



Simulation of Heavy-Ion Collisions for the SPD BBC Phase 0 Detector

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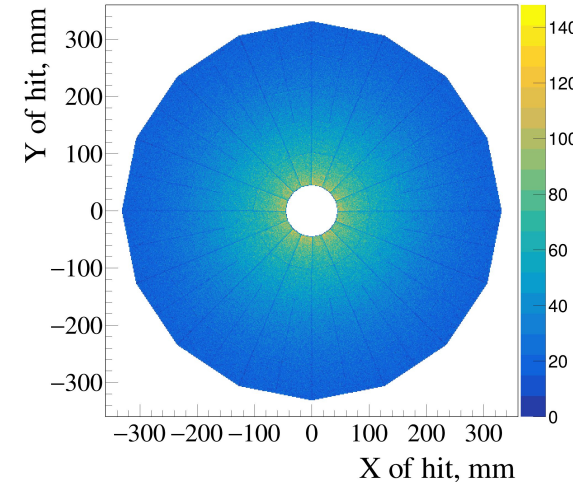
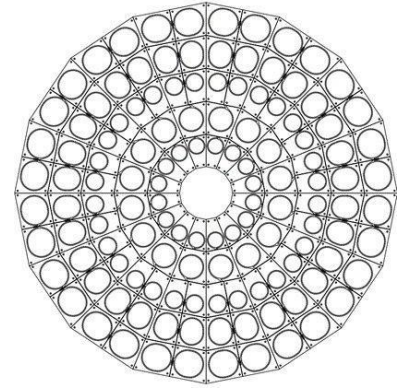
ISHEPP-2025

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Motivation

Phase 0 - first test runs at NICA

1. For **Phase 0**, which is planned to employ a ^{124}Xe beam scattering on a stationary **W** target, the presented generators was chosen for its ability to simulate **clusterization** processes, critical for modeling nuclear fragmentation and secondary particle production in **heavy-ion** fixed-target collisions.
2. **Geant4** was preferred over **SPDRoot** because it fits better for **BBC Phase 0** conditions with **simplified setup**.



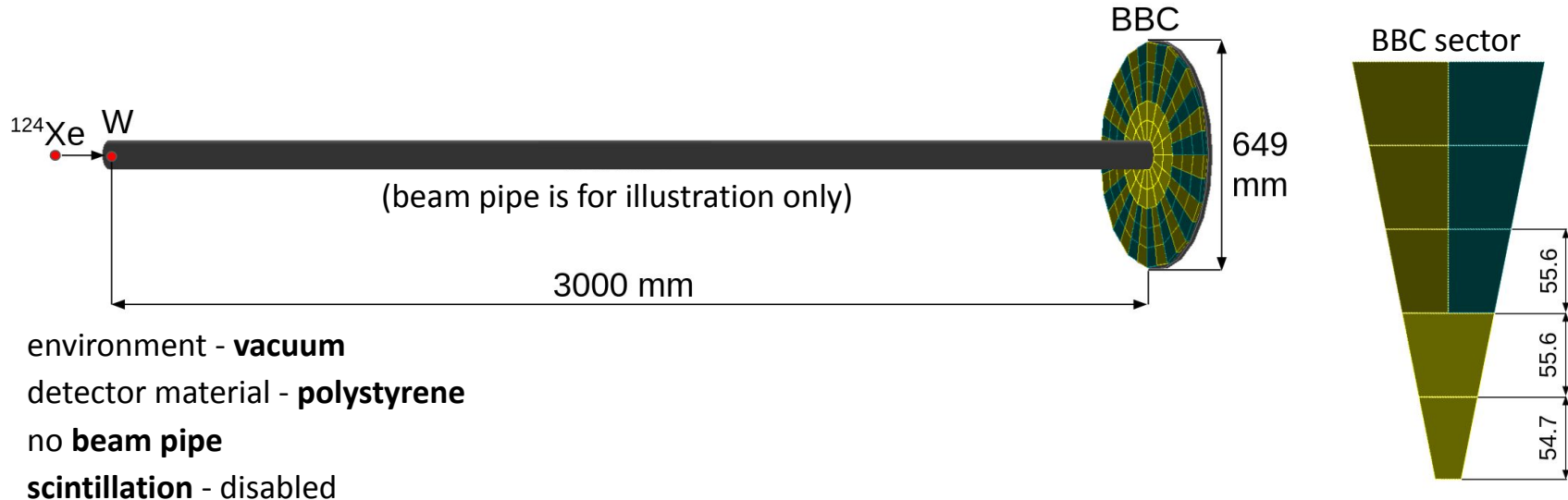
Old ("basic") conditions of the simulation in Geant4

^{124}Xe beam with energy **3 GeV/n** interacts with the fixed **W** target.

The detector is a wheel with an inner radius of **45 mm** and an outer radius of **324.5 mm**, which is divided into **16 sectors** and **5 rows**.

