> M2 Intership for the students of the PSA master - 2023

Study of the static and dynamic background at neutron time of flight facilities

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- keywords: data analysis, simulation, measurements

Context:

The group Données Nucléaires pour les réacteurs (Nuclear data for reactors, DNR) activities focus on nuclear data for future reactors. The development of new nuclear reactor systems and fuel cycles is mostly done via computer simulations and required high quality evaluated nuclear data. The improvement of these databases requires both experimental and theoretical work, to achieve the goal of reducing uncertainty in nuclear application simulations. In this context, our group focuses on the (n, xn) process by measuring (n, xn γ) reaction cross sections. The combination of our experimental results with predictions from models, allows us to deduce the total (n, xn) reaction cross section[1].

Our measurement of (n, *x*n γ) cross section requires high quality data with as low as possible uncertainty. The extraction of the signal from the raw data must therefore be done in the most accurate way. In that step of the analysis, γ-peak fitting requires the substraction of the background. However, simple background parametrization (such as a linear background) is often not detailed enough to extract a correct number of counts from the peak. We have to rely so far on our best estimate of the shape of the background (quadratic, linear, …) but with no general rule to guide us. We want to characterize the background (*static*, from the environnement, and *dynamic*, from the interaction of the beam with the surrouding materials) recorded by our detectors in order to better undertsand the responsible processes, use consistent background shape in our analysis procedures and, if possible, physically remove elements contributing to it.

Objectives

The goal of the intership is to study and characterize the background in neutron time of flight facilties such as Gelina[2] or NFS[3]. The propose work have two axes :

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[1] Measurement of 238U(n, n′ γ) cross section data and their impact on reaction models. M. Kerveno, *et al.* Phys. Rev. C 104, 044605 –

[2] JRC's Neutron Time-of-Flight Facility (GELINA)

[3] Neutrons for Science - Ganil

1. Analysis of existing data sets (W, U, Pu) to extract background profiles, depending on the incoming neutron energy.
2. Simulations of the experimental areas using the Geant4[4] simulation framework (or/as well as others) to predict the effect of neighboring beam lines, beam dumps, … and compare the simulation to the results of part 1. This include: defining the geometry of the experimental hall as accurately as possible, running the simulations and extracting the simulated spectra.

Tools used

- The ROOT[5] analysis package and other data analysis softwares to study the background seen in past experiments.
- The Geant4[6] simulation framework and associated libraries to modelize the experimental hall and get predictions of the background in our experiments.

Deliverables

During the internshio, the student will produce several document and data of interest that will be used in the future by the DNR group :

- Extracted gamma background profile per neutron energy for different targets.
- Geometry of the experimental room in Geant4.
- Simulated spectra of static and dynamic background.

Profile of the candidate

Candidates to the intership are expected to be familiar with programmation languagues such as `C++` and `python`. An experience in analyzing data from γ ray detectors and simulation is a plus. The intern will work autonomously and discuss their finding regularly with the whole research group.

Following a successful internship, the work could be continued by a thesis in the same team.

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[4] Geant4 - A simulation toolkit

[5] ROOT - An open-source data analysis framework used by high energy physics and others.

[6] Geant4 - A simulation toolkit