

# Japanese Geospace Exploration Project

## ERG

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**ERG Working Group**

# ERG project

## **ERG** --- *Energization and Radiation in Geospace*

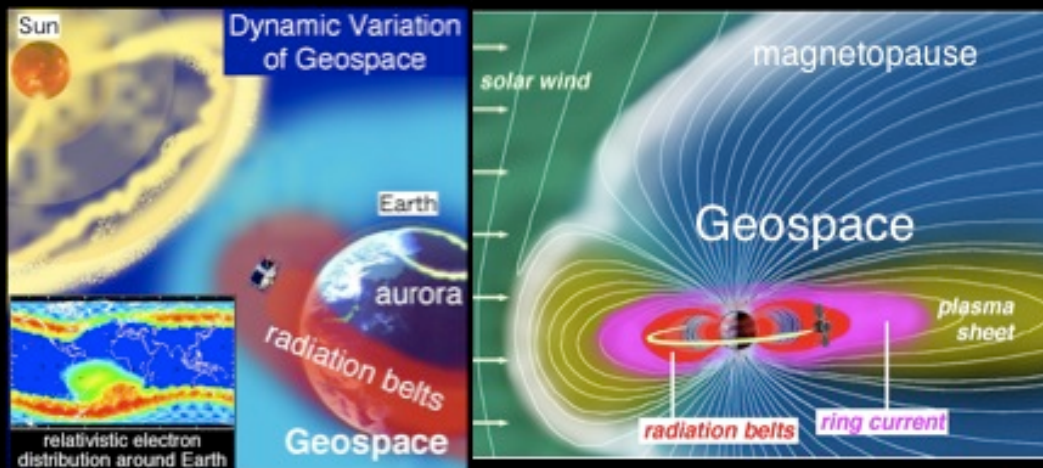
*Small satellite mission to Geospace*

***A mission to elucidate acceleration and loss mechanisms of relativistic particles around Earth during space storms.***

During space storms, the circum-Earth space (Geospace) acts as an effective accelerator of electrons and ions, and dynamic variation of Geospace causes various "space weather" phenomena including auroras.

**ERG** mission will

- achieve comprehensive plasma observations with magnetic & electric field, wave, and particle detectors covering a wide energy coverage ( $10^0$ - $10^7$  eV) to capture acceleration, transport, and loss of charged particles in Geospace, and
- establish inexpensive plasma observatory under strong radiation environment.



- Launch: FY 2012 (next solar max.)
- apogee:  $\sim 6R_E$ , perigee:  $>250$  km
- inclination :  $\leq 10^\circ$  (TBD)
- spin-axis stabilized (sun oriented)
- wet mass:  $\sim 240$  kg
- Science Instruments:
  - DC/AC magnetic & electric fields
  - 4 ion detectors with mass discrimination ( $1$ - $10^6$  eV)
  - 3 electron detectors ( $10$ - $10^7$  eV)

URL : <http://www2.nict.go.jp/y/y223/IM/index.html>

## **ERG Working Group** (more than 80 researchers)

**PI: T. Ono (Tohoku Univ.), Science Coordination Contact: Y. Miyoshi (STEL, Nagoya Univ.)**

### **ERG-satellite**

**Particle Instrument:** M. Hirahara (U. Tokyo), T. Yanagimachi (Rikkyo Univ.) T. Takashima, K. Asamura, Y. Saito, T. Abe, T. Goka, Y. Kazama, S. Kasahara (JAXA), W. Miyake (Tokai Univ.), K. Ogasawara (SwRI)

**Plasma Wave Instrument:** T. Ono, Y. Kasaba, M. Iizima, A. Kumamoto, Y. Kato (Tohoku Univ.), Y. Kasahara, S. Yagitani, T. Imachi, Y. Goto (Kanazawa Univ.), H. Kojima, Y. Omura, Y. Ueda (Kyoto Univ.), T. Okada (Toyama Pref. Univ.)

**Electric Field Instrument:** Y. Kasaba (Tohoku Univ.), H. Hayakawa (JAXA), K. Isisaka, S. Miyake (Toyama Pref. Univ.)

**Magnetic Field Instrument:** A. Matsuoka (JAXA), Y. Tonegawa, F. Tohyama (Tokai Univ.), K. Shiokawa (Nagoya Univ.), K. Yumoto, M. Shinohara (Kyushu Univ.), T. Nagatsuma (NICT)

**Satellite Bus:** H. Saito (JAXA)

### **ERG-ground networks**

K. Shiokawa, N. Nishitani, T. Kikuchi, Y. Otsuka, R. Fujii (Nagoya Univ.), K. Yumoto, H. Kawano, A. Yoshikawa (Kyushu Univ.), N. Sato, A. Yukimatsu, H. Yamagishi, A. Kadokura, M. Taguchi, Y. Ogawa (NIPR), K. Hosokawa (U. of Electro-Communications), K. Hashimoto (Kibi International Univ.)

### **ERG-theory, integrated data center**

K. Seki, Y. Miyoshi, A. Ieda, Y. Ebihara, S. Masuda, Y. Matsumoto, A. Shinbori, T. Hori (STEL, Nagoya Univ.), H. Shimazu, H. Shinagawa (NICT), M. Nakamura (Osaka Pref. Univ.), R. Kataoka (RIKEN), M. Nose, T. Iyemori, Y. Omura, S. Machida (Kyoto Univ.), T. Obara, M. Fujimoto, I. Shinohara, K. Maezawa, Y. Miyashita (JAXA), T. Tanaka (Kyushu Univ.), S. Watanabe, M. Yamada, K. Komatsu (Hokkaido Univ.), T. Higuchi (ISM), K. Murata (Ehime Univ.), M. Hoshino (U. of Tokyo), T. Nagai, K. Asai, T. Terasawa (TITEC), S. Arvelius (IRF)

