Old Space vs. New Space

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Presented in Kampala, Uganda
24 June 2019

The abstract of this talk

The peak of Old Space occurred in 1969 when the United States of America put a man on the surface of the Moon and return him safely to Earth. This year, 2019, is the 50th anniversary of that event. But what happened after the success of NASA's Apollo program? As many of you know, the public lost interest in space, and humanity's activities in space went into deep freeze for a long time. I am profoundly aware of that space "ice age" because I lived through it; I was born in 1959. However, a robust recovery is finally underway, since about 2005. This recovery is called by many as New Space. And it is very different from Old Space. I will discuss this revolutionary paradigm shift. And this shift is important to all of humanity. Because of New Space, all countries, including the country of Uganda, can participate in space. In a nutshell, New Space has vastly lowered the barriers to getting involved in space. Therefore, I hope your country will passionately embrace this golden opportunity to explore and to exploit outer space for your own national needs.

I will ask Mr Stephen Taabu to make this presentation available at the university website so that you can download the pdf version of it.

The world is changing.

Especially the world of rockets and satellites.

Old Space → New Space

It's a huge and dramatic change

A 2-ton satellite under development

Old Space was dominated by

- **Expensive rockets (over 100m USD per launch)**
- **Expensive satellites (over 250m USD each)**
- **Satellites that took 5 to 10 years to develop**

Result:

Only a handful of rich nations could afford to go into space

But during the past ten years that has dramatically changed . . .

. . . New Space has arrived

New Space

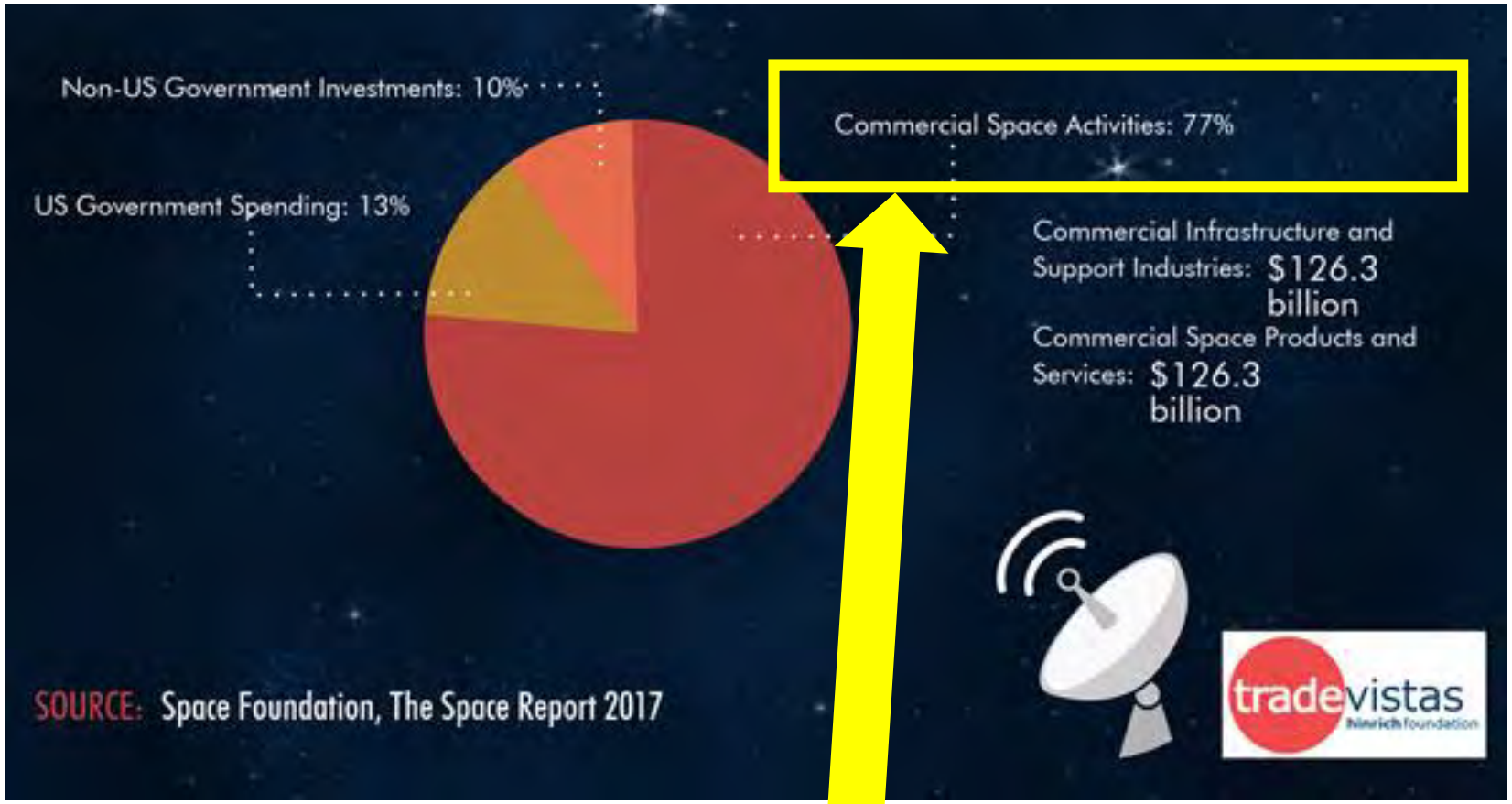
From Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/NewSpace

"**New Space** is a movement and philosophy encompassing a globally emerging private spaceflight industry. Specifically, the term is used to refer to a global sector of new aerospace companies and ventures working independently of governments and traditional major contractors to develop **faster, better, and cheaper** access to space and spaceflight technologies, driven by commercial, as distinct from political or other, motivations to broader, more socioeconomically-oriented, ends. "

So that is a key difference

Old Space was driven by government spending, both civilian and military.

