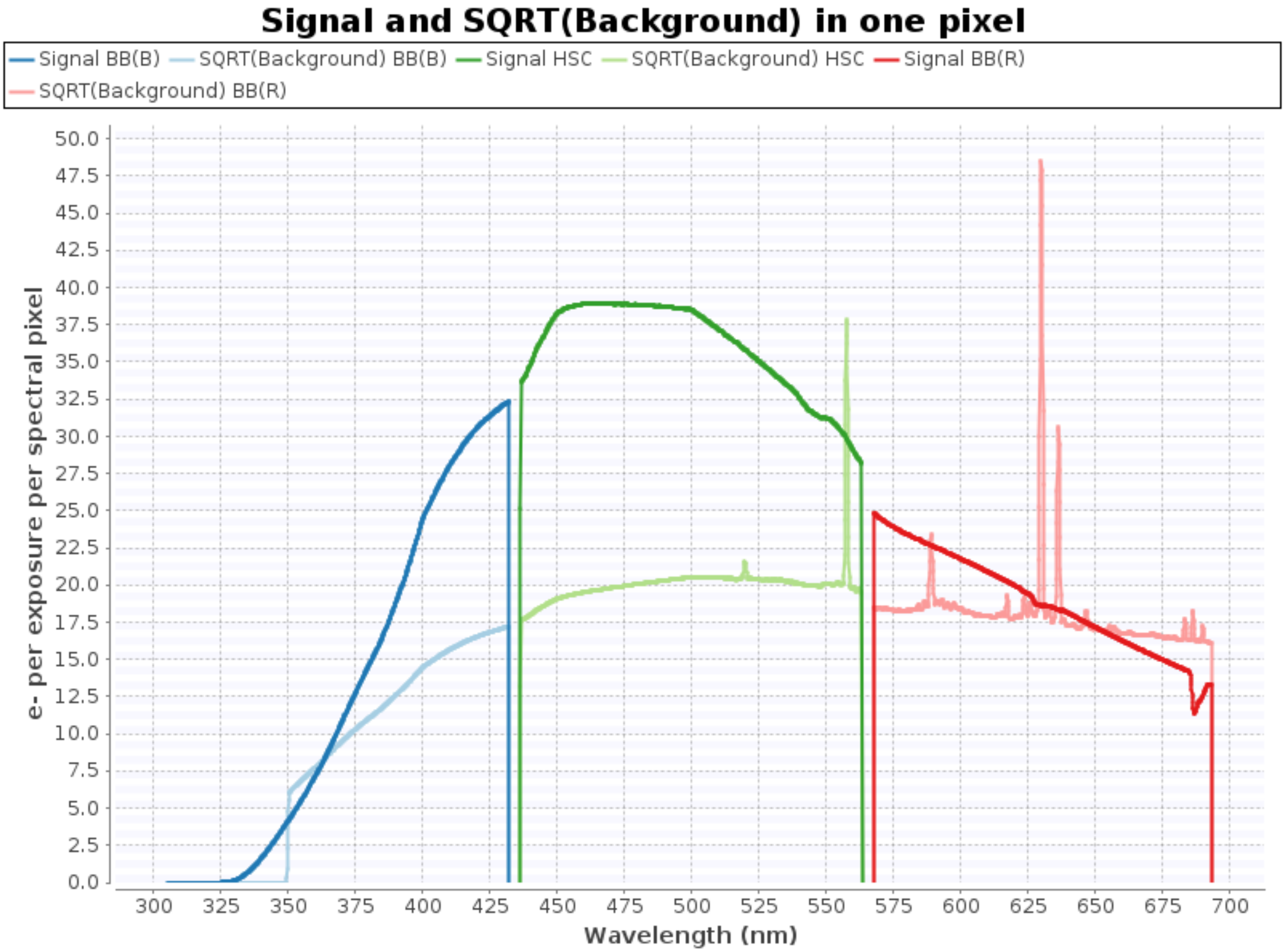
Sky subtraction aperture = 5.0 times the software aperture.

