Gamma-ray emission on SPARC for burning plasma diagno

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In thermonuclear plasmas, gamma-rays are emitted by plasma ions undergoing nuclear reactions. Their spectroscopy conveys much plasma information, such as the DT fusion power [1], the spatial and velocity distributions of the fast ions, and the plasma heating performance [2]. In the present work, we simulate the gamma-ray emission expected in SPARC during a primary reference discharge (PRD) [3], with particular focus on T(D, g)^{5}He, ^{10}B(^{4}He, p g)^{13}C and D(^{3}He, g)^{5}Li reactions. We use realistic plasma profiles calculated with the TRANSP code [4] and simulate radiofrequency heating of the plasma with CQL3D and TORIC. Possible locations for gamma spectrometers based on traditional $LaBr_3$ inorganic scintillators are suggested. For each, the signal-to-noise ratio of gamma-rays over neutrons is evaluated using the ray-tracing code ToFu, and high fidelity Monte Carlo models of radiation transport in SPARC, implemented with MCNP [5] and OpenMC [6]. A dedicated neutron attenuator made of high density polyethylene is designed to allow gamma-spectroscopy during high neutron yield experiments. And finally, the performance of $LaBr_3$ detectors in reconstructing the fusion power generated by SPARC are discussed.

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