

# Collaboration to Go Beyond the Earth

—Through Testing of PROCYON in KyuTech —

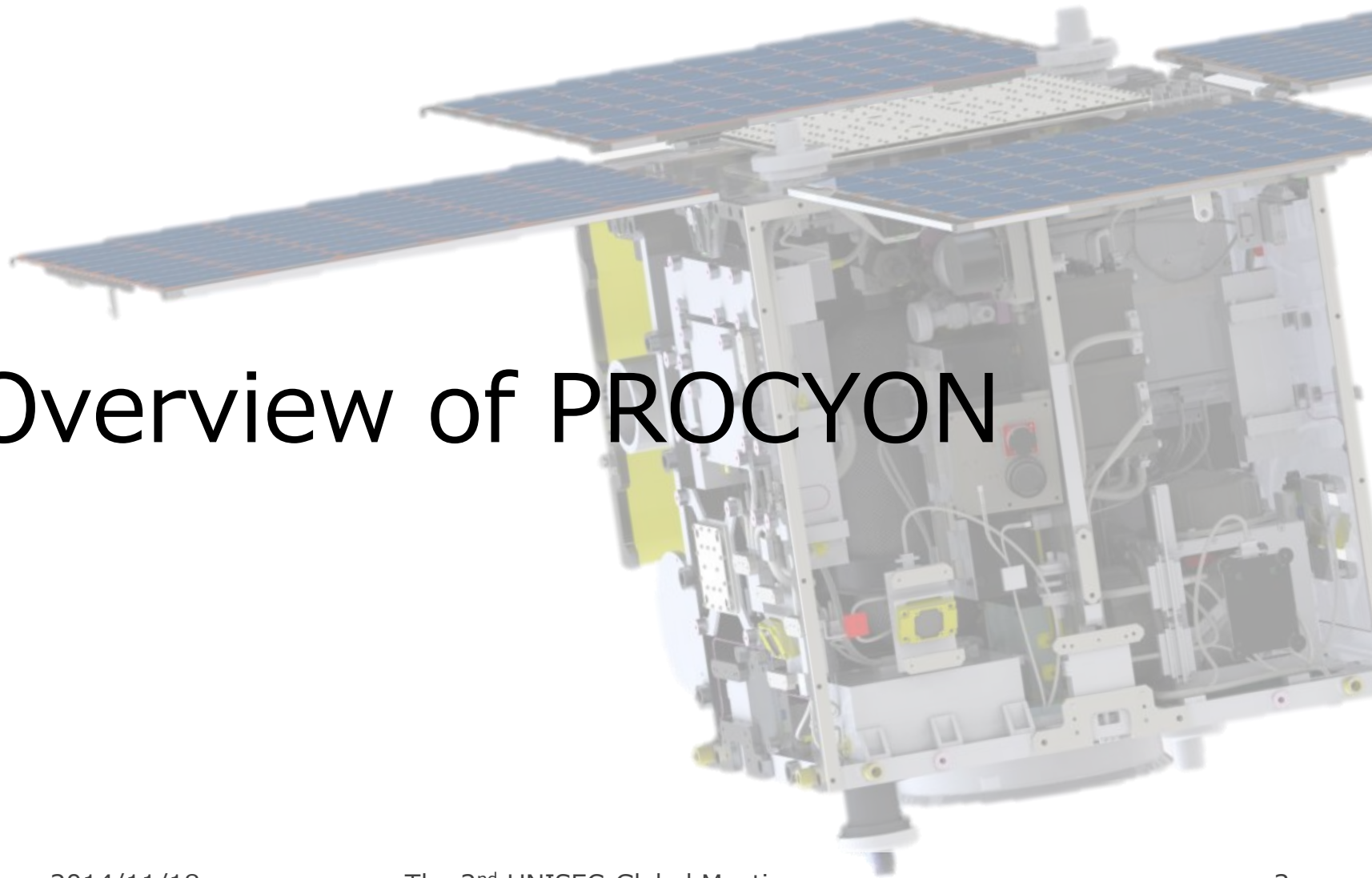
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Japan

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# I. Overview of PROCYON

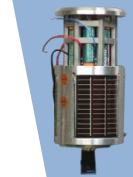
# What is ISSL ?

ISSL (Intelligent Space Systems Lab.) is a laboratory of the University of Tokyo.

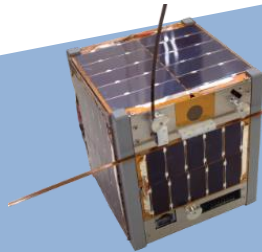
The aim of our research is to realize innovative space systems, which were never possible before.



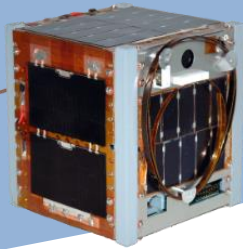
# History of Micro/ Nano Satellites of ISSL



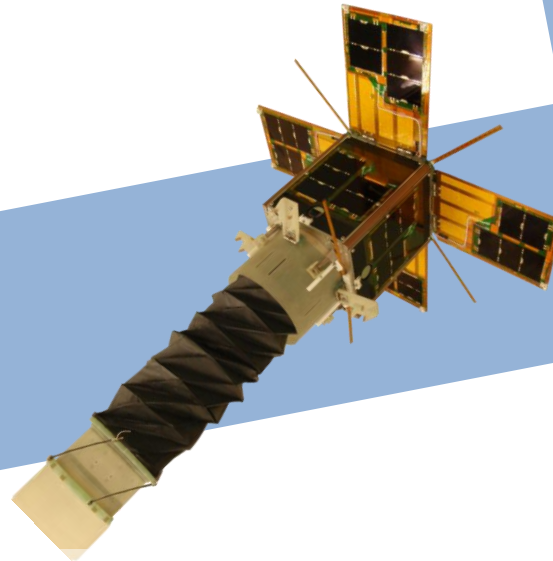
CanSat  
(1999~)



