High-Latitude Time Domain Survey Definition Committee Report

Brad Cenko (NASA/GSFC) &
Masao Sako (Penn)

• NASA GODDARD SPACE FLIGHT CENTER • JET PROPULSION LABORATORY •
• L3HARRIS TECHNOLOGIES • BALL AEROSPACE • TELEDYNE • NASA KENNEDY SPACE CENTER •
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• JAPAN AEROSPACE EXPLORATION AGENCY • LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE •
• CENTRE NATIONAL d'ÉTUDES SPATIALES • MAX PLANCK INSTITUTE FOR ASTRONOMY •

Community Debrief
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HLTDS Definition Committee Members

Brad Cenko
(NASA/GSFC, Co-chair)

Masao Sako
(Penn, Co-chair)

Alessandra Corsi
(Texas Tech)

Michael Fasnaugh
(Texas Tech)

Sebastian Gomez
(STScI)

Rebekah Hounsell
(NASA/GSFC, SN PIT)

Takashi Moriya
(NAOJ)

Gordon Richards
(Drexel)

Russell Ryan
(STScI)

Schuyler van Dyk
(IPAC, RAPID PIT)

V. Ashley Villar
(Harvard)

Solar system liaisons: Susan Benecchi (PSI) & Rosemary Pike (CfA)

Core Community Surveys (CCS)

Example implementation of Core Community Surveys (CCS)

~< 15 min cadence observations over few deg^2 towards Galactic bulge

Galactic Bulge Time Domain Survey

Wide area (thousands of deg2) survey including multiband imaging and slitless spectroscopy

High Latitude Wide Area Survey

~1000 deg^2 in three bands (~JHK)

Galactic Plane Survey

Tiered, multiband time domain observations of ~10s of deg^2 at high latitudes with slitless spectroscopy

