JAXA update

Masaki Fujimoto
Space Plasma Group, ISAS, JAXA

GT(L92): ***Magnetospheric***
REIMEI(L05): ***Aurora imagery & particles***
QZS: ***B-field and energetic particles at L=6.6~10***
ERG*: Inner magnetosphere*

SCOPE/Cross-Scale
Multi-scale formation

Kaguya(L07, T09): ***lunar plasma***

EXCEED: ***Planetary plasma imaging***

MMO(Launch)----------MMO(Arrival)
Mercury

Hinode(L06): ***Corona heating***

Solar-C
Plan A or B

Geotail

Science Objectives: Understanding the magnetotail dynamics

Instrumentation: In-situ particle and E&B fields

Mission Description:

*Launch date 1992 by Delta-II

*Number of spacecraft 1

*Location 8 Re x 30 Re, geocentric distance

*Attitude control spin

Mission Status: Operation approved up to 2012 at ISAS/JAXA, up to 2012 at NASA

Science Programs and Current Activities:

Collaboration with ESA's Cluster and NASA's THEMIS.

Supporting web page at http://darts.isas.jaxa.jp/stp/cef/cef.cgi

International Contributions and Collaborations: Joint with NASA. Especially, data reception at NASA DSN is crucial.

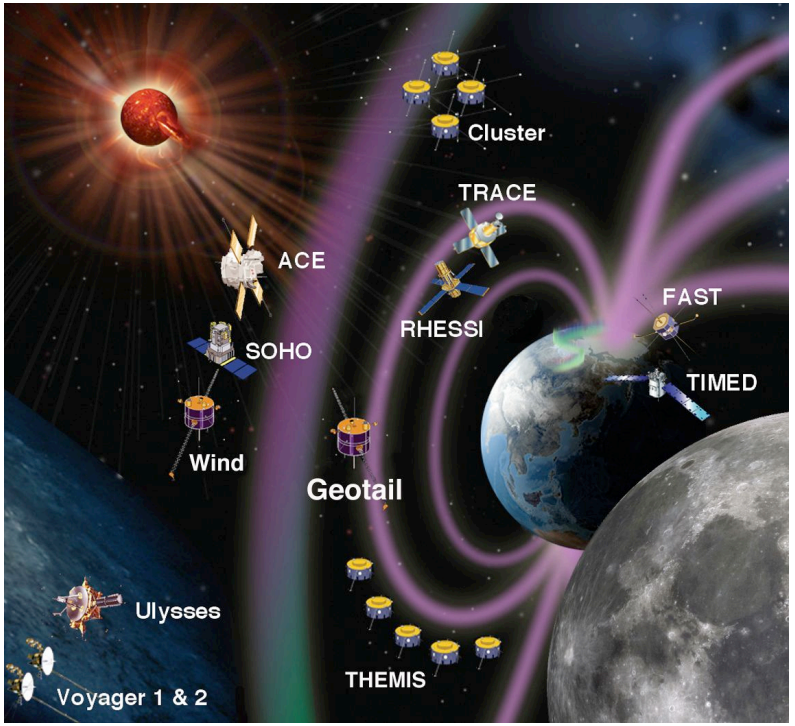
Data Access: Available online at http://www.darts.isas.ac.jp/index.html.en

For more information please contact: Masaki Fujimoto

Geotail

Launched in 1992
as a US-Japanese
joint mission

Now contributing unique
measurements to the
Heliophysics Great Observatory



Instruments (E and B Fields, Waves and Particles):
All in good condition after 18 years in space

Reimei

Science Objectives: High-resolution/high-cadence imaging of aurora and simultaneous high-time resolution detection of precipitating electrons

Instrumentation: In-situ particle and auroral imager

Mission Description:

*Launch date 2005, piggy-back on a Russian rocket

*Number of spacecraft 1

*Location 600km altitude

*Attitude control three-axis stabilized

Mission Status: In operation, without the electron detector (lost in Aug 2008)

Science Programs and Current Activities:

Collaboration with various ground-based observation teams (including NASA's THEMIS team) in progress.

For more information please contact: Masaki Fujimoto

Hinode

Science Objectives: Resolving the corona heating problem

Instrumentation: High resolution imaging of the photosphere (visible), spectroscopy of chromosphere (EUV) and imaging of corona (soft-X).

Mission Description:

*Launch 2006 by MV

*Number of spacecraft 1

*Location Sun-synchronous at 680km altitude

*Attitude control three-axis stabilized

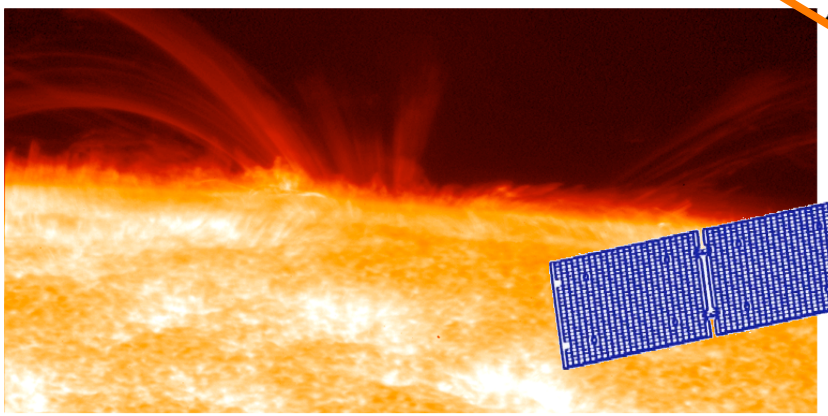
Mission Status: In operation

Science Programs and Current Activities: Intense participation of European and the US scientists via ESA and NASA, respectively. Especially, after the loss of the X-band transmitter onboard, the cooperation of ESA to extend the S-band data reception time has been the crucial element for Hinode science.

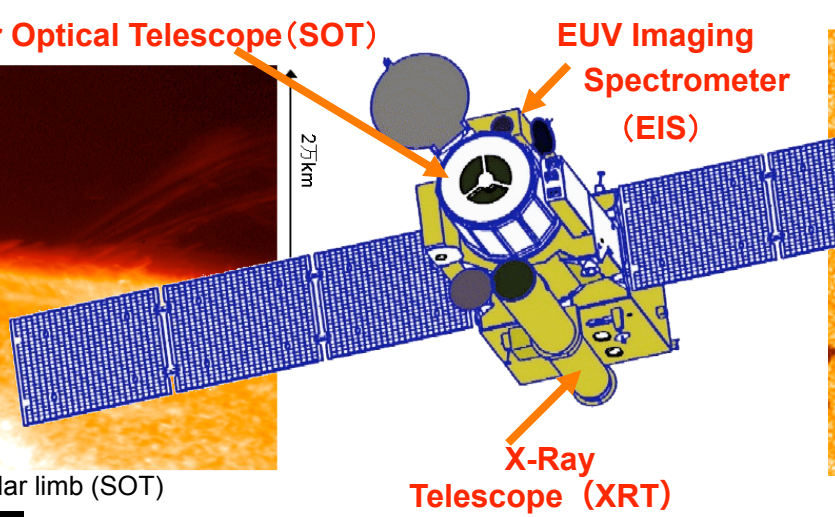
For more information please contact: Taro Sakao

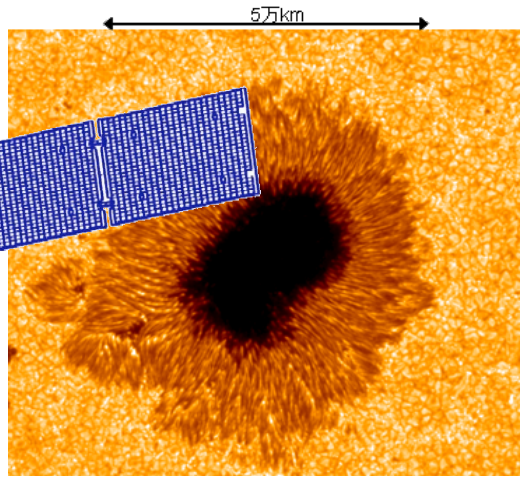
Hinode (Solar-B)

Launched on September 23, 2006 JST. *Hinode* observes the Sun with high spatial resolution in optical, EUV, and X-ray wavelengths.

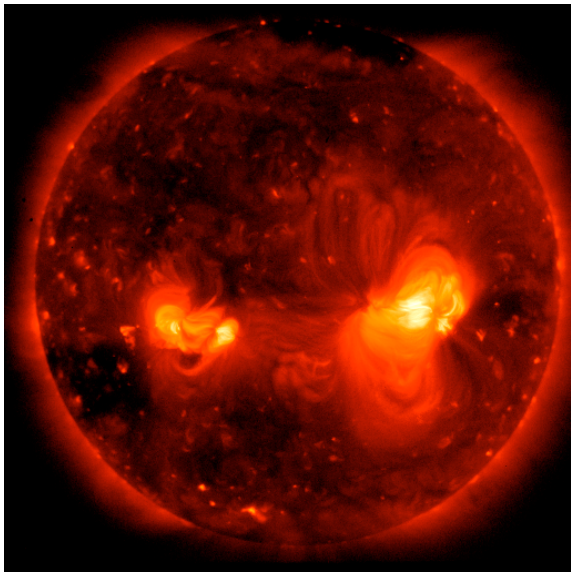


Dynamical upward flows of the gas on the solar limb (SOT)

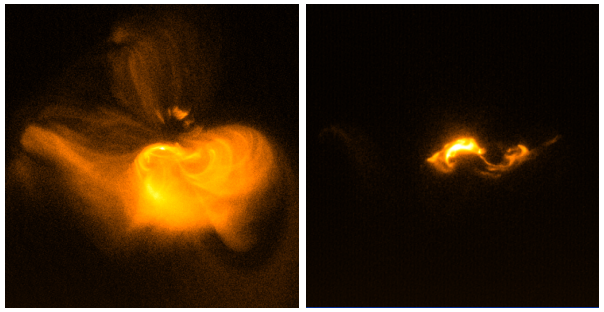




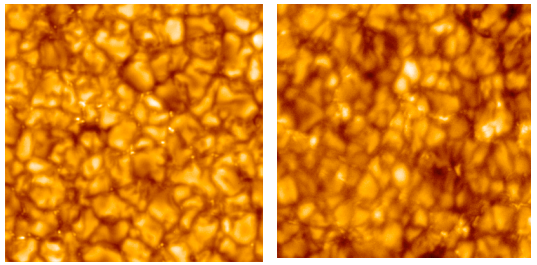
Fine structures of sunspot (SOT)



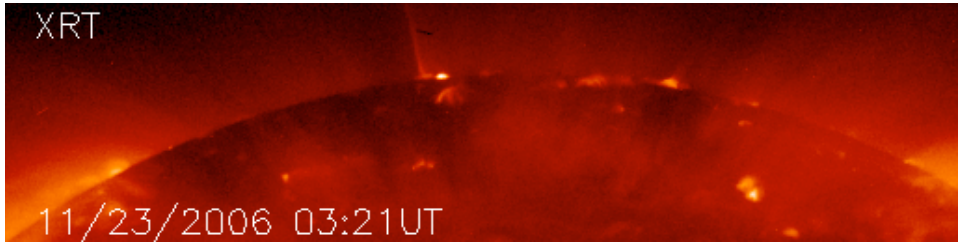
X-ray coronal image of the full Sun (XRT)



X-ray morphology of a major flare
(left) pre-flare corona
(right) flare explosion



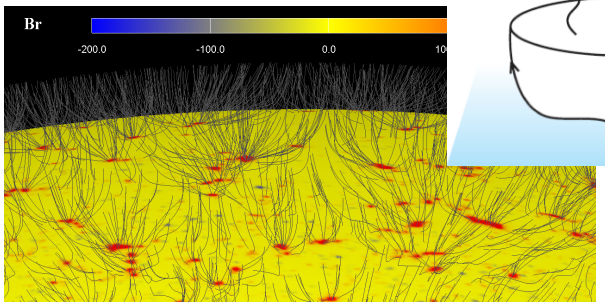
Solar granules: Hinode (left) has great advantage to stable high spatial observations, compared with best seeing site on the ground (right)