XI-IV (2003) & XI-V (2005): 1kg  
Demonstration of CubeSat



PRISM(2009): 8kg  
remote sensing mission



Nano-JASMINE  
(2015~)  
:33kg  
Astrometry mission

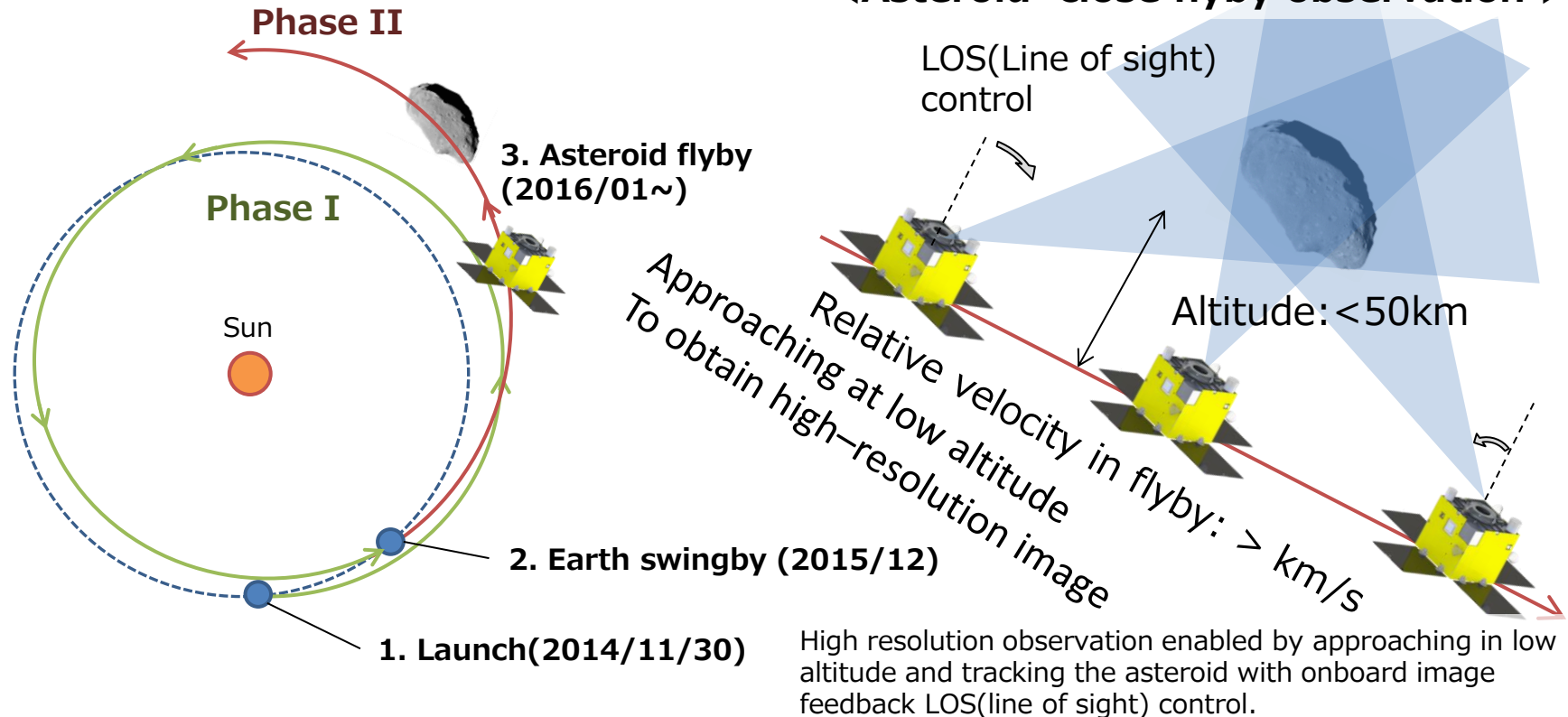
**Our Next challenge:**

**Deep Space Exploration by micro spacecraft  
“PROCYON” mission**

# Mission of micro deep space probe "PROCYON"

(PRoximate Object Close flyby with Optical Navigation)

<Mission sequence of PROCYON Mission> <Asteroid close flyby observation>



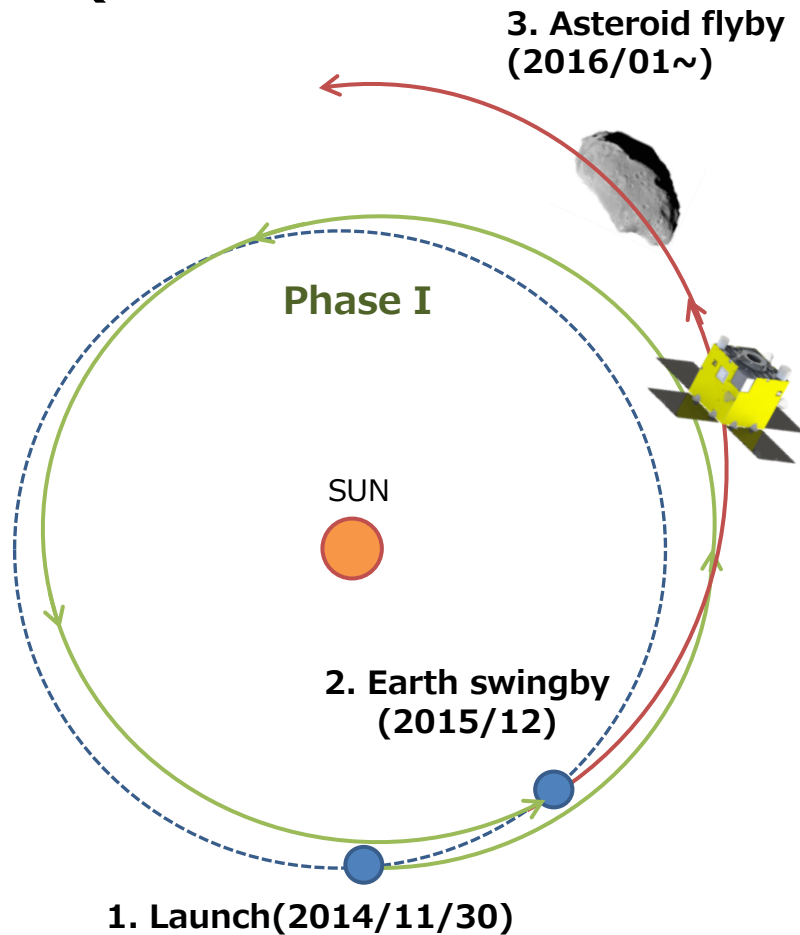
2014/11/18

The 2<sup>nd</sup> UNISEC-Global Meeting

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# PROCYON Mission Objectives

