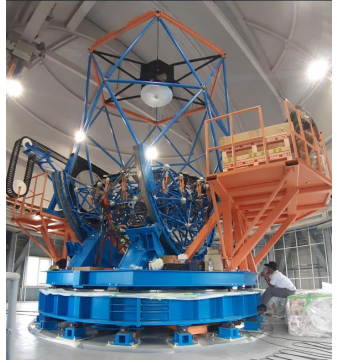


BRIN
BADAN RISET
DAN INOVASI NASIONAL

Utilizing 380 cm Timau Telescope and smaller telescopes for Satellite Observation study and SSA Program

Abdul Rachman

National Research and Innovation Agency of Indonesia

Presented at the FY2025 Seimei User's Meeting, Tokyo, 3 September 2025

Outline

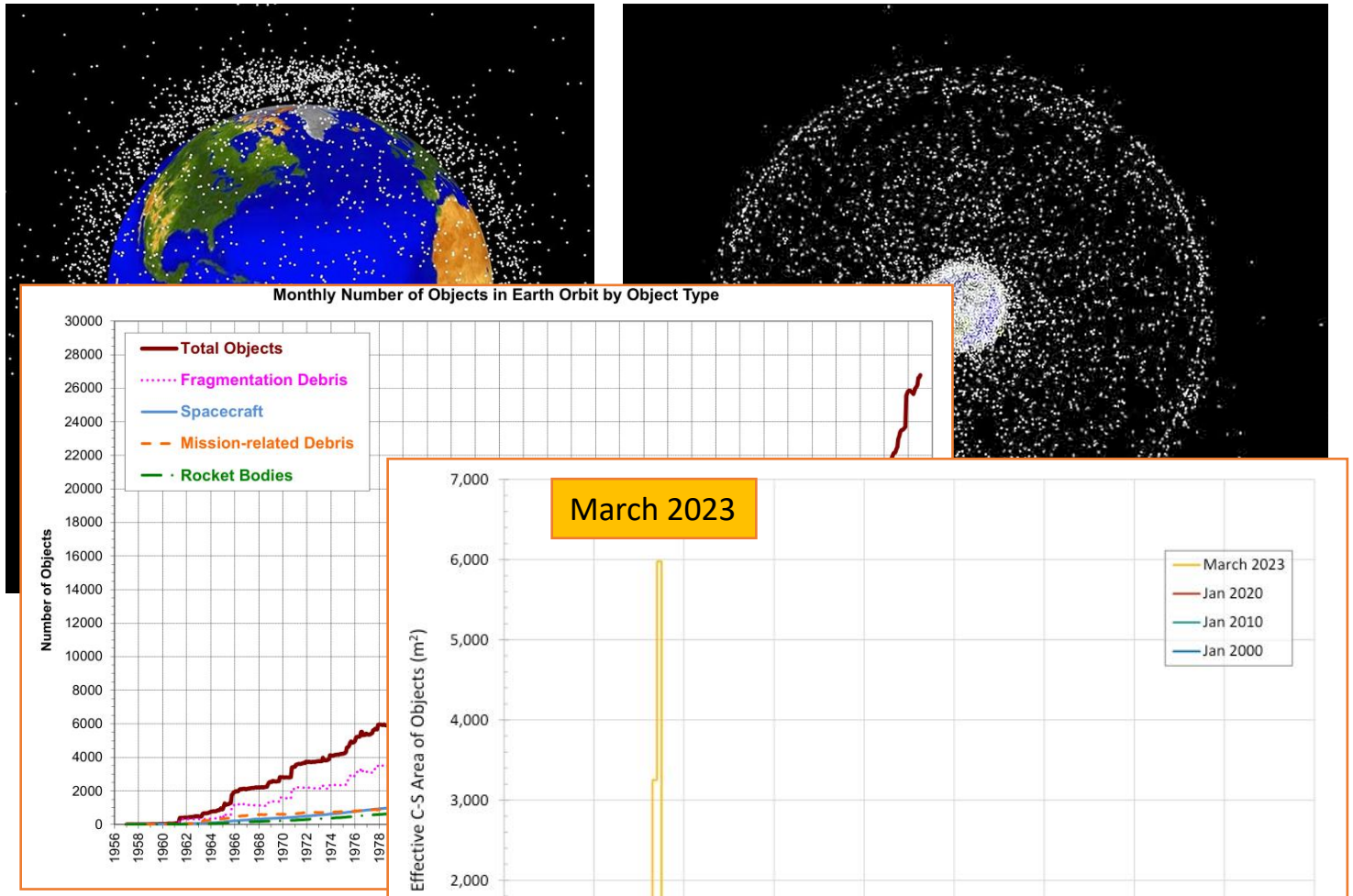
- Space debris issue and Space Situational Awareness (SSA)
- Indonesia’s national motives and geographical advantages
- Several mode of observations and example from MEO satellites
- Timau Telescope and small telescopes at BRIN
- BRIN’s current progress
- Outlook
- Summary

Space debris issue and SSA

1. Hypervelocity speed
2. Uncontrollable motion
3. Increasingly dense population

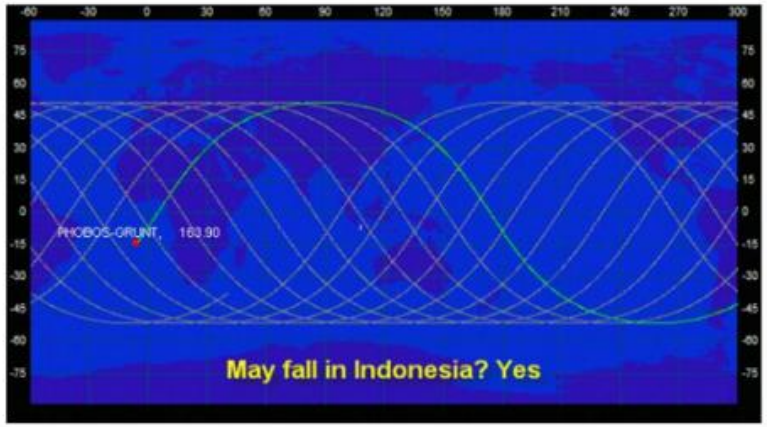
Add to that:

