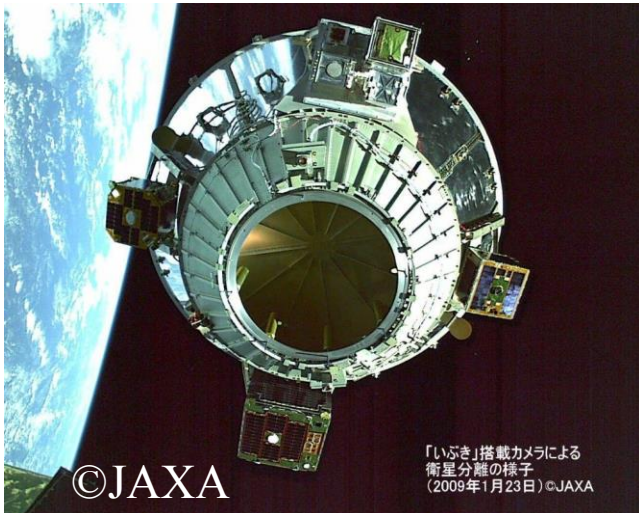


Results and Future Plans of the Center for Nano Satellite Testing (CeNT)

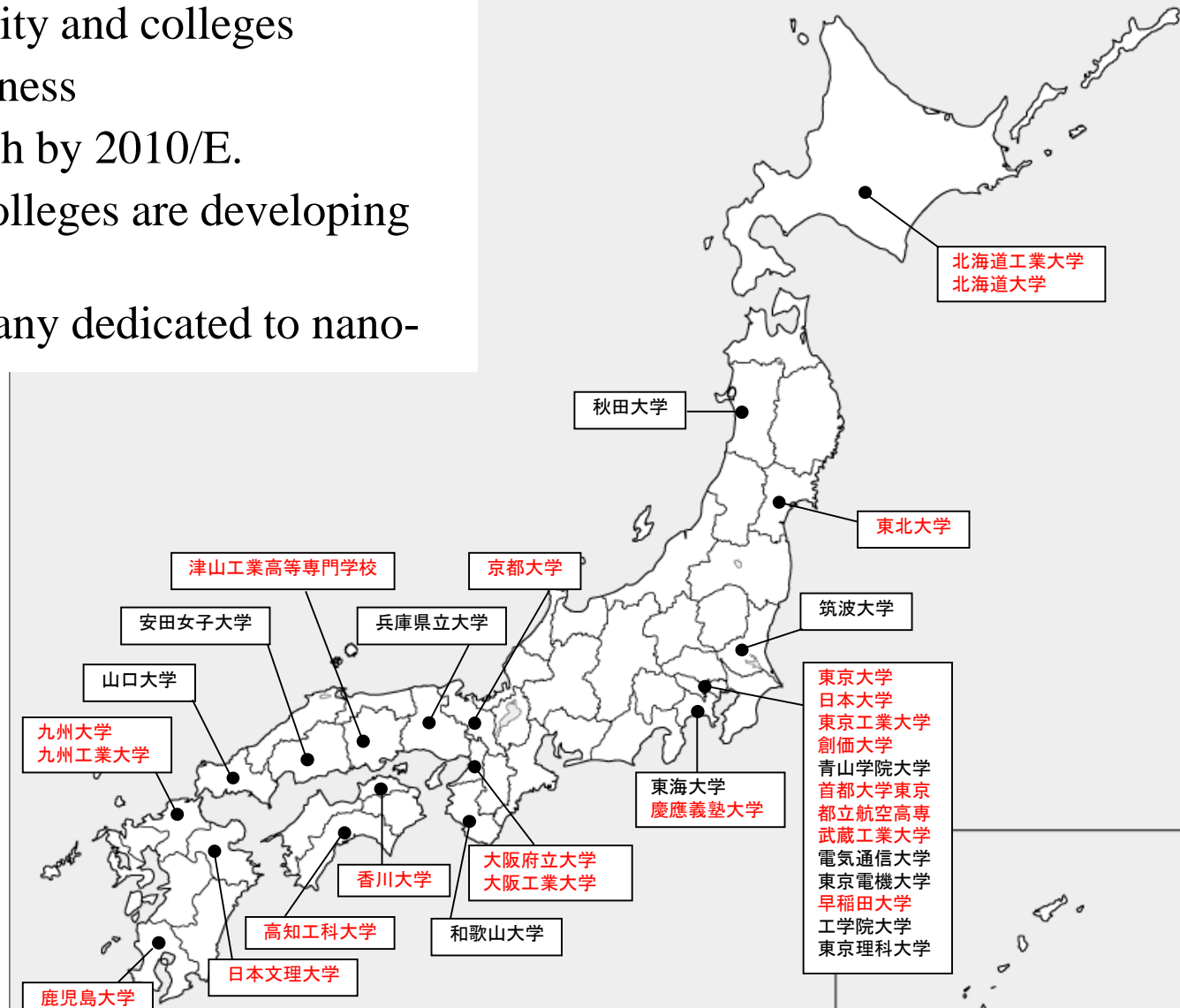
Hirokazu Masui, Sangkyun Kim, Mengu Cho
Kyushu Institute of Technology

Emergence of nano-satellite activities in Japan

- 11 nanosatellites by 8 university and colleges
- 2 nanosatellites by small business
- 5 more universities will launch by 2010/E.
- At least 22 universities and colleges are developing nanosatellites
- Small venture business company dedicated to nano-satellite development

