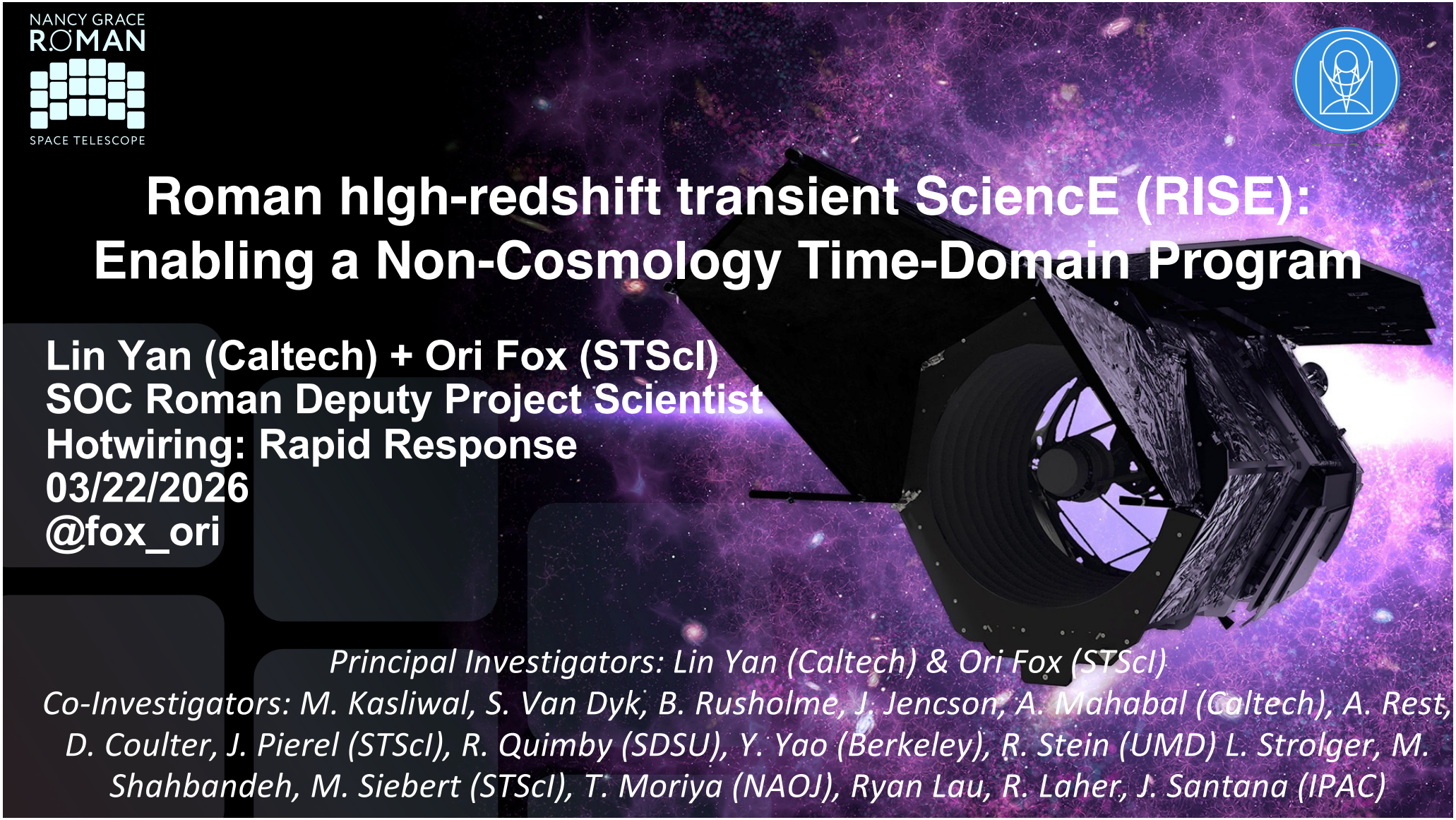


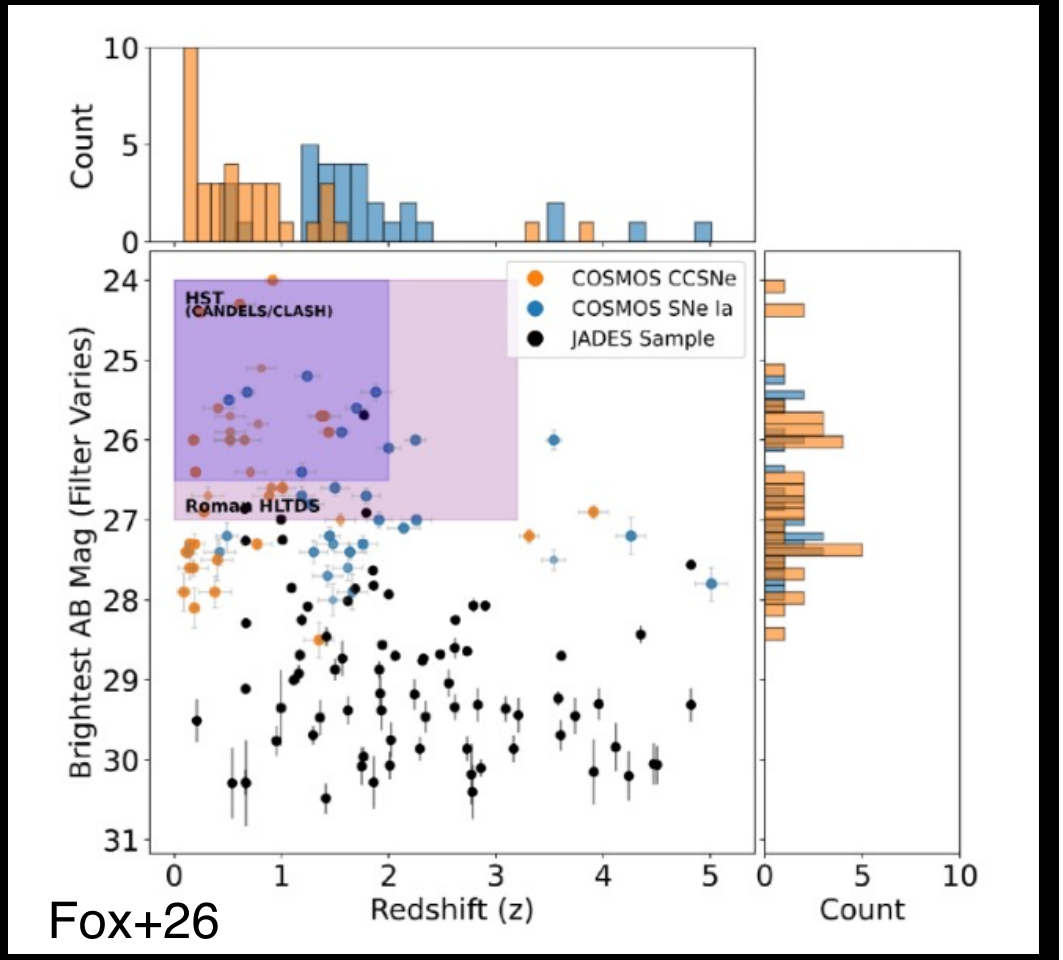
Roman hIgh-redshift transient SciencE (RISE): Enabling a Non-Cosmology Time-Domain Program

Lin Yan (Caltech) + Ori Fox (STScI)
SOC Roman Deputy Project Scientist
Hotwiring: Rapid Response
03/22/2026
@fox_ori

Principal Investigators: Lin Yan (Caltech) & Ori Fox (STScI)
Co-Investigators: M. Kasliwal, S. Van Dyk, B. Rusholme, J. Jencson, A. Mahabal (Caltech), A. Rest, D. Coulter, J. Pierel (STScI), R. Quimby (SDSU), Y. Yao (Berkeley), R. Stein (UMD) L. Strolger, M. Shahbandeh, M. Siebert (STScI), T. Moriya (NAOJ), Ryan Lau, R. Laher, J. Santana (IPAC)

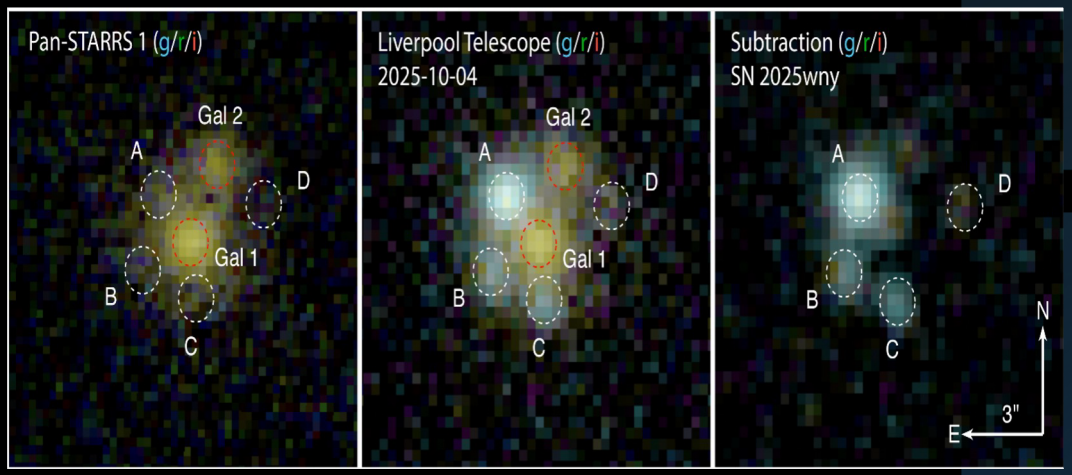
The Future is Now: the Next Frontier

- JADES:
  - 25 arcmin^2, GOODS-S, 1-year baseline
  - Down to 30 AB mag
  - 53 transients (~1-2 transient/arcmin^2)
  - Redshifts ranging from z=0.5-4.8
  - Follow-up MSA spectroscopy
- COSMOS/PRIMER
  - 133 arcmin^2 down to 28 AB mag
  - 72 transients, 9 at 2 < z < 5
  - Follow-up MSA spectroscopy

