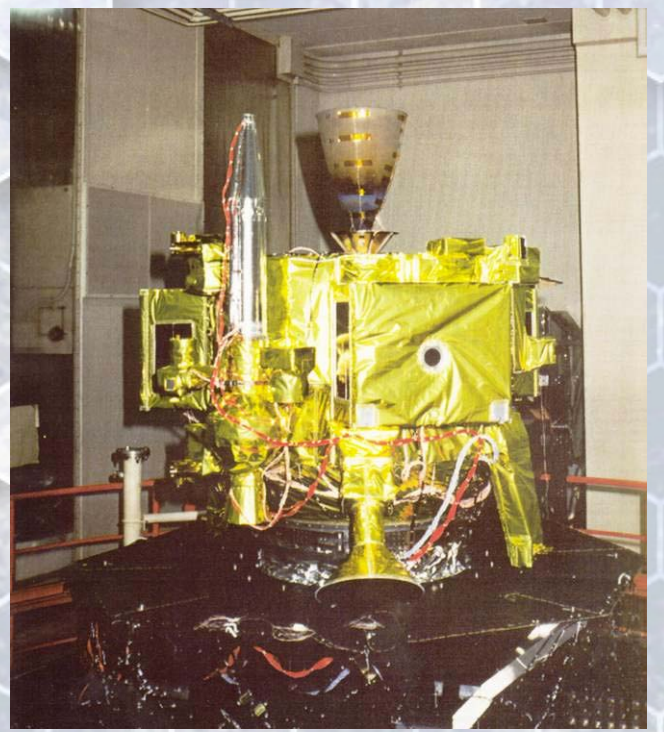
# The Current Status of the Japanese Penetrator Mission Lunar-A

Manabu Kato, ISAS/JAXA

Lunar-A in the lunar orbit



Lunar-A spacecraft and penetrator

# Lunar-A mission

**Outline**

- **Penetrator - hard lander**
- **2-penetrators : deploy at lunar near and far side**
- **Study of lunar internal structure**
  - **Seismic observation → Core radius**
  - **Heat flow measurement**
    **→ topographically unperturbed data**
- **Mission life ~1 year (without temperature control system)**

