



Beihang University

Beihang University Micro-satellite System Research

Dr. WANG Xinsheng

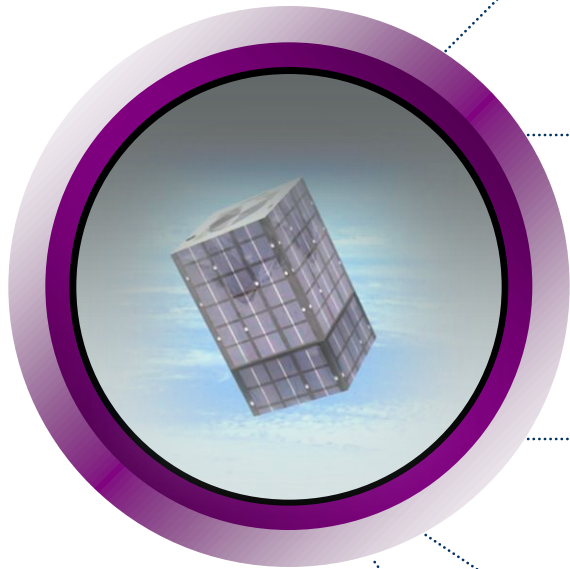
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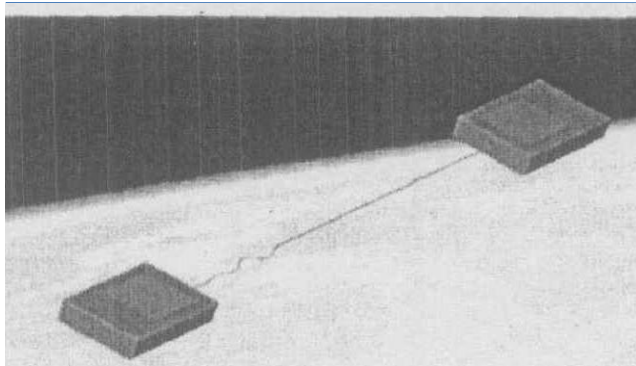
1. Background

1.1 University Micro-satellite Overview

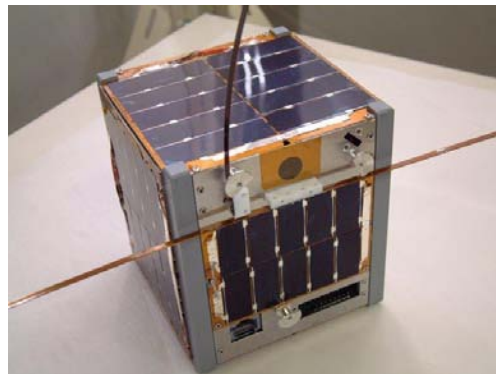
- ❖ University micro-satellites are becoming one of the key research field in future space exploration.
- ❖ Low cost spacecraft applied space exploration
- ❖ Educational Function. Influence faculty/student thinking and engineering skill activities



SSETI



PicoSat
(Stanford University)



XI-V
(Tokyo University)



Delfi-C3
(Delfi University of Technology)



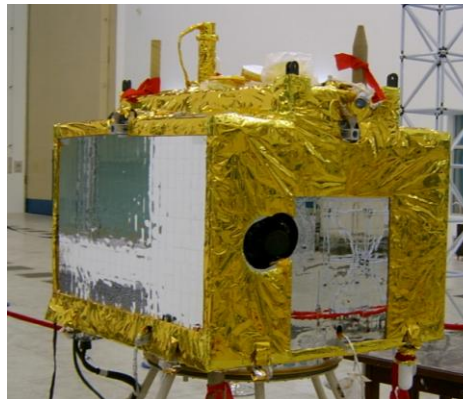
1. Background

1.2 University Micro-satellite Key Technologies:

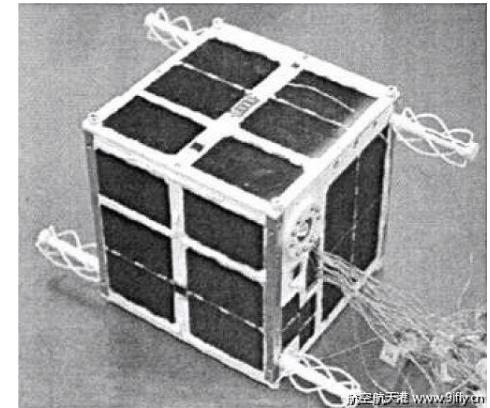
- New concept and new technology
- Advanced MEMS & system integration technology
- New energy sources research
- Micro-satellite constellations



Tsinghua-1
(Tsinghua University)



TS-1
(Harbin Institute of Technology)



ZDPS-1
(Zhejiang University)



1. Background

1.3 BUAA-SAT Mission

- Advanced micro-satellite system integration technology
- Coilable mast deployment technology
- Advanced integrated electrical system
- On-orbit imaging and on-board data compression
- Educational Function (students skill practice)

BUAA-SAT supported by

- Beihang University Student Research Training Program
- Chinese Graduate Student Education Foundation



BUAA-SAT



2. Mission Overview

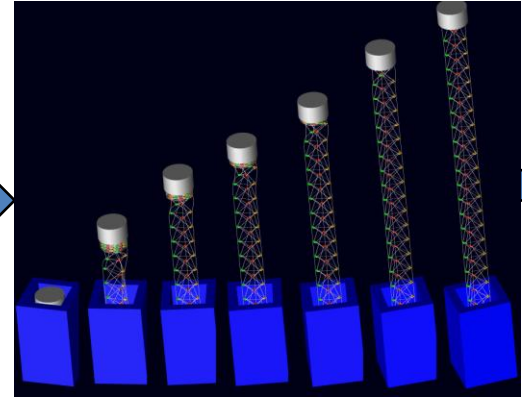
BUAA-SAT Mission Follows:



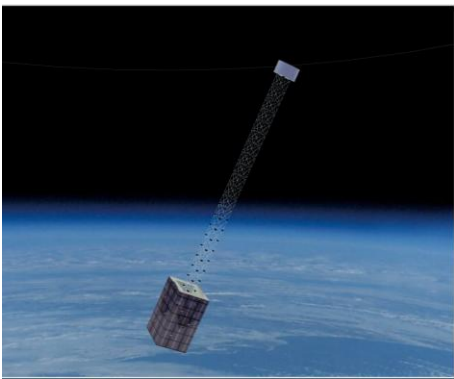
Launch



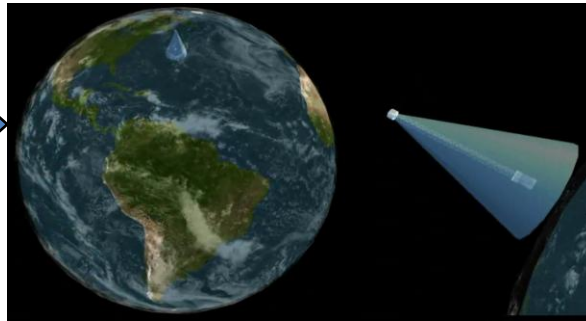
System Initialization
& Damping



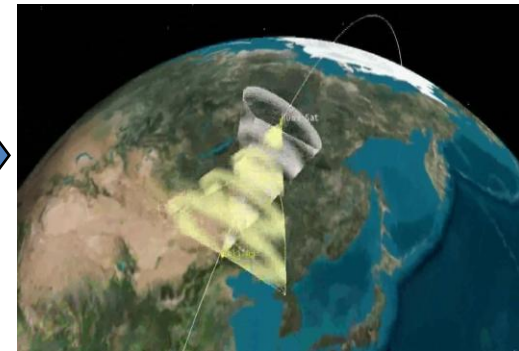
Coilable Mast Deploy



Gravity Gradient Stabilization



Taking Photo of Satellite
& Observing the Earth



Communicating with
Ground Station



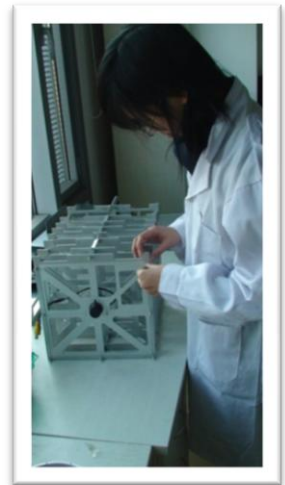
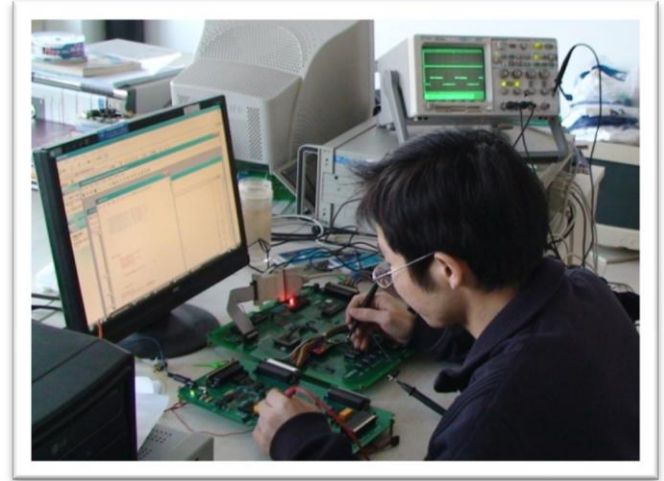
3. Spacecraft Overview

3.1 BUAA-SAT Design Philosophy

- **Modular Design**
- **Plug and Play (PnP)**
- **Low Cost: Commercial of the Shelf (COTS)**
- **Rapid-response application**

System Features:

- ✓ **Standard hardware and software interface**
- ✓ **Allow change up until the last minute**
- ✓ **Easy to assemble and disassemble**
- ✓ **Easy to increase or decrease devices**
- ✓ **Reduce the cost and manufacture cycle**



3. Spacecraft Overview

3.2 BUAA-SAT Consists

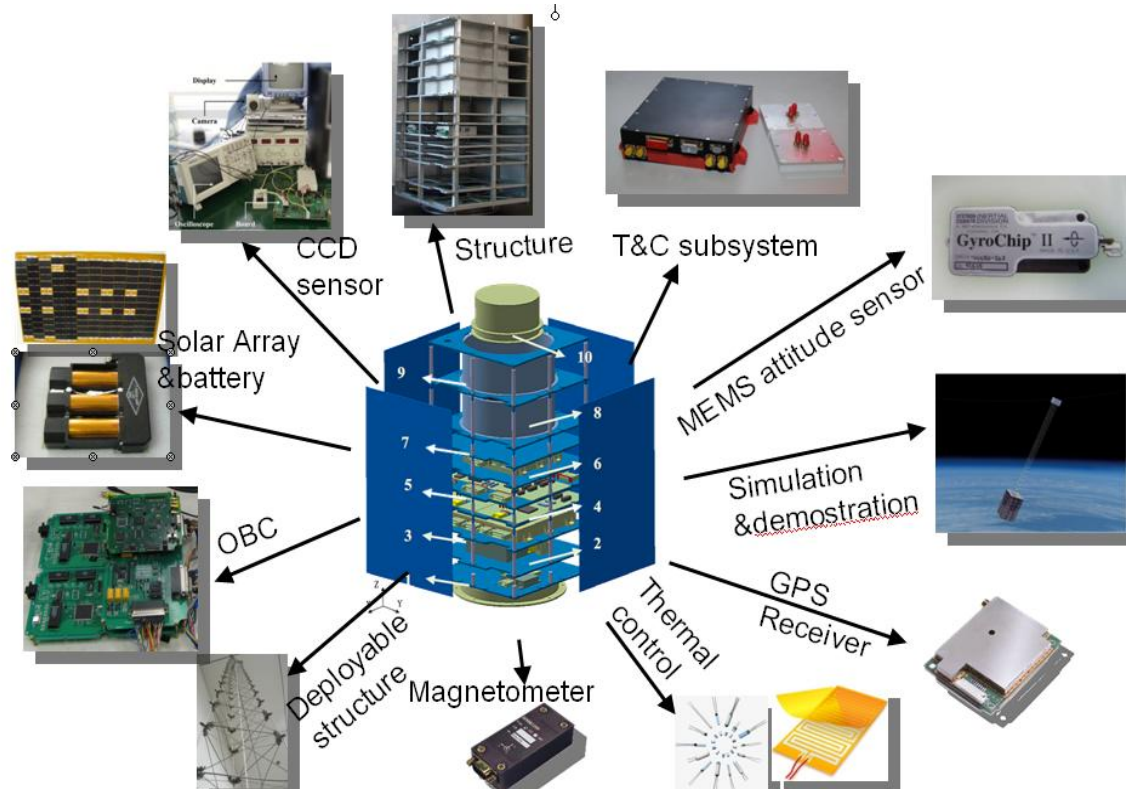
Subsystem	Characteristics
Structure	Layer-Rod Structure
Mechnism	2-meter long Coilable Mast
Thermal	Passive Control/MLI
Command and Data Handle	Base on ARM and CAN Bus
Electrical Power Subsystem	Body Mounted Solar Array, Lithium-ion batteries, Control Device
TT&C	S-band Transceiver UHF/VHF receiver
AOCS	Magnetometer, Coarse Sun sensor, GPS, Magnetrorque
P/L	Three Cameras and FPGA Control Board



