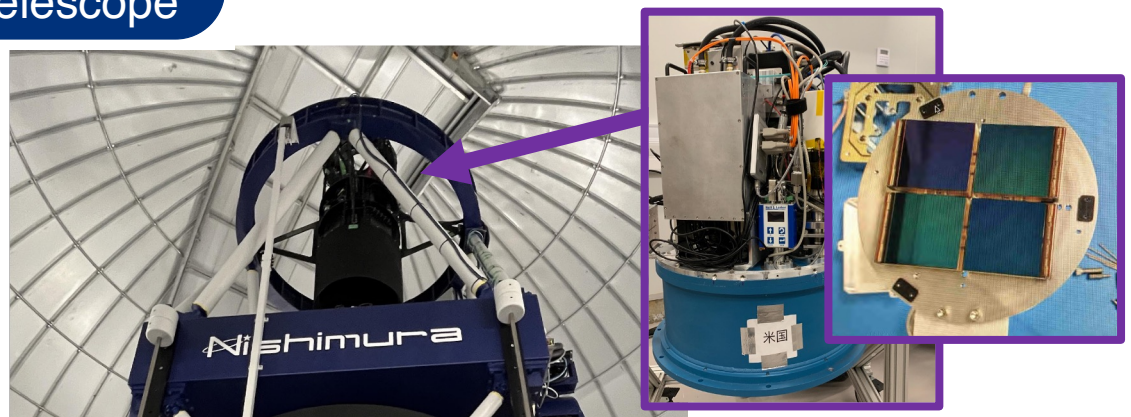
PRIME Microlensing Survey, and Other Sciences in Non-bulge Seasons

PRIME collaboration, JAXA/ISAS
Shota Miyazaki

PRIME

PRime-focus Infrared Microlensing Experiment

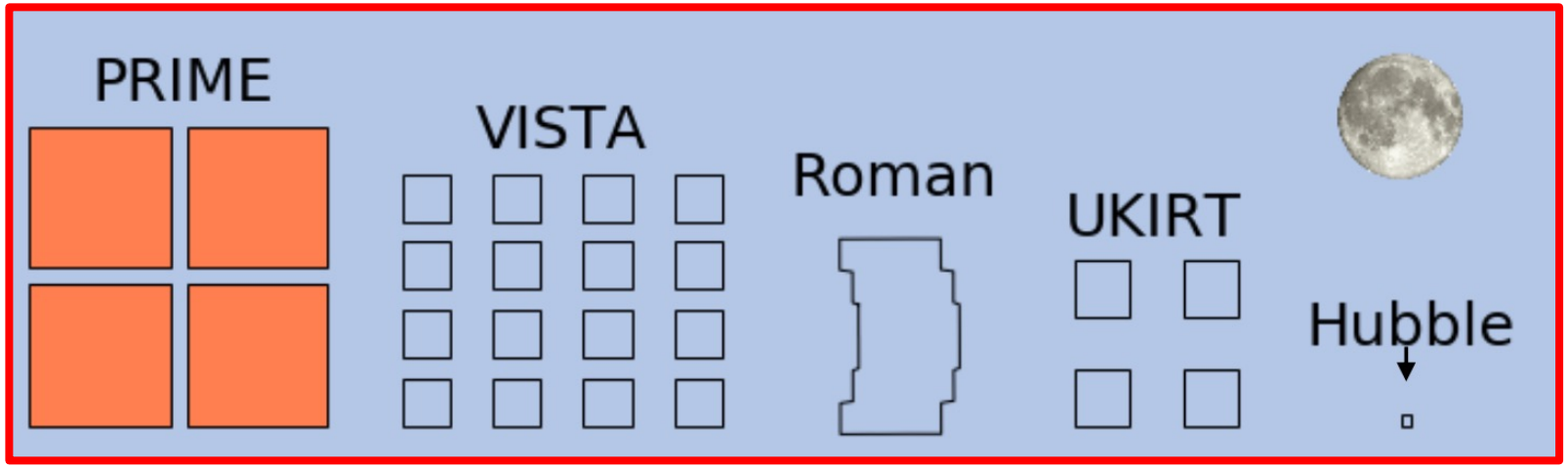


Prime-Cam

PRIME1.8m telescope

site: Sutherland observatory in South Africa
diameter: 1.8m (f ~2.3)
FOV: ~1.3deg^2 (~6 x full moons)
median seeing: ~1.4”
pixel scale: 0.5”/pix

The largest-class FOV in NIR telescopes



PRIME

PRime-focus Infrared Microlensing Experiment

Scientific objectives

NIR Microlensing survey toward the Galactic bulge (~50%)

