JAXA's activities on R&D of space debris observation

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Japan Aerospace Exploration Agency

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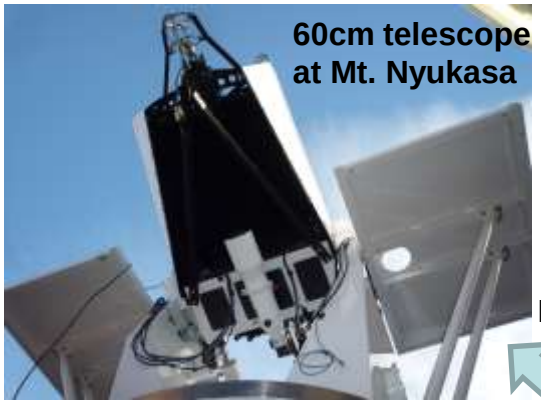
Direct imaging for ADR



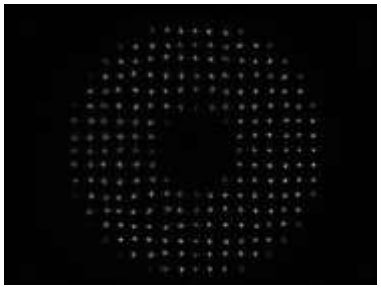
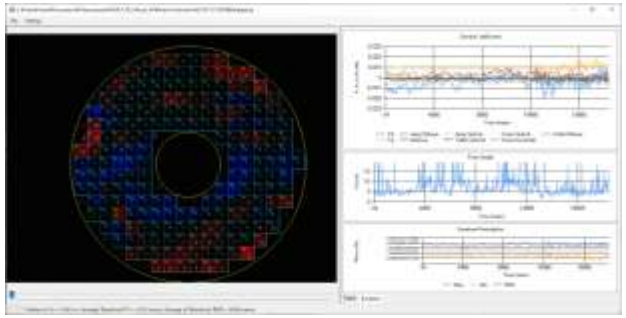
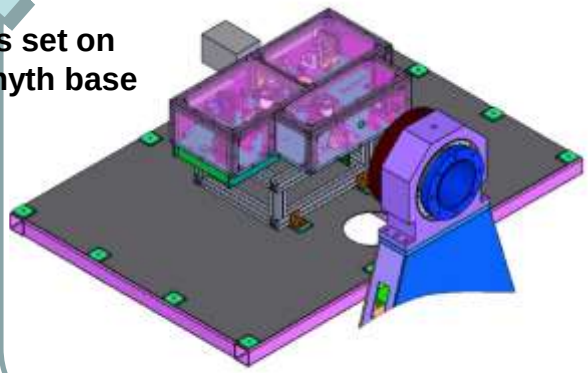


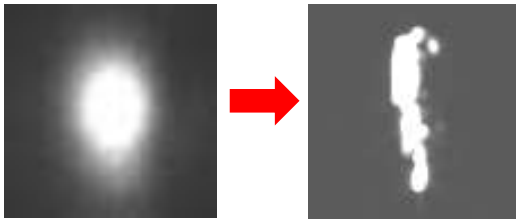
Image of the wave front sensor



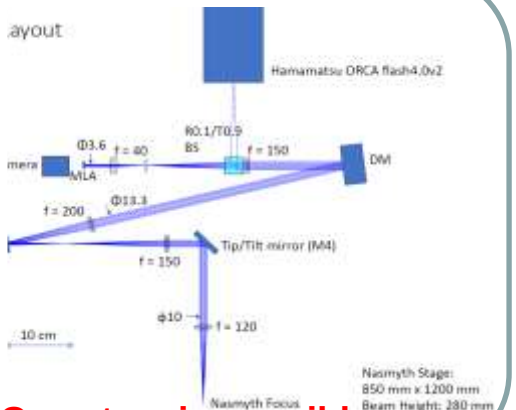
Calculation of the parameters for AO

The AO is set on
the Nasmyth base





Final objective : 1m resolution



Development of optimal AO system is possible

Understanding the motion of ADR targets is important. R&D directorate of JAXA is developing direct imaging technologies of ADR targets. We developed the AO system for the 60cm telescope at Mt.Nyukasa using the optimal parameter derived from the wave front sensor. Correction loop was speeded up last year changing optical setting and modifying the algorithm.

