Reconstruction of Strip-ScECAL

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for ILD-scintillator ECAL

ALCPG11
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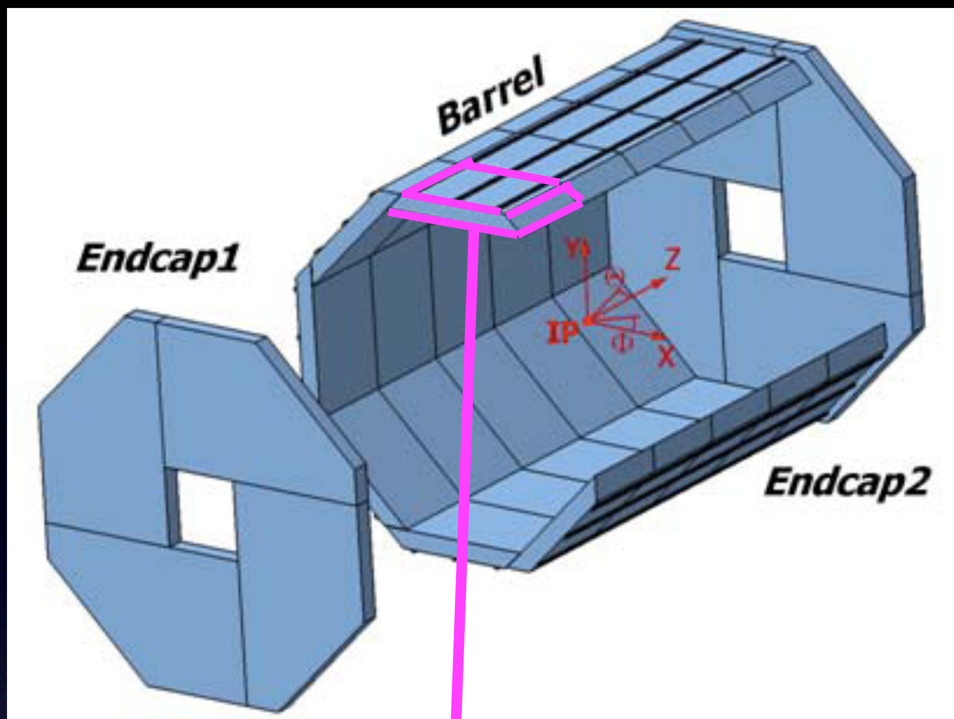
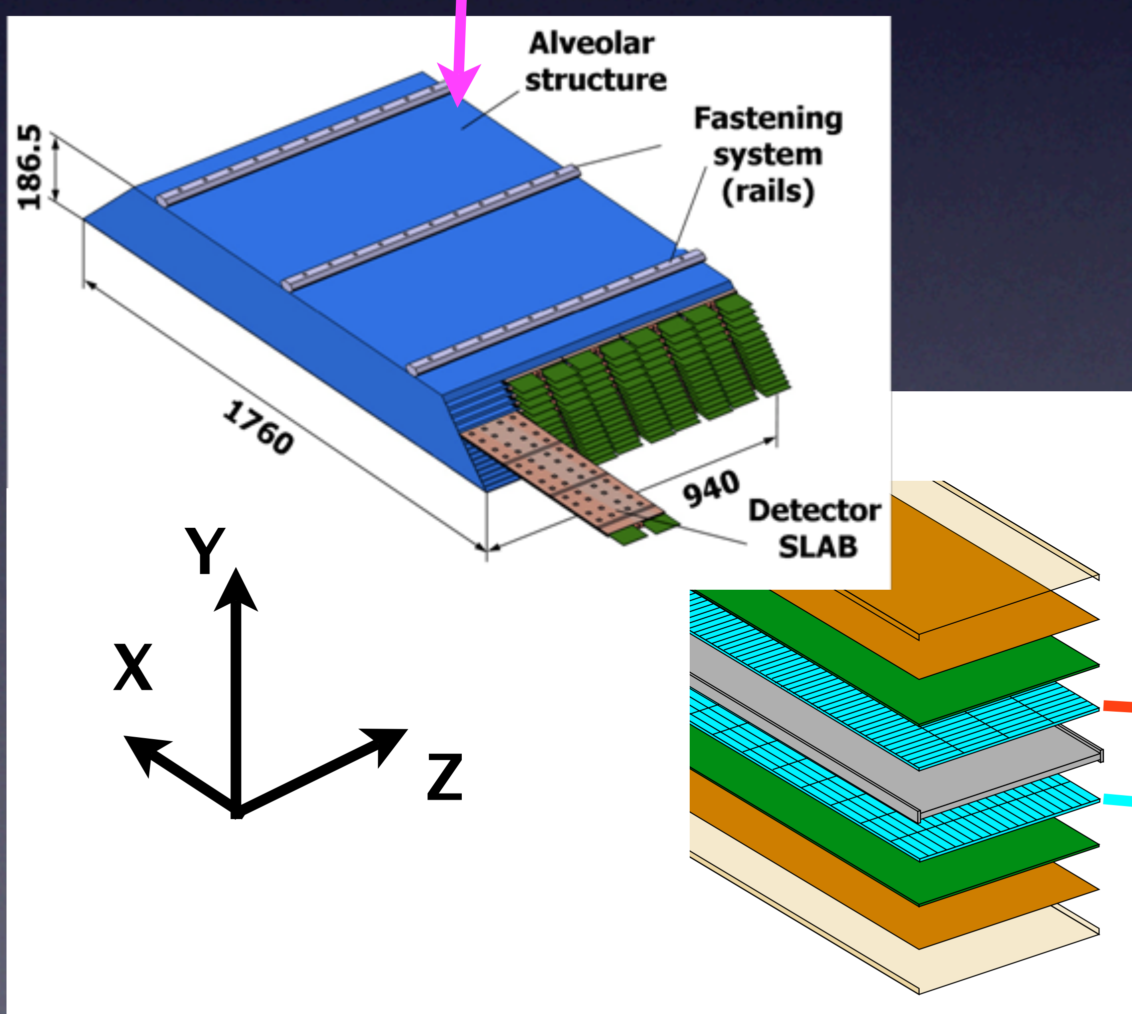
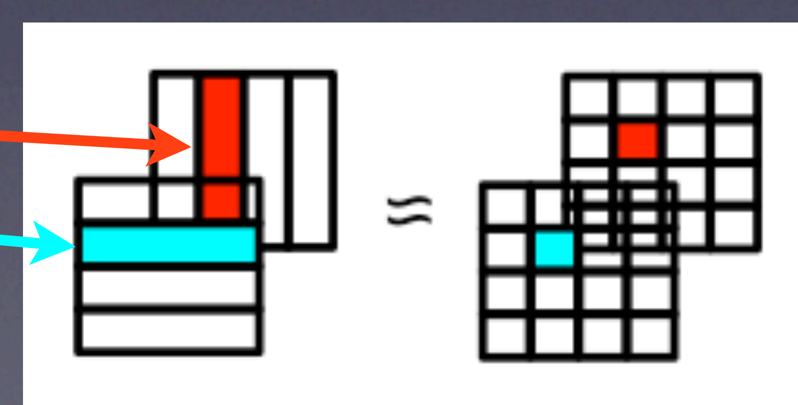
ILD scECAL

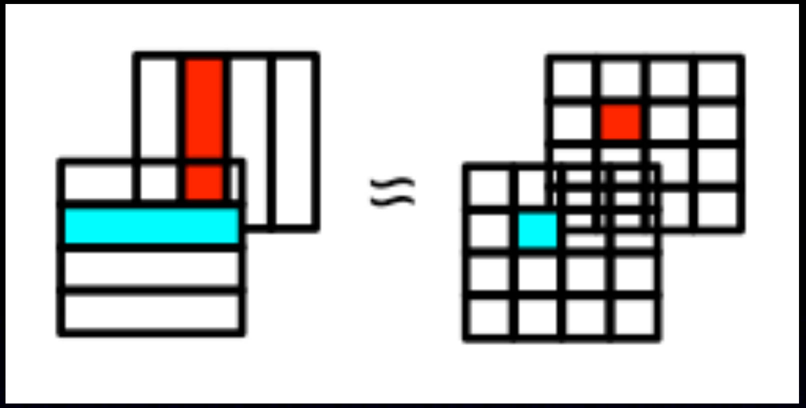


- inner radius: 1.850m
- barrel: 4.900 m long
- 25 Layers
    - W absorber 3 mm thick
    - plastic scintillator
        - x 10^7 channels
        - 5 mm wide
        - 45 mm long
        - 2 mm thick
- JER/$\sqrt{E}$ < 30% @ $\sqrt{s}$ =91 GeV necessary.





Introduction



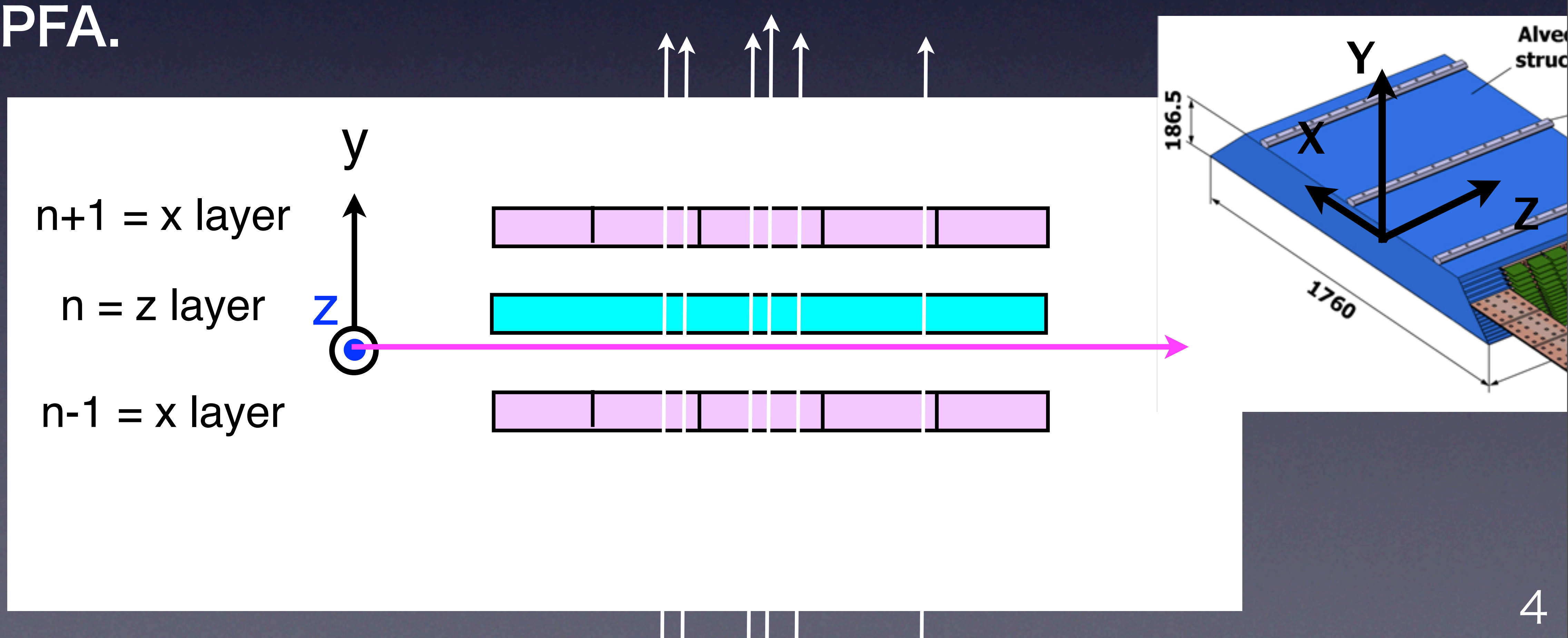
- ScECAL is aiming at "effective" 5 x 5 mm^2 granularity orthogonal directions of scintillator strips in alternative layers with dimension 5 x 45 mm^2

- Possible problem: Ambiguity when multi-particles hit in a strip
- A special algorithm must be developed and its performance must be demonstrated

- "Strip-splitting method"
  - A simple algorithm to distribute energy deposit in a strip into virtually splitted square cells.
  - Energy deposit in the square cells are fed into PandoraPFA i.e. clustering algorithm in PandoraPFA is used.

Strip-Splitting method

1. Assume that n-th is an z-layer (fine segmentation in z direction), while n±1 layers are x-layers (fine segmentation in x direction).
2. Split n-th layer into virtual square cells.
3. Energy deposit in n-th layer
4. is distributed in virtual square cells according to the energy deposits in adjacent (n-1)th and (n+1)th layers.
5. The position and energy of virtual square cells are fed into PandoraPFA.



