Simulation of charged spectator distributions on ScWall for XeCsI@3.9 AGeV
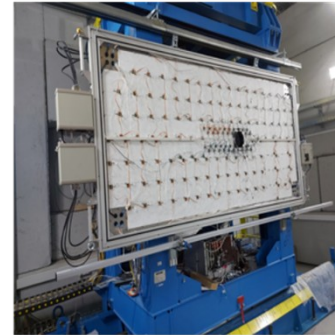
Elizaveta Zherebtsova
INR RAS & NRNU MEPhI

BM@N Collaboration Meeting, 12-16 September 2022

The goal of this work

- A new scintillation detector (ScWall) has been installed in the BM@N experiment and will be operational in 2022.

- Scintillation wall measures dE/dx of fragments

- It is extremely important to check how the dE/dx spectra and multiplicity of fragments are described by different models.
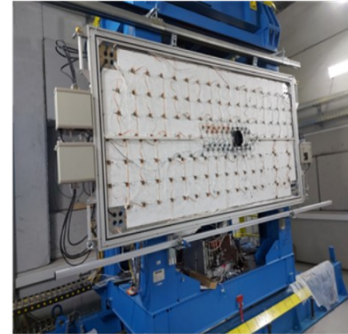
Analyzed Data

Detector: ScWall (Scintillation Wall)

Generators: Full simulation in the BMNROOT for DCM-SMM and PHQMD with MST and SACA

Collision System: Xe+CsI at T0=3.9AGeV ($\sqrt{s_{NN}}$ = 3.296 GeV)

ScWall:

- 36 small cells 7,5 x 7,5 cm^2

- A hole 15 x 15 cm^2

- 138 large cells 15 x 15 cm^2

PHQMD generator

Clusters recognition:

- SACA (Simulated Annealing Clusterization Algorithm)
- MST (Minimum Spanning Tree)

The MST algorithm searches for accumulations of particles in coordinate space:

1. Two particles are 'bound' if their distance in the cluster rest frame fulfills

$$| r_i - r_j | \leq 4 \text{ fm}$$

2. Particle is bound to a cluster if it bounds with at least one particle of the cluster.

- SACA algorithm is based on the search for nucleon configurations with a minimal binding energy: SACA takes randomly one nucleon and adds it to another fragmet until the most bound configuration will be found. In SACA algorithm is it necessary to chose the time for its starting.

J. Aichelin et al., PRC 101 (2020) 044905

PHQMD generator

- To use the SACA fragmentation module, the fragmentation parameters were investigated depending on different predetermined times for the start of cluster formation.

- The first start time was set as 60 fm (time step 1), the final time step corresponds to 160 fm (time step 10), the step is 10 fm.
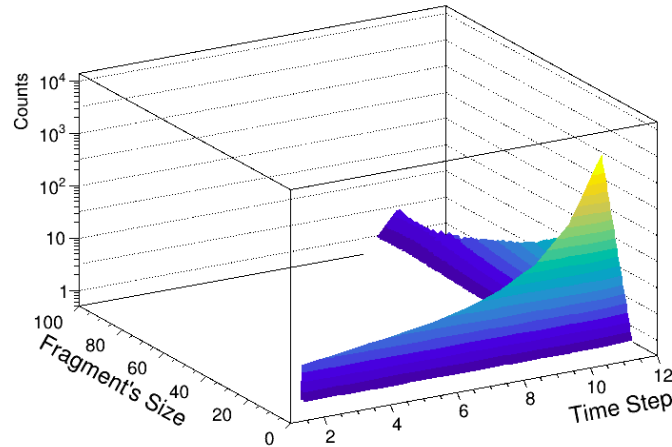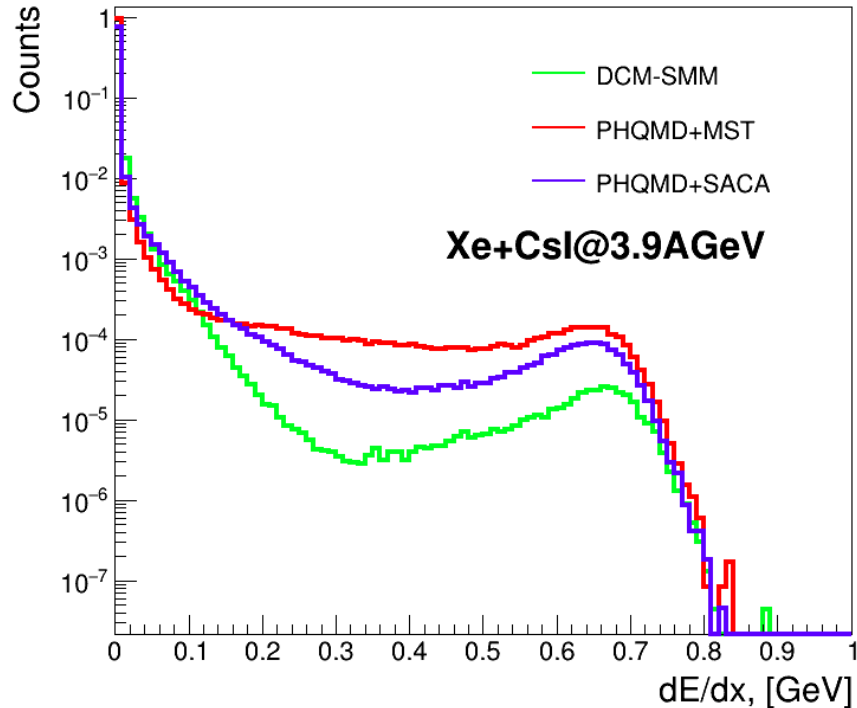

If make the algorithm start too early it will be a huge amount of clusters, if start too late after stabilisation of particles multiplicity, it will be a very few fragments.
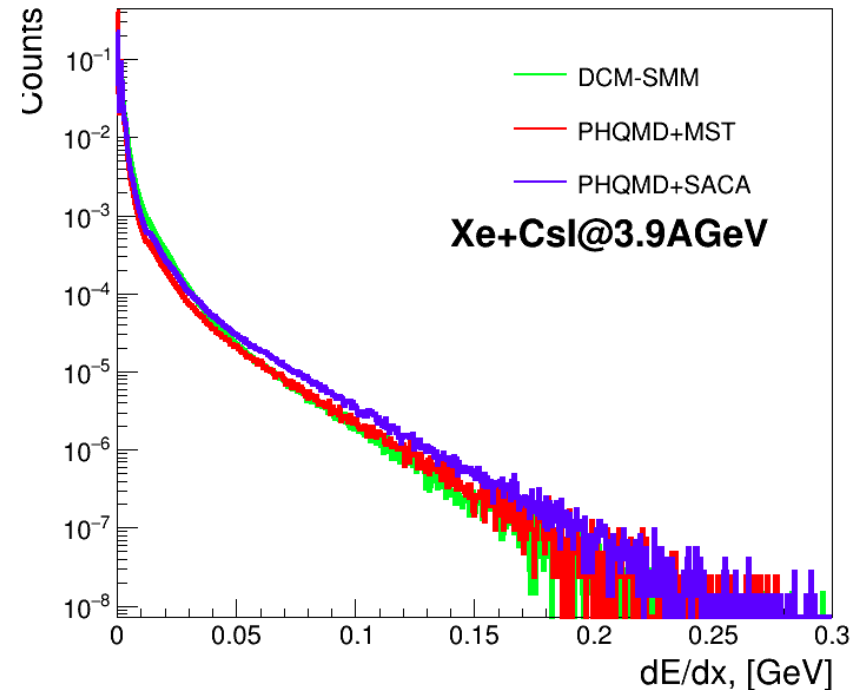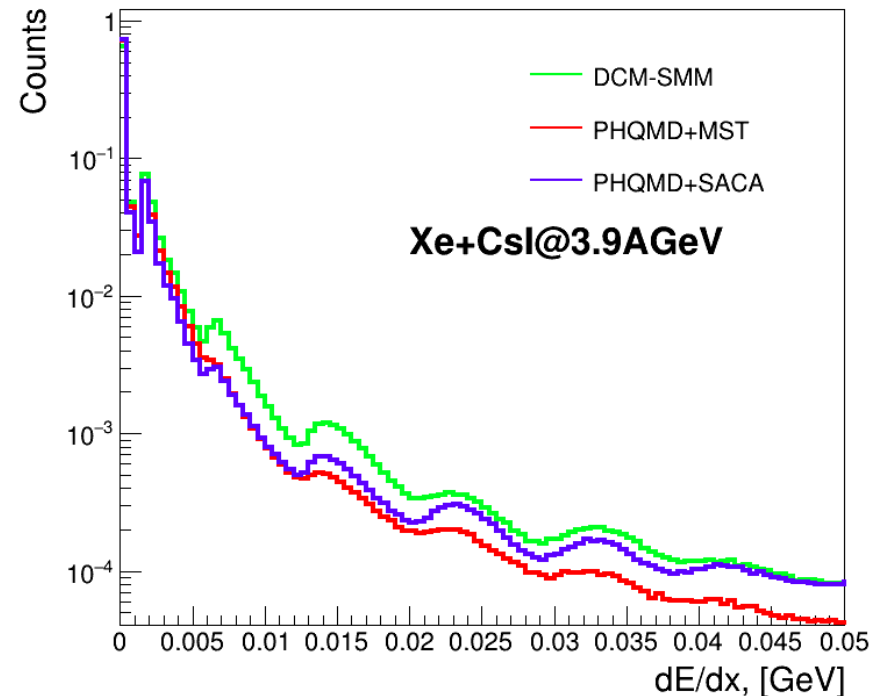
dE/dX in ScWall comparison in different event generators

