2005/June/28

# Status of Asia PFA Study

*ILC Software Mini Workshop*


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*T. Yoshioka (ICEPP, Tokyo U.)*
*.....*

# Asia Simulation Tools

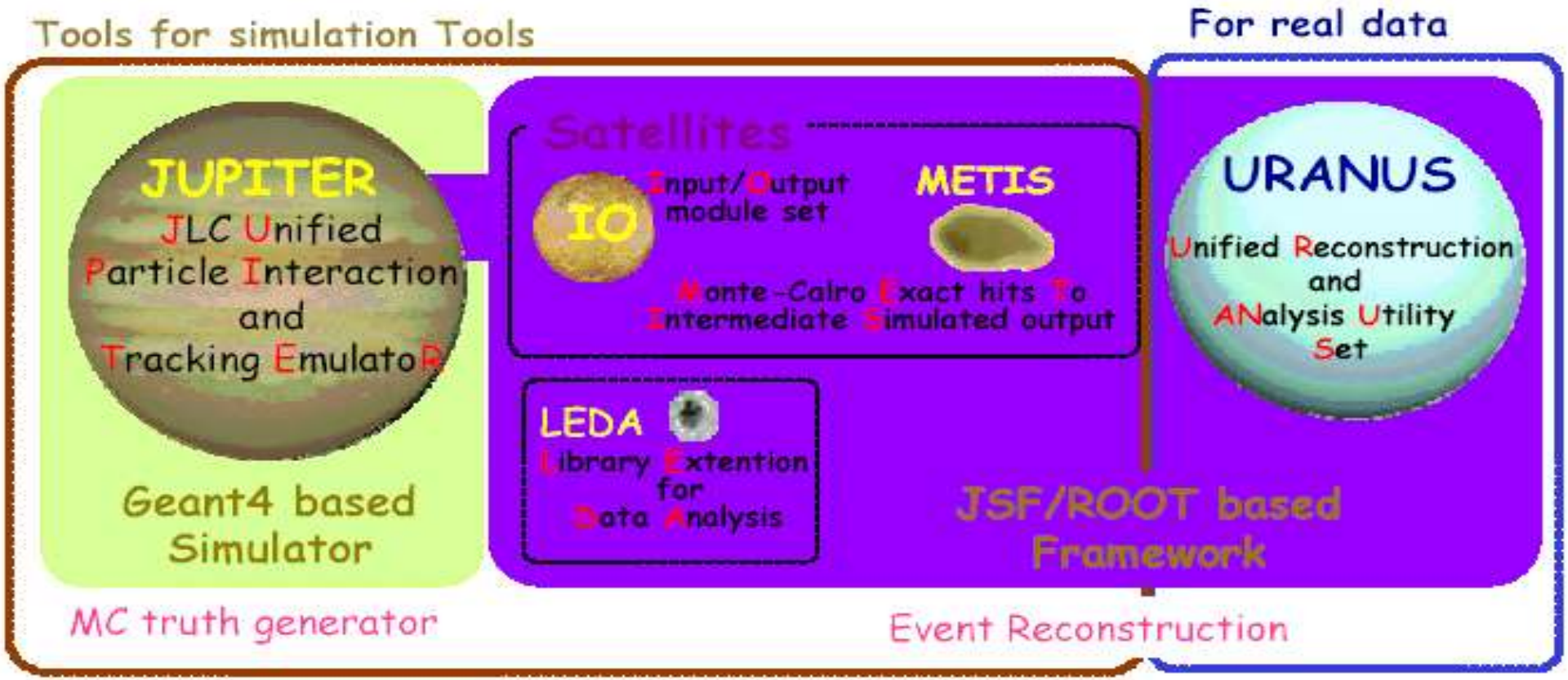
## Last Update: 2005/May/03

*http://acfahep.kek.jp/subg/sim/simtools/index.html*

**Download**

- **SimTools-1-01-bin.tar.gz**
  Collections of pre-compiled binaries, documents, and examples.
- **SimTools-1-01-src.tar.gz**
  Source files correcponding to SimTools-1-01-bin.tar.gz

# Asia Simulation Tools

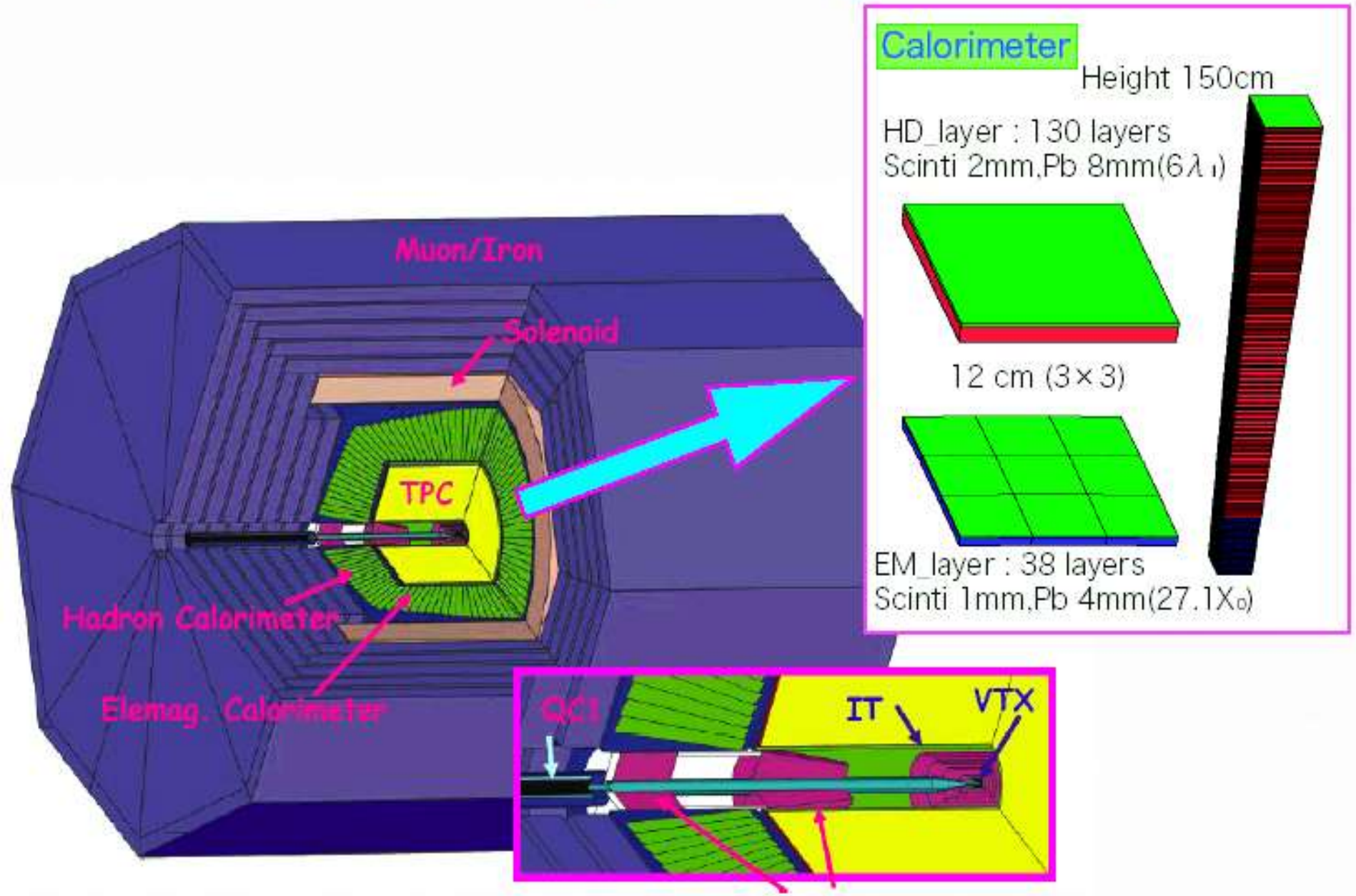



JSF: the analysis flow controller based on ROOT
The release includes event generators, Quick Simulator,
and simple event display

