The results of Small Satellite technology transfer from JAXA

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Background of SOHLA

- In Japan, SMEs and universities associate to develop small satellites
- At Osaka area

- SOHLA, established in 2003: Space Oriented Higashiosaka Leading Association

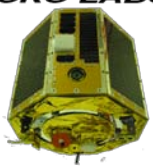
- Object of SOHLA is to develop a small satellites and their commercialization at a low cost

- JAXA is required by public to spread our accumulated space technologies to industries and universities

JAXA's Tech. Transfer Program

Space Technology Transfer Program

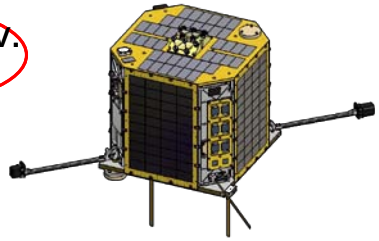
MICRO LABSAT



JAXA' micro satellite technology

Ryukoku Univ.
Kinki Univ.

Osaka Prefecture Univ.
System design and analysis



SOHLA-1

ASTRO TECHNOLOGY SOHLA
Satellite Integration

SME SME SME SME
Component Manufacturing

Univ. of Tokyo,
Osaka Univ.
Experimental Components

- **Space systems engineering**
- **System design and analysis**
- **Space components development**
- **System integration and testing**
- **Satellite operation**

- General ideas under space environment
- Quality management
- Satellite integration and testing techniques
- System management and interface control
- Mission analysis
- Power management analysis
- Attitude control analysis
- Structure and thermal analysis
- Selection of materials and electrical parts
- High reliability micro soldering techniques
- Component manufacturing techniques
- Etc…

Difference of purpose towarads space.

- Main member of SOHLA
  - To Cheer-Up Higashi-Osaka Area, whose main industry is decline.
    - Satellite development is the one of its ways.

- Member of JAXA
  - To spread space technologies to industries and universities
    - Satellite development is the main way to achieve the JAXA’s goal.

Satellite objective?

- SOHLA
  - To complete satellite development
  - Launch Satellite to space
- JAXA
  - Transfer technology to SMES and Univercity, through satellite development
  - To complete satellite development in peace
- SME & Univercity
  - To develop satellite components and to be operate on the space.

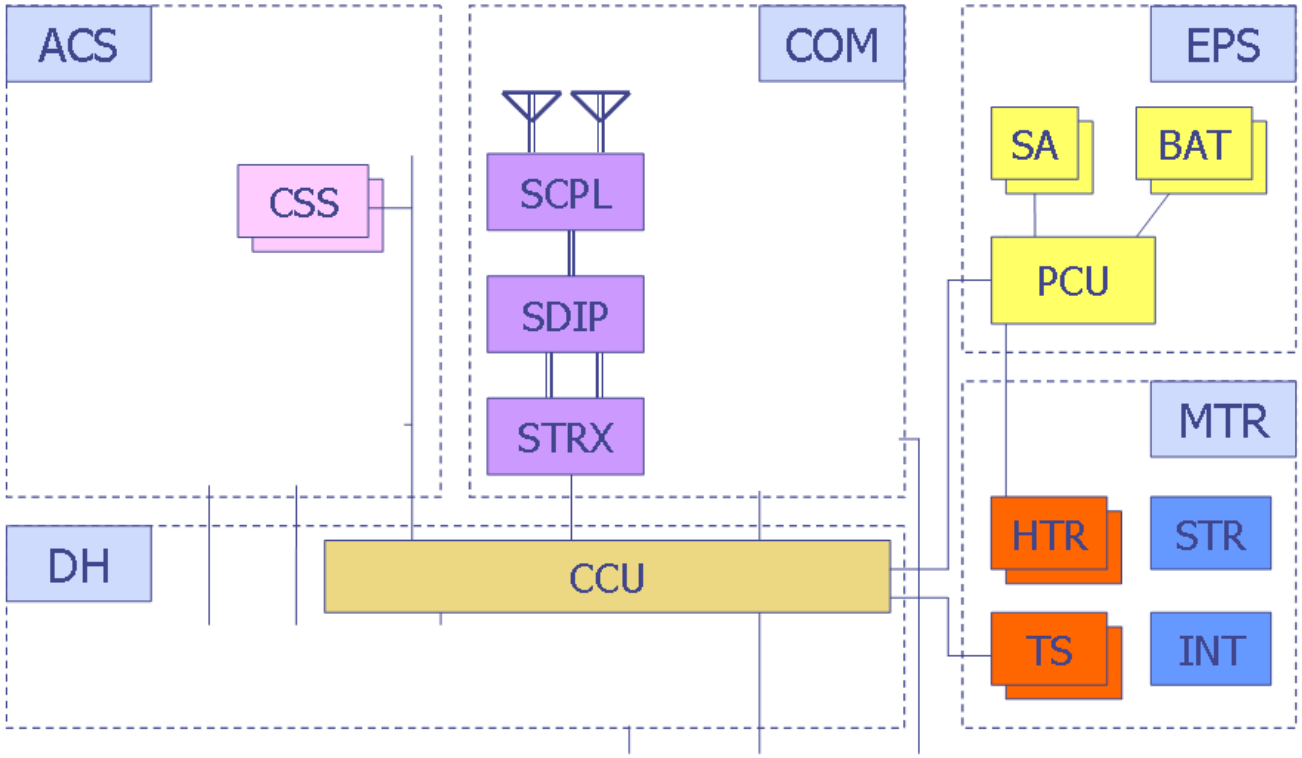
Satellite Overview(named MAIDO)

