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

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Neutral Beam Injectors (NBI) for DEMO-like reactors will need deuterium neutrals at a high energy ($>0.8\text{MeV}$) 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 $\geq 10\text{kW}$), 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 , D_2 , H_2) and pressures ($0.1\text{--}3\text{Pa}$). 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.

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