Tail-Catcher Muon-Tracker for the CALICE Test Beam

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for NICADD at NIU

Outline

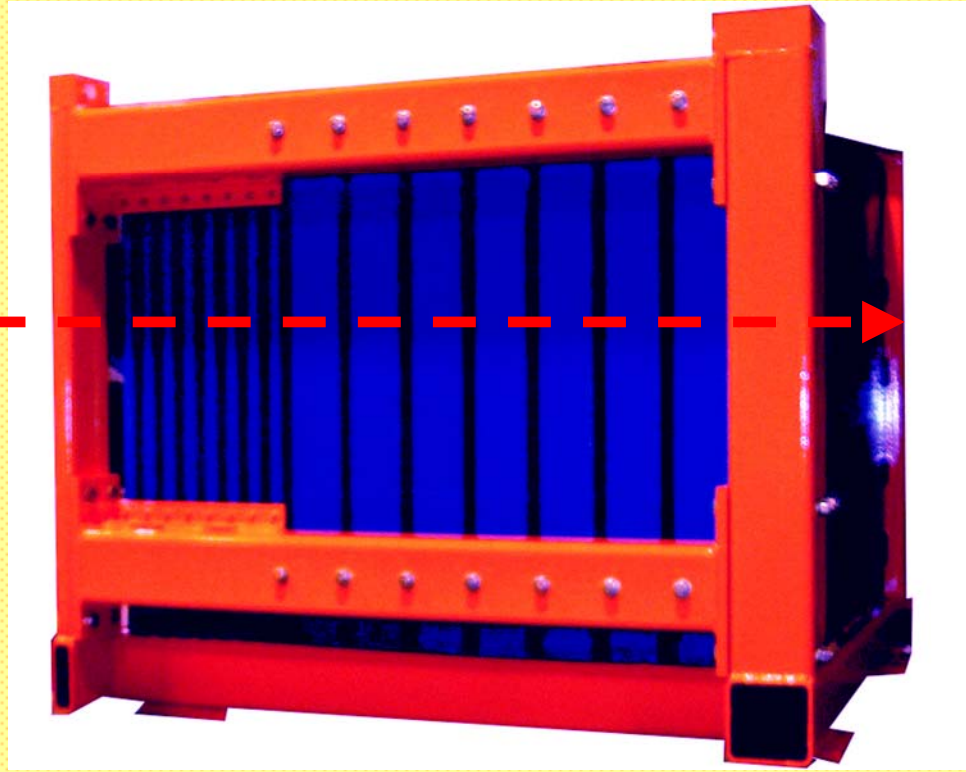
- **TCMT prototype construction-design; quality control studies for extruded scintillating strips and wave length shifting fibers; common readout with AHCAL.**
- **Tests with radioactive source, electron beam at DESY, hadron beam at Fermilab; plans for 2006.**
- **Jet energy resolution simulations for a full SiD detector with and without tail-catcher.**

General Considerations

- **The design of a detector for the ILC is driven by the application of Particle Flow Algorithms for the measurement of hadronic jets.**
- **A realistic simulation of hadronic showers is a prerequisite for the development of a reliable design of such a detector.**
- **The simulation needs to be validated. The measurements obtained in particle beams will be essential. CALICE is going to do that with ECAL, AHCAL, and TCMT prototypes.**

CALICE TCMT Prototype

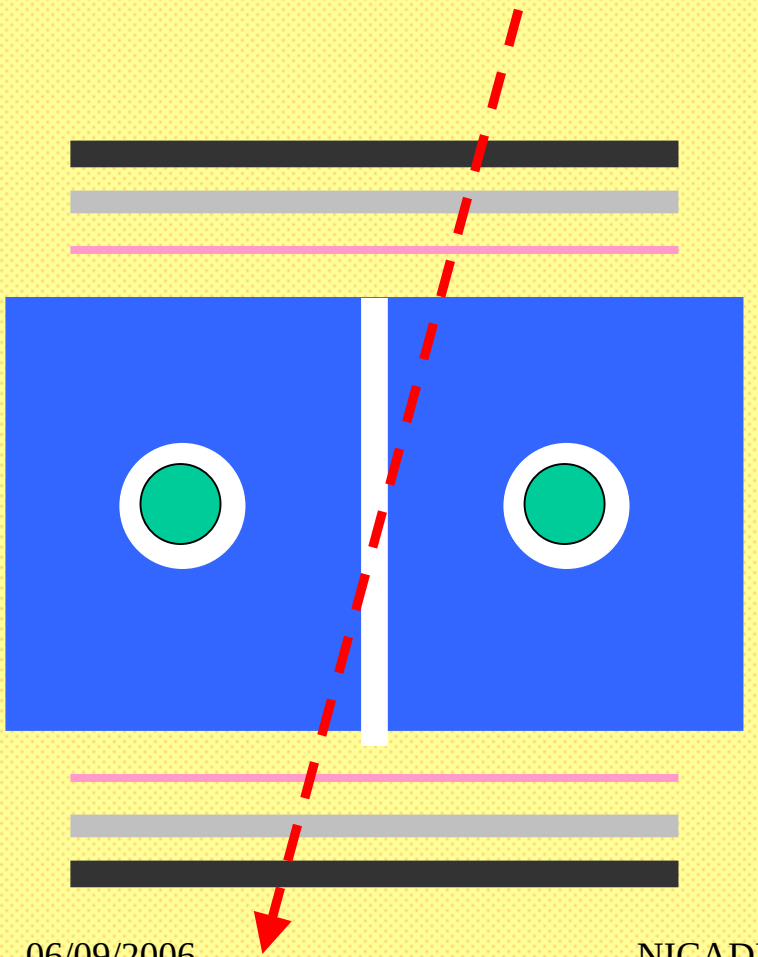
The absorber has 8 layers of 2 cm thick and 8 layers of 10 cm thick steel.
Length is 142 cm.
Height is 109 cm.
Weight is about 10 tons.



