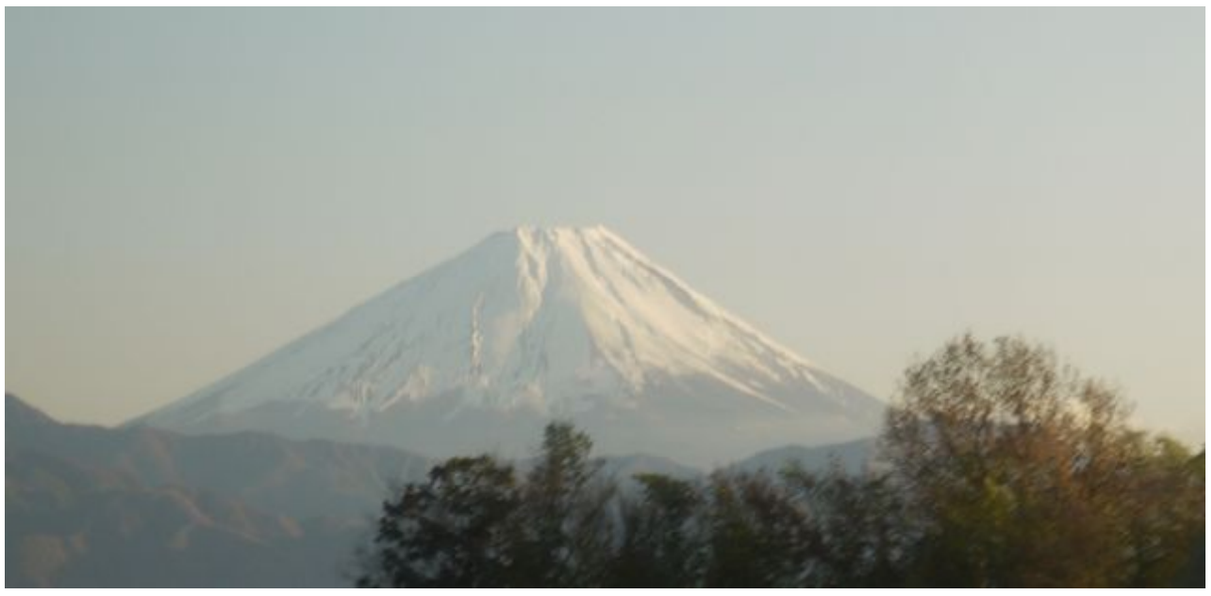
SHINSHU UNIVERSITY

Progress of Strip Splitting Algorithm in 2012

22nd December 2012

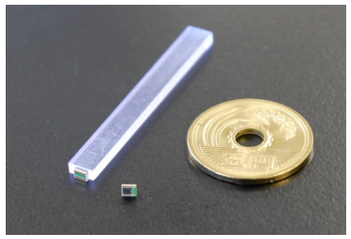
K.Kotera,
Shinshu University



Mt. Fuji from Azusa-go train running near Kofu 16th Dec.2012.

Contents

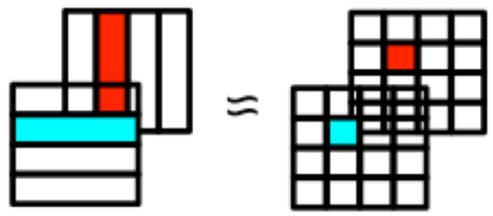
SSA



We are proposing an ECAL concept which uses Strip scintillators.

Each scintillator is read out by using the pixelated photon detector (PPD).

To achieve 5 mm × 5 mm lateral granularity for PFA, and to prevent dead volume from PPD, each scintillator is shaped as a 45 mm × 5 mm strip, with the scintillator strips in odd layers orthogonal to those in the even layers.

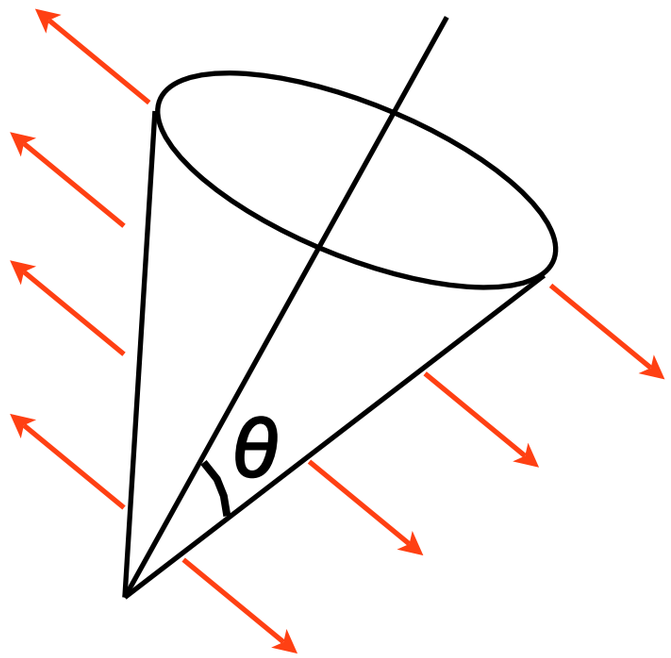


Strip Splitting Algorithm is developed to extract an effective 5 × 5 mm^2 lateral granularity from 45 × 5 mm^2 strip cells.

In the SSA a deposit energy on a scintillator is sprit into a pseudo 5 × 5 mm^2 cells referring the energy deposit on the up and down stream strips segmented in 5 mm with respect to the longitudinal direction of this layer.

Current code was written by D. Jeans

Correction on seeking region



PandoraPFA seeks hits to make a cluster in a region which described with cone + expansion (factor × cell size)

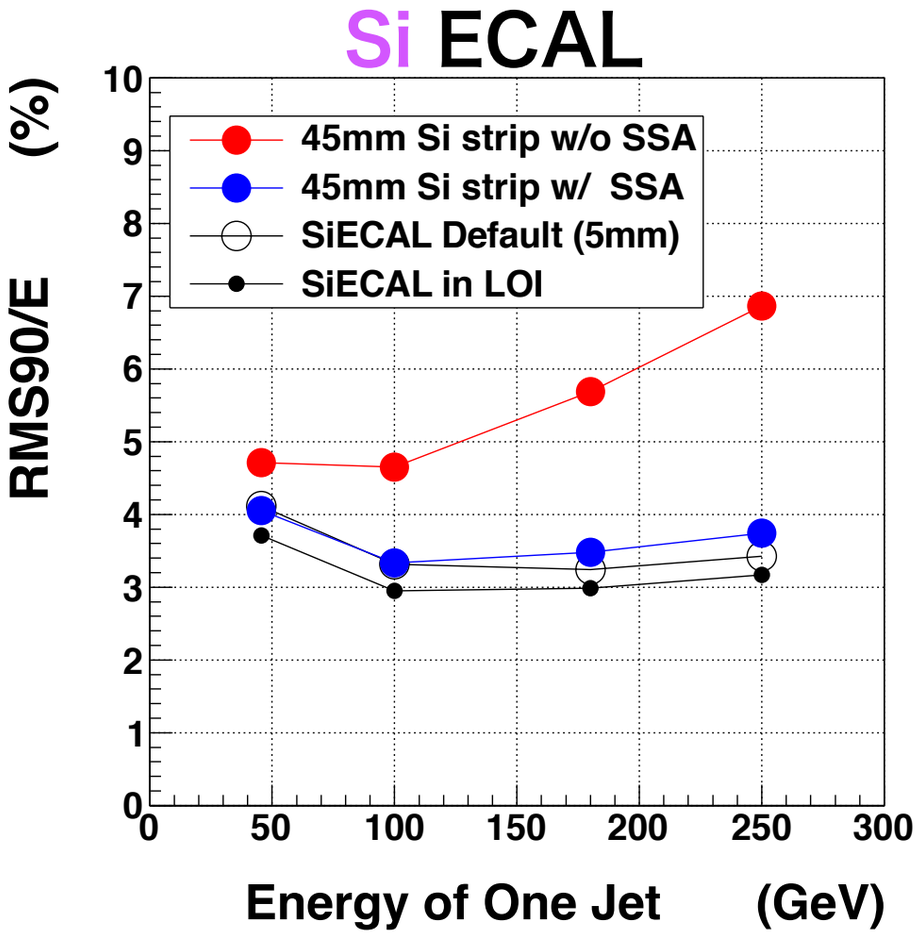
for default ECAL $\tan\theta = 0.3$
1.5 x cell size (5 mm)

For 5 mm segmented ECAL, Pandora seeks hits in cone spread by 7.5 mm outer than cone.

- PandoraPFA estimates cell size using info. from gear file.
  $\sqrt{\text{cell length x cell width}}$ = cell size
- for 45 mm strip ECAL, $\sqrt{45\text{ mm} \times 5\text{ mm}}$ = 15 mm.
  3 times larger than suitable size.

Correction in PandoraPFA : cell size = cell width (5 mm)

After this correction (April)



2.1 mm x 20 tungsten,
4.2 mm x 19 tungsten,
0.5 mm x 30 silicon ,
total 185 mm with other materials

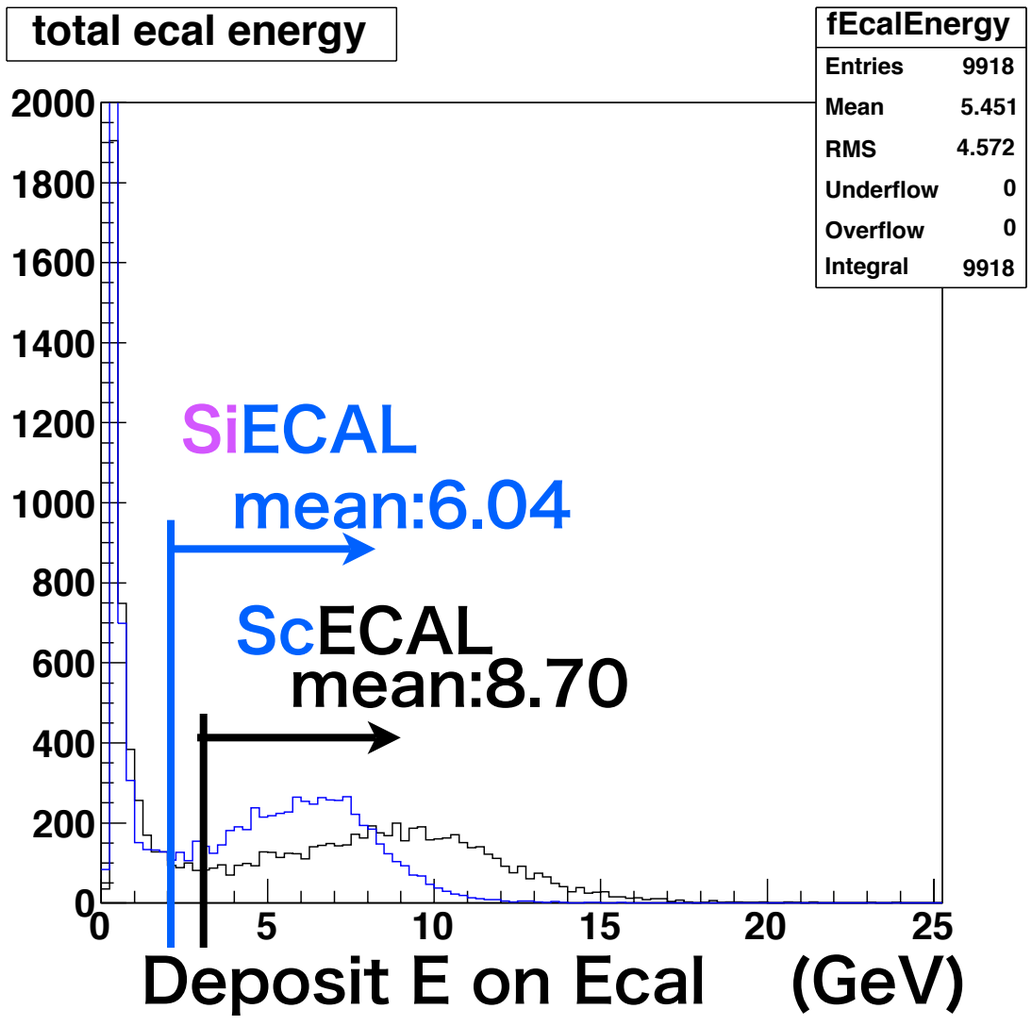
This study was done by using v0-09-02.

