Status of Full-Simulation Calorimeter Study

11/13/2001

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In this talk, I'll report

1. New features in LCDROOT Cluster

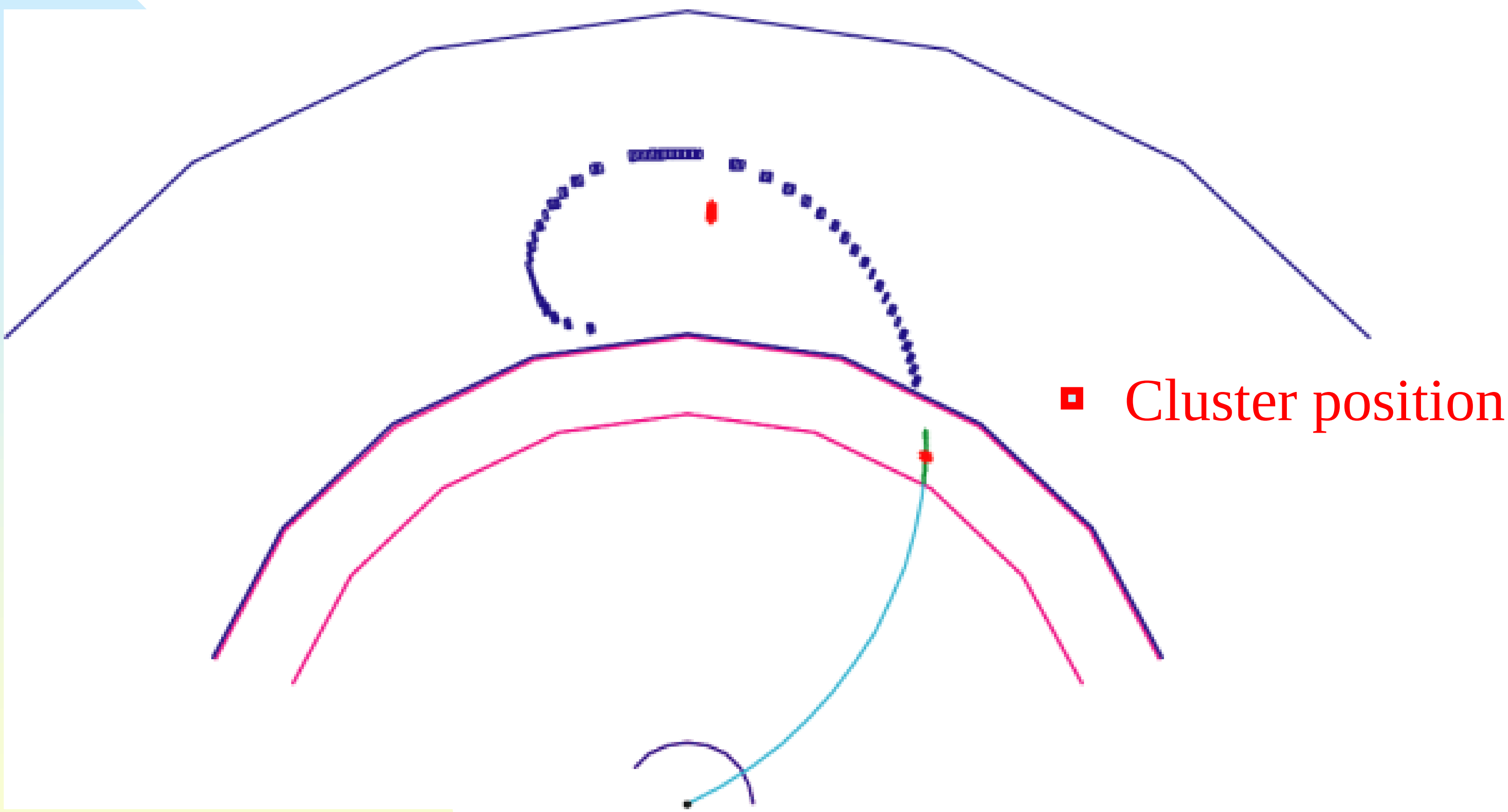
- Change the cluster position definition (from V3.4)
- Modify clustering algorithm (for the next version V3.5)

2. Photon reconstruction study in EM calorimeter

- Separation of scattered particle clusters
- γ selection by transverse information
- γ selection by longitudinal energy deposit information
- SD vs LD

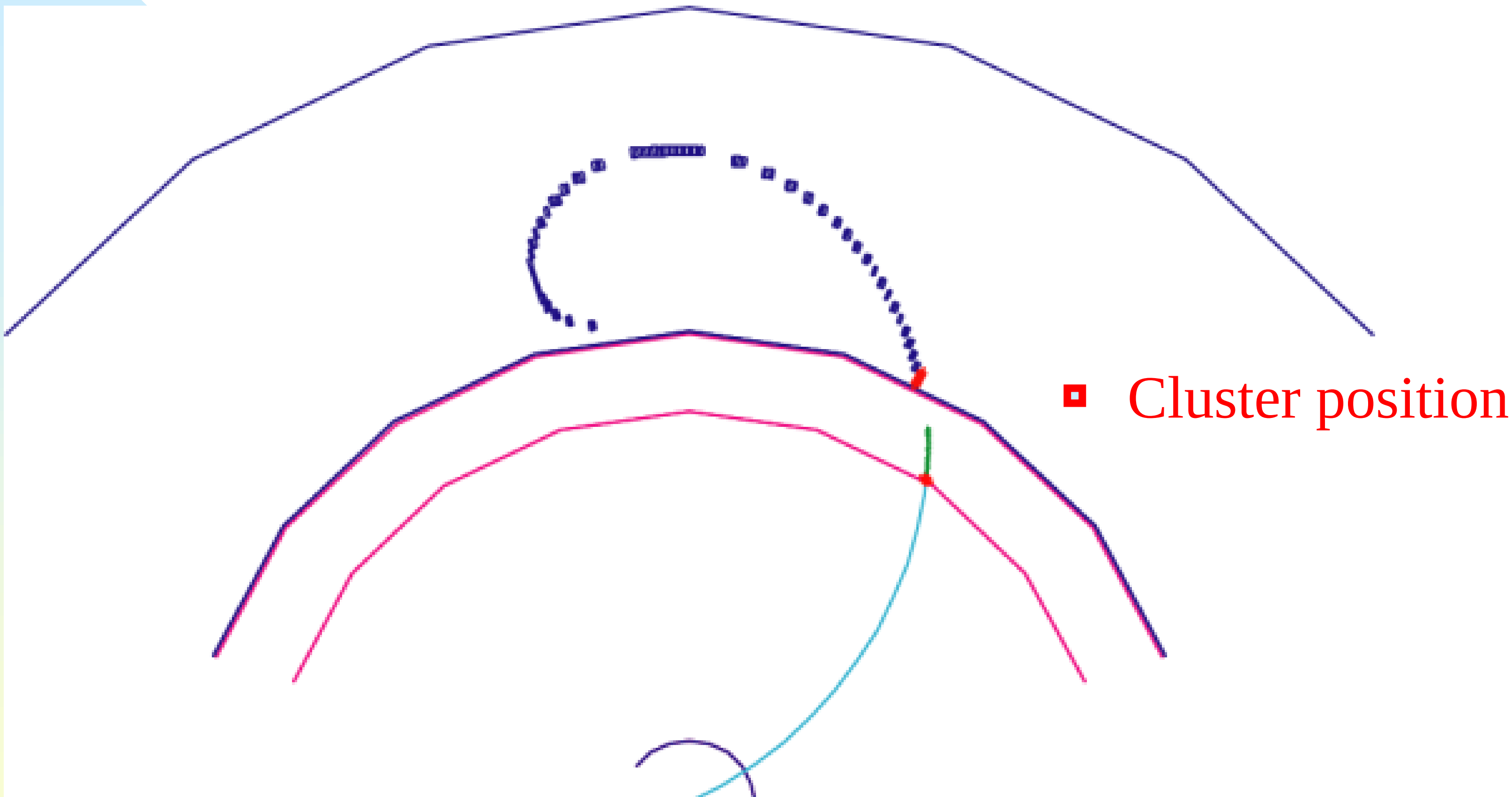
1-1) Change of cluster position definition

So far we define cluster position as energy weighted mean of associated Cal-Hits

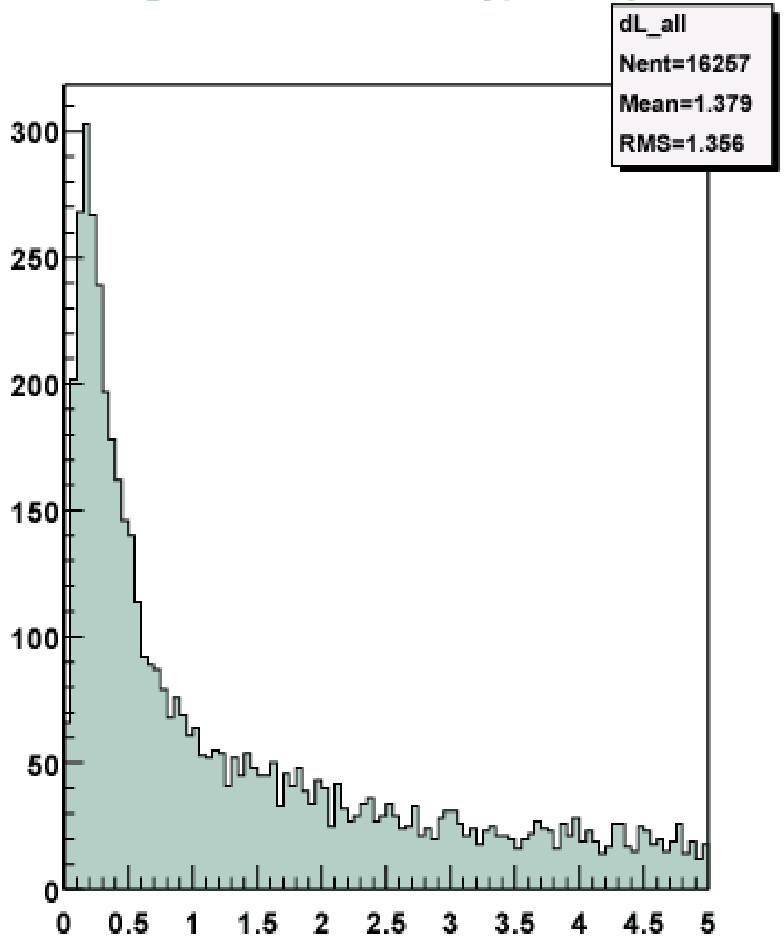


→ To see cluster-tracker matching, we should see cluster starting position

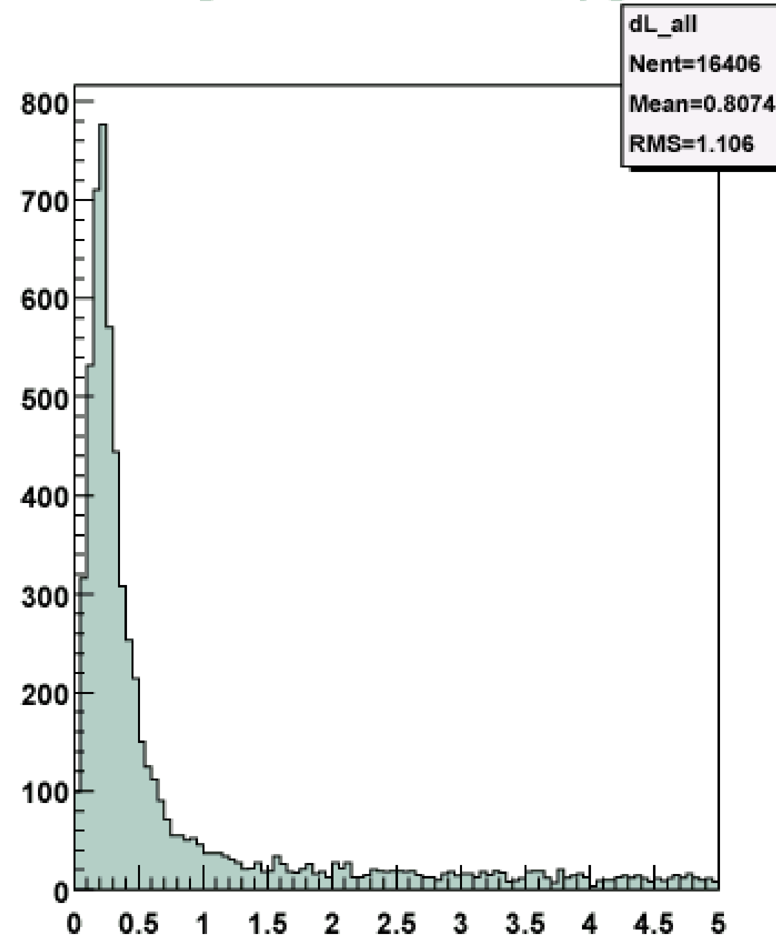
From LCDROOT V3.4 we have changed the definition of cluster position



