The 1st Space Science School

Project Management - Planning and Mission Cost & Risk Management

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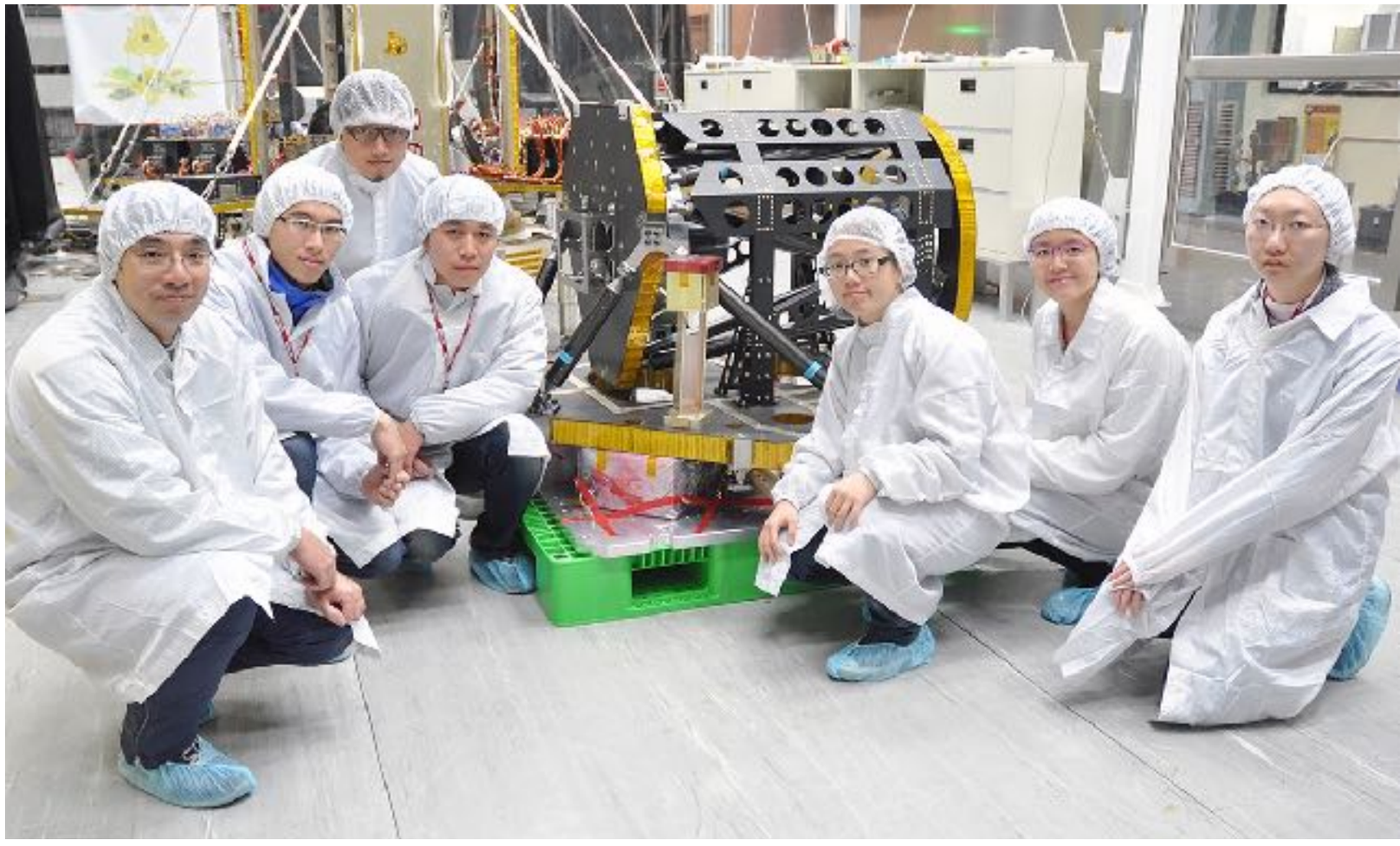
Space Krenovation Park, Sri Racha, Chonburi, Thailand

October 21, 2016

Outline

- Project management
- Planning
- Mission cost
- Risk management



http://spl.ss.ncu.edu.tw/

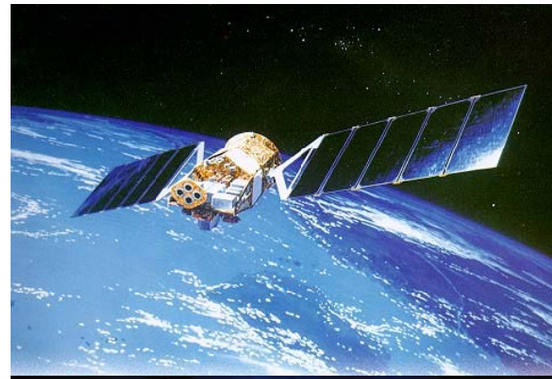
太空酬載實驗室

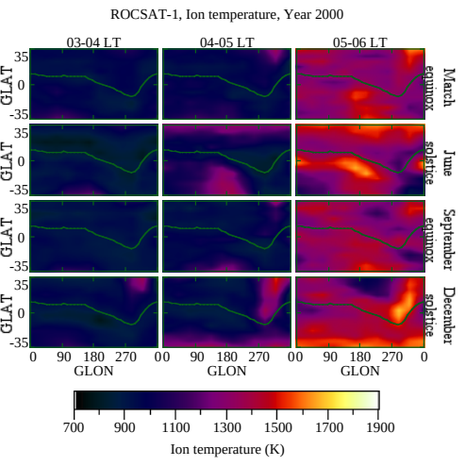
Curriculum vitae

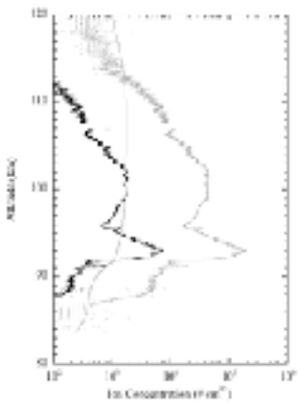
- Degrees:
  - 1988-1992: BS, Dept. of Atmospheric Physics, NCU.
  - 1992-1994: MS, Graduate Inst. of Space Science (GISS)/NCU.
  - 1994-2000: PhD, GISS/NCU.
- Employment history:
  - 2000-2006: Postdoc, GISS/NCU.
  - 2006-2012: Assistant Professor, GISS/NCU.
  - 2012-present: Associate Professor, GISS/NCU.
- Field of research specialization: space payload, environmental tests, and Ionospheric physics.

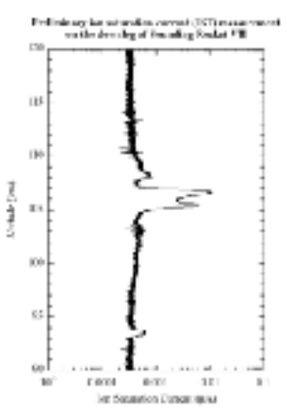
Research topics

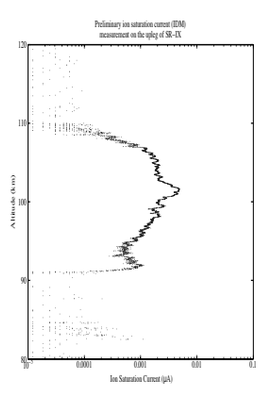
- Space payload: development for science missions
- Environmental tests: unique test environment, e.g. plasma chamber and thermal vacuum chamber.
- Ionospheric physics:
  - Global ionospheric geophysical parameters and dynamics (using satellites).
  - Ionospheric plasma irregularities over Taiwan (using sounding rockets).





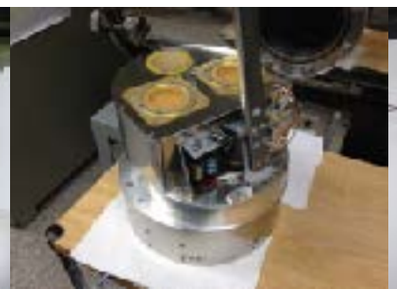






Major research experiences

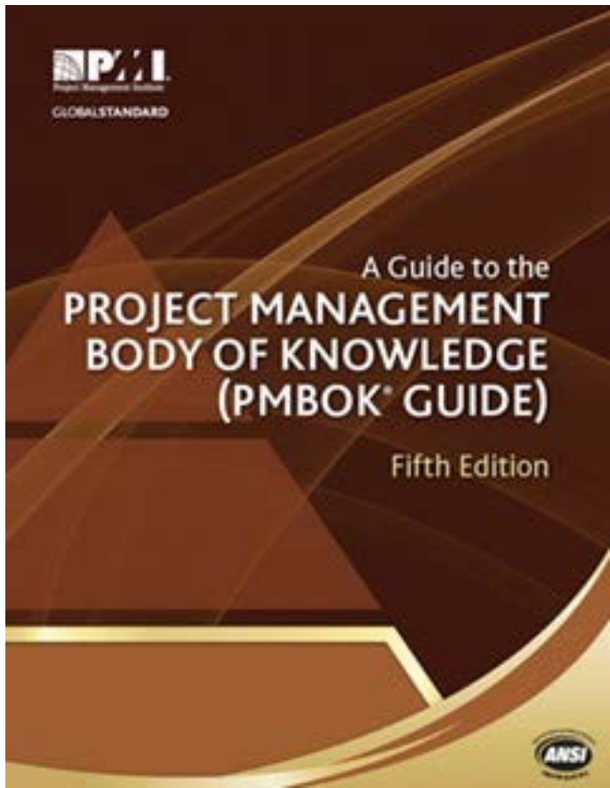
- 1994-2004: ROCSAT-1/Ionospheric Plasma and Electrodynamics Instrument.
- 2003: SR-III/TMA.
- 2004-2006: SR-V/Ion Probe.
- 2006-2010: SR-VII/Plasma Probe.
- 2008-2014: SR-IX/Space Plasma Sensor Package.
- 2011-2014: SR-VIII, IX, and X/Aspectmeter.
- 2012-: FORMOSAT-5/Advanced Ionospheric Probe.
- 2016-: FORMOSAT-7/Ion Velocity Meter.



What is project management?

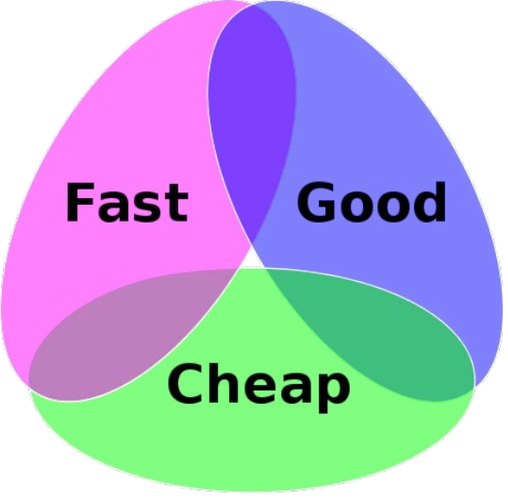
- A project is **temporary** in that it has a defined beginning and end in time, and therefore defined scope and resources. Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Traditionally the project constraint model recognized three key constraints: ***Cost***, ***Time***, and ***Scope***.

- *A Guide to the Project Management Body of Knowledge* (**PMBOK® Guide**), the 5th edition, Project Management Institute, 2013 and its URL is http://www.pmi.org/pmbok-guide-standards/foundational/pmbok



Project management triangle

- You are given the options of ***Fast***, ***Good***, and ***Cheap***, and told to pick any two.
- ***Fast*** refers to the time required to deliver the product.
- ***Good*** is the quality of the final product.
- ***Cheap*** refers to the total cost of designing and building the product.



Pick any two

- This triangle reflects the fact that the three properties of a project are interrelated, and it is not possible to optimize all three – one will always suffer. In other words, you have three options:
- Design something quickly and to a high standard, but then it will not be cheap.
- Design something quickly and cheaply, but it will not be of high quality.
- Design something with high quality and cheaply, but it will take a relatively longer time.

Planning

- Two significant trends are emerging in project management:
  - **Bottom-up planning**: This trend emphasizes simpler project designs, shorter project cycles, efficient collaboration among team members, stronger team member involvement and decision making.
  - **Top-down planning and reviewing**: This trend is characterized by enterprise-wide decision making about the portfolio of projects that an organization should have, as well as by enabling data-mining technologies to make information in the portfolio more transparent.

