Development of Binary Black Hole Observation Satellite "ORBIS"

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Agenda

Space Systems Laboratory
Tokyo Metropolitan University

- Concept of ORBIS
- Mission of ORBIS

Progress of

- Mission Subsystem
- Attitude Determination Subsystem
- Structure Subsystem
- other Subsystem

- Summary

Microsatellite for Science Mission

Space Systems Laboratory in Tokyo Metropolitan University is developing a general-purpose microsatellite with ease of integration for science missions,

because

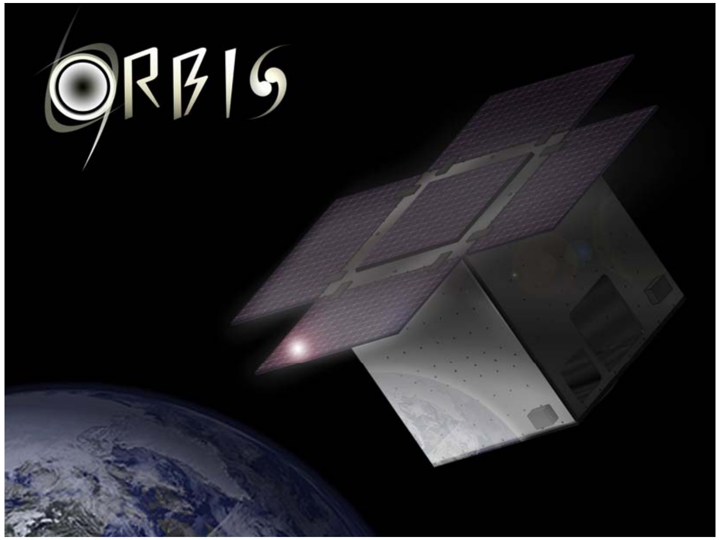
✓ microsatellites are the most promising infrastructure for certain science missions.

✓ and the specification for general-purpose application will make satellites inexpensive and trusted.

Microsatellite for Science Mission

We are developing
ORbiting Binary black hole Investigation Satellite, ORBIS,

as the first one of the general-purpose microsatellites for science mission.



Microsatellite “ORBIS”

Microsatellite for Science Mission

Microsatellites are the most promising infrastructure
for certain science missions.

because

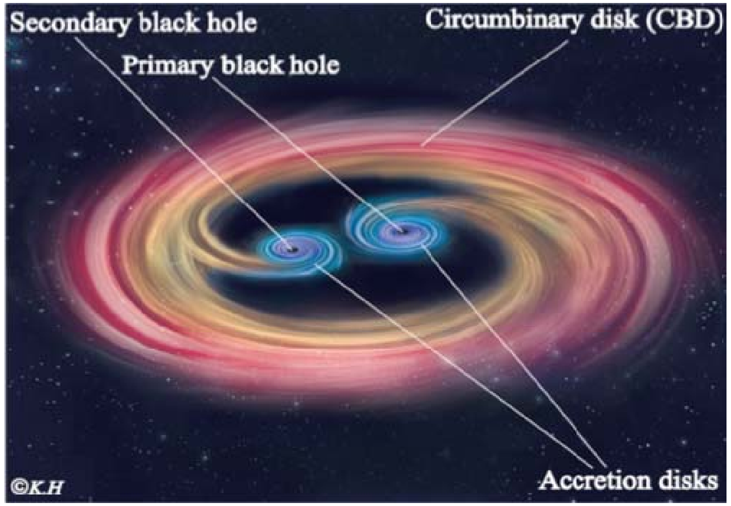
✓ there is no way in the current astronomy to accomplish such science missions as conduct long-term observations for the specified astral bodies with respect to budget, period, and occupancy time.

✓ and some scientists expect an utilization of microsatellite for the observations.

Investigation of Binary Black Hole is one of these science mission which is eagerly requiring microsatellite.

Mission of ORBIS

Binary Black Hole (BBH) consists of a pair of black holes and would contribute to develop kinds of cosmology. Past researches are saying that BBH surely exist but has not been observed yet.



Binary Black Hole

BBH is dark object, and shows
unique cycle variation in X-ray region.