TCMT has 16 cassettes with about 1x1 m² active area, made from 5 cm extruded scintillator strips in alternating x-y orientation.

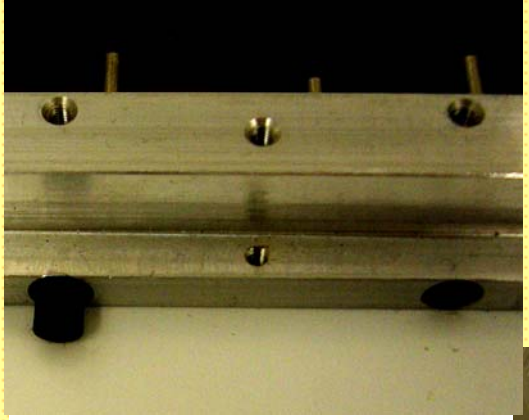
The construction involves DESY, NICADD at NIU, and Fermilab.

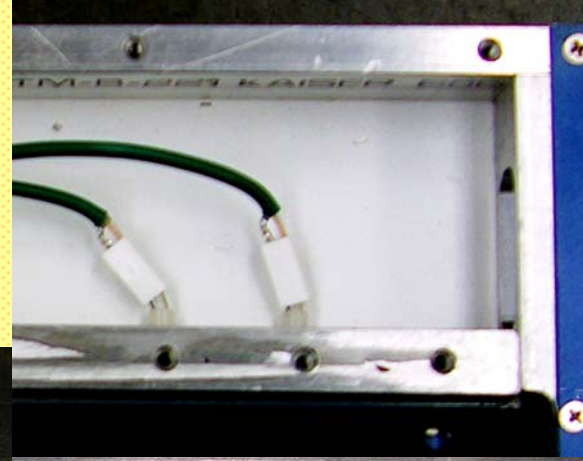
Cassette Schematic Cross Section (not to scale)

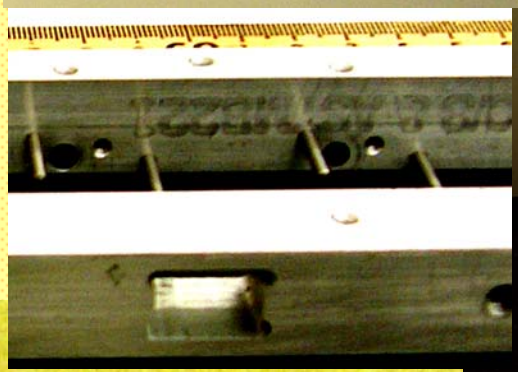


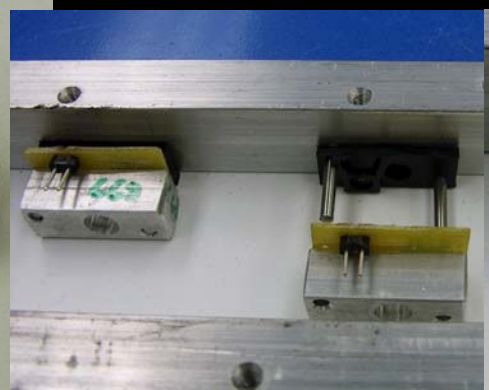
1 mm thick steel;
1 mm thick plastic;
Tyvek/VM2000
5 mm thick scintillator;
Co-extruded holes;
1.2 mm OD WLS fibers;
0.9 mm separation groove.

