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ITR/P5-31: System-Level Optimization of ITER Magnetic Diagnostics: Preliminary Results

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The present accuracy requirements on ITER parameters to be obtained primarily from magnetic measurements are demanding and, in many situations, they might be not achieved. As a consequence, in specifying the diagnostic, either the requirements should be qualified or the overall process for the estimation of each parameter should be modified.
Although previous work in this area has been reported this is the first study combining the complete baseline diagnostic with a realistic and detailed description of the ITER machine, in 3D.
The paper considers two different estimation problems: a) reconstruction of plasma equilibrium (plasma current and plasma-wall gaps); b) identification of n and m of TAE perturbations.
As far as the first problem is concerned, we firstly give an estimation of the parameter reconstruction errors obtainable with standard axisymmetric 2D equilibria using the EFIT++ reconstruction code. In particular the analyses have been carried out on an ITER equilibrium database composed of 322 axis-symmetric static plasma equilibria (with no eddy currents) and 150 axis-symmetric perturbed plasma equilibria (in the presence of eddy currents). The first set of analyses assumed ideal sensors. Additional analyses to account for the sensor measurement errors are also presented. The main conclusion is that, even ignoring additional sources of uncertainty, considered in the next section, the accuracy requirements (e.g. those of ref. [1]) are not met under all conditions. Successively, we evaluate the pick-up on magnetic sensors and the impact on the gap reconstruction accuracy due to three different sources: i) 3D non-axisymmetric eddy currents induced by the plasma and actuator coils; ii) non-axisymmetric in-vessel actuator coils (ELM coils) for plasma control; iii) 3D non-axisymmetric ferritic materials.
The analysis of the TAE perturbations is carried out using a new approach proposed by the authors. It is based on the use of MARS code to generate the magnetic field perturbation due to a given TAE on the plasma boundary, in presence of a fictitious ideal wall, and on the determination of a current-carrying sheet, sufficiently inside the plasma surface, providing approximately the same field on the plasma boundary. This current distribution is then used to determine the propagation of the magnetic field to the sensors, using the CARIDDI code.

Country or International Organization of Primary Author

Italy

Collaboration (if applicable, e.g., International Tokamak Physics Activities)

ITER Organization

Primary author: Prof. AMBROSINO, Giuseppe (Università di Napoli Federico II)

Co-authors: Prof. PIRONTI, Alfredo (CREATE/ENEA/Euratom Association, Università di Napoli Federico II , Naples, Italy); Dr CIANFARANI, Cesidio (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Prof. VILLONE, Fabio (CREATE/ENEA/Euratom Association, Università di Cassino , Cassino, Italy); Dr CRISANTI, Flavio (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Dr VAYAKIS, George (ITER Organization, Route de Vinon sur Verdon, 13115 Saint Paul Lez Durance, France); RAMOGIDA, Giuseppe (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Dr VLAD, Gregorio (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Prof. RUBINACCI, Guglielmo (CREATE/ENEA/Euratom Association, Università di Napoli Federico II , Naples, Italy); Dr ZABEO, Luca (ITER Organization, Route de Vinon sur Verdon, 13115 Saint Paul Lez Durance, France); Dr APPEL, Lynton (EURATOM/CCFE Fusion Association, Culham Science Centre , Abingdon, UK); Dr ARIOLA, Marco (CREATE/ENEA/Euratom Association, Università di Napoli Parthenope , Naples, Italy); Prof. MATTEI, Massimiliano (CREATE/ENEA/Euratom Association, Seconda Università di Napoli, Naples, Italy); Dr BROMBIN, Matteo (Consorzio RFX, EURATOM/ENEA Association, Padova, Italy); Dr TUDISCO, Onofrio (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Prof. BETTINI, Paolo (Consorzio RFX, EURATOM/ENEA Association, Padova, Italy); Dr MICOZZI, Paolo (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Prof. ALBANESE, Raffaele (CREATE/ENEA/Euratom Association, Università di Napoli Federico II , Naples, Italy); Dr DELOGU, Rita (Consorzio RFX, EURATOM/ENEA Association, Padova, Italy); Mr ARSHAD, Shakeib (EU); Dr PERUZZO, Simone (Consorzio RFX, EURATOM/ENEA Association, Padova, Italy); Dr HENDER, Tim (EURATOM/CCFE Fusion Association, Culham Science Centre , Abingdon, UK); Dr FUSCO, Valeria (ENEA/EURATOM Association, Centro Ricerche Frascati , Frascati, Italy); Prof. COCCORESE, Vincenzo (CREATE/ENEA/Euratom Association, Università di Napoli Federico II , Naples, Italy)

Presenter: Mr ARSHAD, Shakeib (EU)

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