

A Proposal to study Digital Calorimeter for GLC detector

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CAL requirements

Energy Flow

Digital CAL

a proposal

motivation of new Calorimeter

- $e+e-$ WW, ZZ, ZH
multi-Jet final states
- **Energy Flow** = **full**
Jet reconstruction
and tau

CAL requirements

calorimeter is to measure the energy
of jets

neutral energy by CAL photons : 25%
neutral hadrons : 15%

charged energy by Tracker

60% of jet energy

separate neutral or charged particle

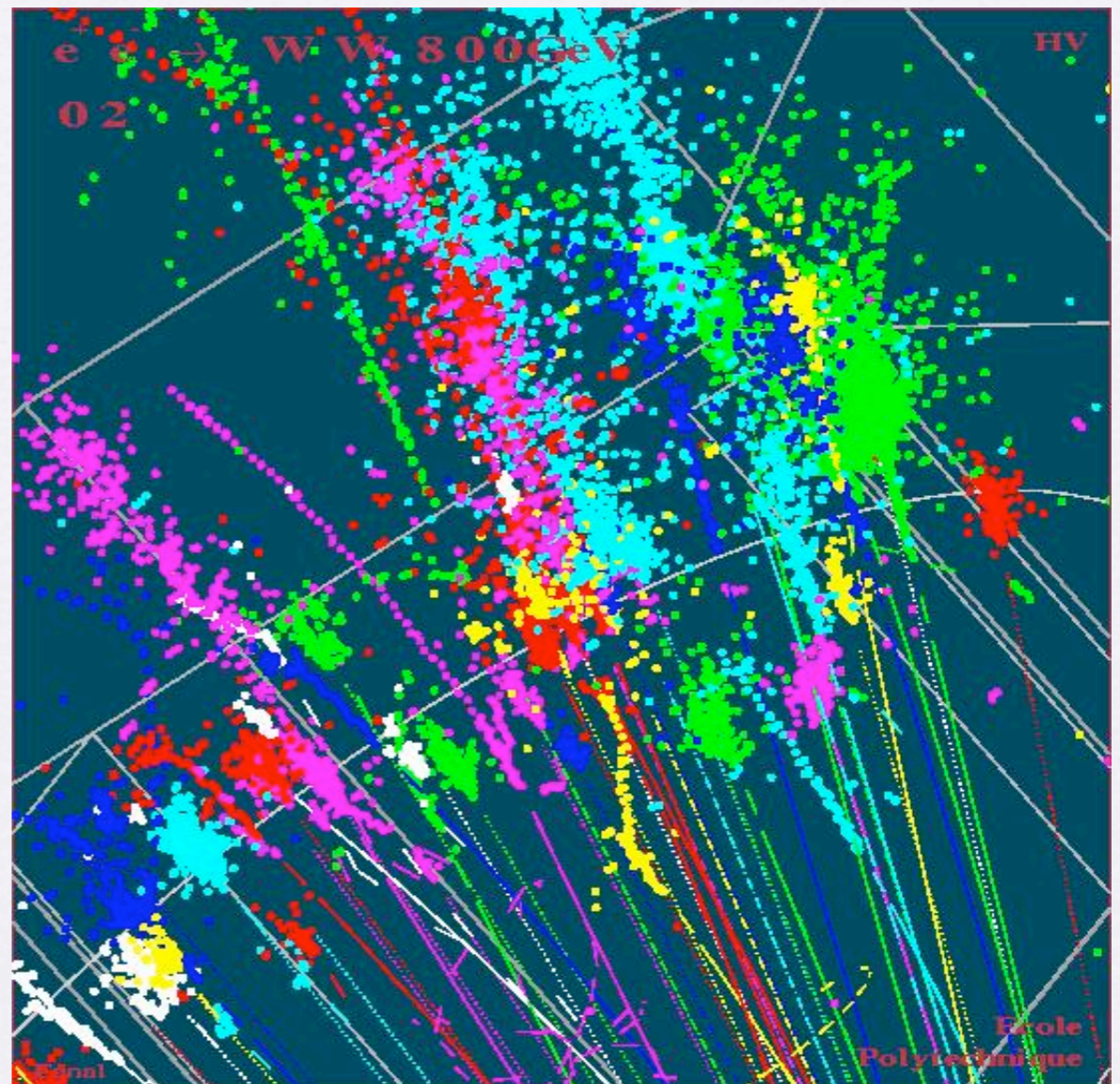
granularity fine : analog
super-fine : digital

Energy Flow

Jet Reconstruction

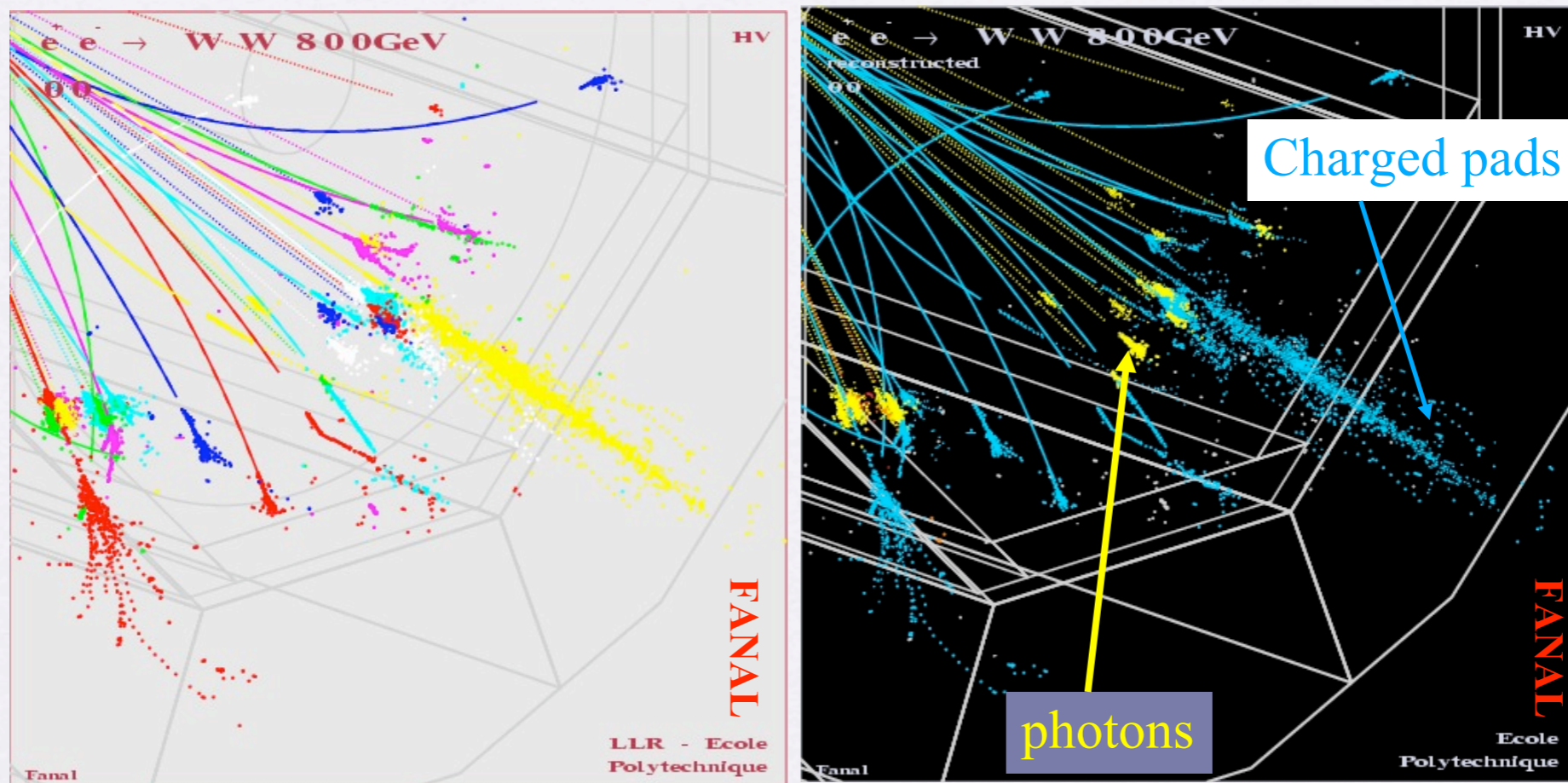
Calorimeter challenge : charged/neutral shower separation requires high granularity, both transverse and longitudinal, to reconstruct showers in 3-D.

Software to recognize clusters and tracks is important as an **ALGORITHM**.



