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Photon Reconstruction Test

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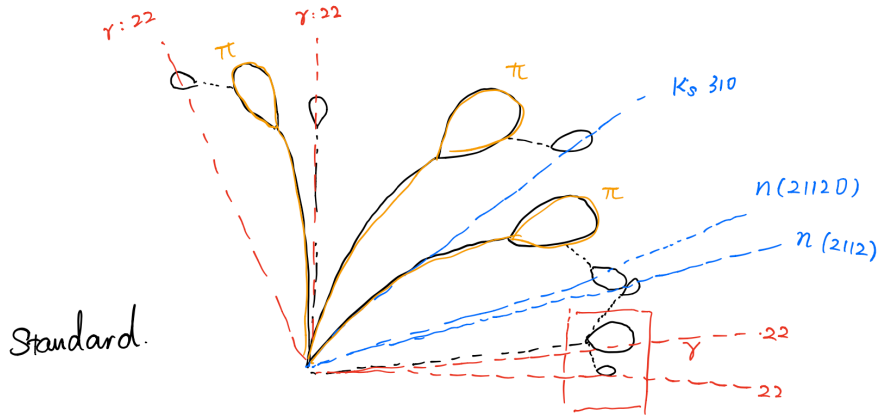
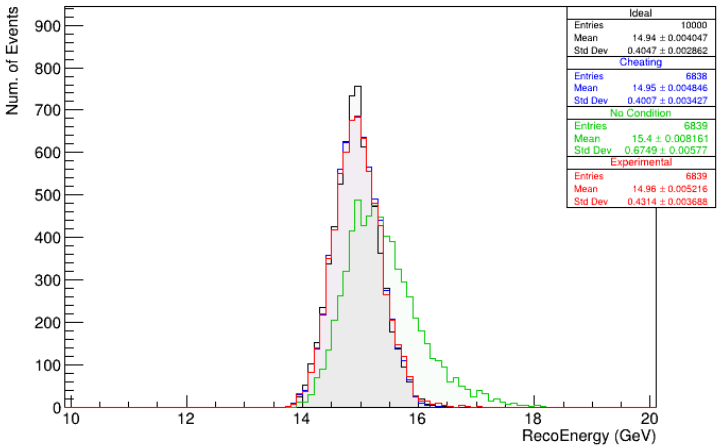
Current Reconstruction Flow

- Arbor
- Merge clusters
- Link cluster & track
- Reconstruct particles
  - Charged particle
  - Photon id
  - Fragment veto



