Applying Computer Vision Algorithms on AHCAL Data

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December 8, 2021

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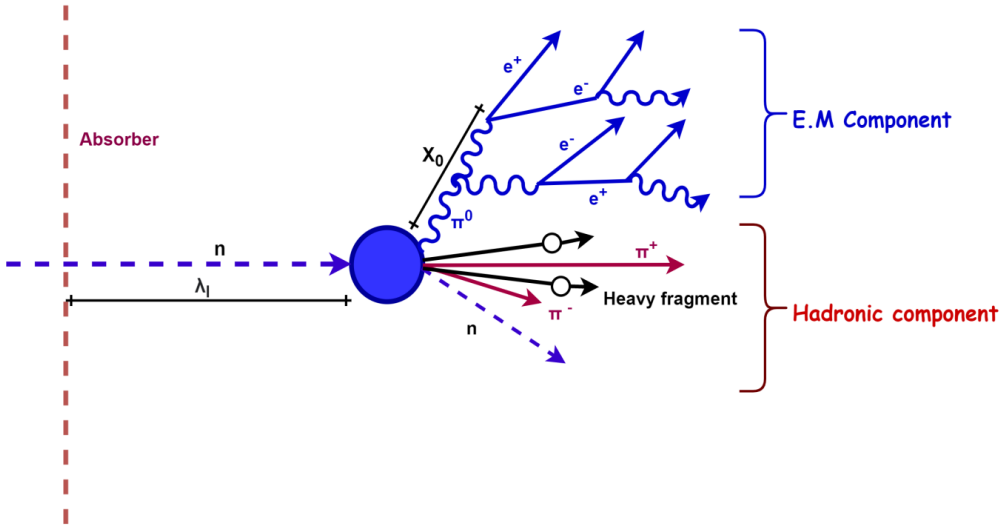
Overview

Hadronic showers



- Hadronic - EM Showers comparison
- less compact
- more invisible energy
- more delayed

Image taken from 'Study of shower shapes recorded with the CALICE-AHCAL in 2018 Test Beam Data' by Olin Pinto Calice Analysis Meeting June 30, 2021

From Event to Energy

- Each event may contain different EM fraction, a different size and timing
- Nevertheless in average they should be similar or show a similar behaviour in data
- Idea: Use well-known Computer Vision Algorithms to calculate the EM-fraction
- Aim: Finding the EM fraction of every event - Software compensation
- Benefits: Different method for particle identification
- Benefits: Might be more robust against angle variations and differences from training data

Computer Vision Algorithms

- Gaussian Blur - smoothen edges and hot/cold pixel/voxel
- Edge Detection - find edges and surfaces
- Floodfill - find areas and blobs
- Marching Cubes - find fitting curve and mesh

Gaussian Blur, Edge Detection, Floodfill

Original

Edgedetection

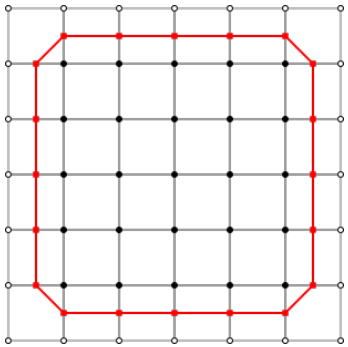
Gauss, Edgedetection

Contrast, Gauss, Edgedetection

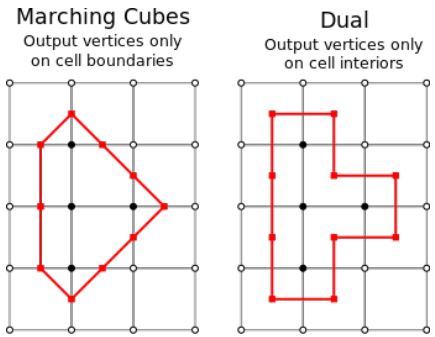
Contrast, Gauss, Edgedetection, Floodfill

