Istituto Nazionale di Fisica Nucleare
SEZIONE DI TORINO

Studies on CALO clusters @ CNAO2024

B. Spadavecchia on behalf of the Turin group

Summary:

- Intrinsic efficiencies of clustering and matching for Z-Id (MC analysis)
- Main difference between MC and exp clusters & correction attempt
- Z distributions (MC vs exp)
- Cluster size analysis; possible drawbacks for clus size = 2
- Effects of cluster position on resolution; geometry plots
- **β** vs E distributions

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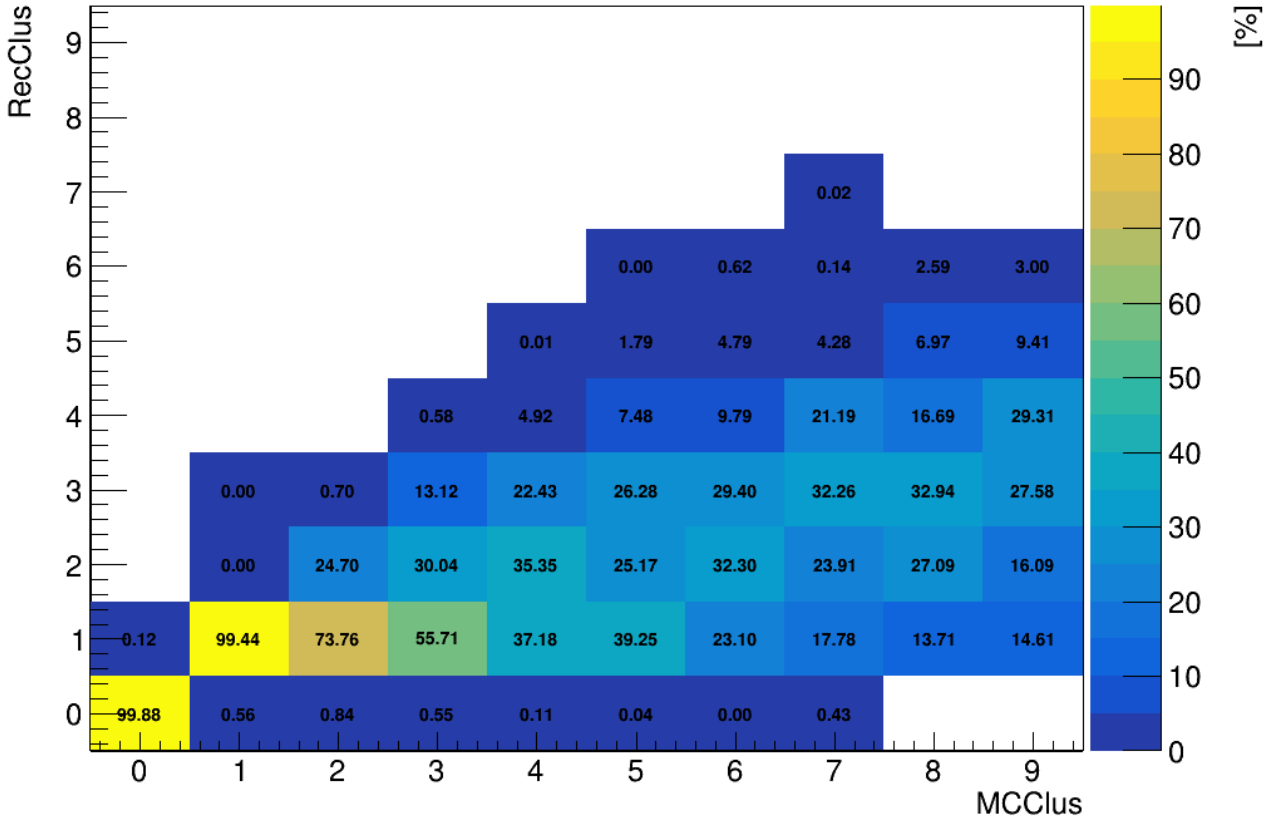
Multiple fragments clustering (MC analysis)



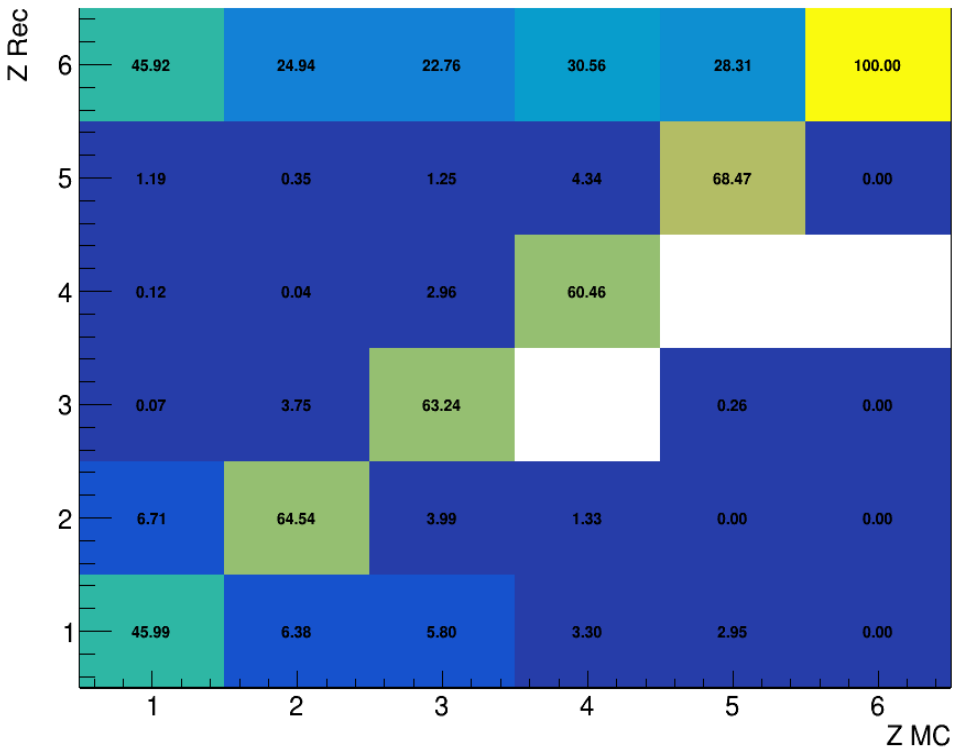
MC clus = first-impinging tracks on the CALO.

The larger the number of MC clusters, the higher the probability they are underestimated P(RecClus < MCClus).

→ multiple tracks merged in the same cluster.

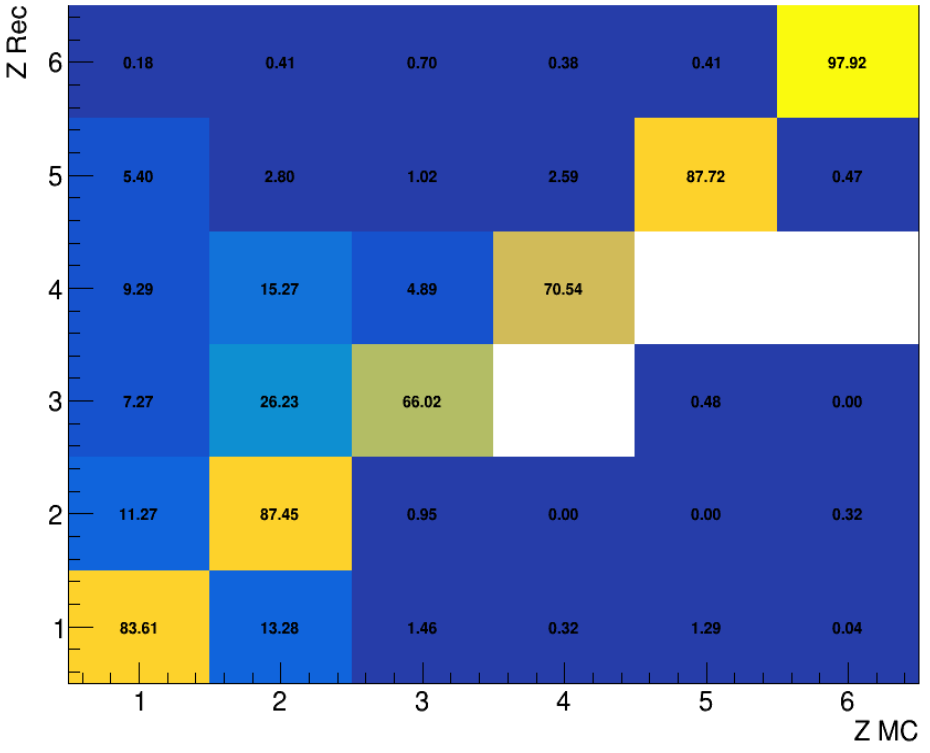
Z misidentification from TW-CALO matching (MC analysis)

Cols normalized



Diagonal values: $P(Z_{rec} = Z_{MC} \mid Z_{MC})$

Rows normalized



Diagonal values: $P(Z_{MC} = Z_{rec} \mid Z_{rec})$

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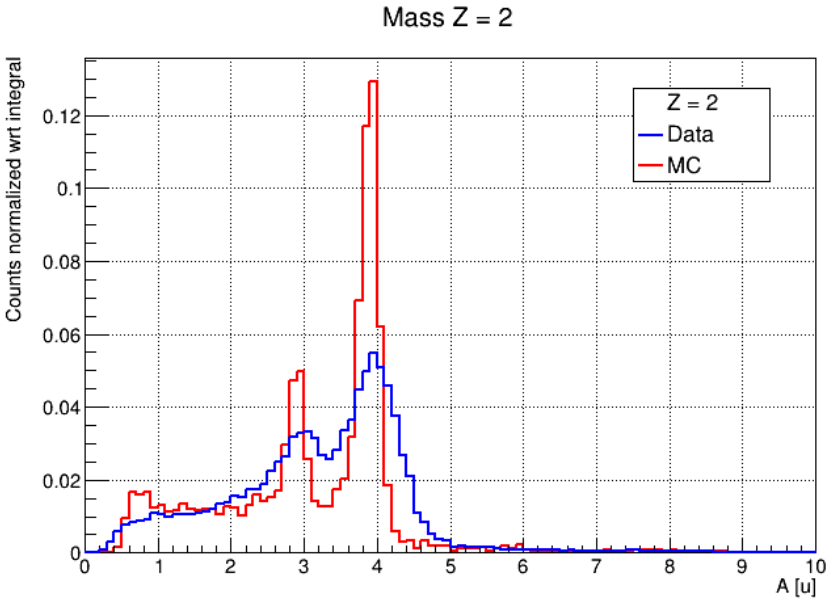
Main difference between exp and MC clusters