- **Implement an "ideal" GLD geometry in the Jupiter**
- **Study the PFA performance**

ps. Version info: Geant4 7.0.p1; ROOT v4.03.02

# Geometry Settings in Jupiter



# LC Shower Models Study (standalone)

**Date: 16 June 2004**

**Author: D.H. Wright (SLAC)**

EM Shower Models

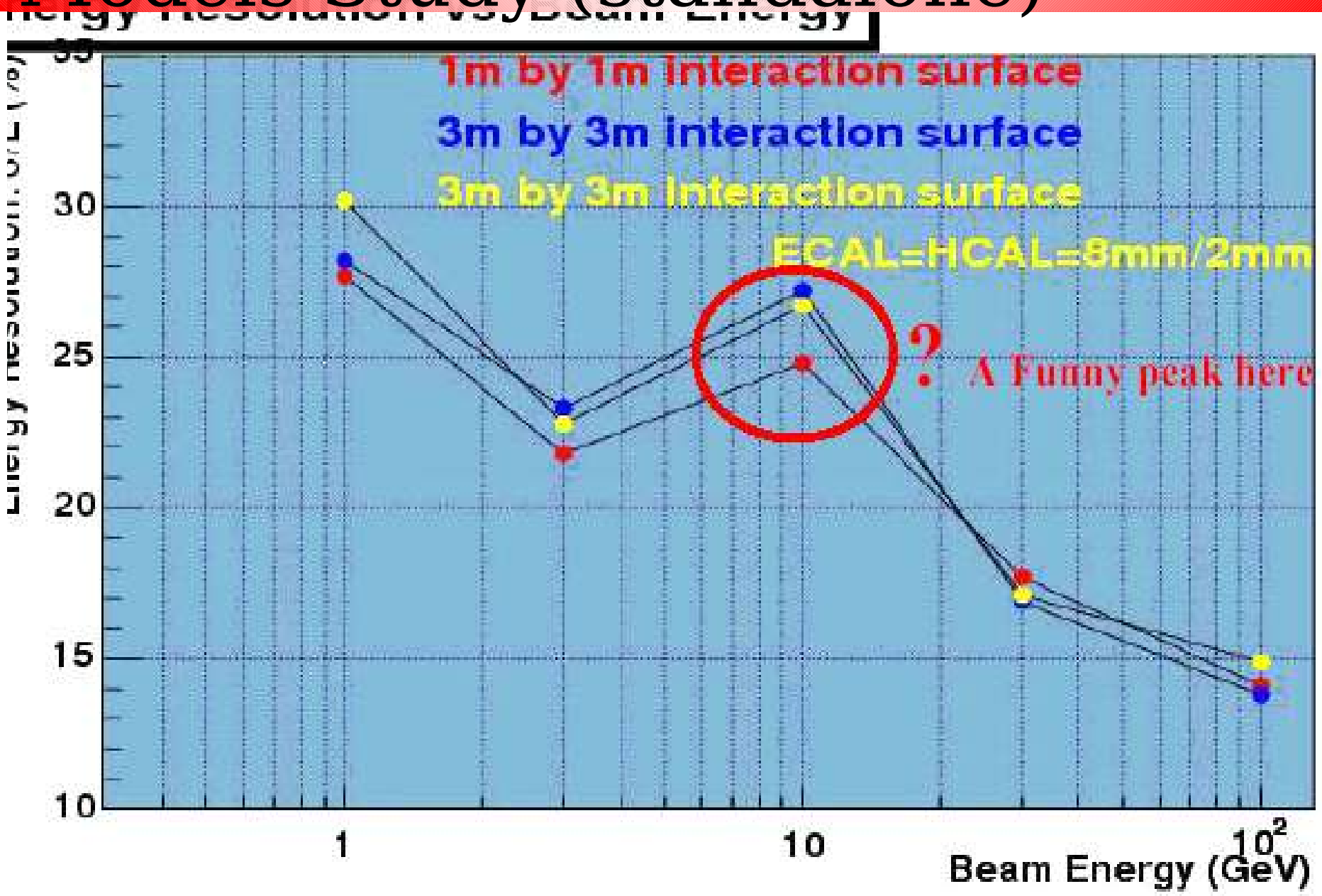
- LCBosonPhysics
- LCLeptonPhysics
- LCIonPhysics

\+ Standard electromagnetic process (in GEANT4)

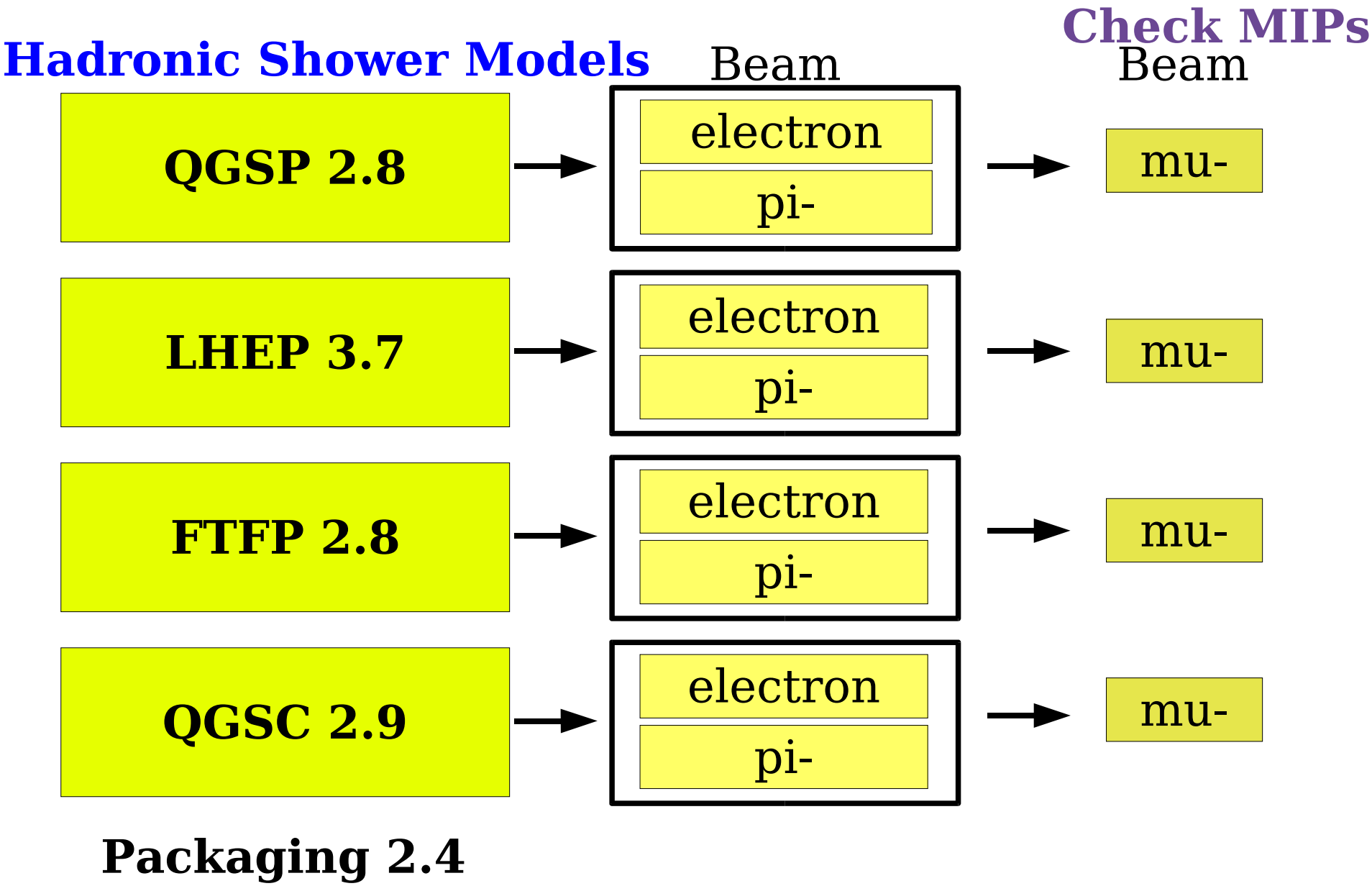
LCDecayPhysics: set max. Step length to be 1mm (save CPU Time)
range cut (save more secondary particles)= 10 micron

**We can't trust the LCHadronPhysics.**
**Bad pi- energy resolution and strange peak at 10 GeV and error message happened sometimes...**

