Clustering for the calorimeter energy reconstruction in Shoe
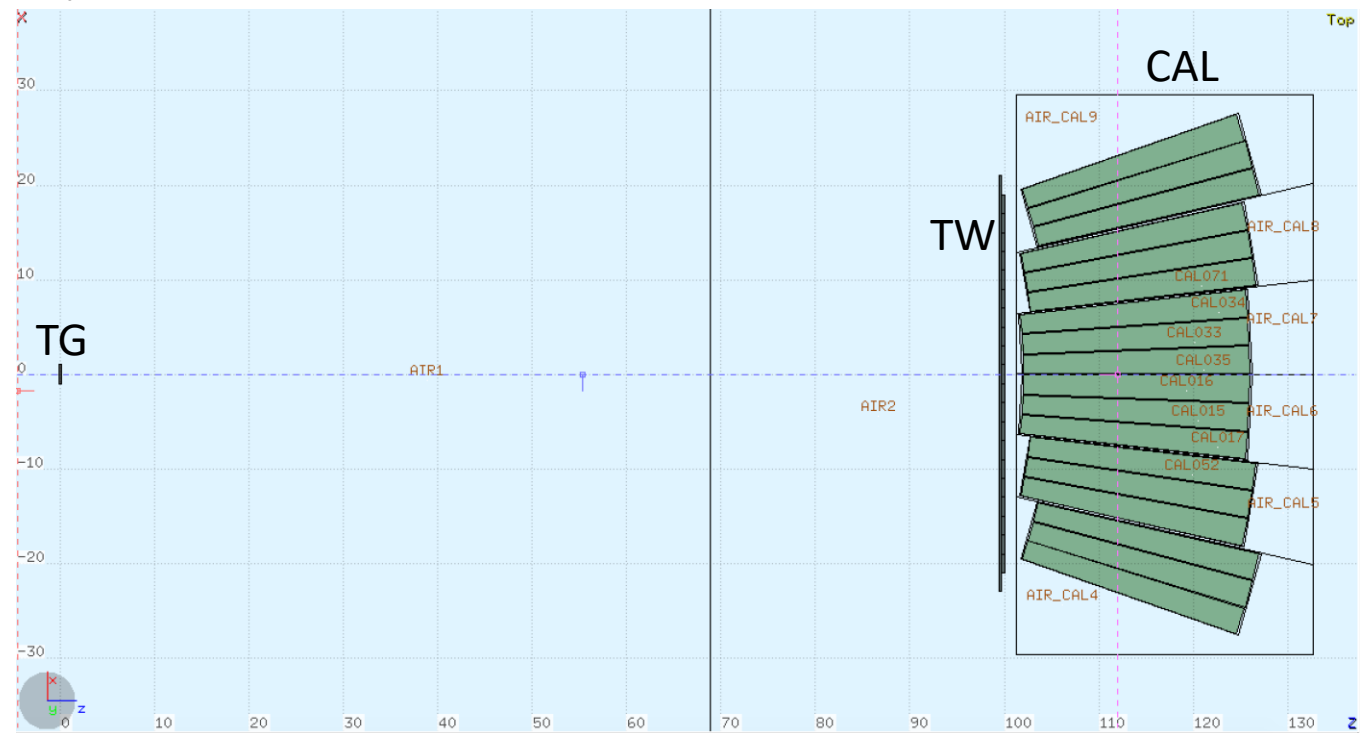
ERNESTO AND FRANCESCA

Study on MonteCarlo simulations

FLUKA simulation:

- Beam: ^{16}O @ 400 MeV/A
- Target (TG), TofWall (TW) and Calorimeter (CAL)
- 10^5 events

The Foot Clustering algorithm

- Shape Cluster and Search Cluster functions create the clusters

- A cluster is created starting from a crystal hit inside the calorimeter

- Loop over four adjacent crystals (above, below, right and left) to current crystal

- If an energy release in one of the crystals is found, a new crystal is added to the cluster

- The ShapeCluster function is called in an iterative way

	★	
★	hit	★
	★	

# The Foot Clustering algorithm

Computation of the centroid of the cluster and the total charge:

- $centroid\ pos = \left(\dfrac{\sum_{cry} x(cry)charge(cry)}{\sum_{cry} charge(cry)}, \dfrac{\sum_{cry} y(cry)charge(cry)}{\sum_{cry} charge(cry)}, 0\right)$

- $charge_{tot} = \sum_{cry} charge(cry)$

A possible alternative: Padme Clustering

PADME Island algorithm:

- The algorithm starts by looking for a local energy maximum: cluster seed

- Neighboring crystals are then attached to the cluster by applying a recursive search

