Split-Off Recognition for the Forward Endcap

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Overview

- investigating photon reconstruction of the forward endcap for my master thesis
- mostly working within Ben Salisbury's restructured EMC code
- currently focusing on recognition of split-off maxima

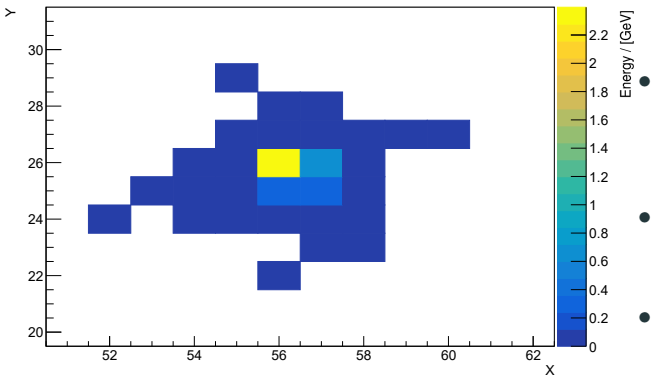
First Step

- developed a reliable way to identify split-offs based on MC information

Now

- developing split-off recognition operating without the use of MC information

What are Split-Offs? - In-Cluster Split-Offs



energy distribution in the calorimeter crystals

- statistical fluctuations cause additional maxima in the energy distribution
- split-off maxima are assigned their own subclusters
- too many particles are reconstructed

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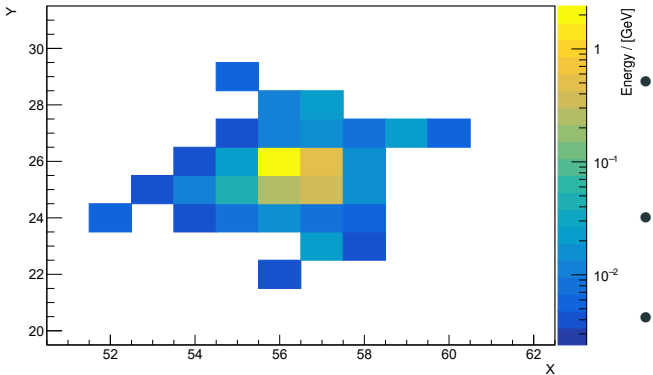

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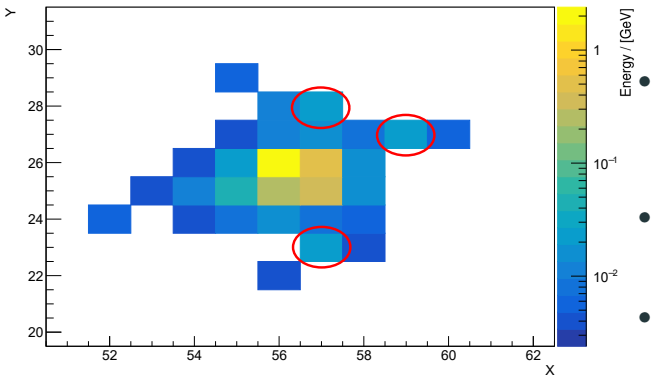

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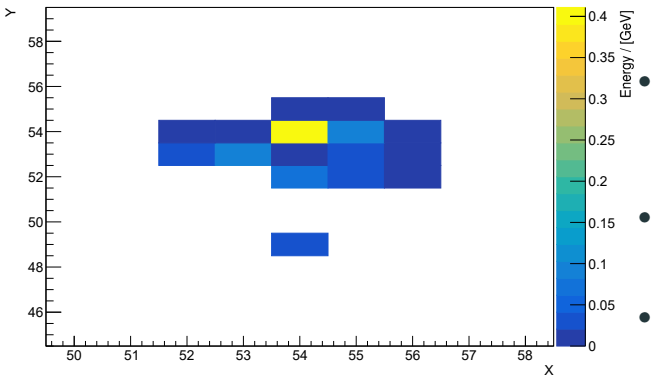
What are Split-Offs? - Out-Of-Cluster Split-Offs



