Abstract

Evaluating the Fusion Power Accuracy using Synthetic Measurement Simulations

Kovalev A.O., Rodionov R.N., Portnov D.V., Vorobiev V.A., Kashchuk Yu.A.

Project center ITER.

This work focuses on the DNFM (FDR design), NFM EQ#1 and MFC performance analysis. Diagnostic tools will measure the Total neutron flux, [n/s] and Fusion power, [MW] of ITER plasma in a wide range of magnitude – up to 7 orders. The systems can be absolutely calibrated with a very good precision (up to 10%) using standardized neutron sources (neutron generators or/and isotope sources).

The plasma as a neutron source is a spatially distributed volumetric object with evolving parameters in time like plasma geometry, magnetic axis position and source neutrons distribution in a plasma poloidal profile.

Observational total uncertainty is a combination of two factors: statistical and systematic error. Statistical error can be minimized by optimization of the detectors sensitive material mass. However, the sources and the possible level of the systematic error shall be well studied on a design stage.

We investigated the reduction of the highlighted plasma parameters impact on a DNFM, NFM EQ#1 and MFC diagnostics systematic error. The Green's function approach was implemented to simulate the fission rates of the neutron diagnostics detectors in time. The ranges of linear dependences, detectors sensitivity to DD or DT source neutrons, concept of calibration strategy with standard distribution of neutrons, current design of systems where included in the model of measurements. The statistical uncertainty was estimated using weighting average method. The sources of the systematic uncertainty are the calibration strategy and provided assumptions, where diagnostic tools as a counters can't distinguish signals caused by DD source neutrons and DT source neutrons. Such effect and its influence on the measurements was reported using DD plasma scenarios, stored in IMAS data base. The second interest of the research is how evolution of plasma parameters effects on the systematic error. Different methods of systematic uncertainty estimation and compensation were observed.

The improved measuring algorithms and integration of neutron diagnostics into one measuring circuit will help us to reduce the systematic error and to achieve the best possible accuracy of measuring parameters.