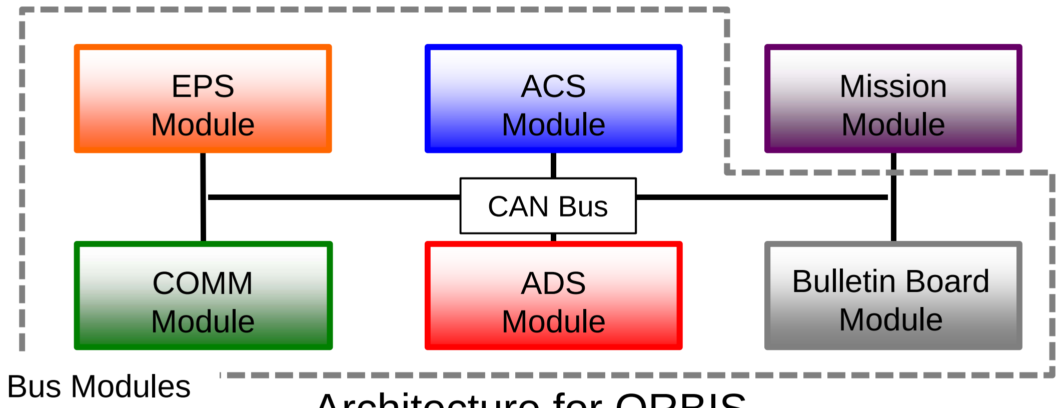
which requires

✓ long term, continuous
✓ and high-precision observation.

So that microsatellite is and only a way for BBH observation.

Architecture for General-Purpose

Architecture for ORBIS is based on distributed autonomous system, where each subsystem is modularized into a block and communicates with the others via CAN bus.



Architecture for ORBIS

Though this architecture is partially realized by Panel ExTenstion SATellite (PETSAT), developed by SOHLA, ORBIS adds another subsystem, Bulletin Board subsystem, to make reduction in labor required for system integration and actively utilize Flag & Play.

ORBIS Project

Space Systems Laboratory
Tokyo Metropolitan University

Concept of ORBIS won the first prize at 18th Satellite Design Contest in 2010, and we officially started ORBIS Project.

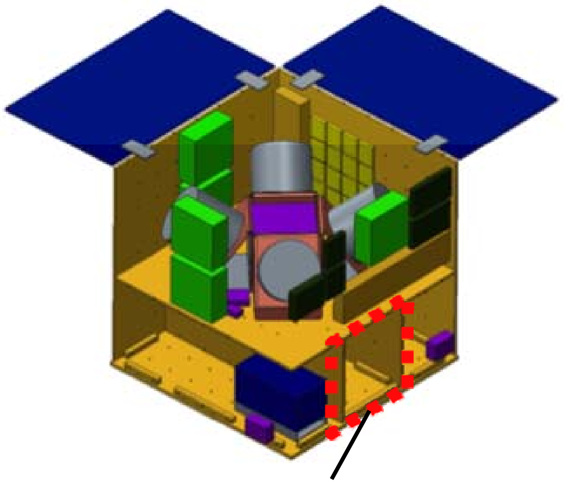
The project team consists of members in TMU, Kogakuin University, Meisei University and ISAS/JAXA.

Now, ORBIS is on BBM and Structure Thermal Model phase.

