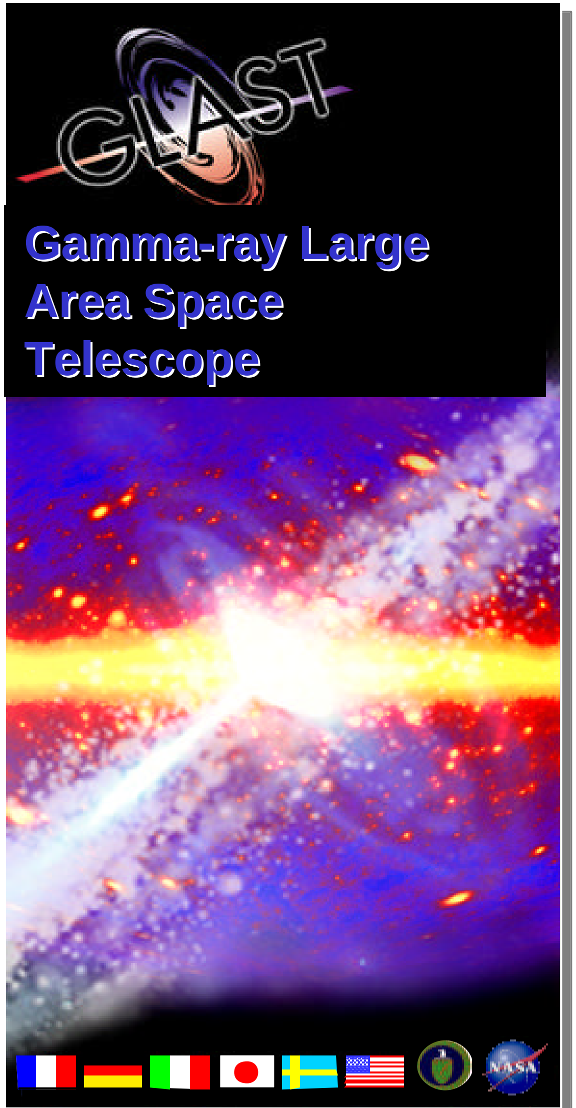


Calorimeter Subsystem

Status and Issues

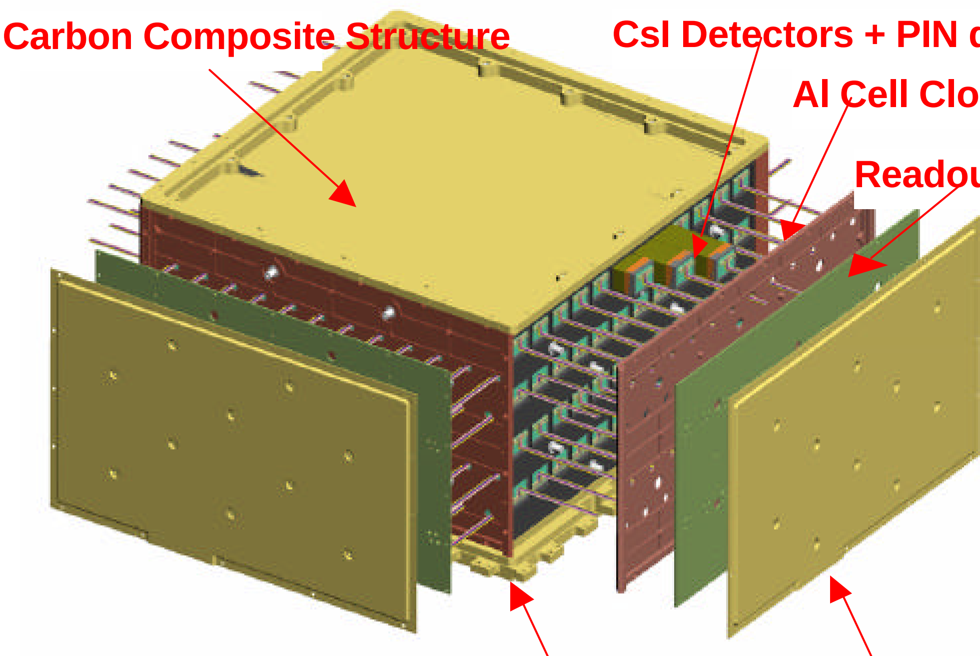
W. Neil Johnson
Naval Research Laboratory

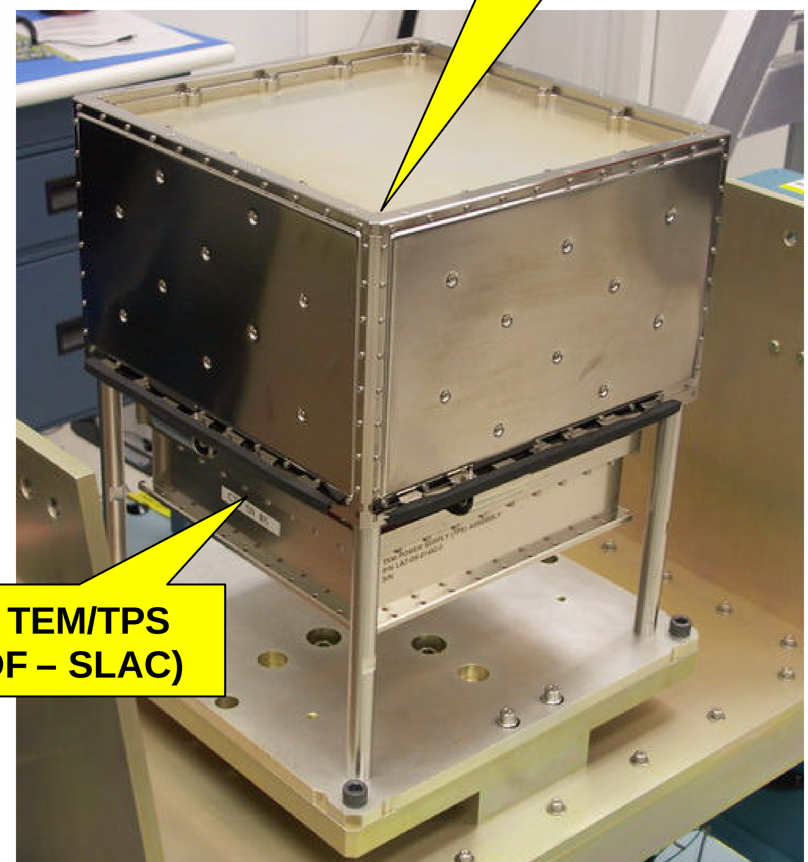
neil.johnson@nrl.navy.mil

Outline

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

Calorimeter Module





16 Identical Flight CAL Modules
+ 2 Spare Modules

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, 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.)

