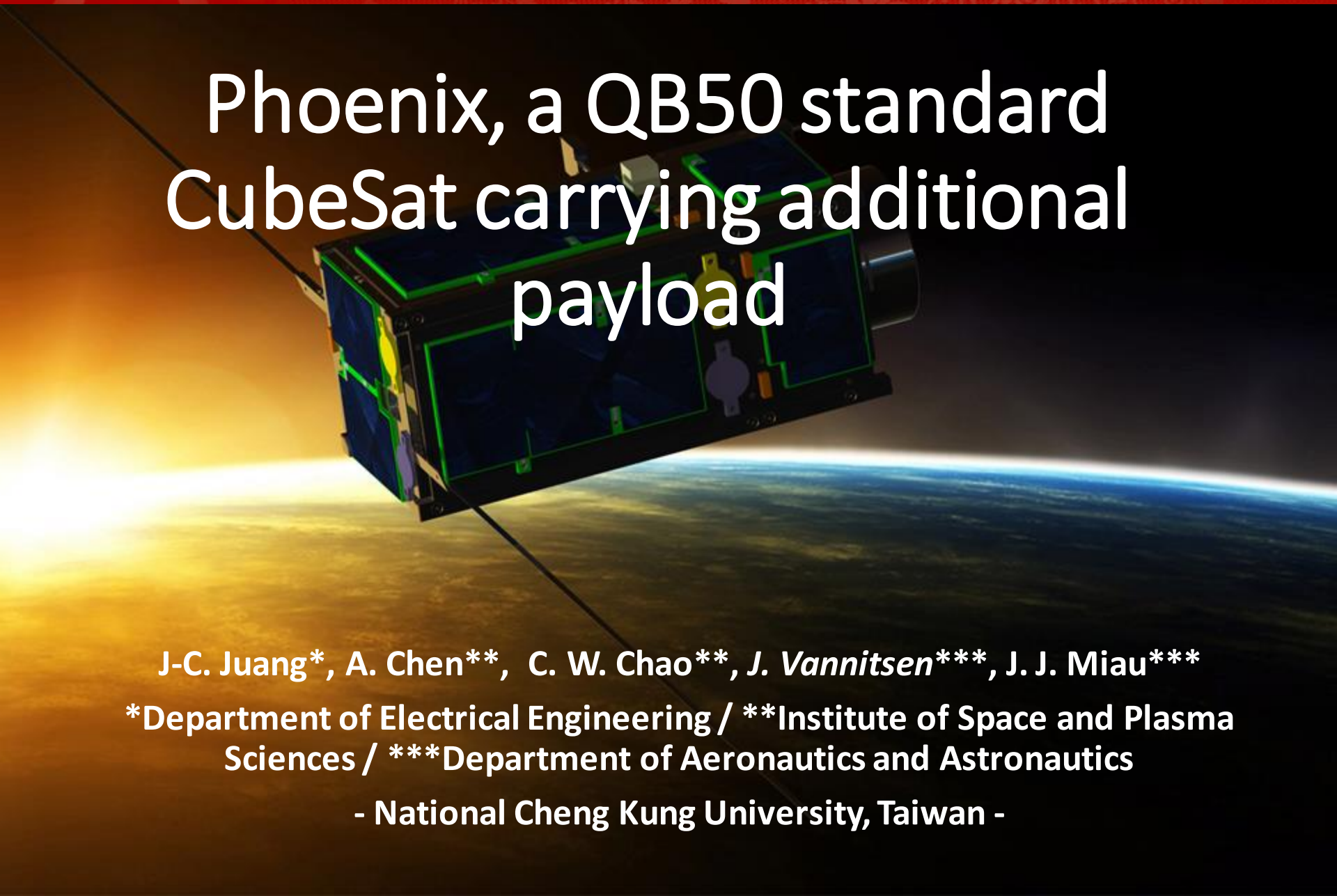
Phoenix, a QB50 standard CubeSat carrying additional payload



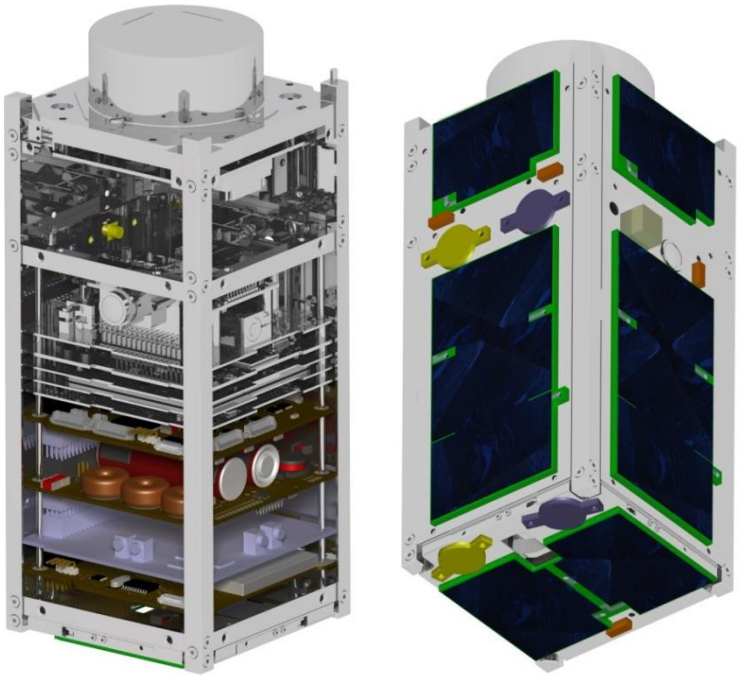
J-C. Juang*, A. Chen**, C. W. Chao**, *J. Vannitsen****, J. J. Miau***

