Contribution ID: **34** Type: **Oral (Regular)**

Uncertainties of magnetic equilibrium reconstructions

Thursday 11 September 2025 14:00 (25 minutes)

Reliable magnetic equilibrium reconstruction is key for the interpretation of experimental data and for physics modelling. Uncertainties of equilibrium quantities are frequently not provided although essential for the validation and quantification of derived physical quantities. A Monte-Carlo approach applicable to a free-boundary equilibrium reconstruction is suitable to provide uncertainties on any scalar, profile or flux-surface magnetic quantities.
The Monte-Carlo approach is aplied to the IDE equilibrium code which couples a kinetic free-boundary Grad-Shafranov solver with a solver of the current diffusion equation [1,2]. The set of external and internal measurements available to constrain the equilibrium are thereby extended by a flux-surface averaged current density provided by the current diffusion. The covariance matrix evaluated from the response function coupling the equilibrium coefficents with the set of measurements is employed in a Monte-Carlo sampling approach to estimate any equilibrium quantity of interest. The set of scalar quantities comprise, e.g., the geometry coordinates of the magnetic axis, the saddle points, dedicated points on the separatrix, the strike-line positions, volume-averaged coordinates, shape coordinates such as upper and lower triangularity, plasma current, Wmhd, plasma self inductivity, various beta values, dedicated q-values, and the distance between the 1st and 2nd X-point. The set of profile quantities comprise, e.g., the current density profile, and the q- and magnetic shear profile. The list of physical quantities can easily be extended as with the applied method the uncertainty of any magnetic quantity can be estimated. The evaluation time is below 1 s for a single equilibrium time point with room for significant improvement applying parallelization techniques.
[1] R. Fischer et al. 2016 Fusion Sci. Technol. 69 526–36
[2] R. Fischer et al. 2019 Nucl. Fusion 59 056010

Speaker's email address

rainer.fischer@ipp.mpg.de

Speaker's Affiliation

Max Planck Institute for Plasma Physics, Garching, Germany

Member State or International Organizations

Germany

Author: FISCHER, Rainer

Presenter: FISCHER, Rainer

Session Classification: Sensor Fusion and Integrated Data Analysis

Track Classification: Sensor Fusion and Integrated Data Analysis