3. Spacecraft Overview

3.3 System Characteristics

- **Dimension:** 300*300*500mm³
- **Weight:** 30~50kg
- **Orbit:** 600km Sun-synchronous
- **Power Supply:** 18W
- **Payload:** 3 Camera
- **Lifetime:** 3 months



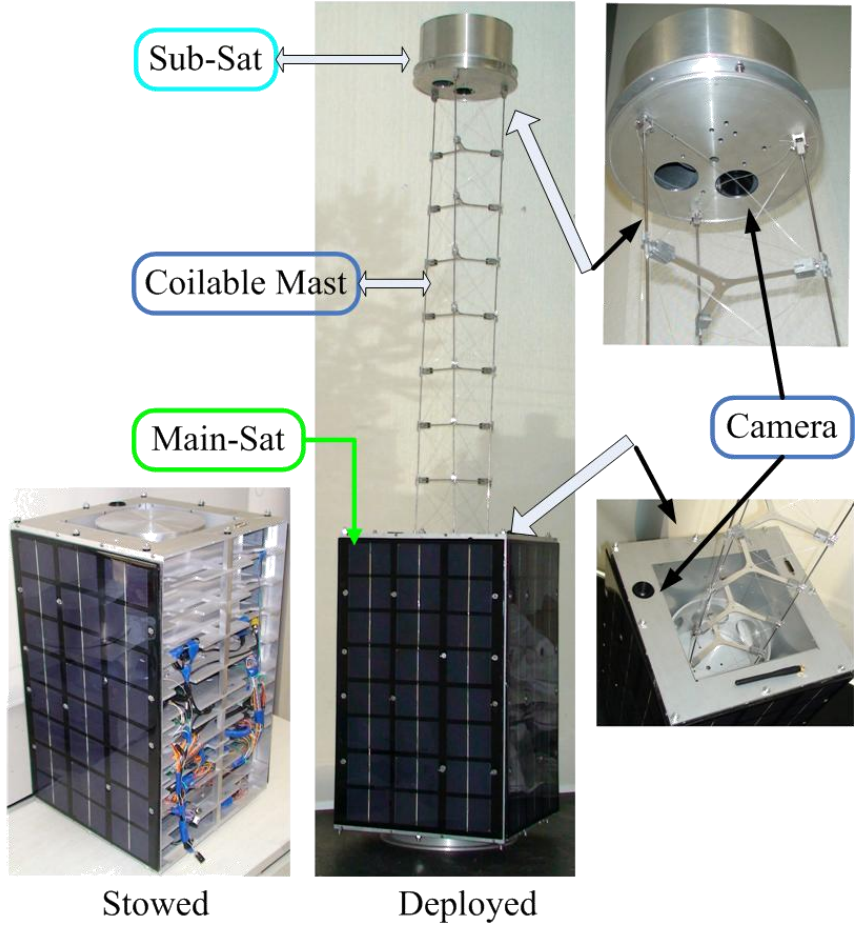
4. Key Technologies & System Tests

4.1 Structure

- Made of Duralumin alloy
- Layer-Rod Configuration

Main-satellite: 300 × 300 × 500mm

Sub-satellite: Φ100 × 100mm

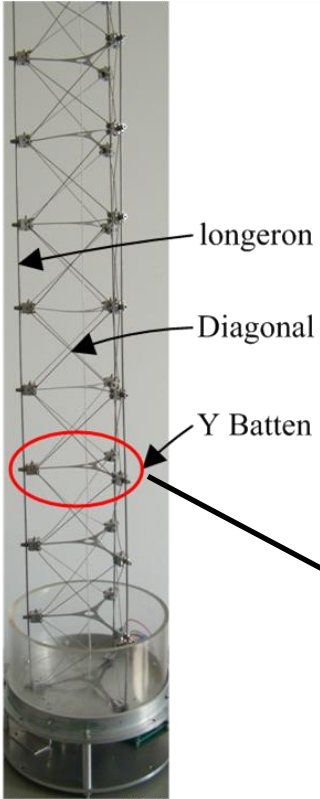


4. Key Technologies & System Tests