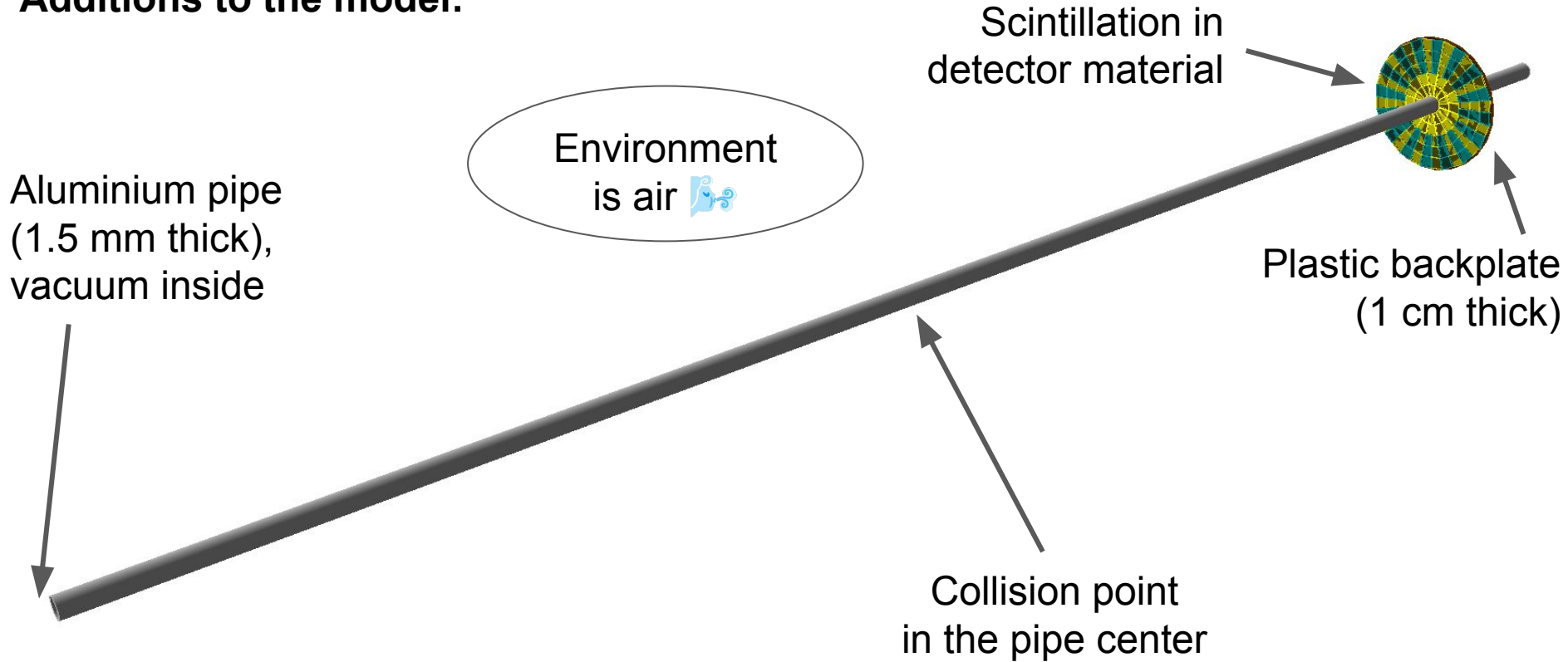
128 scintillators total, the **gap** between scintillators is **0.6 mm**, **thickness** is **10 mm**.

Distance from target to detector is **3m**.



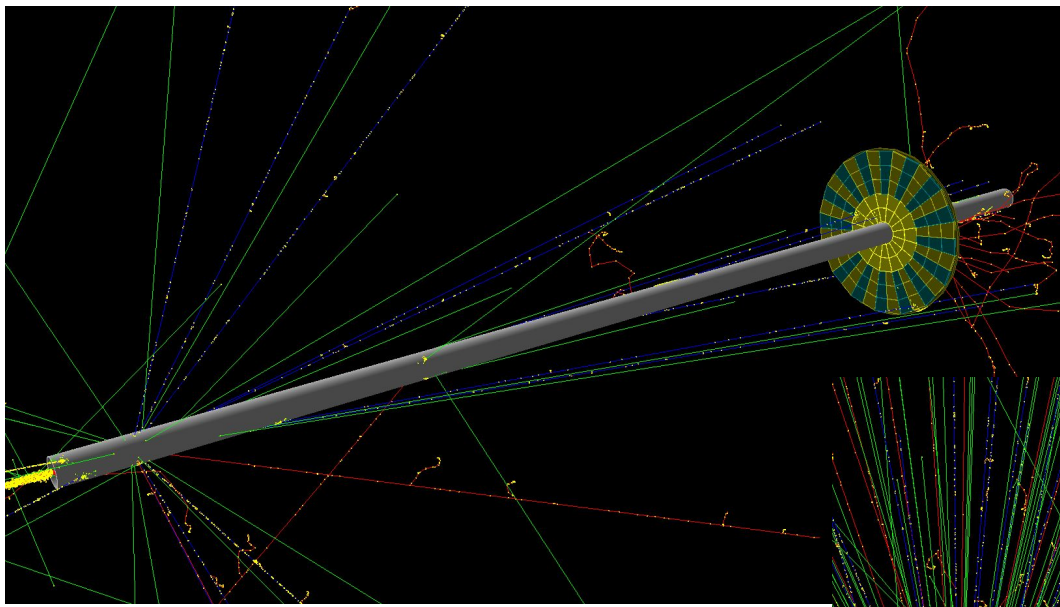
New ("updated") conditions of the simulation in Geant4