FORMOSAT-5 satellite

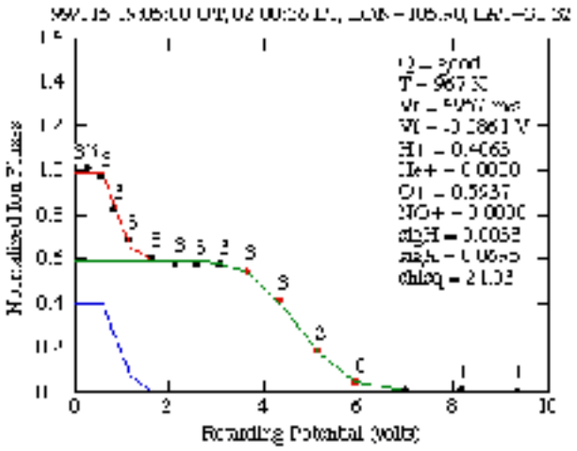
The **FORMOSAT-5** (FS-5) is a remote sensing satellite and currently scheduled to be launched by SpaceX in 2017. The FS-5 is anticipated to fly in a 98.28° inclination sun-synchronous circular orbit at 720 km altitude in the 1030/2230 LT sectors. The primary payload is Remote Sensing Instrument (RSI) organized by NSPO. In addition, a scientific instrument, Advanced Ionospheric Probe (AIP) developed by National Central University, has been chosen as the secondary payload.

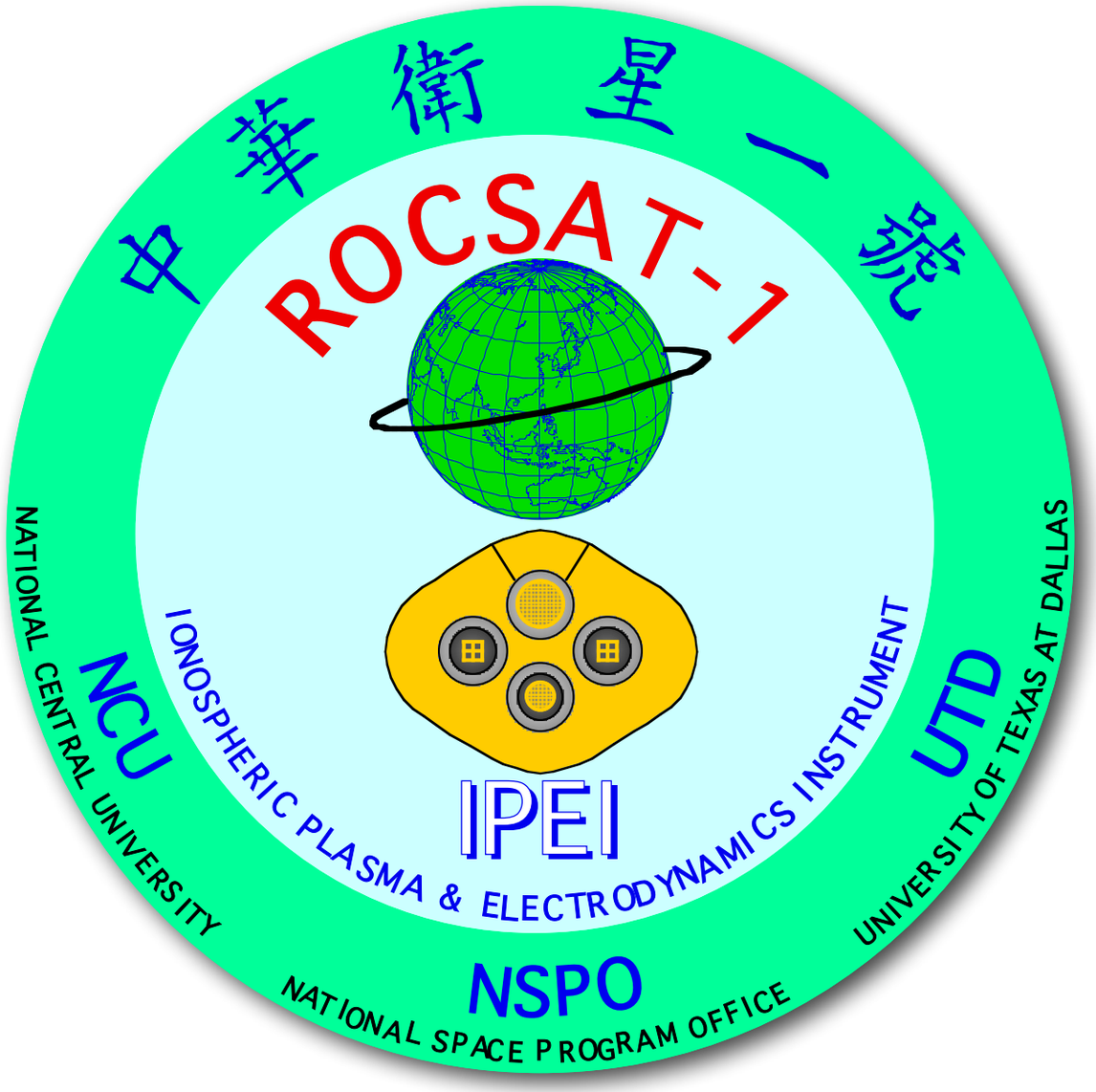
Proposals

- **Creativities**: all-in-one plasma sensor in a small form factor, high sampling rate, etc.
- **Capabilities**:
  - Payload development: PCB fabrication, design software, etc.
  - Environmental test facilities: vibration, thermal vacuum chamber, plasma chamber, etc.
- **Flight heritage**: SR-V and SR-VII for development, and SR-IX for flight test.

