Calorimeters using Scintillator Strips

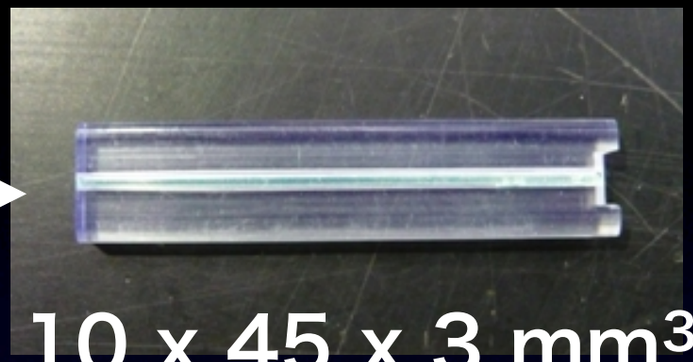
ILC Tokushin - Kick off meeting

13 / Sep. 2011 k. kotera KEK/DESY

Scintillator strip calorimeters

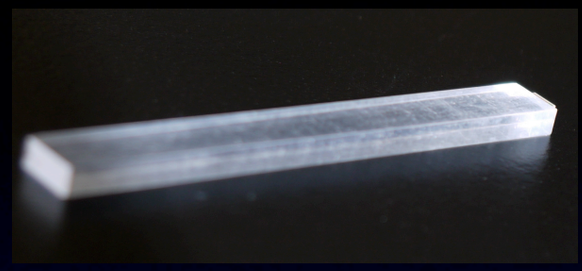
Large size (tracker):
MINOS,T2K
Satellite

history,ScECAL
1st Prototype



10 x 45 x 3 mm³
with WLS fiber

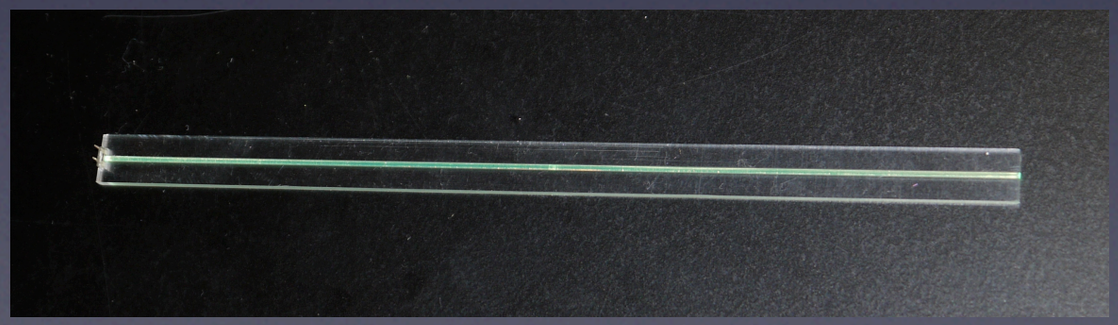
ScECAL 2nd



5 x 45 x 2 mm³
w/o WLS fiber

Next step

10 x 180 x 3 mm³
w/ WLS fiber for HCAL



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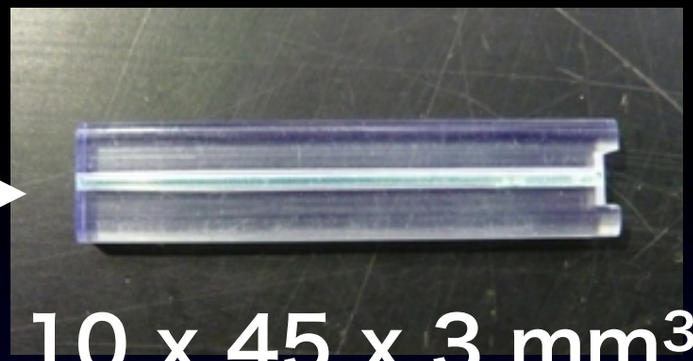

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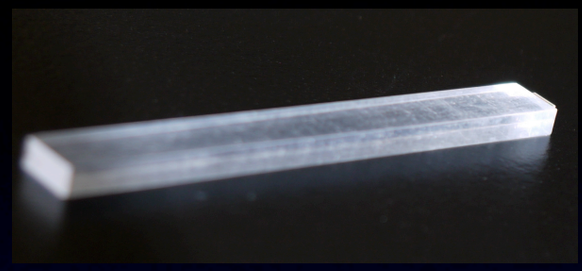

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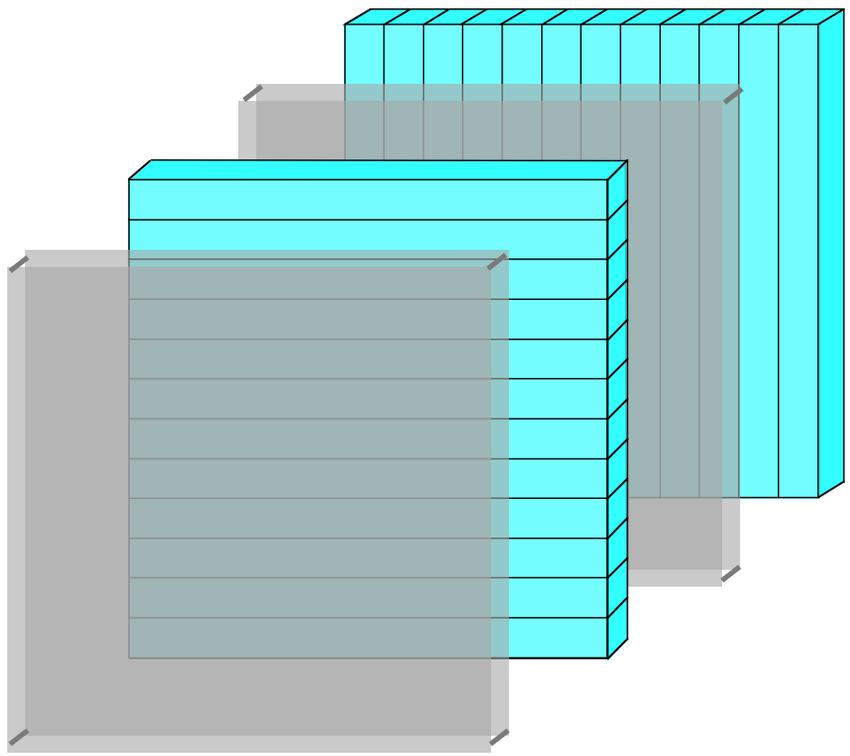

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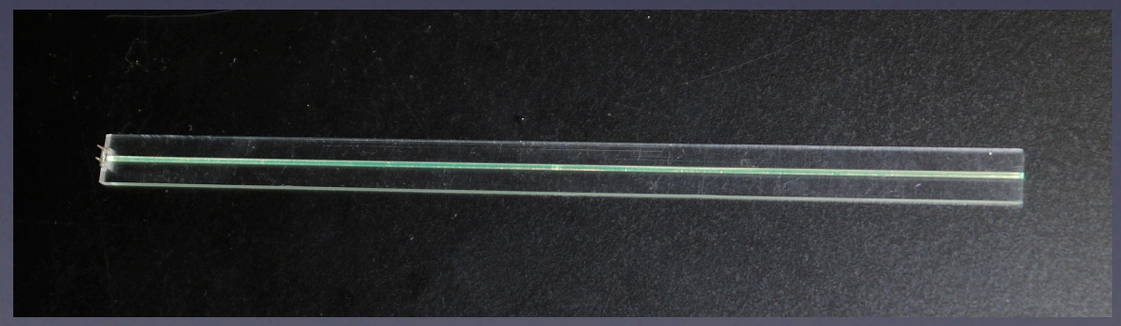

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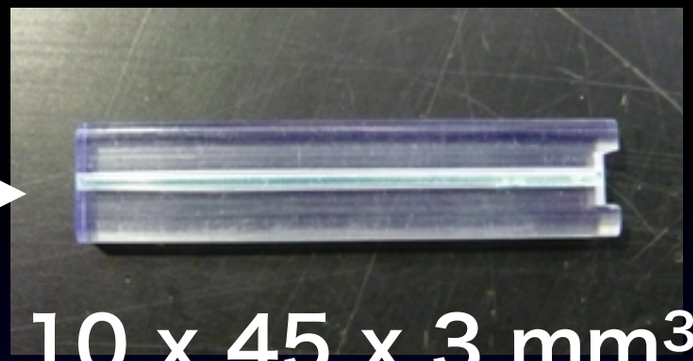

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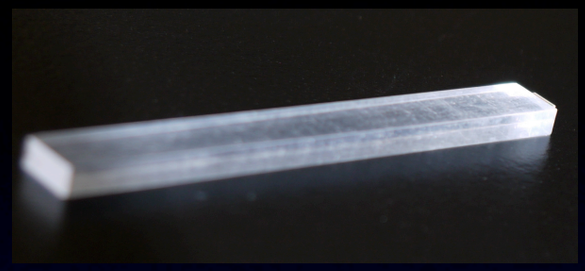