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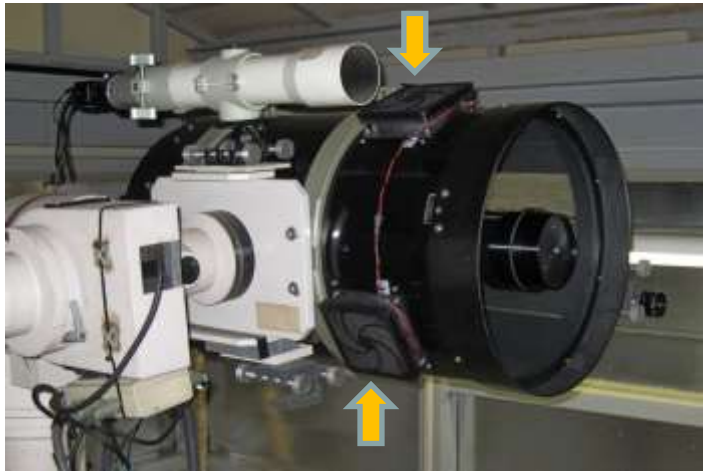

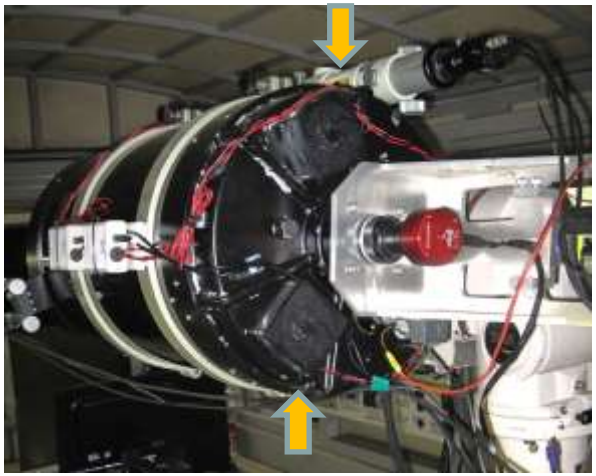

JAXA 35cm telescope with air flow modification

ISS taken by the system

The fast CMOS camera,
ZWO ASI 183MM

Blower off 10ms

Blower on 10ms

We are also developing the direct imaging system using the fast CMOS sensor and the 35cm optical telescope. Modification for suppression of air flow inside the telescope tube was carried out last year to improve the resolution.

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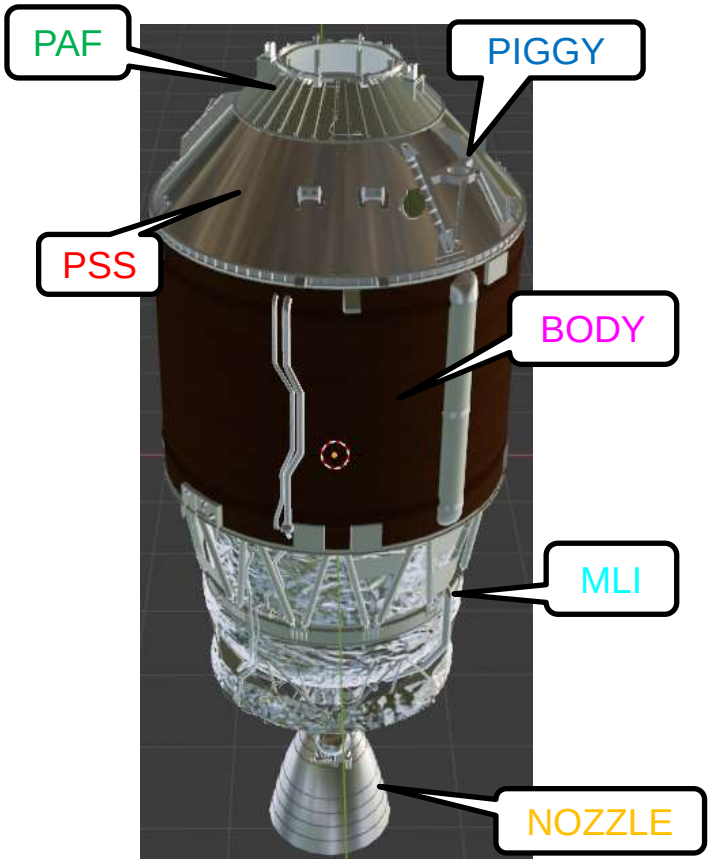
Light curve simulator



