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Orbit Weight Functions for Neutron Emission and One-step Reaction Gamma-Ray Spectroscopy Diagnostics

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Fast-ion distribution functions in the MeV-range can be diagnosed by neutron emission spectroscopy (NES) and gamma-ray spectroscopy (GRS). For a given fast-ion distribution function and diagnostic energy bin, a measurement signal will have contributions originating from various fast-ion orbits [Ref1][Ref2]. These contributions depend on the sensitivity of the diagnostic in orbit phase space, which can be mapped using weight functions. Velocity-space weight functions have previously been used to map the sensitivity in 2D velocity space[Ref3][Ref4][Ref5]. In this work, we present and discuss 3D orbit weight functions for the Joint European Torus NES diagnostic TOFOR[Ref6], an NE213-scintillator[Ref7] and a high-purity germanium GRS diagnostic[Ref8]. The complicated three-dimensional structures of these so-called orbit sensitivities can be mapped by varying the fast-ion energy while tracing out the topological boundaries between different orbit types. Furthermore, the sensitivity is found to vary depending on the diagnostic energy bin of interest, as determined by the requirement to produce a sufficient amount of up- or down-shift of the nominal birth energy of neutrons from D(D,n)^{3}He and gammas from T(p,γ)^{4}He. Using this approach, signal contribution split into orbit types is presented for the first time.

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