Cluster position = Energy weighted mean



Cluster position = Starting position

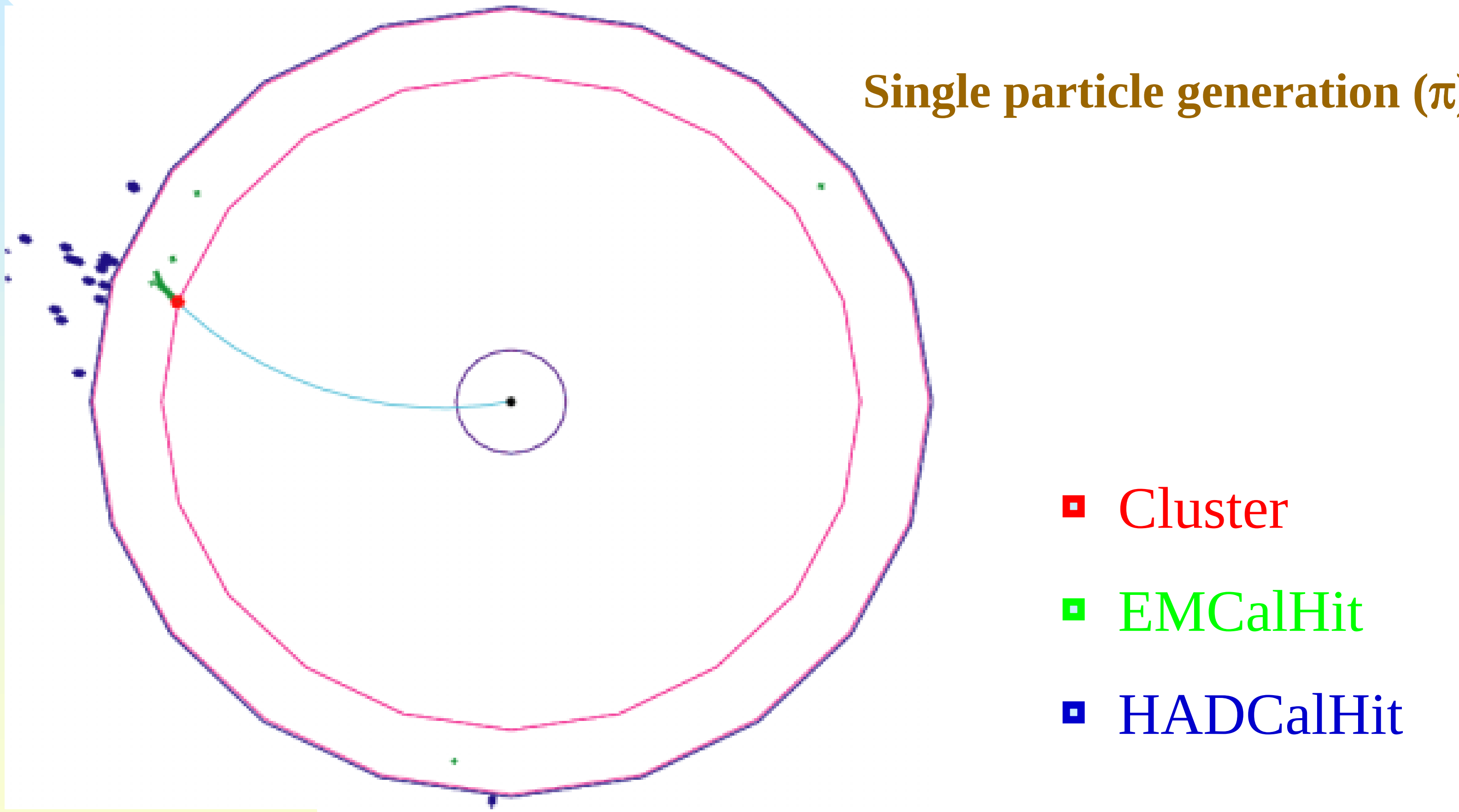


Cluster-Particle distance (cm)

Seeing cluster starting position,
we get better particle-cluster association

1-2) Modify clustering algorithm

So far we used cheater algorithm to form clusters
→ gather all CalHits associated to the same particle



Even there are scattering particles

… Make 1 cluster by gathering these CalHits

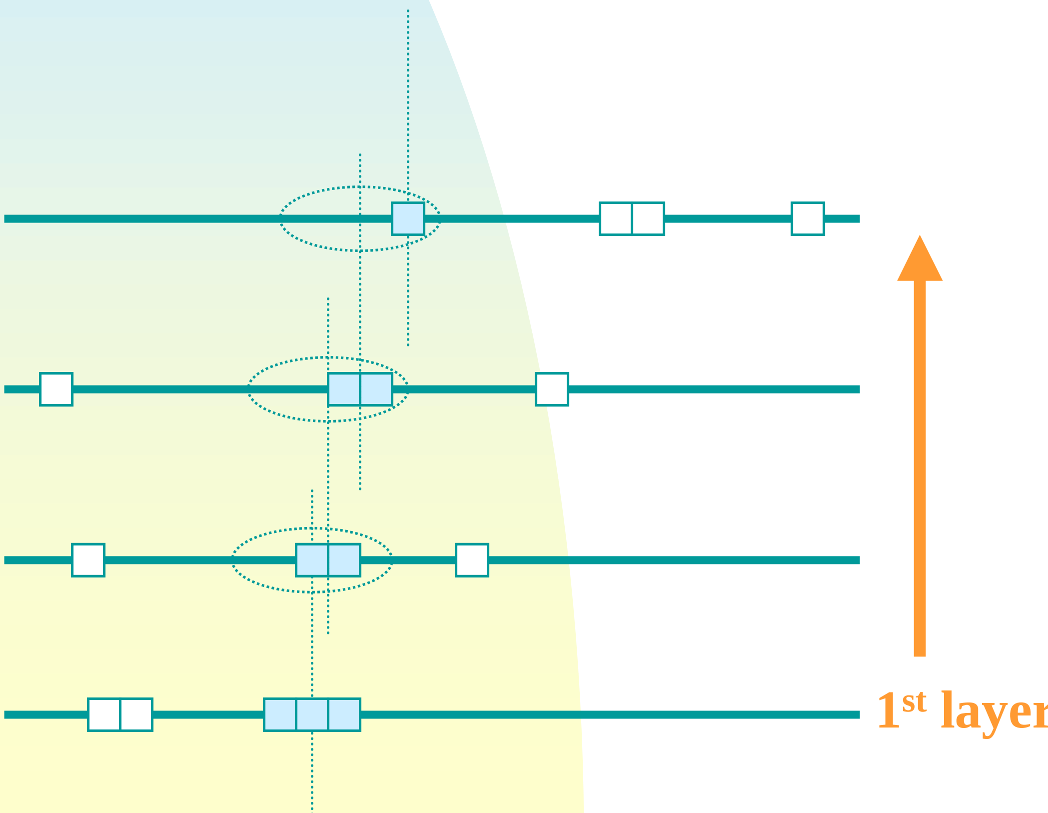
In real experiments, we cannot associate the hits from scattered particles to the original particle

→ Cheater algorithm is not a realistic clustering method

We introduce modified clustering algorithm:

1) Form a cluster by Cheater algorithm

2) Make cluster(s) from grouping CalHits



1. At 1st layer, gather the neighboring hits

2. Calculate energy-weight mean ← reference position

3. Go to the next layer

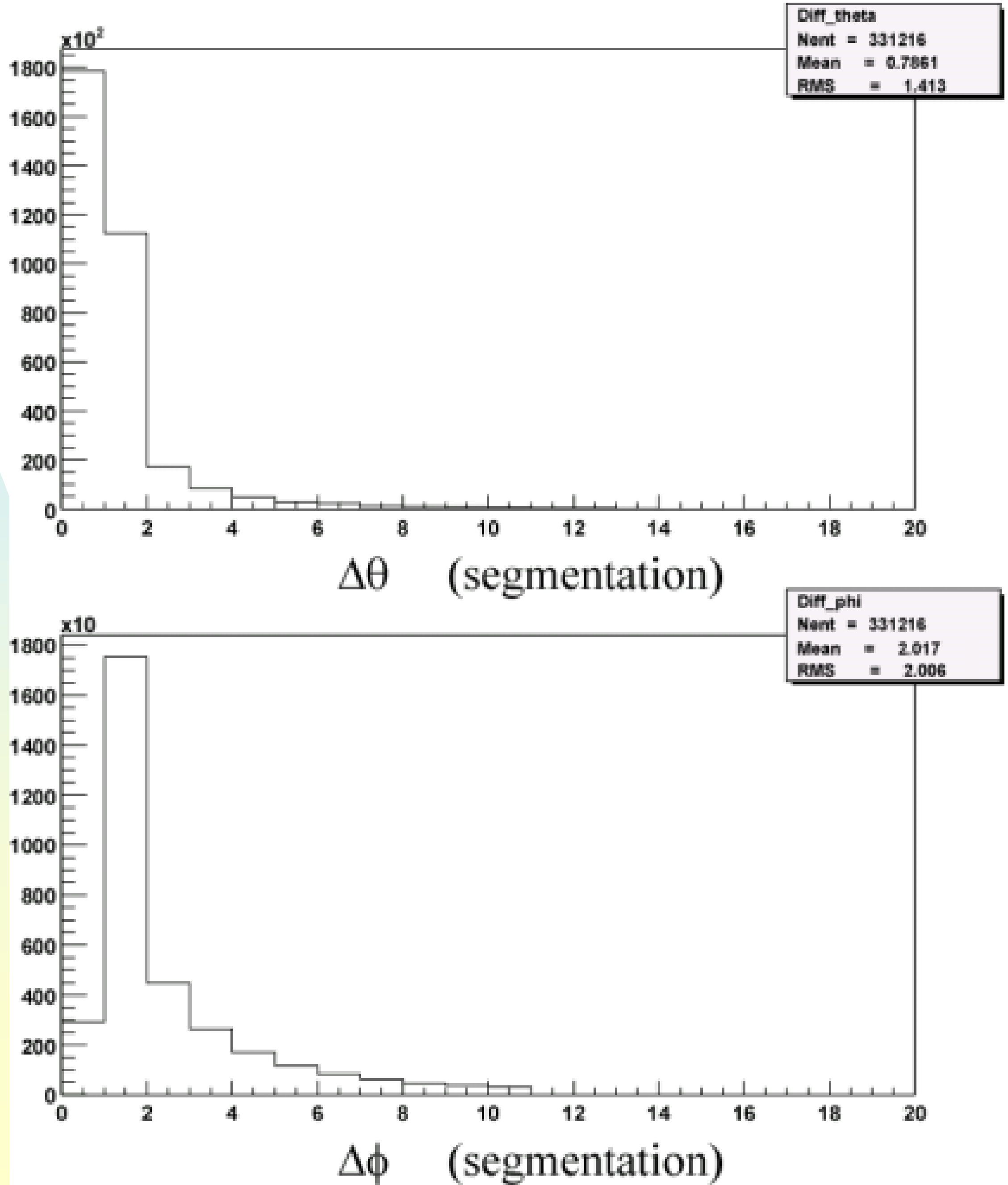
4. Gathering hits within a cone from the reference position