- Strip Splitting Algorithm was tested by using a special ECAL model with Si-Strip readout in order to minimize effects of parameter tunes in PandoraPFA,
- JER improves significantly, by SSA (● → ●) especially H.E.
- A little degradation of strip ECAL is seen at H.E (● → ○).
- Systematic difference between LOI and this ECAL exists (● → •).
  - later I will compare with Default DBD results instead of LOI
- Next step is to see Sc-strip ECAL

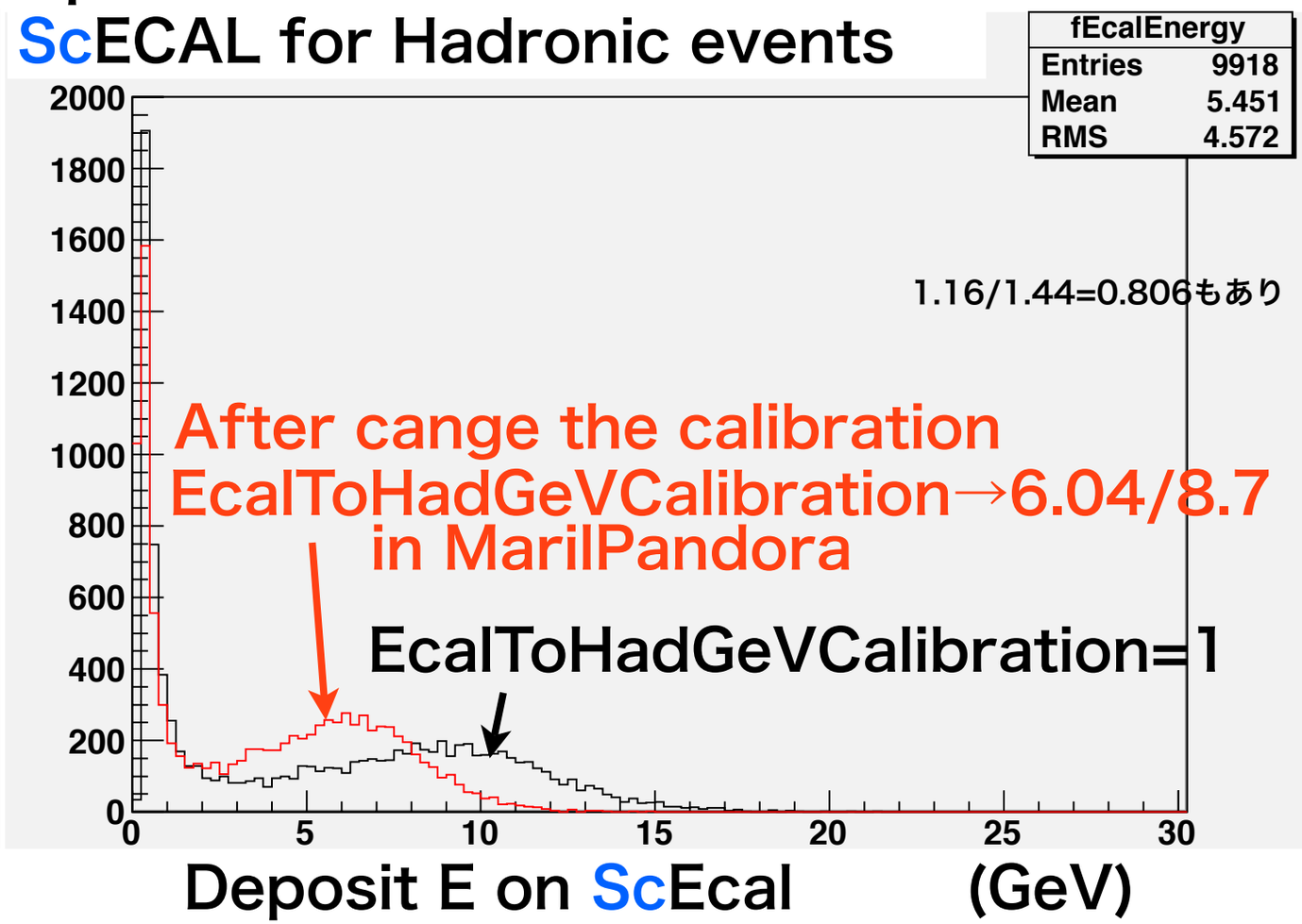
Large difference of energy deposit on ECAL by hadronic events btwn. Si -Sc

➡ Tune a parameter of PandoraPFA

- After tune ECAL with 10 GeV photon
- π^+ 10 GeV (KL maybe O.K.)