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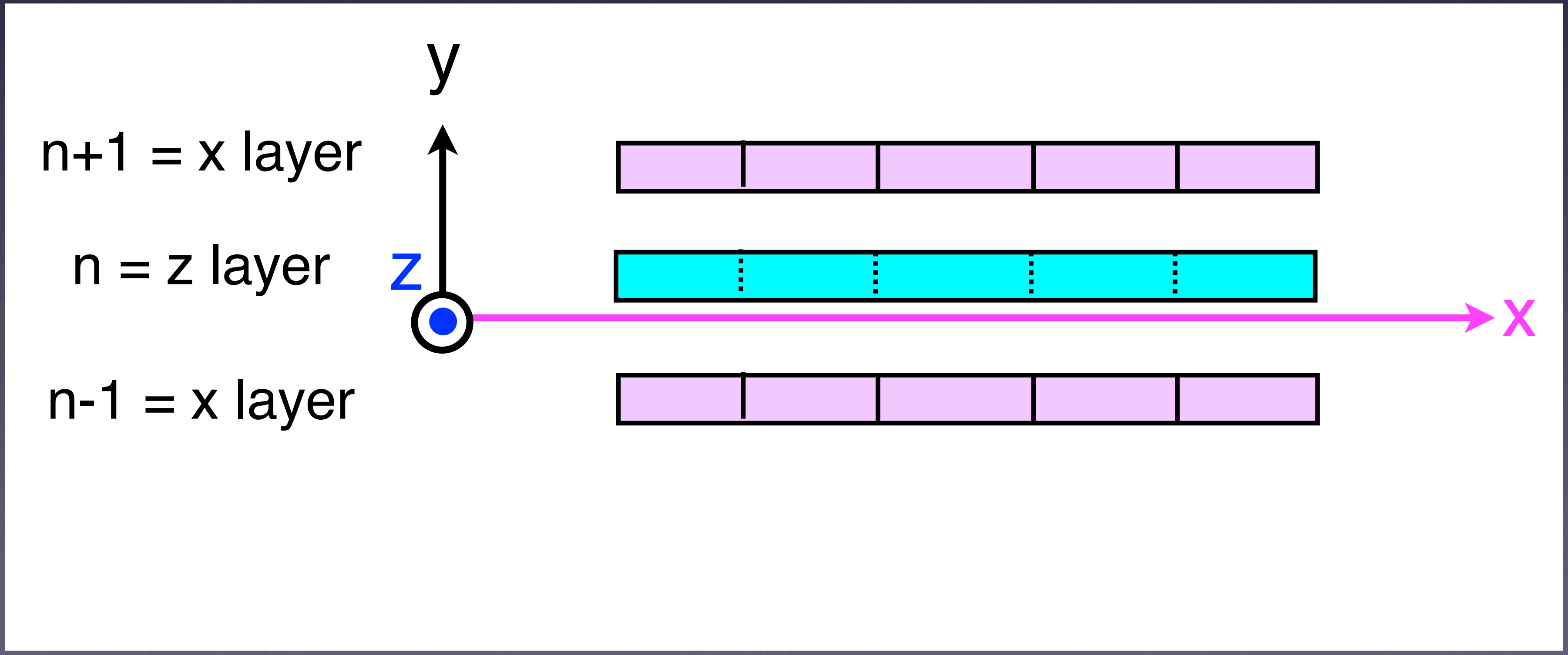

Strip-splitting method

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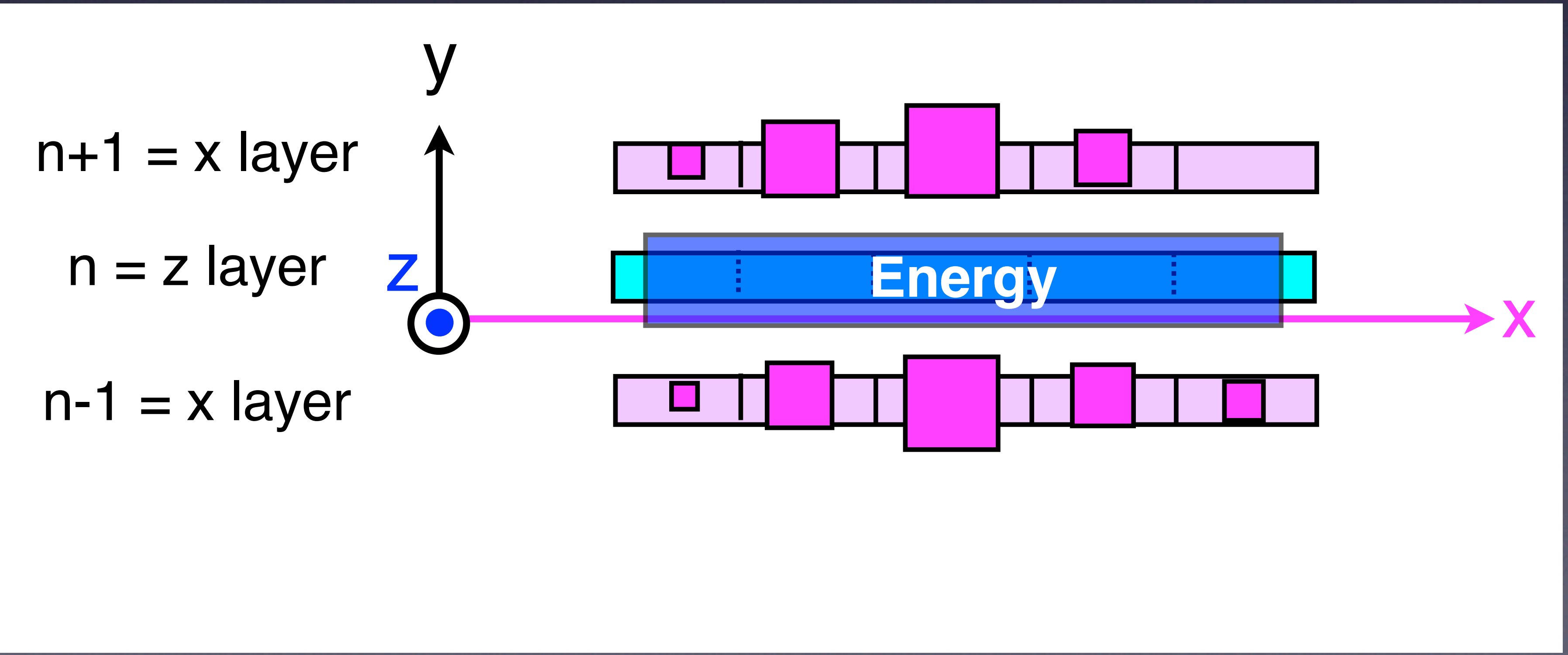

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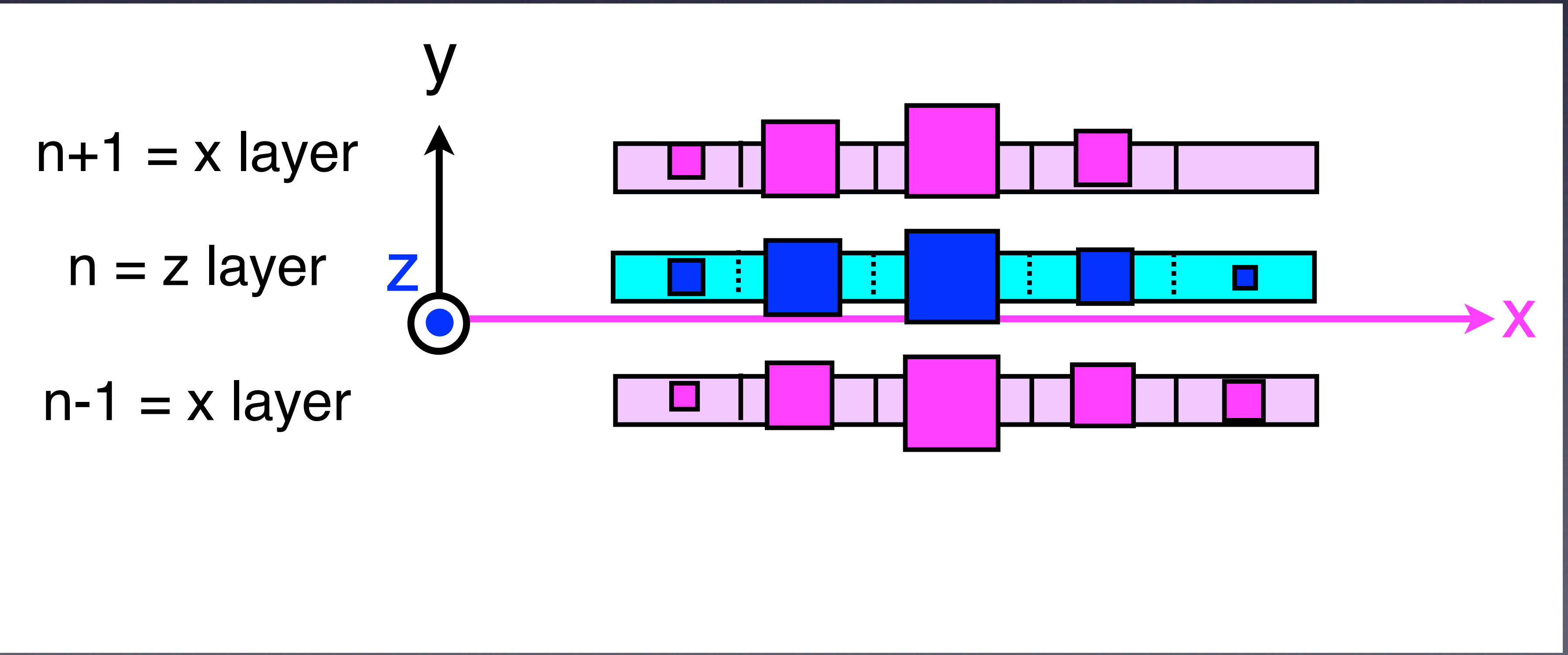

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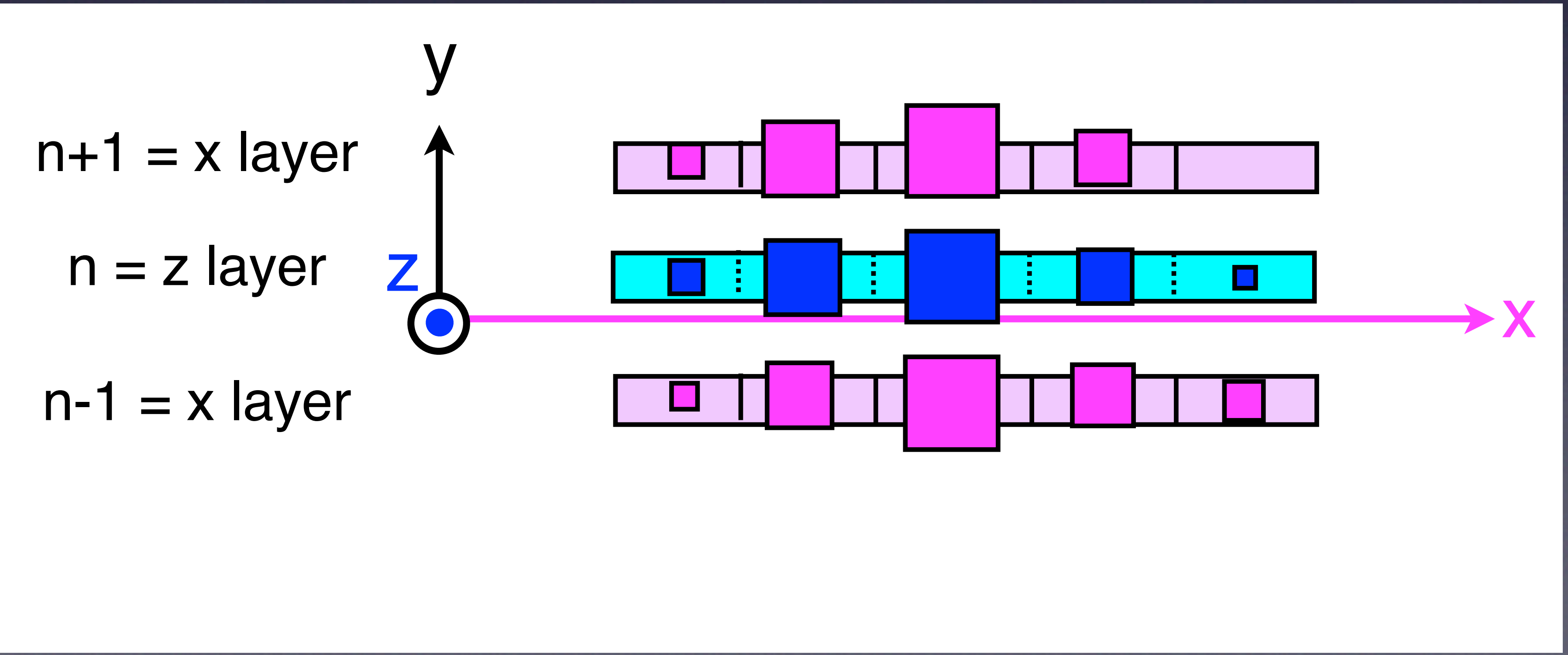
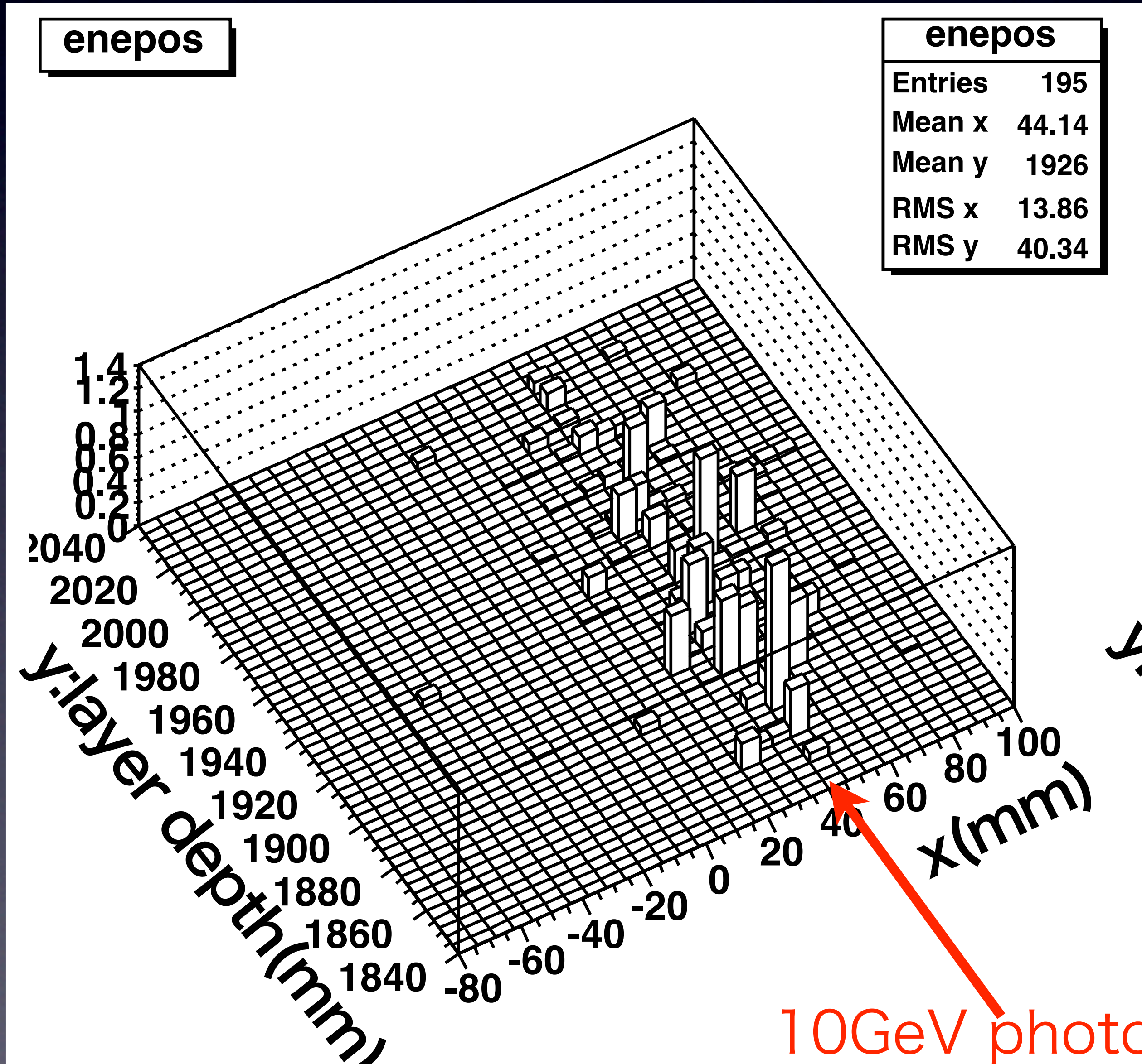