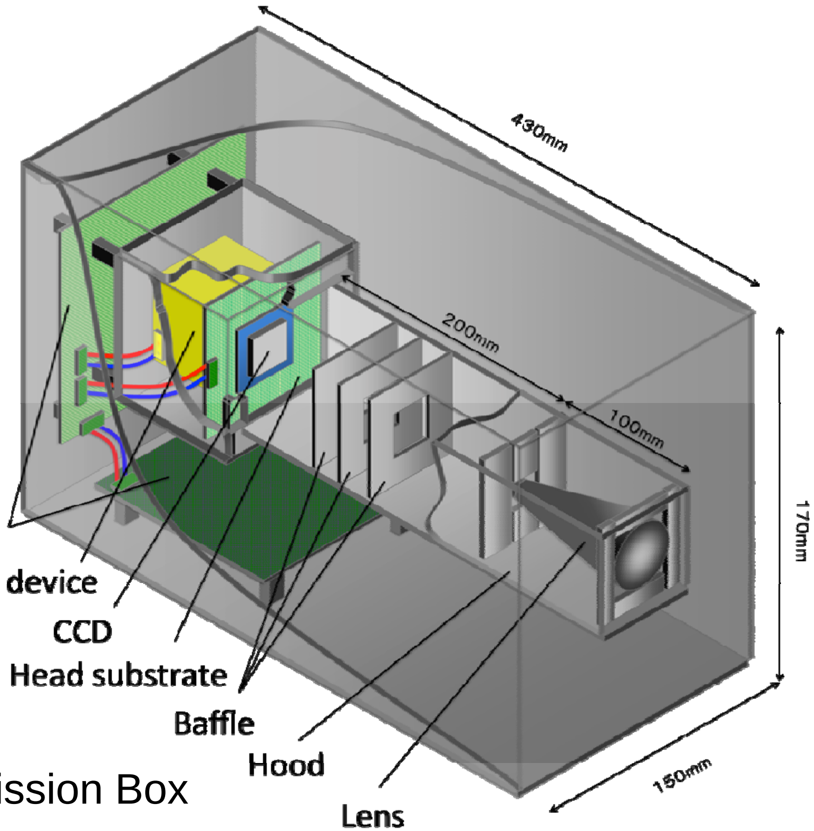
Progress of Mission Subsystem

Mission Subsystem with X-ray observation device is designed to be installed into the mission box in ORBIS.

The incident light is concentrated with a kind of concentration lens to be focused on the CCD.



Mission box comes to center of bottom layer

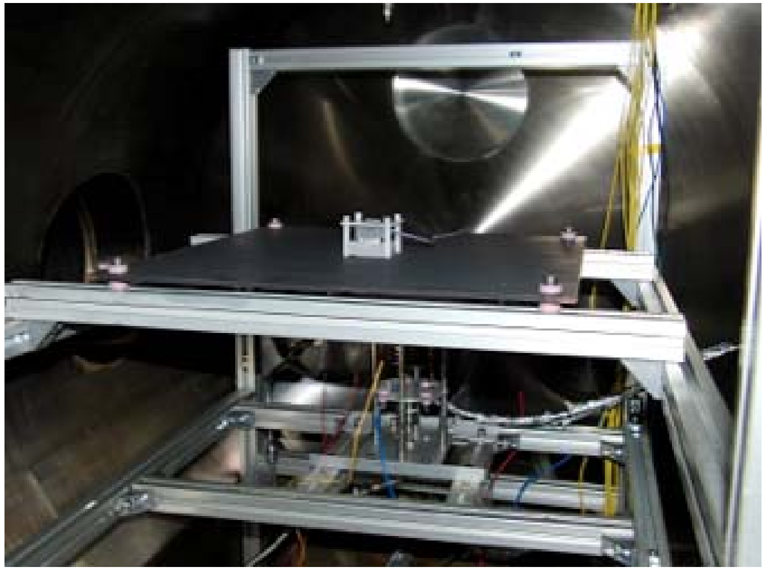


Overview of Mission Box

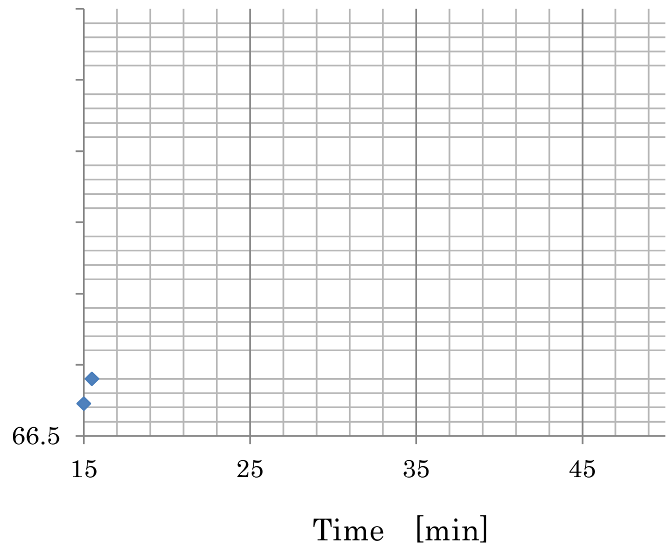
Progress of Mission Subsystem

✓ We conducted some tests on Peltier device in a vacuum chamber, and the result CCD can be cooled to -26[deg]

✓ and now we are designing a light-collecting system and circuits for light-receiving system.



