STEREO IMPACT UPDATE

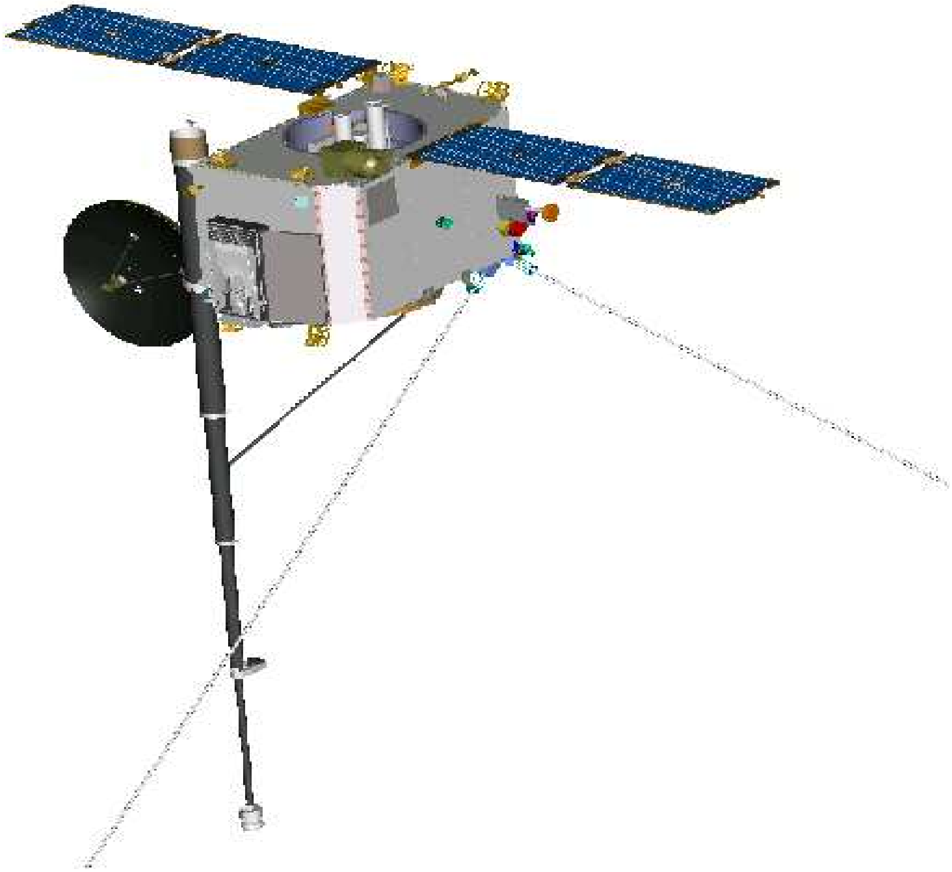
STEREO
IMPACT
UCB - NASA/GSFC- Caltech - U of MD - LANL - JPL - UCLA - SAIC - NOAA/SEC
U of MI - JHU/APL - MPAe - U of Kiel - CESR/CNRS - ESA/ESTEC -
DESPA/OBSPM - KFKI/RMKI

IMPACT (In-situ Measurements of Particles and CME Transients) Instrument Overview

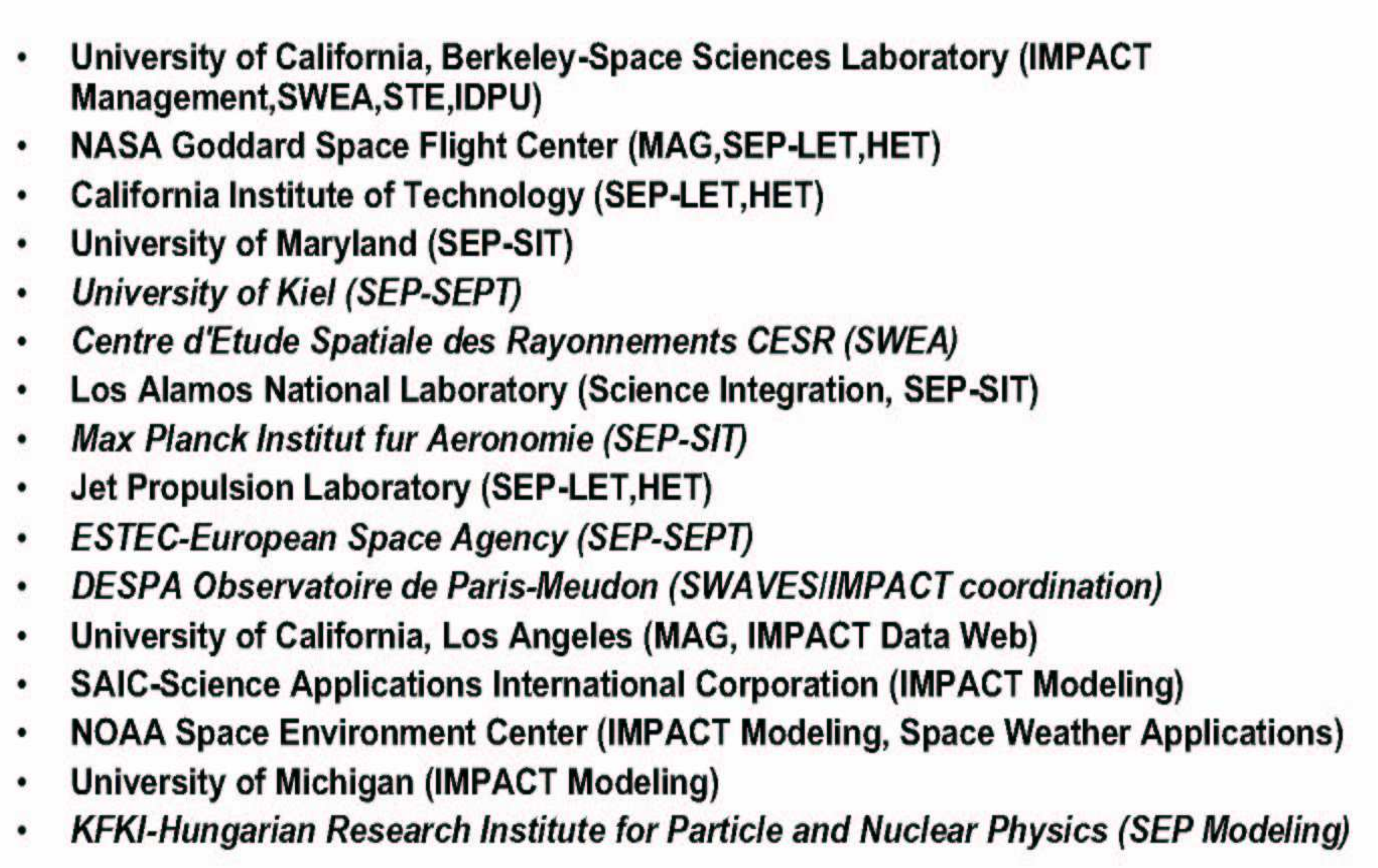
- **Boom Suite:**
  - Solar Wind Electron Analyzer (SWEA)
  - Suprathermal Electron Telescope (STE)
  - Magnetometer (MAG)

- **Solar Energetic Particles Package (SEP)**
  - Suprathermal Ion Telescope (SIT)
  - Solar Electron and Proton Telescope (SEPT)
  - Low Energy Telescope (LET)
  - High Energy Telescope (HET)

- **Support:**
  - IMPACT Boom
  - SEP Central
  - Instrument Data Processing Unit (IDPU)

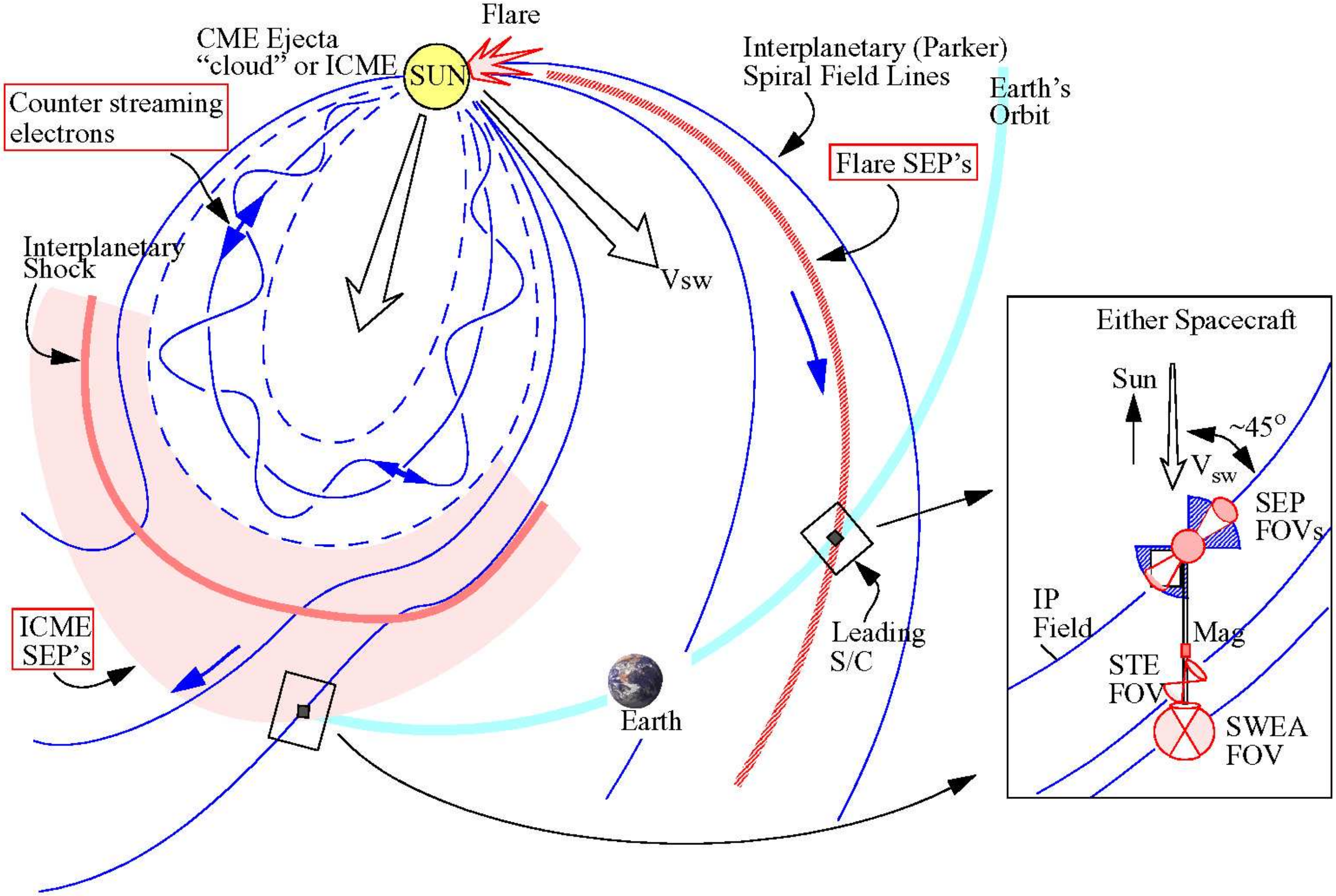


IMPACT Team Member Institutions and Primary Roles

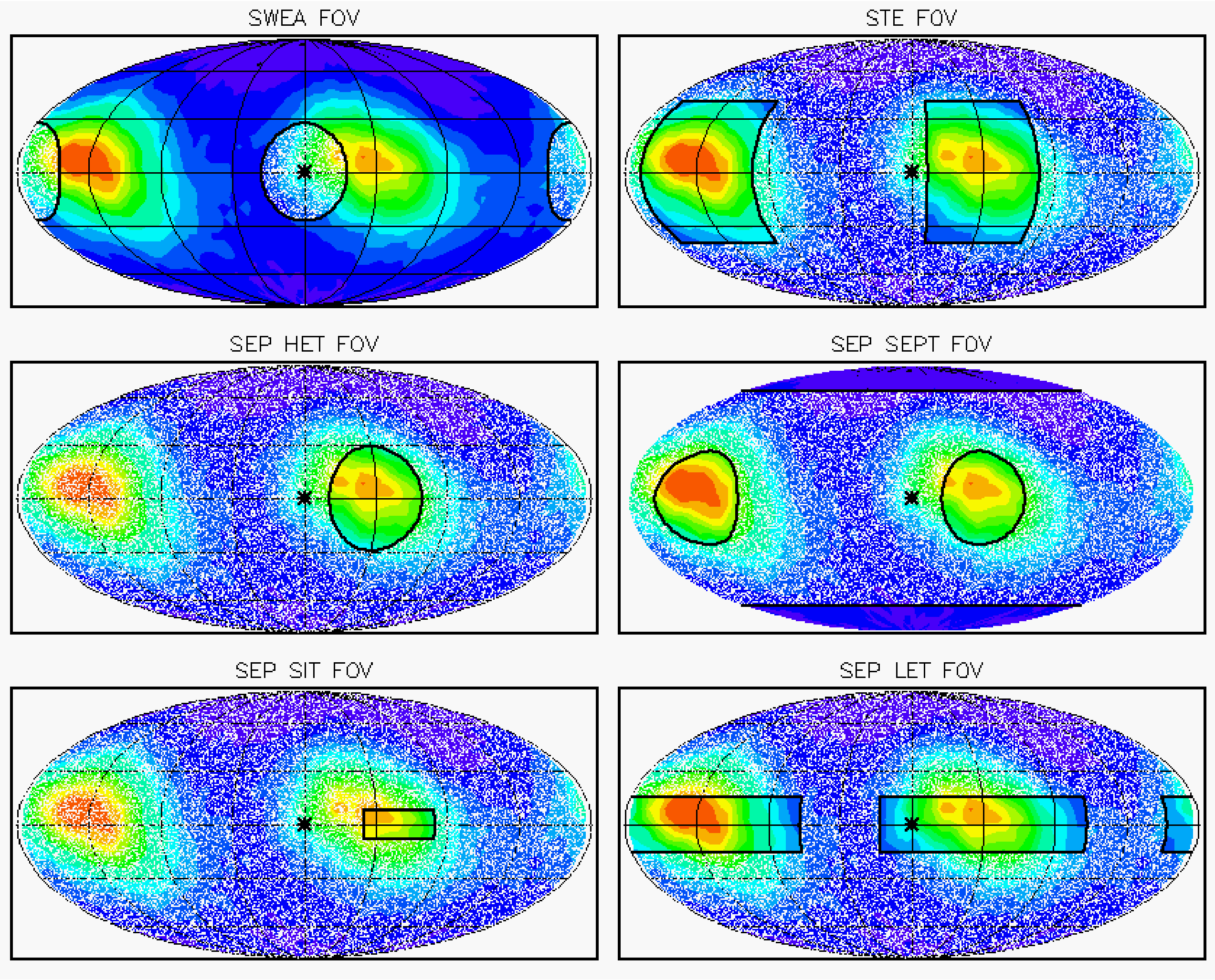


- University of California, Berkeley-Space Sciences Laboratory (IMPACT Management,SWEA,STE,IDPU)
- NASA Goddard Space Flight Center (MAG,SEP-LET,HET)
- California Institute of Technology (SEP-LET,HET)
- University of Maryland (SEP-SIT)
- *University of Kiel (SEP-SEPT)*
- *Centre d'Etude Spatiale des Rayonnements CESR (SWEA)*
- Los Alamos National Laboratory (Science Integration, SEP-SIT)
- *Max Planck Institut fur Aeronomie (SEP-SIT)*
- Jet Propulsion Laboratory (SEP-LET,HET)
- *ESTEC-European Space Agency (SEP-SEPT)*
- *DESPA Observatoire de Paris-Meudon (SWAVES/IMPACT coordination)*
- University of California, Los Angeles (MAG, IMPACT Data Web)
- SAIC-Science Applications International Corporation (IMPACT Modeling)
- NOAA Space Environment Center (IMPACT Modeling, Space Weather Applications)
- University of Michigan (IMPACT Modeling)
- *KFKI-Hungarian Research Institute for Particle and Nuclear Physics (SEP Modeling)*

