Calorimeter segmentation and PFA performance

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LAL Orsay Software Meeting

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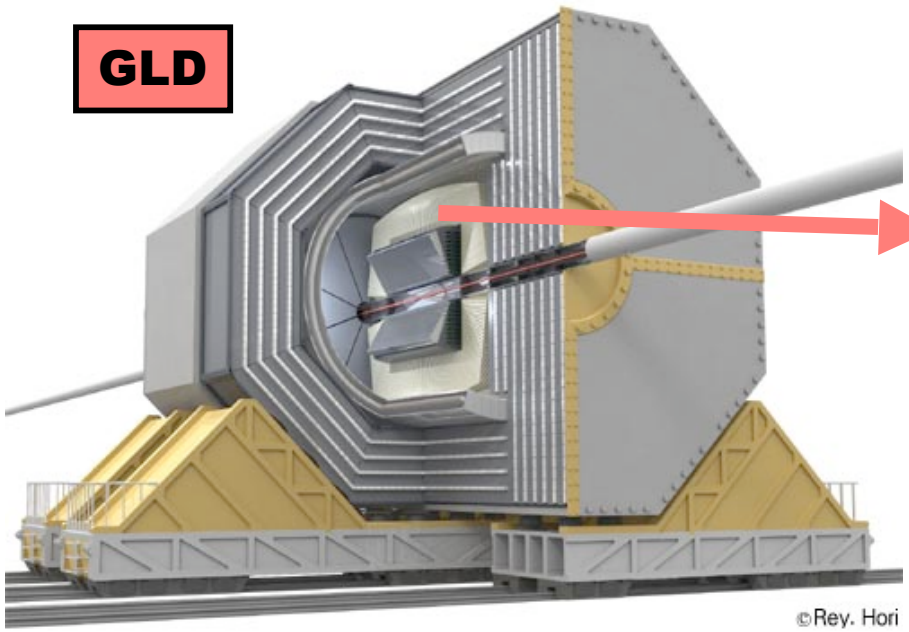
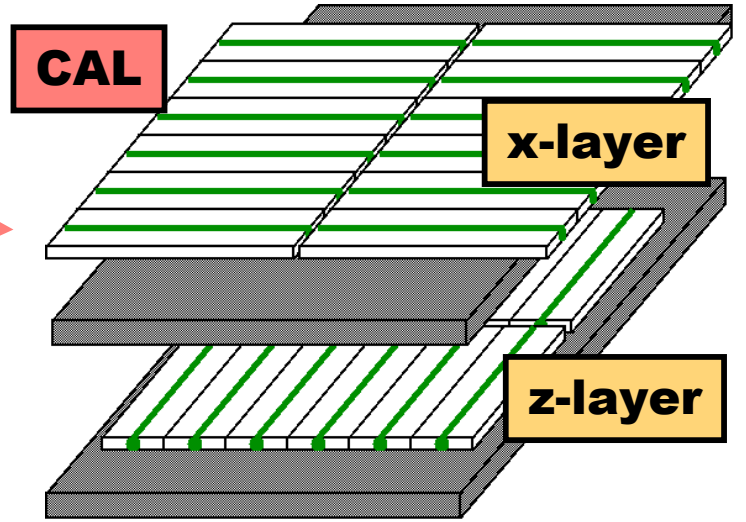
About GLD (Global Large Detector)

- GLD(Global Large Detector) is a large radius tracker and calorimeter based detector concept to achieve the better jet energy resolution.

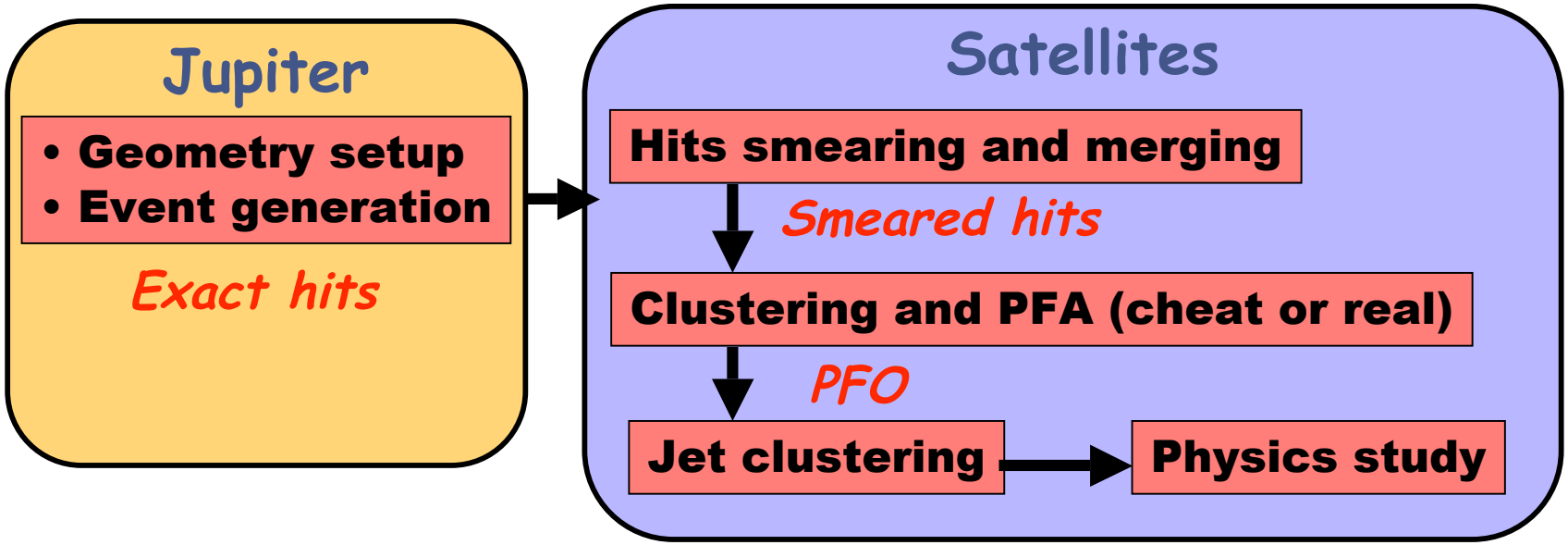




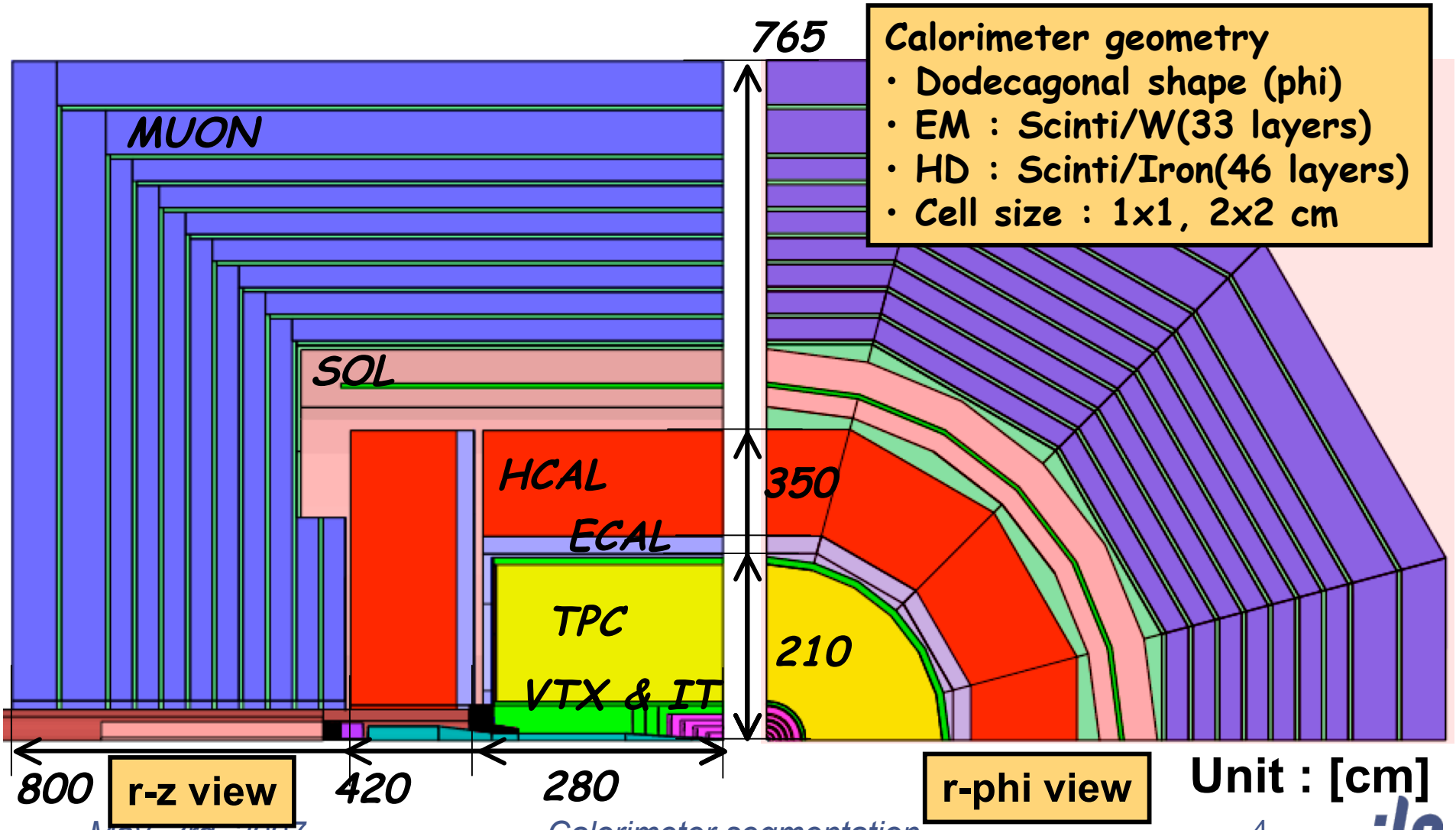
Scintillator based calorimeter with MPPC R/O

