Possibility for neutral density measurements with beam emission spectroscopy

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A sought after and yet quite an elusive measurement on magnetically confined plasma devices is the assessment of neutral particle densities and their profile outside of the plasma boundary. Our work aims to assess the applicability of beam emission spectroscopy (BES) for neutral density measurements.

BES is an active plasma diagnostic employed to measure plasma density, featuring as a standard diagnostics method on many fusion devices. A high energy neutral beam injected into the plasma suffers collisional events with charged plasma particles resulting in photon emission. The emission is used to reconstruct plasma density profiles [1].

Based on previous work, establishing the classical trajectory Monte Carlo method as a viable tool for generating neutral beam atom impact cross-sections with plasma neutral particles [2], we have generated a novel set of Li and H beam projectile cross-sections with neutrals.

The cross-sections were used to augment existing nl-resolved collisional radiative models (CRM) [3] used for plasma density reconstruction. The impact of neutral gas on beam emission was assessed and established as non-negligible for realistic neutral densities. The nHESEL scrape-off layer turbulence code [4] was used to generate various neutral and corresponding plasma density profiles, which resulted in a realistic test set for neutral gas-induced emission on the plasma edge and SOL that was subsequently analysed using the augmented CRM.

Finally, we adapted the CRM to an existing plasma density reconstruction code [5] in an effort to establish a plasma to neutral ratio as a threshold for the viability of neutral density reconstruction.

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