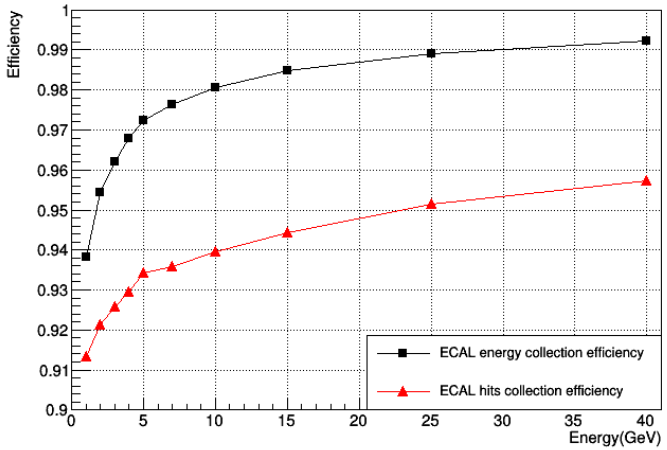


A test the photon reconstruction algorithm is needed

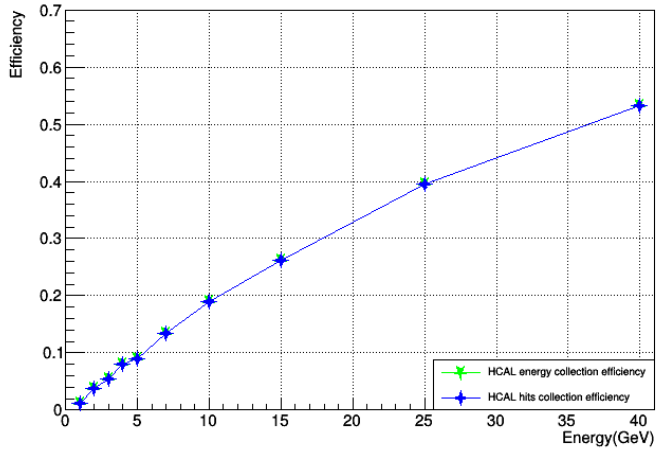
- **Hit collection efficiency**: if algorithm collected enough hits?
- **Splitting probability**: if clustering algorithm lead acceptable neutral cluster splitting?
- **Energy resolution**: if reconstructed energy of photon is healthy? & if the performance is well close to an ideal clustering algorithm?
- **Angle resolution**