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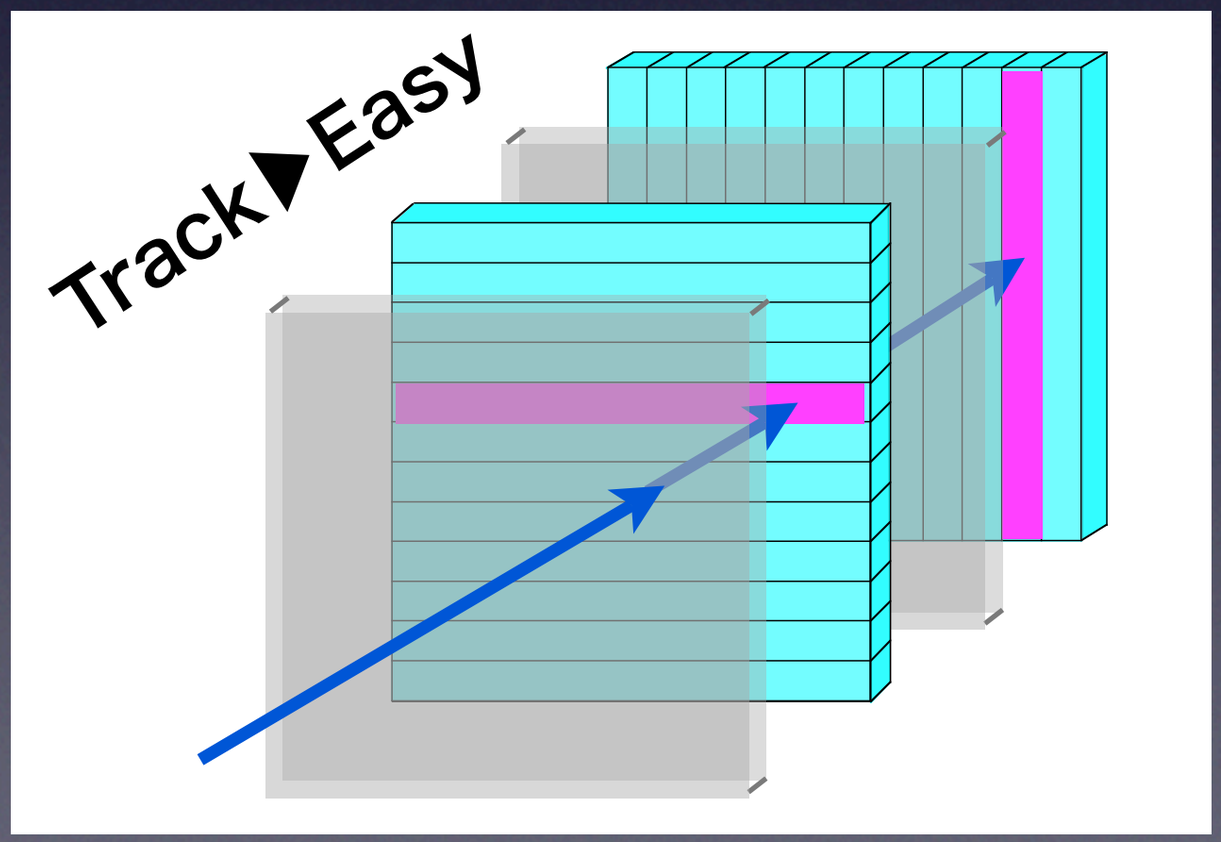

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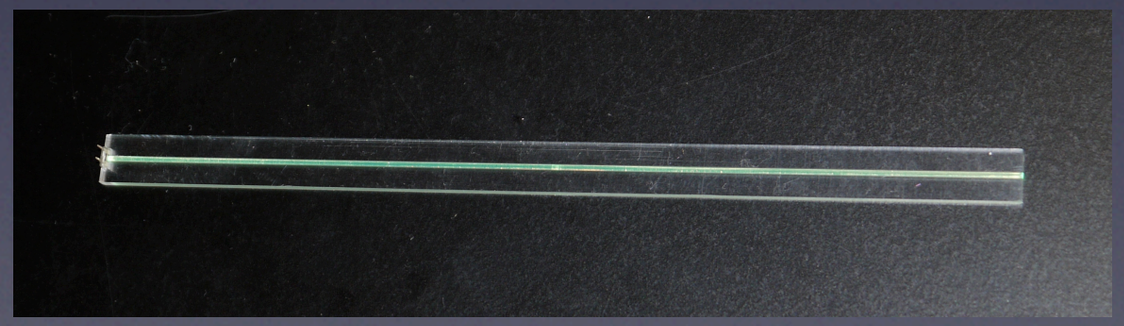

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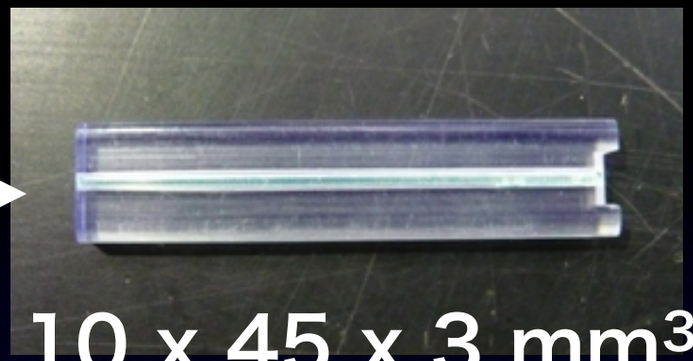

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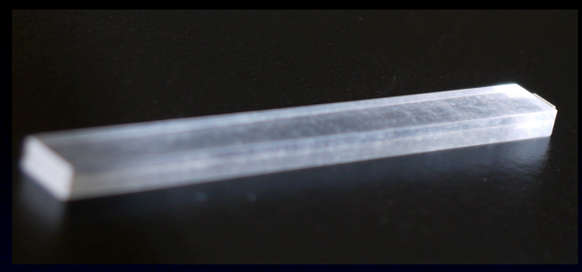

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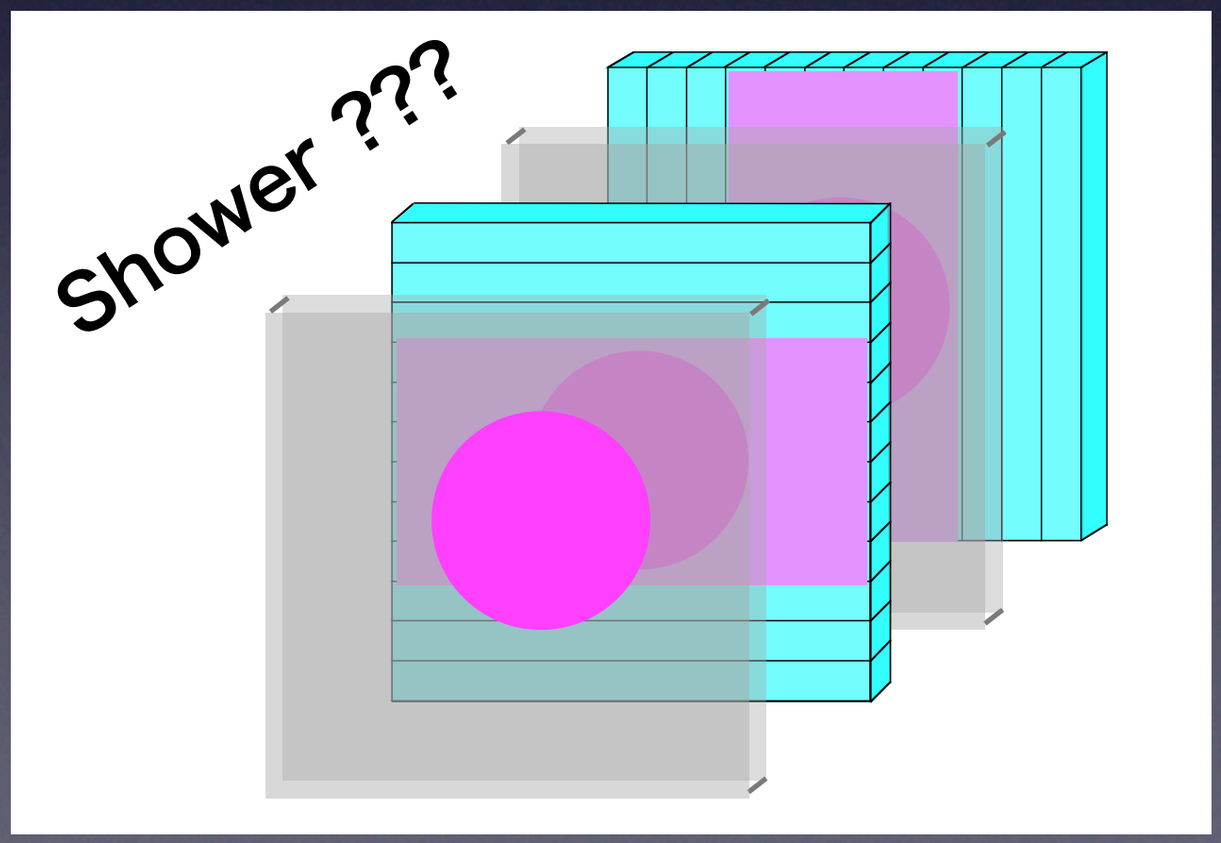