- Requirement: the energy of the neighbor should be below that of the current crystal
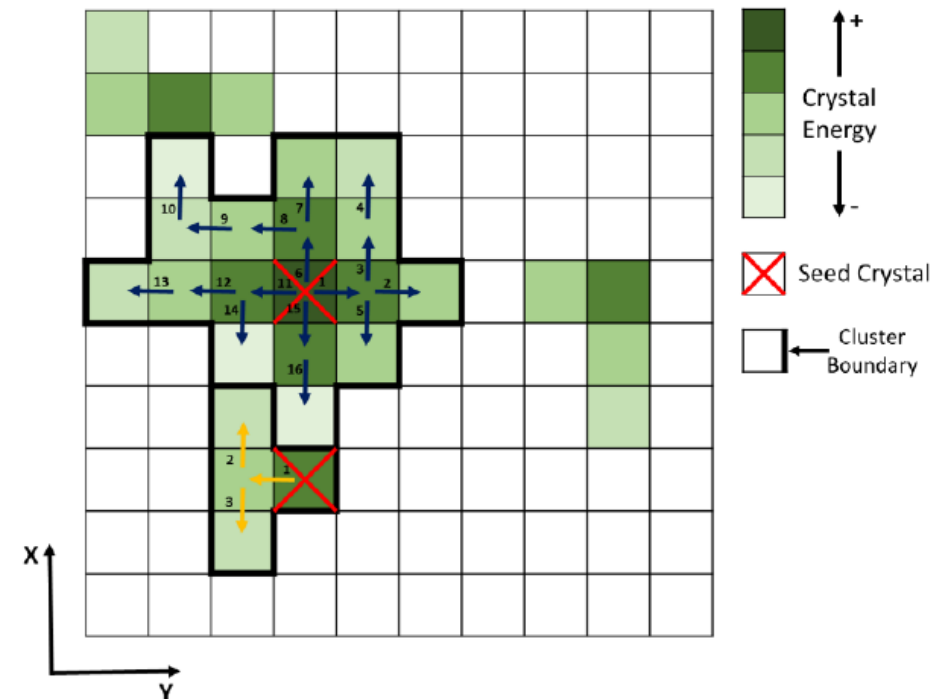
Differences between the two approaches

- The PADME algorithm starts from a seed crystal

- In the PADME algorithm adjacent crystals are added only if the energy release is lower compared to the current crystal to avoid overlapping clusters

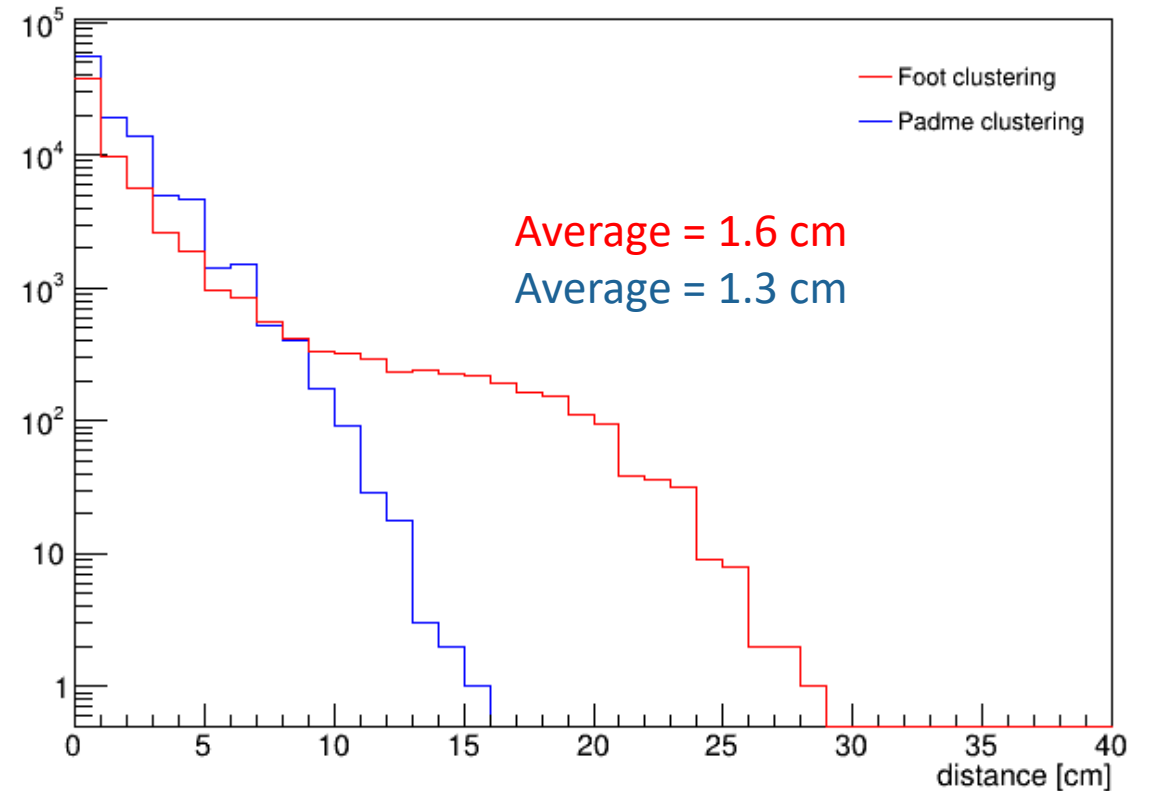- In the FOOT algorithm there's no check for overlapping clusters

