JÜLICH
FORSCHUNGSZENTRUM

Status of Neutral Particle Reconstruction

Lu Cao

10th December， 2014

Outline

- Algorithm of PID correlation (changes)
- Neutral candidate multiplicity
- Single photon in event display
- Summary

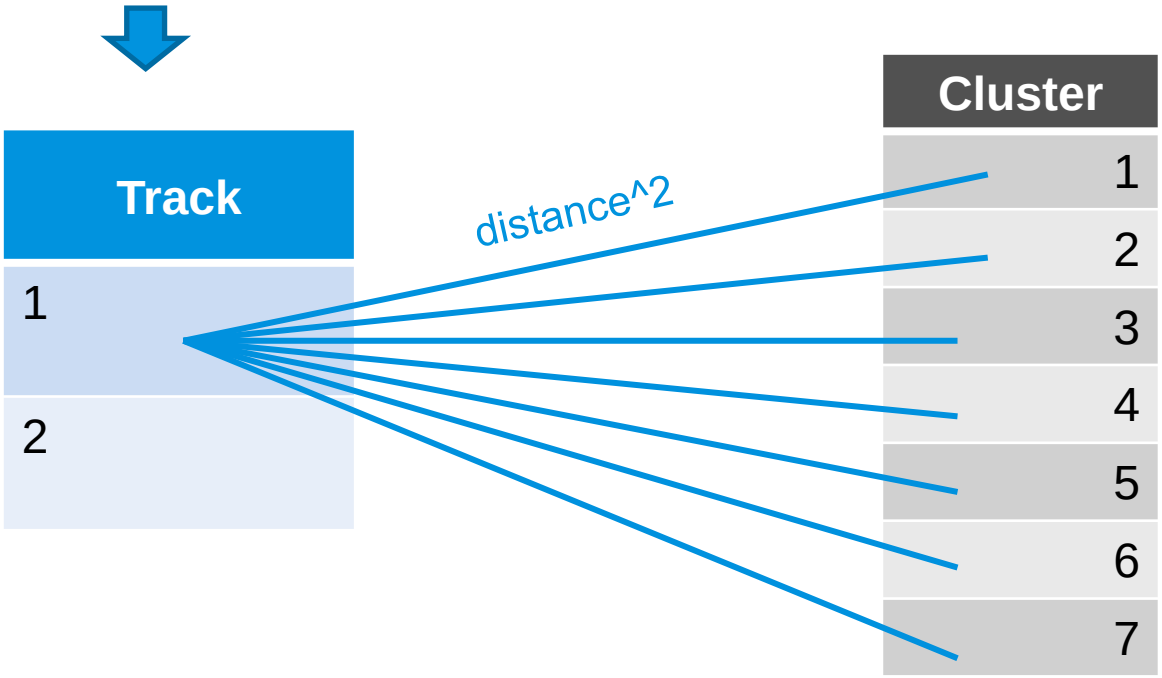
Algorithm of PID Correlation (old)

before #26209
pid/PidCorr/PndPidCorrelator.cxx

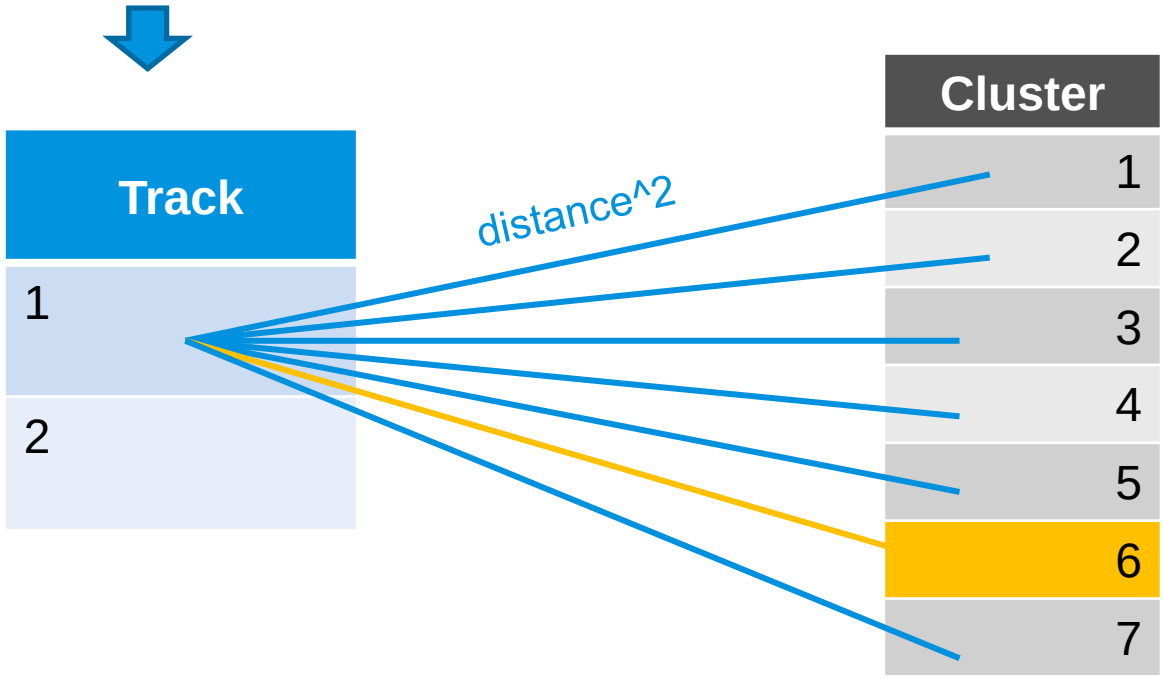
Track
1
2

Cluster
1
2
3
4
5
6
7

Algorithm of PID Correlation (old)

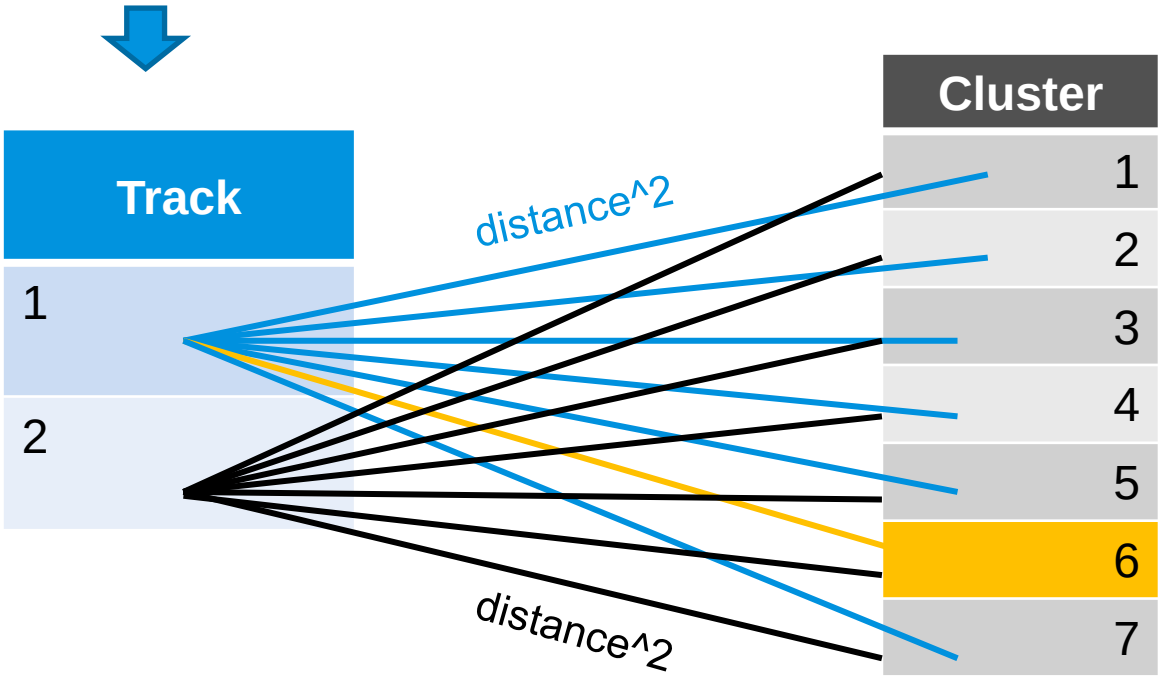


Algorithm of PID Correlation (old)



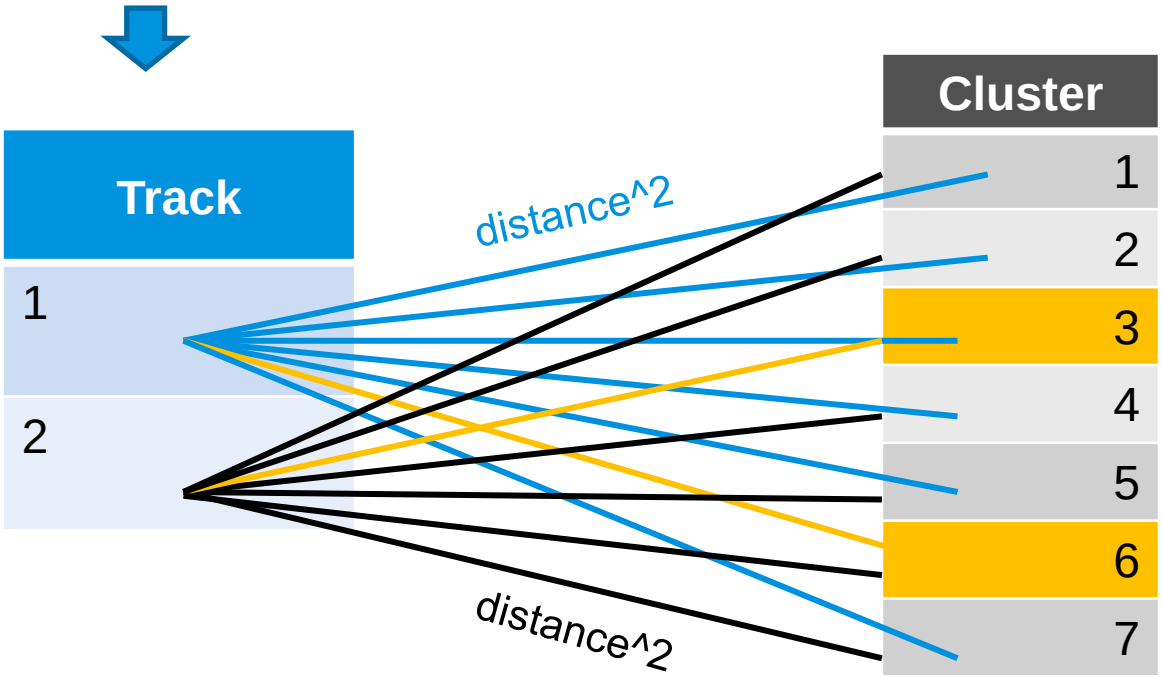
- Emc Quality: shortest distance squared between track and the cluster (in cm^2)

Algorithm of PID Correlation (old)