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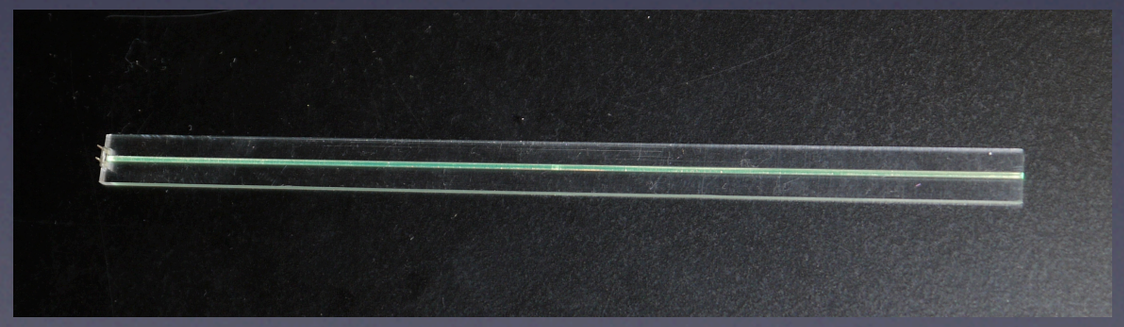
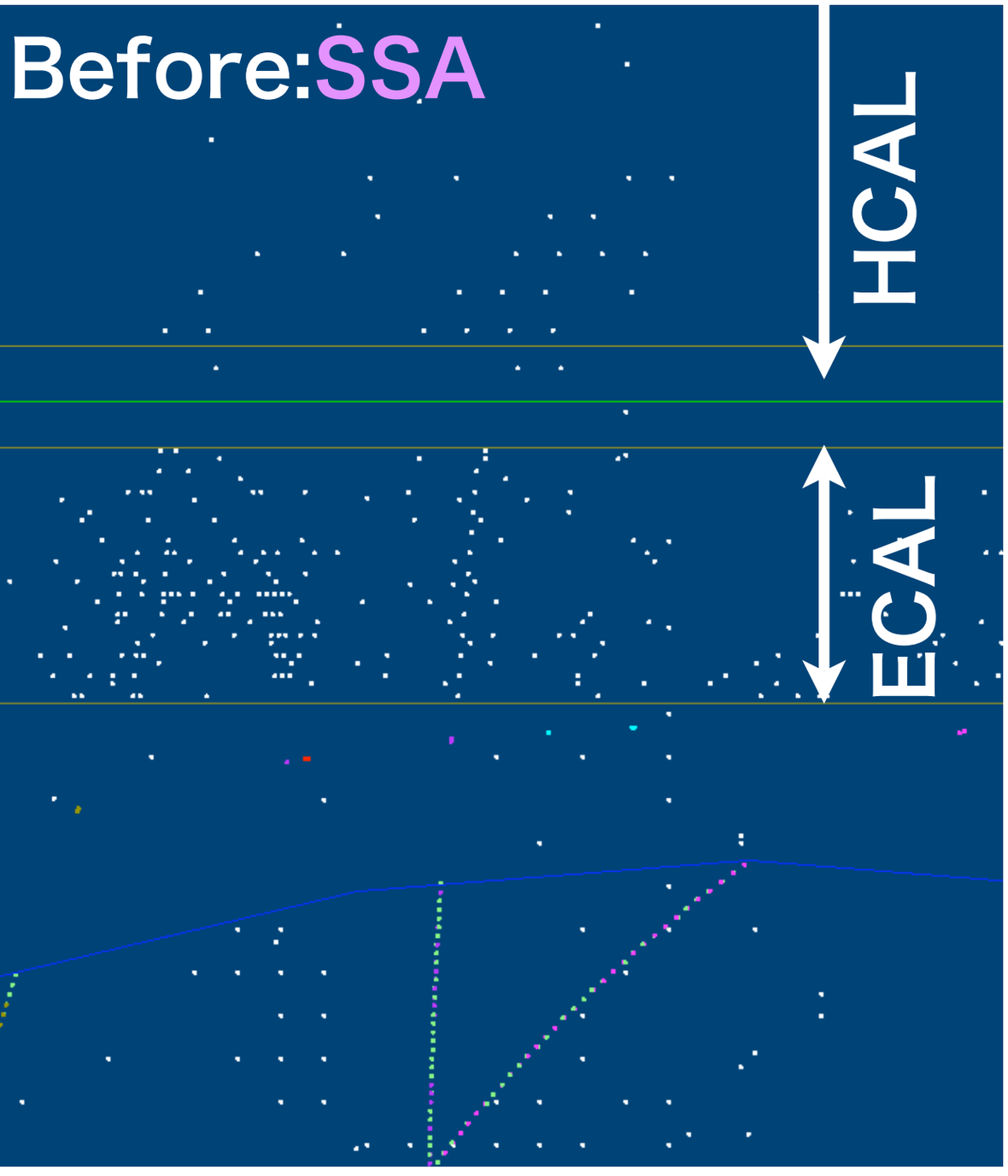
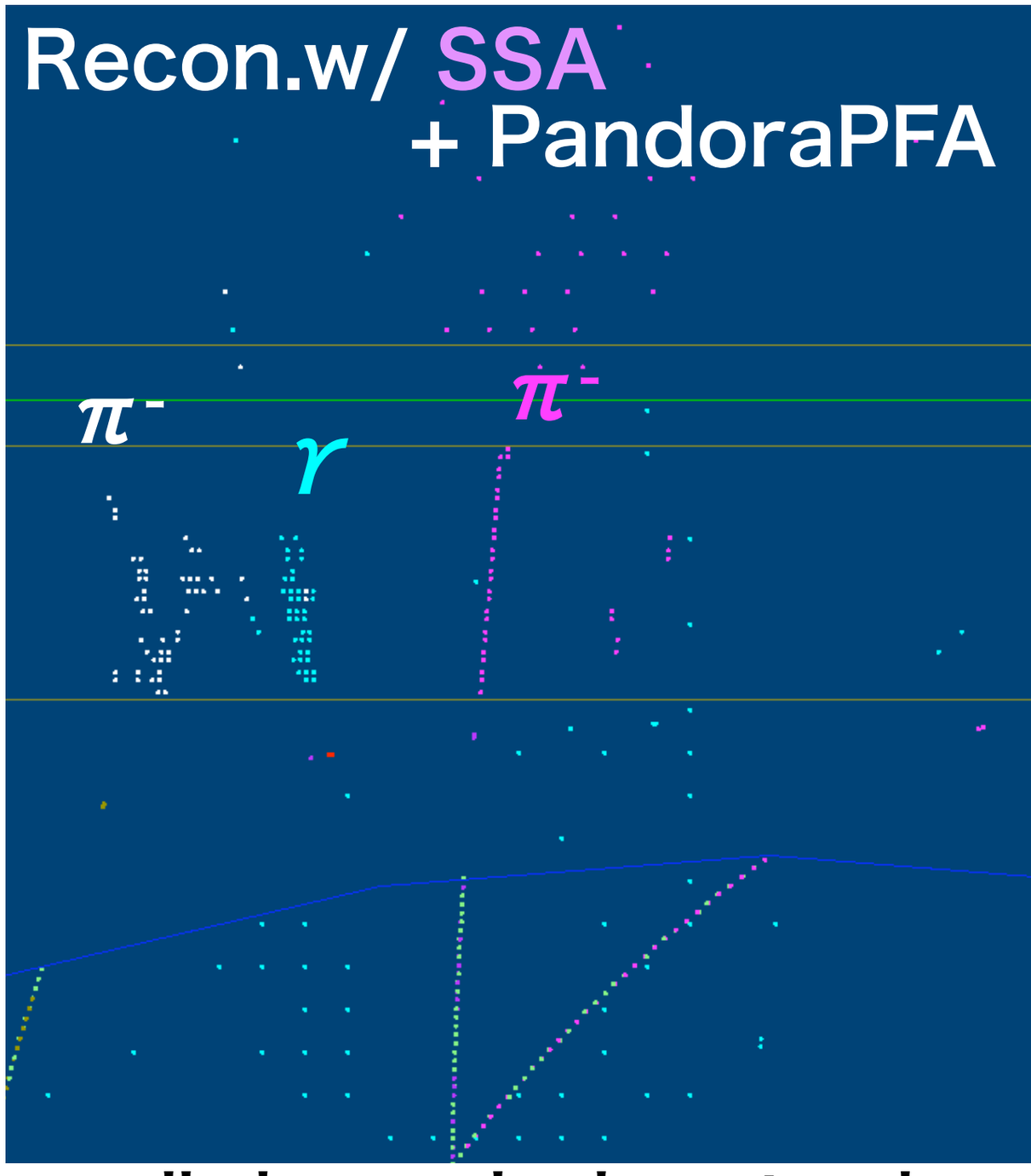


