



BIRDS Satellite Project as a Model for Capacity Building Towards Sustainable Space Program in Africa

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United Nations/ South Africa Symposium on Basic Space Technology
December 14th. 2017.



Outline



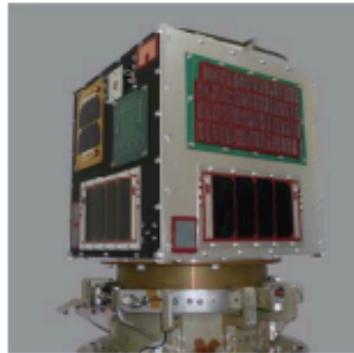
- © Space Engineering at Kyutech
- © Reinventing Space_ *Lets do more with little*
- © BIRDS Satellite Project
- © BIRDS Network
- © Conclusion



Scholarship announcement!

United Nations/Japan Long-term Fellowship
Programme on Nano-Satellite Technologies
Hosted by Kyushu Institute of Technology, Japan

Post-graduate study on Nano-Satellite Technologies



- ❑ 6 graduate students each year –
 - 3 Doctoral degree
 - 3 Master degree.

If you are interested, please see
UNOOSA BSTI website

Deadline is January 2018!

<http://www.unoosa.org/oosa/en/ourwork/psa/bsti/fellowships.html>





International Lean Satellite Workshop- 2018



January 22 - January 24, 2018

Venue: Kitakyushu International Conference Centre
<http://convention-a.jp/en/>

**If you are interested, please see me after my
talk.**

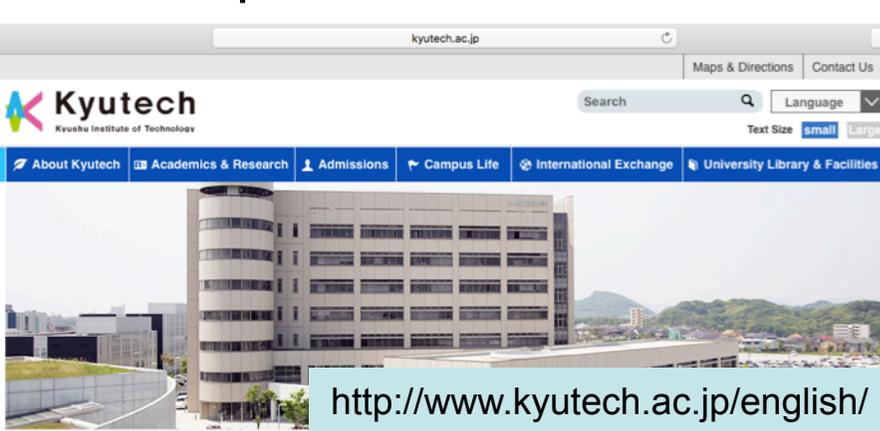
http://cent.ele.kyutech.ac.jp/2018_nets-regist/



Kyushu Institute of Technology

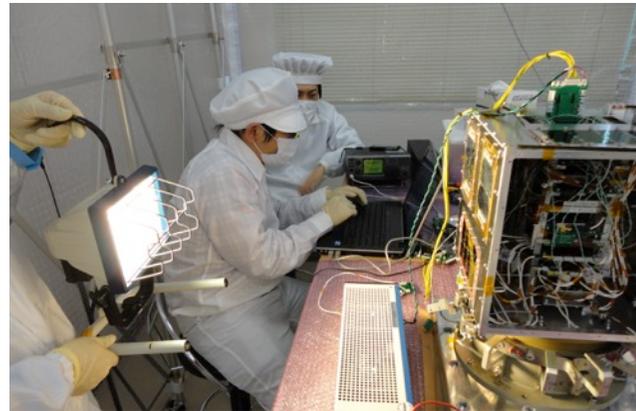
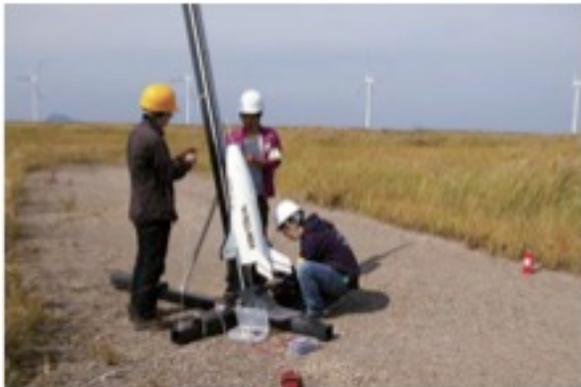


- A national university founded in 1909
 - 4,200 Undergraduate students.
 - 1,300 Graduate students.
 - 360 Faculty members.
 - Engineering, Computer science, Life- science.
- Located in the Kitakyushu region
 - Population of more than 1million.



