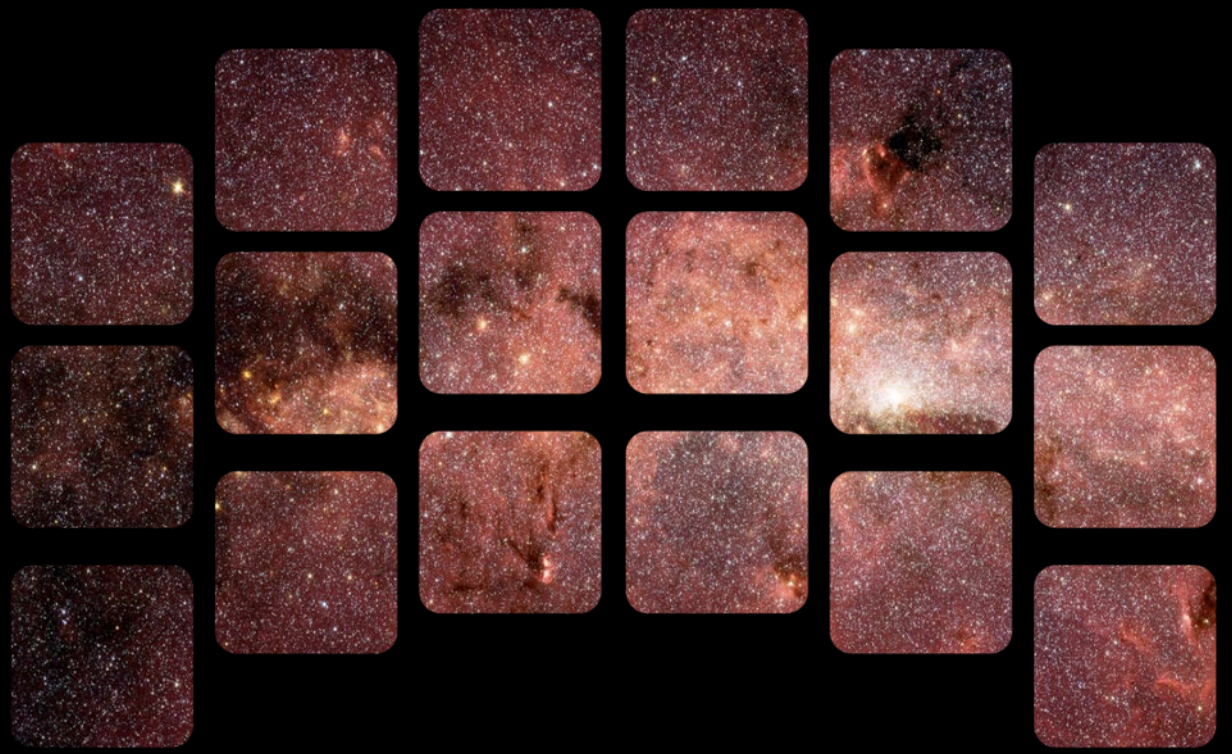
Project Status

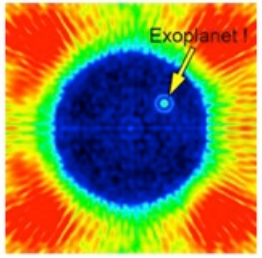
Julie McEnery
Roman Senior Project Scientist

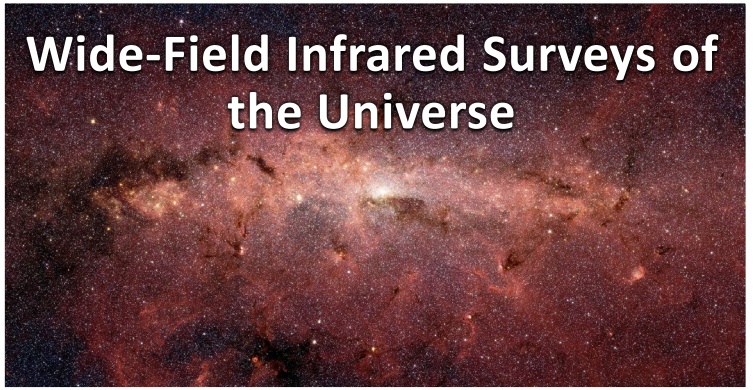


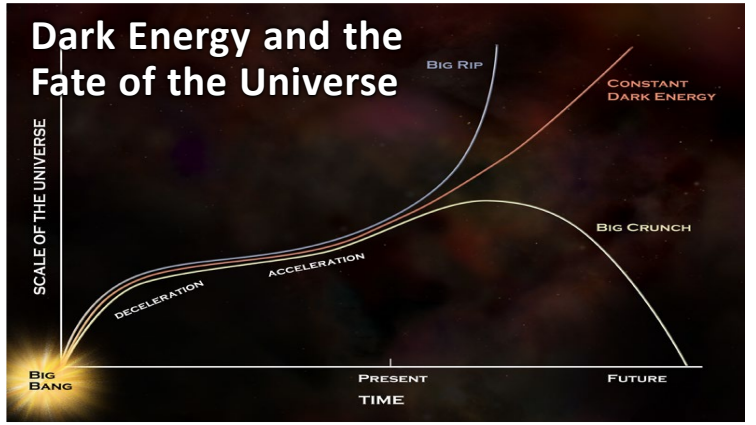
ROMAN
SPACE TELESCOPE

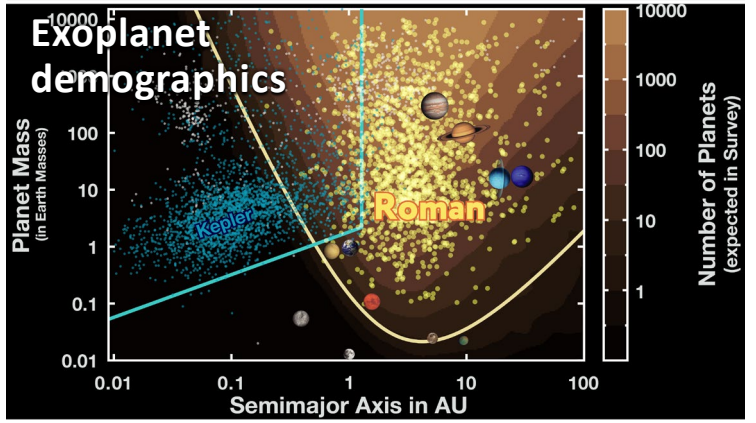
Roman Mission Objectives

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

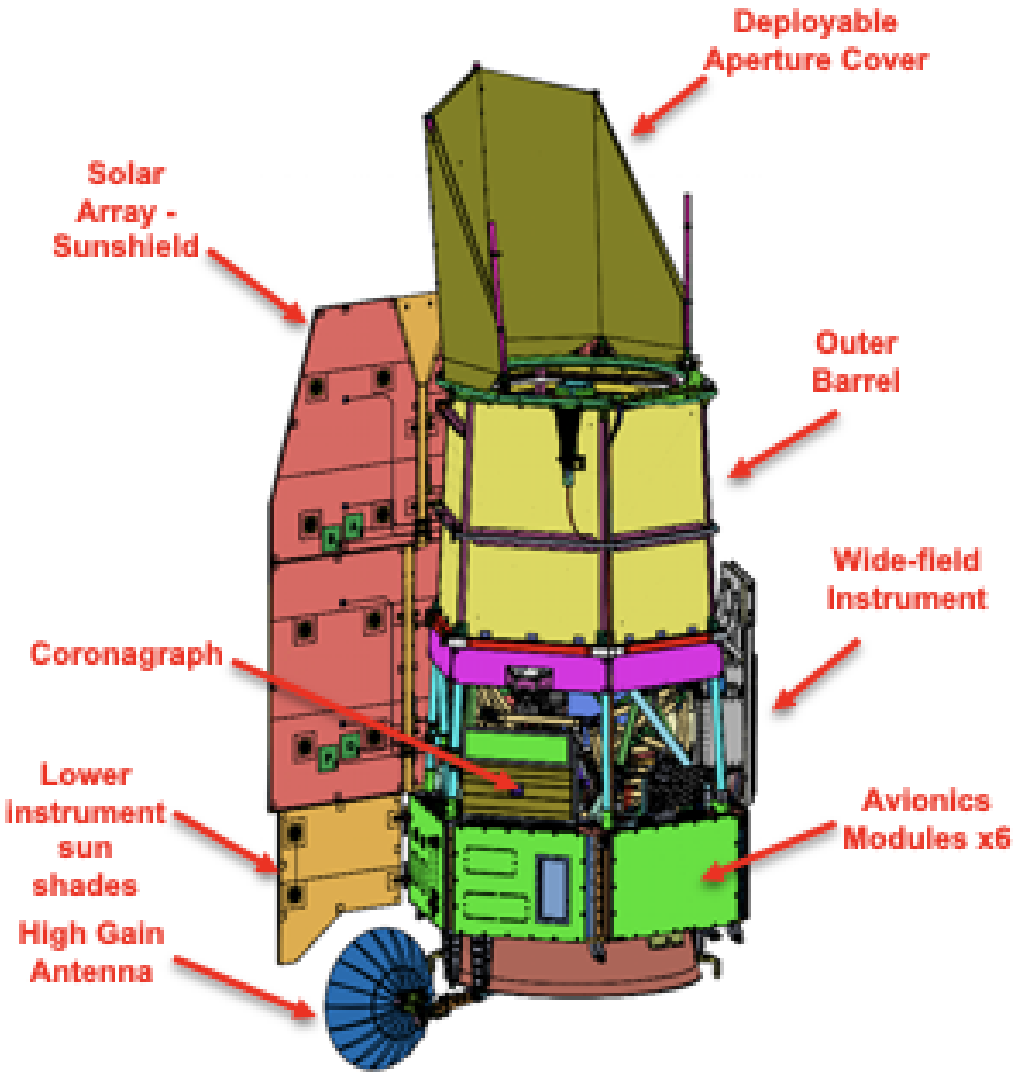








Roman Observatory and Instruments



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

Launch: before May 2027 (Currently working to Oct 2026)