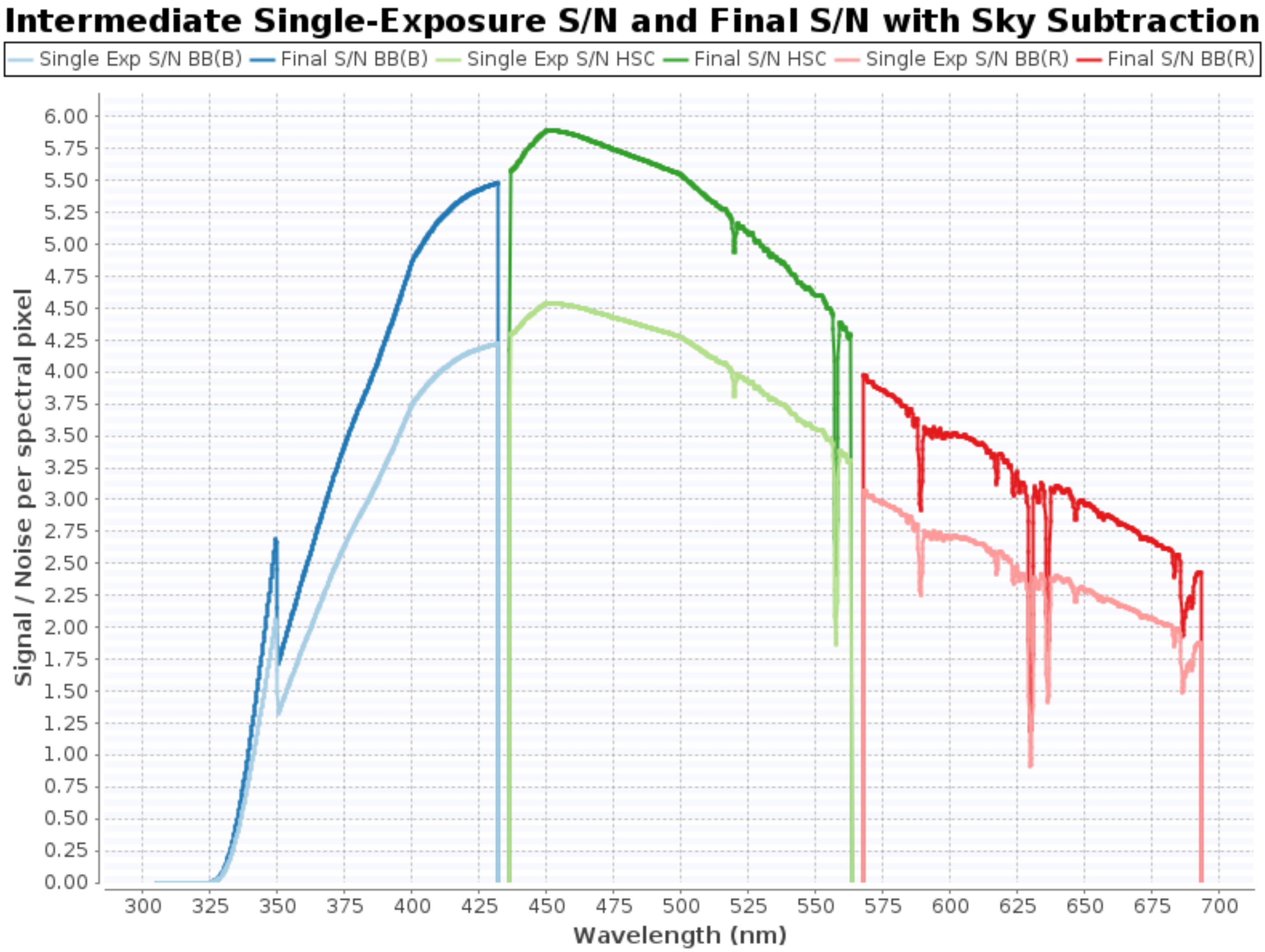
Requested total integration time = 1200.00 secs, of which 1200.00 secs is on source.

The peak pixel signal + background is 2371 e- (1454 ADU). This is 2% of the saturation limit of 106822 e-.

Observation Overheads		
Setup	960.0 s	
Telescope offset	1 x 7.0 s	assuming ABBA dithering pattern
Exposure	2 x 600.0 s	
Readout	2 x 24.3 s	
DHS Write	2 x 10.0 s	
Program time	**37 mins 16 secs**	

Click here for ASCII signal spectrum.
Click here for ASCII background spectrum.
Click here for Single Exposure S/N ASCII data.
Click here for Final S/N ASCII data.


Signal and SQRT(Background) in one pixel
Signal BB(B)
SQRT(Background) BB(B)
Signal HSC
SQRT(Background) HSC
Signal BB(R)
SQRT(Background) BB(R)
e- per exposure per spectral pixel
Wavelength (nm)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
40.0
42.5
45.0
47.5
50.0
300
325
350
375
400
425
450
475
500
525
550
575
600
625
650
675
700



Output:

- Spectra autoscaled.

Input Parameters:
Instrument: GMOS-N

Source spatial profile, brightness, and spectral distribution:
The z = 0.00000 point source is a 30000.0K blackbody with 20.5 Vega in the R band.

Instrument configuration:
Optical Components:

- Fixed Optics
- Grating Optics: B480_G5309
- Detector - Hamamatsu array

Amp gain: Low, Amp read mode: Slow

- Focal Plane Mask: Longslit 1.00 arcsec

Region of Interest: Full Frame Readout
Central Wavelength: 500.0 nm
Binning: 2 × 2

Pixel Size in Spatial Direction: 0.161556arcsec
Pixel Size in Spectral Direction: 0.124nm

Telescope configuration:
- silver mirror coating.
- side looking port.
- wavefront sensor: oiwfs

Observing Conditions:
- Airmass: 1.50
- Image Quality: 85% (≤ 1.09" at zenith, ≤ 1.39" on-source, exact condition specified)
- Cloud cover: 70%
- Water Vapor: 100%
- Sky Background: 80%

Likelihood of execution: 48%

Calculation and analysis methods:
- Mode: spectroscopy
- Calculation of S/N ratio with 2 exposures of 600.00 secs, and 100.00% of them on source.
- Analysis performed for aperture that gives 'optimum' S/N and a sky aperture that is 5.00 times the target aperture.

Gemini Integration Time Calculator
GMOS-N - 2025A.1.1.1

Click here for help with the results page.
Read noise: 4.14 e-/pix
Dark current: 8.3E-4 e-/s/pix
software aperture extent along slit = 1.87 arcsec
fraction of source flux in aperture = 0.56
derived image size(FWHM) for a point source = 1.34 arcsec

