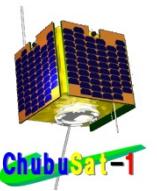
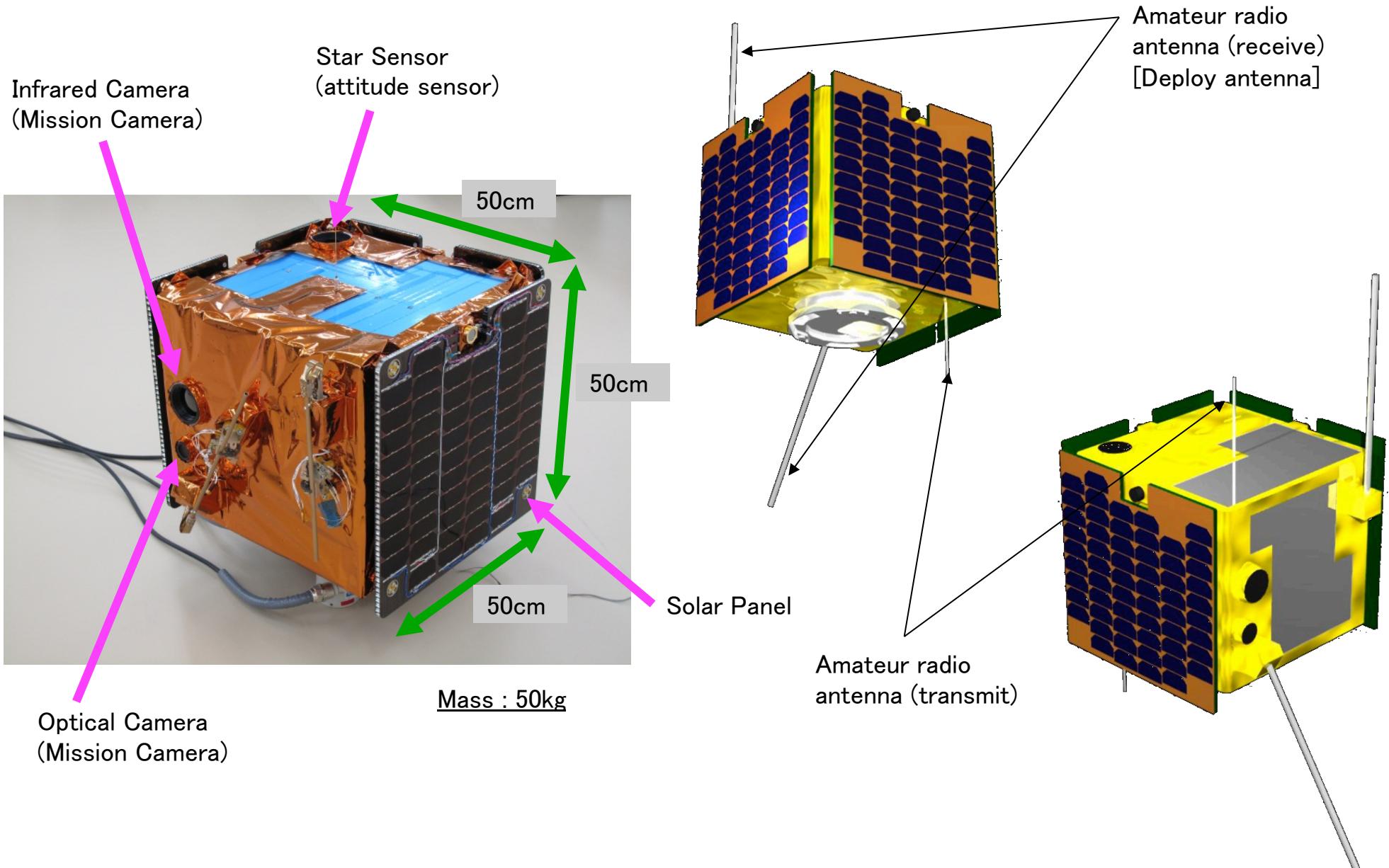


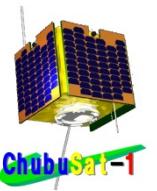
Development of ChubuSat-1 Small Satellite

