LWS Geospace

Radiation Belt Storm Probes Mission

Geospace-related Missions of Opportunity

NASA Heliophysics Division

Living with a Star Program

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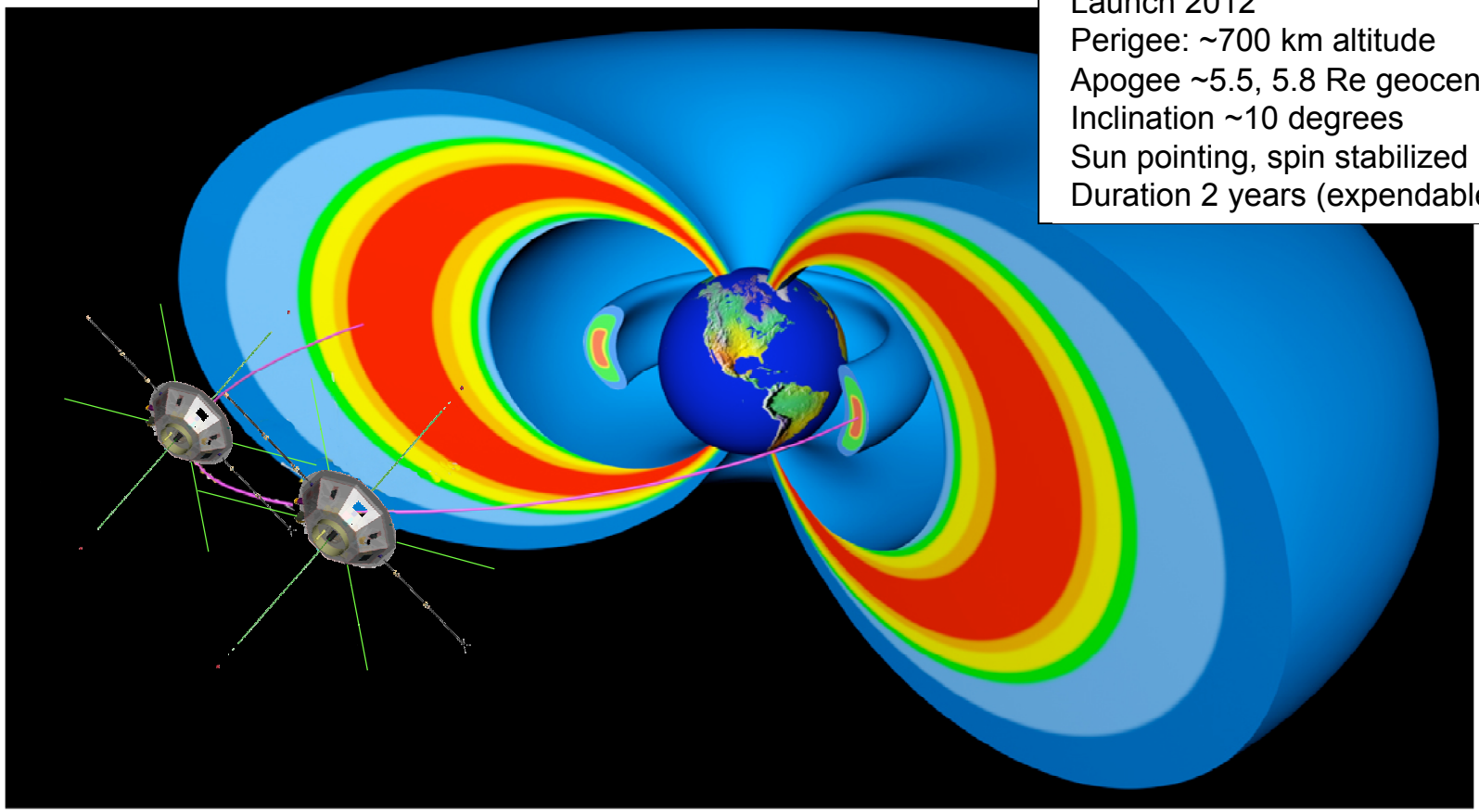
The Radiation Belt Storm Probes Mission

RBSP Mission Facts:

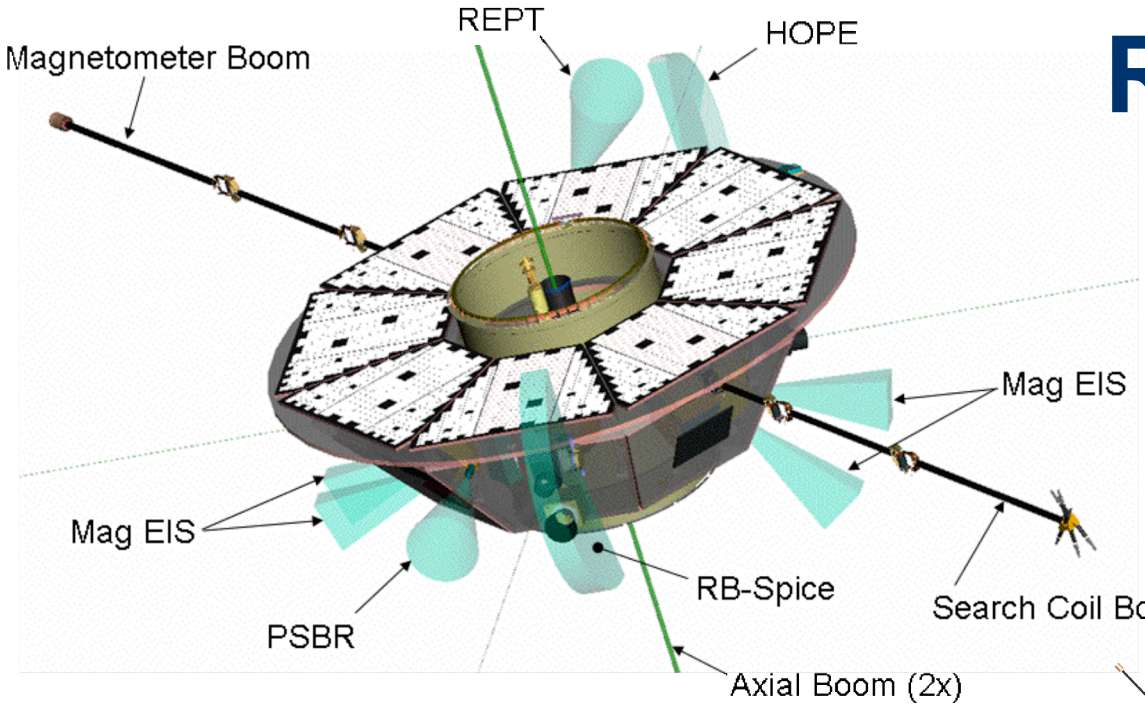
Launch 2012
Perigee: ~700 km altitude
Apogee ~5.5, 5.8 Re geocentric altitude
Inclination ~10 degrees
Sun pointing, spin stabilized
Duration 2 years (expendables 4 years)