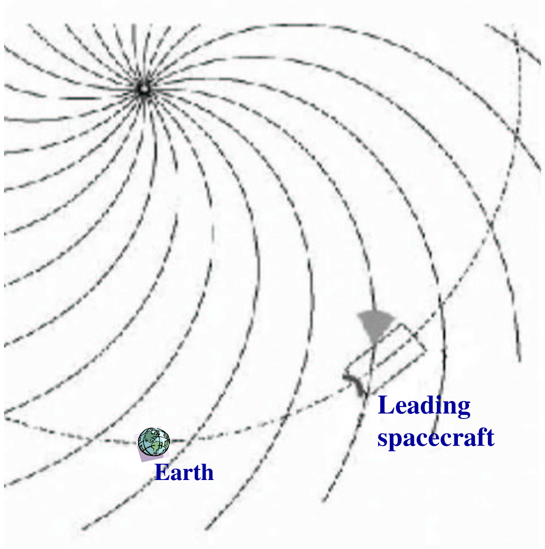
Overall IMPACT Investigation Rationale


Flare
CME Ejecta
“cloud” or ICME
SUN
Counter streaming
electrons
Interplanetary (Parker)
Spiral Field Lines
Earth’s
Orbit
Flare SEP’s
Interplanetary
Shock
Vsw
ICME
SEP’s
Earth
Leading
S/C
Either Spacecraft
Sun
~45°
V_{sw}
SEP
FOVs
IP
Field
Mag
STE
FOV
SWEA
FOV

IMPACT Directional Coverage

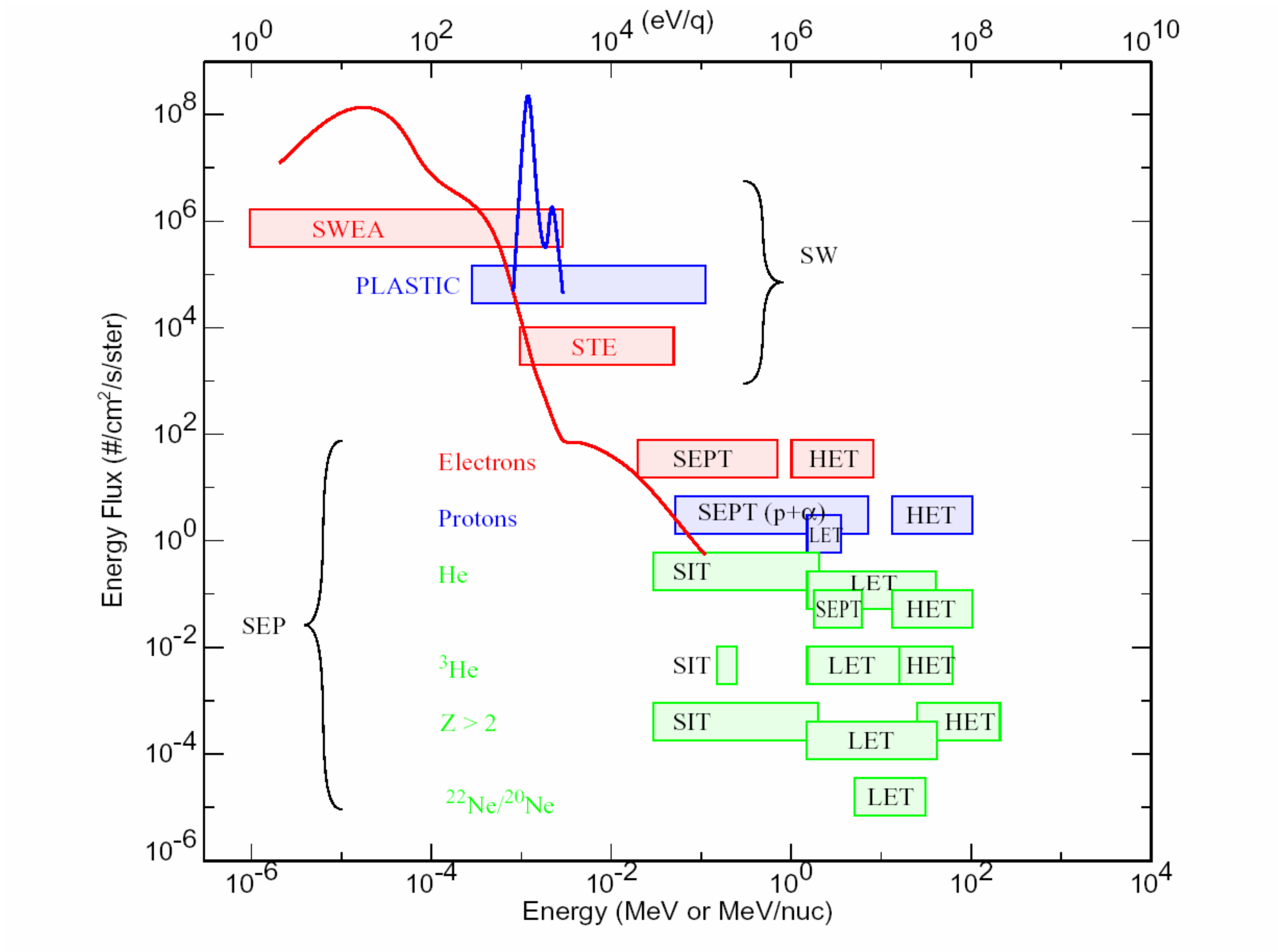


Parker Spiral

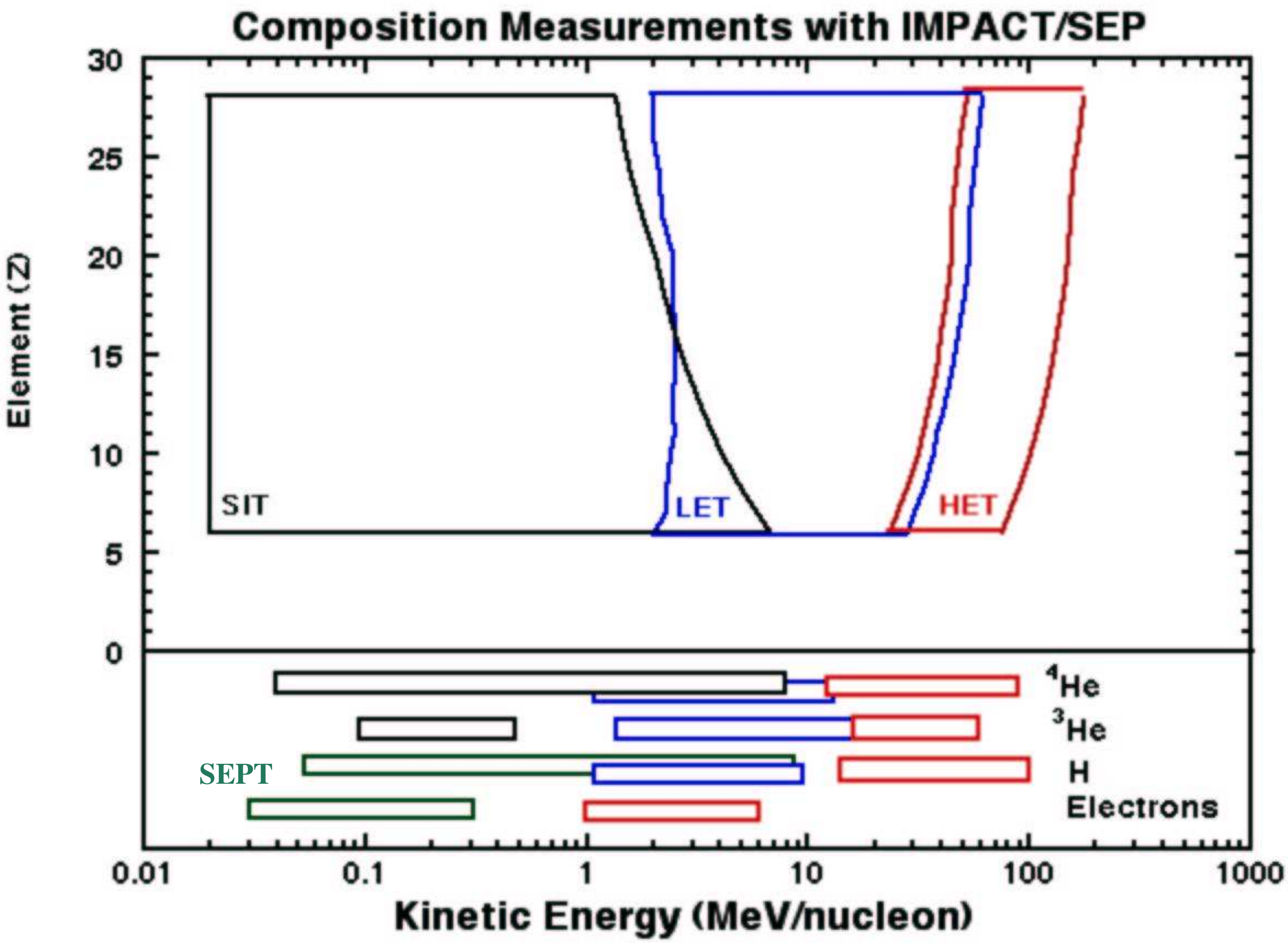


Mercator projection of 4 π angular coverage sphere. Sun in center. Contours show statistics of interplanetary field direction. Dark lines show IMPACT particle instrument fields of view.

IMPACT Energy & Flux Coverage: Solar Wind, Suprathermal and SEP electrons, SEP ions



SEP Ions Composition Coverage



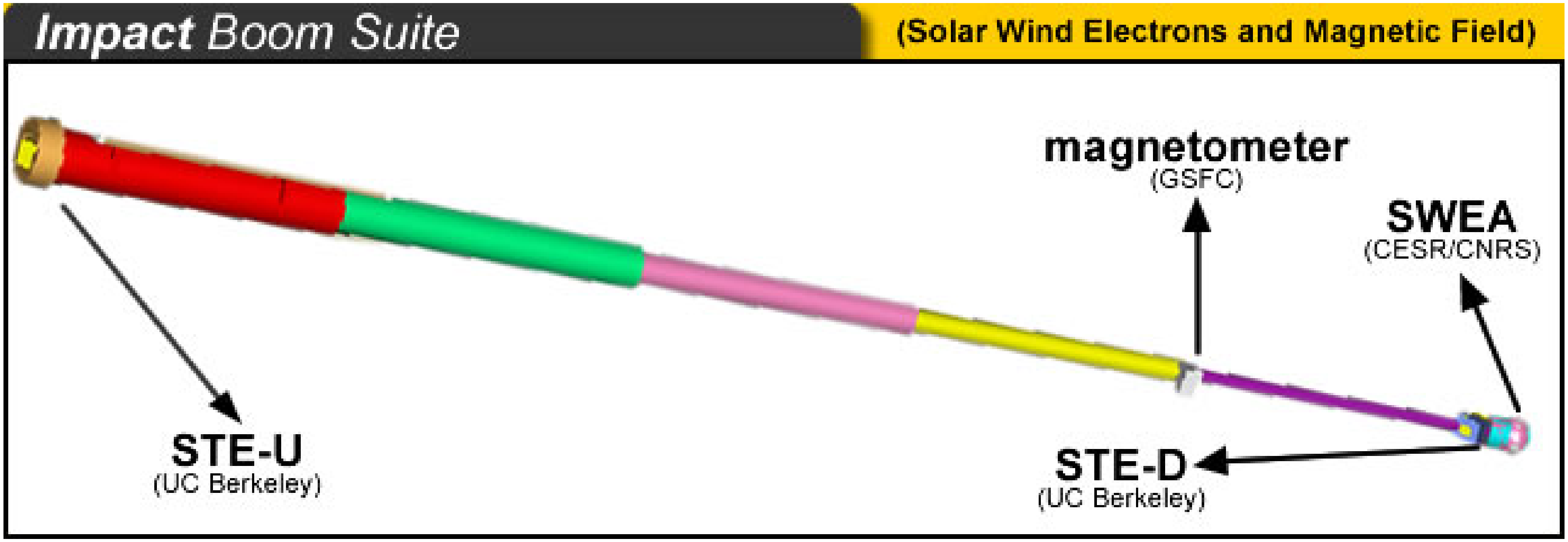
Basic IMPACT Measurements

Experiment	Instrument	Measurement	Energy or Mag. field range	Time Res.	Beacon Time Res. (*)	Instrument provider
SW	STE	Electron flux and anistropy	2-100 keV	16 s	2D x 3E, 60s	UCB (Lin)
	SWEA	3D electron distrib., core & halo density, temp. & anisotropy	~0-3 keV	3D=1 min 2D=8s Mom.=2s	Moments, 60s	CESR (Sauvaud) + UCB (Lin)
MAG	MAG	Vector field	±500nT, ±65536 nT	1/4 s	60s	GSFC (Acuna)
SEP	SIT	He to Fe ions	0.03-2 MeV/nuc	1 min	3S x 2E, 60s	U. of Md. (Mason) + MPAE (Korth) + GSFC (von Rosenvinge)
		^{3}He	0.15-0.25 MeV/nuc	1 min	----	
	SEPT	Diff. electron flux	20-400 keV	1 min	3E, 60s	U. of Kiel (Mueller-Mellin) + ESTEC (Sanderson)
		Diff. proton flux	60-7000 keV	1 min	3E, 60s	
		Anistropies of e,p	As above	15 min	----	
	LET	Ion mass numbers 2-28 & anisotropy	3-30 MeV/nuc	1-15 min.	2S x 2E, 60s	Caltech (Mewaldt) + GSFC (von Rosenvinge) + JPL (Wiedenbeck)
		^{3}He ions flux & anistropy	2-15 MeV/nuc	15 min.	1E, 60s	
		H ions flux & anistropy	1.5-6 MeV	1-15 min.	1E, 60s	
	HET	Electrons flux	1-6 MeV	1-15 min.	1E, 60s	GSFC (von Rosenvinge) + Caltech (Mewaldt) + JPL (Wiedenbeck)
		H	13-100 MeV	1-15 min.	1E, 60s	
		He	13-100 MeV	1-15 min.	1E, 60s	
		^{3}He	15-60 MeV/nuc	15 min	----	
	SEP Common	----	----	----	----	Caltech (Mewaldt) + GSFC (von Rosenvinge)
IMPACT Common	IDPU (+Mag Analog)	----	----	----	----	UCB (Curtis)