New Space is driven by commercial investments – and so it can grow much much faster than government spending. ***The sky is the limit.***



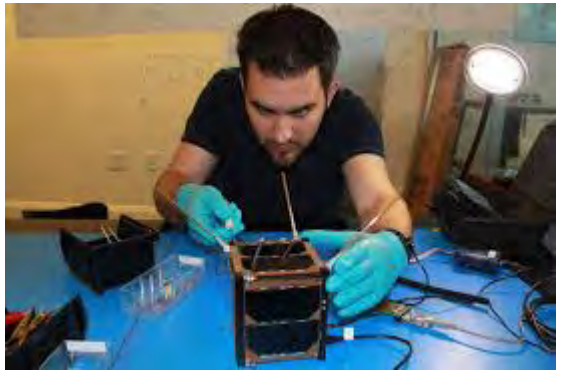
$329 billion in 2016

Gov't space budgets

NASA	**20 BILLION USD per year**
ESA	**7 BILLION USD**
JAXA	**2 BILLION USD**

THE GROWTH IS OCCURRING IN THE COMMERCIAL SECTOR

Spire, Inc., generates data for customers using small satellites



New Space is dominated by:

- **Satellites that can be developed in less than 2 years**
- **Cost less than a house**
- **Can be deployed as constellations**

They use low-cost launch methods. For example, this is a *Rocket Lab* launch in New Zealand for *Spire*.

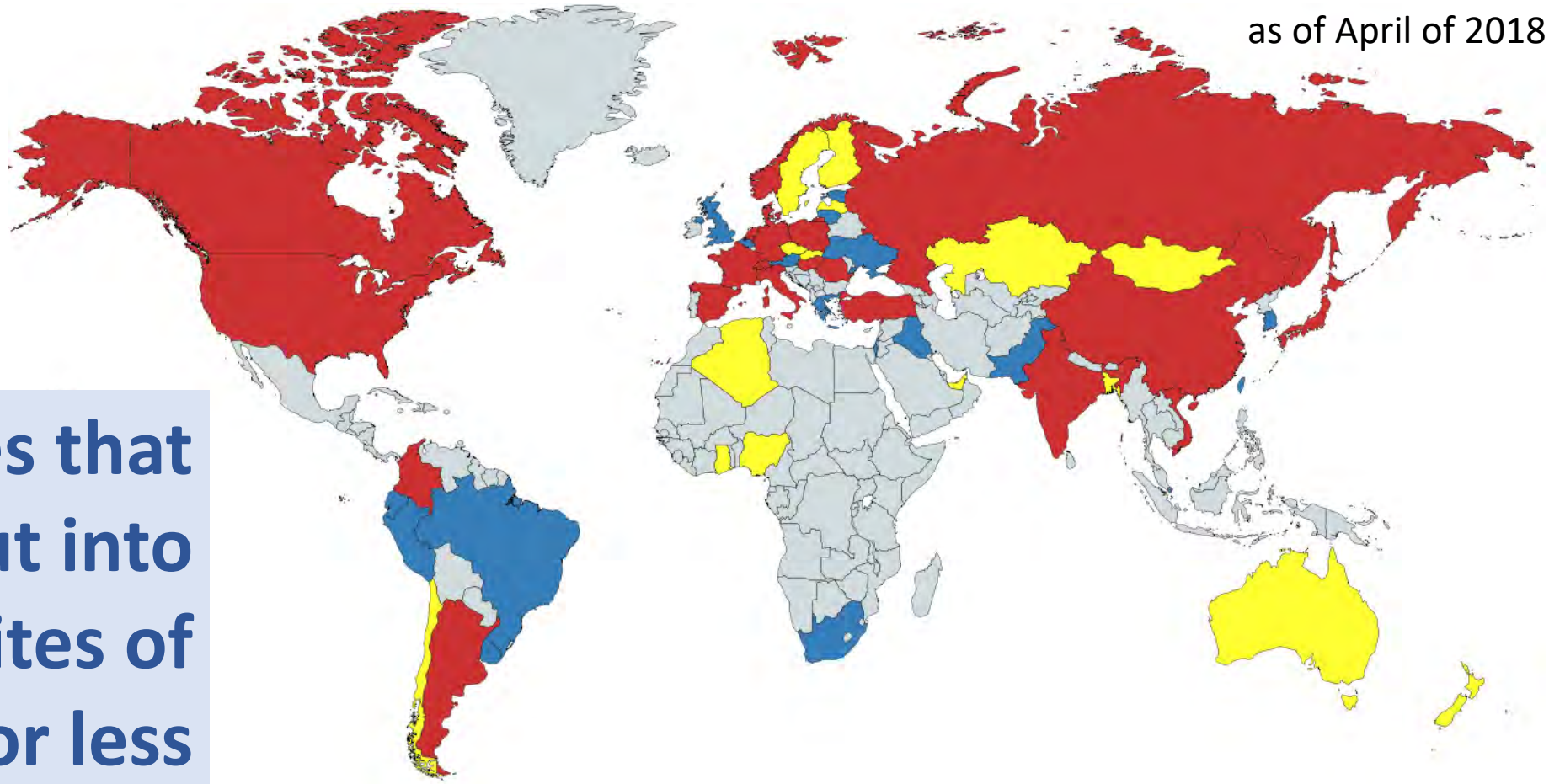
Result:
Any nation can become space-faring

Prior to 2012 (21 countries)

2013~15 (+18 countries)

2016~17 (+15 countries)

as of April of 2018



Countries that have put into orbit satellites of 10 kg or less

What enabled New Space?

There are many factors involved.

But one big factor is the technology used in smartphones.

Because of the volume (billions of units) of produced smartphones, the prices and the physical sizes of components (CPUs, memory chips, sensors, etc.) has fallen dramatically. This in part has enabled the birth of the modern CubeSat.

The Economist

Topics Current edition More

Jun 5th 2014

Nanosatellites

Nanosats are go!

Small satellites: Taking advantage of smartphones and other consumer technologies, tiny satellites are changing the space business

https://www.economist.com/technology-quarterly/2014/06/05/nanosats-are-go

Before discussing the **BIRDS Project**, I would like to mention four industry trends.

These trends come from this very expensive

2017

Executive Report

by Euroconsult

4000 Euros

Trend 1

Over the next 10 years, more than **6,200 smallsats** are expected to be launched

Trend 2

The smallsat market from 2017-2026 will be driven by the roll out of multiple constellations accounting for **70% of smallsats to be launched**, mainly for commercial operators.

