Summary RD7: Calorimetry/muons

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LCWS13

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HELMHOLTZ ASSOCIATION

DESY

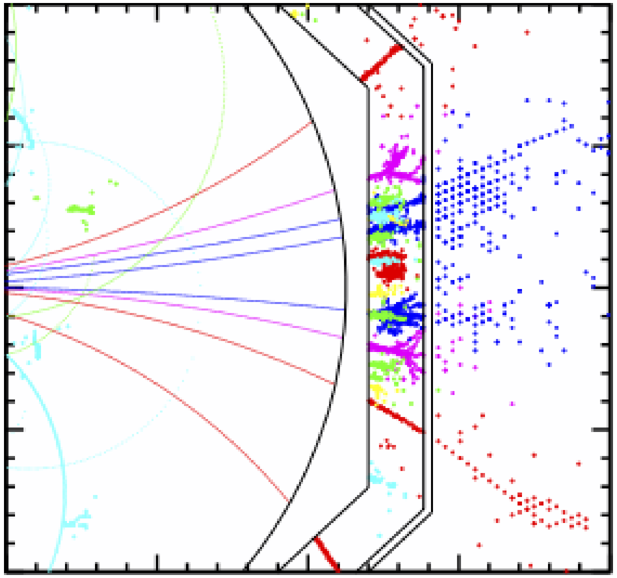
Calorimeters for a Linear Collider

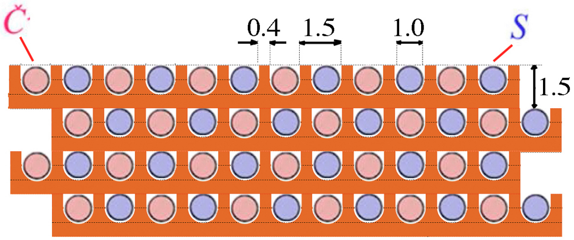
Requirements:

- jet energy resolution of 3-4% for 50-500 GeV jets
- excellent γ/e identification
- fit inside coil: compact, no cooling between absorbers
- CLIC: timing resolution ~1 ns
- forward calorimeters: radiation hardness, fast readout

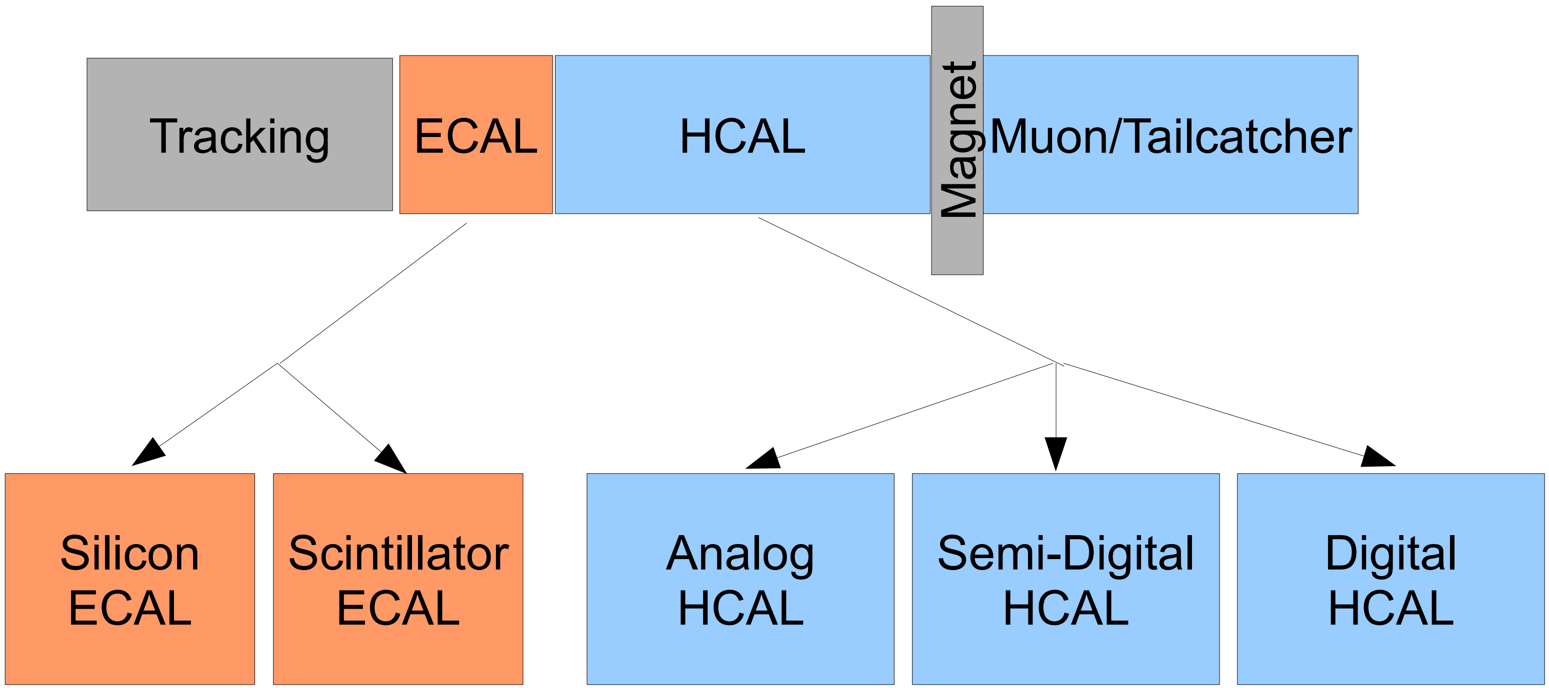
Possible Solutions:

- particle flow
- dual readout





Calorimeters for Particle Flow Algorithms

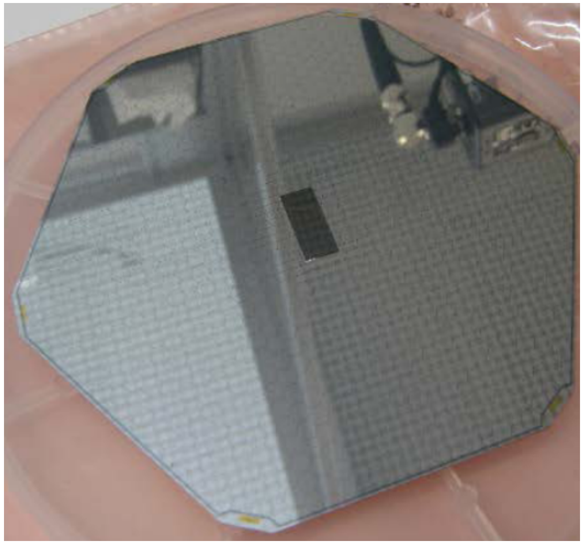


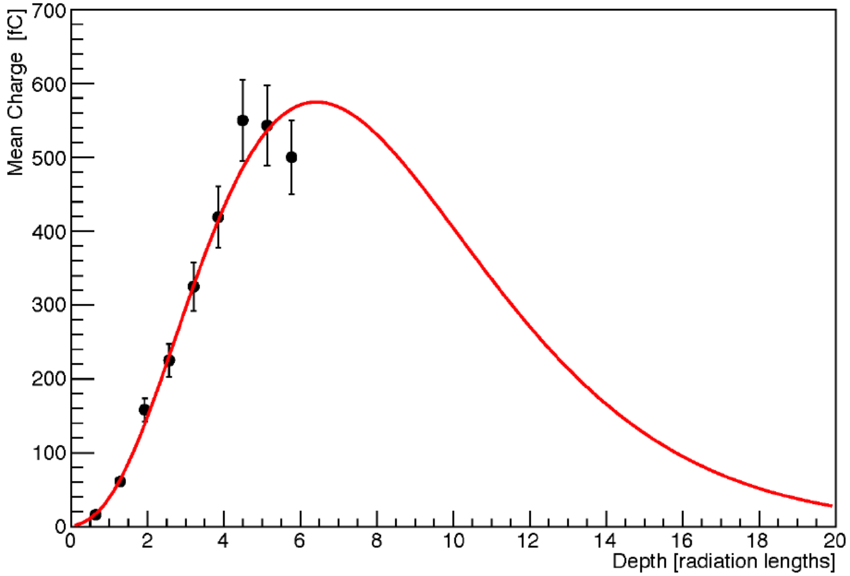
granularity	$0.5*0.5cm^2$	$4.5*0.5cm^2$	$3*3cm^2$	$1*1cm^2$	$1*1cm^2$
active material	silicon pixels	scintillator strips	scintillator tiles	RPCs or µMegas	RPCs
absorber	W	W	Fe or W	Fe	Fe or W

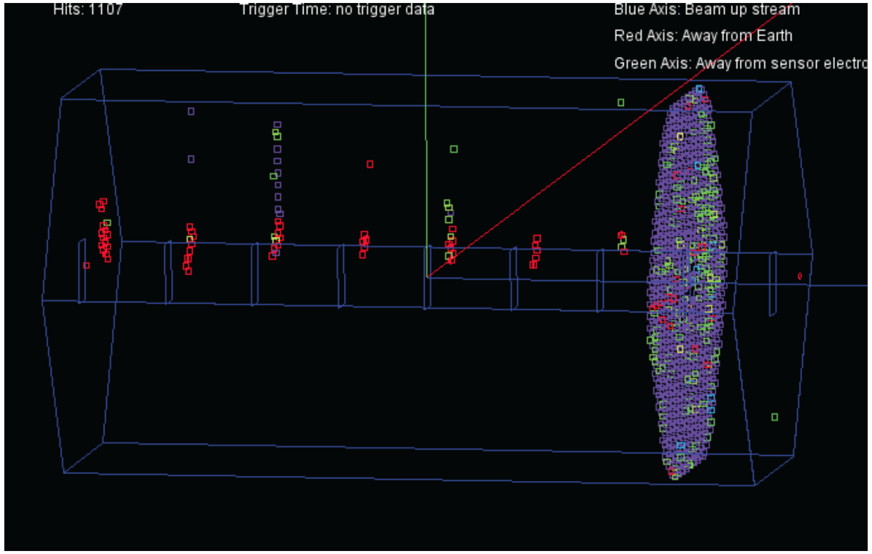
Silicon-Tungsten ECAL for SiD

J. Brau

- Ambitious design
  - Si sensors with 1024 pixels of 13 mm², bump-bonded to KPiX readout chip, readout via Kapton bus cables
  - 1 mm readout gap → 13 mm Moliere radius
- first testbeam results
  - "monster" events: large negative amplitudes, out-of-time

