Event Selection & Energy Correction Summary
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Additional Study on Event Selection

- **Main meeting report slide.**
- **Confirm whether nHits=2 events mean that a particle hits between 2 channels.**
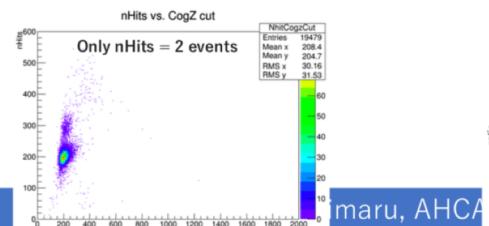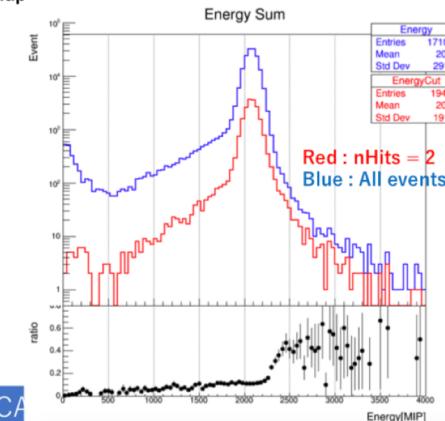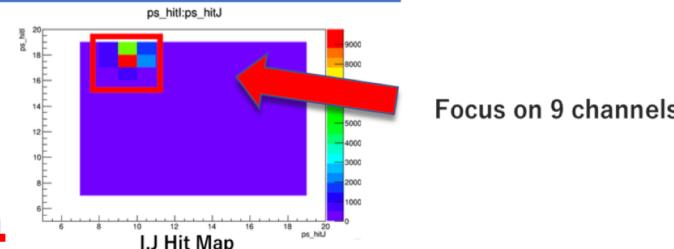
Procedure

- **Count events which a distance of two channels is smaller than $30\sqrt{2}$**
    1. A hit channel is closest to the other channel.
    2. Two hit channels are the diagonal positional relationship.
    3. Not count
- **If there are two responses at random, probability is $20/36 = 55.6\%$**

1. ○

30 mm

2. ○

3. ✕
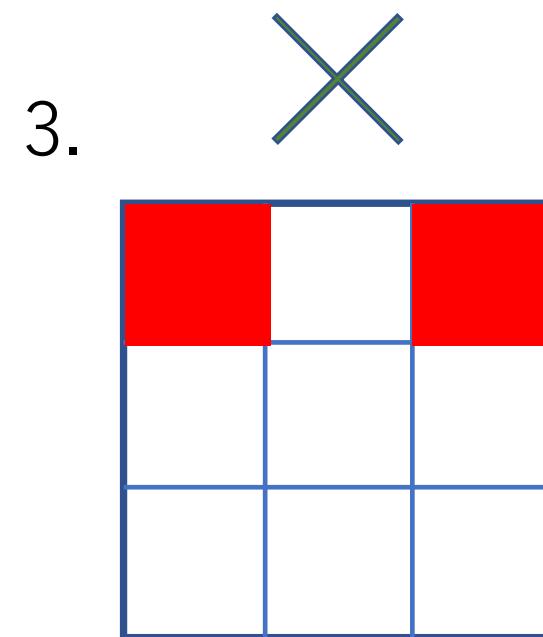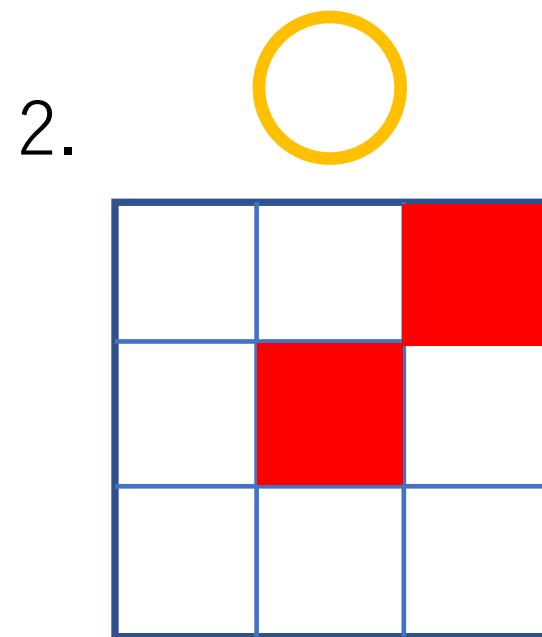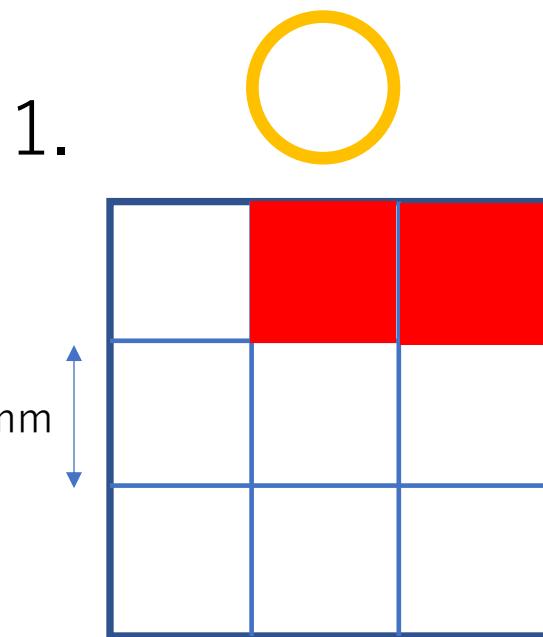
Result

- **Electron**
  - **Run 61202, 10GeV : 4366/5178 = 84.3 %**
  - **Run 61213, 30GeV : 16504/18407 = 89.7 %**
  - **Run 61214, 50GeV : 18002/19479 = 92.4 %**
  - **Run 61217, 100GeV : 12696/13528 = 93.8 %**
- **Pion**
  - **Run 61275, 40 GeV : 1920/2389 = 80.4 %**
  - **Run 61280, 80GeV : 1575/2008 = 78.4 %**
  - **Run 61230, 160GeV : 1798/2010 = 89.5 %**

- **Most events of nHits=2 have events which a positional relationship of two response channels is close.**

HBU Package

PCB（0.700mm,17.5cm）

Reflector（0.110mm,53.9cm）

● XXX（thickness, radiation length）

cassette（0.500mm,1.76cm）

Scintillator（3.00mm,41.8cm）

Reflector（0.110mm,53.9cm）

cassette（0.500mm,1.76cm）　CFM（1.50mm,409cm）

CFM : Defined complex（Air, fibre, coax cable）
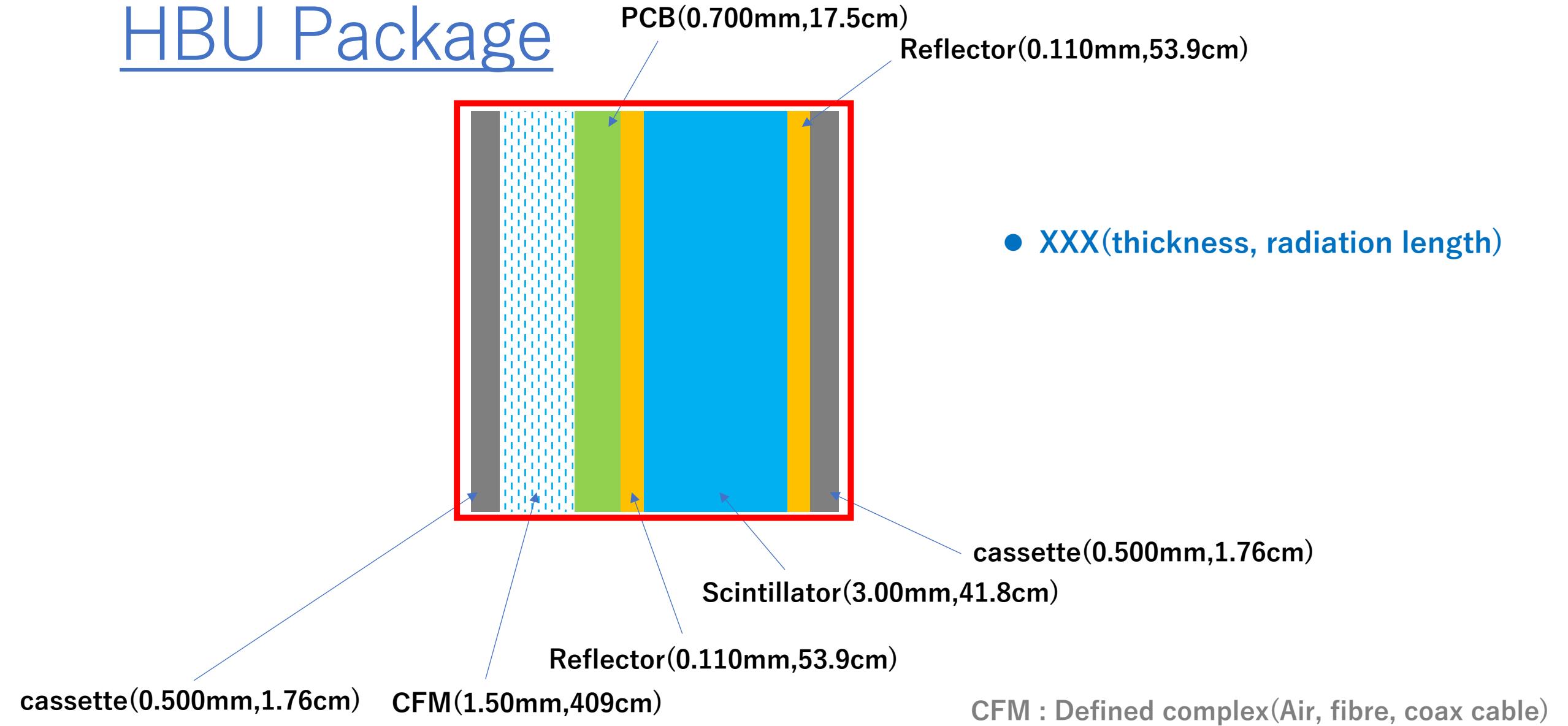
June-July Setup(ignore air thickness)

