Studio della risoluzione in posizione del Calorimetro Elettromagnetico di ALICE

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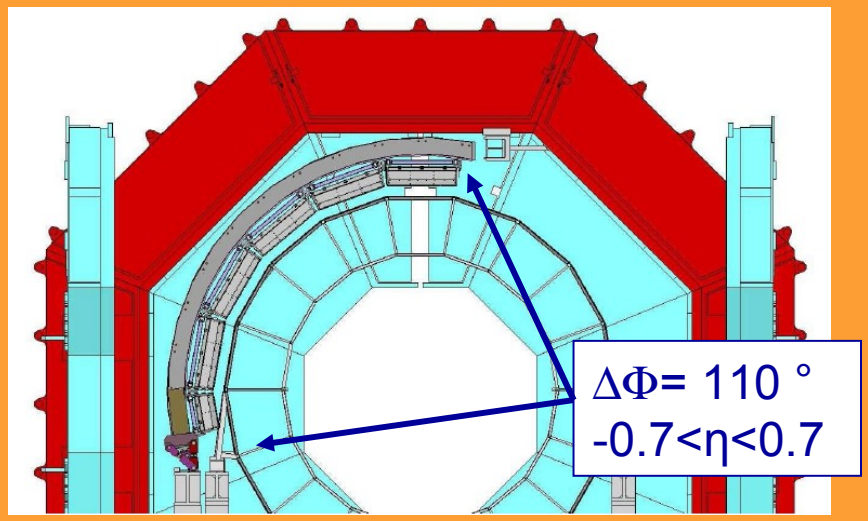
Sommario

- Descrizione EMCal
- Fisica e prestazioni
- Ricostruzione posizione
  - Metodo tradizionale
  - Metodo neurale

Il nuovo calorimetro EM di ALICE

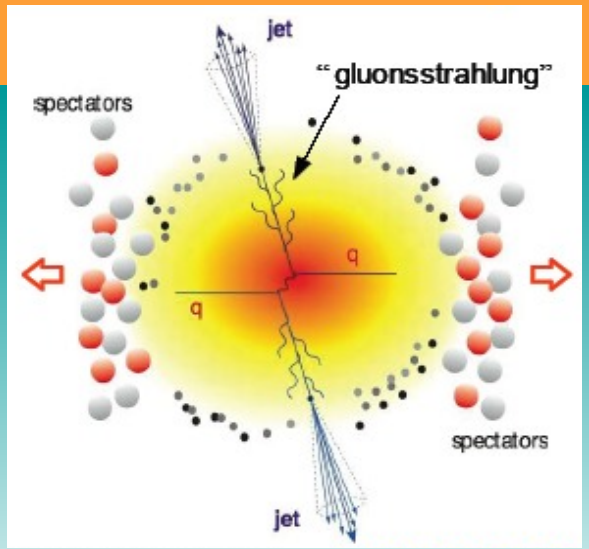


Integrazione in L3

- Fortemente influenzata dalla dislocazione degli altri rivelatori
- Parziale copertura back-to-back al calorimetro PHOS

Perché un nuovo calorimetro?

- Jet trigger
- Ricostruzione dei jet (40-200 GeV)
- Misure di fotoni diretti
- Identificazione di elettroni (heavy flavour)

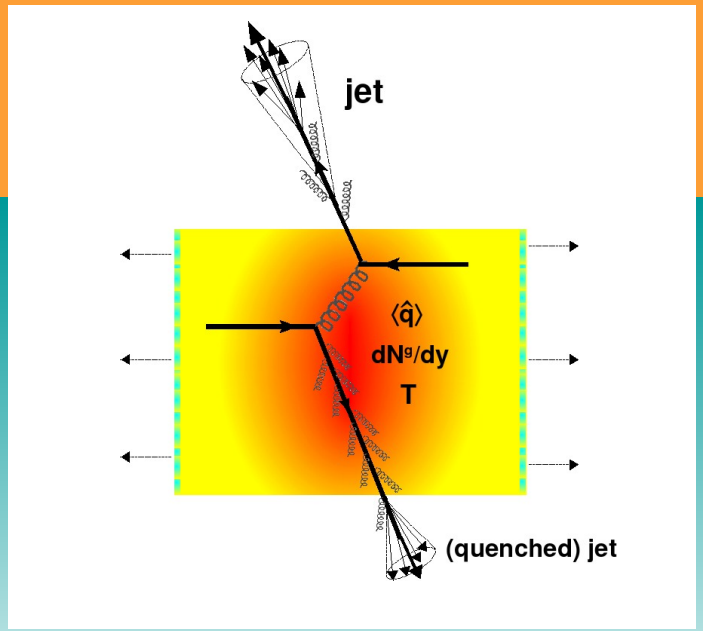


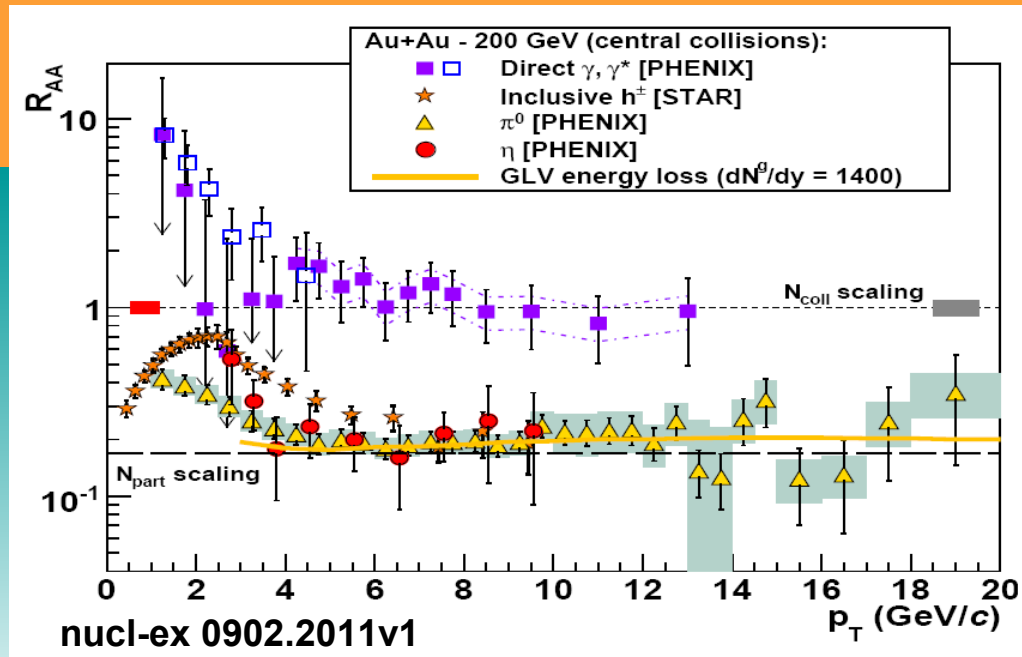
JET QUENCHING

Evidenze dal RHIC

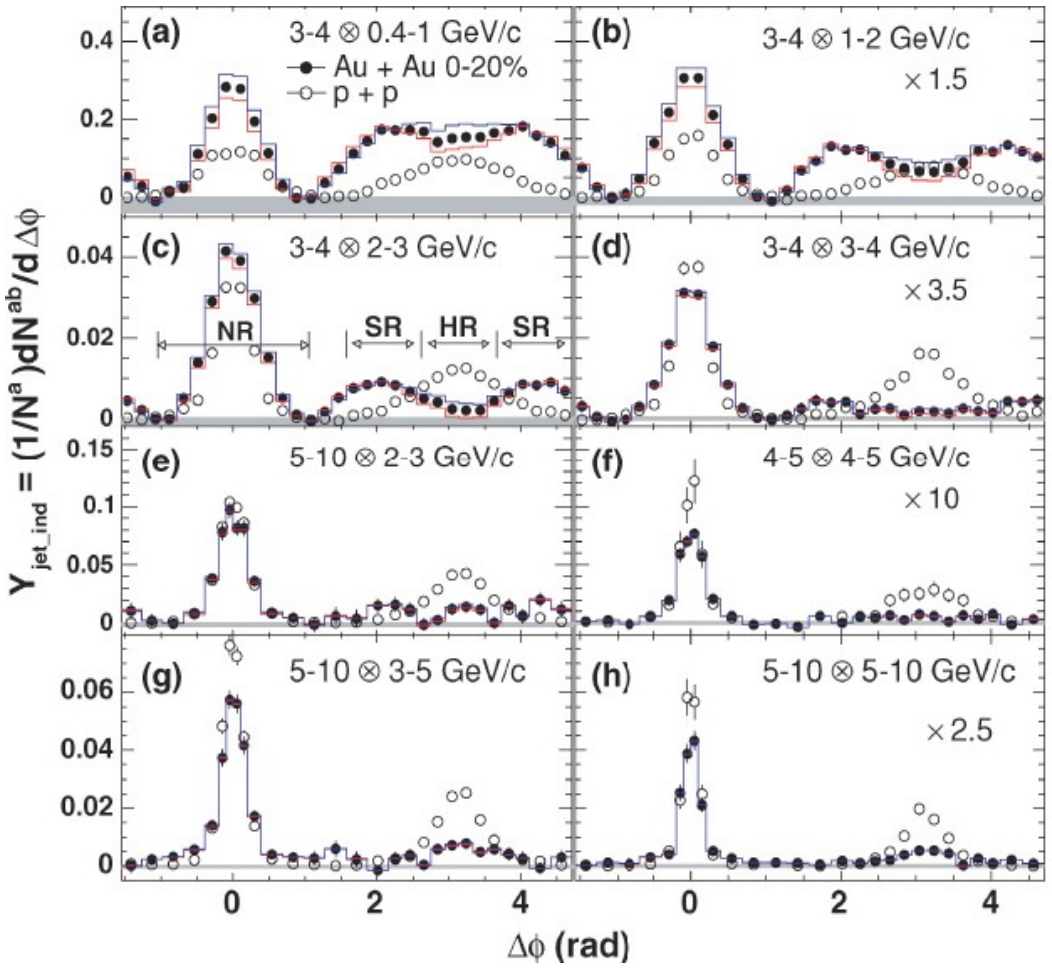
Nuclear Modification Factor

$$R_{AA} = \frac{d\sigma_{AA}/dyd^{2}p_T}{\langle N_{bin}\rangle d\sigma_{pp}/dyd^{2}p_T}$$