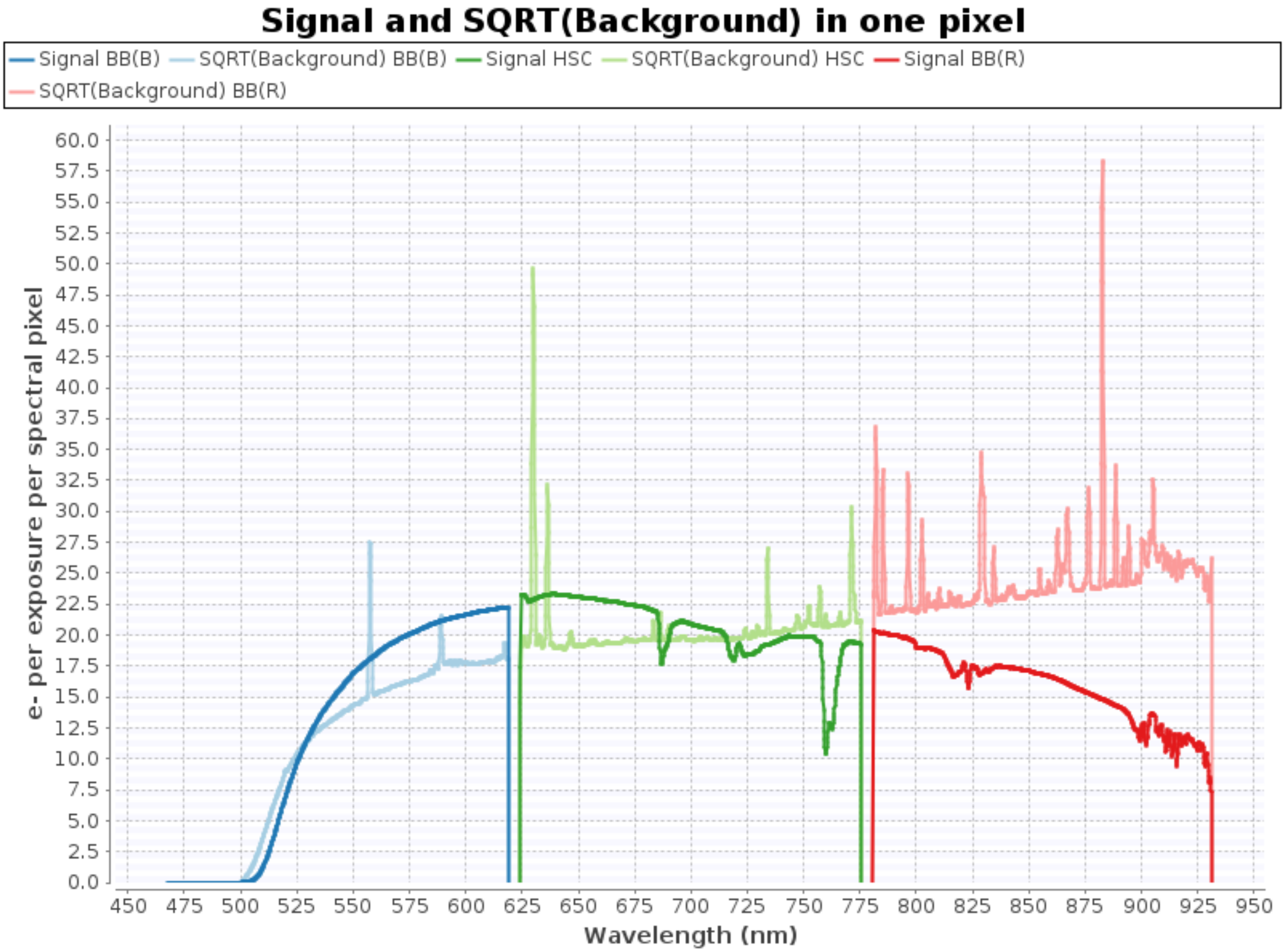
Sky subtraction aperture = 5.0 times the software aperture.

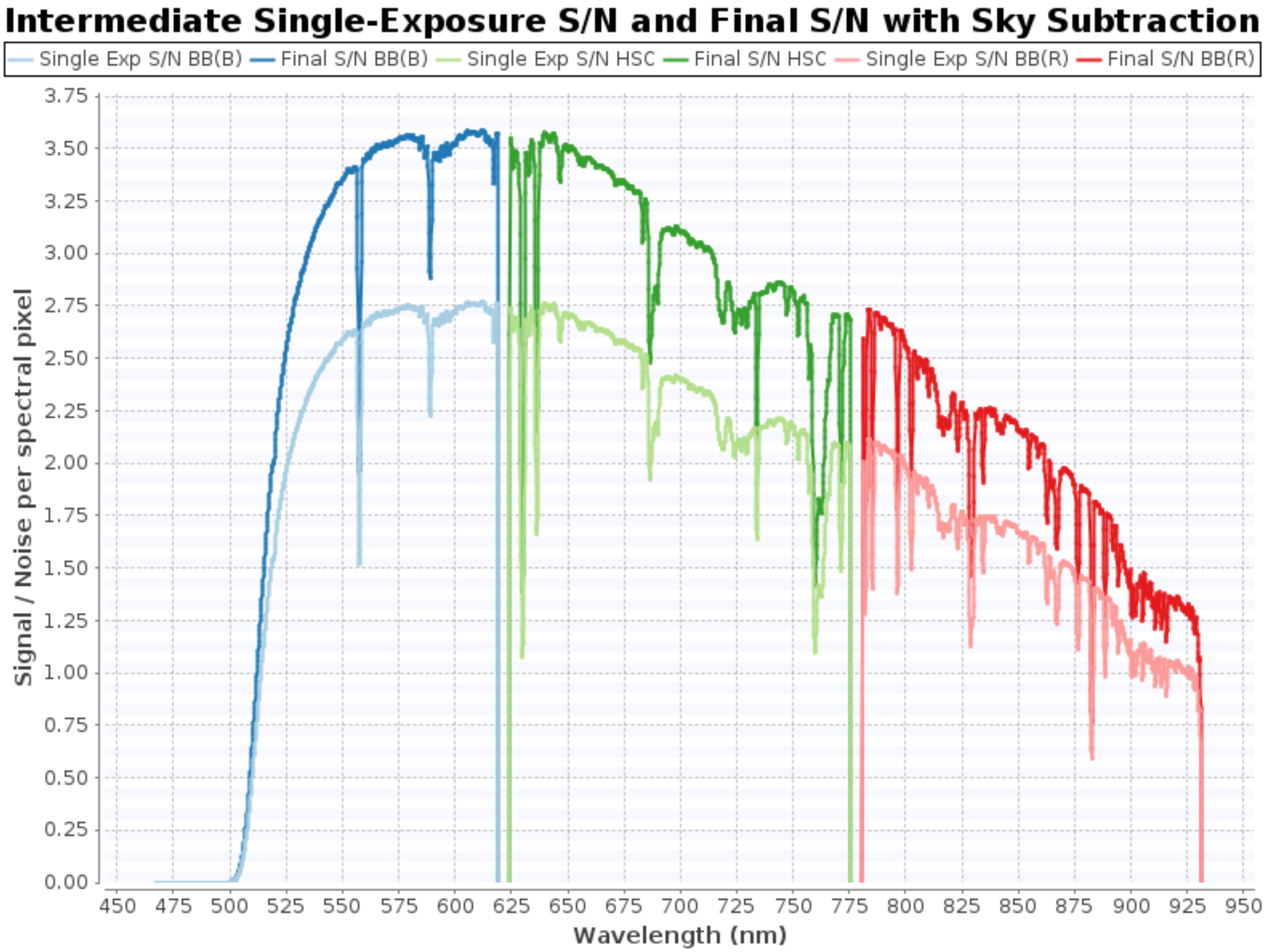
Requested total integration time = 1200.00 secs, of which 1200.00 secs is on source.