EM Calorimeter at GSI

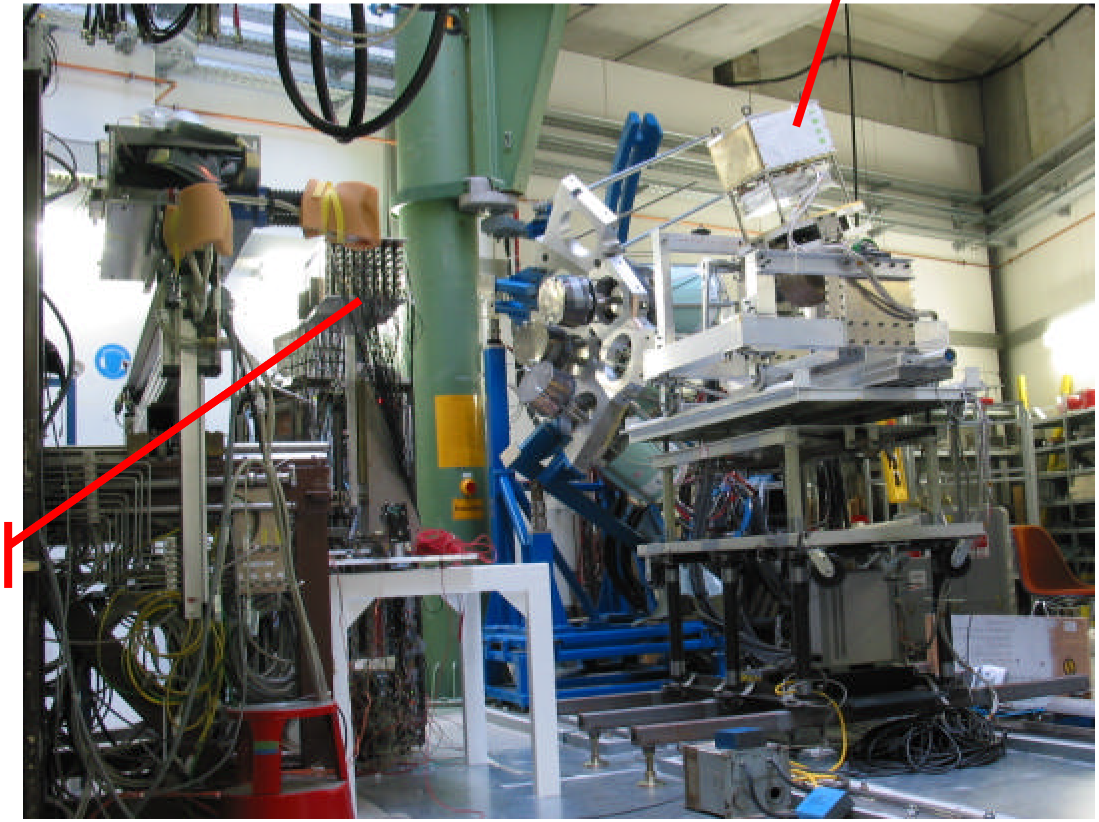
- GLAST setup in FRS cave

EM CAL on translation, lift, and pitch table looking up at muons

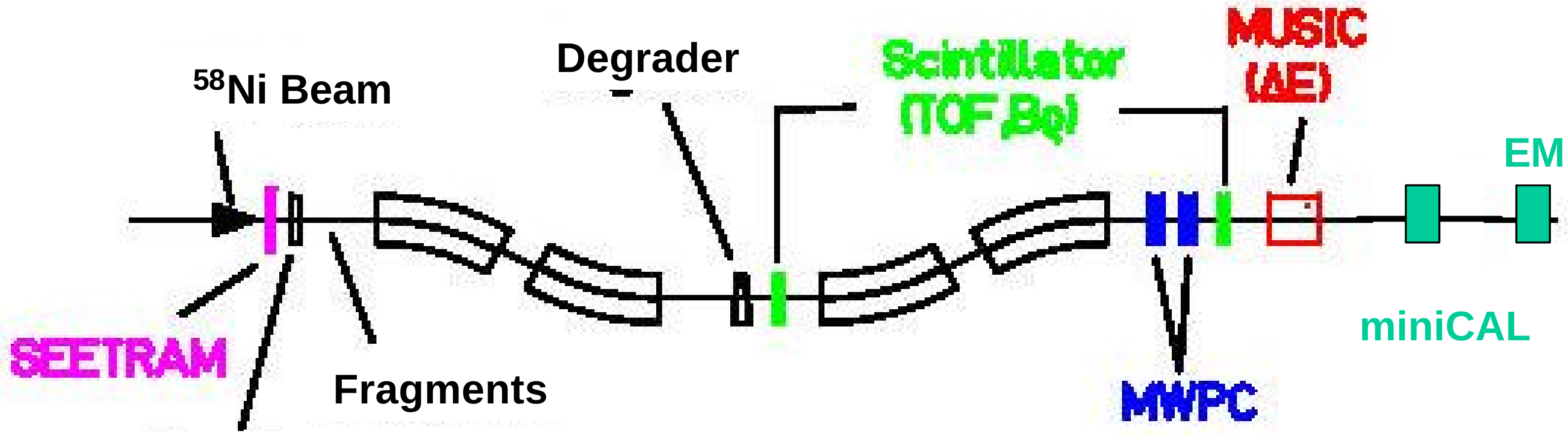
Beam direction

^{58}Ni, ^{28}Si, ^{12}C
up to 1.7 GeV/n

MiniCAL on lift table

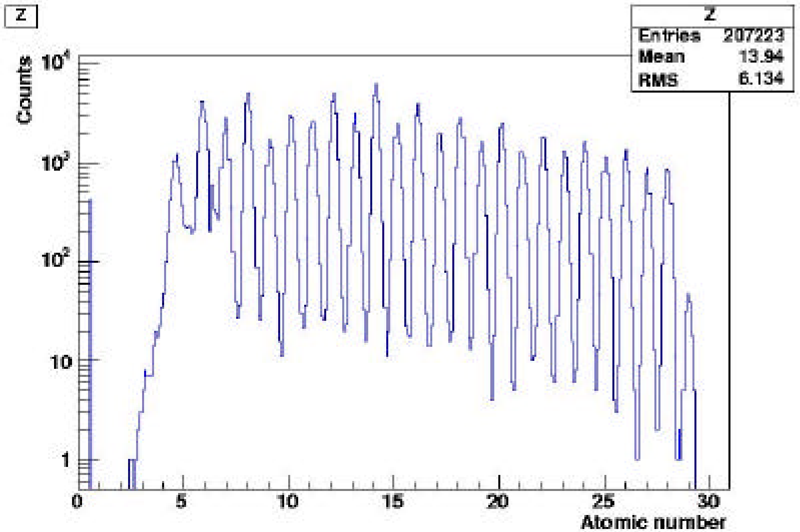


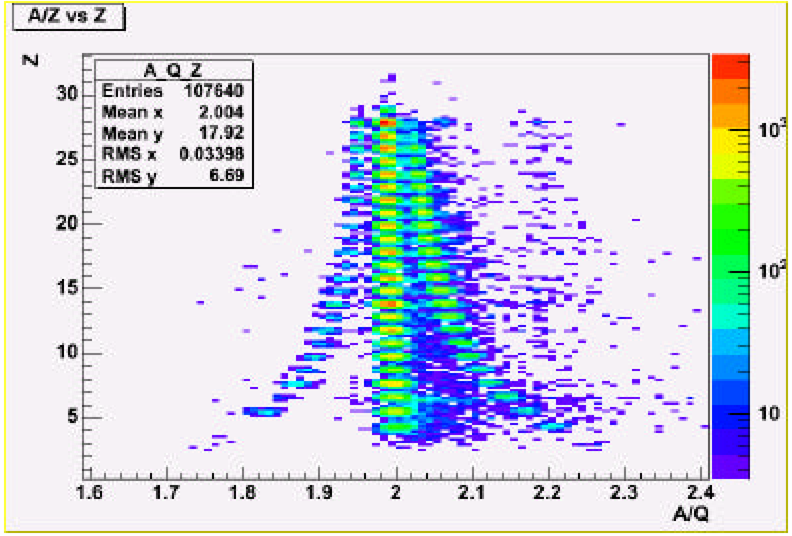
GSI's Fragment Separator (FRS)



