Test Beam: Calorimetry

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NIU/NICADD

General Comments

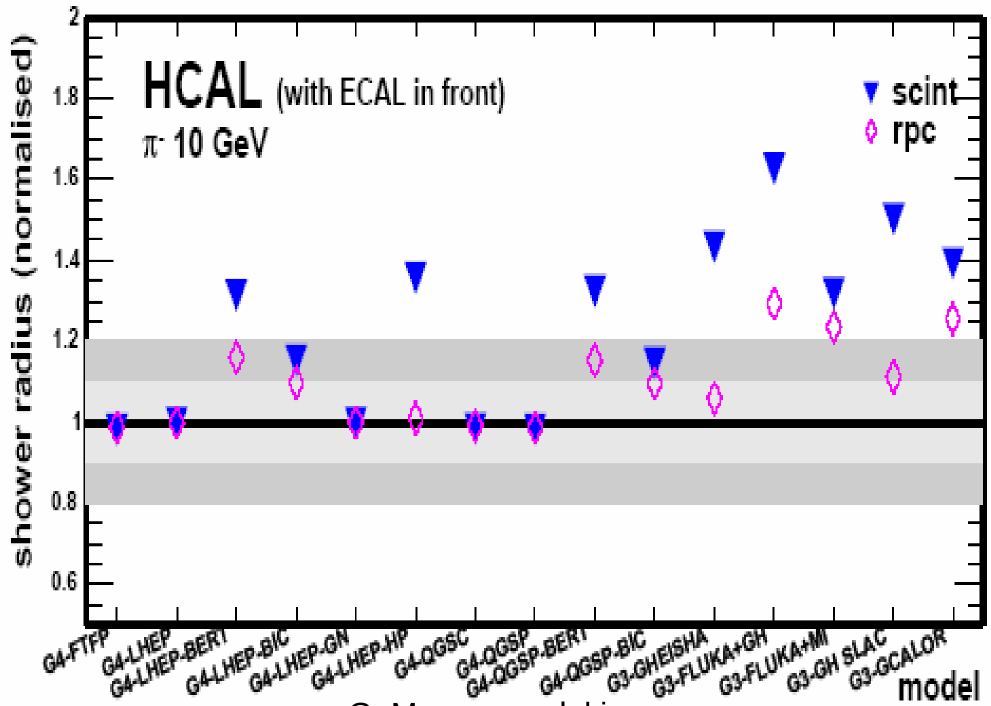
- LC calorimetry R&D: a diverse effort
- Apologies for missing out or inadvertently misrepresenting any particular project
- Most efforts are working with the Particle Flow framework in mind
- Schedules are tentative and reflect the technical assessment of groups and may not reflect the funding realities

Goals

Establish the feasibility of the respective technologies.

Validate and tune hadronic shower Monte Carlo's. This is essential for calorimeters hoping to use particle flow

Refine detector concepts



G. Mavromanolakis

Calorimeter for LC

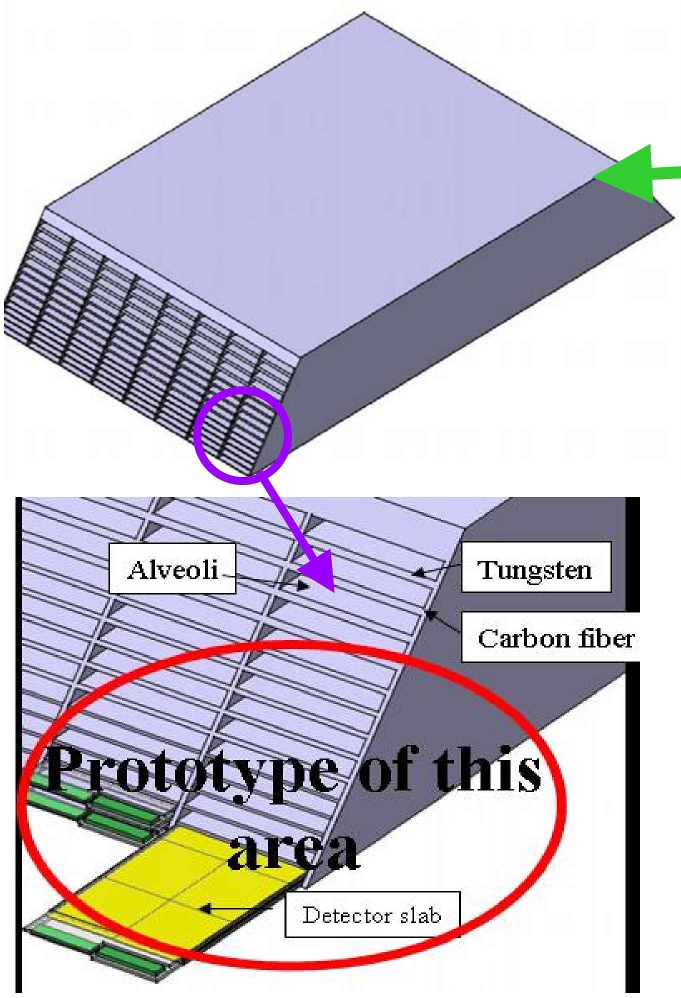
CALICE Si-W ECal

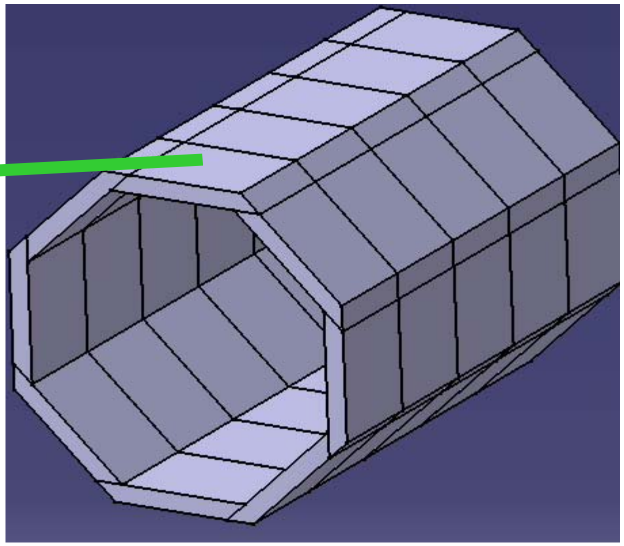
LLR

LAL, Orsay

Imperial College

Si-W ECal

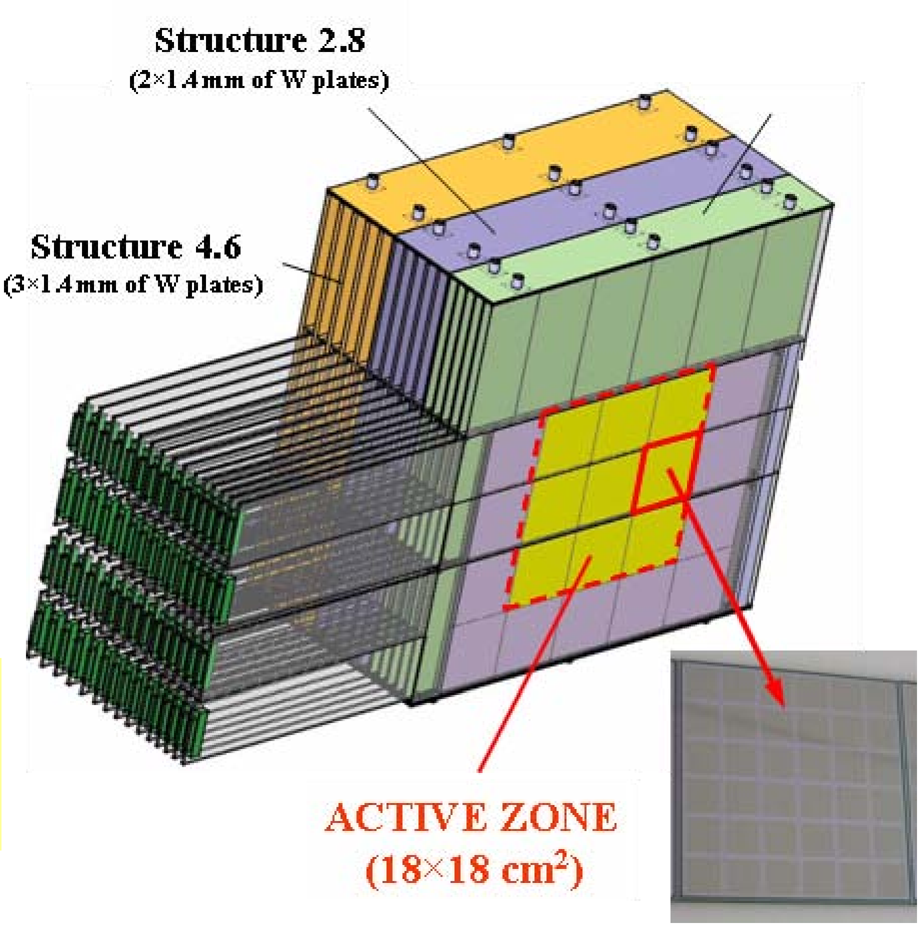




For dense highly segmented calorimetry
Minimize dead zones
Minimize readout gaps (small Moliere R)