- No events selection
- Pure data from PHQMD simulation without any additional cuts on fragments selection
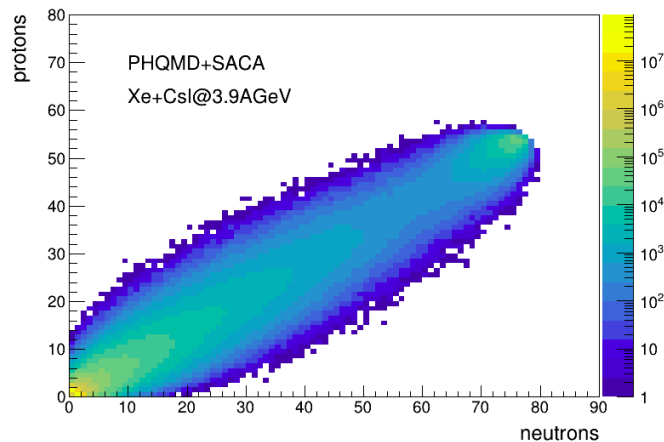
Small cells:

Large cells:

dE/dX in ScWall comparison in different event generators

- No events selection
- Pure data from PHQMD simulation without any additional cuts on fragments selection
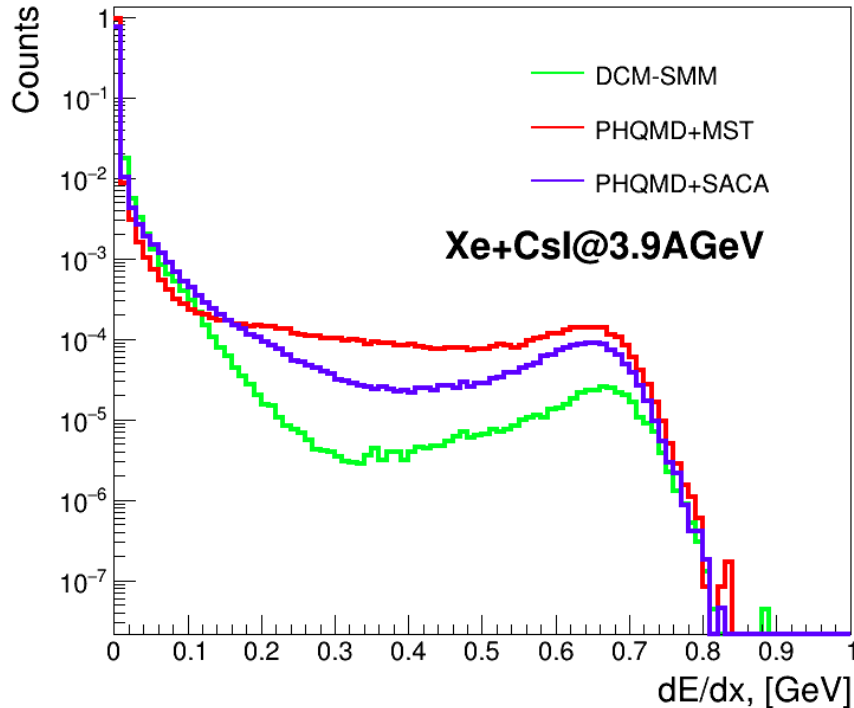
**Small cells:**   **Small cells — zoom view:**

PHQMD-SACA fragmentation module

- The first comparison of models shows that there is a significant discrepancy in the average range of dE/dx of small cells.

- In the course of further studies of cluster formation in the PHQMD generator, the presence of non-existing fragments was found

  - It was applied a fragments selection: (A=1 || (Z≤N & Z≥1)

All fragments:

With fragments selection:
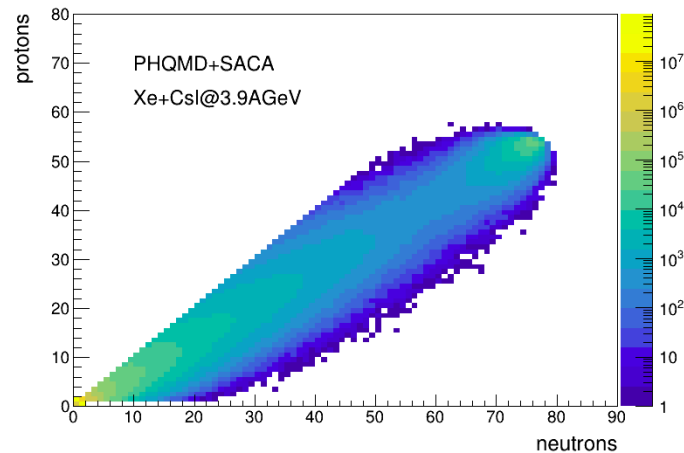
dE/dX in ScWall comparison in different event generators

- No events selection
- Fragments selection in accordance with the rule:
    - (A=1 || (Z≤N & Z≥1)
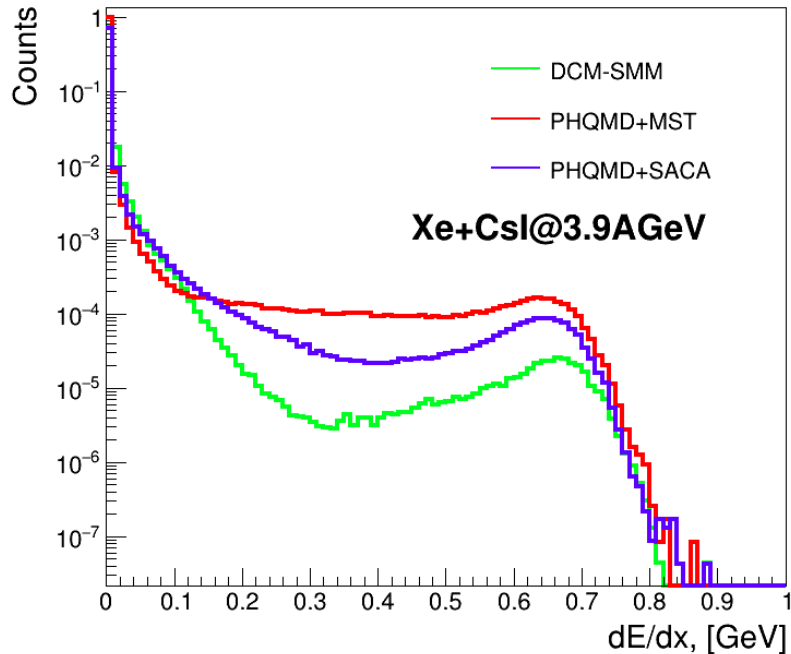
Small cells:

Large cells:
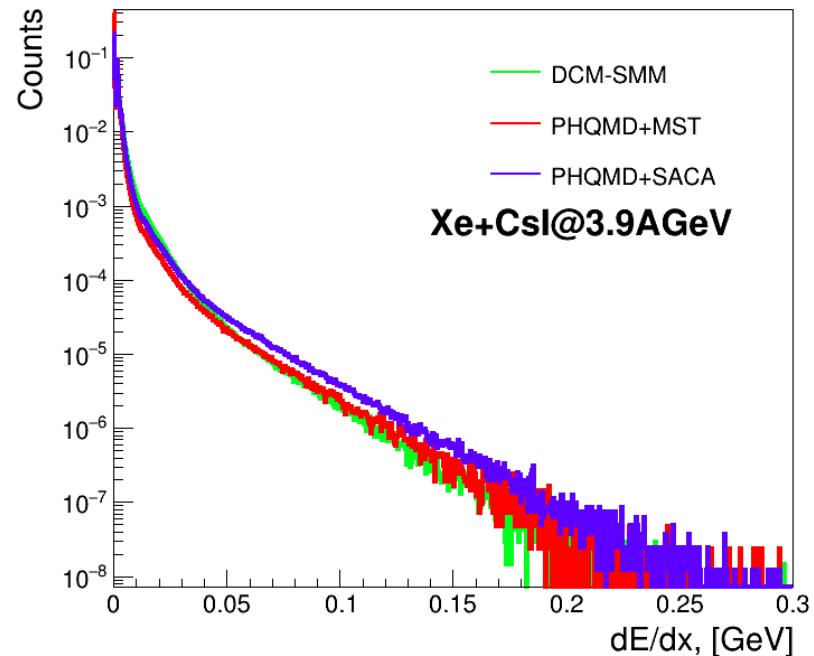
dE/dX comparison in different event generators

- No events selection
- Fragments selection in accordance with the rule:
  - (A=1 || (Z≤N & Z≥1)

Small cells:

Small cells — zoom view:

10
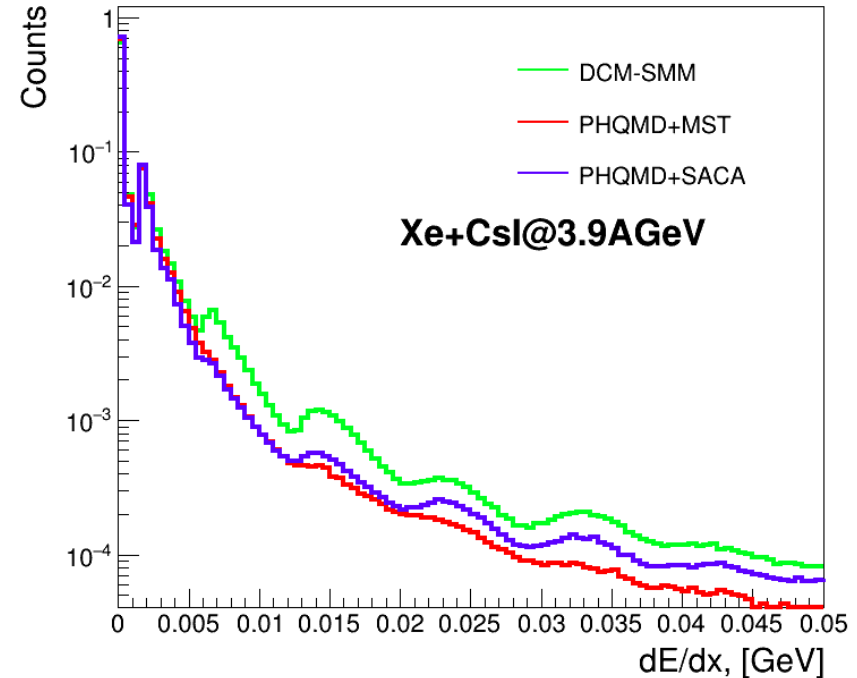
PHQMD-SACA fragmentation module

- During further investigations it was developed a procedure to take into account only physical clusters

All fragments:
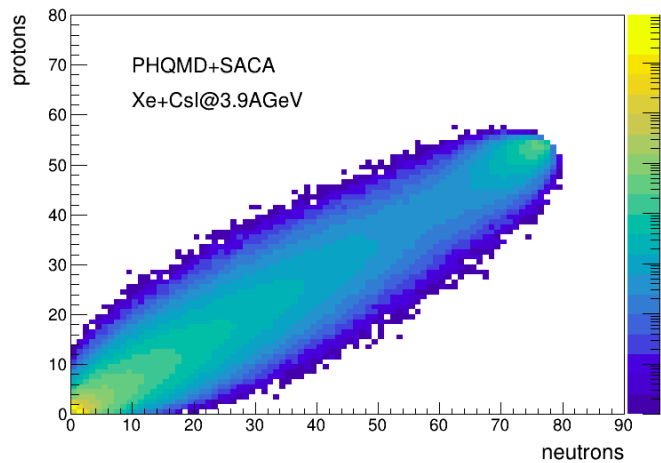
Physical fragments:
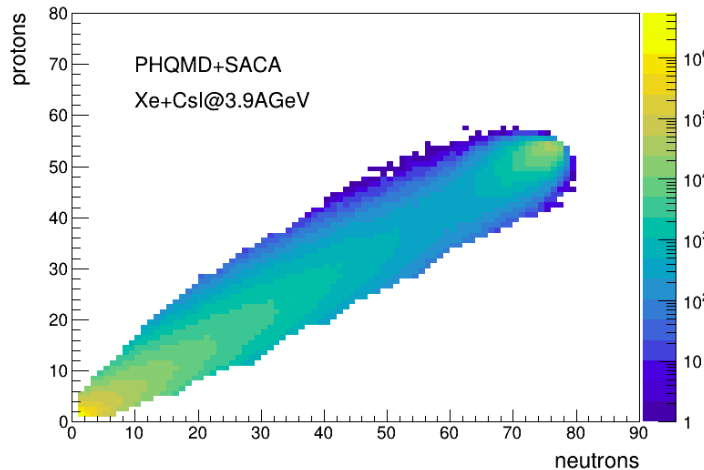
Existing chemical elements:
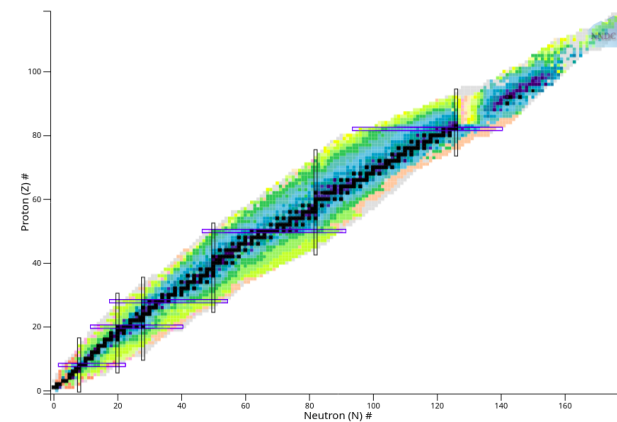
PHQMD-MST fragmentation module

- The same procedure was applied to the MST fragmentation module

All fragments:
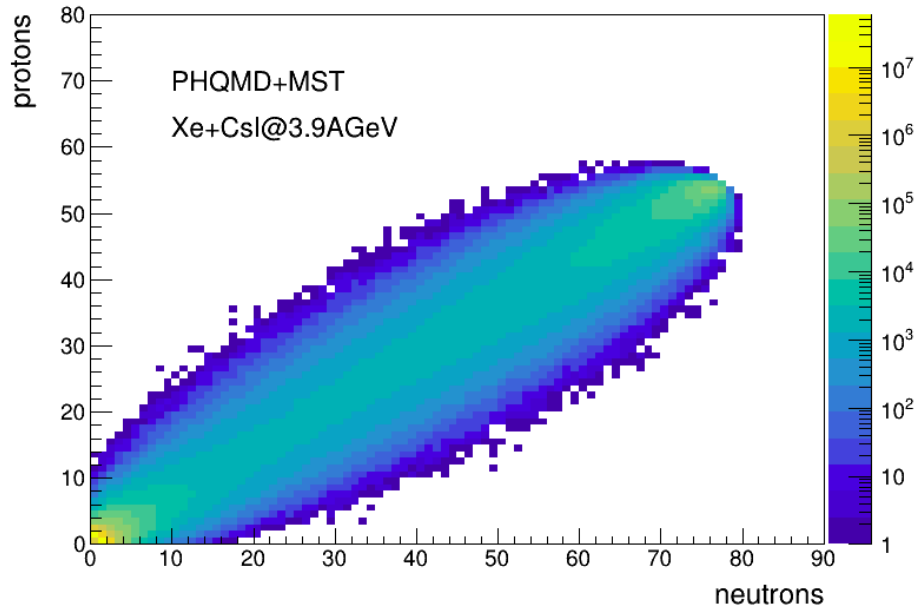
Physical fragments:
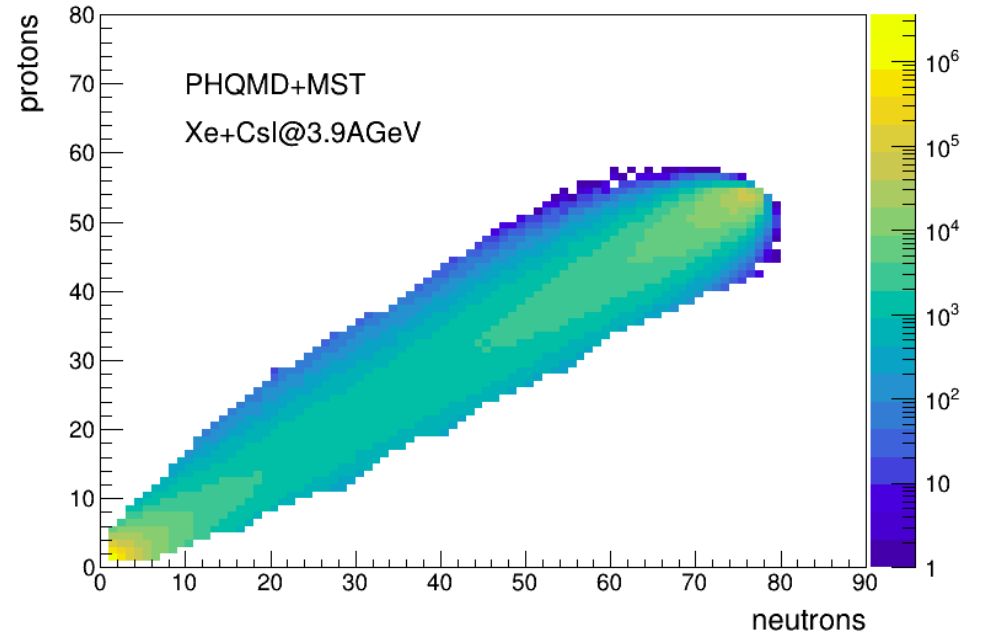
dE/dX comparison in different event generators

