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# Reconstruction of 2D tungsten concentration profiles at HL-2A using Bayesian integrated inference

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In ITER, tungsten has been selected as divertor material due to its low tritium retention and ability to handle large heat loads. But tungsten may also pose an important risk, since such highly charged impurities can be a source of strong radiative power loss, possibly leading to a disruption. In reactor-relevant plasmas, thermonuclear burn will be possible only if tungsten concentrations remain below $10^{-4}$ [Pütterich10]. Therefore, a detailed understanding of core impurity transport in tokamaks, is crucial. This requires reliable local information about impurity distributions, at a time resolution that is adapted to impurity transport time scales. In previous work [Wang19], a Bayesian integrated inference method has been demonstrated on WEST tokamak, which has implemented soft X-ray (SXR) spectroscopy, electron cyclotron emission (ECE), Thomson scattering (TS) in a synthetic testing, significantly improves the accuracy of tungsten concentration profile reconstruction at plasma edge area (figure 1&2).

In this work, the Bayesian integrated inference is applied to the reconstruction of 2D profiles of tungsten concentrations at the HL-2A tokamak by using experimental data during tungsten injection triggered ELM suppression discharge. The analysis is based on integrated analysis of measurements from soft X-ray (SXR) spectroscopy, electron cyclotron emission (ECE), far-infrared (FIR) laser interferometry and frequency-modulated continuous-wave (FMCW) reflectometry. The method enables consistent estimation of 2D profiles of the tungsten concentration, as well as the electron density and electron temperature, including the magnetic equilibrium information as prior knowledge. It is shown that the Bayesian integrated approach considerably improves the reconstruction accuracy near the plasma boundary, compared to the traditional method. With the implementation of neural network surrogate modelling, this method has the potential to deliver the inference result in real-time.

References

[Pütterich2010] T. Putterich et al., "Calculation and experimental test of the cooling factor of tungsten," Nucl. Fusion **50**, 025012, 2010.

[Wang2019] T. Wang, Phd thesis, Ghent University, "Reconstruction of soft X-ray and tungsten concentration profiles in tokamaks using Bayesian method", 2019.

Figure 1. Bayesian integrated inference structure for tungsten concentration reconstruction at WEST by using SXR, ECE and TS diagnostics.

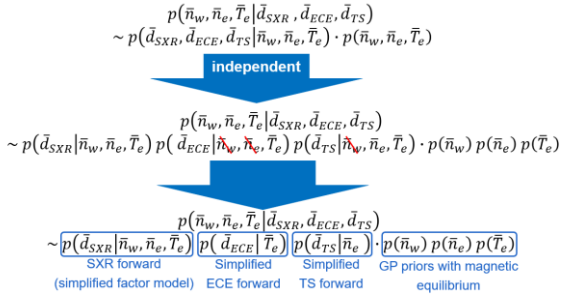
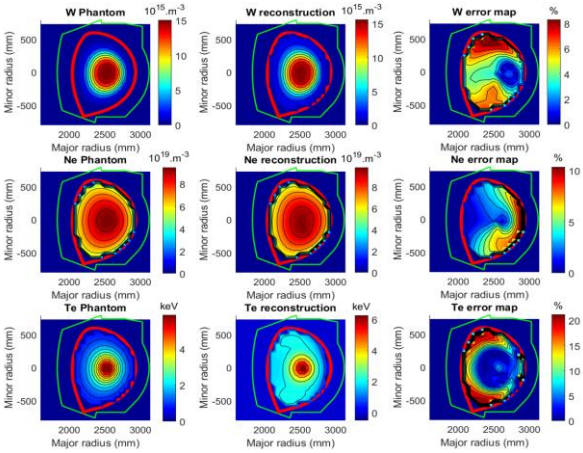



Figure 2. A reconstruction result by using synthetic data. The first column represents the preset synthetic distribution of tungsten density, electron density and electron temperature; the second column represents the reconstructed results; the third column represents the reconstruction errors.




Note: Abstract should be in 1 page.