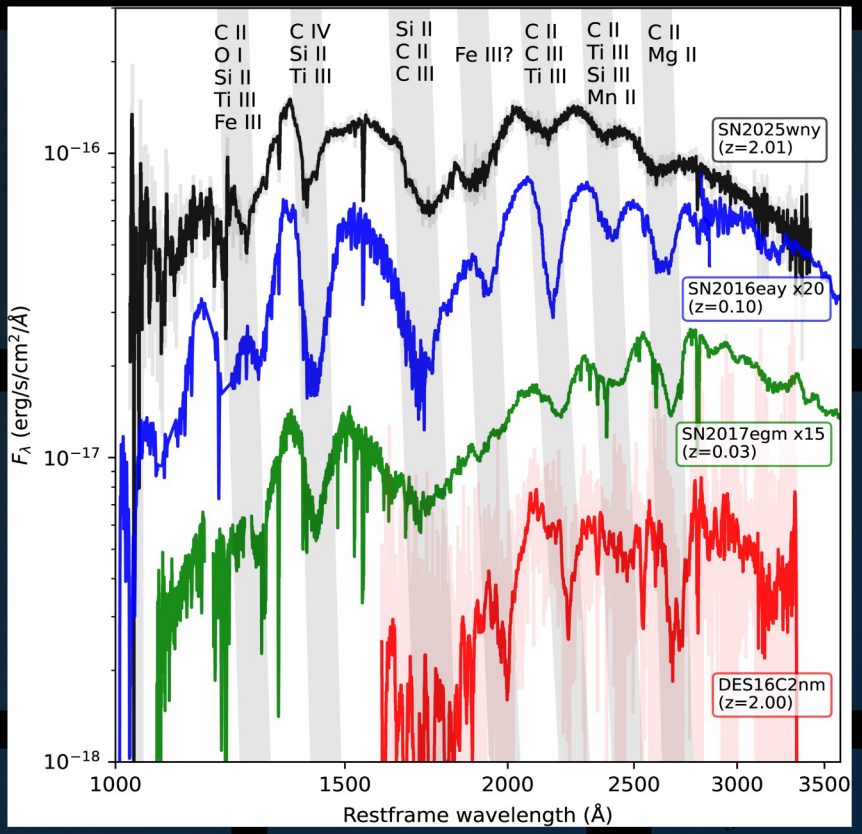


Fox+26

High-z transients – SN2025wny: The first z=2 SLSN-I Lensed by a Foreground Galaxy



Pre-explosion First detection Subtracted



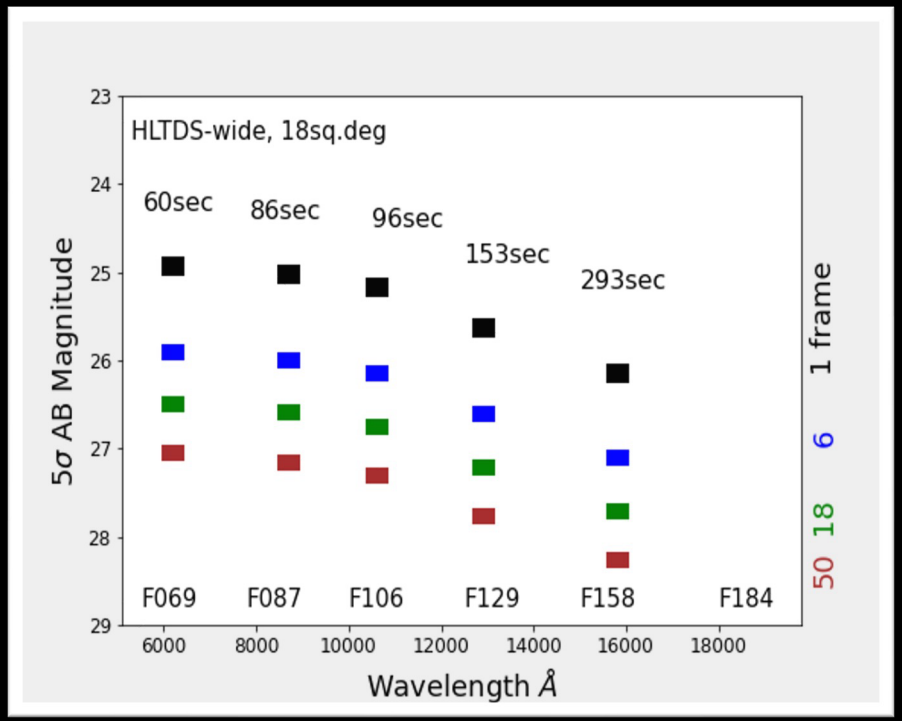
Please see Maggie Li's poster, & Johansson et al. 2025 ApJL 995 17

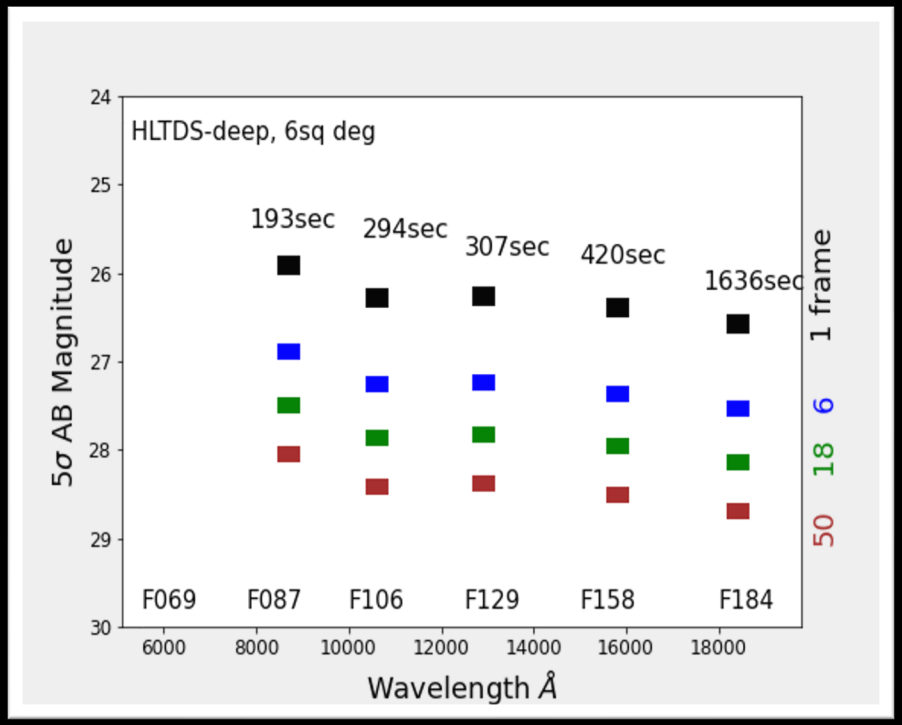
The science motivations of RISE:

- Pushing transient discoveries to redshift 1 – 10
- Pop III stars
- Evolution of massive stars @ high-z
- Evolution of stellar IMF(z)
- High-z TDEs --> SMBH accretion physics
- Much more.....

How deep can RISE stacking reach?

