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TST-2球状トカマク装置における低域混成波プラズマ研究のための高速電子プローブの設計検討

Design of probe for energetic electrons to investigate fast electrons in lower hybrid wave plasmas in the TST-2

篠原孝司[1)], 渡邉理[1)],江尻晶[1)],辻井直人[1)],ジャンソウォン[1)],彭翊[1)], 岩崎光太郎[1)],高竜太[1)], 林彧廷[1)],白澤唯汰[1)],飛田野太一[1)], 田一鳴[1)],安立史弥[1)]
SHINOHARA Kouji[1)], WATANABE Osamu[1)], EJIRI Akira[1)], TSUJII Naoto[1)], JANG Seowon[1)], PENG Yi[1)], IWASAKI Kotaro[1)], LIN Yu-Ting[1)], KO Yongtae[1)], SHIRASAWA Yuita[1)], HIDANO Taichi[1)], TIAN Yuting[1)], ADACHI Fumiya[1)]
1)東大
1)Univ. Tokyo

The performance of spherical tokamak benefits from a smaller aspect ratio. To have a smaller aspect ratio, a machine without a center solenoid to induce a plasma current inductively is a preferable goal. Toward this goal, we need to develop a method for a noninductive current drive. The plasmas whose plasma current is driven by the lower-hybrid wave (LHW) alone have been investigated on the TST-2 spherical tokamak. The characteristics of the LHW plasma have been gradually revealed through comparisons between experiments and numerical simulations. For further understanding, we are developing a probe to obtain the information about energetic electrons generated by the LHW since energetic-electron behavior is expected to play a key role in the LHW plasma.

We carried out a feasibility study of the probe to detect the energetic electrons, motivated by the scintillator-based lost fast-ion probe, which can identify the energy and pitch angle of captured ions. This method is difficult for electrons due to its small Larmor radius in general, but we expected an acceptable size of Larmor radius could be achieved in stable discharges in low magnetic field strength of < 0.1T in TST-2.

The pitch angle of energetic electrons is expected to be small because the LHW mainly accelerate electrons in the direction parallel to the magnetic field. Thus, their Larmor radius was estimated to be so small that it was found that a conventional configuration with one orifice was not applicable. Due to this, we accessed the feasibility of the configuration with two orifices as shown in Fig 1. By these orifices orbits of captured electrons can be limited, or the energy and pitch angle of captured electrons can be determined.

We carried out numerical calculations by using geometries which are manufacturable. A result is shown in Fig 2, in which the number distribution of captured electrons are plotted with the respect to the energy and pitch angle. The result suggest that it is difficult to identify the energy of detected electrons, but that it is possible to identify their pitch angle.

We will report the details of the assessment and the probe design based on the results.

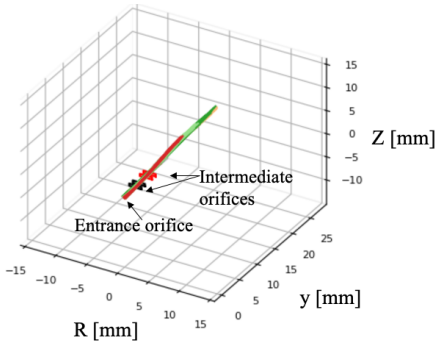

Fig. 1 Orifices to specify electron orbits and calculated orbits specified by the orifices.

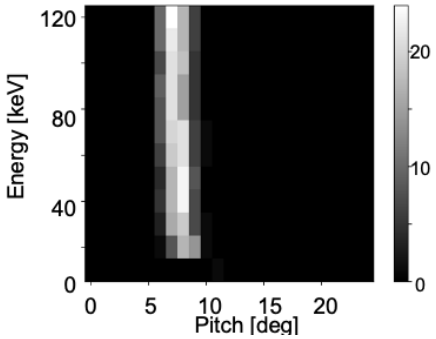

Fig. 2 Number distribution of captured electrons by a set of two orifices on the plane spanned by pitch angle and energy.