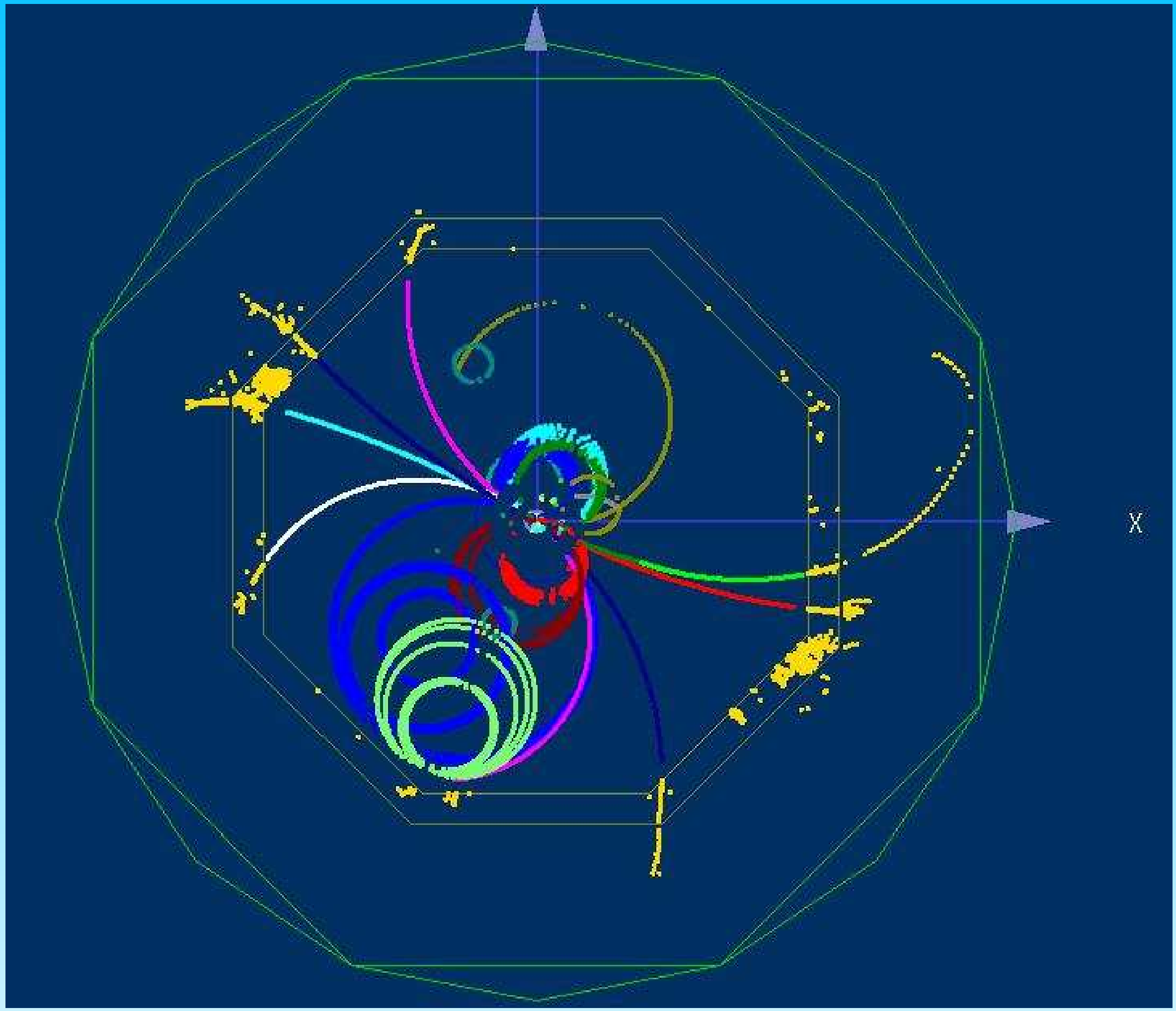

Cluster Shape Analysis

Contents

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first Results

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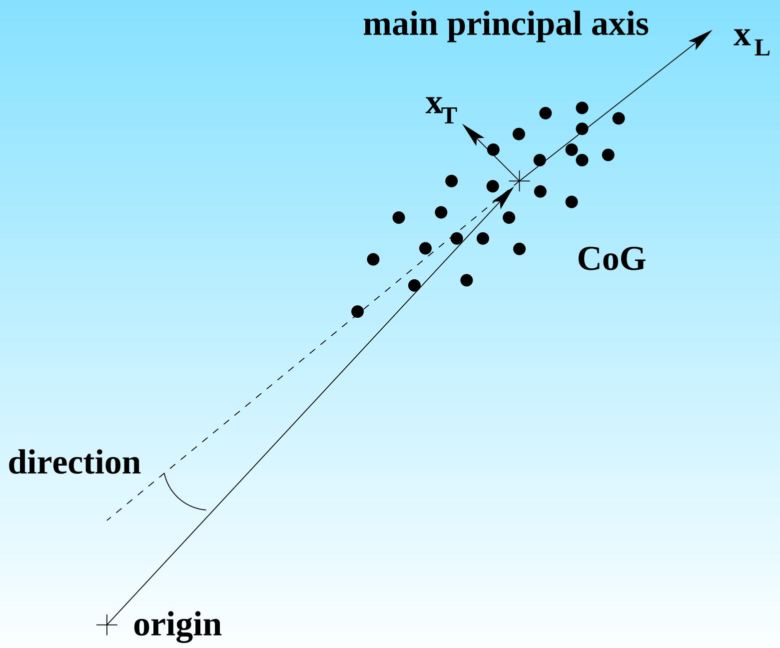
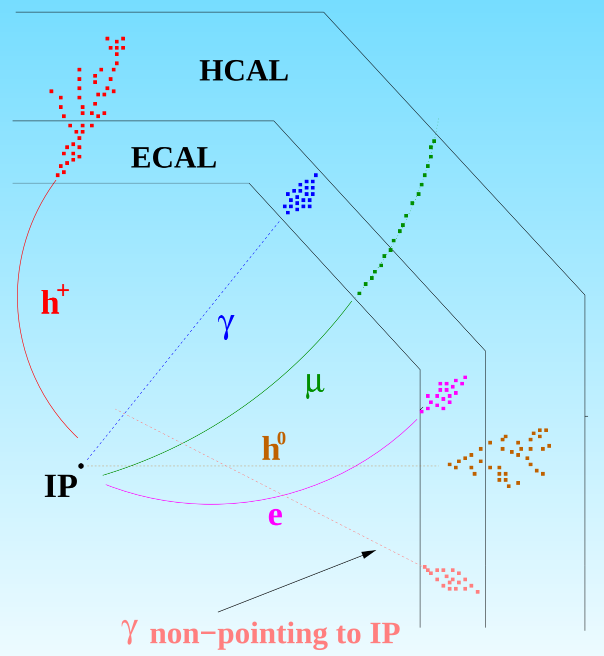
Parameters of Clusters

Cluster: Set of points with an assigned amplitude (energy), mostly in calorimeter

Parameters:

- center of gravity (CoG)
- inertia tensor and main principal axis ⟶ direction of cluster
- shape of the cluster (electro-magn.)





Motivation and Implementation

Motivation:

1) determine direction of cluster, in particular photons which are not directing to IP

2) compare shapes of different clusters, especially photons and neutral hadrons

$\longrightarrow$ find discriminating parameters

$\Longrightarrow$ distinguish between photons and neutral hadrons

(only in ECAL by now)

Implementation:

– class `ClusterShapes(...)`, initialised with sets of amplitudes and coordinates

$\longrightarrow$ properties of clusters (CoG, Shapefit, ...) are calculated within this class

$\longrightarrow$ integrated in a sequence of MARLIN processors

– serves as a utility class

Methods of the class `ClusterShapes(...)`

Constructor `ClusterShapes(nhits,a,x,y,z)`

number of points in cluster and array of amplitudes and coordinates

Methods:

- standard methods (`getNumberOfHits()`, `getTotalAmplitude()` . . .)
- calculate center of gravity (`getCentreOfGravity()`)
- determine axes of inertia (`getEigenValInertia() getEigenVecInertia()`)
- fit 3 dim. profile of a electro-magnetic shower (`Fit3DProfile(chi2,a,b,c,d,xStart)`)
- simple helix fit (`FitHelix(max_iter,status_out,parameter,dparameter,chi2)`)

(needs GSL for linear algebra and fitting)

