DRF: Thesis SL-DRF-20-0717

RESEARCH FIELD

Neutronics / Corpuscular physics and outer space

TITLE

Simulation and tests of a compact neutron source based on the IPHI accelerator

ABSTRACT

Neutron beams are used for many applications in materials science, engineering, archaeology or the study of works of art, where they complement other non-destructive analyses, such as X-ray imaging. These beams are traditionally supplied by nuclear research reactors or spallation sources.

The choice of the source depends on the characteristics of the desired neutron beam (energy spectrum, frequency of neutron pulses, etc.). Today a large proportion of reactors are reaching the end of their life cycle. For example, the Orphée research reactor will be closed in October 2019. To compensate for the reduction in the available neutron beam time (limiting the number of experiments that can be carried out), new alternative sources are being developed. These, called CANS (Compact Accelerator Neutron Sources) produce neutrons through nuclear reactions of charged particles (proton, deutons) on a target, the material of which depends on the type and energy of the incident particles. A CANS is being developed at CEA-Saclay (tests and measurements are under way) at the IPHI-neutrons facility with the longer-term objective of developing the SONATE source. IPHI-neutrons uses high intensity (>10mA) and low energy (3MeV) proton beams on a beryllium or lithium target. The neutrons generated with energies above > 100 keV are then moderated to energies below 50 meV. These new facilities have the advantage of being cheaper and more flexible than nuclear reactors or spallation sources. However, due to their lower power compared to reactors, neutron fluxes are less important. This is why it is necessary to optimise these installations as much as possible and therefore to be able to model their operation from the production of primary neutrons to their final use.

This thesis topic proposes to carry out a full simulation of a CANS, within the framework of the IPHI-neutrons project. This simulation will integrate the production of primary neutrons in the target, the propagation of these neutrons and their slowing down by a cold moderator as well as their transport to the measurement point by an optimized collimator, allowing the minimization of the background noise on the experimental device. Finally, the use of the neutron beam for a radiography application will also be modelled. These simulations will be based on tests and measurements performed on the IPHI-neutrons facility. These will aim at the characterization the neutron beam (energy, spatial distribution, flux) as well as the gamma background noise at the point of detection. The student will actively participate in the installation of equipment, tests and data analysis.

LOCATION

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