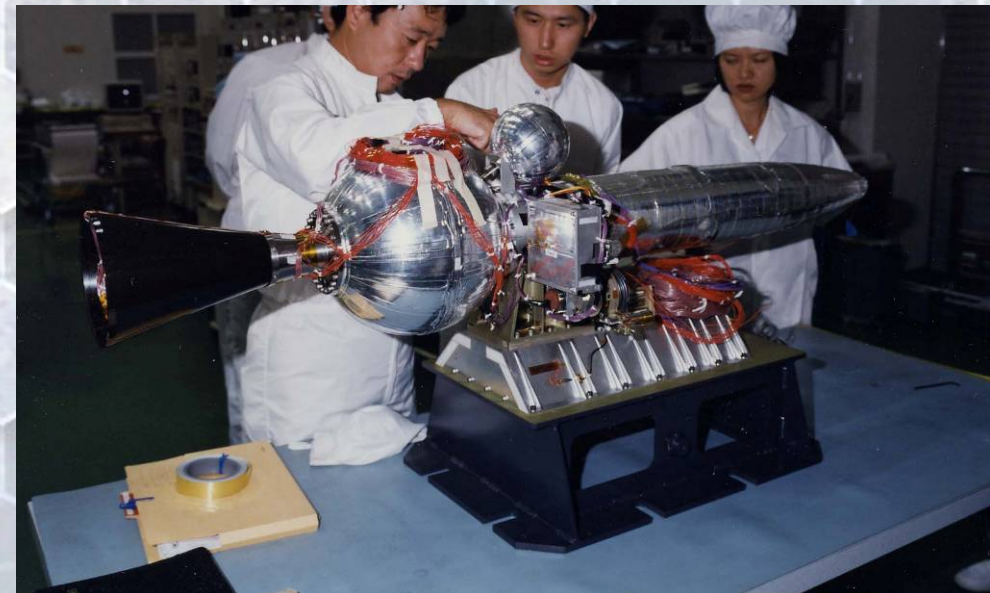
# Lunar-A mission

## Spacecraft

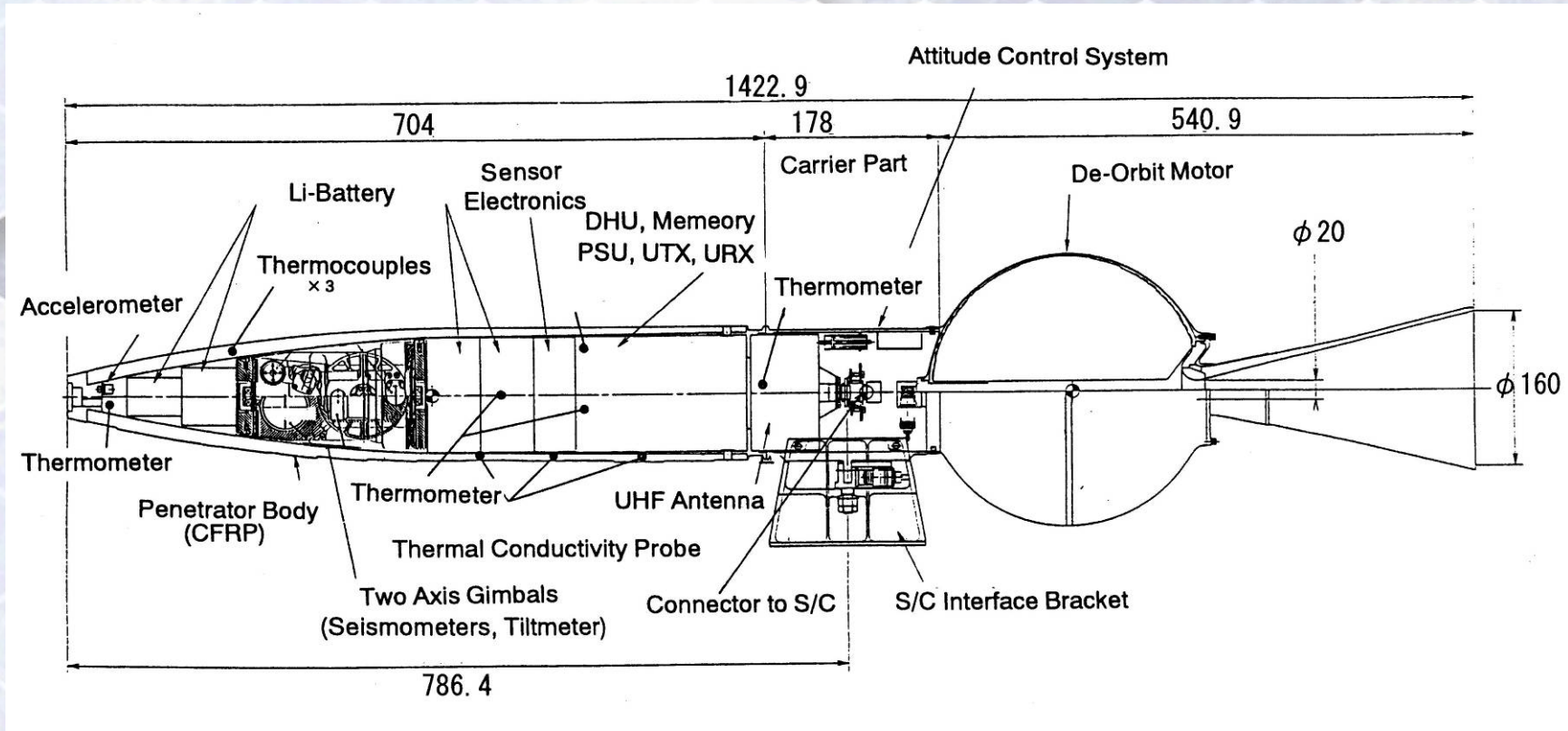
- Attitude control: Spin-stabilized, 6 rpm,
- Thruster: 20N RCS x 6, 1 N x 4
- Diameter: 2.2 m, Height: 1.7m
- Wet mass: 540 kg (Fuel: 190 kg)
- Telecommunication: S/C-PNT via UHF band (128 bps-2 kbps)
  S/C-UDSC DSN via S band (8 kbps)

## Penetrator

- 1.5 m length
- 45 kg weight /probe,
- attitude control and de-orbit motor



# Lunar-A Penetrator Module



Thermal conductivity sensors(5)

Abtenna

Hybrid

Seismometers(2)