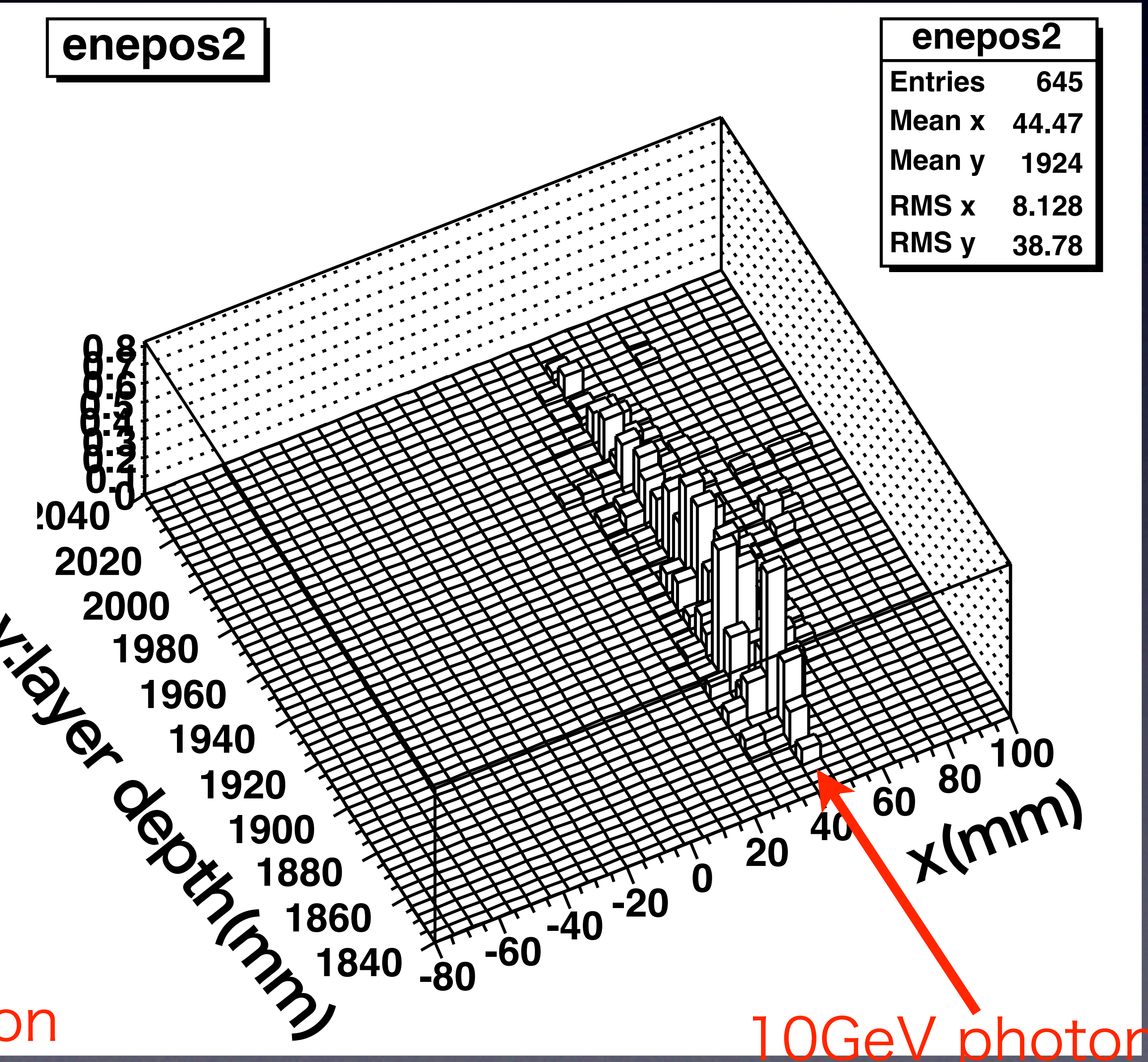
Strip Splitting exam.

A typical event : 10GeV photon

Energy summed up to z direction (y-x plane)

Before Strip-Splitting **After Strip-Splitting**

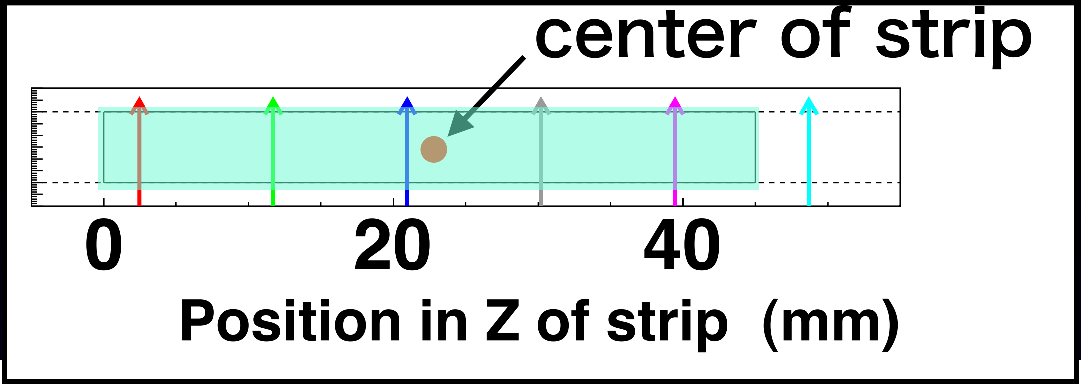




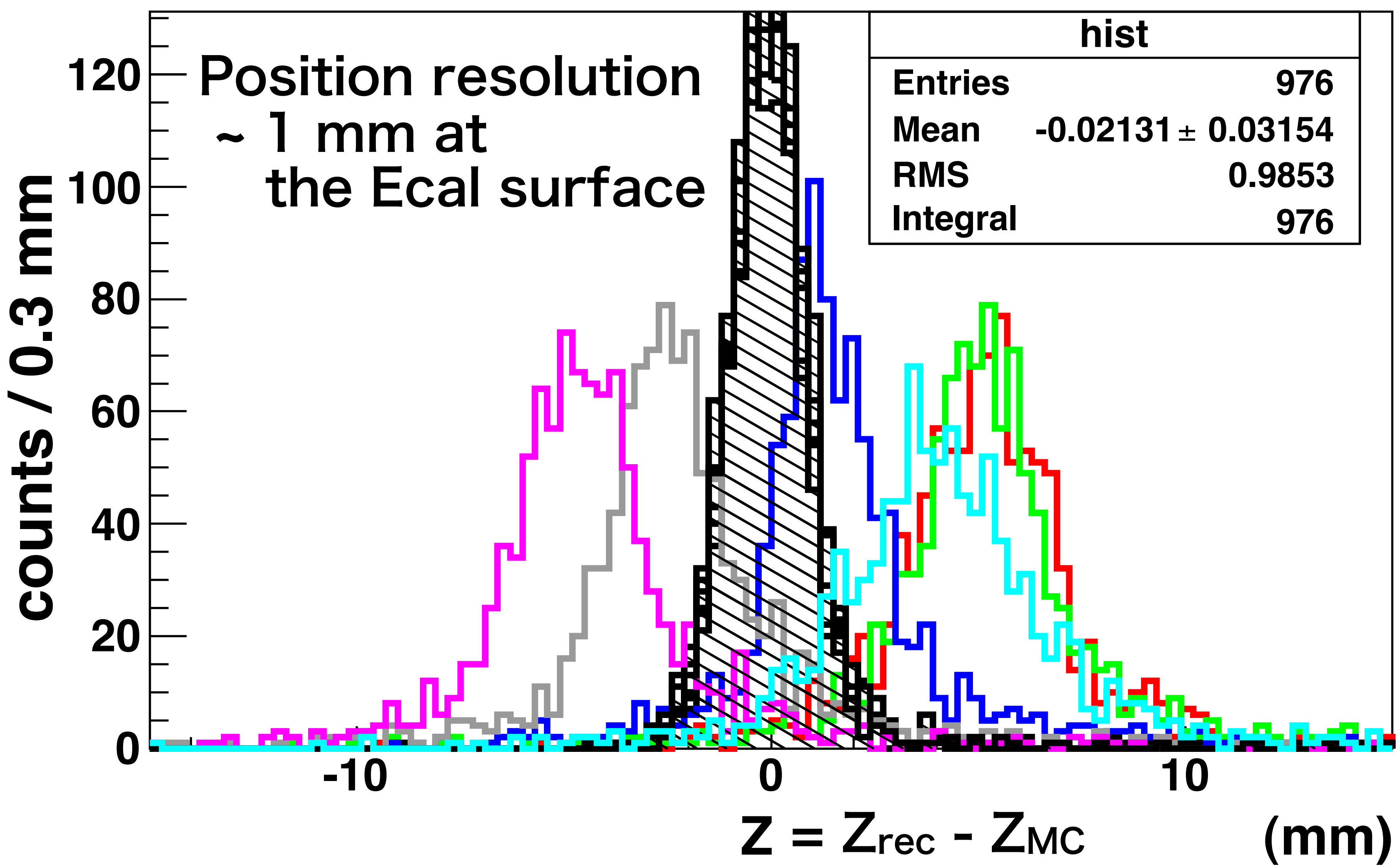
Strip-splitting is working well

Position resolution : in z for 10 GeV photons

a strip



Position difference between reconstructed position and MC true ($z = z_{rec} - z_{MC}$) at the ILD ECAL surface for 10 GeV photons with incident polar angles approximately 90°.