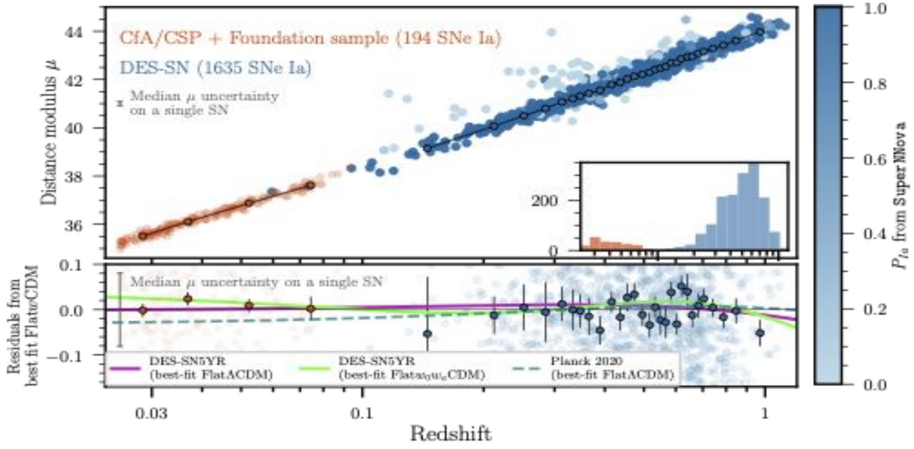
High Latitude Time Domain Survey

ROMAN SPACE TELESCOPE

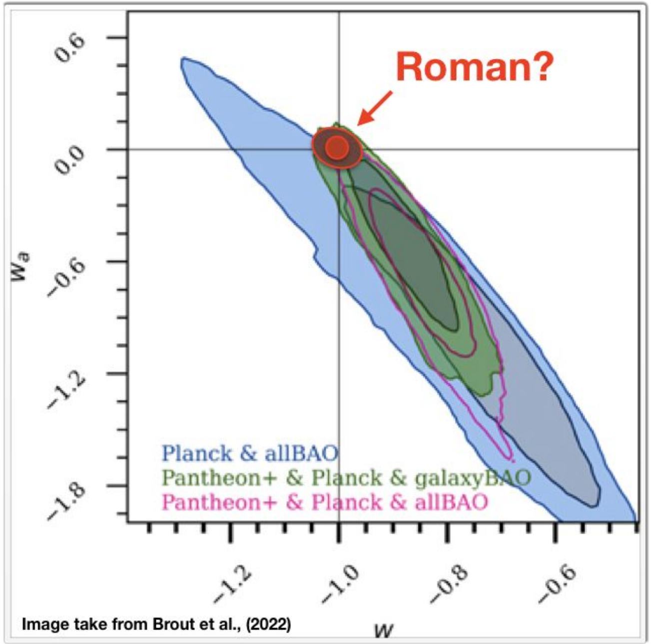
Core Surveys

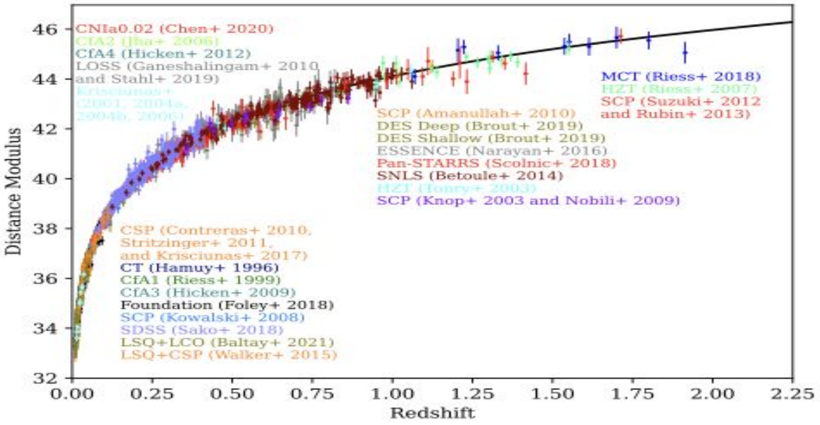
Roman Space Telescope's larger view and fast survey speeds will unveil the evolving universe in ways that have never been possible before.

Main HLTDS Science Goal: SN Ia Cosmology



DES Collaboration 2024 (DES5YR; 1800+ SN Ia)





Brout et al. 2022 (Pantheon+; 1500+ SN Ia)

Rubin et al. 2023 (Union 3; 2000+ SN Ia)

Community Input on Science Enhancements

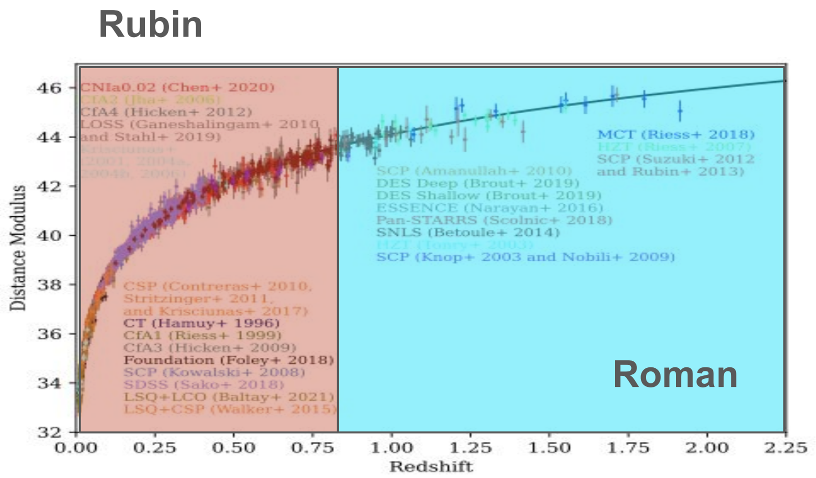
- Roman-organized (2023)
  - White Paper Pitches
  - White Papers
  - White Paper Updates
- IPAC Roman Meeting (July 2024)
  - Public Presentation
  - Working Group Meetings
- STRIDE Working Group (August 2024)
- Community Forum Update (August/September 2024)

Committee Working Groups

- Cadence / Filters / Depth / Area
  - Optimize for SN Ia, but also enable community science.
- Spectroscopy Fraction
  - Relative merit of spectroscopy vs imaging.
- Field Selection
  - Visibility, background, extant/planned complementary data sets.
- Survey Extensions
  - Reference images, pre/post extension.
- Leveraging Complementary Data Sets
  - Roman-supported Subaru time, Rubin overlap, etc.

Our approach - use simulations as a guide, but also use our collective knowledge to make informed decisions.