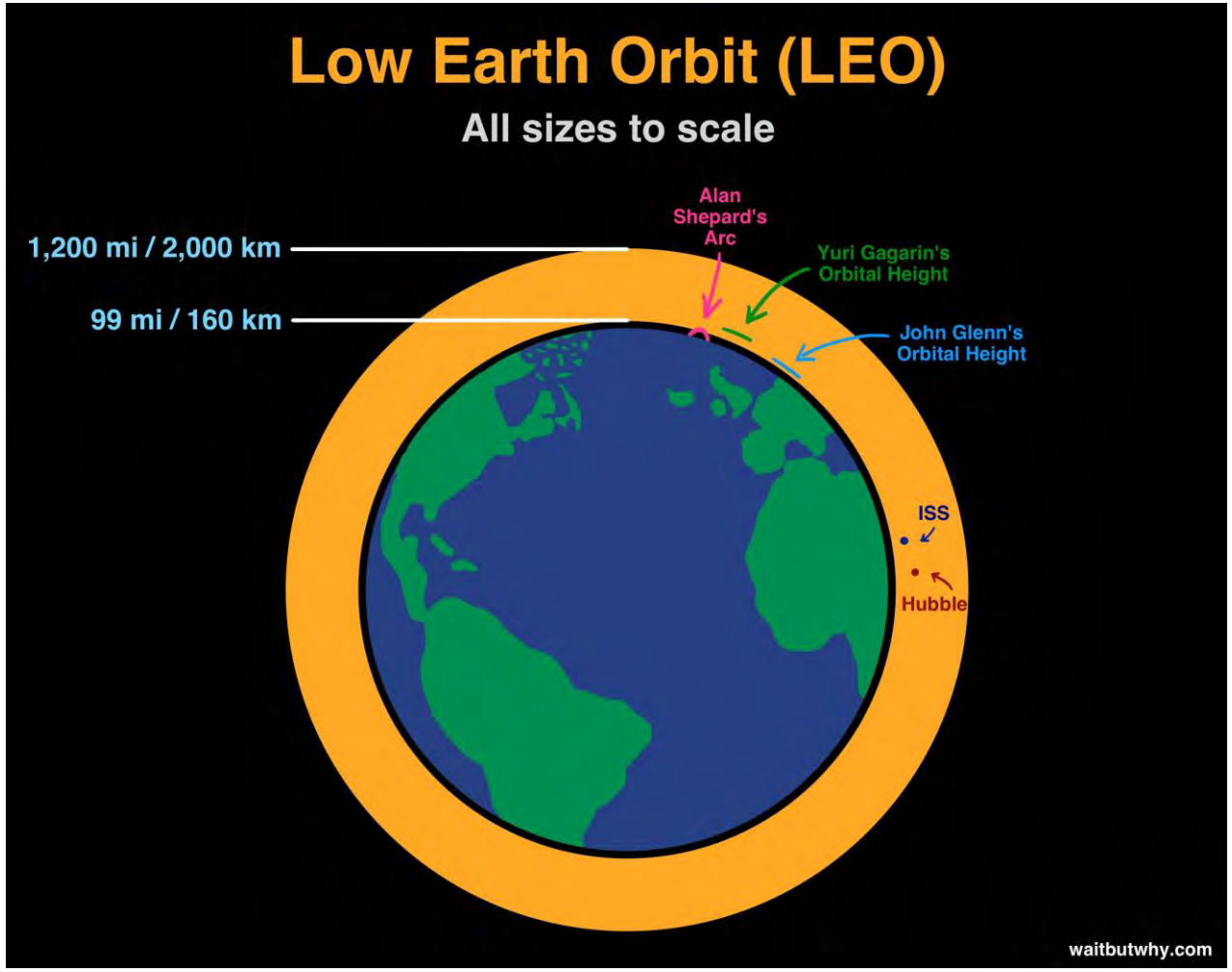
Trend 3

From 2007 to 2016, the total market value of these smallsats was $8.9 billion (including manufacture and launch) and could reach $30.1 billion in the next ten years.

Trend 4

Concerning destination, most smallsats (80%) will be launched into LEO.

Between 160 and 2000 km above Earth is LEO



https://28oa9i1t08037ue3m1l0i861-wpengine.netdna-ssl.com/wp-content/uploads/2015/08/LEO.jpg

Summary of Trends

The space sector is changing right now at a tremendous pace. Nearly all old assumptions are outdated today. During **Old Space**, space was limited to a handful of nations (USA, Russia, France, Japan, China, etc.).

But with **New Space**, it is a whole new ball game. Anyone can enter the space sector. My university helped Bhutan to build and launch its first satellite. Bhutan's population is only 700,000 – less than Uganda.

The thesis of my talk

Why Uganda should establish a space engineering laboratory

Space engineering at Kyutech

Location of your space engineering laboratory:

- Government,
- Academia, or
- Private Industry

Any one of the above should be considered

Purpose of the lab:

- Train engineers (Capacity Building)
- Develop your satellites
- Operate the satellites you have in space

To fully exploit space for national profit, it is necessary to design, build, test, and launch, your own satellites.

A BIG BAD COMMERCIAL SATELLITE

Buying satellites does nothing to develop your engineering workforce!