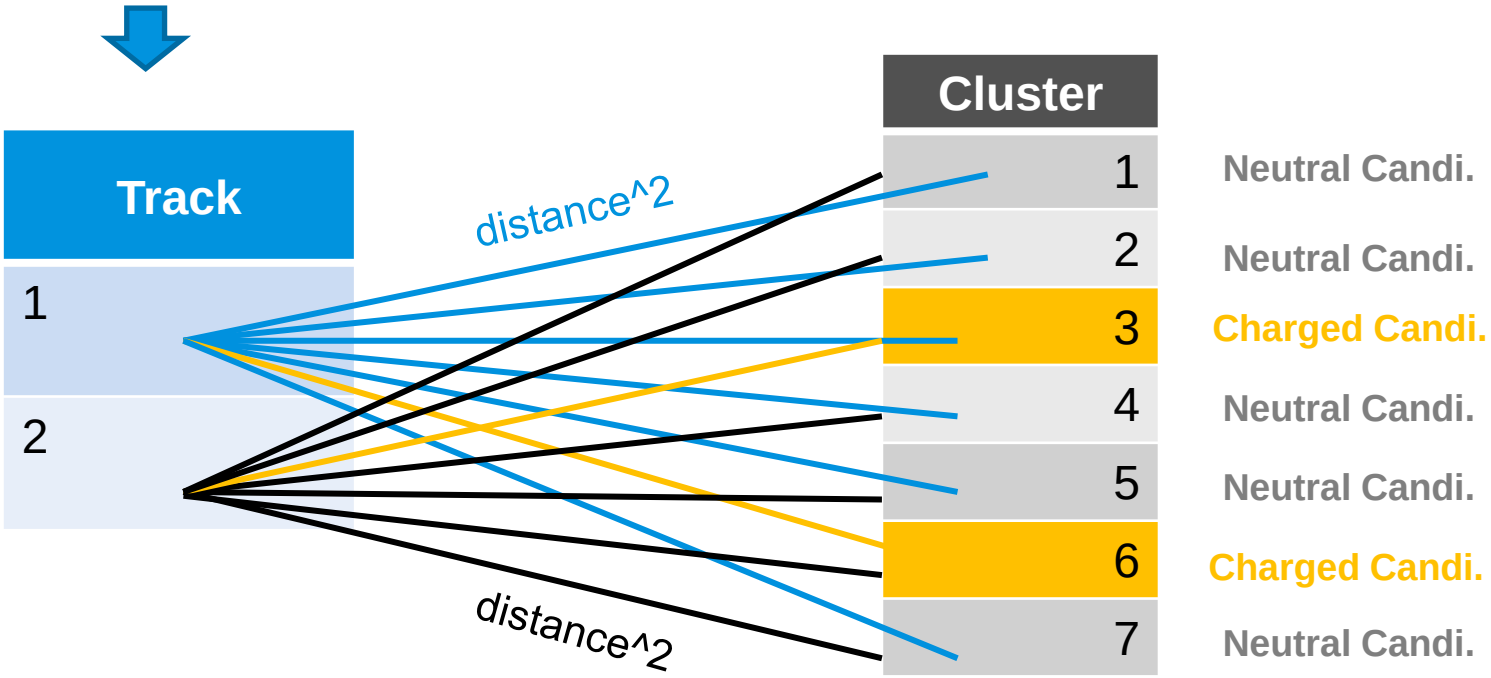
- Emc Quality: shortest distance squared between track and the cluster (in cm^2)

Algorithm of PID Correlation (old)



- Emc Quality: shortest distance squared between track and the cluster (in cm^2)

Algorithm of PID Correlation (old)

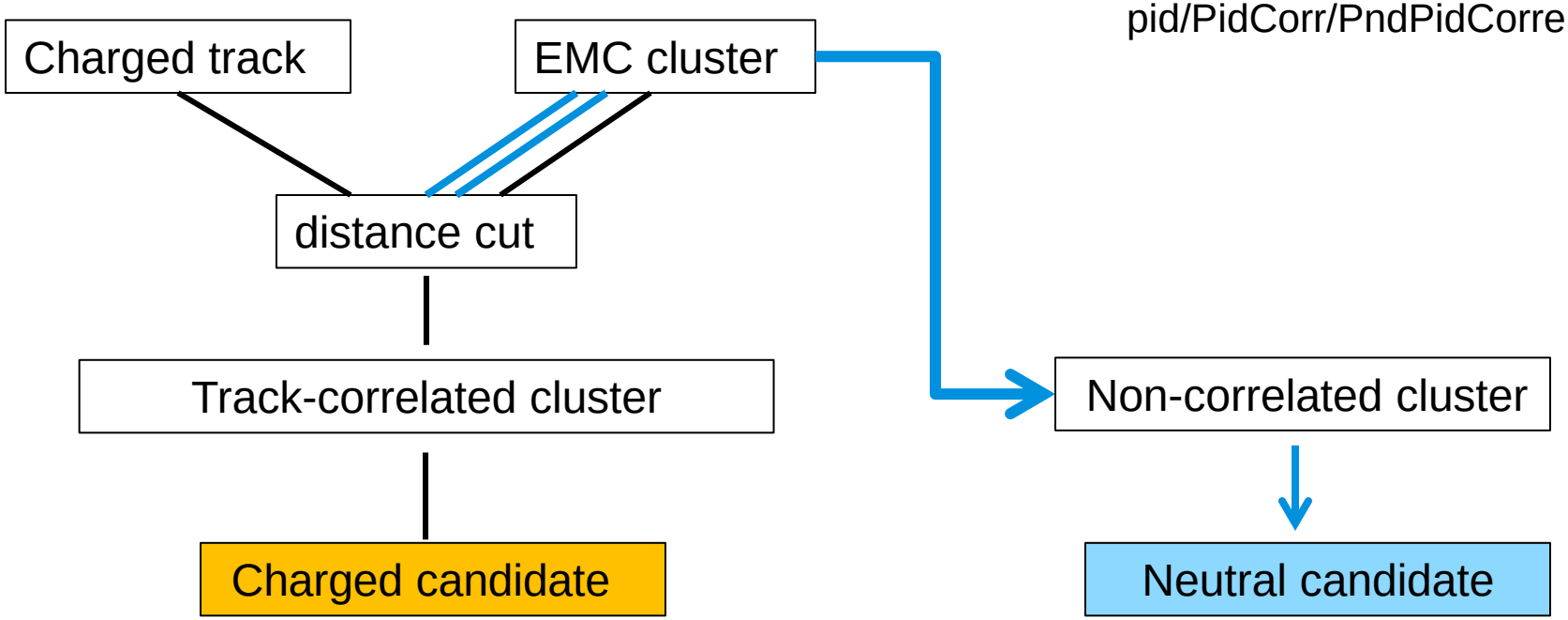


This algorithm is used in subversions before #26209.

- For charged candidates, emc quality is the dist^2 from the closest cluster
- For neutral candidates, emc quality only shows the dist^2 for the last track

Algorithm of PID Correlation (old)

before #26209
pid/PidCorr/PndPidCorrelator.cxx

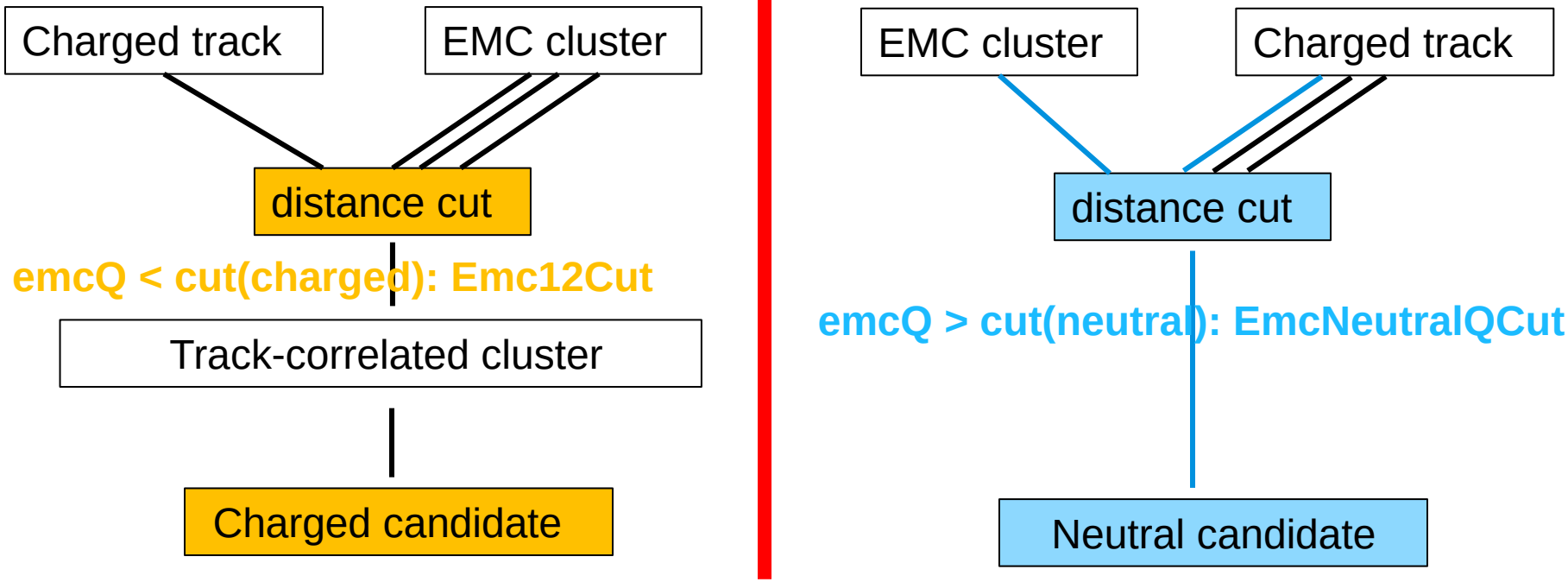


This algorithm is used in subversions before #26209.