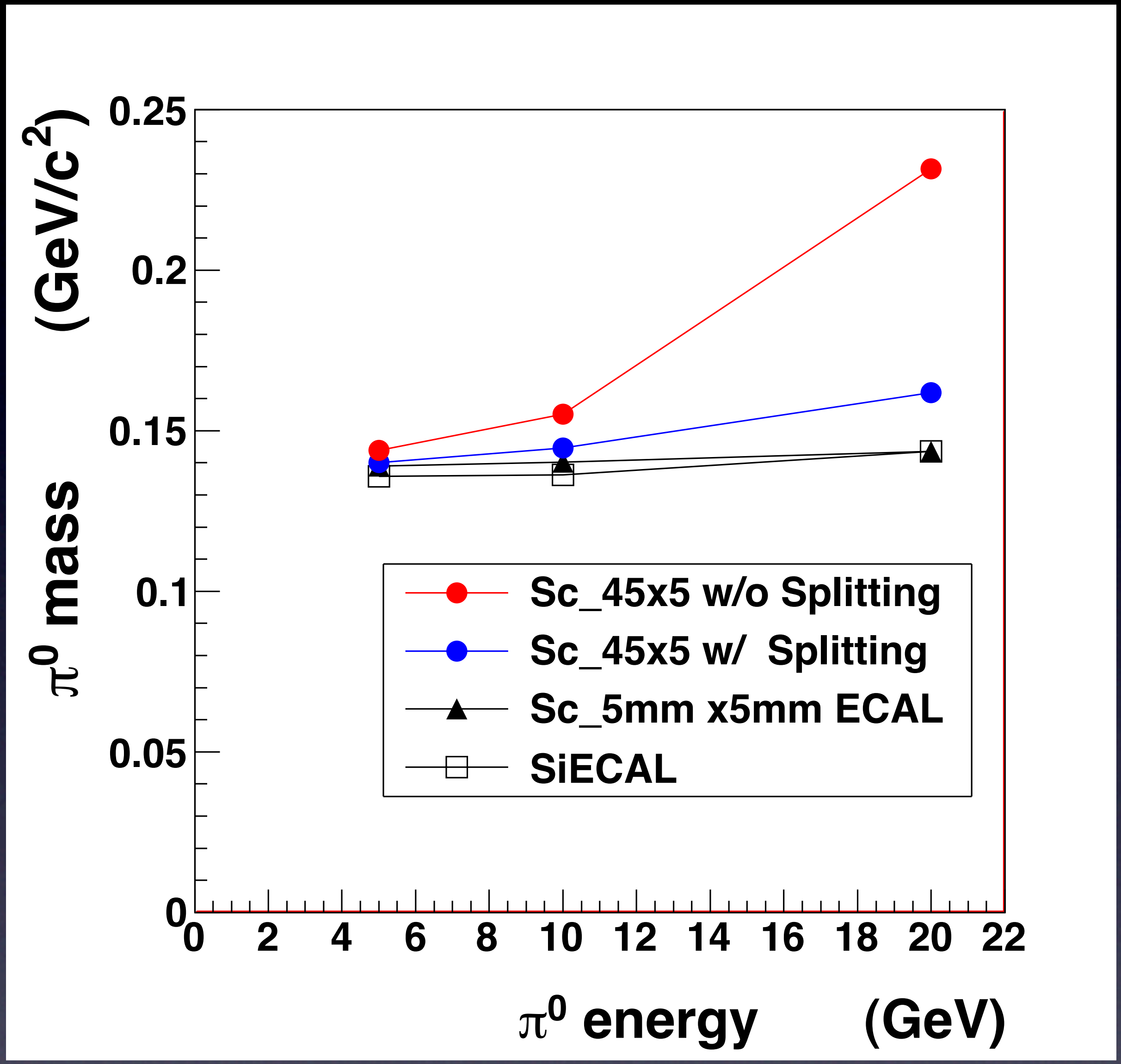
For 45 mm x 5 mm strips:

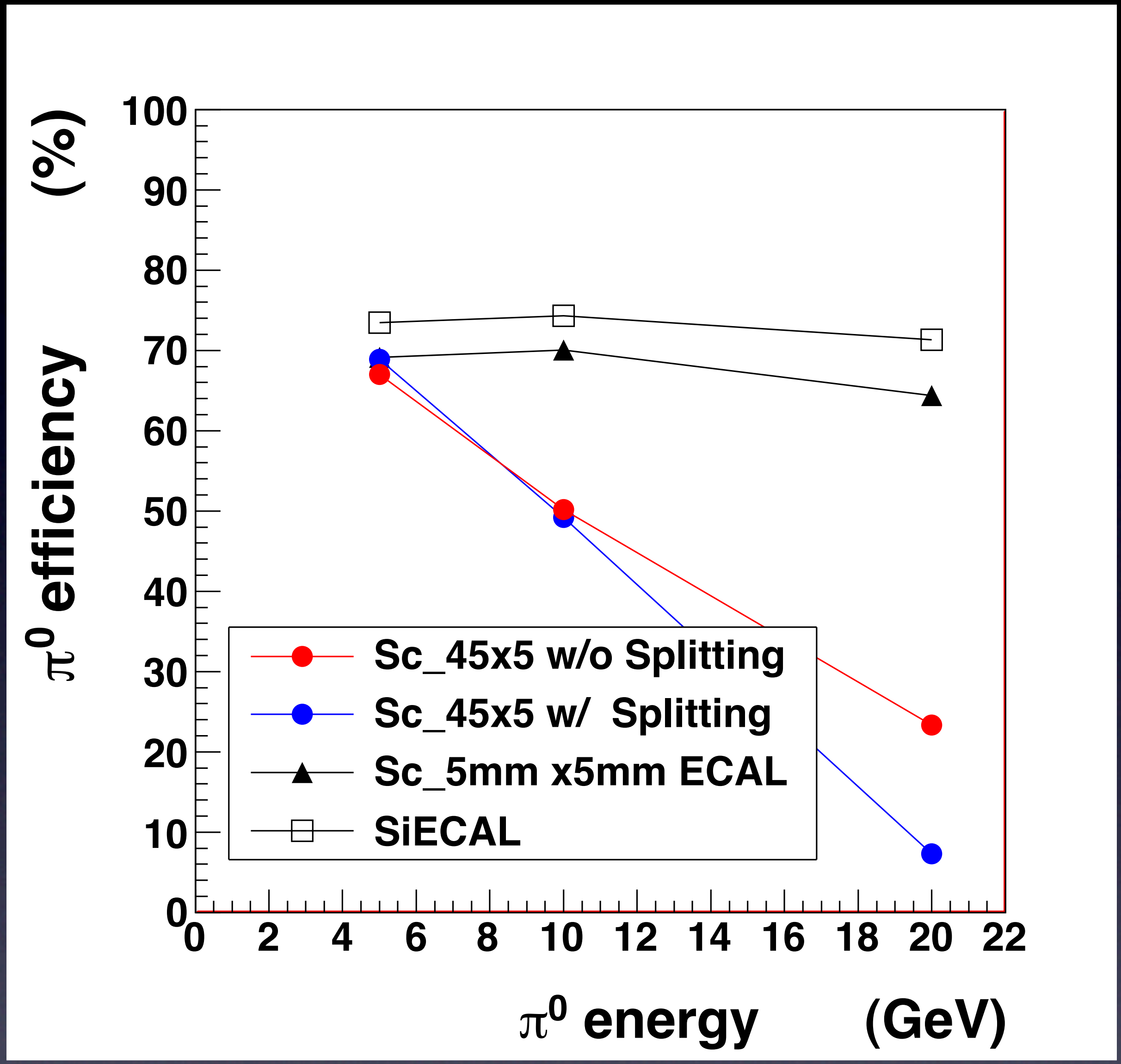
colored: z distributions of energy-weighted mean position without the strip-splitting method

Black: z distribution of reconstructed PFO with strip-splitting method

Systematic shift is removed by the strip-splitting method.

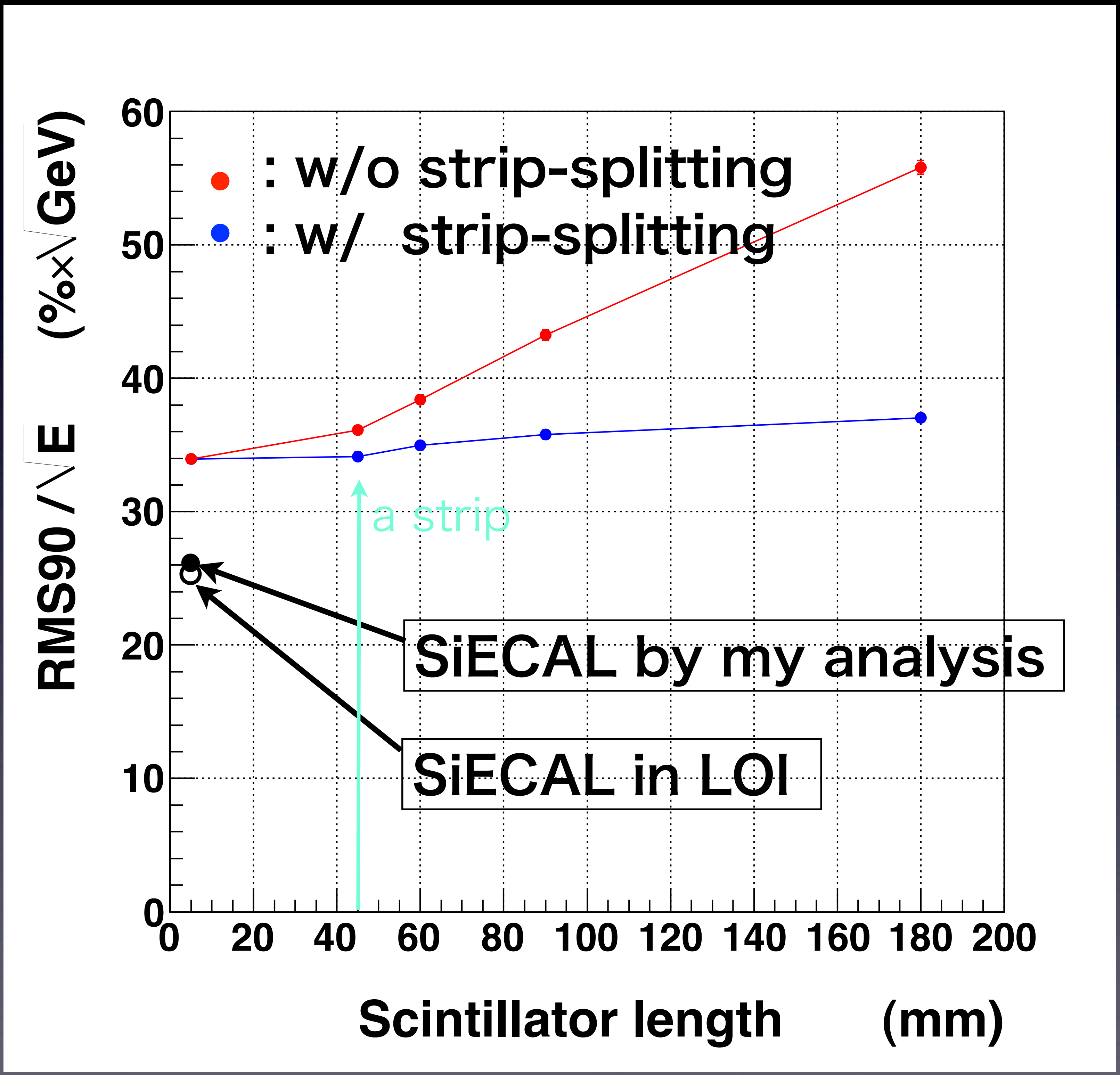
π^0 mass and π^0 recon.efficiency vs. π^0 energy





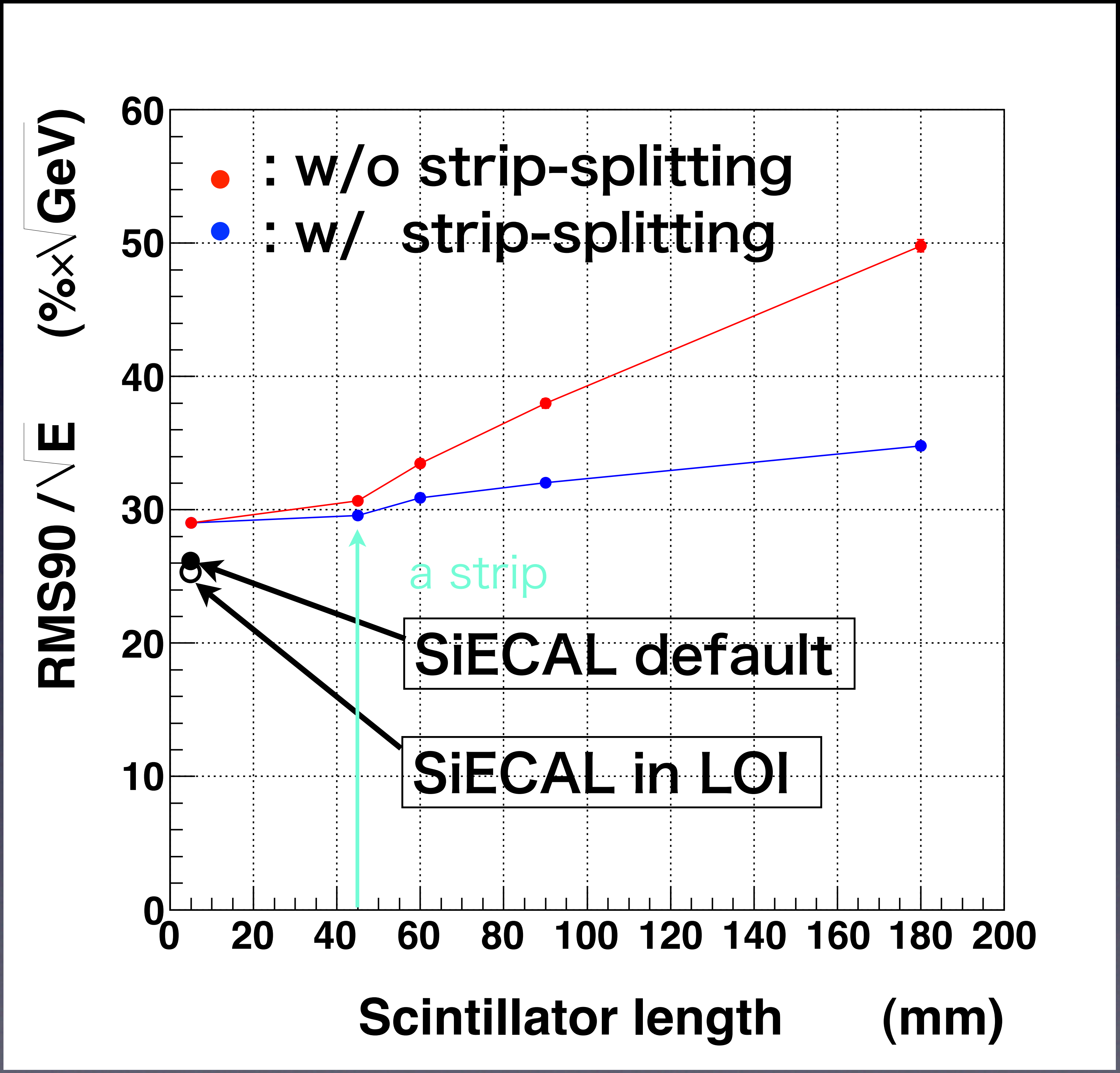
- Reconstructed π^0 mass using strip-Splitting method looks reasonable.
- Efficiency degrades with higher energy.
- Sc5x5squareECAL has reasonable efficiency ▶ This does not explain the difference of JER between SiECAL and ScECAL
- Need tune photon clustering in PandoraPFA

