



My evolution from ISU 3Is to BIRDS Program, a Cross-Border Inter-University Collaboration on Space Research and Education

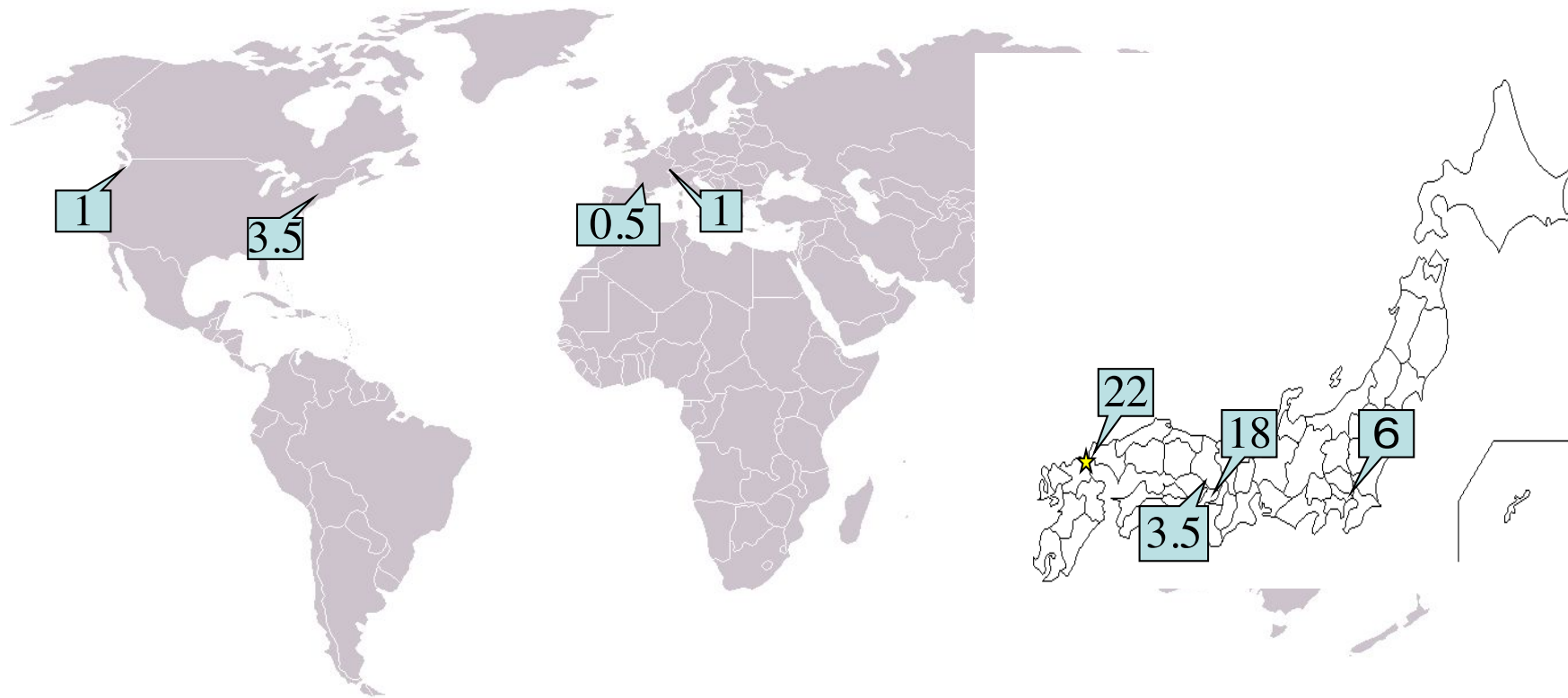
Mengu Cho

Laboratory of Spacecraft Environment Interaction Engineering
Kyushu Institute of Technology, Kitakyushu, Japan

November 19, 2018

6th UNISEC Global Meeting
International Space University, Strasbourg, France

Who am I?



Places I lived before and their years

Born in Osaka, Japan

Graduated from

- Department of Aeronautics, Univ. Tokyo (B & M)
- Department of Aero & Astro, MIT (D)

Worked at Kobe University as a Research Associate after getting Ph.D.

A typical university person thinking of his/her own research fields only

Very bad year (1995)



Big earthquake at Kobe

<https://twitter.com/hashtag/阪神大震災>



Chemical weapon terrorist attack at Tokyo subway

Credit: Asahi Shibun

Above all, I lost my job at Kobe University

So, I went to France



International Space University

- There was a job advertisement at *Aviation Week & Space Technology* looking for “Teaching Associate” at International Space University
- Desperate for finding a job, I applied and got an offer
- Moved to Strasbourg in July 1995 to work on launching the Master of Space Studies (MSS) program



ISU was
located here



Small annex building

ISU MSS

- After the successful SSPs (Summer Session Program, 10 weeks) since 1988, ISU decided to have a permanent campus and one-year Master program, MSS (Master of Space Studies) from 1995
- First class started with 30 students from 14 countries in September 1995
 - Canada, US, France, Germany, Italy, Spain, Portugal, UK, Austria, Kenya, Algeria, Japan, Malaysia, Australia
- My job was to teach how a rocket flies to non-engineers, e.g. lawyers, writers, and others
- ISU 3Is
 - International
 - Intercultural
 - Interdisciplinary



What I learned at ISU

- After working one year, I left ISU in July 1996.
 - I had an offer of Assistant Professor from a Japanese university
- But in one year, I learned
 - There are many types of people in the world.
 - Even if the culture is different, there are people of the same type
 - English fluency is important in discussion. But making points and making others understand are more important.
 - Diverse minds are important. Engineer's mind alone cannot solve problems
 - Teamworking is important. Those who work for the team are respected by members.
- These could never been learned if I were working in an ordinary university

I left France and went back to Japan



Kyushu Institute of Technology (Kyutech)



- 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



My work at Kyutech (1996~2008)

- I restarted my career as an ordinary university person at Department of Electrical Engineering
- Research on
 - Spacecraft Environment Interaction, especially spacecraft charging