A case in high-latitude time domain survey (HLTDS) -- 1-2 mag deeper



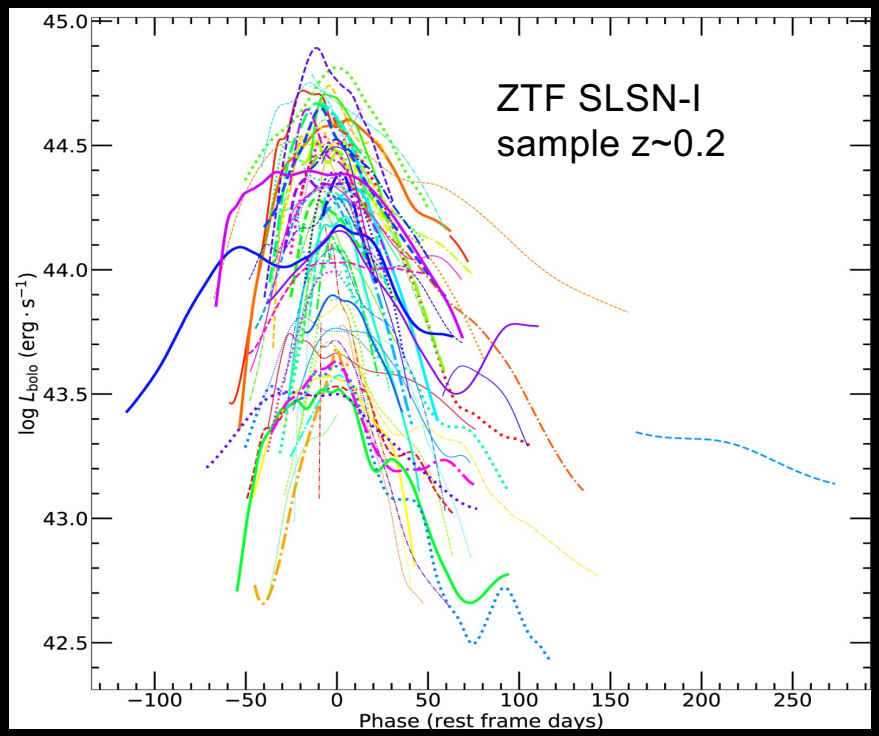


The Take-away: RISE stacking can reach >26-27 mag over 10-20 sq deg area over 5 years time span

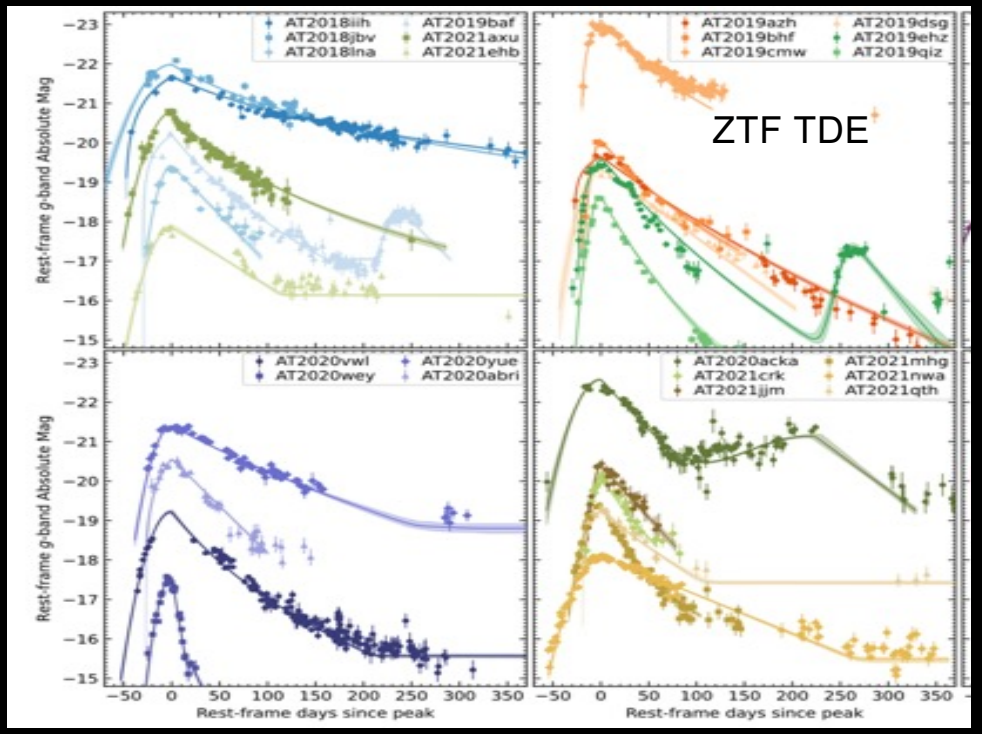
What high-z transients can RISE detect?

luminous and relatively slow: (1) SLSN (2) TDE

ZTF LCs and spectra can serve as templates for high-z events from RISE



Chen, Yan et al. 2023 ApJ

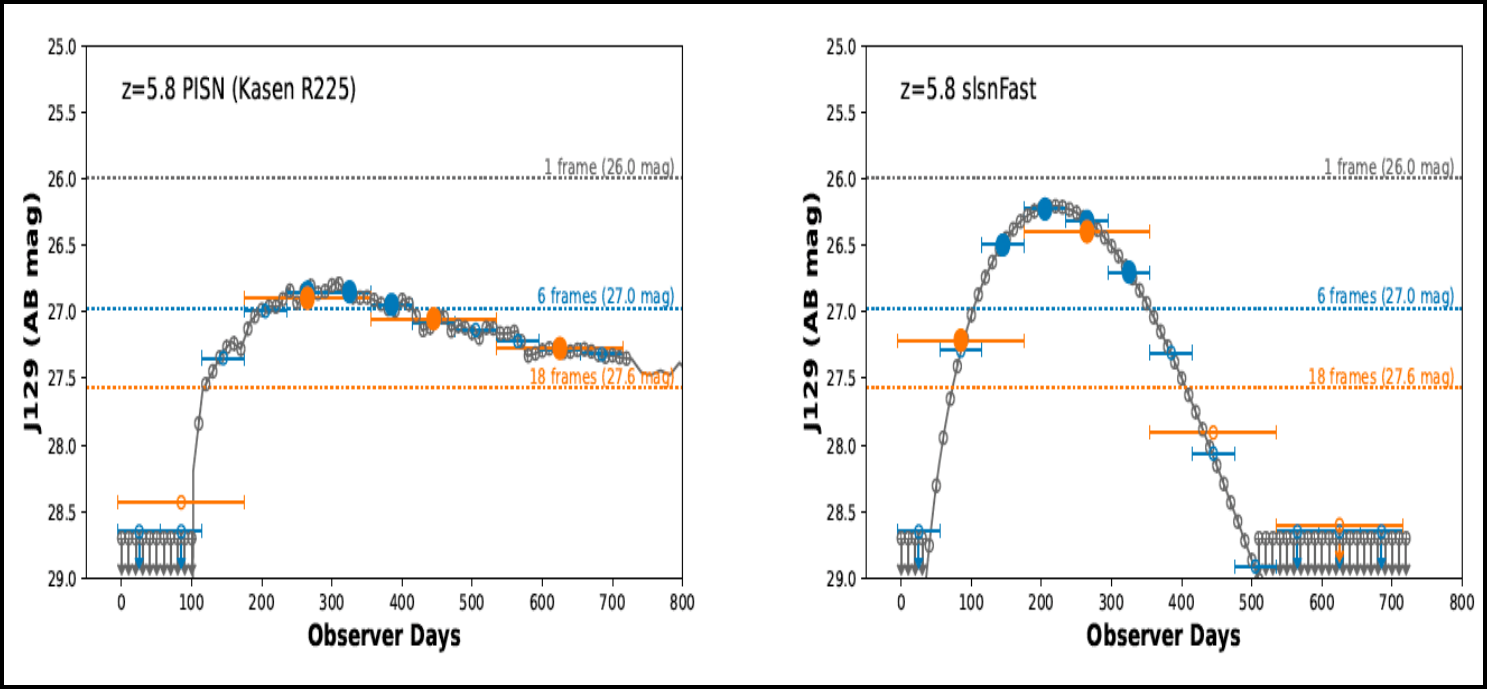


Yao et al. 2023 ApJ

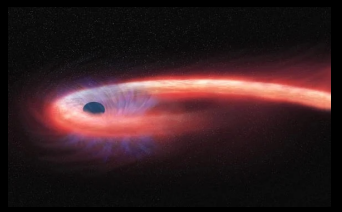
- The expected SLSN LCs:
  - RISE stacking enables not only SLSN detections
  - More importantly sampling multi-epoch LCs for characterization