ECAL, HCAL & Leakage ratio

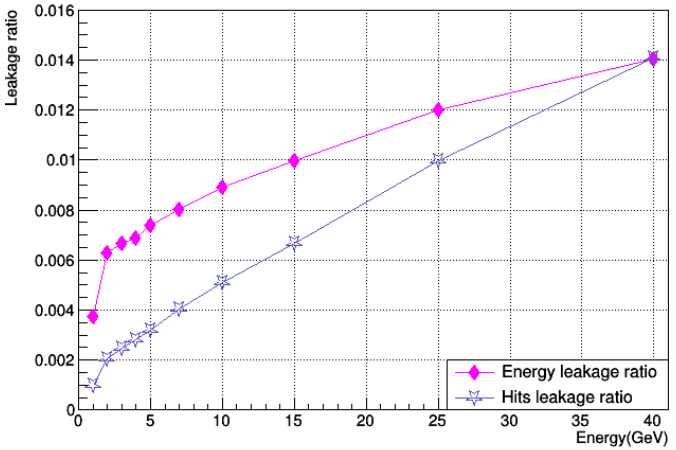
ECAL



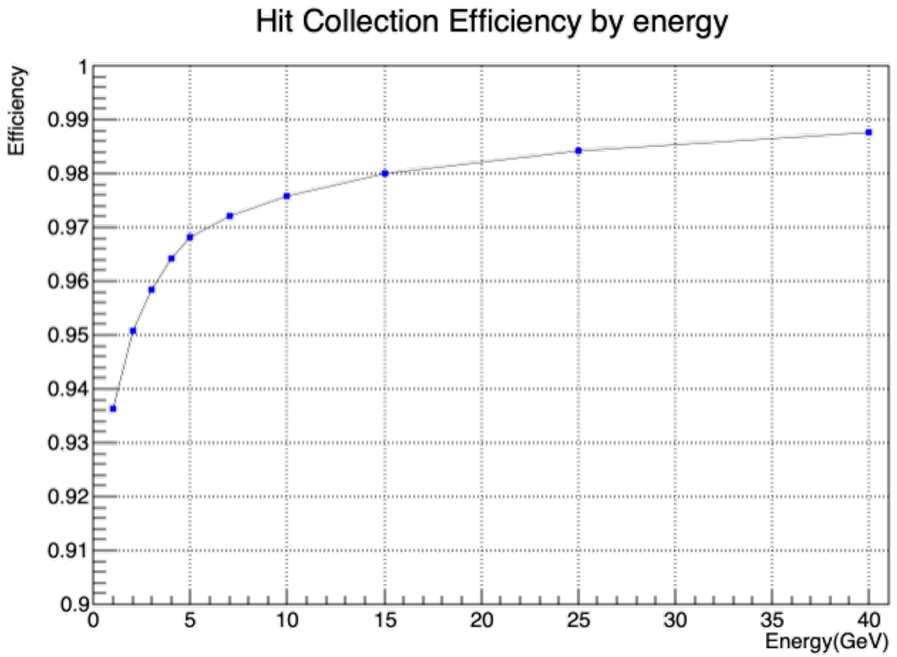
HCAL

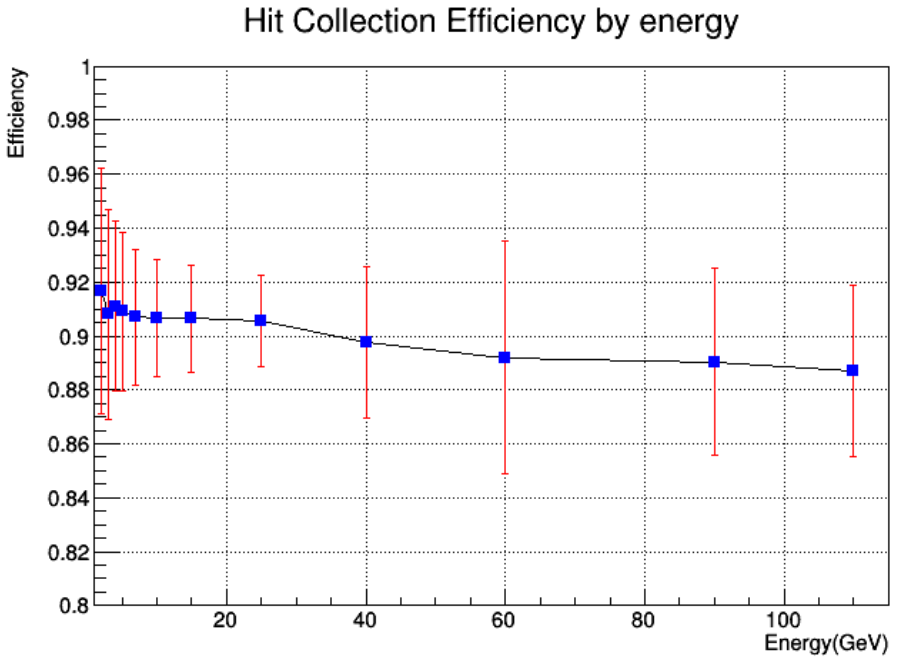


Leakage



Photon Energy Correction





left: $\epsilon_l = \frac{\sum_{clu} E_{hit}}{\sum E_{hit}}$;

right: $\epsilon_r = \frac{\sum E_{clu}}{\sum E_{hit}}$

Is photon energy correction OK?

Split & Back Scatter

$$\boldsymbol{P(Split)} = \frac{N_{event}^{split}}{N_{event}^{all}}$$

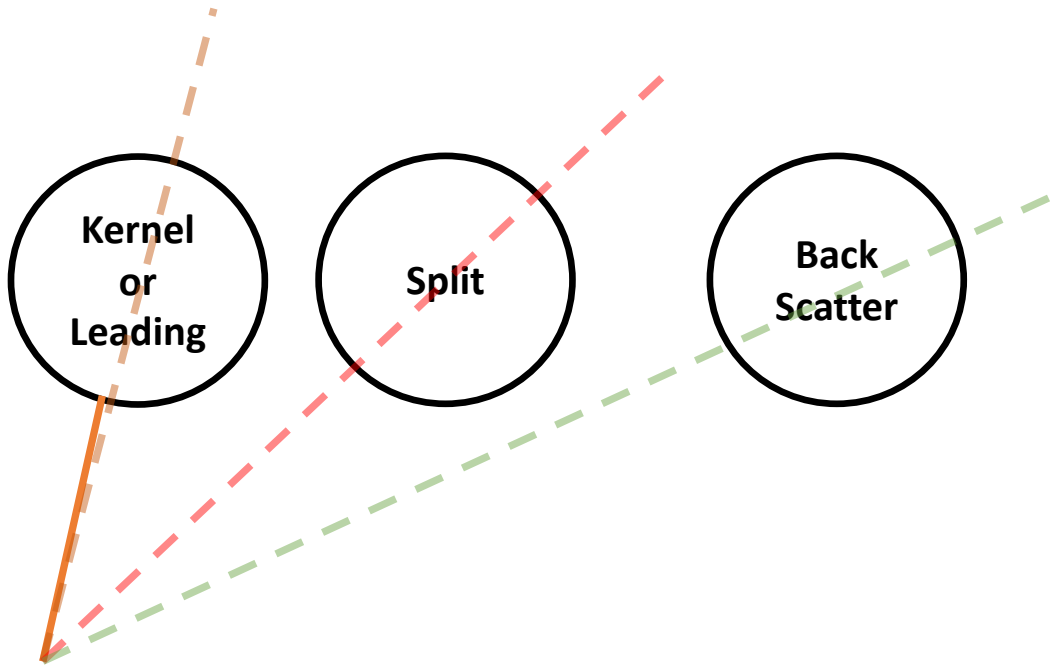
$$\boldsymbol{P(Back\ Scatter)} = \frac{N_{event}^{back}}{N_{event}^{all}}$$

$$\boldsymbol{P(Split\ and\ Back\ Scatter)} = \frac{N_{event}^{split\ \&\&\ back}}{N_{event}^{all}}$$