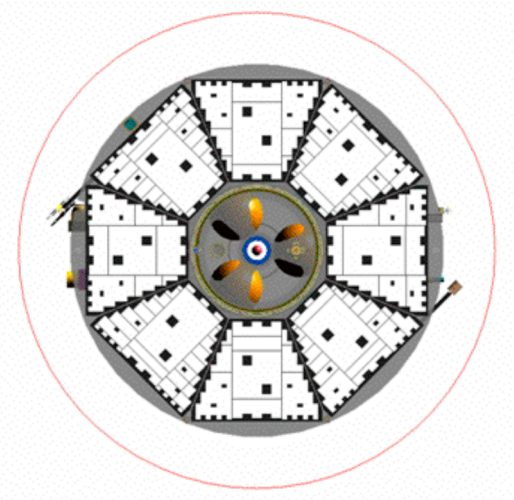


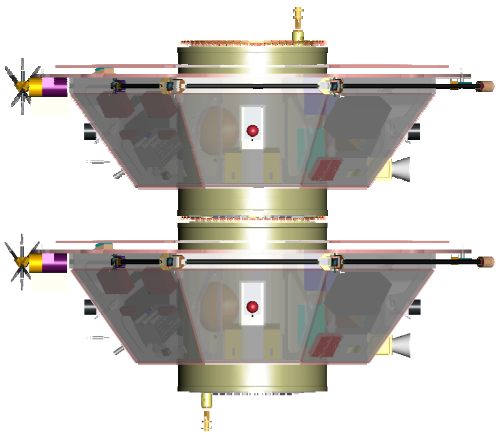
Radiation Belt Storm Probes – twin spacecraft in highly elliptical orbits to understand the basic principals behind relativistic particle acceleration, transport, and loss.