# OUTLINE

## 1. Introduction

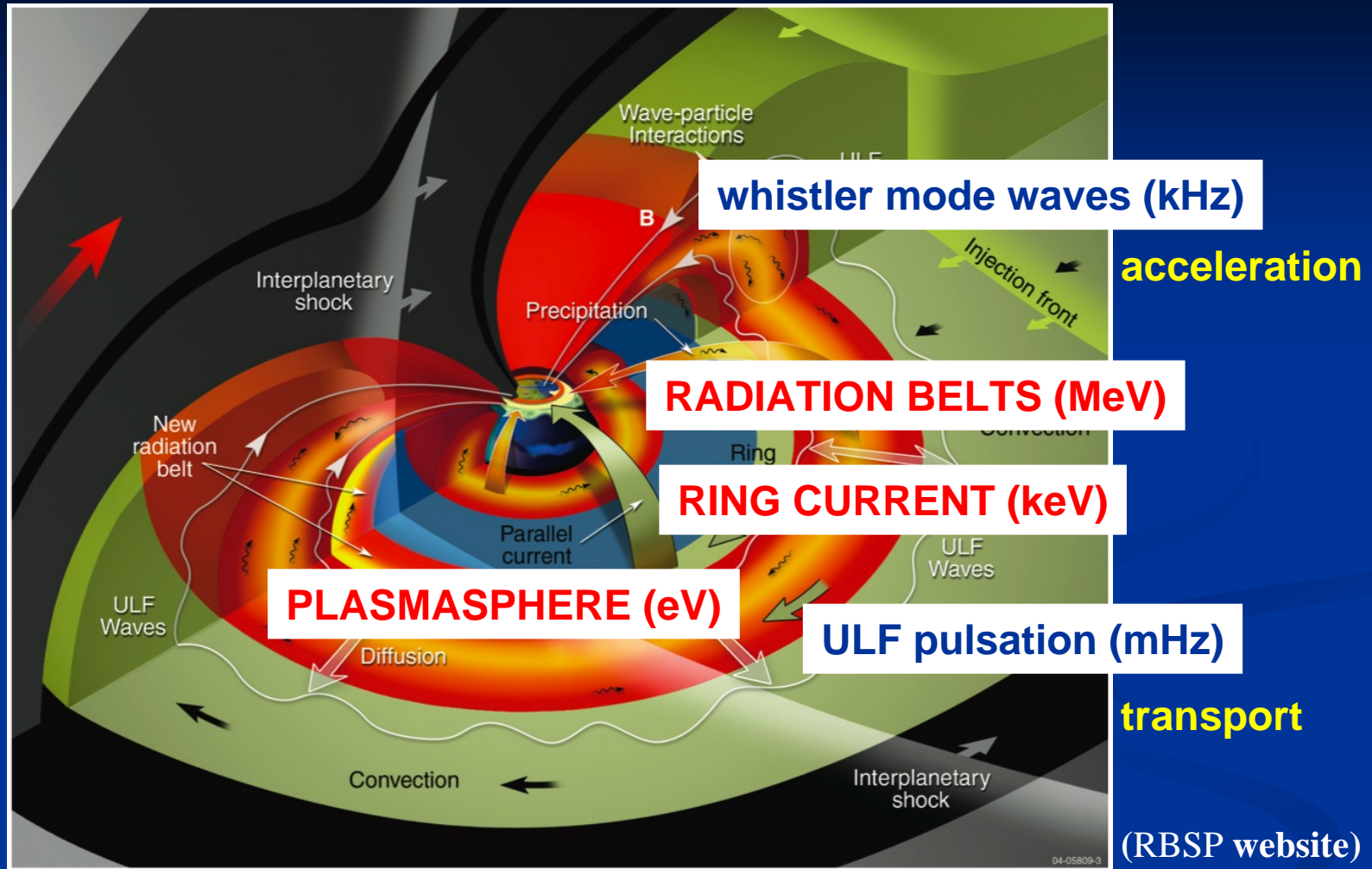
- dynamics in Geospace & subjects of the radiation belts

## 2. *ERG* project

- *ERG* satellite
- *ERG* ground networks/*ERG* theory
- possibility of international collaboration within ILWS

