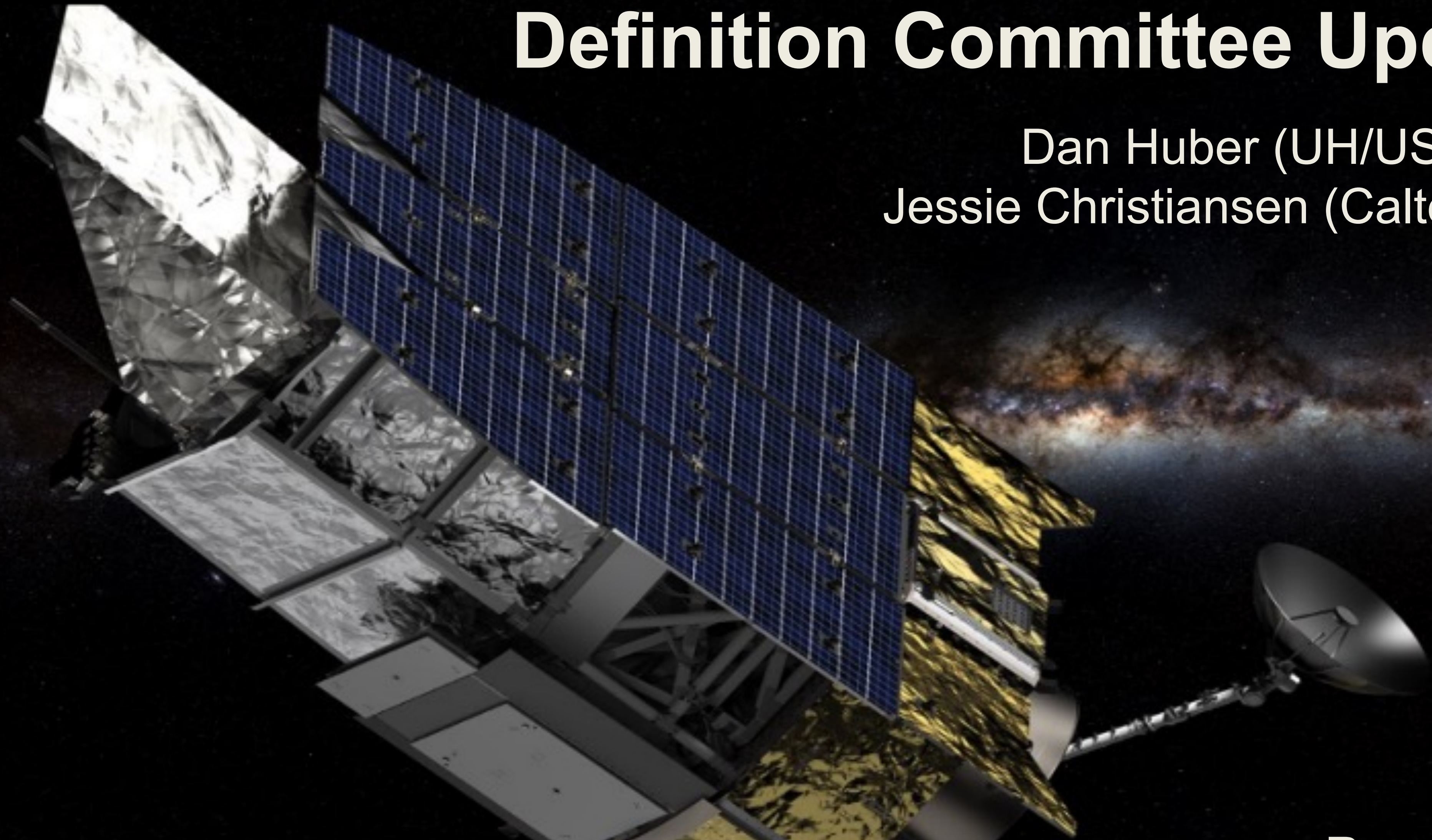
# Galactic Bulge Time Domain Survey Definition Committee Update

Dan Huber (UH/USyd) &
Jessie Christiansen (Caltech/NexScI)



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• CENTRE NATIONAL d'ÉTUDES SPATIALES • MAX PLANCK INSTITUTE FOR ASTRONOMY •

Roman Community Forum
7/24/2024

# GBTDS Definition Committee Members

Jessie Christiansen
(NExScI/Caltech, Co-chair)

Dan Huber
(UH/USyd, Co-chair)

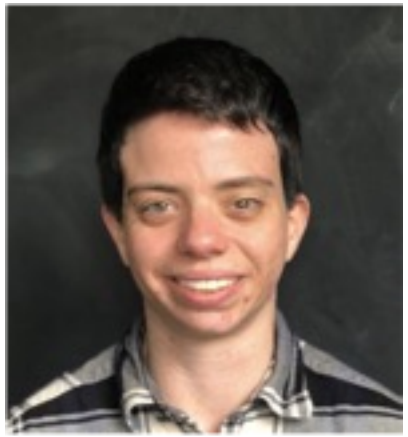
Annalisa Calamida
(STScI)

Jennifer Sobeck
(IPAC)

Matthew Penny
(LSU), PIT Liasion

Ben Montet (UNSW)

Hans-Walter Rix (MPIA)



Kris Pardo (USC)

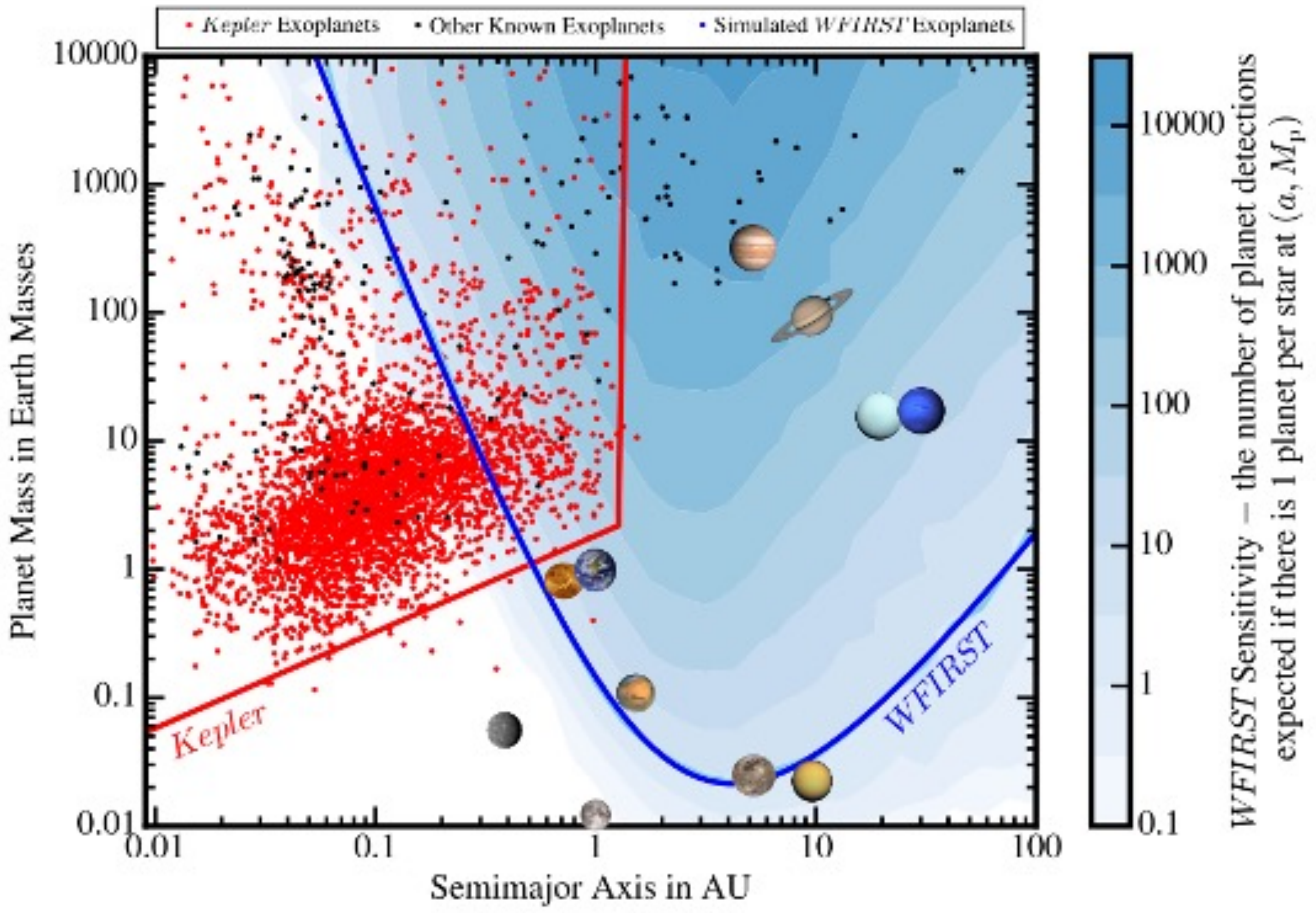
Jessica Lu (Berkeley)

