

# **JAXA Planetary Missions**

**COSPAR**

**Capacity Building Workshop on Planetary Science**

**July 23 - Aug. 3, 2007**

**Montevideo, Uruguay**

**Makoto Yoshikawa**  
**(ISAS, JSPEC / JAXA)**

Hayabusa

はやぶさ

隼

falcon

halcón



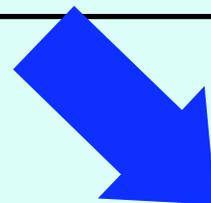
# Japan



# JAXA

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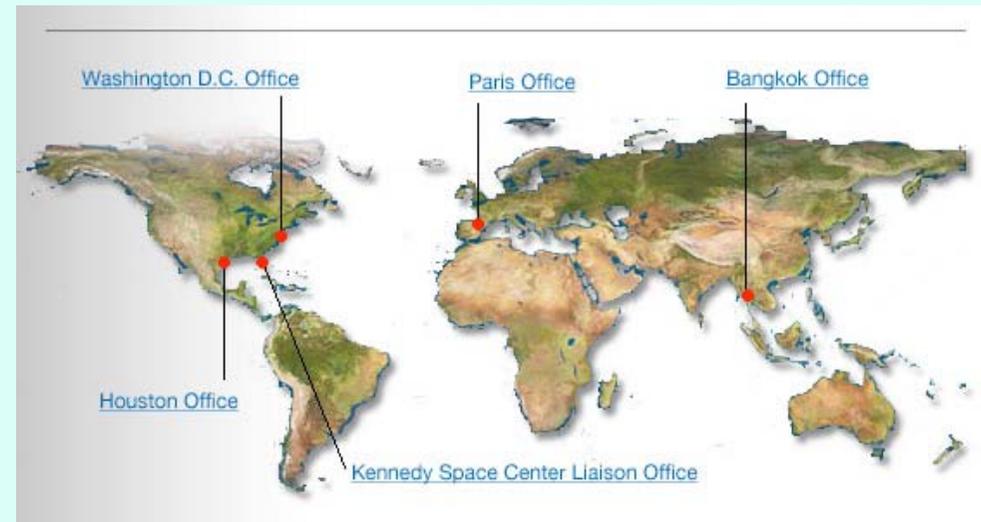
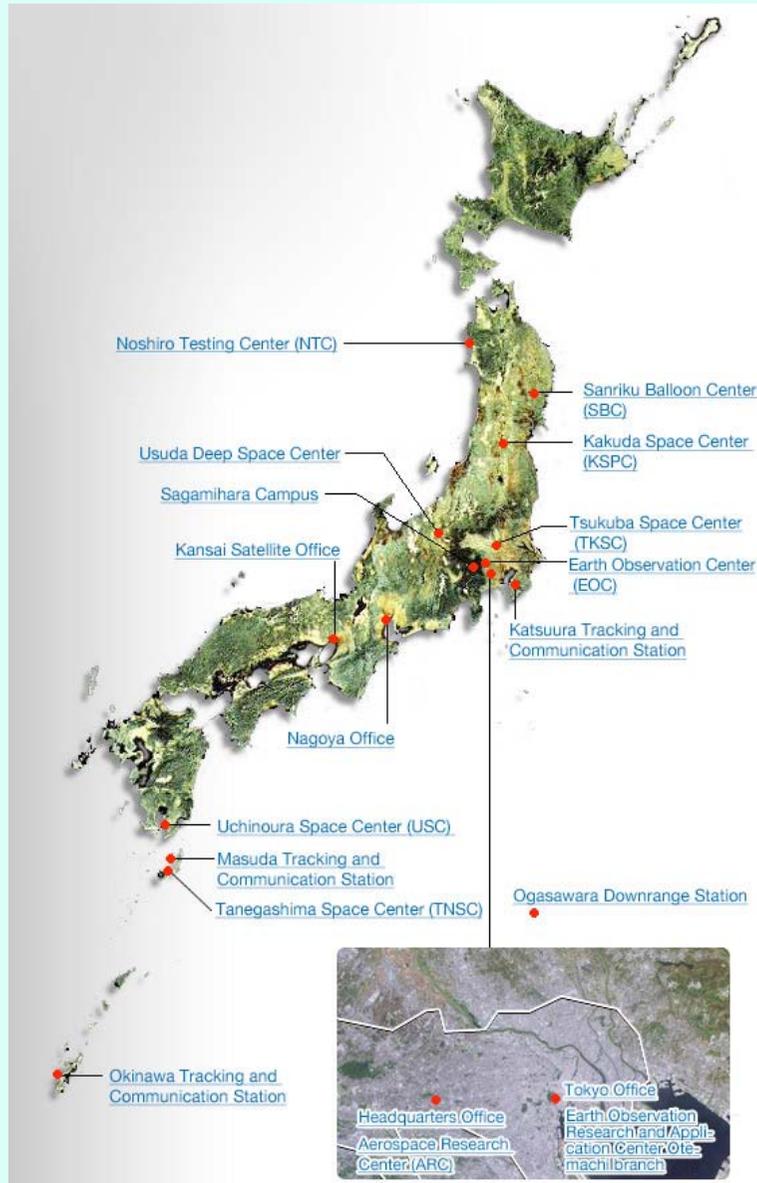
- ISAS  
(Institute of Space and Astronautical Science)
- NASDA  
(National Space Development Agency)
- NAL  
(National Aerospace Laboratory)



**Oct. 2003**

**JAXA**  
(Japan Aerospace Exploration Agency)

# Centers and Offices of JAXA



# JAXA

- ISAS

(Institute of Space and Astronautical Science)

- NASDA

(National Space Development Agency of Japan)

- NAL

(National Aerospace Laboratory of Japan)

Planetary  
Science

**Oct. 2003**

JAXA

(Japan Aerospace Exploration Agency)

**New Group in JAXA since  
April 2007**

# New Group in JAXA for Planetary Mission

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## Over view of JAXA

Office of Space Flight & Operations

Office of Space Application

Institute of Aerospace Technology

**Institute of Space and Astronautical Science (ISAS)**

Aviation Program Group

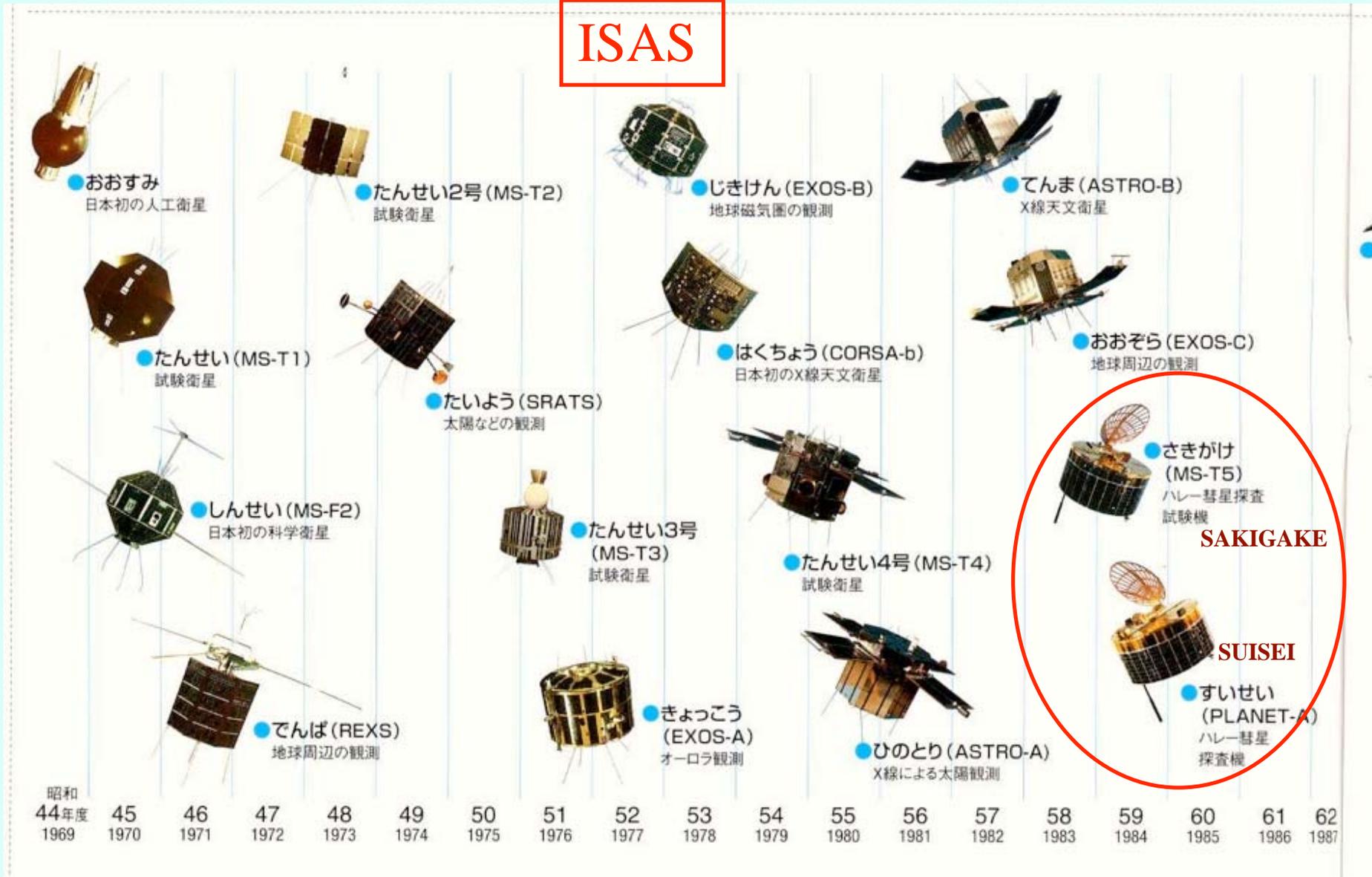
Human Space Systems & Utilization Program Group

