



SELENE Mission Outline

Mission Objectives

System Performance

Mission Instruments

Flight Operation

International Collaboration

January 2007



SELENE Mission Objectives

Science

1. Science of the Moon

Study of origin and evolution of the Moon

2. Science on the Moon

In-situ measurement of lunar environment

3. Science from the Moon

Observation of solar-terrestrial plasma environment

Site search for future astronomical observation

Engineering:

Technology development for future lunar exploration

Outline of the Mission



Mission Orbit

Inclination : *90 deg (polar orbit)*

Main Orbiter : *100 x 100 km (circular)*

Subsatellite Vstar : *100 x 800 km (elliptical)*

Rstar: *100 x 2400 km (elliptical)*

Launch Mass *2885 kg (mission payload*
300kg)

Size

Main Orbiter : *2.1 x 2.1 x 4.8 m*

Subsatellites: *0.99 x 0.99 x 0.65m*

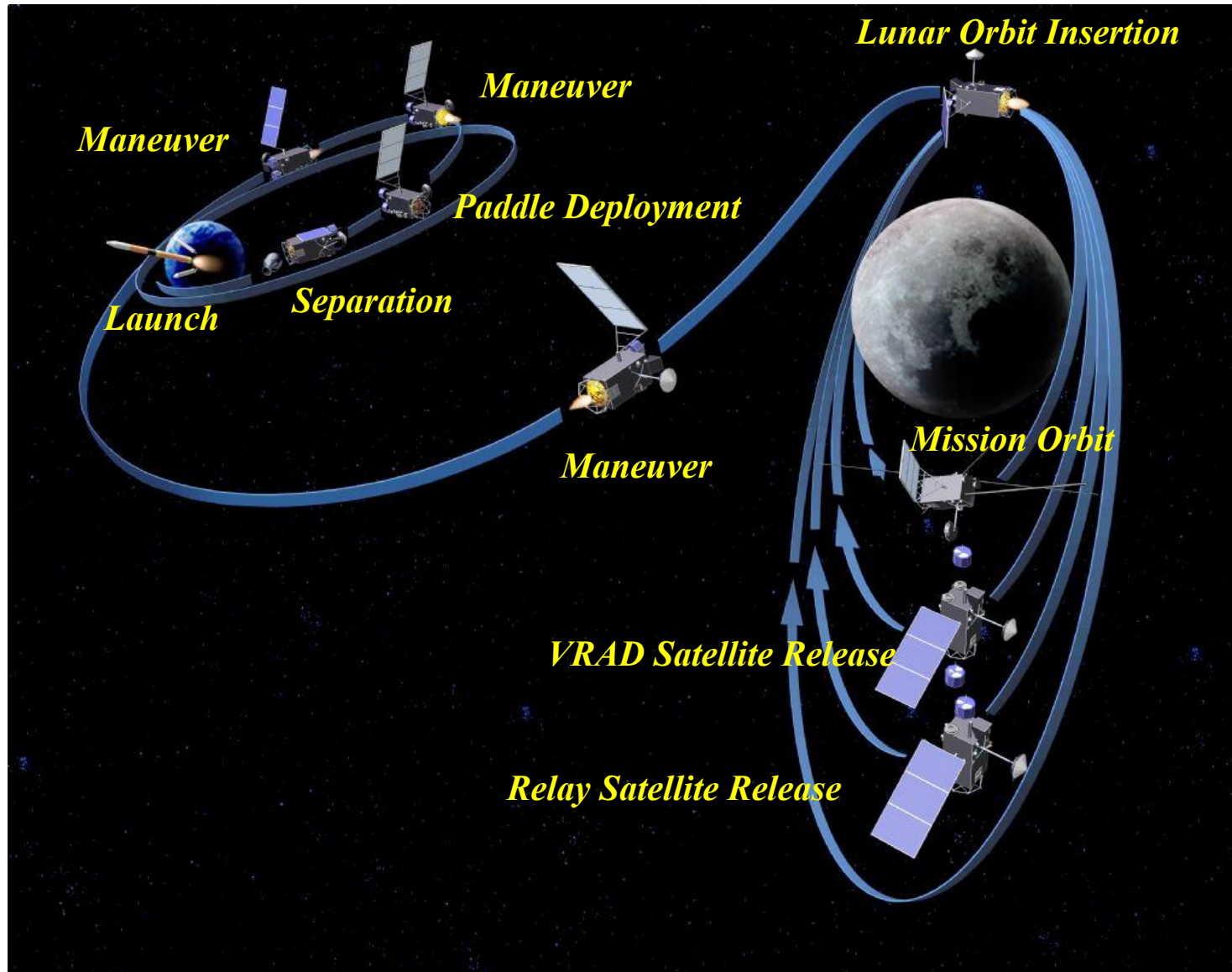
Mission period *1 year nominal*

Attitude Control

Main Orbiter : *3 axis controlled*

Subsatellites: *spin stabilized*

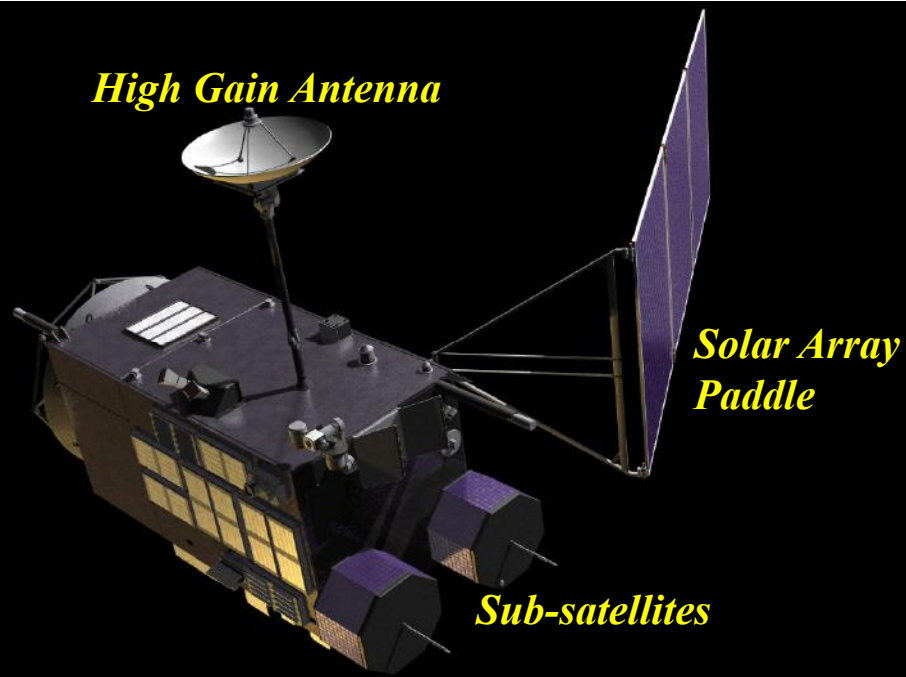
SELENE Mission Profile



Configuration of SELENE Spacecraft



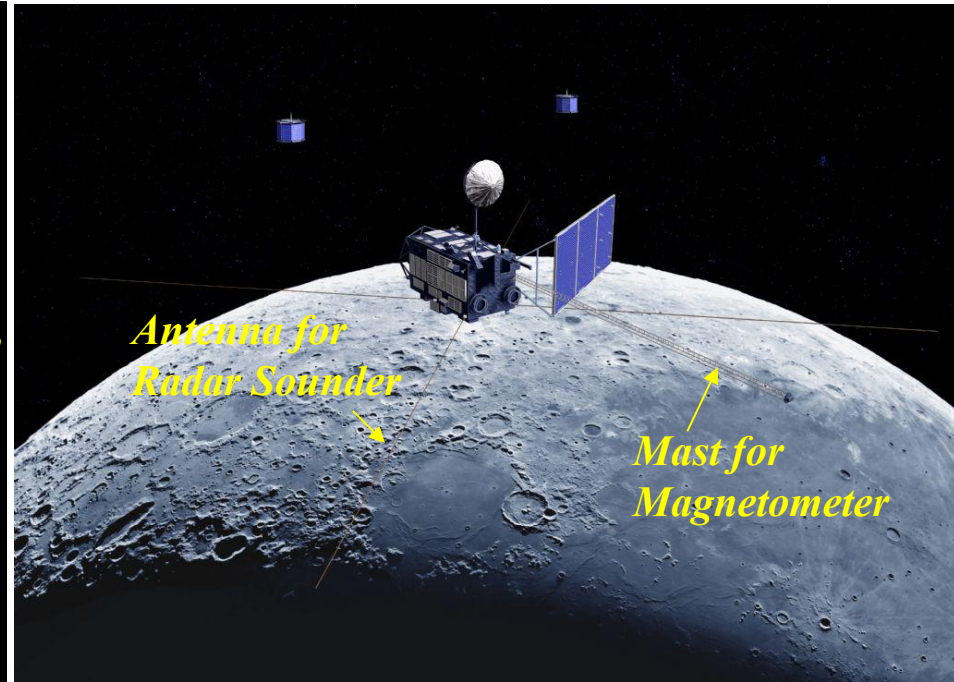
High Gain Antenna



Solar Array Paddle

Sub-satellites

in transfer orbit



