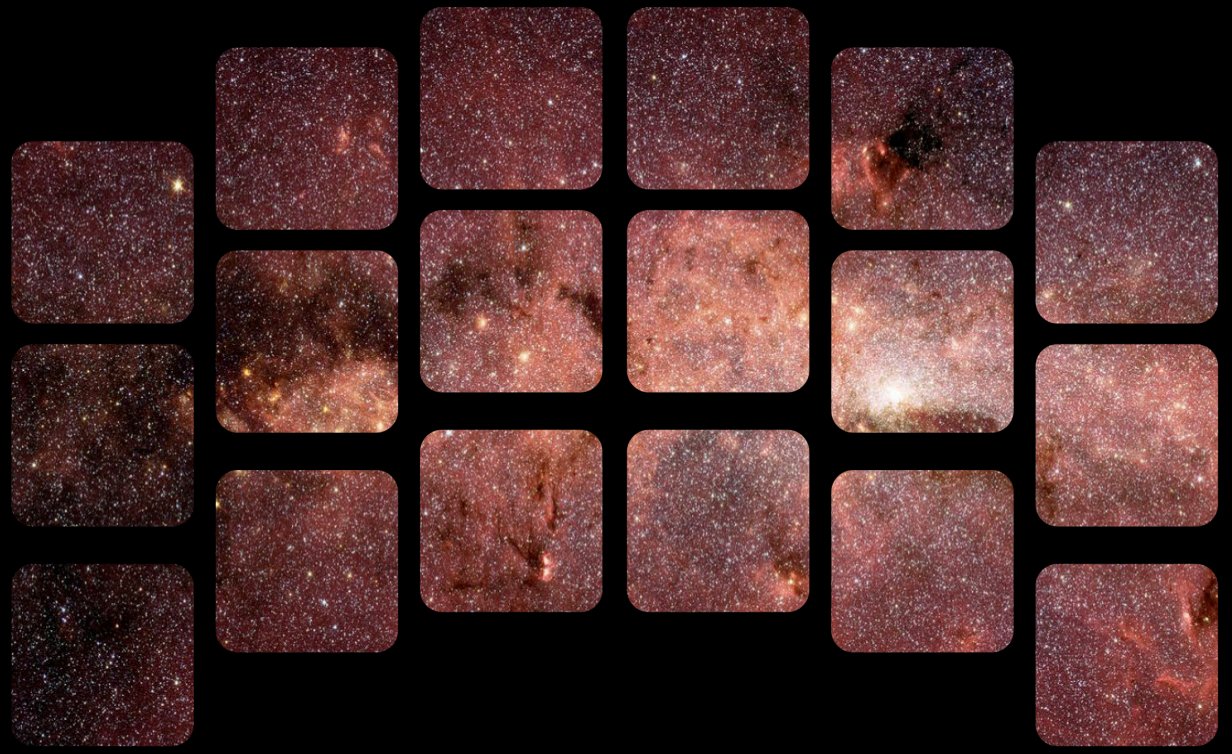
Project Status

Julie McEnery
Roman Senior Project Scientist



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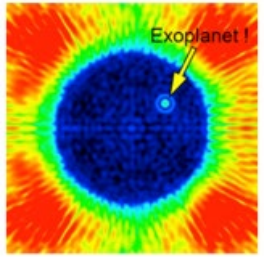
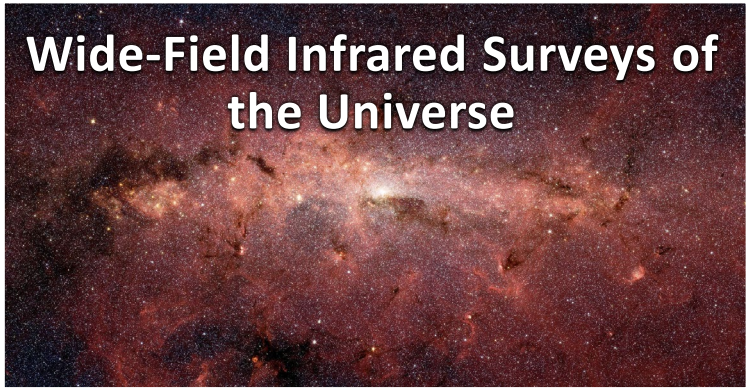
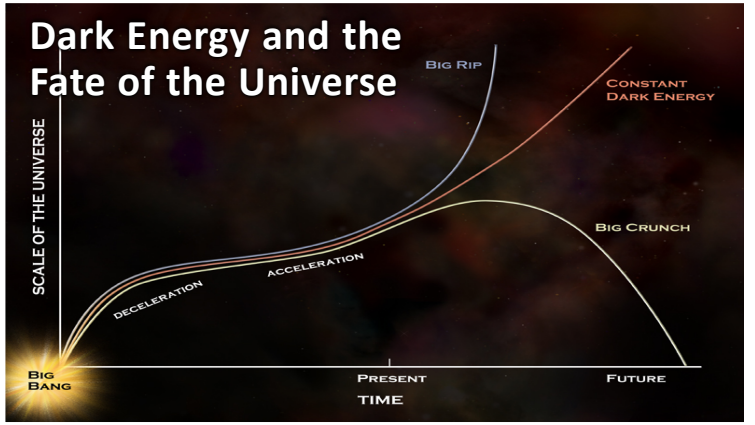
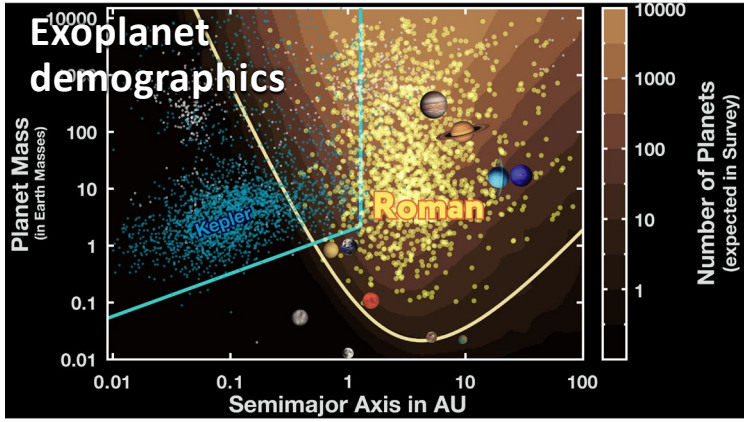
Roman Mission Objectives

- **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 Astrophysics Surveys**
  - Devote substantial fraction of mission lifetime to peer reviewed program
- **Coronagraph technology demonstration**
  - Demonstrate exoplanet coronagraphy with active wavefront control









