

# HEPTA-Sat Program: International Knowledge and Technology Transfer for CubeSat Development

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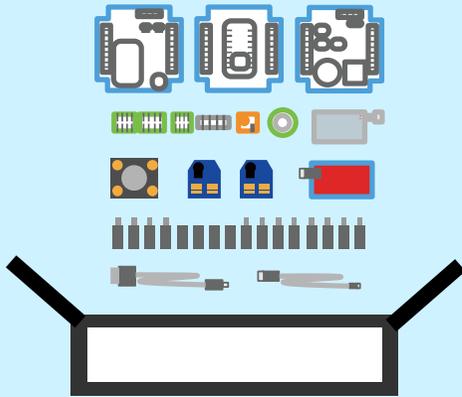


Southern Hemisphere Space Studies Program 2019  
Collaboration with International Space University(ISU)



# Key Features

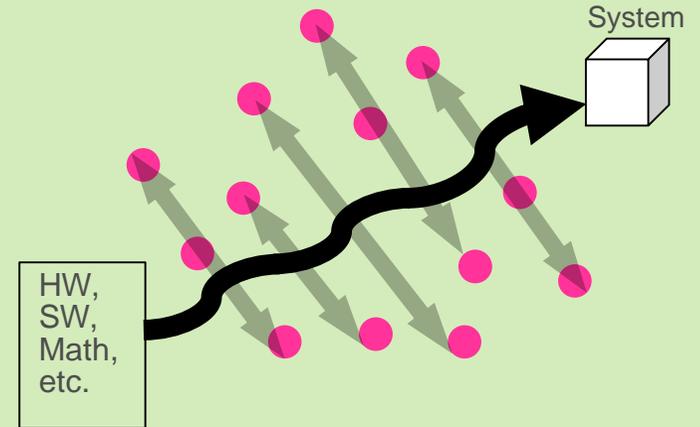
