Contribution ID: **81** Type: **Plenary Talk**

Negative hydrogen ion sources - utilizing low temperature plasmas in ITER's neutral beam systems

Thursday 3 April 2025 09:45 (45 minutes)

Large and powerful negative hydrogen ion sources (H-, D-) will be used at the international fusion experiment ITER to deliver after acceleration and neutralization energetic beams of neutral particles (H, D) to the tokamak. These beams will be used for heating and current drive, but also for plasma diagnostics. The inductively coupled plasma source (ICP) operates at low gas pressure (0.3 Pa) using a frequency of 1 MHz and a total power of 800 kW to illuminate an area of 1 x 2m. The ion source relies on surface conversion of hydrogen atoms and positive hydrogen ions into negative ions at a low work function converter surface, for which caesium is injected into the low temperature plasma. The latter introduces temporal and, together with the magnetic filter field, a spatial component into the otherwise stable plasma, which adds to the challenge of generating up to 60 A of homogeneously extracted negative ions for up to an hour. The diagnostics and modelling of the plasma and the extraction provide access to exciting aspects of plasma physics. The development of such negative ion sources follows the European step-ladder approach to meet the ITER target parameters. The development phases, the status and the challenges, as well as the way forward, are discussed.

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Session Classification: Plenary