# TIME HISTORY OF EVENTS AND MACROSCALE INTERACTIONS DURING SUBSTORMS

## **THEMIS Science Objectives:**

- Onset and evolution of the macroscale *sub-storm instability*, a fundamental mode of mass, and energy transport throughout Geospace.
- Production of storm-time MeV electrons.
- Control of the solar wind-magnetosphere coupling by the bow shock, magnetosheath, and magnetopause.



*Figure B-1. THEMIS objectives are addressed by 300 hrs/yr of tail-aligned four-probe conjunctions.* 

## Alignment with NASA Strategic Objectives:

- How does our planet respond to solar variations? (Quest II of NASA SEC Theme).
- How does solar variability affect society? (Quest IV of NASA SEC Theme).

THEMIS is essential for understanding Earth's space environment and a prerequisite to understanding space weather.

## **Relationship to MMS:**

THEMIS is a macroscale mission, with objectives and orbits complementary to those of micro/meso scale mission MMS.





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<sup>†</sup> Co-Is responsible for hardware delivery are italicized			

 Table B-1.
 THEMIS science team.

## **Mission Primary Objectives:**

- Establish when and where substorms start.
- Determine how the individual substorm components interact macroscopically.
- Determine how substorms power the aurora.
- Identify how the substorm instability couples dynamically to local current disruption modes.

## **Mission Characteristics:**

- Five-probe, 2yr lifetime baseline mission.
- Each tail-phase (winter) apogees align over US/Canada without routine stationkeeping.
- Ground-based determination of auroral onset.
- Instruments identical to ones recently built and flown by high-heritage institutions (Table B-1).
- Team members are leaders in substorm studies.

### **Science Payload:**

- 3D FluxGate and Search Coil Magnetometers (FGM, SCM) obtain 1024 vector/s waveforms.
- 3D Electric Field Instrument (EFI) obtains DC to 1024 vector/s waveforms.
- Electrostatic Analyzer (ESA) measures  $i^+/e^-$  of energy 5eV-30keV (over  $4\pi$  str once per spin).
- Solid State Telescope (SST) measures i<sup>+</sup>/e<sup>-</sup> of 20keV-1MeV (over 108°×360° once per spin).

#### **Spacecraft Characteristics:**

- Spin-stabilized (T<sub>spin</sub>=3s) probes.
- Dynamic stability maintained even during deployment fault scenarios.
- All components have flight heritage and are currently in production.
- Common instrument data processing unit built by single institution minimizes interfaces/risk
- Instrument and sub-system heritage coupled with LV capability provide for a mature design.

#### **Payload Accommodation:**



### Figure B-3. Deployed THEMIS probe.

#### **Education and Public Outreach:**

- Ground observatories at rural schools permit project-based activities & science data access.
- UCB's mature SEGWay program develops informal education materials on main SEC themes and distributes them to large audiences through its established museum partnerships.

#### Management:

- PI Institution has a combined 150 person-years of successful track-record in management of NASA SEC instruments and missions.
- Probe busses built by Swales, a SMEX-Lite commercialization outfit, with demonstrated flight spacecraft development experience.
- Instruments provided by a small and experienced team with proven working relationships.
- Instrument and Mission I&T at Swales with participation of UCB mission operations team.
- International co-I team of leaders in substorm, radiation belt and magnetopause research and a rapid data dissemination plan stimulate high-quality interactions and optimal science return.

#### Launch:

- Delta II 2425-10 at CCAS.
- No epoch restriction on
- launch window.
  Inclination change ΔV accomplished via single apogee kick motor (AKM).
- Probe carrier assembly (PCA) permits standard (Marmon clamp) attach interfaces and release.
- Figure B-4. PCA on 3rd stage in DeltaII 2425-10 fairing.