- No event selection
- Fragment selection:
    - Only physically existing chemical elements
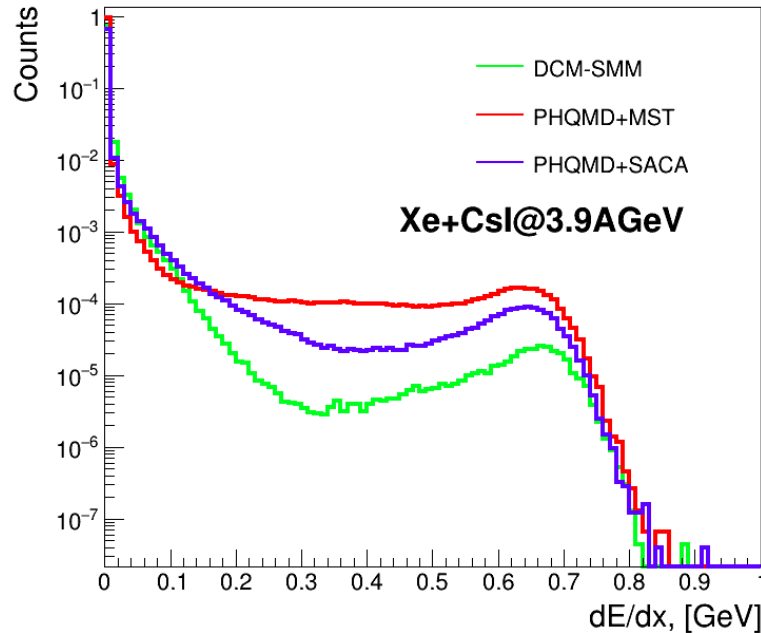
Small cells:

Large cells:
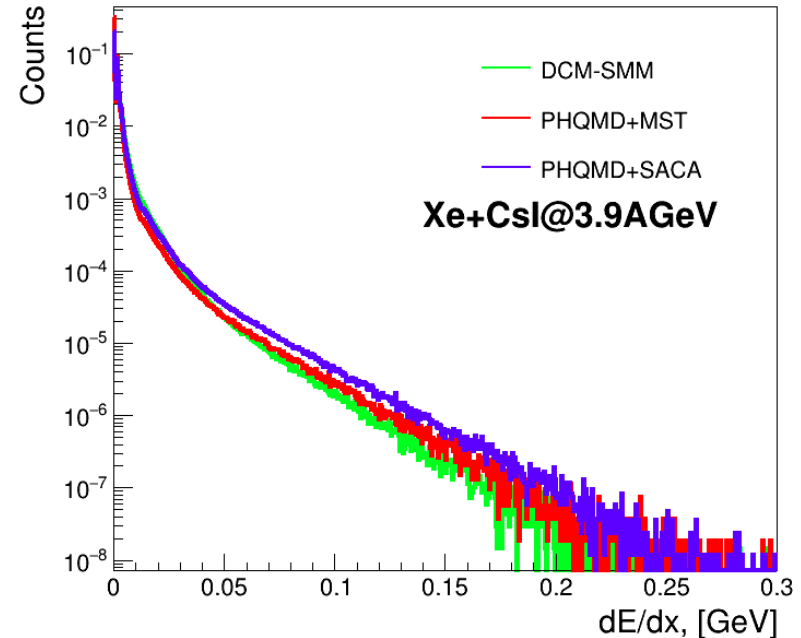
dE/dX comparison in different event generators

- No event selection
- Fragment selection:
    - Only physically existing chemical elements
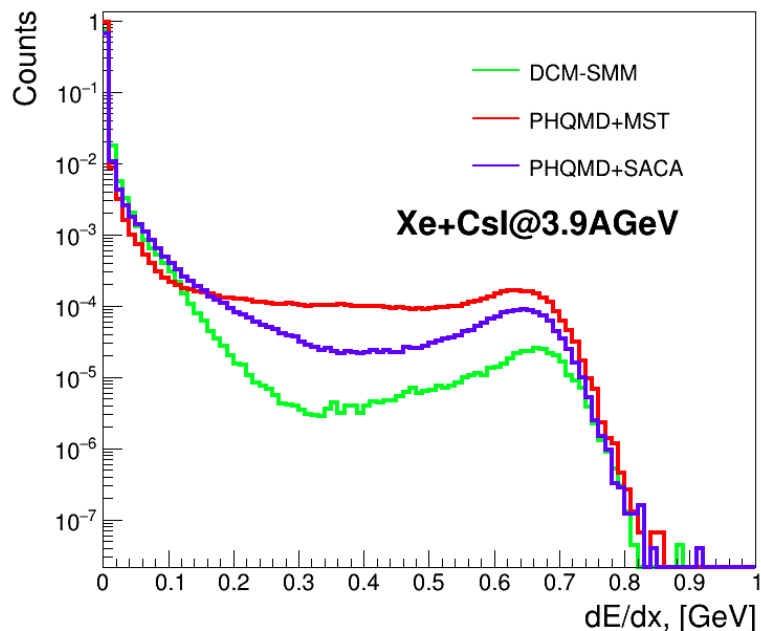
Small cells:

Small cells — zoom view:
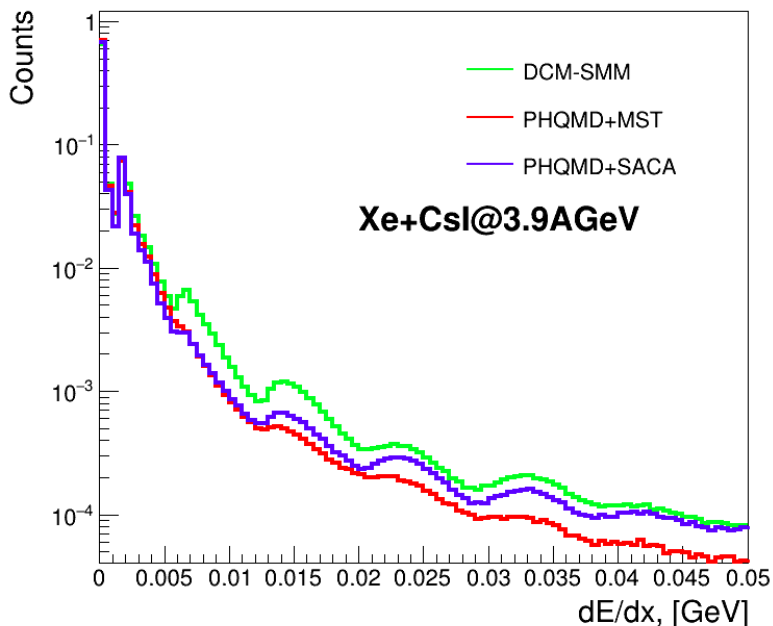
Comparison of ScWall dE/dX in the PHQMD+SACA generator for different selections of fragments
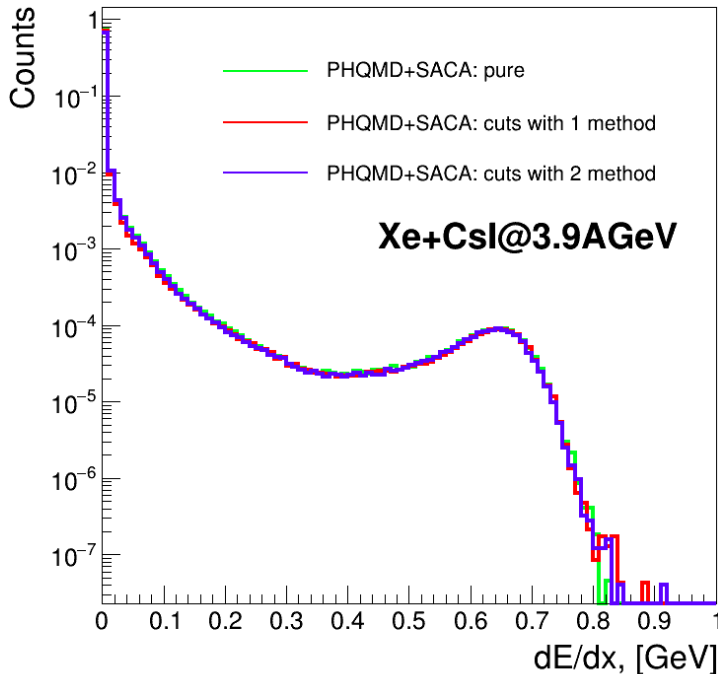
Small cells:

Small cells — zoom view:
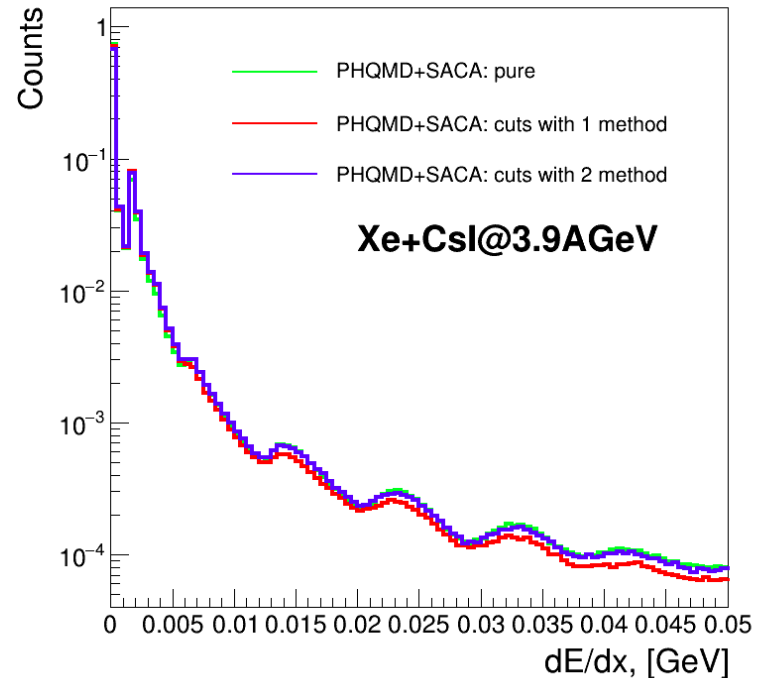
- After various fragment selection there is no difference in dE/dx spectra

15

Comparison of ScWall dE/dX in the PHQMD+SACA generator for different selections of fragments

Small cells:
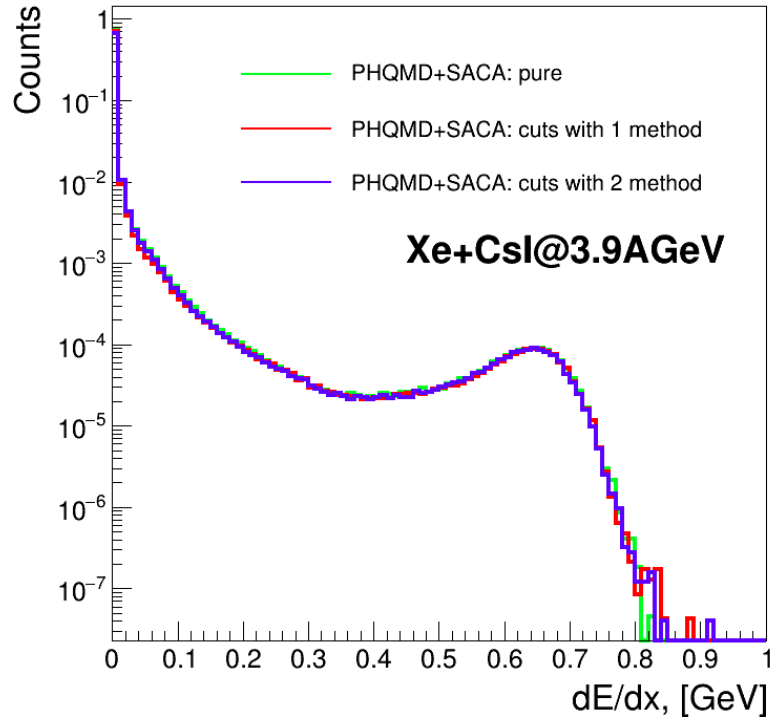
Large cells:
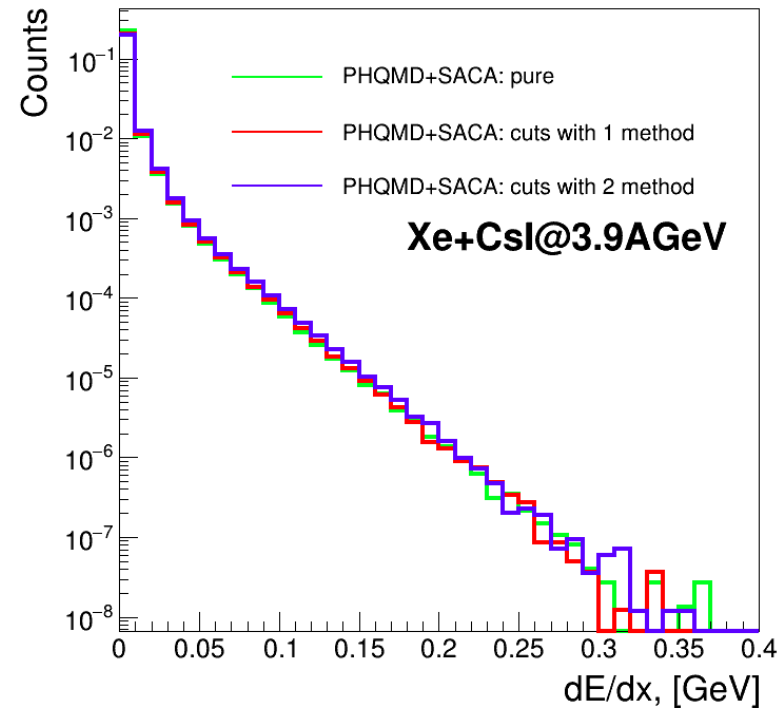
- After various selections of fragments there is no significant difference in dE/dx spectra

