Overview of JAXA‘s Research for Comprehensive Measures on Space Debris

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Content

- Background
- Government space policy related to space Debris
- Research Team for Comprehensive Measures on Space Debris
- R&D on Debris Mitigation and Active Debris Removal
- Topics: Efforts to Raise Awareness at Universities
- Summary

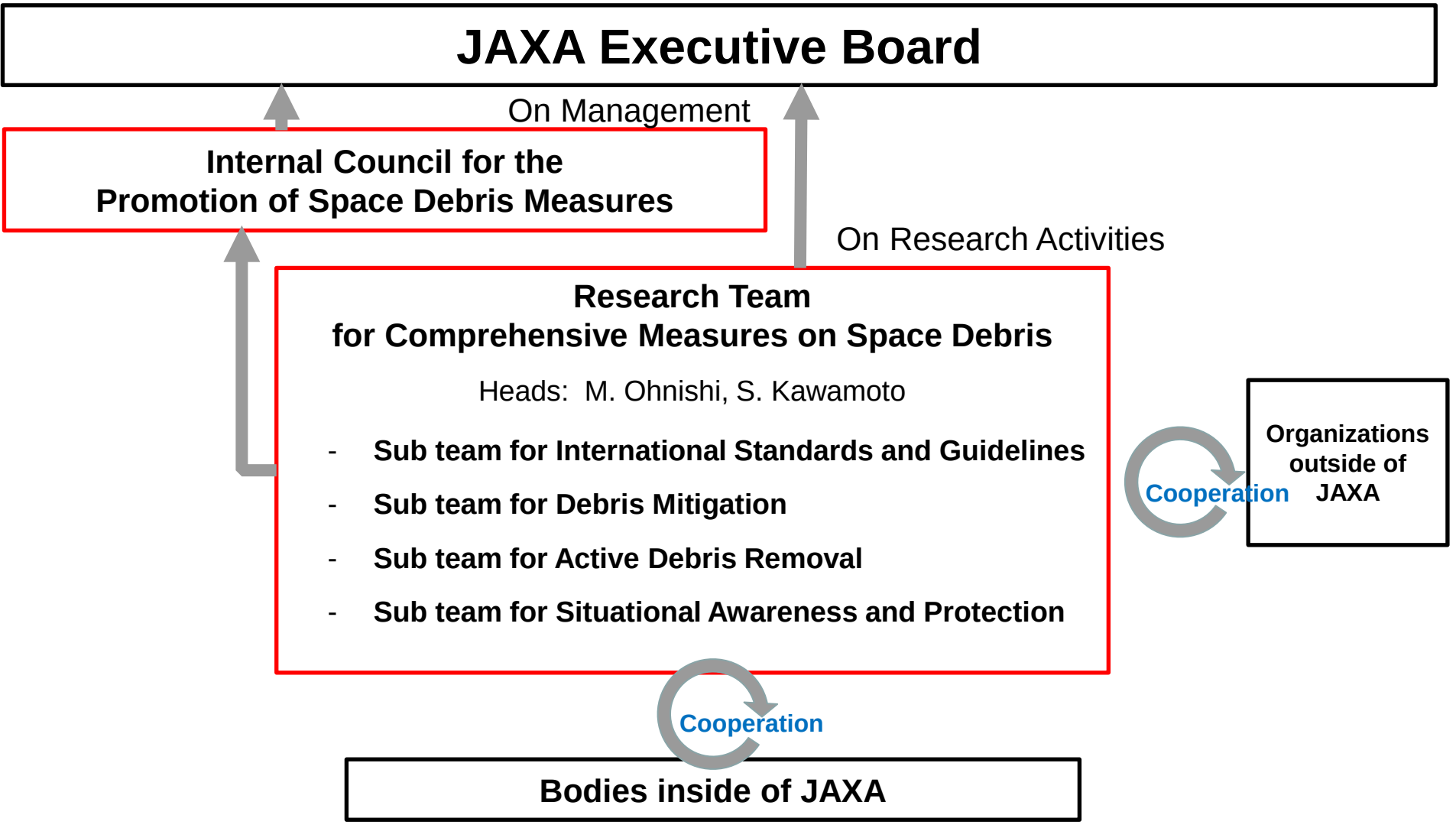
Basic Plan on Space Policy and Space Activities Act

- **New "Basic Plan on Space Policy", established in January 2015:**
  - **Improving the capability of SSA**
  - **Addressing the R&D on debris removal technologies**
- **"Implementation Plan" (Roadmap): revised on a yearly basis**
  - **The current version including the the establishment of the framework for SSA**
- **Japan's new legislation concerning launch and control of satellites was enacted in 2016**
  - **Establishing an authorization regime for launch and control of satellites**
  - **Providing a mechanism for prior review for harmful contamination, ensuring public safety, and accurate and smooth implementation of UN treaties and other measures relevant to outer space**
  - **Specific regulation is now under consideration**