The peak pixel signal + background is 3416 e- (2095 ADU). This is 3% of the saturation limit of 106822 e-.

Observation Overheads		
Setup	960.0 s	
Telescope offset	1 x 7.0 s	assuming ABBA dithering pattern
Exposure	2 x 600.0 s	
Readout	2 x 24.3 s	
DHS Write	2 x 10.0 s	
Program time	**37 mins 16 secs**	

Click here for ASCII signal spectrum.
Click here for ASCII background spectrum.
Click here for Single Exposure S/N ASCII data.
Click here for Final S/N ASCII data.


Signal and SQRT(Background) in one pixel
Signal BB(B)
SQRT(Background) BB(B)
Signal HSC
SQRT(Background) HSC
Signal BB(R)
SQRT(Background) BB(R)
e- per exposure per spectral pixel
Wavelength (nm)
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950



Output:

- Spectra autoscaled.

Input Parameters:
Instrument: GMOS-N

Source spatial profile, brightness, and spectral distribution:
The z = 0.00000 point source is a 30000.0K blackbody with 20.5 Vega in the R band.

Instrument configuration:
Optical Components:

- Filter: OG515_G0306
- Fixed Optics
- Grating Optics: R400_G5305
- Detector - Hamamatsu array

Amp gain: Low, Amp read mode: Slow

- Focal Plane Mask: Longslit 1.00 arcsec

Region of Interest: Full Frame Readout

Central Wavelength: 700.0 nm
Binning: 2 × 2
Pixel Size in Spatial Direction: 0.161556arcsec
Pixel Size in Spectral Direction: 0.148nm

Telescope configuration:

- silver mirror coating.
- side looking port.
- wavefront sensor: oiwfs

Observing Conditions:

- Airmass: 1.50
- Image Quality: 85% (≤ 1.05" at zenith, ≤ 1.34" on-source)
- Cloud cover: 70%
- Water Vapor: 100%
- Sky Background: 80%

Likelihood of execution: 48%

Calculation and analysis methods:

- Mode: spectroscopy
- Calculation of S/N ratio with 2 exposures of 600.00 secs, and 100.00% of them on source.
- Analysis performed for aperture that gives 'optimum' S/N and a sky aperture that is 5.00 times the target aperture.

Gemini Integration Time Calculator
GMOS-S - 2025A.1.1.1

Click here for help with the results page.
Read noise: 3.98 e-/pix
Dark current: 8.3E-4 e-/s/pix
software aperture extent along slit = 1.95 arcsec
fraction of source flux in aperture = 0.53
derived image size(FWHM) for a point source = 1.39 arcsec

Sky subtraction aperture = 5.0 times the software aperture.

Requested total integration time = 1200.00 secs, of which 1200.00 secs is on source.

The peak pixel signal + background is 2345 e- (1302 ADU). This is 2% of the saturation limit of 117963 e-.

Observation Overheads		
Setup	960.0 s	
Telescope offset	1 x 7.0 s	assuming ABBA dithering pattern
Exposure	2 x 600.0 s	
Readout	2 x 24.3 s	
DHS Write	2 x 10.0 s	
Program time	**37 mins 16 secs**	