Number of fired cells in ScWall for different generators

Particles with Z=1:
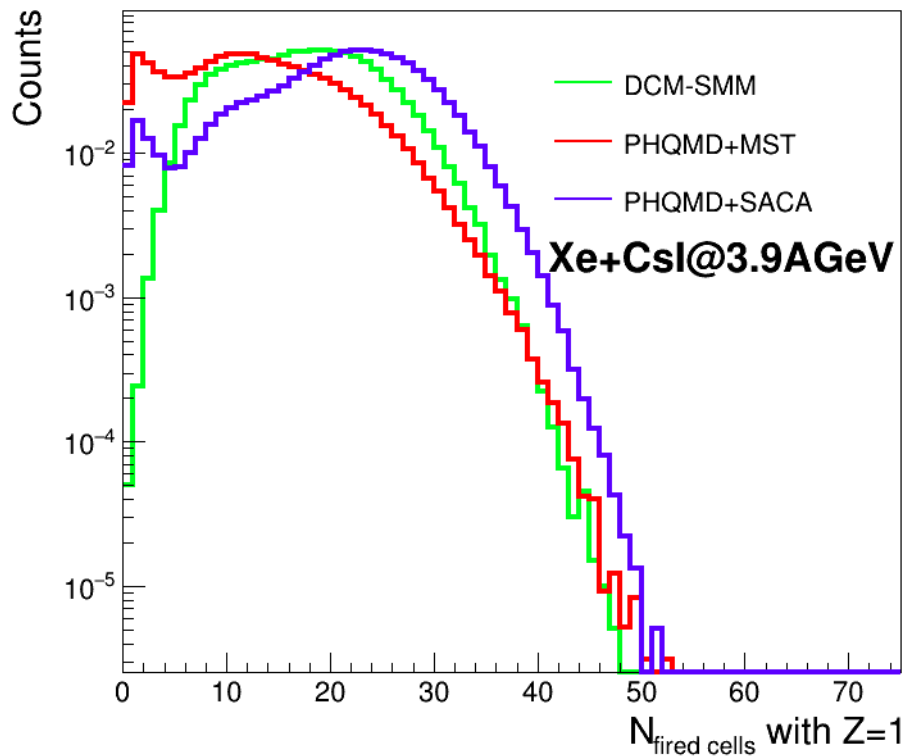
Particles with Z=2:
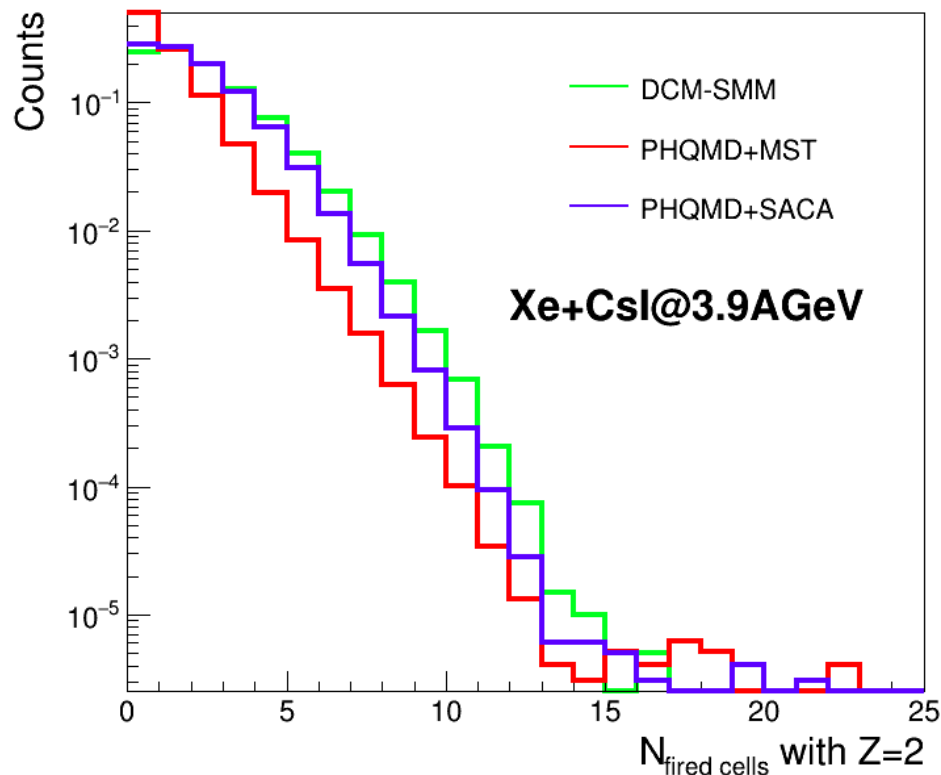
- Z1 particles are more sensitive to the different event generators