Strip Splitting Algorithm

100 GeV Jet x 2: easy case

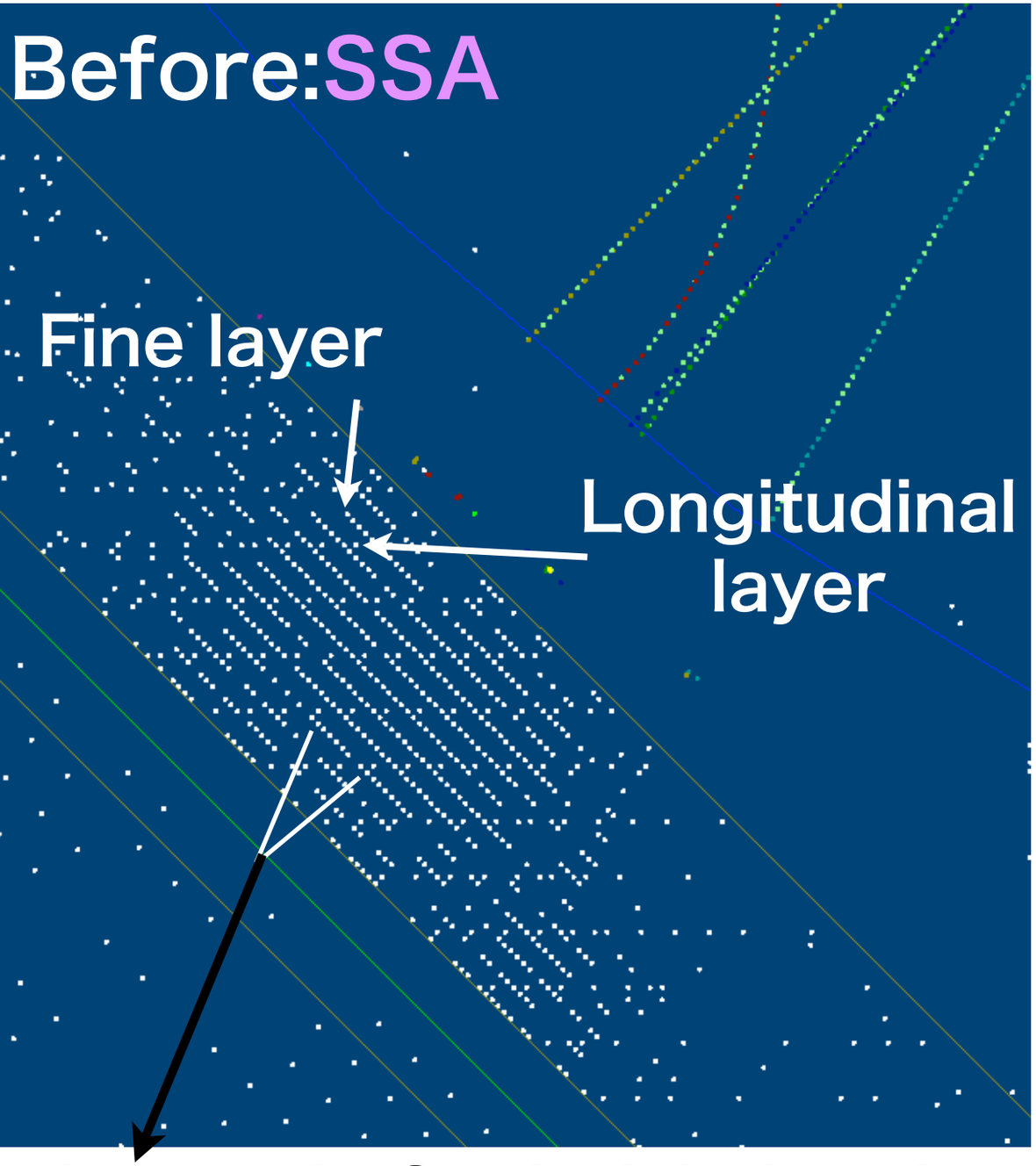


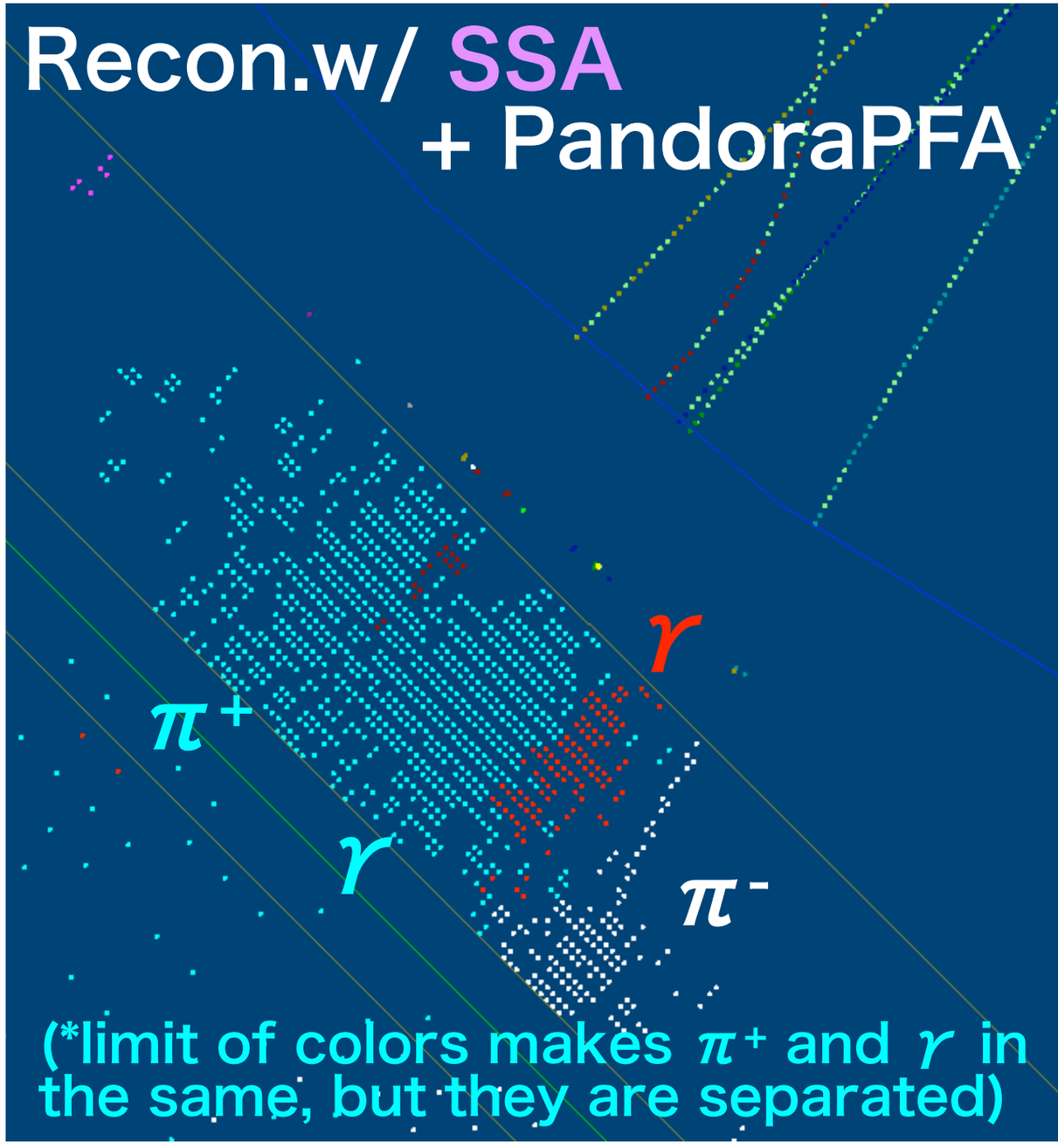


A small shower looks a track

Strip Splitting Algorithm

100 GeV Jet x 2: more difficult case





Interval of scinti. in longitudinal layers is 45 mm,
while fine segmented layers: 5 mm (width of scinti.)