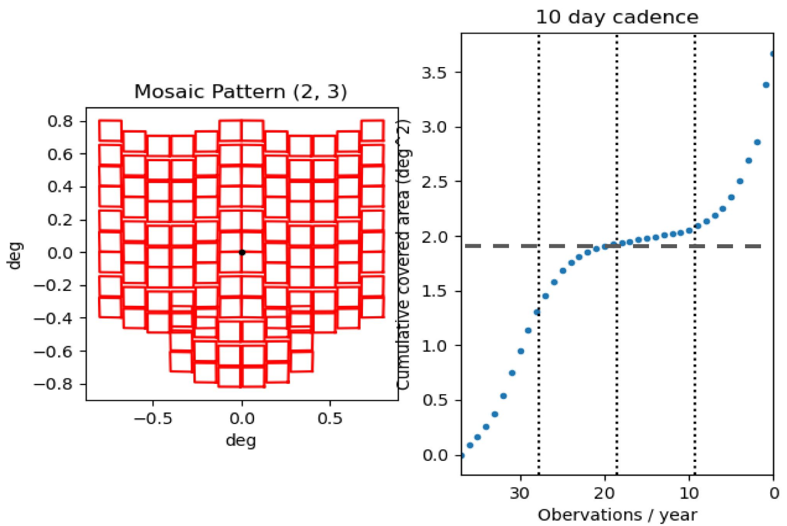
Cadence / Filters / Depth / Area

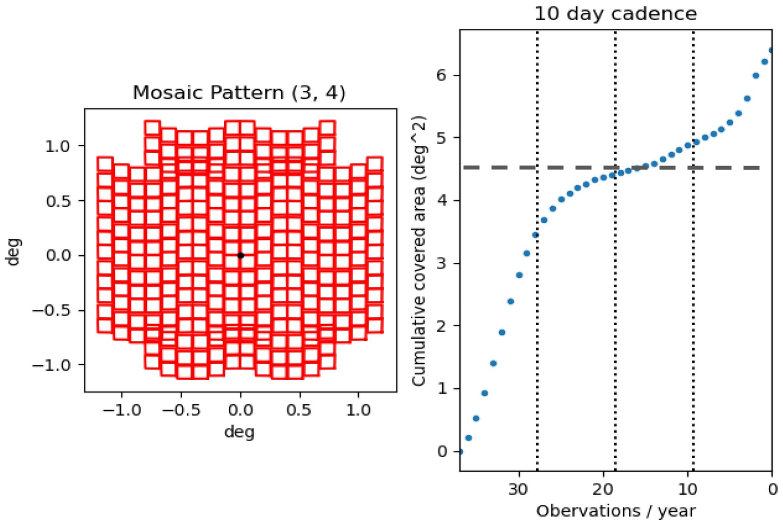


- **Target redshift(s) unique to Roman.**
  - Assume ground-based surveys will collect a large sample of *z* < 0.7 SN Ia - e.g., Rubin.
- **Filters motivated by target redshift and model wavelength range.**
- **Depth determined by target S/N.**
  - Integrated S/N > 30 around rest frame +/- 10 days from peak at target redshift.
- **Exposure times depend on target S/N <u>and</u> cadence.**
- **Area set by allocated observing time, <u>but not all (small) areas are feasible</u>.**

Small Areas

- We observe in the continuous viewing zones, so the footprint rotates through the year. Non-circular mosaics get non-uniform coverage.
- “Good” small/discretized areas:
  - 0.5 deg^2 (1x2)
  - 1.9 deg^2 (2x3+1)
  - 4.5 deg^2 (3x4+4)
  - 7.5 deg2 (4x5+7)