Full simulator analysis scheme

- GLD full simulator is composed by followings
  - ROOT based steering framework : *JSF*
  - Geant4 based event generator : *Jupiter*
  - ROOT based analysis tools : *Satellites*

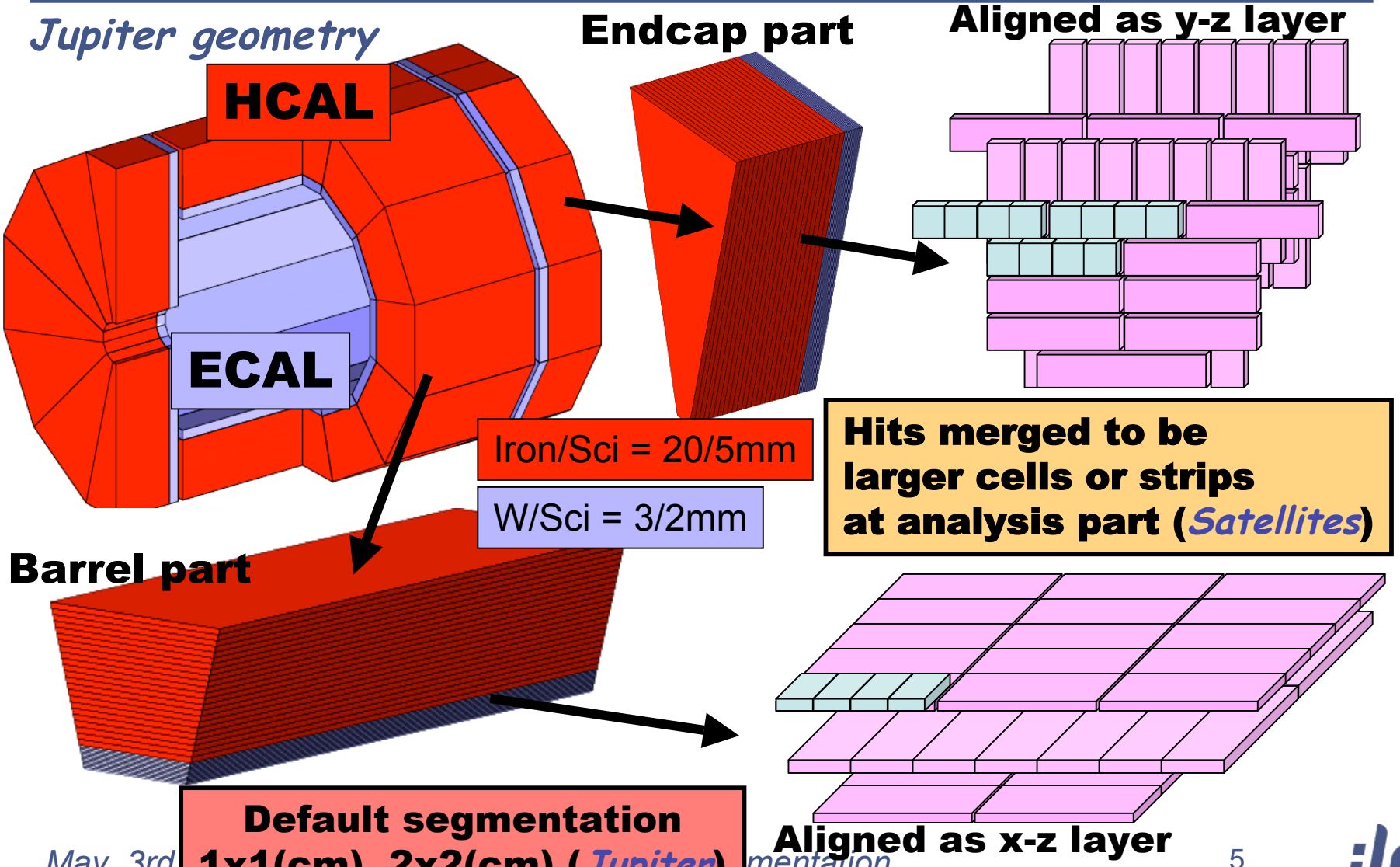


GLD Full Simulator Geometry (Jupiter)



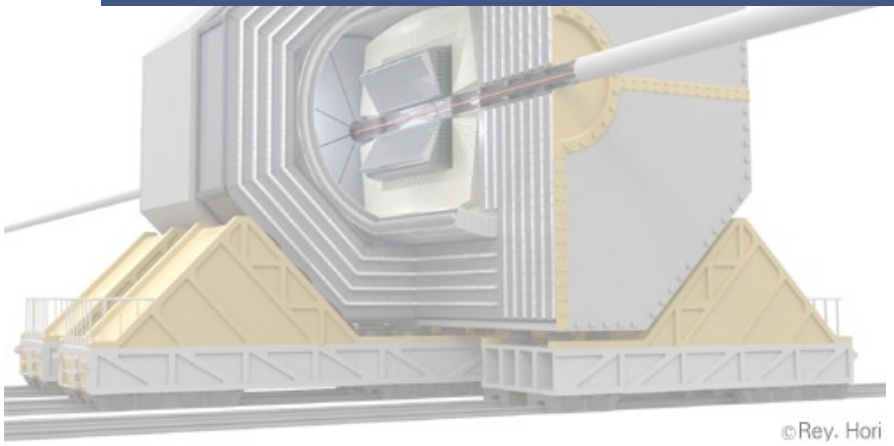
Calorimeter geometry
- Dodecagonal shape (phi)
- EM : Scinti/W(33 layers)
- HD : Scinti/Iron(46 layers)
- Cell size : 1x1, 2x2 cm

Calorimeter geometry in Jupiter



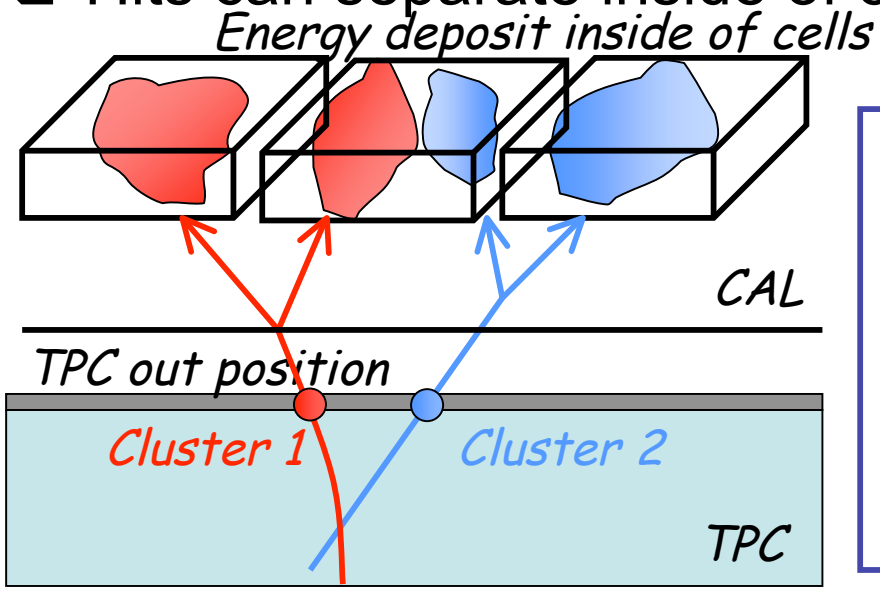
Default segmentation 1x1(cm), 2x2(cm) (*Jupiter*)