Item	Specifications
Size	Octagonal prism (500 x 500 x 500)
Weight	Approx. 50 kg
Power	over 30 W
Attitude Control	Spin stabilized
Orbit	SSO
Comm.	S-band/Amateur band

- Spin rate : 3rpm
- TSA :0-85deg, 95-175deg

- Solar cells are placed on the surface of MAIDO to generate enough electric power .

MAIDO System Block Diagram



NOMINAL mode

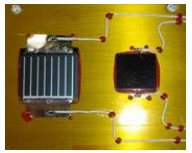
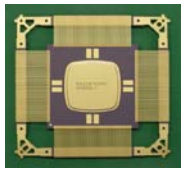
On-orbit Demonstration

●**8** experiments in 50kg class micro satellite

1. **COTS based small GPS receiver demonstration** (JAXA)
2. **High accuracy geomagnetic observation and on-orbit**
   - **radiation monitoring** (JAXA)
3. **Deployable boom demonstration** (Ryukoku Univ.)
4. **Small monitor camera demonstration** (SOHLA/JAXA)
5. **Sun sensor demonstration** (Osaka Prefecture Univ.)
6. **For thunderstorm observation, demonstration of component for broadband measurement of waveform for VHF lightning impulses** (Osaka Univ.)
7. **CIGS solar cells demonstration experiment** (JAXA)
8. **Demonstration of 64bit MPU with 200 MIPS level** (JAXA)