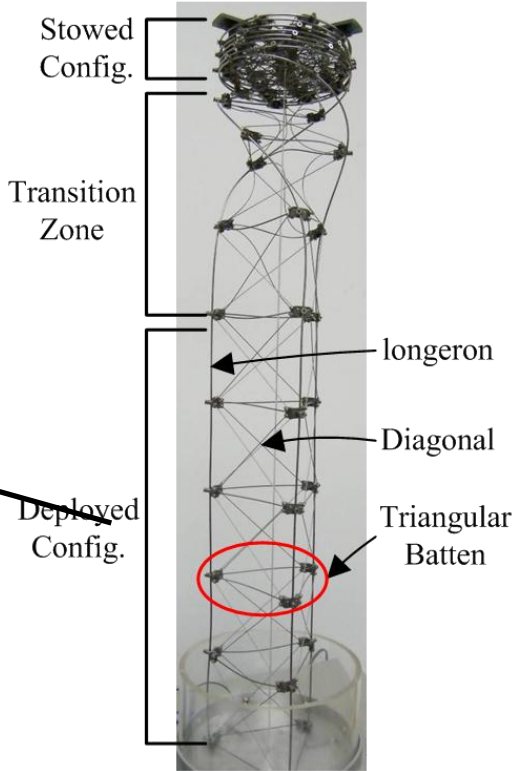
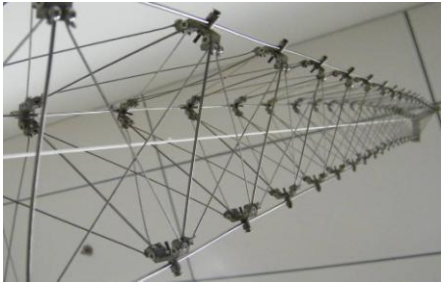
4.2 Coilable Mast

•Consists of longeron, diagonal and Batten.

Two Type According to the Batten style:
1. triangular Batten
2. "Y" type Batten



Y Batten
Coilable Mast

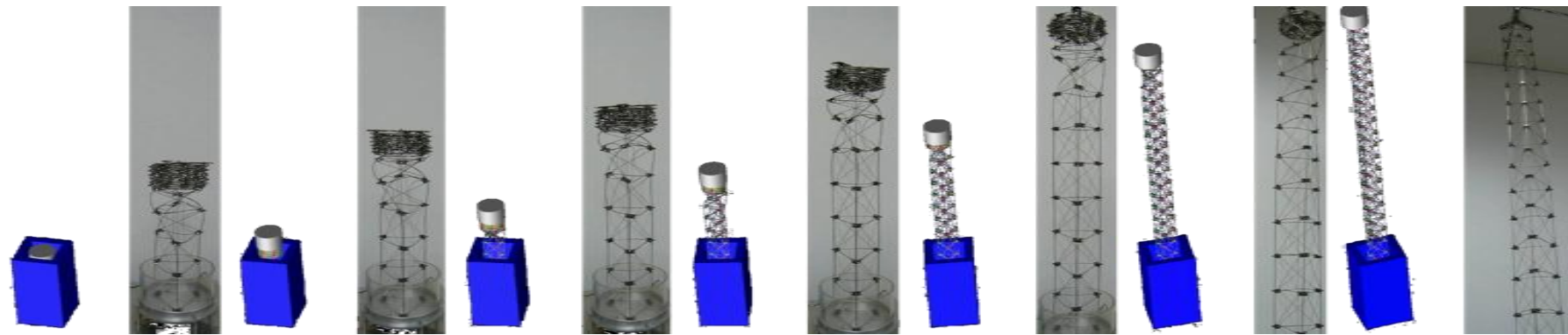
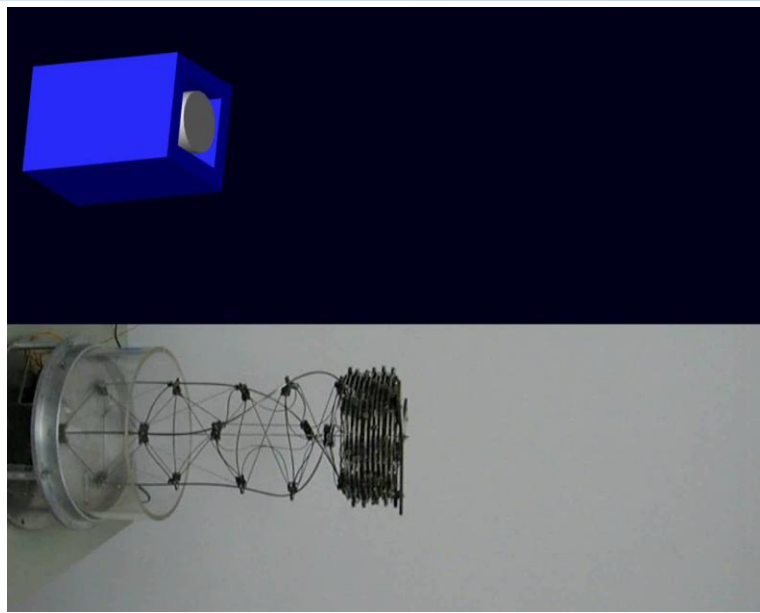


Triangular
Coilable Mast



4. Key Technologies & System Tests

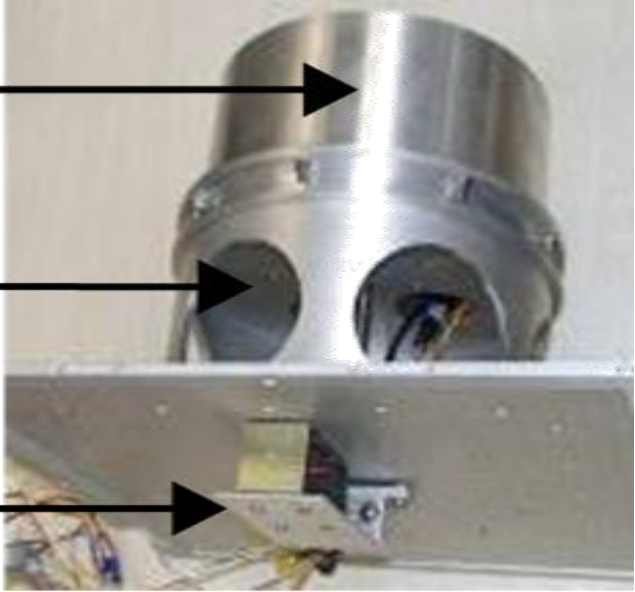
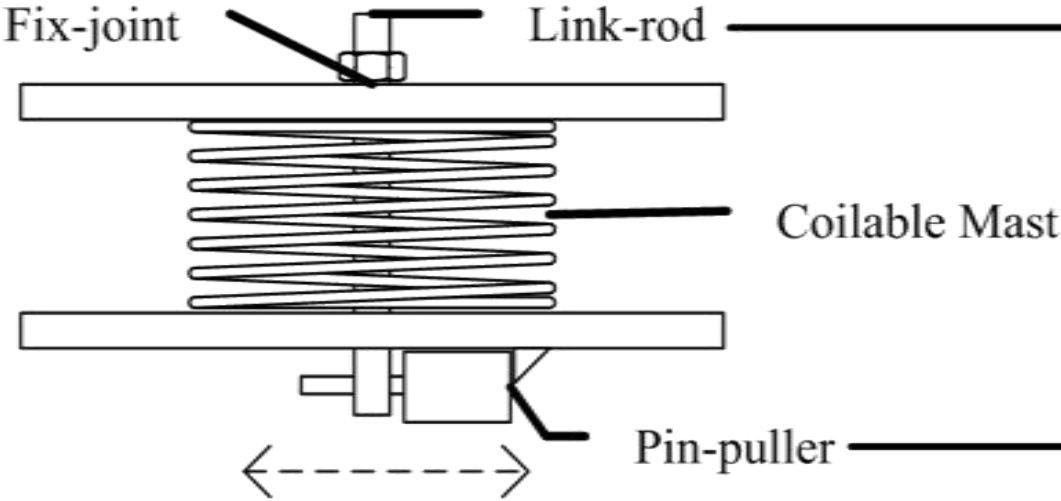
Coilable Mast Verification by the test



