

Bayesian modelling of MAST Upgrade CXRS diagnostic (CELESTE)

Friday 12 September 2025 09:00 (25 minutes)

Stimulated emission by neutral beam (NB) injection is of key importance for diagnosing the state of the core plasma in tokamaks. This paper reports on the development of a new Bayesian model of a spectral diagnostic system with NB injection. Implemented within the Minerva framework and with data entry via the ITER Integrated Modelling & Analysis Suite (IMAS), the model provides a generic probabilistic treatment that can be applied to any appropriate Tokamak device subject to availability of suitable IMAS database instances. A feature of the model is that the NB injection includes the propagation of the beam from the final accelerator grid of the NB source. Downstream distributions, taking account also of the attenuating effects of edge baffles, are expressed as a summation of analytic distributions obtained by coordinate transformation (L. C. Appel, Computer Physics Communications, Vol 312, 2025). Continuing model developments incorporate NB reionisation due to cold mono-atomic and diatomic deuterium neutrals in the duct extending between the NB calorimeter and the core separatrix. A model of NB reionization is necessary without direct measurement of beam power at the plasma separatrix. Finally, the model incorporates a Collisional Radiative Model (S. Bannmann et al 2023 JINST 18 P10029) which gives an inference of both the spectral line emission and the beam attenuation through the plasma itself. Results will be presented demonstrating the use of Beam Emission Spectra for calibrating the sight-lines geometry of the CELESTE (N. J Conway et al. Rev of Scientific Instruments, Vol 77, 2006) diagnostic and determination of plasma minority temperatures, densities and toroidal rotation.

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Session Classification: Uncertainty Propagation, Verification and Validation

Track Classification: Uncertainty Propagation, Verification and Validation