## 1. Training Kit



## 2. Text Book



## 3. Training Program



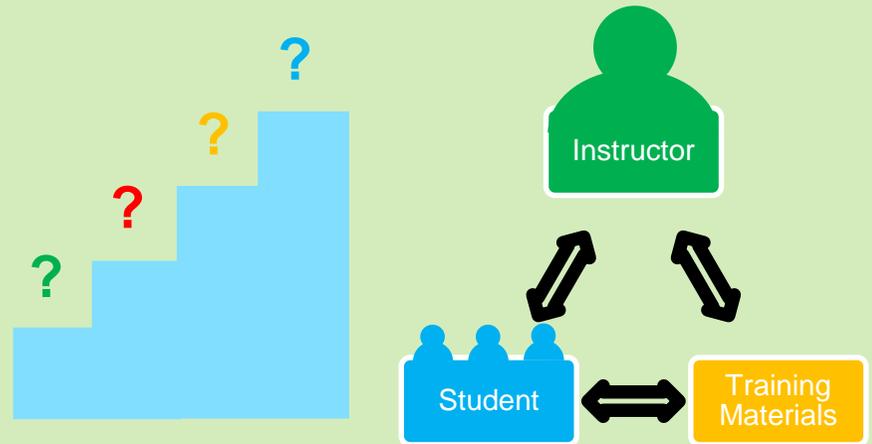
## 4. Hands-on



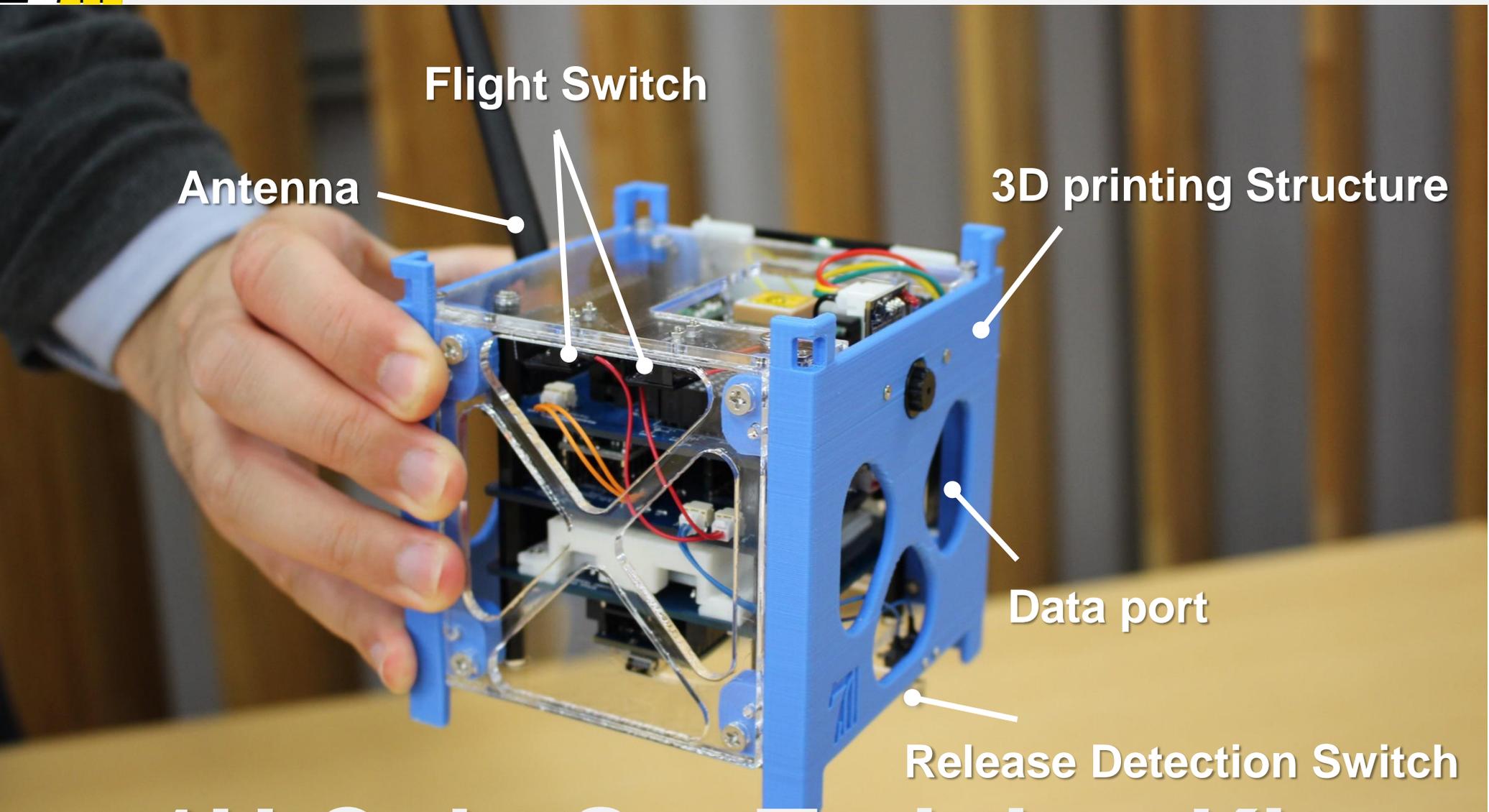
## 5. Self-directed



## 6. Step by Step 7. Interactive Communication

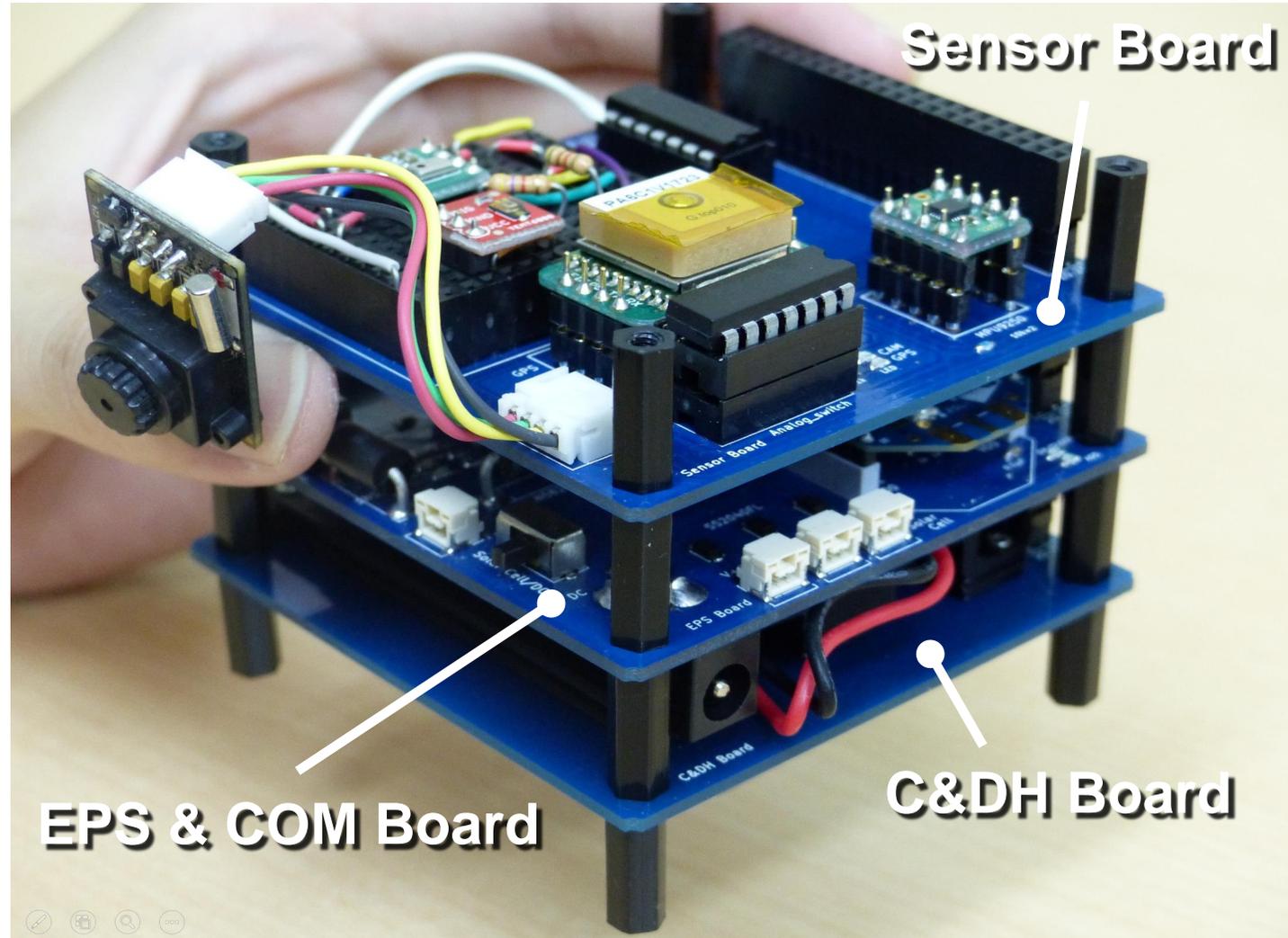
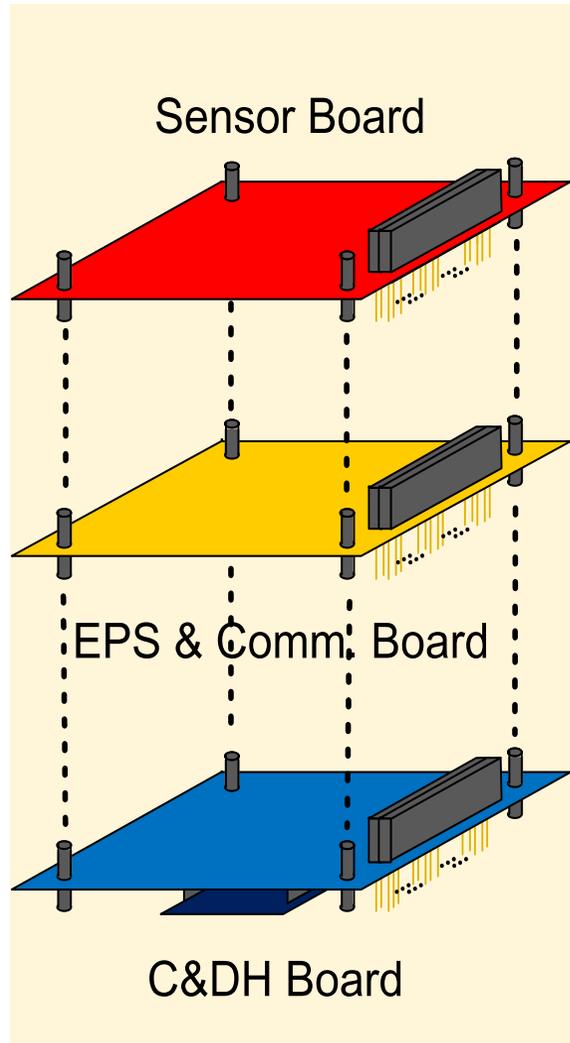


