



The Third Annual Cubesat Workshop, CalPloy, April 27-29, 2006



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# **Current Status of PACE** **(Platform for Attitude Control Experiment)**

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# PACE Mission

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The mission of the PACE project is to offer students hand-on opportunities to experience through the development process of satellite design, analysis, assembly, integration, test, launch and operation.

→ **Primary experiment**

Perform three-axis stabilization of a pico-class satellite.

→ **Secondary experiment**

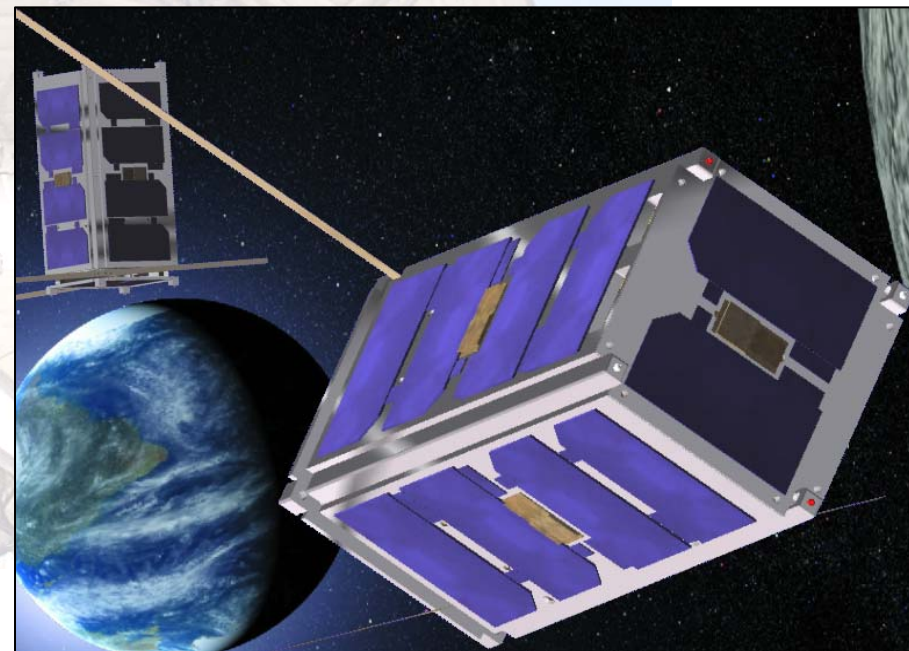
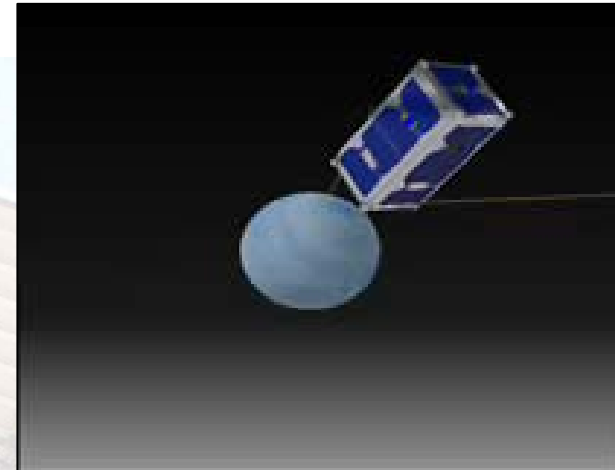
Verify self-made MEMS sensors for space applications.



# PACE Overview



- A double cube design
- Three-axis stabilization requirement
  - Pointing accuracy 5°
- Two CPU design
  - 8051-based: C&DH and ADCS
- MEMS sensor demonstration
  - Coarse sun sensor
  - Temperature sensor