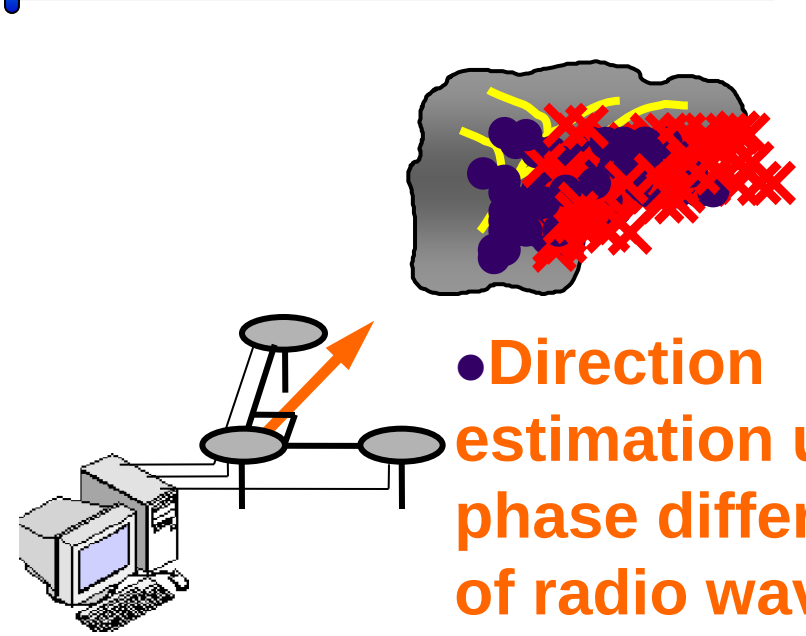




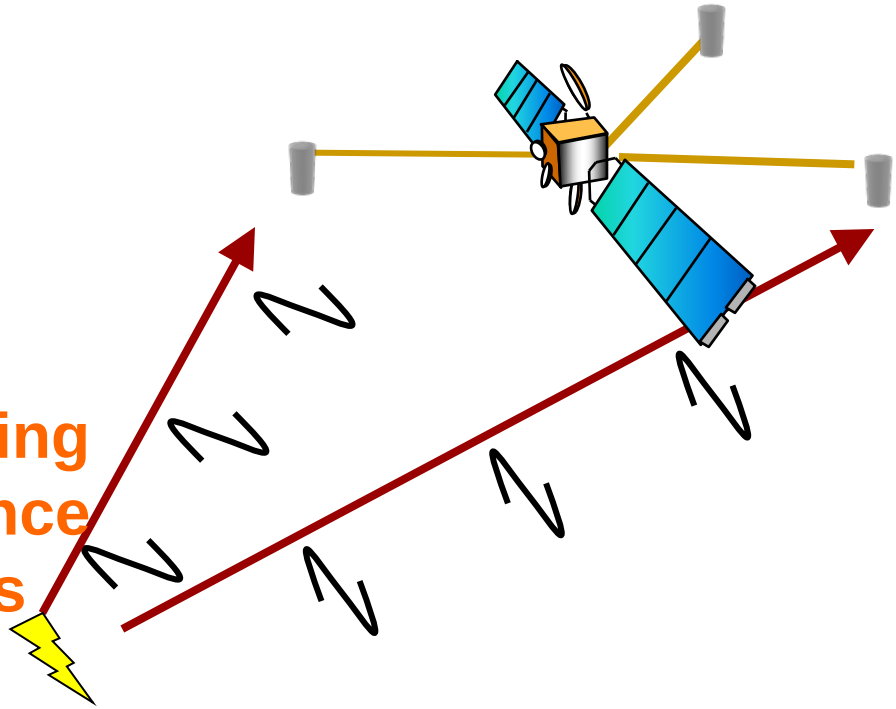




Thunderstorm Observation

- Ground System（in-service）
- Space system (planed)



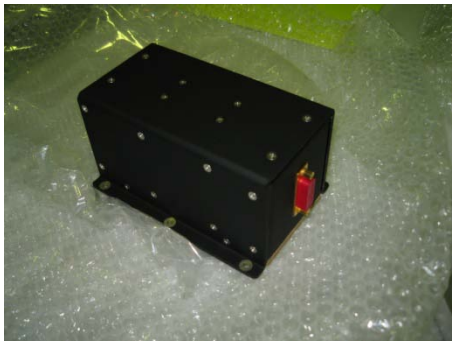
- Direction estimation using phase difference of radio waves
- Data record



- Universities plans to develop a component to observe thunderstorm from low Earth orbit using small satellites

Broadband Measurement for Waveforms of VHF Lightning Impulses (BMW)

- ●Osaka university develops a component to measure VHF broadband waveform of lightning impulses.
  - ●Functional verification of BMW in space
  - ●Understanding features of VHF radio wave from thunderstorms