2013.4.9



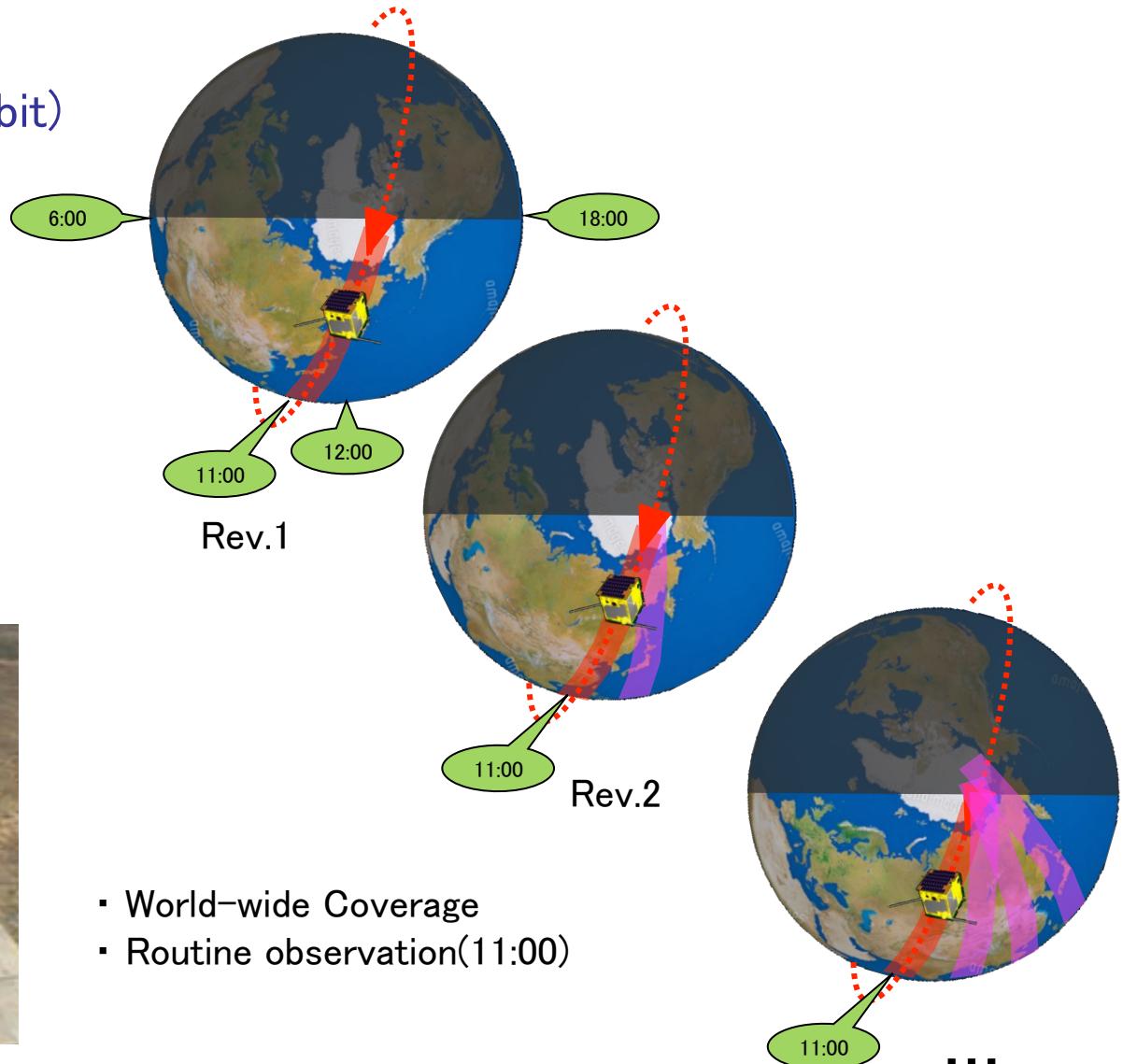
Overview of ChubuSat-1 Small Satellite



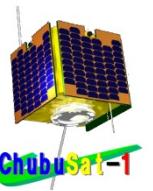


Launch of ChubuSat-1

- ChubuSat-1 will be launched in 2013 by DNEPR Rocket from Yasny launch site
- Orbit :
 - Altitude 520km (Low orbit)
 - Polar orbit (Sun-synchronous orbit)



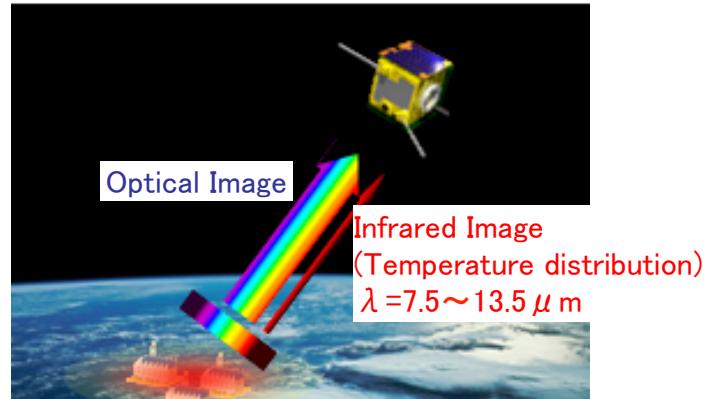
- World-wide Coverage
- Routine observation(11:00)



Mission of ChubuSat-1

(1) Earth remote sensing

Two pictures taken by optical camera and infrared camera gives us both information of optical image and temperature distribution of the target. This information contributes to understanding global warming and monitoring disasters around the world.



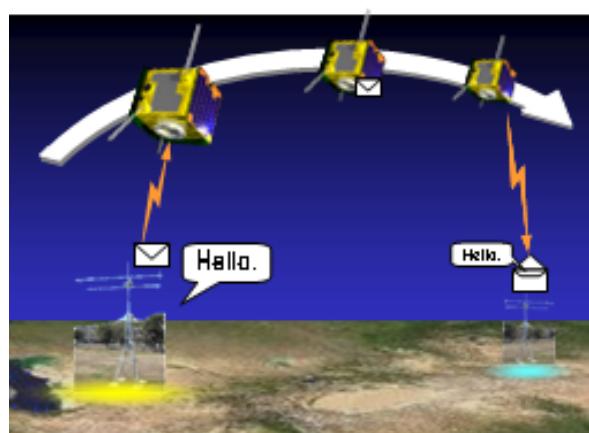
(2) Observation of space debris

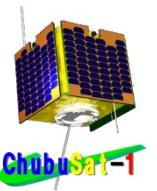
ChubuSat-1 tries to observe the space debris with infrared camera. If this trial succeeds, ChubuSat-1 will be a pioneer of on-orbit observation of space debris with a small satellite and contribute to constructing Japan's original database of space debris.



(3) Relaying of amateur communication

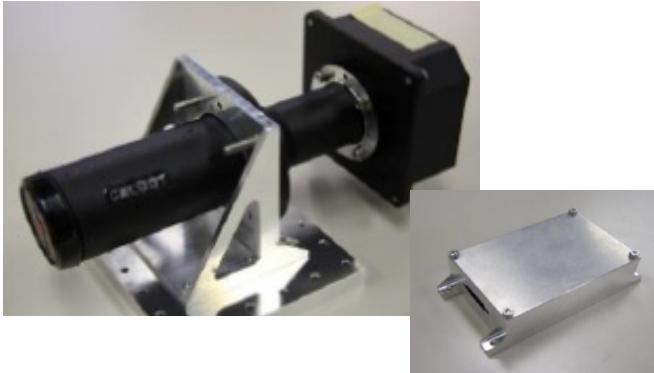
Using on-board amateur radio transceiver, ChubuSat-1 provides the message transfer service to worldwide amateur radio users. Moreover, ChubuSat-1 distributes some image data of on-board optical camera to them. We expect that these services will contribute to expanding the field of amateur radio use.





Mission Component

Optical Camera



- Imager device : CMOS
- 2,048 x 1,536 pixel
- Field of View : 2.1 x 1.6 deg.
- Resolution : 10m
- RS422 115.2kbps
- 2GB storage
- Lens : 180 x 75 x 75mm / 0.6kg
- Box : 110 x 60 x 40mm / 0.3kg
- Power : <5W (5V input)
- Operating Temp. : +0 to +60degC
- Developed by Tokyo University of Science

Infrared Camera

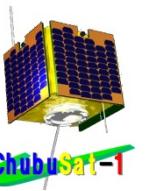


- Uncooled bolometer
- 320 x 240 pixel
- Field ov view : 4.6 x 3.7deg.
- Resolution : 130m
- Power : <1W (5V input)
- LVDS / CMOS interface
- 80 x 80 x 150mm / 0.5kg
- Operating Temp. : -40 to +60degC
- Consumer product

