Update on ECAL Testbeam data Analysis

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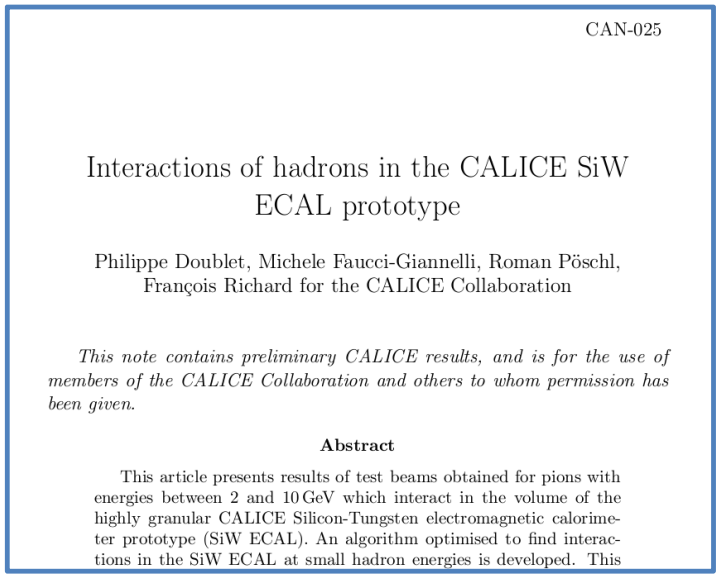
13/02/13

Aim

- Make a publication out of CAN-025 analysis note about the FNAL 2008 ECAL testbeam data
- Check the analysis and make minor improvements
- Adjust the note to make it into a publication



CAN-025

Interactions of hadrons in the CALICE SiW ECAL prototype

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This note contains preliminary CALICE results, and is for the use of members of the CALICE Collaboration and others to whom permission has been given.

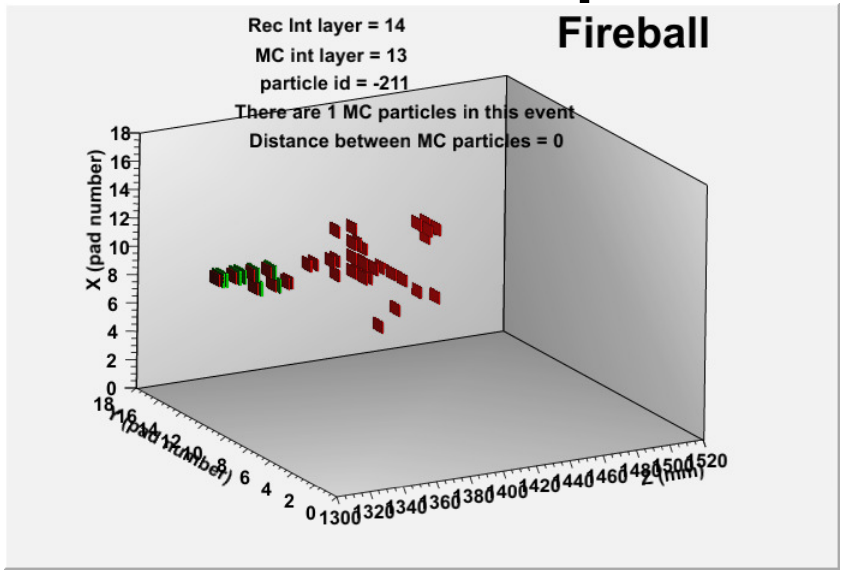
Abstract

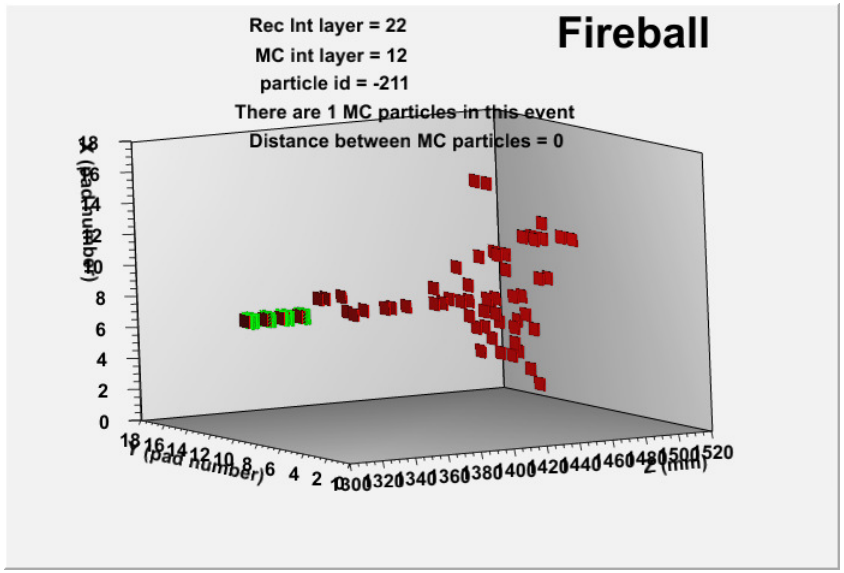
This article presents results of test beams obtained for pions with energies between 2 and 10 GeV which interact in the volume of the highly granular CALICE Silicon-Tungsten electromagnetic calorimeter prototype (SiW ECAL). An algorithm optimised to find interactions in the SiW ECAL at small hadron energies is developed. This