Energy Flow results

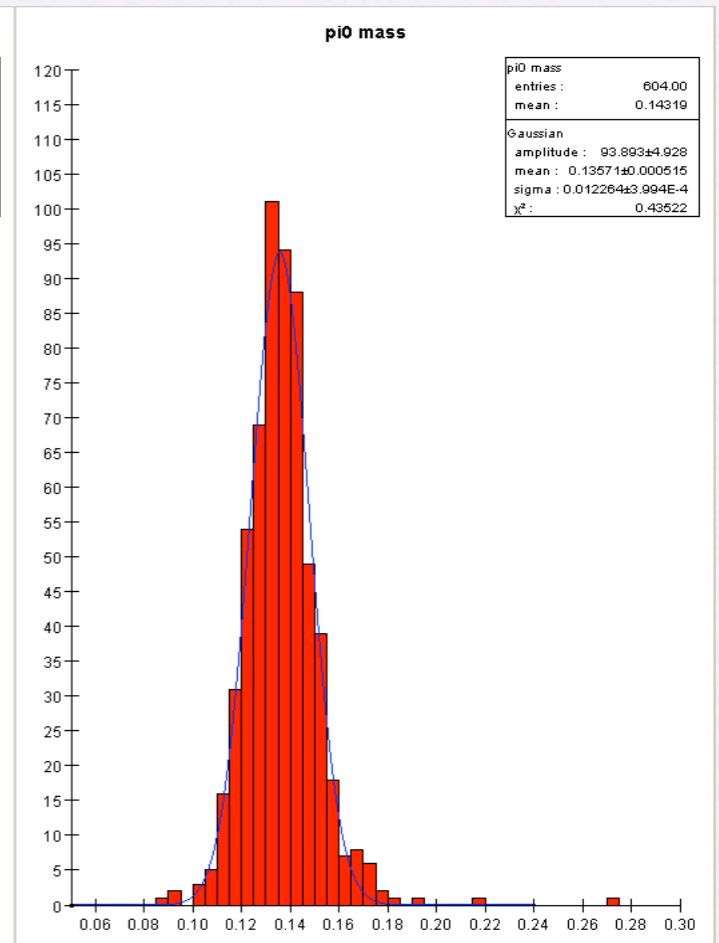
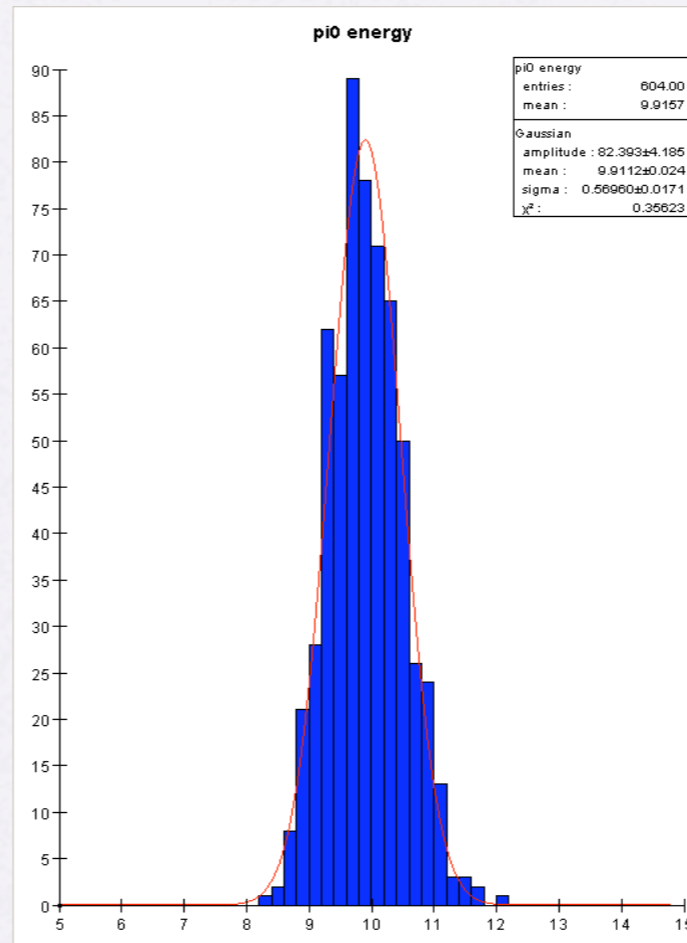
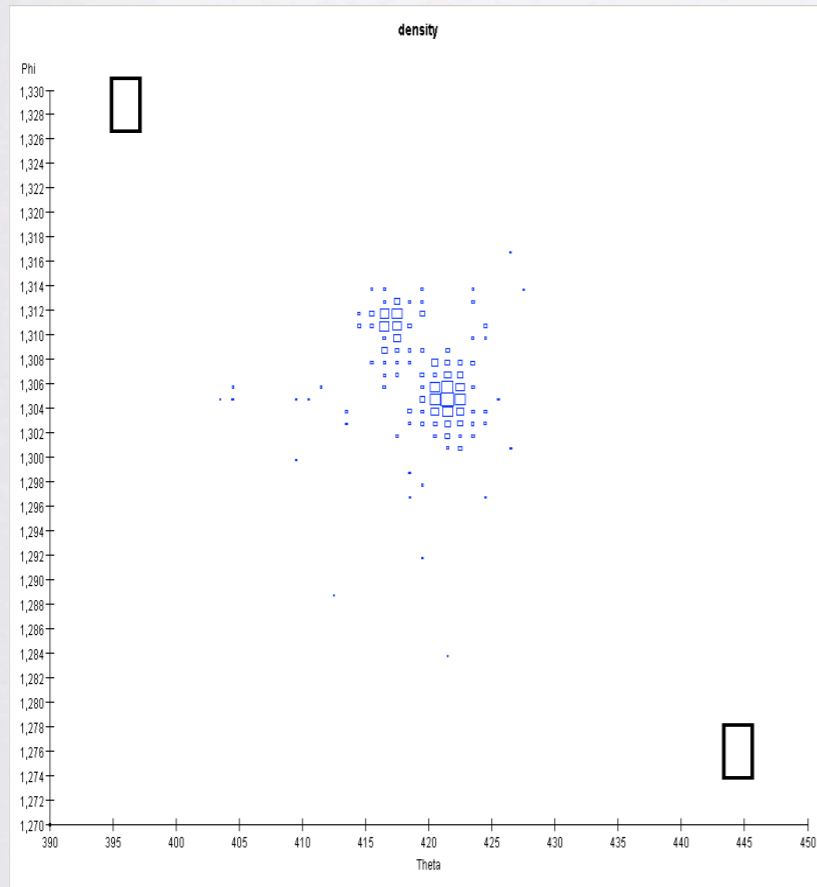
photon finding



