MEMSSAT

MEMS Satellite:

a Test Bed of Micro/Nano Technologies for Space

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4th Round Table on Micro/Nano Technologies for Space
Presentation, May 21, 2003

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Concept

- ***MEMSSat*** is the name given to a kind of Nano-/Pico-satellite, which is based on MEMS Technology, and as a test bed of Micro/Nano Technologies for space.

Outline

- Mission Overview
- Configuration & Budget
- Structure
- Power System
- Attitude Determination and Control System
- On Board Network
- Payload & Experiment
  - Micro Imaging System (CMOS Camera)
  - Micro GPS Receiver
  - Micro Inertial Measurement Unit (MIMU)
  - Micro Propulsion
  - Micro Magnetometer
- Conclusions

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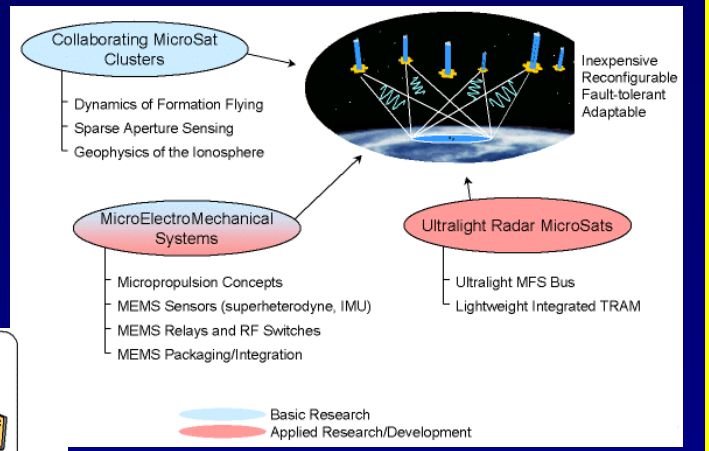
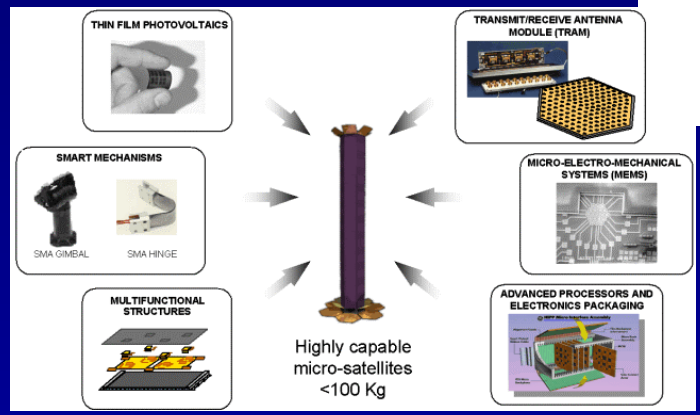
Mission Overview(1)

- As test bed of MNT for space

With considerations of expensive cost and high risk of space mission, new technologies are hoped to demonstrate before their orbit flight. Without interfering natural satellites and existing space missions, MEMS satellite is put forward as a test bed of micro/nano technologies for space.





(Pictures from TechSat21)

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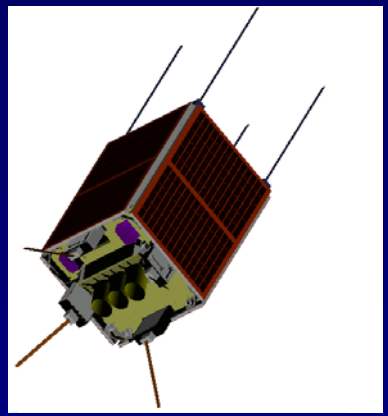
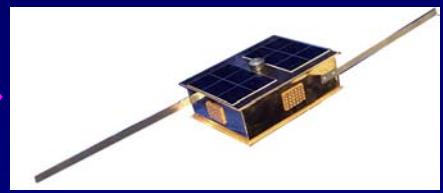
Mission Overview(2)

- Explore Picosatellite





Tsinghua-1 Microsatellite

Mission: Globe disaster forecast & Scientific experiments

Launch Date: June, 2000

Manufacture: Tsinghua University SSTL, and CASIC

THNS-1 Nanosatellite

Mission: Technology Demonstration

Manufacture: Tsinghua University Hangtian Tsinghua Sat. Tech. Ltd

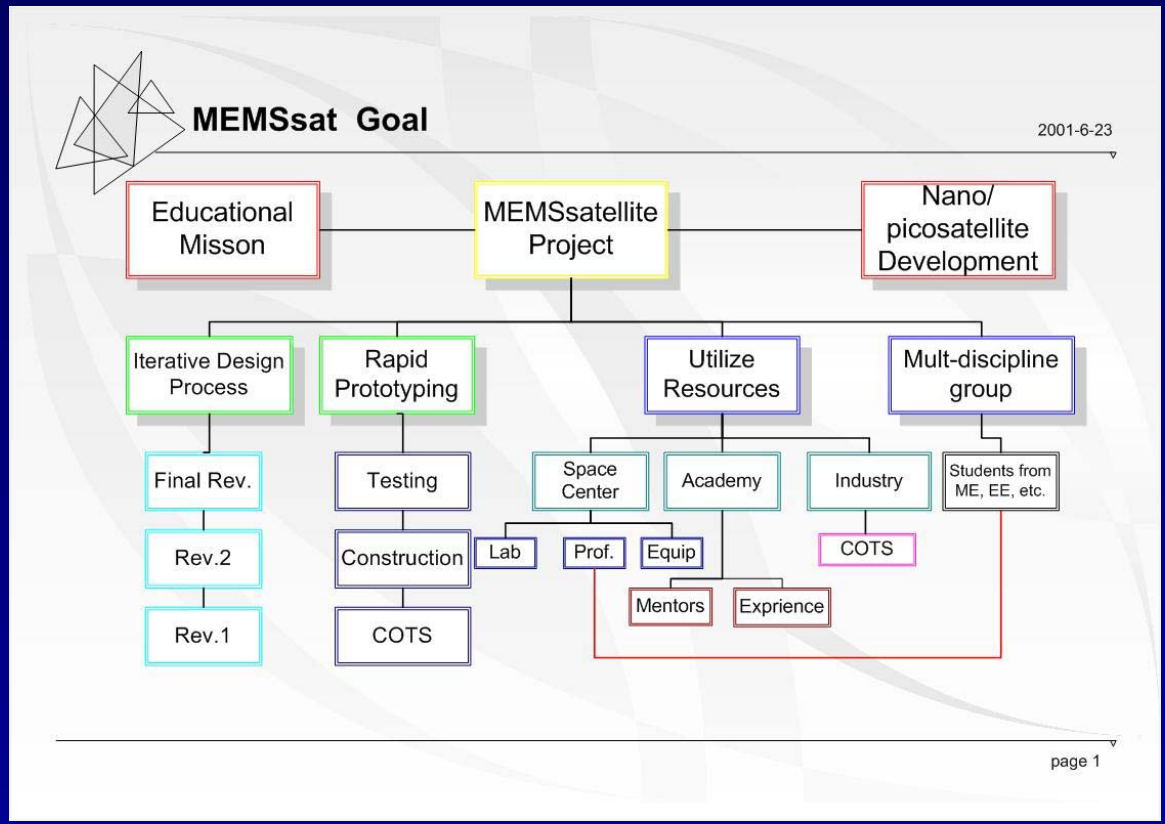
MEMS Satellite

Mission: MEMS Test & Demonstration

Manufacture: Tsinghua University

Mission Overview(3)