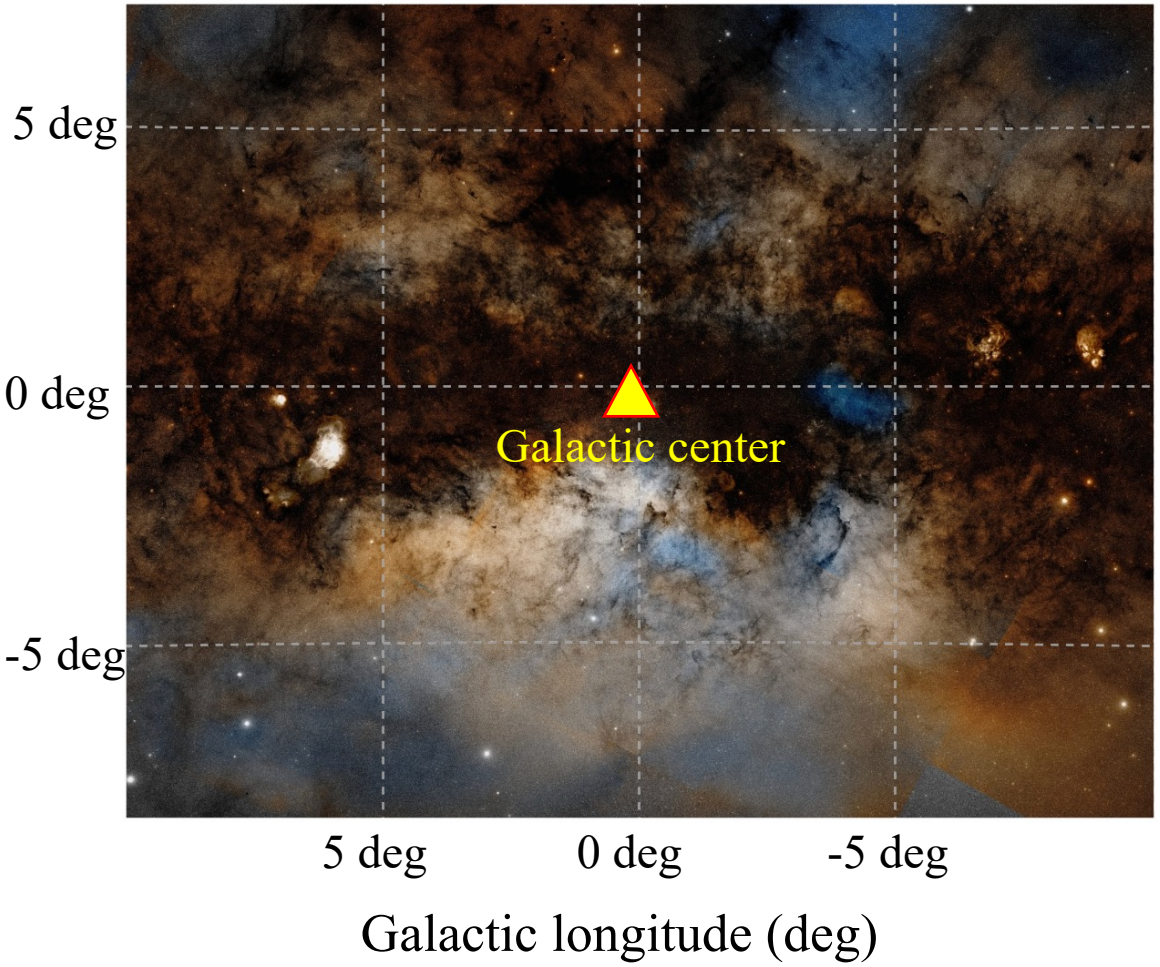
- the NIR microlensing event rate in the Galactic center
  →To optimize the Roman survey strategy
- planet frequency in the Galactic center
- concurrent observations with the Roman telescope

Other sciences in off-bulge seasons (~50%)

- NIR RV surveys for exoplanets in young systems and/or low-mass hosts
- NIR surveys for transiting exoplanets in young stellar clusters
- ToO observations: transient GW, high-z GRB, SNe, …
- Calibrations for Roman

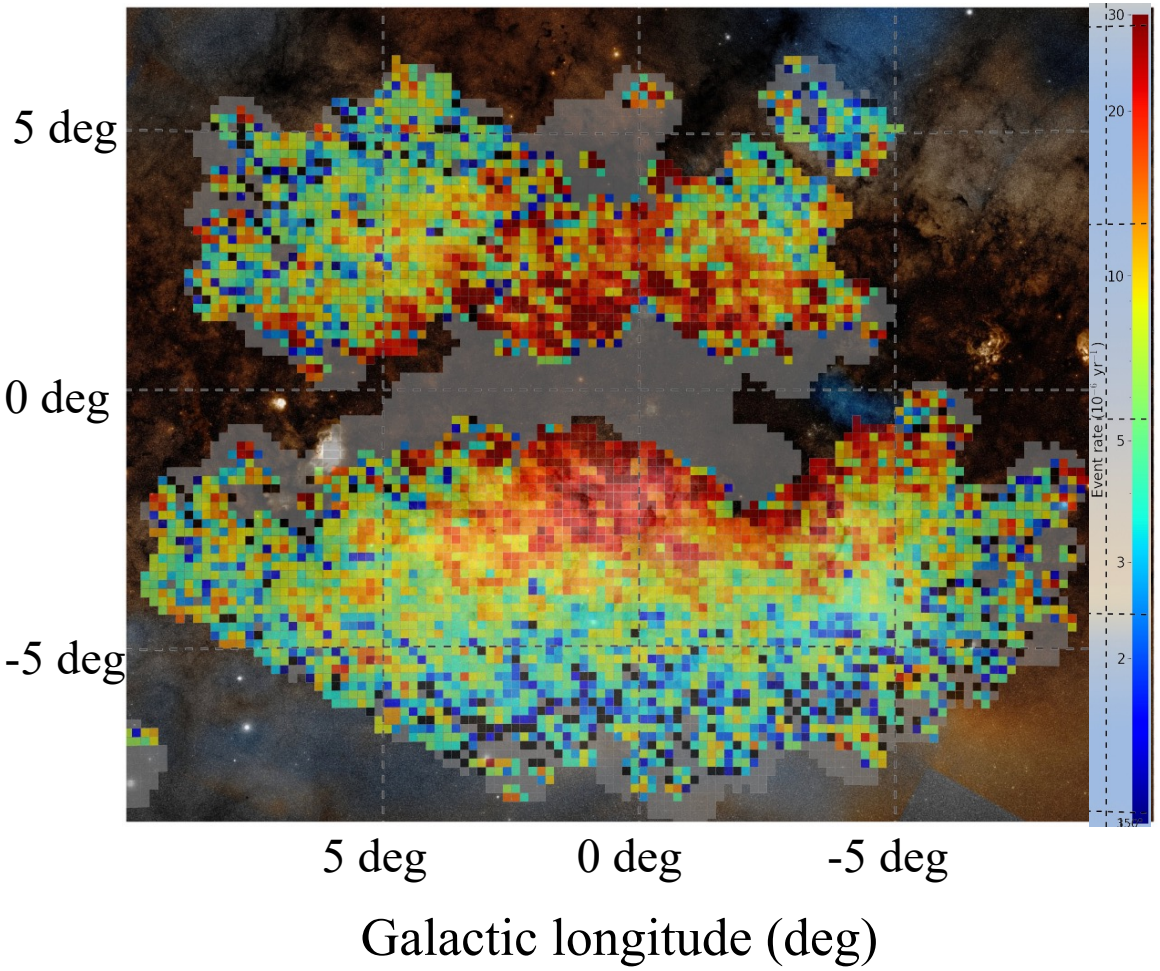
Known microlensing event rate

Image toward the Galactic center region in optical (DSS)



Known microlensing event rate

Microlensing event rate revealed
by an optical microlensing survey (OGLE)



In low Galactic latitudes,

- Microlensing event rates vary at locations significantly.
- The estimates by optical surveys could be systematically biased (Sumi & Penny 2016).