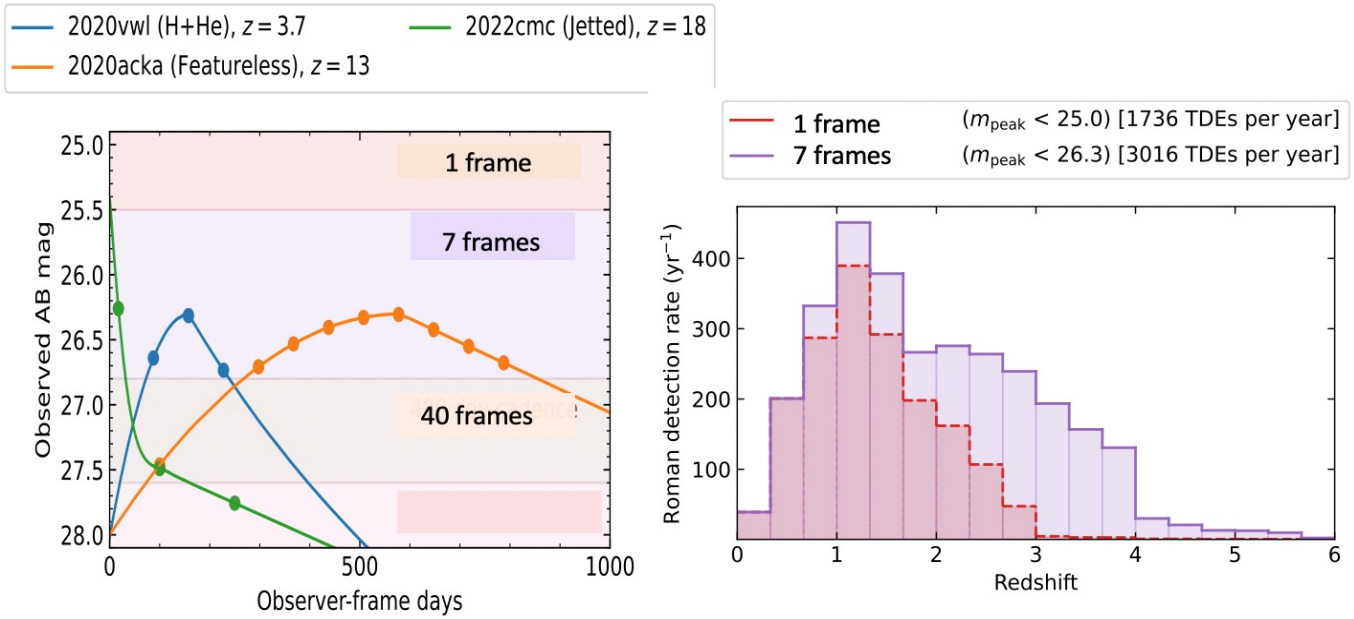
✓ Exotic stellar explosions: e^+ - e^- pair instability SN (PISN) at z ~ 5 - 10 (low metalicity, M_{zams} >100M_{sun})

✓ Superluminous SN (SLSN) at z~ 5 - 10: powered by magnetar

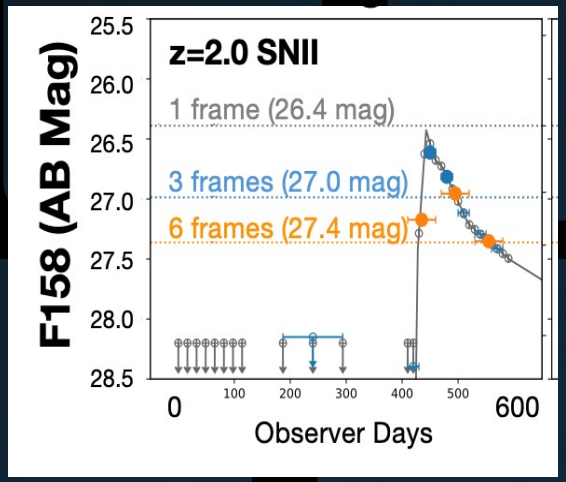


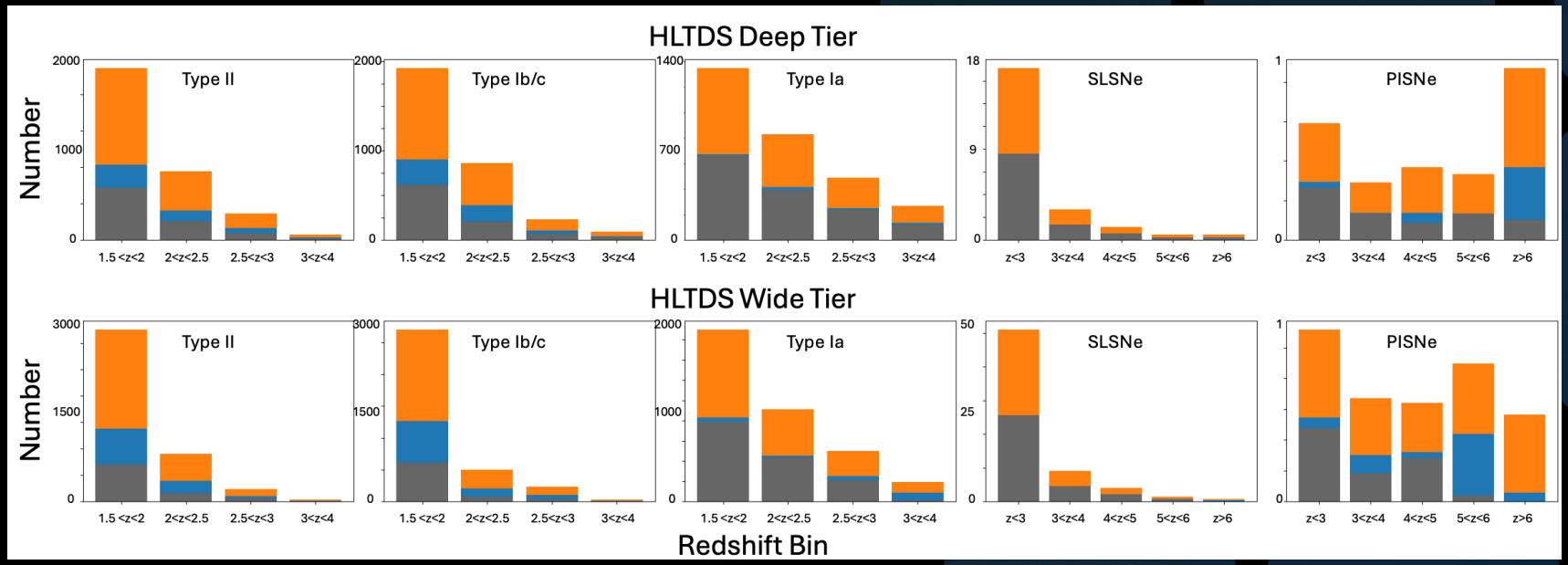
2. TDE at z~1 - 10, SMBH accretion & physics





3. Large samples of z ~ 1 – 3 ccSN:

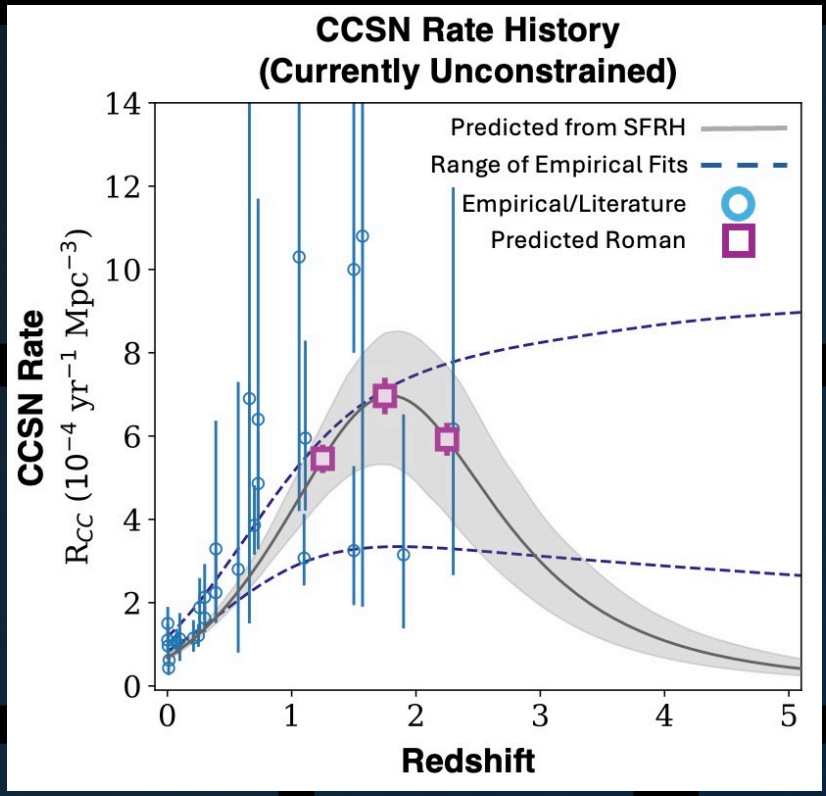




3. Large samples of z ~ 1 – 3 ccSN ==>

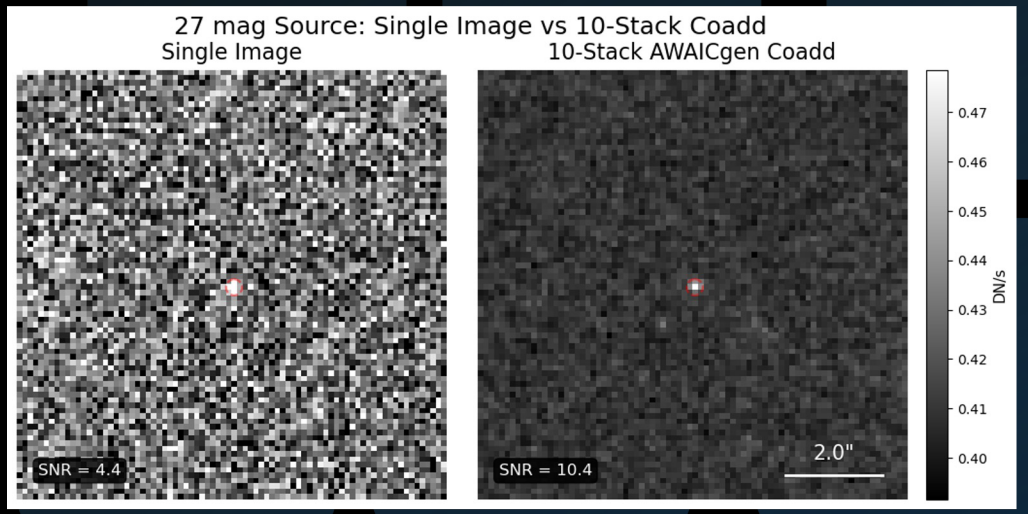
Volumetric rates and luminosity functions as a function of redshift:

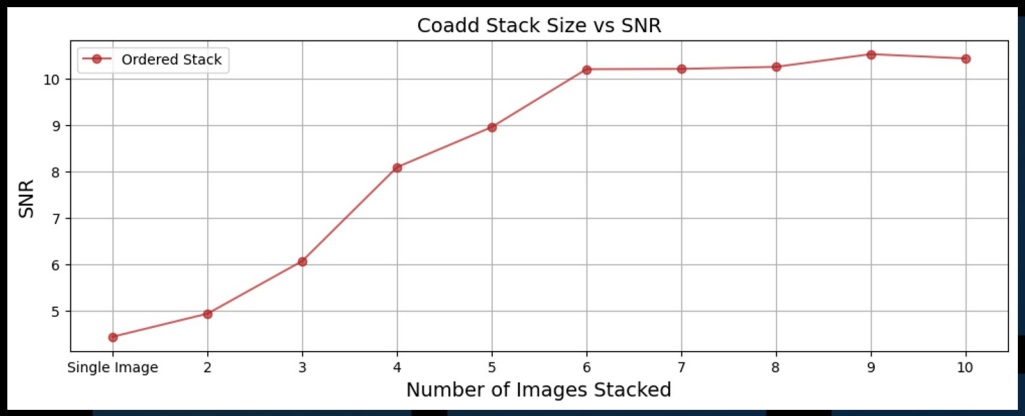
- Rates in high-z Universe are currently very limited, while the SFRH is very well measured
- However, there are a number of uncertainties:
  - Evolving IMF?
  - Higher fraction of BHs?
  - Changing explosion characteristics?
- Measuring CCSN rate history out to and beyond cosmic noon provides important constraints



Some initial results from the RISE pipeline:

1) Stacking using AWAICgen indeed improves SNR (open Universe simulated Roman images)



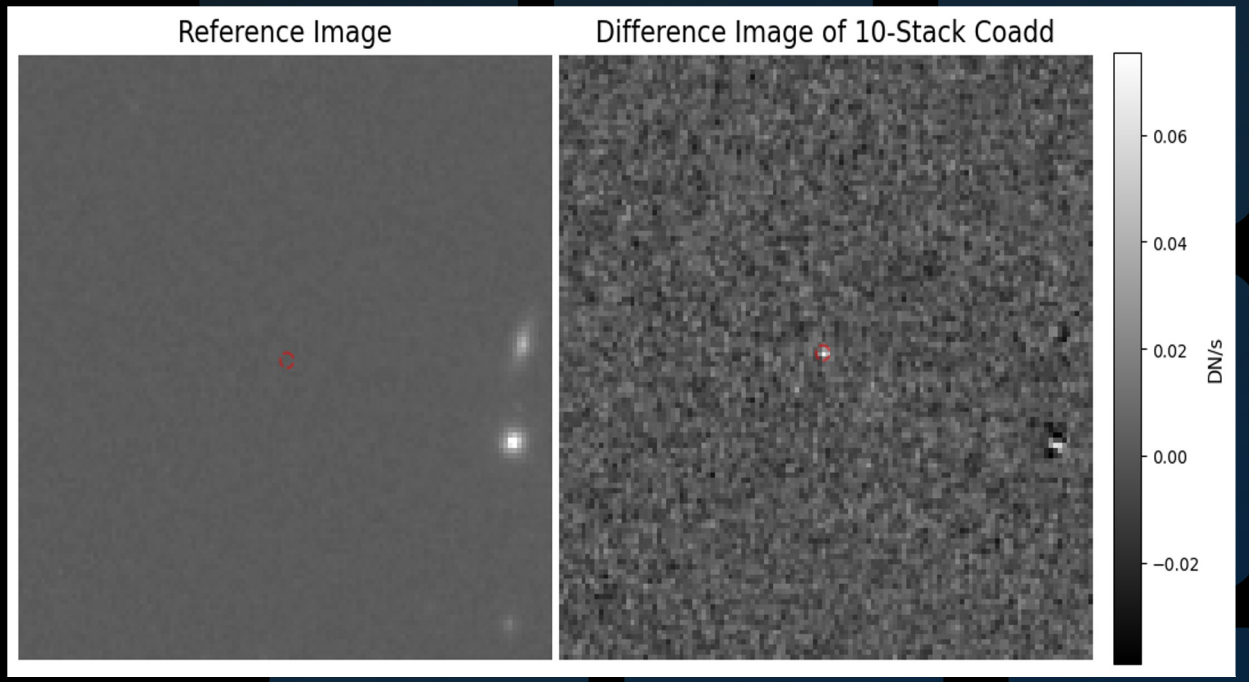


Credit: Joseph Santana

Stacked Image subtraction:

1) The first set of coadded images are run through the pipeline:

2) More improvement to be implemented, such as better PSF matching etc



Credit: Joseph Santana

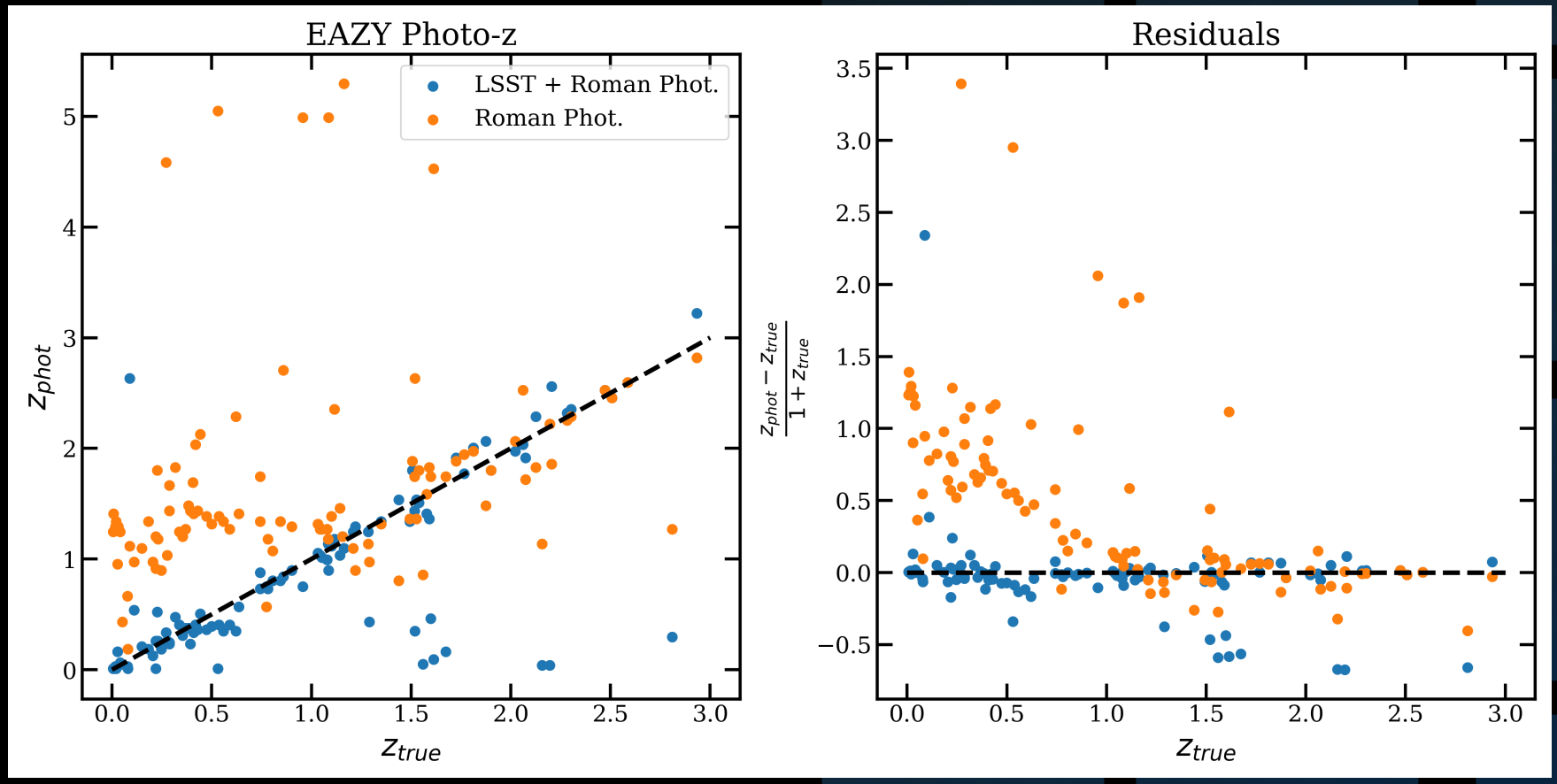
Deep Stack Deliverables

- Image coadd, subtraction and faint alert pipeline.
- Faint alert streams (each coadd & subtraction)
- Machine learning Real/Bogus classifier
- Post-alert characterization and Prioritization