- Education Goal



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Configuration

Physical Characteristics		
Envelope	200mmX200mmX100mm(approx.)	
Mass	3kg(approx.)	
Primary Platform Subsystem		
Attitude Control	Micro magnetometer Magnetorquer	3-axis stable
Solar Panels	GaAs panel	Body-mounted
Batteries	Li-ion battery	
On-Board Computing	32BIT STRONGARM 1110 4MRAM	
On-Board Network	RS232 Serial Bus	
Payload & Experiment		
Micro Imaging System	Four CMOS cameras	
Micro GPS Receiver	Experimental receiver & obit determination	
MIMU Experiment	Micro-accelerometer & microgyro	
Micro Propulsion Experiment	Attitude control and obit maneuver	
Micro Magnetometer Experiment	3-axis attitude determination	

Budget

Module	Component	Mass(g)
Mechanical Structure	Frame	200
ADCS	Electrocircuit	100
	Micro magnetometer	100
	Magnetorquer	40
OBDH	Electrocircuit	100
	On-board Computer	200
Communication	Electrocircuit	140
	Receiver	100
	Transmiter	100
	Antenna	50
Power	Electrocircuit	100
	Battery	100
	Solar panel	200
Other	Connector	50
Payload	Micro propulsion	100
	GPS receiver	150
	CMOS camera	750
	MIMU	400
SUM		3030

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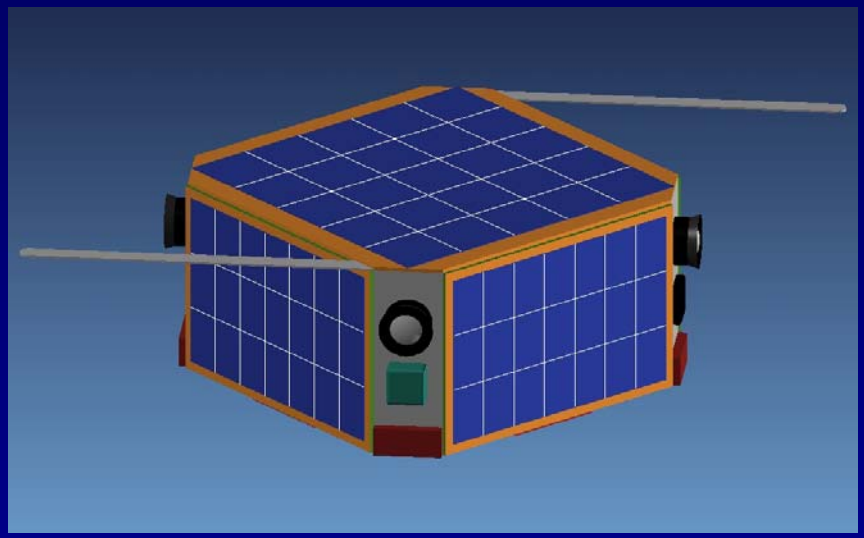
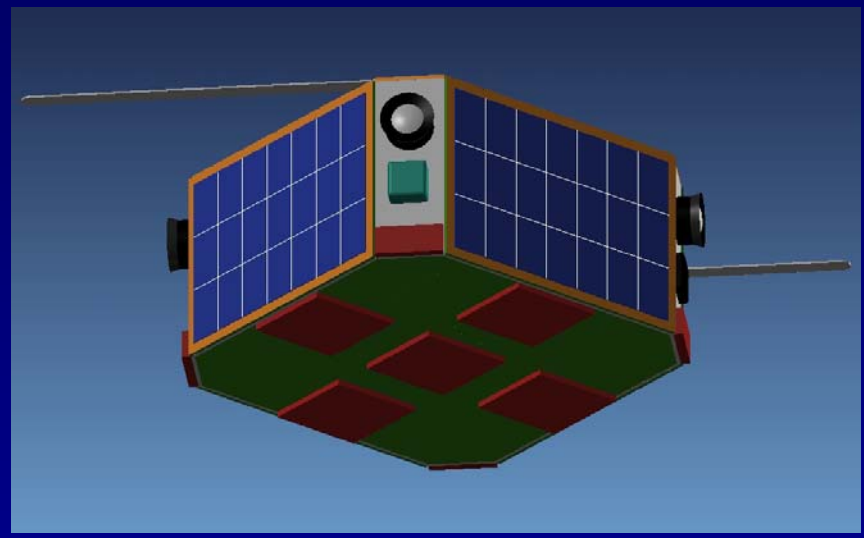
Structure(1)-Profile