Peltier device in a vacuum chamber



Example of result of the test

Progress of ADS

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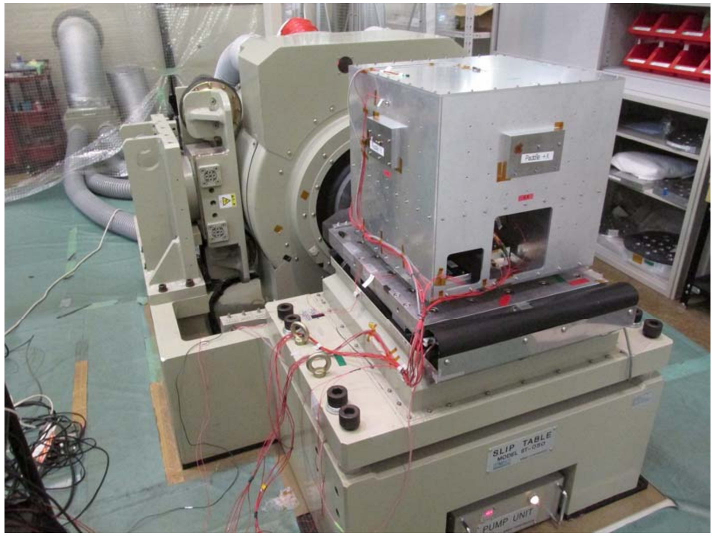
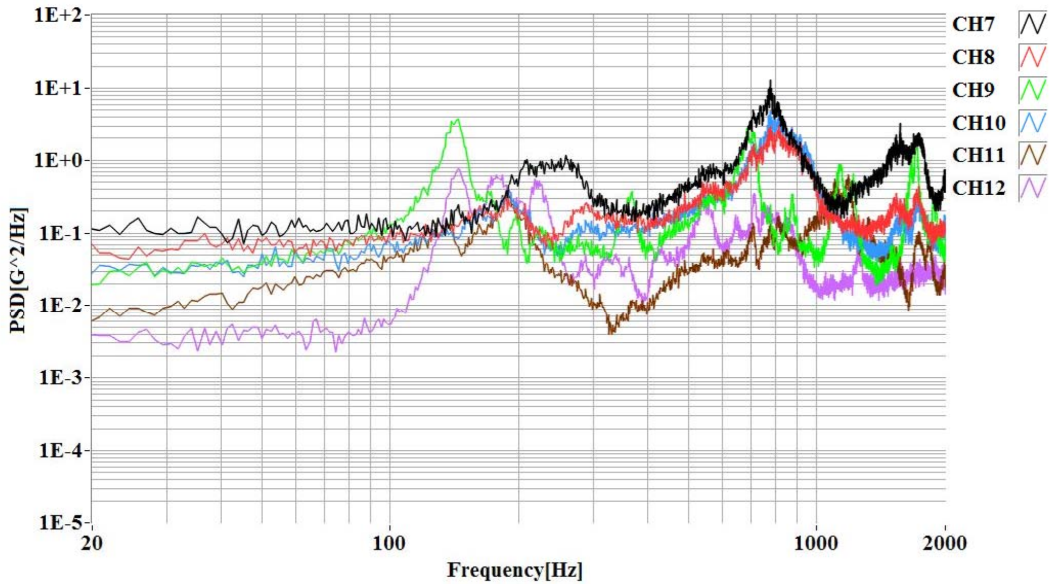
For highly-precise observation, Attitude Determination Subsystem adopts Star Tracker and Gyroscopes. In order to judge whether certain gyroscope can be use for ORBIS or not,
we conducted a static experiment on a gyroscope.

