Internship in AI for experimental physics

Artificial Intelligence for Mass Measurement of Exotic Isotopes

Artificial intelligence opens new perspectives for basic science. It is no exception for nuclear structure studied at the extreme of the nuclear chart by the Super Separator Spectrometer (S^3) under construction at GANIL-SPIRAL2. The Piège à Ions Linéaire du Ganil pour la Résolution des Isotopes en Masse (PILGRIM) is a Multi-Reflection time-of-flight Mass Spectrometer (MR-ToF-MS), with state-of-the-art performances that can only be exploited fully thanks to a joint development with the FASTER (http://faster.in2p3.fr/) data acquisition at LPC Caen. The full project (internship + PhD thesis), will consist in carrying out this development with the FASTER developers and the physicist in charge of PILGRIM. Machine learning techniques will have to be employed to recognize patterns in the time-of-flight of ions extracted as bunches from the S^3 Low Energy Branch (S^3 LEB). For each individual ion, the time of flight will have to be determined with sub-nanosecond precision, correcting for effects due to pile-up, gain and baseline fluctuations. This development should lead at long term to the determination of masses of exotic nuclei with exquisite precision, enabling tests of nuclear physics models in previously uncharted territories.

The internship will have the following objectives, as a follow-up of ongoing work between GANIL, LPC Caen and GREYC:

- Analysis of traces of events recorded with a 5GHz scope, using the PILGRIM spectrometer
- Defining a training model for the neural network technique, to recognize different event patterns
- Starting using the neural network technique to reconstruct time-of-flight spectra and comparing with using simple filters
- Participation to all PILGRIM performance upgrades
    - resolving power improvement thanks to PILGRIM voltage stabilization
    - study of systematic effects due to RF in the RFQ coolers in charge of forming the bunches in the S^3 LEB, prior to their injection into PILGRIM

Data acquisition improvements - FASTER to python visualization / monitoring interface

Expected skills

- Computing techniques including machine learning / AI
- Familiar with techniques used in experimental physics for the detection of particles
- Basic knowledge of statistics for the analysis of experimental data
- Interested in basic science, nuclear physics models and theory
- Fluent in English

This work does not lead to a PhD-thesis

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