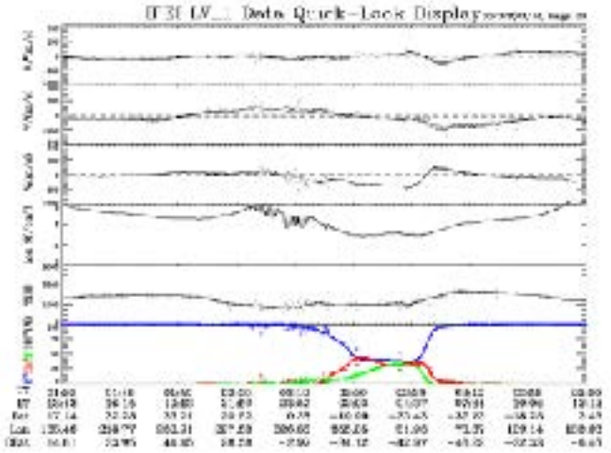
ROCSAT-1/IPEI

SPL



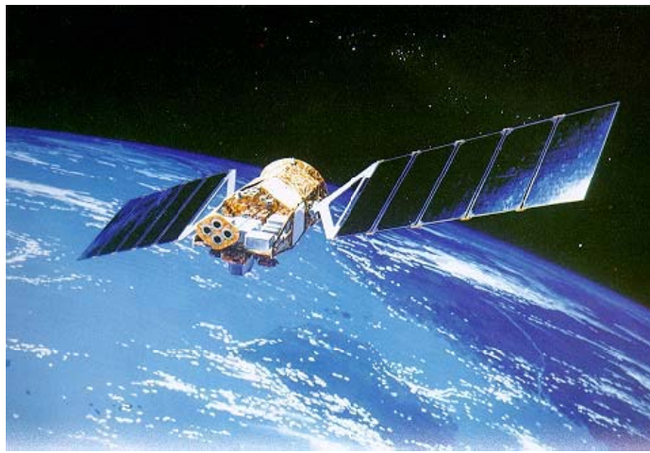


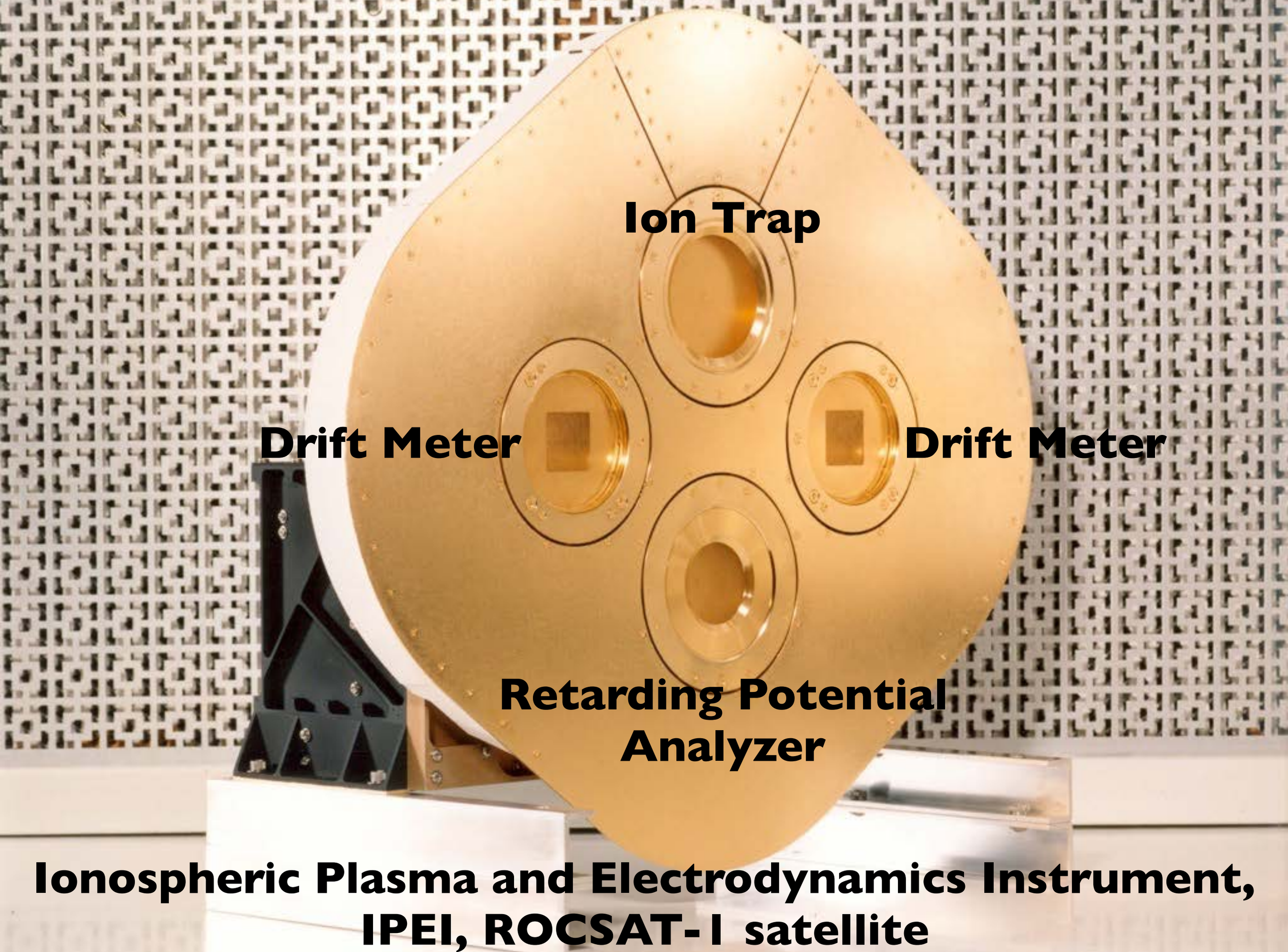
NCU/GISS
Data Center
Users



NSPO
Project Management
Funding Agency

UTD/HSC
Payload
Supplier

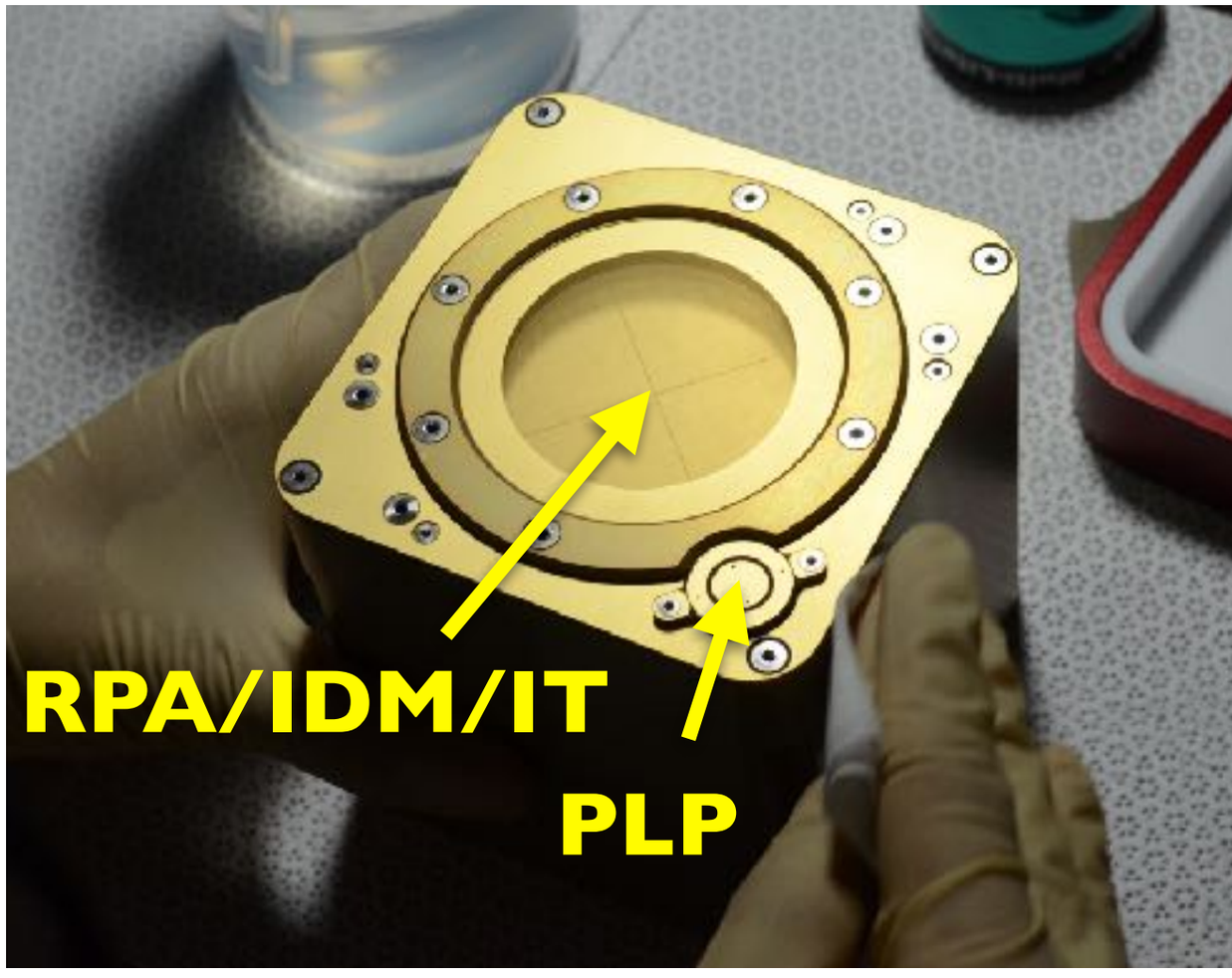




Ionospheric Plasma and Electrodynamics Instrument, IPEI, ROCSAT-1 satellite

Advanced Ionospheric Probe

Advanced Ionospheric Probe (AIP) is an all-in-one thermal plasma sensor to measure ionospheric plasma concentrations (N_i), velocities ($\boldsymbol{V}_i$), and temperatures (T_i and T_e) in a time sharing way to play Ion Trap (IT), Ion Drift Meter (IDM), Retarding Potential Analyzer (RPA), and Planar Langmuir Probe (PLP).



The AIP is capable of measuring ionospheric plasma irregularities with sampling rate up to 8,192 Hz. Electro-formed gold grids used in the AIP can reduce quasi-hysteresis effect on I-V curves and approximate ideal electrical potential surfaces for accurate geophysical parameters.

Facility

- Environmental tests: plasma injection, temperature cycling, thermal vacuum, and vibration test services.
- Payload development: mechanical and circuit design software, digital system development boards for classroom and research.
- PCB prototyping: single/multiple-layer PCB fabrication, through-hole and SMT assembly, and standard equipment for calibration and test.