*Department of Electrical Engineering / **Institute of Space and Plasma Sciences / ***Department of Aeronautics and Astronautics

- National Cheng Kung University, Taiwan -

Agenda

- NCKU satellites
- PHOENIX
- Solar EUV
- Solar EUV Probe
- Test of the Probe
- Summary

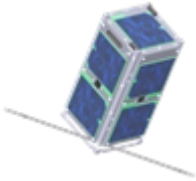


NCKU satellites

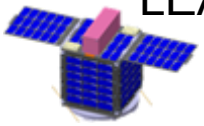
- NCKU has actively developed nano/micro-satellite technologies

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

PACE



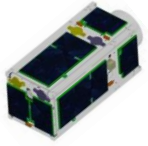
ESEMS



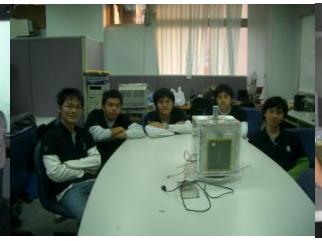
LEAP

CKUTEX

QB50/PHOENIX



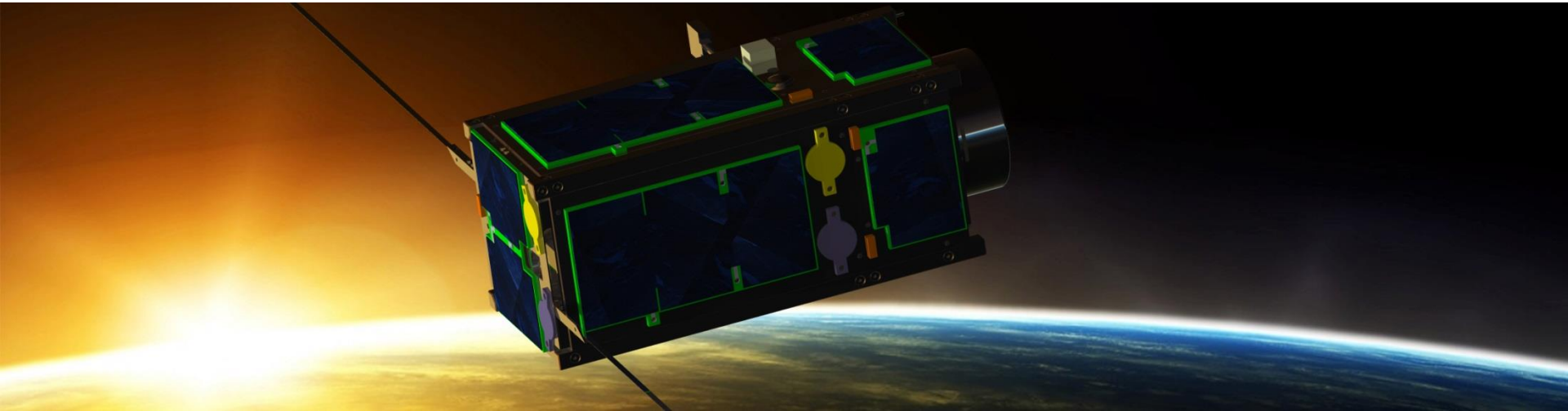
BIRDY



PHOENIX

- **Primary objective**: To fulfill the QB50 in-situ lower thermosphere measurement mission.
  - QB50 set of sensors: Ion and Neutral Mass Spectrometer and thermistors.
  - NCKU set of sensors: Solar EUV probes, to better quantify QB50 INMS data.