## 3. Summary

# 1. Introduction ··· Geospace

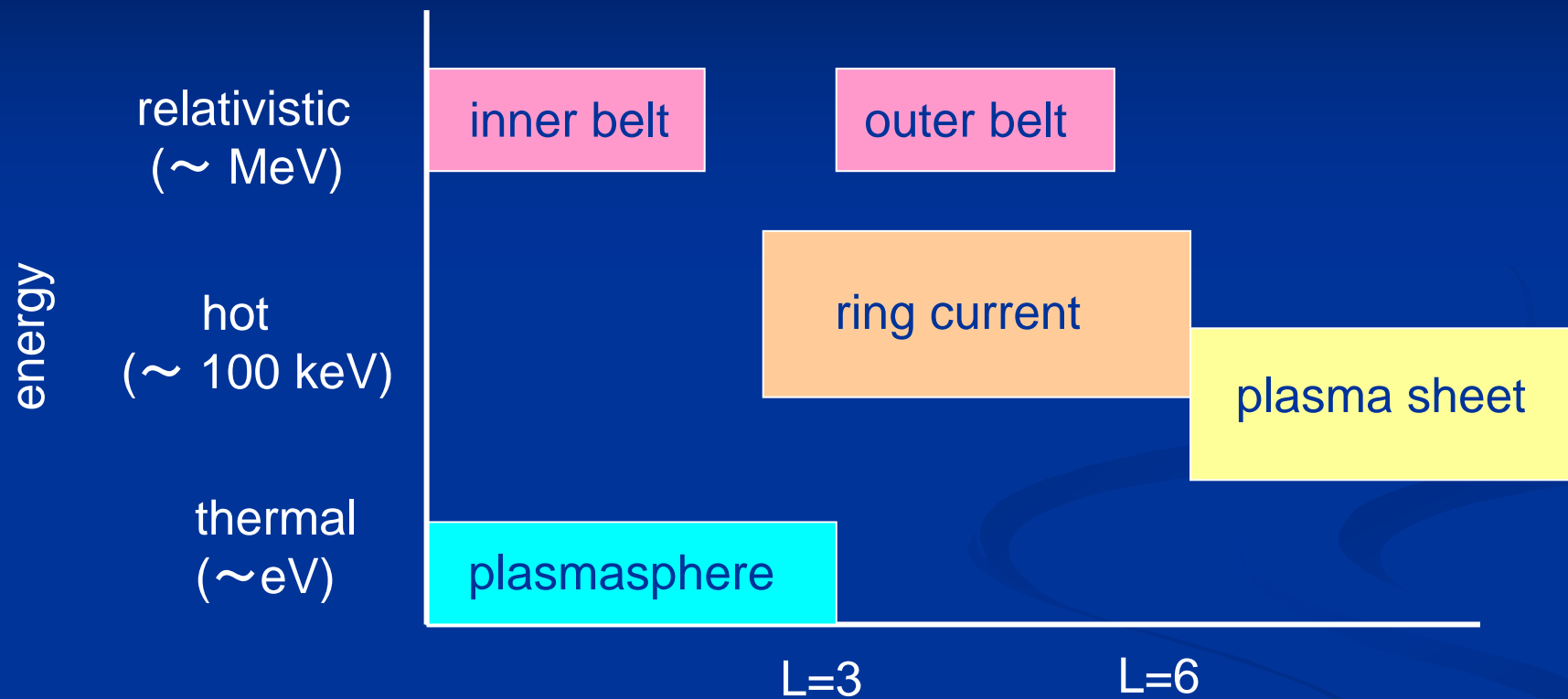


In the inner magnetosphere ···

Cross-Energy Coupling between particles of widely differing energies over 6 orders via wave-particle interactions is important to generate relativistic electrons in the inner magnetosphere.



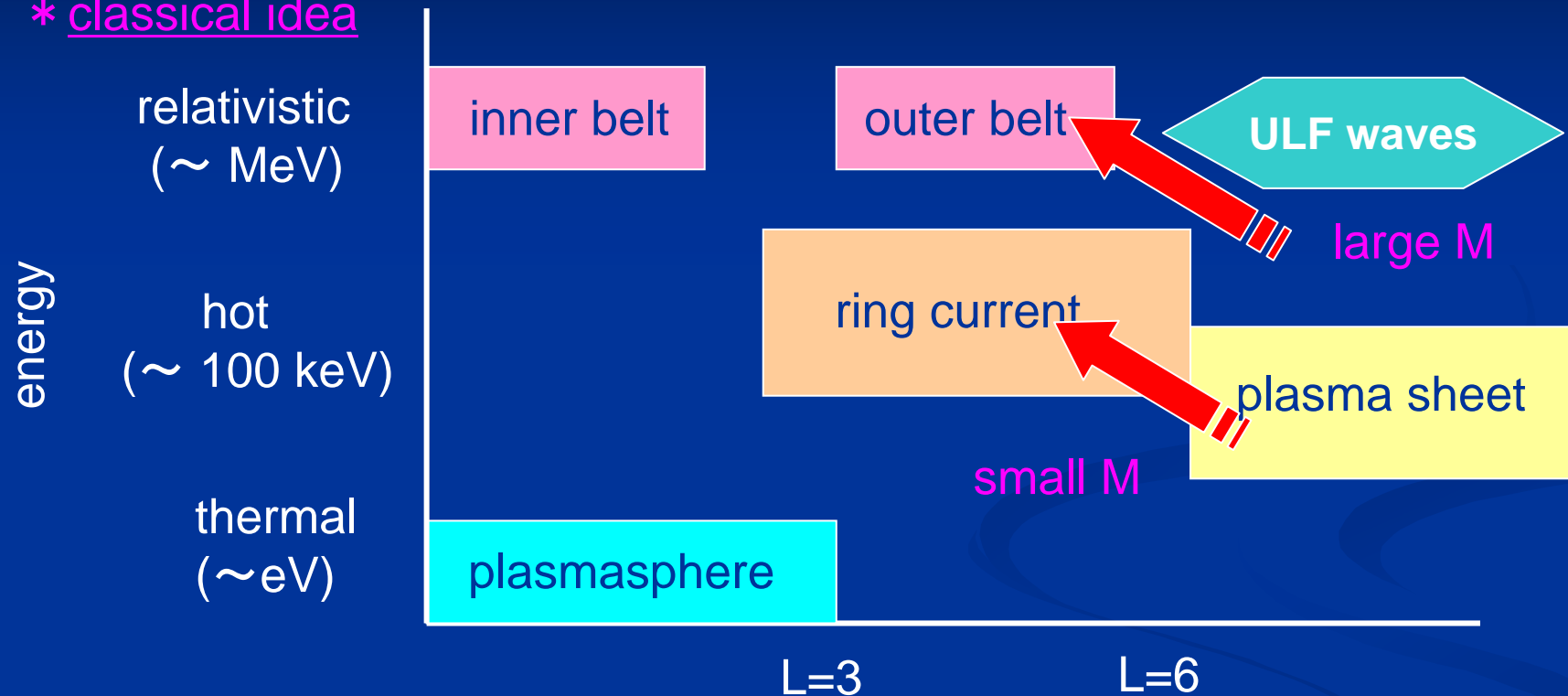
# Particles in the inner magnetosphere



# Particles in the inner magnetosphere

What is the origin of relativistic electrons in Geospace?

