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Conceptual design of the BestTOF neutron spectrometer for fuel ion ratio measurements at ITER

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Measurements of the core plasma fuel ion density ratio (nT/nD) is required for safe and efficient burning plasma operations at ITER. However, this measurement is difficult and very few working techniques have been demonstrated. One candidate method to obtain the fuel ion composition is Neutron Emission Spectroscopy, specifically, measurement and analysis of the DT neutron spectrum of neutral beam heated plasmas. However, none of today's fully implemented neutron spectrometer techniques fulfills all requirements for such measurements at ITER and a suite of instruments will most probably be required.

In [1] the nT/nD measurement was demonstrated using data from the Magnetic Recoil Proton (MPR) spectrometer acquired during JET DT operations in 1997. Due to size and weight constraints the MPR is however not possible to interface at ITER. Instead, a Back Elastic Scattering Time Of Flight (BestTOF) spectrometer is presented here. The goal of the BestTOF design is to obtain a spectrometer that fulfills all requirements for fuel ion density measurements in a broad range of operational conditions at ITER. The technique takes advantage of the well-established (forward) time-of-flight method, while exploring the favourable conditions of (n,d) scattering in the backward direction (i.e., around 180 degrees) regarding cross section and kinematics. This is achieved by introducing deuterium-based scintillators as first, in-beam scatterers in the design.

Aside of size and weight, the requirements of the instrument are a high efficiency and count rate capability to be able to acquire the counting statistics required for performing the analysis; to fulfill the ITER requirements on accuracy, precision and time resolution this means at least several 100 kHz rate of useful counts. The spectrometer also needs an energy resolution of 4% or better. Furthermore, the signal to background at the high-energy side of the DT emission (En > 14 MeV) must be at least 1000.

In this paper we show that the BestTOF design fulfills all of the above mentioned requirements while also being light and compact enough for installation at ITER. The BestTOF is also proposed to be a part of the complete High Resolution Neutron Spectrometer system at ITER [2].

[1] C. Hellesen et al., Nuclear Fusion, Volume 55, Number 2
[2] G.Ericsson et al., These proceedings

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