Example: single Photons and single Neutrons

– photons and neutrons simulated with BRAHMS

$\longrightarrow$ photons with energies of 5, 10 and 20 GeV, neutrons with 5 GeV

$\Longrightarrow$ determine direction of photons for different energies

$\Longrightarrow$ compare cluster shapes of photons and neutrons for 5 GeV

– fitted with the typical shape of an electro-magn. shower, $A_i = a \cdot {x_L^i}^b \cdot e^{-cx_L^i} \cdot e^{-dx_T^i}$

MARLIN processors:

Steering File

```
############################################
#          steering file Marlin
############################################

.begin Global  -----------------------------

    LCIOInputFiles neutron5gev_brahms.slcio
    # LCIOInputFiles photon_5gev.slcio
    # LCIOInputFiles photon_10gev.slcio
    # LCIOInputFiles photon_20gev.slcio

    ActiveProcessors DigitizerAR
    ActiveProcessors ClusteringAR
    ActiveProcessors ClusterProperties

    MaxRecordNumber 1001
    # SupressCheck true
.end   ------------------------------------
```

Steering File

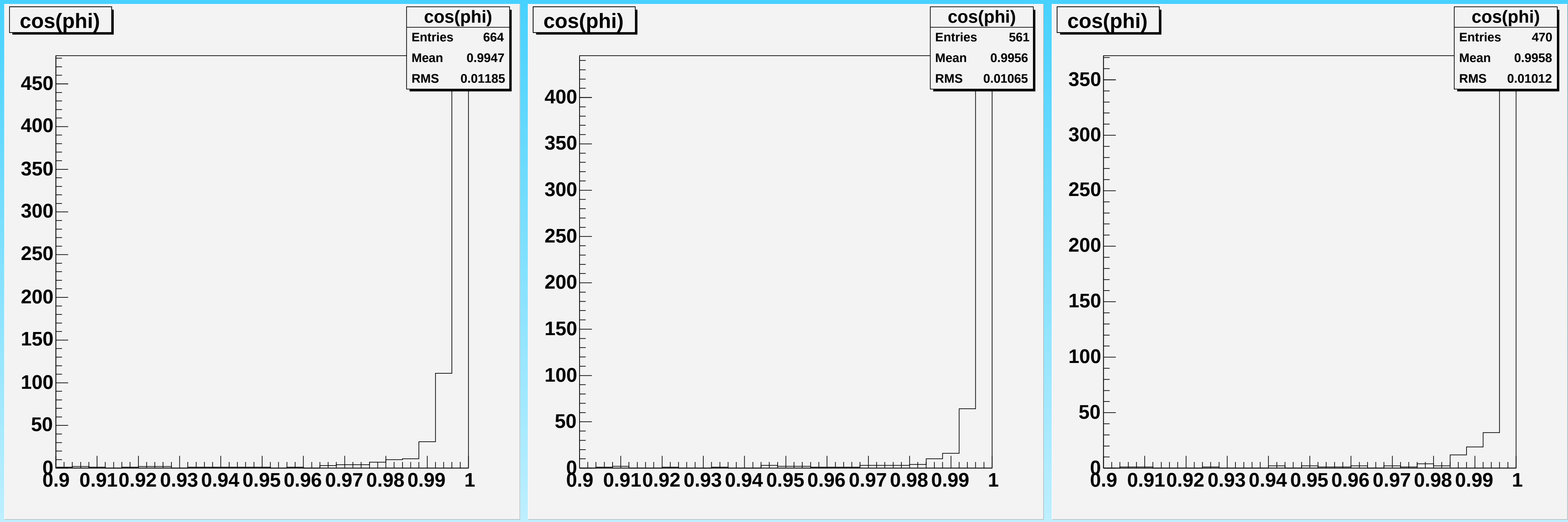
```
.begin DigitizerAR
ProcessorType DigitizerAR
ECALCollections ecal
HCALCollections hcal
        IfDigitalEcal 0
        IfDigitalHcal 0
        ECALLayers 30 100
        HCALLayers 100
        CalibrECAL 1. 1.
        CalibrHCAL 1.
.end
```

```
.begin ClusteringAR
ProcessorType ClusteringAR
        EcalCollections ECAL
        HcalCollections HCAL
        TrackCollections Track
        TypeOfGenericDistance 0
        ResolutionParameter 28. 100.
        StepTrackBack 10. 100.
        DistanceTrackBack 100. 500.
        NToDefineSP 10
        UseTracking 0
.end
```

```
.begin ClusterProperties
        ProcessorType ClusterProperties
SimTrackerHitCollections tpc fch ftd vxd sit
CalorimeterHitCollections ClustersAR
.end
```