# LCHadronicPhysics Shower Models Study (standalone)

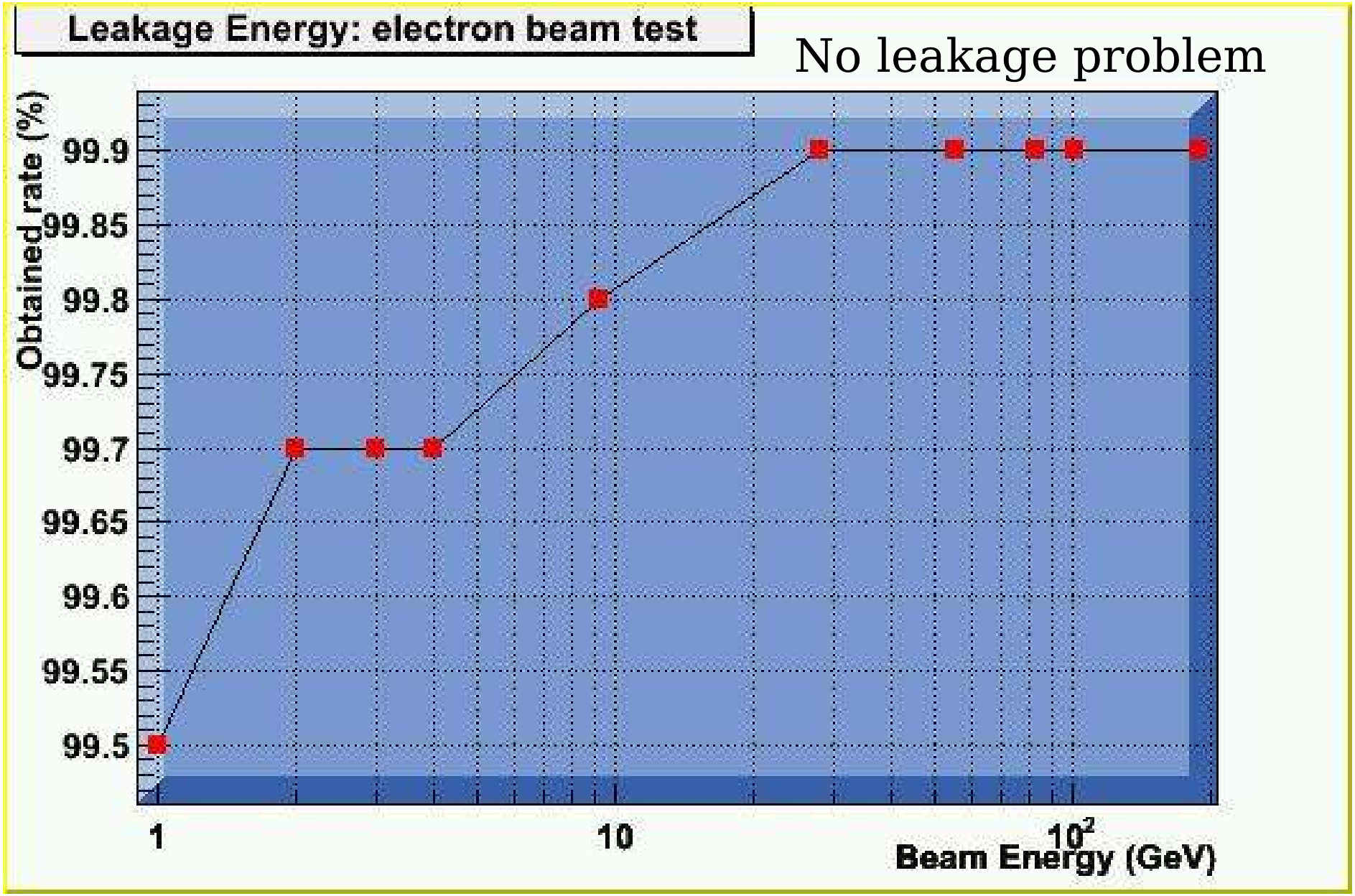


# Hadronic Shower Models (standalone)



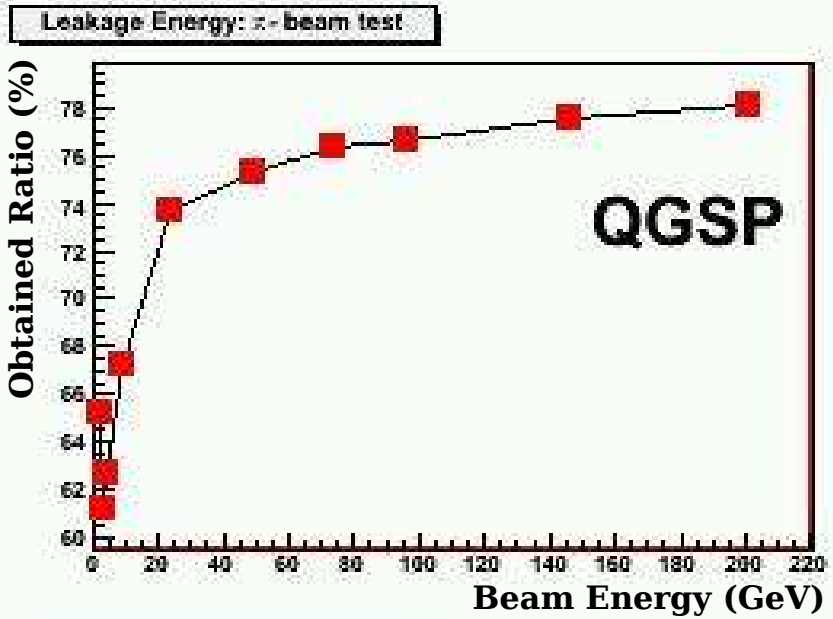

**Packaging 2.4**

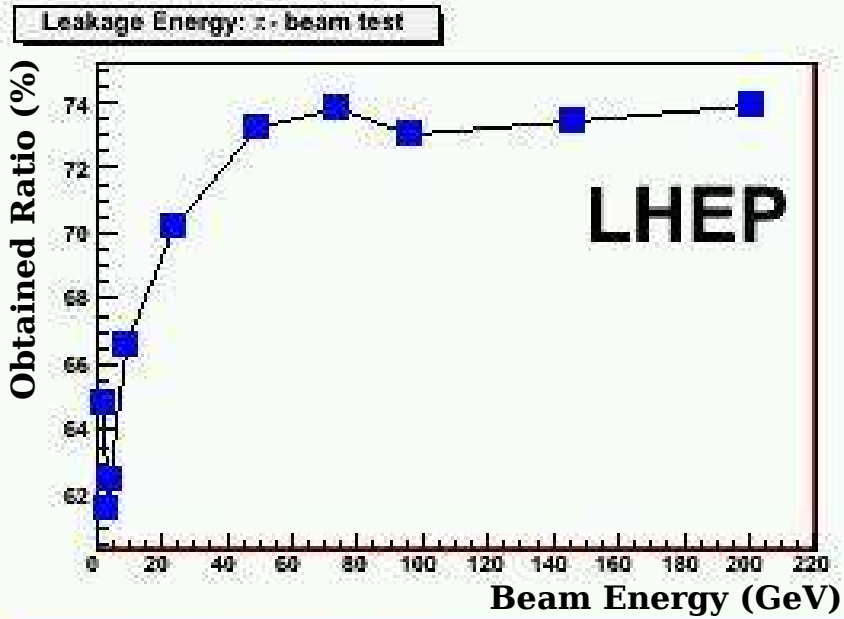
# Leakage Energy Study – e- (standalone)

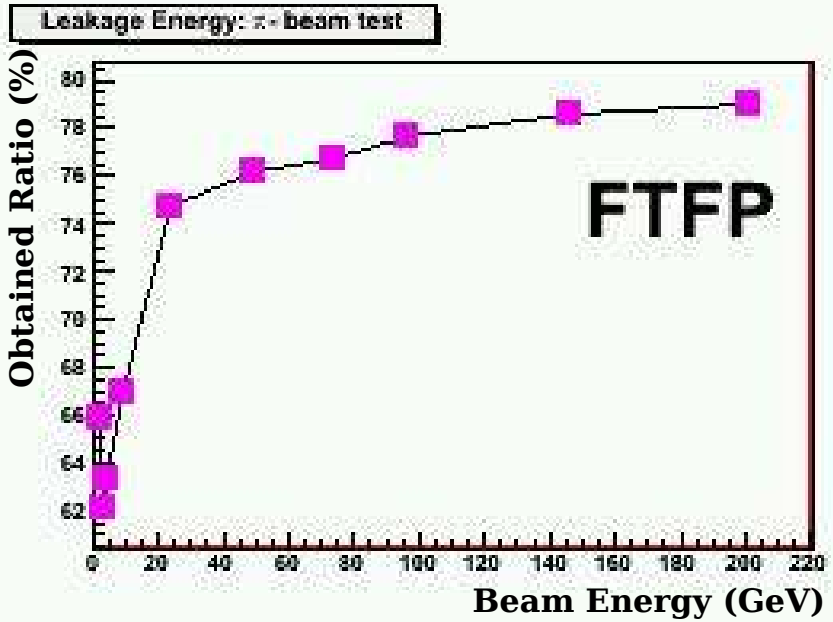


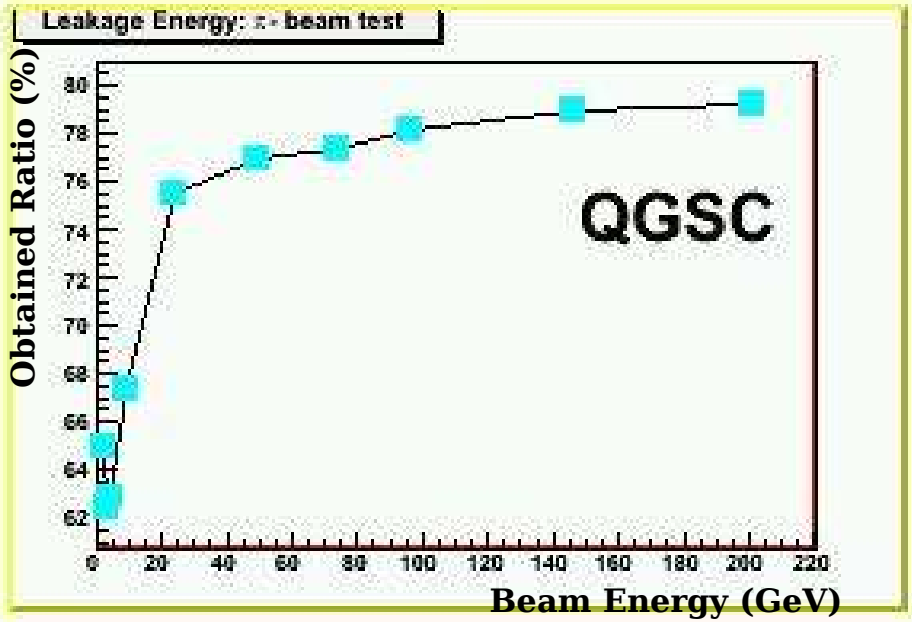
# Leakage Energy Study – pi- (standalone)

