OPTIMIZATION OF PLASMA DIAGNOSTICS USING BAYESIAN PROBABILITY THEORY

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Abstract

The Wendelstein 7-X stellarator will be a magnetic fusion device and is presently under construction. Its diagnostic set-up is currently in the design process to optimize the outcome under given technical constraints. In general, the preparation of diagnostics for magnetic fusion devices requires a physical model of the measurement which relates the physical effect to the measured data (*forward function*), and a diagnostics model which describes the error statistics.

The approach presented here bases on maximization of an information measure (Kullback-Leibler entropy, see ref. [1]). Bayesian probability theory allows one to link measures from information theory with the model for the fusion diagnostics. The approach can be considered as the implementation of a *virtual diagnostic* which generates data from a range of parameters. The virtual diagnostic employs the forward function and accounts for the error statistics. Then, optimization means maximization of the expected utility with respect to the design parameters. It allows for extensive design studies of effects due to physical input and possible benefits due to technical elements. Comparisons with other information measures and approximation methods for the prior predictive value are discussed.

The reconstruction of density profiles by means of a multichannel infrared interferometer at W7-X is investigated in detail. The influence of different error statistics and the robustness of the result are discussed. In addition, the impact of technical boundary conditions is shown.

References:

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