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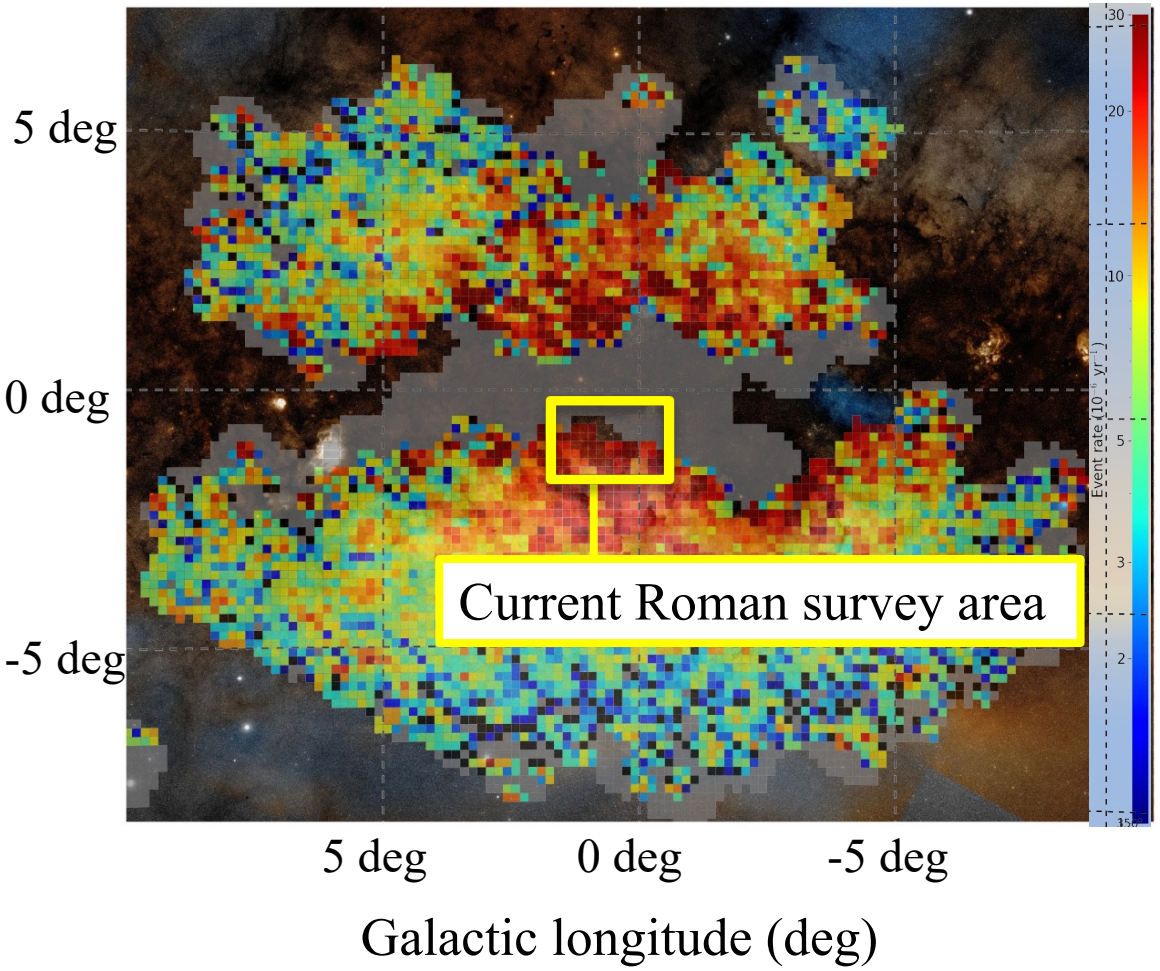

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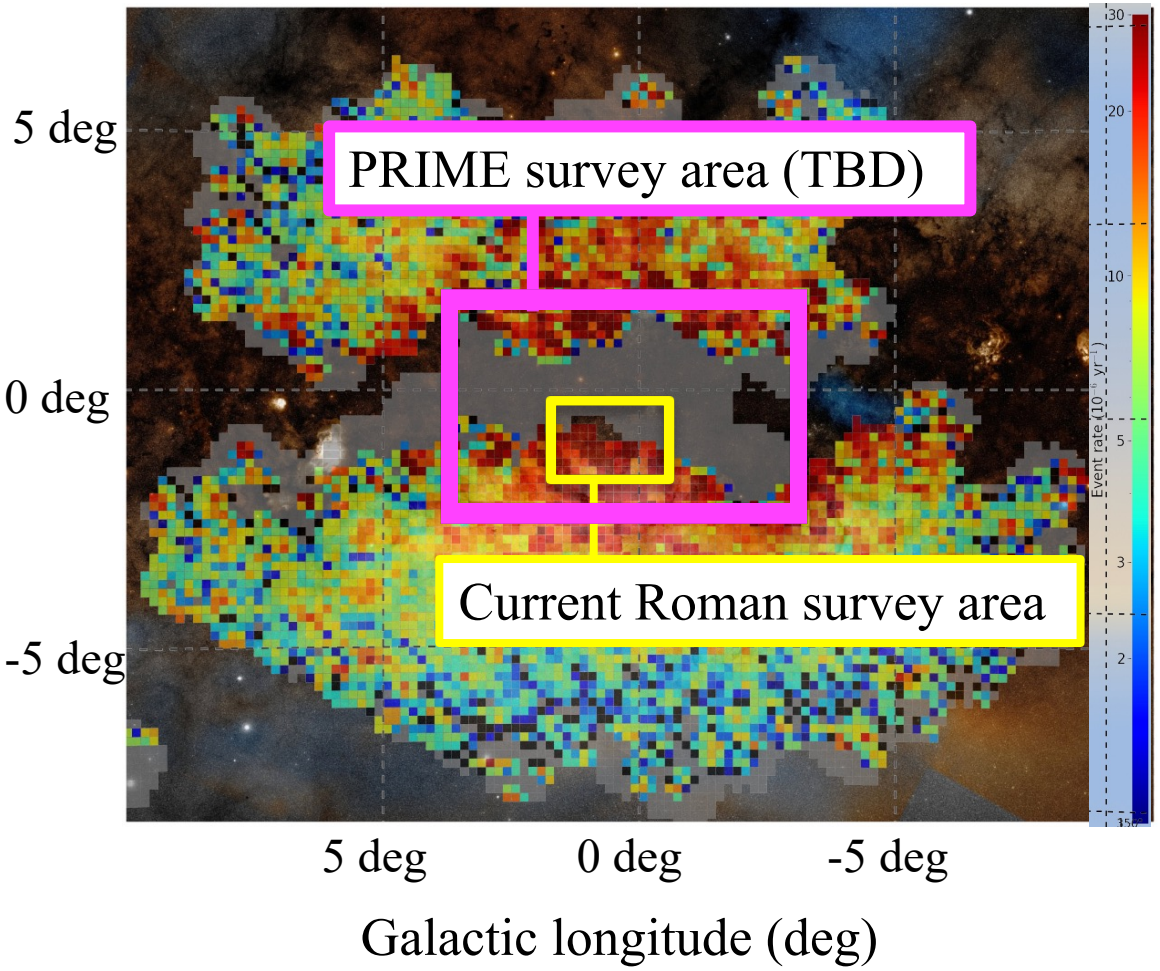
- Microlensing event rates vary at locations significantly.
- The estimates by optical surveys could be systematically biased (Sumi & Penny 2016).