Eduardo Martin (ESO)

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

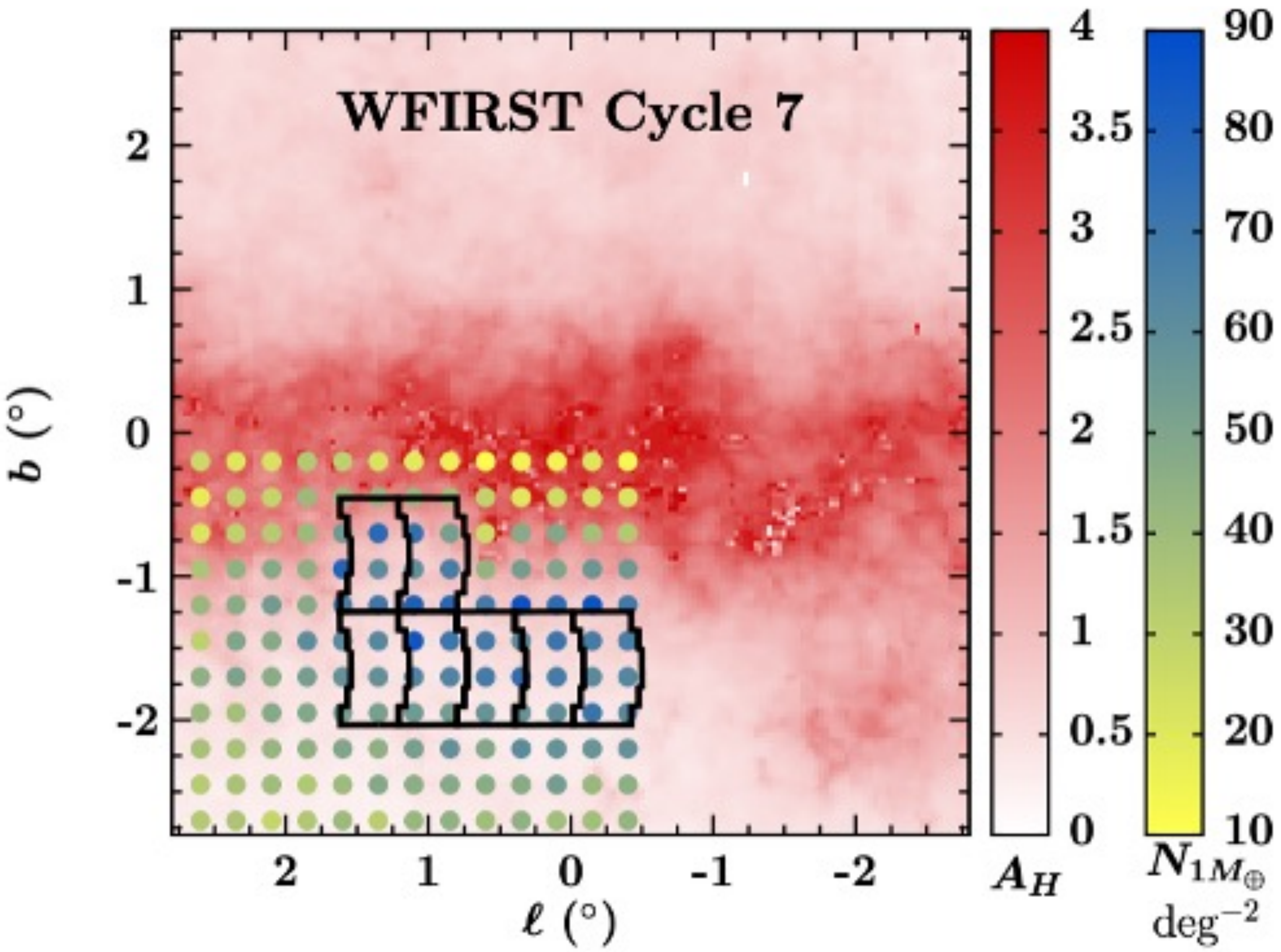
# Roman GBTDS: Science Requirements

*Roman will carry out a statistical census of exoplanetary systems in the Galaxy, from the outer habitable zone to free floating planets, including analogs to all of the planets in our Solar System with the mass of Mars or greater, by monitoring stars toward the Galactic bulge using the microlensing technique.*




Penny+ 2019

# Roman GBTDS: Science Requirements




Penny+ 2019

**Penny+ 2019 survey:**

- 6 x 72 day observing seasons
- 7 fields observed in each season (~2 deg$^2$ survey area)
- 15 minute cadence with broad filter
- 12 hour cadence with narrow filter