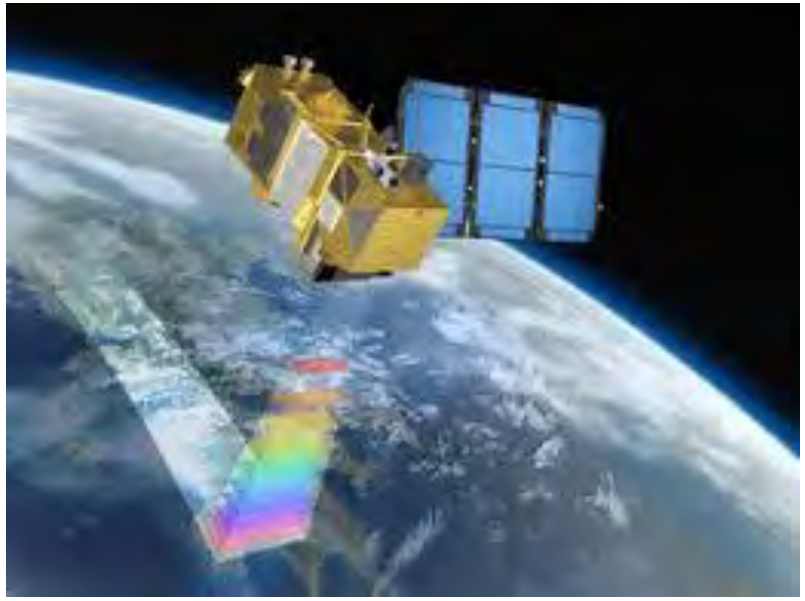
All problems are local

This slide is from Prof. Jordi Puig-Suari

Local Expertise
Problem and Solution ID

New Low-Cost Space Solutions

Problems of agriculture are all local

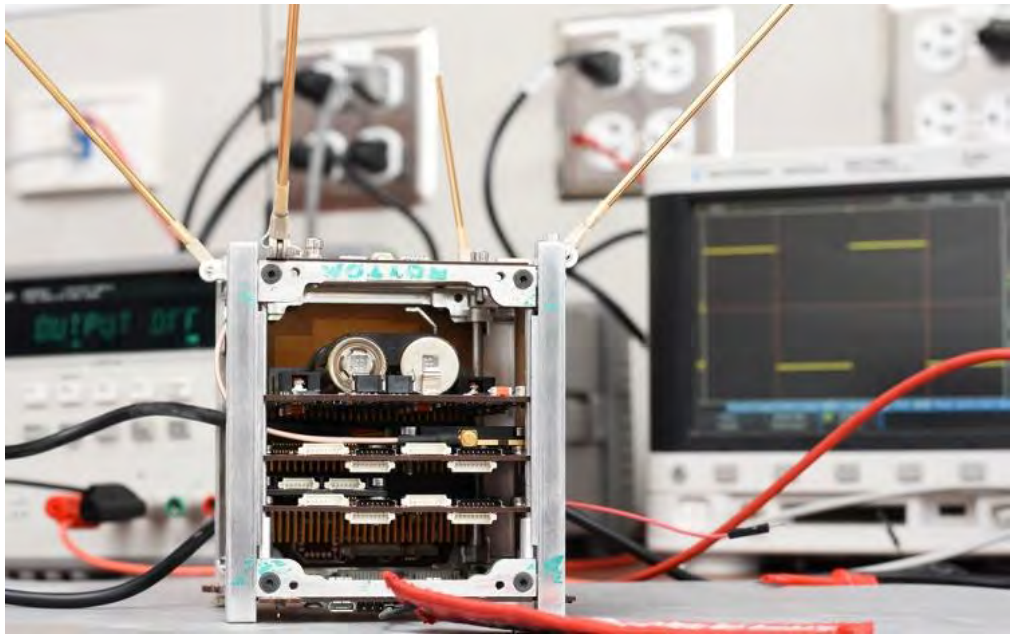


There is a huge amount of photographic data being created each day.

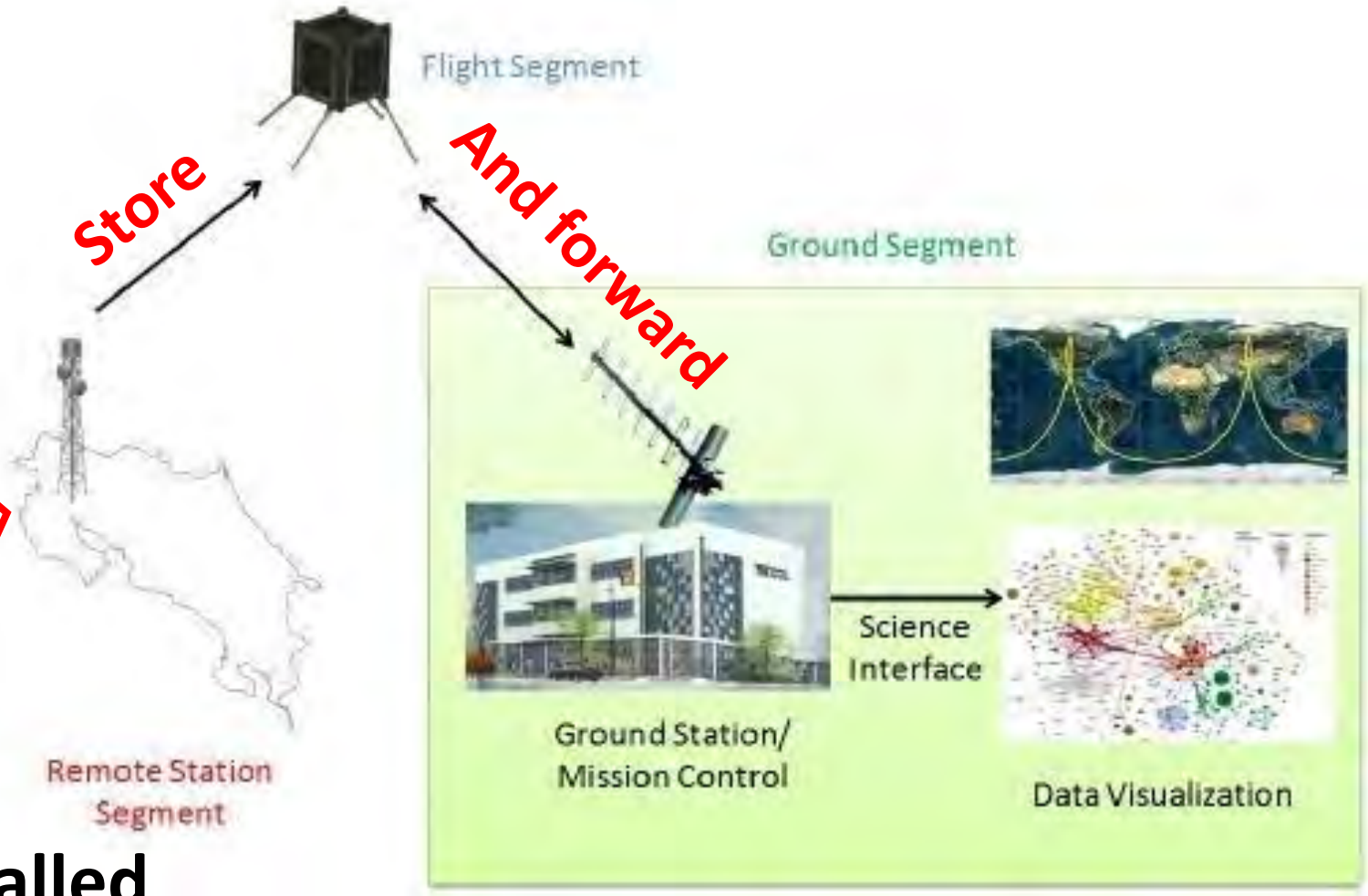
I do not recommend you make satellites that take photos. There is a lot of photographic data that is available on a commercial basis.