**JAXA Space Exploration Center (JSPEC)**

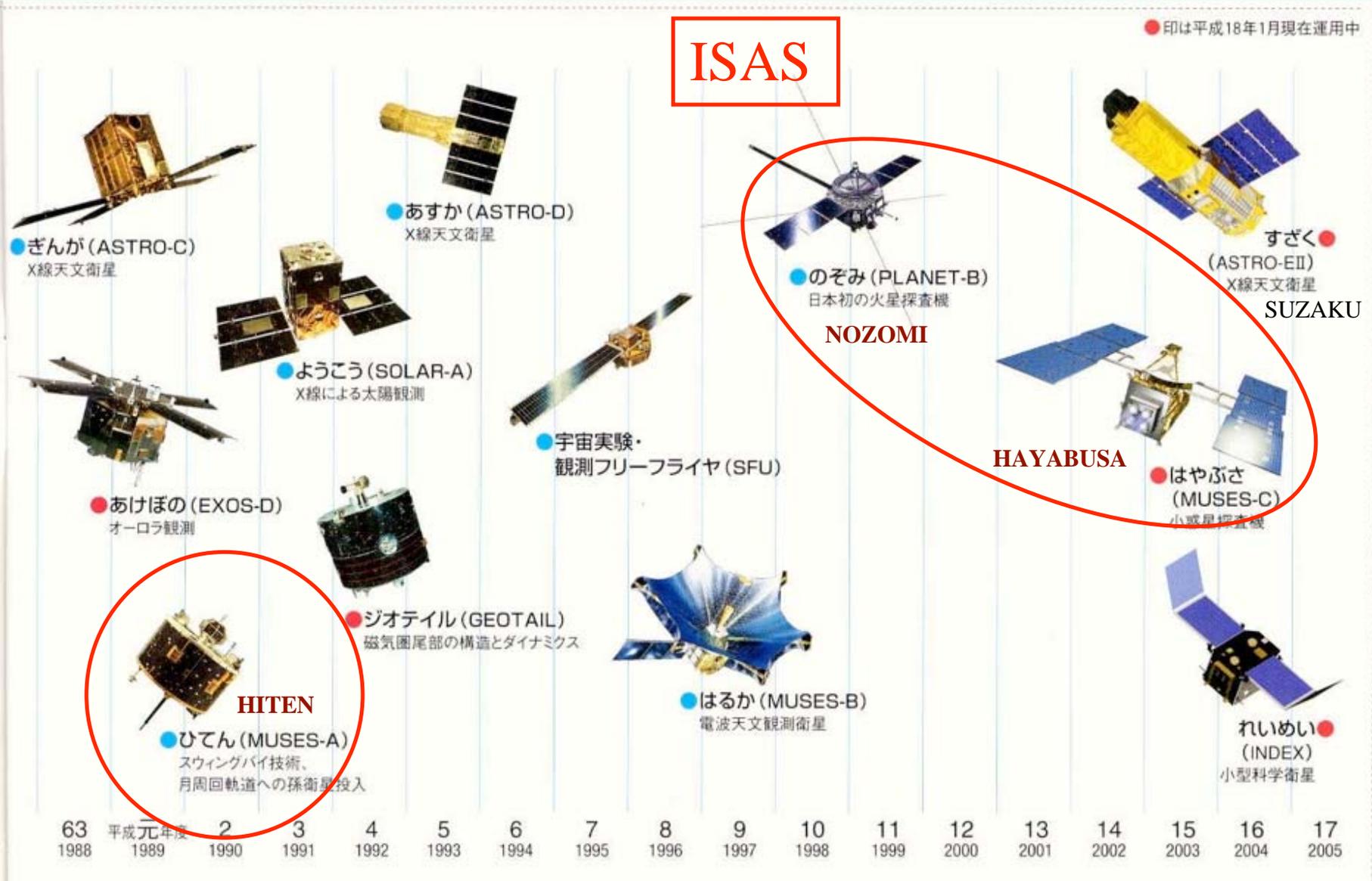
**(Lunar and Planetary Exploration Group)**

# Japan's Astronomical Satellites and Planetary Spacecraft (1)

ISAS



# Japan's Astronomical Satellites and Planetary Spacecraft (2)



あかり 2006年  
**AKARI**



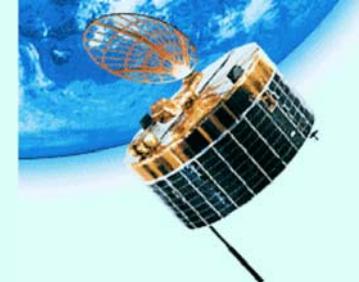
ひので 2006年  
**HINODE**

# Planetary Missions in the Past

- SAKIGAKE, SUISEI
- HITEN
- NOZOMI

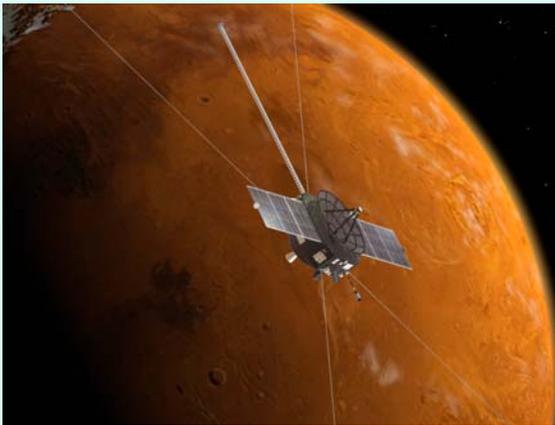


SAKIGAKE



SUISEI

Comet Halley (Launch: 1985)



Mars (Launch: 1998)



Moon (Launch: 1990)

# NOZOMI (1)

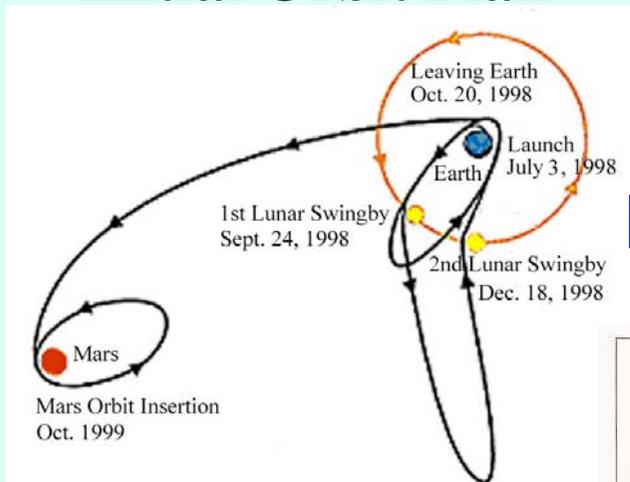
## First big problem

**The thrust was not enough** at the powered Earth swingby

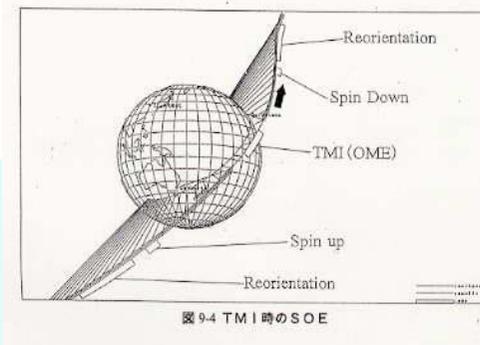
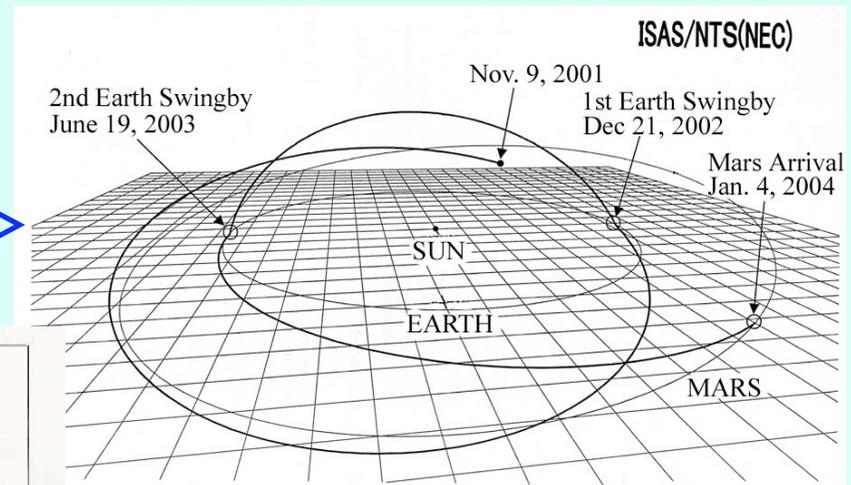
To compensate the acceleration shortage, too much fuel was used