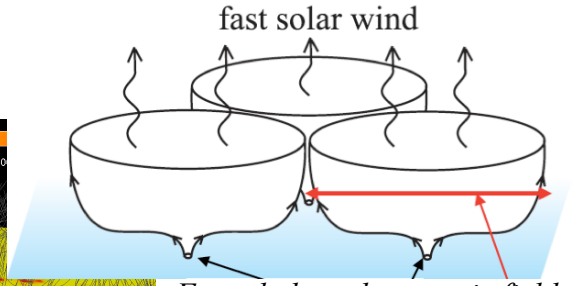


X-ray jets at the polar region

Recent Results from Hinode

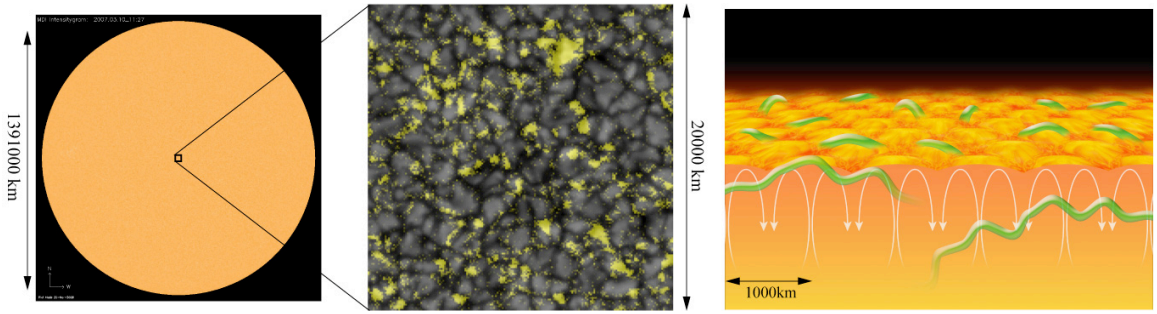
- More than 320 referred papers have been published by the end of June 2010, including special issues in *Science*, *PASJ* (*Publ. Astron. Soc. Japan*), and *Astron. Astrophys.*
- Recent results include:
  - Discovery of kG-magnetic patches in the polar regions of the Sun, and their possible role in accelerating fast solar wind.





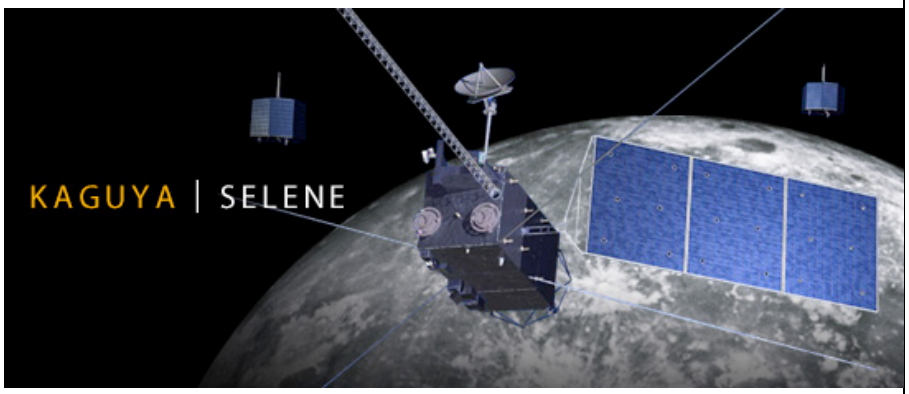
Funnel-shaped magnetic field as an efficient propagetor of Alfven waves for accelerating fast solar wind.

  - Discovery of short-lived transient horizontal magnetic flux covering all over the Sun, suggestive of local dynamo process assoc. with convective motion on the photosphere.



Transient horizontal magnetic field across the Sun most likely generated through local dynamo process assoc. with convective motion at the solar surface.

Kaguya



Science Objectives: Understanding the lunar plasma environment

Instrumentation: In-situ particle (ion composition and electrons) and B fields, plasma waves.

Mission Description:

*Launch 2007 by H-2A

*Number of spacecraft 1

*Location Lunar orbiter, altitude 100km~20km

*Attitude control three-axis stabilized

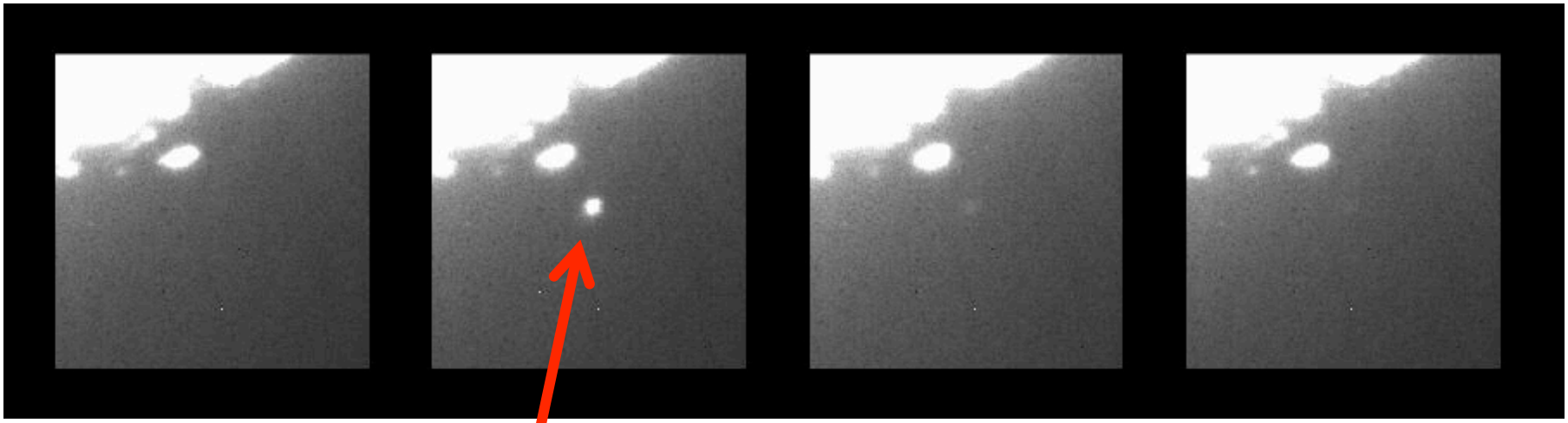
Mission Status: Ended in 2009

Science Programs and Current Activities:

PI of PACE (plasma particle detector onboard Kaguya) is a member of NASA's Lunar Science Institute.

http://www.isas.jaxa.jp/e/enterp/missions/kaguya/index.shtml

For more information please contact: Masaki Fujimoto

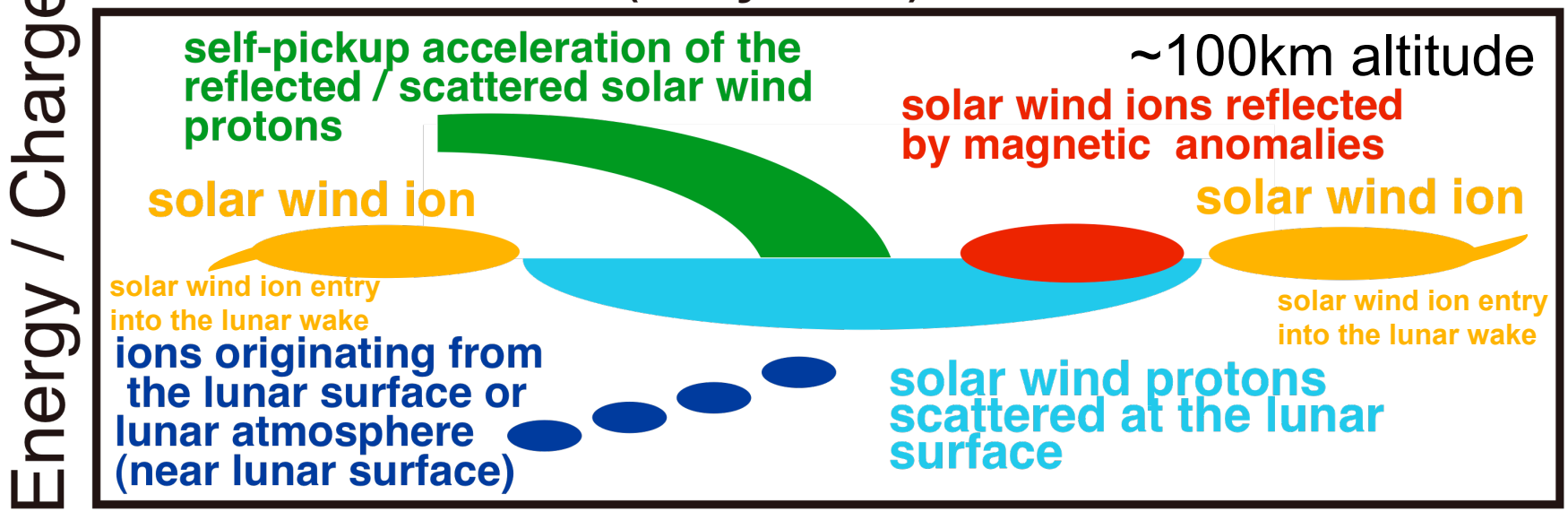


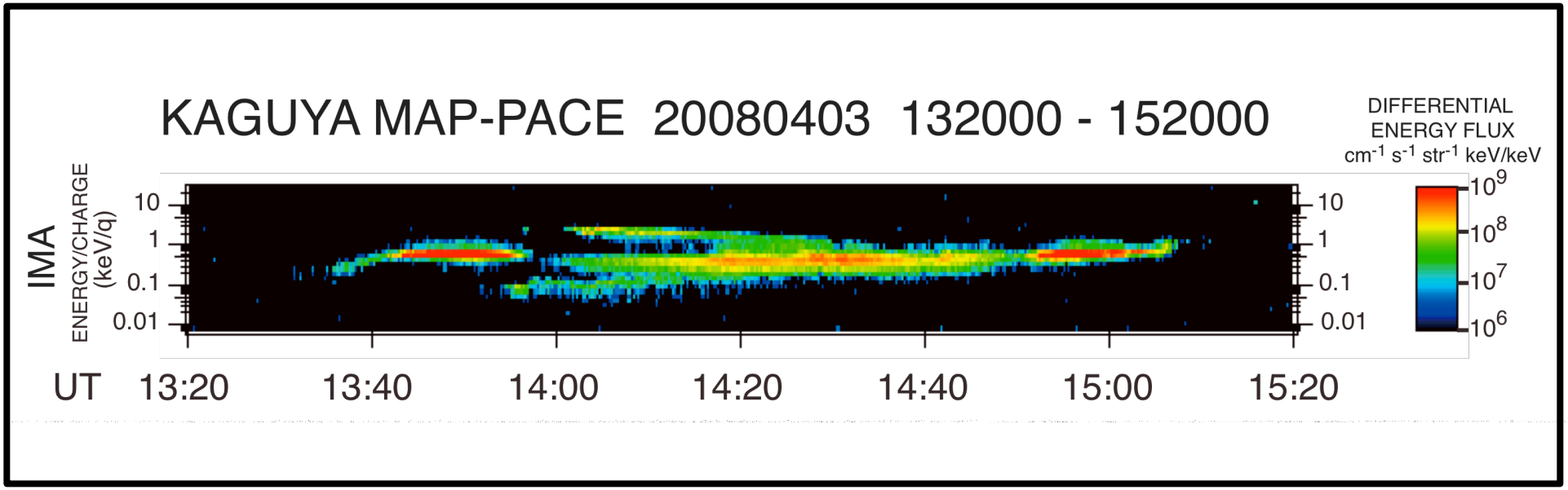
Impact flash of Kaguya

Lunar plasma environment, a new regime:

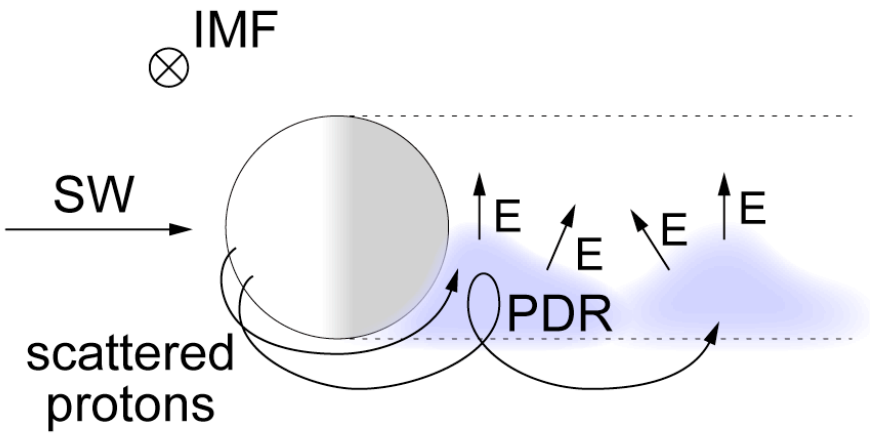
SW proton reflection at the surface,
Physics of the lunar wake, detection of lunar ions,
SW interaction with B-field anomaly

Summary of Low Energy Ions around the Moon (Dayside)