Implemented as the 2nd mission in the Living with a Star Program

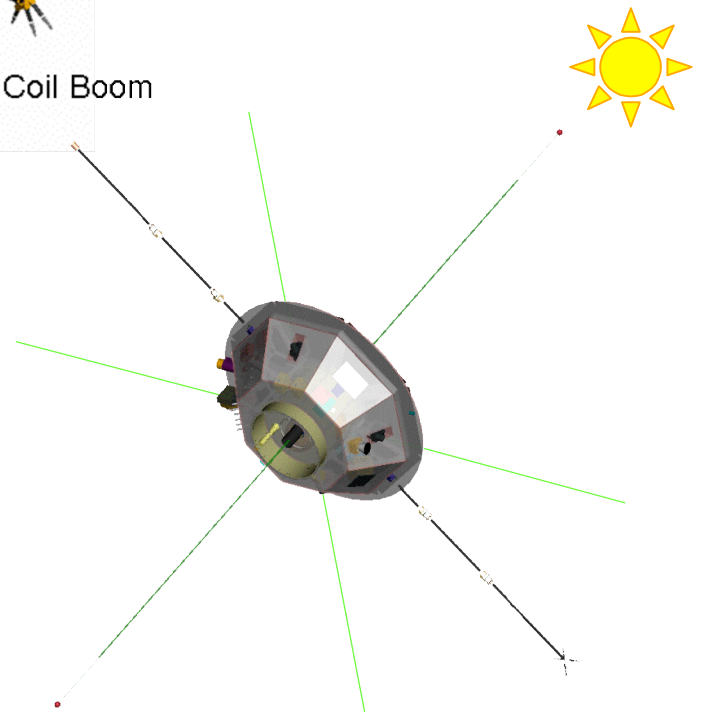
RBSP Design







Launch Configuration



Operational Configuration

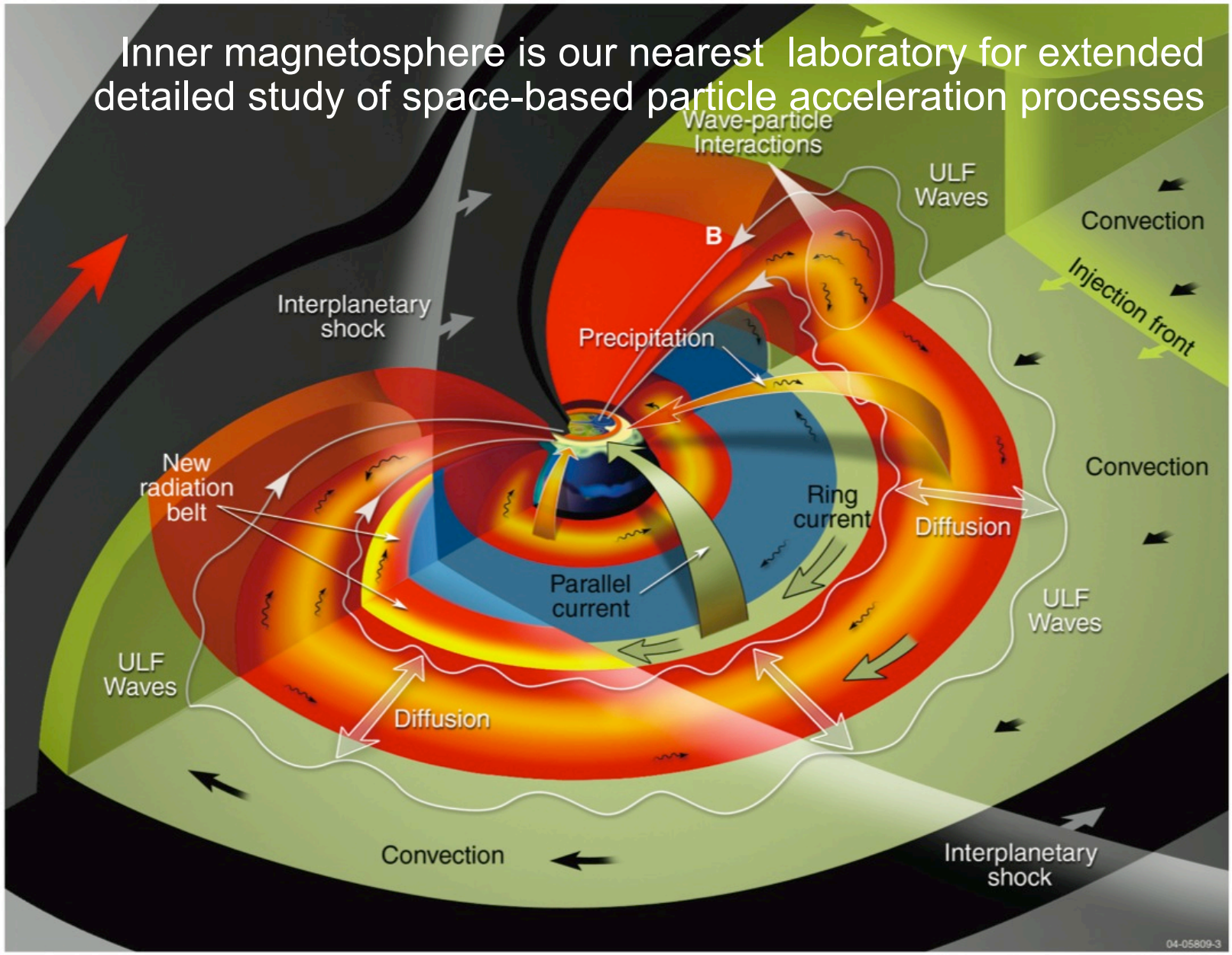
Mission Schedule

Phase A, preliminary design:	6/2006 – 1/2008
Phase B, detailed design:	2/2008 – 1/2009
Phase C/D, development:	2/2009 – 7/2012
Launch:	4/2012
Phase E, flight phase:	8/2012 – 8/2015

RBSP Science Objective

Understand, ideally to the point of predictability, how populations of relativistic ions and electrons in space are formed or changed in response to the variable inputs of energy from the sun

We will fulfill this objective by: Understanding the acceleration, global distribution, and variability of energetic electrons and ions in the inner magnetosphere



Primary target: Physical processes resulting in the low latitude energetic particle populations.

LWS RBSP Specific Objectives

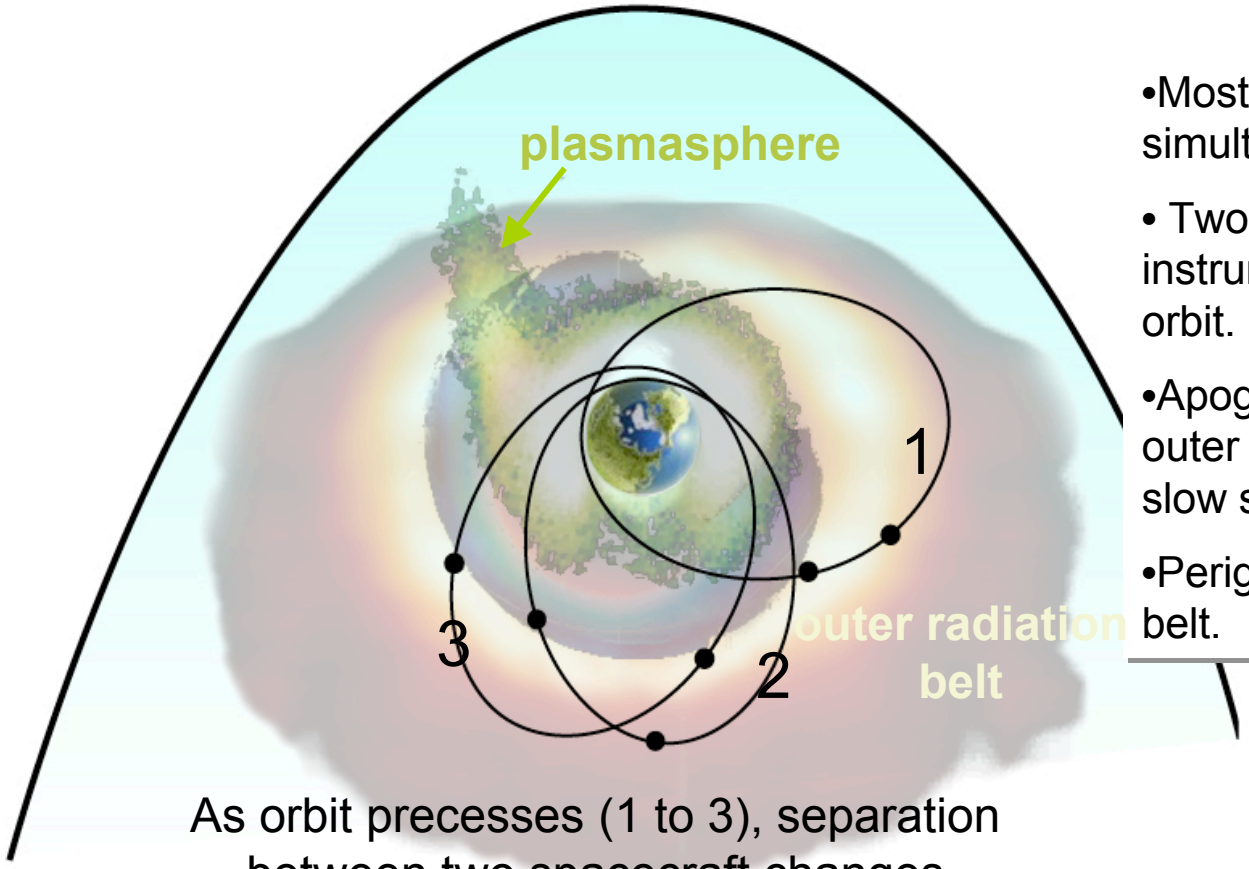
Science:

- Processes affecting the *acceleration, transport, precipitation and loss* of very energetic charged particles;
- Creation and decay of *new radiation belts*;
- A*diabatic and nonadiabatic processes*;
- *”Seed" or source populations* for relativistic particle events;
- *Ring current* and other storm variations and effects on energetic particles;

Application:

- Physics-based *data assimilation and specification models* of the radiation belts for solar cycle time scales.