Cocktail beam at 1.7 GeV/nucleon

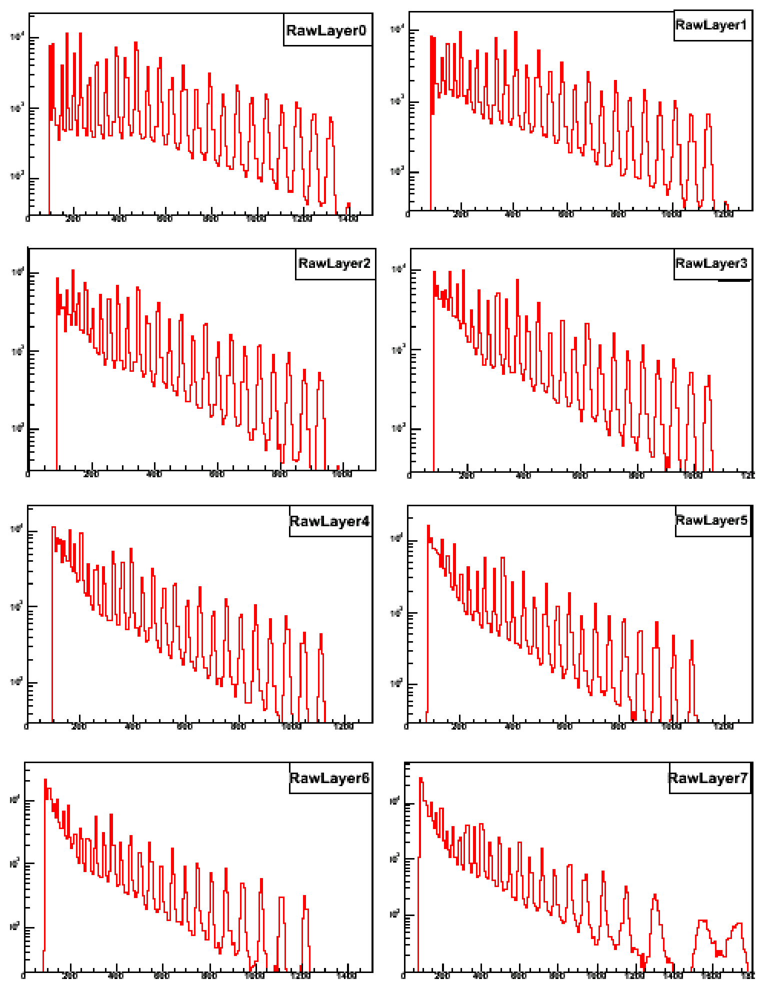
Tagged with t, Z, A, E, direction



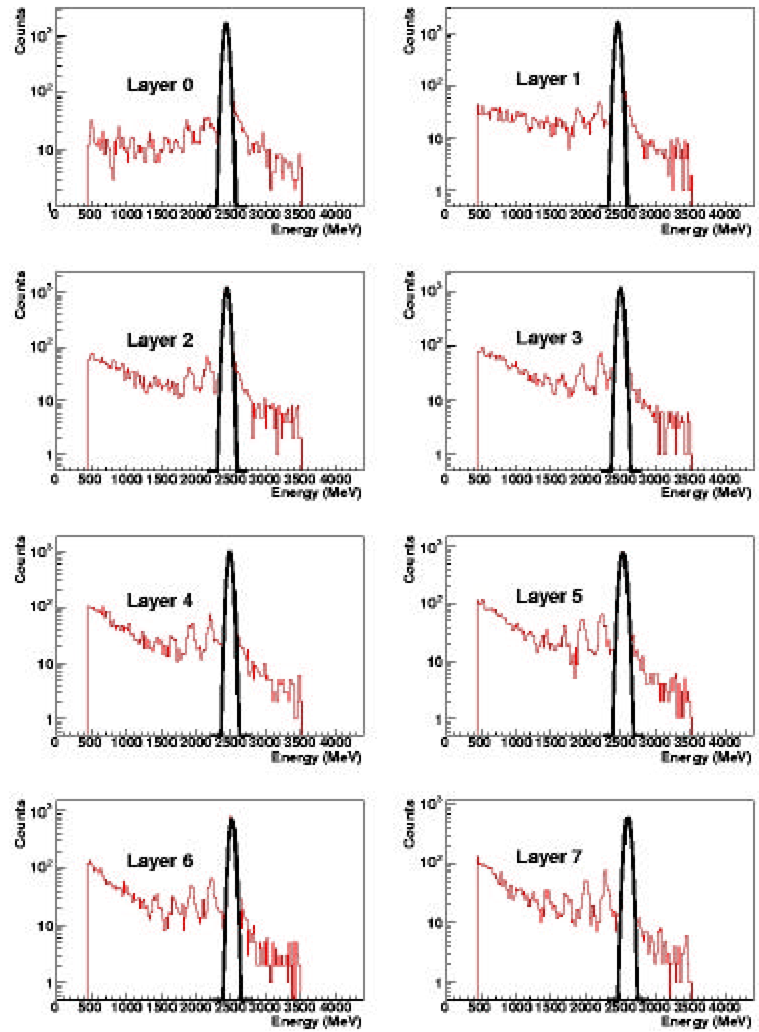


Ion selection

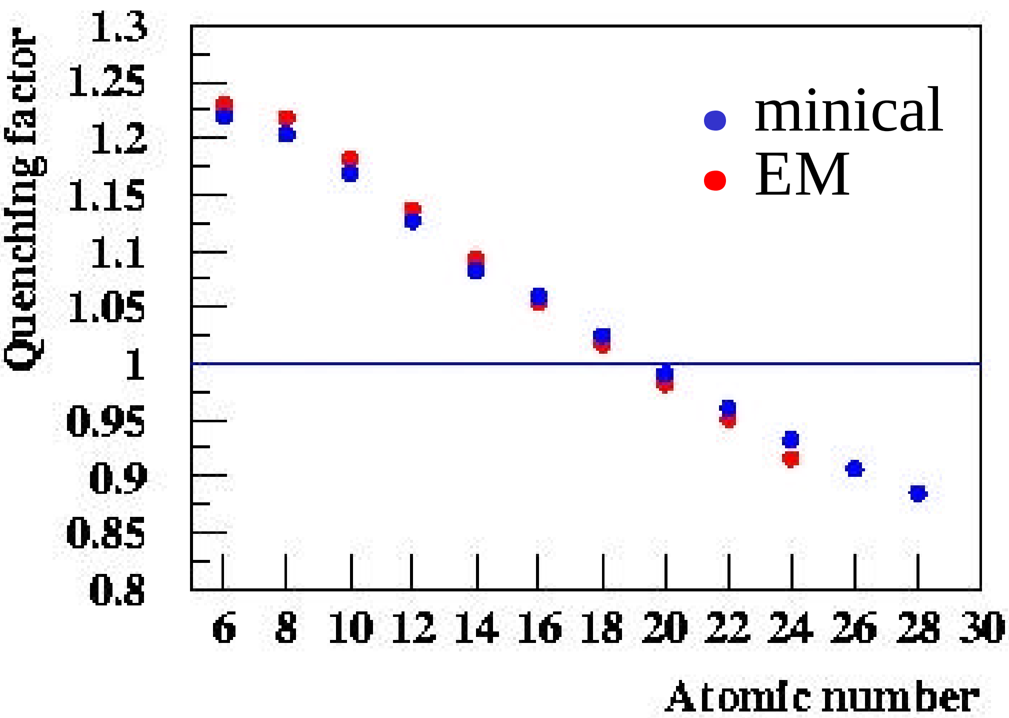
No Z selection applied



Z selection applied (Z=14)



Quenching factors



dL/dE = 1 for protons, muons, electrons.