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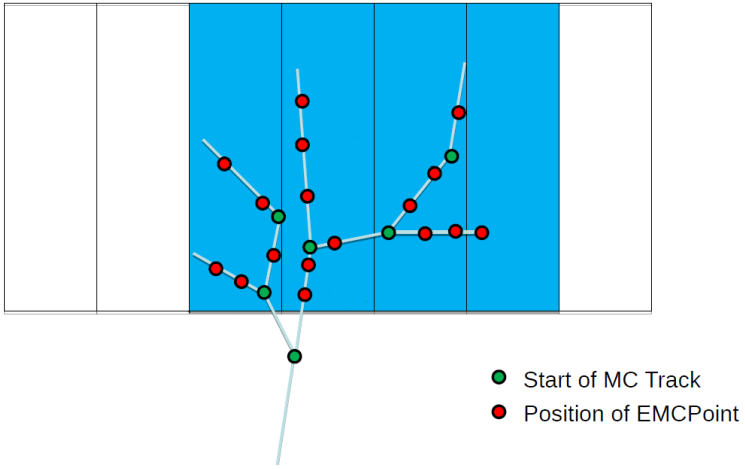
MC Track Matching

- in order to separate real maxima from split-off maxima, the external MC tracks need to be matched to the calorimeter crystals
- first implementation based on angles and crystal positions unreliable

Idea

- match tracks based on energy depositions on MCPoint level
- algorithm for setting cluster Ids in the MCHitProductionProcess, written by T. Stockmanns, already fulfilling similar purpose
  $\rightarrow$ algorithm can be adapted to fit my needs

MC Track Matching Algorithm



[Talk "EMC MC Information" held by T. Stockmanns on 8/24/20]

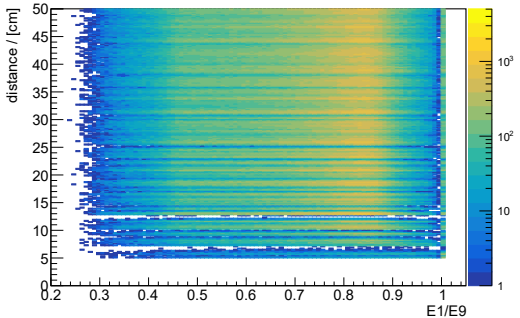
Split-Off Recognizer Class

- track matching algorithm stores all external tracks that deposited energy in a specific crystal in the corresponding EmcMCHit
- stored tracks need to be filtered for relevant ”maxima-causing” tracks

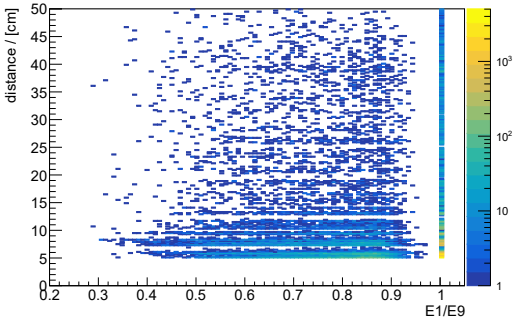
Split-Off Recognizer Filtering

- EmcMCHit must be the maximum in which the track left the most energy
- track must deposit at least 10 MeV in considered crystal
- crystal in which the track left the most energy must lie within the same cluster

1 PED Clusters - Separation by Distance - 2γ Test Simulation



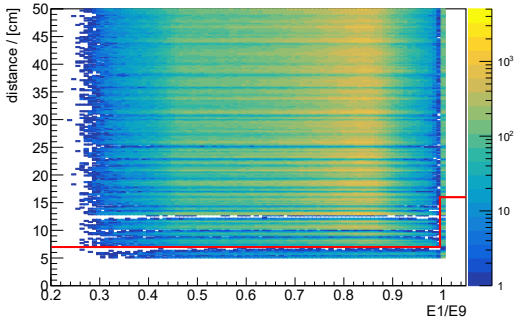
distance to closest cluster vs E1/E9 for 1 PED clusters not containing split-off maxima



distance to closest cluster vs E1/E9 for 1 PED clusters containing split-off maxima

