Japanese Heliophysics Satellite Project
Data Management Activity

Hinode/Solar-C_EUVST
Arase/BepiColombo Mio

ISAS/JAXA
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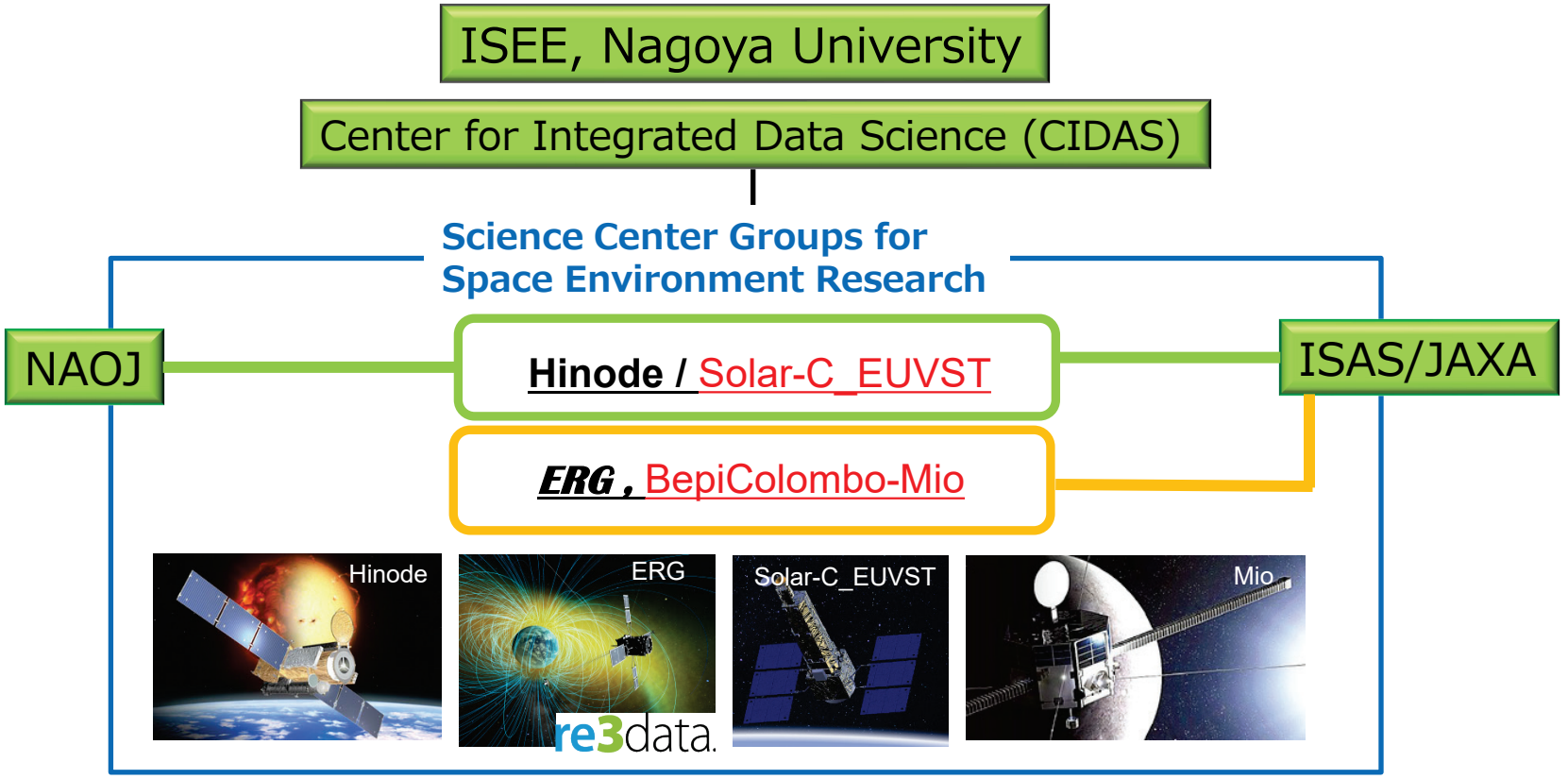
Shinsuke Imada (Solar-C_EUVST Project Scientist)
Tomo Hori (ERG Science Center/Deputy Mgr.)