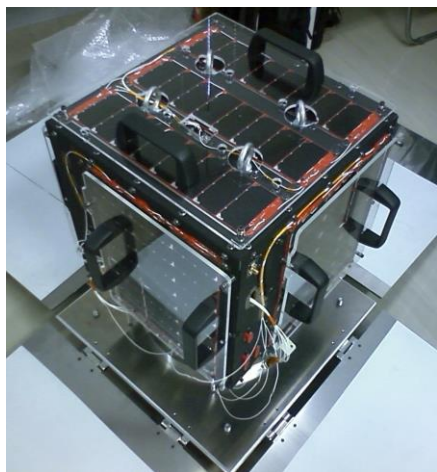


7 nano-satellite launched in 2009

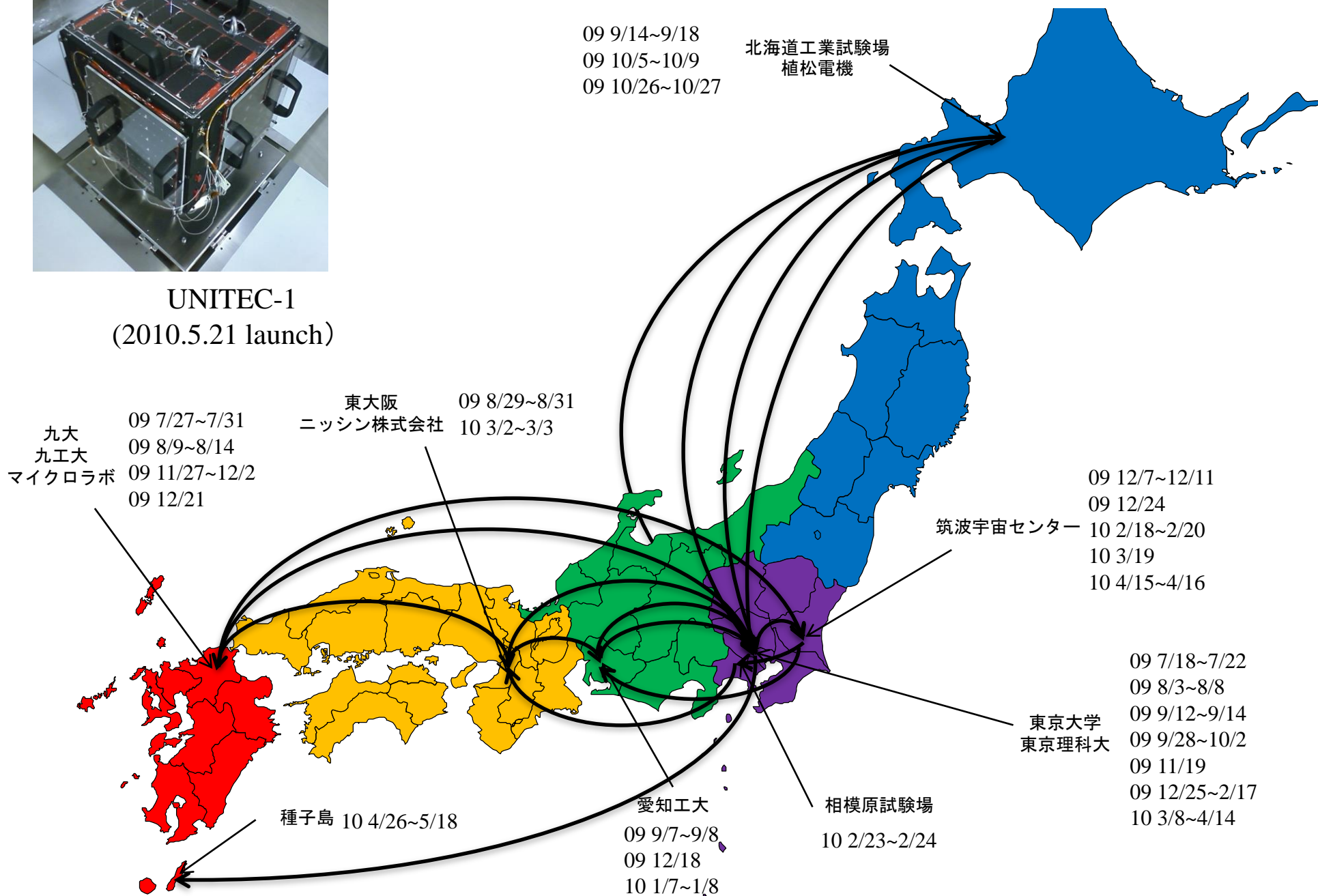


Slide used in 2009

Long testing journey of UNITEC-1

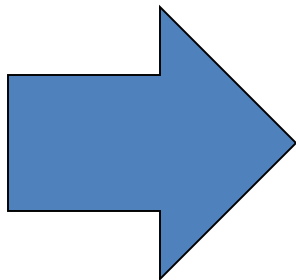


UNITEC-1
(2010.5.21 launch)