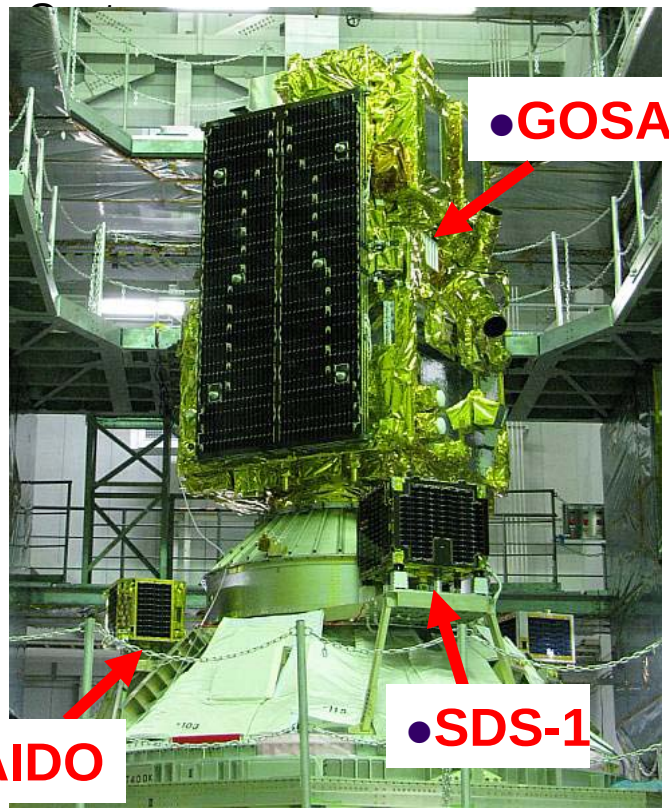


●BMW

●Antenna for BMW

Launch of MAIDO

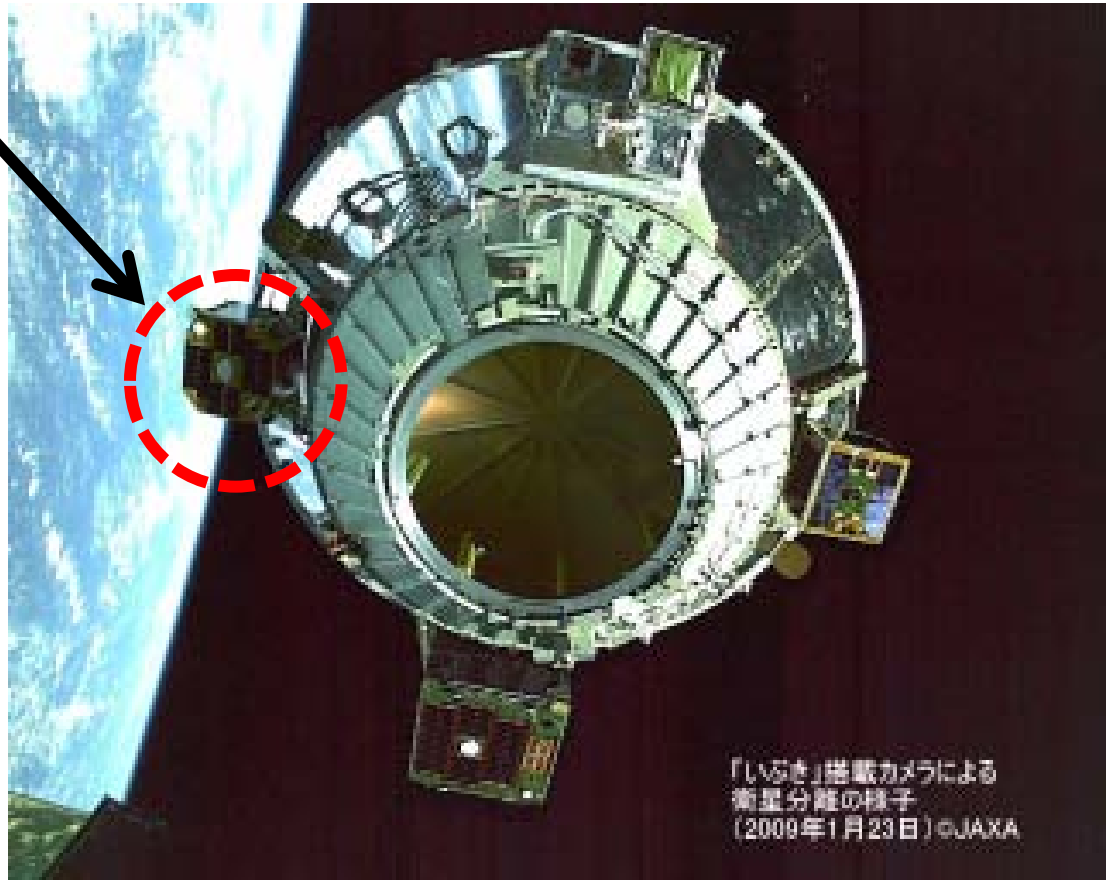
- Tanegashima Space



- Jan. 23, 2009. H-IIA Lift off!

- MAIDO was successfully launched as one of the seven piggyback satellites with GOSAT (Green-house gasses observation satellite) on **January 23rd 2009** with H-2A LV.