Collaborations between ISAS/JAXA and ISEE, Nagoya University

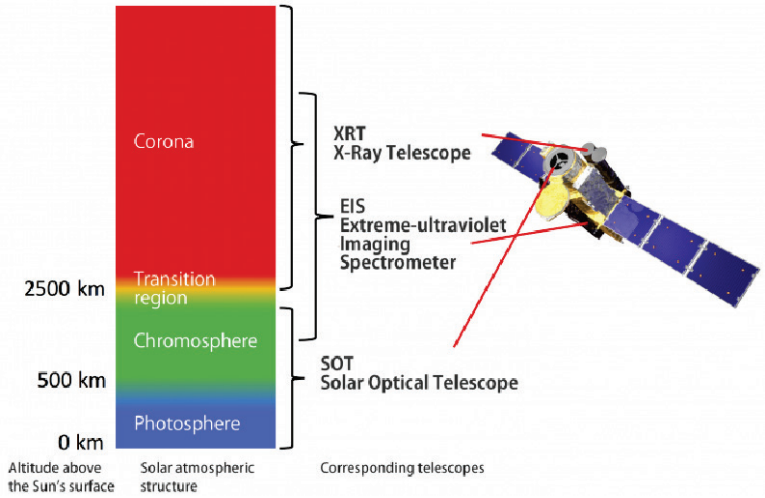
- Hinode Science Center / Solar-C_EUVST (2026L)
- ERG Science Center / BepiColombo Mio



Current status and updates since last year

- ERG (Arase) Science Center (ERG-SC) runs science data production pipelines and most of Level-2/3 (calibrated) data products are routinely generated and archived in CDF.
- Level-2/3 data files are opened to the public with 1-year latency.
- The data users are required to specify the version numbers of data files in their papers (for traceability on an individual file basis).
- SPEDAS plug-in tools for the ERG data have been maintained and released by ERG-SC, and also bundled to the SPEDAS releases.
- The data repository of ERG-SC has been registered on **re3data.org**.
- ISEE has obtained the membership of the Japan Link Center (JaLC), which is a DataCite member, meaning that we are eligible to mint a DOI for our own data.
  - The **ERG science datasets are DOI'd** (very soon).
- As the future direction, a (united) science center for Heliophysics system science is planned, including Hinode, Arase, BepiColombo/Mio, Solar-C_EUVST.

Integrated science data archive developed by Hinode-SC



Hinode satellite data

JAXA/ISAS

packet data → raw data processing

ground data processing

Produce Fits da… (Lv.0)

Hinode simulation/modeling data Original Contents

Nonlinear Force Free Field Extrapolation
Magnetic field inversion
Hinode flare catalogue
Hinode Doctor/Master Thesis List

Hinode-SC

Give analysis environment → SSWIDL
provide ***_prep (calibration program) for producing Lv. 1 data

