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Development of innovative methods for fission trigger construction

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The development of innovative methods for fission trigger construction is part of the FRØZEN project which aims to get a better understanding of the angular momentum generation and the energy partition between fragments in the fission process. The reconstruction of the very first moments after the scission point is essential and requires correlated neutron and gamma detection as well as measuring the kinematic properties of fission fragments. Such a measurement could be achieved thanks to the last generation of hybrid γ-spectrometer named ν-Ball2, coupled to a double Frisch-Grid Ionisation Chamber (dFGIC). In this experiment, a spontaneous ^{252}Cf fission source was used. However, for other fissioning systems that require the use of a primary beam, fission could become a minor nuclear reaction compared to other processes. Additionally, with the increasing size of nuclear physics experimental setup, the need to recognize rarer reaction mechanism, one of the main challenges nowadays in nuclear physics is to develop more and more selective data analysis methods for more and more contaminated datasets.

AI models are being developed to replace the usual data analysis techniques for reconstructing the fission events, exploring the limits of AI implementation in such context. The first implementation is deeply motivated by the computationally expensive and time-consuming characteristics of more usual trace (sampled signal) analysis approaches, currently used to analyze the dFGIC response and tag fission for ν-Ball2 setup. Some promising regression and convolutional neural network models have been tested to obtain precise fission tag time, the deposited energy, and the electron drift time from the dFGIC traces. The second implementation tackles the challenge of recognizing fission events from a polluted dataset by developing an AI-based algorithm to recognize fission solely based on the ν-Ball2 response function. The fission fragments de-excitation process is reconstructed from the correlations between the individual fission fragments pairs and observables, such as gamma and neutron energies and multiplicities. AI models can be used to evaluate the impact of each observable into identifying fission. Once the algorithm is trained, it could be applied to various fissioning systems without the need for an ancillary fission tag detector, such as the dFGIC.

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