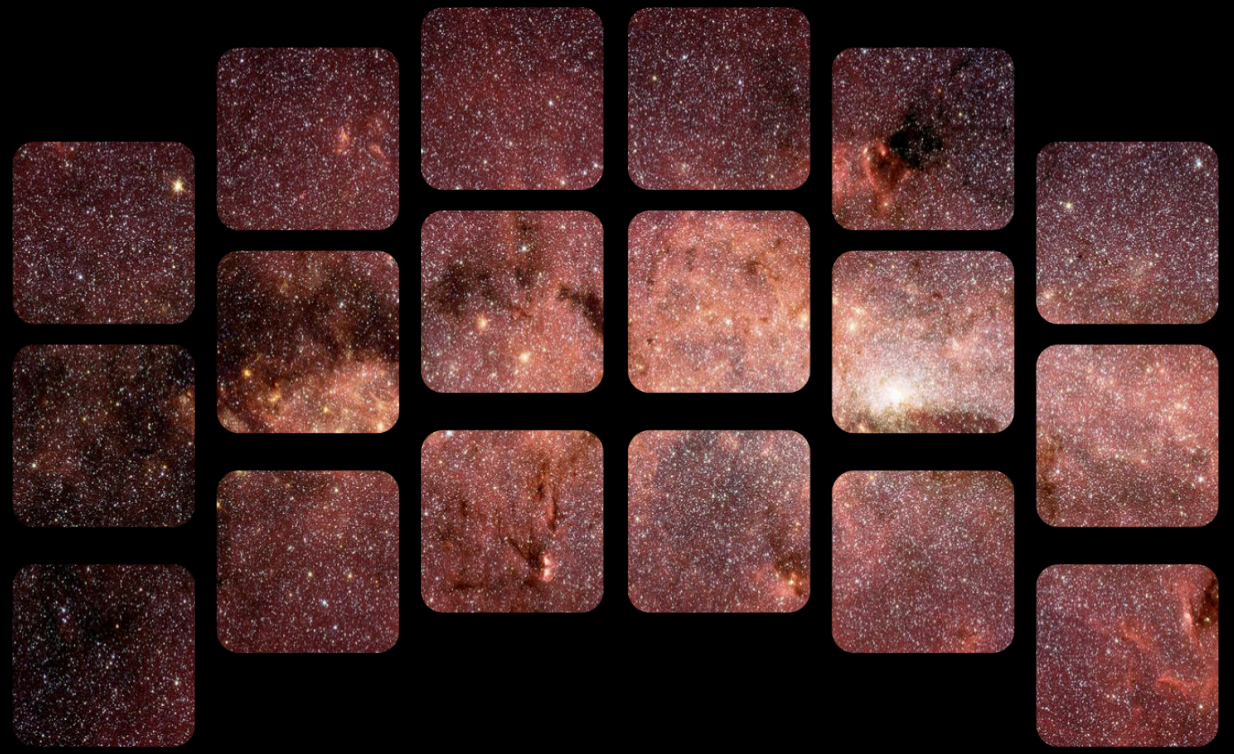
Project Status

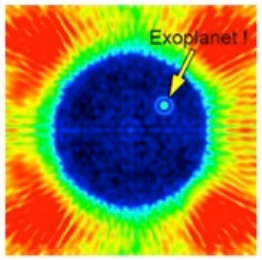


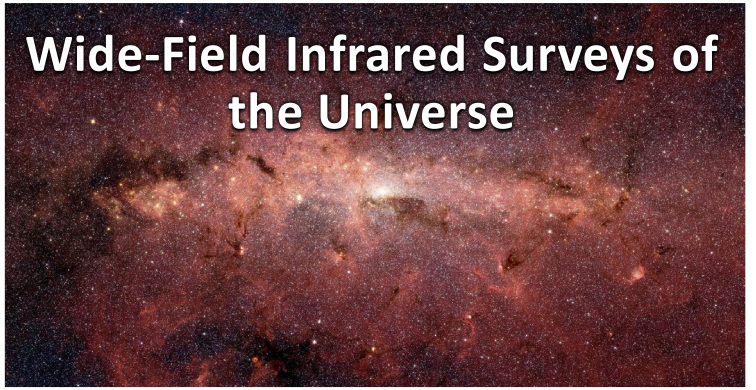
NANCY GRACE
ROMAN
SPACE TELESCOPE

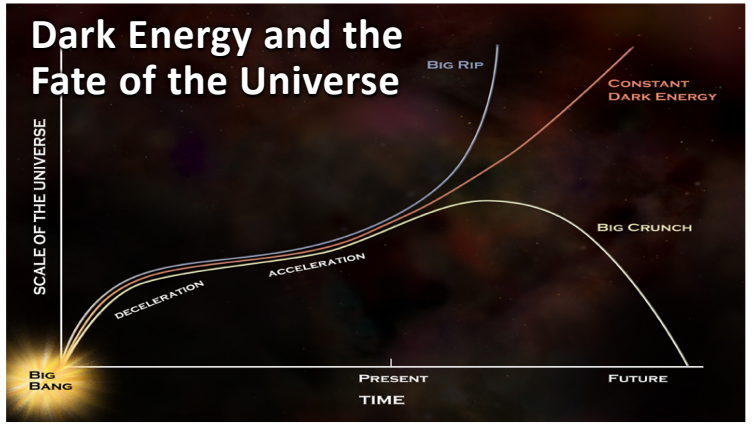
WFIRST is now the Nancy Grace Roman Space Telescope

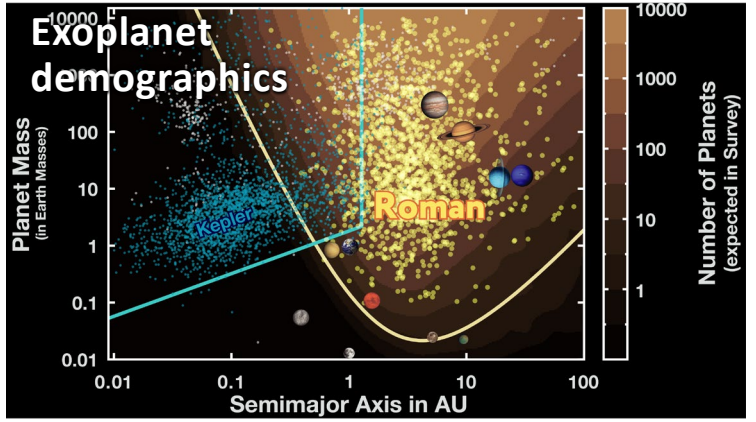
Roman Mission Objectives

- **Wide Field Infrared survey**
  - Imaging and spectroscopy to >26.5 AB mag
- **Expansion history of the Universe**
  - Using supernova, weak lensing and galaxy redshift survey techniques
- **Growth of Structure in the Universe**
  - Weak lensing, redshift space distortions and galaxy cluster techniques
- **Exoplanet Census**
  - Statistical census of exoplanets from outer habitable zone to free floating planets
- **General Observer program**
  - Devote substantial fraction of mission lifetime to peer reviewed general observer program
- **Coronagraph technology demonstration**
  - Demonstrate exoplanet coronagraphy with active wavefront control