# What is HEPTA-Sat kit ?



## 1U CubeSat Training Kit

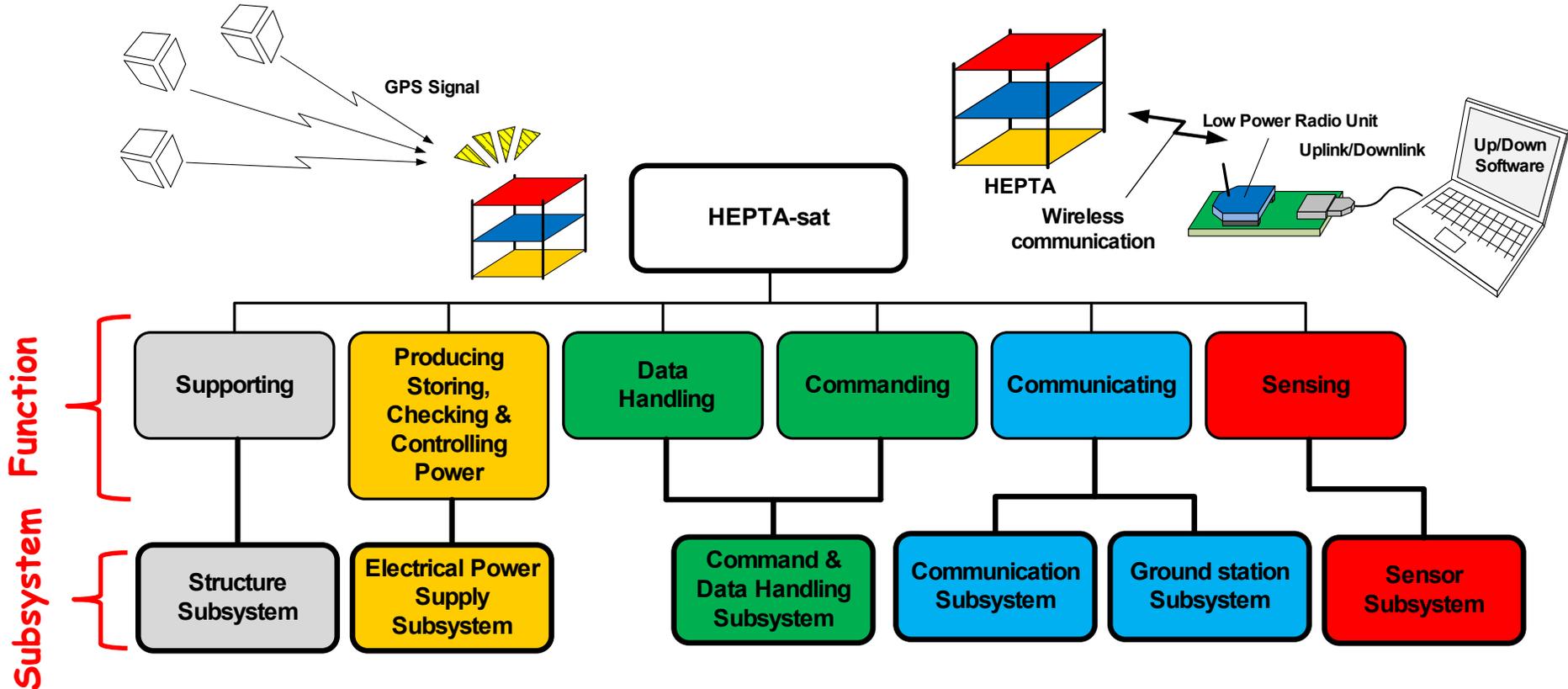
# What is HEPTA-Sat kit ?





