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EX/P6-06: Measurement and Optimisation of the Fast Ion Distribution on MAST

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A key tool to control the q-profile and provide heating and non inductive current drive is Neutral Beam Injection (NBI), which relies on good Fast Ion (FI) confinement. Driving current by Neutral Beam Current Drive (NBCD) scheme is particularly important in STs due to the limited applicability of other non-inductive current drive schemes and because of the limited space available for neutron shielding of a solenoid. Operations with high NBI power and increased FI pressure pose an additional risk of destabilising low-n FI driven instabilities potentially degrading the FI confinement and leading to the loss of core heating and current drive.
Previous results from MAST and other tokamaks indicate the presence of anomalous fast ion redistribution which increases with beam power. In this paper we present a quantification of this effect on the FI population by utilising new diagnostic capabilities for monitoring of the fast ions on MAST such as recently commissioned scanning Neutron Camera (NC) and Fast Ion Dα Emission (FIDA) diagnostics. The observed anomalous FI diffusivity correlates with the amplitude of n=1 energetic particle modes, indicating that they are the probable cause of the anomaly in MAST. Finally it will be demonstrated that broadening the fast ion pressure profile by the application of NBI in an off-axis location can mitigate the growth of these modes and result in a dramatic reduction in the anomalous fast ion redistribution.
Results show the value of neutron profile measurements, not only for diagnosing the fast ion density profile to quantify the effects of instabilities on the FI distribution, but also to allow the optimisation of plasma scenarios and even machine design to maximise the effectiveness of heating and current drive systems. Further modelling work is ongoing to describe these FI driven mode-plasma interactions in more detail. The achieved reduction in anomalous FI transport by controlling the FI distribution is predicted significantly improve NBCD efficiency together with the potential for current profile control and providing encouraging prospects for the use of off-axis NB injection in future tokamak devices.

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