Precise 3D model of H2A R/B

		Intensity	Brilliance		Intensity	Brilliance
R	PSS	1.00000	1000.0	NOZZL	0.26000	400.0
G	PAF	0.11000	100.0	MLI	0.44000	800.0
B	PIGGY	0.26000	200.0	BODY	0.00018	1.0

Optical property of each component

The light curve simulator using 3D model was improved. A new algorithm to find out the optimum solution wad developed. The precise 3D model of H2A R/B including the optical property of each component was also developed. Stereo observation of H2A R/B was carried out last year and the data was analyzed using the simulator. The observation of CRD2 mission's target was started from this May.

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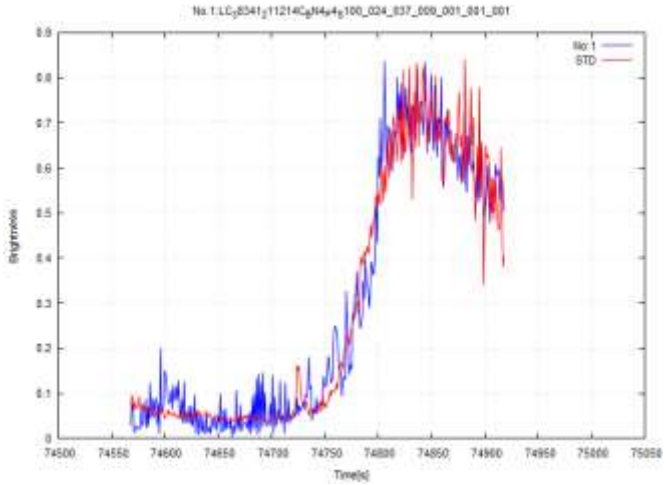
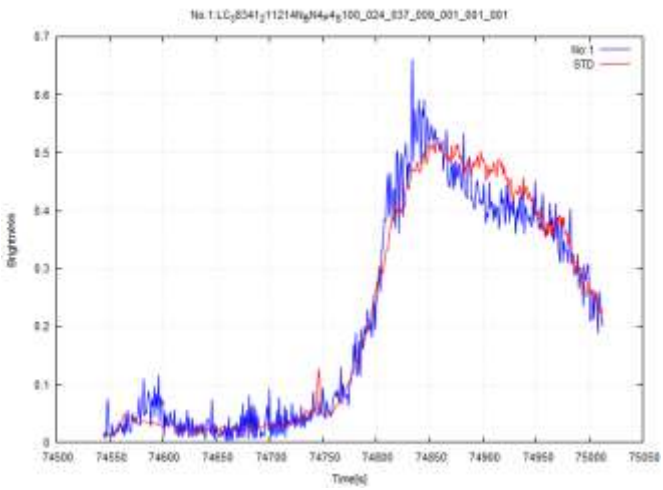
Light curve simulator