The Promotion of Space Debris Measures

- **JAXA's R&D Activities for Space Debris Measures**
  - **Proposing technical guidelines for debris mitigation through the IADC (Inter-Agency Space Debris Coordination Committee).**
  - **Taking advantage of Japan's strengths and promoting R&D on space debris mitigation technologies such as observation, protection and safe removal.**
- **Framework for the Promotion of Space Debris Measures**
  - **Internal Counsel for the promotion of space debris measures**
    - **Members are directors and/or managers.**
  - **Research team for space debris comprehensive measures**
    - **The team consists of 4 sub-teams.**

Framework for the Promotion of Space Debris Measures



International Standards and Guidelines

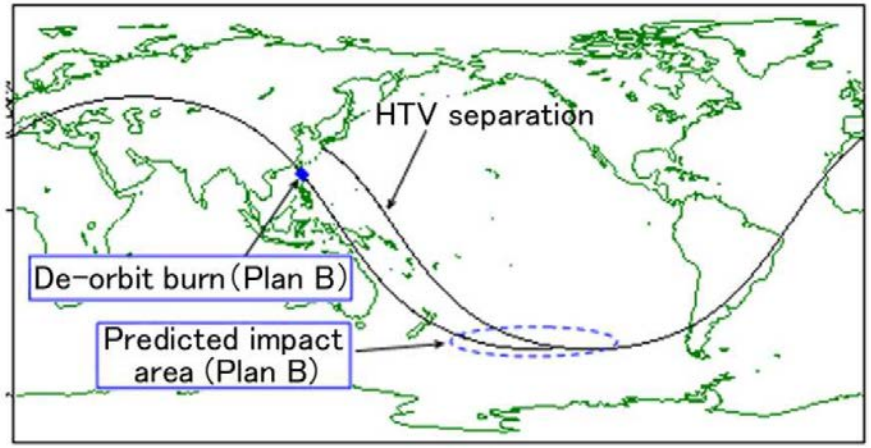
In cooperation with other spacefaring agencies, we put our efforts on creating efficient proposals on international standards or guidelines for space debris mitigation while adopting the latest technologies and findings in related researches.

- **COPOUS (Committee on the Peaceful Uses of Outer Space)**
  - **STSC (Scientific and Technical Subcommittee)**
    - **LTS (Long-Term Sustainability of Outer Space Activities)**
- **ISO (International Organization for Standardization)**
- **IADC (Inter-Agency Space Debris Coordination Committee)**

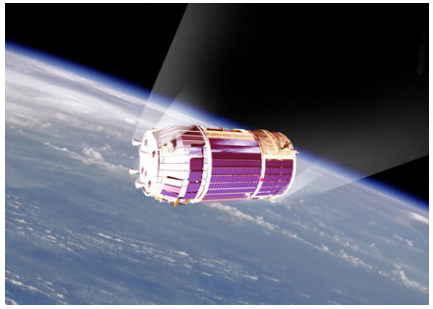
Debris Mitigation

- Compliance with 25 year rule
  - **De-orbit to an unprotected region**
- Design for demise
  - **Fuel tank melted during re-entry**
  - **Re-entry data acquisition system**
- Controlled re-entry for ground safety
  - **Controlled re-entry of HTV and the upper stage of H-IIB**

Melting Material Tank



The Upper Stage of H-IIB Controlled Re-entry



HTV Controlled Re-entry (CG)

Using Melting Material during Re-entry

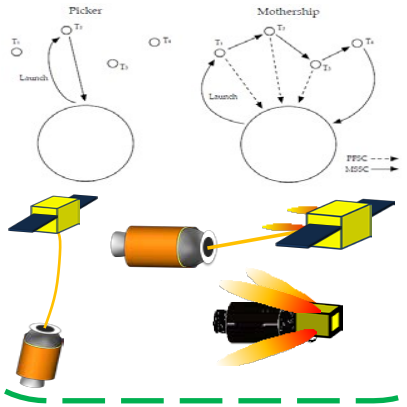
JAXA's Research on Active Debris Removal

Implementation Scenario
(Property, Liability, Business Viability)

Technical Subjects
(Capture of Non-Cooperative Target)

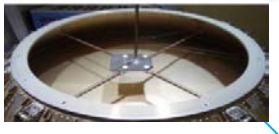
Research Subjects

① Scenario



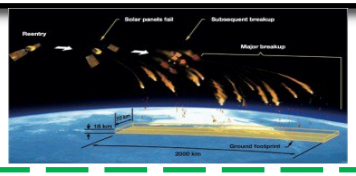
② Propulsion

③ Capture



④ GN&C

⑤ Deorbit & Safety Re-entry



⑥ Simulation

Promising Operational Scenario for ADR

Launch

Orbit Injection

Rendezvous

Approach to Debris (Non-Cooperative Rendezvous)

Proximity Operations

Motion Estimation

Attachment of Tether End

Debris Object in Crowded Region

Deorbit

Debris

Electron Collection

Tether

Flight Direction

Drag Force

Geo-magnetic Field

Electric Current

Deorbit by EDT (Electrodynamic Tether)