Additions to the model:

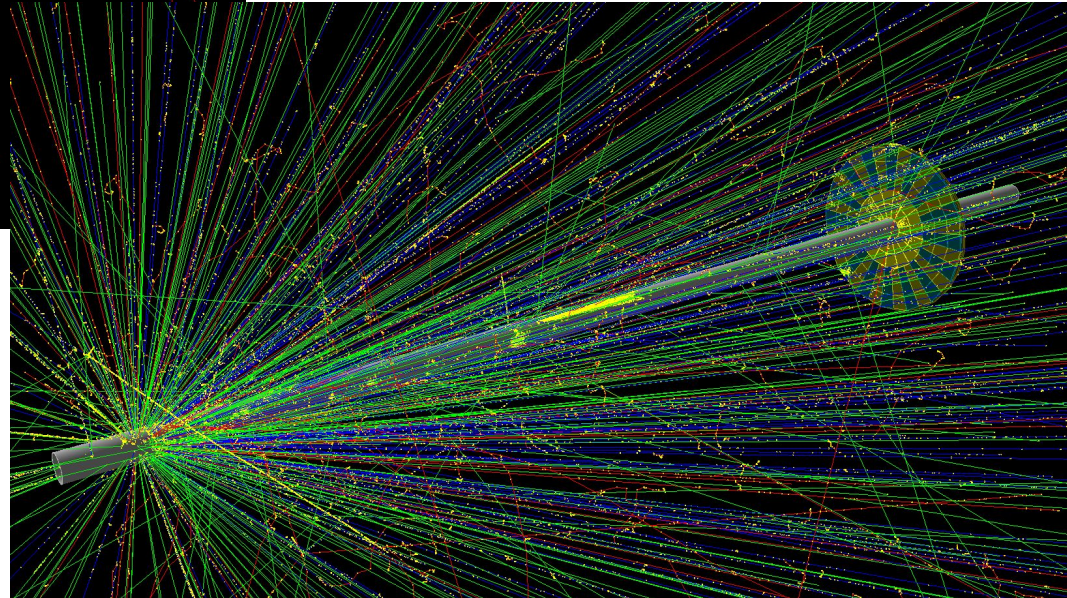


Large
impact factor

Geant4 simulation visualization (1 event)



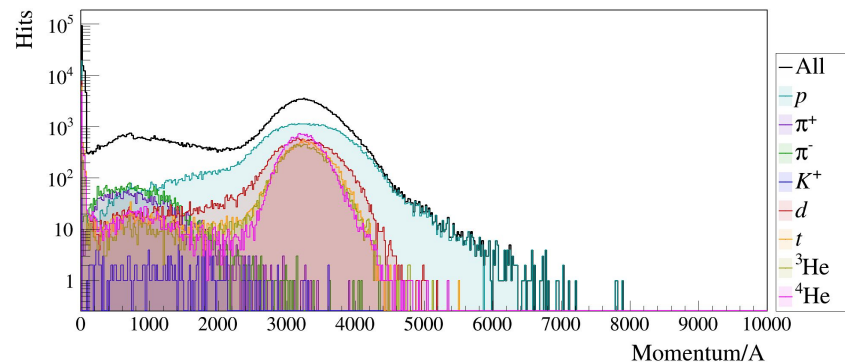
Small
impact factor



Momentum distributions by particle type (normalized on atomic mass)

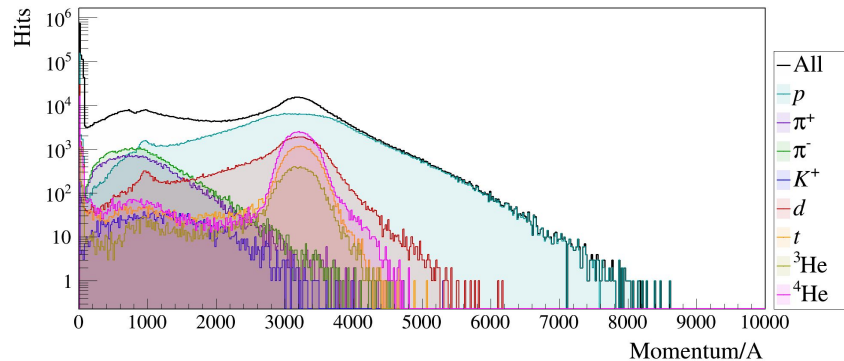
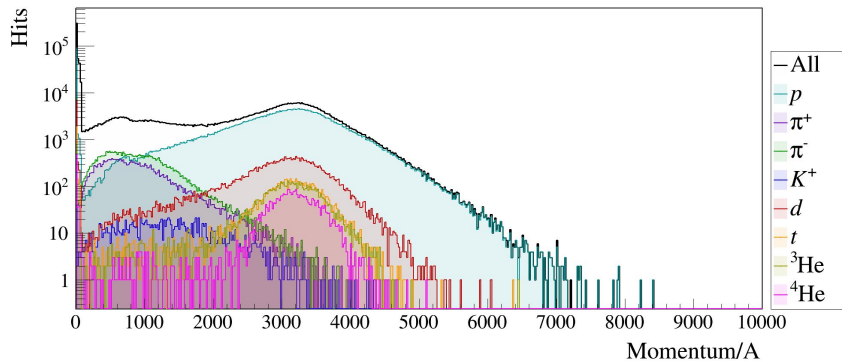
(updated model)