Antenna for Radar Sounder

Mast for Magnetometer

in mission orbit

System Performance



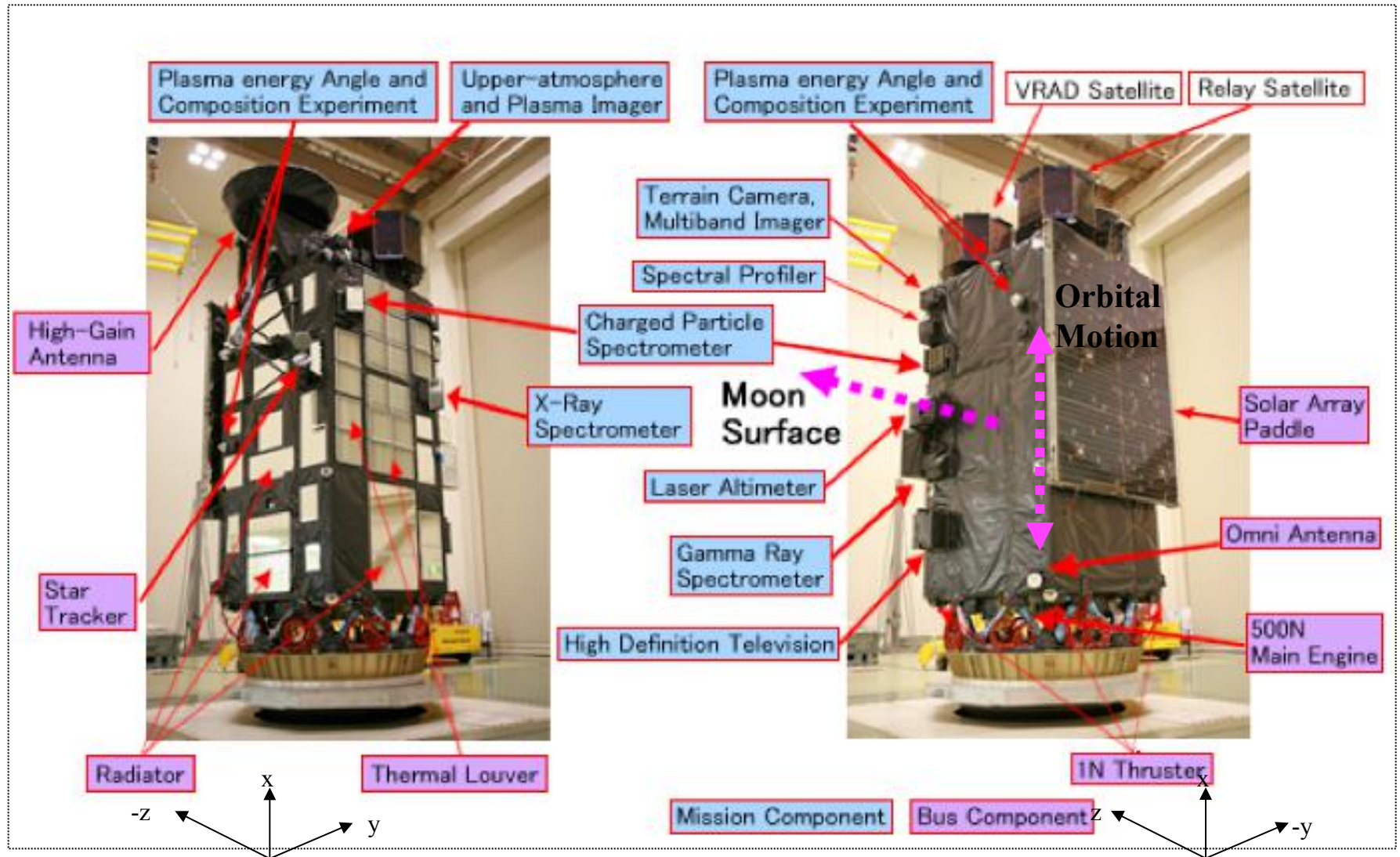
Spacecraft	Subsystem	Performance
Main Orbiter	Telemetry and Commanding	Antenna/Frequency: HGA/X-band(mission), S-ant/S-band(telemetry&command) Bit Rate: 1000bps(command), 2K/40Kbps(telemetry), 10Mbps(mission data)
	Attitude Control	Attitude Control:Zero momentum system Three-axis control Attitude Control Accuracy : ± 0.1 deg(three-axis) 4 Skew Reaction Wheels
	Propulsion	Number of Thrusters: 500N \times 1, 20N \times 12, 1N \times 8 Propellant: Nitrogen Tetroxide 335Kg, Hydrazine 742Kg
	Electrical Power	1 Wing Rigid panel (with 30 deg cant) Power Generation :More than 3,200W (EOL, $\beta = 0$ deg) Un-regulated Bus voltage:52.8V \sim 32.6V Battery : Main-Orbiter ;35Ah Ni-Cd Battely $\times 16$ cells $\times 8$ units
	Data Handling	1553B data bus system MDR recording capacity:100Gbit
VRAD Satellite		Mass 50Kg , Elliptical Orbit 100km \times 800km Attitude stabilization :Spin-stabilized, 13Ah Ni-MH Battery $\times 16$ cells $\times 1$ unit
Relay Satellite		Mass 50Kg , Elliptical Orbit 100km \times 2,400km Attitude stabilization :Spin-stabilized, 13Ah Ni-MH Battery $\times 16$ cells $\times 1$ unit