Research community

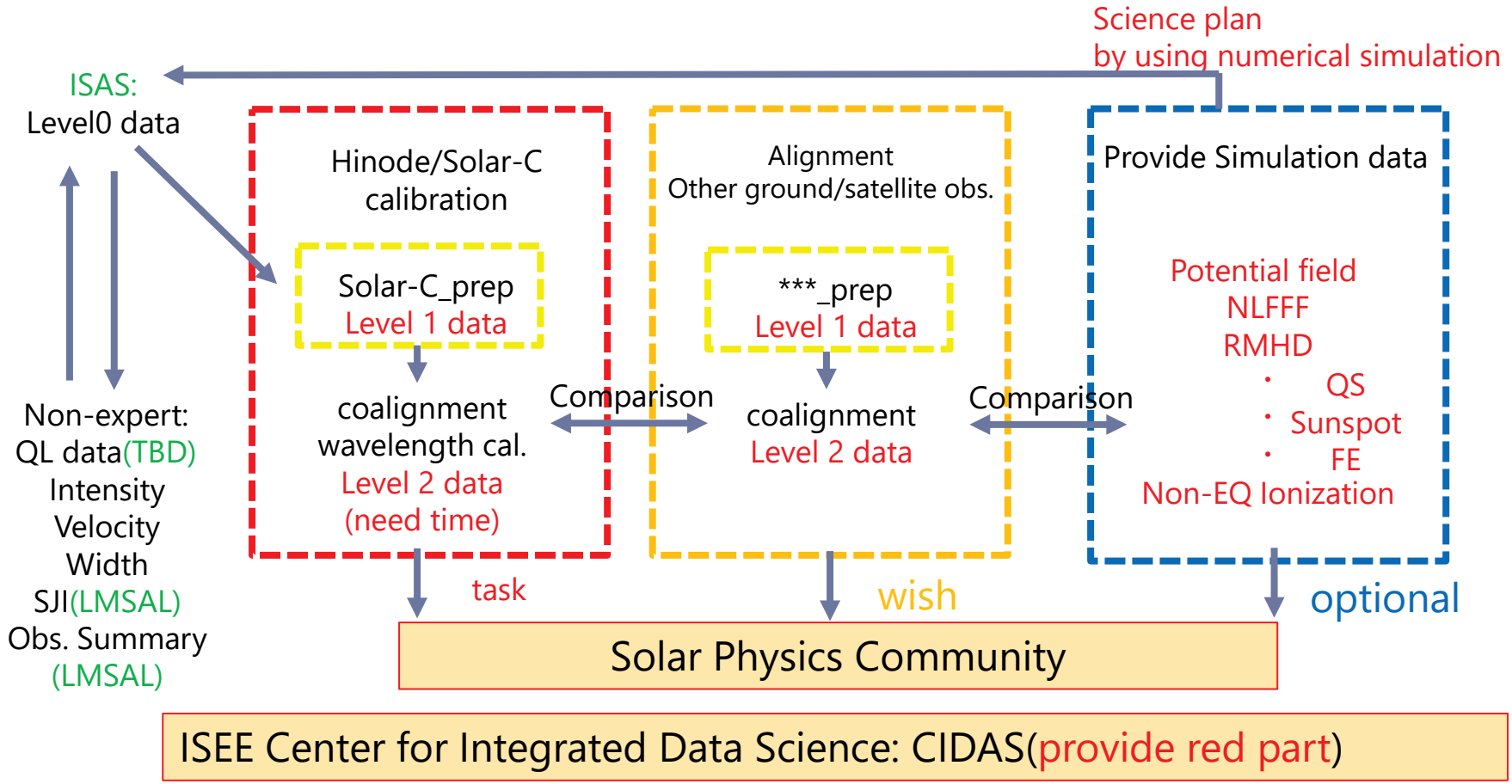
CIDAS system @ISEE

Hinode data

Many data sets (exposure time, scanning, data summing…)
Science objects are also different (→ meta data)
Data format, availability, etc. differs for different data sets.
SOT: Spectropolarimeter (Spatial 2D, Wavelength 4D, Time)
: Imager (Spatial 2D, Time)
EIS: Spectrometer (Spatial 2D, Wavelength 1D, Time)
XRT: Imager (Spatial 2D, Time)
Typically ~30 GB for one day, originally (~ 2008/03).
After X-band antenna trouble we use S-band antenna (~1/16)
We try to recover by using many downlink station.

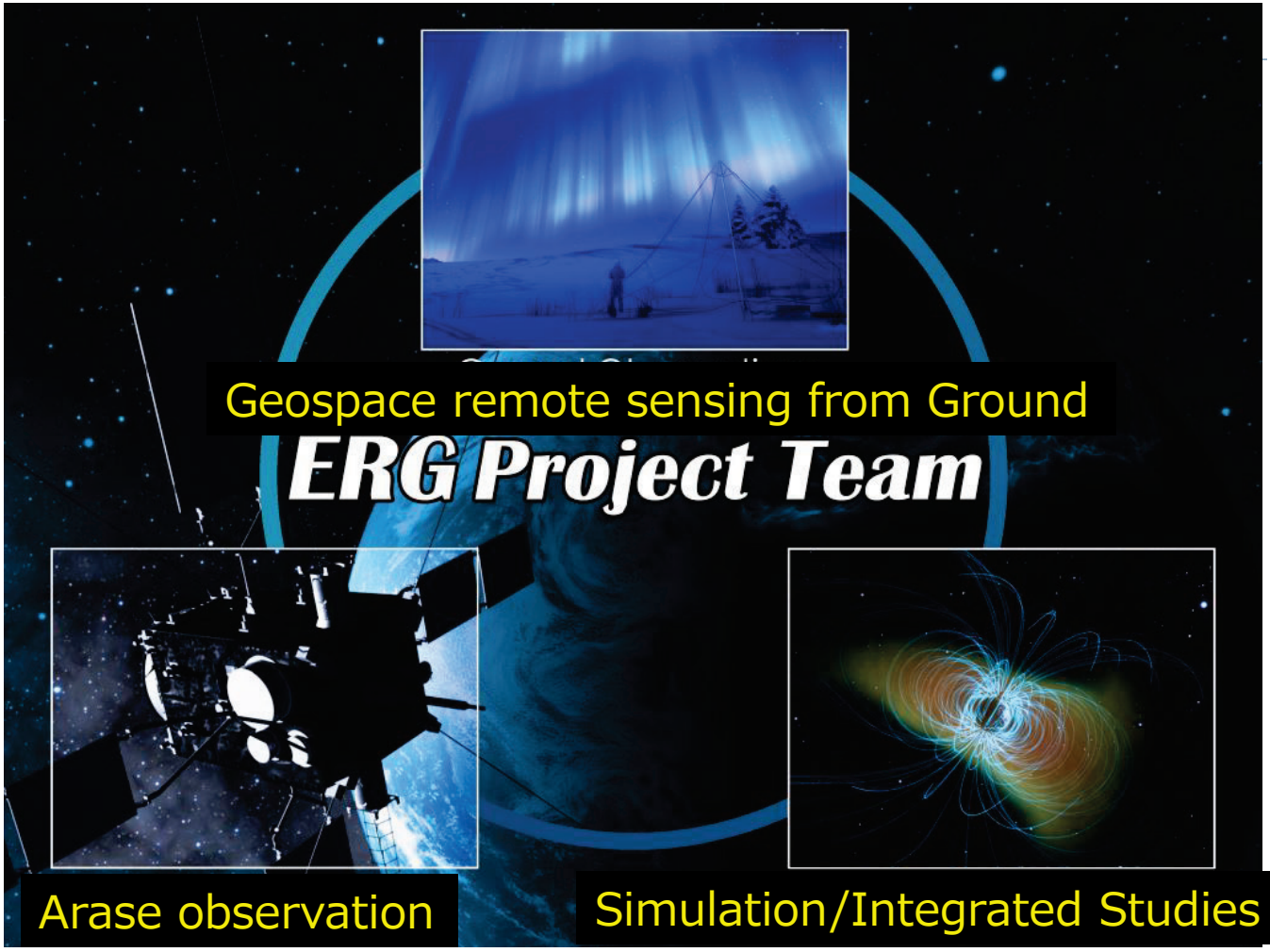
Originally HSC was at National Astronomical Observatory Japan. After 2011.3.11 Earth Quake, we set up HSC@Nagoya (Non-Tokyo Area). ISAS is Tokyo area.