Space Plasma Simulation Chamber

Temperature cycling test

Environmental tests

Thermal vacuum test

Vibration test

Monitoring

DAQ

SOLIDWORKS

MSC Software

Design software

NATIONAL INSTRUMENTS

LPKF Laser & Electronics

RF

PCB plotter

EUV exposer

Payload development

PCB fabrication

Embedded system

Pick and place assembly system

SMT solder paste printer

Through-hole conductivity/plating

Multi-layer prototyping

Reflow oven

虛擬儀控教學設施

Undergraduate courses

Circuits

Digital Logic Design

Graduate courses

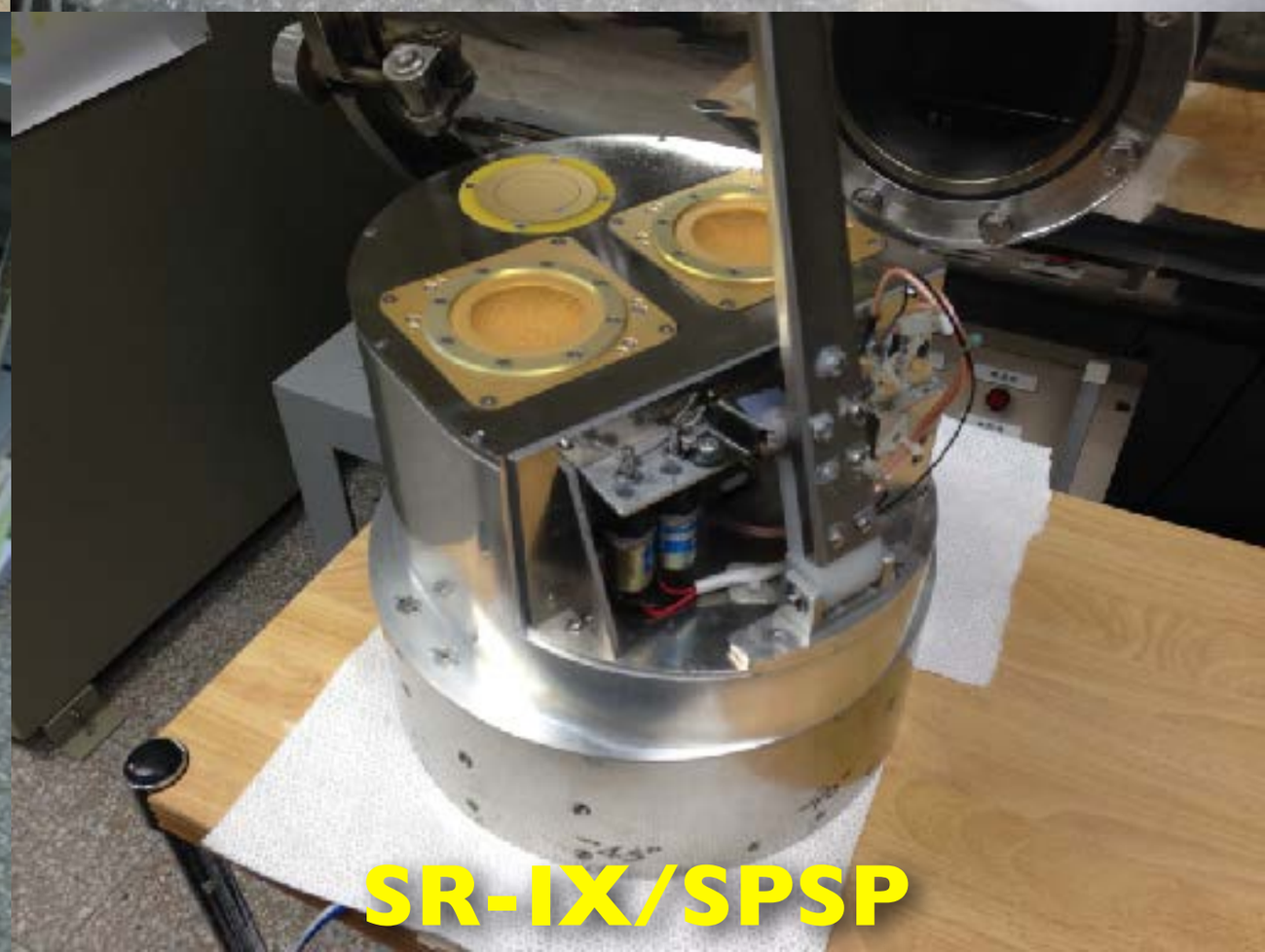
Plasma Measurement

Calibration and Test for Space Instrument

SR-III/TMA

SR-V/IP

SR-VII/PP

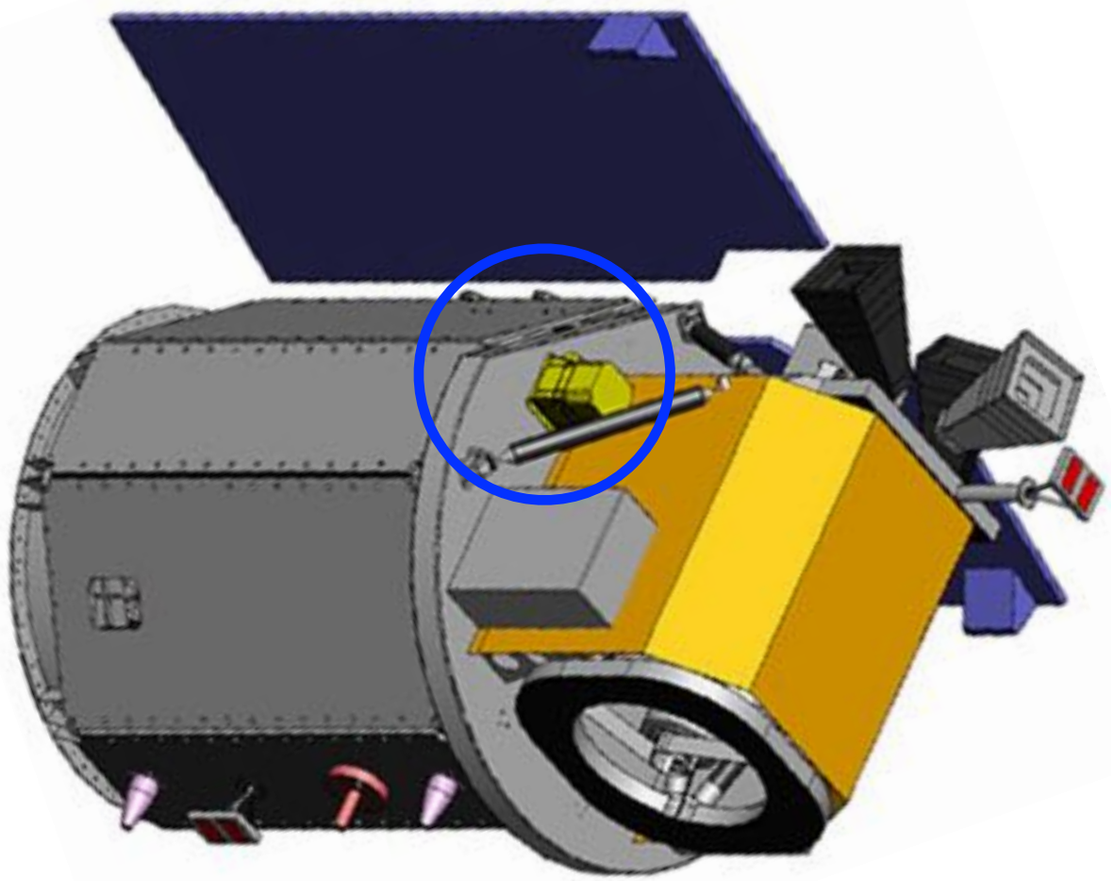


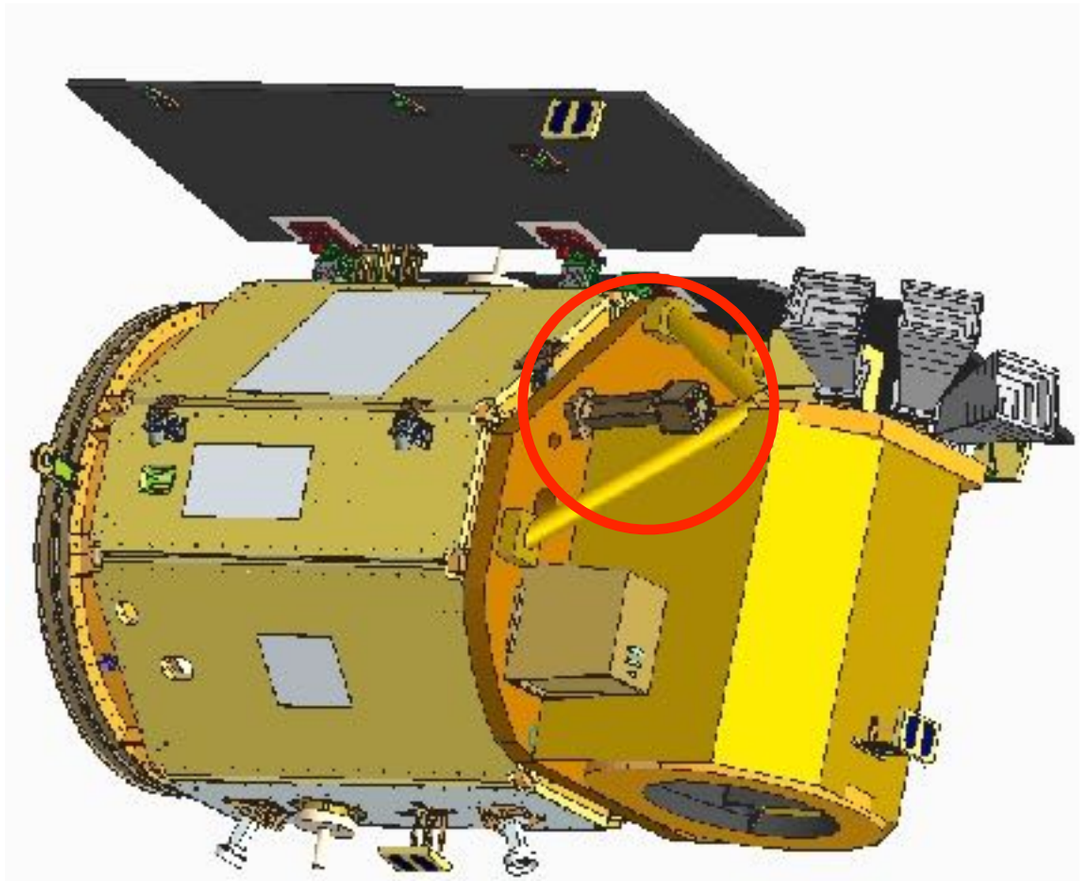
SR-IX/SPSP

Budget

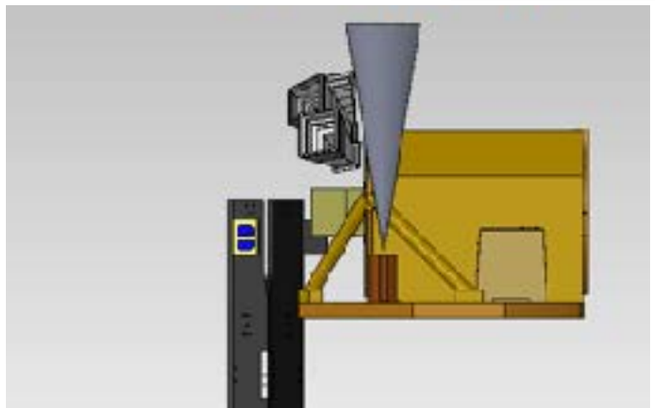
- FORMOSAT-5/AIP: USD 1.27M → **USD 1M** to NCU in comparison to **USD 5.37M** for ROCSAT-1/IPEI to UTD.
- Team members: a faculty and students without professional engineers.
- Sub-contractors:
  - University: NCU/ME. **FAIL**
  - Professional institute: NCSIST. **FAIL**
  - Private company: T&C. **PASS**

A stand is required to increase field of view



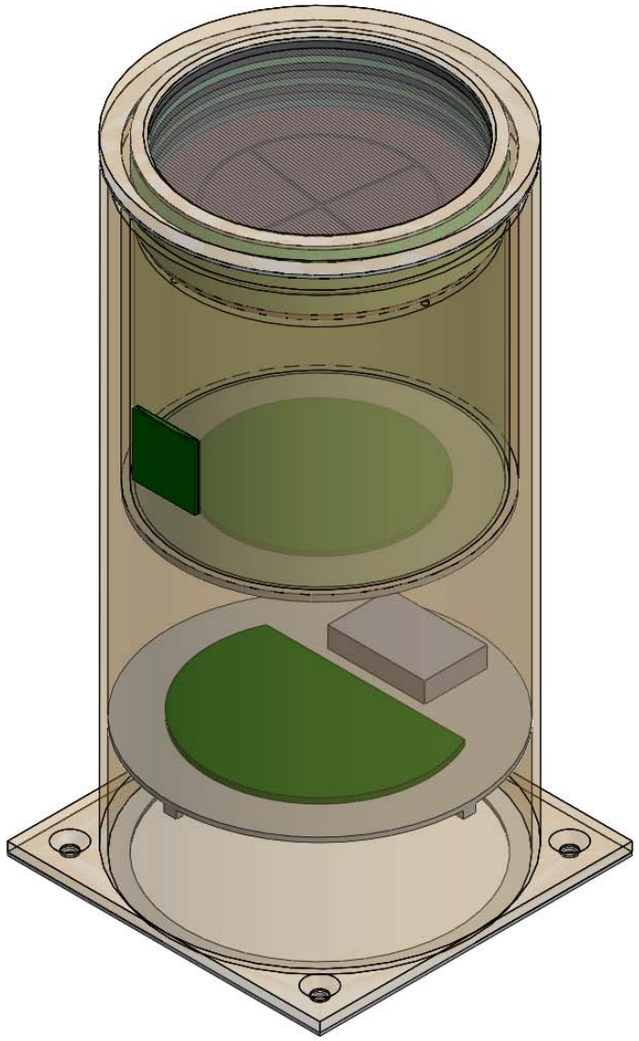


FOV ~**18° x 18°**

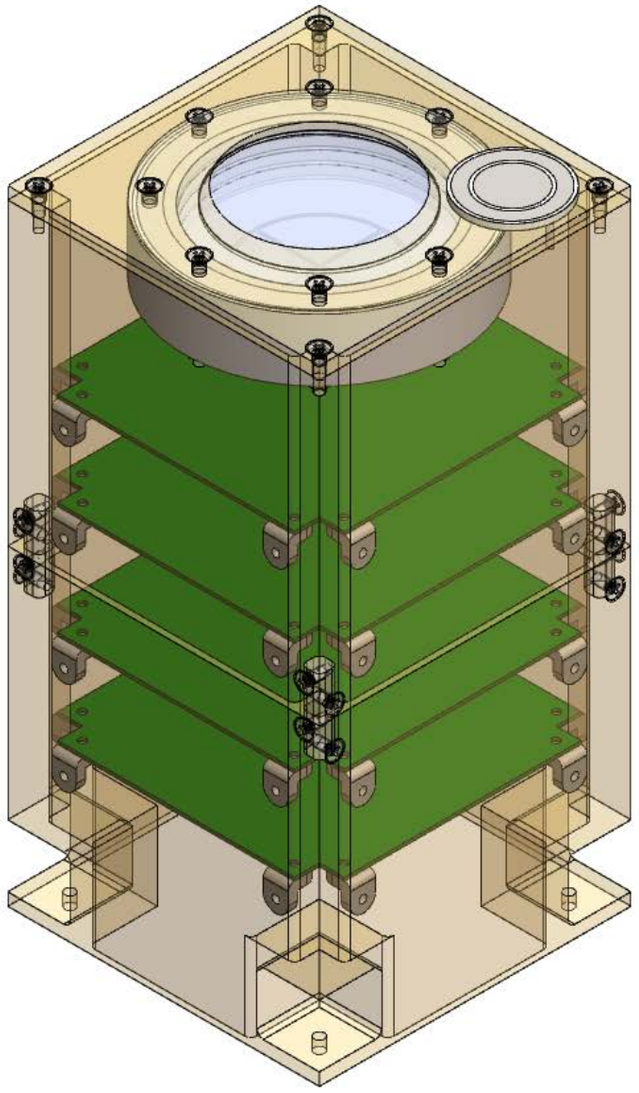


FOV ~**46° x 46°**

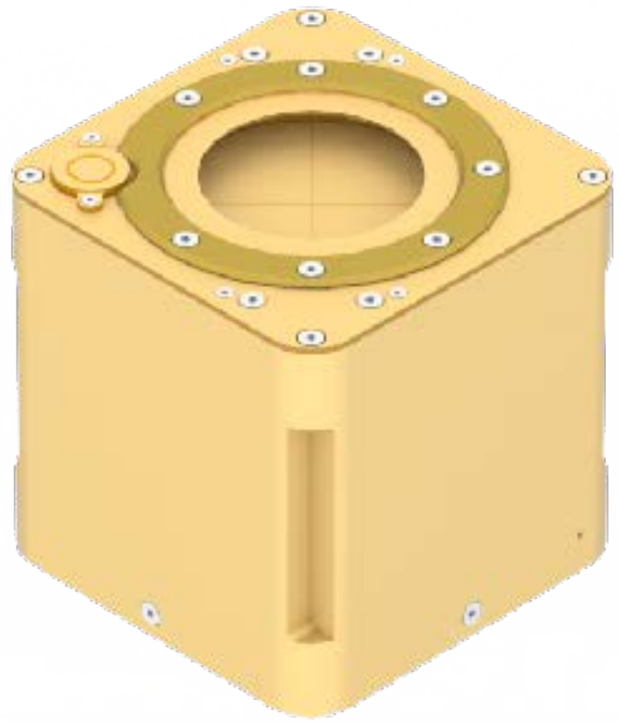
Sensor configuration



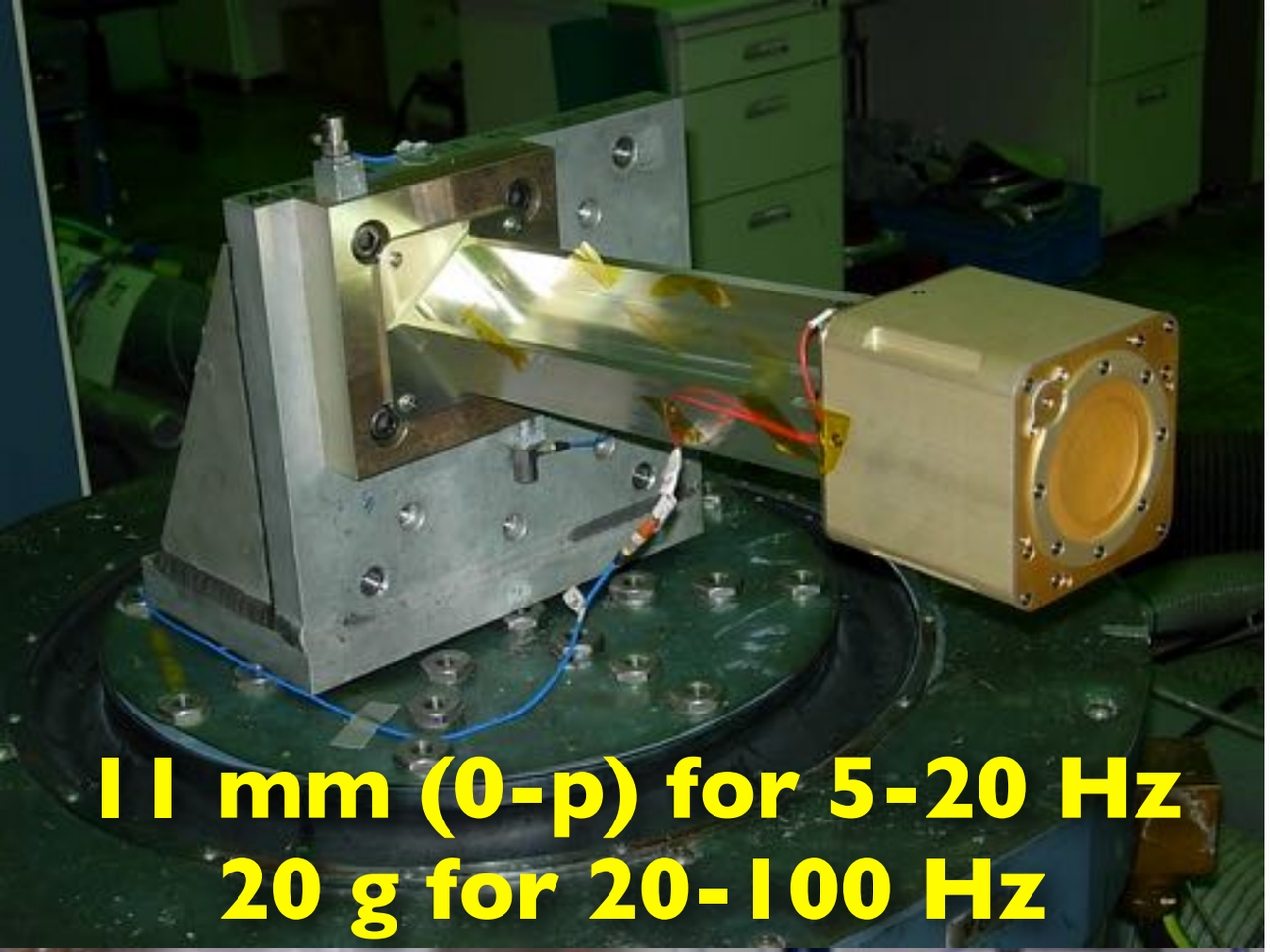
Proposal
(WSD + 0M)



MDR/SDR
(WSD + 2M)