Length dependence of JER 45 GeV with realistic generator



- Realistic simulation (generator)
  - intrinsic strip shape
    - not needed to merge square cells in generator(no doubt to cheat square information)
  - MPPC dead volume
  - reflector dead volume
  - PCB boad
  - copper radiator …
- StripSplitting method works well
- different of JER between SiECAL and ScECAL remains

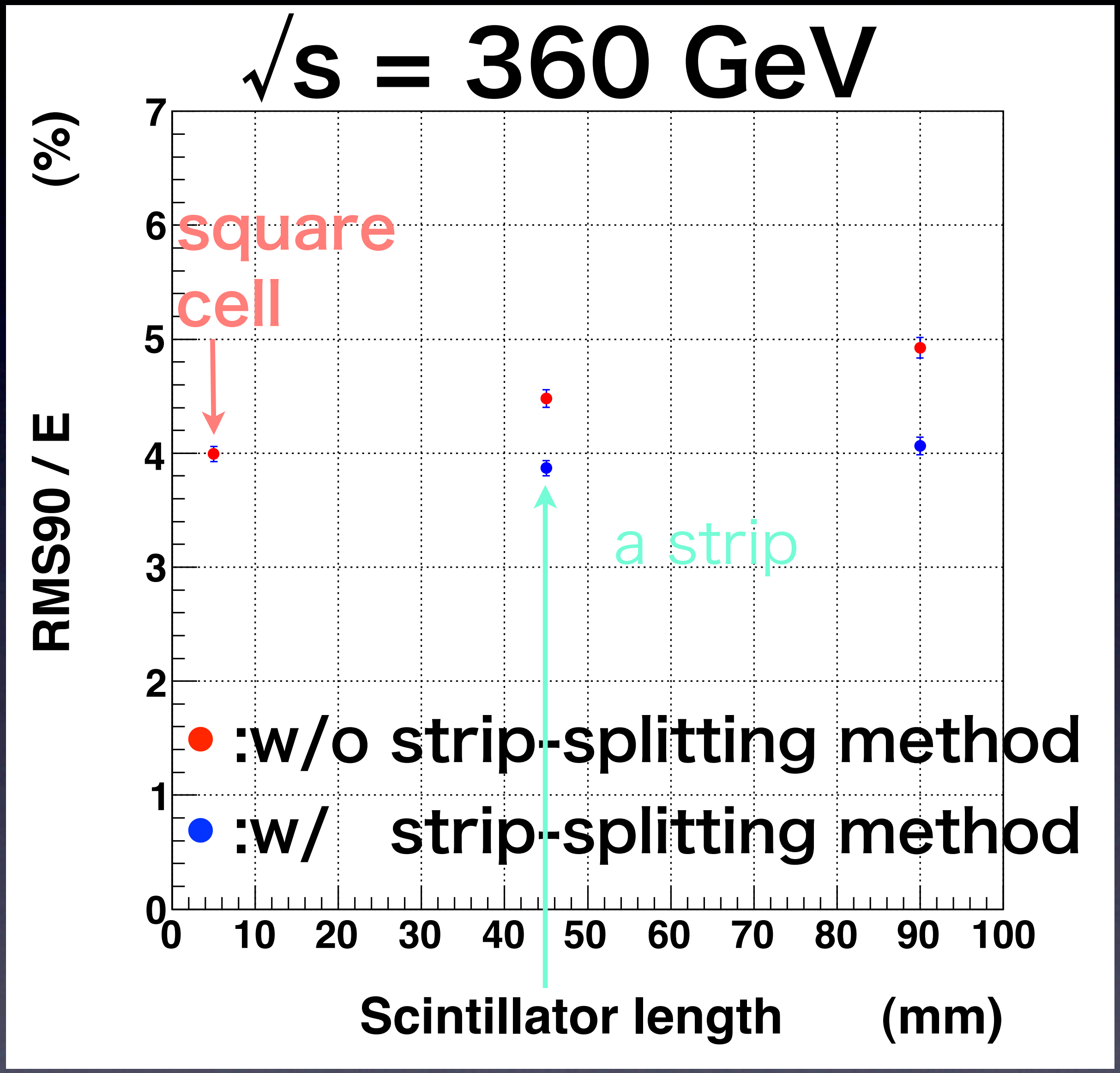
Length dependence of JER 45 GeV after tuned by author of PandoraPFA

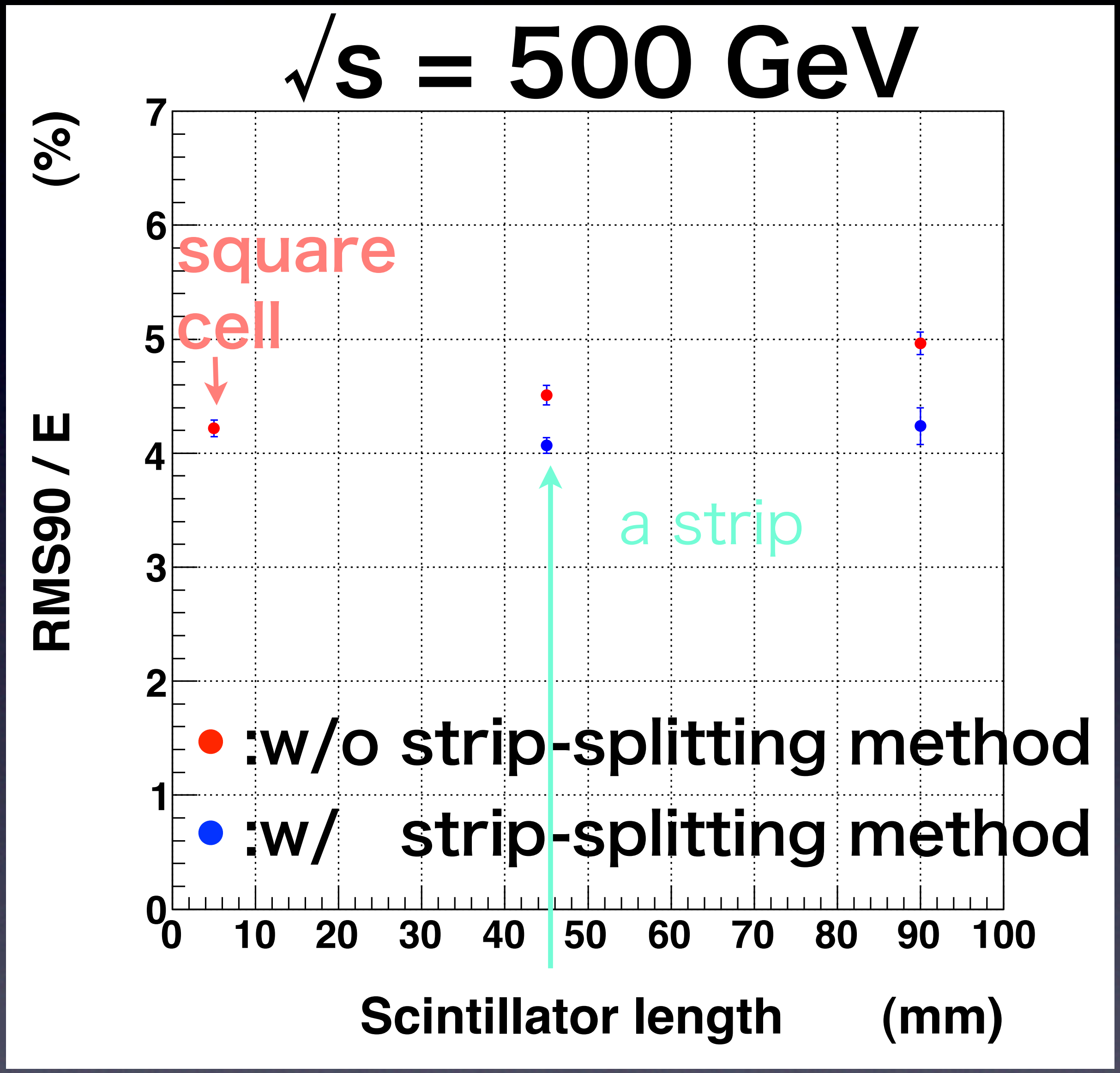


- PandoraPFA is tuned
- Sc45x5mm^{2}StripECAL achieves to have JER/√E less than 30%.

Jet energy resolution vs. scintillator strip length at higher energy

-PandoraPFA is NOT tuned

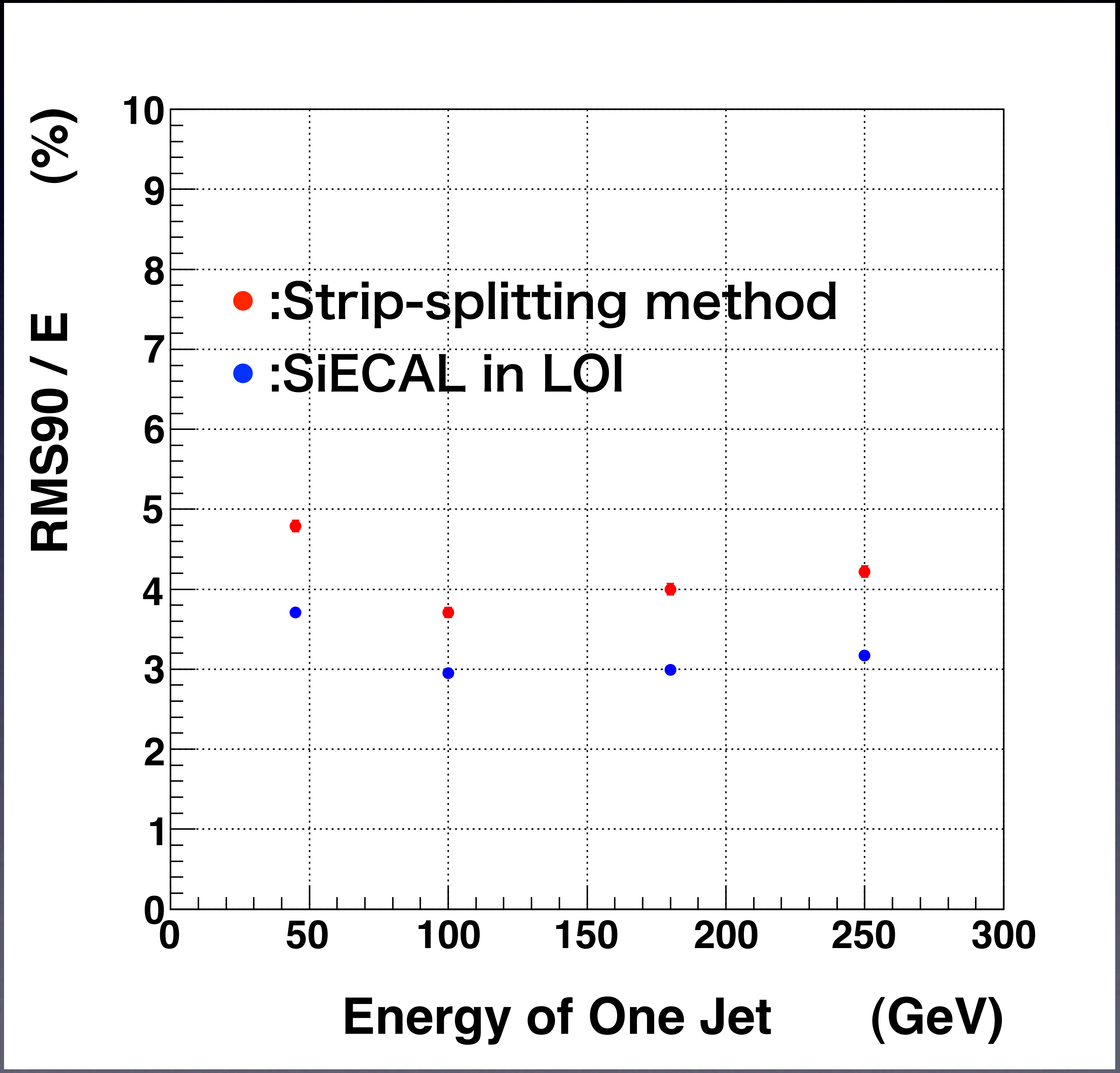




Even at √s = 500 GeV, 45 mm x 5 mm ScECAL shows similar performance to that of 5 mm x 5 mm square tile ScECAL.