From Hinode Science Center to Solar-C Science Center



ISEE Center for Integrated Data Science: CIDAS(provide red part)

ERG /Arase *Project*



More than 100 researchers in Japan and Taiwan have joined this project.

Please see Miyoshi+[2018, EPS] for overview of the project.

[Miyoshi+, EPS, 10.1186/s40623-018-0867-8, 2018]

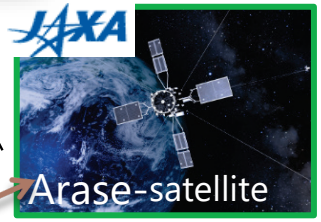
ERG-Science Center (ERG-SC)

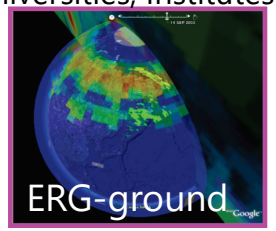
Google ERG Science Center

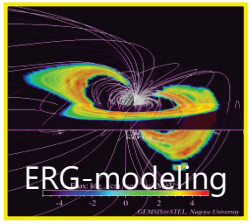
ERG project data

Universities, Institutes

Universities, Institutes

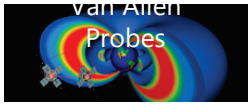






Planning of satellite operation and campaign observations

collaboration



ISEE **ERG – Science Center** JAXA

operated by ISEE/Nagoya Univ. and ISAS/JAXA

collaboration

THEMIS

IUGONET

science data archive | integ. data analysis tools | observation planning

Data analysis workshop/training

Researcher Student Researcher

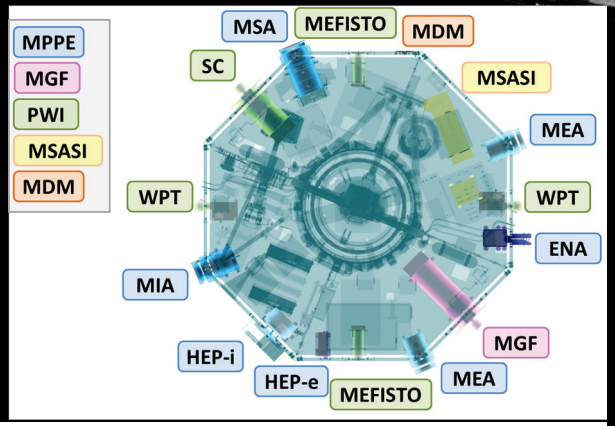
Student Researcher Student

ERG-SC serves as the center of data archive, science coordination, and scientific research

BepiColmbo/Mio (Mercury Magnetospheric Orbiter)

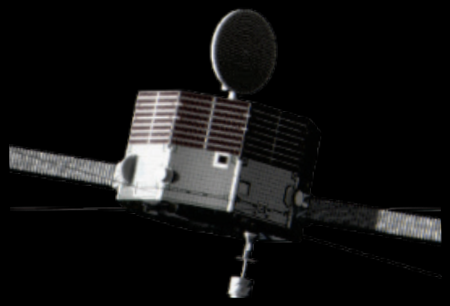
- **BepiColombo: Joint ESA/JAXA mission to Mercury**
- **Launch: 20 October 2018**
- **Arrival: December 2025**

