

## Exploring nuclear fragmentation at heavy-ion colliders

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As the kinetic energy of nuclei grows, studying their fragmentation in collisions with fixed targets becomes an increasingly complicated task. Secondary spectator fragments emitted at small angles close to the beam do not allow the placement of advanced detectors for their registration. This explains the use of nuclear photoemulsion or track detectors at  $\sim 1\text{--}100$  AGeV beam energies [1-3], where the universality of spectator fragmentation has been demonstrated [3]. It is impossible to detect spectator fragments in nucleus-nucleus collisions at RHIC and at the LHC. However, as shown in the present work, some features of the fragmentation at highest collision energies still can be deduced from forward neutrons and protons detected by Zero Degree Calorimeters [4]. We employ our Abrasion-Ablation Monte Carlo for Colliders model (AAMCC) to predict various correlations between the total charge of undetected nuclear spectator fragments  $Z_{bound}$ , their total mass  $A_{bound}$  and the numbers of free forward neutrons and protons and describe measured dependencies [1-3]. AAMCC is based on the well-known Glauber Monte Carlo model [5] to calculate the numbers of participant and spectator nucleons and on the nuclear evaporation, Fermi Break-up and SMM models from Geant4 library [6] to simulate decays of excited spectator matter. The calculated correlations between the numbers of free spectator neutrons and  $Z_{bound}$  are shown in Fig.1 for two collision energies. While the general shape of the correlation is preserved at the LHC, a higher yield of central events with small  $Z_{bound}$  is predicted due to a larger  $\sigma_{NN}$  in the calculations at the LHC.

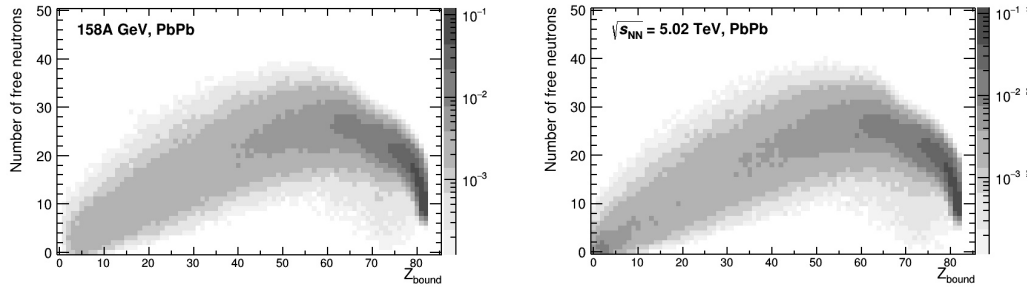


Figure 1: Correlations between the numbers of free spectator neutrons and  $Z_{bound}$  calculated with AAMCC model for  $^{208}\text{Pb}\text{--}^{208}\text{Pb}$  collisions at the CERN SPS (left) and the LHC (right).

In future LHC experiments  $Z_{bound}$ ,  $A_{bound}$  and the numbers of spectator neutrons and protons can be related to collision impact parameter which, in its turn, can be independently evaluated from the numbers of produced particles detected in the central barrel. We propose to evaluate  $Z_{bound}$  along with  $A_{bound}$  in each event by subtracting the measured numbers of free protons and neutrons from  $Z$  and  $A$  of initial nuclei corrected for estimated numbers of participants. In this way the studies of nuclear fragmentation can be extended to LHC energies in order to confirm or refute the universality of spectator fragmentation.

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