Kyushu Institute of Technology

Laboratory of Spacecraft Environment Interaction Engineering (LaSEINE)

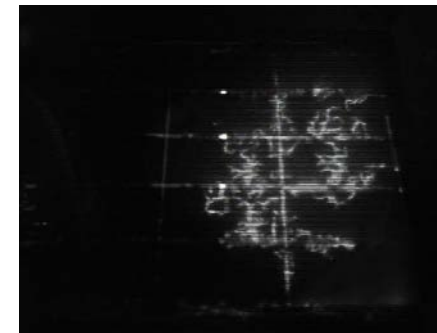
Original research themes

- Inauguration: December 2004

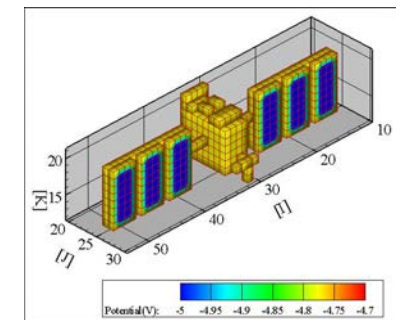
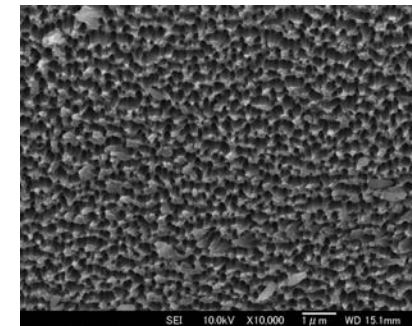


Initial members

Spacecraft charging



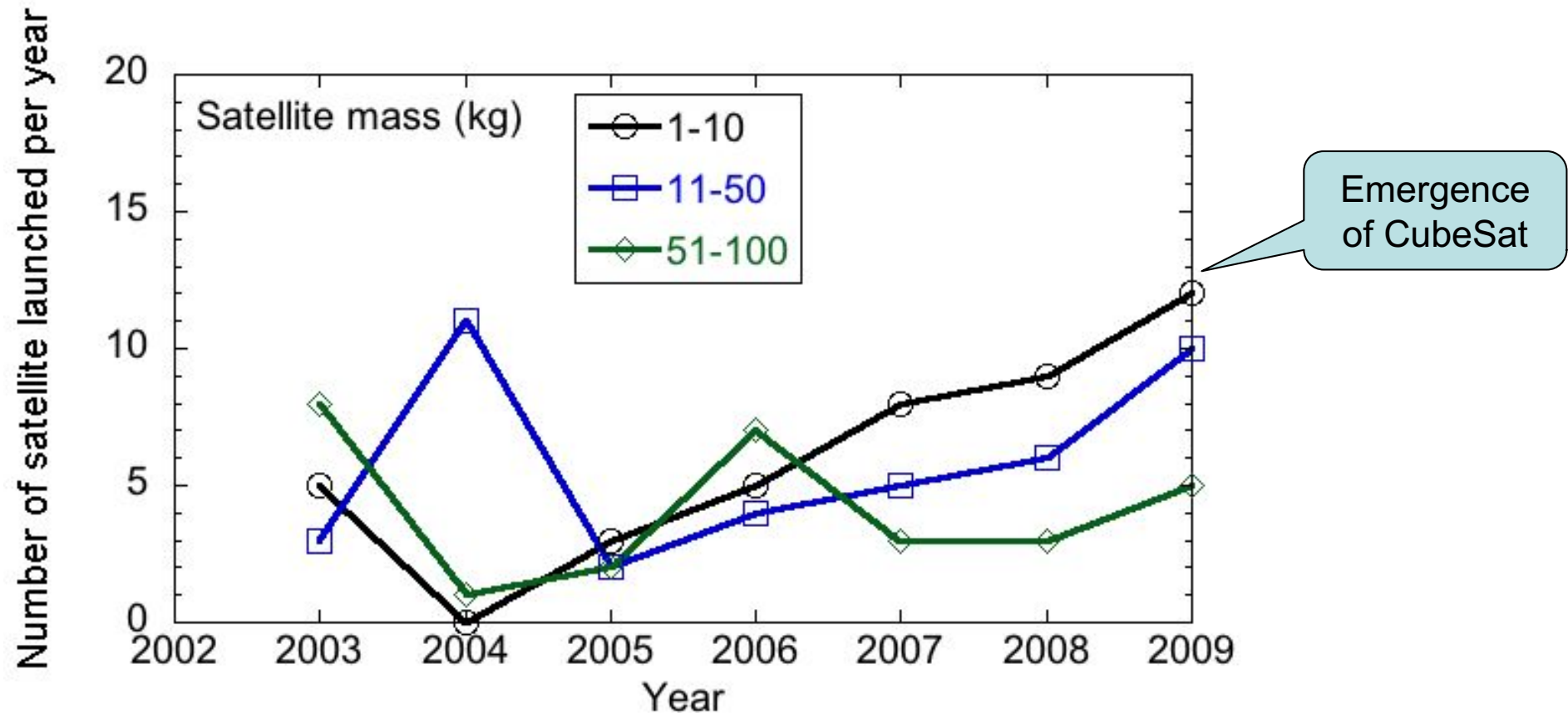
Debris



Material degradation Charging simulation

Emergence of small satellites

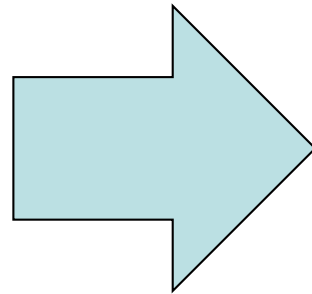
Number of small satellites launched worldwide per year



- Satellites affordable even to universities, small business, developing/emerging countries
- Interest in capabilities for basic space technology development