Click here for ASCII signal spectrum.
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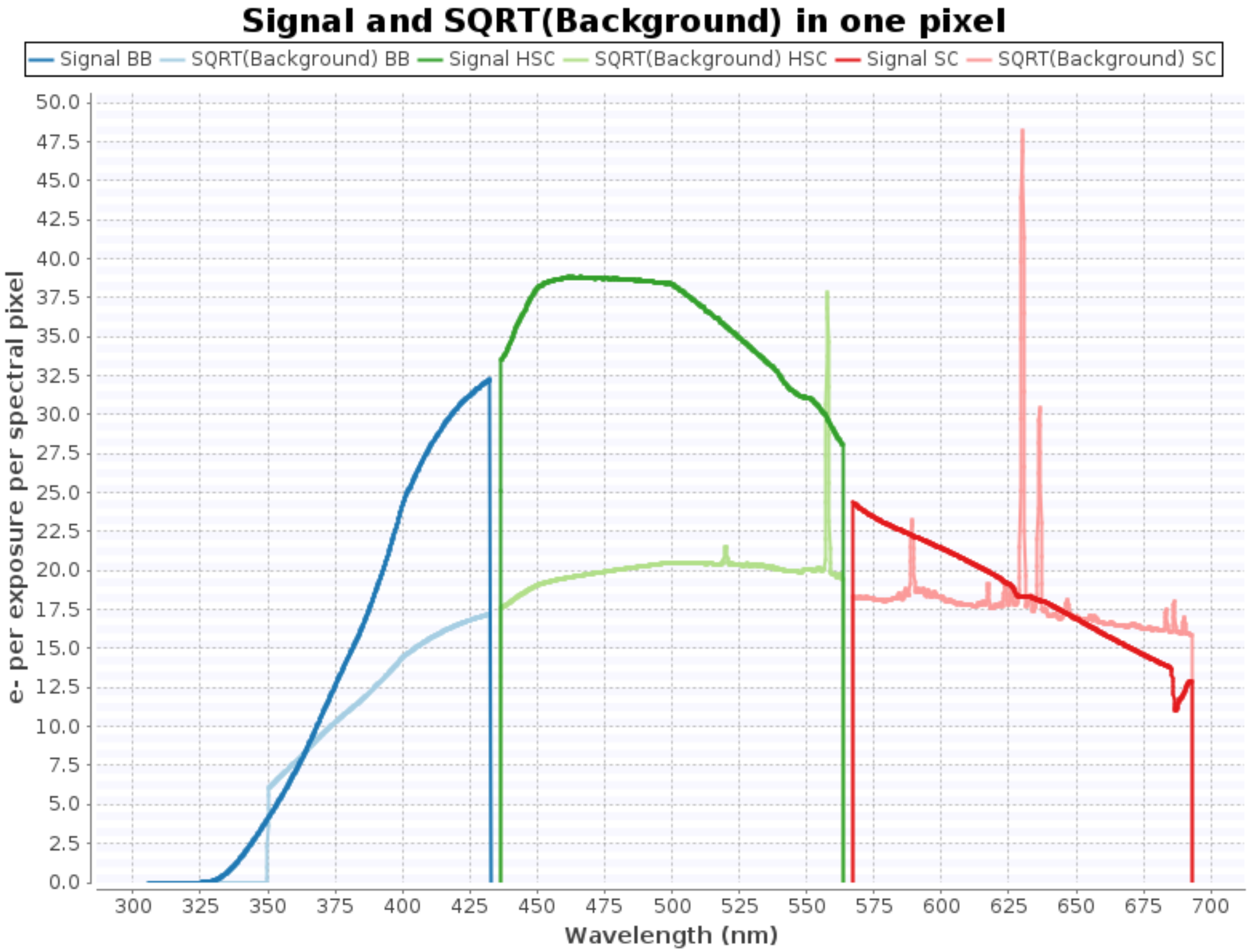
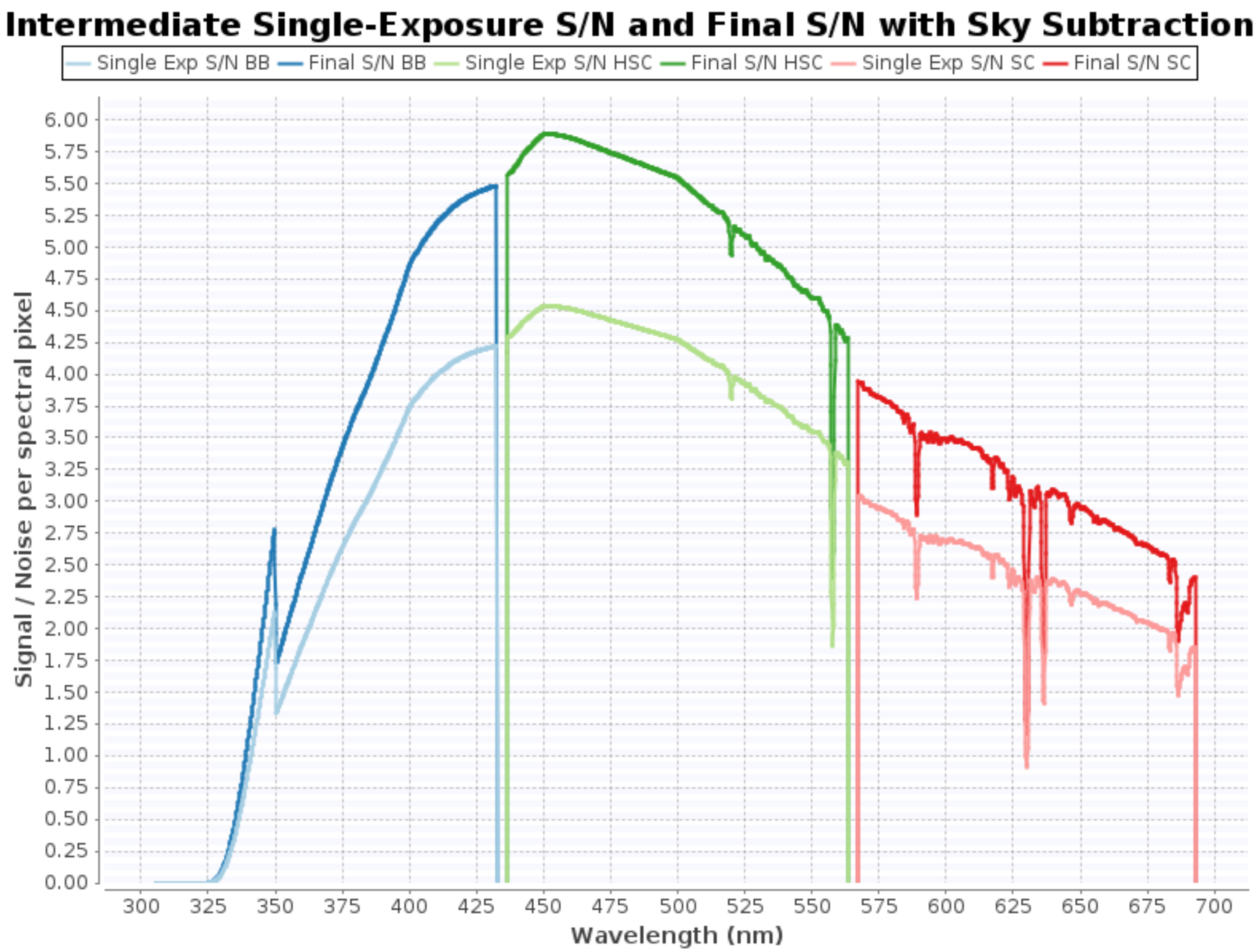

Signal and SQRT(Background) in one pixel
Signal BB
SQRT(Background) BB
Signal HSC
SQRT(Background) HSC
Signal SC
SQRT(Background) SC
e- per exposure per spectral pixel
Wavelength (nm)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
40.0
42.5
45.0
47.5
50.0
300
325
350
375
400
425
450
475
500
525
550
575
600
625
650
675
700



Output:

- Spectra autoscaled.