- The PADME algorithm is now implemented in Shoe

Comparison on cluster dimensions

Number of hits for each cluster
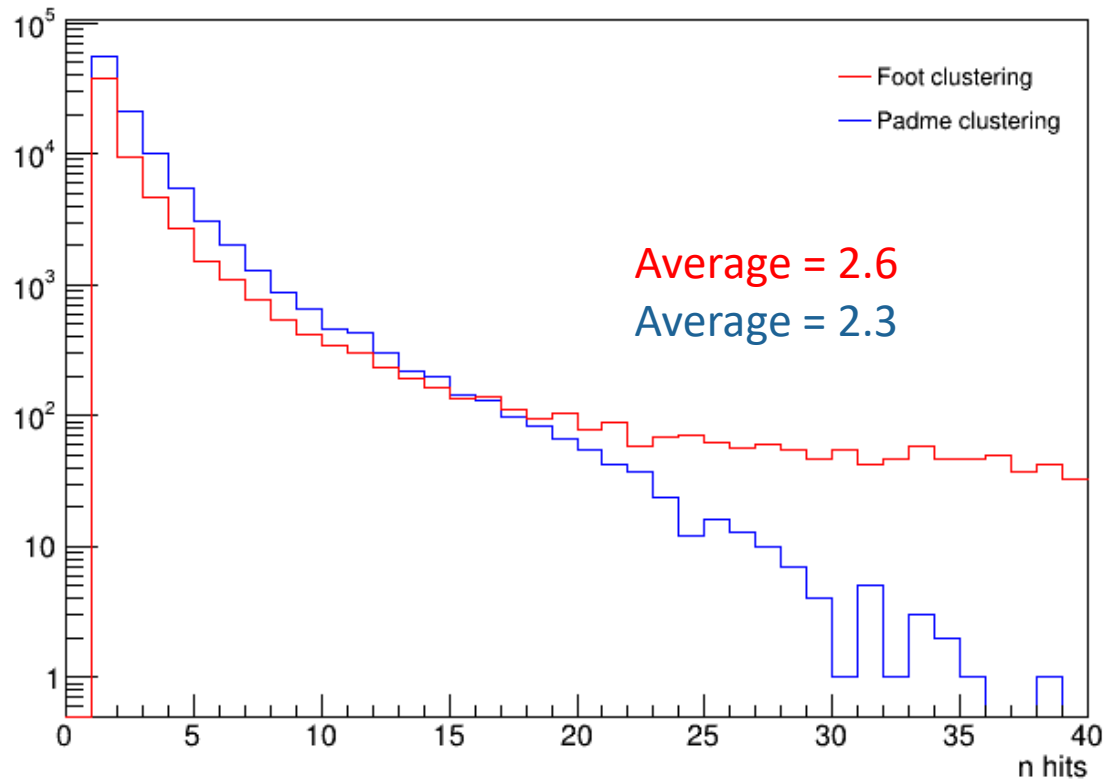
Average distance between the cluster centroid and each hit

Average = 2.6
Average = 2.3

Average = 1.6 cm
Average = 1.3 cm

Comparison on cluster dimensions

Average distance between the cluster centroid and the crystal corresponding to the maximum energy release

Cluster dispersion: standard deviation of the cluster hits with respect to the centroid position