Contrast, Gauss, Edgedetection, Floodfill

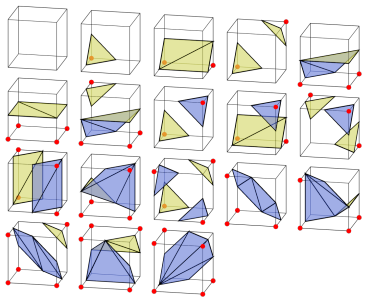
Marching Cubes



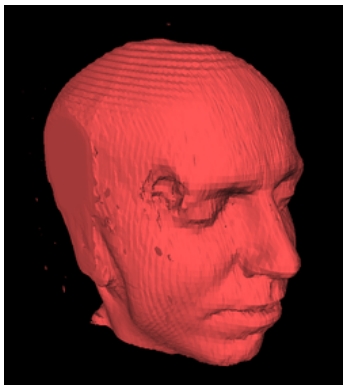
Marching Cubes example of a 2d square



Comparision between MC Cubes and trivial example



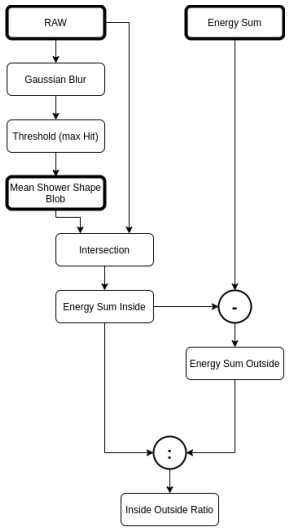
All 18 possible cases of 3d Marching Cubes



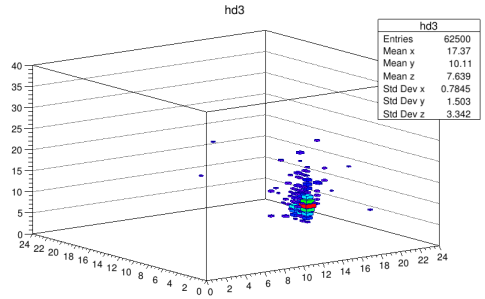
Mesh of a head with Marching Cubes

taken from: http://www.boristhebrave.com/2018/04/15/dual-contouring-tutorial/ and Wikipedia