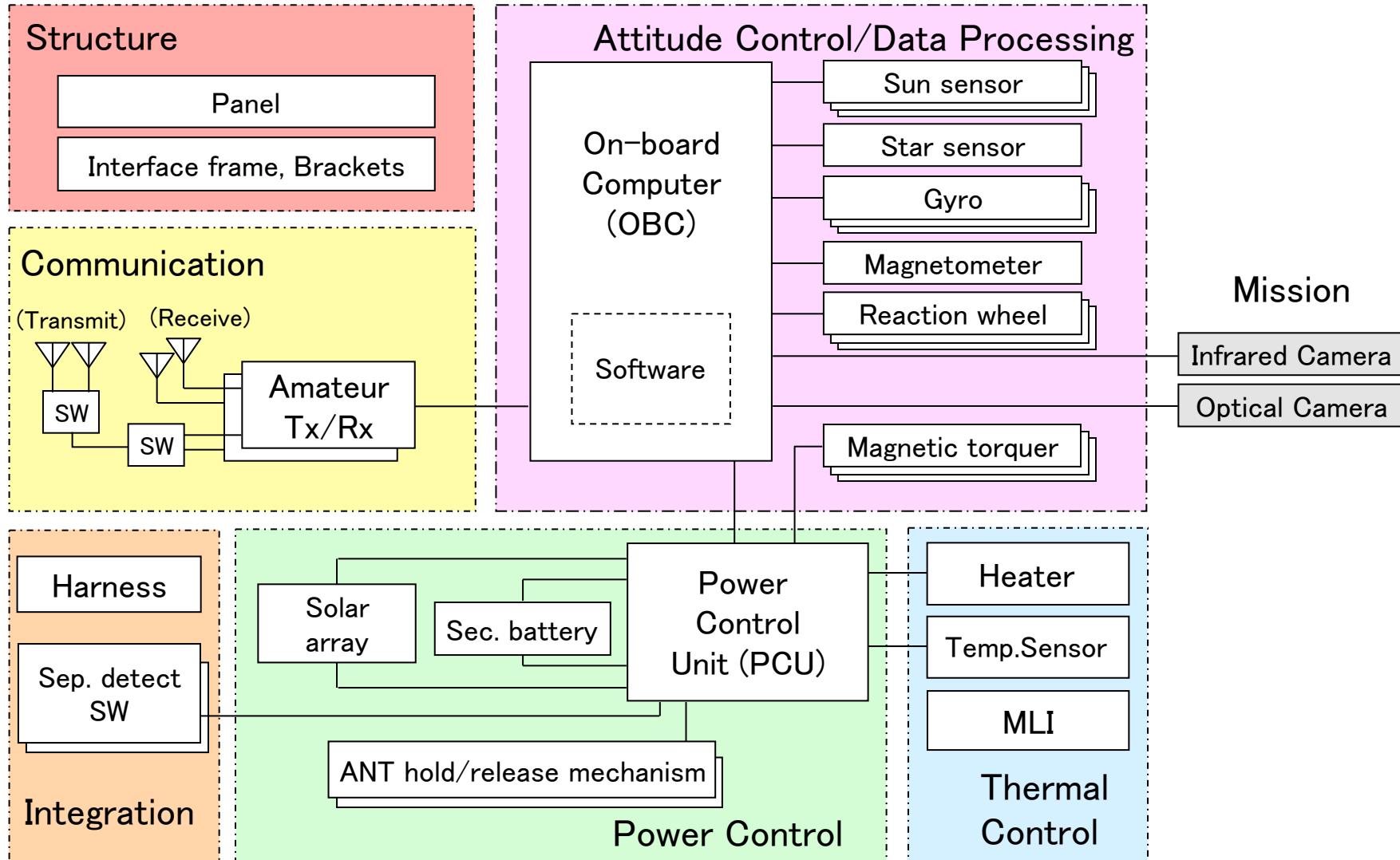
Amateur radio transceiver



- Up : 1200bps@145MHz
- Down : 9600bps@437MHz
- Developed by the aerospace company in Nagoya

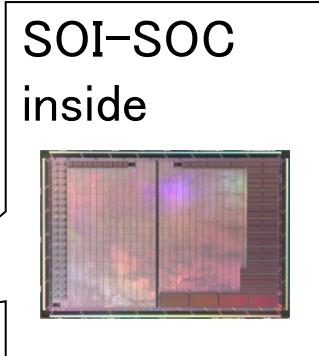
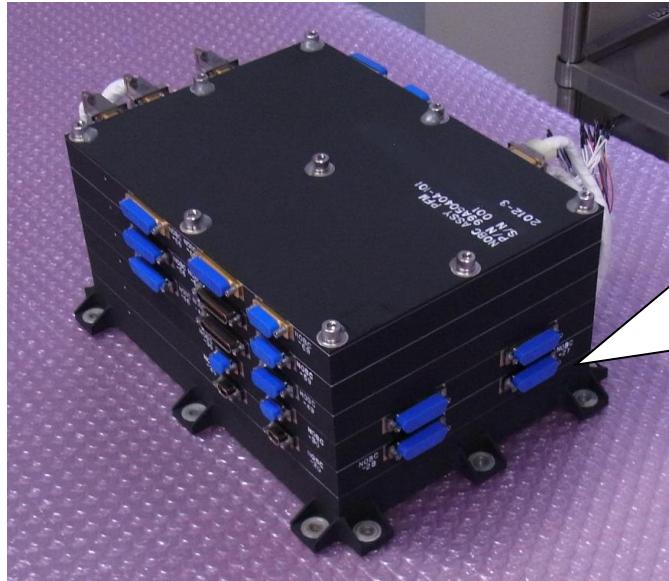


ChubuSat-1 System block diagram



Data Processing Subsystem

On-Board Computer(OBC)



Silicon On Insulator, System On Chip

- Processing speed : 50MIPS
- Data Bus Width : 32bit
- Redundant CPU (Main/Backup)
- Storage : 64MByte SDRAM
- Radiation resistant
- Power : <16W
- Size : 27cm x 21cm x 13cm
- Mass : 5kg

[OBC Function]

- (1) Boot initialization
- (2) Operation control: on-board software control, external interface control, satellite time control
- (3) Attitude control: calculate torque command to each actuator using attitude output from each sensor.
- (4) Data processing: command decoding, telemetry gathering, editing and encoding, and communication between peripheral components.
- (5) Mission component control.
- (6) Prevention of overcurrent failure propagation
- (7) Failure detection, isolation and reconfiguration (FDIR) function
- (8) Re-programmable on orbit.