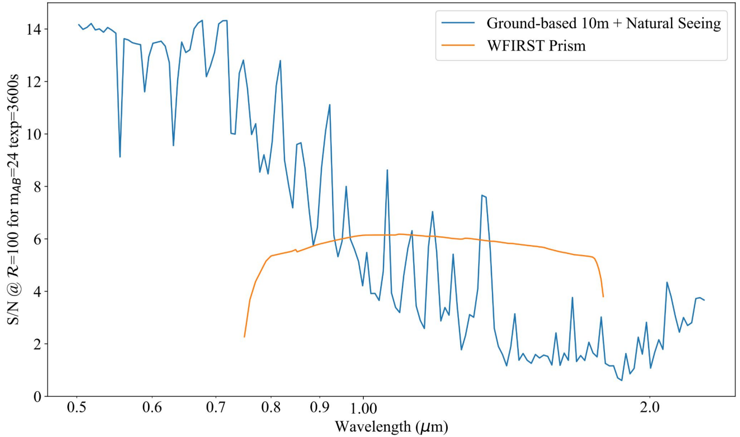




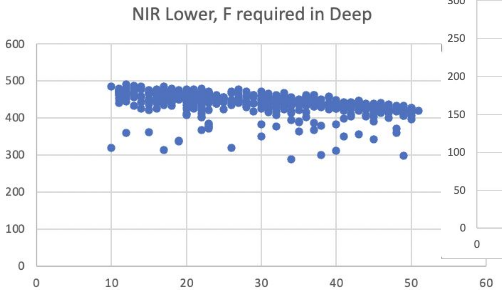
Prism Spectroscopy

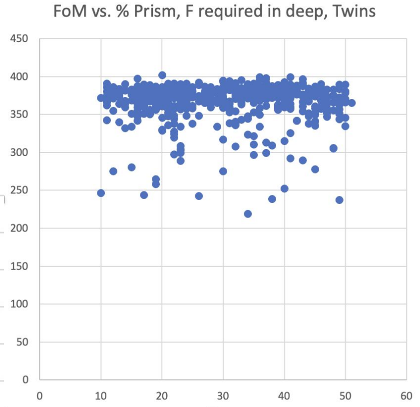
- Roman's prism offers unique opportunity to do NIR spectroscopy difficult from the ground.
- It is expensive.
- Need for new analysis tools:
  - Host subtraction.
  - Typing and redshift with time-series spectra.
- For SN Ia cosmology (e.g., twinning), prism spectra have limited immediate benefit, but may uncover unknown systematics.
- For community science, some spectra beneficial for classification, training, etc., and highly unique to Roman.