## (Phase I : 2014/11/30~2016/12)

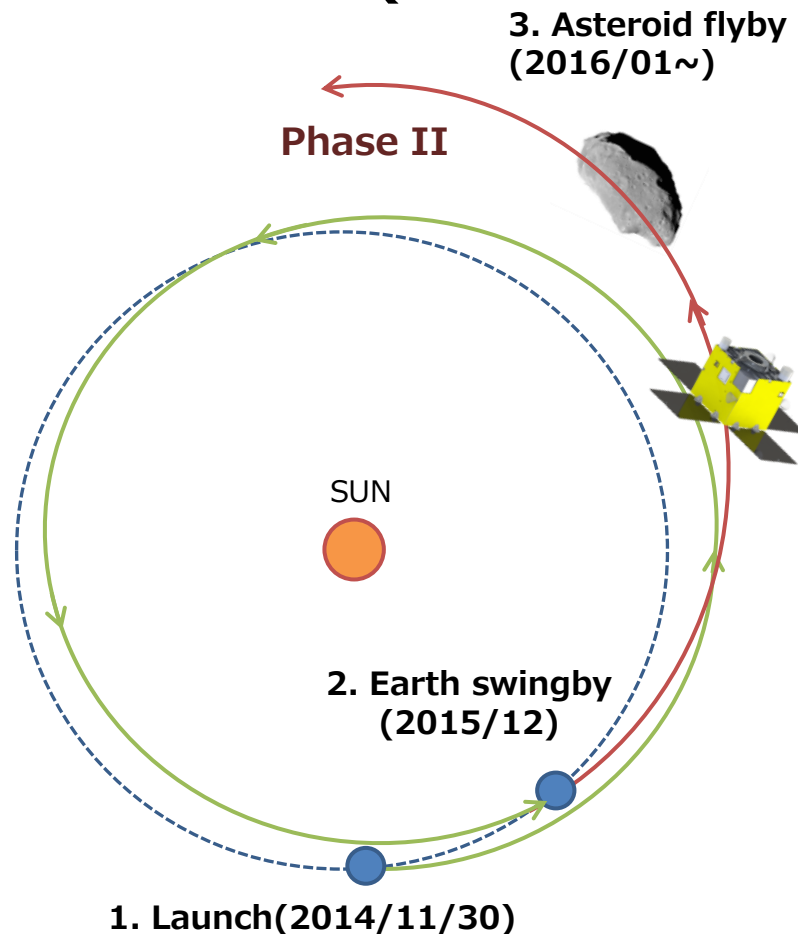


**1. Demonstration of 50kg-class bus technology for deep space exploration** (Nominal Mission)

- a. Demonstration of bus technologies for deep space exploration such as
- power supply
  - heat control
  - attitude control
  - Communication
  - trajectory determination

- b. Trajectory control with micro electric propulsion system in deep space

# PROCYON Mission Objectives (Phase II : 2016/12~)



## 2. Demonstration of deep space exploration technology (Advanced Mission)

- c. Communication with High-efficiency Xband GaN Amplifier
- d. Navigation in deep space with VLBI
- e. Flyby navigation with radio/optical hybrid navigation