AHCAL Absorber(17.2mm,1.76cm)

Tail Catcher

......

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1st   2nd   37th   38th   39th   1st   2nd   12th

(Tokyo module)

AHCAL

Preshower Detector

Frame(17.2mm,1.76cm)

Absorber(12.1mm,1.76cm)

Absorber(74.0mm,1.76cm)
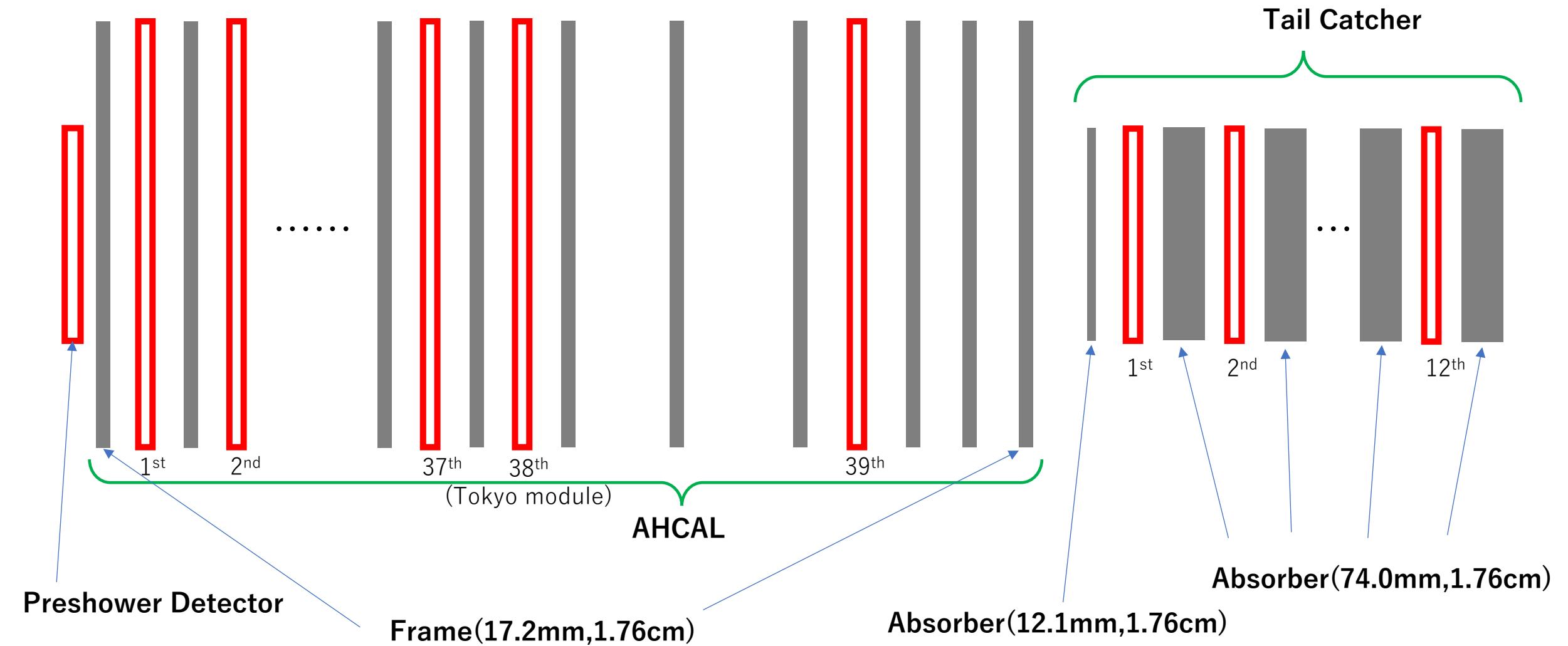
Simple Weight

- **Simple weight : ratio of absorber thicknesses**
  - **AHCAL 39th layer**
    - Absorber is three times thicker than other layers.
  - **1st layer of Tail Catcher**
    - Ratio : $(17.2 \times 3 + 2.00)/17.2$: MC
    - Ratio : $(17.2 \times 3 + 12.1)/17.2$: Data
 - **Other layers of Tail Catcher**
   - Ratio : $74.0/17.2$

Caution!

Energy Sum

Run 61230, Pion 160 GeV
Data

| EnergySum	
Entries	66904
Mean	4126
Std Dev	1262
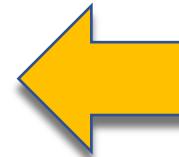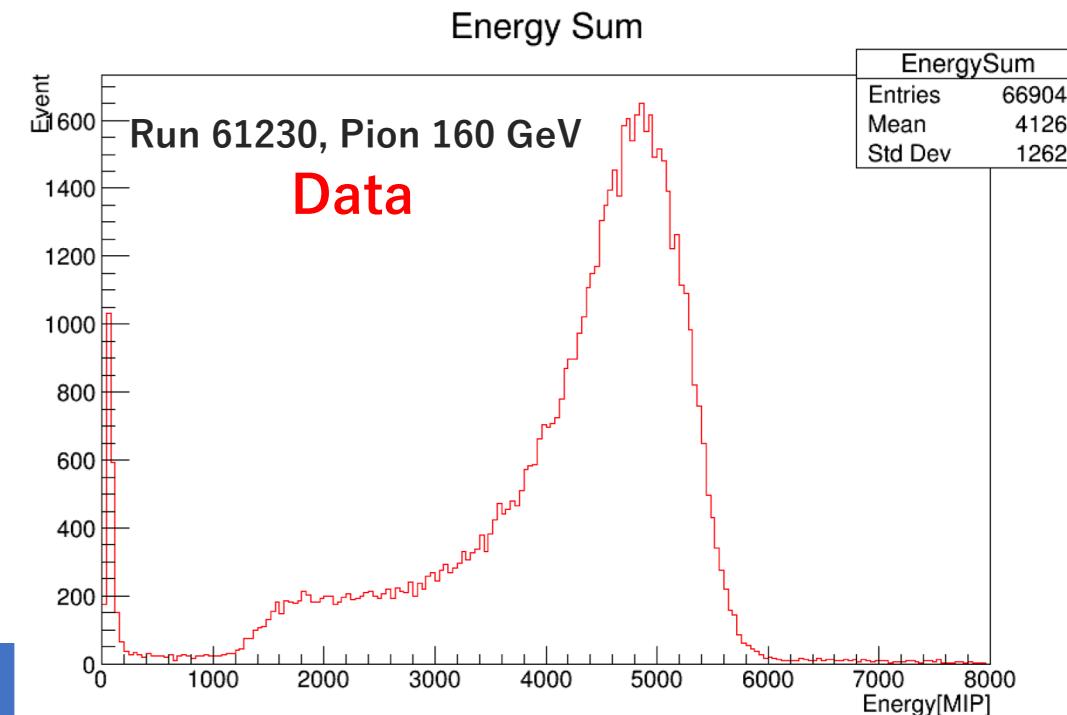
Result