CALICE-j.C.Brient

Energy Flow results

EM-CAL : 10GeV $\square_0 \rightarrow \square_1$



Eff-photon~95%

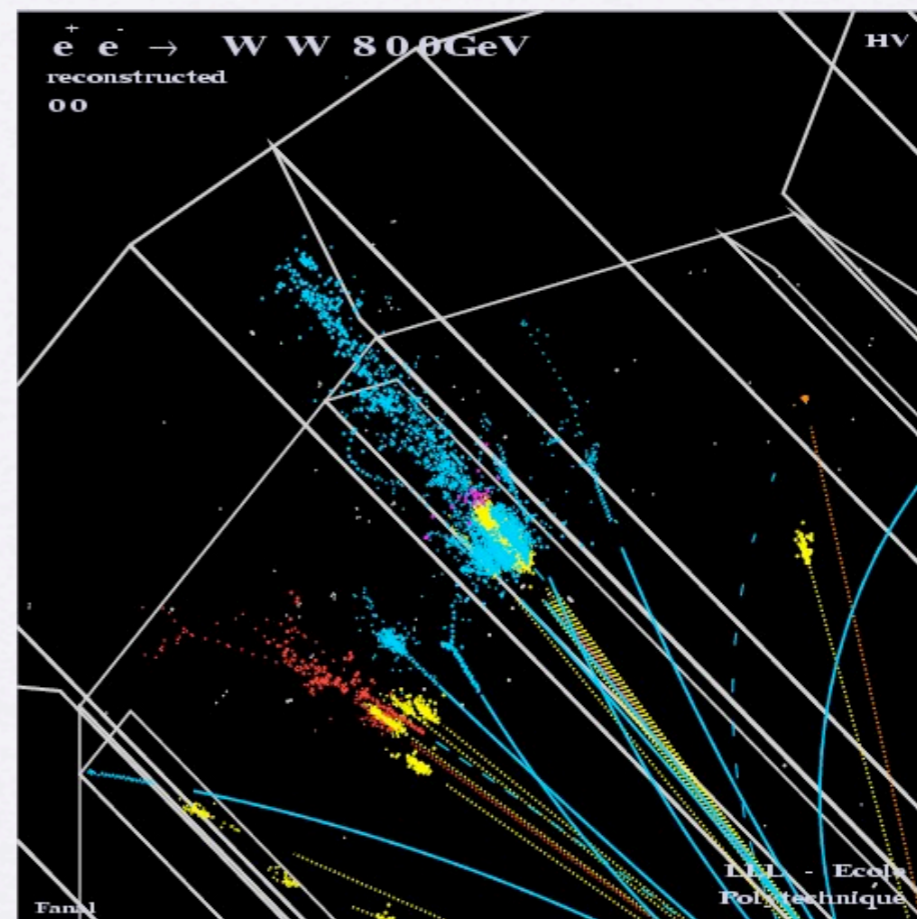
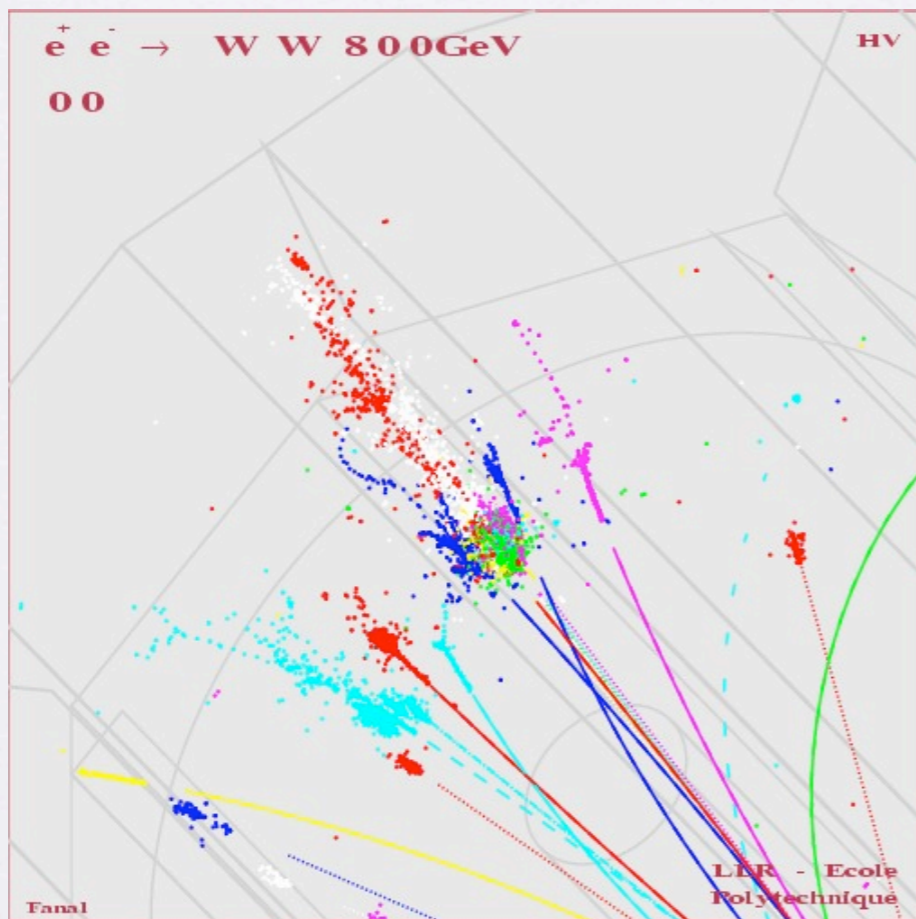
10 GeV
reconstructed energy