Mission Duration: 5 yr, 10yr goal

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

ROMAN
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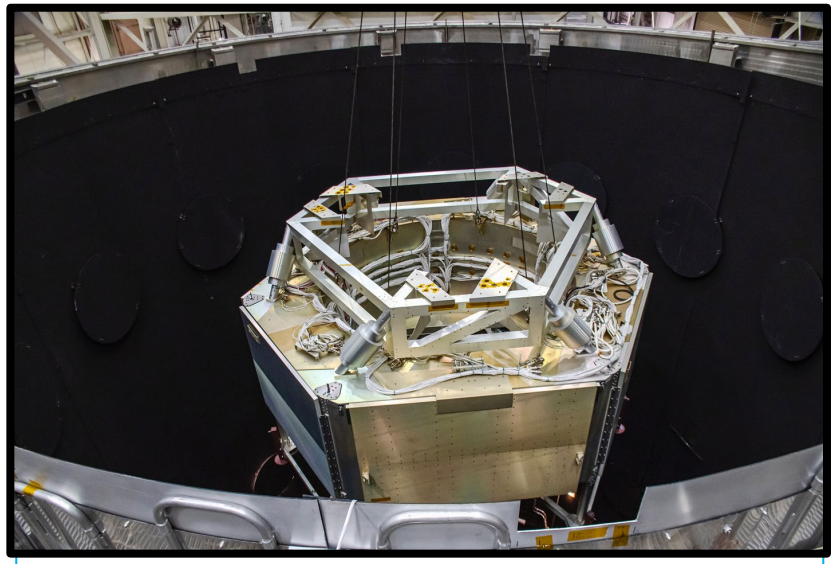
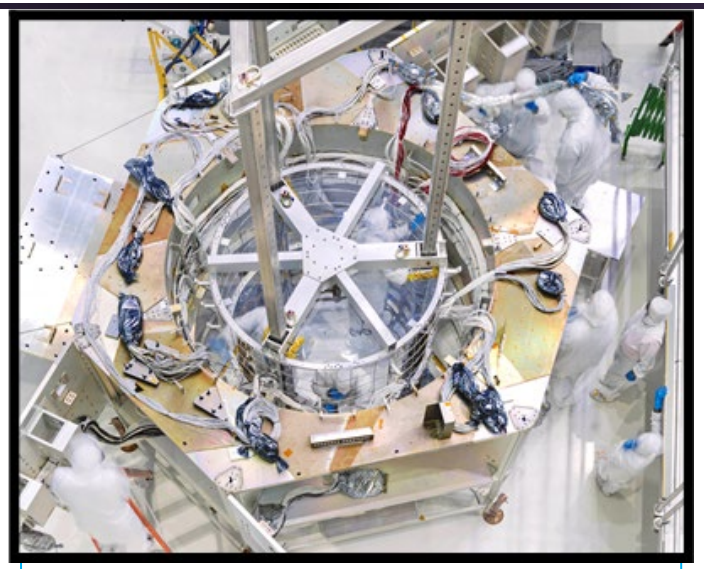
Spacecraft I&T Underway!

Spacecraft Highlights



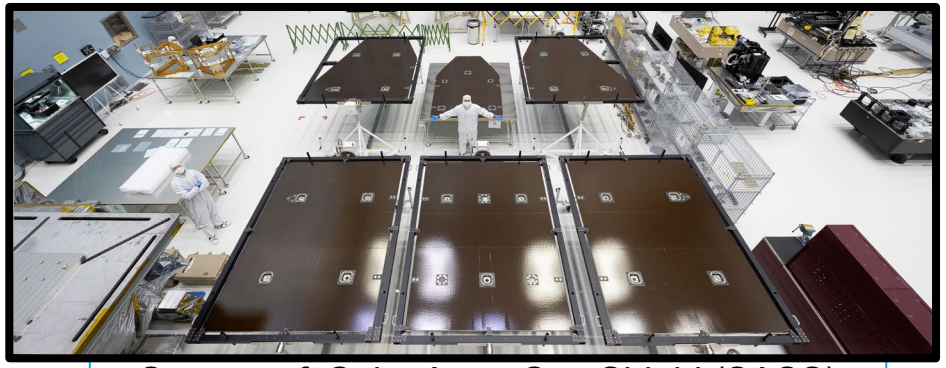
Spacecraft Bus flight harnesses (on mockup) completed bakeout ahead of schedule.



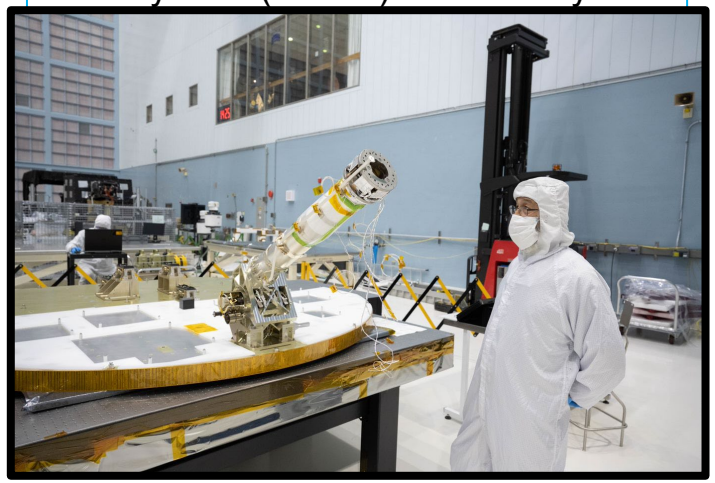
Flight harnesses being integrated into Spacecraft Bus

Spacecraft High Gain Antenna System (HGAS) – assembly

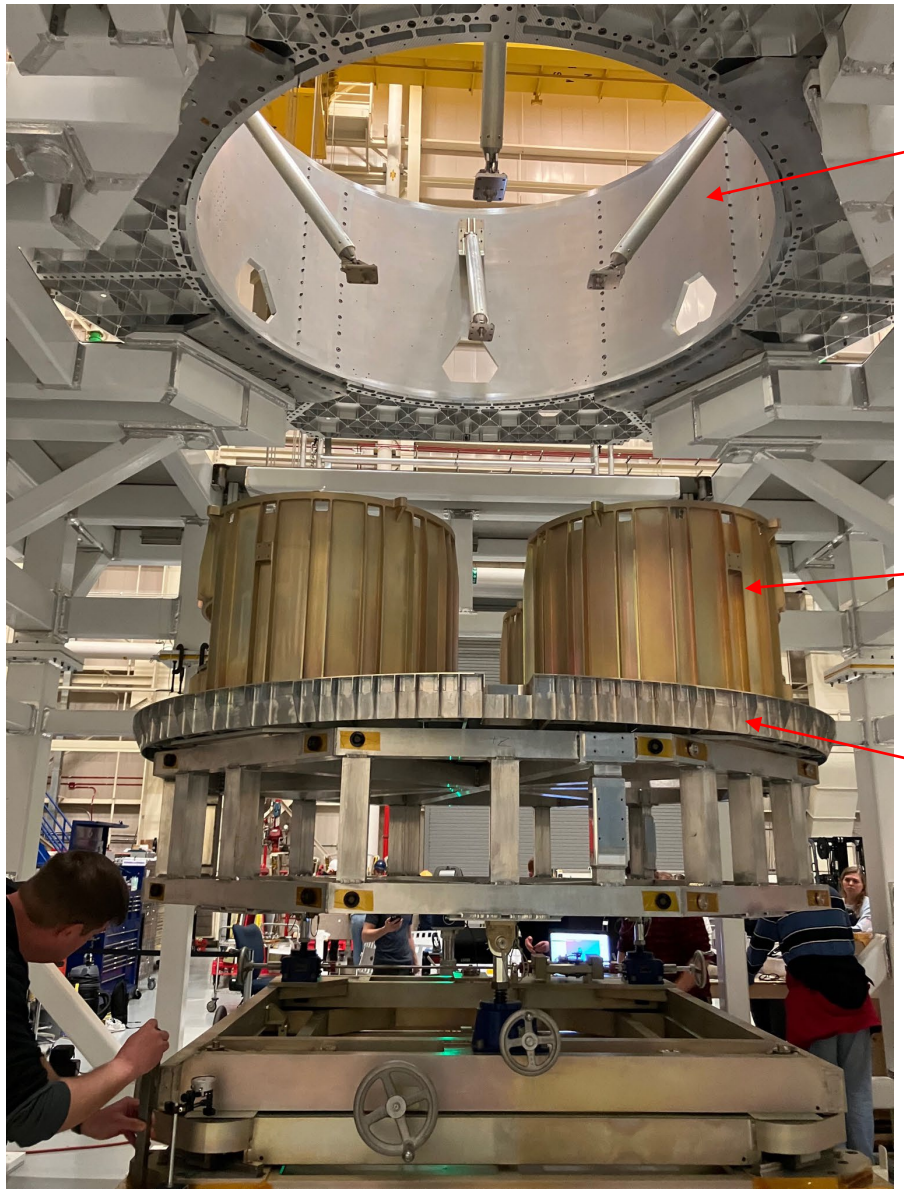
Prop Deck Subassembly Lift to Prop Support Frame in B11 High Bay



Spacecraft Solar Array Sun Shield (SASS) panels –
6 flight SASS substrate panels shipped to cell vendor in March for cell laydown



Spacecraft Fit Checks – Propulsion Deck to Bus (left) and Communications Panel to Bus (right)



Central cylinder of bus on Pantheon

Upper/Lower Skirts

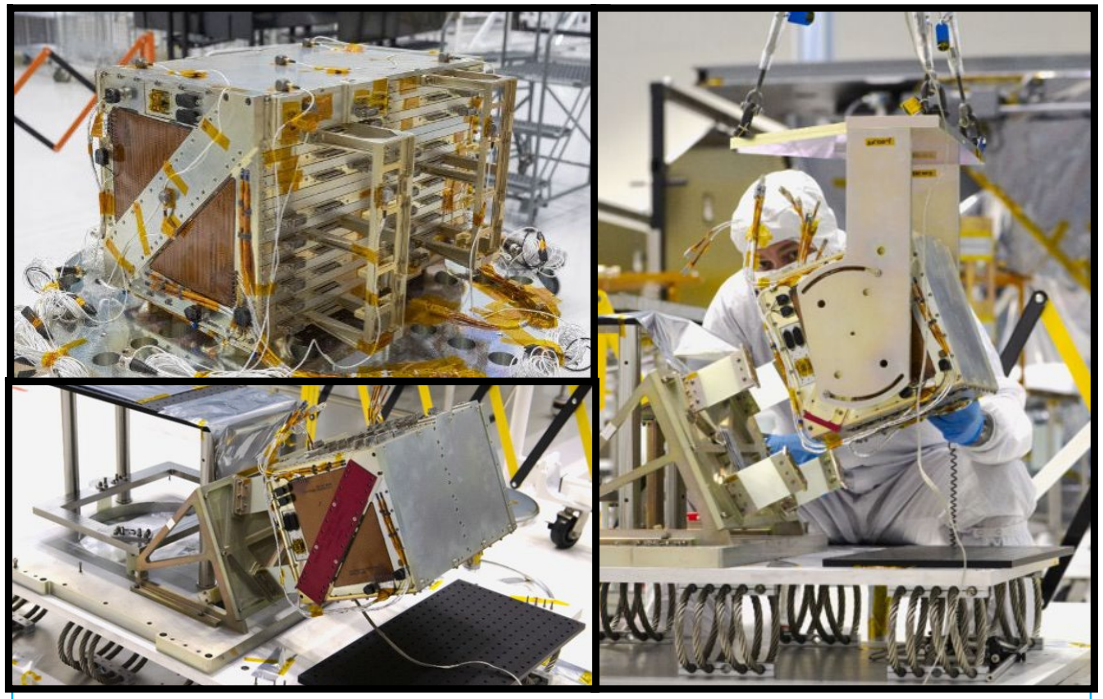
Tank stands

Comm Panel

Prop deck

Propulsion deck with tank stands being raised into central cylinder of bus – close-up (left), Communications Panel being raised up into central cylinder of bus (right)