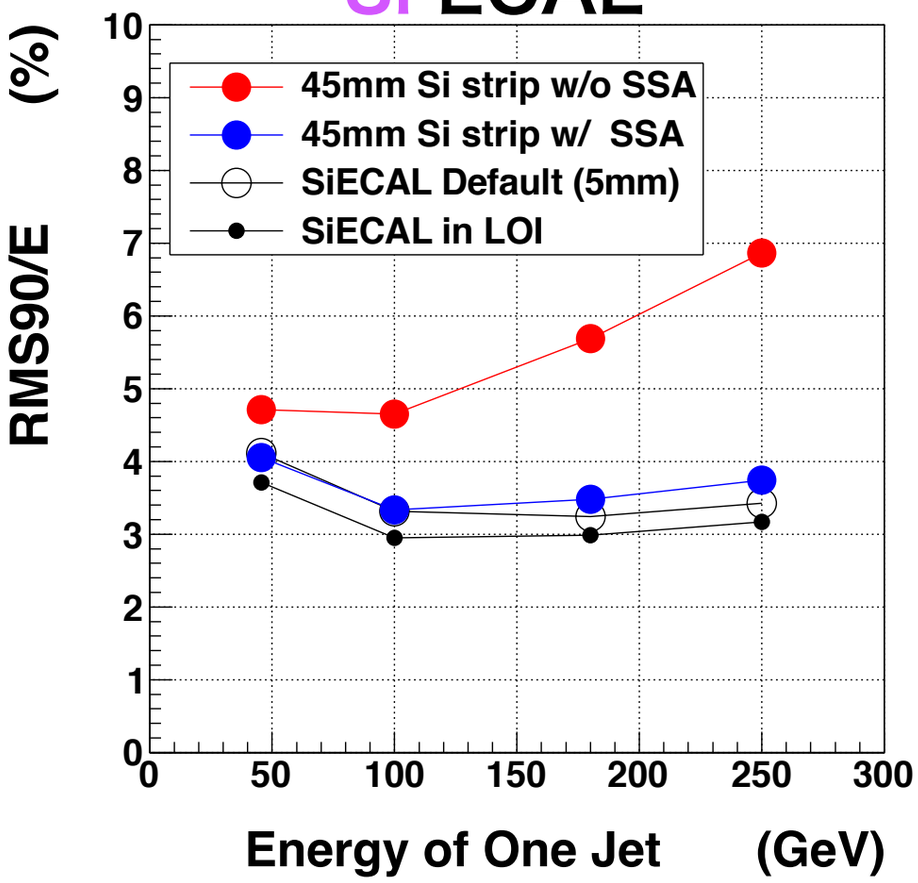


Optimization of Calibration of ScECAL for Hadronic events

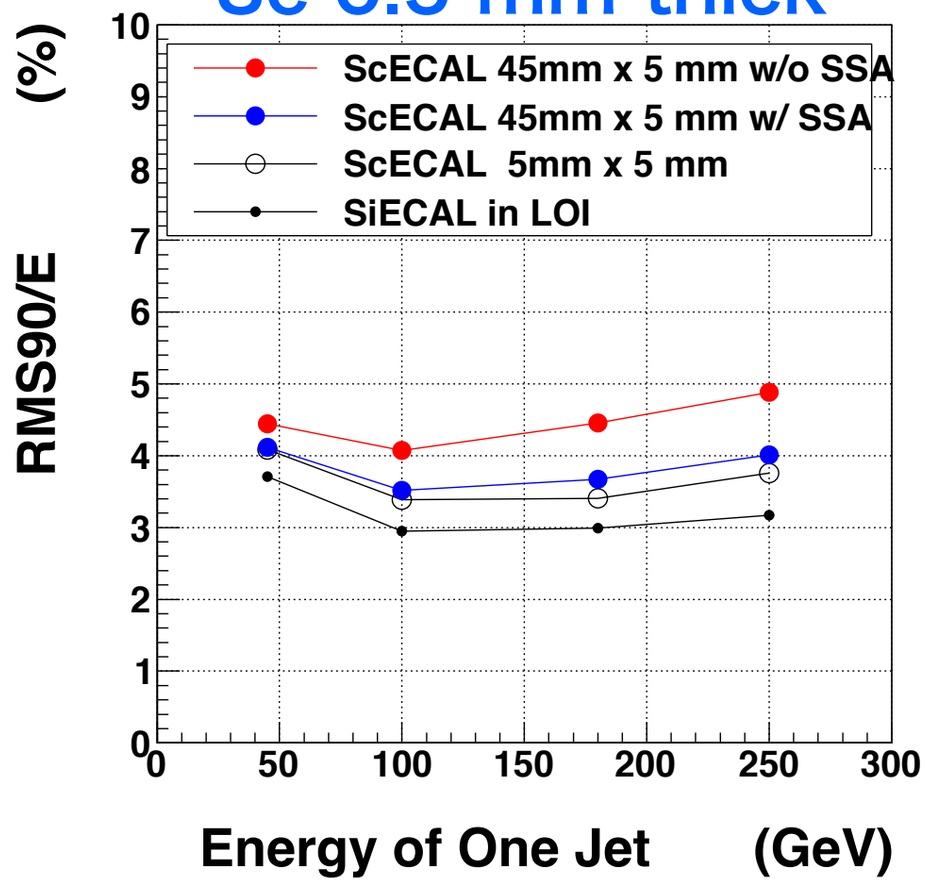


Scintillator strip ECAL

Si ECAL

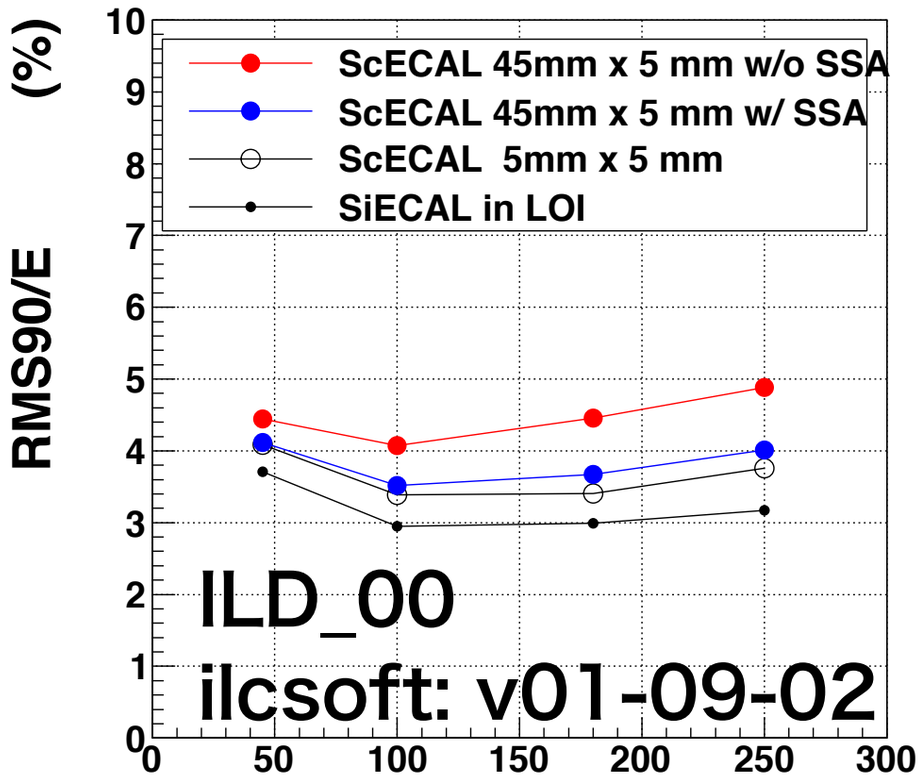


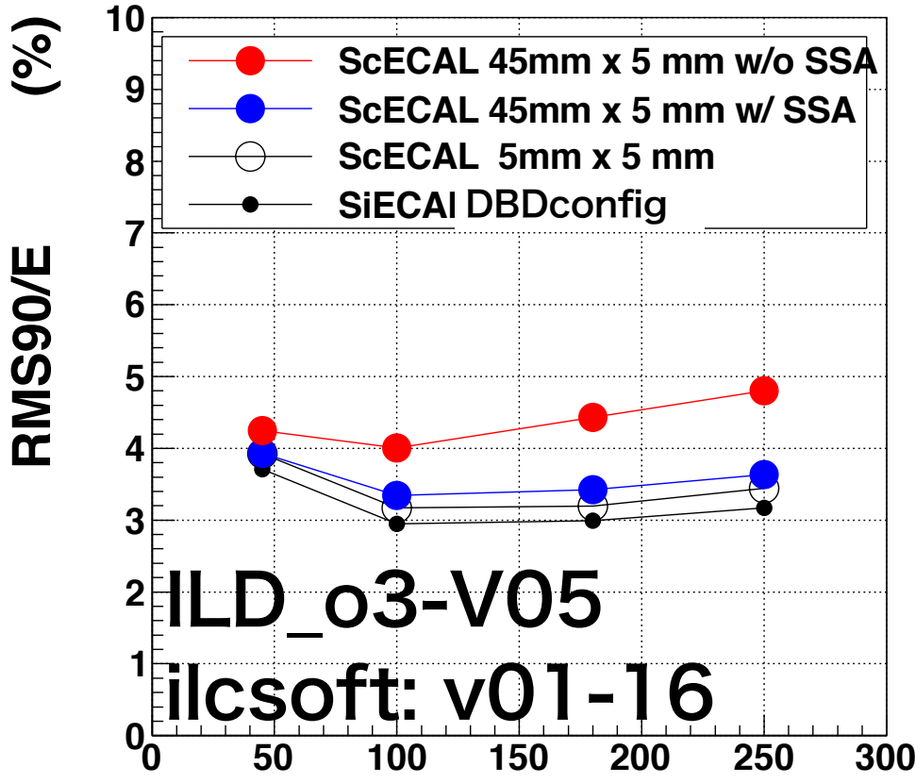
Sc 0.5 mm thick



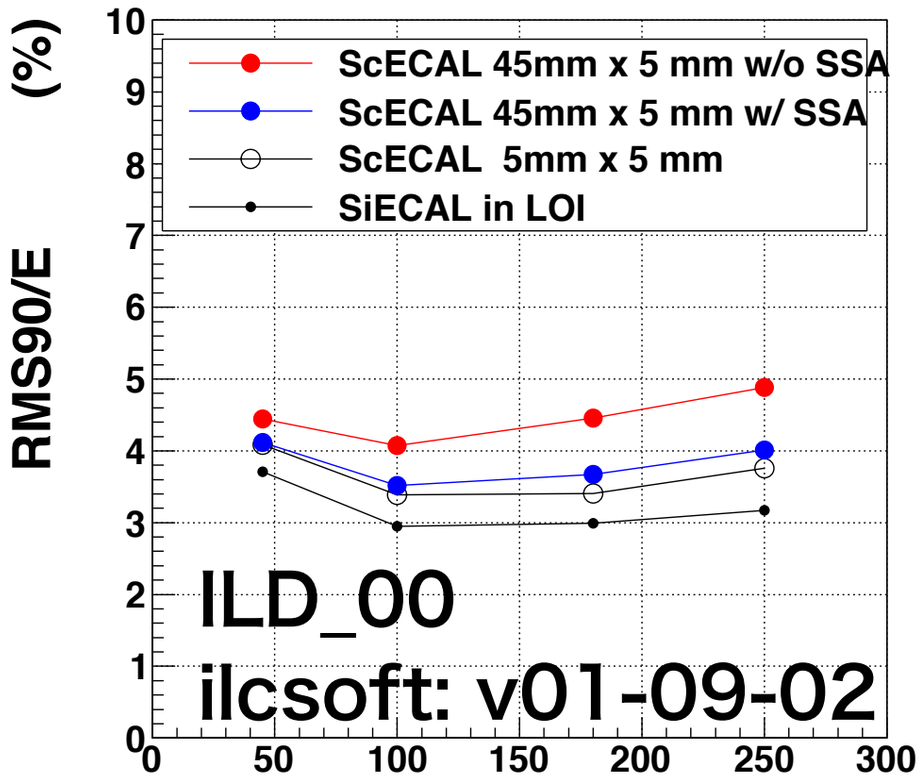
- SSA works well also for Sc-Strip ECAL (right blue).
- Systematic difference between LOI and ScECAL increases.
- In comparing the case w/o SSA, JER of Sc strip ECAL is better than Si strip ECAL.

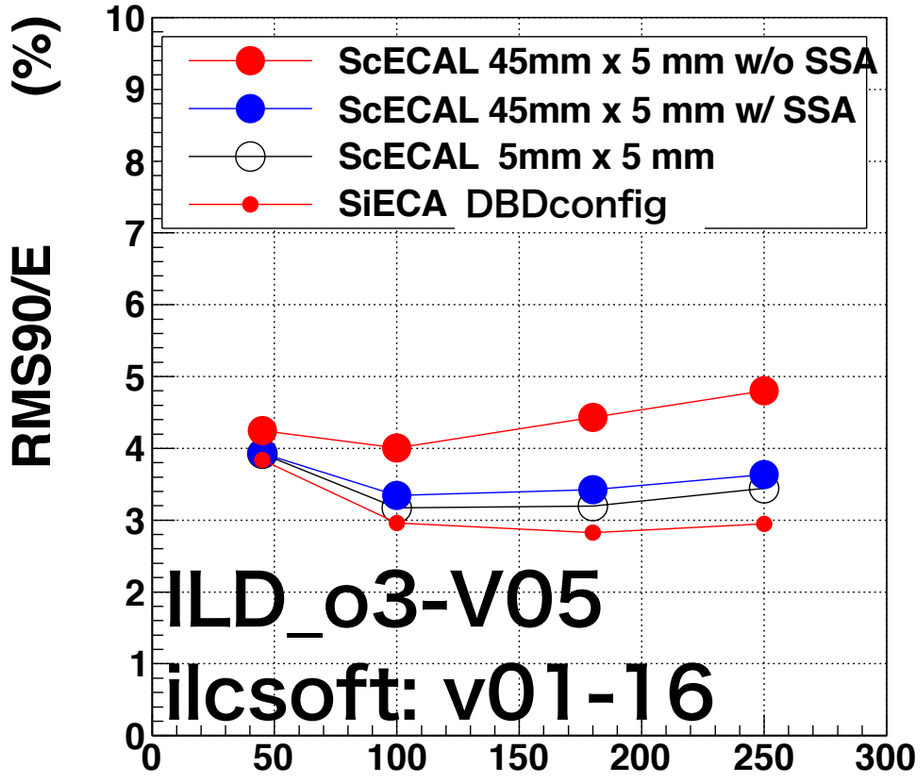
ILD_00 to ILD_o3-V05(DBD version)



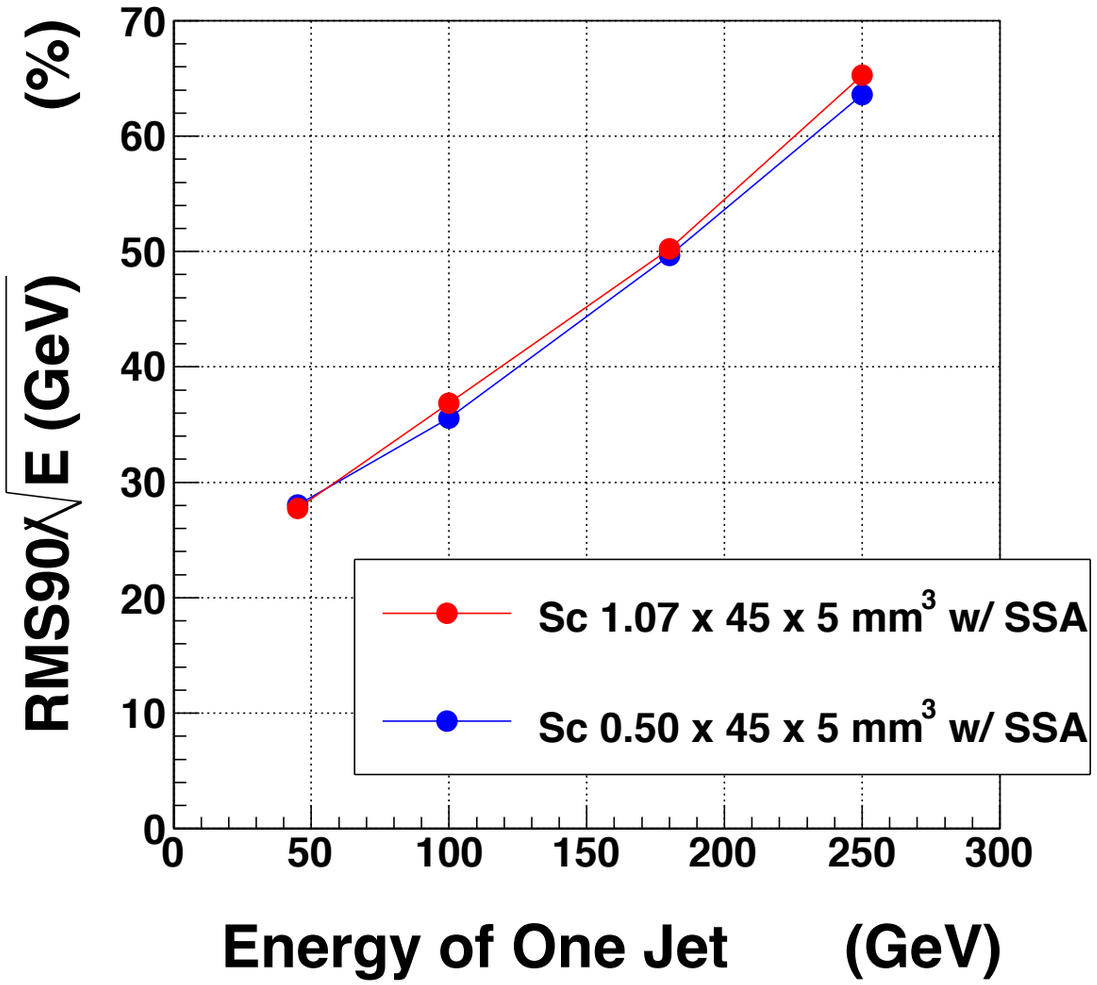


Chasing does not finish.