18%/ $\square E$

mass
136±12MeV

Energy Flow results

Neutral Hadron identifier



muon ID

CALICE-j.C.Brient

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Energy Flow results

Jet Erec/Egen

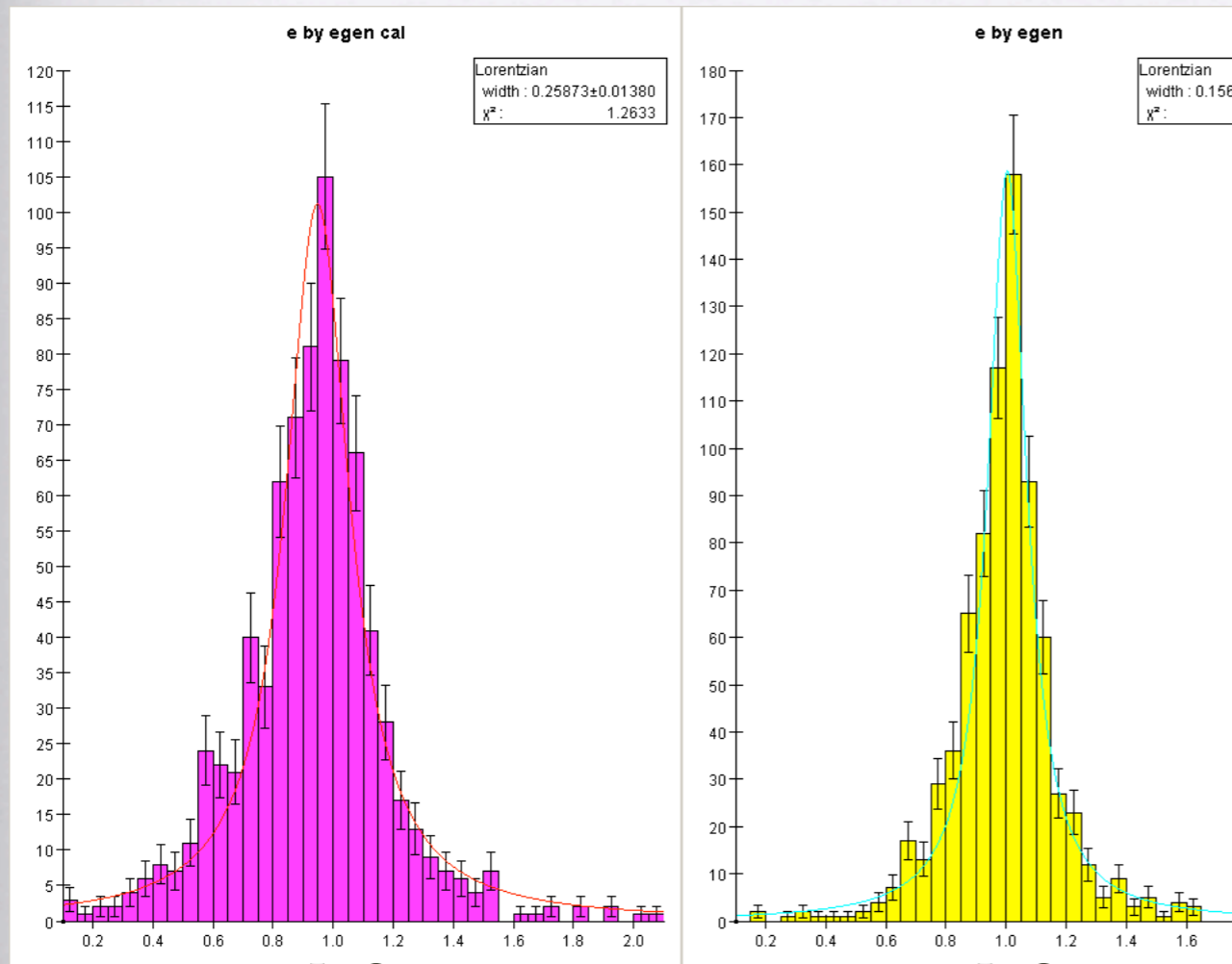
Calorimeter only

Eflow

ZH(140) at 500 GeV ,

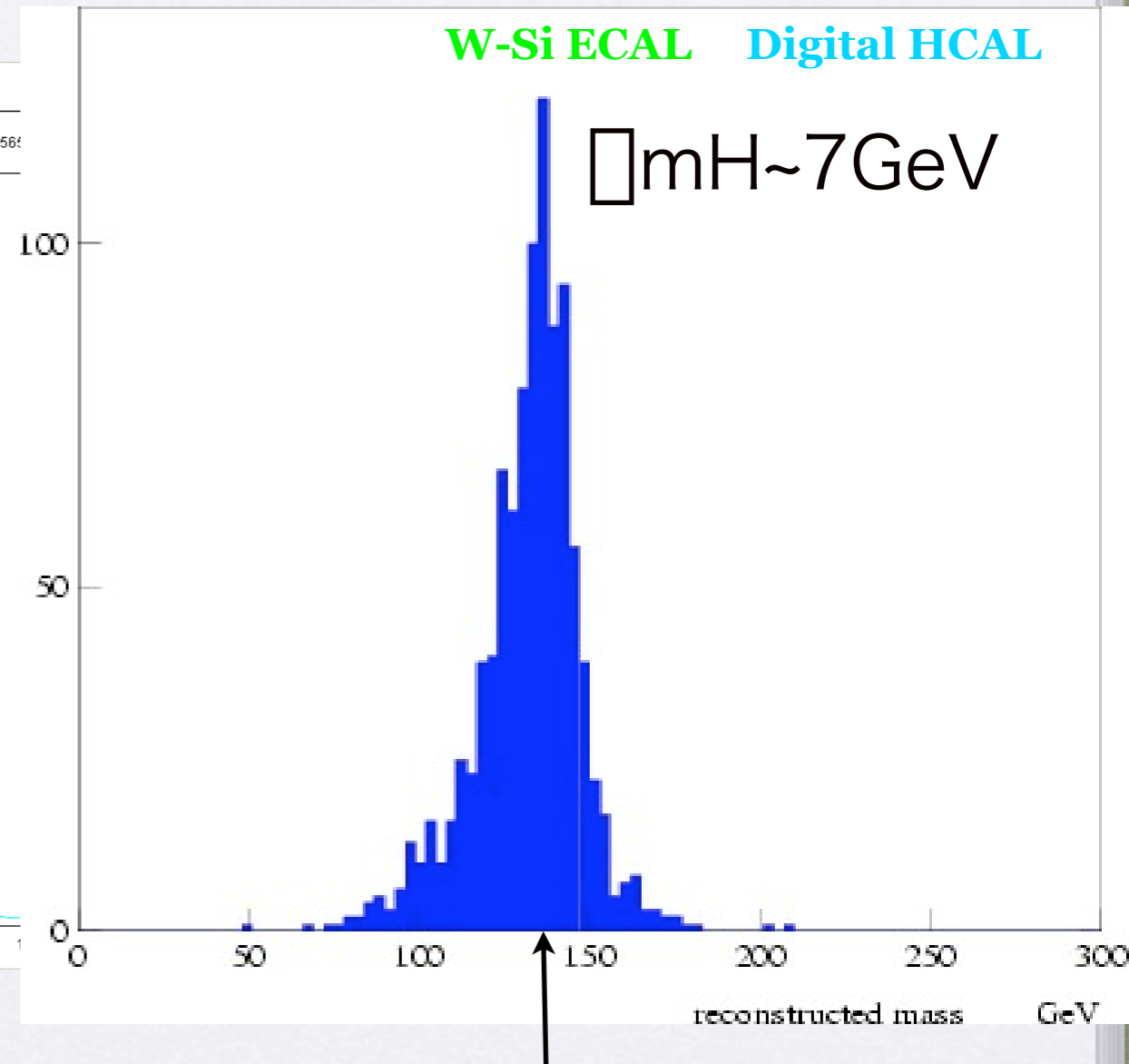
Z $\square\square$ and H cc,bb,ZZ,WW hadrons

W-Si ECAL Digital HCAL



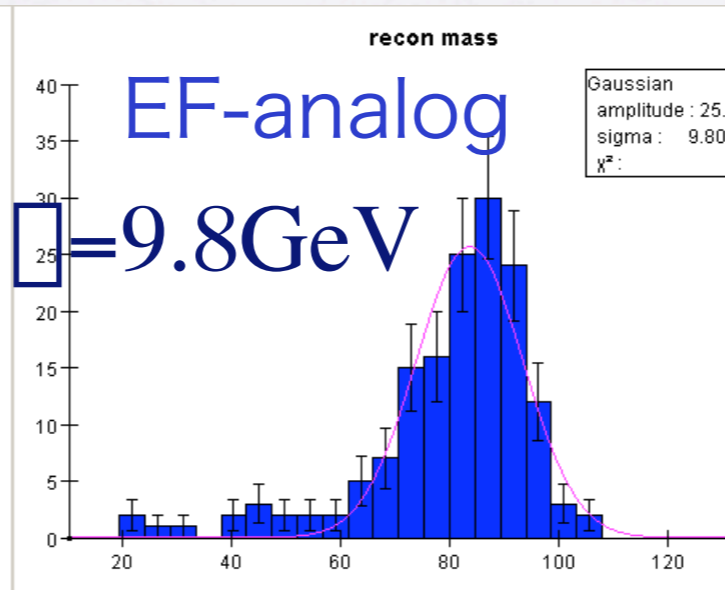
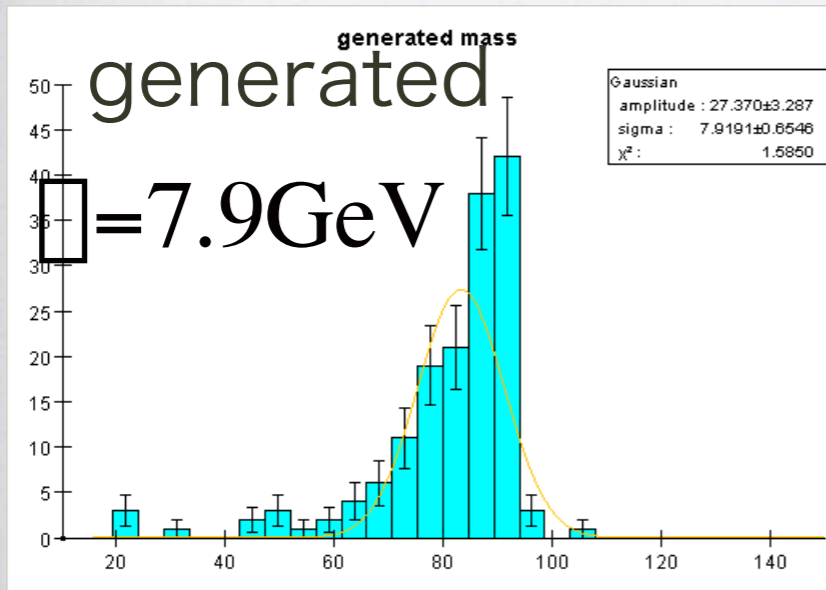
1.0
width~0.26