Mission Approach

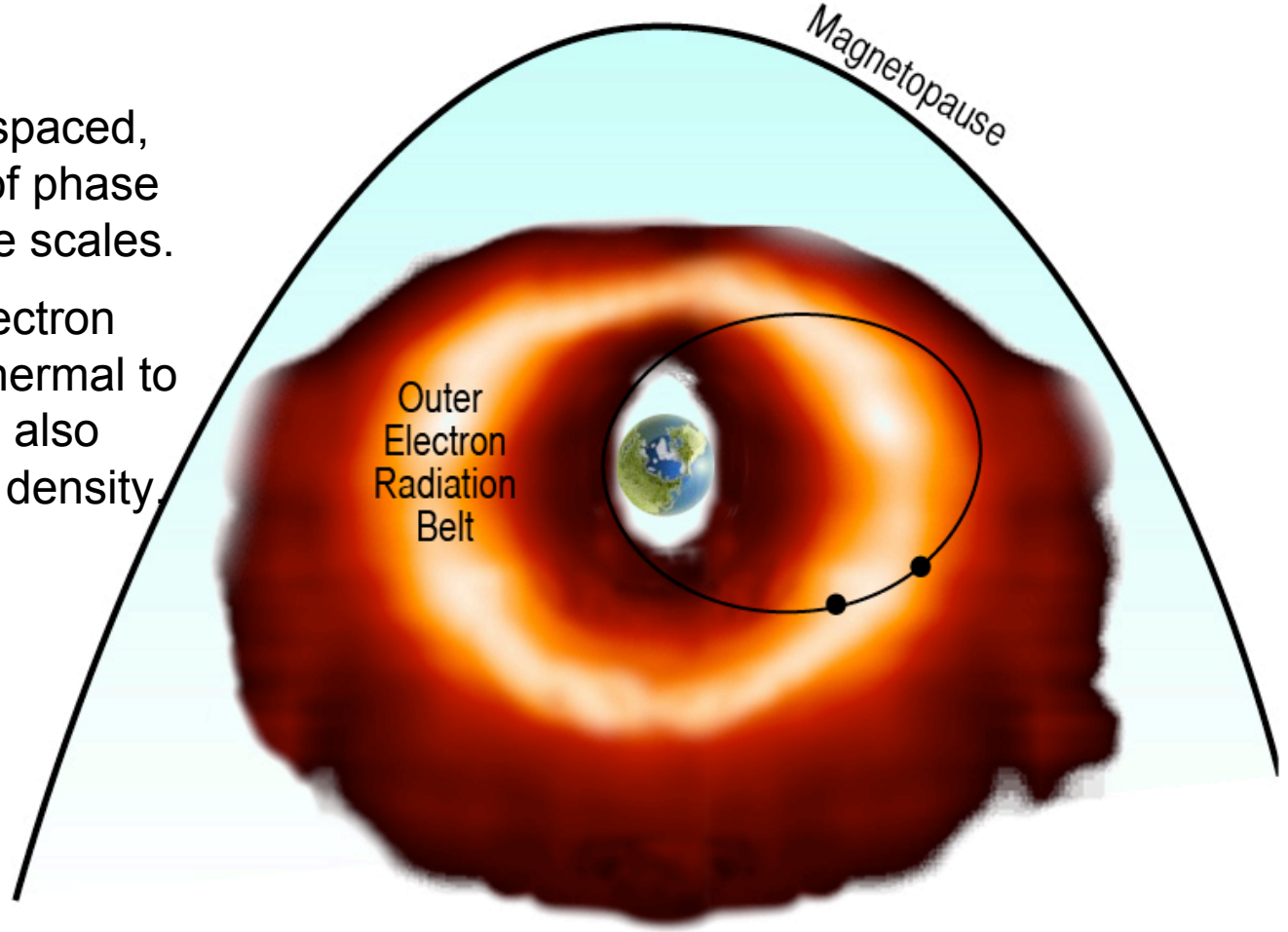


As orbit precesses (1 to 3), separation between two spacecraft changes ("lapping" 4-5 times per year)

- Most important: multi-point, simultaneous measurements.
- Two spacecraft with identical instrumentation in a nearly common orbit.
- Apogees of ~ 5.5, 5.8 Re to sample outer belt and ring current and for slow separation of orbit "petals".
- Perigee of ~ 700 km to sample inner belt.