1 mm thick scintillator



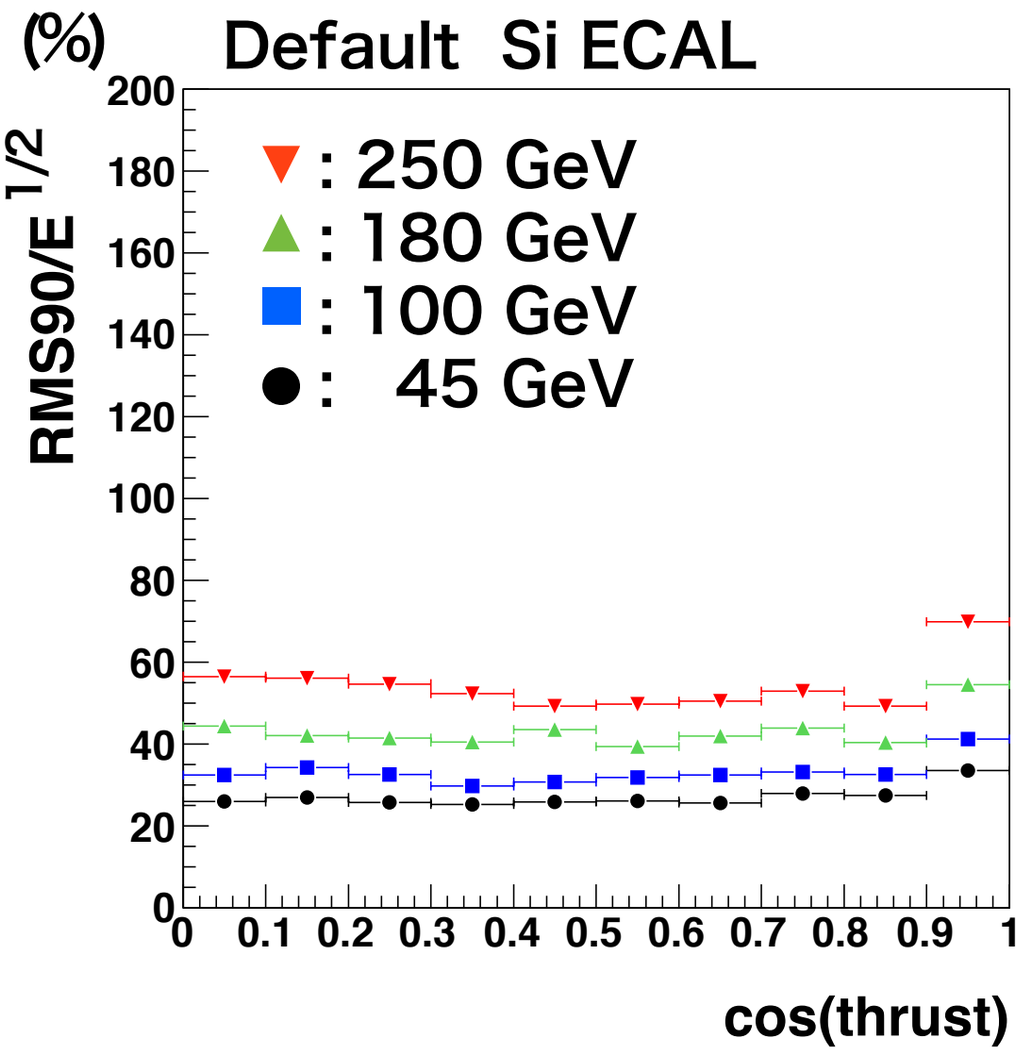
This study was done by using v0-09-02.

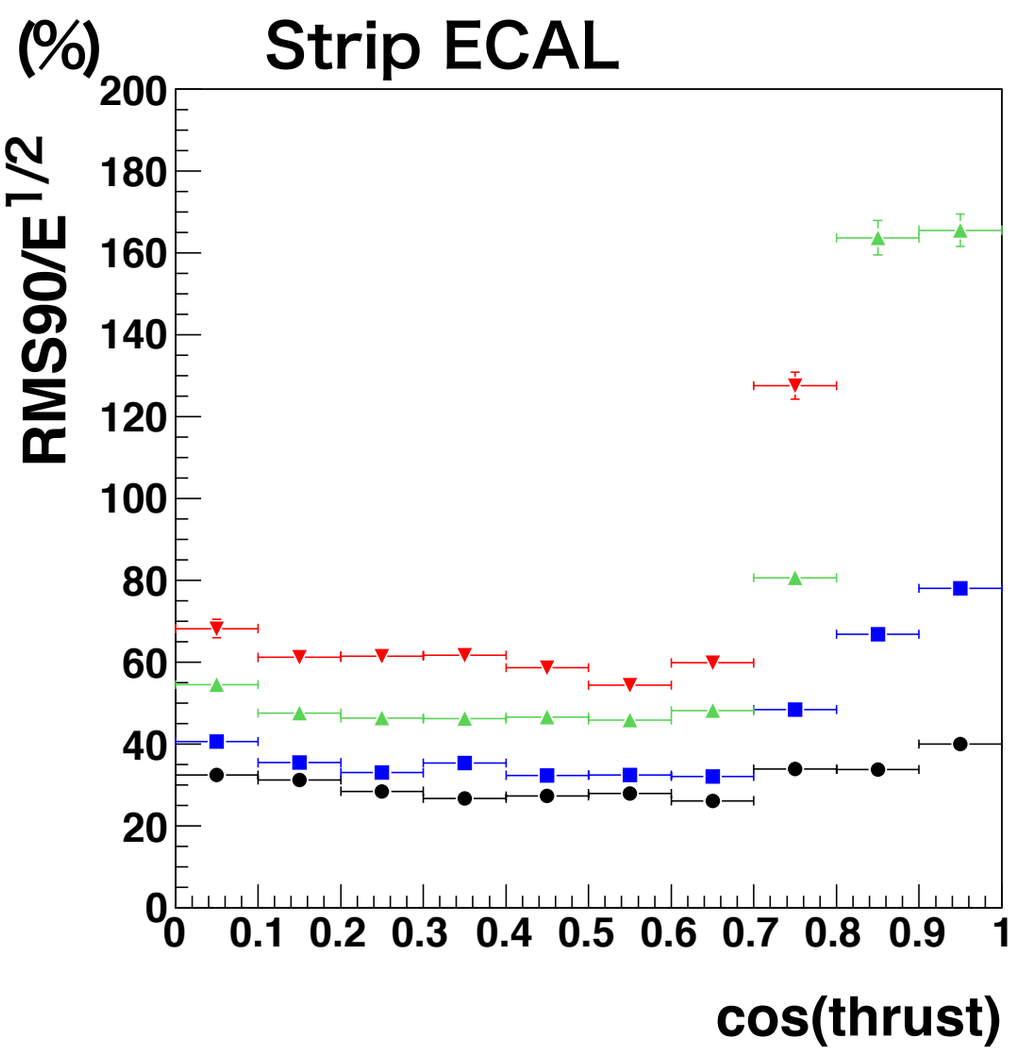
- To make 0.5 mm thick scintillator strip ECAL is difficult with current technology.

Therefore;

- 1 (.07) mm thick scintillator has been tested in Mokka-Marlin.
- JER with 1 mm thick scintillator is comparable with 0.5 mm sc.
- Total module thickness of Ecal becomes only 1.5 cm greater than default Si ECAL of 18.5 cm.

Endcap problem of strip ECAL (ILD meeting in Kyushu)

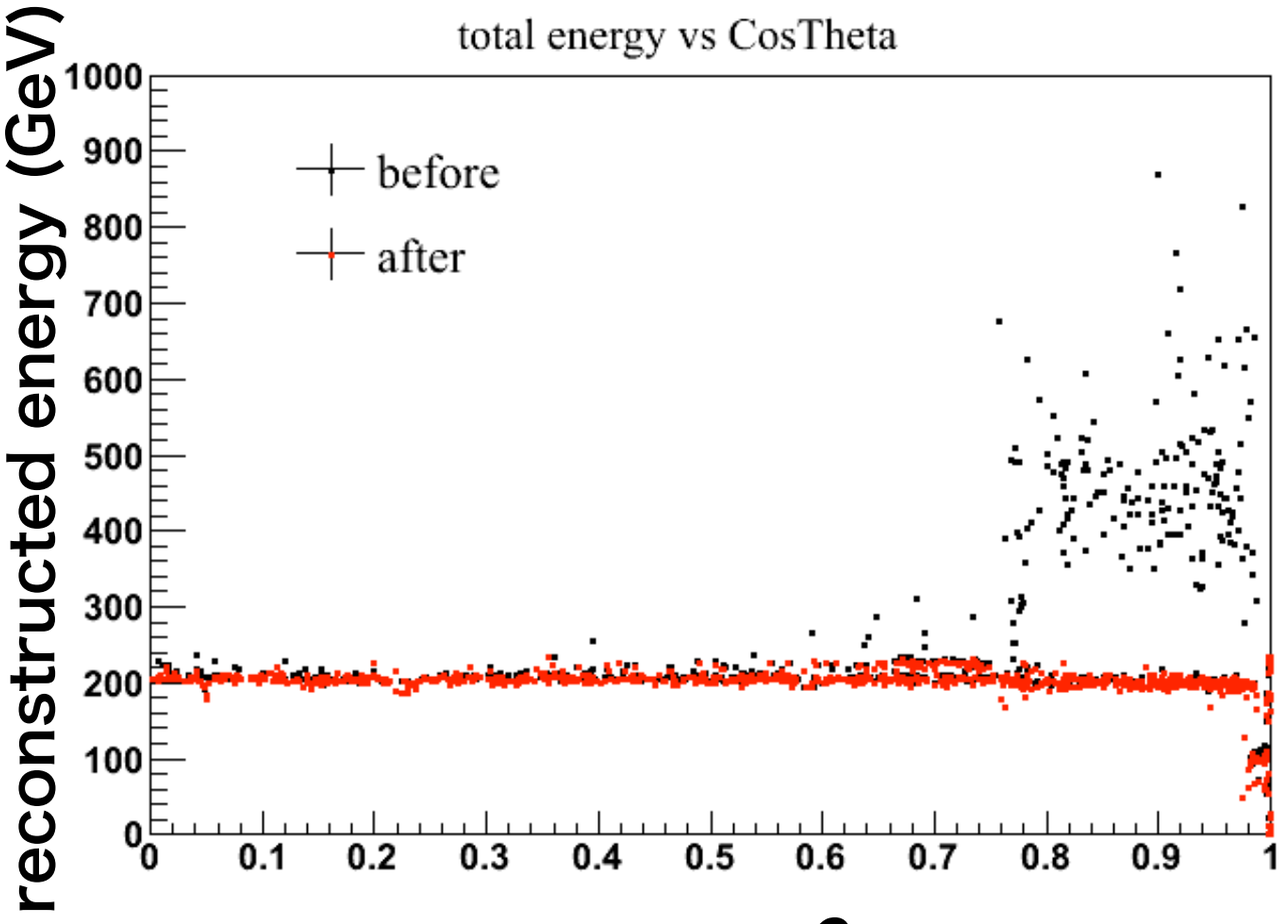




Energy conservation is violated on the Endcap

20 × 10 GeV photons (total 200 GeV) are injected simultaneously in completely the same direction (4π direction).