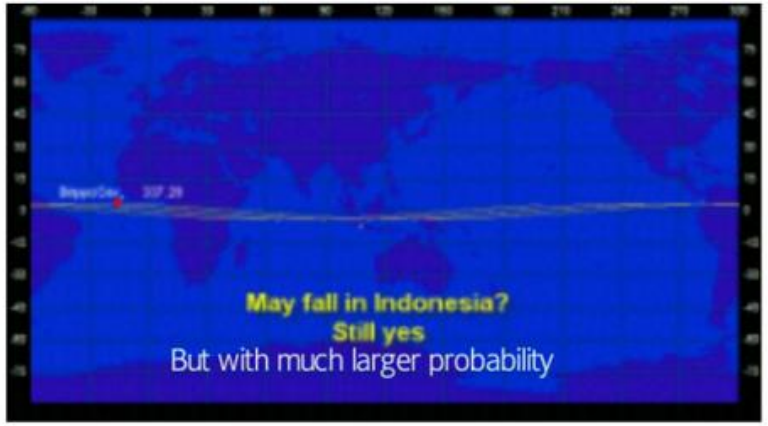
- Lack of international treaty
- Relatively low awareness on SSA and STM among satellite operators
- Rapid increase of resident space objects especially in low Earth orbits



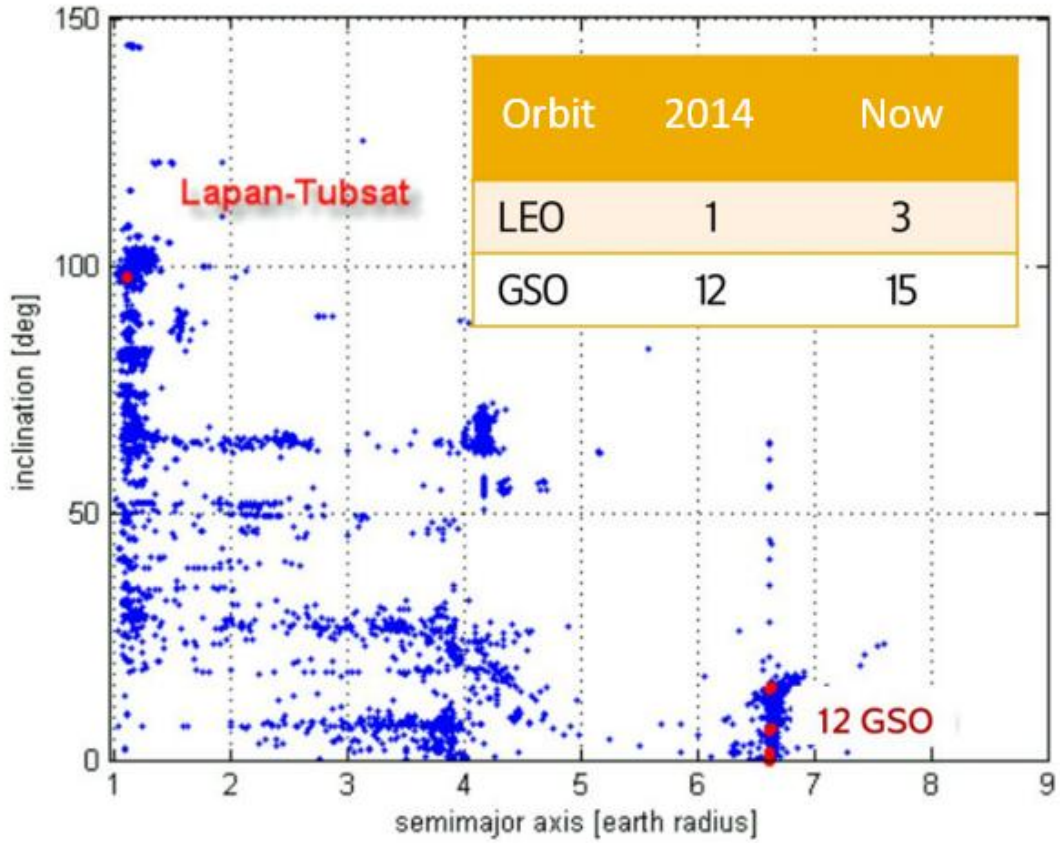
Our national motives

- Due to its extensive geographical coverage along the equator, Indonesia is susceptible to the reentry of large space objects regardless of their orbital inclination.





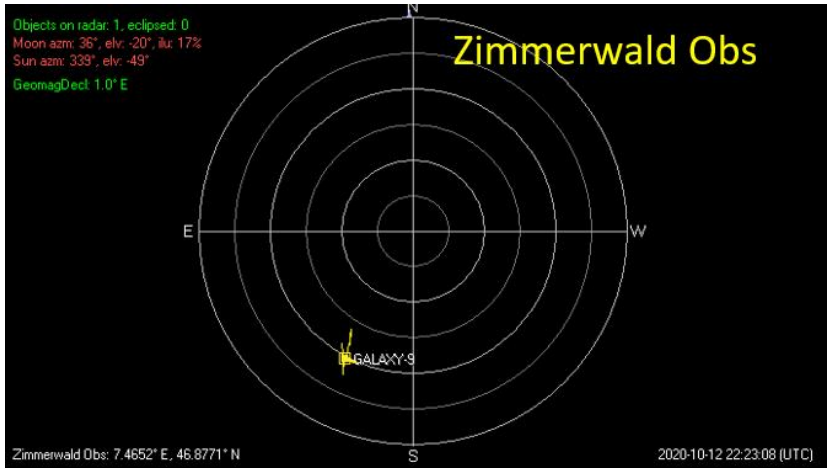
- The likelihood of other active satellites and space debris colliding with Indonesian satellites is growing due to the increasing numbers of all entities.