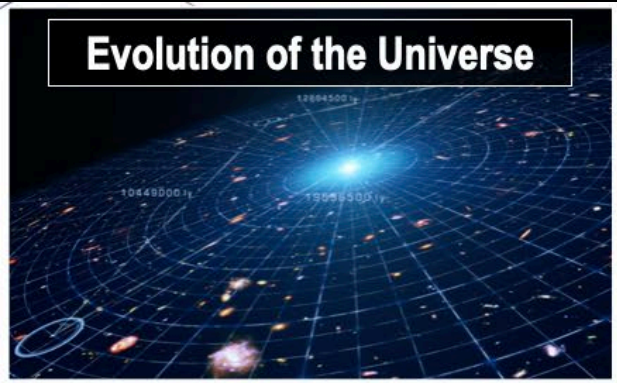


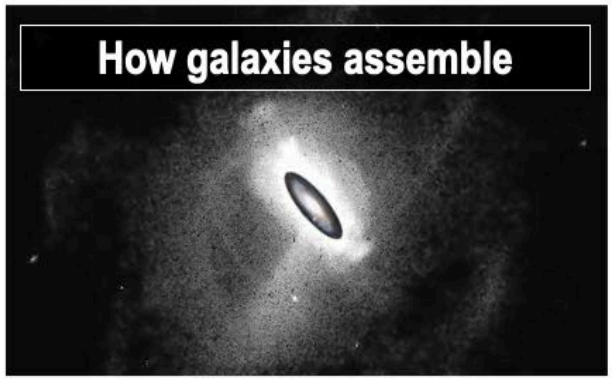


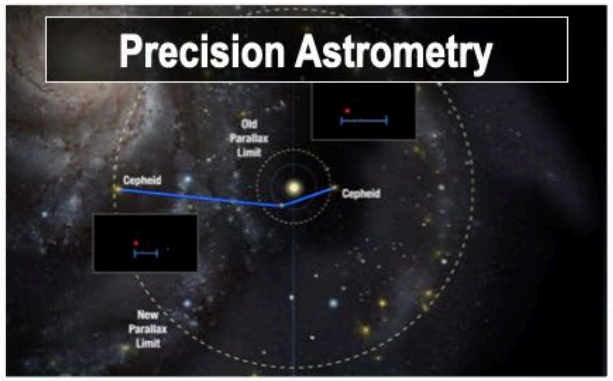


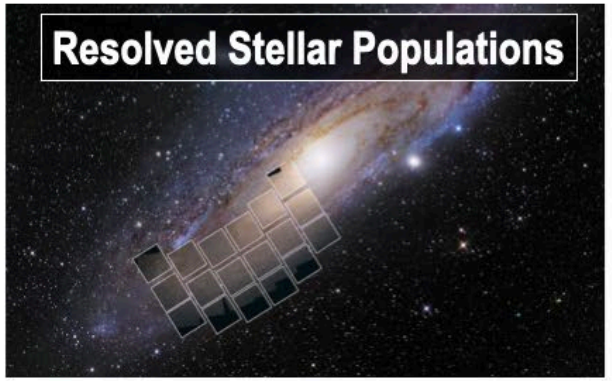


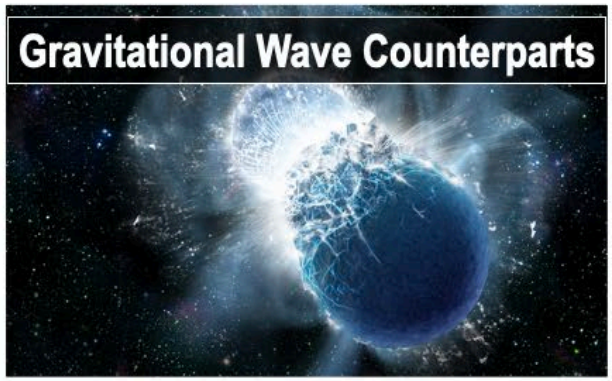
Roman's very Broad Science Menu includes:

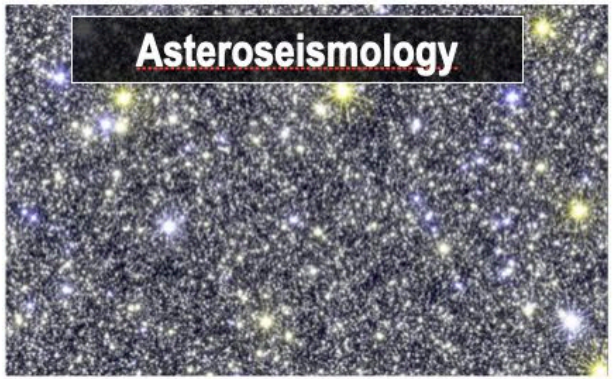


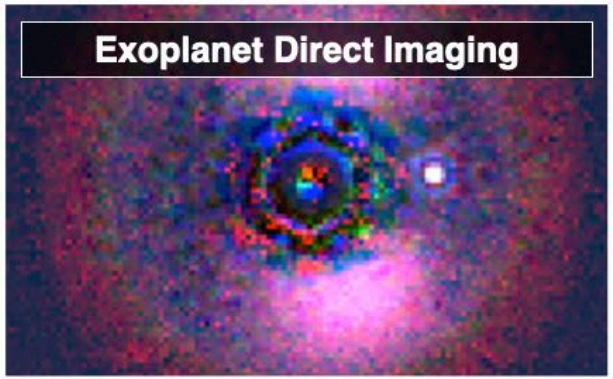


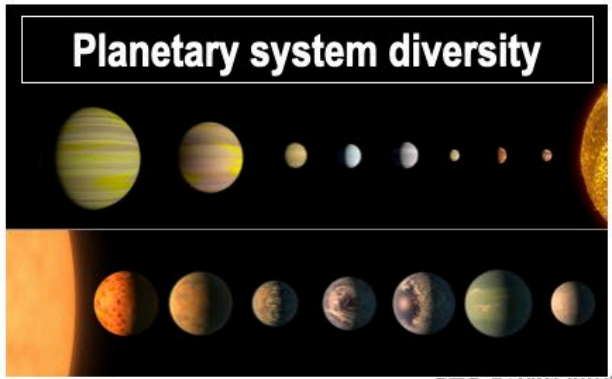




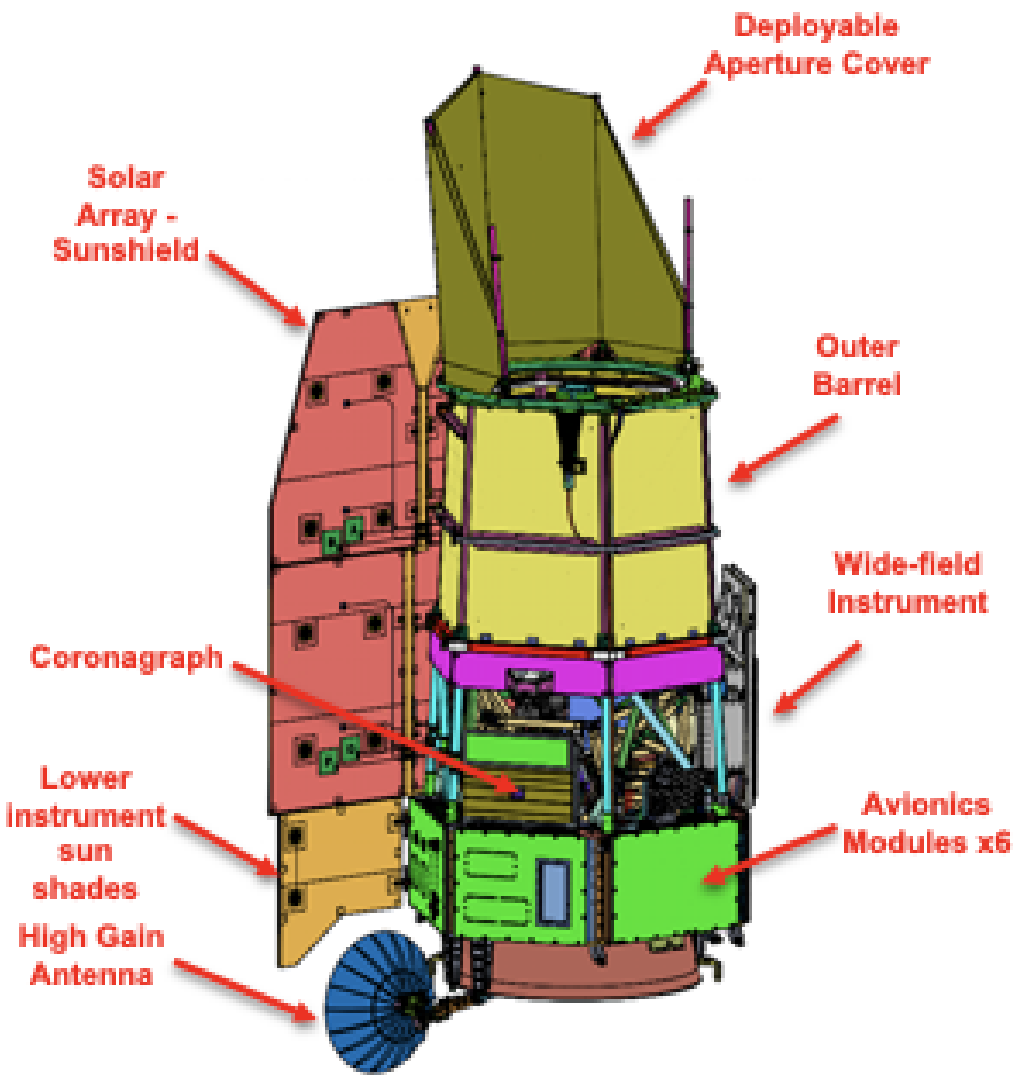








Roman Observatory and Instruments



Telescope: 2.4m aperture

Two Instruments:

Wide Field Imager / Slitless Spectrometer

- Vis/Near IR bandpasses (0.48 – 2.3 micron)
- Field of view 0.281 deg^2 (~200× HST WFC3-IR)
- 18 4k × 4k detectors (288 Mpixels)