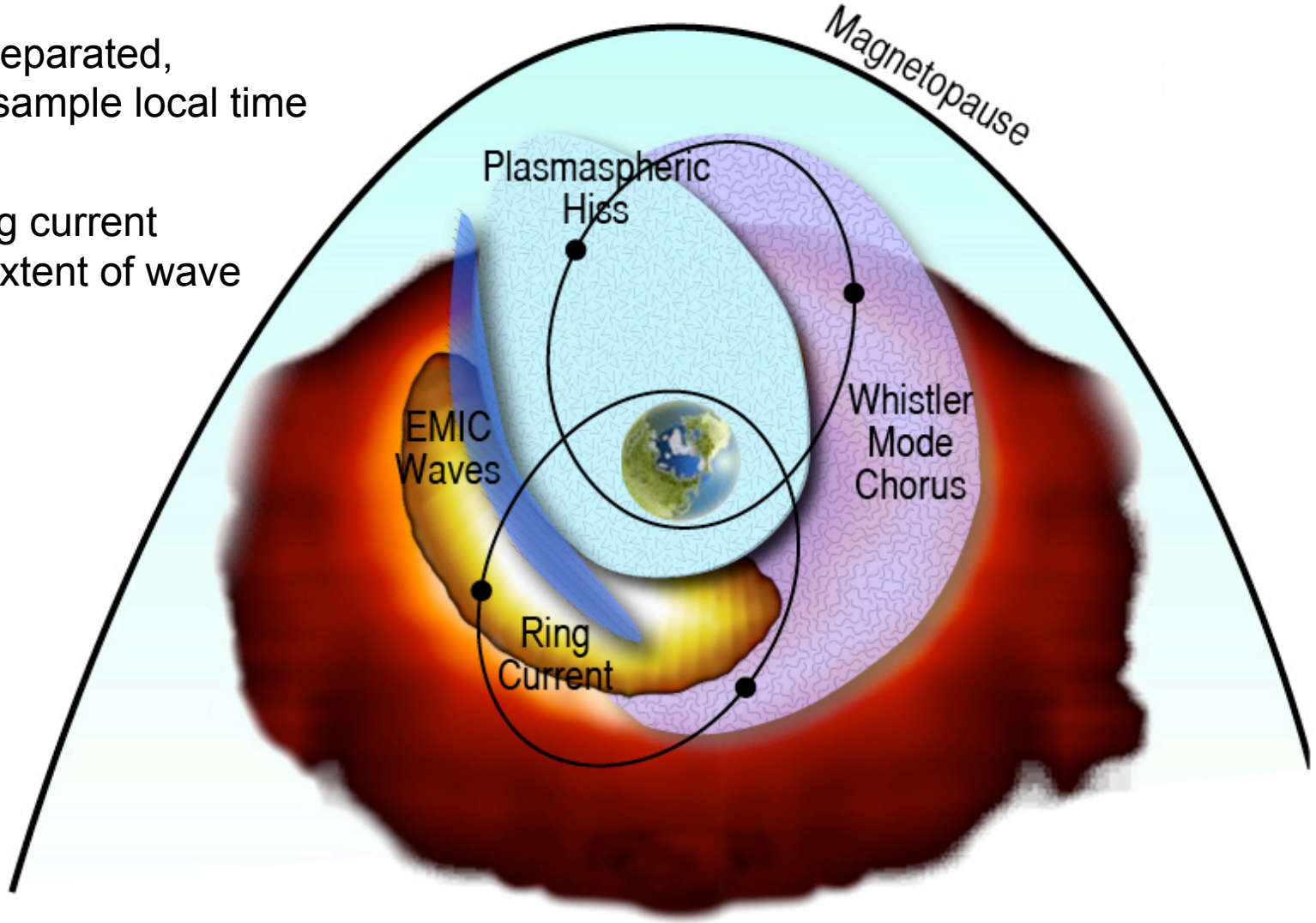
Analysis of Radial Profiles

- Two RBSP, when closely spaced, will build up radial profiles of phase space density on storm time scales.
- RBSP will measure full electron and ion distributions from thermal to relativistic energies and will also determine the local plasma density.



Local Time Dependent Dynamics

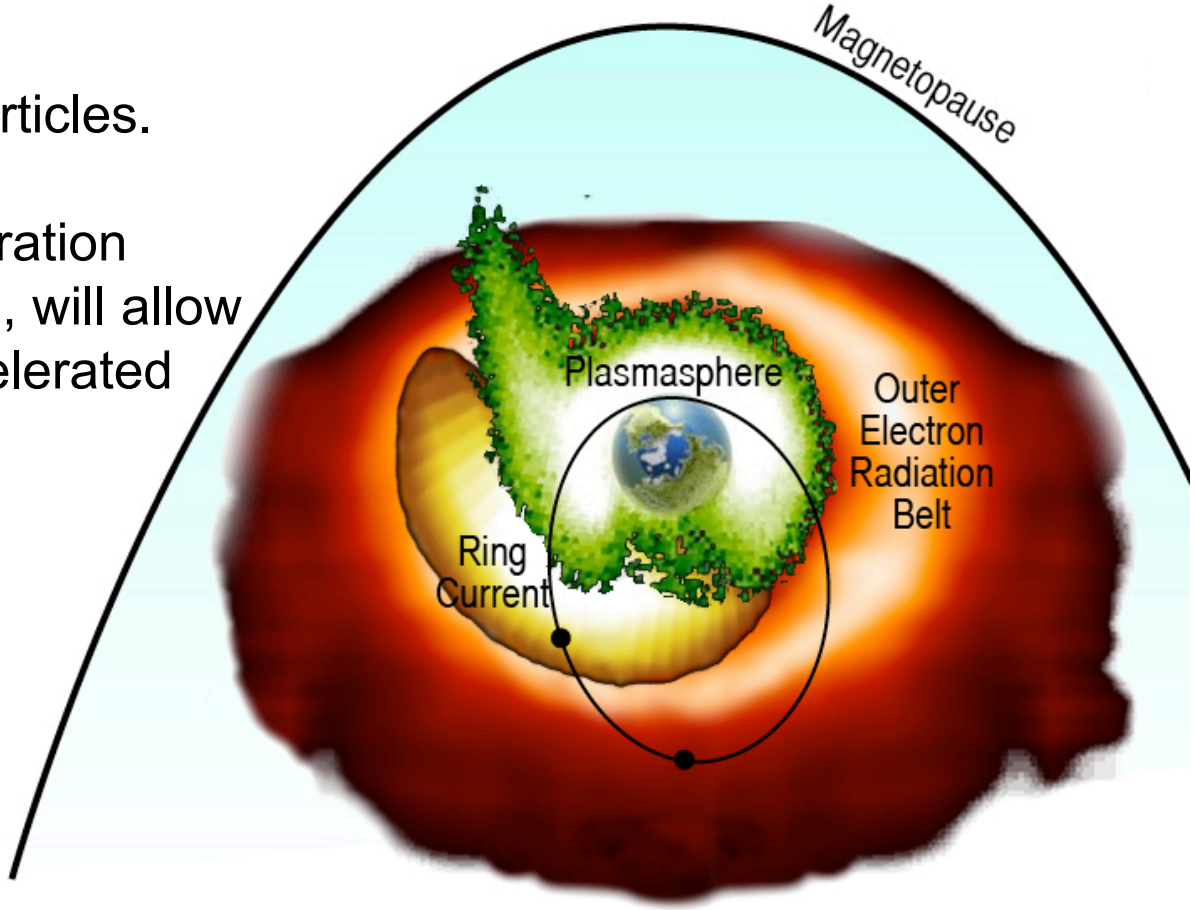
- When widely separated, spacecraft will sample local time behavior.
- Examples: ring current asymmetries; extent of wave effects.



Determination of Source Populations

- Three source populations for relativistic particles:
  - Plasma sheet
  - Substorm injected plasma
  - Pre-existing relativistic particles.