Correlazioni angolari



Phys. Rev. C 78, 014901 (2008)

Ricostruzione del jet

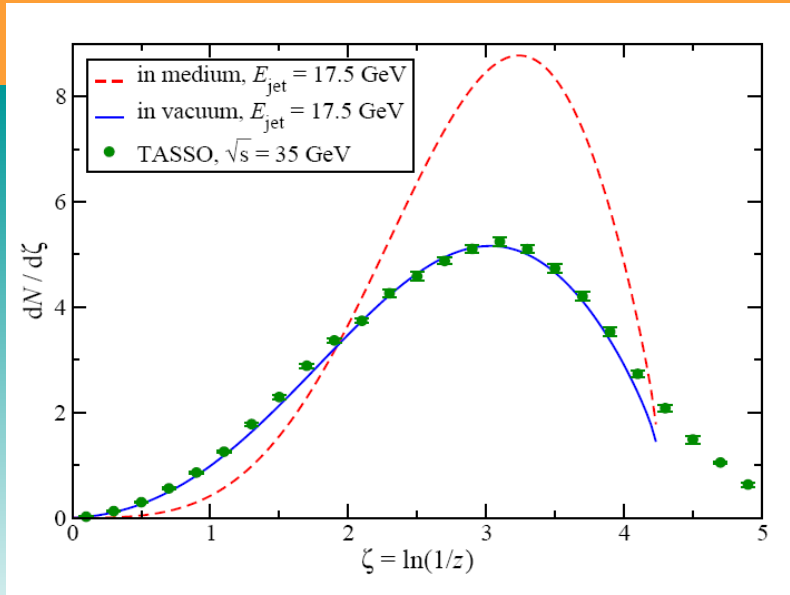
1) Jet spectra

$$R_{AA}^{jet}(p_T;R^{\max},\omega^{\min}) = \frac{dN^{AA}(p_T;R^{\max},\omega^{\min})/dydp_T^2}{\langle T_{AA}\rangle\, d\sigma^{pp}(p_T;R^{\max},\omega^{\min})/dydp_T^2}$$

2) Jet shapes

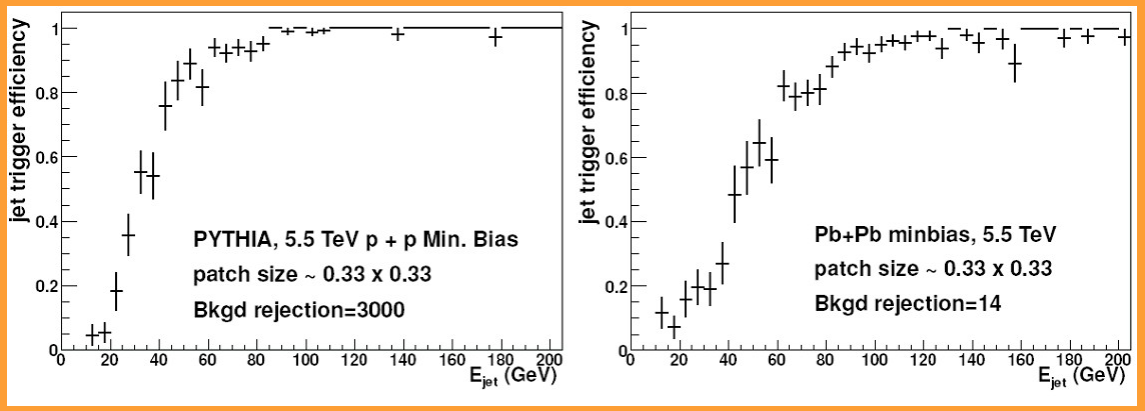
$$\Psi(r) = \frac{1}{N_{jet}}\sum_{jets}\frac{p_T(0,r)}{p_T(0,R)}, \quad 0 \le r \le R$$