Attitude Control Subsystem

Attitude sensor



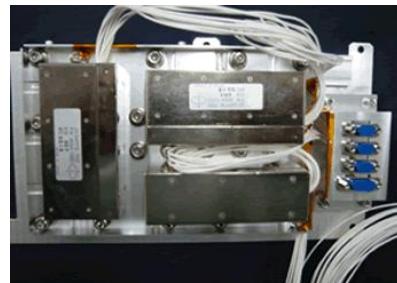
Star sensor



Sun sensor

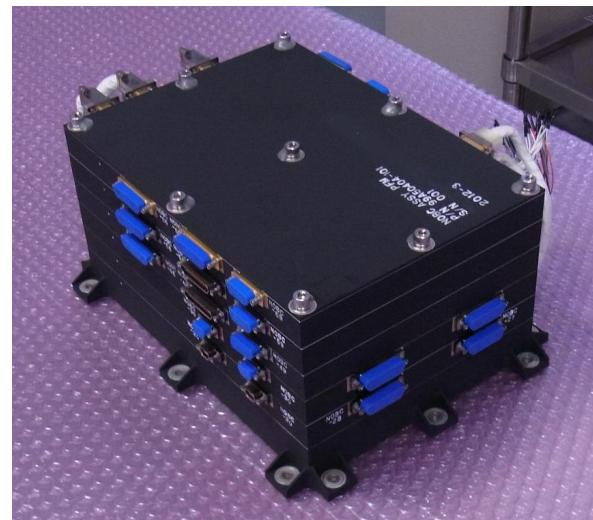


Magnetometer



Gyro

On-Board Computer



Actuator



Reaction wheel

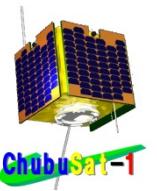


Magnetic Torquer

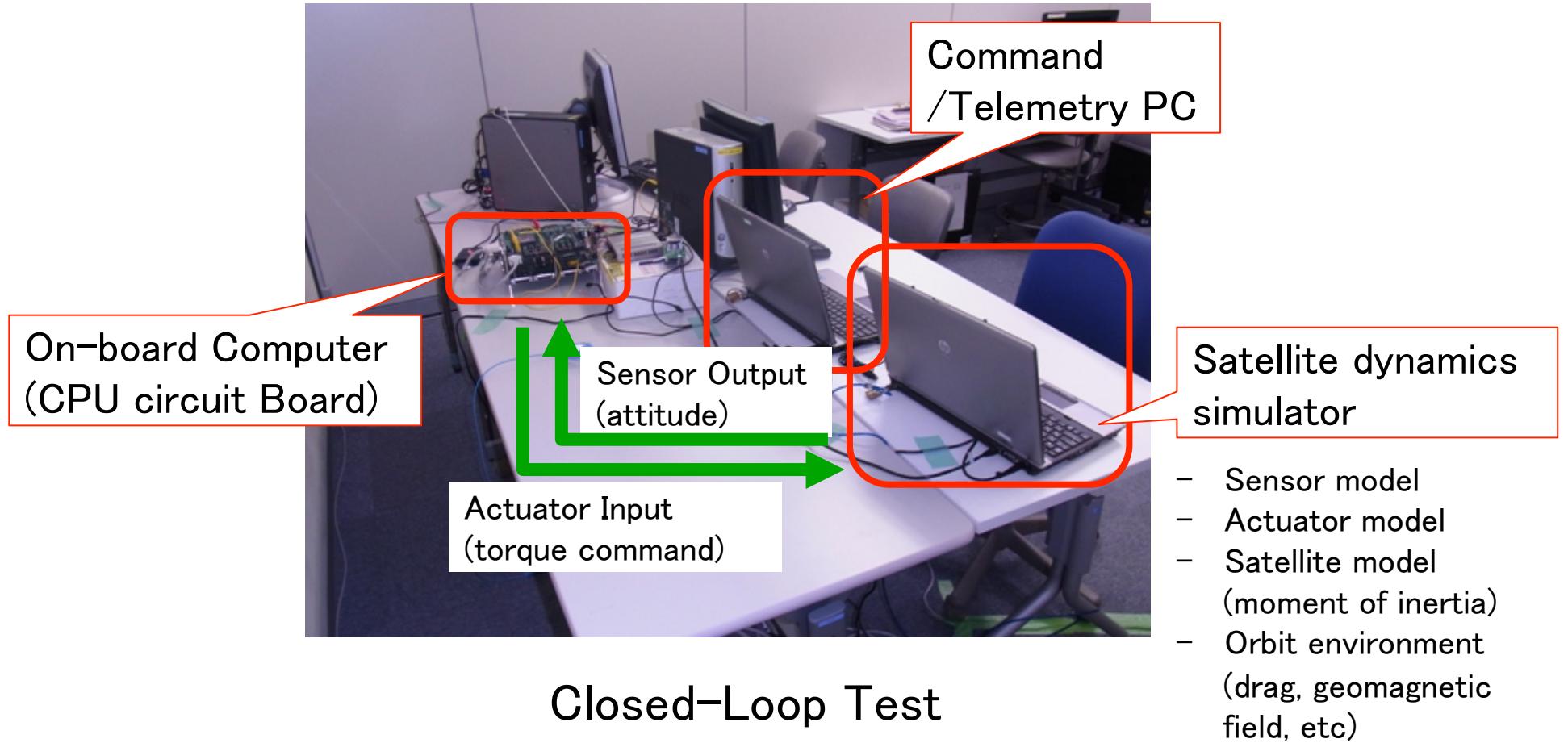
[Control Mode]

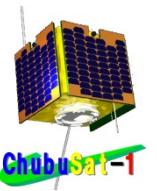
- Rotating rate control
- Sun pointing
- Target pointing
- Geocentric pointing
- Inertial pointing

➤ Pointing accuracy : <0.8deg.



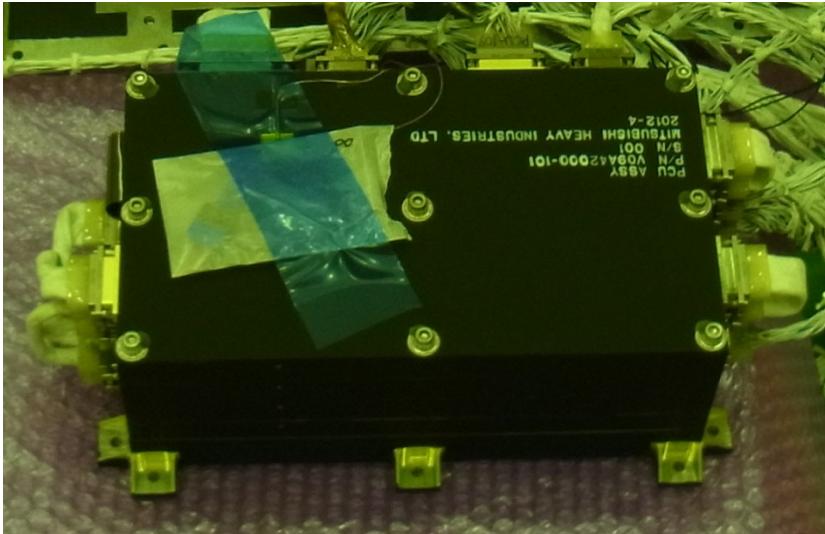
Attitude Control Subsystem





Power Control Subsystem

Power Control Unit (PCU)



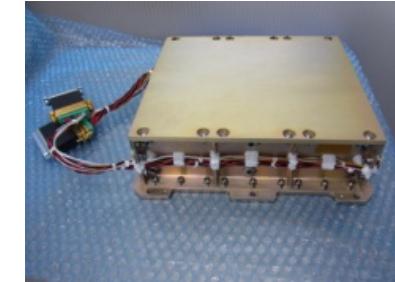
- Primary Bus voltage : 23–36V
- Handling power : 85W max.
- Power supply : +5V, +/-15V, +/-12V
- Heater control : 8ch
- Temperature monitor : 16ch
- Power : <9W
- Size : 30cm x 18cm x 12cm
- Mass : 5kg