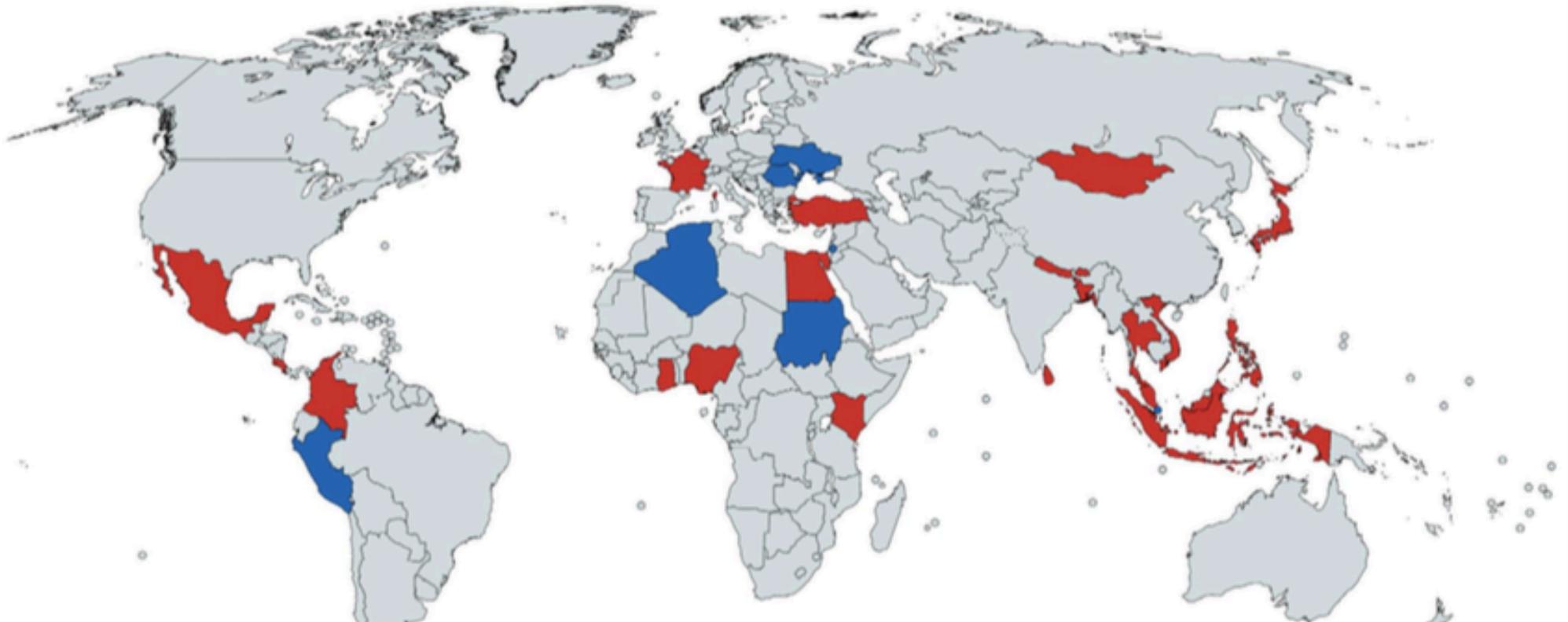


- Started in April 2013 at Graduate School of Engineering, Kyutech to support PNST.
 1. Research toward a Master or Doctoral degree.
 2. On-the-job training such as space environment testing workshop.
 3. **Project Based Learning (PBL) through a space project.**
 4. Space-related lectures in English.
 - **Not only engineering, but also space policy and others.**





Where are we from?



We are highly diverse and interdisciplinary mid-career Space Engineers from across the Globe.

Created with mapchart.net ©

Graduated

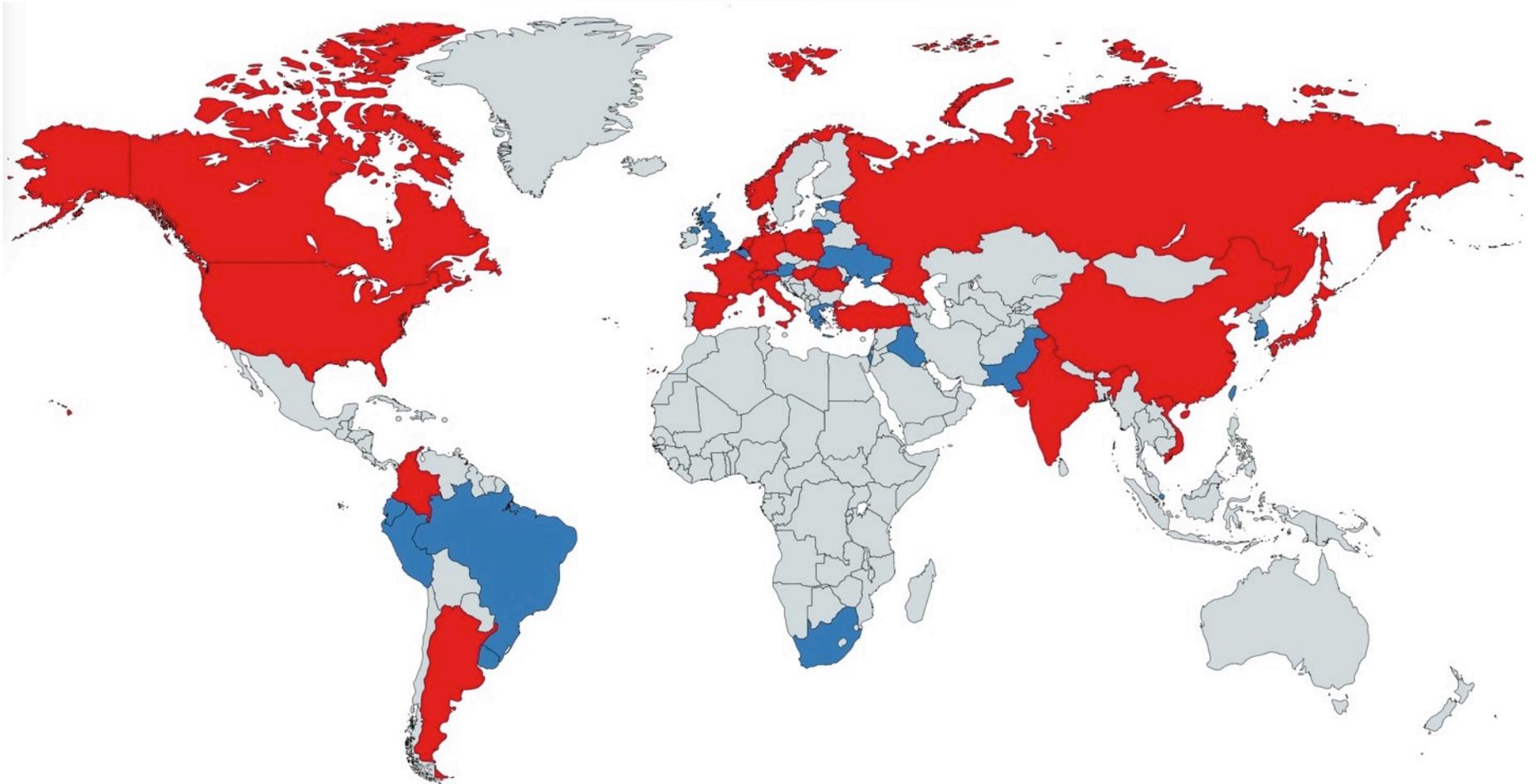
Current (as of October 2017)