UrQMD 4



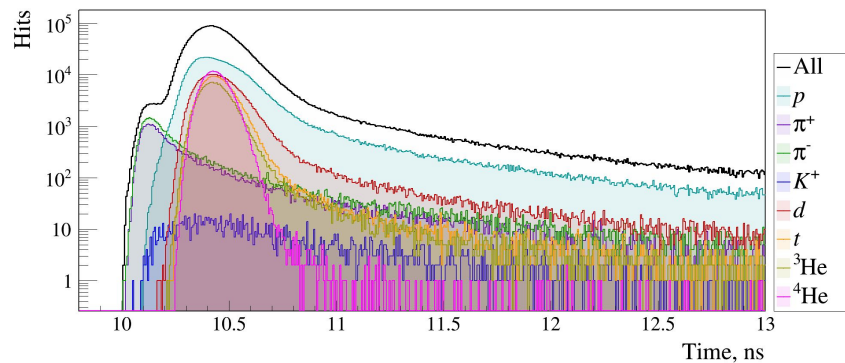
PHQMD

DCM-SMM



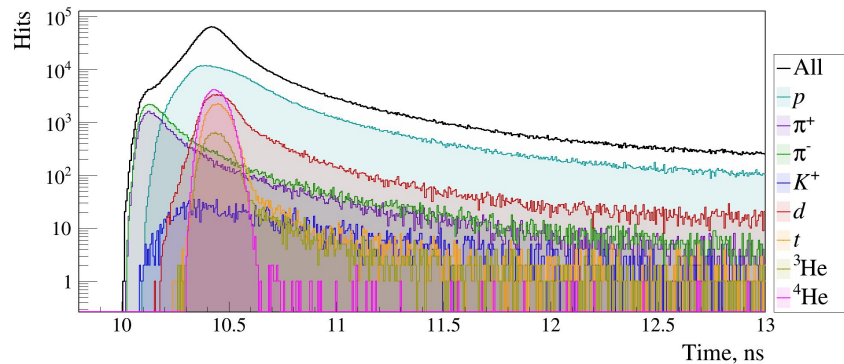
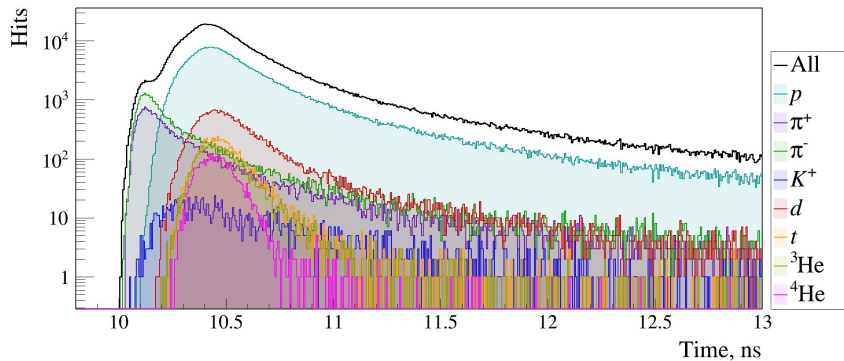
Time-of-flight (basic model)