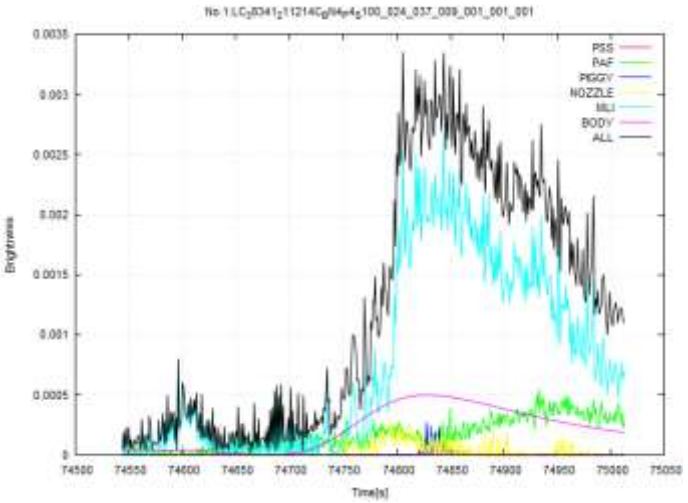
The analysis result of stereo observation of H2A rocket body

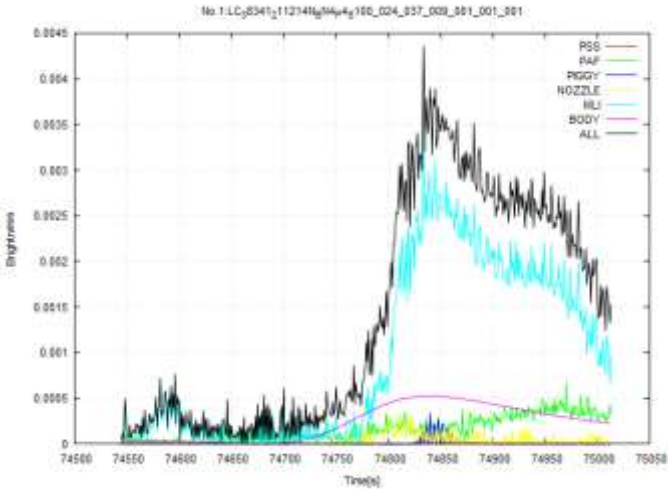
Observation(red)/
Simulation(blue)





Contribution of
each component





-Observation at Chofu-

-Observation at Nyukasa-

Attitude ((R1,R2,R3)=(−7.7, −0.4, −123.0)[deg])

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Light curve simulator

The simulated movie

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Observation sites in Australia

We are operating a remote observation site in Siding Spring Observatory of Australian National University. The site are used for GEO, LEO and NEO observation. LEO survey observation are being carried out. The observed data was applied to the propagation model of space debris, NEODEEM developed by Kyushu University and JAXA.

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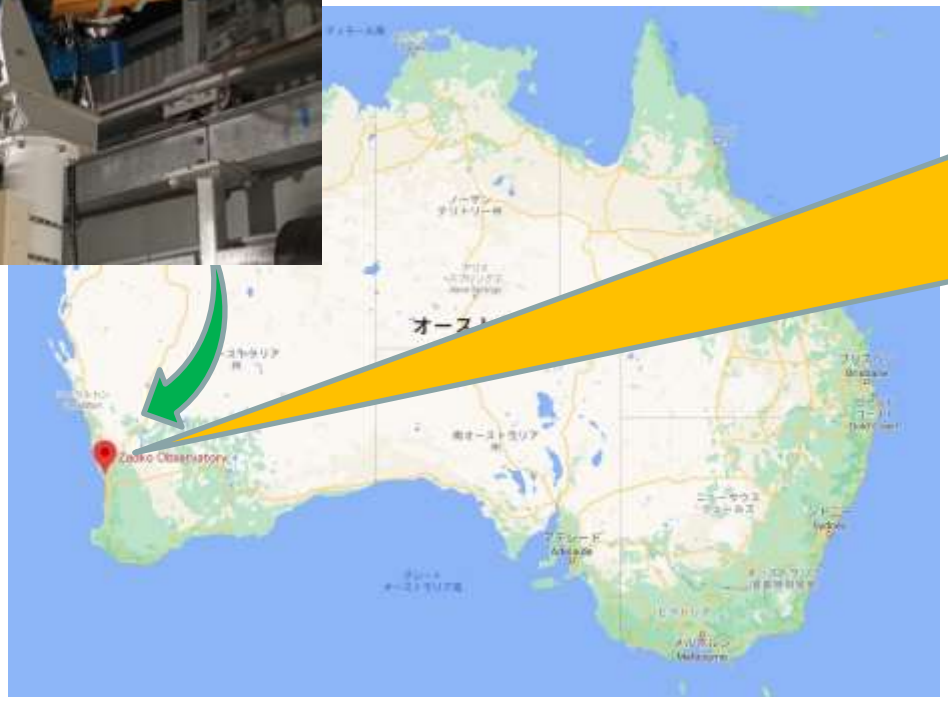
Observation sites in Australia