~60% better 1.0
width~0.16

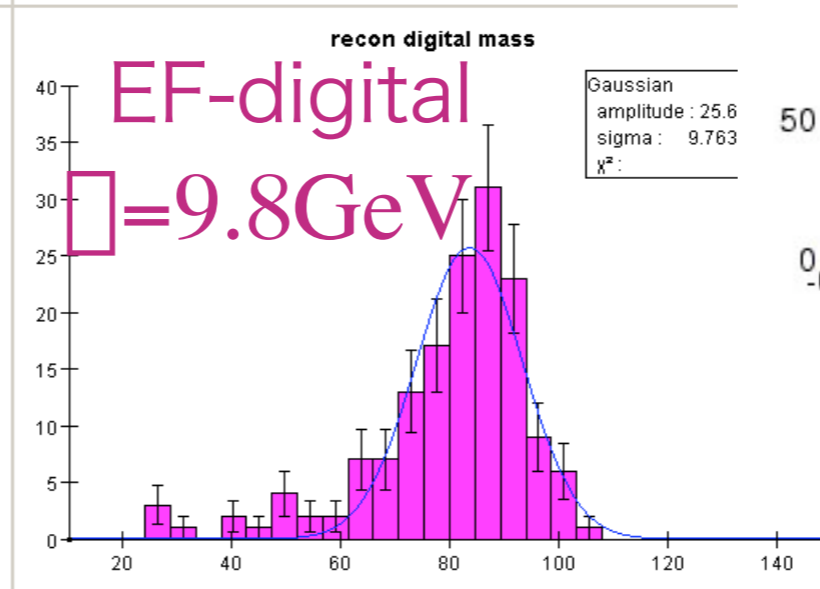
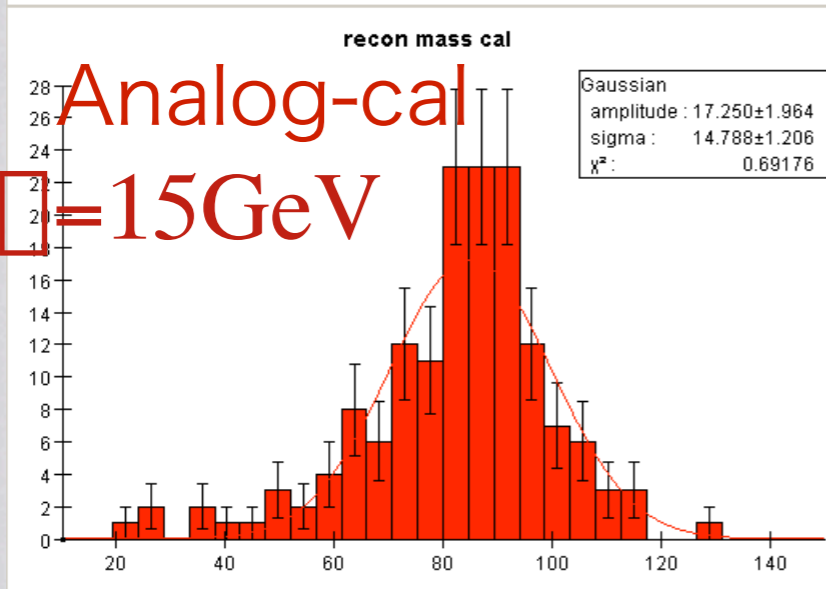
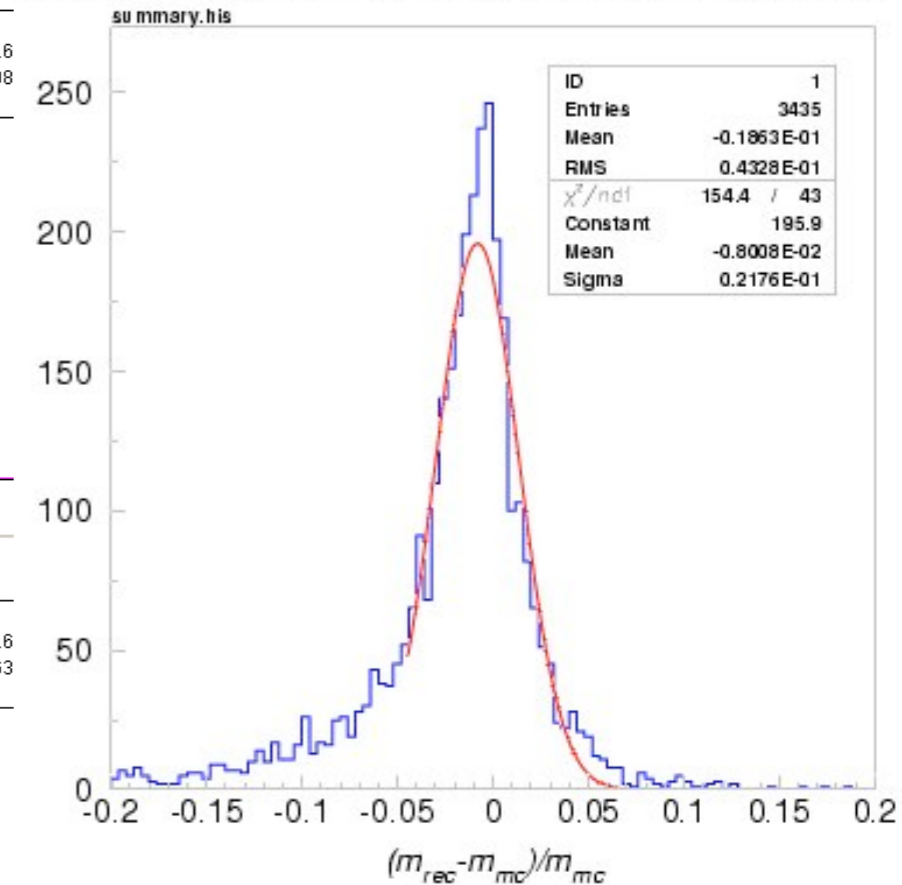


Energy Flow results

Z Jet+Jet 2cm² cells ee WW JJ
EM+H 1x1 cells



mass reconstruction from WW pair production



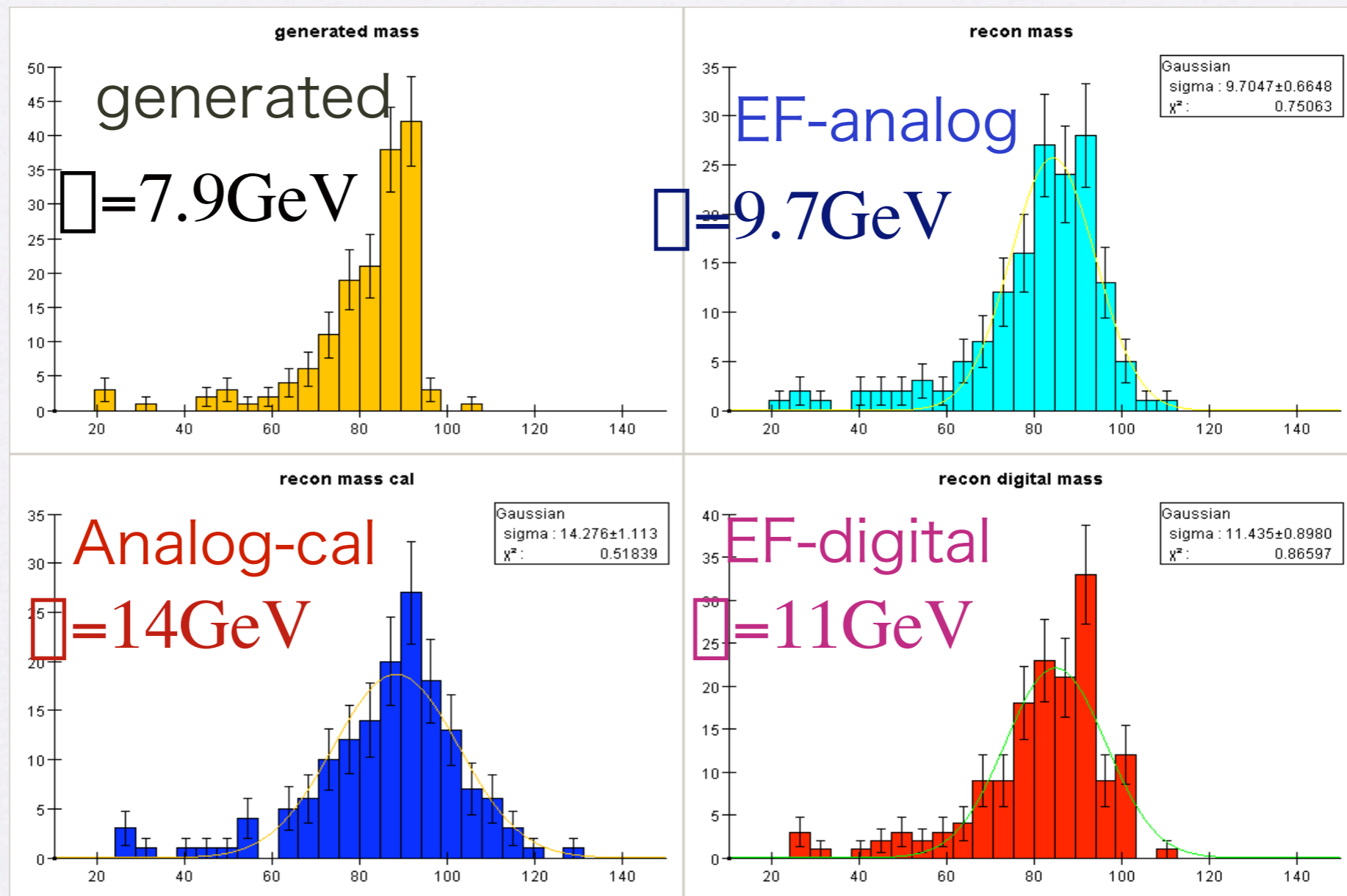
$M_W = 2.6\text{ GeV}$

M(Z)

Energy Flow results

Z Jet+Jet

6cm² cells



V.Zutshi

M(Z)