UrQMD 4



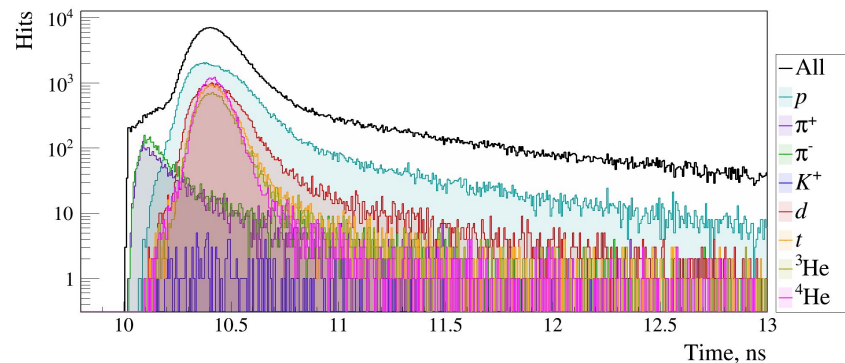
PHQMD

DCM-SMM



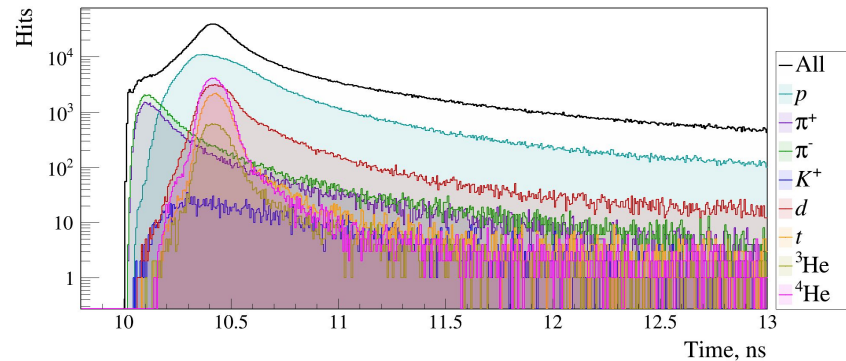
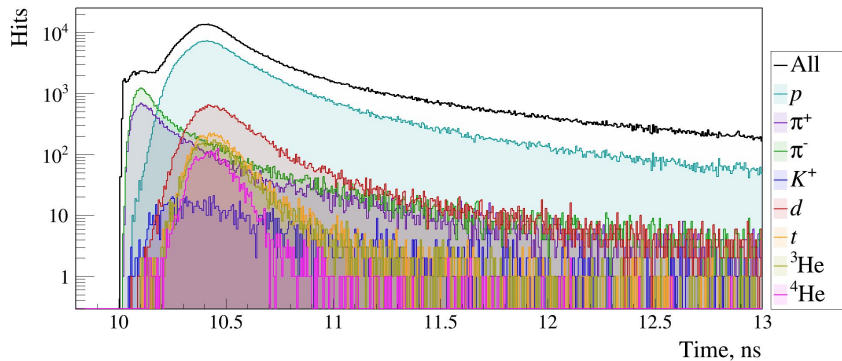
Time-of-flight (updated model)

UrQMD 4



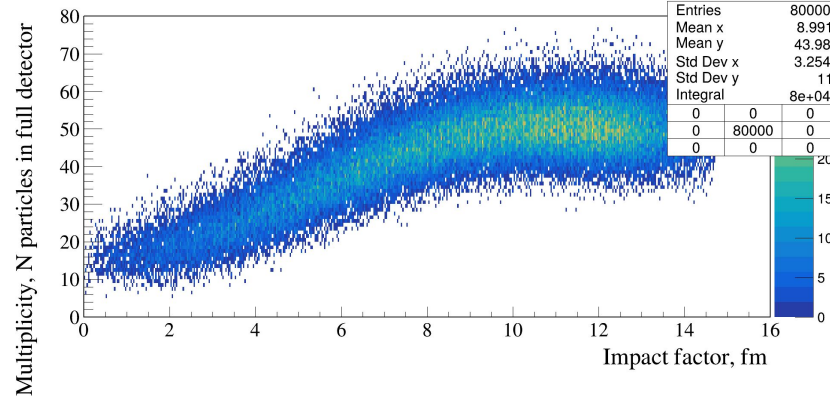
PHQMD

DCM-SMM

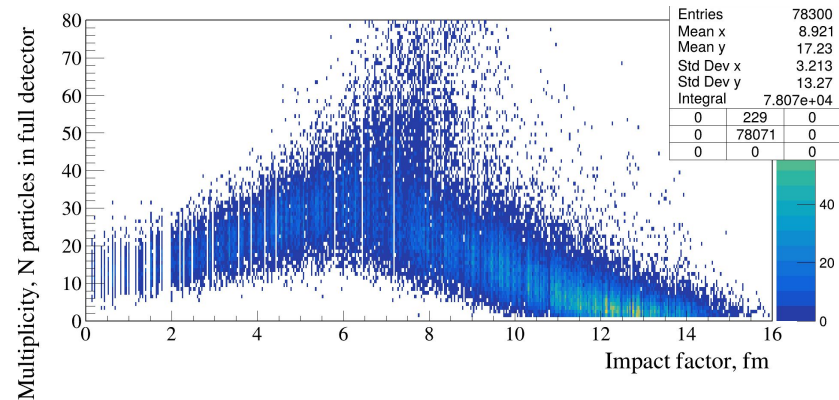


Multiplicity in detector by impact parameter (updated model)

