Collaboration to Go Beyond the Earth
—Through Testing of PROCYON in KyuTech—

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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.

2014/11/18

The 2nd UNISEC-Global Meeting
History of Micro/ Nano Satellites of ISSL

CanSat (1999~)

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>

1. Launch (2014/11/30)
2. Earth swingby (2015/12)
3. Asteroid flyby (2016/01~)

<Asteroid close flyby observation>

Relative velocity in flyby: > km/s
To obtain high-resolution image

Altitude: <50km
High resolution observation enabled by approaching in low altitude and tracking the asteroid with onboard image feedback LOS (line of sight) control.
PROCYON Mission Objectives
(Phase I : 2014/11/30~2016/12)

1. Launch (2014/11/30)
2. Earth swingby (2015/12)
3. Asteroid flyby (2016/01~)

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

- Solar Array Panel
- X-Band HGA
- X-Band LGA for Uplink
- X-Band LGA for downlink
- Cold Gas Jet Thrusters
- X-Band MGA
- Cold Gas Jet Thrusters
- Ion Thruster
- Sun Sensor

Weight (Wet): about 65 kg
External View of PROCYON

- Cold Gas Jet Thrusters
- Telescope
- Star Tracker
- Geocolona Imager (LAICA)
- X-Band LGA for Downlink
- X-Band LGA for Uplink
- Cold Gas Jet Thrusters

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Telescope system

PROCYON carries small telescope for optical navigation & asteroid observation.

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

The optical system can observe 12\textsuperscript{th} magnitude stars so that it can detect the target asteroid early enough to perform optical navigation before flyby.

Scan-mirror mechanism
I-COUPS

Ion thruster and Cold-gas thruster Unified Propulsion System

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 developing subsystems

To achieve such a challenging & short-time project, it is necessary to collaborate with other universities and laboratories to share experiences & proficiencies.

System Integration

ISSL / the Univ. of Tokyo

SAP Holding & Releasing Mechanisms

Nippon Univ.

Communication System

ISAS / JAXA

Data Handling System

Tokyo Univ. of Science

Thermo-Structure

Hokkaido Univ.
ISSL / the Univ. of Tokyo

Mission Telescope

Meisei Univ.
ISSL / the Univ. of Tokyo

Propulsion System

Koizumi Lab / the Univ. of Tokyo
ISAS / JAXA

Science Observation

Rikkyo Univ.
Collaboration in testing

Environment exposure tests were conducted in KyuTech
II. Testing of PROCYON in KyuTech
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.

- Vibration Test
- Shock Test
- Thermal / Vacuum Test

accelerometer
2014/11/18

Large crane
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Small crane
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 a large advantage in terms of
- Cost reduction
- Keeping schedule
Why KyuTech? (3)

• Wide range of supports by well-experienced KyuTech staff.
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
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 an example of collaboration between universities.
Thank You.