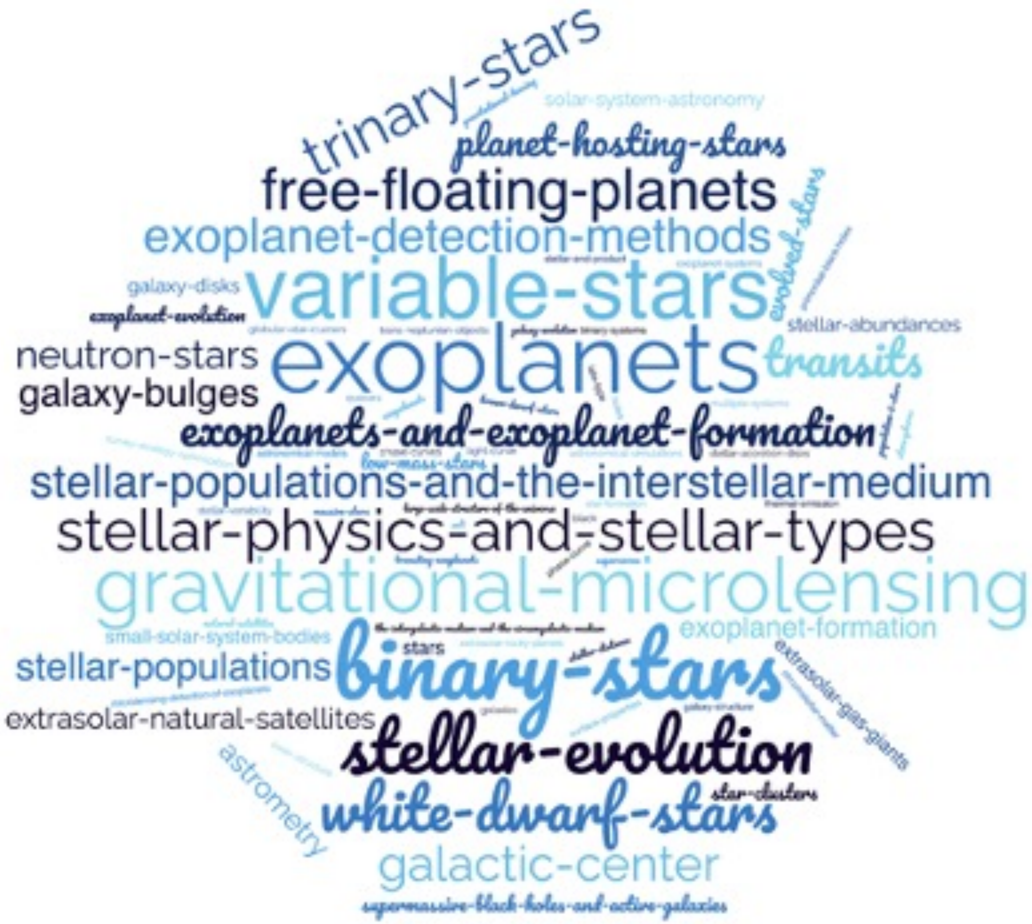
**Survey changes considered:**

**(while meeting science requirements)**

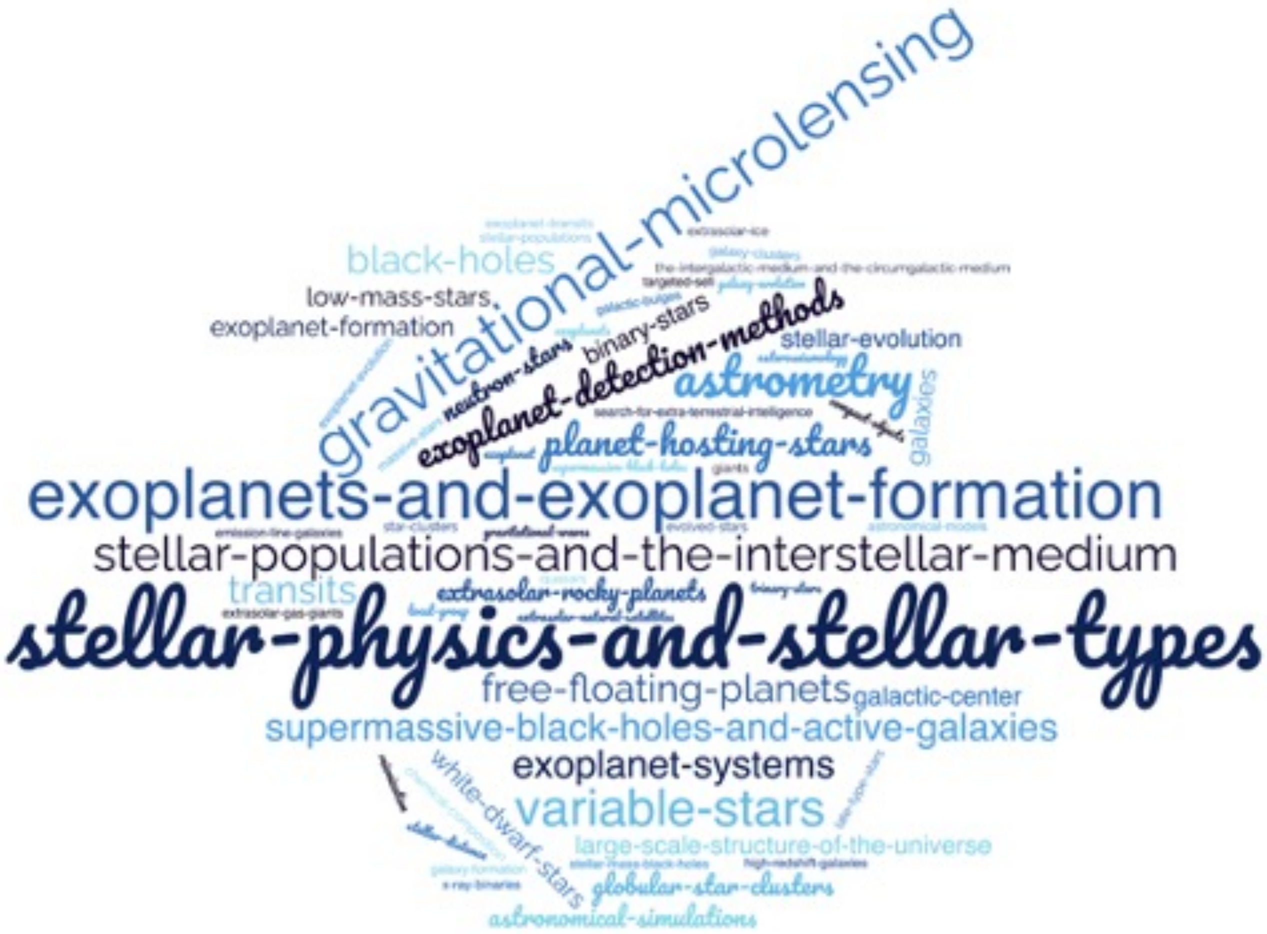
- 60-72 day observing seasons
- 5-9 fields observed in each season
- 7-15 minute cadence with broad filter
- 3-12 hour cadence with narrow filter(s)

# Roman GBTDS: Community Input

## 23 White papers




## 43 Science Pitches



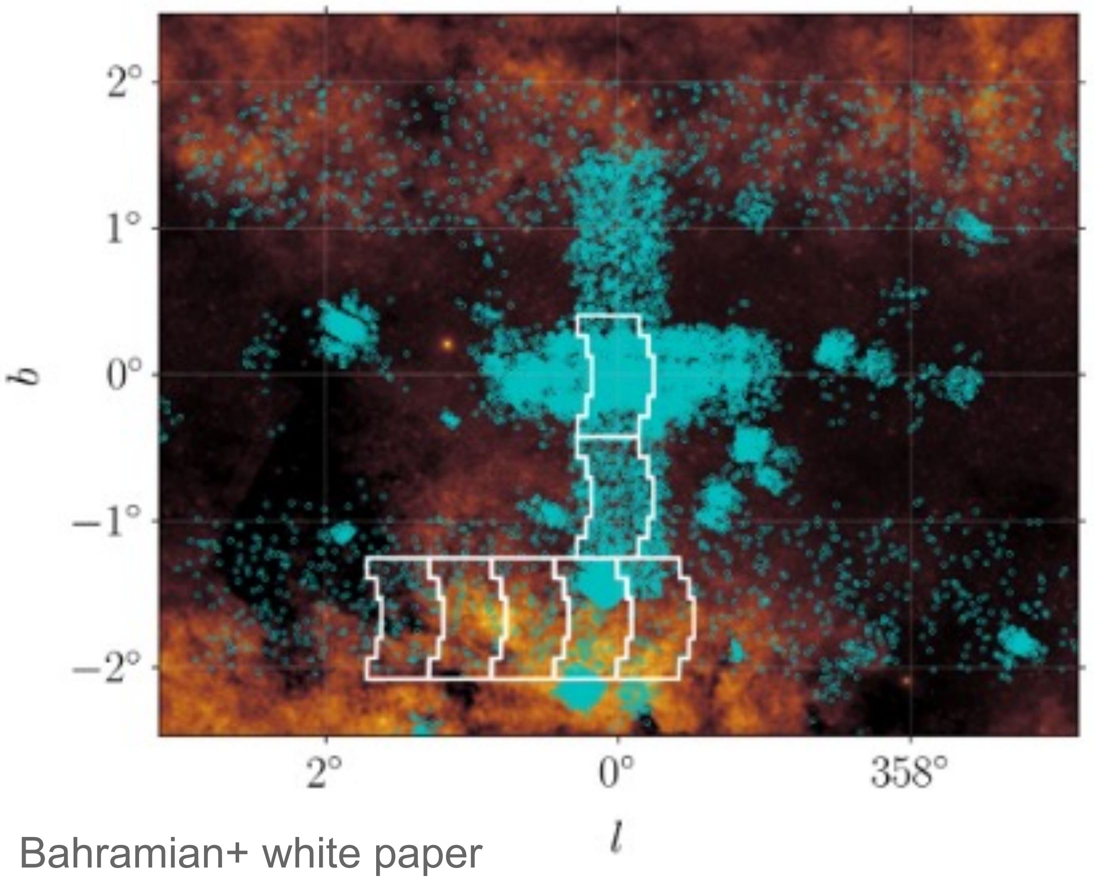

Follow-up call for updates sent to white paper authors in March 2024

# GBTDS Definition Committee: Where we stand

- **Feb 2024:** Kick-off meeting (~25 hours of committee meetings since then)
- **Mar 2024:** Design & organize review process for white papers & science pitches
- **Apr-Jun 2024:** Reviews, rankings & discussion of science ideas
- **Jul 2024:** Report to community for feedback and iteration. ***We are here!***
- **Aug-Sep 2024:** Refine trade studies / investigations, simulations and develop nominal implementation plans
- **Oct 2024:** Preview results of survey definitions to community for feedback
- **Nov 2024:** Report due to Roman project