5. Repeat 2 to 4

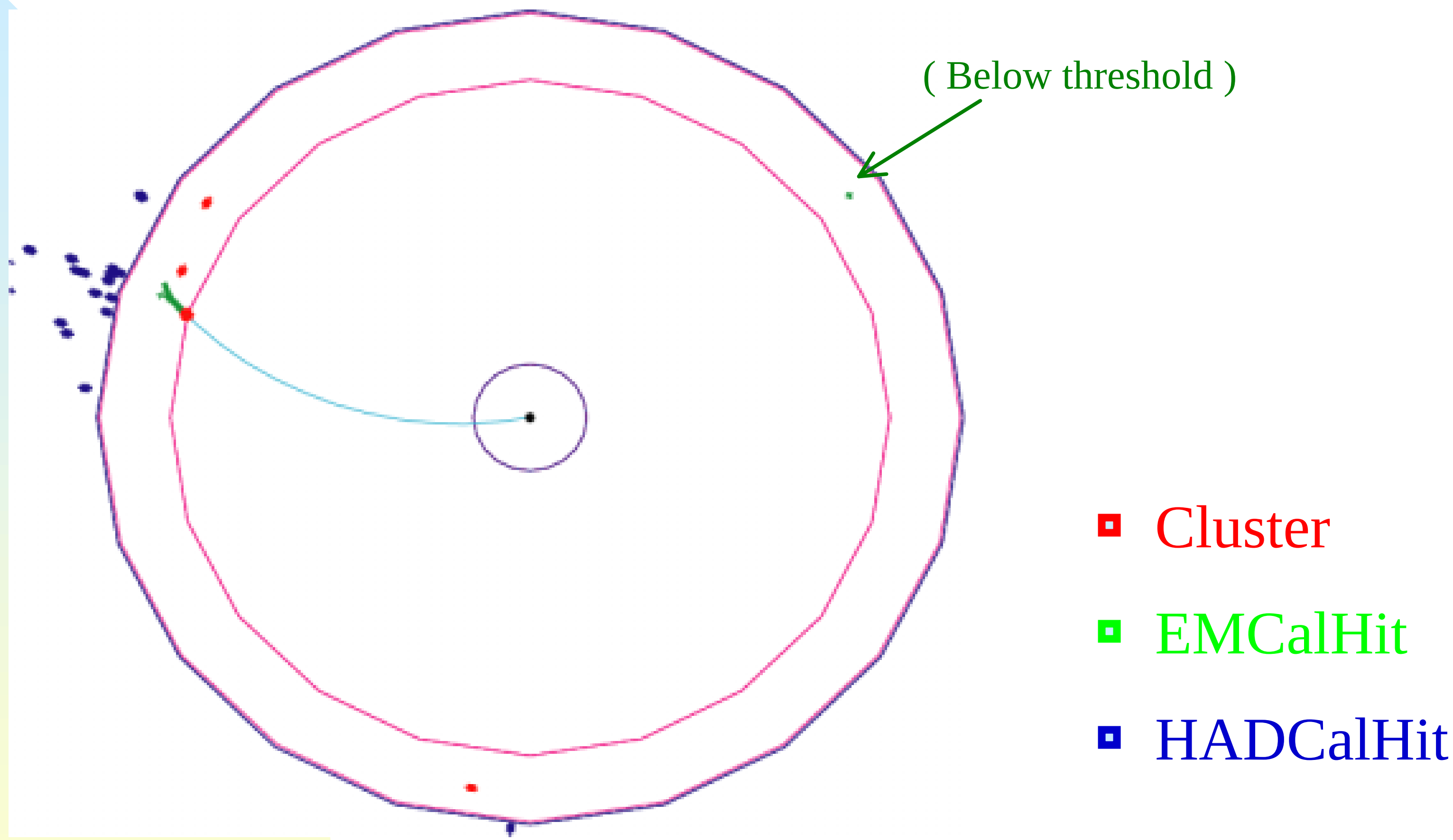
cone width:

	$\Delta\theta$	$\Delta\phi$	
	50mrad	40mrad	(SD)
	140mrad	110mrad	(LD)

Δθ and Δϕ between the near calhit in the same particles



Now we have more realistic clustering



… This will be available from LCDROOT V3.5

2. Photon reconstruction study in EM calorimeter

In energy flow analysis, we use

Tracker for Charged particles

Calorimeters Neutral particles

↓

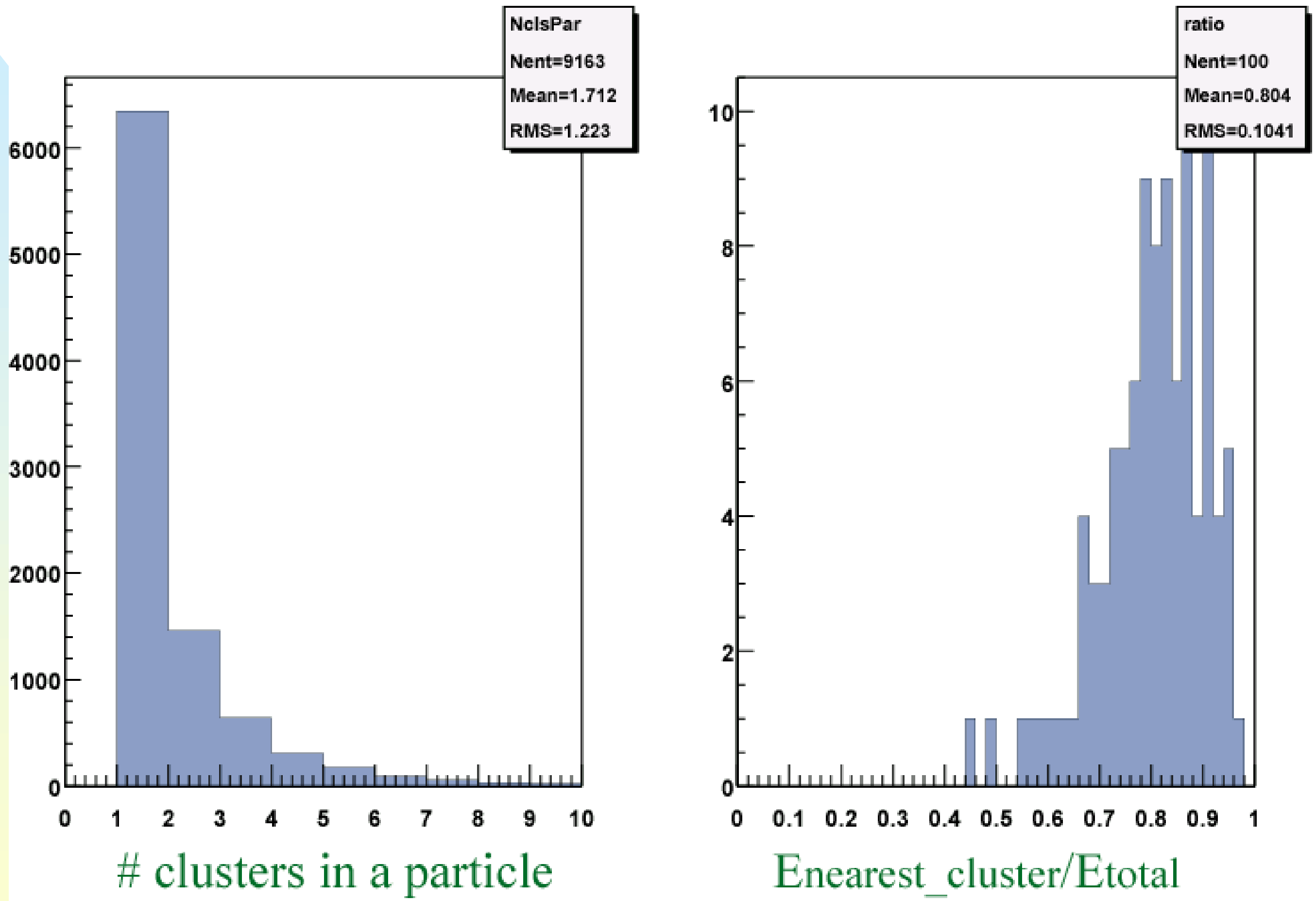
EM calorimeter … γ

HAD calorimeter … Neutral hadron

At first, the γ reconstruction studies in EM is important

2-1) Separation of scattered particle clusters

As we showed, there are one or more clusters from one particle

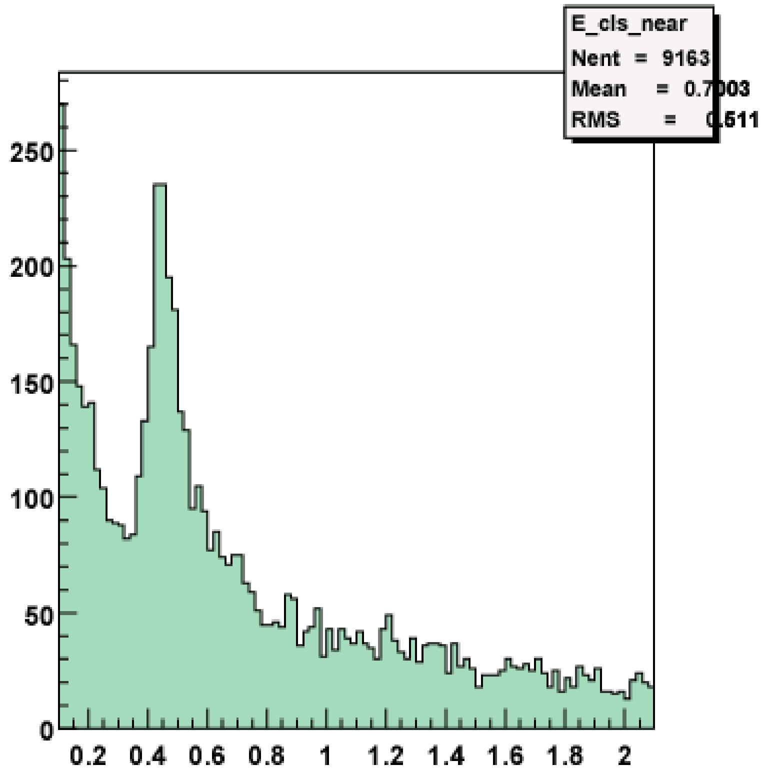


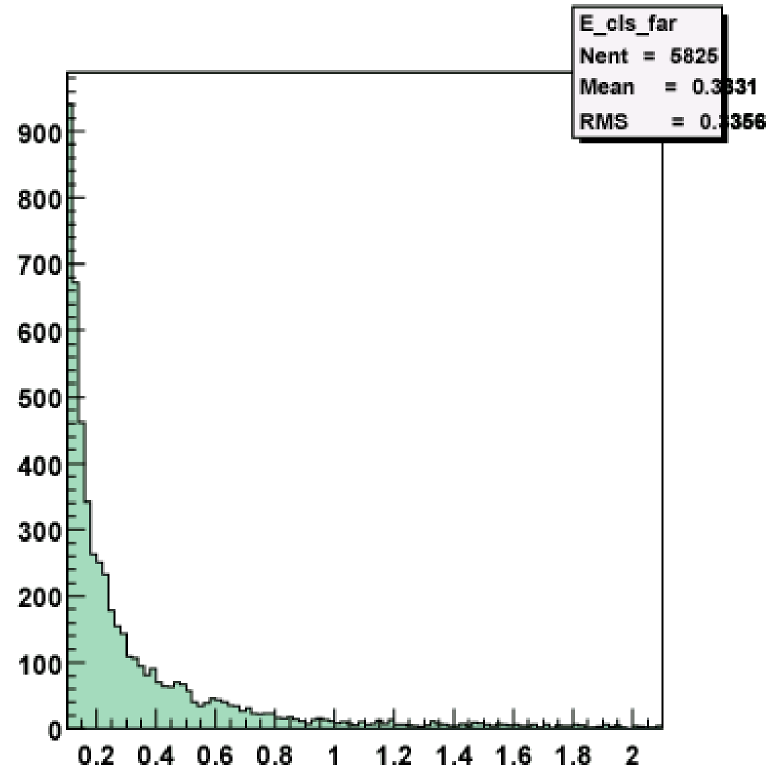
Average # of clusters in a particle … 1.7

Scattered particles carry 20% of total event energy

I don’t know how to treat the clusters from scattered particles yet.
But if we want to have correct jet direction, for example,
we want to reject such clusters..