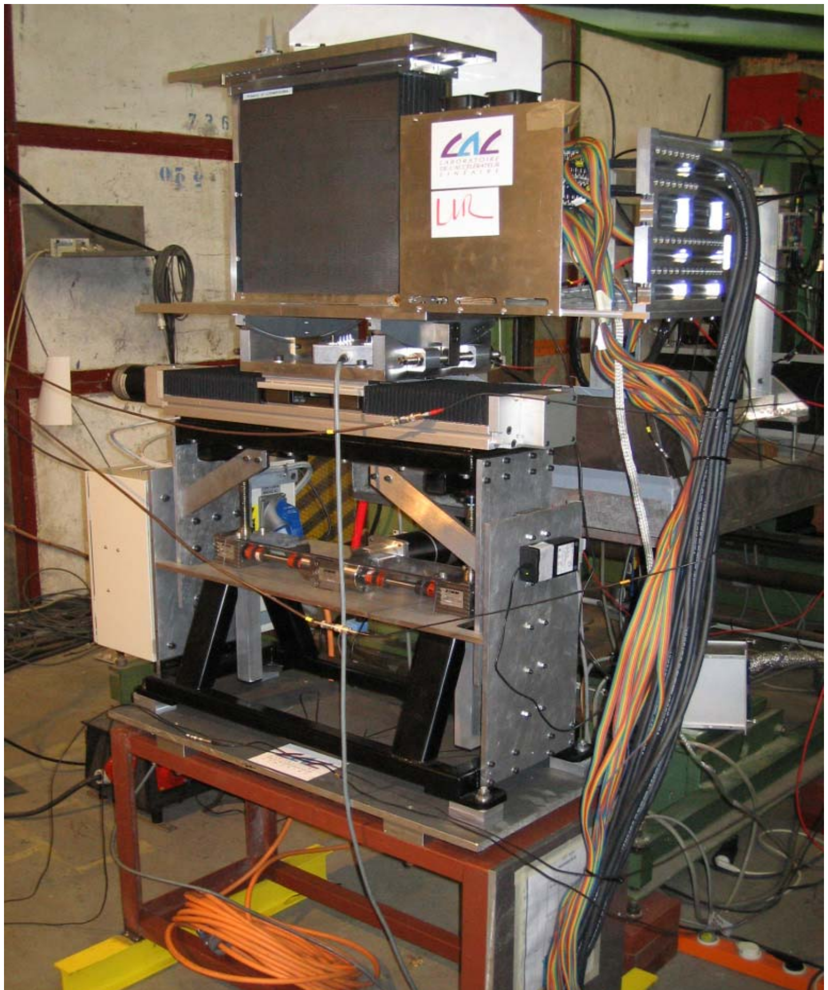
Prototype Geometry

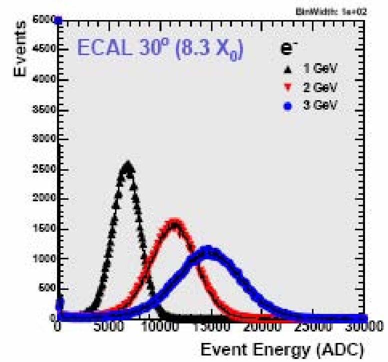
30 layer prototype
3 independent W-CFi structures
(1.4, 2.8 and 4.6mm W plates)
Detectors can be slid in the gaps

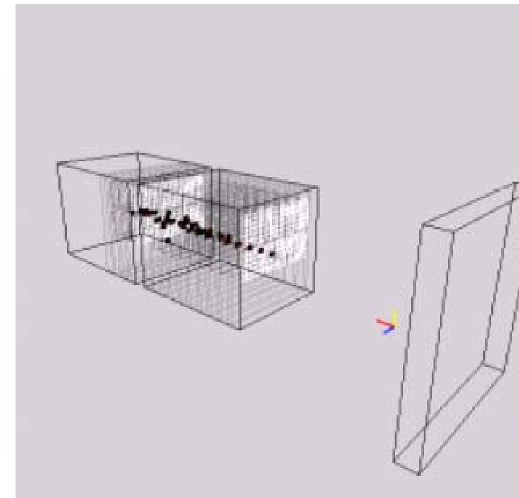


Active area: 3x3 wafers
Each wafer has 36 1cm x 1cm pads
Total channel count ~10k

Exposure to beam







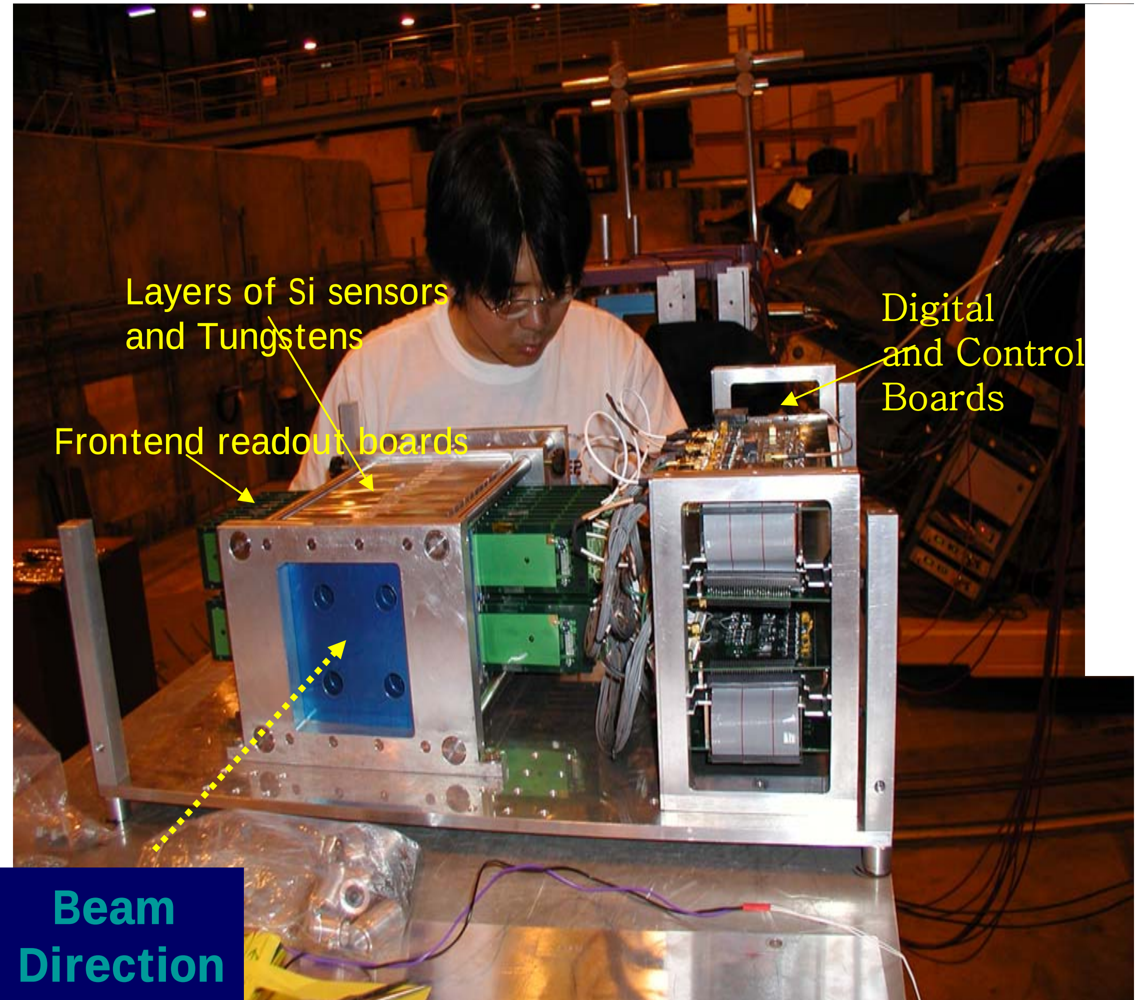
Test in Feb. 2005 at DESY
14 layers (~ 3k channels)
20x10^6 events collected

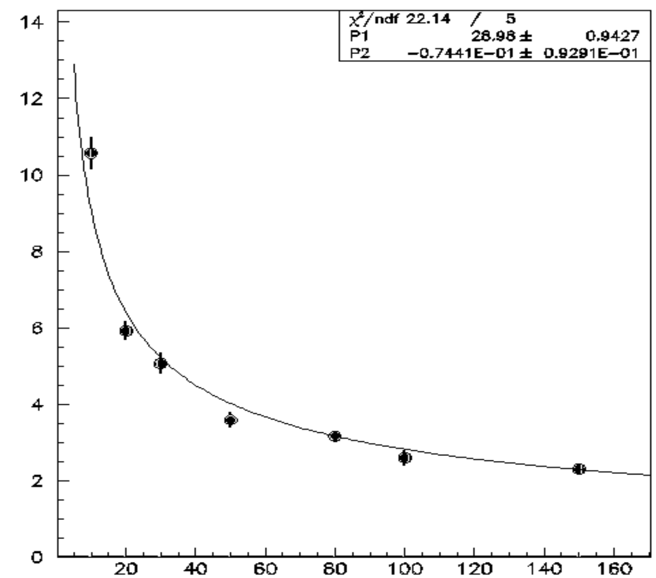
Longer run with full detector in 06
Readout integration R&D continues

Si-W ECal {Korea}

Ewha Univ.
Korea Univ.
Kyungpook National Univ.
SungKyunKwan Univ.
Yonsei Univ.

