SCALP

Scintillating ionization Chamber for ALPha particle production

in neutron induced reaction

Master 2 internship

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Neutron induced reactions on oxygen have been studied with strong interest because of the uncertainties generated on the helium production in fuel and on the neutron multiplication factor in nuclear reactors [1,2]. Still large discrepancies exist and new measurements are welcome in order to acquire new data aiming at the uncertainty reduction [3]. SCALP is a new scintillating ionization chamber [4] used as an active target to measure the cross section of (n, alpha) reactions on various gaseous targets such as ^{19}F or ^{16}O, from the reaction threshold up to 20 MeV. It consists of an ionization chamber filled with CF_4 (for fluorine measurements) or CF_4+CO_2 (for oxygen measurements) allowing the detection of the energy deposed by the light charged particles emitted in the (n, alpha) reaction. In addition, four Photo-Multiplier Tubes detect the scintillation light produced by the interaction of the particles in the gas active volume. Taking advantage of the fast response of the scintillation, the neutron kinetic energy can be inferred by time-of-flight measurements. SCALP is then well adapted to mono-energetic neutron beams or to white neutron beams that will be delivered at the NFS facility [5]. Because of its good resolution, SCALP discriminates different channel outputs, enabling to disentangle the different reactions [6].

In order to supply new data sets for the evaluation process, SCALP will be used at different facilities among Europe. For this we have submitted contribution to the nELBE facility (Dresden, Germany) [7] and the GELINA facility (Geel, Belgium) [8] and were granted by these two facilities enough time to study the (n, alpha) reaction on fluorine 19. Due to the low intensity of those two neutron sources, measurements of the ^{16}O(n, alpha)^{13}C are not foreseen; only the evaluation of the detector response in energy and time-of-flight resolution will be accomplished operating with a gas mixture CF4 + CO2 (3%). The two above experiments were planned in March and April 2020; due to the COVID-19 they were cancelled and should be reprogrammed before the end of this year, at least during the first semester of 2021.

In addition, we will take advantage of the commissioning of the NFS neutron beam (Caen, France) next autumn to carry out the first tests as well as the first measurements with the SCALP device.

The present internship will focus on the data analysis of measurements performed next fall and early next year. The candidate will need good programming (C++, PYTHON) and data analysis (ROOT) skills. If possible, the student will also be involved in the measurements at the different facilities.

[1] M. Salvatores and R. Jacqmin, Uncertainty and Target Accuracy assessment for innovative systems using recent covariance data evaluations (International Evaluation Co-operation, NEA/WPEC-26, 2008), 464

[2] M. B. Chadwick et al., The CIELO collaboration, Nuclear Data Sheets 118 (2014).

[3] Courcelle, Nuclear Science NEA/WPEC-22, 2006

[4] G. Lehaut, et al. Scintillation properties of N 2 and CF 4 and performances of a scintillating ionization chamber, Nucl. Instrum. Meth. A 797 (2015), 57-63.

[5] X. Ledoux, et al., The Neutrons for Science Facility at SPIRAL-2, Nucl.Data Sheets 119 (2014) 353-356.

[6] B. Galhaut, et al., SCALP: Scintillating ionization chamber for ALPha particle production in neutron induced reactions, EPJ Web Conf. 146 (2017) 03014.

[7] https://www.hzdr.de/db/Cms?pNid=35

[8] https://ec.europa.eu/jrc/en/research-facility/linear-electron-accelerator-facility