## f. Asteroid close flyby observation



# Asteroid Close Flyby Observation by PROCYON

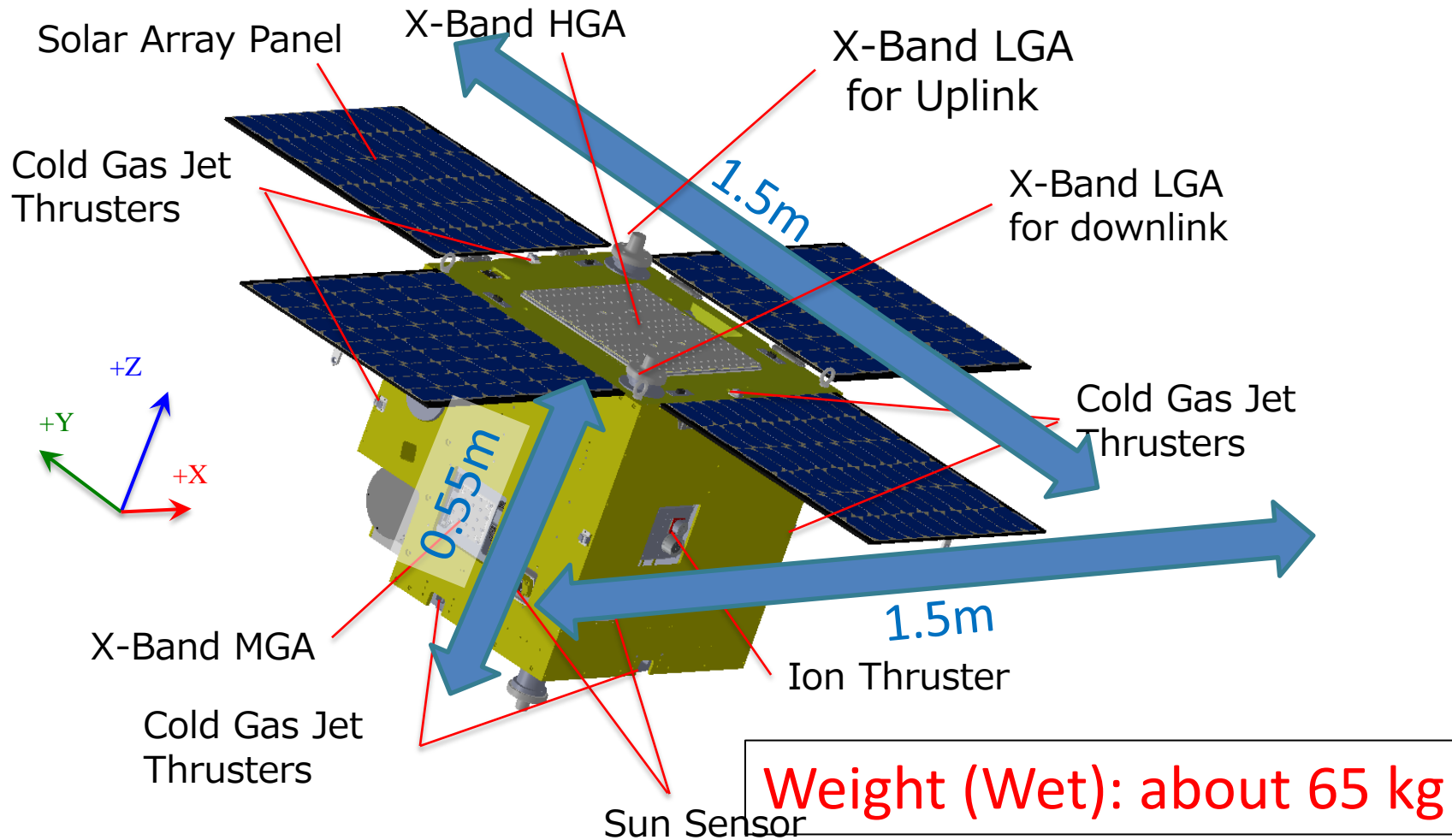


**Conventional flyby observation  
(Stardust NASA)**  
(altitude:178km, resolution:15m)

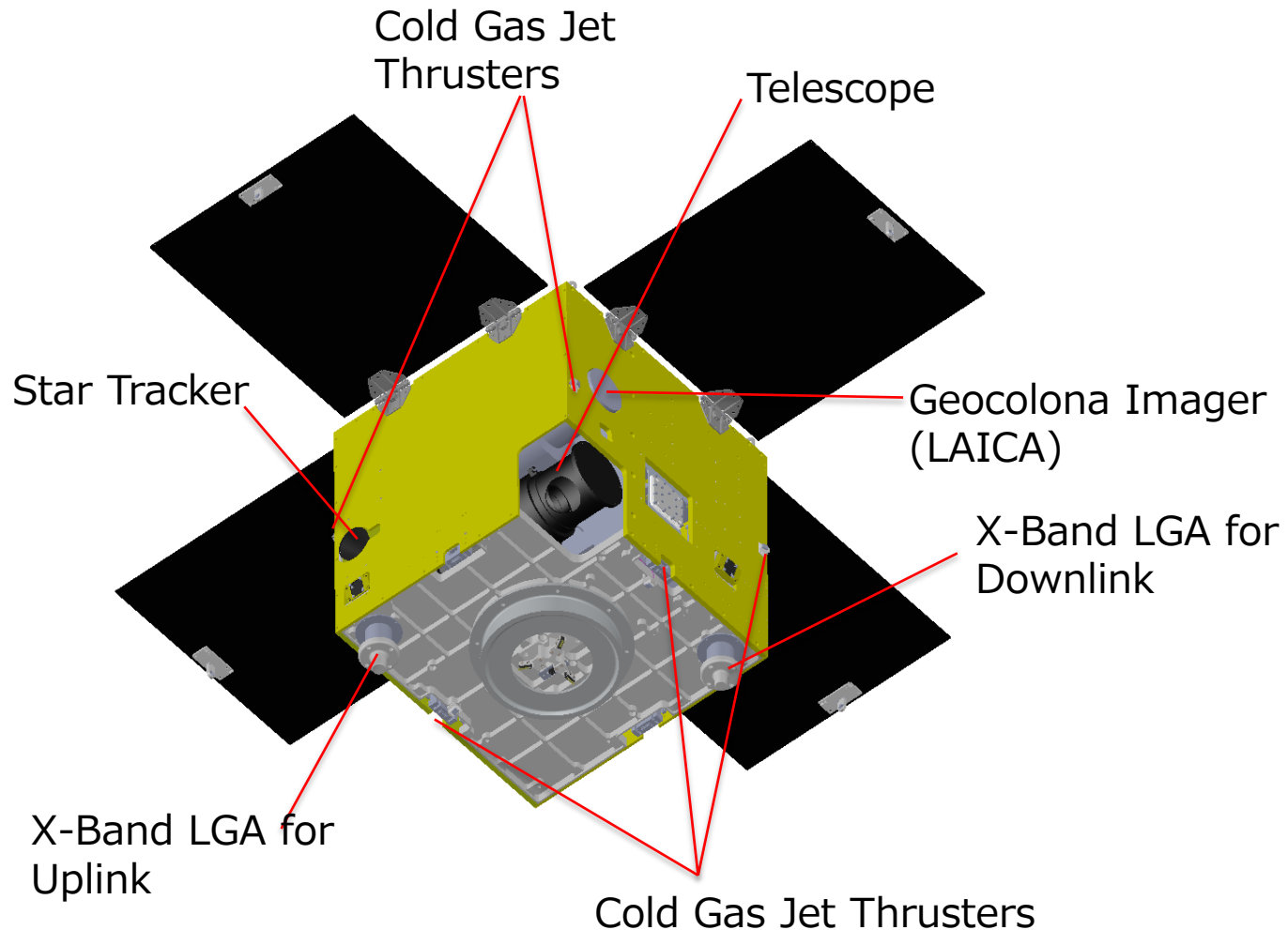


**Close flyby observation  
by PROCYON**  
(altitude: <50km, resolution: ~m)

# External View of PROCYON



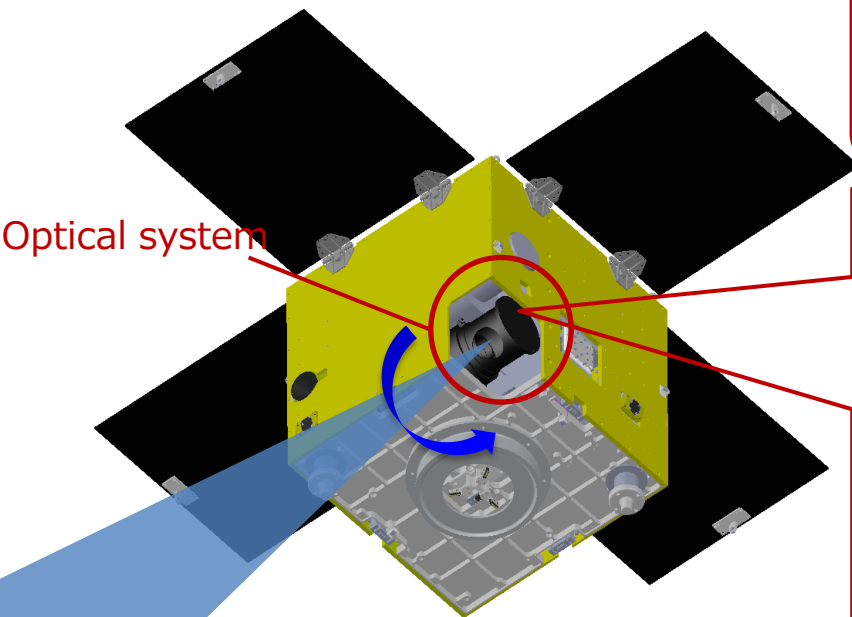
# External View of PROCYON



# Telescope system

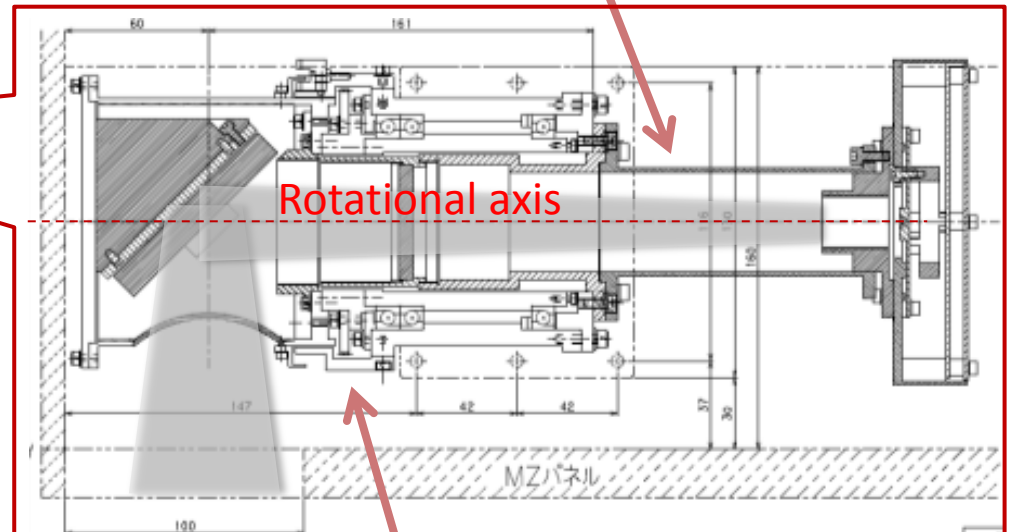
PROCYON carries small telescope for optical navigation & asteroid observation.

The optical system can observe 12<sup>th</sup> magnitude stars so that it can detect the target asteroid early enough to perform optical navigation before flyby