They are many more useful applications for small nations to consider

This is just one example. This is the example of **Irazu**, the first satellite of Costa Rica, which is a small nation in Central America.



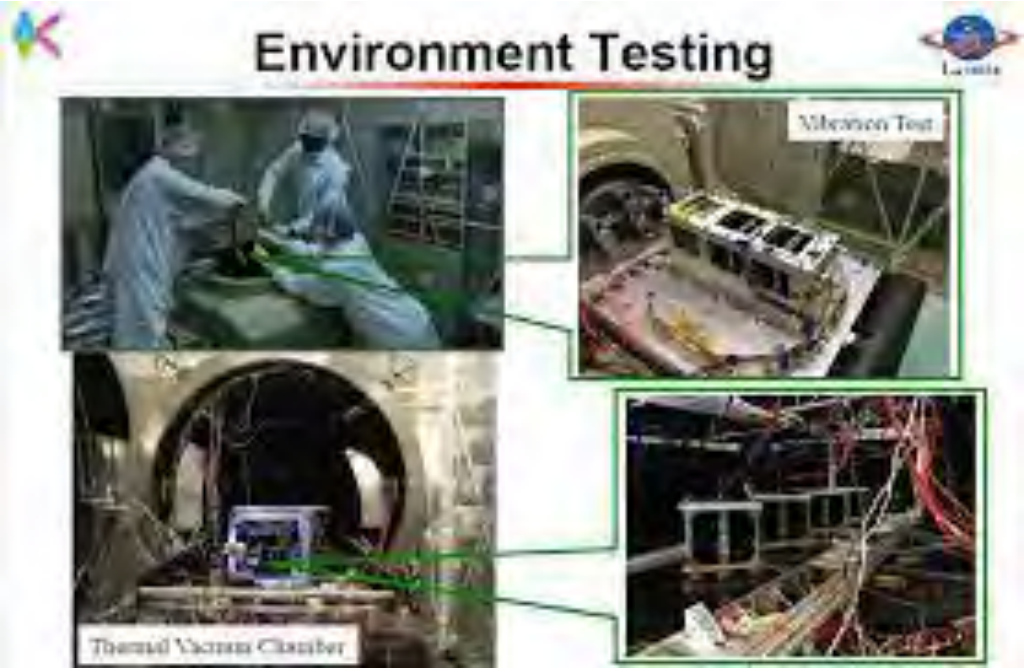
The mission of this satellite was simple. Just Store-and-Forward.



Remote stations are installed throughout the jungles of the country

https://www.google.co.jp/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=2ahUKEwjrh_PR0u_iAhUBD6YKHQTkAHAQjRx6BAgBEAU&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FMission-concept-of-the-Irazu-Project-13_fig2_328127269&psig=AOvVaw2iCI_zEm4k4SGVcdkZLNpK&ust=1560830967727487

You can install sensors all over your country and get the data using CubeSat **store-and-forward.**



The Irazu satellite is just 10 cm x 10 cm x 10 cm in size. It is working right now in space.

Note:

1. **It was built inside of Costa Rica**
2. **It was tested at Kyutech by their students (see photos above)**
3. **It was put into space via the ISS under contract between JAXA and Kyutech.**

So Costa Rica selected store-and-forward.

What will Uganda select?

The ball is in your court.

How to Get Started

(one way)

The BIRDS Project delivers the technical competence to build satellites inside of your own country

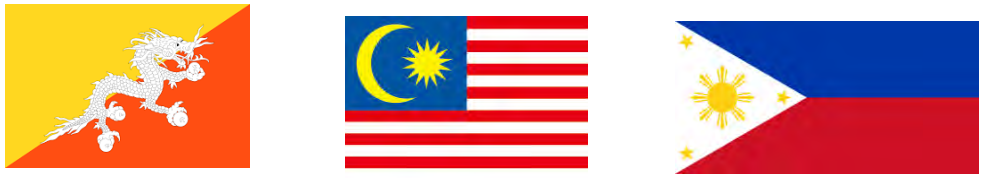
BIRDS-I (2015-2017)

JAPAN GHANA MONGOLIA NIGERIA BANGLADESH THAILAND TAIWAN

This is our track record with BIRDS satellites

BIRDS-II (2016-2018)

BHUTAN MALAYSIA PHILIPPINES



BIRDS-III (2017-2019)

JAPAN SRI LANKA NEPAL

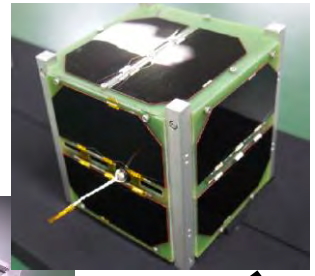
Kyutech is now recruiting for

BIRDS-5 Project,

which starts April of 2020

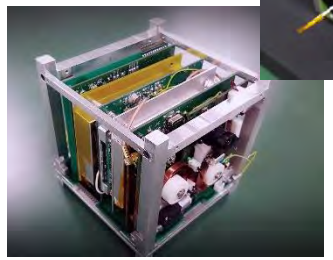
This is the essence: Learn the *entire* satellite development process from start to finish