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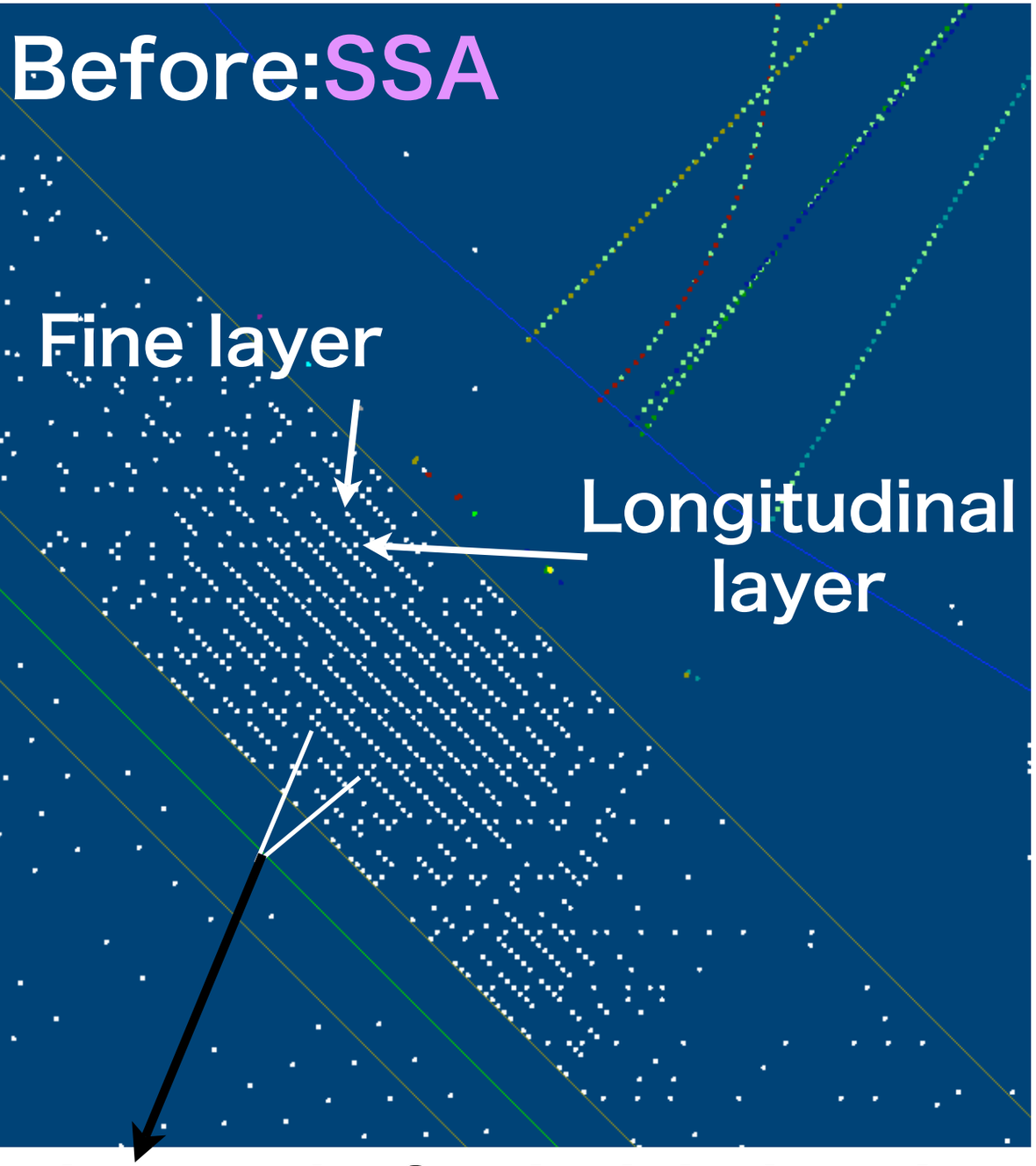