20%~30% Missing Energy

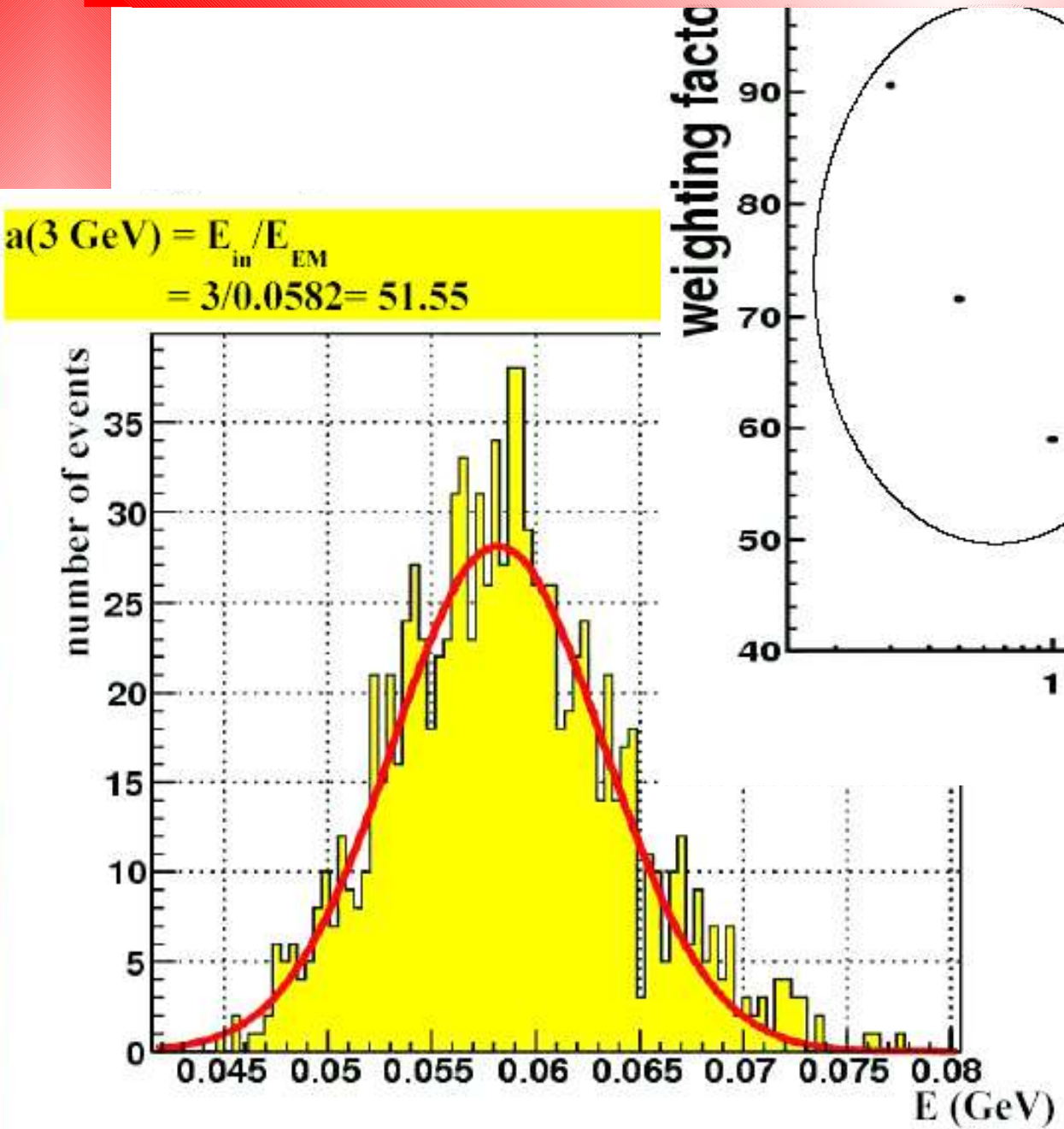


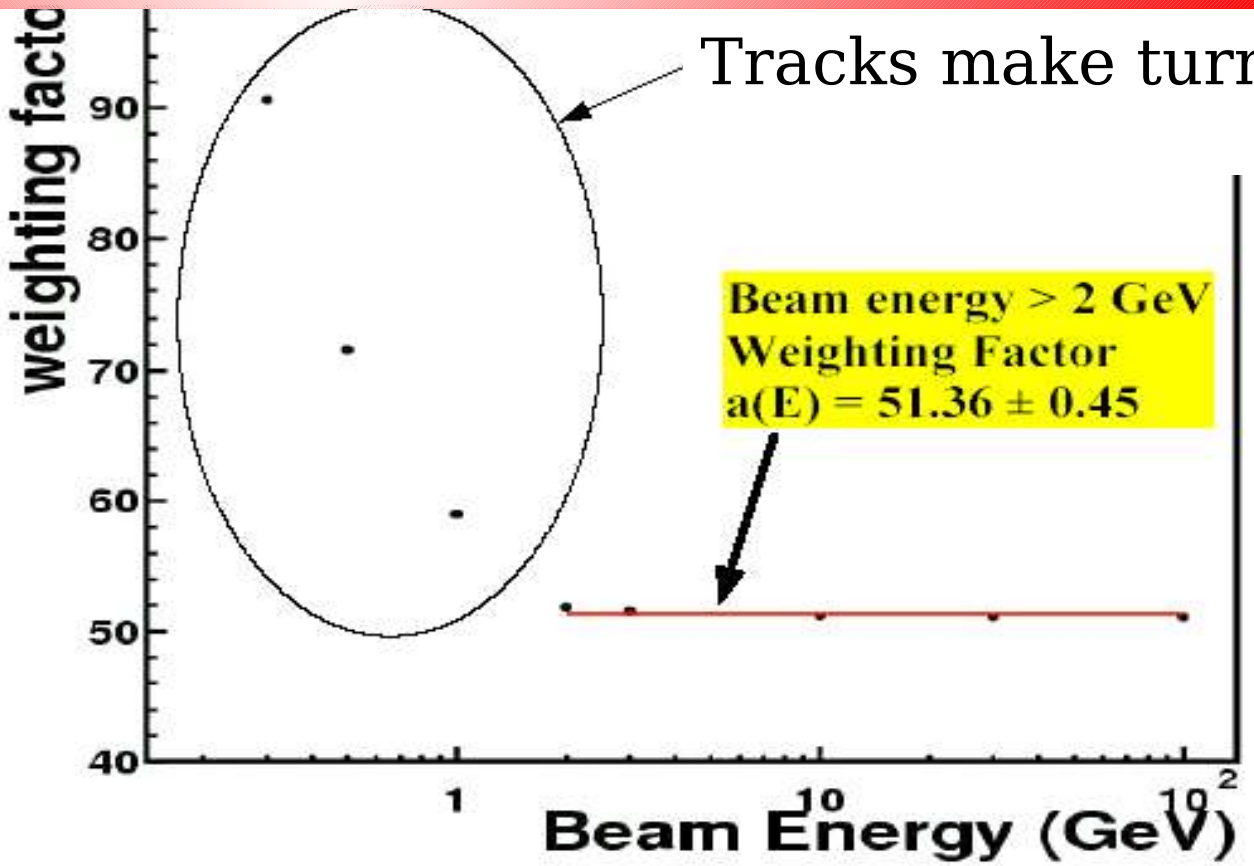



# Energy Calibration: electron



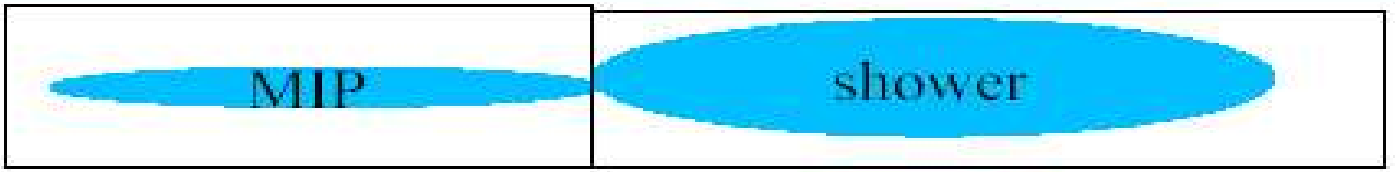
# Electron energy Calibration

## With QGSP (Jupiter): e/π ratio

$$\frac{a(E) = 51.36 \pm 0.45}{a(E) = 51.51 \pm 0.45} = 1.00 \pm 0.01$$

Counted by the average values

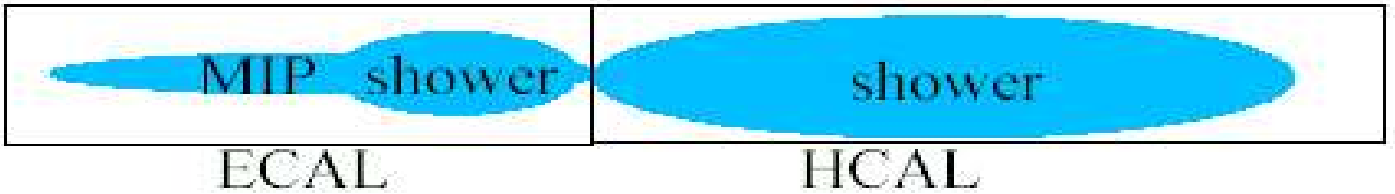
Keep MIPs in ECAL only



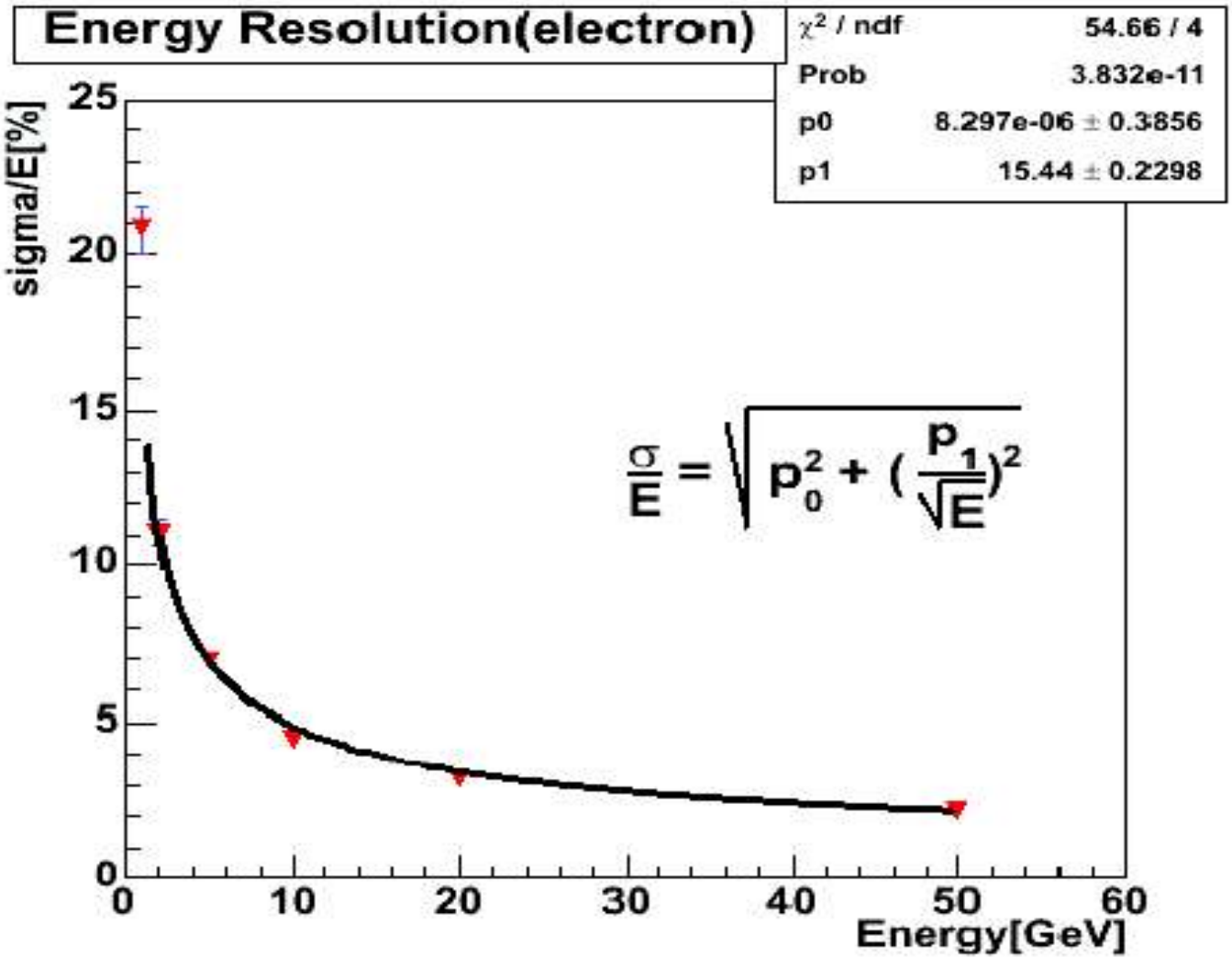

$$\frac{a(E) = 51.36 \pm 0.45}{a(E) = 46.22 \pm 0.45} = 1.11 \pm 0.02$$