Why Space Technology?



- Every nation need **skilled workforce to compete** effectively in today's global market.
- **Space technology** has been identified as one of the available tools for **achieving sustainable goals**.
- **Applications** are evident in several areas of human endeavours such as **earth observation, communication, navigation and science**.
- How can we **create a sustainable, prosperous and peaceful future here on Earth?**
 - Growing population.
 - Planetary boundaries.



~2012 (21 countries)

2013 ~ 2015 (+18 countries)

Small satellite activities are expanding worldwide



Reinventing Space

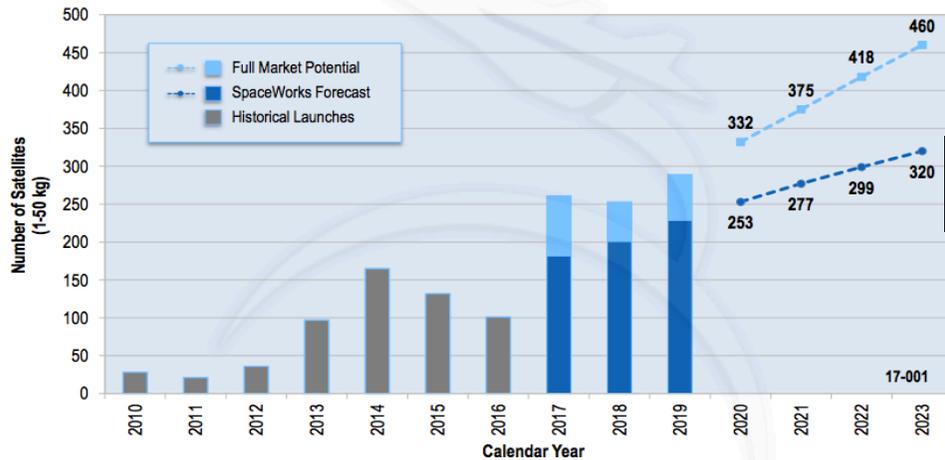


Global participation in space activity is growing as satellite technology matures and spread due to **proliferation of *Lean Satellites (1kg -50kg)***

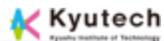
http://spaceworksforecast.com/docs/SpaceWorks_Nano_Microsatellite_Market_Forecast_2017.pdf

2017 Nano/Microsatellite Launch History and Forecast (1 - 50 kg)

Projections based on announced and future plans of developers and programs indicate nearly 2,400 nano/microsatellites will require a launch from 2017 through 2023



Trend of small satellite launch



Project Cost

Delivery Time

Launch

Simplicity

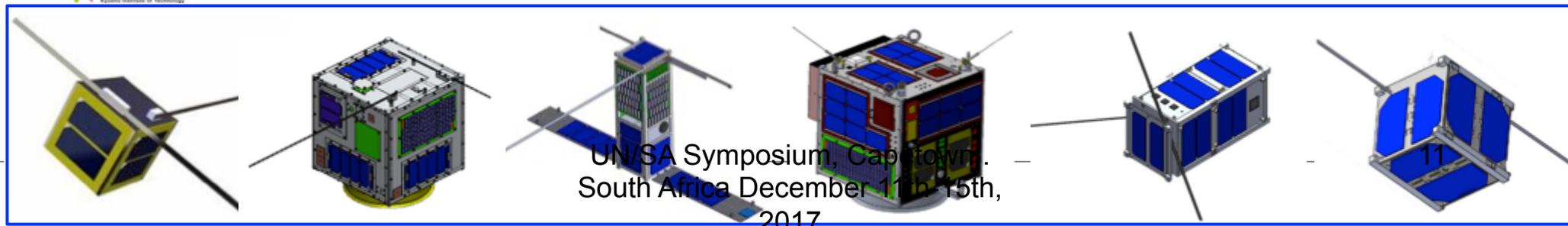
Waste Mitigation

High Risk Taking

Mission Duration

Reliability Requirement

Risk Mitigation Approach



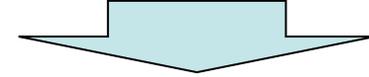
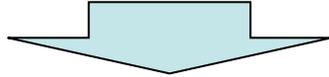
UN/SA Symposium, Capetown, South Africa December 11th-15th, 2017



....Lets go Lean



Space missions *cost too much* and *take too long* to achieve the mission objective.



Reinventing space using modern technology and *willingness to accept risk* to *do much more*, much *faster with fewer resources*.



Lean satellite project

- ◎ Reduction in space mission cost and delivery time.
- ◎ Acceptance of higher mission risk and fragility.
- ◎ More responsive to world events and end user needs.
- ◎ More economical sustainable business model for space industry.
 - *Developing countries can adopt this model.*



BIRDS Project Overview



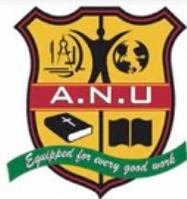
Successfully building and operating the first national satellite and making the foremost step toward indigenous space program at each nation.



