Solving Magnetospheric Acceleration, Reconnection and Turbulence (SMART)

MISSION DEFINITION

MMS-SMART will perform the first definitive study of magnetic reconnection in space and will test critical hypotheses about reconnection derived from the latest theories and spacecraft measurements. The SMART payload is optimized to make the required high-time-resolution measurements of plasmas, electric fields, and magnetic fields. SMART will also provide important supporting measurements of energetic particles and ion composition. The SMART plasma composition instrument is a new design that for the first time will solve the problem of identifying minor ions within regions of high proton fluxes. SMART will also solve known difficulties associated with low-energy plasma and electric-field measurements by including a flight-proven charge neutralization device. The accuracy of the electric field measurements will be further optimized by the inclusion of an electron-drift electric-field detector, which is immune to the plasma sheath effects that typically bedevil double-probe detectors. A three-phase low-inclination orbit strategy will probe the most likely reconnection sites on both the dayside magnetopause and in the magnetotail. Data from the three mission phases will be assimilated into continuously refined reconnection models in a way that will lead to fundamental advances in our understanding of reconnection. SMART will also address the MMS secondary science objectives.

SCIENCE OBJECTIVES

Overall Scientific Objectives: To discover the detailed physics of the reconnection process including the factors that control it, its spatial distribution, and its temporal behavior.

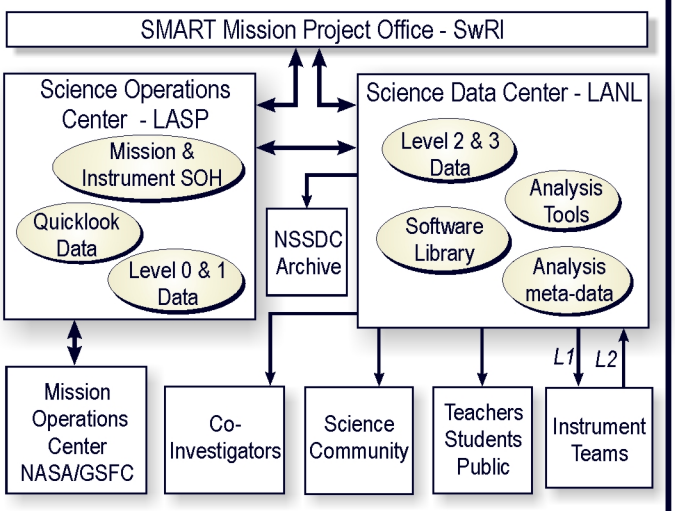
Primary Science Questions:

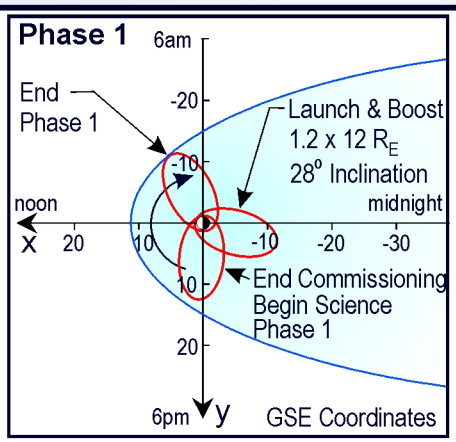
1) What are the kinetic processes responsible for collisionless magnetic reconnection, and how is reconnection initiated?
2) Where does reconnection occur in the magnetopause and in the magnetotail, and what influences where it occurs?
3) How does reconnection vary with time, and what factors influence its temporal behavior?
4) How do flux transfer events and plasmoids/magnetotail flux ropes form, and how do they evolve?