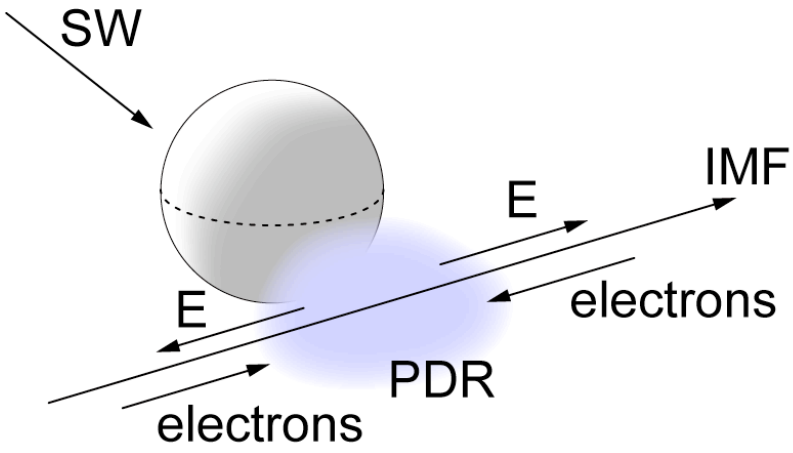


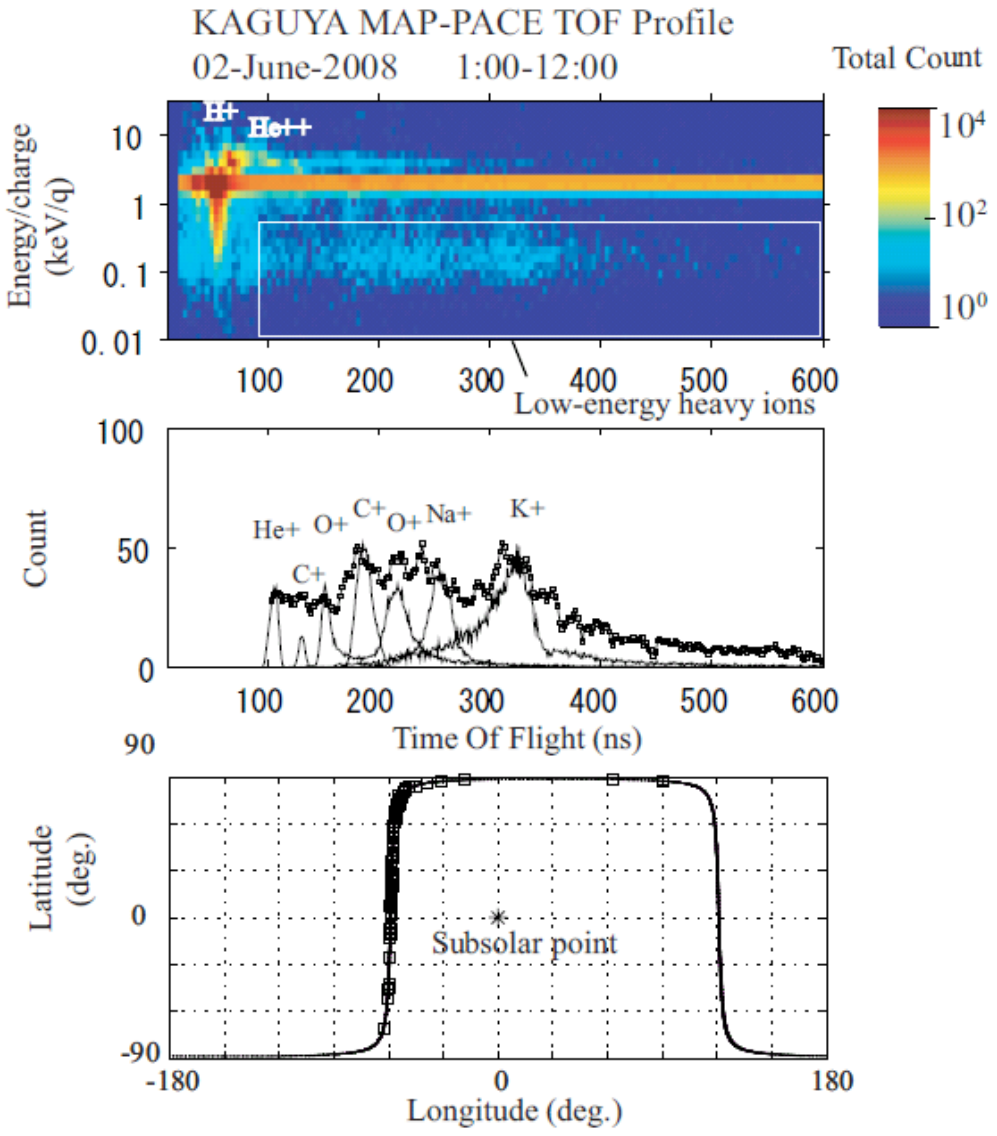


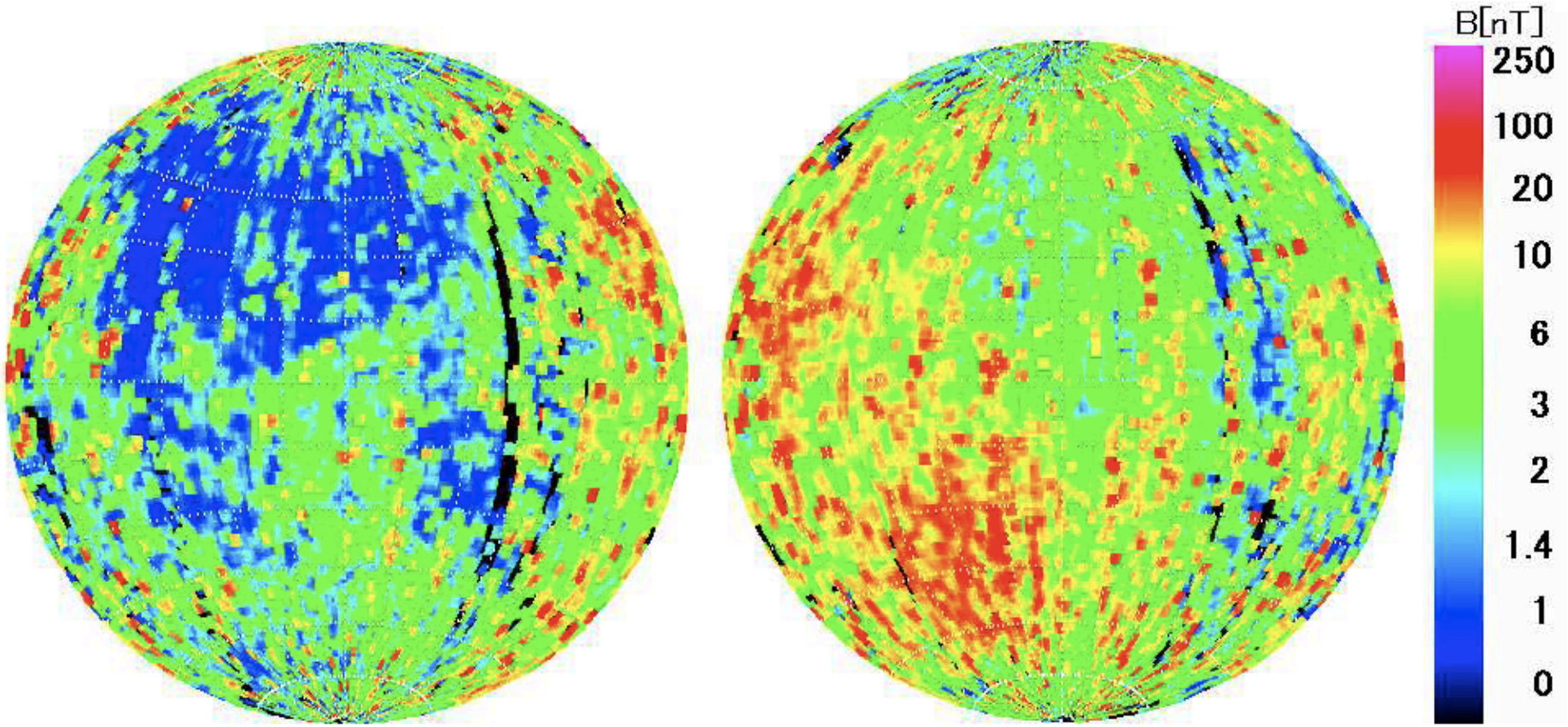
a side view



b tilted view






B[nT]
250
100
20
10
6
3
2
1.4
1
0
Near Side
Far Side

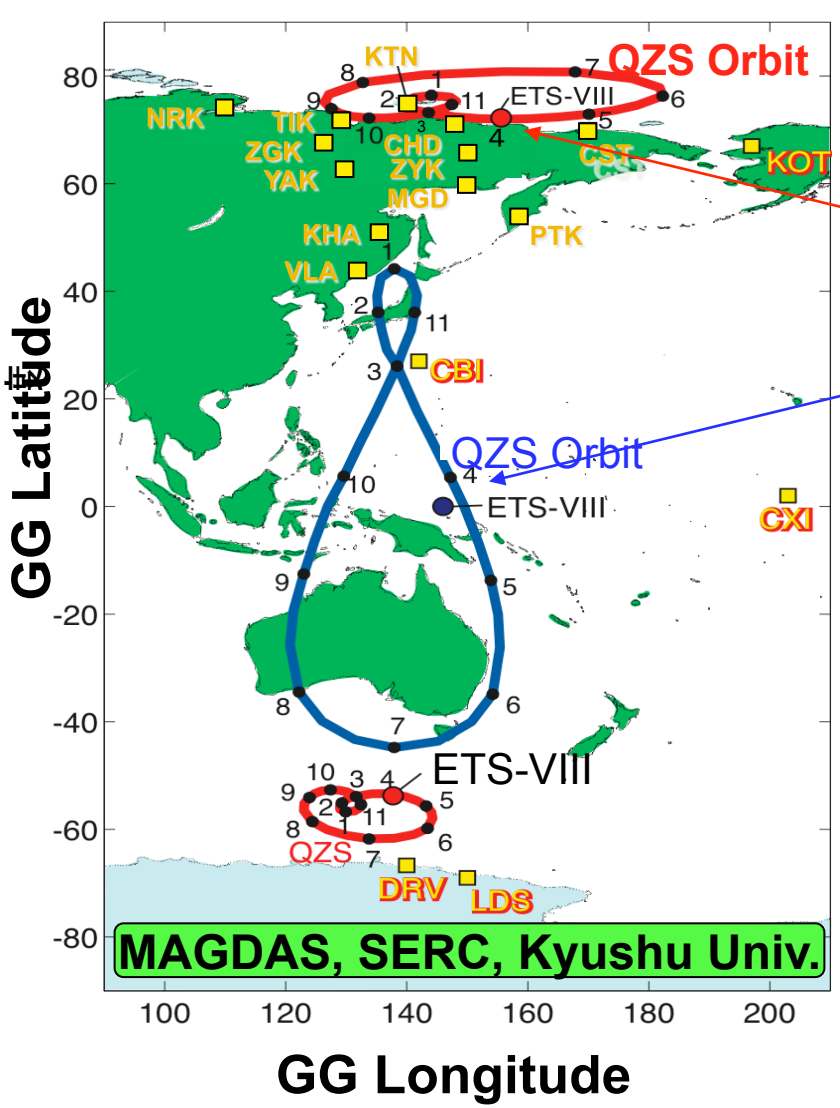
QZS: Quasi-Zenith Satellite

A JAXA's tech-demo sat with space weather instruments onboard

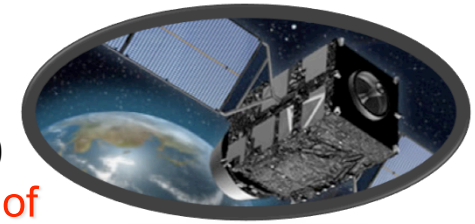
For more information please contact: Masaki Fujimoto

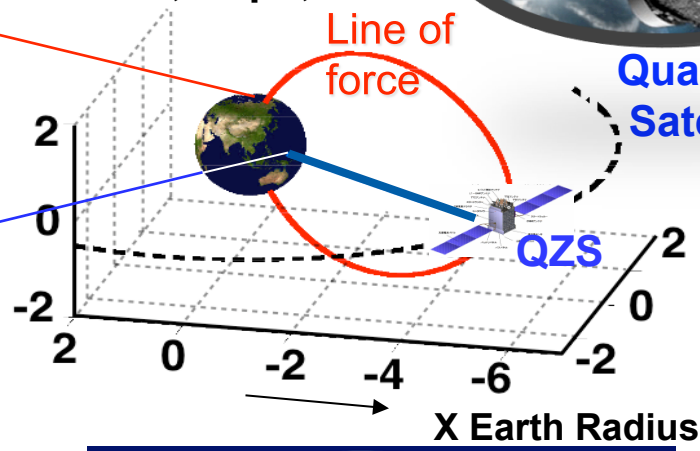
Substorm Study with QZS, MAGDAS and Space Simulator

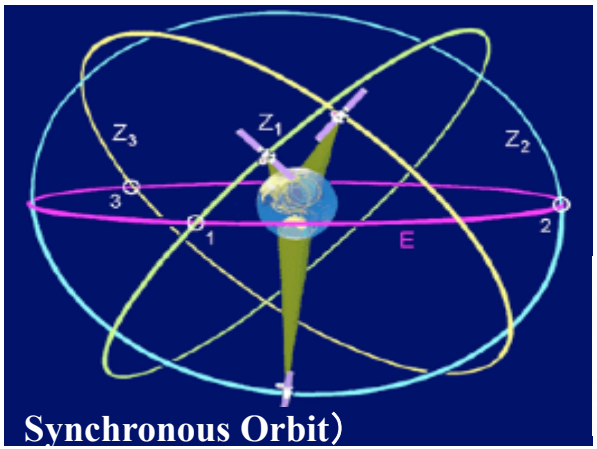
T.Obara (JAXA), K. Yumoto (Kyushu Univ.), H.shinagawa(NICT)



Altitude：36000km
Synchronous Orbit
Launch; Sept., 2010







QZS Technical Data Acquisition System (TEDA) Specification

ELS (Electron Sensor)

Energy Range	0.3MeV～1.4MeV
Sensor Type	Silicon Type Sensor (PIN type)
Energy Resolution	<25keV
Maximum Count	5×10^4event/sec
G-Factor	0.0442 cm^2･sr
Field of view	±21.8°

APS (Alpha particle and Proton Sensor)

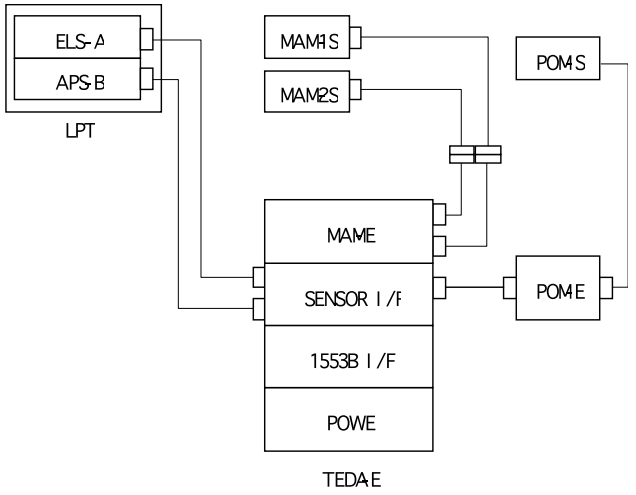
Energy Range	Proton : 1.5MeV～250MeV Deuteron : 8 MeV/n～26 MeV/n Tritium : 9.2 MeV/n～21 MeV/n Helium3 : 21 MeV/n～84 MeV/n Helium4 : 10 MeV/n～400 MeV/n
Sensor Type	Silicon Type Sensor (PIN type)
Energy Resolution	<25keV
Maximum Count	5×10^4event/sec
G-Factor	0.0085 cm^2･sr
Field of View	±16.7°

MAM (Magnetometer)

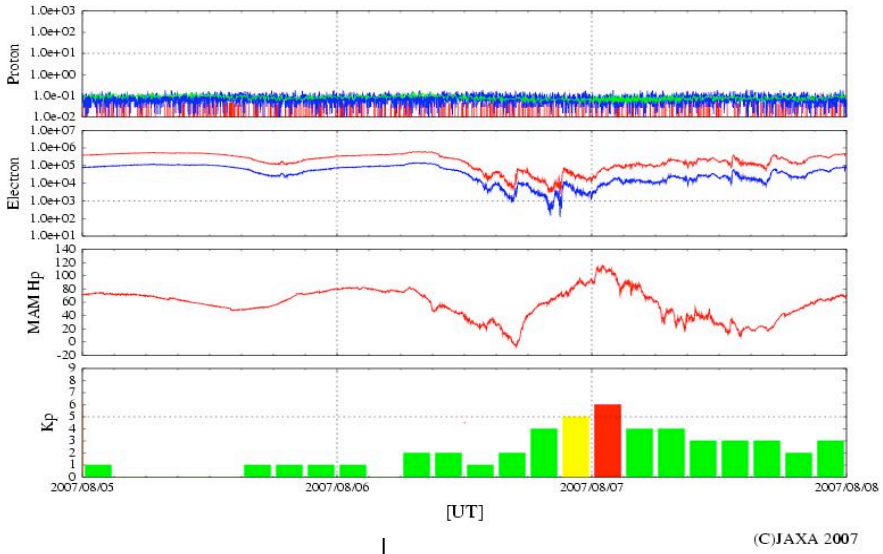
Range	±65536 nT ±4096 nT
Time Resolution	1 sec

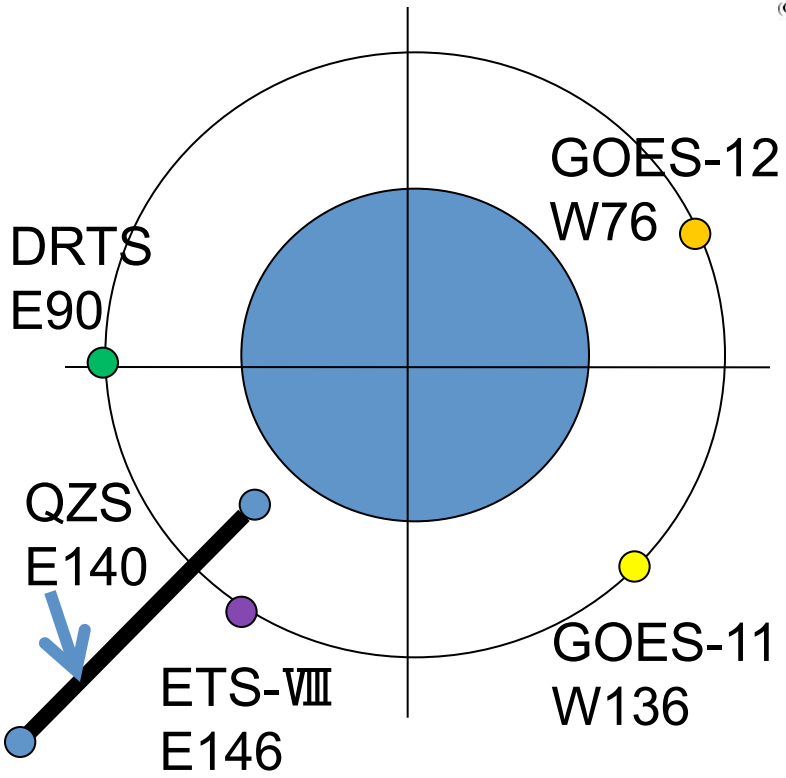
POM (Potential Monitor)

Range	-10kV～+5kV
Resolution	12bit
Error	±5% FS



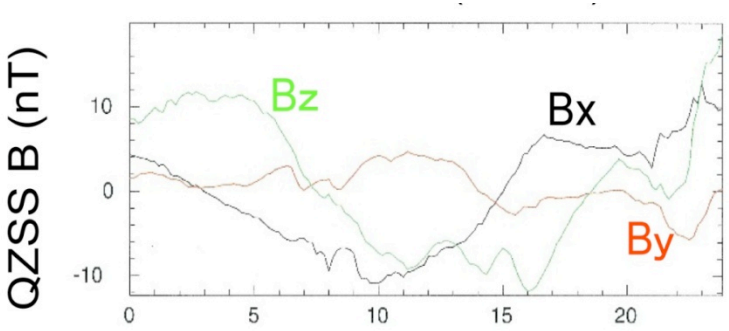
<TEDA Block Diagram>



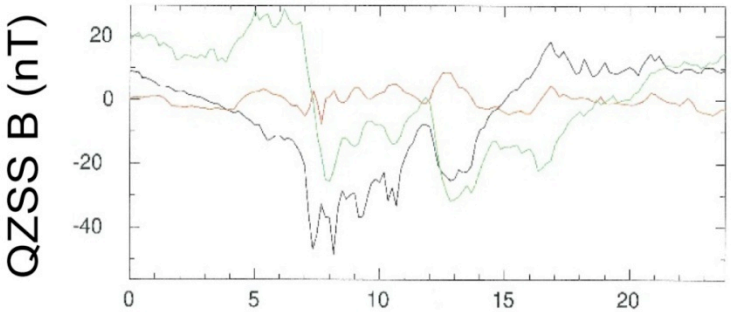


We are going to compare simulation results to clarify a basic process of Substorm.