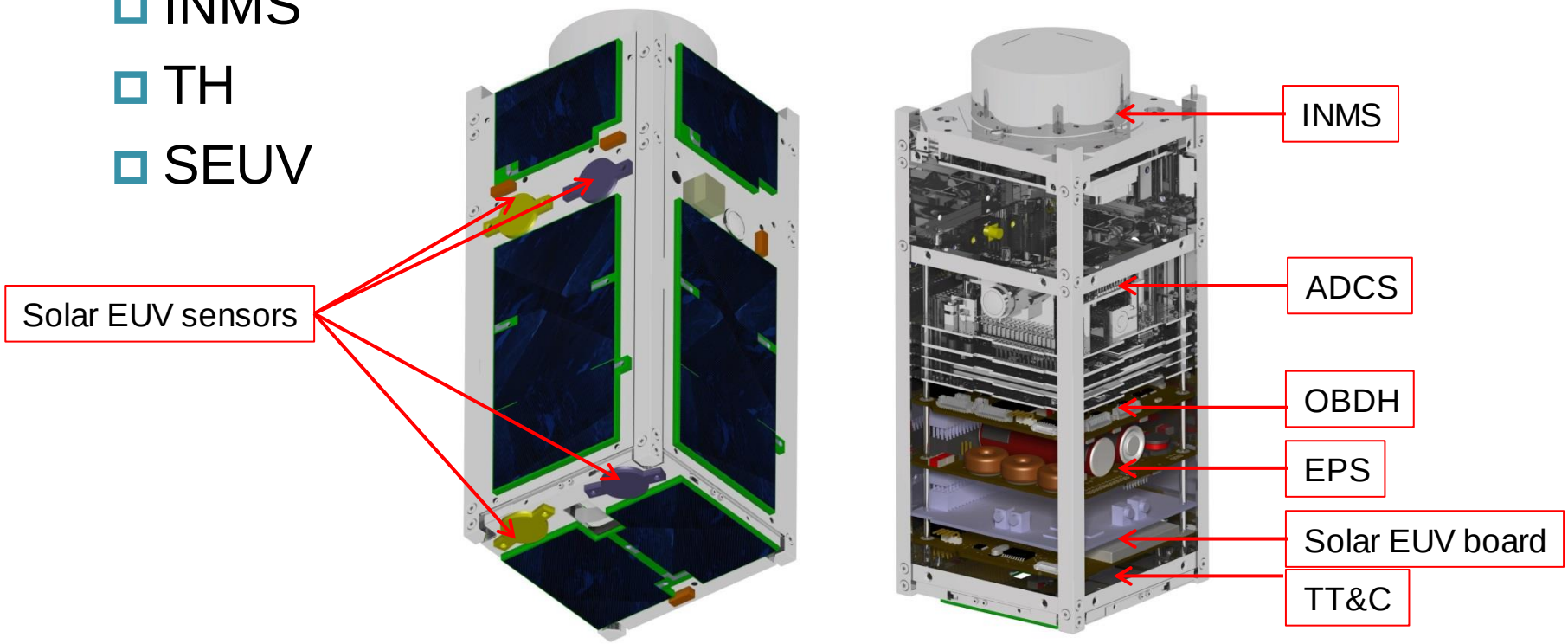
- **Second objective**: Education tool to give hands-on experience to students on a satellite mission. “Learning by doing”.
  - PHOENIX design, assembly, integration and testing.



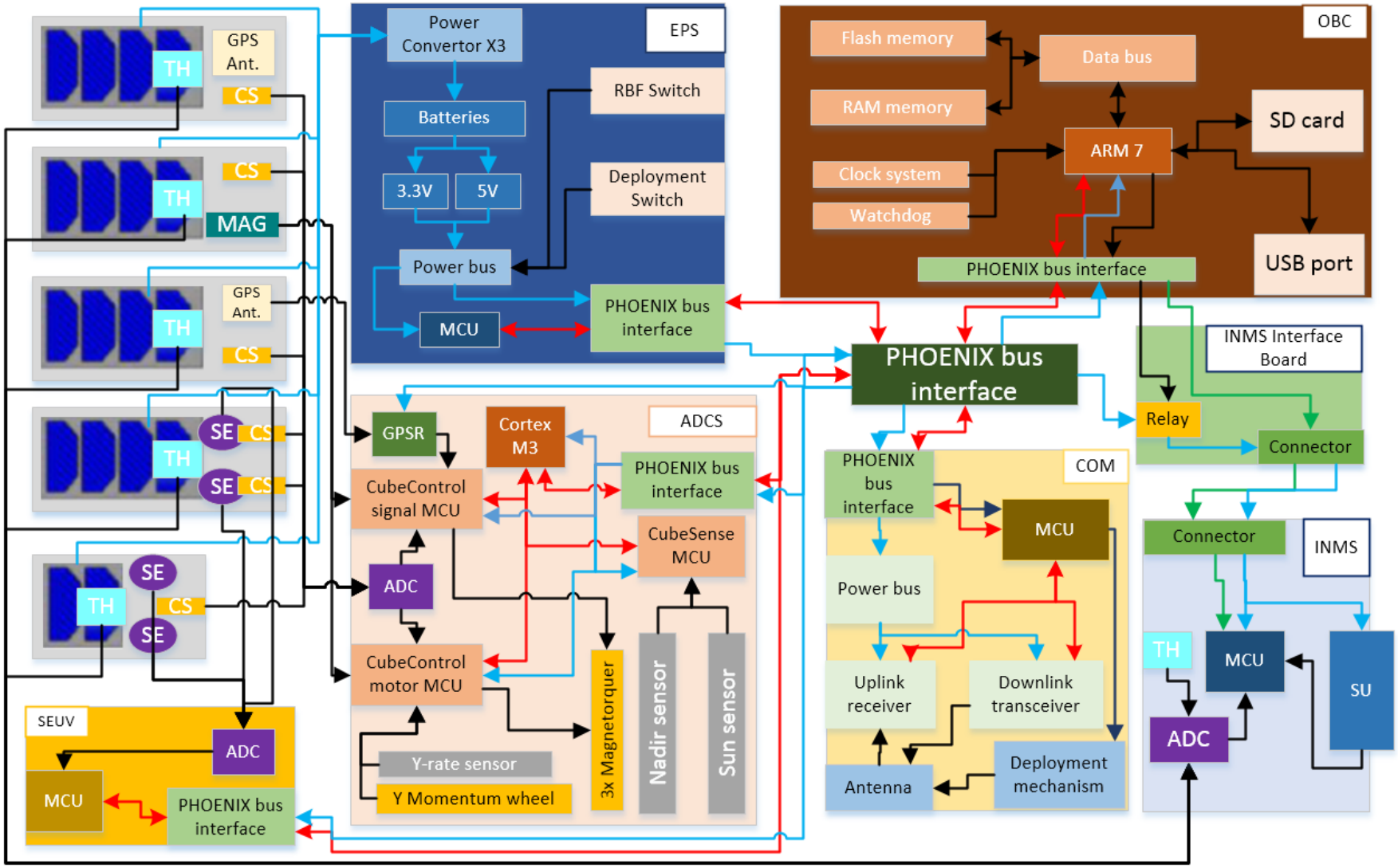
PHOENIX

- 2U CubeSat standard < 2kg.