Z -> qq study with Cheated PFA



Cheated PFA (Perfect clustering)

- Different mother particle's CAL hits have been clustered as different cluster (***perfect clustering***).
- Use track information for charged particle and remove charged track related cluster from CAL. (PFA)
- Hits can separate inside of cell (***Infinite segmentation***)



Switch merging at Satellites

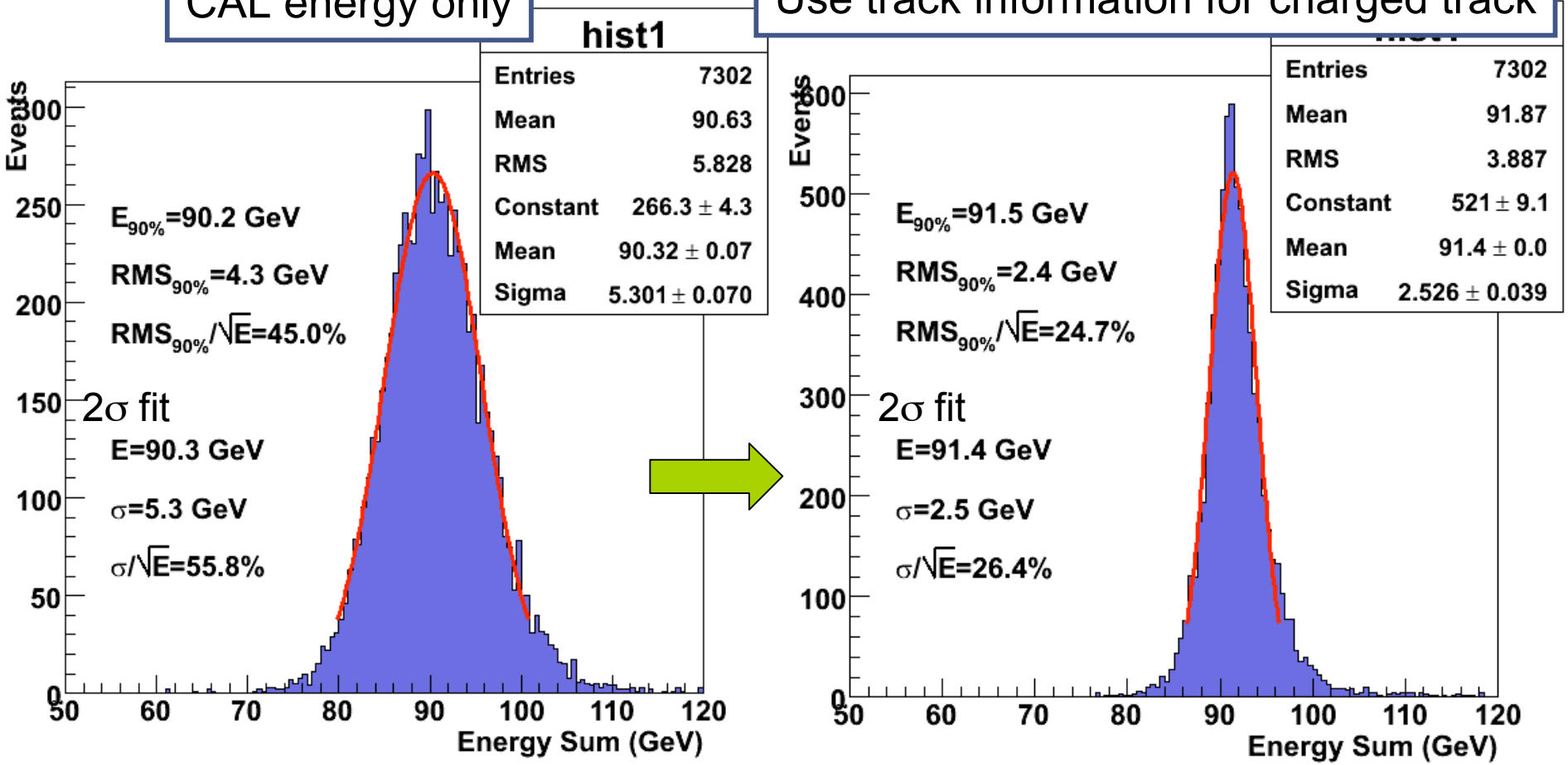
- Not merged:
  - Infinite segmentation
- Merge hits:
  - Merge hits inside of the cell and mother particle is assigned as largest energy deposit

Cheated PFA performance

(Z->qq(uds) E_{cm}=91.2 GeV, Infinite segmentation)

