Monte-Carlo Simulations of a Scintillator Array for Direct Reaction Studies

One of the major challenges of modern nuclear physics is to understand how the structure of the atomic nucleus evolves for « exotic » systems with a large difference between the number of neutrons and protons |N-Z|. This evolution leads to quantum phenomena unique to this many-body system and informs us on components of the nuclear interaction unconstrained up to now.

At LPC, the nuclear structure group uses specific nuclear reactions in which only one nucleon of an exotic nuclei is removed (ex: $^{A}X(p,2p)^{A-1}Y$). These knock-out reactions proceed in a single step allowing to study the nucleon configurations involved. To do so, one need to determine the states of the residual nuclei populated in the reaction by measuring kinematical properties of the reaction products (protons, heavy residual, gamma-rays, neutrons).

This internship subject is focused on simulating the geometry and the response of an array of scintillator CsI(Na) crystals called CATANA [2] aiming at measuring the total energy of the protons or the gamma-rays emitted during such knockout reactions.

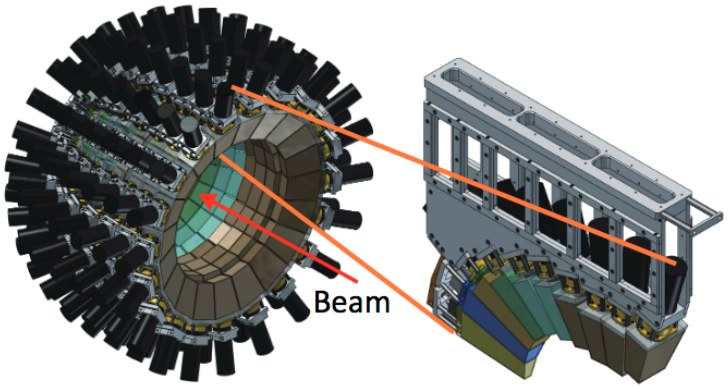

Figure 1 Configuration of CsI(Na) detectors in CATANA array

To do so, the candidate will use a C++ software package developed in the group based on GEANT4 [2] and ROOT [3] libraries. Its goal will be to:

- Integrate the geometry of the crystals and the full array in the simulation
- Define the response functions of the crystals and simulate a given reaction
- Analyze the results of the simulations and benchmark them on published experimental spectra.

Candidate profile:

- Knowledge of C++ programming is essential.
- Knowledge of ROOT-CERN or GEANT4 libraries would be a bonus.
- Rigorous, methodical, interest for open scientific problems.

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[1] Y. Togano et al., NIM B 463, 195 (2020).
[2] https://geant4.web.cern.ch/
[3] https://root.cern.ch/