JAPAN



GHANA



MONGOLIA



NIGERIA



BANGLADESH



THAILAND



TAIWAN



First satellite of the country

7 Participating countries

2 years to achieve satellite Missions

5 Units of 1U CubeSats

6 Missions

4 Faculty members

Team of 15 graduate students

Operation from 7 ground stations



<http://birds.ele.kyutech.ac.jp/>



Essential Values



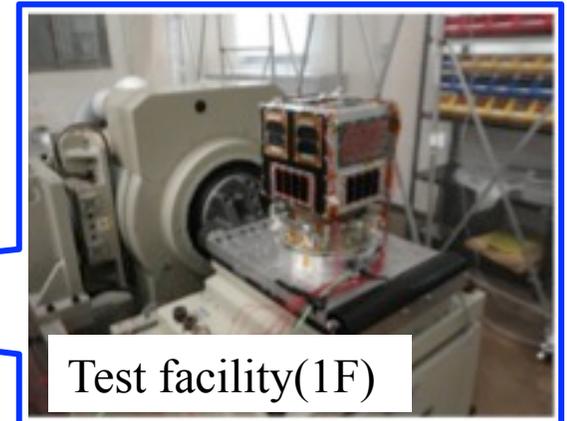
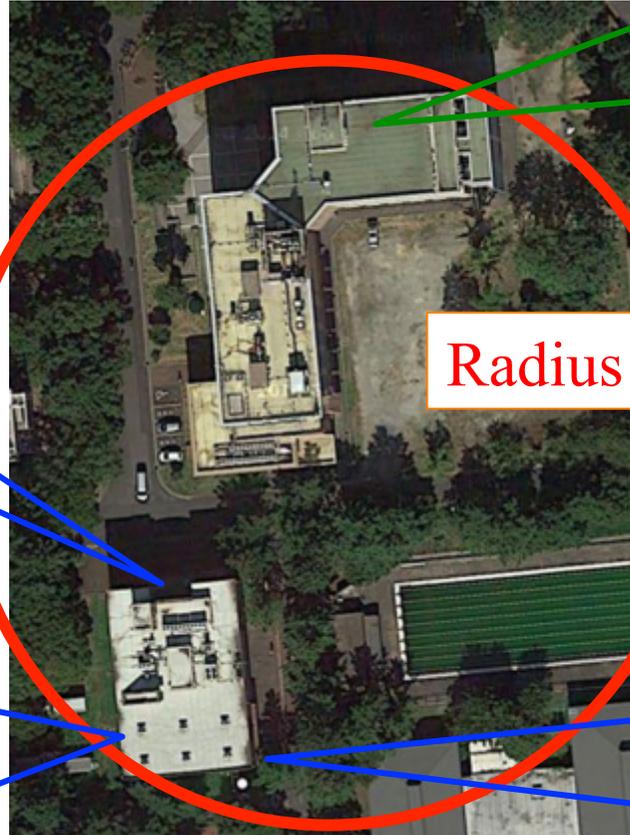
- ◎ Human network to achieve innovative System Engineering.
 - Demonstrate that a 1U CubeSat can be built and operated successfully in a **time frame shorter than 2 years** even for countries with **limited (or zero) satellite experience** with proper design and planning.
 - Starting a **sustainable and robust space program** with minimum budget at universities in emerging or developing countries.
 - **Competition and collaboration** among student members accelerate satellite development process and enhance the satellite quality.
- ◎ International Ground station network for CubeSat.
 - Obtain **key experiences regarding operation of satellite** constellation.
 - **Synergetic mission value and capability** via international operation.

Development Philosophy

- Minimize waste of “waiting” and “moving”
 - All development , AIT done at Kyutech