Orbit plan was changed after the Earth swingby

### Initial Orbit Plan



### New Orbit Plan

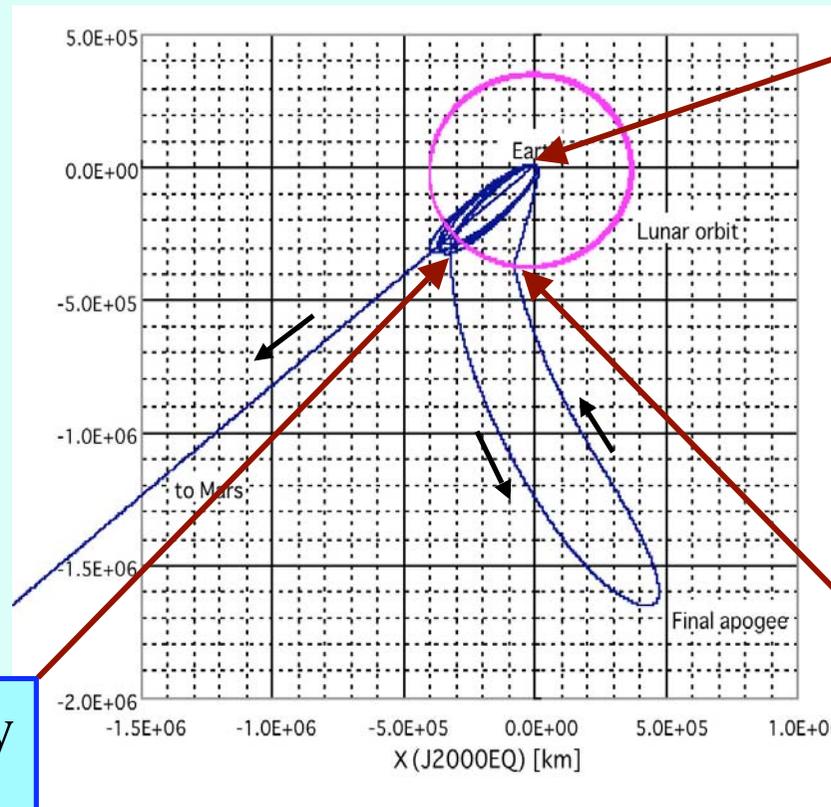


# NOZOMI (2)

## Orbit : around the Earth

Launch  
(July 3, 1998)

TMI :  
unsuccessful  
(Dec. 20, 1998)



1st Lunar Swingby  
(Sept. 24, 1998)

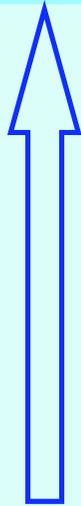
2nd Lunar Swingby  
(Dec. 18, 1998)

(in inertial frame)

# NOZOMI (3)

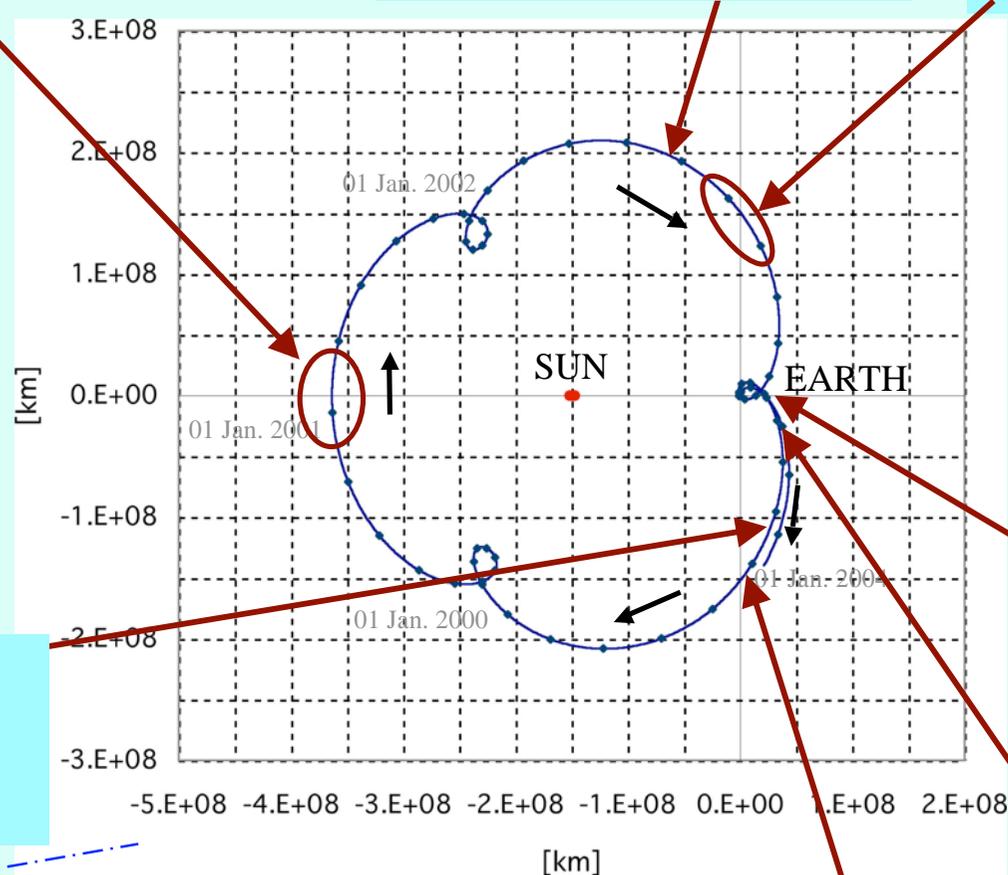
## Orbit : interplanetary

Solar conjunction  
(Dec. 2000 - Jan. 2001)



S-band downlink  
stopped  
(July 5, 1999)

(in rotational frame)



No telemetry  
(after Apr. 26, 2002)

No beacon  
(May 15 - July 14, 2002)

Earth swingbys  
(1st: Dec. 21, 2002)  
(2nd: June 19, 2003)

No beacon  
(after July 8, 2003)

Mars flyby (Dec. 14, 2003)  
Mission end (Dec 19, 2003)

# NOZOMI (4)

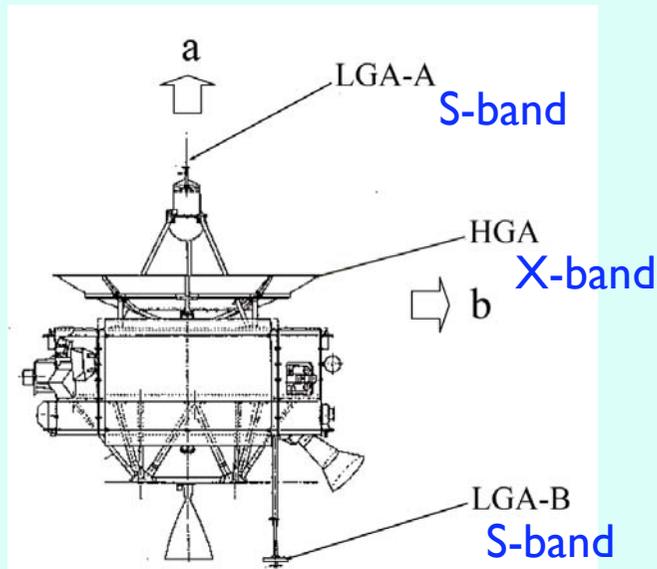


## Second big problem

**S-band downlink was stopped**

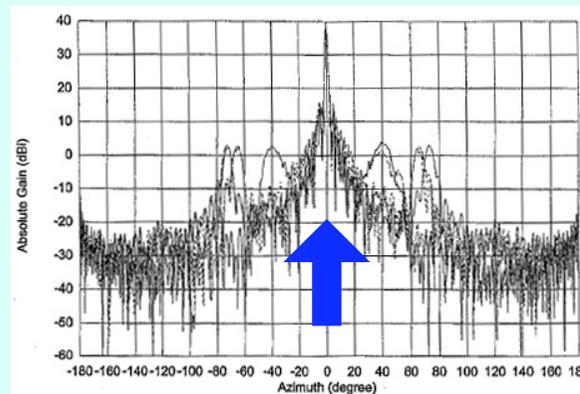
We can use X-band, but there is a attitude constraint

We used the side lobe of HGA around 90 degs.



