P 5: Helmholtz Graduate School II

Time: Monday 16:15–17:55 Location: A 0.112

P 5.1 Mon 16:15 A 0.112

Bayesian inference of the electron cyclotron emission diagnostic at Wendelstein 7-X — •Udo Hoefel[1], Neha Chaudhary[1], Oliver Ford[1], Matthias Hirsch[1], Sehyun Kwak[1], Nikolai B. Marushchenko[1], Hans Oosterbeek[1], Andrea Pavone[1], Jonathan Schilling[1], Torsten Stange[1], Jakob Svensson[1], Yuriy Turkin[1], Gavin Weir[1], Robert C. Wolf[1,2], and the W7-X team[1] — [1]Institute for Plasma Physics, Greifswald branch — [2]Technical University Berlin

Wendelstein 7-X (W7-X) is an optimized stellarator that uses a 32 channel heterodyne electron cyclotron emission radiometer (ECE) as a standard diagnostic to measure the electron temperature profile with high temporal resolution.

In order to obtain a systematic calibration procedure with rigorous uncertainty estimates, modelling within the Bayesian Minerva framework has been used to infer the absolute effective sensitivities and beam widths from a periodic switching between a (hot) source at room temperature and a (cold) source at liquid nitrogen temperature.

As the ECE measures the radiation temperature and not directly the local electron temperature, a Gaussian process based profile inversion has been done to extract the electron temperature profile. For this purpose, the radiation transport code TRAVIS has been implemented in Minerva, allowing complex models of multiple diagnostics to include ECE data.

P 5.2 Mon 16:40 A 0.112

Bayesian modelling of multiple diagnostics at Wendelstein 7-X using the Minerva framework — •Sehyun Kwak[1,2], Jakob Svensson[2], Sergey Bozhenkov[2], Humberto Trimino Mora[2], Udo Höfel[2], Andrea Pavone[2], Maciej Krychowiak[2], Andreas Langenberg[2], and Young-chul Ghim[1] — [1]Department of Nuclear and Quantum Engineering, KAIST, Daejeon 34141, Korea — [2]Max-Planck-Institut für Plasmaphysik, 17491 Greifswald, Germany

Consistent inference of physics parameters and their uncertainties for large scale experiments requires the capability of handling the physics models of multiple sophisticated diagnostic systems. The Minerva framework has been developed for scientific inference and Bayesian modelling for complex systems, and is the standard analysis infrastructure for the W7-X experiment. It will be shown how Bayesian models implemented in the Minerva framework are capable of inferring electron temperature and density profiles from multiple diagnostic (Thomson scattering, interferometer, He-beam) data in a consistent way. The physics models for each diagnostic have been implemented and analysed individually as well as combined. The profiles are modelled by Gaussian processes with hyperparameters for varying length scales determined by a Bayes Occam*s razor criteria. The full posterior of profiles, hyperparameters, and calibration are explored by Markov chain Monte Carlo sampling. The results show all possible combinations of profiles, hyperparameters, and calibration with their associated uncertainties. Calibration of the Thomson scattering system is automatically handled by the combined model.

P 5.3 Mon 17:05 A 0.112

Bayesian Evaluation of Infrared Thermography determining Surface Heat Flux Densitie — •Dirk Nille, Udo von Toussaint, Micheal Faitsch, Bernhard Sieglin, and the ASDEX Upgrade Team — Max-Planck-Institute for Plasma Physics, Boltzmannstr. 2, D-85748 Garching, Germany

In fusion research the determination of the heat flux distribution onto the material surrounding the plasma is crucial, as power exhaust is a major challenge in the development of a future fusion power plant. Infrared thermography provides spatially and temporally resolved data for this purpose. This is an inverse problem, where the result of the quantity of interest is observed and the cause has to be reconstructed.

Basis is to solve the heat diffusion equation in the target material with the surface temperature as boundary condition, given by measurements. A direct evaluation is in use for decades by deterministic codes, developed for fast evaluation of data. Standard deviation during quasi-static conditions is used as error bars.

Bayesian evaluation is based on a forward model – describing the response of the physical object, the target material – and a model describing the quantity of interest in order to find the most probable cause leading to the measurement. For this purpose adaptive kernel – a multi-resolution model – are used to describe the heat flux density distribution. Taking into account the known experimental uncertainty yields reconstructions of better quality and reliable credibility ranges.

This allows more detailed analysis about the plasma transporting heat from the confined area to the observed target material.

P 5.4 Mon 17:30 A 0.112

Power loads in the scrape-off layer of Wendelstein 7-X — •Holger Niemann[1], Adnan Ali[1], Peter Drewelow[1], Florian Effenberg[2], Marcin Jakubowski[1], Ralf König[1], Fabio Pisano[3], Aleix Puig Sitjes[1], Thomas Sunn Pedersen[1], Glen Wurden[4], and W7-X Team[1] — [1]Max-Planck-Institut für Plasma Physik, Wendelsteinstraße 1, 17491 Greifswald — [2]University of Wisconsin, Madison, USA — [3]University of Cagliari, Cagliari, Italy — [4]Los Alamos National Laboratory, Los Alamos, USA

The advanced stellarator Wendelstein 7-X has a five-fold symmetry and started its first campaign (OP1.1) with a limiter configuration in 2015. Five uncooled graphite limiter were placed periodically on the inboard side of the plasma vessel. This campaign was followed by a divertor campaign (OP1.2a) in 2017. The limiters were replaced by ten symmetrically positioned upper and lower uncooled divertors. Infrared camera systems were used in both campaigns to observe the surface temperature of the plasma facing components. From the measured evolution of the surface temperature the heat flux is evaluated with the THEODOR code. We measured heat fluxes up to 7-8 MW/m^2 on the limiter and up to 10 MW/m^2 on the divertor. The Double fall-off length was measured at the limiter with the narrow scrape-off layer(SOL) being of order of 8 mm and far SOL of order of 2 cm. The width of the SOL shows a clear scaling with connection length. In the divertor campaign the heat flux pattern varies strongly with the magnetic configuration. Depending on the configuration the local measured strike line width is in the range from around 1 cm to around 3 cm.