Number of fired cells in ScWall for different generators

Particles with Z=3:
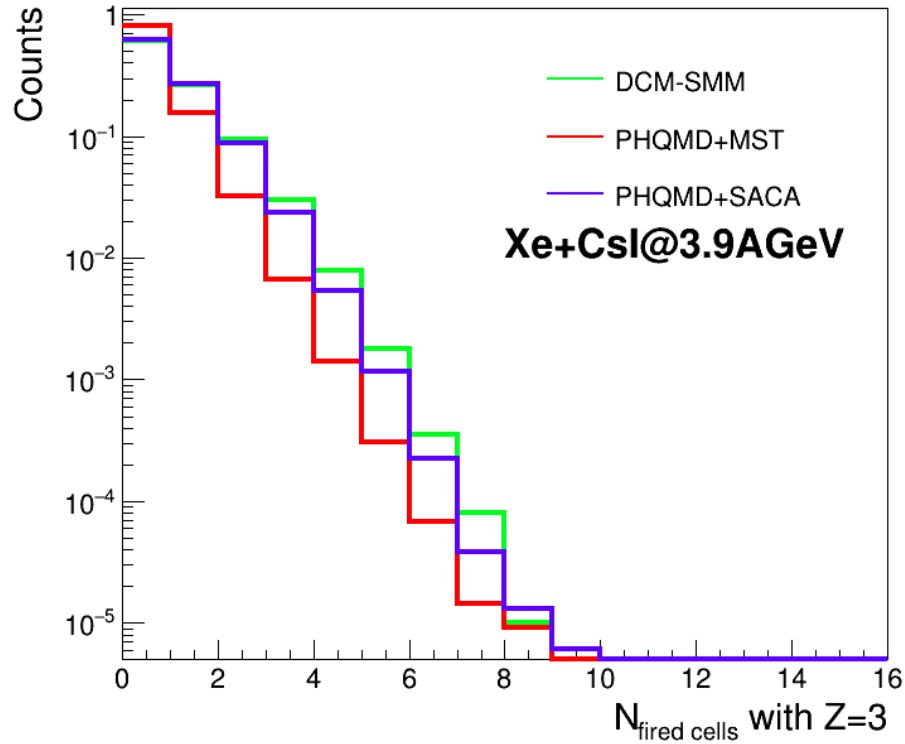
Particles with Z=4:
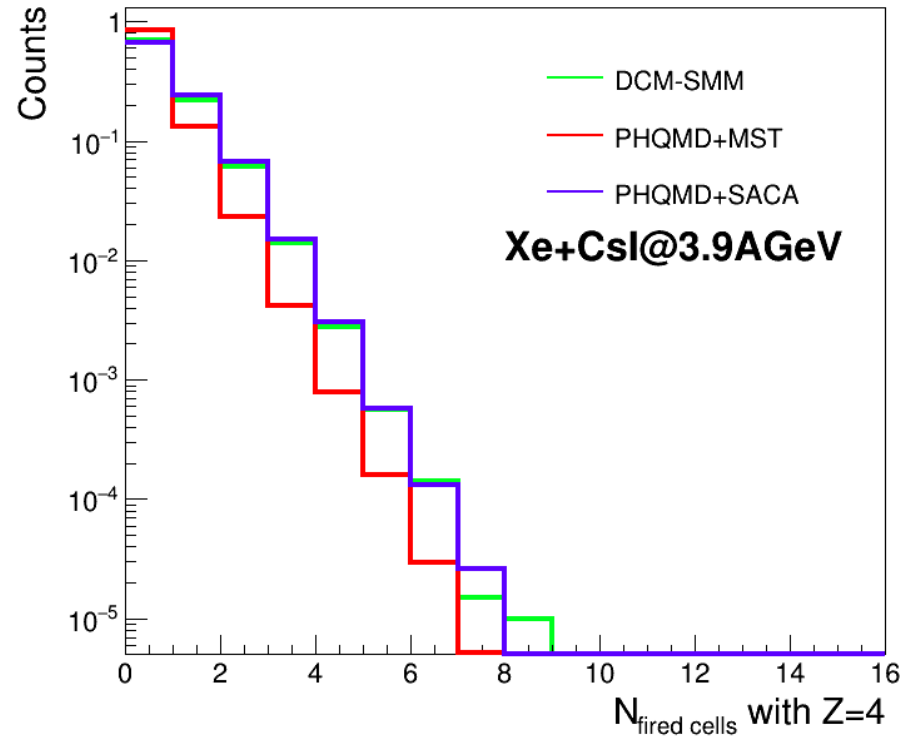
Number of fired cells in ScWall for different generators
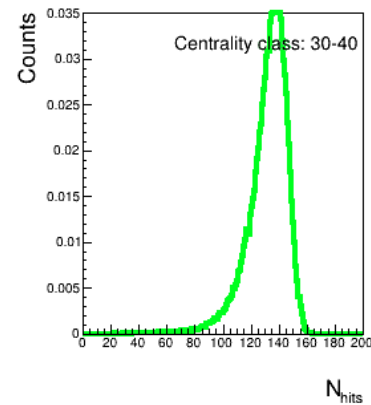
Particles with Z=5:
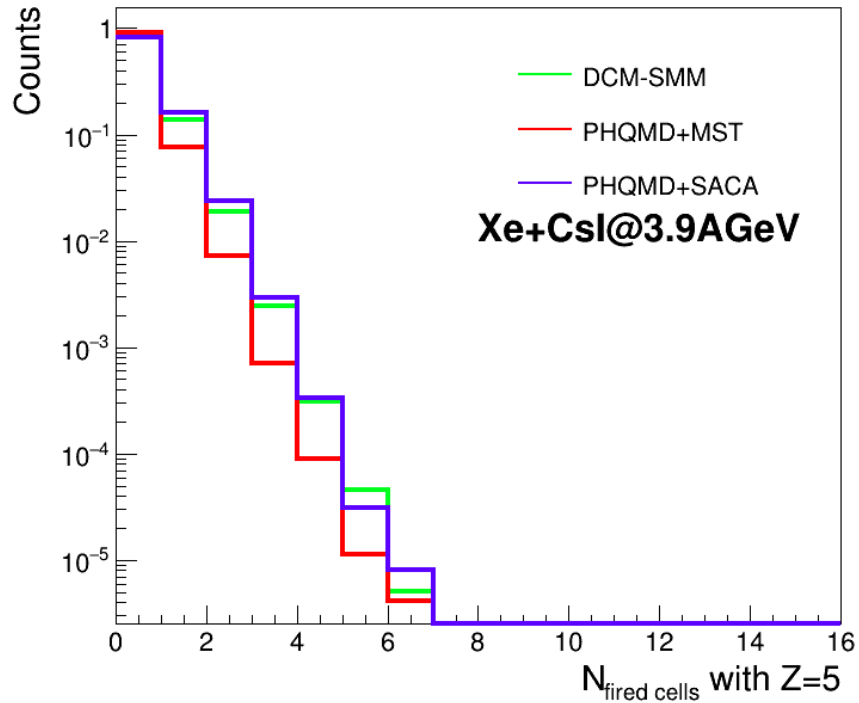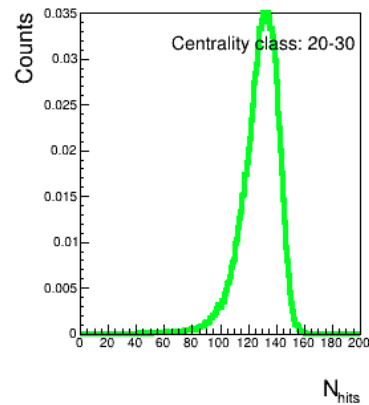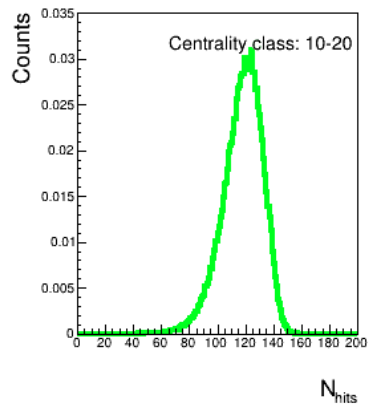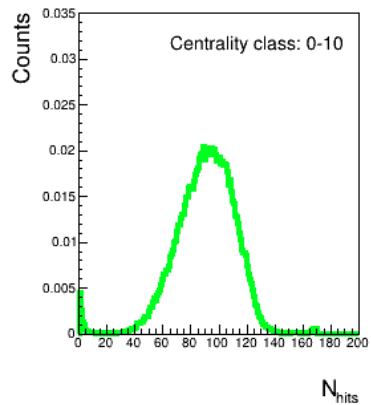
Particles with Z=6:
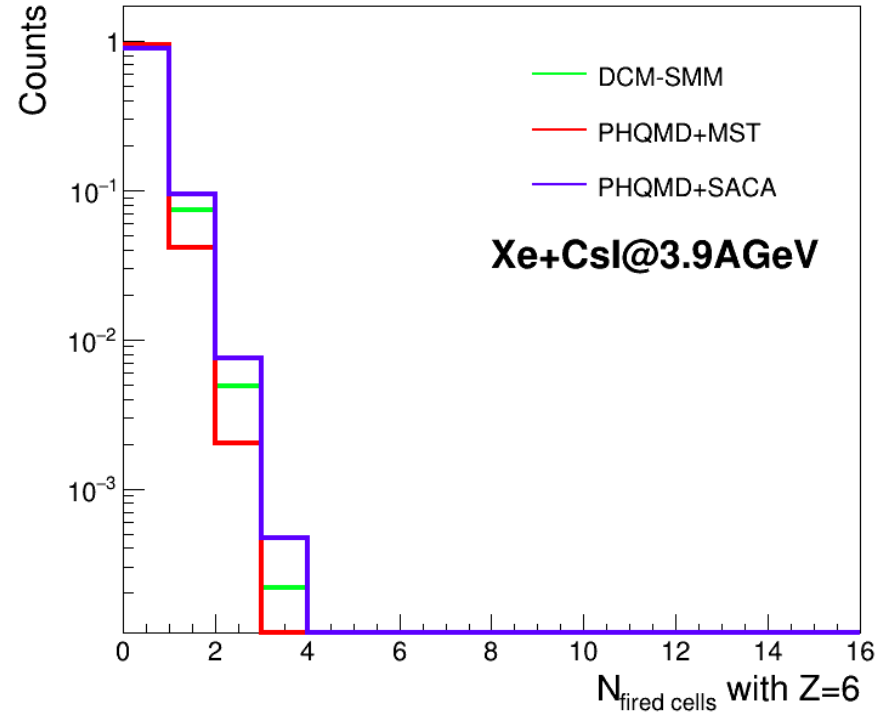
19

