

Upgrades to the Wendelstein 7-X Phase Contrast Imaging Diagnostic and Plans for the OP2 Campaign

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A phase contrast imaging (PCI) diagnostic was implemented on the W7-X stellarator starting in the OP1.2 experimental campaign (2017-2018) [1]. The PCI diagnostic creates an image of plasma density fluctuations using light from a CO₂ laser that passes through the plasma which captures the line-integral of the fluctuations along the optical path of the laser. The phase contrast imaging technique is sensitive to a wide range of fluctuation scales, including MHD modes, Alfvén eigenmodes, turbulent fluctuations, and can be modified to measure radio-frequency waves. The typical measurement range spans frequencies of about 2 kHz to 600 kHz, and wavenumbers of approximately 1 cm⁻¹ to 10 cm⁻¹, although the actual range depends on the optical magnifications used. This presentation describes the changes to the PCI diagnostic that are in development for the OP2 campaign, partly imposed by infrastructure upgrades for the W7-X stellarator and partly due to design improvements, which includes changes to the beam path and optical layout of the transmitting and receiving tables. The W7-X PCI diagnostic was designed for two detectors, with the intention of examining correlations of fluctuations from different radial locations using a spatial filtering technique. Plans for implementing the spatial filtering technique are compared with an alternate design that allows for simultaneous measurement of the plasma image and the Fourier spectra of the fluctuations. Plans for an optical heterodyne system, to be used for detection of ion-cyclotron resonance heating (ICRH) waves and possibly ion-cyclotron emission (ICE), are presented as a future addition to the diagnostic.

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[1] E. Edlund *et al*, Rev. Sci. Instr. **89**, 10E105 (2018).