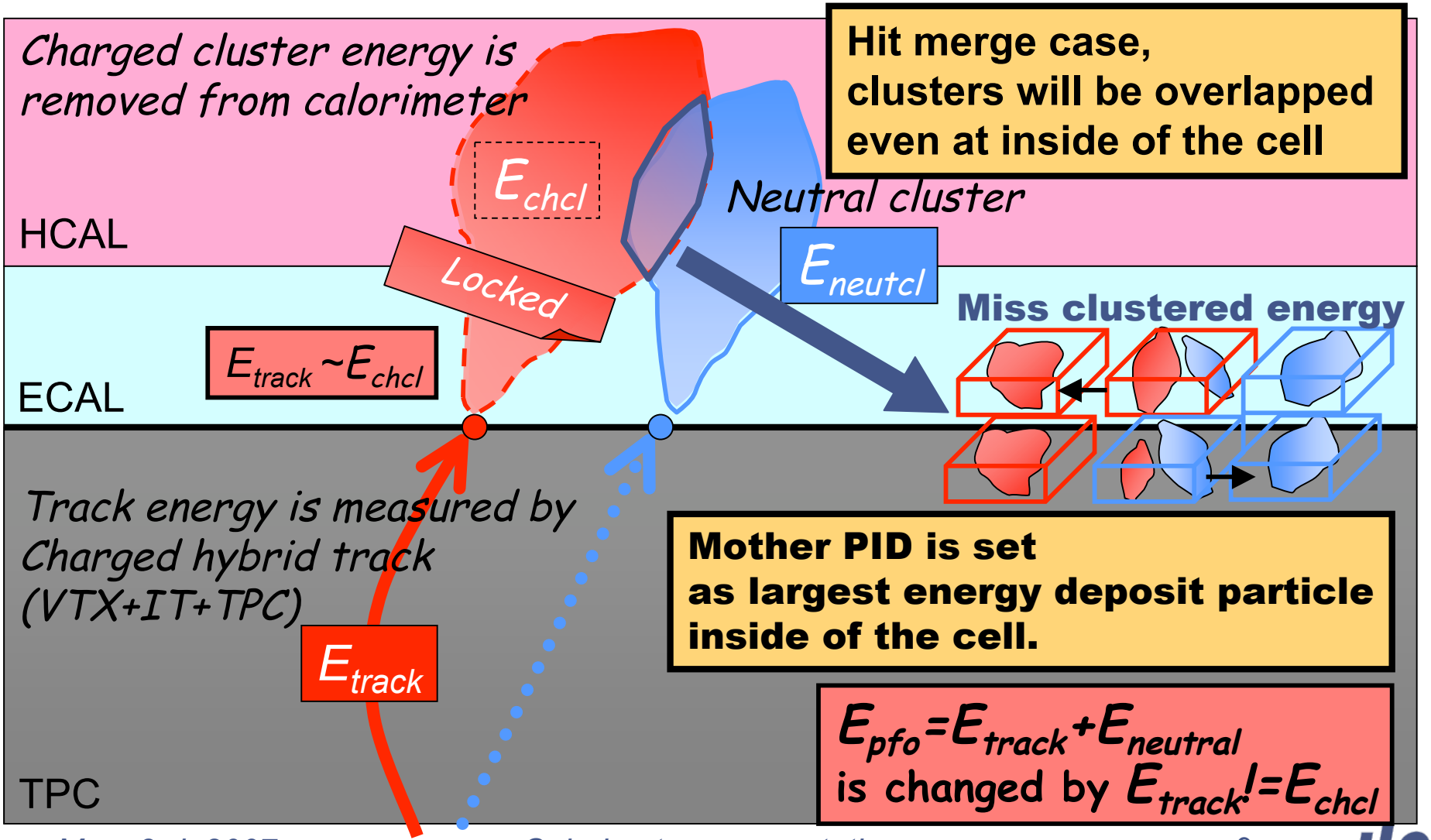
CAL energy only

Use track information for charged track



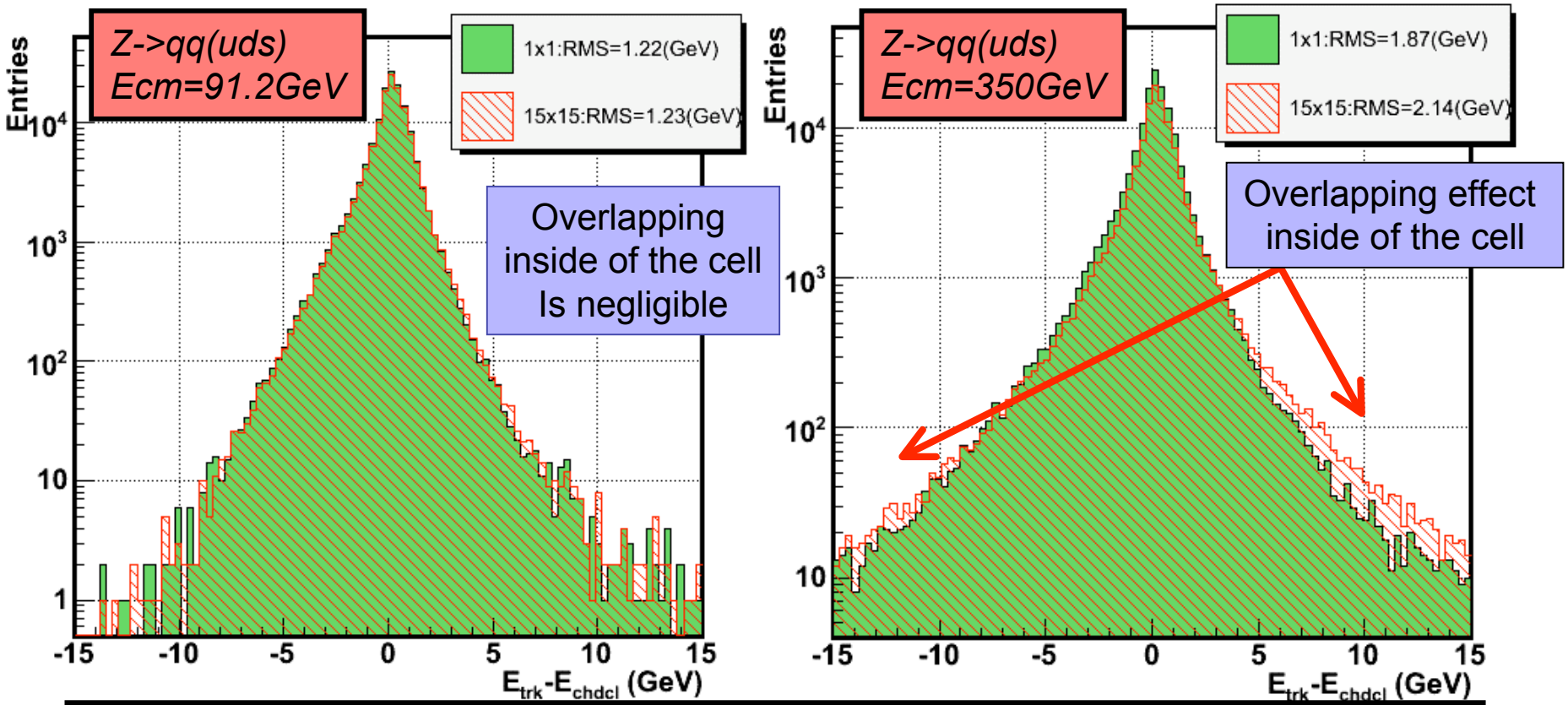
This resolution includes calibration uncertainty, calorimeter resolution

Charged and neutral cluster overlap after hits merging



Energy difference of charged cluster and track energy

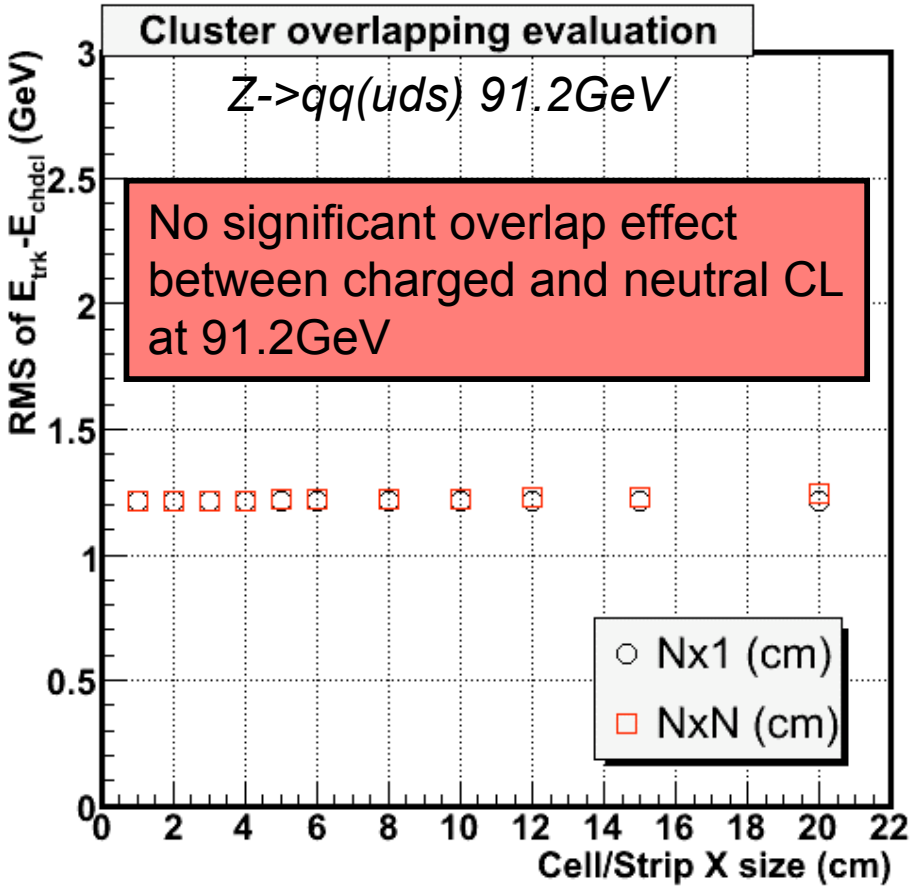
Difference of track and charged cluster energy (E_{trk}-E_{chdcl}) will change because of *cluster overlapping between charged* and *neutral cluster* inside of the cell.

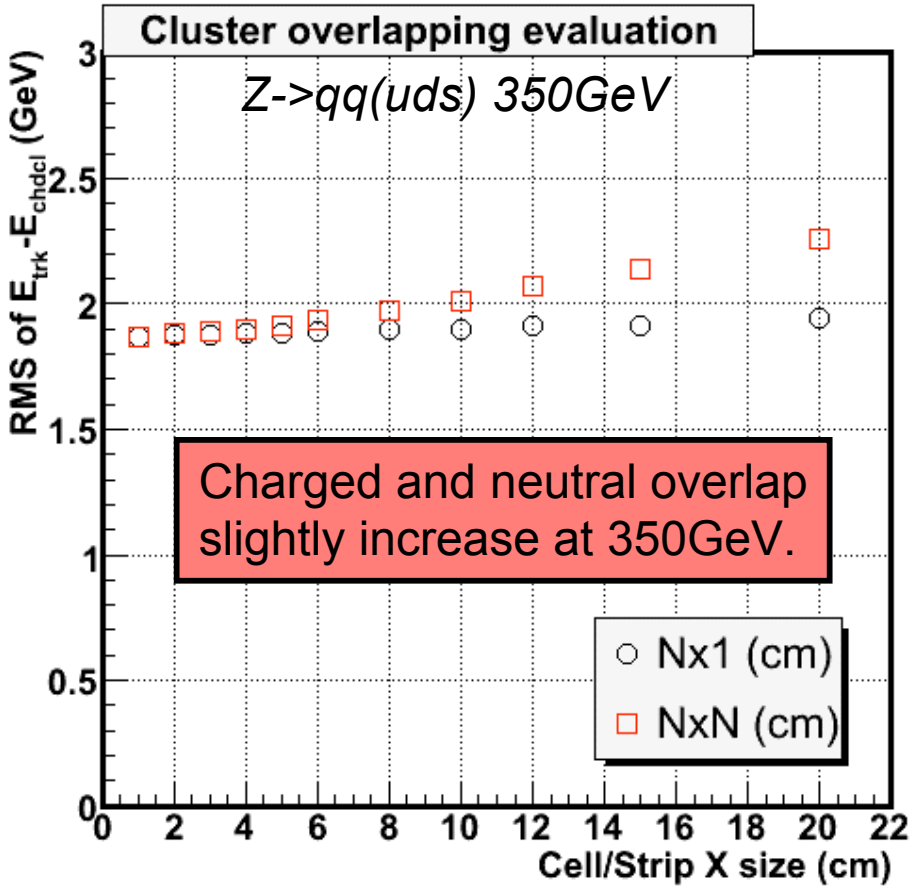


Energy difference between charged track and charged cluster is caused by cluster overlapping with neutral cluster

