23Pa37

電磁波加熱によるトカマクプラズマ形成に対する中心ソレノイド直流電流依存性

DC_{CS} dependence for tokamak plasma formation by RF heating

渡邉理,山崎響, 高竜太, 岩崎光太郎, 辻井直人
Osamu WATANABE, Hibiki YAMAZAKI, Yongtae KO, Kotaro IWASAKI, Naoto TSUJII

The University of Tokyo, Kashiwa 277-8561, Japan
(Received 3 December 2020 / Accepted 21 February 2021)

Using an equilibrium calculation code implemented stability analysis [1], it was predicted that tokamak plasmas stability can be improved by stationary direct current of central solenoid (DC_{CS}).

The DC_{CS} changes amount of magnetic field energy change caused by plasma current change in inner region of the central solenoid (CS region) without change of the tokamak plasma configuration. Because solenoid coil has no leakage magnetic field ideally, the DC_{CS} don't modify the vertical magnetic field profile in the plasma region generated by poloidal field coils. As long as the same configuration tokamak plasmas, in both of the plasma and CS regions, also of the modifications of the magnetic field intensities caused by the plasma current change are independent of the DC_{CS}.

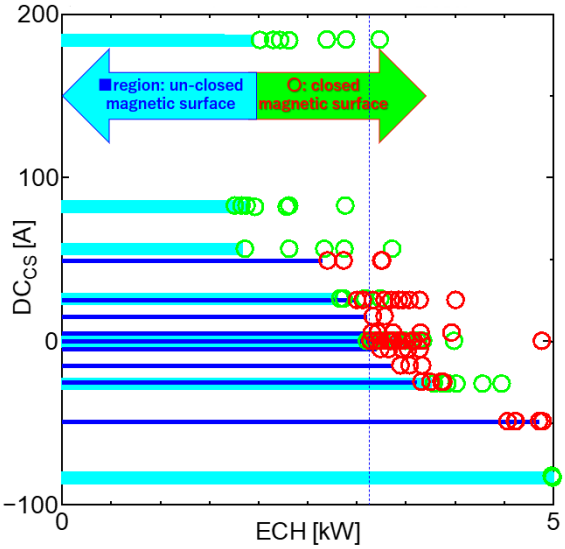

Fig. 1 Power threshold for tokamak plasma formation. The minimum ECH power necessary for tokamak plasma formation depends on DC_{CS}. Circles mean success of tokamak plasma formations. The region below the maximum ECH power, where the tokamak plasma couldn't be formed, is indicated by rectangular bar. Sky-blue bars and green circles use switching power supplies (PS). Blue bar and red circle use stabilized DC PS. Rotation direction of DC_{CS} is same to poloidal coil current.

However, the amount of the magnetic field energy change in the CS region changed by the plasma current change can be changed by the DC_{CS}. Different of amount of magnetic field energy change caused by same change of plasma current should be meaning different of tokamak plasma stability.

If same configuration tokamak plasmas have different stability, these formation processes might be different each other. In order to confirm it, ECH start-up of tokamak plasma formations with same parameters except the DC_{CS} were done. As the results, the minimum ECH power necessary for tokamak plasma formations depends on the DC_{CS}, as shown in Fig. 1 [2]. Particularly, DC_{CS}=200 A reduced the minimum ECH power necessary for the tokamak plasma formation to about half.

Radiation losses would be decided in every moment with plasma profiles which are changing during the tokamak plasma formation process. And, the stored thermal energy at the formed tokamak plasma is same in the same configuration and is independent of the DC_{CS}. However, the magnetic field energy ejected by the plasma current drive from the CS region is changed by the DC_{CS}, and transports to the plasma torus connected by mutual inductance to the CS coil. Even if the ECH power as the injected power has been kept constant in time, the net heating power would be changed by the DC_{CS}. Therefore, the minimum ECH power necessary for tokamak plasma formation should be able to reduce by the DC_{CS}. In addition, in order to reduce the plasma current, its reduced magnetic field energy in the CS region by increase of the plasma current must be restored by the ECH. If the reduced magnetic field energy is higher, its recovery is needed longer time.

For this relax of the tokamak plasma formation condition about the ECH power by the DC_{CS}, it is pointed out that also change of n-index caused by leakage magnetic field may affect. Currently, it has been tried to that related physics including these influences separate in this study.

[1] O. Watanabe. *JPSJ* **85**.9 (2016): 094503.
[2] O. Watanabe, *et al*. *PFR* **16** (2021): 2402059.