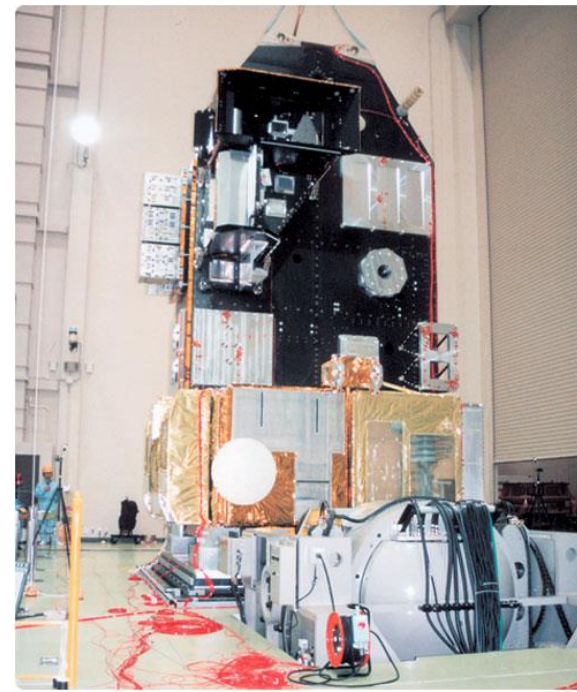
Can we use test facilities at JAXA?

CubeSat



Do we test here?

Probably not



Proposal of Nano-satellite Environment Test Center

- Center dedicated for environment test of nano-satellites
 - Carry out all the test necessary for nano-satellites or components of **50cmx50cmx50cm, 50kg**
 - Provide a quick test place for prototypes developed by local industries
 - One-stop-service for space environment test

Slide used at IAC 2009

Original idea of nanosatellite testing center was in 2008

Task sharing

	Nanosatellite test center	Space agency
Satellites to be tested	Nanosatellite (≤ 50 cm only)	As big as ISS (> 10 m)
Users	<ul style="list-style-type: none"> •University •Local Community •Small business •New comers to space 	<ul style="list-style-type: none"> •Government •Space industry
Priority	First come, first serve	National space projects

Center for Nanosatellite Testing (CeNT)

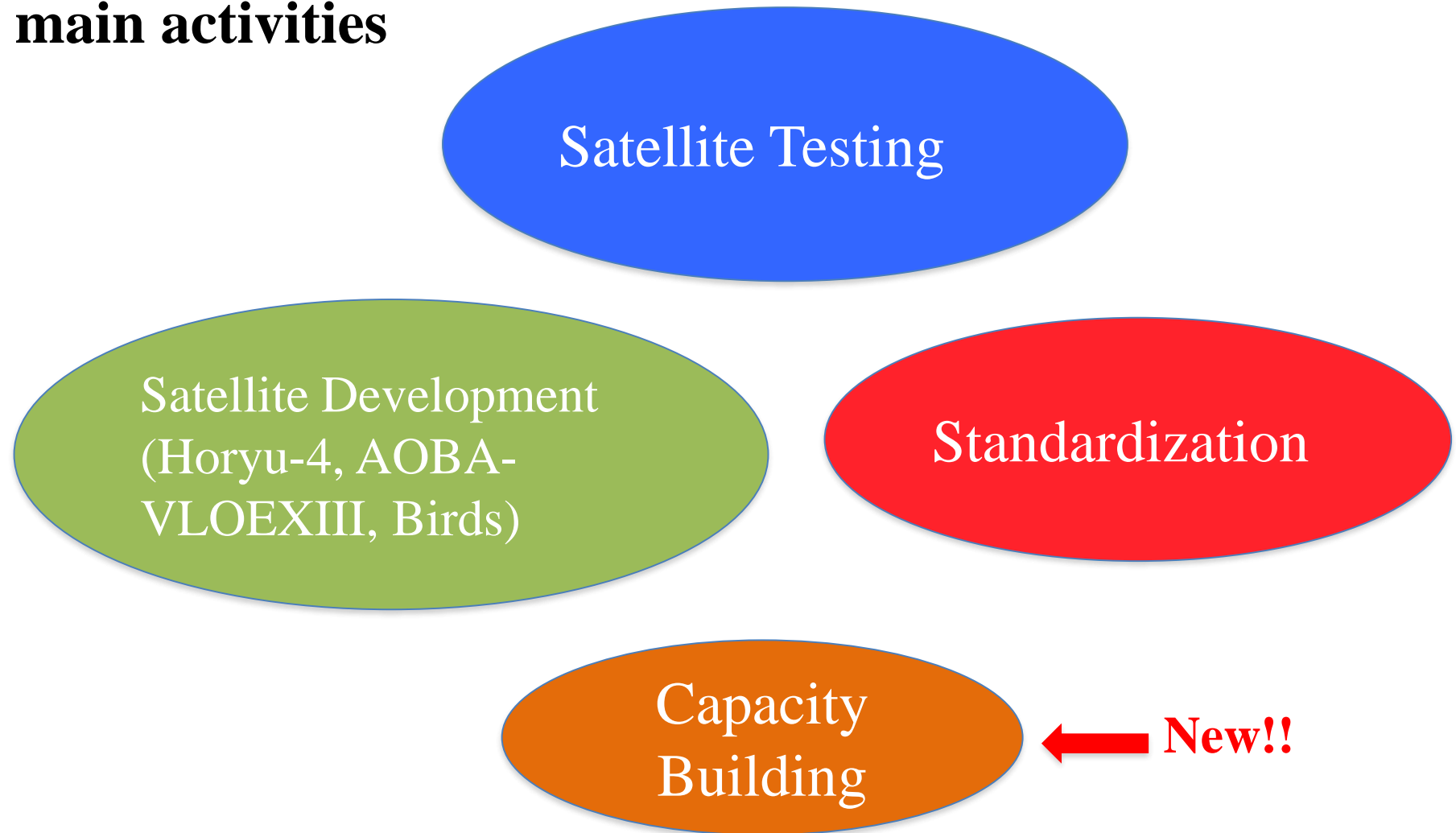
- Funding support by “Hodoyoshi Project” (2010~2013)
 - (P.I. Prof. Nakasuka)
- Founded on July 7, 2010
- Inauguration ceremony on Jan. 18, 2011