Nearest clusters to the particles | **Scattering particle clusters**

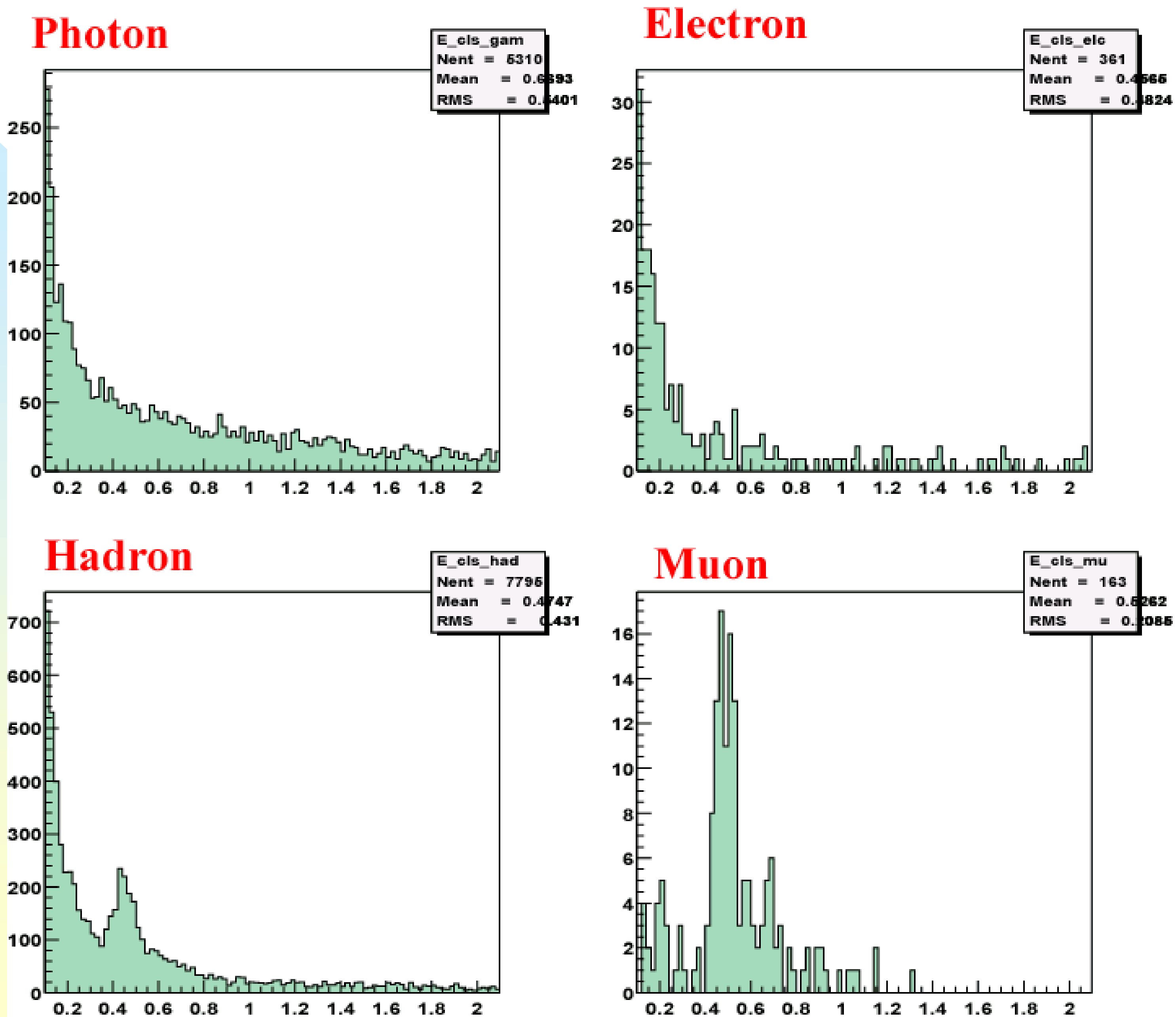




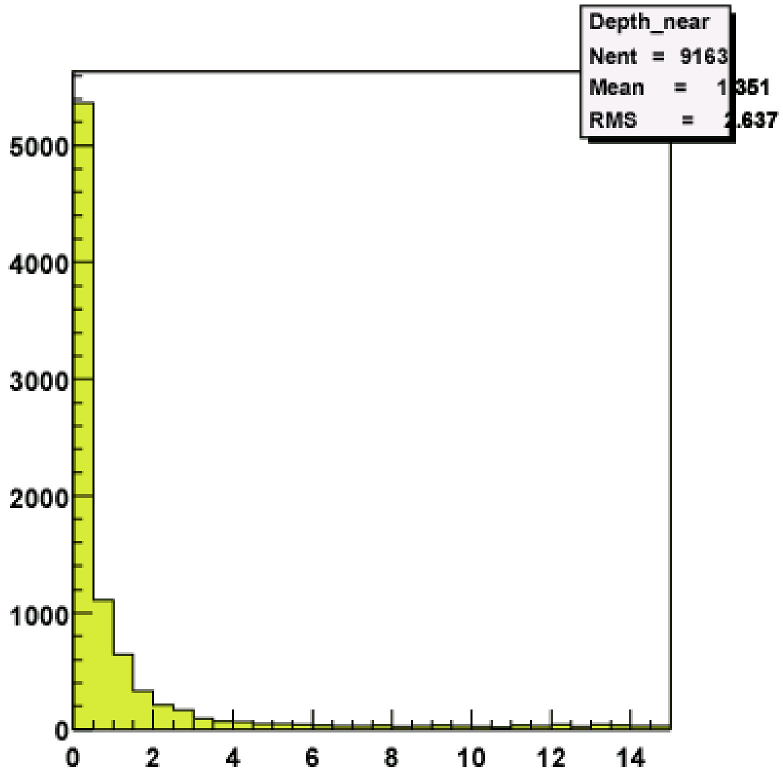
Cluster Energy (GeV)

Scattered clusters have less energy… apply a cut Ecls>0.35GeV

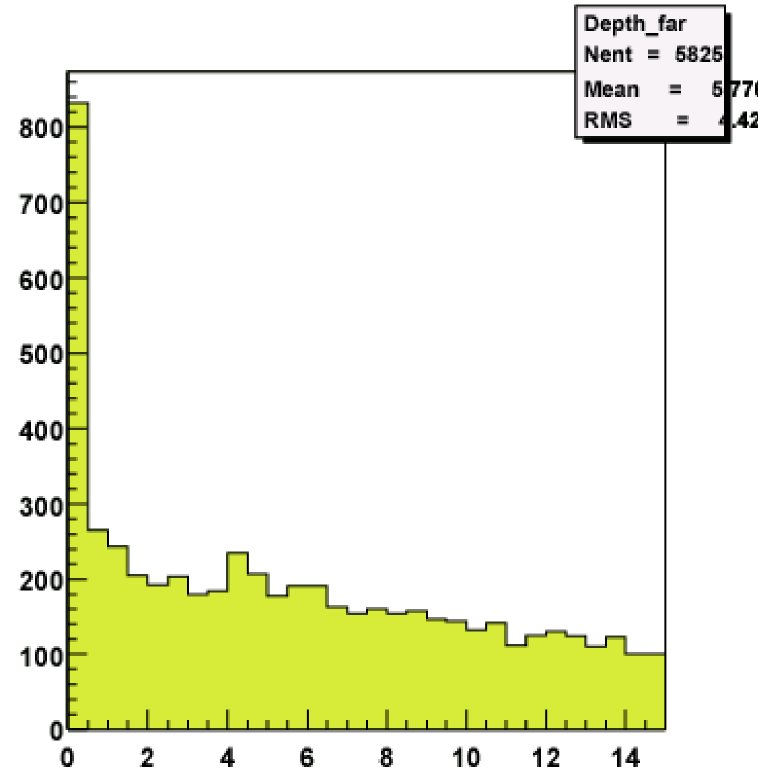
Cluster Energy (GeV)



Nearest clusters to the particles



Scattering particle clusters



Cluster Starting depth (cm)

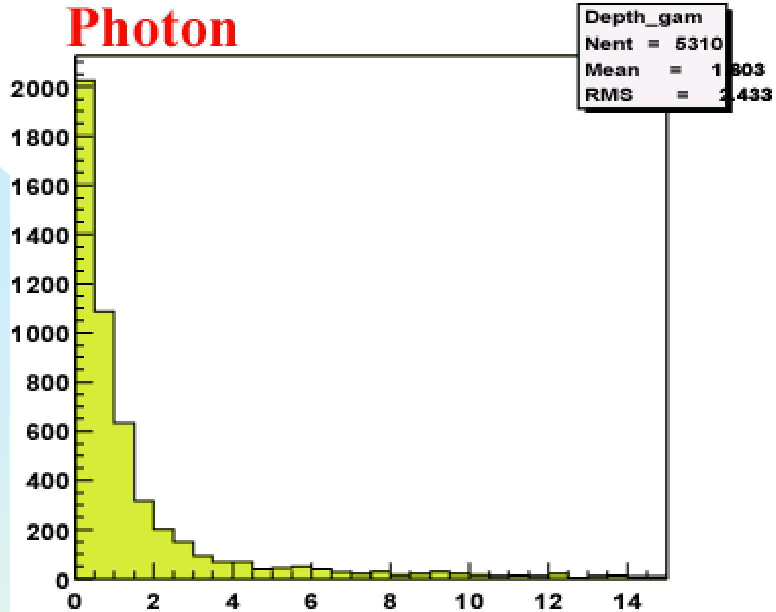
Nearest clusters to the initial particles start from surface of EM CAL

apply clus. starting depth<2 cm

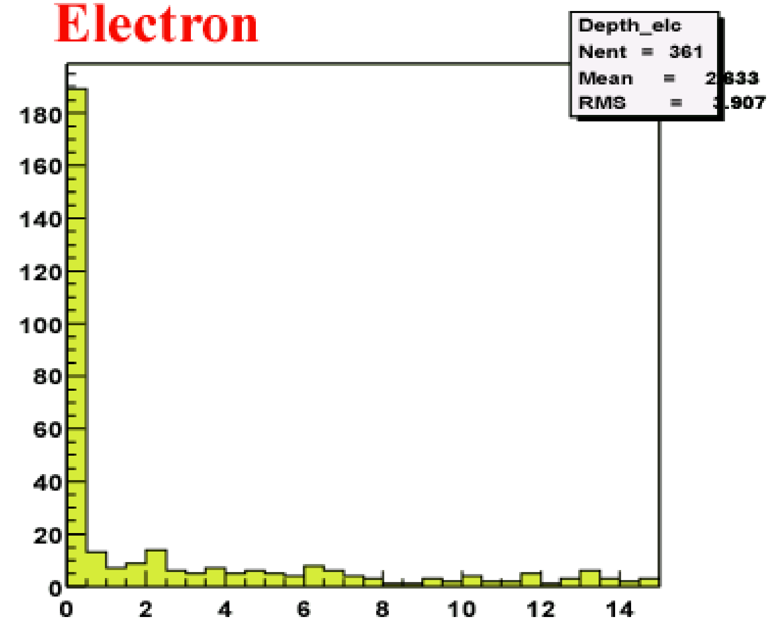
	#particle	#cluster	
	9163	14988	(purity = 61%)
Ecls > 0.35 GeV	7487	9405	(80%)
depth < 2cm	6864	7702	(89%)

Cluster Starting depth (cm)

