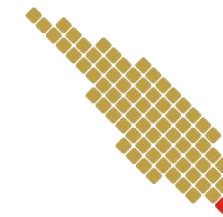


Seimei telescope.



**BRIN**

BADAN RISET  
DAN INOVASI NASIONAL



**ITERA**



## Introduction to Timau Telescope and Idea for Research Collaboration with Seimei Telescope

Emanuel Sungging Mumpuni\*, Thomas Djamaluddin, Gerhana Puannandra Putri, Hakim L. Malasan, Robiatul Aji Muztaba, Abdul Rachman. Clara Y. Yatini

Seimei User Meeting – 10/09/2024

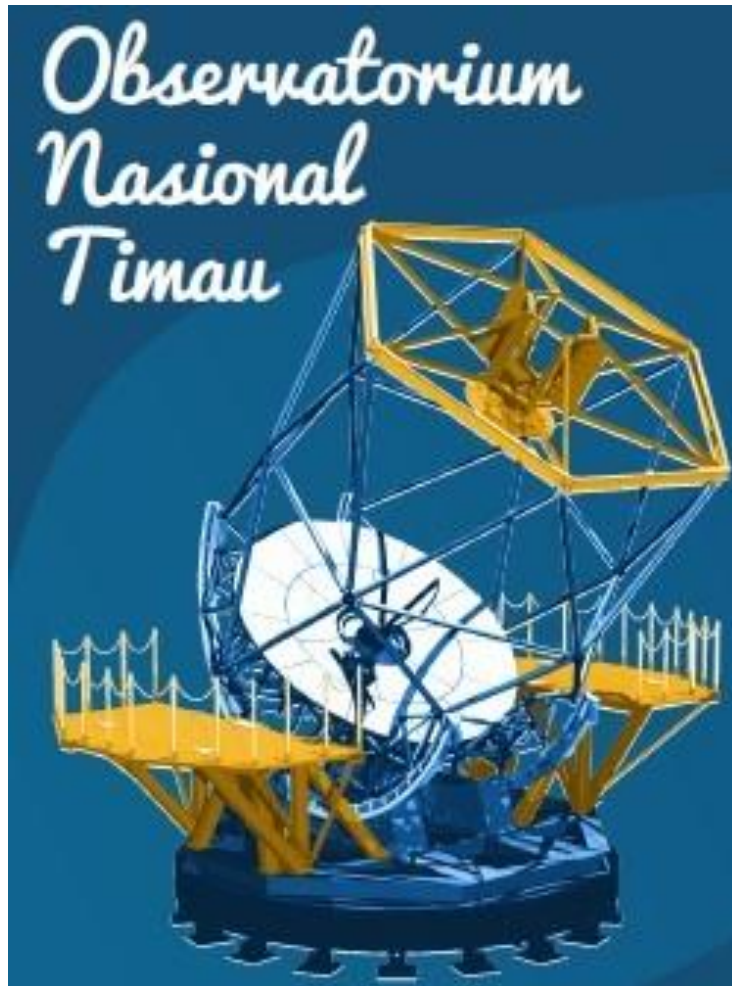


# Introduction



- Indonesia is establishing a modern astronomical observatory on Timor Island, East Nusa Tenggara, Indonesia. This future observatory aims to answer fundamental astronomical questions and to strengthen the nation through education, research, science and technology.
- This facility is located on Mount Timau ( $9^{\circ} 35' 50.2''$  S,  $123^{\circ} 56' 48.5''$  E) at an altitude of around 1,300 meters above sea level. Current measurements show seeing of 1.2 arcseconds in median and as low as 0.6 arcseconds, but the humidity varies and may reach 70–95%.
- With its unique location near the equator with annually dry climatology, equipped with Optical and NIR camera, this facility open the opportunity for study toward the center of the Milky Way galaxy during the dry season, in which the center of the Milky Way galaxy is high above the sky, this situation will give low air mass, and longer time observation. Although study on the center of the Milky Way galaxy is one important aspect that will be conducted with the new facility, however in this state of statu nascendi, there is much potential of this facility needed to be explored.

# National Astronomy Observatory of Timau



Developing Indonesia from the vicinity

New center for astronomy facility in the eastern part of Indonesia



Located in the conservation forest, at the base of Mount Timau

## Conditions:

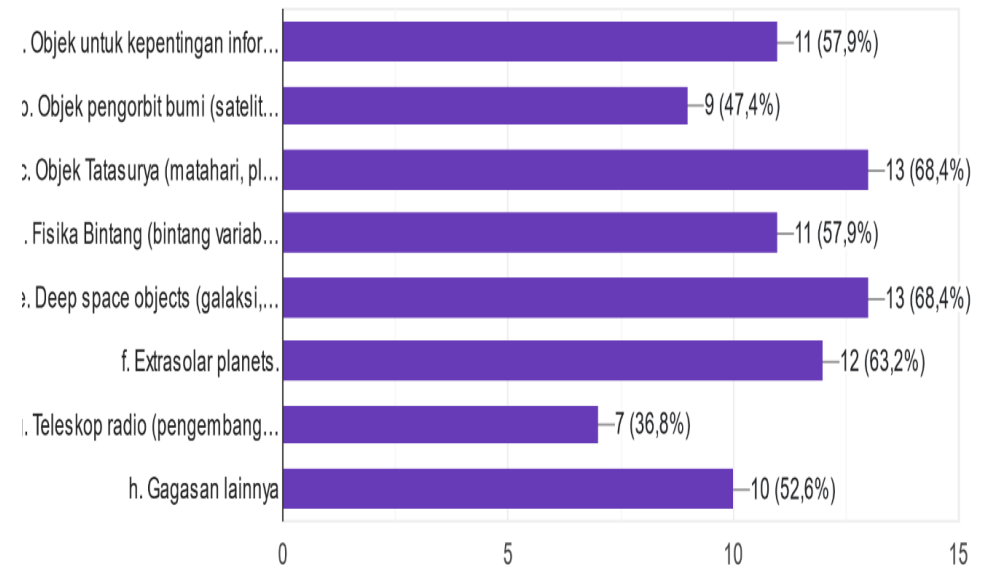
- Located slightly to the south of the equator;
- Favorable annual climate and weather;
- Located in conservation areas, far from the residential area;
- Located in an area of 34 Ha which is dedicated to the observatory;
- Received permission from Japanese astronomers (Kyoto University) to use their telescope;

## Research Interest (as per 2022) – Reorganization , LAPAN Integrated into BRIN (New Agency)

- a. Public Interest (New Moon, Muslim Praying Time, Light Pollution, etc.).
- b. Earth Orbiting Objects.
- c. Solar System Objects.**
- d. Stellar Astrophysics.
- e. Deep space objects.**
- f. Extrasolar planets.
- g. Radio telescope.
- h. Others ...