Acceleration sensor

Batteries

Batteries

CFRP body

Rotarional mechanism

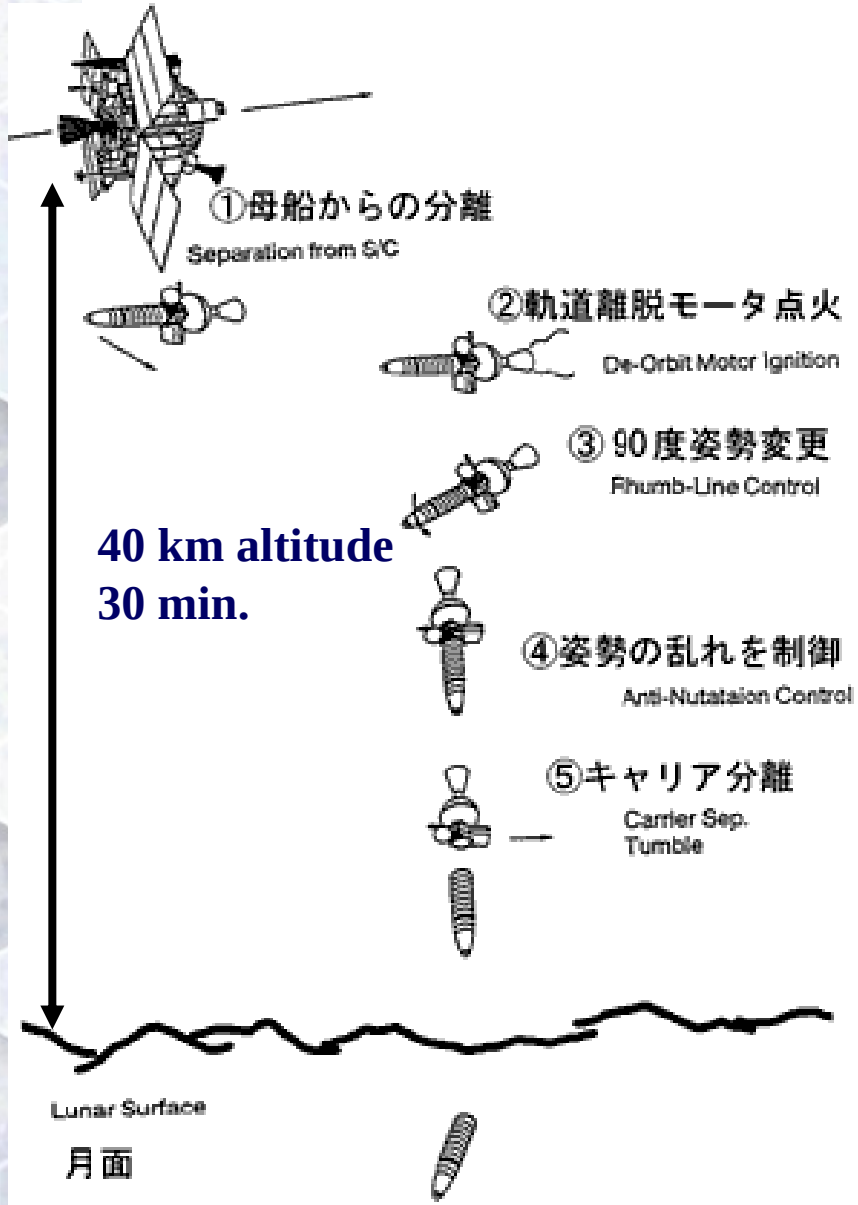
787.6

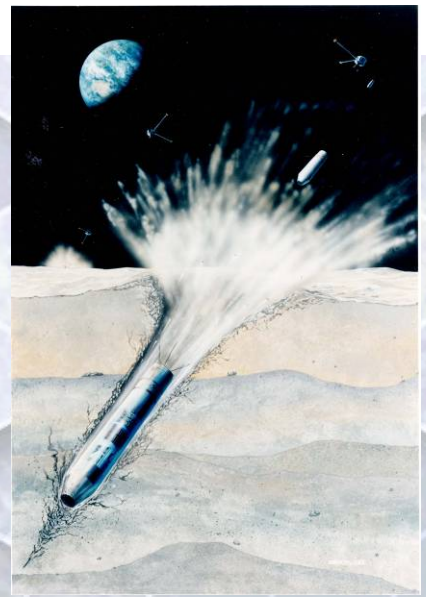
Tilt sensors(2)

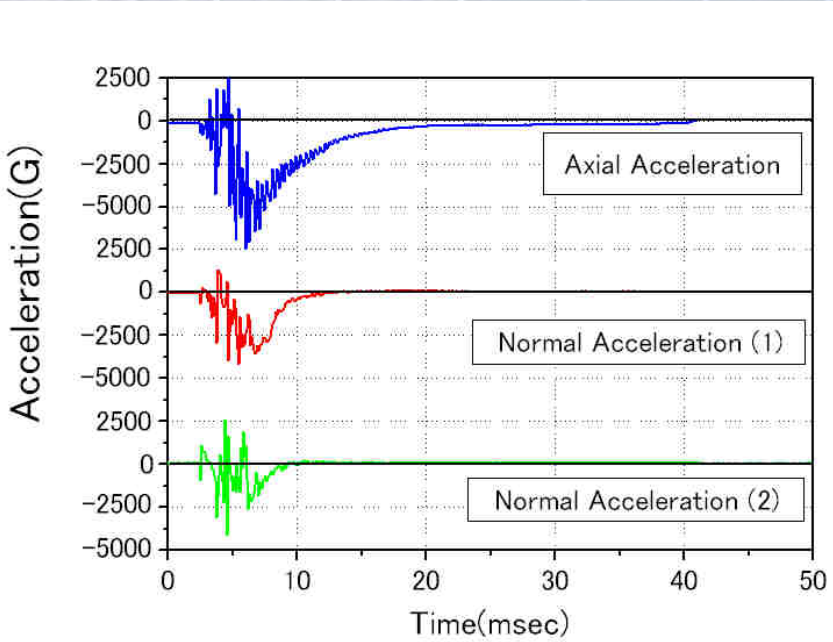
Data processing unit (DPU) , transmitter and reciever