Optical system

By rotating the scan-mirror, it can control Line of Sight, which enables tracking of the asteroid during close approach



Rotational axis

Scan-mirror mechanism

# I-COUPS

Ion thruster and **C**old-gas thruster **U**nified **P**ropulsion **S**ystem

Combination of ion thruster and cold gas jet thruster, which shares the same propellant (Xe).

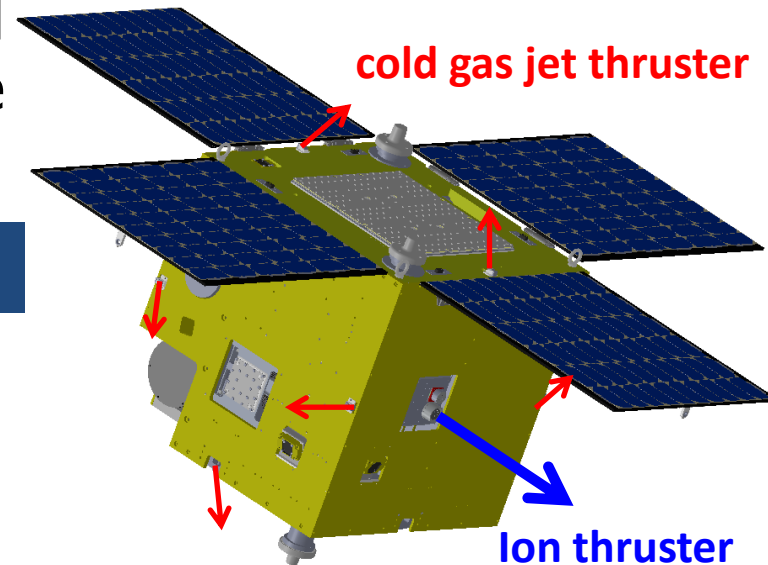
## High efficiency Ion Thruster

- For Orbit Transfer



## High Thrust Cold-gas Jet Thruster

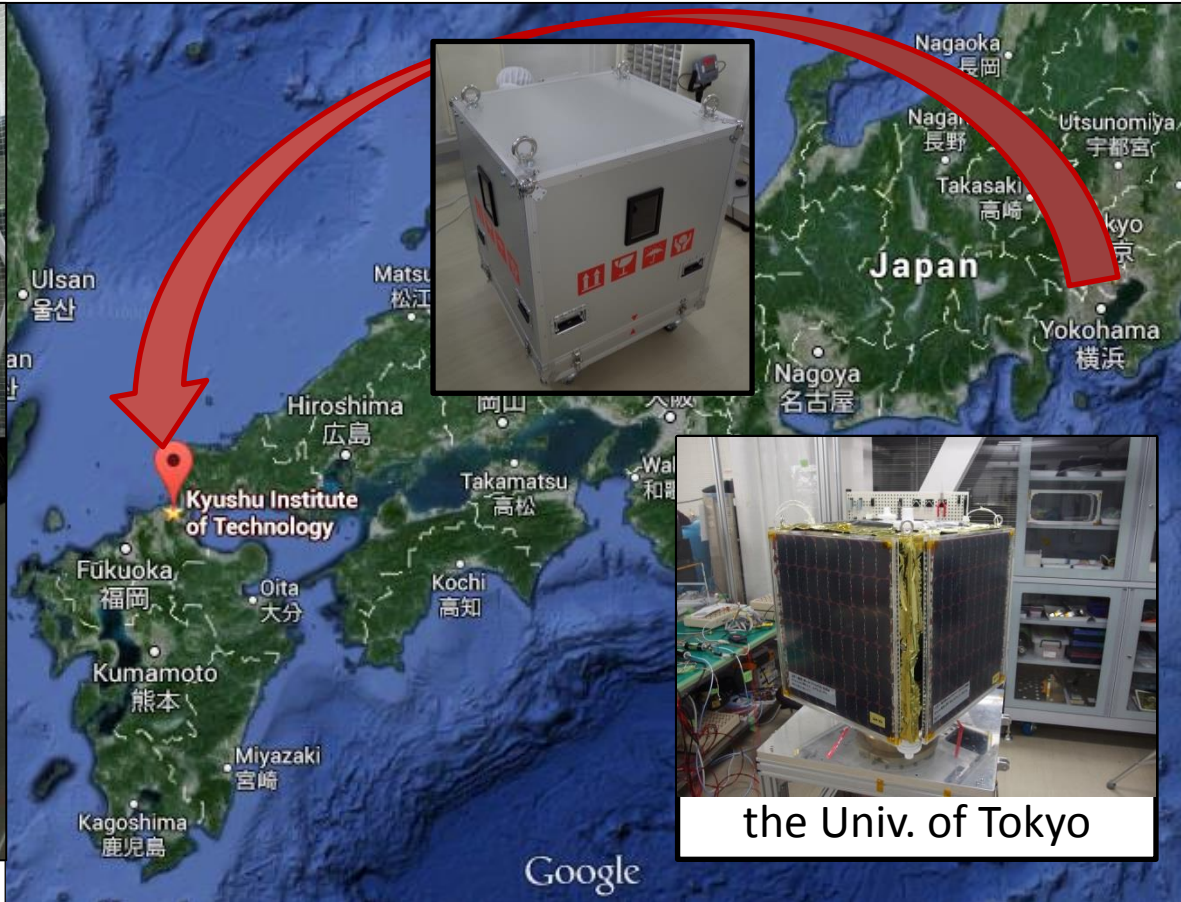
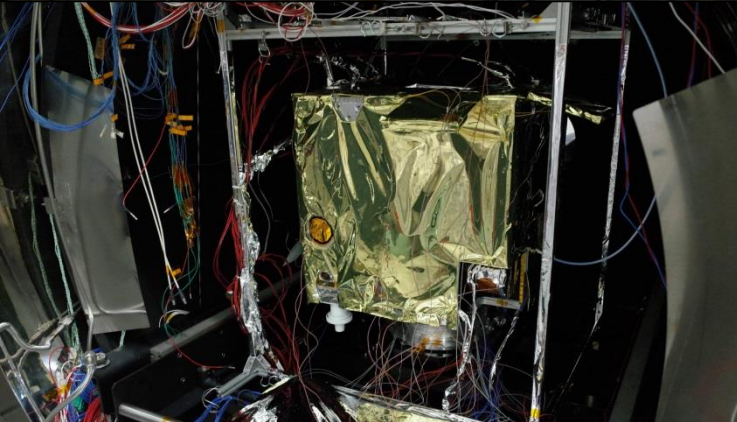
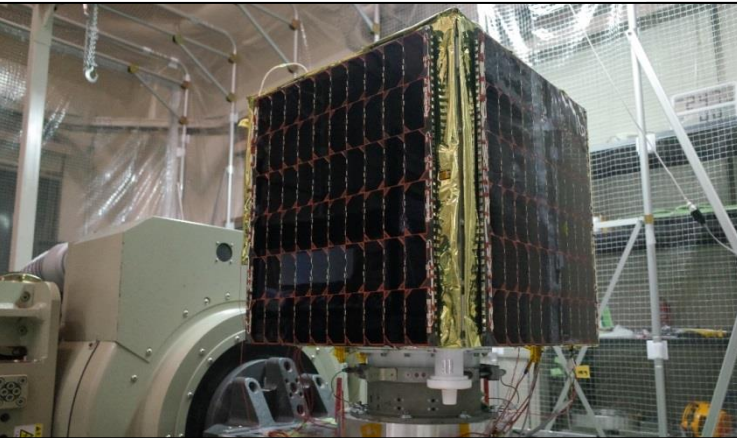
- For Unloading
- For Time-limited Trajectory Control Maneuver