- **Run 61275, Pion 40 GeV**
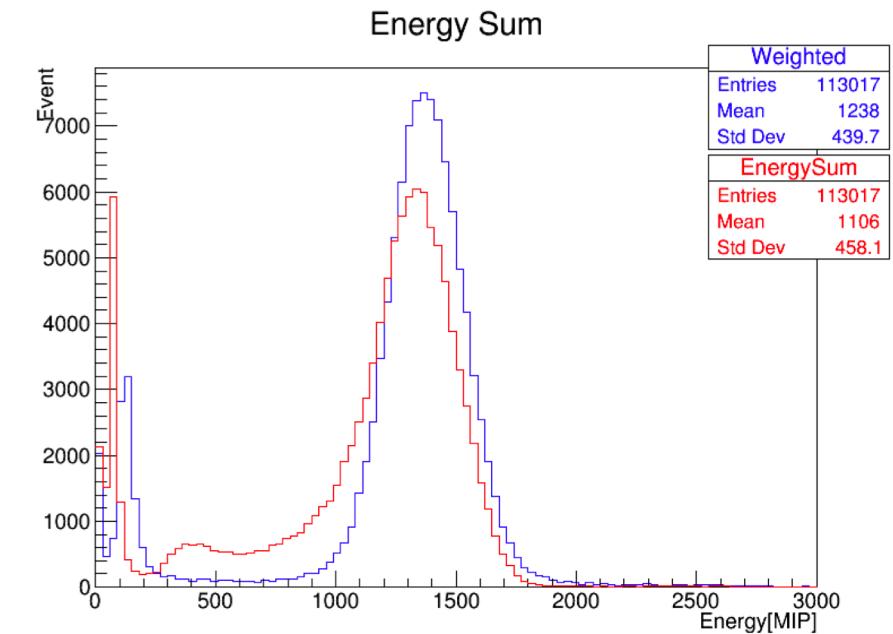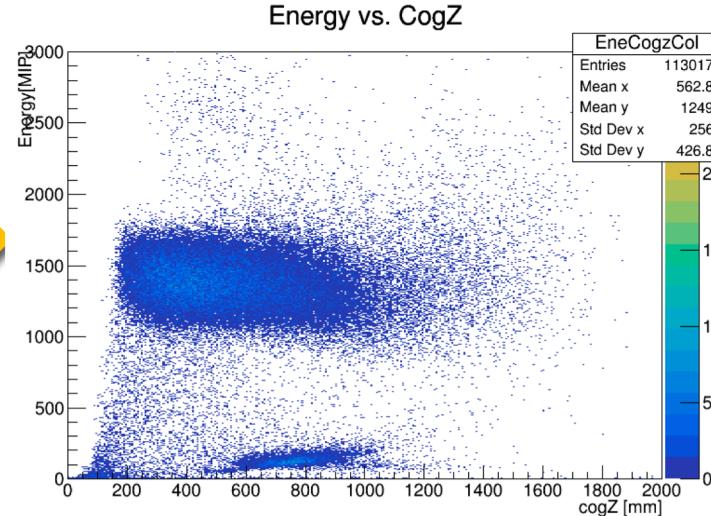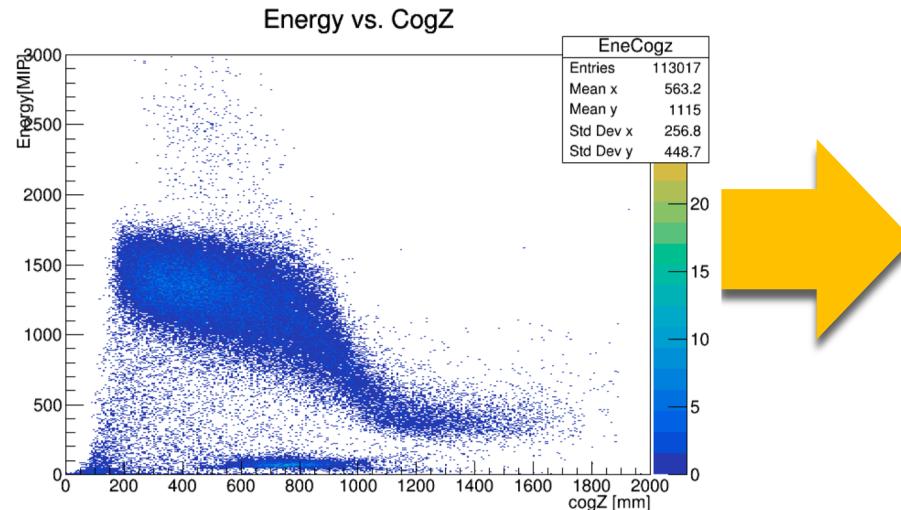
Result

- **Run 61280, Pion 80 GeV**
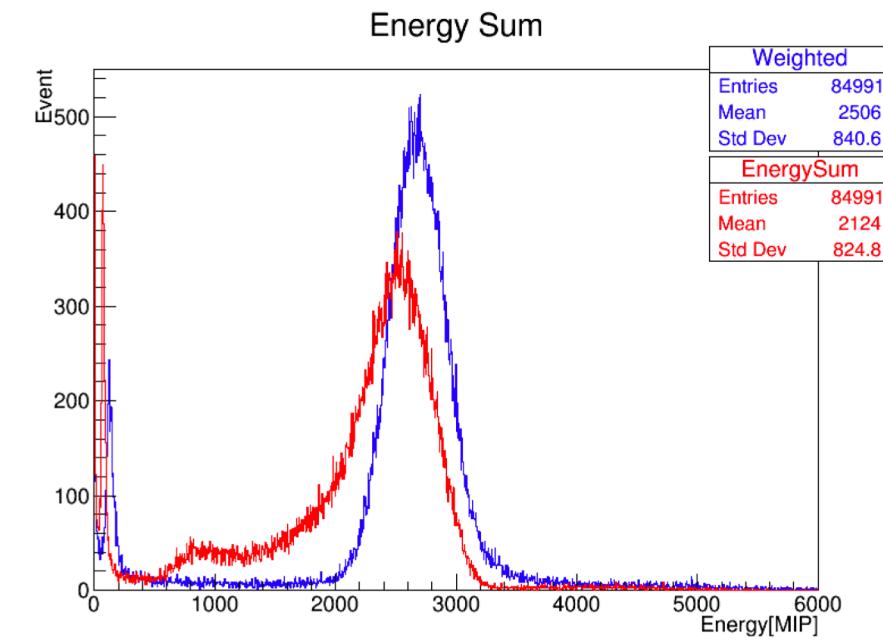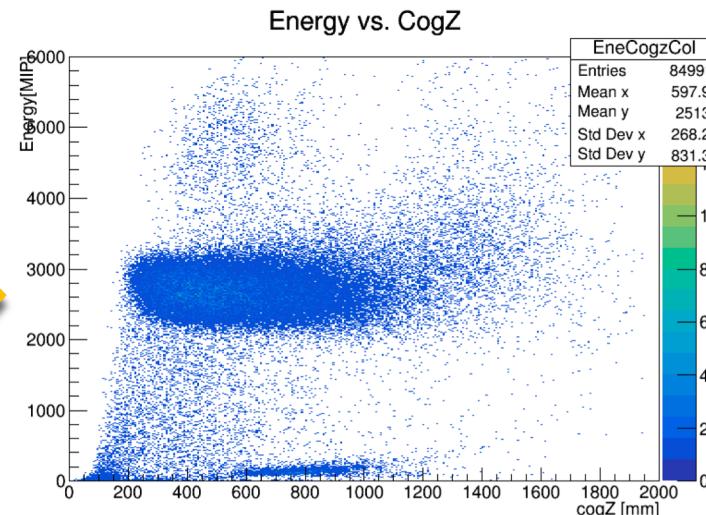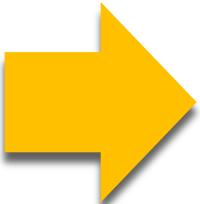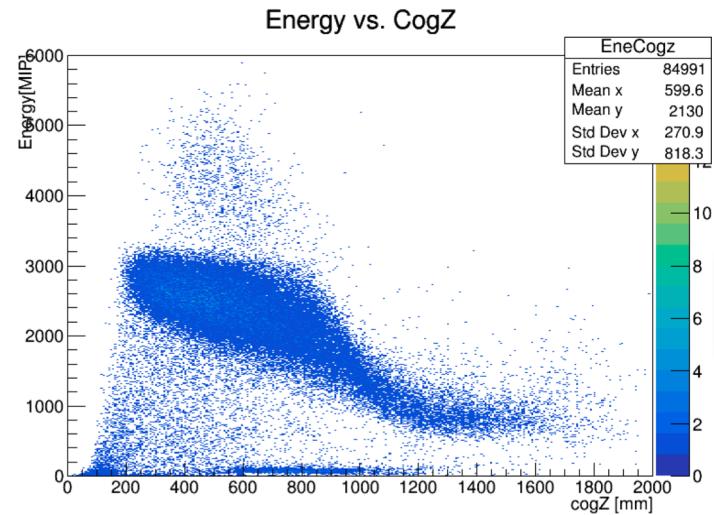
Result

