C.3.3 Low Energy Telescope (LET)

C.3.3.1 Measurement Objectives

The Low-Energy Telescope (LET) is designed to make measurements of the intensity and energy spectra of H, He, and heavier elements accelerated in solar energetic particle (SEP) events, including measurements of two key isotope ratios: $^3He/^4He$ and $^{22}Ne/^{20}Ne$. These measurements will be coordinated with other in situ and imaging observations from STEREO in order to study particle acceleration on the Sun and in interplanetary space. LET will also provide real-time fluxes of species important to space weather applications, including H and He from ~1.5 to 13 MeV/nucleon, and heavier elements from ~2 to 30 MeV/nucleon. Finally, LET will provide measurements of the anisotropy of incident particles over ~260º of the ecliptic plane.

C.3.3.1.1 Elemental Composition and Energy Spectra. Using the standard dE/dx-E technique implemented using silicon solid state detectors, LET identifies particles which stop in the instrument in two general energy ranges corresponding to depths of penetration in silicon of ~20 to ~70 µm ("Range 2") and ~70 to ~2000 µm ("Range 3"). It identifies stopping H and He from ~1.5 to ~13 MeV/nucleon as well as heavier nuclei with typical energies of ~2 to 30 MeV/nucleon. Figure C.3.3-1 illustrates the energy range over which LET can resolve elements ranging from H to Ni. For nuclei which penetrate the instrument, particle identification is still possible (using multiple dE/dx measurements) for abundant species that include He, C, O, Ne, Mg, Si, and Fe.

As a result of its low energy threshold and relatively large overall geometry factor, 4.5 cm^2sr, LET will be able to measure particle intensities even in small SEP events and to measure abundances of rare species in larger events.

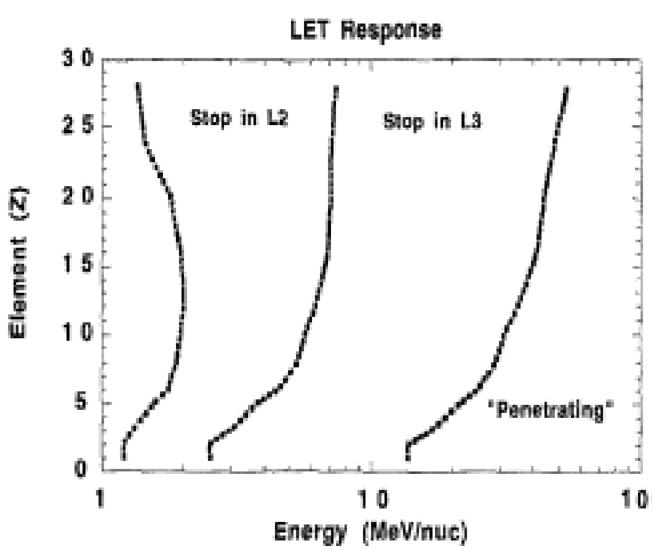

Figure C.3.3-1. The energy range over which LET can resolve elements.

C.3.3.1.2 Isotope Measurements. It generally requires ~5 to 10 times better resolution to identify isotopes than to identify elements using the dE/dx-E approach. There are more than a hundred distinct detector combinations that are used for particle identification in LET, and the resolution achieved in each of these will depend mainly on the range of angles with which particles traverse the dE/dx detectors that are used. It is expected that over ~80% of the full geometry factor the resolution will be good enough to resolve ^3He above levels of ~10% of ^4He in the Range 2 detector combinations, and above levels of ~1% in the Range 3 detector combinations. In addition, it should be possible to resolve the neutron-rich isotope ^{22}Ne over ~40% of the Range 3 geometry factor. The abundances of both of these isotopes (especially ^3He) are known to vary considerably from one SEP event to another.

C.3.3.1.3 On-Board Particle Identification. During large SEP events the telemetry allocation to LET will allow for the transmission of pulse-height data for only a small fraction of the particles that trigger the telescope. Therefore, on-board processing algorithms will be used to identify the charge and energy of up to several thousand particles per second. Each identified particle will be accumulated in a species versus energy matrix that can be telemetered once per minute (coarse energy grid for real time data) or once per 15 minutes (finer energy grid). This approach will ensure that high-time-resolution statistically-accurate data will be available for both space weather applications and SEP acceleration/transport studies. We expect that LET will be able to identify the following species in real time: H, ^3He, ^4He, C, N, O, Ne, Mg, Si, and Fe.