SELENE Mission Instruments

Category	Observation	Instrument	Measurement
Science of the Moon	Element Abundance	X-ray Spectrometer (XRS)	Al, Si, Mg, Fe, etc.
		Gamma-ray Spectrometer (GRS)	U, Th, K, H etc.
	Mineral Composition	Multi-band Imager (MI)	mineral distribution
		Spectral Profiler (SP)	mineral composition
	Topography, Geological Structure	Terrain Camera (TC)	geographical features
		Lunar Radar Sounder (LRS)	subsurface structure
		Laser Altimeter (LALT)	topography
	Gravity Field	Differential VLBI Radio Source (VRAD)	lunar gravity field
		Relay Satellite (RSAT)	far side local gravity field
Science on the Moon	Magnetic Field	Lunar Magnetometer (LMAG)	magnetic field
		Electron Energy Analyzer (part of PACE)	surface magnetic field
	Radiation Environment	Charged Particle Spectrometer (CPS)	energetic particles
	Plasma Environment	Plasma Energy Angle and Composition Experiment (PACE)	electrons and ions
	Ionosphere	Radio Science (RS)	ionospheric electrons
Science from the Moon	Solar-Terrestrial Plasma Environment	Upper-Atmosphere and Plasma Imager (UPI)	earth magnetosphere, aurora
		Wave Receiver (part of LRS)	planetary radiations
Publicity	Earth and Moon	High Definition TV (HDTV)	high-definition movie

Integration of Mission Instruments





Global Mapping of Chemical Composition

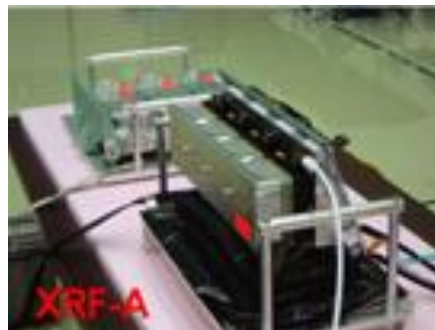
X-ray Spectrometer (XRS)

Al, Si, Mg, Fe distribution

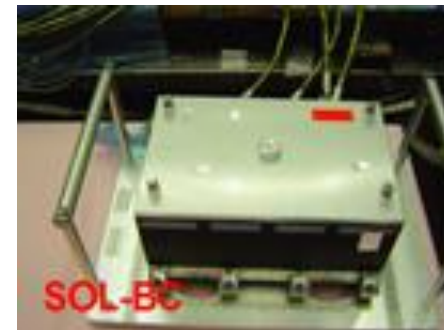
CCD sensors

Range 0.5-10keV

Spatial Resolution 20 x 20km



X-ray Spectrometer



X-ray Monitor and Calibrator

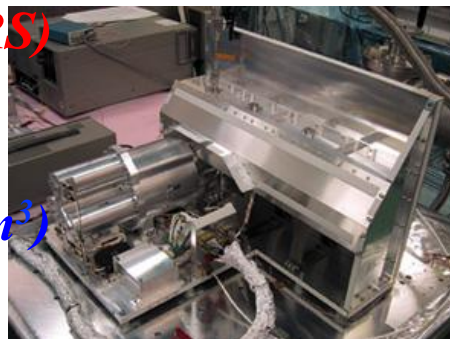
Gamma-ray Spectrometer (GRS)

U, Th, K, Ca, Ti, Si, Al, Na distribution

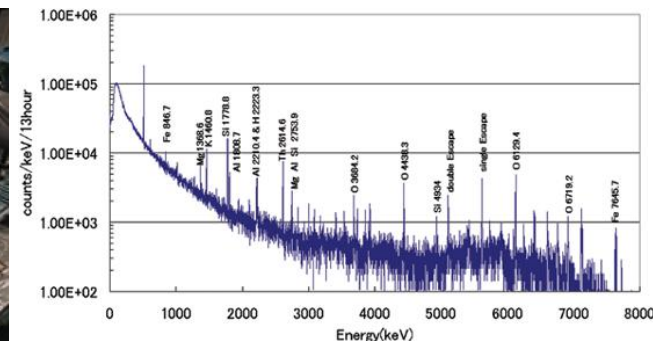
High-purity Ge Crystal(250cm³)