We installed our telescope and analysis system to Zadko Observatory owned by the University of Western Australia. As the site is located at the western side of Australia, the telescope there will be used to carry out precise orbital determination of targeted objects (like the target of CRD2 mission) with the combination of data take at the Siding Spring Observatory and track un-cataloged LEO objects detected also at the Siding Spring Observatory one cycle before.

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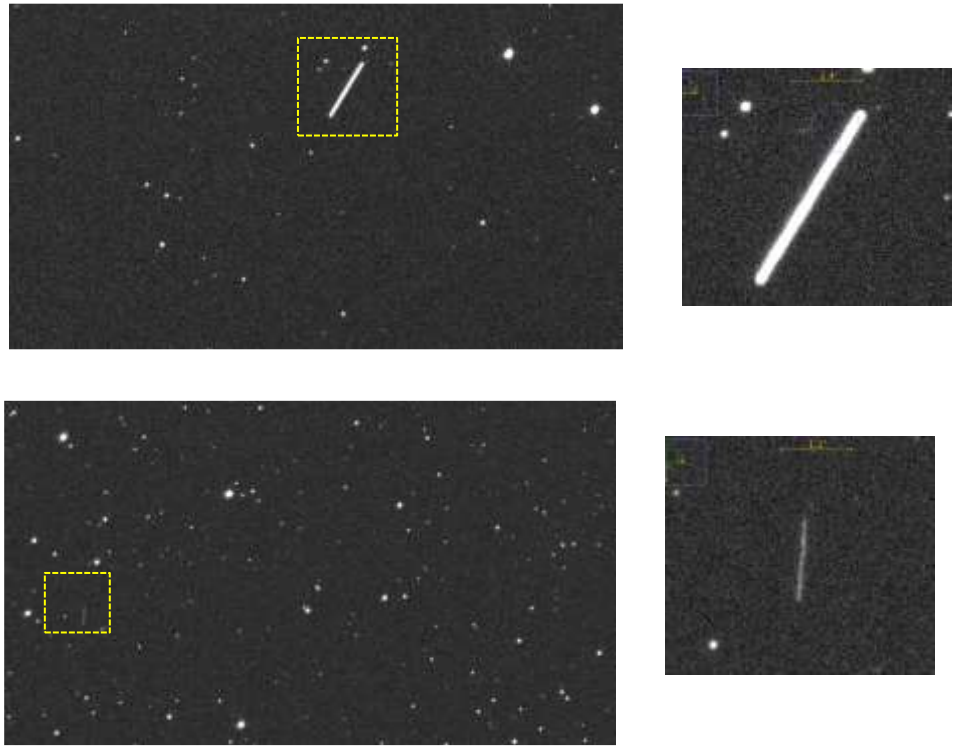
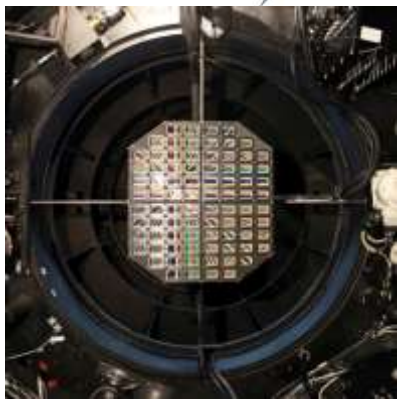
LEO objects detection from CMOS data