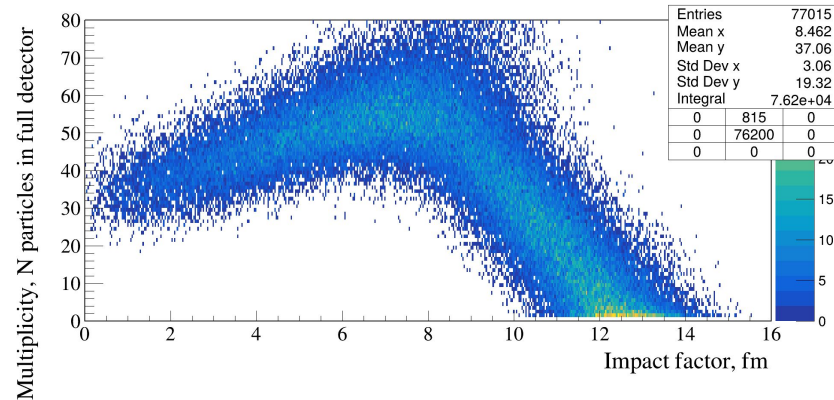
UrQMD 4



PHQMD



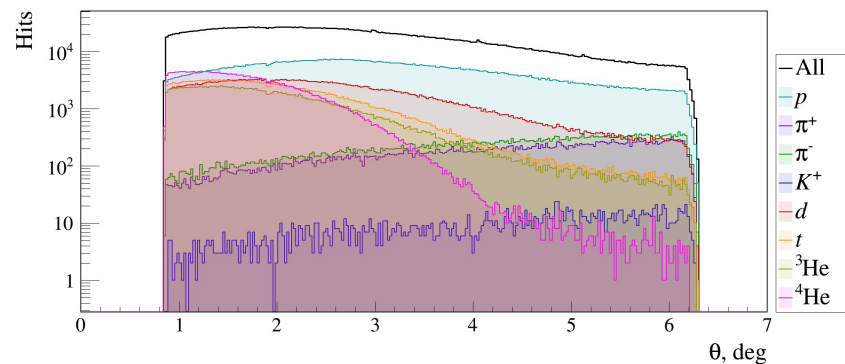
DCM-SMM



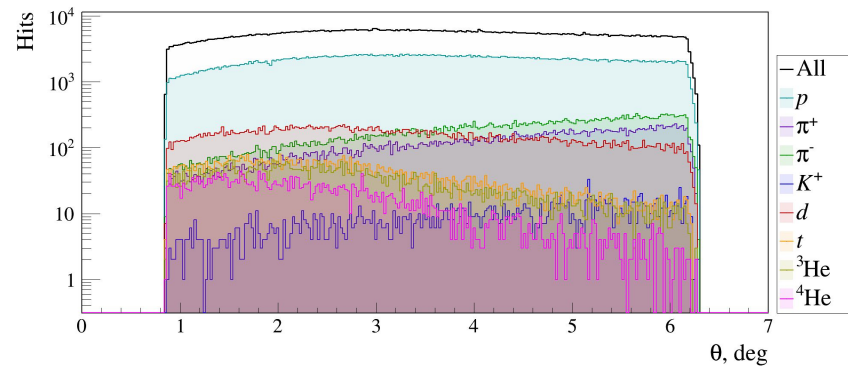
Loading by angle

(basic model)