Coronagraph

- Visible bandpass
- Contrast 10^{-8}-10^{-9}

Data Volume: 11 Tb/day

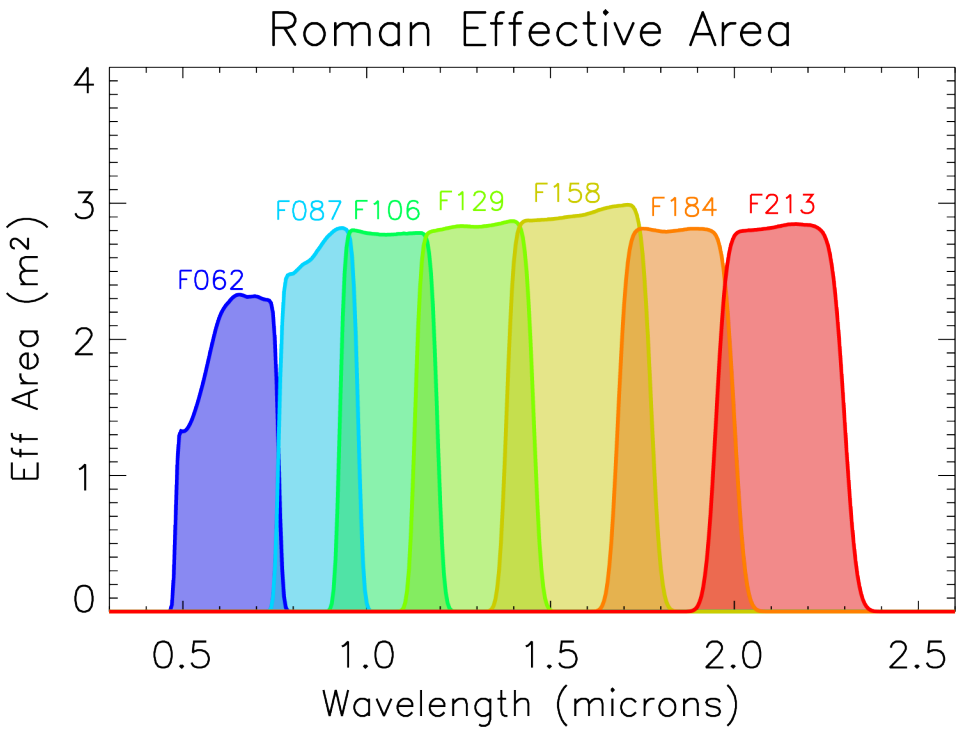
Orbit: Sun-Earth L2

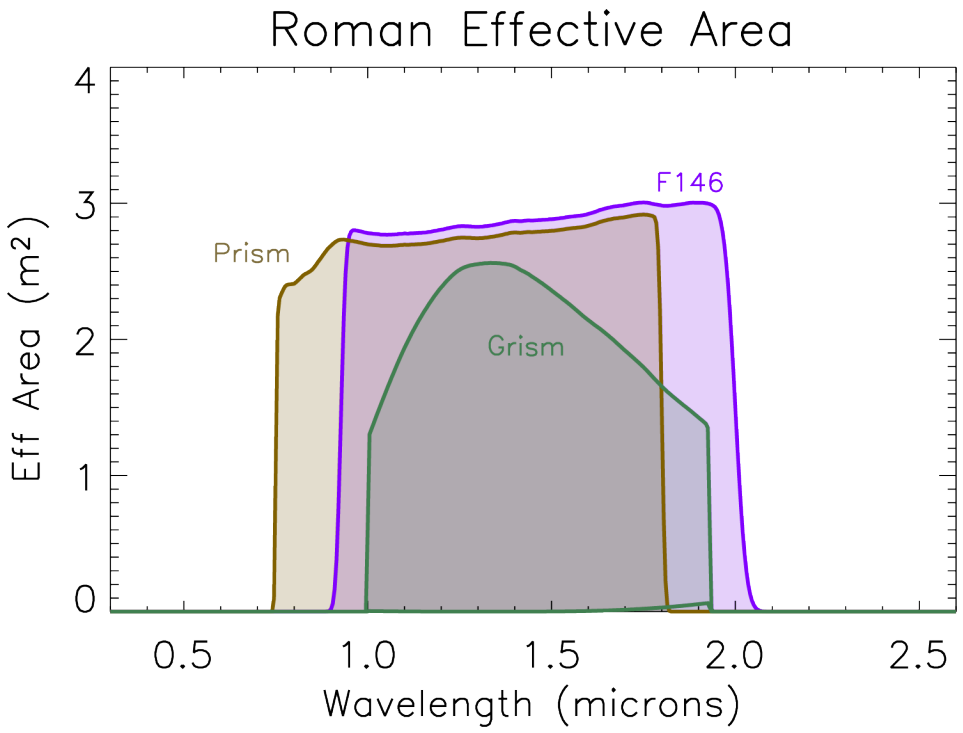
Mission Duration: 5 yr, 10yr goal

https://roman.gsfc.nasa.gov/science/Roman_Reference_Information.html

Wide Field Instrument: Filters/Dispersers

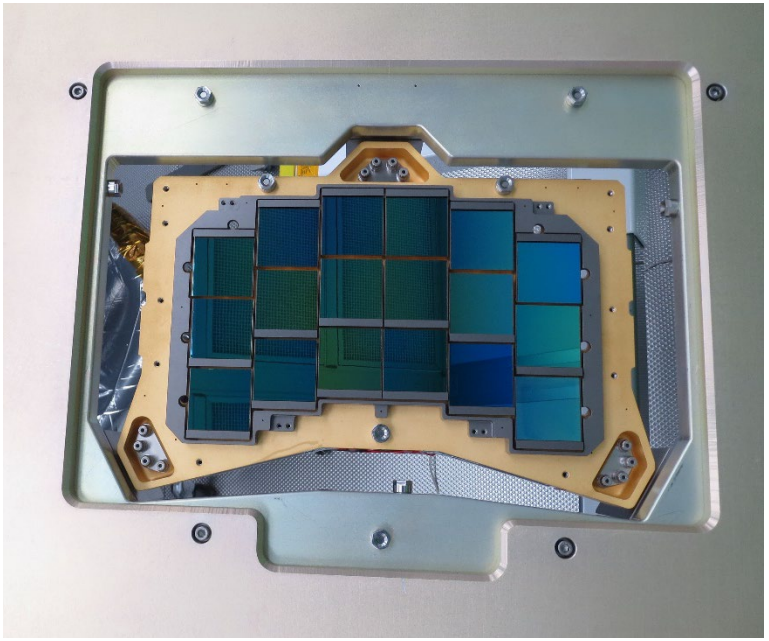
- **Imaging capability is ~1 sq. deg. per day at any band to 5σ AB depth of F062=29.6, F087=29.2, F106=29.1, F129=29.1, F158=29.1, F184=28.5, F213=27.2, F146=29.4.**
- **Spectroscopy via prism (0.6-1.8μm, *R*~100, ~24AB) and grism (1.0-1.9μm, *R*~600, ~22AB)**





