NEUTRONIC CALCULATIONS IN SUPPORT OF THE DESIGN OF THE ITER HIGH RESOLUTION NEUTRON SPECTROMETER

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The HRNS (High Resolution Neutron Spectrometer) is an enabled ITER diagnostic system conceived to provide information about various plasma parameters such as the ion temperature, the fuel ratio and the fast ions' density and energy spectrum. The present reference position for the HRNS is about 12 m from the plasma centre in Equatorial Port Cell 1. A close to radial line-of-sight is foreseen, with a long narrow conical collimator crossing the longitudinal axis of the port plug from the first wall to the cryostat and protruding beyond the bioshield. The detection system has not been defined yet, but three main techniques are under investigation: thin-foil proton recoil (magnetic and non-magnetic), time-of-flight and compact neutron spectrometry (proton recoil scintillators and diamonds).

This paper presents neutronic calculations required to address important issues related to the optimization of the HRNS design, in particular concerning the definition of the interfaces and the choice of the detector system. The calculations have been carried out using the MCNP5 Monte Carlo code in a full 3-D geometry. The HRNS collimation system has been included in the latest MCNP ITER 40° model (Alite-4). The ITER scenario 2 reference DT plasma fusion neutron source peaked at 14.1 MeV with Gaussian energy distribution has been used.

Neutron fluxes and energy spectra (>1 MeV) have been evaluated at different positions along the HRNS collimator and at the detector location. The signal-to-noise ratio (i.e.: the ratio of collided to uncollided neutrons), the breakdown of the collided spectrum into its components, the dependency on the first wall aperture and the gamma-ray spectra have also been analysed. The impact of the results on the design of the HRNS diagnostic system is discussed.