Number of fired cells in different centrality classes

- No events selection
- Pure data from PHQMD-SACA simulation without any additional cuts on fragments selection
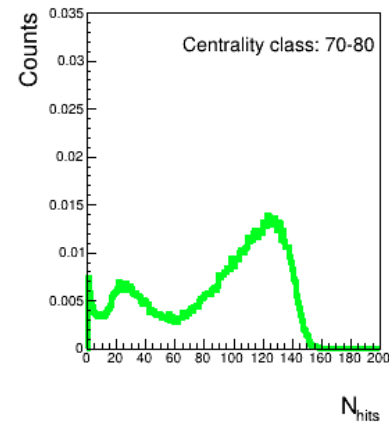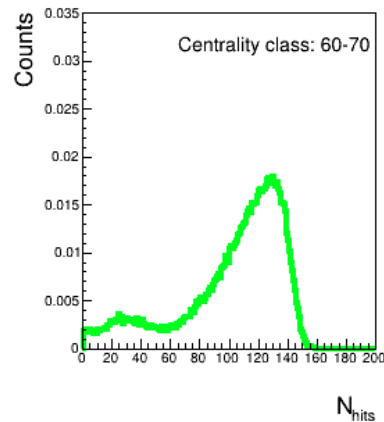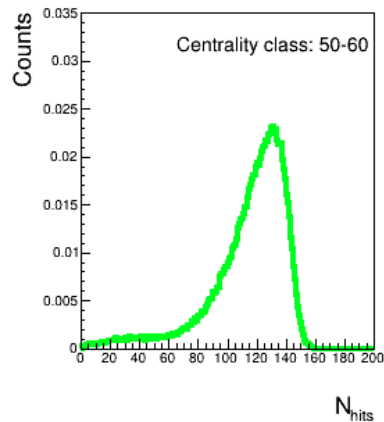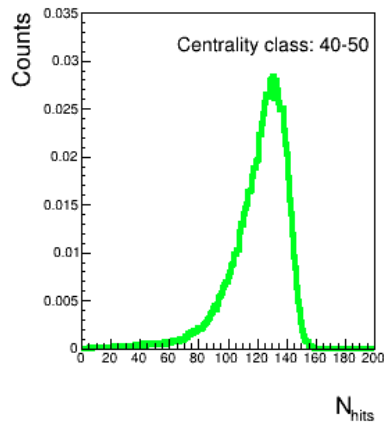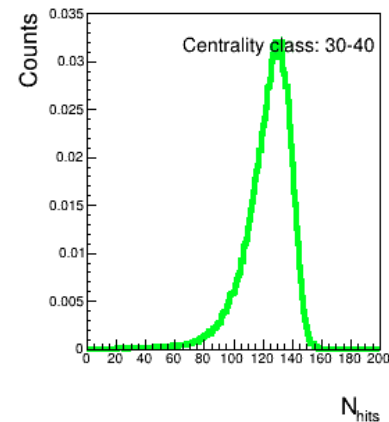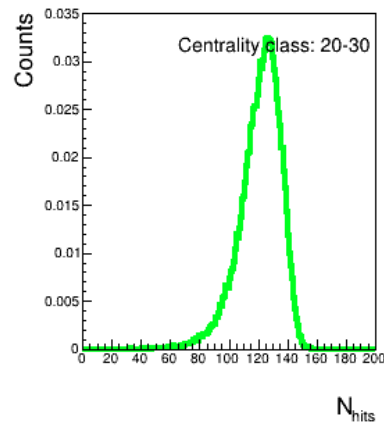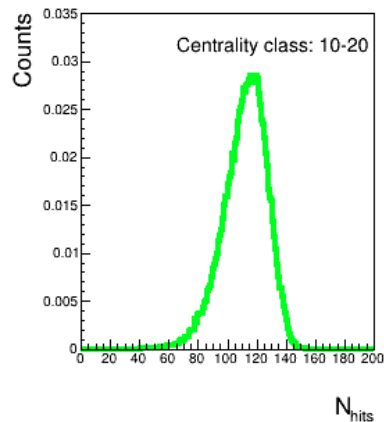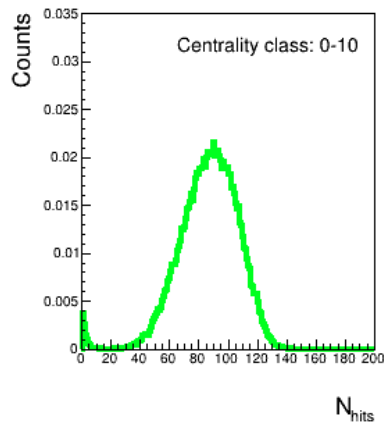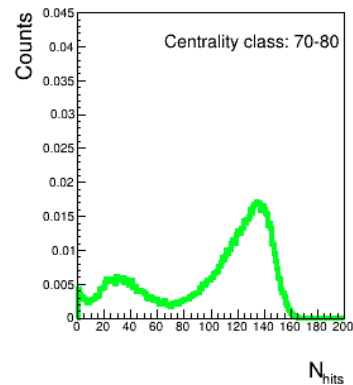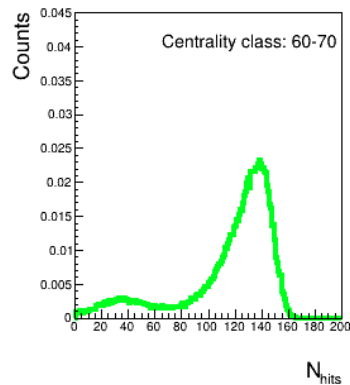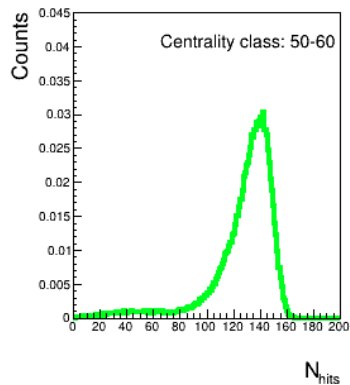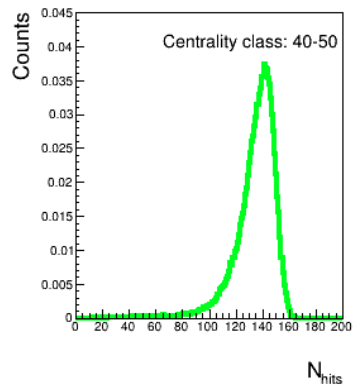
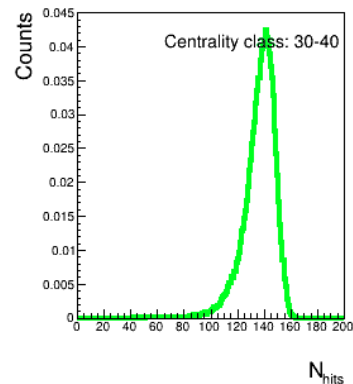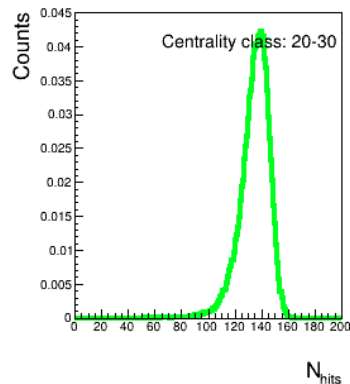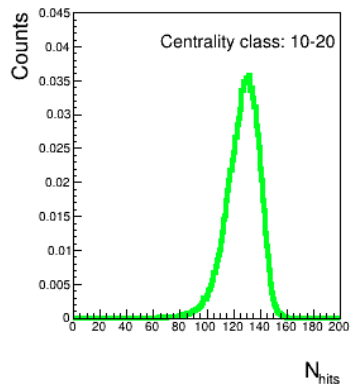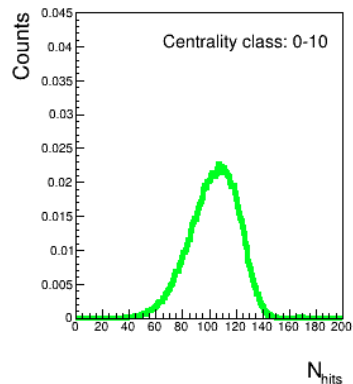# Number of fired cells in different centrality classes

- No events selection
- PHQMD-SACA fragments selection in accordance with the rule: (A=1 || (Z≤N & Z≥1)
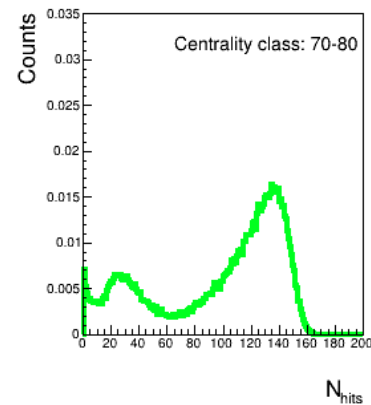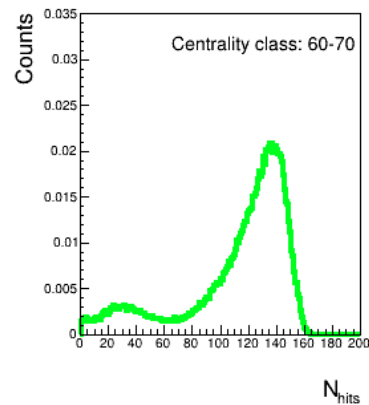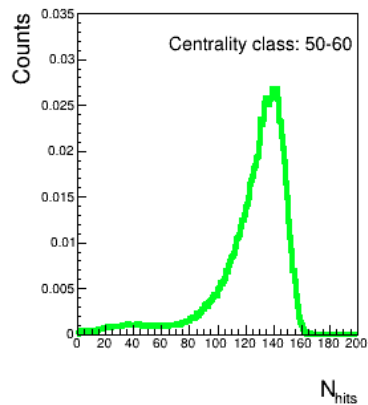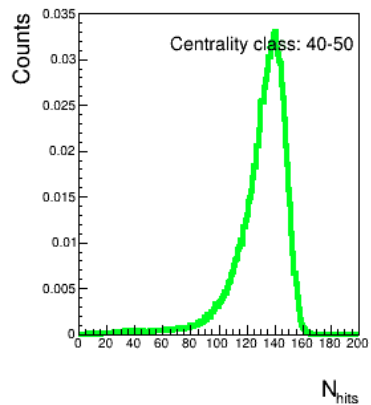
Number of fired cells in different centrality classes

- No events selection
- PHQMD-SACA fragments selection:
  - Only physically existing chemical elements

Conclusions

- Comparison of ScWall dE/dx distributions was performed for different cell sizes between DCM-SMM and PHQMD with SACA/MST.

- The presented models are comparable in terms of the smallest and largest values of dE/dx, but deviate from each other in the intermediate region of dE/dx.

- The number of fired cells for particles with Z=1 is more sensitive to the type of generator

- The number of fired cells is more sensitive to the selection of fragments than the dE/dx in ScWall

Back Up

Impact parameter in different generators