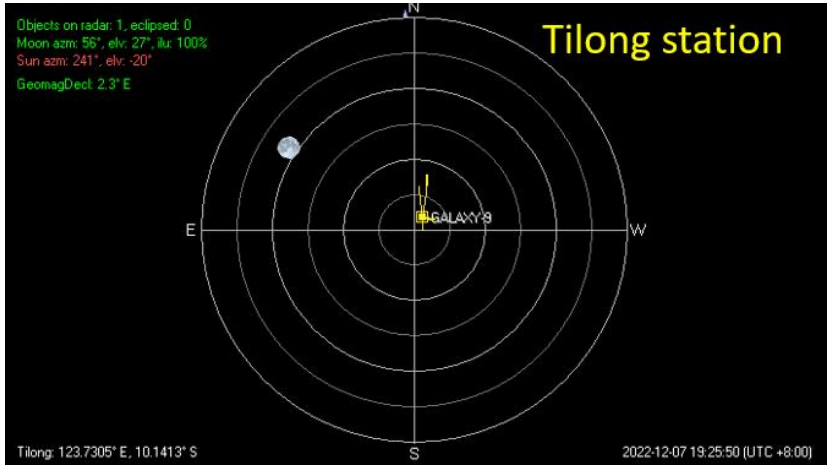
Indonesia’s geographical advantages

- The extensive geographical coverage along the equator allows for successive periodical observations of a specific object.

- The equatorial location allows us to observe GSO satellites at closer range than high latitude stations.



Range = 38,900 km



Range = 36,000 km

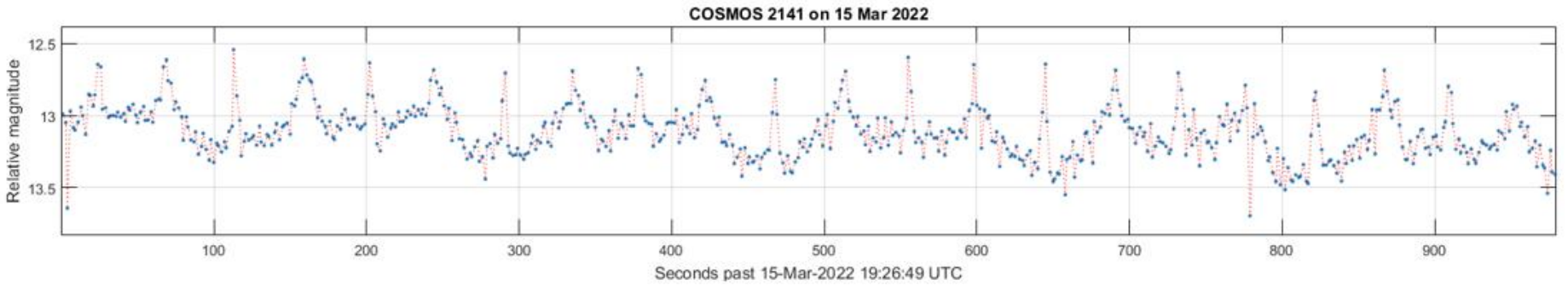
Astrometry

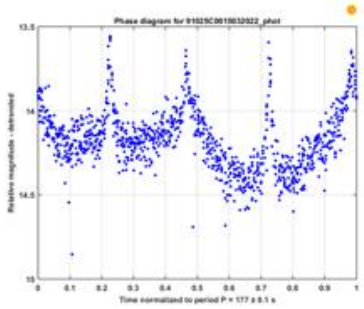
- To detect, track, and determine the precise orbits of artificial objects in space, primarily to monitor and manage orbital hazards.
- Using survey telescopes and follow-up telescopes.
- Survey observations serve to discover new objects, either for statistical population modeling, or for tracking and cataloguing (using follow-up telescopes).

Photometry and color photometry

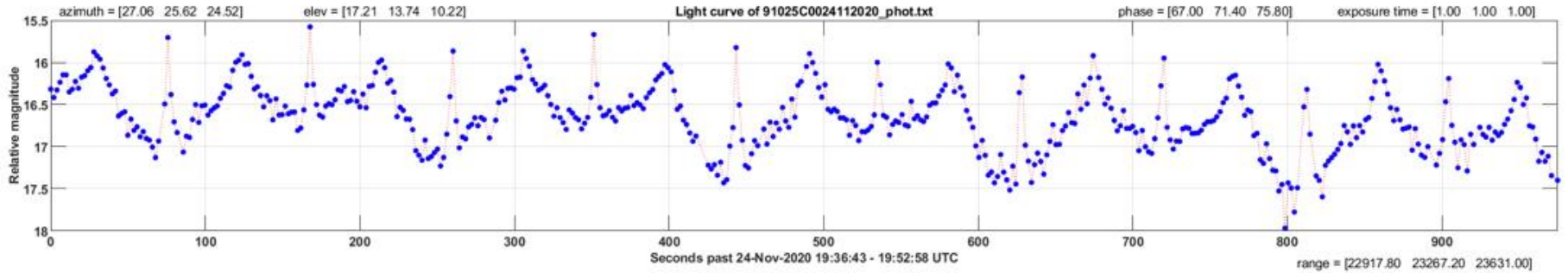
- Attitude study of satellites and space debris to get their spin period and spin axis orientation.
- Shape, age, and surface material of the targets.
- Information obtained will benefit active debris removal mission and on orbit servicing among other benefits