The Roman survey field was determined by extrapolating the results from optical surveys.

We do NOT have any measurements of the event rate in NIR.

PRIME surveys the NIR event rates

Microlensing event rate revealed
by an optical microlensing survey (OGLE)



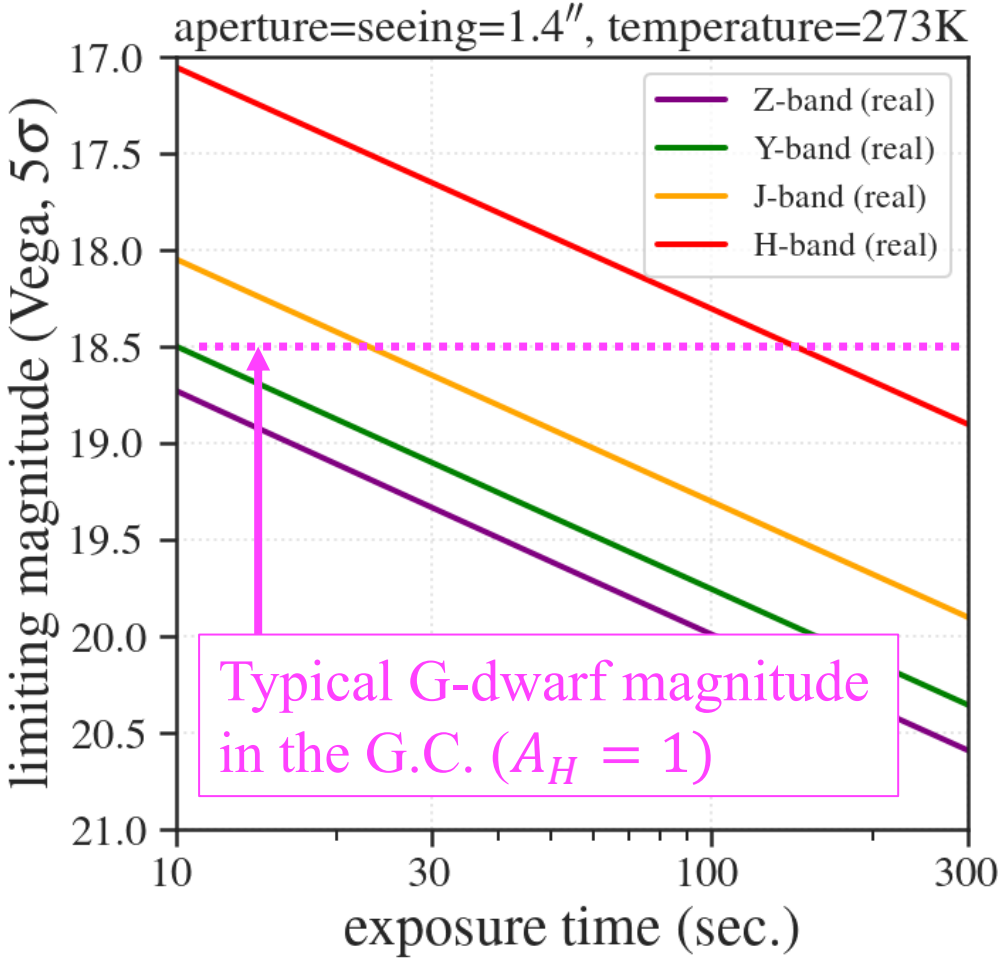
In low Galactic latitudes,

- Microlensing event rates vary at locations significantly.
- The estimates by optical surveys could be systematically biased (Sumi & Penny 2016).

PRIME will investigate the NIR event rate in the low latitude regions and contribute to optimizing the survey strategy of Roman without extrapolating results in the optical survey regions.

Expected yields based on a simulation

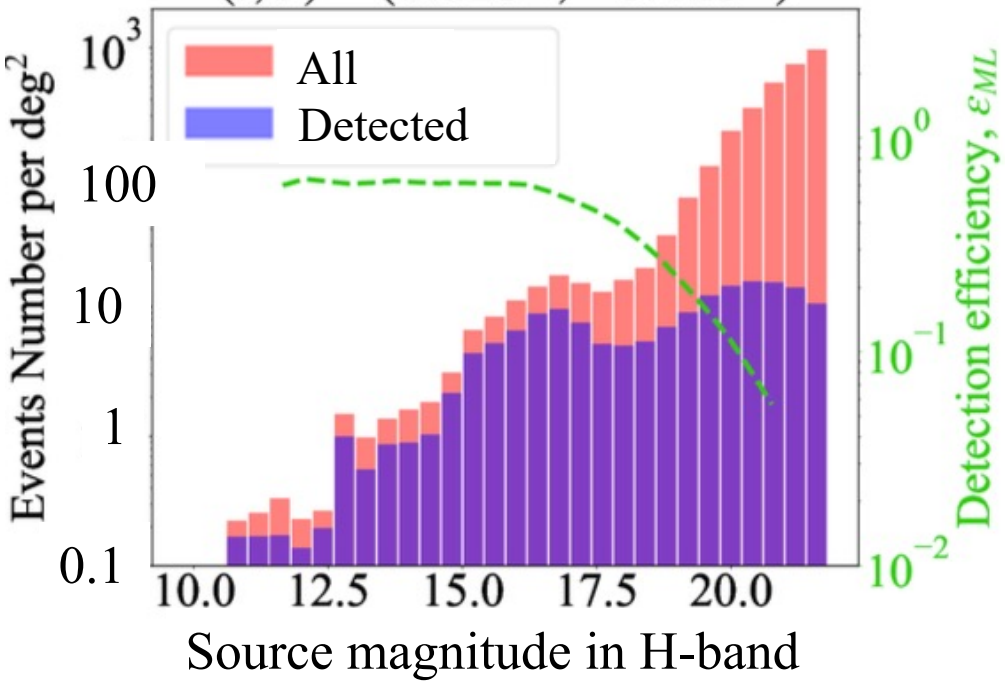
We estimate the survey yields based on a simulation using a Galactic model.