G. Aldering



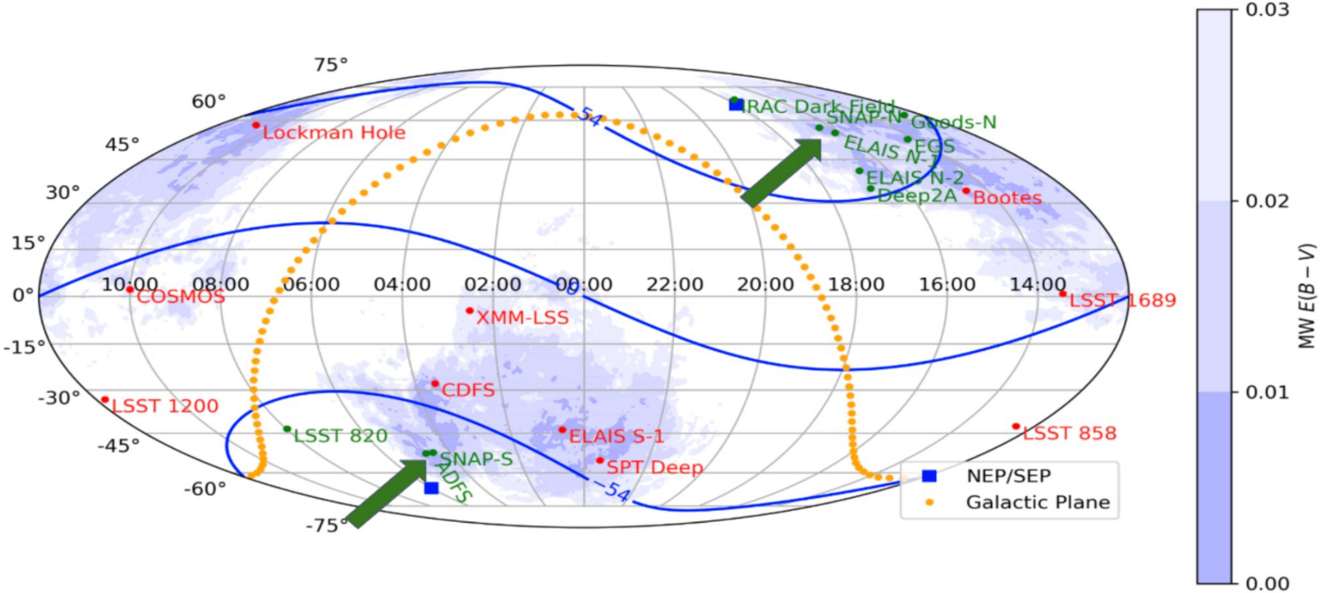
D. Rubin





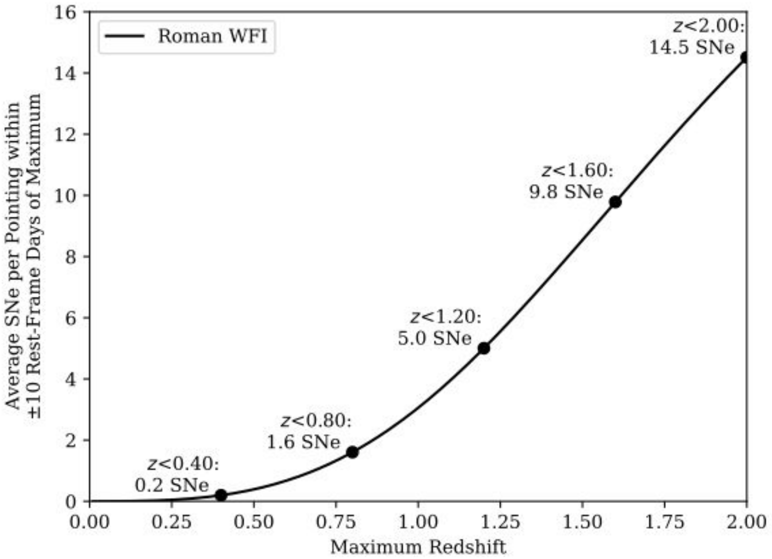
Field Selection

- Must be in continuous viewing zones (CVZs).
- Low zodiacal background and low Galactic extinction.
- Availability of ancillary and complementary data.



Complementary Data

- Figure of merit calculation depends on assumptions of complementary (lower redshift) SN Ia
  - Nearby (z < 0.1) sample assumed to anchor Hubble diagram.
  - Rubin sample at intermediate z (z~0.6) will soon be acquired.
- Survey Design Implications
  - Without Rubin sample, simulations favor much larger area and *R*-band to discover sufficient events at z ~ 0.5
- Our recommendation:
  - Unanimous desire for Roman to focus on unique (NIR and high-z) science
  - Work with Roman project to attempt to negotiate public release of relevant Rubin data sets



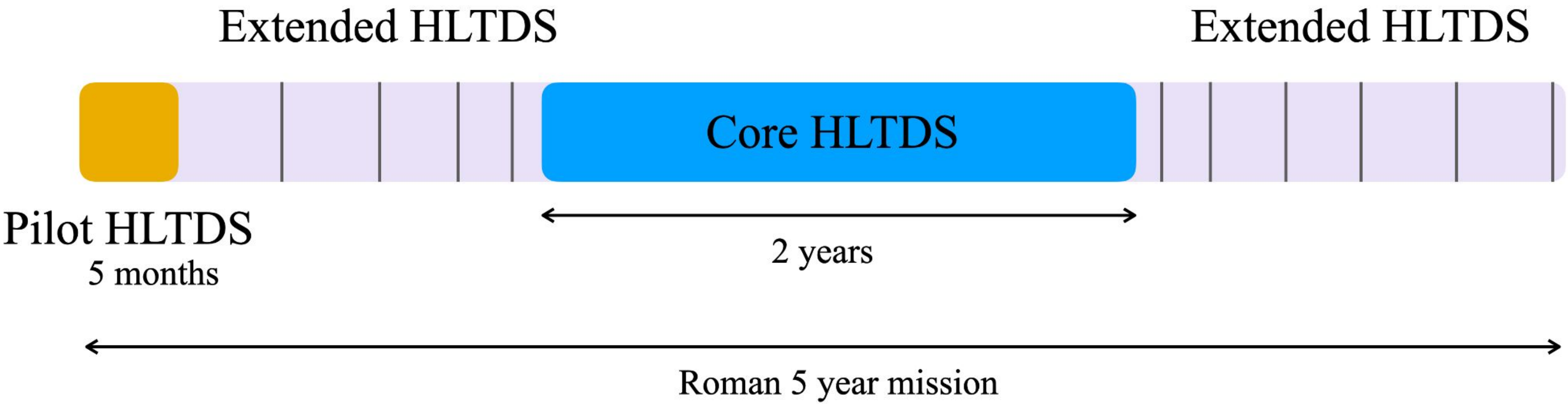
Leveraging Complementary Data Sets

- **100 nights of Subaru** time have been reserved for joint Roman-Subaru science.
- For the HLTDS, these could be critical for:
  - Host galaxy spectroscopy (PFS)
  - Spectral transient classification / characterization (PFS)
  - Concurrent imaging of HLTDS fields (HSC)
- Currently discussing synergies with Subaru team.