Si-W ECal



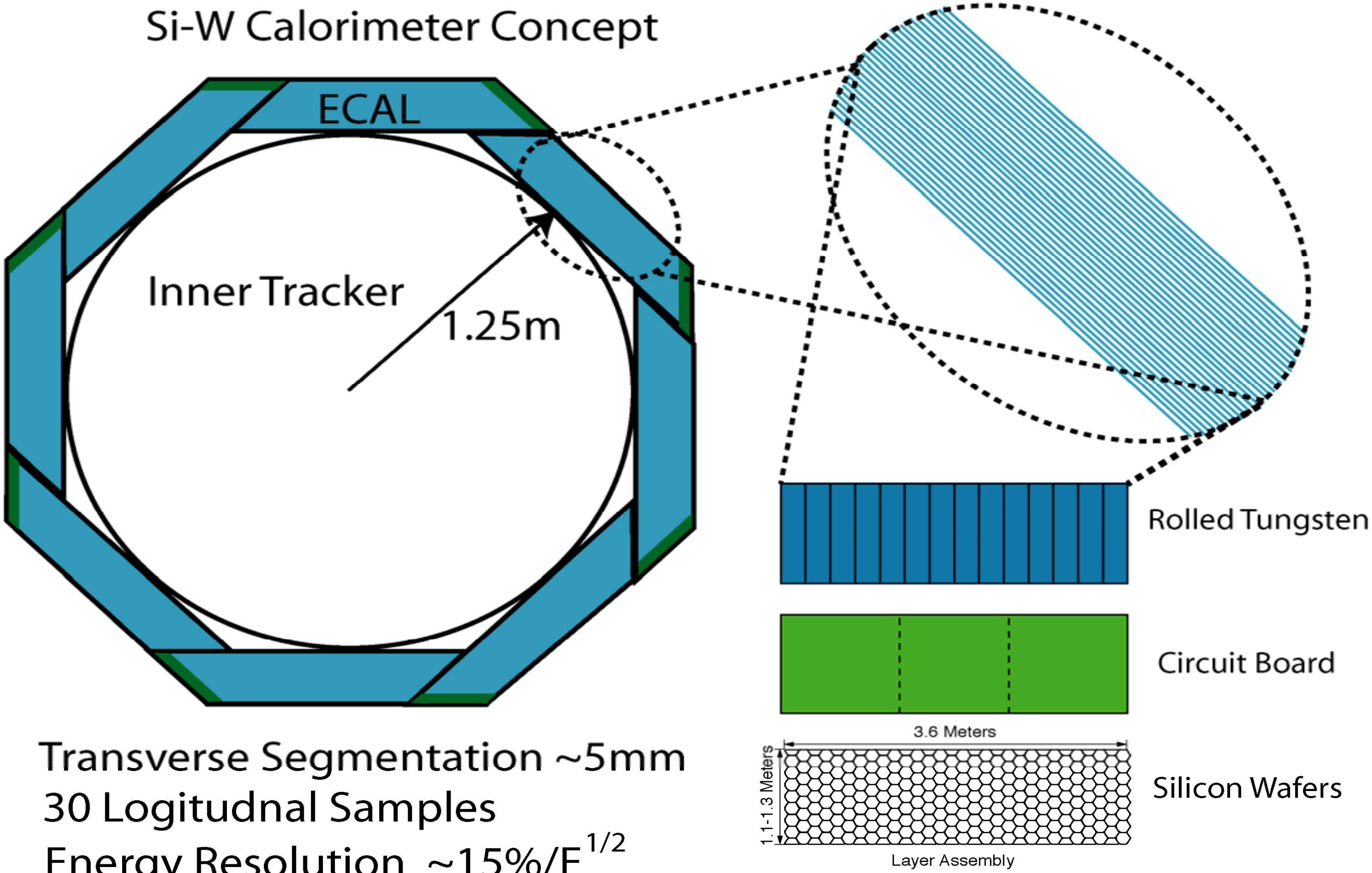


Obtained 28%/sqrt(E)
Further analysis going on
R&D for thinner layers and
AC-coupled sensors in progress

Si-W ECal {US}

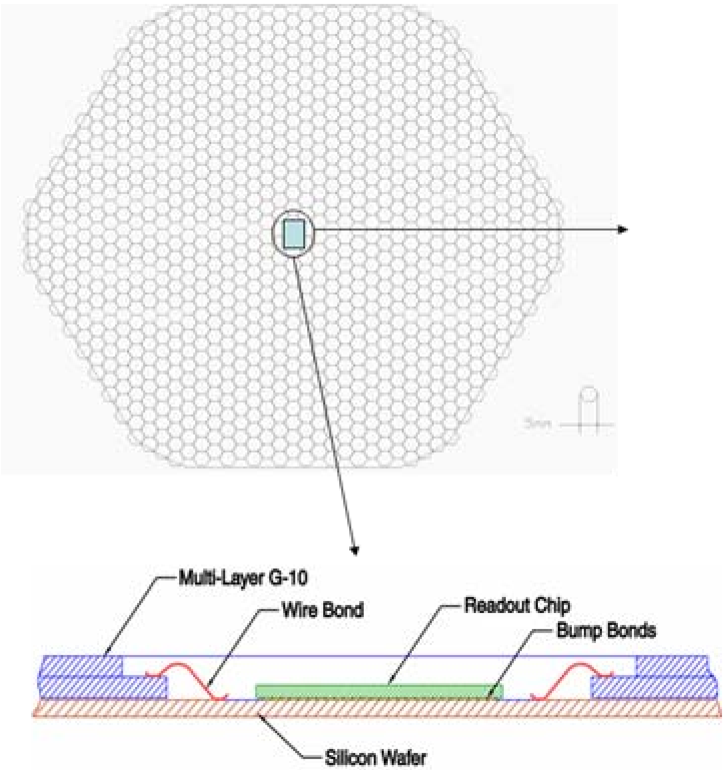
BNL,
UC-Davis
Univ. of Oregon
SLAC

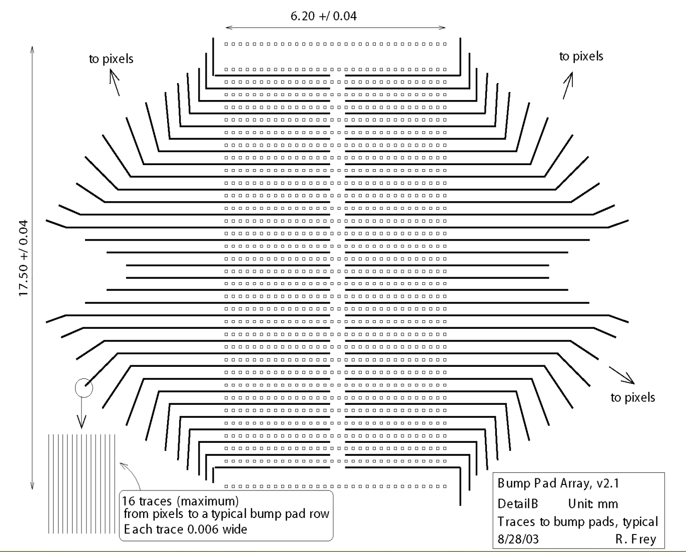
Si-W ECal



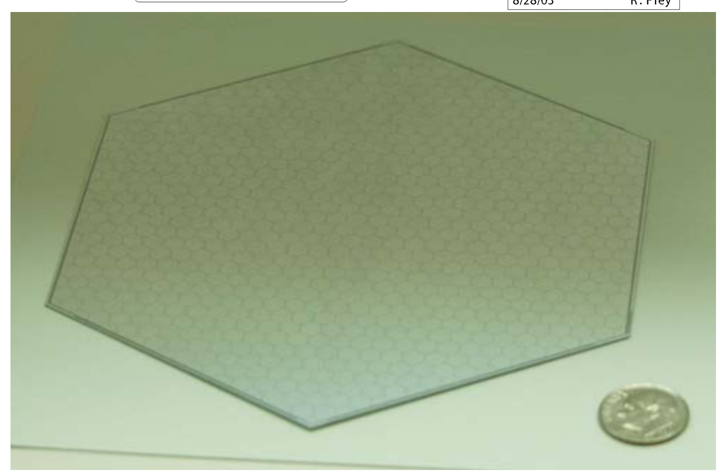
Transverse Segmentation ~5mm
30 Logitudnal Samples
Energy Resolution ~15%/E$^{1/2}$

Readout Electronics

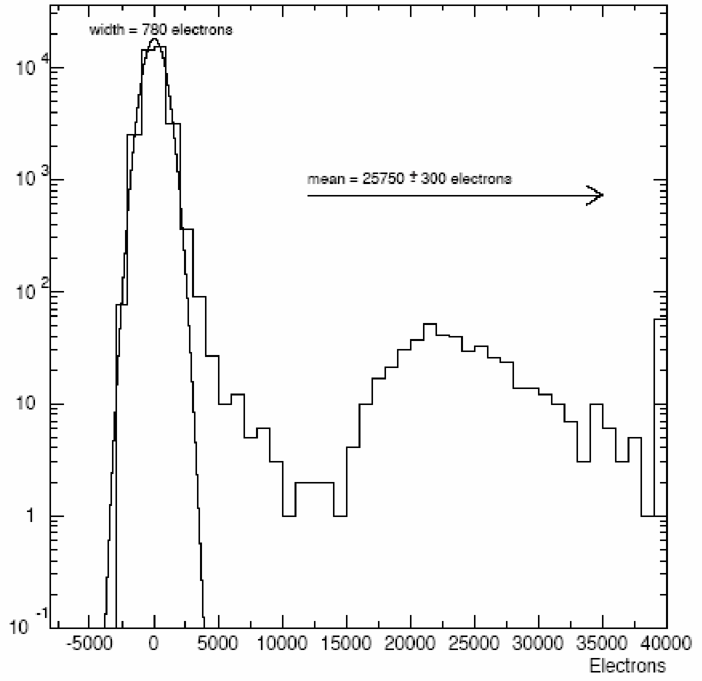




1 chip/wafer
Chip bump-bonded to wafer

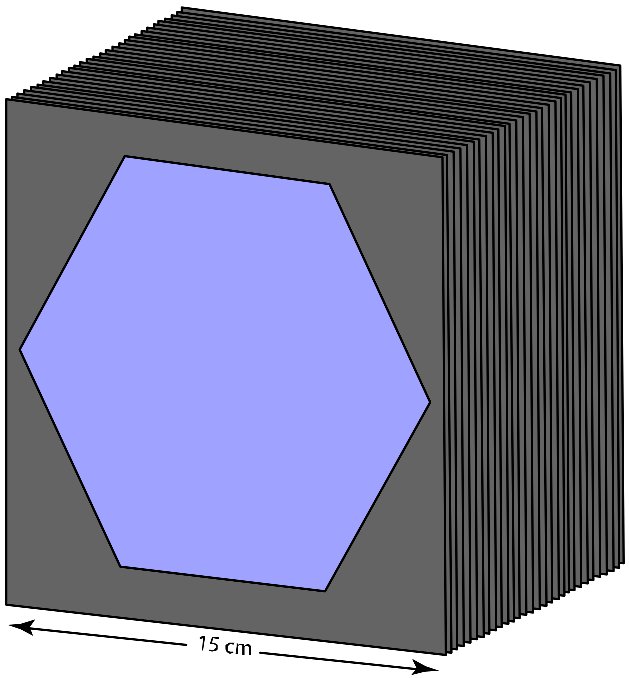


Status and Plans



1 wafer/layer (750 pixels)
30 layers
2.5 and 5 mm Tungsten plates

64-channel chip submission soon
One layer beam test in 2006
Full assembly in mid-2007



