Toroidal helicon plasma generation in TORPEX

S. Vincent[1], Ph. Guittienne[1], C. Sepulchre[1], P. Quigley[1], M. Baquero-Ruiz[1],
R. Jacquier[1], A. Howling[1] and I. Furno[1]

[1] *EPFL, Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland*

Helicon antennas have long been known to provide high plasma generation efficiency in linear devices, and have been the subject of extensive experimental and theoretical studies in the last decades [1]. Mainly restricted to low temperature plasmas so far, the use of helicon waves is now considered as a promising candidate for current drive in tokamaks [2]. However, with the exception of a few small scale toroidal devices [3, 4], the experimental characterization of toroidal helicon waves is still scarce in the literature.

To fill this gap, a helicon antenna has been assembled and mounted on TORPEX [5], a toroidal device of major and minor radii 1 m and 0.2 m respectively. Installing a helicon antenna that encompasses the device's poloidal cross section, on a toroidal device of the size of TORPEX, is unprecedented. This was possible by the use of a birdcage-type resonant antenna [6], which consists of a set of 15 copper legs connected in parallel through 1820 pF capacitors. It is 25 cm long and 32.5 cm in diameter, and is mounted around a 30 cm diameter glass tube that is connected to the TORPEX main vessel via dedicated flanges. Fed by a 13.56 MHz radio frequency power supply operating up to 1 kW, the antenna resonates and produces an oscillating transverse magnetic field through its central plane.

Helicon waves are then launched, first in a pre-existing magnetron-generated plasma. The conditions for direct helicon plasma generation are also evaluated depending on the gas (Hydrogen, Argon) and pressure. The propagation conditions and spatio-temporal features of helicon waves in toroidal geometry are characterized using the extensive set of diagnostics avalaible on TORPEX, such as two arrays of 96 Langmuir probes and a 2D movable B-dot probe.

References

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