- For charged candidates, emc quality is the dist^2 from the closest cluster
- For neutral candidates, emc quality only shows the dist^2 for the last track

Algorithm of PID Correlation (new)

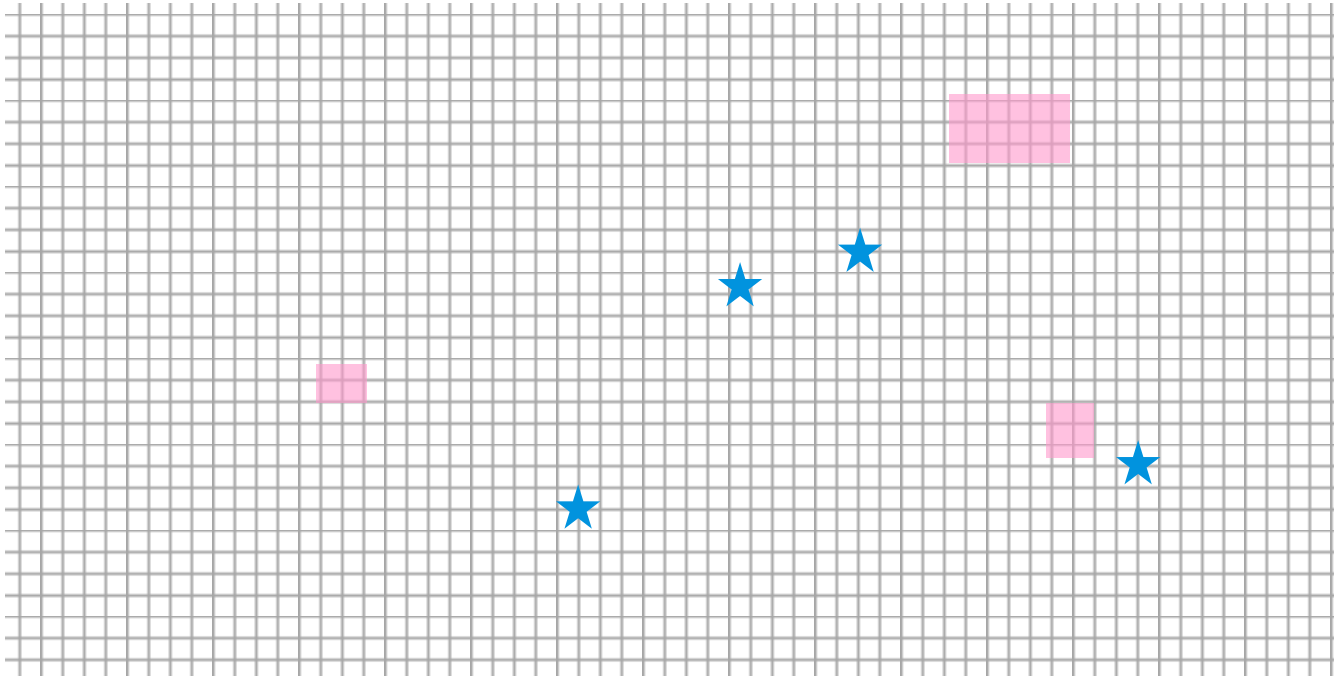
since #26209
by Stefano
pid/PidCorr/PndPidCorrelator.cxx



- PID correlation for charged and neutral are **separated**
- For charged candidates, emc quality is the dist^2 from the closest cluster
- For neutral candidates, emc quality is the dist^2 from the closest track
- Two independent distance cuts are requested

Charged Particle Correlation

Map of crystals on EMC

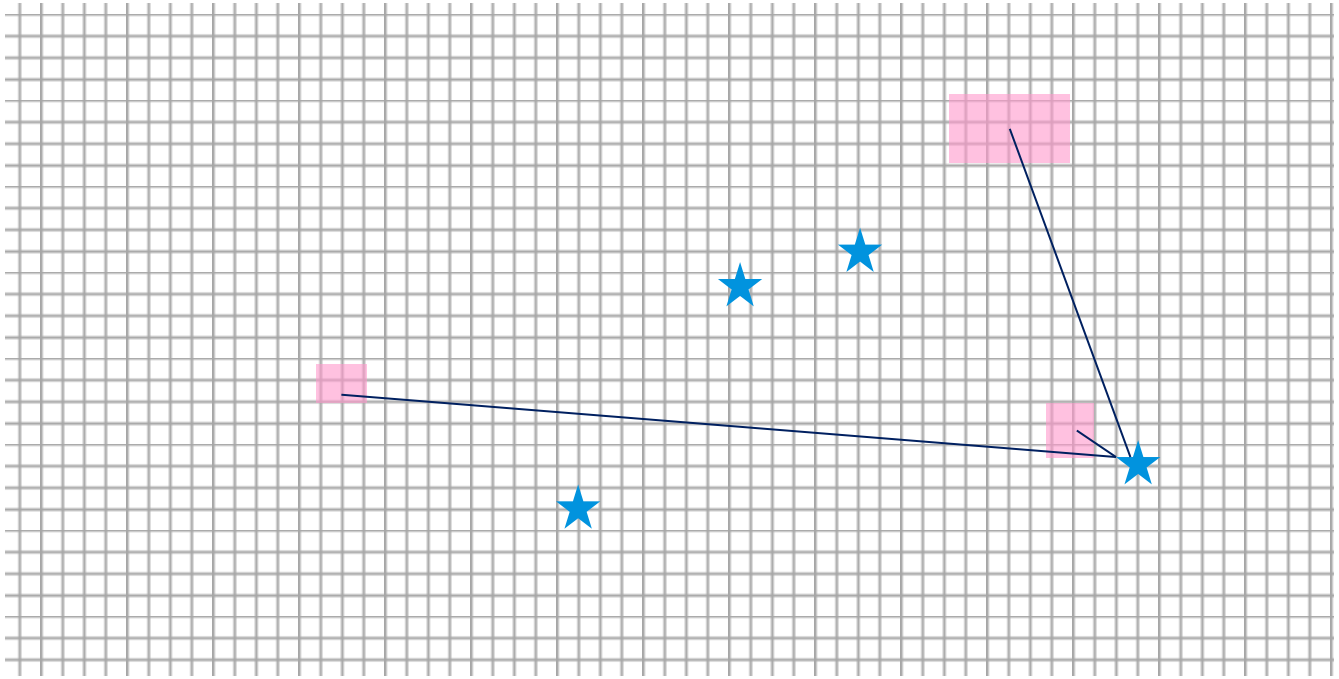


extrapolation of track

EMC cluster

Charged Particle Correlation

Map of crystals on EMC

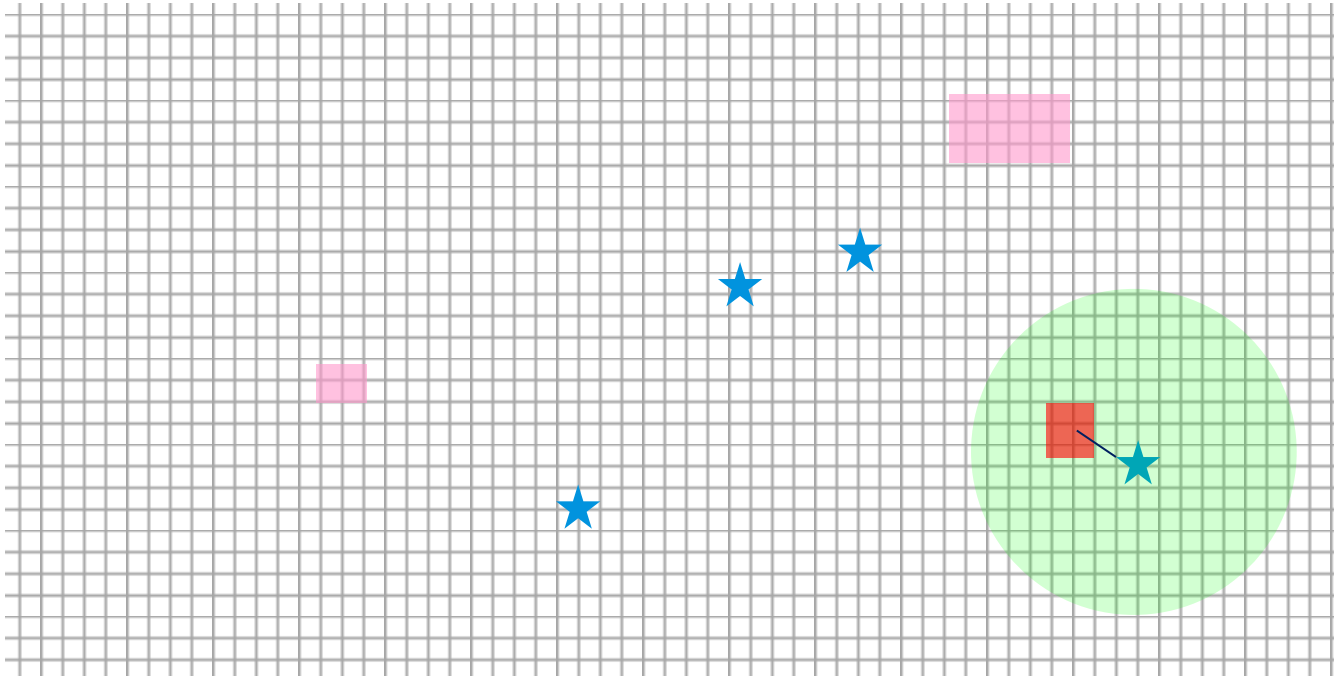


extrapolation of track

EMC cluster

Charged Particle Correlation

Map of crystals on EMC



extrapolation of track

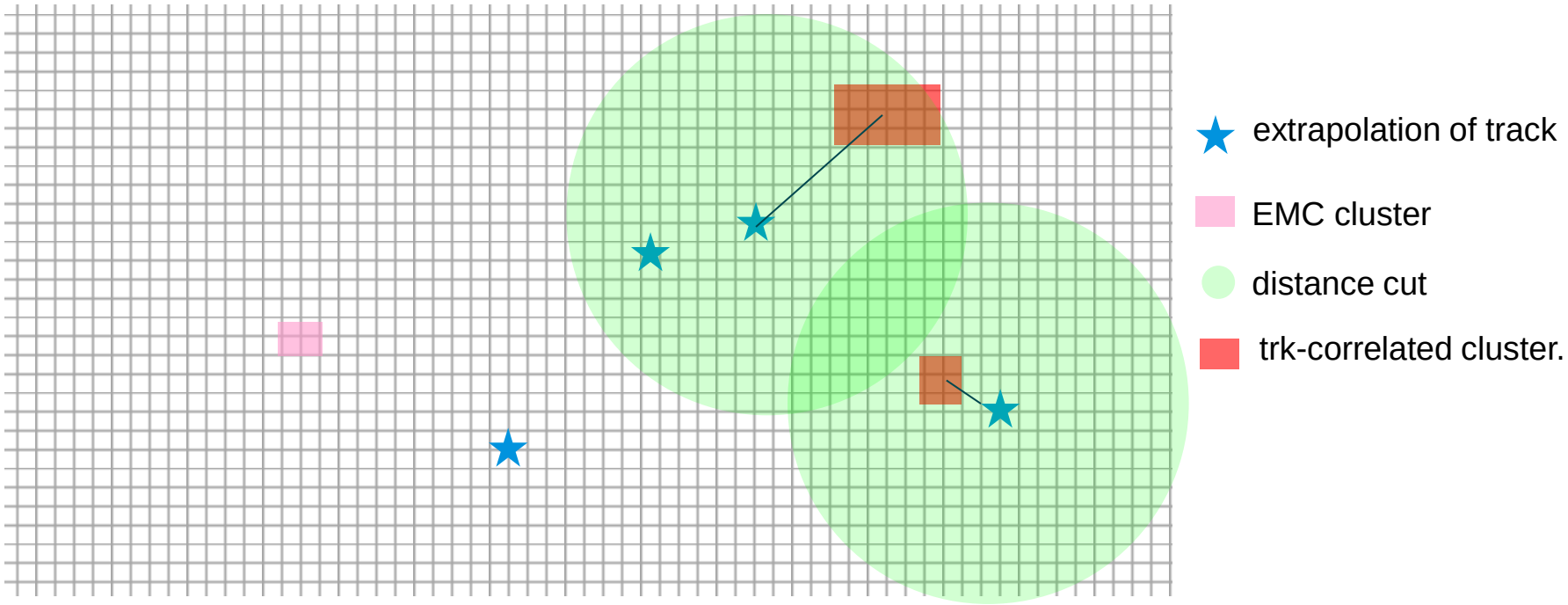
EMC cluster

distance cut

trk-correlated cluster.

