SgrA*

PRIMEの初期成果・進捗

(Sumi+25: https://arxiv.org/abs/2508.14474)

Daisuke Suzuki (UOsaka)
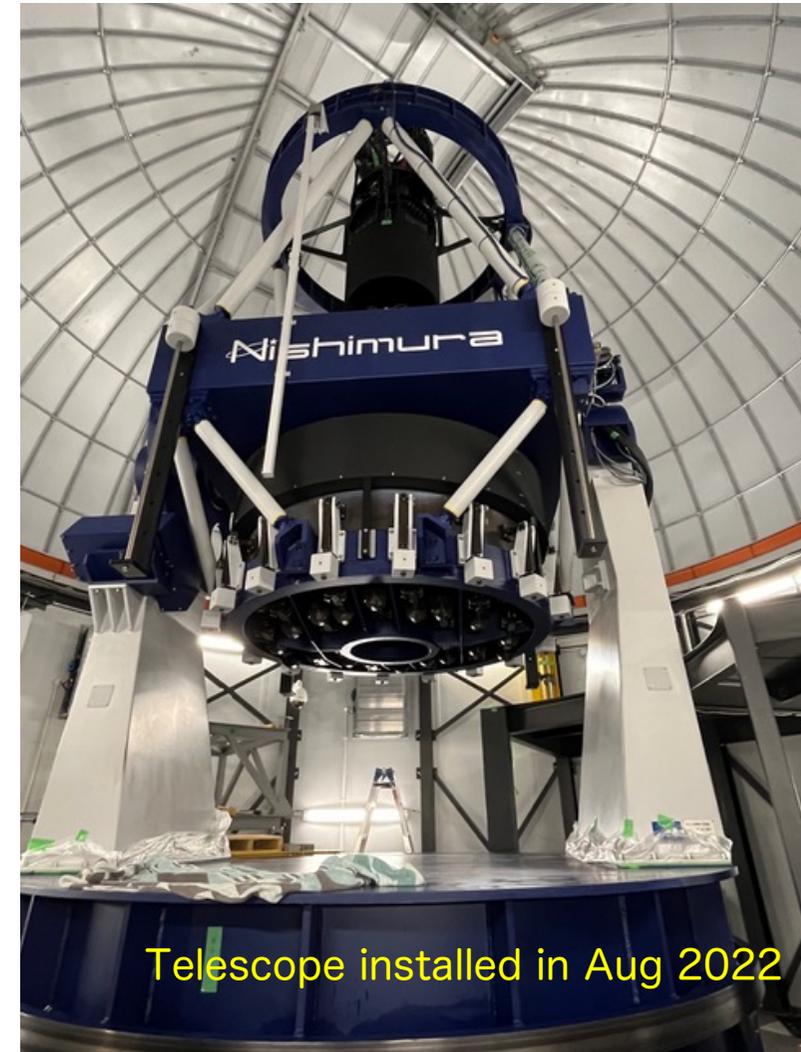
On behalf of the PRIME collaboration

Gopira symposium 2025@Kyoto

PRime-focus Infrared Microlensing Experiment

@SAAO in South Africa

- ✓ Wide FOV
- ✓ NIR
- ✓ Southern sky

Telescope installed in Aug 2022

PRime-focus **I**nfrared **M**icrolensing **E**xperiment

PRIME telescope

@SAAO in South Africa

> **New NIR telescope** build in 2022 for H-band microlensing planet survey

  - ✓ 1.8m primary mirror
  - ✓ Four H4RG-10 detectors used in PRIME-Cam
  - ✓ FOV = 1.45deg^2
  - ✓ Filters: ZYJH, NB1063, NB1243, NB1630
  - ✓ Lim Mag: 18.5mag in H-band (5sigma, 100s exp.)

> Operated by UOsaka team

> Time allocation:

  - ✓ μlens survey:50%
  - ✓ SAAO: 14%, OU, ABC, NASA/UMD 12%

> μlensing survey has started in 2024
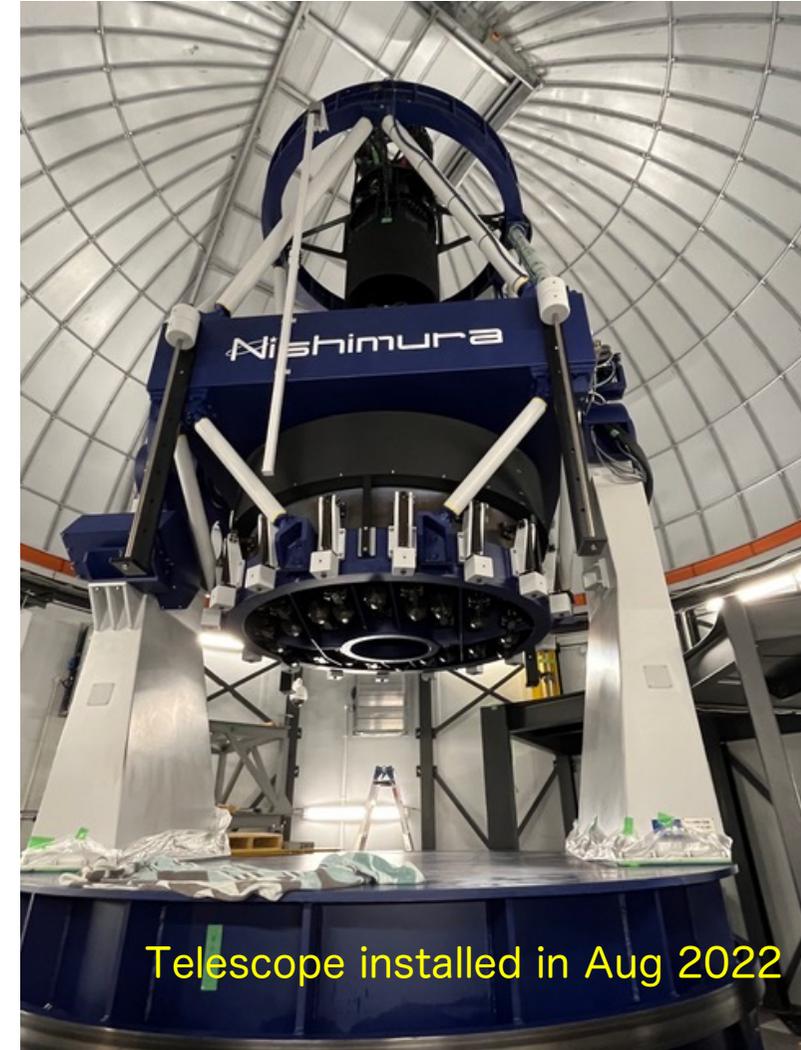
Telescope installed in Aug 2022