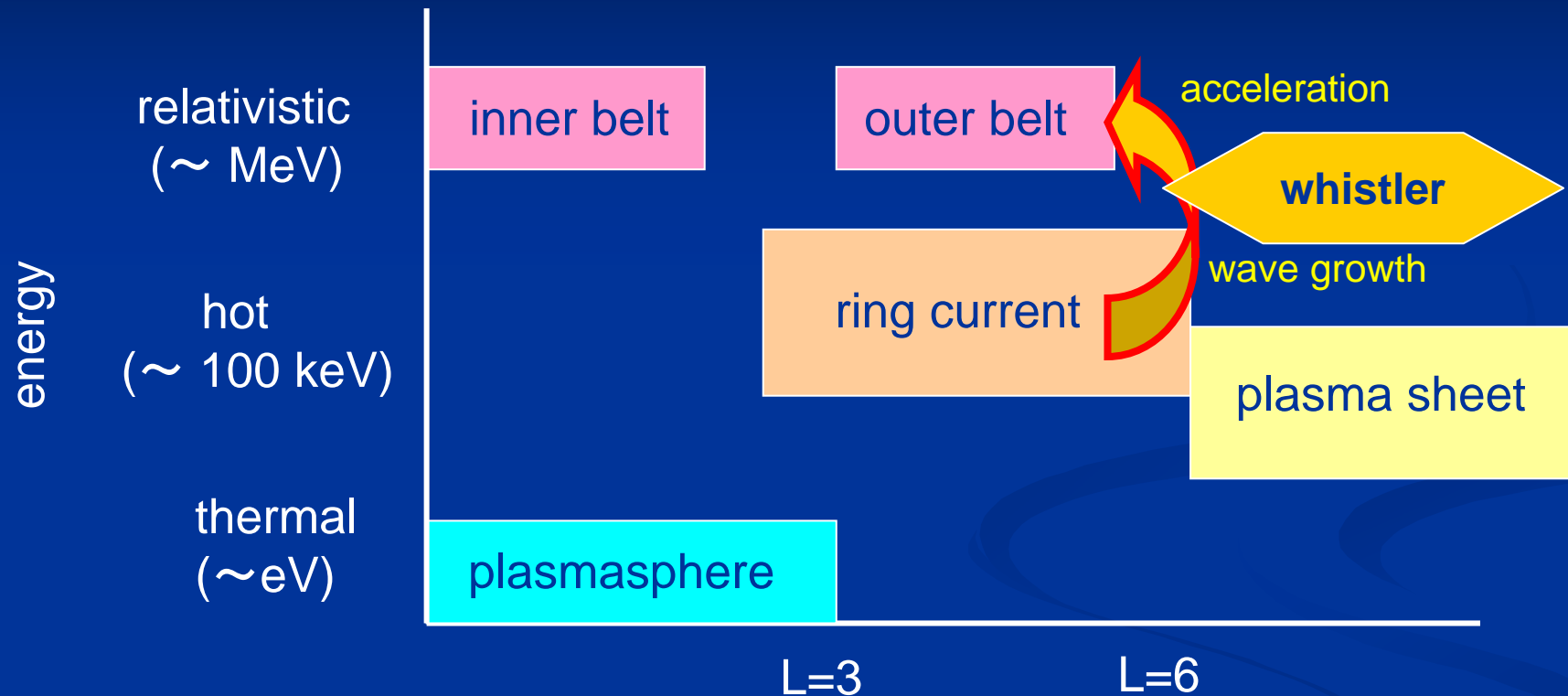
\* classical idea



Adiabatic transportation via ULF pulsations  
is important for particle acceleration.

# Particles in the inner magnetosphere

\* new idea

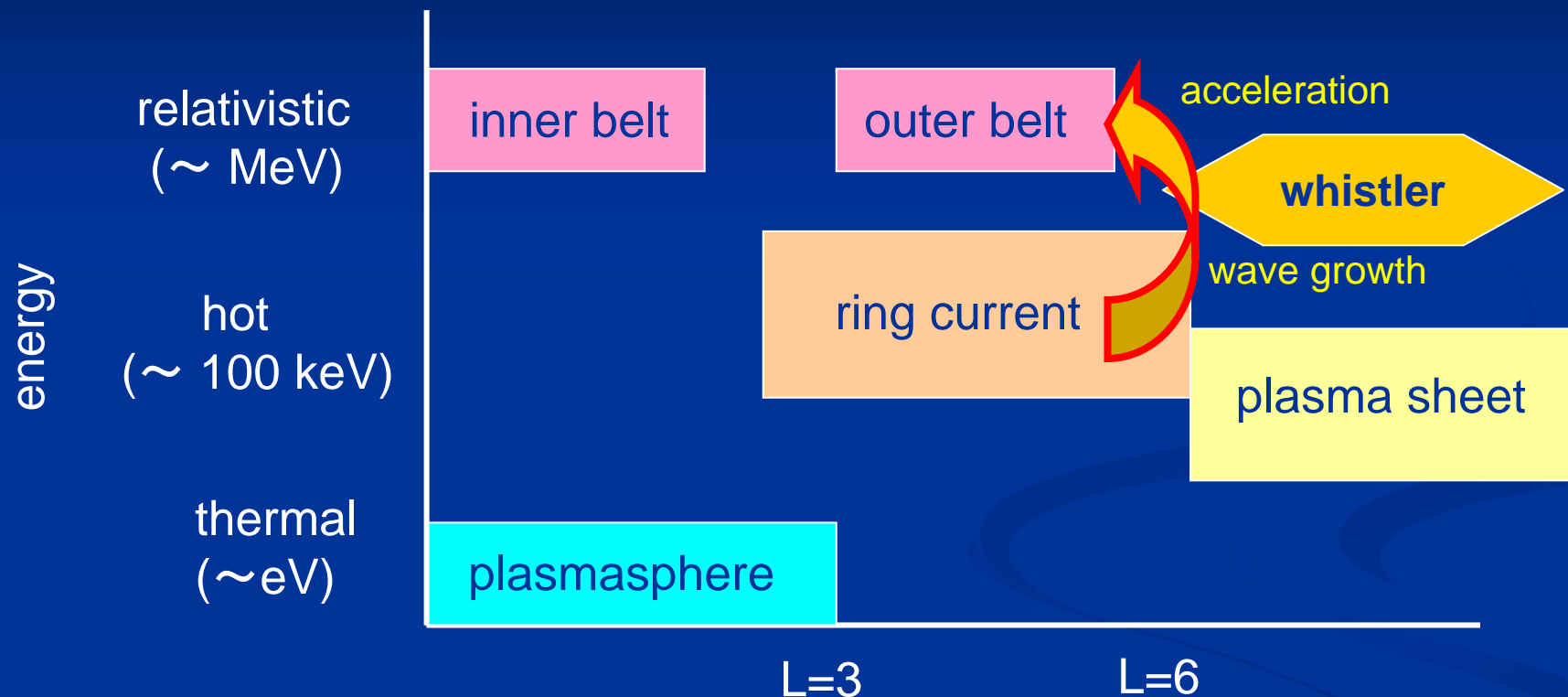


Non-adiabatic processes via plasma waves such as whistler and magnetosonic waves are important for particle acceleration.