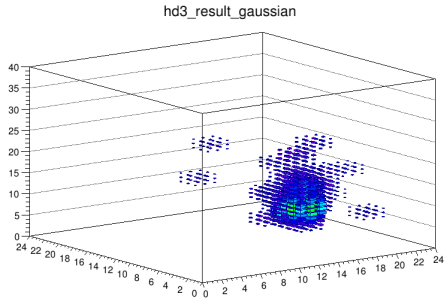
Particle Identification



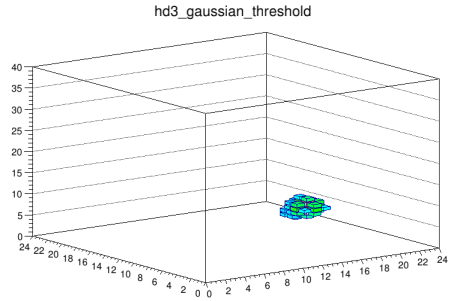
Sequence of inside-outside-ratio



10GeV Electrons Eventdisplay

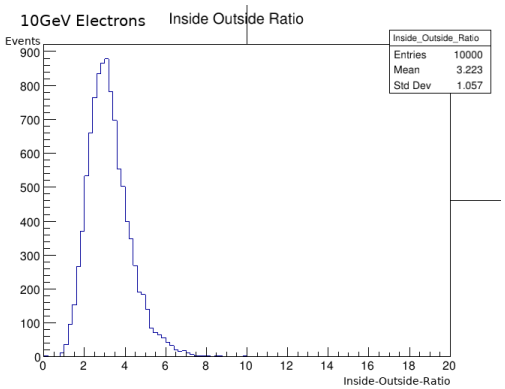


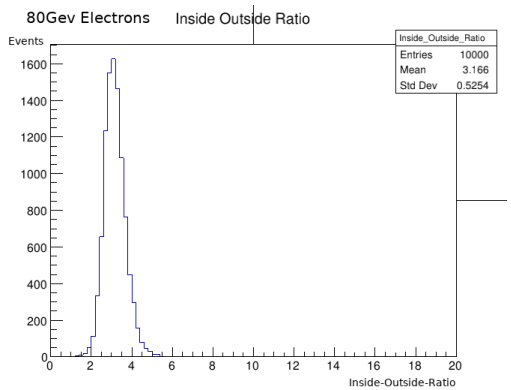
Eventdisplay with applied Gaussian Blur

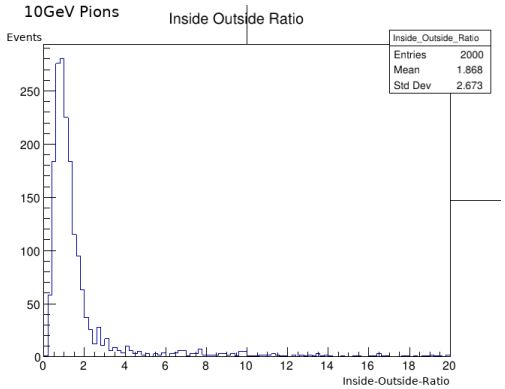


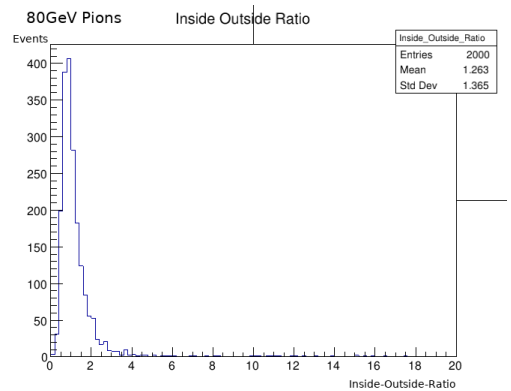
Eventdisplay with Gaussian Blur and threshold

Particle Identification

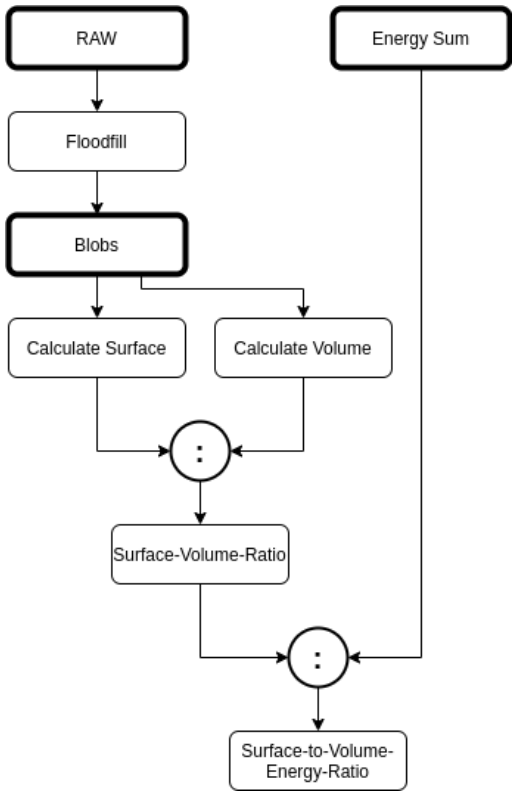






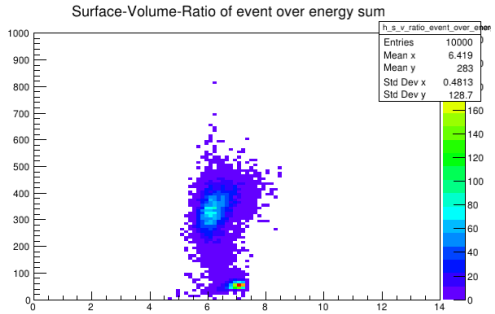


Surface-to-Volume Ratio

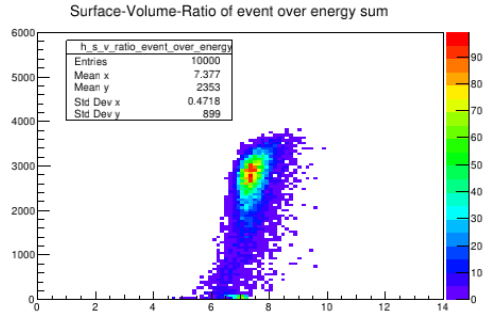


Calculation sequence of the volume to surface ratio for hadronic showers to estimate the compactness of the event

