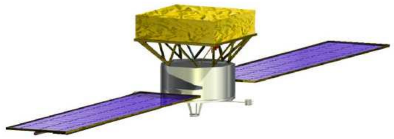
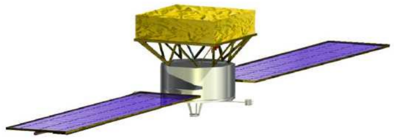


Level III Specifications

Required to demonstrate through tests the following:

- Single Crystal Energy Resolution < 1% for min ionizing carbon
- Position Resolution — < 1.5 cm in all 3 dimensions/layer
- Angular Resolution — $<7.5 \times \cos^2(\theta)$ degrees for cosmic muons
- Measurement Dead Time — <100 μsec
- Calorimeter Power — Not to exceed 116 W (TBR).
- Environmental — Must withstand environmental conditions in LAT Instrument Performance Spec.

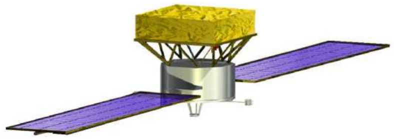


Level III Specifications

- Demonstrate position and angular resolution with muons.
- Power consumption is straightforward
- Environmental can be done at NRL

- Dead time: Does one stick a scope on the system, or does one need to prove that 101 micro-seconds after a first event, a second event was recorded and not corrupted?
  - ⇒ Should prove latter (not possible at SLAC?)
  - ⇒ Who has to prove we know what the dead time is?

- The Specification that explicitly requires a beam is the carbon energy resolution:
  - ⇒ Plan a beam test at GSI (not truly Min-I), as was done with BTEM-99
  - ⇒ The issue is getting time more than infrastructure
  - ⇒ Plan to take the EM, and if possible, later one of the 18 FM



Pre-LAT-Integration Tests

Detector Parts:

- All diodes get tested for leakage current and dark current
- Some diodes get tested for sensitivity
- All crystals are mapped for relative and absolute light yield

Pre-Electronics Module (crystals with diodes in Carbon fiber frame):

- Test each PEM with Lab electronics and muons in France
- Test each PEM with Lab electronics and muons in US

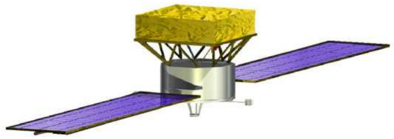
Electronics:

- Functionality of ASICs and FEE boards
- Integral and differential non-linearity measurements

Assembled modules:

- Test each PEM with Flight electronics and muons in US
- Shock and vibration tests
- Thermal vac

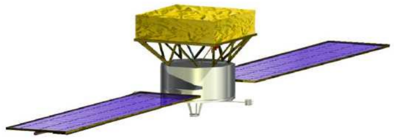
    => can all be done at NRL (throughput in thermal vac is an issue)



In-Flight Calibration

In-Flight Calibration
(from Presentation of E. Grove at September 2000 software meeting)

- Supplements and corrects detailed pre-launch calibration.
- What needs to be calibrated?
  - Energy measurement
    - Need relative calibration among crystals and overall absolute calibration.
      - Goal: Relative calib <1% at all energies.
      - Goal: Absolute calib ~3% at all energies.
  - Position measurement
    - Need light asymmetry calibration in each crystal.
      - Requirement from bkg-rejection: ~3 cm knowledge (~10% of crystal length).
        - » Requirement: Light asymmetry slope knowledge to ~10%.
      - Goal: Improve pointing for conversions in SuperGLAST.
        - » Need ~3 mm knowledge.
        - » Goal: Light asymmetry slope knowledge to ~1%.



In-Flight Calibration

- Functional requirements (top level)
  - Electronic calibration: eCalib shall generate pedestal and integral linearity model for each gain range for each PIN diode.
    - Required accuracy is TBD; goal is 3%.
    - Data source is Charge-Injection Calibration Mode.
  - Absolute light yield: GCRCalib shall calculate the absolute light yield at the center of each log for each PIN diode.
    - Required accuracy is TBD; goal is 3%.
    - Data source is GCR Calibration Mode.
  - Light asymmetry model: GCRCalib shall produce maps of light asymmetry (i.e. light collection efficiency as a fcn of longitudinal position) of each log end and the sum of ends for each log.
    - Required accuracy is 10%; goal is 1%.
    - Data source is GCR Calibration Mode.