Post-Alert Value Added Deliverables to Prioritize Follow-Up

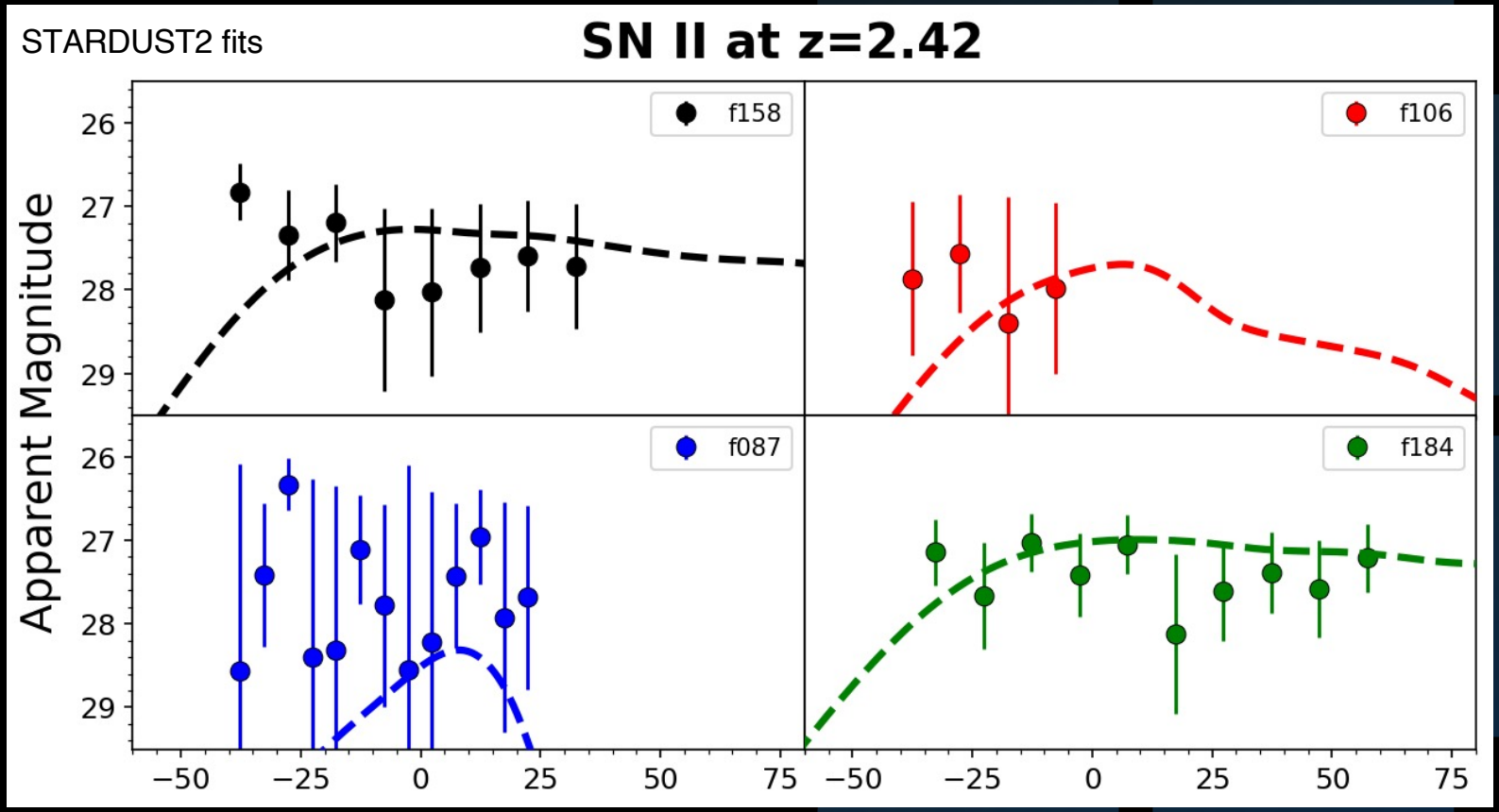
- Forced photometry light curves
- Photometric redshift estimates of the host galaxies
- Constraints from transient colors
- Light-curve fitting
- Machine Learning with JWST high-*z* SN samples (please help)

Post-Alert Characterization: Roman+LSST Photo-z's



Courtesy A. Nugent (see talk on Thursday)

Post-Alert Characterization: Characterizing Light-Curves



Courtesy C. DeCoursey

Post-Alert Characterization: Machine Learning Classifier

- Combine Inputs
  - Forced-photometry light-curves
  - Host-galaxy photo-z
  - Color-Magnitude phase-space
  - Light curve fits
- Training Data Set
  - JWST high-z transient sample as a training/truth set
  - Low-z data from YSE
- Possible solutions
  - Explainable boosting machines
  - Variational autoencoders
  - Explore multi-modal data + foundation model (akin to SkAI's SELDON for Rubin)

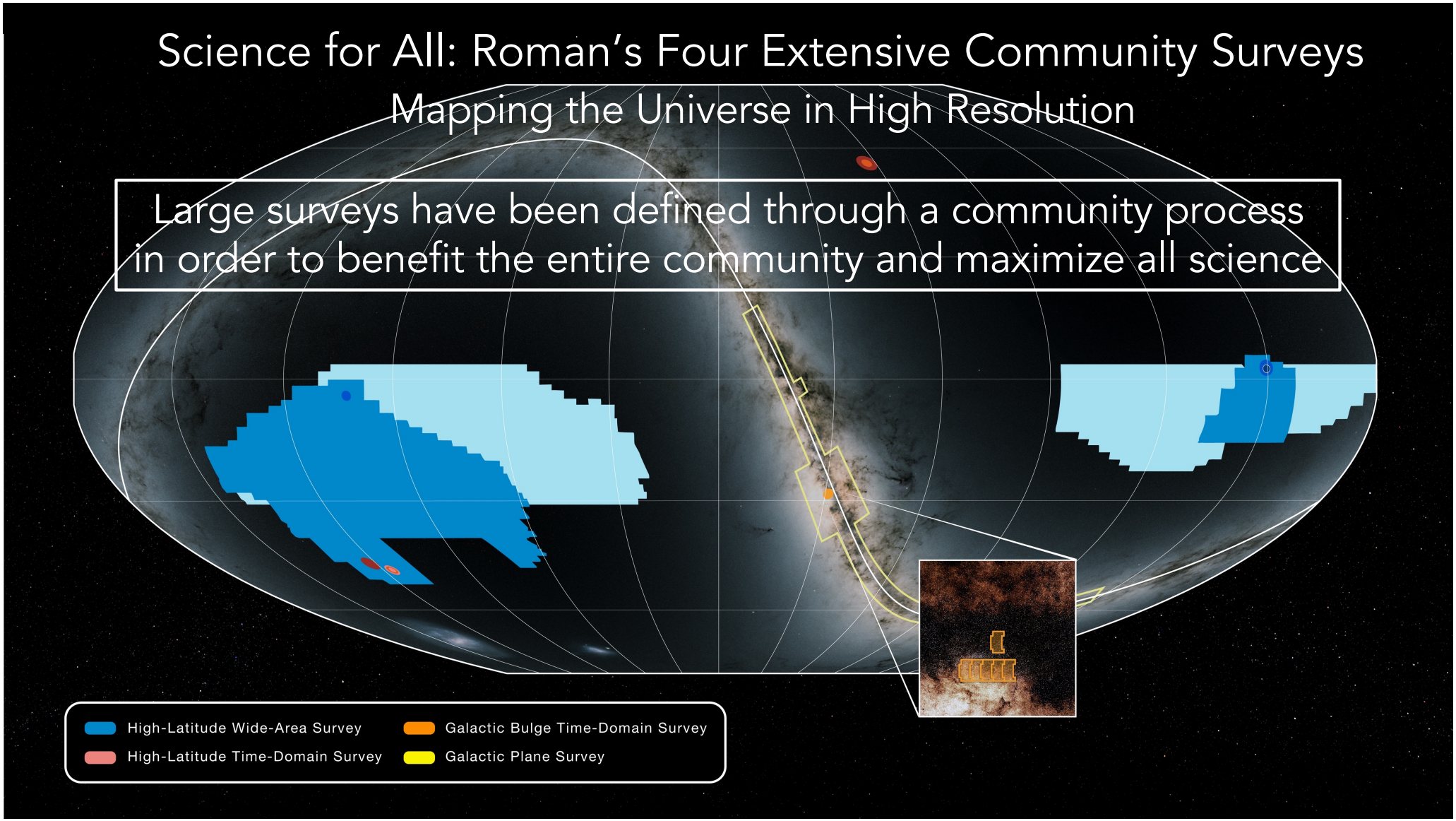
Conclusions

- High-*z* supernovae represent the next frontier of time-domain astronomy
- Roman will provide a time-domain survey unparalleled in terms of combined depth and area
- RISE is a new Roman WFI program that will deliver deep stacks and value added analysis, and needs more work for science to be implemented successfully
- Ultimately, Roman can’t do it alone. A combined program from JWST, Roman (and Rubin) will provide the possibility of connecting all of these dots and probe the evolution of the high-*z* universe in a robust, comprehensive approach