# System Configuration



Sun sensor

Sun cell

C&DH & MEMS circuit

Kill switch

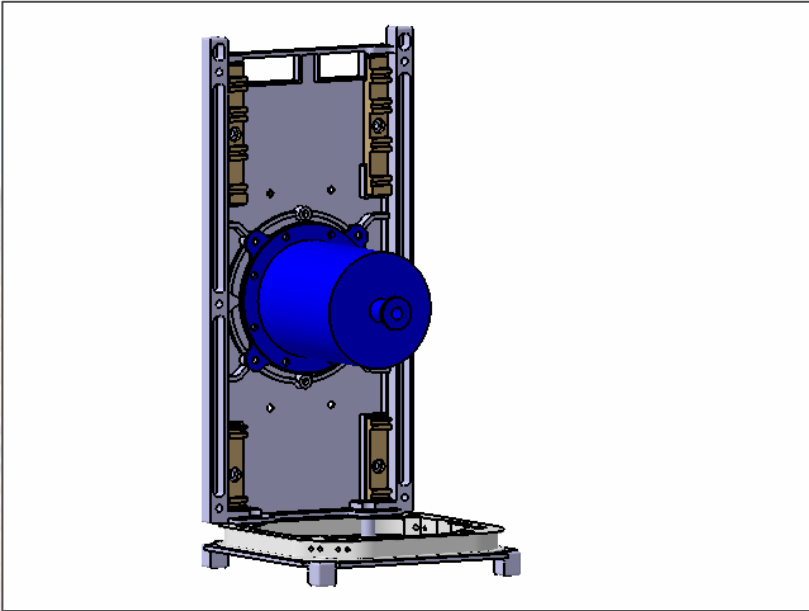
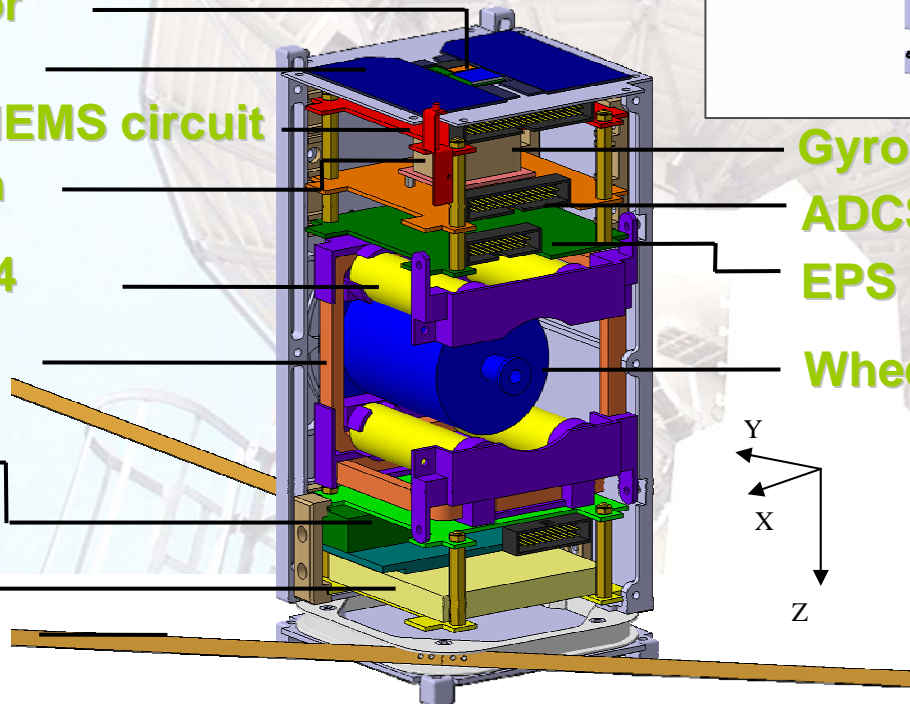
Battery X 4

Coil x 3

TT&C

CW

Antenna



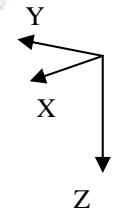
Gyro

ADCS

EPS

Wheel

(By CATIA)

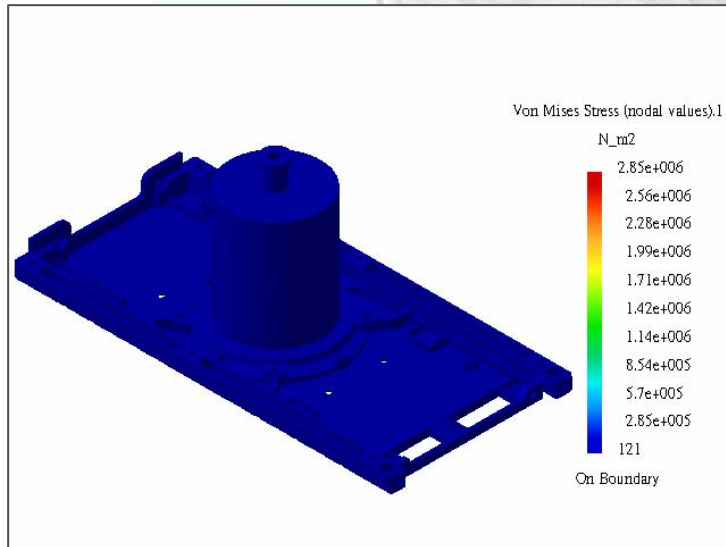
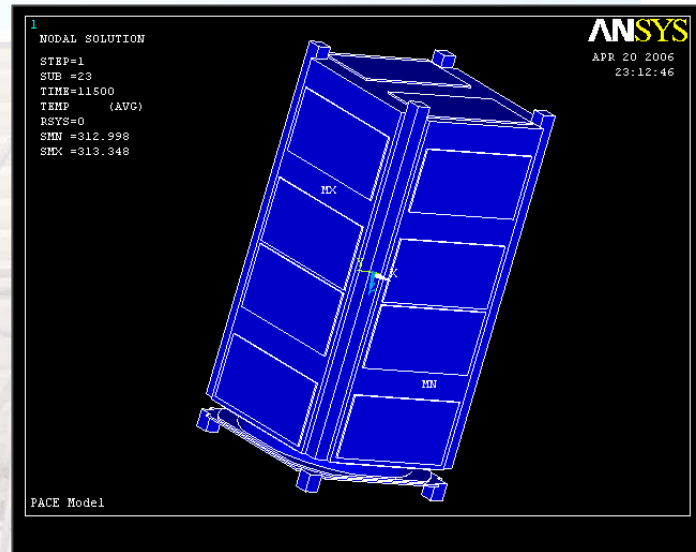
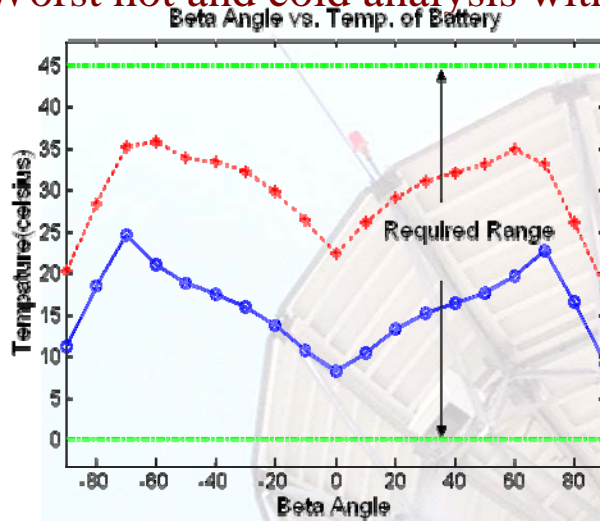