Measurement system unit(MSU)

# Deployment Sequence of Penetrator





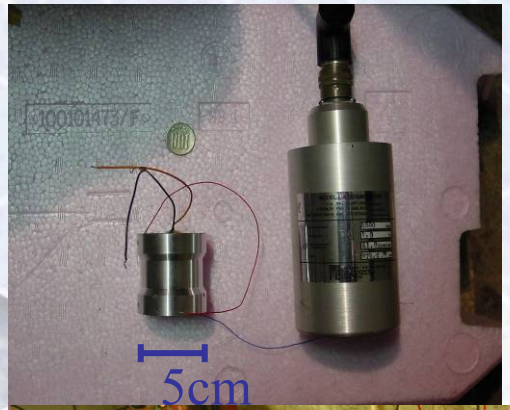
# Present Status of the Lunar-A mission(1)

- **The Lunar-A mission has been suspended since 2004 and the launch date is not fixed.**
  - **S/C: recall and replacement of some thruster bulbs used for the reaction control system.**
  - **Penetrator: found a major malfunction in the CPU system after the penetration test.**
- **The Lunar-A project had been extensively reviewed by both the internal and the external review boards from the viewpoint of technology and management in 2004**

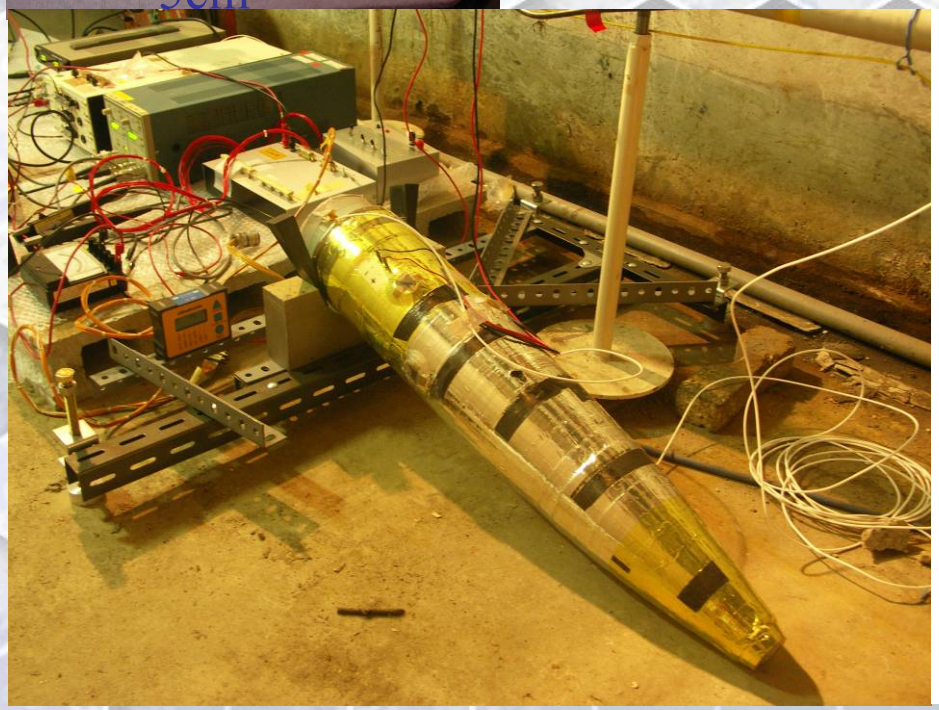
# Present Status of the LUNAR-A mission (2)

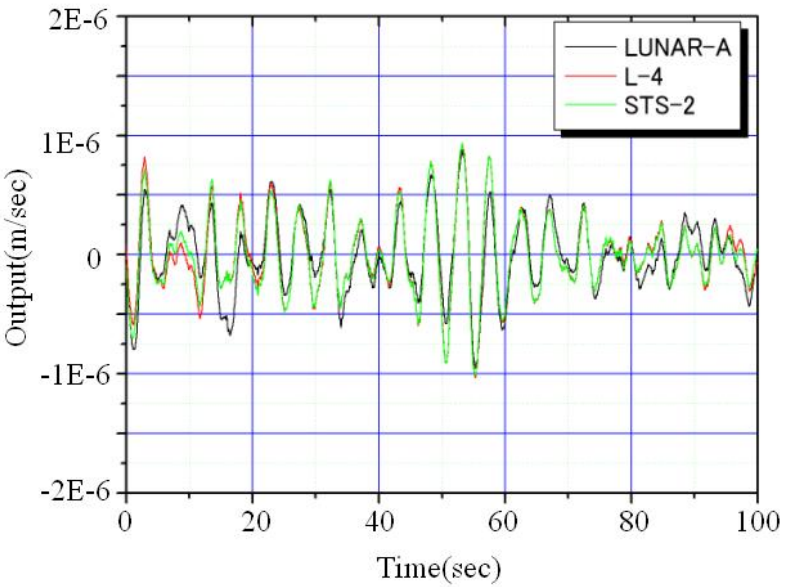
- **Spacecraft and Career system**
  **Suspension of the development**
- **Penetrator**
  **Concentrating on the development for the technical accomplishment in 3 years from fiscal year 2005.**