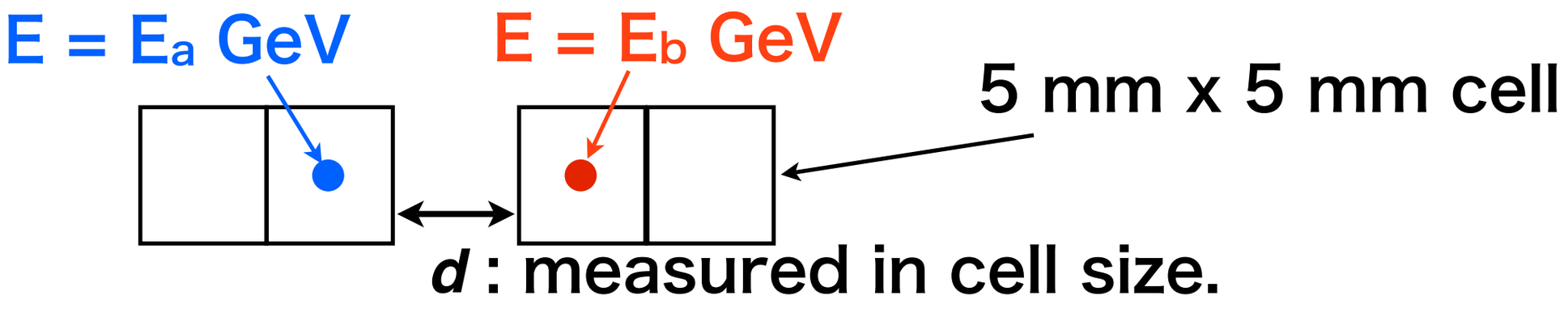
- before fix the problem some events have very large energy on the endcap
- After fix it, the energy conservation almost comes back
- I will explain how I did it in next.



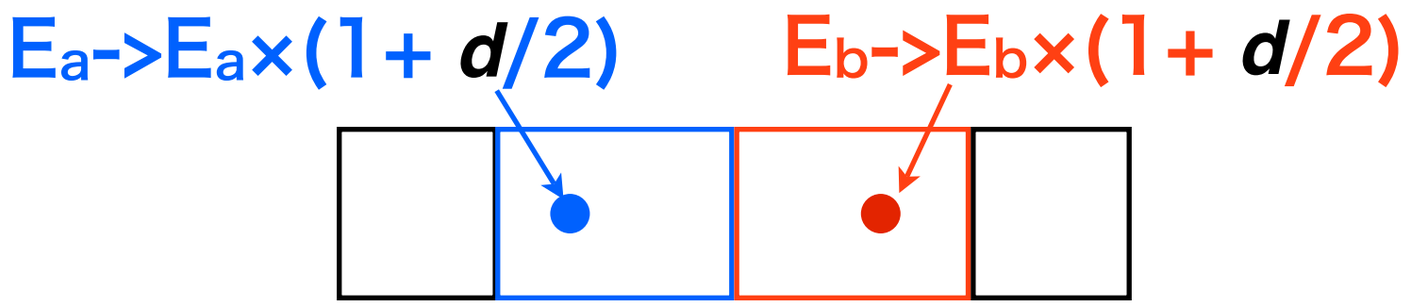
by T.Ogawa, Shinshu

“Gap correction” makes the problem

- In the digitizer for ECAL an energy correction for the cell gap is implemented.



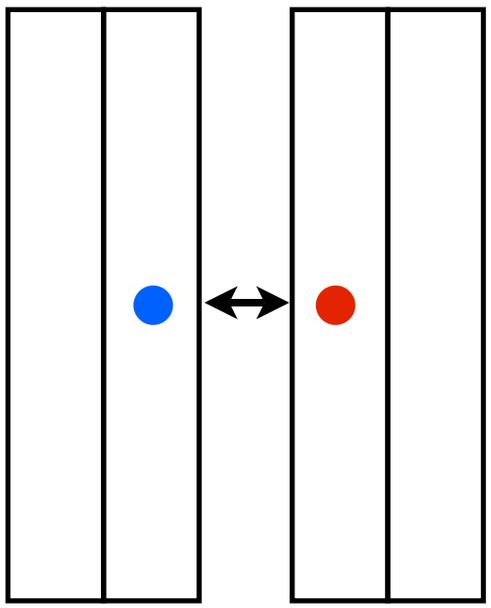
  - It investigates every pairs of hits
- If $d < 1$ (cell size), E_a and E_b are corrected by $\times(1+ d/2)$



- actual criterion (definition) of a gap is:
  (cell size + 0.25 mm) < distance of hits < 2 x (cell size - 0.25 mm) in x or y.

Strip Case

- 45 mm x 5 mm scintillator ECAL



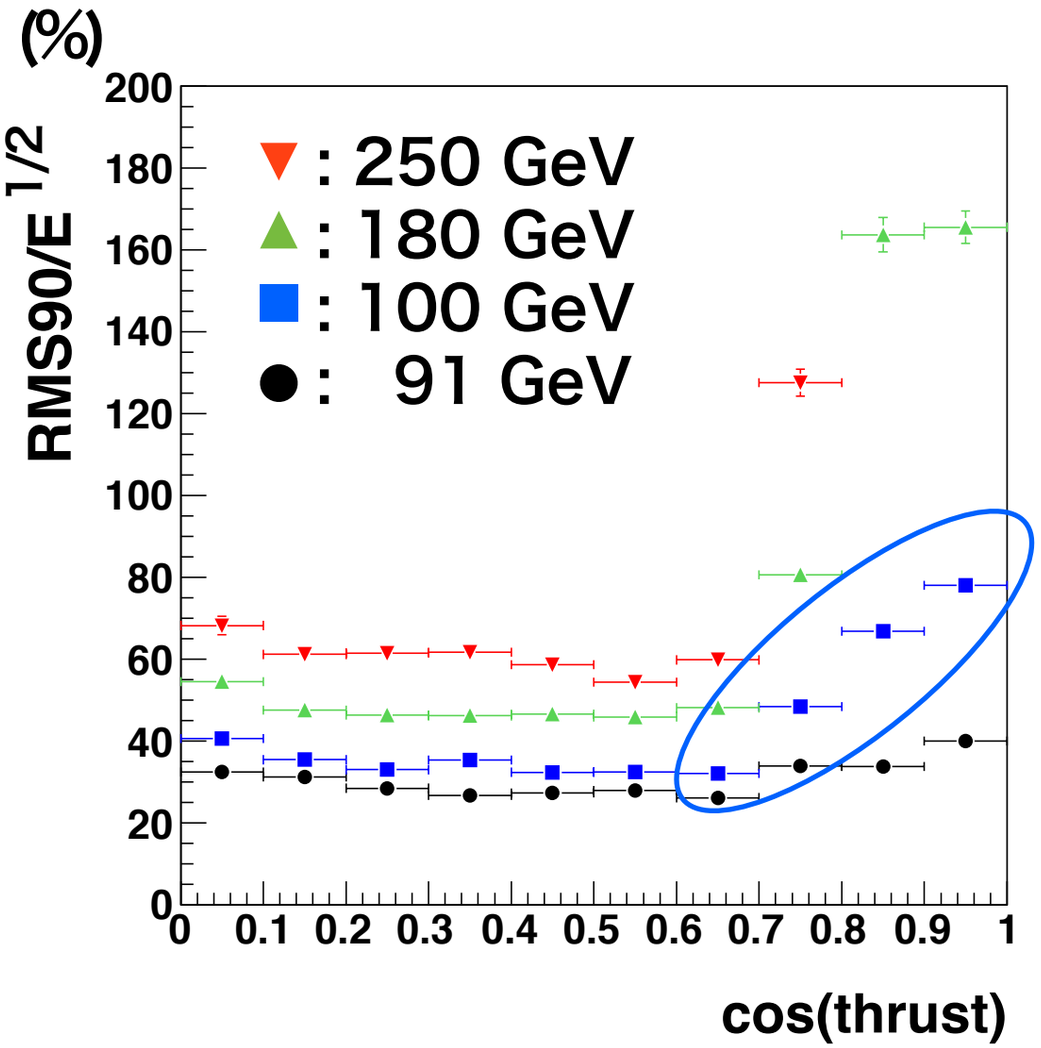
gap should be less than the width of strips

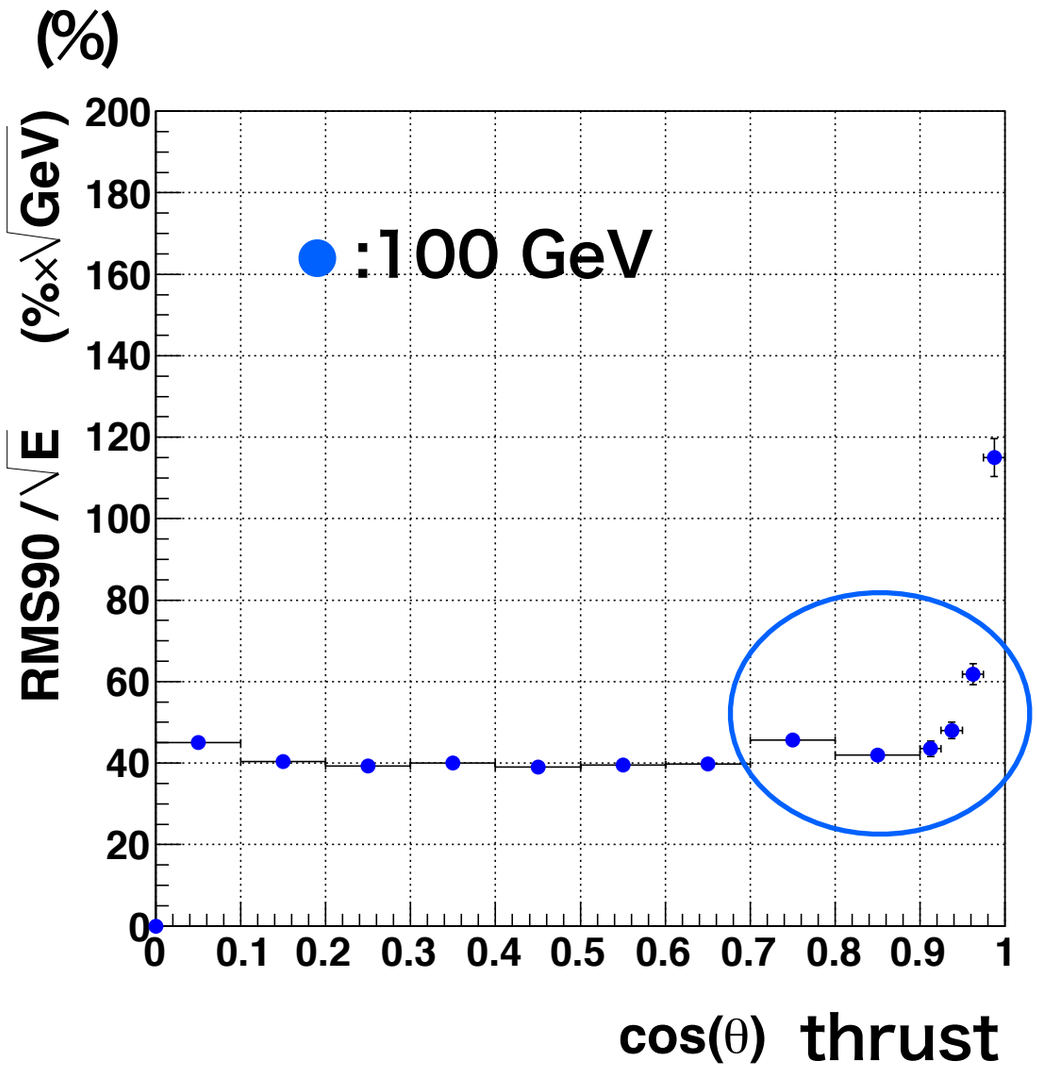
The other case, gap should be less than length of strips

very large gaps can exist

This case can make wrong. However, alignment of strips on the endcaps is simple. Where, such problem can occur?

