Feasibility of an Imaging Motional Stark Effect Diagnostic for Edge Current Measurements on MAST-U

S. Gibson1, A. Thorman2, C. A. Michael3, M. Carr2, N. C. Hawkes2, J. Howard4 and R. M. Sharples1

An Imaging Motional Stark Effect (IMSE) diagnostic has been designed for MAST-U. Synthetic diagnostic images were forward modelled including realistic spectral broadening effects. The diagnostic would be capable of recovering edge current features with a width on the order of ~2cm. At a temporal resolution of 1ms, the polarisation angle profile can be measured with an uncertainty of $\sigma \approx 0.5^\circ$.

**Motivation**

Local measurement of the edge current density is necessary for:
- Verification of neoclassical current models
- Improved Edge Localised Mode (ELM) stability analysis

**The IMSE Diagnostic**

The IMSE diagnostic[3] is a *polarisation interferometer*, which captures 2D snapshot images of neutral beam emission.

**Diagnostic Design**

**Waveplates**

Choose L to maximise fringe contrast.

**Bandpass Filter**

Choose CWL to capture only full energy beam component and tilt filter $\sim 2\nu$ to track doppler shift across field of view.

**Fringes**

Fringes arise from thick waveplates.

Field widening

No field widening

**Lenses**

Camera lens focal length determines image fringe frequency. Require at least 10 pixels per fringe for acceptable resolution.

**Modelling Performance**

Forward modelled noisy images were generated to retrieve the polarisation angle uncertainty in a typical MAST scenario, when considering shot, read and dark noise according to the camera specifications.

**Spectral Broadening**

To what extent do spectral broadening effects impact the achievable resolution of edge current features? 

**Edge Current Scenario**

Using a high power MAST-U plasma scenario, an increase in the polarisation angle of 3 degrees is observed over the pedestal region, indicative of edge bootstrap current.

Broadening effects limit the maximum spatial resolution of these features to 2cm.

**Outlook**

To what extent can we resolve bootstrap current vs radial electric field? Determine performance in other MAST-U scenarios Determine improvement in equilibrium reconstruction using IMSE as a constraint