# What is HEPTA-Sat kit ?

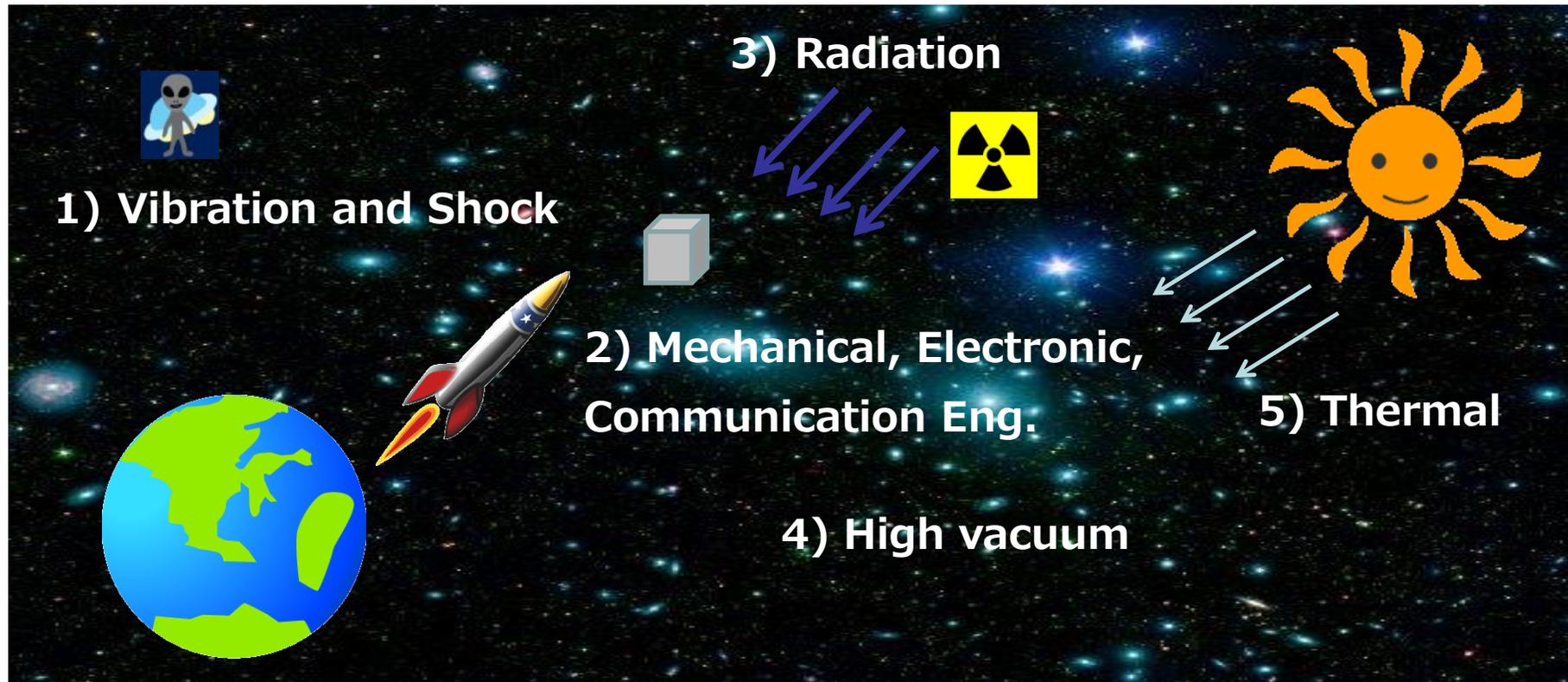
- Composed of 6 function and 6 primary sub-systems.



- You can learn how each subsystem functions and how to integrate subsystems into a satellite through experiencing the process of **assembly**, **integration** including programming & system implementation and **test**.

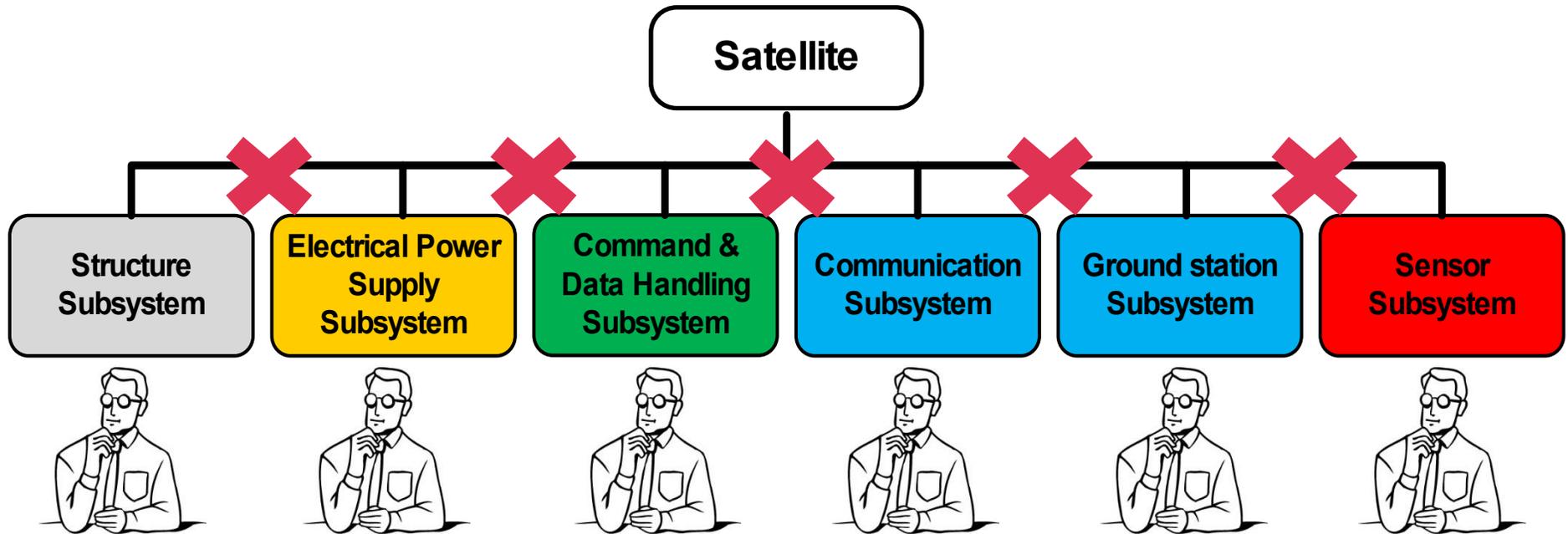
# Why CubeSat Training?