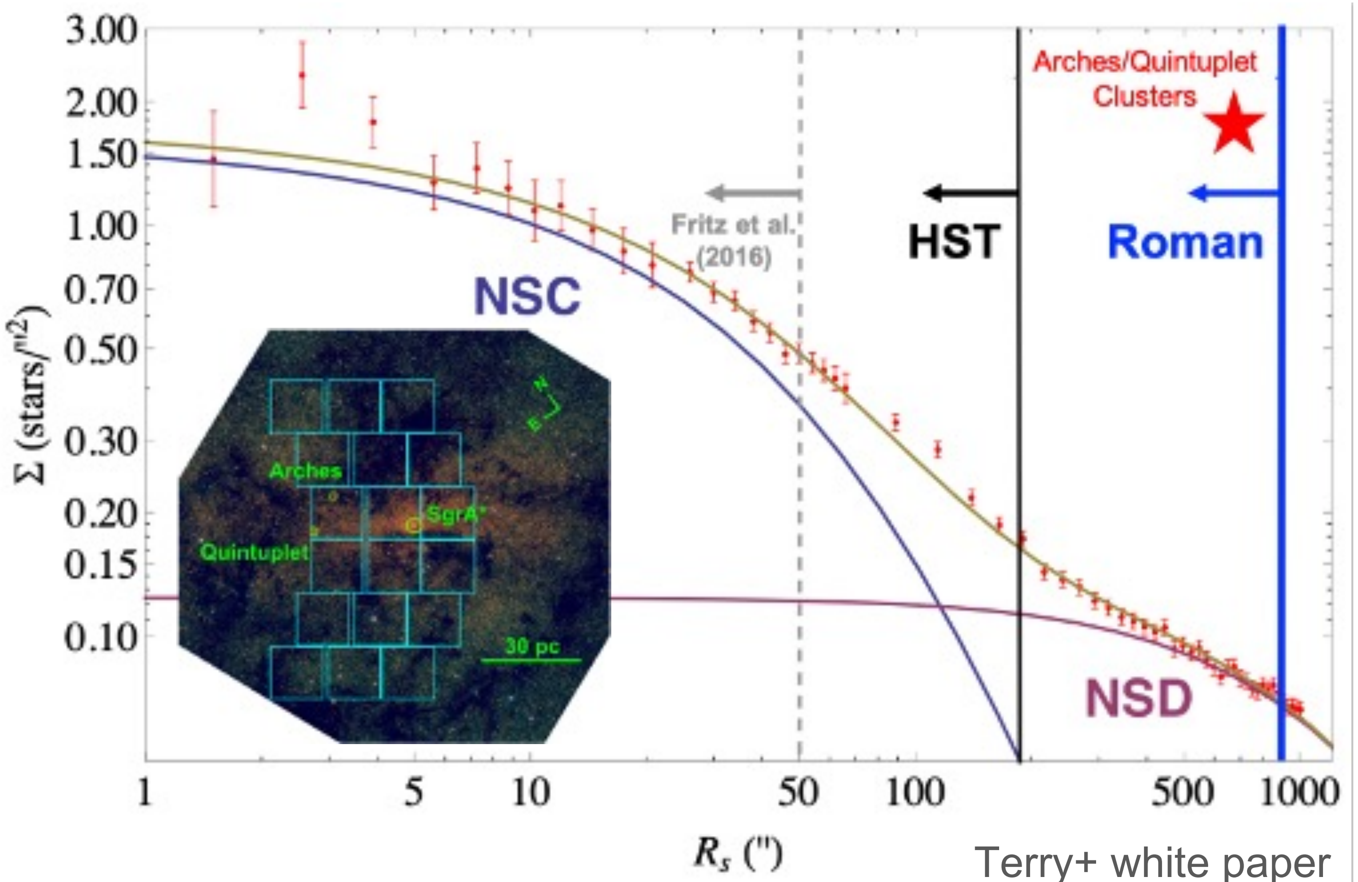
# Possible Modification: Add Field at the Galactic Center