TCMT Cassette

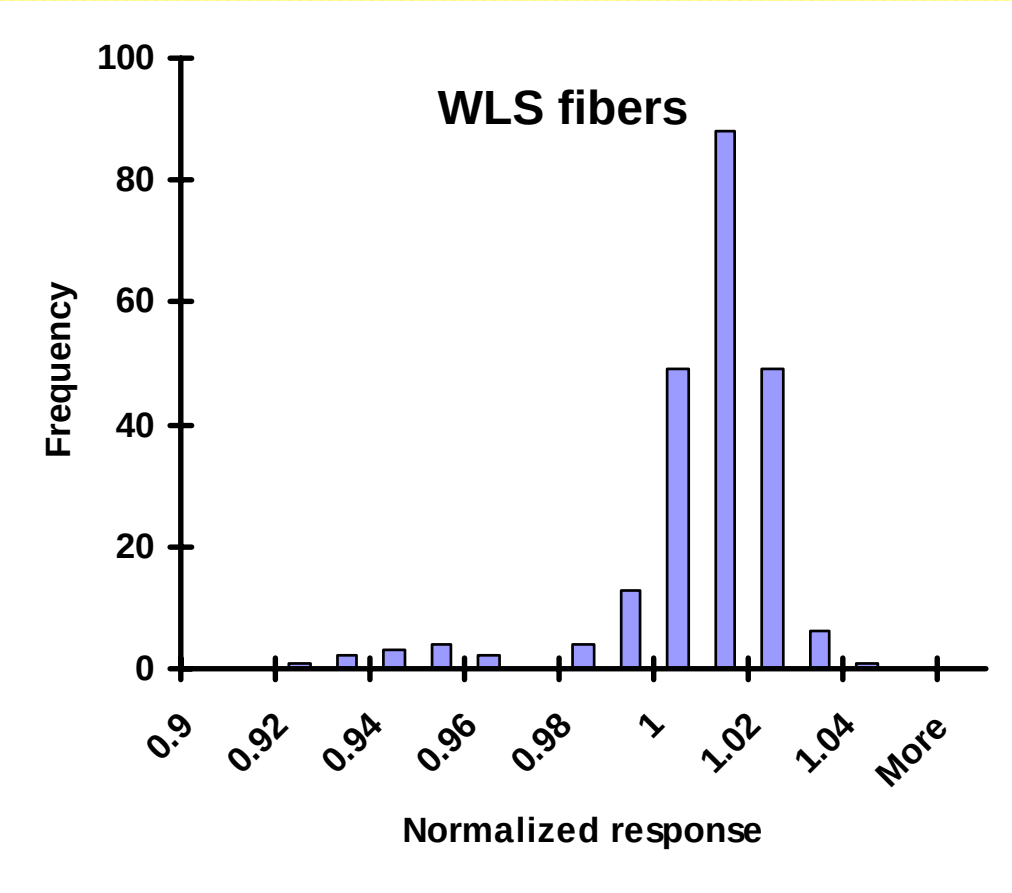








TCMT Quality Control



- **All extruded strips were tested with Sr-90. Each cassette has strips with light yield within 10%.**
- **All WLS fibers were tested with scintillator and Sr-90 on the top. WLS fibers response are within 1%.**

TCMT Calibration-monitoring

- **Each TCMT strip has a BIVAR UV LED.**
- **LED driver provides opportunity to monitor SiPM gain by recording a single photo electron spectrum at a low-light-level and linear range by recording saturation, which is sensitive to amount of dead micro-cells at a high-light-level, for each SiPM.**
- **LED driver board is under production.**

Readout Tests

- **One TCMT cassette was instrumented with 18 silicon photo detectors (SiPM).**
- **All elements of the readout chain were fully tested, including common readout with AHCAL and electron beam test at DESY in November 2005.**

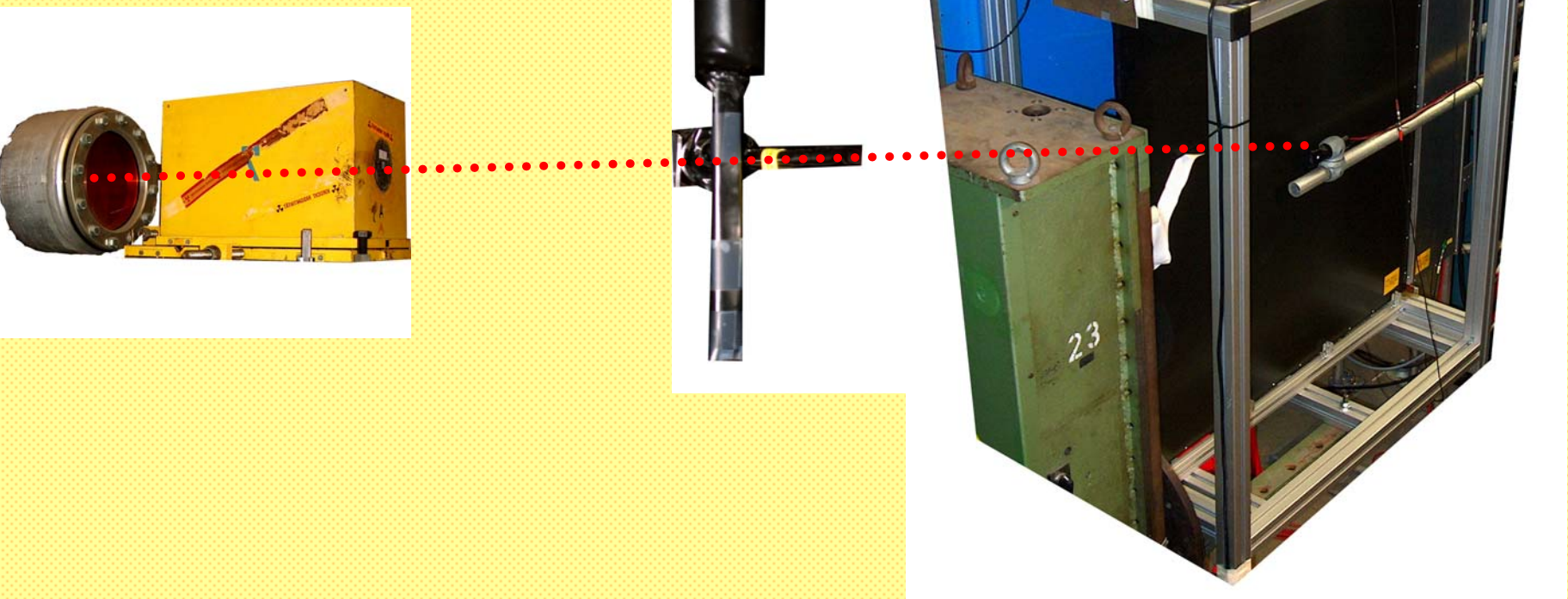
Beam Test at DESY (not to scale)