Overall IMPACT Status, Test Readiness

- Instruments are in various states of readiness for test, as described below
  - SEPT instrument now in environmental testing; PER review held in January 2004

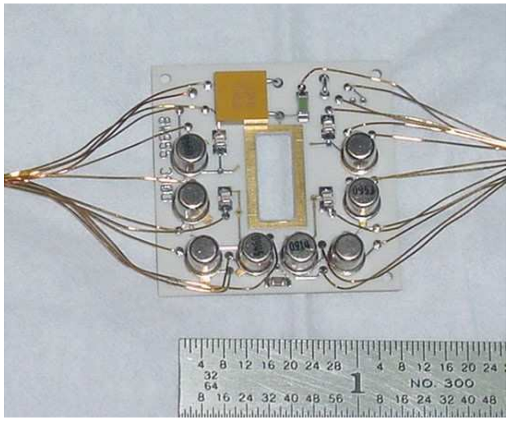
- Working towards a suite delivery to APL in October 2004
  - Boom and SEP suites deliver separately to APL
  - FM2 delivered ~2 weeks after FM1


Impact Boom Suite
(Solar Wind Electrons and Magnetic Field)
magnetometer
(GSFC)
SWEA
(CESR/CNRS)
STE-U
(UC Berkeley)
STE-D
(UC Berkeley)

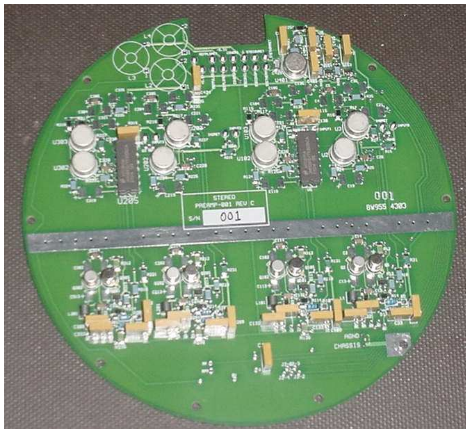
STE-U Status

- STE-U currently in fabrication
  - Detector boards built, detectors installed, in test
  - First preamp board complete and tested, remaining 3 in fabrication
  - Housing fabricated
  - STE door life test complete, >10x expected life, 5 year mission

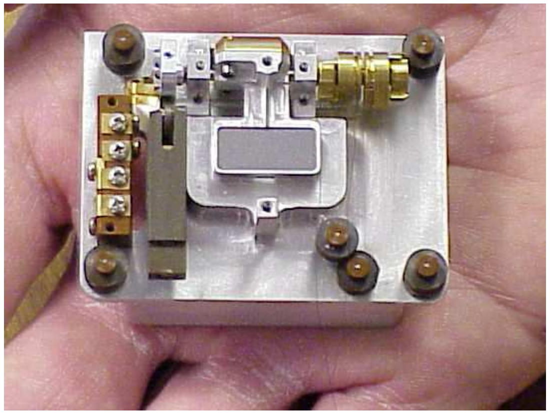
Flight STE Detector Board



Flight STE-U Preamp



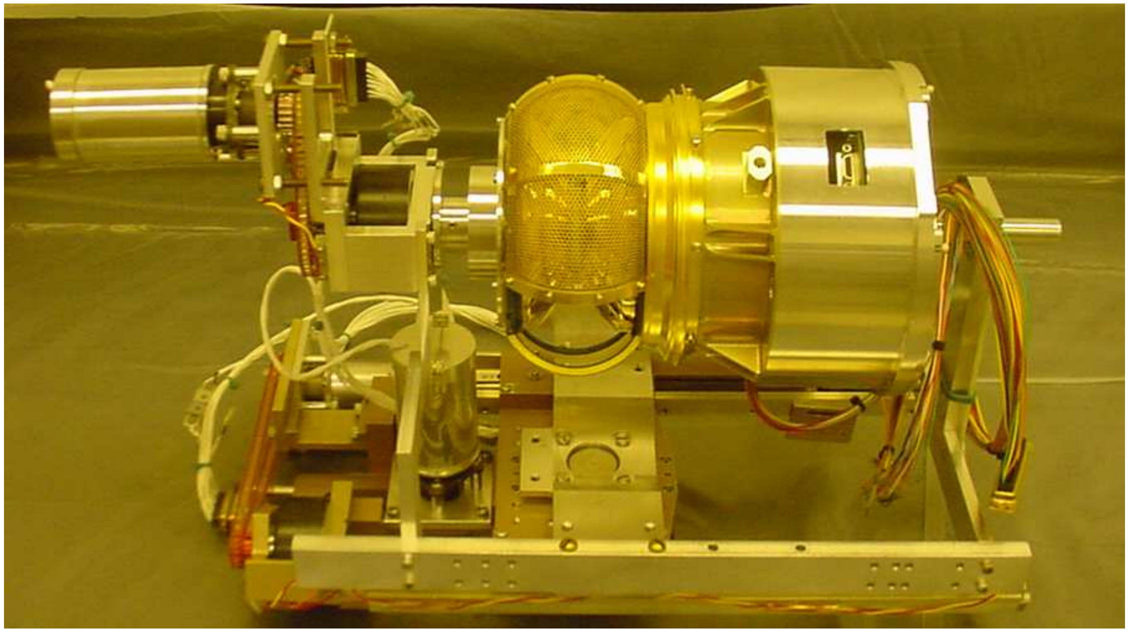
ETU STE Housing with Door



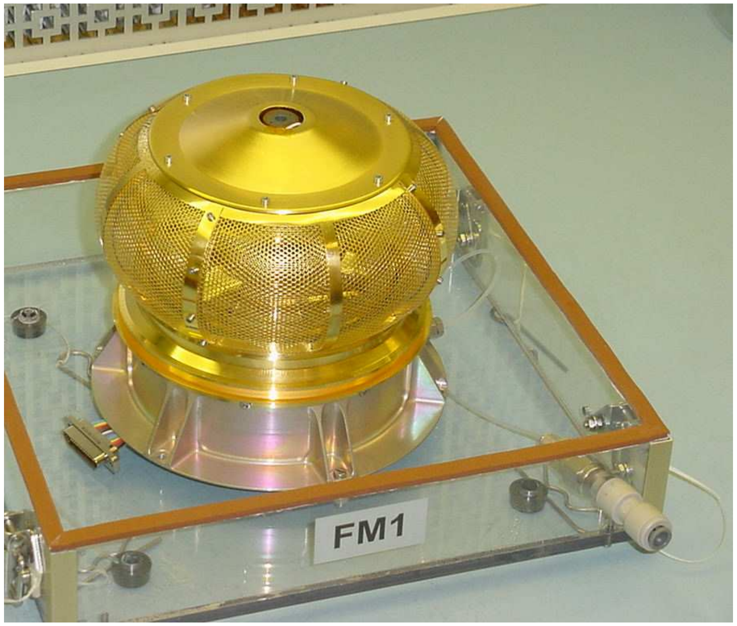
SWEA/STE-D Status

- **FM1 SWEA calibrated and delivered to UCB**
  - One open issue with a part failure
- **FM2 SWEA in calibration at CESR**
- **FM1 STE-D and pedestal electronics in fabrication**

ETU SWEA/Pedestal/STE-D assembly on manipulator at UCB



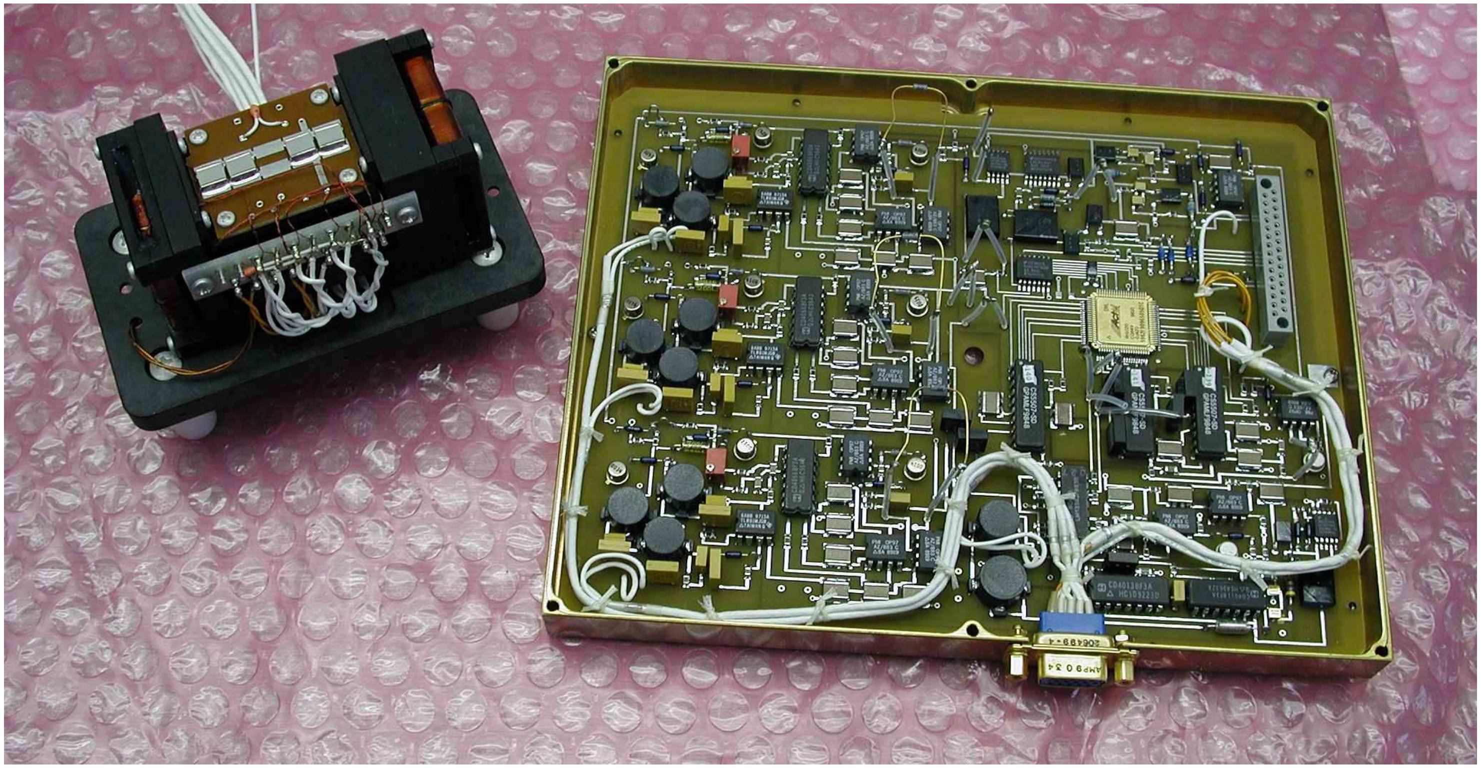
FM1 SWEA at UCB



MAG Status

- MAG FM1 complete, conformal coated, and in final tests
  - Some issues with conformal coat of heater boards
- MAG FM2 ready for conformal coat