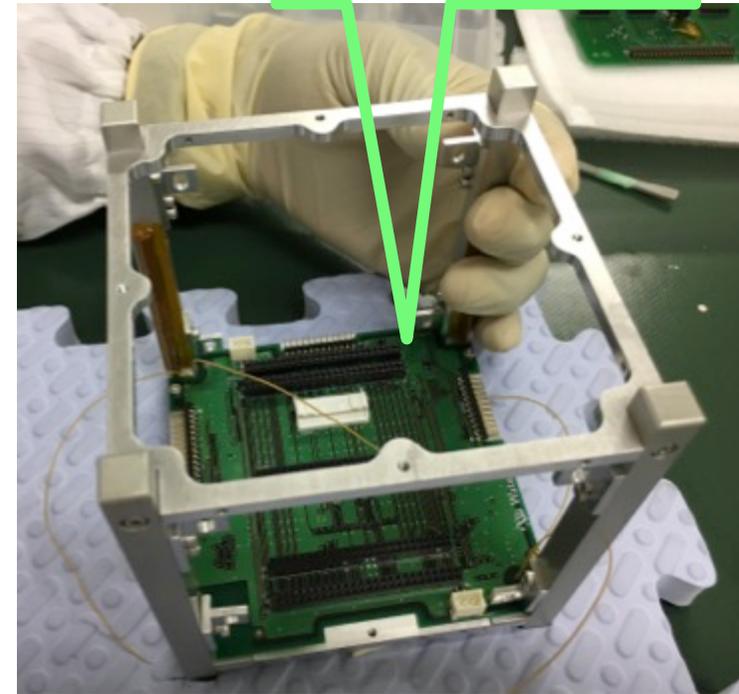
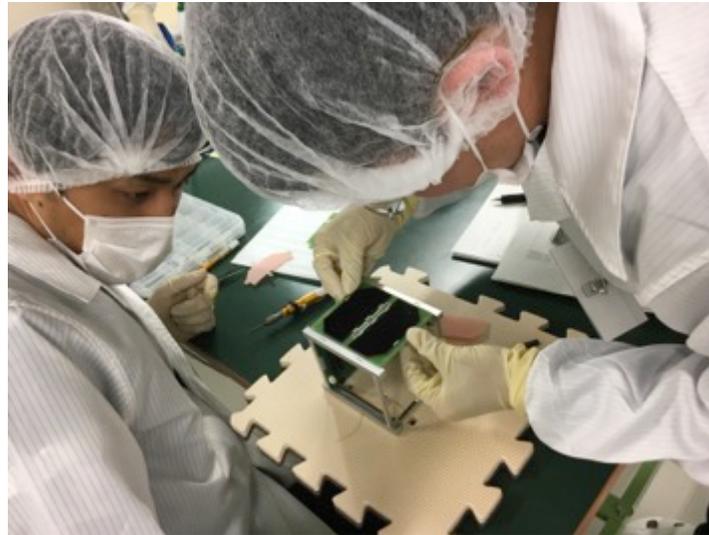
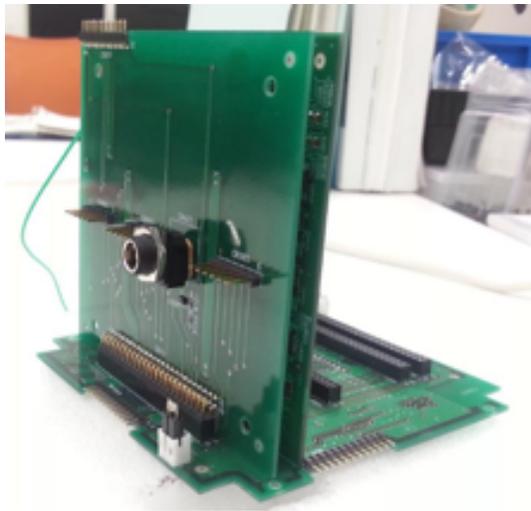
Kyushu Institute of Technology



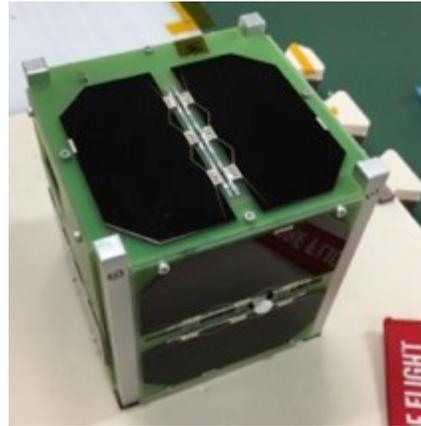
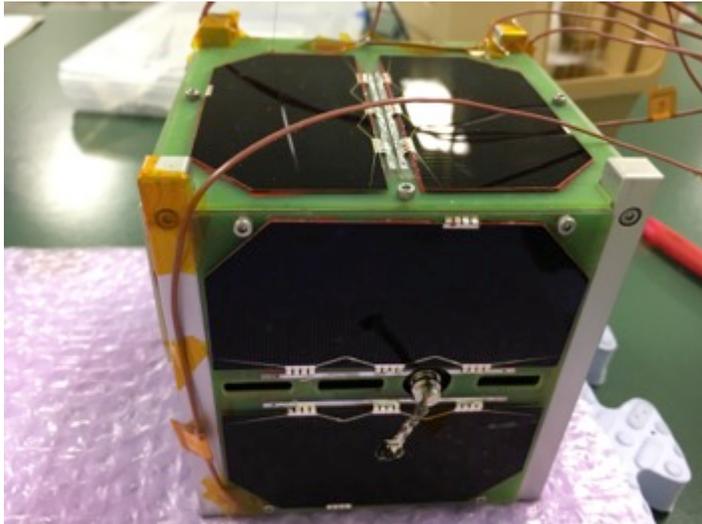
- **Modularized and Less harness** design.
- Share **same frequency** for TM & TC (UHF/VHF).
- Using **Backplane style** used in UWE-3.
- **Miniaturized single board** for OBC, COM and EPS.