Jet energy resolution vs. jet energy

-PandoraPFA is NOT tuned for scecal



The tendency is similar to that of SiECAL in LOI

Planed layer structures are different than each other of ScECAL and SiECAL: SiECAL has fine layers 1 - 20th layers

Similar layer structure for ScECAL was tested ▶ no effect

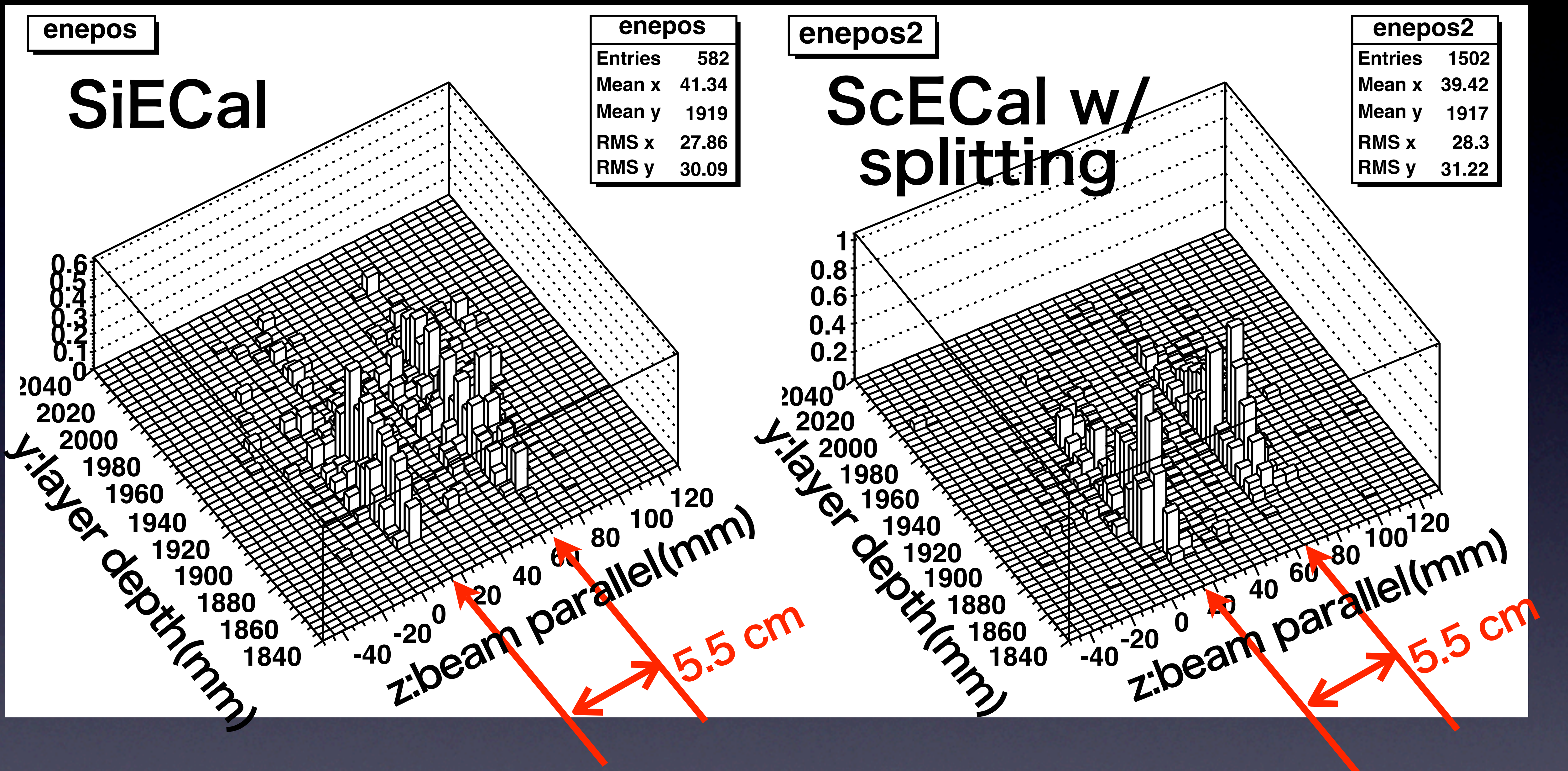
Difference of JER between ScECAL and SiEAL can be reduced by tuning

Summary

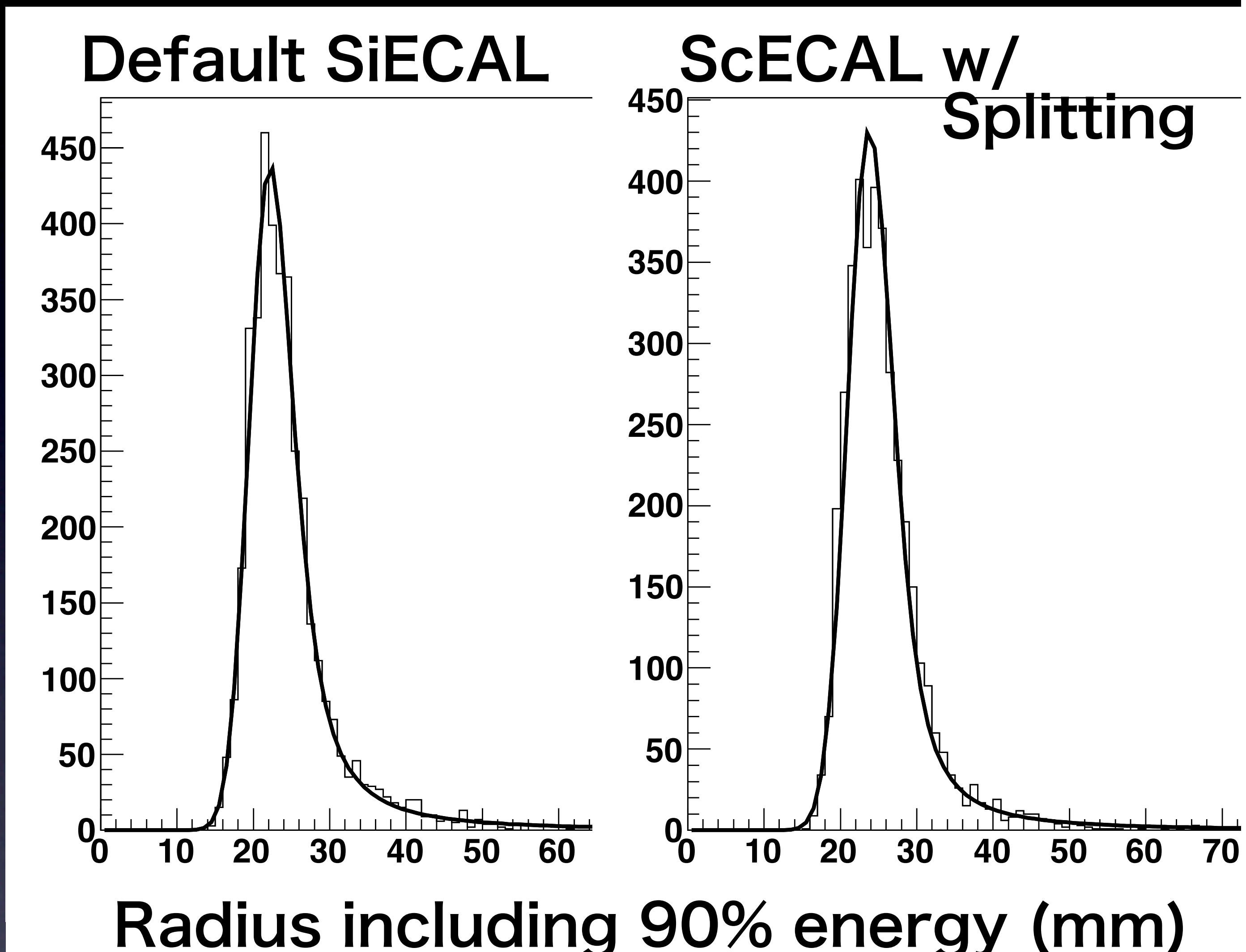
- ScECAL employs Scintillator strip technology to reduce the number of channels
- We need to develop special algorithm for Sc_Strip_ECAL.
- Strip-Splitting method was devised.
- Strip-Splitting method seems promising: up to $\sqrt{s} = 500$ GeV, ScECAL with 45x5 mm scintillator strip shows the similar performance to that 5 x 5 mm scintillator ECAL has.
- Sc45x5mm^{2}ECAL achieved JER/$\sqrt{E}$ < 30% for $\sqrt{s} = 91$ GeV with more realistic simulation than previous version.
- Difference of performance between SiECAL and ScECAL should be removed with fine tuning of PandoraPFA.

