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#4-126 3D flux measurements of pile-oscillation: initial results of the BLOOM program in CROCUS using the SAFFRON detector array

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The BLOOM experimental program is an ongoing pile-oscillation program taking place in the CROCUS reactor at EPFL since summer 2024. Pile-oscillations are a type of semi-integral experiment in which a sample is periodically inserted in and extracted from a reactor, inducing a reactivity change. Modern programs, such as BLOOM or the CEA MAESTRO program, go beyond measuring and analysing the changes in reactivity or, more generally, in the global perturbation of the reactor state. Instead, they place additional emphasis on assessing the local effect of the sample on the neutron flux, thereby providing supplementary and complementary information on the sample's impact. BLOOM is the first pile-oscillation program performed in CROCUS. It was designed as a follow-up to the PETALE program focused on stainless steel nuclear data, using samples directly cut from the spare reflectors of PETALE. Unlike PETALE, which concentrated "only"on the main components of stainless steel –iron, nickel, and chromium –, BLOOM aims at to explore a broader range of samples relevant to the evaluation and validation of stainless steel-related nuclear data. This includes common minor alloy elements and different steel alloys such as molybdenum, titanium, silicium, zinc, stainless steel 316, and inconel-800, but also more exotic alloy element elements such as yttrium, tungsten, and tantalum, totalling 25 different materials and 40 samples. The oscillations are carried out in open-loop, meaning without compensation of the changes in criticality caused by the samples, with the previously qualified POLLEN linear oscillator. The experimental channel used for oscillation has been designed to fit inside one of CROCUS'control rod guide tubes, thus requiring no modifications to the core geometry and enabling easy and rapid sample insertion or removal as it is air filled. In the current setup, it accommodates samples up to 1 cm in diameter. From a neutron flux measurement perspective, BLOOM takes advantage of EPFL's previous developments in miniature neutron detectors. During the oscillations, a comprehensive 3D monitoring of the neutron population is achieved thanks to the SAFFRON detectors array, which comprises 149 fixed detectors distributed throughout the core of CROCUS, along with 11 mobile ones. With a total count rate of 200'000 counts per second per watt, SAFFRON enables both measuring the entire core response to the perturbation and verifying the point kinetics hypothesis. In addition, due to the small size of the detectors, some of the mobile ones are used to instrument the oscillation channel itself: 9 additional miniature detectors are arranged in a ring around the sample at its mid-height irradiation position, thereby capturing the local flux perturbation with exceptional proximity –at only 2 mm from the perturbations. This unprecedent proximity in pile oscillation experiment is coupled to an exceptional sensitivity to the sample, as their small size (sub mm) compared to the sample (i.e., form factor) also maximizes the observed flux variation. These factors result in a high precision estimation of the local flux perturbations, which will be advantageous for the subsequent validation and assimilation efforts. In this contribution, we present the experimental setup, the conducted experiments, the initial experimental results, and a preliminary comparison to their Monte Carlo simulations.

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