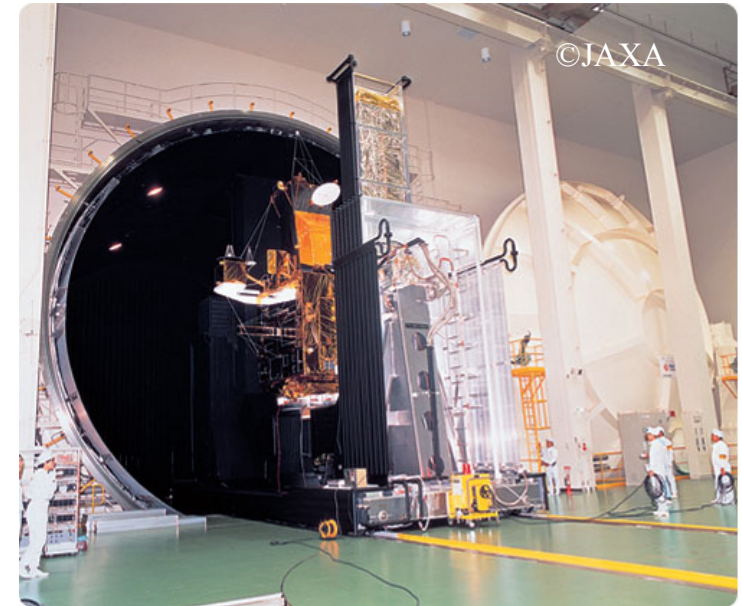
Needs of test facilities

Nano-satellite



Can we test here?

Probably not

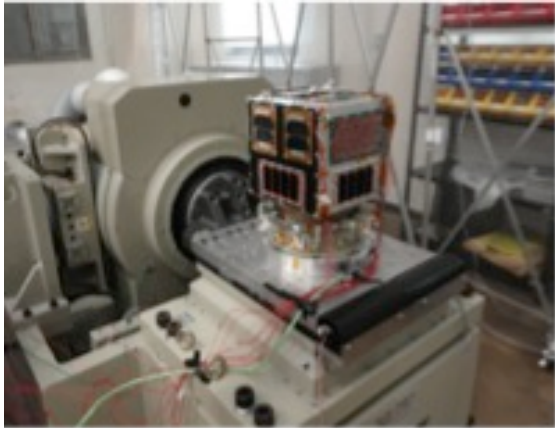




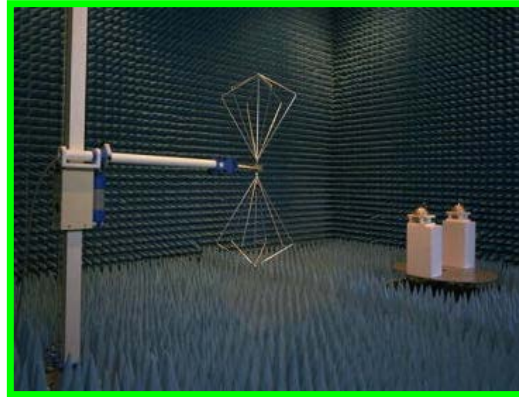
Center for Nanosatellite Testing



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



Vibration



EMC & Antenna pattern



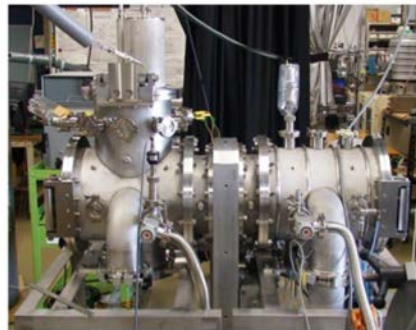
Pressure & Leak



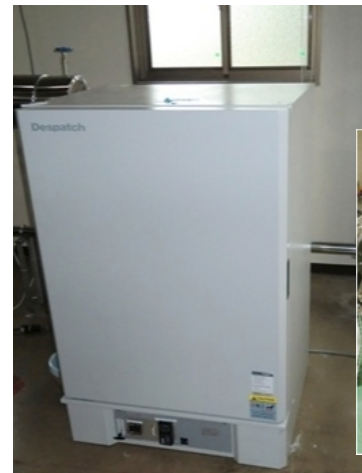
Thermal vacuum



Assembly & Integration



Thermal vacuum



Thermal cycle



Shock



Outgas
(ASTM E595)



α & ϵ measurement

Preparation started in 2008. Launched officially in 2010



UN/Japan Long-term Fellowship Programme



- Presentation of UN Basic Space Technology Initiative (BSTI) at 27th International Symposium on Space Technology and Sciences, Tsukuba, Japan (2009)
 - Called for a partner to host a long-term fellowship programme for basic space technology capacity building
- Kyutech and UNOOSA began developing fellowship programme



Dr. Werner Balogh
(MSS 96)



Breakfast next morning



Demands for Space Capacity Building



- Small satellite is an ideal entrance for developing countries to join the space sector
- Demands for capacity building through small satellites
- Various training programs via agencies, companies and universities in space faring countries
 - Often tied with sales of big/medium satellites
 - Not successful, especially if the training is done in agencies or companies
 - Lack of hands-on experience
 - Not covering the entire system life cycle of satellite
- Key points
 - Experience the **complete cycle** of designing, building, testing and operating through **hands-on**
 - Strategy for **sustainability** after the training



UN/Japan Long-term Fellowship Programme



- 2010: Doctor on Nano-Satellite Technologies (DNST) initiated at Kyutech
 - 2 Doctoral students selected per year
 - Kyutech provides financial support
- Objective
 - Provide hands-on experience necessary to build capabilities in basic space technology, especially infrastructure building through research and testing of nano-satellites
- Very competitive
 - 20x competition for 2 slots



Kyutech visit to UNOOSA (2011.2)