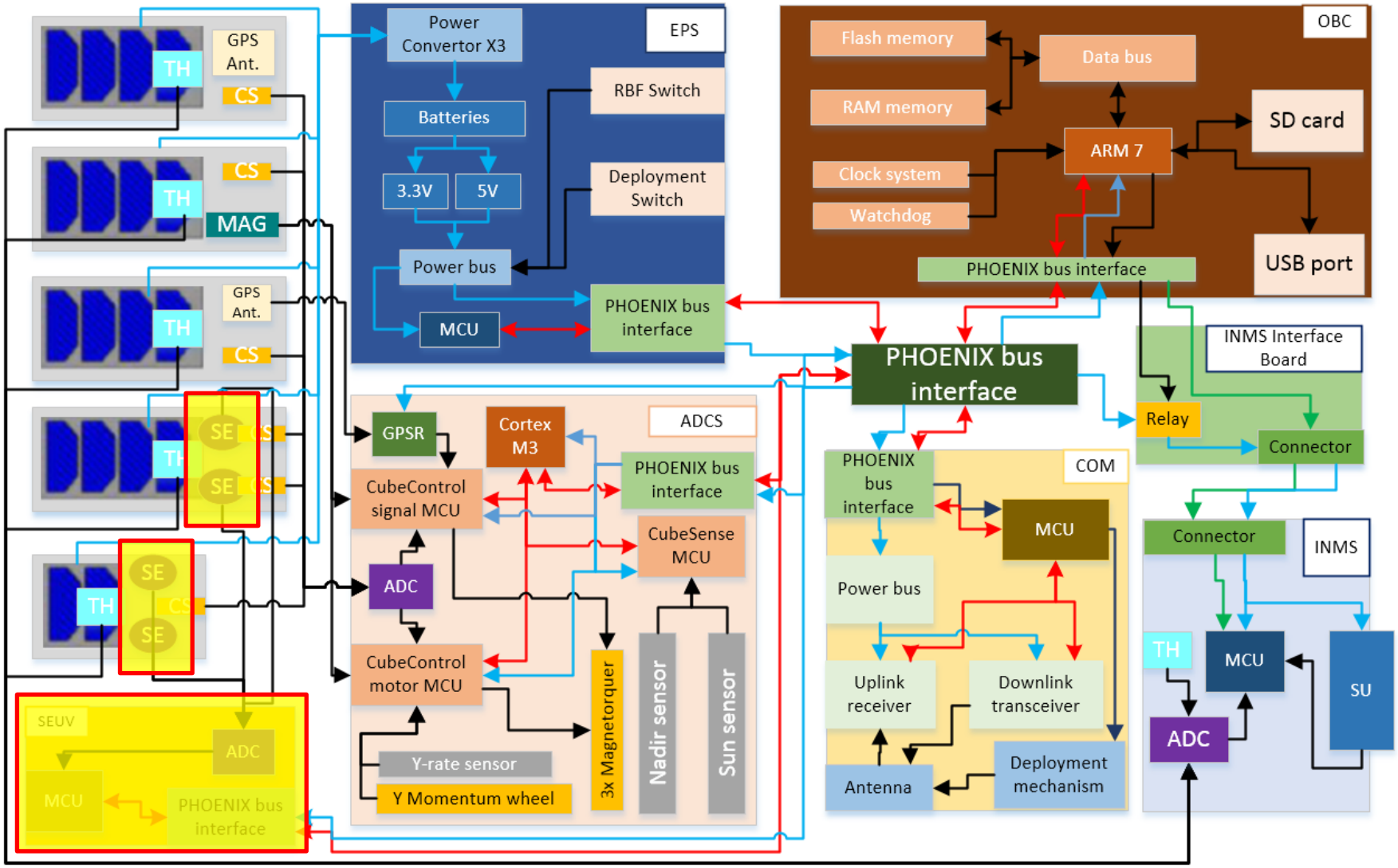
- Three payloads
  - INMS
  - TH
  - SEUV



PHOENIX


GPS Ant.
TH
CS
MAG
SE
Power Convertor X3
EPS
RBF Switch
Batteries
3.3V
5V
Deployment Switch
Power bus
MCU
PHOENIX bus interface
Flash memory
Data bus
RAM memory
SD card
ARM 7
Clock system
Watchdog
USB port
OBC
PHOENIX bus interface
INMS Interface Board
Relay
Connector
GPSR
Cortex M3
ADCS
CubeControl signal MCU
CubeSense MCU
ADC
CubeControl motor MCU
Y-rate sensor
Y Momentum wheel
3x Magnetorquer
Nadir sensor
Sun sensor
COM
Power bus
Uplink receiver
Downlink transceiver
Antenna
Deployment mechanism
INMS
SU
SEUV

PHOENIX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PHOENIX bus interface
INMS Interface Board
Relay
Connector
GPSR
Cortex M3
ADCS
CubeControl signal MCU
CubeSense MCU
ADC
CubeControl motor MCU
Y-rate sensor
Y Momentum wheel
3x Magnetorquer
Nadir sensor
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PHOENIX bus interface
COM
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Downlink transceiver
Antenna
Deployment mechanism
Connector
INMS
TH
MCU
SU
ADC
SEUV
ADC
MCU
PHOENIX bus interface

PHOENIX

- FlatSat assembled, integrated & tested.
- Internal AITRR: 5 Dec. 2014.
- PHOENIX EQM assembly: Dec. 2014.
- PHOENIX FM delivery: August 2015.
- NCKU ground station already in use.