Quenching factor = measured/calculated deposited energy= dL/dE

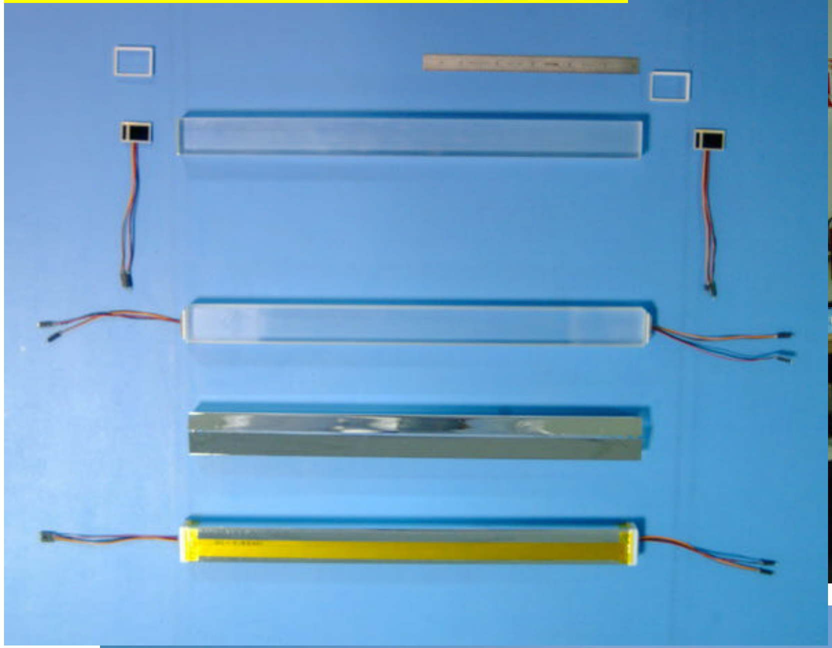
Z=6 (C): dL/dE=1.23
Z=14 (Si): dL/dE=1.08
Z=26 (Fe): dL/dE=0.90

« Quenching »: dL/dE <1
« Antiquenching »: dL/dE>1

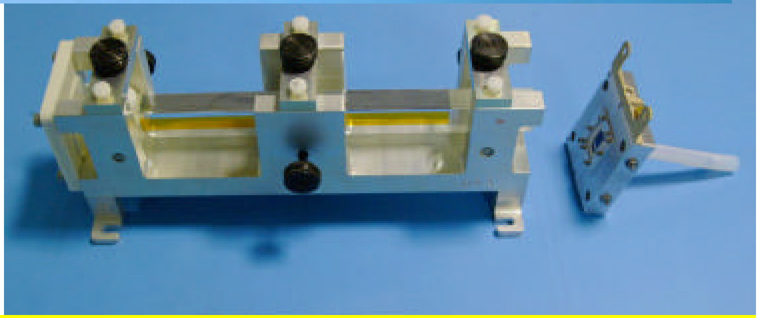
Flight Hardware Manufacture and Test

Crystal Detector Elements (CDE)
Swales Aerospace

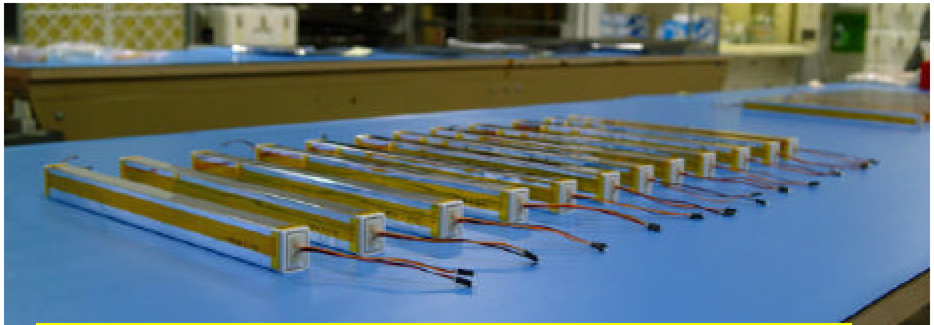
CDE Components



Tooling for 72 CDEs bonded per week



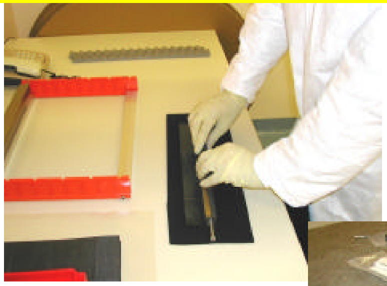
Crystal jig and diode mask and seal



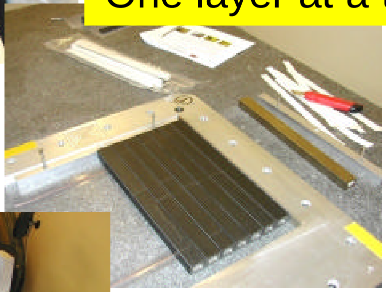
Finished CDEs – 1 layer of 1 module

Carbon Composite Structures
IN2P3 Ecole Polytechnique

Mandrel wrapping w/ prepreg

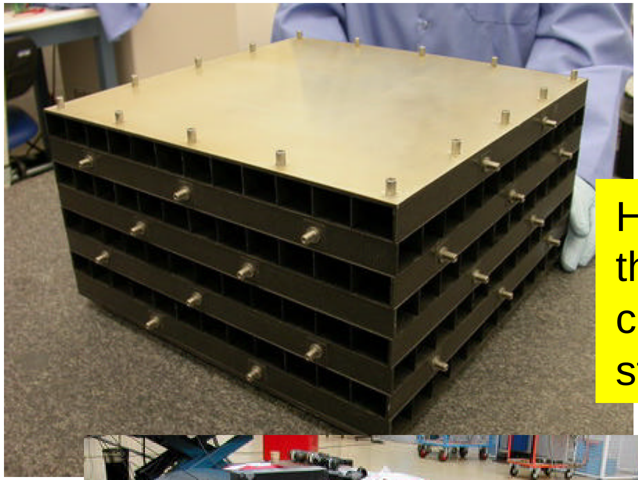


One layer at a time



Stack layers in alignment tooling

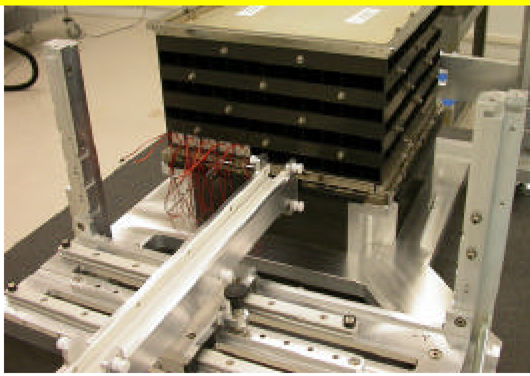
Vacuum bag assembly for autoclave curing