# Collaboration in testing

Environment exposure tests were conducted in KyuTech



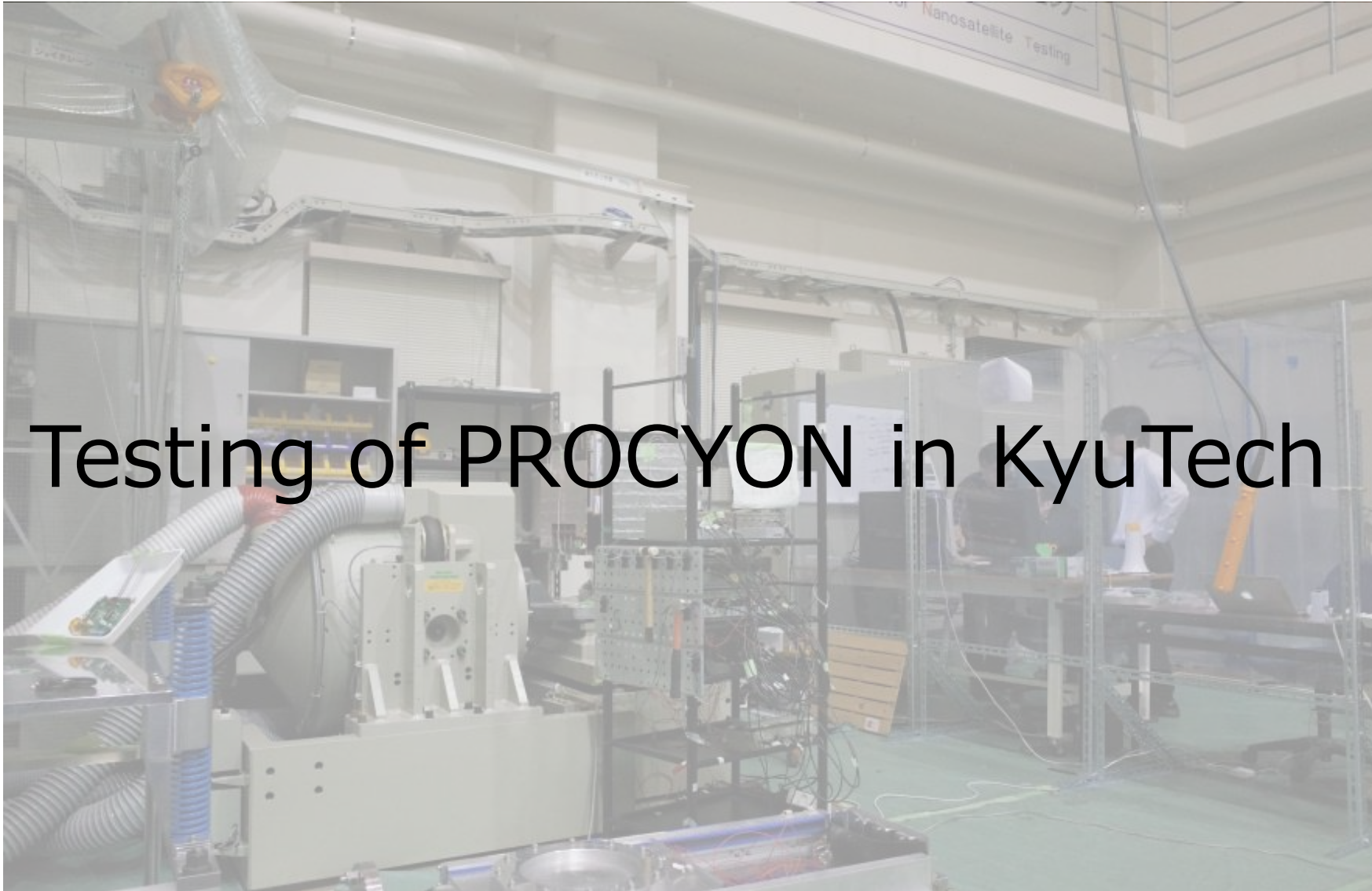
Environment Exposure Tests

2014/11/18

The 2<sup>nd</sup> UNISEC-Global Meeting

the Univ. of Tokyo

## II. Testing of PROCYON in KyuTech



2014/11/18

The 2<sup>nd</sup> UNISEC-Global Meeting

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# Why KyuTech?