PNST



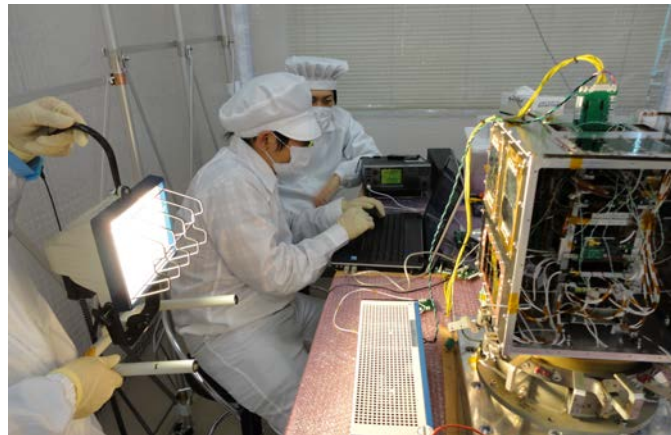
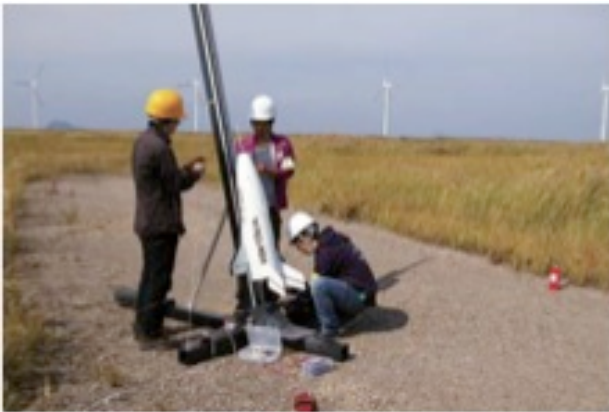
- Based on the success of DNST, Kyutech applied for MEXT (Ministry of Education, Culture, Sports, Science and Technology) fellowship priority program in 2013
- 2013: [Post-graduate study on Nano-Satellite Technologies \(PNST\)](#)
 - 2 Masters students selected per year
 - 4 Doctoral students selected per year
 - Covered by MEXT fellowship (tuition, living, airfares, etc.)
- The MEXT priority program mandated Kyutech recruiting the same number of non-MEXT scholarship students
 - Enrollment of 12 students every year expected including Master course students who required extensive coursework
 - Needs of English-based post-graduate program



Space Engineering International Course (SEIC)



- 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





PNST/SEIC students



Fiscal Year	PNST				Non-PNST enrollment to SEIC	Foreign students enrollment total	Japanese students enrollment
	Application			PNST Enrollment			
	Number of countries	Web registration	Application documents submitted				
2013	28		83	5	4	9	10
2014	55	509	69	6	4	10	5
2015	44	156	45	6	17	23	9
2016	52	386	71	6	10	16	10
2017	98	1439	128	6	7	13	11
2018	55	338	94	5	8	13	13
Total				34	50	84	58

84 foreign students enrolled in 6 years

Application for 2019 PNST scholarship is now open.
Deadline is January 20, 2019. Google “PNST BSTI”



Comparison with MSS

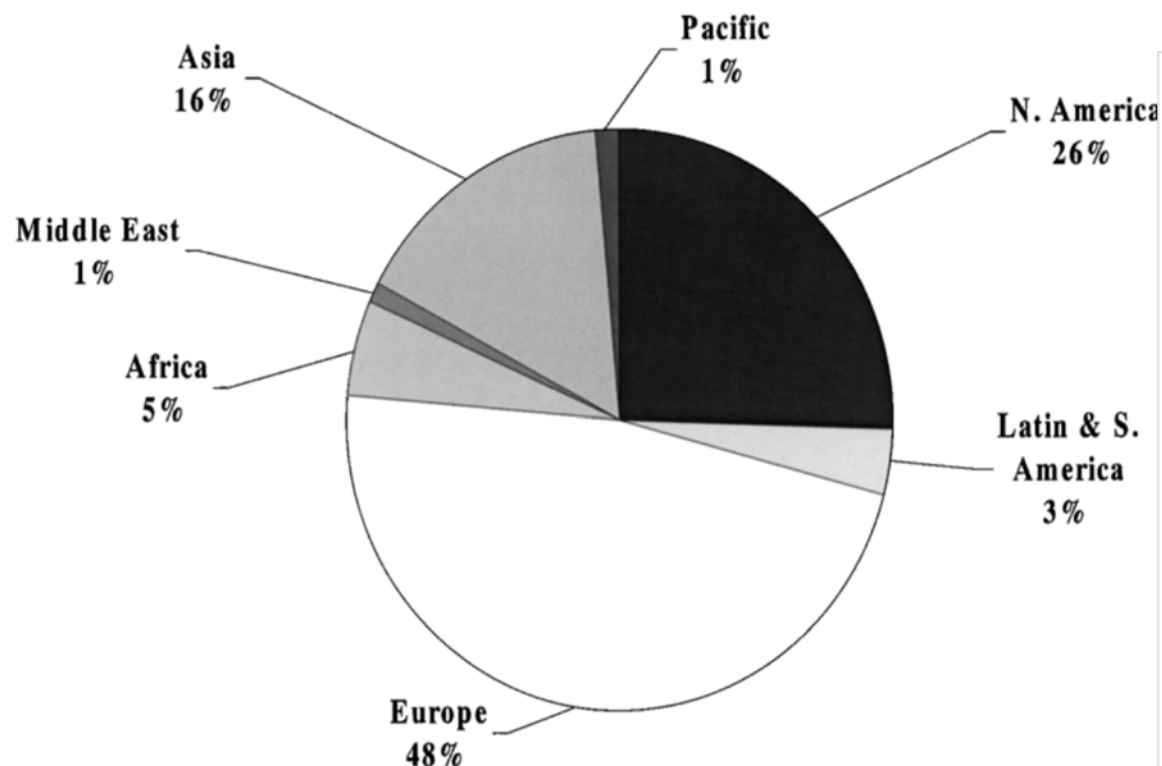
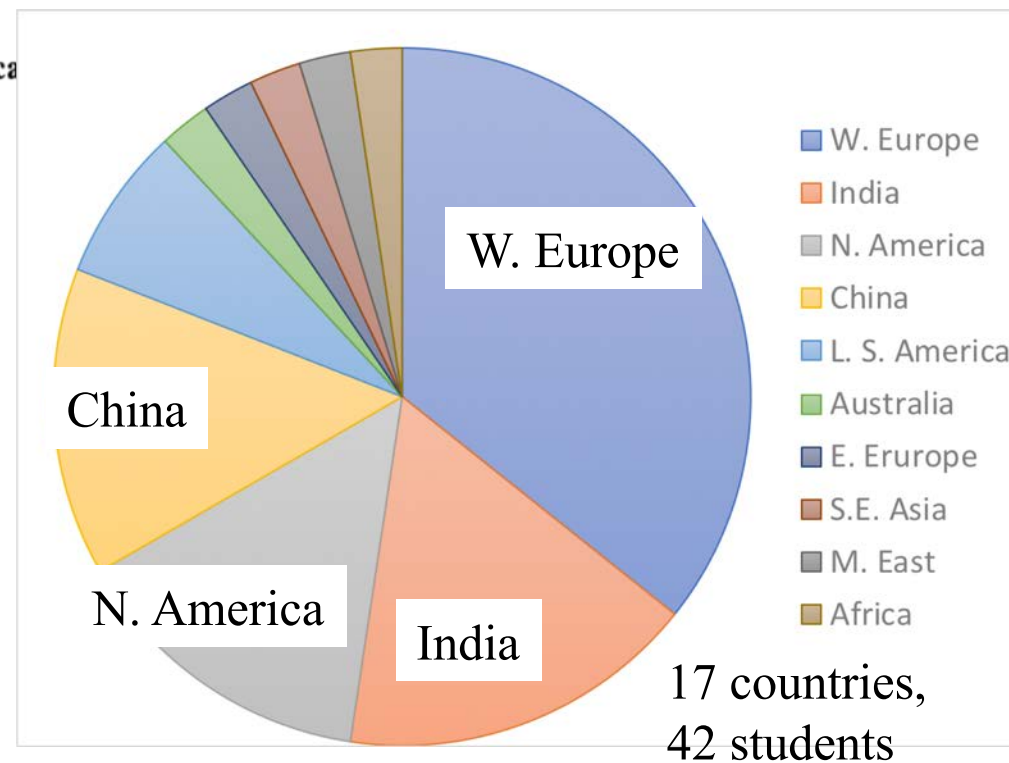