Solar Panel



- GaAs triple junction cell
- Cell Size 8cm x 4cm
- Number of Cell :
20 x 3strings x 3panels
- Efficiency 29%

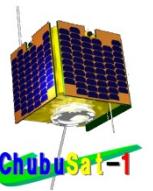
Battery



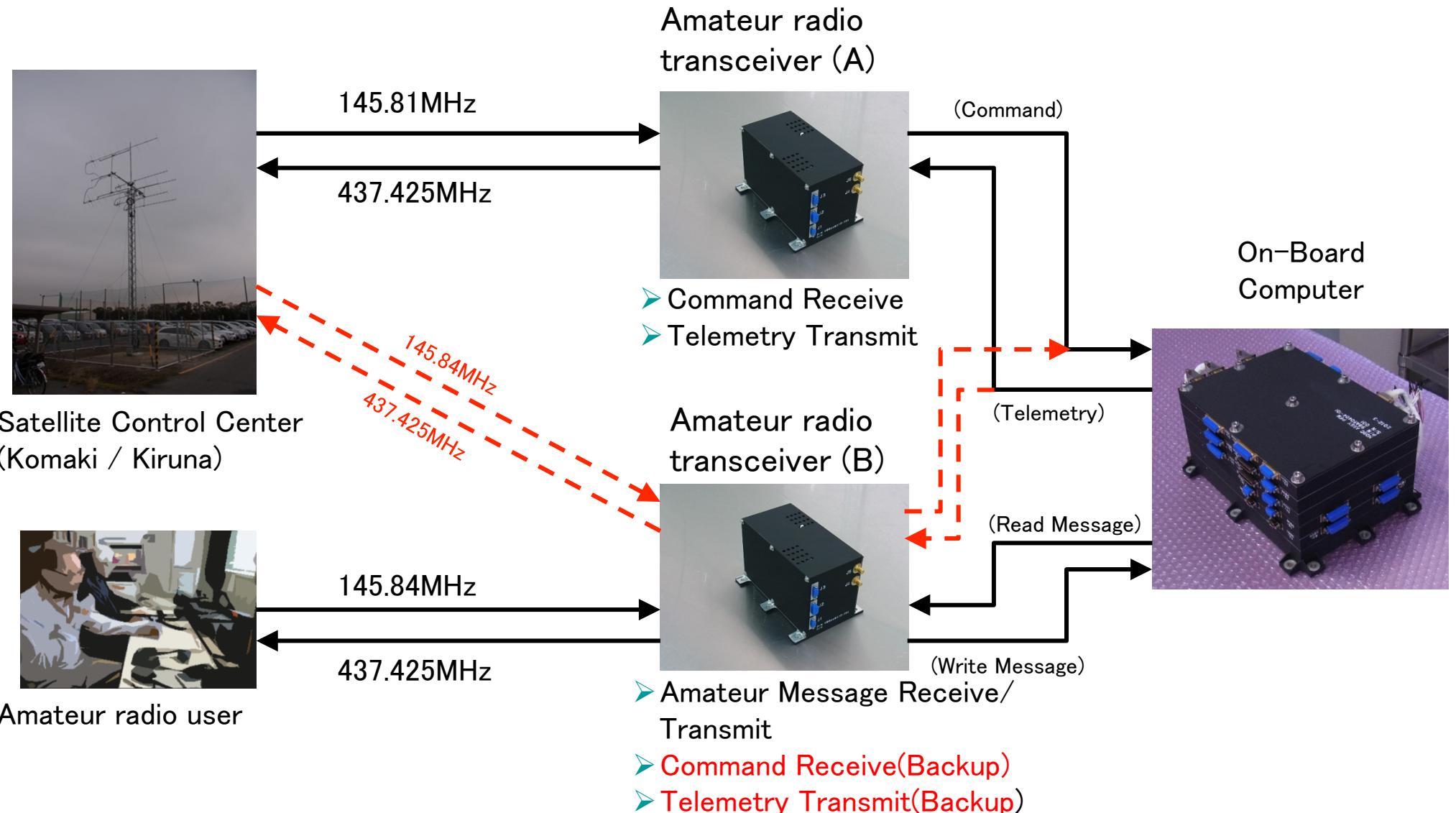
- NiMH battery
- Capacity : 9.5Ah
- Discharge voltage :
23 – 29V
- Life : >10,000 cycle

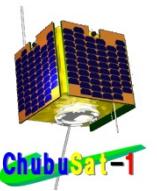
[PCU Function]

- (1) Regulation of solar power
- (2) Battery charging/discharging
- (3) Power distribution
- (4) Heater ON/OFF Control
- (5) Battery temperature monitor
- (6) Safety design(activation pin, and separation detect switch)
- (7) Power status report to OBC.



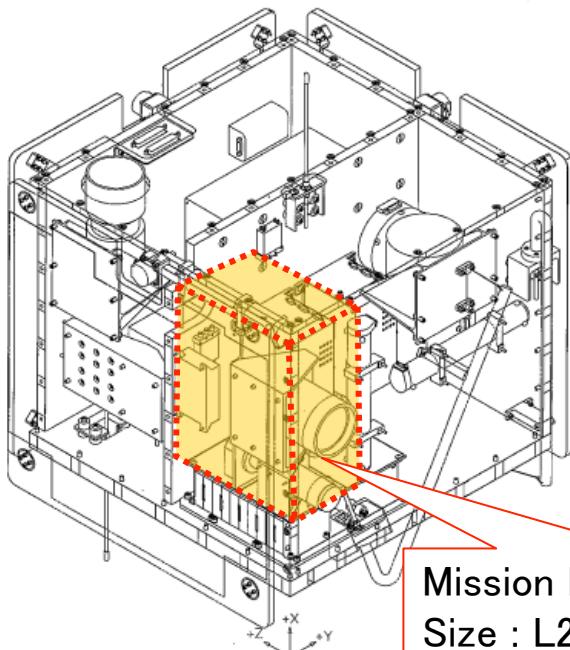
Communication Subsystem



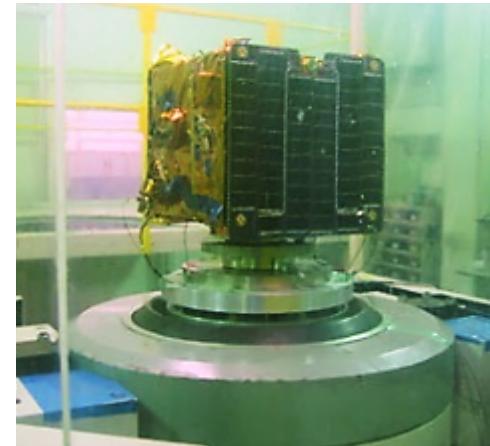


Structure

- Main Structure : 7 panels (Top/Bottom/Side x4 /Middle)
- AL skin / AL honeycomb Sandwich panel
- Vibration test and shock test to verify the structure endure the DNEPR rocket launch environment