Increase overlap with CHANDRA X-ray sources




Bahramian+ white paper

Probe stellar populations in the galactic center

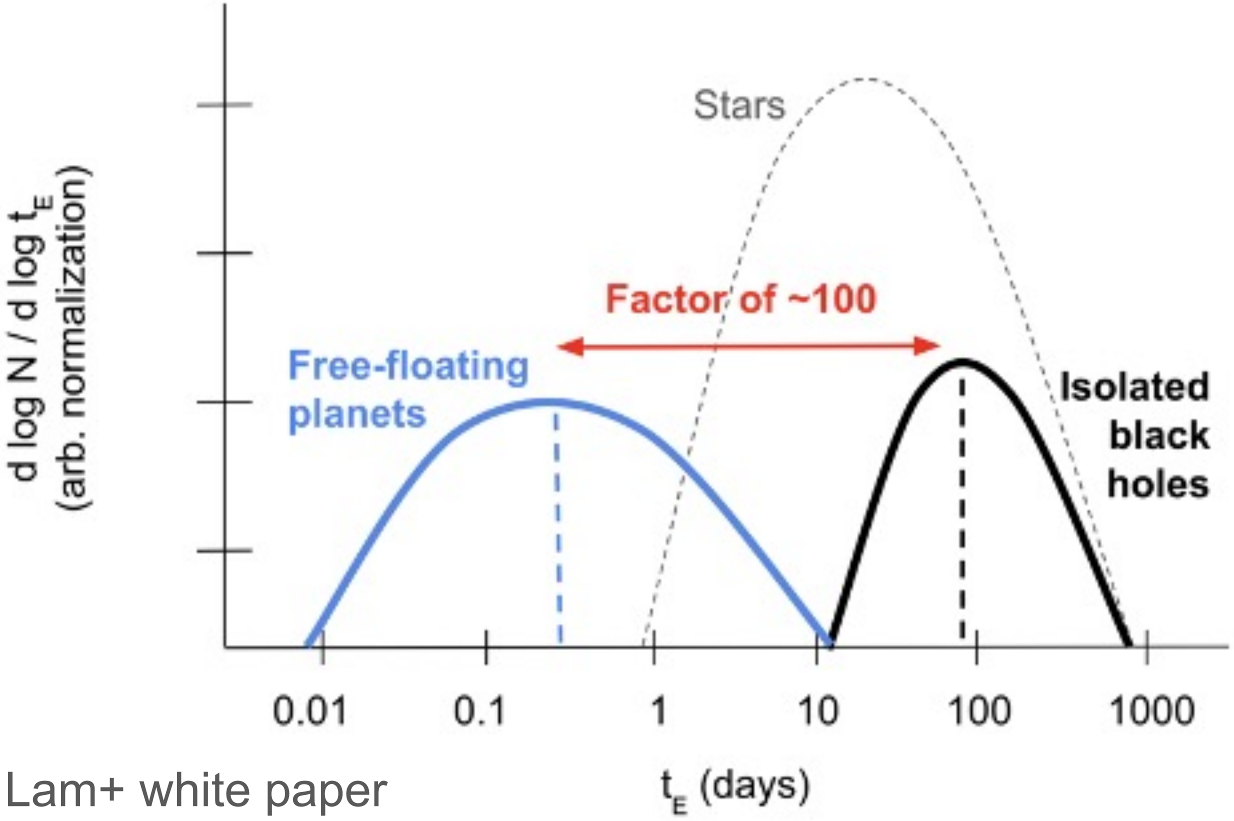



Terry+ white paper

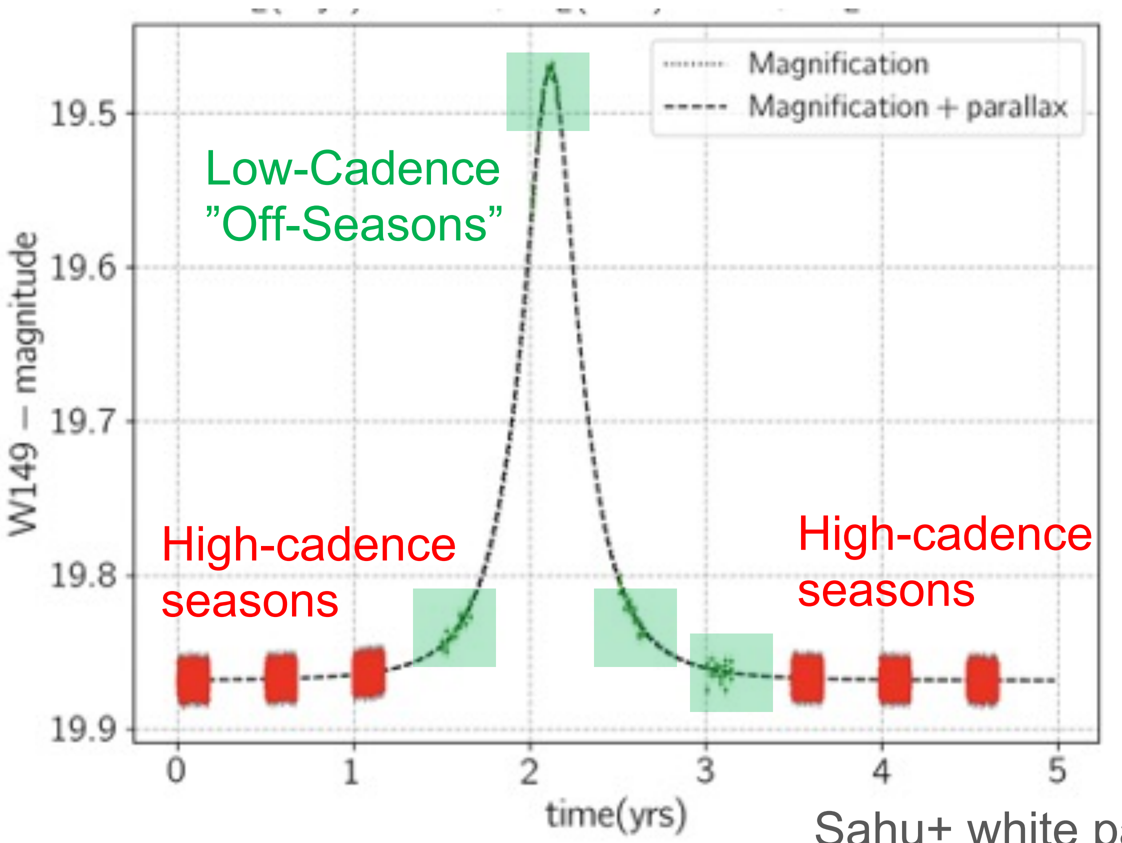
Additional science: stellar/compact object binaries, variable stars, transiting exoplanets

# Possible Modification: Off-Season Observations

Low cadence observations during “off-seasons” will enable well-sampled light curves and astrometry for isolated black-hole microlensing events




Lam+ white paper

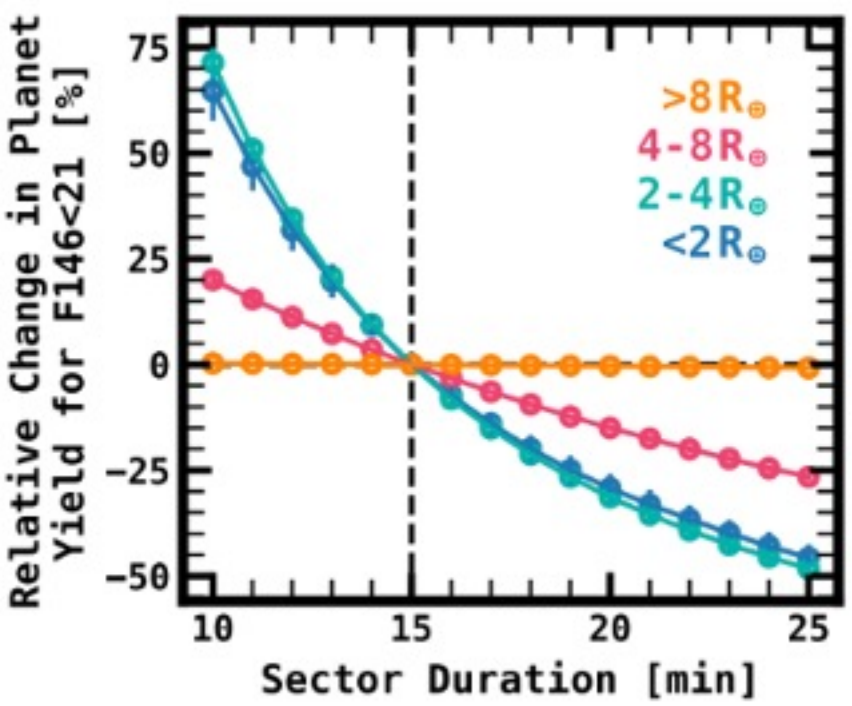



Sahu+ white paper

Possible cadences: 1 obs / 1-10 days. Would likely not be strictly periodic! See also recent Gould white paper for moving high-cadence seasons (https://arxiv.org/abs/2407.06484)

# Possible Modification: Faster Cadence

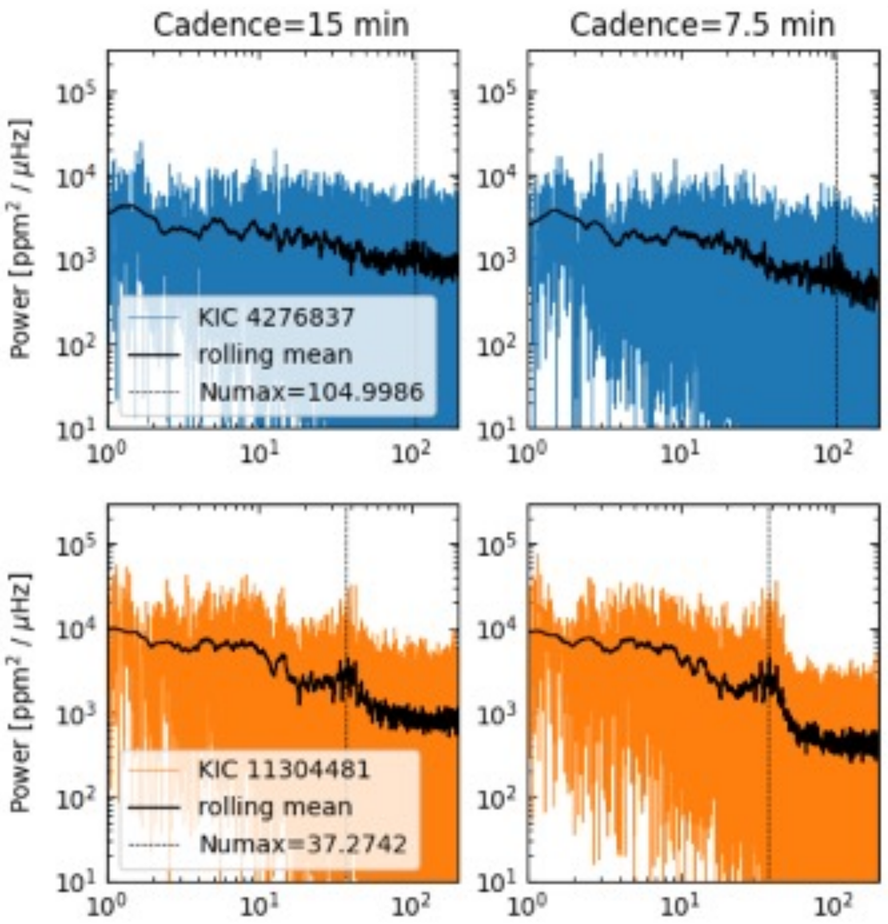
## Transiting Exoplanet Yield




Wilson+ white paper, see also recent Gould, Yee & Dong white paper for FFPs

Requires balance with adding more fields. Possible variation: observe 1 field at twice cadence or overlapping fields?