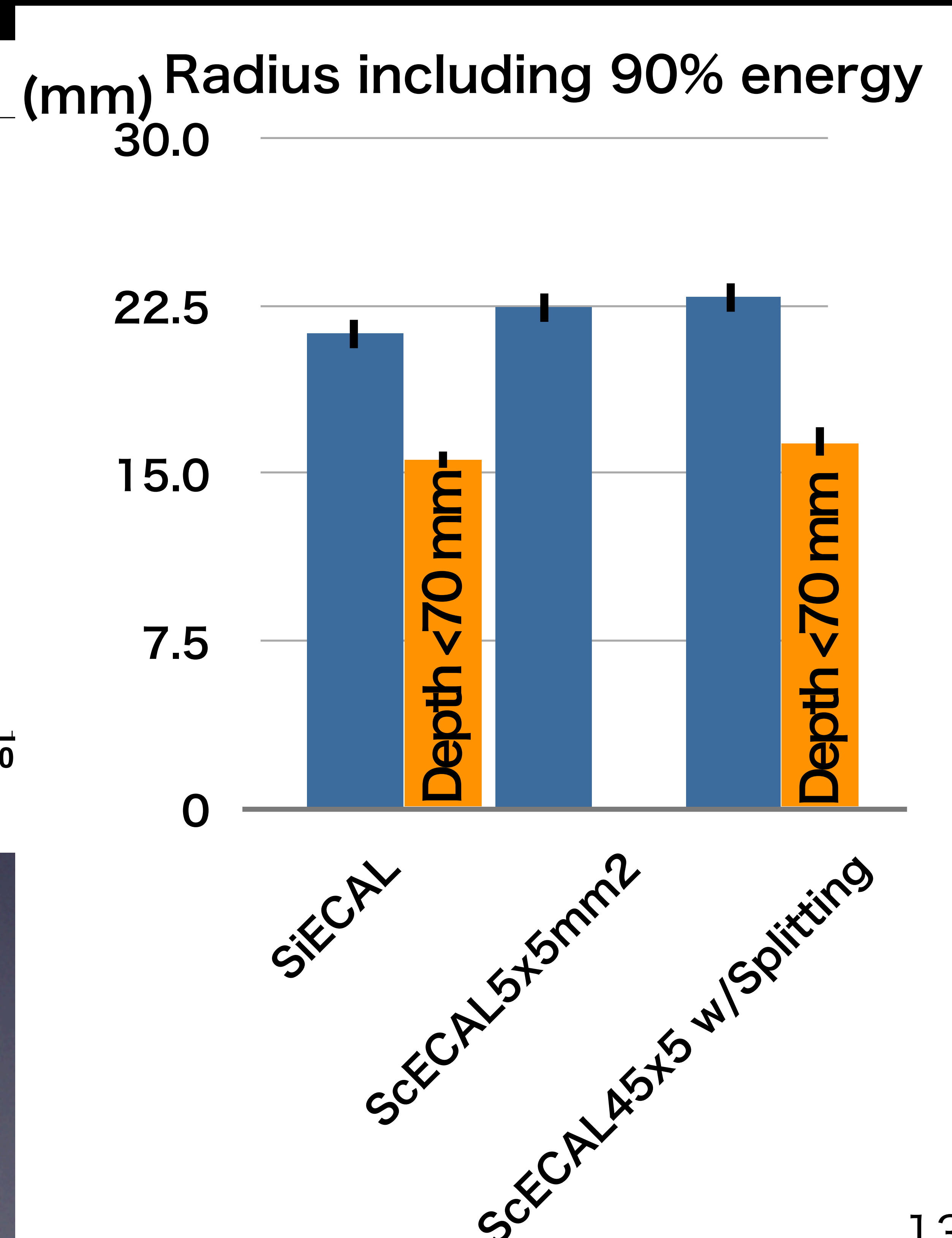
back up

Two photon clusters in SiEcal and ScStirpEcal with Splitting method



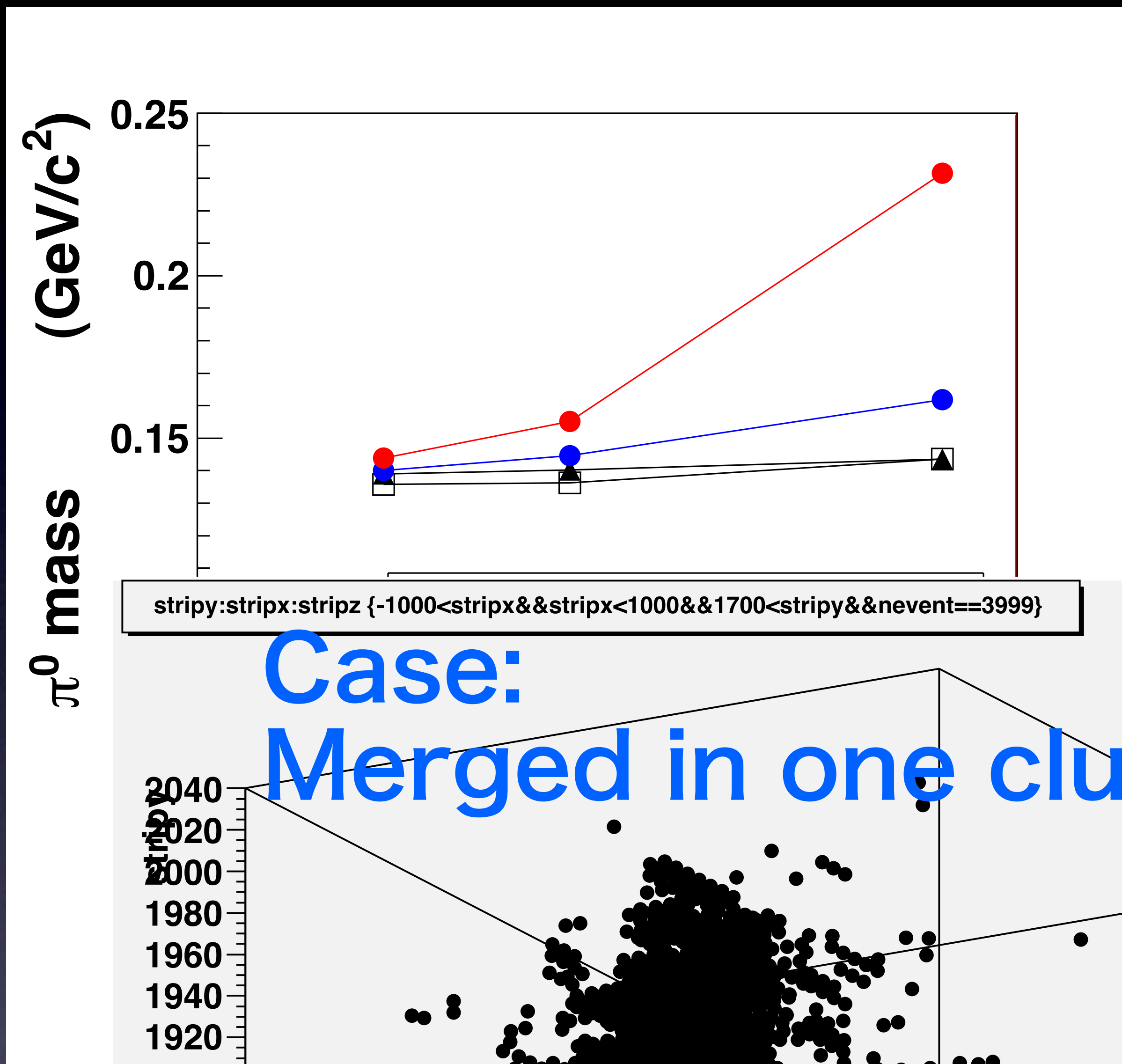
Radius of 10 GeV photon in ECAL

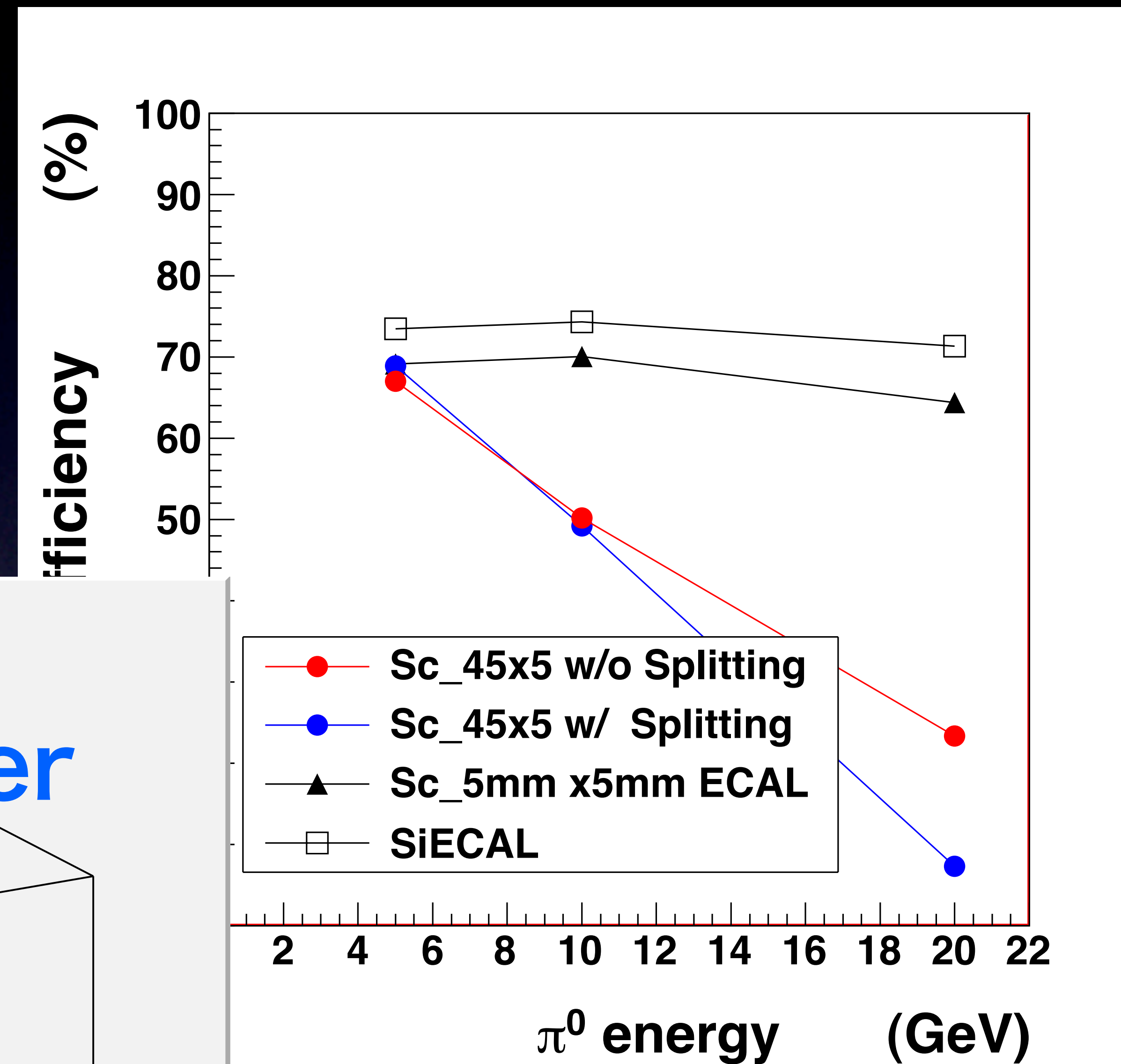


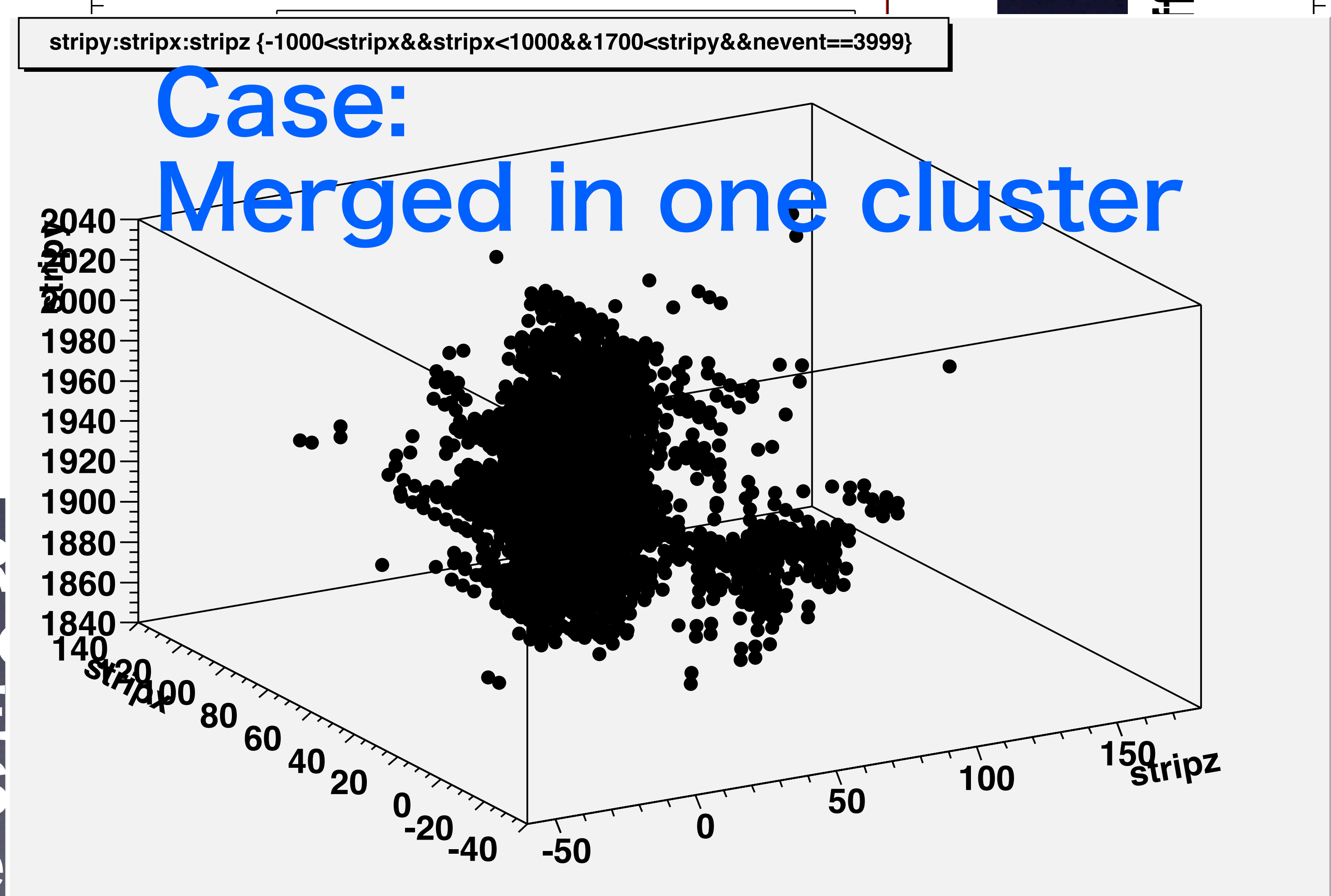


-MPV of Landau-gaussian fit to cluster radius including 90% energy is not so different between SiECAL and ScECAL

π^0 mass and π^0 recon.efficiency vs. π^0 energy







- R… plitting method looks r…
- E… gy.
- S… ficiency ▶ This does not e… n SiECAL and ScECAL
- Need tune photon separation for strip-Splitting method.