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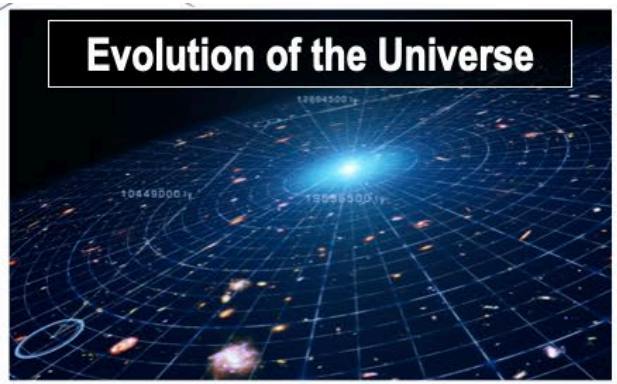
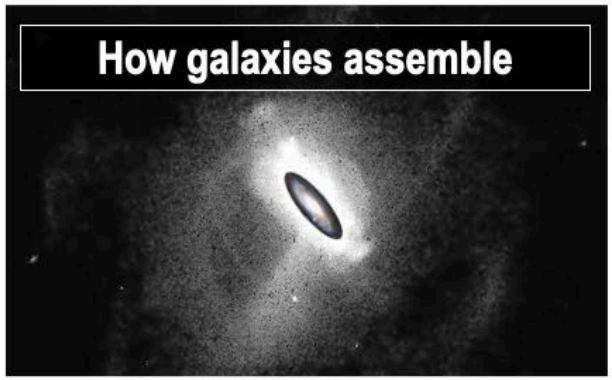
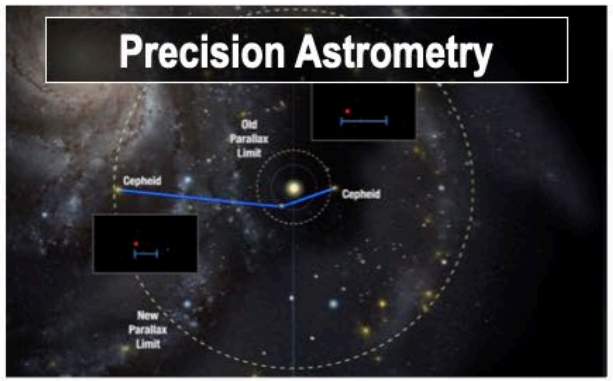
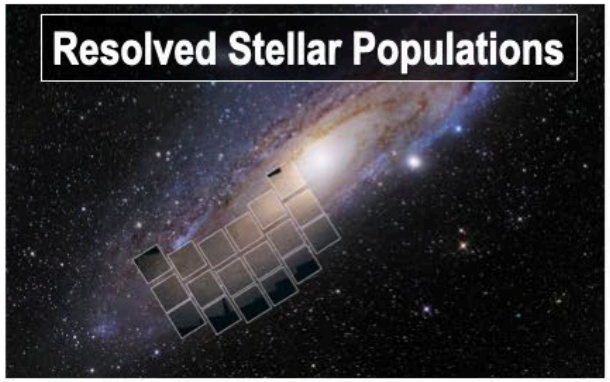
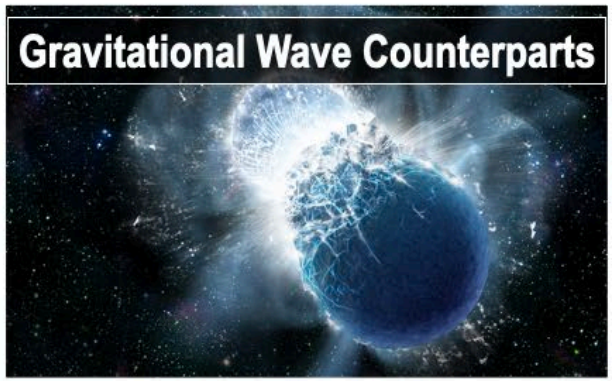
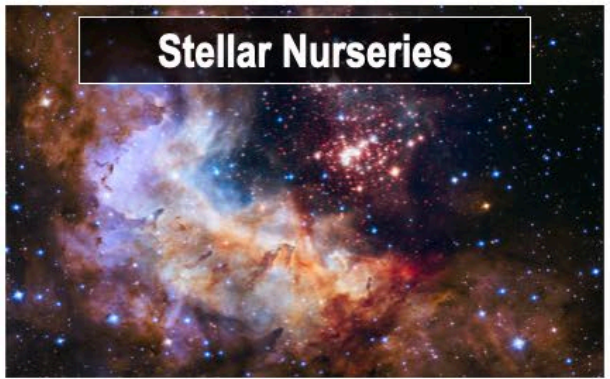