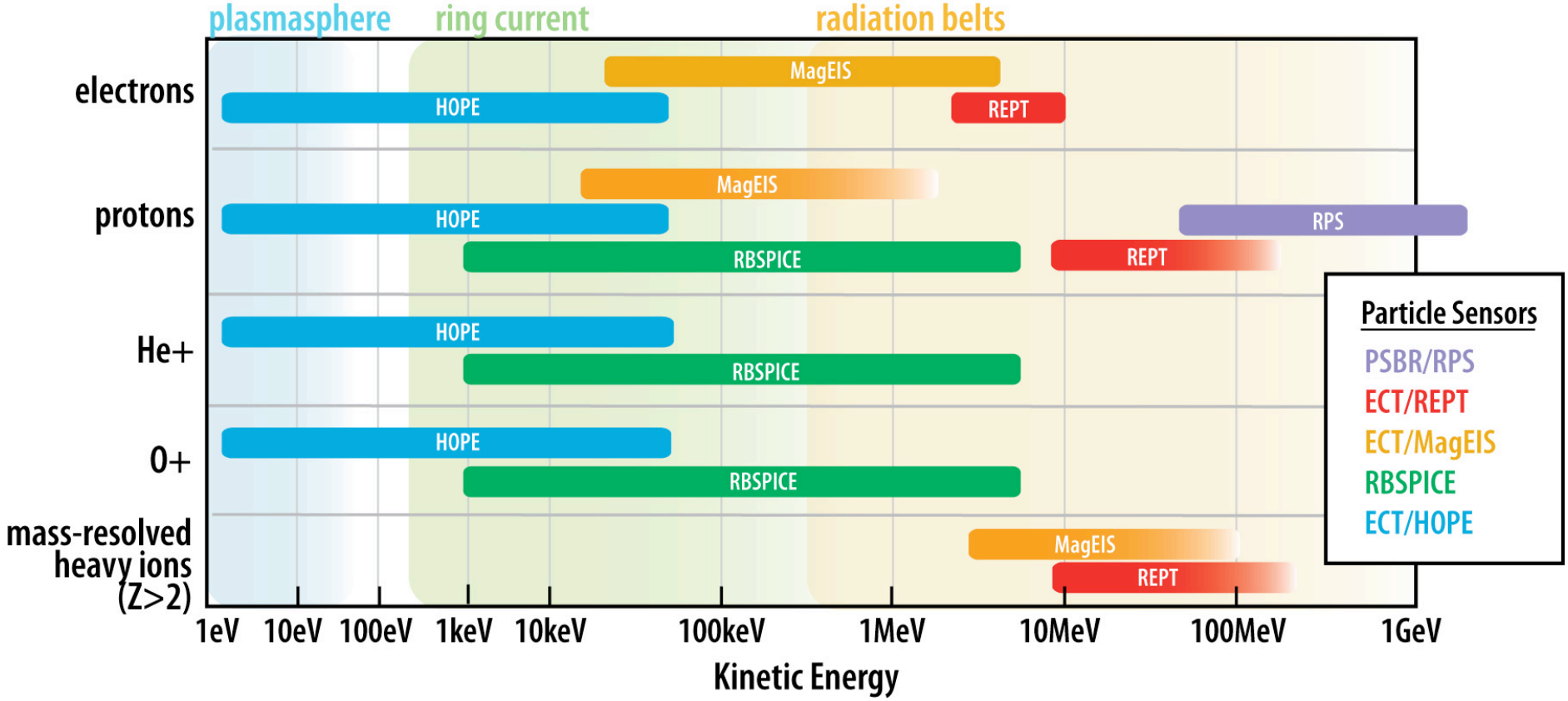
- One RBSP within an acceleration region, and the other beyond, will allow measures of “seed” and accelerated populations simultaneously.



Science Teams	Science Investigation	Instruments/Suites
Dr. Harlan Spence, PI Boston University,	Measure near-Earth space radiation belt particles to determine the physical processes that produce enhancements and loss	***ECT***: **E**nergetic Particle, **C**omposition and **T**hermal Plasma Suite
Dr. Craig Kletzing, PI University of Iowa,	Understand plasma waves that energize charged particles to very high energies; measure distortions to Earth's magnetic field that control the structure of the radiation belts	***EMFISIS***: **E**lectric and **M**agnetic **F**ield **I**nstrument **S**uite and **I**ntegrated **S**cience Suite
Dr. John Wygant, PI University of Minnesota,	Study electric fields that energize charged particles and modify inner magnetosphere	***EFW***: **E**lectric **F**ield and **W**aves Instrument
Dr. Louis Lanzerotti, PI New Jersey Institute of Technology	Understand the creation of the "storm time ring current" and the role of the ring current in the creation of radiation-belt populations	***RBSPICE***: **R**adiation **B**elt **S**torm **P**robes **I**on **C**omposition **E**xperiment
Lt. Col. Clark Groves, PI National Reconnaissance Office	Specification models of the high-energy particlesin the inner-most Van Allen radiation belt	***RPS***: **R**elativistic **P**roton **S**pectrometer