- **Run 61230, Pion 160 GeV**
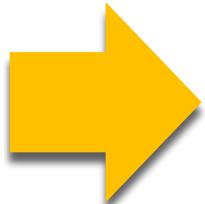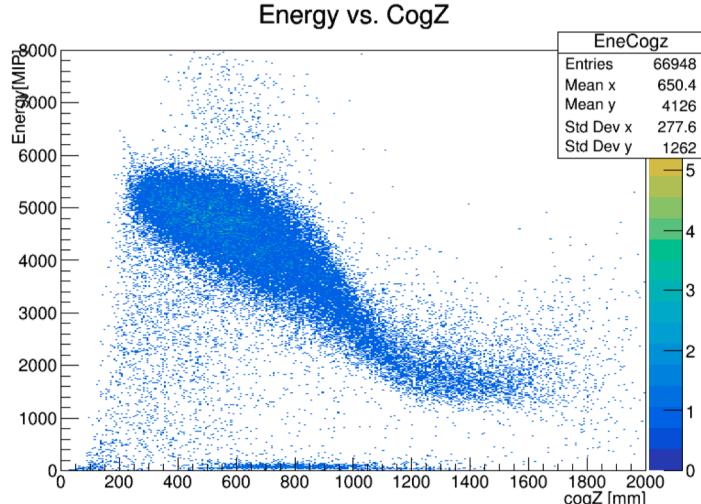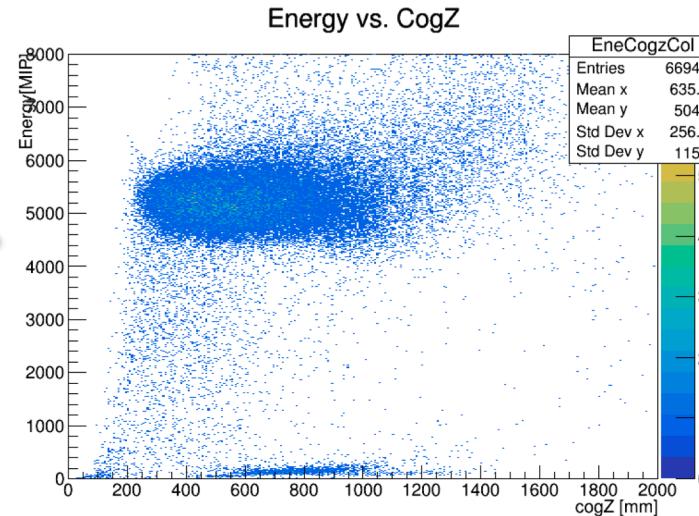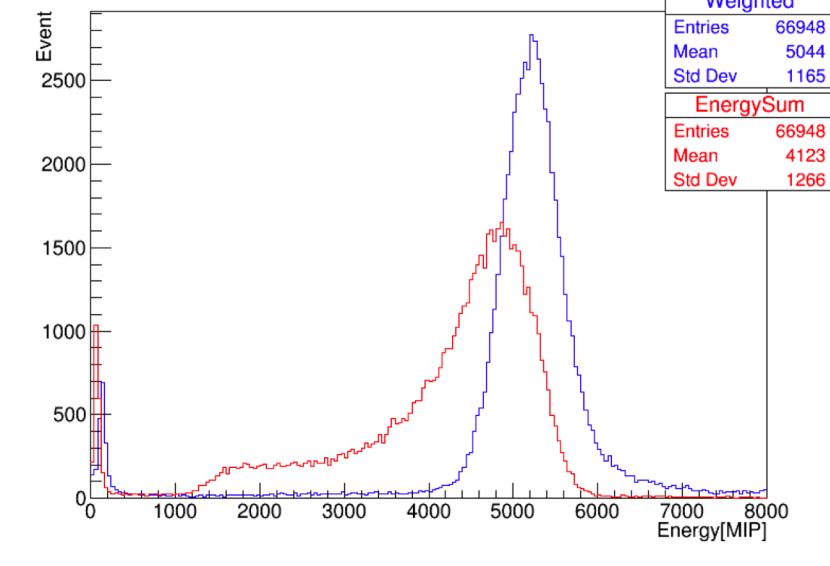
Result

- **Run 61230, Pion 160 GeV**
- **Tail appears in higher energy.**
  - **We must consider a better optimal weight.**
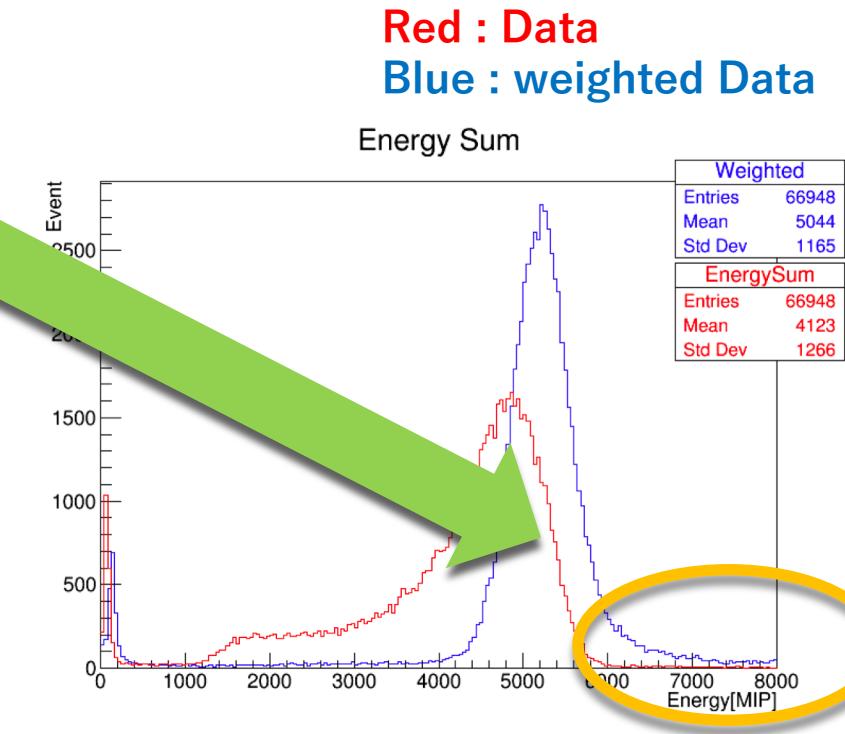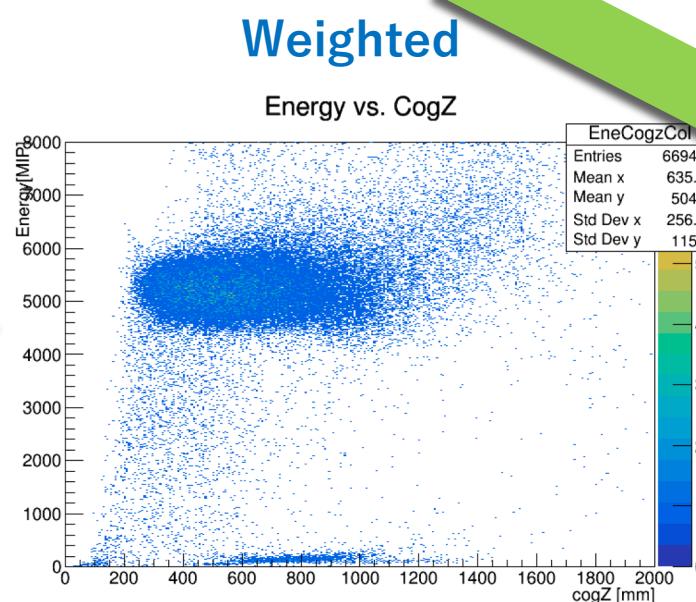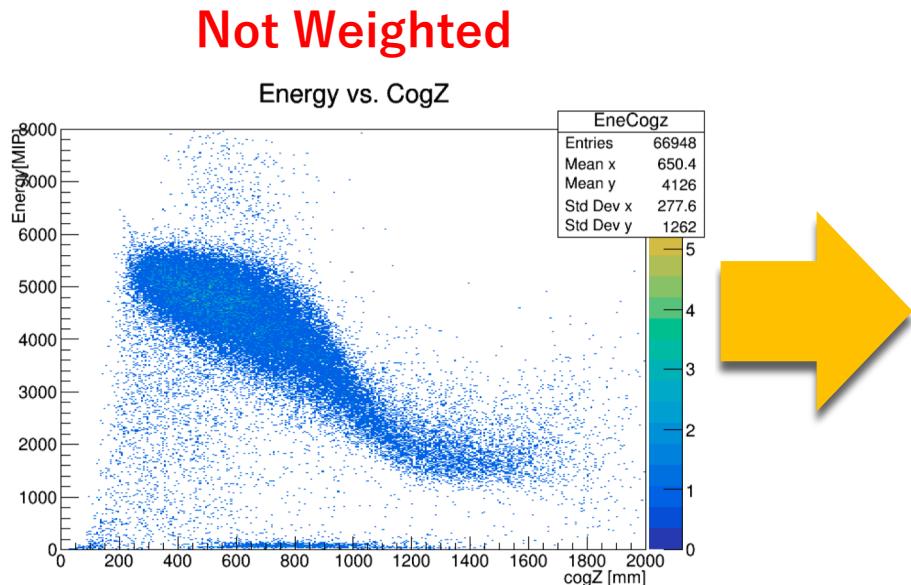
Saturation Correction

