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# Modelling of MAST-U neutral beam re-ionisation and the impact on the beamline ducts and in-vessel components

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Neutral beam injection is one of the primary auxiliary heating systems for tokamak plasmas. Once the neutral beam leaves the neutraliser collisions with background neutral particles in the beamline and tokamak vessel re-ionises part of the neutral beam. These particles can be deflected by the tokamak magnetic field, potentially damaging unshielded components.

The first stage of the Mega Amp Spherical Tokamak Upgrade (MAST-U) has two Positive Ion Neutral Injectors (PINIs), one injecting power to be deposited close to the magnetic axis of the plasma (on-axis) and one injecting power that is deposited further out in the plasma (off-axis). Each injector has been designed to run for up to 5 seconds, with 2 seconds of neutral beam required for MAST-U core scope. The increase in neutral beam pulse length and the increase in complexity of the in-vessel hardware compared to MAST increases the risk posed by re-ionisation to the beamline ducts and in-vessel components.

This paper describes modelling of the neutral beam re-ionisation along the beamlines and into the MAST-U vessel, within a field envelope applicable to the operational space of the machine. Monte-Carlo simulations using the MAGNET code give the re-ionised power loading on both beamline ducts, which was used to position thermocouples on the duct liners. Thermal and structural analysis of the duct liners has been carried out using ANSYS.

The potential for significant amounts of re-ionised power entering the MAST-U vessel has resulted in the installation of graphite tile plating at the end of the ducts, compatible with co-injection. The power loading on these plates and other in-vessel components as modelled by MAGNET has been verified using the LOCUST code. Analysis has confirmed that the graphite tiles are compatible with core scope operation.

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