Range 100 keV-10MeV

Spatial resolution 160km



Gamma-ray Spectrometer High Energy Resolution





Global Mapping of Mineral Assemblage

Multi-band Imager (MI)

UV-VIS-IR imager

*Spectral bandwidth ranging from
0.4 to 1.6 μm ,*

9 filters(bandwidth 10-30 nm)

Spatial resolution 20m

Spectral-Profiler (SP)

*Continuous spectral profile ranging
from 0.5 to 2.6 μm (spectral sampling
5nm)*

Spatial resolution 500m

Multi-band Imager



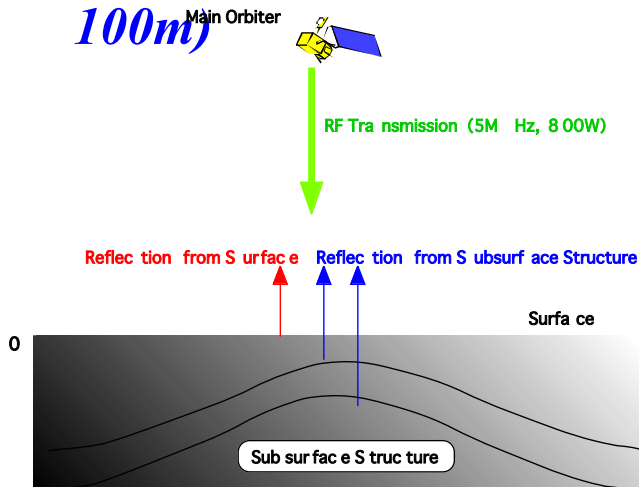


Subsurface Structure and Topography

Lunar Radar Sounder (LRS)

Mapping of subsurface structure using active sounding (frequency 5 MHz)

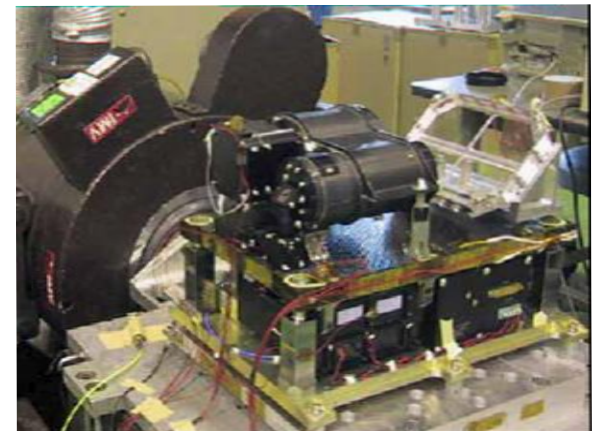
Depth 5 km (Resolution 100m)



Terrain Camera (TC) **Laser Altimeter (LALT)**
Stereo camera, Spatial resolution 10m

Nd:YAG+ADP laser altimeter,
Footprint 30m
Height resolution 5m,
Spatial resolution 1600m
(pulse rate 1Hz)

Terrain Camera





Gravimetry and Selenodesy

*Four Way Doppler Measurement by
Relay Satellite and Main Orbiter
Transponder (RSAT)*

*Far-side gravimetry by Doppler
measurement of orbiter via relay
satellite (perilune 100km,
apolune 2400km in altitude)*