Quiet Day

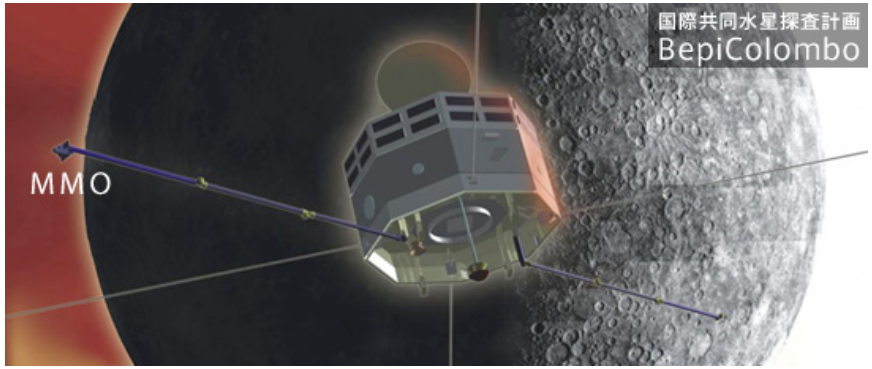


Active Day



MHD simulation by NiCT

BepiColombo MMO



Science Objectives: Understanding the Hermean plasma environment

Instrumentation: In-situ particle (ion composition and electrons) and E&B fields.

Mission Description:

***Mercury Magnetosphere Orbiter**

Joint with ESA

***Launch 2014 by Ariane5**

***Number of spacecraft 2**

(MMO + MPO: Mercury Planetary Orbiter)

***Location orbiter, 400kmx7Rm**

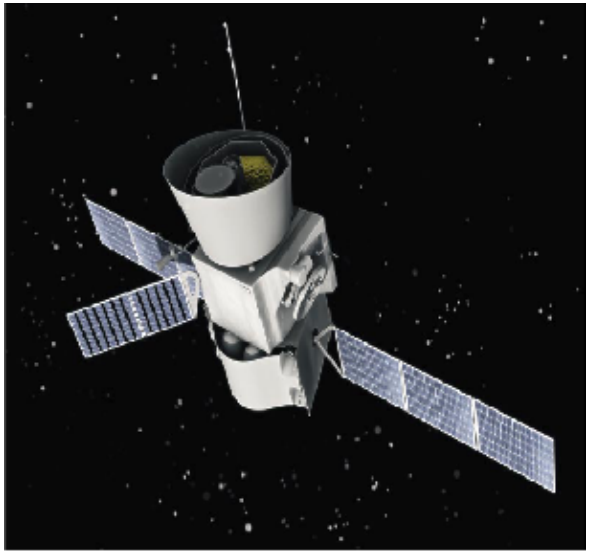
***Attitude control spin stabilized**

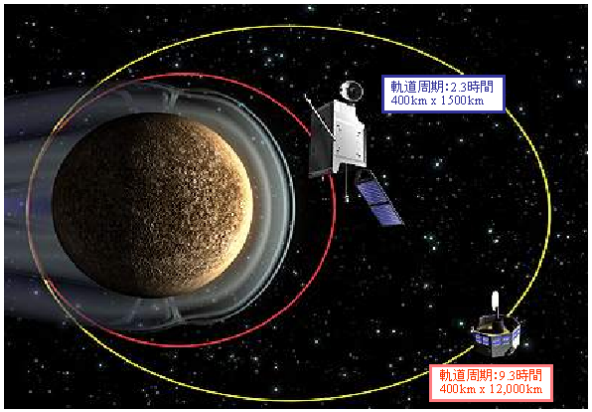
Mission Status: in preparation

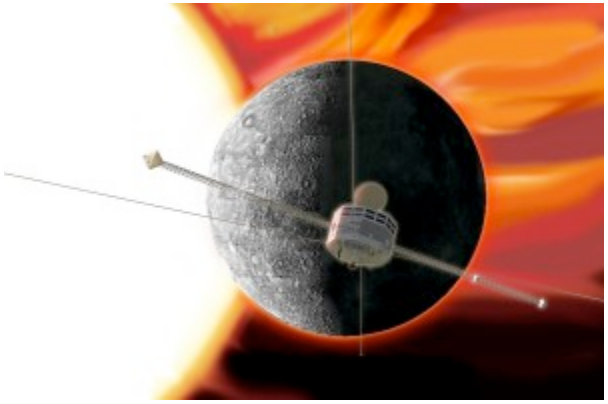
Science Programs and Current Activities:

Collaboration with the NASA's MESSENGER team in progress.

For more information please contact: Masaki Fujimoto







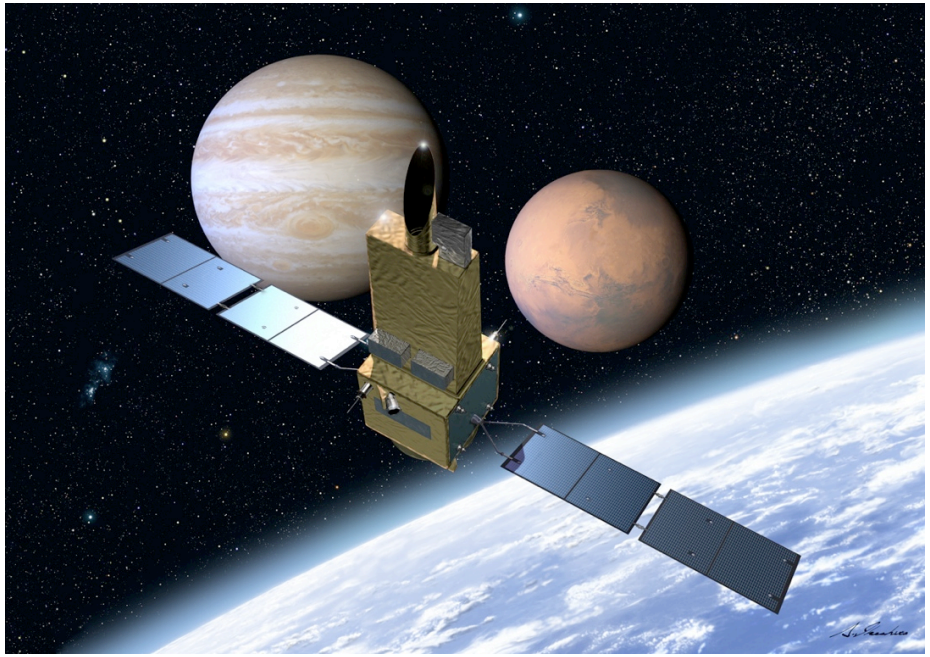
BepiColombo

ESA+JAXA two-spacecraft mission to Mercury
JAXA's MMO and ESA's MPO
Launch2014 Arrival2020

- BepiColombo in general
- Nice collaboration with the MESSENGER team: Inviting MSNGR members to BC SWT, invited to MSNGR SWT, co-hosting a session on Mercury at COSPAR08

- JAXA's MMO
  Mercury Magnetospheric Orbiter
- Recent observations of lunar plasma environment by Kaguya re-elevating the scientific interest on MMO science objectives
- The MMO team gaining benefit from the THEMIS team at UC Berkeley
- Science operation discussion getting heated by looking at MSNGR's flyby results
- More ground station needed for data reception
- Collaboration with SolarOrbiter/SolarPorbe+

EXCEED



Science Objectives: **Imaging from a low-earth orbit of planetary plasma dynamics with the EUV wavelengths.**

Instrumentation: **EUV telescope**

For more information please contact: Masaki Fujimoto

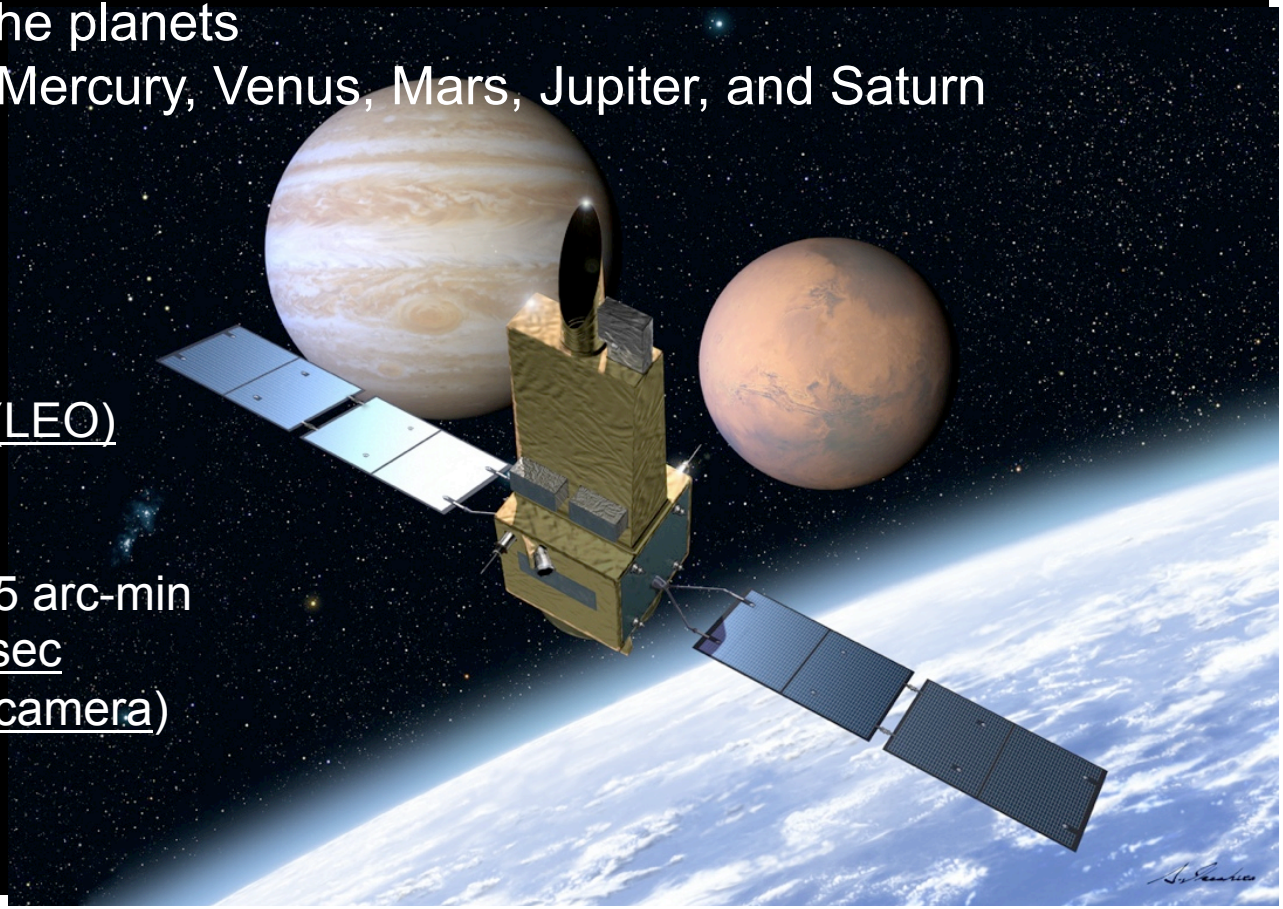
Overview of the EXCEED mission

(EXtreme ultraviolet spectrosCope for ExosphEric Dynamics)

- An earth-orbiting Extreme Ultraviolet (EUV) spectroscopic mission
- The first mission of the ISAS/JAXA Small scientific satellite series (Sprint-A)
- EXCEED measures EUV emissions from tenuous gases and plasmas around the planets
- Observation targets : Mercury, Venus, Mars, Jupiter, and Saturn