Collimator

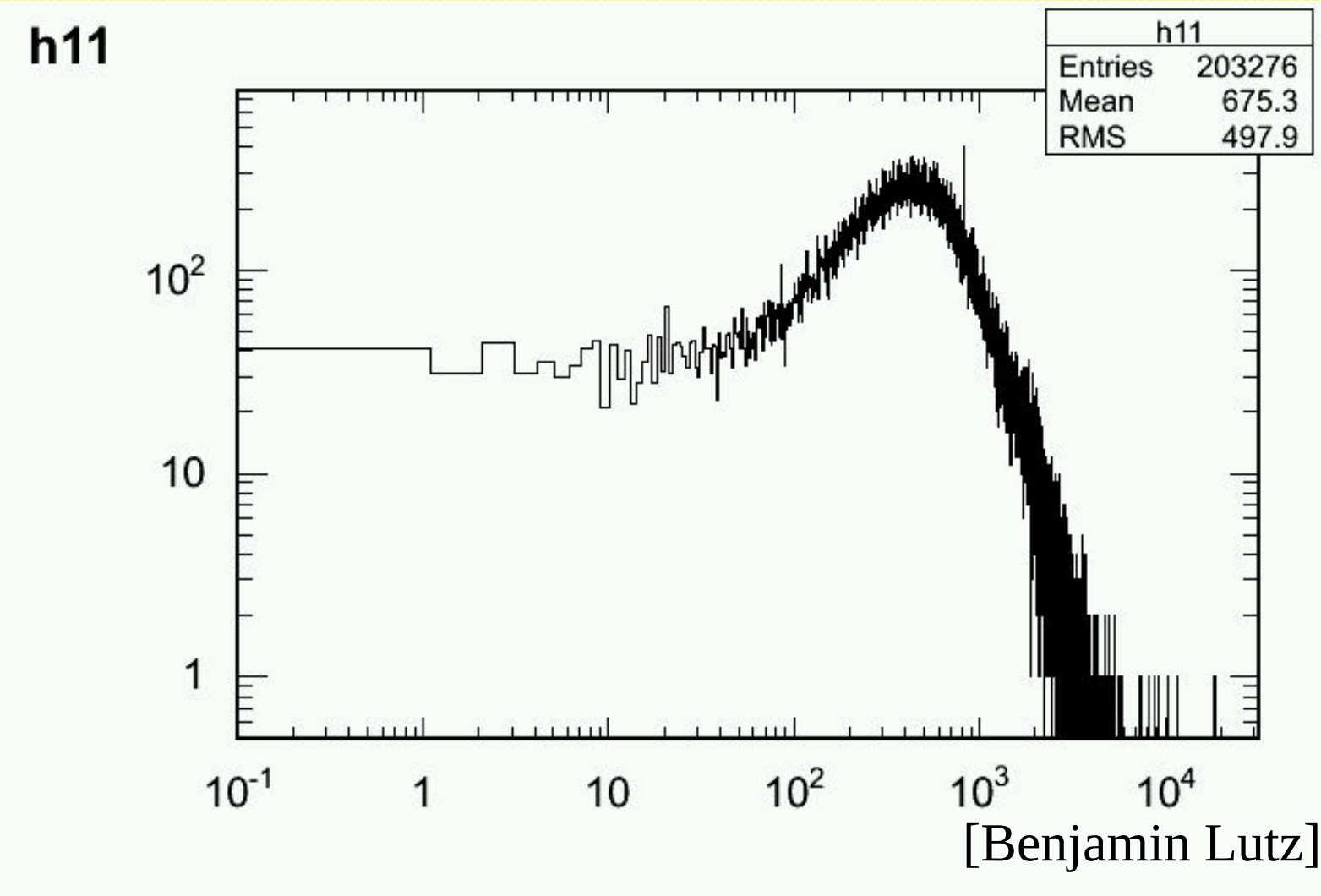
Finger counters (trigger)

TCMT (blue)

AHCAL (black)