Mission Bay :
 Size : L20 x W30 x H10cm
 Payload mass : 2kg
 Power : 6W
 Heater control is provided



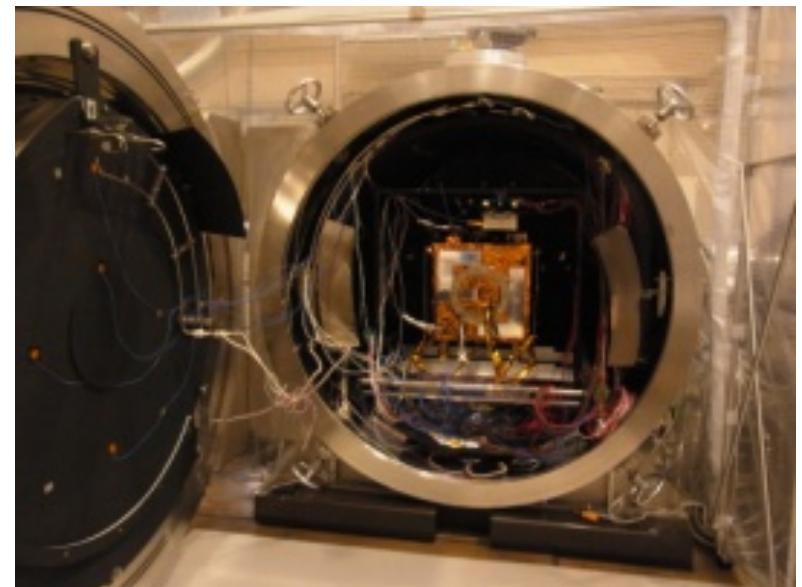
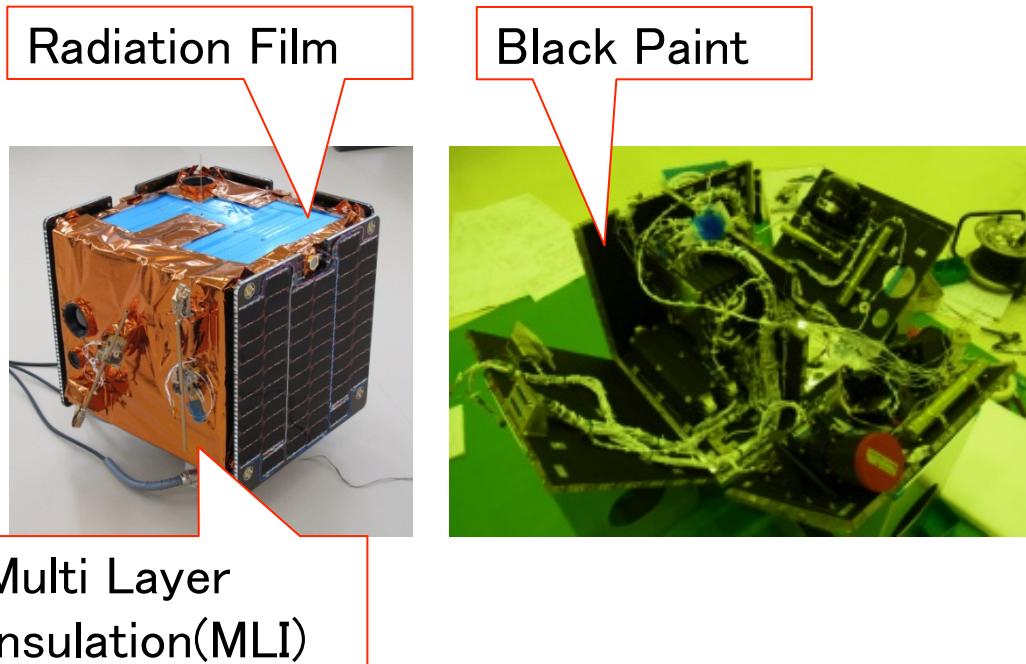
Vibration Test



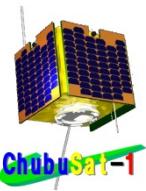
Shock Test

Thermal Control Subsystem

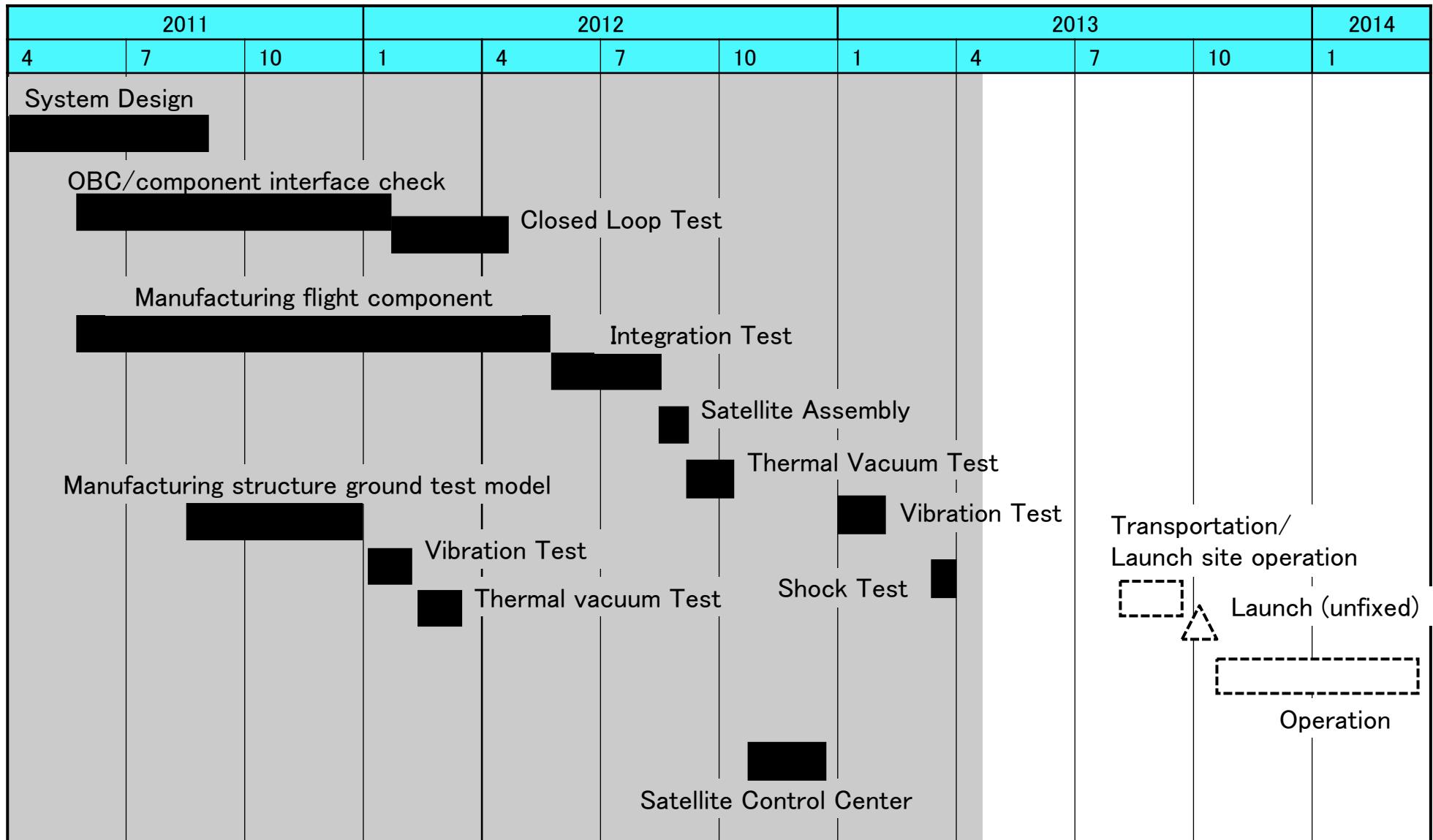
- Passive control : MLI, Radiation Film and Black paint
- Active control : Heater and Temp. sensor
- Thermal vacuum test to verify the satellite system performance in hot/cold vacuum environment