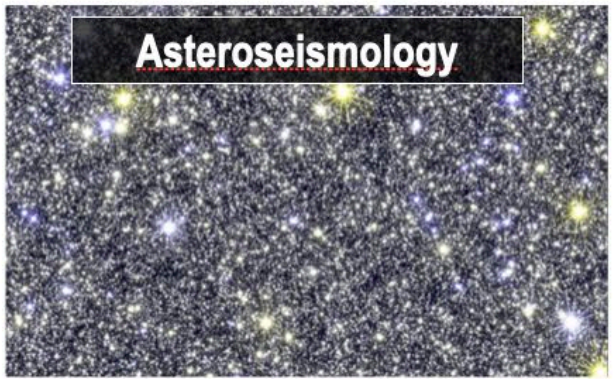


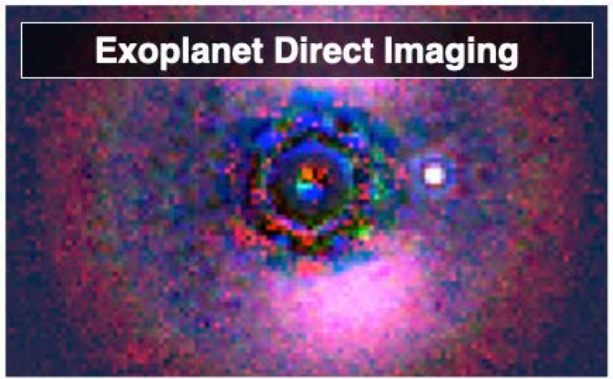


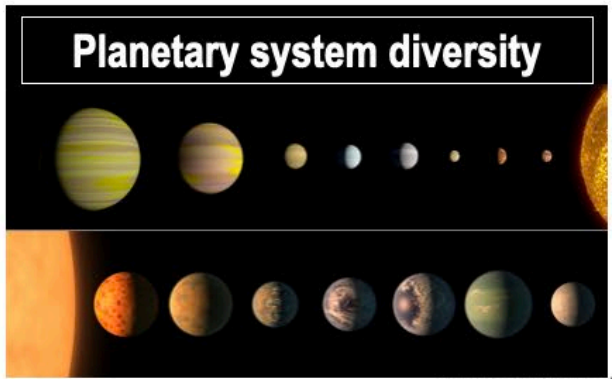




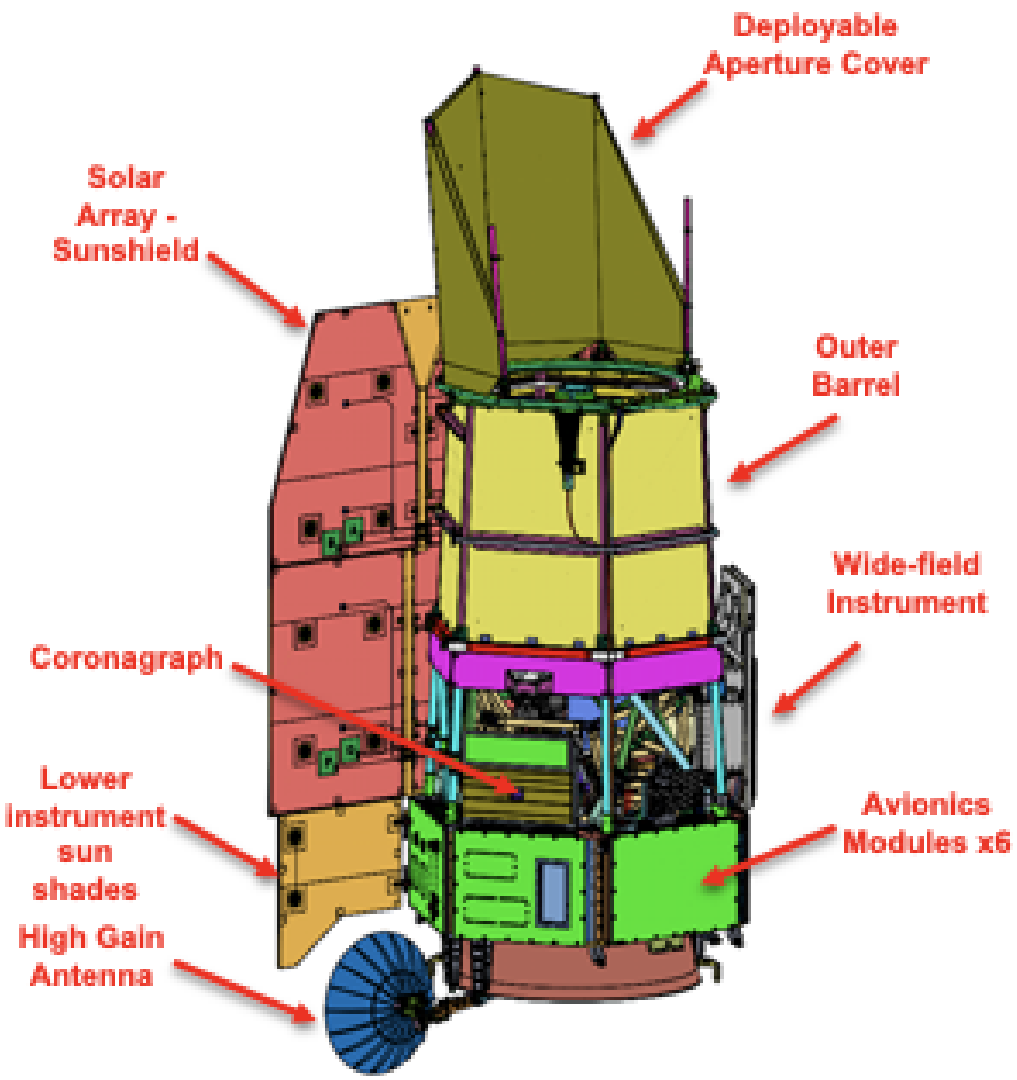








Roman Observatory and Instruments



Telescope: 2.4m aperture

Two Instruments:

Wide Field Instrument

- 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 Instrument

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

Data Volume: 11 Tb/day

Orbit: Sun-Earth L2

Mission Duration: 5 yr, 10yr goal

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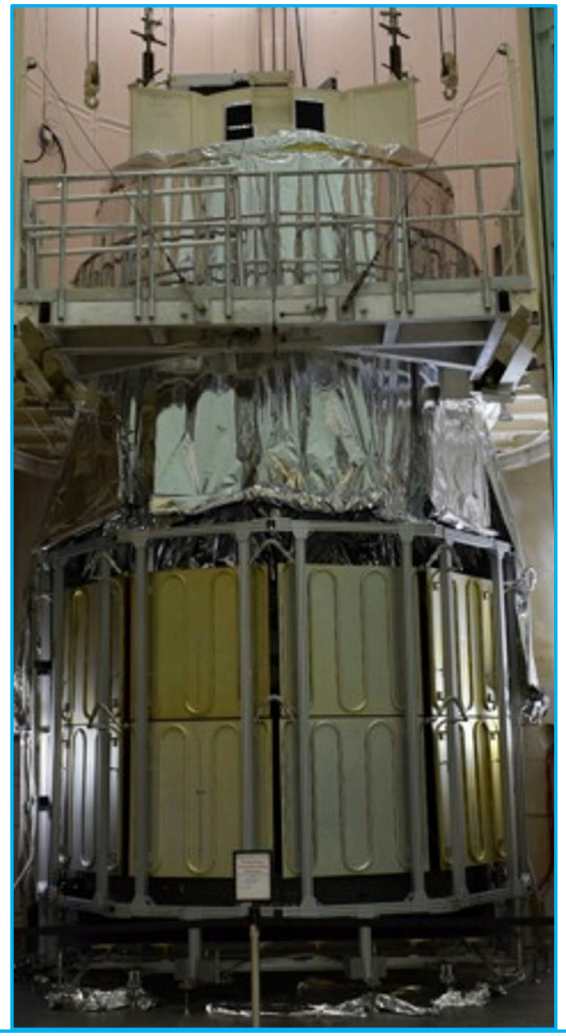
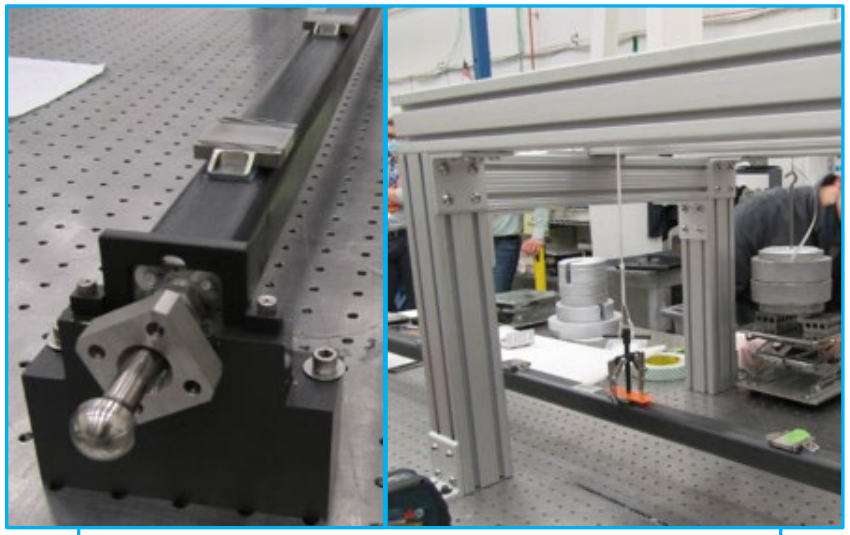
Project Status

- **Launch Vehicle selection process underway**
- **Telescope**
  - All optics coated, currently in integration, assembly and test of optical telescope assembly
- **Spacecraft**
  - Procurement of flight subsystems underway (all significant contracts awarded)
  - Engineering units for systems built and tested
- **Wide-Field Instrument**
  - Optical bench received, Be element wheel received
  - Flight detectors characterized and installed in flight mosaic plate
  - Flight electronics being assembled, engineering test unit electronics testing completed
  - Flight grism, prism, filters currently undergoing optical characterization and environmental test
- **Coronagraph Instrument**
  - Flight detectors (EMCCDs) in hand, being integrated mechanically
  - Flight and spare Shape Pupil Coronagraph coronagraph masks completed
  - 1st of 2 flight deformable mirror arrays (DMs) performing well in JPL testing; 2nd on the way
  - Precision Alignment Mechanisms passed vibration testing
  - Prisms and polarizer assemblies delivered