Streaks detected with the algorithm



105cm Schmidt telescope Tomo-e Gozen

GDEP DLEARNING BOX II

- 2 x NVIDIA QUADRO RTX8000 GPU
- 4 x 4608 CUDA cores
- 48 GB GPU Memory
- NVLink
- Intel i9-10940X CPU 3.30 GHz
- 28 CPU cores
- 128 GB RAM Memory

GPU machine installed at Kiso observatory

University of Tokyo has developed a large CMOS camera, Tomo-e Gozen, which is for 105cm Schmidt telescope at the Kiso observatory. The Tomo-e Gozen camera is the world's first wide-field CMOS camera. The entire focal plane area of the Kiso Schmidt telescope, 9 degrees in diameter, is covered by 84 chips of 35 mm full HD CMOS image sensors. We modified our original stacking method and developed the GPU based algorithm of the detection of steaks created by LEO objects. Orbital determination will be carried out using the tracked data taken at the remote observation sites in Australia in near future.

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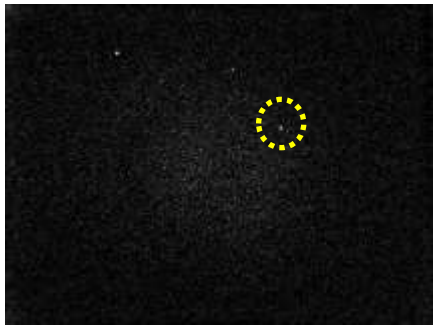
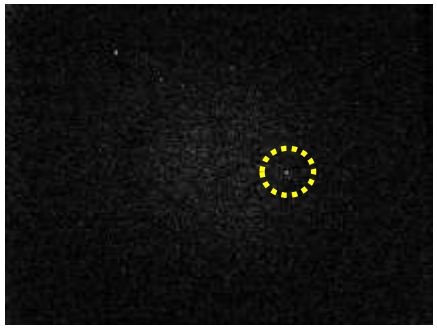
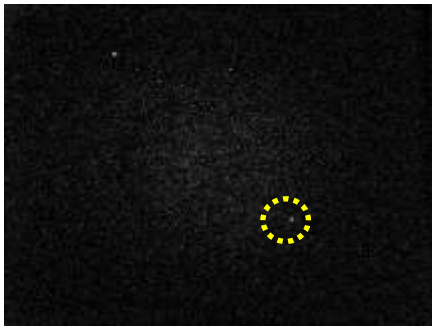
SSA using STT

Simulation of observation of LEO objects using STT







Detected space object
(cosmos2251 DEB)

As the star trackers(STT) are optical sensors and are equipped to a lot of satellites, STTs may be used for SSA. We are considering the possibility of doing some businesses including collision avoidance services. The image-processing technologies developed by JAXA will be applied to compensate the small size of the optics. By putting 4 satellites into dawn-dusk orbits at 800km, about half of objects from 700-900km are detected once every day. By analyzing the data from small onboard camera of RAISE-2（Small satellite of JAXA) using our analysis pipe-line, couple of space objects were detected.