Flight Model



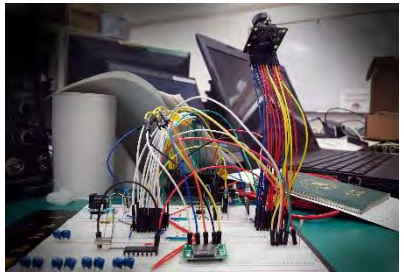
Deploy in space

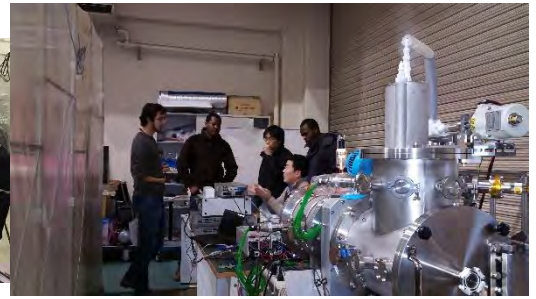
Engineering Model



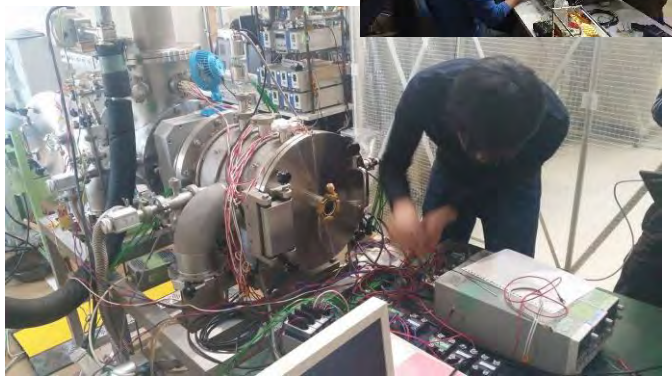
End

Breadboard





Design



Extensive environmental testing

Start

One BIRDS Project from start to finish is exactly 24 months.

Projects overlap by one year

BIRDS-1 (duration of 2 years)

Finished

BIRDS-2 (duration of 2 years)

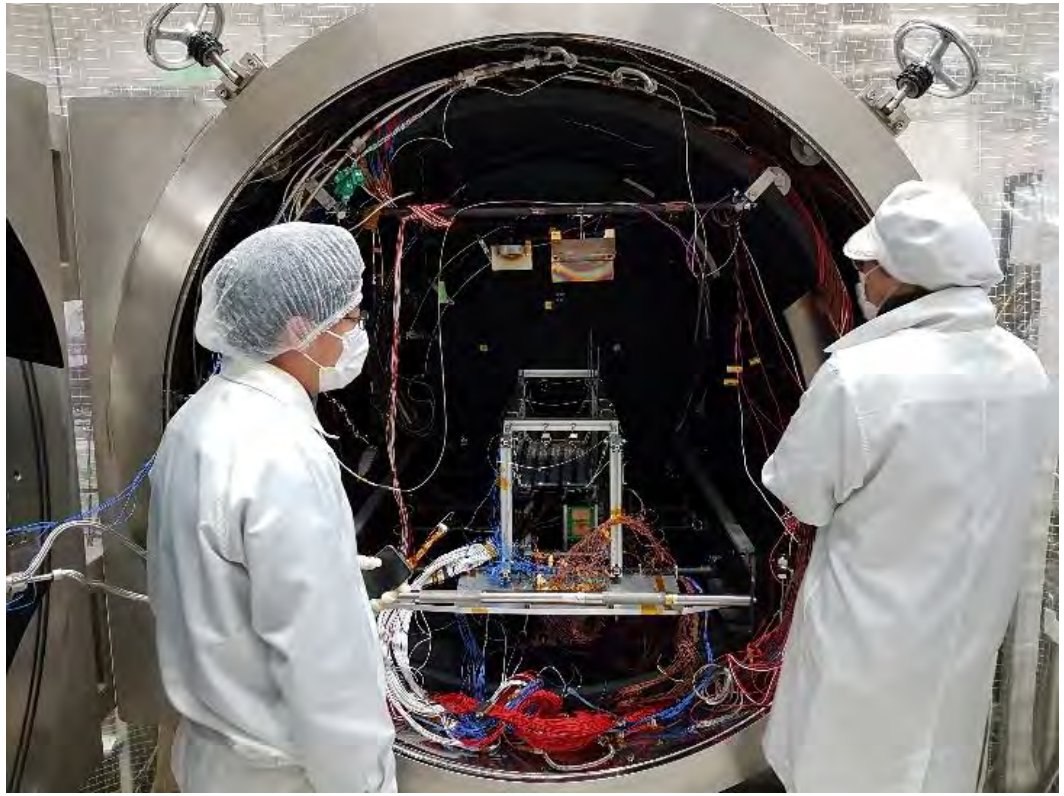
Still in orbit

Deployed on 17 June 2019

BIRDS-3 (duration of 2 years)

Now being developed

BIRDS-4 (duration of 2 years)



BIRDS-2 CubeSats undergoing thermal vacuum testing at Kyutech in January of 2018

Kyutech invites Uganda to join the BIRDS-5 Project, which starts in April of 2020.

Cost of BIRDS-5

- Cost of satellite hardware and for its launch is 15m JPY (about 140,000 USD)
- Scholarships for the students (just $25K per student per year, which covers all conceivable costs)
- Ground station ($25K if turnkey but $6K if built by engineering students)

Training Potential

This slide is from Prof. Jordi Puig-Suari

Flexible High-Tech Workforce

Training Tool

Small Sats fulfill training needs

This slide is from Prof. Jordi Puig-Suari

- Multi-disciplinary Project
- High-Tech Integrated System
- Hands-on Project (*must build something*)
- High Quality Manufacturing
- Policy & Documentation Requirements
- High motivation **(SPACE!)**

Additional Benefits

This slide is from Prof. Jordi Puig-Suari

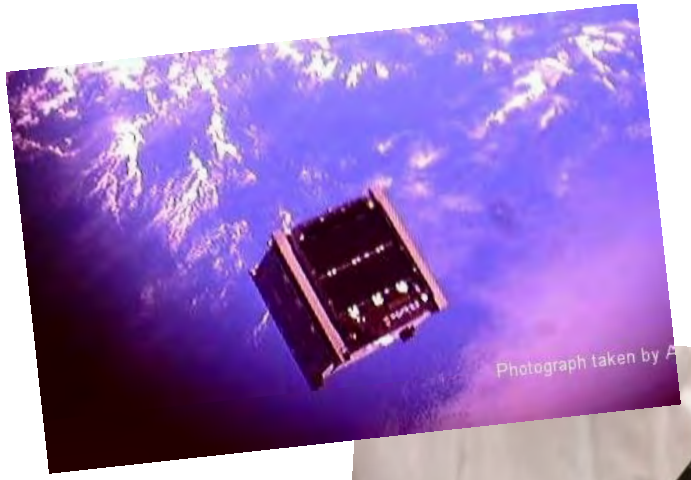
- Exciting projects for Educators
  - Retain experts
- National Pride / Political PR
  - Funding opportunities
  - Science outreach
- Many Opportunities for Collaboration
  - Supportive community
- Emerging Industry
  - Nobody is far behind