- **Run 61230, Pion 160 GeV**
- **Comparison of w/and w/o saturation correction**
- **When saturation correction is applied, the tail appears.**
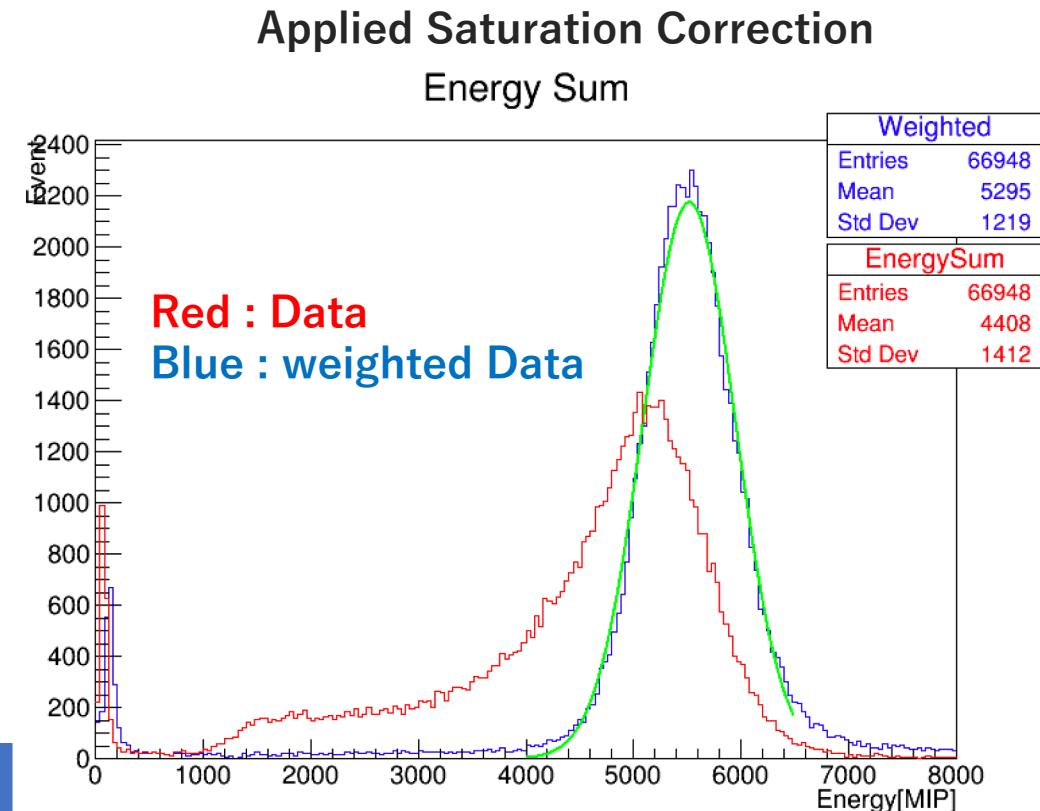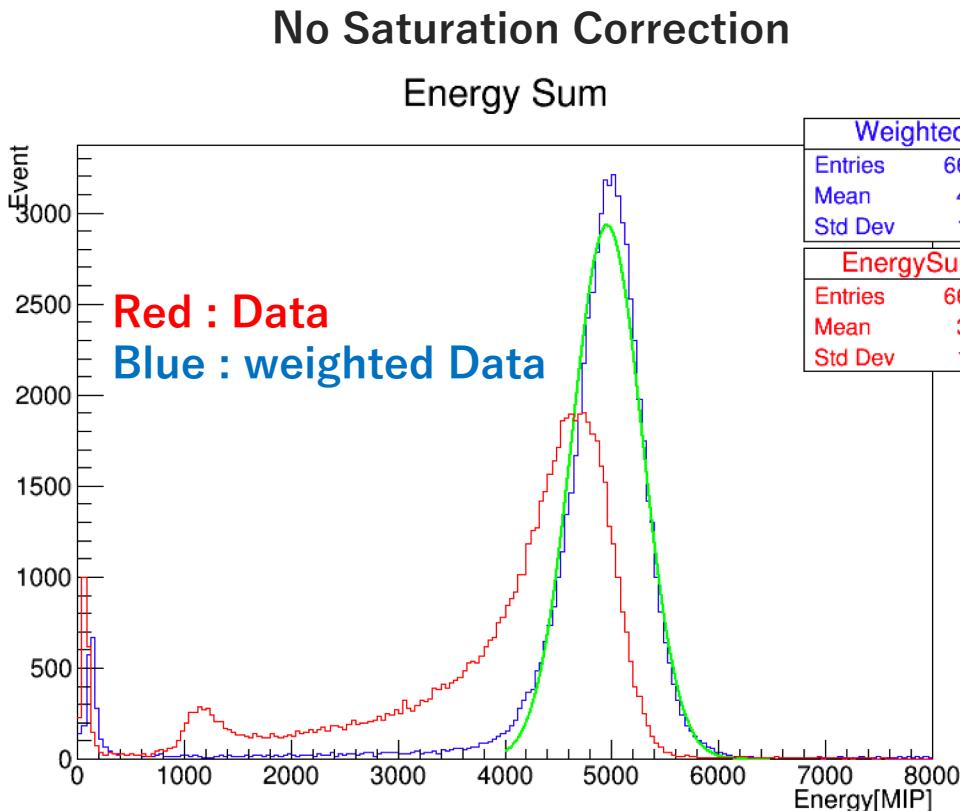
Tail Events at High Energy

- **Run 61230, Pion 160 GeV**
- **Events which may be independent of the tail-catcher are checked.**

- **Few high energy particles just come（?）.**
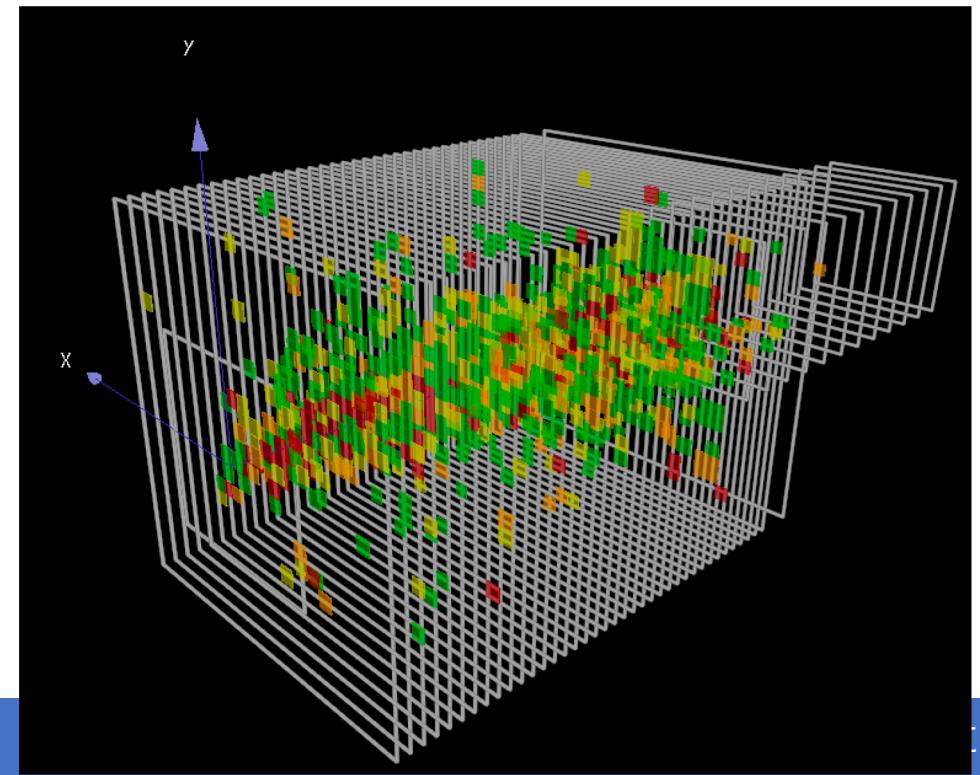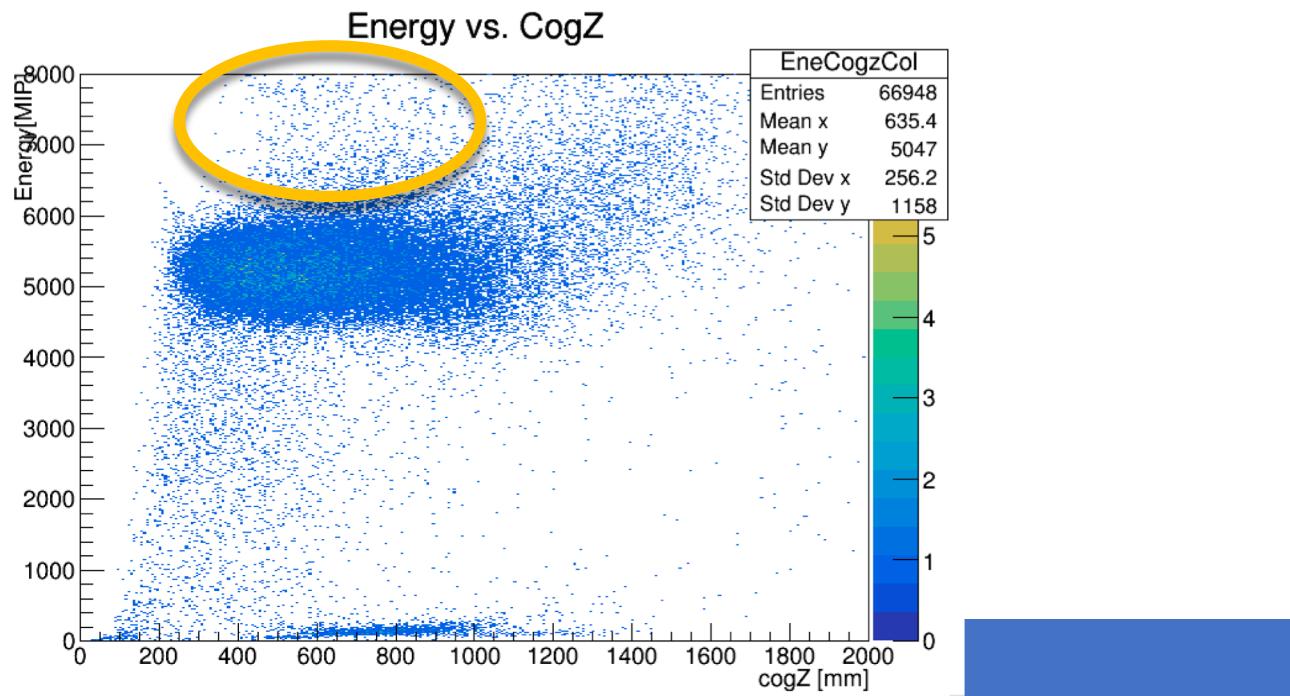
Tail Events at High Energy