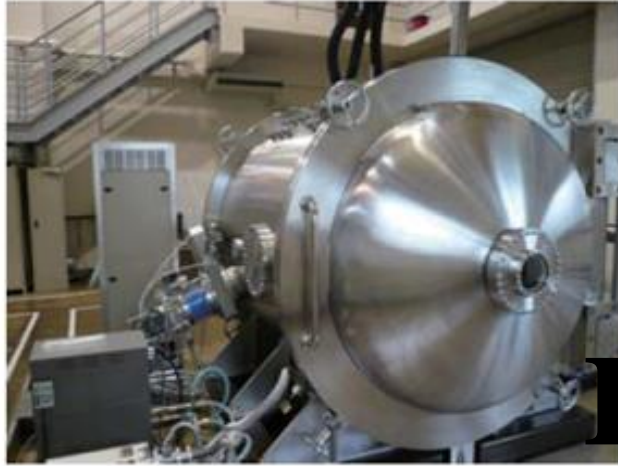
2011.1.18

CeNT Activities

4 main activities



Results of CeNT activities and future plan



Introduction of Testing facility

Concept

One-stop facility

- Providing all kinds of testing except radiation

Traceability

- Comparison with old data.
- Anomaly investigation in testing and on-orbit operations.

Easy to use

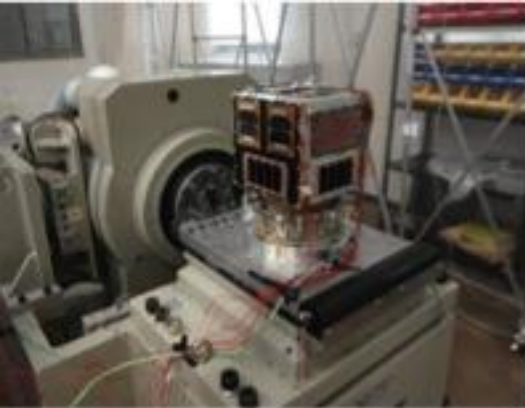
- Only one phone call with minimum paperwork

A unique facility specialized to lean satellite.

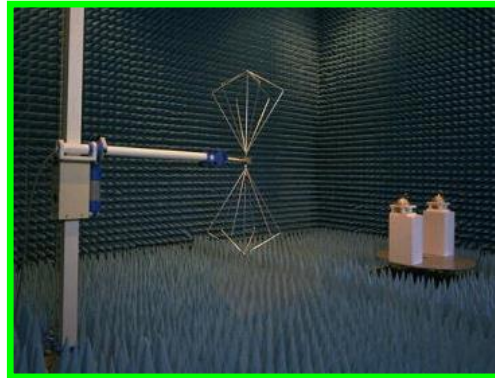
Open to Japanese and foreign users

Nano-satellite environment tests

To be capable of doing all the tests for a satellite up to 50cm, 50kg



Vibration



EMC & Antenna pattern



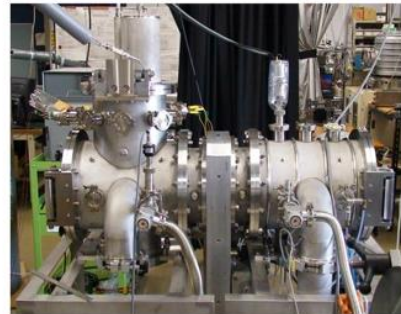
Pressure & Leak



Thermal vacuum



Assembly & Integration



Vacuum thermal shock



Thermal cycle



Shock



Outgas
(ASTM E595)



α & ϵ measurement

Mechanical testing

Vibration

→Mandatory for all piggy-back satellite

Advantage :

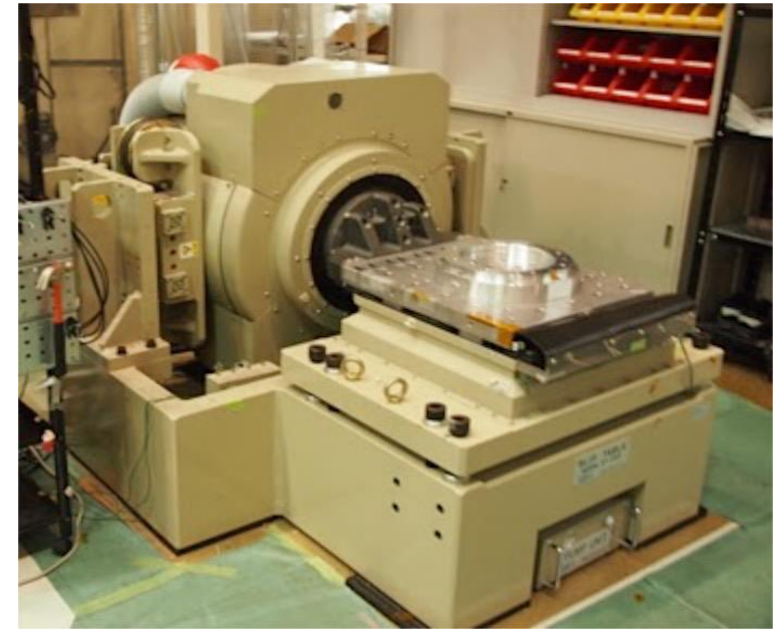
Quick review system based on LabVIEW

→Nominal testing time:
2.5 days for 50kg
1.5 days for 1U

Shock

Air gas gun type

→Producing high level separation shock for various launchers, H2A, Dnepr, etc..