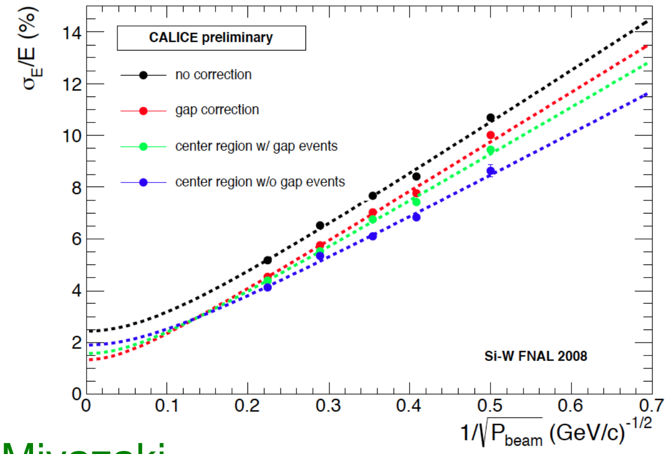






Silicon-Tungsten ECAL for ILD

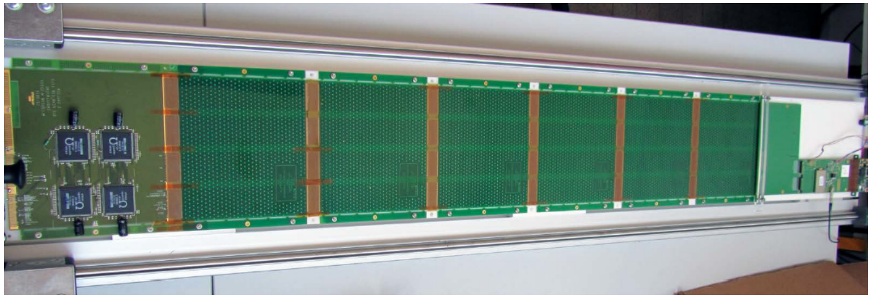
Analysis of Physics Prototype data



Y. Miyazaki

Towards "ILD-sized" Engineering Prototype

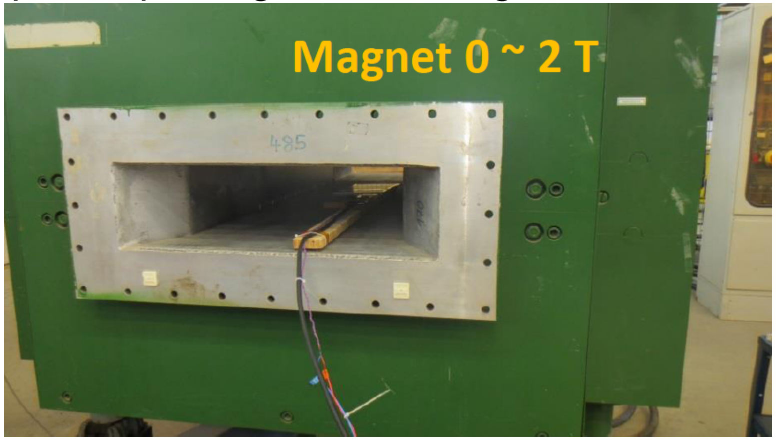
- DAQ, mechanics, tooling, automation



R. Cornat

Tests of Engineering Prototype

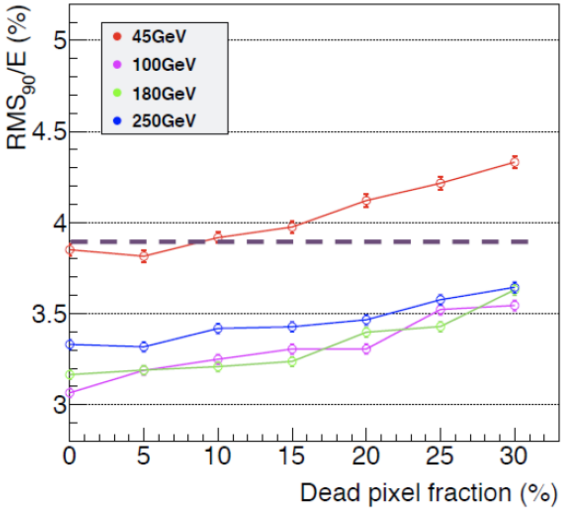
- operation of small prototype (up to 10 layers)
- power pulsing, also in magnetic field