IMPORTANT POINT

Options for New Space Players

This slide is from Prof. Jordi Puig-Suari

- Invest in New Space infrastructure
  - Low barrier to entry
  - Commercial technology base
  - Low to medium performance
  - Workforce development
  - Short schedules
- Modest short term results
- Great long term potential
  - Including new local industry



About my university in 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

Main, and original, entrance to the Tobata Campus

Space Engineering Research and Educations at Kyutech

- Space Engineering Education at Tobata Campus since 1993
  - Undergraduate (30 students/class) and graduate levels
- Laboratory of Spacecraft Environmental Interaction Engineering **(LaSEINE)**
  - Established in 2004
- Center for Nanosatellite Testing **(CeNT)**
  - Established in 2010
- Member of *International Astronautical Federation* (IAF) since 2011
- **Department of Space Systems Engineering from April, 2018**

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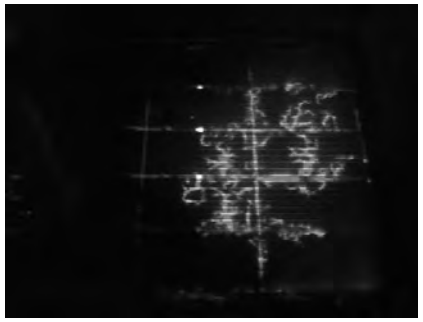
Kyushu Institute of Technology

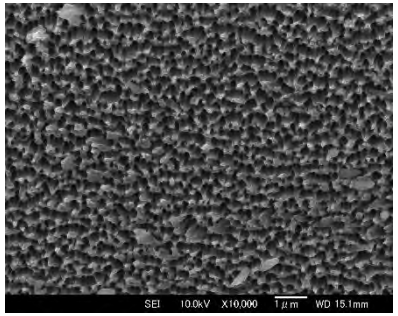
Laboratory of Spacecraft Environment Interaction Engineering (LaSEINE)

- Inauguration: December 2004
- 12 academic + 3 administrative staffs
- Annual research budget: 1 ~ 2 m USD
- 1400m^2 laboratory space
- Partners
  - Space agency
  - Space industries
  - Local small industries
  - International institutions