As a result, Estimate Accuracy of Attitude Angle is 9.3×10^{-4} [deg] on the gyroscope, showing the gyroscope can satisfy ORBIS's requirement, less than 1.0×10^{-3}, at native environment.

Progress of STR

We designed Structure Thermal Model of ORBIS and conduct series of vibration tests on it under the vibration levels of Qualification Test of H-IIA.


Overview of vibration test
at Kyushu Institute of Technology



Example of result of vibration test

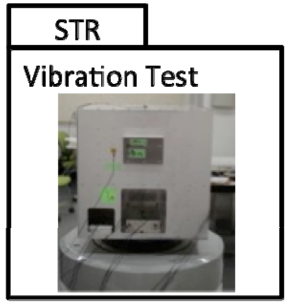
The result gave us important information to improve the structure.

Progress of other subsystem

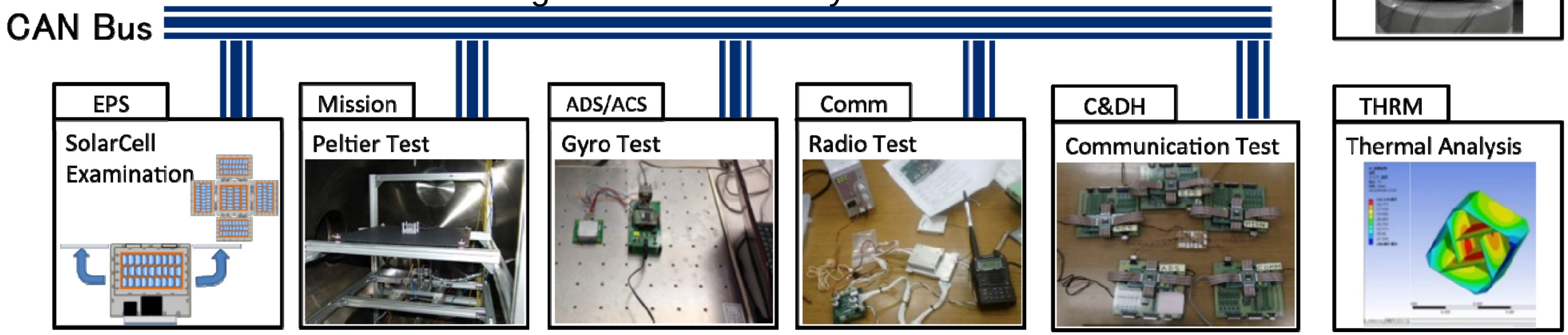
✓ C&DH conducted a communication test on CAN bus and now is designing common circuit board of ORBIS which is installed into all the subsystems.

✓ EPS estimated the amount of power supply and consumption to distribute power to all the subsystems.

✓ ACS analyzed disturbance of reaction wheels and now developing the simulator of entire ADCS.