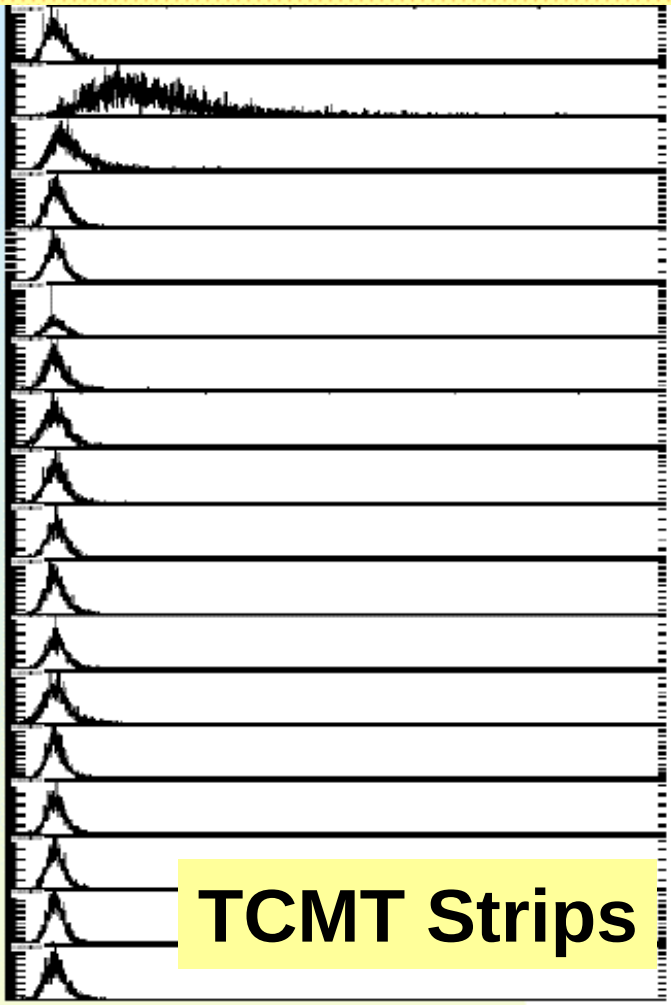


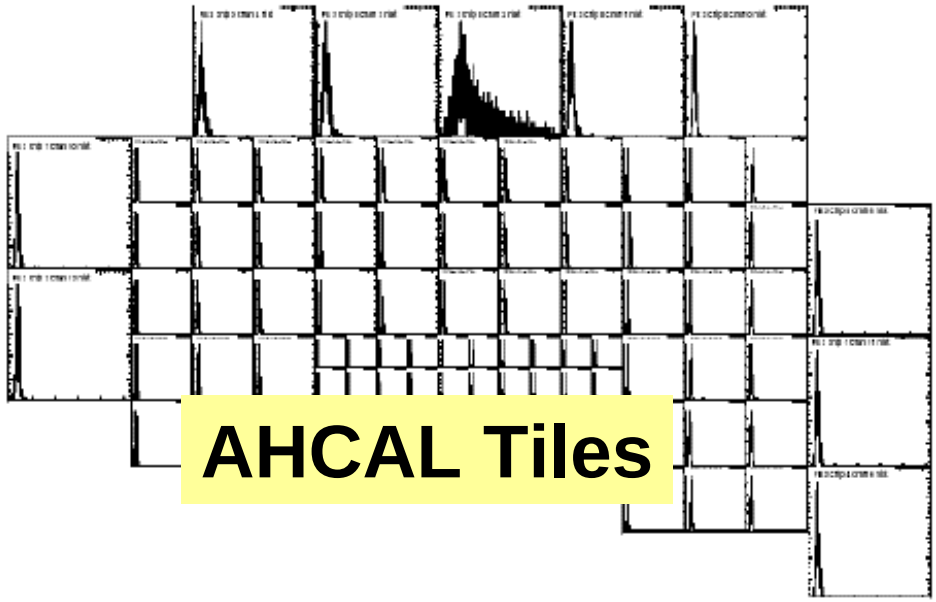
“Channel 11” Response to Electrons



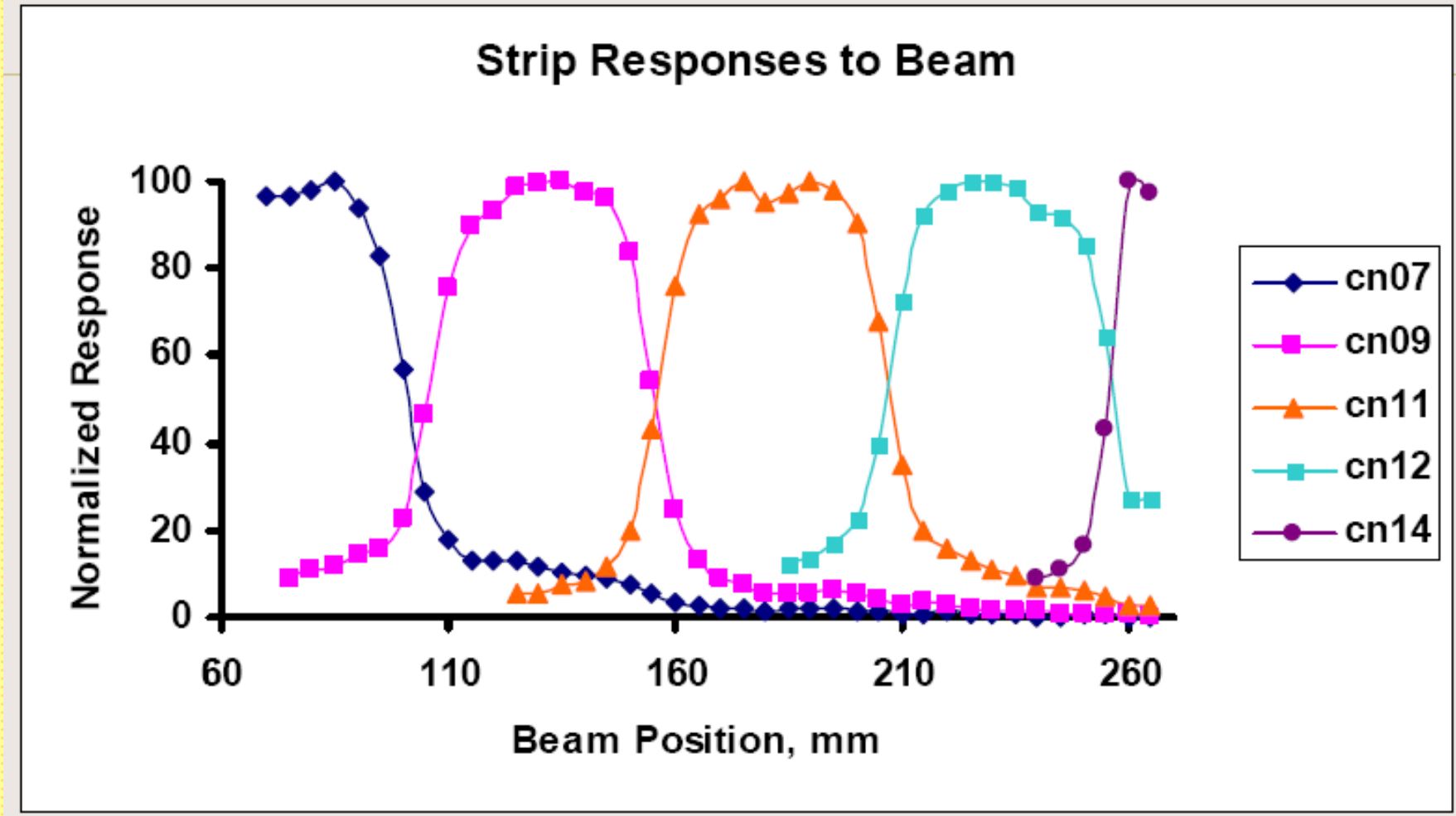
[Benjamin Lutz]