Counted by the average values

All energy obtained in ECAL scintillator



# Energy Resolution: e-

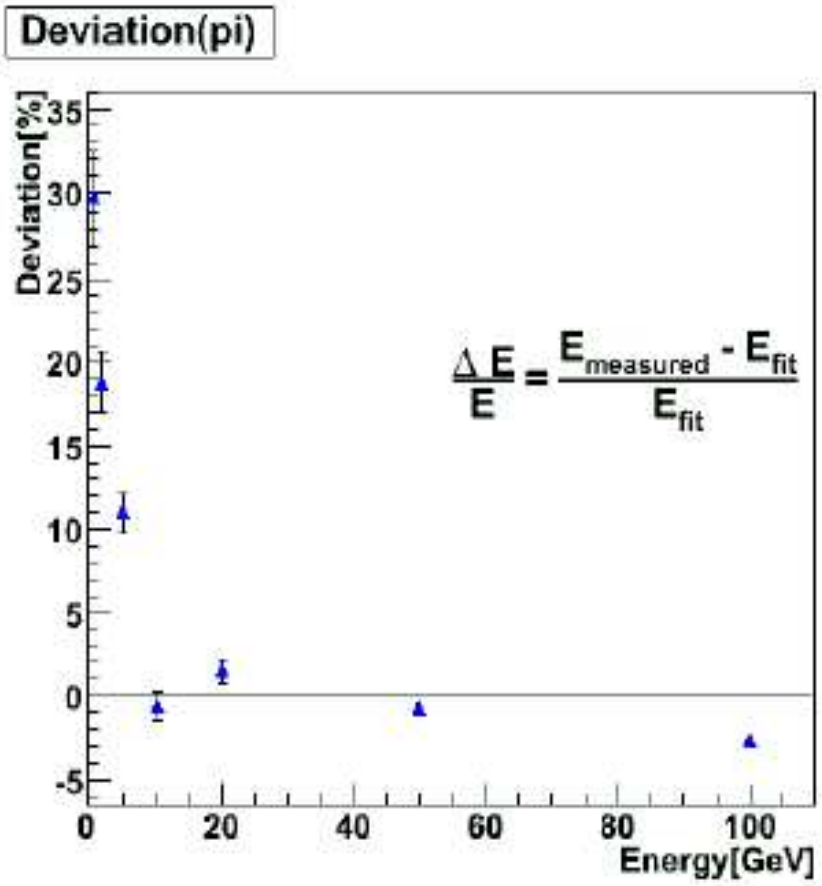


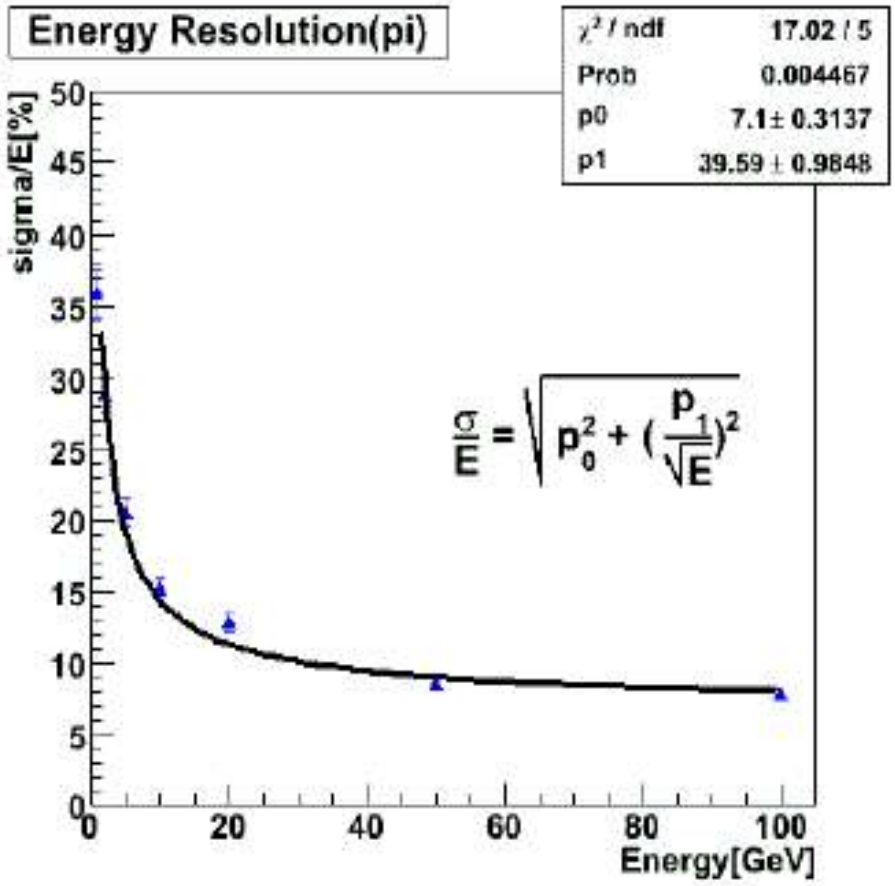

electron 1000event geant4.7.0.p01

# Energy Resolution: pi-

## Linearity and Resolution

Used QGSP



# Realistic PFA: Clustering

## *Clustering Procedure*

- Current Scheme of the realistic PFA

*1.Small Clustering* (collect fired cells with its neighbors)
- Define thrust and broadening for each small cluster.