C.3.3.1.4 Beacon Data. Real-time space-weather data from LET are of special interest for characterizing in real time the origin of SEP events observed by STEREO. This information is important for predicting the degree to which a given event will produce particle fluxes at Earth. Depending on location, STEREO may observe particle fluxes many hours before they reach Earth (if one of the two spacecraft is initially better connected to the shock than Earth is). The longitudinal range over which SEP fluxes typically extend differs considerably, depending on whether the event is impulsive or gradual. Among the composition signatures that can distinguish impulsive and gradual events are the $^3He/^4He$ ratio and element ratios that include Ne/O and Fe/O. Fluxes of H, He, and heavier ions will be available from LET in real time on a continuous basis. Table C.3.3-1 and Figure C.3-8 summarize the species that LET will provide to the Beacon data.

Table C.3.3-1 LET Beacon Data

	Energy Range (MeV/nuc)	
Species	E_{min}	E_{max}
Hydrogen	1.5	6
Helium	1.5	6
$^3He/^4He$	3	6
CNO	1.5	6
CNO	10	30
Fe	1.5	6
Fe	10	30

C.3.3.1.5 Data Products. The following data products will be provided from LET.

Real Time Fluxes of Key Species: See the description of Beacon Data products in C.3.3.1.4 and Table C.3.3-1.

Matrix Rate Data: Measurements of ten species in ~5 energy intervals each are obtained. Data for H and He are reported every minute and for heavier ions every 15 minutes (see description in C.3.3.1.3 and IMPACT summary Table A.1).

Pulse Height Data: The LET bit rate will allow the pulse-height data for ~5 particles per second to be transmitted in their entirety. These data will be used to identify rare species and to check the operation of the onboard algorithms. The pulse height data for a typical particle requires ~50 bits. A priority system will ensure that all particle classifications are sampled regularly, with priority given to some of the highest-resolution detector combinations.

Engineering Rates: Singles rates will be recorded for each of the individual detectors, including all the discriminator levels. These are useful for monitoring instrument health. Also included will be coincidence rates of various detector combinations that are needed for normalizing the event rates.

Housekeeping Data: These include detector leakage currents, temperatures at selected points in the instrument, and various power supply voltages.

C.3.3.2 Approach

LET will resolve elements using energy loss (ΔE) versus residual energy (E') implemented with the arrangement of detectors illustrated in Figure C.3.3-3. In the primary mode of operation an energetic particle incident from the "A end" of LET (the top in Figure C.3.3-3) passes through one of the 5 L1A detectors, enters the following L2A detector, and comes to rest either in that L2A detector or in the adjacent L3A detector. The absence of a signal in the L3B detector indicates that a "stopping particle" has been detected. Total energy is obtained from the sum of the detector signals, and the nuclear charge, Z, is identified based on response tracks in the two dimensional ΔE vs. E' plane. For particles stopping in L3 two separate determinations of Z are obtained, improving resolution and permitting a consistency check which can be used to suppress backgrounds.

For particles which penetrate into L3B or beyond there is an ambiguity: on some trajectories the particles could have either stopped or passed out the back of the instrument without detection in following detectors. Because of this ambiguity these "penetrating particles" are processed with a lower priority. For those penetrating particles included in the LET telemetry, pulse heights from all triggered detectors are read out and from the pattern of these pulse heights it is possible to determine whether the particle stopped or