- **Run 61230, Pion 160 GeV**
- **Events whose cogZ are in tail-catcher are checked.**

- **Energy sum is high although nHits is small.**
  - ➢**Applied weight is too big.**
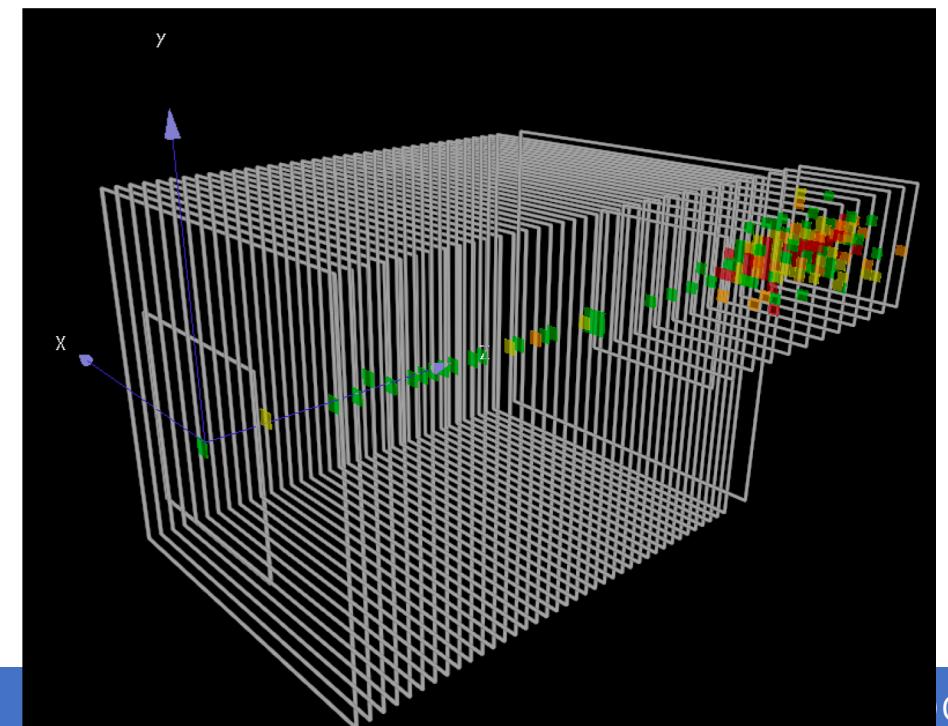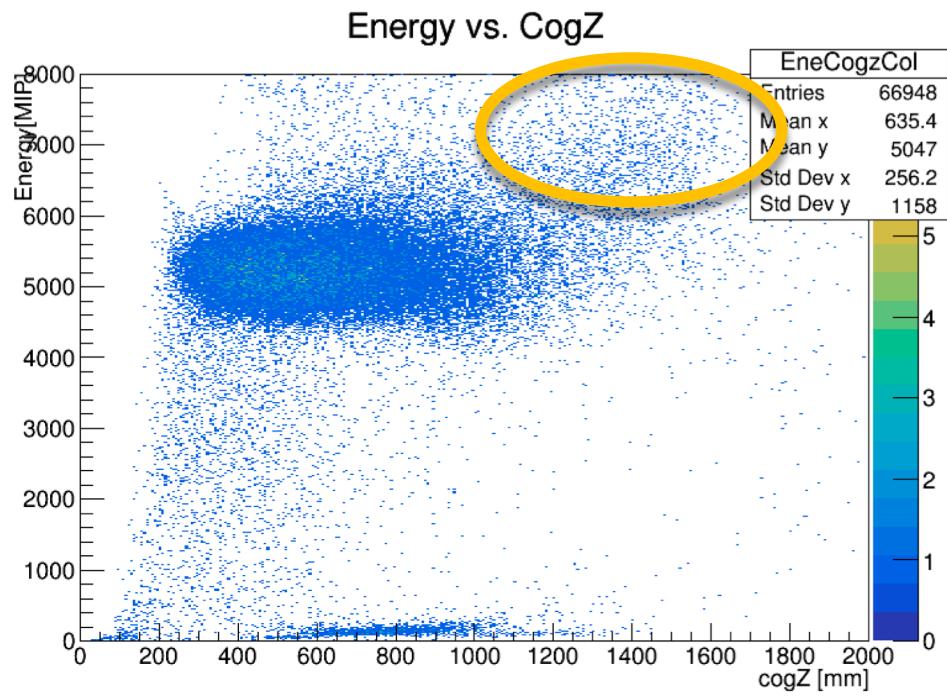
Better Optimal Weight

- **Simple weight : ratio of absorber thicknesses**
  - **AHCAL 39th layer**
    - Absorber is three times thicker than other layers.
  - **1st layer of Tail Catcher**
    - Ratio : $(17.2 \times 3 + 2.00)/17.2$: MC
    - Ratio : $(17.2 \times 3 + 12.1)/17.2$: Data
  - **Other layers of Tail Catcher**
    - Ratio : $74.0/17.2$

- **Run 61230, Pion 160 GeV**
- **Ratio of absorber thicknesses is applied as weight, and in addition I tried to change fraction of absorber thicknesses in order to optimize energy resolution.**
  - **Other layers of Tail Catcher**
    - Ratio : XXX/17.2 (1st layer : $(17.2 \times 3 + 12.1)/17.2$)

Better Optimal Weight

- **Run 61230, Pion 160 GeV**
- **Thickness of TC absorbers is 74.0 mm originally.**

- **Energy sum distributions are fit by Gauss.**
- **Fraction of absorber thickness vs. rms**
  - **Fitting function : quadratic function**