Partial Demonstration

KITE

End Mass

e^-

e^-

Tether

Current

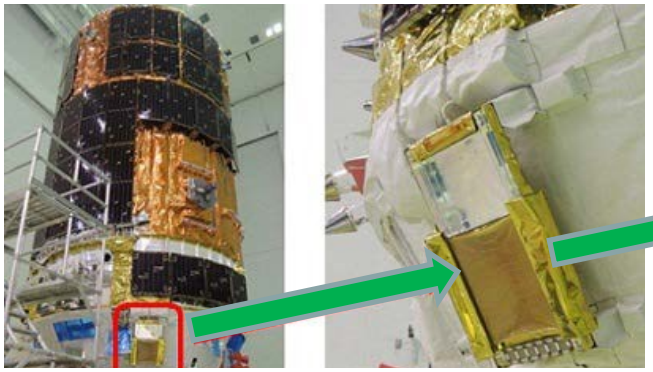
HTV

Electron Emitter

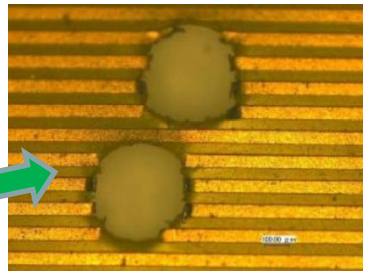
e^-

Situational Awareness and Protection

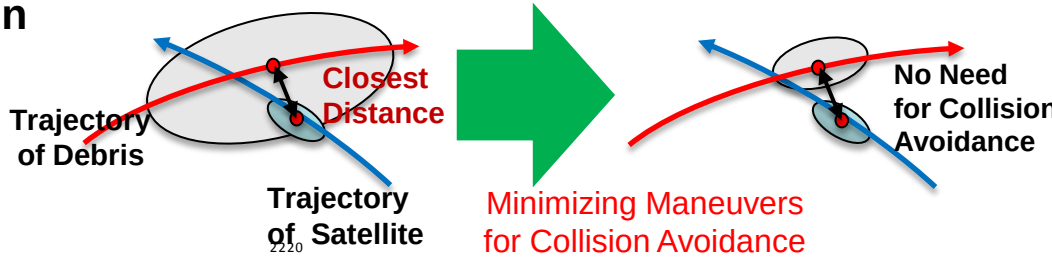
- **Observation**
  - Observatory from ground
  - Radar from ground
  - Onboard Camera in orbit
  - Impact sensor in orbit
- **Maneuver Planning**
  - Improving the orbit determination and prediction of space debris
- **Modeling**
  - Reflected in the design rules for spacecraft as well as in the regulatory rules for debris prevention
- **Protection**
  - Reflected in the design guidelines and damage evaluation



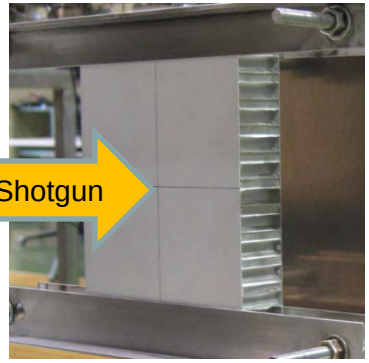
Impact Sensor Demonstration by HTV-5

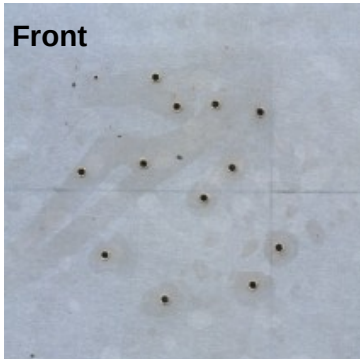


Impact Sensor Test on ground



Minimizing Maneuvers for Collision Avoidance





Shotgun Like Collision Test to Honeycomb Sandwich Panel

UNISEC and UNISEC Global

- The **University Space Engineering Consortium** was established in Japan as an NPO. It supports practical space development activities in universities and colleges, such as small satellite & hybrid rockets.
- **UNISEC Global** is a consortium of local chapters, aiming at facilitating university students' practical space projects e.g. building & launching satellites and rockets.
- Improving awareness of long term sustainability of space activities.

Deorbit Device Competition (DDC)

Facilitate the sharing of innovative solutions for debris mitigation & developing effective deorbit devices that can be demonstrated and validated with CubeSats.

Eligibility: Space engineers, researchers, students, all interested in contributing to the harmonious space development

Requirement: Proposal for the ideas on deorbit device which suits CubeSat. (1U, 2U, 3U)

Final presentation: Finalists were invited to Bulgaria to attend the 4th UNISEC-Global Meeting on Oct 21, 2016.
http://www.unisec-global.org/ddc/index.html

Results

22 applications from 15 countries.
10 finalists from 8 countries.

4 December 2017, "Debris Mitigation Competition" will be in Rome, Italy (Sapienza University di Roma)

Summary

- **JAXA is promoting a comprehensive approach to space debris measures.**
- **JAXA focuses on the R&D of key technologies for 3 subjects: “Debris Mitigation”, “Active Debris Removal”, and “Debris Situational Awareness and Protection”**
- **Cooperation with international partners, universities, and private companies is important for feasible and sustainable space activities.**

Thank you for your attention!