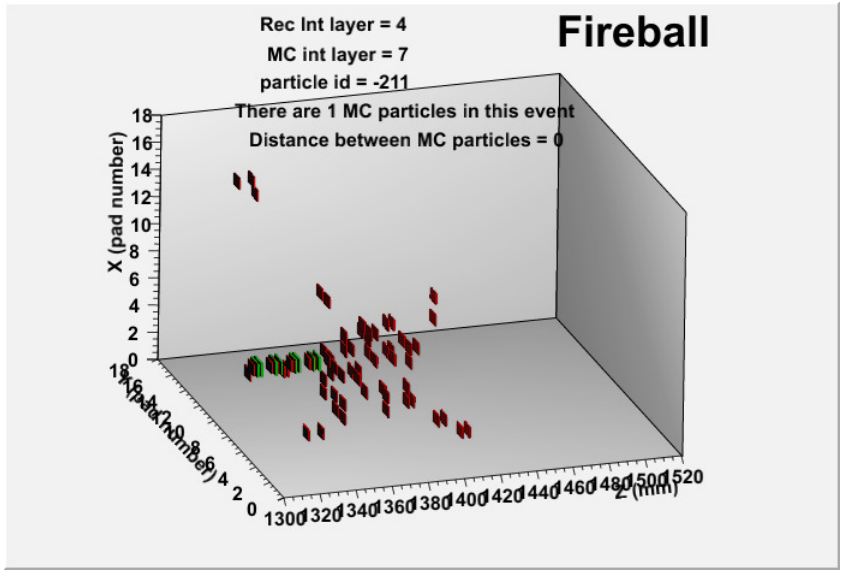
Analysis summary

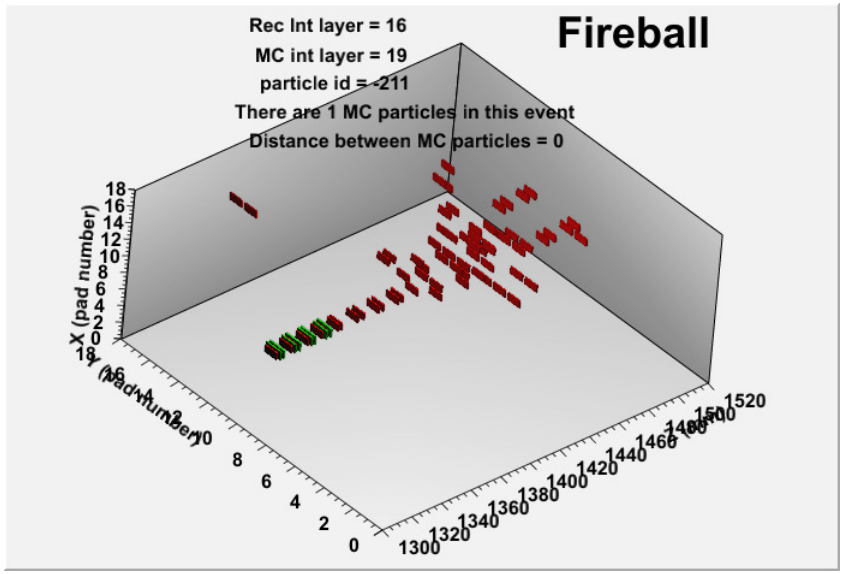
- Event cuts:
  - correct trigger, minimum number of hits, no noisy layers, hits in correct region of Ecal, muon rejection
- Clustering to find the incoming particle
- Event classification based on 4 types: FireBall, Pointlike, Scattered, Mip
  - Absolute and relative energy increase in subsequent Ecal layers