-Spin-stabilized (4 sec)
-Focusing on Mercury's environment (magnetosphere, exosphere, and dust)



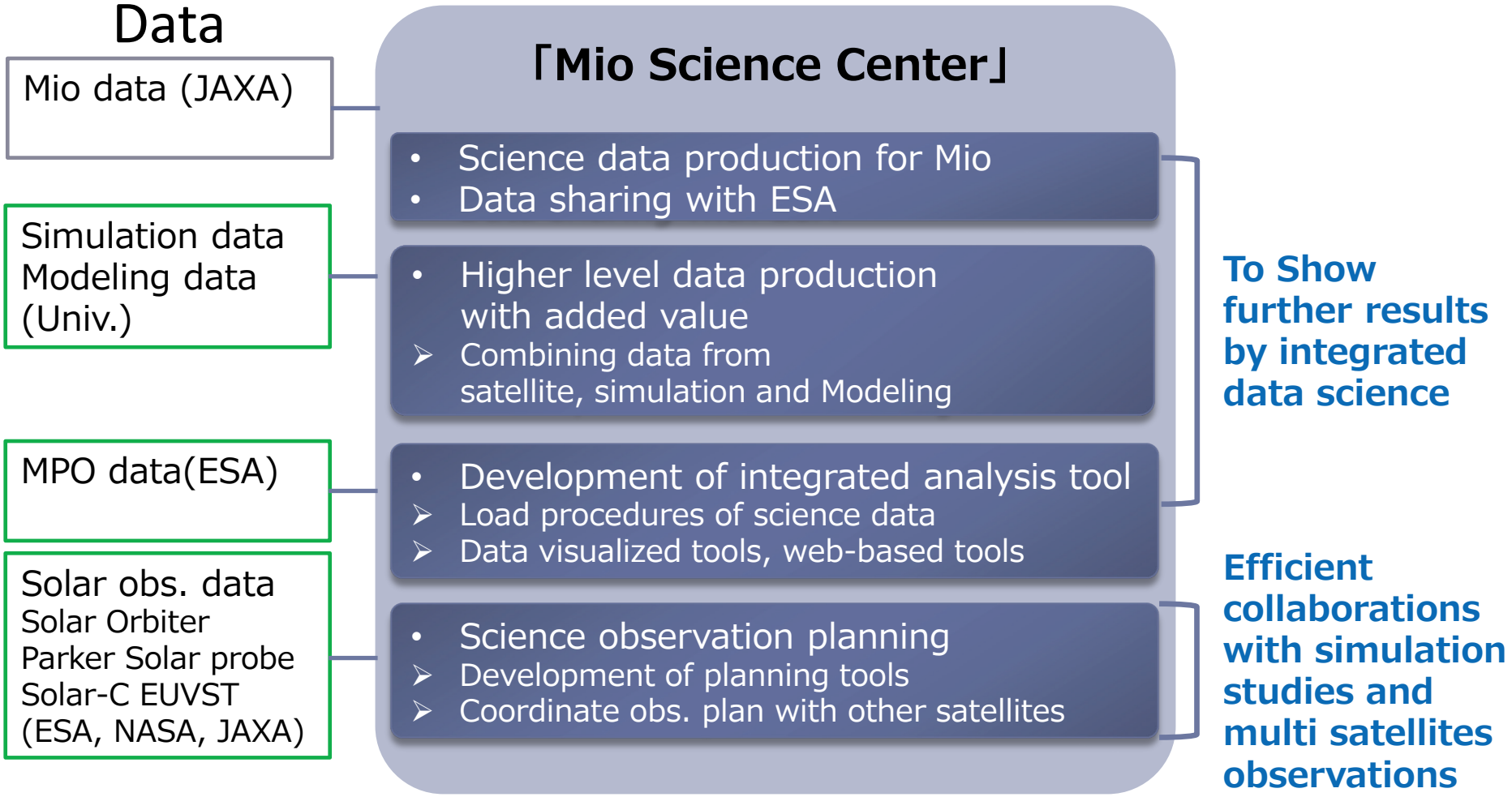
Mercury Planetary Orbiter (MPO)