- **When fraction is 67.2 mm/74.0 mm, rms becomes the best value.**

Result of Gaussian fit

Energy Sum
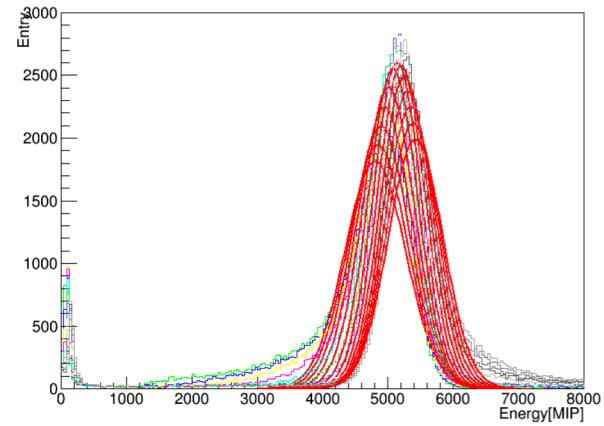
Fraction for Optimal Weight
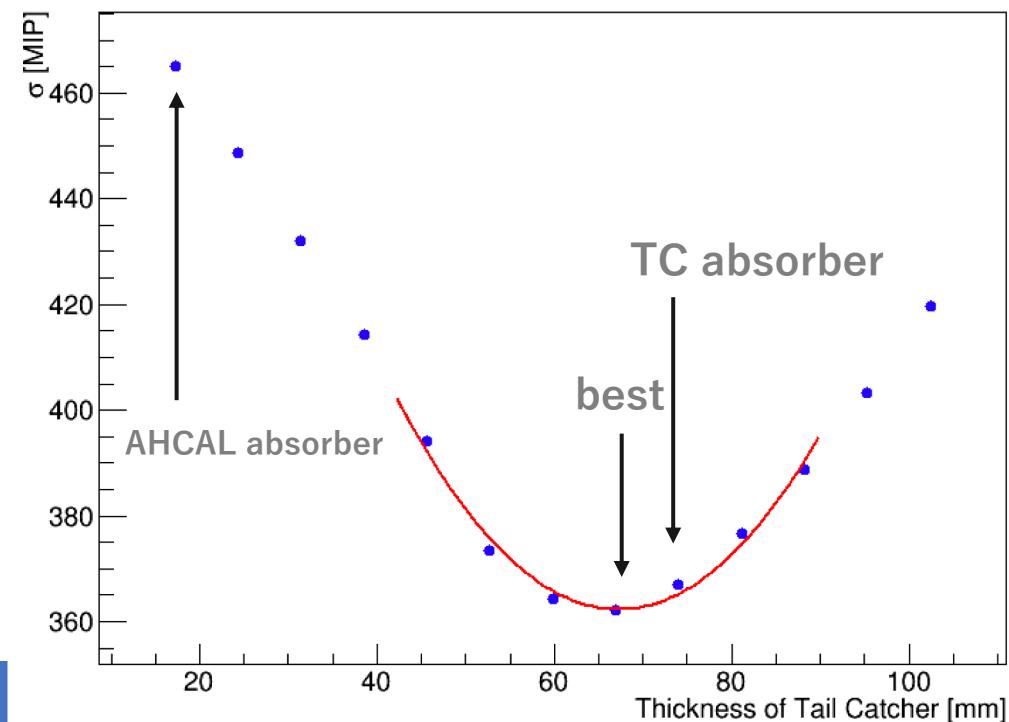
Result with Better Optimal Weight

- **Run 61230, Pion 160 GeV**
- **Tail events become smaller a bit.**

● **Red : Original Data**
● **Black : weighted w/ TC absorber**
● **Blue : weighted w/ better ratio**

weighted w/ better ratio

Energy vs. CogZ

EneCogzCol	
Entries	66948
Mean x	638.8
Mean y	5011
Std Dev x	261.1
Std Dev y	1142

Energy Sum
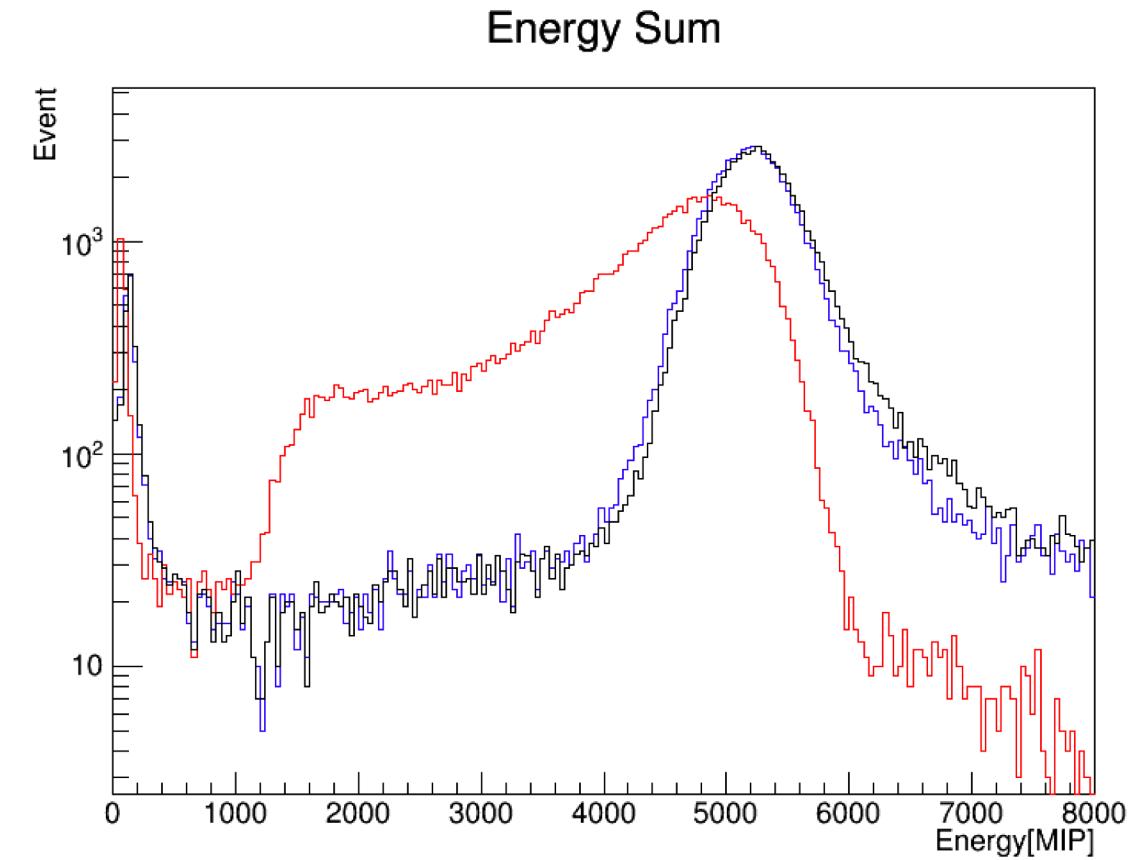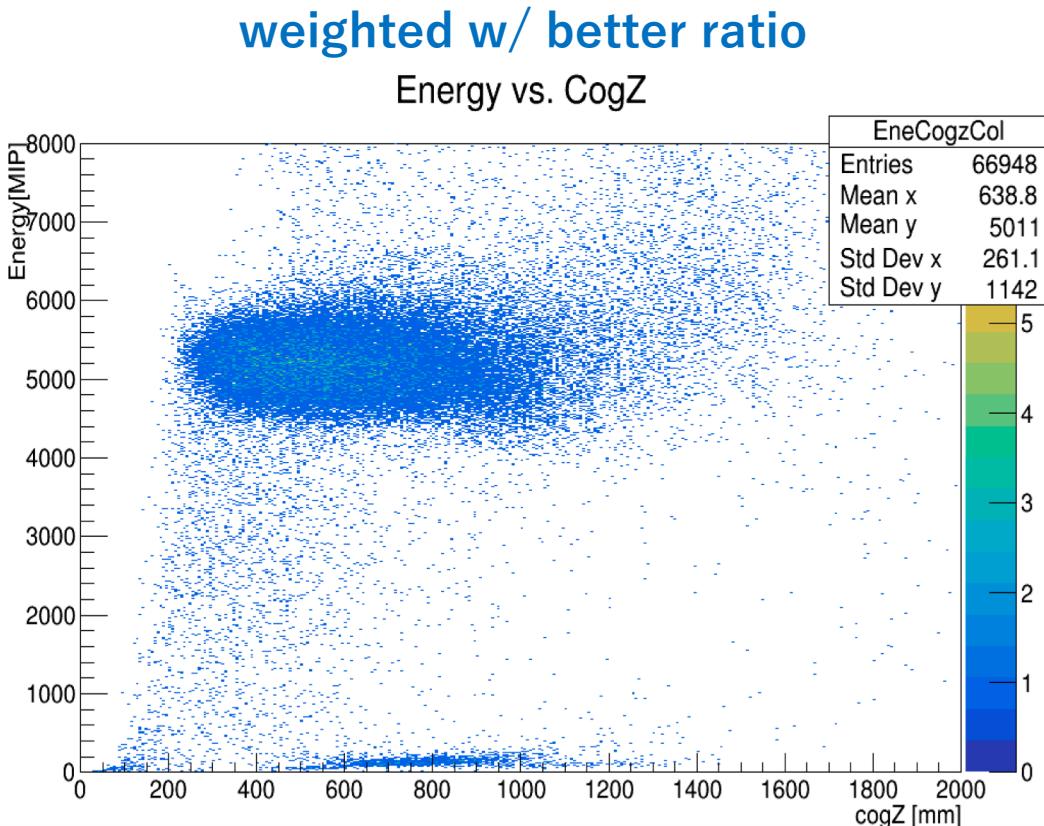
Linearity

- **Check linearity of pion runs**
- **Plots use the simple optimal weight, not the better optimal weight.**

- **Linearity seems good.**
  - **Green band : rms**

- **Reconsider a better energy correction method because a tail appears in high energy, in particular 160 GeV Pion run.**