Dimension : 100x100x228 (mm)

Weight : 1656g

## ➤ Thermal Analysis

Worst hot and cold analysis with ADCS 3-axis stabilization requirement.



## ➤ Stress & Dynamic Analysis

Lateral mode : 652 Hz >> 25Hz

Longitudinal mode : 1079Hz >> 40Hz

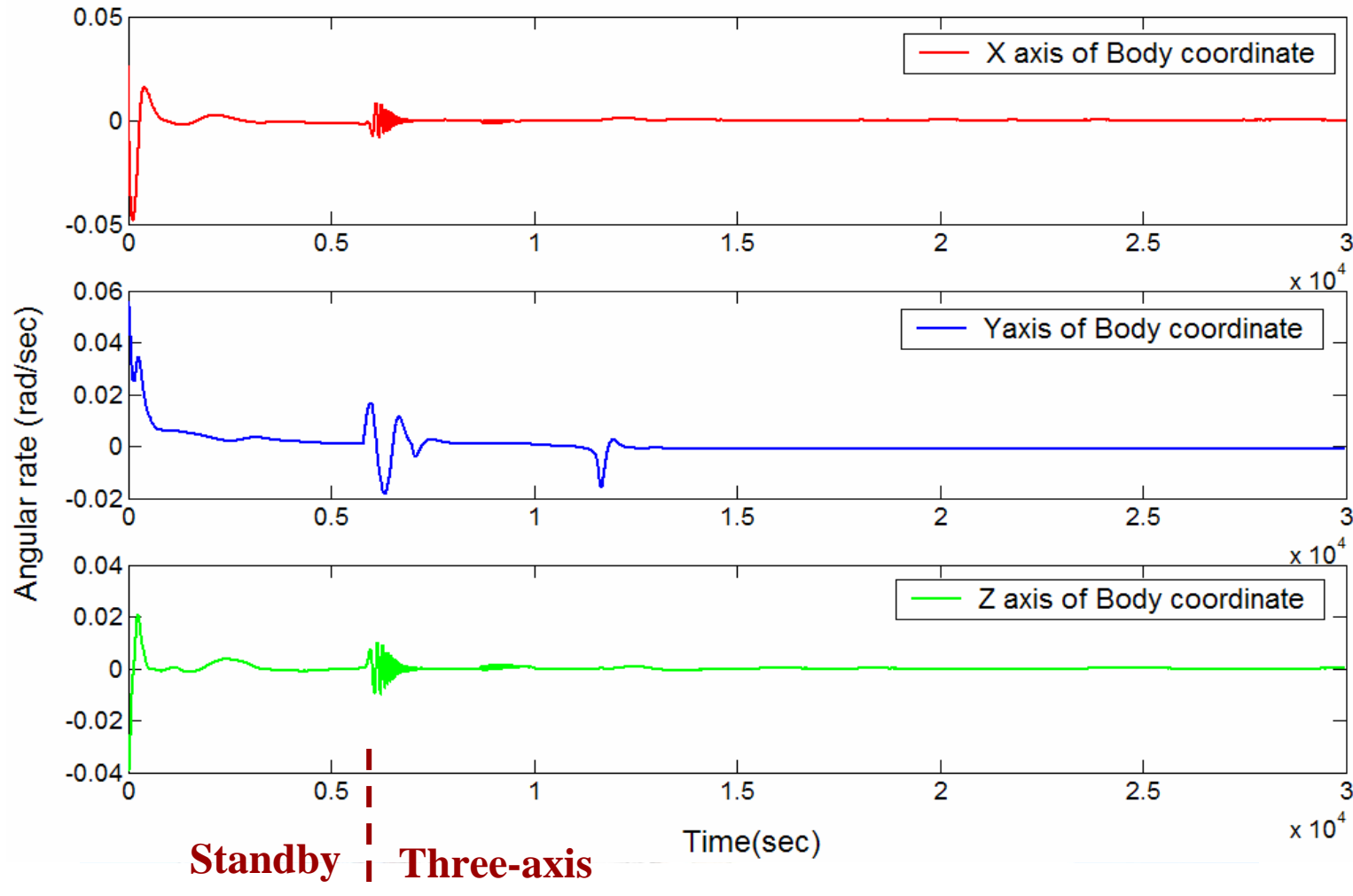
Yielding stress : 440MPa >> 30~40MPa



# Attitude Control Simulation(1/2)



→ Initial → Standby → Three-axis mode

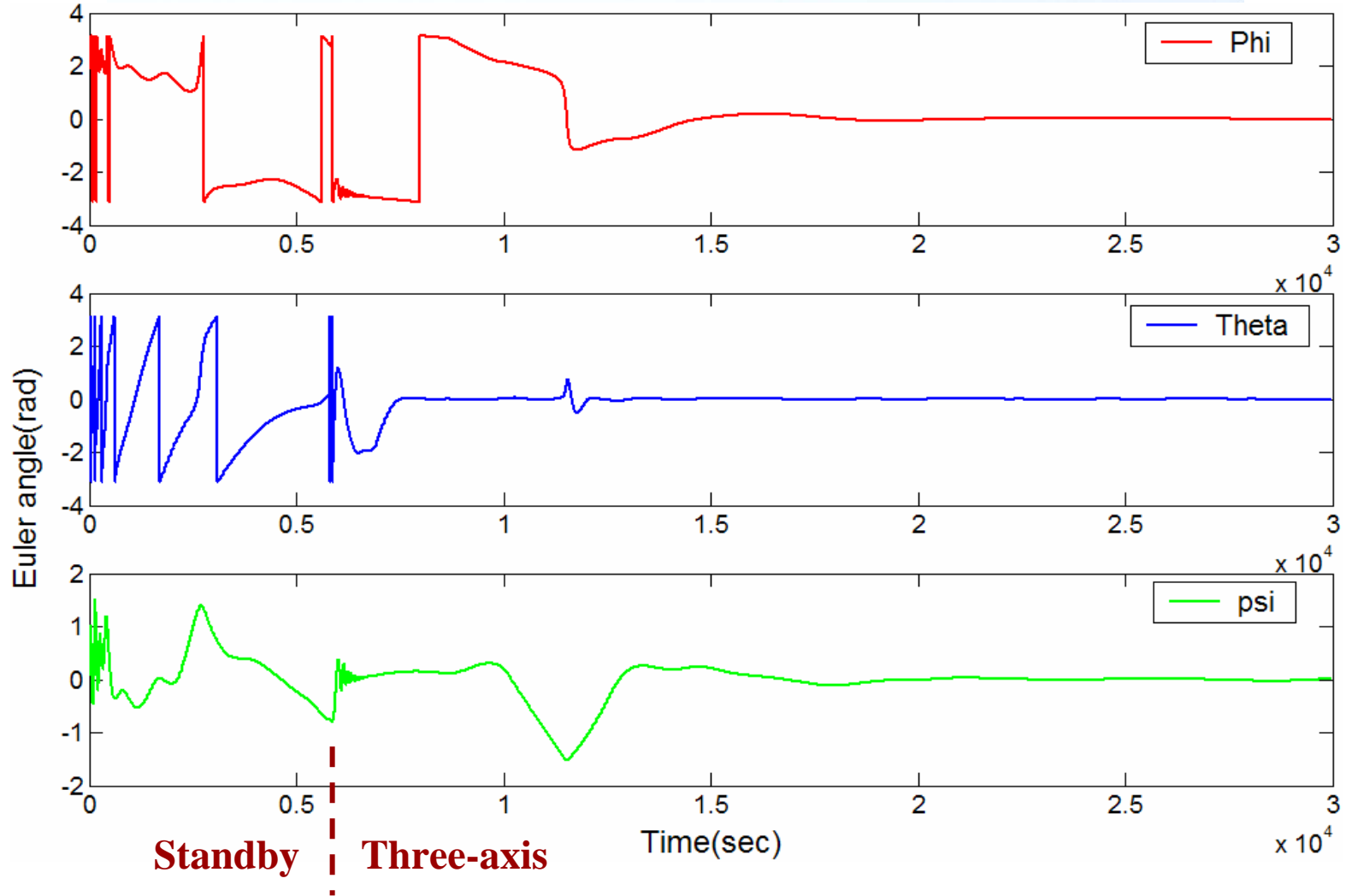




# Attitude Control Simulation(2/2)

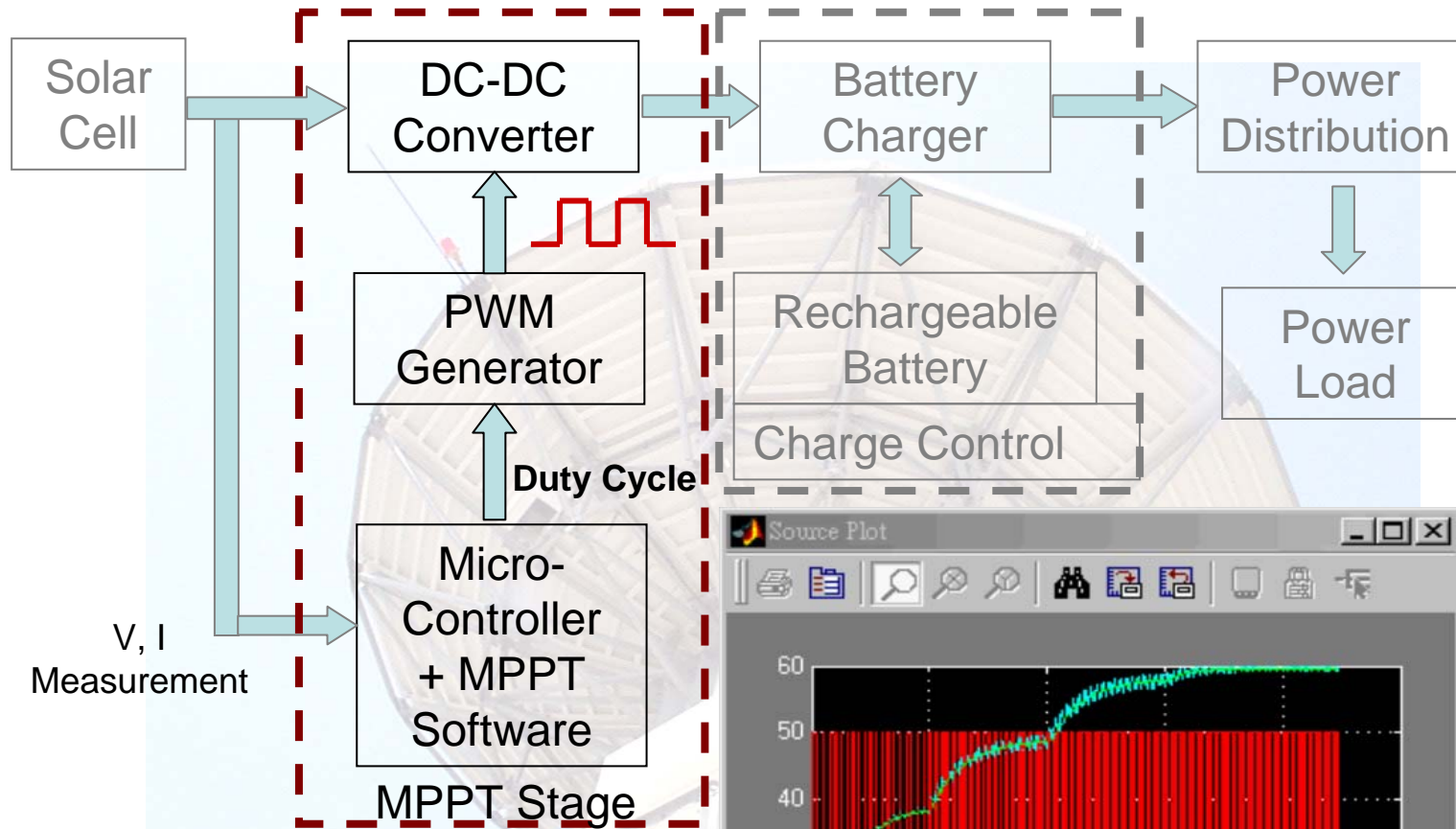


→ Initial → Standby → Three-axis mode

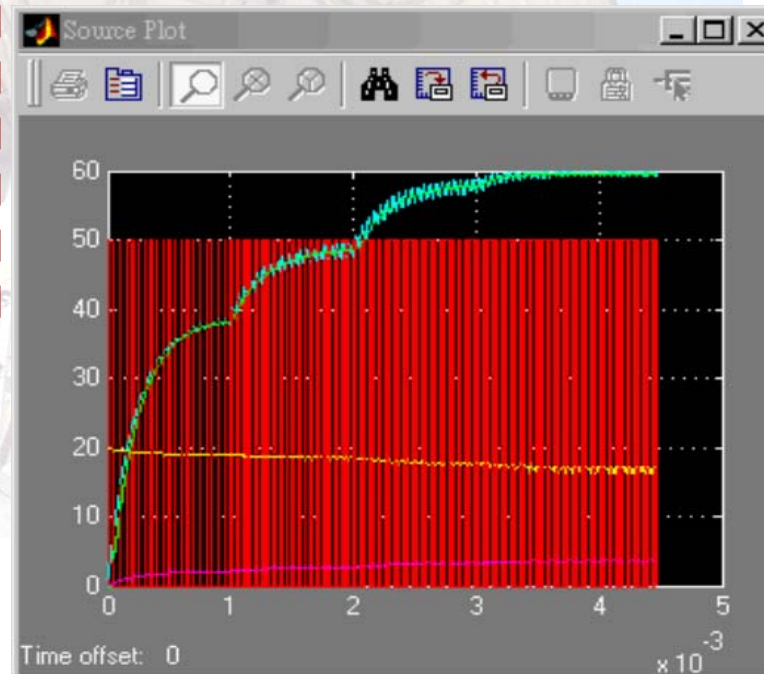




# Maximum Peak Power Tracker



PACE EPS using peak power tracking module to improve solar cell efficiency performance.



- Power
- Duty cycle
- I
- V





# Ground Station



win2k-fd uw86fhe

我的電腦

資源回收筒

Nova for Windows ver. 2.2b, registered to NCKU, NCKU

File Setup Views Utilities AutoTracking Kep. Elements Help

Unregistered HyperCam 2

5 Sats

- Azimuth
- Elevation
- Range
- Height
- AOS time
- LOS time
- Until
- Duration
- AOS Az.
- Max El.
- LOS Az.
- Visual
- Orbit #

NOAA 10

NCKU

NOAA 15

NOAA 17

開始

WeatherLink 5.5.1 05/09/...

Nova for Windows

Multicam Surveillance System ...

