Small satellites Deployment from “Kibo”

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JAXA provides opportunities for launching small satellites with the support from technical coordination to launch and deploy for the purposes shown as below:

(a) To contribute for easy, fast and on time to launch and operation of small satellites by private enterprises and universities, expanding the application of the space development and capacity building.

(b) To promote a technical demonstration by using the small satellites.
ISS  is a huge manned construction located about 400km above the Earth.
15 countries participate in the ISS program
Japan strives to make concrete international contributions through extensive utilization of Kibo and HTV.
Unique Capability of Kibo – Exposed Facility

Kibo has a unique Exposed Facility (EF) with an Airlock (AL) and a Remote Manipulator System (JEMRMS), and has a high capacity to exchange experimental equipment.
Kibo’s unique function:
JEM AL (JEM Airlock) and
JEMRMS (JEM-Remote Manipulator System)

JAXA developed the unique system “J-SSOD”
(JEM Small Satellite Orbital Deployer)
to deploy the satellite and inject the orbit from Kibo.
In 2012, the first satellites were deployed from Kibo: this has opened up new capabilities for ISS/Kibo utilization and **new possibilities of the Micro/Nano-satellite**.

It is able to operate the satellite deployer using Kibo, both airlock and robotic arm, is not only **J-SSOD** but also **NRCSD** and **Cyclops**.

As of Today, **154** have deployed from Kibo and the deployment system has been attracting global attention as being a new space transportation system for the satellite.
J-SSOD: JEM Small Satellite Orbital Deployer

I. Cargo Integration and launch

- **Cargo Transfer Bag**
- **J-SSOD Satellite Case**
- **Resupply Vehicle & Launcher**

II. Preparation in Kibo/ISS

- **JEM Airlock (Inside Kibo)**
- **Multi-Purpose Experiment Platform (MPEP)**
- **JEM PM Inboard**
- **J-SSOD Satellite Case**

III. Transferring outboard through JEM Airlock

- **JEM**
- **MPEP**
- **JEM Airlock (View from outboard)**

IV. Deployment from J-SSOD

- User starts to operate the satellite 30 minutes or more after deployment

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Micro-Satellite Developed by User

Developed by User

Resupply Vehicle

& Launcher

Satellite Case

To Outboard
J-SSOD: JEM Small Satellite Orbital Deployer
# J-SSOD: JEM Small Satellite Orbital Deployer

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
</table>
| Satellite Size        | CubeSat: 1U, 2U, or 3U (*1)  
50 kg class satellite: 55 × 35 × 55 cm                                      |
| Satellite Mass        | CubeSat: 1.33 kg or less per 1U  
50 kg class satellite: 50 kg or less                                          |
| Orbital Altitude      | approximately 380 - 420 km (*2)                                               |
| Inclination           | 51.6°                                                                         |
| Deployment Direction  | Nadir-aft 45° from the ISS nadir side                                          |
| Deployment Velocity   | CubeSat: 1.1 - 1.7 m/sec  
50 kg Microsat: 0.4 m/sec                                                       |
| Ballistic Coefficient | 100 kg/m² or less (*3)                                                        |

*1) CubeSat specification:  
10 cm (W) × 10 cm (D) Height: 1U: 10 cm, 2U: 20 cm, 3U: 30 cm  
*2) Depends on ISS altitude.  
*3) Depends on ballistic coefficient, altitude at release, solar activity, etc.
CubeSat Deployment Mission Overview

SERPENS  Launch and Deploy:2015

Investigator:
University of Brasilia (Brazil)
Agência Espacial Brasileira (AEB)
Japan Manned Space Systems Corporation

Size: 3U
Diwata-1  
Launch and Deploy: 2016

Investigator:
University of the Philippines (The philippines)
Department of Science and Technology (DOST)
Tohoku University/Hokkaido University

Size: Micro-Satellite (55cm × 35cm × 55cm)
The final Safety Review Panel (Phase 3) reviews the safety-related verification results.

Results of verification (test and analysis) conducted by the user are reviewed by JAXA to confirm that the satellite complies with the J-SSOD interface requirements.

Satellite Development by University or Company

Phase 0/1 Safety Review
Phase 2 Safety Review
Safety Data Package Release for Review
Phase 3 Safety Review Complete
Interface Compatibility Review
Satellite H/O to ISS Resupply Vehicle Cargo Integration
Launch on ISS Resupply Vehicle
Deployment !

L-7.5mon
L-6mon
L-5.5mon L-5mon
L-0

On-orbit stowage duration depends on operations constraints.
(Typically up to 6 months)

The batteries cannot be recharged beyond this point.

<For example : Safety Issue >
Structure Failure
Battery Rapture
Antenna Inadvertant Deployment
7 Cubesats were launched by HTV6 (Dec. 9/2016) and deployed by J-SSOD (Dec. 16/2016 and Jan. 19/2017).

<table>
<thead>
<tr>
<th>Satellite</th>
<th>AOBA-Velox III</th>
<th>TuPOD</th>
<th>EGG</th>
<th>ITF-2</th>
<th>STARS-C</th>
<th>FREEDOM</th>
<th>WASEDA-SAT3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>2U</td>
<td>3U</td>
<td>3U</td>
<td>1U</td>
<td>2U</td>
<td>1U</td>
<td>1U</td>
</tr>
</tbody>
</table>

**Overview**

| Investigator | Kyushu Institute of Technology / Nanyang Technological University, Singapore | GAUSS Srl, Italy / Japan Manned Space Systems Corporation (JAMSS) | University of Tokyo | University of Tsukuba | Shizuoka University | Nakashimada Engineering Works, Ltd. / Tohoku University | Waseda University |

**Mission**

| Mission            | Demonstration of PPT (Pulsed Plasma Thruster) | Deployment of two daughter satellites (TubeSats) | Demonstration to unfold a toroidal inflatable structure for aeroshells | Builds a network of people using satellite data. | Conducts technical demonstration of a tether extending system by using a mother and a daughter satellites. | Demonstrates a de-orbit device using a thin-film unfolding mechanism in space. | Image projection on the surface of a drag chute with a micro projector |

*Latest mission with J-SSOD in 2016-2017*
Joint Global Multi Nation Birds (Birds Satellite Project)

Launch and deploy: 2017

Investigator: Kyushu Institute of Technology
    Japan, Ghana, Bangladesh, Mongolia, Nigeria, Taiwan, Thailand

Size: 1U 5 satellites

Mission:
1. Take photograph of homeland via onboard cameras (CAM)
2. Digi-singer Mission (SNG)
3. Determination of Satellite Precise Location (POS)
4. Atmospheric Density Measurement (ATM)
5. Demonstrate Ground Station Network for CubeSat Constellation (NET)
6. Measure single-event-latchup in orbit (SEL)
Interface between your satellite and J-SSOD

• The design and verification shall be complied with
  JX-ESPC-101133(Latest version)
  JEM Payload Accommodation Handbook(JPAH) - Vol. 8 -
  Small Satellite Deployment Interface Control Document

• The satellite developer have to verify **all** requirements of
  JPAH vol.8.

  Especially important section is
  2.1.2 Dimensional Requirement
  2.1.3 Rails
  2.1.4 Envelope Requirement
  2.1.6 Separation Spring
  2.2.1 Deployment Switch
  2.3 Operational Requirement
  2.4.1 Random Vibration and Acceleration
  2.4.4 Thermal Environment
  5.2(2) Radio Frequency Capability and Emission/Operation Authority