Kondo et al. in prep.

PRIME will survey with ~120-sec exposures in H-band, which can monitor typical G-dwarfs in the Galactic bulge.

Microlensed source magnitudes with 16min cadence at $(l, b) = (0.125°, -0.125°)$

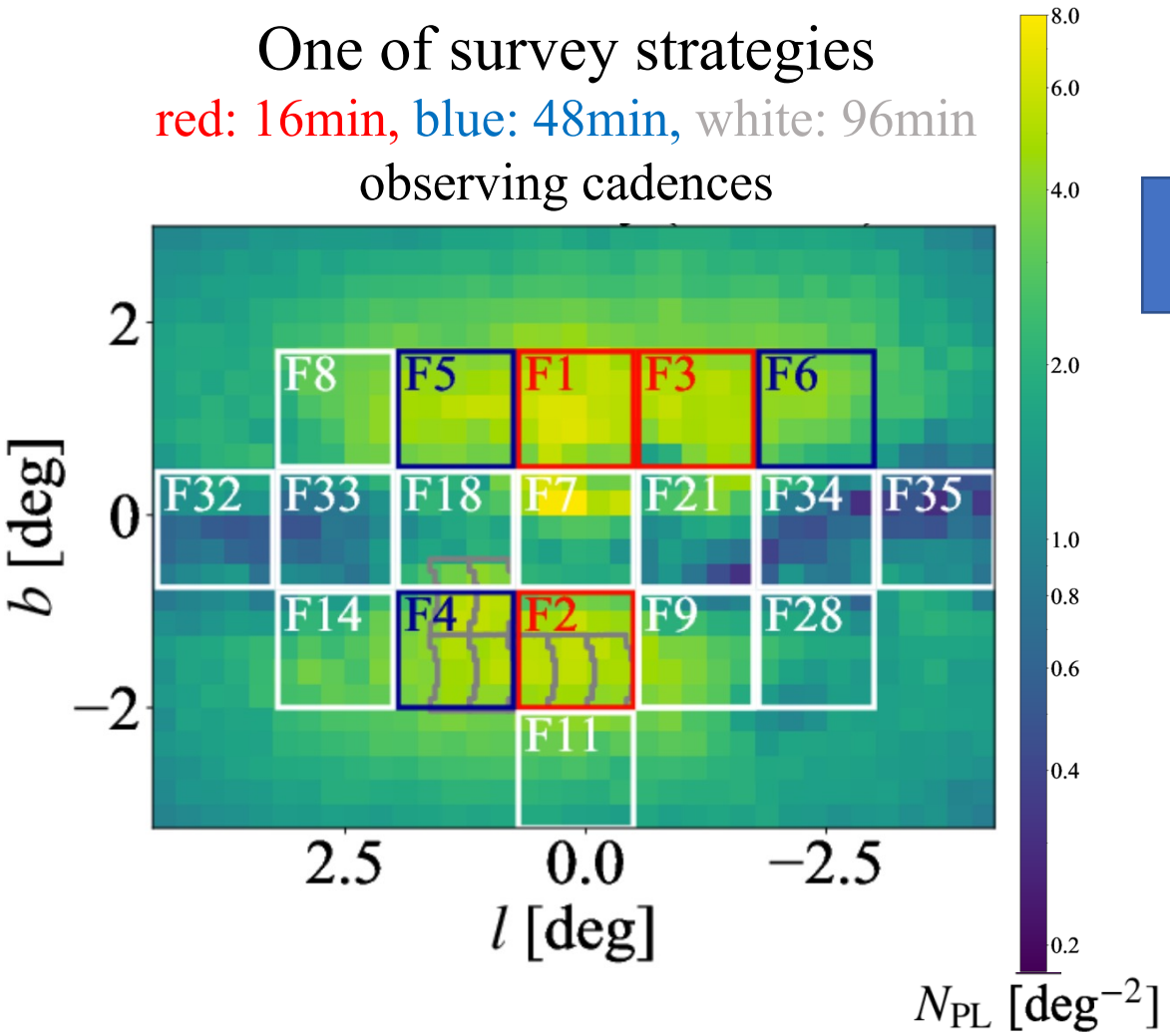


Expected planet detections

One of survey strategies

red: 16min, blue: 48min, white: 96min

observing cadences



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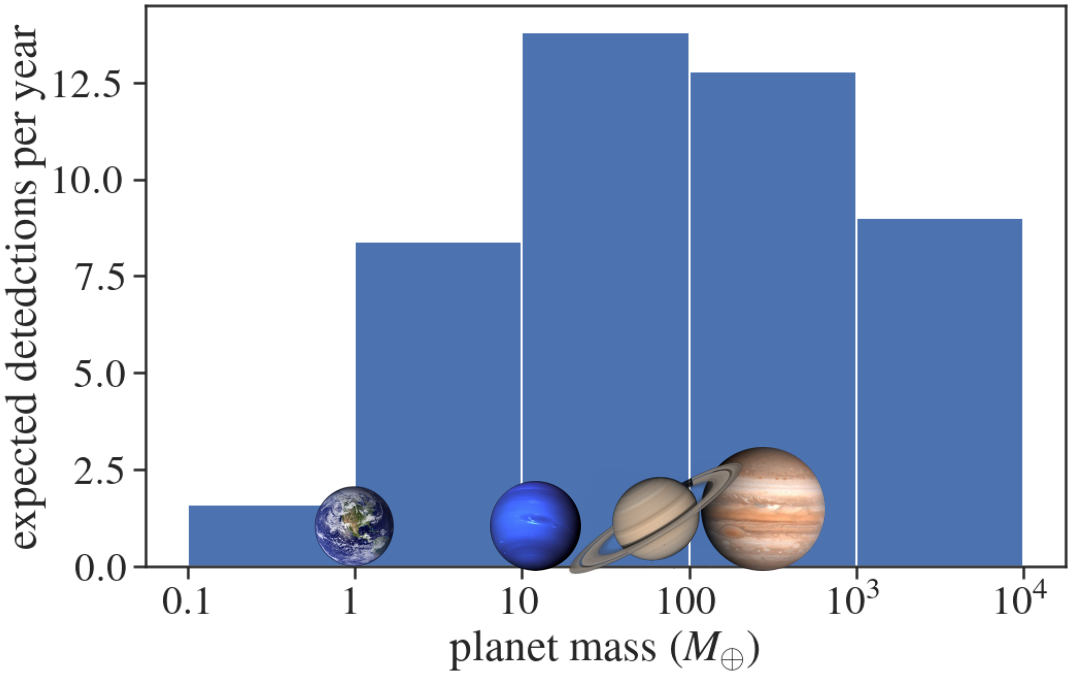