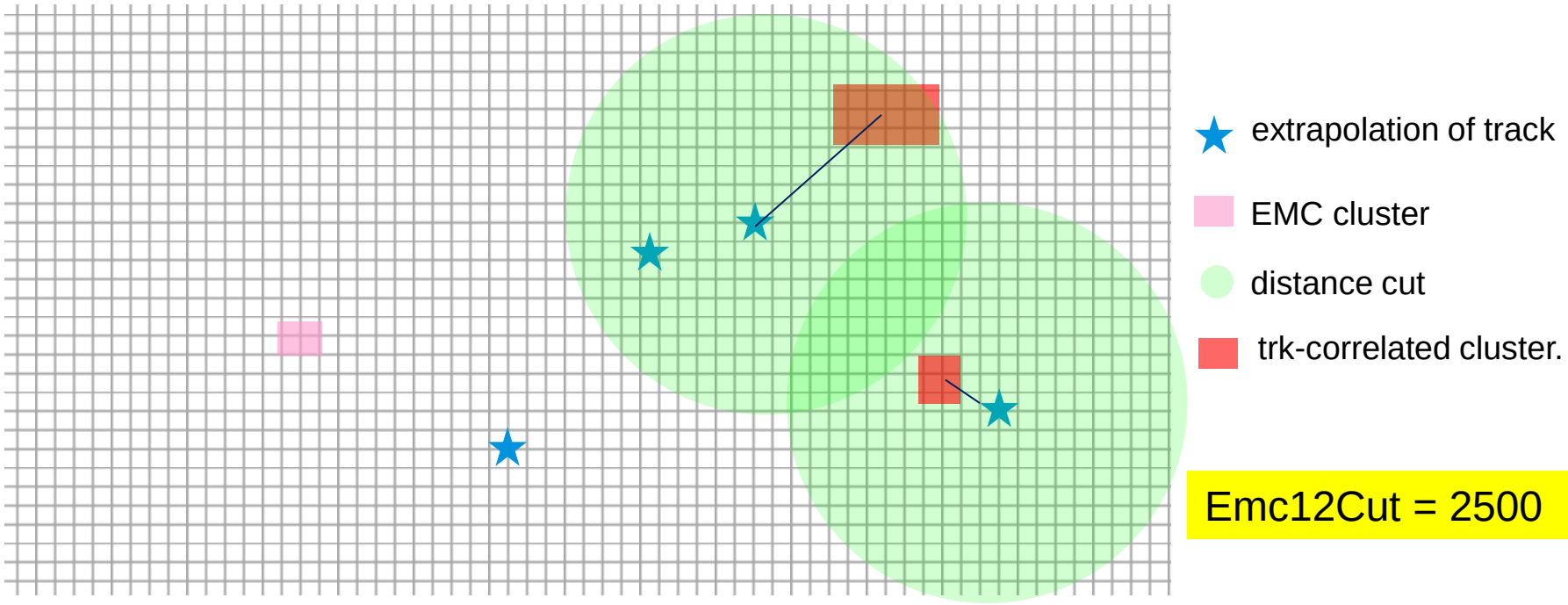
Charged Particle Correlation

Map of crystals on EMC



Charged Particle Correlation

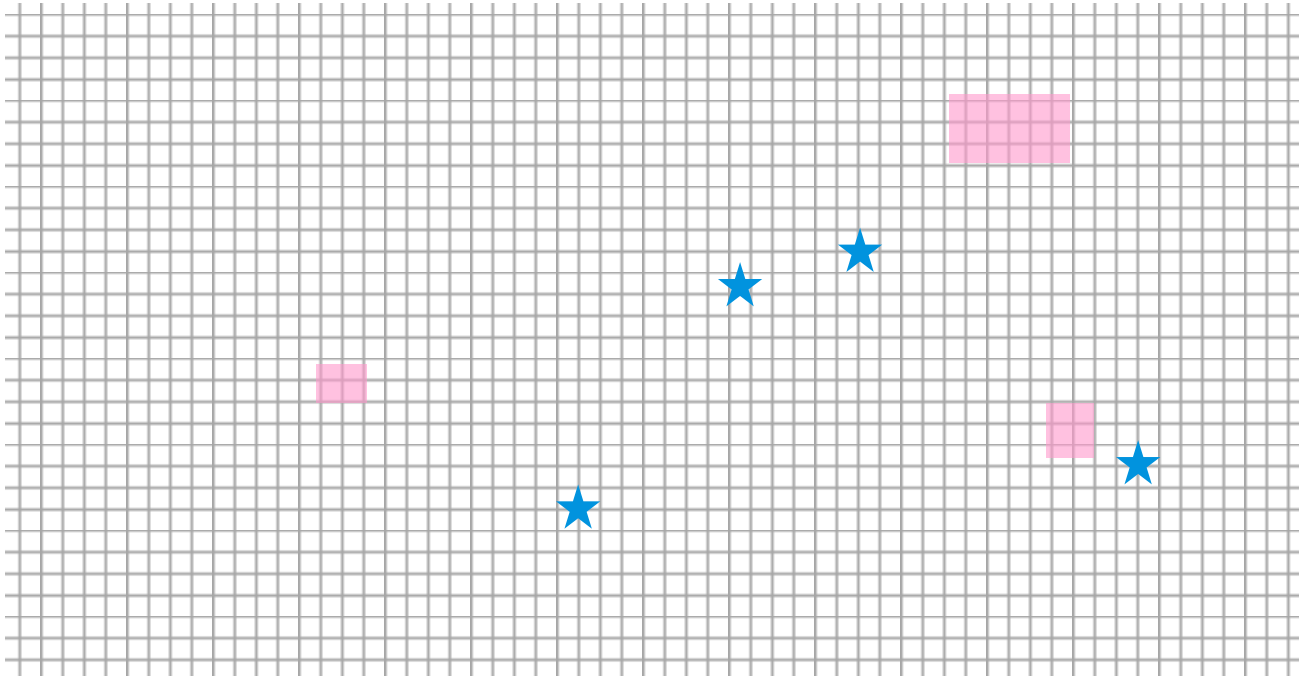
Map of crystals on EMC



- Distance cut (Emc12Cut) will not effect on the number of charged candidates, only change the correlations and the EmcQ of charged candi..