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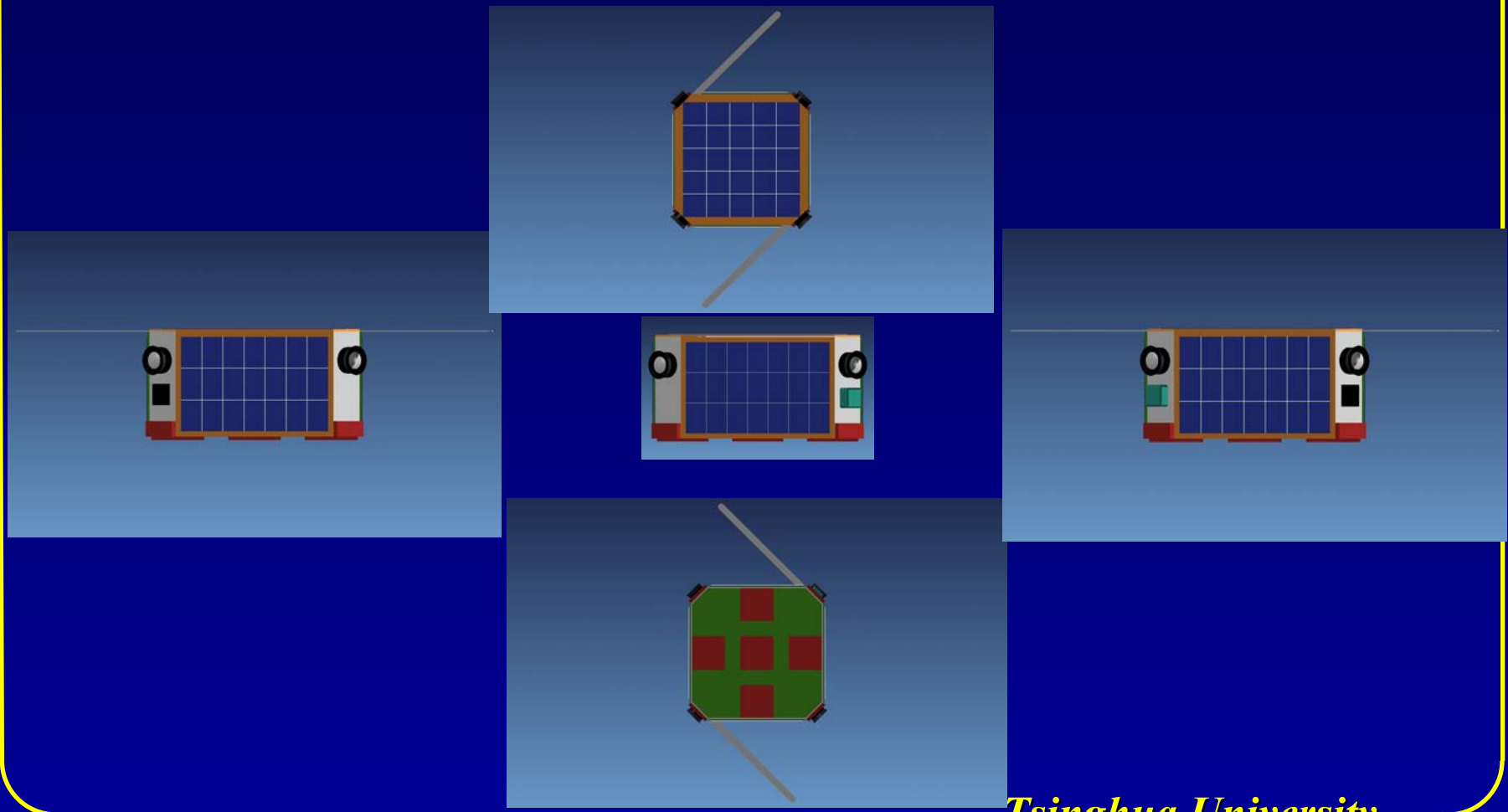
Structure(2)-View



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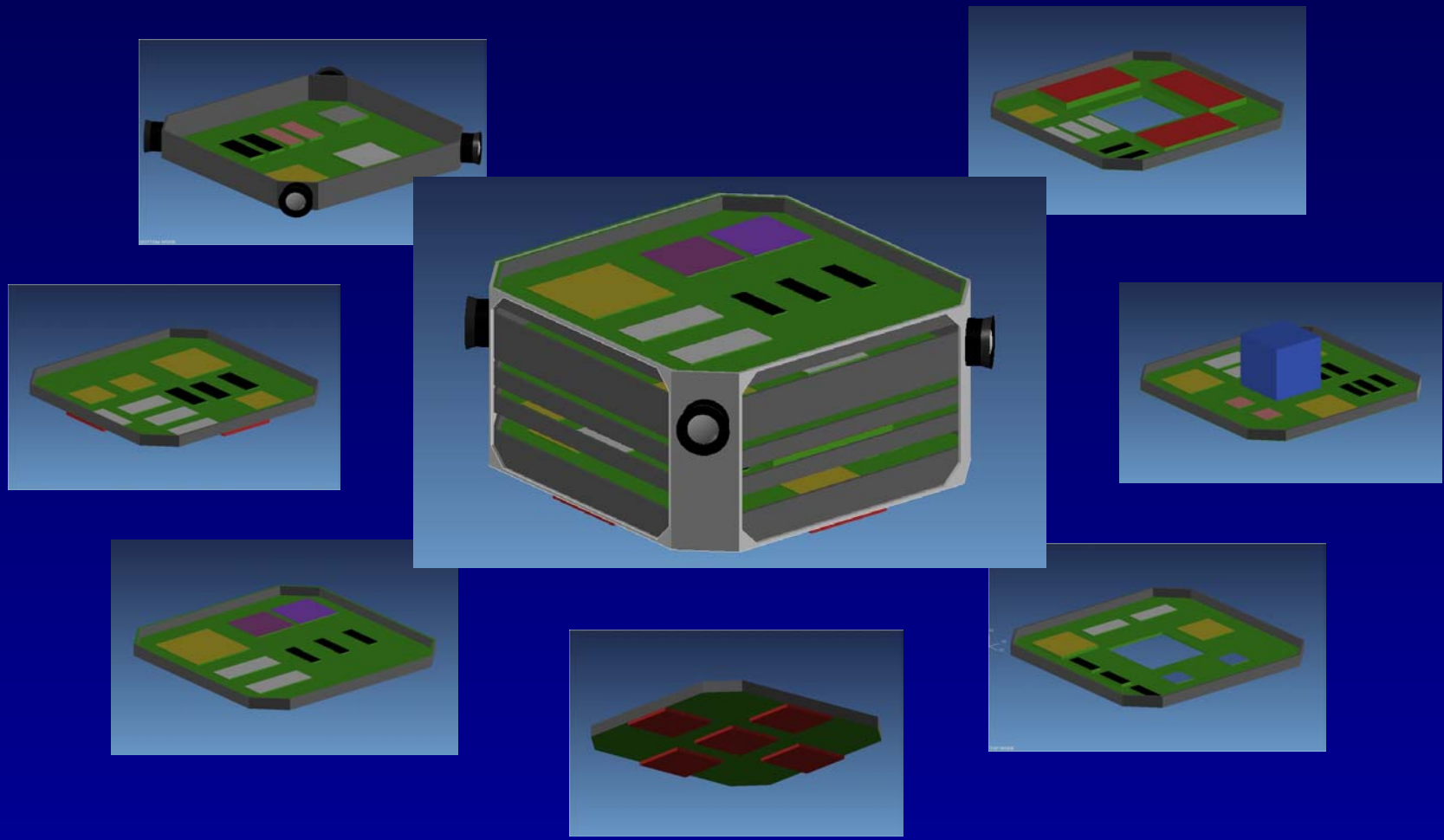
Structure(3)-Interior