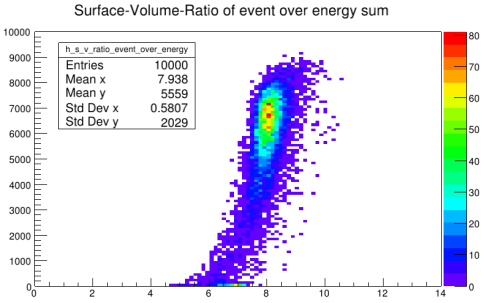
Surface-to-Volume Ratio



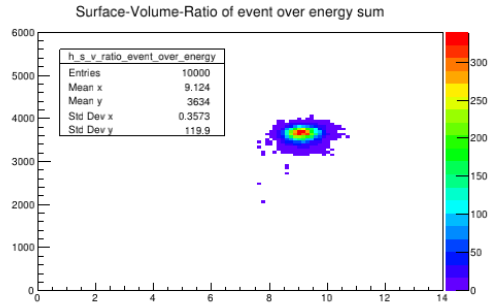
MC Pions, 10GeV



MC Pions, 80GeV



MC Pions, 200GeV



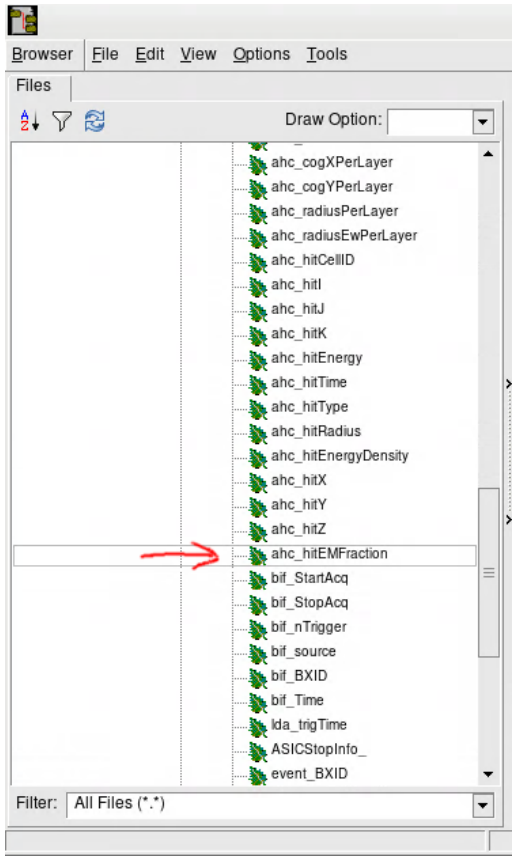
MC Electrons 80GeV

X-Axis: Surface-to-Volume-Ratio vs Y-Axis: Energy Sum

MC Truth

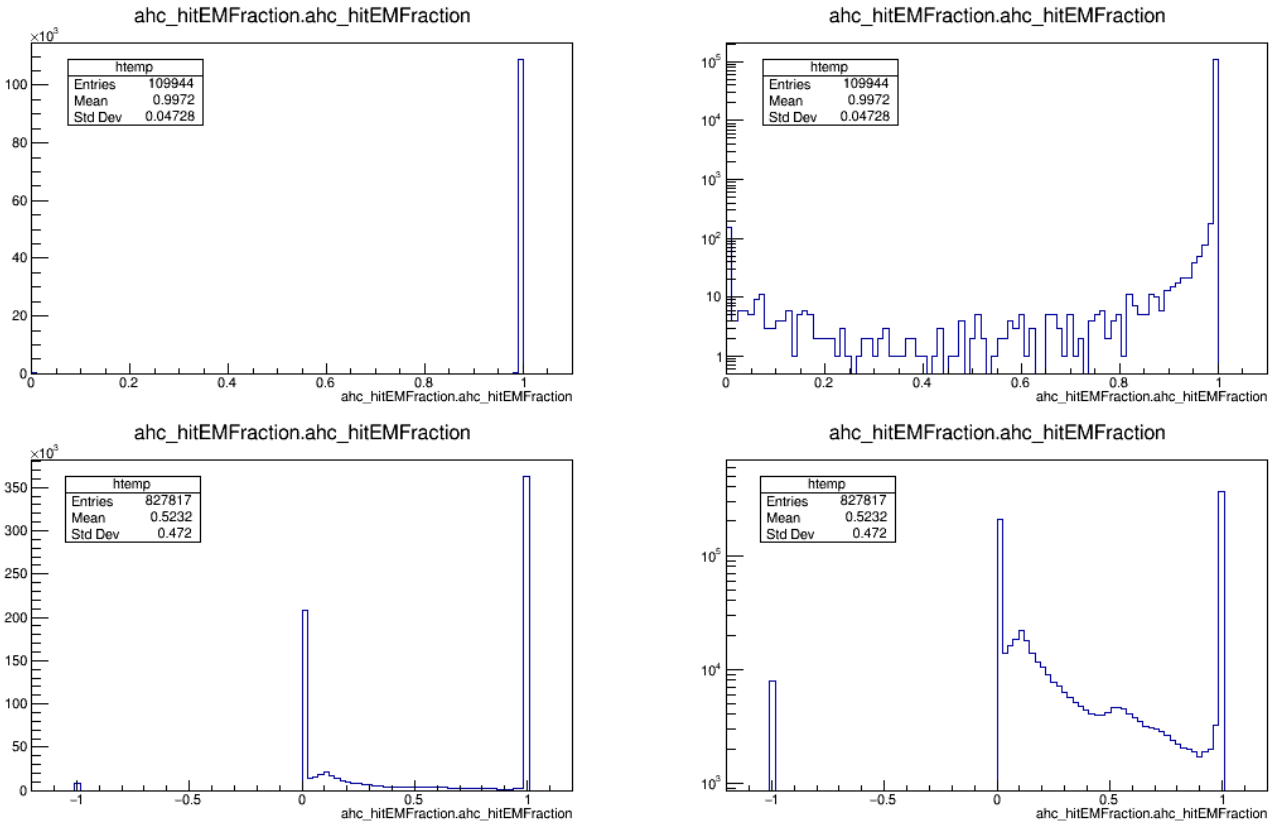
- Validation is needed for MC truth data
- Therefore the MC truth data should be present