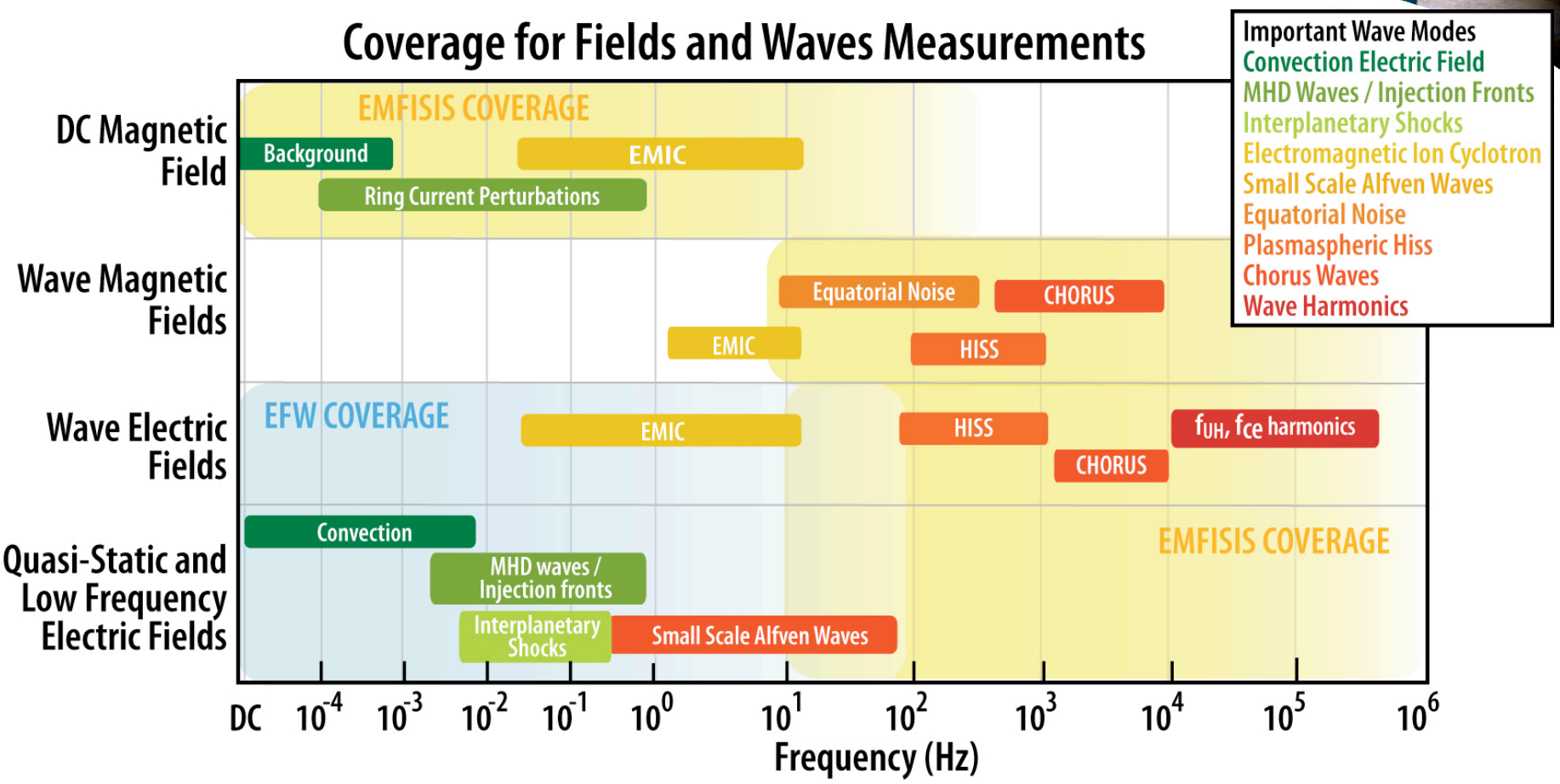
Particle Experiments

Coverage for Electron and Ion Pitch Angle Distributions



Details of energy ranges to be finalized in Phase B

Field and Wave Experiments



NASA's Intent for the SW Beacon

NASA's Heliophysics Division intends to deploy space weather beacon antenna on all future missions

- if and when it makes sense to do so considering mission goals, location, resources, etc.
- for as long as the space weather community finds the data to be of value

Assumptions for RBSP SW Beacon

- Implementation of SW beacon will be "ACE/STEREO-mode" … the RBSP mission will provide transmit only.

  (mission science data is stored and downlinked once per day)

- Small subset of RBSP science dataset will be continuously transmitted (~200 bps) via the beacon.
- Little or no onboard processing
- Ground processing for SWx products provided by receiving organization(s).
- RBSP teams to supply some processing algorithms

potentially useful RBSP data products:

	#bits/ component	Data Product Report Rate (bps):
Magnetic Field		
1 vector sample per 5 spins x 3 components	16	0.80
Electric Field		
1 vector sample per 5 spins x 3 components	16	0.80
ULF Wave Power		
1 vector magnetic field sample per 6 secs x 3 components	16	8.00
Plasma Density		
1 spacecraft potential value (±250 V) per 5 spins	12	0.20

Particle Count Rates (electrons & protons)						
energy bin centered at or near:	~bin width:	per # spins	# angles per quarter spin	#az angles		
25 eV	50 eV	5	1	1	12	0.40
300 eV	100 eV	5	5	1	12	2.00
1 keV	5 keV	5	1	1	12	0.40
30keV	10 keV	5	5	1	12	2.00
70 keV	30 keV	5	5	1	12	2.00
150 keV	50 keV	5	1	1	12	0.40
300 keV	100 keV	5	5	2	12	4.00
600 keV	200 keV	5	1	2	12	0.80
1 MeV	1 MeV	5	5	2	12	4.00
3 MeV	2 MeV	5	1	1	12	0.40
>10 MeV*	n/a	5	5	1	12	1.00
>50 MeV*	n/a	5	1	1	12	0.20
>400 MeV*	n/a	5	5	1	12	1.00

NOTES:

Spin rate (s)= 12

*no electrons reported above 10MeV

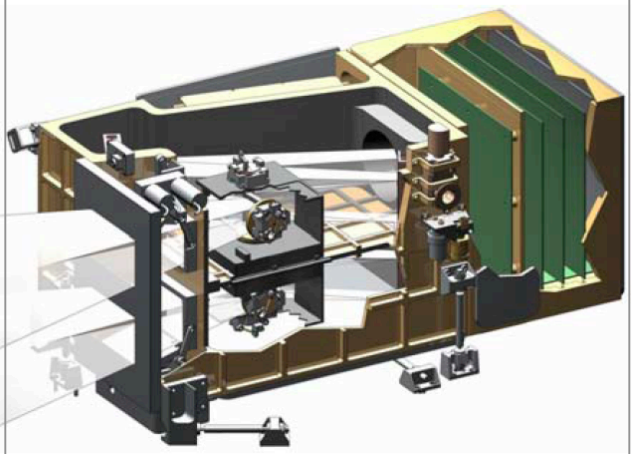
TOTAL DATA PRODUCT REPORT RATE: **28.40**

LWS Geospace Missions of Opportunity

BARREL

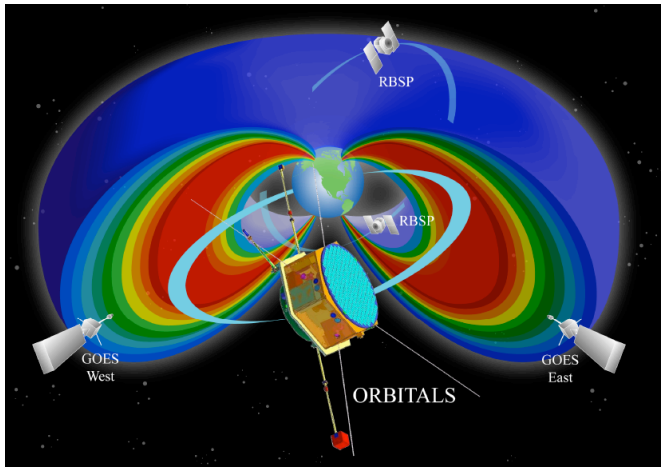
Robyn Millan
Balloon Array for RBSP Relativistic Electron Losses