Examples FireBall events

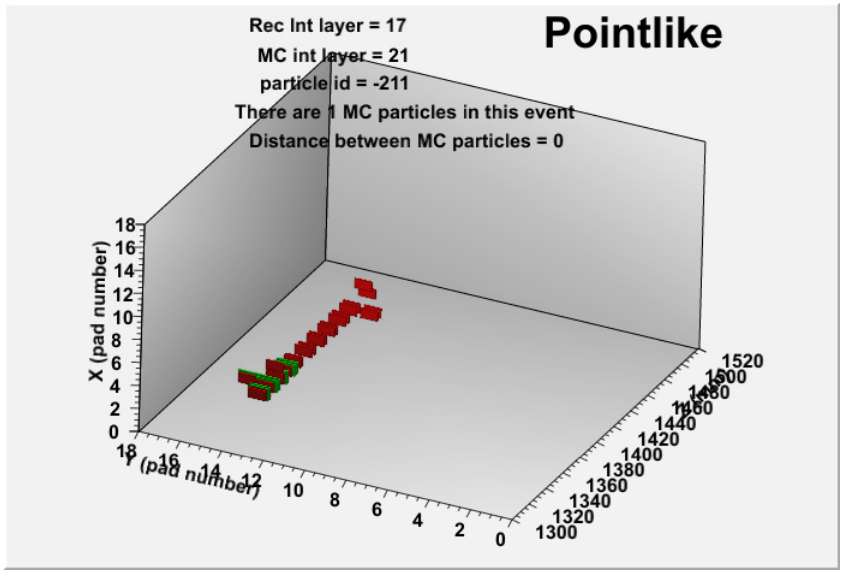


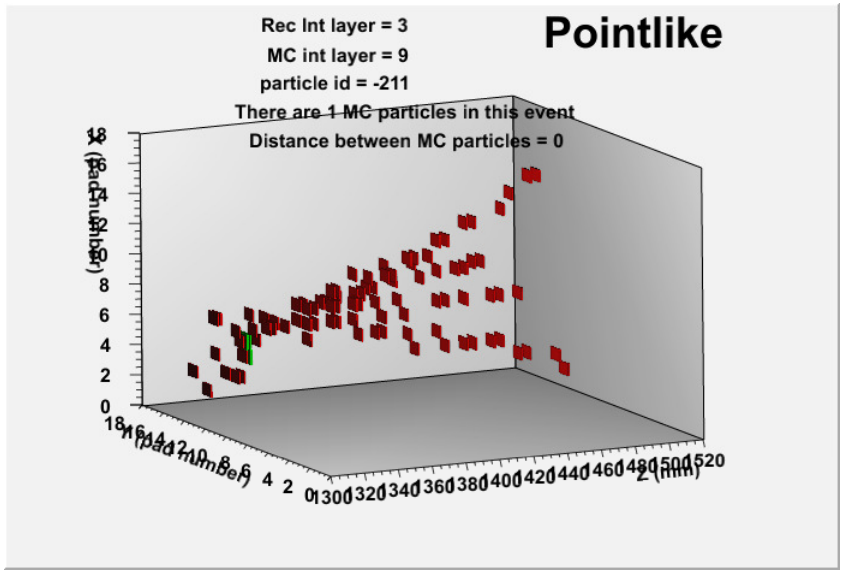


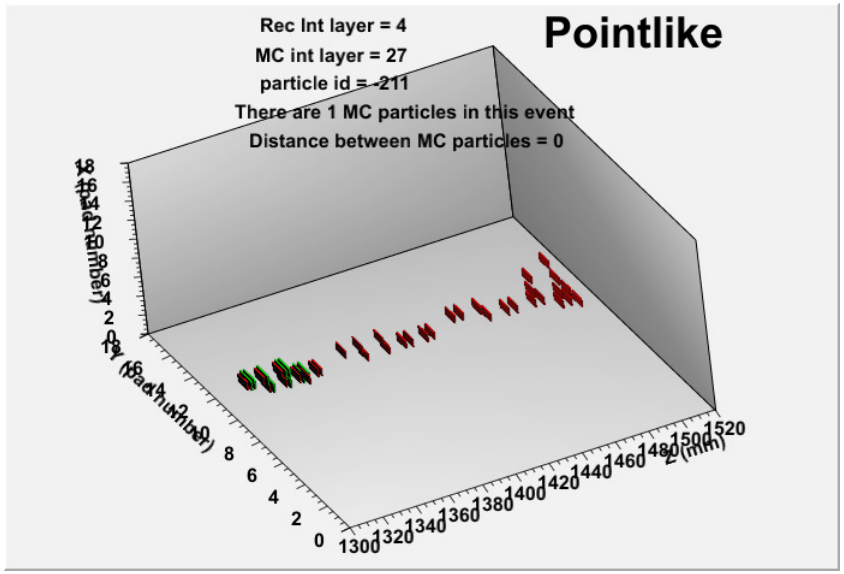


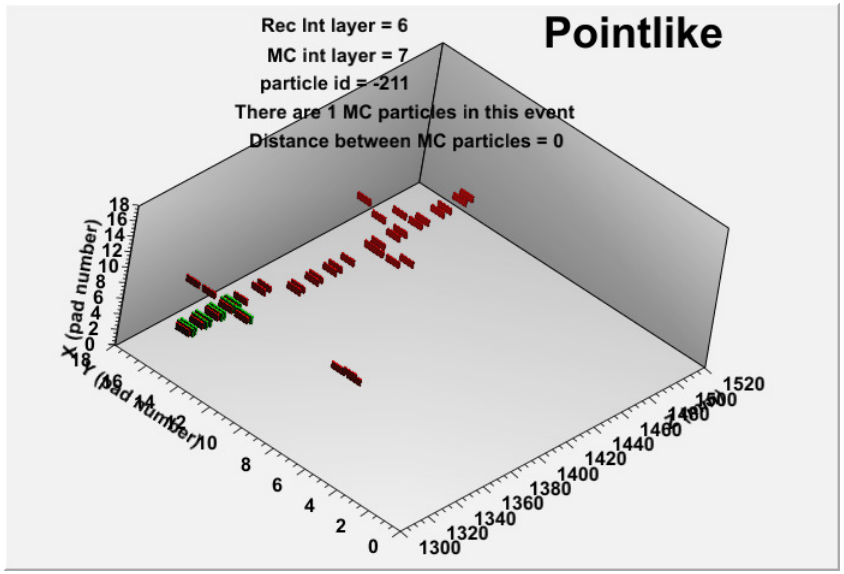


Example of Pointlike events









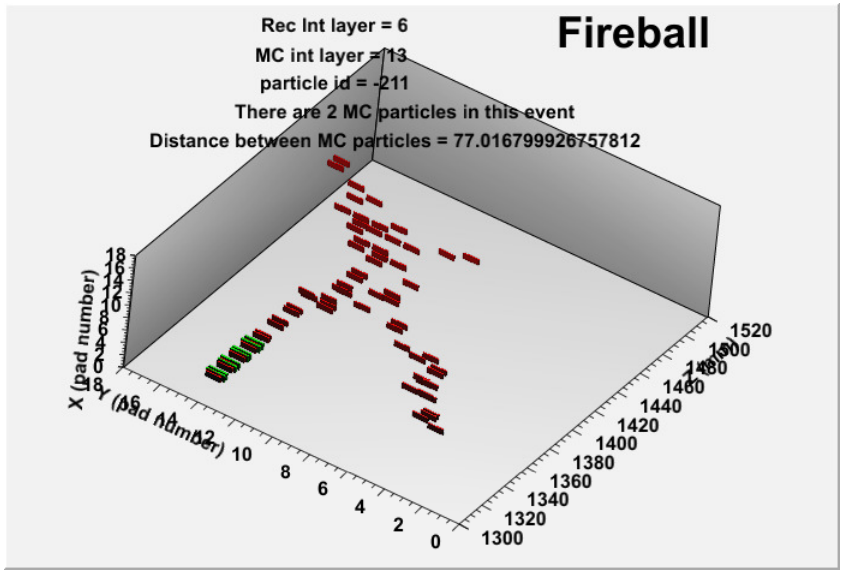
Progress

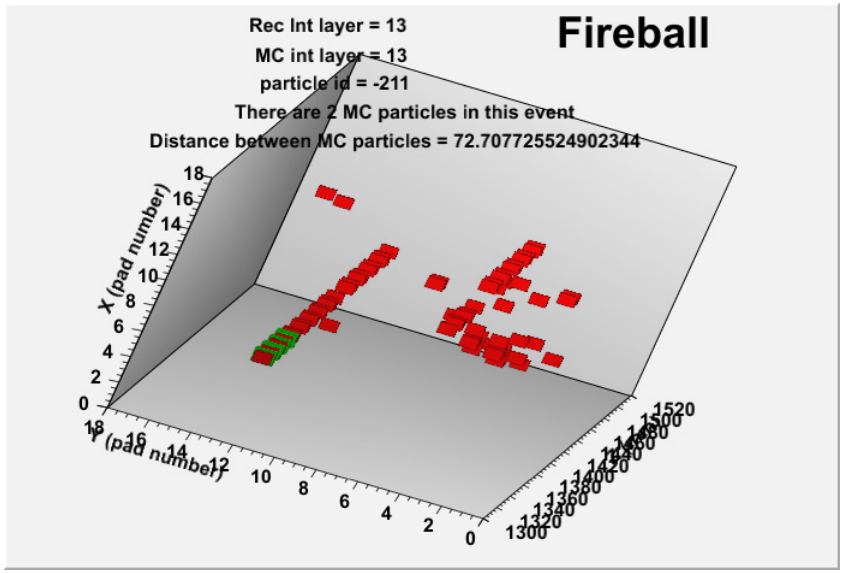
- Understanding the analysis code
  - 4 Marlin Processors: SelectAndConvert, MipFinder, InteractionFinder, CaliceEcalHitInfo
- Changes:
  - Rewrote MipFinder
    - the cluster with the smallest slope is chosen -> reduces the contamination in the interaction finding
  - Adjusted InteractionFinder
    - Energy criteria were not as described in the note
    - the energy around the extrapolated mip track is used in the classification of events, changed it to a fit to the hits -> reduces the contamination but also heavely influences the scattered events count -> need a more elaborate MC to check
  - Adjusted SelectAndConvert
    - Included the event trigger cut (used to be in the last processor)
    - All other cuts described in the note are there except for a rejection of events with multiple incoming particles