下午

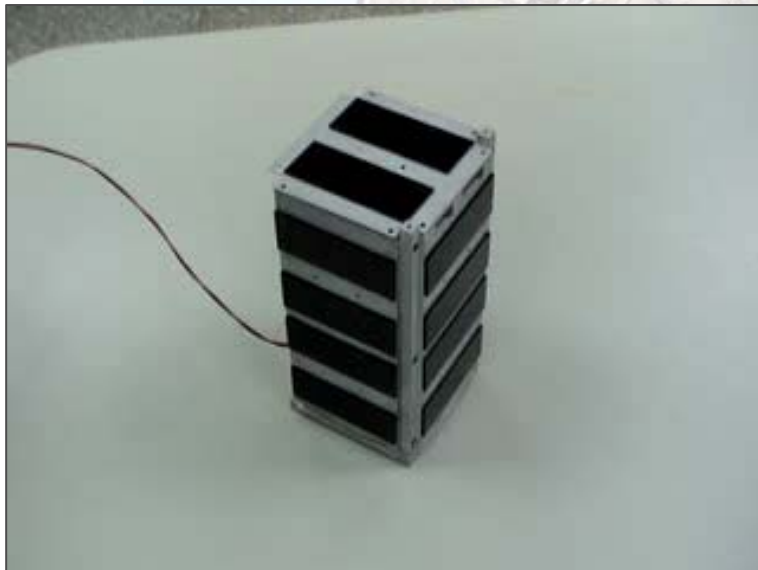


# Antenna Deployment

## ➤ Deployment mechanism

Heating the Ni-Cr resistance to melt nylon wire and release the Antenna.