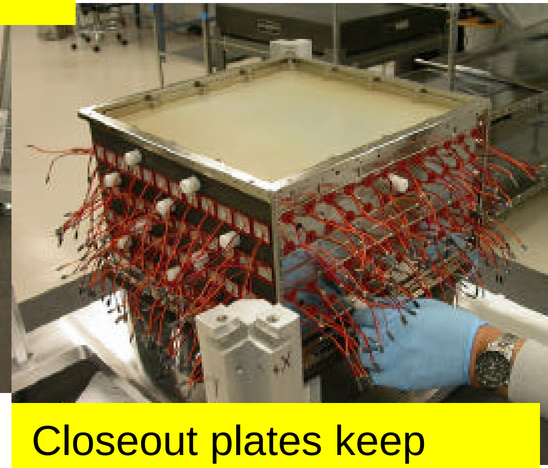
Hot out of the oven – a completed structure

Each one is assembled w/ dummy CDE for vibration strength testing

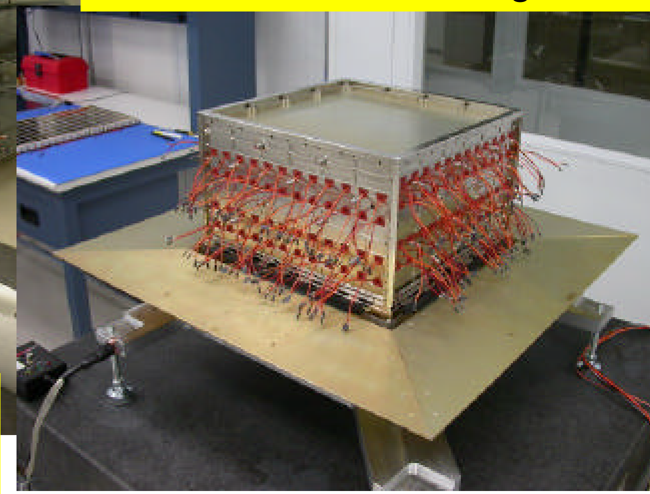
PreElectronics Module (PEM) Assembly
Naval Research Lab