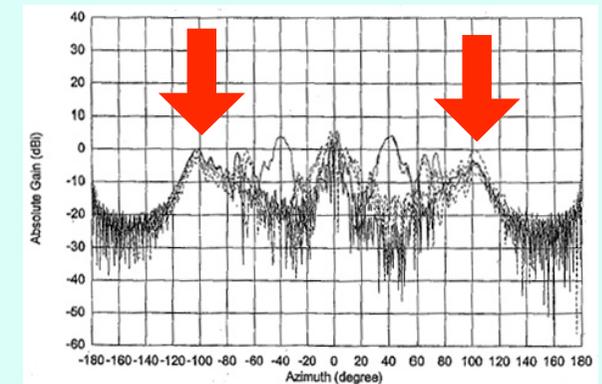
X-band

(a)



RHCP

(b)



LHCP

# NOZOMI (5)

## Third big problem (major problem)

**Shutdown of one of the power supply units**

no telemetry, no heater

no control (attitude & orbit)

**No telemetry**

use an autonomous function  
(On and off of the downlink signal)

**No heater**

use sunlight to melt the fuel

**Two earth  
swingbys were  
successful**

But the power supply unit  
did not recover and we  
could not put NOZOMI in  
the orbit around Mars

# Planetary Mission at Now

- HAYABUSA

||

Falcon

I will talk about  
HAYABUSA mission on  
30 July (next Monday).



# Planetary Missions in Preparation

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<Launch>

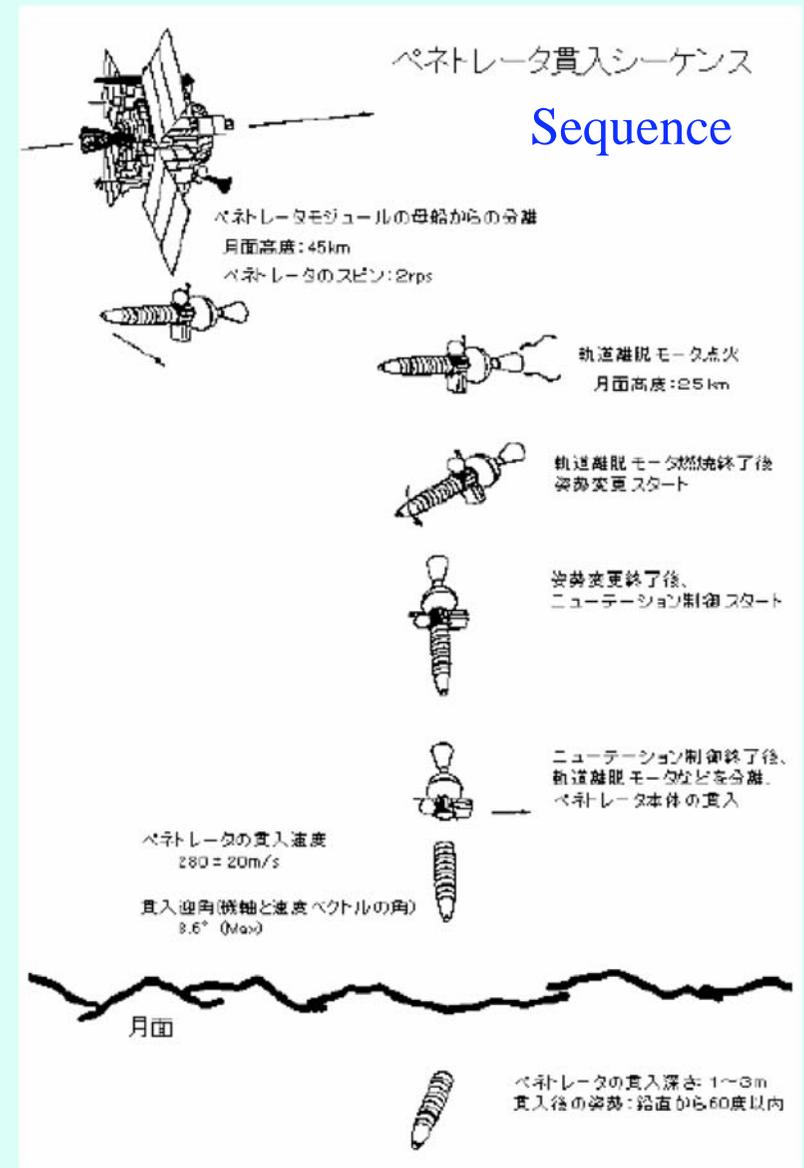
- LUNAR-A : cancelled
- SELENE (KAGUYA) : August 16 ⇔ September, 2007
- PLANET-C : 2010
- BepiColombo : 2013

# LUNAR-A



- Lunar penetrator Mission
- It has a seismometer and a thermal flow sensor.

This mission was cancelled in 2007, because it took very long time to develop the penetrator, and the spacecraft became old.

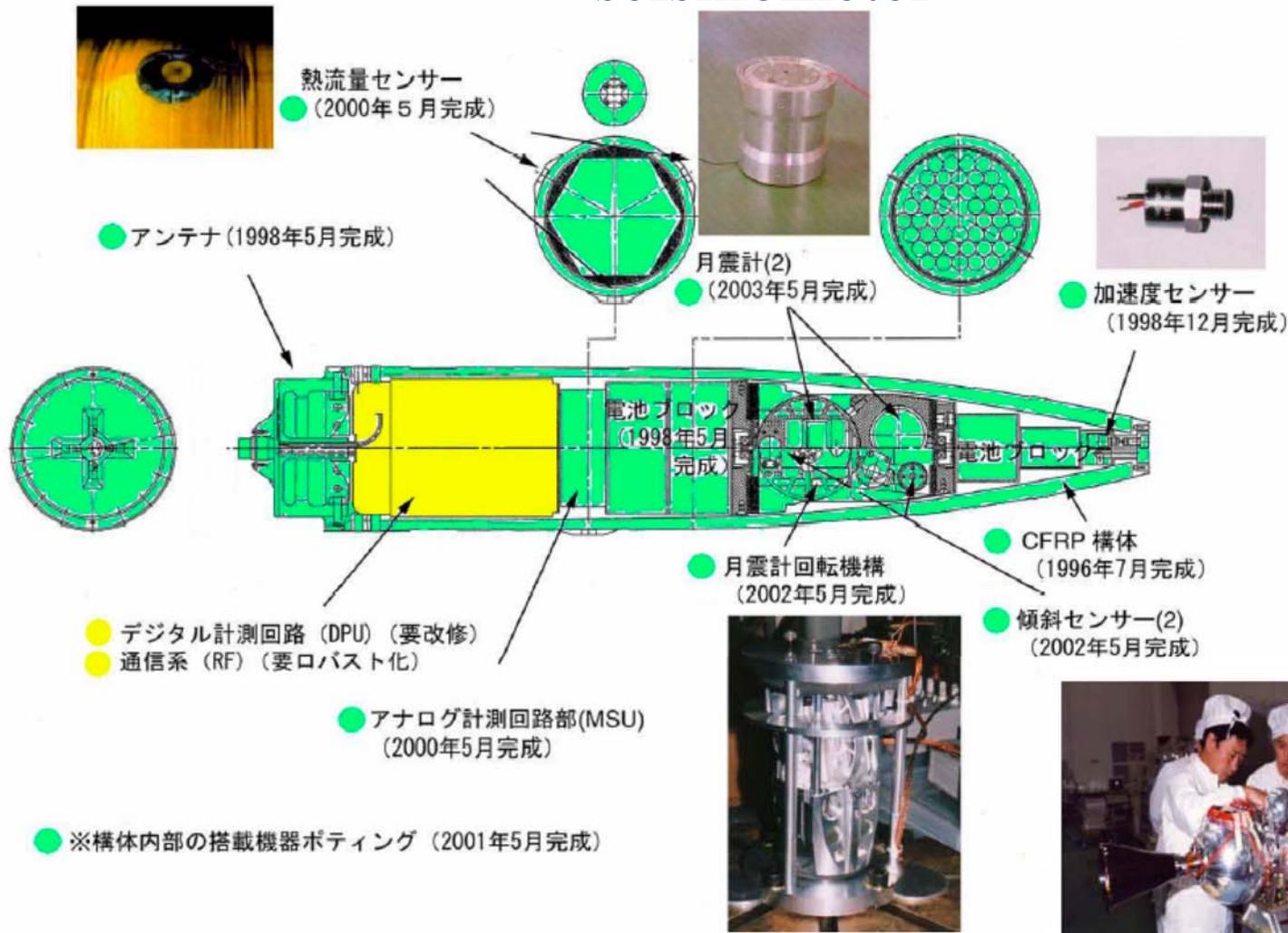


# LUNAR-A : Penetrator

thermal flow sensor

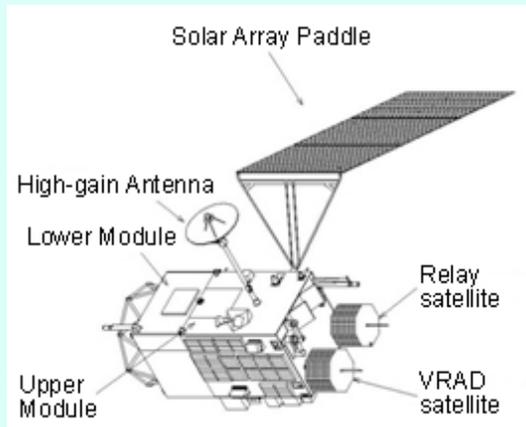
seismometer

The development of penetrator will be finished in 2007.