*2. Gamma Finding* (Separate gamma/e to hadron)
- Small Cluster-based
- Tube-based

*3. Cluster-Track Matching* (Separate charged to neutral)
- Tube-based

*Note (should be fixed in near future)*
- Cheating method is used for muons.
- Assuming the remaining clusters be neutral hadrons.

Flow to make clusters

# Realistic PFA: Clustering

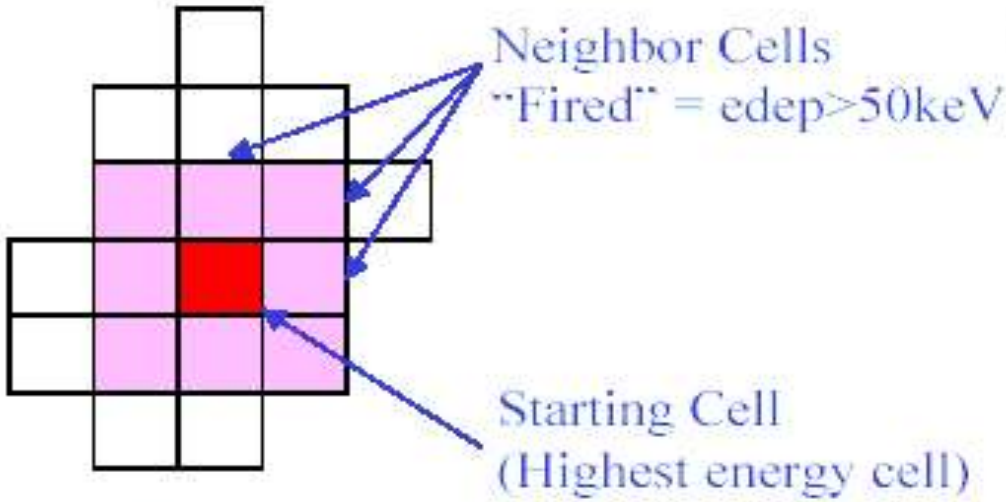
## *Small Clustering*

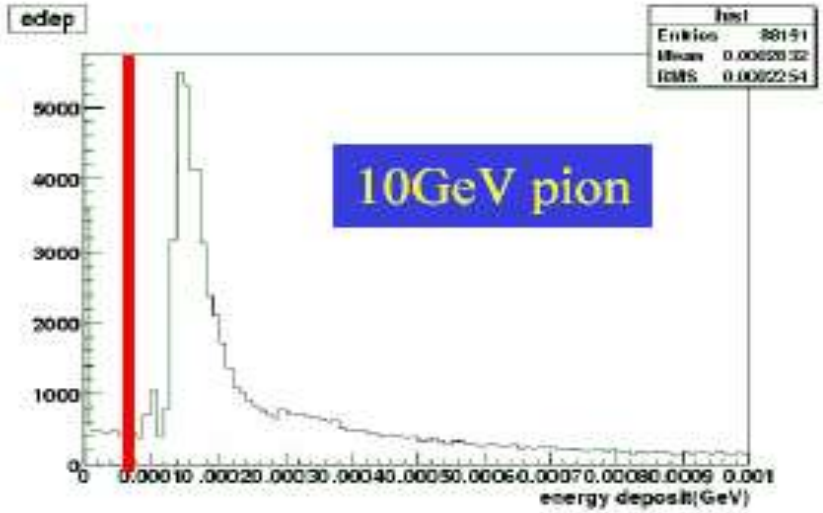
Step1 : Combined the hits into"one-hit" in one cell.

Step2 : Find the "starting cell" among those "fired cell" in ECAL and HCAL which contains the highest energy deposition.

Step3 : From the "starting cell", find its "fired" neighbor cells to form a small cluster.

Details were reported by Jeri at the GLD meeting on 2005/5/25:
http://www.awa.tohoku.ac.jp/~mechang/gld-talks/jeri-20050525.pdf



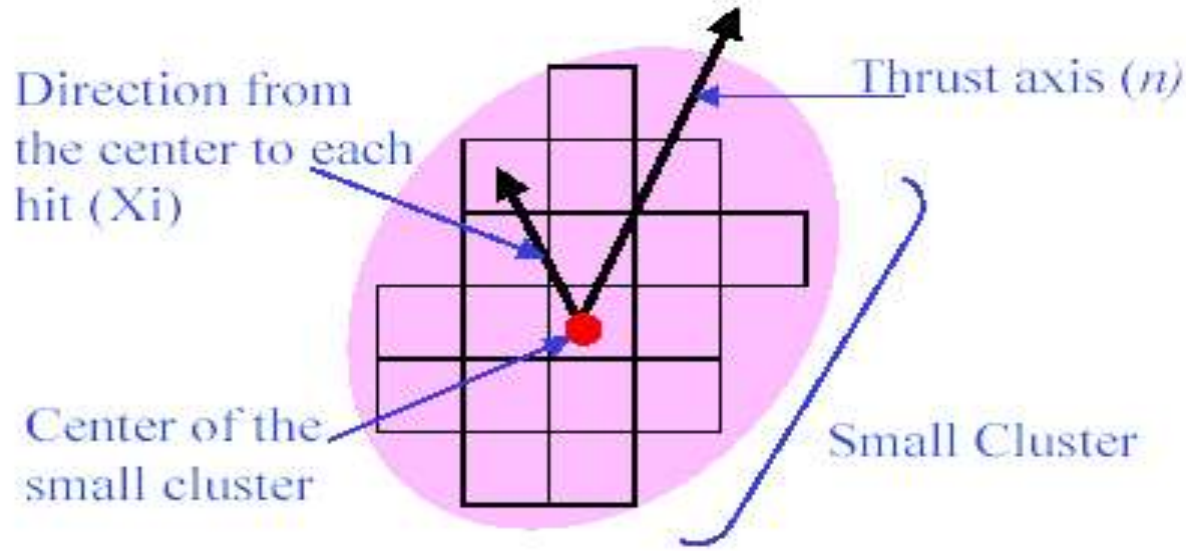
# Realistic PFA: Clustering

## *Variables for Small Cluster*

- *Energy-weighted Thrust & Broadening*

$$T \equiv \frac{\sum_i |\vec{X}_i \cdot \vec{n}| E_i}{\sum_i |\vec{X}_i|}$$

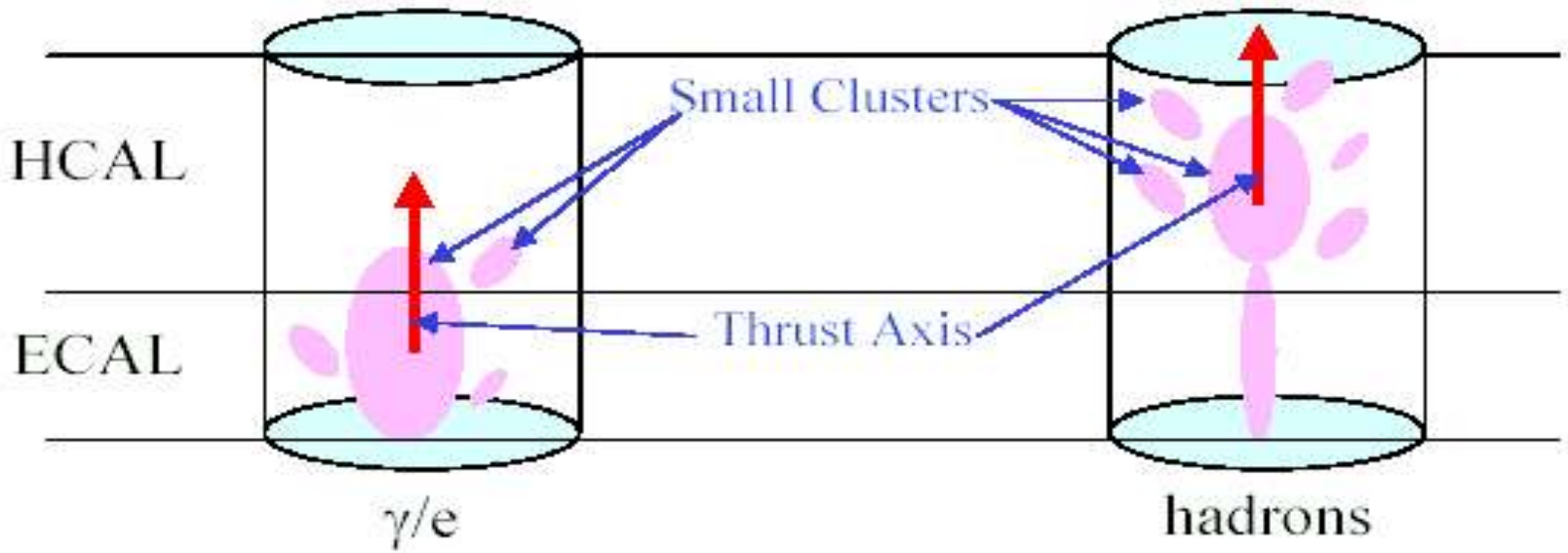
$$B \equiv \frac{\sum_i |\vec{X}_i \times \vec{n}| E_i}{\sum_i |\vec{X}_i|}$$




- Thrust axis $n$ is defined as to maximize the T.