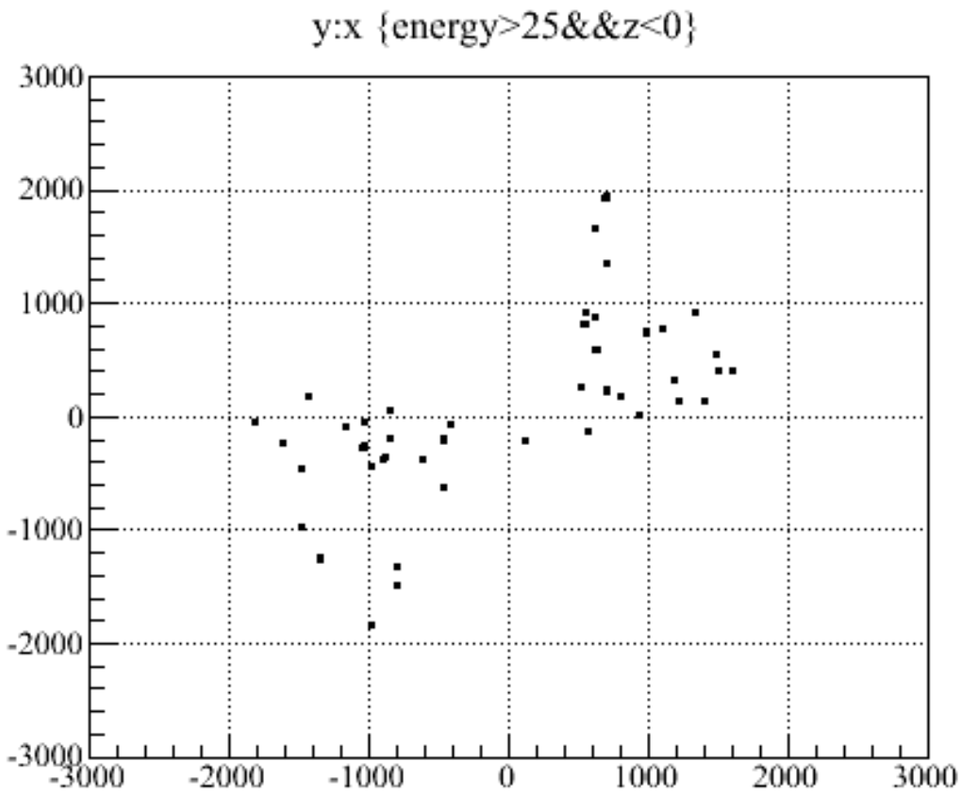
Endcap problem of strip ECAL (ILD meeting in Kyushu)



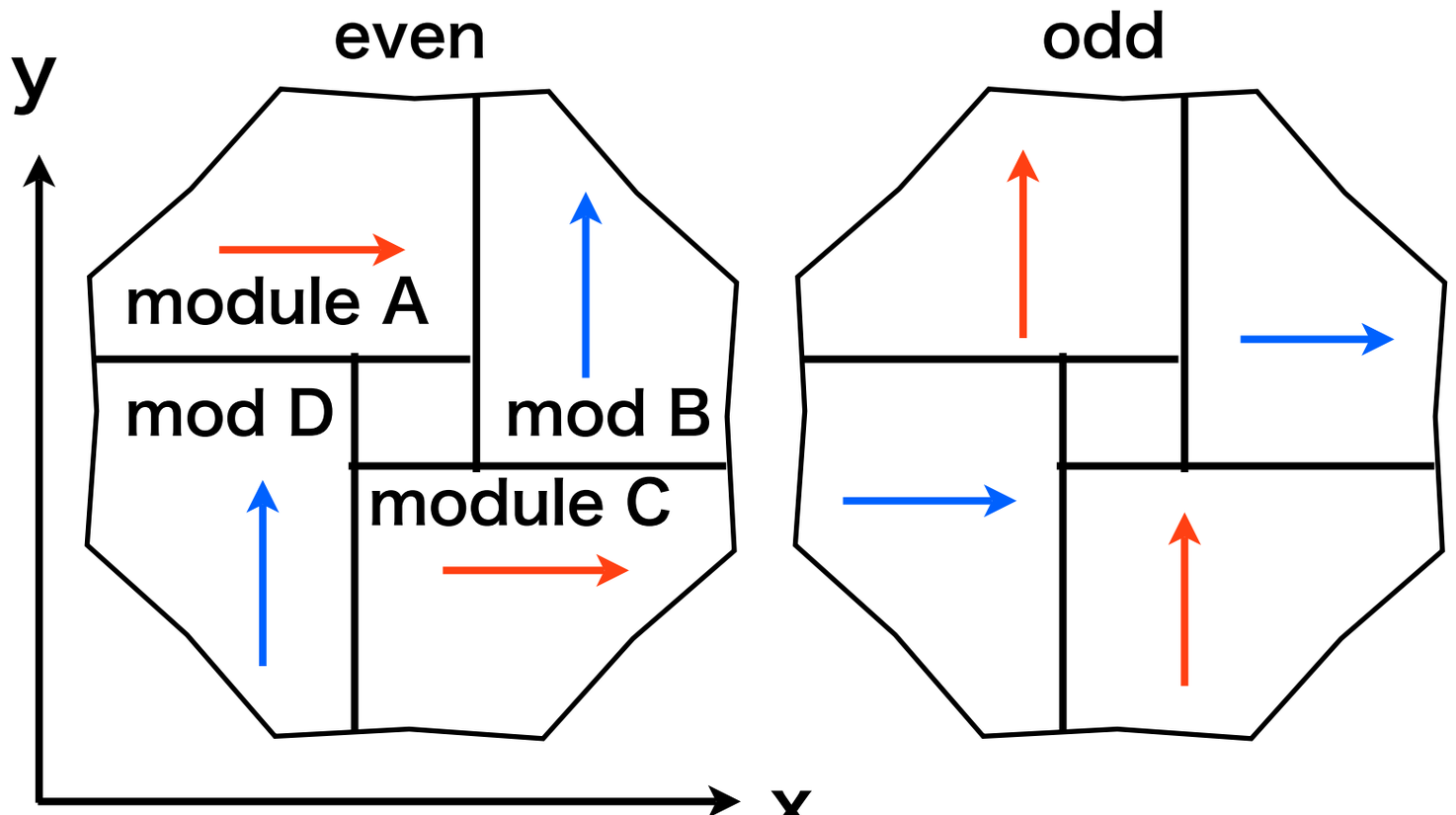


gap correction < cell width

Strip Case



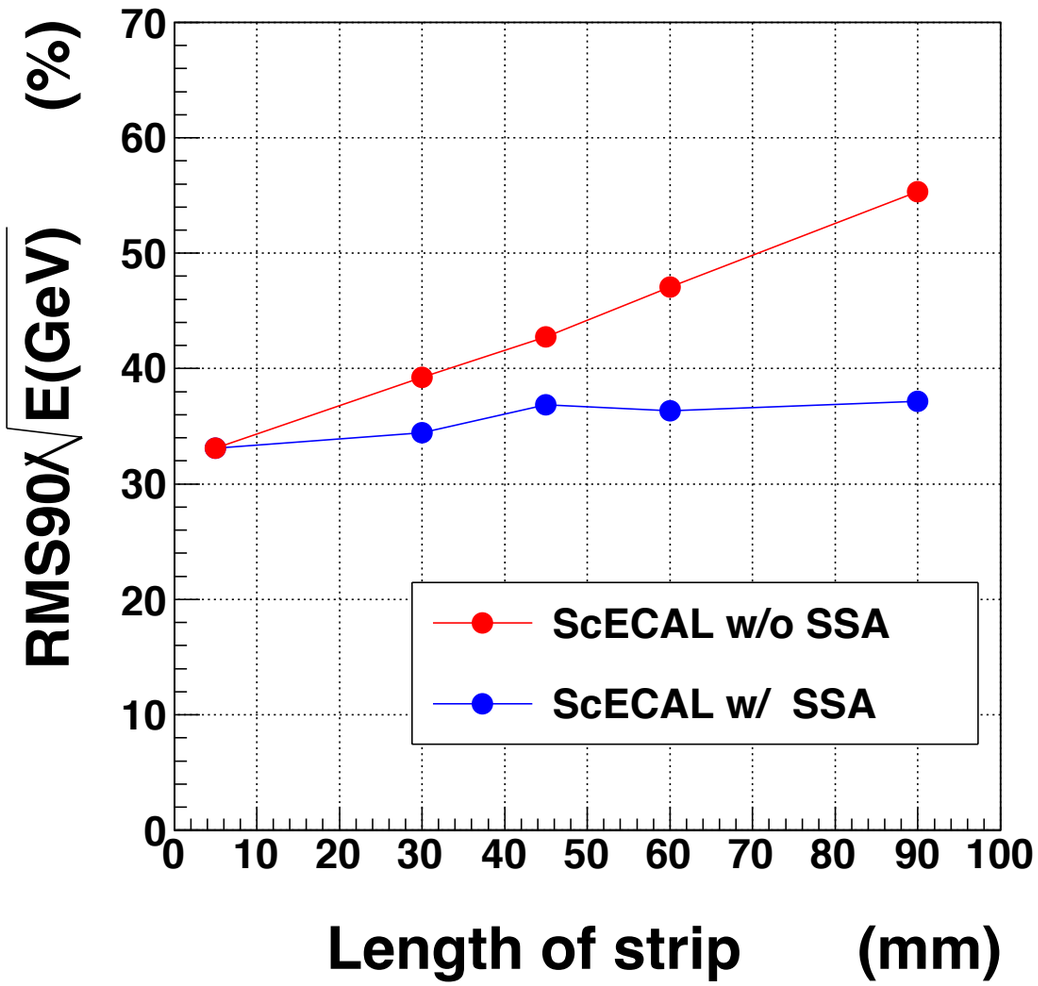
by T.Ogawa, Shinshu

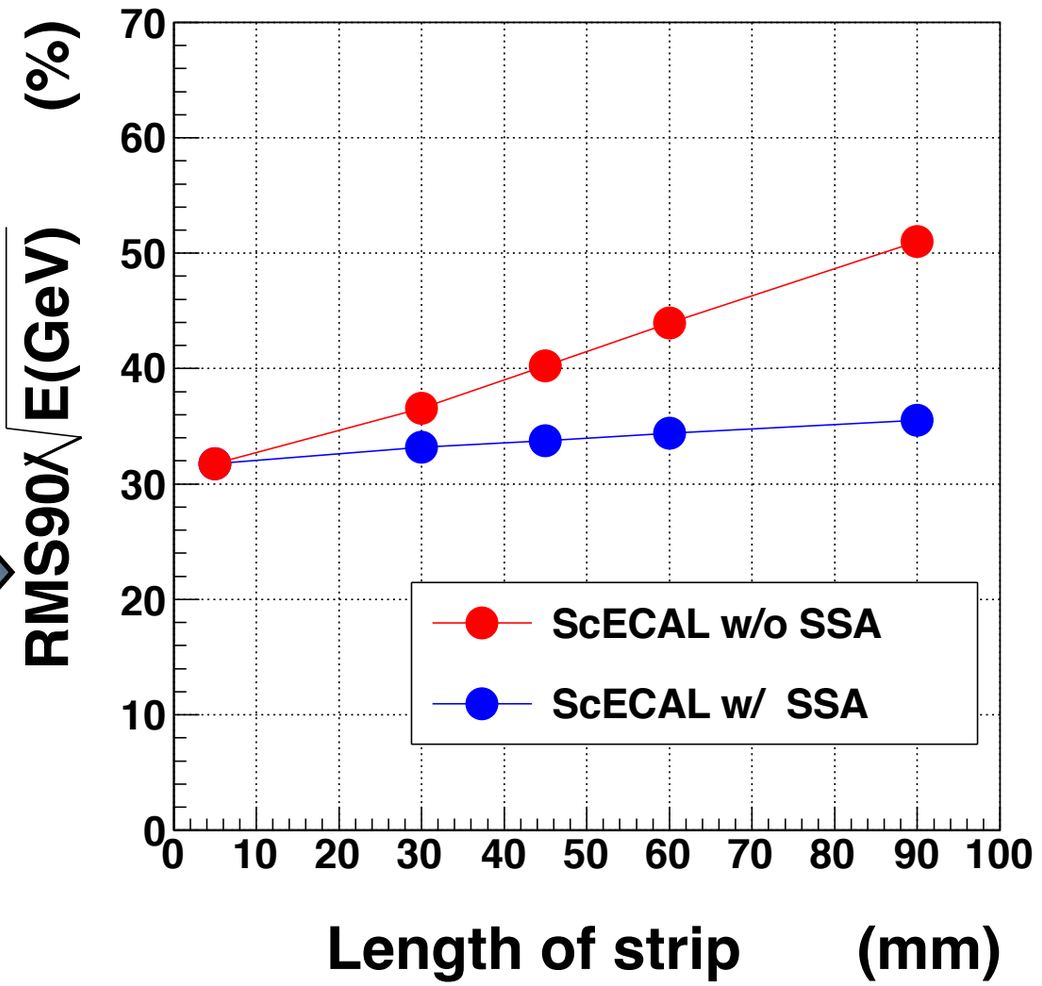


Daniel Jeans found essential reason

- In even (odd) layer Module A and C have longitudinal direction of strips along X(Y), while the module B and D have the longitudinal direction of strips along Y(X).
- Even though, strip length was given in X(Y) direction in gap correction code for all modules.