4. Rencana umum kolaborasi riset yang ingin diajukan (boleh pilih lebih dari satu):

19 jawaban



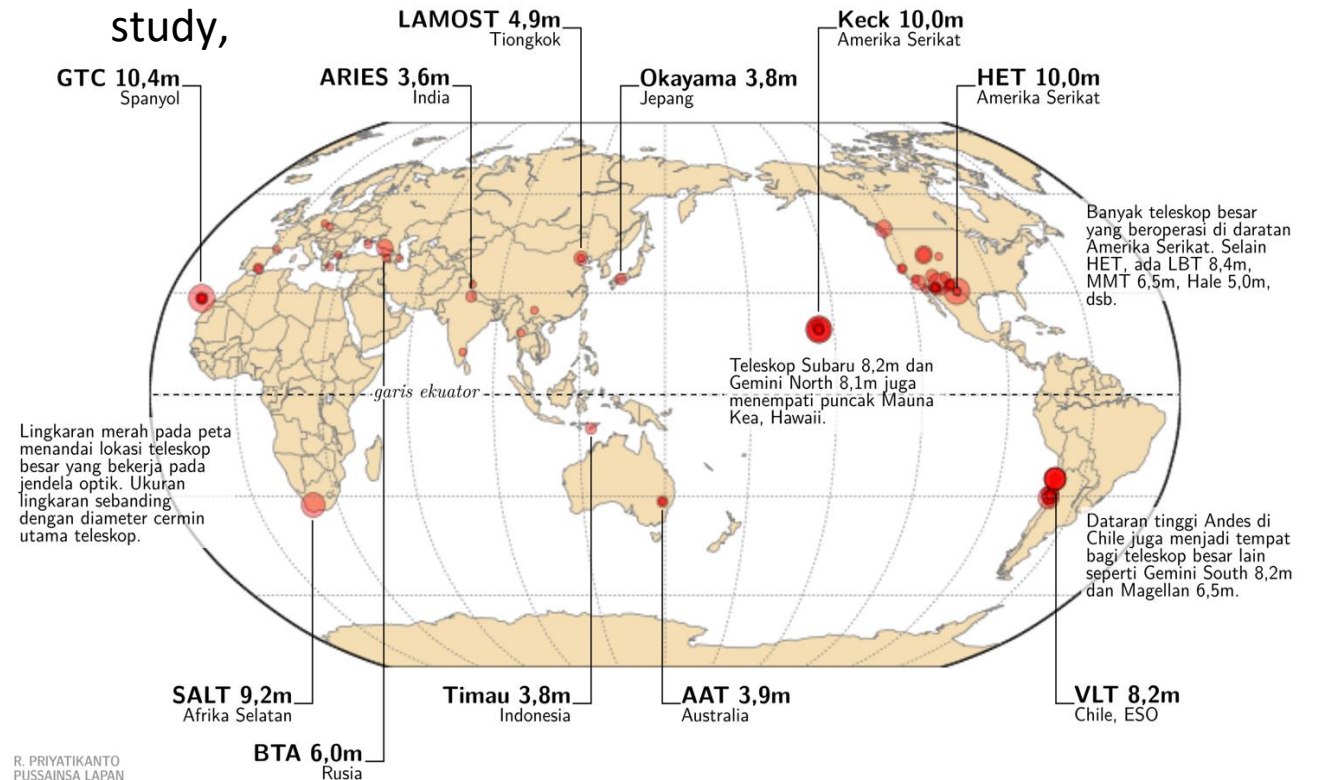


While the telescope is used for general purposes, it is prioritized for time-domain astrophysics (*supernova*, stellar flare, etc.). Besides, near-earth objects are another important aspect of collaborations (IAWN, APAON, or other network).

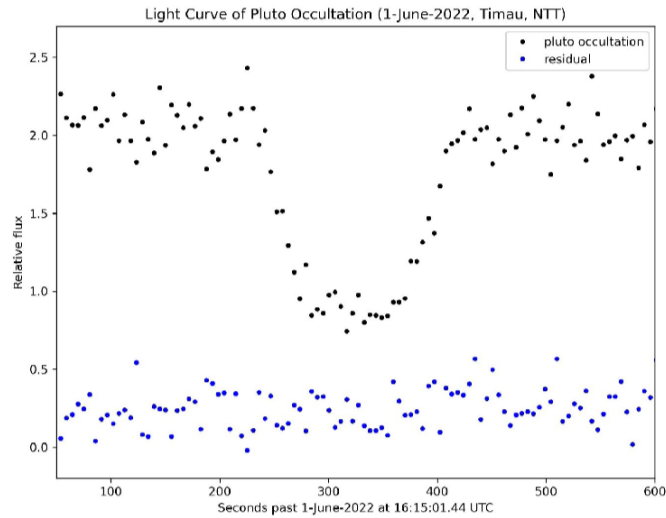


## TELESKOP 380 cm hopefully can join international endeavor:

- Teleskop Ritchey-Chretien with **18 segmented mirror supported by active optic** with light structure to support the *agility (for fast respond study)*.
- **2 Nasmyth** focus for first generations:
  - Simultaneous imaging **sdss optic** (g, r, i) (Maruo, 2020),
  - NIR with filter wheel (Y, J, H).
- Current design is optimized to meet photometry & astrometry study,







# Update 2022: Multi Purpose Photometry Measurement

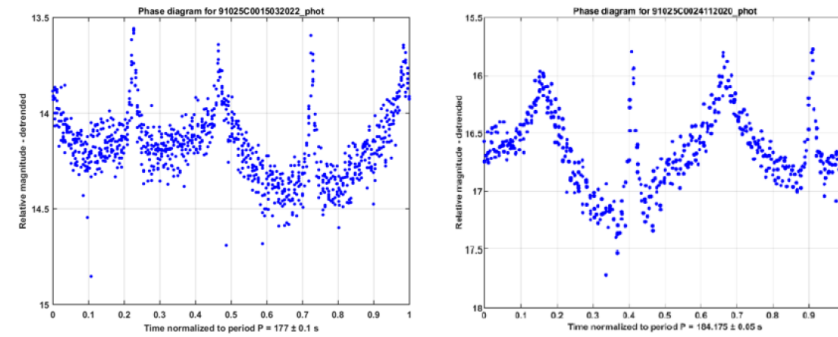


Figure 5. Phase diagrams of the light curves for case 1 produced by this study (left) and the one from the AIUB database (right).