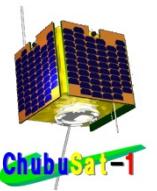


Thermal Vacuum Test

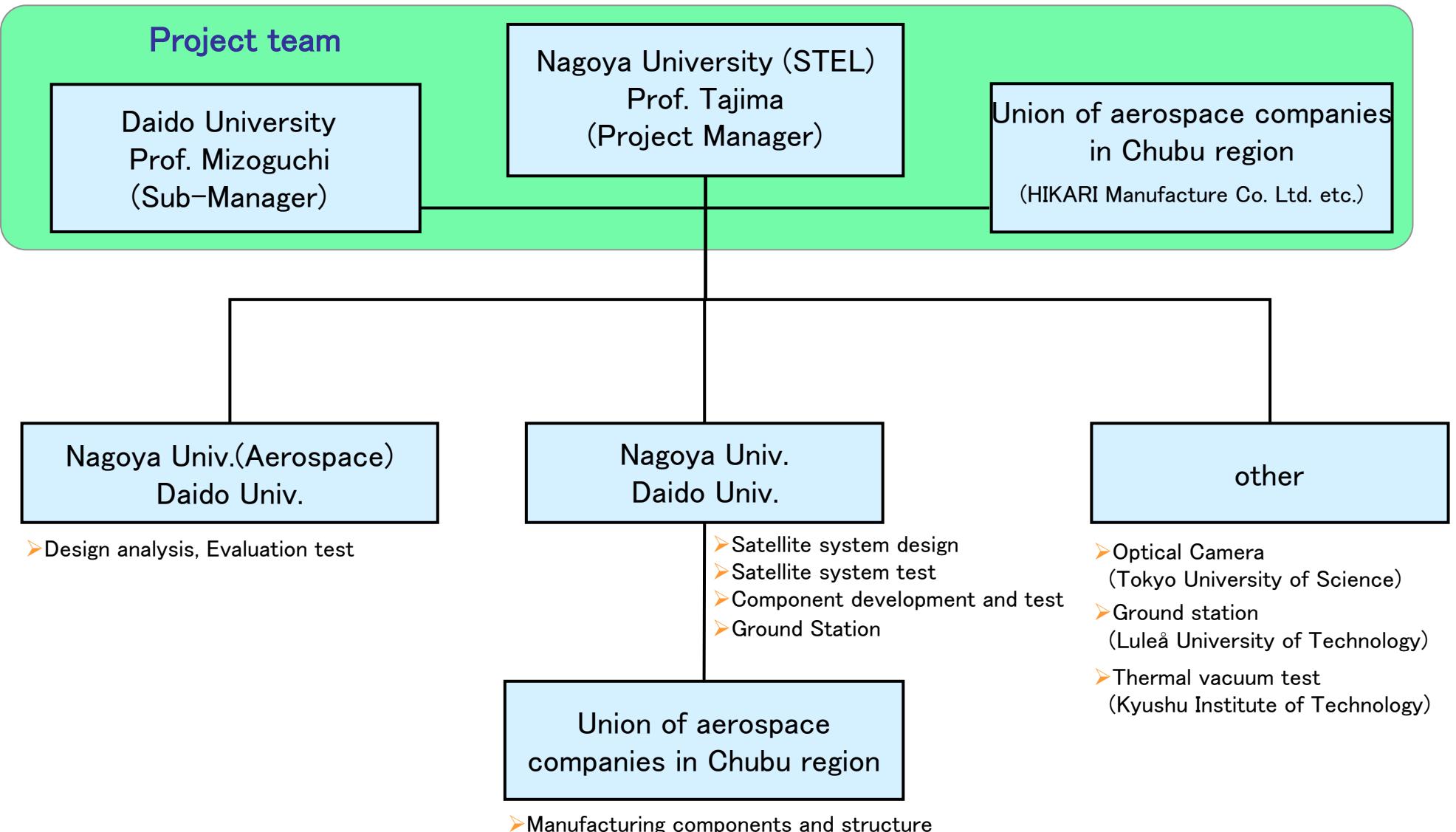


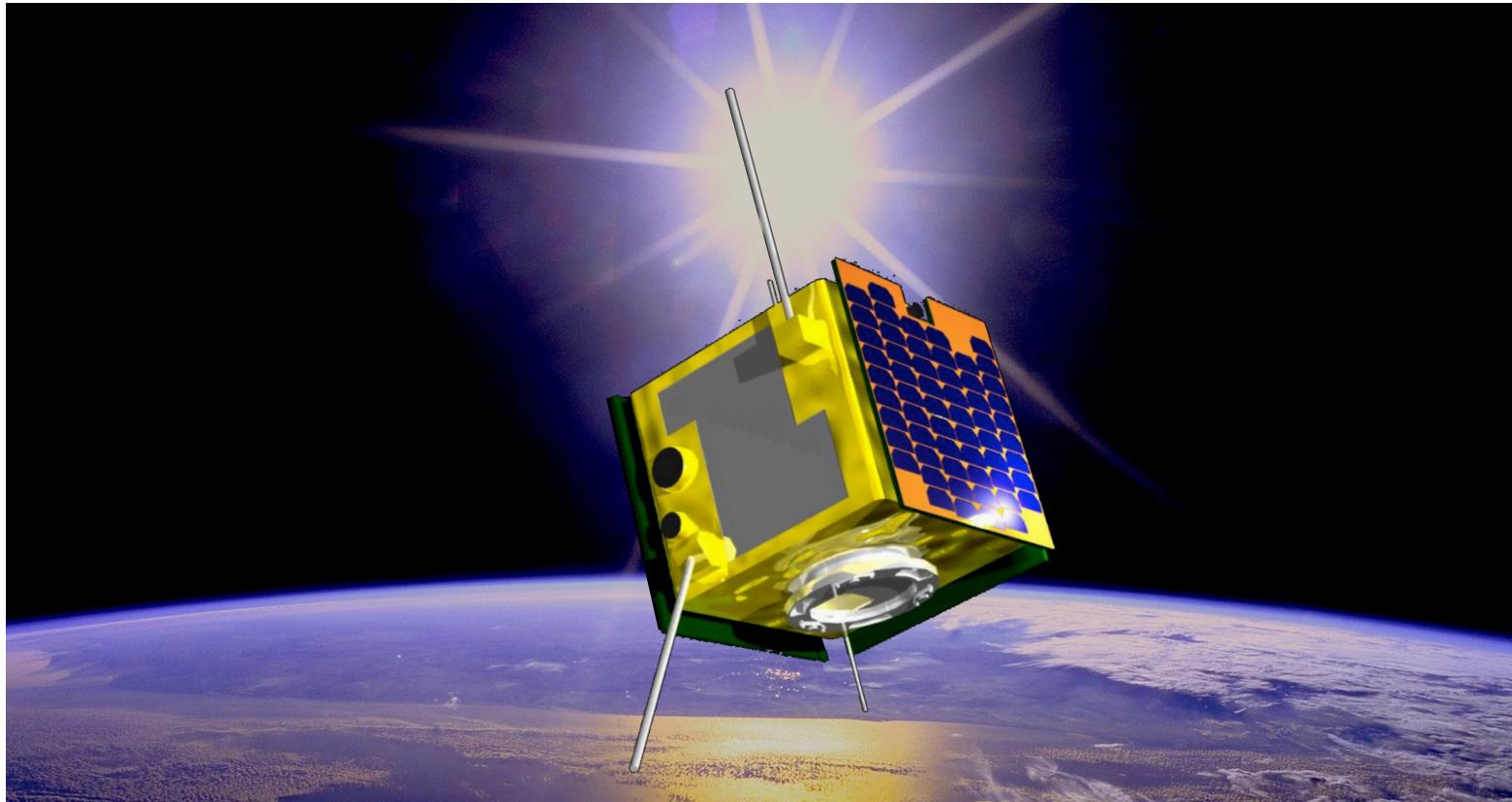
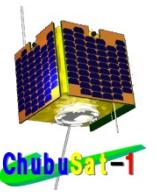
ChubuSat-1 Schedule

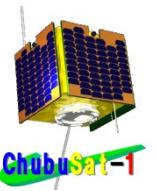




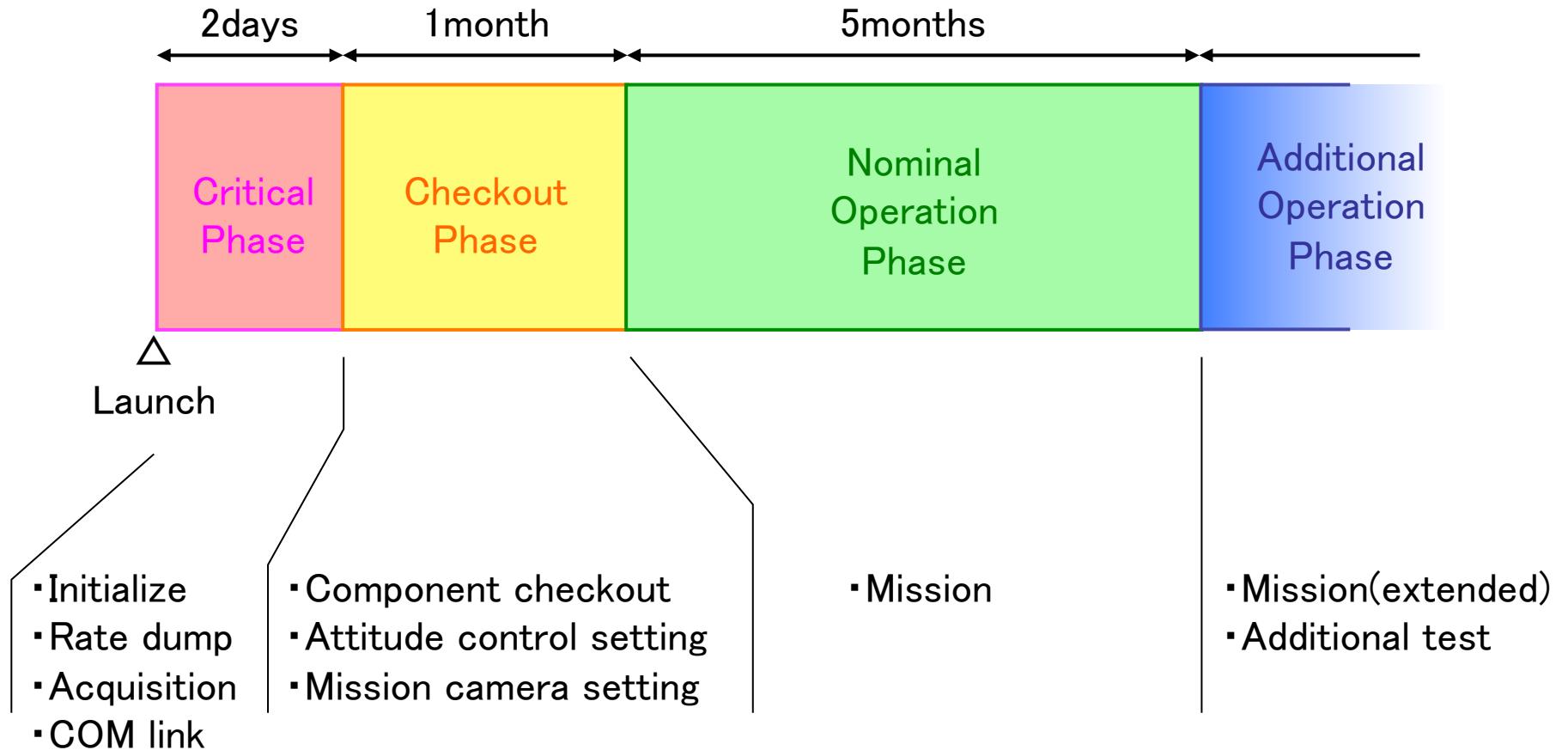
ChubuSat-1 Development Team

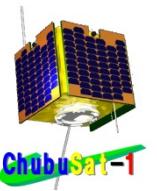






Operation of ChubuSat-1





Technical task through the operation of ChubuSat-1

1. Improvement of the pointing accuracy and stability
 - Analysis of attitude telemetry data
 - Modifying the satellite simulation model
 - Tuning the attitude control parameter or improve the algorithm
(verification by the ground test)
 - Upload the parameter or the algorithm and evaluation
2. Image processing
 - Study of processing method considering the satellite position, attitude, camera specification, etc. (Ortho-rectified, Composite, etc.)
 - Development processing software and evaluation using image data from ChubuSat-1
(or pre-evaluation using existing image of other satellite)