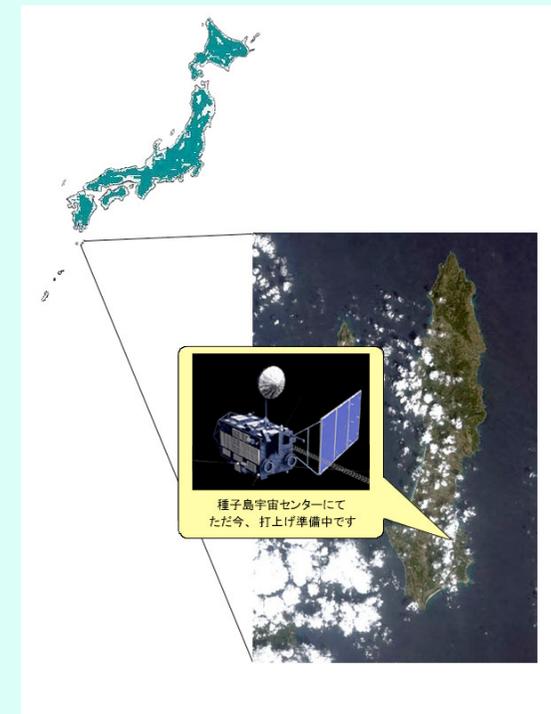
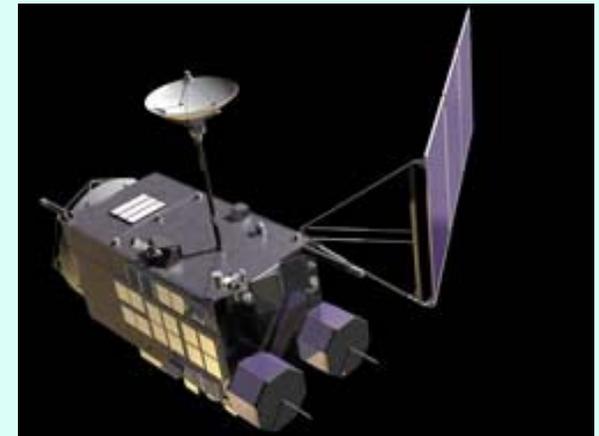


# SELENE (KAGUYA)

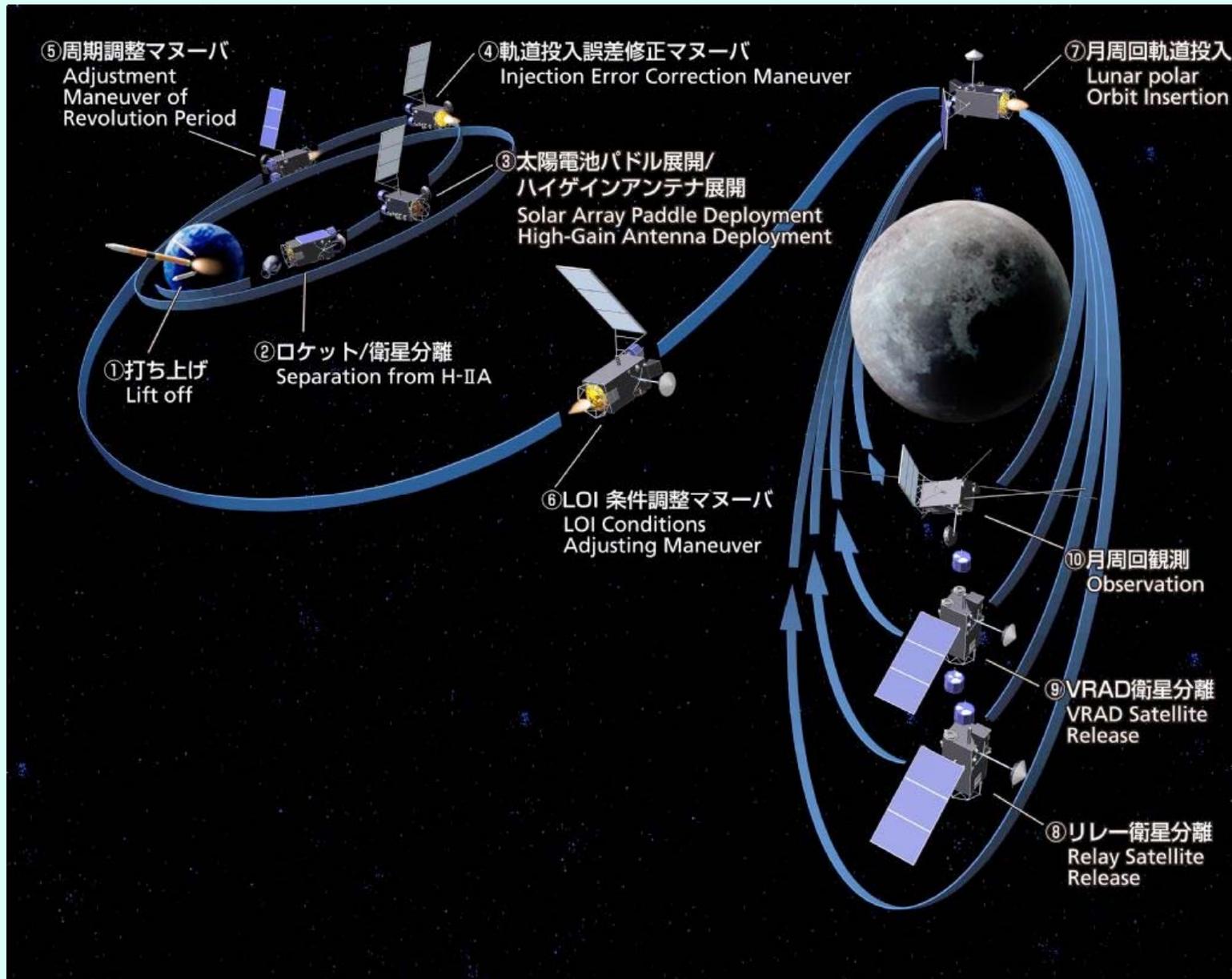
- Orbiting around the moon
- One main orbiter and two small orbiters
- 14 instruments and one high definition camera
- Launch : September 2007



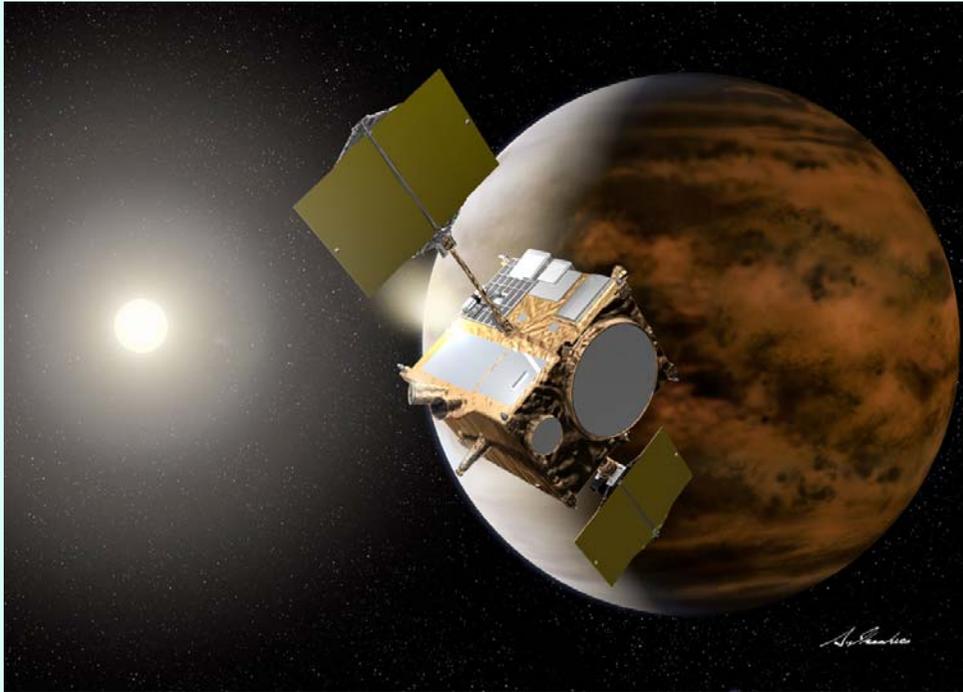
X-ray Spectrometer [XRS]  
Gamma-ray Spectrometer [GRS]  
Spectral Profiler [SP]  
Multiband Imager [MI]  
Terrain Camera [TC]  
Lunar Radar Sounder [LRS]  
Laser Altimeter [LALT]  
Lunar Magnetometer [LMAG]  
Upper atmosphere and Plasma Imager [UPI]  
Charged Particle Spectrometer [CPS]  
Plasma energy Angle and Composition  
Experiment [PACE]  
Radio Science [RS]  
High Definition Television [HDTV]  
Four way Doppler measurements by relay satellite  
and main orbiter transponder [RSAT-1,2]  
Differential VLBI Radio source-1,2 [VRAD-1,2]