Major specifications

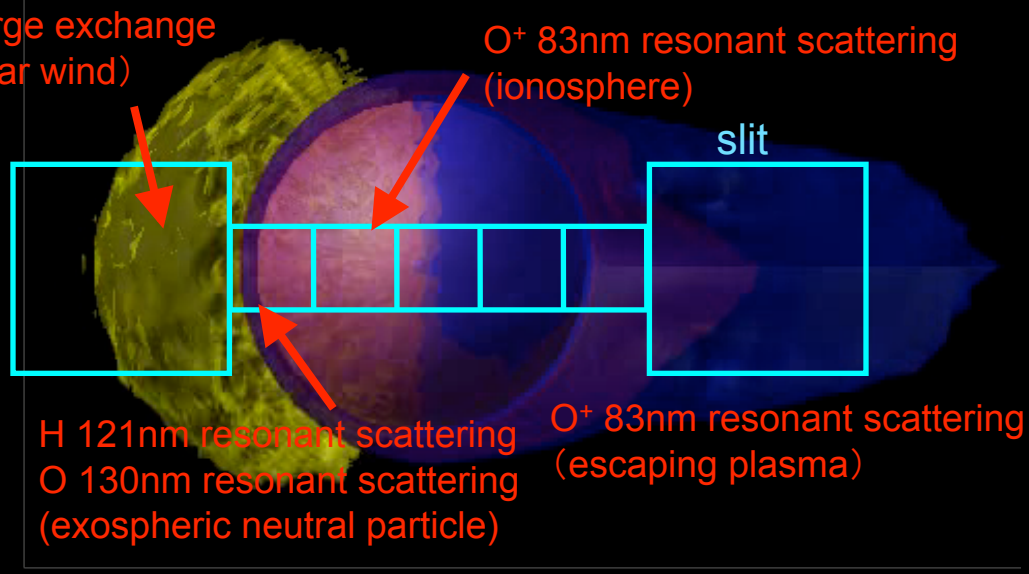
- Launching : 2012
- Weight：330kg
- Size：1m×1m×4m
- Orbit：950km×1150km (LEO)
- Inclination: 31 deg
- Mission life ：>1 year
- Pointing accuracy : ±1.5 arc-min (improved to be ±5arc-sec by using a FOV guide camera)



Two main targets of the EXCEED mission

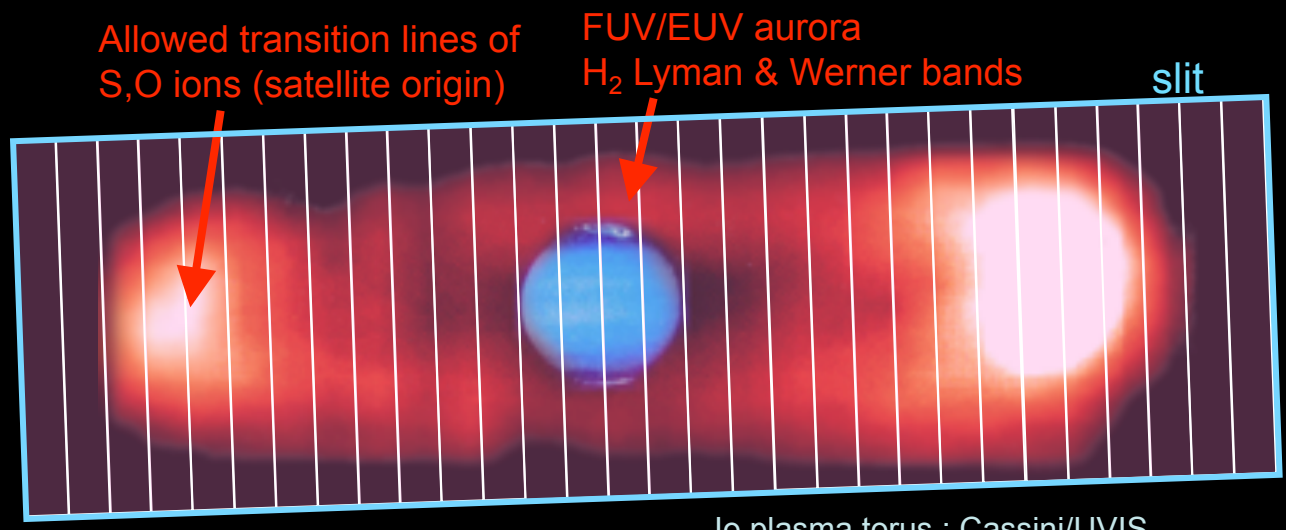
(1) Simultaneous observation of exosphere, ionosphere, and escaping plasma down the tail

Venus, Mars, and Mercury



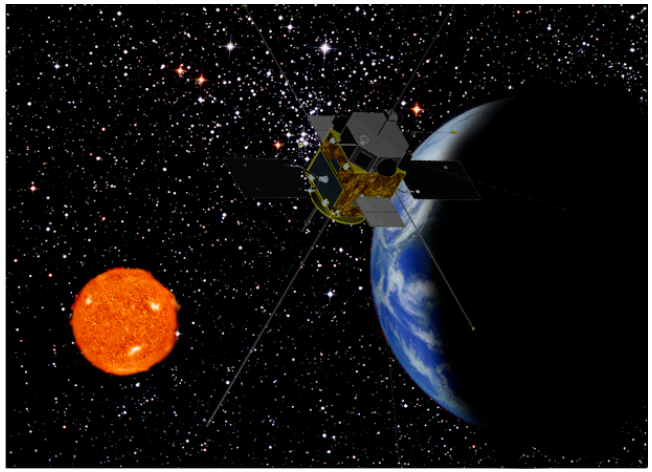
(2) Aurora and plasma torus

Jupiter and Saturn



Io plasma torus : Cassini/UVIS
Jupiter's UV aurora : HST/WFPC2

ERG



Science Objectives: Exploration of the inner-magnetosphere

- Coupling among particles of different species and of different energy ranges
- Origin of relativistic electrons
- Loss process of radiation belt electrons

Mission Implementation Description:

*Estimated launch date 2015

*Prime mission duration ~1 yr

*Number of spacecraft 1

*Apogee ~5 Re geocentric distance

Perigee 350km alt

*Attitude spin stabilized

*Instruments in-situ particle and E/B field

*Size JAXA's small science satellite program

Measurement Strategy: The suite of particle detectors making full coverage over the energy range of interest

Enabling and Enhancing Technology Development:

- A new particle detector focused on the medium energy range
- Wave-particle correlator

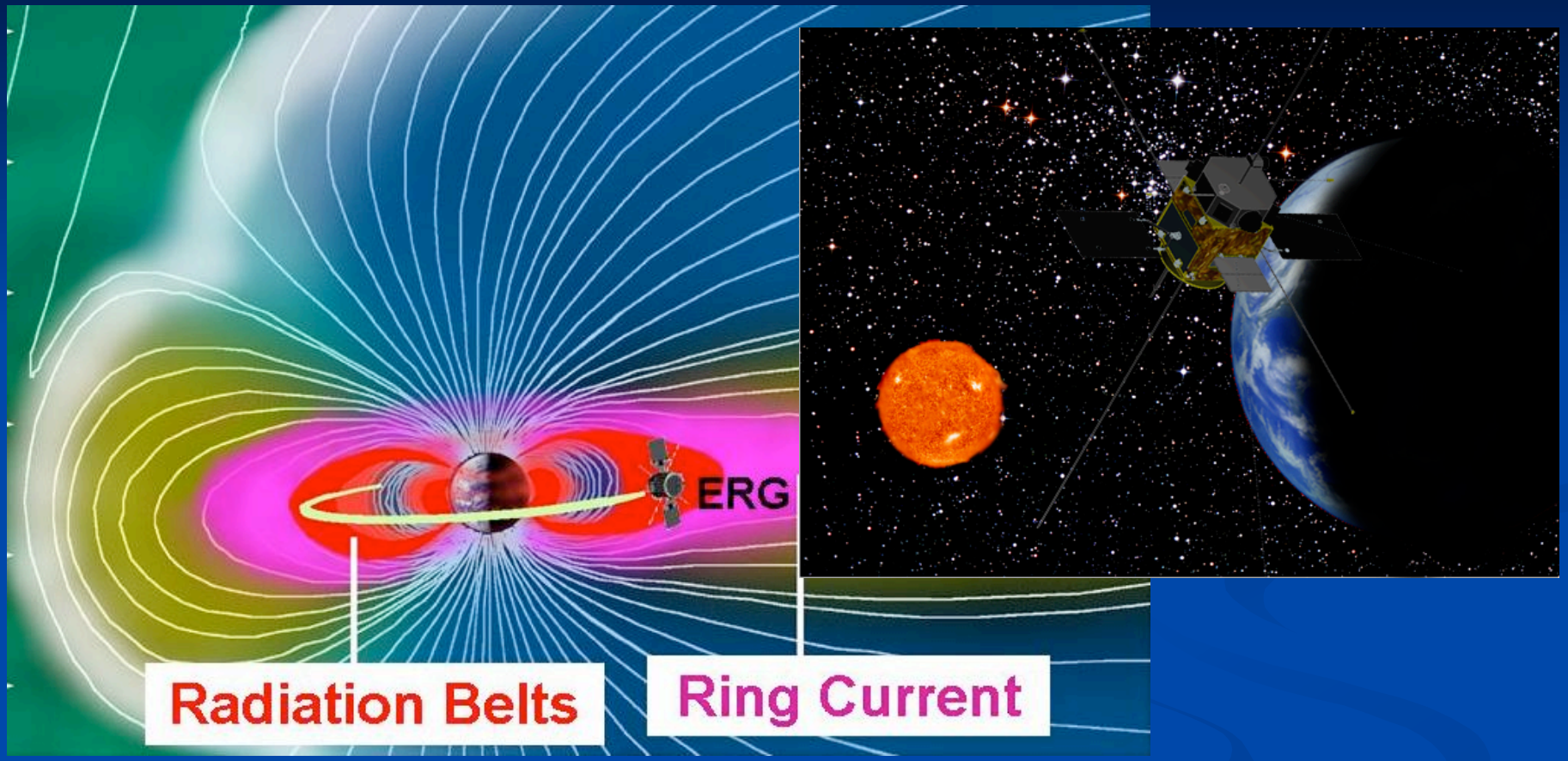
Participating Agencies and International Involvement:

- Taiwan as an instrument provider,
- Joint observations with NASA's RBSP, CSA's Orbital, and IKI's RESONANCE.

For more information please contact: Masaki Fujimoto

The *ERG* project:

Proposed for the 2nd slot of the ISAS small science satellite program



- orbit: Geosynchronous Transfer Orbit with low inclination
- apogee: ~5 Re perigee: TBD
- launch date: FY 2014 (next solar maximum)

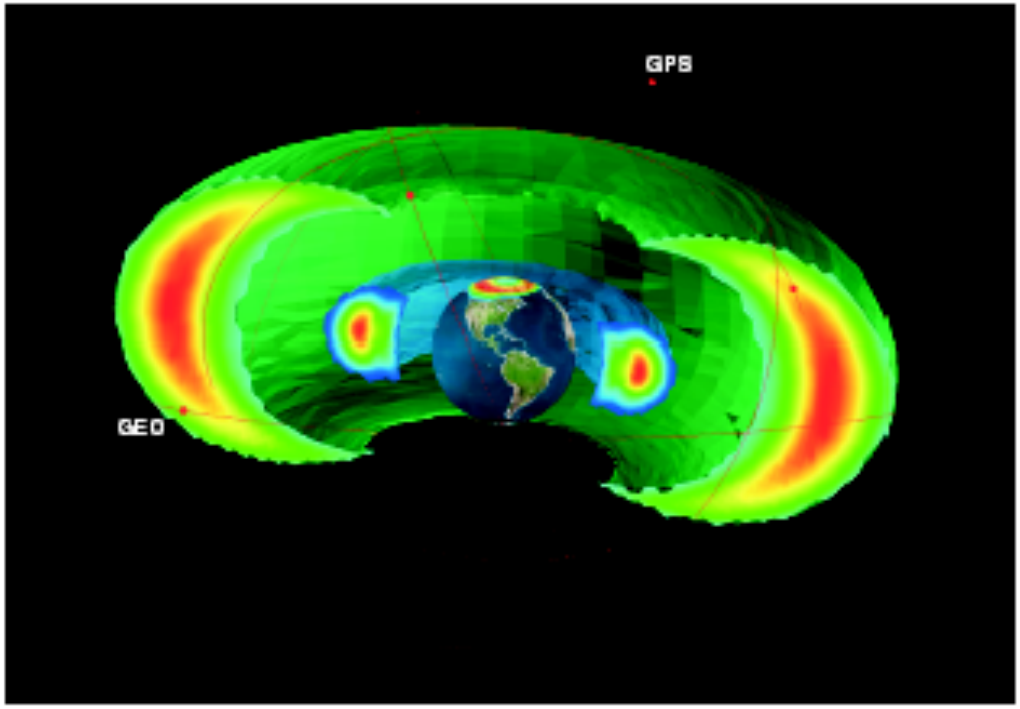
ERG

project goal

understanding cross-energy couplings for generation and loss process of relativistic particles

&

variation of geospace during space storms



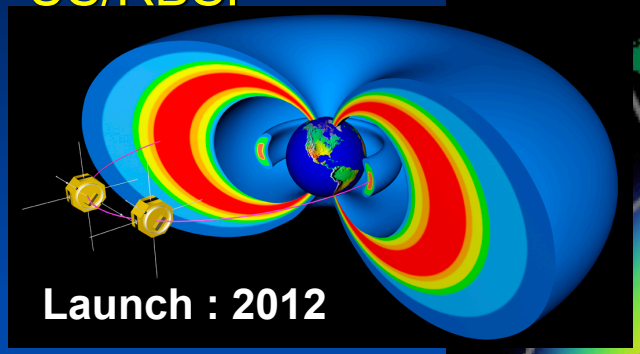
Significance of this project.

