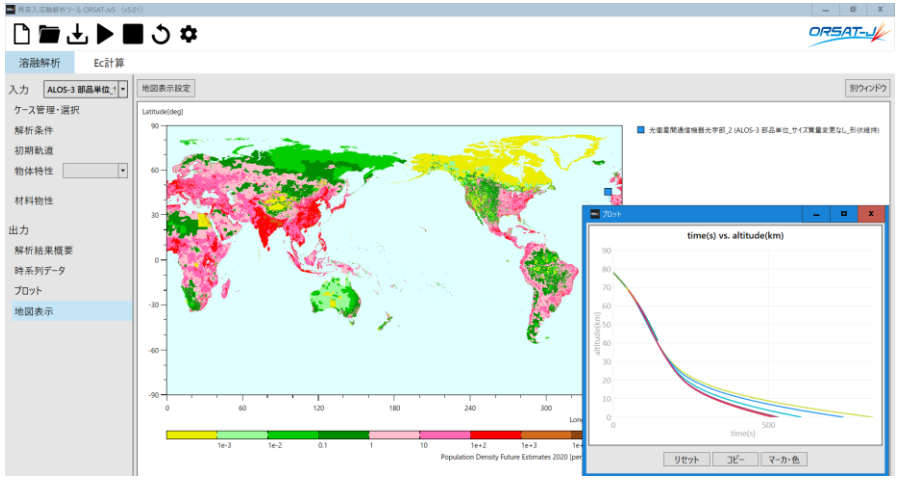
Introduction



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- System Safety and Space Operations Safety Engineer of Japan Aerospace Exploration Agency (JAXA) from 2016, Previously an engineer at chemical industry
- Expertise:
  - System Safety of the Launch Vehicle Payload, JAXA Safety Review Secretariat
  - Space Debris Mitigation, Re-entry Safety, Space Operations Safety
- Developing “Object Re-entry Survival Analysis Tool - Japan (ORSAT-J)”
- Member of the International Space Debris Community, IADC, ISO

a. How does the LST affect nano-satellite programs especially in universities and emerging countries

- UN LTS Guidelines are voluntary documents. However, countries are encouraged to implement them. (It may be incorporated into national regulations.)
- Every nano satellites owner/operator should pay attention to the Guidelines
- The LTS guidelines consists of four sections: A through D

A. Policy and regulatory framework for space activities
B. Safety of space operations
C. International cooperation, capacity-building and awareness
D. Scientific and technical research and development

- Section B is particularly relevant to nano satellites developers and operators!

B. Safety of space operations

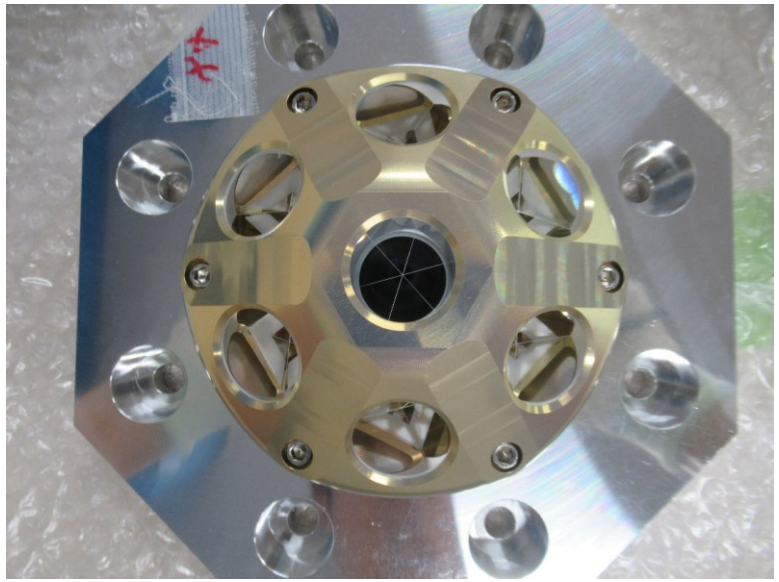
Guideline B.1
Provide updated contact information and share information on space objects and orbital events