4. Key Technologies & System Tests

4.3 Locking & Releasing Device

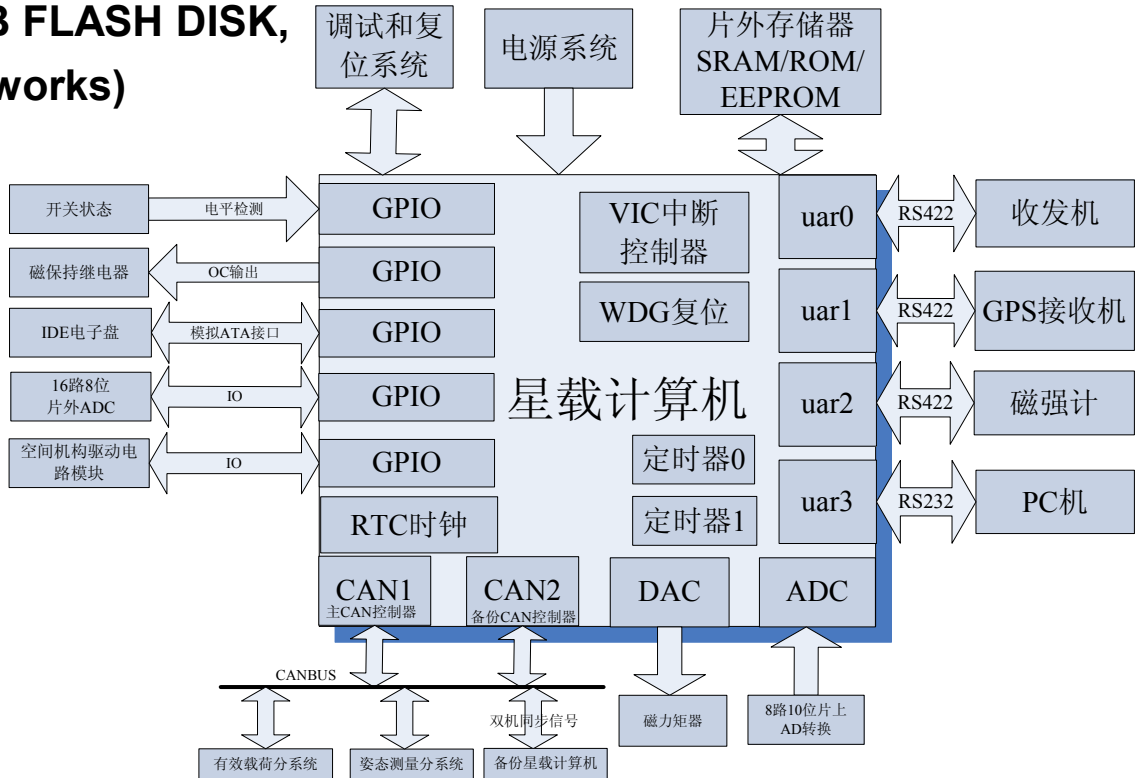
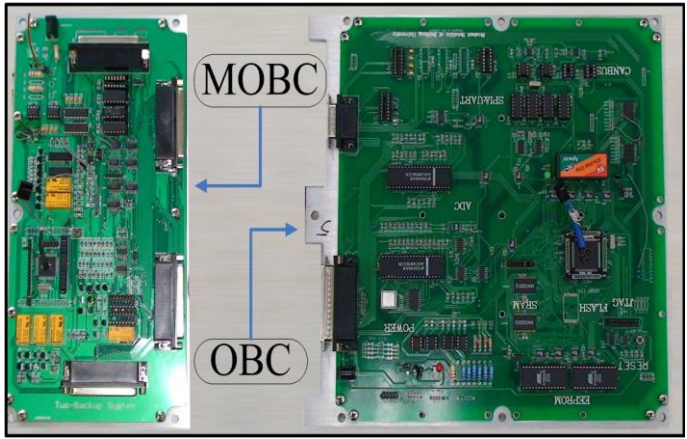
Lock and Release the mast