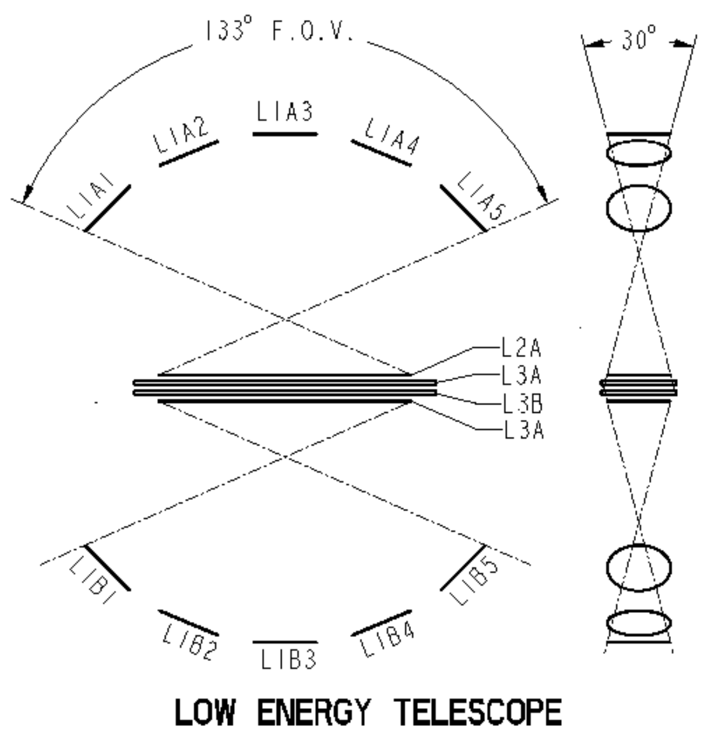

Figure C.3.3-3. The Low Energy Telescope (LET).

penetrated. Even for a particle which fully penetrates the instrument, it may be possible to use the change of the ionization rate as it slows in the instrument to estimate the total energy and then to identify the charge. This technique extends the range energy for identifying abundant species to approximately twice the maximum stopping particle energy.

Particles incident from the B end of LET (the bottom in Figure C.3.3-3) are treated in the same manner but with the roles of the A-and B-detectors interchanged.

C.3.3.2.1 Detectors. All 14 of the detectors used in LET are ion-implanted silicon PIN diodes. The sizes and configurations of these detectors are summarized in Table C.3.3-2. The L2 detectors are segmented into a linear array of ten pads, each of which is separately pulse height analyzed. The combination of the L1 detector and the L2 pad which was hit provides an indication of the particle's trajectory. This information is used to derive a correction for the pathlength of the particle through the ΔE detectors (L1 and, if penetrated, L2). It also provides the directional information needed to measure the anisotropy of the particle fluxes (see next section).

The L1 detectors have two individually instrumented readout electrodes: a central circular area of 0.4 cm^2 surrounded by an annular area of 1.6 cm^2. The smaller area, with its correspondingly smaller capacitance, provides a lower-noise signal for improved measurement of protons. It also will have a lower count rate, which will help to minimize pulse pile-up for proton measurements in the largest energetic particle events. Note that the L2 and L3 detectors were originally to be provided by Waseda. The recovery options for the loss of the Waseda contribution are discussed in Appendix F.

C.3.3.2.2 Field of View and Angular Resolution. The LET instrument is designed to be oriented with the vertical axis in Figure C.3.3-3 along the mean direction of the Parker spiral magnetic field and with the plane of the figure in the ecliptic (see Figure B.1). In this orientation LET has a field of view extending approximately 20º above and below the ecliptic plane and covering ±65º about the forward and backward mean field directions within the ecliptic. Individual combinations of the hit L1 detector and L2 pad typically define particle incidence directions to within ±15º.

The Current Field of View accommodation issues for LET are described in section C.3.0.1.

C.3.3.2.3 Front-End Electronics. The ionization charge signal from each hit detector element is processed with a linear electronics chain comprising a charge-sensitive preamplifier, shaping amplifier (1µs peaking time), linear gate, peak detector, and Wilkinson rundown ADC. This design, which is based on front-end electronics designs successfully used on a long series of previous space missions, is being implemented in a custom VLSI circuit to reduce mass, power, and volume requirements.

Digital circuitry for controlling the VLSI pulse height analyzers (PHAs), performing coincidence logic, accumulating rates, buffering event data, and interfacing with the SEP common electronics will be implemented in programmable gate arrays. Discriminators for each electronics chain are implemented by comparison between the Wilkinson rundown count and programmable digital values.