- Satellite is possible to learn variety of elemental technologies
  - Mechanical engineering, electronic engineering and communication engineering and it's system integration.
  - To learn the space systems engineering, CubeSat development project based learning is a very effective training way.



# Why HEPTA-Sat kit ?

- It is sometimes **hard to gain knowledge or experience** of the **whole development process** because the roles are divided into team members.



- Not only a **local optimization insight** but also **global optimization insight** for developing the system.
- The training program offer a such kind of experience before starting real satellite in a **short time and low cost**.

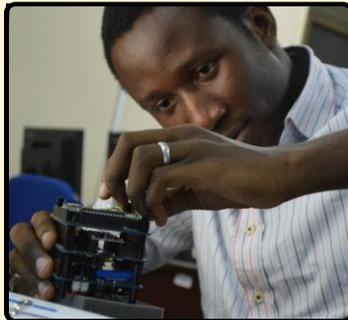
# What is HEPTA-Sat Training Program ?

- 1) Understanding basic satellite system architecture.
- 2) Experiencing the pico-satellite development process in a short time.
- 3) Acquiring the basic knowledge of space engineering.

**Step 1:**  
Lecture



**Step 2:**  
Hardware Assembly



**Step 5:**  
Field test



**Congratulations!**



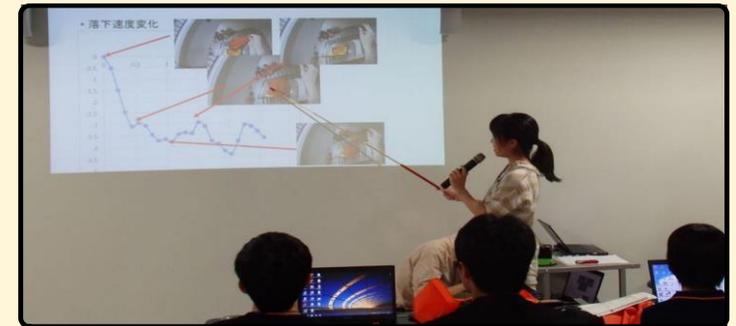
**Step 3:**  
Hardware & Software  
Integration