Wide Field Instrument Highlights

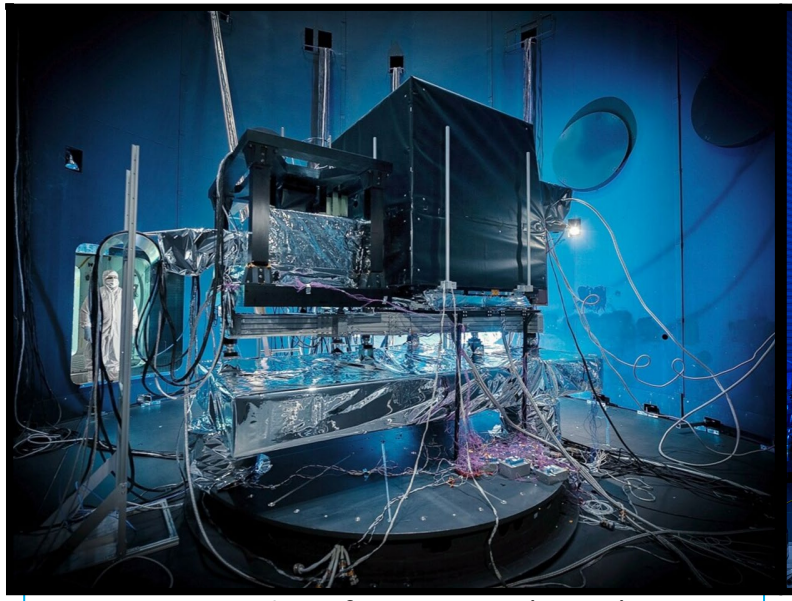


Focal Plane Electronics (FPE) assembly, thermal cycling, and vibration testing completed.

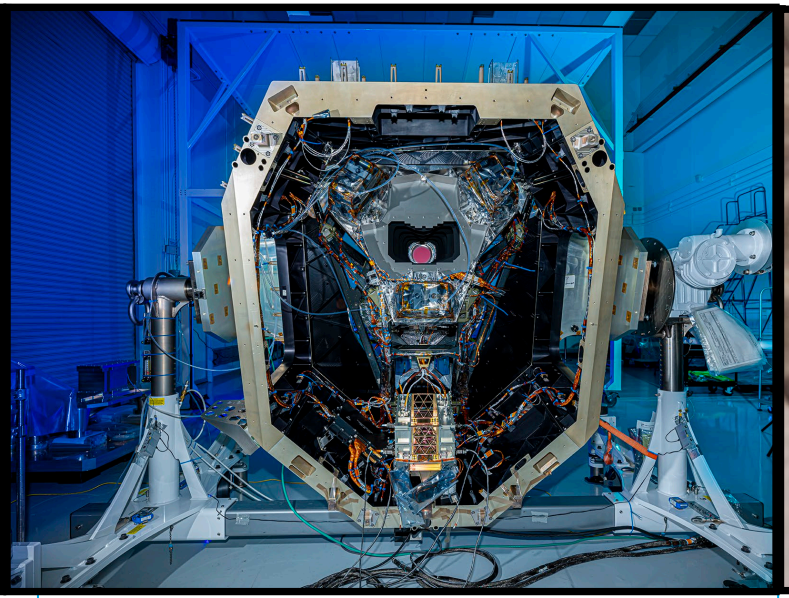
Digital Harness work completed

Focal Plane Assembly (FPA) after successful vibration testing. FPS assembly and thermal vacuum testing complete. FPS shipped to Ball in early May

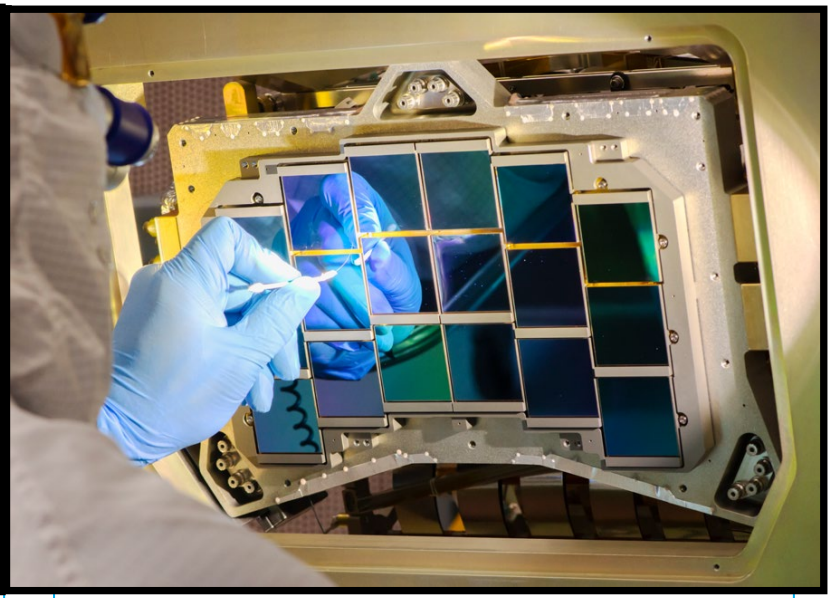
WFI Hardware Deliveries



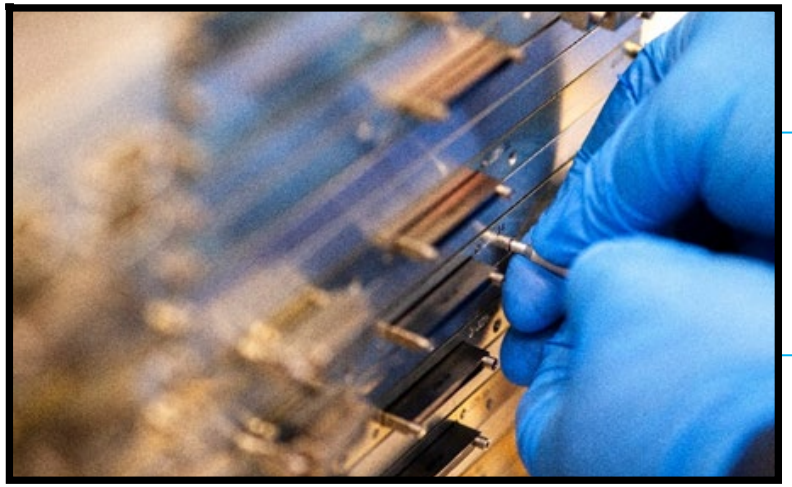
Stimulus of Ray Cones (SORC)
Delivered to Ball



Simplified Relative Calibration System (sRCS)
Delivered to Ball



Focal Plane Assembly (FPA)
Delivered to Ball



Focal Plane Electronics (FPE) Delivered to Ball

Goddard WFI Team

Coronagraph Updates

- 5 flight spare detectors from ESA in transit to JPL
- Avionics (control electronics)
  - Delivered: cameras and focus & tip/tilt control loops
  - 3 remaining elements will be delivered in June/July
    - **rework to fix bad DM control components is complete!**

Electronics Heat Transport Subsystem bakeout

- Roman's need date for Coronagraph extended to May 15, 2024 (Decision Memo in signature)
  - Restores funded schedule margin on *required* capability delivery
  - No cost or schedule impact to *Roman* I&T
  - Over Guide request to support extra time funded from HQ reserves;
  - limited-to-no *goal* capability pre-delivery testing; depends on evolution of funded schedule margin
- PPBE24/25 OG: flight-like Roman Coronagraph optical testbed at JPL
  - enable commissioning of goal capabilities *after* instrument delivery
  - unlock then full potential of Coronagraph's latent capabilities
  - OG would fund flight-like hardware purchases, supporting personnel

Budget and Schedule

- **No change to launch readiness date or budget since last APAC meeting**

Core Community Survey Definition

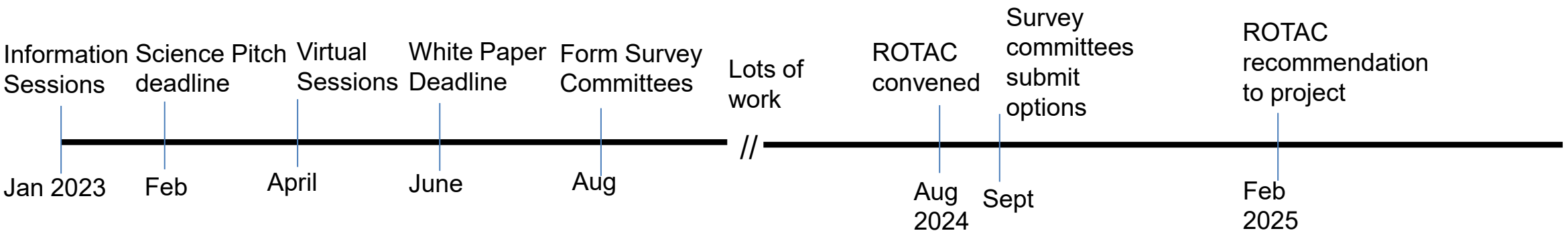
- **Goals:**
  - Provide observations needed to enable mission science objectives in cosmology and exoplanet demographics
  - Maximize science return
  - Ensure breadth of science and community across all surveys
  - Maximize community engagement and input in definition of surveys
  - Establish a transparent 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 review plans with our advisory committees.

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

Core Community Survey Definition



- **Science pitches – few para description of science case for core survey – Done!**
- **White paper – more detailed description of science case, metrics and envelope of needs – Done!**
- **Survey committee for each core survey with expertise representative of broad science return**
  - Extensive community and science team engagement to identify 4 point designs: minimum, underguide, baseline and overguide
- **Roman Observations Time Allocation Committee has expertise relevant to each core survey and general astrophysics surveys**
  - Makes a recommendation of each core survey, and time allocated to general astrophysics surveys
- **Final survey definitions at least 18 months before launch**
- **First General Investigator proposal call release 1 year before launch**