Si-Scin-Pb ECal

Como

ITE-Warsaw

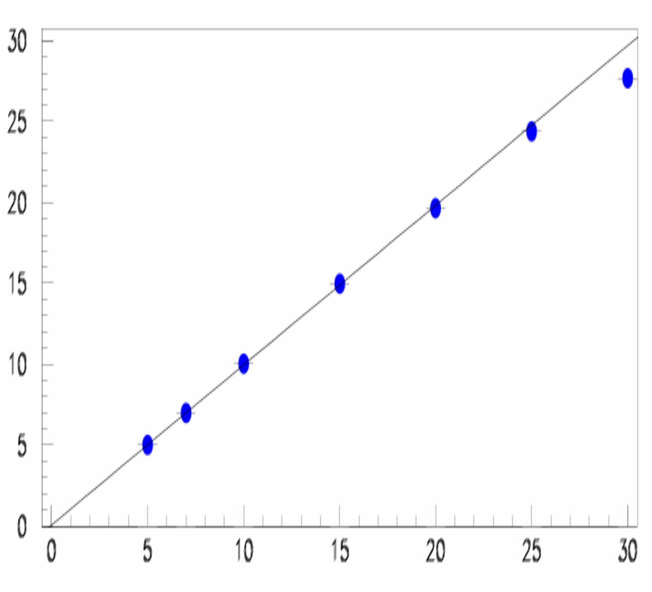
LNF

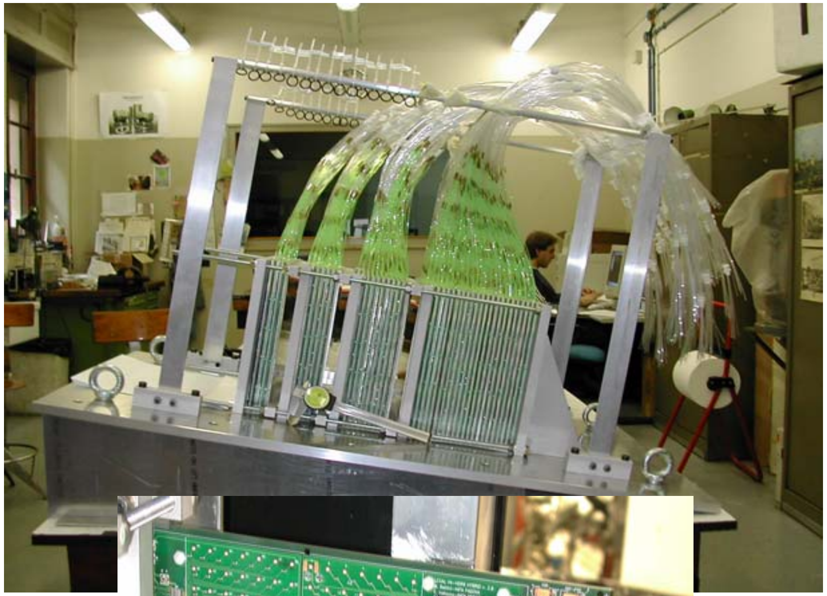
Padova

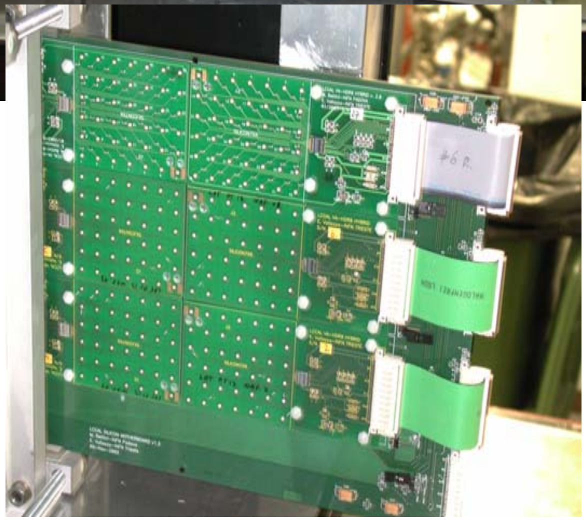
Trieste

LCcal

45 layers
25cm x 25cm x 0.3cm Pb
25 (5cm x 5cm) Scint. Tiles
3 Si pads at 2,6 and 12 X_0

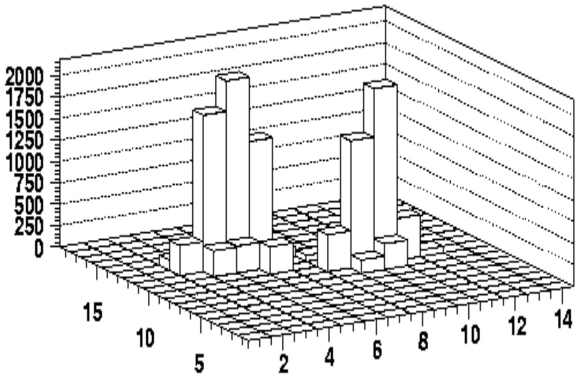




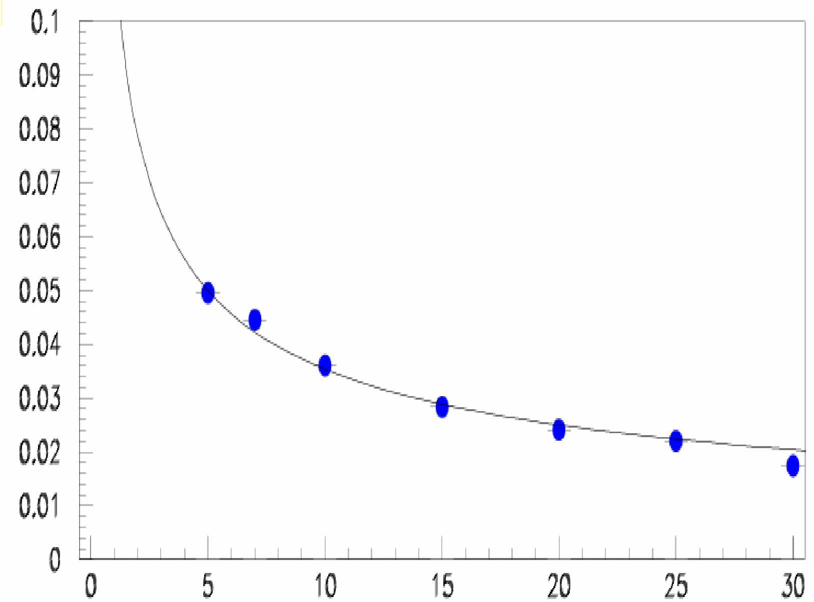


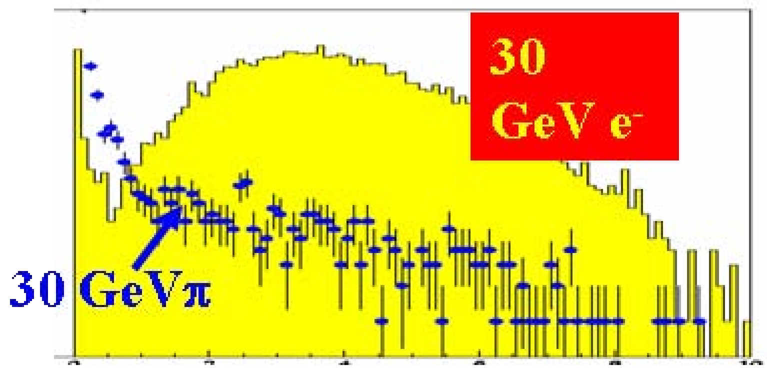
Status and Plans

- The LCcal prototype has been built and fully tested.
- Energy and position resolution as expected: $\sigma_E/E \sim 11.-11.5\% / \sqrt{E}$, $\sigma_{pos} \sim 2$ mm (@ 30 GeV)
- Light uniformity acceptable.
- e/π rejection very good ($<10^{-3}$)



Event display - PAD



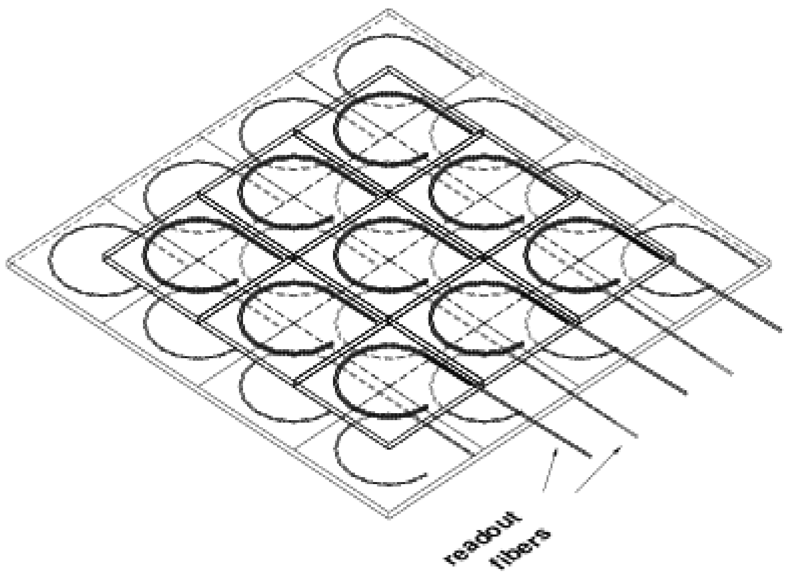


Looking to combined tests with HCal

Scin-W ECal

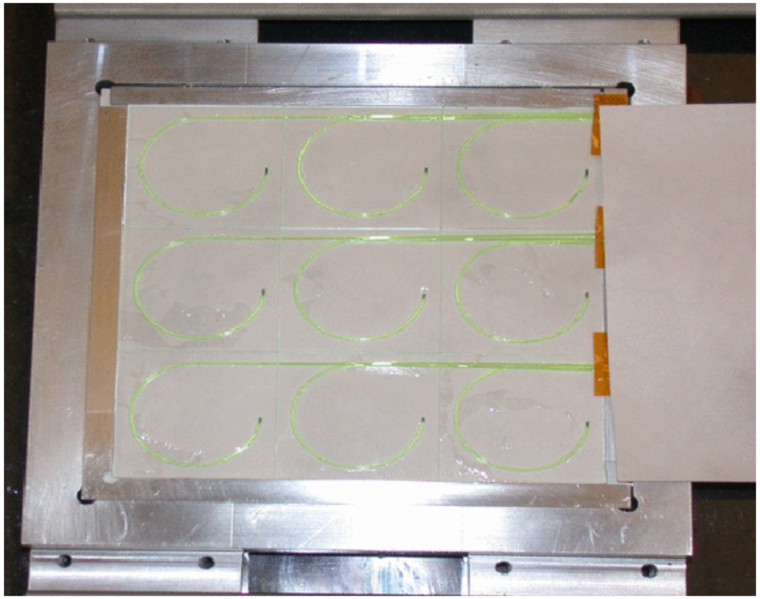
Colorado

Scint. ECal



½ - ¾ X_0 Tungsten
5x5 cm^2 tiles WLS fiber readout
Cells in alternate layers are offset