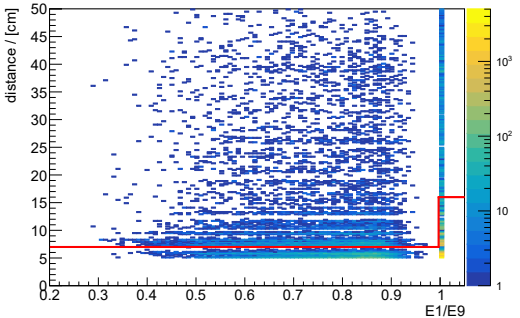
1 PED Clusters - Separation by Distance - 2γ Test Simulation

>99% correctly identified



distance to closest cluster vs E1/E9 for 1 PED clusters not containing split-off maxima

72% correctly identified



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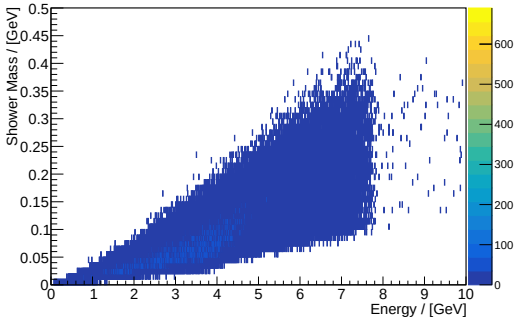
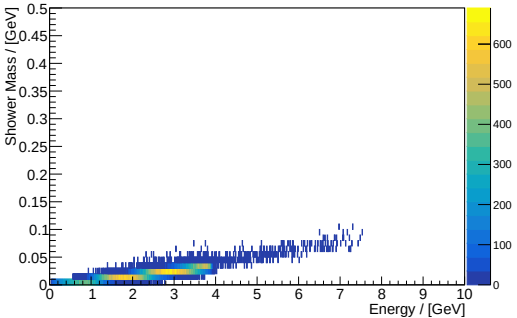
2 PED Clusters - Separation by Shower Mass - 2γ Test Simulation



shower mass vs cluster energy for 2 PED clusters not containing split-off maxima



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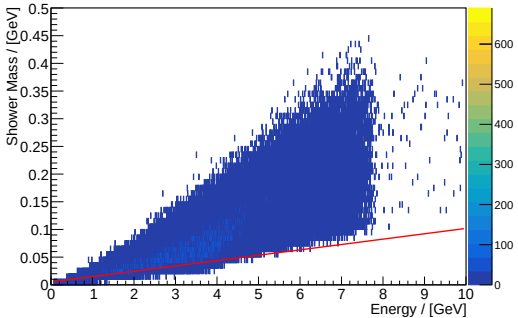

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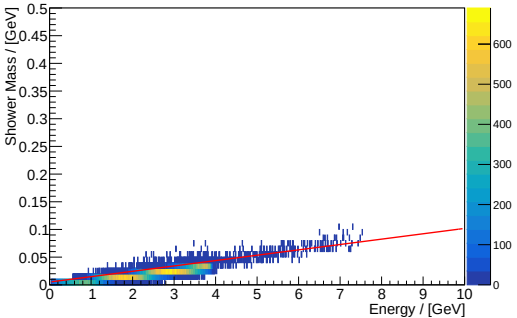
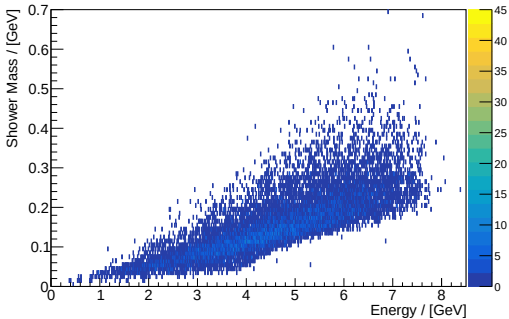
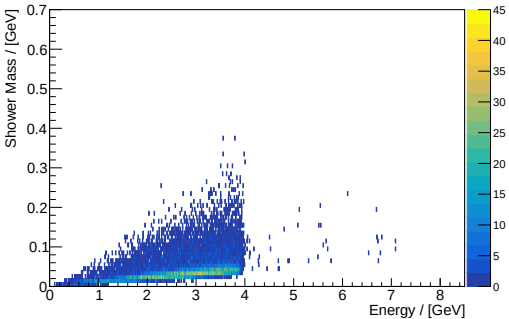