CDE Insertion into structure



Closeout plates keep CDEs in place



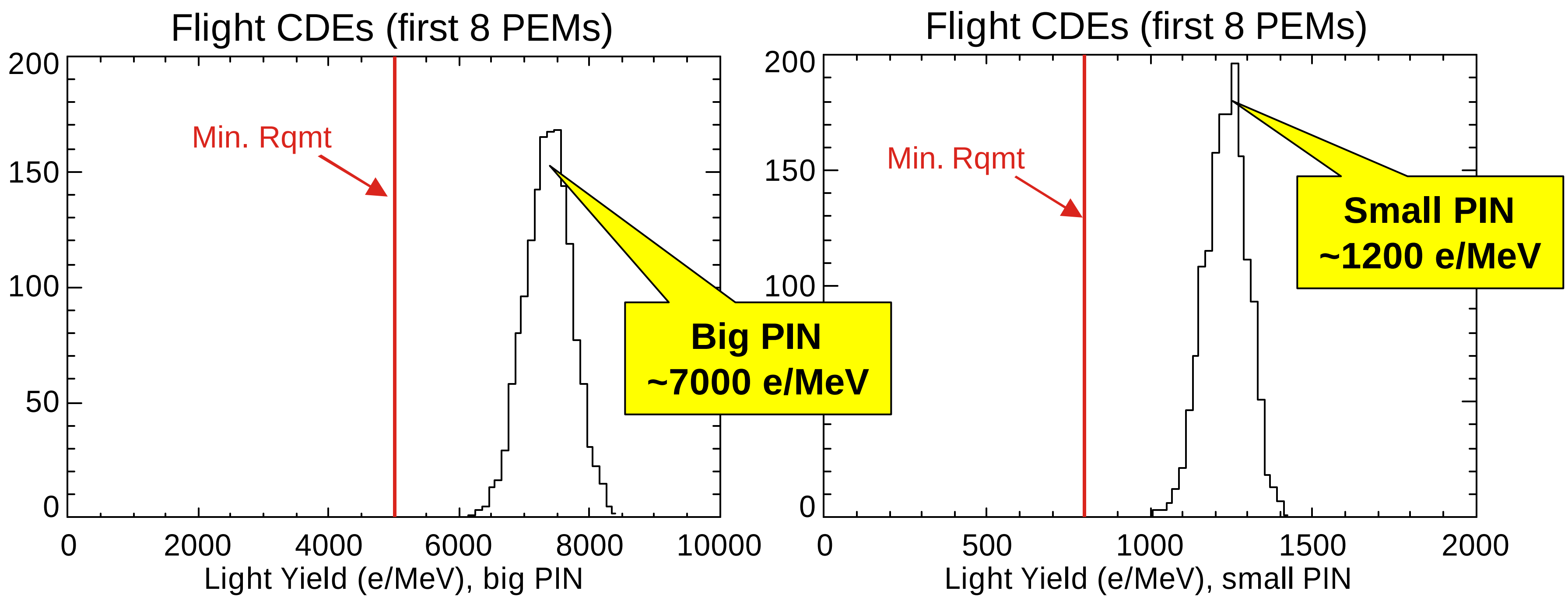
Finished PEM awaiting test

Even Eric can do it

Connect test electronics for muon testing

7 PEM awaiting AFEE installation

PEM Checkout – Light Yield

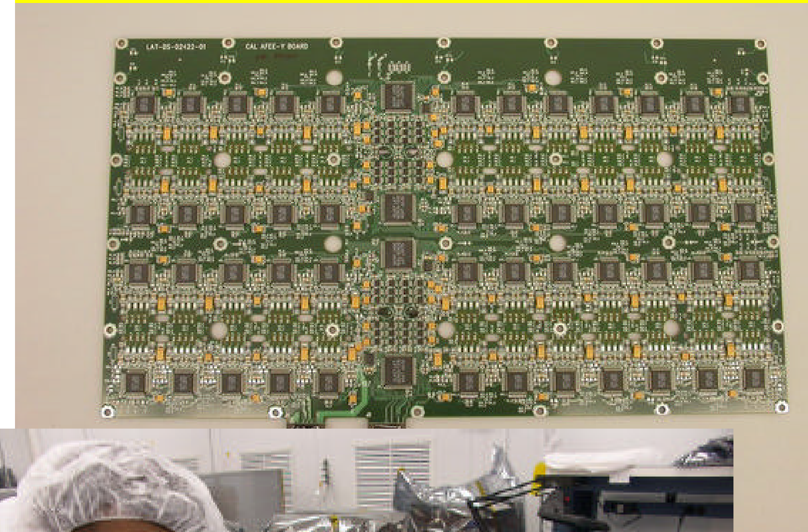


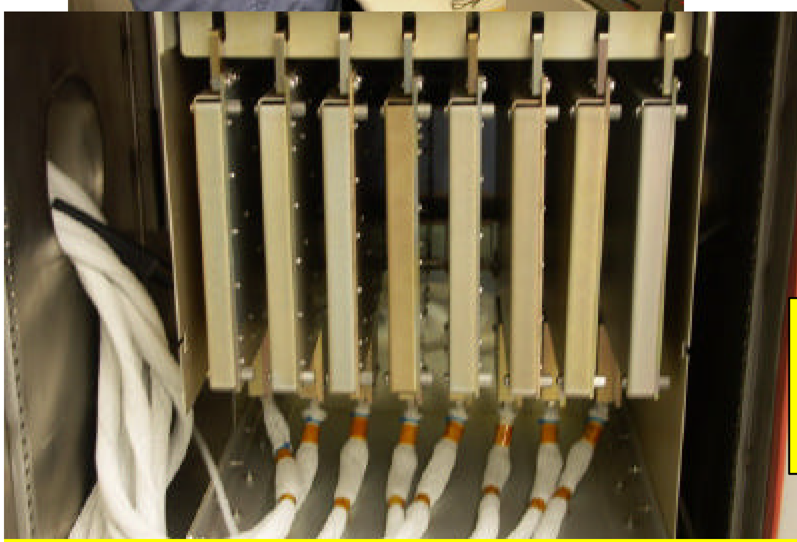
- **Using cosmic muons**
  - **Verify PIN diode bonds – end vs end, big vs small**
  - **Check light yield**
  - **Map light asymmetry**

CAL Front End Electronics
Naval Research Lab

Over 12,000 ASICs packaged and tested

AFEE circuit board – 4 per CAL module





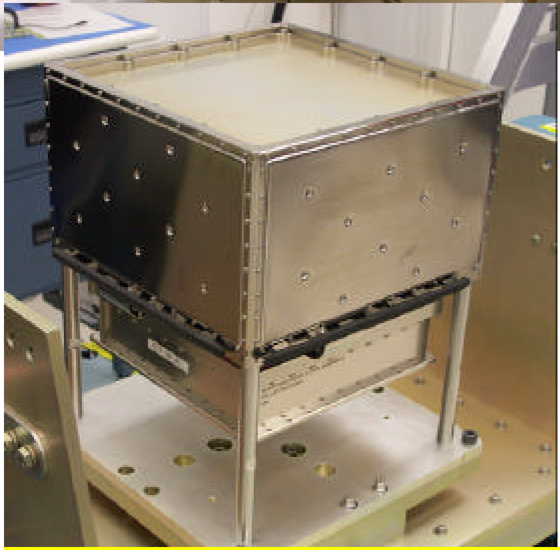
AFEE burn-in and T cycling – 8 at once

AFEE soldering – 192 wires per side

CAL FMA Final Assembly
Naval Research Lab

Installation of SLAC's EM2 TEM/TPS

Installation of EMI Side Panels – lots of fasteners

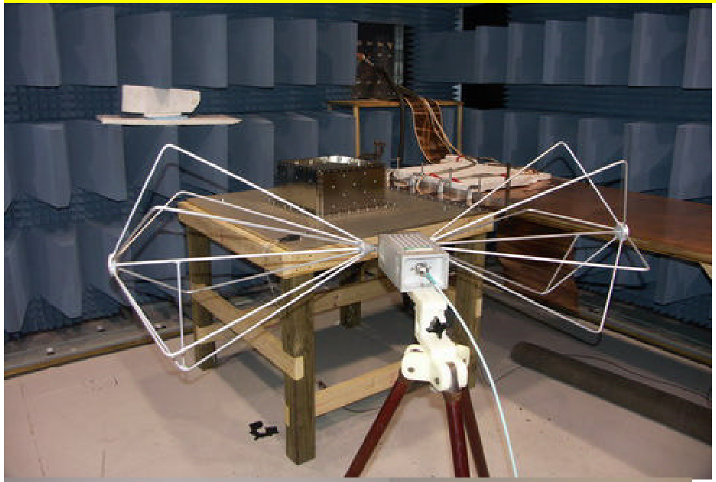


FMA CAL tower complete!

CAL clean room and shipping containers

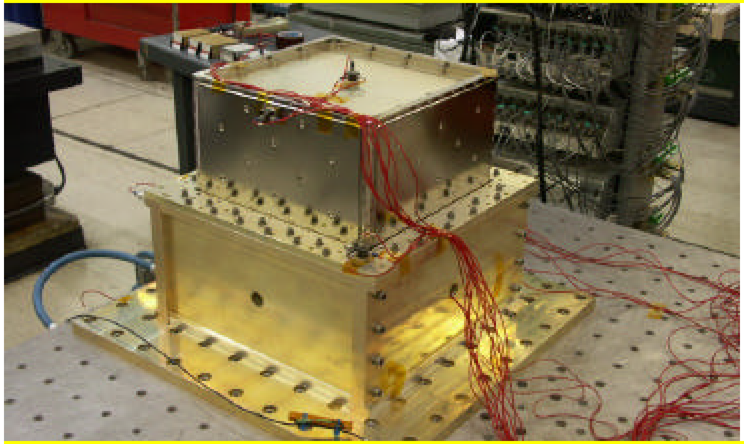
FMA Environmental Testing
Naval Research Lab

FMA in EMI/EMC Testing



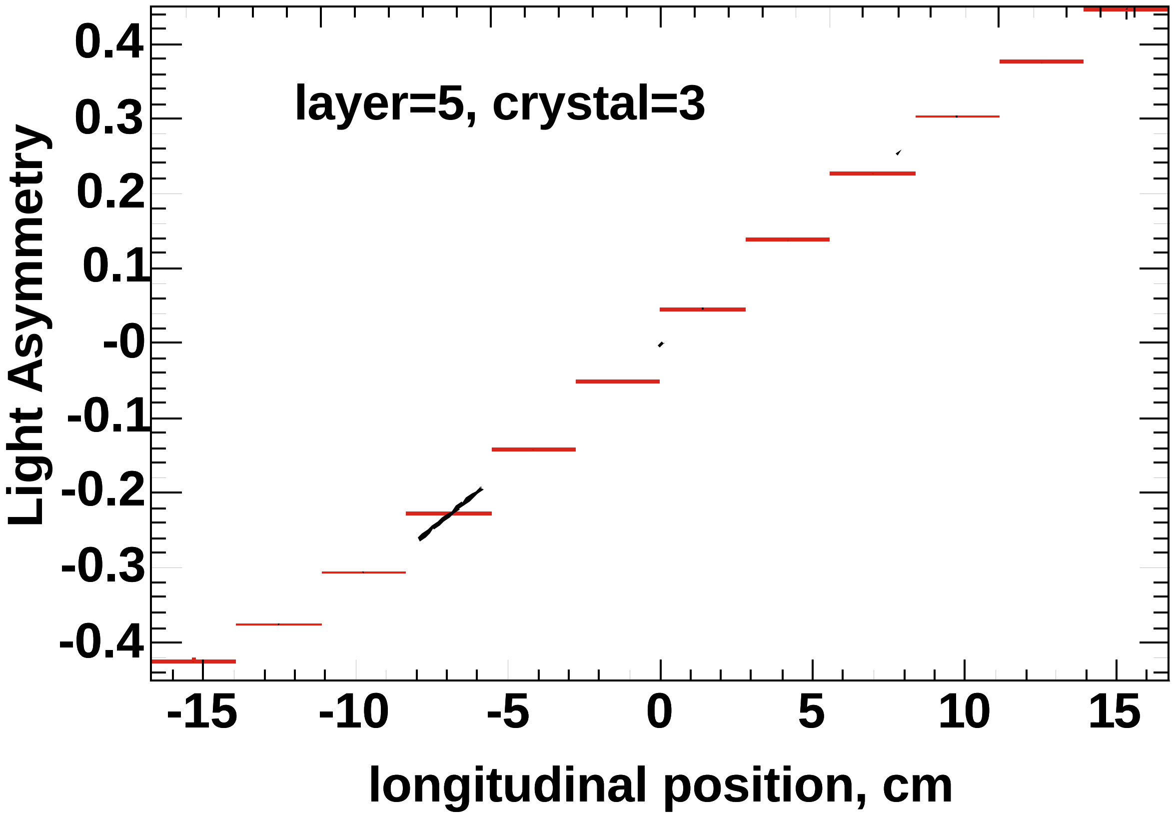
Comprehensive performance test takes careful monitoring