**Step 4:**  
Mission Design

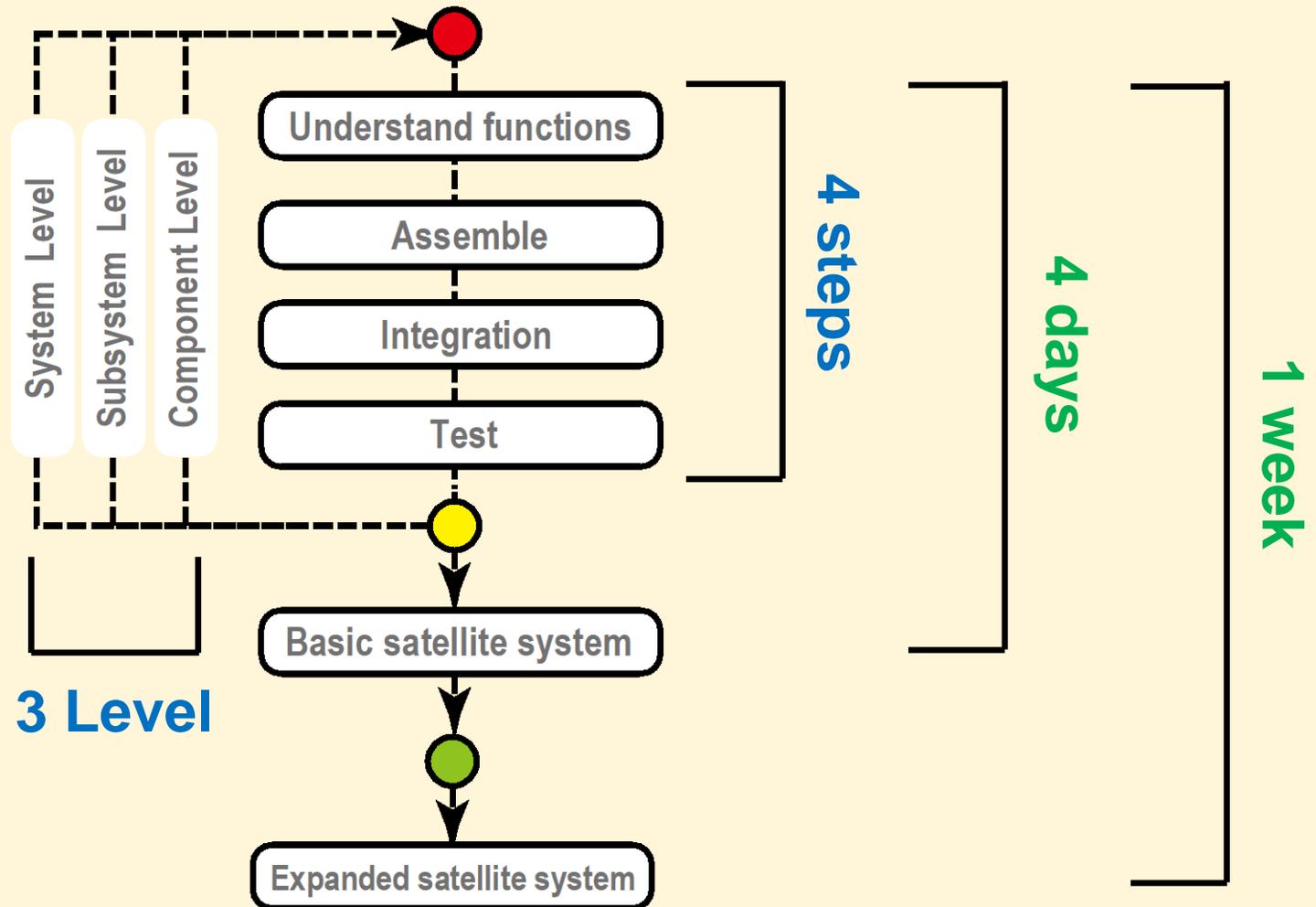


**Step 6:**  
Review & Presentation

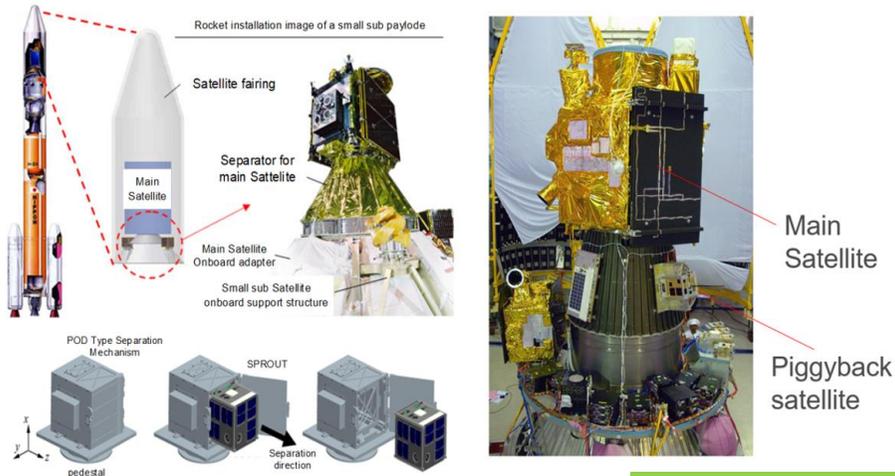


# from Scratch to Satellite System

- Focuses mainly on **understanding**, **assembling**, **integrating**, and **testing** the function of the CubeSat model and carrying out it in a **hands-on manner** step by step from the **component level to the system level**.



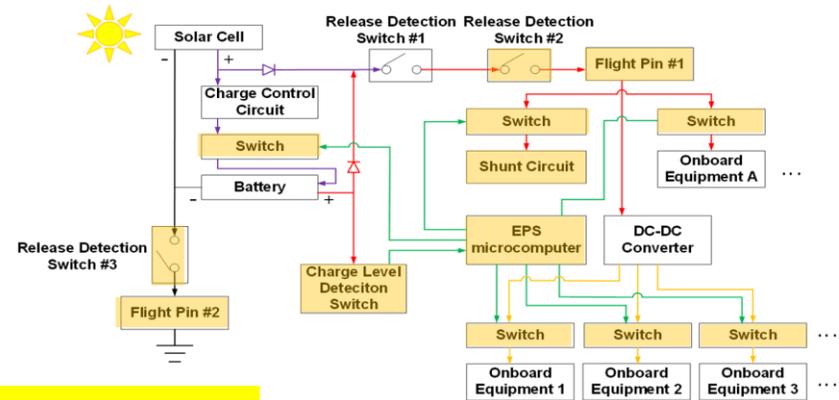
- Satellite needs a separation system that deploys the satellite from the launch vehicle to the orbit.



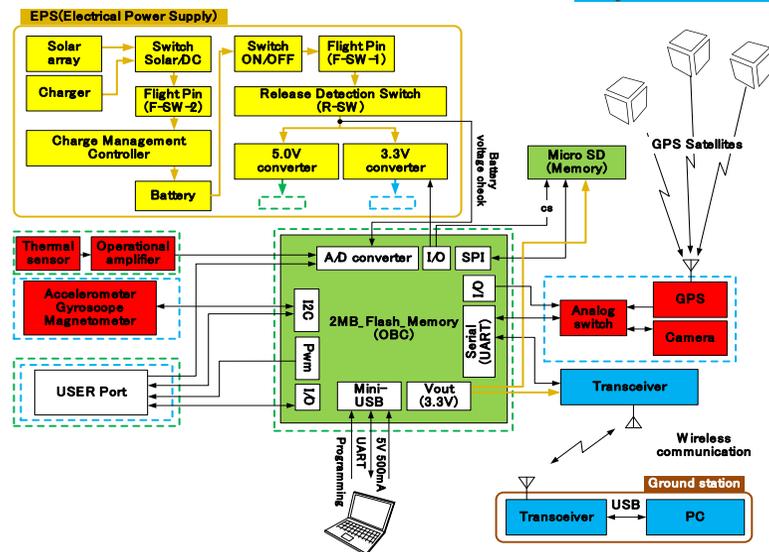
Introduction  
System Architecture

## 1. Check Function and architecture of EPS Subsystem

- An example of EPS subsystem that considers reliable and secure electric power supply, management of proper power supply, and safety assurance.