100 GeV JER depending on strip length





JER is improved for all conditions.

A little degrading of JER using 45 mm strips with SSA in previous study has gone.

Summary

- We are developing a reconstruction tool for strip-segmented Calorimeter, called Strip Split Algorithm.
- Strip 45 mm ECALs have good JER with SSA.
- Moving to ILD_o3 model (DBD version) has been done.
- Degrading problem on the endcap is understood and fixed.
- Cause of A little bit degrading from Silicon Default ECAL is under investigation.

To do

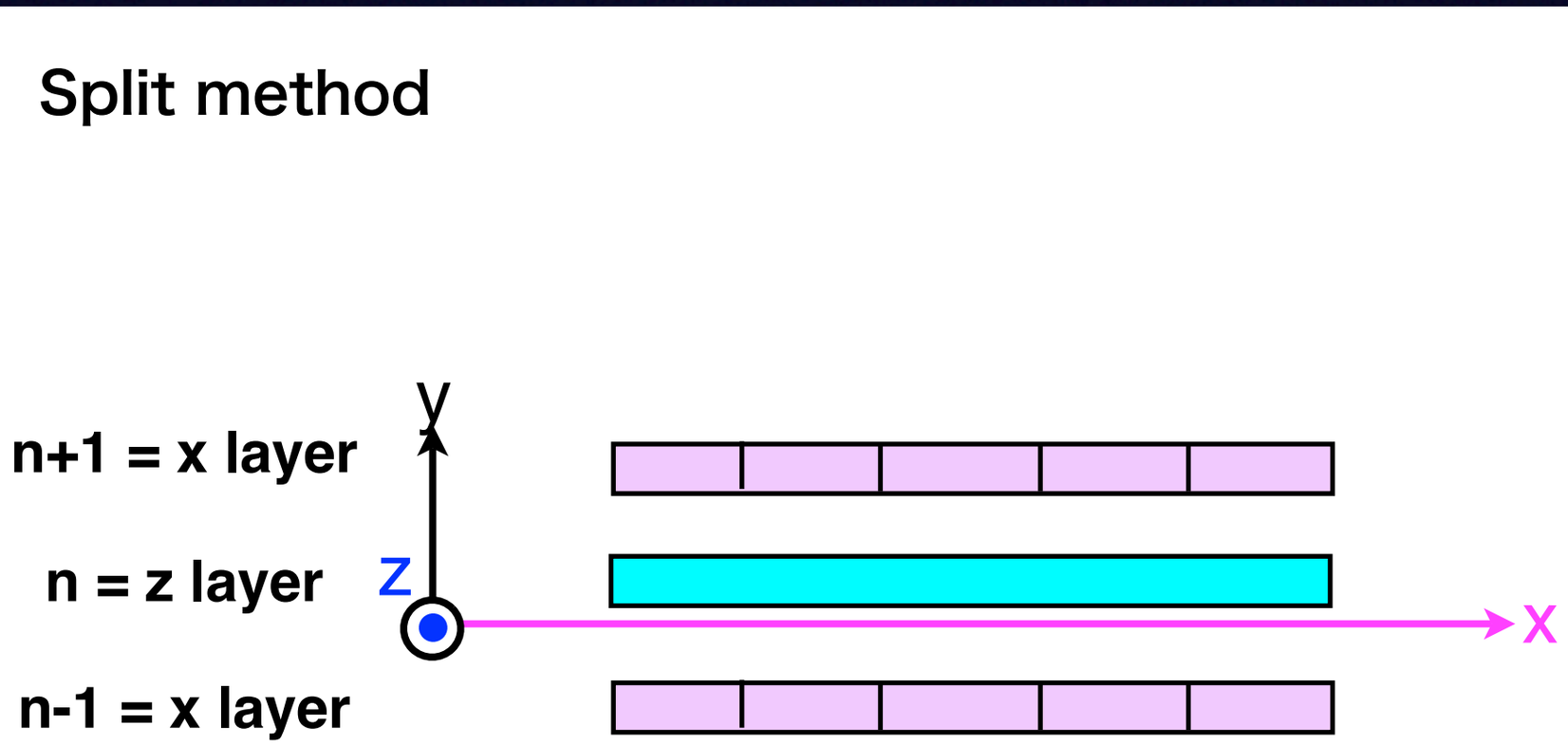
- Separation demonstration of tau decay into pi, rho, and a1 is ongoing.
- We began to study on the case of the two fold ambiguities.
- To show performance with some Physics mode.
-

Backup

granularity is more important!
for PFA

1. Assume that n-th is an z-layer (fine segmented in z direction), while n±1 layers are x-layers (fine segmented in x direction).
2. a shower comes from the bottom
3. split each strip in n-th layer into pseudo-square cells

Split method



4. energy deposit in n-th layer is distributed in pseudo cells referring adjacent n±1th layers.
5. The position and energy of pseudo square cells are fed into PandoraPFA.

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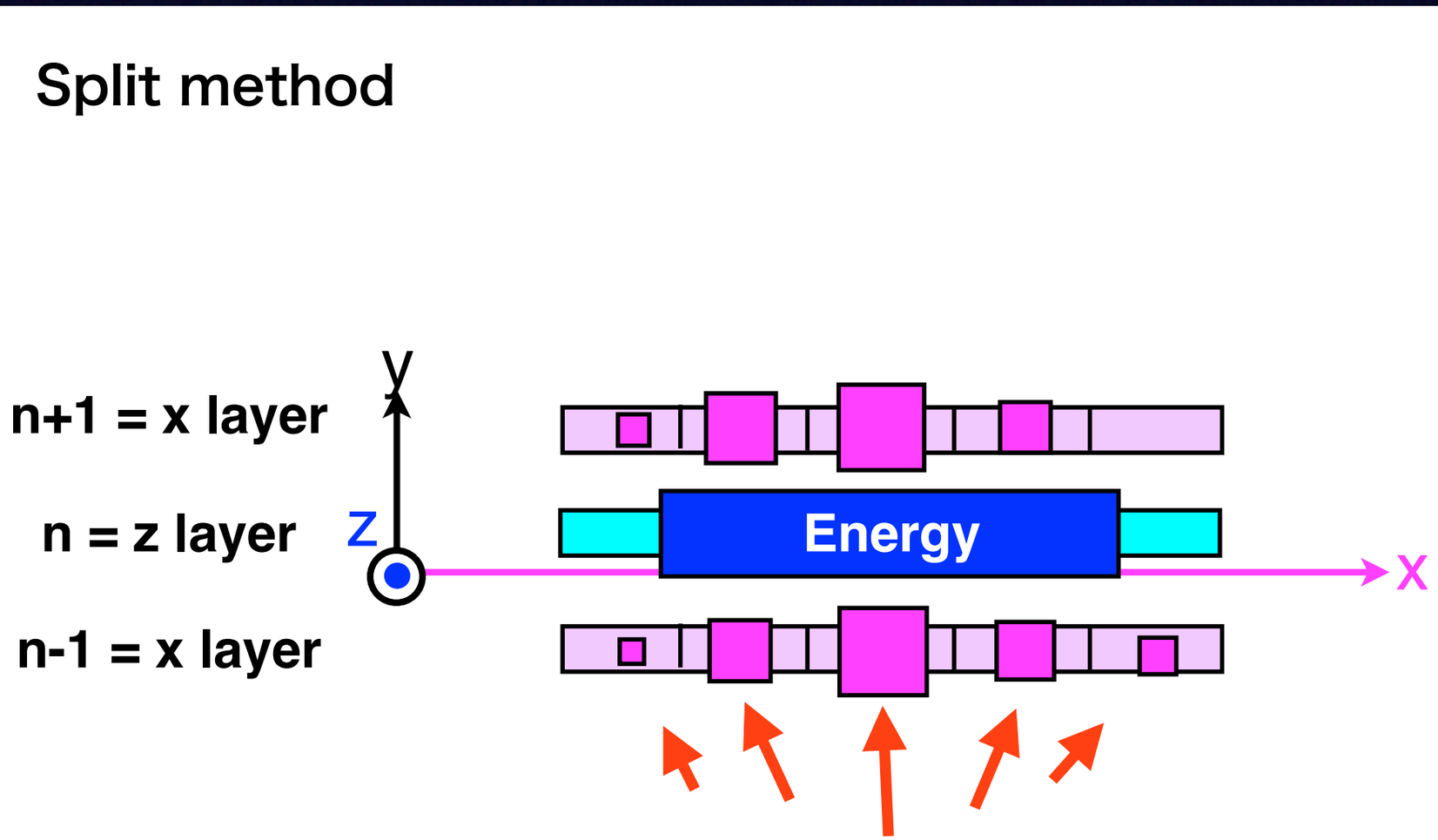

