Space Environment Experiments ~ Active Debris Removal

Feb. 27, 2015
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Space Systems Division
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Contents

1. Exposed Experiments with ISS/Kibo Robot Arm

2. Active Debris Removal
International Space Station (ISS)

- The manned construction located about 400km above the Earth
- The facility for conducting experiments and research for a long time

Weight: approx. 420 t
Power: 82–120kw
90 min. per orbit
Flights for Assembly: Shuttle 40 times, Proton 10 times
Max. 6 flight crew

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United Kingdom
Canada
France
Spain

Belgium
germany
Sweden
Italy
Japan
The Netherlands
Norway
Denmark
Switzerland
United States
Brazil

International Space Station (ISS)
Kibo

Experiment Logistics Module-
Pressurized Section

Robot Arm

Pressurized Module

Exposed Facility

Experiment Logistics Module-Exposed Section

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Kibo/Pressurized Module (PM)

Air Lock
Kibo/Exposed Facility (EF)

Equipment Exchange Unit (EEU)
Kibo/Robot Arm
KOUNOTORI : H-II Transfer Vehicle (HTV)

PLC: Pressurized Logistics Carrier
The PLC will carry supplies that will be used aboard the ISS. The ISS crew will be able to enter and work within the PLC.

ULC: Unpressurized Logistics Carrier
The ULC will carry the Exposed Pallet.

Avionics Module
The Avionics Module contains navigational and electrical equipment.

CBM: Common Berthing Mechanism

EP: Exposed Pallet
The EP will carry unpresurized payloads or other equipment.

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Activities in Kibo

Material Science Research
Life Science Research
Space Medical
Life in Space
Exposed Experiments
Social science & Education
CALET CALorimetric Electron Telescope

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### Satellite Specifications

<table>
<thead>
<tr>
<th>Satellite Size</th>
<th>1U, 2U, 3U (*1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit</td>
<td>Elliptical with altitude of 380~420km (*2)</td>
</tr>
<tr>
<td>Inclination</td>
<td>51.6°</td>
</tr>
<tr>
<td>Ballistic Coefficient</td>
<td>Less than 100kg/m² (*3)</td>
</tr>
<tr>
<td>Direction</td>
<td>Nadir-aft 45° from the ISS nadir side, in terms of ISS body coordinate system (*4)</td>
</tr>
<tr>
<td>Velocity</td>
<td>1.1 - 1.7 m/sec</td>
</tr>
<tr>
<td>Life expectancy on orbit</td>
<td>100~250days (*5)</td>
</tr>
</tbody>
</table>

*1) CubeSat: W10cm × D10cm
1U: L10cm, 2U: L20cm, 3U: L30cm
*2) Depend on ISS Altitude
*3) to make satellites decayed faster than ISS orbit
*4) to avoid collision with the ISS
*5) depends on ballistic coefficient, released altitude, solar activity, etc.
J-SSOD Mission

Satellite Install Case
JEMRMS  J-SSOD (MPEP)

Exposed Facility

Air Lock  Satellite Install Case

MPEP  J-SSOD (MPEP)

JEMRMS  Cube Sat

Exposed Facility

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- Cuboid mechanism equipped with experiment samples of 7 on the upper surface and 13 on the side surfaces
- Crew attaches samples on ExHAM and installs it on airlock
- JEMRMS SFA grapples ExHAM and attaches it to the handrail.
- After the experiment, ExHAM is retrieved from the handrail by the JEMRMS SFA again and returned to the Kibo’s PM via airlock.
- Samples can be returned to Earth
ExHAM Flight Model
Please remind that the following proposal is based on the discussion among the debris research members including the presenter and it is not a consensus of any agency or any organization.
Future Space Environment

Projection of the LEO Populations (Reg Launches + 90% PMD)

IADC-13-01
Stability of the Future LEO Environment

ADR2020/05

GSO < LEO
Small debris < Large debris
Satellite < Upper Stage

NASA Orbital Debris Quarterly News
Vol15, Issue2
ADR Promotion

Active Debris Removal

Law/Rule  Organization  Technology
ADR UNION (tentative name)

External Organization
- IADC etc.

Guideline Info, Debris Status

Legal Section
- ADR Rule
- Establishment & Enforcement
- Rule Operation
- Report

ADR Operation Section
- Selection of debris to be removed (including negotiation of ownership)
- Supply debris info.
- Decision of ADR Executor
- ADR Order
- Report

ADR EXECUTOR
- Manufacture,
- Launch & Operation of ADR Sat5

COPUOUS
- Assignment
- Report

Debris Info. Inquiry
- Debris Owner

User of Space
- Cost

ADR UNION (tentative name)
ADR Funding

Sustainable Space Development

Maintenance Space Environment

Space Debris
@LEO @MEO @GEO

ADR Operation

ADR Executor

Country A
Ownership

Country B
Ownership

Legal Section
Rule Operation

ADR Operation

ADR Order
Development ADR UNION (tentative name)

Activities on ADR UNION

2015
- #1 Declare ADR Promotion
  - Share ADR spirit
  - Declare ADR promotion

2020
- #2 ADR UNION Establishment
  - Establishment of ADR UNION

2025
- #3 ADR spirit Penetration
  - Growing tendency of ADR spirit

2030
- #4 Sustainable ADR Operation
  - Increase participant

International Organization/Meeting on ADR

COPUOS

IADC

Activity on International Law

Operation Section

Legal Section

SDMI

System Design and Management

Empowered by Innovation

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