

Bayesian inference of 2D tungsten concentration profiles at WEST using soft X-ray and bolometer diagnostics

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Tungsten (W) will be used in the ITER tokamak for its divertor and first wall. The strong plasma radiation from heavy impurities like tungsten may cause significant power loss and can pose a major risk to the energy confinement. Reliably estimating the tungsten concentration in a fusion device is therefore critical for transport studies and active impurity control. This is often achieved by analyzing the line-integrated plasma radiation recorded by various diagnostics, such as soft X-ray (SXR), bolometry and extreme ultraviolet (EUV). However, results from independent analyses of individual diagnostics often exhibit inconsistencies. A coherent combination of the data from multiple diagnostics can be achieved using the integrated data analysis (IDA) approach based on Bayesian probabilistic theory. This provides joint estimates of tungsten concentration profiles, as well as kinetic profiles (temperature and density), together with their uncertainties. The joint posterior probability distribution of the profiles must be explored by a Markov chain Monte Carlo (MCMC) sampler. The difficulty of sampling from the high-dimensional and strongly correlated joint posterior distribution has been resolved in this work by applying reparameterization. First results using synthetic data and experimental data from WEST indicate the strong potential of this method.

Member State or International Organizations

Belgium

Speaker's email address

hao.wu@ugent.be

Speaker's Affiliation

Ghent University

Author: Mr WU, Hao (Ghent University)

Co-authors: Dr JARDIN, Axel (Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)); Dr WANG, Tianbo (ITER Organization); Dr MAZON, Didier (CEA Cadarache); Prof. VERDOOLAEGE, Geert (Ghent University)

Presenter: Mr WU, Hao (Ghent University)

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