Launch of MAIDO

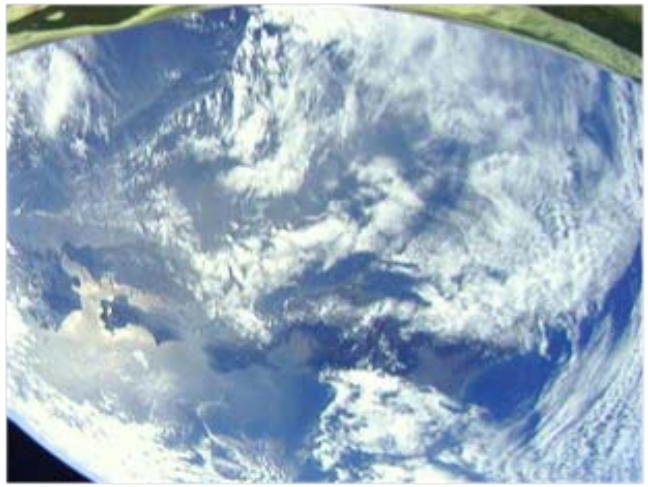


From GOSAT (Primary payload) monitor camera

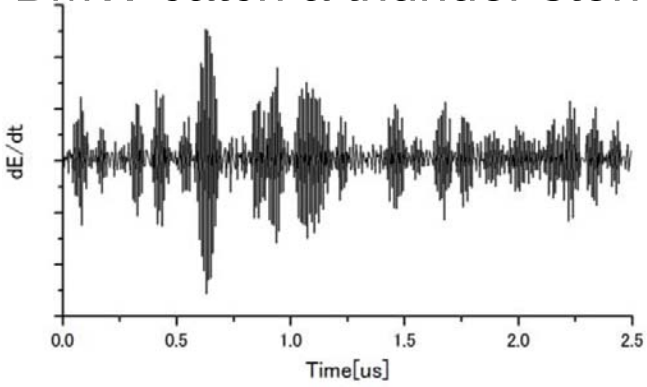
Satellite operation-1

		MAIDO Satellite Operation Events
2009/1/23	Critical phase	Launch up
		Separation, 1st AOS
		EPS check out
		ACS check out
		Nutation dump
2009/1/24		Spin Axis Control Spin Rate Control
2009/1/31	Critical phase	GPSR check out
2009/2/02		Moniter camera get pictures from space
2009/2/08		Radiation monitor check out
2009/2/09		BMW antenna deployment
2009/2/12		BMW detects the thunder storm from space
2009/2/15		GPSR continuous operating test
2009/2/23		H-band antenna deployment

picture of Japanese Islands



BMW catch a thunder storm



Satellite Operation-2

		MAIDO Satellite Operation Events
2009/2/24	Nominal phase	BMW experiments
2009/2/26		GPSR+SLR (To estimate orbit determination accuracy)
2009/3/04		
2009/3/23		BMW experiments
2009/4/07		
2009/4/09		AMI continuous operating
2009/4/15		
2009/4/17		Boom deployment test
2009/4/23		
2009/4/25		Moniter cmaera get pictures
2009/5/15		
2009/5/25		
2009/10/10		MAIDO FINAL Operation

Boom Deployment results

Send a power down command

Mission Experiments Results

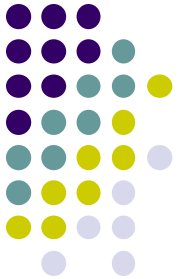
Mission	Conducted operations and results
Orbit determination technology demonstration	All functions were working well.
radiation monitoring	Radiation absorbed dose was measured with propriety
CIGS solar cells	Degradation of Si solar cell (reference) and thin-film solar cells are compared
64bit MPU Advanced Micro processing In-orbit experiment (AMI)	All parts were working well. -MPU is functioning in 50MIPS SEUs are observed MPU cache area. -Error detection and correction is also working well.
Moniter Camera	All functions were working well. Use this camera, Deployable boom can be confirmed
Deployable Boom	Function was working well
Sun Sensor demonstration	All Functions were working well.
Broadband Measurement for Waveforms of VHF Lightning Impulses (BMW)	All functions were working well.

Technology Transfer and its results

- Satellite main Structure
- On Board Computer
- Battery
- Moniter Camera

All Components had been working well till final operation.

Example of Technology Spreading



- BMW
  - Deveolping new BMW for ISS (International Space Station)
- Moniter Camera
  - 3 Cameras in Space
  - 1 Camera waiting for launch
  - Developing advanced-Moniter Camera
    - high resolusion
    - easily data handling
    - action mode

Conclusion

- The Satellite program
  - To complete satellite development
  - Launch and operate satellite in successfully
- Technology transfer activity
  - system analysis
  - components