# Shock durability of the scientific instruments (1): Seismometer

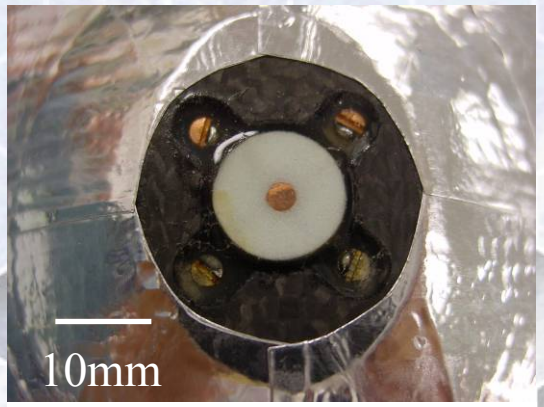



- **Investigation of dynamic response for small oscillation comparable to the deep moonquakes**



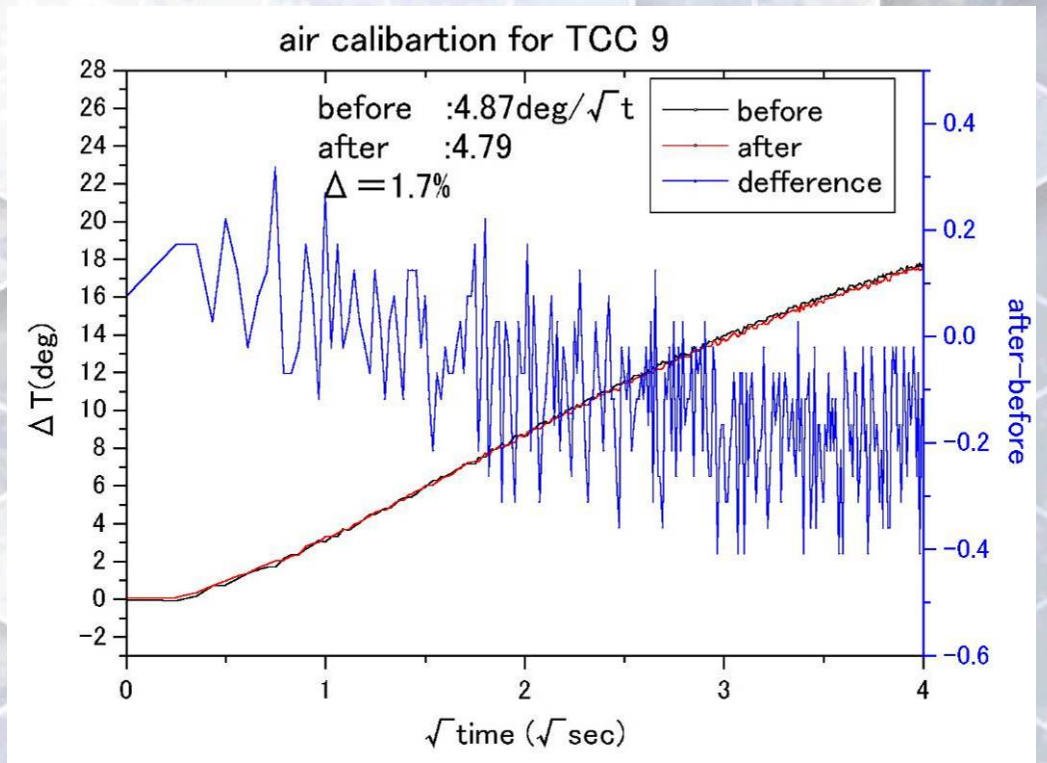


# Shock durability of the seientific instruments(2): Thermal sensors




Before penetration

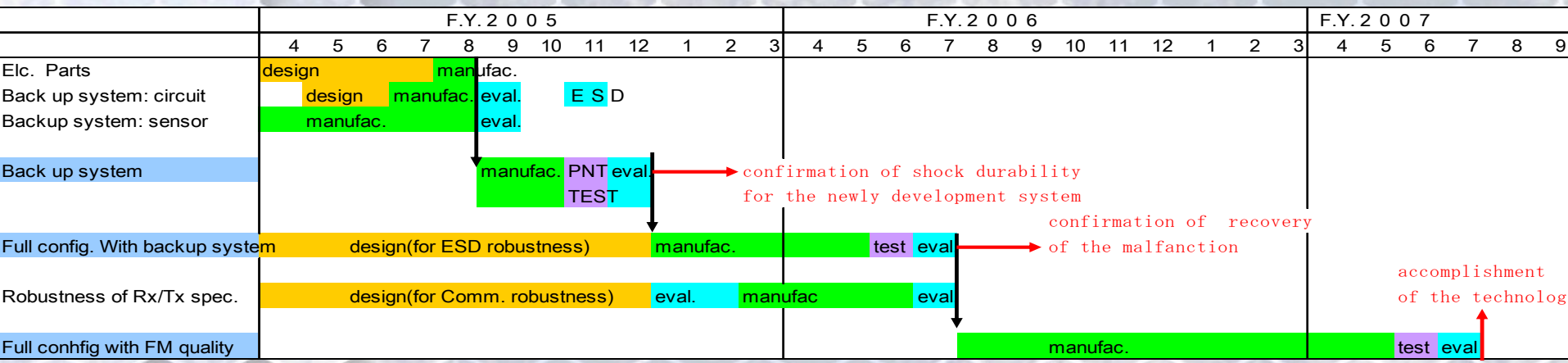
After penetration



# Technical completion of the penetrator system

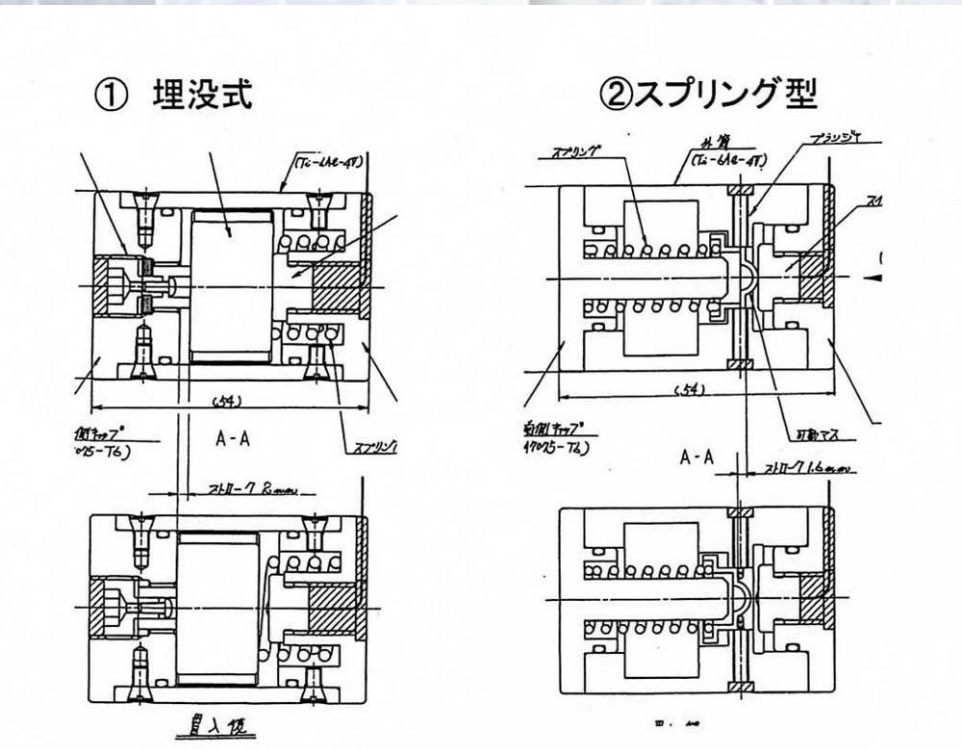