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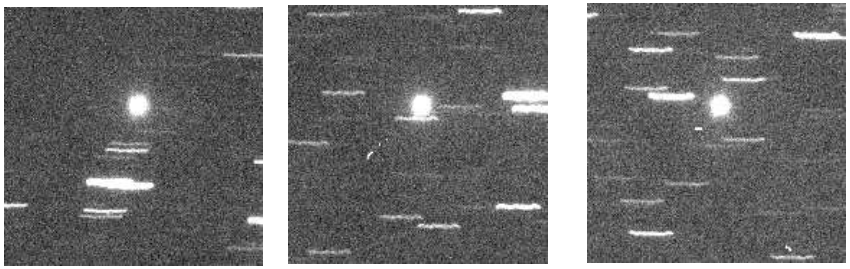
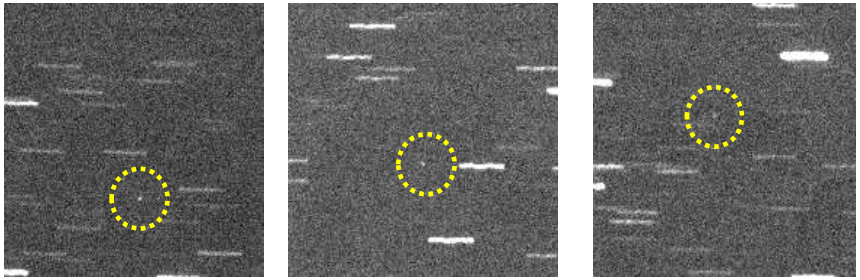
Collaboration with DSTL of UK



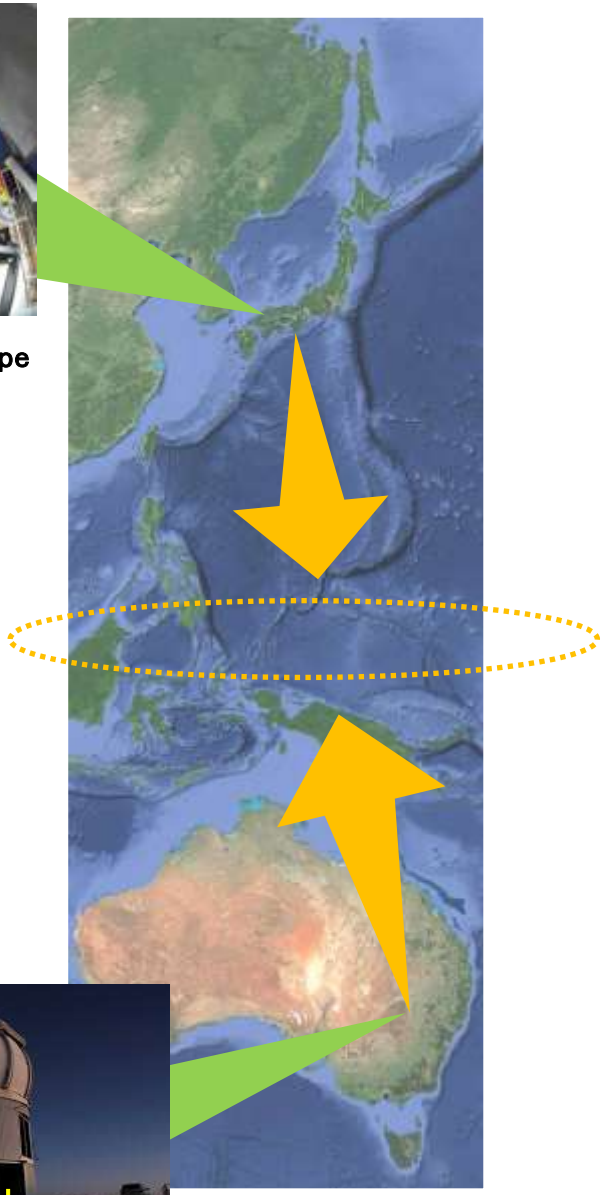
Detected object of 12-magnitude (4m in size)



Detected object of 19-magnitude (16cm in size)

JAXA has started the collaboration with DSTL of UK about the optical observation for SSA. Last year, DSTL and JAXA carried out collaborative observation of GEO belt using 1m class telescopes from both sides. JAXA developed the pipe-line for analysis of the data and detected the objects of 19-magnitude (about 16cm in size).

BSGC 1m telescope



SkyMapper Telescope