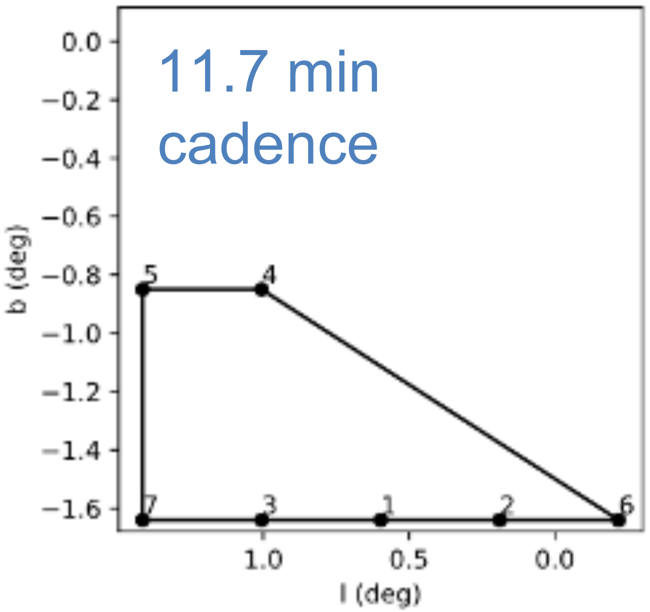
## Asteroseismology of Red Giants



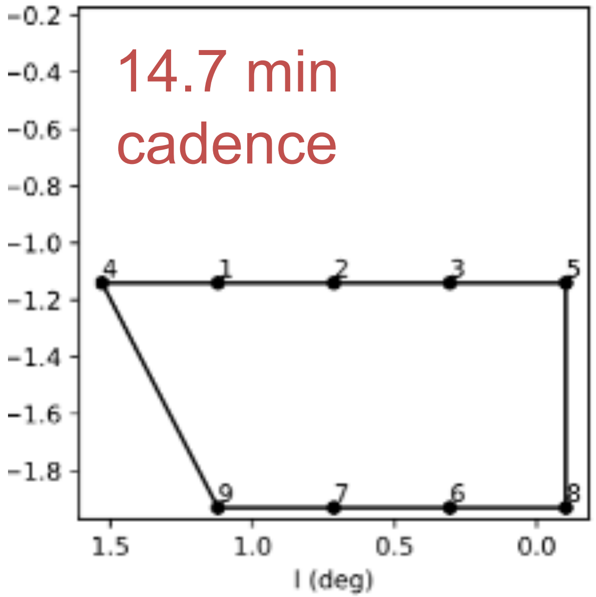

Downing, Weiss, Pinsonnault & Zinn; Huber+ white paper

# Tradeoffs: Cadence, Fields, Exposure Time

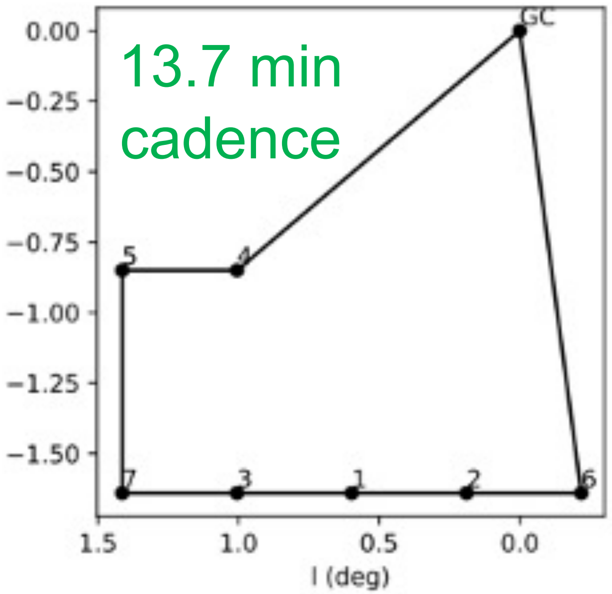
**7 contiguous**



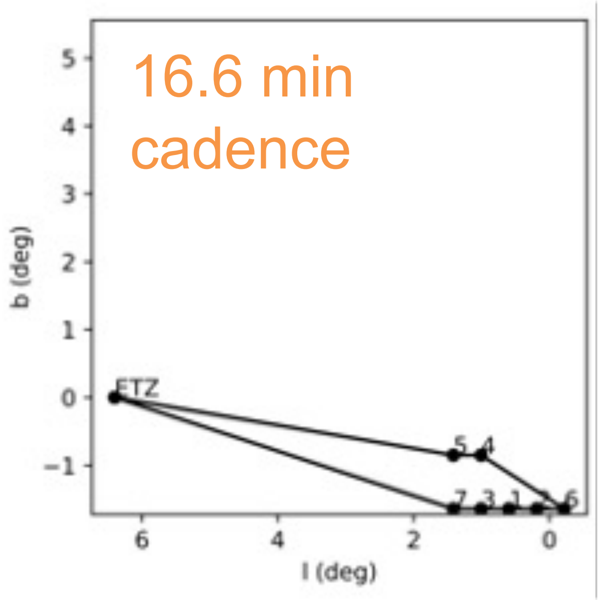

**9 contiguous**




**7 cont. + GC**




**7 cont. + ETZ**



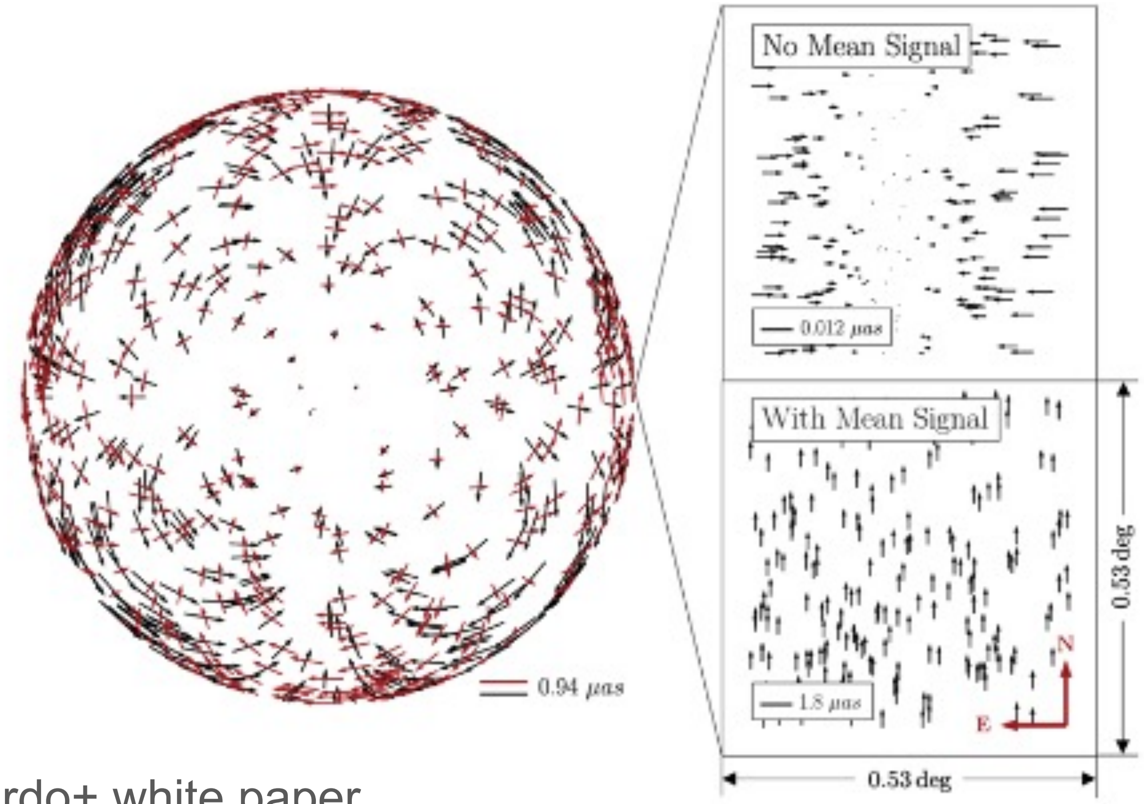

Simulations by Matthew Penny

for fixed exposure time (48 sec)