- Improvement of electronics design for robustness against ESD, and addition of back up system for possible malfunction which occurred in the previous QT level experiment.
- Assurance of robustness of the communication system between the penetrator and the spacecraft.

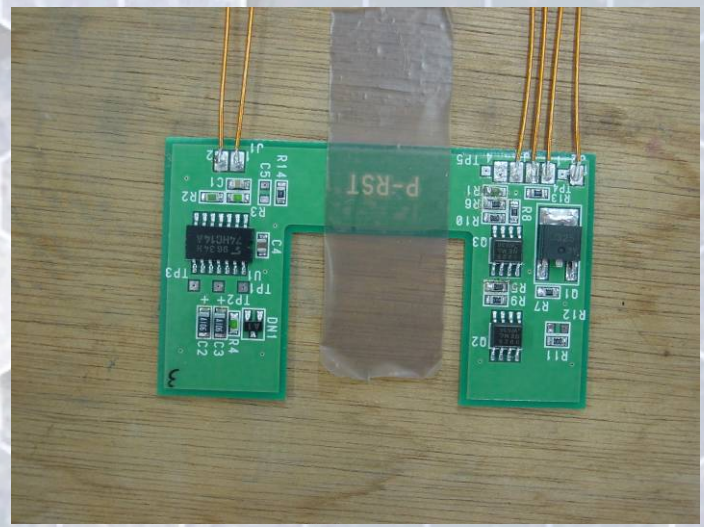
## Outline of the schedule



# Development of the back up system

- “Reset sensor”: mechanical switch triggered by the deceleration force at the penetration
- Timer power off circuit: disconnection of power supply of CPU for about 600 msec