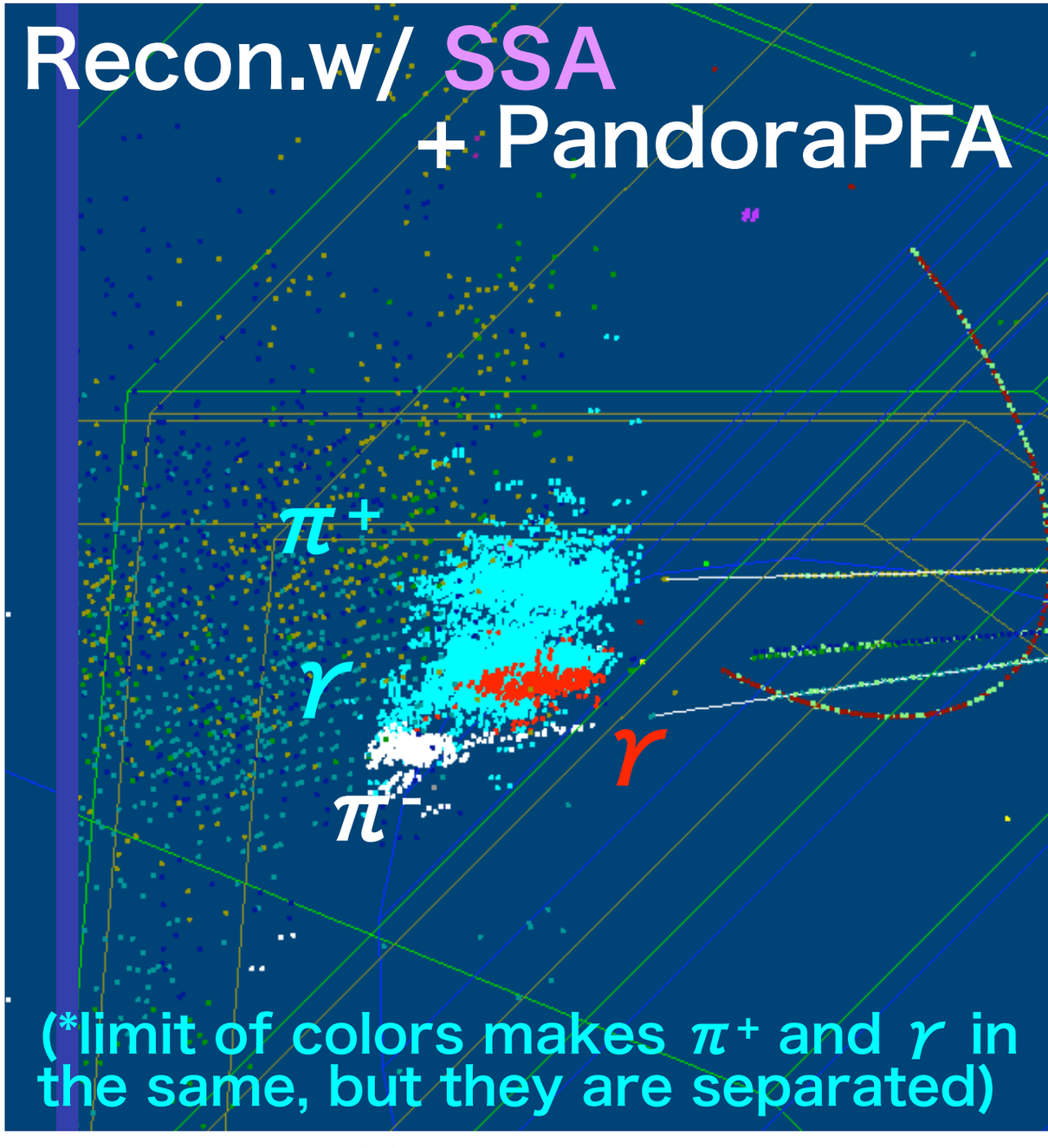

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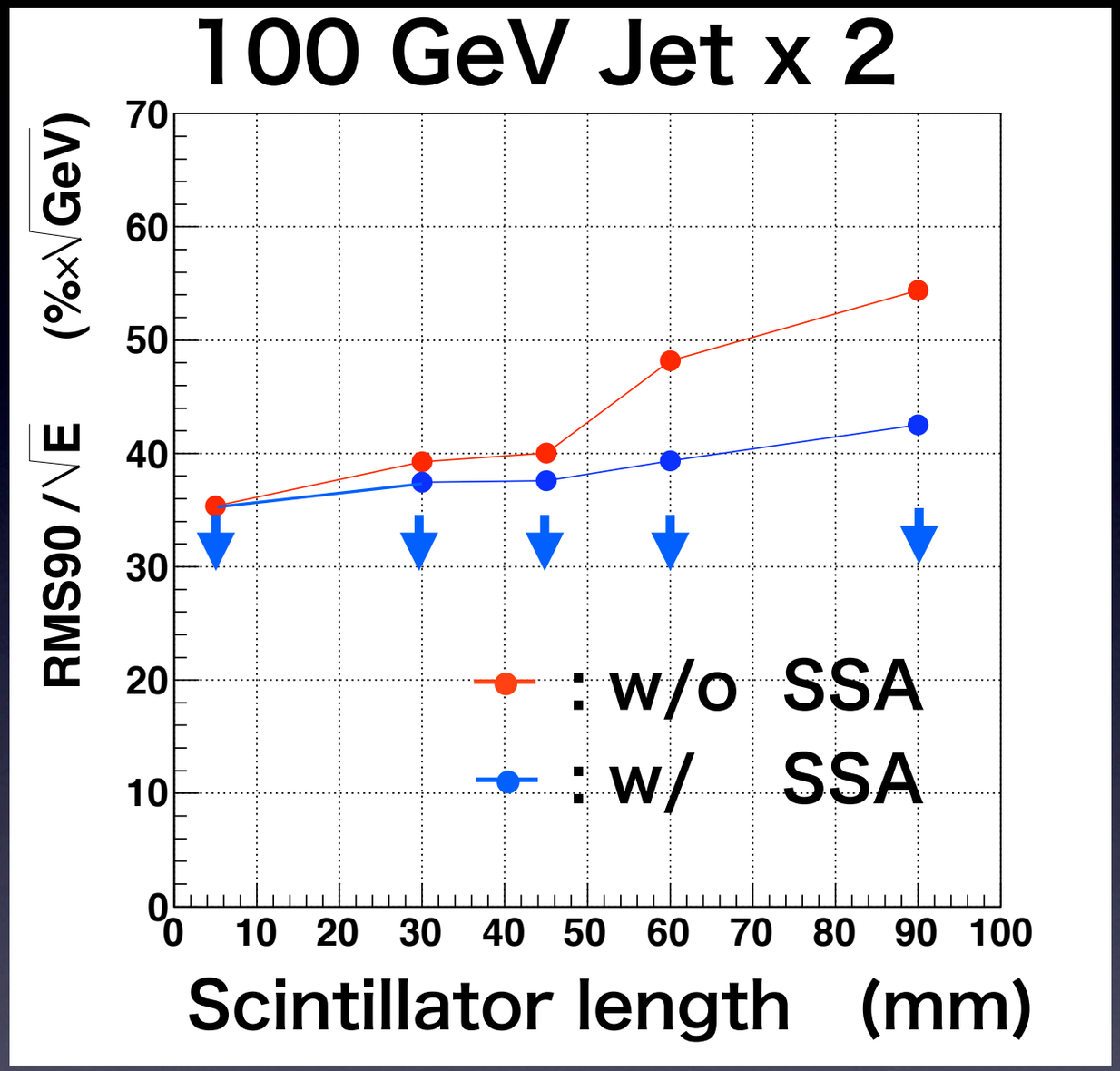
Jet energy resolution

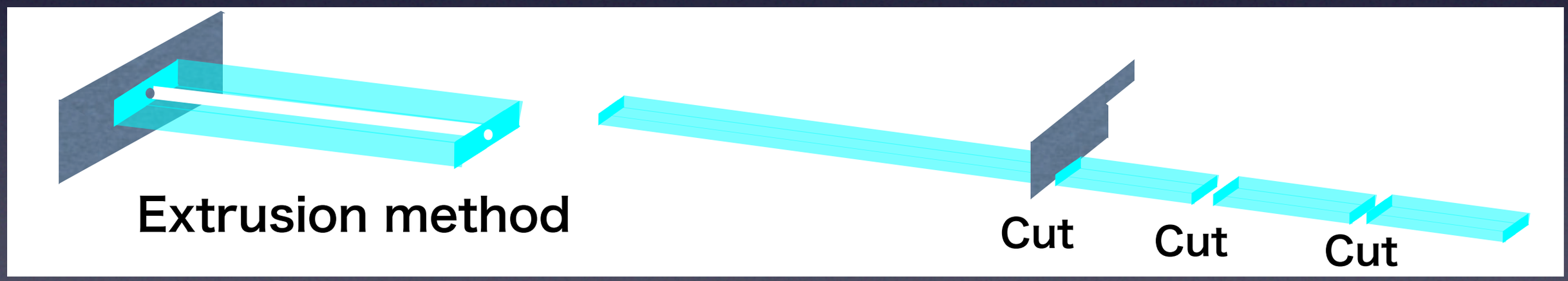


- Certainly SSA prevents degrading of jet energy resolution increasing due to the effect of scintillator length.
- We need to tune PandoraPFA parameters to get better resolutions

Plan: Special tuning of PandoraPFA for ScECAL, modification of SSA with some ideas.

Motivation to use Scintillator strip

- To use Plastic scintillator
  - Feasibility of plastic scintillator technic,
- To use Strip shape
  - Reduction on the number of sensors,
    - cost, noise, feasibility,
  - Ease to make scintillator strips,



- .... difficulties need be over come for extrude method
  - quality of total reflection,

Sensor:

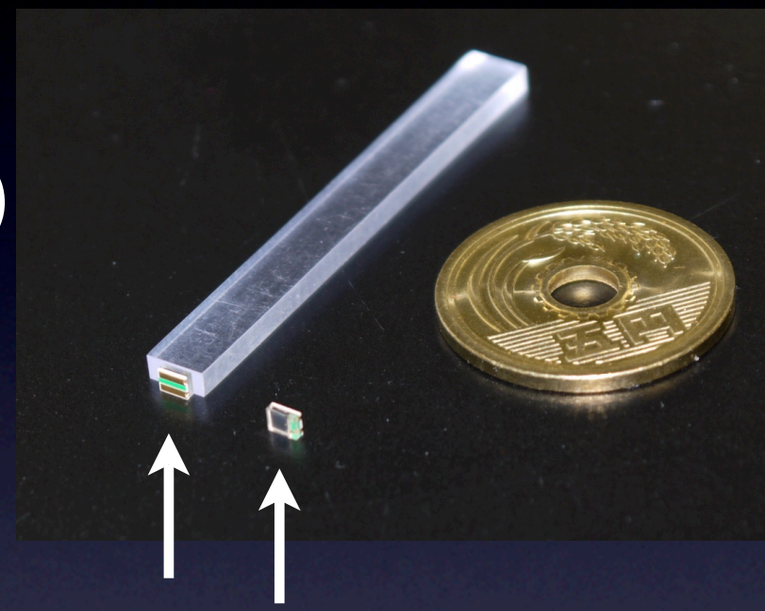
- Requirements
  - Smallness to reduce dead volume
  - High sensitivity
  - Tolerance : Strong Magnet Field(3.5T)
  - Tolerance : radiation
  - Feasibility

Sensor: PPD(MPPC)

- Requirements : MPPC
  - Smallness to reduce dead volume
  - High sensitivity
  - Tolerance : Strong Magnet Field(3.5T)
  - Tolerance : radiation
  - Feasibility

Sensor: PPD(MPPC)

- Requirements : MPPC
  - Smallness to reduce dead volume : 1.9×2.4×0.85 mm^3
  - High sensitivity
  - Tolerance : Strong Magnet Field(3.5T)
  - Tolerance : radiation
  - Feasibility



Sensor: PPD(MPPC)

- Requirements : MPPC
  - Smallness to reduce dead volume : 1.9×2.4×0.85 mm^3
  - High sensitivity : > Gain ~10^5
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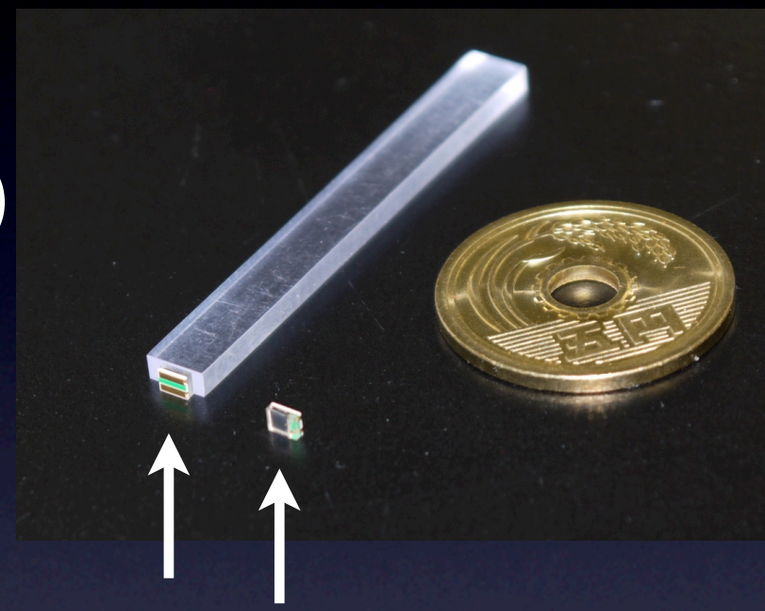

