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Fusion's Fast Neutrons: Measurement, Management and Tritium Breeding

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Nuclear fusion offers the promise of a sustainable, low-carbon energy future. However, the success of this technology hinges on our ability to understand and manage the intense neutron environment within a fusion reactor. Unlike fission systems, fusion reactors generate high-energy neutrons (approximately 14.1 MeV) that interact with structural materials, leading to activation and potentially enabling tritium breeding through neutron-lithium reactions.

This talk provides an overview of the role of neutron balance in fusion reactors, with a focus on its use for tritium breeding and the potential extraction of energy to power a steam turbine. Special emphasis is placed on the metrology of measuring neutron fluxes in fusion-relevant environments. As part of earlier work, the author conducted high-precision flux wire measurements at the McMaster Nuclear Reactor (MNR), which serve as a benchmark for characterizing the neutron field. This well-established fission reactor diagnostic technique may also be adapted for metrological tasks in fusion reactors, such as ITER and IFMIF-DONES.

The presentation will outline the principles of neutron flux measurements and potential adaptations for fusion contexts. It will also illustrate possible applications, including validating blanket module simulations, supporting materials testing campaigns, and assessing tritium breeding efficiency.

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