GOLD



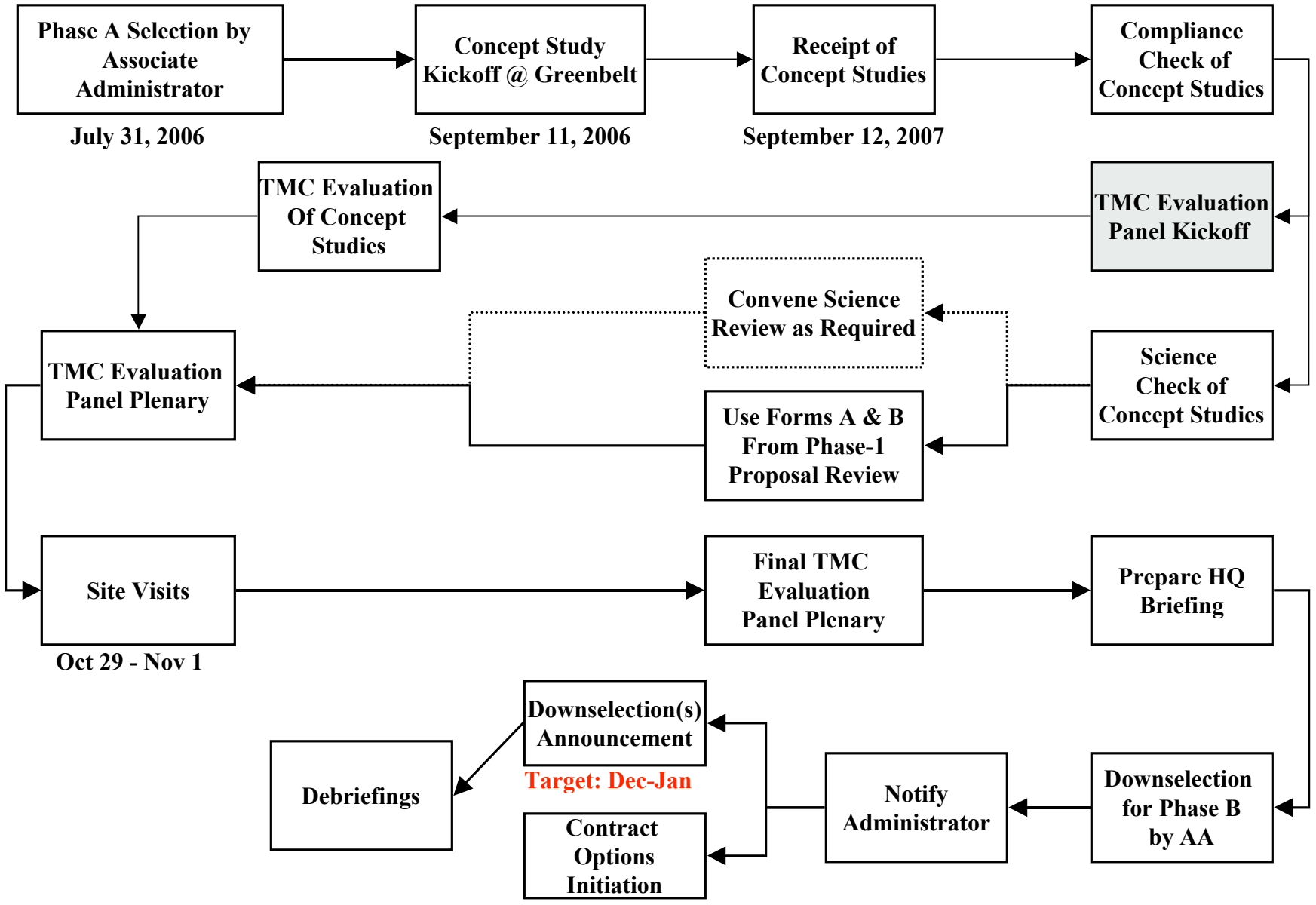
Richard Eastes
Global-scale Observations of Limb and Disk

MORE



Daniel Baker
Mission of Opportunity RadBelt Experiment

Geospace-Related Missions of Opportunity Phase A Downselect Flowchart



The Path Forward

- Goddard Space Flight Center has been assigned responsibility for the Missions of Opportunity
- Phase A Concept Study Reports
  - The content and format of the study reports are specified in the *Guidelines and Criteria for the Phase A Concept Study* document.
  - Per the Concept Study Guidelines schedule, final reports must be delivered to address specified NLT 4:30 pm EDT, **September 12, 2007**.
  - HQ/Barbara Giles has responsibility for the downselect process.
  - LaRC/Waldo Rodriguez is the Acquisition Manager and will manage the evaluation process.
- After that time, the choice of which investigation team, if any, will continue into Phase B will be based upon review of the Phase A concept studies and other programmatic considerations.
- Afterwards, approval to proceed into implementation will require successful completion of a full Confirmation Review with the Science Mission Directorate (SMD) Associate Administrator (AA).

NASA FY08 Budget News

Q5. *NASA's FY08 budget contains the following statement regarding the Geospace Mission of Opportunity, "The Phase A studies will conclude in FY2008, however it is anticipated that no investigation will be selected for Phase B in FY2008". Are you able to provide clarification on this statement? Is our Phase A study being canceled?*

A5. The FY2008 budget language reflects the fact that NASA, working with the Office of Management and Budget (OMB), was not able to support a separate LWS Geospace Mission of Opportunity funding line for the years FY08 and beyond, within the resources requested for NASA in the President's FY08 budget request. This announcement does not affect FY2007 budget planning. All mission of opportunity teams should continue their work as planned. **The Heliophysics Division will review the results of the concept studies and the available funding at the end of the planned Phase A activities and make a decision at that time as how to proceed.** (posted: February 8, 2007)