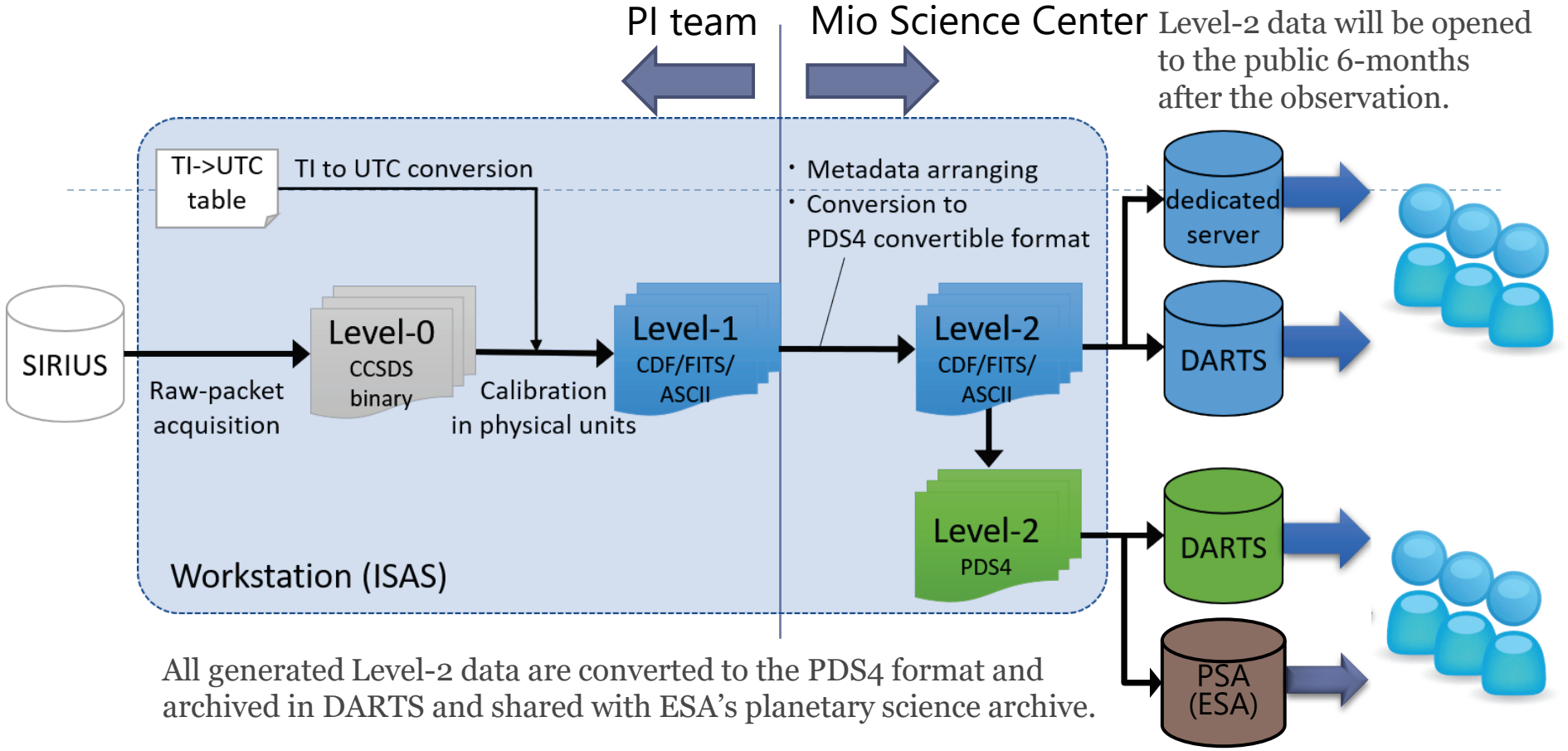
Mercury Magnetospheric Orbiter (MMO): Mio



	BepiColombo/MMO				MESSENGER	
Plasma (SW, MS)	MPPE	MEA	Low-energy electrons	3eV-26keV	-	
		MIA	Low-energy ions	15eV-29keV	FIPS	50eV-13keV 1-40 amu/e
		MSA	Ion mass spectroscopy	1eV-38keV 1-60 amu/e m/Δm = 40 (<13keV) m/Δm = 10 (>13keV)		
		HEP-ion	High-energy ions	30keV-1.5MeV	EPS	25keV-1MeV
		HEP-ele	Hihg-energy electrons	30keV-700keV	EPS	25keV-1MeV
		ENA	Plasma imaging	10eV-3.3keV	-	
	MGF		Magnetic field	DC - 64Hz L: <0.25Hz, M: 8Hz	MAG	DC - 20Hz
	PWI		Electric field, plasma wave, radio wave	DC - 10MHz (E) few - 640kHz (B)	-	
Exosphere	MSASI		Na-exosphere image	Spatial resol.: 3-30km R = 65000	MASCS	Spatial reol.: 25-800km R = 1000
Dust	MDM		Dust environment	10s pg*km/s	-	