Environment exposure tests of PROCYON were conducted mainly in KyuTech.

- Thermal / Vacuum Test (FM)
- Vibration Test (STM / FM)
- Shock Test (STM)

## Why PROCYON team went all the way from Tokyo to KyuTech?

# Why KyuTech? (1)

KyuTech have many kinds of equipments necessary or useful to conduct tests for 50kg-class satellite



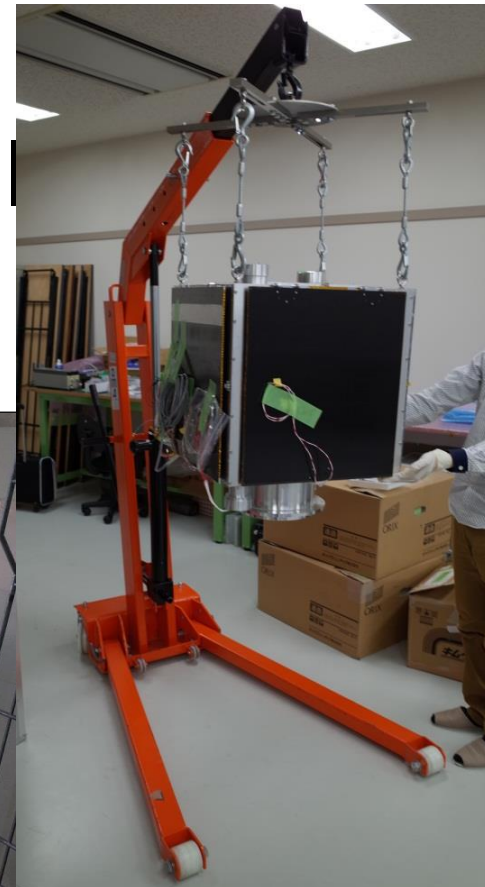
accelerometer

2014/11/18



Large crane

The 2<sup>nd</sup> UNISEC-Global Meeting



Small crane

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# Why KyuTech? (2)

In KyuTech, three major environment exposure tests ;

-thermal / vacuum test

-vibration test

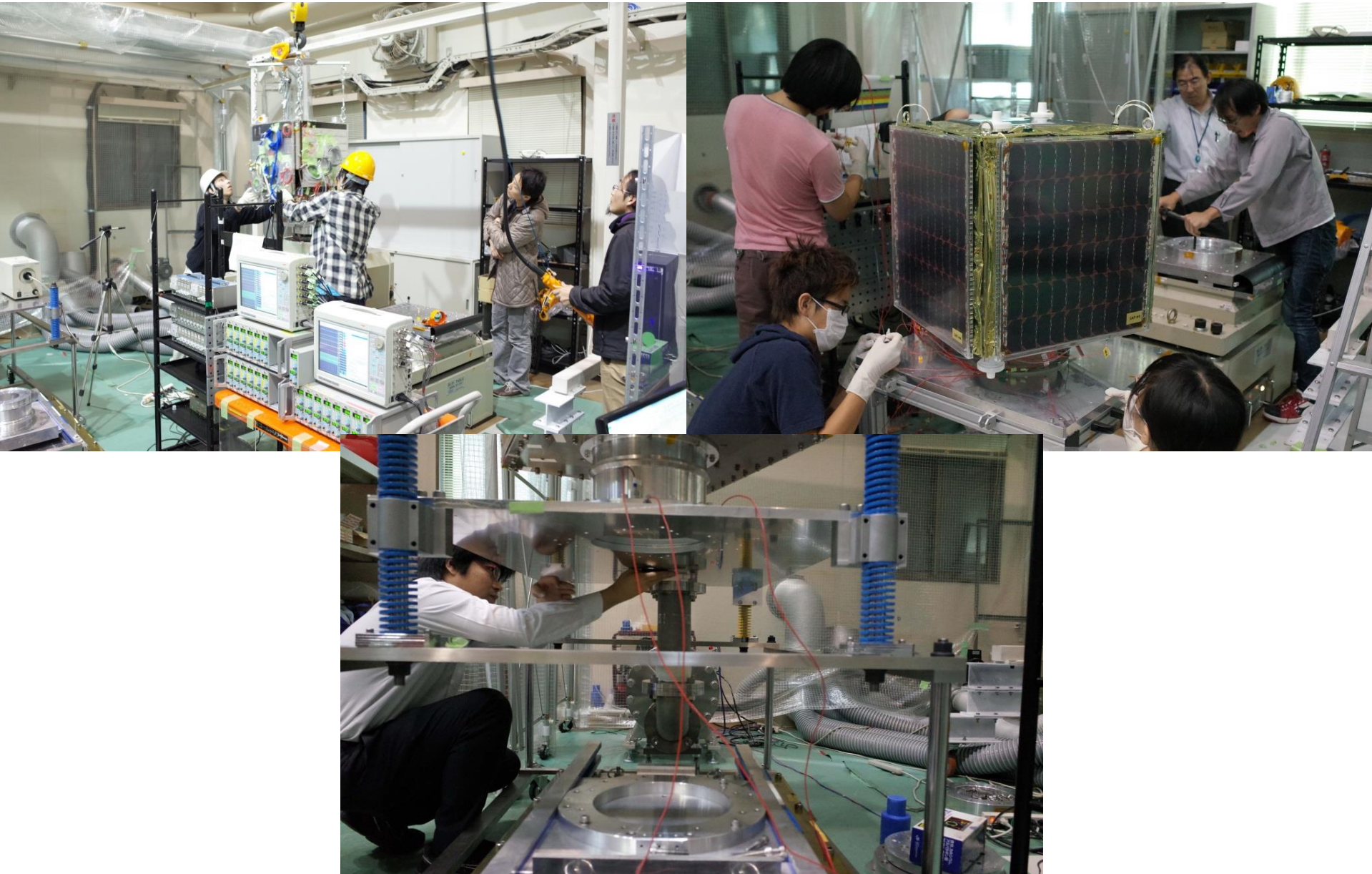
-shock test

can be conducted **in one place**.