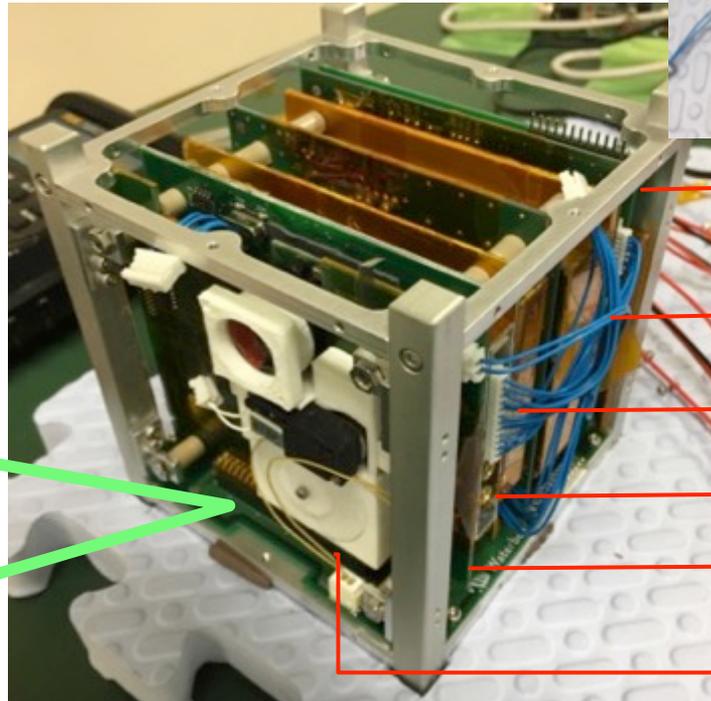
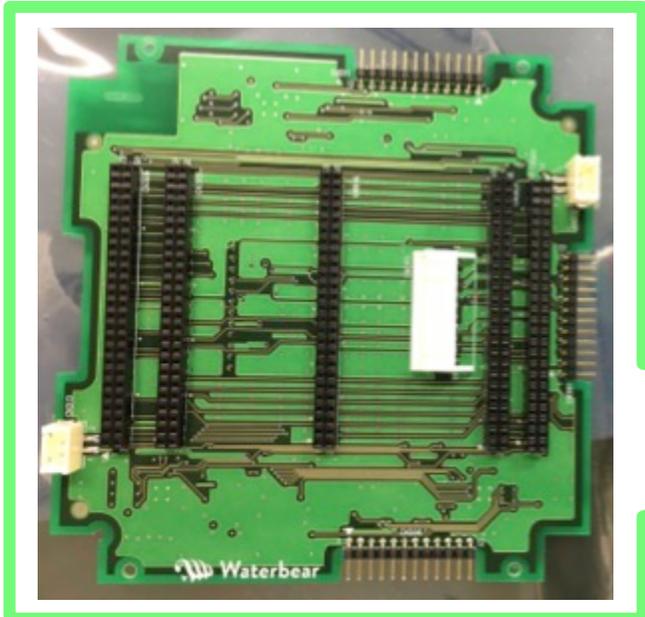
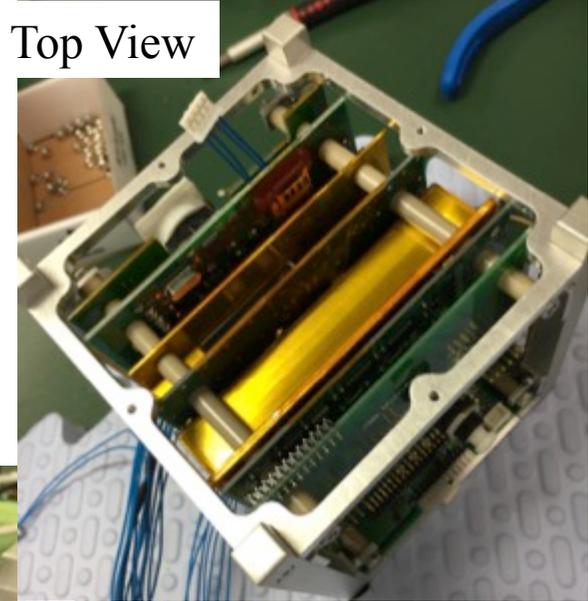
Main board and Backplane Designed by Sagami Tsushin Co.,Ltd



System Configuration



Top View



- Front Access Board
- OBC/EPS/COM Board
- Battery box
- 1200bps/ 9600bps TX
- Mission Board
- Antenna Board

- © Take photograph of homeland via onboard cameras (CAM)
Using 2 Cameras (SCAMP at 0.3MP, OV5642 at 5MP).



- © Digi-singer Mission (SNG)
Exchange of voice data from satellites to Ham Radio receivers (UHF band)



- © Measure Single Event Latch-up in orbit (SEL)
By taking log of microcontroller reset events over period of time.





Missions; Ground based Missions



© Determination of Satellite Precise Location (POS) without GPS

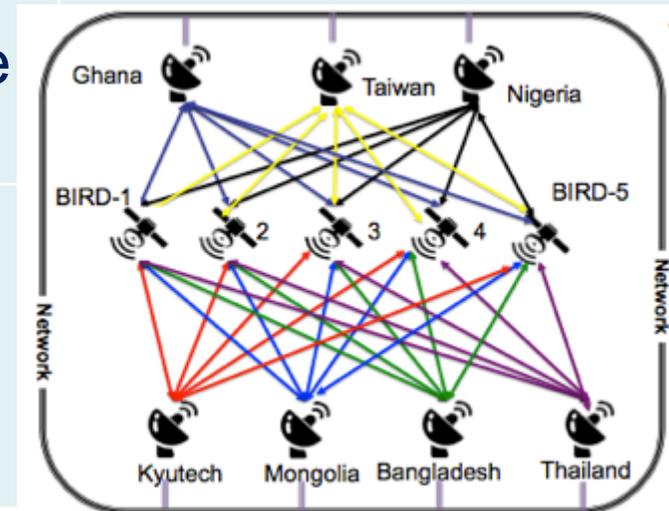
Using analysis of TOA from time lag among multiple ground stations



© Atmospheric Density Measurement (ATM)

Using Orbital analysis from precise satellite tracking information (POS).

© Demonstrate Ground Station Network for CubeSat Constellation (NET)





■ BIRDS Project Partner Nations

5 units of 1U CubeSats operated from 7 UHF/VHF ground stations

First time in the World!

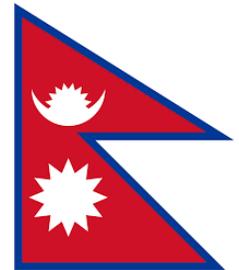


Strategy for sustainability



- BIRDS program aims at **fostering university space programs in non-space faring countries.**
- Often a **national space program suffers disruption because of political and economical disturbance.**
- **University space program is immune to the external disturbances.**
- To start with the **minimum budget**, a university is an ideal place.
 - CubeSat chosen as a training platform for affordability enough at university budget level.
- The university **space program cannot grow forever.**
 - Need to hand over the national space program to the government or companies.
 - University continue to support the program and provide human resources.