Linearity Check
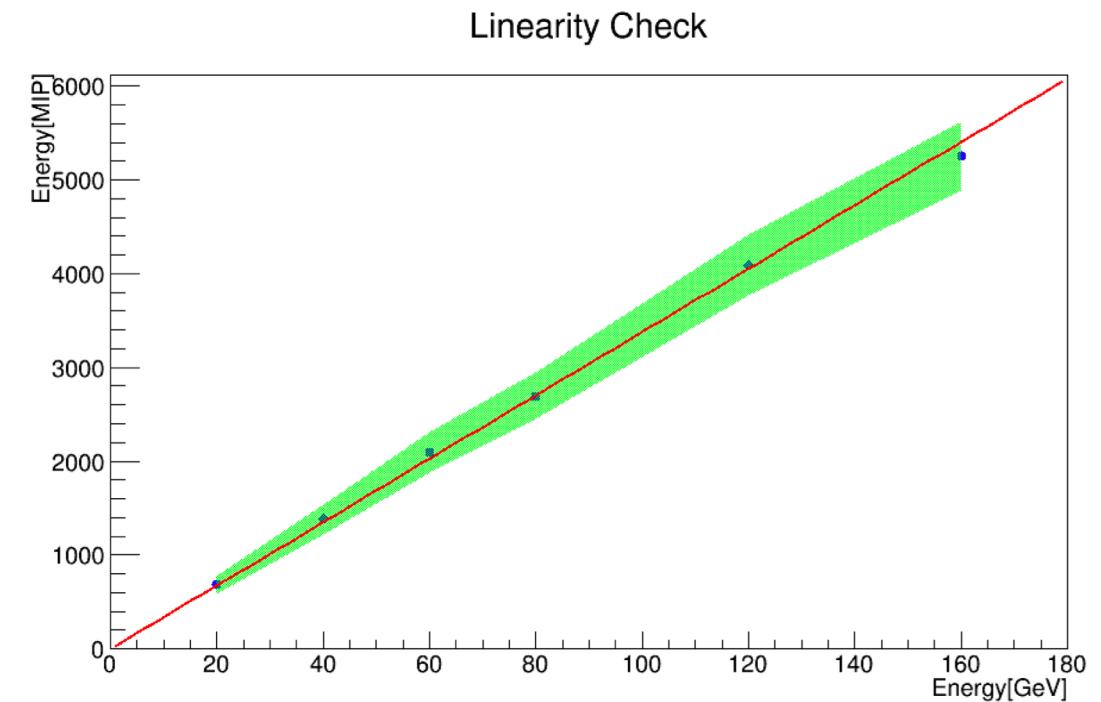
Energy Resolution

- **First look(?) into energy resolution with pion runs**
- **Plots use the simple optimal weight, not the better optimal weight.**

- **The slope of line means energy resolution.**
  - $X : 1/\sqrt{E[GeV]}$
  - $Y : rms[MIP]/energy[MIP]$

- **Energy resolution : $72.5\%/\sqrt{E[GeV]}$**

- **This result is not bad, but must be reconsidered about optimal weight, new calibration constants and so on.**

Energy Resolution

χ^2 / ndf   0.0009369 / 5
p0   0.7253 ± 0.03972

20GeV
40GeV
60GeV
80GeV
120GeV
160GeV

σ[MIP]/Energy[MIP]

$1/\sqrt{Energy[GeV]}$
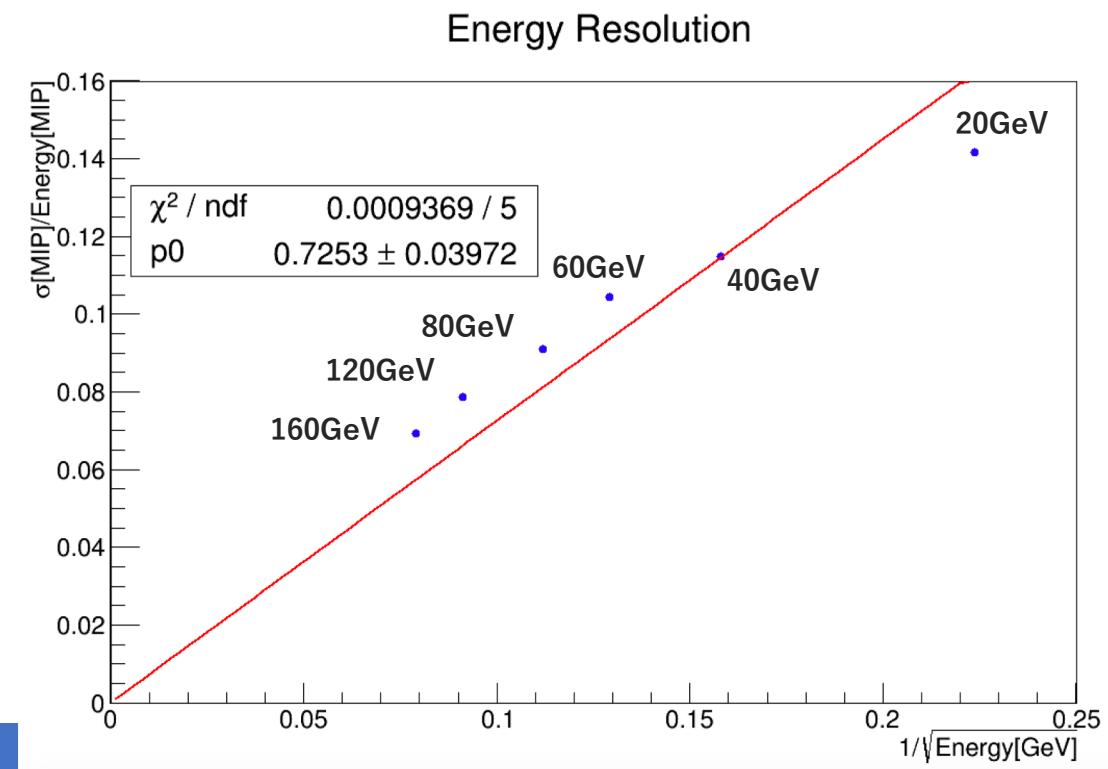
Summary and ToDo

- Most events of nHits=2 have events which a positional relationship of two response channels is close.
- When just ratio of absorber thickness is used as weight, energy sum becomes better although a tail appears in high energy due to heavy weight.
  - Weight which energy resolution is the best decreases the tail events.
- $72.5\%/\sqrt{E[\mathbf{GeV}]}$ energy resolution was obtained roughly.

- We might combine this simple weight and the ratio of normal TC and extended TC. ->(main meeting slide)
  - Solve many problem on MC/Data comparison and differences of normal/extended TC.
- A totally new idea of weight might be needed.

Thank you for all!

**I could spend a dense time in this analysis workshop!**

backup

Calibration Constants

```xml
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  <parameter name="DBInit" type="string" value="flccaldb02.desy.de:calice:caliceon:Delice.1:3306"/>
  <parameter name="DBCondHandler" type="StringVec">
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    Ahc2ModuleConnection               /cd_calice_Ahc2/TestbeamJune2018/ModuleConnection            HEAD
    Ahc2ModuleLocationReference        /cd_calice_Ahc2/TestbeamJune2018/ModuleLocationReference     HEAD
    Ahc2HardwareConnection             /cd_calice_Ahc2/TestbeamJune2018/HardwareConnection          HEAD
    Ahc2DetectorTransformation         /cd_calice_Ahc2/TestbeamJune2018/DetectorTransformation      HEAD
    E4DPedestal                        /cd_calice_Ahc2/TestbeamJune2018/Pedestal                    ahc2_pedestal_180926
    E4DGainConstants                   /cd_calice_Ahc2/TestbeamJune2018/gain_constants              ahc2_gainconstant_181212
    E4DGainSlopes                      /cd_calice_Ahc2/TestbeamMay2018/gain_slopes                  HEAD
    E4DMipConstants                    /cd_calice_Ahc2/TestbeamJune2018/mip_constants               ahc2_mip_constants_181205
    E4DMipSlopes                       /cd_calice_Ahc2/TestbeamMay2018/mip_slopes                   HEAD
    E4DDeadCellMap                     /cd_calice_Ahc2/TestbeamMay2018/DeadCellMap                  HEAD
    E4DSaturationParameters            /cd_calice_Ahc2/TestbeamJune2018/SaturationParameters        ahc2_SaturationParameters_181212
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    E4DPhysicsCalibIntercalibration    /cd_calice_Ahc2/TestbeamMay2018/PhysicsCalibIntercalibration HEAD
    E4DTimeSlopes                      /cd_calice_Ahc2/TestbeamMay2018/TimeSlope                    HEAD
    E4DTimeOffset                      /cd_calice_Ahc2/TestbeamMay2018/TimeOffset                   HEAD
  </parameter>
</processor>
```

Combined weight

- **The weight and the ratio of normal TC and extended TC.**
  - Solve many problem on MC/Data comparison and differences of normal/extended TC.

Pion 120 GeV

nHits vs. CogZ