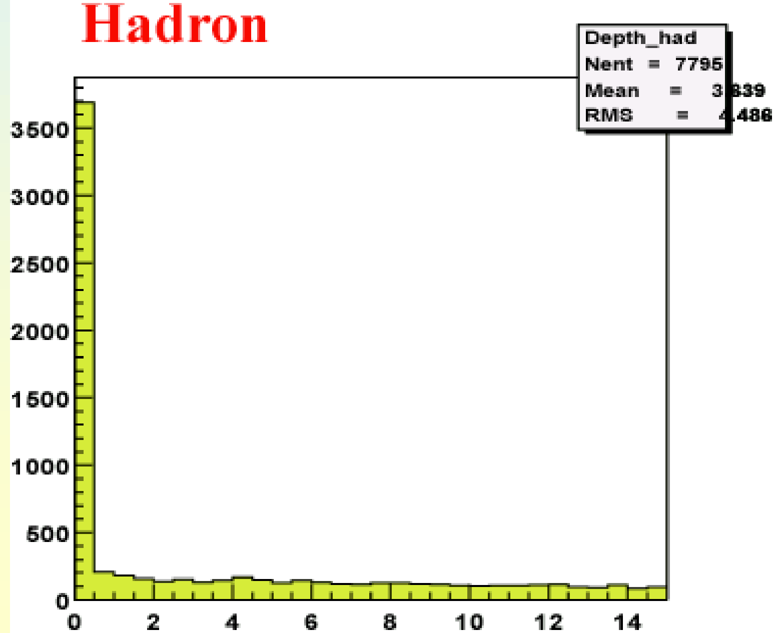
Photon



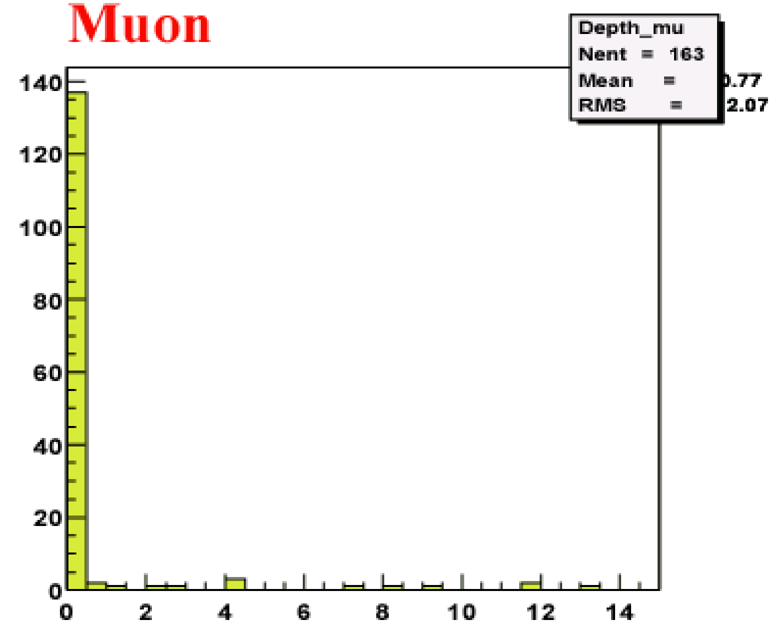
Electron



Hadron



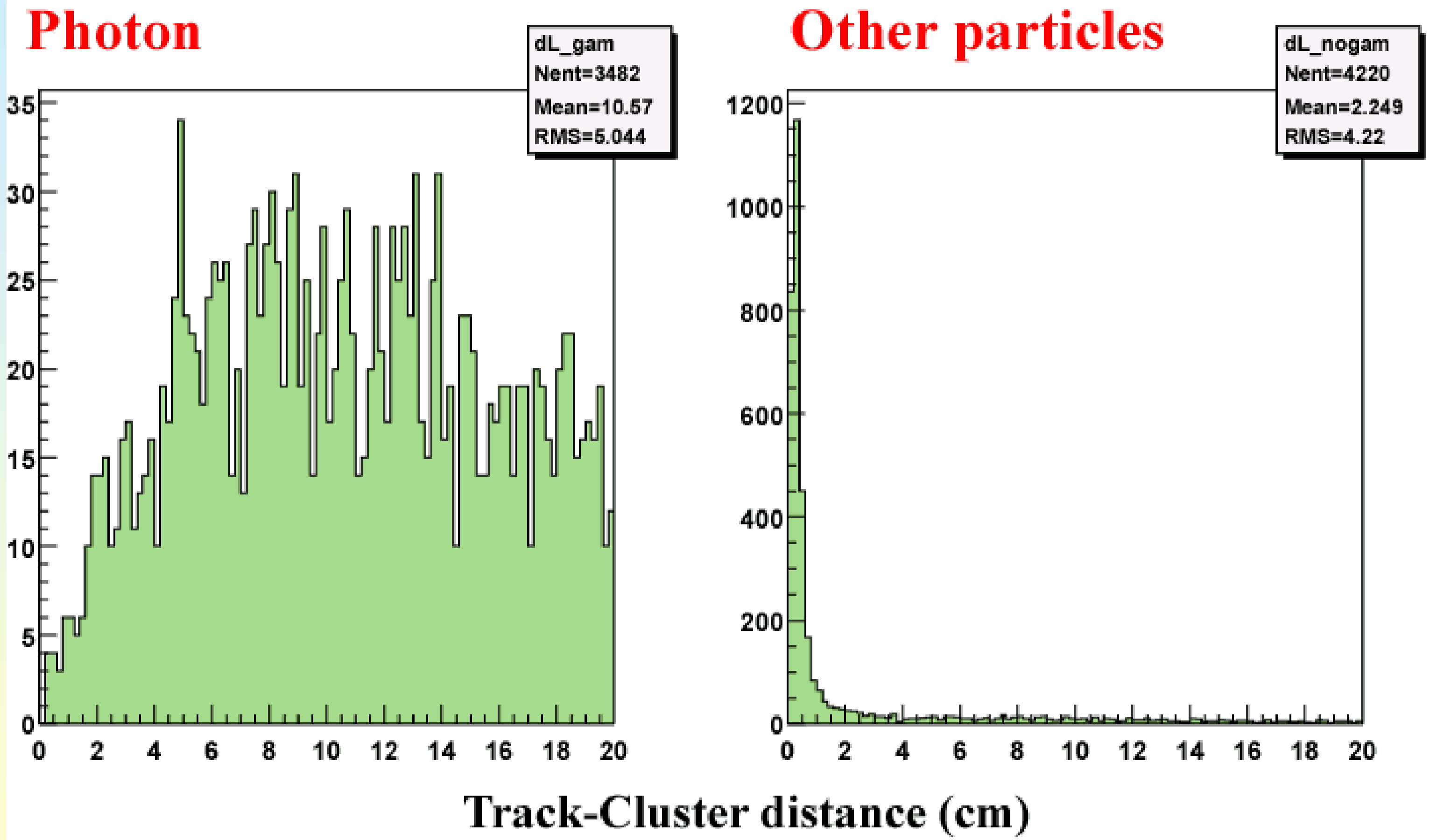
Muon



2-2) γ selection by transverse information

To separate Charged/Neutral Clusters we see track-cluster matching

1) Extrapolate Charged tracks to the Cluster radius,
2) Associate the nearest track to the cluster



Apply a cut: Track-cluster distance > 2.5 cm

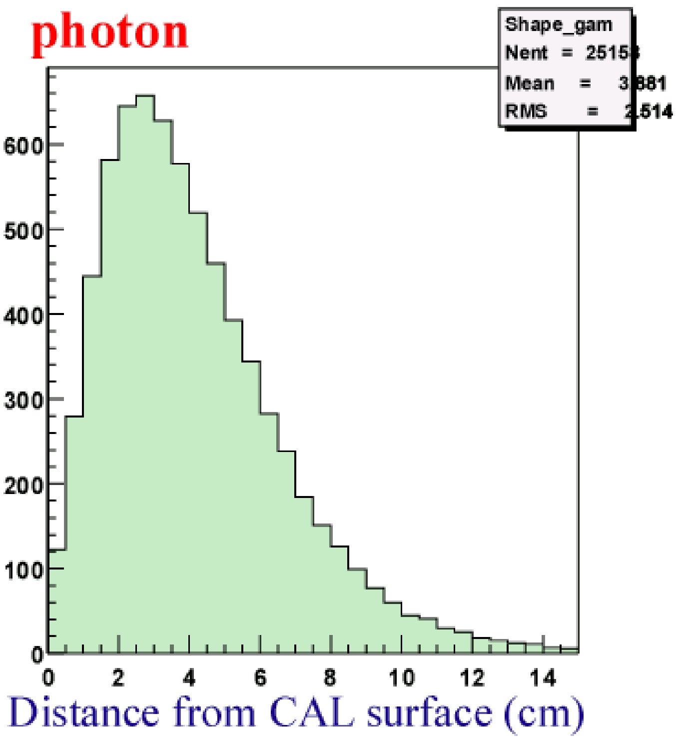
→ γ selection π 70% ε 88% (for Ecls>0.35GeV clusters: SDMar01)

2-3) γ selection by longitudinal information

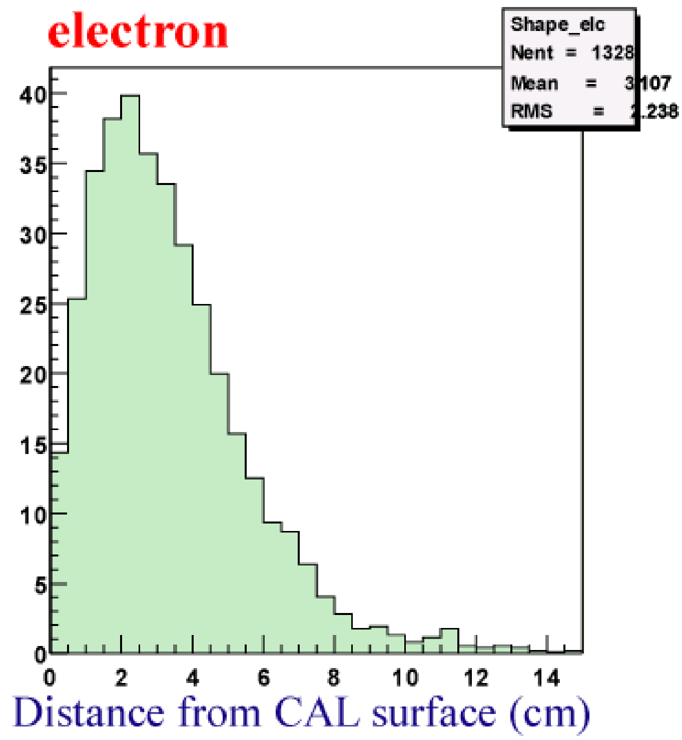
It is useful to separate EM particles / hadron
by seeing longitudinal Edeposit information