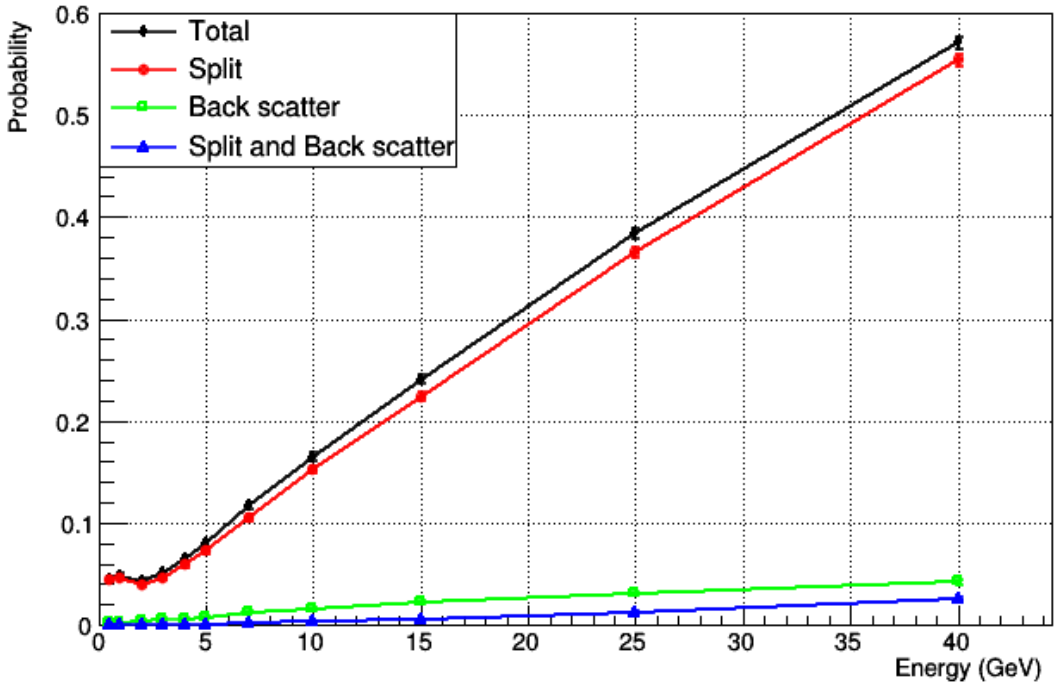
$$\boldsymbol{P(Total)} = \frac{N_{event}^{split\ or\ back}}{N_{event}^{all}}$$