Fields requiring long slews may be prohibitively expensive in terms of cadence or sensitivity and better suited for General Astrophysics programs

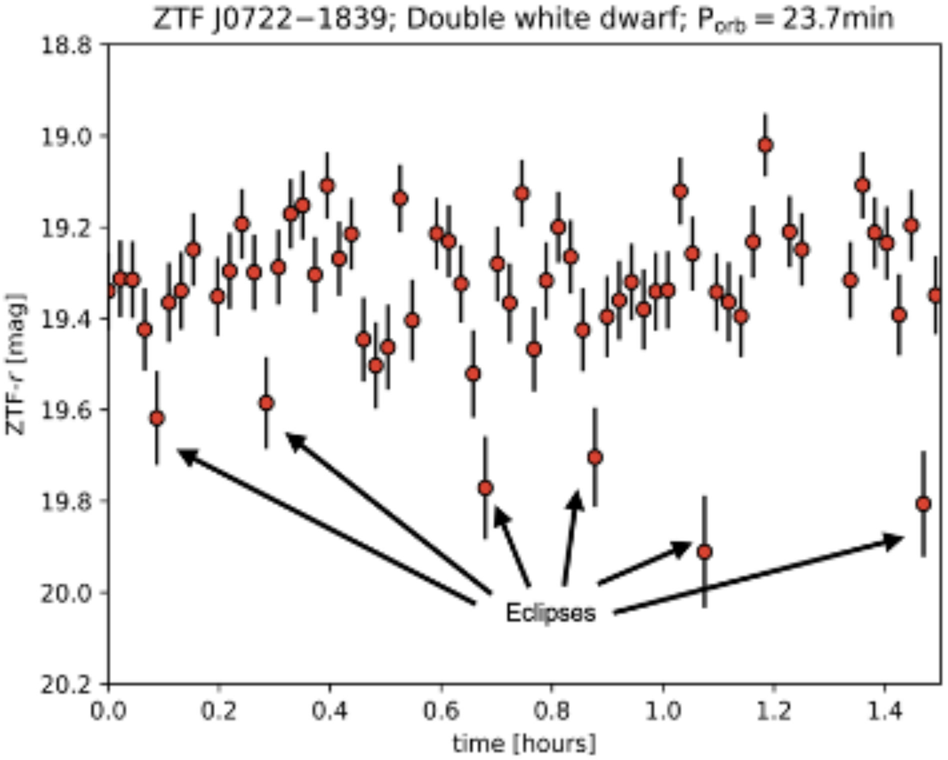
# Possible Modification: Observe 1 Field at High Cadence

## Gravitational wave detection




Pardo+ white paper

## Short-period eclipsing binaries

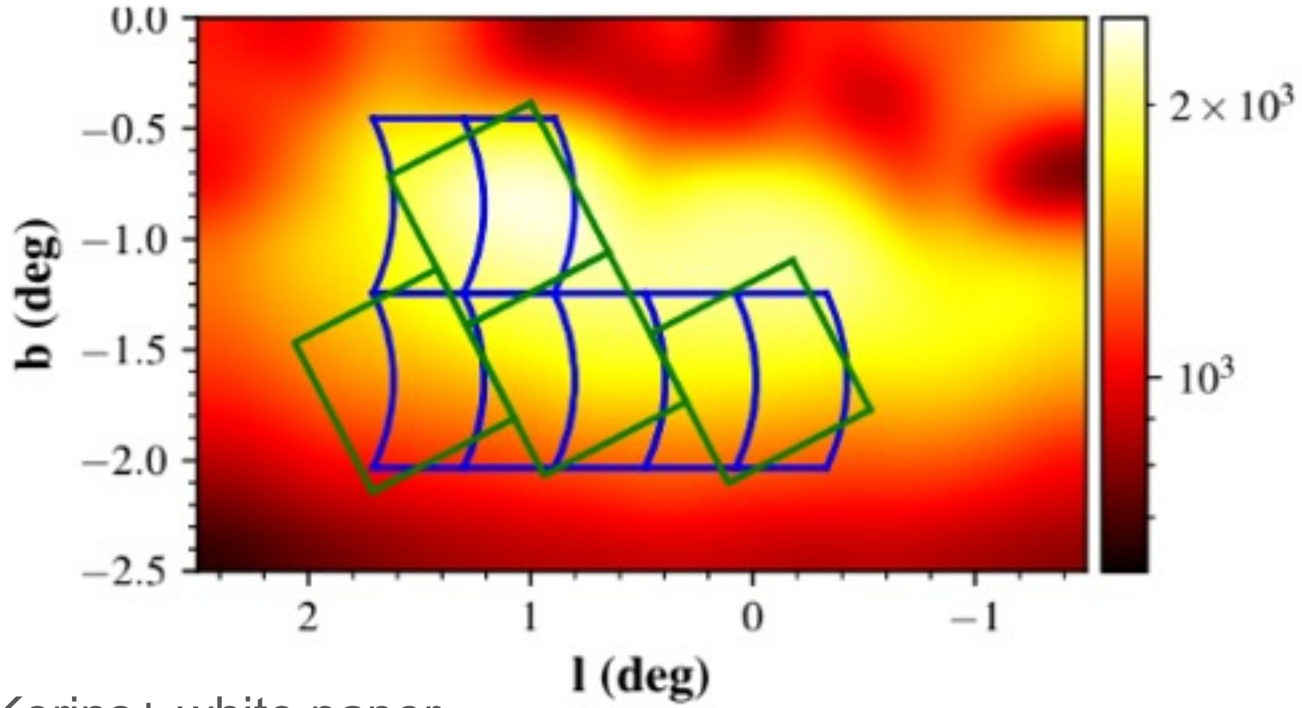



Kupfer+ white paper

Time investment may become too expensive unless only done for 1-2 seasons (in which case General Astrophysics program may be suitable)