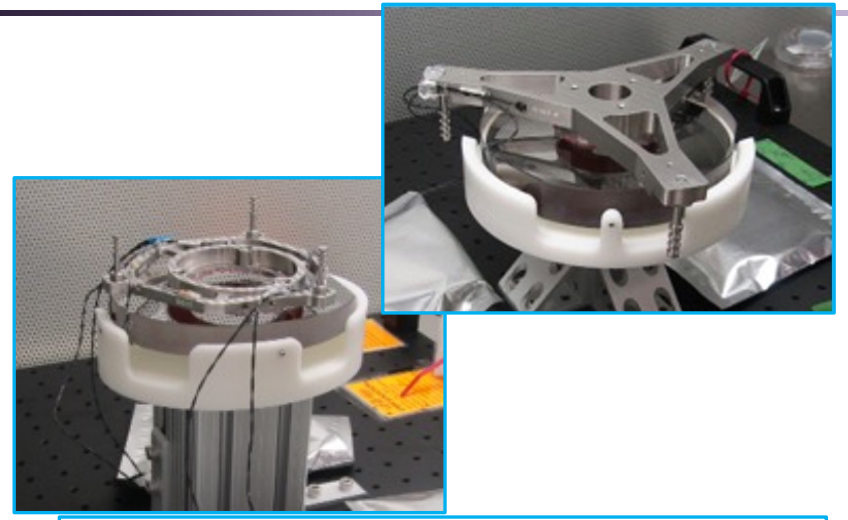
Telescope Hardware



Primary Mirror Assembly in Chamber IIIA with shrouds in place



Secondary Mirror Support Tube cable bracket bonding and proof testing



Completed the Pick-Off Mirror Assembly (left) and the Tertiary Mirror Assembly - Mirror 4

Fold Mirror 2 Assembly Stycast Operation

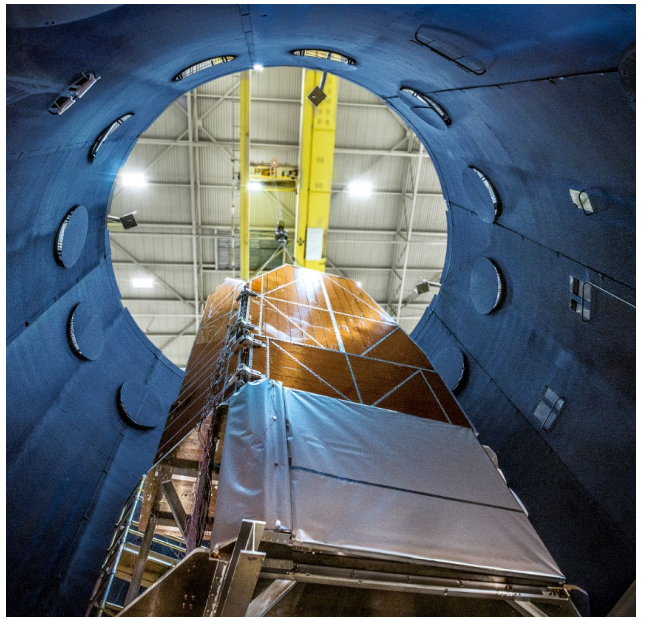
Aft-Optics Structure in the build process

Spacecraft Hardware

The Code 547 Team finishing up the precision assembly in the B.5 high bay

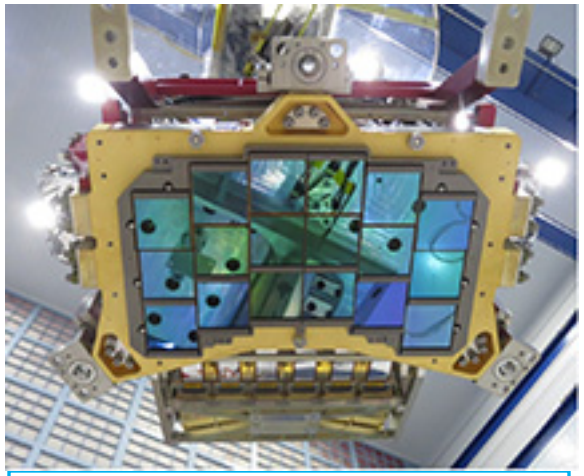
Spacecraft Bus Mock-up for Flight Harness Fabrication

Precision Spacecraft Bus Mock-up with Avionics panels and interfaces to the Instrument Carrier (IC) and Wide Field Instrument (WFI), Coronagraph Instrument (CGI) and Optical Telescope Assembly (OTA) connector panels for flight harness fabrication and routing

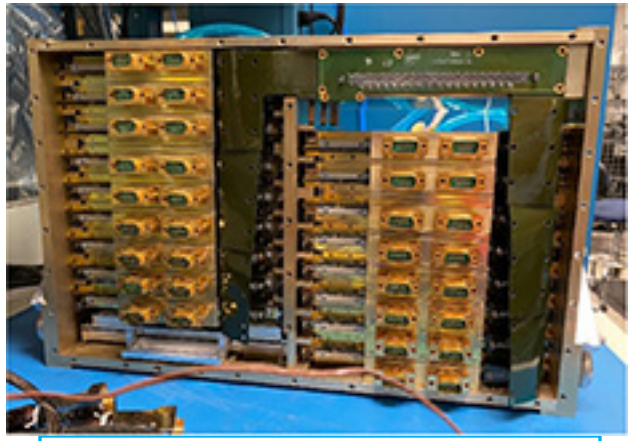


Solar Array Sun Shield (SASS) Engineering Development Unit

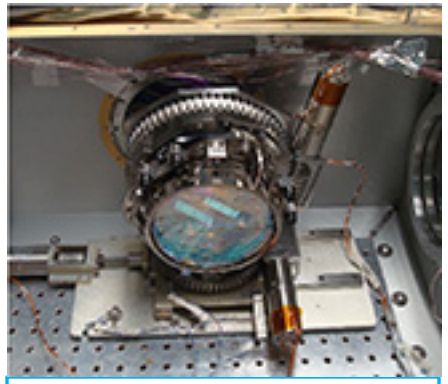
WFI Hardware



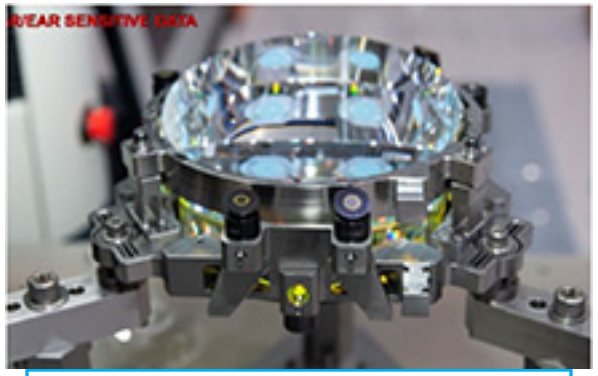
Focal Plane Assembly Engineering Test Unit successfully completed environmental testing