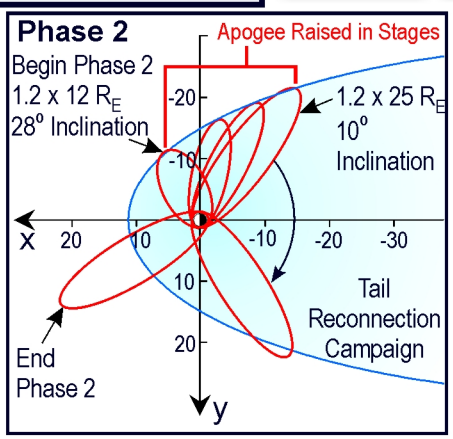
Secondary Science Questions:

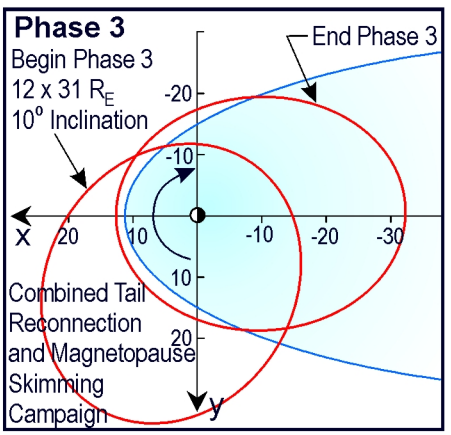
1) What is the role of inductive electric fields and wave-particle interactions in acceleration processes?
2) What are the properties and processes associated with magnetospheric turbulence?

MISSION OPERATIONS AND DATA FLOW









EDUCATION AND PUBLIC OUTREACH

The MMS-SMART PI, **Dr. James L. Burch,** is personally committed to the SMART E/PO effort. The SMART E/PO lead is Rice University professor Patricia Reiff, a well-known leader in space physics E/PO and teacher enhancement programs. SMART E/PO products will be distributed through an established network of teacher organizations and museums as well as through SECEF and LWS outreach programs. SMART E/PO will

- Support three or four Master Teachers each year as part of Rice University's Master of Science Teaching Program.
- Develop two inquiry-based modules–"Micro to Macro" and "What Changed?"–aligned with national math and science standards for use in teacher workshops.
- Produce "Sounds of Space," which uses data "sonification" techniques to make SMART science accessible to visually impaired learners.
- Disseminate SMART science to students, teachers, and the public through the SMART web site, museum exhibits, immersive planetarium shows, and an updated version of the Space Weather CD-ROM.
- Evaluate during Phase B the addition of a small student-developed SSD to the SMART payload.

SCIENCE PAYLOAD

Fields
*Spin Plane Double Probe (SDP; 4 ea.)
*Axial Double Probe (ADP; 2 ea.)
*Electron Drift Instrument (EDI; 2 ea.)
*Analog Flux Gate Magnetometer (AFG)
Digital Flux Gate Magnetometer (DFG)
Search Coil Magnetometer (SCM)
*Central Electronics Box (CEB)

Fast Plasma
*Dual Electron Sensors (DES; 4 ea.)
*Dual Ion Spectrometers (DIS; 4 ea.)
*Instrument Data Processing Unit (IDPU)

Plasma Composition
Hot Plasma Composition Analyzer (HPCA)

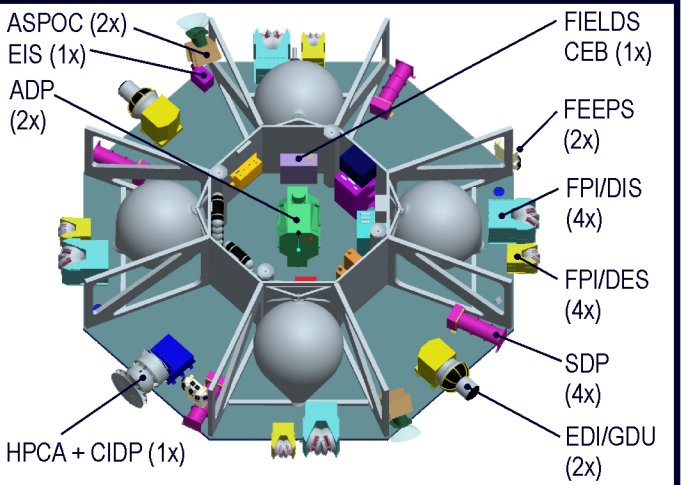
Energetic Particles
*Fly's Eye Energetic Particle Sensor (FEEPS; 2 ea.)
Energetic Ion Spectrometer (EIS)

Spacecraft Potential Control
*Active Spacecraft Potential Control (ASPOC; 2 ea.)

