First MAST-U detachment results indicate enhanced role of molecules

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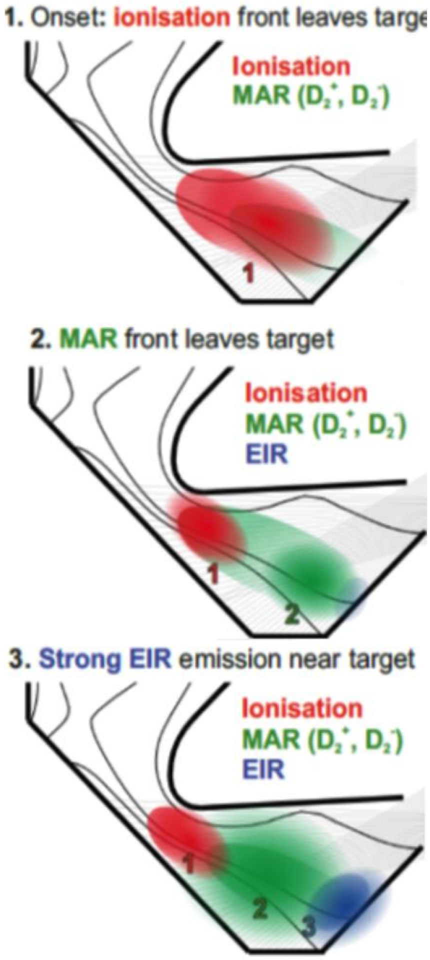
MAST-U is a new spherical tokamak with a tightly baffled, double null Super-X divertor. This configuration increases the operational window of detachment, which is a necessity for power exhaust on reactors. The physics of detachment is analysed during a core density ramp using novel Balmer line spectroscopic analysis that shows four phases of detachment.

In **Phase I** the ionisation region detaches from the target and the plasma interacts with the cloud of molecules below it, leading to molecular ions with low target electron temperature ($T_{e,t} < 5$ eV). Those ions react with the plasma leading to ion losses and neutral sources through Molecular Activated Recombination and Dissociation (MAR and MAD). Further increases in the core plasma density results in the divertor plasma having insufficient energy to promote the creation of molecular ions ($T_{e,t} < 1$ eV), leading to a separation of the MAR region from the target (**phase II**). If the core density is further increased, electron-ion recombination (EIR) starts to appear (with $T_{e,t} \leq 0.2$ eV diagnosed) (**phase III**); ultimately, the EIR region detaches from the target as the electron density decays near the target (**phase IV, not shown**).



Our results, which will be compared against simulations, show plasma-molecule interactions are critically important beyond the detachment onset and are a key element of the Super-X divertor as the ionisation can be held stably from the target with a molecular interaction region below it.

This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion) and from the EPSRC [grant number EP/T012250/1]