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Investigating the role of neutral particles in the linear device Magnum-PSI

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In the linear plasma device Magnum-PSI up to 5eV hydrogen plasmas can generate reactor-relevant heat and particle fluxes. Due to the simplified geometry, stable plasma conditions and excellent diagnostic accessibility, Magnum-PSI is an attractive device to study the basic physical and chemical processes in recombining and detaching SOL plasmas. During pulsed operation, high density ELM-like bursts with temperatures up to 15eV can also recreate ionizing plasma conditions. In this talk a number of studies involving plasma-neutral interactions will be reviewed.

First: Divertor detachment can be simulated in Magnum-PSI by varying the background neutral pressure. A detailed characterization of the plasma parameters, heat and particle loads and optical plasma emission (Balmer series and Fulcher band) was performed, revealing a clear transition between regimes dominated by ionization, MAR, and electron ion recombination (EIR).

Second: During Nitrogen seeding experiments an increase in recombination was observed. A global plasma model has been set up to investigate the complete N2/H2 chemistry, revealing two new recombination reaction paths to be dominant: 1) the ion conversion of NH followed by dissociative recombination, and 2) proton transfer between H2+ and N2, producing N2H+. These two processes are referred to as N-MAR (nitrogen-molecular activated recombination). The main N2/H2 processes derived from the global model have been implemented into B2.5-Eunomia, confirming the significant contribution of N-MAR to the total recombination rate.

Third: TS and CTS measurements very close to the target were compared to the energy and particle fluxes measured at the target surface, revealing significant momentum and energy losses in the last 3 mm of plasma. Also, the expected pre-sheath acceleration due to the Bohm criterion was not observed in high density scenarios. In this regime (the 'thermal pre-sheath') ion acceleration is overruled by momentum and energy transfer to neutrals.

Finally: DIFFER is currently seeking funding to build an active spectroscopy diagnostic based on laser induced fluorescence (LIF) in the vacuum ultraviolet (VUV) wavelength range. This VUV-LIF diagnostic would accurately measure the ro-vibrational state distribution of Hydrogen molecules in divertor detachment conditions, elucidating the importance of the MAR process under various plasma conditions and wall materials. Together with the current set of diagnostics, this will result in a unique complete picture of the near surface plasma processes.

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