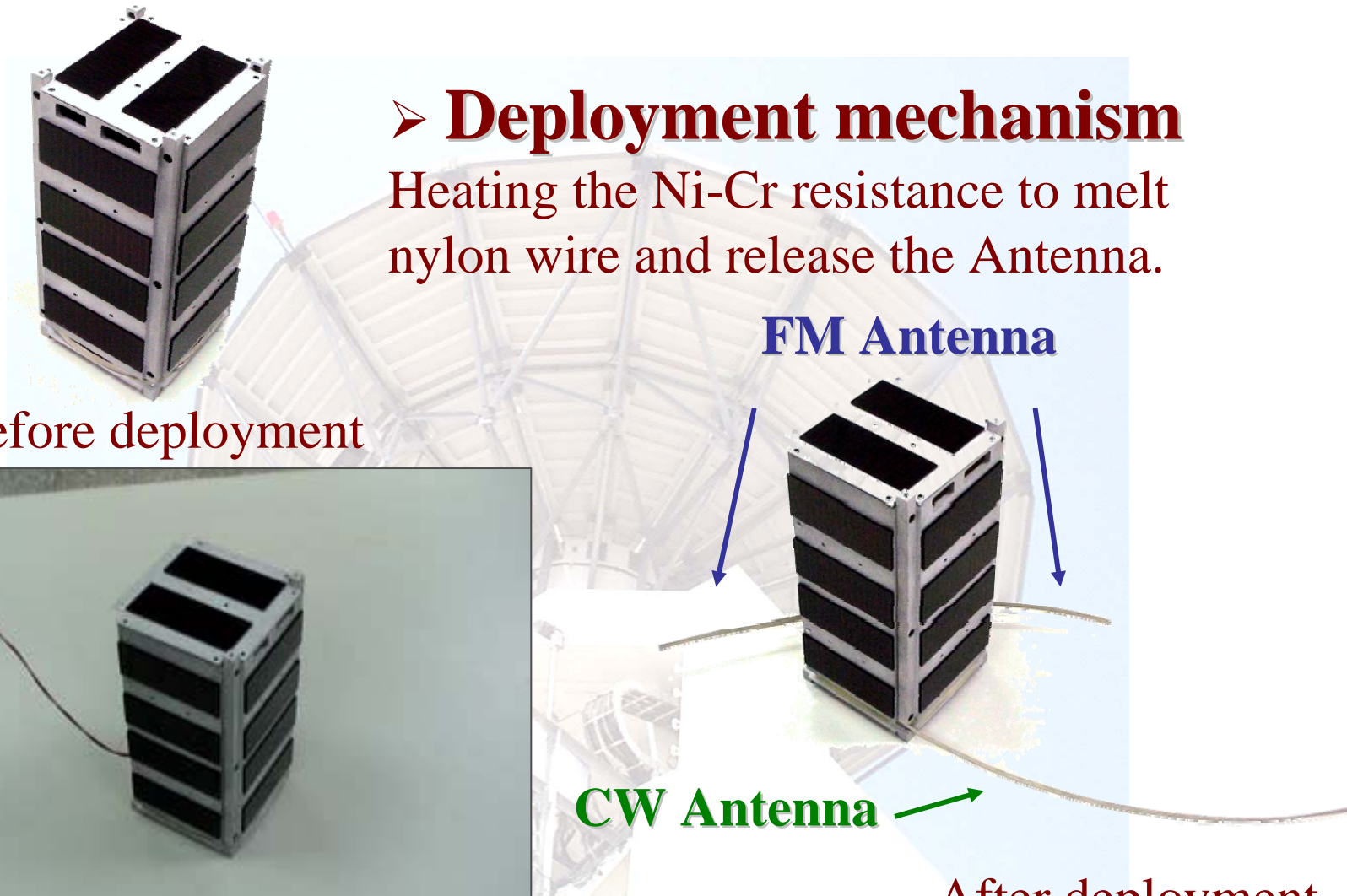
Before deployment



FM Antenna