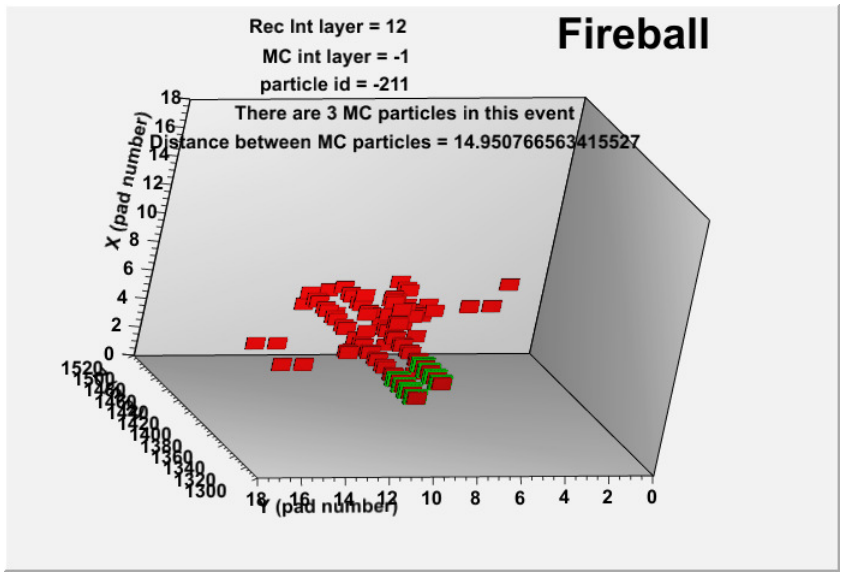
Progress

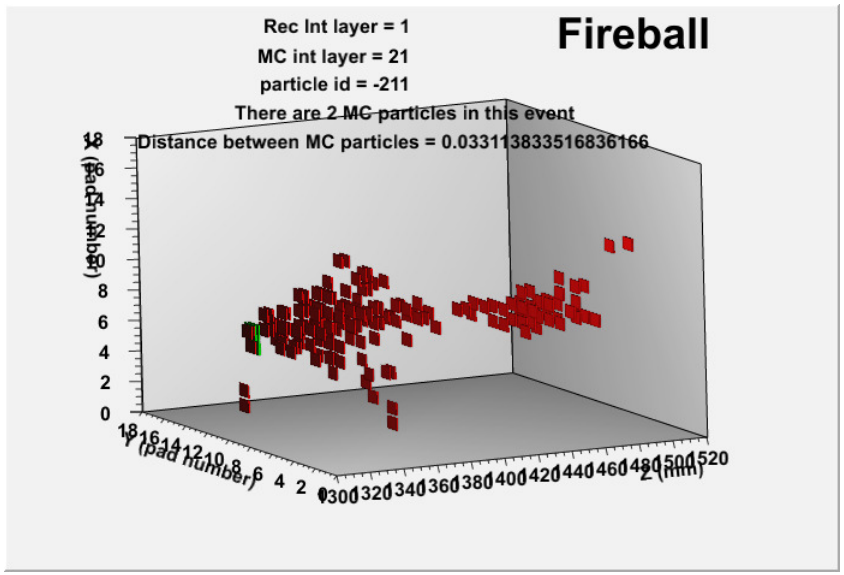
- Exclusion of double events should be done in MipFinder
  - Used the Overlay Processor to test how to reject them:
    - Slope of two large clusters < cutvalue -> seems to work
    - Minimum distance between two large clusters -> rejects almost all good events
    - Moments of the hit distribution -> are not discriminative
  - I have to reject many overlayed events because only one of the MC particles actually enters the ECAL! (In SelectAndConvert)
  - The cut on the slope rejects 95 – 90% of the double events in MC, leaving a contamination of 3 – 11% in the final event sample. For most of these events the second particle has no hits in the first ECAL layers

Examples of double events

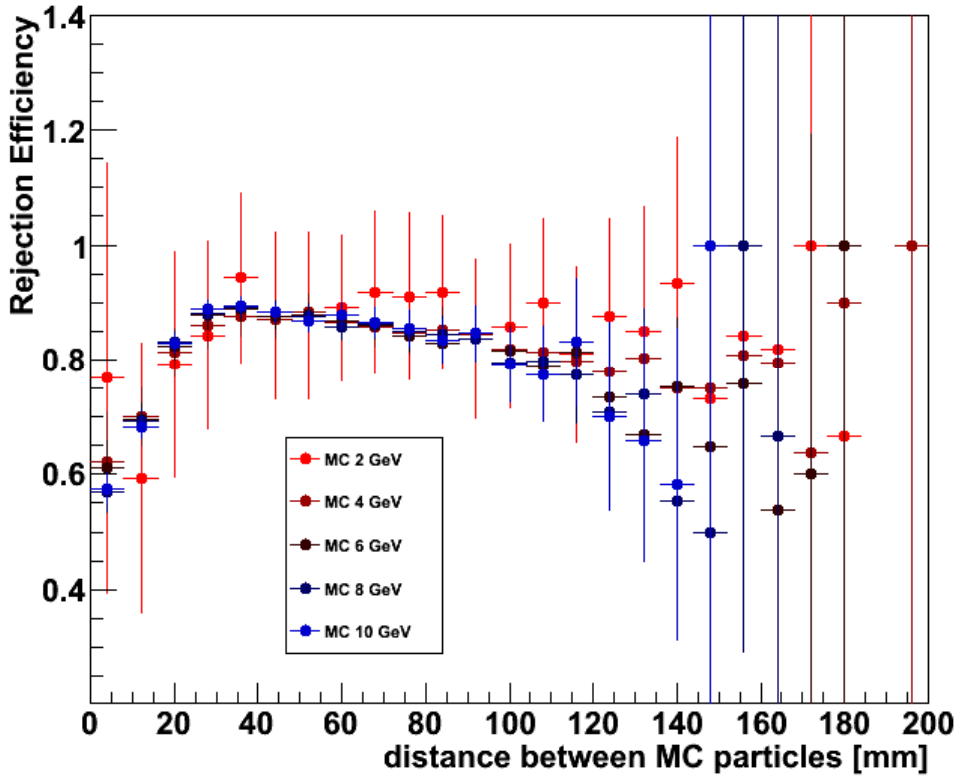








Rejection efficiency for events with multiple incoming particles



Energy	2 GeV	4 GeV	6 GeV	8 GeV	10 GeV
Efficiency	0.95	0.92	0.91	0.90	0.89
Contamination (%)	3.0	9.2	11.5	11.5	11.0

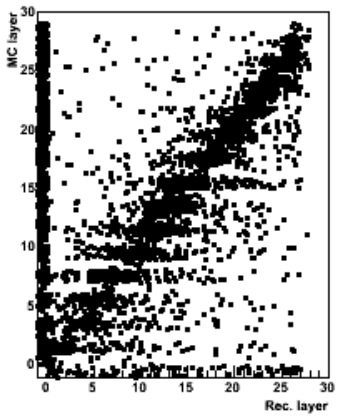
Interaction finding efficiency

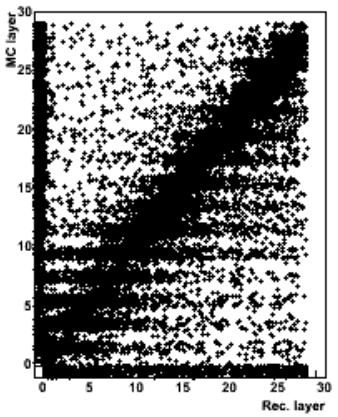
Energy	2 GeV	4 GeV	6 GeV	8 GeV	10 GeV
Efficiency	0.67	0.84	0.95	0.96	0.96
Contamination (%)	2.7	5.4	7.7	8.4	9.0
Number of events	6132	32355	52672	67881	76495