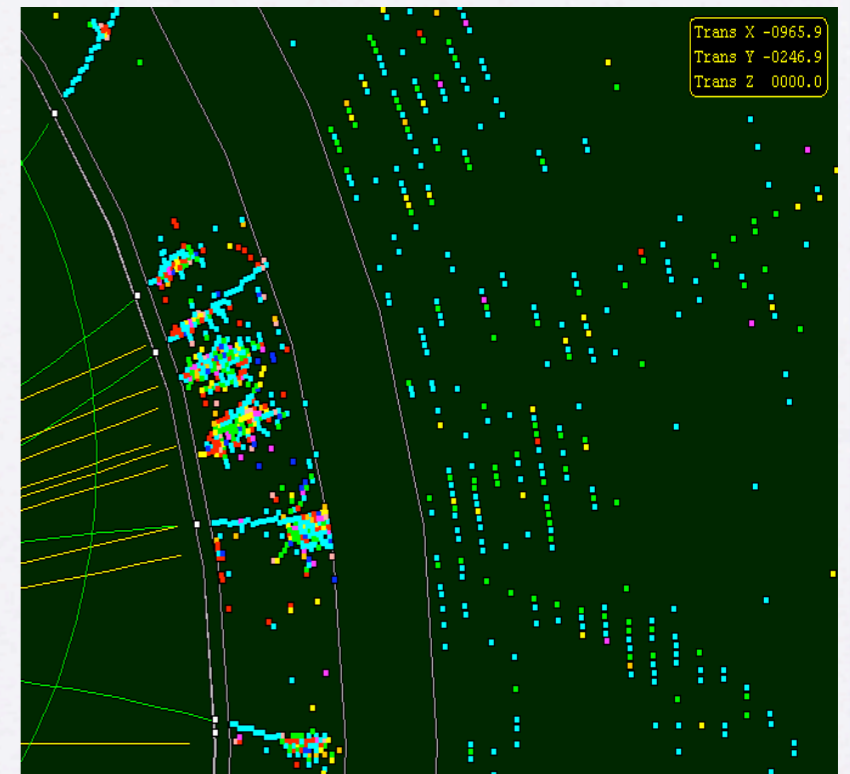
EM-Calorimeter

EM-cal	Energy Flow type	JLC-base
active-matter size (mmxmm)	Silicon 5 x5 ~10x10	scintillator 40x40
absorber thickness (mm)	Tungsten (W) 2.5	Lead (Pb) 4
Radiation length (mm)	3.5	5.6
resolution	11%/□E	15%/□E

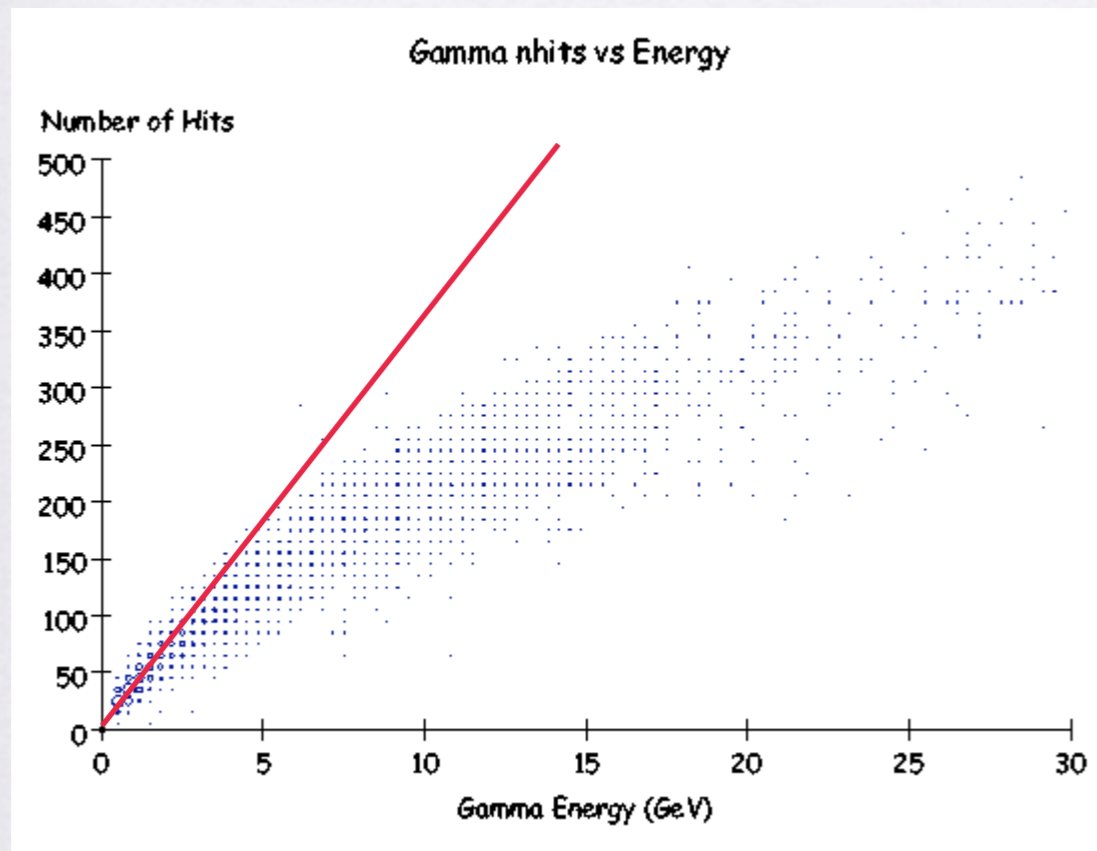
H-CAL

H-cal	Energy Flow type	JLC-base
active-matter size (mmxmm)	scinti-or-RPC/ GEM 10 x10 ~20x20	scintillator 150x150
absorber thickness (mm)	Steel 7	Lead (Pb) 8
interaction length (cm)	17	17
resolution	30%/ \sqrt{E} for a jet	40%/ \sqrt{E} for a particle
R/O	Digital/Analog	Analog