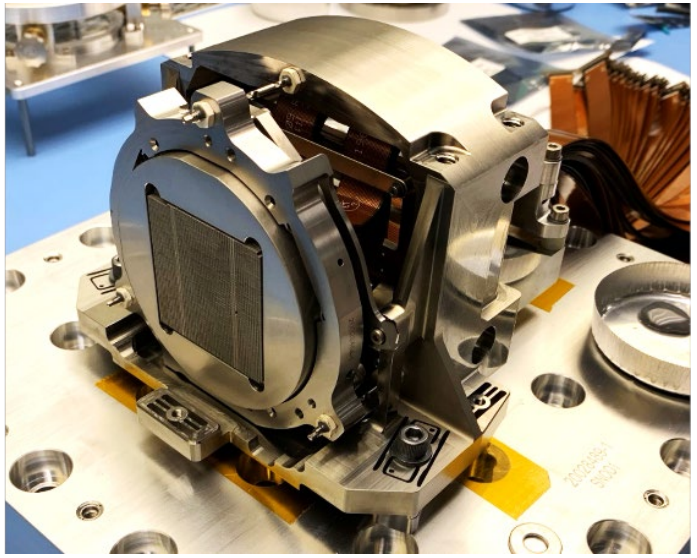
Roman Space Hardware Telescope Status

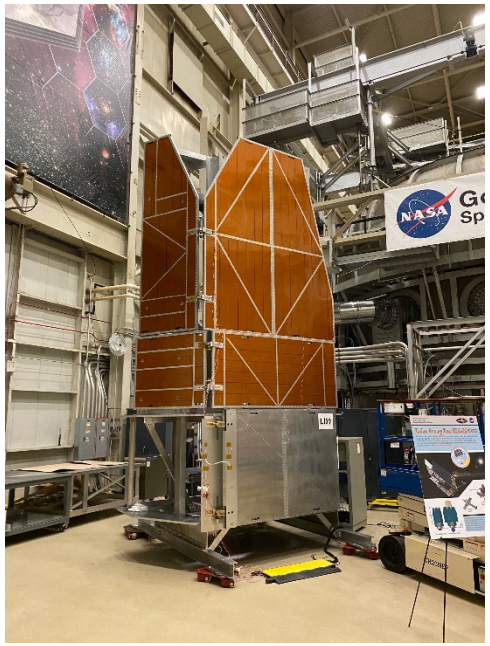
- **Advanced to phase C (i.e. started implementation phase) in February 2020**
- **Mission Critical Design Review in Sept 2021**
- **Flight hardware being built**
  - **Telescope (L3Harris)**: Primary and secondary mirrors have been refigured, polished and coated; coronagraph relay optics polished and coated;
  - **Wide Field Instrument (GSFC/Ball)**: Completed installation and alignment of all 18 engineering test unit (ETU) sensor chip assemblies (SCA) on the ETU mosaic plate
  - 15 out of 18 flight candidate SCAs in hand
  - added new F213 filter (1.95-2.3 micron) – now have imaging filters covering entire spectral range supported by mirrors/detectors!



Roman Space Telescope Hardware Status cont.

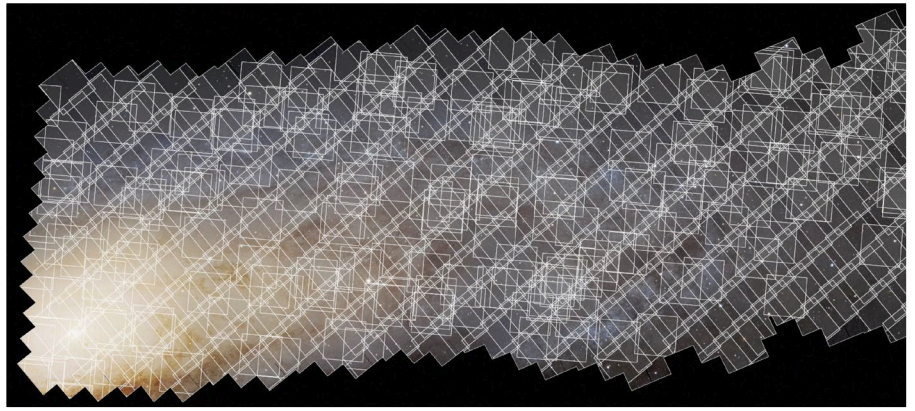
- **Coronagraph (JPL)**
  - Deformable mirror technology has been demonstrated
  - Two flight actuators in hand
- **Spacecraft (GSFC)**
  - Procurement of flight subsystems well underway
  - Mechanical Hardware Engineering Development Units (EDUs) nearly complete
- **On track for launch in mid-2020's**

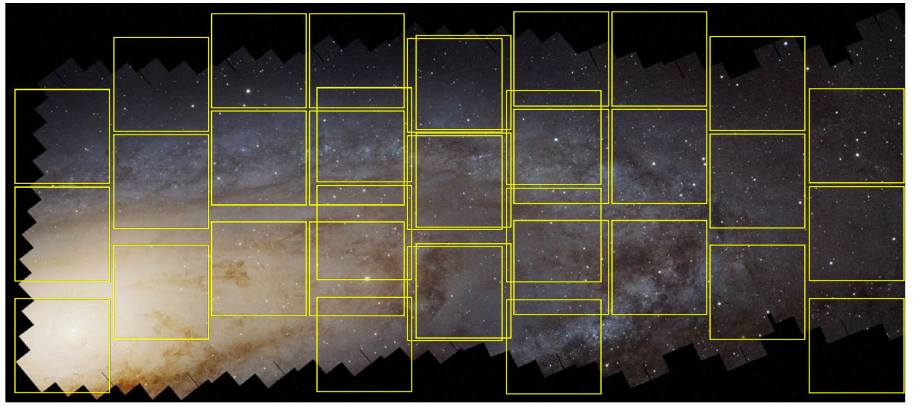




Roman as a Precise Survey Facility

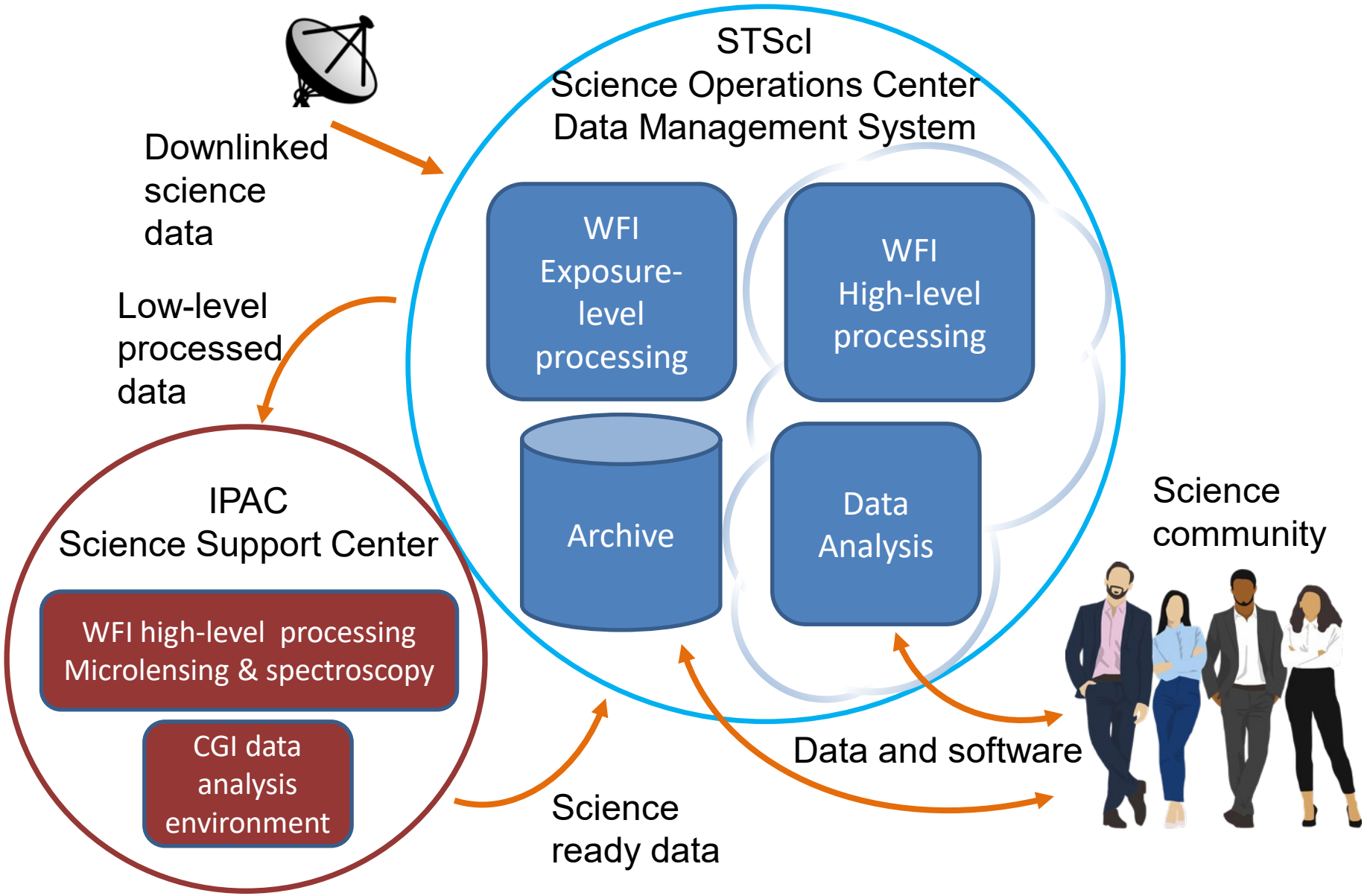
- **The power of Roman is not *just* that it has a large field of view:**
  - Very efficient observations
    - Rapid slew & settle
    - no Earth occultations
    - no South Atlantic Anomaly
  - Well understood and stable PSF
    - Stable thermal environment (L2 orbit, thermal control of all parts of the optical system)
    - Rigid optical structure with vibration isolation from the spacecraft
    - Stable attitude control
  - Excellent flux calibration
    - Relative calibration system





