DESIGN CONSTRAINTS AND PARAMETERS FOR FUSION ALPHA LOSS DIAGNOSTIC BASED ON ACTIVATION TECHNIQUE

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In ITER, alpha particle loss measurements remain difficult and further progress is needed. A number of standard measurement methods have been proposed but techniques capable of operating in the fusion reactor conditions need development[1,2]. Direct charged particle detection in the fusion alpha energy range relies on two interaction processes: inelastic scattering on atomic electrons and nuclear reactions. The performance and reliability of the standard measurement techniques based on the first process are questionable as the detectors will have to operate in the harsh ITER first wall environment. In addition, they may suffer from saturation from background radiation without any shielding space available. Detector background in the intense neutron gamma n/γ radiation field is mainly due to Compton electrons absorption which is weakly dependent on the detector and cover material chosen.
Neutron activation methods for determining the neutron fluence at the measuring points have a long history in the neutron metrology and tokamak applications of the neutron activation method are well developed[3]. By contrast, the charged particle activation method is a novel concept recently tested on JET[4] and which may offer a useful and more robust solution for performing alpha particle loss measurements in an ITER device.
As a first step towards an ITER design, the major parameters needed for the modelling of the diagnostic are presented and discussed. The design constraints are derived from the ITER diagnostic system measurements criteria [2] and from the predicted level of alpha particle ITER first wall load given by the ASCOT code[5]. Calculations of the diagnostic response and expected performance are carried out using the radionuclide inventory code FISPACT[6] with the EAF-2007 nuclear data libraries. Finally, research needs for the further development of this diagnostic technique are outlined.

[1] S.Zweben et al Nucl. Fusion **40** 1 (2000) 91
[2] A.J.H. Donne et al Nucl. Fusion **47** (2007) S337
[3] N.Jarvis et al, Fusion. Sci. Technol **20** (1991) 265
[4] G.Bonheure et al Fusion. Sci. Technol **53** (2008) 806
[5] T.Kurki-Suonio et al, Nucl. Fusion **49** (2009) 095001
[6] R.A. Forrest, UKAEA FUS (2007) 534