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Helicons Current Drive System in Tokamak T-15

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The innovative efficient current drive scheme in the tokamaks using the Helicons radiation has recently been proposed [1] to stabilize high normalised beta strongly shaped reactor relevant plasmas. The scheme has shown broad current profile tailoring capabilities in modern tokamaks, reactors FNSF-AT, ITER and DEMO, and uses reliable RF CW technique developed for large accelerators. This paper describes the conceptual design of RF systems for tokamak T-15 and proposal for JT-60AS in order to check the predictions [1] in the experiments, to analyse commercially available RF power sources and their efficiency, transmission RF energy lines, matching elements and RF energy launch into tokamak chamber.

In this paper we consider a new system for the scheme to maintain CW current by fast waves, at frequencies of 500-700 MHz, being lower of so-called Lower Hybrid (LH) frequency. In this frequency range there are commercially available CW klystrons of megawatt level, running stationary. The advantages of the scheme (partially tested at lower frequencies in tokamaks) are the use of electrically strong antennae of resonator/waveguide type and substantially greater coupling antenna-plasma (frequency 10 times greater of IC frequency).

Apart of impressive ITER project in final signing stage there is the bilateral NRC KI - DIII-D GA Agreement for joint testing of the proposed Innovative Off-axis CD scheme on operating tokamak DIII-D with its high electron beta plasmas needed for helicons scenario. It appears that Russia can fulfill its ambitious 4 MW Helicons CD project on T-15 tokamak after pioneering 1 MW testing on DIII-D tokamak: of highly effective method of Off-axis current generation via a quasi-stationary fast waves (helicons), which provides a reliable way of CW operation in DEMO and fusion Power Plant, combining a clear physical mechanism and the developed technology for large accelerators in previous 40 years in the range of 350 - 1000 MHz. The T-15 Helicons system project will be presented by demonstration of Advanced Traveling Wave Antennae (TWA) to be used for Helicons excitation and 4 MW 509 MHz 1.2 MW klystron based RF complex with four TWA antennae, each fed by 1 MW waveguide transmission line (totally 4 lines), circulators etc.

[1] Vdovin V., Plasma Physics Reports vol.39 (2013) #2, 125

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