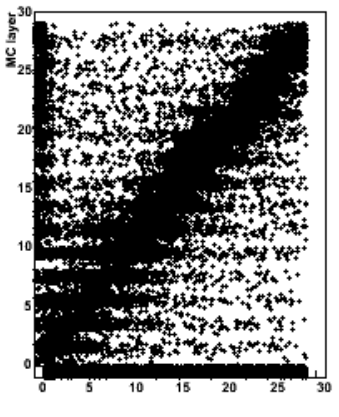
Efficiency = (Number of correct interacting events found)/(Total number of interacting events)

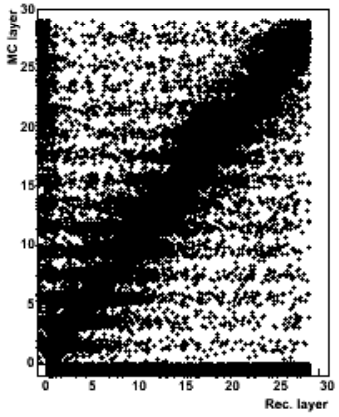
Contamination = (Number of non-interacting events classified as interacting)/
(Total number of events classified as interacting)

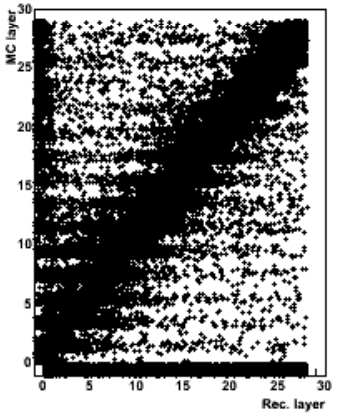
Interaction layer