4. Key Technologies & System Tests

4.4 On-board computer

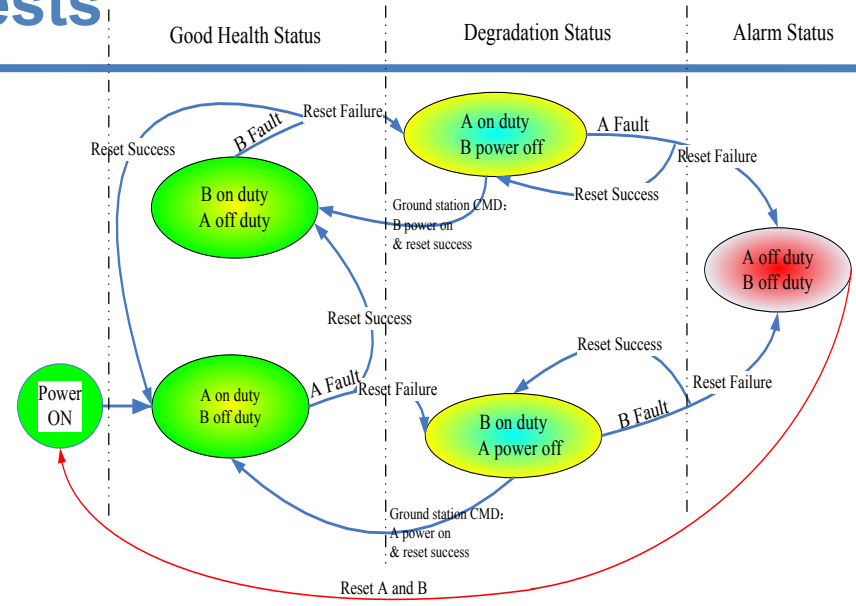
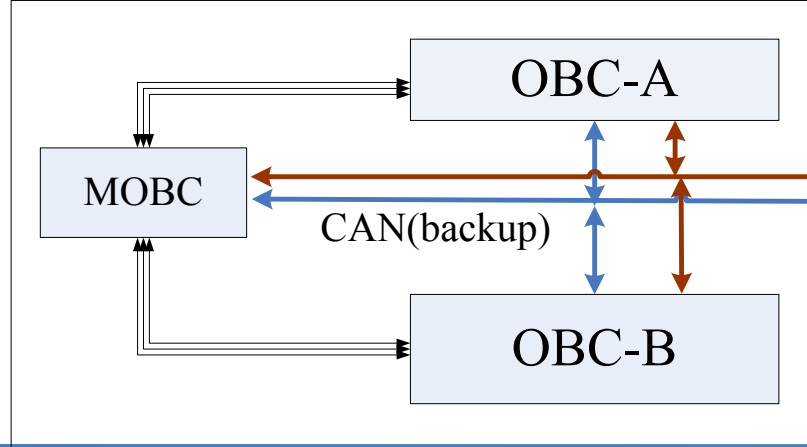
- Fault Tolerant Based on COTS
- ARM CPU @48MHz,
- 32KB PROM, 2MB SRAM, 128MB FLASH DISK,
- CAN bus 500kbps, I/F, RTOS(Vxworks)



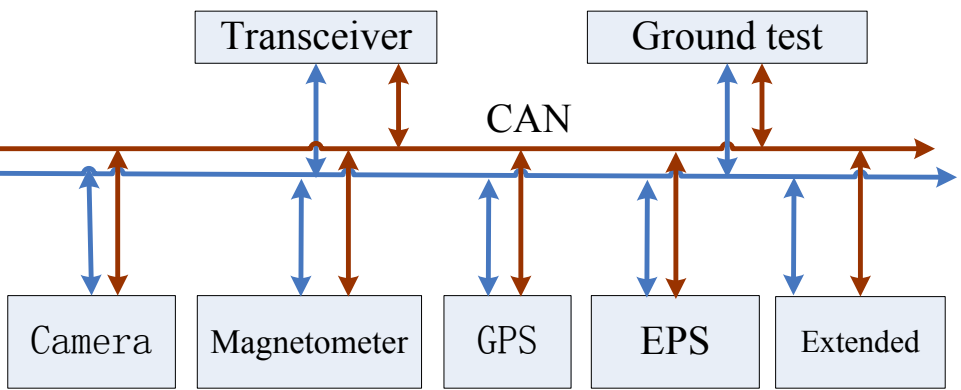
4. Key Technologies & System Tests

On-board Data Handle (OBDH)

- OBDH subsystem consists of
- OBC-A
 - OBC-B (backup)
 - Monitor OBC (MOBC) monitor A and B.(2+1)



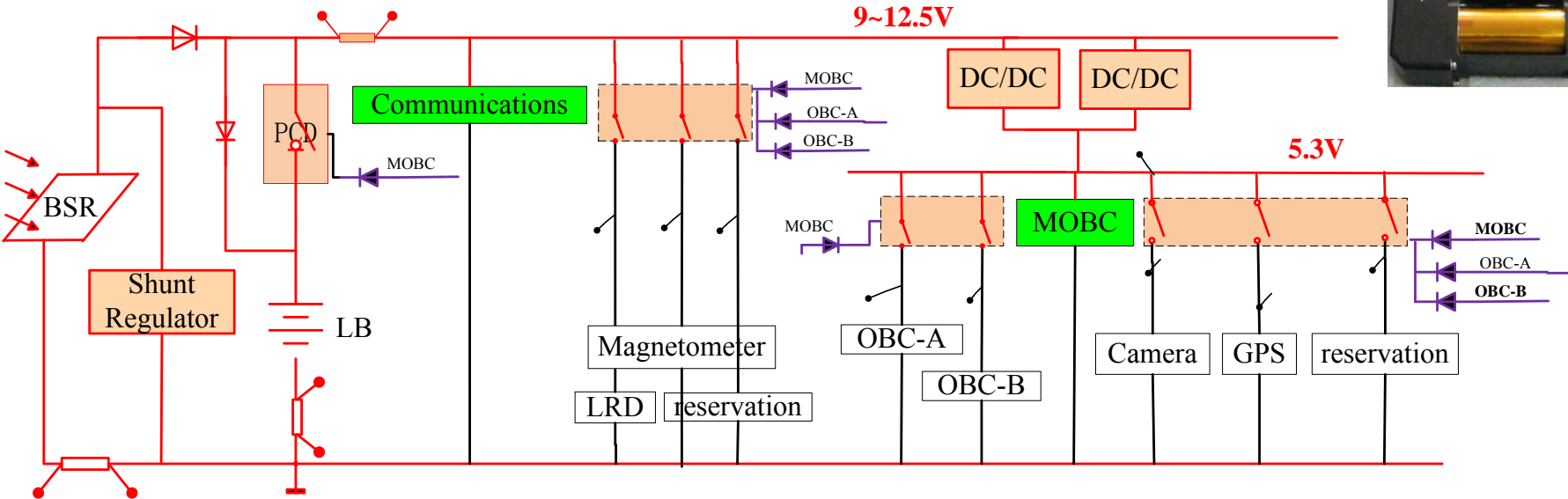
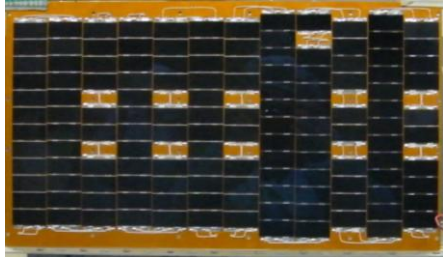
On-Board Software FDIR Strategy