Input Parameters:
Instrument: GMOS-S

Source spatial profile, brightness, and spectral distribution:
The z = 0.00000 point source is a 30000.0K blackbody with 20.5 Vega in the R band.

Instrument configuration:
Optical Components:

- Fixed Optics
- Grating Optics: B480_G5327
- Detector - Hamamatsu array

Amp gain: Low, Amp read mode: Slow

- Focal Plane Mask: Longslit 1.00 arcsec

Region of Interest: Full Frame Readout
Central Wavelength: 500.0 nm
Binning: 2 × 2

Pixel Size in Spatial Direction: 0.161556arcsec
Pixel Size in Spectral Direction: 0.124nm

Telescope configuration:

- silver mirror coating.
- side looking port.
- wavefront sensor: oiwfs

Observing Conditions:

- Airmass: 1.50
- Image Quality: 85% (≤ 1.09" at zenith, ≤ 1.39" on-source)
- Cloud cover: 70%
- Water Vapor: 100%
- Sky Background: 80%

Likelihood of execution: 48%

Calculation and analysis methods:

- Mode: spectroscopy
- Calculation of S/N ratio with 2 exposures of 600.00 secs, and 100.00% of them on source.
- Analysis performed for aperture that gives 'optimum' S/N and a sky aperture that is 5.00 times the target aperture.

Gemini Integration Time Calculator
GMOS-S - 2025A.1.1.1

Click here for help with the results page.
Read noise: 3.98 e-/pix
Dark current: 8.3E-4 e-/s/pix
software aperture extent along slit = 1.87 arcsec
fraction of source flux in aperture = 0.56
derived image size(FWHM) for a point source = 1.34 arcsec

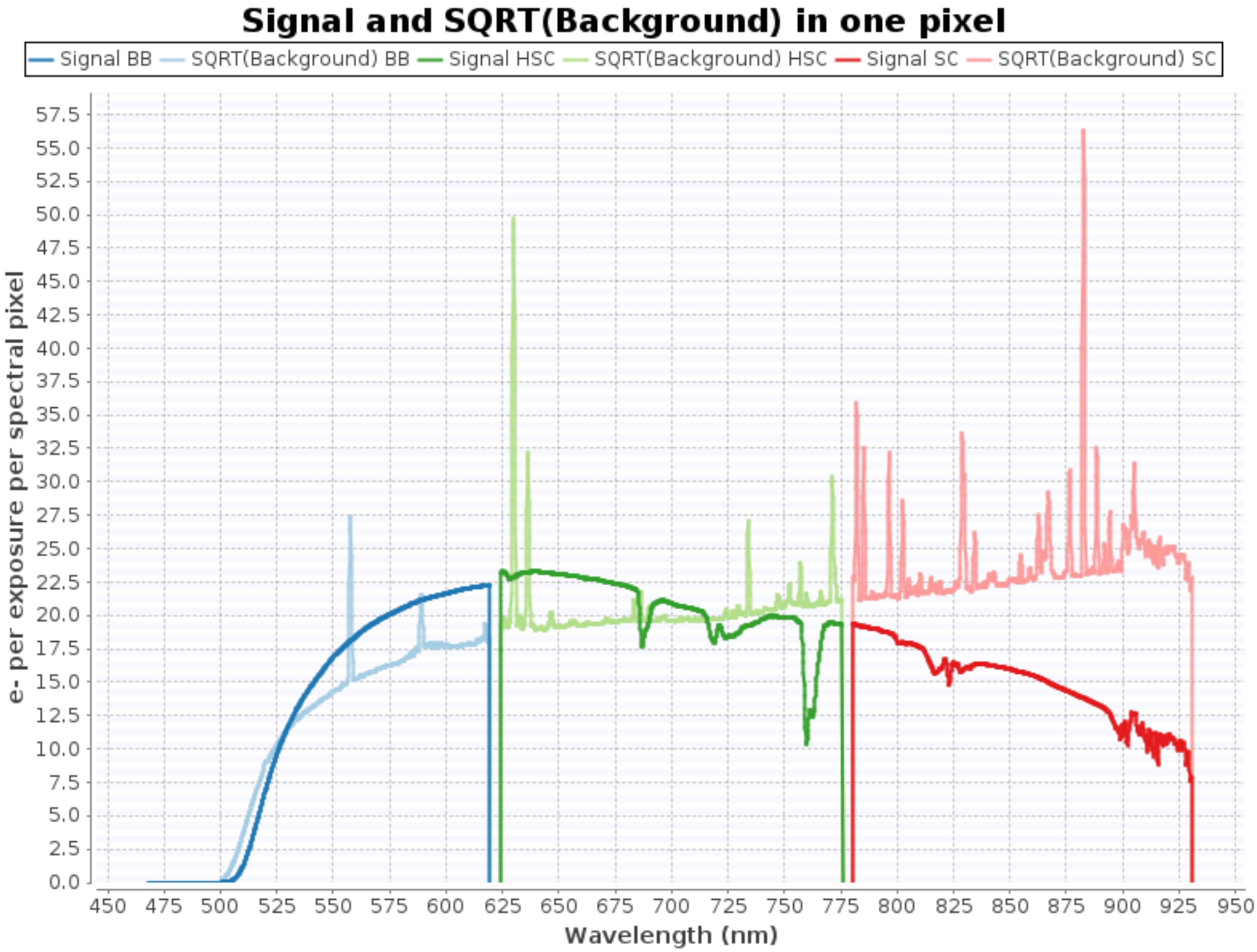
Sky subtraction aperture = 5.0 times the software aperture.