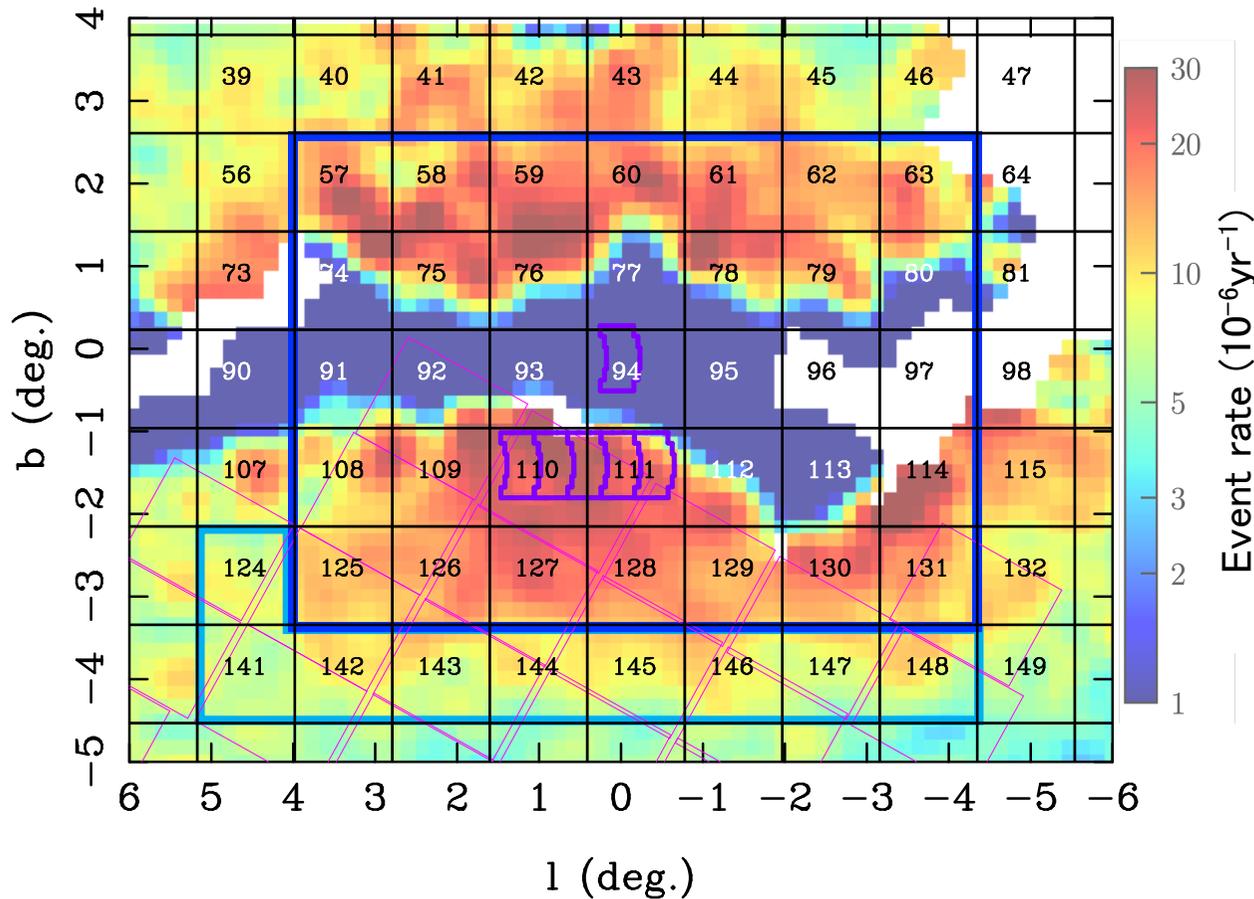# Updates from the last year

- ❖27th International Microlensing conference @Cape Town and **official openning of PRIME in January 2025**

- ❖650 microlensing candidates (incl. a few planetary events) have been found as of today.

- ❖Initial result was summerized in Sumi+2025 (recently accepted)

- ❖Preliminary analysis of NIR microlensing event rate in 2024 data

- ❖Thousands of variable objects were found (led by Matsunaga-san)

- ❖~20 GCN circluars issued for the ToO observations so far.

@Cape Town, SAAO HQ

PRIME TELESCOPE
DR ROSALIND SKELTON | MANAGING DIRECTOR, NRF SAAO | eNCA

18 53 NOUNCES STAGE 3 ROLLING BLACKOUTS WILL BE IMPLEMENTED FROM 5PM TODAY | CITY OF CAPE TOWN
DURBAN 20 / 29   PIETERMARITZBURG 17 / 30   MAHIKENG 20 / 33   BLOEMFONTEIN 21 / 36


@Sutherland Observatory

PRIME Microlensing survey in 2024-June 1, 2025

- Uniform survey of 35 fields (roughly 50deg^2) in H-band to get the baseline

- J-band every 3nights

- Y-band every 10nights

- 60sec exposure in H-band
  - ~1hr cadence

- 120sec exposure in J and Y

- w/ dithering to mitigate the hot/warm pixels

- GC sky field (l, b)~(10, 10) is taken every 2hrs after 2025

# PRIME Microlensing survey in 2024-June 1, 2025

Sumi+25
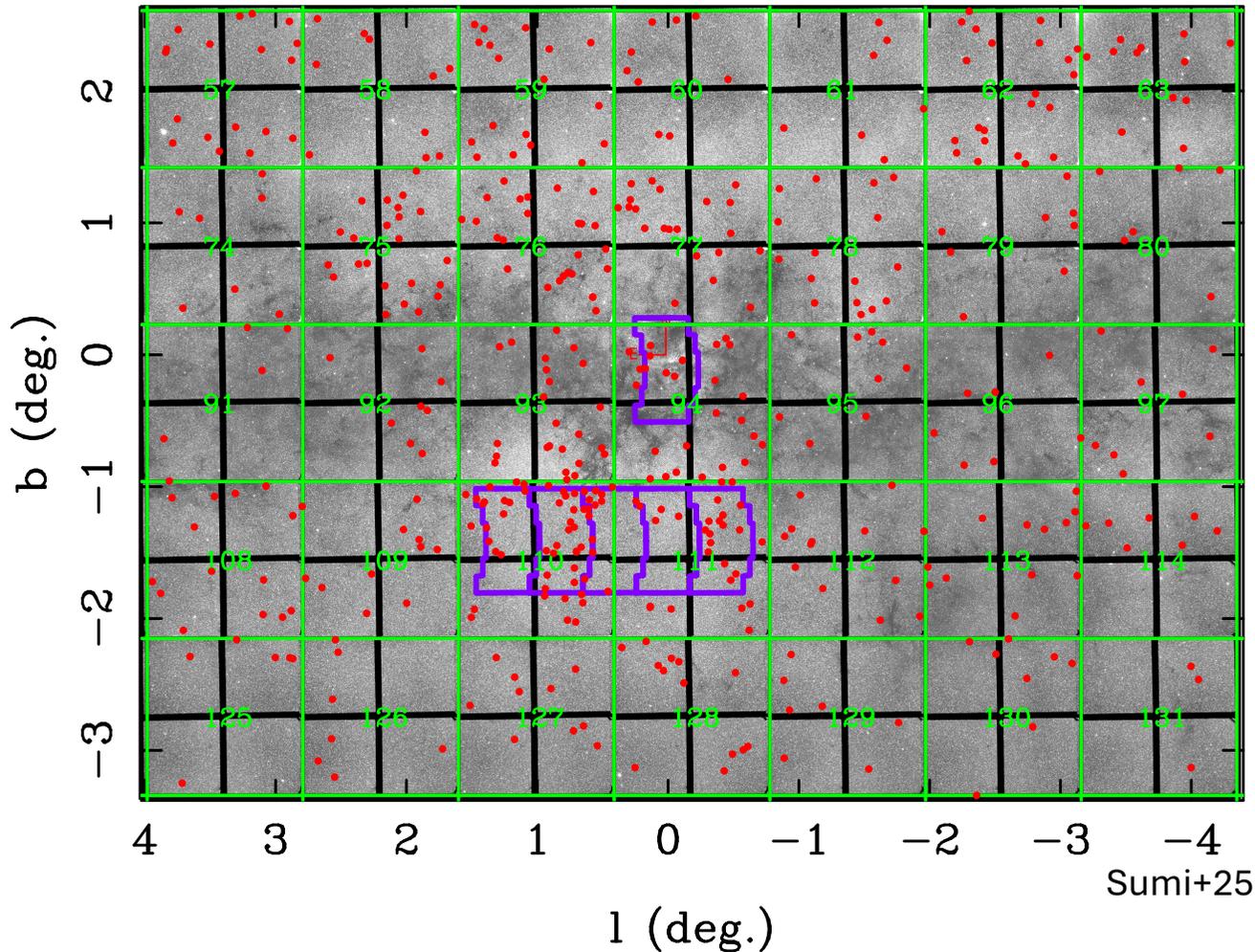
> **486 microlensing events in 2024-June 1, 2025**