PRIME is expected to discover

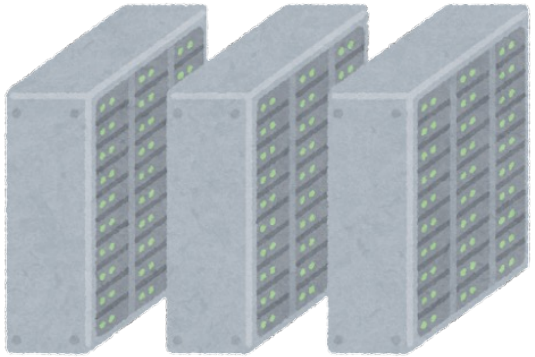
- ~ 3500 microlensing events per year
- ~ 45 microlensing planets per year

which are an order of magnitudes more than a current optical survey (MOA).

Data policy for microlensing survey

PRIME collaboration, led by Osaka U. and NASA/GSFC, will conduct data releases in the microlensing survey.

- Data release without reduction (level 1)
  Raw image data for the microlensing survey will be made public as soon as (technically) possible after daily observations.
- Data release with reduction (level 2)
  Image data after reduction will be made public by PRIME collaboration ASAP.
- Catalog-level data release (level 3)
  Optional. Light curves and some catalogs.
  We aim to maximize the use of the microlensing survey data, consulting with NASA.

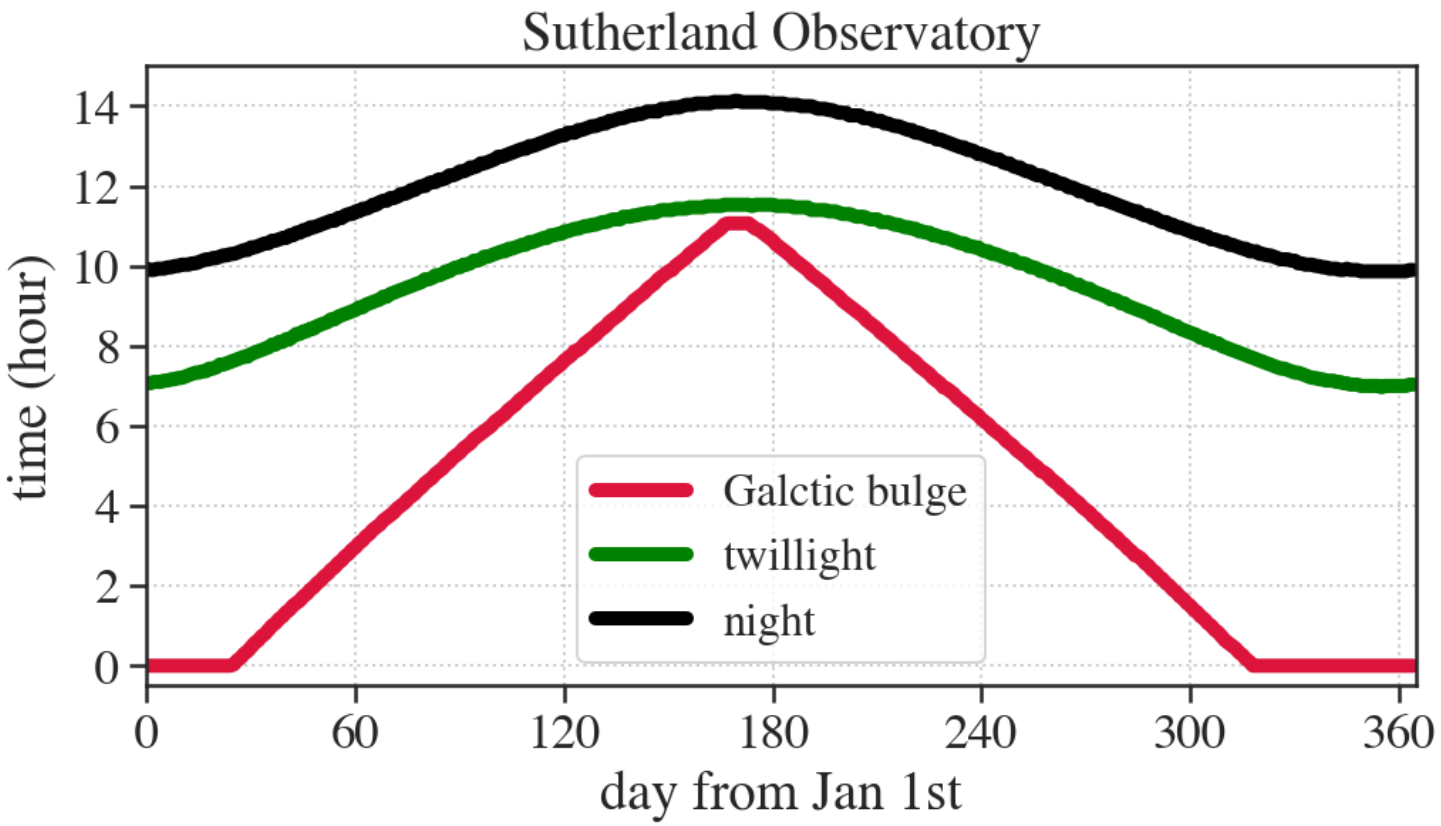


We plan to use small-scale servers at Osaka U. or an archive system at NASA. (TBD)