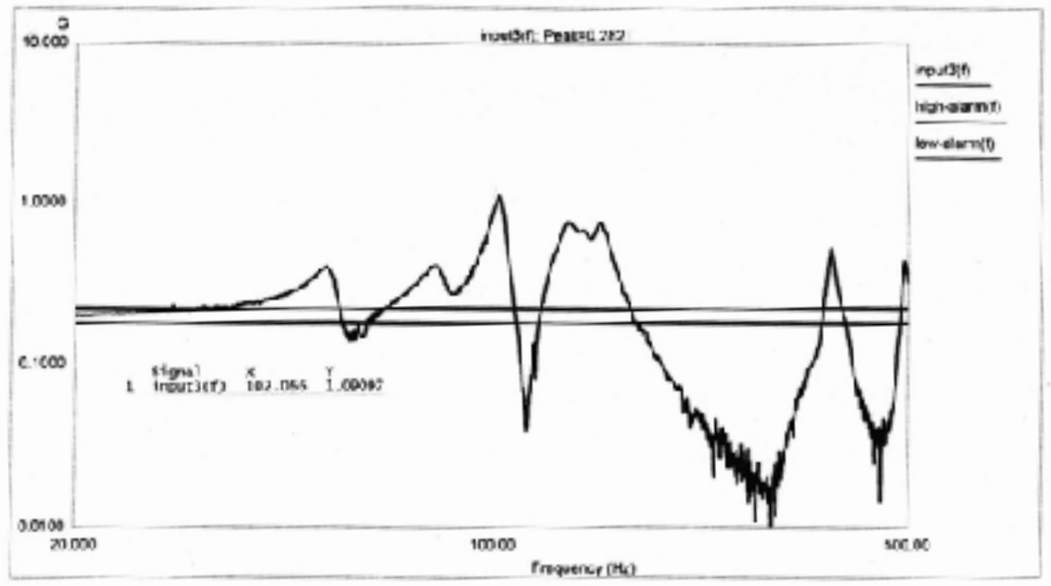


PAR
(WSD + 21M)



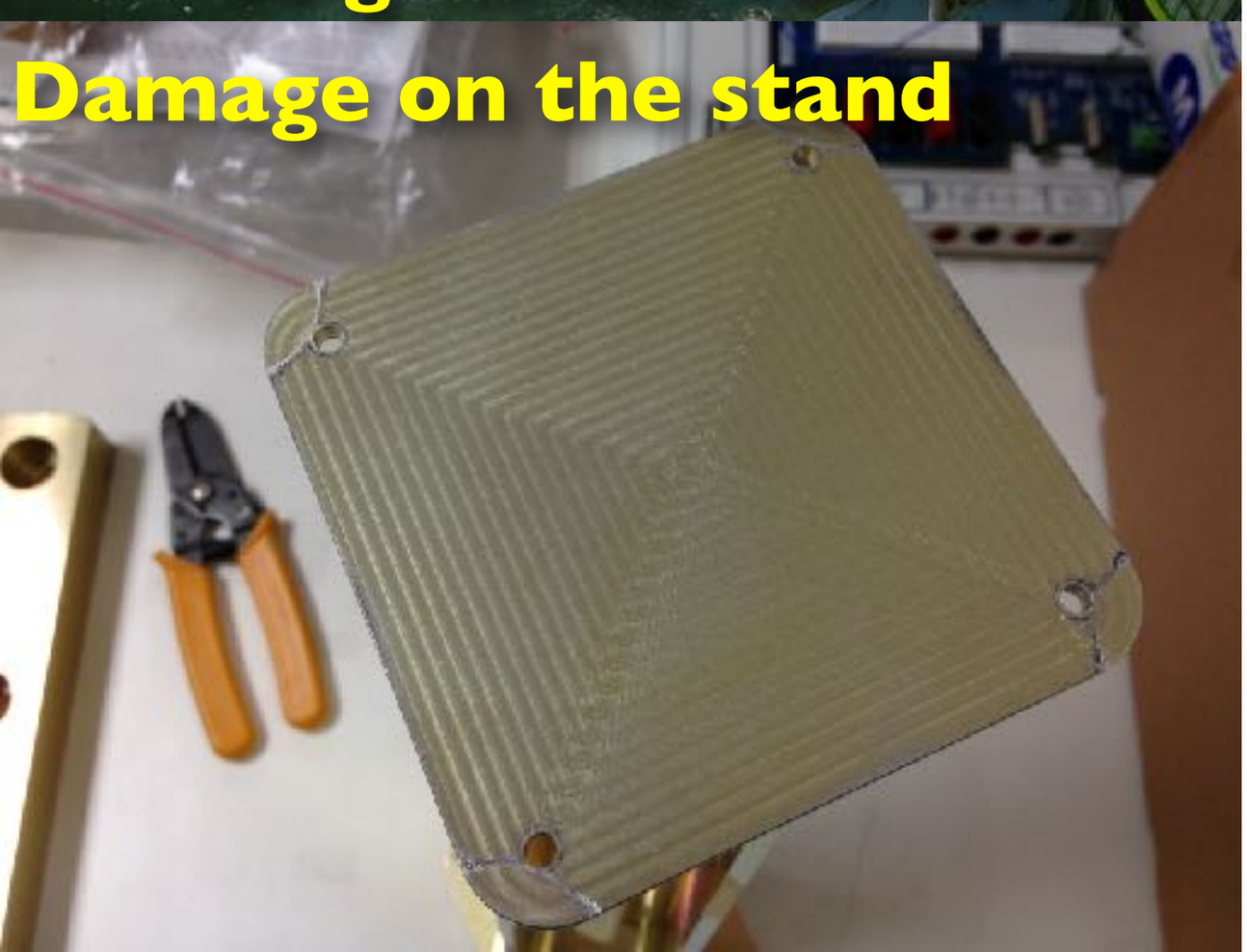
11 mm (0-p) for 5-20 Hz
20 g for 20-100 Hz

Before sine vibration



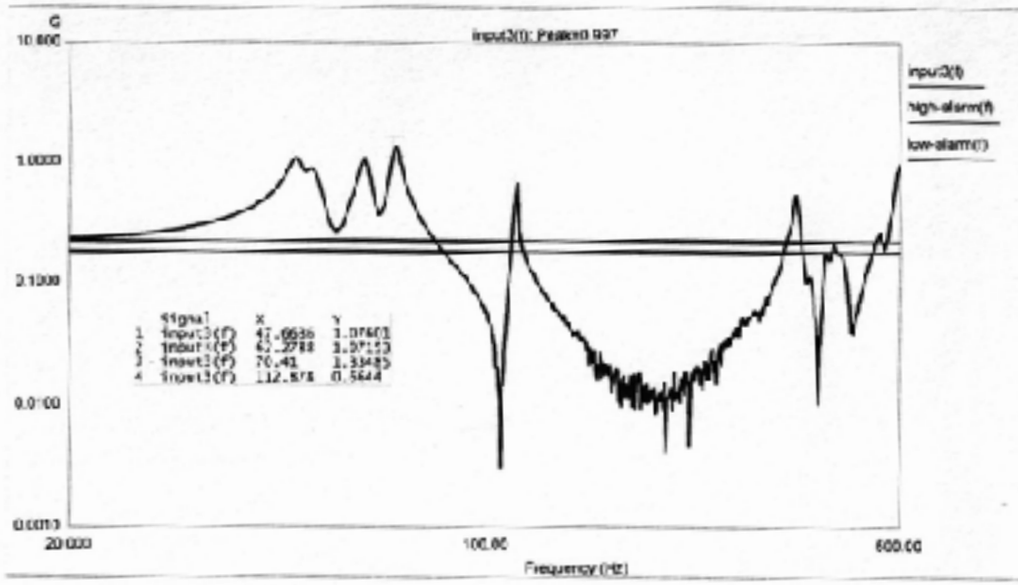
Level: 100 % Control Peak: 0.226855 G Full Level Time: 00:02:19 Sweep Type: Logarithmic
Frequency: 495.973047 Hz Demand Peak: 0.200000 G Time Remaining: 00:00:00 Sweep Rate: 2 Oct/Min

Data saved at 05:32:41 AM, Thursday, August 08, 2013 Report created at 09:32:48 AM, Thursday, August 8, 2013



Damage on the stand

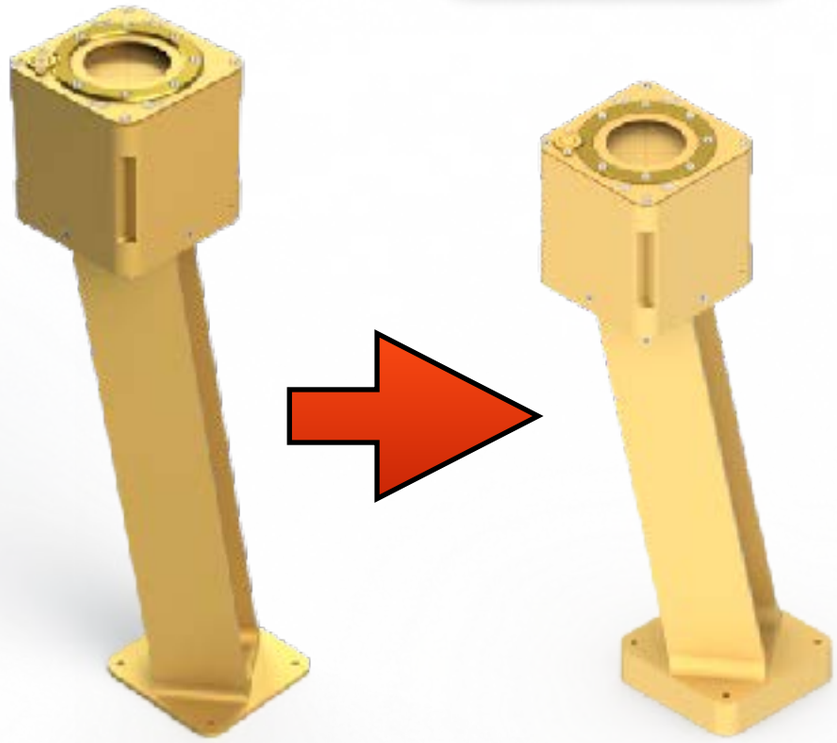
After sine vibration



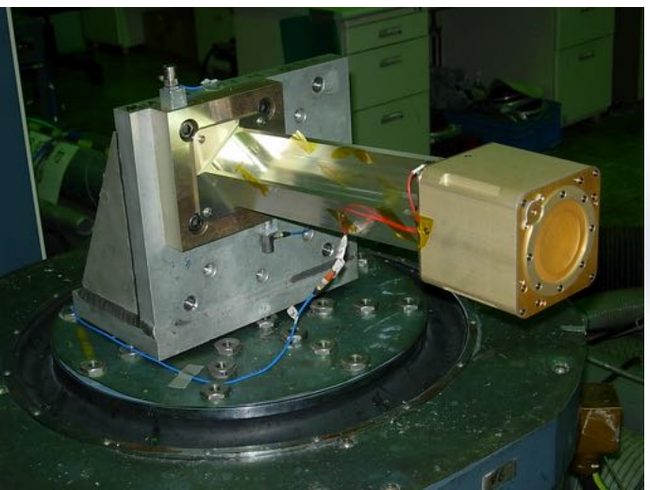
Level: 100 % Control Peak: 0.151465 G Full Level Time: 00:02:19 Sweep Type: Logarithmic
Frequency: 495.973047 Hz Demand Peak: 0.200000 G Time Remaining: 00:00:00 Sweep Rate: 2 Oct/Min

Data saved at 11:11:12 AM, Thursday, August 08, 2013 Report created at 11:11:14 AM, Thursday, August 8, 2013

Change stand and fixture



- Bottom plate from 4 mm to 25 mm.
- Height from 350 mm to 300 mm.
  - FOV from 52.0° to 46.4°.
  - Mass from 1.28 kg to 1.18 kg.
  - 1st mode natural freq. from 121 Hz to 136 Hz (≥120 Hz).
- Locations of the holes on the fixture are rotated to 45°.



Mechanical specifications

- Mechanical: **5.554** kg (shall be ≤ 5 kg) in total mass.
  - Sensor: **2.046** kg (shall be ≤ 1 kg) and installed on the top panel.
    - Head: 100 L x 100 W x 100.6 mm H and **0.8617** kg.
    - Stand: 140 L x 130 W x 300 mm H with footprint 100 L x 100 W and **1.184** kg for field of view (FOV) **46.4°** (≥ 45°).
  - SPEU: installed inside S/C, 180 L x 180 W x 60 mm H and **1.761** kg.
  - Harness between SPEU & sensor: **1.747** kg and **3.8** m.