> Variable objects are detected via image subtraction pipeline

> μlensing events have been selected by eye-scan of Delta-flux light curves
> - ✓ Machine learning software is being developed for systematic search in real time

PRIME FWHM for the bulge survey

median= 1.33 arcsec
mode = 1.20 arcsec
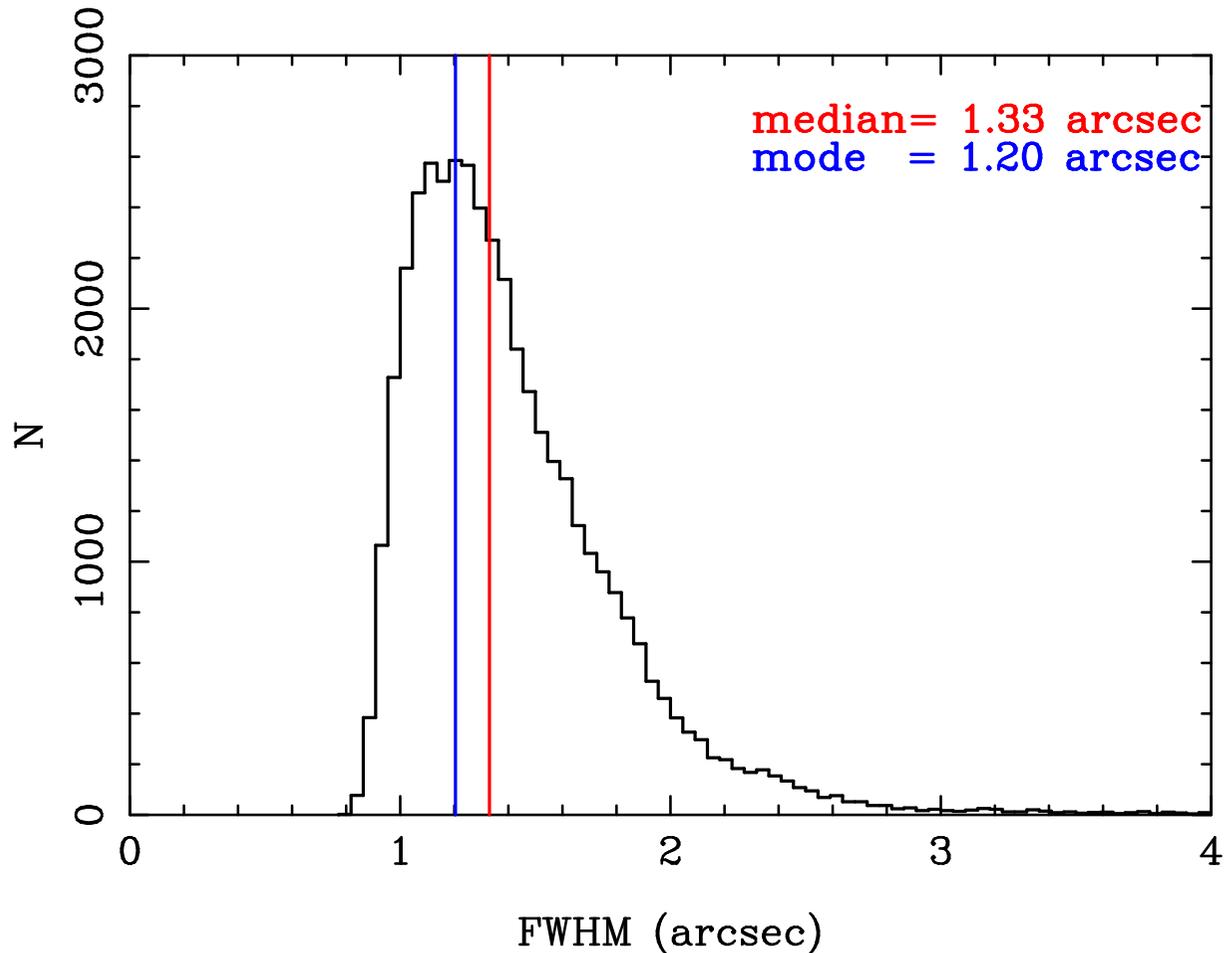
➤ DIMM (V-band) median: 1.4", which expects 1.1" in H

➤ PRIME telescope is 5m above the ground

➤ But, optics (50% EED of 0.45"), dome seeing, focusing...

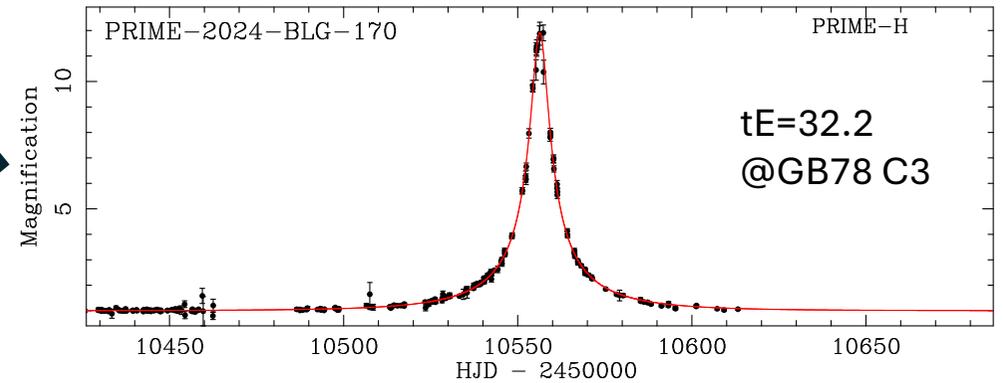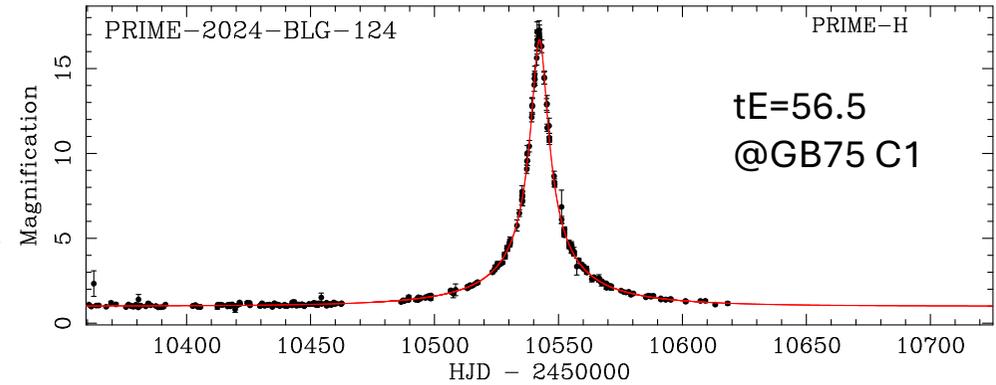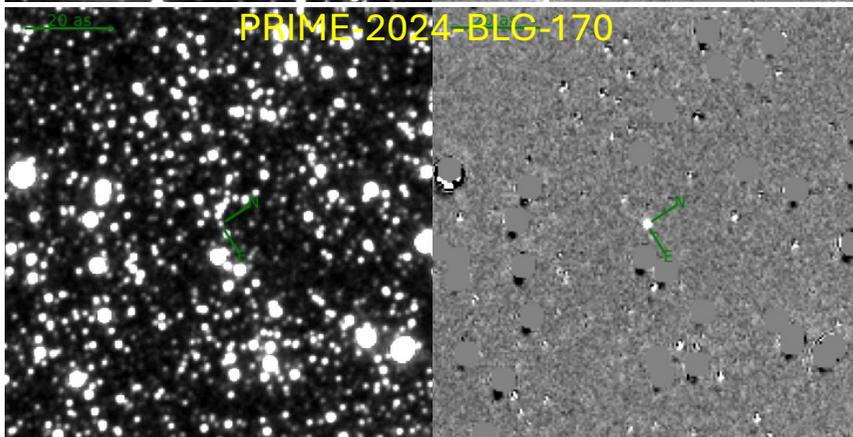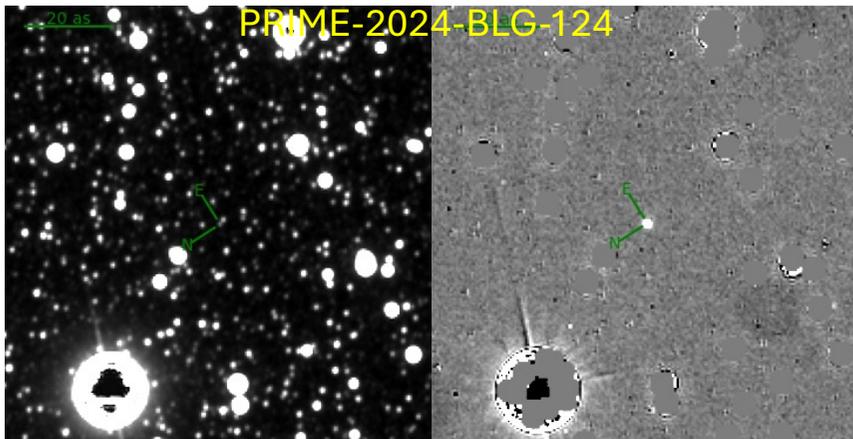➤ Good enough for a ground based microlensing survey