Simple logic equations based on the states of these discriminators allow rapid classification of detected particles as H, He, or Z > 2 ("HiZ") nuclei. The processing of each of these categories of events will be separately throttled under the control of the SEP microprocessor to optimize the mix of processed events. In addition, trigger rates will be accumulated for each category to allow absolute flux normalizations of the processed events.

The LET PHAs will include test pulsers which can be used under the control of the SEP microprocessor to perform functional tests of the electronics as well as to monitor the gain and offset stability of the analog front end.

C.3.3.2.4 Interface with Common Electronics. The interface between the LET front end circuitry and the SEP common electronics will be via a small number of digital signals. These include control lines for enabling the processing of H, He, and HiZ events, an interrupt line signalling when attention is needed from the SEP DPU described in section C.3.5.2., and serial lines for transferring data to the DPU and control bits (e.g., discriminator levels, enable/disable for coincidence terms, test pulse amplitude) to the front-end logic.

The front-end electronics will provide a multiplexed analog line to the common electronics carrying DC housekeeping voltages representing such quantities as detector leakage currents. The interface will also carry conditioned DC power at the voltages required by the front end and bias voltages for the silicon detectors.

Table C.3.3-2. LET Detectors

Detector ID	Number of Units	Shape and Dimensions	Active Area (cm^2)	Thickness (µm)	Contact Arrangement
L1A, L1B	10	circular 1.6 cm diam.	2.0	15	0.4 cm^2 central area aurrounded by 1.6 cm^2 annular area
3L2A, L2B	2	rectangular 1.6 x 6.4 cm	10.2	50	10 pads, each 1.6 cm x 0.64 cm
L3A, L3B	2	rectangular 2.0 x 7.5 cm	15.0	1000	single full-area contact