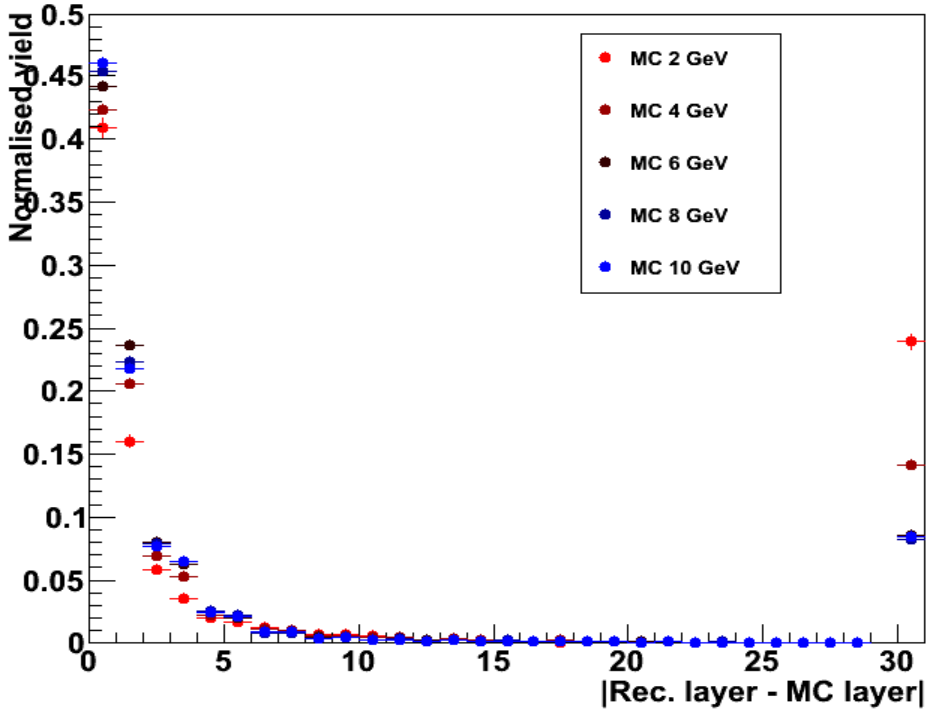




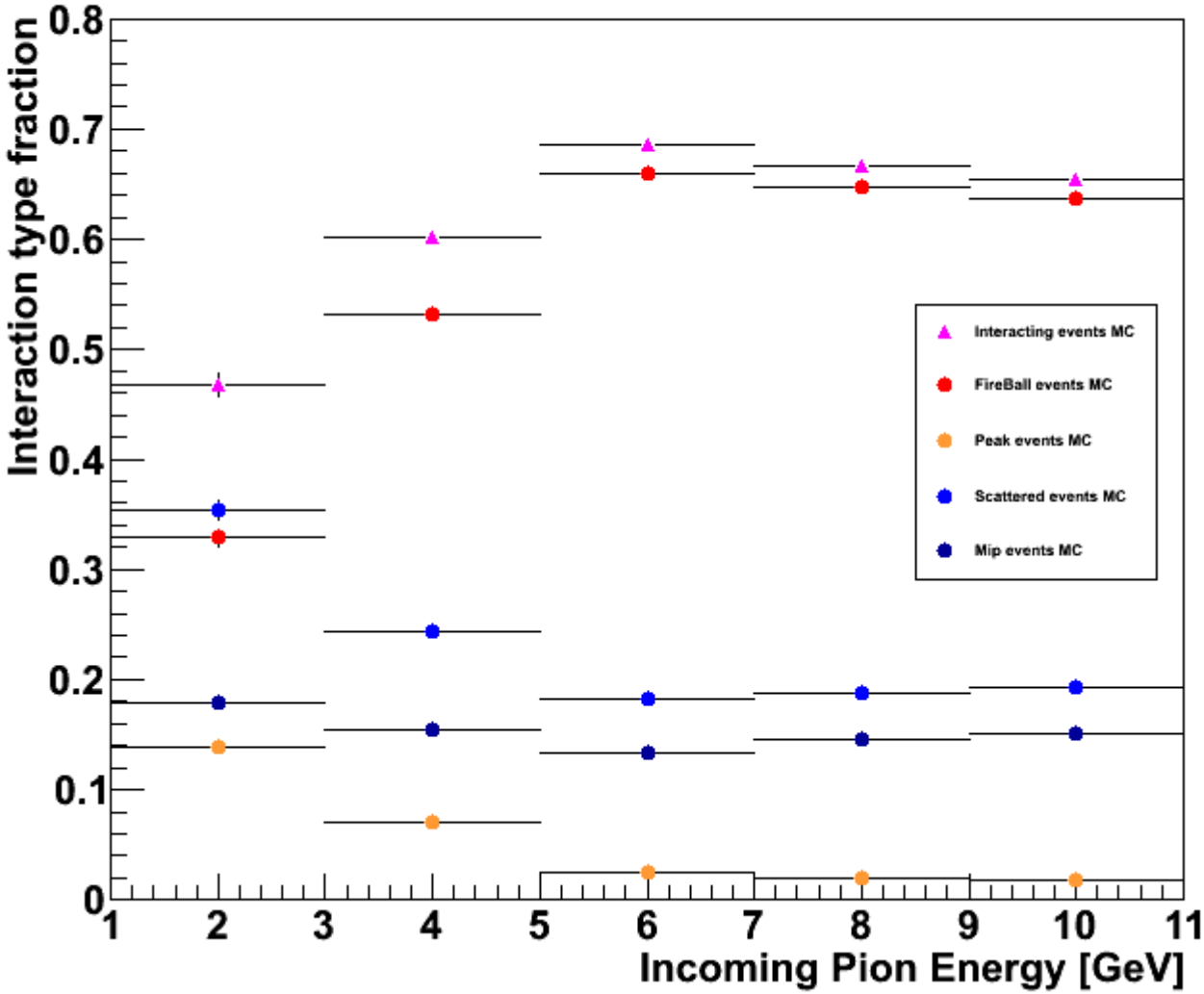




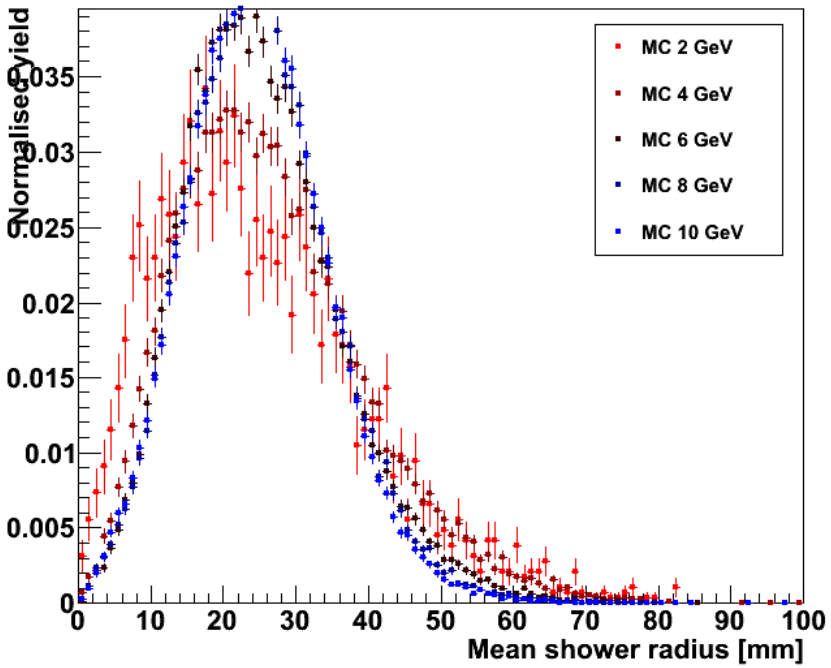




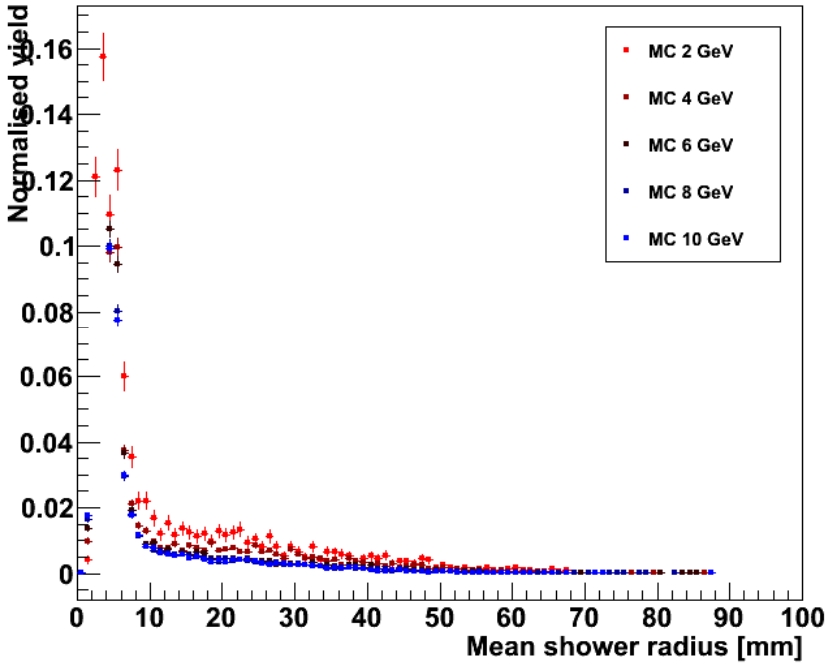
Interaction types



Shower radius

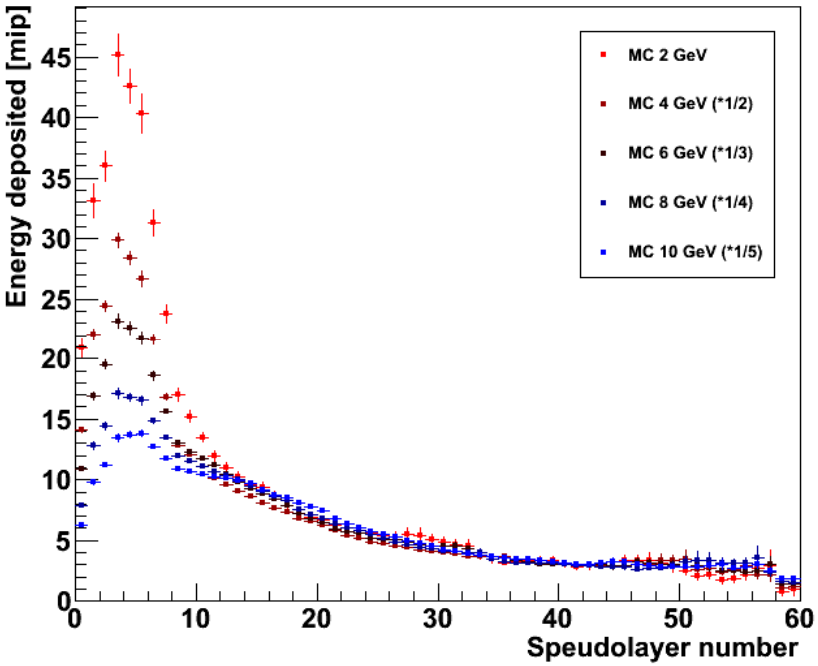


Interacting events

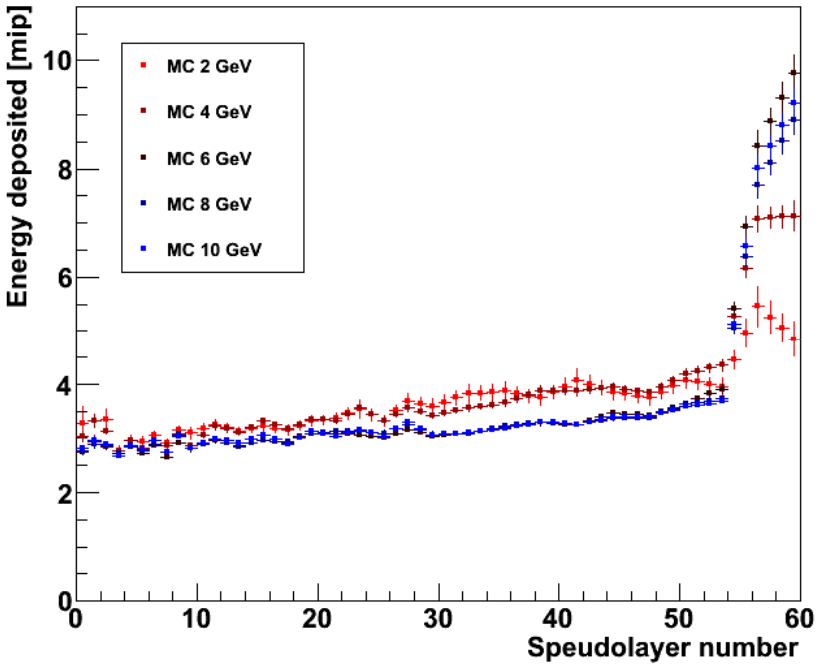


Non interacting events

Longitudinal energy profile



Interacting events