$$= P(Split) + P(Back\ Scatter)$$

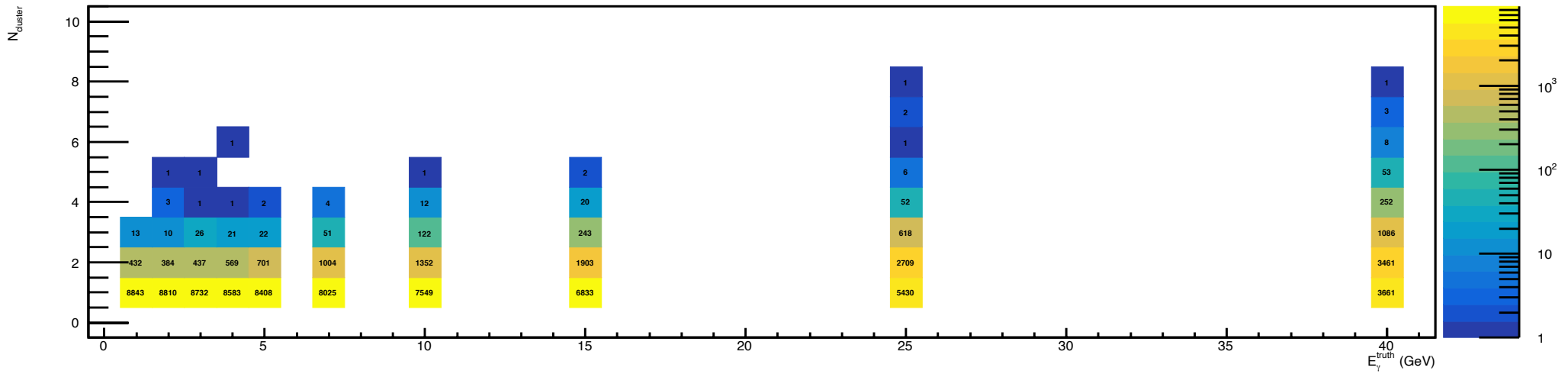
$$- P(Split\ and\ BackScatter)$$



Split & Back Scatter



Split & Back Scatter



Energy	1.0	2.0	3.0	4.0	5.0	7.0	10.0	15.0	25.0	40.0
Statistic	9288	9208	9197	9175	9133	9084	9036	9001	8819	8525

Reconstruction Accuracy & Precision

Leading: Reconstructed photon with **highest energy**

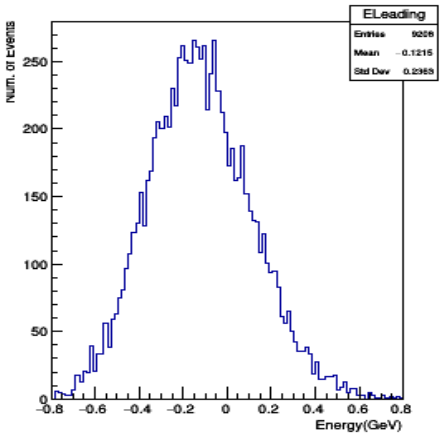
Ideal: **All hits** expect that from back scattering ->

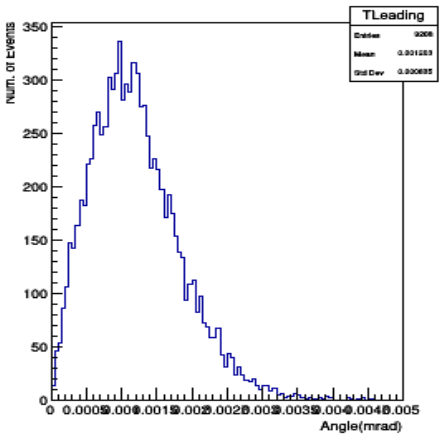
(**100%** hit collection efficiency &

merge split into leading cluster)

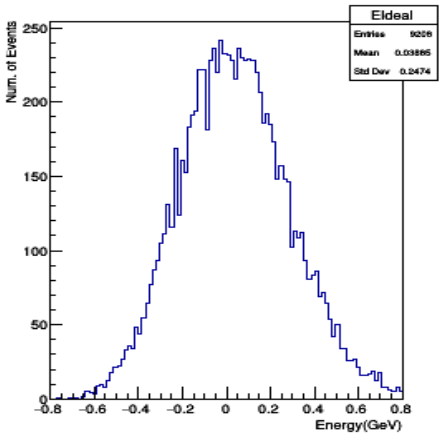
Merge: All **reconstructed particle** -> (clustering algorithm without a dedicated back scatter veto function)

