§68. Particle Circulation Control and High Power Non-inductive Current Drive under the Hot Wall in QUEST

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In FY2015, the hot wall was operating at 473K during experimental campaigns and finally 1000s duration discharges could be obtained by 8.2 GHz RF with and without additional H_2 gas puffing. Unfortunately water-cooling channel have not installed yet, therefore we can just only heat up the hot wall. The 28GHz gyrotron was set up and could be operated up to 140kW, 2sec. Finally more than 30 kA could be achieved in fully non-inductive current drive manner. New transmission system with several mirrors becomes to be available and has the capability to control injection angle, mode and polarization.

1. Introduction

Spherical tokamak (ST) has a possibility to realize a cost-effective future fusion power plant, which is coming from its further compactness and better stability to high β plasma. Conversely, the advantage naturally causes some difficulties that a figure of merit, P/R, is higher than that on other magnetic fusion devices such as conventional tokamaks, where P, and R show injected and productive power, and major radius, respectively. Therefore its steady state operation must be more challenging and must be resolved. The QUEST (Q-shu University Experiment with Steady State Spherical Tokamak) project focuses on the steady state operation (SSO) of ST, especially power and particle balance with taking wall behavior into consideration [1-12]. QUEST takes advantage of its capability to maintain plasmas for a long time and aims at research of SSO. While non-inductive plasma start-up is a crucial issue to operating ST plasma as and QUEST has the target to develop new and effective plasma start-up method.

2. Newly installed experimental apparatus

The hot wall has been installed and operated since 2014 Autumn/Winter campaign. The photos of the hot wall is shown in Fig. 1. The hot wall is expected to modify H recycling using controlled wall temperature in the range of 300-773K. The surface of the hot wall is coverd with APS-W and its area corresponds to approximately one-third of the whole PFW of QUEST. A 28 GHz gyrotron was developed with cooperation of Tsukuba Univ. and it could be operated with new transmission line

3. Experimental Results

After the operation of the hot wall, the background H_2 pressure became to be higher and plasma could start-up and be maintained with just only prefilled gas to intiate plasma of 10 kA in plasma current at 393K and 473K for approximately 1000 s. as shown in Fig. 2 Although the H flux to the wall was a similar level in both discharges, the evacuating H_2 at 393K was significantly lower than that of the background level. This means that significant number of H has been stroring into the plasma facing wall during

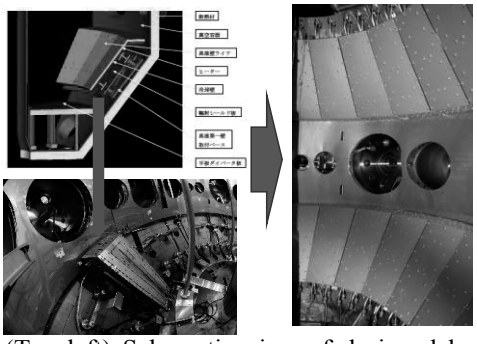

Fig. 1 (Top left) Schematic view of designed hot wall, which is composed of surface panels, temperature regulated stages with heater and water cooled channel, and radiation shield. (Bottom left) Photo of a temperature regulated stage during installation. (Right) Photo of the hot wall just after the fully assemble.

the plasma discharge at 393K. While the PFW at 473K is working as H source. It clearly shows that higher wall temperure is likely to provide higher recycling property and the hot wall may be able to control the H recycling.

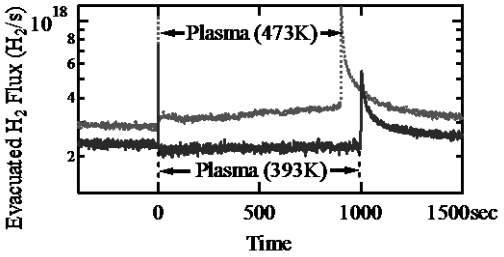

Fig. 2 Time evolutions of evacuated H_2 at 393K (solid) and 473K (dotted) during long duration discharges are illustrated. Background levels of H_2 flux before the experiment are most of the same ($2.3x10^{18}$ H_2/s).

Using new installed gyrotron, more than 30 kA in plasma current could be achieved in fully non-inductive current drive manner. The obtained plasma current is significantly sensitive to the injected mode and it means the one-path absorption of RF plays an effective role in current drive on QUEST. Details of the experiment is still under analysis. It is a future work.

4. Summary

It finds that the hot wall may have the capability to control hydrogen recycling during 2015 experimental campaigns. The gyrotron and transmission line, which was newly installed in 2015, were available and could operation well.

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