The Same 3 GeV/c Electron Events in TCMT and AHCAL





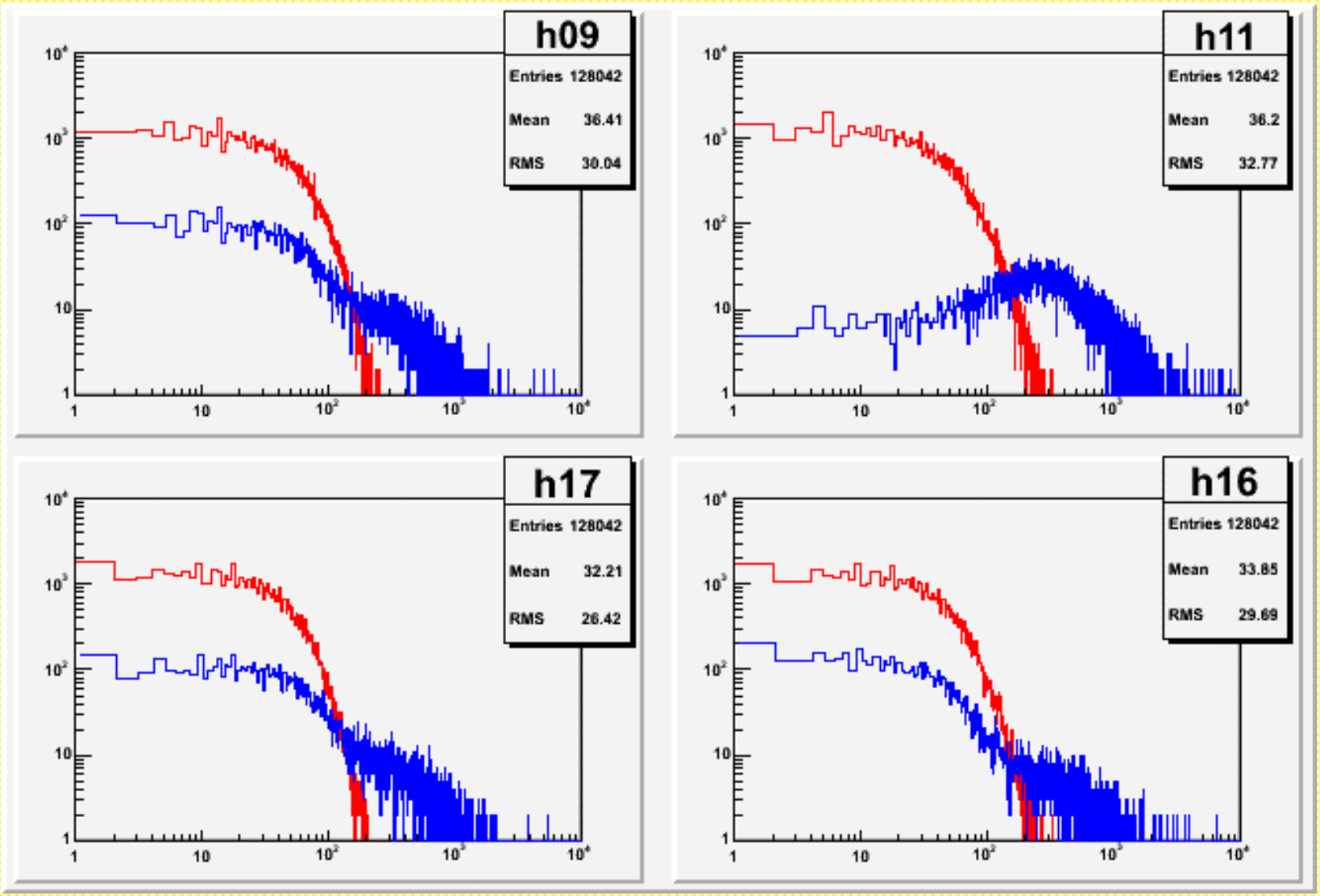
Transverse Cassette Scan with Electron Beam



Beam Test at Fermilab in February 2006

The test involves DESY, NICADD at NIU, ICL, and Fermilab.