# SELENE : mission sequence

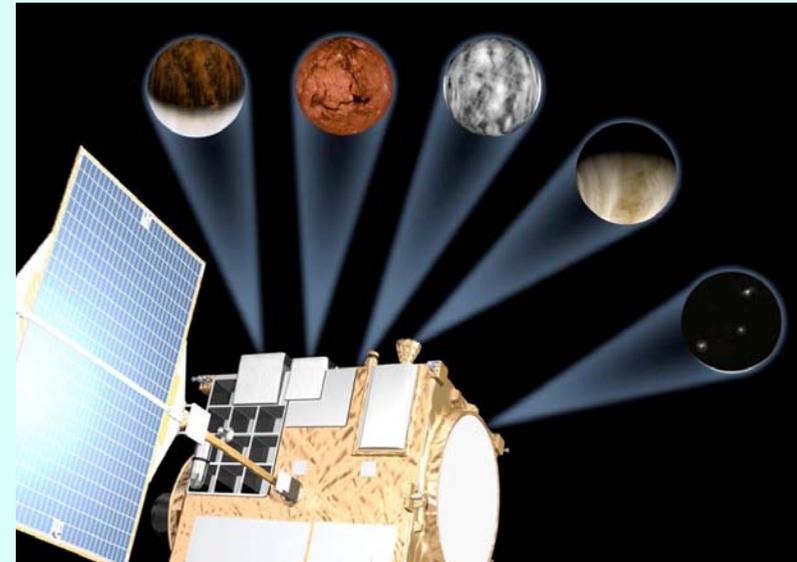


# PLANET-C



## Venus Climate Orbiter

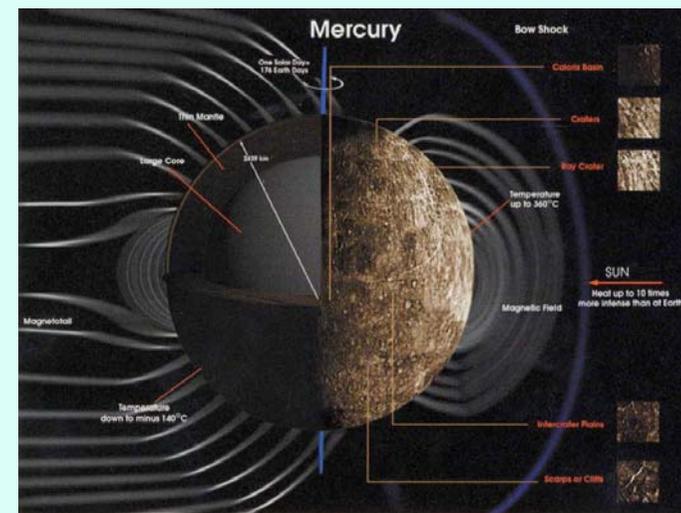
- Atmosphere of Venus
- Imaging the whole planet with different wavelength
- Launch : 2010



- Infrared Camera1 (IR1)  
 $\lambda=1.0\mu\text{m}$ , view=12degs
- Infrared Camera 2 (IR2)  
 $\lambda=1.7/2.0/2.3/2.4\mu\text{m}$ , view=23degs, view=12degs
- Middle Infrared Camera (LIR)  
 $\lambda=9-11\mu\text{m}$ , view=12des
- UV imager (UVI)  
 $\lambda=280/360\text{nm}$ , view=12degs
- Thunder, atmospheric light Cameras (LAC)  
 $\lambda=777/551/558\text{nm}$ , view=12degs

# BepiColombo

## MMO



Magnetosphere, magnetic field

ESA MPO : Mercury Planetary Orbiter  
JAXA MMO : Mercury Magnetospheric Orbiter

- Magnetosphere of Mercury
- Launch : 2013

# Planetary Missions under Study

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- HAYABUSA-2, HAYABUSA-MK2
- SELENE-2, SELENE-X, ...
- SOLAR SAIL
- ....

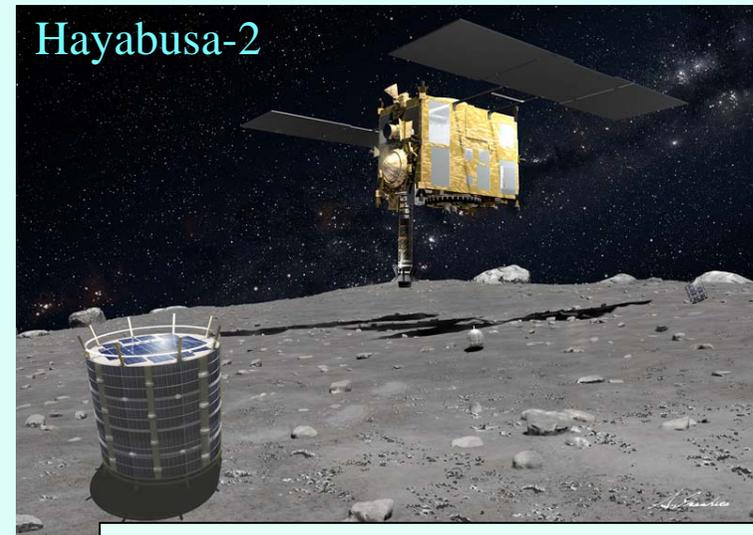
(Mission to Venus, Mars, Jupiter)