Y. Sudo

Robustness & Optimisation

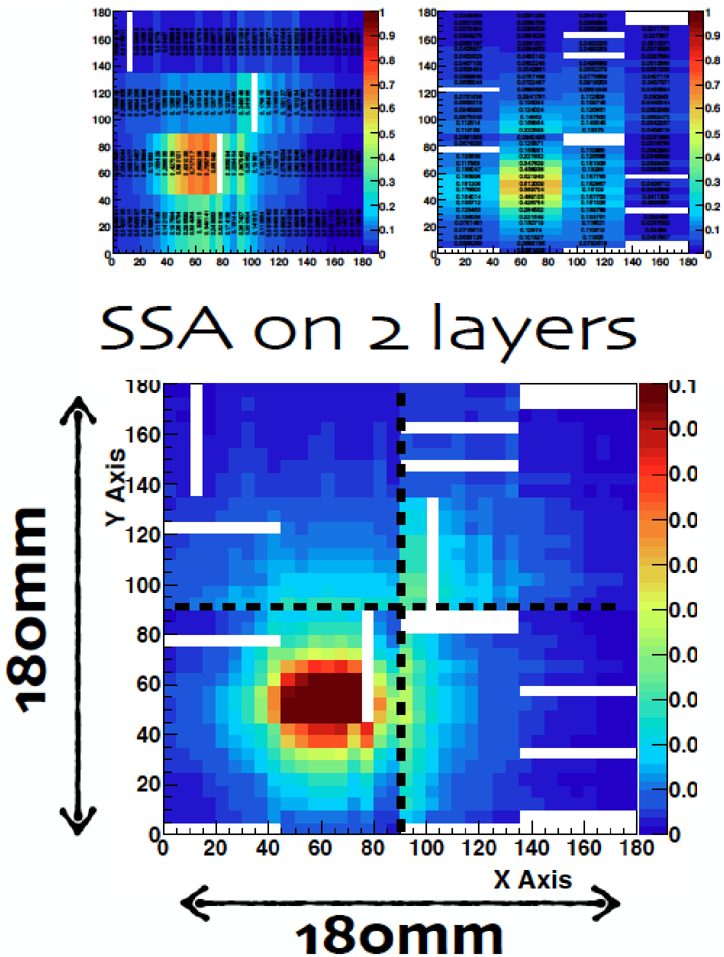
- could allow for cost reductions



C. Kozakai
V. Balagura
T. Tomita

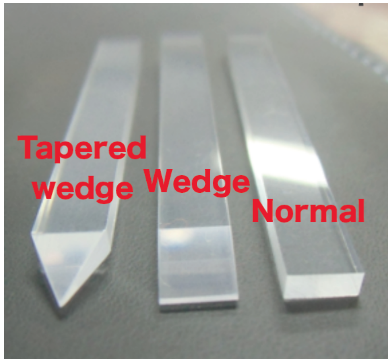
Scintillator-Tungsten ECAL & Hybrid ECAL for ILD