Thermal testing

Target : up to 50kg, cube-sat and sub-system

Small ($\varnothing 0.3\text{m}$) and Large($\varnothing 1.5\text{m}$)

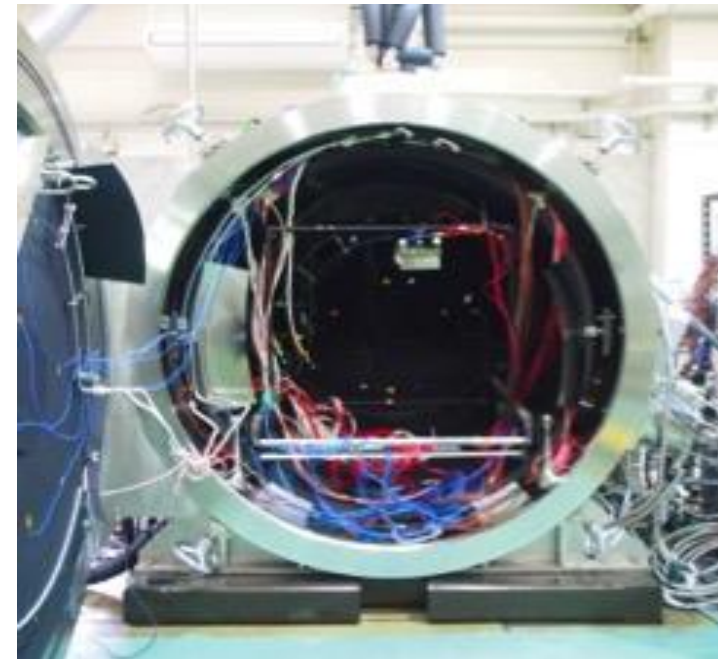
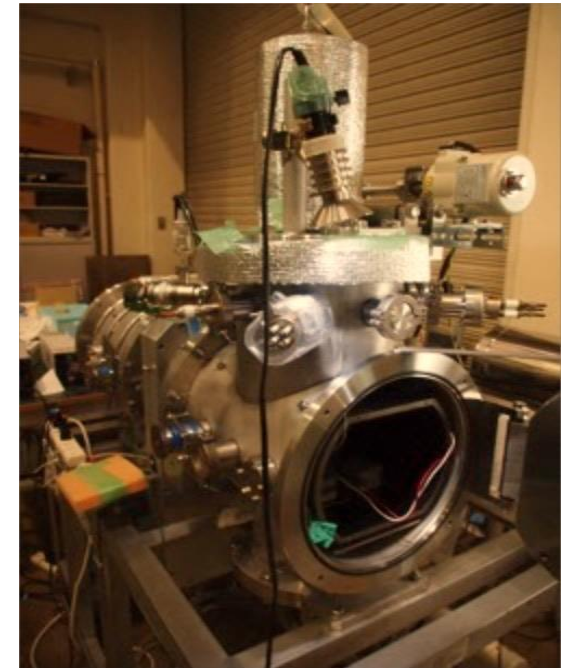
Purpose 1:

Verification of thermal design and operation under low and high temperature environment.

Purpose 2:

Detection of hidden defects and bugs in the program.

