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MAST Upgrade Divertor Facility: A test bed for novel divertor solutions

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The challenge of integrated exhaust consistent with the other requirements in DEMO-class tokamaks (ITER-like and alternative DEMOs, FNSF approaches) is well-known. The exhaust solution is likely to be fundamental to the design and operating scenarios chosen. While no facility can address all of the challenges, the new MAST Upgrade tokamak can explore a wide range of the aspects related to the divertor plasma. MAST Upgrade has unique capabilities to produce conventional and novel divertor configurations for detailed studies and comparison in a single device. The two closed divertor chambers are each surrounded by 8 poloidal field coils for detailed control of the magnetic geometry, including strike point location, field line length within the divertor, poloidal flux expansion and their variation across the scrape-off layer, whilst keeping the shape of the core plasma unchanged. It will be equipped with neutral beam heating, and a wide range of high resolution diagnostics with a strong emphasis on the scrape-off layer and divertor plasma, allowing new levels of detail in testing of models.

To extrapolate to future devices where full tests in advance are not feasible, theory-based and semi-empirical models can be used. These models, and their necessary compromises and simplifications, need to be validated and improved using the plasma physics mechanisms expected to be important at DEMO-scale, and this is at the heart of the MAST Upgrade programme. Possible paths to confident performance predictions will be outlined, with the role of MAST Upgrade indicated.

Specific physics areas to be explored include:

i) Plasma detachment, especially how novel magnetic configurations can make detachment easier and more controllable, e.g. the role of variation in mod(B) along the divertor leg.

ii) How divertor configuration and detachment state affect the plasma pedestal and access to H-mode.

iii) Controllability of double null, with potentially different detachment behaviour in upper and lower divertors.

iv) Behaviour of the inner leg in double null for different configurations (SX, SF, conventional).

v) Cross-field transport which determines the power footprint on the divertor and the ease of detachment. Longer divertor legs allow cross-field transport to be more effective.

In most cases the studies will focus on the underlying mechanisms, e.g. plasma filaments / blobs are often actors, and are affected by the scenarios and divertor configurations and state of detachment.

While MAST Upgrade is not a prototype, in this presentation we will address how it can be used to inform design questions for alternative and novel divertors in DEMO-class devices.

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Eligible for student paper award?

No

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