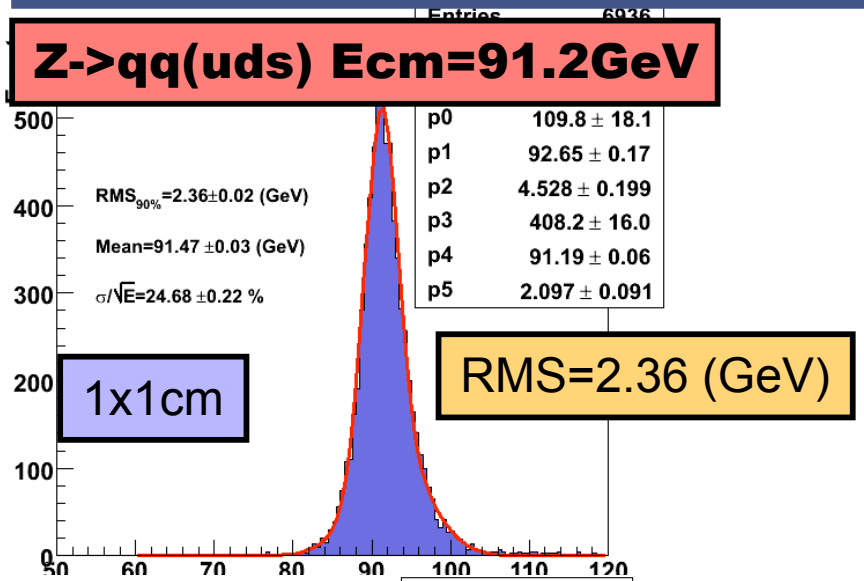
Cluster overlapping effect at several segmentations

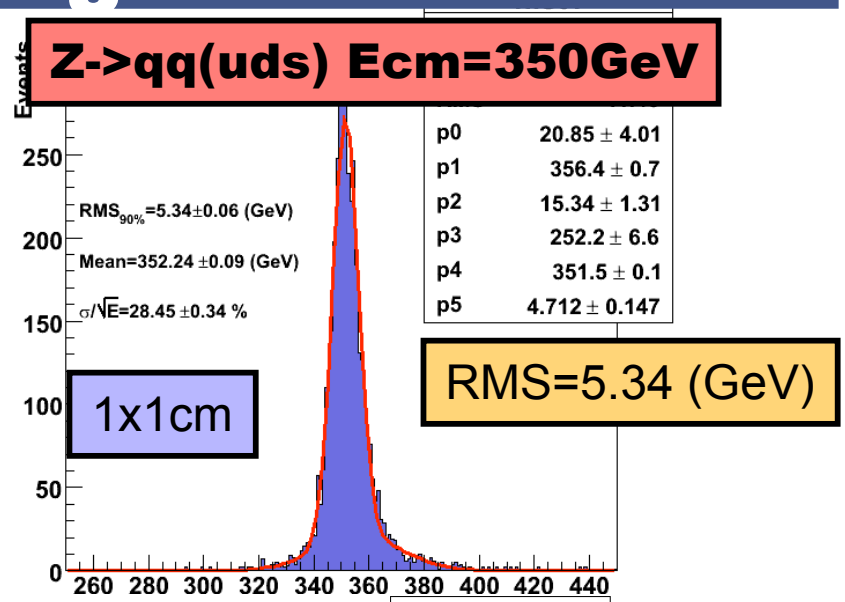
- Vertical : RMS of E_{track} and related $E_{cluster}$ difference (E_{trk}-E_{chdcl})
- Horizontal : Segmentation of calorimeter (nxn(cm)=cell, nx1(cm)=strip)