Schedule	WSD	Due	Extension
38M→ 65M	2012/01/13	2015/03/12	2017/06/30
Milestone	**Due**	**Delivery**	**Status**
MDR / SDR	2012/03/12 (WSD + 2M)	2012/03/6	On time
PDR	2012/05/12 (WSD + 4M)	2012/05/09	On time
CDR	2012/09/12 (WSD + 8M)	2012/09/11	On time
DRR	2013/01/12 (WSD + 12M)	2013/01/08	On time
PAR	**2013/08/12 (WSD + 19M)**	**2013/10/08**	**Delay**
SMRR	2014/07/12 (WSD + 30M)	2014/07/08	On time
ITR	2015/11/20 (WSD + 46M)	2015/11/20	On time
IOCR	2017/06/30 (WSD + 65M)		
FR	2017/06/30 (WSD + 65M)		

Penalty: USD 60K

60 days x USD 1K per day

財團法人國家實驗研究院

國家太空中心

收款收據

法人登記簿第2540號

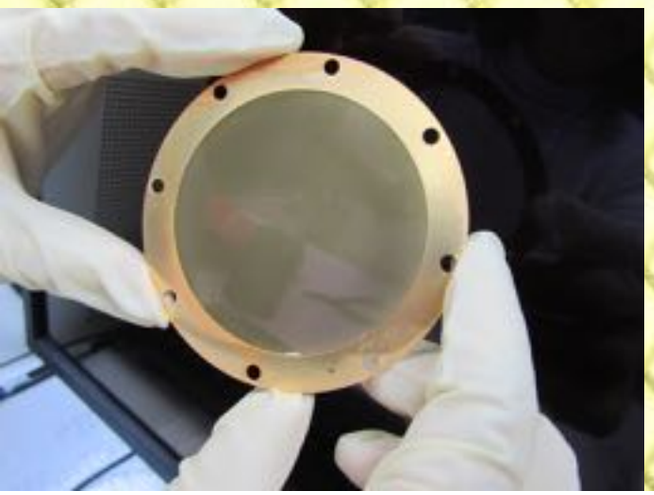
統一編號：80778312

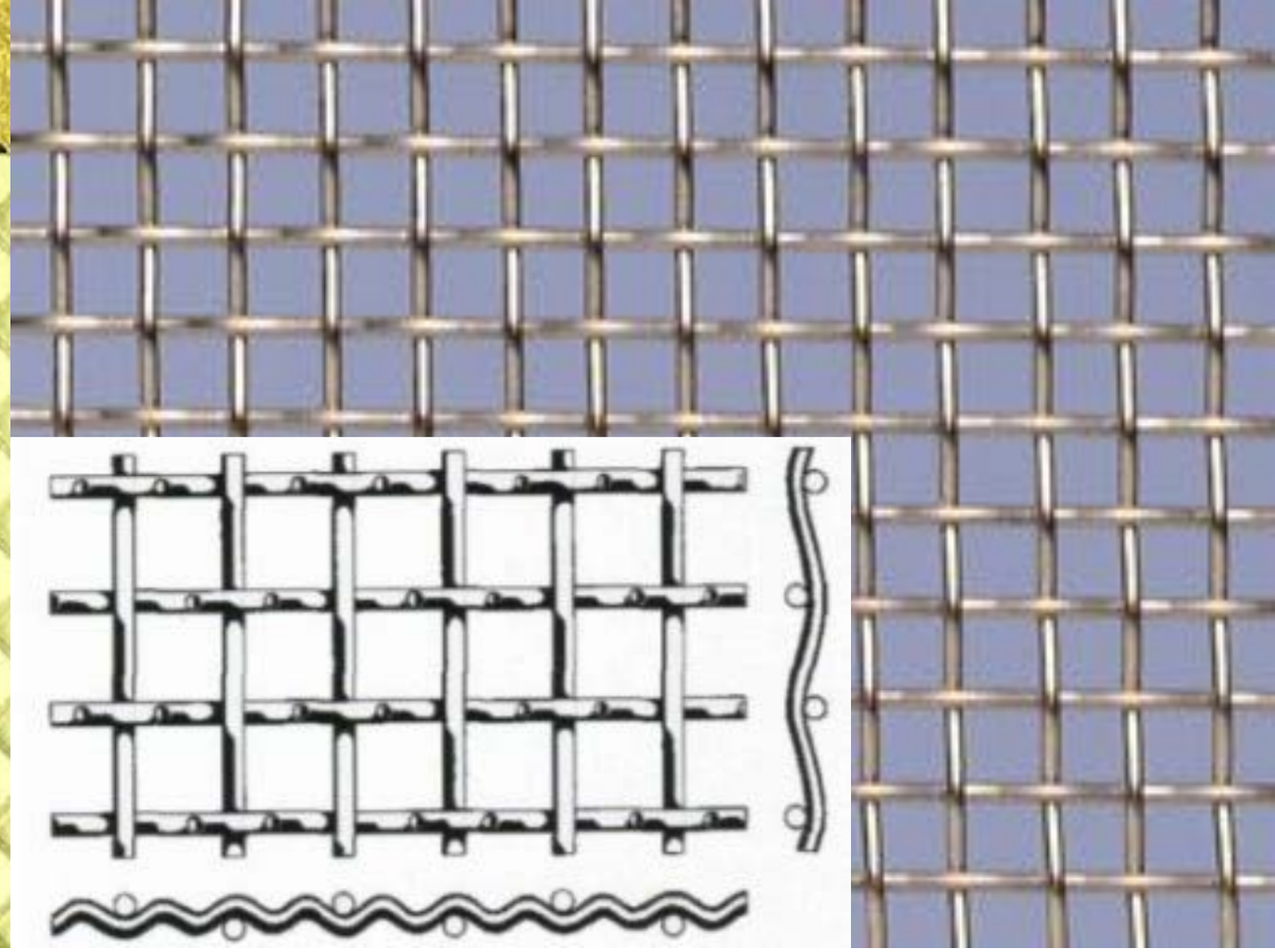
太空 第 102318號

民國102年12月27日

繳款人	收入科目及代號	事由	金額	備註
國立中央大學	42190101 其他業務外收入	NSPO-S-100005福衛五號科學酬載	NTD $1,772,277.00	逾期罰款台灣銀行新竹科學園區分行支票

(1) 第一聯：收據





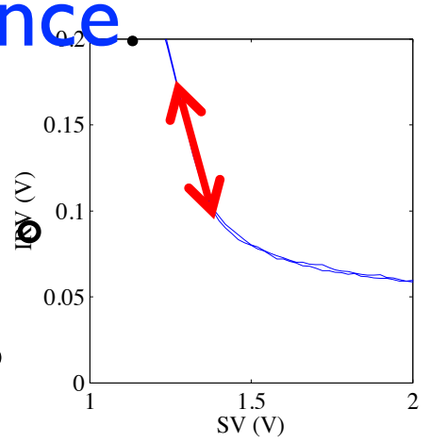
Electro-formed grids (AIP)

99.98% gold grid, good equal potential surface, reduced I-V hysteresis, poor resilience.

Mesh density: 100 LPI.

Grid diameter: 0.5 mil

Transparency: 0.9025 ◦



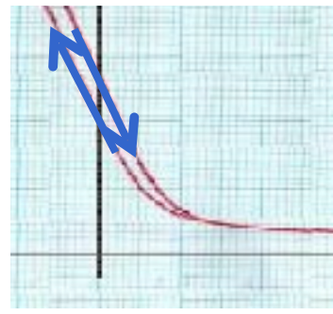
Weaved grids (IPEI)

Stainless steel grid coated in gold, bad equal potential surface, apparent I-V hysteresis, good resilience.

Mesh density: 50/100 LPI.

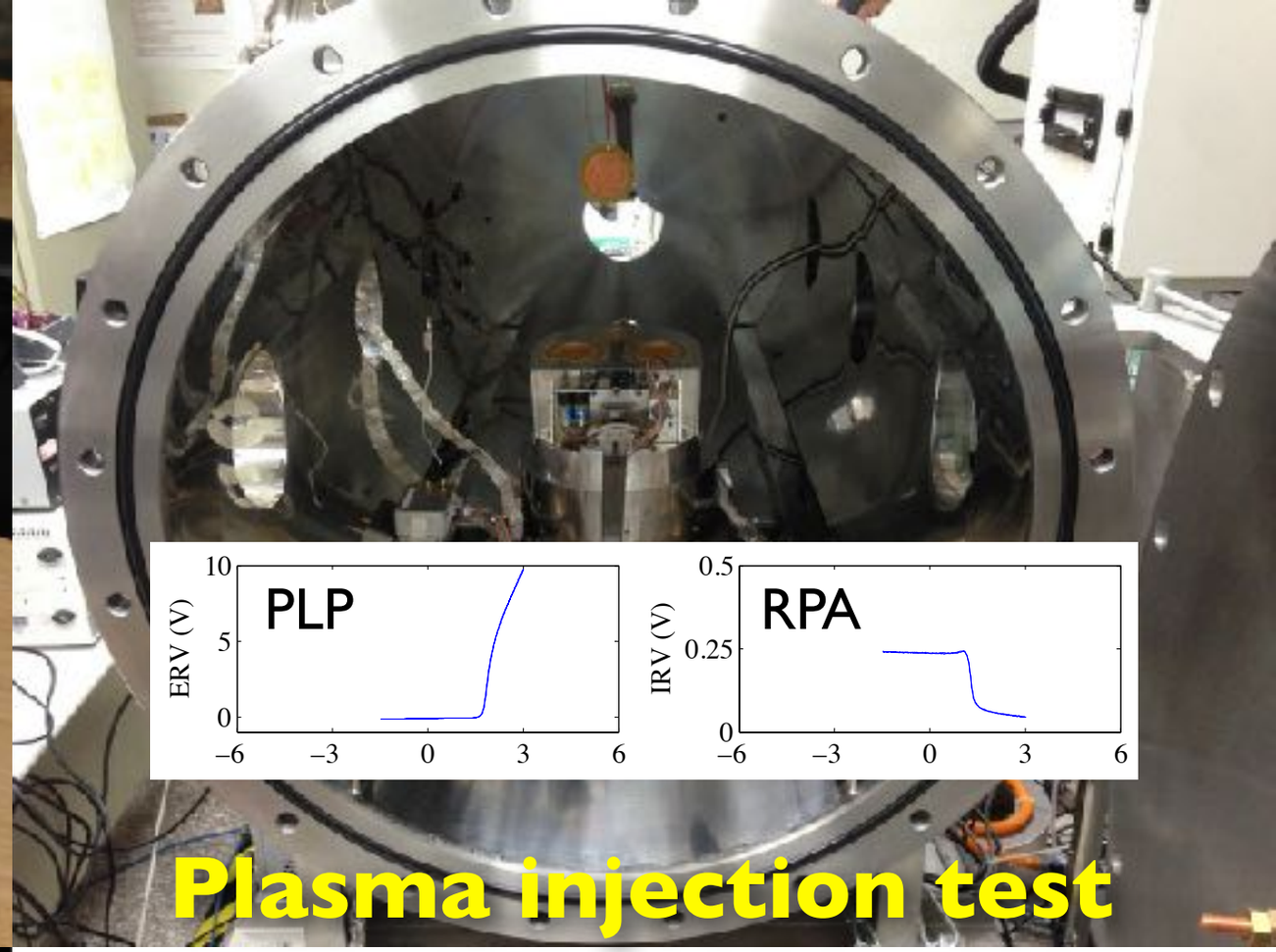
Grid diameter: 1 mil.

Transparency: 0.9025/0.81.

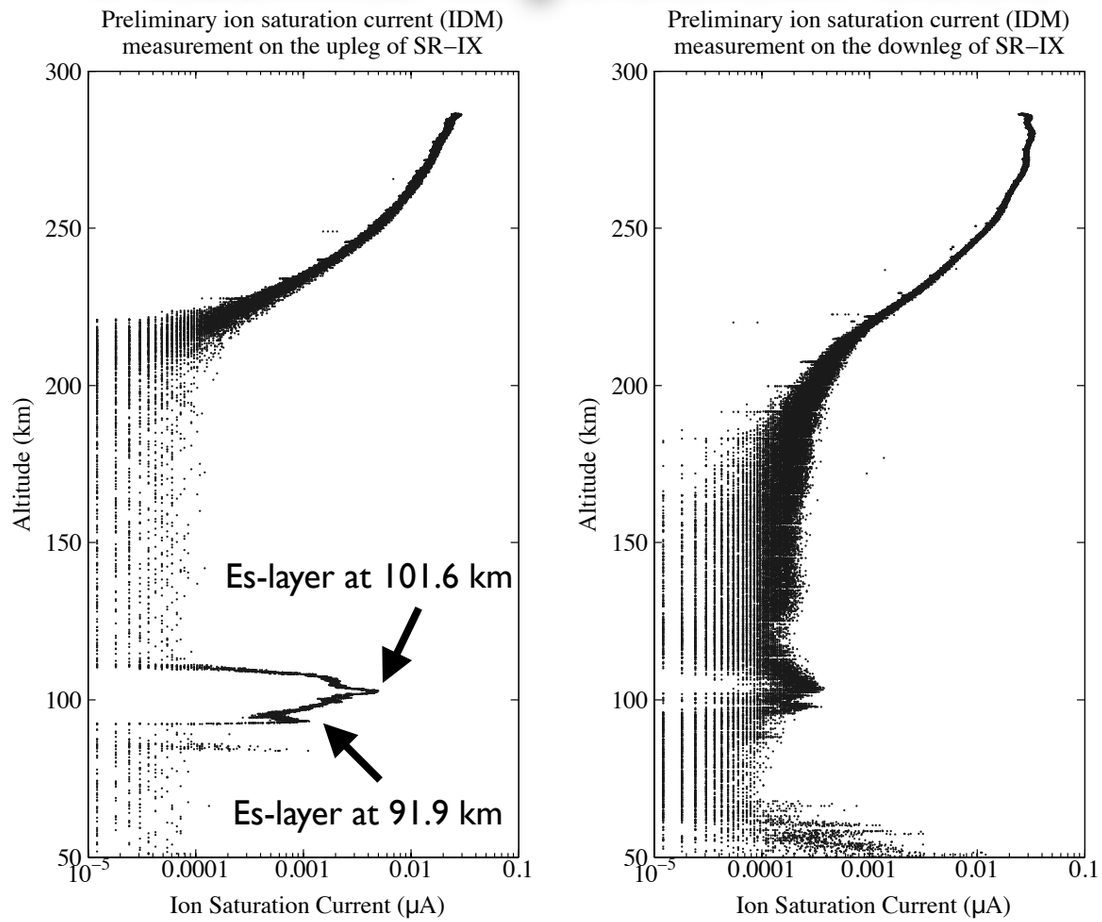


1 mil (10^{-3} inch = 25.4 μm) and diameter of a human hair ~4 mil.