Core Community Survey Definition progress

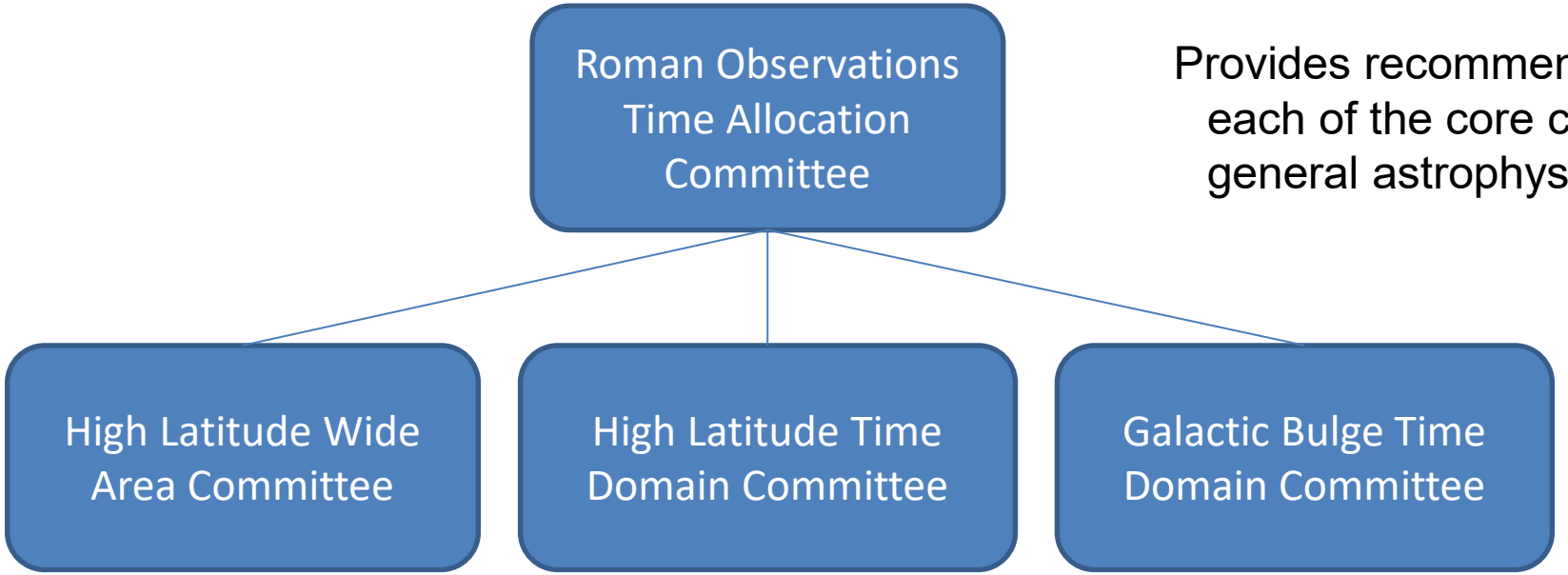
- **Held 6 virtual sessions (two for each survey)**
  - Discussed what should be in the white papers
  - Short presentations of some of the science pitch ideas

- **72 white papers received**
  - 23 Galactic Bulge Time Domain Survey
  - 36 High Latitude Wide Area Survey
  - 23 High Latitude Time Domain Survey

- **Next Step – form the survey committees**
  - About to issue call for self nominations

Peer process to define and review survey plans

- **Set up and charter a tiered committee structure to do the work of recommending survey definitions based on community input**
  - Committees include representatives of all science areas to be addressed by each survey (determined from white paper submissions etc)



Provides recommendations on balance between each of the core community surveys, and the general astrophysics survey allocation above 25%

Evaluate white papers, solicit additional community input, evaluate survey options against science metrics, produce recommendations for survey with options for enhancements/descopes

Principles in Forming Community Survey Definition Committees

Strive to represent both the breadth of science the community wants to see done with Roman's surveys (guided by science pitches and white paper submissions) and the diversity we want to see in Roman's future user base

Keep committees to a size that is functional, and in which all members will feel responsibility and ownership of the committees' work

Ensure committee members

- ➔ Have a community-oriented mindset
- ➔ Have significant scientific, technical, or community-building expertise relevant to the work of defining a core community survey
- ➔ Are prepared and able to do significant work

Form committees as soon as is feasible

Early Survey Definition Call

- **Issued a call for white papers to provide science case for defining one of the General Astrophysics surveys early**
  - Up to 1 month survey to be executed within the first two years of the mission
    - Allows for a substantial survey but doesn't lock down early observations
  - Survey will be defined via community process (similar to the core surveys), no PI
- **Review panel convened, meets biweekly**
  - Goal is for them to 1) recommend whether to proceed with an Early Definition Survey and 2) rank survey options (NOT white papers)
  - The panel have discussed each white paper, next meeting with focus on recommendations
- **Survey options (determined based on topics in received white papers)**
  - Deep field (0.3-1 sq. deg, depth of ~30 mag) **(+grism)**
  - Intermediate depth/wider area survey + enabling synergy with other facilities (~20-50 sq. deg, ~27 mag)
  - Survey enabling observation of Solar System small bodies
  - High time cadence, small field of view survey
  - Galactic Plane survey
- **Expect recommendation within 1-2 months**

Roman WFI Observations and TDAMM

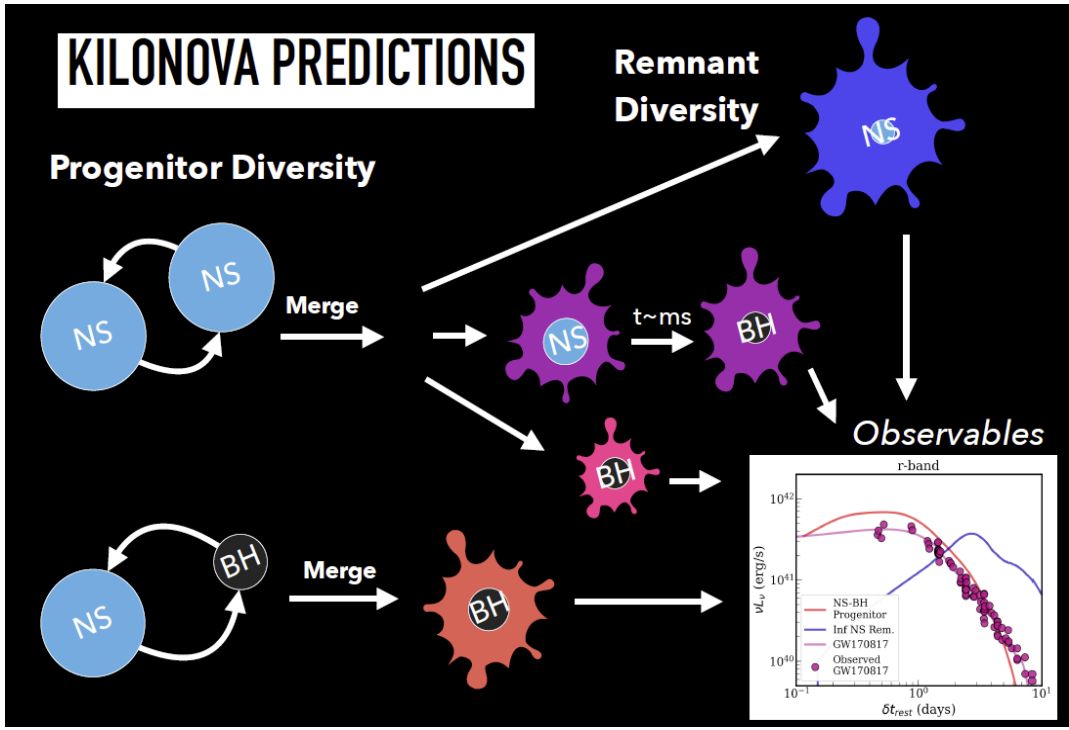
- **Three Core Community Surveys address the 2010 Decadal Survey science goals while providing broad scientific power**
  - **High Latitude Wide Area Survey**
    - Wide area multiband survey with slitless spectroscopy, at least two observations per field
  - **High Latitude Time Domain Survey**
    - Tiered, multiband time domain observations of 10s deg^2 at high latitudes, ~5 day cadence
  - **Galactic Time Domain Survey**
    - ~<15 min cadence observations over few deg^2 towards galactic bulge
- **Minimum 25% time allocated to General Astrophysics Surveys**
  - Anything that people come up with, including TDAMM relevant observations

All three Core Community Surveys and GA Surveys enable TDAMM!

High Latitude Time Domain Survey

Slide from Jillian Rastinejad

- **Blind search for Kilonova**
  - Roughly same rate of discovery as Rubin but to much higher redshift (important as GW detector horizon increases)
- **Stellar mass BBH Mergers in AGN disks**
  - Motion of the remnant black hole through the AGN disk can trigger a bright flare on timescale of days-months 20-500 days after LVK trigger
- **Unique discovery space for transients**
  - Deep, infrared, timescales of days
- **>10000 supernova discoveries**
- **Tidal Disruption Events, orphan GRB afterglows etc**

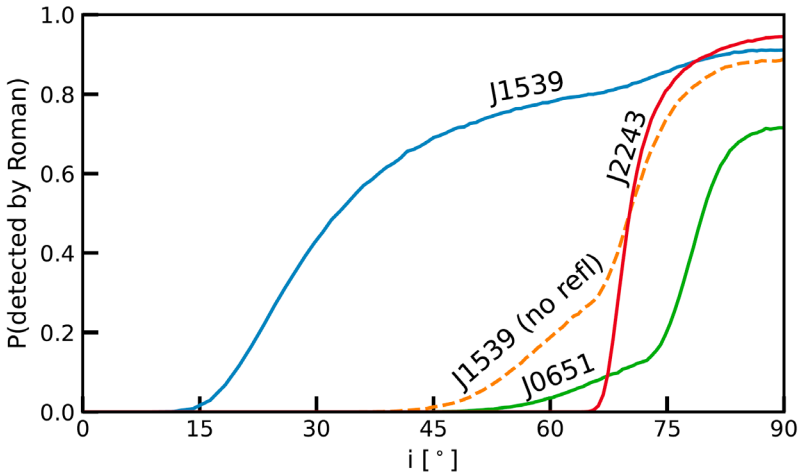


High Latitude Time Domain Survey

- **Monitor ~10^5-10^6 AGN out to z<6 and look for 5-12 day periodicity.**
  - This would uncover precursors to LISA sources, and provide constraints on LISA source population and hosts
- **AGN variability**
  - Long term, even monitoring of blazars – candidate counterparts to neutrino events
  - Reverberation mapping to probe geometry of torus

Galactic Bulge Time Domain Survey

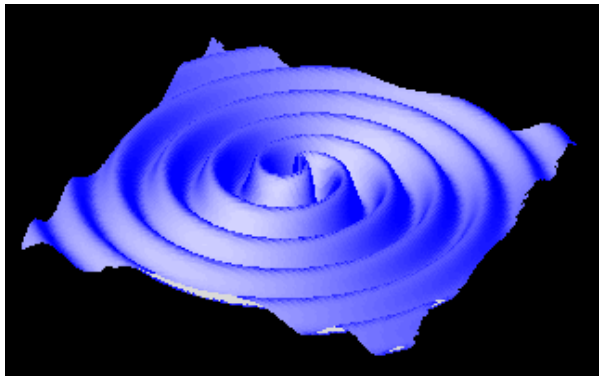
- **Short-period Galactic white dwarf binaries**
  - the only guaranteed persistent sources for multi-messenger gravitational wave astronomy. Roman will discover a sample of binary systems that are also detectable by LISA. Early identification of these targets by Roman will predict and optimize multi-messenger science yield achievable in concert with LISA