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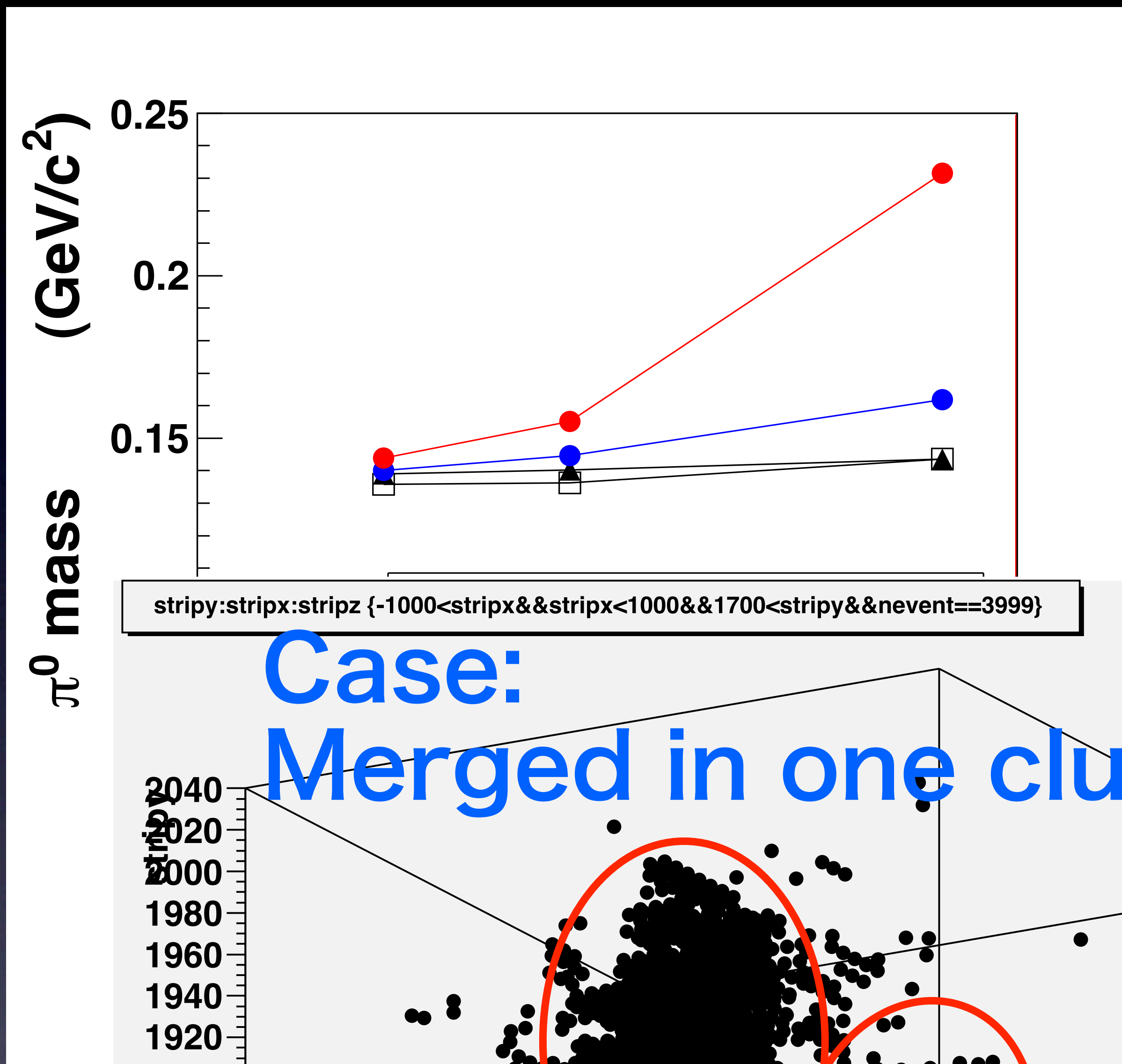

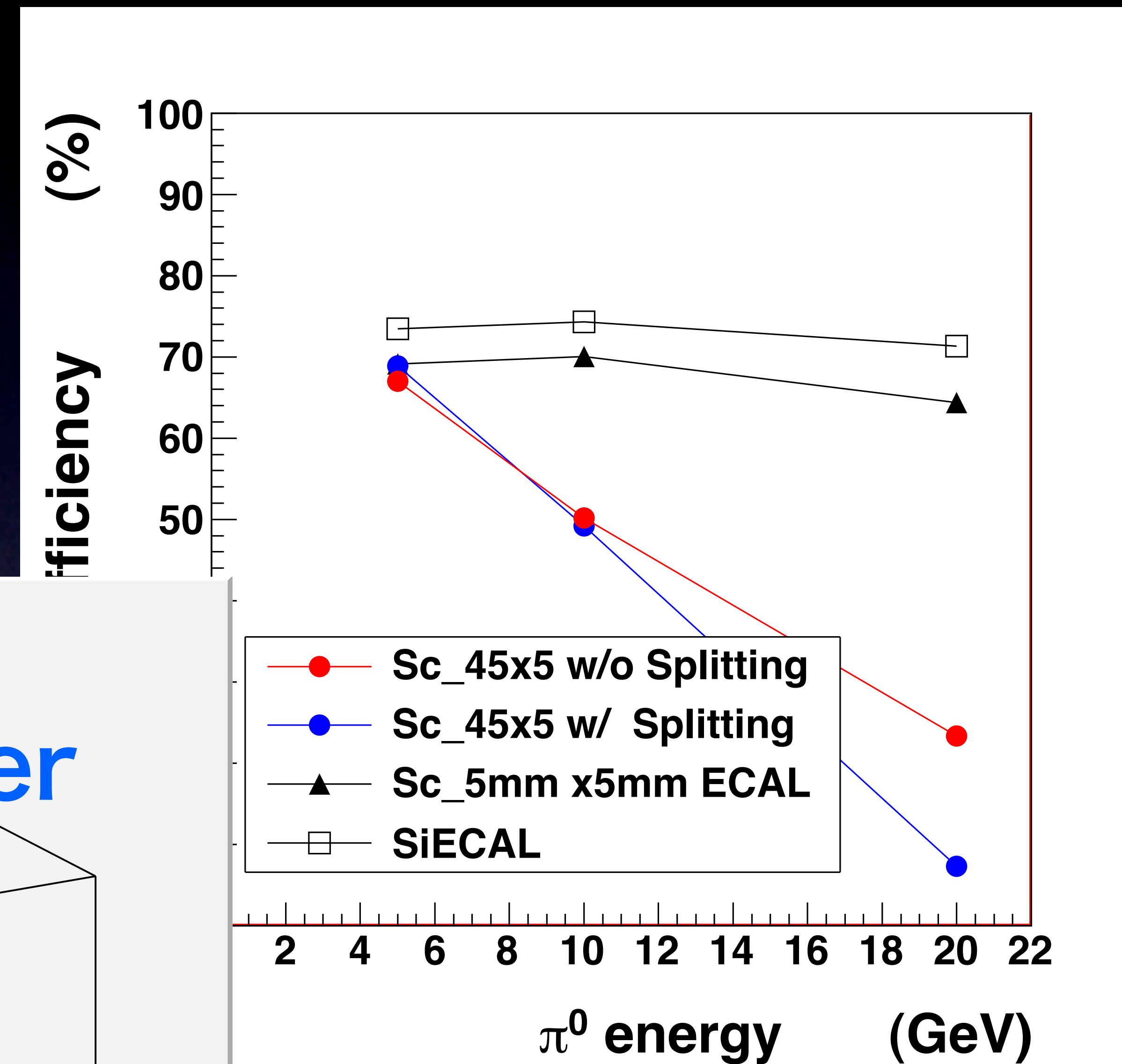

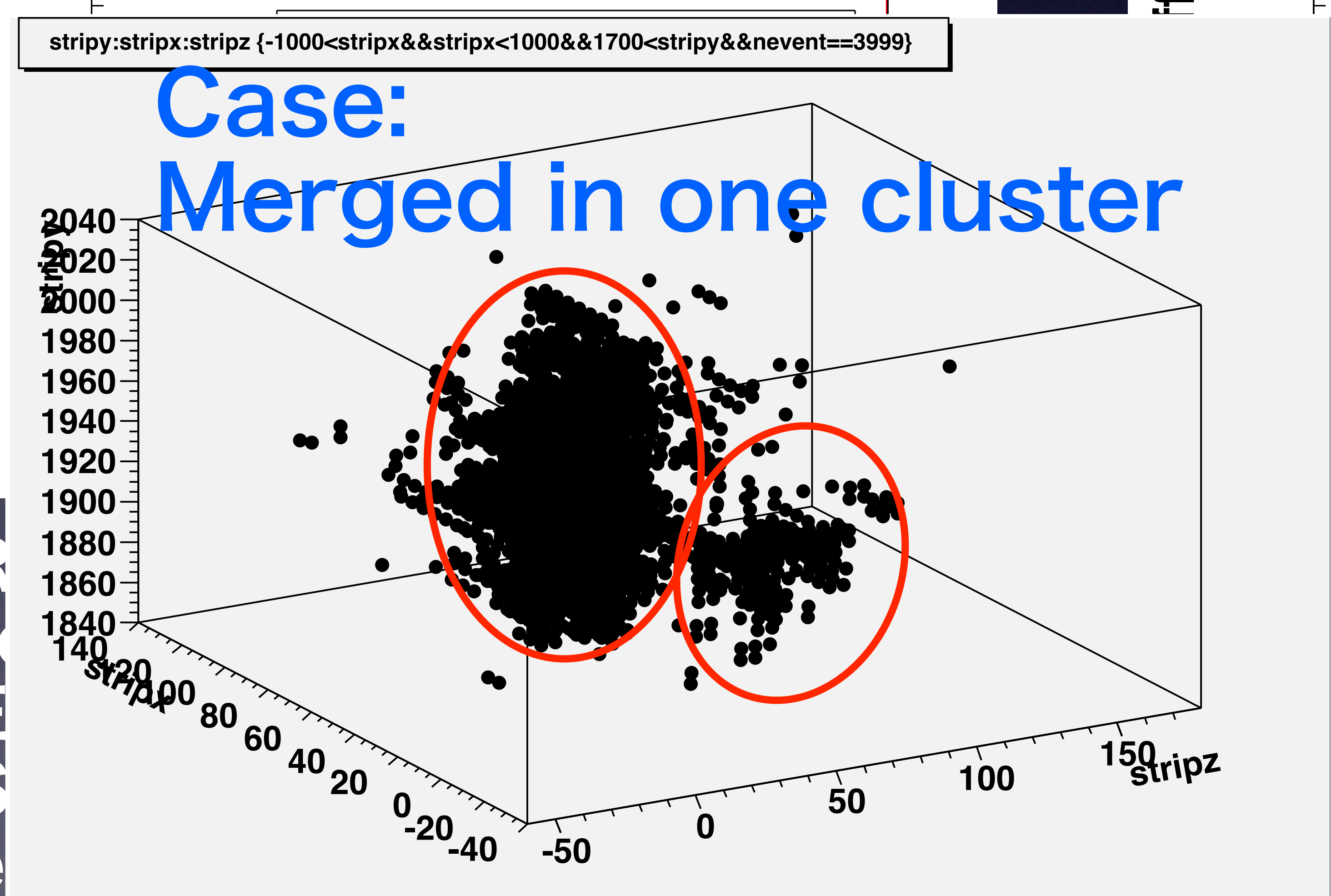

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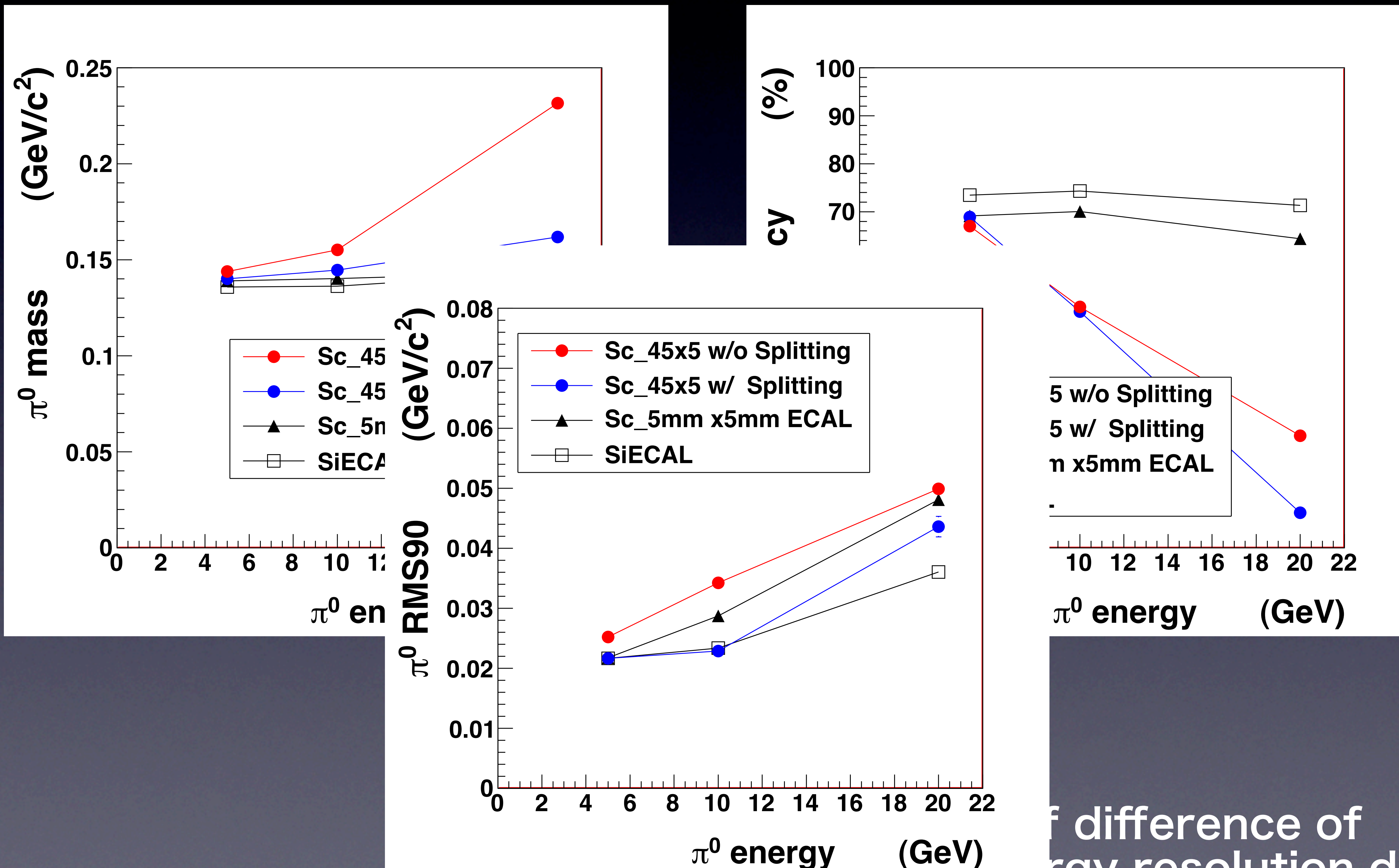
Energy resolution of 10 GeV photon in various conditions



f difference of
photon energy resolution does