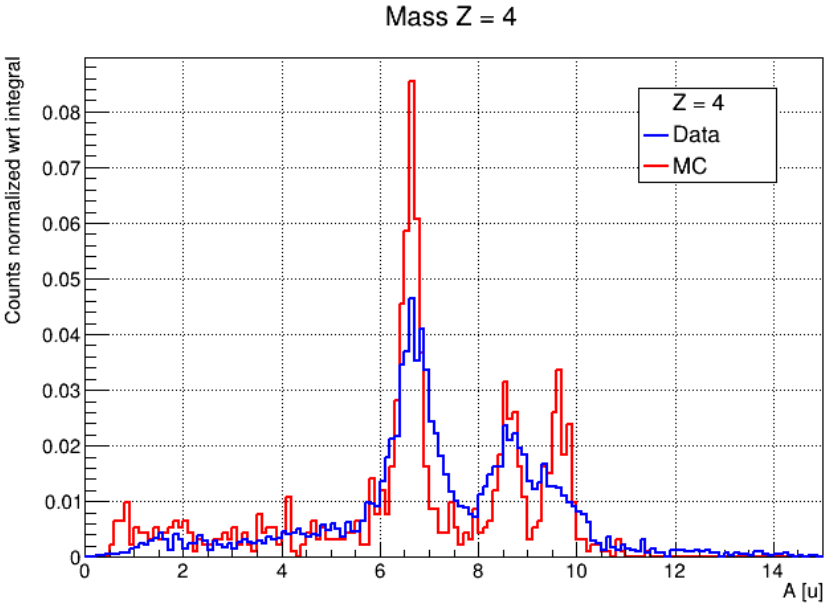


Clusters are created from true E_{kin} values in MC, from (not equalized) ADC values in exp data

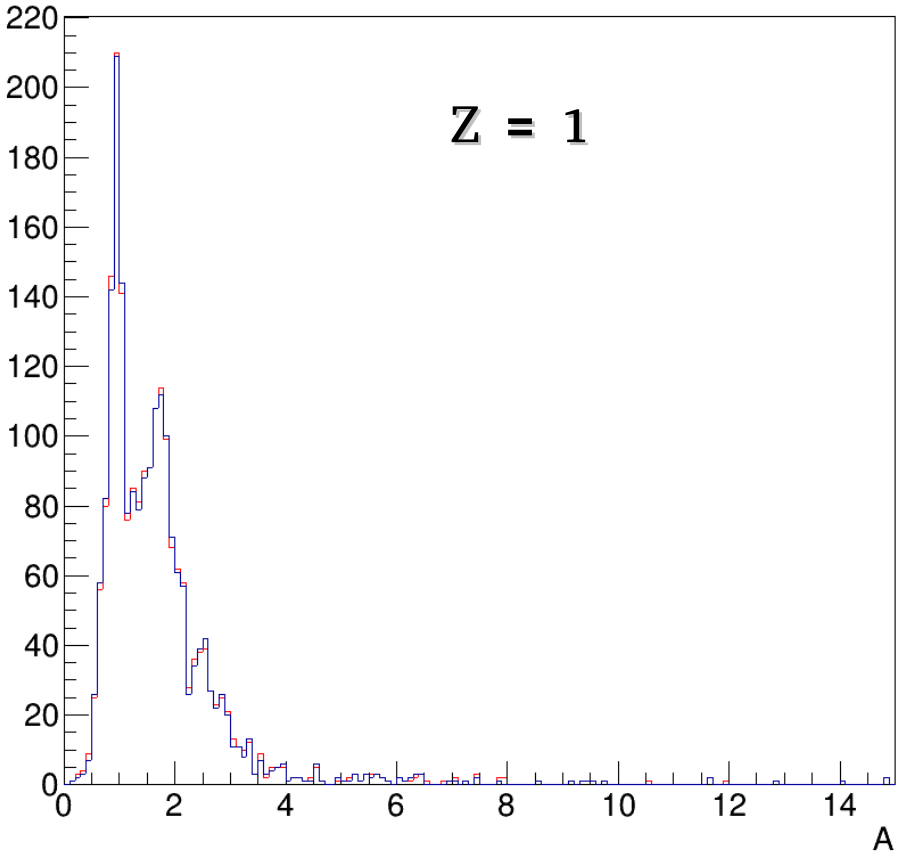
→ I tried a second iteration of cluster shaping, position computing and matching **after** a "first guess" TW-CALO matching.

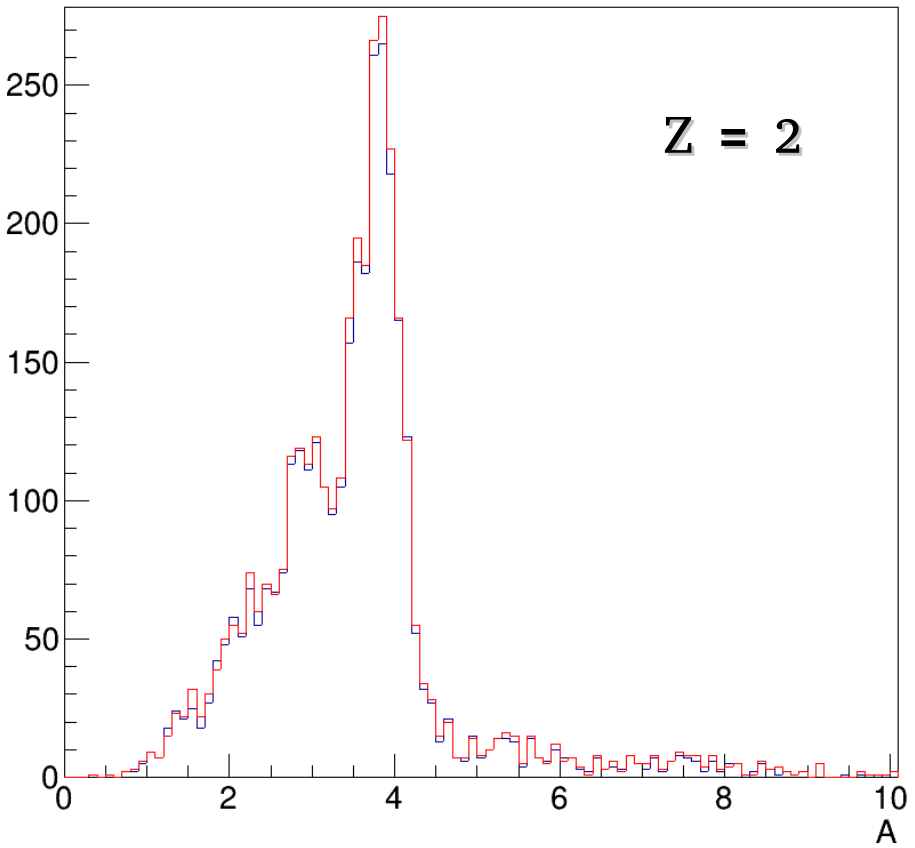
Mass identification performance in MC is still way better (almost optimal) wrt exp data

→ are clusters created differently?



Before and after 2nd iteration for 400k events (clus size > 1, run 7072)





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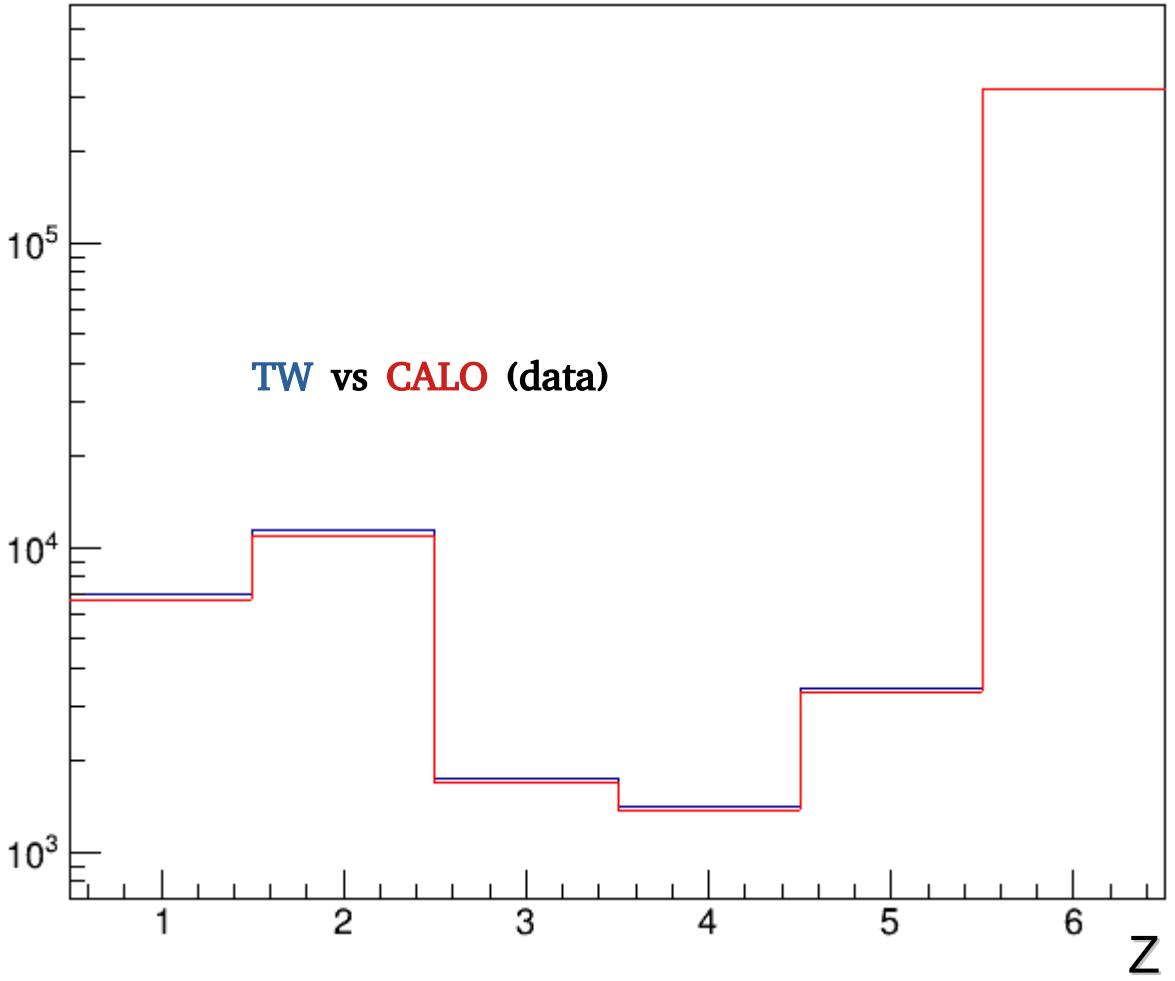
Z distribution for 400k events after 2nd iteration