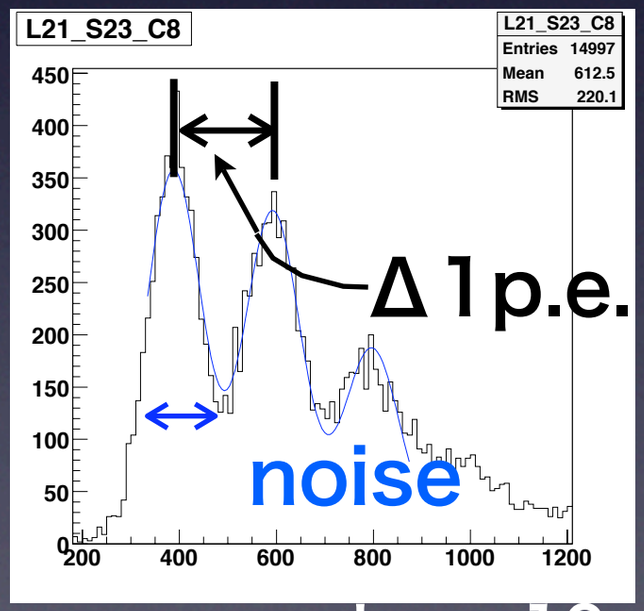

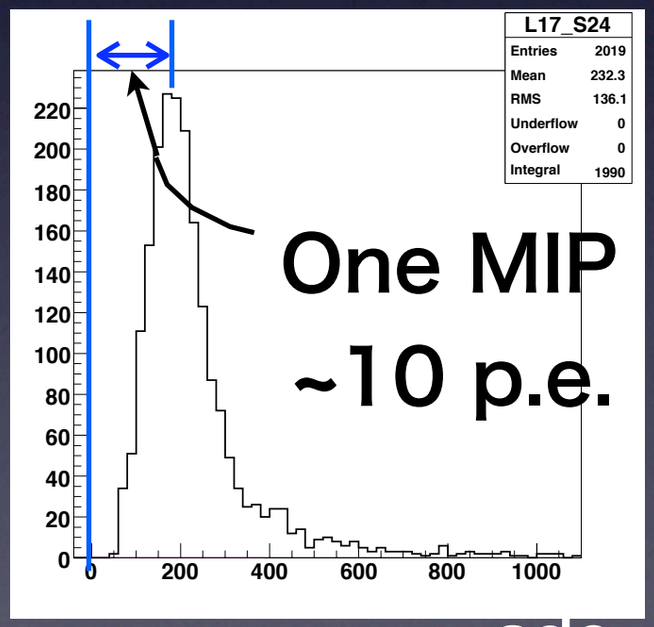

Zero suppression of 0.5 MIP cut is enough far from noise level

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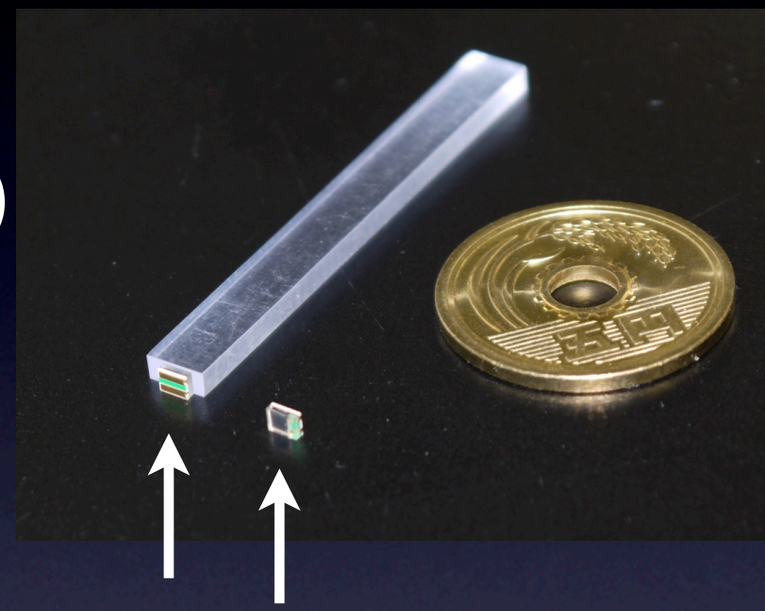
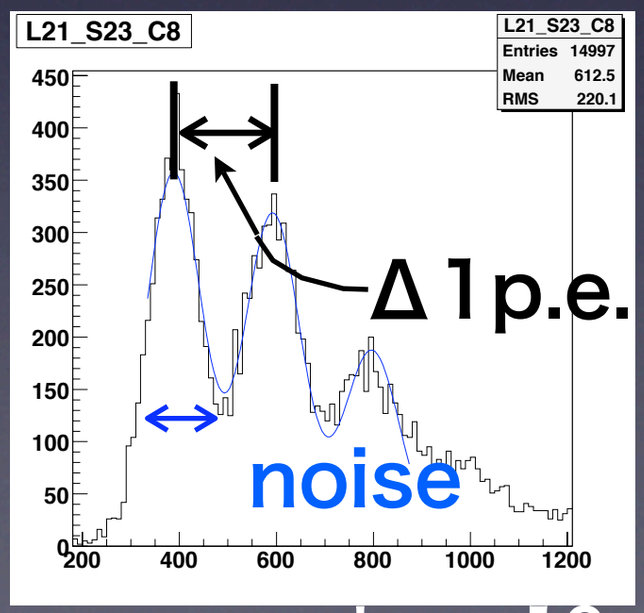
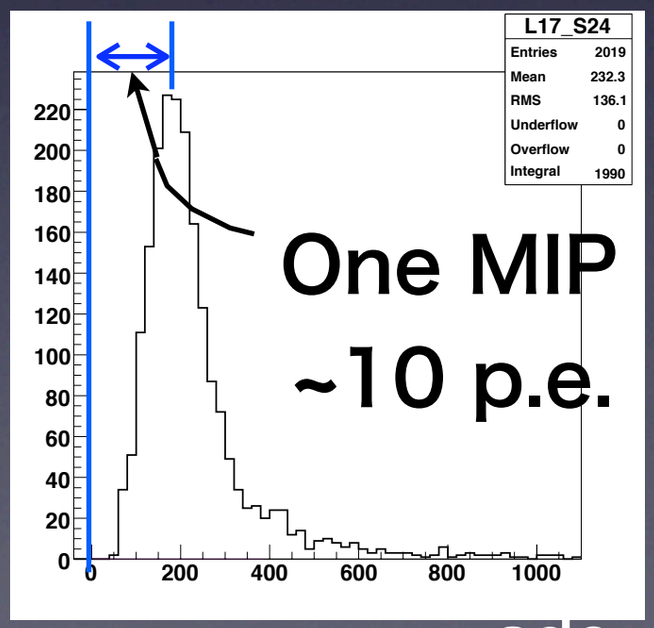
  - Feasibility : 12 yeas verified by using failure acceleration by heat : Arrhenius model