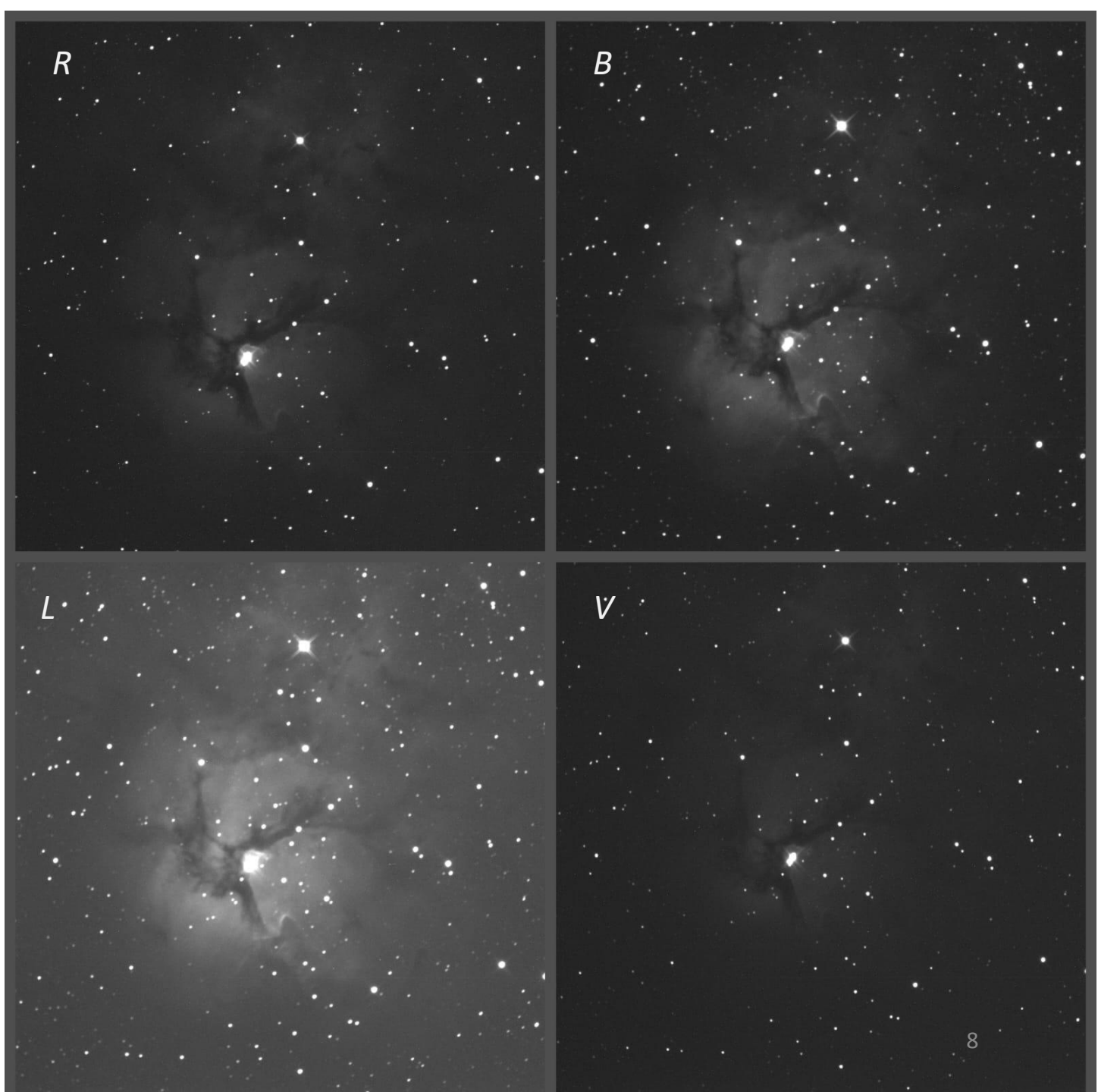
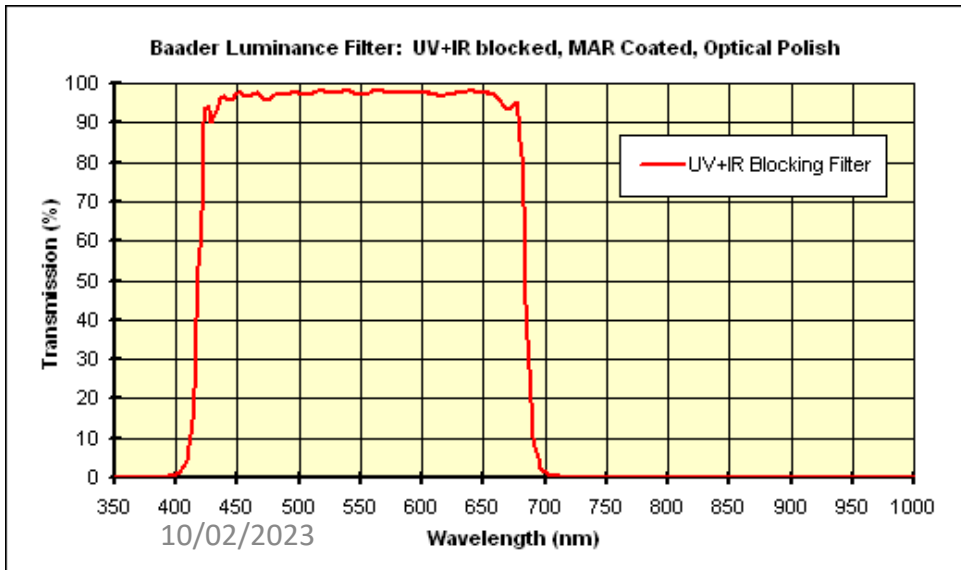
- Pluto occultation (international collaboration, Mumpuni et al, 2023), (BRIN + ITB + ITERA + USA)
- Photometry for space debris, (Rachman et al., 2024), BRIN + AIUTB,
- National space debris cooperation is already discussed among several local smaller observatories (ITERA),
- Development of a robotic facility for Space Situational Awareness (Rachman et al.,)



# Triffid nebula (NGC 6514=M20) observed on 27 July 2022 (BRIN + ITB + ITERA + UPI + Undana)

Images were taken under thin cloud near Kupang city.

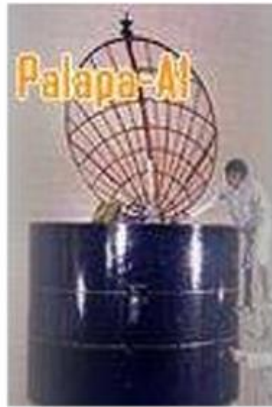
*B* (240 sec), *VR* (120 sec) and *L* (luminance). (Malasan et al., 2024);



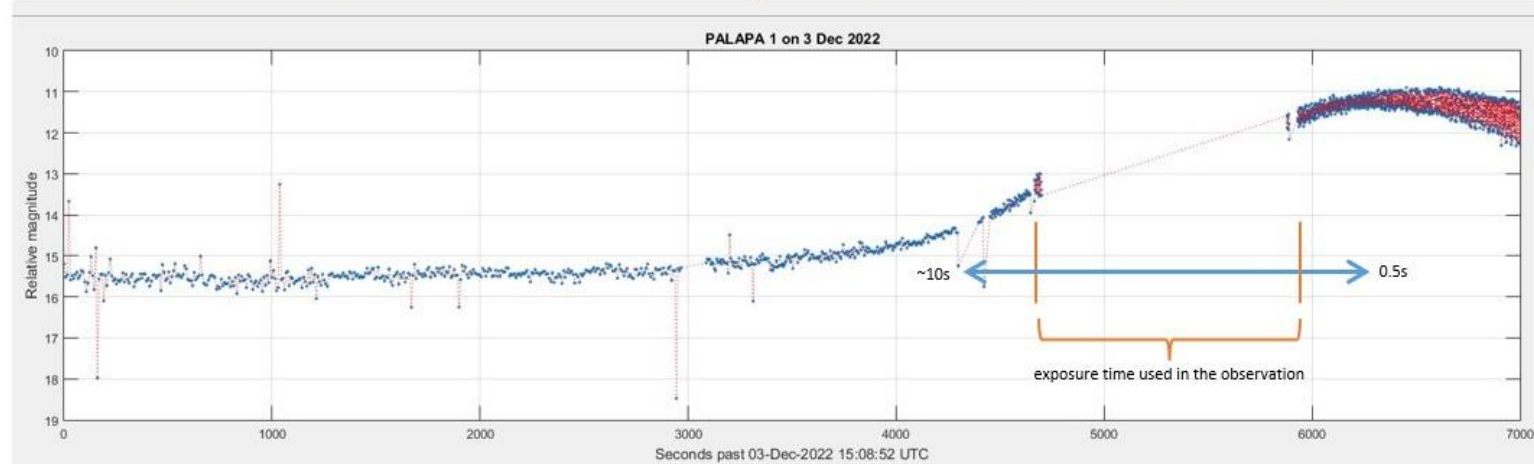
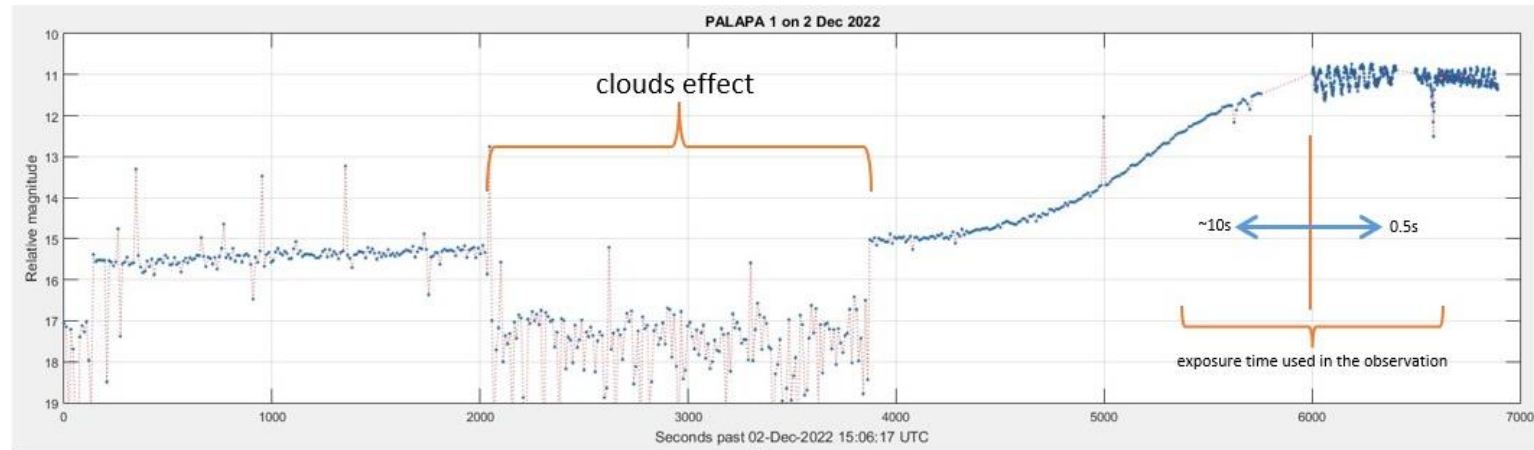


# Two light curves of PALAPA A1 satellite obtained from BRIN station at Tilong, Kupang in Dec 2022

The satellite is the first Indonesian satellite which was launched in 9 July 1976 and in operation until the end of 1983.