Response to 120 GeV/c Protons



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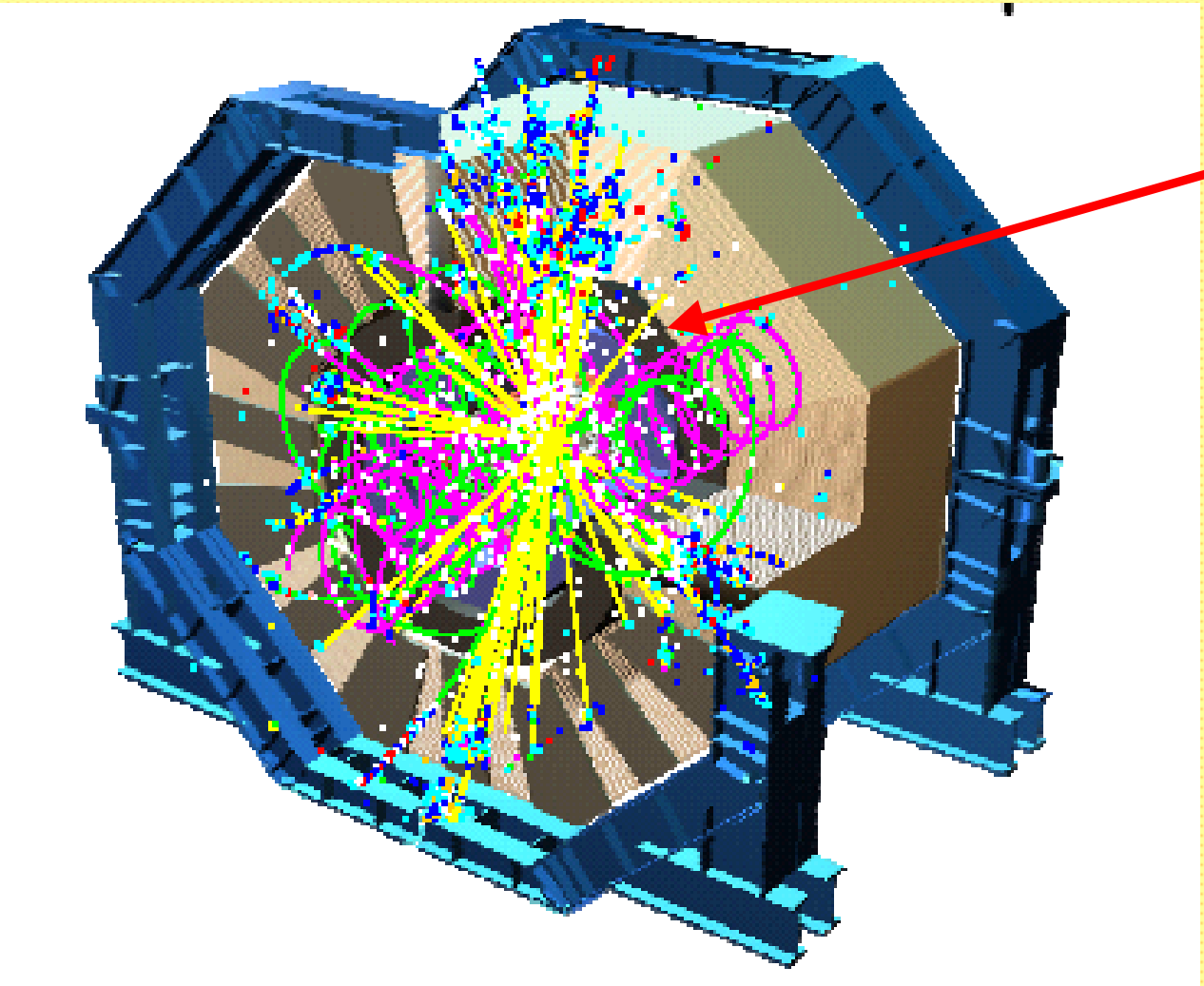
Future Plans:
Beam Tests of Hadronic Calorimeter Including TCMT

- Energy scans with single pion and proton responses (1-60 GeV).
- Incident angle scans (3 angles at 2 energies).
- Calibration runs (with defocused muons).
- Muon responses (3-20 GeV).