Average = 0.4 cm
Average = 0.3 cm

Average = 1.2 cm
Average = 0.5 cm
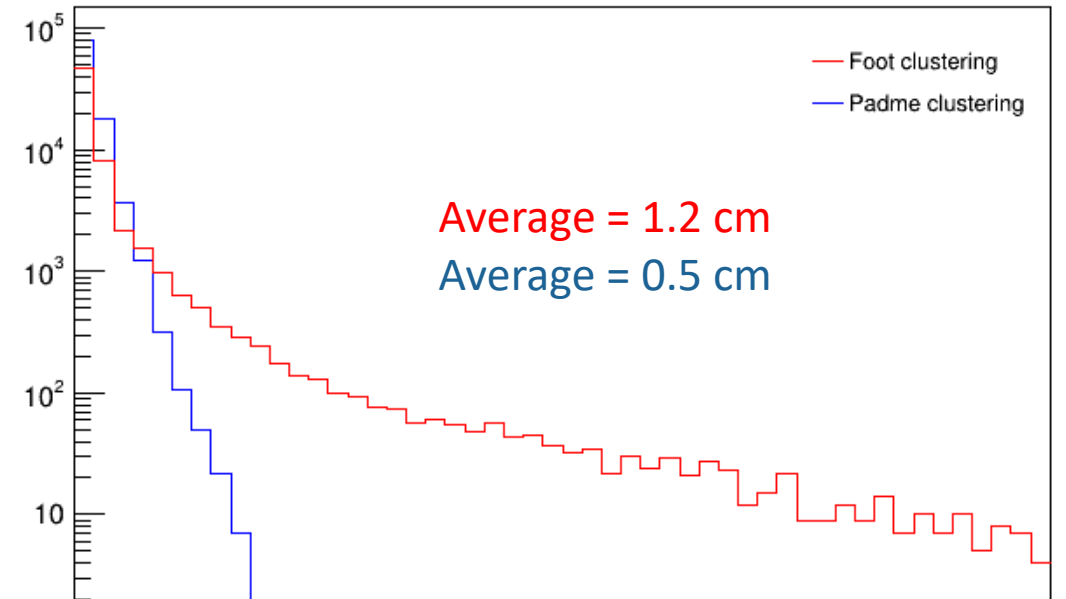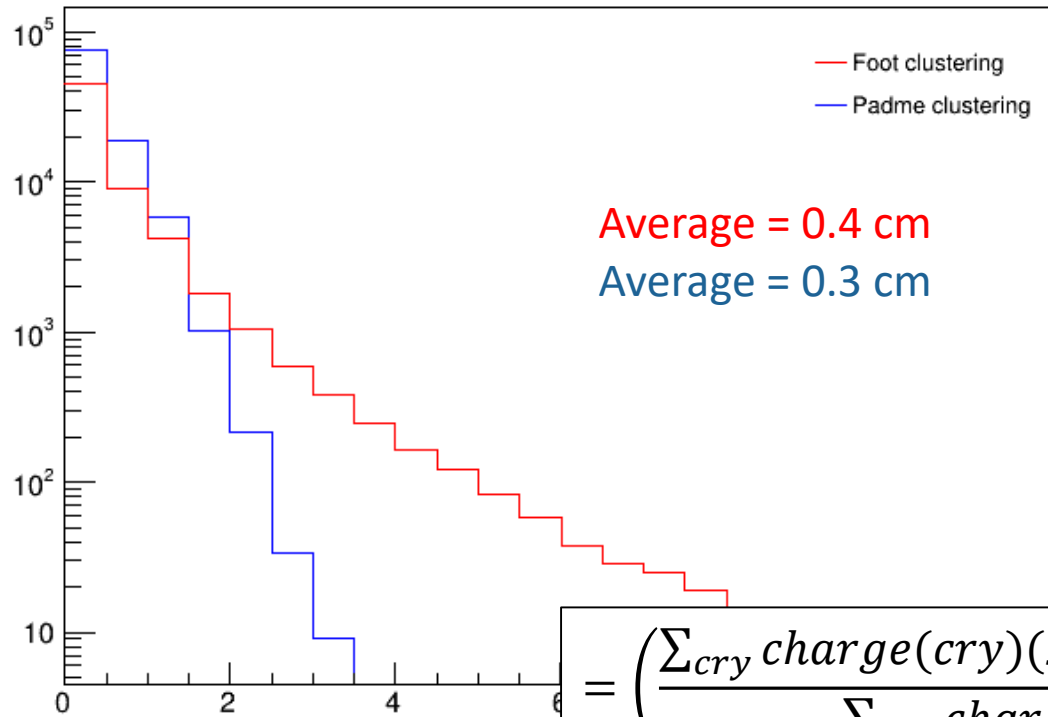
$$= \left(\frac{\sum_{cry} charge(cry)(x(cry) - pos_x)^2}{\sum_{cry} charge(cry)}, \frac{\sum_{cry} charge(cry)(y(cry) - pos_y)^2}{\sum_{cry} charge(cry)}, 0 \right)$$