Neutral Particle Correlation

Map of crystals on EMC

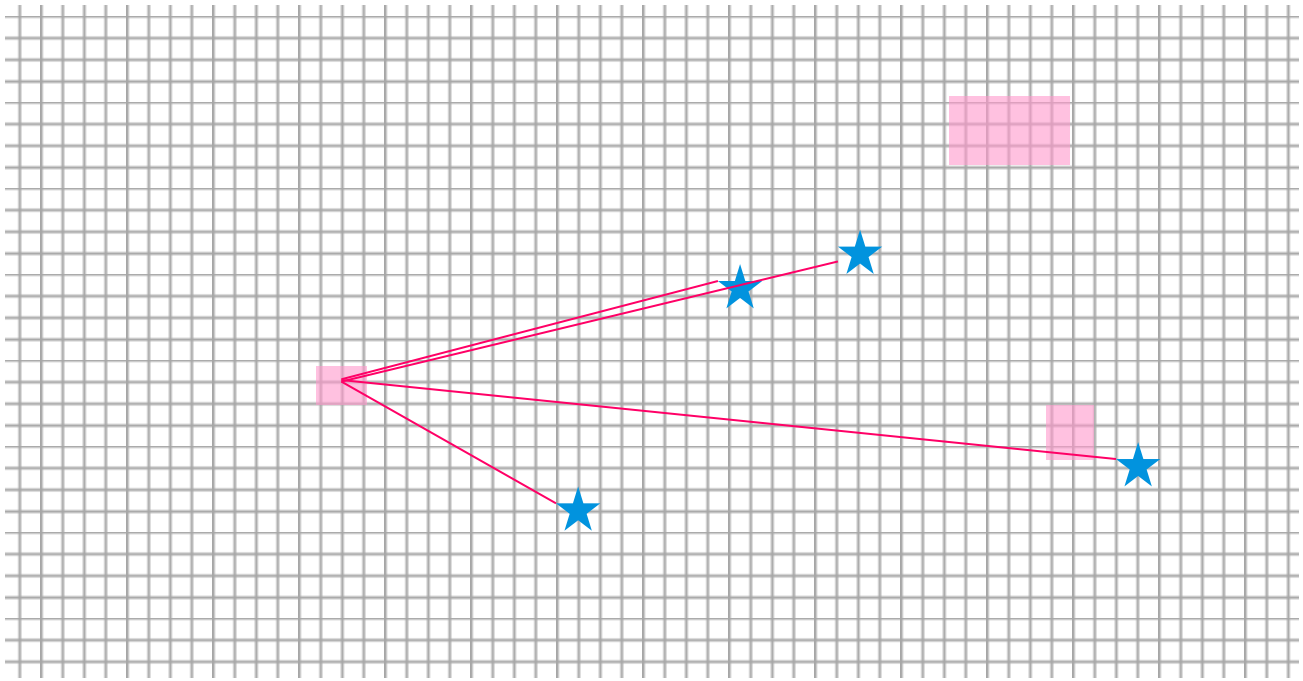


extrapolation of track

EMC cluster

Neutral Particle Correlation

Map of crystals on EMC

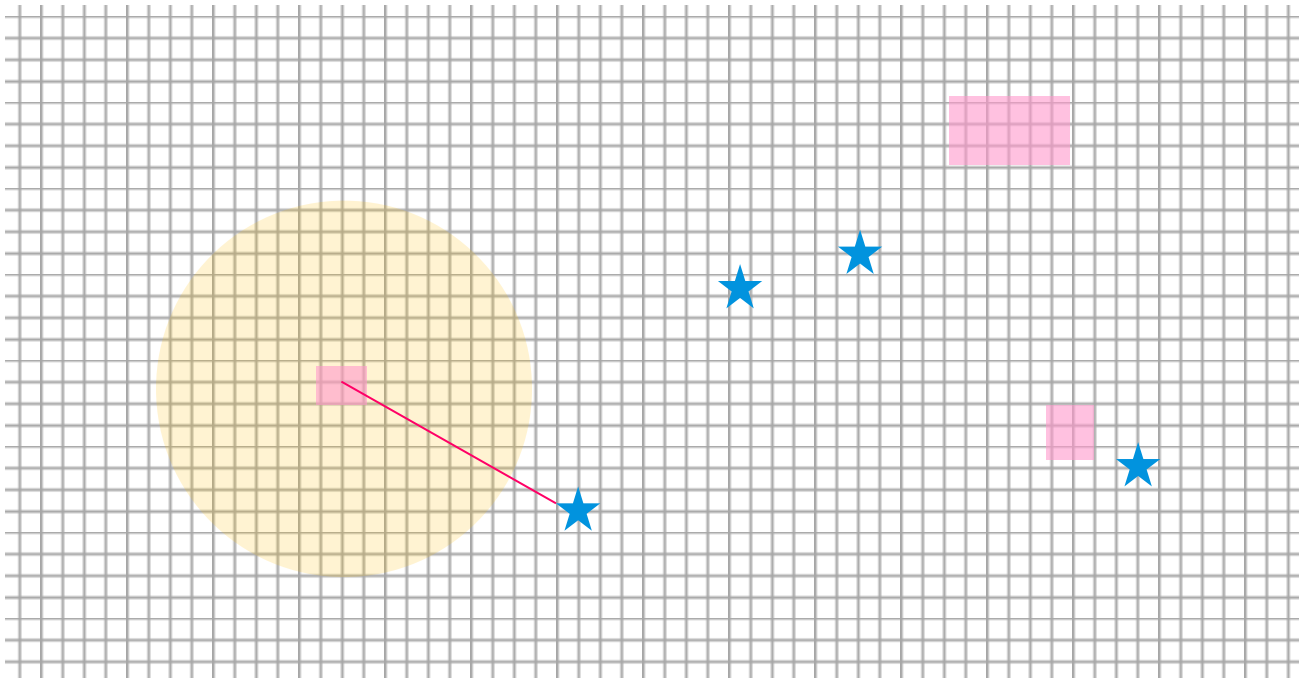


extrapolation of track

EMC cluster

Neutral Particle Correlation

Map of crystals on EMC



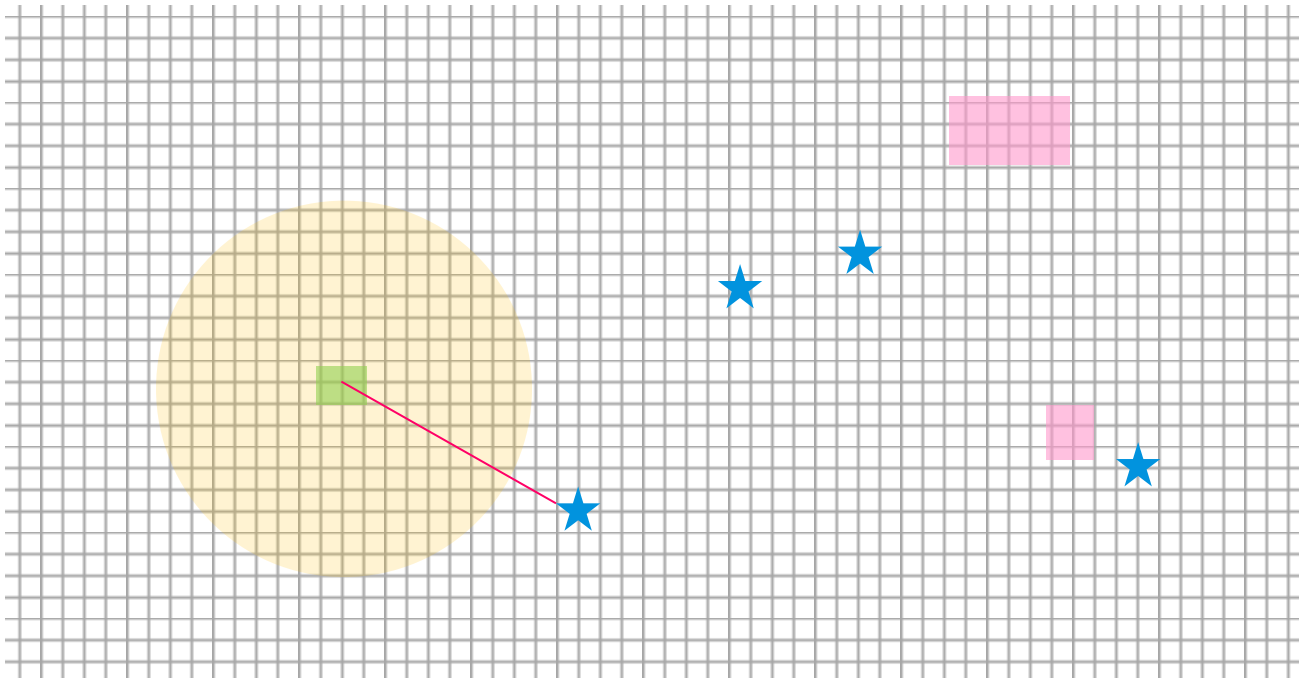
extrapolation of track

EMC cluster

distance cut

Neutral Particle Correlation

Map of crystals on EMC



extrapolation of track

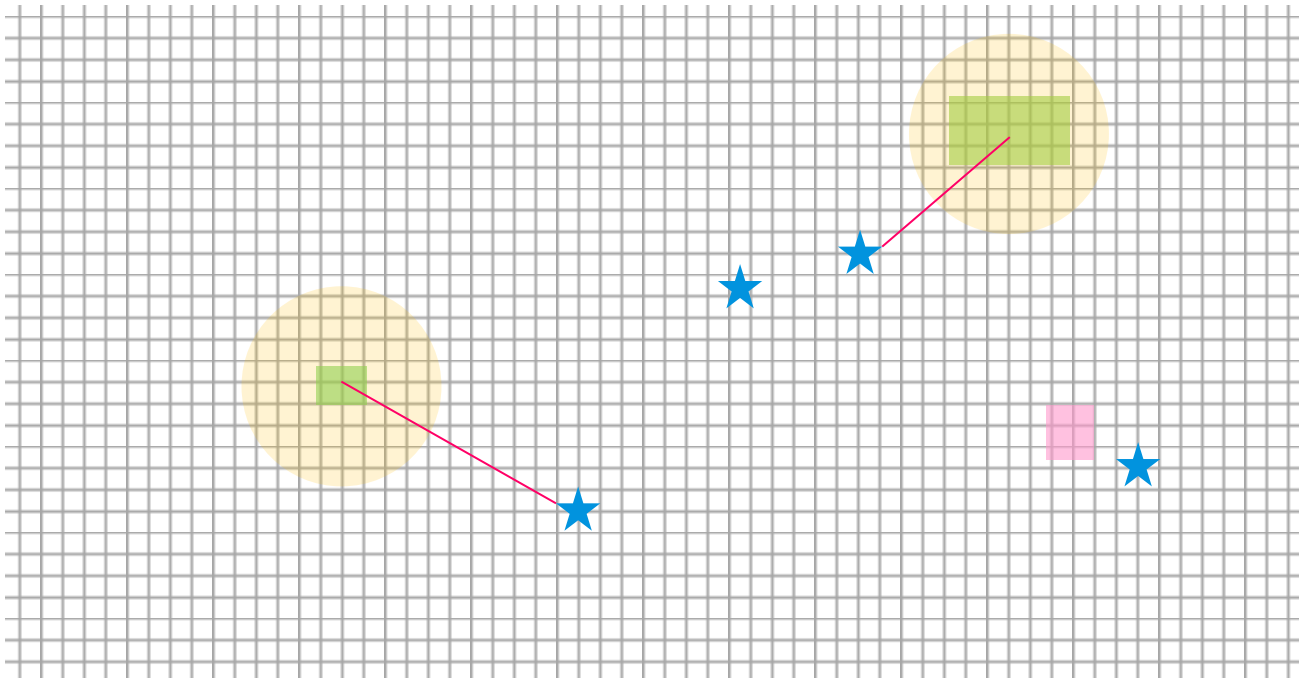
EMC cluster

distance cut

neutral cand.

Neutral Particle Correlation

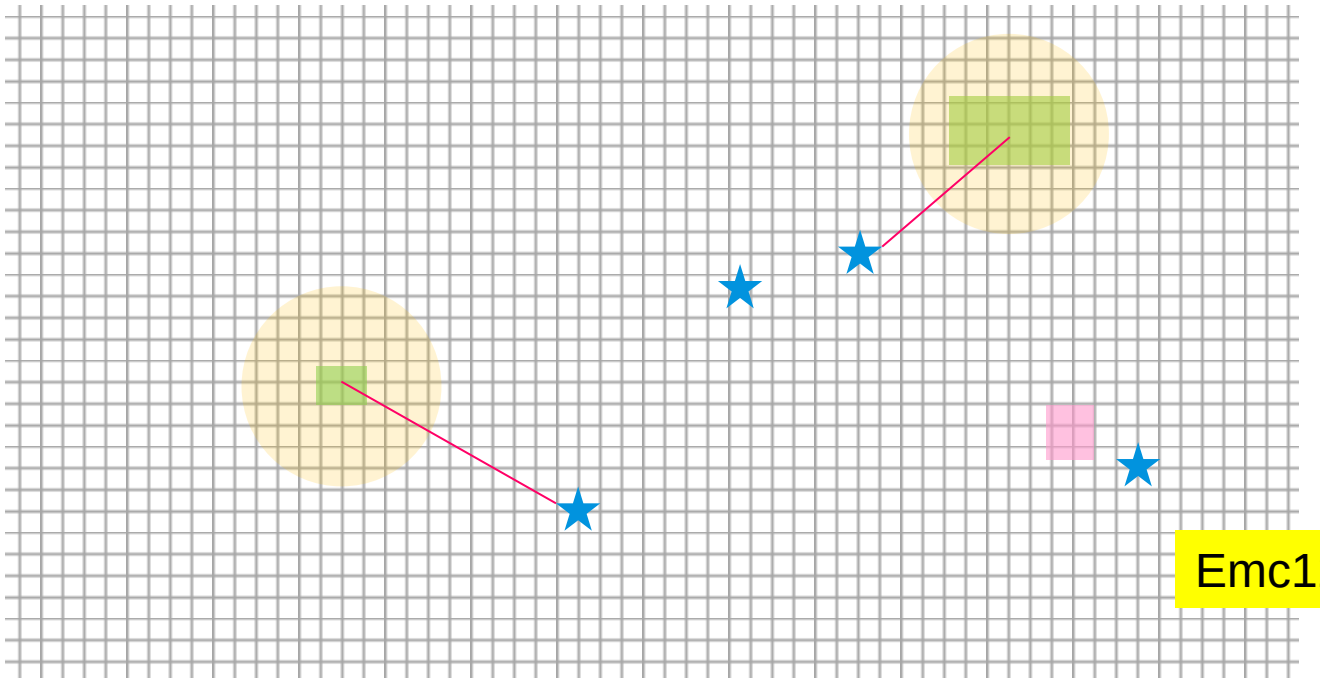
Map of crystals on EMC



- Distance cut (Emc12NeutralQCut) will decide the number of neutral candidates.

Neutral Particle Correlation

Map of crystals on EMC



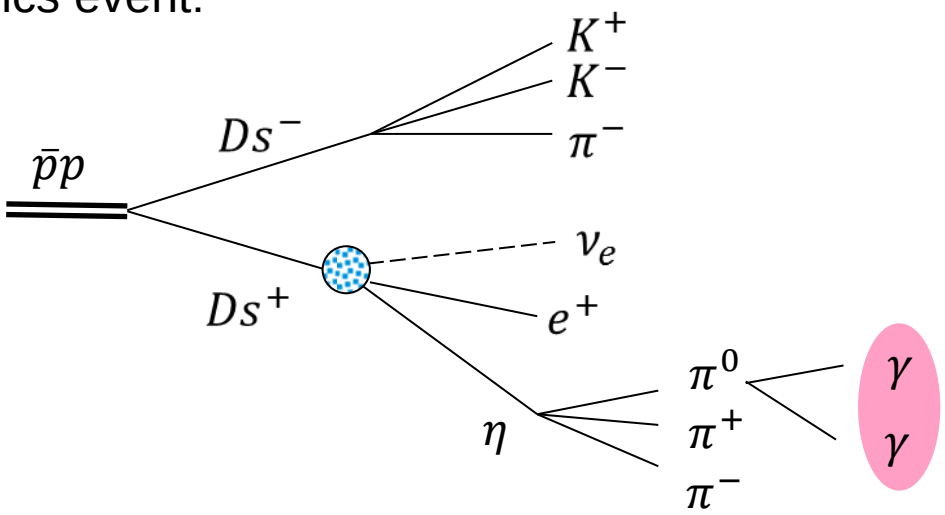
Emc12NeutralQCut = 400

- Distance cut (Emc12NeutralQCut) will decide the number of neutral candidates.

