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P1.1074 Approaching the ion source parameters for ITER's NBI systems with the test facility ELISE

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The test facility ELISE represents a 1/2-size scaled experiment for the development of the RF-driven negative hydrogen ion source of the ITER neutral beam injection (NBI) systems. ELISE is dedicated to demonstrate the ITER requirements in terms of extracted negative hydrogen current densities (329 A/m^2 H-, 286 A/m^2 D-) with an electron-to-ion ratio of less than one at a source pressure of 0.3 Pa for durations of up to one hour. Taking into account the stripping losses in the accelerator, accelerated current densities of 230 A/m^2 H and 200 A/m^2 D are targeted at ITER NBI whereas at ELISE less stripping losses are expected due to its three stage acceleration system (about 15% max. instead of 30% at ITER). The beam can be extracted and accelerated up to total energies of 60 keV with the constrain of having a pulsed power supply available, leading to beam blips of 10 s every ~150 s while having continuous plasma operation. In order to achieve high ion and low electron current densities, caesium is seeded into the low temperature hydrogen plasma, imposing the complexity of a strong temporal dynamics. Another challenging requirement concerns beam homogeneity: deviations in the uniformity of the large beam (about 1x1 m^2 composed of 640 beamlets) of less than 10% are allowed only. ELISE went into operation in 2013 and made remarkable progress since then, starting from short pulse operation (10 s) to the ITER target of 1000 s for H- and 3600 s for D-. Recently the target parameters for hydrogen were demonstrated representing a milestone for the success of ITER NBI. Beside the challenge to control the high temporal dynamics of the co-extracted electron current, the caesium management in the source and the beam uniformity turned out to be very sensitive on the ion source parameters. As for deuterium the amount of co-extracted electrons is higher with stronger temporal dynamic than in hydrogen and as deuterium operation requires higher caesium amounts the current activities are focussing on improved suppression and control of co-extracted electrons together with the supply of sufficient caesium for the 1 hour pulses, both mandatory to achieve the targets for deuterium beams.

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