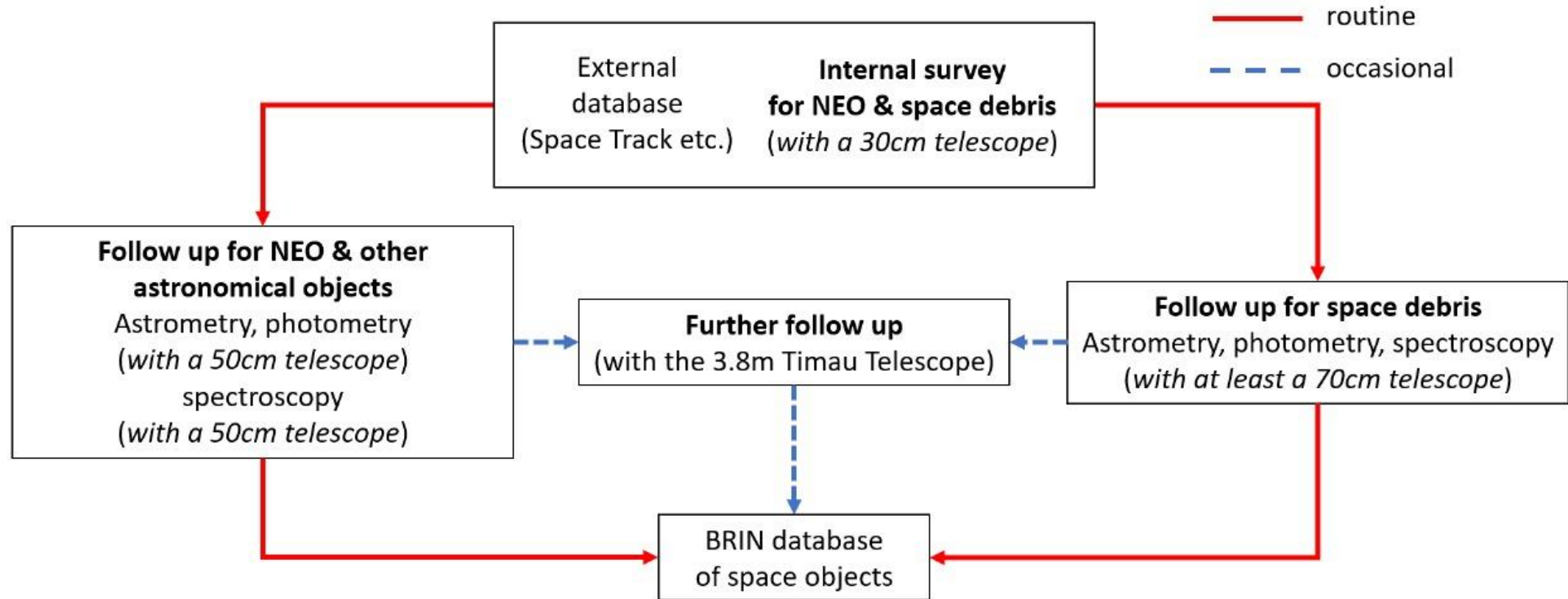


Telescope system used  
in the observation



# Robotic Telescope Utilization at TNOI

Version: 24.10.2023





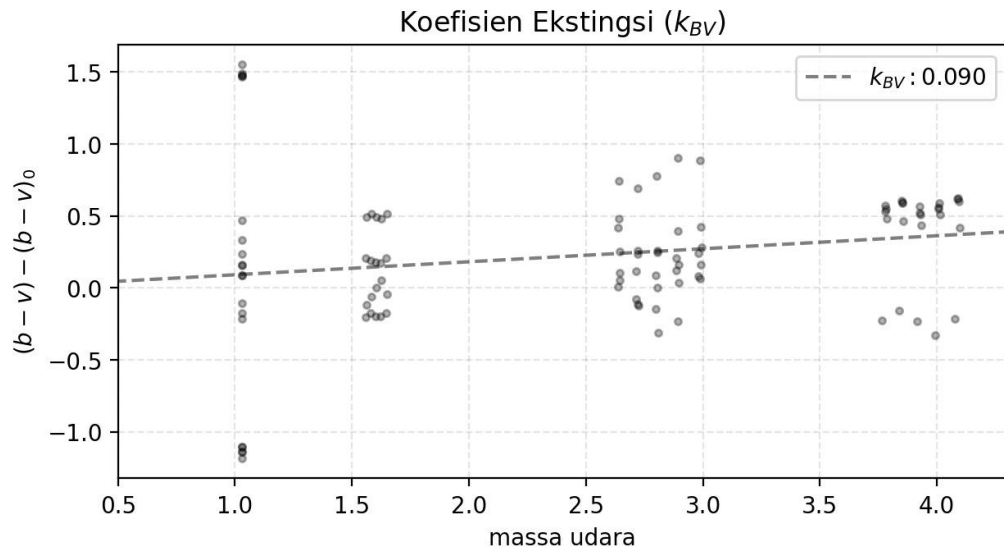
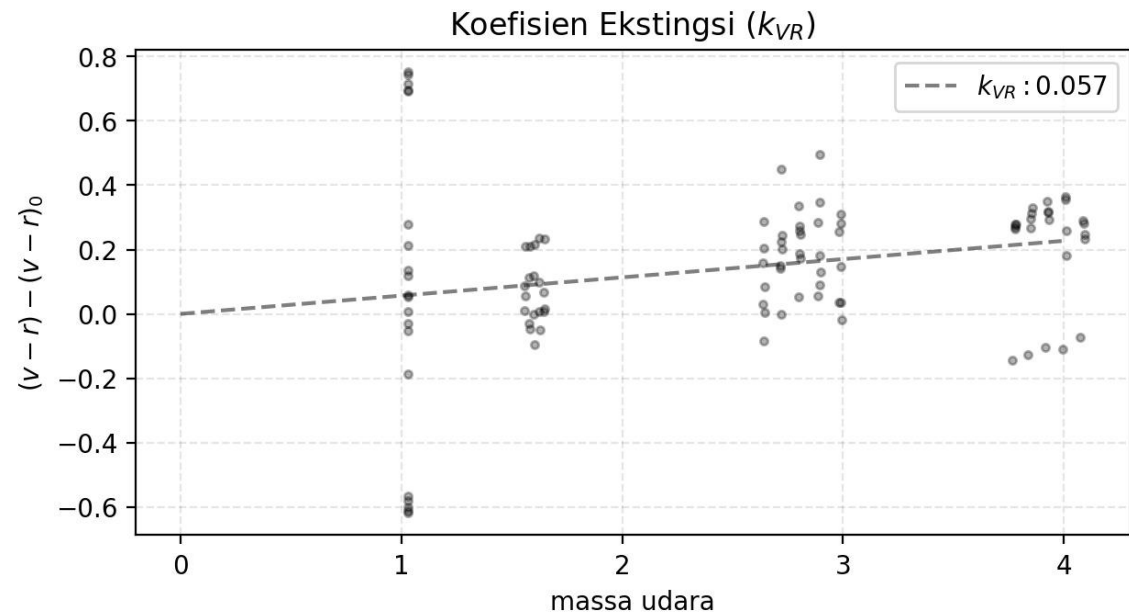
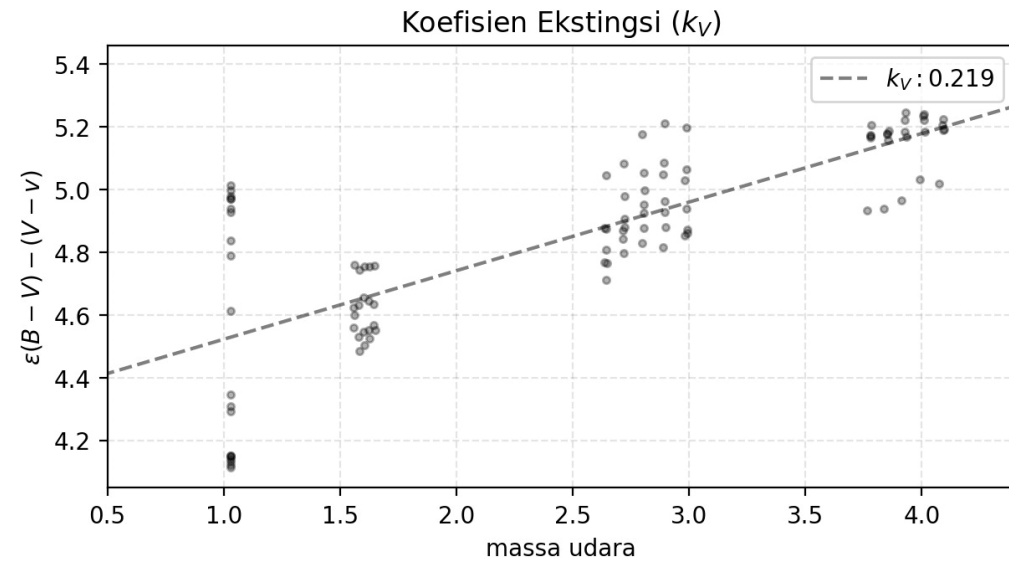
# CCD Photometry 2023 (BRIN + ITB + ITERA + UPI)