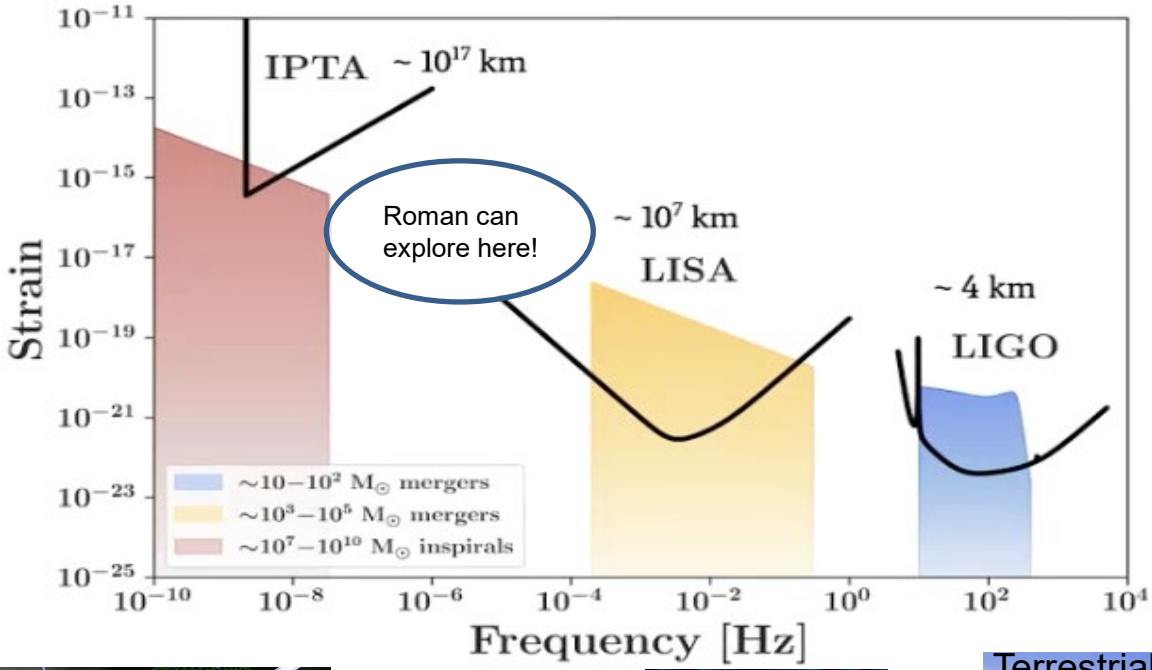


Roman detection probability vs inclination for three benchmark binary systems at the distance of the galactic bulge. Digman & Hirata 2023

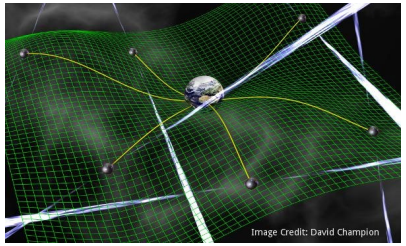
- **Monitor the galactic center for flares/outbursts**
- **LOTs of non MM TDA**
  - Asteroseismology
  - Exoplanet detection via microlensing and transit techniques – connections to HWO
  - High time cadence observations of things behind the galactic bulge – SN, AGN etc

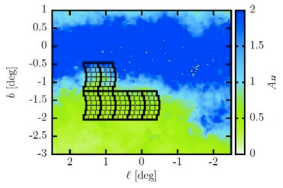
Galactic Bulge Time Domain Survey as GW detector

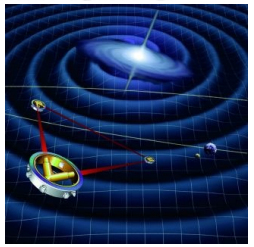




Galaxy sized







- **Roman observations of correlated stellar motion of stars in the galactic bulge can be used to detect gravitational waves in the gap between galaxy coverage of pulsar timing arrays, and LISA**

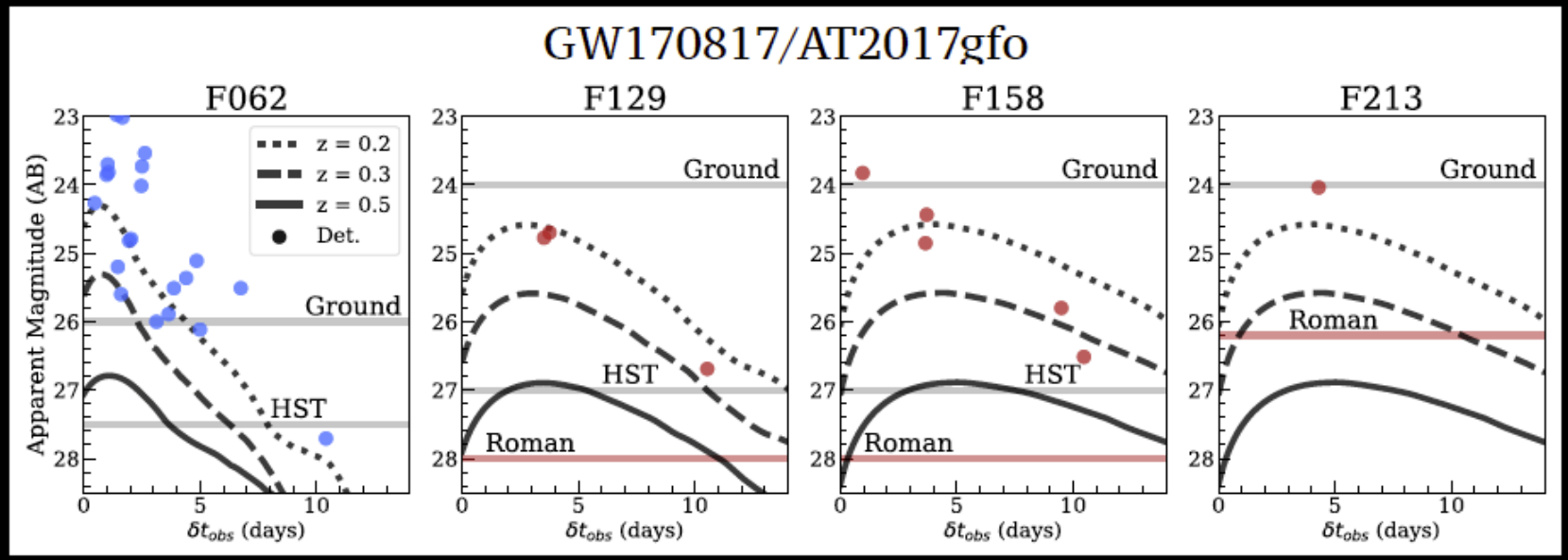
Wang et al, 2022

GA Surveys – Target of Opportunity observations

Roman's Wide Field Instrument Is Uniquely Poised to Observe the Diversity of Red KN Components

Filters	F062	F087	F106	F129	F146	F158	F184	F213
Wavelength (μm)	0.48-0.76	0.76-0.98	0.93-1.19	1.13-1.45	0.93-2.00	1.38-1.77	1.68-2.00	1.95-2.30
Sensitivity (5σ AB mag in 1 hr)	28.5	28.2	28.1	28.0	28.3	28.0	27.5	26.2

https://roman.gsfc.nasa.gov/instruments_and_capabilities.html



- Roman will have outstanding ability to identify kilonova in follow up observations of gravitational wave and GRB triggers
  - Sensitivity in the near-IR and ability to survey large regions
- Roman will also find kilonova in blind searches of data from the high latitude time domain survey
  - But we need to know what filters, cadence, , spectroscopy will enable discovery and identification

Slide by Jillian Rastinejad

Roman and observatory capabilities

- **All Roman data is immediately publicly available**
- **Latency requirements are <48 hours for level 1-3.**
- **Catalogs, final calibrated data within 6 months of receipt of last relevant data**

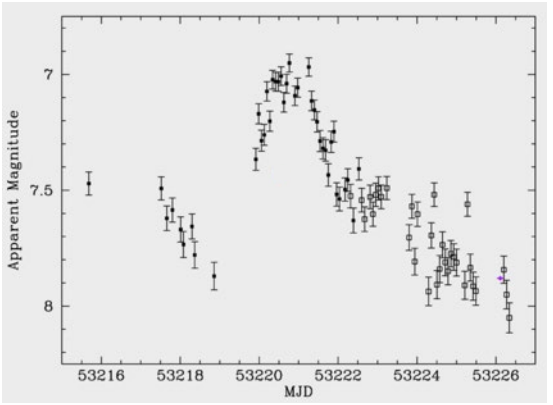
- **TOO requirement – within two weeks of receipt at the SOC@STScI**
  - In principle possible to reduce this to ~1-2 days by adding additional staffing

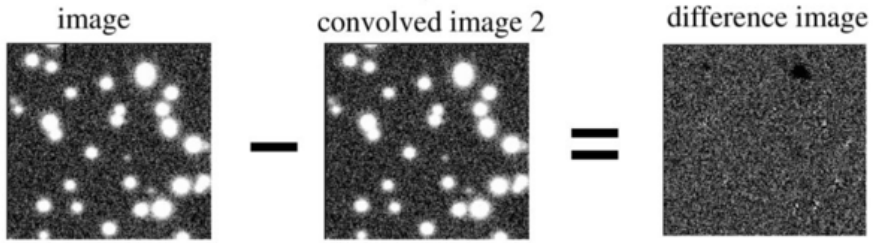
GBTD Survey Data Products and Availability

- **Data products available via Roman archive**
  - Daily during survey seasons
    - Per epoch (~15 minutes) PSF and difference image photometry for ~200 million objects
  - Every 8 days
    - Updates to reference image and object catalog, including position and FWHM
  - End of season
    - Reprocessing of photometry with updated calibrations and object catalog
    - Metrics for variable objects
    - Microlensing event catalog
  - End of survey
    - Reprocessing of photometry and event analysis
    - New versions of daily/8 day/end of season products
    - Pipeline detection efficiency metrics and simulated inputs

Catalogs: Variability (non-bulge fields)

- **To be run in the pipeline to satisfy the requirement for time-domain information for variable sources**
- **Photometry-based variability catalogs**
  - Inputs
    - Release-level merged survey catalogs
    - Individual images (level 2 or level 3)
  - Operations
    - Compare flux in static catalog to fluxes in individual images
  - Outputs
    - Database of the individual-image photometry for the entire su
- **Difference-imaging variability catalogs**
  - Inputs
    - Individual rectified images that overlap spatially
  - Operations
    - Convolve with PSF-matching kernel if needed
    - Subtract a template constructed from all but the most recent image
    - Identify point-sources in the difference above a threshold
  - Outputs
    - Level 4 catalog of sources that exceeded the threshold along with associated metadata





Roman as a Time Domain Mission

- Roman has adjusted its science planning to elevate the level of support for time-domain astronomy in response to Astro2020 starting in FY24

- Roman's Project Infrastructure Teams associated with time-domain astronomy are planning on:
  - Enabling rapid image differencing
  - Providing prompt variable/transient alerts to brokers within ~24hrs of processing
  - Supporting light curves, photometry, moving object identification, catalog production
  - Developing tools to classify various transient phenomena
  - Developing tools to enable time series Roman photometry from external triggers

Roman and DEIA Initiatives

- **Demographics**
  - There are a lot of people working on the Roman project
    - >1000 people across GSFC, JPL, STScI and IPAC with a broad range of roles: Scientists, engineers, managers, project support specialists, technicians, science writers etc