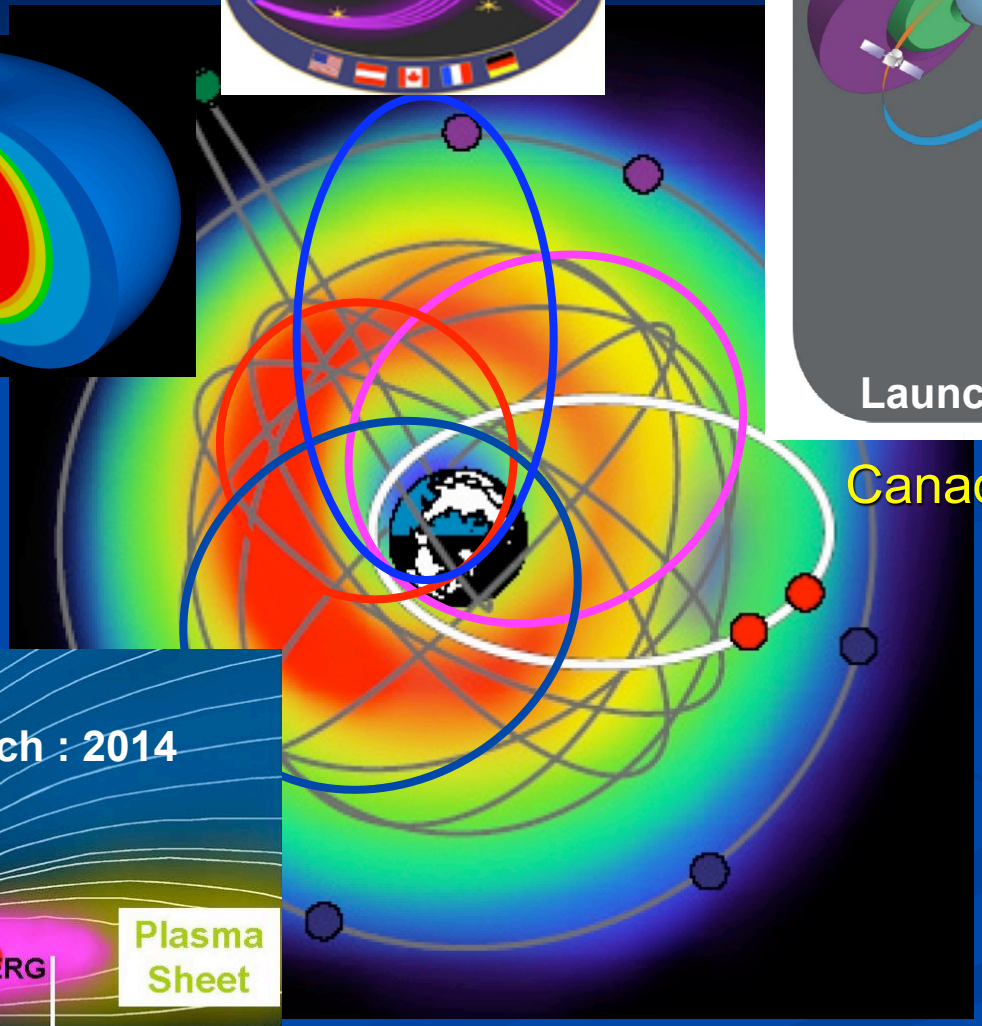
- **direct observations on generation of relativistic electrons at the magnetic equator in the inner magnetosphere**
  → contribution to understanding of the particle acceleration.
- **instrumental development to measure plasma and fields under the incidence of radiation belt particles with small satellite**
  → contribution to the future Jovian mission.

International Collaboration

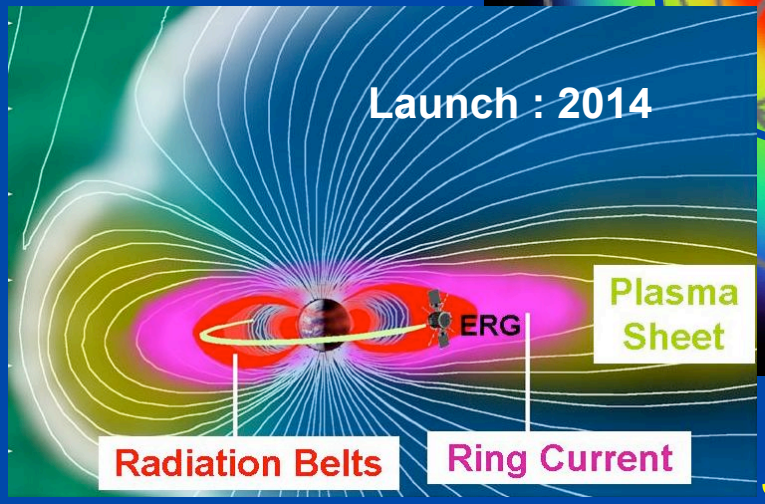
THEMIS

US/RBSP





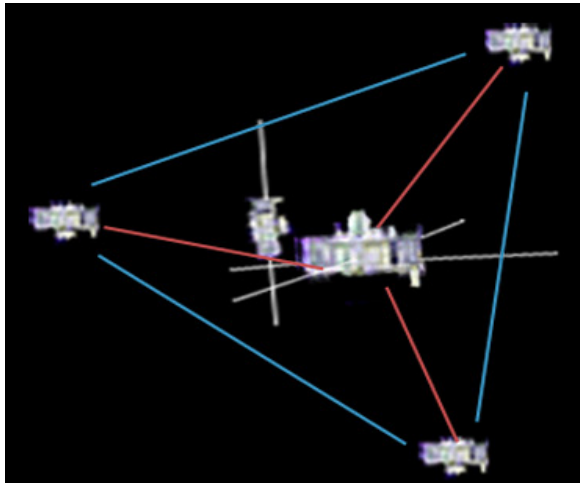
Canada/ORBITALS



Russia/RESONANCE

Japan/*ERG*

SCOPE



Science Objectives: Fundamental understanding of shocks, reconnection and turbulence

- Coupling among physical processes of different scales
- Energy dissipation, particle acceleration and plasma transport
- The Plasma Universe theme

Mission Implementation Description:

*Estimated launch date 2019

*Prime mission duration ~3 yr

*Number of spacecraft Mx1+NDx1+FDx3
(Mother Near-Daughter pair + three Far-Daughters)

*Apogee 25 Re geocentric distance

Perigee 10 Re geocentric distance

*Attitude spin stabilized (ND: sun-pointing spin axis)

*Instruments in-situ particle and E/B field

*Size JAXA's mid-class science satellite program

Measurement Strategy: Simultaneous multi-scale observations via M-ND pair plus FDs

Enabling and Enhancing Technology Development:

- Ultra-fast electron detector
- Inter-spacecraft communication
- Huge onboard data storage

Participating Agencies and International Involvement:

- CSA to provide the three FDs
- Strong and world-wide interest.

http://sprg.isas.jaxa.jp/scope_en/index_en.html

For more information please contact: Masaki Fujimoto

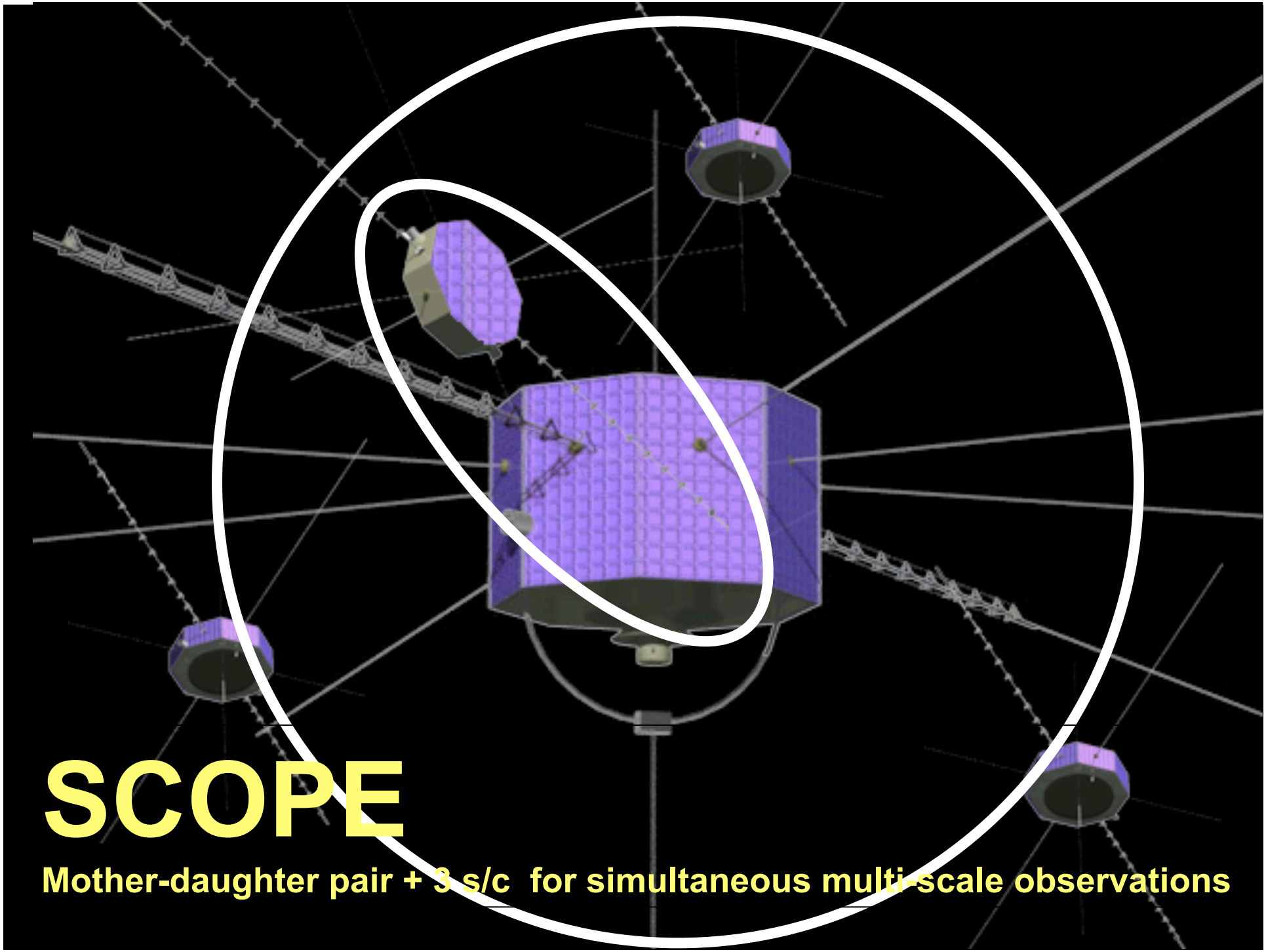
Next generation:
Simultaneous multi-scale measurements