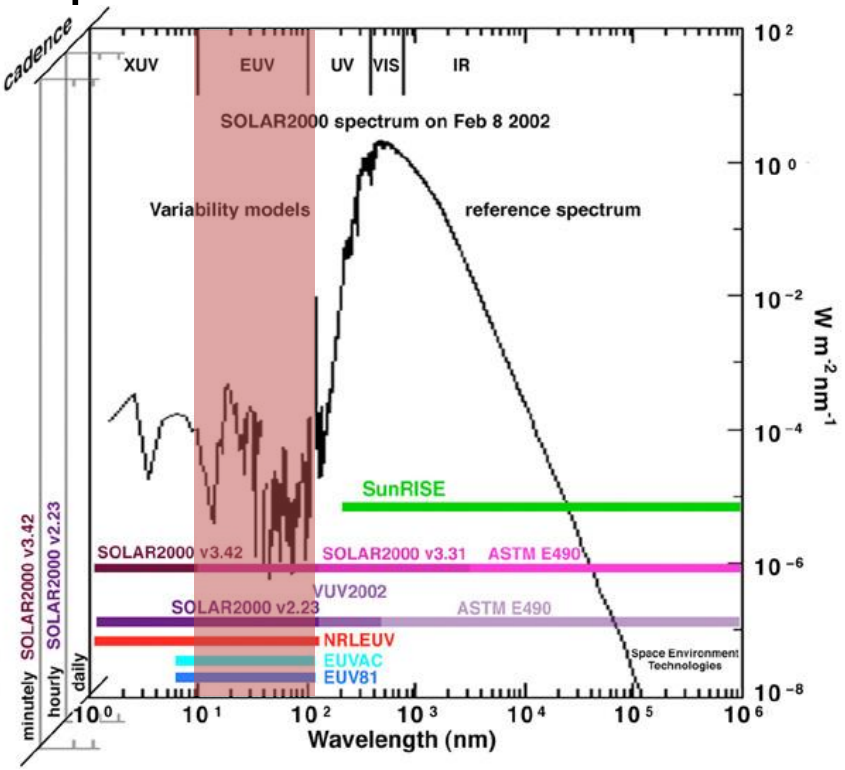
PHOENIX FlatSat

INMS inspection

PHOENIX Internal AIT Readiness Review

Solar EUV

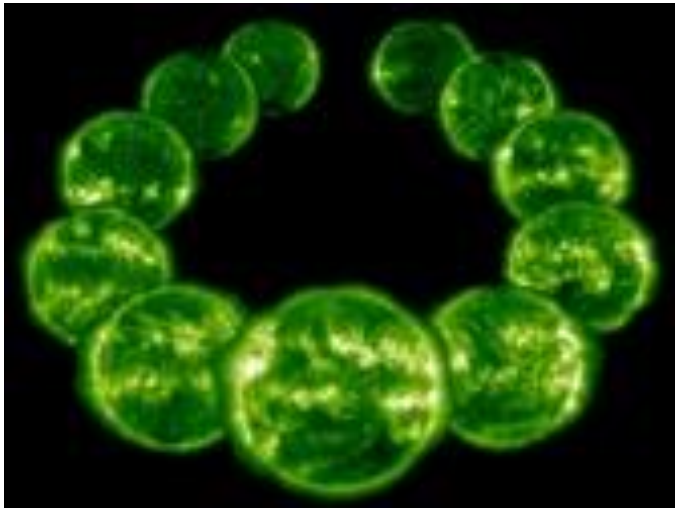
- Solar EUV (Extreme UltraViolet) irradiances
  - Wavelength: 10 nm (30 nm) to 100 nm (124 nm)
  - Generated by the solar corona effect
  - Absorbed in the upper atmosphere
  - Heats and ionizes the upper atmosphere → thermosphere and ionosphere
  - Variability



Source: spacewx

Measurement of Solar EUV

- Photometer
  - Filtered photodetectors
- Grating spectrograph
  - Optical instrument
  - grating