Fig. 2 Where ISU Students Came From: 1998–2001.

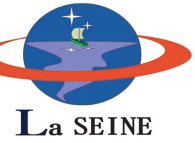
From Yasunori Fujimori, 2001



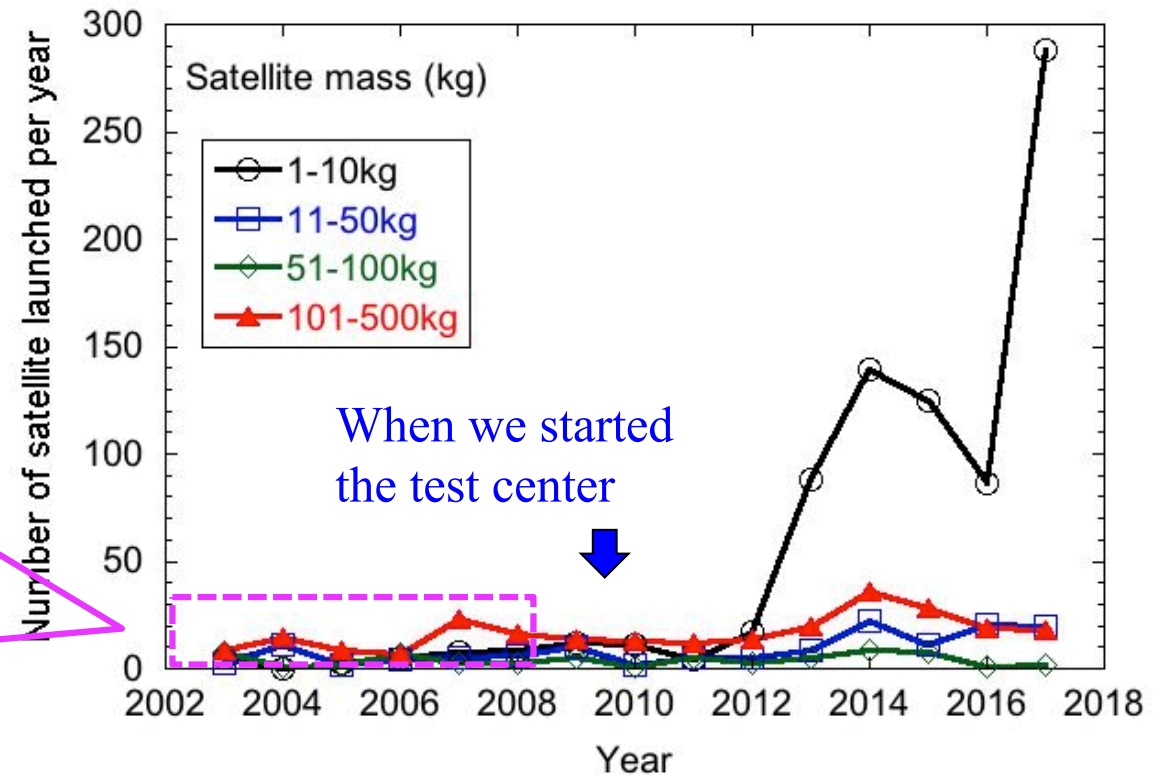
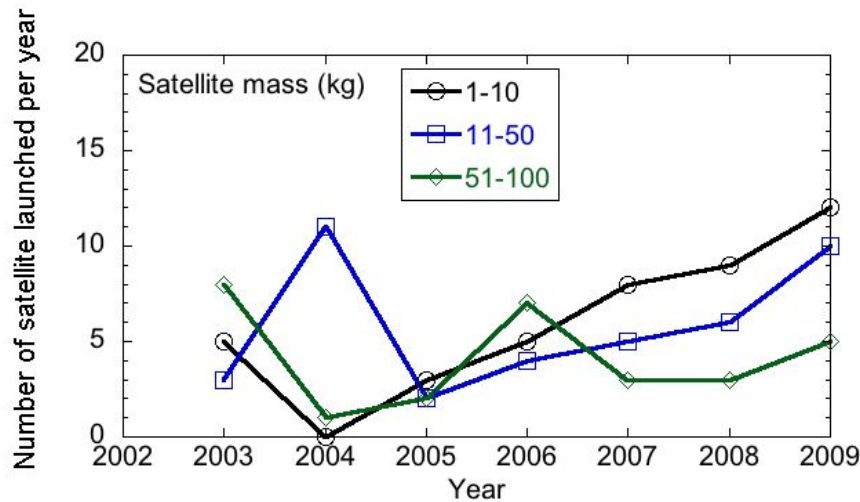
MSS 2018 students distribution