FM1 MAG Electronics and FM2 MAG Sensor

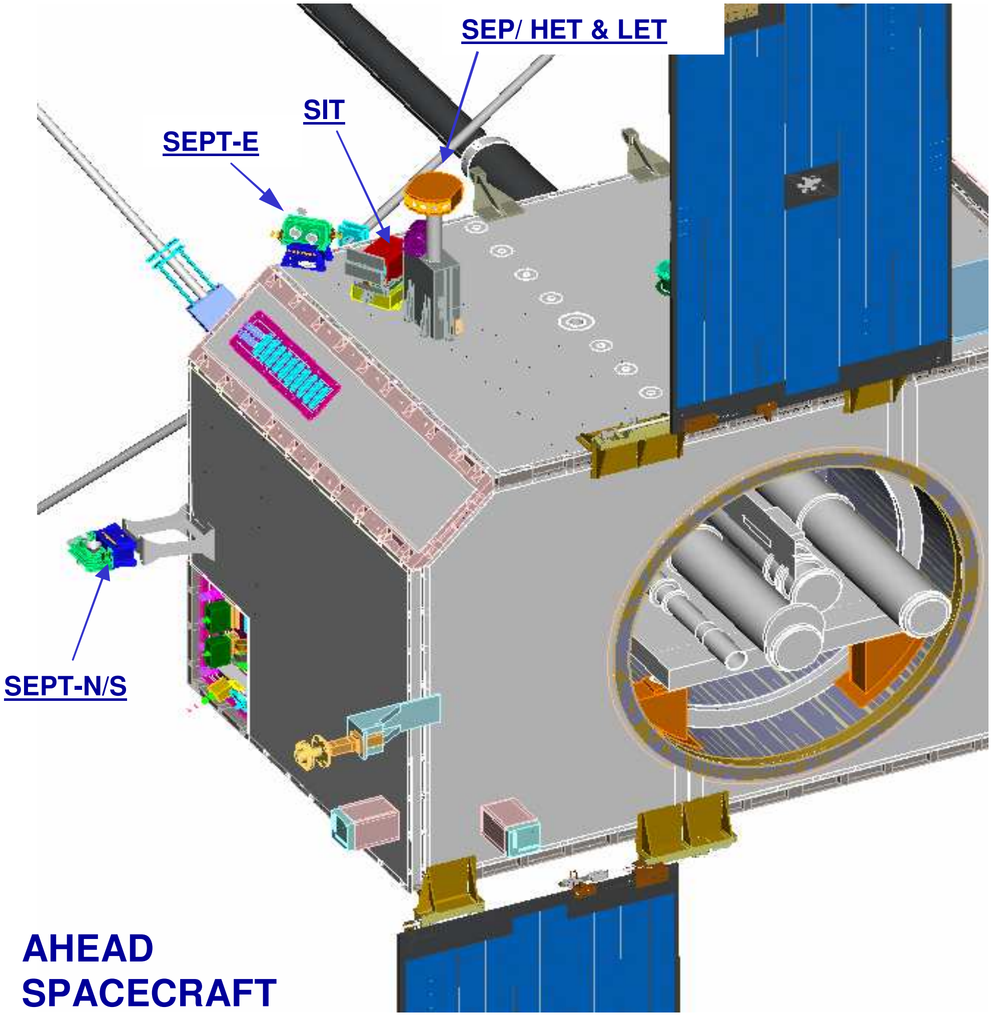


Boom Status

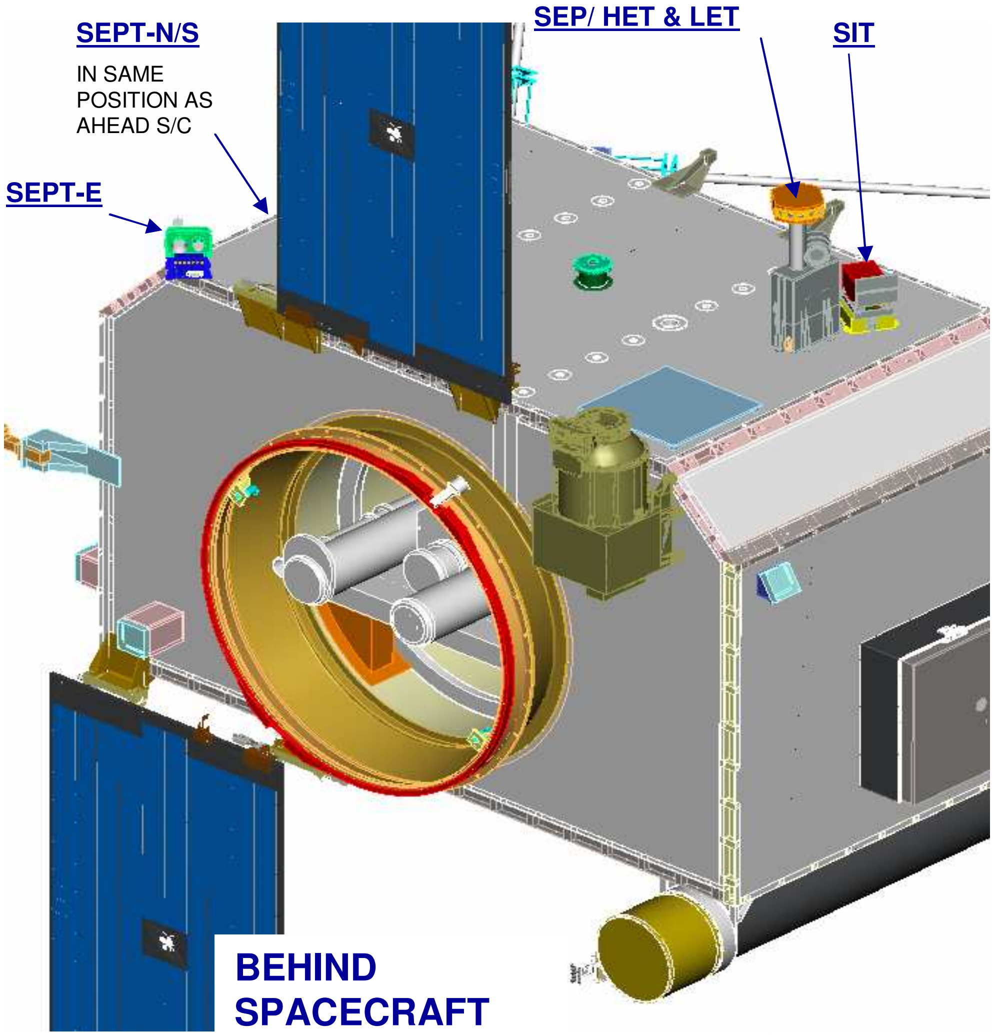
- Qual boom through qualification program
- FM1 and FM2 booms fabricated, in assembly

Qual boom ready for
thermal balance test

SEP Sensors on the Spacecraft

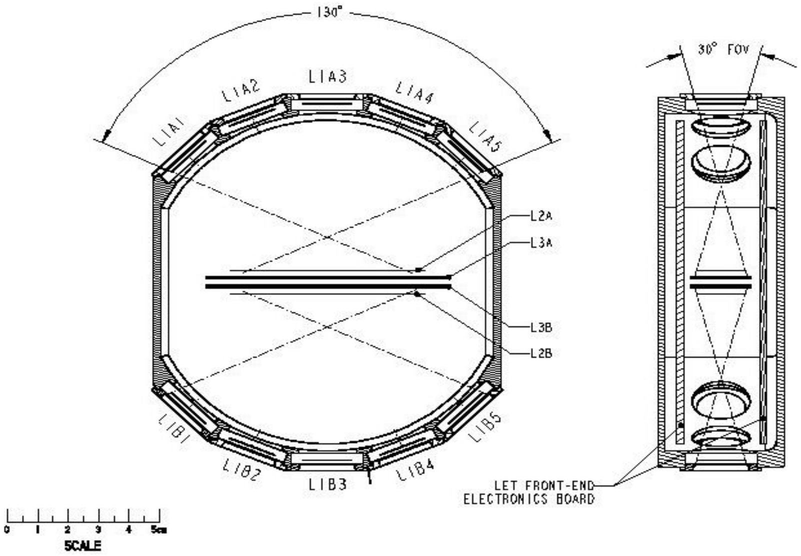

SEP/ HET & LET
SIT
SEPT-E
SEPT-N/S

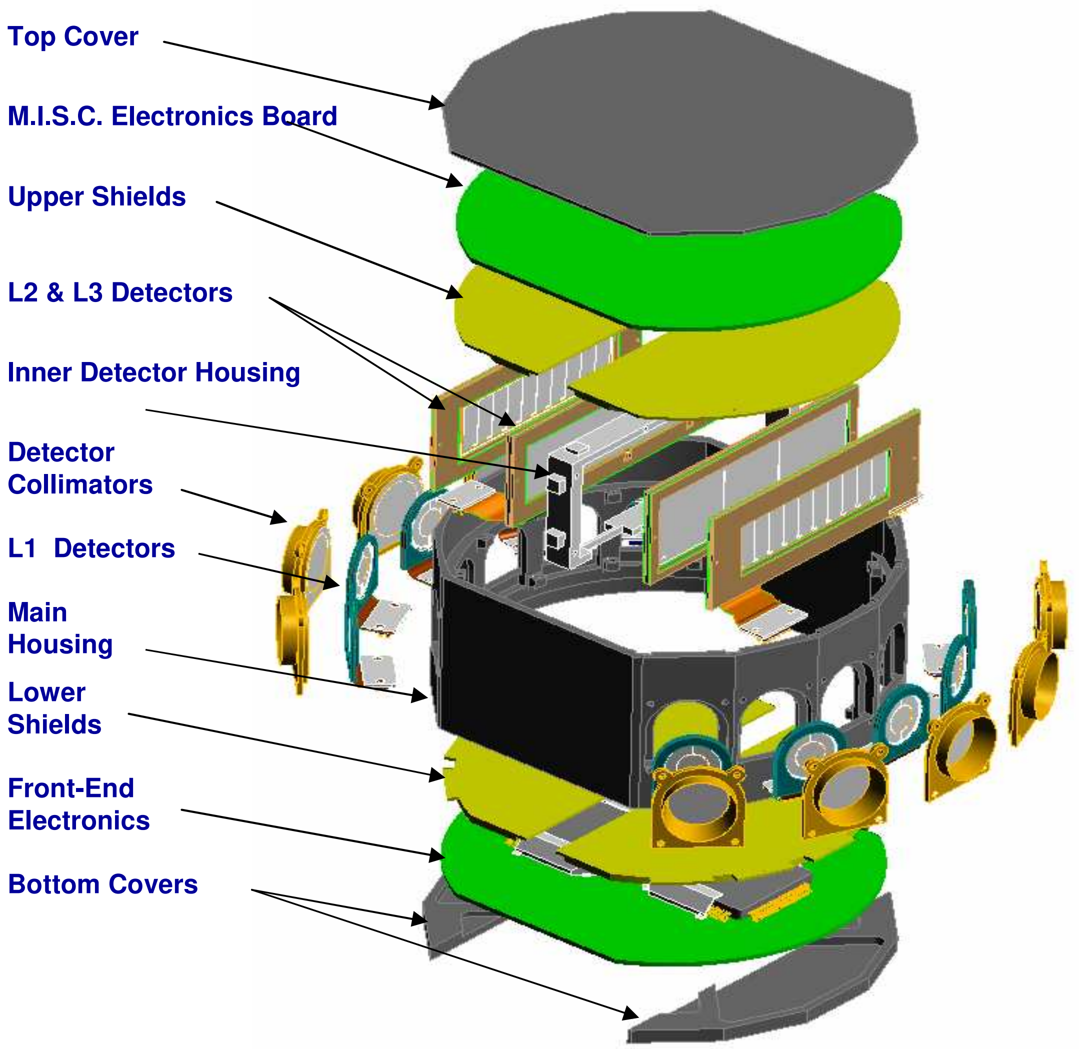
AHEAD SPACECRAFT


SEPT-N/S
IN SAME POSITION AS AHEAD S/C
SEPT-E
SEP/ HET & LET
SIT

BEHIND SPACECRAFT

Low Energy Telescope (LET) Schematic


130°
L1A1
L1A2
L1A3
L1A4
L1A5
L2A
L3A
L3B
L2B
L1B1
L1B2
L1B3
L1B4
L1B5
LET FRONT-END ELECTRONICS BOARD
30° FOV
0 1 2 3 4 5cm
SCALE