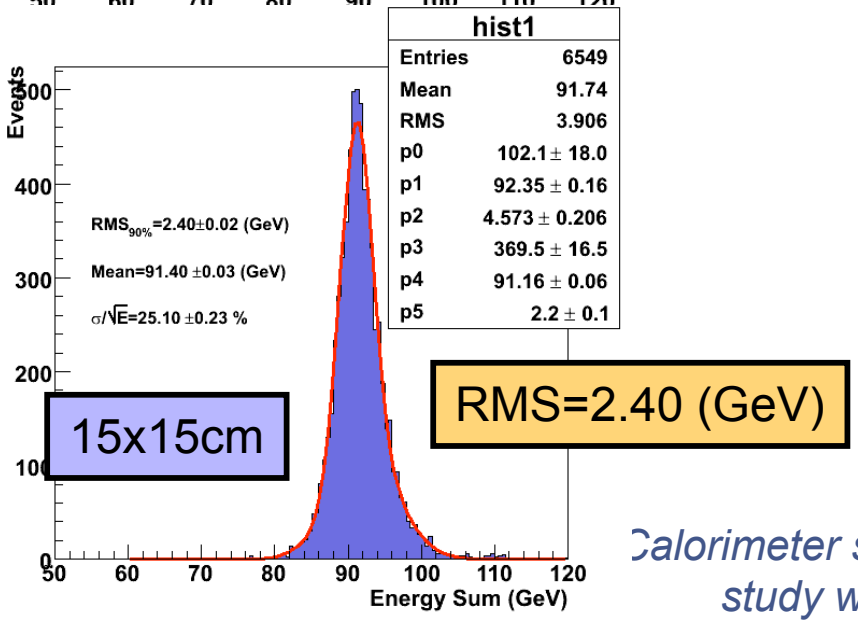


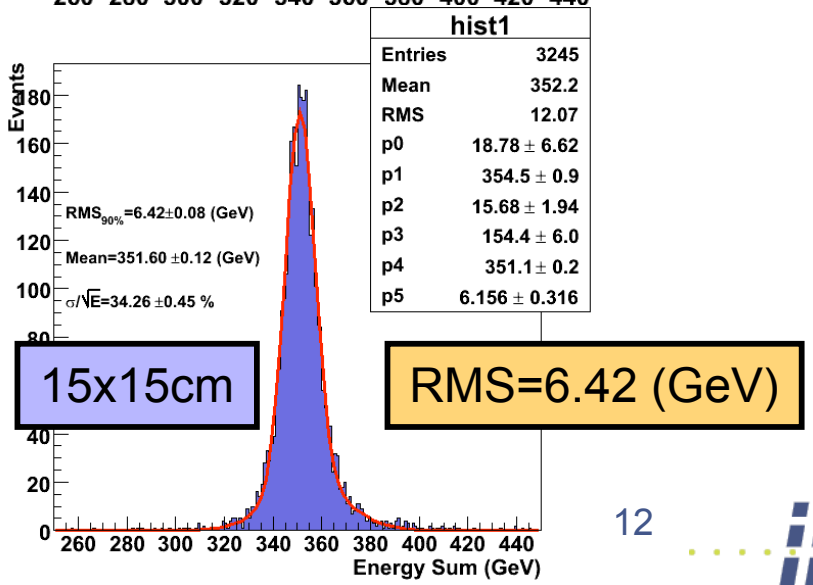


Jet energy distribution with different segmentations



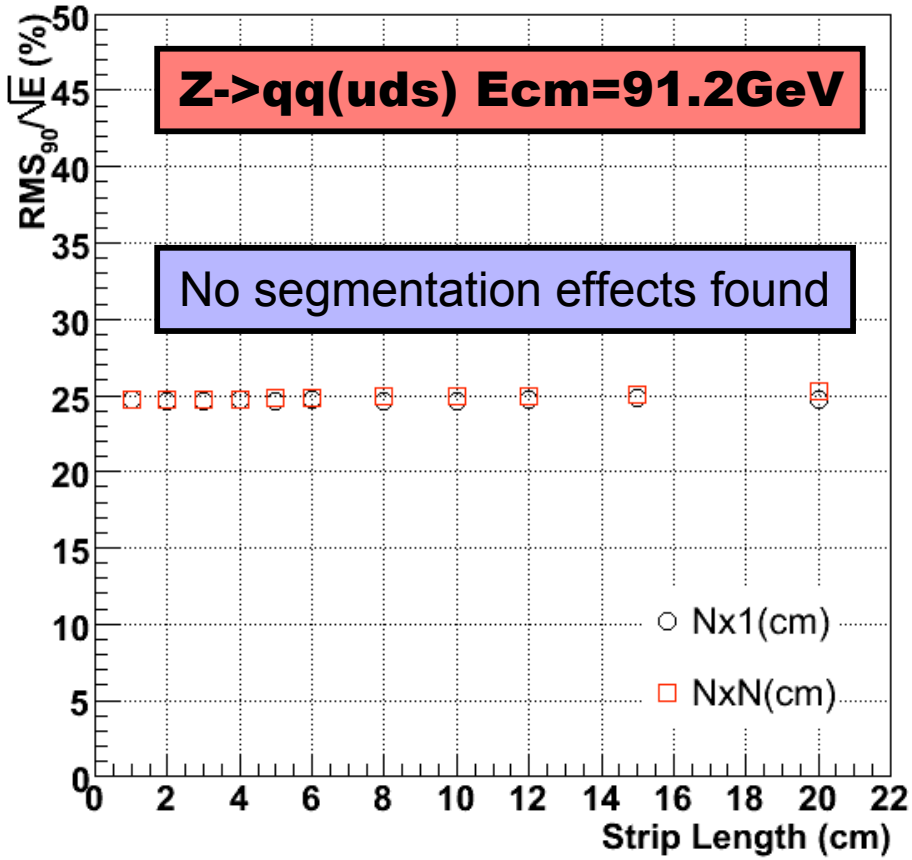


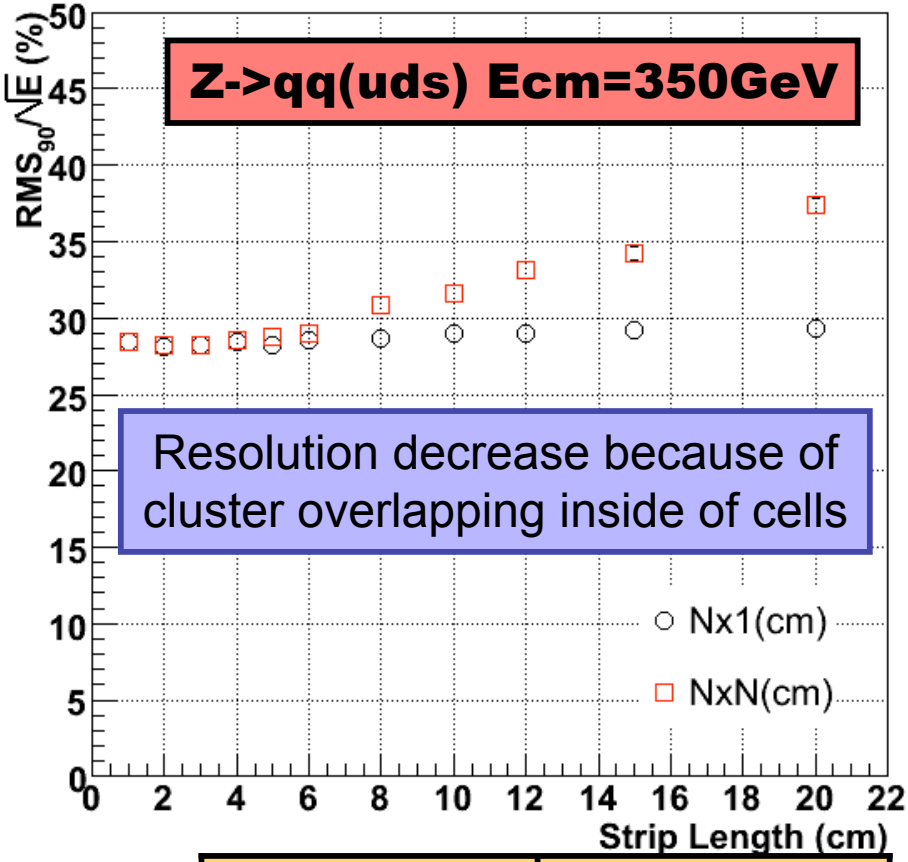




Calorimeter seg
study with . . . .

Cheated PFA jet resolution with several segmentations

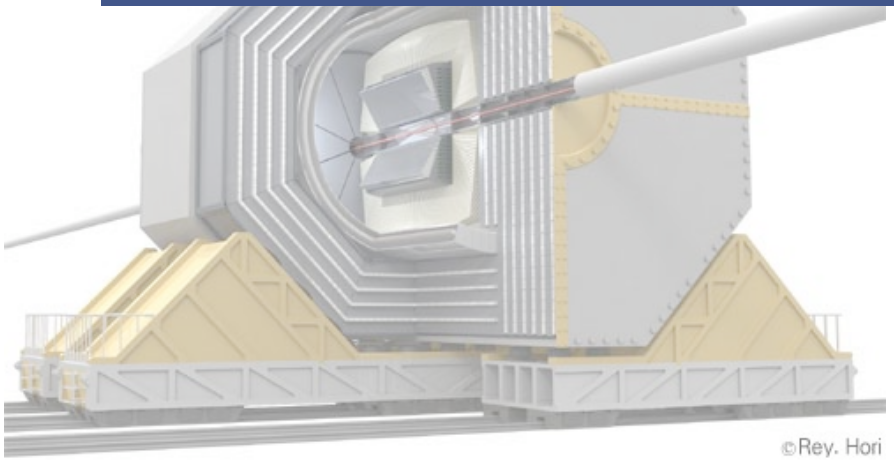




1x1(cm)	24.7 ± 0.2%
5x5(cm)	24.8 ± 0.2%
10x10(cm)	25.0 ± 0.2%

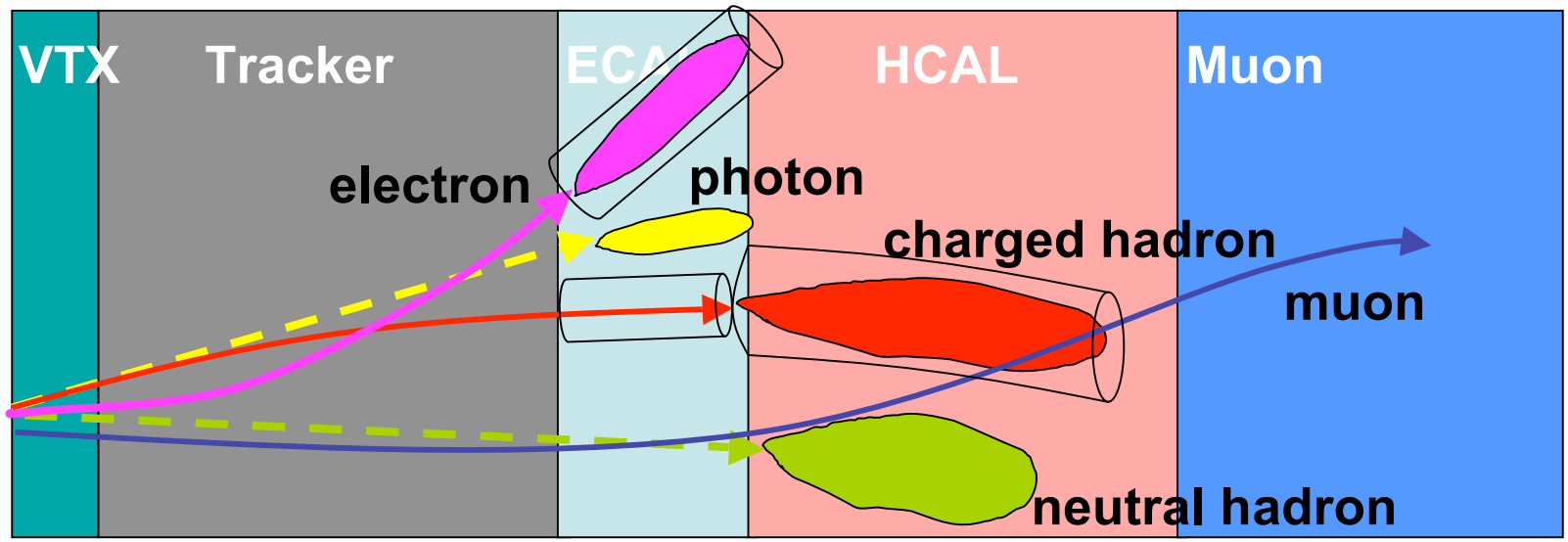
1x1(cm)	28.4 ± 0.3%
5x5(cm)	28.8 ± 0.3%
10x10(cm)	31.6 ± 0.4%