Starting to work with SiPM's
Working with Fermi/NIU to produce extruded scintillator with tight tolerances



Calorimeter for LC

Scintillator HCal

DESY

Imperial College

ITEP

JINR

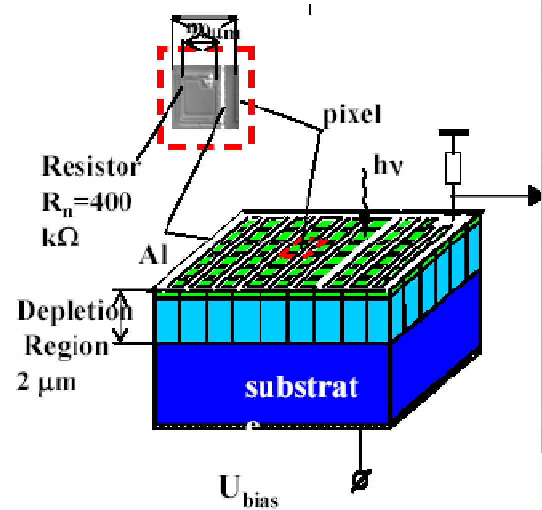
LAL

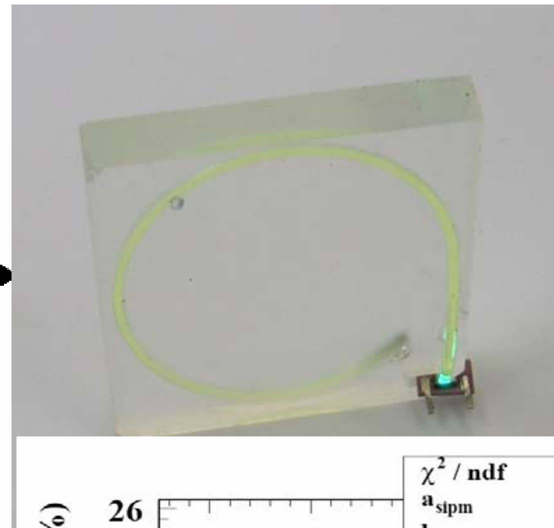
LPI

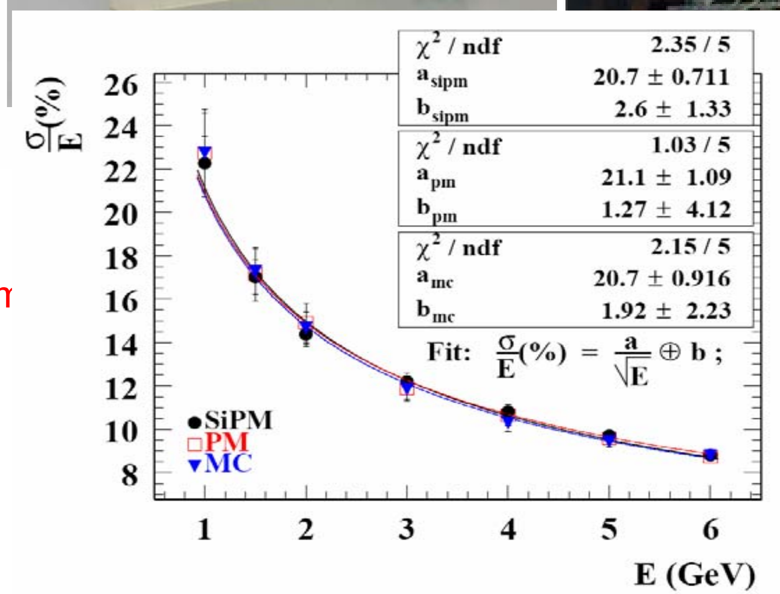
MEPhI

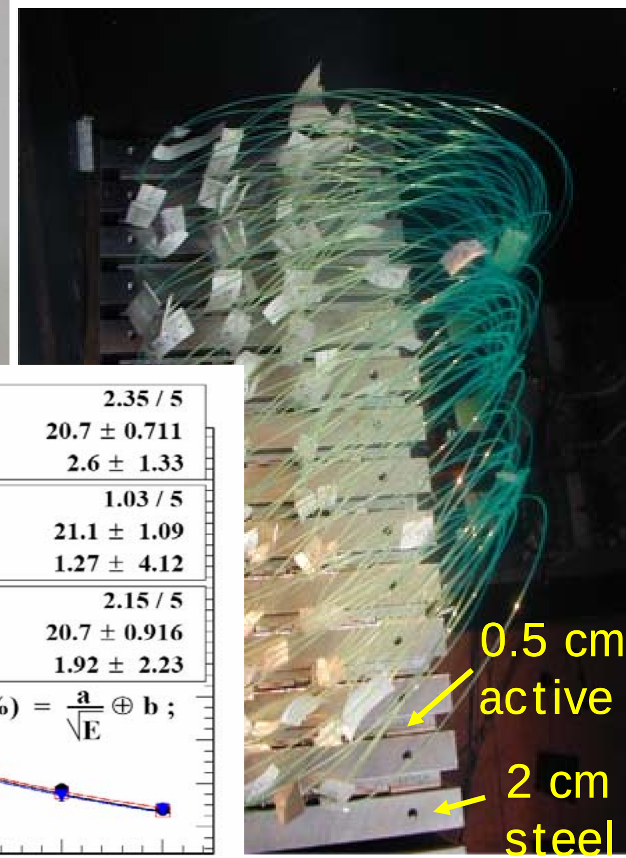
NIU/NICADD

Scint. HCal



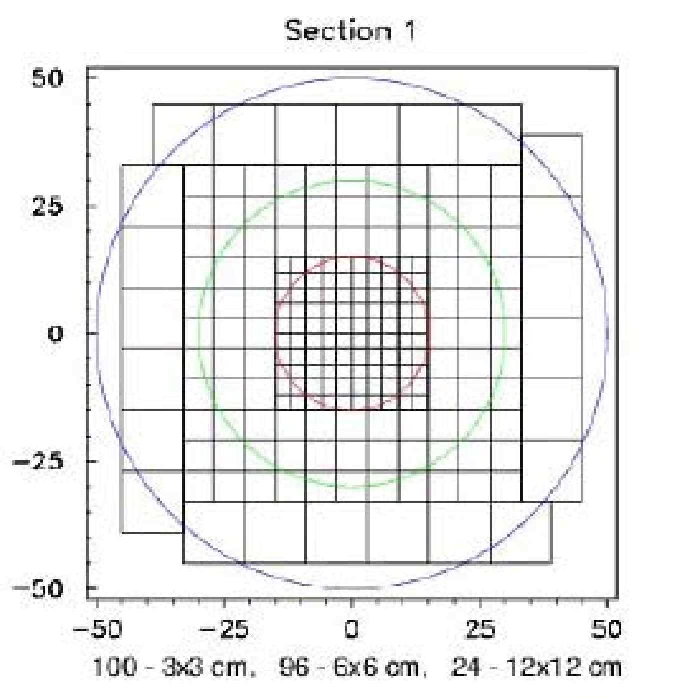




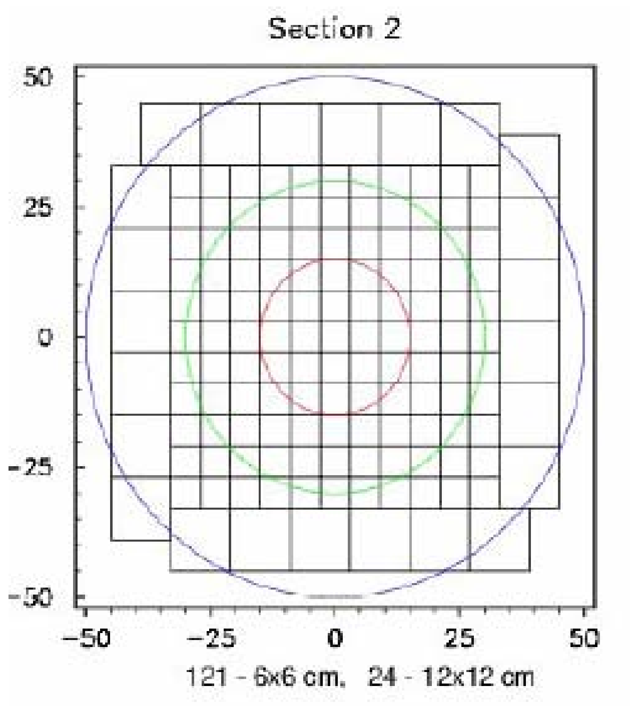


~1000 pixels on 1mm x 1mm
Bias voltage ~ 50-60V
Gain ~ 10^6
Quantum x geom ~ 12-15%