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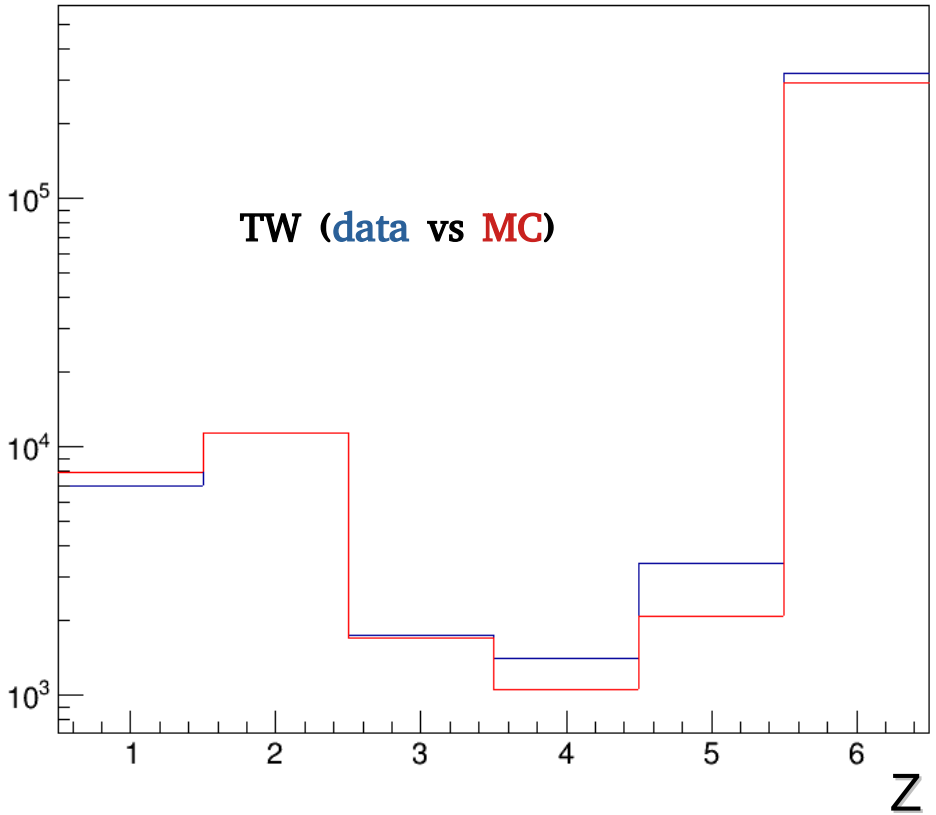

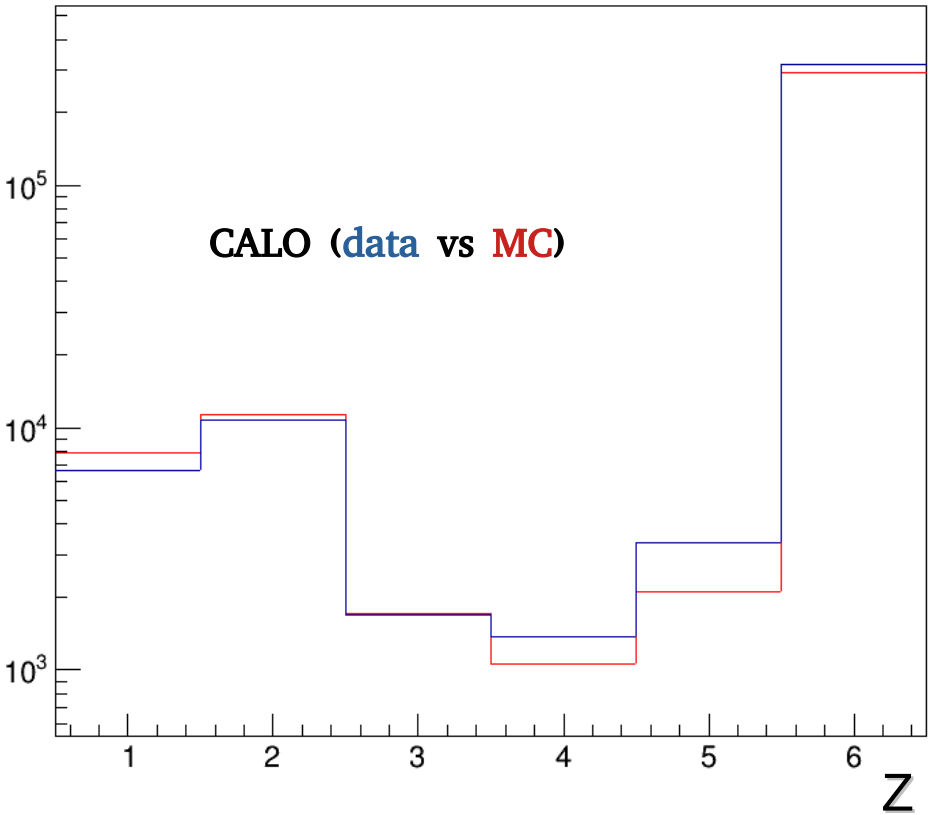

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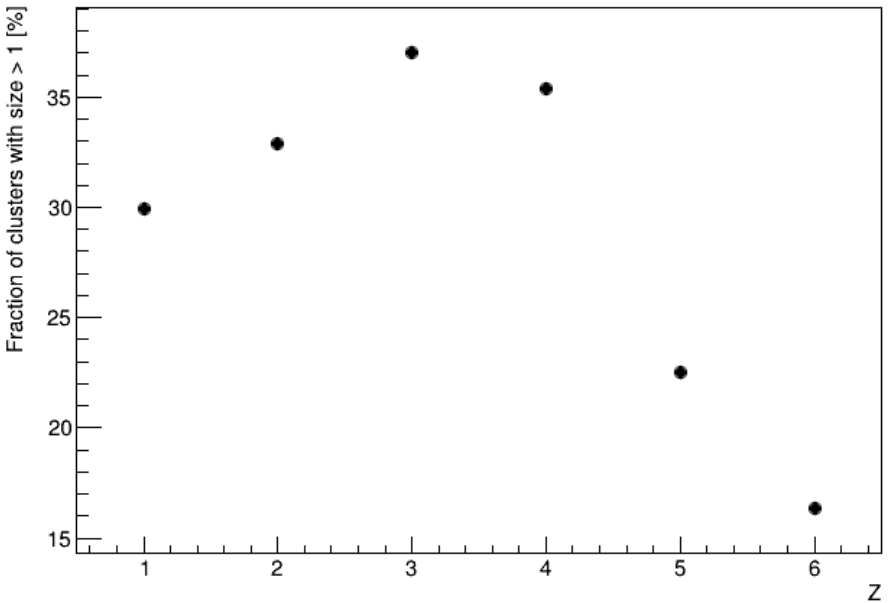
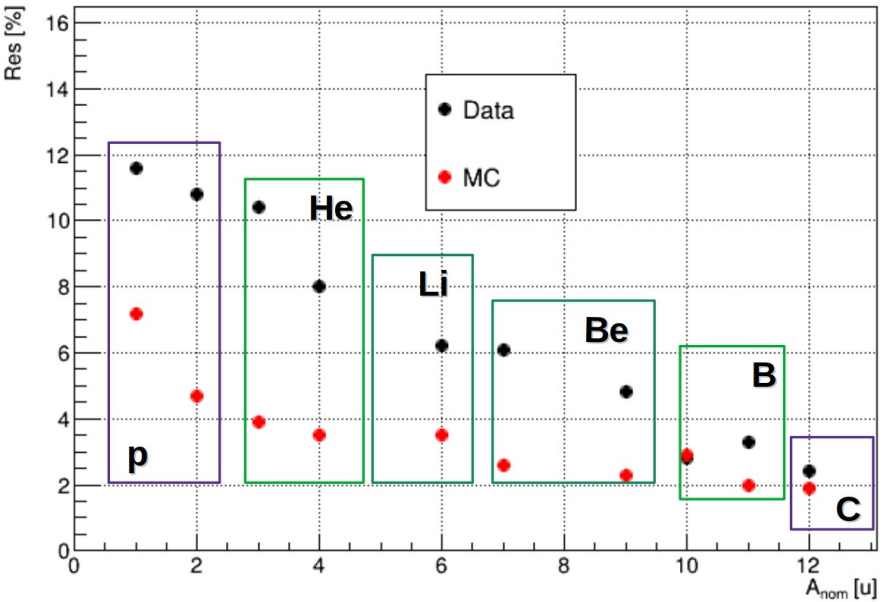
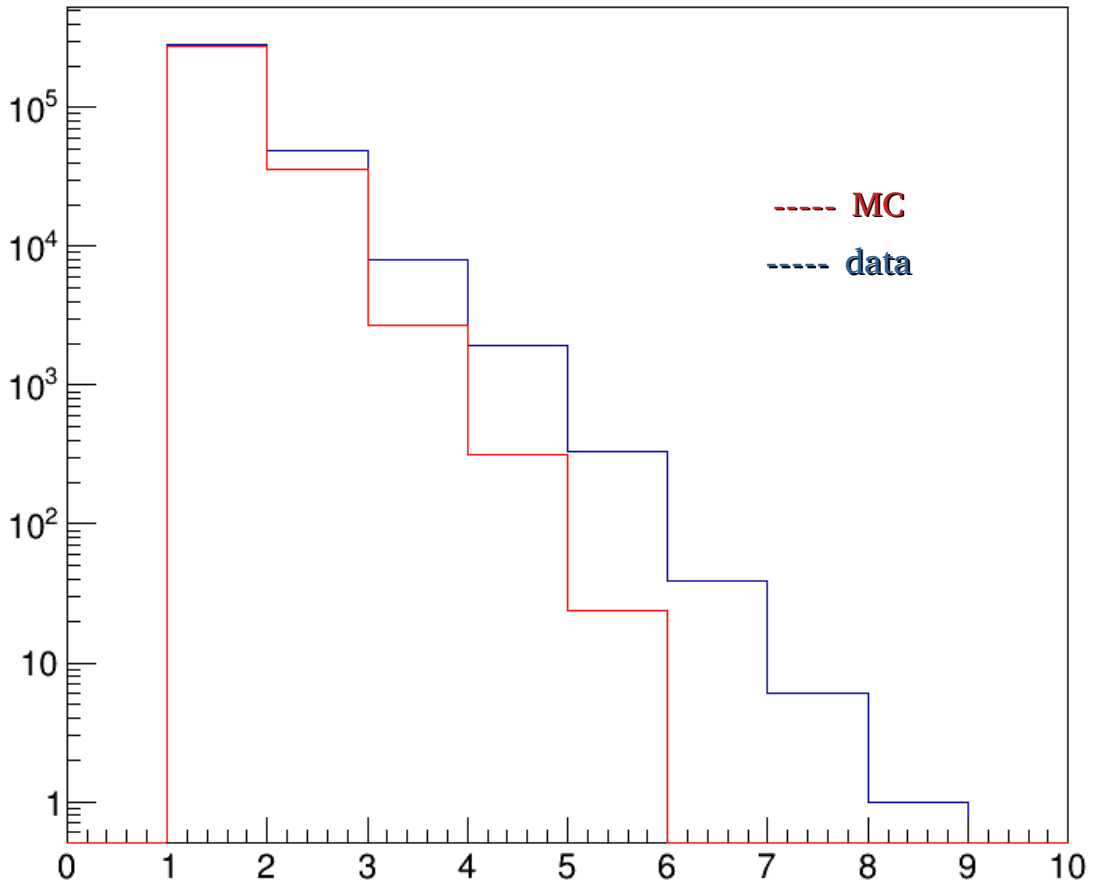
Fraction of clus size > 1 / total clusters