For details, see Akeson et al. 2019 https://arxiv.org/abs/1902.05569

Roman Science Data Management



Roman Science Operations

- **Data system consists of:**
  - Pipeline for low level data processing
  - Pipeline for high level processing
  - Science platform (HLPP) allowing users to interact with data and high-level processing software in the cloud
  - Archive with HST/JWST/MAST like functionality
- **Continuing to refine data processing plans at STScI (SOC) and IPAC (SSC) on relative roles between science centers and science teams**
  - Expanded catalog functions to be implemented by science centers: deblending, photo-z, some time-domain functions etc
  - Astrometry functions – e.g. tying to *Gaia*
  - Some elements of PSF characterization
  - Instrument simulations
- **Evaluating science platform and cloud computing options and solutions**
  - Including considerations of interoperability with other facilities (e.g. *Rubin*)

Science Investigation Teams

- **Supernova Cosmology: Ryan Foley, Saul Perlmutter**
- **Nearby Galaxies: Ben Williams**
- **Extragalactic: Brant Robertson**
- **Weak Lensing and Galaxy Redshift Survey: Olivier Dore**
- **Exoplanet Coronagraphy: Bruce Macintosh, Margaret Turnbull**
- **Archival Research: Alexander Szalay**
- **Cosmic Dawn: James Rhoads**
- **Exoplanet Microlensing: Scott Gaudi**
- **Milkyway: Jason Tumlinson**

Adjutant Scientists
David Spergel - WFI
Jeremy Kasdin - CGI

- **~300 scientists in total**
  - scientific performance requirements related to the specific science area,
  - design of overall observational strategy concept,
  - science data analysis techniques,
  - ground and space calibration requirements,
  - science simulations, precursor observations,
  - ground calibration, observational needs, data processing, ancillary data collection/incorporation, analysis, dissemination and documentation of the proposed science investigation.

- **Current science team contracts expire later this year**

Roman Science Interest Group

- https://roman.gsfc.nasa.gov/science/rsig.html

- **Meeting presentations and notes available on the meetings tab**
  - Recent discussions have been on the observing program
- **Annual opportunities to join this group**

- (for SOC role at STScI) see also: https://www.stsci.edu/roman/about/roman-advisory-committee-rstac

Megan Donohue (Chair)	**Michigan State U.**
Zeljko Ivesic	U. Washington
Jessica Lu	UC Berkeley
John MacKenty	STScI
Ashley Villar	Columbia U / Flatiron Institute
Alice Shapley	UCLA
Keith Bechtol	UW, Madison
Saurabh Jha	Rutgers U
Peter Melchior	Princeton U
Dara Norman	NOIRlab
Jessie Christiansen	NEXSci/ CalTech
Rachel Bean	Cornell U
Ryan Hickox	Dartmouth
Lisa Storrie-Lombardi	Las Cumbres Observatory
Dimitri Mawet	CalTech

Roman Opportunities

- **Opportunities for participation in *Roman* offered in ROSES-2021**
  - **Key Project Teams:** Science teams to conduct scientific investigations using the data from the major surveys identified by the Astro2010 Decadal Survey
  - **Coronagraph Community Participation Program:** Investigators to work with the coronagraph instrument team to plan and execute tech demo observations
  - **Wide Field Instrument Preparatory Science:** Investigators to work on science preparation activities related to mission performance verification and science operations preparation

- **All *Roman* observing time is available through open processes**
  - Major surveys will be defined using a community-driven open process
  - Key Projects – funded science investigations using these surveys – openly competed
  - Roman observing time will be available for General Observer (GO) projects
  - All data will be available to the community with no period of limited access

Roman Observations

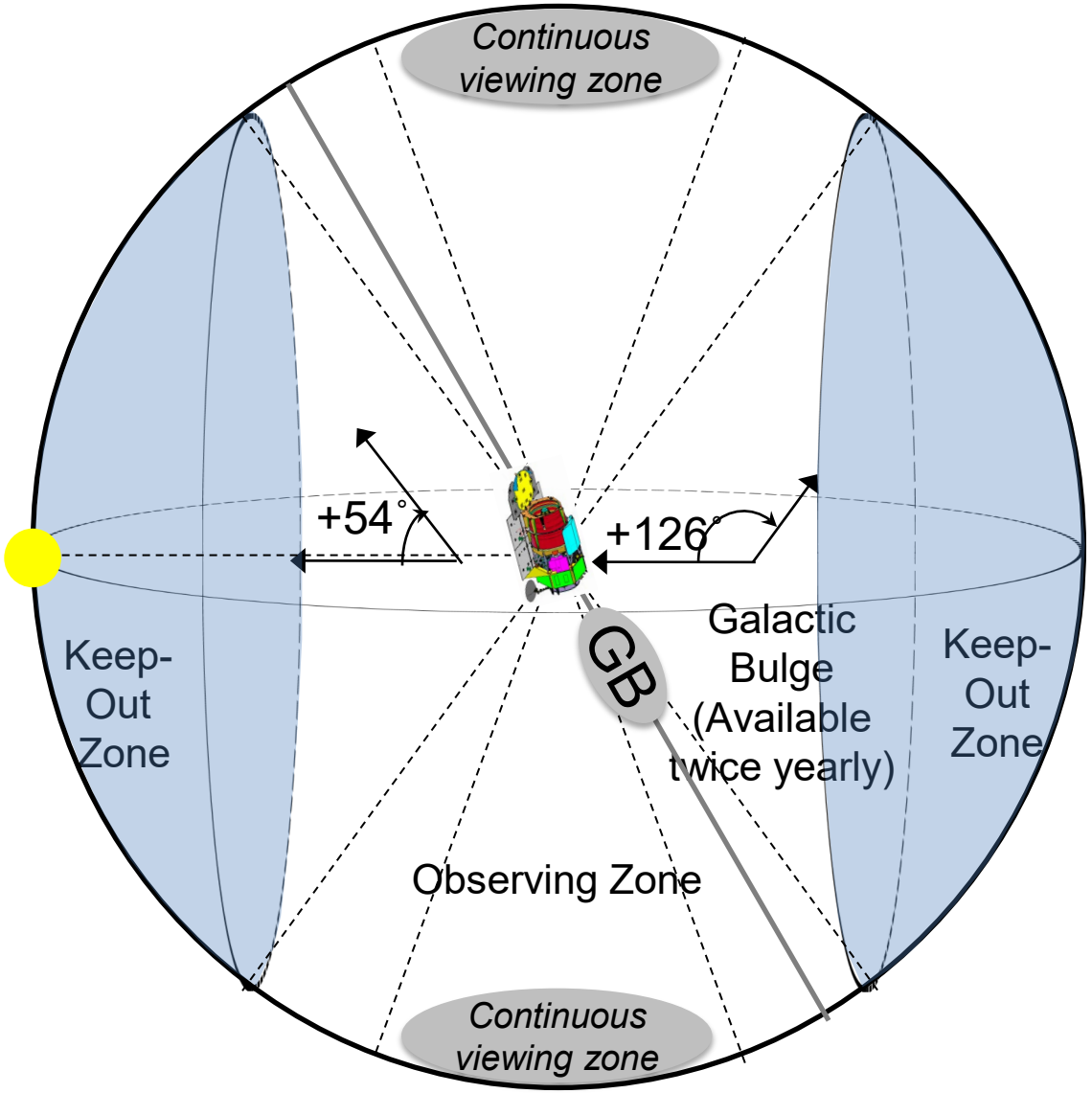
- **Core Community Surveys:** a significant fraction of the prime mission used for revolutionary surveys of unprecedented scale
- **Three Core Community Surveys that provide broad scientific power and address 2010 Decadal Survey science goals**
  - Extragalactic Wide Area Survey
  - Extragalactic Time Domain Survey
  - Galactic Time Domain Survey
- **The definition of Core Community Surveys will be established via an open process, with a goal of maximizing the overall science return while simultaneously meeting the cosmology and exoplanet science requirements**
- **Several calls for General Observer surveys closer to, and after, launch**
- **No proprietary period for any *Roman* data**

Roman Field of Regard

Observing Zone:
- **54˚-126˚ off Sun Line**
- **360˚ about Sun Line**
- **±15˚ about line of sight**

Slew/settle times are rapid – typically ~1 min for adjacent field of view

Earth/Moon avoidance angles are a minor sporadic constraint



Extragalactic Time Domain Survey in fields within 20˚ of the ecliptic poles, located in continuous viewing zone(s)