Neutral Candidate Multiplicity

oct14 #26514

- In physics event:

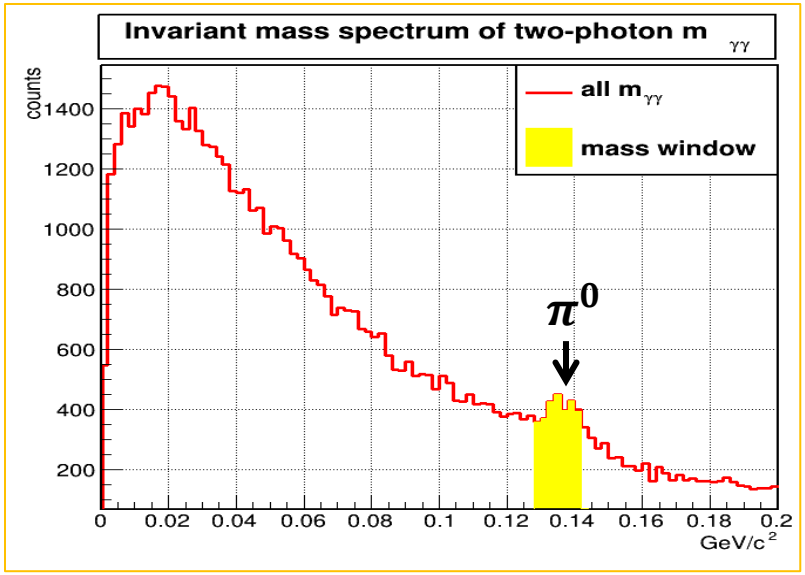


$P_{beam} = 8.0\ GeV/c$

- In single photon event:

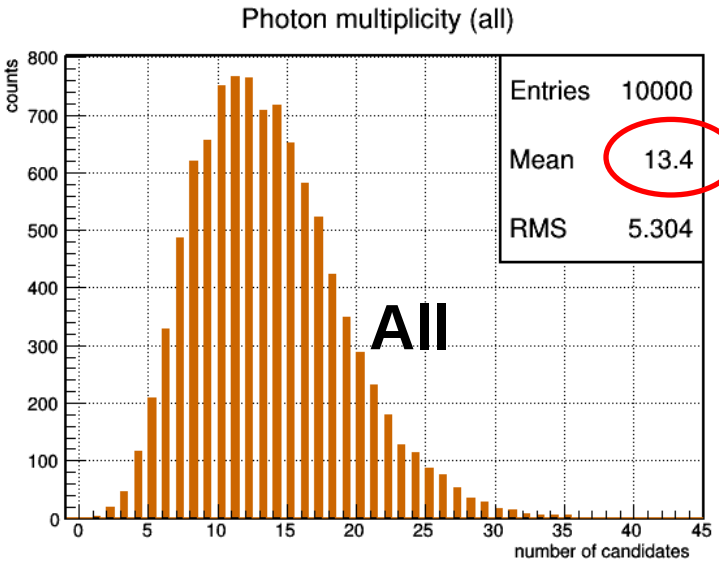
Box Generator:
momentum range (0.5, 4) GeV/c; full range of theta & phi

- In physics event:

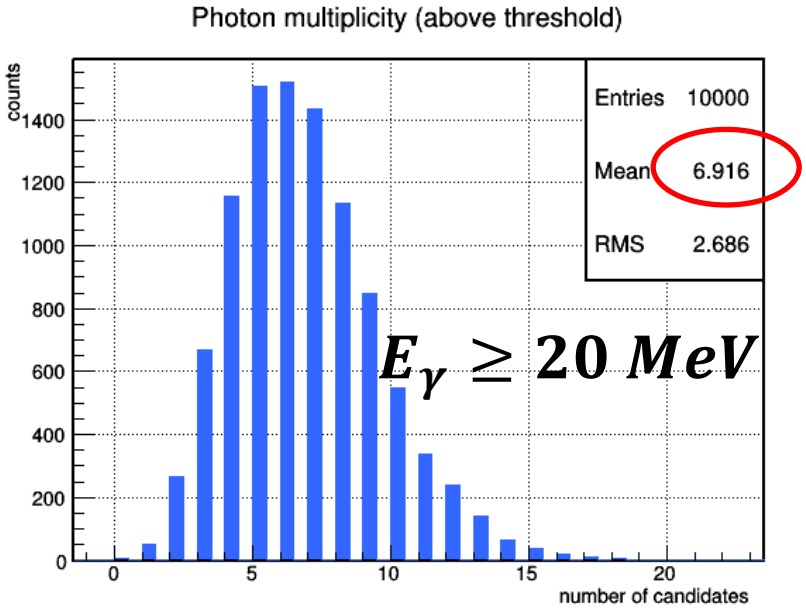


oct14 #26514

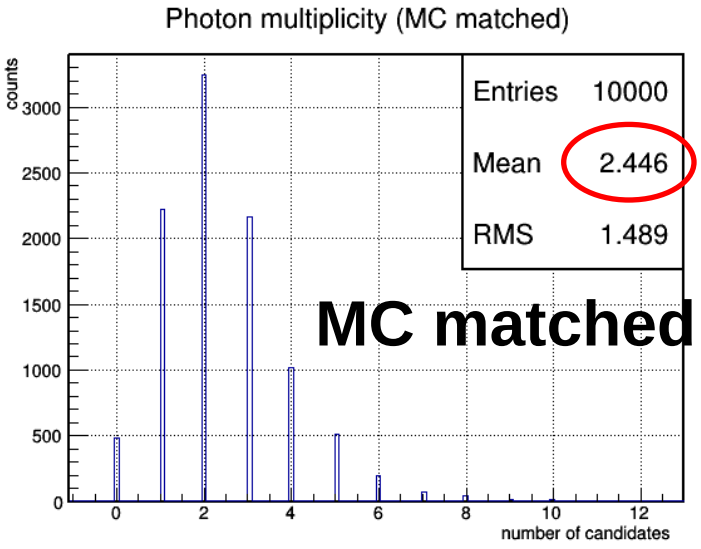
in Sep. #25800



in Sep. 24.91



8.89



2.99

Neutral Candidate Multiplicity

oct14 #26514

- In single photon event:

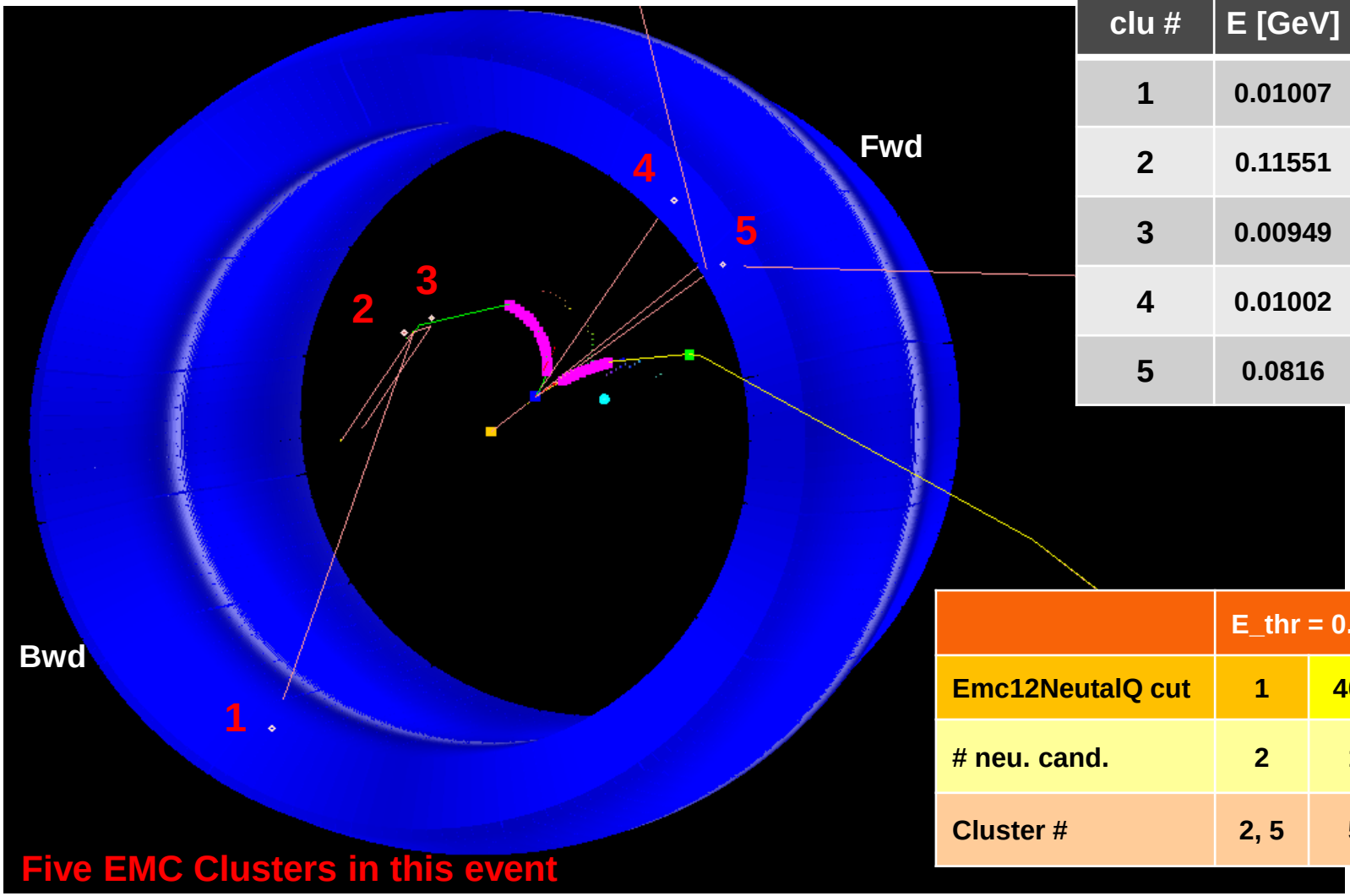
Box Generator: 100 evt
momentum range (0.5, 4) GeV/c; full range of theta & phi

Energy threshold = 20 MeV

tot. charged candi. = 15

Dist. cut	1	5	10	15	20	25	30	35	40
w/o thr.	223	223	219	214	212	209	207	206	204
w. thr.	98	98	97	94	93	91	90	90	90