3) Medium-modified fragmentation functions

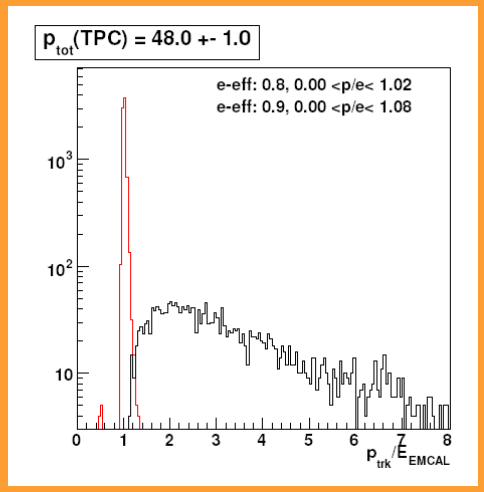


Le prestazioni dell'EMCal

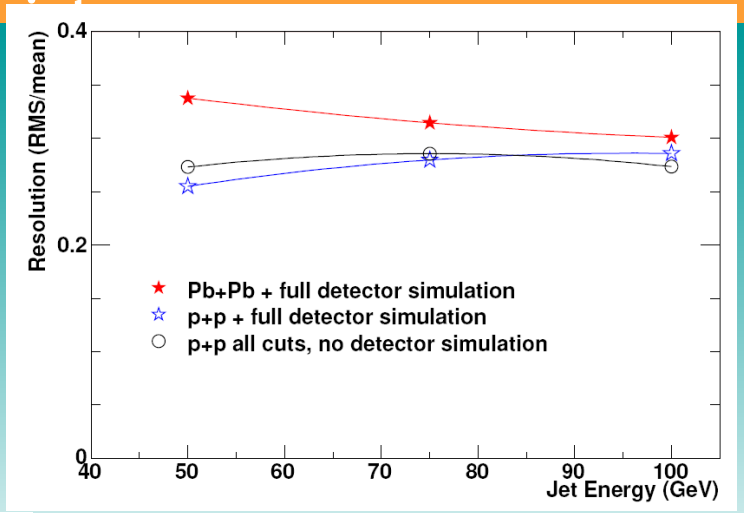
Jet Trigger



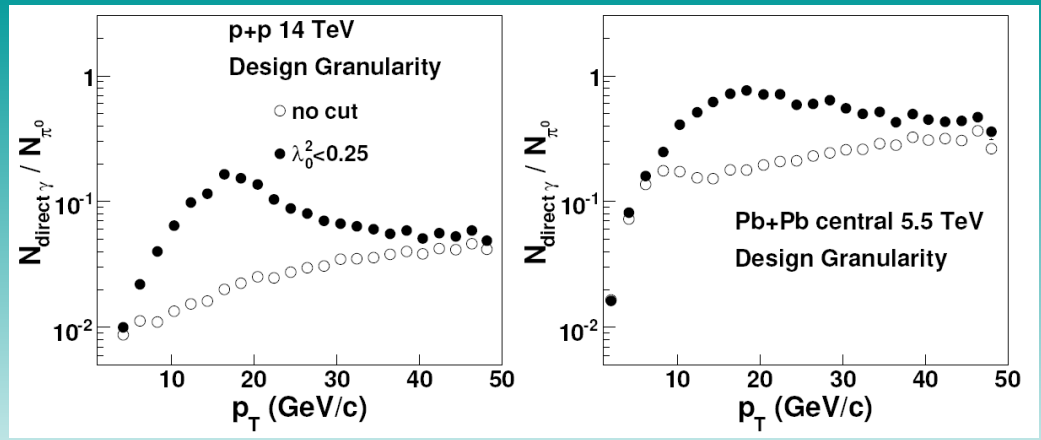
Discriminazione e^-/π^-



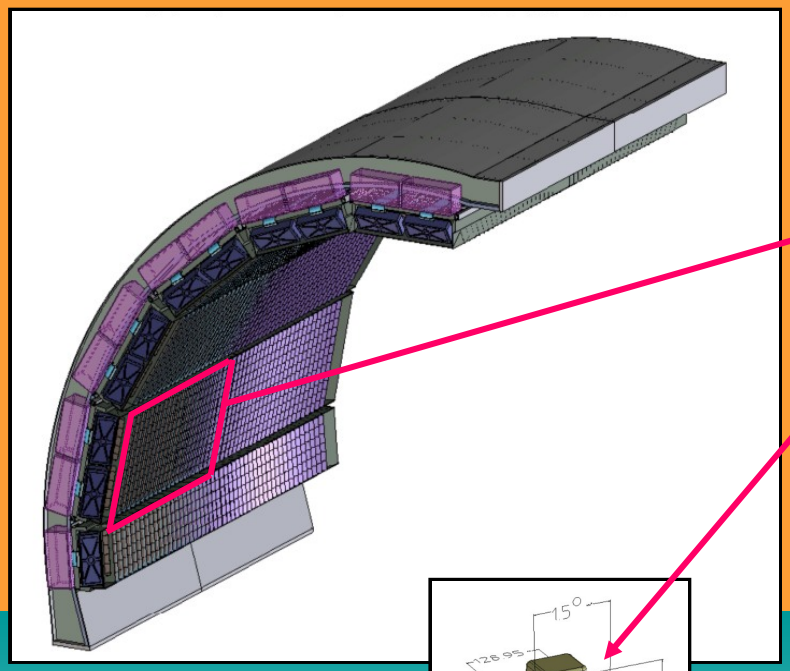
Ricostruzione energia

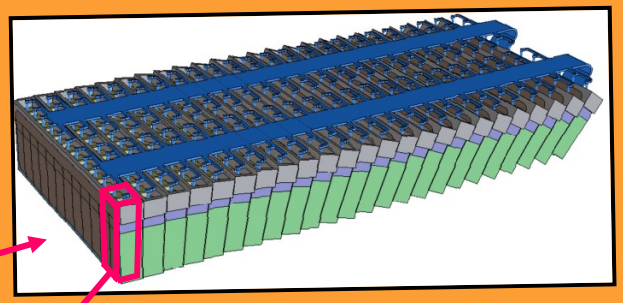


Discriminazione γ/π^0



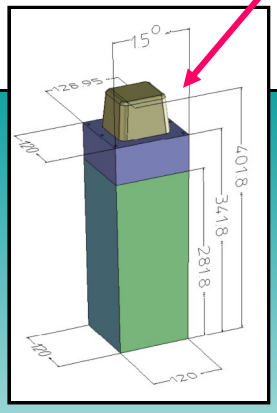
EMCal: il progetto





10 super moduli da
12 x 24 moduli

2 super moduli da
4 x 24 moduli



Modulo da

2 x 2 torri

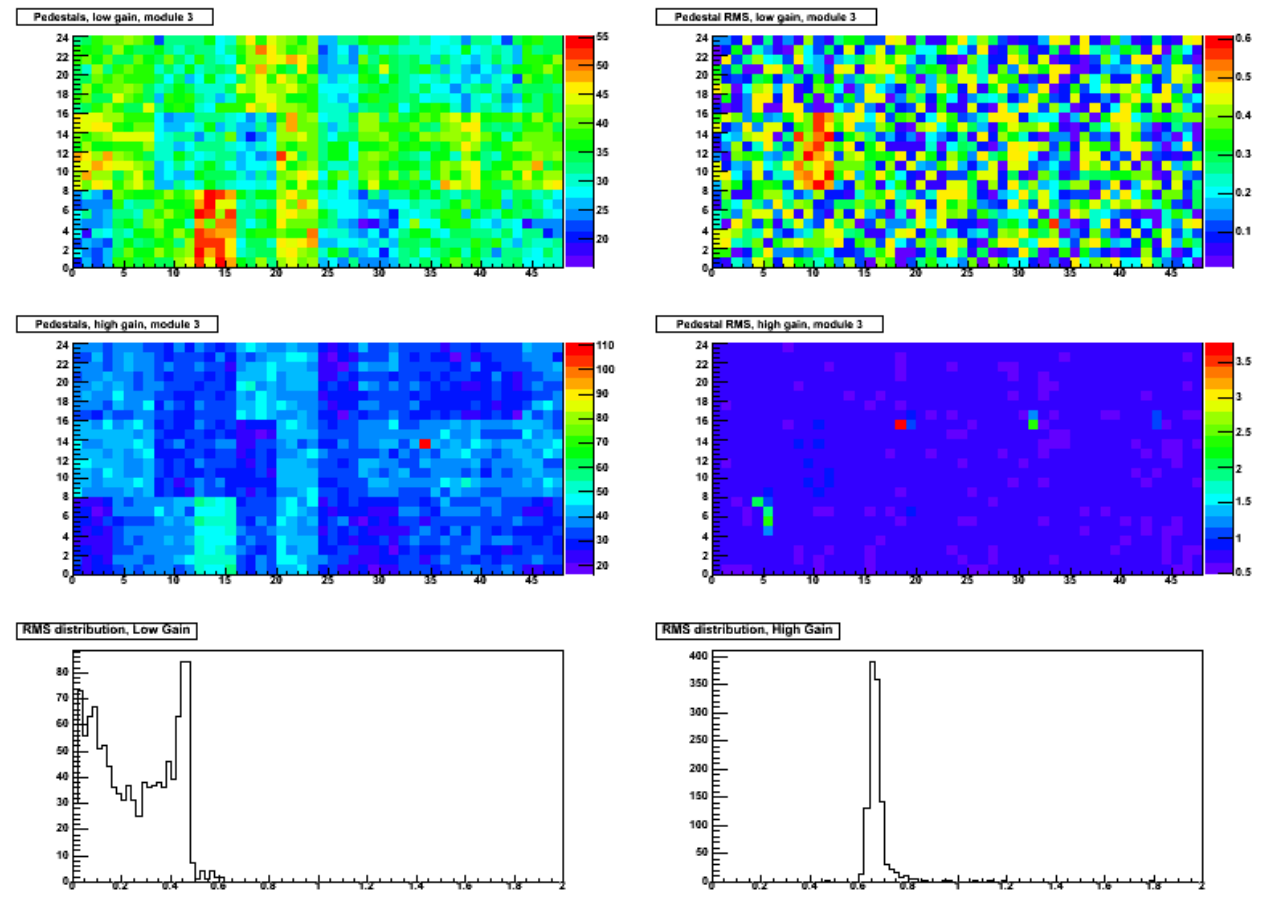
- Numero totale di torri 12288
- Installazione 4 SM entro Agosto 2009

Commissioning dell'EMCal /1

- Prime misure del pedestal al P2

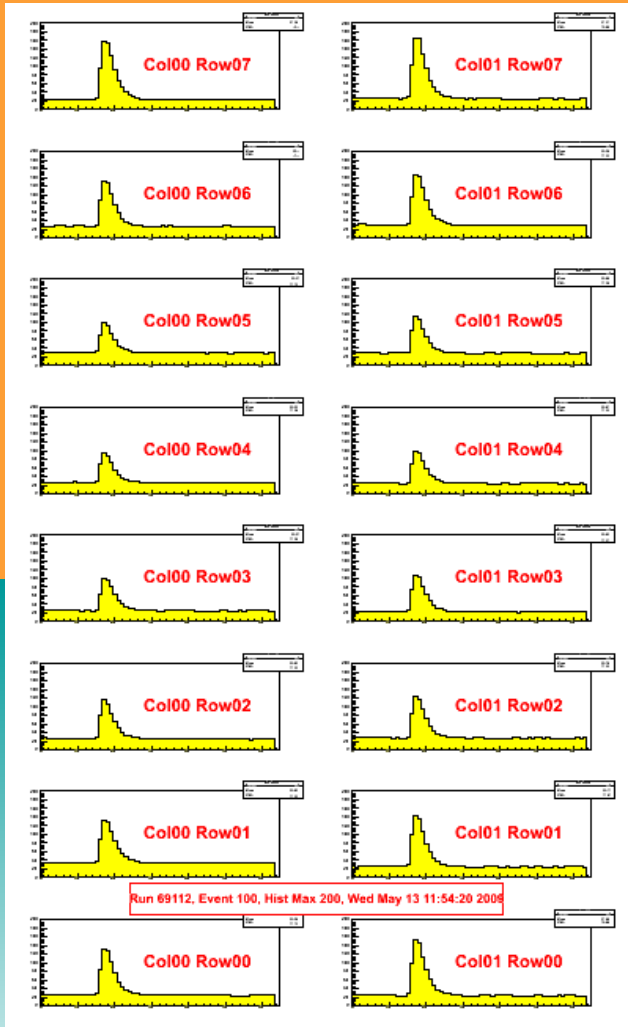
Low gain

High gain



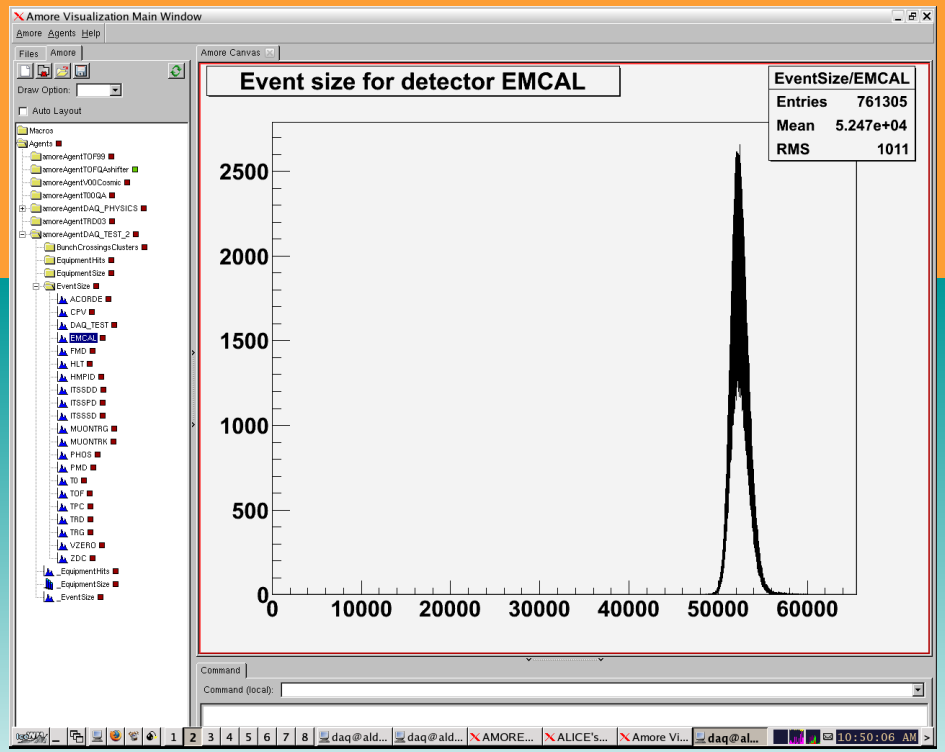
Commissioning dell'EMCal /2

- Prime misure con il LED al P2



Commissioning dell'EMCal /3

- Test in corso (DCS, online monitoring, TRU, busy box…)
- Integration test (Global partition)