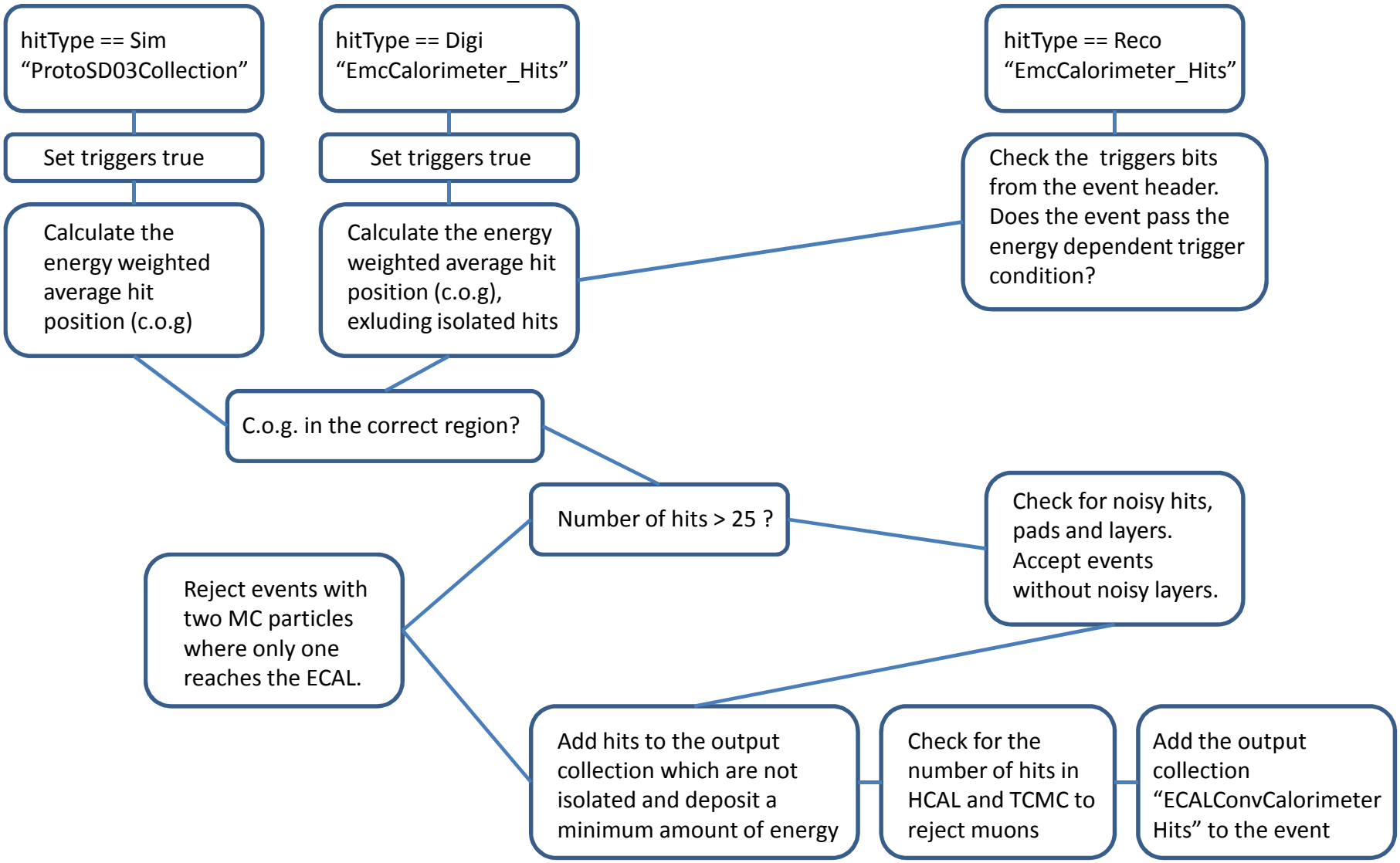
Non interacting events

Next

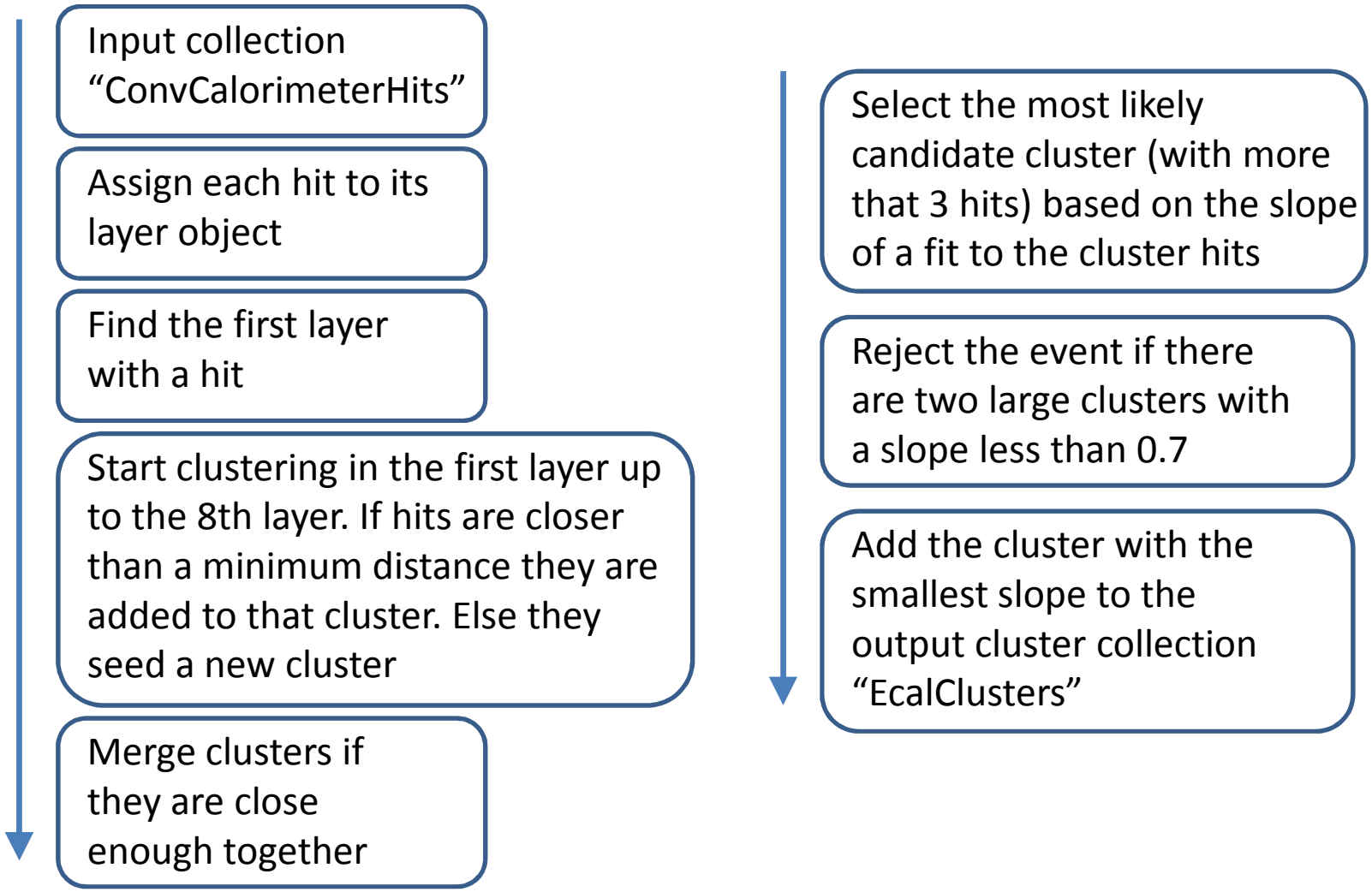
- Compare to data
- Check optimisation of (some) cut values
- Prepare publication taking into account the suggestions of the Calice cummunity
  - David Ward:
    - Revise the set of physics lists
    - Systematic error related to residual double events