Z -> qq study with Realistic PFA



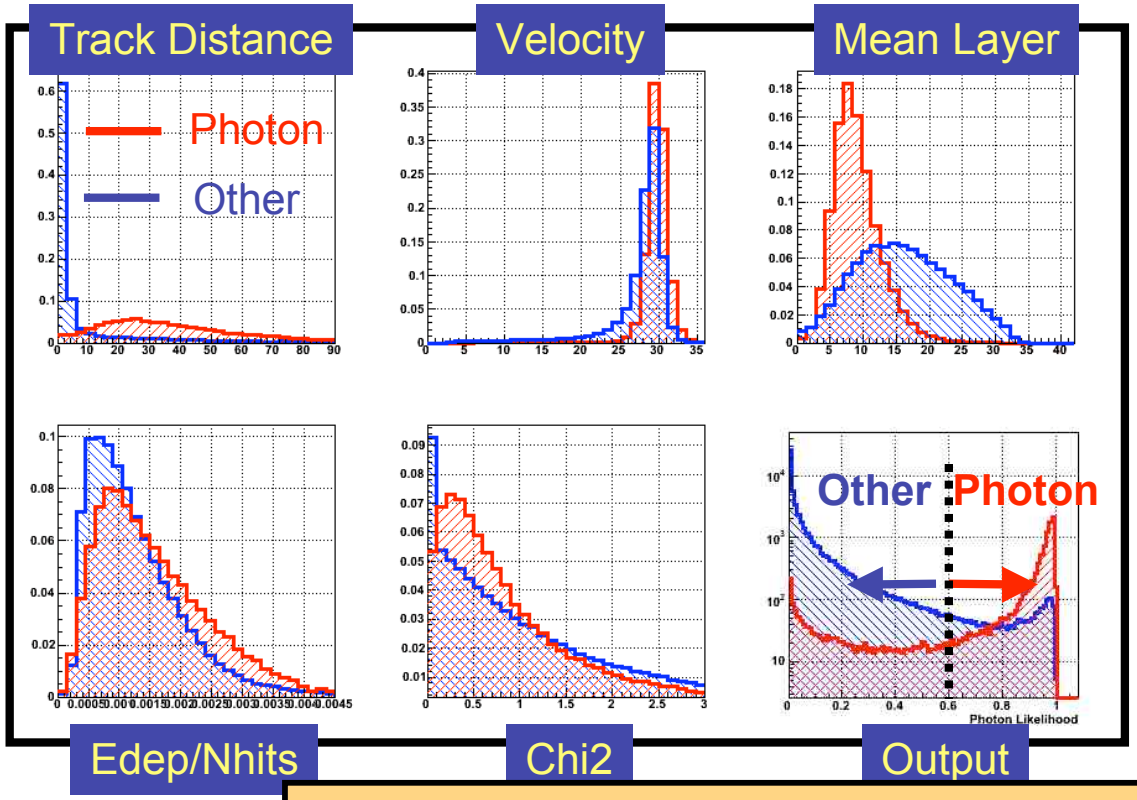
Realistic GLD-PFA scheme

1. Small clustering (Nearest neighboring method)
2. Photon finding. (Likelihood method)
3. Charged particle finding.
4. Neutral hadron finding. (Likelihood method)
5. Other satellite hits. (Muon use true hits)

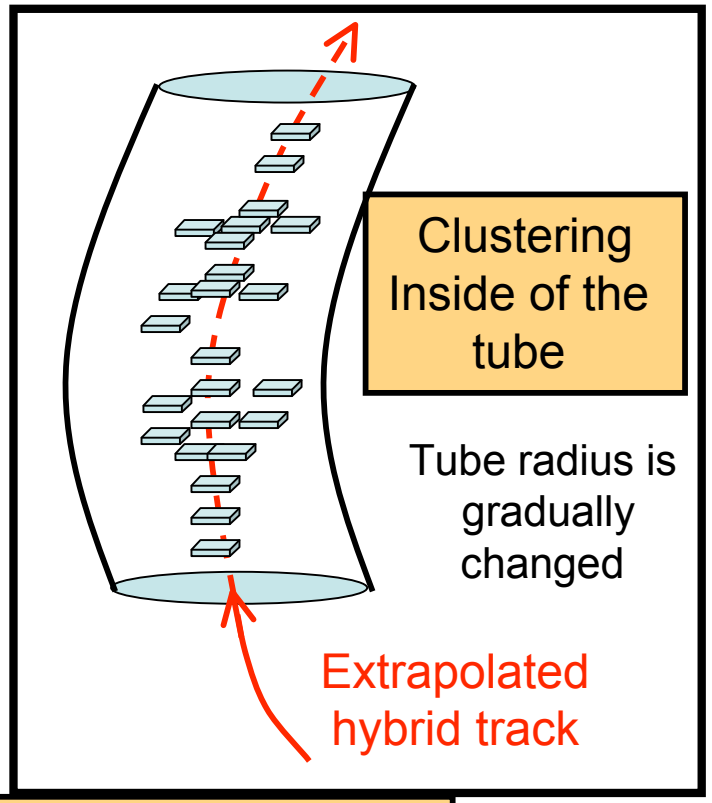


Detail of the GLD-PFA

Photon Likelihood



Track-Cluster matching



Neutral hadron use same scheme as photon
Detail might be talked from T.Yoshioka-san.

Realistic PFA performance test

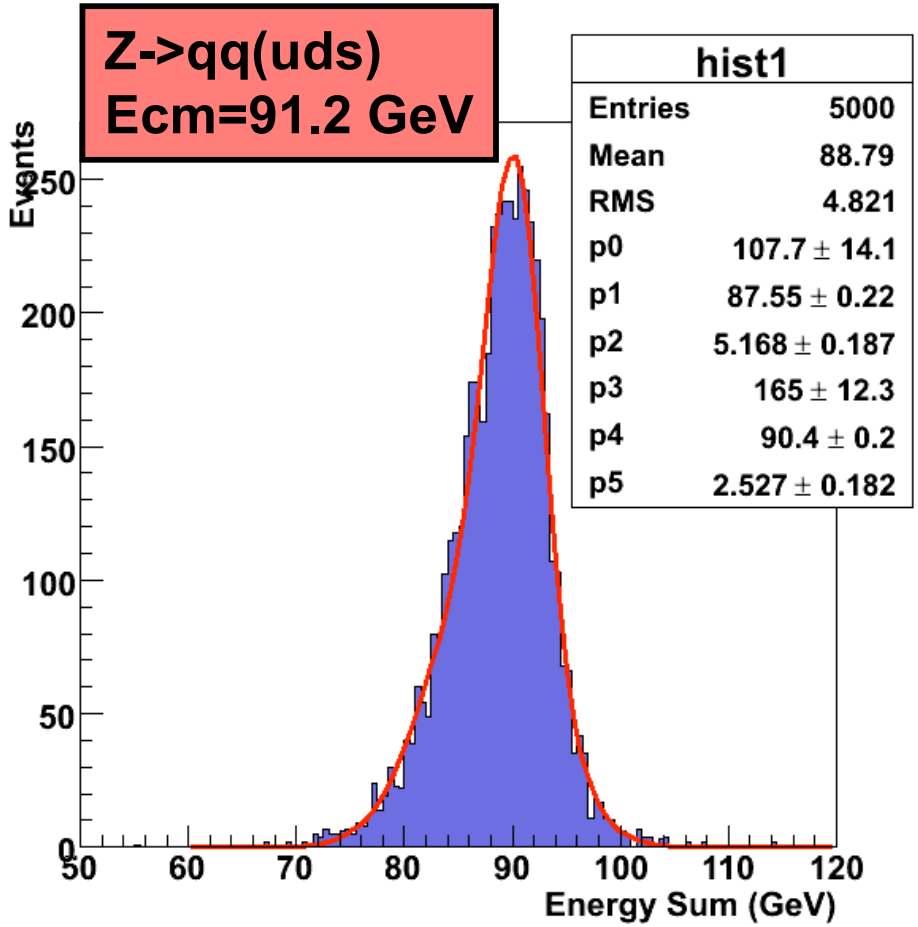
e^+e^-->Z->qq(uds)