# Realistic PFA: Clustering

## *Gamma Finder (Tube-based)*

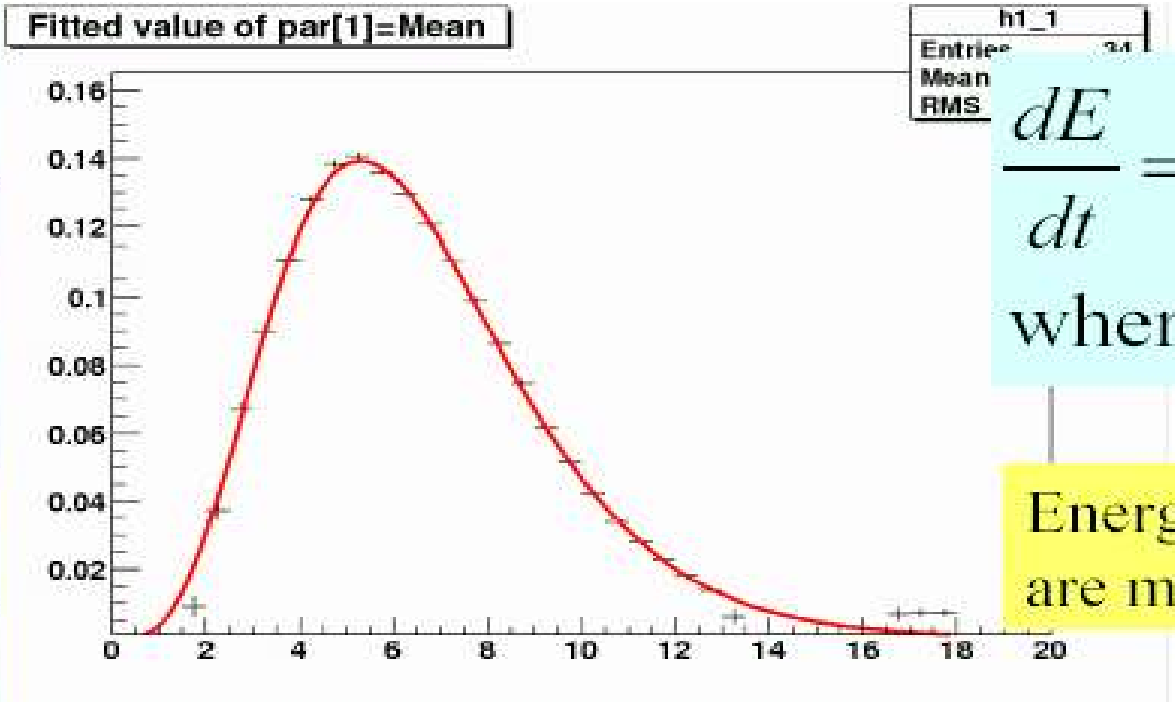



1. Find "mother" small cluster in ECAL (look for the maximum number of hit cell)
2. Make a tube along the mother thrust axis.
3. Compare energy sum between HCAL/ECAL within the tube.

# Realistic PFA: Clustering

## *Gamma Fitter (Small Cluster-based)*

- Fit the longitudinal profile of the energy deposition of small clusters as an electromagnetic cascade (gamma distribution).




$$\frac{dE}{dt} = E0 \cdot b \frac{(bt)^{a-1} \exp(-bt)}{\Gamma(a)}$$

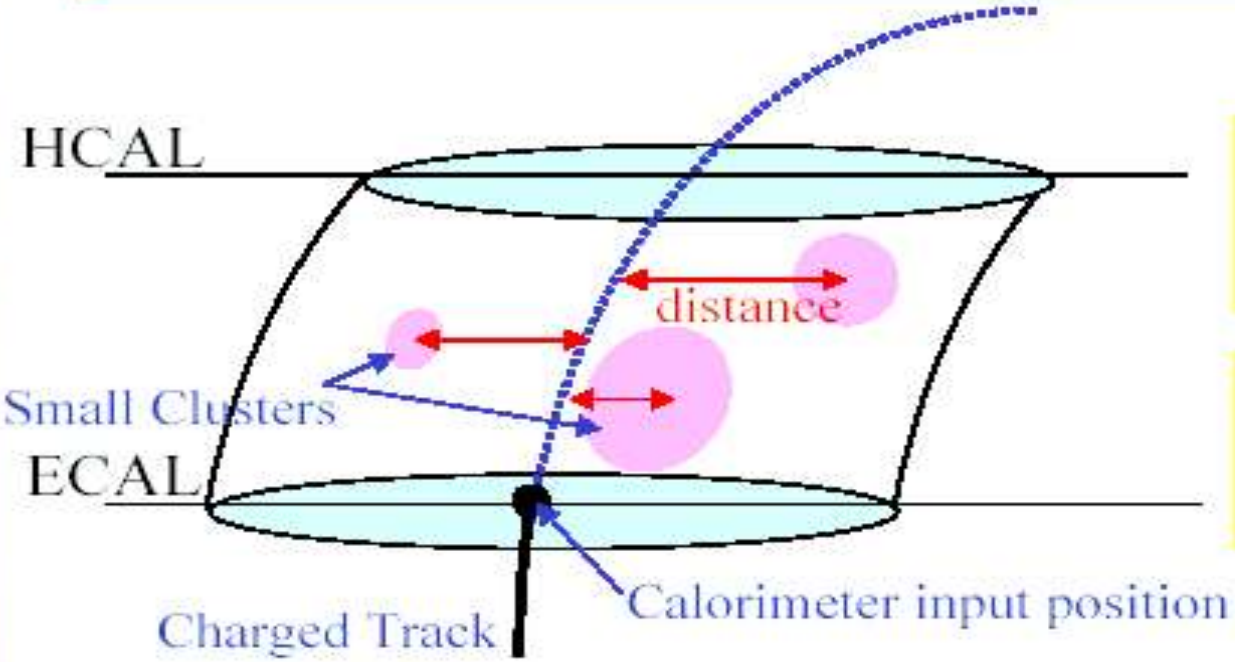
where $t = x / X_0, b \cong 0.5$

Energy deposit in three layers are merged to reduce fluctuation.

# Realistic PFA: Clustering

## *Track Matching (Tube-based)*

- Extrapolate the charged track and calculate a distance between center of small cluster and the track. Connect small cluster that in a certain tube radius.

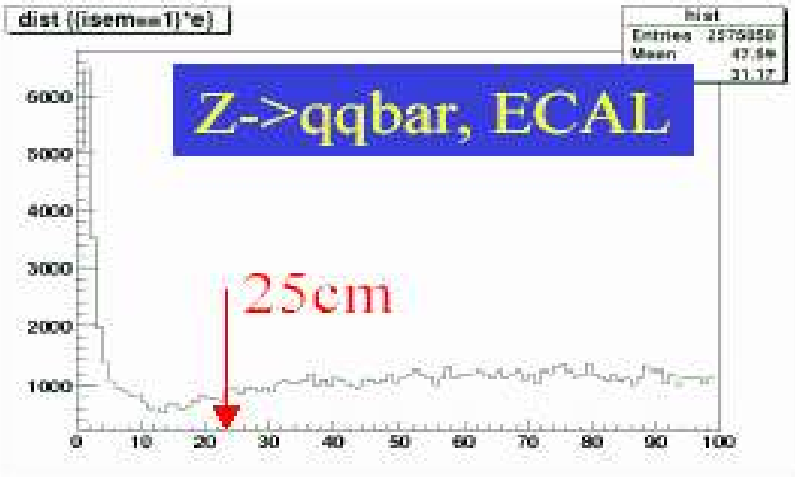


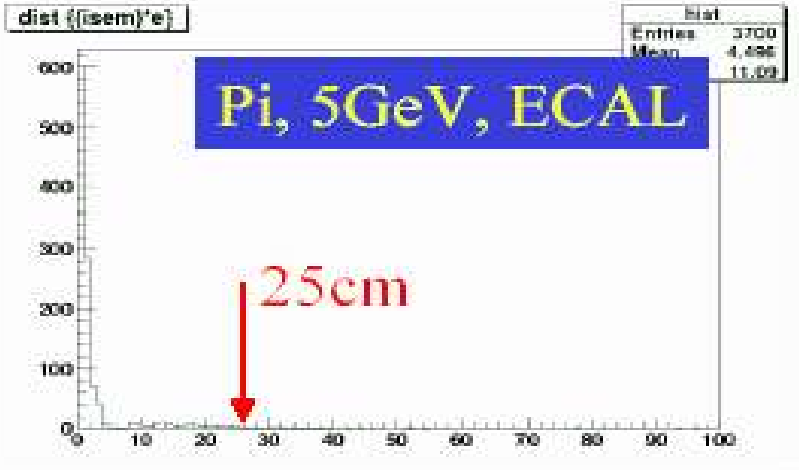

- Tube radius for ECAL and HCAL can be changed separately.