PRIME photometry in GB94
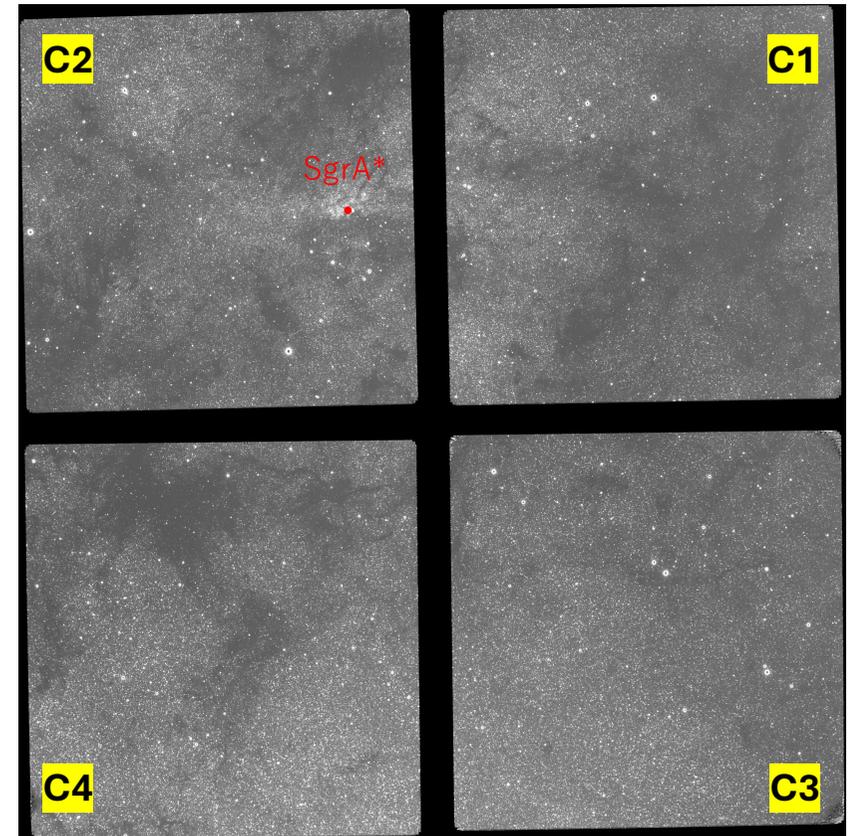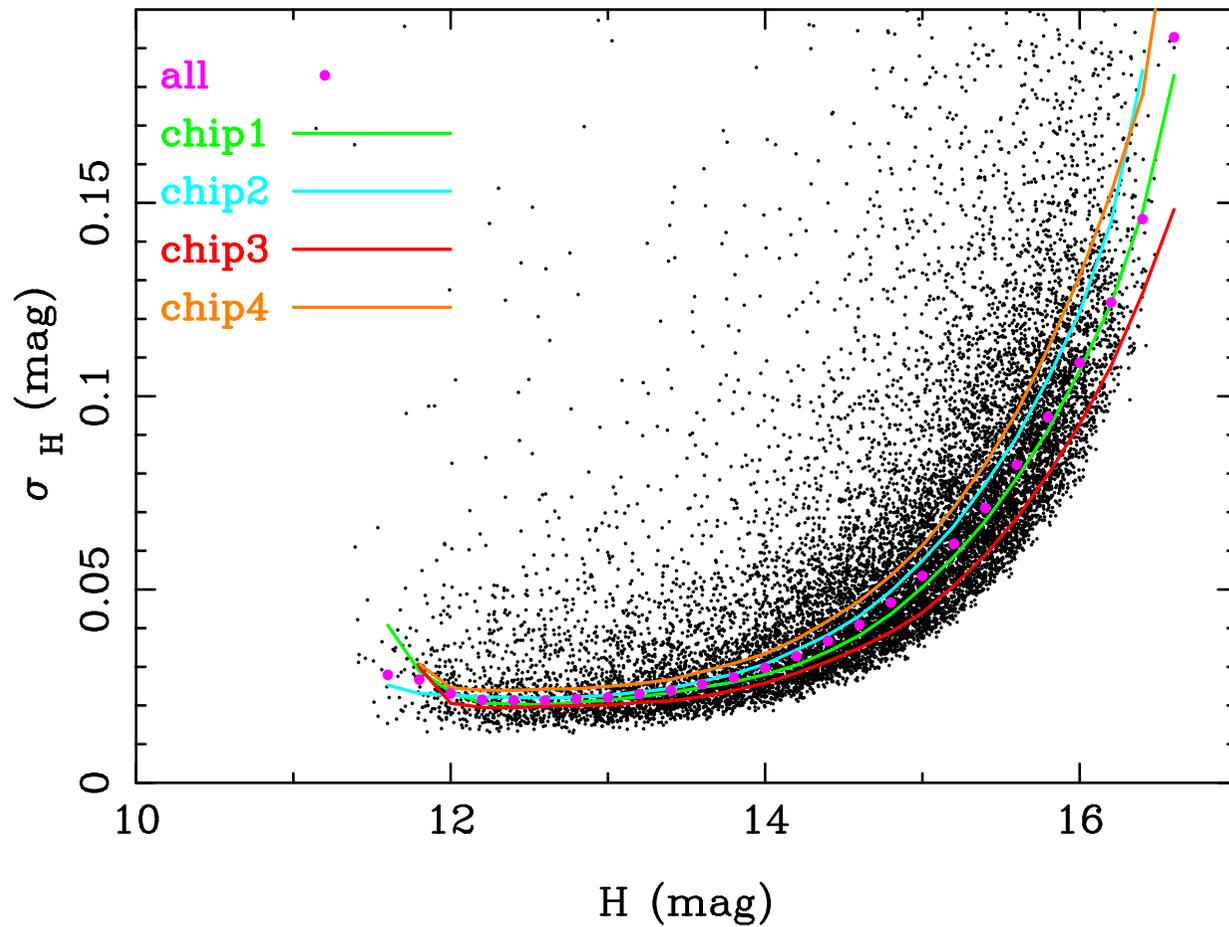
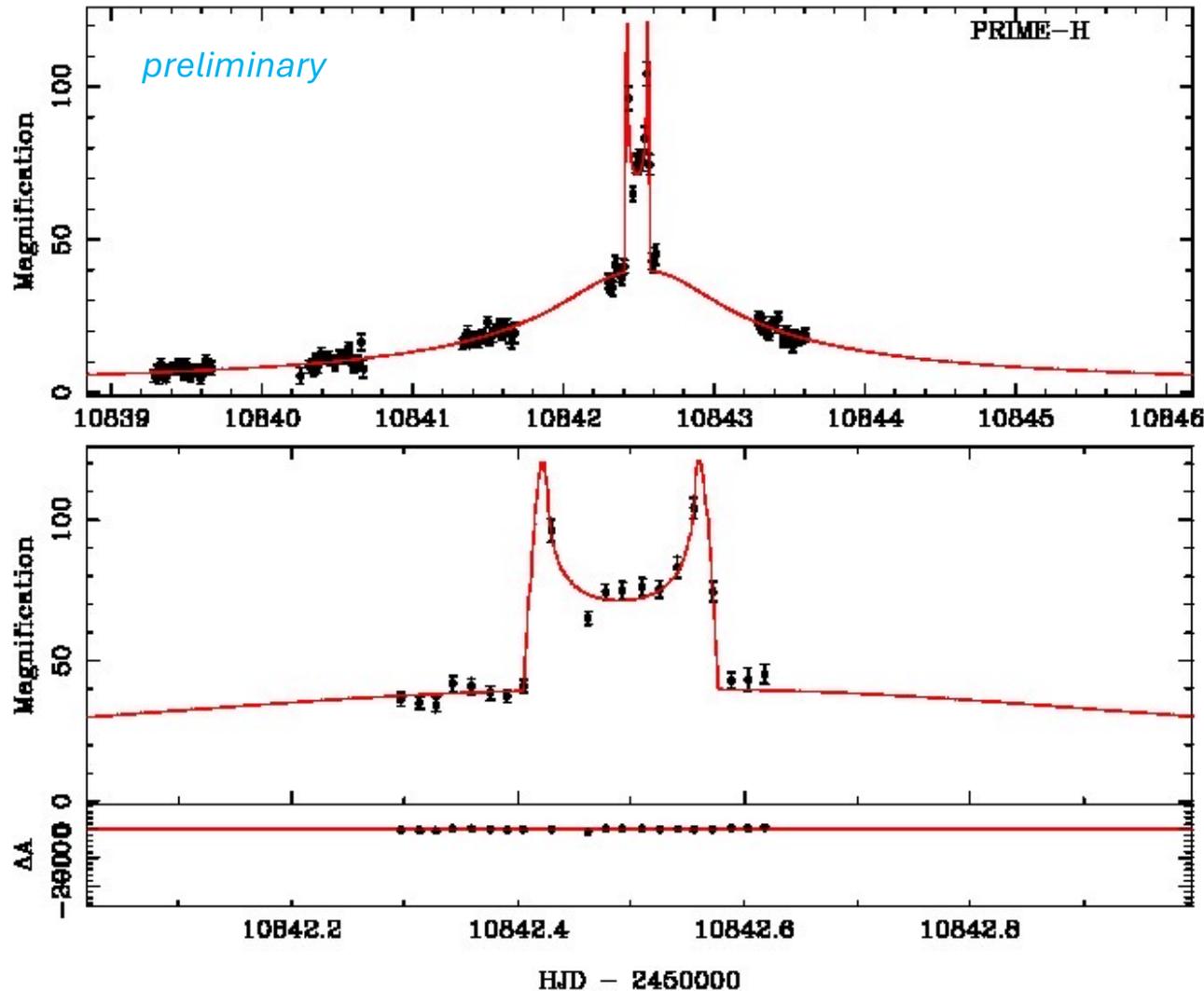# Difference Image Analysis