Comparison on cluster dimensions

Average distance between the cluster centroid and the crystal corresponding to the maximum energy release

Cluster dispersion: standard deviation of the cluster hits with respect to the centroid position
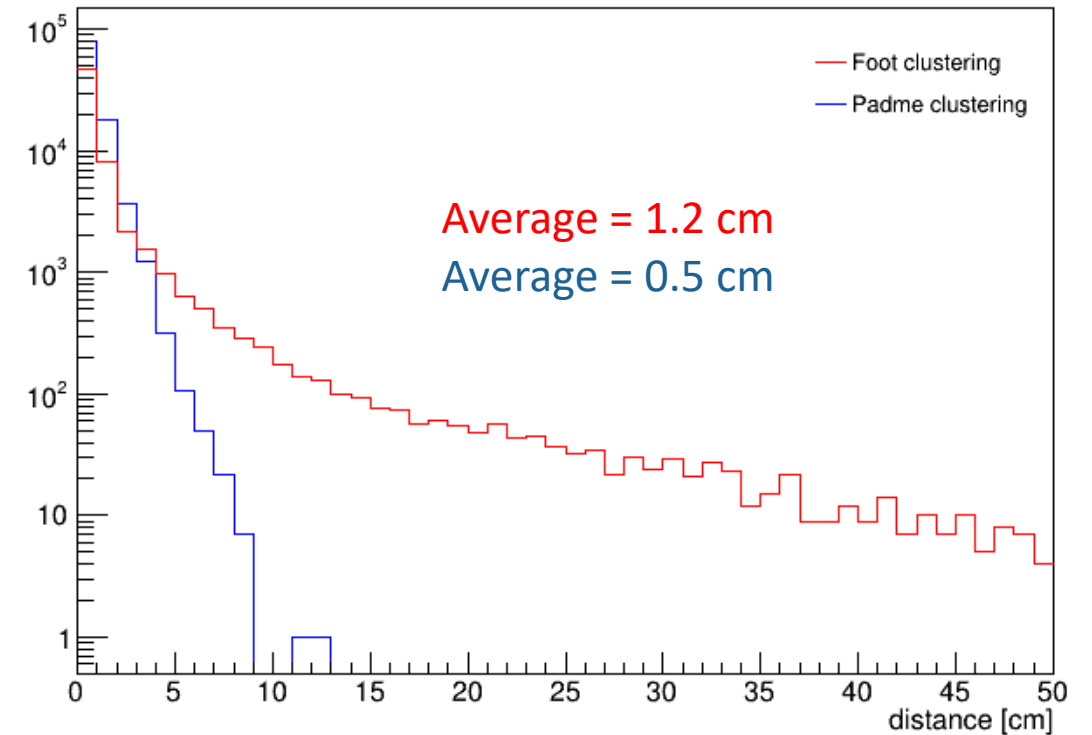