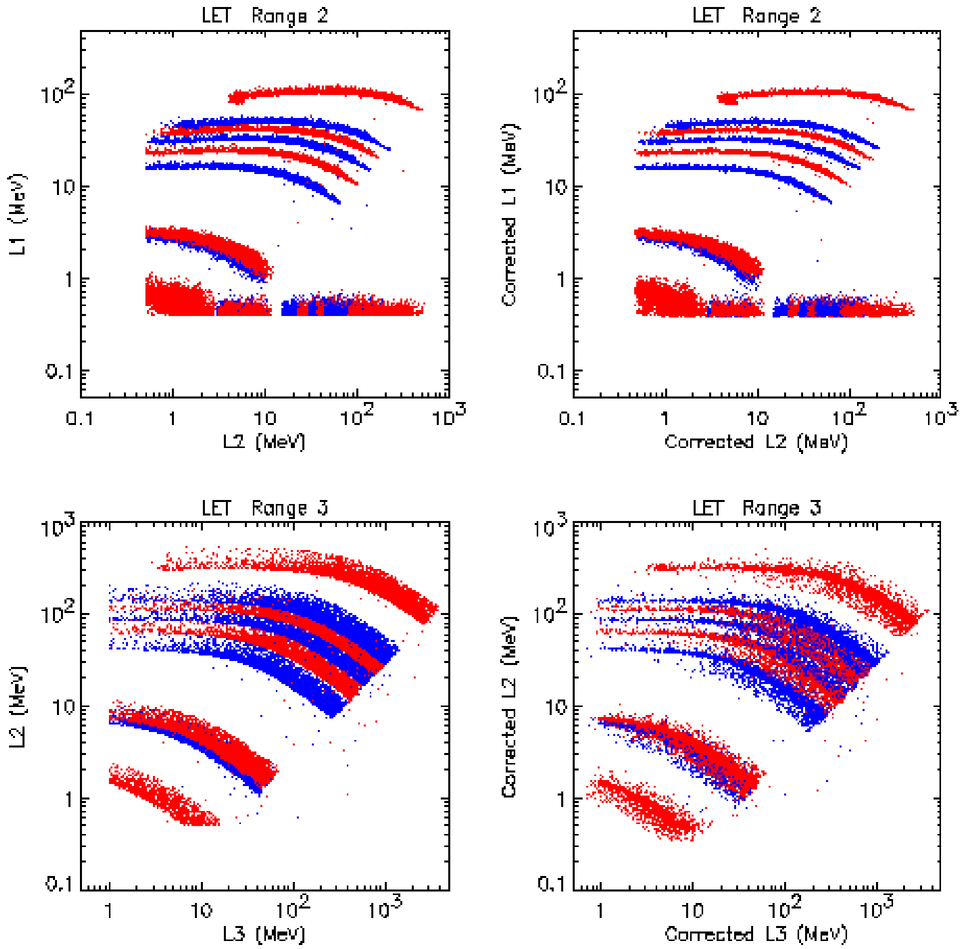

Figure C.3.3-4. Simulated response of the LET instrument to selected elements and isotopes.

C.3.3.2.5 Expected Performance. Figure C.3.3-4 shows results of simulating the response of the LET instrument to selected elements and isotopes satisfying its various trigger conditions. The panels on the left side of the figure show the pulse heights without correction for particle trajectory. Uncorrected data of this sort are sufficient for classifying events as H, He, or HiZ on the basis of discriminator levels.

The panels on the right-hand side of Figure C.3.3-4 show the instrument response after approximate corrections for the trajectory based on the hit L1 detector and L2 pad. After making these corrections in the SEP DPU the event data are classified according to species, energy, and direction of incidence and used as the basis for updating counters maintained in RAM.

C.3.3.2.6 LET Resource Requirements. Studies of the LET design during Phase A have led to several refinements of the design and also to improved definition of the required resources. The net result is a design that will be better able to satisfy the science requirements and that will involve reduced risk.

C.3.3.2.6.1 Segmented L1 Detectors. The STEREO science goals require that LET be able to measure accurately the highest SEP fluxes that are likely to be encountered, and that it be capable of making accurate composition measurements under these conditions. In addition, LET must also be able to measure small ^{3}He-rich events, which requires a relatively large geometry factor. A survey of ACE data over the past 2.5 years has shown that the maximum count rates of > 0.6 MeV protons expected for the sum of the ten L1 devices could reach ~400,000 per second, too great for the current electronics designs. The minimum count rates are likely to be < 10^{-3} per second. To handle this wide dynamic range in intensity a variable geometry factor is required. This has led to the adoption of an existing design for the L1 detectors in which each device has a small, separately instrumented central “bulls-eye” region constituting 20% its active area. This smaller region (and perhaps only a subset of the 10 detectors) would be used during the times of highest particle intensities. To implement this approach requires a total of 20 L1 analysis circuits per spacecraft rather than 10, which has both a power impact and a mass impact (more board area).

C.3.3.2.6.2 Custom VLSI Circuitry. In the IMPACT proposal it was assumed that there would be 16 VLSI pulse height analyzer circuits per chip requiring 4 mW for each channel. The VLSI design is now much farther along and the first prototype circuits have been fabricated by MOSIS. Two separate VLSI package designs are now envisioned, one with 10 channels per chip (for L1 and L2) and a second with a single channel per chip (for L3 and for HET). It is now also recognized that there will be an “overhead” power requirement in each of these chips (~2 mW each), and

Table C.3.3-3 LET Mass Requirements

	Proposal (grams)	Phase A Estimate (grams)	Change (grams)	Explanation
LET Sensor	390	390	0	
LET Electronics	48	121	73	Segmented L1 detectors, refined VLSI design, moved two Actels from logic board to front end
TOTAL:	438	511	73	

Table C.3.3-4 LET Power Requirements

	Proposal (mW)	Phase A Estimate (mW)	Change (mW)	Explanation
LET Sensor	0	0	0	
LET Electronics	120	180	60	Segmented L1 detectors, moved two Actels from logic board to front end
TOTAL:	120	180	60	

that the power per channel will depend somewhat on the dynamic range requirements (4 mW for L2 and L3; 3 mW for L1). One additional small change in the LET power and mass is due to a change in bookkeeping - two Actel chips originally bookkept with the SEP common electronics are now considered part of the LET front end.