current   subtracted

PRIME-2024-BLG-124

PRIME-2024-BLG-170

tE=56.5
@GB75 C1

tE=32.2
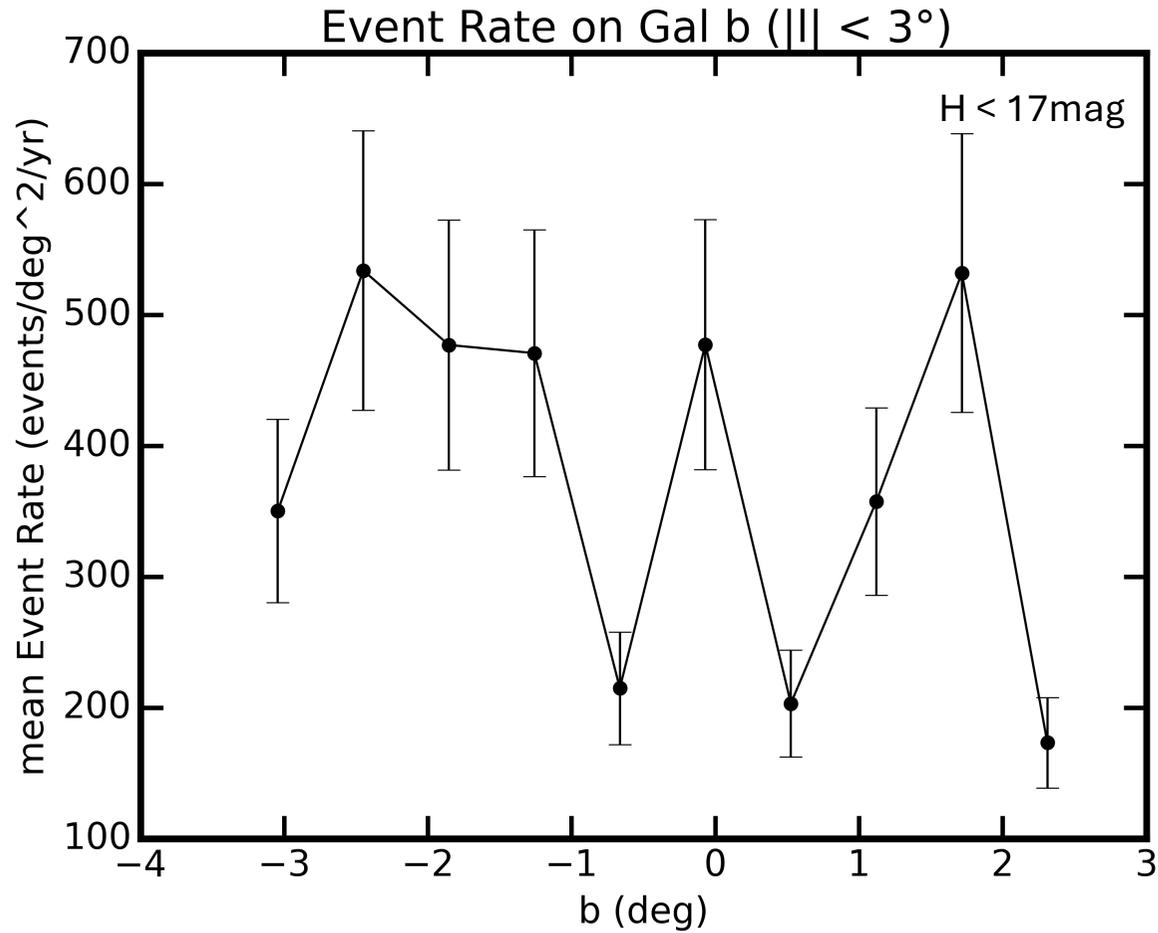@GB78 C3

First microlensing planet in the PRIME survey

- $t_E \sim 20$days

- Mass-ratio, $q \sim 3.6E-3$

- Finite source effect is marginally detected

