Seminar

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Institute for Plasma Research

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Title: Study of nuclear reactions for structural materials and investigation of reactor shielding

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Date: 30th May 2025 (Friday)

Time: 09:30 AM

Venue: Committee Room 1, IPR

Abstract

Neutron-induced reactions are of prime interest from the point of nuclear reaction theory, fission and fusion reactor technology, fast reactor design and control calculations, neutron fluence monitoring, safeguards, neutron therapy, medical physics, activation, prompt radiation analysis, radionuclide production, and applications of data in dosimetry. Advanced reactor systems, such as Accelerator-Driven Sub-critical Systems (ADSs) and the International Thermonuclear Experimental Reactor (ITER), are being developed by different research and development groups to meet the criteria for clean energy production. The aim is to develop future generations of fission and fusion reactors with upgraded safety features and economics-enhanced resource use with a minimum amount. To understand and regenerate the operation and performance of fission-based power plants, fusion devices, and accelerators, the concerned simulation codes must have a wide range of nuclear data, like cross-section and decay properties for all the materials of interest in the device. Hence, the part of the work focuses on nuclear cross-section data that requires improvement for applications such as future fusion devices and structural materials for fission reactors. With an emphasis on experimental measurements and covariance, this work provides a thorough analysis of neutron-induced nuclear processes. The experiments were carried out at the Purnima Accelerator at the Nuclear Physics Division, BARC, Mumbai, India, and the 14UD Bhabha Atomic Research Center-Tata Institute of Fundamental Research (BARC-TIFR) Pelletron accelerator at TIFR. The neutron activation technique and off-line γ-spectroscopy were used to accomplish the measurements. In addition to a thorough explanation of the uncertainty analysis using the ratio measurement technique. The current results were compared using the TALYS code with the evaluated data libraries ENDF/B-VII.1, JENDL-4.0, and JEFF-3.3. For reactor structural materials and reactor technological improvement, the outcomes are quite pertinent. Furthermore, from the early days of reactor technology development, when a variety of radioactive sources were used, radiation shielding has become a more significant research field. This is because radiation is extremely detrimental to living things and should be safeguarded. For this, a suitable amount of additives in the concrete mixture can enhance shielding from γ-rays and neutrons. With this perception, the concrete has been prepared with different amounts of tungsten carbide (WC) and boron carbide (B_4C) additives. These samples were experimentally analyzed through γ-ray (^{60}Co) and neutron (^{252}Cf) sources at Defence Laboratory Jodhpur, Rajasthan, India. The theoretical prediction codes XCOM, MCNP, Auto-Zeff, and NXcom were used to compare the present findings. The outcomes show that the modified compositions are better as compared to the pristine concrete.