- Zooming-in to the electron-scale at the key region embedded inside the larger-scale region of interest

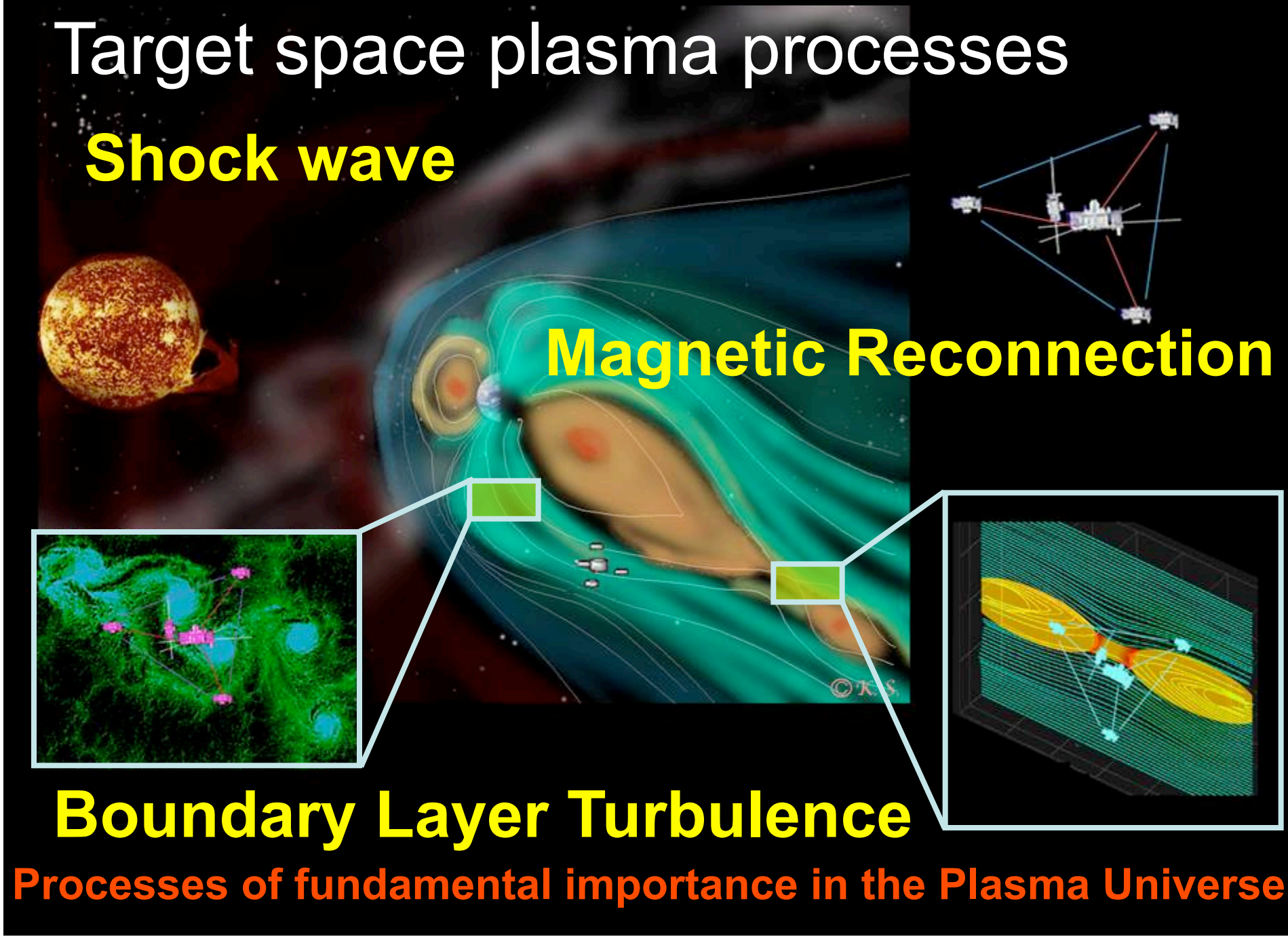
and

monitoring surrounding ion/MHD-scale dynamics at the same time

Large FOV and high-resolution pixels at the same time, in the case of imaging.


SCOPE
Mother-daughter pair + 3 s/c for simultaneous multi-scale observations

Target space plasma processes



Processes of fundamental importance in the Plasma Universe

SCOPE in the world-wide collaboration scheme

To be launched by JAXA's H2-A
SCOPE mother and near/far-daughter (JAXA)
Far-daughters (CSA)

Dual launch partner (EU?)

China's component

Russia's component

The world-wide collaboration that covers fully the scales of interest is what the space plasma physics community truly wishes.

Solar-C Plan-A/B

Science Objectives for Plan-A: Magnetic fields at high latitudes and the solar dynamo problem

Science Objectives for Plan-B: High resolution and cadence imaging of chromospheric dynamics

Mission Implementation Description:

*Estimated launch date late 2010's

*Orbit

Off-ecliptic via Jupiter swing-by for Plan-A

Sun-synchronous for Plan-B

*Attitude three-axis stabilized

*Instruments imaging at various wavelength

*Size JAXA's mid-class science satellite program

Enabling and Enhancing Technology Development:

- Plan-A: Interplanetary cruise
- Plan-B: Expanding the Hinode technology

Participating Agencies and International Involvement:

- Strong interest in the European and the US communities

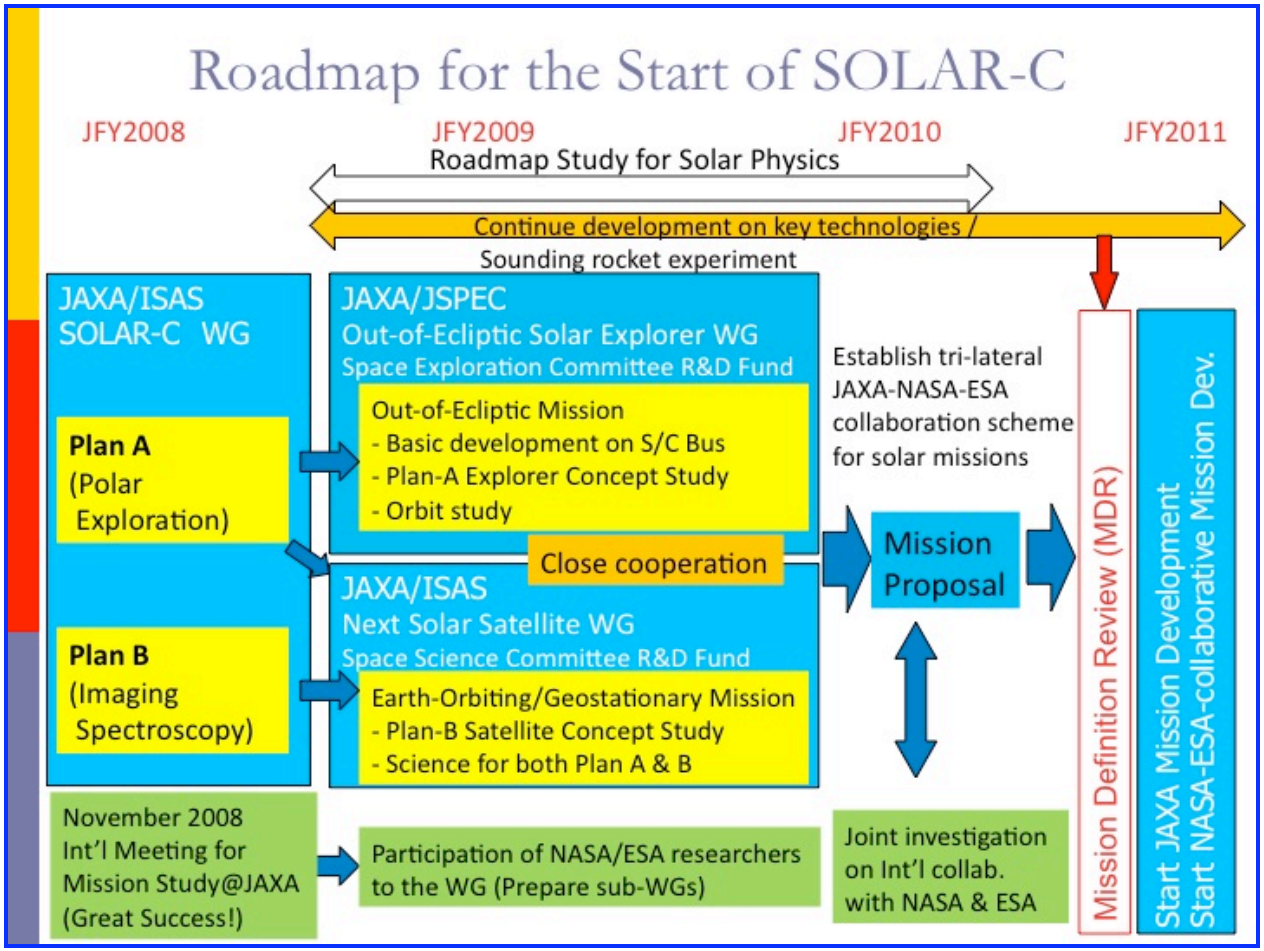
For more information please contact: Taro Sakao

Two *SOLAR-C* Mission Concepts Under Study

- *Plan A*
  Out-of-ecliptic magnetic/X-ray and helioseismic observations of the polar and the equatorial regions to investigate properties of the polar region, meridional flow and magnetic structure inside the Sun down to the bottom of the convection zone.
- *Plan B*
  High spatial resolution, *high throughput, high cadence* spectroscopic (polarimetric) and X-ray observations *seamlessly from photosphere to corona* to investigate magnetism of the Sun and its role in heating and dynamism of solar atmosphere.
- *Launch Date*: Japanese fiscal year *2016 (provisional)*
  - Expects joint observations with highly complementary missions
  - *NASA SDO* (whole sun field of view)
  - *ESA&NASA Solar Orbiter* (In-situ and stereo obs with SOLAR-C)

Timeline towards the Solar-C Mission

- International sub-WG activities currently ongoing, to identify top-level solar science/ instrumentation for the next decade.
- Development & assessment of Solar-C key technologies in progress with ISAS & JSPEC R&D funds.
- Second International SOLAR-C Science Definition Meeting held in Mar. 2010 at ISAS to review study results from the sub-WGs and discuss Plan-A/B sciences.
- Acting to establish framework for international collaboration with NASA and ESA in JFY 2010-2011.
- Followed by Mission Proposal submission to JAXA around JFY 2010-2011.
- Provisional launch in JFY 2016.



Japanese solar community wish to have the present international collaboration among solar physicists will evolve into JAXA-NASA-ESA collaboration.

GT(L92): ***Magnetospheric***

REIMEI(L05): ***Aurora imagery & particles***

QZS: ***B-field and energetic particles at L=6.6~10***

ERG*: Inner magnetosphere* [data reception]

SCOPE/Cross-Scale
Multi-scale formation
[collaboration in mission]

Kaguya(L07, T09): ***lunar plasma***

EXCEED: ***Planetary plasma imaging***

MMO(Launch)----------MMO(Arrival)
Mercury
[data reception]

Hinode(L06): ***Corona heating***

Solar-C
Plan A or B
[collaboration in mission]