The above considerations have led to small increases in the required mass and power (see Tables C.3.3-3 and C.3.3-4). On the other hand, the power requirements are now much better known, and the chip design is more conservative than was assumed in the proposal. The net result is that schedule and cost risk have been reduced.

C.3.3.2.6.3 Bit Rate Requirements. After discussions with STEREO Project management it was decided to ask for an increase in the IMPACT bit rate allocation. The portion of this new allocation assigned to LET will increase its bit rate by a factor of four (see IMPACT summary Table A.1). This increase will improve the science return from LET and reduce the time required for functional testing throughout the program. It will also reduce data-compression requirements. The totals in Table C.3.3-5 reflect the new LET bit rate.

Table C.3.3-5 LET Bit-Rate Requirements

	Proposal (bps)	Phase A Estimate (bps)	Change (bps)	Explanation
LET	80	320	240	Reduce testing time during I&T Improve science return

C.3.3 Development Plan

C.3.3.3.1 Trades in Progress. The most significant trade studies for LET involve the ASIC packaging and selecting the optimum thickness of the front detectors.

The trade study for the ASIC centers on the number of signal channels per chip. It simplifies the electrical layout to have two versions of the ASIC, one with one channel of signal processing and one with 10 channels. The chip with 10 channels results in savings in board area and therefore mass. However, having all chips have 10 channels is not a good match in certain detector configurations and would be wasteful of power. This trade study is ongoing and we expect a resolution during Phase B.

A trade study is being performed to select the optimum thickness for the L1 detector. This detector, which has a nominal thickness of 15 µm, should be kept thin to keep the threshold for two-parameter analysis as low as possible. This will maximize the number of nuclei that can be analyzed (since energy spectra in SEP events tend to be steeply falling functions of energy) and allow investigation of smaller events. However the use of such thin detectors can potentially lead to problems with manufacturing yield, electronic noise (due to the large detector capacitance), and thickness non-uniformity. A small number of prototype 15 µm detectors of the design planned for LET have been ordered from Micron Semiconductor to assess the risk of using devices this thin. Early in Phase B we will determine whether the L1 detectors for the flight instruments should be of this thickness or somewhat thicker (e.g., 20 µm).

C.3.3.3.2 New Technology Development; Descope Options. The LET L1 detectors are thinner than ion-implanted detectors previously used in space, although silicon surface barrier detectors of comparable thickness and area have been successfully used. As mentioned in Section C.3.3.3.1, above, prototypes of these detectors have been ordered from Micron Semiconductor to establish whether it is practical to use 15 µm ion implanted devices. Early results appear promising. If the manufacturing yield should be unacceptably low we have the option of increasing the detector thickness somewhat, with a corresponding increase in the threshold energy of LET.

Another new technology development item for LET is the signal processing ASIC, which will also be used in HET and SIT. This circuit is being developed in close coordination with other circuits being developed for balloon projects at Caltech. During Phase A, significant progress in developing the SEP ASIC has been realized. Currently, two ASICs are under consideration: a single-channel version and an 10 channel version. Other than the number of signal processing channels per chip, the circuits would be identical. A version of the design that does not include the digital portion of the chip has been submitted to MOSIS and the article has been fabricated and returned for testing, which is now underway.

The LET design lends itself to a number of descope options. LET is a double-ended design with 5 front sensors per side, providing excellent angular coverage for anisotropy studies. At the cost of degrading these studies and at the cost of a portion of collecting power, the number of LET front detectors could be reduced and/or LET could be converted into a single-ended design. These descope options would need to be exercised early in the program to realize any significant cost or schedule savings.

C.3.3.3.3 Long Lead Items. Long lead items for LET include solid state detectors and the ASICs. During Phase A, we have made significant progress in defining and developing these items. We have received a sample of a 13-µm-thick front detector from Micron Semiconductor, which is a prototype of the thin front detectors on LET. We have also submitted designs of the signal processing ASIC to MOSIS and received samples back for test. We believe these activities have significantly reduced schedule risk.

C.3.3.3.4 Breadboard, Engineering Model (EM) Plans. LET electronics is packaged on two nearly identical PCBs containing front-end SICs, Actel FPGAs, memory ICs, connectors and passive filters. Its purpose is to analyze signals from solid state detectors by converting charge into digital information which is further analyzed, buffered and then passed on to the SEP CPU.