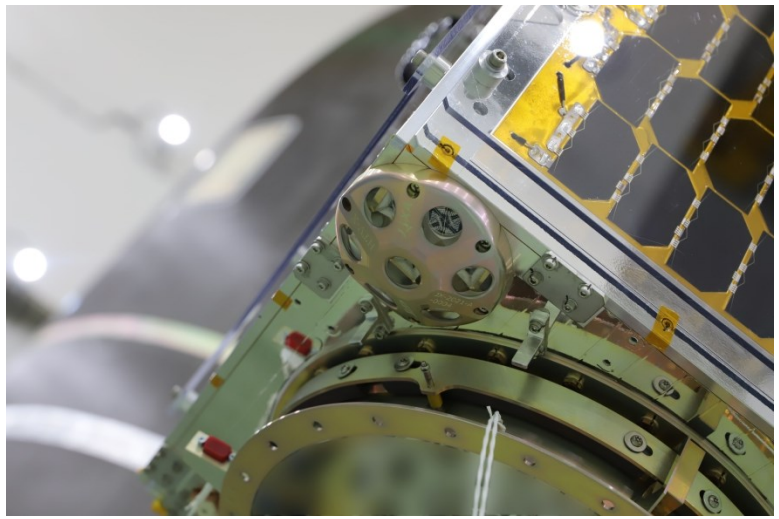
- The low-Earth orbit is increasingly congested, leading to a greater number of conjunction events than ever before
- Establishing framework for timely communication in preparation for conjunction and collision events is a key challenge
- Resource constraints are a concern for university satellites. Other challenges include insufficient understanding of formal governing framework, lack of experience of procedure, and the problem of student turnover

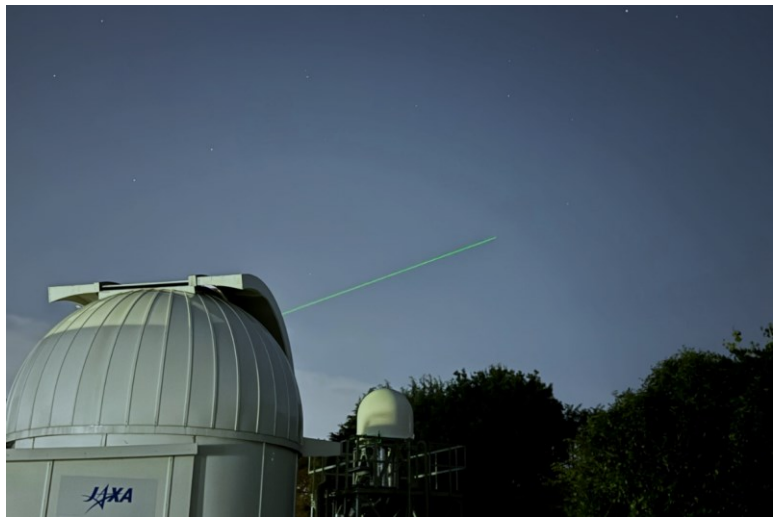
Guideline B.2

Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects

- High-precision orbital position data enables more effective collision avoidance operations (and reduces CDM)
- Operating satellites have good orbital determination accuracy if routine telemetry data is available, but this is not the case for debris (JAXA's "Mt. Fuji" laser reflector contributes to improving orbit determination accuracy of debris)
- For rideshare missions, difficult to identify your satellite immediately after separation from the rocket







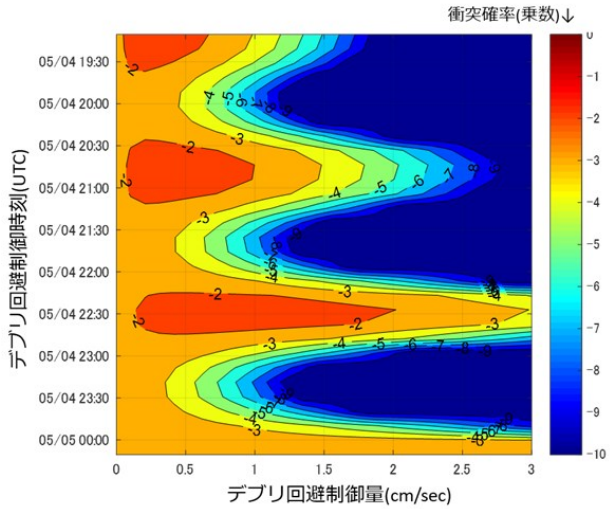
https://www.jaxa.jp/press/2024/08/20240822-1_j.html

Guideline B.3
Promote the collection, sharing and dissemination of space debris monitoring information

- Recognize that operators remains responsible even after a nano satellite becomes space debris (In the event of a collision between an active spacecraft and debris)
- After mission completion, lower the orbital altitude as much as possible
- The presence of the laser reflector (introduced in B.2) facilitates orbital determination after becoming space debris

