§80. Current Ramp-up Experiments Using the Superposition of the Ohmic and RF Power in the Outer Divertor Configuration of QUEST

Mitarai, O. (Tokai Univ., Kumamoto),
Nakamura, K., QUEST Group (Kyushu Univ.)

i) Introduction

We apologize that as planned experiments have not been made in this fiscal year, we describe our next project in detail in this annual report.

The plasma current start-up experiments without central solenoid have been successfully demonstrated in the iron core STOR-M tokamak. Outer vertical field coil can initiate the plasma current with the help of the iron core transformer, which stabilize the initial plasma position vertically. As the stray field is initially zero in this coil layout, the plasma current start-up is quite reliable and reproducible. Upon resolving the plasma current start-up problems in a spherical tokamak (ST), we can proceed to further studies on the tougher problems to realize an D-^{3}He spherical tokamak reactor. The tough problem is fueling. Gas puffing, pellet injection and compact toroid (CT) injection are extremely difficult for the high temperature D-^{3}He plasmas. In this annual report, we propose the new type of experiments in QUEST to overcome fueling difficulty.

ii) Second plasma merging fueling

Figure 1 shows the one of the proposed idea. We call this a merging fueling. Second smaller plasma current containing the newly fueled particles is repetitively produced above the main plasma current by additional OH transformer. The plasma current directions of those two plasmas are the same. Therefore, the second plasma current is pulled down by the main plasma current, or pushed down by the horizontal field. Two plasmas are merged into one and then fuel is transferred to the main plasma. This is a kind of merging experiments, which is being conducted in UTST and VEST. Reconnection and merging fueling can be studied using these devices.

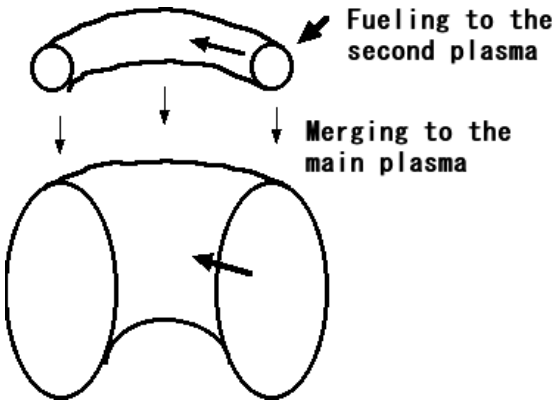

Fig. 1. Concept for merging fueling of the second tokamak plasma into the main tokamak plasma.

iii) Coaxial Helicity Injection (CHI) fueling experiments

In QUSET the coaxial helicity injection experiment has been planned by US and QUEST teams to study the plasma current start-up. As we have solved the plasma current start-up problems using the iron core transformer, we believe we do not need plasma current start-up experiments anymore. Therefore, we consider further application of CHI in QUEST.

The main plasma current up to ~60 kA similar to #23917 can be produced by ECRH in the positive n-decay index configuration as shown in Fig.2. The plasma configuration is calculated by the Hasegawa equilibrium code. After establishing the long pulse discharge, CHI is applied at the electrode on the bottom divertor and vacuum chamber to produce the plasma current. This CHI produced plasma current and the main plasma current have the same current direction. Therefore, the CHI produced plasma current may be merged into the main plasma current.

If repetitive CHI plasma currents are merged into the long pulse of the main plasma, and then density is maintained or increased, it would be concluded that fueling is possible. These novel fueling methods would increase the possibility of realizing a fusion reactor.

This work is performed with the support and under the auspices of the NIFS Collaborative Research Program NIFS14KUTR104.

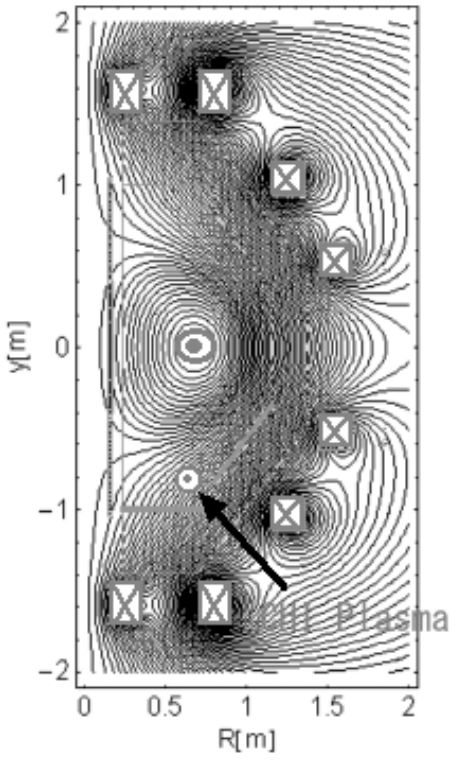

Fig. 2. Main plasma cross section of QUEST for CHI merging fueling experiments.