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#04-167 First in-core gamma spectroscopy experiments in the zero power reactor CROCUS

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Gamma rays in nuclear reactors, arising either from nuclear reactions or decay processes, significantly contribute to the heating and dose of the reactor components. Zero power research reactors offer the possibility to measure gamma rays in a purely neutronic environment, allowing for validation experiments of computed spectra, dose estimates, reactor noise and prompt to delayed gamma ratios. This data can contribute to models, code validation and photo atomic/nuclear data evaluation. To date, most experiments have relied on flux measurements using ion chambers or spectrometers set into low flux areas. The CROCUS reactor allows for flexible detector placement in the core, and has recently been outfitted with gamma detection capabilities to fulfill the need for in-core gamma spectroscopy, as opposed to flux. In this paper we report on the experiments and accompanying simulations of gamma spectrum measurements in a zero power reactor core. The CROCUS reactor is a two-zone, uranium-fueled light water moderated facility operated by the Laboratory for Reactor Physics and Systems Behaviour (LRS) at the Swiss Federal Institute of Technology Lausanne (EPFL). With a maximum power of 100 W, it is a zero power reactor used for teaching and research. Herein we also introduce, in detail, the new LEAF system: A **L**arge **E**nergy-resolving detection **A**rray for **F**ission gammas. It consists of an array of four detectors – two large 127x254 mm Bismuth Germanate (BGO) and two smaller 12x50 mm Cerium Bromide ($CeBr_3$) scintillators. We describe the calibration and characterization of LEAF followed by first in-core measurements of gamma ray spectra in a zero power reactor at different sub-critical and critical states and different locations. The spectra are then compared to code results, namely MCNP6.2 pulse height tallies. We were able to distinguish prompt processes using photon production tracking, and delayed peaks from decay databases. The results indicate the possibility of on line isotope tracking and burn-up validation. We provide the data as validation means for codes that attempt to model these processes for energies up to 10 MeV. We finally draw conclusions and discuss the future uses of LEAF.

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