Longitudinal energy deposit shape

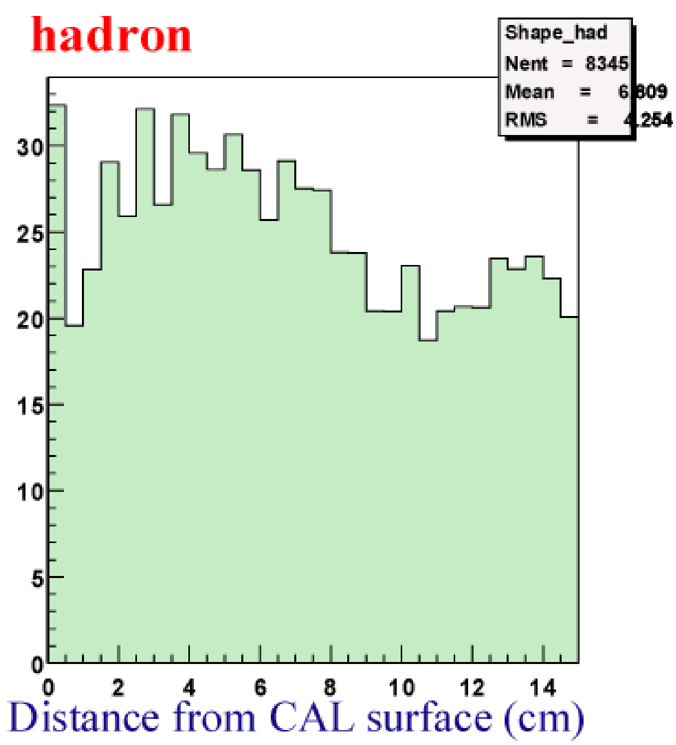
photon



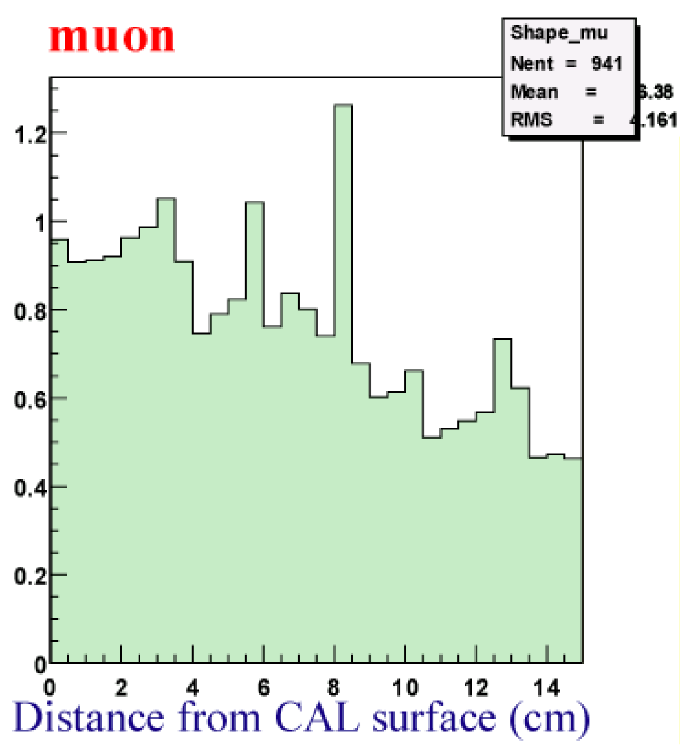
electron



hadron

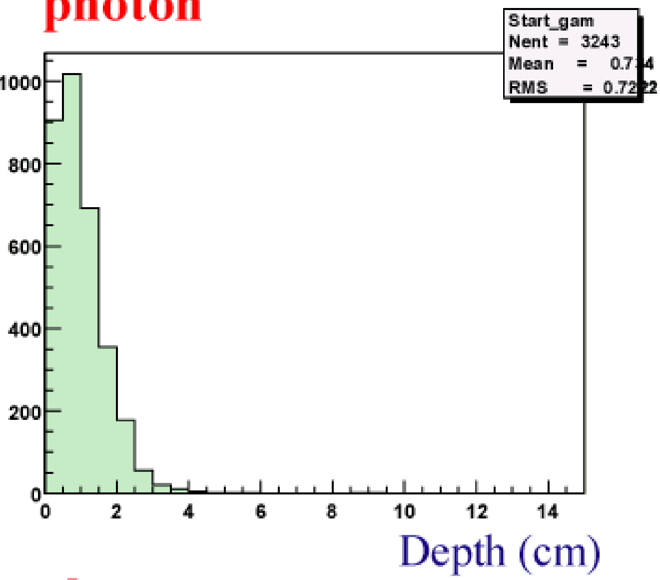


muon

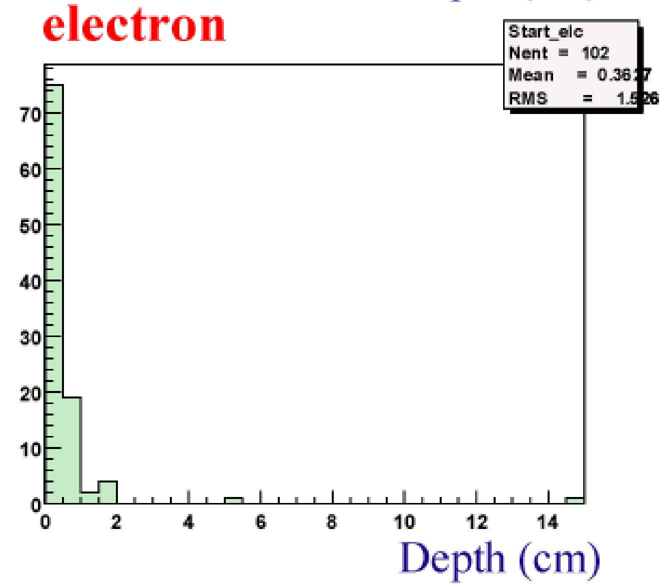


Depth where CALHit Energy > min-I

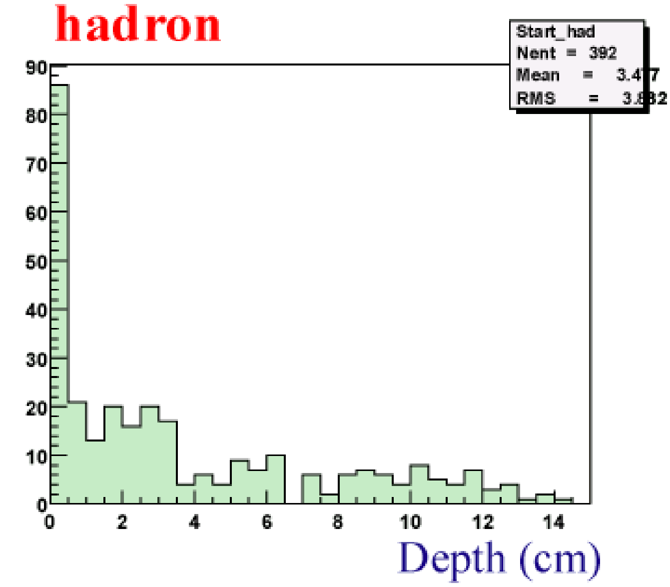
photon



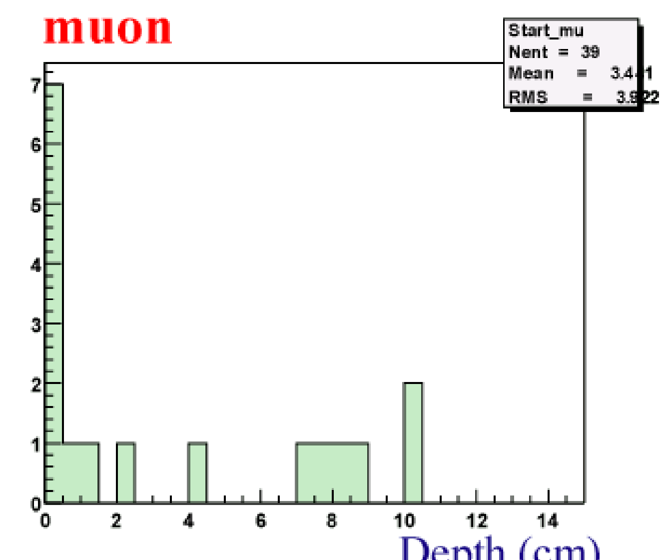
electron



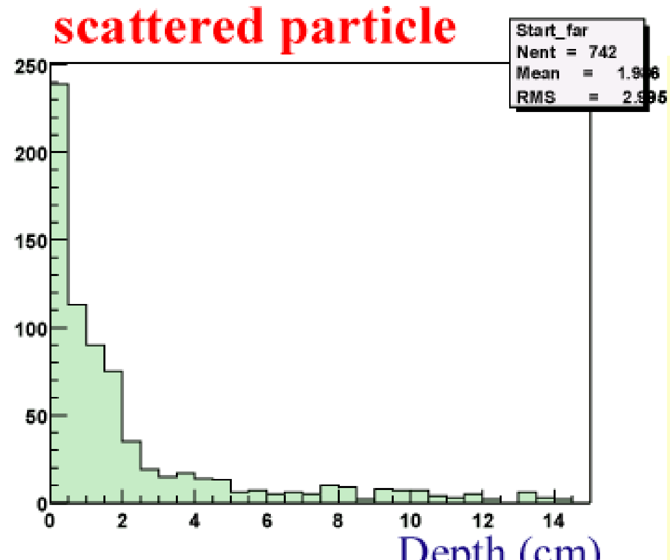
hadron



muon



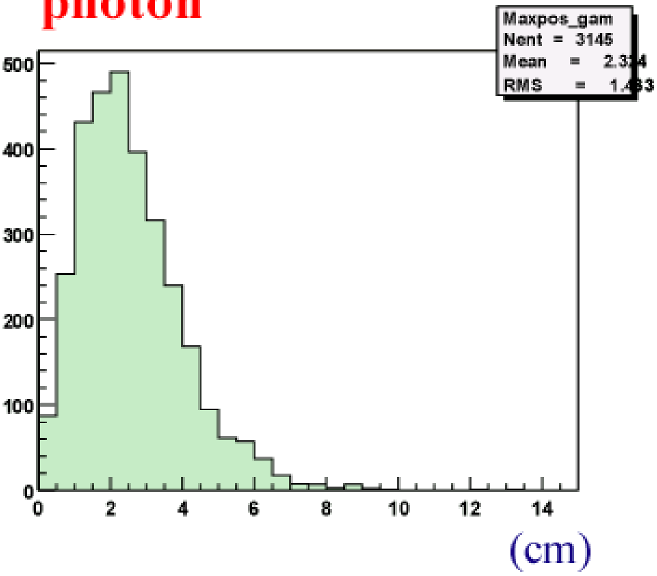
scattered particle



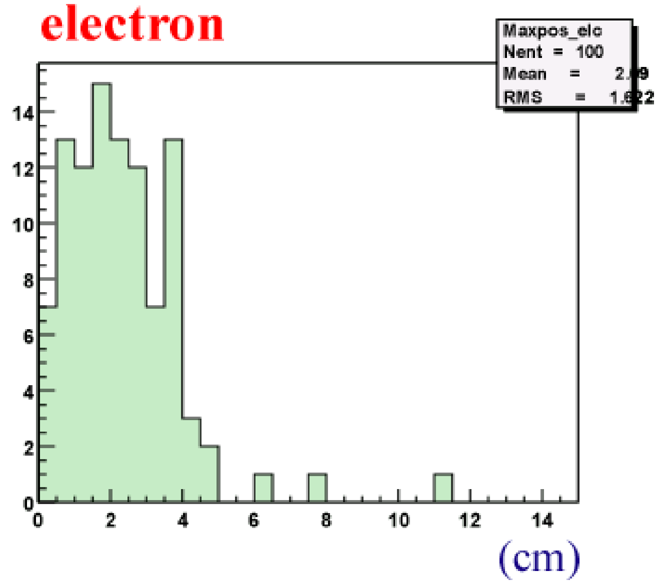
Apply a cut: depth < 2 cm

Cluster starting layer - max Edeposit layer distance

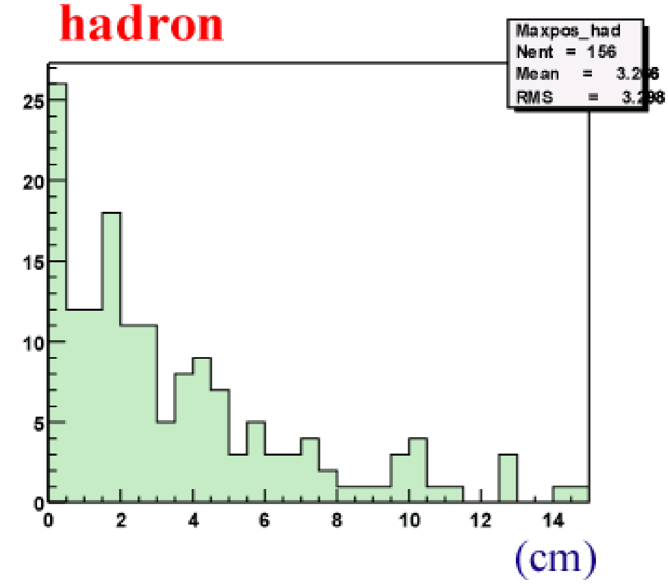
photon



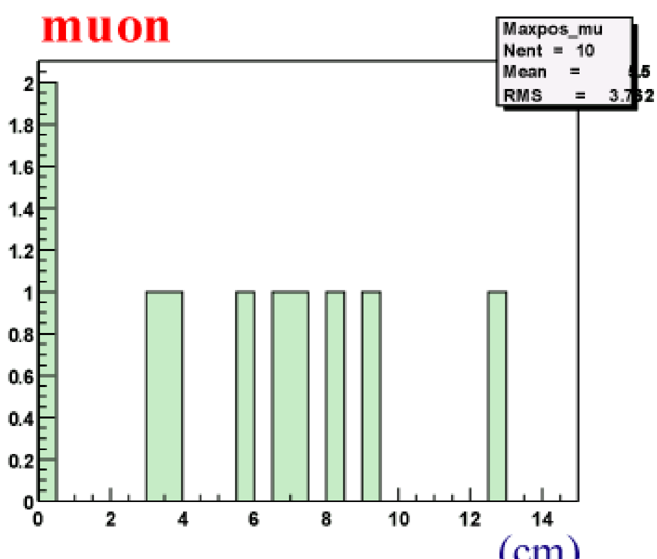
electron



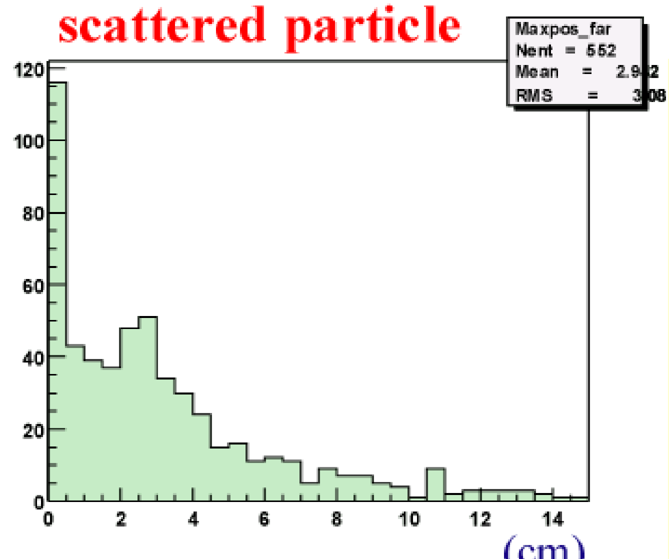
hadron



muon



scattered particle



Apply a cut: 0.5 < distance < 7 cm

Summary of γ selection (SDMar01 detector)

	N(γ)	N (not γ)	N(scattered)	
Ecls>0.35 GeV	3665	3822	1918	
Cluster depth<2cm	3331	3533	838	
Track-cluster cut	3243	648	742	π 70% ε 88%
Longitudinal cuts	3036	274	376	π 82% ε 83%

→ **Longitudinal energy deposit information is effective to reject both hadrons and scattered clusters**

2-4) SD vs LD detectors

… Currently we have several detector designs

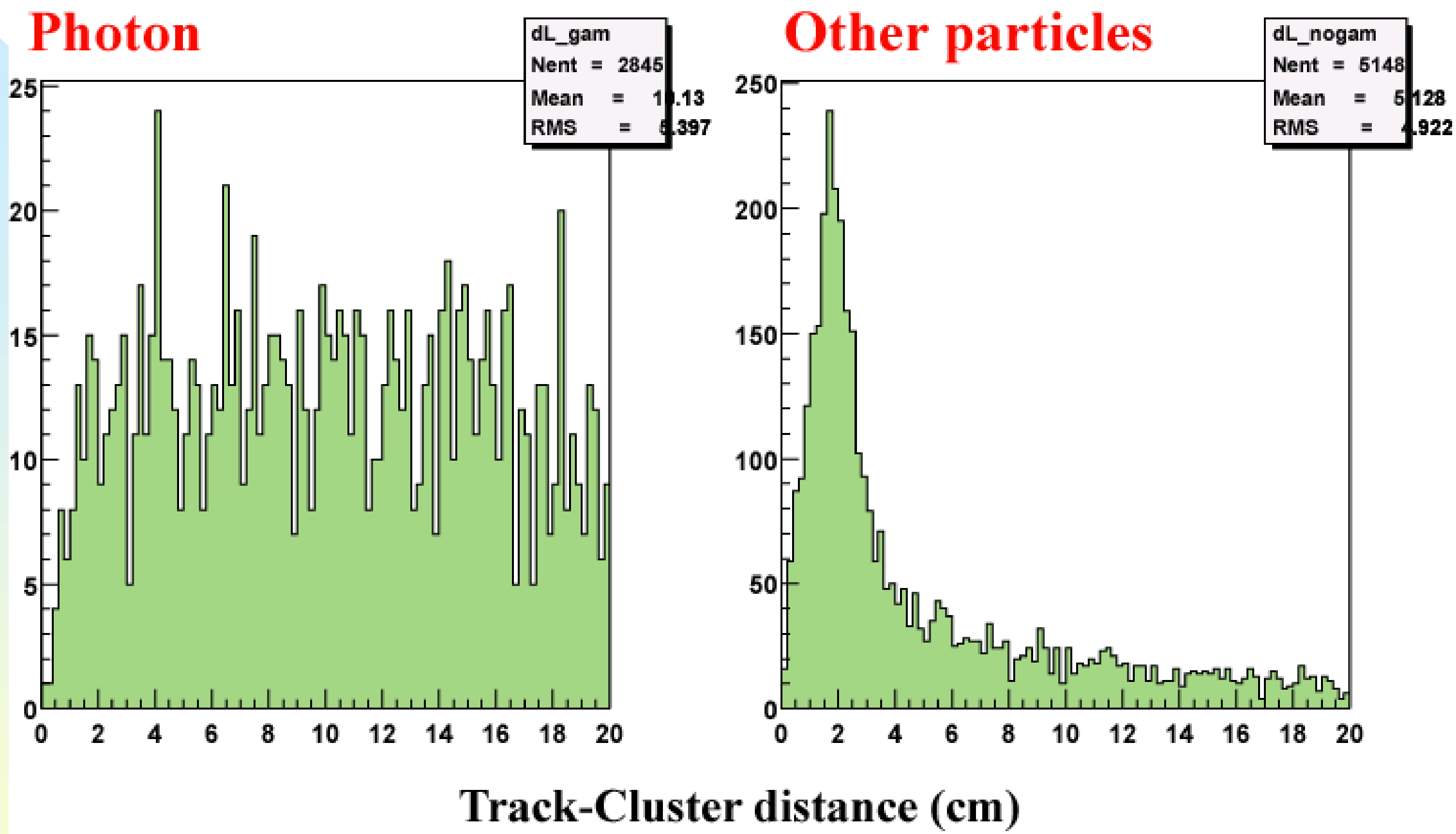
SD(Mar01) : W-Si EM cal

granularity	7.5 mrad
# layers	30 layer
inner radius	127 cm

LD(Mar01) : Pb-scint EM cal

granularity	40 mrad
# layers	10 layer
inner radius	196 cm

LD (Mar01)