Prototype Geometry

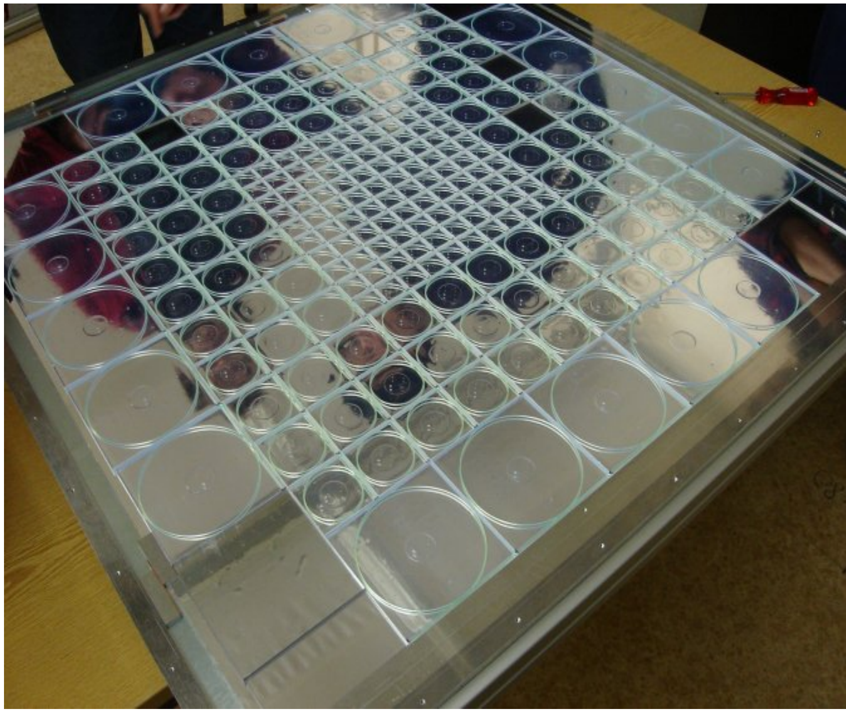


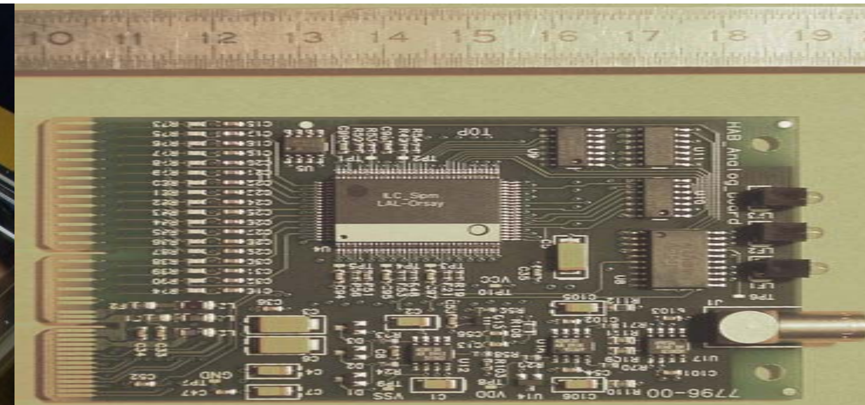
30 layers

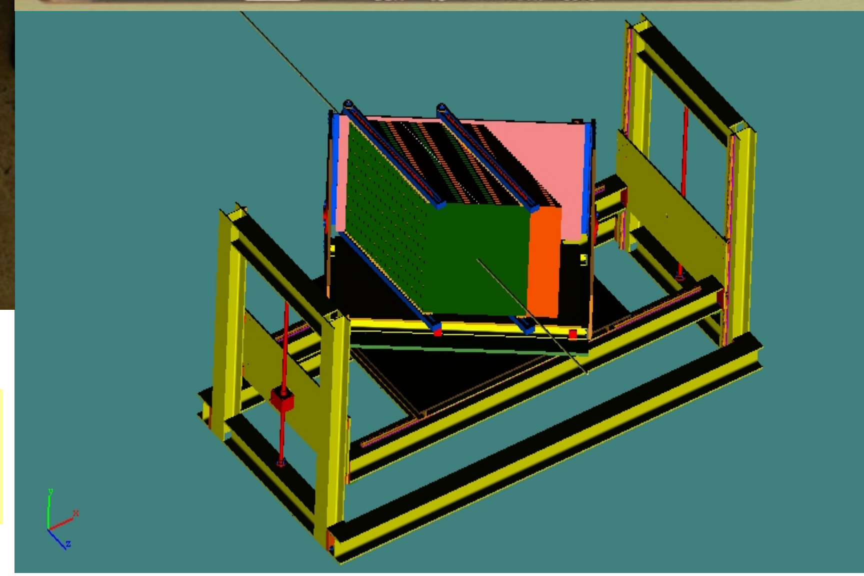


8 layers

Status and Plans







In the construction and assembly phase
Hoping to see beam in mid-2006

RPC HCal

ANL

Boston Univ.

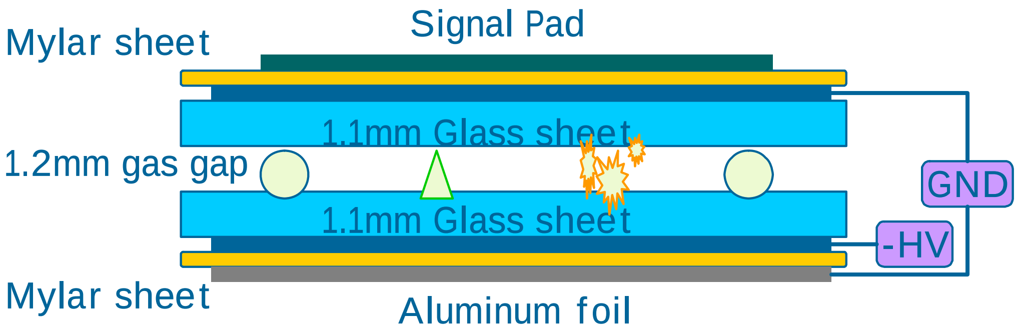
Univ. of Chicago

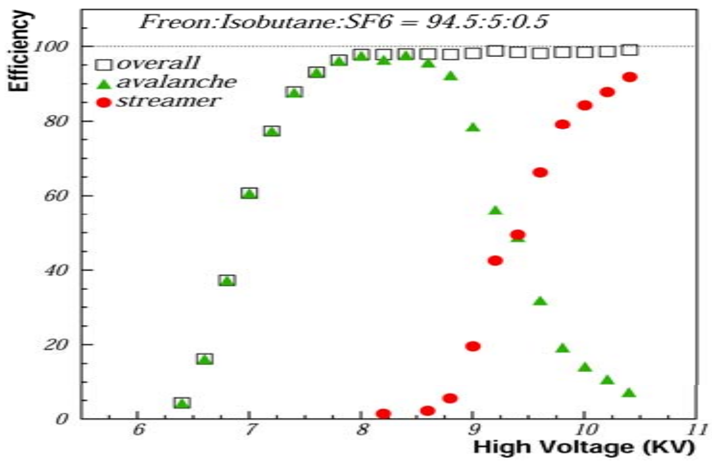
Fermilab

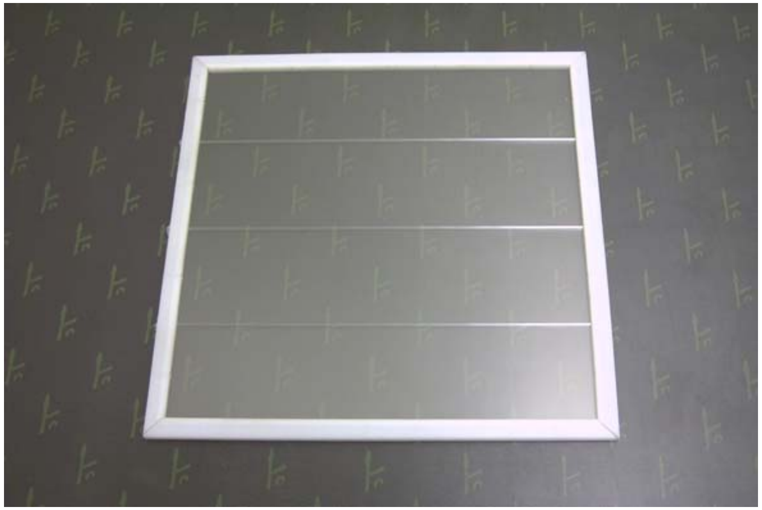
Univ. of Iowa

RPC-based HCal

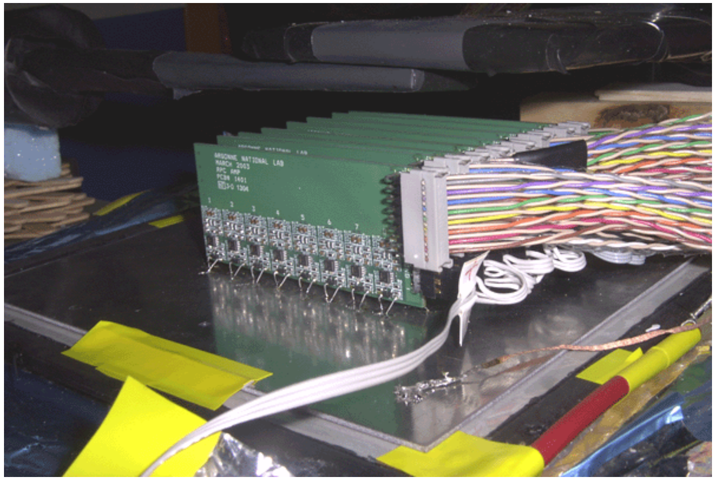
10 RPC's built for studying
no. of gaps, resistivity,
chamber configuration and size