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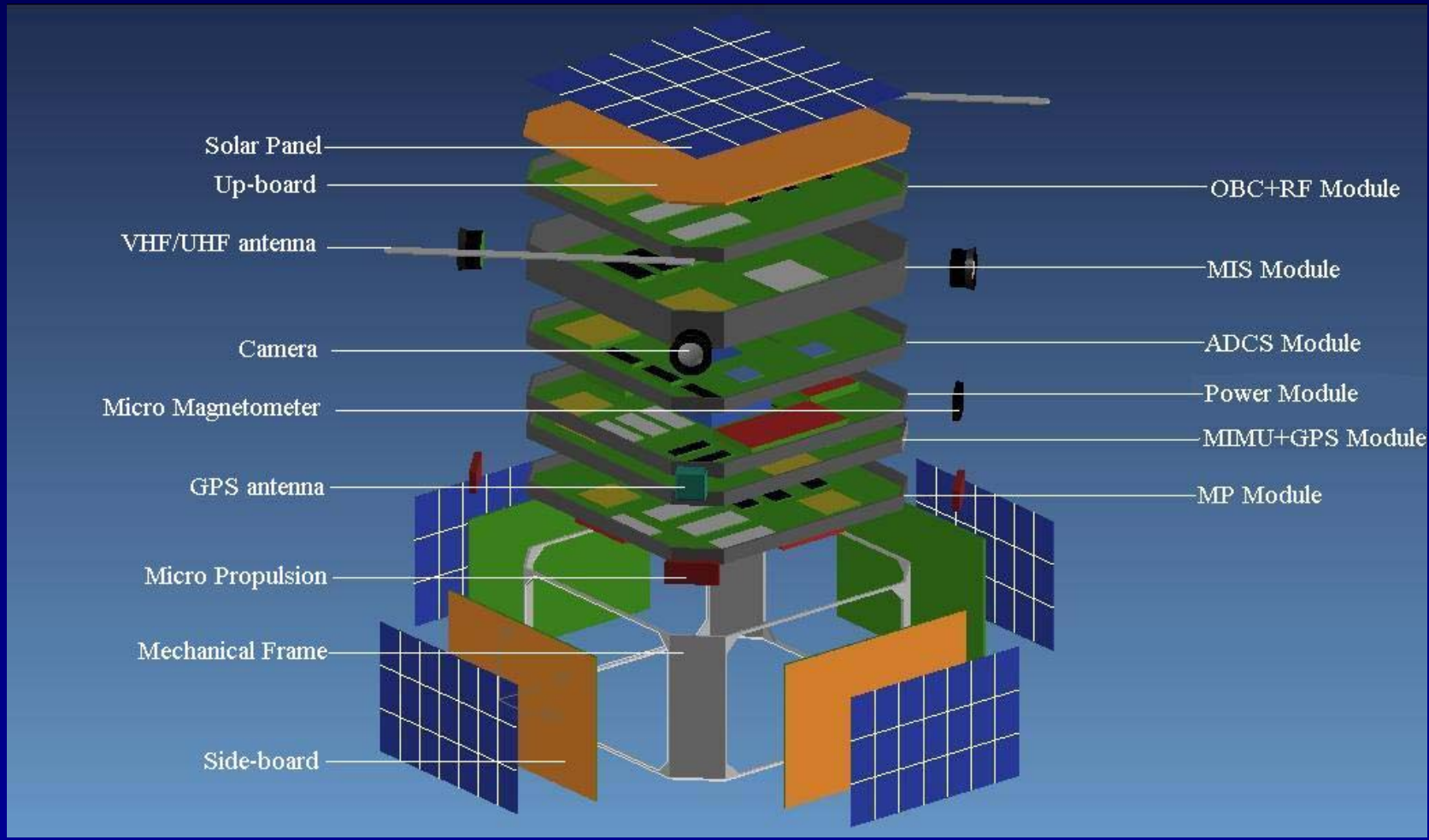
Structure(4)-Explosion



Power System(1)

- The power system is comprised of:
  - 5 solar panels (GaAs)
  - battery packs (Li-ion)
  - Battery Charge Regulator (BCR)
  - Power Condition Module (PCM)
- Peak output power: 2 watts
- Average output power: 1 watts.

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Power System(2)

- Estimating

Formula:

$$A = \frac{P}{1.7 \times 1353 \times Ii \times Is \times e^{-fN} \times U \times Pa}$$

Conclusion:

If the power need is 2W, the area of each solar panel A=0.0146m^2. Actually, the area of each solar panel, which we used, is 0.015m^2.

Parameter Definition:

(1) the power of solar panel generation: P(W)

(2) sunlight factor: Is (caused by the eclipse time, typical 1/3)

(3) illumination factor: Ii (typical value is 0.7)

(4) degradation rate: e^{-fN}. N is the life time, the typical value of f is 0.025

(5) efficiency of solar cells: U (GaAs=18%)

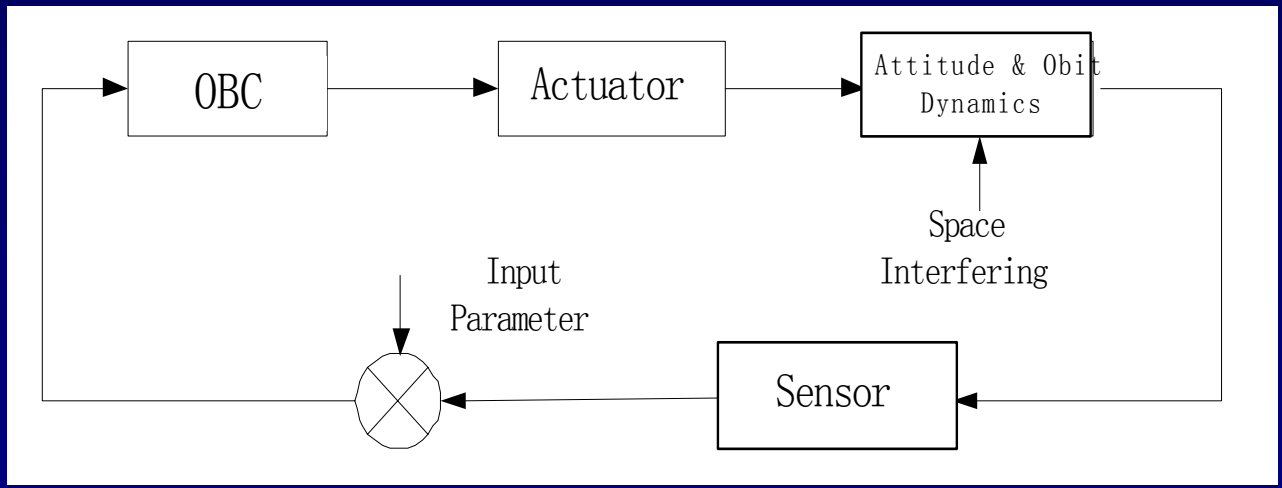
(6) packing factor: Pa (78%)