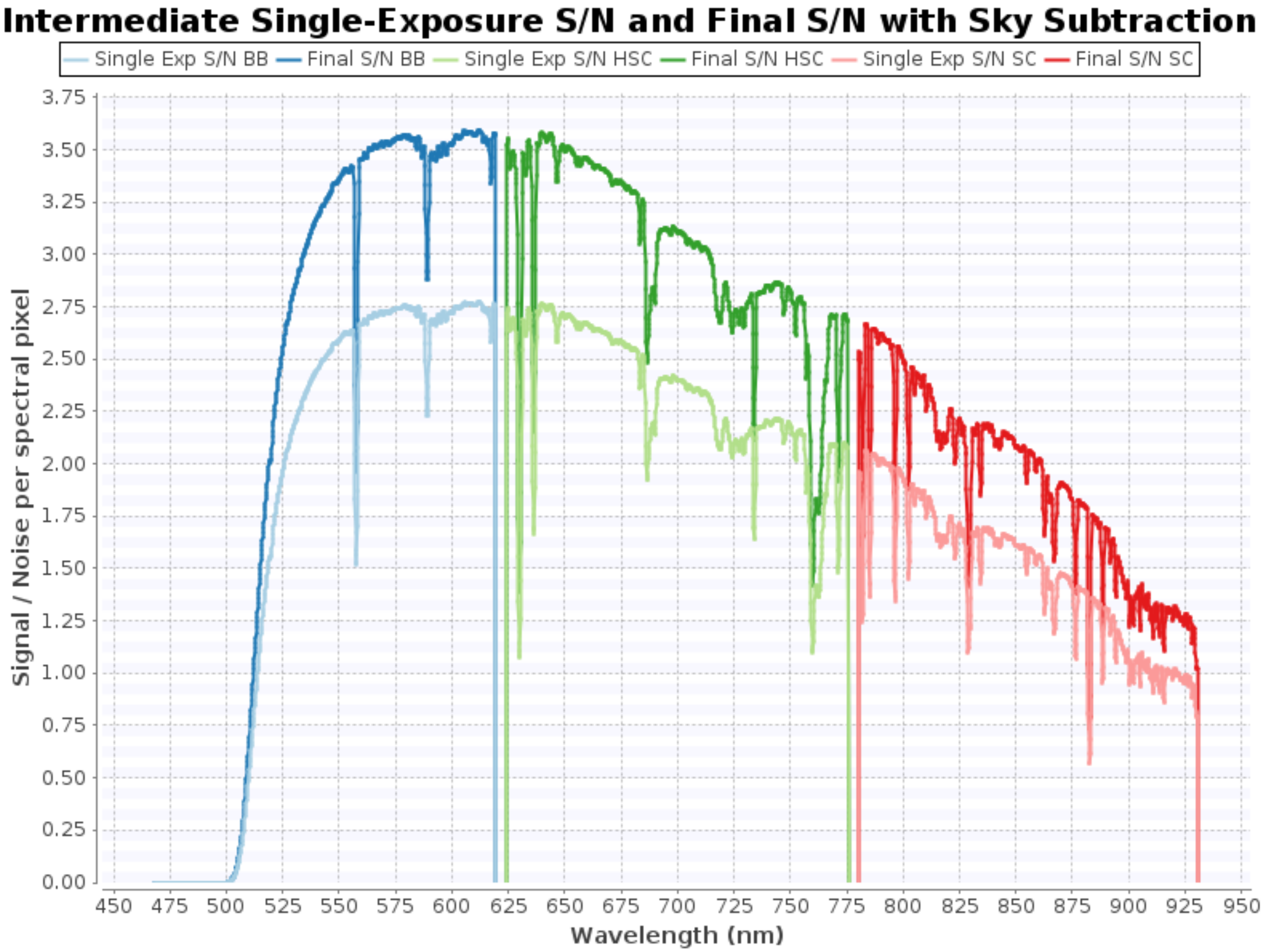
Requested total integration time = 1200.00 secs, of which 1200.00 secs is on source.

The peak pixel signal + background is 3184 e- (1768 ADU). This is 3% of the saturation limit of 117963 e-.

Observation Overheads		
Setup	960.0 s	
Telescope offset	1 x 7.0 s	assuming ABBA dithering pattern
Exposure	2 x 600.0 s	
Readout	2 x 24.3 s	
DHS Write	2 x 10.0 s	
Program time	**37 mins 16 secs**	

Click here for ASCII signal spectrum.
Click here for ASCII background spectrum.
Click here for Single Exposure S/N ASCII data.
Click here for Final S/N ASCII data.


Signal and SQRT(Background) in one pixel
Signal BB
SQRT(Background) BB
Signal HSC
SQRT(Background) HSC
Signal SC
SQRT(Background) SC
e- per exposure per spectral pixel
Wavelength (nm)
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
450
475
500
525
550
575
600
625
650
675
700
725
750
775
800
825
850
875
900
925
950



Output:

- Spectra autoscaled.

Input Parameters:
Instrument: GMOS-S

Source spatial profile, brightness, and spectral distribution:
The z = 0.00000 point source is a 30000.0K blackbody with 20.5 Vega in the R band.