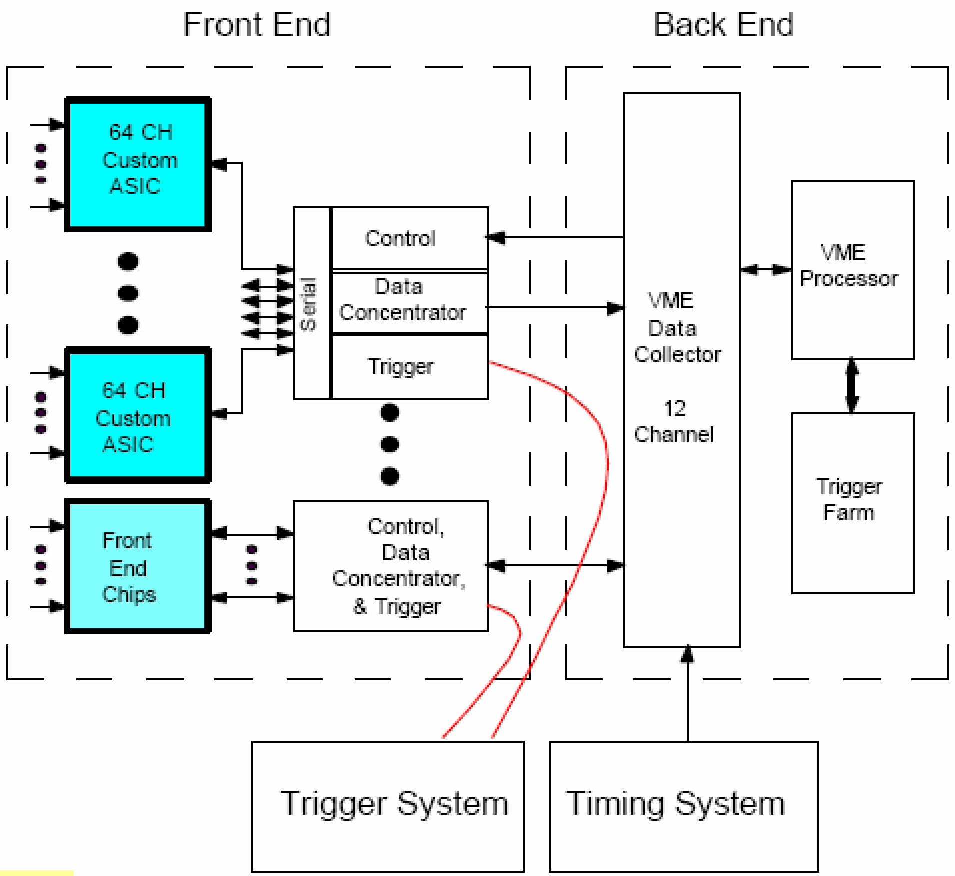






Status and Plans





40 layers
1cm x 1cm pads
64 channel custom ASIC
(1-bit readout)
Also used for GEM-based
HCal prototype

Hope to be ready for beam in 2006-07

RPC HCal {Russia}

IHEP-Protvino

RPC-based HCal

Was done

1. Chamber R@D itself

2. Tests of 1m2 RPC plane with strips

-1.2 mm monogap glass RPC, 6 mm thickness

- robust design with 2mm steel caps

- efficiency ~94 %, nonuniformity ~2%

3 .Tests of RPCs in 5T mag field in DESY

-There was no difference in RPC behavior when 5T was on or off

-Prototype of 64 ch. FEE printed board was tested successfully , PCB is outside of RPC and includes 8 channel MINSK chips OKA (amp.+disc.), ALTERA EP1K50 as FPGA and RS232 driver for sequental read out with PC

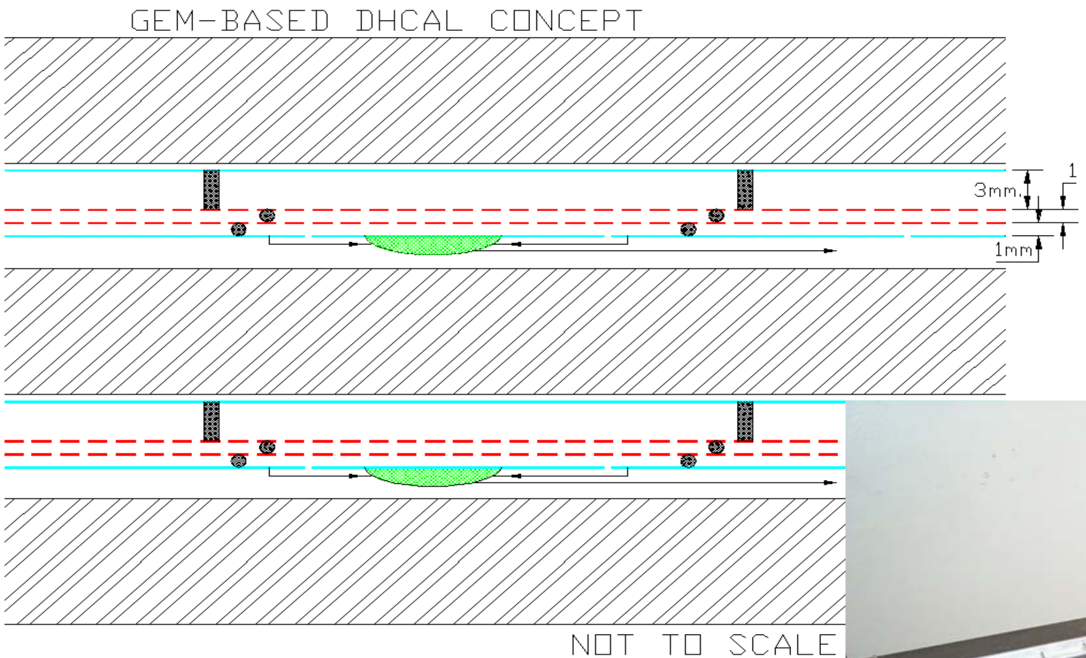
Ongoing

Beam tests in IHEP of 1 m2 RPC plane with 32x32=1024 channels (Nov05)

GEM HCal

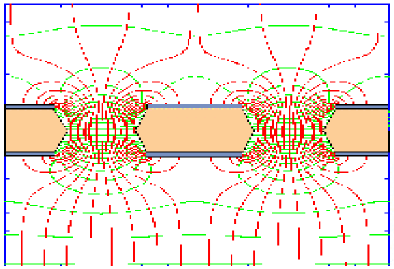
Univ. of Texas, Arlington
Univ. of Washington
Changwon National Univ., Korea
Tsinghua Univ., China

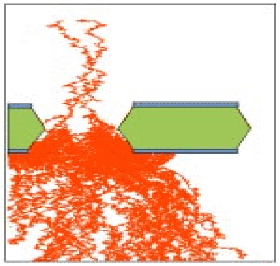
GEM-based HCal

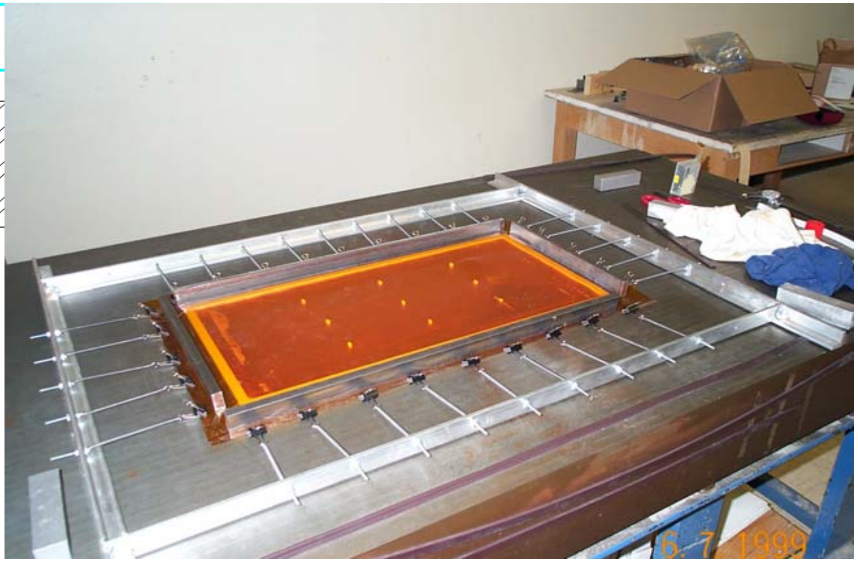


Ar/CO_2 gas mixture
Amplification with dual foils
G ~ several thousand

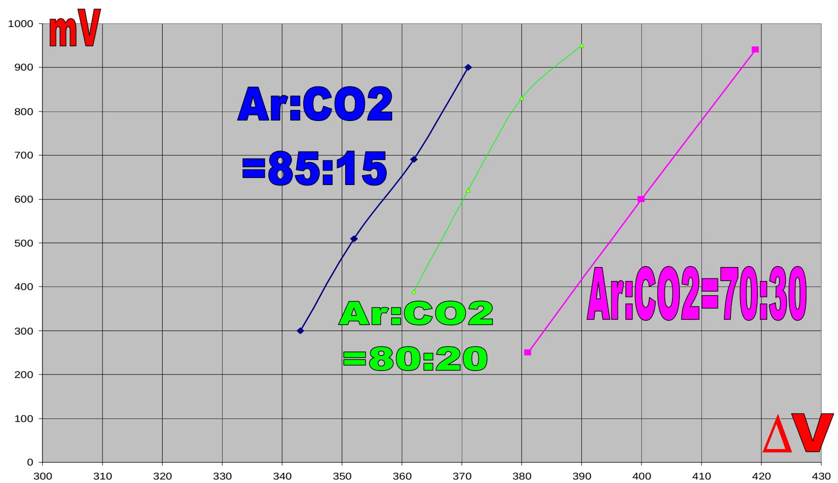
Each layer 8-9 mm thick
1cm x 1cm pads
1-bit readout