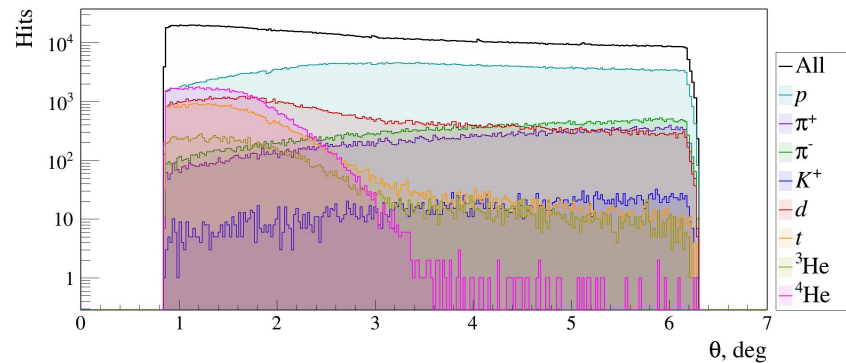
UrQMD 4



PHQMD



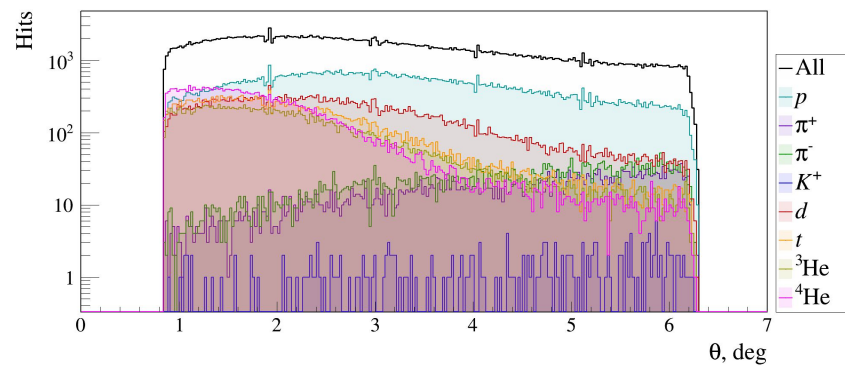
DCM-SMM



Loading by angle

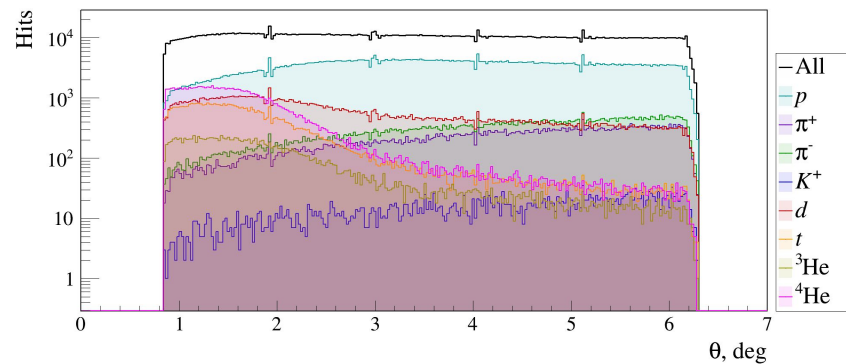
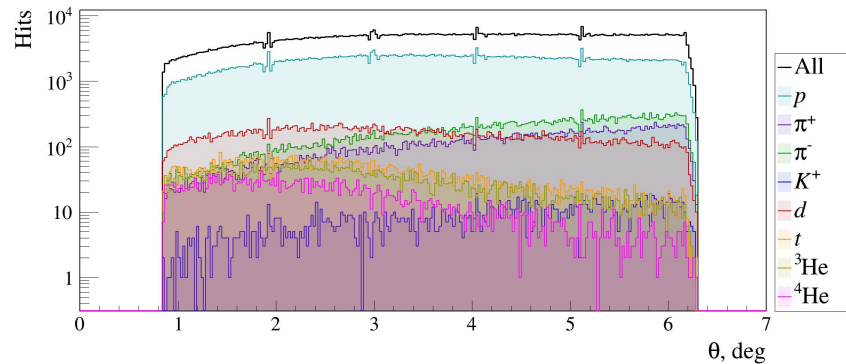
(updated model)

UrQMD 4



PHQMD

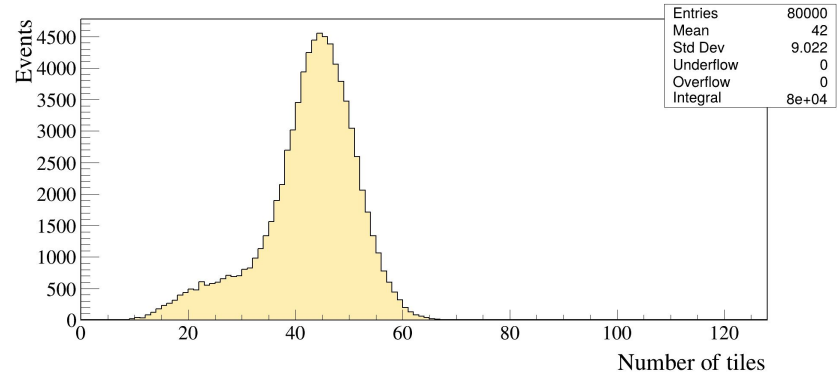
DCM-SMM



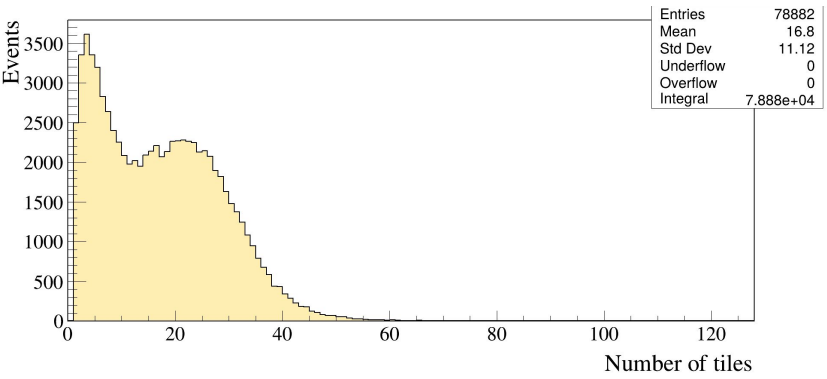
Multiplicity in detector (basic model)