Payload Processor
*Central Instrument Data Processor (CIDP, redundant)

(*Element of minimum payload)

PAYLOAD LAYOUT



PAYLOAD MASS & POWER ALLOCATIONS

Subsystem	Mass (kg)		Power (Watts)	
	CBE	Contingency	CBE	Contingency
Fields	32.40	3.72	13.84	1.89
Fast Plasma	15.00	1.60	11.34	2.27
HPCA	5.88	1.17	6.13	1.23
Energetic Particles	2.54	0.45	1.52	0.21
ASPOC	3.68	0.37	1.96	0.49
CIDP	0.76	0.11	1.92	0.19
Misc.	4.79	1.19	N/A	N/A
Total	**65.05**	**8.61**	**36.71**	**6.28**

TEAMING ARRANGEMENT

Southwest Research Institute: Primary Contractor	SMART Team Lead Ion Composition Lead Central Instrument Data Processor Lead Payload Integration Lead
University of New Hampshire:	Fields Suite Lead
Goddard Space Flight Center:	Fast Plasma Lead Theory & Modeling Lead
Applied Physics Laboratory:	Energetic Particles Lead
Austrian Academy of Sciences:	ASPOC Lead

Other Hardware-Providing Institutions:

Fields
Austrian Academy of Sciences
French Center for Terrestrial and Planetary Environments
Swedish Institute of Space Physics
Swedish Royal Institute of Technology
Technical University of Braunschweig
University of California at Los Angeles
University of Colorado at Boulder
University of Iowa

Fast Plasma Investigation
Japan Aerospace Exploration Agency

Ion Composition
Applied Physics Laboratory
Lockheed Martin Advanced Technology Center
Los Alamos National Laboratory

Energetic Particles
The Aerospace Corporation

MISSION MANAGEMENT

Principal Investigator
Dr. James L. Burch, SwRI

Project Manager
Mr. Bill Gibson, SwRI

Payload Systems Engineer
Mr. Ron Black, SwRI

Fields Team Lead
Prof. Roy Torbert, UNH

Fast Plasma Lead
Dr. Thomas E. Moore, GSFC

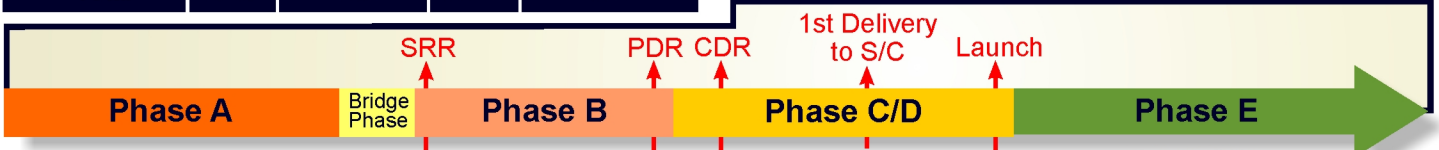
Plasma Composition Lead
Dr. David Young, SwRI

Energetic Particle Lead
Dr. Barry Mauk, APL

Theory and Modeling Team Lead
Dr. Michael Hesse, GSFC

Education & Public Outreach Lead
Prof. Patricia Reiff, Rice Univ.

SCHEDULE AND COST SUMMARY



Phase A	Bridge Phase	Phase B	Phase C/D	Phase E
10/03-09/04 $970K FY03 $1000K RY		10/04-1/06 $20,432K FY03 $22,010K RY	02/06-04/10 $88,300K FY03 $100,463K RY	04/10-04/13 $12,526K FY03 $16,277K RY

Total Cost $139.75 M RY **20% cost reserves on Phase C/D, 10% cost reserves on Phase E**

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