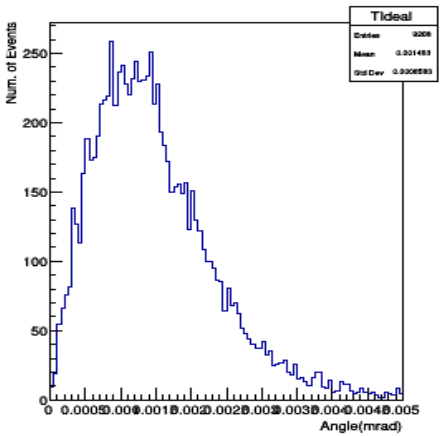
Leading



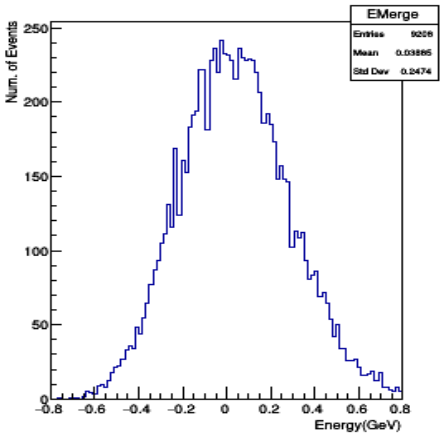


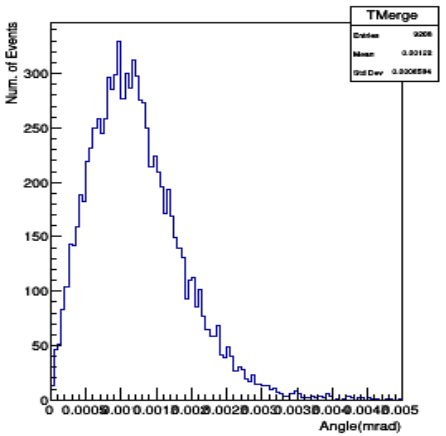
Ideal



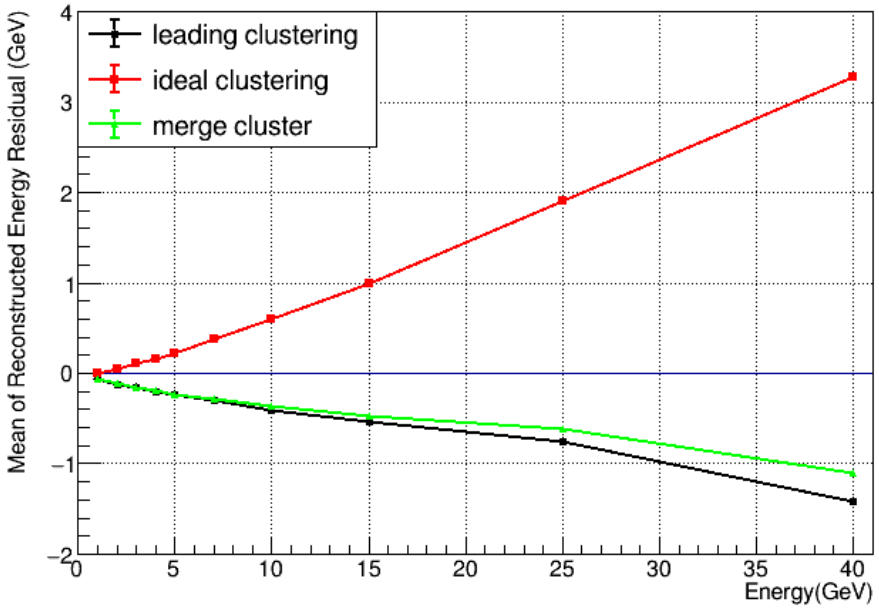


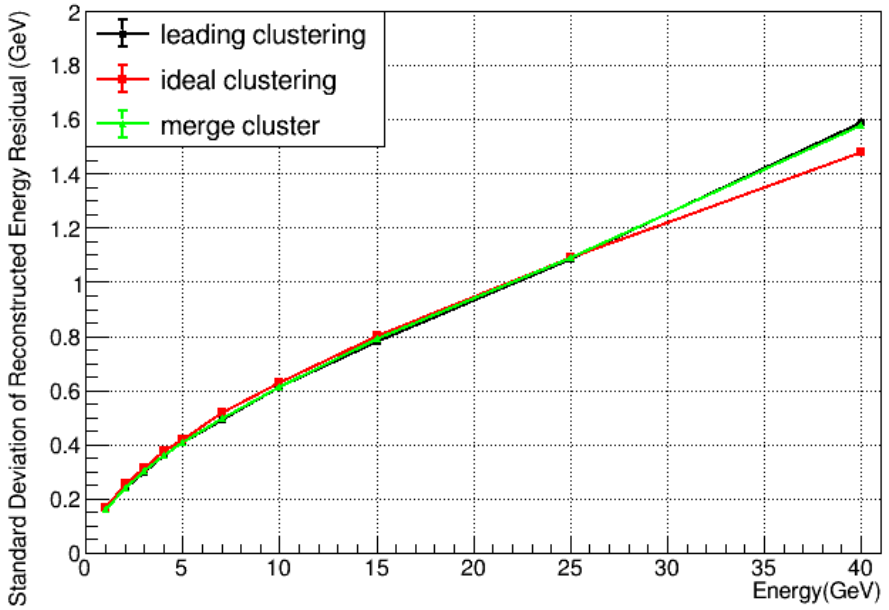
Merge