# Particles in the inner magnetosphere

\* new idea



Non-adiabatic processes via plasma waves such as whistler and magnetosonic waves are important for particle acceleration.

Comprehensive observations have never been performed at the magnetic equator because the observation in the radiation belts is quite difficult due to strong radiation incident.

## 2. The *ERG* project

### project goal –

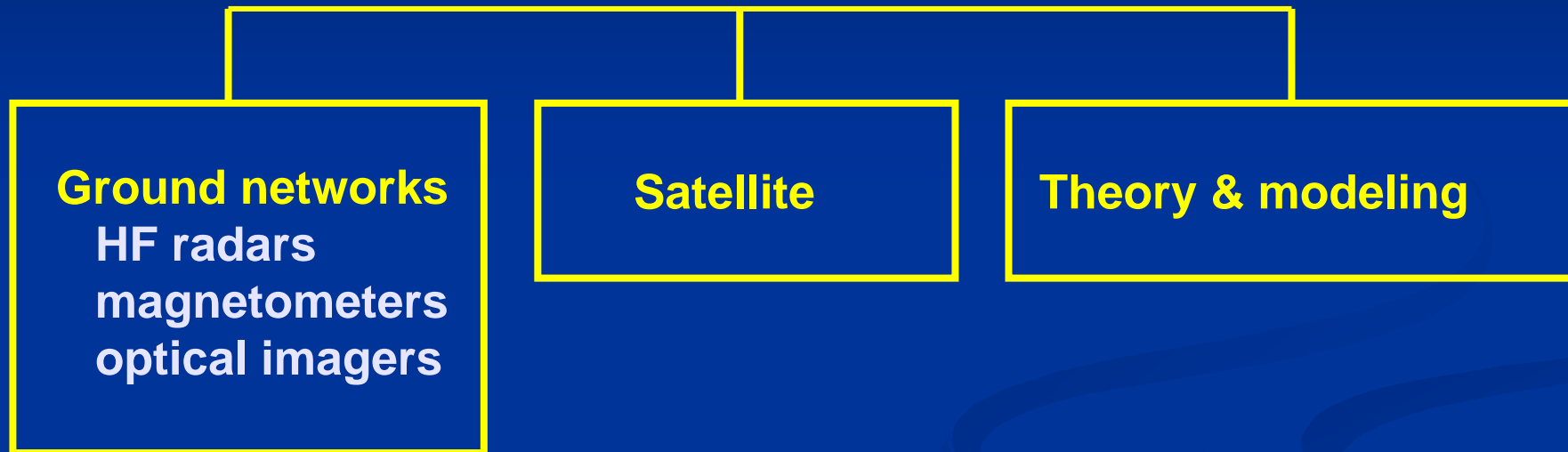
understanding cross-energy couplings for  
generation and loss process of relativistic particles  
&  
variation of geospace during space storms