(7) illumination density: I (1353W/m^2)

(8) equal section area: T (1.7A, A is the area of one solar panel's surface, m^2)

Attitude Determination and Control System (1)

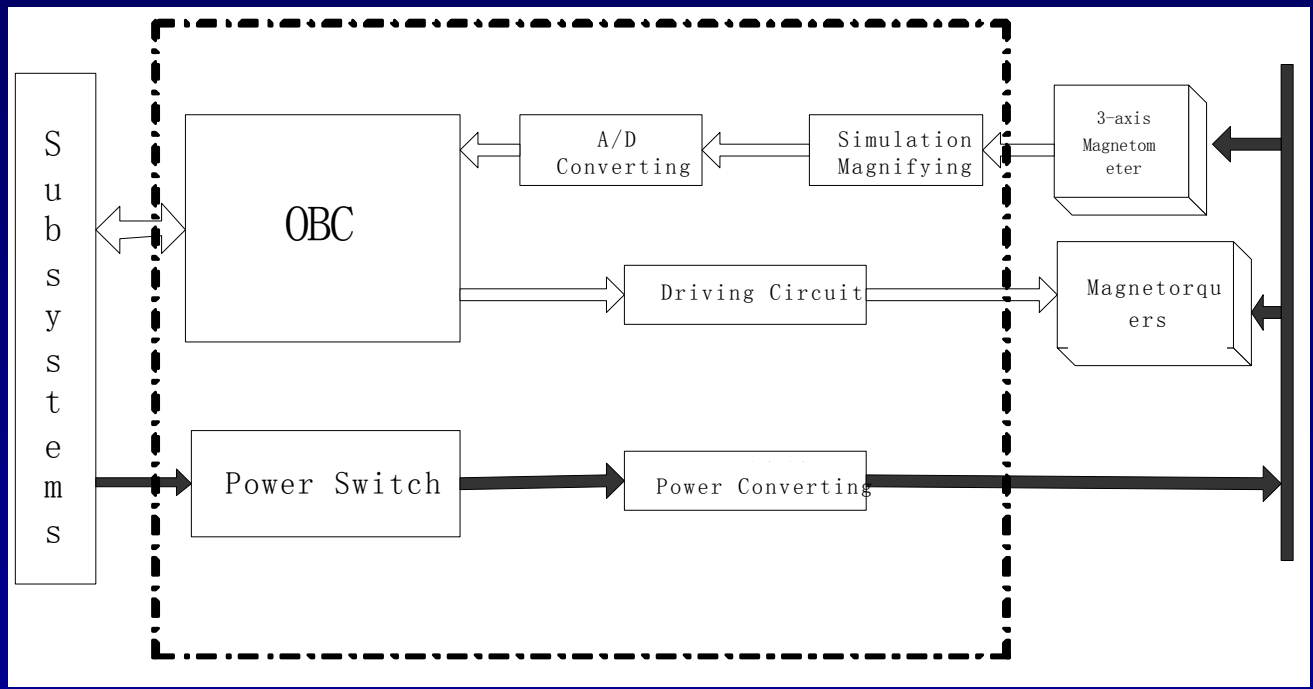
- Autonomous attitude control diagram



- Components
  - **Sensor: Magnetometer & MIMU**
  - **Actuator: Magnetorquer & Propulsion**

Attitude Determination and Control System (2)

- Operating principle diagram



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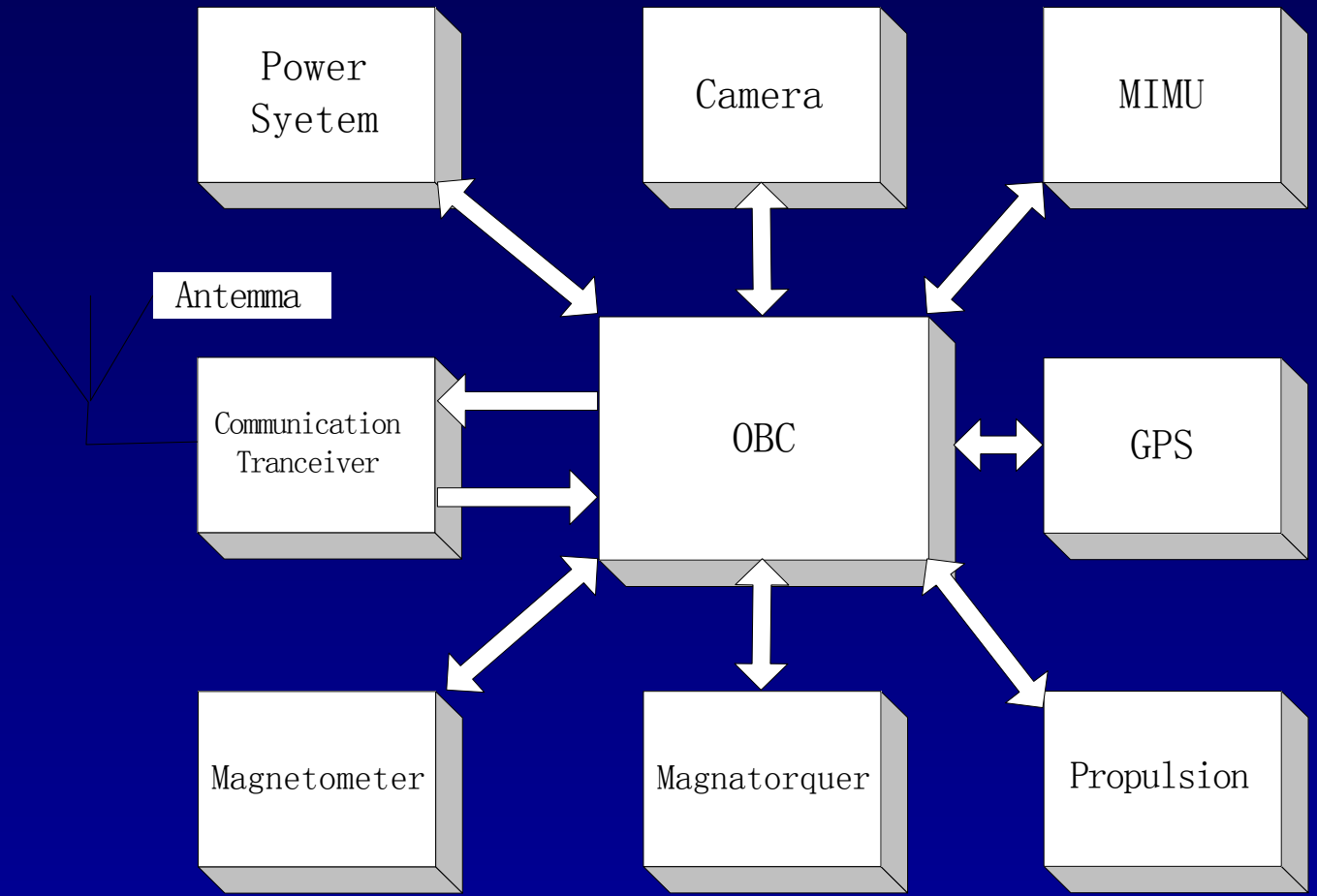
On Board Network