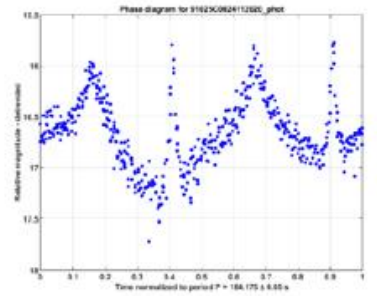
Phase diagram





BRIN





AIUB

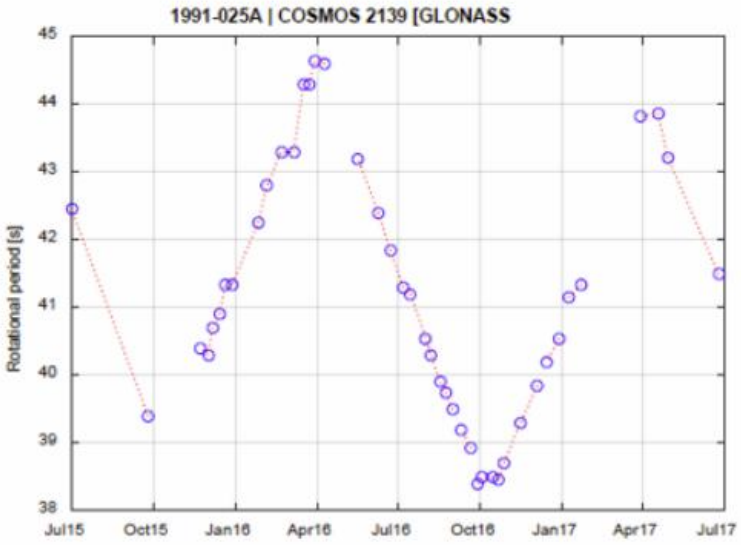
Rachman et al., 2024

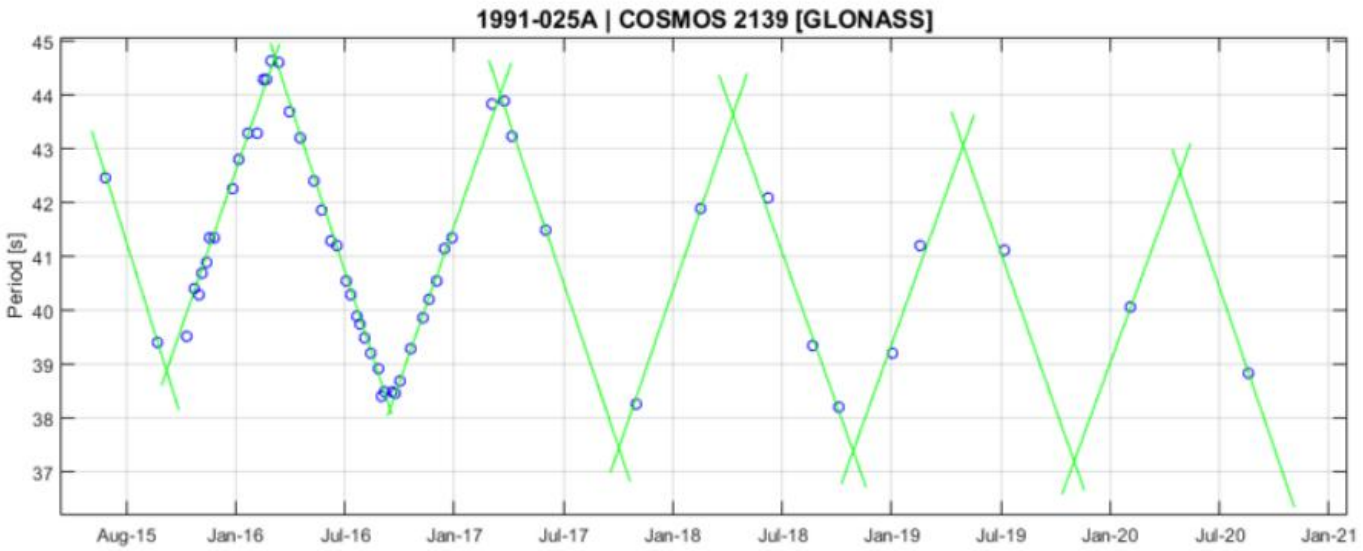
Spectroscopy

- Using reflectance spectroscopy to measure solar light reflected from the target
- Can be used to infer age and surface material of the targets. Long observations for studying the effect of space weathering on the targets.

Example from defunct GLONASS satellites

Light curve data were taken using the 1-m ZIMLAT telescope at Zimmerwald Observatory in Switzerland.





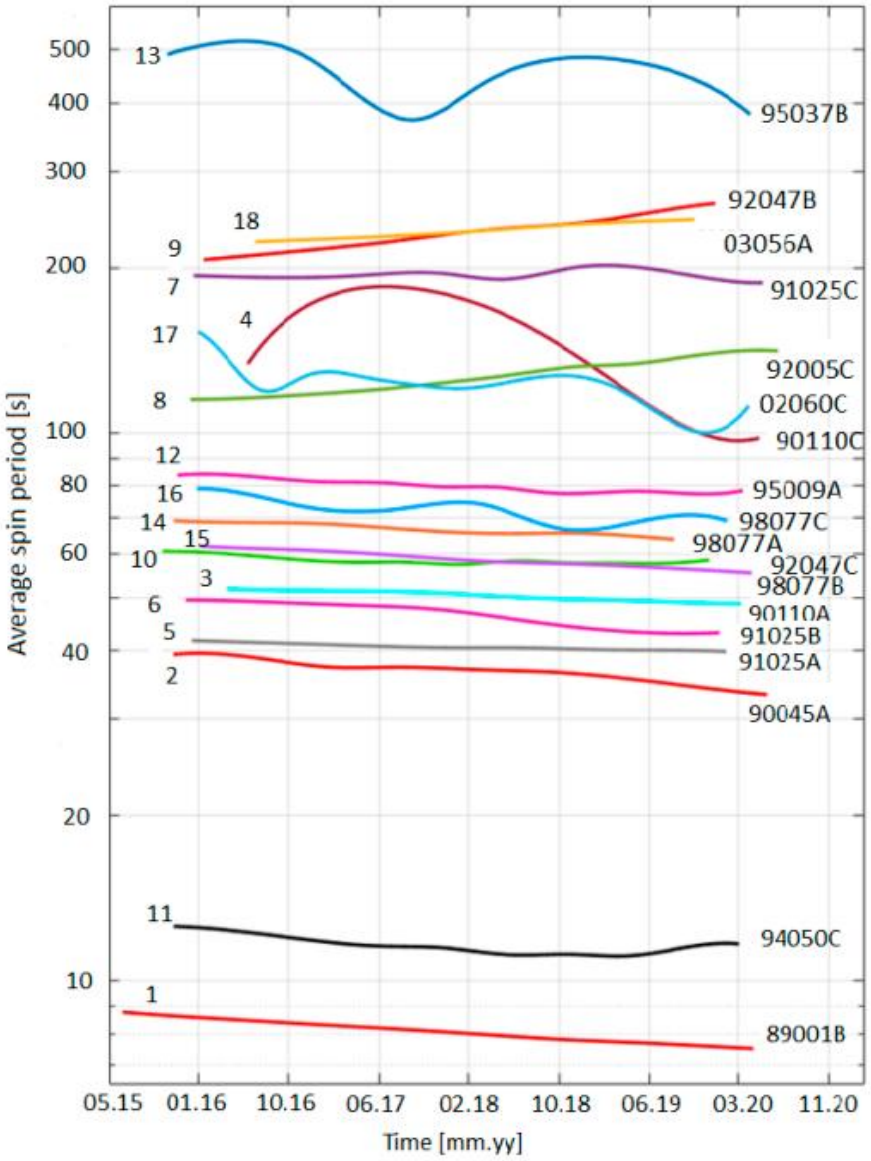
Spin period evolution of COSMOS 2139. The left image is the base for the empirical model which is used in the updated image on the right.