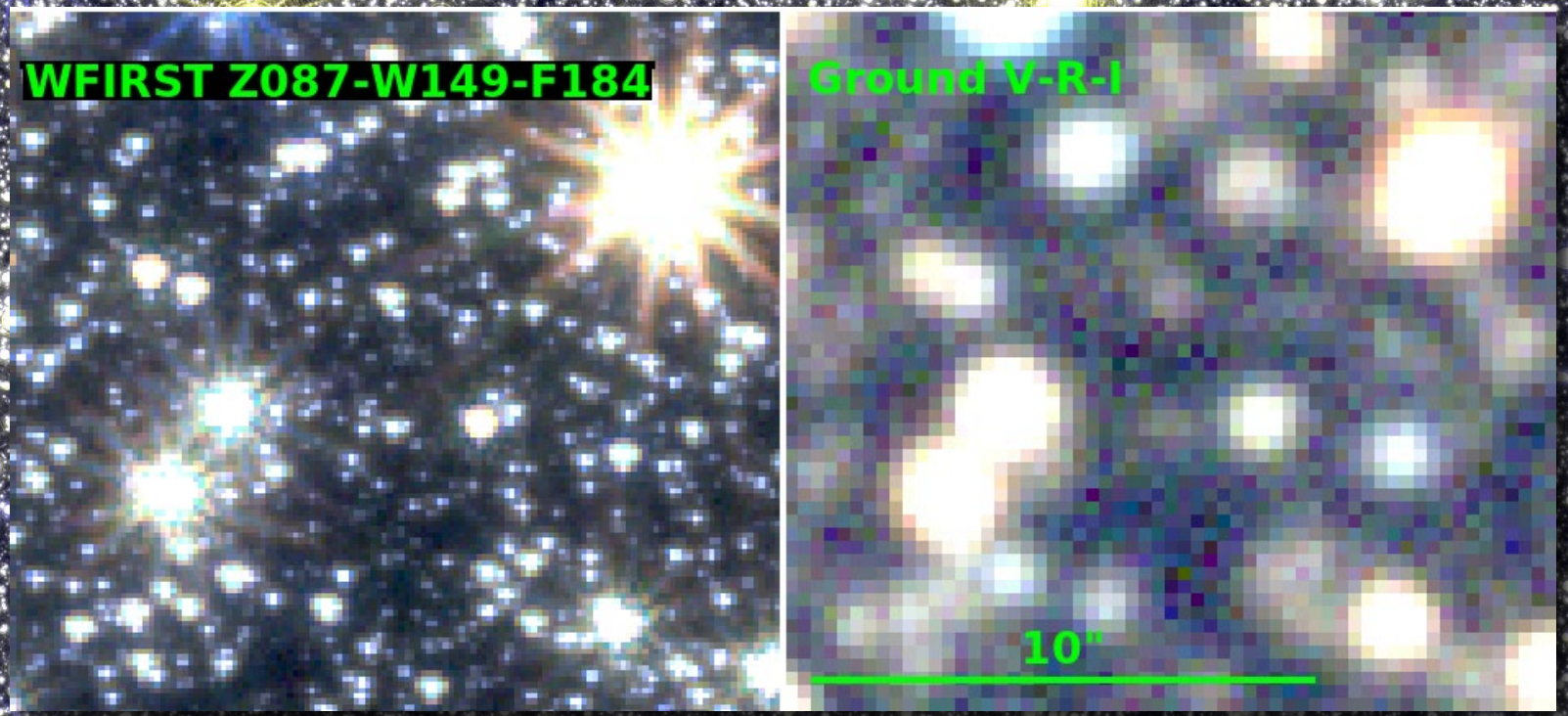
Extragalactic Wide Area Survey (also GO & Coronagraph)observations can be located within the full Observing Zone

Galactic Time Domain Survey can observe inertially fixed fields in the Galactic Bulge (GB) for 72 days twice a year

Roman Galactic Time Domain Survey

- *Roman*'s time domain imaging survey of the Galactic Bulge
- Envisioned as ~2 square degrees in wideband infrared imaging every 15 minutes, plus other band(s) every ~day
- Over 40,000 images across 5 years = ~2Ms
- Depth ~25AB (epoch), ~31AB (coadded)
- Detects hundreds of millions of stars in each epoch
- Enables exoplanet demographics via microlensing
- But this is just the beginning…
  - precise photometry & stellar parameters for ~100M stars
  - asteroseismology of millions of red giants
  - millions of distances from parallax
  - a hundred thousand transiting planets!
  - thousands of trans-Neptunian objects

~1% of *Roman*'s field



Images from M. Penny; S. Gaudi

Roman *Galactic Exoplanet Survey Science Investigation Team*

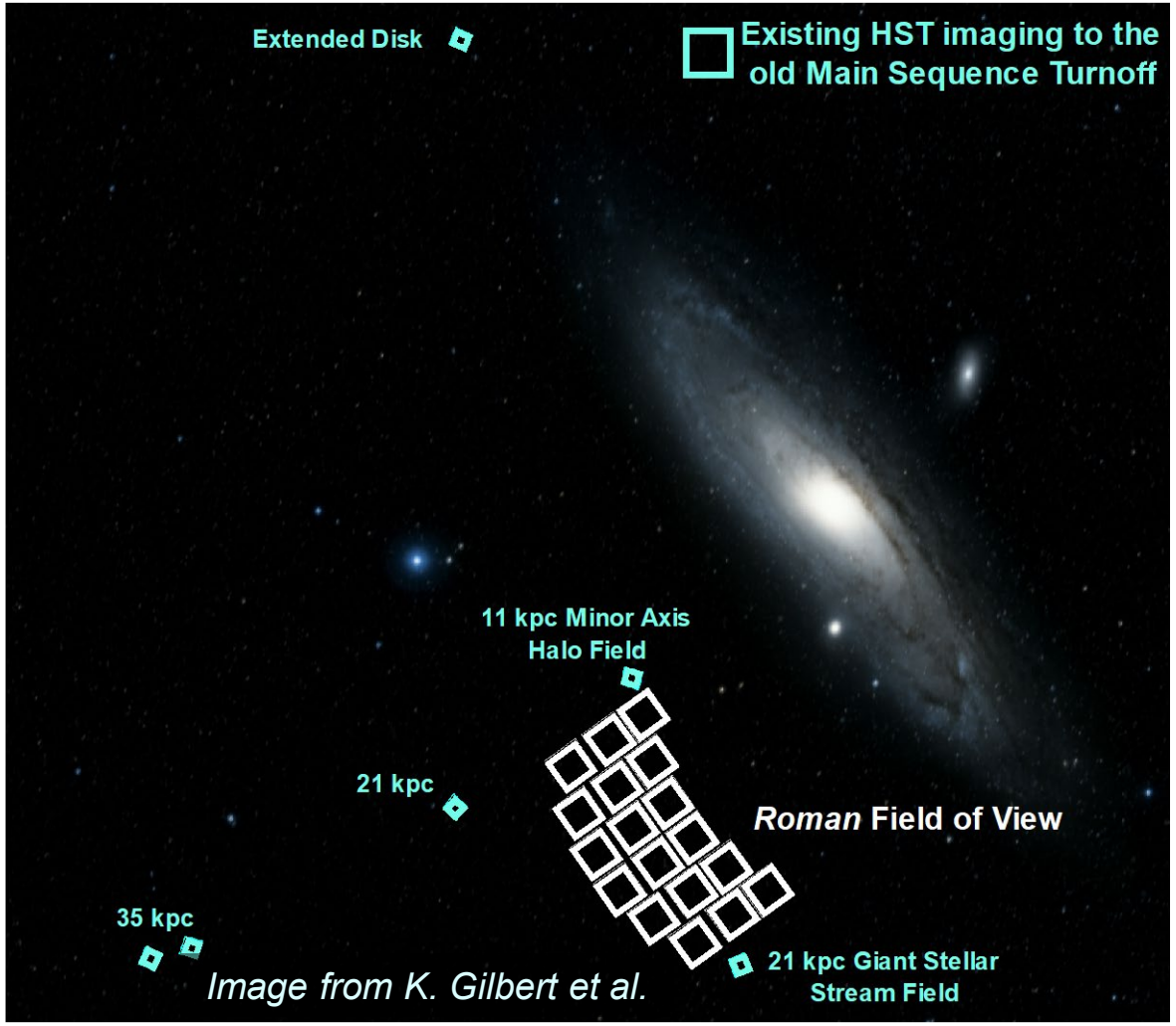
Roman General Observer Surveys

- *Roman* will devote ≥400 days of telescope time in the first five years to surveys defined by GO opportunities
- Envisioned as a few tens of projects of significant scale, substantial science outcomes, and lasting value to the community

Studies of absolutely anything are permitted for submission; taking galaxy assembly as an example…

Roman General Observer Surveys

Studies of absolutely anything are permitted for submission; taking galaxy assembly as an example…