Guideline B.4
Perform conjunction assessment during all orbital phases of controlled flight

- Issues with timely communication systems (B.1)
- Issues with orbital determination accuracy (B.2)
- Lack of collision avoidance expertise and formal procedures
- Inability to respond even when notified (lack of maneuverability)



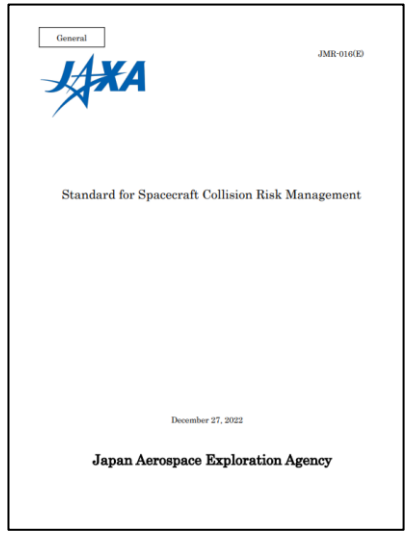
⇒You can use the knowledge of JAXA!

- RABBIT:**R**isk **A**voidance assist tool based on debris collision pro**babilit**y

https://rabbit.jaxa.jp/index_ja.html

- JMR-016 Standard for Spacecraft Collision Risk Management

https://sma.jaxa.jp/TechDoc/Docs/E_JAXA-JMR-016.pdf


General
JMR-016(E)
Standard for Spacecraft Collision Risk Management
December 27, 2022
Japan Aerospace Exploration Agency

Guideline B.6
Share operational space weather data and forecasts

Guideline B.7
Develop space weather models and tools and collect established practices on the mitigation of space weather effects

- Understand the risks of space weather to nano satellites. Japan has space weather forecasts from NICT. (https://swc.nict.go.jp/)
- Effects of geomagnetic storms (In 2022, Starlink experienced orbital decay shortly after launch, losing approximately 40 satellites)
- Effects of radiation (Avoid special operations like software updates or orbital changes)

Guideline B.8
Design and operation of space objects regardless of their physical and operational characteristics

- Design to enhance the trackability of nano satellites
  - ✓ Passive methods (increase radar cross sectional area, increase optical reflectivity)
  - ✓ Active methods (equipped with LEDs, beacons, etc.)
  - ✓ Laser ranging using reflectors (explained in B.2)

- Design to mitigate space debris
  - ✓ Restrictions on object release in orbit
  - ✓ Prevention of break-ups caused by internal energy
  - ✓ Prevention of collisions with other objects
  - ✓ Clearance from protected orbital regions after post-mission disposal

  -> JAXA is currently developing easy tools for nano satellite developers to implement debris mitigation evaluation

Guideline B.9
Take measures to address risks associated with the uncontrolled re-entry of space objects

- Low-melting temperature materials should be selected during design of nano satellites (Titanium, etc., should not be used.)

Guideline B.5
Develop practical approaches for pre-launch conjunction assessment

- N/A

Guideline B.10
Observe measures of precaution when using sources of laser beams passing through outer space

- N/A

b. What are the necessary technological breakthrough to live with LST

Design for the nano satellite itself

- Design of telemetry function enabling routine orbit determination
- Design for improved orbit determination accuracy
- Collision avoidance capability (small thrusters, etc.)
- Deorbit devices (drag sails, etc.)
- Enhanced satellite bus reliability, while need to achieve low cost
- Improved demisability during atmospheric re-entry

Ground equipment and operational framework (resource)

- Observation equipment for their own operations
- Formal operational framework and procedures (normal operations, collision avoidance, contingency plans, disposal/decommissioning operations)
- Timely exchange of operational data (inc. collision risk assessment) with external entities and data disclosure
- Technology transfer and training for students
- Compliance with laws, regulations, and guidelines
- Exchange of best practices for operations with the SSA community

c. What should UNISEC-Global do to live with LST?

UNISEC serves as a key framework for exchanging best practices regarding university satellites for LTS. It can contribute to "**C. International cooperation, capacity-building and awareness**" of the LTS guidelines.

Guideline C.1 Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities

- UNISEC can promote international cooperation on LTS for university satellites

Guideline C.2 Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange

- UNISEC can share state-of-the-art technical insights on actual satellite development and operations

Guideline C.3 Promote and support capacity-building

- UNISEC can promote capacity-building for university students and emerging countries

Guideline C.4 Raise awareness of space activities

- UNISEC can raise awareness of space activities with newcomers such as university students