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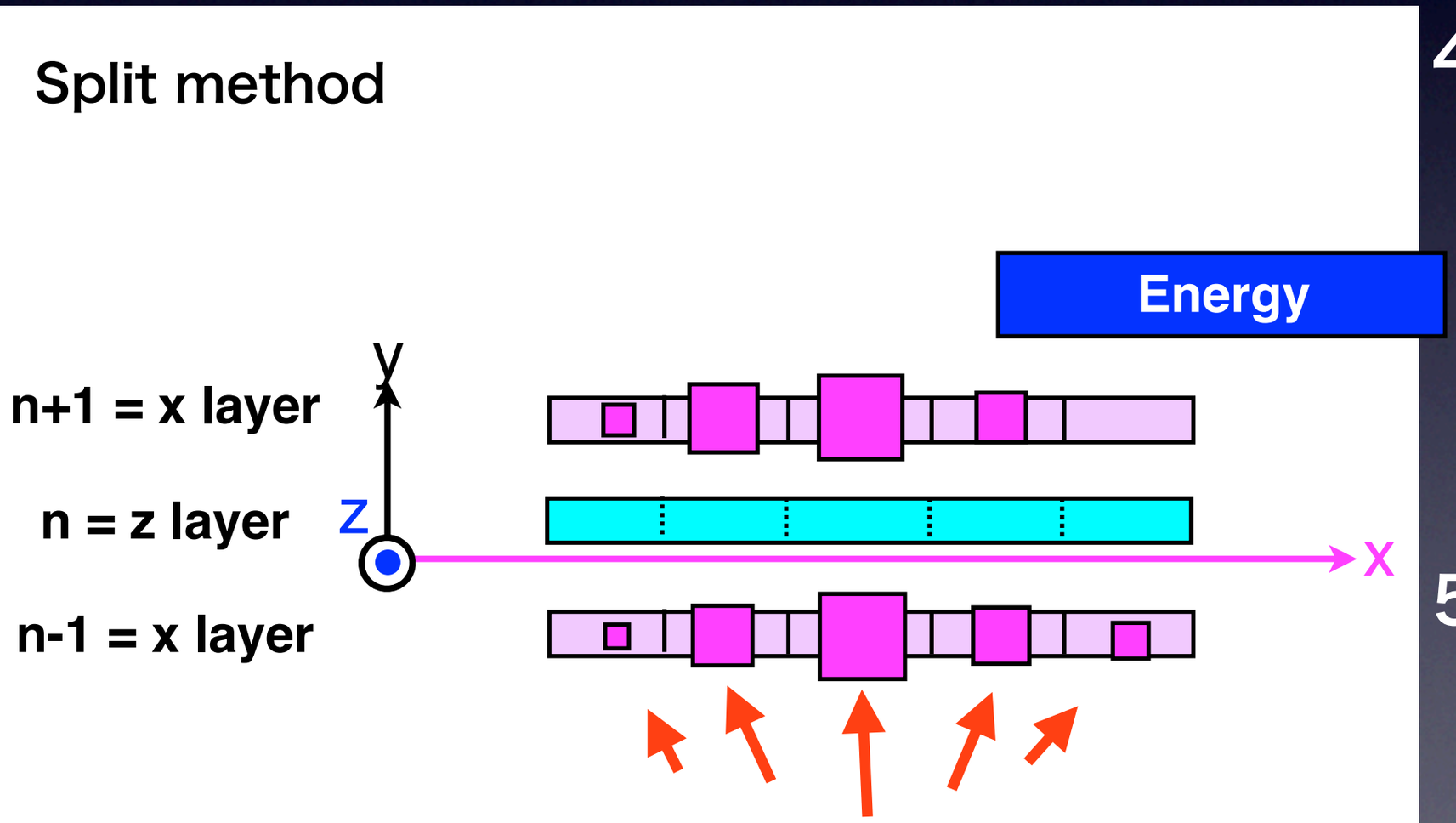

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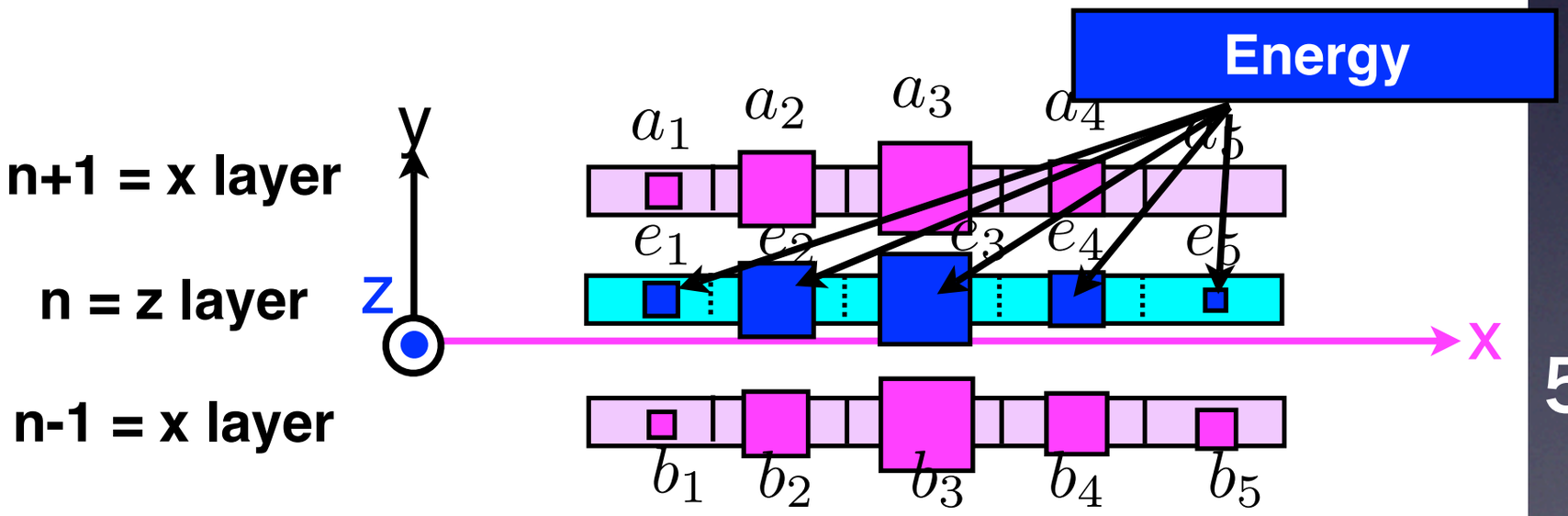

$$e_i = E_{\mathrm{n}} \cdot \frac{a_i + b_i}{\sum a_i + \sum b_i}$$

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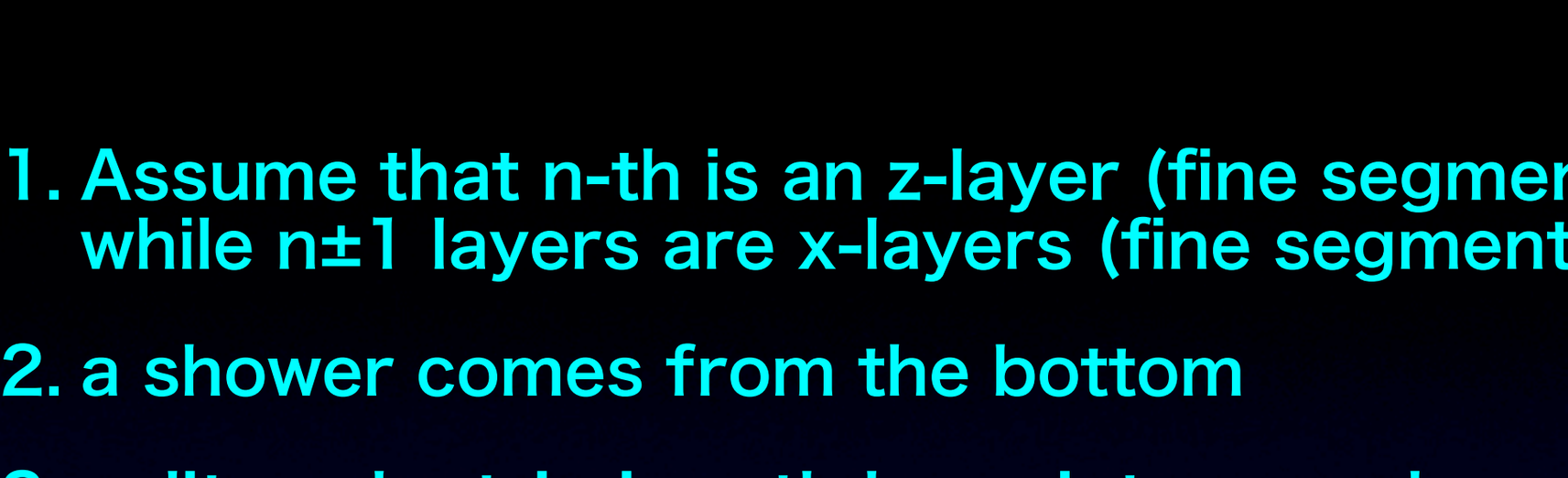


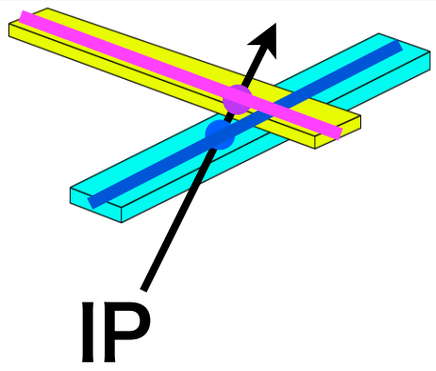
Strip Splitting Algorithm

4. energy deposit in n-th layer is distributed in pseudo cells referring adjacent n±1th layers.
5. position and energy of pseudo square cells are fed into PandoraPFA.

“hybridEcalSplitter” by D. Jeans

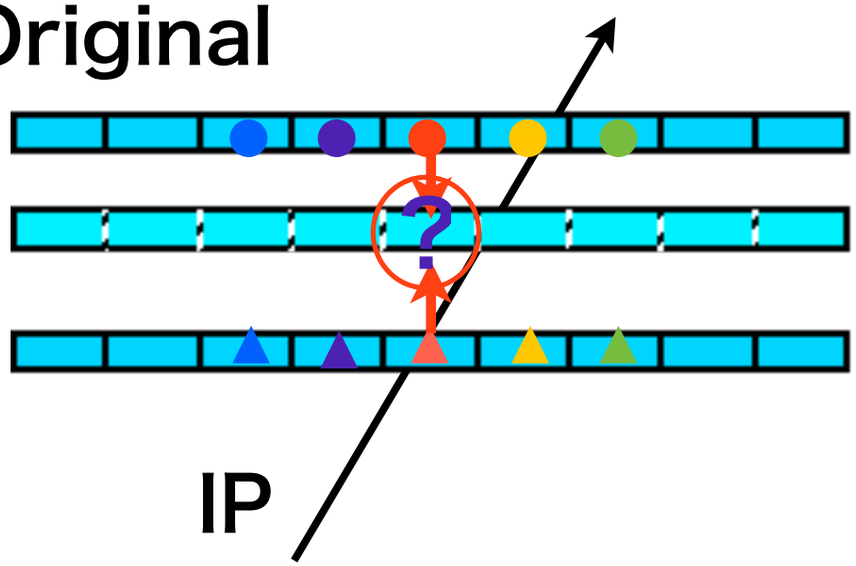
Every recent my jobs were done with this.

1. split algorithm: elegant than original SSA

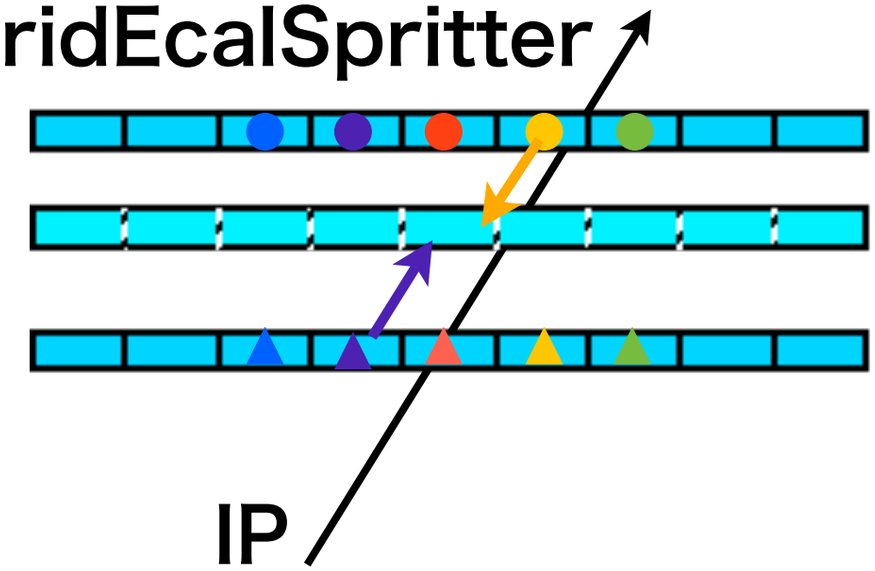


To refer the energy in the nearest neighbor layer, it scans intersection of center lines of respective scintillators toward the IP

Original



hybridEcalSpritter



Energy in virtual cell (?) =
Energy on this strip ×
(●+▲) / (▲+▲+▲+▲+▲ + ●+●+●+●+●)

Energy on this strip ×
(●+▲) / (▲+▲+▲+▲+▲ + ●+●+●+●+●)

ILD_00 to ILD_o3-V05(DBD version)