Ricostruzione della posizione: metodo dei pesi log

Ricostruzione del punto d'impatto: $x_{REC} = \frac{\sum w_i x_i}{\sum w_i}$

- **Media lineare (linear weights):**

$$w_i = E_i / E_{TOT} \qquad E_{TOT} = \sum E_i$$

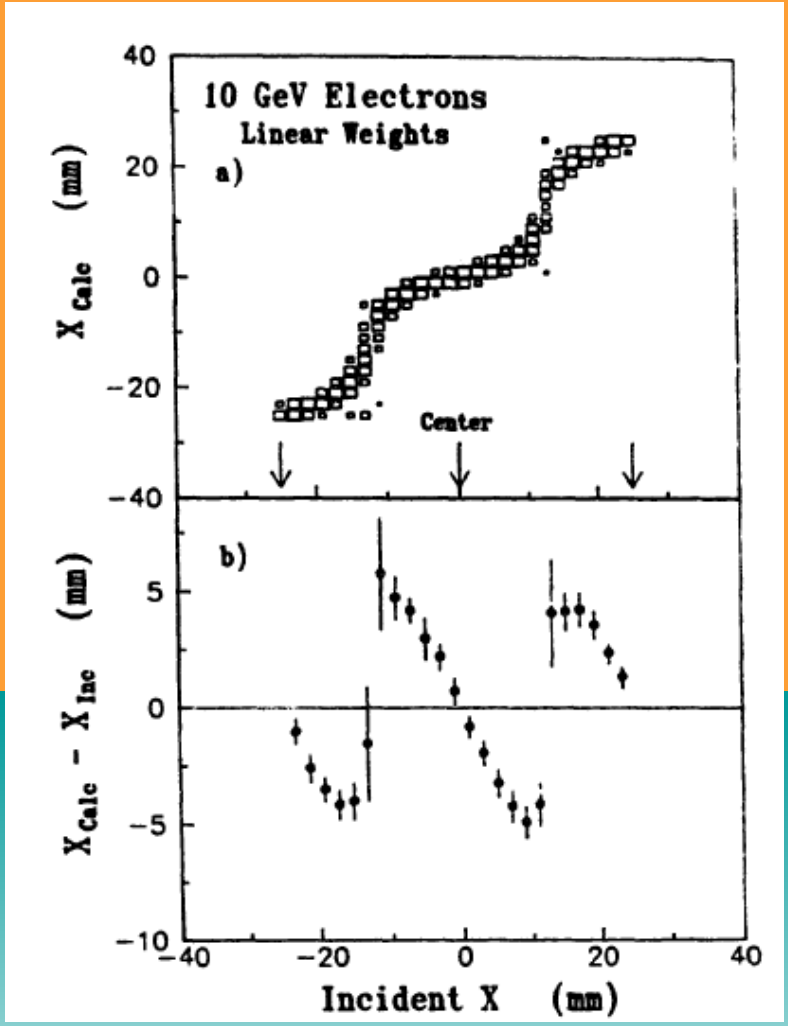
- **Media con pesi logaritmici (T.Awes et al.)**

$$w_i = \max\left\{0, \left[w_0 + \ln\left(\frac{E_i}{E_{TOT}} \right) \right] \right\}$$

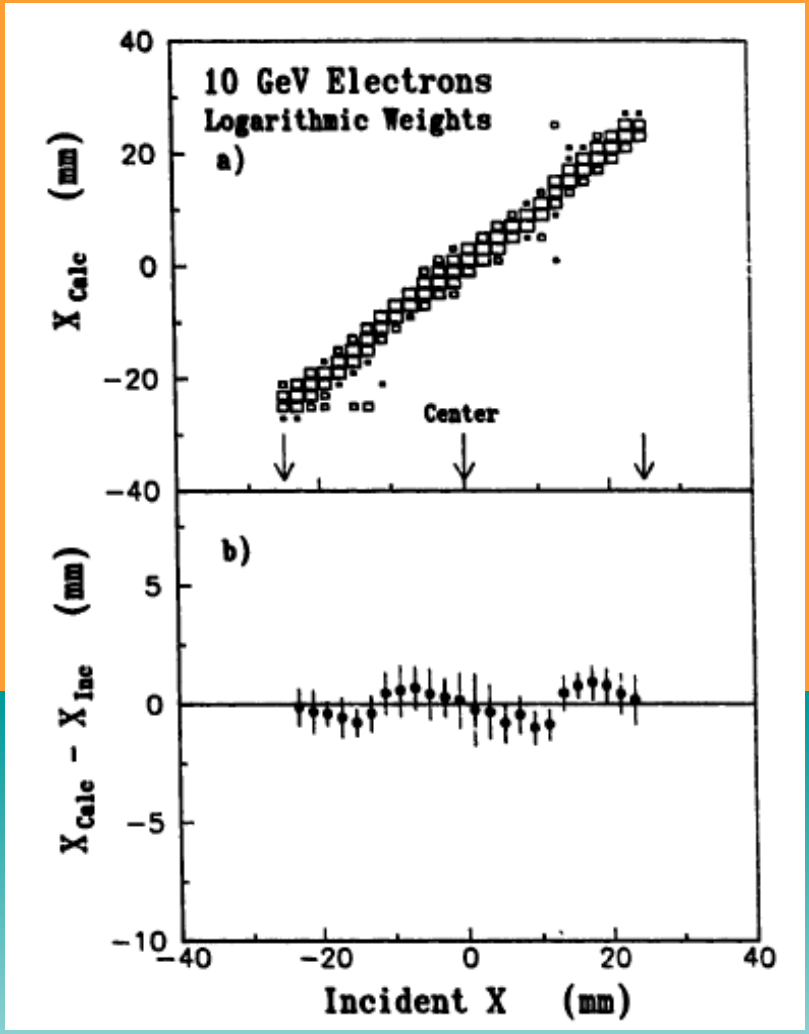
dove w_0 è un parametro da regolare

PER IL CALORIMETRO DI ALICE $w_0 = 4{,}5$

Pesi lineari



Pesi logaritmici



T.Awes et al., NIMA 311(1992)130

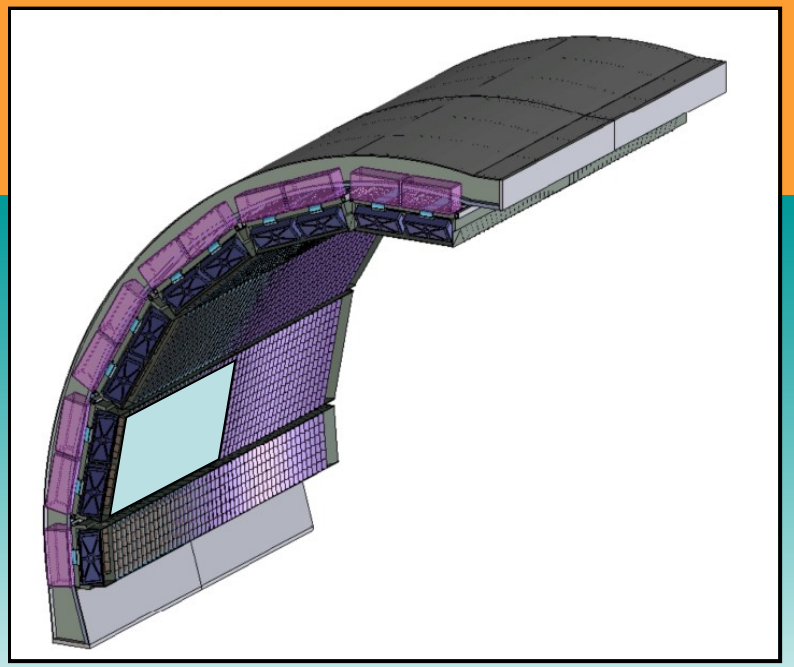
Aliroot v4-15-Rev-06

Studio su eventi “box” con un solo elettrone

($\Delta\Phi = 160 – 180$, $\Delta\eta = 0\text{-}0.32$)

B = 0 T

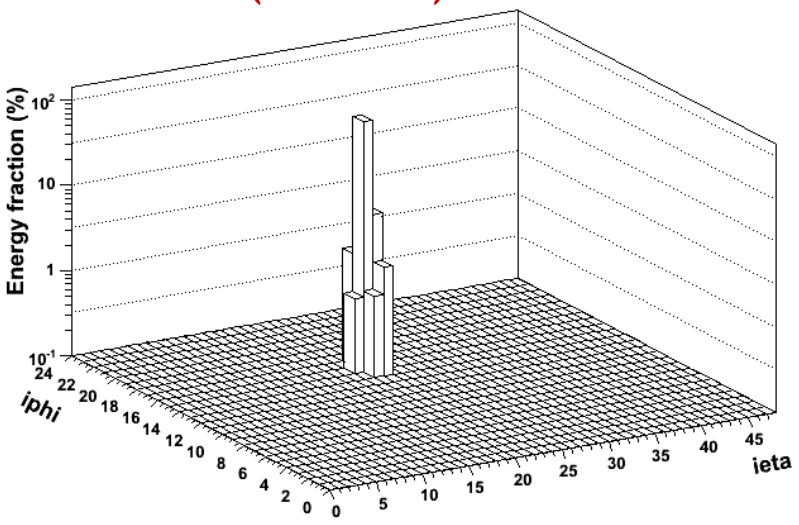
- 4K eventi 1 GeV
- 4K eventi 2 GeV
- 4K eventi 5 GeV
- 4K eventi 10 GeV
- 4K eventi 20 GeV
- 4K eventi 150 GeV



Energia depositata (%) nelle torri del calorimetro

LOG scale!!!