Growth of Small Satellite Activities Worldwide

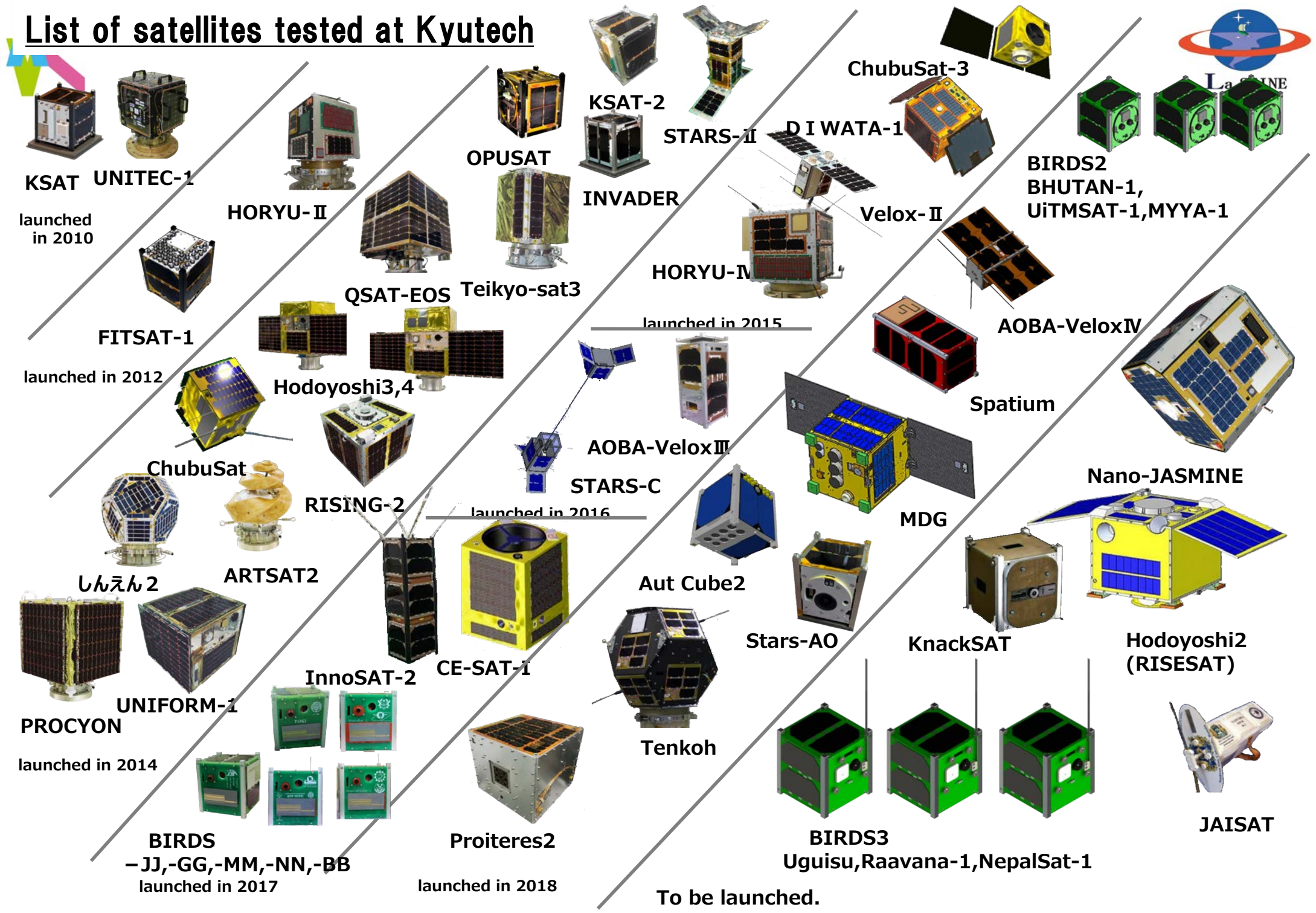


Number of small satellites launched worldwide per year



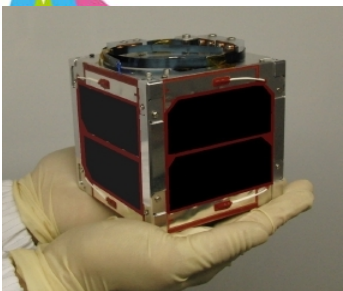
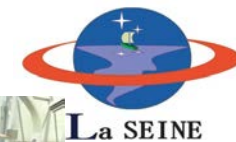
Source: Kyushu Institute of Technology