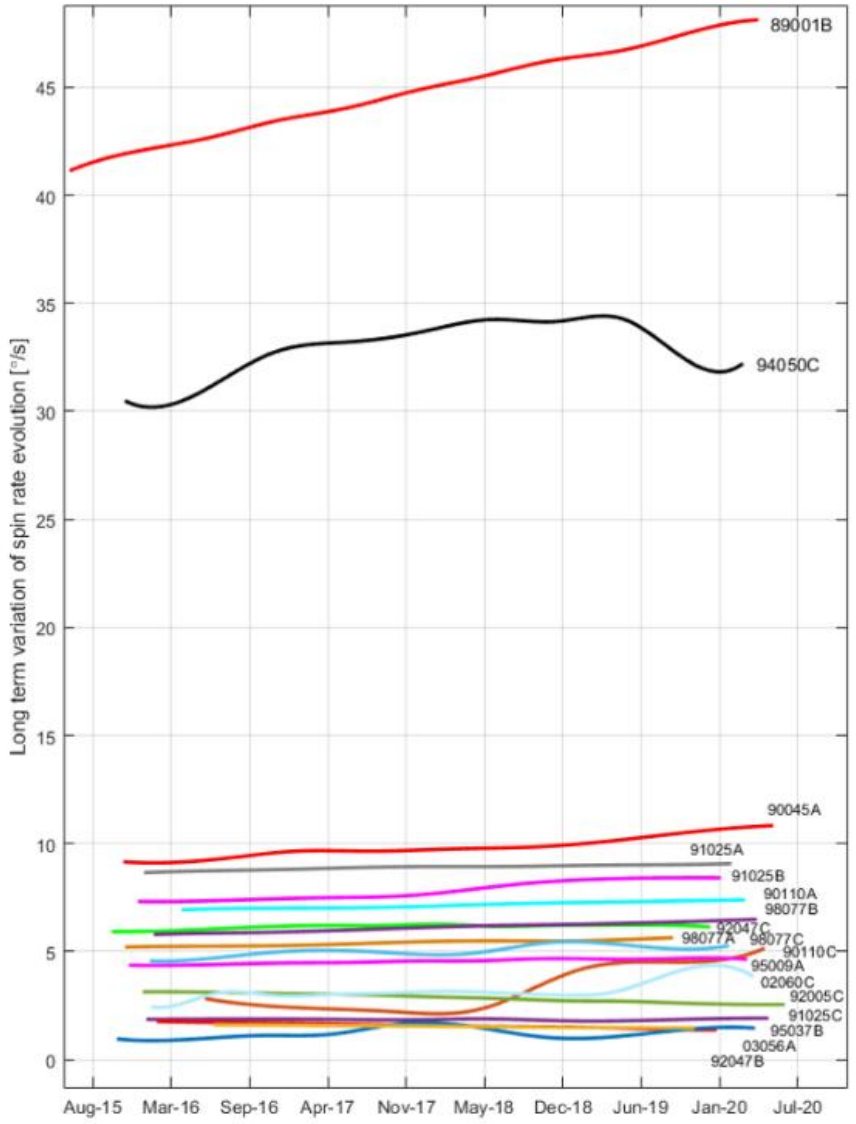
Example from defunct GLONASS satellites

Average characteristics of the spin period evolution. ω is the angular velocity.

No	Cospar ID	Average Spin Period [s]	Average Velocity [°/s]	Average Cycle Amplitude [s]	Average Cycle Period [yr]	Secular Trend Change of ω Per Year [°/(s·yr)]	Average Segment Change in ω Per Month [°/(s·mo)]
1	1989-001B	8.11	44.68	1.10	0.95	1.408	1.040
2	1990-045A	37.00	9.77	2.71	1.13	0.340	0.111
3	1990-110A	50.17	7.19	4.26	1.11	0.120	0.089
4	1990-110C	136.81	3.59	108.43	1.25	0.359	0.394
5	1991-025A	40.71	8.89	6.05	1.02	0.095	0.212
6	1991-025B	46.62	7.83	8.56	1.35	0.300	0.179
7	1991-025C	193.41	1.86	18.06	1.09	0.001	0.028
8	1992-005C	127.80	2.84	12.95	0.90	−0.143	0.056
9	1992-047B	232.31	1.58	49.73	0.97	−0.093	0.060
10	1992-047C	58.82	6.13	2.84	0.78	0.059	0.068
11	1994-050C	11.94	32.05	5.52	0.96	0.634	2.680
12	1995-009A	79.92	4.56	16.74	0.87	0.083	0.182
13	1995-037B	469.58	1.17	513.24	0.98	0.028	0.243
14	1998-077A	66.55	5.42	2.10	0.95	0.109	0.033
15	1998-077B	58.76	6.14	1.51	0.94	0.165	0.034
16	1998-077C	72.38	5.02	8.76	0.98	0.181	0.109
17	2002-060C	127.90	3.05	52.56	0.79	0.140	0.304
18	2003-056A	235.17	1.53	18.32	0.96	−0.046	0.021