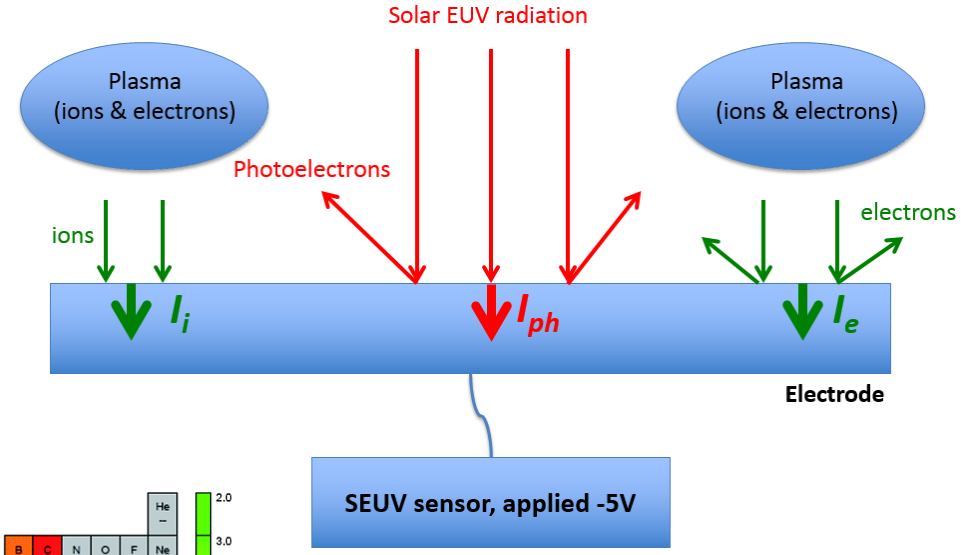


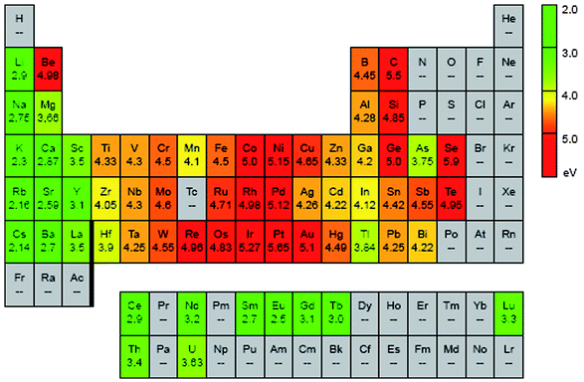
Source: NASA

Source: NASA

Solar EUV Probe

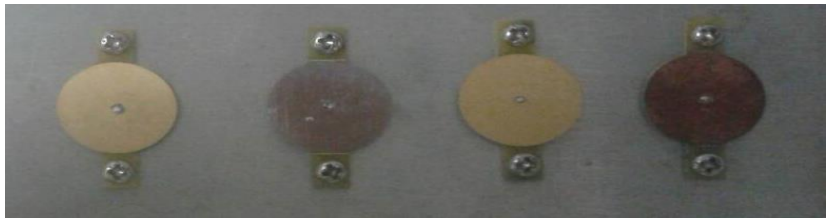
- The solar EUV probe is based on the photoelectric effect.
  - A conductor is connected to a voltage source in a plasma environment
  - Current is generated
    - Ion
    - Electron
    - Photoelectron
  - Work function
    - Gold
    - Tin