Mass: 200g
Dim. $\phi$ 36×54

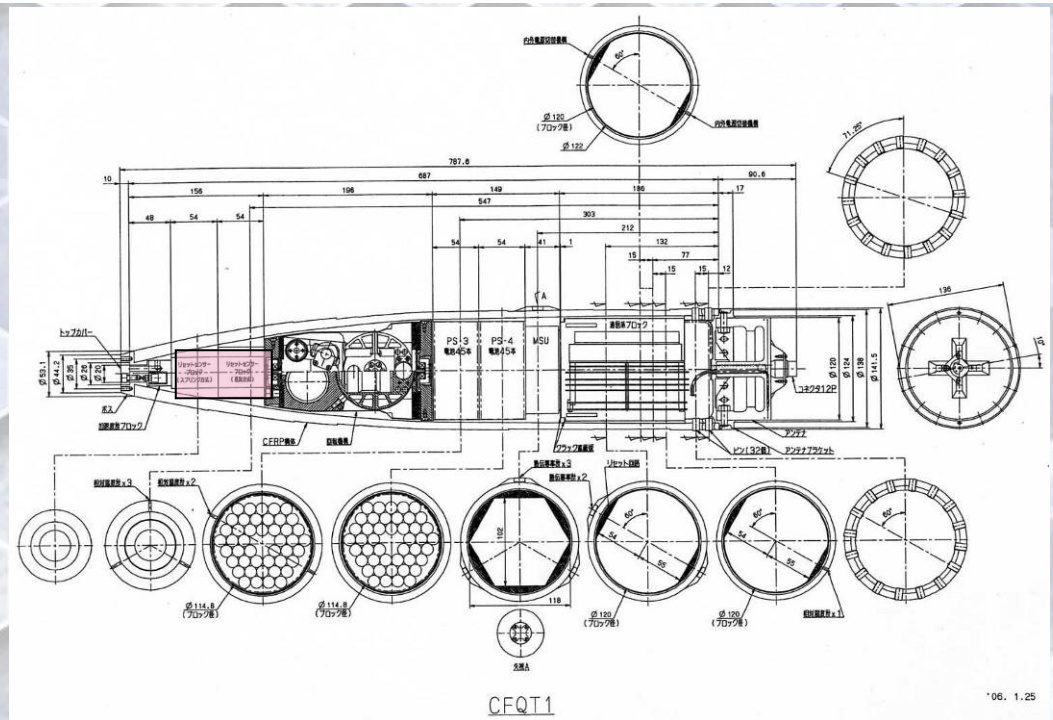
# The #1 experiment (Nov/2005)

- 8 “reset sensor”s and 2 electronics circuits were tested .
- Some electronics parts in substitution for the discontinuance products were also tested.
- All the sensors, circuits, and elec. parts worked completely after the penetration experiment.

New Mexico Tech.

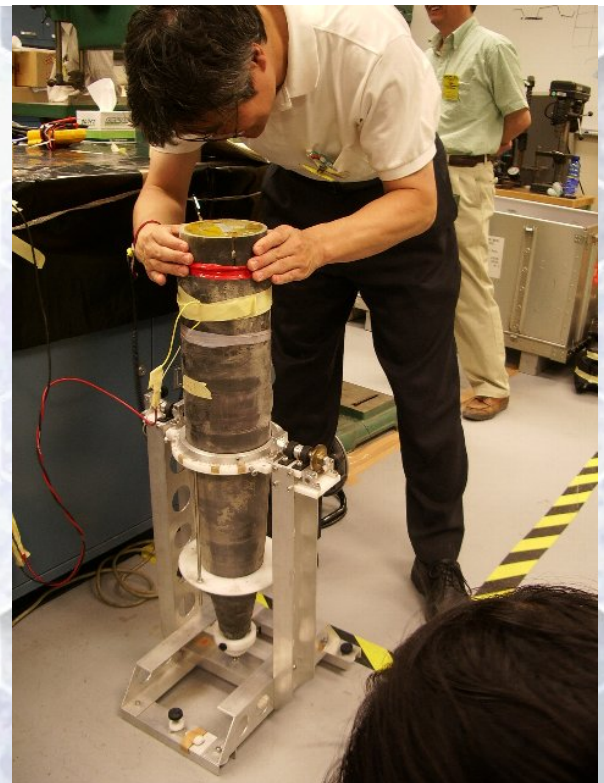
# The #2 experiment (June , 2006)