→ It is possible to find
for long term test as 1 week



Recent update



Clean room (80m²)
Class 7 or better for integration and
functional testing

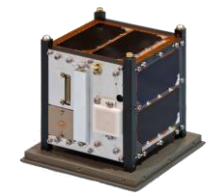


Solar simulator
30cmx30cm area with 1400W/m²

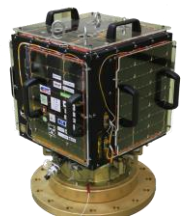


2.4m S-band (2.4GHz) antenna

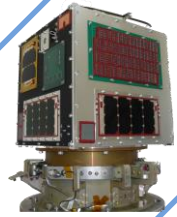
List of satellites tested



KSAT
launched in 2010



UNITEC-1



HORYU-II



FITSAT-1

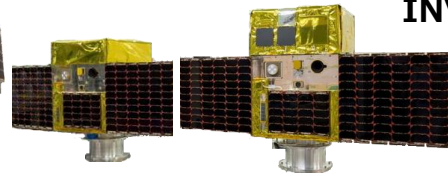
launched in 2012



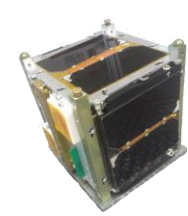
QSAT-EOS



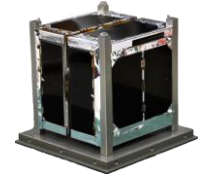
OPUSAT



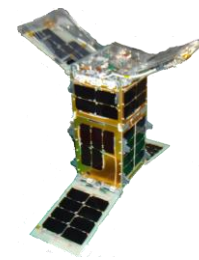
Hodoyoshi3,4



KSAT-2



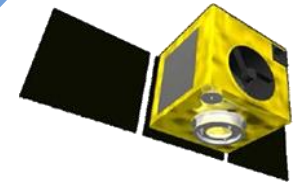
INVADER



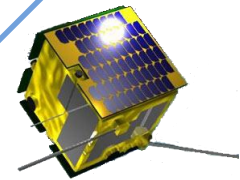
STARS-II



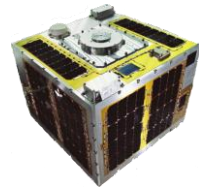
Teikyo-sat3



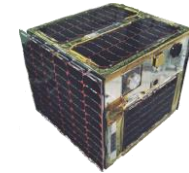
ChubuSat-3



ChubuSat



RISING-2



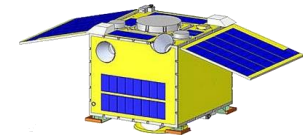
UNIFORM-1



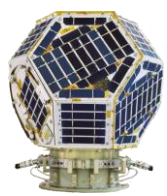
DIWATA-1



Nano-JASMINE



Hodoyoshi2 (RISESAT)

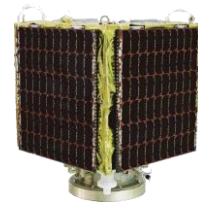


しんえん2

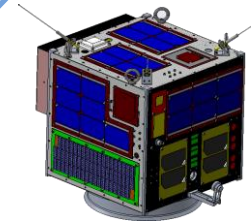


ARTSAT2

launched in 2014

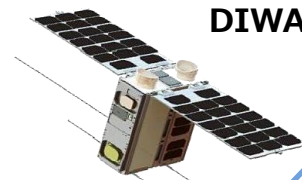


PROCYON



HORYU-IV

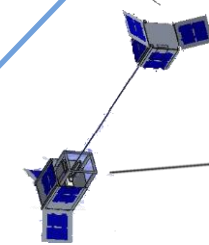
launched in 2015



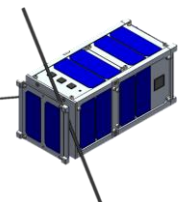
Velox-II



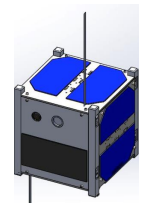
CE-SAT-I



STARS-C



Aoba-VeloxIII



BIRDS

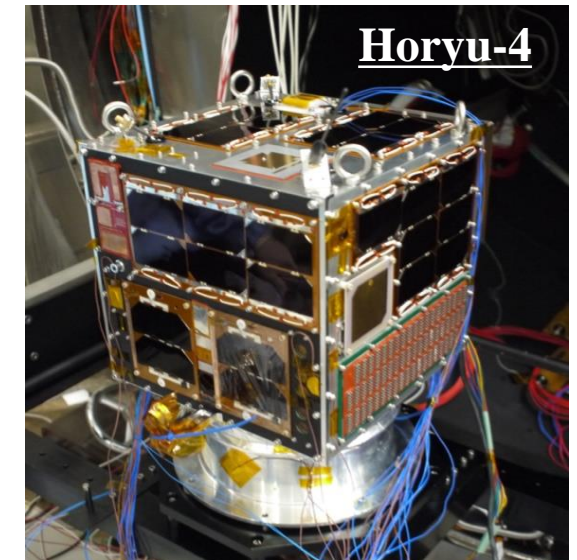
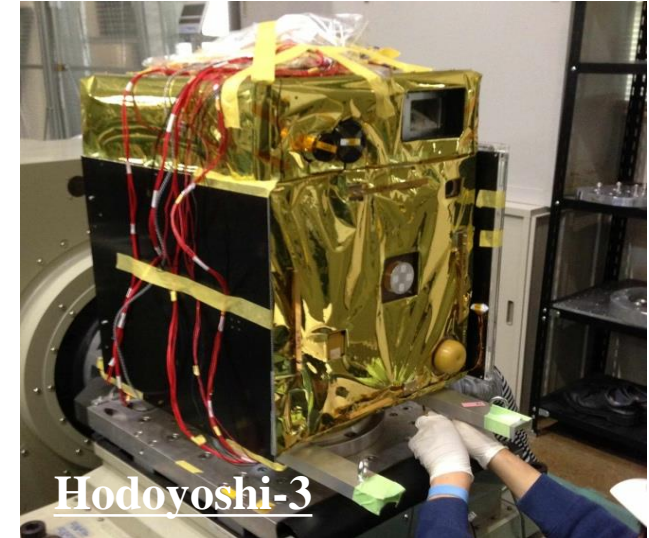
To be launched.

Two-thirds of less-than-50kg Japanese satellites

Past results

(Number of satellite tested in CeNT)

Fiscal Year	Total	University	Company	Foreign user
2010	3	3	0	0
2011	5	5	0	0
2012	11	8	2	1
2013	14	10	2	2
2014	9	6	1	2
2015	7	3	2	2
2016	5	3	2	0



Five Kyutech satellites are included in these numbers.

From FY2010 to FY2014,
many environmental tests related
to the Hodyoshi project

Past results

(Test campaigns)

Fiscal Year	Total	Mechanical	Thermal	Others
2010	5	2	2	1
2011	12	8	3	1
2012	24	15	7	2
2013	48	28	13	7
2014	33	18	10	5
2015	21	15	5	1
2016	12	4	4	4
Total	155	90	44	21

Operation rate of these machines strongly depends on the H2A piggy back program. In 2014, four H2A rockets were launched.