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- Aims and activities:
  - Absolute photometry, (plan on spectrophotometry)
  - Deduce extinction coefficients, extinction curve, sky brightness, scintillation, telluric lines, exercise on stability of acquisition system,
  - Capability of spatial and temporal imaging,
  - Check precision of differential photometry,
- Target: Equatorial standard *BVRI* stars, standard *BVRI* clusters, short-period variables, Planetary Nebulae
- Instrument: Takahashi Mewlon+ EQ mounting, SBIG STF-CCD camera, *BVRI* filters,

# CCD photometry 2023



Date: 13 September 2023

Site: ObsNas, Timau

Moon phase: 3% (28 days old)

Ext coeff in  $V = 0.219$  mag/airmass

Ext coeff in  $B = 0.409$  mag/airmass

Ext coeff in  $R = 0.162$  mag/airmass

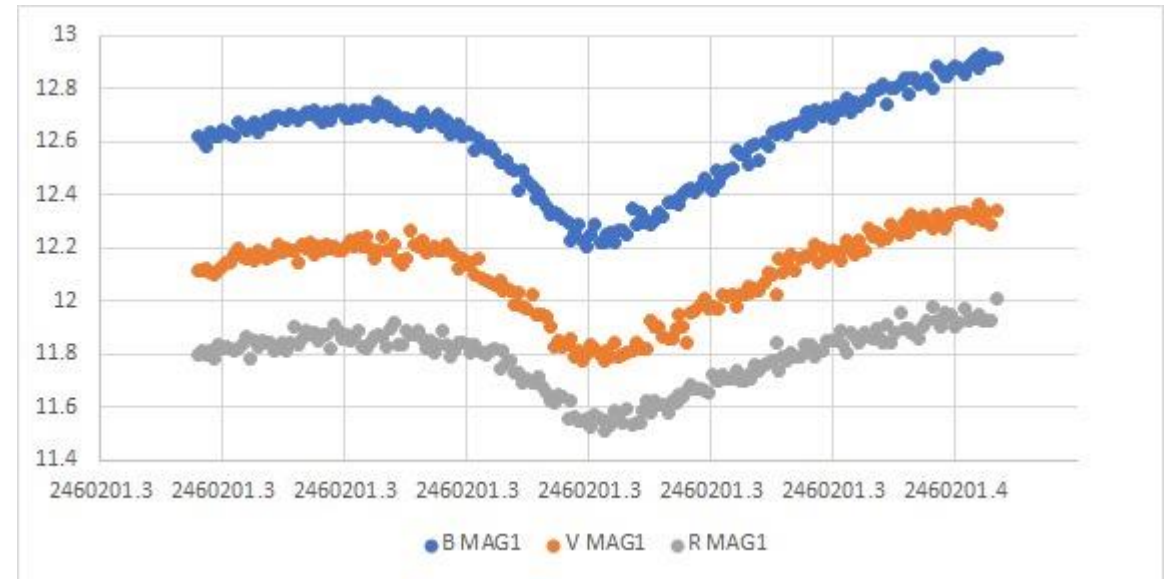
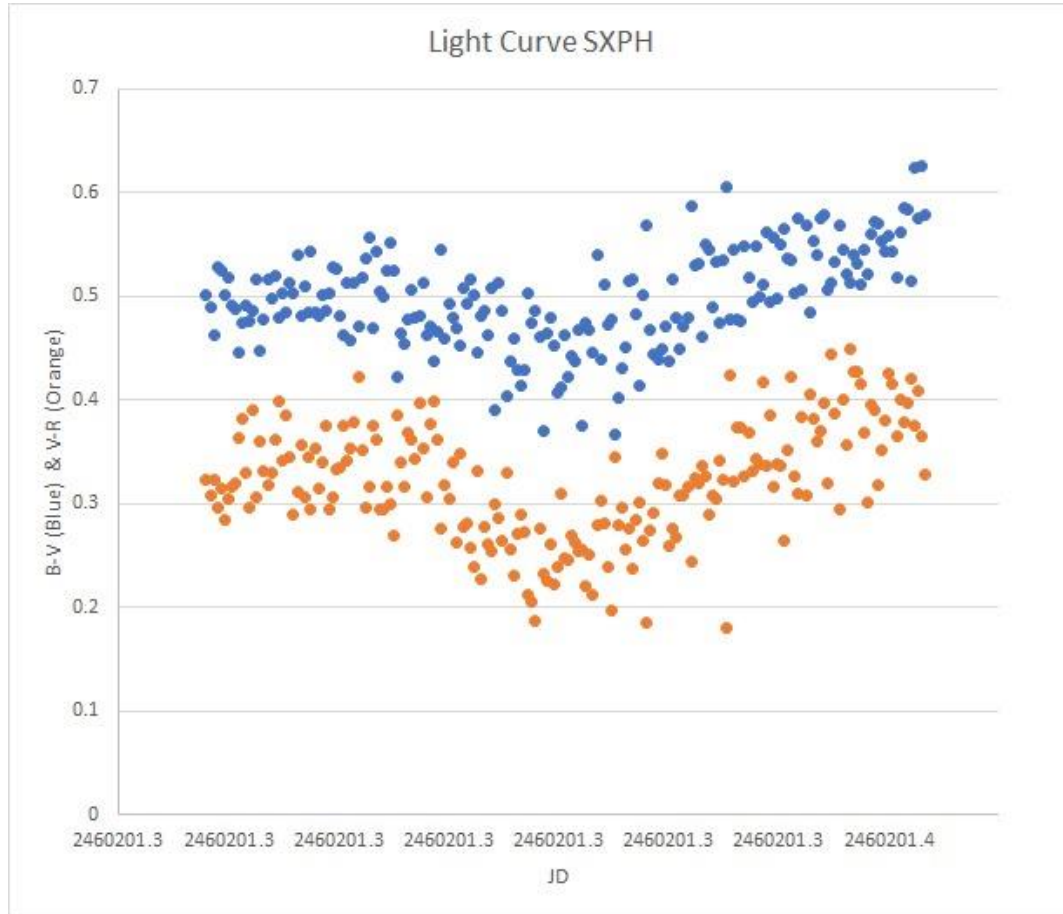