Is there a correlation between cluster size > 1 and resolution worsening? → not definitely

Clus size distribution for 400k events: data vs MC

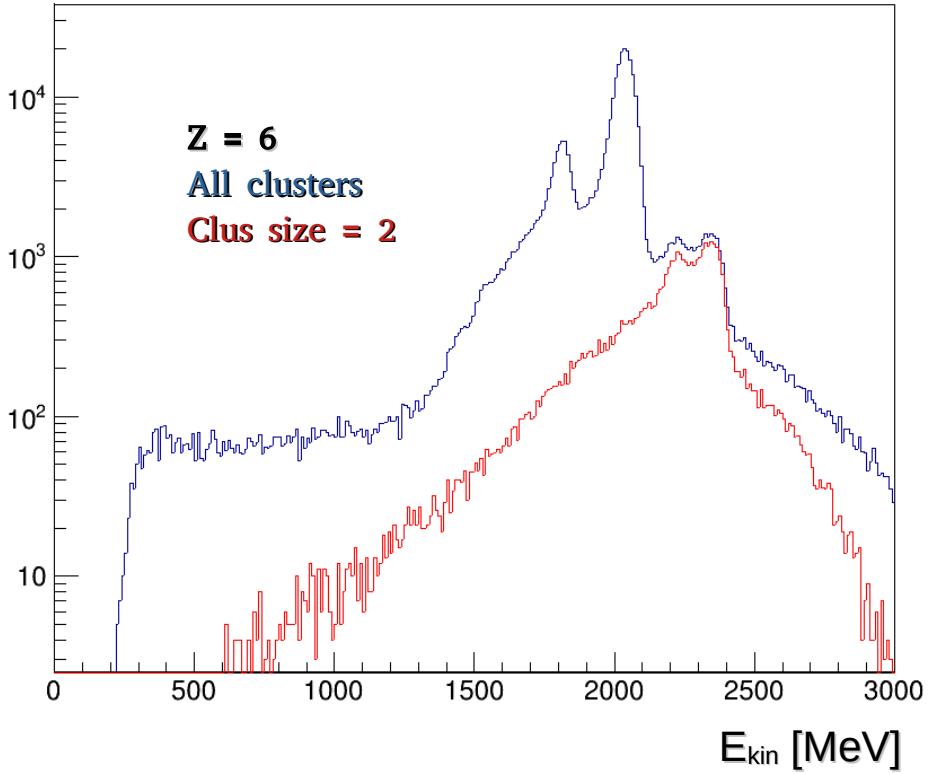


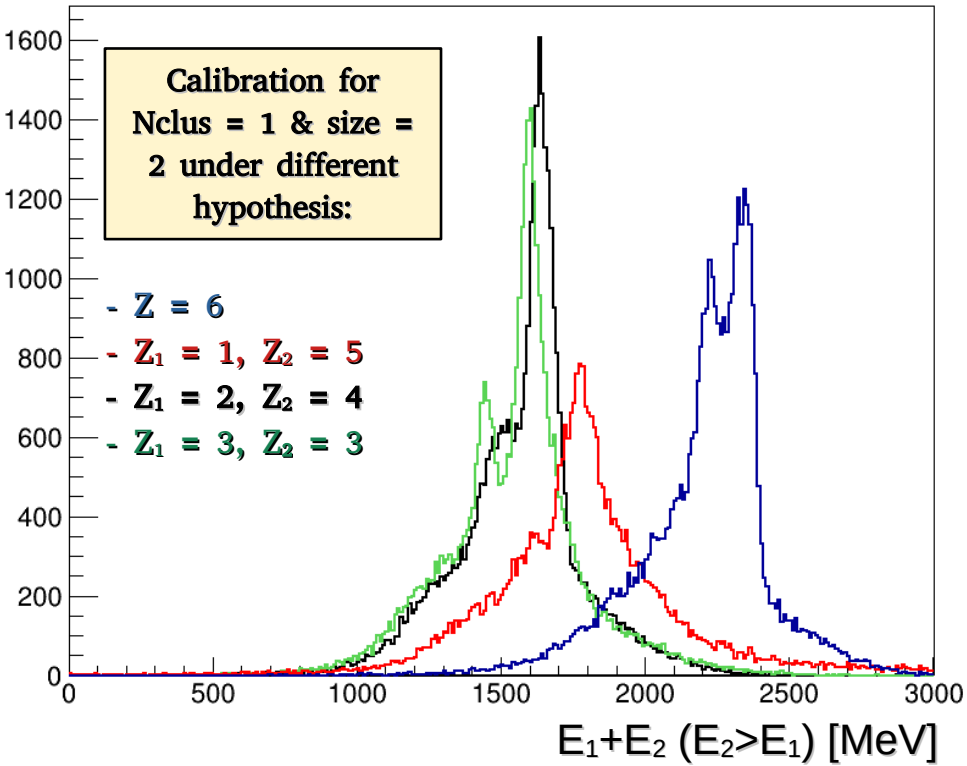
Are there noisy clusters?
Possible, but

warning: log scale on y

→ 3-4% of clusters have size > 2.

Z = 6, clus size = 2





Possible multiple fragments with Z_{tot} = 6 grouped together → energy overestimation due to calibration.

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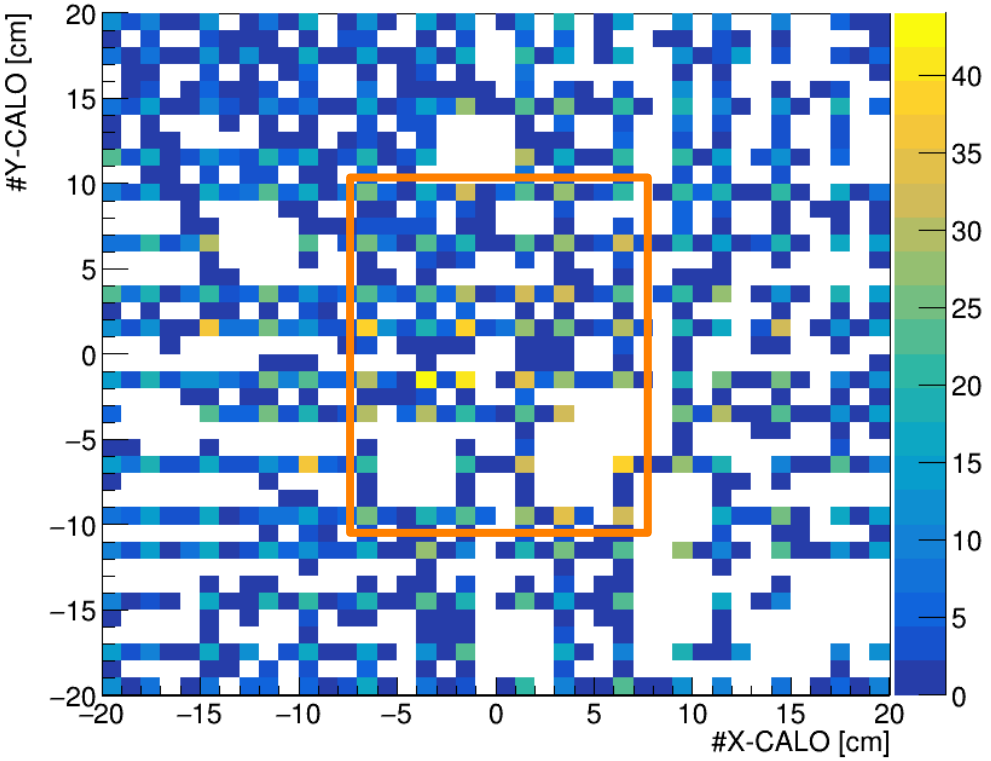
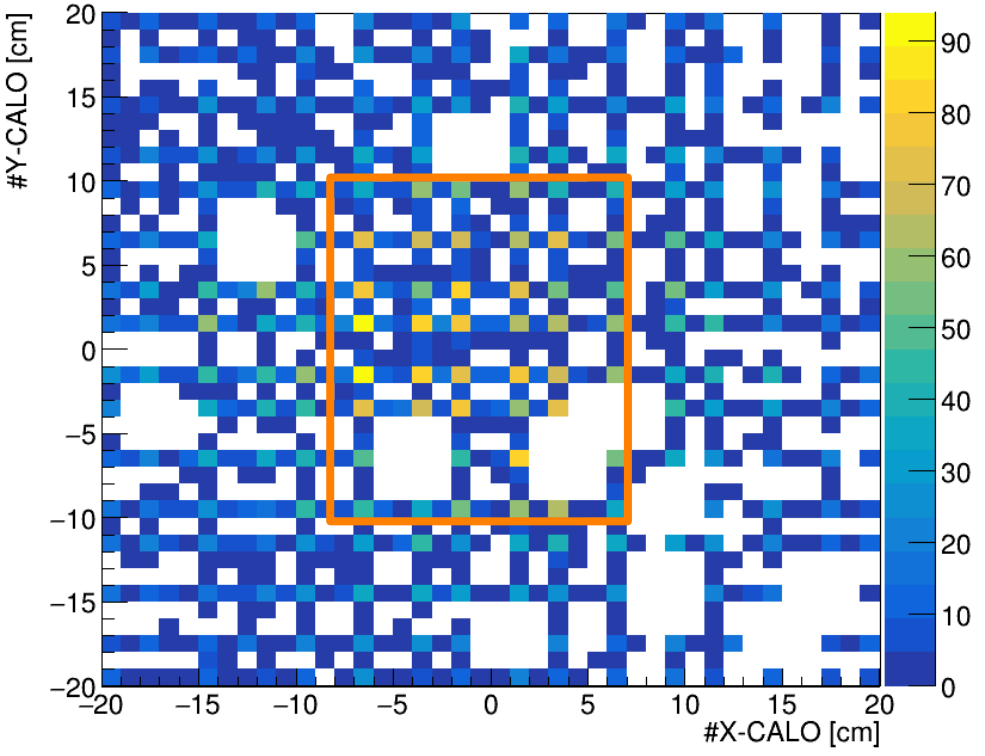
Cluster distribution (run 7072) Z = 1, 2