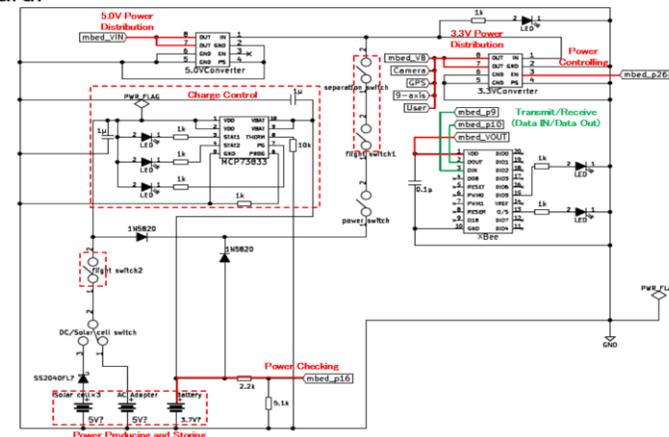


EPS Architecture  
Circuit Diagram



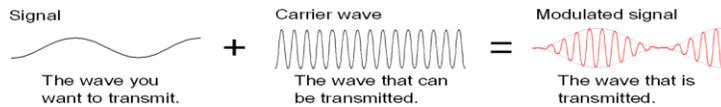
## 1. Check Function and architecture of EPS Subsystem

- The circuit diagram of HEPTA-Sat's EPS and communication board.

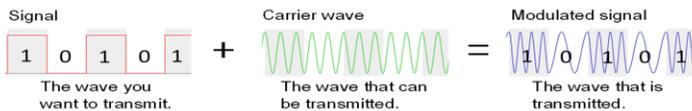


## 2. Check of function and architecture of Communication Subsystem

- There are variations in the modulation and demodulation scheme.
- Amplitude Modulation (AM) or Frequency Modulation (FM) are ways of broadcasting radio signals. Both transmit the information in the form of electromagnetic waves.
- AM works by modulating (varying) the amplitude of the signal or the carrier to be transmitted according to the information being sent, while the frequency remains constant.



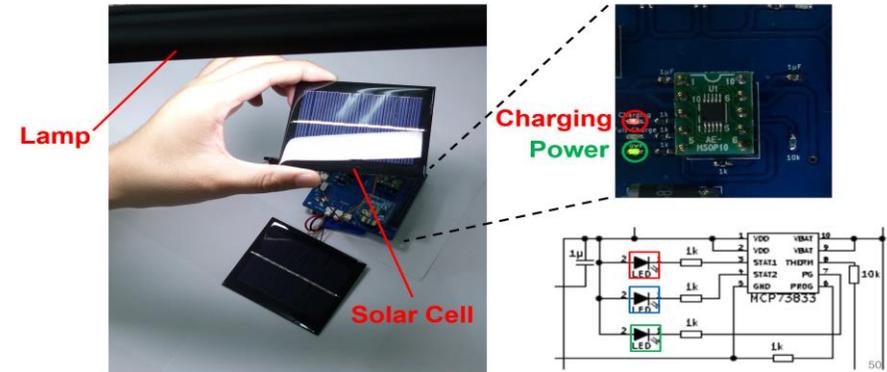
- Digital data is also conducted by modulation and demodulation. The following figure is the schematic diagram of frequency modulation of digital data.



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## 14. Installation of Solar Cells

- Set the switch "DC / Solar cell" on the board to "Solar cell".
- Charge with desktop lighting!
- It can be confirmed that charging is possible.



Technical Term

Test

Integration

Assembly

## 10. Software & Hardware Integration: Detect acceleration by using 9-axis Sensor

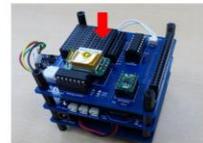
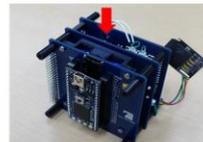
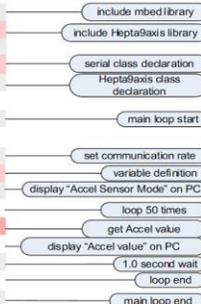
- Software and hardware integration of EPS & communication board and C&DH board are conducted
- Acquire the acceleration sensor data.

File name : Detect\_Acceleration

```
#include "mbed.h"
#include "Hepta9axis.h"

Serial pc(USBTX,USBRX);
Hepta9axis n_axis(p28,p27,0xD0,0x18);

int main()
{
    pc.baud(9600);
    float ax,ay,az;
    pc.printf("Accel Sensor Model\r\n");
    for(int i = 0; i<50; i++) {
        n_axis.sen_acc(&ax,&ay,&az);
        pc.printf("%f,%f,%f\r\n",ax,ay,az);
        wait(1.0);
    }
}
```



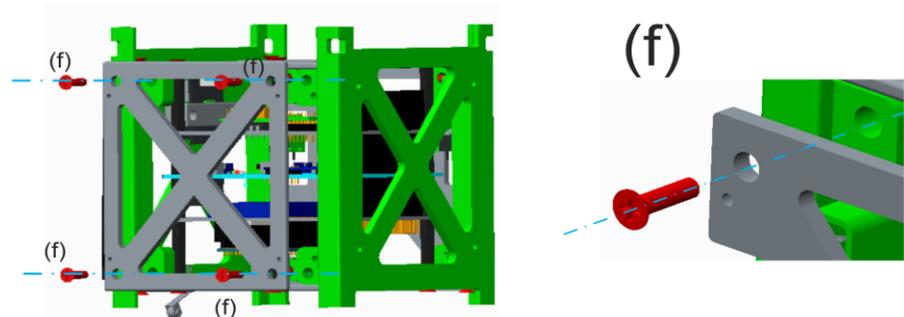
X-axis Acceleration = 9.820779 [m/s<sup>2</sup>]  
Y-axis Acceleration = 0.378459 [m/s<sup>2</sup>]  
Z-axis Acceleration = 0.005394 [m/s<sup>2</sup>]