Average = 0.4 cm
Average = 0.3 cm

Average = 1.2 cm
Average = 0.5 cm
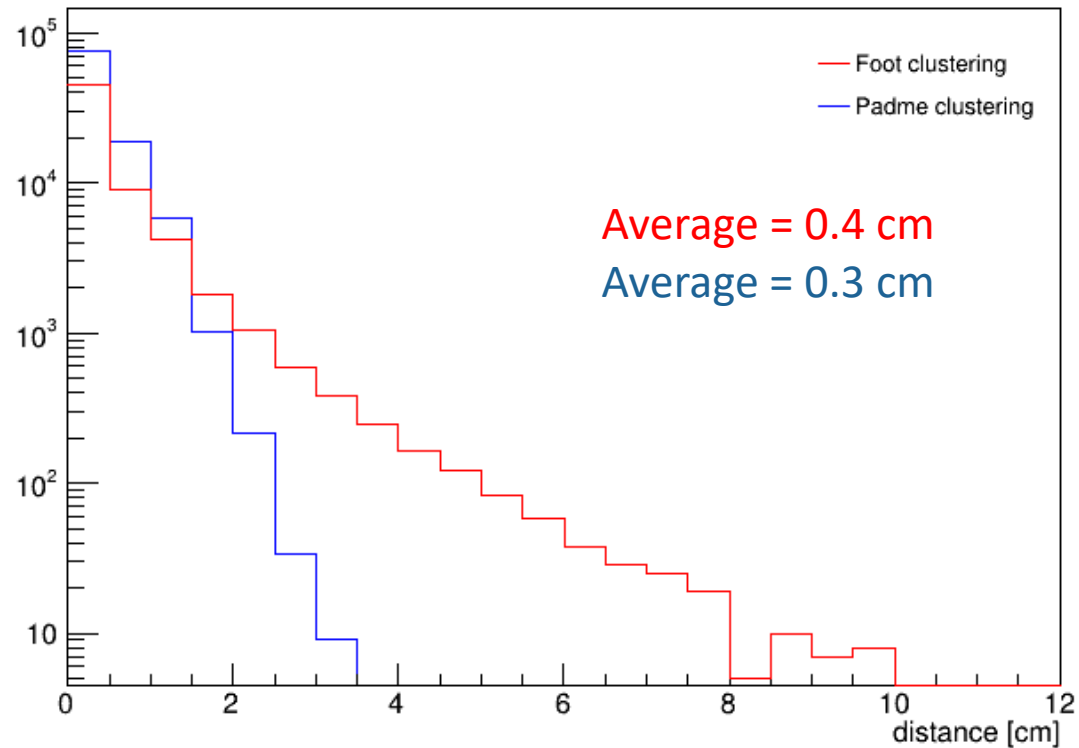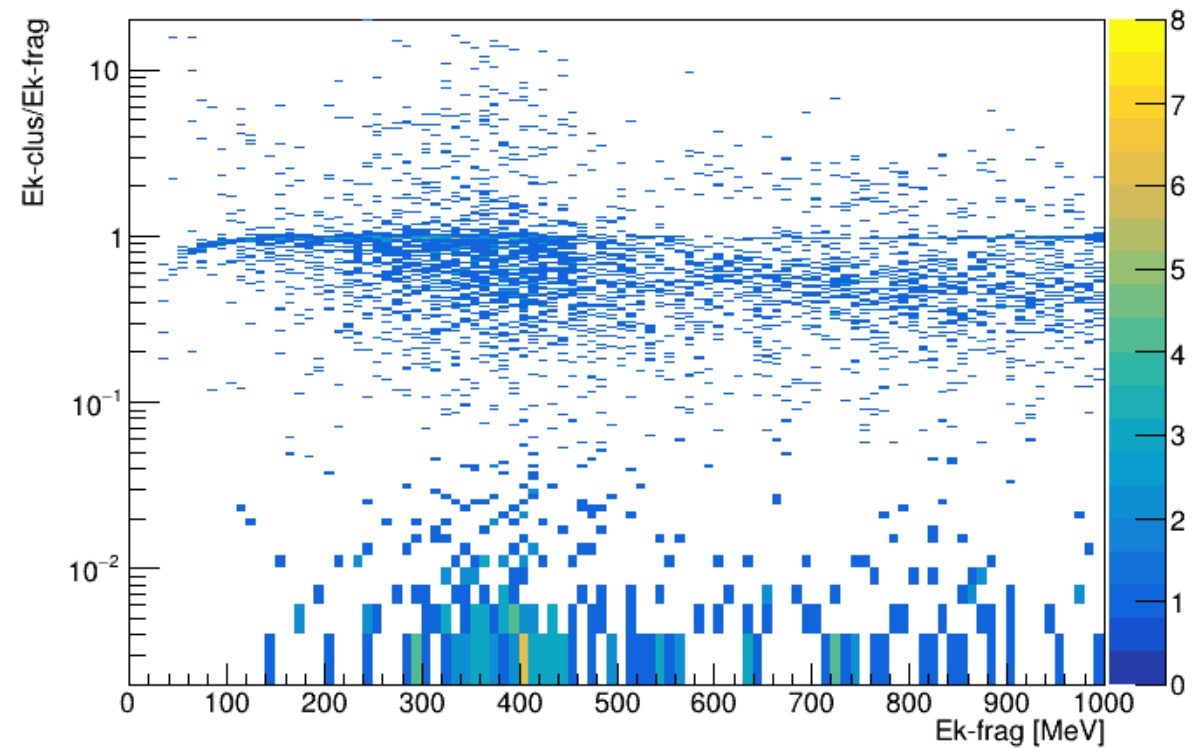
Energy reconstruction

- Only particles produced in the interaction of the beam with the target and reaching the calorimeter are considered

- From the MCtruth the kinetic energy of each fragment (particle) is known -> Ek-fragment

- The fragment interacts in the calorimeter and produces a cluster

- Comparison of the cluster energy Ek-cluster with the energy of the fragment Ek-fragment

