Postdoctoral position

Development of a modular multi-detector experimental setup for the measurement of atomic and nuclear parameters

Field
Physics, nuclear instrumentation, radionuclide metrology

Description
PLATINUM Project (PLATeforme d'Instrumentation NUmérique Modulable – Modular Numerical Instrumentation Setup) is aiming to develop a modular setup to test new instrumentation based on, at least, two detectors operating in coincidences.
The underlying idea behind the project is to detect simultaneously the interaction of particles in two independent detectors, while measuring physical information such as the type of particle and its energy (particle spectroscopy). This detection principle is used in absolute intensity measurements or with active systems (in order to improve detection limit by performing continuous background suppression). Besides, such experimental setup is also capable to provide parameters needed to reconstruct the decay scheme of nuclei such as: the internal coefficients, the fluorescence yields or the angular correlations between photons produced during a gamma cascade process.
The Laboratoire National Henri Becquerel (LNHB) researchers are worldly known for their expertise in the completion of the nuclear decay scheme of various nuclides. These nuclear data are determined from the evaluation based on the existing literature, which is sometimes inconsistent or incomplete. This is in particular true in case of very weak gamma ray transitions or states with high internal conversion yields (for example, recent studies have revealed that ^{103}Pa, ^{129}I and ^{147}Nd exhibit such kind of inconsistency). It is therefore critical for LNHB to master coincidences detection methods using the latest developments in numerical acquisition based on list-mode data format to access complementary information improving the knowledge on decay schemes.

The work proposed to the candidate is to develop and optimize the acquisition part of the coincidence setup using a fast numerical module with list-mode data capability before performing off-line analyses. The development will be divided in three steps:

1. **Selection and optimization of the numerical acquisition**

Various commercial modules are available in the laboratory and will be compared for the coincidences experimental setup. Several tests with different particle energies and counting rates will be necessary in order to optimize acquisition parameters such as the decay constants and time coincidence gates.

2. **Instrumental validation**

The performances of the acquisition will validated after integrating the selected modules in a two-gamma spectrometer coincidence setup. The setup will be developed to perform autonomous rotation from one detector to another to measure angular correlation of gamma rays emitted by the decay of a radioactive source (^{60}Co and ^{22}Na). These tests will be performed

to verify the metrological stability of the detection system and to evaluate the experimental uncertainties associated.

3. **Coincidences correction application**

The developed experimental setup will be used to study radionuclides with more complex decay schemes (such as ^{133}Ba ou ^{152}Eu). The effects on the coincidence corrections in gamma spectrometry will be quantified (in various geometry) using an experimental approach coupled with Monte Carlo simulation.

Contract
1 year

Expected employment start date
In 2021

Location
CEA Saclay, Gif-sur-Yvette FRANCE

Host laboratory

The LNHB, located in CEA Paris-Saclay, is a laboratory from CEA (Commissariat à l'Énergie Atomique et aux Énergies Alternatives -- French Alternative Energies and French Alternative Energies and Atomic Energy Commission) responsible for the French ionizing radiation metrology. It is one of the national metrology institutes federated by the Laboratoire National de métrologie et d'Essais (LNE) since 2005. The LNHB is composed of around 50 permanents members among which about 25 are part of the LMA (Laboratoire de Métrologie de l'Activité – Activity Metrology Laboratory). LMA is in charge of primary metrology for the measurement of activity and the transfer of references to accredited calibration laboratories and users in the fields of application such as: nuclear medicine, nuclear industry, environmental monitoring.

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