# CCD temperature stability



Peak-to-peak variation = 0.4 C

# Light and color curves SX Phe



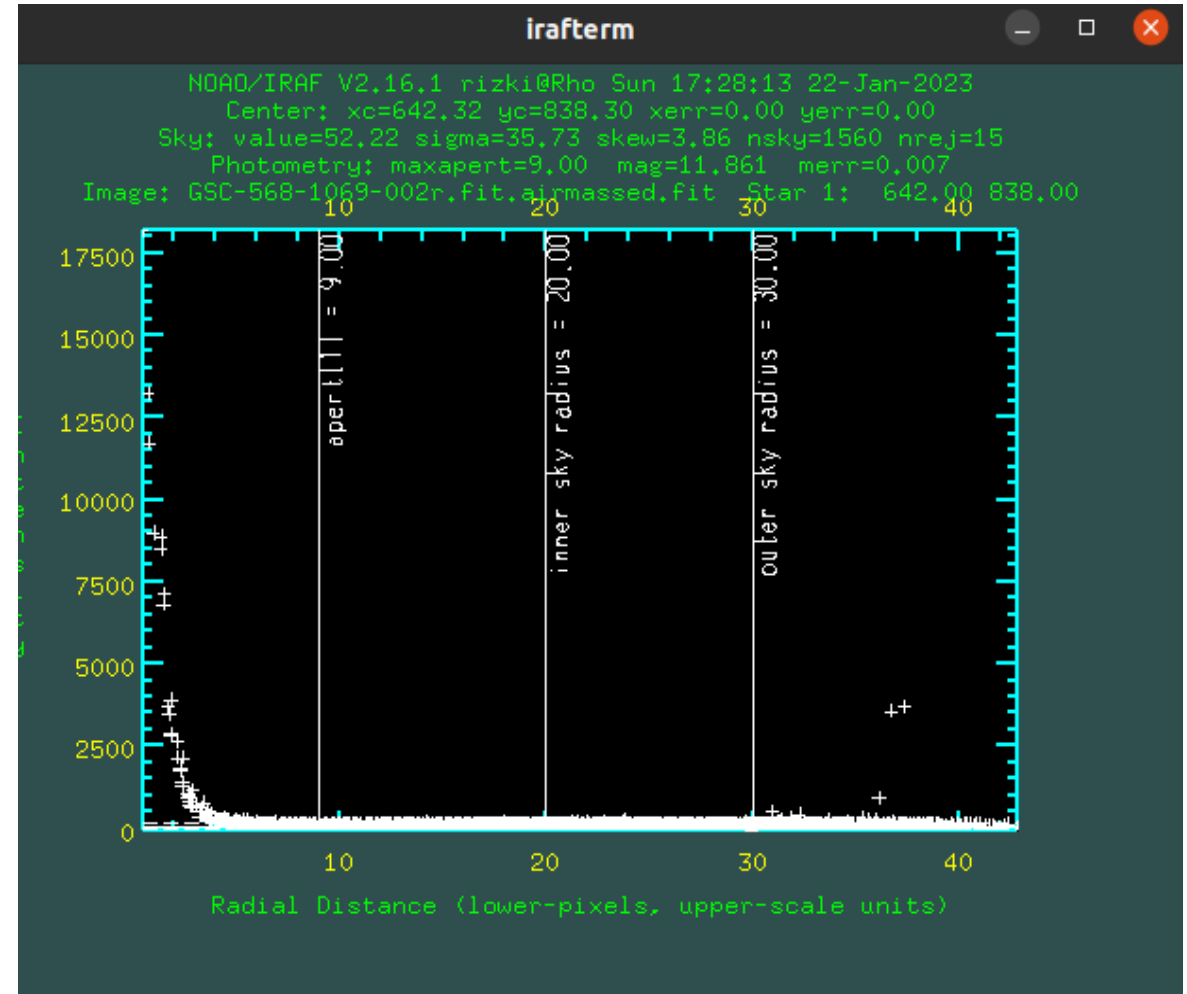


# Sky brightness

Sky brightness (an exploratory study, see Malasan et al., 2024) was deduced from the MSKY values produced by applying apphot analysis in IRAF to the *V* images. Since an on-chip binning 2x2 was imposed, the super-pixel size was, 10.8 micron. For the focal length of 2500mm, the resolution would be 0.891"/pixel. Using transformation equations, the sky brightness in *V* was determined to be

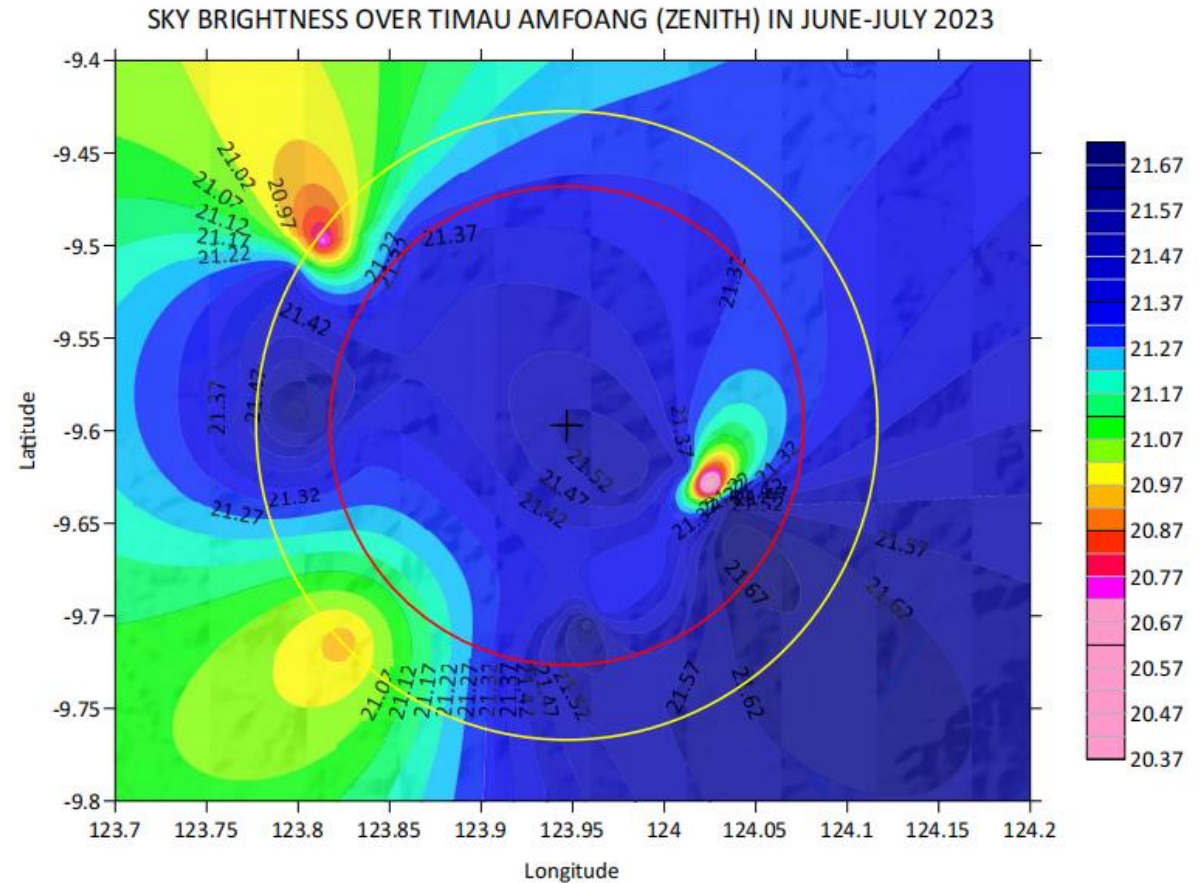
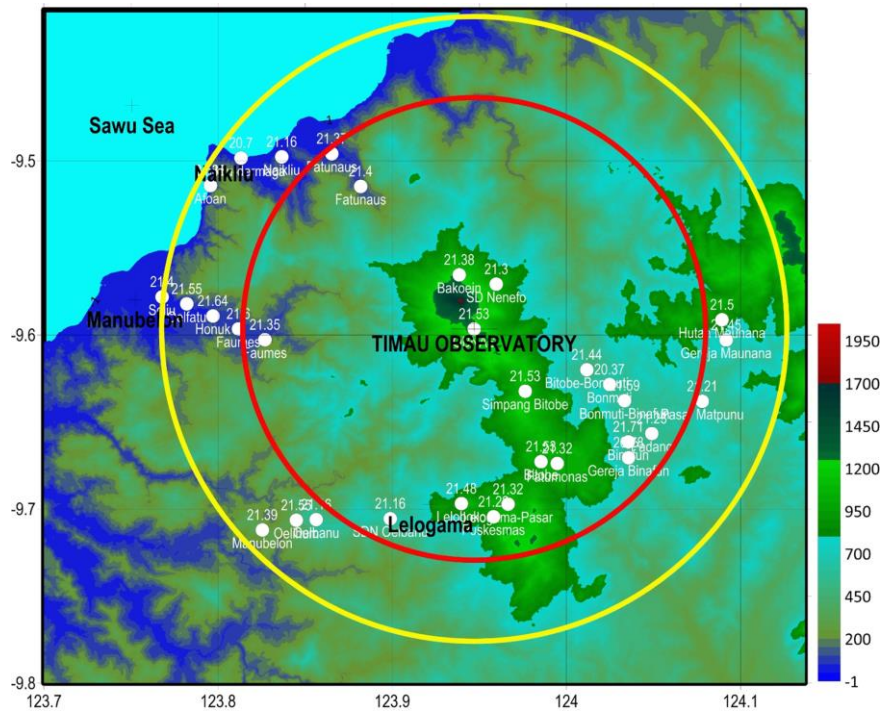
**20.30 magnitude/["]<sup>2</sup>.**