shower mass vs cluster energy for 2 PED clusters containing split-off maxima

High PED Clusters - Separation by Shower Mass - 2γ Test Simulation



shower mass vs cluster energy for 2 PED pseudo-clusters coming from high PED clusters not containing split-off maxima



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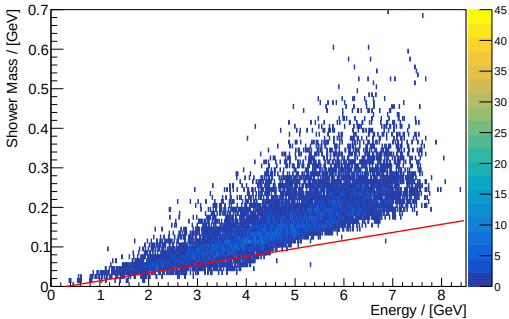

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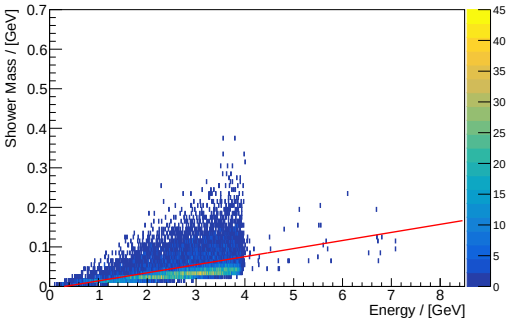
70% correctly identified



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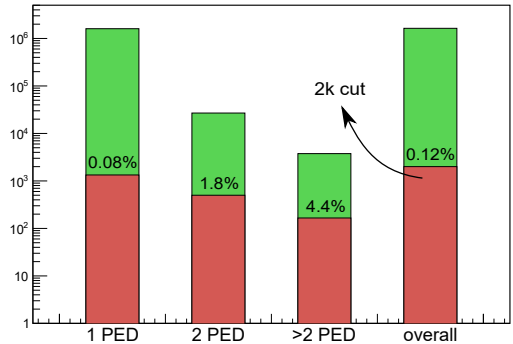
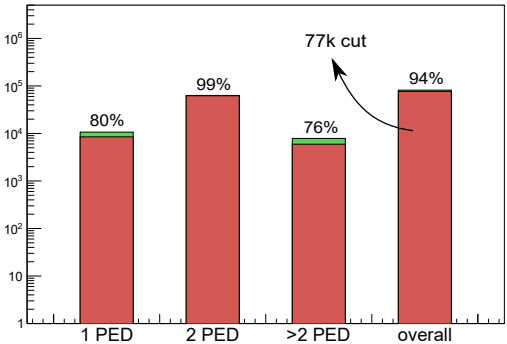
Results - $\bar{p}p \rightarrow 6\gamma$ @ 8 GeV Simulation - cut Maxima