Subaru Telescope (Mauna Kea, HI)

Committee Recommendation

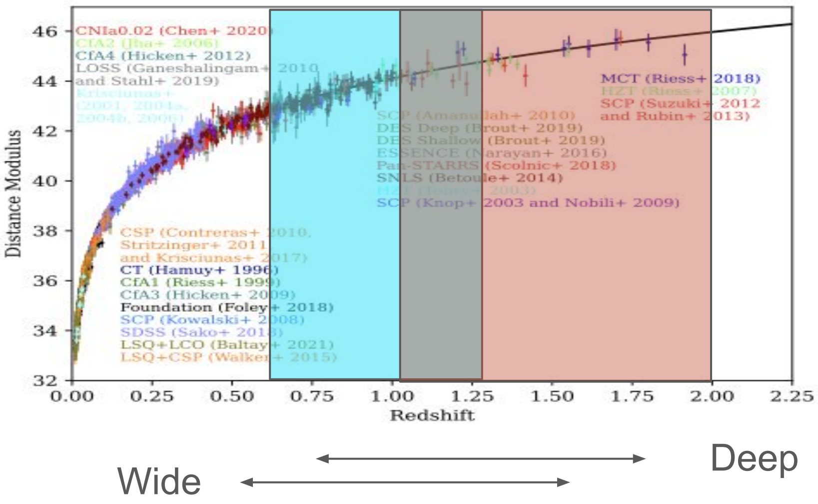
3 Components

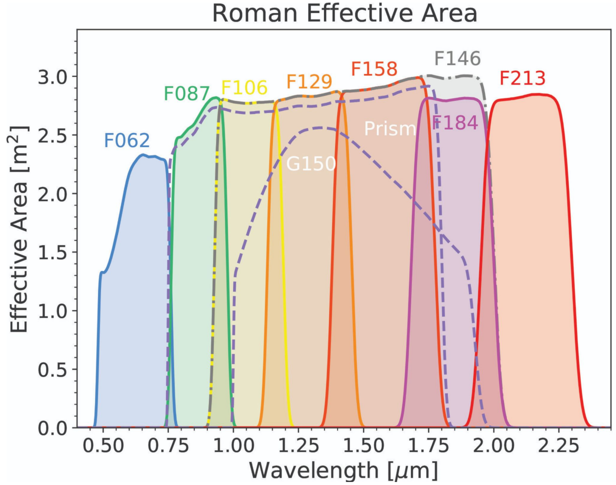


180-day in-guide recommendation
(+/- 20 days for over-/under-guide)

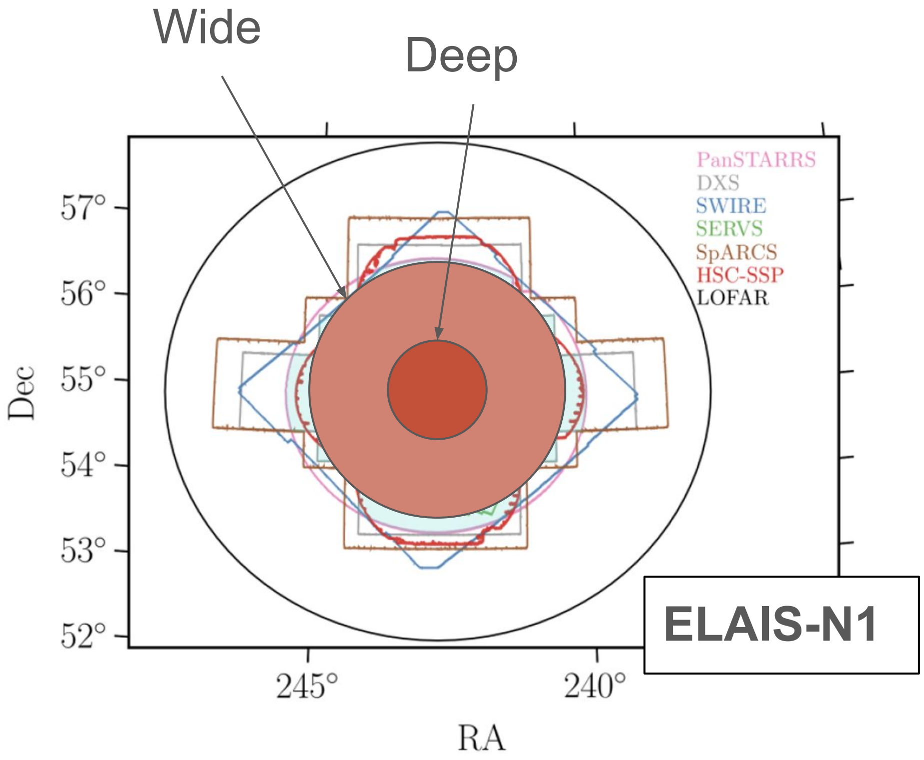
- Core Component (158 d)
  - Target z=0.9 (wide), z=1.7 (deep)
  - 35% Wide, 44% Deep, 21% Prism
  - 10-day interlaced imaging cadence
    - RZJ / RYH wide
    - ZYH / ZJF deep
  - 5-day prism cadence
    - 900 sec wide
    - 3600 sec deep
- Pilot Component (15 d)
  - Early science, templates, and preparation.
  - 8 visits to all imaging and prism fields in first ~5 months of Roman.
- Extended Component (7 d)
  - Long-term monitoring.
  - High-z, exotic transients.
  - 8 visits to deep imaging fields before and after Core Component.