Science for All: Roman's Four Extensive Community Surveys

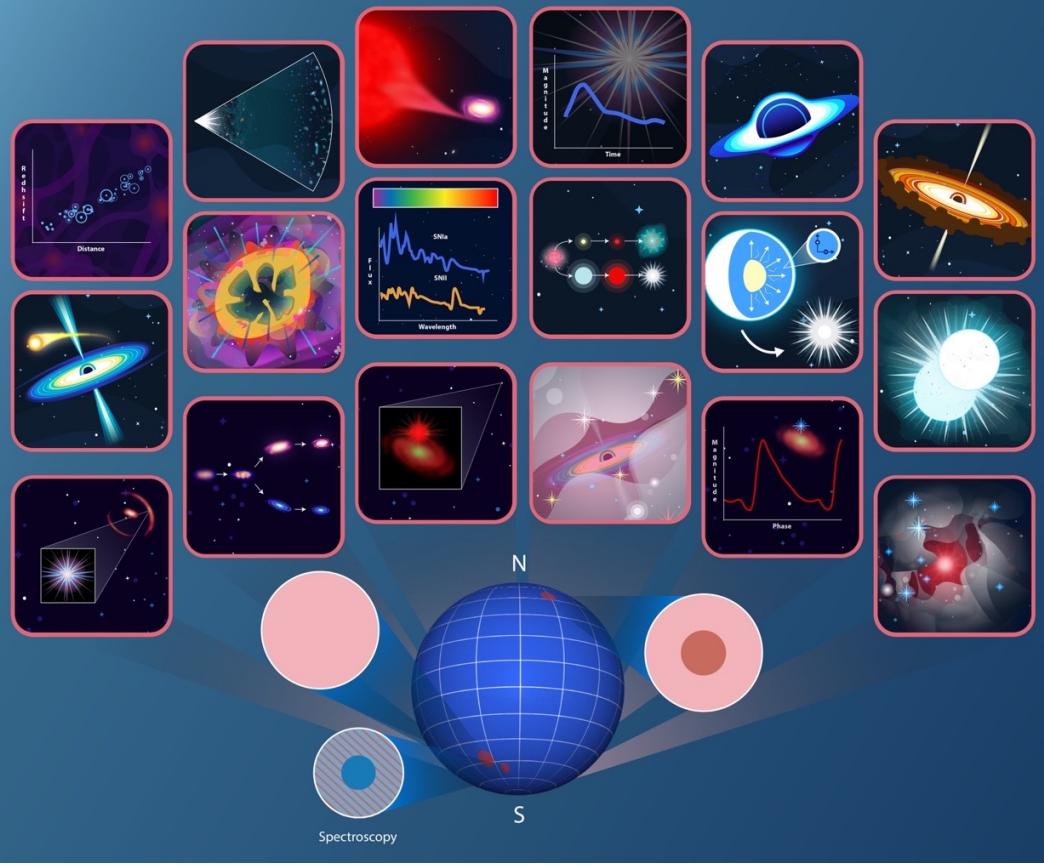
Mapping the Universe in High Resolution

Large surveys have been defined through a community process in order to benefit the entire community and maximize all science



High-Latitude Time-Domain Survey

The Cosmic Movie: Scout supernovae and other transients, scan the variable near-infrared universe, and sharpen our view of cosmic expansion.



20,000

Type Ia SNe count: Cosmology studies out to ~z >2.5

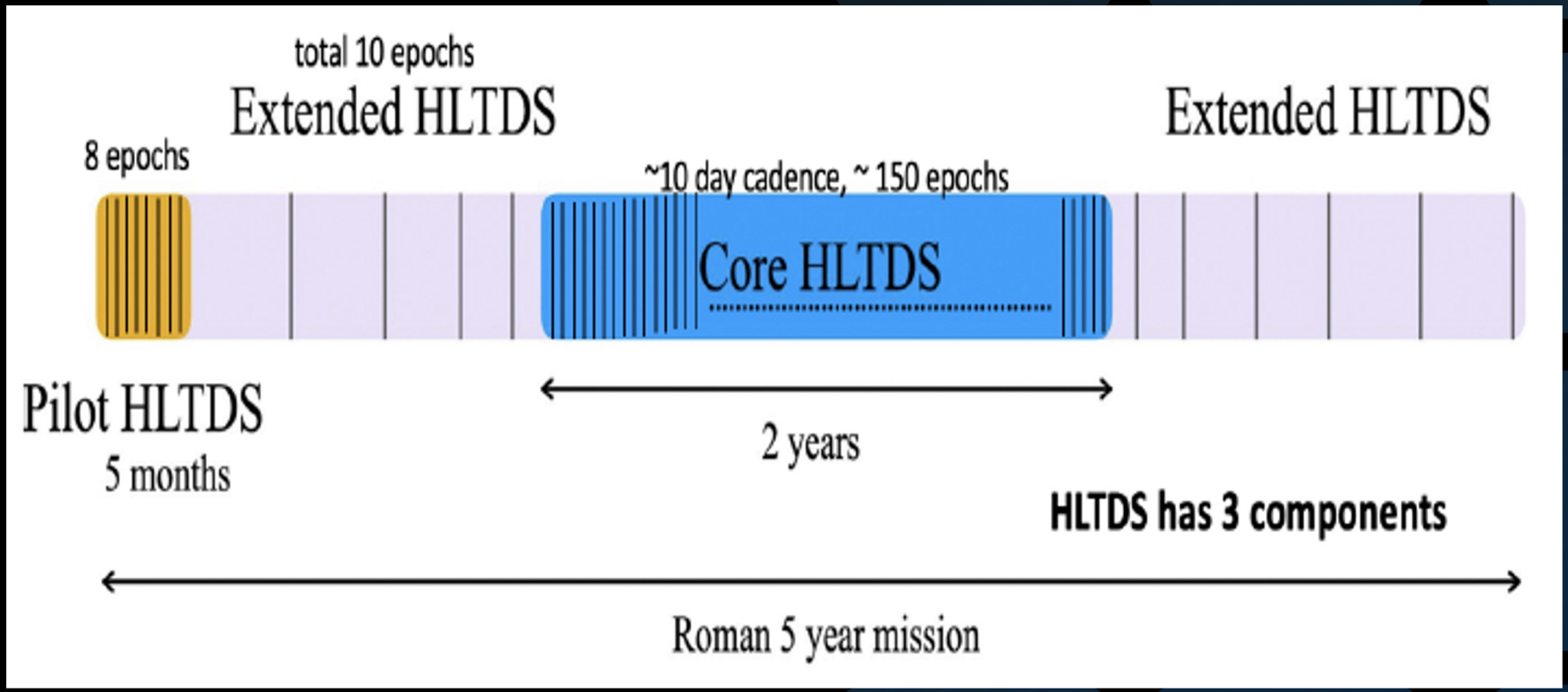
100,000

Transient light curve estimate

Deep Stack

Coadded epochs will cover an area 100 times larger than Hubble's largest comparable survey

Why HLTDS is ideal for RISE



High-Latitude Wide-Area Survey

The Big Map: Explore dark energy and dark matter — and everything that makes up the cosmic web!