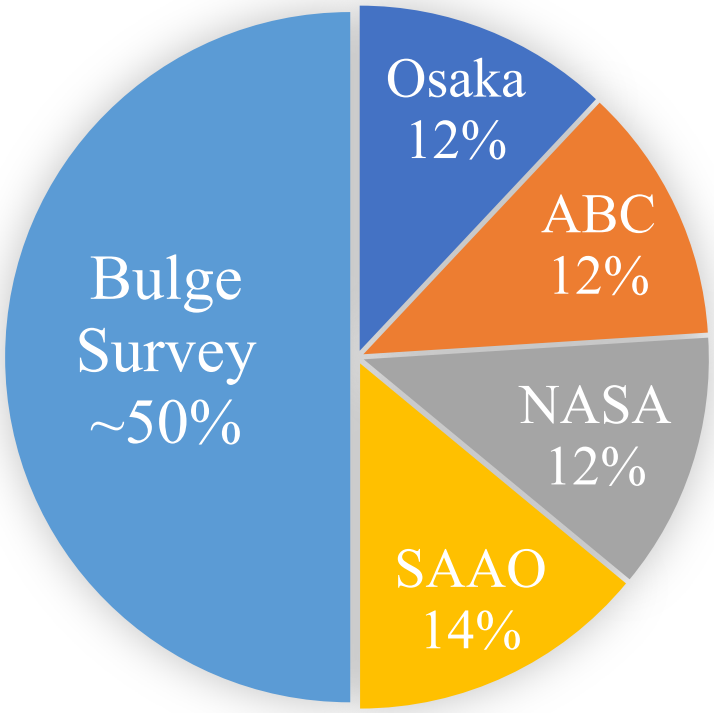
Other Sciences for Non-bulge Seasons

PRIME observation time allocation

PRIME is dedicated to conducting the microlensing survey.
The fraction of the observable time toward the GB is ~50% of nighttime.
The other time is allocated and divided by each institution.



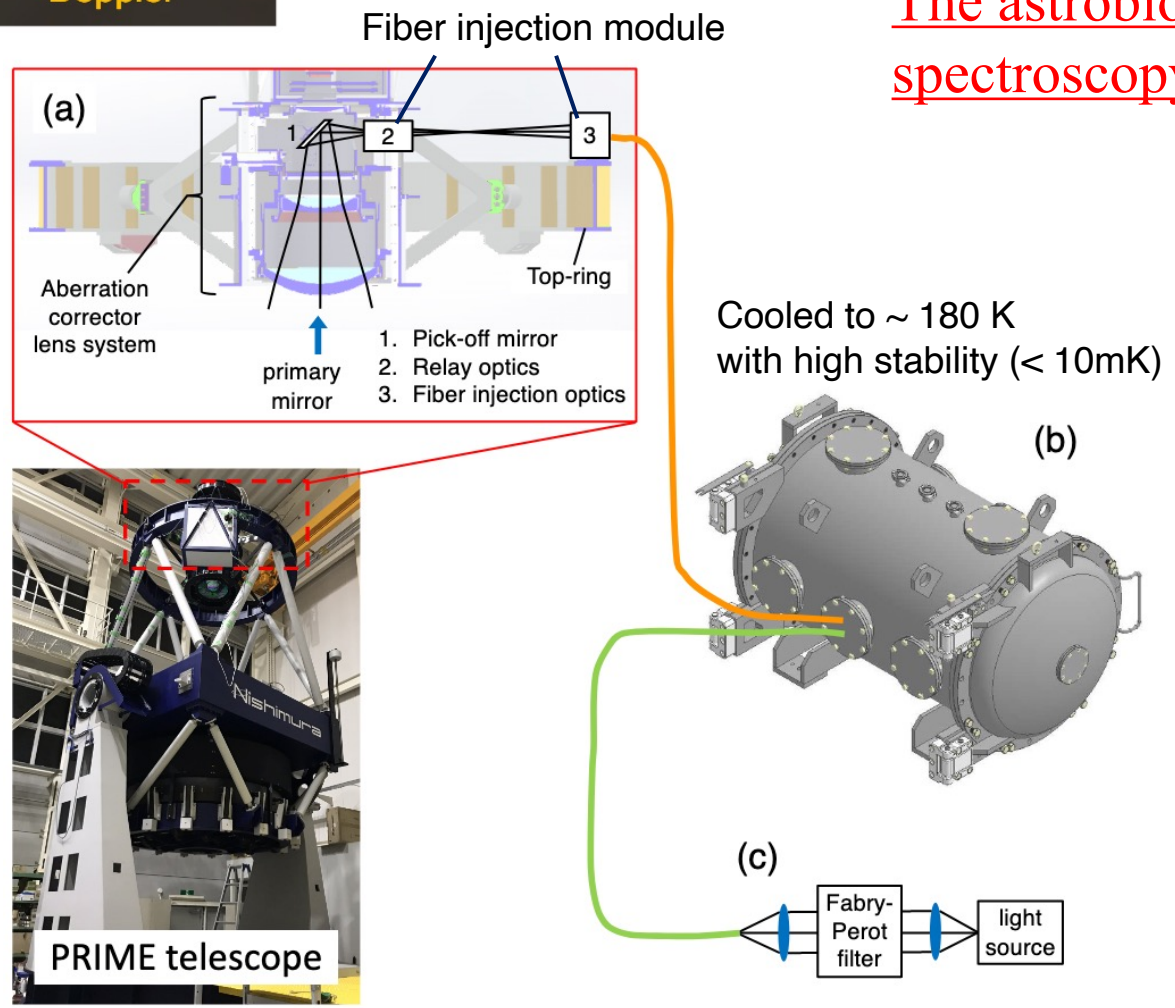
Percentages for time allocation



SAND

The South Africa Near-Infrared Doppler instrument

The astrobiology center will build a new NIR high-dispersion spectroscopy instrument on the PRIME telescope in 2024-2025.



Scientific objectives

- Survey for Jovian planets in young systems
- Survey for habitable planets around nearby low-mass dwarfs

