Calorimeter Subsystem

Status and Issues

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Outline

- Introduction
- Engineering Model GSI Beam Test
- Flight Manufacturing Status
- The Future
- Issues and Concerns
- Summary
Calorimeter Module

Carbon Composite Structure
CsI Detectors + PIN diodes (CDE)
Al Cell Closeout
Readout Electronics
Mounting Baseplate
Al EMI Shield

First Flight CAL FM A

16 Identical Flight CAL Modules + 2 Spare Modules

EM2 TEM/TPS (T&DF – SLAC)
CAL EM - Heavy Ion Beam Test

- Proposal PI: Benoît Lott, CEN Bordeaux-Gradignan
- Gesellschaft für Schwerionenforschung, Darmstadt, Germany
  - Relativistic heavy ions
    - Pure and “Cocktail” beams of $A = 2Z$ daughters
    - Tagged with $t, Z, A, E, \text{ direction}$
- Goals of test
  - Develop CAL cosmic ray calibration algorithms
    - Measure scintillation “saturation”, “quenching” in CsI(Tl)
    - Develop algorithms to identify charge, mass-changing nuclear interactions
  - Test performance of EM CAL
  - Compare performance with MiniCAL

Analyses: IN2P3/CENBG (Benoît, et al.)
IN2P3/GAM (Frédéric Piron, et al.)
GLAST LAT Project Collaboration Meeting Sep 27 – 29, 2004

EM Calorimeter at GSI

- GLAST setup in FRS cave
  - Beam direction:
    - $^{58}\text{Ni}$, $^{28}\text{Si}$, $^{12}\text{C}$ up to 1.7 GeV/n
  - MiniCAL on lift table
  - EM CAL on translation, lift, and pitch table looking up at muons

W N Johnson

Calorimeter Subsystem Status
GSI’s Fragment Separator (FRS)

Cocktail beam at 1.7 GeV/nucleon
Tagged with t, Z, A, E, direction
Ion selection

No Z selection applied

Z selection applied (Z=14)
Quenching factors

Quenching factor $= \frac{\text{measured/calculated deposited energy}}{dL/dE}$

- Z=6 (C): $dL/dE=1.23$ « Quenching »: $dL/dE <1$
- Z=14 (Si): $dL/dE=1.08$ « Antiquenching »: $dL/dE >1$
- Z=26 (Fe): $dL/dE=0.90$

$dL/dE = 1$ for protons, muons, electrons.
Flight Hardware
Manufacture and Test
Crystal Detector Elements (CDE)
Swales Aerospace

CDE Components

Tooling for 72 CDEs bonded per week

Crystal jig and diode mask and seal

Finished CDEs – 1 layer of 1 module
Carbon Composite Structures
IN2P3 Ecole Polytechnique

- Mandrel wrapping w/ prepreg
- One layer at a time
- Stack layers in alignment tooling
- Vacuum bag assembly for autoclave curing
- Each one is assembled w/ dummy CDE for vibration strength testing
- Hot out of the oven – a completed structure
PreElectronics Module (PEM) Assembly
Naval Research Lab

CDE Insertion into structure

Closeout plates keep CDEs in place

Even Eric can do it

Connect test electronics for muon testing

Finished PEM awaiting test

7 PEM awaiting AFEE installation
Using cosmic muons
- Verify PIN diode bonds – end vs end, big vs small
- Check light yield
- Map light asymmetry
GLAST LAT Project Collaboration Meeting Sep 27 – 29, 2004

CAL Front End Electronics Naval Research Lab

Over 12,000 ASICs packaged and tested
AFEE burn-in and T cycling – 8 at once

AFEE circuit board – 4 per CAL module
AFEE soldering – 192 wires per side

The evil eye of QA inspector
Installation of SLAC’s EM2 TEM/TPS

FMA CAL tower complete!

Installation of EMI Side Panels – lots of fasteners

CAL clean room and shipping containers
FMA Environmental Testing
Naval Research Lab

FMA in EMI/EMC Testing

Comprehensive performance test takes careful monitoring

Remove FMA from shipping container for vibration testing

FMA on vibe slip table for lateral test
Light Asymmetry – Cosmic Muons

layer=5, crystal=3

longitudinal position, cm

Light Asymmetry

layer=5, crystal 3

light asymmetry nonlinearity

longitudinal position, cm
FMA Cosmic Muon Testing

- raw spectrum, scaled by 0.25
- selected spectrum - histogram
- selected spectrum - landau fit

Events per bin vs. muon signal, ADC units
LEX8 noise determines data sparsification energy threshold (Log Accept)

Log Accept Threshold will impact energy resolution at low energies.

192 Pedestal width measurements w/ Cosmic muons
\[ \sigma \sim 0.2 \text{ MeV} \]

Log Accept Threshold
- Need \( 3\sigma \) threshold to limit event size
- Quantization of Log Accept setting is 0.75 (1.5) MeV
- For ground testing, log accept threshold of 0.75 – 1.5 MeV is achievable.
- In orbit, higher noise is expected.
Calorimeter Assembly Flow and Build Status

- **Crystal Detector Element (CDE) Assembly**: 1424 / 1830
- **CsI Crystals**: 1755 / 1830
- **PIN Diode**: 4800 / 4380
- **Optical Wrap**: 12 / 18
- **Metallic Structure**: 24 / 110
- **PreElectronics Module (PEM)**: 8 / 18
- **Module Assembly & Test**: 1 / 16
- **Front-End Electronics**: 24 / 110
# Near Term Schedule

<table>
<thead>
<tr>
<th>Flight Module</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Module A</td>
<td></td>
</tr>
<tr>
<td>2 week Thermal Vacuum Test</td>
<td>13-Oct-2004</td>
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<tr>
<td>Final Calibration and Performance Tests</td>
<td>27-Oct-2004</td>
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<tr>
<td>Ship to SLAC I&amp;T</td>
<td>1-Nov 2004</td>
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<tr>
<td>Ready for Integration</td>
<td>4-Nov-2004</td>
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<tr>
<td>Flight Module B</td>
<td></td>
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<tr>
<td>Assembly Complete</td>
<td>1-Oct-2004</td>
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<tr>
<td>Environmental Tests Complete</td>
<td>5-Nov-2004</td>
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<tr>
<td>Ready for Integration</td>
<td>2-Dec-2004</td>
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<tr>
<td>Flight Module 1</td>
<td></td>
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<tr>
<td>Assembly Complete</td>
<td>8-Oct-2004</td>
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<tr>
<td>Environmental Tests Complete</td>
<td>5-Nov-2004</td>
</tr>
<tr>
<td>Ready for Integration</td>
<td>8-Dec-2004</td>
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Issues

- **Performance**
  - *Higher than expected CDE Light Yield*
    - Too much gain, max energy measurement in single Crystal
      ~50 GeV rather than required 100 GeV
  - *Power consumption at -30 deg C is ~ 8 watts over allocation of 65 watts.*

- **Manufacturing and Test**
  - *CAL ASICs have significant ESD vulnerabilities*
    - Care in handling and interconnect of AFEE cards is needed to avoid electrostatic discharge damage to board interface signal lines.
Summary

- CAL subsystem is well into production of flight hardware.
- The first flight module has been completely assembled and is in environmental test. No issues to date.
- First delivery to SLAC I&T is scheduled for early November.