600 million

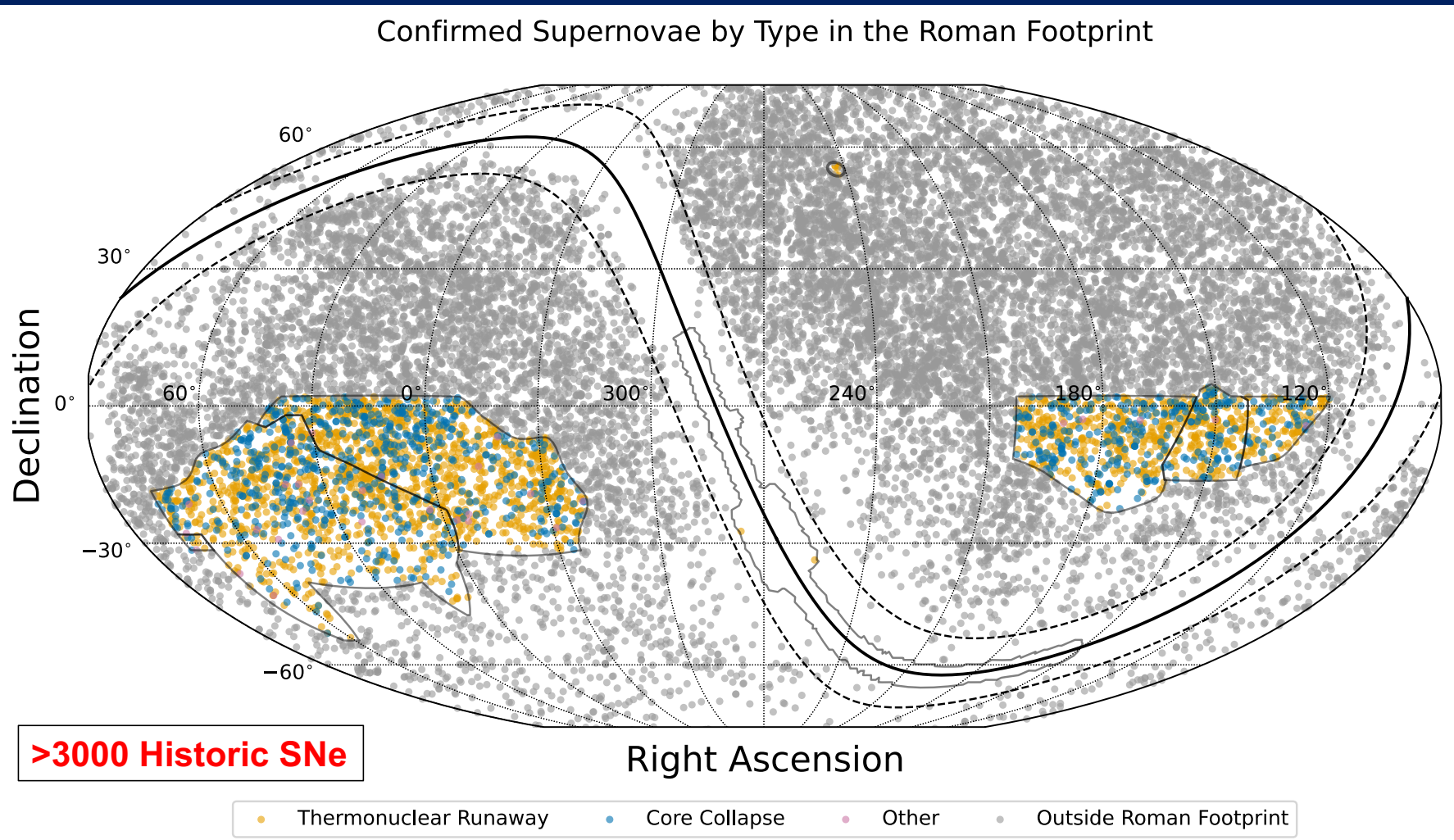
Estimated galaxy shape measurements over 12% of the sky

11 million

Spectroscopic galaxy redshifts over 6% of the sky — up to z ~3

1,000 times larger

Deep field imaging and spectra — compared to Hubble's largest deep surveys


Confirmed Supernovae by Type in the Roman Footprint
60°
30°
0°
−30°
−60°
Declination
60°
0°
300°
240°
180°
120°
Right Ascension
>3000 Historic SNe
Thermonuclear Runaway
Core Collapse
Other
Outside Roman Footprint

Galactic Plane Survey

Capturing Our Cosmic Home: Reveal the Milky Way's panoramic view in unprecedented detail, and explore regions still largely unknown.

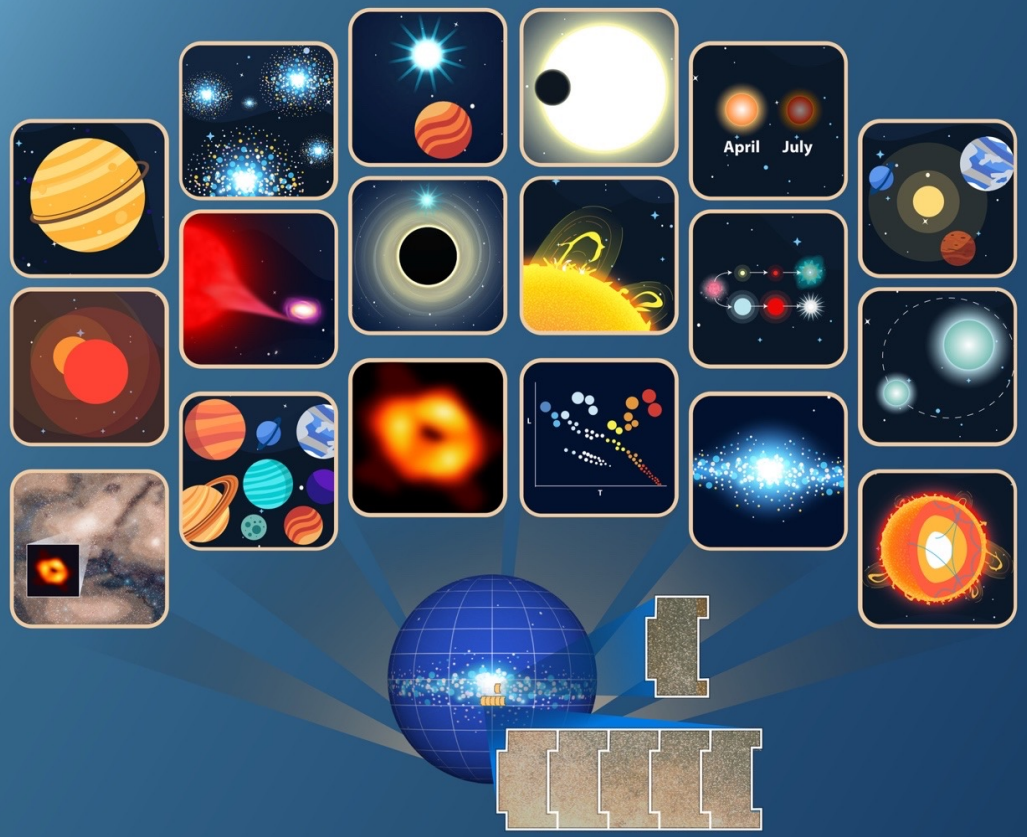
20 billion
Estimated number of detected stars

35 %
Fraction of Milky Way's disk plane with contiguous imaging

10 times
Deeper than any previous survey of the Milky Way disk

Galactic Bulge Time-Domain Survey

The Treasure Hunt: Classify thousands of exoplanets, discover solar system analogs, and uncover fresh stellar physics with over 100 million stars.



1,000

Bound and free-floating cold exoplanets, down to 0.1 Earth mass, with microlensing detections

100,000

New exoplanet detections, mainly with transits

100,000

Masses of red giant stars using asteroseismology

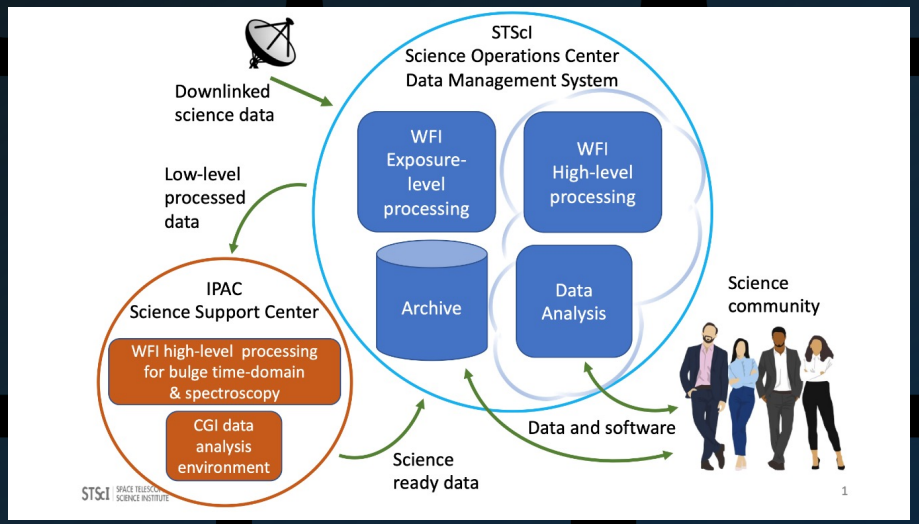
How to Actively Explore Roman Surveys and Data

- **Visualization tools**
  - Map of sky coverage, exposure depth, existing data
  - Notebooks available on the Nexus
- **Exposure Time Calculator (ETC)**
  - Example workbooks for each survey with given depths
  - Add in your sources of interest to estimate S/N
  - Capabilities via Pandeia available on the Nexus
- **Astronomer's Proposal Tool (APT)**
  - Implementation strategy w/ dithers, cadence, etc.
- **Simulation Tools**
  - Understand data quality, test your science case on simulated data, develop your own workflows
  - Simulated data, simulation tools, and example notebooks available on the Nexus
- **RDox Documentation**
  - Deep dive into instrument details, data formats, and data structures
  - Detailed instructions on using tools and software
  - Descriptions of the community planned surveys

Prompt Data Products and Data Releases

- All data will be available with no proprietary period via MAST and within the Roman Research Nexus
- Processed data will be available on timescales that range from 48 hours (for the individual calibrated “Level 2” prompt data products) to periodic releases (for uniformly processed survey data provided at regular data releases)
- Data Releases will include updated reference files, calibrated data, and high-level data products, including image co-adds, catalogs, difference images, and community-contributed products

More Details



Example High-Level Data Products:

- Co-Added Mosaics
- Source and photometry catalogs
- 1D spectra
- Variability and light-curve catalogs
- And community contributed data products

Roman Social Media for Scientists

@NancyRomanSci on bluesky, X, Instagram, and Facebook

The social media channel for scientist-focused updates.

Don't miss out on the latest Roman science info!