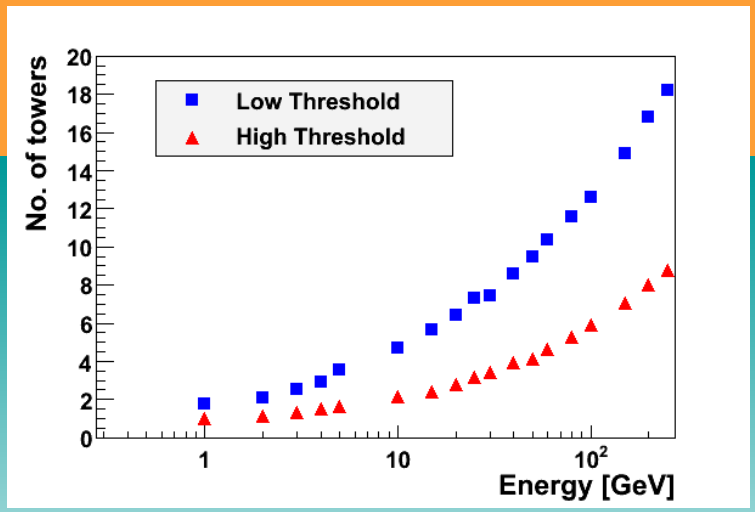
elettrone (20 GeV)