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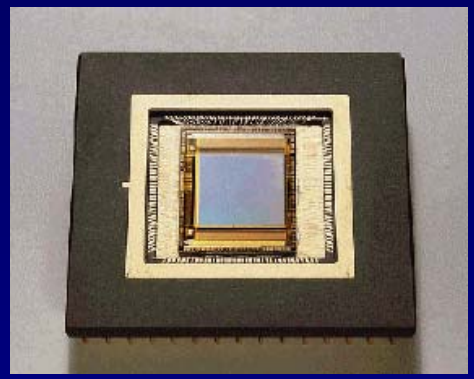
Payload(1)-Micro Imaging System

- MIS principle experiment system

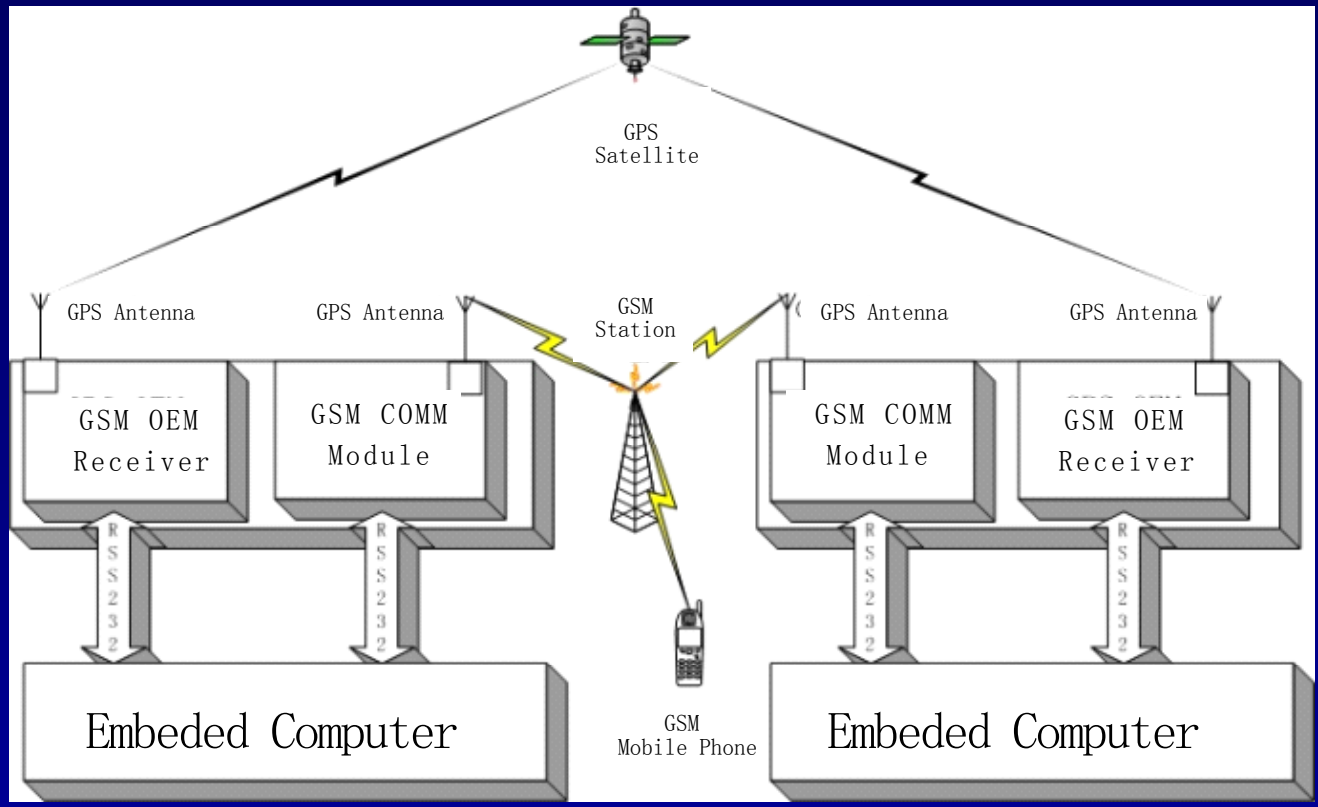


CMOS Imaging Sensor Chip

Sample

Payload(2)-Micro GPS Receiver

- GPS Demonstration & Communication Exp



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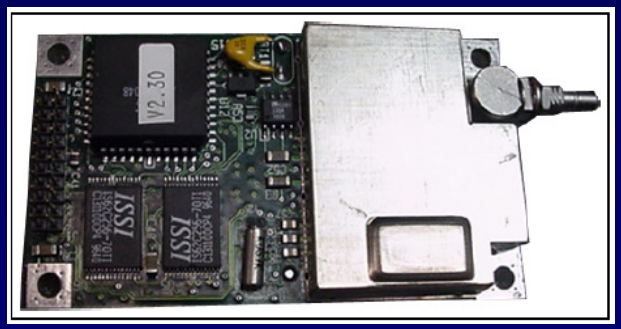
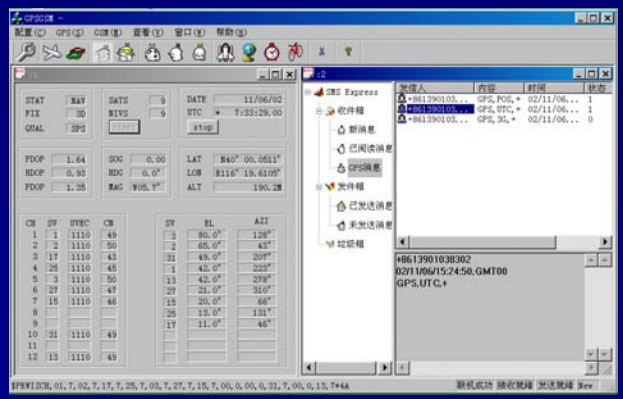
Payload(2)-Micro GPS Receiver