# Hayabusa-2 and Hayabusa-Mk2

Itokawa



1999 JU3



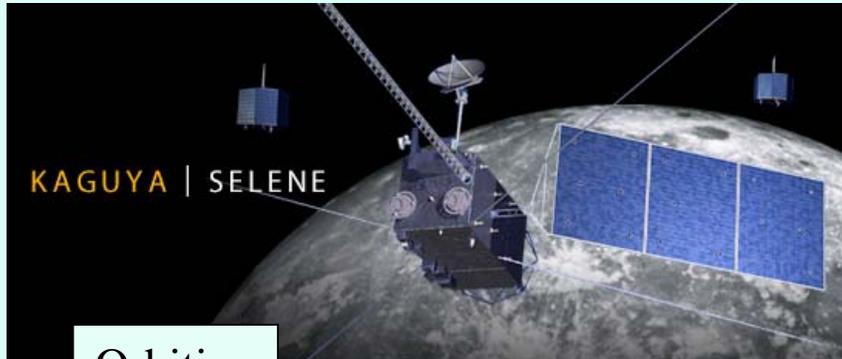
Wilson-Harrington



Proposed to  
Cosmic Vision of ESA

# SELENE-2, SELENE-X, ...

## SELENE (KAGUYA)



Orbiting

## SELENE-2



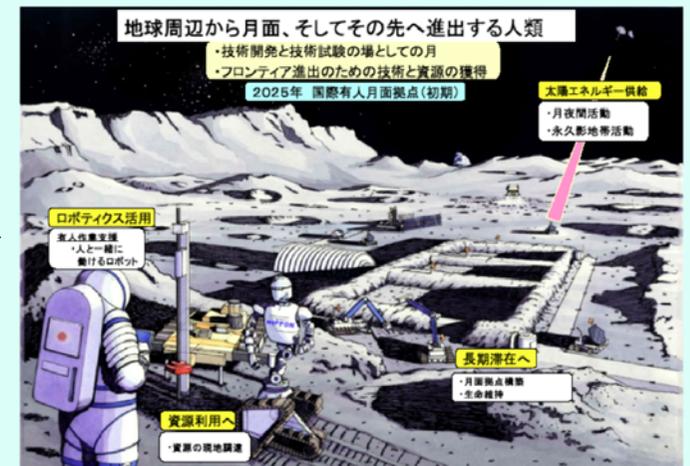
Landing



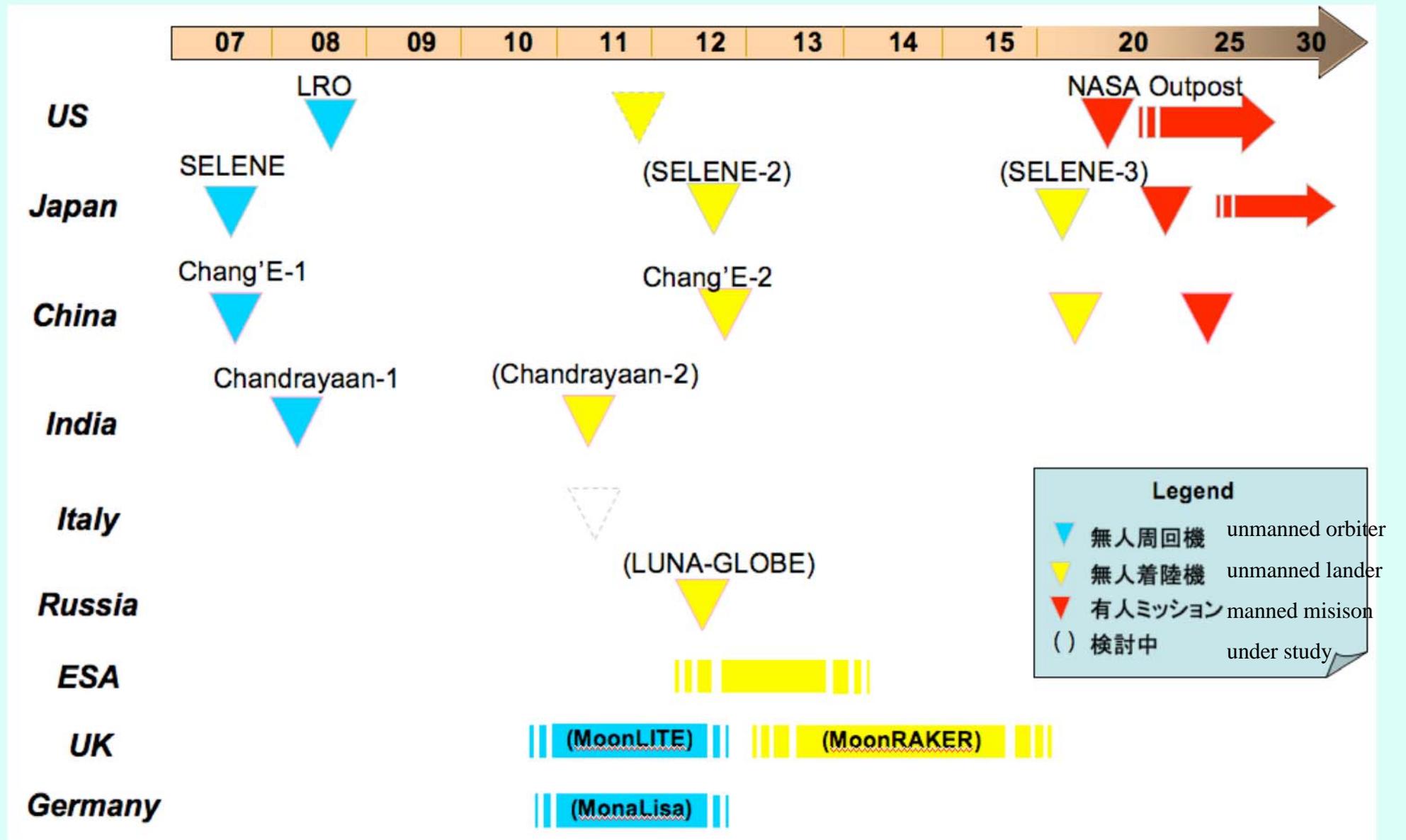
## SELENE-X



Advanced Lander

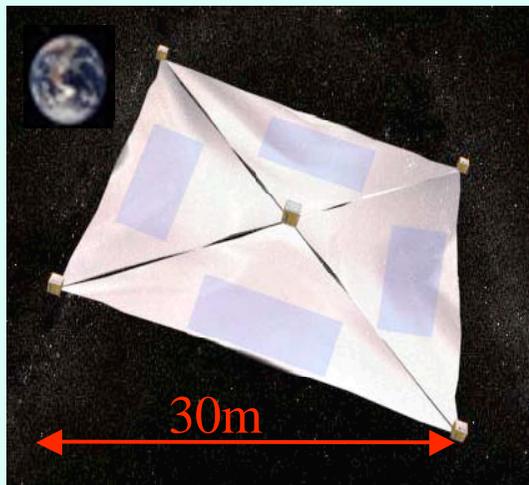


# Missions to Moon



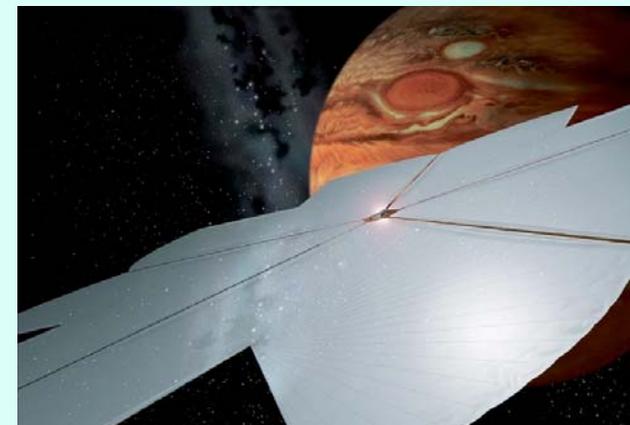
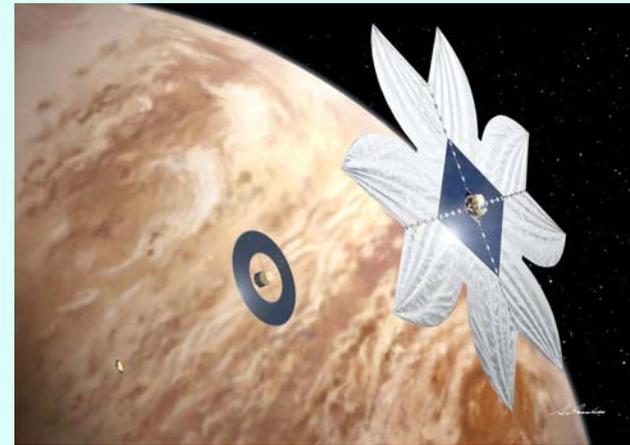
# Solar Sail

- Solar sail + Electrical propulsion



Small experimental spacecraft

2011?



Mission to Jupiter and Trojans

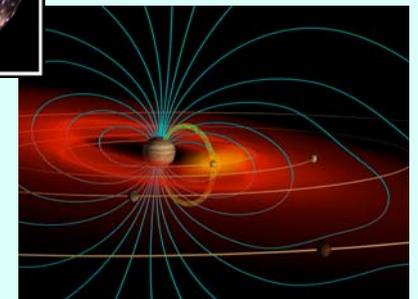
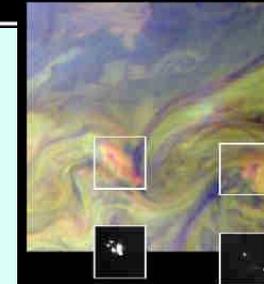
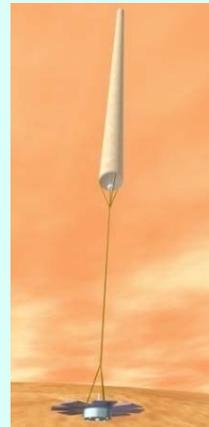
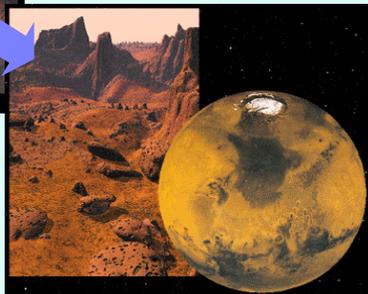
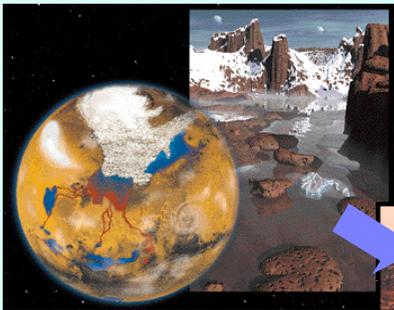
2014?