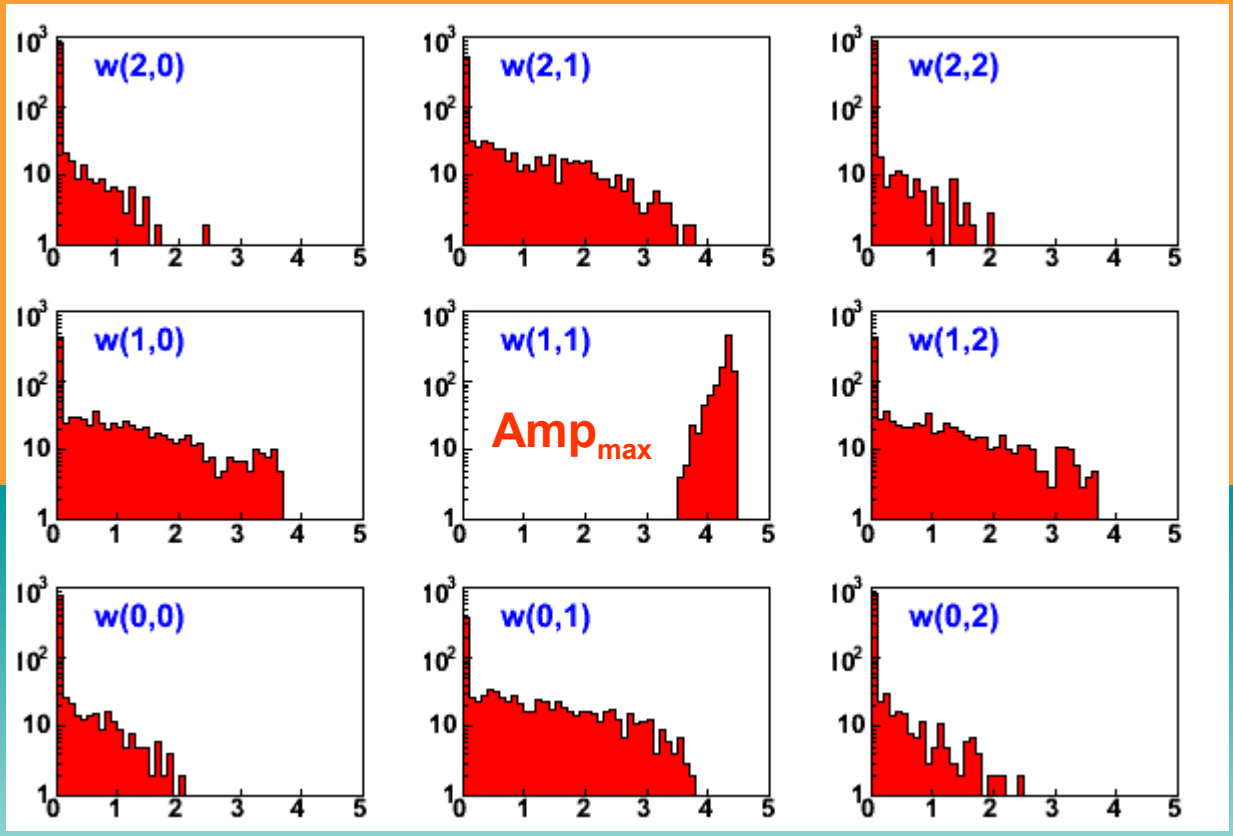
Effetto della soglia

Low Thr. $E_{tower} \geq 0$ GeV, $E_{cl} > 0.2$ GeV

High Thr. $E_{tower} \geq 0.45$ GeV, $E_{cl} > 0.5$ GeV

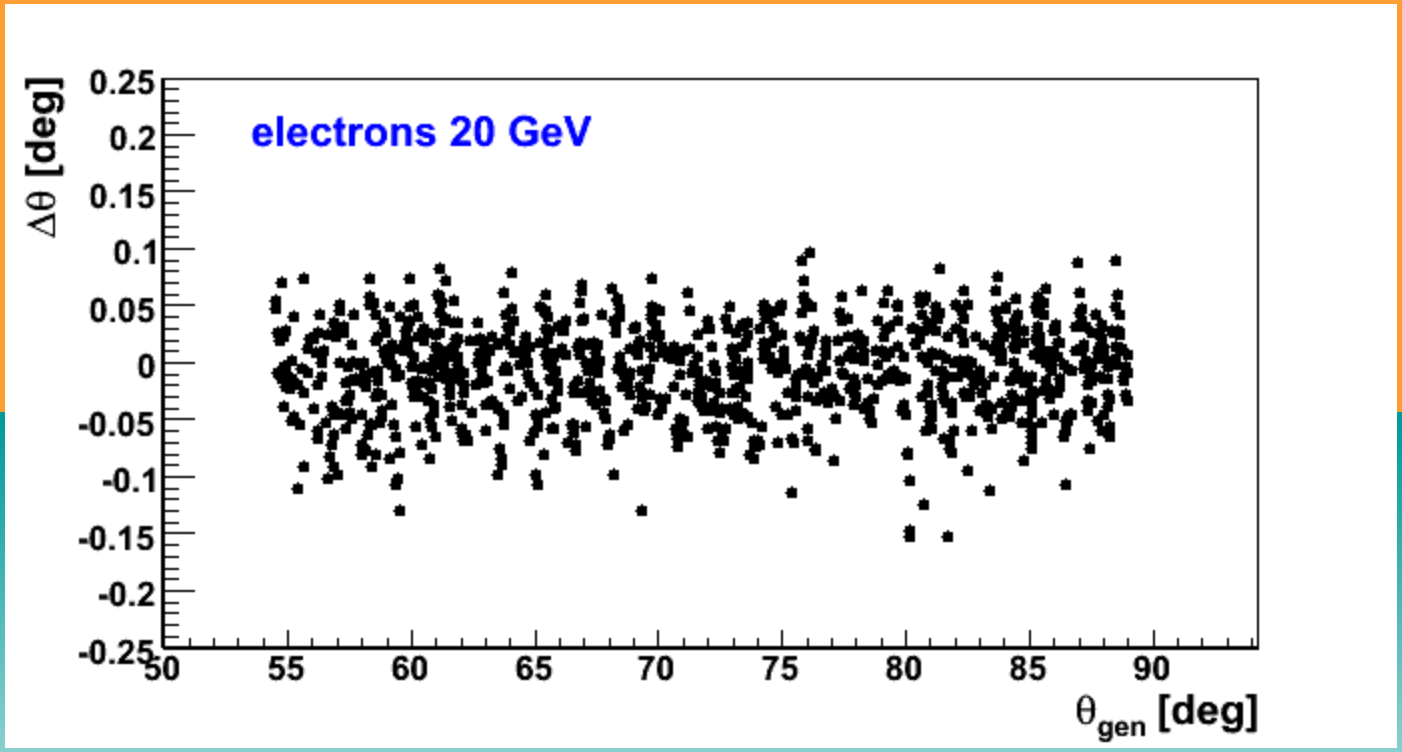


Risultati Media Logaritmica /1



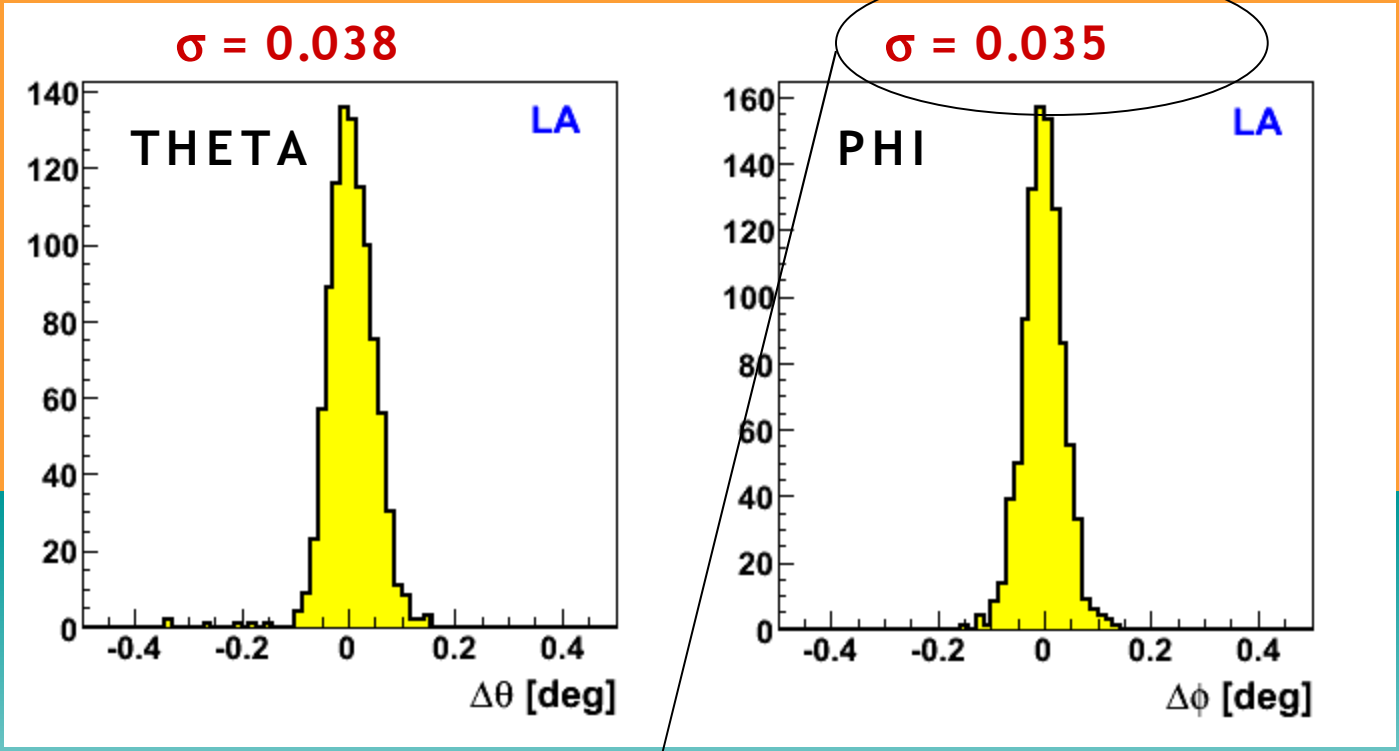
Risultati Media Logaritmica /2

$$\Delta\theta = \theta_{gen} - \theta_{rec}$$



Risultati Media Logaritmica /3

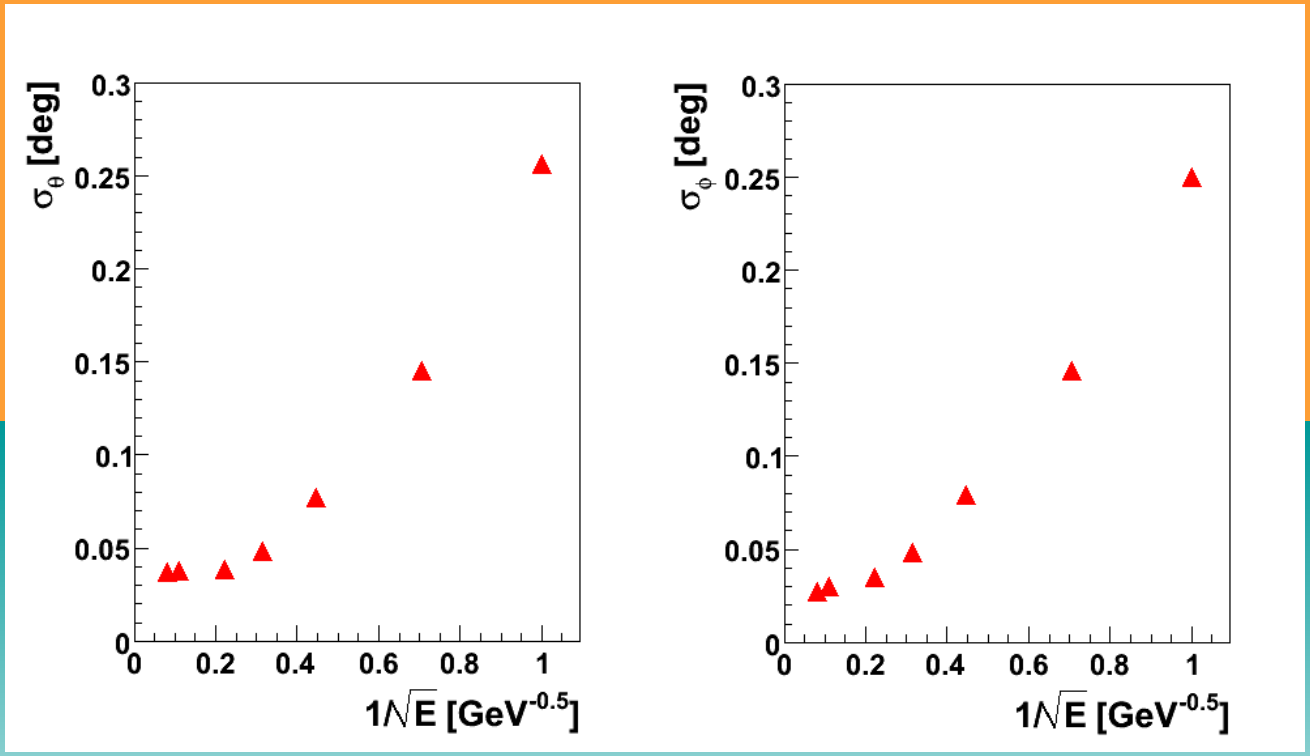
elettroni (20 GeV)



$$\Delta \Phi \times R_{IP} \approx 3mm$$

Risultati Media Logaritmica /4

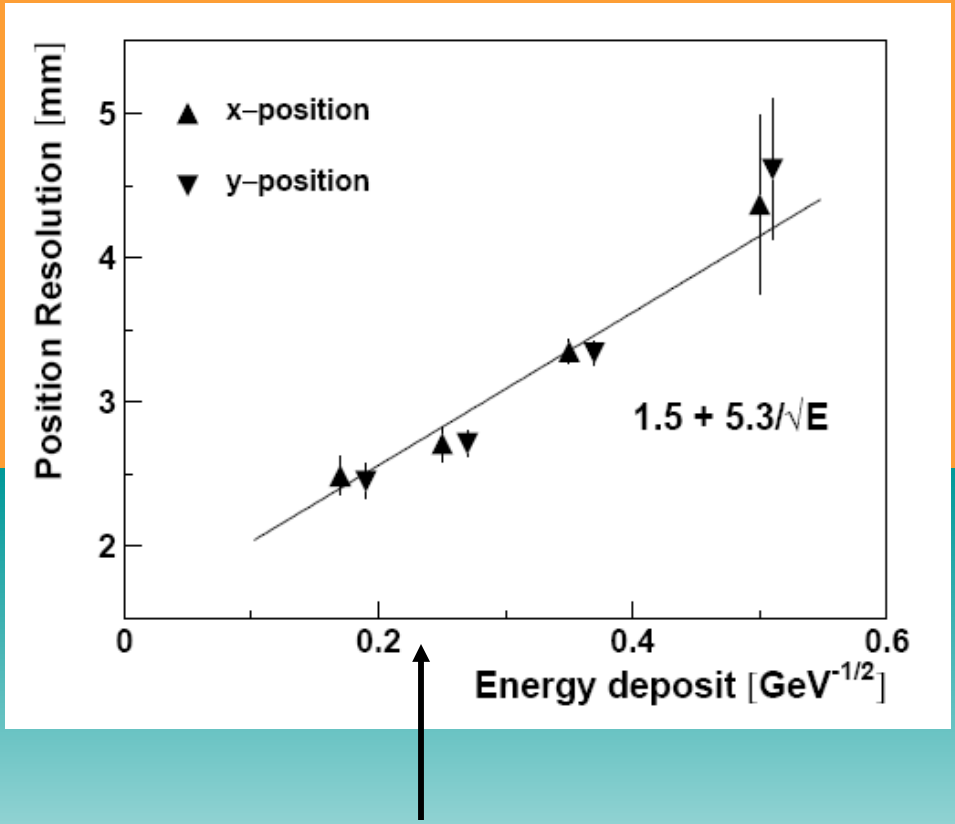
Risoluzione VS energia



Effetto della soglia sulla risoluzione in posizione (espressa in gradi)

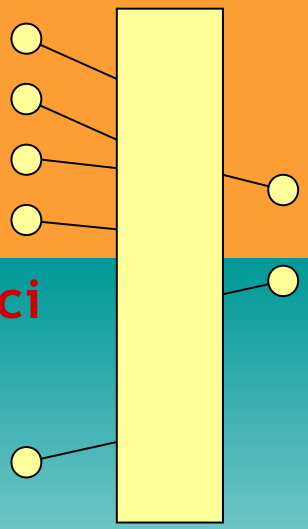
	Low Threshold		High Threshold	
Energy [GeV]	σ_θ	σ_ϕ	σ_θ	σ_ϕ
1	0.256	0.250	0.299	0.320
2	0.145	0.146	0.214	0.224
5	0.077	0.079	0.148	0.144
10	0.048	0.048	0.090	0.084
20	0.038	0.035	0.050	0.042
80	0.038	0.030	0.037	0.029
150	0.037	0.027	0.037	0.027

Confronto con risultati beamtest (FNAL 2005)



Ricostruzione della posizione: Metodo Rete Neurale

TMultiLayerPerceptron
(metodo di apprendimento BFGS)



Neuroni input (pesi logaritmici w_i)

neuroni output (theta, phi)