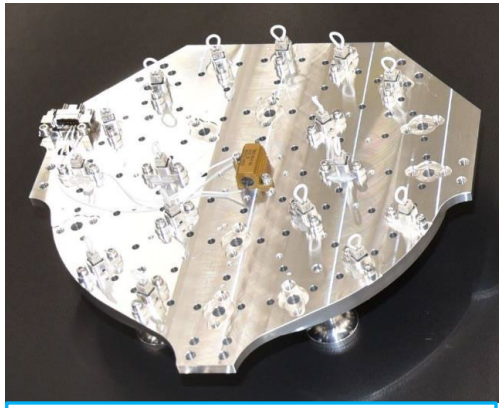
Focal Plane Electronics Engineering Test Unit in final assembly



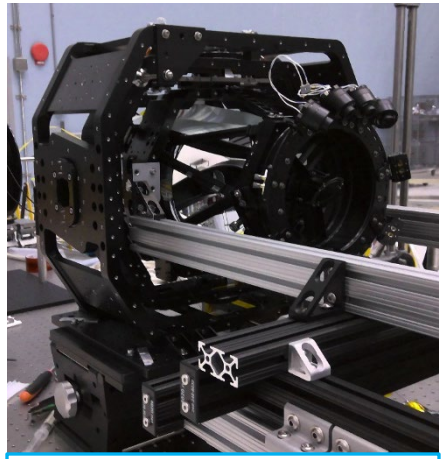
Flight grism successfully completed cryo vacuum performance testing



Flight prism successfully completed ambient performance testing

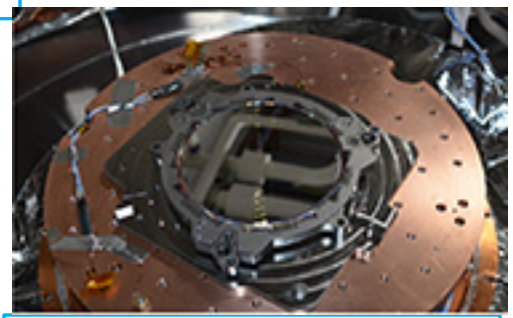


Relative Calibration System Light Emitting Diode packages completed for thermal vacuum and life testing



Star Projector Assembly integrated into gimble stage

Flight Alignment Compensation Mechanism successfully tested with Mosaic Plate Assembly simulator



Filter Engineering Test Unit successfully completed cryo cycling and performance testing

Flight gear motor for Element Wheel Assembly received at Ball and in-process for integration

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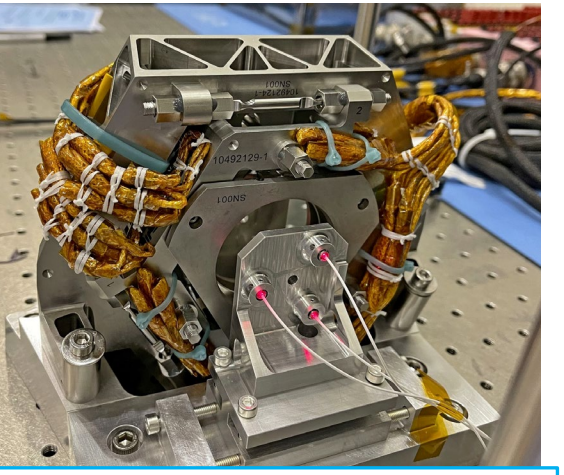
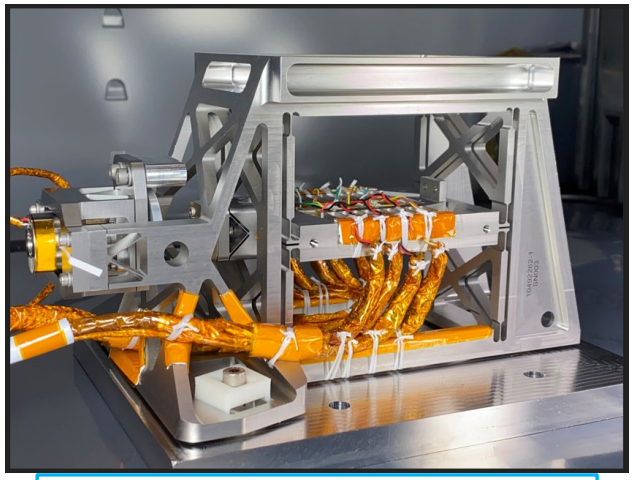
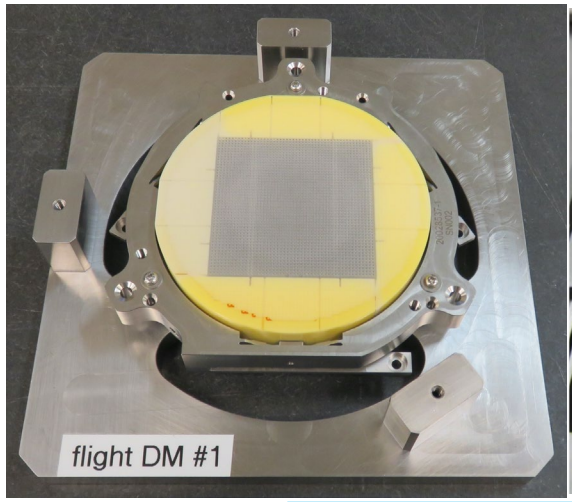
Coronagraph Instrument