Design verification of the first ASIC (analog section) took place at the end of Phase A on a stand-alone test fixture controlled by a CPU-like breadboardwith microprocessor RTX2000, which is very similar to the flight rad-hardunit, RTX2010. We will proceed with the test fixture approach for several more rounds until both ASIC flavors and their final EM and flight rad-hard versions are verified. In addition to testing the front-end part of LET electronics, this approach will contribute to developing certain sections of the microprocessor code which will be later incorporated into the flight firmware.

For a proof of concept one LET EM PCB will be then built to integrate multiple ASICs and other EM parts mentioned above. Most of the EM parts will be of the same surface-mount type as the flight parts, so that footprints and PCB layout will have to change as little as possible from EM to flight PCB design. We will adapt to long lead time items' schedule in all stages of EM and flight LET electronics testing by using detector simulators (which electrically simulate detector's capacitance and leakage current) interchangeably with real detectors.

After initial bench testing, the LET EM PCB will be integrated with the SEP breadboard electronics card-cage by way of a flight-like flexy-strip and heat-activated ZIF connector which resides on a wire-wrapped backplane motherboard. A similar concept was successfully used on ACE mission to ease assembly, repair, testing and to improve reliability, although with small mass penalty.

C.3.3.3.5 Fabrication Plan. The fabrication plan for LET will be very similar to that used by the Caltech, JPL, and GSFC groups on the ACE SIS instrument development. GSFC will provide the mechanical design and fabrication of the flight instrument and will also provide the necessary thermal design support. Caltech will be responsible for the design and fabrication of the electronics and flight software. The detector procurement efforts will be led by M. Wiedenbeck of JPL. Activities associated with the testing of LET and HET detectors will be divided between Caltech/JPL and GSFC.

C.3.3.3.6 Calibration Plan. The LET front-end electronics will be calibrated on the bench over a wide range of operating temperatures using a pulser and calibrated test capacitors. Based on our experience with similar circuitry on ACE it is expected that they will be linear to a high degree of precision, requiring only two numbers, the gain and offset, to characterize the response of a given ADC at a given temperature.

A full functional test of LET prior to delivery will require exposure to heavy ion beams at the Michigan State University Cyclotron. While the primary purpose of this exposure is to test the functionality and response of LET over its full dynamic range, including high-rate conditions as in a large SEP event, this exposure will also provide valuable calibration data on the location of the tracks of ions from H to Ni, and on detector uniformities.

It is also possible to obtain coincidences between L1 and L2 in the laboratory using radioactive alpha-particle sources that include ^{228}Th, ^{244}Cu, and ^{241}Am. This approach will be used for stimulating the instrument during integration and testing.

C.3.3.3.7 Ground Support Equipment (GSE). Ground support equipment will be developed at Caltech/JPL under the direction of M. Wiedenbeck. It will be based on a PC or workstation running an appropriate variant of the Unix operating system and will have the capability of collecting data either via Ethernet or RS232 in the formats provided by several alternative sources: the SEP DPU or DPU simulator (supplied by Caltech), the IMPACT DPU (IDPU) simulator (supplied by UC Berkeley), or the Berkeley IMPACT GSE. The GSE will format and archive test data, perform limit checking of selected quantities, and provide a variety of data displays. It will be capable of processing data either in real time or during playback from previously stored files.

The GSE computer and core software will be identical for LET and HET, with different subroutines as needed to process the different data formats and to make instrument-specific displays. In addition, the GSE software will include routines to extract and display SIT and SEPT data from the IDPU and S/C data streams.

C.3.3.3.8 Special Facility Plans. Most of the integration and test activities will take place in Room 5 of Downs Laboratory at Caltech. This large laboratory was developed for the integration and test of the CRIS and SIS instruments on ACE. It is not a certified clean room; however, it contains two clean benches, on which most of the assembly operations will take place. For environmental tests, we will use facilities at JPL and/or GSFC. We plan to do an end-to-end functional test of LET at the Michigan State University Cyclotron accelerator.