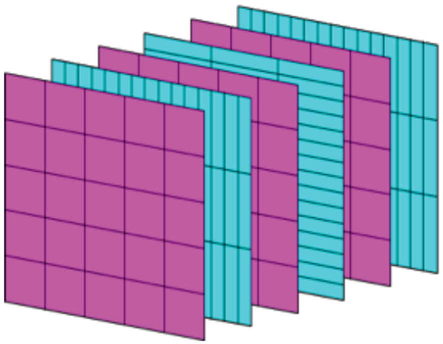
ScECAL Engineering Prototype: Testbeam



T. Ogawa

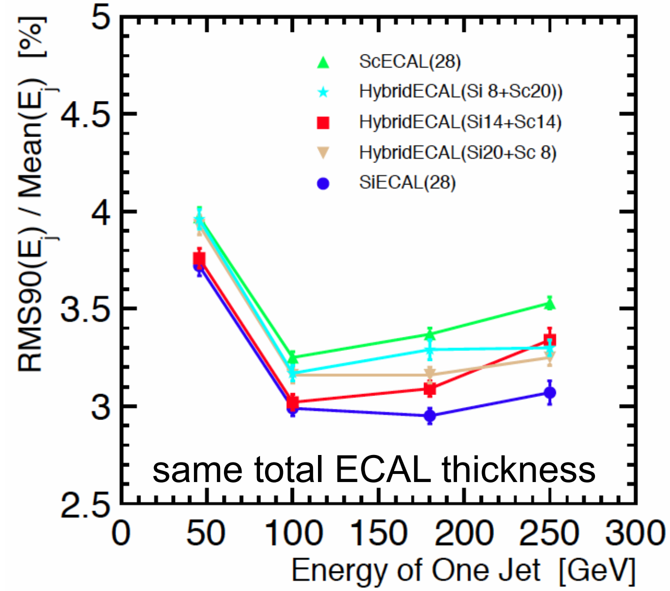
ScECAL Optimisation





K. Kotera, S. Ieki

Hybrid ECAL Studies

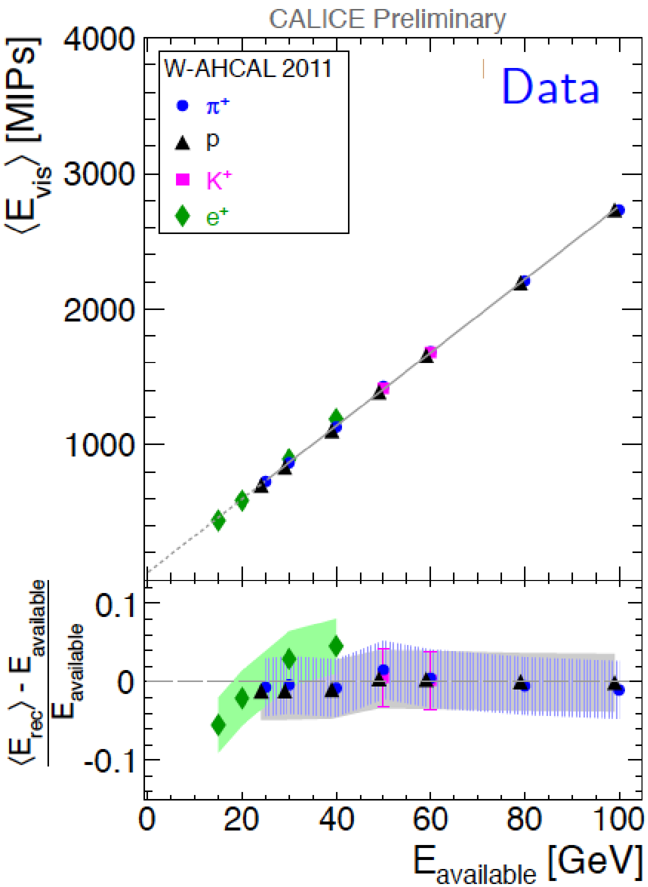


H. Ueno
T. Ogawa

Analog HCAL

Analysis of Physics Prototype data

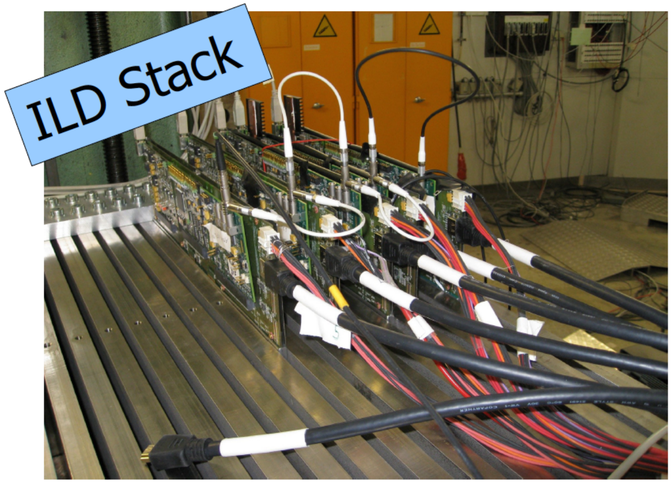
- tungsten absorber (CLIC)



E. Sicking

Tests of Engineering Prototype

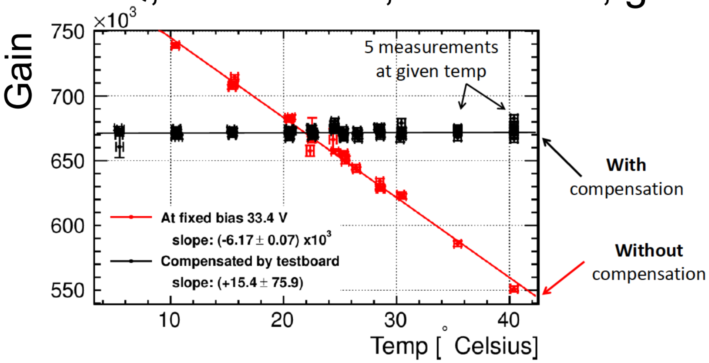
- operation of small prototype
- power pulsing