10/02/2023



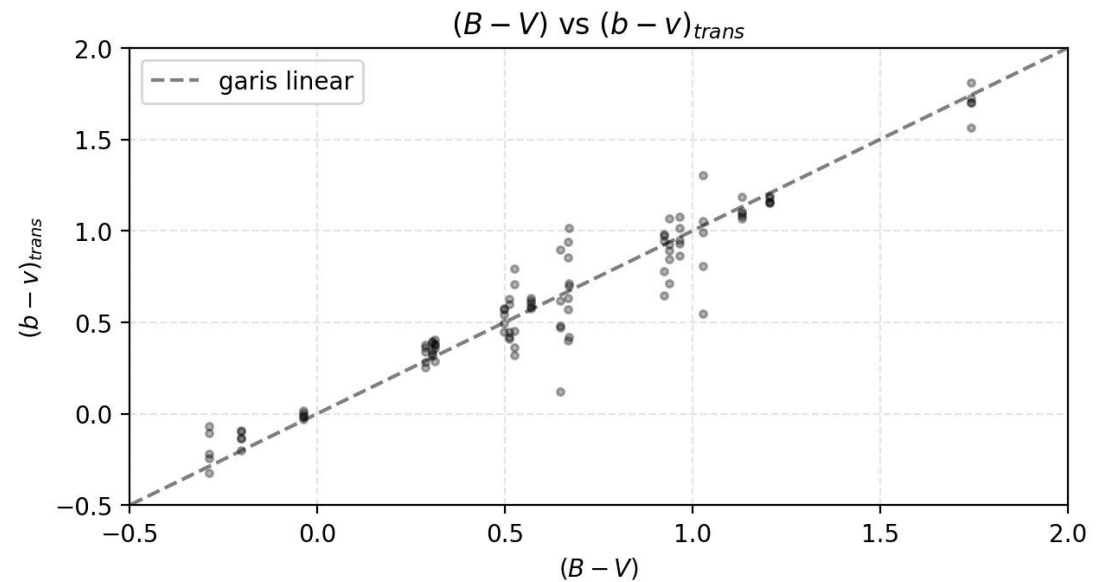
# Map of Light Pollution Around The Observatory

- Yatini et al., *tbp.*, (BRIN + Undana)



# Notes (Update \*2024)

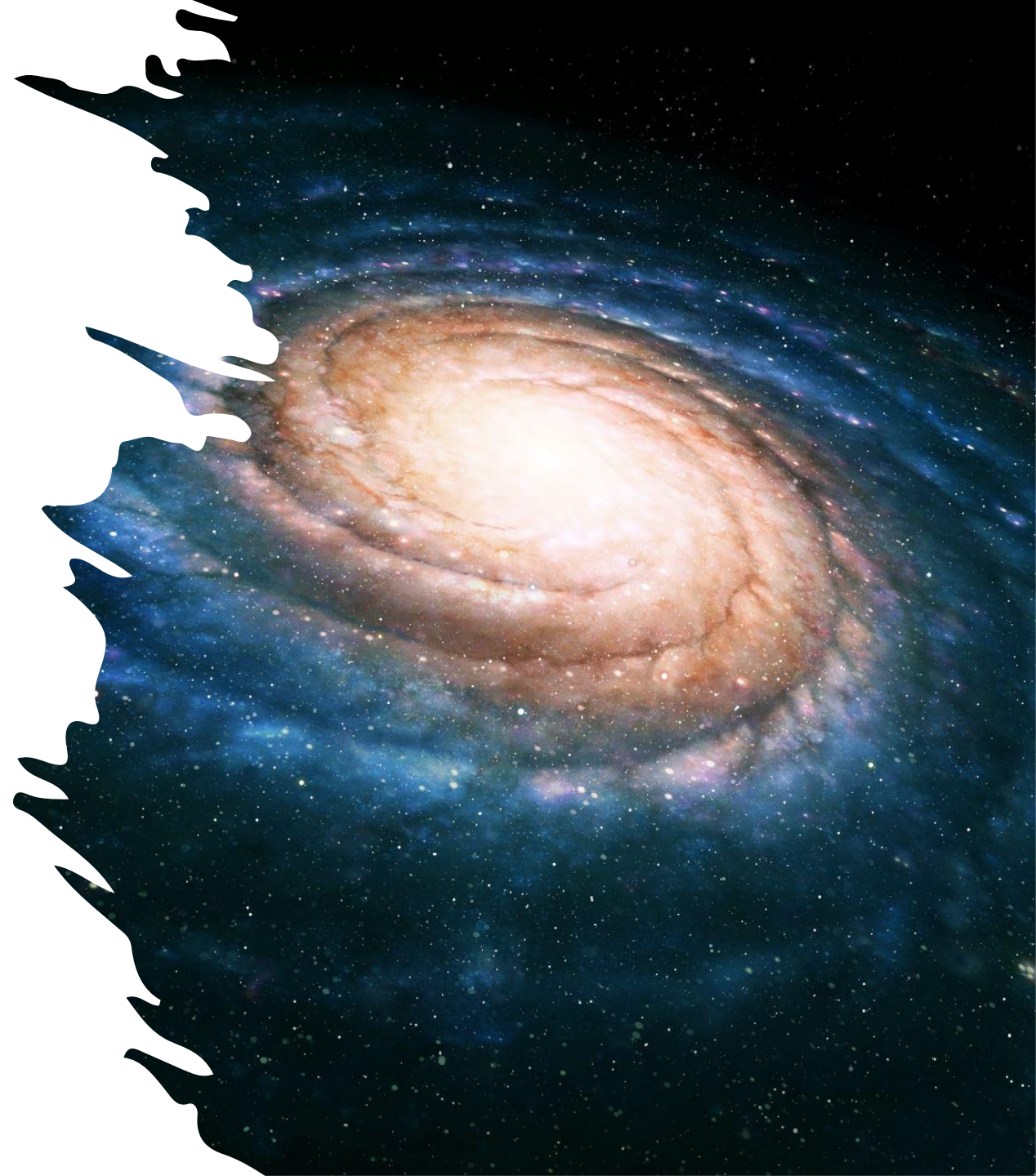
- Need  $V$  and  $V-R$  as well
- Sky brightness from photometry?
- Light curve of SX Phe,
- Image of Orion M42,
- Image of NGC 1252,
- \*During May 2024 measurement, typical extinction coefficients in V-band to be 0.32 mag/air mass
- Typical seeing measurement gave 0.9" (Akbar et al., 2019, Bayu et al., 2022),