Layer nascosto

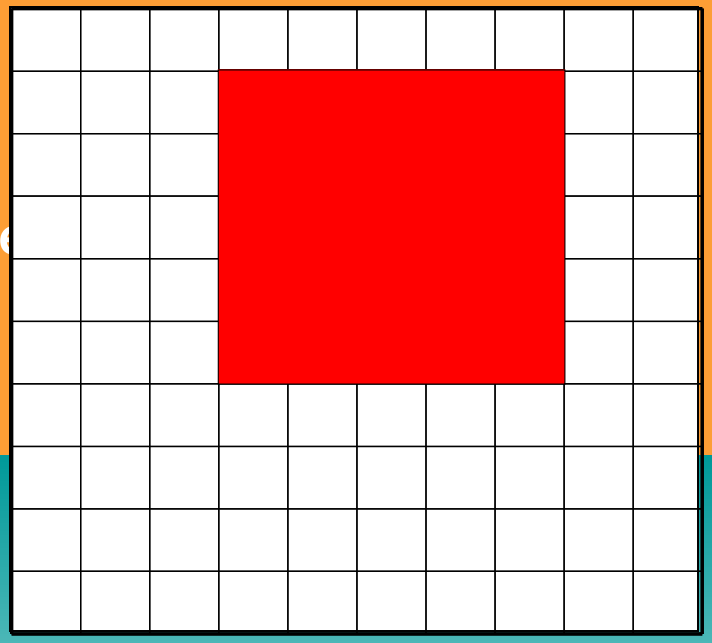
Metodo Rete Neurale /1

Struttura MLP 26-12-1

Input: pesi w_i del cluster 5x5

+ θ/ϕ della torre centrale

Output: θ/ϕ



Training set: 3000 eventi;
Test set: 1000 eventi;
N_{epoche}: 100

Metodo Rete Neurale /2

Testate diverse strutture di MLP:

- **2 MLP 26-12-1**

Input: pesi E_i/E_{tot} del cluster 5x5 + θ/ϕ della torre centrale Output: θ/ϕ

- **2 MLP 10-9-1**

Input: pesi w_i del cluster 3x3 + θ/ϕ della torre centrale Output: θ/ϕ

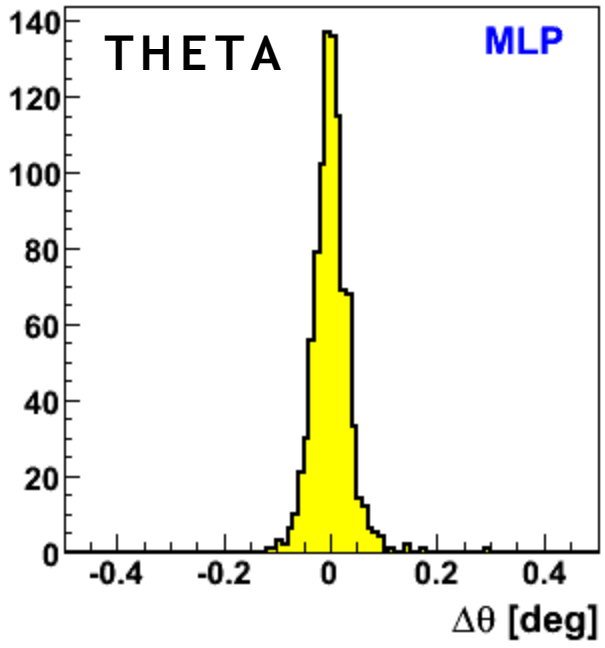
- **1 MLP 27-12-2**

Input: pesi w_i del cluster 5x5 + θ e ϕ della torre centrale Output: θ e ϕ

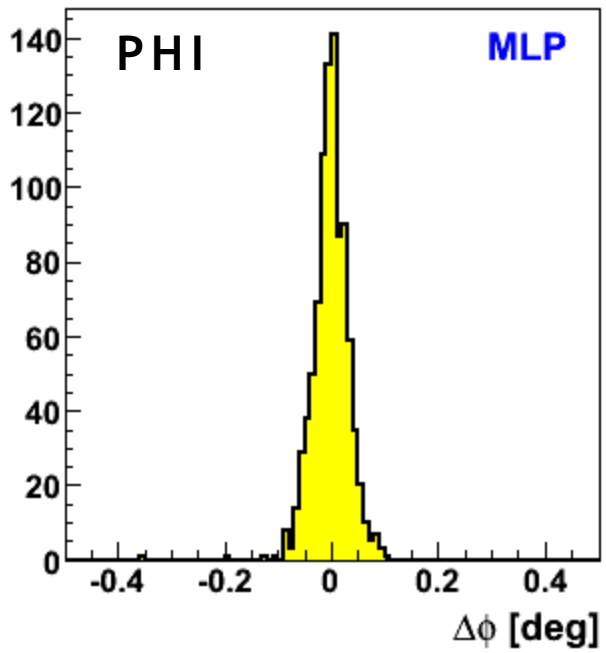
Risultati Metodo Rete Neurale

elettroni (20 GeV)

σ = 0.028

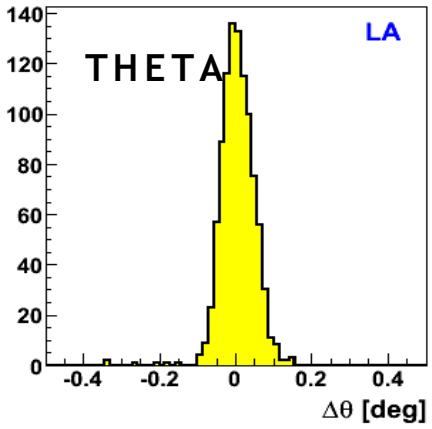


σ = 0.029

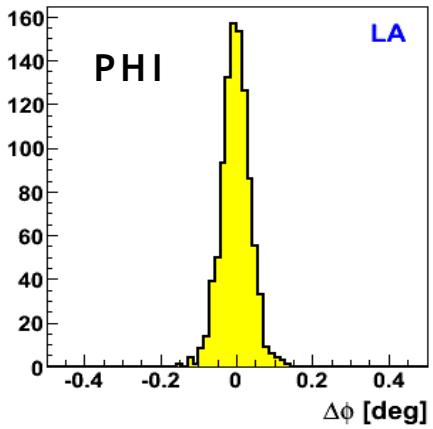


Risultati Metodo Rete Neurale

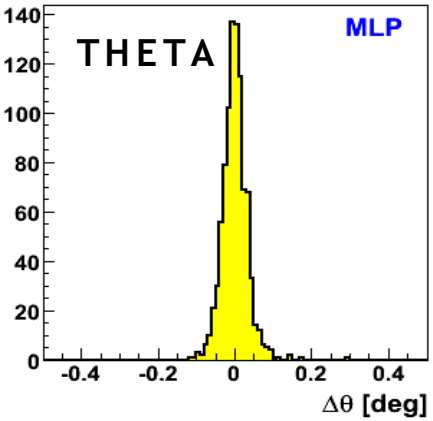
σ = 0.038



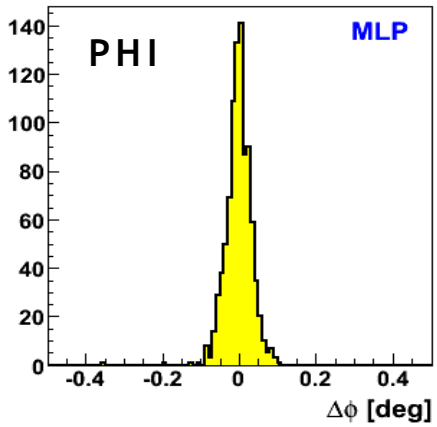
σ = 0.035



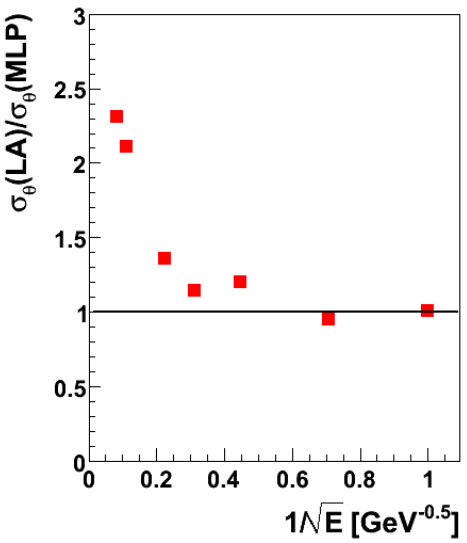
σ = 0.028

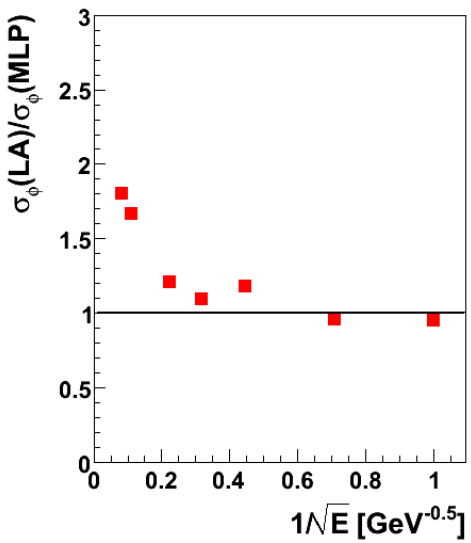


σ = 0.029



Confronto dei due metodi





	Trad. Method		MLP Method	
Energy [GeV]	σ_θ	σ_ϕ	σ_θ	σ_ϕ
1	0.256	0.250	0.254	0.263
2	0.145	0.146	0.152	0.152
5	0.077	0.079	0.064	0.067
10	0.048	0.048	0.042	0.044
20	0.038	0.035	0.028	0.029
80	0.038	0.030	0.018	0.018
150	0.037	0.027	0.016	0.015

(gradi)