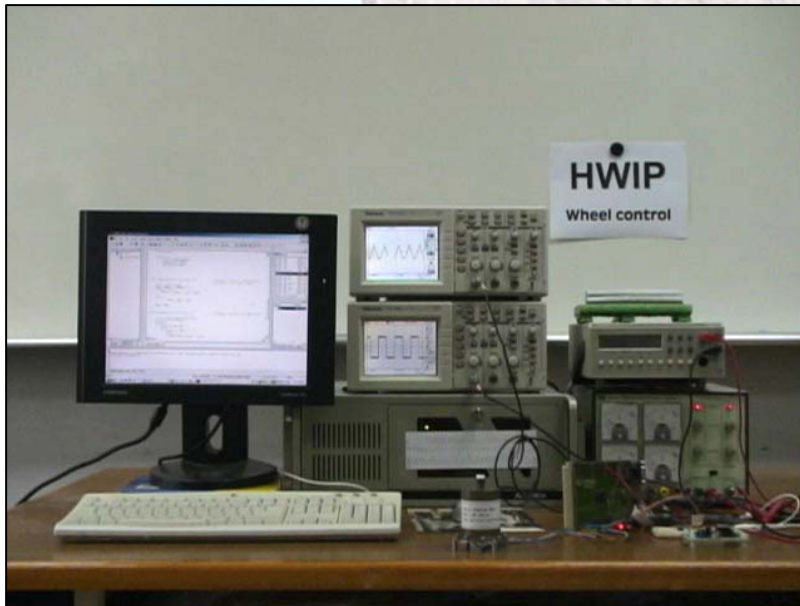
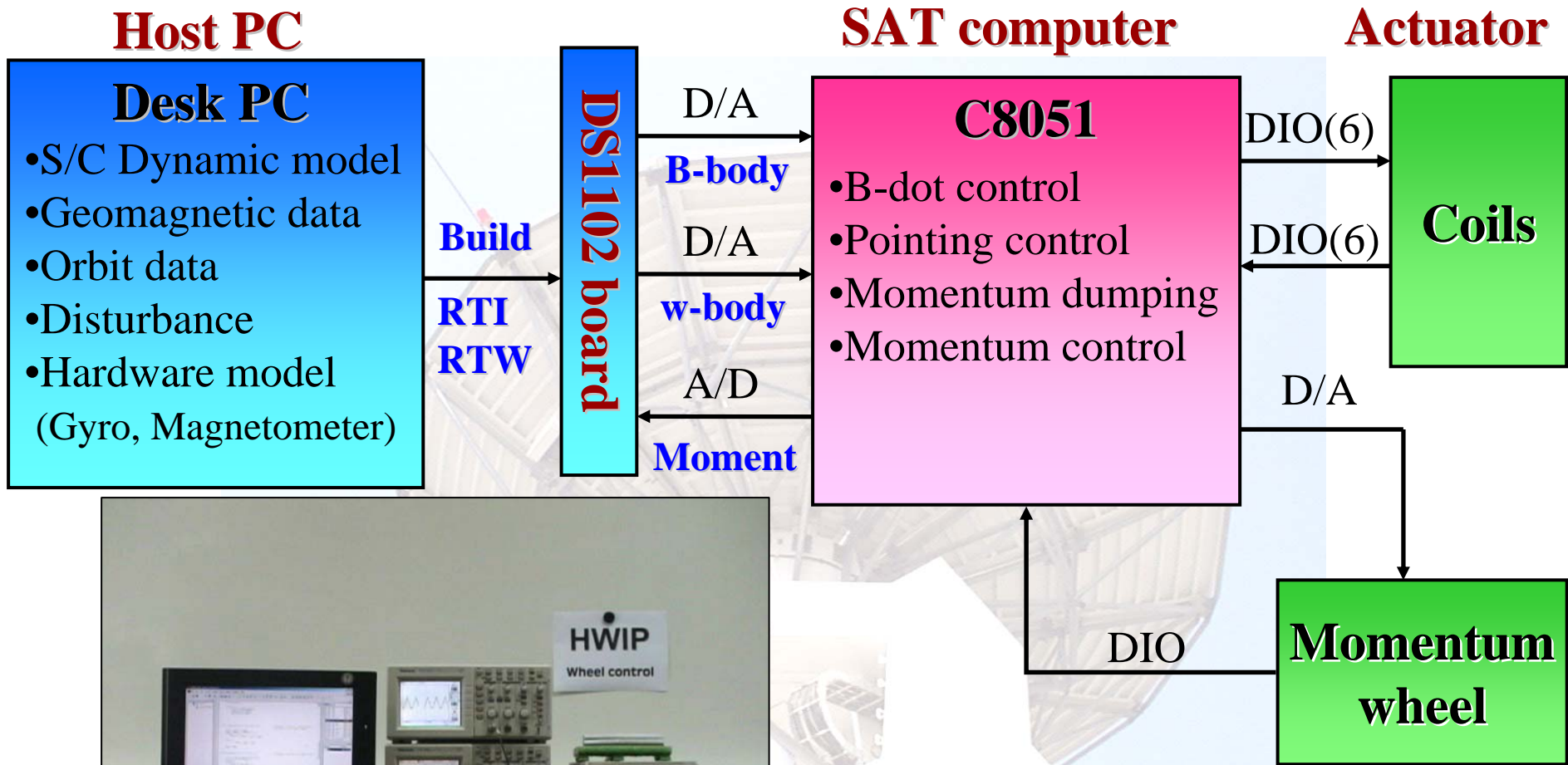
CW Antenna

