§43. Studies on Steady State Spherical Tokamak by the "Plasma Boundary Dynamics Experimental Device (QUEST)" in Kyushu University

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Abstract

During the 2004-09 middle term plan and target, QUEST project aiming at proof-of principle of steady state spherical tokamak operation (SSTO) has started as a new domestic and international fusion plasma project in the frame work of bi-directional collaboration with the NIFS. A medium-size spherical tokamak has been successfully built in 2008, which is managed by a promotion committee which is open to the external researchers. The first target, "10-20 kA full current driven plasma for a short pulse", has been successively achieved in 2009-10.

QUEST PROJECT (Advanced PWI research in steady state spherical tokamak plasma)

On the expertise acquired through the SSTO(Steady State Tokamak Operation) project, particularly experience with driving plasma current by radio frequency waves the QUEST project [1-3] has been proposed to demonstrate steady state operation of ST plasma by RF waves and investigate the controllability of particles under the high temperature wall relevant to the future reactor condition. Aiming to contribute the ITER project the RF technology and in-situ diagnostics of the wall properties are under development. In the frame work of inter-university Joint-Use research program in the RIAM and bi-directional collaboration [4] with the NIFS the AFRC aims to establish a COE in national fusion research. Under the new IEA Implementing Agreement on Spherical Tokamas the AFRC is collaborating with abroad institutes. The project administration is open to external researchers, i.e., research plan, collaboration items and experimental schedule are discussed at JSPF annual meeting.

Recent Achievement of the non-inductive current drive

The Lower Hybrid Current Drive (LHCD) system with 16 fundamental rectangular waveguide lines at 8.2GHz in the previous our TRIAM-1M tokamak has been modified for the EBWH/CD experiments in the QUEST. An antenna system has been designed and fabricated for EBW/CD. The cooling capability of this antenna was designed to inject rf power of 200 kW to the plasma. The fields at each two waveguide inputs were mixed at the orthomode transducer with phase difference, and were lead to the antenna in desired elliptical polarization state. Thus, phased array in the 8 [4x2] square waveguide elements can control the incident angle *i.e.* refractive indexes[5]. In this experiment the O-mode with $N_{\parallel}$~0.4 was injected. The cyclotron resonance locates at R~0.29 m (0.58 m for 2nd). As shown in fig.1, I_p could be ramped up to 10 kA alone by RF injection and a spherical tokamak configuration whose major and minor radii are 0.58 and 0.34 m, respectively has been established [6]. The external vertical field was constant and Ip could be sustained for 0. 7 s. The acceleration up to 100 keV of the energetic electrons is also observed in the later phase [7,8]. The low recycling condition was essentially required for current ramp-up[8-12]. The fluctuations during the current ramp-up are also investigated[13-15].

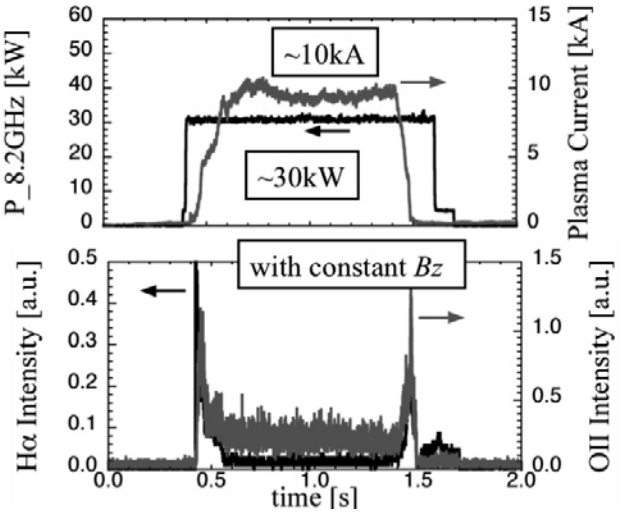

Fig. 1. Non-inductive current drive using 8.2 GHz at 30 kW microwave. Ip could be sustained for 0.7 s

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