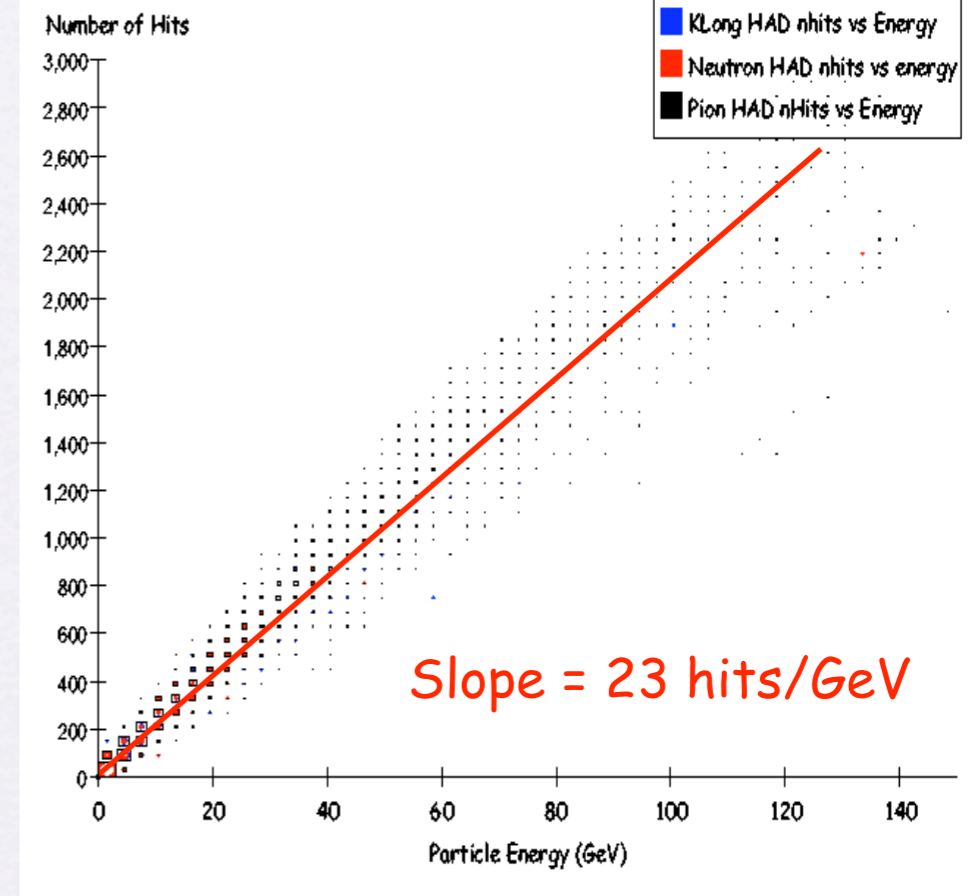
Digital-CAL



Nhits 5 mm X 5 mm EM cells



Nhits 10 mm X 10 mm DHCAL cells



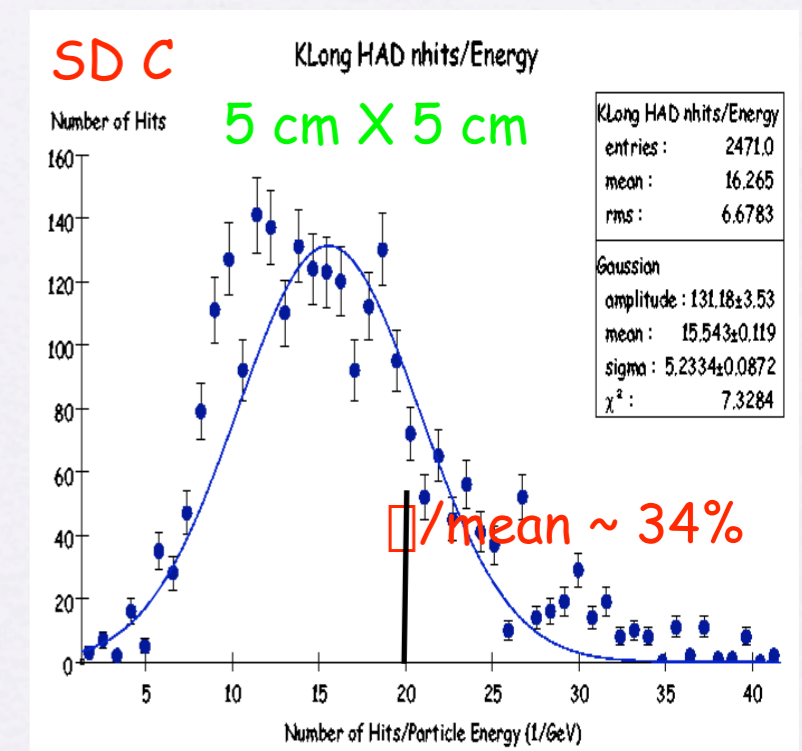
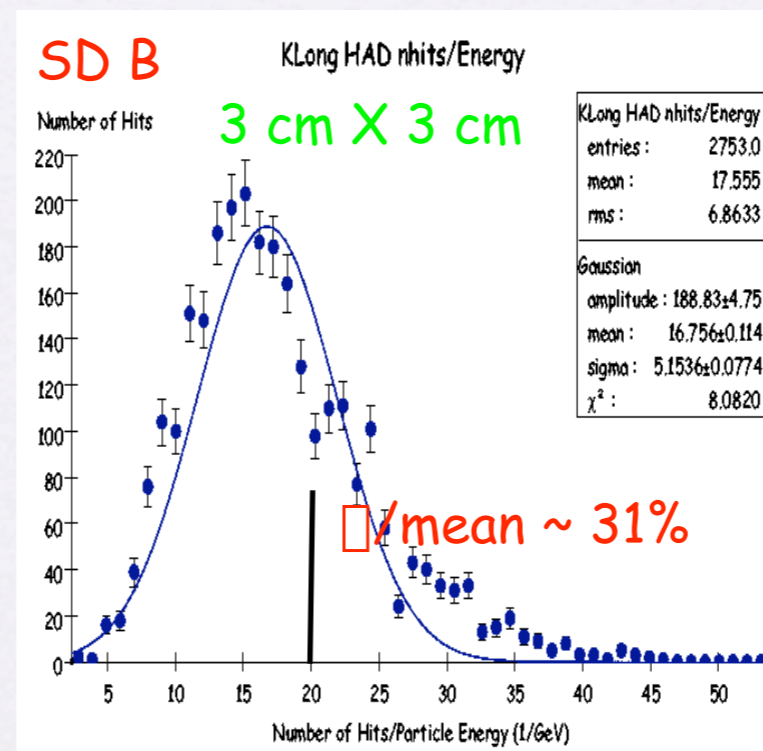
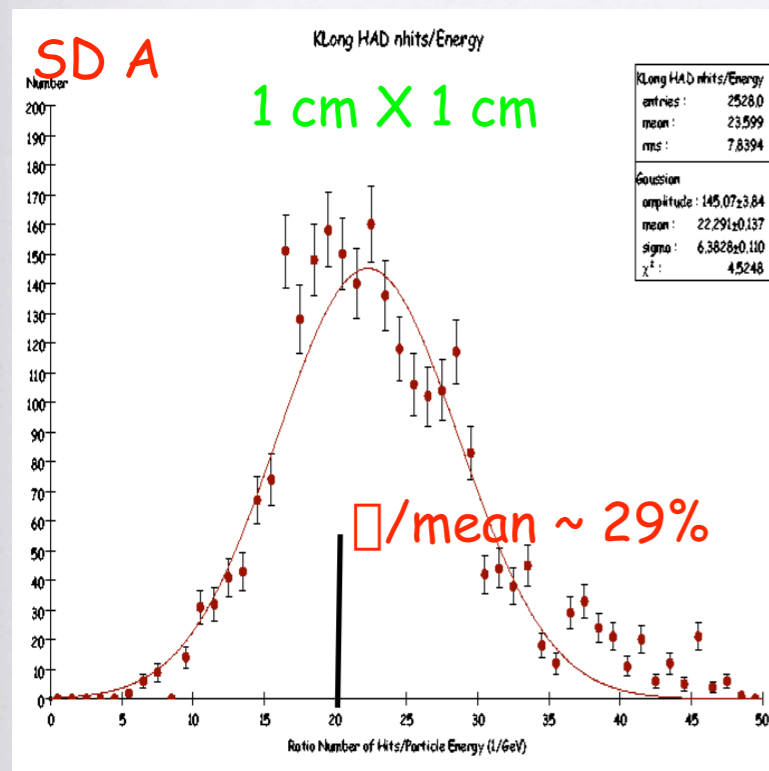
Average : ~43 MeV/hit

