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A Beryllium-emitter based Self Powered Neutron Detector for European ITER Test Blanket Modules

Neutron flux is an important quantity to be measured in the Test Blanket Modules (TBM) of ITER, the experimental nuclear fusion reactor under construction at St. Paul lez Durance in France. Self-Powered Neutron Detectors (SPND) are commonly used for neutron flux monitoring in fission reactors as they are easier to manufacture, use and maintain than many other kinds of nuclear detector. Commercially-available SPNDs are tailored to measure the thermal neutron flux, however in the ITER TBM, the fast neutron flux must also be measured up to energies of the D-T fusion neutrons. An SPND with Beryllium as the emitter material is under design, for application in European ITER TBM.

This work focuses on selection and testing of newer materials for wide neutron spectrum and newer geometrical designs which can be suitably fitted into smaller spaces for instrumentation in the TBM systems of ITER.

Beryllium was identified as a candidate for the emitter material of an SPND to detect fast neutrons, like those expected in HCLL TBM of ITER. Alumina was chosen for insulator and Niobium for the collector material. For first test, thin foils of these materials are stacked to assemble a sandwich-like SPND. The assembly is irradiated with the 14 MeV neutron generator of Technical University of Dresden (TUD-NG) and high-resolution picoammeter is used to measure small electric currents generated in the detector.

A two-step Monte-Carlo simulation regime based on MCNP5 is devised to transport first neutrons and then electrons in the model of the SPND and estimate the electric current. Experimental tests are underway to check the response of the detector in mixed neutron-gamma field. Individual contributions from neutrons and gammas need to be carefully estimated and tested experimentally.

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