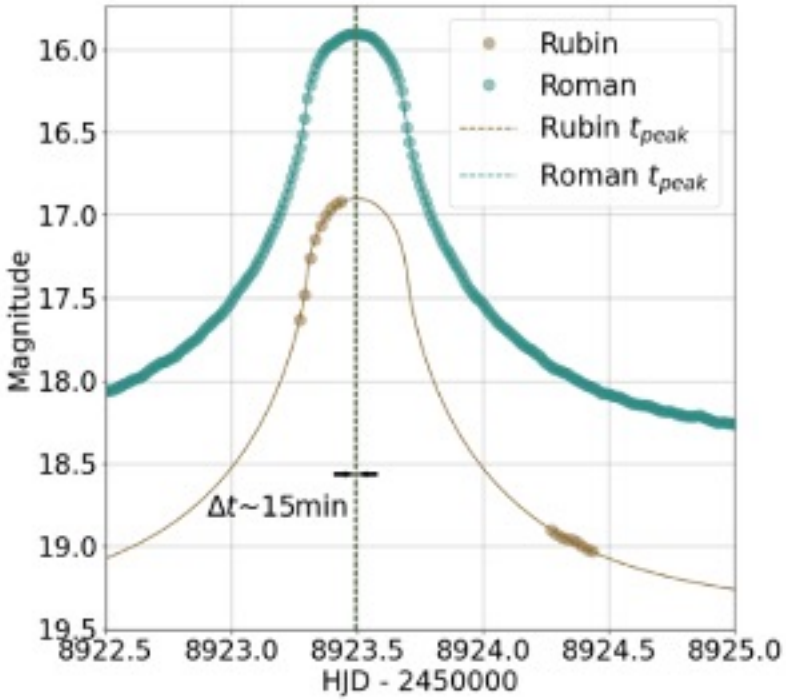
# GBTDS: Synergies with other Surveys

Simultaneous observations with Roman and Euclid




Kerins+ white paper

Free-floating planet observed by Roman & Rubin

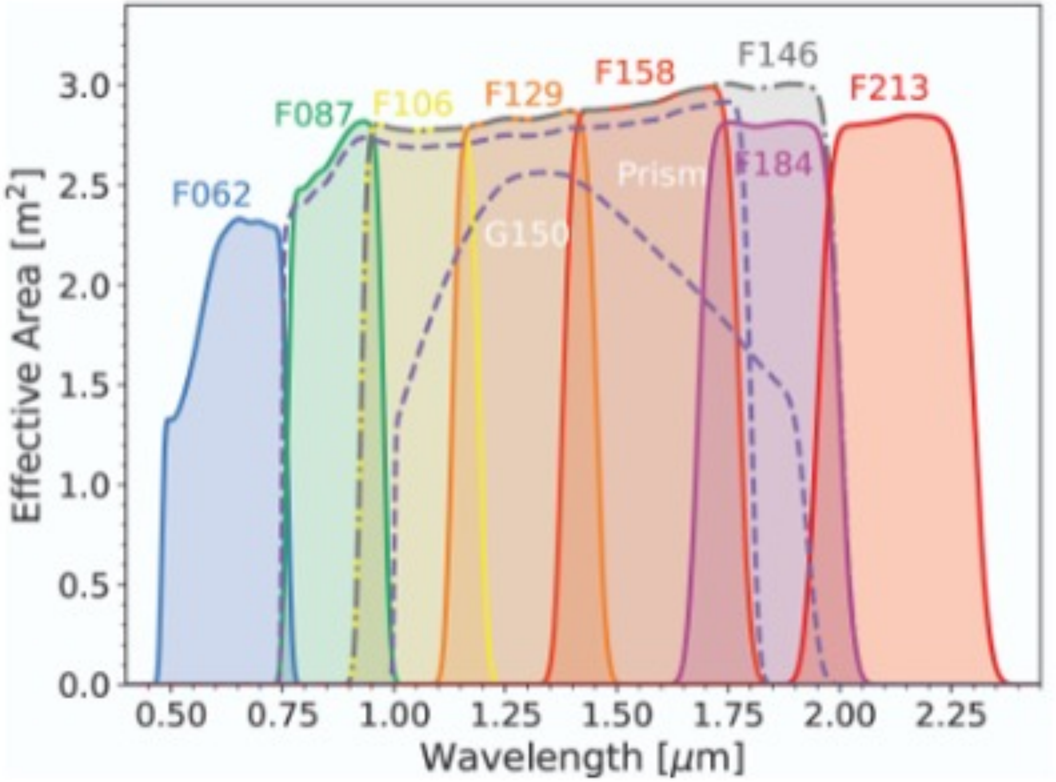



Street+ white paper

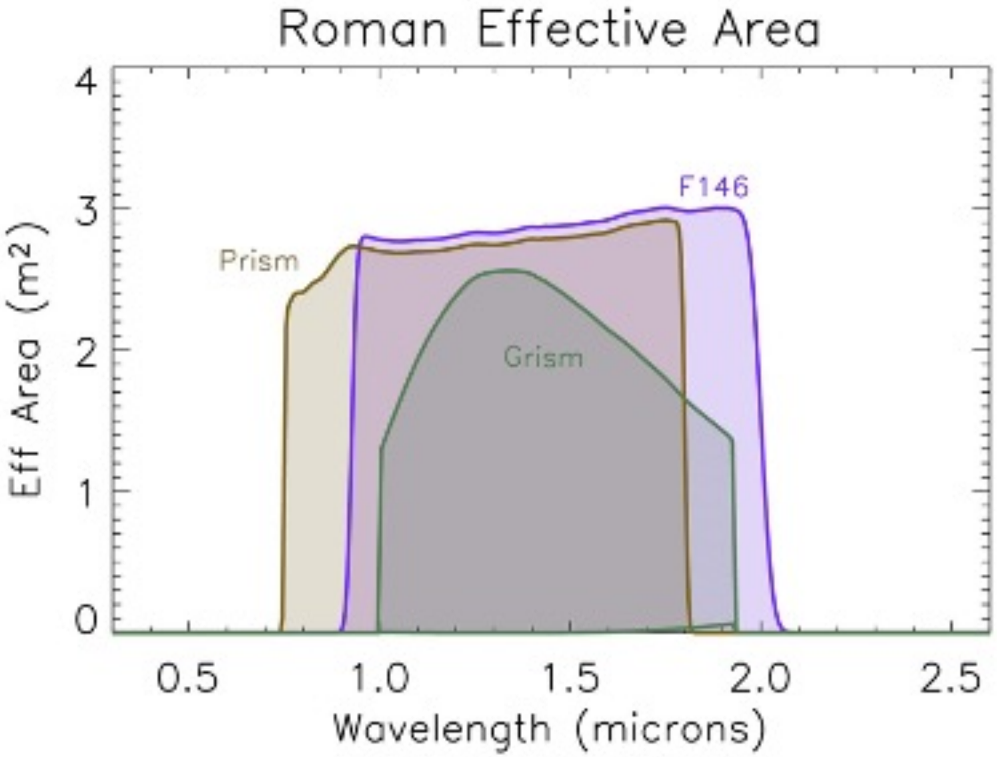
(Currently) no impact on survey design, but important to keep flexibility to enable and support these synergies!

# Other Ideas: Multiband Photometry & Spectroscopy

Observe each field in each one of the Roman filters




Observe each field with R~500 GRISM




Could be done either once at the beginning of the survey, at the beginning & end of each season, or with low cadence throughout the seasons

# Roman GBTDS: A Straw Design

**Underguide (380 days)**

**Nominal (420 days)**

**Overguide (440 days):**

Next steps: simulate impact on exoplanet microlensing yields!

# Roman GBTDS: A Straw Design

| Underguide (380 days) |
|---|
| 6 x 63 day seasons with contiguous fields only |
| Take one image of all microlensing fields in all filters |
| |
| |
| |

| Nominal (420 days) |
|---|
| 6 x 70 day seasons including galactic center |
| Take one image of all microlensing fields in all filters |
| Take one spectrum of all microlensing fields |
| |
| |

| Overguide (440 days): |
|---|
| 6 x 72 day seasons including galactic center |
| Take one image of all microlensing fields in all filters |
| Take one spectrum of all microlensing fields |
| 4 off-season 1 obs/1 day cadence observations |
| 1 day high-cadence observations of 1 field in each season |



Next steps: simulate impact on exoplanet microlensing yields!

# Roman GBTDS Update: Feedback

- **Aug-Sep 2024:** Refine trade studies / investigations, simulations and develop nominal implementation plans
- **Oct 2024:** Preview survey definitions results to community for feedback
- **Nov 2024:** Report due to Roman project

Let us know your thoughts! Venues to provide feedback:

- Online Roman Community Forum (here!)
- Via email to the committee co-chairs: christia@ipac.caltech.edu and huberd@hawaii.edu

# Roman GBTDS: Science Requirements

- **EML 2.0.1:** RST shall be capable of measuring the mass function of exoplanets with masses in the range 1 $M_{Earth} < m <$ 30 $M_{Jupiter}$ and orbital semi-major axes ≥ 1 AU to better than 15% per decade in mass.
- **EML 2.0.2:** RST shall be capable of measuring the frequency of bound exoplanets with masses in the range 0.1 $M_{Earth} <$ $m < 0.3M_{Earth}$ to better than 25%.
- **EML 2.0.3:** RST shall be capable of determining the masses of, and distances to, host stars of 40% of the detected planets with a precision of 20% or better.
- **EML 2.0.4:** RST shall be capable of measuring the frequency of free floating planetary-mass objects in the Galaxy from Mars to 10 Jupiter masses. If there is one $M_{Earth}$ free-floating planet per star, measure this frequency to better than 25%.
- **EML 2.0.5:** RST shall be capable of estimating $\eta_{Earth}$ (defined as the frequency of planets orbiting FGK stars with mass ratio and estimated projected semimajor axis within 20% of the Earth-Sun system) to a precision of 0.2 dex via extrapolation from larger and longer-period planets.
- **EML 2.2.3**: RST shall be capable of providing calibrated data records with relative astrometric measurements having a statistical precision of <=1mas per measurements for a star of $H_{AB}$=21.4 in at least two passbands

see white papers by Bennett+ and Yee+ for impact of survey design choices