

Fragmentation of isospin-symmetric ^{20}Ne at the LHC: a challenge and an opportunity

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In 2025, data on ^{16}O – ^{16}O and ^{20}Ne – ^{20}Ne collisions were collected at the LHC for the first time. Unlike in the LHC runs with ^{208}Pb beams conducted since 2010, a significant fraction of spectator fragments emitted in collisions of light isospin-symmetric nuclei, such as ^{16}O and ^{20}Ne , also have equal numbers of neutrons and protons. Consequently, these fragments exhibit magnetic rigidity similar to that of beam nuclei. As the transverse momenta of spectator fragments are expected to be close to the nominal beam momentum, such $2Z = A$ secondary nuclei may circulate in the LHC. This poses a challenge for tuning the collider beam optics to suppress the circulation of $2Z = A$ fragments, in order to prevent their collisions with beam nuclei and reduce contamination of the ^{16}O – ^{16}O and ^{20}Ne – ^{20}Ne data due to beam transmutation [1].

The cross sections of production of ^2H , ^4He , ^6Li , ^{10}B , ^{12}C , and ^{14}N spectator fragments in ^{16}O – ^{16}O were estimated [2] with the Abrasion-Ablation Monte Carlo for Colliders model with pre-equilibrium Minimum Spanning Tree clustering (AAMCC-MST) [3]. While contamination of ^{16}O – ^{16}O data is considered negligible based on recently collected data [4], this has not yet confirmed for ^{20}Ne – ^{20}Ne collisions.

We report the results of AAMCC-MST modelling of the production of spectator neutrons, protons, as well as ^2H , ^4He , ^6Li , ^{10}B , ^{12}C , ^{14}N , ^{16}O , and ^{18}F fragments in ^{20}Ne – ^{20}Ne collisions at $\sqrt{s_{NN}} = 5.36$ TeV. Prior to simulating ^{20}Ne fragmentation at the LHC, we validated AAMCC-MST using data on fragmentation of $\sim 0.4A$ – $5A$ GeV ^{20}Ne and ^{22}Ne projectiles in nuclear emulsion and on elemental targets [5,6]. Three density profiles for ^{20}Ne and ^{22}Ne were employed: a deformed Woods–Saxon, a five- α bi-pyramidal configuration, and a spherical profile for ^{20}Ne . Calculations were also performed with and without MST clustering. Comparisons of results obtained with different calculation options demonstrate the sensitivity to both the details of the nuclear structure of $^{20,22}\text{Ne}$ and the fragmentation modelling.

In all previous studies of neon fragmentation, neither protons nor neutrons were registered. The data on spectator neutrons and protons from ^{20}Ne – ^{20}Ne collisions collected by the ALICE Zero Degree Calorimeters (ZDC) [7] will provide a unique opportunity to study fragmentation of isospin-symmetric ^{20}Ne . Following validation of fragmentation models with these new data, new methods of luminosity monitoring and centrality determination for collisions of light nuclei can be developed with involving both neutron and proton ZDCs.

References

- [1] G. Nijs, W. van der Schee, Phys. Lett. B 872 (2026) 140061
- [2] A. Svetlichnyi, S. Savenkov, R. Nepeivoda, I. Pshenichnov, Physics 5 (2023) 38
- [3] R. Nepeivoda, A. Svetlichnyi, N. Kozyrev, I. Pshenichnov, Particles 5 (2022) 40
- [4] A. Hayrapetyan, V. Makarenko, A. Tumasyan et al., Phys. Rev. Lett. 136 (2026) 162301
- [5] N.N. Abd-Allah, M. Mohery, Czechoslov. J. Phys. 51 (2001) 1189
- [6] A.T. Neagu, E. Firu, M. Haiduc, J. Phys. G Nucl. Part. Phys. 40 (2013) 035102
- [7] C. Oppedisano, R. Arnaldi, E. Chiavassa, Nucl. Phys. B - Proc. Suppl. 197 (2009) 206

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