Space Plasma Sensor Package



Plasma injection test

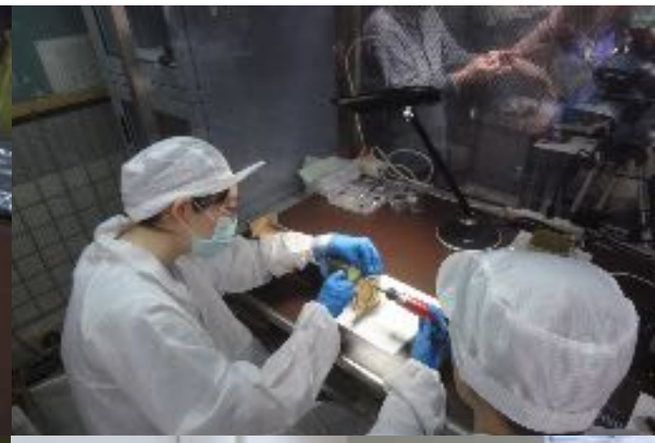
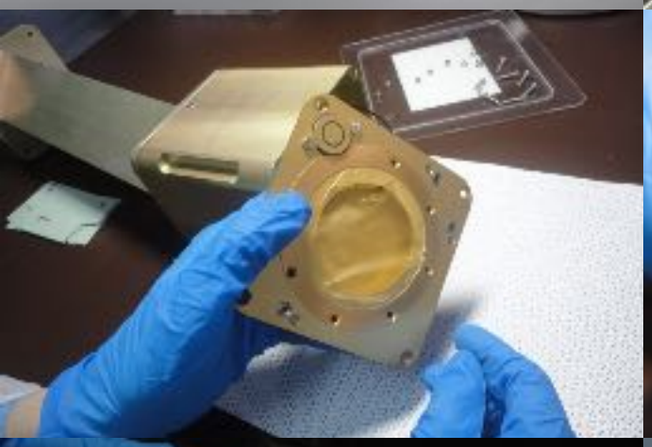


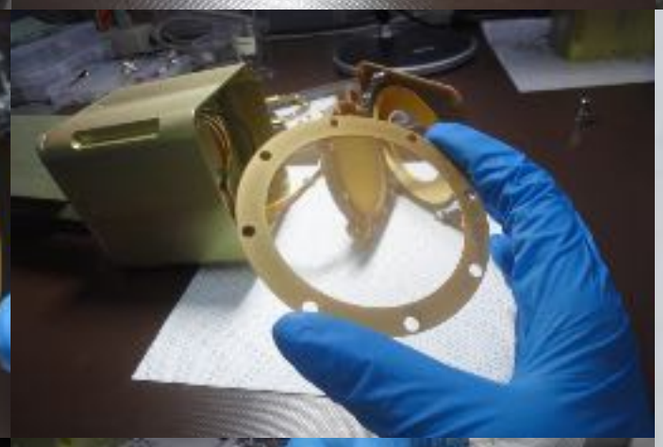

Grid broken by unknown cause

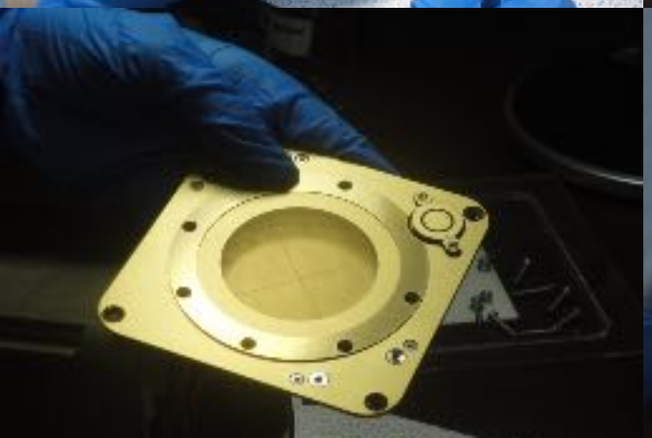
Replace and test

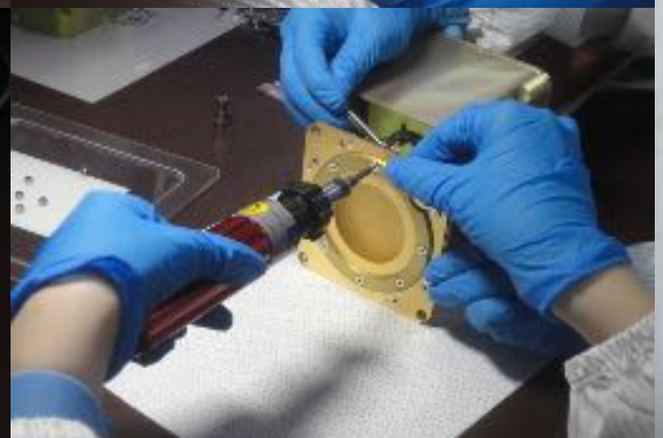
2016/03/11 to 2016/04/29



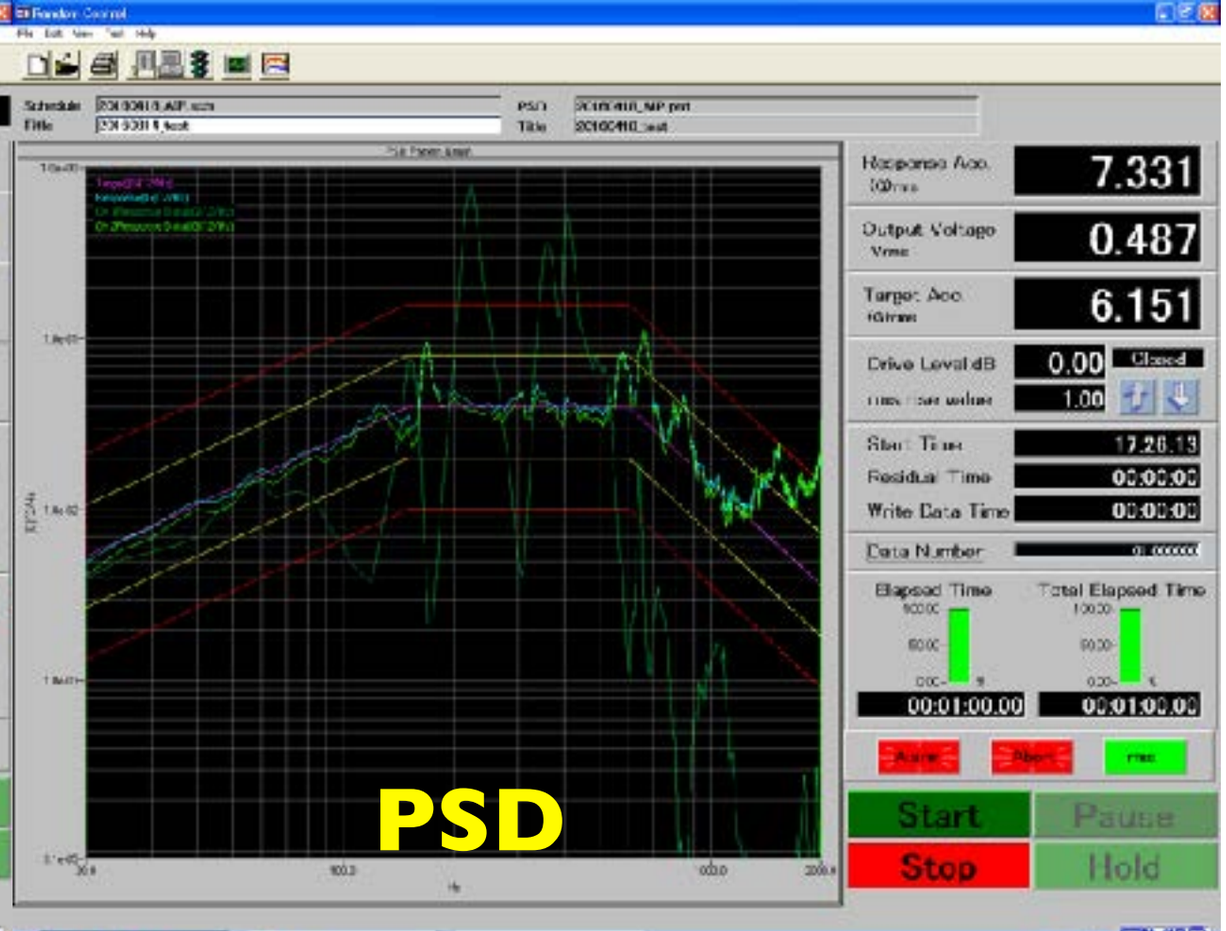











136.5 Hz
Before random
Sine
ResponseAcc (G) 0.003
Drive Level 0.0 dB Set
Output Voltage (Volts) 0.000
Drive Frequency (Hz) 496.38
Elapsed Time 0:02:19
Finish Time 17:21:50
Sweep Time 0.02:19
Sweep Direction Stop
Down Up
Sweep Speed 2.3219Min
Alarm Abort
Start Pause
Stop Hold


PSD
Response Acc. 7.331
Output Voltage 0.487
Target Acc. 6.151
Drive Level dB 0.00 Closed
1.00
Start Time 17:26:13
Residual Time 00:00:00
Write Data Time 00:00:00
Data Number
Elapsed Time
Total Elapsed Time
00:01:00.00
00:01:00.00
Start Pause
Stop Hold

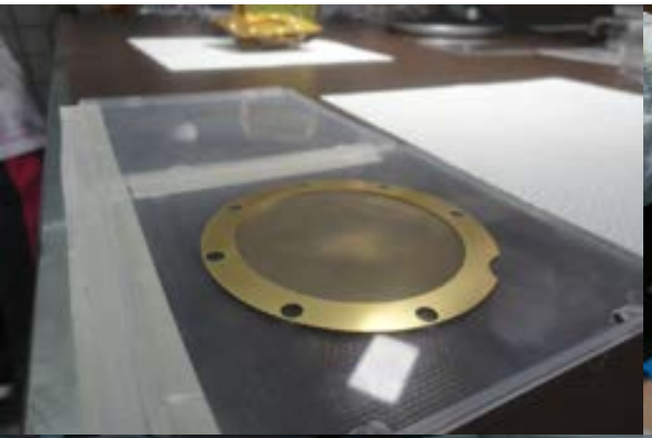

135.2 Hz
After random
Sine
ResponseAcc (G) 0.002
Drive Level 0.0 dB Set
Output Voltage (Volts) 0.000
Drive Frequency (Hz) 496.38
Elapsed Time 0:02:19
Finish Time 17:33:55
Sweep Time 0.02:19
Sweep Direction Stop
Down Up
Sweep Speed 2.3219Min
Alarm Abort
Start Pause
Stop Hold