# Other missions under study

- Venus : orbiter, balloon, decent probe
- Mars : NOZOMO-2, lander
- Jupiter : magnetosphere, atmosphere, Galilean satellites

Proposed to  
Cosmic Vision of ESA

Proposed to  
Cosmic Vision of ESA

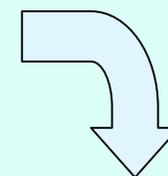
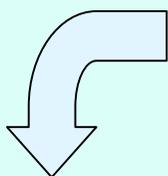
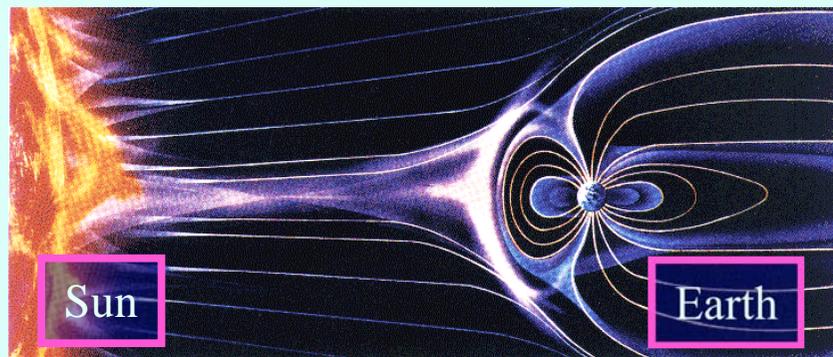


# Summary

# Scientific Objectives (1)

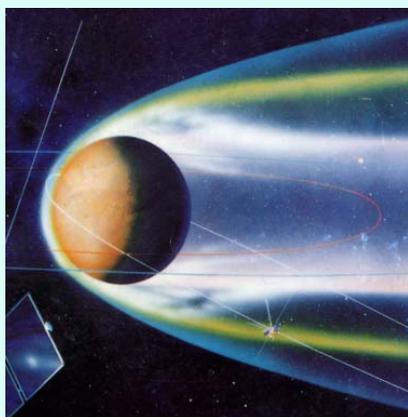
Keyword: **Magnetic field, Magnetosphere**

Orbiter



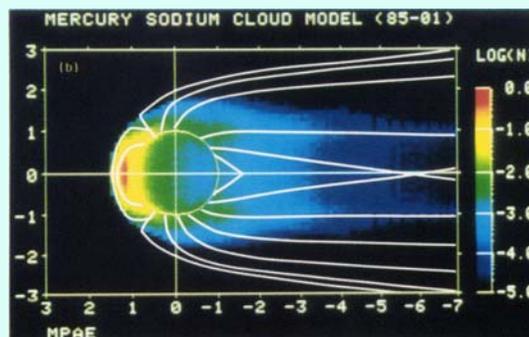
No global magnetosphere

Mars, Venus



Small magnetosphere

Mercury



Gigantic magnetosphere

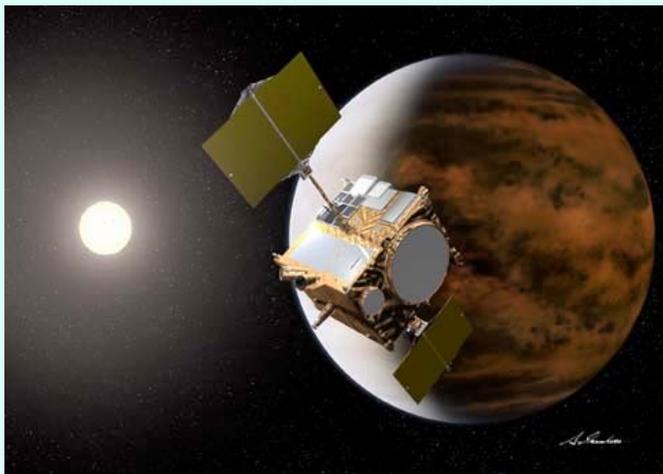
Jupiter



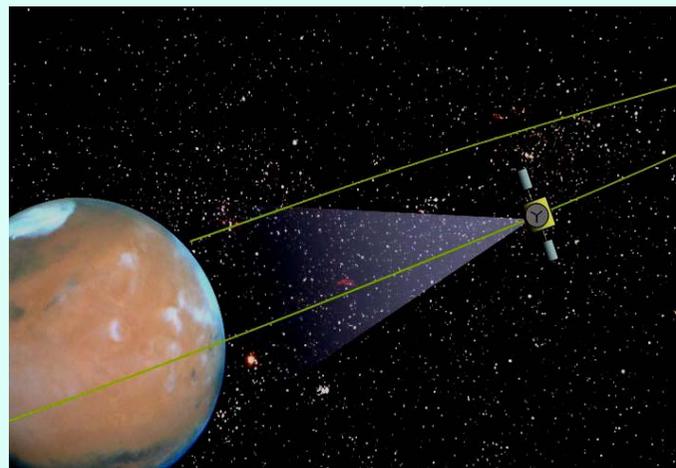
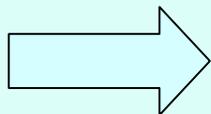
# Scientific Objectives (2)

Keyword: **Planetary Meteorology**

Orbiter, Balloon, Lander



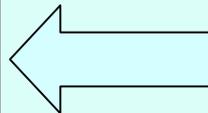
Planet-C



High-resolution global mapping from Mars-stationary orbit



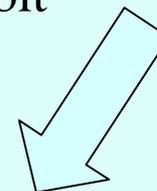
Understanding the evolution and diversity of planetary climate



Mars  
lander

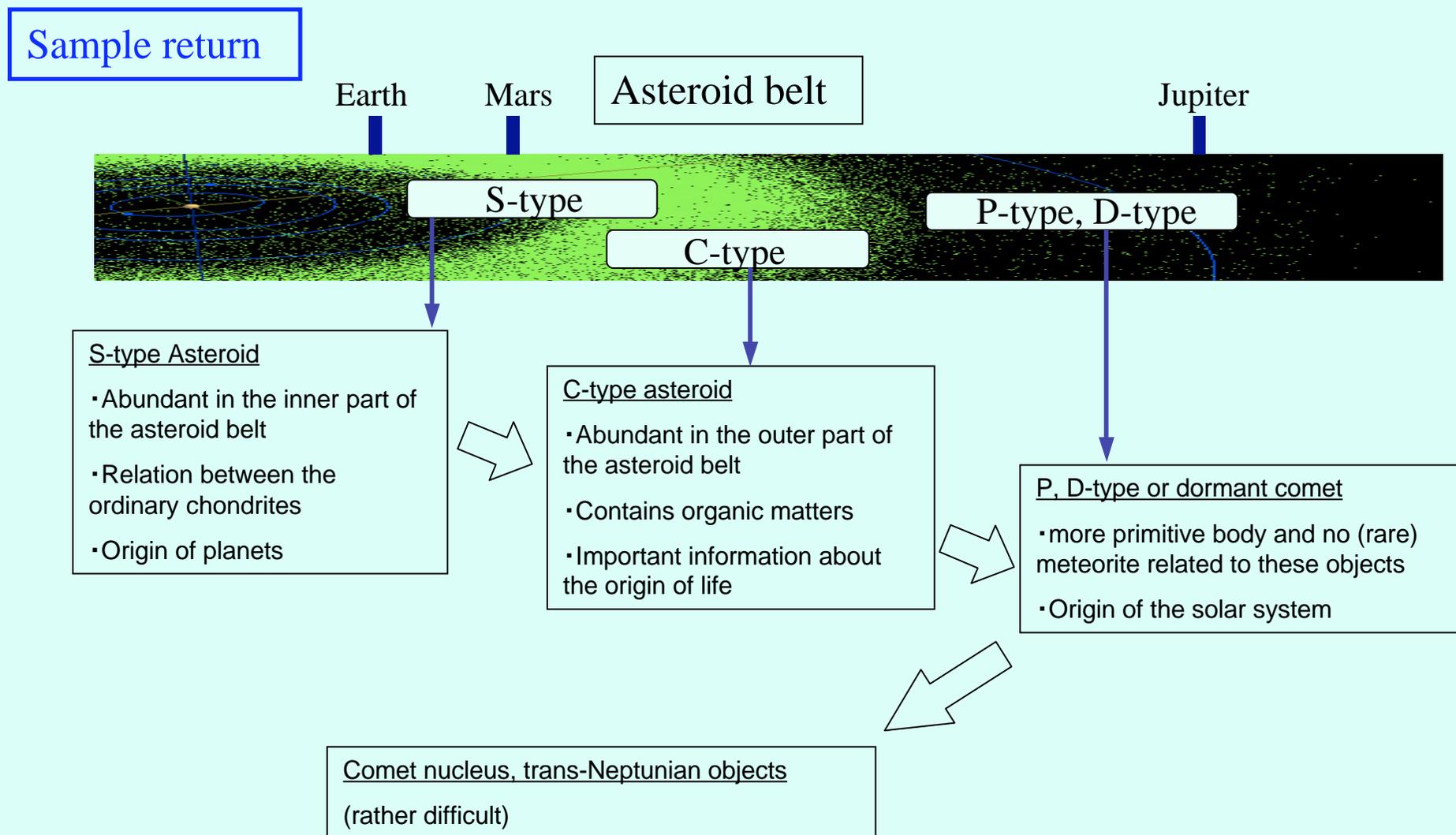


Venus balloon



# Scientific Objectives (3)

Keyword: **Origin and Evolution of Solar System**



# And Moon

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- Science : the material on the surface, the interior structure, the origin, etc
  - Technology : landing, moon base, for much farther exploration, human activities...
- 
- Extending human frontiers
  - Economic Expansion
  - A Global Partnership
  - Inspiration and Education

# Summary

## Planetary Mission of JAXA

Moon

SELENE series → manned mission

Planetary Magnetosphere

Mercury, Venus, Mars → Jupiter

Planetary Climate

Venus, Mars → Jupiter

Primitive Bodies

Hayabusa series