- Implementing a processor for the n-tuples

MC Truth



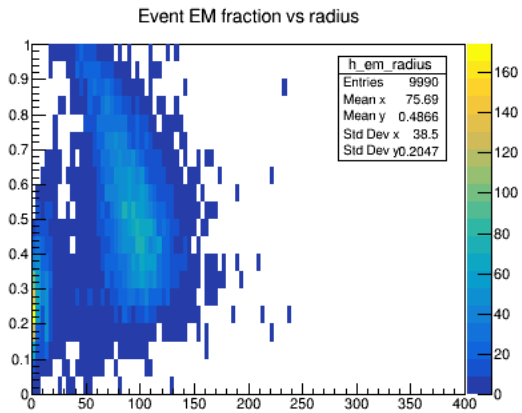
Screenshot of the n-tuples in the RootTree

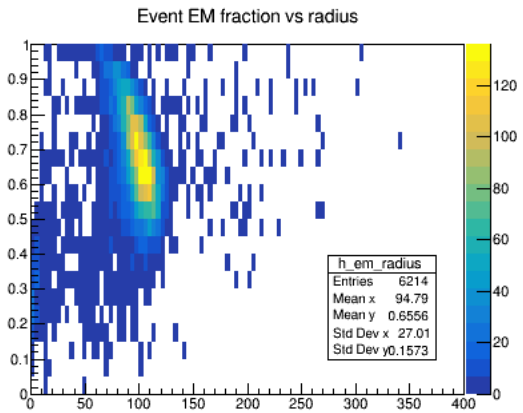
Hit EM Fraction for 10Gev

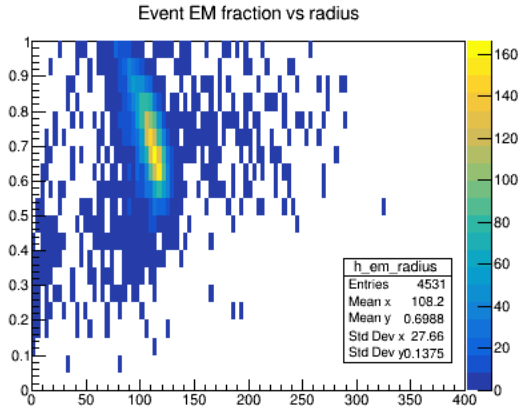


10GeV Hit EM Fraction: Electrons (left, top) linear and (right, top) log scale, Pions (left bottom) linear and (right, bottom) log scale