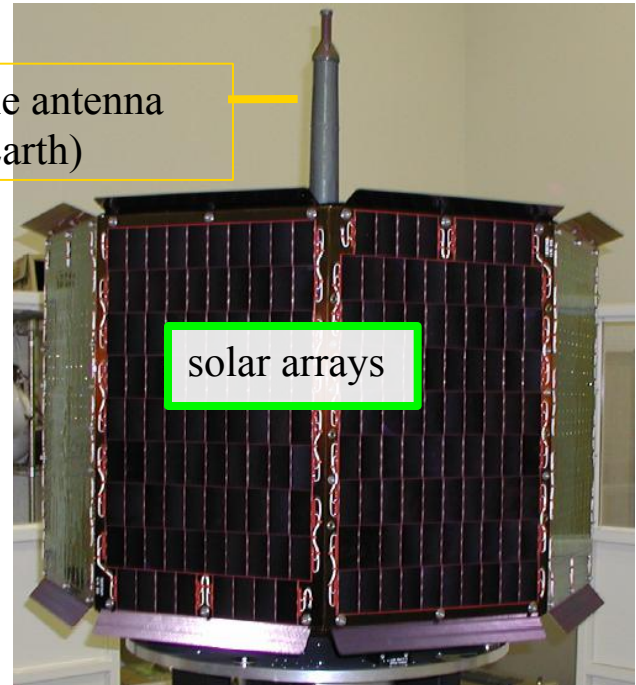
*Differential VLBI Radio-Source
(VRAD)*

*Three S-band sources and one
X-band source*

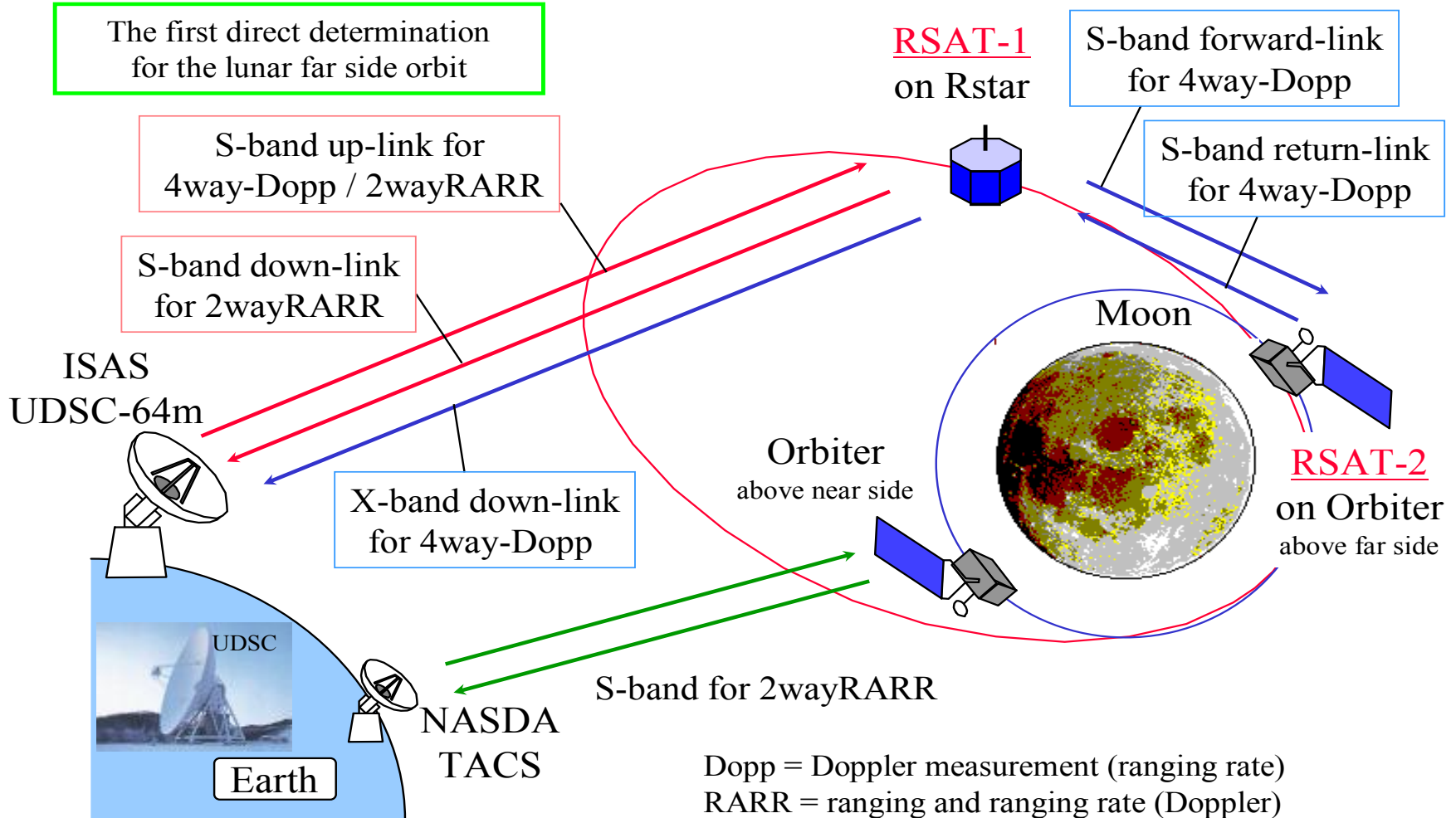
*Relay satellite and VRAD satellite
Differential VLBI observation from
ground station(3 stations).*

S/X-band dipole antenna
(toward Earth)

solar arrays



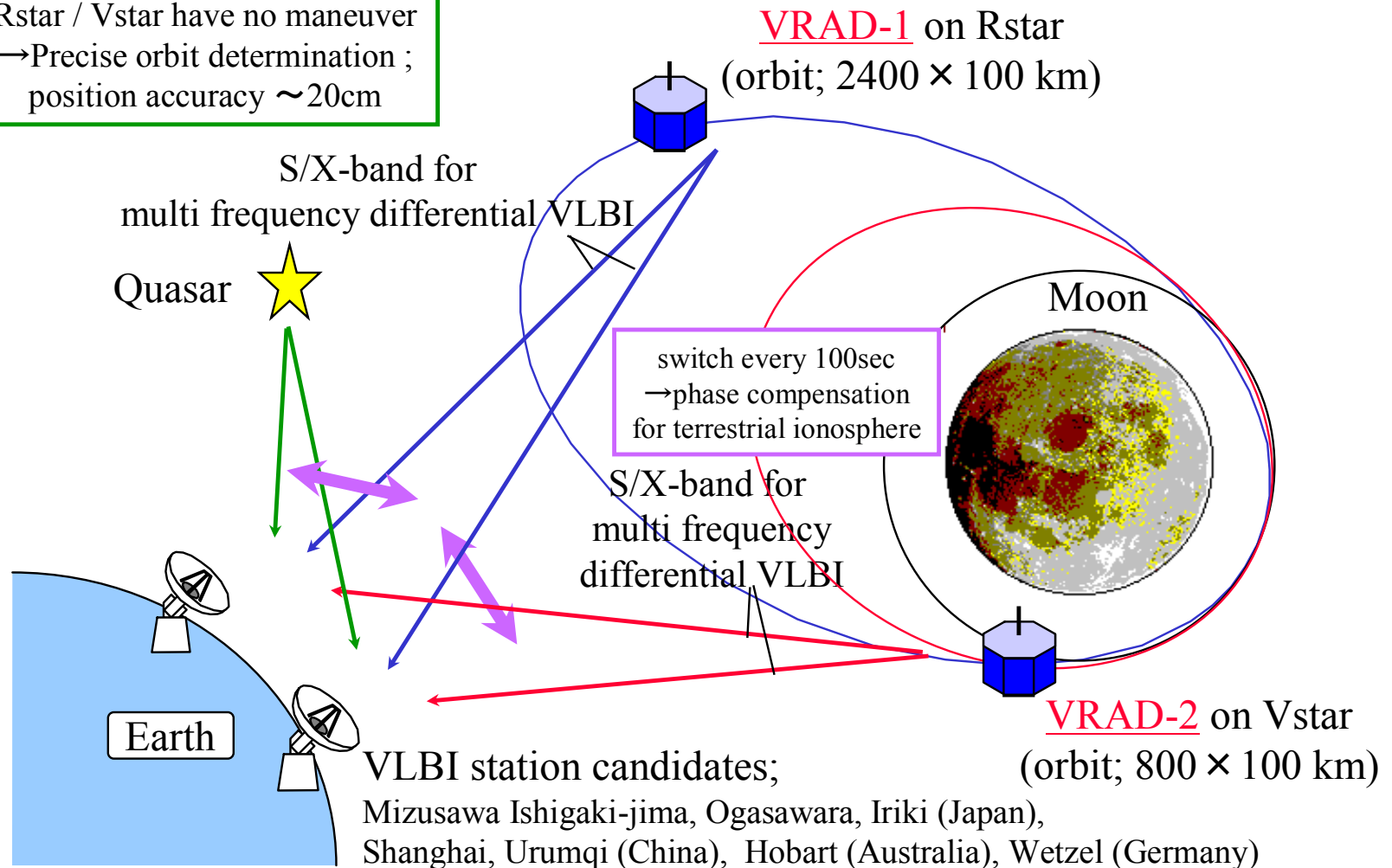
RSAT: 4-way Doppler measurement using Relay Satellite Transponder