Community Engagement – open access

- **Roman is a survey mission with no proprietary period on science data**
  - Everyone gets access to data at the same time!
  - Each observation has a broad range of science applications
- **Roman's Science Platform and model of doing analysis in the cloud provides broad access to computing**
  - Minimize barriers for people at institutions without access to significant local computing
- **The bulk of Roman's observing time (core community surveys) are community owned and defined**

New Roman Science Teams and Community Support

- **Roman Science investigation team contracts ended in 2021**
- **ROSES selections recently announced**
- **What are we trying to achieve**
  - Variety of award sizes and durations
    - Lower barrier for early career scientists
  - 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

Engaging with Undergraduate Serving Institutions

- **Formed a focus group of faculty from undergraduate serving institutions to better understand challenges and barriers to engaging in Roman**
  - Heavy teaching load means that
    - Timing of calls is extremely important, because there are times of year where it is impossible to work on proposals or white papers
    - Difficult to work on projects that require a sustained effort across the year, and/or rapid responses. Can be easier to work on independent topics as part of a larger collaboration
      - This may be eased once we form the science collaborations
  - Discussed how to support undergraduate research
    - Added optional addendum to support undergrad research as part of the Roman ROSES proposal call
      - Might extend this to have the addendum written by undergrads in the next call

Three Opportunities in Recent Solicitation

- **Wide Field Instrument Science**
  - Support to prepare for and enhance the science return of *Roman* that can be addressed with its Wide Field Instrument
    - Multiple calls between now and launch
    - Regular (2 years, up to $150k/year) and Large (4 years and ≲$500k/year) categories
    - Option for undergraduate research addendum
- **WFI Project Infrastructure Teams**
  - Sustained funding for teams to work in partnership with the science centers to develop infrastructure needed to enable the community to pursue *Roman*'s ambitious science goals in cosmology and exoplanet demographics
    - Additional science areas that require extensive and sustained infrastructure development will also be considered.
- **Coronagraph Community Participation Program**
  - Opportunity to work with the coronagraph instrument team to plan and execute its technology demonstration observations.
    - Multiple calls between now and launch

Engaging with Roman-WFI

- **Technical working groups that cut across all science areas**
  - Forum for people to work together on topics/methods that cut across science areas
  - Brings together Science community, science centers, and project
  - Have been very successful over past 5 years, will update group structure later this year
  - Established Code of Conduct

- **Community-led Science Collaborations**
  - Enable people to engage with Roman science independently of NASA-selection
  - Facilitate the formation of quasi-independent community-led collaborations with rotating leadership
  - Supported by Science Centers and Project Infrastructure Teams
  - Start with 3 collaborations, each of which will have working groups for specific science areas

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CPP DEIA considerations

- **US CPP competed via ROSES as ~6 small proposals, not 1 large team**
  - decrease ‘gatekeeping’
  - lower barrier to entry for early career PIs
  - more engagement beyond Pasadena/Baltimore/DC hubs
- **Expanding engagement:**
  - 4 international partner reps (CNES, JAXA, MPIA, ESA)
  - Participate in institutional URG/MSI-targeted student internship programs
- **After CPP is assembled, will collaboratively develop:**
  - code of conduct
  - collaboration/mentorship opportunities for postdocs and students
- **Coronagraph Instrument team (incl. CPP) expectations**
  - work collaboratively toward team goals
  - avoid flag planting and gatekeeping

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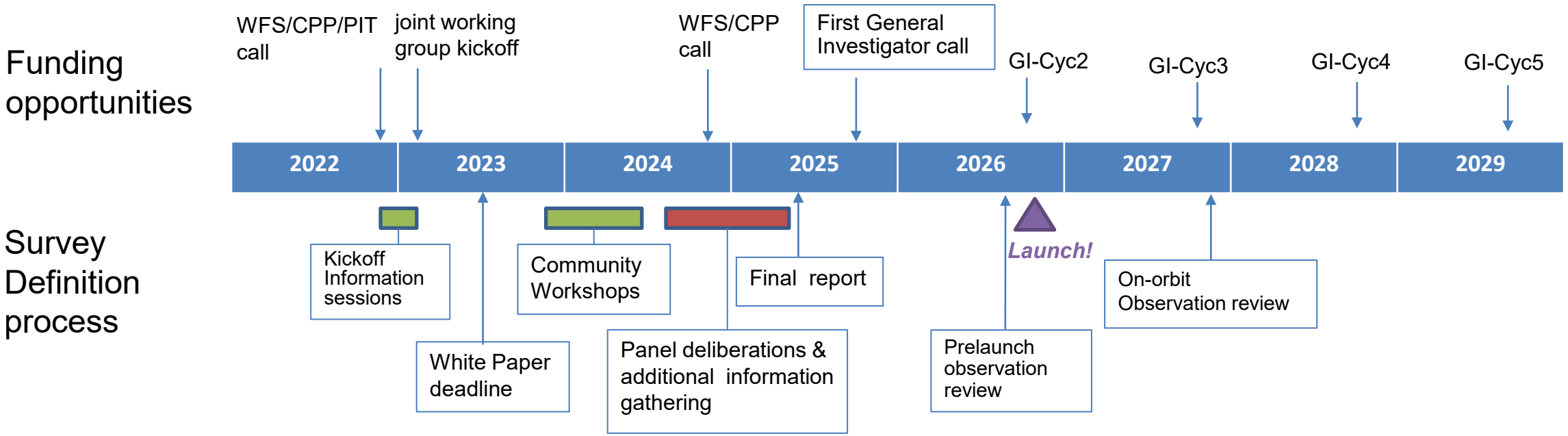
What's different from what we did before?

- **Larger number of small teams/individuals, many on short term**
  - Greater turnover, more flexibility to adjust science team to evolving science landscape and project needs
  - Multiple opportunities for new people to join
- **WFI Project Infrastructure Teams with long term baseline**
  - Expectation of continuing through to end of prime phase
  - Provides continuity and enhanced support to the community
- **Strong emphasis on science community coordination that is independent of the individual selected proposals**
  - Community-led Science Collaboration
  - Reset structure of joint working groups (keeping the ones that work well)
- **Undergrad supplement for WFS**
- **ROSES solicitation in ~2 years**
  - Additional CPP and WFS opportunities

The Road Ahead



- **Roman progressing; remains within cost & schedule commitments**
- **For more information**
  - https://roman.gsfc.nasa.gov/engaging_with_Roman.html

Plan for Forming Community Survey Definition Committees

Fill committee seats through a combination of:

- ➔ Self-nominations
  - call to be released and broadly advertised upon announcement of ROSES team selections
  - call will describe
    - expectations for and anticipated activities of the committee
    - timeline over which committees will be active
    - support that the committees can expect
  - will consist of a cover letter + short form CV, covering
    - motivations for joining committee
    - what they would expect to contribute to the work of committees and what level of effort they could support, without requiring any specific minimum level of effort
    - their scientific, technical, or community-building experience relevant to the work of defining the survey
  - we plan a 3 week turn-around for the deadline
- ➔ Identifying highly qualified members of community who have shown significant interest in Roman and its surveys

Plan for Forming Community Survey Definition Committees

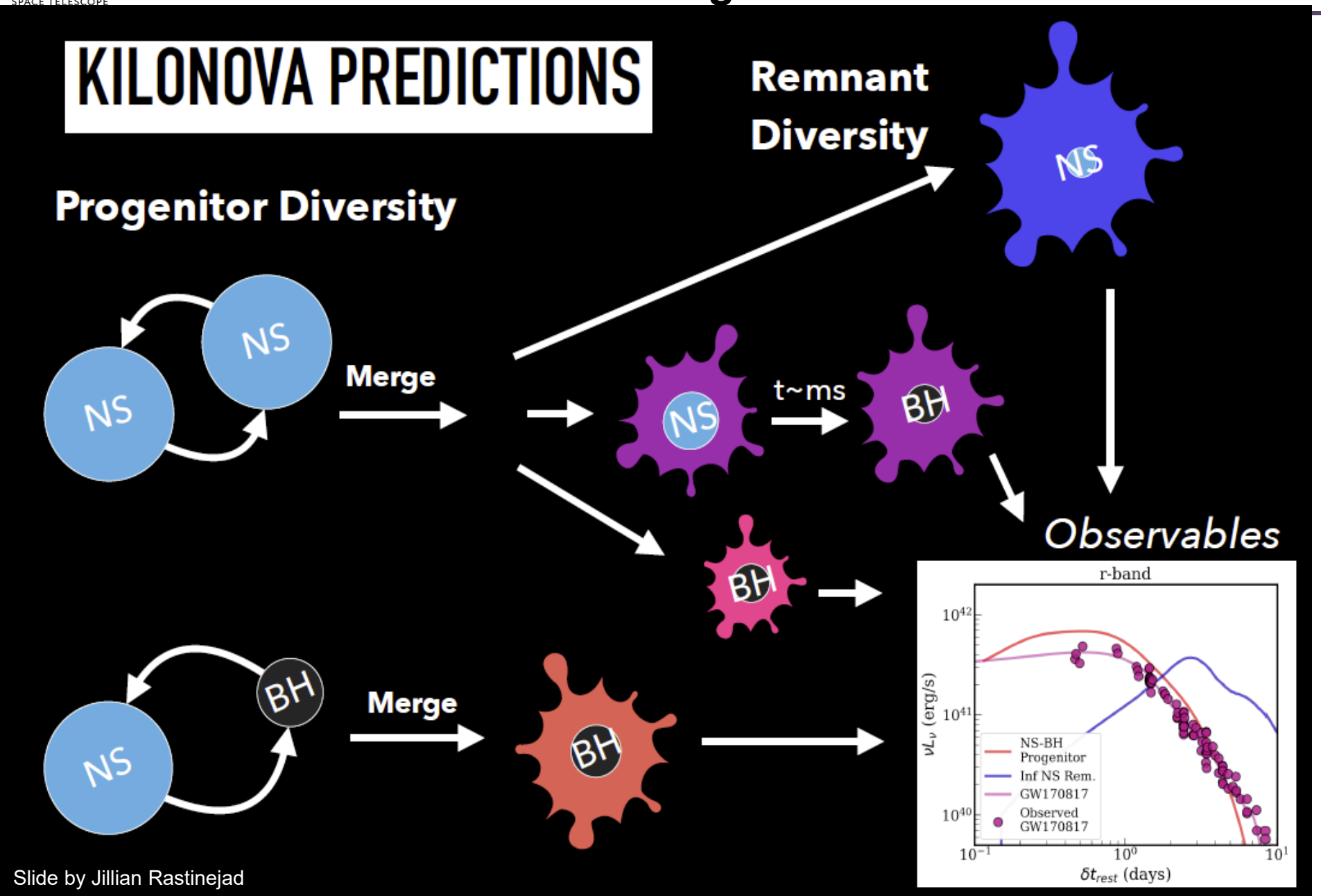
Identify chairs of committees first; work in consultation with chairs to identify membership

- ➔ Aiming for sizes of ~8 to 15 members for each committee
- ➔ Starting on smaller side, so there is room for committees to identify if they feel they are missing particular expertise

While we will strive for balanced and diverse committees, we do not generally intend to place any quotas or minimums on committee membership across any specific groups (e.g., career stage)

Roman Observations Time Allocation Committee will be formed at a later date

Merging neutron stars and nucleosynthesis – aka where does gold come from?