List of satellites tested at Kyutech

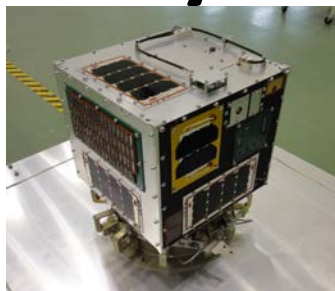




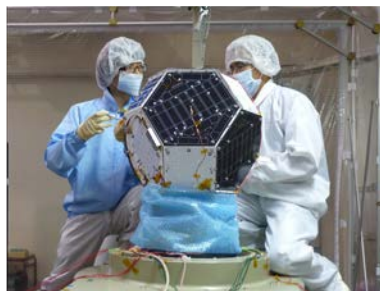
Kyutech Satellite Heritage



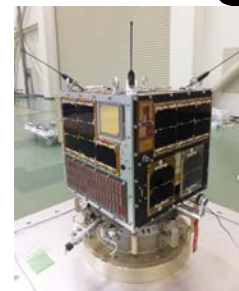
HORYU-1 (1U)
2006-2010
Not launched



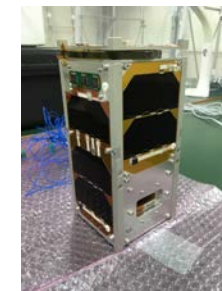
HORYU-II
2010-2012
Launch 2012/5/18



Shinen-2
2013-2014
Launch 2014/12/03



HORYU-IV
2013-2016
Launch 2016/02/17



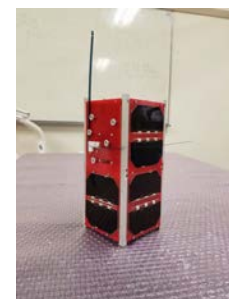
AOBA VELOX-III
2014-2016
ISS Release 2017/01/19



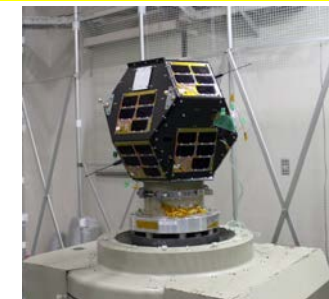
BIRDS-I constellation
2015-2017
ISS release 2017/07/07



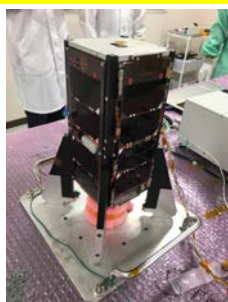
BIRDS-II constellation
2016-2018
ISS release 2018/08/10



SPATIUM-I
2016-2018
ISS release 2018/10/06



Ten-Koh
2016-2018
Launched 2018/10/29



AOBA VELOX-IV
2016-2018
Launch 2018



BIRDS-III constellation
2017-2019
Launch 2019

- In total, 14 satellites were launched (No.1 in Japanese universities)
- 4 more will be launched by the end of 2019



HORYU-IV Project



Launched on Feb. 17, 2016



44 members from 18 countries
First and second generations of PNST/SEIC students



BIRDS Program



Satellite program for non-space faring countries

Mission Statement

By successfully building and operating the first national satellite,
make the foremost step toward indigenous space
program at each nation.

BIRDS-I (2015-2017)

JAPAN



GHANA



MONGOLIA



NIGERIA



BANGLADESH



BIRDS-II (2016-2018)

JAPAN



BHUTAN



MALAYSIA



PHILIPPINE



BIRDS-III (2017-2019)

JAPAN



SRI LANKA



NEPAL



BIRDS-IV (2018-2020)

JAPAN



PARAGUAY



PHILIPPINE





Program features



- 1U CubeSat constellation of
 - BIRDS-I: 5 satellites by **Bangladesh***, **Ghana***, Japan, **Mongolia***, and Nigeria
 - BIRDS-II: 3 satellites by **Bhutan***, Malaysia and Philippine
 - BIRDS-III: 3 satellites by Japan, **Sri Lanka*** and **Nepal***
 - BIRDS-IV: 3 satellites by Japan, **Paraguay*** and Philippine
- Made by students at Kyutech
- 2 years from concept design to disposal
- Released from ISS
- Network operation by multiple ground stations

** First satellite for the country*



Group photos of BIRDS-I, –II and –III teams



Educational aspects



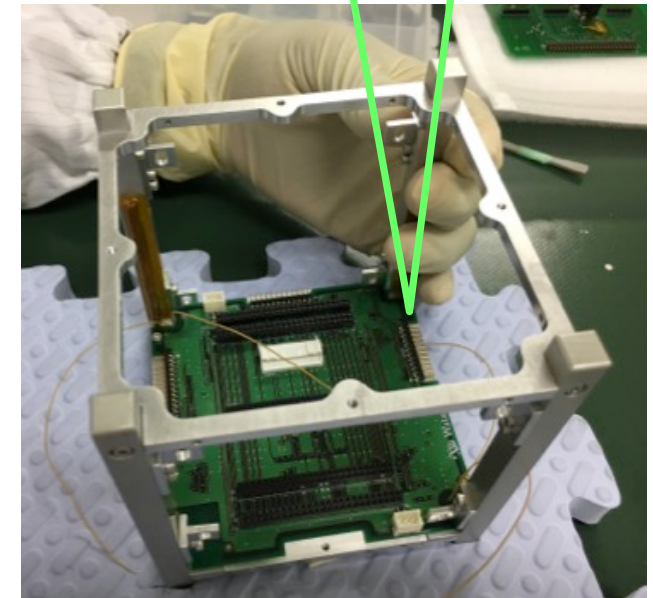
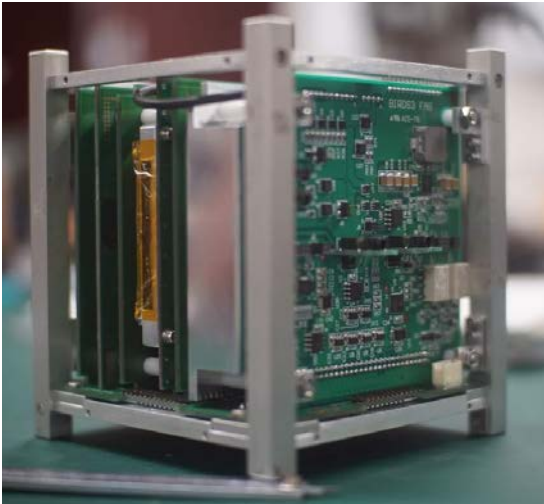
- A short-term goal
 - Build and operate satellites
 - Give the students **confidence** that they can do it
- Long-term goal
 - Students initiate their own space program in home countries
 - The full mission success
 - **The former students successfully build and operate the second satellite in their home countries**
- Let students learn the entire **processes** of a satellite project from beginning to end
 - Witness each decision process and make decisions by themselves
- Fit the project within the degree timeline. 2 years longest
 - Selected 1U CubeSat and ISS launch as a platform