Mio-Science Center



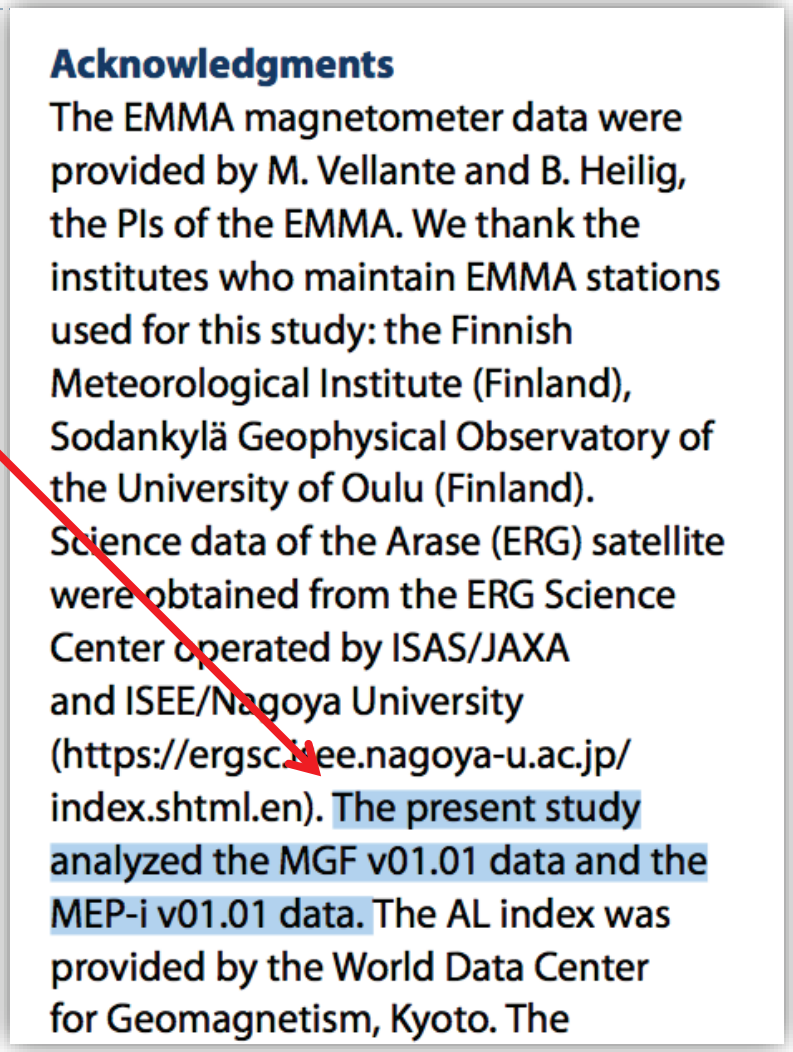


All generated Level-2 data are converted to the PDS4 format and archived in DARTS and shared with ESA's planetary science archive.

Level	Contents	Scope	File format
Level-0	Raw-telemetry	Internal	CCSDS-Binary
Level-1	Calibrated data in physical units	Internal	CDF, FITS, ASCII
Level-2	Calibrated data in physical units with appropriate metadata	Public	CDF, FITS, ASCII PDS4
Level-3	Processed data by combining multiple data from different instruments	Public	CDF, FITS, ASCII PDS4

Traceability from an article to science data

- ERG project requires all data users to write the version numbers of used data in Acknowledgments section, allowing data to be truly "**traceable and thereby reusable**".
  - Although the data version continues to be incremented as new calibrations / correction methods are applied, anyone can **reproduce the same analysis as the authors did** with exactly the same data files.
  - Information on source data and data processing programs, which are stored in ERG-SC CDF files, guarantees **traceability** up to the level of raw data and its processing code.



Acknowledgments

The EMMA magnetometer data were provided by M. Vellante and B. Heilig, the PIs of the EMMA. We thank the institutes who maintain EMMA stations used for this study: the Finnish Meteorological Institute (Finland), Sodankylä Geophysical Observatory of the University of Oulu (Finland). Science data of the Arase (ERG) satellite were obtained from the ERG Science Center operated by ISAS/JAXA and ISEE/Nagoya University (https://ergsc.isee.nagoya-u.ac.jp/index.shtml.en). The present study analyzed the MGF v01.01 data and the MEP-i v01.01 data. The AL index was provided by the World Data Center for Geomagnetism, Kyoto. The

[Yamamoto+, GRL, 2018]

次期太陽観測衛星

Solar-C_EUVST

JAXA Epsilon M-class mission

A fundamental step towards answering how the plasma universe is created and evolves, and how the Sun influences the Earth and other planets in our solar system

Science objectives;

I. Understand how fundamental processes lead to the formation of the dynamic solar atmosphere and the solar wind

II. Understand how the solar atmosphere becomes unstable, releasing the energy that drives solar flares and eruptions

Strategy;

Quantify the processes of mass loading and energy transport / conversion at work

Key features (not ever done);