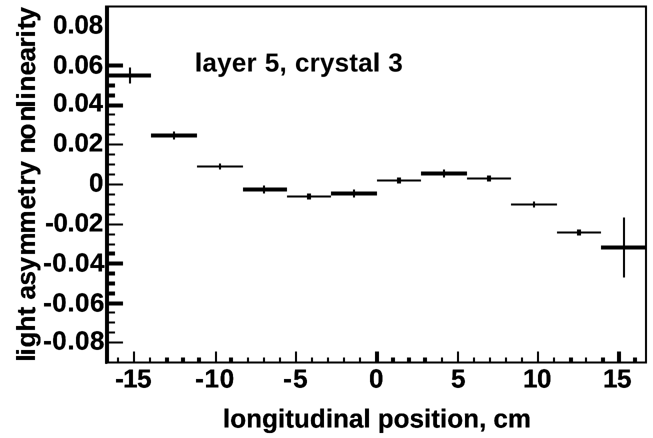
Remove FMA from shipping container for vibration testing

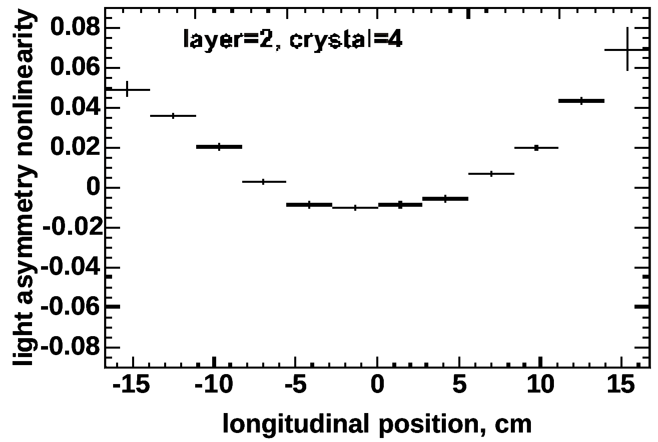


FMA on vibe slip table for lateral test

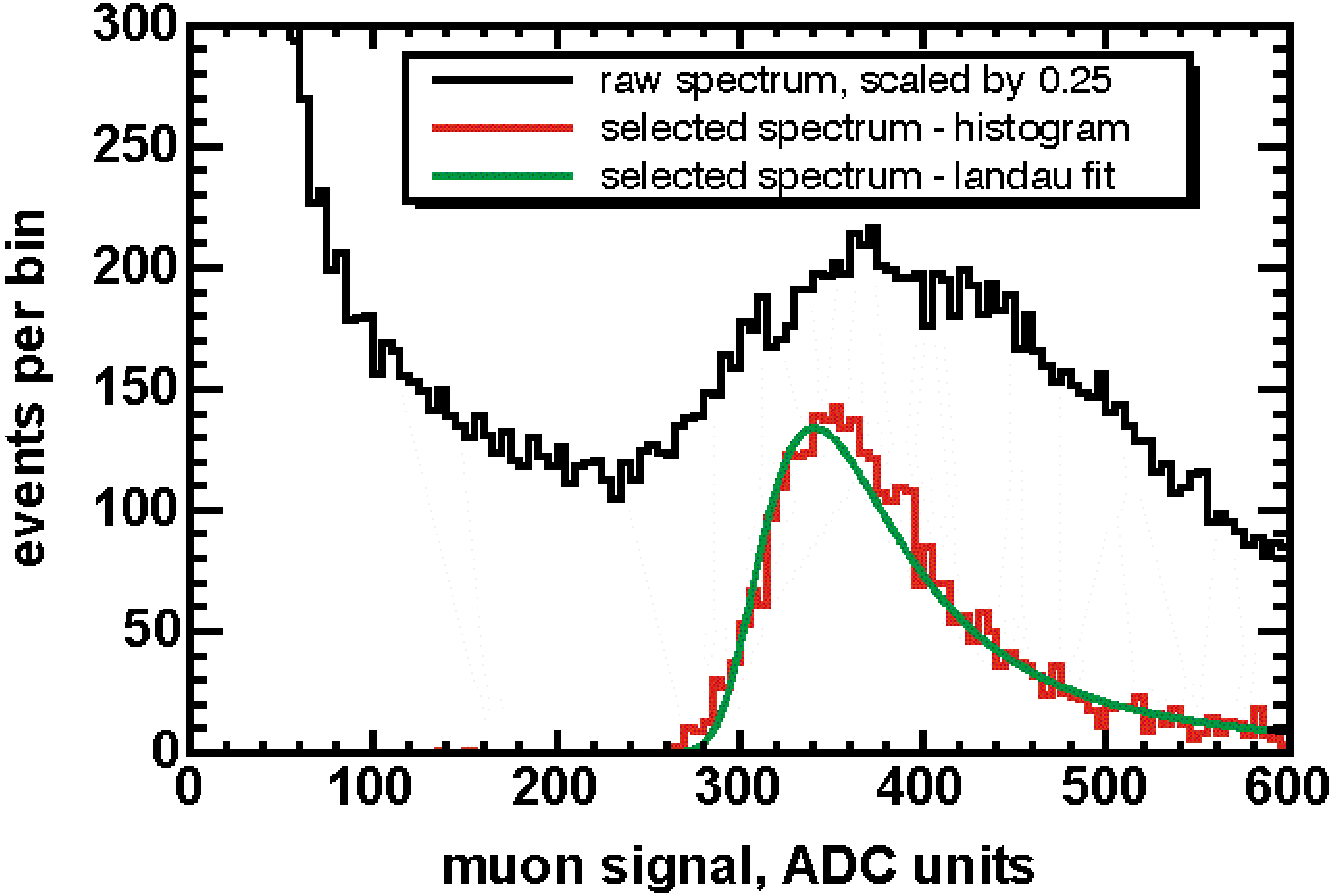
Light Asymmetry – Cosmic Muons



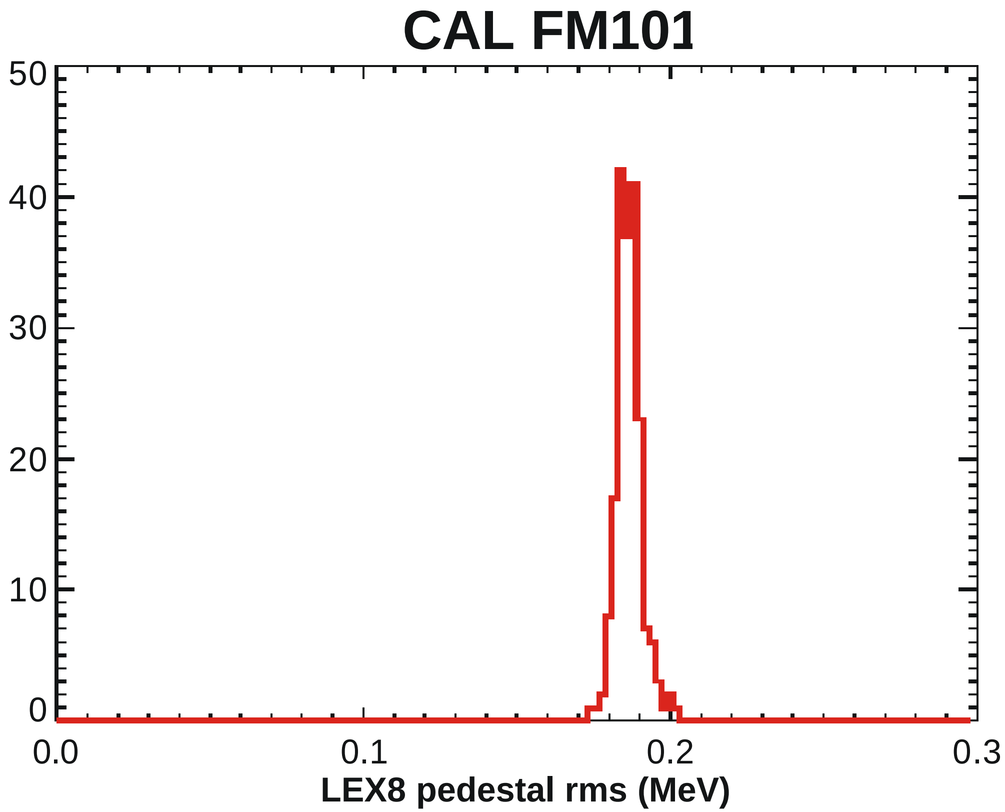




FMA Cosmic Muon Testing



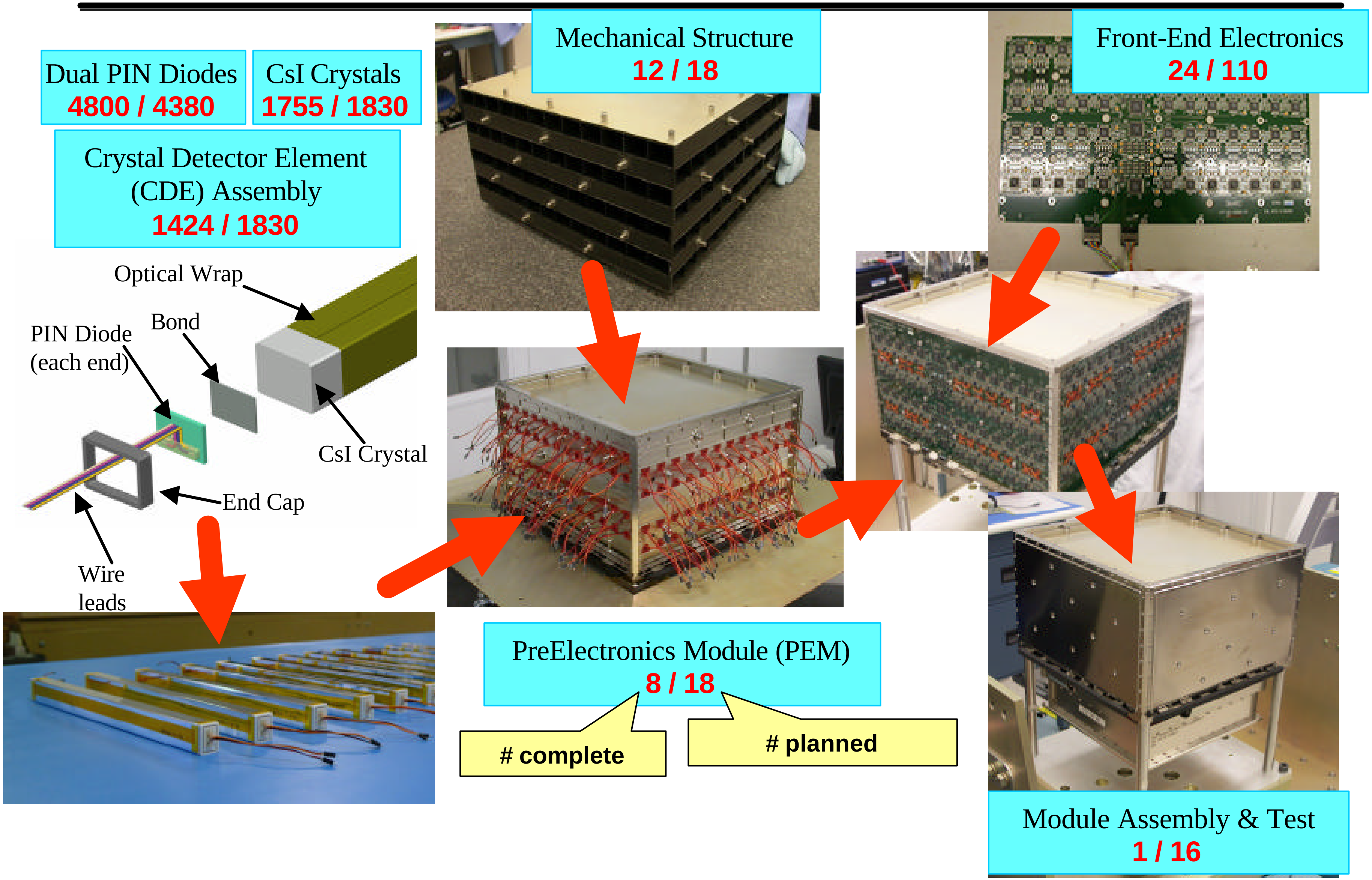
LEX8 Noise Measurement



Distribution of 192 pedestal widths (rms)

- 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
  - σ ~ 0.2 MeV
- Log Accept Threshold
  - Need ~ 3 σ 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



Near Term Schedule

Flight Module A		**Completion**
	2 week Thermal Vacuum Test	**13-Oct-2004**
	Final Calibration and Performance Tests	**27-Oct-2004**
	Ship to SLAC I&T	**1-Nov 2004**
	Ready for Integration	**4-Nov-2004**
Flight Module B		
	Assembly Complete	**1-Oct-2004**
	Environmental Tests Complete	**5-Nov-2004**
	Ready for Integration	**2-Dec-2004**
Flight Module 1		
	Assembly Complete	**8-Oct-2004**
	Environmental Tests Complete	**5-Nov-2004**
	Ready for Integration	**8-Dec-2004**

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.