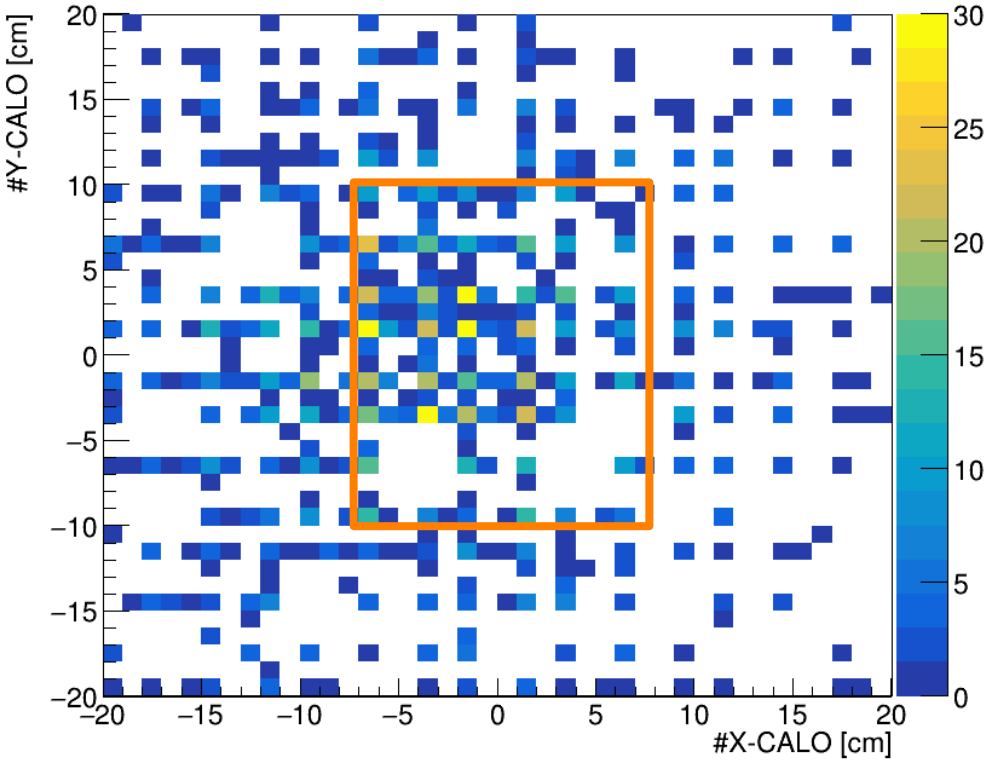
More effects of energy calibration can be investigated by looking at clusters distribution.

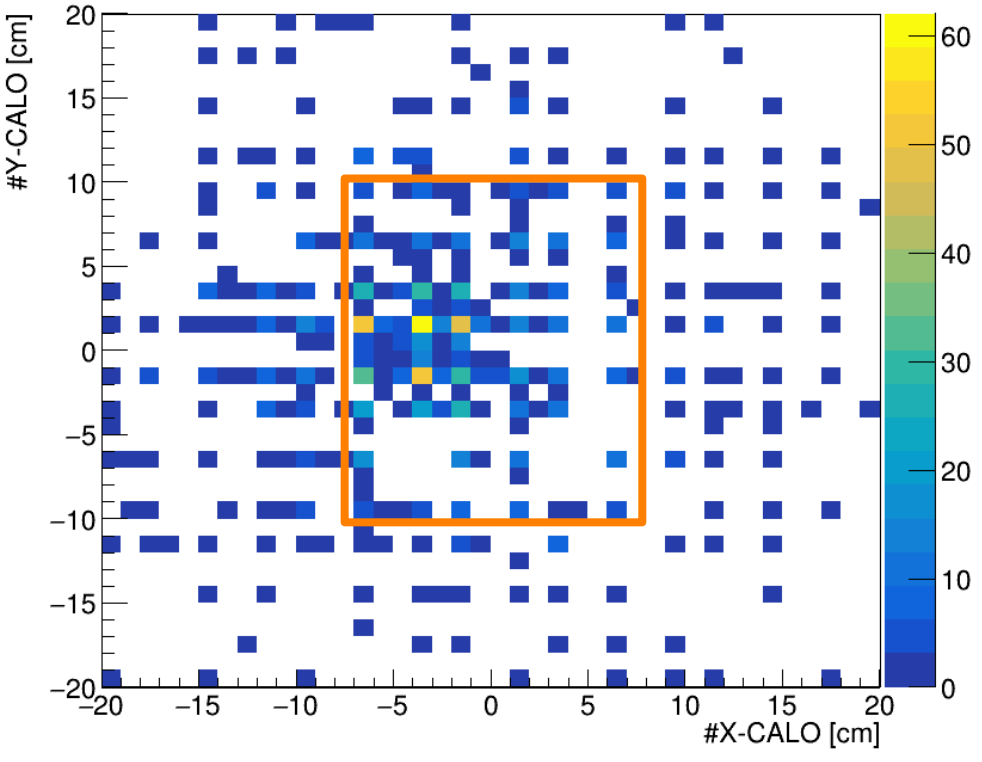




Cluster distribution (run 7072) Z = 3, 4

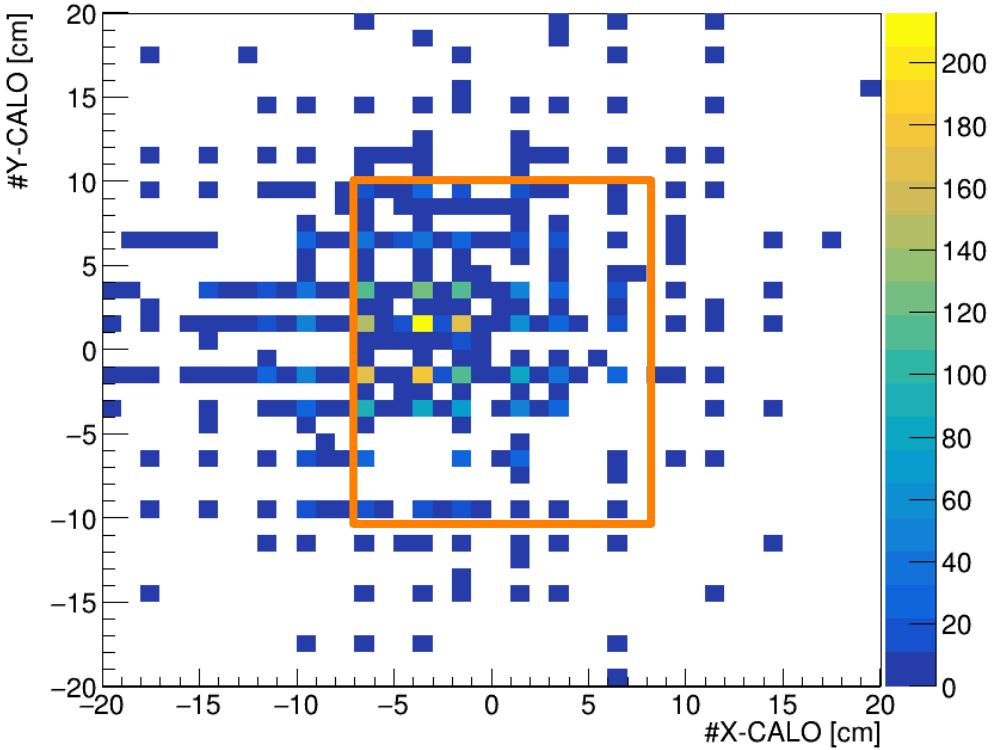
With increasing Z, the fraction of outer clusters (out of the orange box) decreases.