VRAD: Multi frequency differential VLBI using VLBI Radio Sources



Rstar / Vstar have no maneuver
→ Precise orbit determination ;
position accuracy $\sim 20\text{cm}$





Magnetic Field Measurement

*Mapping the distribution of crustal magnetic field and their direction
Determination the correlation of magnetic anomalies with surface geology*

Lunar Magnetometer (LMAG)

3-axis ring-core sensor

Precision 0.1nT

Mast 12m

Electron Reflectometer

*Electron Energy Analyzer of
Plasma Analyzer (PACE)*

Range 5 eV/q-15 keV/q



12 m mast extended

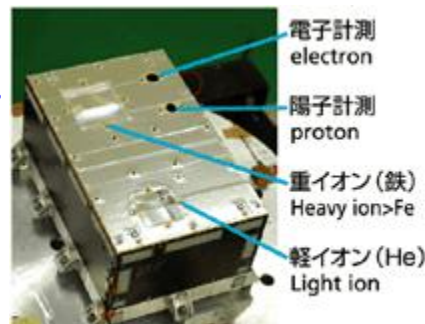


Electron Energy Analyzer



Science on the Moon

Charged Particle Spectrometer (CPS)
Measurement of high-energy particle
Isotope detector (1-30MeV(LID) and
8-300MeV(HID))
Alpha ray detector 4-6.5MeV

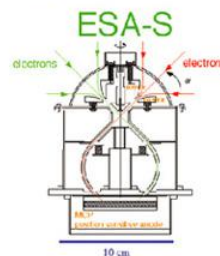


Particle Spectrometer

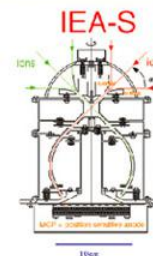


Alpha Ray Detector

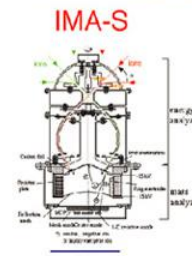
Plasma Energy Angle and Composition
Experiment (PACE)
Electron energy analyzer 5 eV-15 keV
Ion energy analyzer 5 eV/q-28 keV/q
Ion mass/energy analyzer 1-60 AMU



Electron Energy



Ion Energy



Ion Mass/Energy

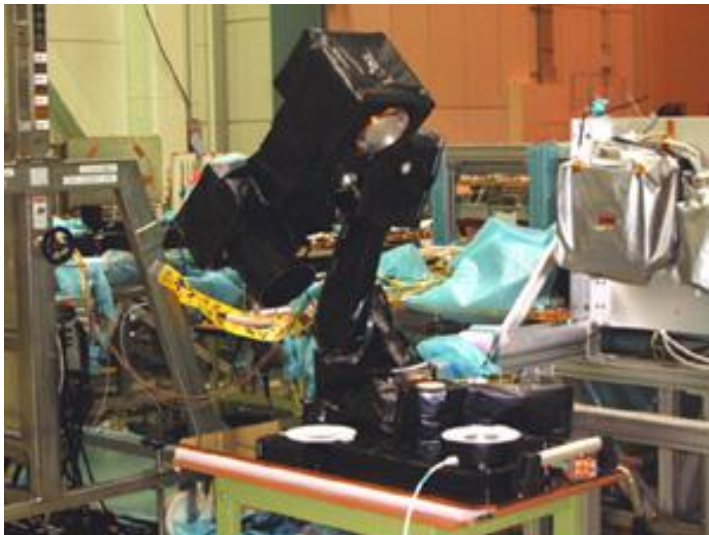
Radio Science (RS)
To detect the tenuous lunar ionosphere
using S, X-band coherent carriers on
VRAD satellite.



Science from the Moon

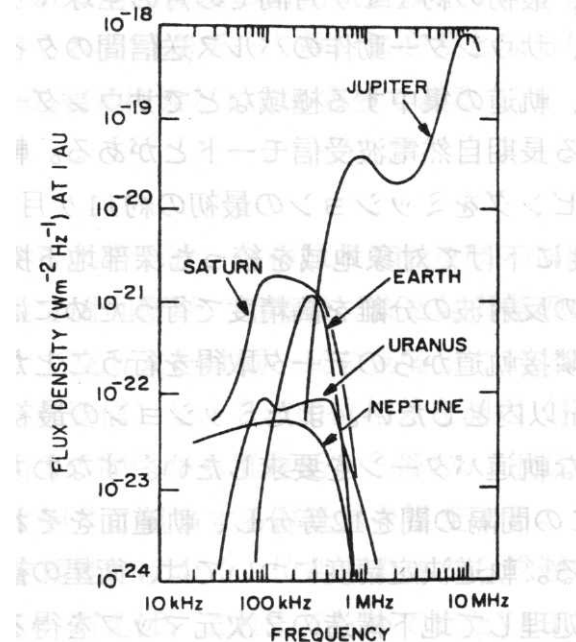
Upper-Atmosphere and Plasma Imager (UPI)

Observation of plasma dynamics around the earth from lunar orbit, EUV-VIS.



Wave Receiver of Radar Sounder Experiment (LRS)