T.Takeshita-kek-GLCdet2003

Digital-H-CAL

optimize cell size

K_L^0 Analysis HCAL (only) Digital Results

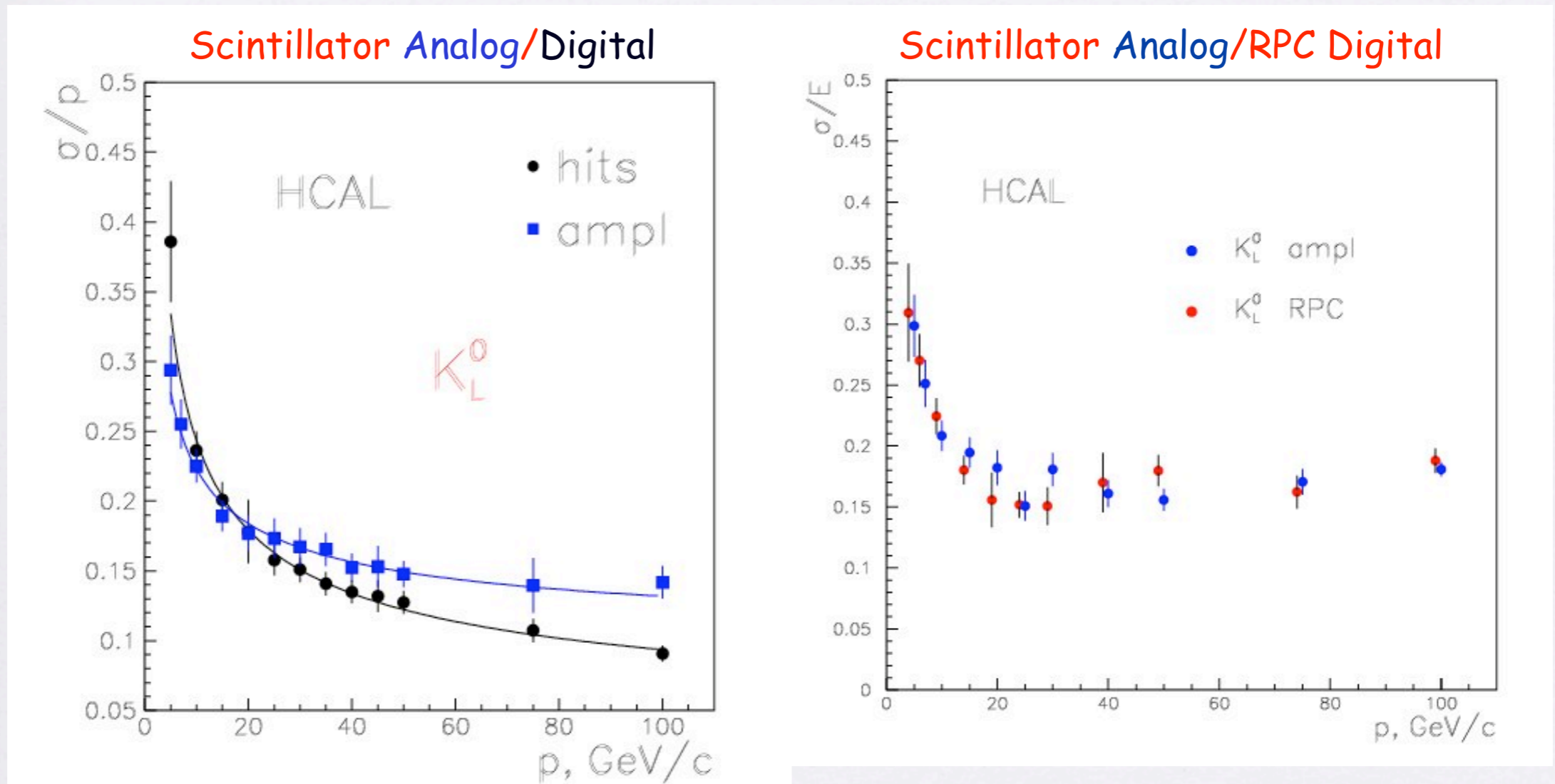


Nhits/Energy

Digital-H-CAL

K_L^0 Analog vs Digital

energy resolution

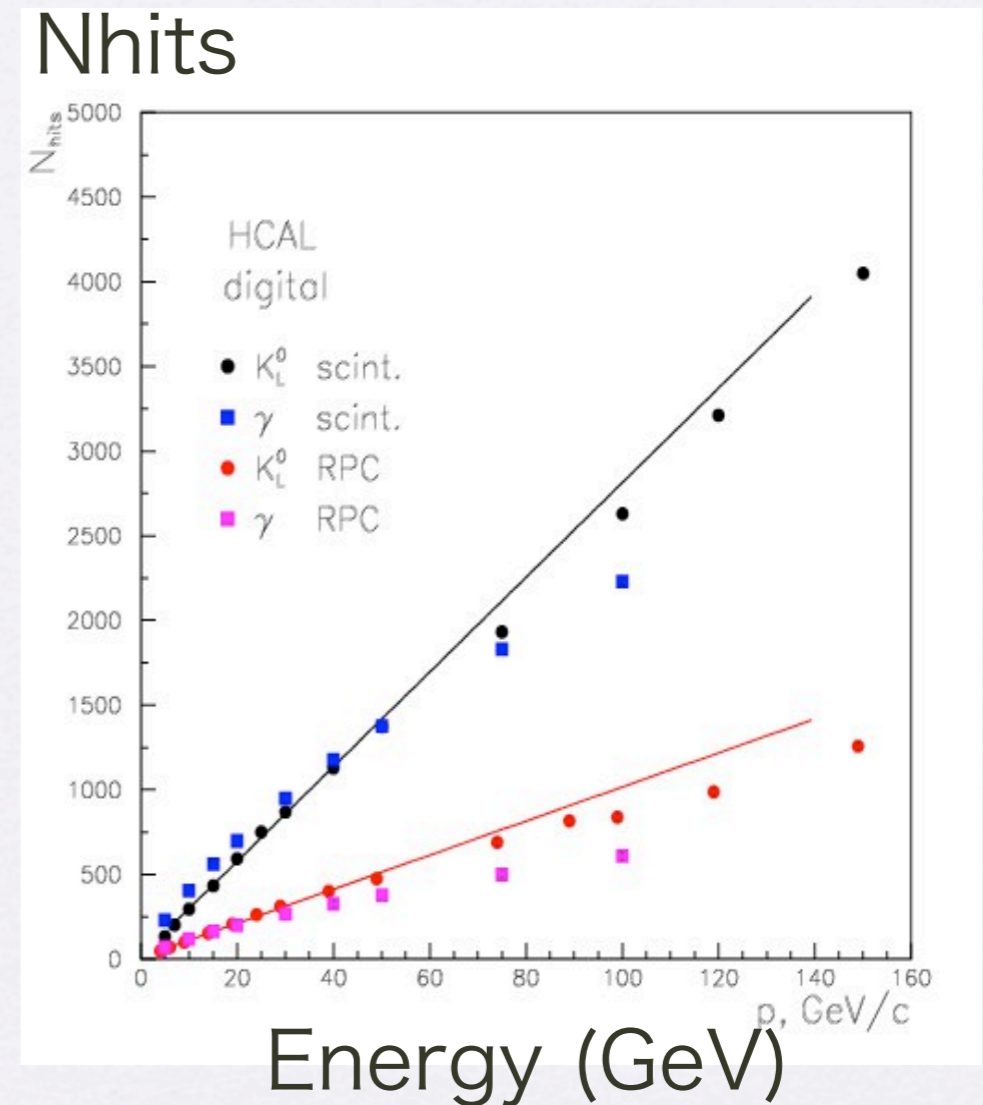


Digital-H-CAL

Compensation in Digital HCAL?

digital HCAL is
~compensating

Factor of 3 difference
in signal from scintillator
compared to gas



Digital-H-CAL

digital scintillator Hadron Calorimeter

Study Issues

- optimal transverse cell size and longitudinal segmentation
- optimal absorber material/thickness
- analog vs digital readout

Digital-H-CAL

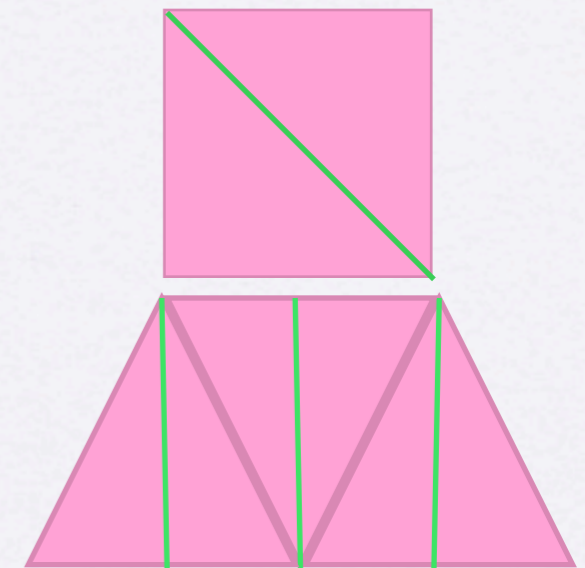
digital scintillator Hadron Calorimeter

Full-Simulation

Small tiles : bench test

photon detectors - SiPM, EBCCD,,,

Small detector : beam test



Summary

Digital - Hadron-CAL

- fine granular calorimeter could fully reconstruct JETs by Energy Flow algorithm
- need to **verify the Energy Flow by a real hardware**

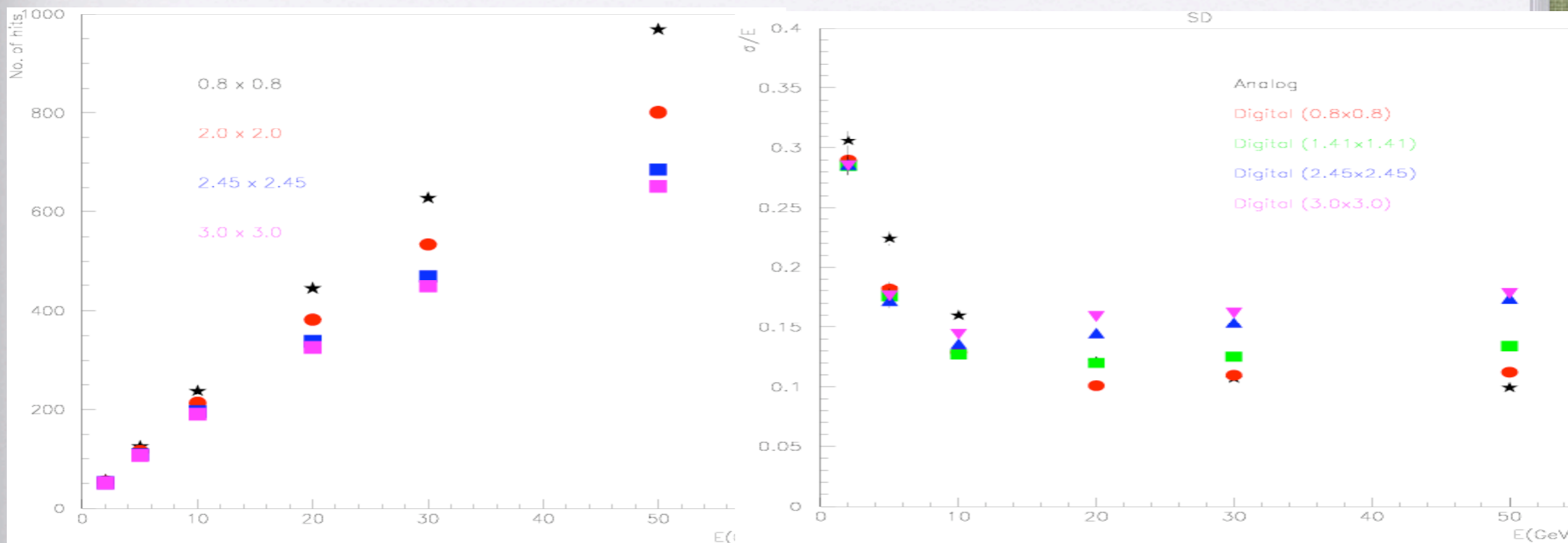
BakcUp

Digital EM-CAL

pad size dependence

Nhit vs. E

E resolution



Digital H-CAL

$$\square_+ \rightarrow p\square_0$$