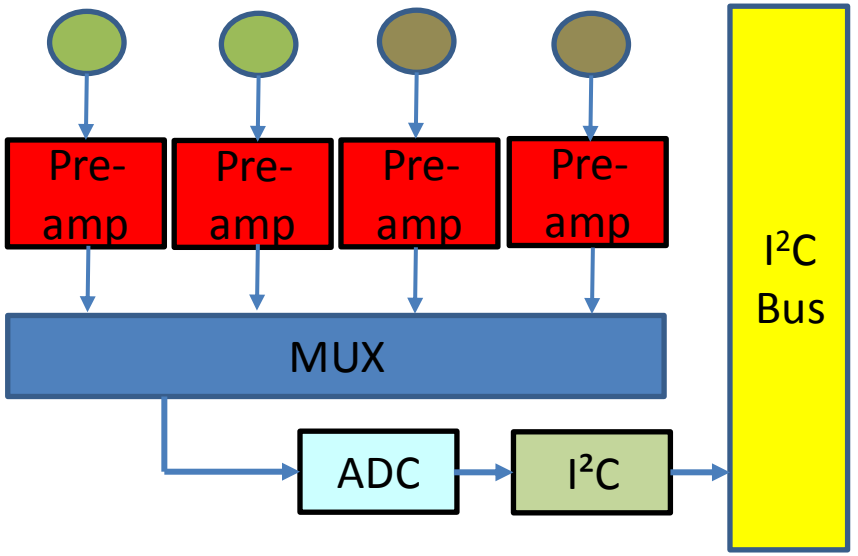


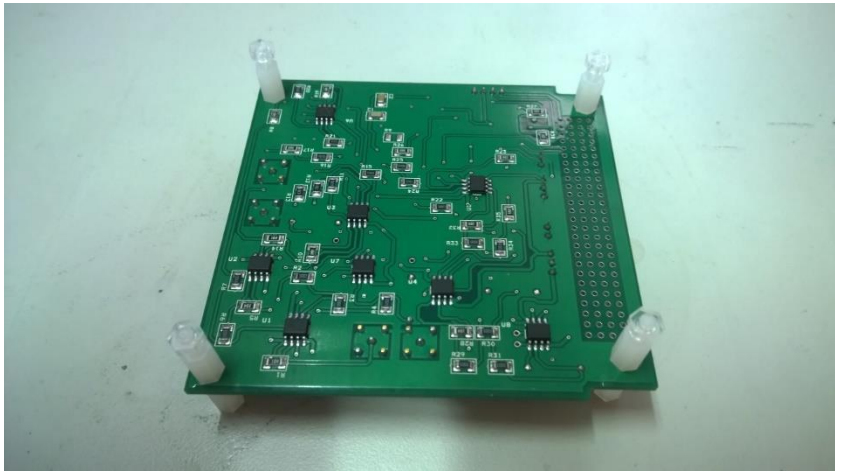


Solar EUV Probe EM

- Engineering model
  - Four electrodes
  - PC/104 form factor
  - I²C interface

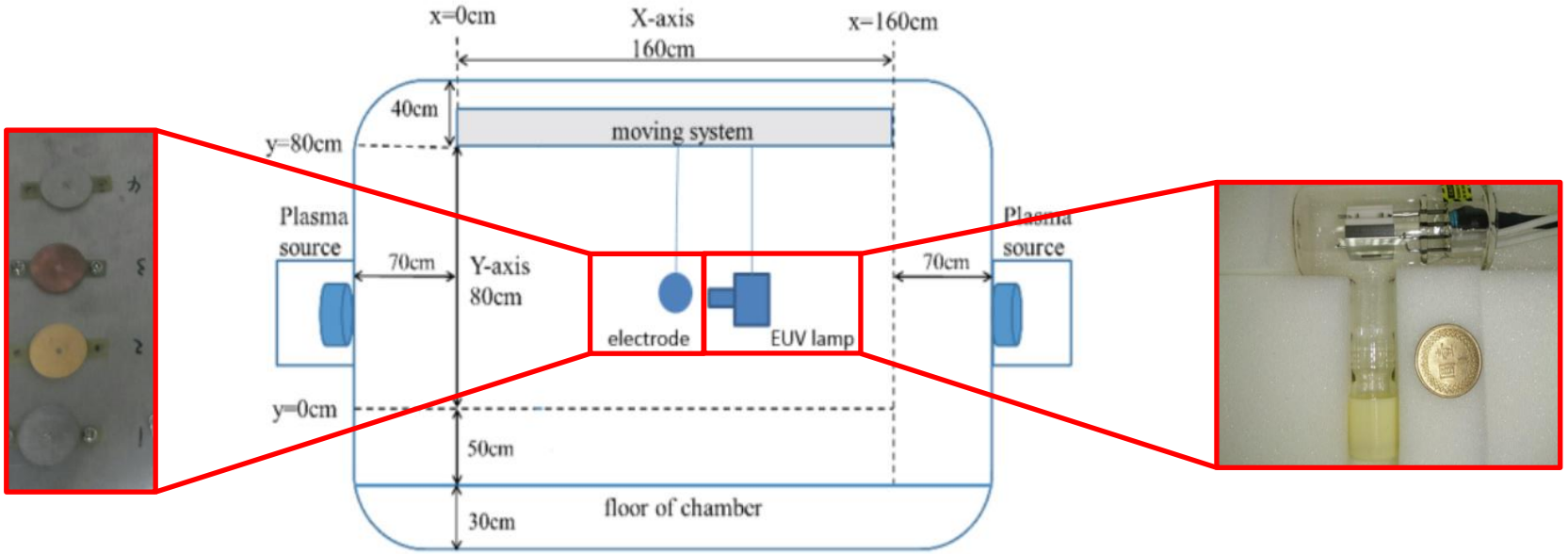






Test of the Probe

- Test using NCKU space plasma chamber.
  - Deuterium lamp is placed in front of probes in vacuum environment.



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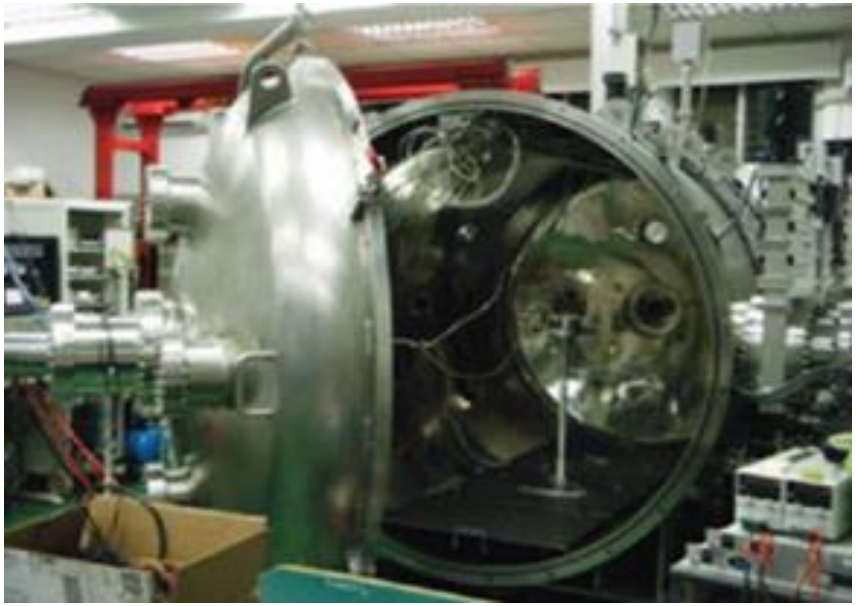