Roman General Observer Surveys

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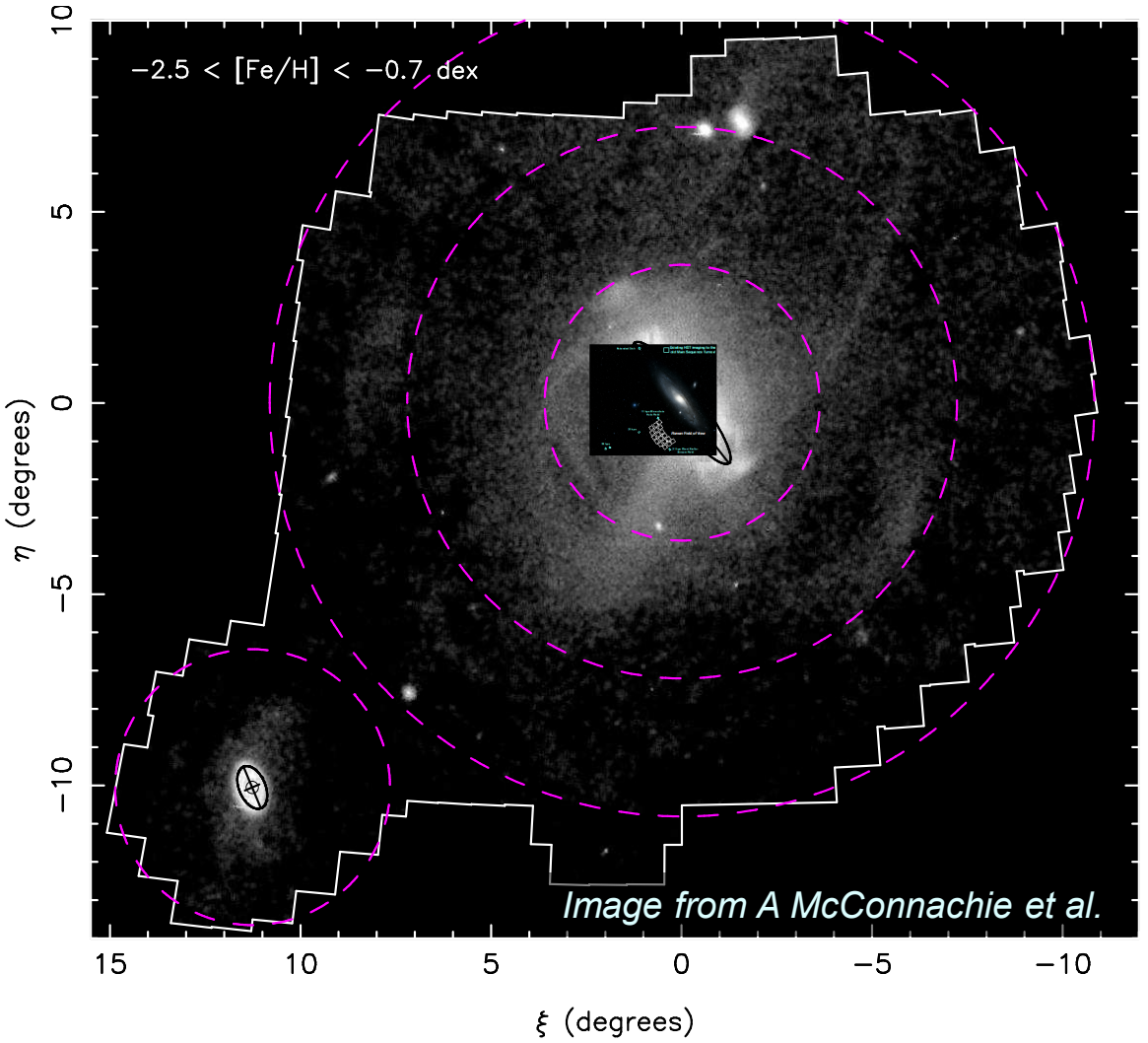

Roman General Observer Surveys

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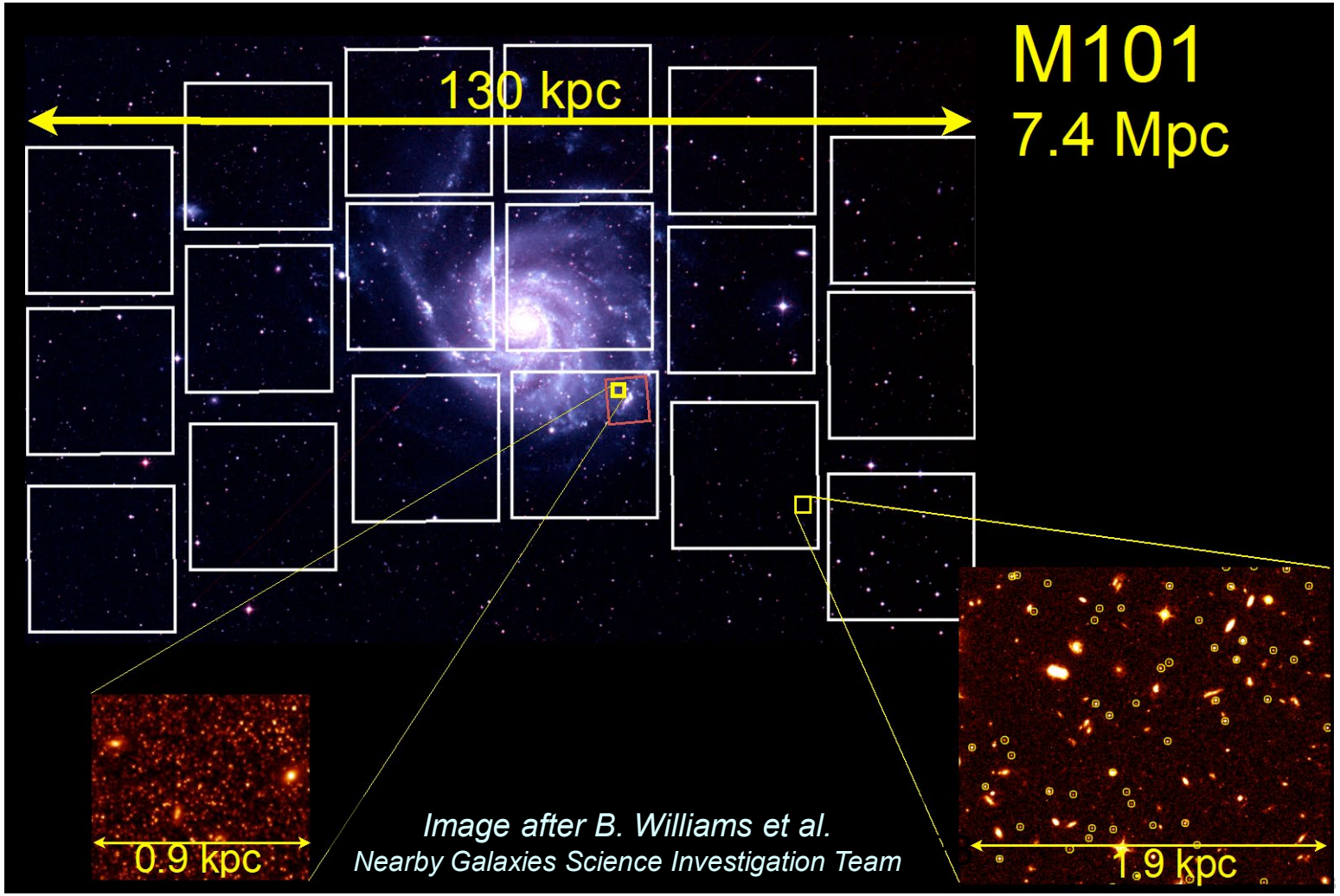
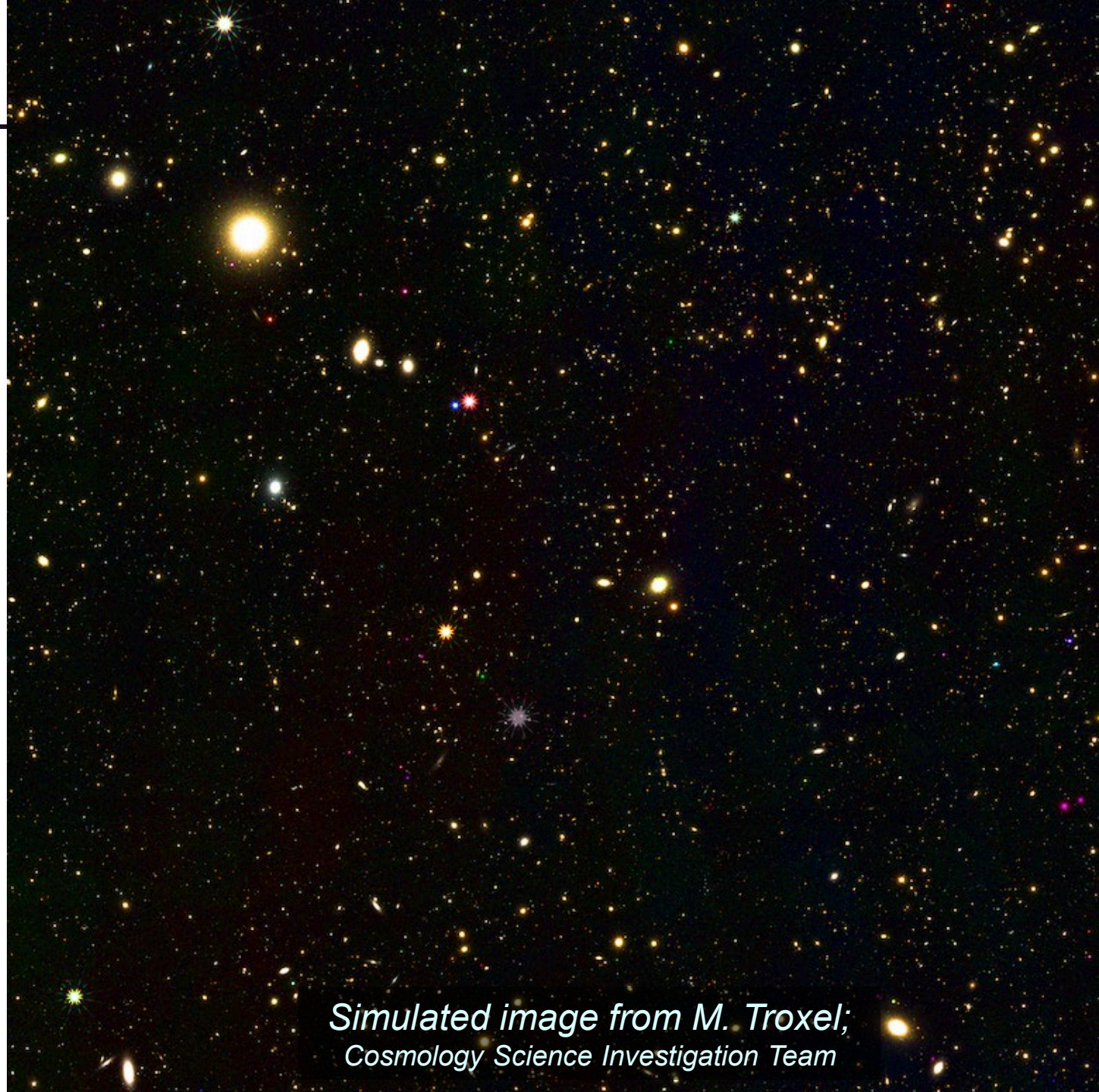