O. Hartbrich
A. Ebrahimi

Towards "ILD-sized" Engineering Prototype

- DAQ, automation, calibration, gain stabilisation

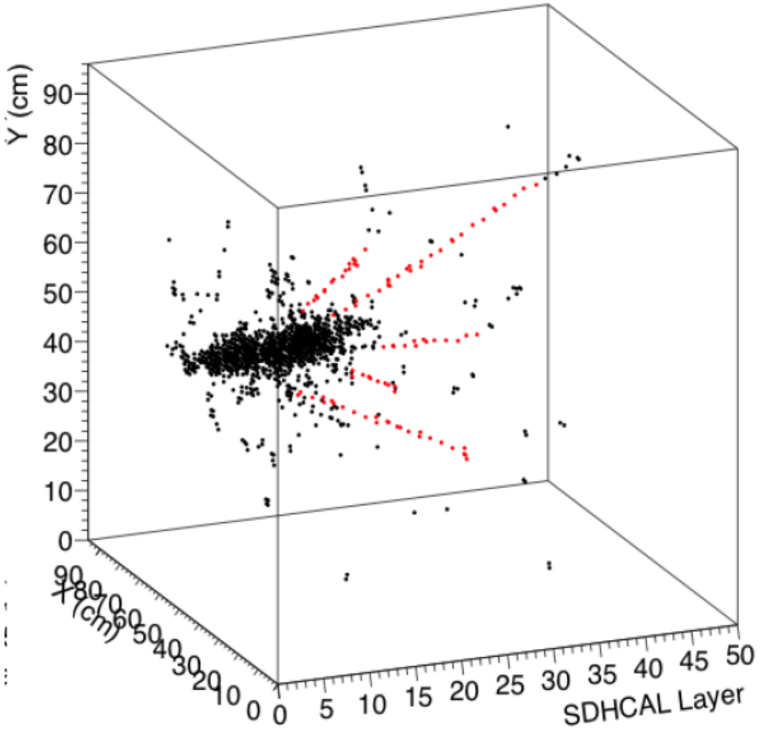


J. Kvasnicka
G. Eigen

SDHCAL

RPC: 1m³ Prototype Analysis

- energy resolution
- Hough Transform for finding tracks in hadronic showers

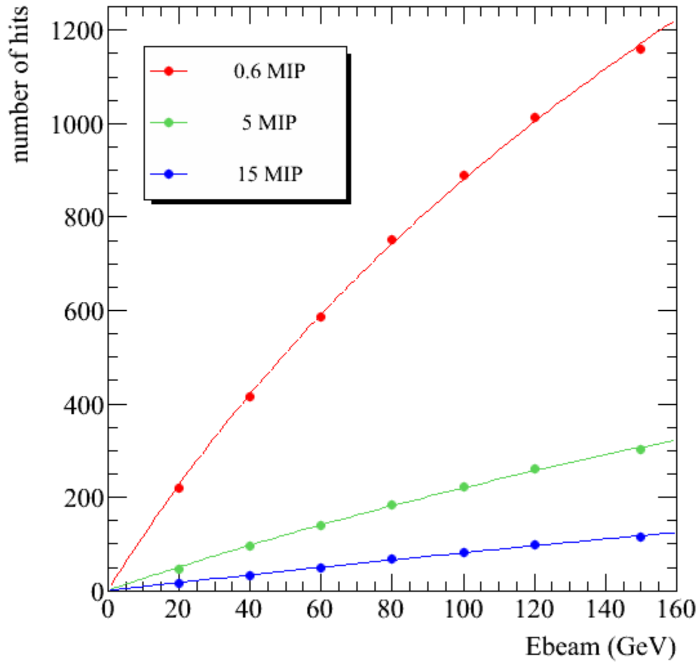


A. Steen

I. Laktineh

Micromegas: 4 layers (+ 46 layers RPC)

- data corrected to a virtual full Micromegas SDHCAL



Micromegas: Towards 1m³ Prototype

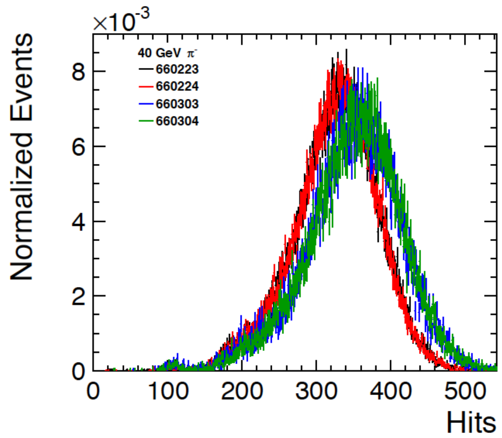
- spark protection → resistive Micromegas

M. Chefdeville

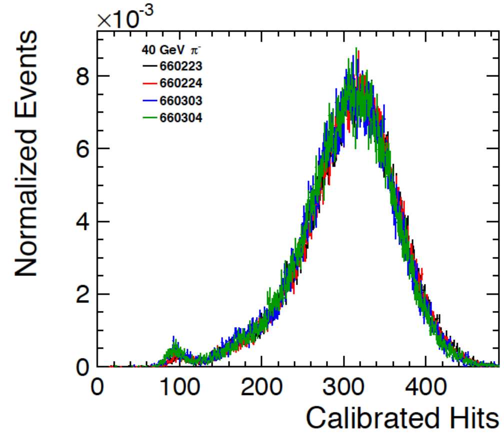
Digital HCAL

Analysis of Physics Prototype data

- detailed RPC simulation; calibration, non-linearity correction, software compensation