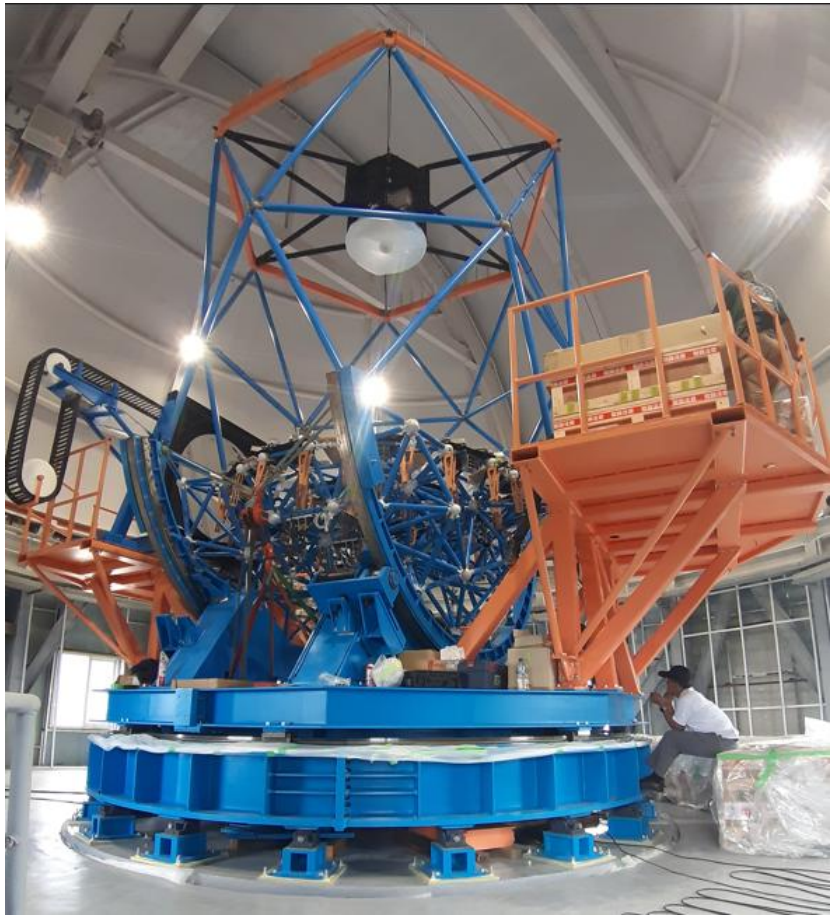
Example from defunct GLONASS satellites

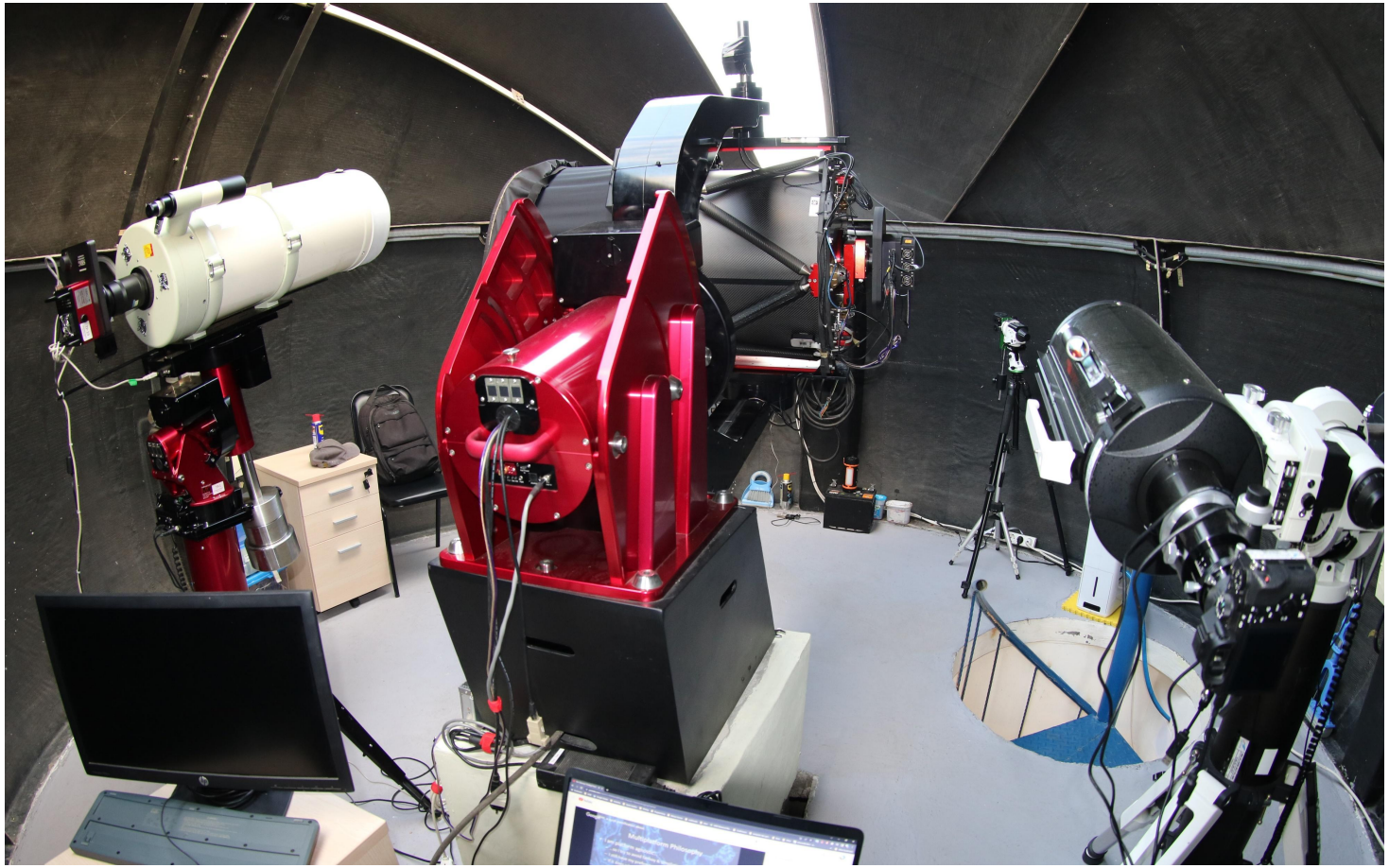




Long-term variation in the average spin period. Cubic splines are used to represent the average dynamics of the evolution. COSPAR ID and the reference object's number are indicated. (Rachman et al., 2025)

