Synthetic Phase Contrast Imaging Diagnostic for Wendelstein 7-X

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Phase contrast imaging (PCI) is a powerful plasma diagnostic, providing line-integrated measurements of the fluctuating electron density ($\tilde{n}_e$). The information provided by PCI is essential for studies of plasma turbulence, magnetohydrodynamic modes, and mode conversion of waves in the ion cyclotron range of frequencies. However, the line-integrated nature of PCI measurements often makes a simple interpretation of experimental results problematic. To maximize the amount of information that may be extracted from PCI data, it is thus a great advantage to implement synthetic diagnostics, which are capable of computing the PCI signal obtained from model $\tilde{n}_e$ profiles. Among other things, such tools permit the regions giving rise to the PCI signal to be pin-pointed and experimental data to be compared with theoretical models.

This contribution describes the first results from the synthetic PCI diagnostic developed for the optimized stellarator Wendelstein 7-X. The PCI system is the main core turbulence diagnostic at Wendelstein 7-X [1] and the focus of the synthetic diagnostic development has therefore been on computing PCI signals from turbulent $\tilde{n}_e$ profiles modeled using nonlinear, global gyrokinetic codes, specifically GENE-3D [2] and EUTERPE [3]. To provide additional insight into the basic factors influencing the PCI signals, the synthetic diagnostic further includes the option to calculate PCI signals from a background $\tilde{n}_e$ profile rotated by a prescribed poloidal velocity field. Results from such studies indicate that the bulk of the PCI signal originates from regions near extrema of the poloidal velocity field. Additionally, the basic framework is validated by the close reproduction of experimental PCI signals for a background $\tilde{n}_e$ profile from GENE-3D rotated by a poloidal velocity field due to the neoclassical radial electric field.

References

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