Instrument configuration:
Optical Components:

- Filter: OG515_G0330
- Fixed Optics
- Grating Optics: R400_G5325
- Detector - Hamamatsu array

Amp gain: Low, Amp read mode: Slow

- Focal Plane Mask: Longslit 1.00 arcsec

Region of Interest: Full Frame Readout

Central Wavelength: 700.0 nm
Binning: 2 × 2
Pixel Size in Spatial Direction: 0.161556arcsec
Pixel Size in Spectral Direction: 0.148nm

Telescope configuration:

- silver mirror coating.
- side looking port.
- wavefront sensor: oiwfs

Observing Conditions:

- Airmass: 1.50
- Image Quality: 85% (≤ 1.05" at zenith, ≤ 1.34" on-source)
- Cloud cover: 70%
- Water Vapor: 100%
- Sky Background: 80%

Likelihood of execution: 48%

Calculation and analysis methods:

- Mode: spectroscopy
- Calculation of S/N ratio with 2 exposures of 600.00 secs, and 100.00% of them on source.
- Analysis performed for aperture that gives 'optimum' S/N and a sky aperture that is 5.00 times the target aperture.

Team Information *Limited to 1 page of text*

Our team includes scientists at UIUC, DARK, NOIRLab, Cambridge, STScI, UC Santa Cruz, MIT, Harvard, and Washington State Univ., and has a wealth of expertise with transient searches using wide field surveys. YSE also includes members from QUB and U. Hawaii who will assist in the timely analysis of PS data. All Co-Is have sufficient funding to support this project. PI Henna Abunemeh is supported by TA-ship. Co-I Wasserman is supported by the National Center for Supercomputing Applications' Center for Astrophysical Surveys Fellowship. Co-I Narayan is supported by a NASA ADAP, NASA HST and the NSF CAREER grant. Co-I Wasserman is working on the Recommendation System for Spectroscopic Follow-up to facilitate finding early-time SNe Ia in the Legacy Survey of Space and Time. Co-I Wasserman along with Co-I Narayan are on the Rubin commissioning team. Co-I Perkins is supported by an NSF Astronomy and Astrophysics Grant.

Publications

Our team includes members of the Foundation and Young Supernova Surveys launched to investigate the physics and progenitor systems of young SNe. These works have resulted in 30+ publications to date, spanning progenitor studies, cosmological inference, and host-galaxy analysis (and with several more nearing submission): Godoy-Rivera et al., 2017, MNRAS, 466, 1428 • Kilpatrick et al., 2017, MNRAS, 465, 4650 • Zheng et al., 2017, ApJ, 841, 64 • de Jaeger et al., 2018, MNRAS, 478, 3776 • Foley et al., 2018, MNRAS, 475, 19 • Jones et al., 2018, ApJ, 867, 108 • Kilpatrick et al., 2018, MNRAS, 473, 4805 • Kilpatrick et al., 2018, MNRAS, 480, 2072 • Kilpatrick et al., 2018, MNRAS, 481, 11 • Li et al., 2019, ApJL, 870, 12 • Nicholl et al., 2019, MNRAS, 488, 1878 • Pan et al., 2019, MNRAS, 491, 5897 • Takaro et al., 2019, MNRAS, 493,986 • Siebert et al., 2019, MNRAS, 486, 5785 • Dimitriadis et al., 2021, ApJ, 927, 78D • Jones et al., 2021, ApJ, 908, 143 • Kilpatrick et al., 2021, MNRAS, 504, 2073 • Tinyanont et al., 2021, MNRAS, 512, 2777 • Gagliano et al., 2022, ApJ, 924, 55G • Jacobson-Galán et al., 2022, ApJ, 932, 58J • Jacobson-Galán et al., 2022, ApJ, 924, 15J • Terreran et al., 2022, ApJ, 926, 20T • Angus et al., 2022, Nat Astron, 6, 1452 • Ward et al., 2023, ApJ 956, 111 • Davis et al., 2023, MNRAS, 523, 2530 • Aleo et al., 2023, ApJ, 266, 1 • Fulton et al., 2023, ApJ, 946, 1 • Kilpatrick et al., 2023, MNRAS, 524, 2 • Coulter et al., 2023, PASP, 135, 1048 • Wang et al., 2023, arXiv:2305.03779 • Jacobson-Galan et al., 2023, ApJ, 952, L23 • Kilpatrick et al., 2023, ApJ, 952, L23 • Jacobson-Galan et al., 2023, arXiv:2403.02382

Use of Other Facilities or Resources

The selected targets will come from the Young Supernova Experiment (YSE), which utilizes data from Pan-STARRS. YSE covers approximately 1512 deg^2 of the sky (756 deg^2 at half capacity) with a 3-day cadence, reaching depths of 21.5 mag in the *gri* bands and 20.5 mag in the *z* band. Additionally, DECam imaging in the *griz* bands is being obtained for 200 deg^2 every three nights, reaching depths of 22.6 mag. To achieve higher cadence light curves during the brightest phases of the supernovae, these data are combined with public Zwicky Transient Facility (ZTF) observations, which are part of an NSF-funded survey using the 48-inch telescope at Palomar. ZTF alerts are ingested and processed in real-time by the ANTARES broker, within milliseconds of release. Other public transient surveys, including ATLAS, ASAS-SN, and DLT40, also provide complementary information, which are incorporated into ANTARES via TNS.

Previous Use of Gemini

☆ 2015A-0253; 2015B-0313; 2017A-0306; 2017B-0058; 2017B-0169, 2018A-0277, 2018B-0317, 2019A-0289, 2020A-0263,2021B-0395, 2022A-0324, 2022A-0317, 2022B-0319, 2023A-0311, 2023A-0314:

This is a new proposal requesting time for spectroscopic follow-up of Type Ia supernovae observed within days of peak to investigate their spectral evolution. Co-I Wasserman previously led a program spanning four semesters to follow up on young SNe Ia. This program was awarded 11 hours on Gemini North and 11 hours on Gemini South in 2021B, 2022A, and 2023A, along with an additional 11 hours on Gemini South in 2022B.

Name	Degree	Thesis or Project Title
Henna Abunemeh	PhD	Exploring Type Ia Supernova Luminosity Bias and Diversity
Amanda Wasserman	PhD	Evaluating the Selection of Transients for Spectroscopic Follow-up
Haille Perkins	PhD	Nucleosynthesis of Rare Transients