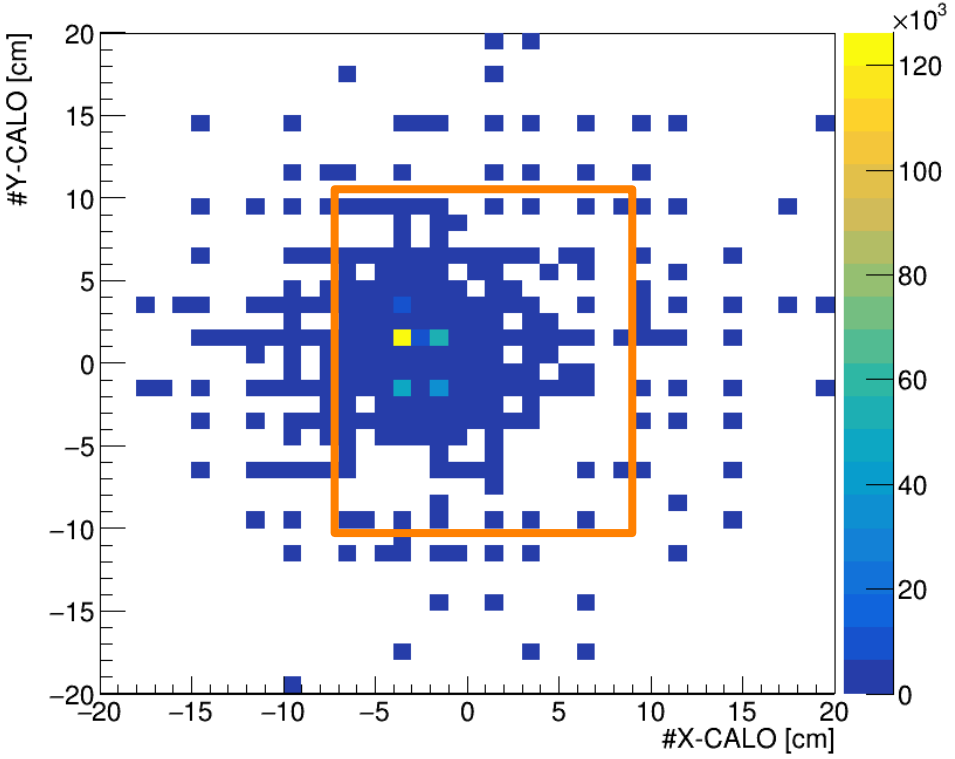




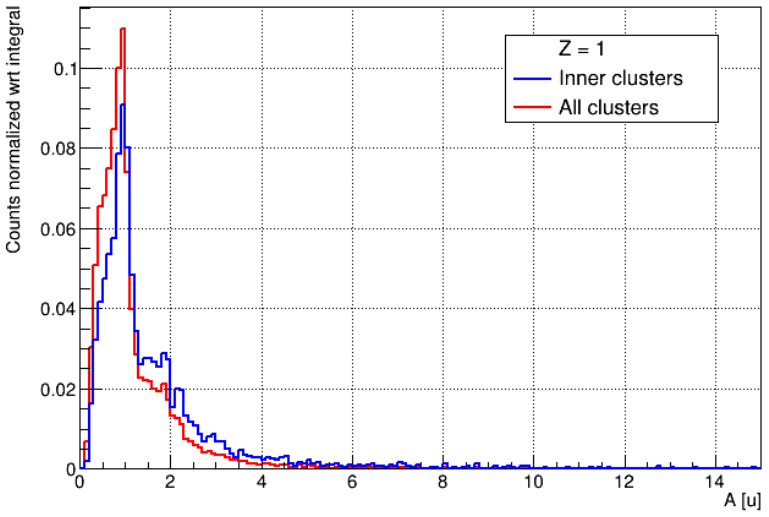
Cluster distribution (run 7072) Z = 5, 6

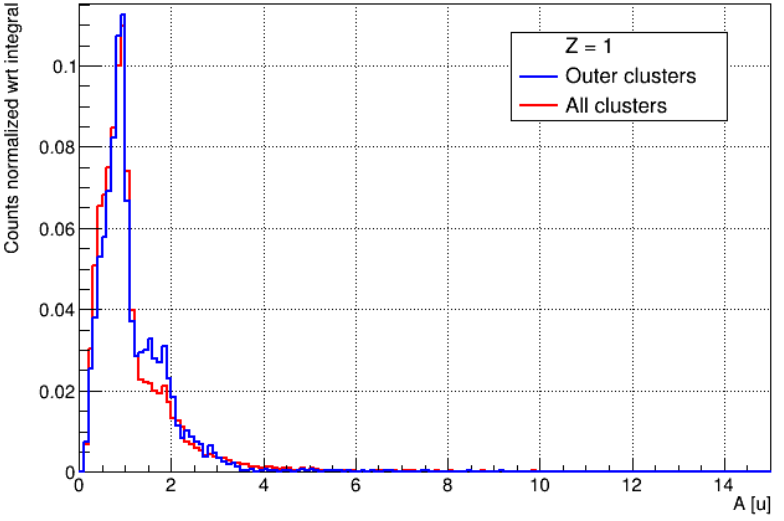
With increasing Z, the fraction of outer clusters (out of the orange box) decreases.

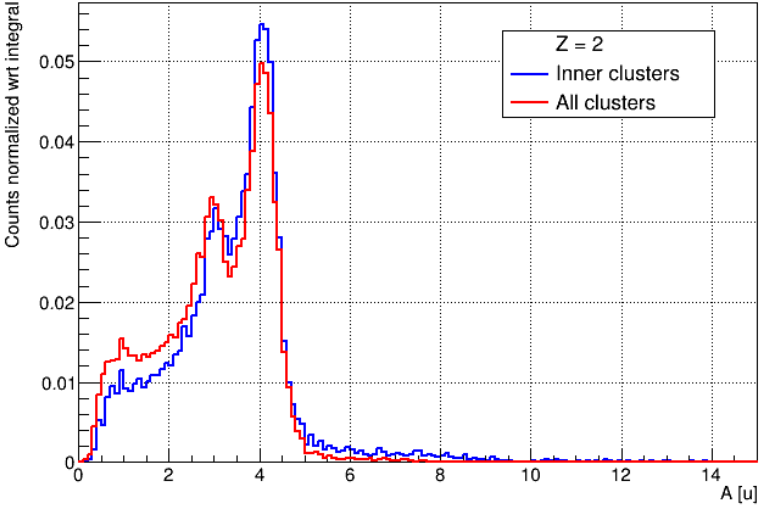


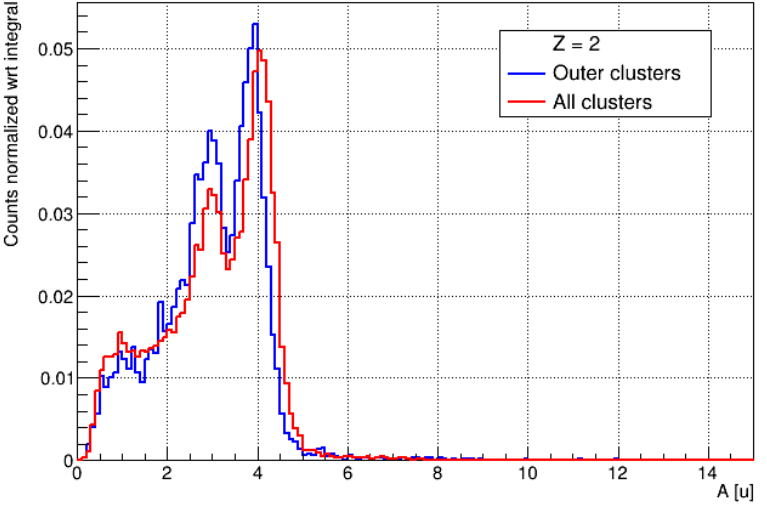


Inner vs outer clusters (Z < 3)