GPS Module

GSM Module



Software

Demo

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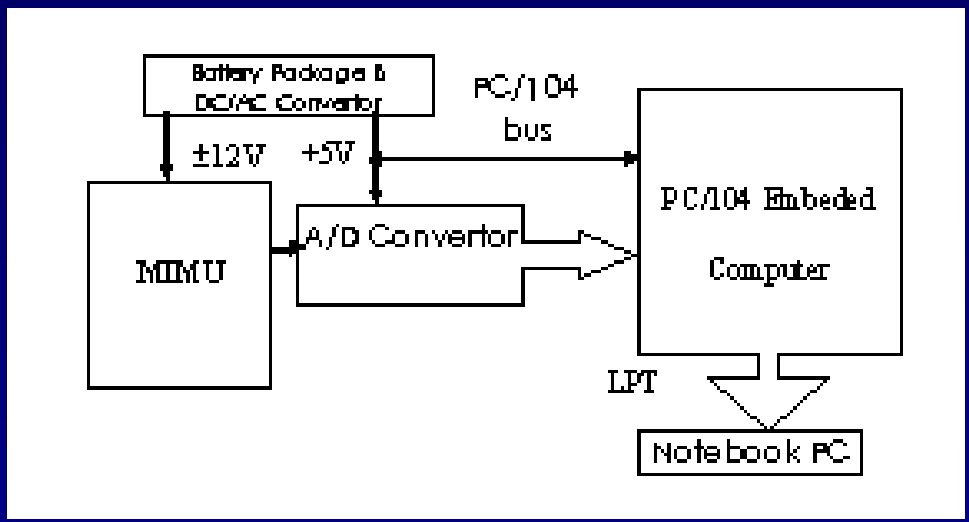
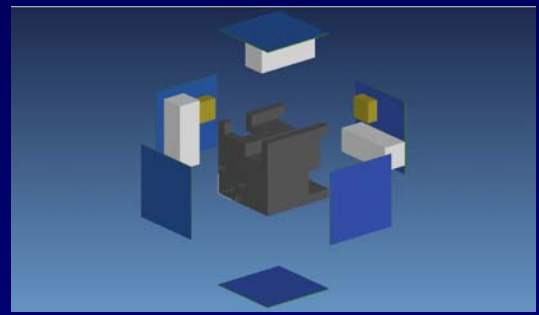
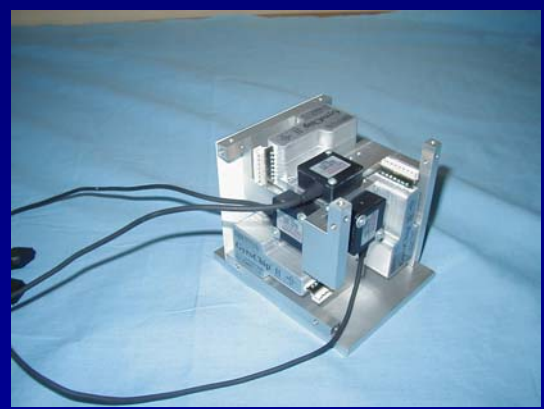
Payload(3)-MIMU