Single Photon in Event Display



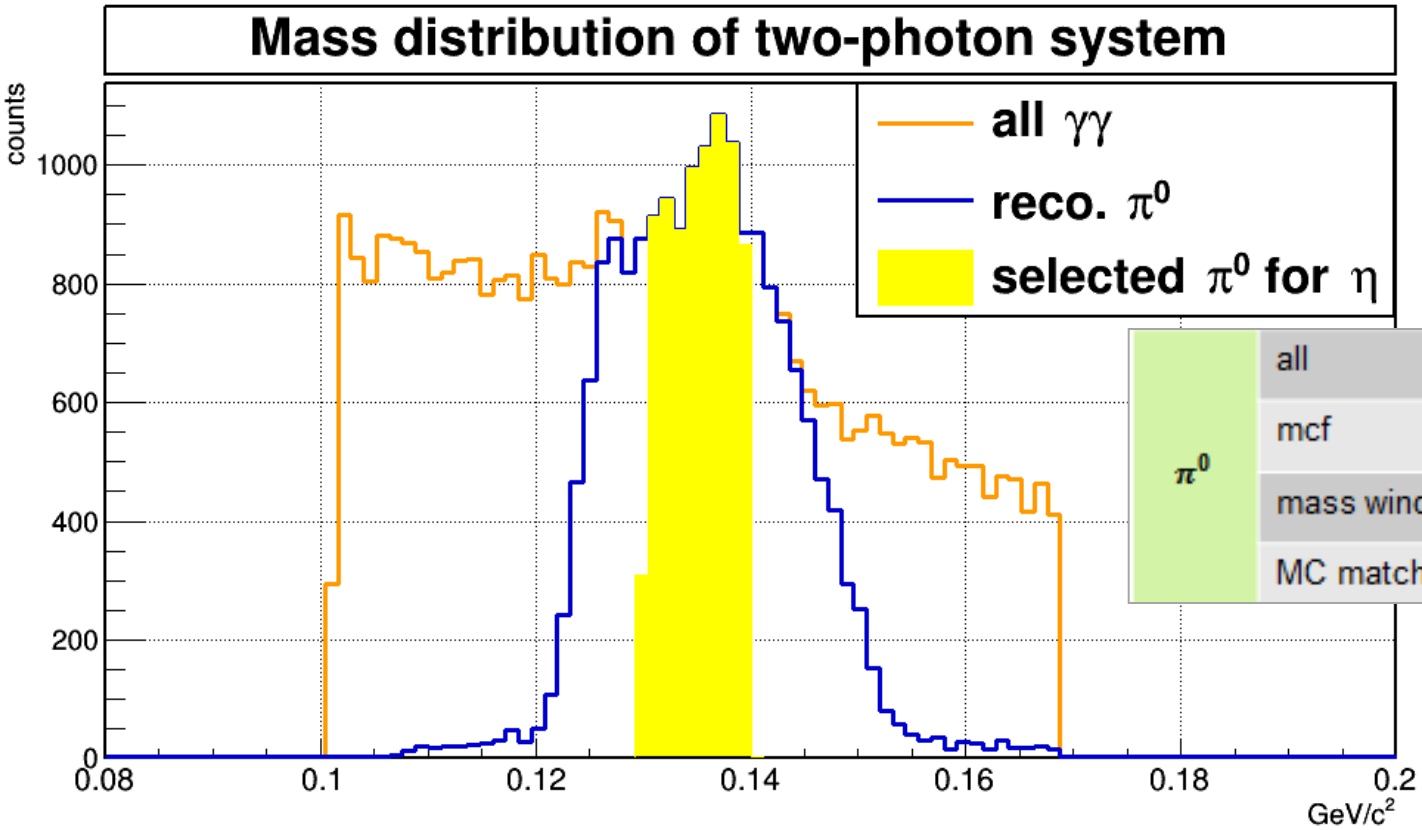
clu #	E [GeV]	Q [cm^2]
1	0.01007	> 10^6
2	0.11551	312.39
3	0.00949	908.35
4	0.01002	1586.37
5	0.0816	1884.61

	E_thr = 0.02 GeV		
Emc12NeutalQ cut	1	400	2000
# neu. cand.	2	1	0
Cluster #	2, 5	5	-

Neutral Candidate Multiplicity

- In physics event:

- 10k evt
- pandaroot oct14
- $E_\gamma \geq 20MeV$
- EmcQ cut : 400



π^0	all	44285	
	mcf	19806	
	mass window	8509	85%
	MC matched	2756	

Summary

- Neutral PID correlation is independent from the charged now
- Algorithm (oct14 #26514) is checked with event display
- Energy threshold for photon is necessary (e.g. Emc12Thr: 20 MeV)

- Understand high photon multiplicity in physics event
- Modify present algorithm/parameters if possible

