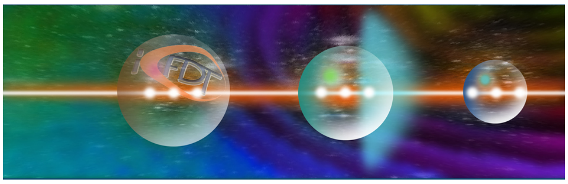

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The SPARC Formula for DT Tokamak Neutron Diagnostics

Monday, 21 October 2024 11:00 (20 minutes)

A deuterium-tritium (DT) fuel mix has been commonly proposed for the first generation fusion power plants. Majority of the DT reaction energy is carried away by the 14 MeV DT neutrons; thereby, monitoring of the fusion power (Pfus) and control of the plasma burn can be accurately done through the neutron diagnostics. Quite a limited experience exists in the integrated neutron diagnostics for DT tokamaks, from the concluded (JET, TFTR) or upcoming (ITER) projects. The SPARC tokamak presents a robust, economic, and future proof solution to this, with its four neutron diagnostics subsystems optimized in terms of physics performance and rapid engineering deliverability. SPARC has a fleet of flux monitors of ionization chamber and proportional counter types, two independent neutron activation systems, a spectrometric neutron camera for plasma profile monitoring, and a high-resolution magnetic proton recoil spectrometer for the plasma core. These systems ensure redundancies of sensors and methods, are designed to fetch high accuracy (σ<10%) of Pfus, cover a wide dynamic range (>8 orders of magnitude, <5.E19 n/s), and provide high resolutions of time (10 ms), space (~7 cm), and energy (<2% at 14 MeV). The design calculations are assisted by sophisticated neutronics simulations using Monte-Carlo and deterministic methods, and heavily detailed facility geometry descriptions. At the same time, extensive prototyping activities at CFS and the collaborating neutron generator sites (MIT and FNG) are supporting the sensor development. A minimum viable yet rigorous, in-situ calibration methodology has been developed employing strong sources of fast neutrons. Finally, a preliminary assembly and commissioning plan has been developed, fitting into the tight schedule of the SPARC project, aiming for its first plasma and fusion breakeven (Q>1) in 2026.

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For a list of co-authors, see the author list of the article "P. Raj et al, Rev of Sc Instr. 2024, Proceedings of the HTPD 2024 conference".

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