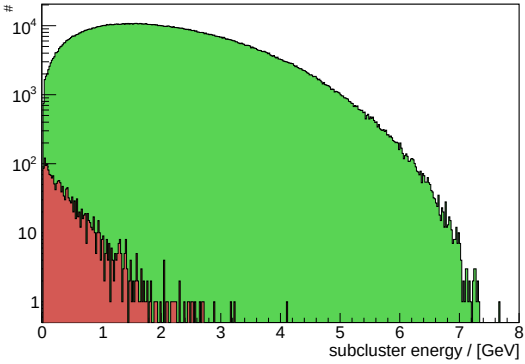


cut maxima caused by primary particle

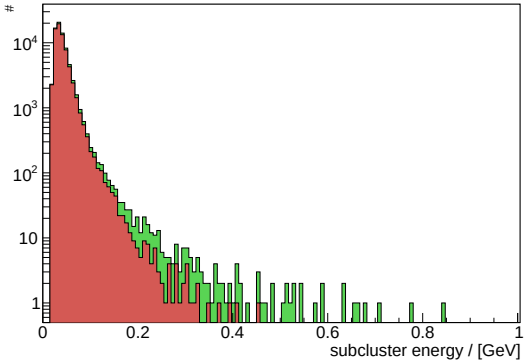


cut maxima caused by split-off

Results - $\bar{p}p \to 6\gamma$ @ 8 GeV simulation - cut Subcluster Energies

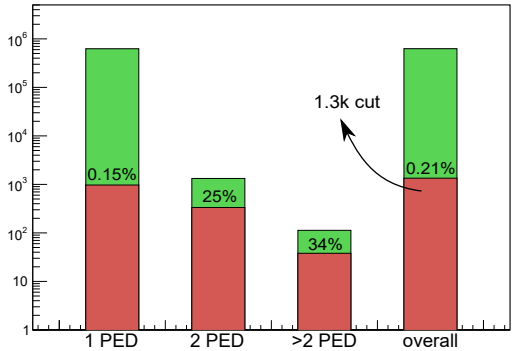


E of subclusters with primary maximum

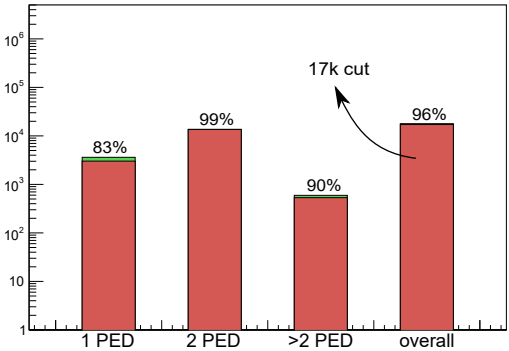


E of subclusters with split-off maximum

Results - $\bar{p}p \rightarrow \eta\,\pi^0\,\pi^0 \rightarrow 6\gamma$ @ 1.94 GeV Simulation - cut Maxima



cut maxima caused by primary particle



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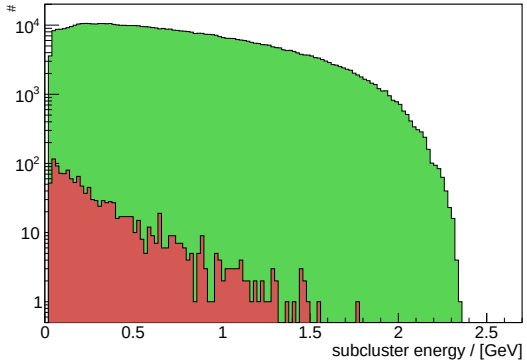

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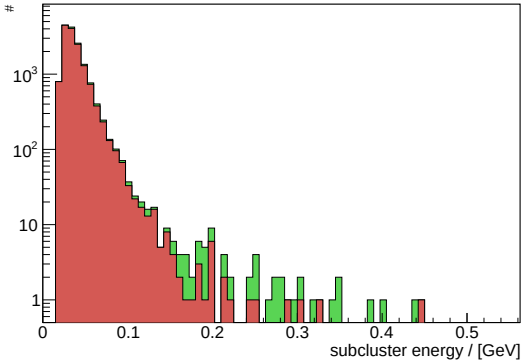

E of subclusters with split-off maximum

Summary

- effective cuts in place to find split-off maxima in any type of cluster
- able to identify well over 90 % of split-off maxima
- only fraction of a percent of ”real” maxima cut by mistake
- more ”real” maxima cut for low subcluster energies, but majority of low energy primaries survive
- split-off/primary separation weakens for low energy simulations, but still reasonable

Next Steps

- implement tagging of supposed split-offs into reconstruction chain
- investigate merging of out-of-cluster split-offs into main cluster

Thanks for your Attention!