Assessment of the Fast Particle Spectra for Tangential Spectrometer for H/He and DT ITER Operation

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The study of fast ion behaviour in reactor conditions is among the major goals of the ITER project. Additional heating by NBI and ICH creates population of suprathermal ions with an anisotropic distribution in velocity space. The energy spectrum measurements of CX neutrals and neutrons made by the Tangential Neutron Spectrometer (TNS) contribute to the reconstruction of the fast ions' distribution function in combination with the radial measurements by the NPA, RNC, and HRNS diagnostics. It will help determine the consequences of instabilities which cause the redistribution of fast ions in the plasma and to the assessment of their impact on plasma heating and current drive. Assessing the capabilities of diagnostics at different phases of ITER operation is an essential part of ITER research planning. Simulations of the signals that will be measured at different phases of ITER operation require computational tools, so called synthetic diagnostics (SD), with realistic geometry and parameters corresponding to the ITER diagnostic design. To assess the accuracy and resolution of the measurements of the TNS in all ITER scenarios we have developed a TNS SD compatible with the ITER IMAS suite of codes. The module developed enables simulation of the anisotropic spectra of the charge-exchange (CX) neutrals and neutrons originated from interactions between suprathermal and thermal ions together with the background spectra. Simulations of realistic signals require appropriate approximations for the processes which produce the main and background signals. In our simulations the distribution of the suprathermal ions is calculated by solving the 3D Fokker-Plank equation for the different scenarios foreseen in the ITER research plan. This includes the pre-DT and DT phases of ITER operation with different orientations of the NBI as foreseen in the ITER design. Simulations of the spectrum of the CX neutrals are based on the DOUBLE-MC code extended to simulate anisotropic sources and neutrons. Background spectra at the location of the TNS detectors for neutrons were calculated on the basis of a parameterisation of the MCNP simulations with realistic ITER geometry and features of the machine components. Assessment of the CX neutrals and DT neutrons spectra is carried out for H-NBI during the pre-DT phase and D-NBI heated baseline DT scenarios. The impact of the fast particle distribution on the spectra is studied.