Contribution ID: **347** Type: **not specified**

P4.011 An innovative helicon plasma source for an alternative concept of DEMO negative ion beam injector

Thursday, 20 September 2018 11:00 (2 hours)

Neutral Beam Injectors (NBI) for DEMO-like reactors will need deuterium neutrals at a high energy (>0.8MeV) and a fair injector overall efficiency (>50%) for plasma heating and current drive. The neutralization efficiency of positive ions drops for energy higher than 100keV/nucleon and so NBIs based on negative ions are required. A conceptual design of injectors (so called Siphore at the IRFM in the CEA, Cadarache in France) expects to extract negative deuterium ions from a plasma 3m long and 15cm wide, and to photo-neutralize the accelerated D-.
Here, we review the progress at the Swiss Plasma Center of EPFL to develop an innovative helicon device (so called RAID: Resonant Antenna Ion Device). It consists of a resonant network plasma source at 13.56MHz (deliver power ≥10kW), connected to a cylindrical vacuum chamber (1.8m long, 0.4m diameter), surrounded by 6 Helmholtz coils providing a magnetic field (up to 800G on axis).
RAID has proven high reliability to propagate helicon wave in different gases (Ar, D2, H2) and pressures (0.1-3Pa). Indeed, the resonance properties of the antenna enables easy power matching with low input current. Spectroscopy measurements have shown a significant volume production of negative ions at the periphery of the column, explained by a strong radial gradient of electron temperature. Today, RAID is equipped with a full set of diagnostics (optical emission spectroscopy, Langmuir probes, cavity ring down spectroscopy and photodiodes) and it will be complemented in the coming months by a 3-axis magnetic probe for a full characterization of helicon wave field.
This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 20142018 under grant agreement no. 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

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Session Classification: P4