X-axis Acceleration = 0.416794 [m/s<sup>2</sup>]  
Y-axis Acceleration = 0.064673 [m/s<sup>2</sup>]  
Z-axis Acceleration = 9.853600 [m/s<sup>2</sup>]

## 3. The structure of HEPTA-Sat

Fabrication and Assembly of the structure subsystem of HEPTA-Sat

- Next, assemble the trusses.





## Host Countries / Organizations

- All Nations University (Ghana): 2015
- GGPEN (Angola): 2016
- Katmandu University (Nepal): 2017
- Sofia University (Bulgaria): 2017
- CNES(France): 2017-2019
- Stellenbosch University (South Africa): 2017
  - UN/South Africa Symposium on Basic Space Technology  
"Small Satellite Missions for Scientific and Technological Advancement" 2017
- United Arab Emirates University (UAE): 2018
- International Space University (France): 2018
- Oman Astronomical Society (Oman): 2018
- Japan International Cooperation Agency (Japan): 2018
- Luxembourg University (Luxembourg): 2018
- South Australia University (Australia) and International Space University (France): 2019
  - Southern Hemisphere Space Studies Program 2019

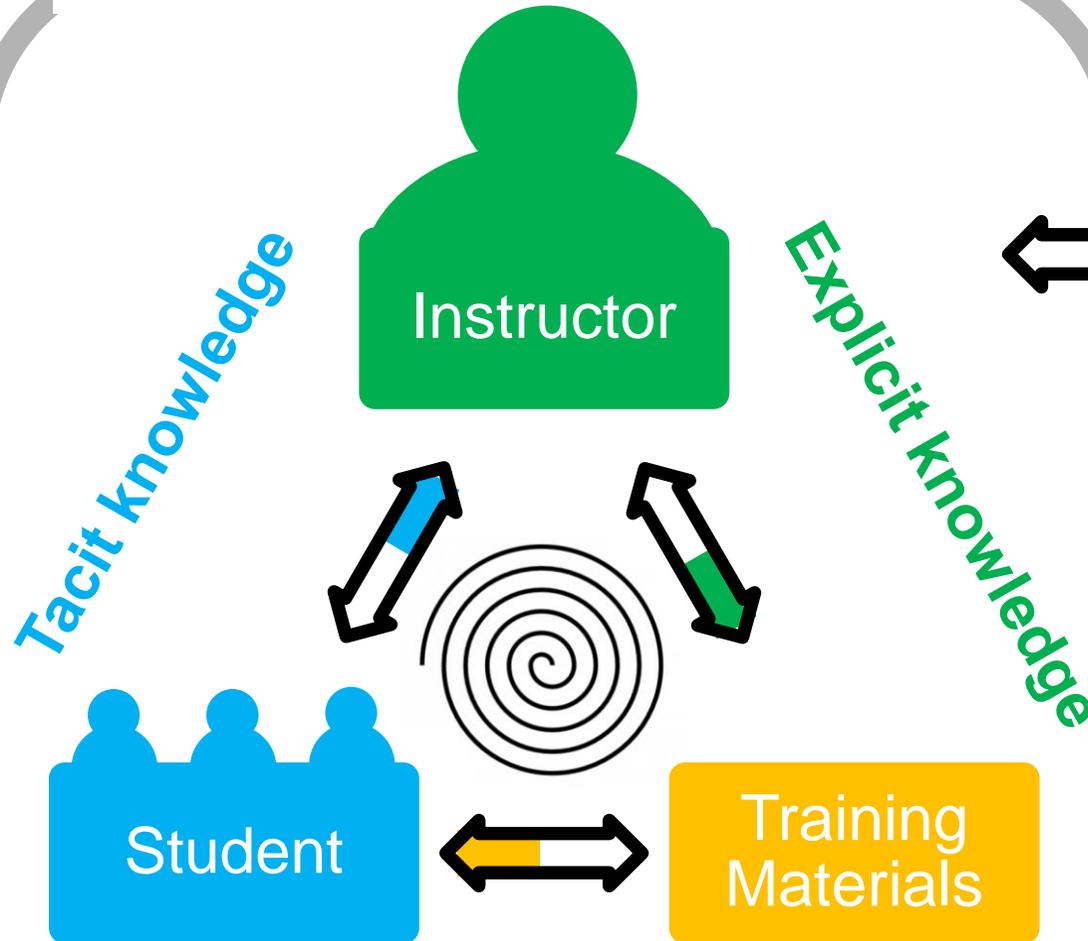
■ Participating Country

■ Host Country

# Interactive Communication

Version Up

Class Room



Various fields  
 Engineer, Scientist,  
 Lawyer, Artist, Manager

Feedback from the real world

**HEPTA-Sat Program:  
International Knowledge and Technology  
Transfer for CubeSat Development**

Masahiko Yamazaki (UNISEC-global, Nihon University)

**Thank you for your Attention  
Questions?**

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Email: [yamazaki.masahiko@unisec-global.org](mailto:yamazaki.masahiko@unisec-global.org)

## The 10th CanSat Leader Training Program:

# CLTP10



**August 19-30, 2019, Nihon Univ.,**

**Japan**