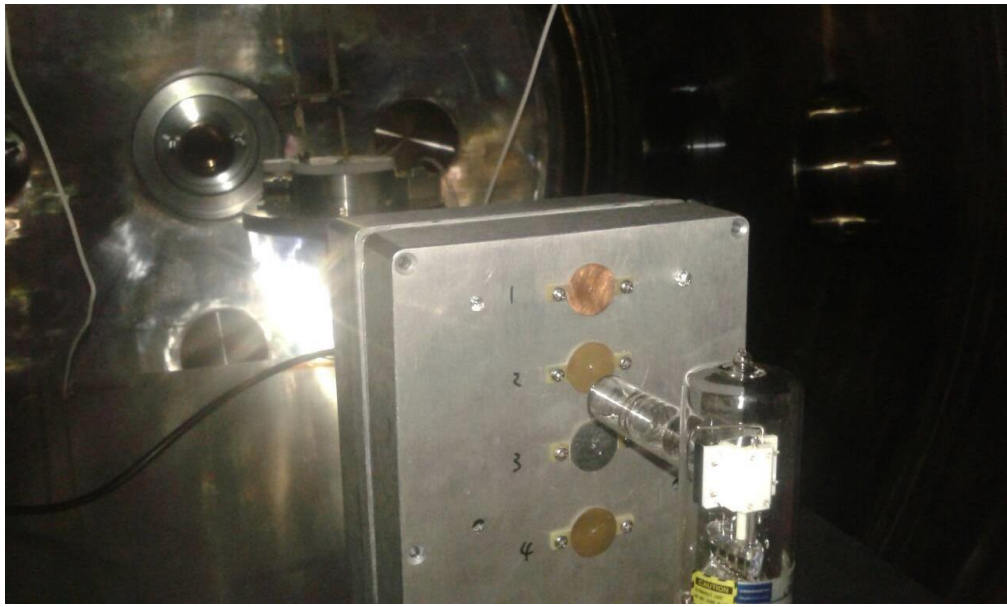

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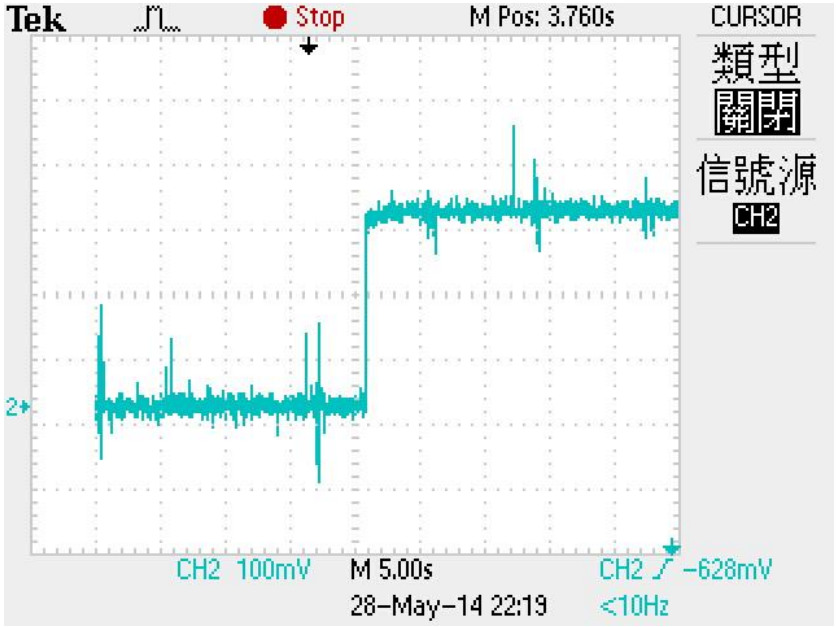
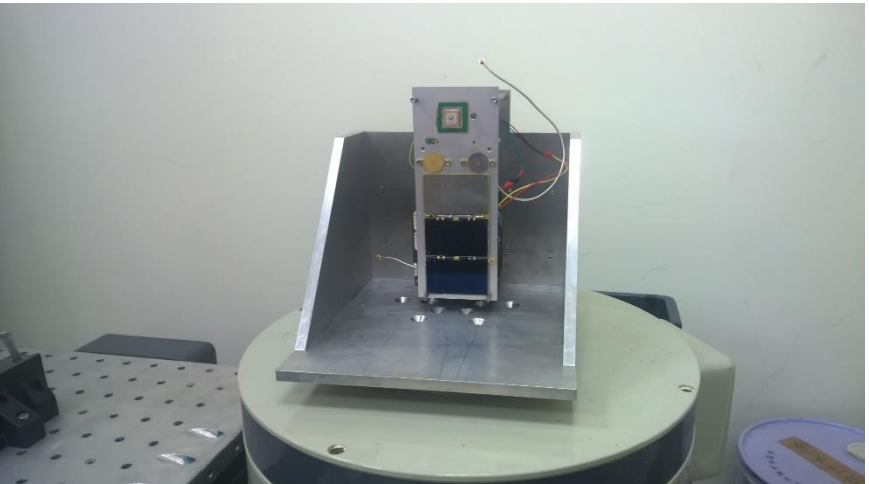
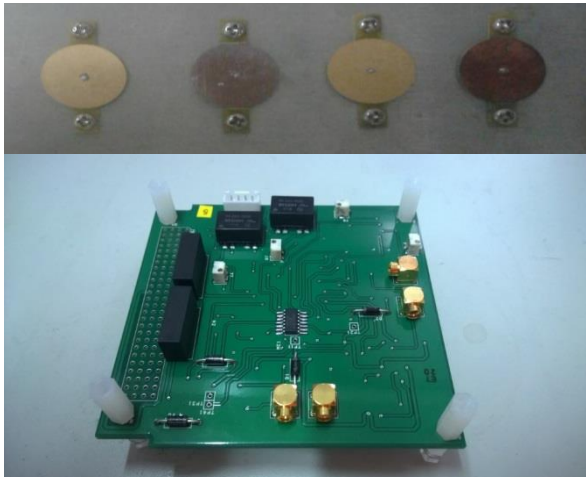


Summary

- Solar EUV: major energy source in thermosphere with significant variability.
- To better quantify QB50 INMS data, a solar EUV probe is installed in QB50/PHOENIX CubeSat.
- The solar EUV probe EM is designed, prototyped and tested.





THANK YOU FOR YOUR ATTENTION!

QUESTIONS?

Contact:
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juang@mail.ncku.edu.tw