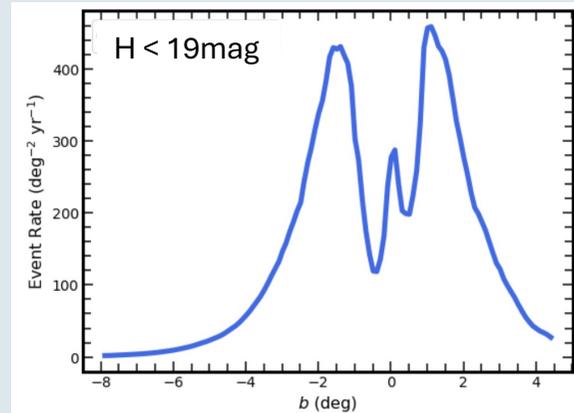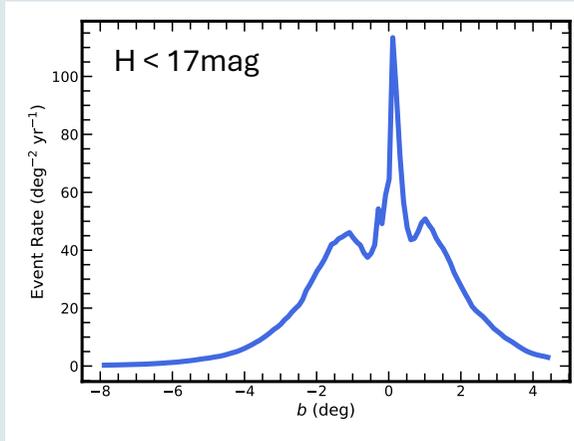- Only PRIME alert. (Not alerted by KMT and OGLE although this is in their survey fields)

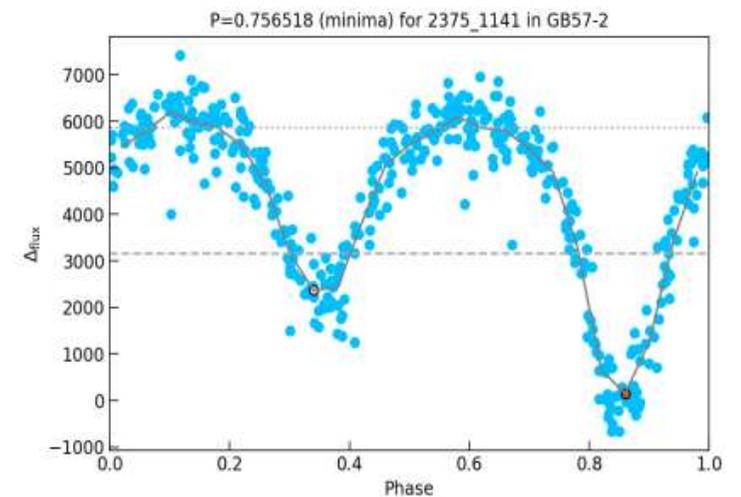# PRIME Microlensing Event Rate

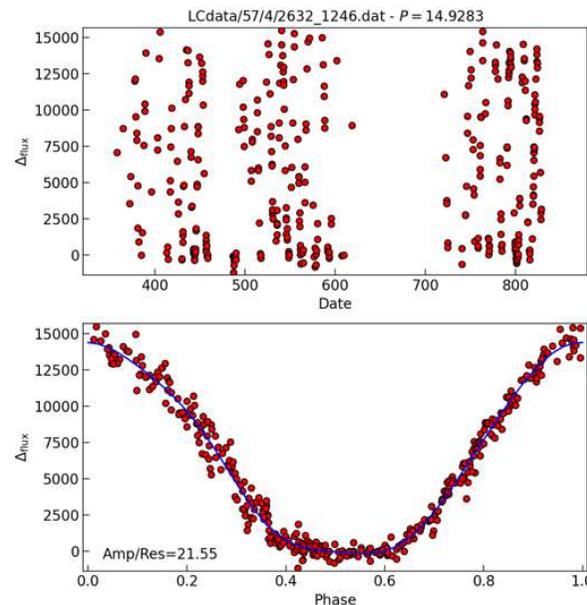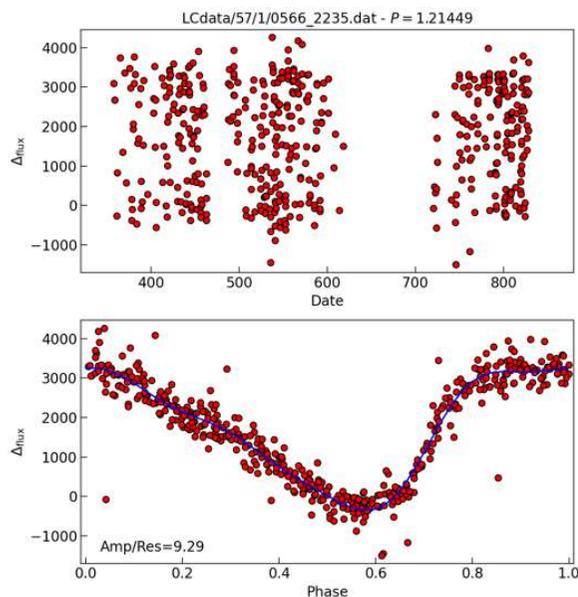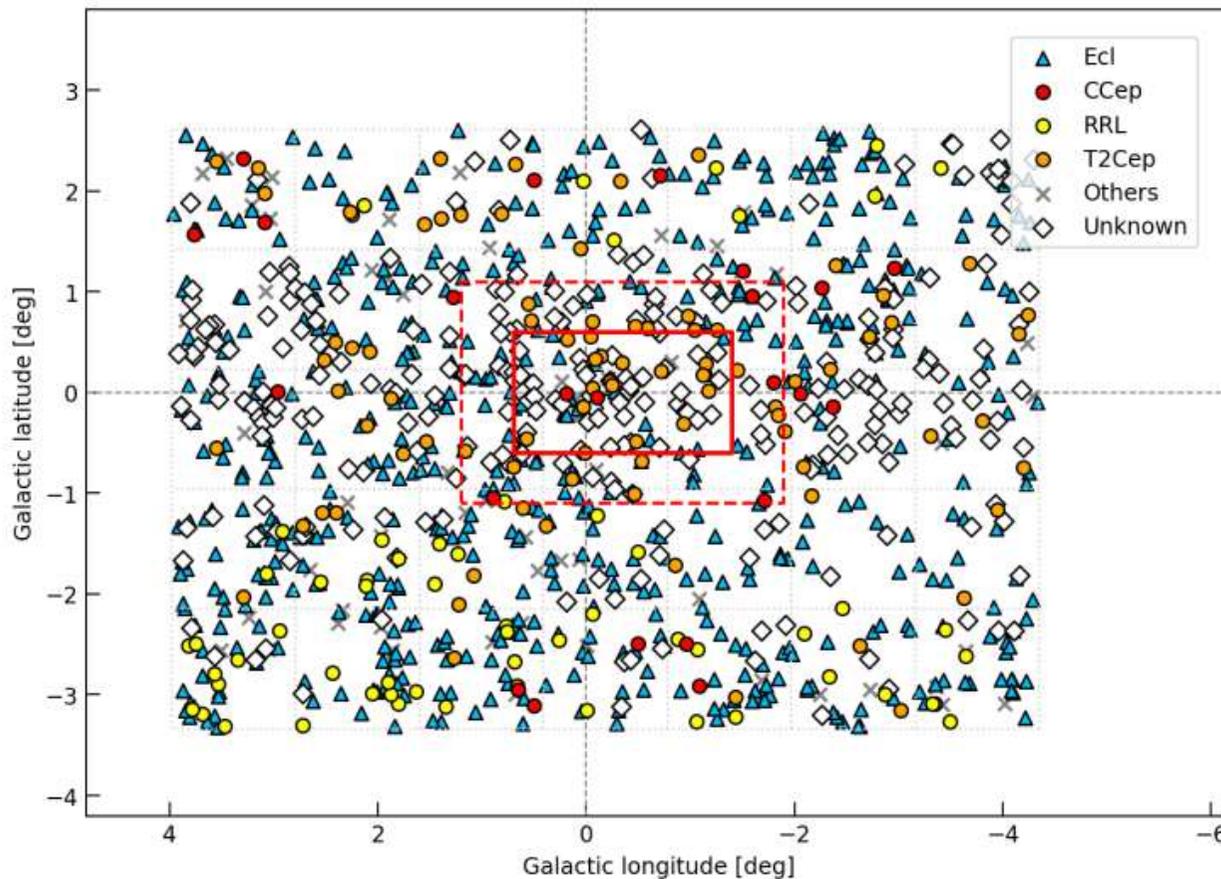Very PRELIMINARY