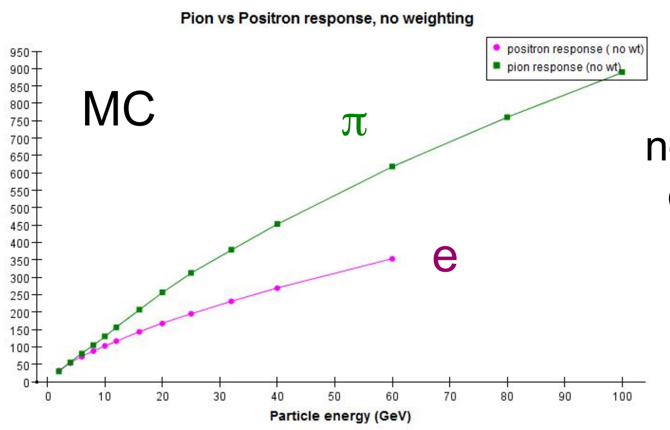


calibration

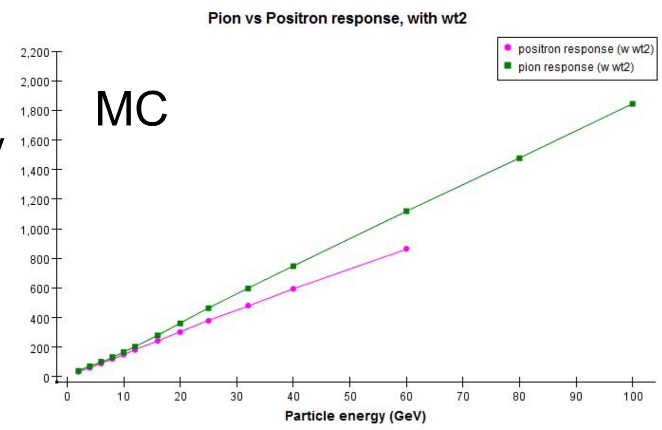


C. Grefe

tungsten



non-linearity correction



B. Bilki
L. Xia

iron

Further Developments

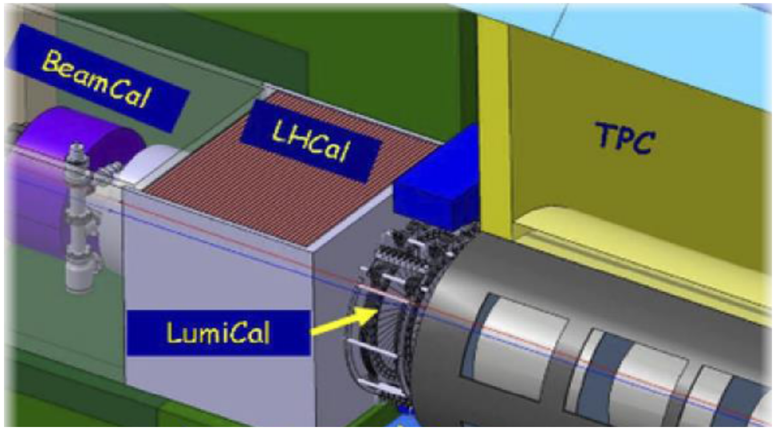
- 1-glass RPCs, high rate RPCs, HV distribution, gas recycling

J. Repond

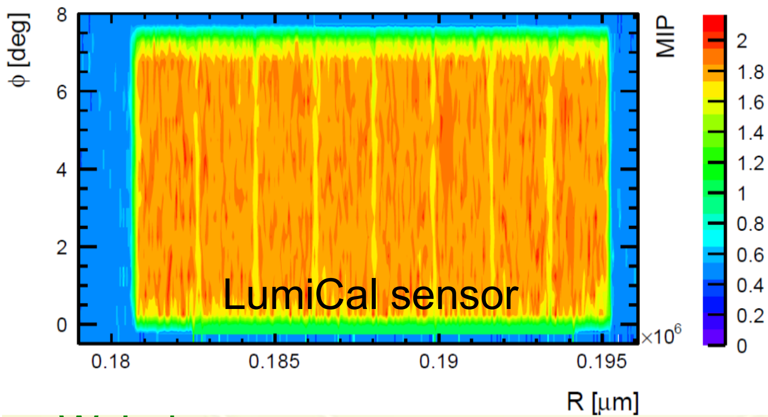
FCAL & Muon/Tailcatcher

FCAL Requirements:

- LumiCal: high precision, high occupancy
- BeamCal: radiation hardness, fast readout



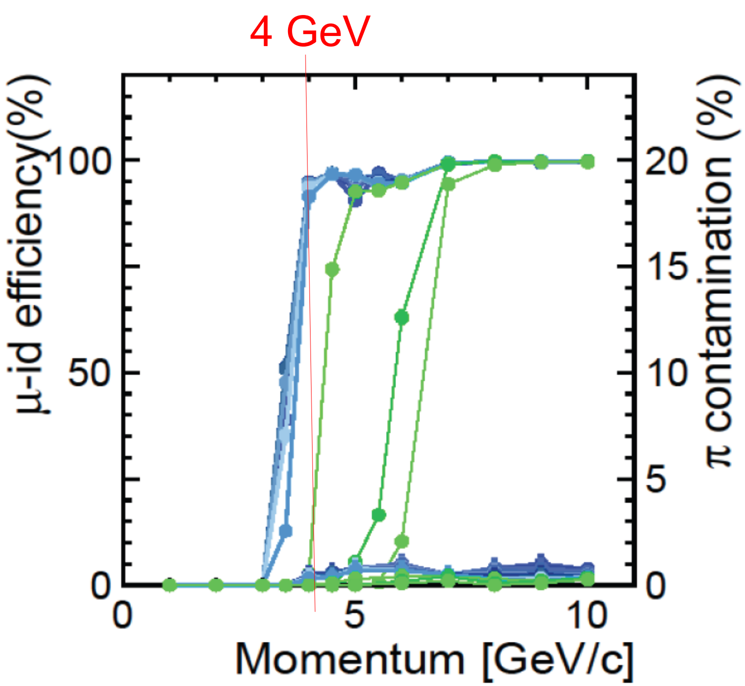
- Testbeam; irradiation studies at SLAC



W. Lohmann
B. Schumm

Muon/Tailcatcher Requirements:

- large instrumented area
- tailcatcher technology will probably correspond to HCAL



- efficient µ-ID for momenta > 4 GeV

V. Saveliev

Dual Readout: DREAM / RD52

J. Hauptman

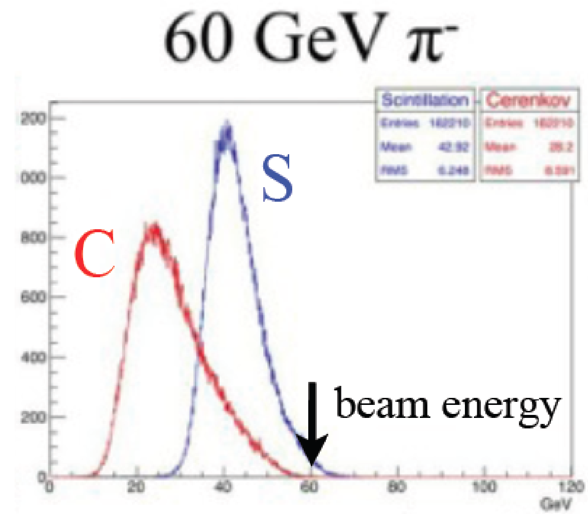
Goal: understand fundamental limitations of hadron calorimetry (response function, linearity, resolution)

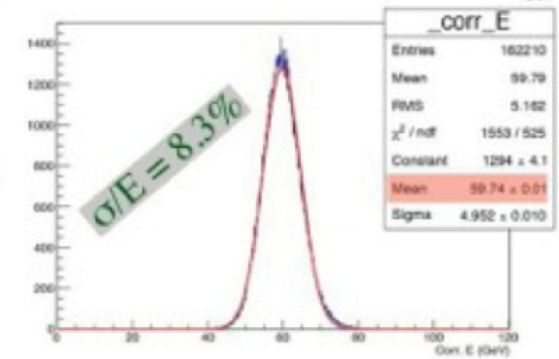
Idea for dual readout: fluctuations of EM fraction in hadron showers limit resolution → measure EM and HAD fraction simultaneously

- Scintillator fibers: sensitive to EM and HAD fraction
- Cerenkov fibers: mainly sensitive to EM fraction

> **e performance:** no constant term, reasonably well described by GEANT4 simulation

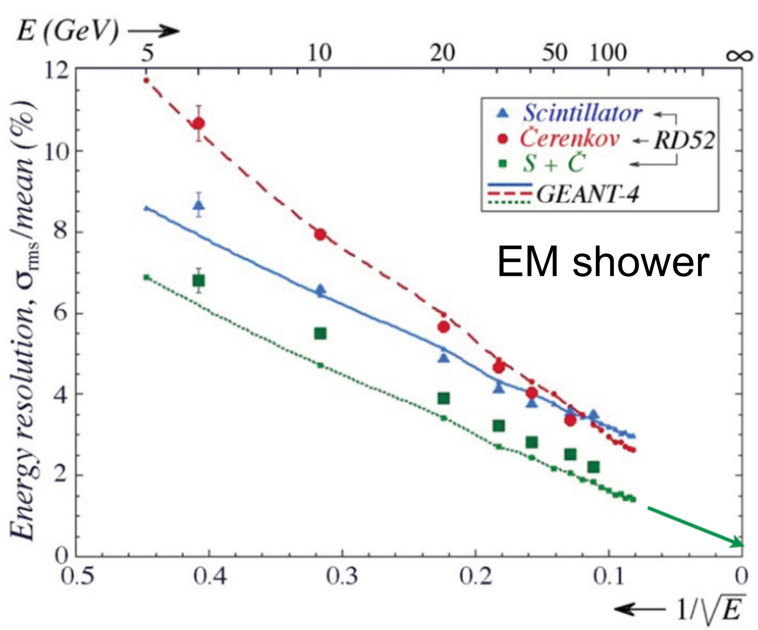
> π **performance:** nice gaussian response





corresponds to 64%/√E

expected limit: 15%/√E



Summary

- performance of all PFA calorimeter technologies shown in large scale beam tests
  - nice physics results
  - knowledge about shower development in unprecedented detail
- several projects: first results from engineering prototypes addressing detector integration
  - scalability, power pulsing
  - automation, mass production
- started studies for detector optimisation in terms of cost