After deployment



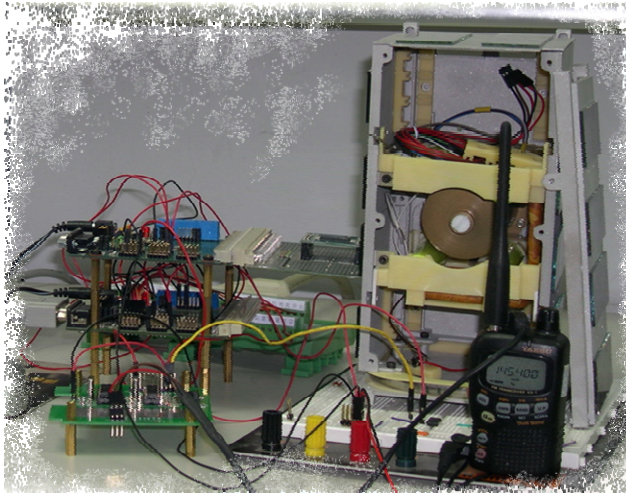


# Hardware in Loop (HWIL)



•HWIL demo

# Communication Test



•ADCS

•EPS

•C&DH

•TT&C

ADCS, C&DH,  
TT&C, EPS



Ground Station

Downlink: AX.25

Uplink: Self-Defined



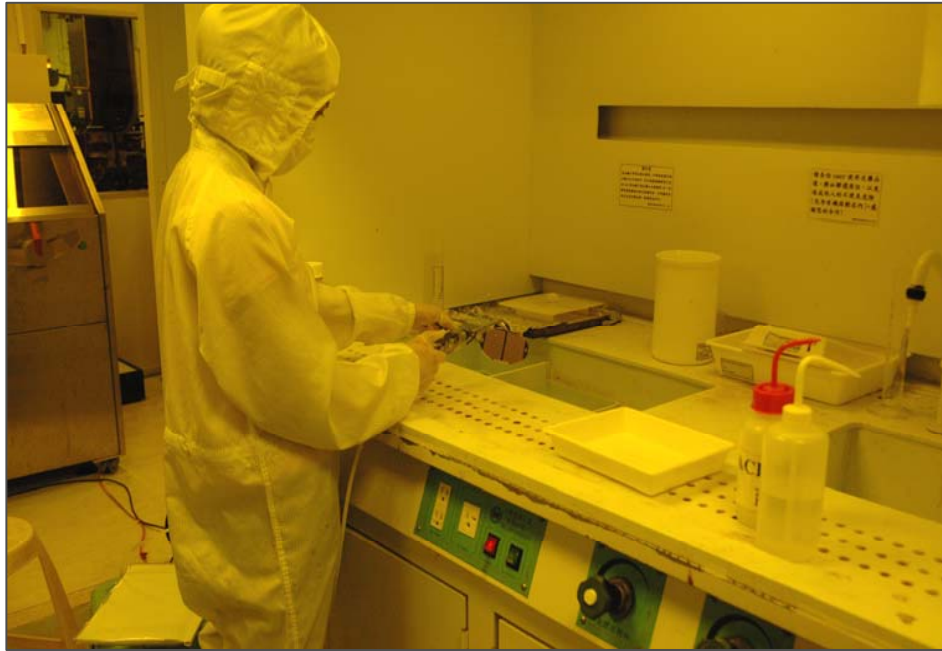
•Ground Station



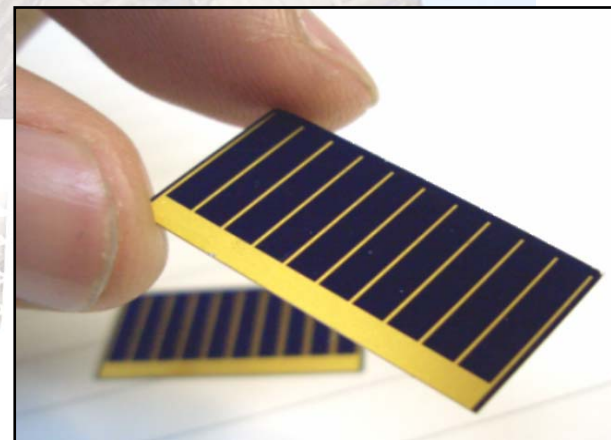
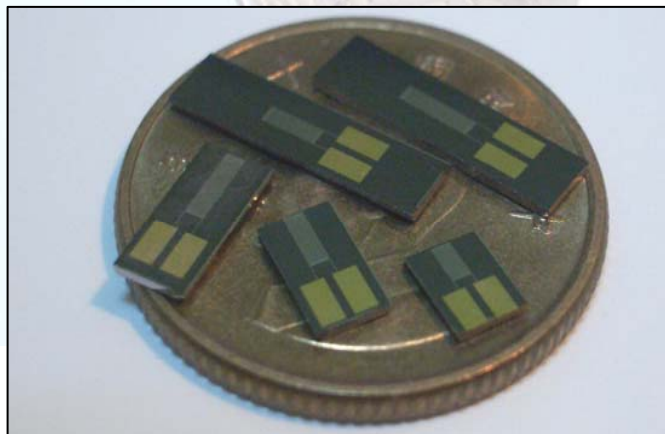
•Experiment Demo



# MEMS Sensor



Coarse sun sensor is made of commercial grade solar cell packaged by MEMS fabrication process. Temperature sensor is silicon-based MEMS sensor.



- Coarse sun sensor
- Temperature sensor



**Thanks for your attention!**



**The support of Ministry of Education, Taiwan, to this project is gratefully acknowledged.**