Search for short-period variables

- **Lomb-Scargle period search for 0.05 < P < 100 days.**
  - To avoid aliases, I ignored P~1 and 0.5 days.
  - Clipping based on the scatters around folded light curves and eye inspection.

- **1080 short-period variables were selected.**

Cross-match with previous catalogs

Type	Number
Classical Cepheid	23
Type II Cepheid	87
RR Lyrae	58
Eclipsing Binary	583
Other kinds	61
No match	268
Total	1080

Foreground variables were detected even in low-latitude areas, while new variables are expected to be intrinsically bright stars in the bulge.
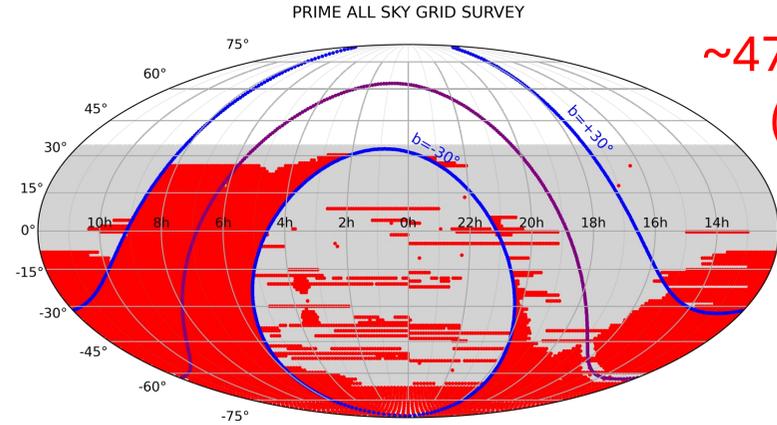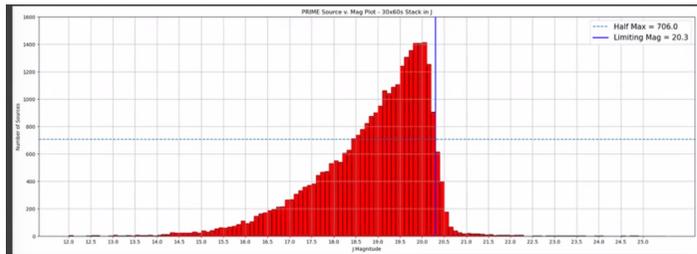
PRIME OBS TIME distribution

Time Usage by Each Institute as of 2025-10-30
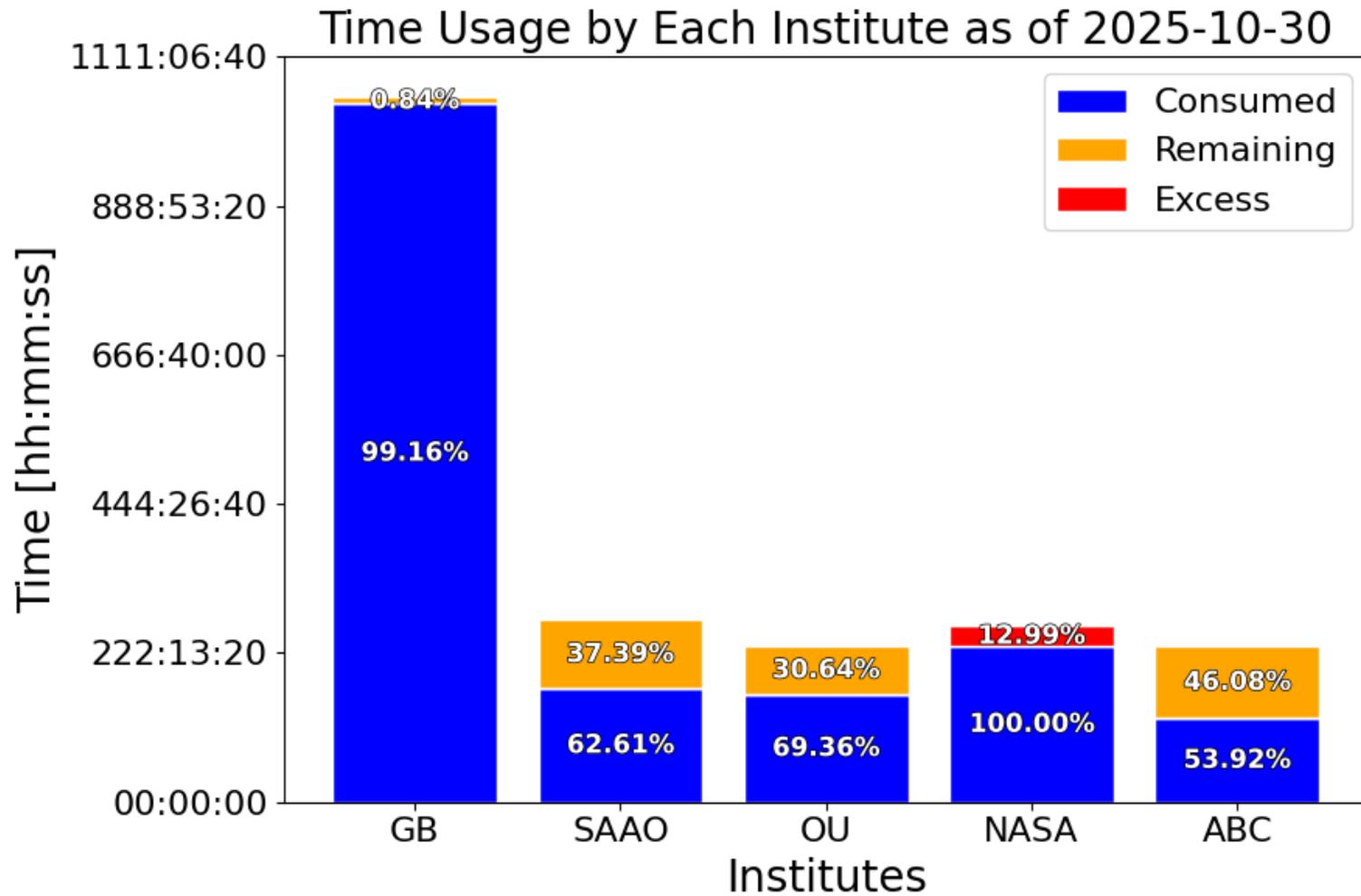
Status of non-bulge science

