Numerical and experimental investigations of a linear microwave plasma source for metal foil pumps for DEMO

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In future fusion power plants like DEMO, minimizing the tritium fuel inventory is a critical design issue. For this, the hydrogen isotopes have to be separated from other components of the exhaust gas close to the divertor so that they can be immediately recirculated. At KIT a direct internal recycling system is being developed using a metal foil pump (MFP) which can selectively separate hydrogen isotopes by superpermeation even against a pressure gradient. For this process to work, the hydrogen must be in a suprathermal state, i.e. in the form of atoms or ions. This is achieved with a linear microwave plasma source, the so-called Duo-Plasmaline. Since the Duo-Plasmaline is an integral part of the MFP, hydrogen plasmas from the Duo-Plasmaline are being investigated numerically and experimentally at the University of Stuttgart. In the numerical model the transport of electrons and heavy species are calculated self-consistently with the electric field of the microwave and a reduced set of plasma chemical reactions. Since the MFP system will be in close proximity to the torus, the influence of strong magnetic fields up to 1 T is investigated. In addition to the plasma properties such as density and temperature, the ignitability and the heating mechanism of the plasma at high magnetic fields are of interest. The results are compared to findings from the experiment FLIPS in Stuttgart, where the Duo-Plasmaline was investigated in a homogeneous magnetic field with up to 250 mT.