### 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.

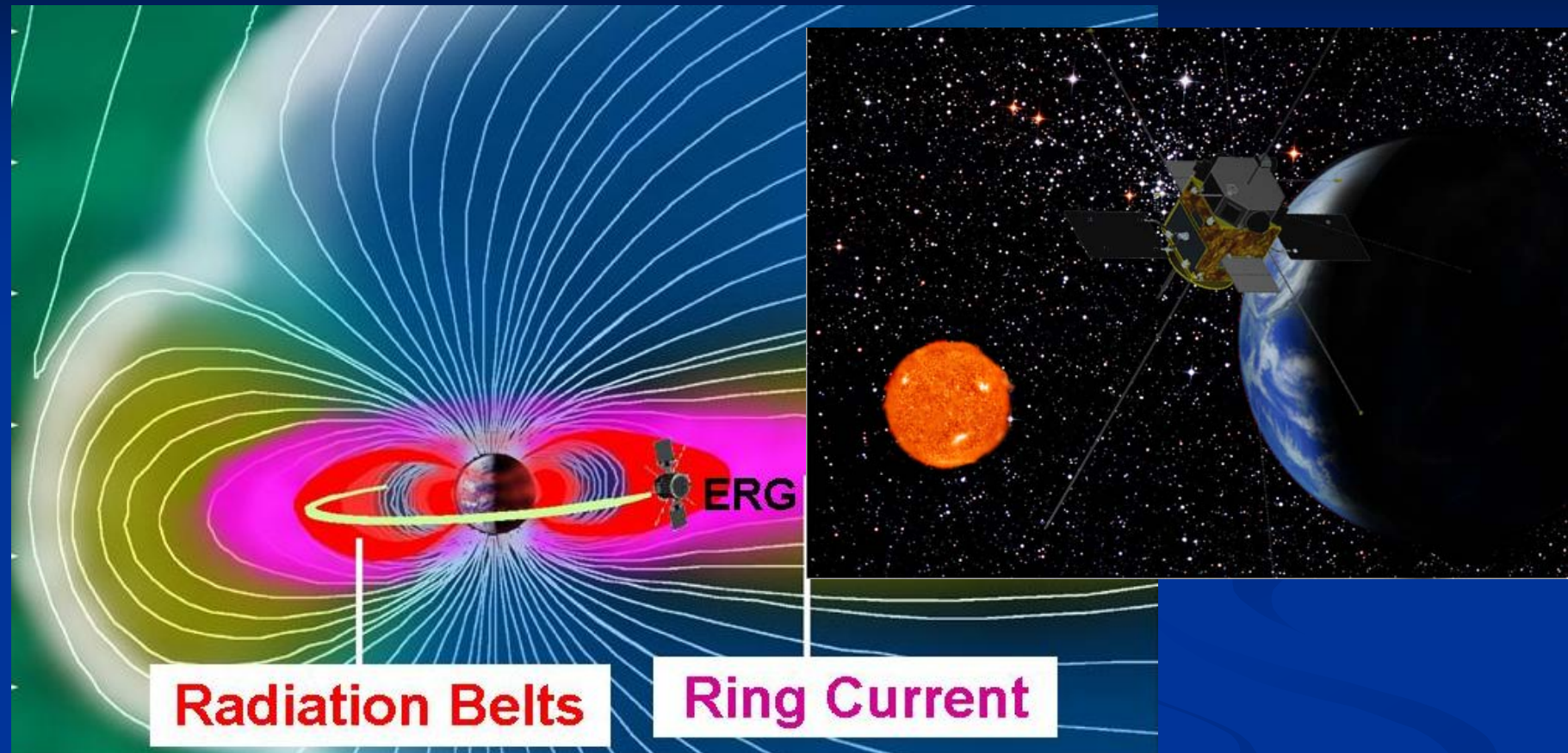
# Organization of the *ERG* project

## *ERG* project



**Science Coordinate Team**  
(Science coordination/International collaboration)  
**Project Data Center**

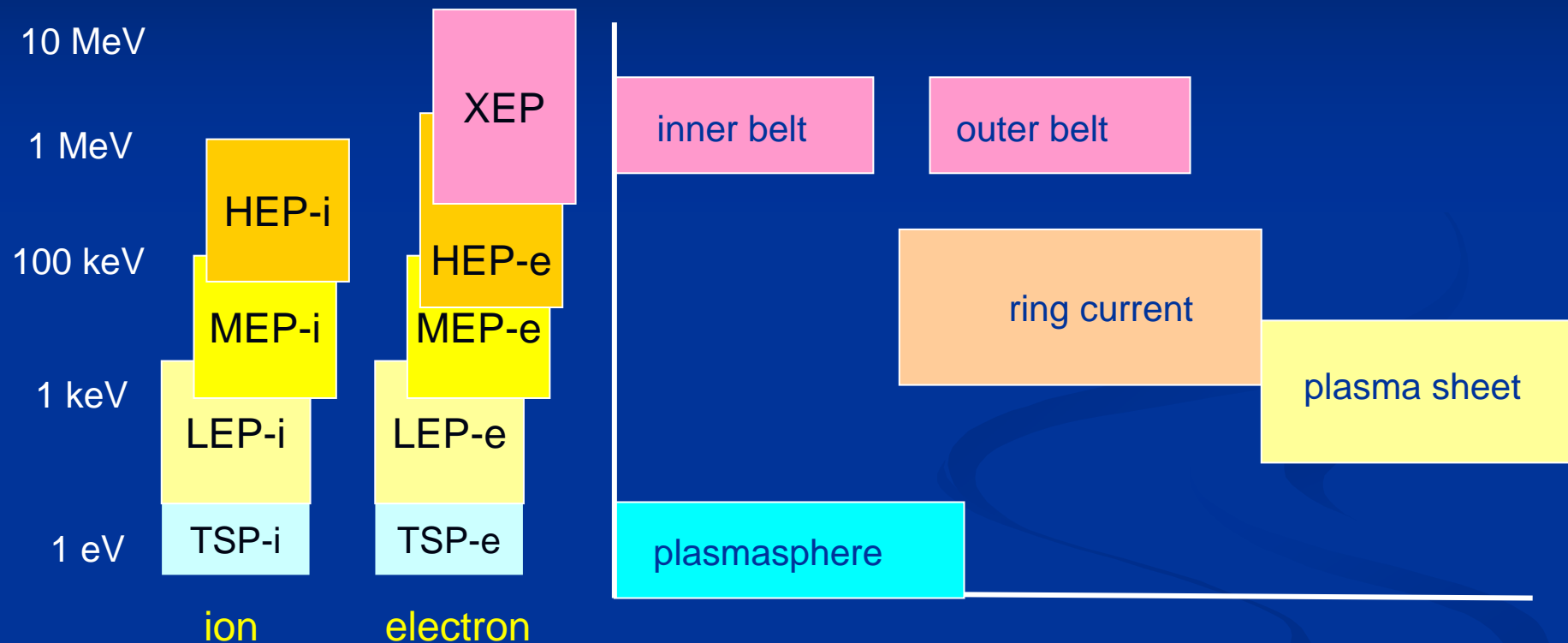
# The *ERG* satellite



- orbit: Geosynchronous Transfer Orbit with low inclination
- apogee: 5.5-6.0 Re perigee: TBD
- launch date: FY 2012 (next solar maximum)