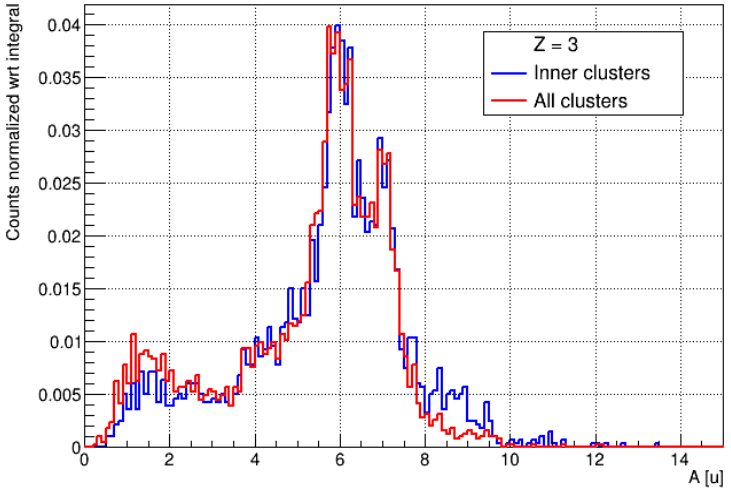


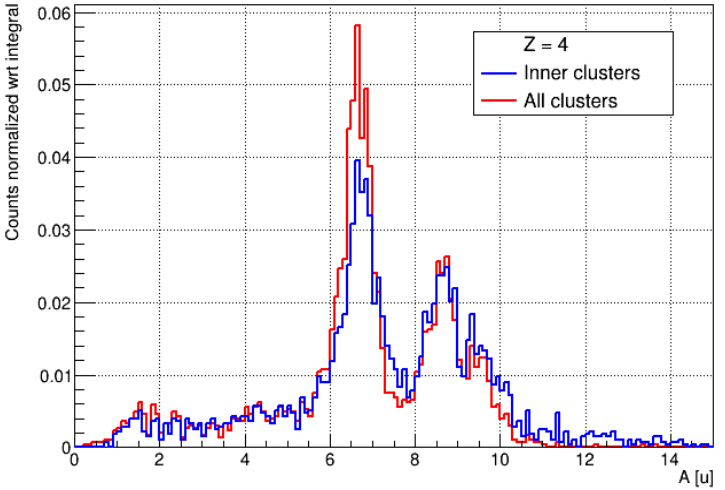


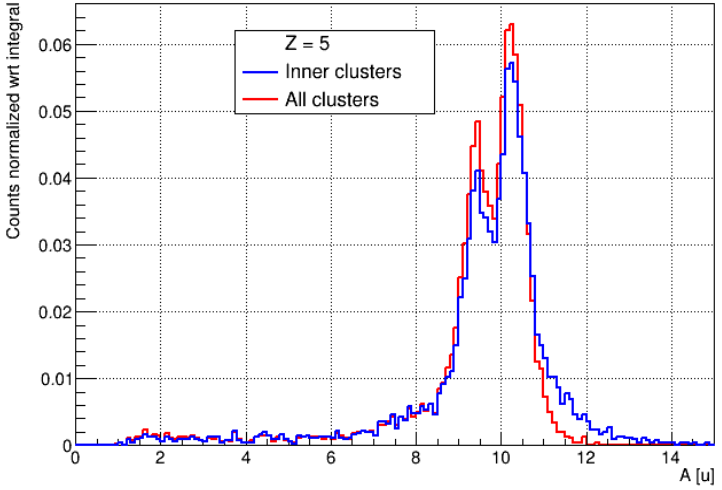


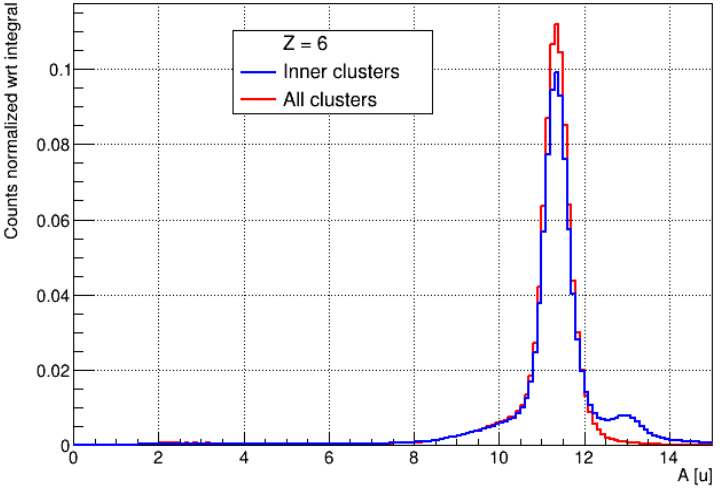


Inner clusters vs all clusters (Z > 2)









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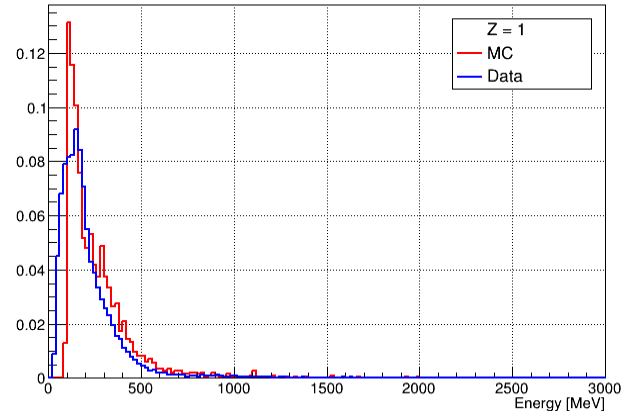
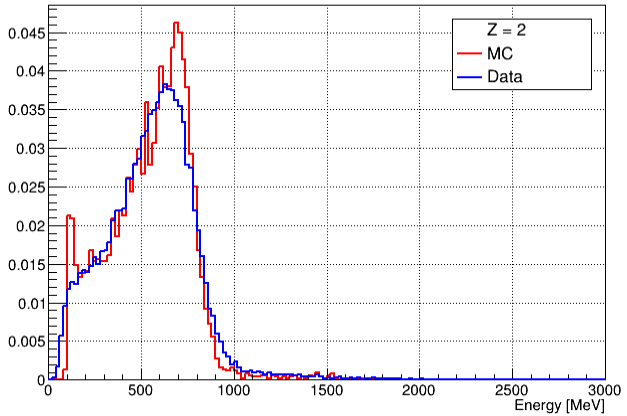
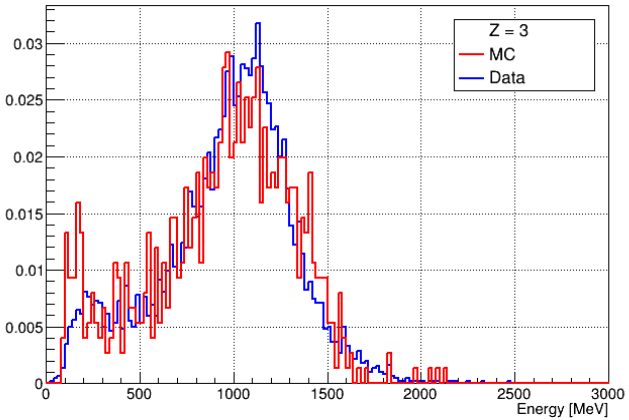
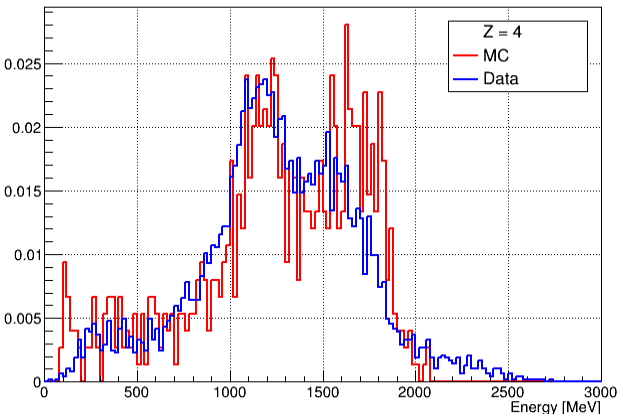
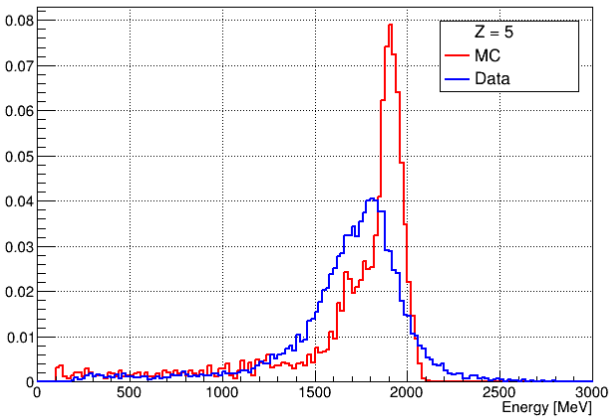
Normalized E_{kin} distributions - data vs MC

