THEMIS SciRR
EFI Science Measurement and Operations Requirements
June 3-4, 2003

Science Requirements

- The EFI shall determine the plasma pure convective motion at the times of onset at 8-10RE
- The EFI shall determine the dawn/dusk electric field at 18-30RE
- The EFI shall determine the low frequency (T~1min) wave mode and Poynting flux at the times of onset at 8-10RE
- The EFI shall measure the electric component of waves on the whistler branch during time of onset on all probes.

Performance requirements (measurement range and accuracy, measurement resolution)

- The EFI shall measure the 3D DC E-field with a time resolution of 10 s.
- The EFI shall measure the 3D AC E-field from 0-6 Hz, and up to 4 kHz for the whistler branch.
- The EFI shall measure the Spacecraft Potential with a time resolution better than the spin rate (3 seconds)
- The EFI FFT Spectra Range shall be 16Hz - 8kHz, with df/f ~50% (16 steps)
- The EFI Dynamic Range from 16Hz - 8kHz shall be 10^-4-10^1 mV m/ Hz^1/2
- The EFI HF RMS (Log power) measurement shall cover 100-500 kHz with a minimum time resolution of spin rate.

Measurement Accuracy Requirements:

- The EFI shall achieve an accuracy better than 10% or 1mV/m in the GSM Ey component during times of onset.

Resource requirements (mass, power, data volume/rates)

- The EFI shall not exceed the allocated mass budget (SYS-)
- The EFI shall not exceed the allocated power budget (SYS-)
- The EFI shall meet the following thermal requirements:
  Survival temperature range (no-op): -50C to +65C
  Operating temperature range: -20C to +40C (Swales +55C)
  Cold start: -50C

Fabrication, Integration and Test (Parts: MIDEX Quality Requirements, I&T, Hazards & Controls, Facilities, Calibration, Environmental Test, Spacecraft Integration)

- The transfer function of all EFI channels shall be measured on the ground to ensure absolute DC measurement accuracy to better than 0.1 mV/m.
- The physical mounting and electrical wiring of the installed EFI, FGM, and SCM sensors shall be verified and recorded for each sensor on each probe.
- The EFI, SCM, FGM, and DFB GSE shall support the intercalibration of the combined fields system.

- The functional test plan for DC and AC EFI testing shall be able to detect any number of dead analog channels (failure of BIAS, STUB, GUARD circuits as well?).

- Care shall be taken during Probe I&T to not damage the EFI preamps via ESD.

Contamination requirements (Particulate or molecular, Electromagnetic, Electrostatic)

- All instruments and the SC bus shall comply with the Electrostatic Cleanliness (ESC) standard described in TBD document. Compliance will be assured via the ESC Czar. (SYS-)

IDPU Requirements (Data Collection, Timing Signals, Flight Software processing)

IDPU Data Requirements: (I.IDPU-)

- The IDPU shall support the time tagging of DFB data to a resolution of 6.25 us.
- The relative sampling times of FGM, SCM and EFI channels shall be fixed and well known for all modes of operation.

IDPU/DFB Requirements: (I-IDPU-

- The IDPU DFB shall provide an FFT solution for determining the parallel and perpendicular components of E (and B) in both survey and burst modes and produce spectra for each quantity separately (FPGA-based)
- The IDPU DFB shall integrate FGM digital data and EFI data to produce E·B (FPGA-based)

IDPU/BEB Requirements: (I-IDPU-

- The IDPU BEB shall provide sensor biasing circuitry, stub and guard voltage control, and boom deployment for the EFI
- The IDPU BEB shall distribute a floating ground power supply to the EFI sensors
- The IDPU BEB shall generate six independent BIAS, GUARD and STUB voltages with an accuracy of 0.1% for distribution to the EFI sensors.

IDPU/LVPS Requirements:

- The IDPU/LVPS shall provide required regulated voltages and noise characteristics for the Instruments as detailed in the Instrument-IDPU ICDs (I.IDPU-)
- The LVPS shall be capable of providing the transient power needs required during all instrument boom deployments as detailed in the ICD (I.IDPU-)

IDPU/Flight Software Requirements:

- The IDPU/Flight Software shall provide for symmetric EFI boom deployment, EFI bias level sweeps and spin-fit E-field calculation.

Probe requirements (Attitude knowledge, Stability, Alignment)

Attitude Determination Requirements:

- The Bus spin axis shall be approximately 10 degrees to the ecliptic normal (spinning on nearly ecliptic plane)
- The Bus Izz-Zsc stability shall be less than 5.6 degrees
- The Bus Izz-Zsc stability knowledge shall be less than 1 degree
- The Bus shall maintain positive stability during nominal and worst-case EFI wire boom deployment and respin

Mechanical Requirements:

- The EFI radial booms shall be symmetrically placed around the probe center

Thermal Requirements:

- The EFI booms shall be above -20C during deployment

Operational requirements (Launch and Early Orbit, Maneuvers, Dayside/Nightside Operation)

Deploy and Commissioning Operations:

- Deploy of radial and axial booms must occur in real time.
- Deploy of radial booms will occur in stages, with SCIENCE STOPS in between.
- A SCIENCE STOP consists of halting the deployment of the radial booms with each pair at potentially a different deployed length, followed by several SLOW SWEEPS over the course of enough time for the SC to visit different density regimes.
- A SLOW SWEEP consists of a set of commands run by the IDPU/DPMB, instructing the BEB to cycle through a limited, but sufficient set of (BIAS, GUARD, STUB) settings in order to set the proper operating point for each sensor.
- The data from a given SCIENCE STOP must be processed and evaluated prior to beginning the next stage of the EFI sensor deployment on a given SC.
- Further SLOW SWEEPS will be scheduled over the subsequent N weeks after full deployment in order to track the development of the photoemission from the sensors.

Routine Operations:

- The nominal mode of operation for the EFI shall be sunlit; see Eclipse Operations for changes when in eclipse.
- SLOW SWEEPS will be scheduled at 1-4-month intervals throughout routine science operations to allow adjustment of optimal (BIAS, GUARD, STUB) settings.
- SLOW SWEEPS will be scheduled within TBD orbits of the first opportunity for entering a new plasma regime (solar wind, magnetosheath, etc.) to allow determination of changes to biasing scheme, if necessary.

Eclipse Operations:

- The EFI BEB and preamps will stay on during normal duration eclipses in order to keep preamps warm, and to maintain low-fidelity E-field measurements.
- Small, positive bias current will be supplied to sensors to maintain some fidelity of E-field measurement in eclipse.
- The EFI BEB will be operated in a TBD manner during long eclipses, consistent with SC-wide survival operations.
- A set of SLOW SWEEPS will be run after any long eclipse to determine instrument health.

John Bonnell, 6 June 2003.