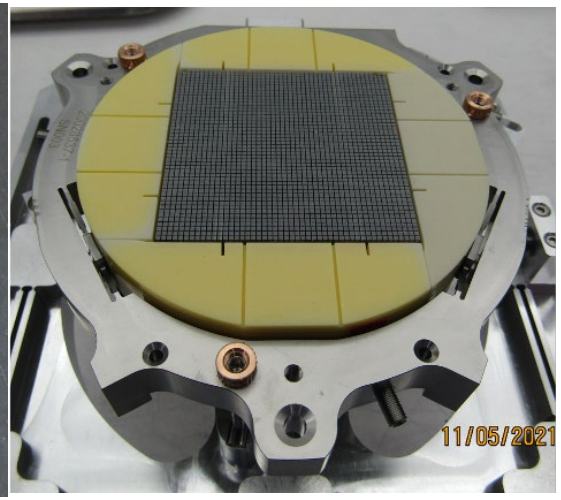


Fast Steering Mirror



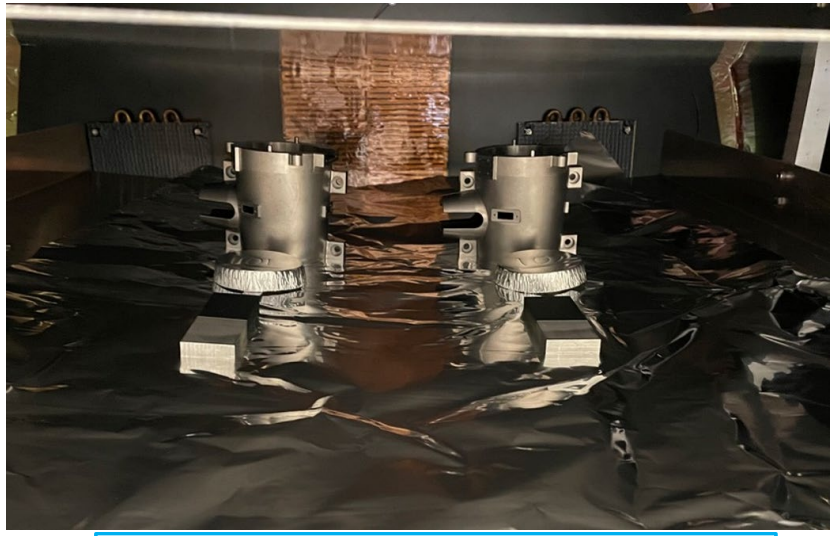
Focus Control Mirror



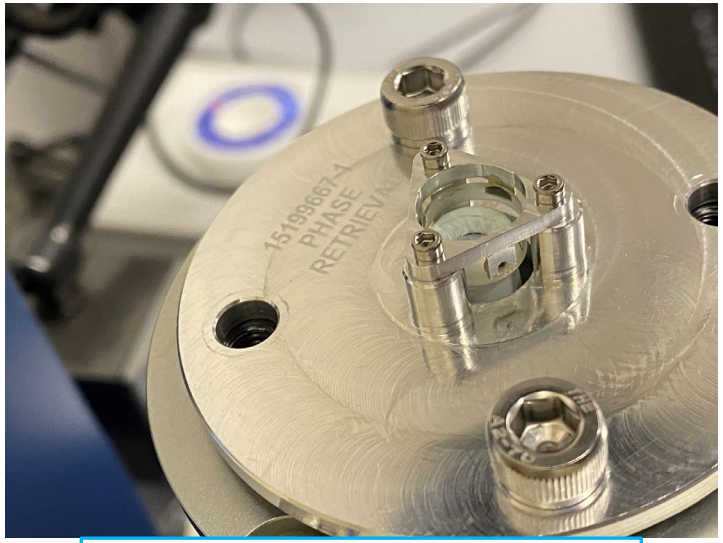


Deformable Mirrors

Camera Radiation Shield



Flight camera housing (ExCAM and LoCAM) black paint bake-out



Phase Retrieval Lens assembly

Roman Budget and Schedule

Cost and Schedule – some definitions

- **Agency Baseline Commitment (ABC)**
  - Budget and schedule agreement between NASA HQ and appropriators (i.e., Congress)
  - Includes schedule and funding reserves held/controlled by NASA HQ to achieve a high confidence budget and schedule
    - Usually 70% Joint Confidence Level
  - It is a big deal to change this!
- **Management Agreement (MA)**
  - Scope, budget and schedule agreement between NASA HQ and Roman project
  - Includes schedule and funding reserves held/controlled by the Roman project to execute within acceptable risk
    - Usually 50% Joint Confidence Level

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COVID-19 Impacts

- **COVID-19 operations March 2020 - September 2021 affected execution efficiency and global supply chains during project's planned peak years**
- **Decreased efficiency at every level – from parts suppliers through major contractors up through the Roman project**
  - Shutdowns, mandatory remote work, and constraints on on-site work (physical distancing, masking) directly affected efficiency of work
  - Global supply chain issues included increased no-bids and bid durations (sometimes doubling); no expediting options; slipped deliveries, sometimes without warning; choke points developed
  - Pandemic added scope to address the new requirements – from new approval processes for on-site work to redefining work instructions to continuously iterating with suppliers on their schedule
- **Project mitigated these impacts to the extent possible by increasing communication with suppliers and adjusting the workflow as needed**
  - Schedule slack and then reserves were adjusted, applied, and eventually consumed to mitigate the impact to critical path -- led to an overall schedule replan

COVID-19 Replan (May 2021)

- **Baseline schedule in Feb 2020 at KDP-C**
  - ABC launch readiness date: Oct 2026
  - MA launch readiness date: Dec 2025
- **Roman carefully tracked COVID-19-related schedule and cost impacts separately from everything else and included forecast COVID-19 impacts to continue through Sept 2021 (19 months)**
- **COVID-19 Replan in May 2021 increased lifecycle cost by $382M and slipped the launch by 7 months**
  - ABC LRD: May 2027
  - MA LRD: July 2026
  - Adjusting both ABC and MA minimized COVID-19 changes to risk posture approved at KDP-C

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Critical Design Review (Sept 2021)

- **We passed!**
- **Independent cost and schedule assessment find mission is achievable within ABC cost and schedule with high confidence**
- **Issue – inadequate project reserves within MA cost and schedule**
  - Allocate HQ budget and schedule reserves to project
  - Increased lifecycle cost MA by $246M; no change to ABC
  - Shift MA launch date by 3 months; no change to ABC
    - ABC launch remains no later than: May 2027
    - MA launch readiness date: October 2026

Roman Observations and community engagement

Roman Observations

- **Three Core Community Surveys address the 2010 Decadal Survey science goals while providing broad scientific power**
  - **High Latitude Wide Area Survey**
    - Wide area multiband survey with slitless spectroscopy
    - Enables weak lensing and galaxy redshift cosmology mission objectives
  - **High Latitude Time Domain Survey**
    - Tiered, multiband time domain observations of 10s deg^2 at high latitudes
    - Enables Type Ia supernova cosmology mission objectives
  - **Galactic Time Domain Survey**
    - ~<15 min cadence observations over few deg^2 towards galactic bulge
    - Enables exoplanet microlensing mission objectives
- **Minimum 25% time allocated to General Astrophysics Surveys**
- **90 days for Coronagraph technology demonstration within first 18 months of mission**

Core Community Surveys are for Everyone

- **Core Community Surveys:** a significant fraction of the prime mission used for revolutionary surveys of unprecedented scale.

Core Community Surveys definition will be via an open process, maximizing the overall science return while meeting the cosmology and exoplanet science requirements

Core Community Survey Definition

- **Goals:**
  - Provide observations needed to enable mission science objectives in cosmology and exoplanet demographics
  - Maximize science return
  - Ensure breadth of science and community across all surveys
  - Maximize community engagement and input in definition of surveys
  - Establish a transparent process
  - Ensure final survey definition recommendations made by a body and process the community perceives as representative and balanced

We are developing the community process with our science centers (who lead the implementation) and will review plans with our advisory committees. What's presented here is not a final plan for review, but an outline of the kind of things we have in mind to guide discussion.

Community Engagement

- **Workshops to inform community about Roman capabilities**
  - Outline available parameter space for each survey
  - Constraints are that each survey provides data needed to meet the science requirements, and at least 25% time (TBC) is retained for General Astrophysics Surveys
- **White paper call for papers detailing science that can be done with the survey**
  - Encourage development of metrics/figures of merit, and description of specific observational needs
- **Additional workshops to enable community cooperation and consensus**
  - Provides a forum for iterative development of survey concepts

An Inclusive Process

- **Make sure that the entire community has a voice in the survey definition process**
- **Reach out as broadly as possible**
  - Leverage mailing lists at both Roman science centers (STScI and IPAC) in addition to existing Roman mailing lists and other astrophysics lists (e.g. Chandra)
  - AAS, APS etc (town halls, special sessions, announcements in newsletters)
- **Enable and encourage participation from early career scientists**
  - Provide travel support for workshops
- **Proactively reach out to researchers at undergraduate serving institutions and minority serving institutions**
  - Formed a small focus group to get input on how Roman can best engage and support that part of our community