# Science Instruments of the ERG satellite : *plasma & particles*

## PPE: Plasma and Particle Experiment

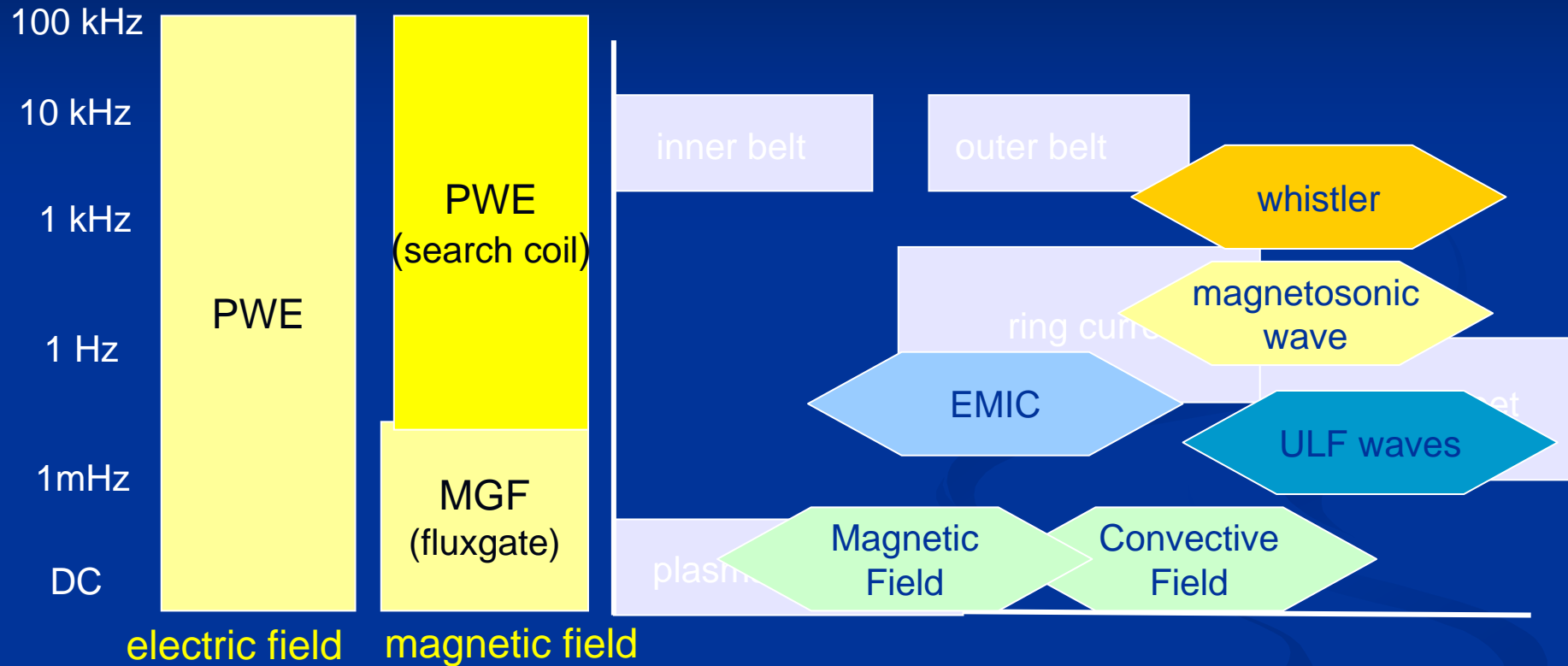


ERG/PPE measure widely differing energies over 6 orders with ion mass discrimination.

# Science Instruments of the ERG satellite : *fields & waves*

PWE: Plasma Wave and Electric Field Experiment

MGF: Magnetic Field Measurement



ERG/PWE and MGF measure electric and magnetic field for wide frequency range from DC to MHz.

# Mission Status & Schedule

- 2006/11 - The official working group of the *ERG* satellite was approved in JAXA/ISAS.
- FY 2007 - Pre-Phase A study is now going.
- FY 2008 - The proposal for Phase-A study will be submitted to JAXA/ISAS.**
- FY 2009-2011 - Development of Flight Model
- FY 2011-2012 - Integration Test
- FY 2012 - Launch



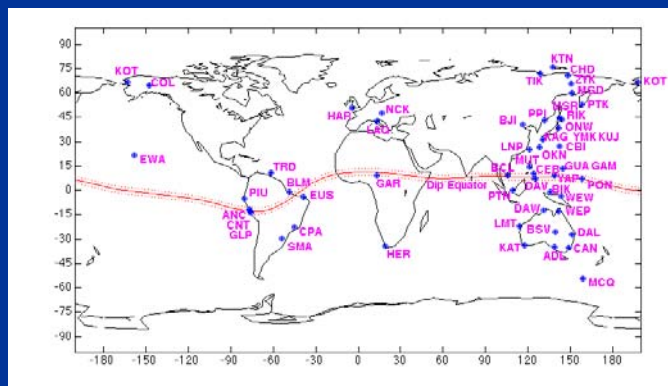
# The *ERG* ground networks – remote sensing of geospace

## - Radar Network: SuperDARN network, FM-CW radar



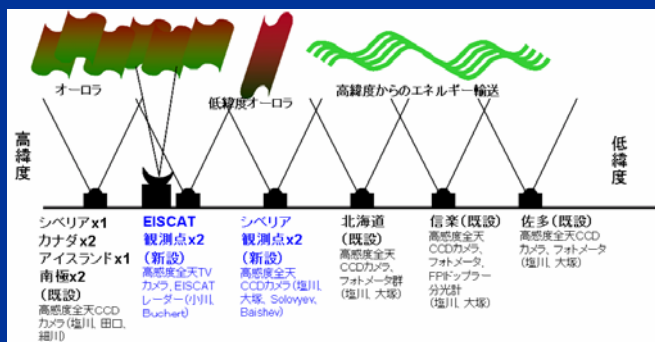
- Global convection pattern
- ULF pulsation
- Electric field penetration

## - Magnetometer Network: MAGDAS/CPMN, Silk-Road, Antarctic Network



- Global magnetic field variation
- Remote sensing of ring current
- diagnostics of plasmasphere

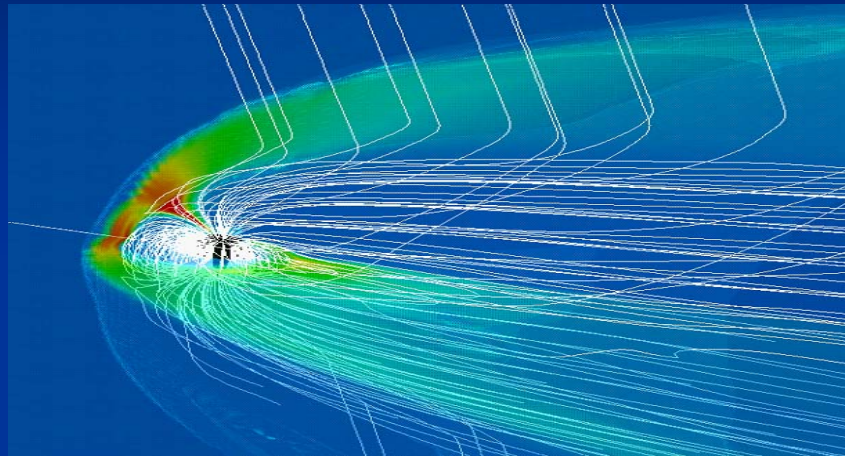
## - Optical Network: Canada, Norway, Siberia, Antarctica



- Estimation of ionospheric conductivity
- Visualization of magnetospheric plasma distribution

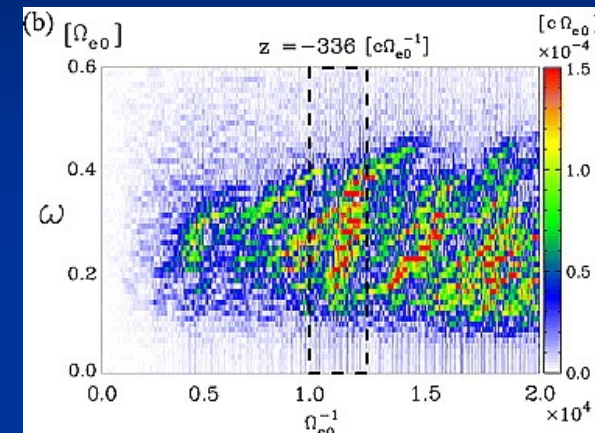
# The *ERG* theory/simulation

## • theory & simulation



global simulation

Tanaka [1995]



micro simulation

Kato and Omura [2007]

Comprehensive simulations including both micro wave-particle interaction and macro processes, which can be compared with the observations, are necessary for the *ERG* project.