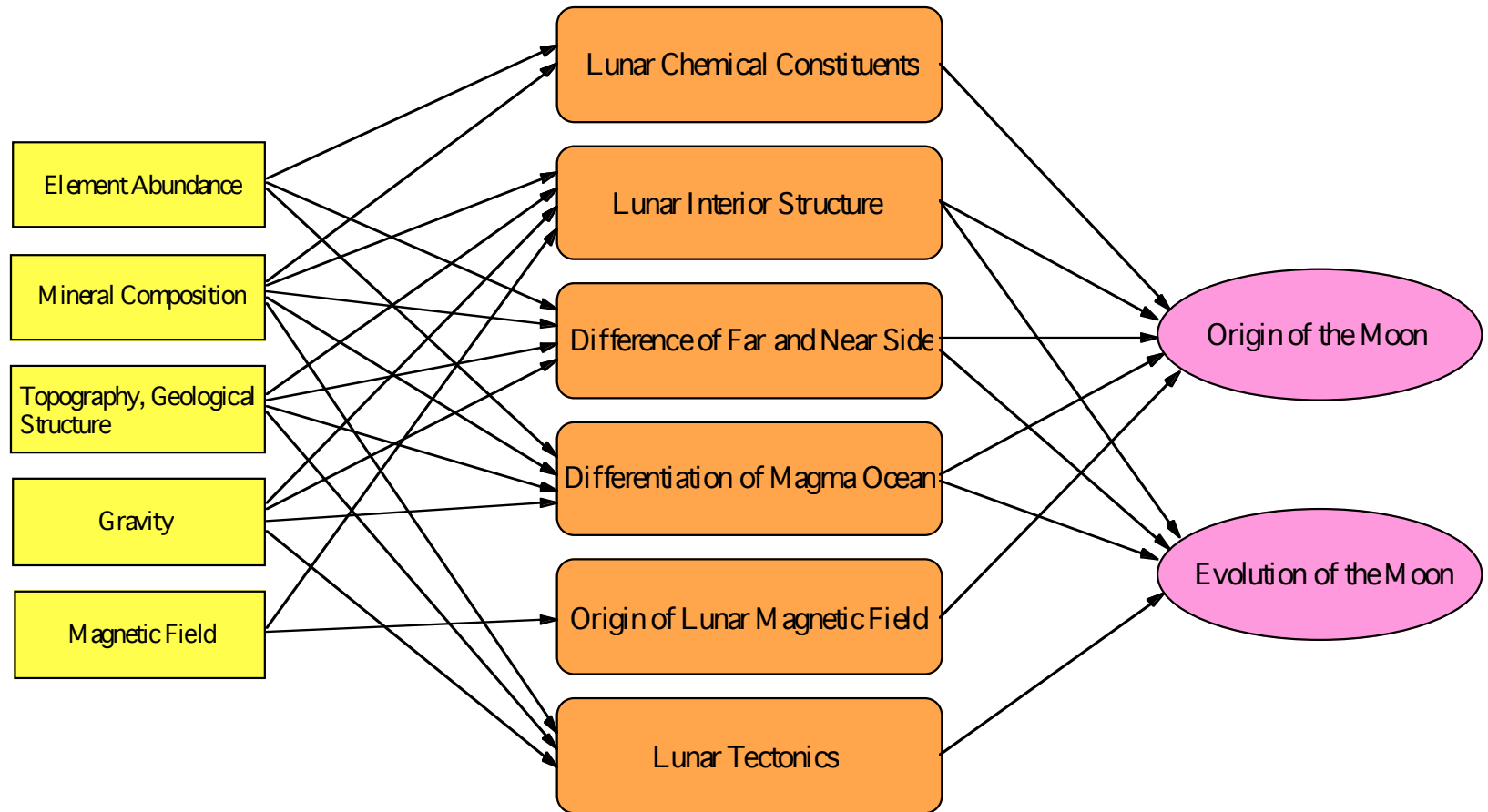
Measurement of plasma waves, radio waves, and planetary radiation, Frequency range 10 Hz to 30 MHz.