Filter	Wide	Deep
R (F062)	60 ×2	—
Z (F087)	86	194 ×2
Y (F106)	96	294
J (F129)	153	307
H (F158)	293	419
F (F184)	—	1637

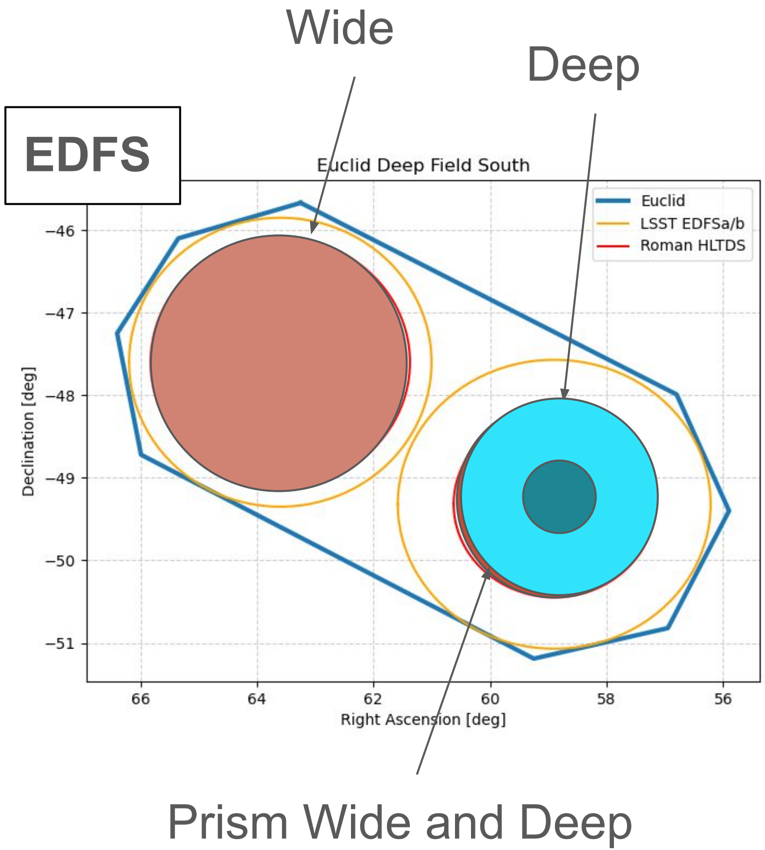




HLTDS Fields



15 + 6 deg^2 Wide and Deep Imaging
4 + 0.6 deg^2 Wide and Deep Prism



Under- / Over-Guide

- **Under-guide**
  - Eliminate Extended Component entirely.
  - Reduce Wide Imaging area by 20%.
  - Not ideal!
- **Over-guide**
  - Emphasis on community science.
  - Annual deep-field K-band observations over 5-year Roman mission.
  - Un-cadenced deep-field R-band observations to complete full *RZYJHFK* filter set.