✓ Pre-defined All-Sky-Grid Imaging with J-band

PRIME ALL SKY GRID SURVEY
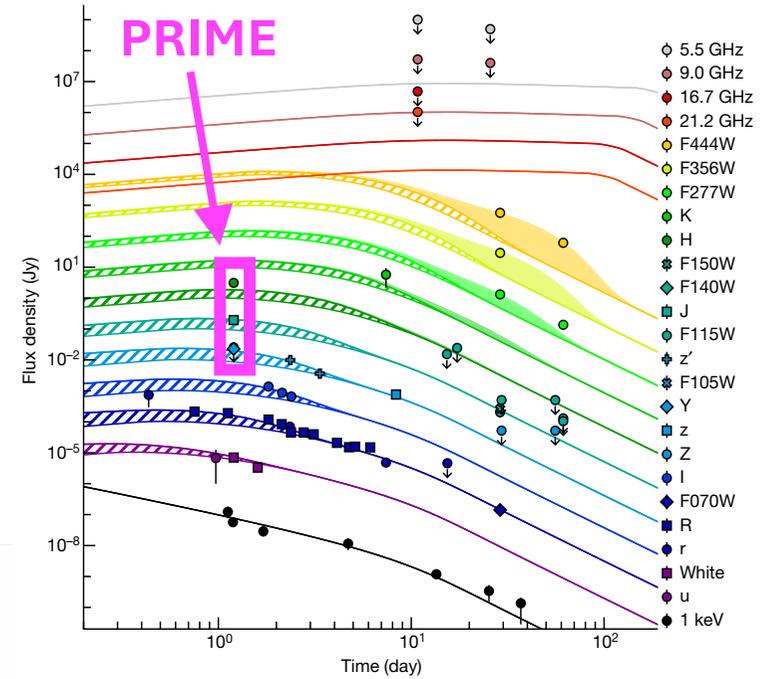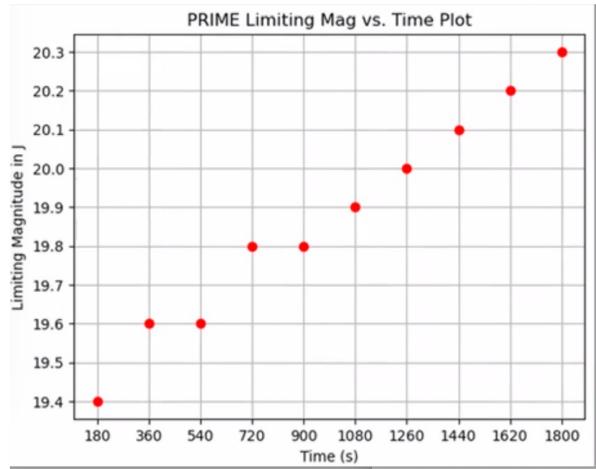
~47% are imaged
(not analyzed yet)

✓ ToO for trangients, Kilonova survey led by NASA team

20.3 mag in J-band for 30min exposure time

PRIME Limiting Mag vs. Time Plot

PRIME

Legend:
5.5 GHz, 9.0 GHz, 16.7 GHz, 21.2 GHz, F444W, F356W, F277W, K, H, F150W, F140W, J, F115W, z′, F105W, Y, z, Z, I, F070W, R, r, White, u, 1 keV

GRB230307A (Yang+24)

17

Challenges

❖ **Image quality: the bulge images could be shallower than expected**

- whereas the image quality (limiting magnitude) toward high-latitude is as *preliminary*
  epected
- => sky subtraction and stacking process
  could be improved for the bulge survey images

w/ sky subtraction   w/o sky subtraction

❖ **Evaluation of Brighter fatter effect, persistence**

❖ **Remote observations**: The system is ready, but...

❖ **Automation of observations**: needs some major updates of software

❖ **Data storage (raw data=121TB/yr), catalog release...**

❖ **Man power and budget...**
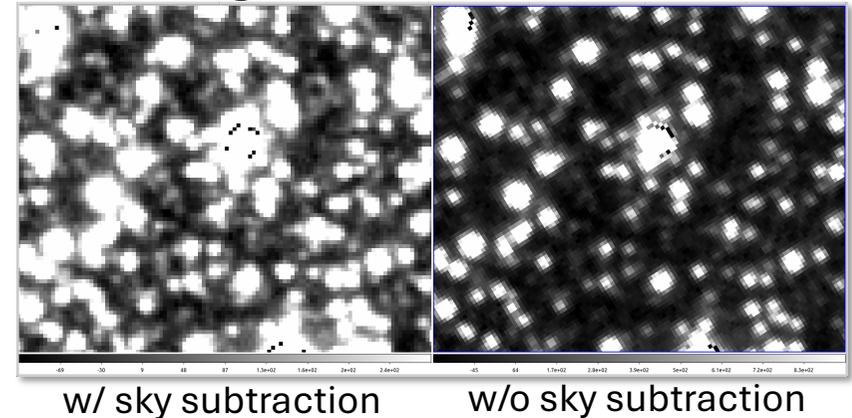
PRIME F2F meeting at Rome

❖ To complete the MOU

❖ Data challenge
- o Ian Bond's (MOA's) pipeline
- o Ryusei Hamada's pipeline (with Kishalay De)
- o NASA team pipeline

❖ To make better ToO system

PRIME-JASMINE

❖ PRIME Miras survey led by Matsunaga-san et al.

❖ NIR Microlensing Event rate map to test the Galactic models

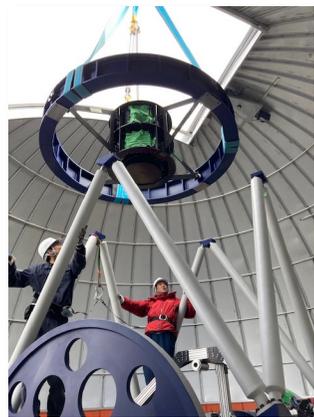❖ Astrometry: PRIME astrometry proposal (w/ VVV and Gaia) was accepted for the UOsaka – UCL fund

Summary

➢**PRIME microlesing survey started in 2024.**

➢~650 microlensing events (incl. a few planets) have been discovered

➢Thousands of variable objects

➢NIR microlensing event rate is being analyzed.
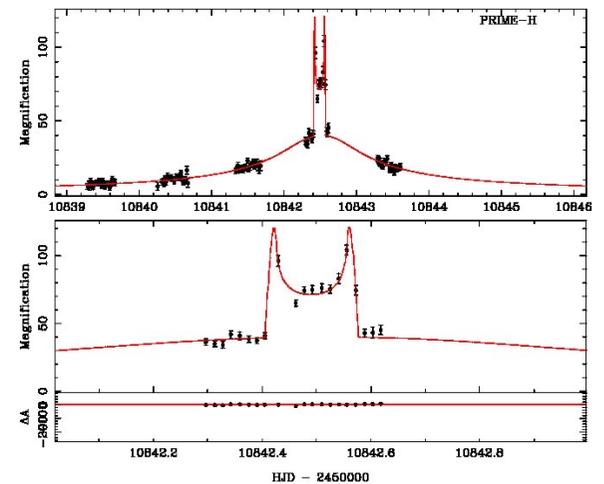
➢~20 GCN circular were issued (~50 ToO was triggered so far)

2020 Oct

2022 July

2022 Oct

2025 June