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Improved Understanding of Edge Plasma Dynamics Through Visible Imaging on MAST

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Diagnostics imaging spectral line emission at visible wavelengths are widely used in the fusion community to gather a wealth of information about plasma conditions and transport processes particularly in the cooler regions of the scrape-off layer (SOL). Visible imaging diagnostics have been used extensively on MAST to diagnose the plasma boundary as the open vacuum vessel and divertor design offer significant access for wide-angle camera views. These diagnostics have provided insight into filamentary cross-field transport processes in the SOL and divertor, distortion of the magnetic topology by application of resonant magnetic perturbations (RMPs) and imaging of the flow of impurity species. High-speed imaging (>100kHz) of the divertor is providing insight into the effects of an x-point on the propagation of filaments in the common flux region from upstream to divertor strike points in L-mode and H-mode confinement regimes. There is evidence for the existence of filaments in the private flux region of the inner divertor leg, emerging near the X-point and moving toward the inner divertor target. Fast imaging has been used to study filament motion upstream in the main chamber across the whole poloidal cross-section of the region between the X-points. Fast imaging of ELMs both upstream and in the divertor show these transients propagate through the SOL in the main chamber and show the propagation of the heat pulse to plasma-facing surfaces. A wide-angle coherence imaging diagnostic has been developed for use on MAST to image impurity flows in the SOL with up to 1kHz time resolution and 1-2mm spatial resolution. Flows of C1+, C2+ and He1+ impurity charge states have been measured in the divertor and main chamber. Notable first results from this new diagnostic include observations of the poloidal position of stagnation point moving in response to vertical shifts of the plasma away from a balanced double-null magnetic configuration. These measurements are in broad agreement with interpretive modelling results. Moreover coherence imaging has provided the first measurements of impurity flows with X-point lobe structures due to RMPs. These data support EMC3-EIRENE code predictions that the ion flow velocity within the lobes differs from the unperturbed SOL.

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