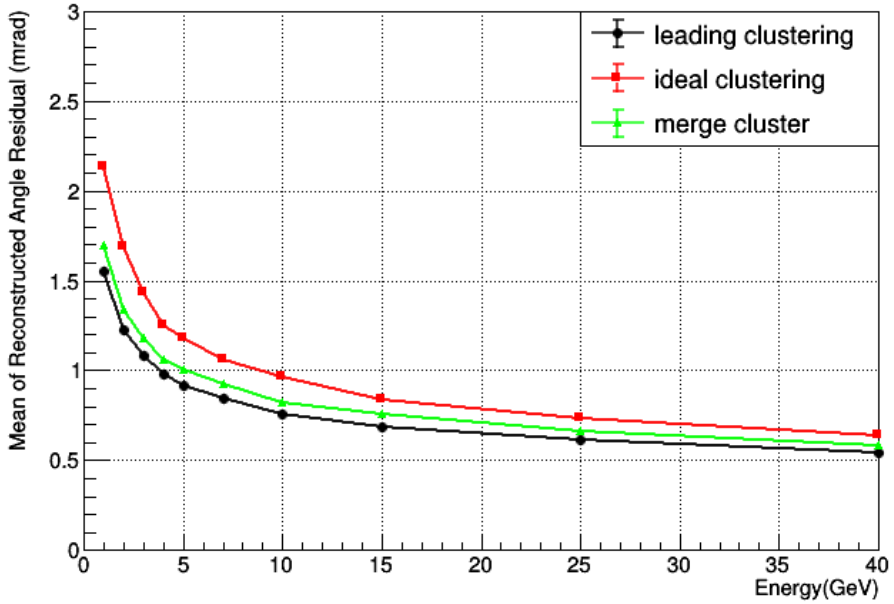


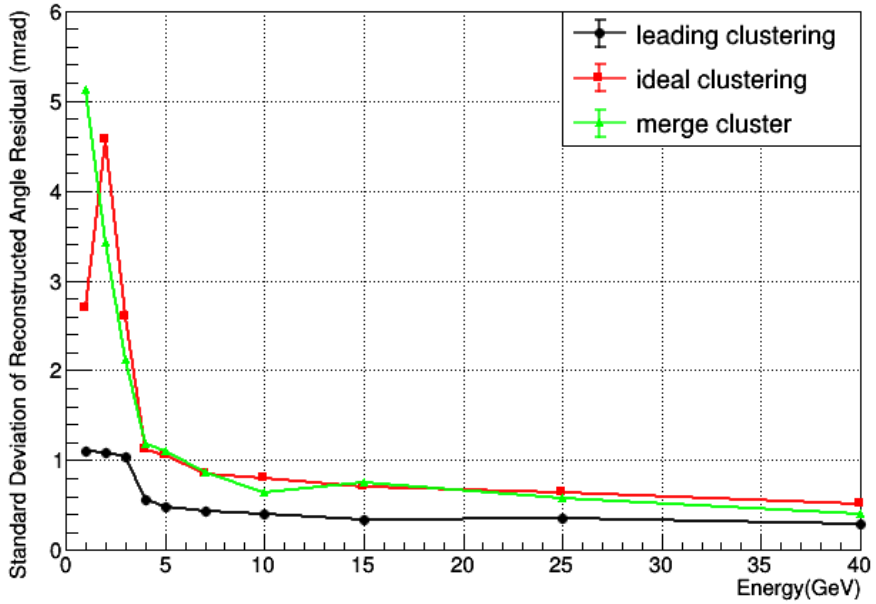
Energy


leading clustering
ideal clustering
merge cluster
Mean of Reconstructed Energy Residual (GeV)
Energy(GeV)
4
3
2
1
0
−1
−2
0
5
10
15
20
25
30
35
40