Top Cover

M.I.S.C. Electronics Board

Upper Shields

L2 & L3 Detectors

Inner Detector Housing

Detector Collimators

L1 Detectors

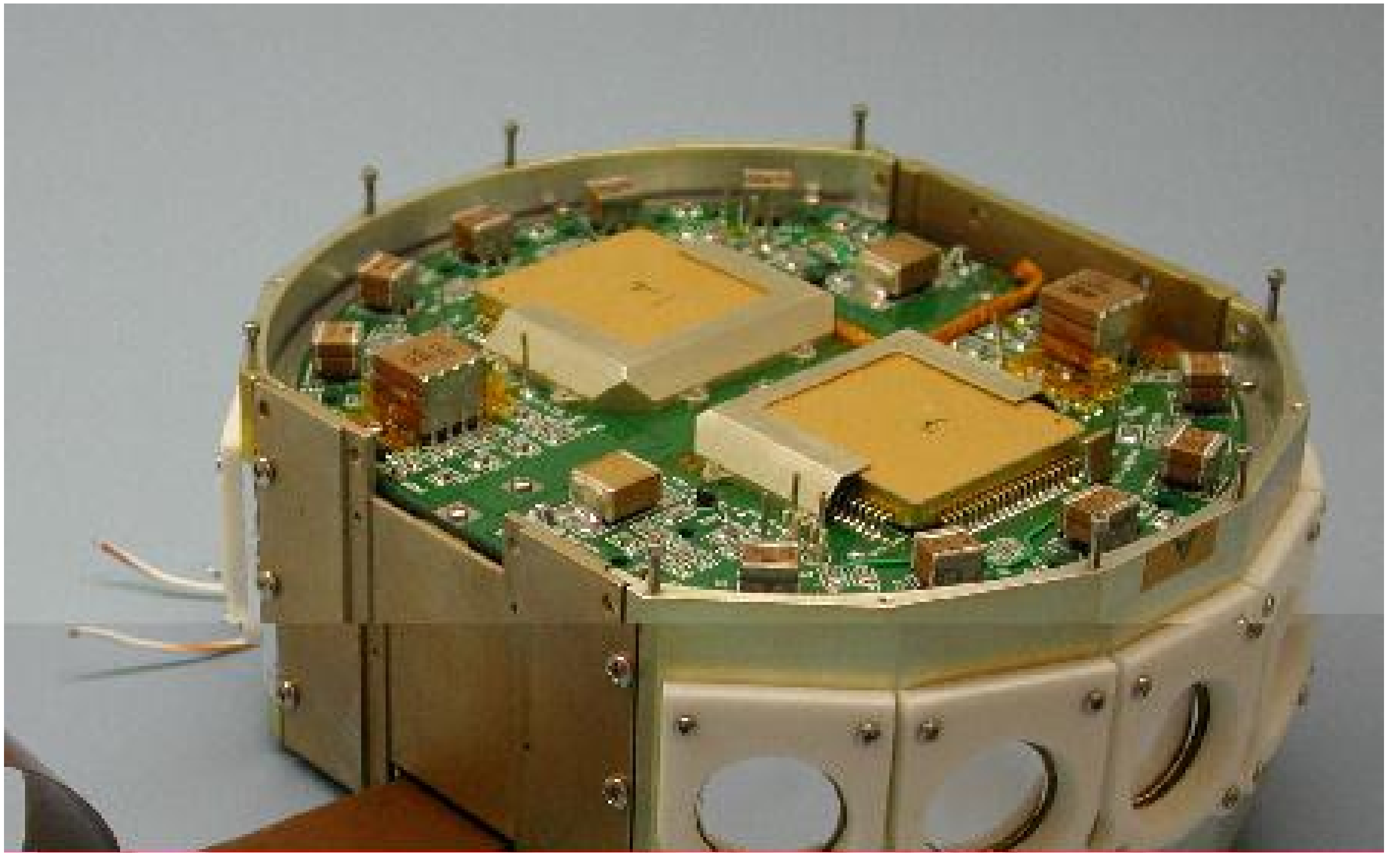
Main Housing

Lower Shields

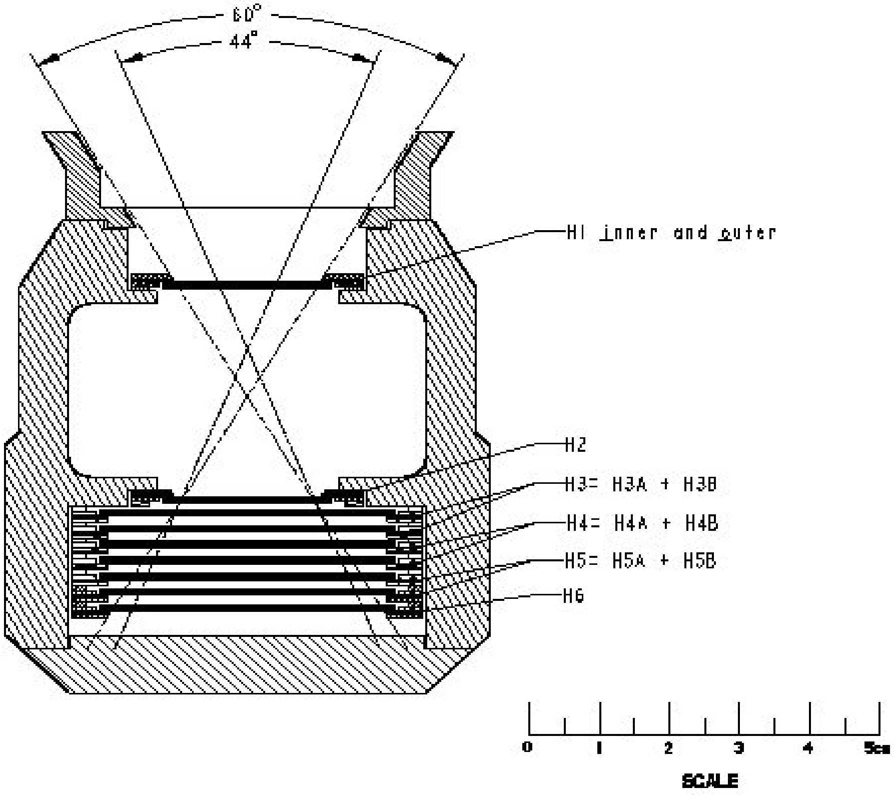
Front-End Electronics

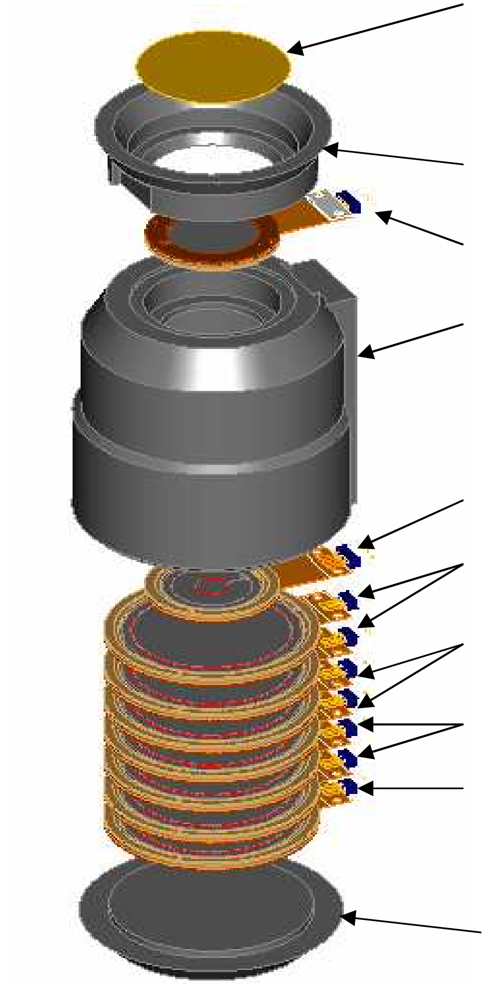
Bottom Covers

Low Energy Telescope (LET) EM Unit



HET Telescope Schematic


60°
44°
H1 inner and outer
H2
H3= H3A + H3B
H4= H4A + H4B
H5= H5A + H5B
H6
0
1
2
3
4
5cm
SCALE



Front Foil, 1/3mil Kapton
500A VDG inside
GSFC Comp. Coat and ITO
outside

Collimator

H1 Detector

Telescope Main Body

H2 Detector

H3A & H3B Detectors

H4A & H4B Detectors

H5A & H5B Detectors

H6 Detector

Telescope Bottom Cover

LET/HET/SEP Central Status

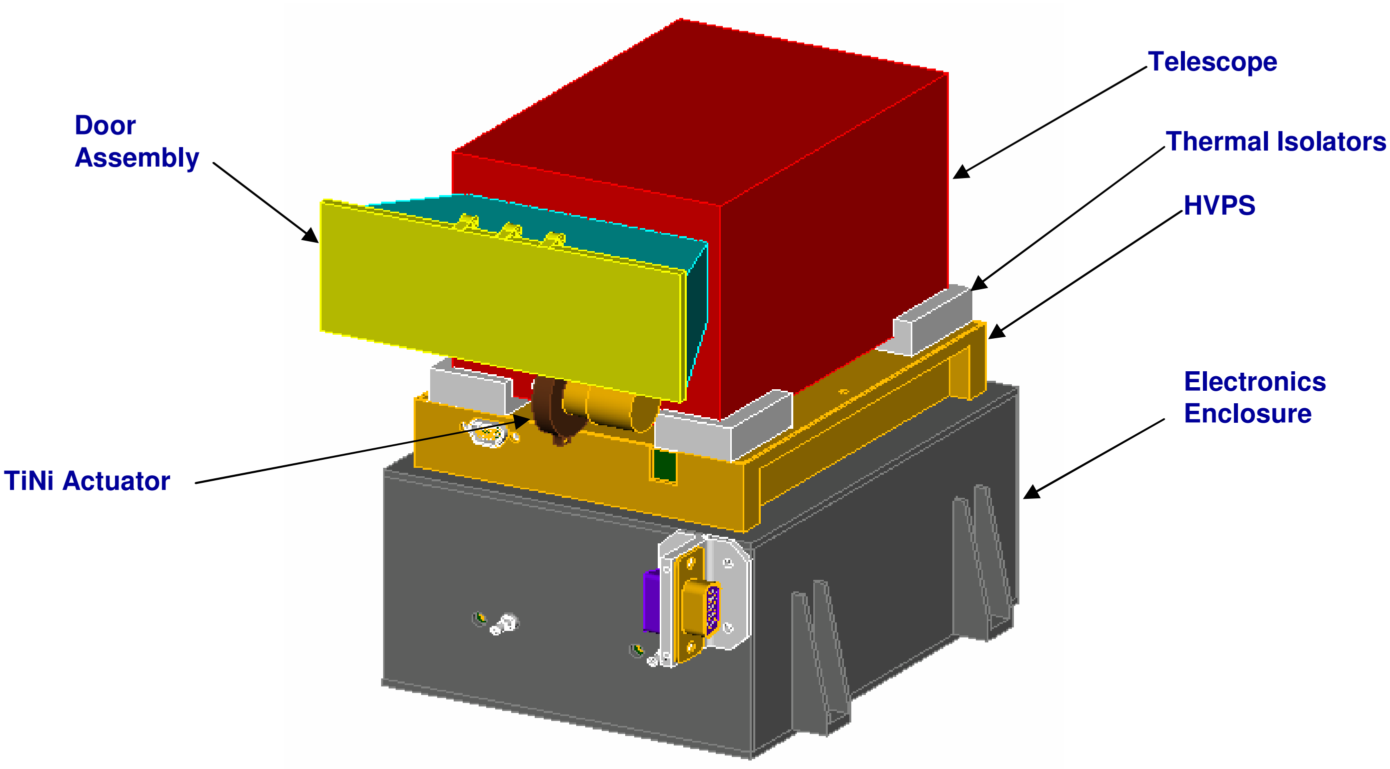
- SEP Central
  - Flight PCBs mostly assembled and in test
  - Housings are in final design stages – expect flight parts in March/April
  - Software ~80% complete

- LET
  - Detector testing mostly complete – will get a few replacements for failed devices
  - Hybrids complete except for quality testing
  - LET PCBs about 80% assembled
  - Housings are in final design stages – expect flight parts in March/April
  - Software ~90% complete

LET/HET/SEP Central Status (continued)

- **HET**
  - **Final ETU get-together in January at Caltech to exercise commands, uploads to E2PROM, and uploads to RAM**
  - **HET detectors: 9 H1 detectors (will fly 4) and 10 H3 detectors (will fly 14) are in house; testing is underway**
    - Leakage current growth problem with most of these detectors
    - A second batch has been received, will go to test soon
    - More detectors have been ordered
  - **Hybrids: flight PHASICs have all been received**
  - **Actels: Design and test complete, flight Actels programmed**
  - **FM1 and FM2 boards loaded, FM1 board passed final tests**
  - **Housings are in final design stage – expect flight parts by mid March**
  - **Software ~80% complete**
  - **Comprehensive Performance Test not yet defined**

SIT Instrument Assembly

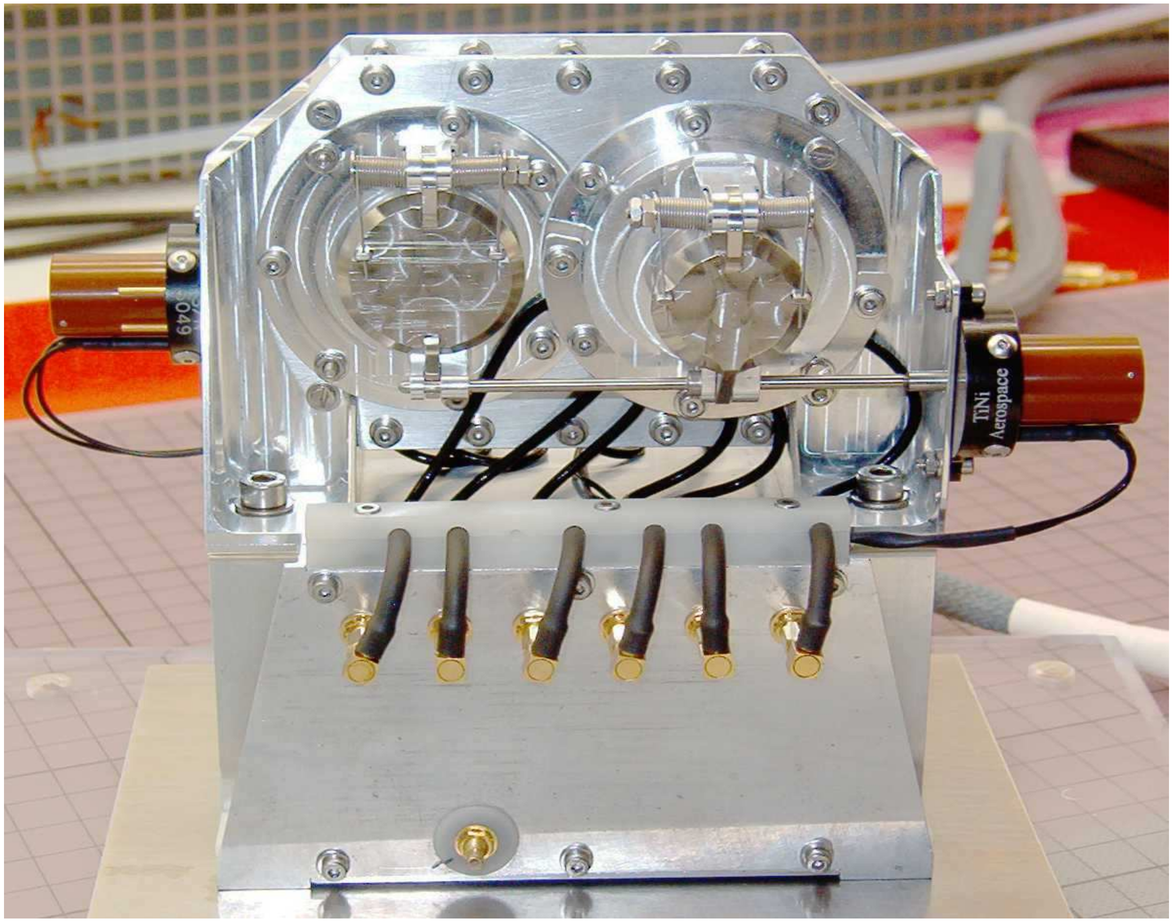

Door
Assembly
Telescope
Thermal Isolators
HVPS
Electronics
Enclosure
TiNi Actuator

SIT STATUS

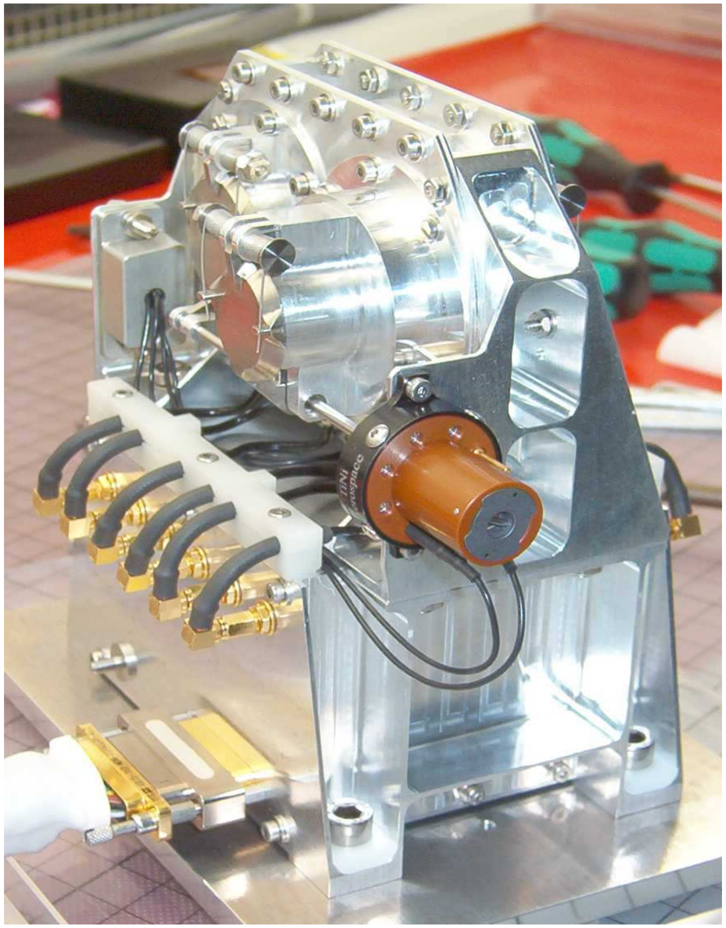
- SIT Telescope
  - ETU Telescope at UMd participating in SIT testing
  - Flight Foils at GSFC, MCPs tested at UMd and stored at GSFC
  - Flight SSDs under test at GSFC
- TOF System
  - New FM1 delivered to UMd, in test. FM2 in fab at MPAe.
- Energy Board
  - ETU is integrated in the ETU electronics at UMd. Flight units are under construction at GSFC.
- Logic Board/MISC
  - The updated ETU logic board and updated motherboard have been integrated with the remaining electronics. Testing is underway at UMd.
- HVPS
  - FM1 passed tests at UMd with ETU instrument. FM2 in assembly at UCB.
- Flight Software
  - Version 11/20/03 is installed in the ETU under test at UMd.

