Analysis techniques for the simultaneous measurement of impurity ion temperatures and velocities in MAST-U using Coherence Imaging Spectroscopy

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The ability of Coherence Imaging Spectroscopy (CIS) to quantify 2D profiles of ion flow velocities inside fusion devices such as MAST [1], DIII-D [2], Wendelstein 7-X [3] and ASDEX-U [4] has been well documented. In addition to these studies, we present an extension of the capabilities of CIS to allow for the simultaneous determination of impurity ion flow velocities and temperatures through the demodulation of the phase and contrast, respectively, of interference fringes super-imposed on CIS images. Testing and optimisation of the Fourier demodulation techniques and SART inversion algorithms has been carried out using synthetic CIS images of various MAST-U Super-X divertor plasmas. Synthetic images were generated using single and multi-delay 'pixelated' phase mask (PPM) CIS instruments, developed by Allcock [5], which will be installed on MAST-U during the MU02 experimental campaign. A PPM CIS offers greater spatial resolution when compared to the linear phase mask used in [1] due to the bonding of polarising filters of different orientations directly to the CIS camera sensor. These techniques have wide reaching applications in the validation of future fusion device simulations and detachment studies as CIS is the only diagnostic capable to simultaneous determining 2D ion temperature and velocity profiles. The use of a multi-delay PPM CIS, which encodes interference information in multiple carrier frequencies increasing fringe contrast and thus the accuracy of temperature measurements, is novel and further compounds the effectiveness of CIS as a tool for the direct measurement of the effect Super-X divertor designs have on impurity transport and temperature profiles.

References

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