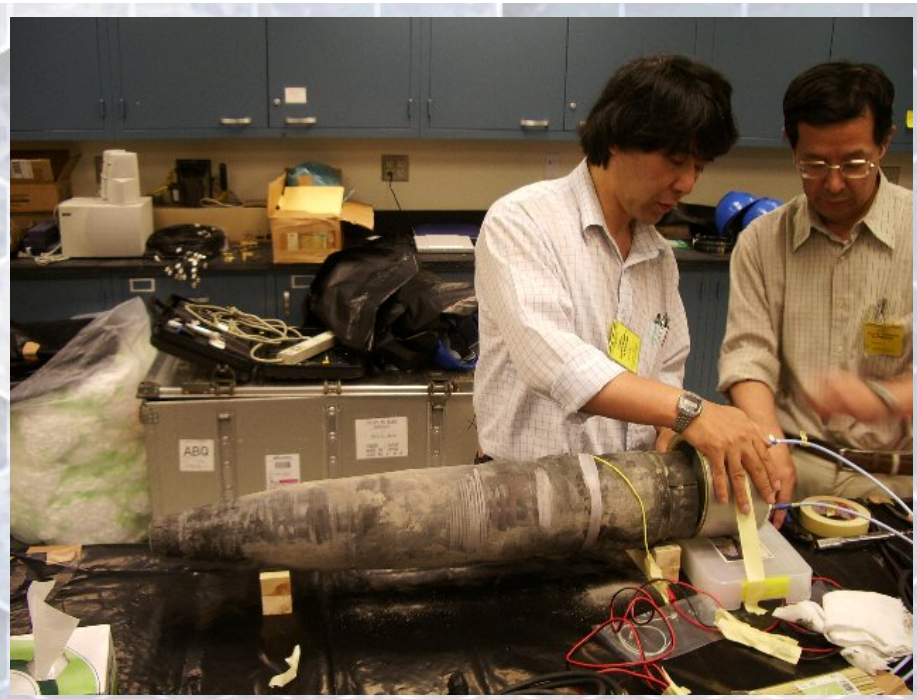
- **Fully integrated / power on status.**
  - **Some modification of DPU for robustness of ESD protection.**
  - **Two reset sensors + one circuit for back up system.**
- **Change in experimental procedure for avoiding ESD input.**



# Results of the #2 experiment (June, 2006)

- Successfully communicated with the penetrator after the exp.
- All the functions of instruments work well.
- Detailed examination of instruments and evaluation of sensor performance are now ongoing.

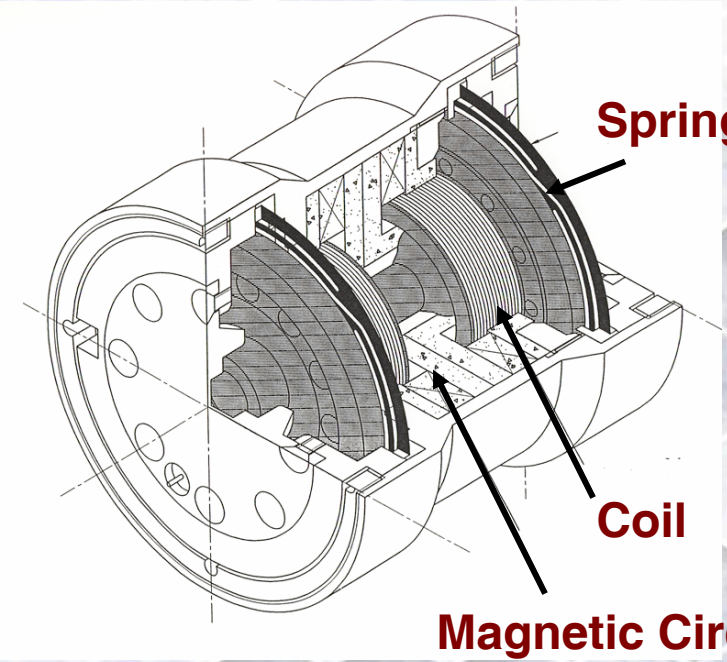




# Final experiment (July(TBD), 2007)

- Fully integrated of  the flight model specification .
- Confirmation of technical accomplishment by the improvements both for possible malfunctions and for robustness on the communication system.

# Lunar-A Seismometer




**Sensor Size: 50 mm x 50φ**
**Sensor Mass: 0.35 kg**
**Electronics: 0.52 kg**
**Gimbals: 2.30 kg**
**Power Consumption:**
**40 mW (monitoring period),**
**175 mW (measuring period)**
**Eigen Period: 1.0 ∽1.2 Hz**

# Summary

- **Lunar-A mission :**
  - **not cancelled but the launch timing is not fixed at present.**
  - **S/C and the career system are preserved**
- **Penetrator**
  - **3-years program is now undertaking**
  - **Scientific instruments : finished**
  - **Development of the back up system : finished**
  - **Confirmation of recovery of the malfunction :finished**
  - **Further improvement for the robustness on the communication system :FY2007**

# Lunar-A Penetrator Structure