C.3.3.3.9 Outstanding Issues. At the end of Phase A, the spacecraft has still not provided a clear field of view for the LET telescopes. We are still working with the spacecraft contractor to minimize the blockage.

C.3.3.3.10 Concerns. We are assuming that the contamination control plan will allow us to develop our hardware using the same facilities and using the same processes that we used for developing our CRIS and SIS instruments on ACE. We assume that upon delivery, our instrument will be cleaned externally using ethanol.

We are concerned about the shortening of the schedule, which occurred since our proposal was submitted and accepted. Measured from the beginning of Phase B to instrument delivery, we have lost 3 to 7 months, depending on whether IMPACT delivers at the beginning or end of the current delivery window.

We are very concerned about ITAR issues and these are discussed in section C.3.5.7.

C.3.3.4 Operational Constraints

C.3.3.4.1 Areas of Concern. LET may be powered on at ambient pressure or in a good vacuum but must not be powered on in a partial vacuum (10^{-5} Torr < pressure < ambient). For vacuum operation, LET must be in a vacuum of < 10^{-5} Torr for 24 hours before being initially powered on.

C.3.3.4.2 Special Bus Requirements. Not applicable to LET.

C.3.3.4.3 Special Requirements for I&T. In order to functionally test LET it will be necessary to stimulate the front detectors with an alpha-emitting radioactive source. It is necessary to purge LET continuously with dry nitrogen (purity of LN2 boil-off), except for brief periods. Solvents should be used sparingly around LET, and only while it is being purged.

C.3.3.4.4 Special Requirements for Commissioning. LET should be allowed to outgas for at least 24 hours after launch, before turn-on.

C.3.3.4.5 Special Requirements for Operations. There are no special requirements for LET with regard to operations. Occasional commanding is all that is required.

C.3.3.5 Management processes

C.3.3.5.1 Roles and Responsibilities. LET will be developed as a collaborative effort amongst personnel at Caltech, JPL, and GSFC. T. von Rosenvinge of GSFC will act as interface spokesperson with the IMPACT project. He will also direct the effort at GSFC, which includes mechanical design, which will be executed by S. Shuman, thermal design, fabrication of mechanical parts, some of the detector testing, and algorithm definition for the onboard software, which will be provided by D. Reames. The effort at Caltech will include contributions from E. Stone, who will direct the overall effort; R. Mewaldt, who will provide science inputs to the design and be responsible for the calibration activities; A. Cummings, who will manage the effort; W. Cook, who will be the chief engineer and have overall responsibility for the electrical design; B. Kecman, who will serve as lead electrical engineer and be responsible for the assembly and testing effort of the electronics; and A. Davis, who will code much of the flight software. At JPL, M. Wiedenbeck will lead the effort and be responsible for detector procurement and testing as well as the development of the electrical GSE. In addition, the technicians who will attach parts to the boards will be from JPL. These roles and responsibilities are very similar to those successfully employed to develop the ACE/SIS instrument.

C.3.3.5.2 Heritage. The LET sensor system is derived in part from the successful LEMT instrument flown on Wind. Instead of hemispherical domes filled with circular, thin front detectors, LET will use fewer, but similar, front detectors arranged in a “ferris wheel” design. Much of the electrical design, including low-power front-end electronics, will be based on designs executed for the ACE/CRIS and ACE/SIS instruments. The microprocessor will be the same as the one used in the CRIS and SIS instruments. The particle identification algorithm and rate buffer assignments will be similar to that used on Wind/LEMT. One particularly strong heritage aspect is the personnel. Almost all of the same people who will be working to produce LET also worked on ACE/SIS.

C.3.3.5.3 Product Assurance Plans. Caltech, JPL, and GSFC will follow the Performance Assurance Implementation Plan for the STEREO IMPACT Instrument Suite (Appendix B).

C.3.3.5.4 Planning and Interface with IMPACT Team. W. Cook will work directly with D. Curtis on issues involving the electrical interface with the IMPACT IDPU. T. von Rosenvinge of GSFC will be the point of contact for mechanical and administrative issues. Regular IMPACT conference calls and meetings are scheduled to ensure coordination between the groups.