Design and Configuration

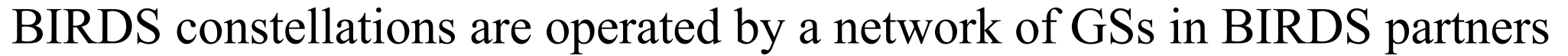


- Each satellite has the same design (per generation)
- Harnessless design
- Each satellite uses the same frequency



Easy assembly and disassembly

The satellite was designed to make the development time short₂₉





BIRDS partners

- Most of the BIRDS partners are universities
- Each partner who owns a satellite pays
 - Launch cost
 - Hardware cost
 - Student cost (at least two students sent to Kyutech)
 - Ground station cost in each country
- Each partner is committed to initiate space education/research program
 - BIRDS graduates form its core



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.
 - Affordable 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
- Even after handing over the big projects to the outside body, the university still can continue its own space research and education
 - Need to provide the human resource to the national space program



BIRDS Network



- Made of BIRDS partners
- 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



Cross-Border Inter-University Collaboration on Space Research and Education



- Mission
 - “To advance the peaceful use of outer space for the benefit of humanity by using a network of universities conducting space research and education”
- Each member institution of the BIRDS Network (BIRDS partners) will launch its own space research and education program.
- Annual workshops
 - Japan (2016), Ghana (2017), Mongolia (2018), Bangladesh (2019) and so on...



BIRDS workshop 2017 @Ghana



BIRDS workshop 2018 @Mongolia



BIRDS-I



Satellite delivery on February 8, 2017



Launched successfully to ISS on June 4, 2017



BIRDS-I



Released successfully to orbit from ISS on July 7, 2017



VIPs at JAXA Tsukuba Space Centre

Heard beacon signals from all the five satellites



GEDC Airbus Diversity Award



BIRDS-I project
manager, Tejumola
Taiwo (Nigeria)
Now at ISU

BIRDS project won 2017 GEDC (Global Engineering Deans Council) Airbus Diversity Award out of 45 entries from 18 countries as a successful example of **using diversity to effectively conduct engineering education**



BIRDS-II



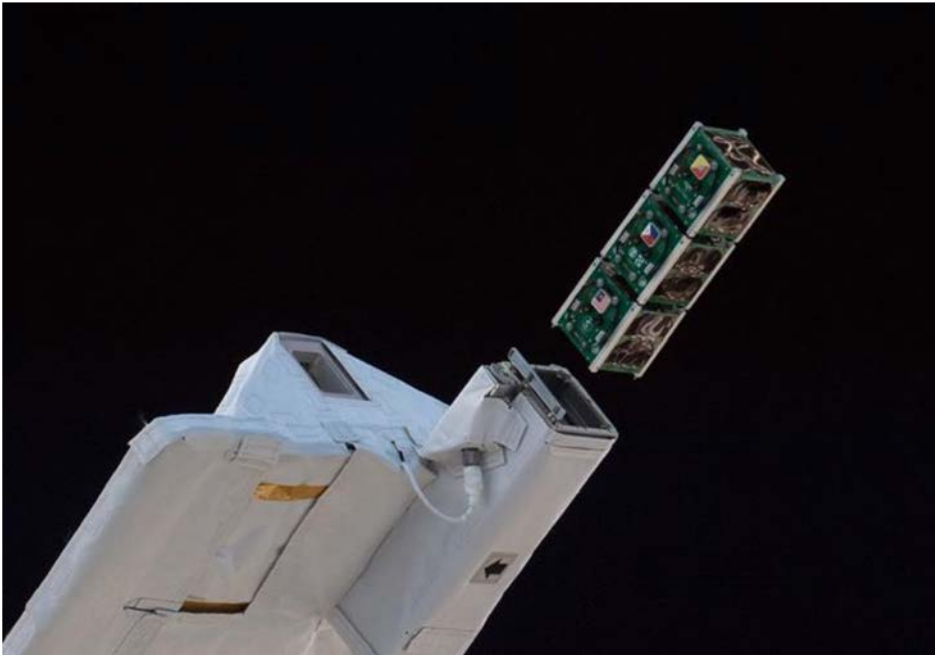
Satellite delivery on May 17, 2018



Launched successfully to ISS on June 29, 2018



BIRDS-II



Released on Aug.10, 2018



Signal was received on Aug.10, 2018



BIRDS-III and BIRDS-IV



- BIRDS-III
 - Reflect lessons learned from BIRDS-I and -II
 - Currently FM assembly phase
 - FM completed in later 2018
 - Released from ISS in spring 2019
- BIRDS-IV
 - Kicked off on November 12, 2018
- We plan to continue up to BIRDS-V



Engineering Model of BIRDS-III



BIRDS project 10 rules



1. **No Excuse**
2. **Be on time**
3. **Respect others**
4. Be responsible
5. Watch schedule
6. Act as a team player
7. Have a long view
8. Be clean
9. Work hard
10. Have fun



Conclusion



- 3Is experience at ISU shaped my academic career, which is something different from an ordinary university person
- Small satellites (a.k.a. Lean satellites) have a possibility of bringing **diversity** to the space sector
 - Bringing *new talents, new ideas*, and *new money*
- BIRDS program is a unique capacity building program to foster space development and utilization capability in non-space-faring countries by
 - Making students experience the entire processes of a satellite project
 - Making networks to support the cross-border inter-university collaboration on space research and education
- The mission success criteria of BIRDS program
 - After graduation, students succeed in developing and operating **the second satellite in their home country**
 - BIRDS network will assist the infant space programs each other
- Collaboration with UNISEC-Global, ISU and other space educational institutions is very important