Roman Extragalactic Wide Area Survey

- *Roman*'s wide+deep imaging and spectroscopic survey
- Envisioned as ~2,000 square degrees in multiband infrared imaging & slitless spectroscopy at ~1-2μm
- Depth ~27AB / 10^{-16} erg/s/cm^2 (5σ)
- Detects hundreds of millions of galaxies (imaging) and tens of millions (spectroscopically), mostly at redshifts 1-3 but with significant numbers beyond z=10!
- Enables cosmology techniques such as weak lensing & baryon acoustic oscillations
- But this is just the beginning…
  - tens of thousands of galaxy clusters
  - thousands of galaxies at redshift 10-15
  - stellar streams and dwarfs around nearby galaxies

Roman Imaging

- YJH
- ~27AB
- 1/18th FOV
- ~30min



Roman Extragalactic Time Domain Survey

- *Roman*'s tiered, temporal imaging and spectroscopic survey
- Envisioned as ~20 square degrees in five-band infrared imaging & slitless spectroscopy at ~0.6-2μm
- Depth ~25-26AB (epoch), ~30AB (coadded)
- Track the brightness of more than a million galaxies every ~5 days for ~2 years with unprecedented photometric accuracy
- Enables supernova cosmology measurements
- But this is just the beginning…
  - variability of active galactic nuclei
  - proper motion ~10μas; possible extragalactic parallax
  - ~3000 Ia supernova, but ~10,000 supernovae total
  - transients (e.g. TDEs; SPRITEs?)
  - distances from RR Lyrae; tRGB

Roman Extragalactic Time Domain Survey

- *Roman*'s tiered, temporal imagin
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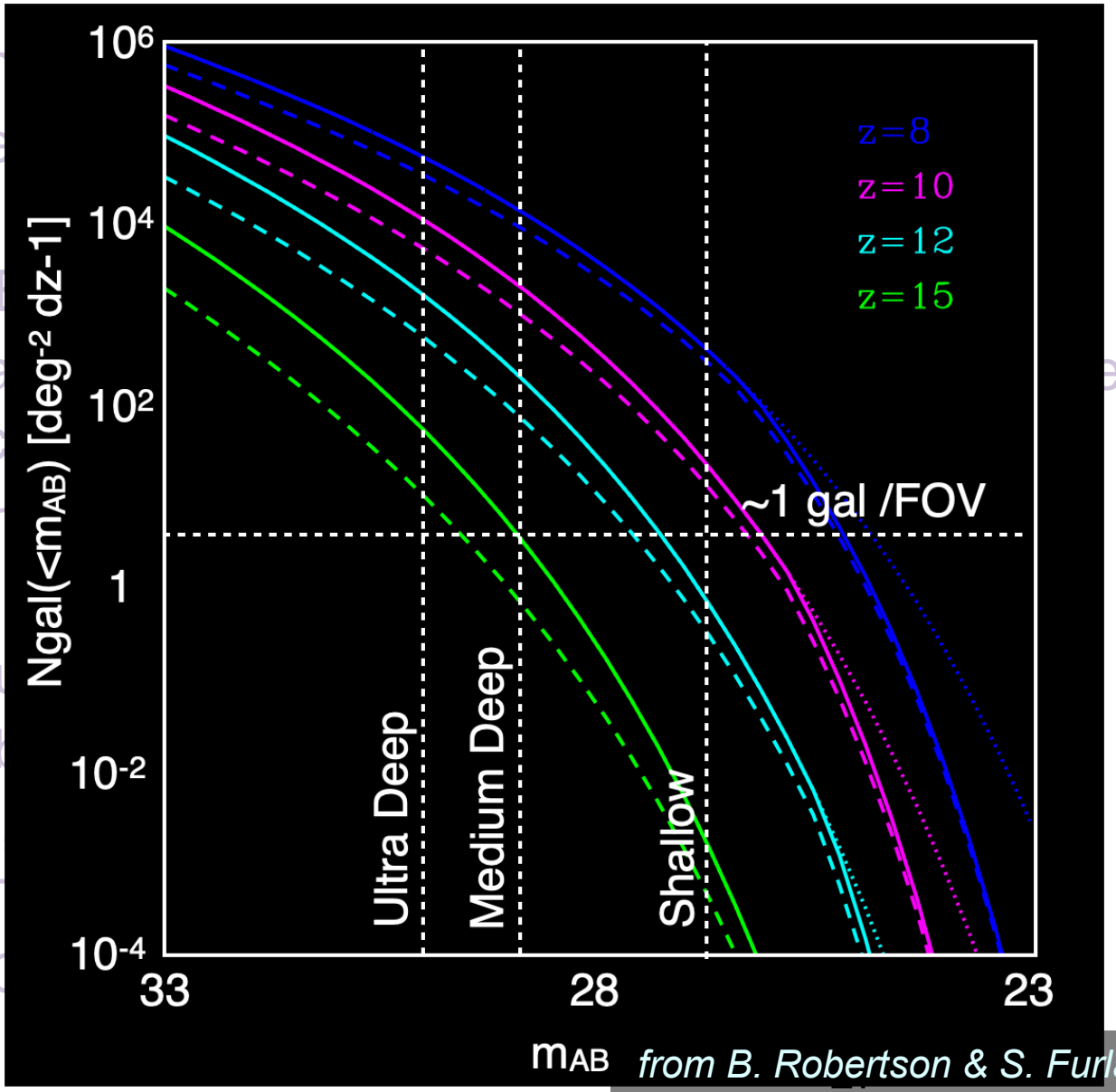

from B. Robertson & S. Furlanetto

Engaging the Community

- *All Roman* observing time is available through open processes
- Major **Core Community Surveys** will be defined using a community-driven *open process*
- Observing time available via **General Observer** *proposal opportunities*
- **Key Projects** – funded science investigations using these surveys – will be *openly competed*
- **Preparatory Science** – funded work preparing for any of the above, also via *proposal opportunities*
- All data will be available to the community with *no period of limited access*