Simulation of SiD for ILC



Possible Tail-catcher

LCFOA-2006
M. Breidenbach

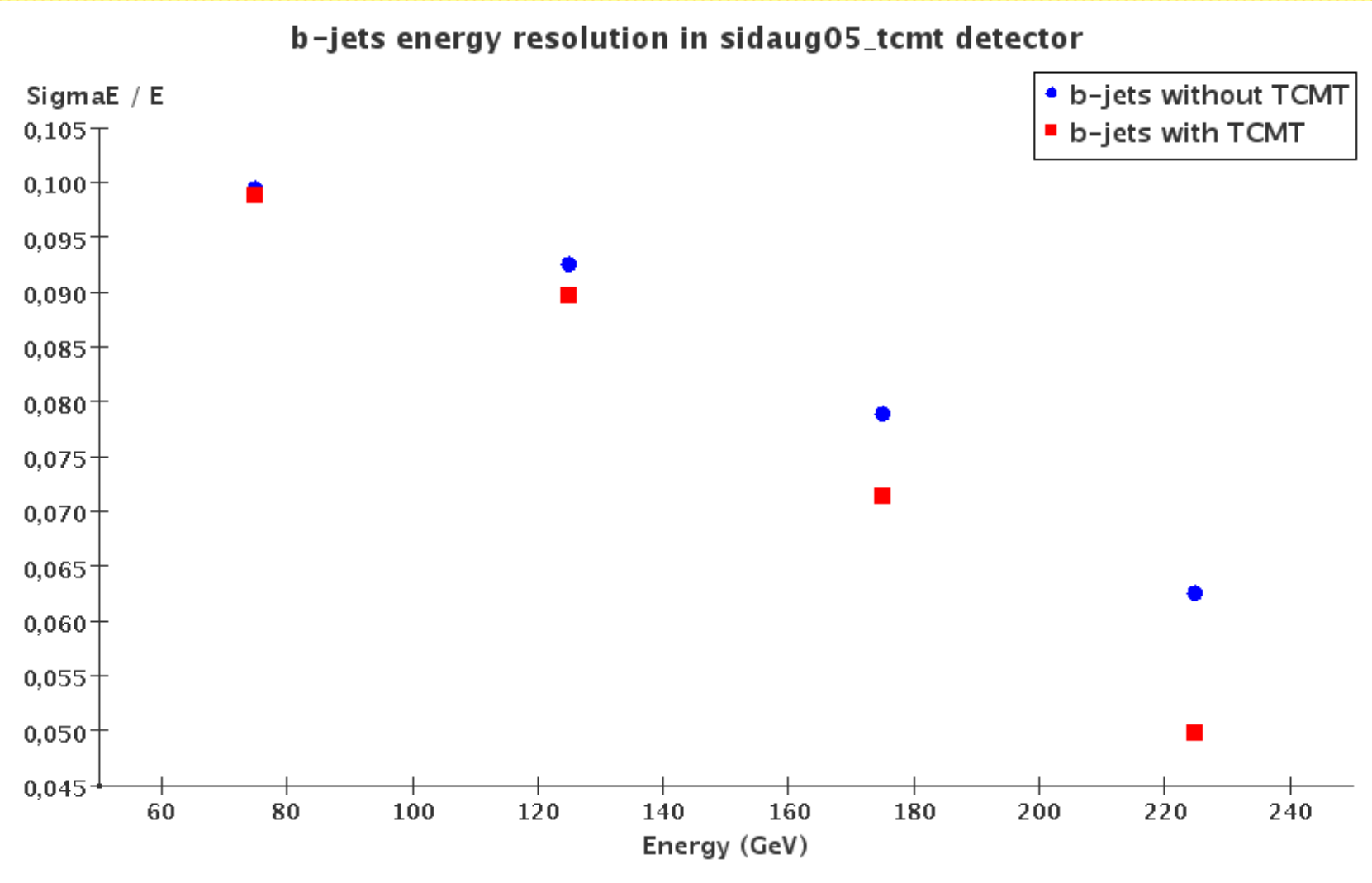
SiD Design Dimensions

- **The ECAL and HCAL have 4.6 nuclear λ; 5T solenoid coil and cryostat have 1.27λ.**
- **HCAL outer radius is 2.37 m.**
- **The muon system will start outside of the solenoid and cryostat at the radius of about 3.50 m.**
- **The outer solenoid flux return layers of steel plates with gaps where consideration of a tail-catcher would be natural.**

Full Detector Model Simulation with Tail Catcher

- **sidaug05-tcmt has a non-projective 5x5 mm² ECAL; 20 mm SS and 10x10 mm² Scintillator HCAL; SS and 30x30 mm² Scintillator tail-catcher muon-tracker (G. Lima);**
- **The tail catcher has 48 layers of 20 mm SS, 5mm scintillator and 3 mm G10. The thickness of SS in the tail catcher was the same as in the HCAL.**

TCMT Effect (Calorimeter Only)



Summary

- The TCMT cassette was integrated into the AHCAL electronics and DAQ chain.
  - The TCMT prototype making good progress with one cassette and have all cassettes ready for SiPM .
- Should be ready for beam tests at CERN in 2006 with a few cassettes.
  - Pilot simulations of b-jets in the full SiD model with tail catcher demonstrate improvement in b-jet energy resolution.

References

A. Pla-Dalmau, A. Bross, V. Rykalin, “Extruded Plastic Scintillator at Fermilab” FERMILAB-Conf-03-318-E, 2003

A. Dyshkant, D. Beznosko, G. Blazey et al., “About NICADD Extruded Scintillating Strips” FERMILAB-PUB-05-010-E, 2005

A. Dyshkant, D. Beznosko, G. Blazey et al., “Quality Control Studies of Wavelength Shifting Fibers for a Scintillator- based Tail-Catcher Muon-Tracker Linear Collider Prototype Detector’ FERMILAB-PUB-06-129-E, 2006