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MODELING ICP DISCHARGE IN A DRIVER OF AN ION SOURCE *)

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Neutral beam injectors are widely used in various magnetic plasma confinement experiments for heating and diagnostics of plasma. The process of beam formation starts inside of an ion source [1], where either an arc discharge or a radio frequency (RF) driver is utilized for plasma generation. For long term operation usage of a RF driver is preferable [2].

At the Budker Institute of Nuclear Physics a heating injector with a 4-driver ion source, set to produce 120 keV negative ion beams with duration of up to 100 s, is being designed for plasma heating and current drive in the TRT tokamak [3]. The objective of our work is to develop a RF plasma driver for its ion source capable of working with long pulses. The driver is a cylindrical chamber made of ceramic, inside of which the plasma discharge is sustained with RF field generated by an external antenna. To protect the ceramics from heat fluxes and spraying a screen is placed inside of the chamber.

The dirver power transfer efficiency to plasma depends on many parameters, such as the chamber geometry, gas pressure [4], configuration of the protective screen, external magnetic field. In order to optimize the driver for long pulse operation and to study the influence various driver parameters have on the discharge we have been developing a 3D hydrogen ICP model within the driver. The model uses fluid approximation for both electrons and ions.

This study presents a description of the model, main parameters of the calculated plasma, including ion composition, electron energy, density distribution of electrons and ions and plasma potential in the driver and comparison with experimental values.

References

[1]. R.S. Hemsworth, T. Inoue. Positive and negative ion sources for magnetic fusion // IEEE TPS 33(6), 1799 – 2005.

[2]. A. Krylov et al 2006 Caesium and tungsten behavior in the filament arc driven Kamaboko-III negative ion source // Nucl. Fusion 46 S324 – 2006

[3]. Yu.I. Belchenko et al. Possible Scheme of Atomic Beam Injector for Plasma Heating and Current Drive at the TRT Tokamak // PLASMA PHYSICS REPORTS Vol. 47. — 2021.

[4]. D. Zielke et al. RF power transfer efficiency and plasma parameters of low pressure high power ICPs // Phys. D: Appl. Phys. 54 155202 – 2021.

*) abstracts of this report in Russian