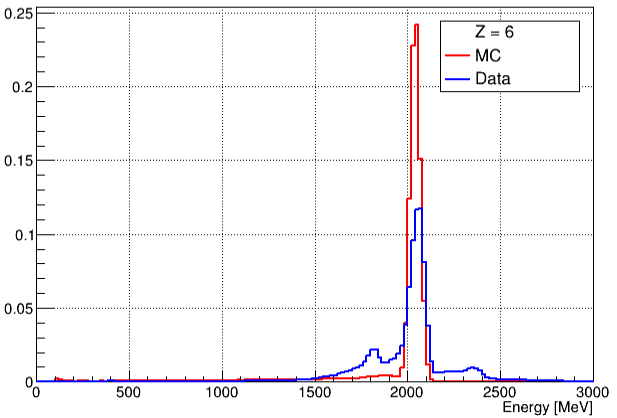




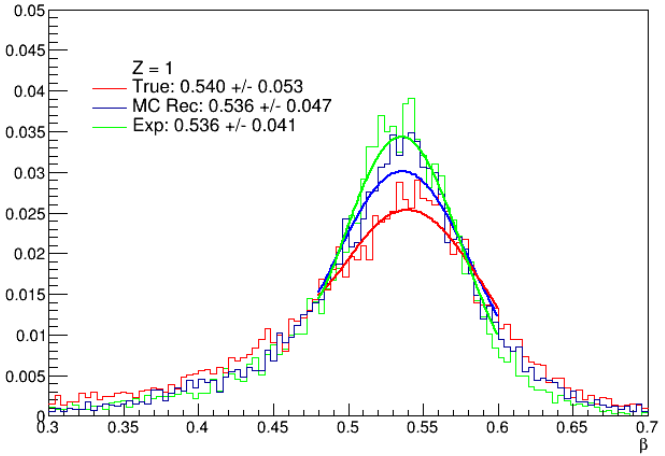


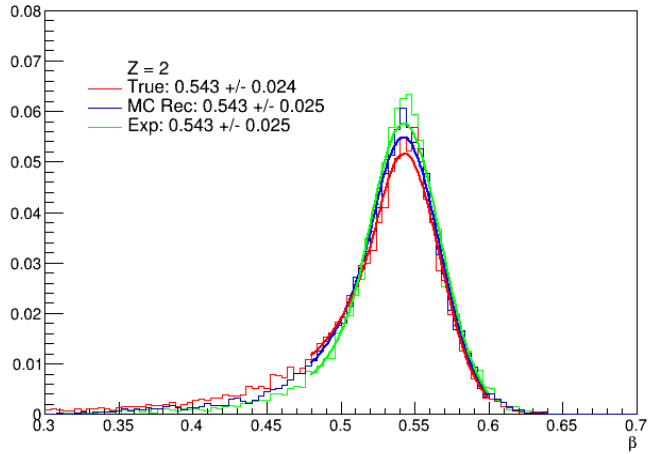


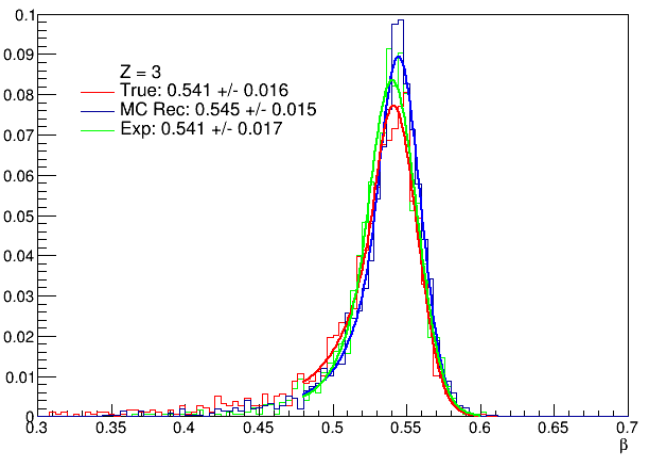


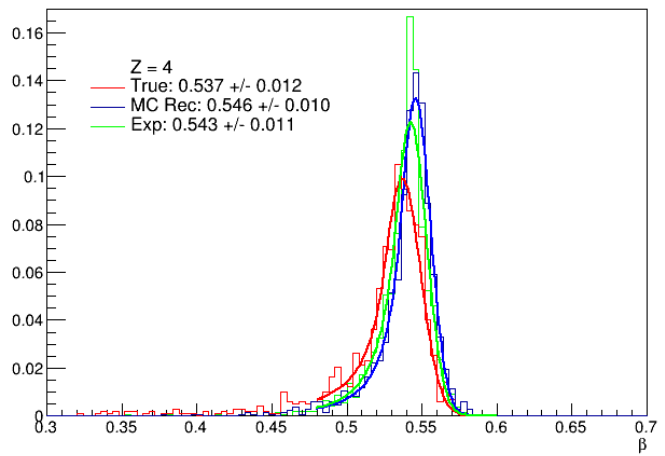


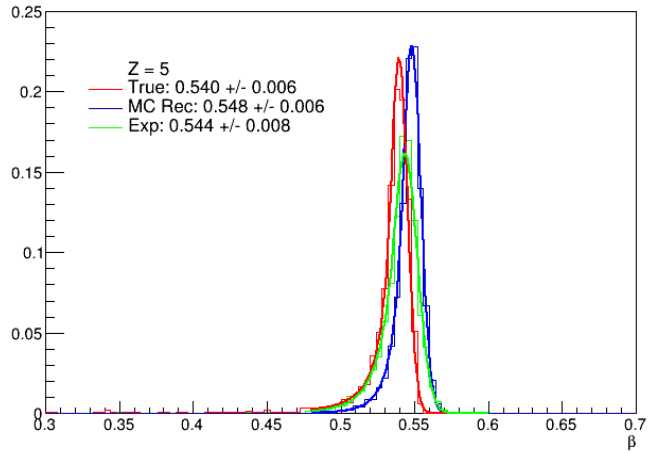
Normalized β distributions - data vs MC

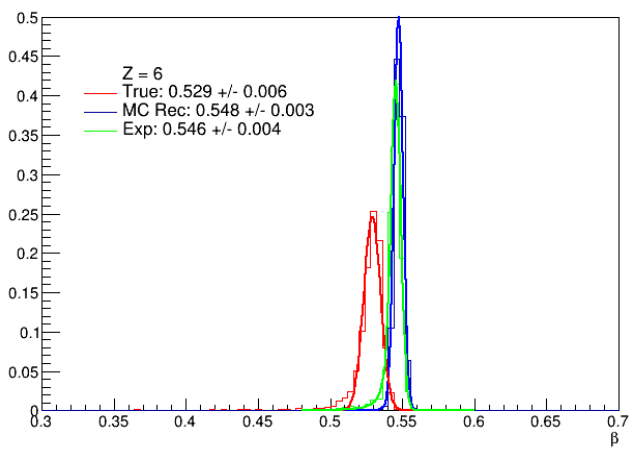




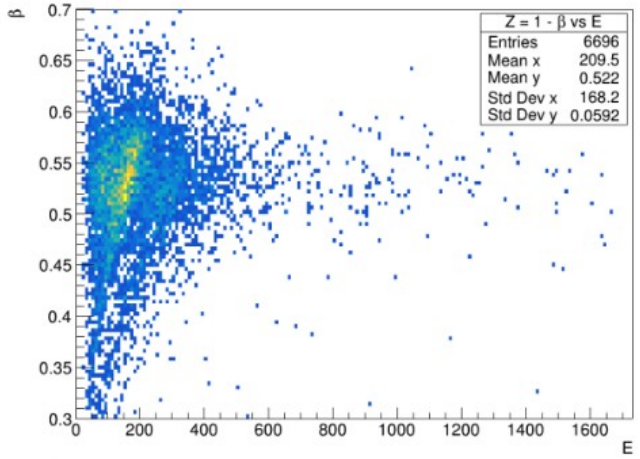


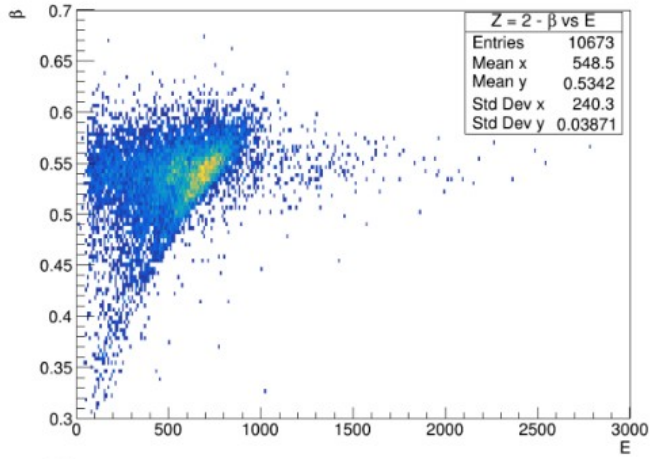


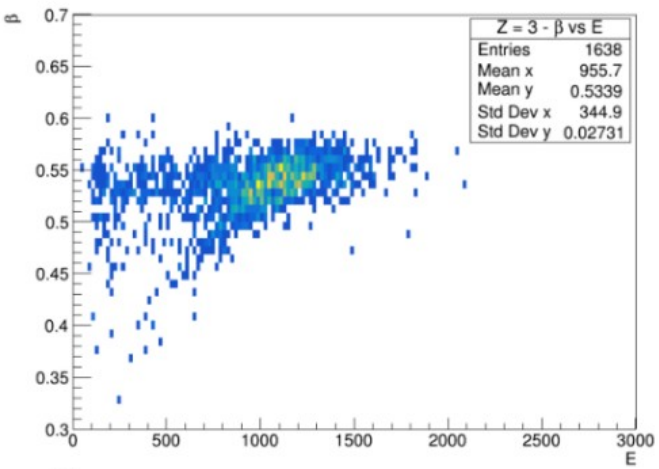


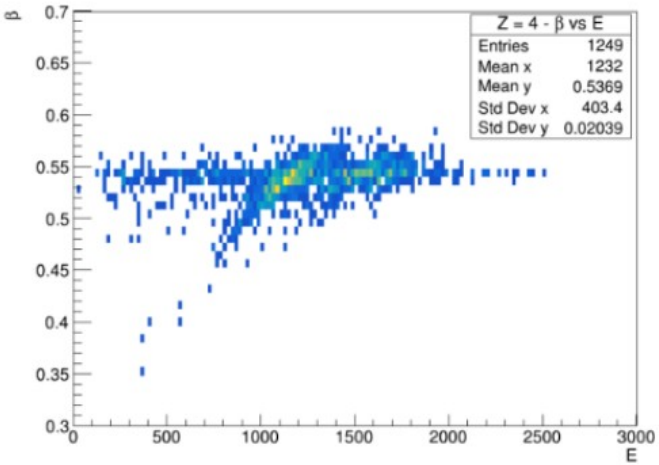


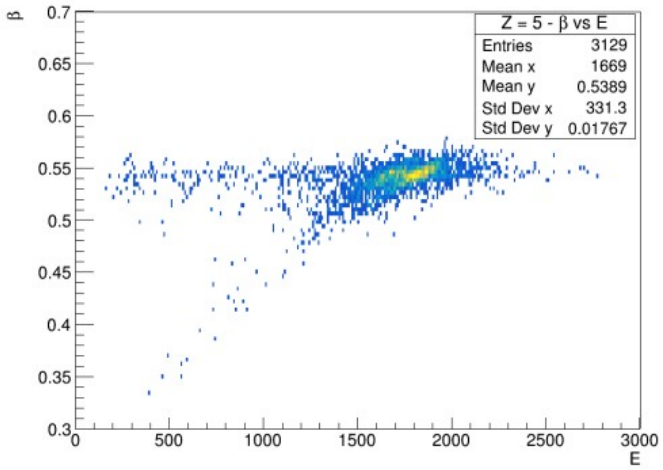
β vs E_{kin} distributions

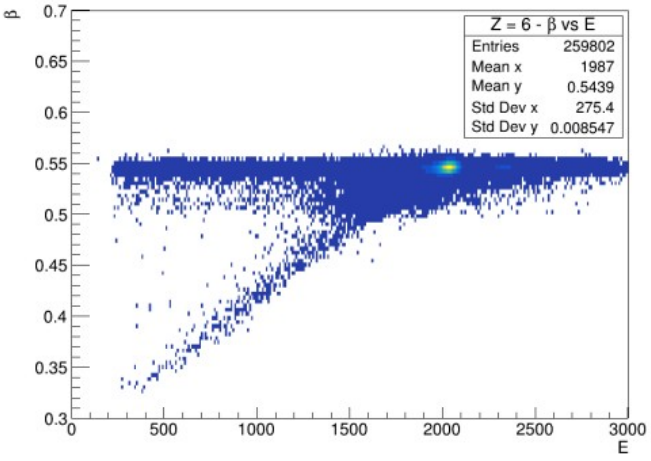












Conclusion and possible future studies

- Intrinsic efficiencies of clustering and matching for Z-Id (MC analysis)

  → in MC reconstruction, clustering of multiple fragments and Z misidentification is also present, anyhow mass resolution is close to optimal;
- Main difference between MC and exp clusters & correction attempt

  → MC clusters are created from true energy values, however a 2nd clustering and matching based on energy does not improve mass reconstruction → gain/ADC response equalization before calibration might help;
- Z distributions (MC vs exp)

  → TW and CALO Z distributions are in good agreement (taking into account for geometry losses and calibration inefficiencies) → still room for improvement of exp vs MC Z distribution.
- Cluster size analysis; possible drawbacks for clus size = 2

  → cluster size > 2 are about 3% of the total; multiple fragments clustering leads to energy overestimation → possible "cure" coming from calibration and ADC equalization, further benefits from the tracking system;
- Effects of cluster position on resolution; geometry plots → inner clusters show (slightly) better mass resolution only for Z > 2 → however, calibration improvements for outer crystals might help;
- **β** vs E_{kin} distributions → no new outcome wrt to older analysis, E_{kin} distributions still in low agreement with MC

  → currently trying calibration wrt to E/Z values.