A) ***Wide T-coverage*** (10^4-10^7 K)

Observe the whole regimes of the solar atmosphere as a single, coupled system

B) ***High resolution*** (spatial ~ 0.4", temporal ~ 1 sec)

Capture the dynamic evolutions of elementary structures

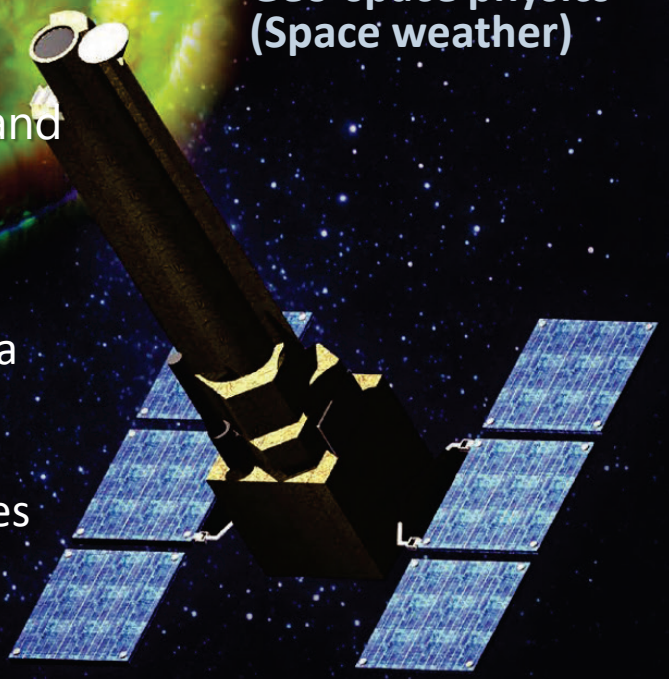
C) ***Spectroscopy***

Determine the physical states of the targets

(V, ρ, T, composition, ionization)

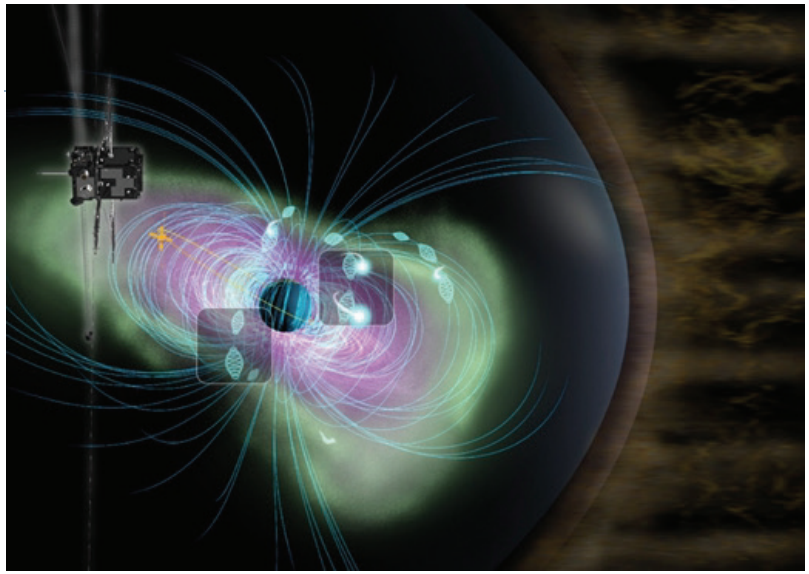
Close connection to

- Astrophysics
- Plasma physics
- Geo-space physics (Space weather)



~500kg in Sun-synchronous orbit

Geospace Exploration Satellite: ERG (Arase)



- **Launch:** Dec. 20, 2016
- **Extended Mission:** – March 2022
- **Apogee :** 32246 km
- **Perigee :** 400 km
- **Inclination Angle :** 31.427deg
- **Spin Periods :** 8 sec
- **Orbital Periods:** 563.85 min

■ Electrons:

LEPe (19 eV – 20 keV) : 3D
MEPe (8 keV – 80 keV) : 3D
HEP (70 keV – 2 MeV) : 3D
XEP (400 keV – 20 MeV) : 2D

■ Electric Fields:

PWE: EFD (DC – 256 Hz): waveform/spectrum
potential
PWE: OFA/WFC (10 Hz – 32 kHz):
spectrum/waveform
PWE: HFA (20 kHz – 10 MHz): spectrum

■ Ions w/ mass discriminations

LEPi (10 eV/q – 25 keV/q): 3D & TOF
MEPi (8 keVq - 180 keV/q): 3D & TOF

■ Magnetic Fields:

MGF: (DC-128 Hz): waveform
PWE: OFA/WFC (10 Hz – 32 kHz):
spectrum/waveform