leading clustering
ideal clustering
merge cluster
Standard Deviation of Reconstructed Energy Residual (GeV)
Energy(GeV)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
40

Angle





Reconstructed direction of ideal clustering: **center of gravity** of all hits energy

Reconstructed direction of merge clustering: vector sum of momentums of all reco. particles

Condition of back scatter

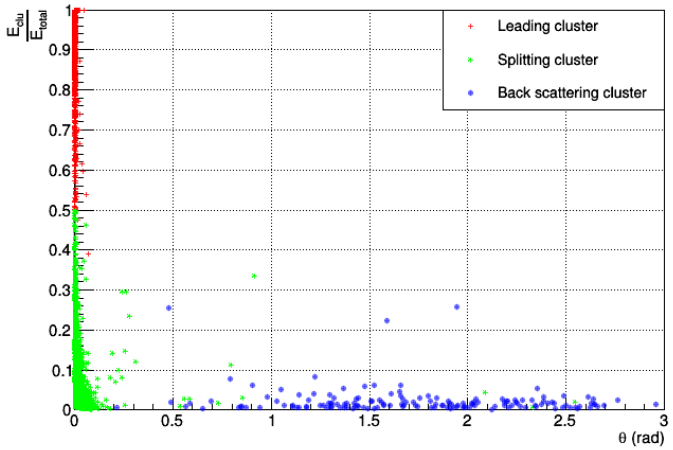
- Hit:
  - cased by a back scatter particle
  - obtuse angle between fly direction and born direction of this particle
- Cluster or reconstructed particle:
  - include >50% back scattering hits

```
bool PhotonIDTest::isBackScatterP(MCParticle *par)
{
    TVector3 VTX = par->getVertex();
    TVector3 EndP = par->getEndpoint();
    TVector3 dx = EndP - VTX;

    if (par->isBackscatter() && VTX.Angle(dx) > 0.5 * TMath::Pi())
    {
        return true;
    }
    else
    {
        return false;
    }
}
```

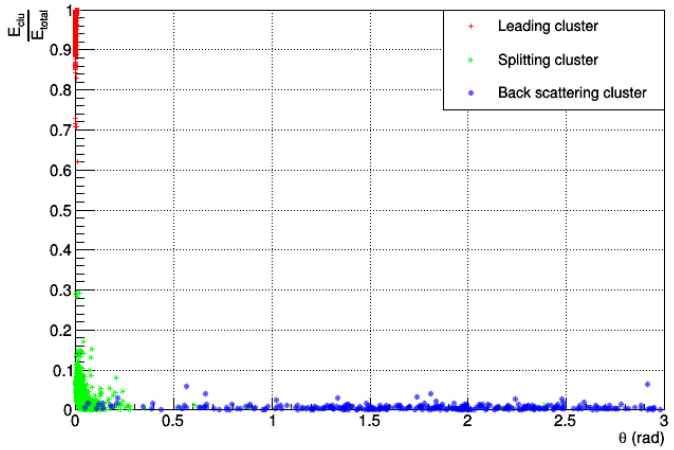
```
std::vector<int> tag_isBackScatter = isBackScatterHit(hits, evt);

double num_BackScatter = std::accumulate(
    tag_isBackScatter.begin(),
    tag_isBackScatter.end(),
    0);
double ratio = num_BackScatter / (double)tag_isBackScatter.size();

if (ratio >= 0.5)
{
    return true;
}
else
{
    return false;
}
```

Condition of back scatter

$E_{truth} = \{1, 2, 3, 4\}\ GeV$



$E_{truth} = \{5, 7, 10\}\ GeV$



$E_{truth} = \{15, 25, 40\}\ GeV$