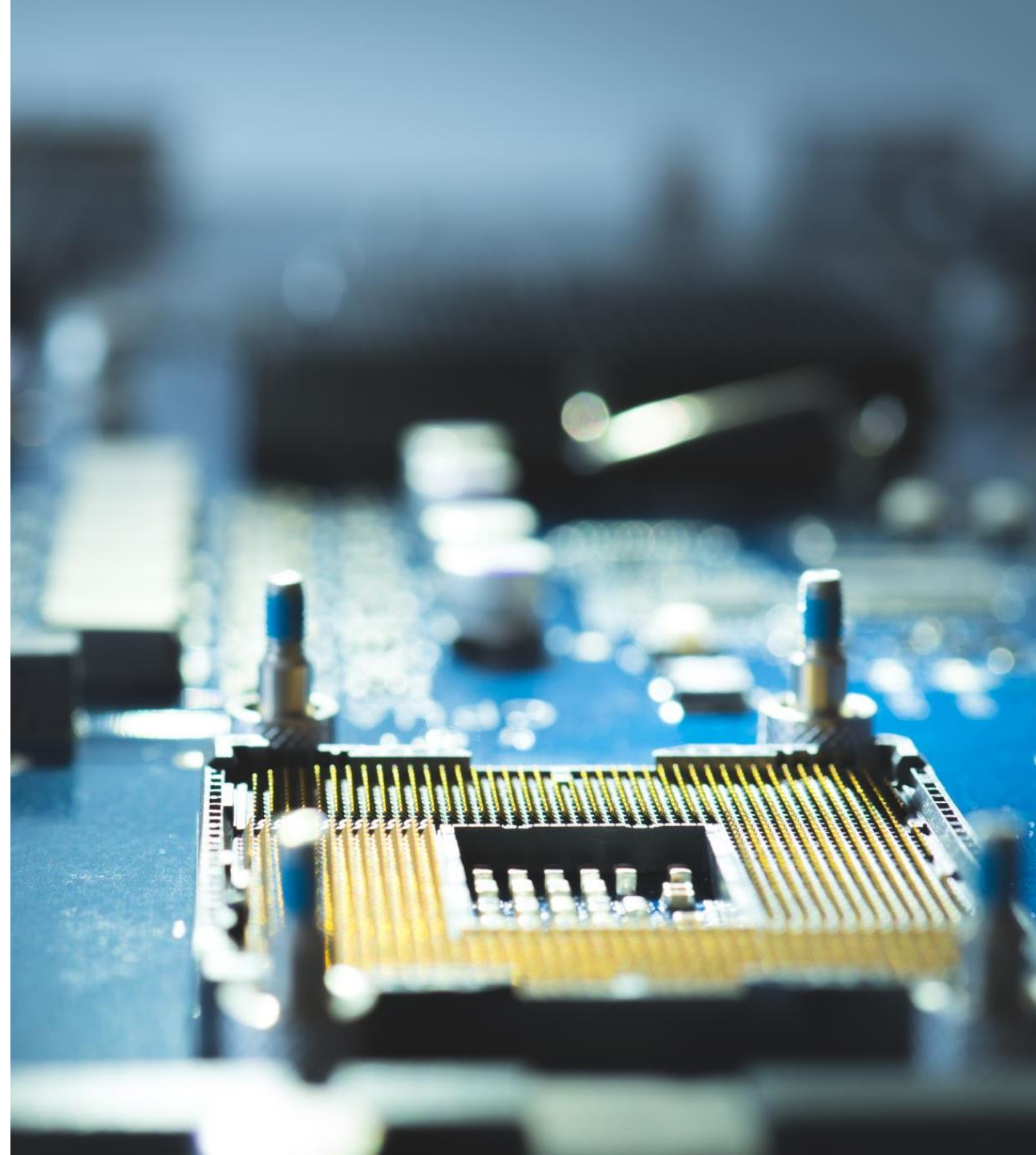
# Astrophysics

- \*Emission line stars in the Milky-way & Its structure (Novae, PNe, WR, Be) – ITB + ITERA + BRIN **(Optic)**,
- **Supernova** – Kyoto Uni + USTC + Turku Uni + ITB + ITERA + NARIT + UGM, including the development of spectrograph/ESM **(Optic + NIR)**,
- **Binary Asteroid** –NARIT, ITERA, UPI, & ITB + UGM/AbdR **(NIR + Optic)**;
- **Solar-like stars** – Doctor candidate in Kyoto/MZN (Optic),
- **MERAKp** (Multiband Exploration of the Regions Around the Key constellation of Pavo)/RP, **(Optic + NIR)**
- \*Dark and Quiet Skies, astronomy and large constellations: addressing emerging issues and challenges – BRIN + UPI. Inversion layer & Atmosphere Transmittivity in IR (Hitran) , **(Optic + NIR + Radio)**
- \*Galaxy & extra galaxy study – ITB + BRIN/TDj, **(Optic + NIR)**
- Satellite observation – AIUB Switzerland + Slovakia + BRIN/AbdR; **(Optic)**
- (\*) no specific program decided;



# Instrumentation

- Scientific performance of 3Optika and NIRKA for proper spatial and temporal photometric observations – ITB + BRIN + UGM + ITERA,
- System integration for telescope control & subsystem – BRIN + UGM + UPI,
- GUI, pipeline, and data processing – BRIN + UGM + UPI,
- Spectrograph development, USTC China + Kyoto University + Turku University + BRIN + UGM + ITB + ITERA,







# Conclusion and Way Forward

- Timau sky is suitable for time domain observation due to night stability and less extinction, it is expected that subtle variability can be observed for various cases, the question remain: How fast & faint the objects? → Timau telescope with sky condition can deduce the proper scientific cases (time vs brightness cases);
- BRIN has annual meetings related to aerospace which can be used to discuss the result of Timau research & development:
  - ISAST (International Seminar on Aerospace Science and Technology), (Science)
  - ICARES (International Conference on Aerospace Electronics and Remote Sensing Technology / IEEE program), (Engineering & Instrumentation)
- Several program are prepared for 2025 - 2029, ideas and collaborations are welcome,



# Indonesian Program

- RIIM (Indonesian Research Funding), 3-5 years, (platform for Timau),
- LPDP Targeted (for young students under 27 years), expected can continue study in Kyoto University,
- By Research Degree (domestic university),
- Postdoctoral,
- Visiting Researchers/Professor (1-3 months),
- **\*Board of Scientific & annual user meeting,**



# References

- Akbar et al., 2019 , 10.1088/1742-6596/1245/1/012024 ;
- Malasan et al., (2024), ICMNS 2023, ITB;
- Maruo, M., (2021), *Development of the Optical Three-Band Simultaneous Imaging Camera for Indonesia*, Thesis
- Mumpuni et al., 2018NatAs...2..930M
- Priyatikanto et al., (2023), 2023MNRAS.518.4073P
- Rachman, (2024), ICMNS 2023;
- Saputra et a., 2022, 10.1088/1742-6596/2214/1/012013
- Yatini et al., (tbp);





# Thank You Very Much

Let us collaborate, and please visit us in Indonesia. Contact [prantariksa@brin.go.id](mailto:prantariksa@brin.go.id) , +62 811-1064-6830