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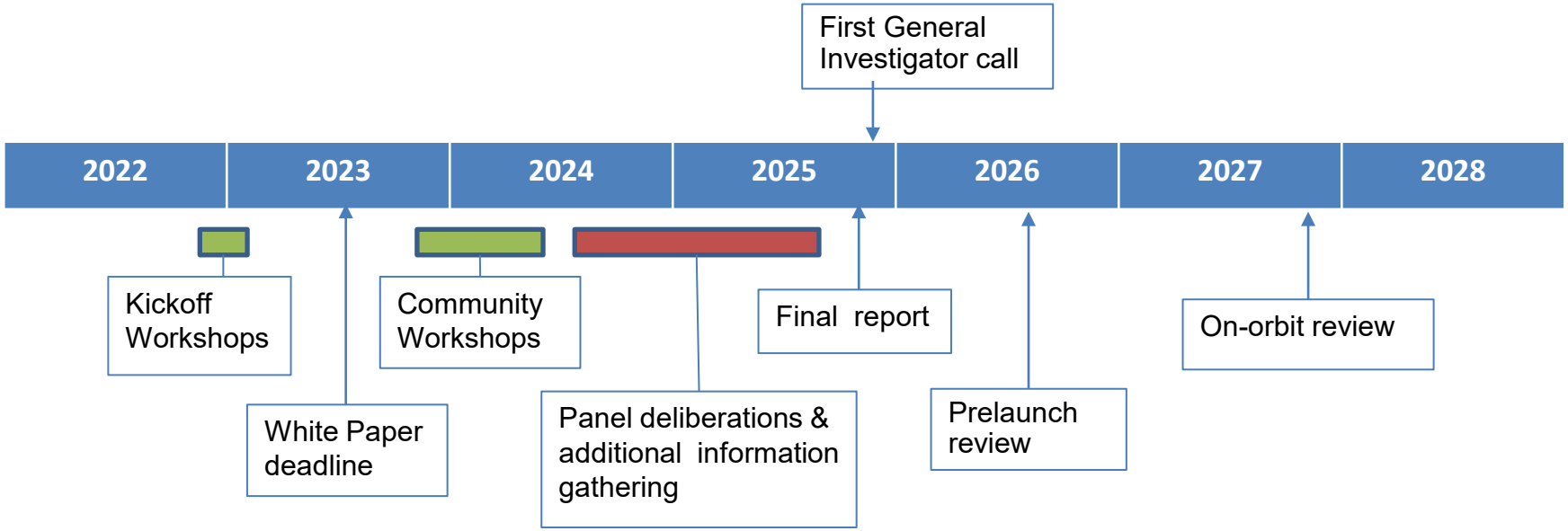
Evaluation and Recommendations

- **Set up and charter a committee structure to do the work of recommending survey definitions based on community input**
  - Individual survey committees (one for each of the core community surveys)
    - Solicit and incorporate additional community input via a variety of mechanisms (workshops, focused white paper calls, Town Halls, etc.)
    - Evaluate survey options against science metrics/figures of merit
    - Produce recommendations for survey definition with options for extensions/enhancements
      - Needs to be specific enough that it is clear how to implement
  - Top level Steering committee (comprising reps from the individual survey committees + advocates for general astrophysics surveys)
    - Provides recommendations on balance between the various core community surveys and the general astrophysics survey program

Notional Timeline



New Roman Science Teams and Community Support

- **Roman Science investigation team contracts ended in 2021**
- **Draft ROSES Solicitation for new teams/community support will be released within the next two weeks**
- **What are we trying to achieve**
  - Variety of award sizes and durations
  - Multiple funding opportunities between now and launch for support for people at US institutions to work independently or with existing science teams
  - Longish term stable support of teams to allow development of software/pipelines etc
  - Ability for people to engage with Roman project/science teams independently of funding

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Three Opportunities

- **Wide Field Instrument Science**
  - This opportunity provides support to prepare for and enhance the science return of *Roman* that can be addressed with its Wide Field Instrument (WFI).
    - Multiple calls between now and launch
    - Regular and Large categories
- **Infrastructure Teams**
  - This opportunity provides sustained funding for teams to develop infrastructure needed to enable the community to pursue *Roman*'s ambitious science goals in cosmology and exoplanet demographics that are part of Roman's mission success criteria.
    - Additional science areas that require extensive and sustained infrastructure development will also be considered.
- **Coronagraph Community Participation Program (CPP)**
  - This provides an opportunity for proposers to work with the coronagraph instrument team to plan and execute its technology demonstration observations.
    - Multiple calls between now and launch

Wide Field Science Proposals

- ***Preparing for and enhancing* Roman *WFI Science***
  - Can include, but are not limited to, any combination of the following topics:
    - Precursor observations using ground- and/or space-based observatories to prepare for future *Roman* science observations and/or to provide calibration capability;
    - Development of *Roman* analysis software beyond that provided by the Science Centers. This could include topics like machine learning techniques in time domain astrophysics, high precision astrometric measurement techniques, etc.;
    - Development of algorithms for joint processing with data from other space- or ground-based observatories such as deblending algorithms, photometric redshift training and calibration, or forced photometry;
    - Theoretical and/or phenomenological modeling directly related to Roman capabilities;
    - Instrument calibration and characterization;
    - Development of survey strategies;
    - Development of simulation tools, producing simulated datasets, and conducting or participating in data challenges.
- ***Supporting the* Roman *project and Science Centers***
  - WFS supported teams are expected to form part of the funded Roman science community providing support and guidance to the Roman project and science centers.

Science Team Community Briefing (Nov 15-19)

- https://roman.gsfc.nasa.gov/science/workshop112021/

- **Each WFI science investigation team organized a session**
  - Survey optimization and considerations
  - Simulations
  - Quantitative evaluation of broad range of science questions
  - Precursor observations (and results!)

- **Also reports from Calibration and detectors working groups**

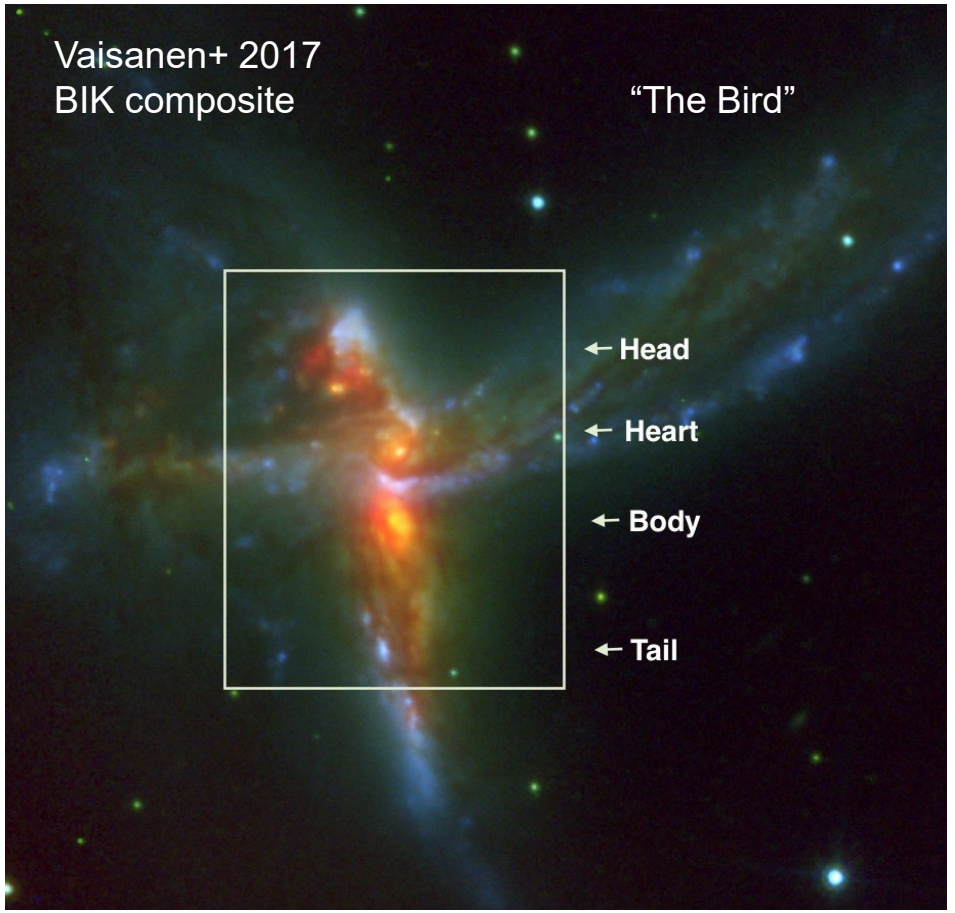
- **Excellent attendance**
  - Several hundred people over the course of the week