SEPT

Front View


TiNi
Aerospace

Side View

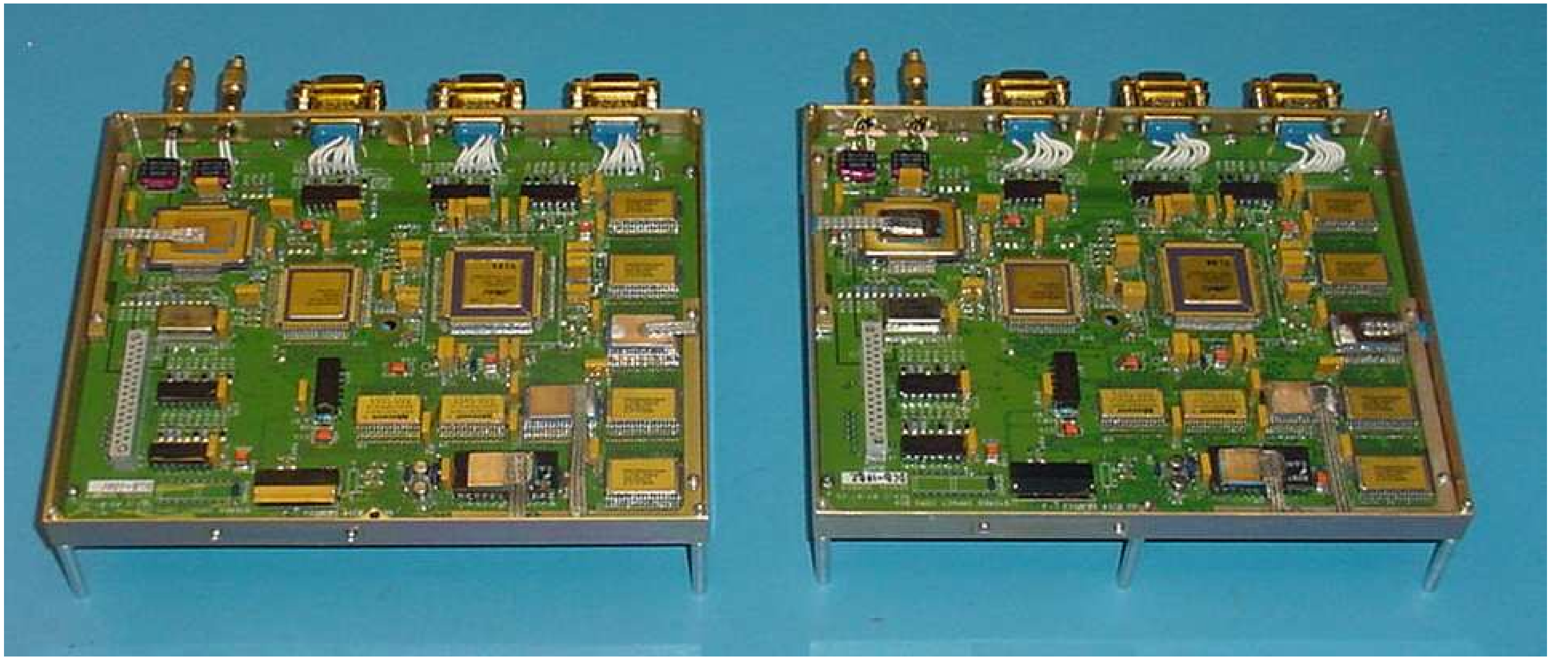


SEPT Status

- Four SEPT flight units and two brackets fully assembled, bench tested, and ready for environmental tests.
- Test Readiness Review for SEPT held on FEB 13, 2004.
- Vibration
  - Vibration test for SEPT-NS (FM1 and FM2) performed Feb 16 – 20, 2004.
  - Vibration test for SEPT-E (FM1 and FM2) performed Feb 20 – 24, 2004.
  - SEPT-NS FM2 failure during door opening test after vibration, Problem Report IMPACT PFR 7001 submitted on Mar 01, 2004.
  - Need for re-vibration of TBD axes to TBD levels.
- TV
  - Thermal vacuum test for SEPT-E and SEPT-NS (FM1) performed Mar 4 – 11, 2004.
  - Thermal vacuum test for SEPT-E and SEPT-NS (FM2) in progress.
  - Indications of possible detector problems (increased leakage current) detected during TV. Indications of possible door opening problems detected during TV. Analysis in progress.
  - Possible need for (partial) repetition of TV pending outcome of analysis.
- Thermal balance test scheduled for July 2004 at GSFC.

IDPU Status

IDPU Flight Data Controller Boards



- Data control board flight units done
- Comprehensive performance test run on ETU
- PLASTIC software progressing

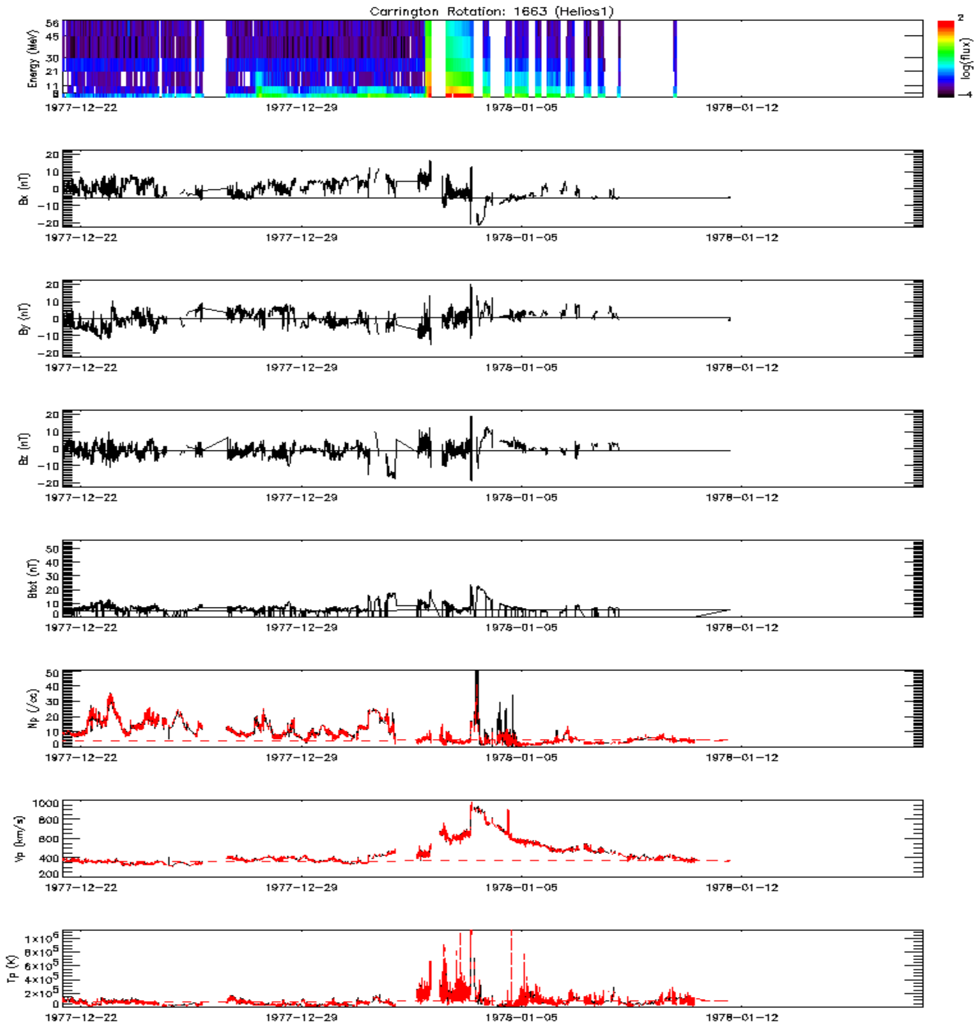
Science Data

- **Semantics**
  - Level 1 Data – Highest Time Resolution Data in Physical Units (available in CDF, ASCII, FITS, etc.) accessed from UCB
  - Level 2 Data – "Key Parameter" Data with 1 - Minute Resolution accessed from UCLA (interactive plotting and ASCII files available)
  - Level 3 Data – "Value – Added" Data (event lists…) accessed from UCLA
  - Beacon/Space Weather Data – Data containing NRT data products accessed from SSC
  - UCB will host a web page with links to all the above data sets
- **Level Two Browser**
  - UCLA will provide online browsing capability of Level 2 (Key-Parameter) Data from IMPACT, PLASTIC, and SWAVES (SECCHI?)
  - User able to select particular data sets across these instruments and instruments from other spacecraft for plotting
  - UCLA browser will support downloading of Level 2 Data in ASCII format
- **Level One Data in CDF**
  - List of Useful CDF Tools at: http://sprg.ssl.berkeley.edu/impact/peters/cdflinks.htm
  - Extremely Useful CDF Conversion Tool at: http://translators.gsfc.nasa.gov/home.jsp
- **Level One Summary Plots**
  - UCB will create a set of standardized summary plots using Level 1 (high time resolution) Data and including PLASTIC, SWAVES, and other data sets (ie. L1 spacecraft, GOES data, …) (SECCHI?)
  - UCB is investigating interactive plotting of Level One Data using ION (IDL Over the Net)
  - Allows access to UCB internal IDL libraries without the user needing to fuss with IDL or our software
  - Haven't done it before at UCB so will take time and resources
  - Like any widget, it would only be as smart and as flexible as we can dream up

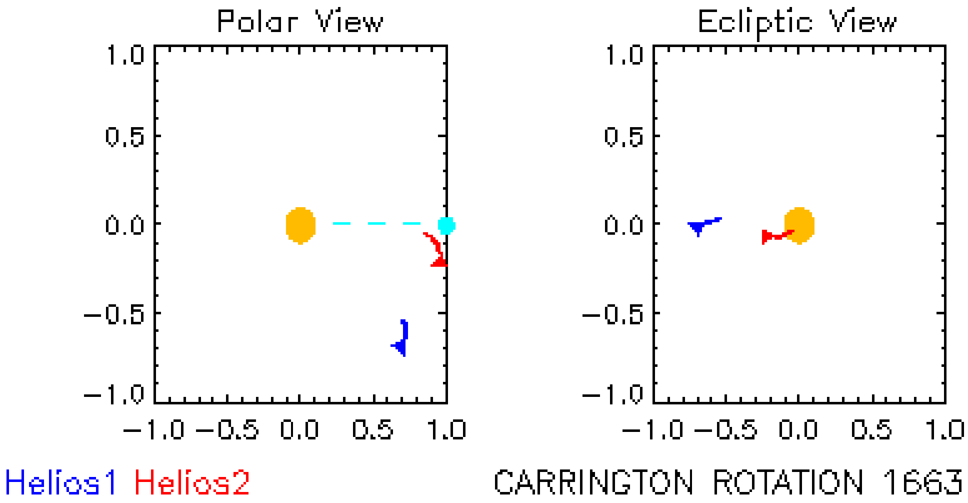
Peter Schroeder
peters@ssl.berkeley.edu
http://sprg.ssl.berkeley.edu/impact/peters

Summary Plots and Browser Developments

Example from Helios 1/2 data for Carrington Rotation 1663 (left), Spacecraft locations (bottom), and SECCHI image placeholder from SOHO (S. Yashiro CDAW website images)

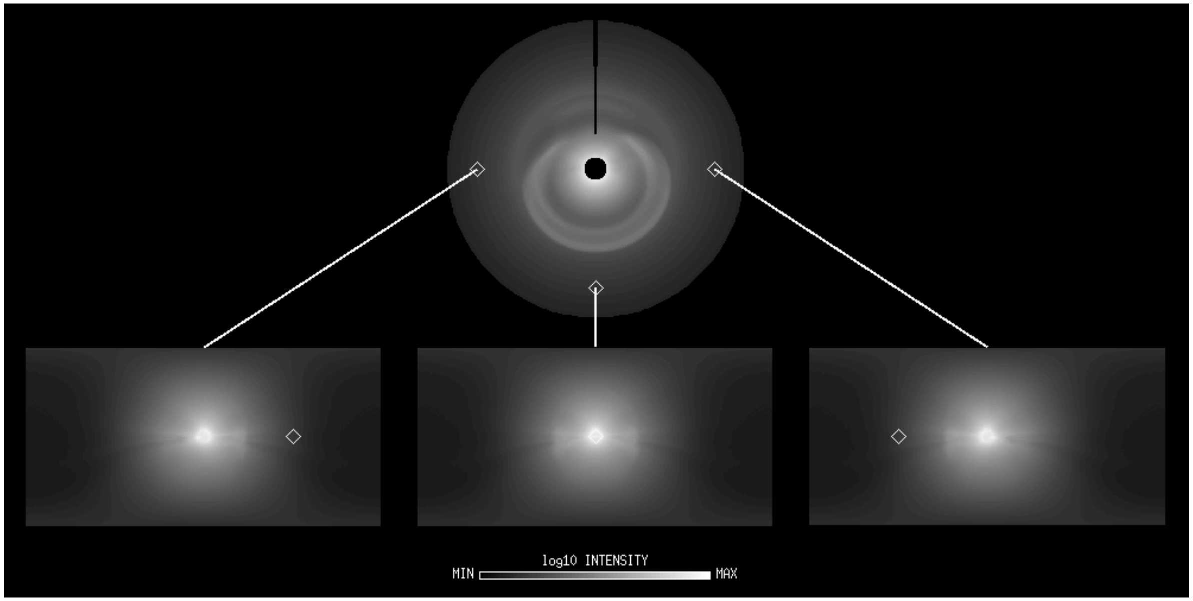


- Helios prototype under development
- Plan to integrate SWAVES data
- Need plan for plastic
- Plan for L1 data integration (ACE, WIND)
- Integrate imaging somehow