Slide by Jillian Rastinejad

Project Infrastructure Teams

- The APAC requests additional conversations with Roman regarding the stand-up of infrastructure teams, especially those with focus on pipeline and user-tool software architectures

- Proposal deadline was March 21, anticipate team selection by Summer
  - Since we haven't yet reviewed the proposals and selected the teams, we can't yet talk about specifics

- However, it is useful to discuss coordination of pipeline and software development

Roman pipelines and software

- **Science centers – SOC@STScI and SSC@IPAC are responsible for production pipelines, user tools and associated architecture**

- **The SOC and SSC jointly run the Roman software and pipelines working group**
  - Open to Roman science community

Response to CAA report on Roman Observations

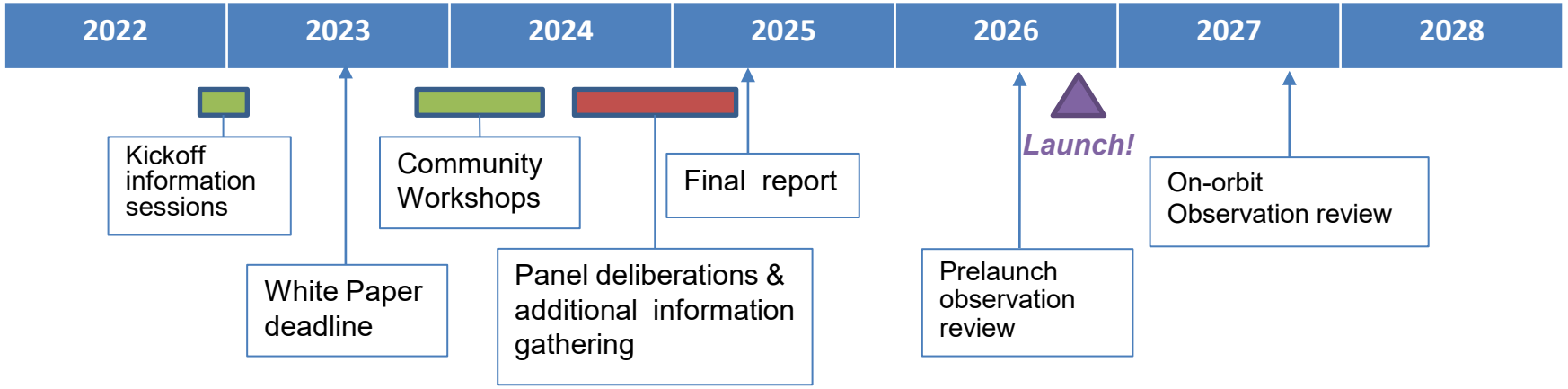
- **Committee of Astronomy and Astrophysics Report on Roman Space Telescope Observations**
  - Provided a set of 10 principles to guide NASA and Roman on the process for assigning mission observing time allocations

- **Some takeaways include**
  - Endorses community led approach to setting Roman observation program
  - Emphasizes importance of competitively balancing/awarding time between each of the three CCS and GA Surveys

- **We agree with the findings and conclusions in the CAA report**
  - The Roman mission (science centers + project) have developed and started implementing a plan to define the core community surveys that builds upon the principles laid out in the CAA report

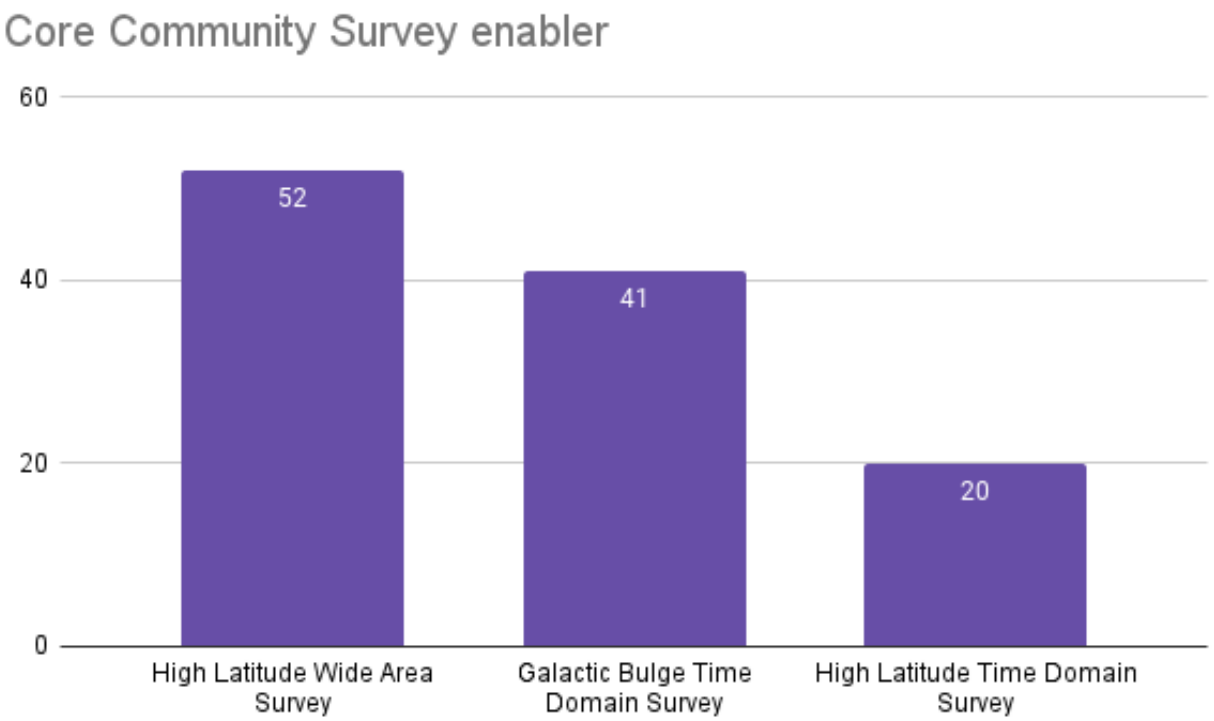
Community Definition of Core Surveys

- **Workshops to inform community about Roman capabilities**
  - Outline available parameter space for each survey (done!)
- **Science Pitch/White paper call for papers detailing science that can be done with the survey**
  - Submit science pitch and/or white paper for Core Community Survey definition
    - Science pitch – few paragraphs describing science case for one of the community surveys, short questionnaire on survey parameters
      - Deadline 17 Feb 2023, low bar to entry to encourage high participation
    - White papers – several page document with details on science case, sketch of survey design and methods/metrics on how to evaluate science metric against survey parameters
      - Deadline summer, detail enables more meaningful evaluation
- **Additional workshops/information gathering to enable community cooperation and consensus**
  - Provides a forum for iterative development of survey concepts



Science Pitches: Demographics

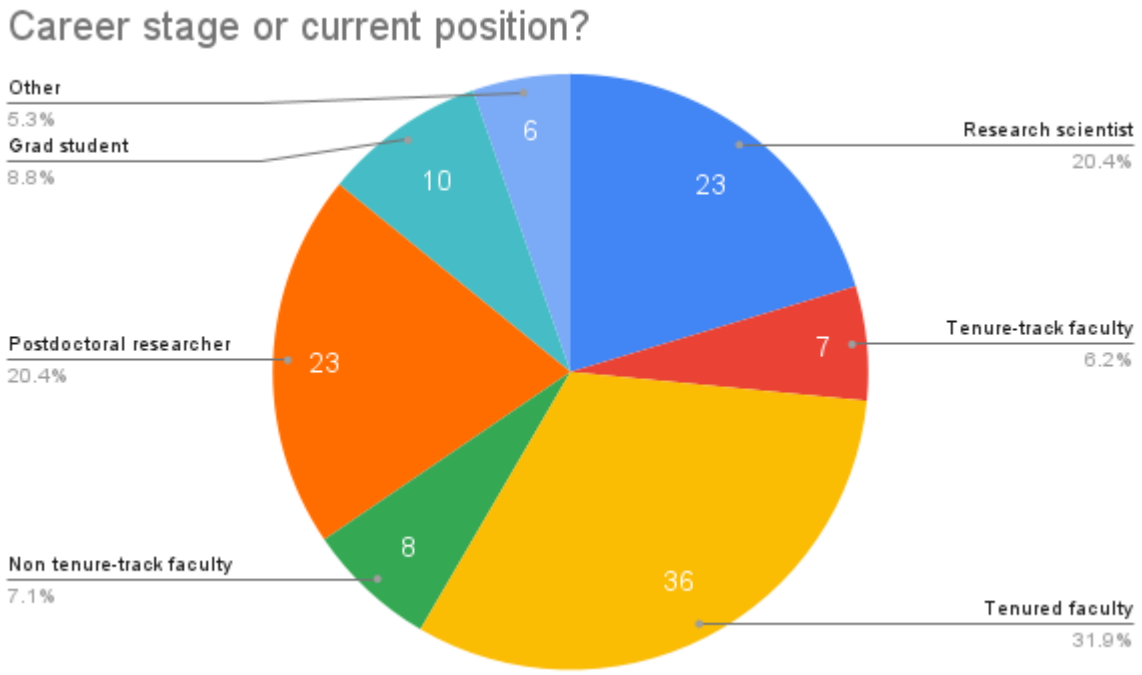
- **113 science pitches received from the astronomical community**
  - 96 unique submitting authors*
  - International response
    - 67 US, 18 Japan, 22 ESA and 6 other (Australia, Canada, Israel)
  - Robust response for all three core community Surveys