Hit EM Fraction vs Radius for different energies

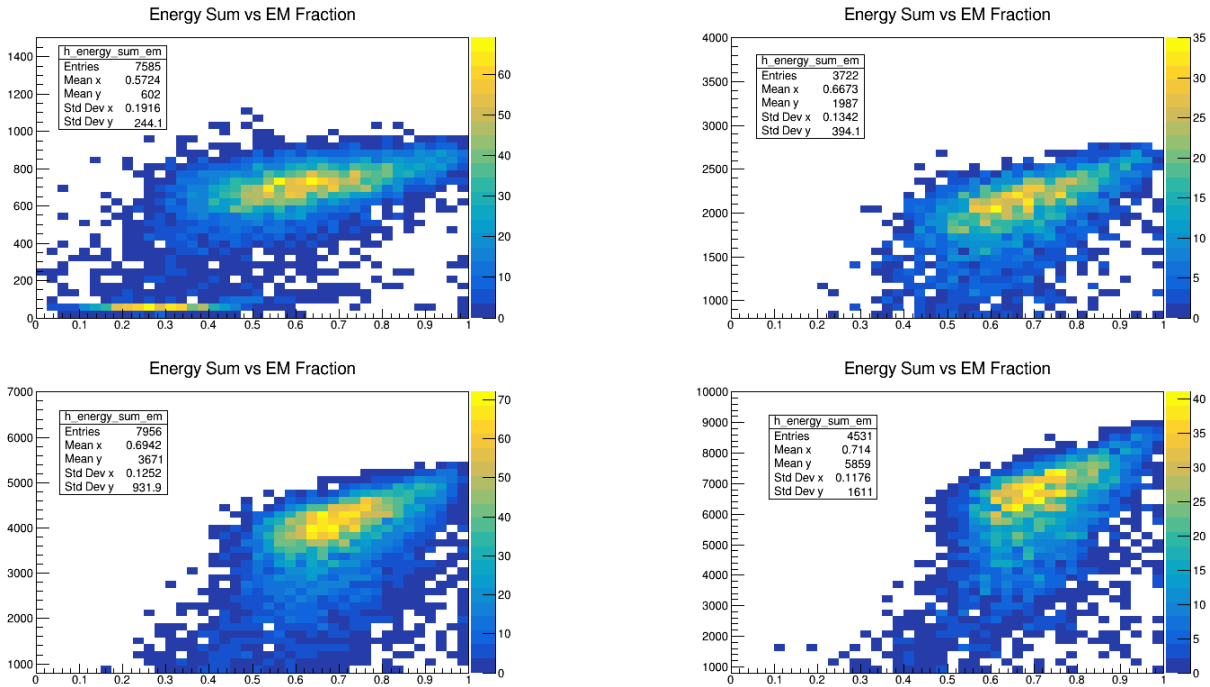






X-Axis: Radius, Y-Axis: EM-Fraction, All Pions, 10GeV (left, top), 80GeV (right, top), 200GeV (left bottom)

EM Fraction



X-Axis: EM Fraction, Y-Axis: Energy sum, All Pions, 20GeV (left, top) 60GeV (right, top) 120GeV (left bottom) 200GeV (right, bottom)

Outlook

- Diving deeper into the algorithms
- Compare the results with MC truth value
- See how far I can get
- compare and combines the results with the other approaches

Questions?