Luhmann

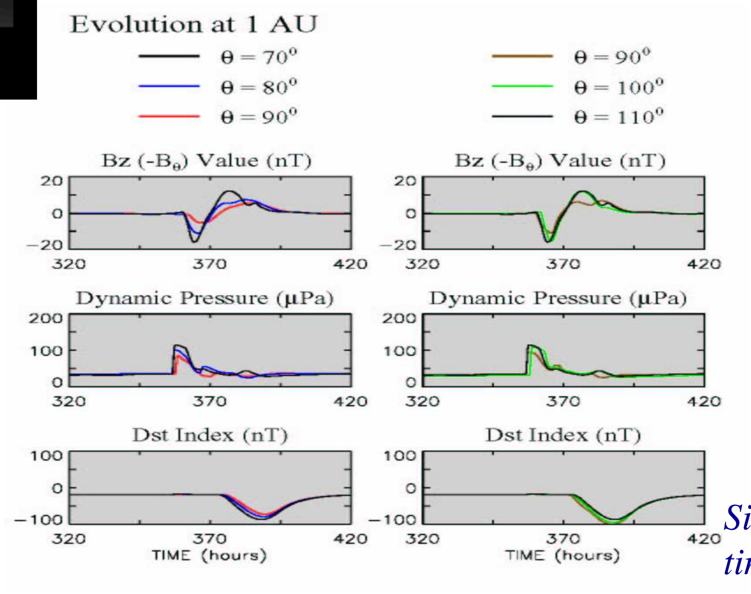
Modeling is needed to connect IMPACT observations to SECCHI images



Simulated coronograph images

CISM CME model, courtesy of Dusan Odstrcil

Simulated in situ data

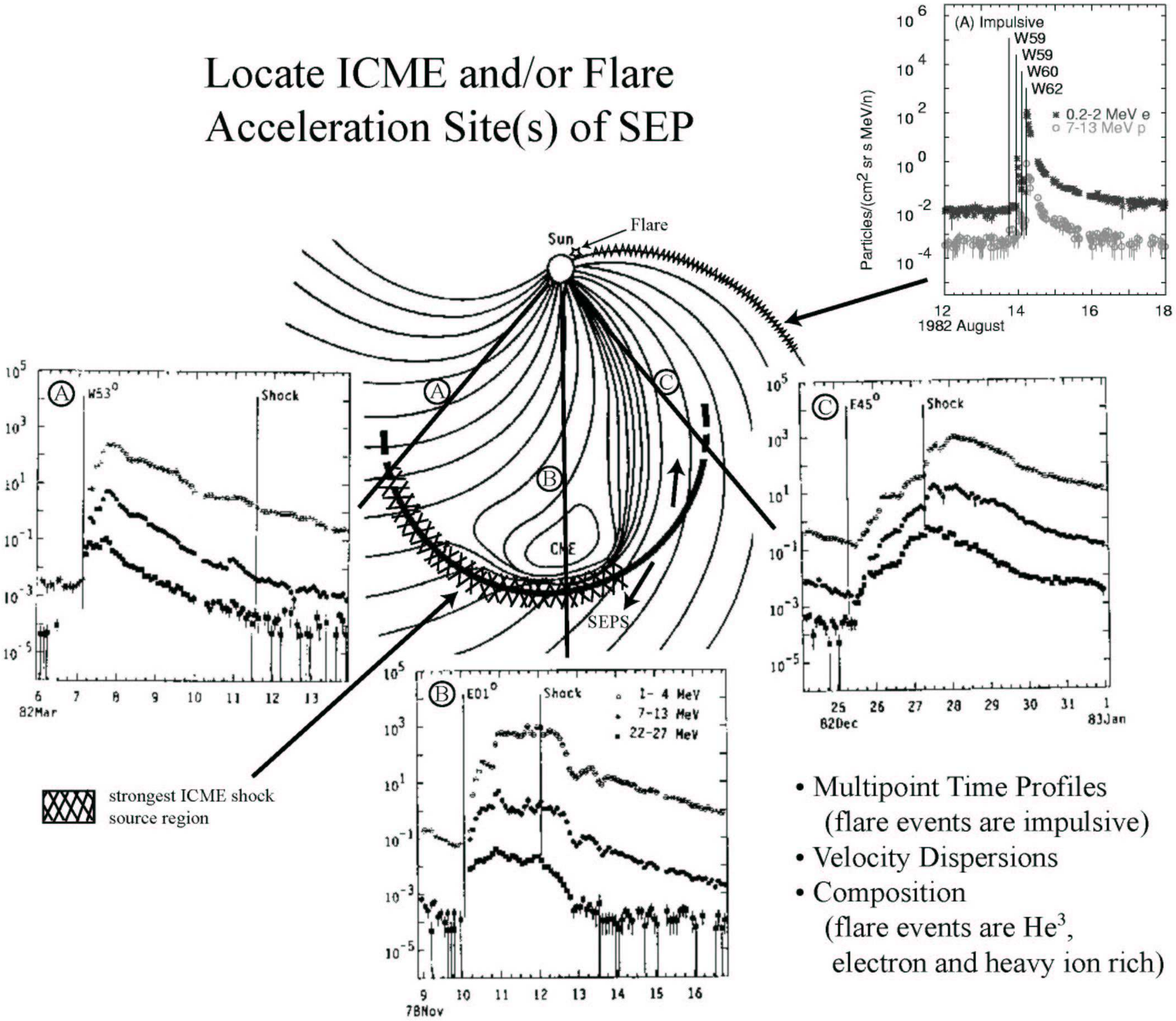


Simulated time series

spare

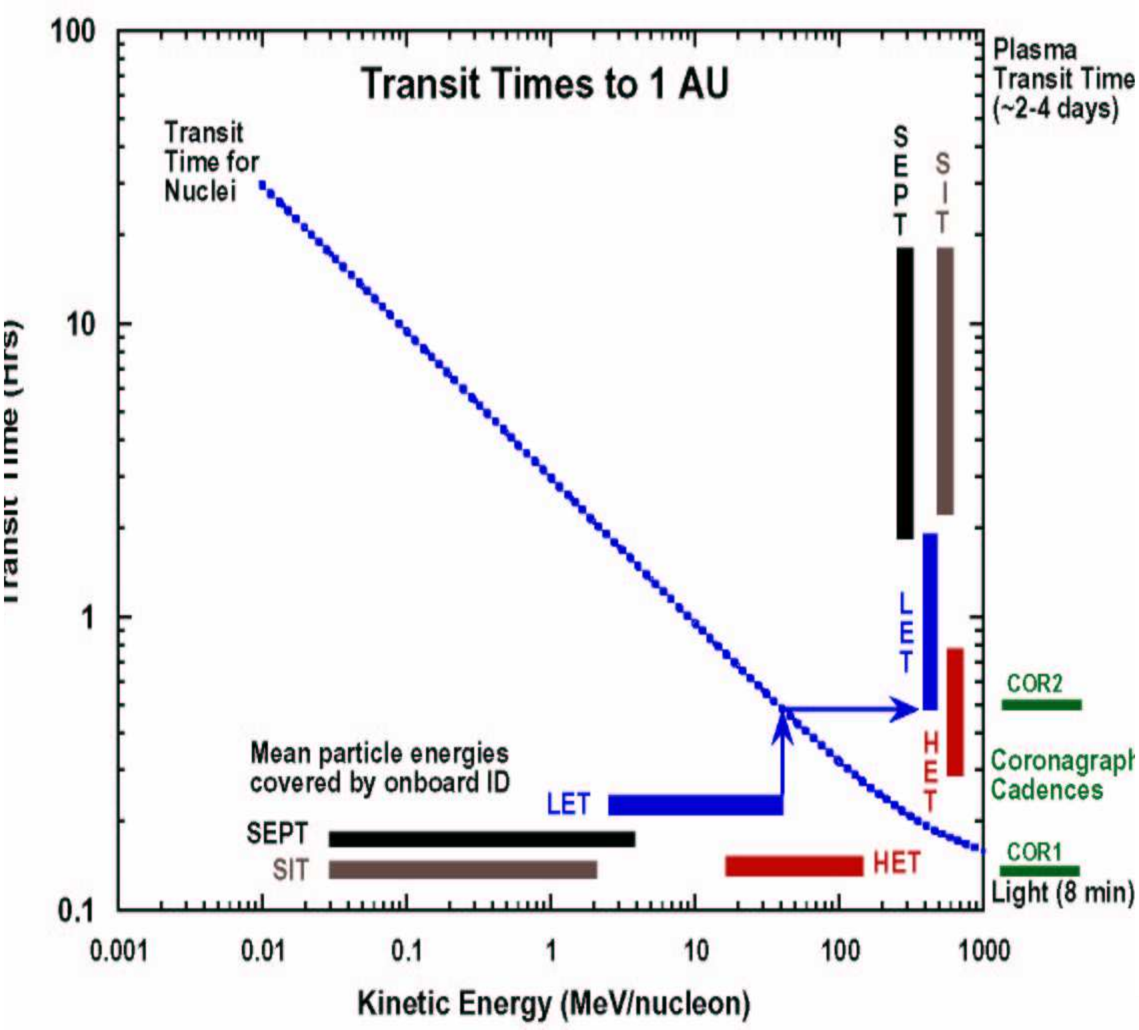
STEREO IMPACT UPDATE

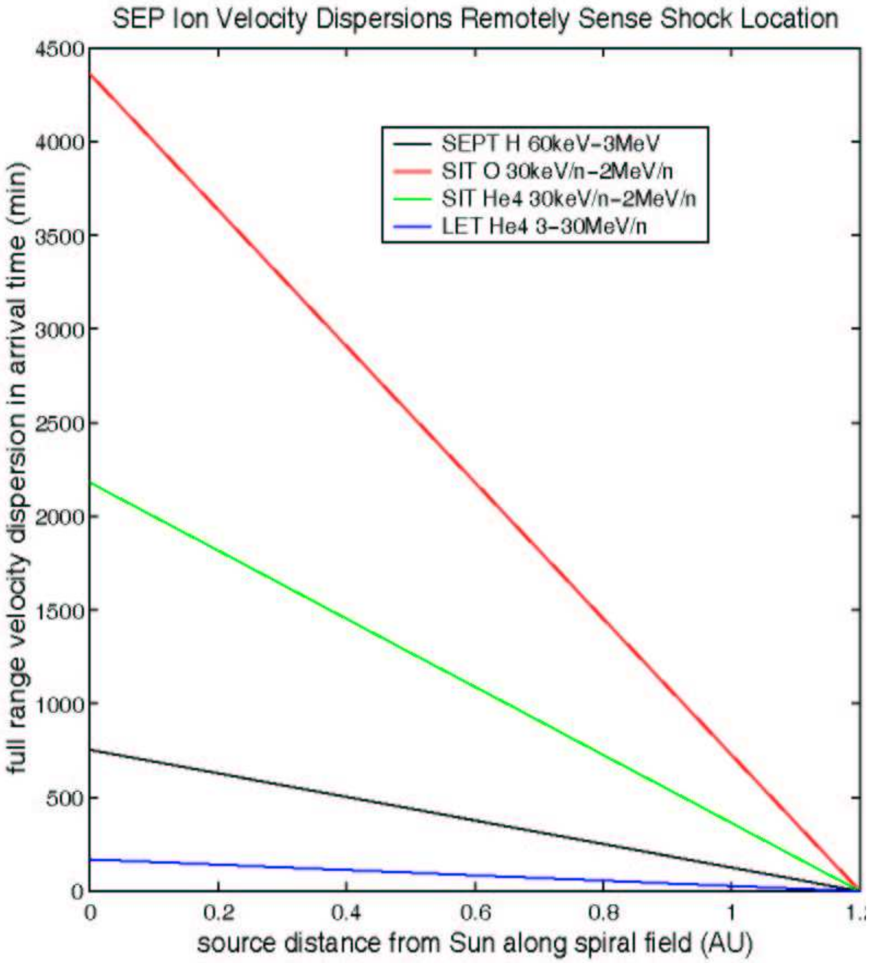
Locate ICME and/or Flare Acceleration Site(s) of SEP



- Multipoint Time Profiles
  (flare events are impulsive)
- Velocity Dispersions
- Composition
  (flare events are He^3,
  electron and heavy ion rich)

Acceleration Sites can be Inferred from SEP Timing





Locating Acceleration Sites and Inferring Magnetic Topology Using IMPACT Electrons