average ≈ 31 tile

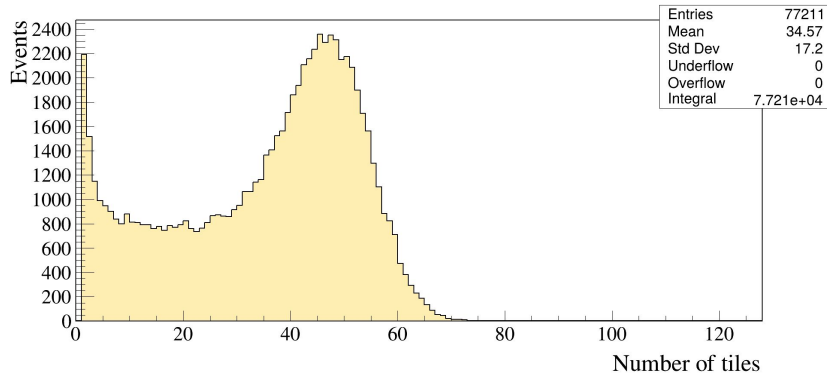
UrQMD 4



PHQMD



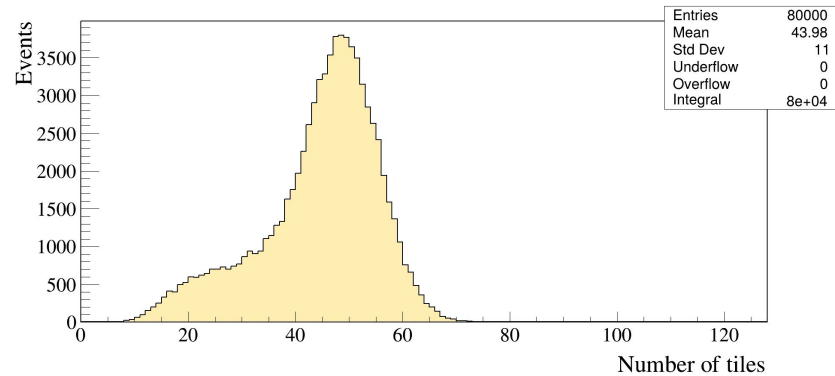
DCM-SMM



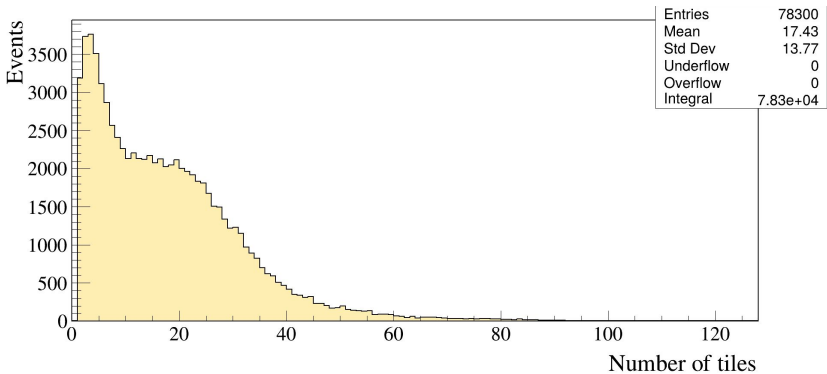
Multiplicity in detector (updated model)

updated > basic
by ~5% tiles

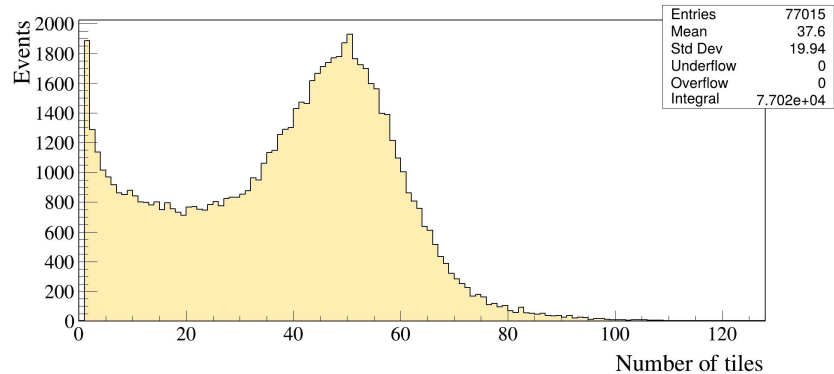
UrQMD 4



PHQMD



DCM-SMM



Conclusions

- Simulation of interactions between ^{124}Xe beam and fixed **W** target at **3 GeV/n** using generators **PHQMD 4.1**, **UrQMD 4.0**, and **DCM-QGSM-SMM** was performed.
- Most important parameters - **loading by angle** and **number of hitted tiles** - were **estimated**.
- A quite **large number** of nuclear **fragments** was observed, so the detector is **sensitive** to fragments.

Future plans:

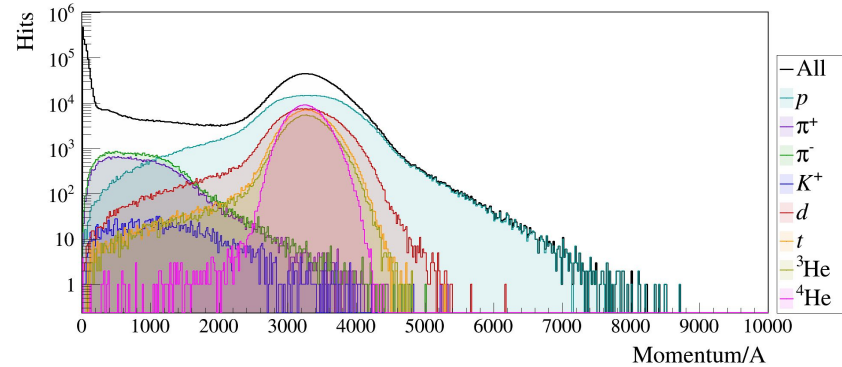
- Simulate collisions with other **targets** as **Ag, Au, Cu**, etc.
- Develop methods to **estimate background** in the model
- Incorporate **time** and **energy resolution** parameters of the detector into simulations
- Investigate **spatial** and **temporal correlations** between detector **tiles** for potential detection of angular multiparticle **correlations**
- Perform dedicated studies of **Xe+Xe** collisions in **collider mode** using **2 BBC wheels** to explore wheel-to-wheel correlations

**Thank you
for your attention!**

Momentum distributions by particle type (normalized on atomic mass)

(basic model)

UrQMD 4.0



PHQMD

DCM-SMM