Direction of Photons

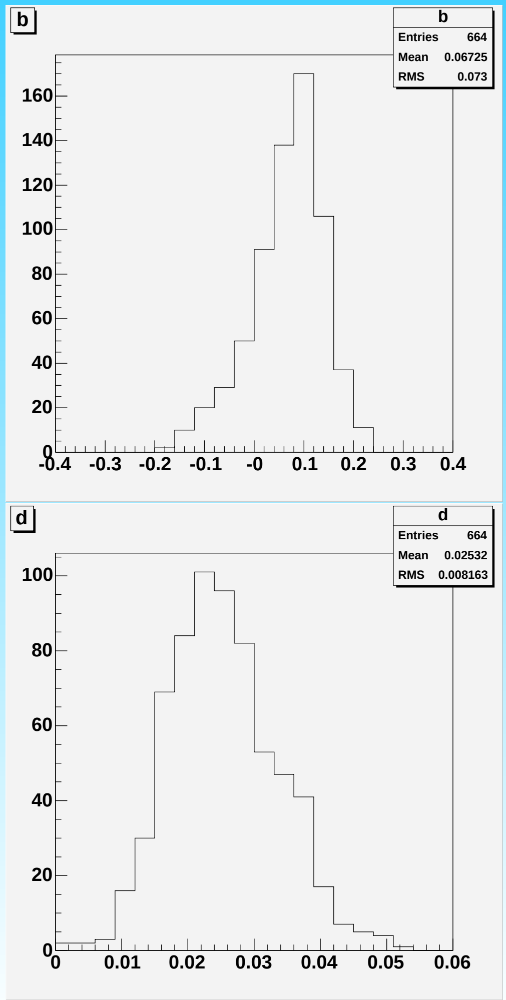
$cos(\phi)$ for single photons of 5, 10 and 20 GeV



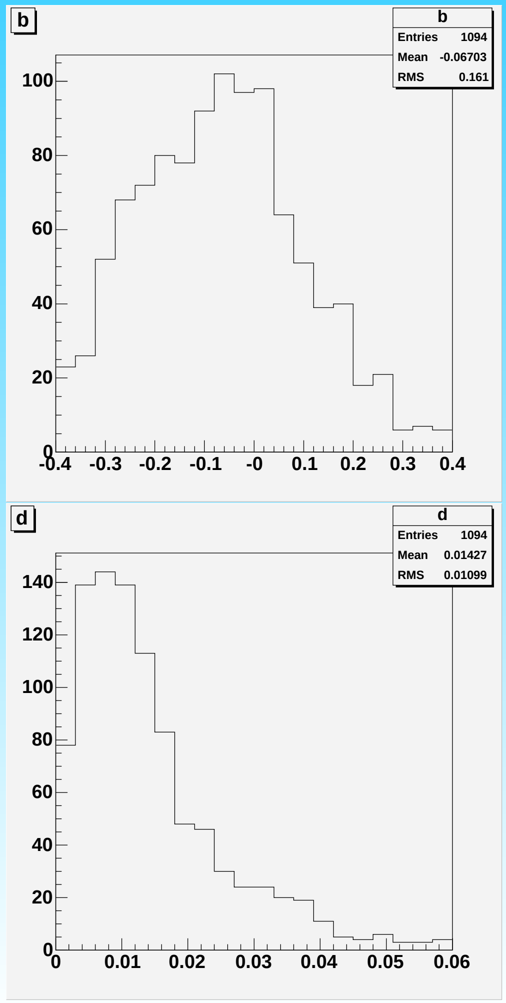
Cluster Shapes

Fit results for photons and neutrons of 5 GeV

γ



n



Outlook

– improve separability by:

1) calculate parameters a,b,c,d for photons as a function of energy

2) take these parameters and calculate the χ^2 for the clusters in the event

$\longrightarrow$ should be fairly small for photons

$\longrightarrow$ large for neutral hadrons

$\Longrightarrow$ separate between photons and neutral hadrons

– use a ANN for separation