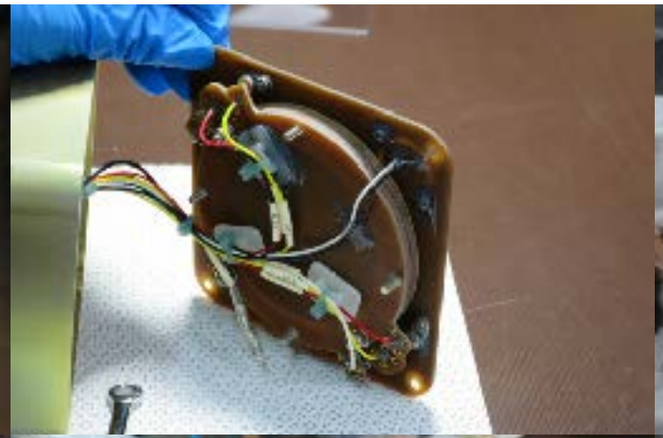

X axis

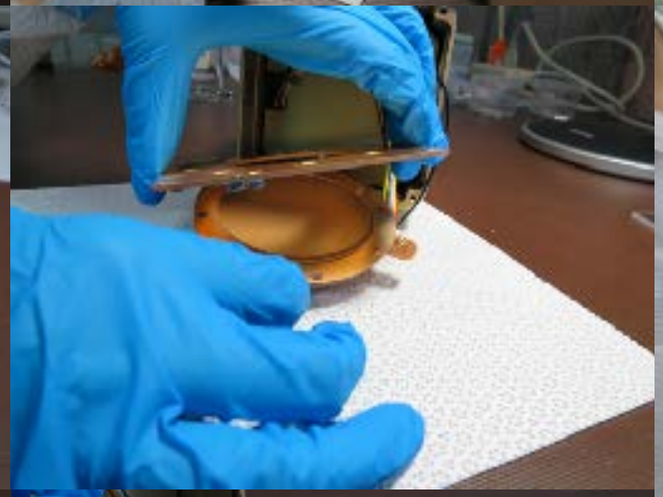
Grid depressed by a finger

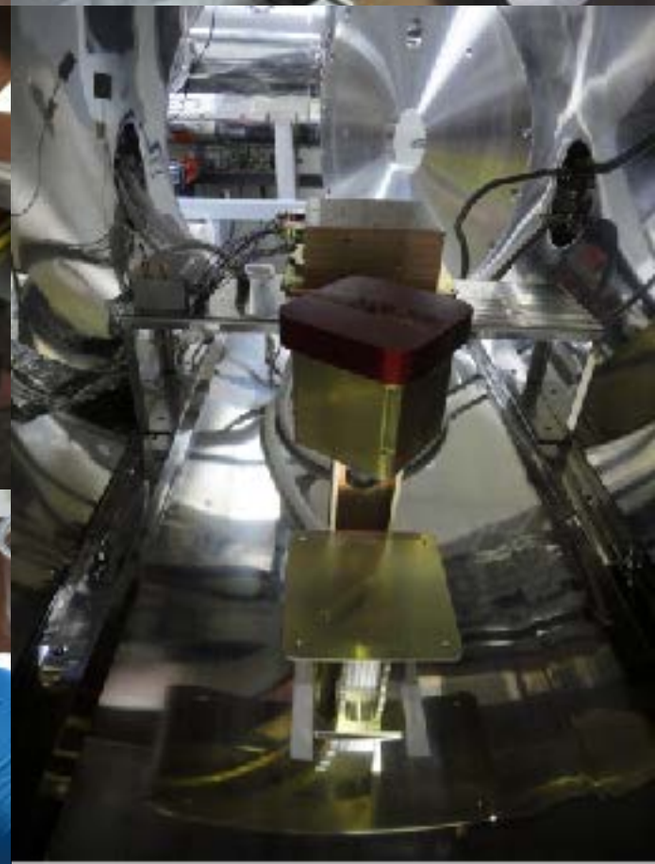
Replace and test again

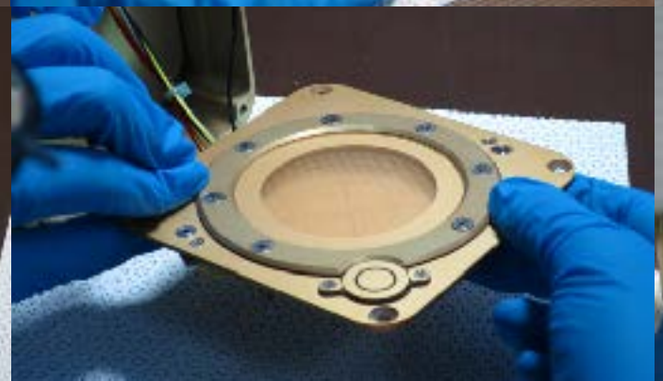
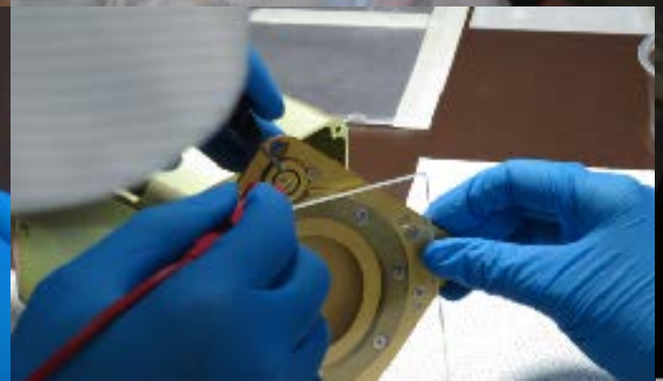
2016/05/11 to 2016/06/01



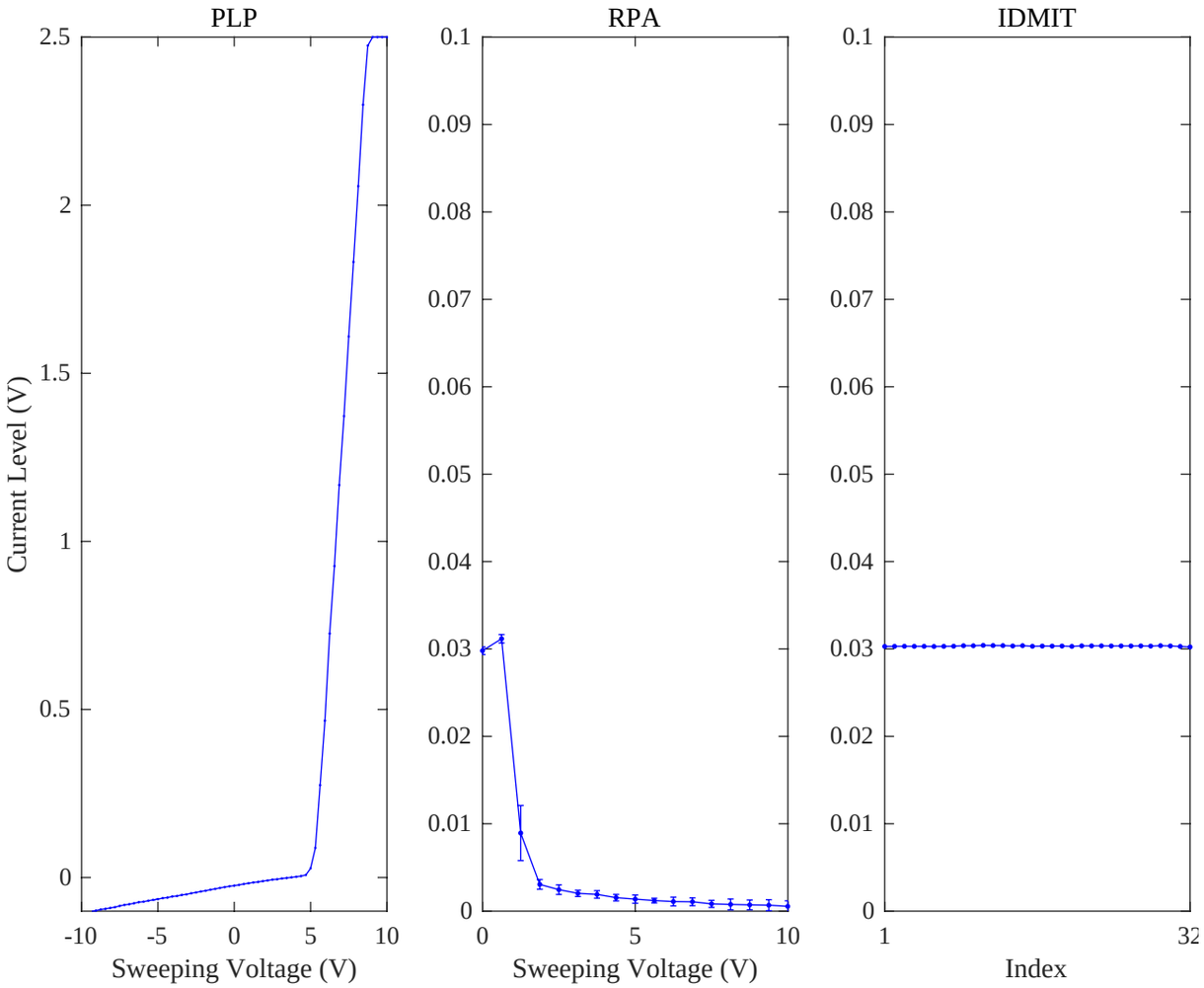




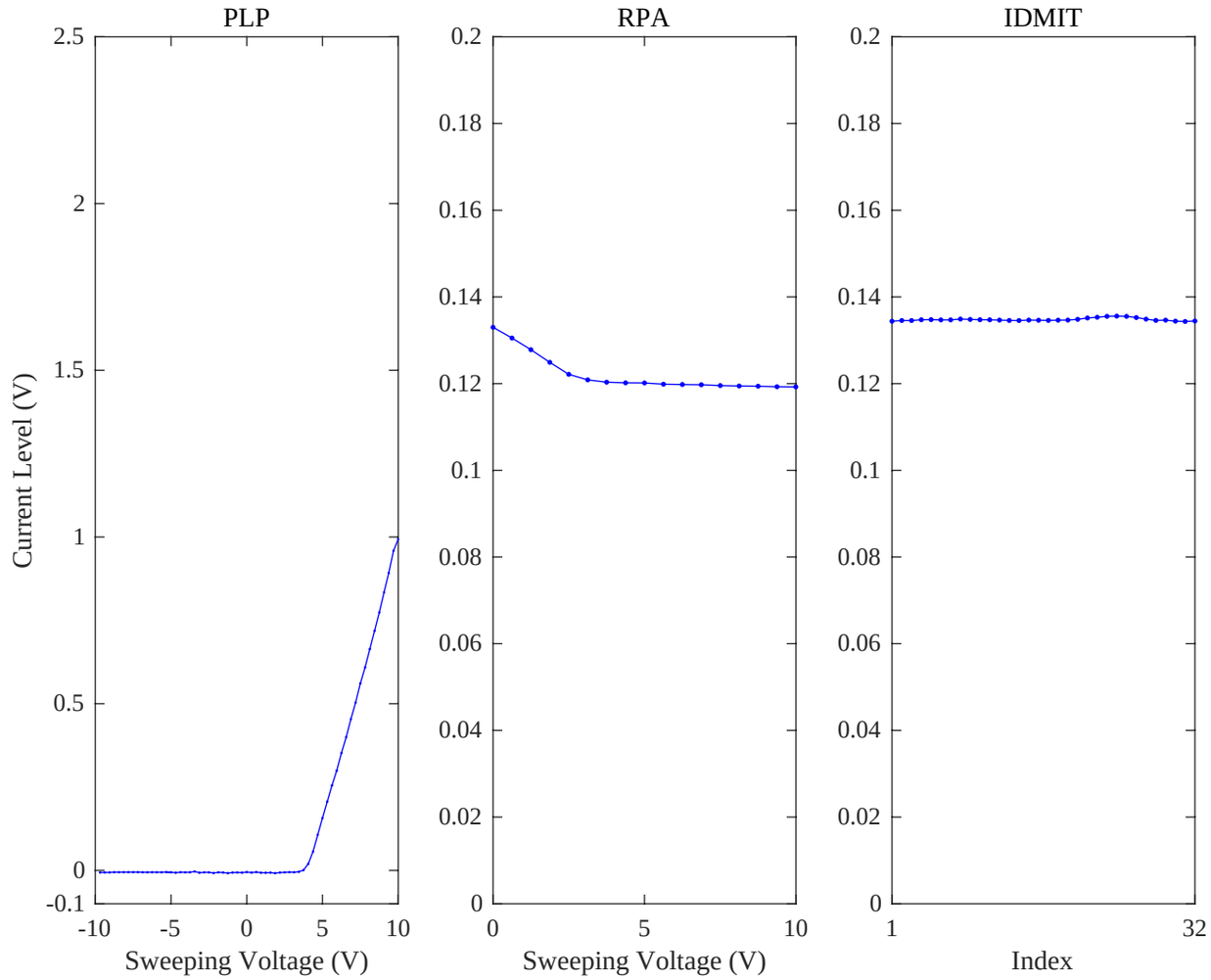



Plasma injection test



FAST mode

Sensor perpendicular to plasma source



NORMAL mode

Sensor faced to plasma source

Pre-launch static fire test (AMOS-6) at SLC40 on 9/12016 → FS-5 launch delayed

Summary

- A project shall have a good proposal. However, it does not mean the good proposal shall be funded.
- The cost could be estimated, but it won't meet your expectation. The budget could be allocated, but there are more expenses than you expected.
- There are countless risks to run a project. If you don't try, you'll never know.
- The past representations of a project investigator and his/her team are one of the crucial factors to determine success or failure of the project.