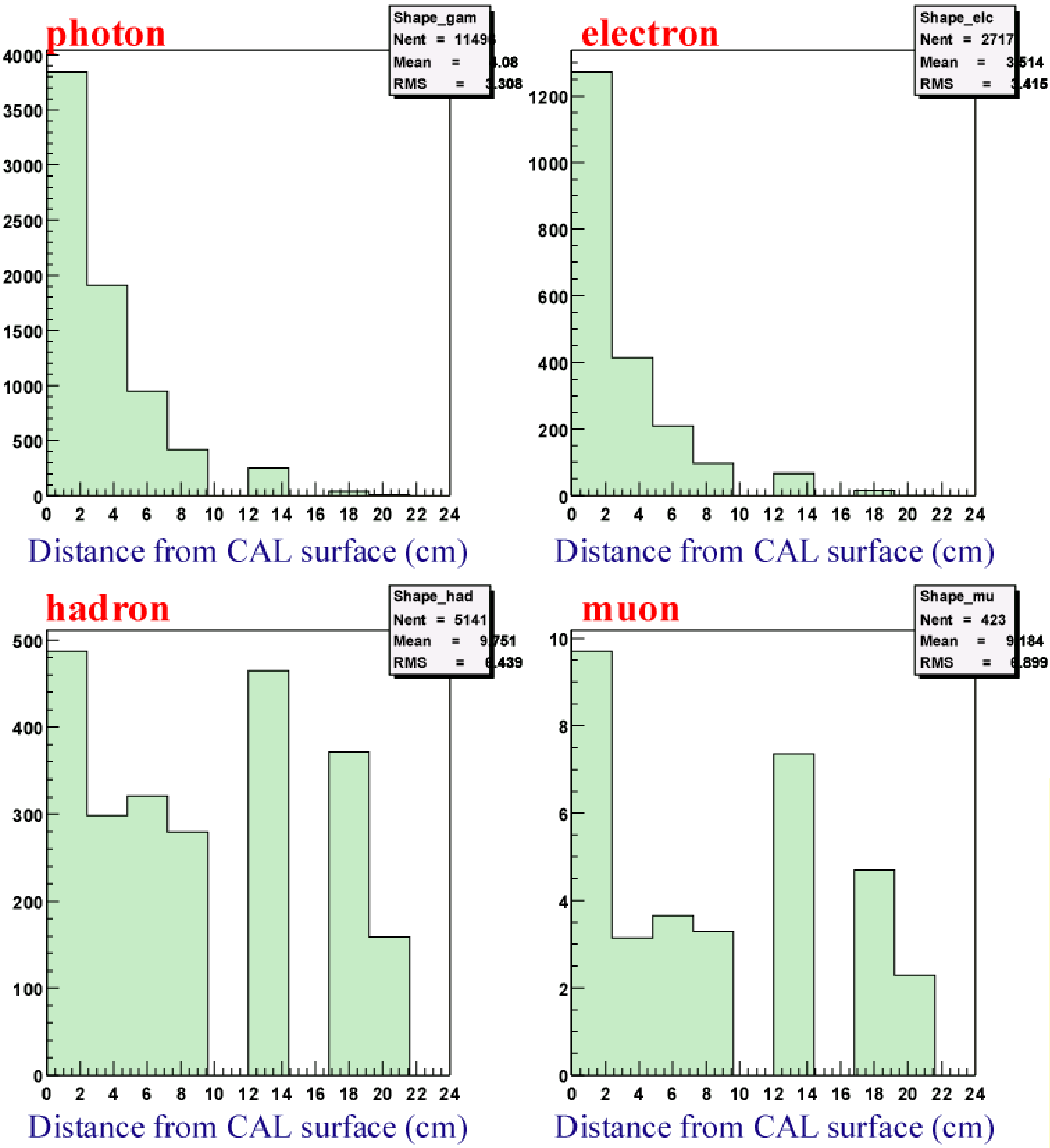


Apply a cut: Track-cluster distance > 6 cm

→ γ selection π 48% ε 79% (for Ecls>0.35GeV clusters: LDMar01)

LD (Mar01)

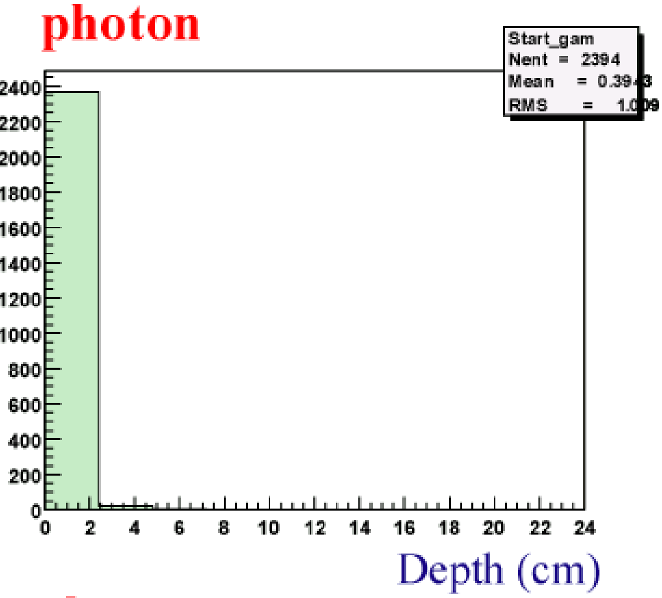
Longitudinal energy deposit shape



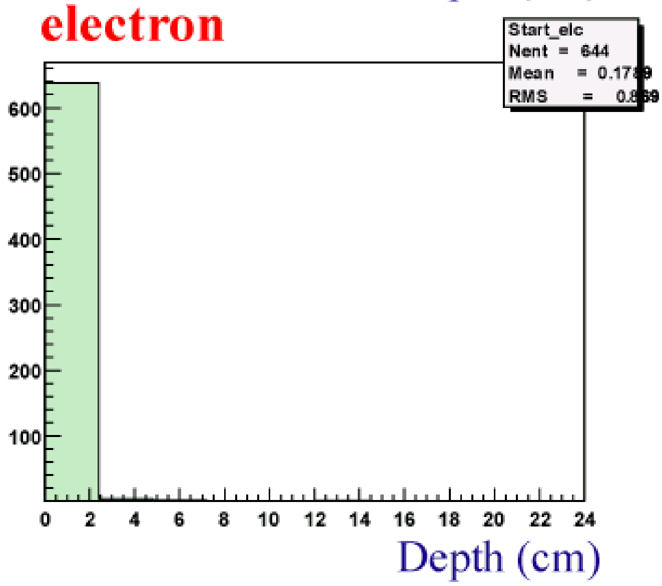
Depth where CALHit Energy > min-I

LD (Mar01)

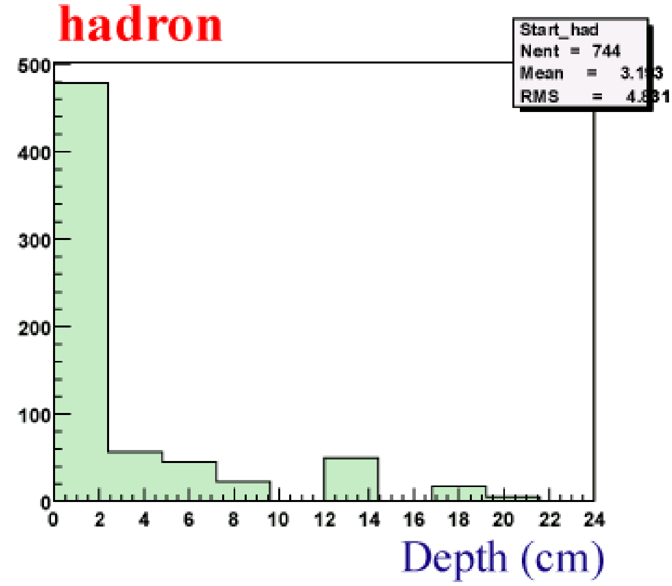
photon



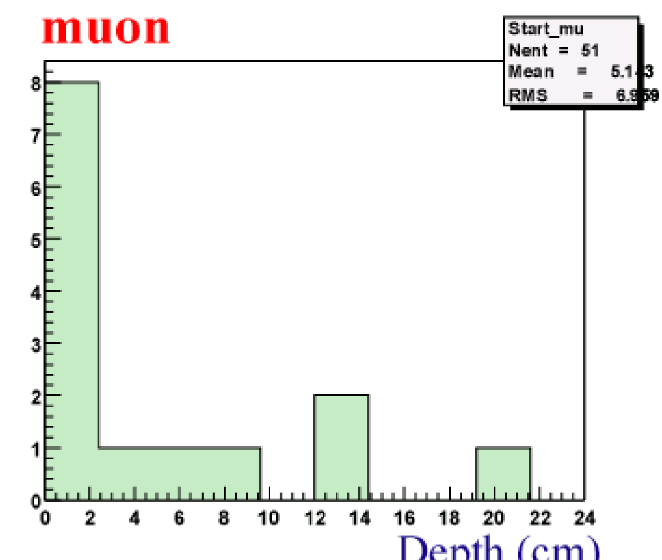
electron



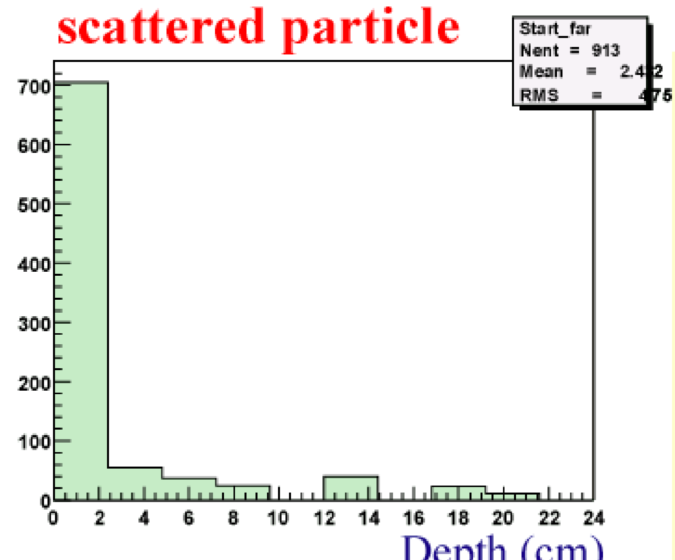
hadron



muon



scattered particle

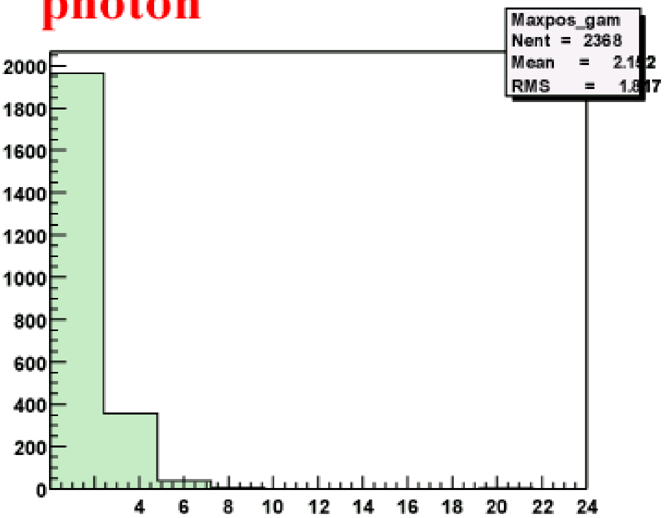


Apply a cut: depth < 2.4 cm

Cluster starting layer - max Edeposit layer distance

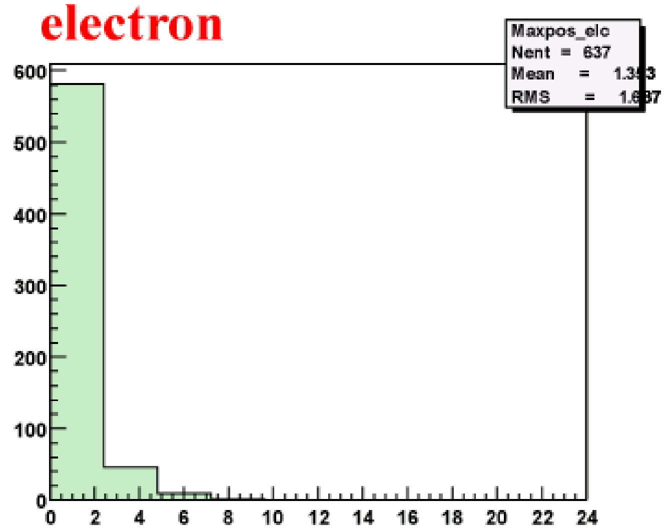
LD (Mar01)