- Experiment diagram





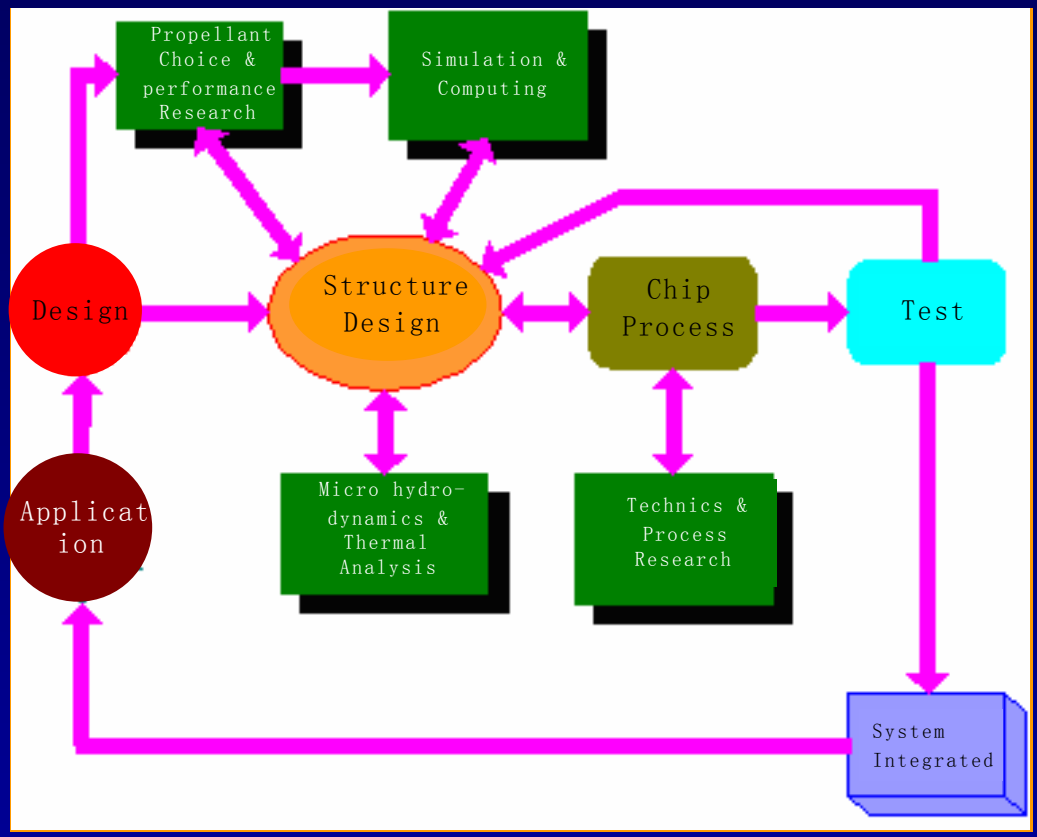
Structure



MIMU

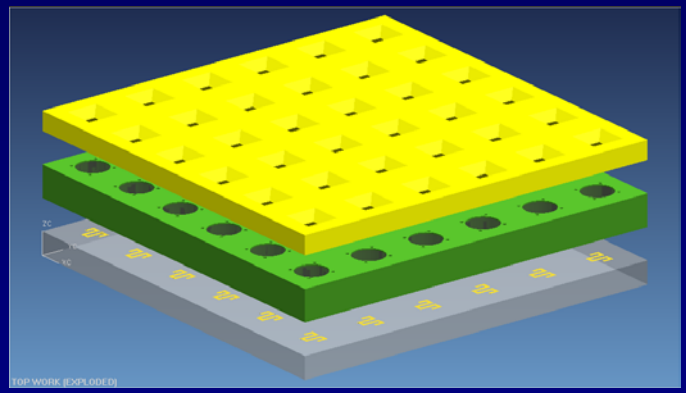
Payload(4)- Micro Propulsion

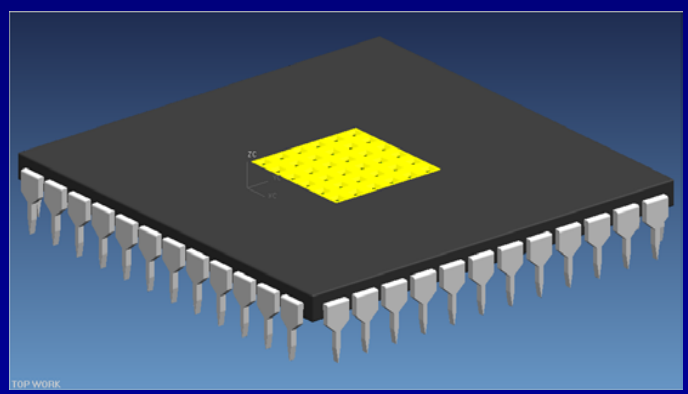
- Technology Route Diagram

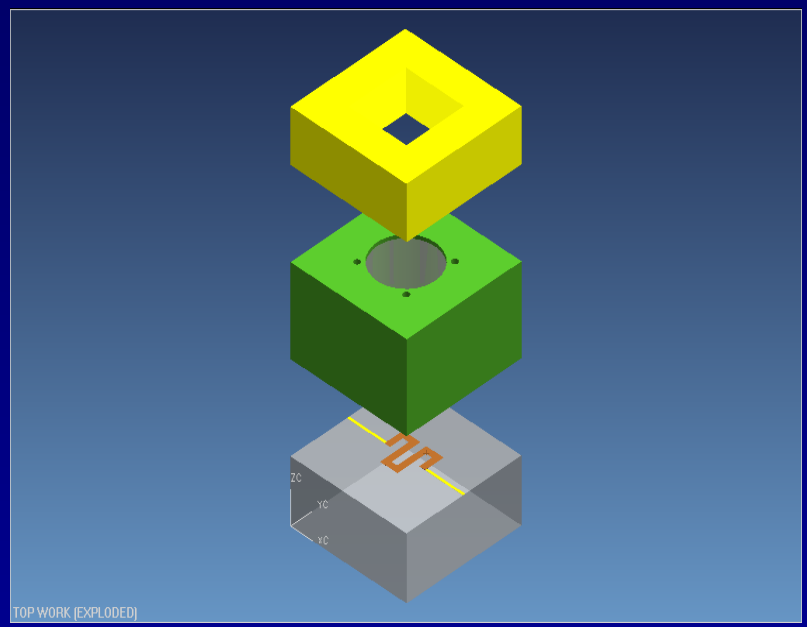


Payload(4)- Micro Propulsion

- Array & Unit Structure







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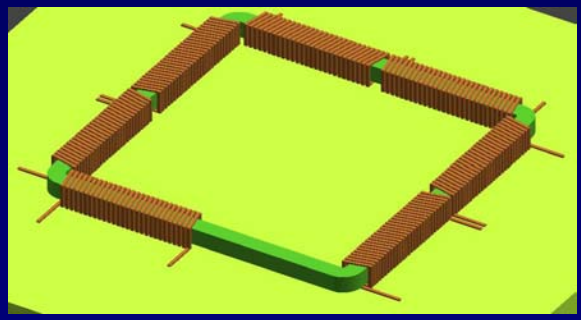
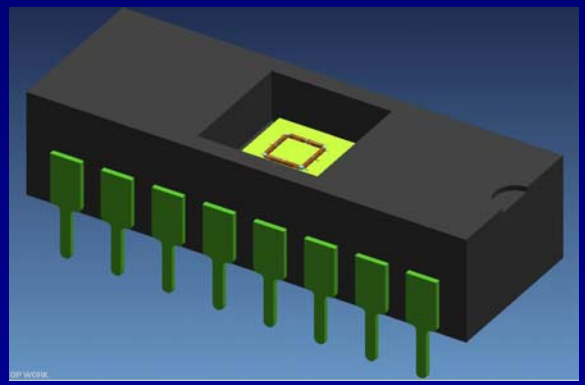
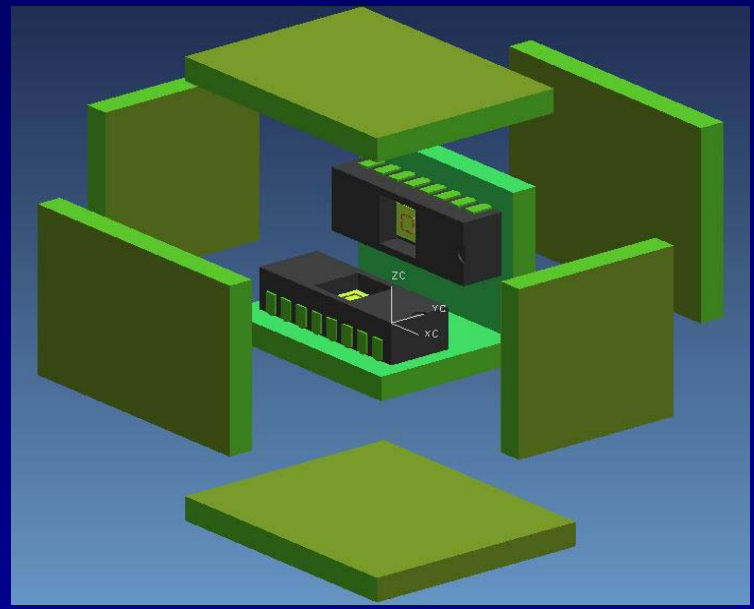
Payload(5)- Micro Magnetometer







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Conclusions

- MNT Reliability
  - Provide a flight test for MNT Reliability
  - Develop a application platform technology of MEMS
- University Teams
  - Heritage designs for rapid development
  - Undergraduate to Ph.D. education and research
- Benefits
  - Low cost demonstration of new MNT
  - Building teams for future technology demonstrations

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MEMSSat Team Members

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Thank you!