Nagoya Univ. starts the new project of modeling study for Geospace; GEMSIS (Geospace Environment Modeling System for Integrated Studies).

# Science Coordinate Team/Project Data Center

## **- Science Coordinate Team**

- Planning and coordination of science program.
- Making an arrangement of the international collaborations.

## **- Project Data Center**

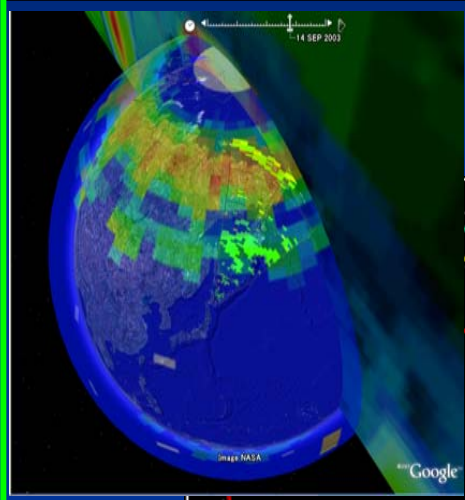
Synergy between ground-based as well as satellite observations and modeling/simulation is a key to maximize the science output.

- Developing of a software package to enhance the synergy between observations and modeling is considered important.
- Related observation database in commonly used format like CDF will be implemented.

# ERG Trinity

ERG-ground networks

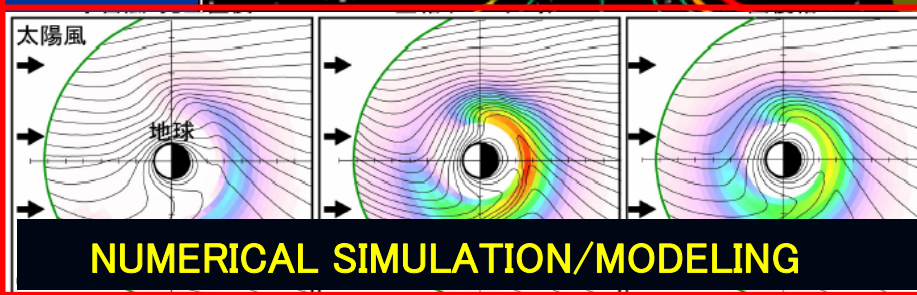
REMOTE SENSING



ERG-satellite



ERG-model/simulation

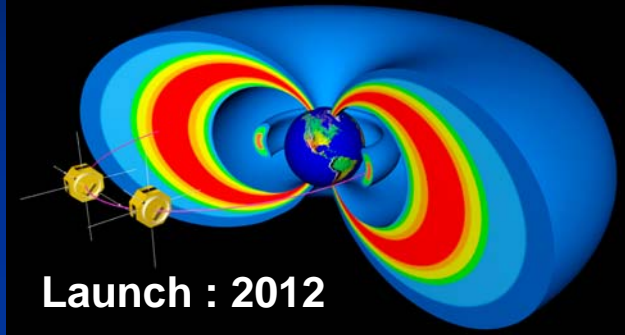


The data from the *ERG* satellite and ground networks are integrated with numerical simulation and modeling for comprehensive and quantitative understanding.

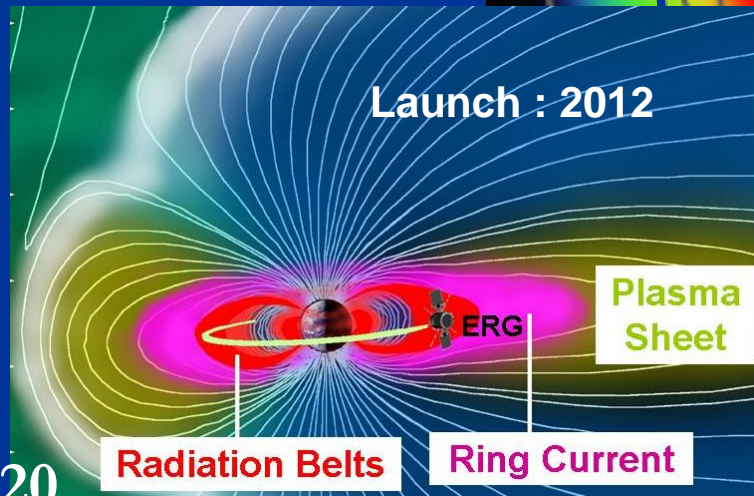


# Possibility of International Collaboration within ILWS

US/RBSP



Canada/ORBITALS



Japan/*ERG*

Russia/RESONANCE  
China/KuaFu

### 3. Summary

- The mission in Geospace; **ERG**, is now pre phase-A study in JAXA/ISAS, and we will **submit the proposal for Phase-A study in FY 2008.**
- **The ground network observations are ready for the project.**
- The design of **the data center is now planning.**
- The collaboration with **RBSP, ORBITALS, KuaFu, RESONANCE, THEMIS** mission, **ground networks** would be very good chance for study of geospace during the next solar maximum, and we would like to make a collaboration with these missions.

*The **ERG** mission proposal is now preparing.  
Your supports and inputs on international collaboration  
will be appreciated.*

**ERG** Project Office: [ERG\\_adm@st4a.stelab.nagoya-u.ac.jp](mailto:ERG_adm@st4a.stelab.nagoya-u.ac.jp)