- **Supported by SOC/STScI**
  - Hosting virtual meeting, moderating sessions, recording archiving talks

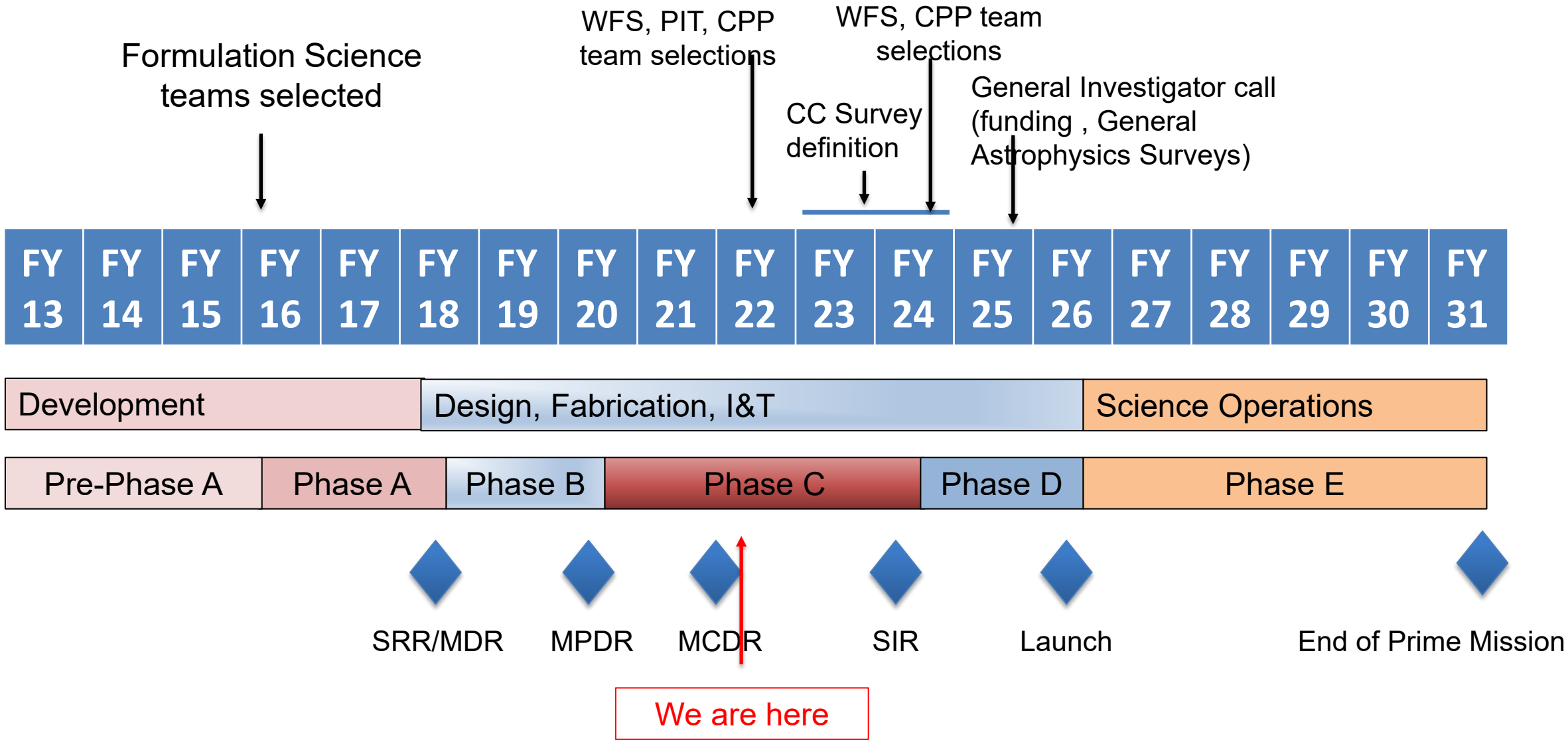
Meetings, Workshops and Conferences

- **Exploring the Transient Universe with the Nancy Grace Roman Space Telescope (Feb 8-10)**
  - Lots of excellent talks
  - Discussions on how to optimize the core community surveys
- **Joint Processing Splinter Session (Jan 11)**
  - Largely science focused discussion of benefits/needs for joint Roman-Rubin-Euclid analysis
  - Originally planned to be in-person at AAS
- **Cosmology with the Nancy Grace Roman Space Telescope (Jan 27)**
  - Discussed each of the core cosmology investigations, followed by a panel discussion exploring other cosmology probes with Roman

Transients from Ultra Luminous Infrared Galaxies (ULIRG) (Tom Reynolds)



Timeline


Formulation Science teams selected
WFS, PIT, CPP team selections
CC Survey definition
WFS, CPP team selections
General Investigator call (funding , General Astrophysics Surveys)
FY 13
FY 14
FY 15
FY 16
FY 17
FY 18
FY 19
FY 20
FY 21
FY 22
FY 23
FY 24
FY 25
FY 26
FY 27
FY 28
FY 29
FY 30
FY 31
Development
Design, Fabrication, I&T
Science Operations
Pre-Phase A
Phase A
Phase B
Phase C
Phase D
Phase E
SRR/MDR
MPDR
MCDR
SIR
Launch
End of Prime Mission
We are here

ROMAN SPACE TELESCOPE

The Road Ahead

- **Successful Mission Critical Design Review, Sept 2021**
  - Observatory design is complete, proceeding with building flight hardware

- **Opportunities to engage with Roman**
  - Monthly lecture series: https://roman.ipac.caltech.edu/Lectures.html
  - Planning to start monthly project status updates
  - Draft ROSES proposal call out in few weeks
  - Community process to define a General Astrophysics Survey kicking off Summer 2022 (if recommended by RFI evaluation committee)
  - Community process to define Core Community Surveys kicking off late 2022/2023

- **Astro2020**
  - Recommendation for non-advocate review of balance of observing time between core community surveys and general astrophysics surveys
    - Now ongoing with CAA subcommitteee

- **Exciting to see things coming together**