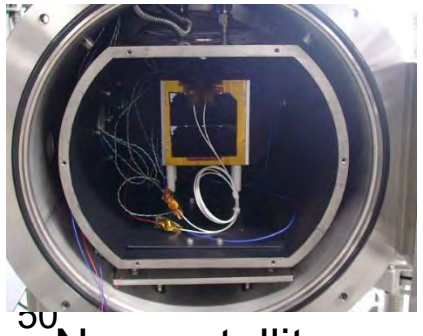
Spacecraft charging



Debris



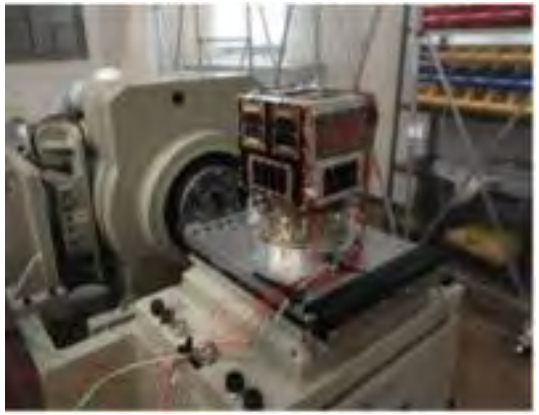
Material degradation



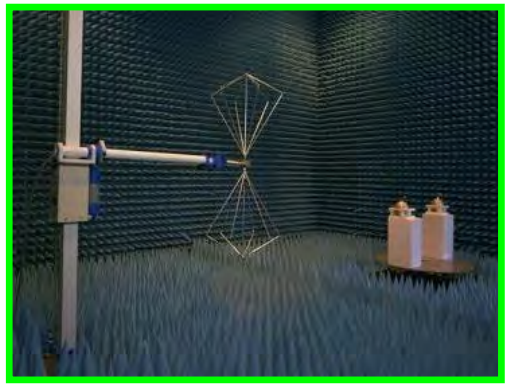
Nanosatellite environment test

Center for Nanosatellite Testing

We can test any satellite up to 50 kg in size



Vibration

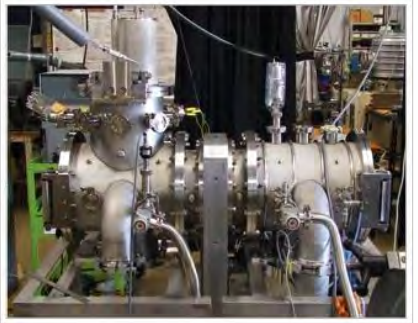


EMC & Antenna pattern

Pressure & Leak

Thermal vacuum

Assembly & Integration



Thermal vacuum

Thermal cycle

Shock

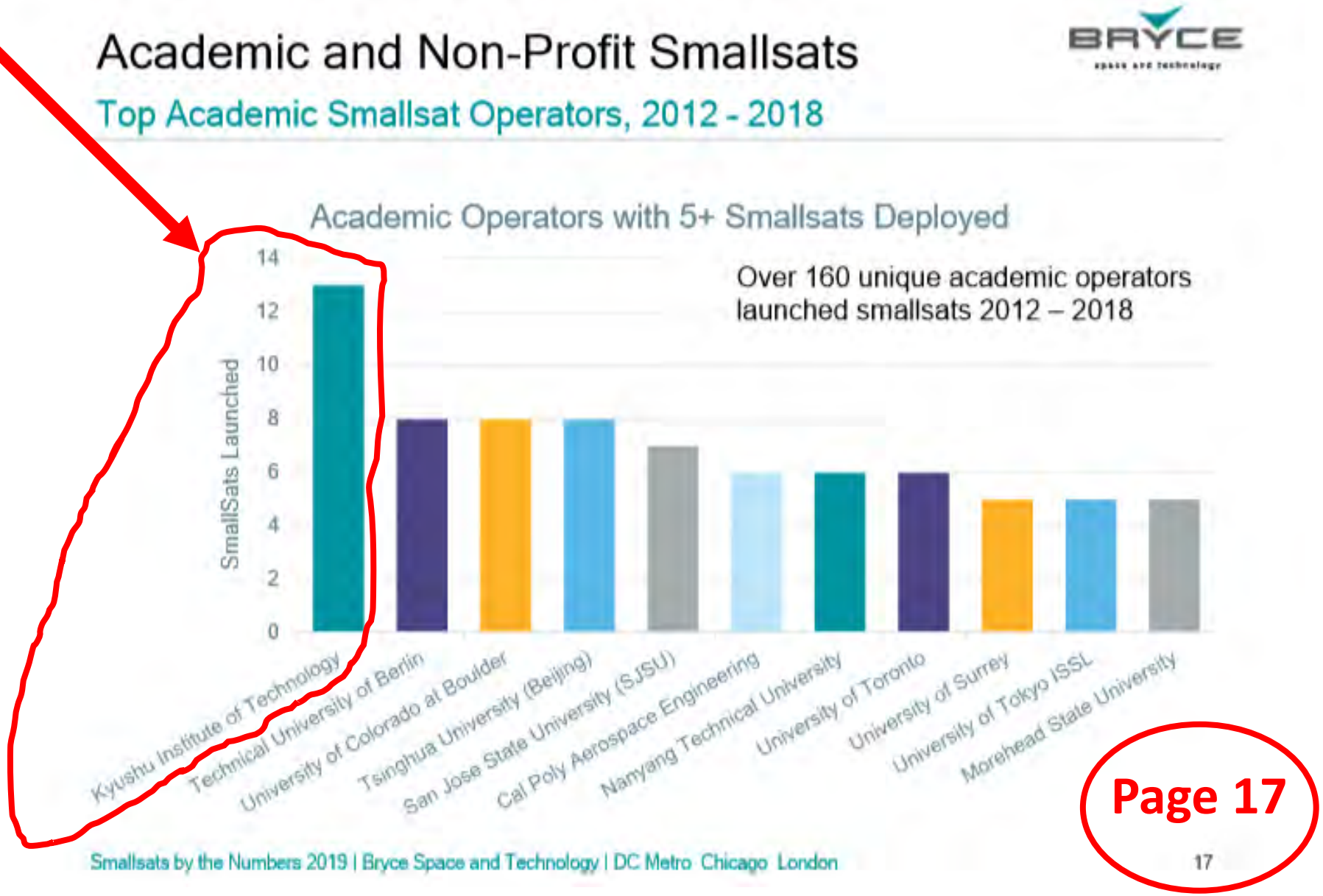
Outgas
(ASTM E595)

Kyutech is the No. 1 university in the world in one amazing respect

https://brycetech.com/downloads/Bryce_Smallsats_2019.pdf

This shows 13 satellites but since this was published we have launched 5 more …

… our grand total now stands at 18 satellites



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The 18 satellites that we have launched so far

Kyutech Satellite History

G.Maeda, 13 June 2019

No.	Satellite name	(a) Date of Launch (b) ISS deployment	Nations involved	Note
1	HORYU-II	(a) 2012/5/18	Japan	
2	Shinen-2	(a) 2014/12/03	Japan	
3	HORYU-IV	(a) 2016/02/17	Japan	
4	AOBA VELOX-III	(a) 2017/01/19	Japan and Singapore	
5	BIRDS-I : Ghana	(b) 2017/07/07	Japan and Ghana	Ghana's first satellite
6	BIRDS-I : Mongolia	(b) 2017/07/07	Japan and Mongolia	Mongolia's first satellite
7	BIRDS-I : Nigeria	(b) 2017/07/07	Japan and Nigeria	
8	BIRDS-I : Bangladesh	(b) 2017/07/07	Japan and Bangladesh	Bangladesh's first satellite
9	BIRDS-I : Japan	(b) 2017/07/07	Japan	
10	BIRDS-II : Philippines	(b) 2018/08/10	Japan and Philippines	
11	BIRDS-II : Malaysia	(b) 2018/08/10	Japan and Malaysia	
12	BIRDS-II : Bhutan	(b) 2018/08/10	Japan and Bhutan	Bhutan's first satellite
13	SPATIUM-I	(b) 2018/10/06	Japan and Singapore	
14	Ten-koh	(a) 2018/10/29	Japan	
15	AOBA VELOX-IV	(a) 2019/01/18	Japan and Singapore	
16	BIRDS-III : Nepal	(b) 2019/06/17	Japan and Nepal	Nepal's first satellite
17	BIRDS-III : Japan	(b) 2019/06/17	Japan	
18	BIRDS-III : Sri Lanka	(b) 2019/06/17	Japan and Sri Lanka	Sri Lanka's first satellite

Finally, a word about pursuing a Masters Degree or Phd at Kyutech

Space Engineering International Course

After this talk, see me for a SEIC brochure

- Taught in English
- You must have a bachelor's degree in some field of engineering
- Masters degree in two years
- Phd in three years
- SEIC has between 45 and 60 students at any given time, mostly foreigners
- You will learn a lot about space engineering through *hands-on training*

Post-graduate study on Nano-Satellite Technologies

After this talk, see me for a PNST brochure

If accepted, you are placed into SEIC

- PNST, since 2013, a full scholarship
- Jointly administered by the UN and Kyutech
- Six persons selected each year, 3 Masters and 3 Phd
- Applications accepted during September thru January
- Apply through the website given below
- You must be from a non-space-faring nation

PNST website: http://www.unoosa.org/oosa/en/ourwork/psa/bsti/fellowships.html

Japan International Cooperation Agency

ABE scholarships are available to Ugandan professionals who seek a masters degree

Two of our ABE students made this 7-min. video→
https://www.youtube.com/watch?v=lJ7H9icDeIo

30-min. TICAD video [discusses ABE]
https://www.youtube.com/watch?v=lA2z-CbrfKs

Thank you for your attention from the BIRDS Family

BIRDS -1 -2 -3 and -4