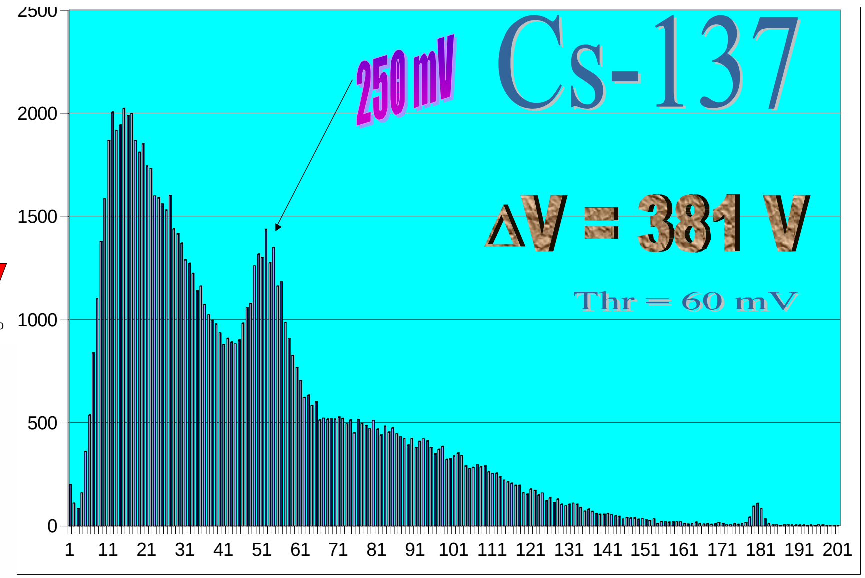


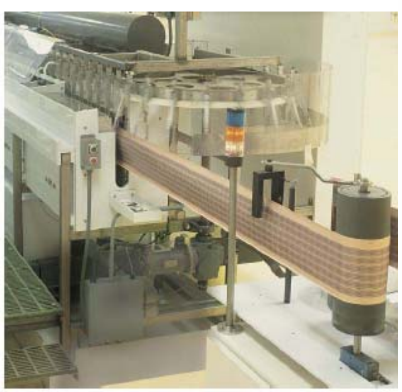


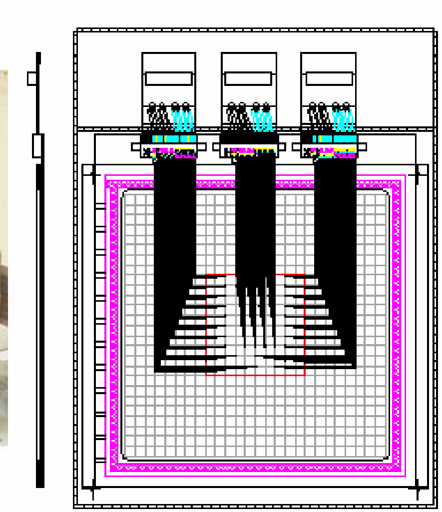
Status and Plans



Signal size, cross-talk, efficiency studies with prototype detector







Assembly of five 30cm x 30cm GEMs
Development and testing of long foils
Completion of 1m^3 prototype in 2006

Dual-Readout Calorimetry

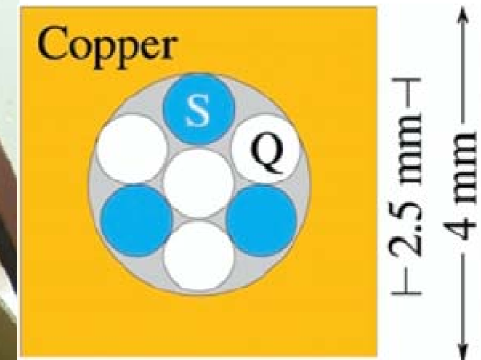
Texas Tech. Univ.

UC-San Diego

Iowa State

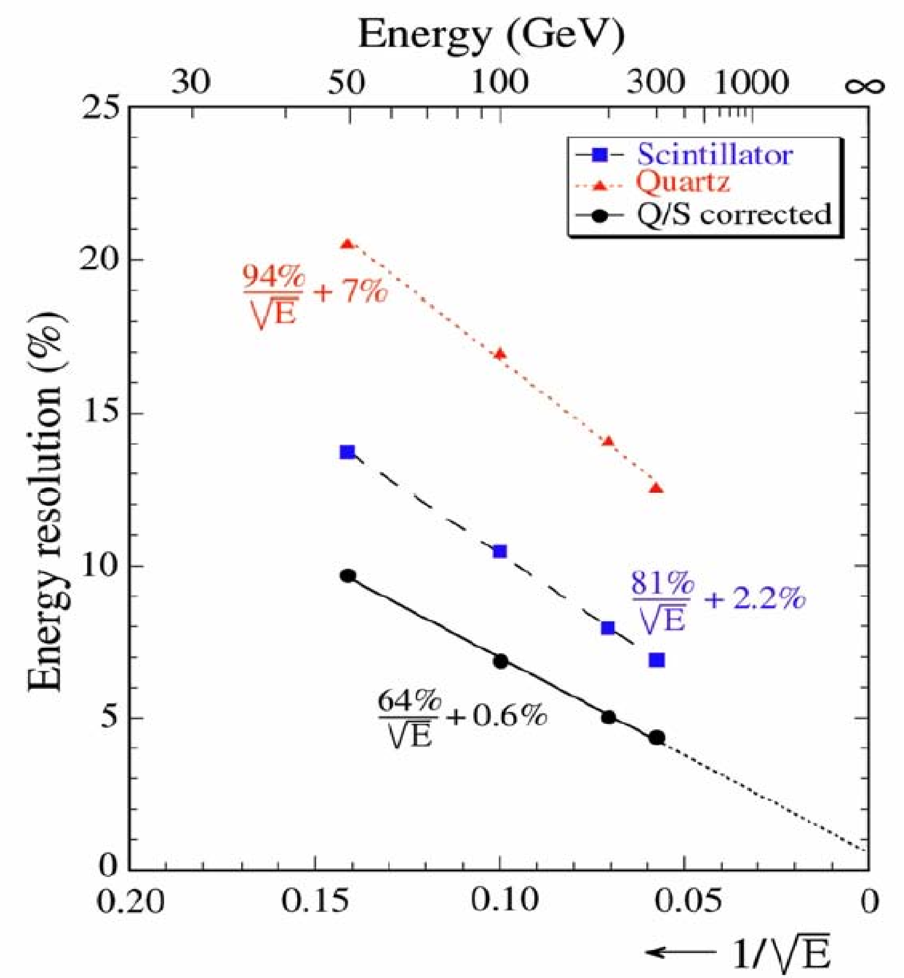
DREAM

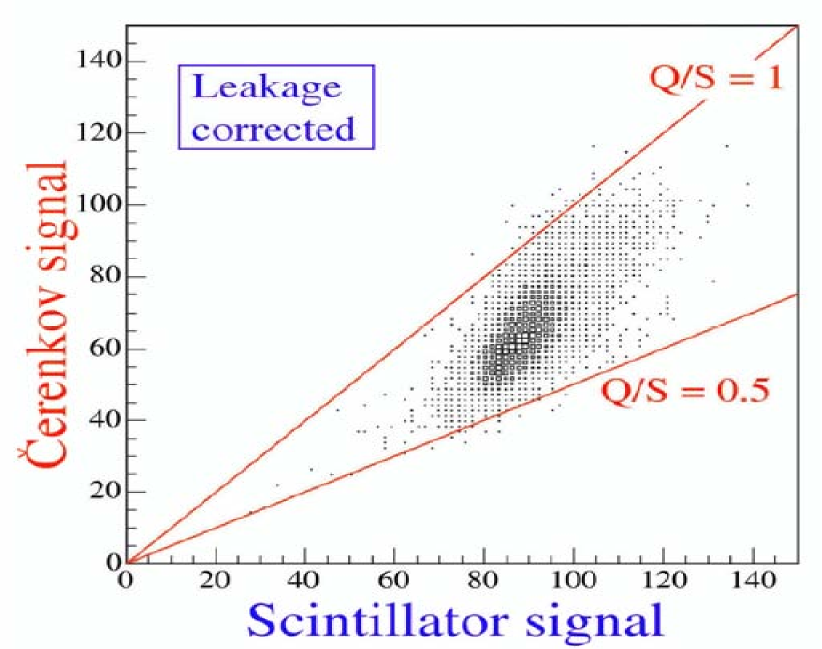
Measure the EM content event by event



Copper absorber structure
Scintillating (dE/dX) and
Quartz fiber (Cerenkov)

Status and Plans





Investigate designs suitable for an ILC detector
Introduce non-hydrogenous Sci-Fi
2006-07 test beam timescale

Getting together for beam

Fermilab FNAL-TM-2291

International Linear Collider Calorimeter/Muon Detector Test Beam Program
(A Planning Document for Use of Meson Test Beam Facility at Fermilab)

February 22, 2005

J. C. Brient and J. Yu

For the ILC Calorimeter Test Beam Group

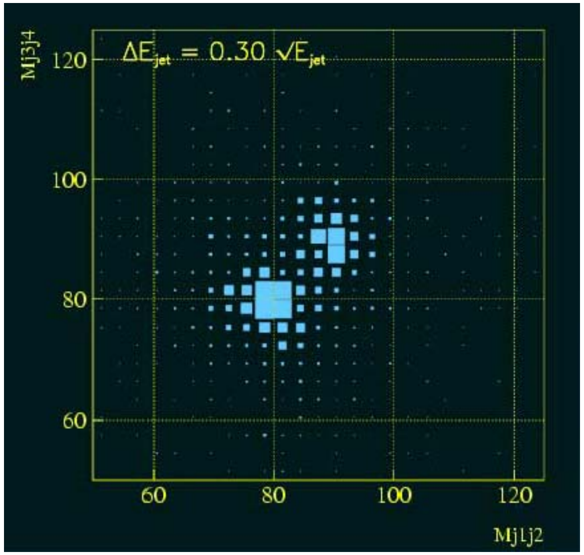
Abstract

The linear collider requires a detector with excellent performance to fully exploit its physics potential. In particular, requirements from the measurement of hadronic jet energies indicate a goal of developing the calorimeter with an unprecedented jet energy resolution of 30%/√E or better. In order to meet this challenge, novel technologies and reconstruction techniques are being developed, which need to be tested with particle beams. The recent decision by the International Technology Recommendation Panel (ITRP) concerning the linear collider accelerator technology imposes a time scale of at most a few years for the basic detector design choices. A vigorous test beam program over the next few years is necessary to provide a solid basis for these decisions. In this regard, the International Linear Collider Calorimeter and Muon Detector Test Beam Group submit this planning document to Fermilab. The main goals of the test beam program outlined in this document are to evaluate the different choices of technologies proposed for the calorimeter and to understand, validate and improve the Monte Carlo modeling and simulation of hadronic showers. This document contains a description of fourteen distinct calorimeter and muon detector/tail-catcher groups and their requirements for specific test beam resources. This planning document also lays out time scales and institutional responsibilities for the proposed test beam program. It provides plans for the users of the Fermilab Meson Test Beam Facility, and needs for upgrades to particle energy ranges and intensities, and associated engineering and computing support services.

Abstract

Summary

Unprecedented calorimetric performances demanded at the ILC.



A world-wide effort gearing up to meet this challenge