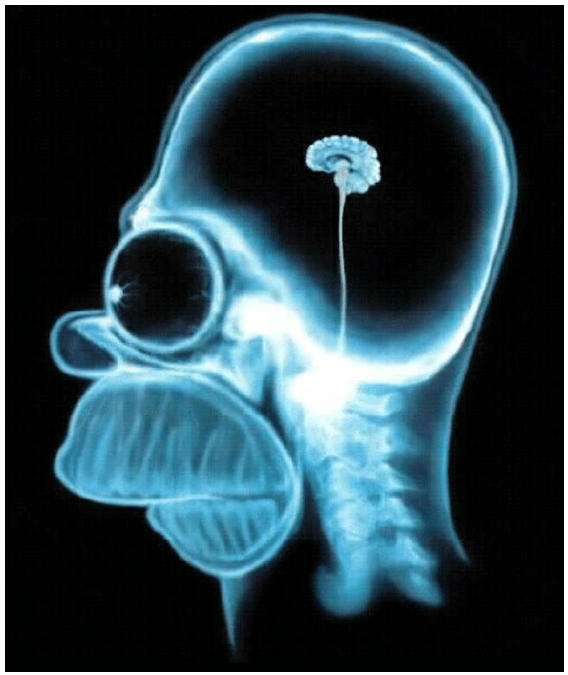
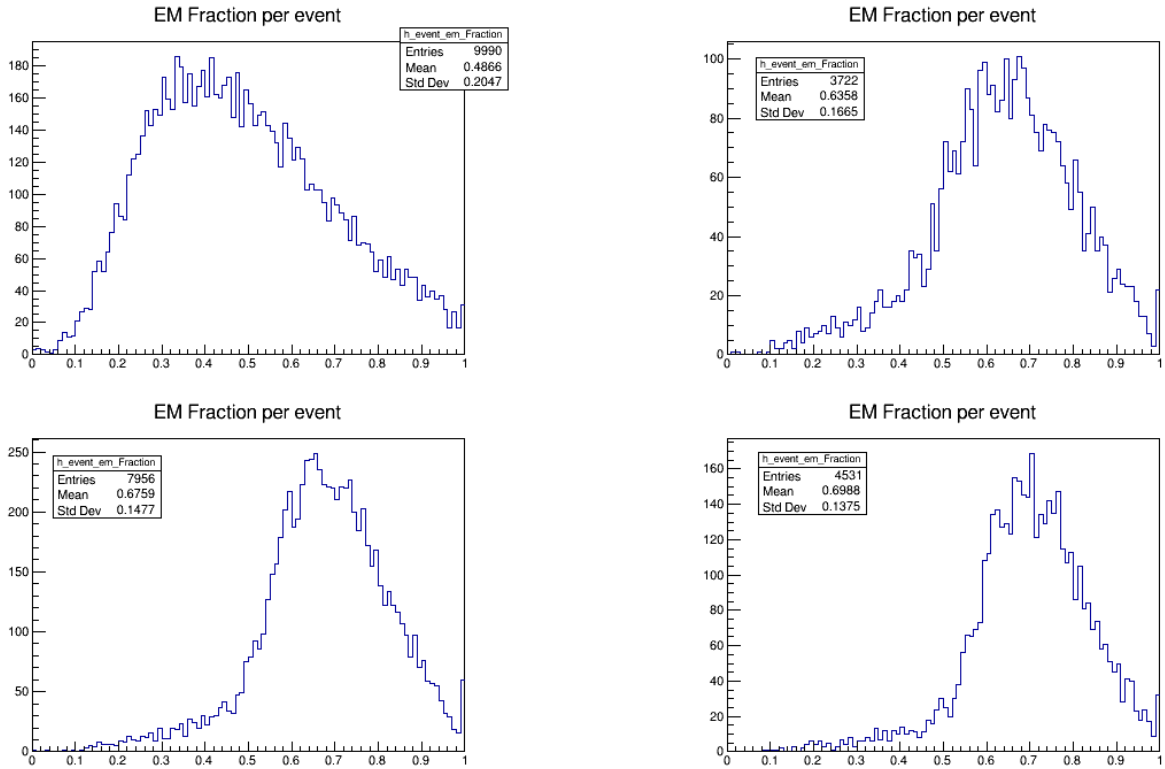


Figure: Me, myself and I, missing a crayon

BackUp - EM Fraction



X-Axis: EM Fraction, Y-Axis: Number of Events, All Pions, 10GeV (left, top) 60GeV (right, top) 120GeV (left bottom) 200GeV (right, bottom)