** Does not account for overlap (partial or full) in co-authorship*

Science Pitches: Demographics

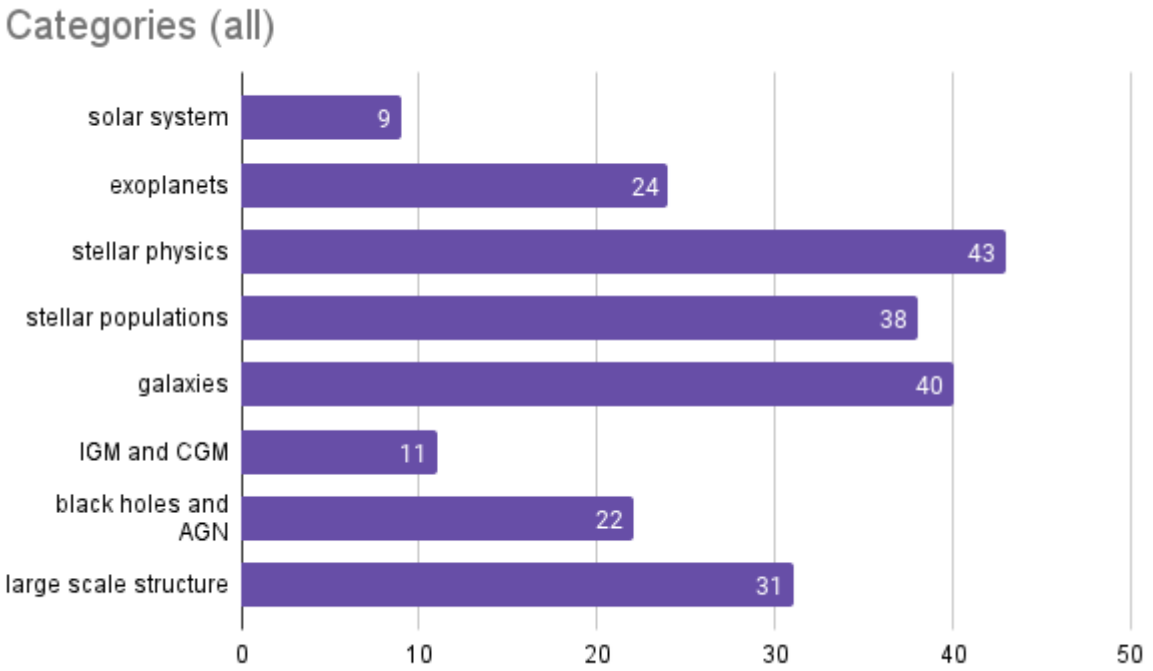
- **113 science pitches received from the astronomical community**
  - 96 unique submitting authors
  - International response
    - 67 US, 18 Japan, 22 ESA and 6 other (Australia, Canada, Israel)
  - Robust response for all three core community Surveys
  - Successfully engaged astronomers new to Roman community
  - Successfully engaged junior astronomers
    - 35% of submitting authors graduate students, postdocs, or tenure-track faculty



Broad Range of Science Topics

Provided Keywords

Selected Category



High Latitude Wide Area Survey: Science Topics

The HLWA Survey is a wide area (>1700 deg^2) multiband survey with slitless spectroscopy.

- Cosmology and large scale structure
  - IR background
  - galaxy clusters and gravitational lensing
  - IR transients
- Milky Way
  - Galactic structure and history (tidal streams, dwarf satellites, etc.)
  - star formation and stellar evolution (stellar clusters, brown dwarfs, transients)
- Nearby and Distant Galaxies
  - galactic structure (tidal streams, groups and mergers, satellites, etc.)
  - dwarf galaxies
  - precision distance ladders
  - star formation and stellar evolution
  - active galaxies and galay evolution
  - very rare transients, transients with long time baseline variations
- Solar system science
  - minor body discovery/tracking

Galactic Bulge Time Domain Survey: Science Topics

The GBTD Survey is ~<15 min cadence observations over few deg^2 towards Galactic Bulge for six ~70 day seasons spanning the prime mission phase.

- Stellar Variability
  - Stellar flares, eclipsing binary stars, cataclysmic variables, x-ray binaries, asteroseismology
- Exoplanets
  - Exoplanet microlensing (and extensions for additional companions, brown dwarfs), exoplanet transits (including transiting planets around white dwarfs, earth-like planets in earth transit zone), exomoons
- Multimessenger Astrophysics
  - White dwarf binaries/LISA counterpart sources
- Stellar populations
  - Astrometry, initial mass function
- Transients
  - Galactic center, XRBs etc
- Compact Object Census
  - Finding isolated black holes and neutron stars via microlensing
- Looking behind the galactic bulge
  - Quasars, supernova (exploring advantages of high cadence observations)
- Synergies with other facilities

High Latitude Time Domain Survey: Science Topics

The High Latitude Time Domain Survey provides tiered, multiband time domain observations on timescales of days of 10s deg^2 at high latitudes.

- All types of SNe
- Rare Transients
  - Strongly lensed supernova, tidal disruption events, statistical samples of rare and exotic (Pop III star) supernovae at high *z* (including z>10), fast blue optical transients
- AGN
  - evolution with redshift of AGN dust via dust reverberation mapping, low mass AGN beyond Local Universe, massive black hole binaries
- Galaxy Evolution
  - using survey as a deep field to study cosmic dawn, investigate the bright-end of the UV luminosity function and massive galaxy formation in the early universe at z>10
- Multimessenger Astrophysics
  - kilonova detection
- Milky Way
  - solar system planetary analogs, stellar mass black holes, detecting the stellar pulsation of stars near the tip of the red giant branch to measure distance and identify the edge of the MW's stellar halo, nearby bright stars for joint radial velocity/astrometry

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Looking Forward

‘Lessons learned’ relevant to white paper call and targeting future engagement

- By design (for brevity and simplicity), science pitches capture ideal requirements. White papers will need to switch gears and discuss ‘envelope’ of acceptable survey specifications. *This is not something people are generally used to doing.*

- By design, science pitches are high level. For some, it is not obvious they are feasible within reasonable bounds. White papers will need to illustrate feasibility.

- While breadth of science pitches was excellent, there were a few areas that stood out as potentially under-represented.

Looking Forward

A few areas where targeted future engagement may be particularly fruitful:

- Many pitches noted synergies with other facilities: maximizing synergies with existing or future facilities or surveys should be a two-way discussion
  - UV/optical/NIR
    - Subaru, LSST, Euclid, DESI, Kepler and Tess, Zwicky Transient Facility, the La Silla Schmidt Southern Survey, the WAVES spectroscopic survey (with 4MOST), the ISAS/JAXA JASMINE NIR astrometry mission
  - radio:
    - VLA Sky Survey (VLASS), MWA/ASKAP, MeerKAT, and 21-cm surveys with the SKA and the Hydrogen Epoch of Reionization Array (HERA)
  - X-ray: *eROSITA*
  - Other: LISA

There are likely more synergies at multi-wavelengths than captured, especially radio and X-ray

Looking Forward: White Paper Call

Turn majority of ‘maybe’ responses into white paper contributions:

- Provide ample time for white paper creation
  - Targeting a mid-June deadline, with an announcement and updated call circulated ~ end of March
- Make expectations for, and future use of, white papers as clear as possible in call
- Hold a series of topical virtual sessions for targeted back and forth discussion
  - organized by survey and potentially broad science topic
  - advertise broadly and openly while sending targeted invites to relevant pitch authors
  - goals:
    - make connections between researchers interested in similar topics and encourage discussion
    - answer questions, clarify goals of white papers and bounds of surveys

Roman Coronagraph Instrument

Discussion of considerations for observations beyond first 18 months

WFIRST, Roman and Coronagraph History

- **Some history**
  - WFIRST was recommended by Astro2010 as wide field near-IR mission with 5-year prime mission; 2010
  - Added Coronagraph instrument as technology demonstration but treated as science instrument, increased prime mission to 6 years; 2013
  - Descoped Coronagraph Instrument to technology demonstration only, decreased prime mission to 5 years; 3 months reserved for Coronagraph instrument observations within first 18 months; WIETR 2017
  - Descoped IFS from Coronagraph Instrument, replace with Prism; Sept 2019 (pre-PDR)
  - Coronagraph Instrument team directed to focus only on threshold (TTR5) requirements but retain PDR design, change to class D; Feb 2020 KDP-C
    - Following SRB and CGI tiger team recommendations

- **TTR5:** *Roman shall be able to measure brightness of an astrophysical point source w/ SNR ≥ 5 located 6 – 9 λ/D from an adjacent star with VAB ≤ 5, flux ratio ≥ 10-7; bandpass shall have a central wavelength ≤ 600 nm and a bandwidth ≥ 10%.*

Threshold Technical Requirement 5

Band	λ_{center}	BW	Mode	FOV radius	FOV Coverage	Pol.	Coronagraph Mask Type	TTR5
1	575 nm	10%	Narrow FOV Imaging	0.14" – 0.45"	360°	Y	Hybrid Lyot	Y
2	660 nm*	15%	Slit + R~50 Prism Spectroscopy	0.17" – 0.51"	2 x 65°	-	Shaped Pupil	-
3	730 nm	15%	Slit + R~50 Prism Spectroscopy	0.18" – 0.55"	2 x 65°	-	Shaped Pupil	-
4	825 nm	10%	"Wide" FOV Imaging	0.45" – 1.4"	360°	Y	Shaped Pupil	-

- **TTR5 means that only band 1 is required for full success**
  - Robust technology demonstration
  - Science return is modest
    - 0 imaged mature exoplanets
    - Valuable to study inner region of spatially extended sources/debris disks

- **We should manage community expectations of performance above TTR5, or science with CGI above TTR5**
  - But, internally, Roman and NASA can prepare for both these things

Phase E observations

- **The Coronagraph instrument is currently allocated 3 months of observing time within the first 18 months of the mission**
  - It is expected to take much less than 3 months observing to meet TTR5
  - Our working assumption is that the remainder of the 3 months will be used for additional technology demonstration or science observations with the Coronagraph
    - How this time gets used will depend on the as-built capabilities and the results from the TTR5 observations
    - Recommendations on how to use this time will be made by Coronagraph instrument team, and the Community Participation Program Team (including representation from SSC/IPAC)

	First 18 months	Prime mission (5 year)	Prime mission (original 6 year)
CGI	3 months (fixed)	3	12
HLWA Survey	6.2 months	24	24
HLTD Survey	1.6 months	6	6
GBTD Survey	3.2 months	12	12
GA Surveys	4.0 months (minimum)	15	18

Cannot add more CGI observations in 5 year prime mission without breaking science requirements (in cosmology and exoplanet demographics) or >25% GA survey requirement. Would need to also increase planned mission lifetime.

Considerations for observations beyond 18 months

- **Coronagraph instrument is a class D tech demo with minimal redundancy – likelihood of limited instrument lifetime**
  - Execute additional CGI observations early in the mission, or at least soon after the end of the initial 18-month period
    - Make decisions early, don't wait until the end of the 18-month period
    - Maximize efficiency
      - Currently working options to allow CGI parallel ops (e.g. for calibrations) during WFI observations
  - Consider science operations similar to a typical explorer
    - Higher fraction of resources to the community/instrument team, relatively modest level of user support

- **To stay within cost and schedule constraints, the CGI team have descoped activities not needed for TTR5**
  - Testing Shaped Pupil Coronagraph mode
    - Consider adding testing of SPC modes before launch on testbed
  - Pipeline support for Shaped Pupil Coronagraph mode

A possible option for continued observations

- **Hold review early in mission (e.g. 6 months into science observations)**
  - Add TBD months of Coronagraph Instrument observations within first 3 years, increase prime mission duration
- **Reschedule some of the Core Community Survey observations to later years to create space for Coronagraph Instrument observations in early mission**
    - This may be complicated, as teams may have planned science investigations that depend on the CCS surveys being executed when originally planned. (can mitigate this by collecting information during GI proposal selection)
- **Continue (or recompete) Community Participation program, and plan the second set of CGI observations in a similar way as the first 3 months.**
  - This may be the most efficient way to exploit the pathfinder role for Coronagraph
  - Would need to manage the process in an open transparent way, so that the community has a voice

Note that it is premature to make firm decisions on the best path forward before the science community has had an opportunity to become involved in Coronagraph Instrument. No need to make choices today!