    - Classification error and error in the interaction layer determination
    - Restrict the range for the interaction layer?
    - Improve naming of event classes
    - Add more histograms vs pion energy, show consistence with data at higher energy

[Backup]

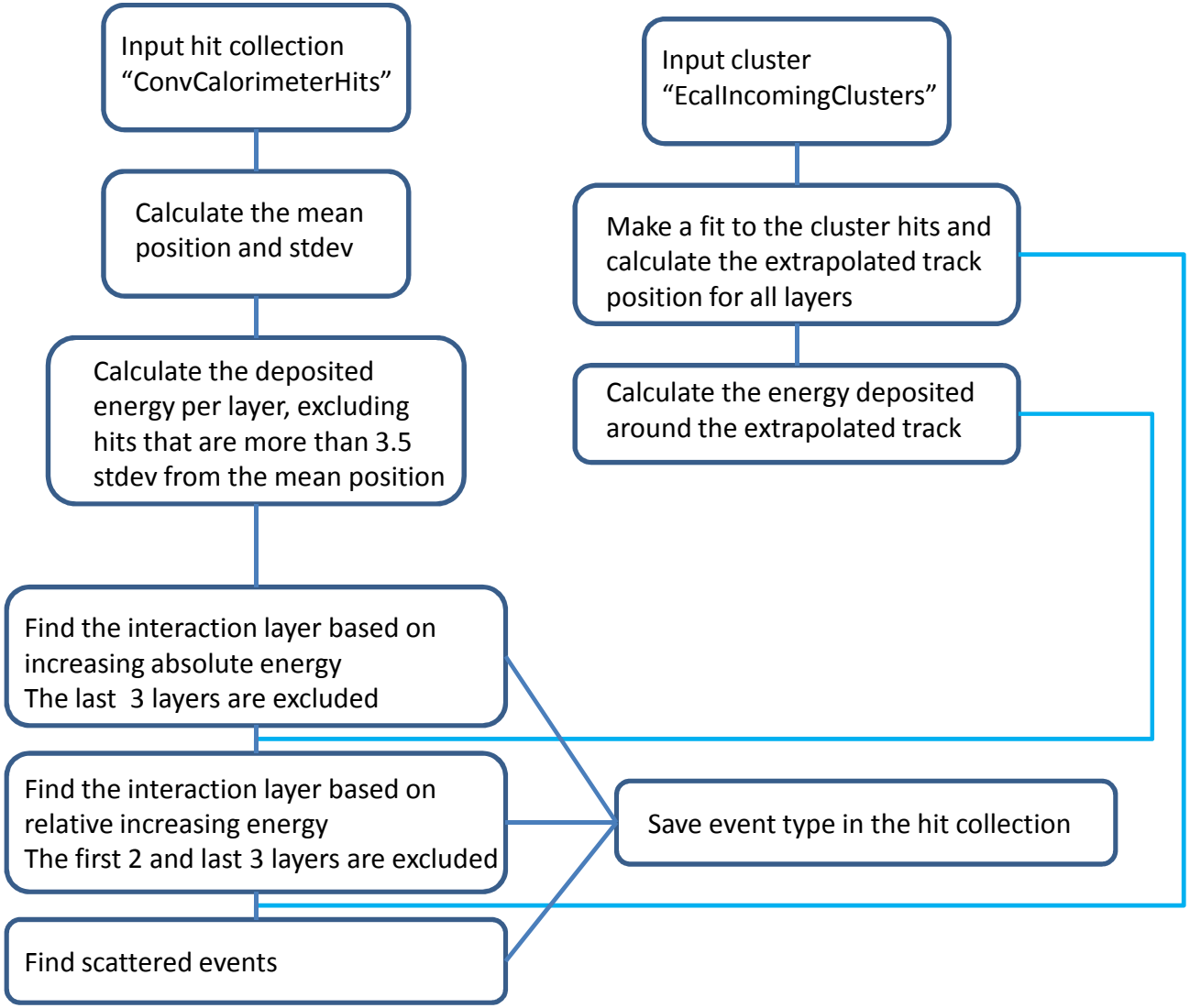
Step 1: SelectAndConvert



Step 2: MipFinder2



Step 3: InteractionFinder



Step 4: CaliceEcalHitInfo