Ecm= 91.2, 350 GeV

Variation of cell size
- 1cmx1cm
- 2cmx2cm
- 4cmx4cm
- 5cmx5cm
- 10cmx10cm

Strip size use Ncm x 1cm

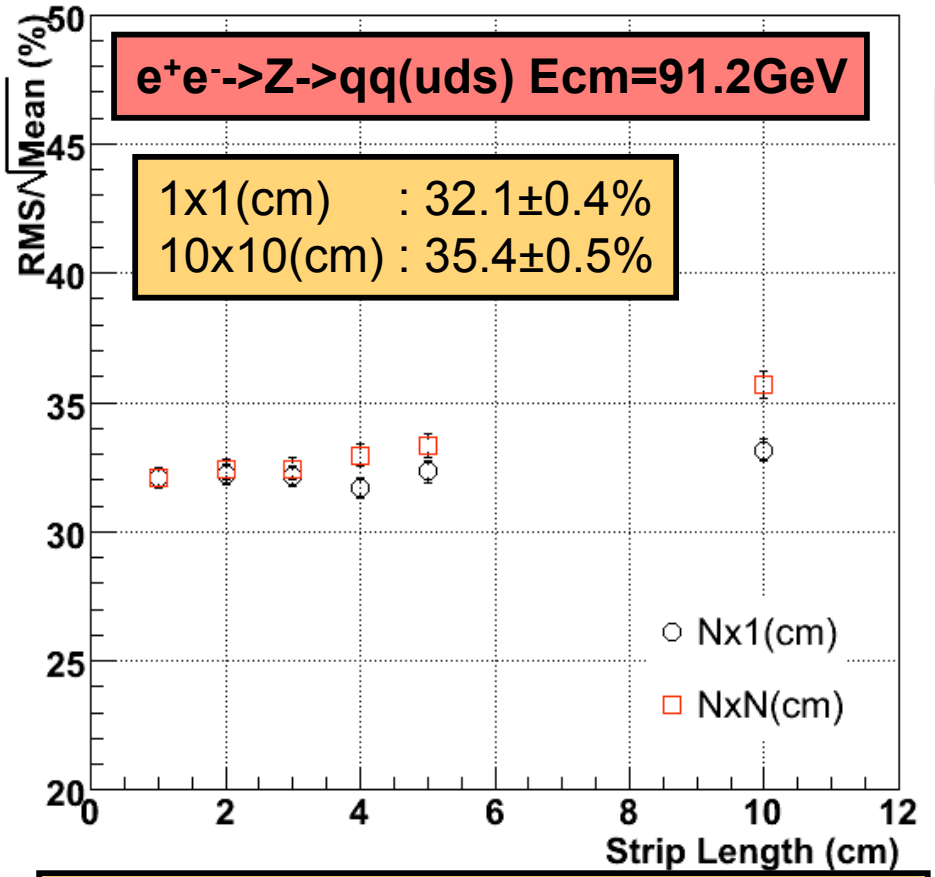
EM/HD different cell size
EM:1cmx1cm, 4cmx4cm
HD:1,2,4,5,10cm cells

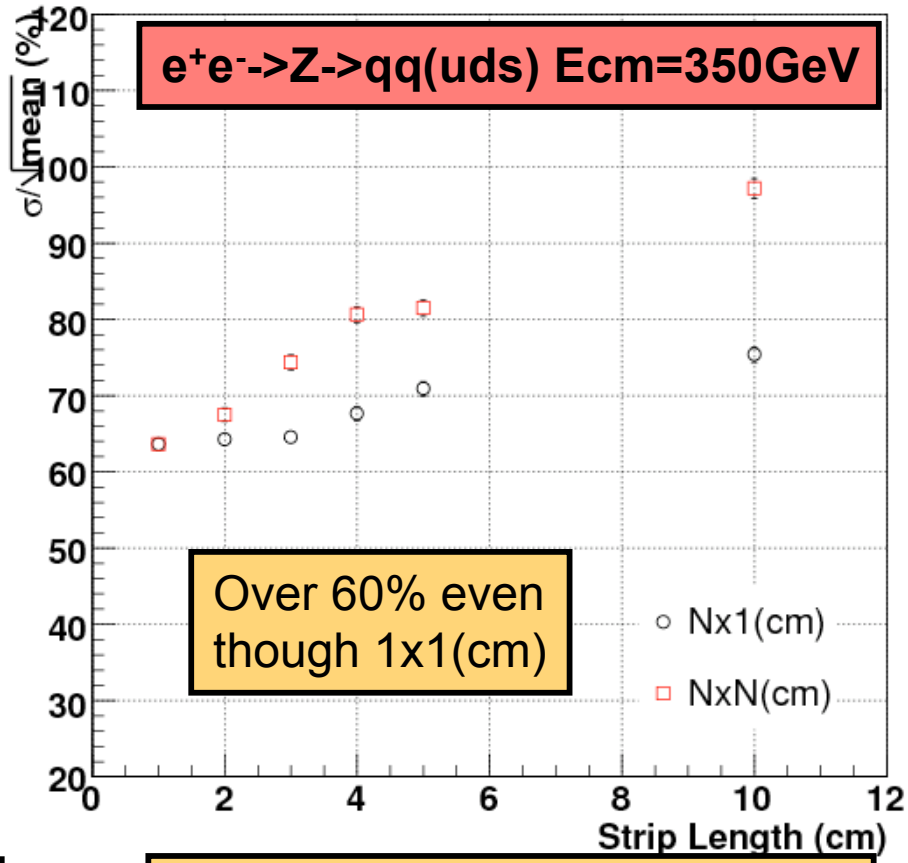


Cell size : 1cmx1cm
σ=2.53 GeV

Cell/Strip Size dependence of Realistic PFA performance

Same PFA scheme applied to cell/strip calorimeter, no strip clustering!





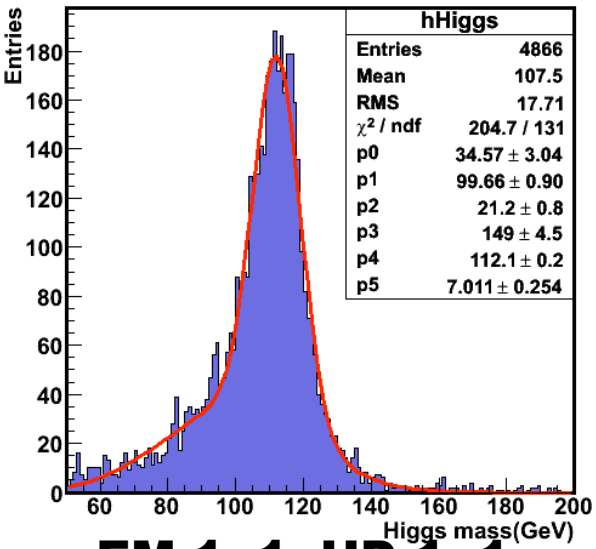
Clustering performance depends on the segmentation of the calorimeter.

350 GeV case,
PFA is not working well for now.

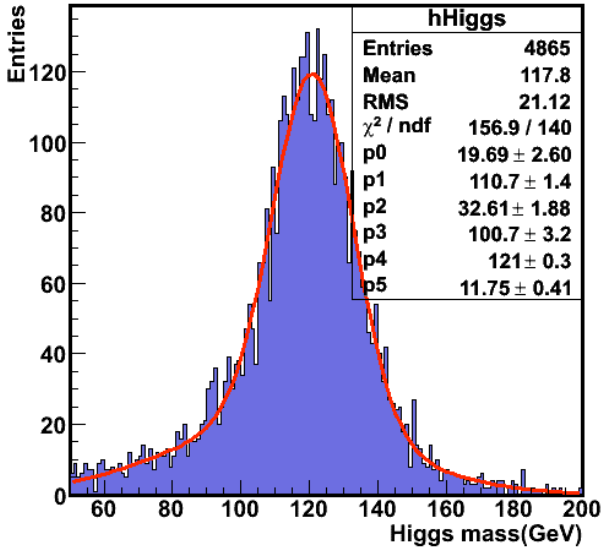
Higgs Jets analysis with different cell size

e^+e^-->Zh->$\nu\nu$h, 350GeV
Higgs mass plot with realistic PFA

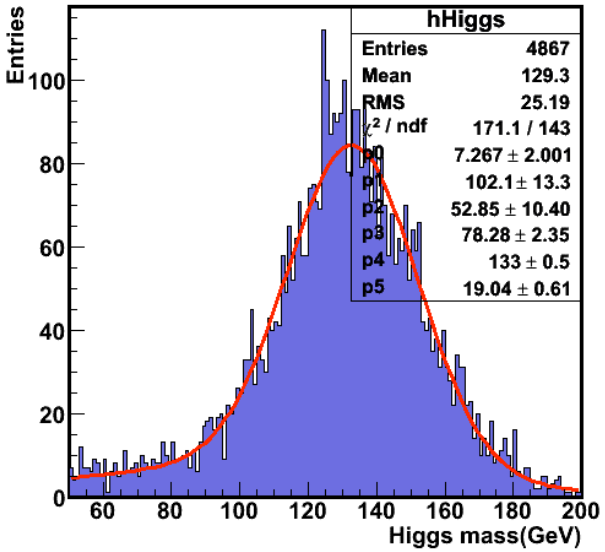
Apply jet clustering (JADE base) after processing realist PFA



EM:1x1, HD:1x1

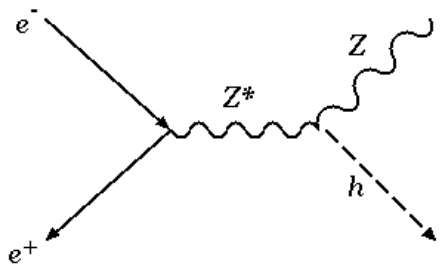


EM:4x4, HD:4x4



EM:10x10, HD:10x10

These studies are still on-going.



Conclusion

- GLD strip and cell calorimeter segmentation study was performed with cheated and realistic GLD PFA.
- PFA performance should be progress at the high energy jets event like Z->qq(uds), Ecm=350GeV compare to the 91.2 GeV.
- Next step is improving PFA performance at high energy part and strip clustering, physics study.