Half of the satellite developers using H2A piggy back rides in 2014 conducted tests at CeNT.

International collaboration and Capacity building



International Collaborations

Satellite developed by Kyutech

Project	Developer	Countries involved	Launch date
Horyu-4	Kyutech	18	2016.02.17
AOBA-Velox III	Kyutech and NTU	2	2017
Birds	Kyutech and others	7	2017
AOBA-Velox IV	Kyutech and NTU	2	2018
Micro Dragon	VNSC and 5 Japanese Univs.	2	2018
SPATIUM	Kyutech and NTU	2	TBD

NTU : Nanyang Technological University (Singapore)

Satellites supported by Kyutech

Project	Developer	Launch date
Irazu	Costa Rica	2018
UBAKUSAT	Turkey	?



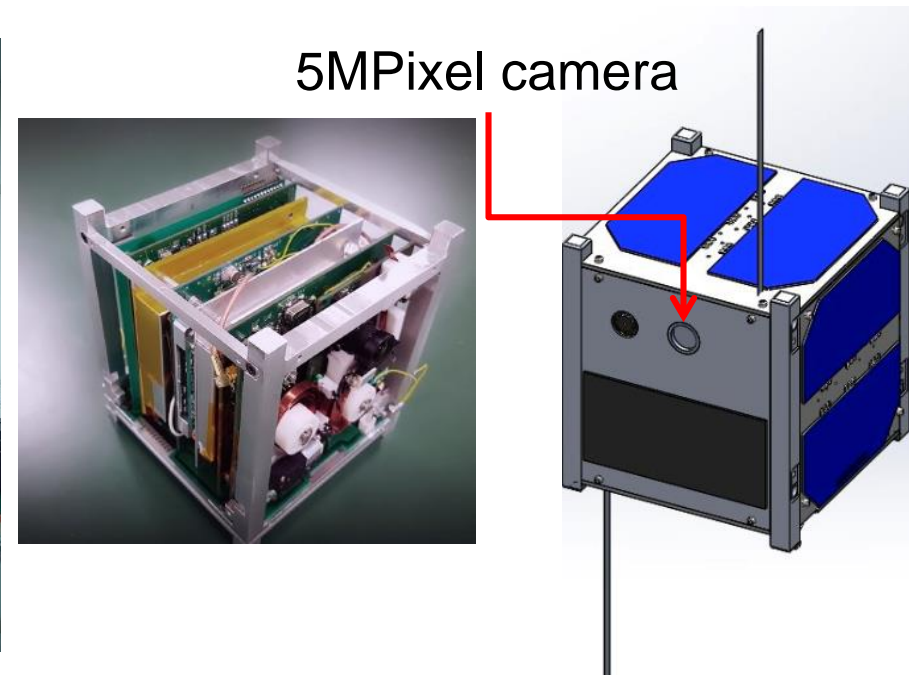
BIRDS project (2015~)



By successfully building and operating the first satellite of nation, make the first step toward indigenous and sustainable space program at each country

- 1U CubeSat constellation of 4 satellites by **Bangladesh***, **Ghana***, Japan, **Mongolia***
- Made by students at Kyutech
- To be released from ISS in 2017
- Earth observation, Outreach, Space environment measurement

** First satellite for the country*





- Fellowship to students from non-space-faring countries
 - Tuition and living costs
 - On-the-job training on satellite development, especially infrastructure
- “Post-graduate study on Nano-Satellite Technologies (PNST)”
 - 6 students (2 Master, 4 Doctor)
 - Funded by Japanese government fellowship
 - Application for October 2017 admission is now open
 - **Application deadline is January 22, 2017**

To be selected

- ◆ *Passion* to be engaged in space technology (determined through original essay at the first stage, and through Skype interview at the second stage)
- ◆ Good English skills
- ◆ Must be under age 35

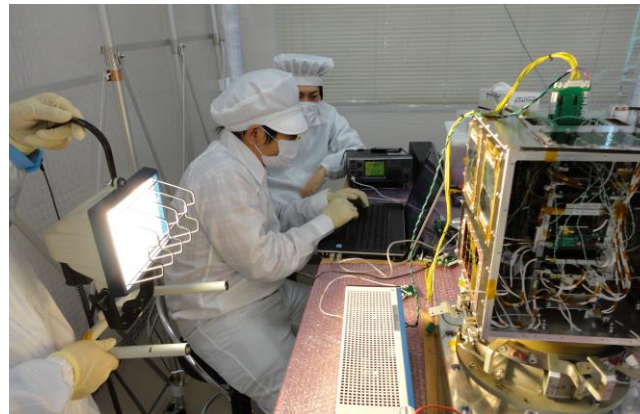
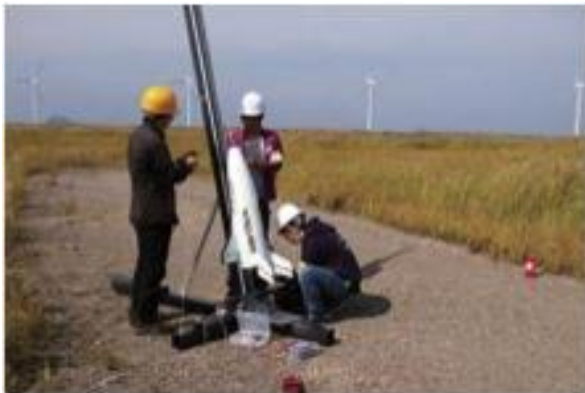
Google “PNST UNOOSA”