This is large advantage in terms of

- Cost reduction
- Keeping schedule

# Why KyuTech ? (3)



# FM Thermo-Vacuum Test

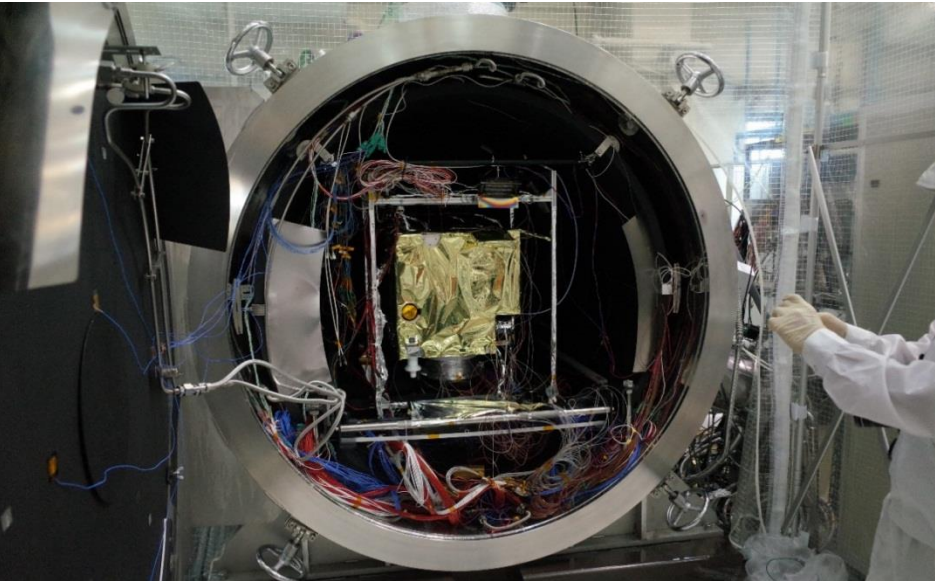


Date : 2014/08/26~31

PROCYON team monitors PROCYON for 24h,  
KyuTech staffs monitor chamber for 24h.

In FM thermal / vacuum test, we borrowed up to 49  
thermocouples to monitor the temperature of PROCYON.

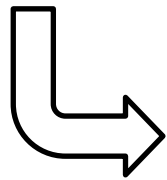
# FM Environment Exposure Tests



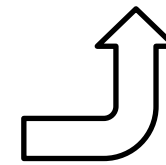
PROCYON FM Thermal /Vacuum Test



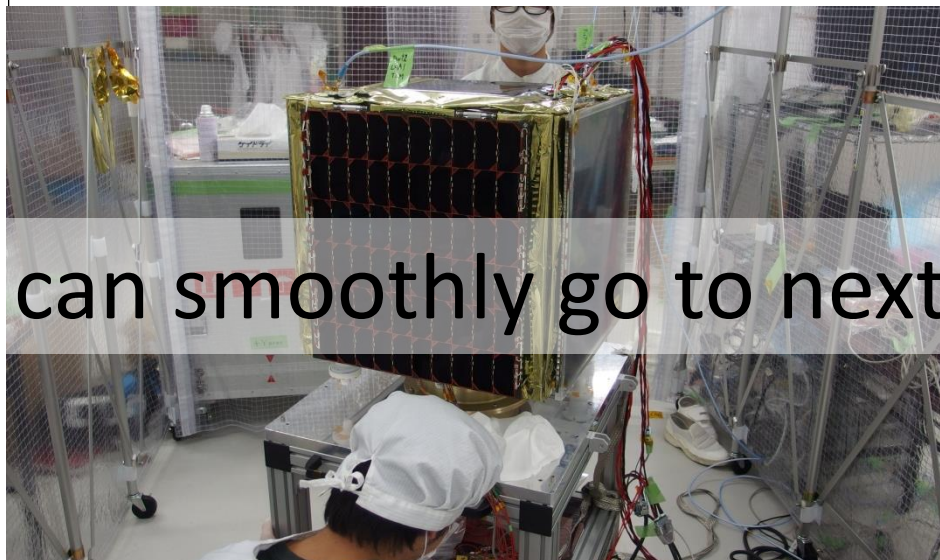
PROCYON FM Vibration Test



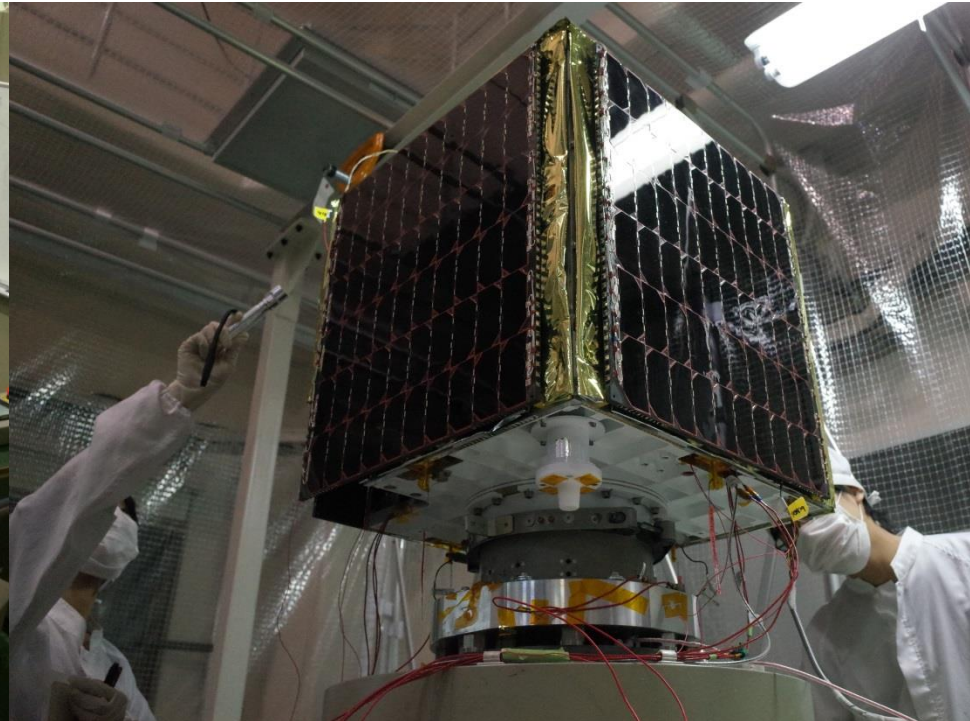
Maintenance & functional tests (3F)



We can smoothly go to next test



# FM Vibration Test



Date : 2014/09/13~15

In FM vibration Test, we used 22 accelerometers of KyuTech.

# Current Status of PROCYON

PROCYON has been already delivered to launch provider (JAXA).

It will be launched together with Hayabusa2 on Nov. 30 2014.



# Conclusion

- Overview of PROCYON and some components are introduced.
- To achieve PROCYON mission, collaboration between labs And universities is necessary.
  - Testing of PROCYON in KyuTech is introduced as a example of collaboration between universities.

# Thank You.