- Human network
 - Formed during intensive two years project by “living under the same roof”
 - Assist the infant space programs survive the hard time
- Ground station network
 - The backbone of the inter-university network
 - Enable constellation operation in future.
 - Space research using a small satellite constellation generating scientific outputs



The BIRDS CubeSats



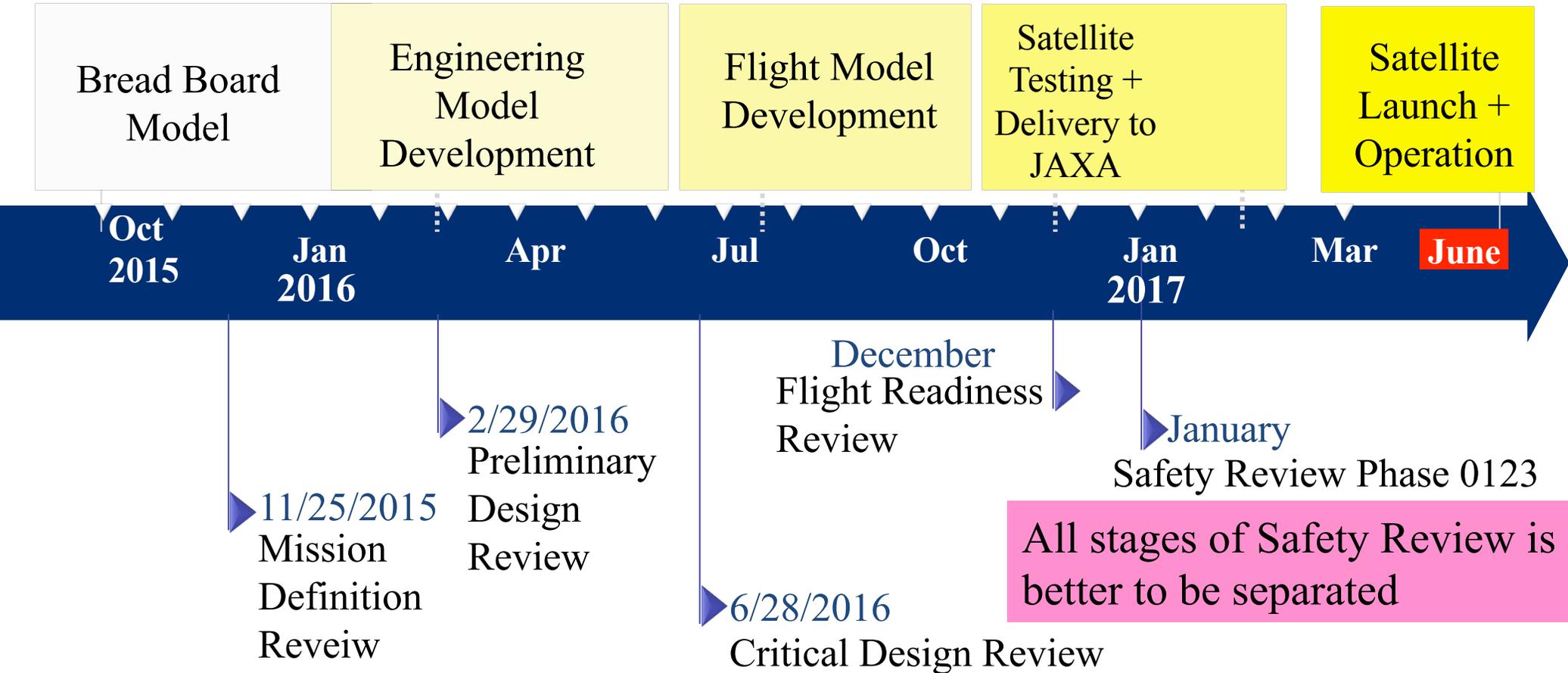
Multi-spacecraft manufacturing using **lean concept** to **reduce waste** and focus on activities that **add values** to the manufacturing process.



Project schedule

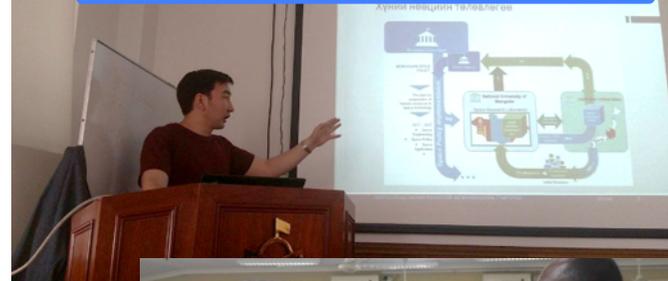
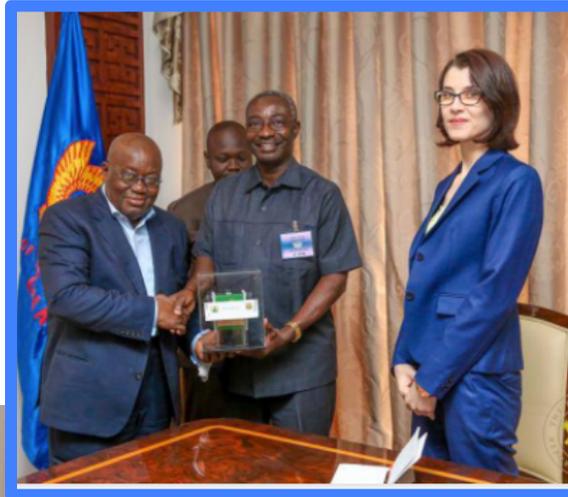


Project timeline fit into 2years which is appropriate for a graduate student Master degree