Space Engineering International Course (SEIC)

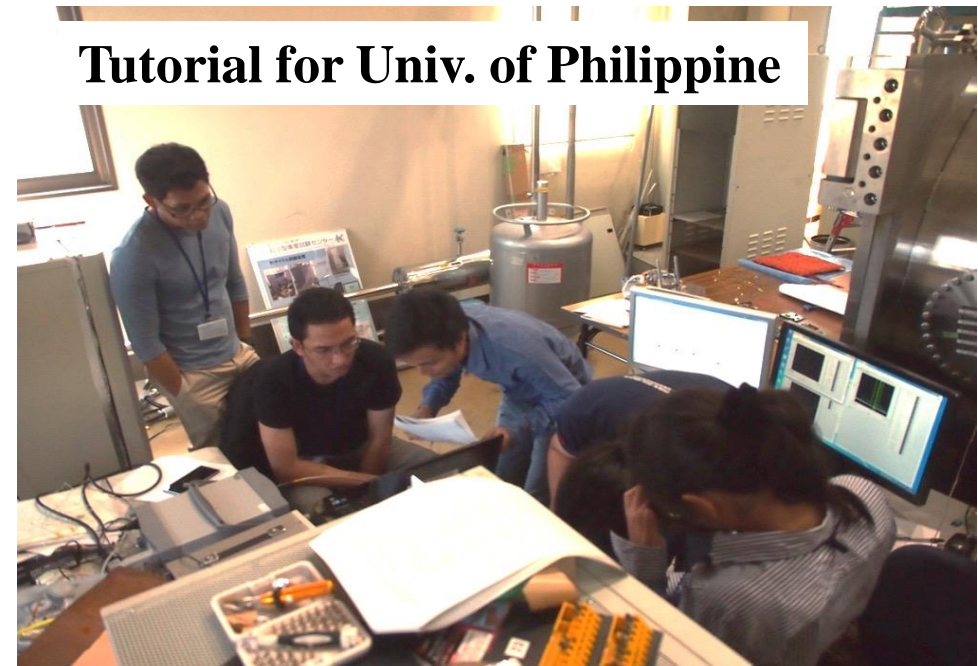
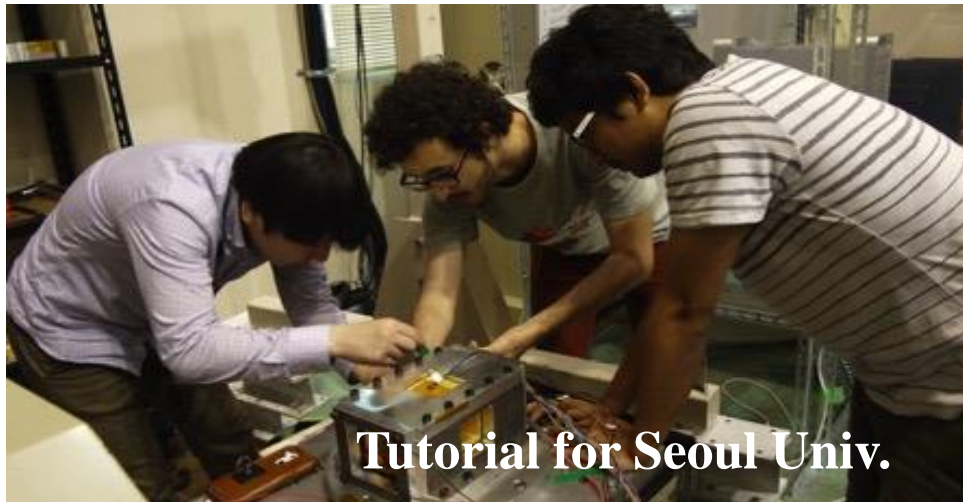


- Started in April 2013 at Graduate School of Engineering, Kyutech
- Research toward a Master or Doctoral degree
- On-the-job training such as space environment testing workshop
- Project Based Learning (PBL) through a space project
- Lectures in English
 - Space Systems Engineering, Satellite Engineering, Space Environment, Environment Testing, Power System, Structure and Material, Dynamics, Propulsion, Plasma, Semi-conductor, and more



Satellite testing tutorial

- 10 day short course on environment testing
 - 15 hours Lectures on mechanical, thermal and radiation testings
 - Hands-on tutorial on vibration, shock, thermal cycle and thermal vacuum





What Kyutech can do for you

- Test your satellite
 - Singapore, Philippine, Vietnam, Malaysia, Finland, Egypt
- Train your engineers/students on satellite testing
 - South Korea, Philippine
- Educate your engineers/students on space engineering through SEIC
 - Various countries
- Assist your satellite program
 - Consultation, testing and launch coordination
 - **Costa Rica**, Turkey
 - Start up CubeSat program by SEIC students
 - **Bangladesh, Mongol, Ghana, Bhutan**, Nigeria

Countries launching the first satellite of country



Future Plan

- Innovation in lean satellite testing
- Work toward self-independence
 - Acquisition of ISO-17025 (General requirements for the competence of testing and calibration laboratories)
 - Certification of lean satellite components based on ISO-19683
 - International collaboration