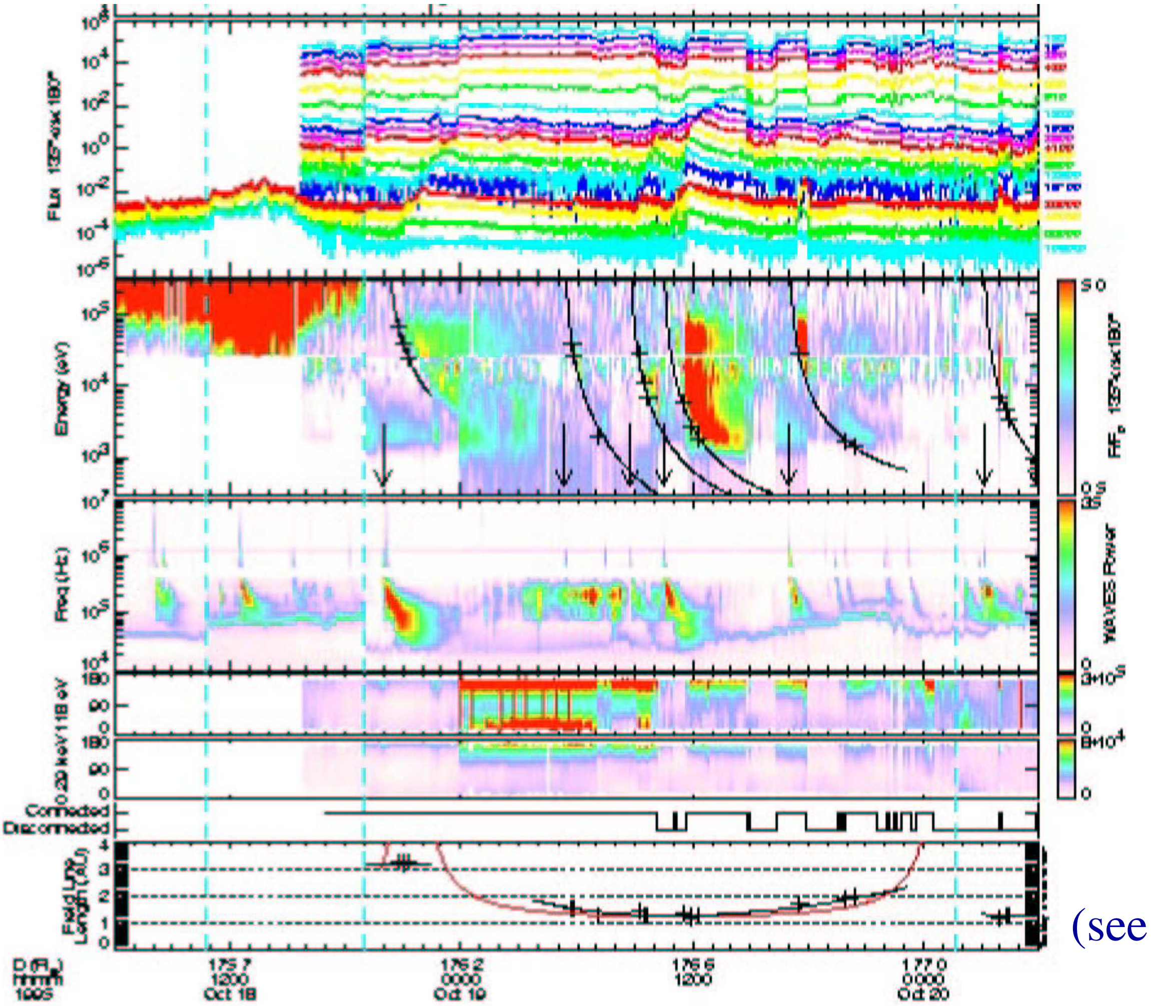
WIND SWEA, STE and SEPT-type electron measurements

Electron velocity dispersion gives field line length, topology

Radio burst gives electron injection times

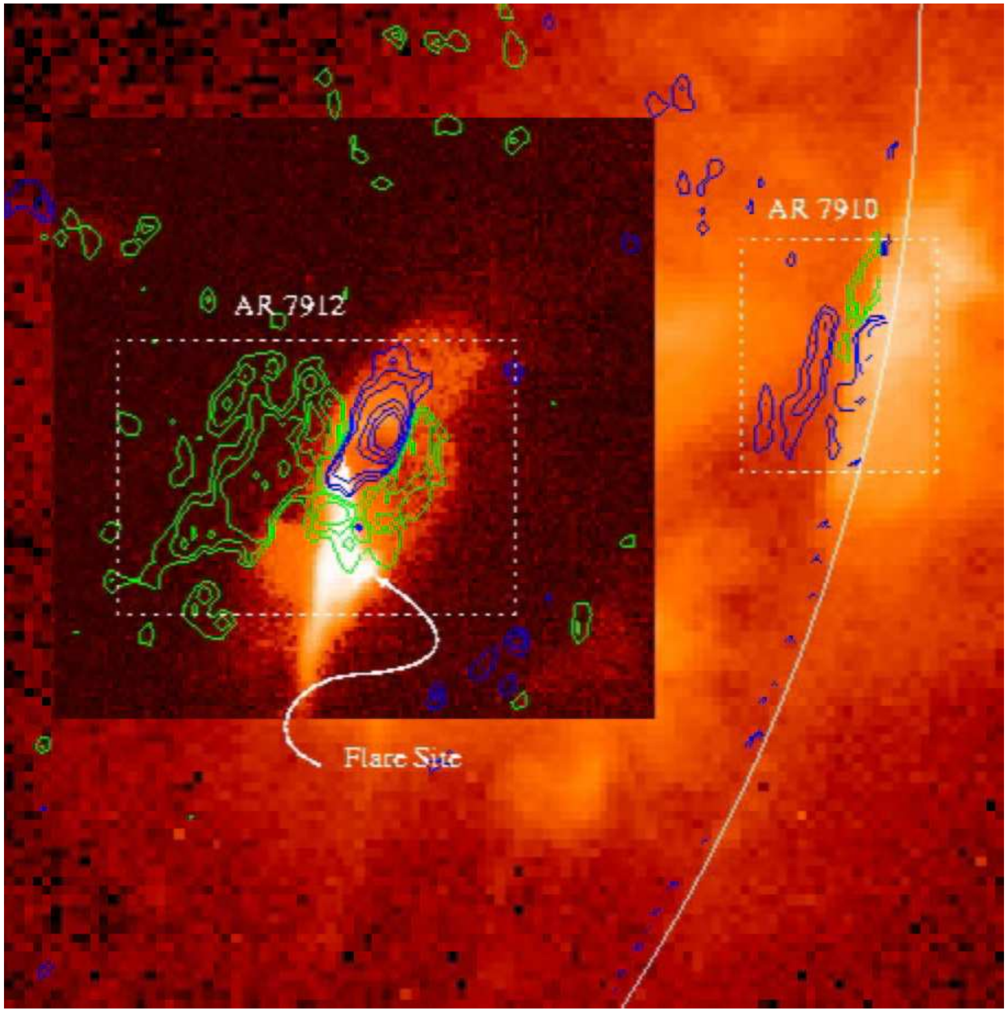
SWEA-type electrons indicate ICME field lines solar connectivity

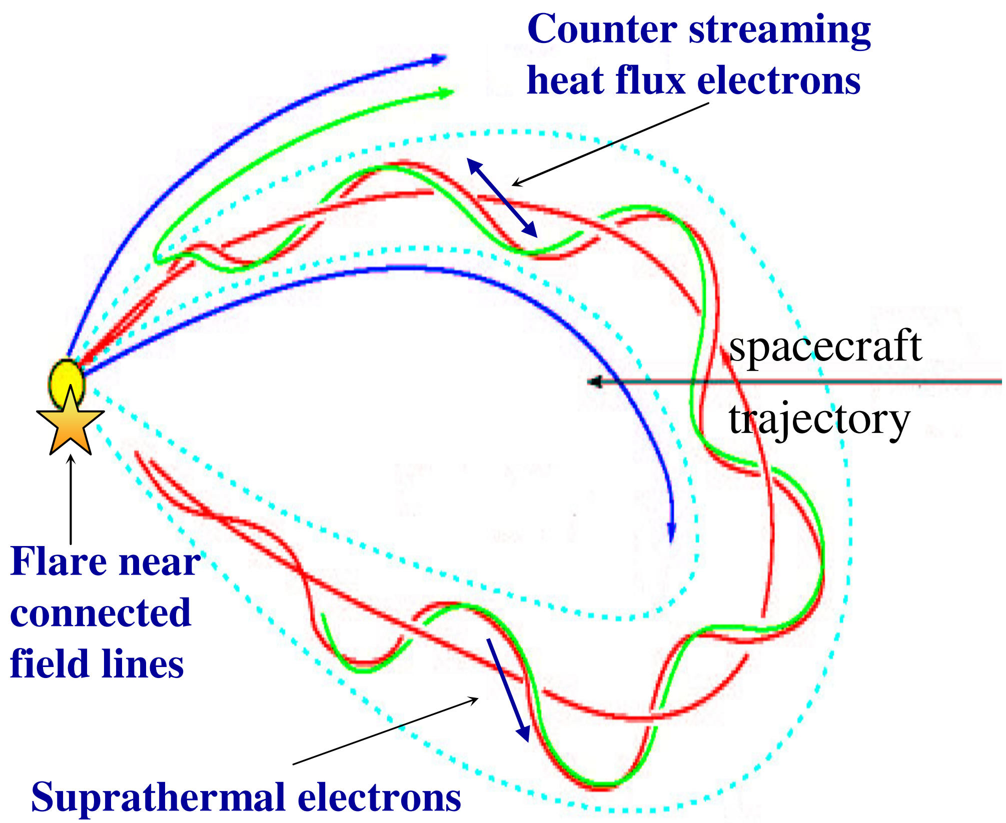
Field line length in ICME model vs. inferred length



(see next page)

Image of Possible Flare Source of Electrons (from Yohkoh SXT)





Counter streaming heat flux electrons

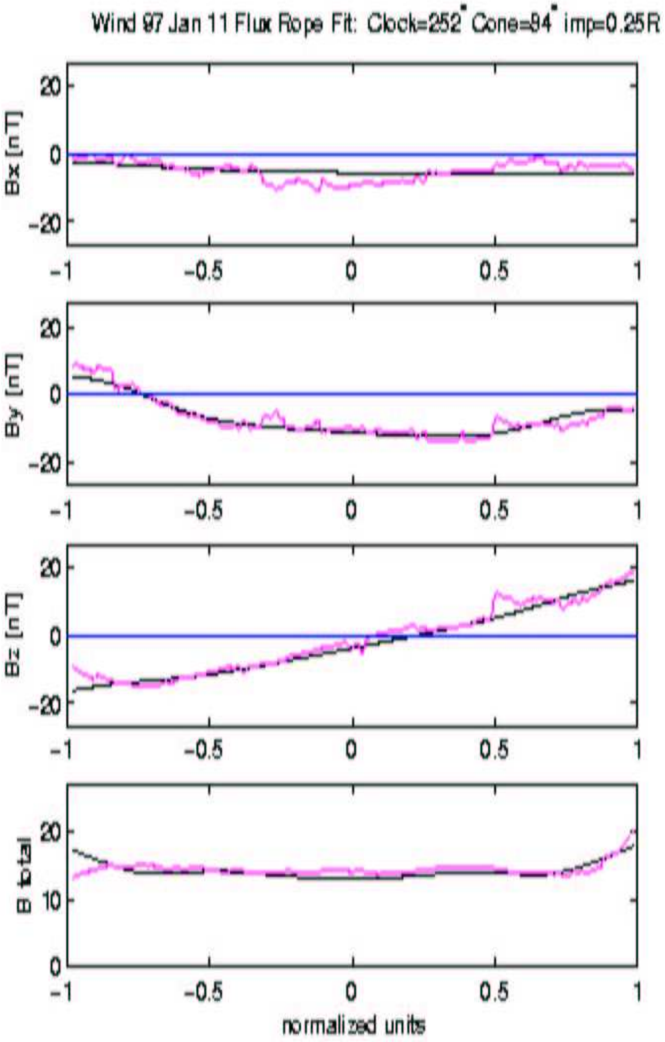
spacecraft trajectory

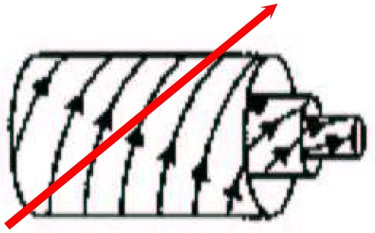
Flare near connected field lines

Suprathermal electrons

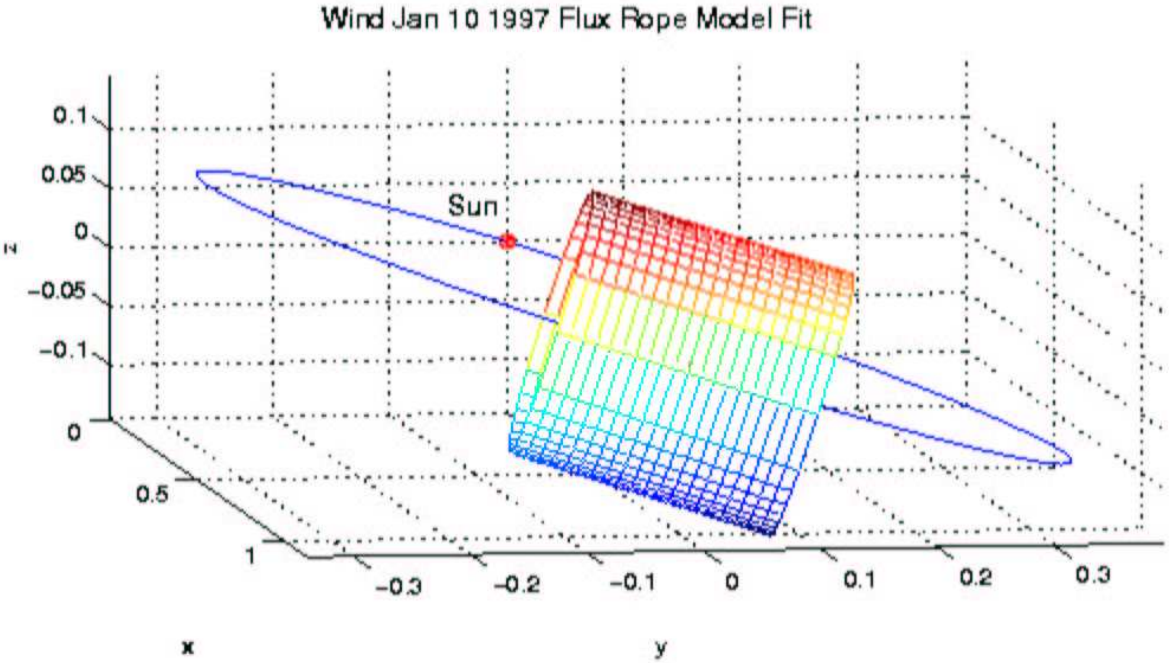
(figures from D. Larson)

Magnetic Topology Measurements Using Magnetic Fields





"Fly Through" Model ICME Flux Rope (or other models) to reproduce Vector Field observations.



(flux rope fits by Tamitha Mulligan, from the paper by Yan Li et al., JGR 2001)