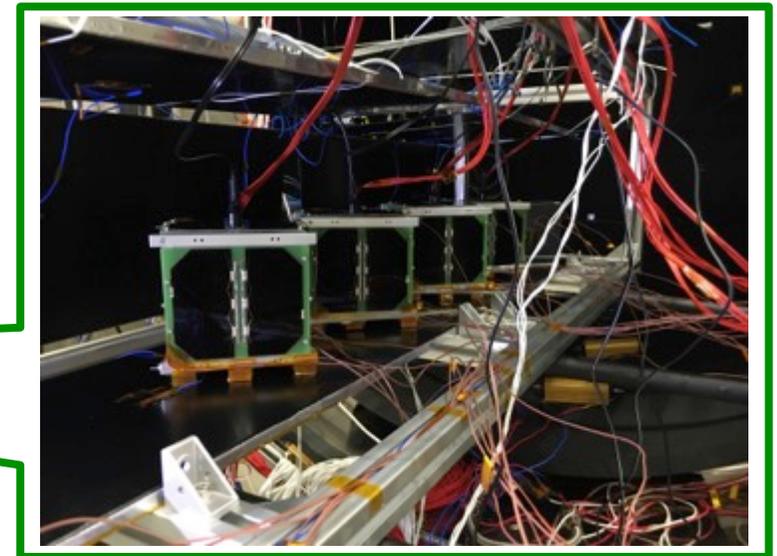
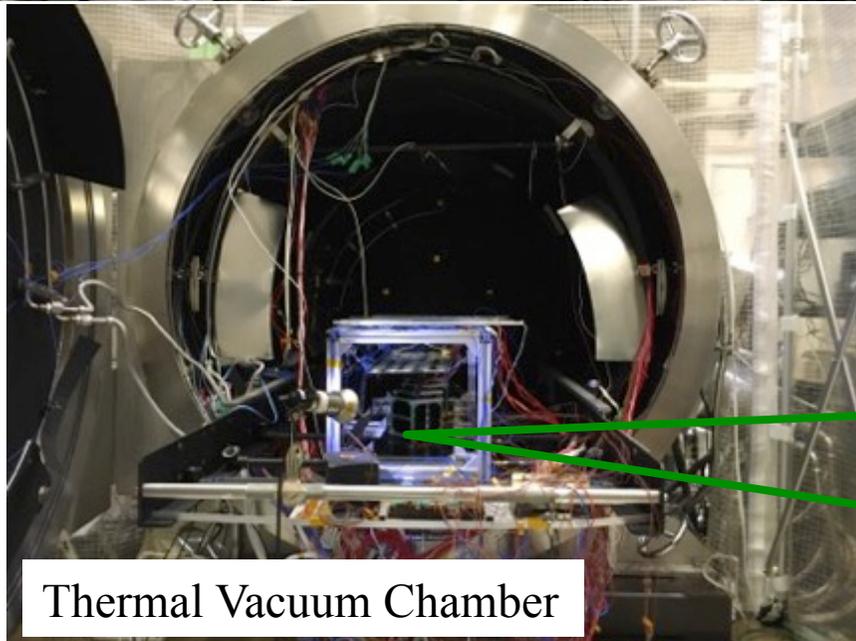
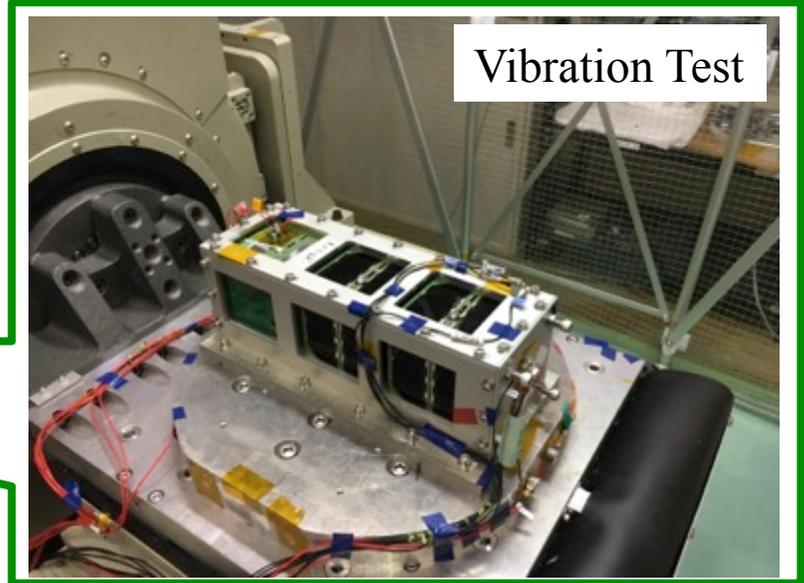


Outreach Activities





Environment Testing





GEDC-Airbus Diversity Award



AIRBUS

GEDC
GLOBAL ENGINEERING DEANS COUNCIL

↗ 45 ENTRIES	🌍 18 COUNTRIES
🌐 18 NATIONALITIES	🏛️ 41 UNIVERSITIES/ ORGANISATIONS

UNESCO
United Nations
Educational, Scientific and
Cultural Organization

Under the patronage of
UNESCO

BIRDS Satellite Project won the 2017 Global Engineering Dean Council, Airbus Diversity Award for Engineering Education.



Concluding Remarks



- © BIRDS-1 Satellite Project is undertaken by **15 students from 6 countries** (Japan, Ghana, Mongolia, Nigeria, Bangladesh and Thailand).
- © **Lean Satellite project concept** is used in the development of the CubeSats.
- © **The 5 CubeSats were launched into the ISS on June 4th (JST) and deployment to space on July 7th, 2017**
- © **Participating students from developing countries shall return home and start a sustainable space program.**
- © BIRDS-2 kicked off in October 2016 with Philippines, Bhutan, and Malaysia. BIRDS-3 started in October 2017 with Nepal & Sri-Lanka.

Thank you for your attention



Joint Global Multi Nation Birds

<http://birds.ele.kyutech.ac.jp/>