photon



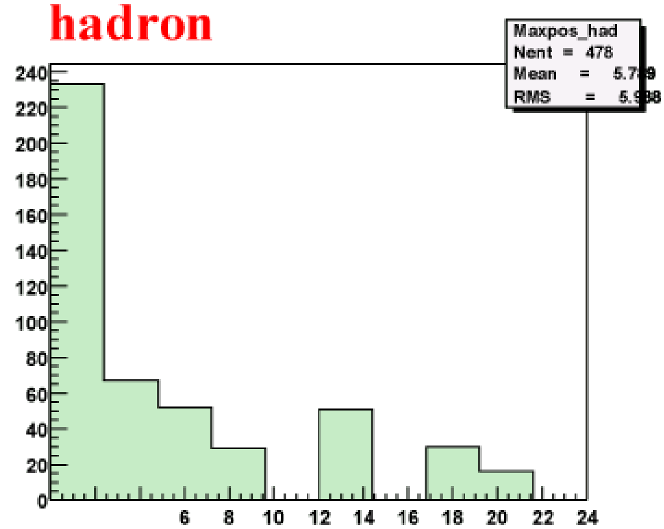
(cm)

electron



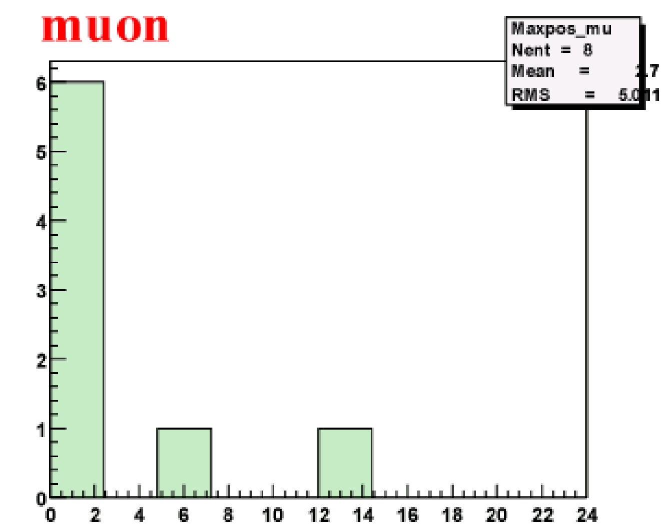
(cm)

hadron

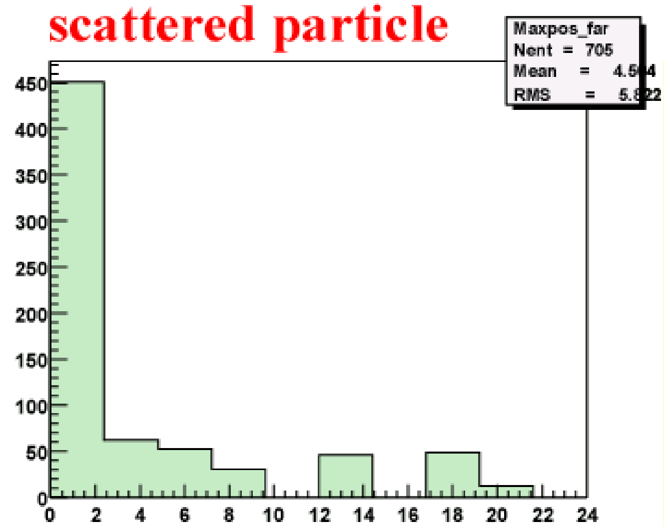


(cm)

muon



scattered particle



Apply a cut: distance < 7.2 cm

SD vs LD

SD (Mar01)

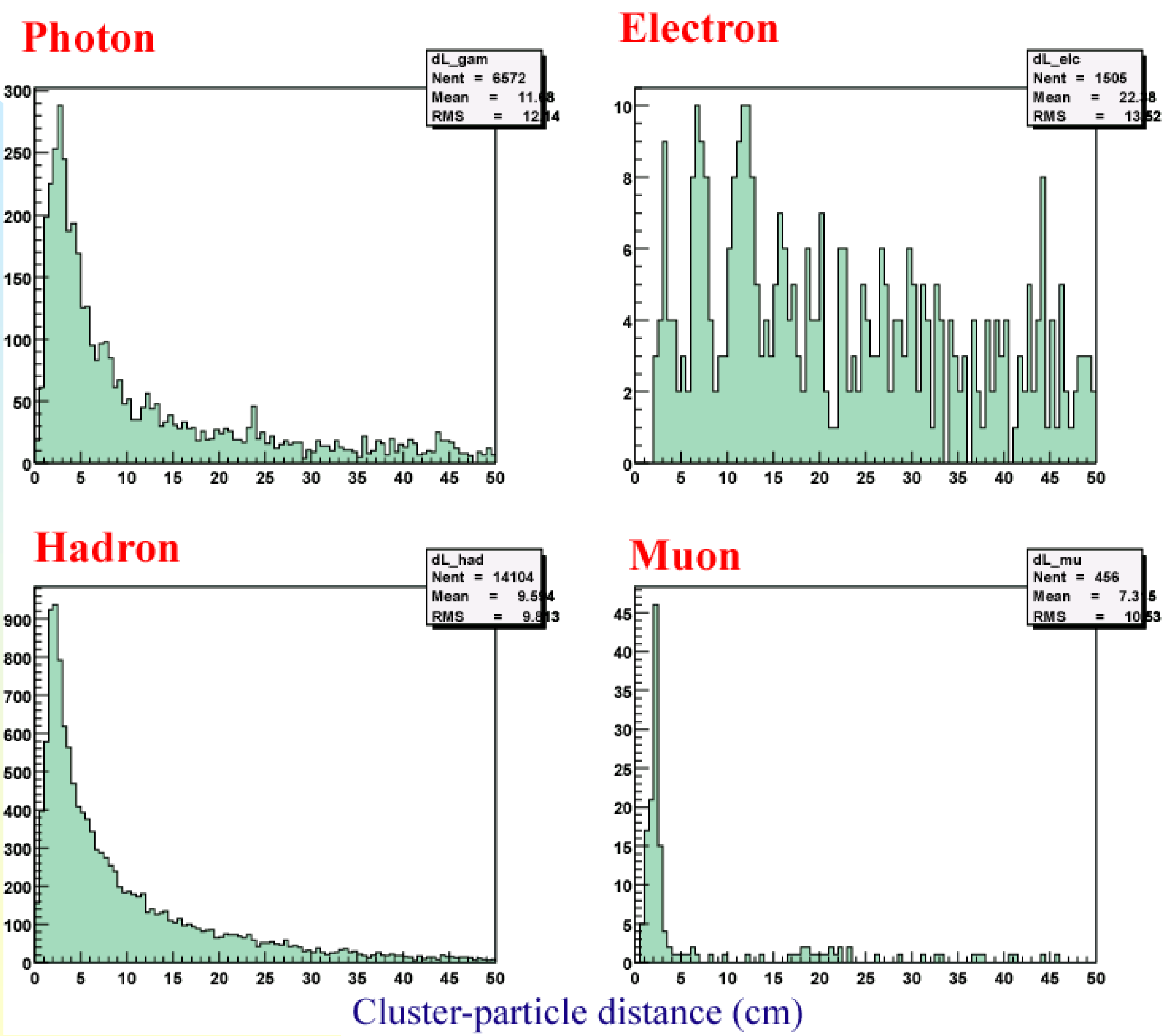
	N(γ)	N (not γ)	N(scattered)		
Ecls>0.35 GeV	3665	3822	1918		
Cluster depth<2cm	3331	3533	838		
Track-cluster cut	3243	648	742	π 70%	ε 88%
Longitudinal cuts	3036	274	376	π 82%	ε 83%

LD (Mar01)

	N(γ)	N (not γ)	N(scattered)		
Ecls>0.35 GeV	3043	4932	2659		
Cluster depth<2.4cm	2667	4207	1119		
Track-cluster cut	2398	1645	913	π 48%	ε 79%
Longitudinal cuts	2361	1138	566	π 58%	ε 78%

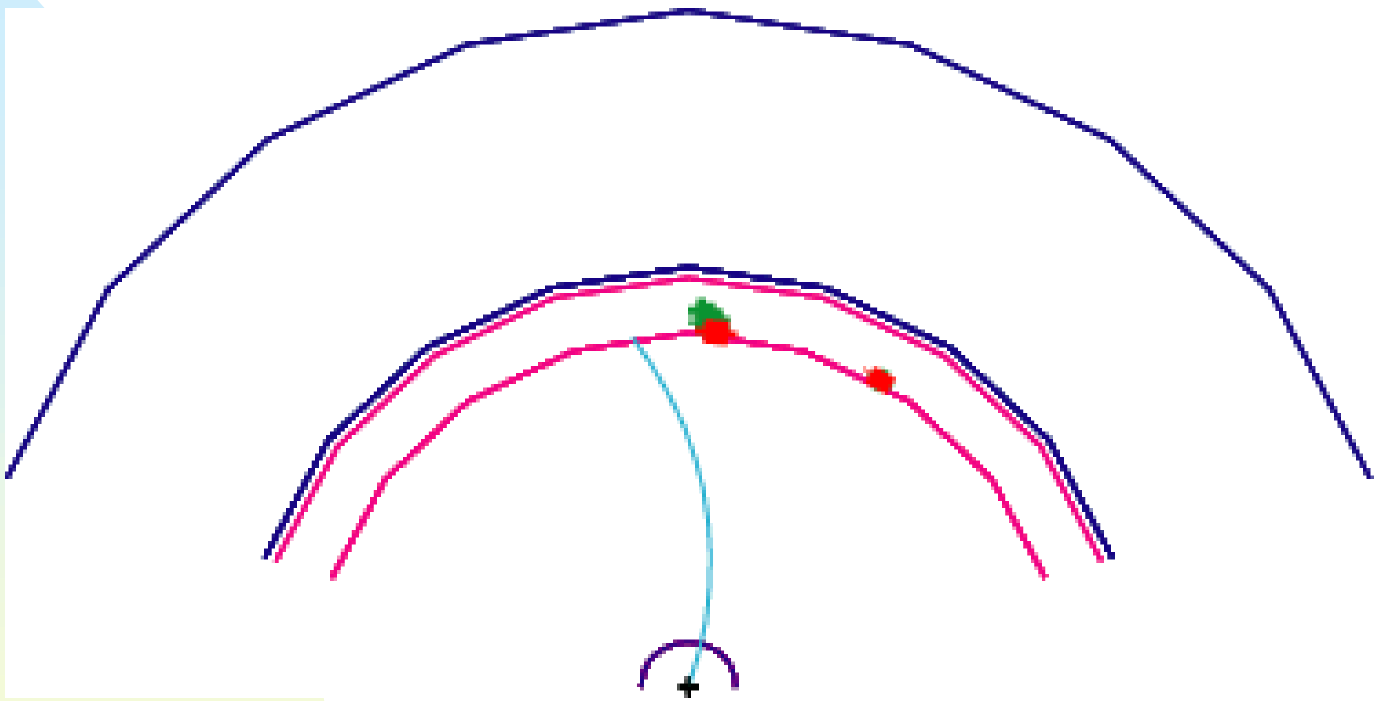
Too bad??

… Do we have some bug in LD Full simulation??



Cluster-Initial particle distance

Electron generation (LD)



...???

Summary

1) We update the clustering algorithm
for more realistic simulation studies

2) Photon reconstruction in EMCal
Longitudinal information is very useful
→ χ^2fit or Neural Network?
Need to check the LD data set…

3) Future plan

GEANT4 (now in progress)

HAD Cal study

Tune FastMC parameters