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ECH Start-up Experiment with Stationary Direct Current of Central Solenoid Coil on TST-2

TST2における中心ソレノイドコイルに定常直流電流を印加したECH start-up実験

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A tokamak plasma formation by a non-inductive heating is accelerated by a stationary direct current of a central solenoid coil. On TST-2, at an equilibrium tokamak plasma with plasma current 0.5 kA, the tokamak formation time by 4.5 kW ECH is reduced at about 4ms/30A. The plasma current sustainment time after stop the heating is also proportion to the stationary direct current of the central solenoid coil. Even if the stationary direct current is different, because the leakage magnetic field from the central solenoid coil is vanishingly weak, the maximum plasma current is almost same in same condition of poloidal field coil current. Just during a time evolution of the plasma current, the tokamak plasma is influenced by the magnetic field energy generated by the central solenoid coil with the stationary direct current.

1. Introduction

Tokamak plasma formations by non-inductive heating are studied for reduction of central solenoid coil (CS) from central structure of tokamaks.[1] Because the CS is usually use to inductive heating by pulse current, it had not given any role at non-inductive heating tokamak experiment except the plasma position control.

Before the tokamak plasma formation, a vertical magnetic field in the CS inner region is generated by poloidal field coils current, when the CS has no current. Because a vertical magnetic field in a magnetic axis is reversed by a plasma current driven at tokamak formation, the vertical magnetic field in the CS inner region is also reversed. If the CS has a sufficient current which is applied to same direction as poloidal field coil current, the vertical field in the CS inner region is not reversed but is reduced. Thus, the magnetic field energy in the CS inner region is reduced by the plasma current driven. This energy transition is same as an inductive heating tokamak plasma.

A tokamak formation by 2.45 GHz ECH with the stationary direct current applied to the CS (DC_{CS}) is tested on the TST-2 spherical tokamak. The tokamak formations time are compared based on the DC_{CS}.

2. Experiment set up

Figure 1 shows a right half of a cross section of TST-2.

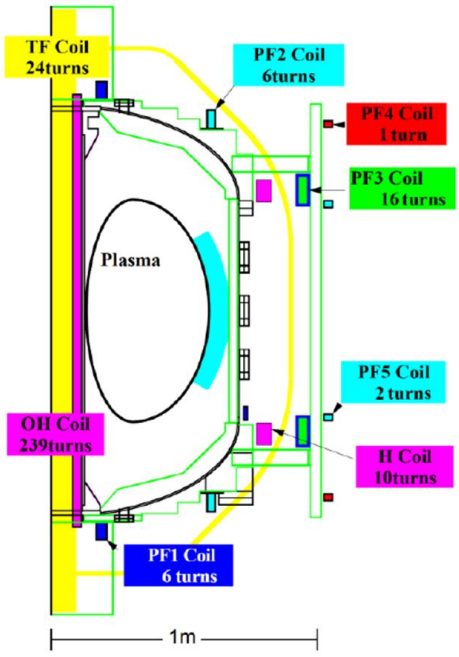

Fig.1. Right half of cross section of TST-2.

PF1-3 are poloidal field coils applied a direct current controlled by IGBT or by a DC power supply. Couples of PF3 and PF2 coils are applied a same direction current. A plasma current is driven in invert direction of these coils current. Only a couple of PF1 coil is applied an invert direction current to the PF3. A central solenoid coil named OH coil. A central solenoid coil named OH coil is applied a stationary direct current by a DC power supply. The current direction of the CS is defined positive as same direction to the PF3 coil current.

A deuterium plasma is heated by an electron cyclotron resonance due to 2.45 GHz microwave. The heating power is constant in time.

3. Experiment result

A time evolution of plasma current is accelerated 4 ms by the DC_{CS}=30 A, shown in Fig. 2. In both shots, the poloidal field coils current are 25 A and are controlled by DC power supply.

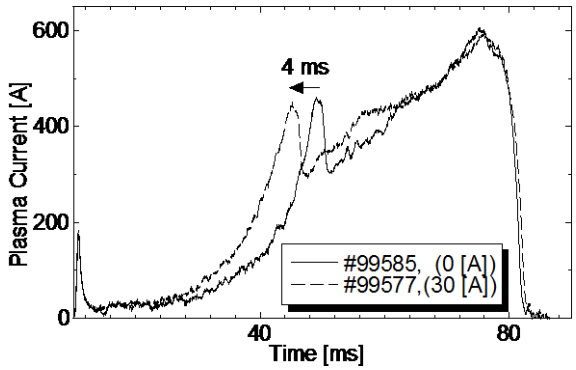

Fig.2. Time evolution of plasma current. A current jump is accelerated 4 ms by the DC_{CS}=30 A.

The maximum plasma current is roughly same. The current decay of the DC_{CS}=30 A shot is look like slightly slower than the DC_{CS}=0 A shot.

4. Conclusions and Discussions

A tokamak plasma formation time by a non-inductive heating can be reduced by a stationary direct current, which is applied to a central solenoid coil. In addition, a decrease of the plasma current after stop the heating might be decelerated.

This phenomenon should be related to the magnetic field energy in the CS inner region. The magnetic field energy in the CS inner region is changed by not only the CS current, but also the plasma current.[2]

References

[1] Osamu WATANABE, *et al*., Plasma Fusion Res. 3, 049 (2008)

[2] Osamu WATANABE, submitted to JPSJ.