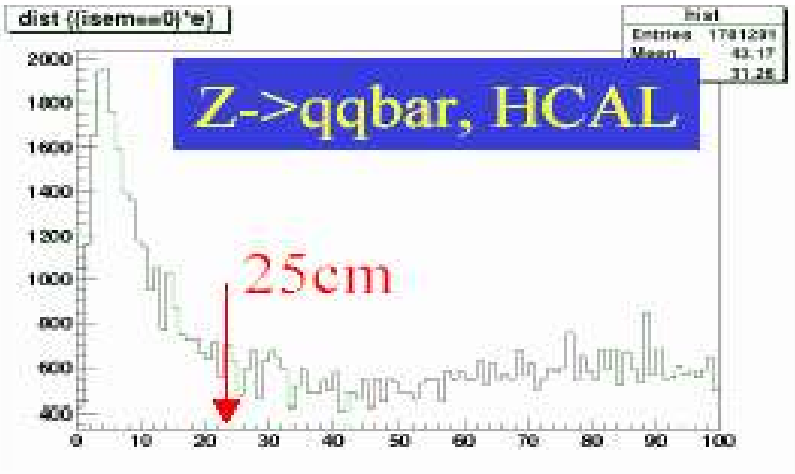
- Calculate the distance for any track/small cluster combination.

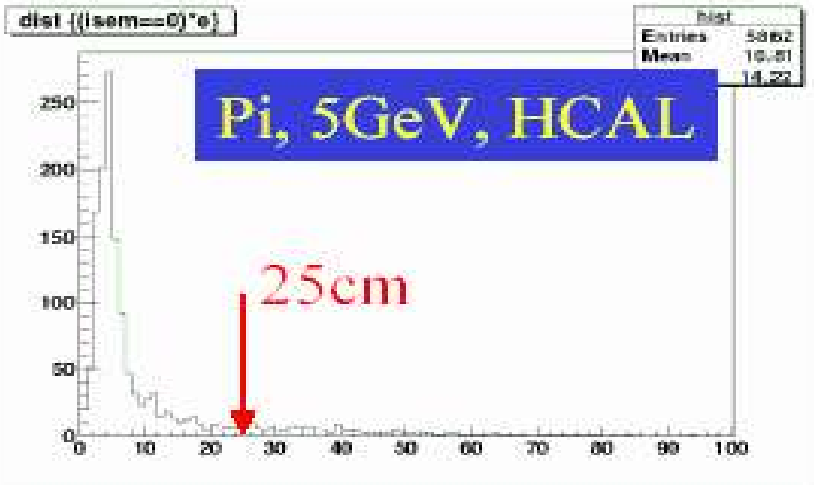
# Realistic PFA: Track-Matching

## *Distance Distribution*



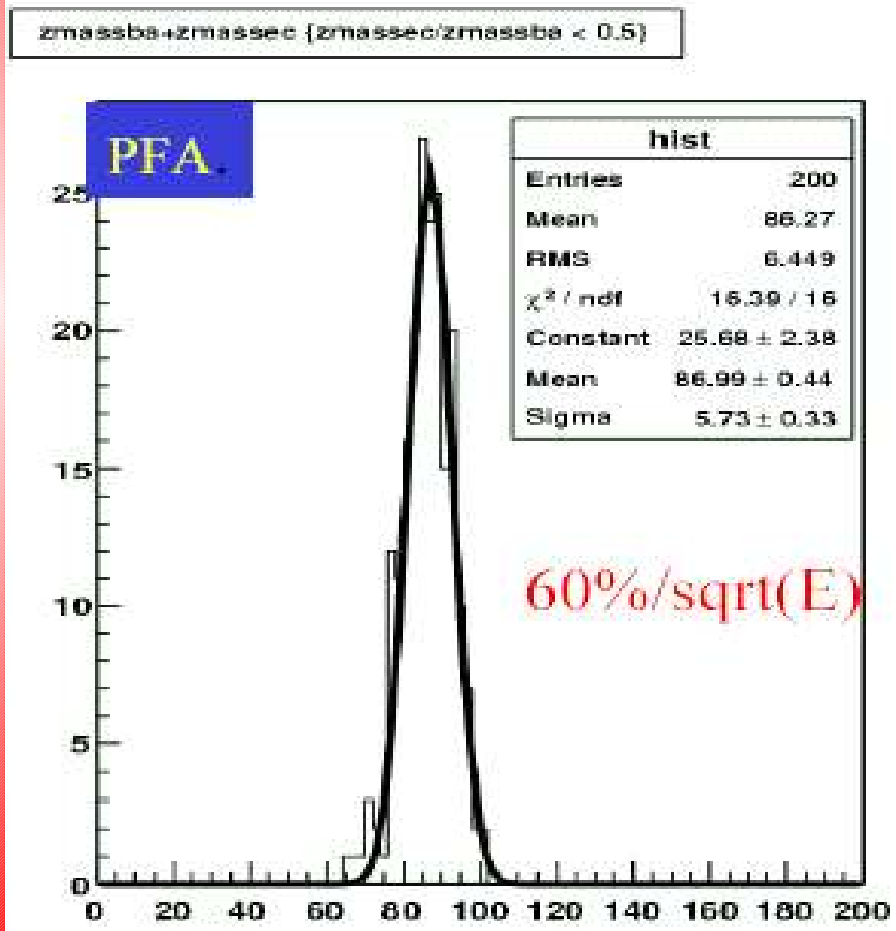



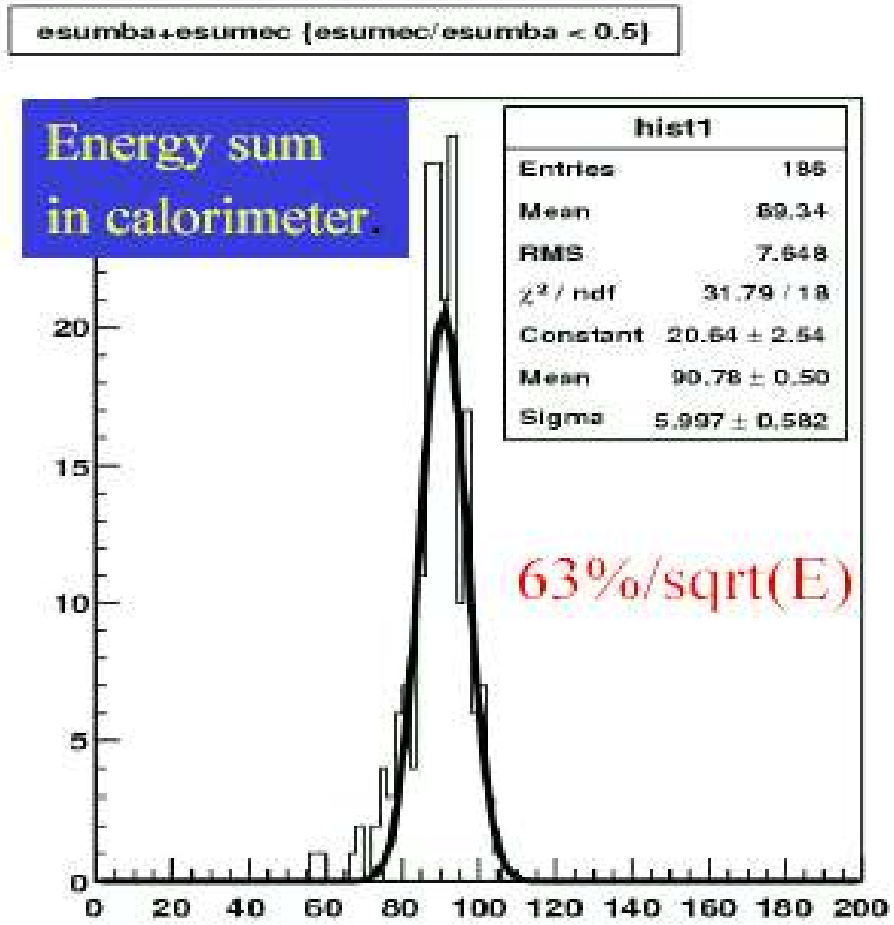



# Realistic PFA: Physics Event

## *Performance Check*

Cheated PFA: 28.3%



# Summary

## *Plan for Snowmass*

- *Till ACFA8*
  - So far, the only Barrel region was used for PFA study. Endcap region should be taken into account.
  - So far, only 4cm x 4cm cell size was used. Try at least one another cell size, say 1cm x 1cm.
  - Gamma Finding algorithm study – efficiency study.
  - Track/cluster matching algorithm study.
- *Till Snowmass*
  - Calorimeter segmentation vs. resolution.
  - Material study.
  - Digital cal. and Strip cal. studies.
  - Magnetic field study.
- *Goal at Snowmass*
  - Complete the realistic PFA and determine the magnetic field, radius, length and granularity.