Cosmic Ray Calibration (new)

- High flux of GCRs gives good calibration over full dynamic range (see Appendix).
- Derive calibration with statistical precision of better than few % each day over full dynamic range.

He:	~140 Hz	
CNO:	~10 Hz	⇒ ~1100 per xtal per day
Si:	~0.4 Hz	
Fe:	~0.8 Hz	⇒ ~70 per xtal per day

- Flight s/w flags and telemeters GCR data in Calibration Mode (4-Range Mode).

❑ Functional Requirements

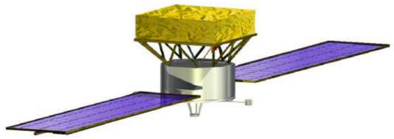
- GCRCalib shall process Calibration Mode telemetry.
- GCRCalib shall query Perf State to modify algorithms, fault tolerance.
- GCRCalib shall accumulate energy loss and light asymmetry maps in GCR DB.
  - See algorithms.

In-Flight Calibration

How often do calibration parameters need to be updated?

Timescales of Weeks.

- CsI light yield varies with radiation dose.
  - Test at NRL's ^{60}Co Irradiation Facility to ~20 kRad (~20 years or more on orbit) showed 25% degradation in light yield.
  - So ~1% per year, very long timescale.
- CsI light yield varies with temperature, ~1/2 % per deg C.
  - Large thermal mass $\Rightarrow$ no ΔT effect on orbital time scales.
  - Long-term ΔT possible from thermal surface degradation or seasonal exposure.
  - Active thermal control minimizes this effect.
- PIN diode bonds may degrade with time.
  - CLEO degradation was slow. Hamamatsu has fixed problem.
  - Failure on launch is more likely. Calibrate it out once.
- FEE gain and linearity may vary with radiation dose.
  - DMILL process is tolerant to relatively small dose on orbit.
  - Any change will be on long timescale.
- FEE gain and linearity may vary with temperature.
  - Again, thermal mass of calorimeter means timescale is long.



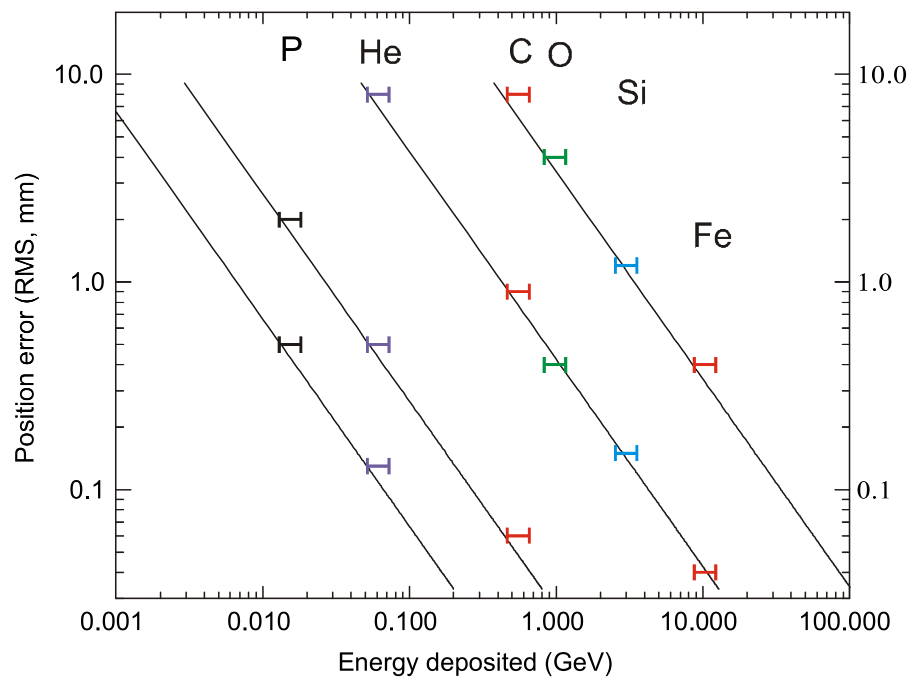
Calibration with Cosmic Rays

High flux of GCRs gives good calibration of full dynamic range.

- Concept:

1. ACD flags events > few MIPs.
2. ACD flags 1 in 1000 single-MIPs.
3. Accept only events with good TKR.
4. Accept only events with no charge-changing interactions in CAL.
5. Correct ΔE for pathlength in CsI bar.
6. Accumulate dE/dx in each bar.

- Derive calibration with statistical precision of better than few % each day over full dynamic range.



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