Picture cited from internet

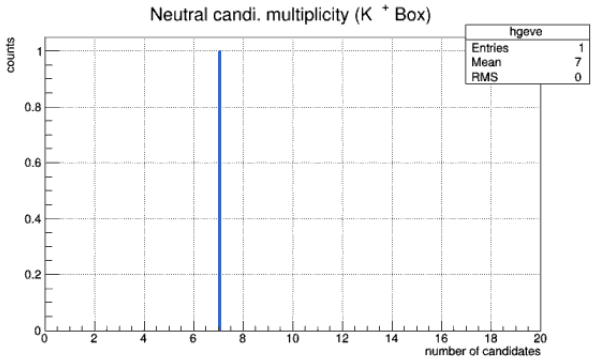
Thank you

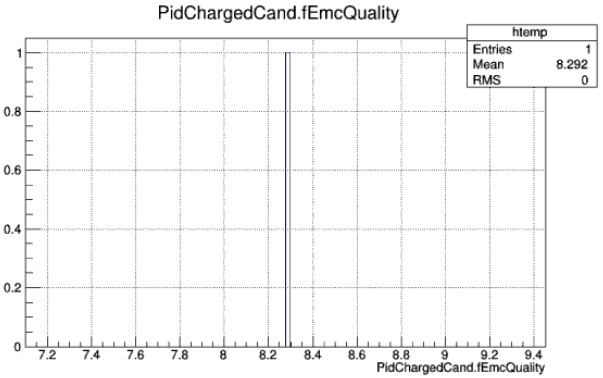
l.cao@fz-juelich.de

Backup Slides

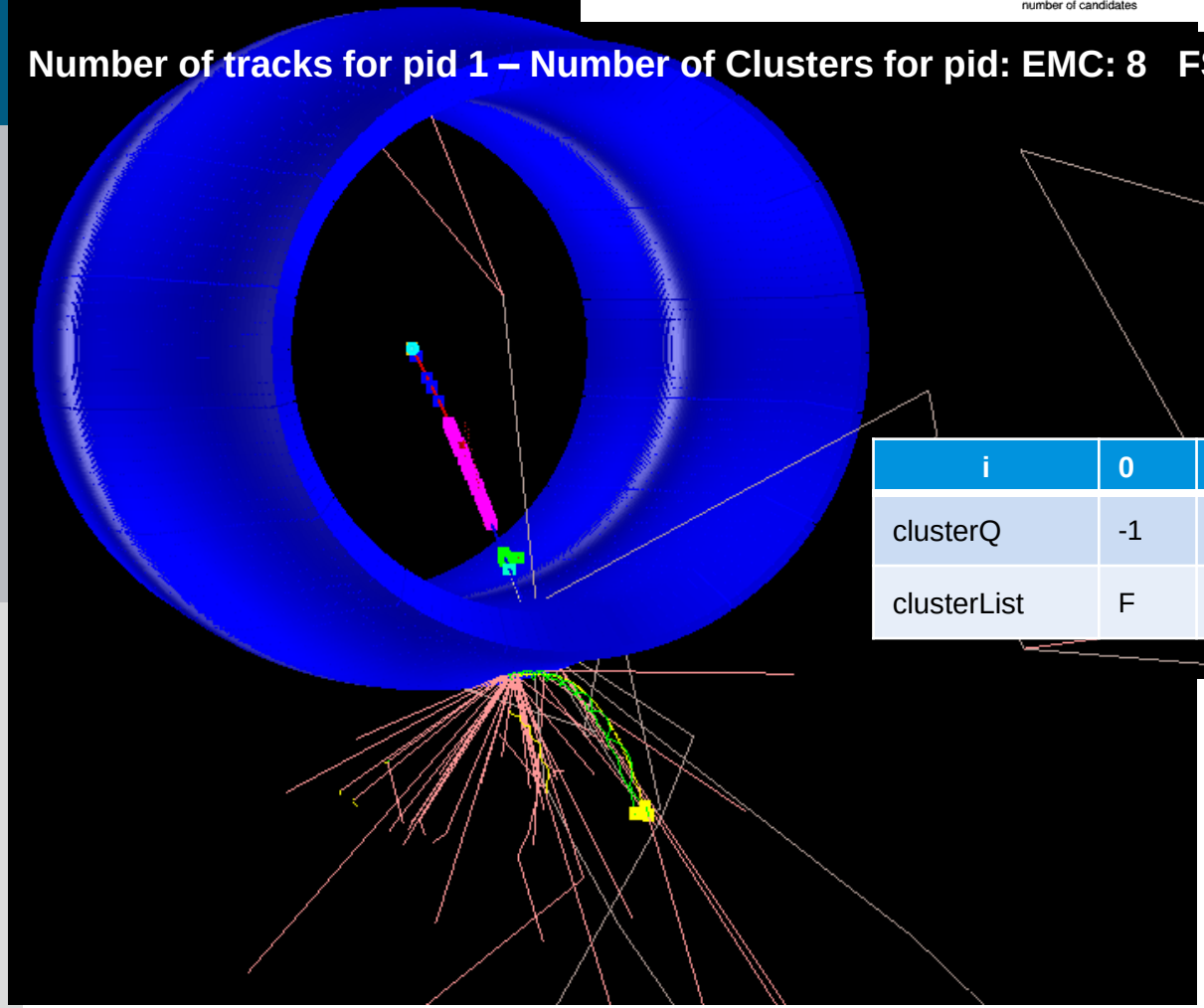
Single event K+

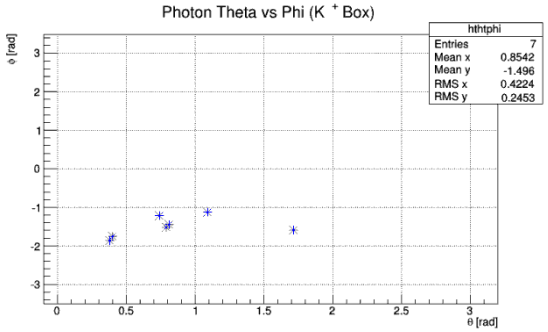
G3



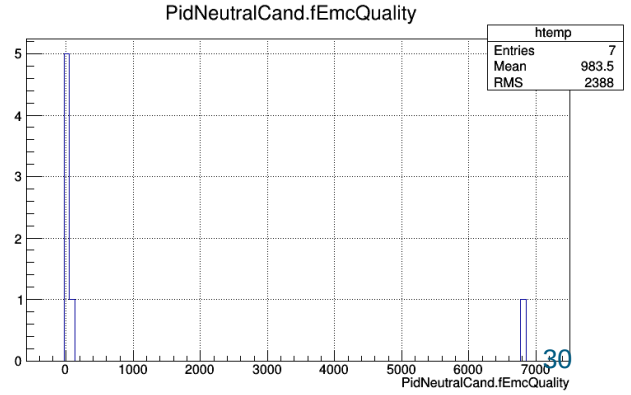


Number of tracks for pid 1 – Number of Clusters for pid: EMC: 8 FSC: 0

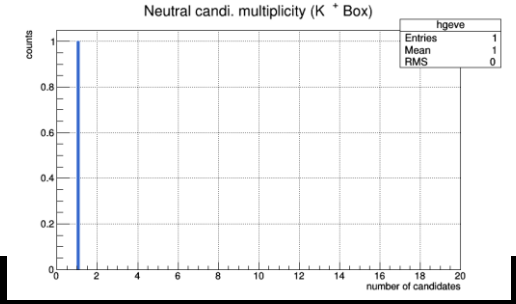




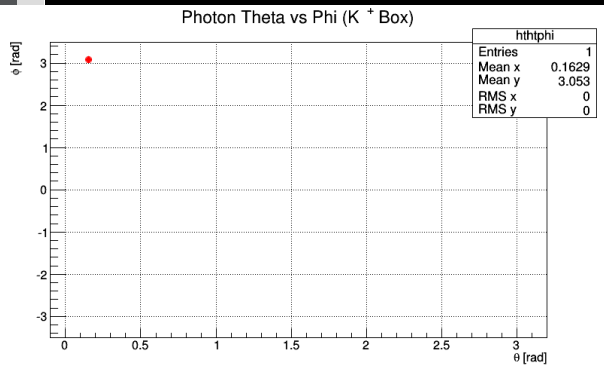
i	0	1	2	3	4	5	6	7
clusterQ	-1	56.63	-1	8.29	-1	-1	6832	-1
clusterList	F	F	F	T	F	F	F	F

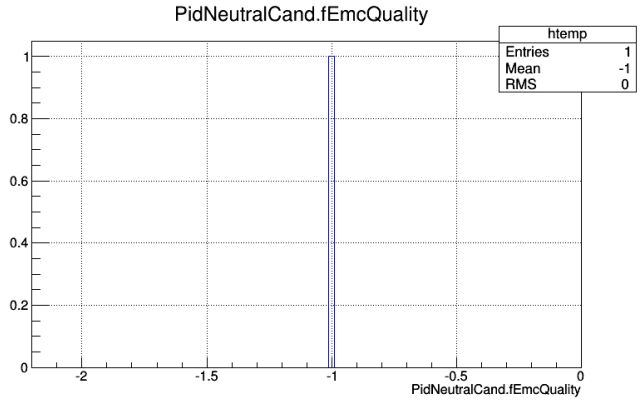


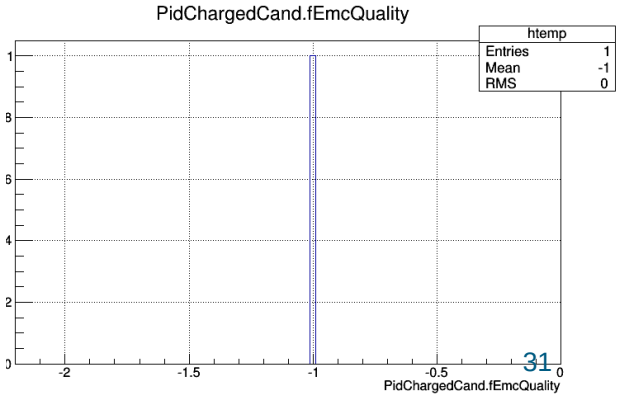
G4



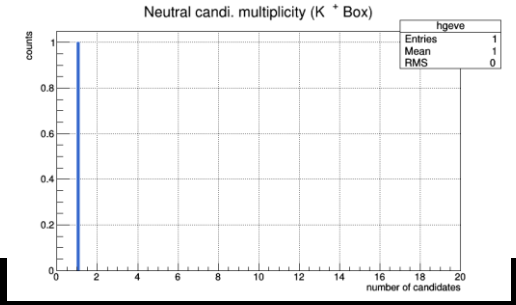
Number of tracks for pid 1 – Number of Clusters for pid: EMC: 0 FSC: 1



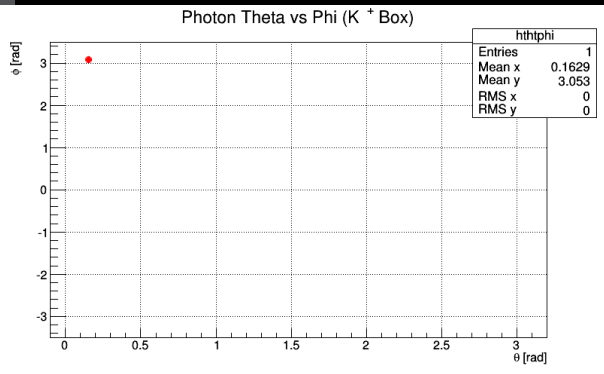


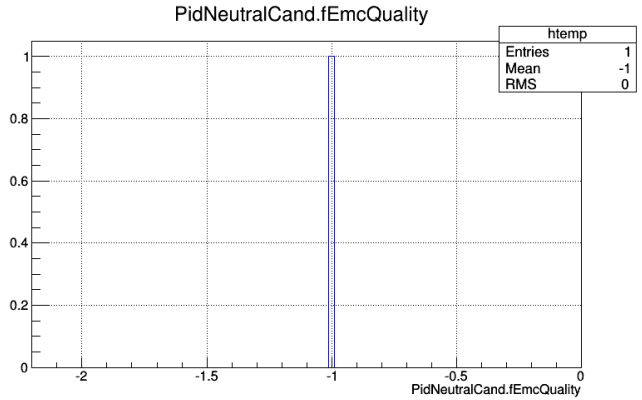


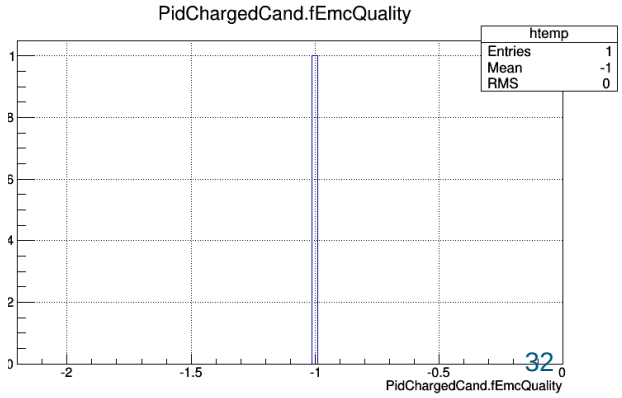
G4



Number of tracks for pid 1 – Number of Clusters for pid: EMC: 0 FSC: 1







Results of Efficiency & Resolution

E_gamma>=20 MeV		entries	~ %
e^+		7705	**77%**
D_s^-	all	3207	
	vtx	2297	
	mcf	1631	**17%**
η	$\pi^+\pi^-$ all	11399	
	$\pi^+\pi^-$ vtx	8139	
	eta all	2111	
	eta mcf	1116	**11%**
π^0	all	**44285**	
	mcf	19806	
	mass window	8509	85%
	MC matched	**2756**	
$(e^+\nu_e)$	w/o cut	209	**2%**
	w. cut	93	**0.93%**

E_gamma>=30 MeV		entries	~ %
e^+		7705	**77%**
D_s^-	all	3207	
	vtx	2297	
	mcf	1631	**17%**
η	$\pi^+\pi^-$ all	11399	
	$\pi^+\pi^-$ vtx	8139	
	eta all	2011	
	eta mcf	1070	**11%**
π^0	all	**41625**	
	mcf	18630	
	mass window	8070	81%
	MC matched	**2657**	
$(e^+\nu_e)$	w/o cut	202	**2%**
	w. cut	89	**0.89%**

Full sim with oct14: 10k evt

Results of Efficiency & Resolution

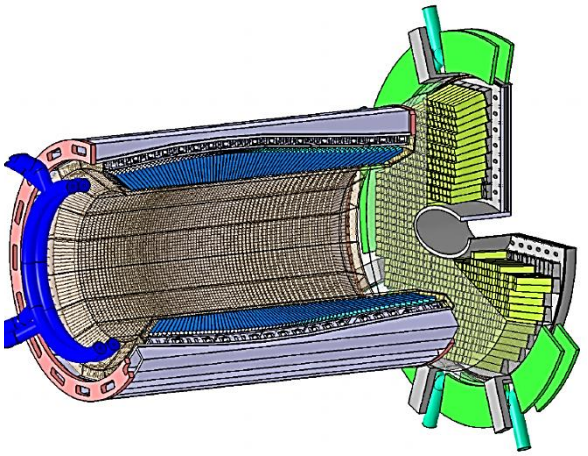
Full sim : 10k evt

E_γ threshold [MeV]		Mass resolution (vtx) [MeV/c^2]	Vertex resolution [μm]			Momentum resolution [%]	
			X	Y	Z	Pt	Pz
30	η	8.4	285	303	917	2.2	1.7
20	η	8.4	287	296	909	2.2	1.7

- $E_\gamma > 20$ MeV is approved with present results
- Performances with Geant3 and Geant4 are also compared:
  Similar efficiency, but better resolutions of mass and vertex with G4

Main requirements for EMC

	Required performance value		
Common properties			
energy resolution σ_E/E	$\leq 1\,\% \oplus \frac{\leq 2\,\%}{\sqrt{E/\mathrm{GeV}}}$		
energy threshold (photons) E_{thres}	10 MeV (20 MeV tolerable)		
energy threshold (single crystal) E_{xtl}	3 MeV		
rms noise (energy equiv.) $\sigma_{E,noise}$	1 MeV		
angular coverage $\%\,4\pi$	99 %		
mean-time-between-failures t_{mtbf} (for individual channel)	2000 y		
Subdetector specific properties	backward ($\geq 140°$)	barrel ($\geq 22°$)	forward ($\geq 5°$)
energy range from E_{thres} to	0.7 GeV	7.3 GeV	14.6 GeV
angular equivalent of crystal size θ	4°		1°
spatial resolution σ_θ	0.5°	0.3°	0.1°
maximum signal load f_γ ($E_\gamma > E_{xtl}$)	60 kHz		500 kHz
($p\bar{p}$-events) maximum signal load f_γ ($E_\gamma > E_{xtl}$)	100 kHz		500 kHz
(all events) shaping time t_s	400 ns		100 ns
radiation hardness (maximum annual dose $p\bar{p}$-events)	0.15 Gy	7 Gy	125 Gy
radiation hardness (maximum annual dose from all events)	10 Gy		125 Gy



Barrel and forward end-cap EMC

Reconstruction thresholds

- $E_{xtl} = 3\,\mathrm{MeV}$
- $E_{cl} = 10\,\mathrm{MeV}$
- $E_{max} = 20\,\mathrm{MeV}$

Dynamical Energy Range

- backward endcap EMC: 10(20) MeV- 0.7 GeV
- barrel EMC: 10(20) MeV- 7.3 GeV, and
- forward endcap EMC: 10(20) MeV- 14.6 GeV.