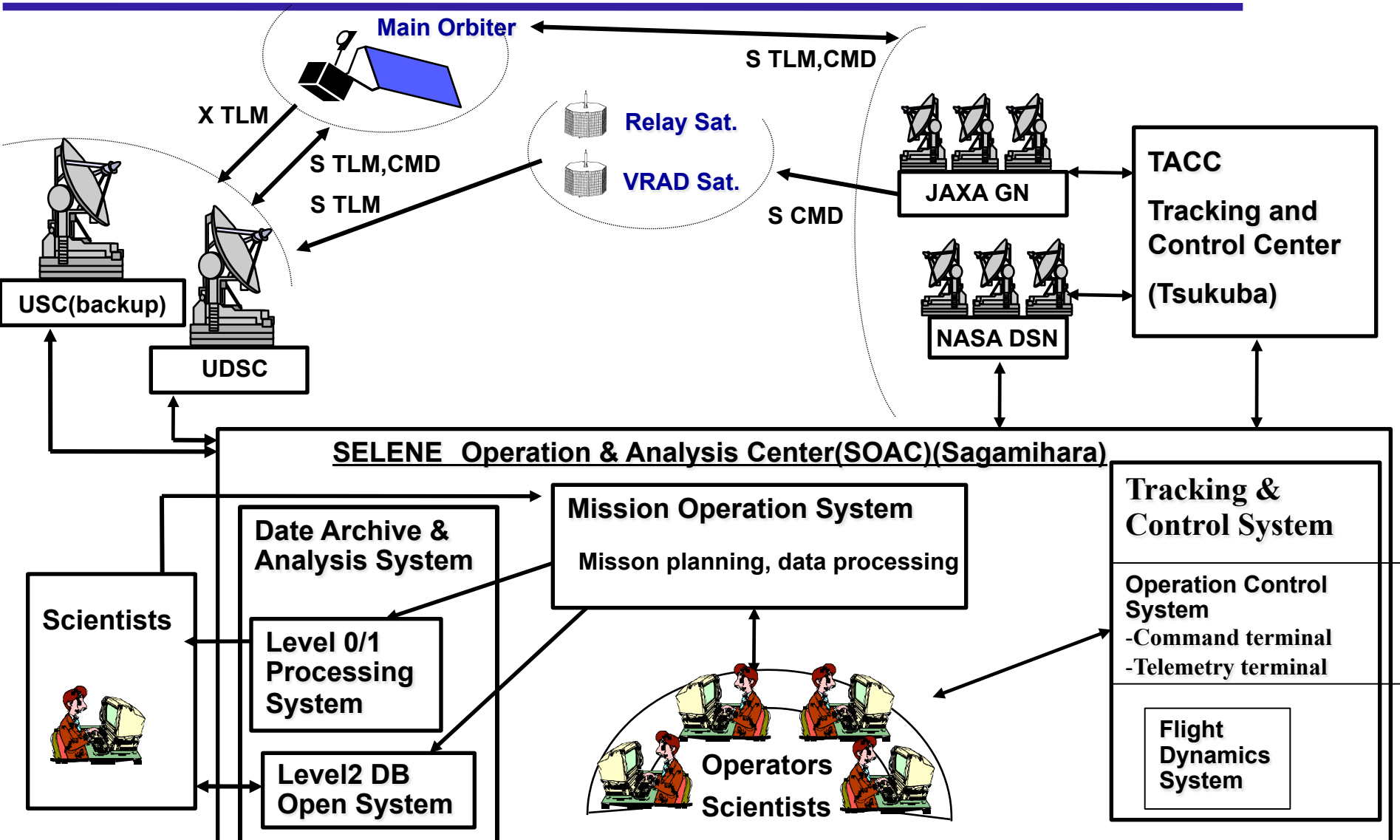
Planetary radiation



Integrated Research for Origin and Evolution of the Moon



Ground System for Flight Operation



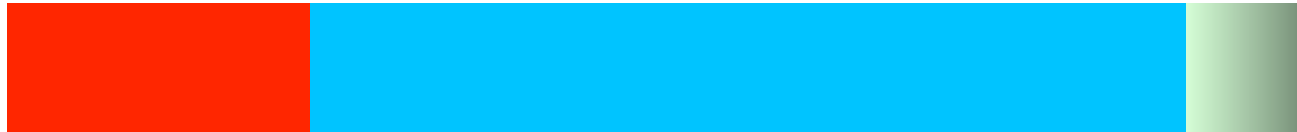


Flight Operation Plan

Launch

Launch+3months

TBD



Critical Phase

Observation Phase

Extra-mission Phase

Initial Checkout Phase (10 months)

(depending on amount of fuel)

pre-determined plan (nominal, off-nominal plan)

*yearly plan
monthly plan
weekly plan (timeline
upload twice a week)*



Flight Operation Plan(Mission Phase)

Weekly Operation

<i>Day1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
-------------	----------	----------	----------	----------	----------	----------

Operation Request



Timeline Integration

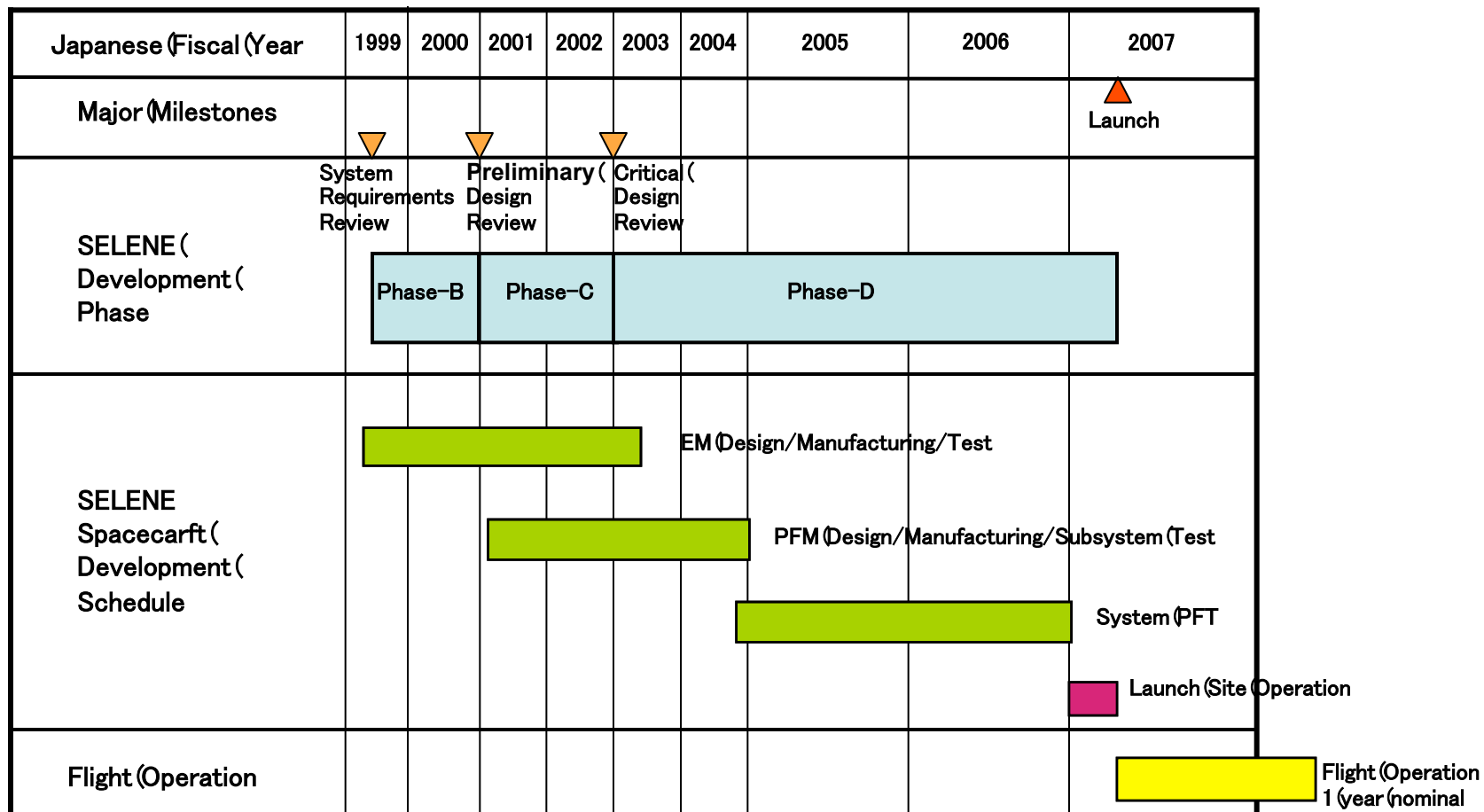


Uplink





Schedule



Abbreviation

EM: (Engineering Model

PFM: (Proto Flight Model

PFT: (Proto Flight Test (

▲ We are here.



Current Status for International Collaboration

1. Collaboration with NASA/LRO

- The Statement of Intent (SOI) was mutually agreed and cooperative agreement is under coordination.*
- SELENE will develop E-matrices (gravity files) with participation of NASA using the Geodyn software system.*
- E-matrices will be used for LRO mission planning in NASA.*
- SELENE will produce SELENE altimetry data in the format of Planetary Data System (PDS) for LCROSS mission planning in NASA.*
- NASA will provide DSN support for SELENE initial mission operation.*

2. Collaboration with ISRO/Chandrayaan

- A discussion is planned on the cross validation / calibration at Chandrayaan 2nd science working group meeting in India, this February.*

Summary and Concluding Remarks



- *Integration test is almost completed and will be ready for launch in summer this year.*
- *SELENE will provide scientific data that will be used as a common data base for planetary scientists in the world.*
- *SELENE will be a kick-off mission in the series of Japanese lunar exploration and utilization program.*