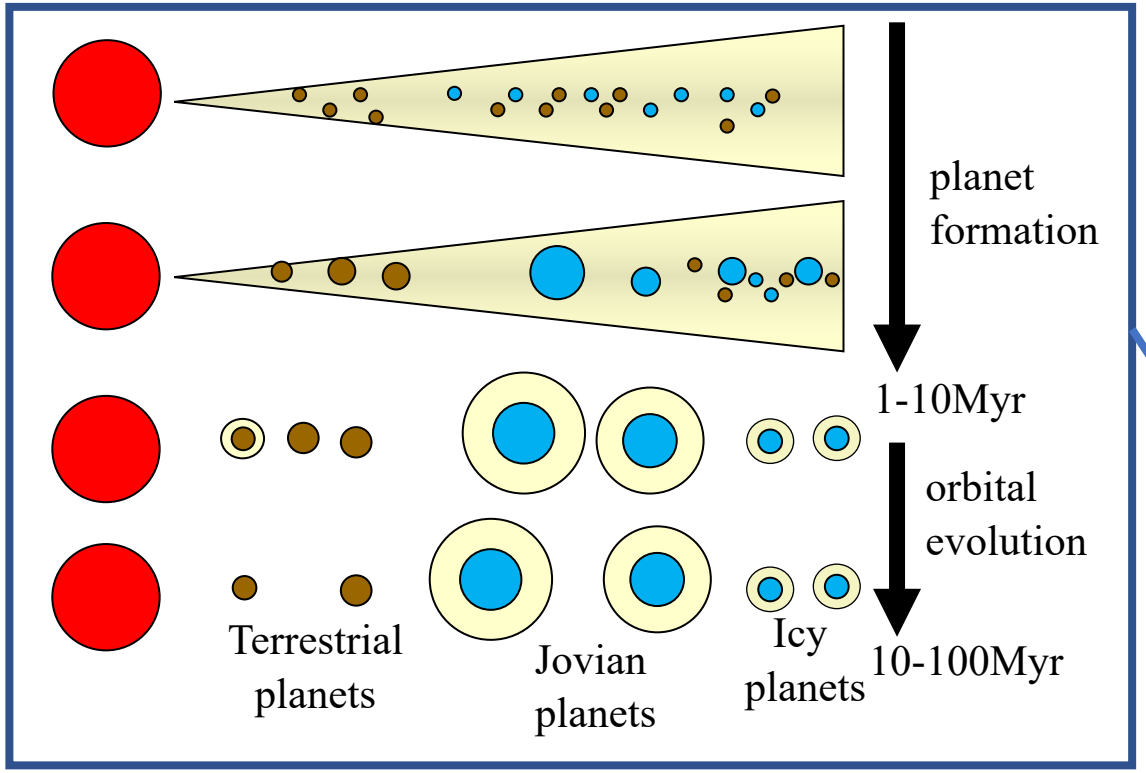
Spec.

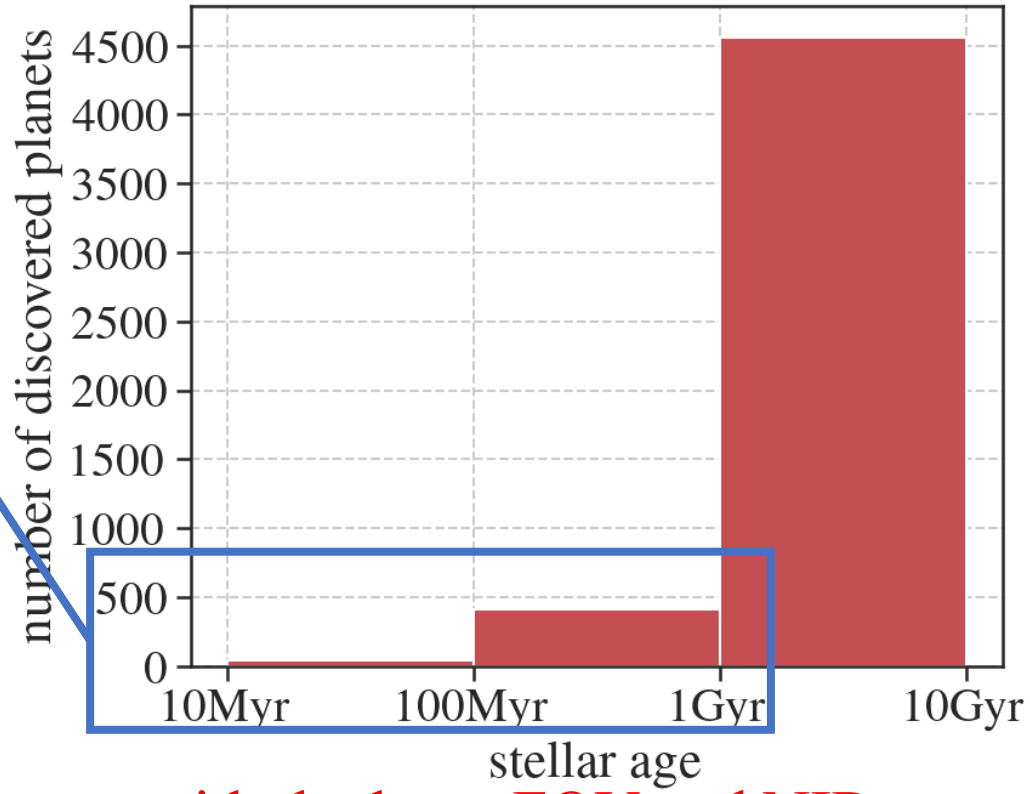
- Wavelength z,Y-band (0.83－1.10um)
- Resolution R~55,000 at maximum
- Precision σ_{RV}~2m/s for M-dwarf@10 pc without systematic noises

A plan for the Osaka time

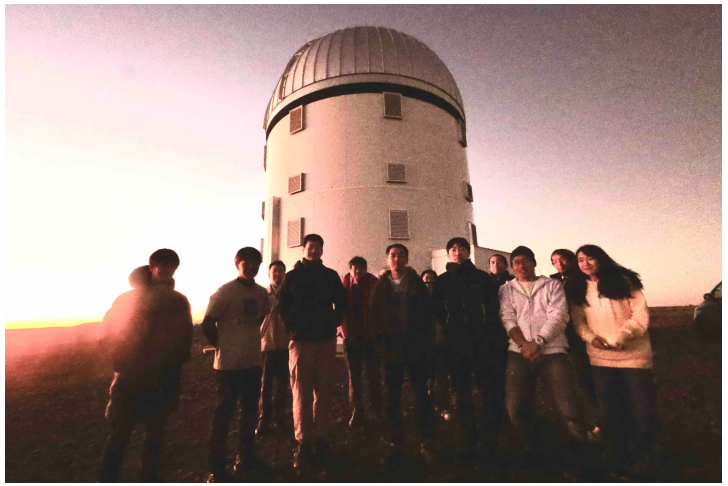
Search for transiting planets in young stellar clusters

Most of discovered planetary systems are older than 1Gyr,
while the timescales of planet formation and orbital evolution are 1-100Myr.





PRIME will explore the young planetary architecture with the large FOV and NIR.

Summary

- PRIME will conduct NIR microlensing survey toward the Galactic center whenever the Galactic bulge is observable.
- The image data in the microlensing survey will be made public after daily observations ASAP.
- Other PRIME observing times are allocated by each institution.
- The Osaka team welcomes any collaborations!