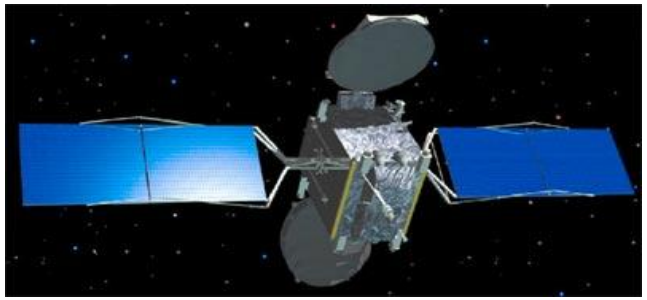
Timau Telescope and small telescopes at BRIN



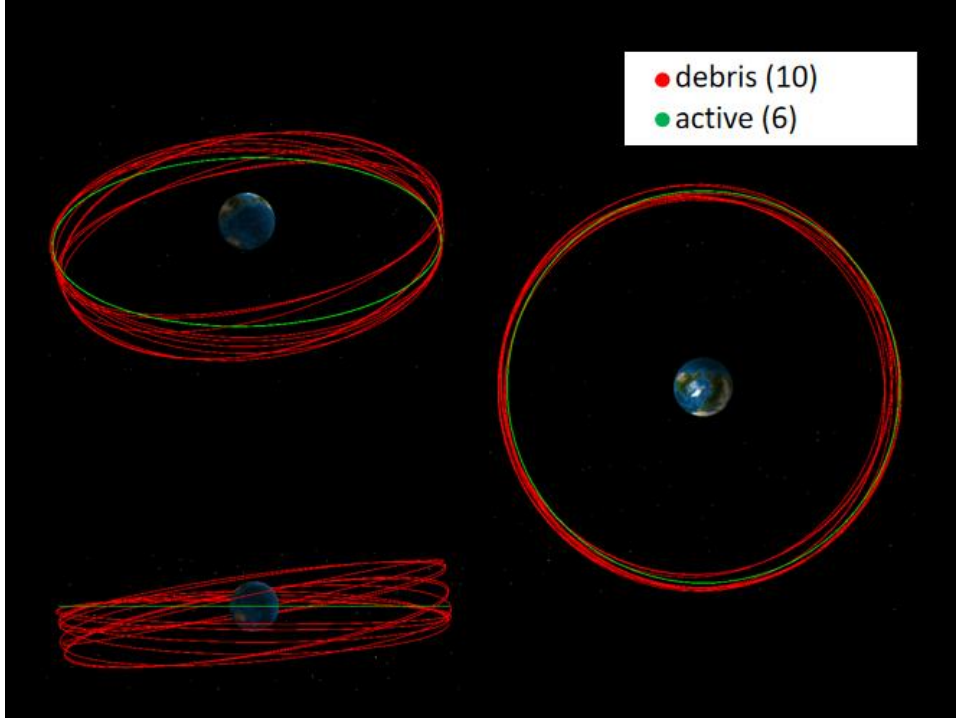


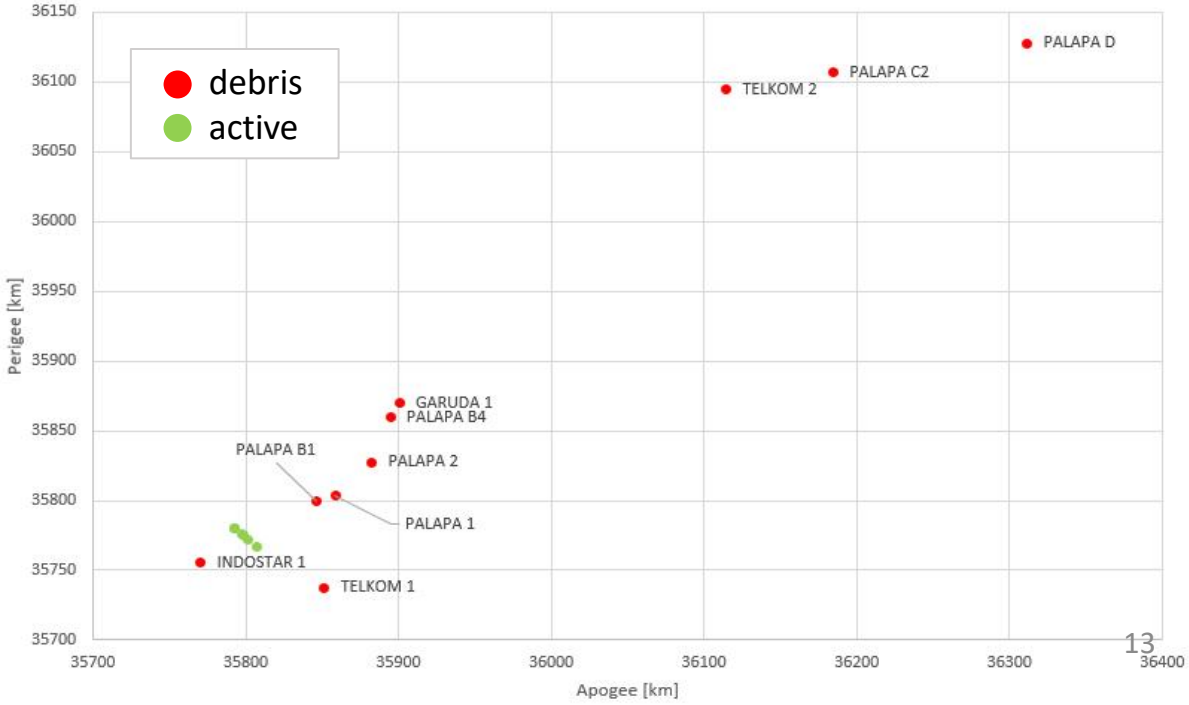
BRIN's current progress

In 2023 and 2024 we used the 50cm telescope located in Kupang to observe all Indonesian defunct satellites and successfully obtained their basic attitude characteristics.