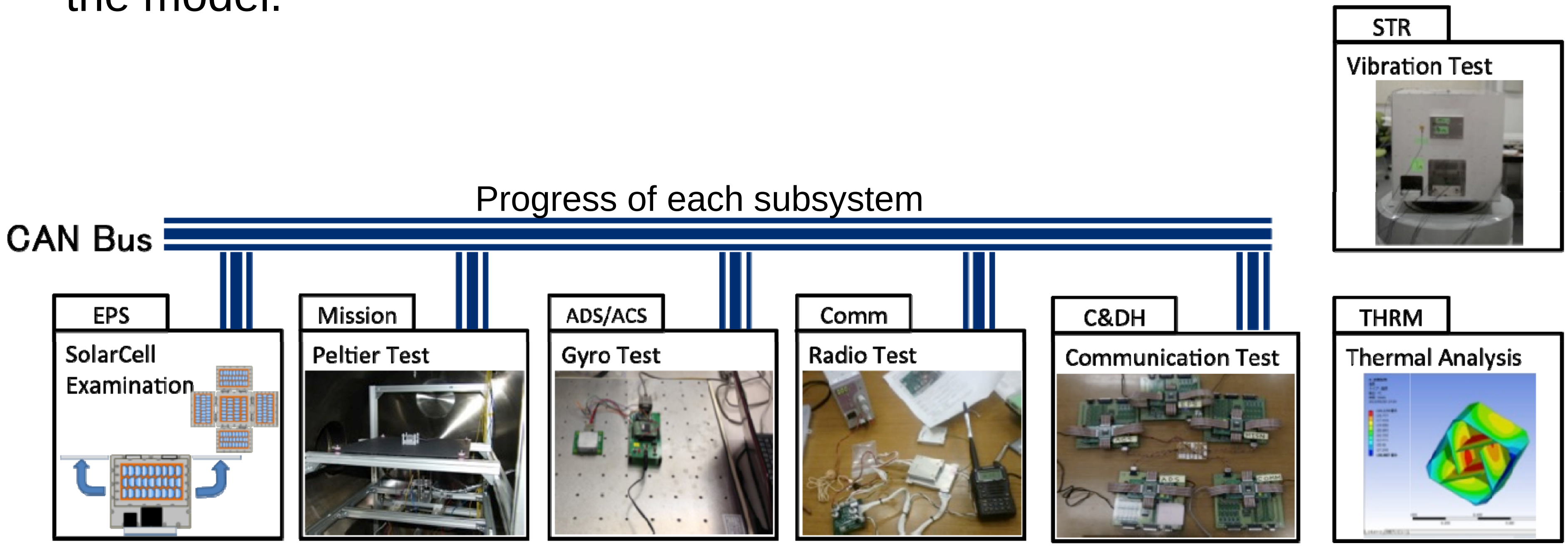
Progress of each subsystem



Progress of other subsystem

✓ COMM analyzed the data traffic for Amateur band and S-band and tested some of them.

✓ TCS estimated the amount of thermal input, where the evaluation of contact thermal resistance in the most important and will be tested with the model.



Summary

- Space Systems Laboratory in Tokyo Metropolitan University is developing a general-purpose microsatellite for science mission, ORBIS.
- We set investigation of the Binary Black Hole as its mission.
- ORBIS is now under BBM phase and each subsystem is developing and testing their own module.

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Specification of ORBIS

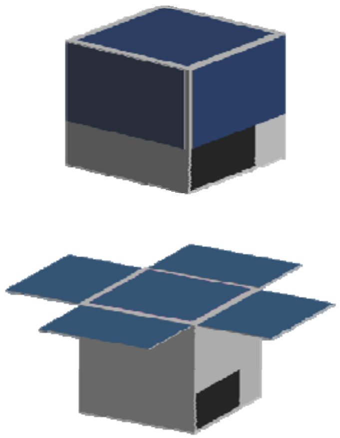
Structure

ORBIS has 4 paddles of EPS.

Its dimension is 460×460×440[mm] in closing

and 980×980×440[mm] in opening.

Its weight is 46[kg].



EPS

The amount of electric power supply is 78[W] on 28[V].

Specification of ORBIS

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ACS

A method of attitude control is zero-momentum in 3 axis.

COMM

ORBIS adopt Amateur band and S-band.

Amount of communication are
84[MB/day] in Amateur Band and
21[MB/day] in S-band.

Orbit

LEO on 550[km] / Inclination is 31[deg] / Orbital period is 96[min]

Microsatellites for Science Mission

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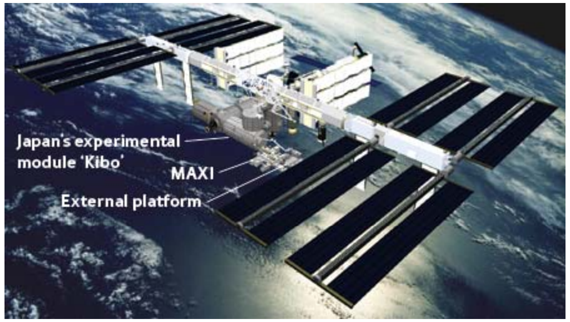
Science missions using existing satellites or ground equipment

✓ cannot take enough time for observation and

✓ if they can, their sensitivity will be lower.

Proposal for ground equipment is very hard



Sensitivity of MAXI is not enough for certain science mission

Microsatellites are best suited for science missions which needs both long term and high-sensitivity observation.