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#4-181 Design of a Liquid Neutron Filter Device at the JSI TRIGA Reactor for Fission Rate Measurements under Simulated High-Temperature Conditions

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Accurate nuclear cross-section measurements are fundamental to advancing nuclear science and technology. To enhance data quality, a novel device is under development with the objective of experimentally simulating high temperatures, enabling fission rate measurements for heavy actinides that significantly influence temperature feedback effects in nuclear reactors. This is achieved with a liquid neutron filter: a container filled with water and boric acid. By varying the concentration of boric acid dissolved in water, the device simulates a thermal spectrum shift due to the characteristic "1/v"absorption cross-section behavior of B-10. This research is being conducted as part of a bilateral project between the Jožef Stefan Institute in Slovenia and the French Atomic and Alternative Energies Commission, Cadarache Research Centre. The device design includes three measurement tubes extending into the liquid filter. One tube will be used for neutron activation analysis, while the other two will house fission chambers—one with a fissile deposit of U-235 serving as a reference and the other with fissile deposits of nuclides of interest. Calculations of the predicted measurement results were performed for U-238, Am-241, Np-237, and Pu-239, in addition to U-235. By monitoring the relative changes in the signals of each fission chamber as the boron concentration varies, changes in fission cross-sections as a function of the spectrum shift can be accurately assessed. Neutron activation analysis will be possible through the irradiation of samples in an aluminum holder equipped with either a cadmium or aluminum box filter. A selection of foils for the activation tube indicated that reactions on the In-115, Ag-109, and Au-197 isotopes are the most sensitive to the thermal spectrum shift. A preliminary device design has been developed through neutron transport simulations using the MCNP and ADVANTG codes. After evaluating all potential beam port locations in the TRIGA Mark II reactor at the Jožef Stefan Institute, the Radial Beam Port was determined to provide the most suitable neutron flux conditions for device installation. Due to the geometric similarity among the beam ports, the device can also be used for measurements in different reactor locations in the future. Two methods are considered for the measurement of boric acid concentration: volumetric measurement during solution preparation and dilution, and a relative measurement using an external neutron source and an additional neutron detector positioned near one of the inlet pipes leading into the liquid filter, with changes in boric acid concentration inferred from variations in the neutron detector signal.

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