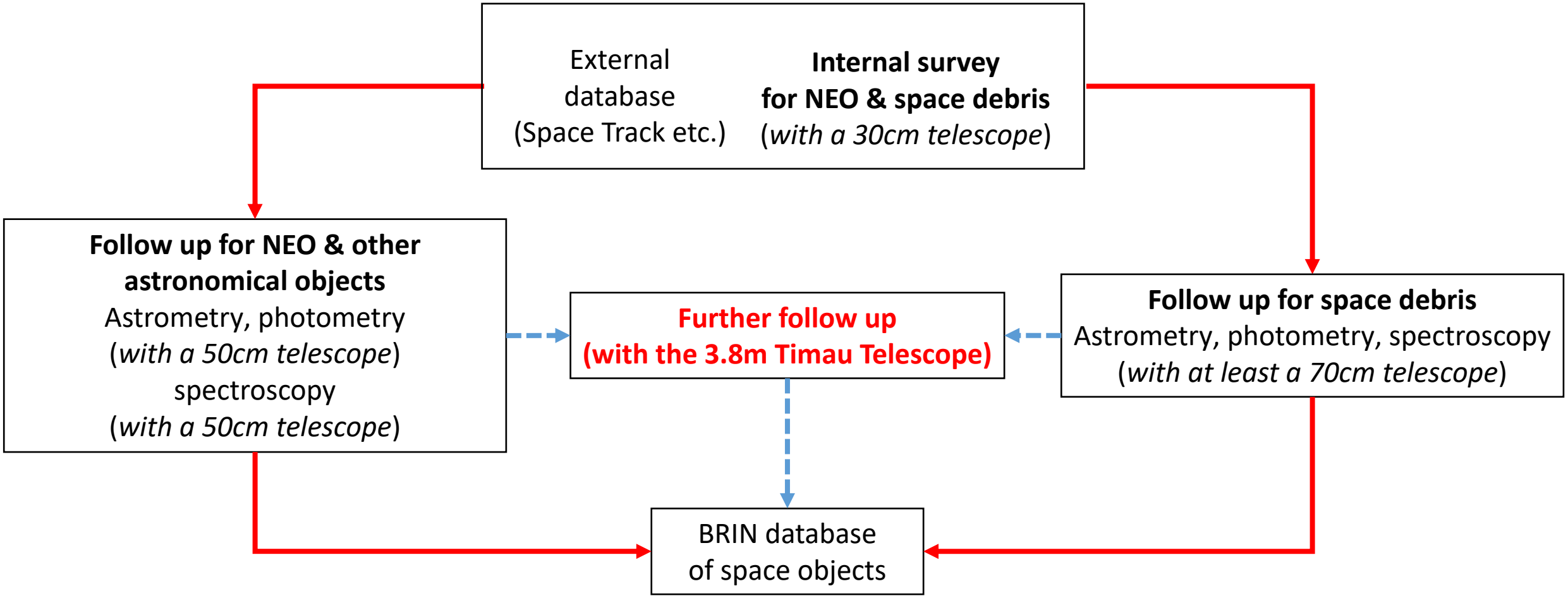


Satellite	Inclination	Mass (kg)	Attitude	Remark
PALAPA 1	9.42	574	rotating, unknown spin period	from our own observation
PALAPA 2	10.09	574	rotating, unknown spin period	from our own observation
PALAPA B1	12.51	1200	rotating, unknown spin period	from our own observation
PALAPA B4	12.51	1200	rotating, spin period known	from our own observation
PALAPA C2	10.31	3000	tumbling	from our own observation
INDOSTAR 1	12.14	1350	rotating, spin period known	from our own observation
TELKOM 1	5.87	2763	tumbling	from our own observation
GARUDA 1	7.86	4500	rotating, spin period known	from our own observation
TELKOM 2	2.89	1930	rotating, spin period known	from our own observation
PALAPA D	3.81	4100	rotating, spin period known	from our own observation
BRISAT	0.02	3540	controlled	from orbital data on the internet
TELKOM 3S	0.02	3550	controlled	from orbital data on the internet
TELKOM-4	0.02	5800	controlled	from orbital data on the internet
NUSANTARA SATU	0.04	4100	controlled	from orbital data on the internet
NUSANTARA TIGA	0.03	?	controlled	from orbital data on the internet
TELKOMSAT 113BT	0.02	~4000	controlled	from orbital data on the internet





Outlook


External database (Space Track etc.)
Internal survey for NEO & space debris (with a 30cm telescope)
Follow up for NEO & other astronomical objects
Astrometry, photometry (with a 50cm telescope)
spectroscopy (with a 50cm telescope)
Further follow up (with the 3.8m Timau Telescope)
Follow up for space debris
Astrometry, photometry, spectroscopy (with at least a 70cm telescope)
BRIN database of space objects

Summary

- Satellites including space debris are elements of SSA.
- Indonesia’s interest in SSA does not only come from needs but also from its geographical advantages.
- Satellites and space debris observations can be performed by several mode of observations such as astrometry, photometry, and spectroscopy.
- Timau Telescope and other small telescopes at BRIN will be used together in the context of SSA.


Timau National Observatory All-Sky Camera
Time (WITa): 28-08-2025 22:31:38
Exposure time [s]: 12
Gain: 300
Sunrise: 28-08-2025 05:49:30
Sunset: 28-08-2025 17:43:08
N
E
W
S
Thank you
https://allskycam.or.id/brin-timau-allskycam
Latitude (deg): -9.58
Longitude (deg): 123.94
Altitude (m): 1300 asl
Camera: ZWO ASI174MM
Temperature (C): 43.3