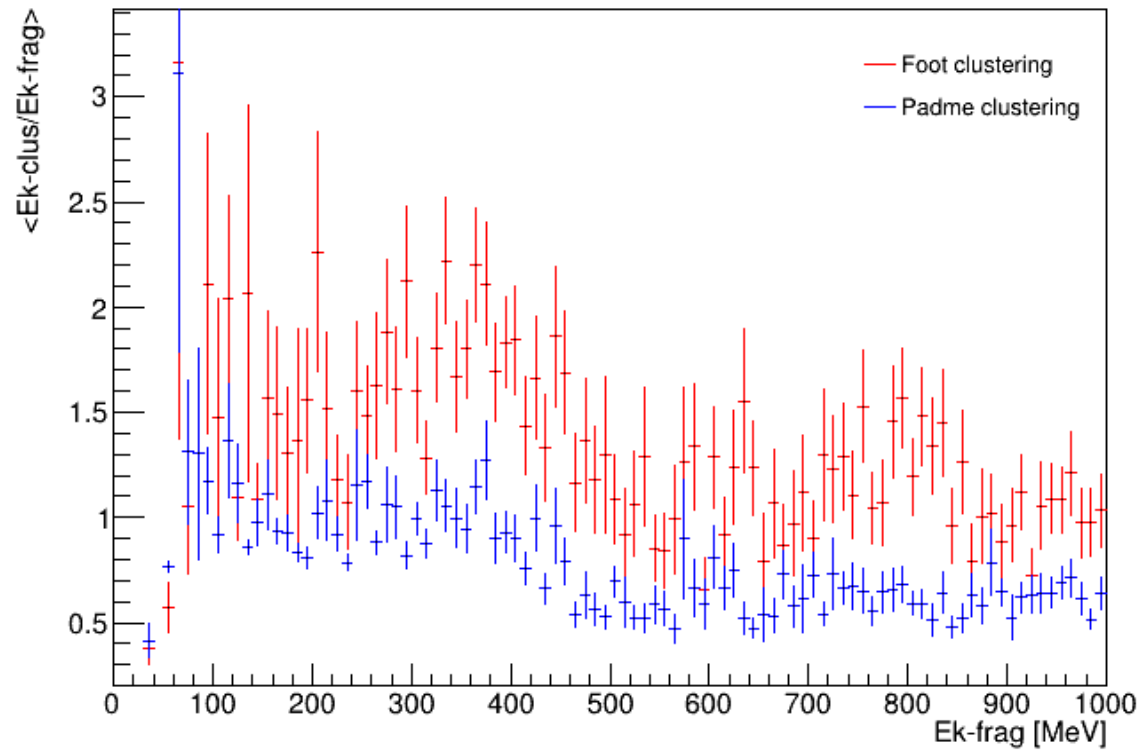- Ek-clus / Ek-frag

Energy reconstruction

Foot
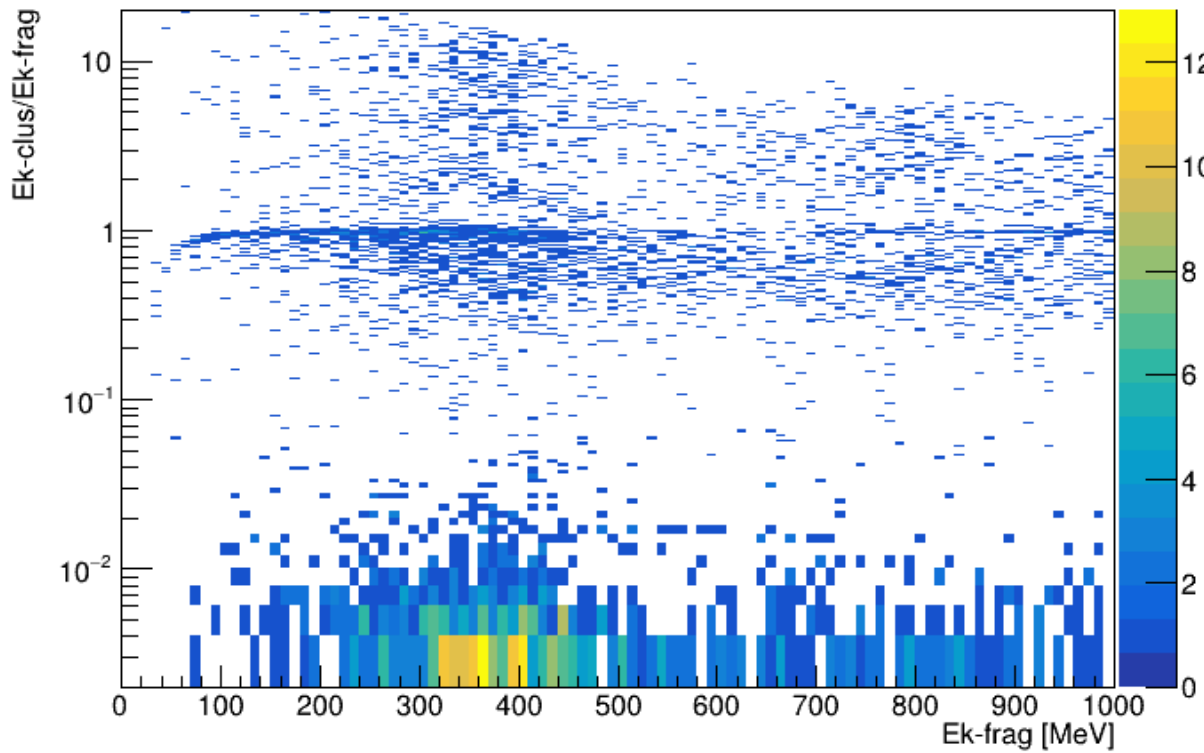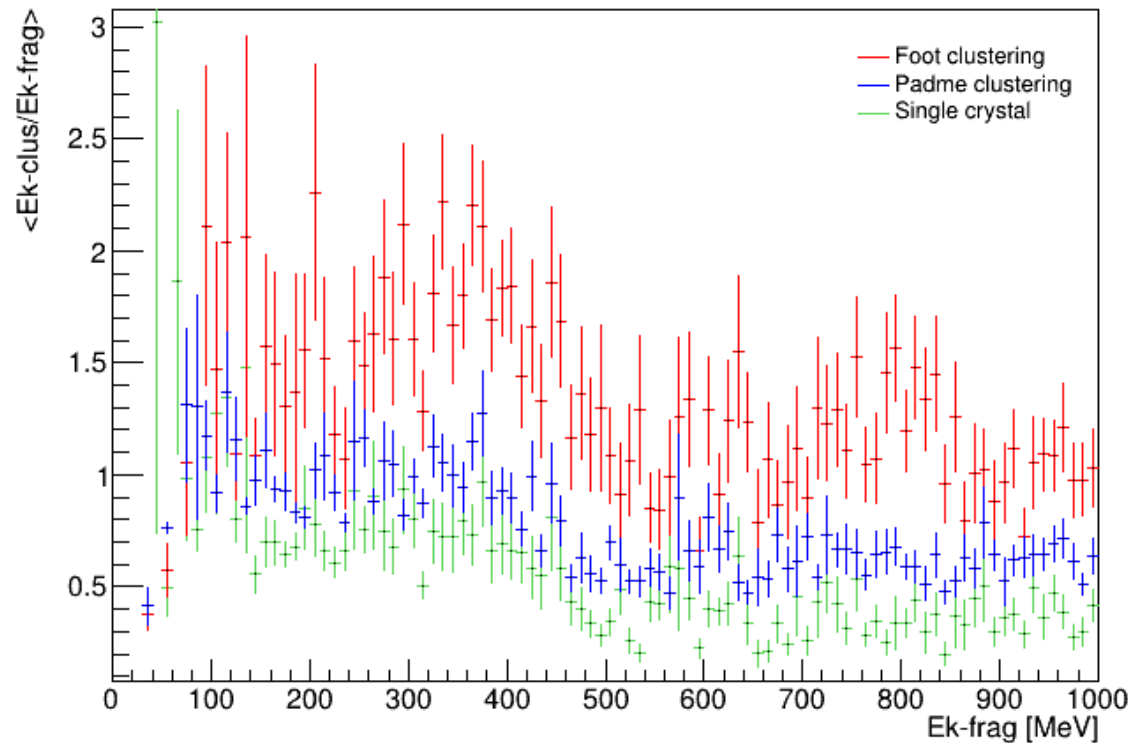
Padme

Energy reconstruction

Average ratio performed over the complete energy range $E_{k\text{-frag}}$

$$\left\langle \frac{E_{k-clus}}{E_{k-frag}} \right\rangle = 1.5 \pm 2.5 \qquad \text{Foot}$$

$$\left\langle \frac{E_{k-clus}}{E_{k-frag}} \right\rangle = 0.8 \pm 1.2 \qquad \text{Padme}$$

Energy reconstruction

If we take one single crystal instead of using the clustering (green):

Average ratio performed over the complete energy range $E_{k\text{-frag}}$ for one single crystal

$$\left\langle \frac{E_{k-hit}}{E_{k-frag}} \right\rangle = 0.6 \pm 1.3$$

Conclusions

- The PADME algorithm has been implemented inside Shoe

- Several tests to compare the shape of the clusters with FOOT and PADME algorithm: as expected the clusters are smaller for the PADME case

- By comparing the reconstructed energy with the two clustering methods, it appears that the PADME algorithm works better

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