4. Key Technologies & System Tests

4.5 Electrical Power Subsystem (EPS)

- Body-mounted Solar Array
- Lithium-ion Batteries
- Power Control
(unregulated voltage: 9~12.5V; regulated: 5.3V)

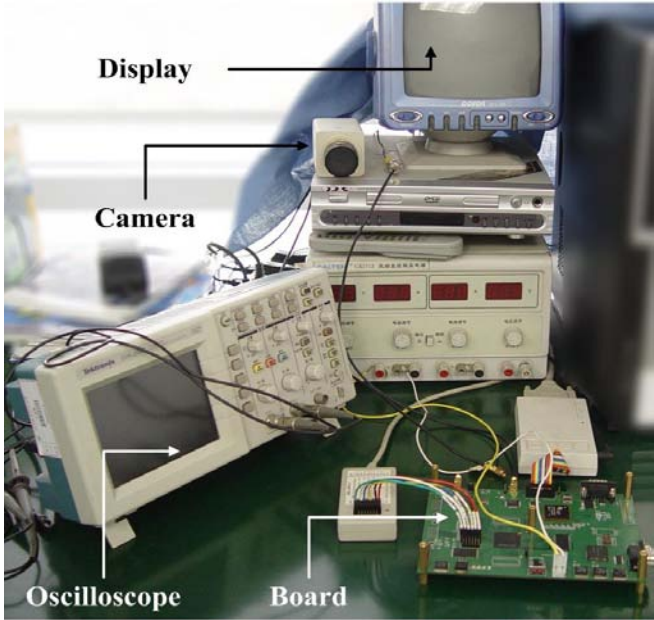
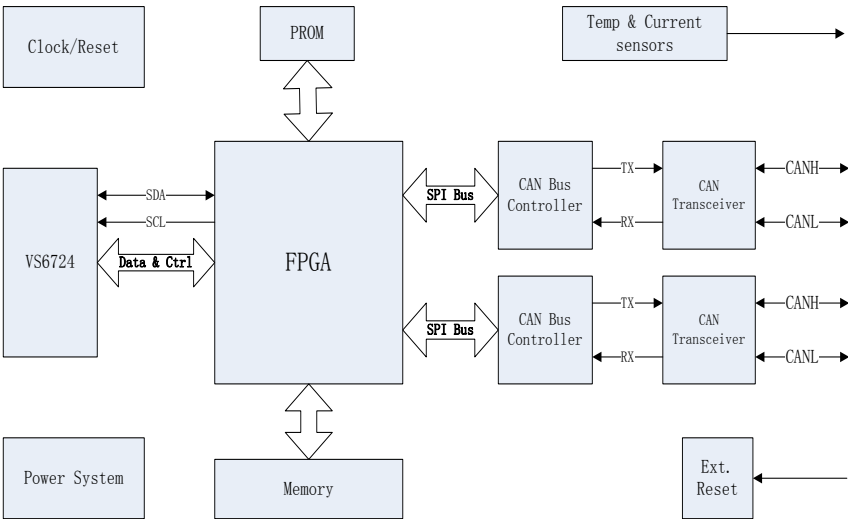


4. Key Technologies & System Tests

4.6 Payload Subsystem

P/L Consists of

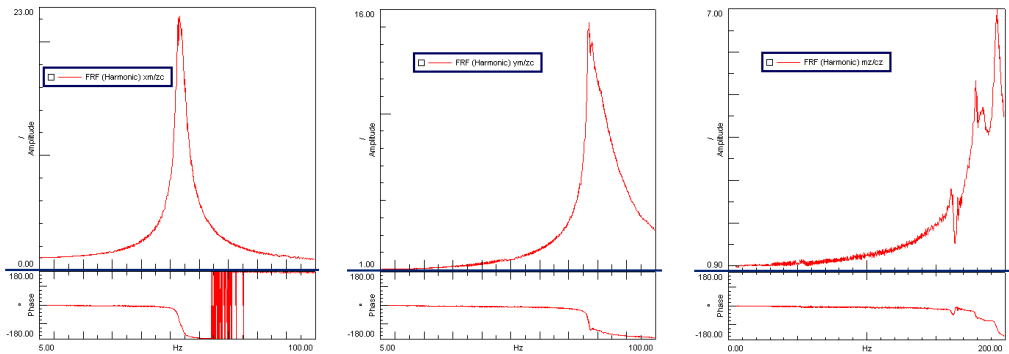
- 3 Cameras
- 1 Image Compression and Transmission Board
(Image of Main-satellite, Sub-satellite, Mast and the Earth)



4. Key Technologies & System Tests

4.7 BUAA-SAT System Test(1)

I. Structure Vibration Test



Vibration Testbed

II. Random vibration test

	Require(Hz)	Test(Hz)	Analysis(Hz)
Transverse(x)	>12	53.5	46.058
Transverse(y)	>30	65.5	47.134
Longitudinal	>20	193.5	115.53

4. Key Technologies & System Tests

4.7 BUAA-SAT System Test(2)

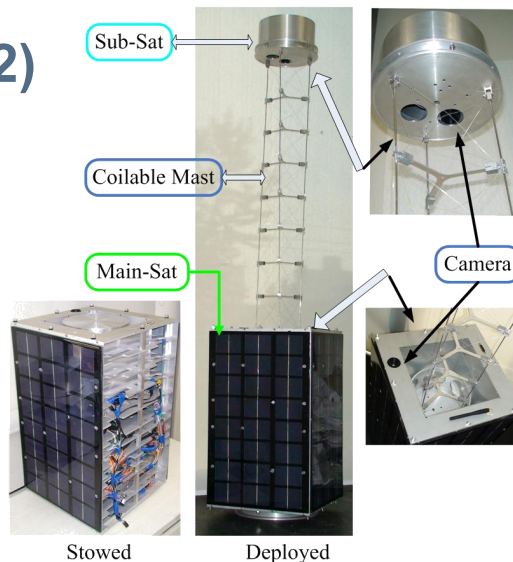
III. System Integrated Test

i). Function Test:

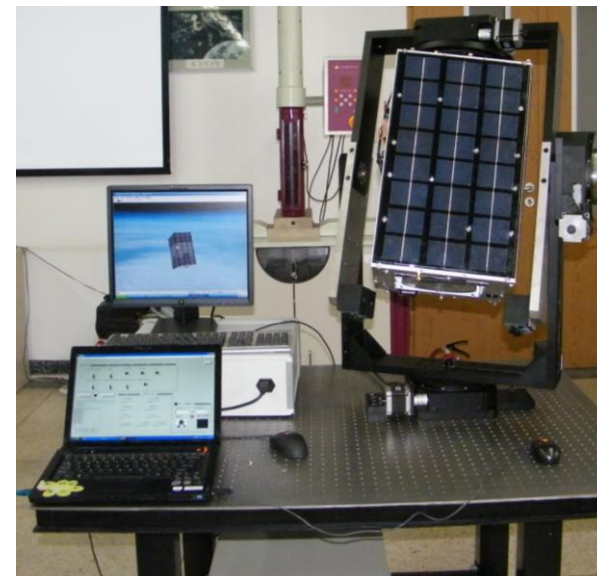
- Power Supply
- Transceiver
- P/L data Processing
- OBDH Management
- Attitude Determination
- Mast Deploying

ii). Platform Ground Test

- BUAA-SAT System
- 3-axis Rotate-Platform
- Visual Simulation System (VSS)
- Virtual Ground Station (VGS)



System Integrated Test



Platform Ground Test



4. Key Technologies & System Tests

4.7 BUAA-SAT System Test(3)

IV. Vacuum Environment Test

i) Coilable Thermal Test

- **Operation Temperature:**
-20°C~120 °C。
- **Vacuum Environment:**
<10-7Pa Vacuum would be needed to test Cold Welding effect.



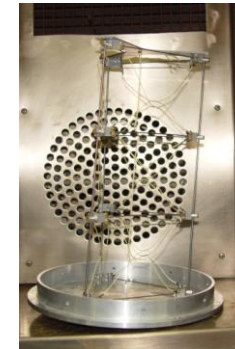
Heating Cage Facility



Vacuum Chamber



Thermal Vacuum Test

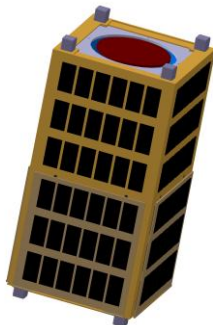
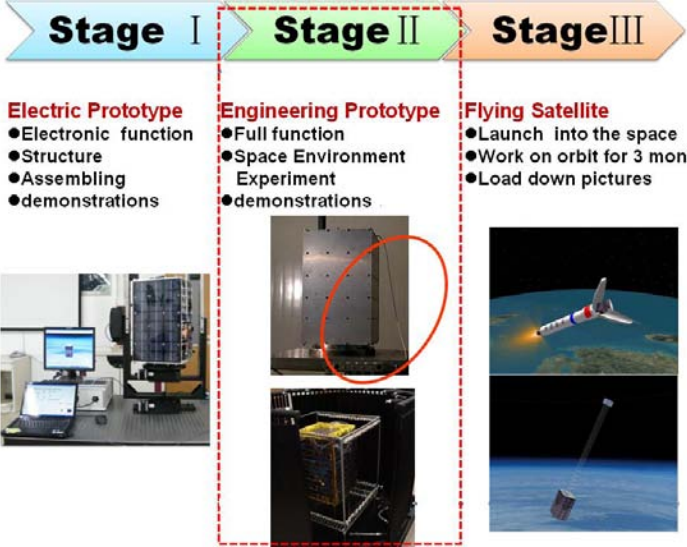


High/Low Temperature Test

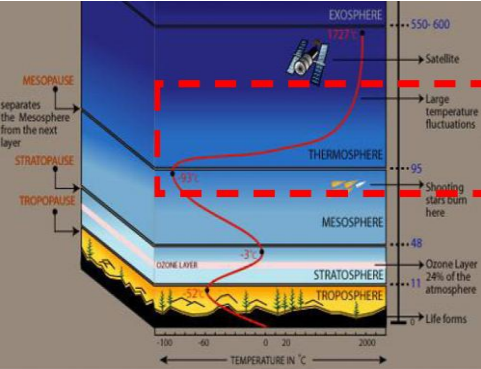


5. Future Work

- I. Work on Stage3:
**BUAA-SAT Flight Model;
 Aerospace Engineering Problems
 Considered;**
- II. Looking for Launch Opportunities
**Long March Piggyback
 or Abroad Commerical Launch?**
- III. Finding Financial Assistance
???
- IV. University Collaborations
BUAA-Picosat Space Exploration



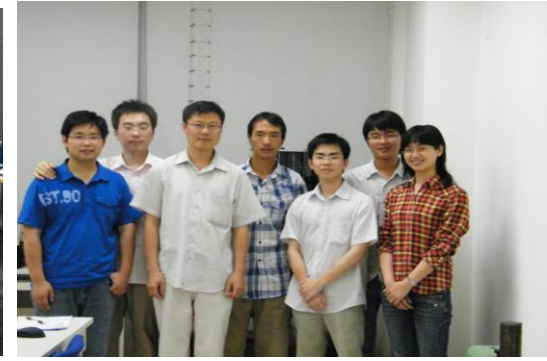
BUAA-Picosat



6. Conclusions

- **BUAA-SAT Ground Prototype Model Accomplished;**
- **Students' Aerospace Engineering Experience obtained;**
- **An Experienced R&D team has been trained;**

**Young Creative Talents
Are Precious Wealth in 21 Century**





北京航空航天大学

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Thank you