Conclusioni

- In un ampio intervallo di energia il metodo neurale fornisce risultati migliori rispetto al metodo tradizionale

- Metodo applicabile a tutta la superficie dell'EMCal

Sviluppi futuri

- altri tipi di particelle (fotoni, adroni…)
- altre energie (ottimizzazione dei pesi della rete a varie energie)

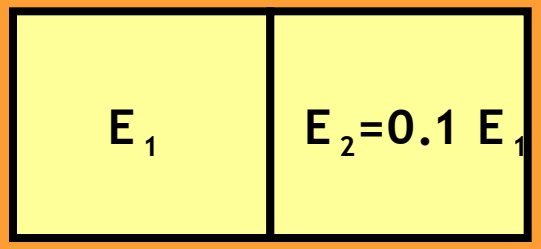
Maggiori dettagli in Nuovo Cimento B Vol. 124 N. 2 (2009)

BACK-UP SLIDES

Ricostruzione della posizione: metodo dei pesi log /2

w_0 ha due effetti:

- Trascurare le torri su cui è stata rilasciata poca energia (ad esempio w_0=3 trascura le torri con energia inferiore a 1/1000 dell'energia totale)



Esempio: 2 torri coinvolte

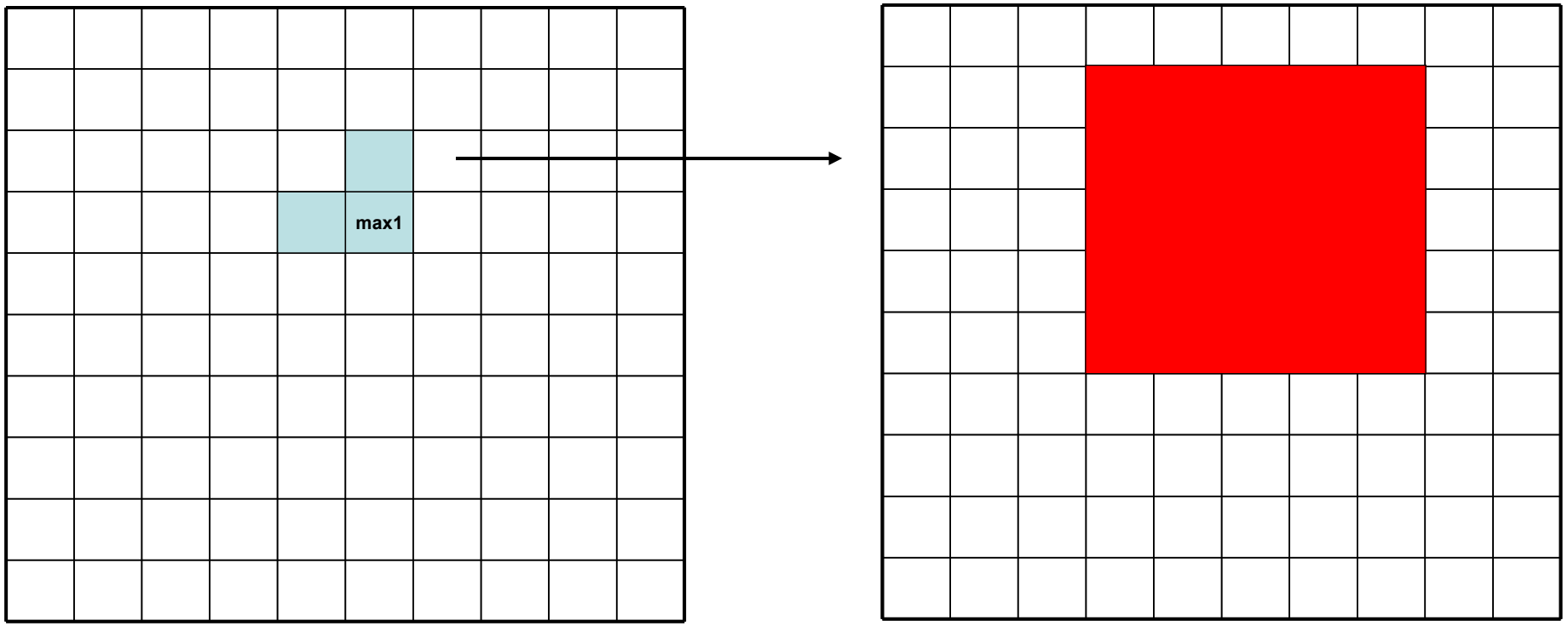
- Modifica i pesi relativi

W_0=2	W1= -0.04 + 2 = 1.96	w2 = -1.04 + 2 = 0.96	w2/w1~0.5
W_0=3	W1= -0.04 + 3 = 2.96	w2 = -1.04 + 3 = 1.96	w2/w1~0.66
W_0=5	W1= -0.04 + 5 = 4.96	w2 = -1.04 + 5 = 3.96	w2/w1~0.80

Per grandi valori di w_0, le torri con minor deposito di energia hanno pesi relativi maggiori

PER IL CALORIMETRO DI ALICE w_0 = 4,5

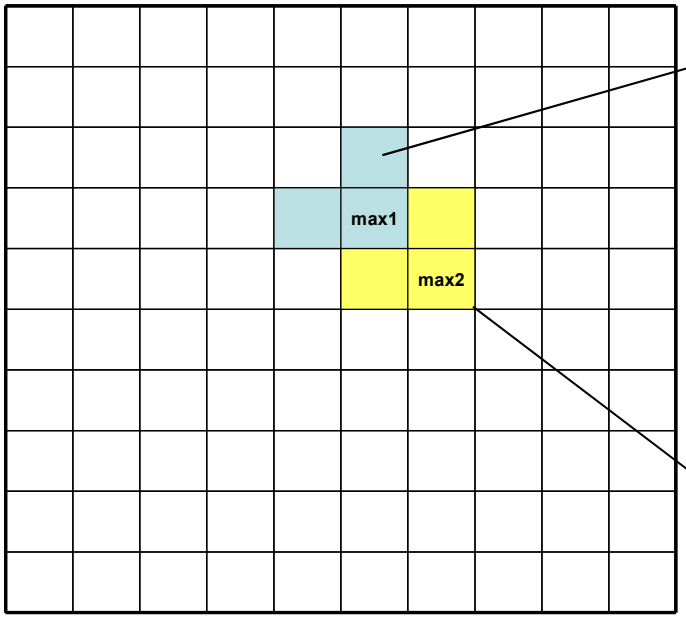
AliRoot clusterization -> SINGLE CLUSTER



MLP approach

AliRoot clusterization -> TWO CLUSTERs

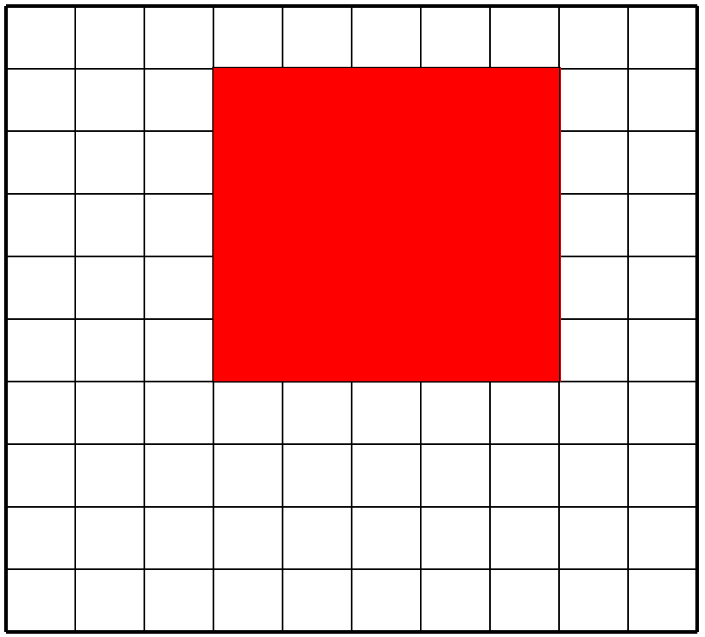
(originating from two particles or from one shower wrongly split)

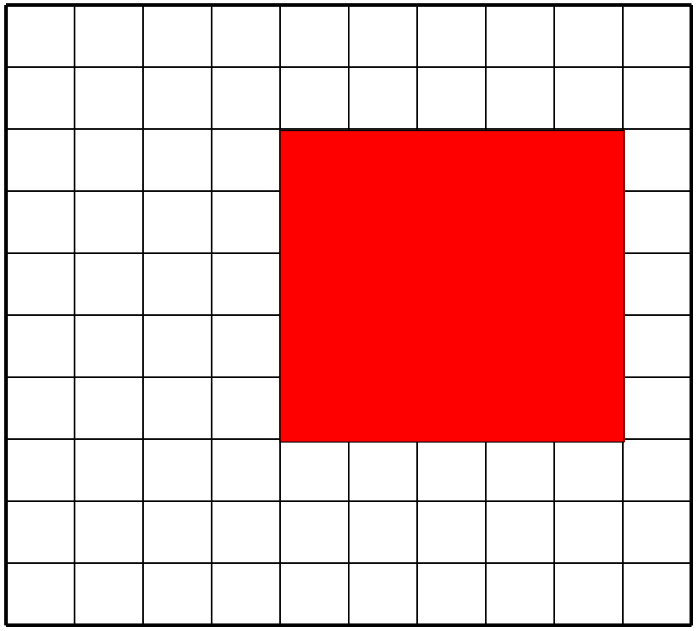


Cluster1

Cluster2

MLP approach





Clusters are processed sequentially (not simultaneously)!

Also in the reconstruction performed by AliRoot, the 2 clusters are processed independently and, for each cluster, only the contributions coming from the cells belonging to that specific cluster are taken into account