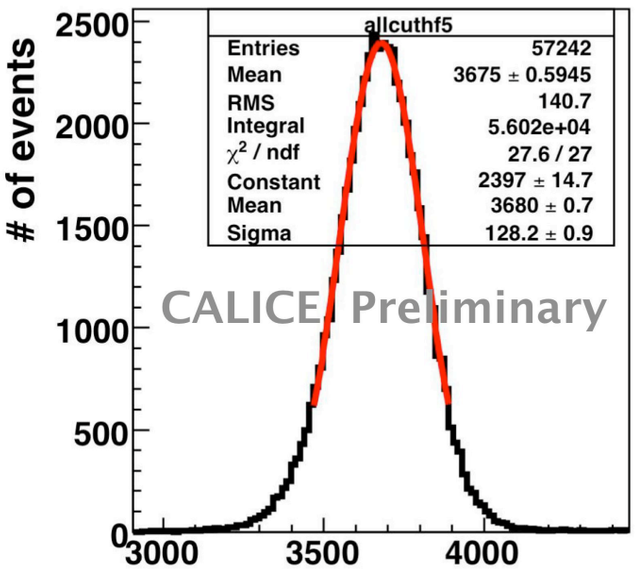


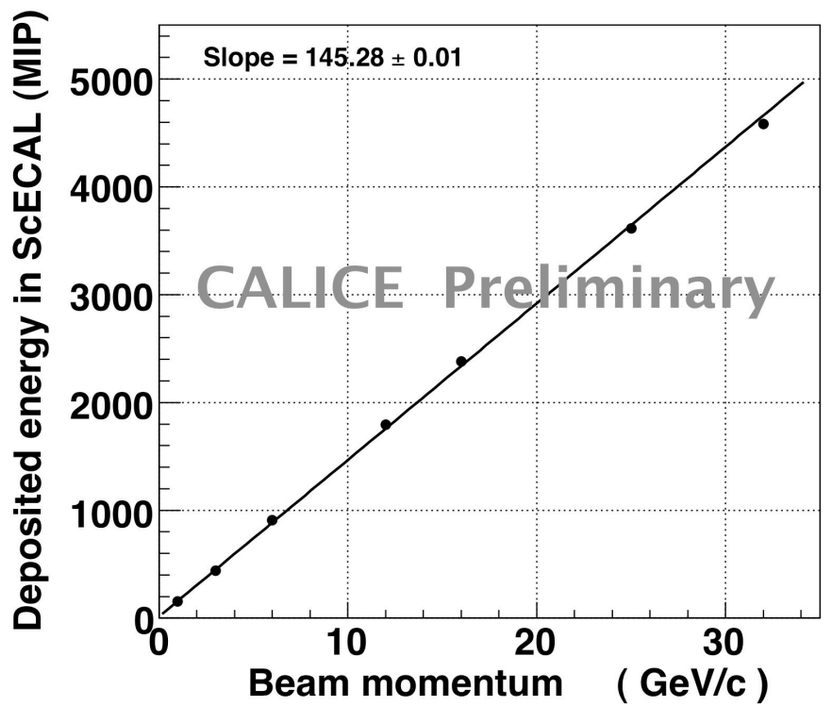


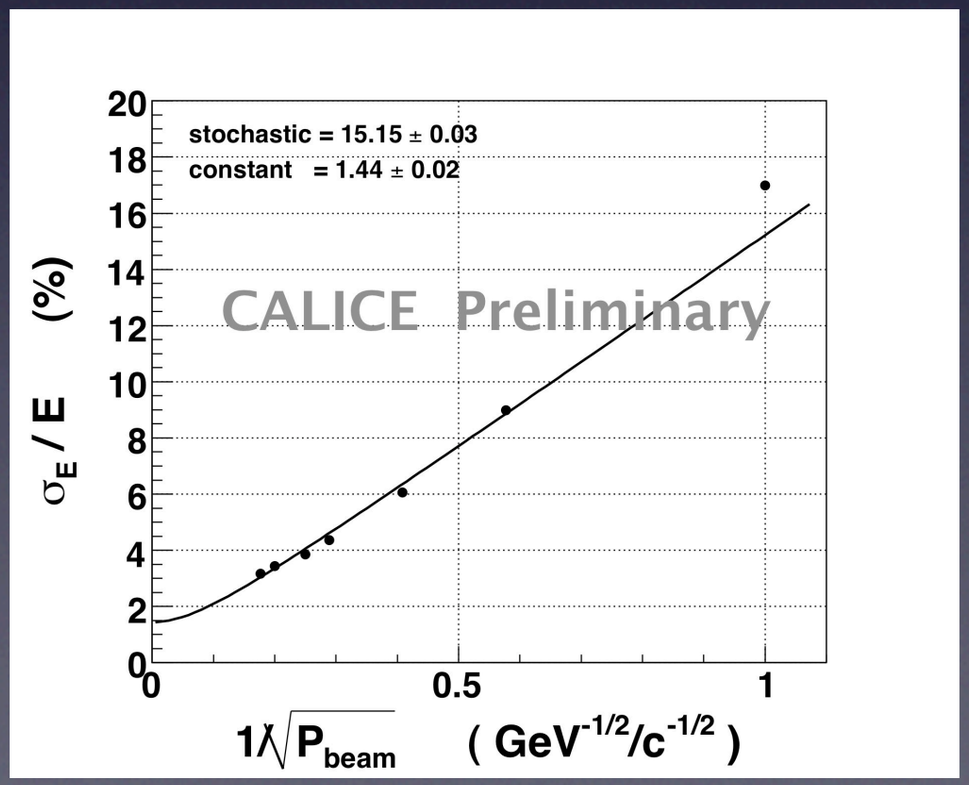
Zero suppression of 0.5 MIP cut is enough far from noise level

Performance of prototype No.2

18 cm x 18 cm 30 layer: 45 mm x 10 mm scint.x2160







Calice Preliminary

constant term	1.44±0.02%
stochastic term	15.15±0.03%

* only statistic errors

Expected achievements on strip and MPPC issues in the project

- Plastic scintillator:
  - good total reflection on surface,
  - quality control of transparency and photon yield,
    - ▶ Uniformity ▶ energy resolution,
  - reflecting method (good film),
- MPPC:
  - number of pixels ▶ prevent saturation,
- Mechanical support of scintillator and MPPC on the electronics,
- LED calibration system,
- Modification of SSA,
- Scintillator HCAL.

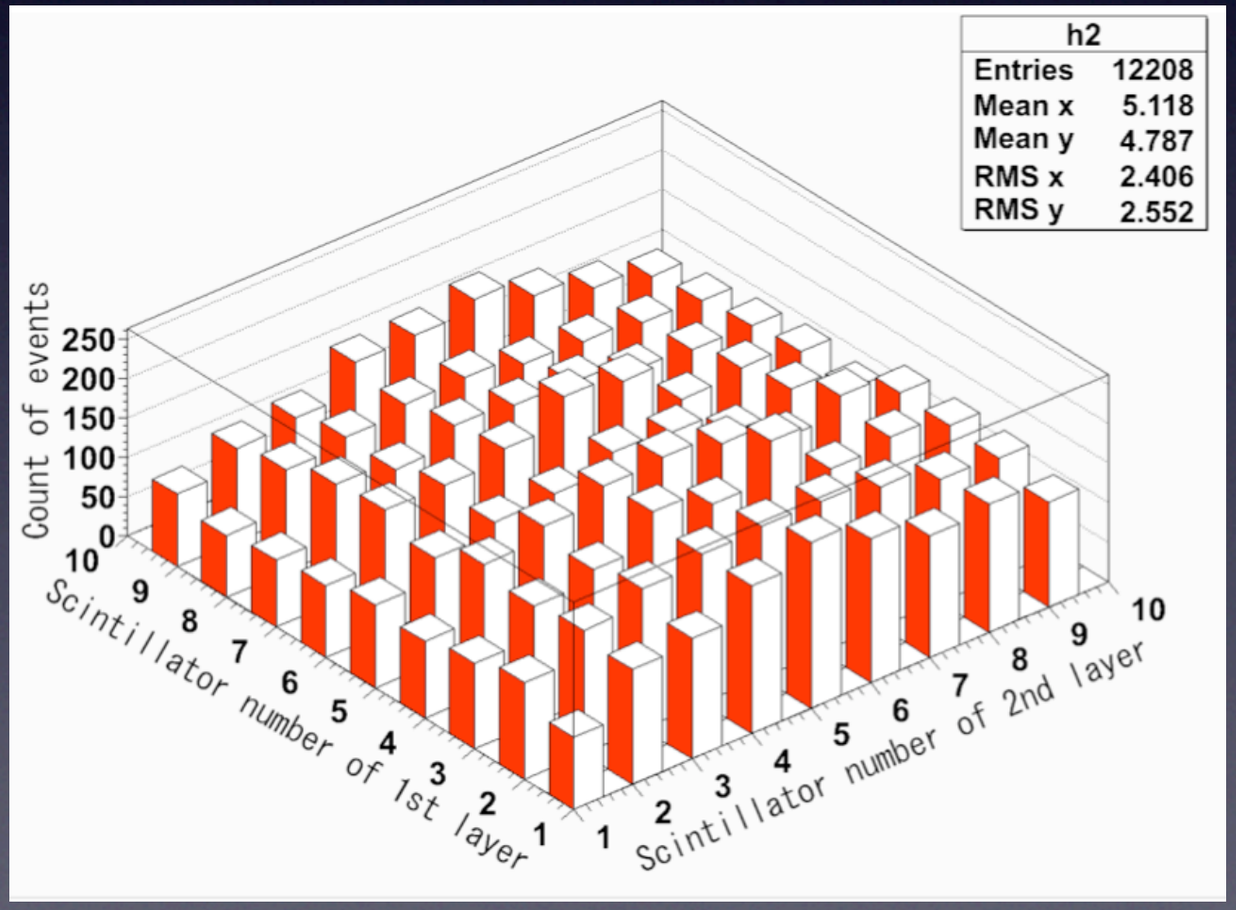
Scintillator HCAL a trial

3 cm x 3 cm

Same cost →

1 cm x 9 cm

With SSA
Granularity 1 cm x 1 cm ?



by M. Harada(Shinsu-u:under graduate)

A toy module:
- Strip: 10 x 180 x 2 mm^3 w/ WLS fiber,
- 180 mm x 180 mm 2 layers,
- 3.5 mm thick W-Co absorber,
- 1 MIP = 5 p.e.,
- cosmic muon events,
- 10 mm x 10 mm segmentation for mip, OK,
- consistents with MC.

Summary

- We are developing calorimeter for ILC detector using “Scintillator strip”,
- PPD(MPPC) is suitable to this purpose: we will develop this novel photon detector more,
- 45 mm x 10 mm x 3 mm strip prototype module shows this technic has high potential,
- To get 5 mm x 5 mm granularity, 5 mm x 45 mm scintillator is used in our next plan,
- To get better performance, quality control of scintillator should be established in this project,
- Strip splitting method needs more tuned up,
- HCAL also comes with our range.