§11. Mass Dependence of Confinement in CHS Plasmas with NBI Heating

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In LHD experiment, a program for studying plasma confinement using discharges with deuterium gas has been discussed for many years. Largest motivation for this program is to obtain the confinement improvement with the effects of larger mass of ions. Such effects of mass have been observed in tokamaks giving various aspects of better performance of discharges. On the other hand, there are limited amount of knowledge about the mass dependence of confinement in helical systems. Actually existing experimental data obtained from helical devices in operation and those from the devices in the past show almost negligible effects of mass on the confinement.

CHS experiment started in 1988 in Higashiyama site of Nagoya university and had continued operation in that site for about 10 years. In 1999, CHS device was transported to Toki site of NIFS and has been running till 2006. In Higashiyama site, experiments of plasma discharges with deuterium gas were made for various scientific purposes with a careful control of the safety for the radioactivity due to neutron production by deuterium reacion.

Although noticeable differences in the confinement was not observed, we observed clear differences in some of physical quantities between the discharges with hydrogen and deuterium. One of such differences is the recycling rate after stopping gas puff in the NBI heated discharges. Two typical discharges are shown in Fig. 1 and Fig. 2.

All operational parameters are the same except the gas species for puffing. The magnetic field strength was 0.88 T. A plasma is produced by ECH starting at 0.03 sec. NBI in co-injection started at 0.04 sec. with a strong pulsed gas puff at the same timing (in the 1st frame of the figures). ECH was stopped at 0.045 sec. NBI was continued to 0.15 sec. Total sum of the calculated deposition power is shown in the 2nd frame (relatively lower trace among two). Plasma density increased till 0.07 sec., at which the gas puffing was stopped and the density started to decrease (in the 1st frame). Plasma energy measured by a diamagnetic loop is shown in the 2nd frame (Edmg in the unit of Joule).

Since a significant amount of fueling gas to the plasma comes from the wall recycling, ion species in the plasma is not simply determined by the species of gas from the puffing. Balmer lines (Hα or Dα) were monitored with a high-resolution spectroscopy in order to obtain the ratio of ion species in the plasmas. Both discharges have contents of nominal ion species above three quarters of total contents. As is shown in the decay rate of the density after stopping gas puffing, the wall recycling rate for deuterium is significantly higher than hydrogen. Wall conditioning of CHS experiment for these discharges was the titanium getting and the condition was kept about the same for these two discharges.

In the 3rd frame, ratios of experimentally obtained energy confinement time and the one calculated with various scaling models are plotted in time traces. The scaling models include the dependences of confinement on the plasma density, heating power and magnetic field. By comparing these discharges, we learn that there is no clear difference in the confinement between hydrogen and deuterium discharges.

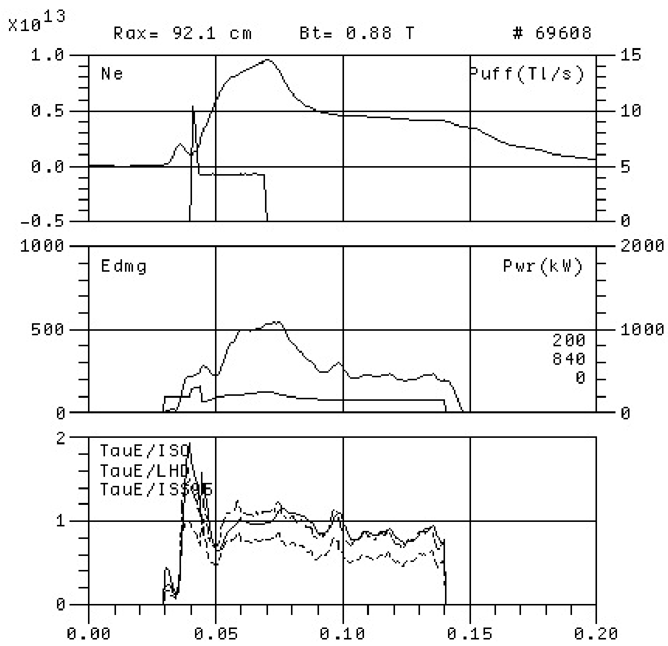

Fig. 1. NBI discharge with hydrogen gas puff

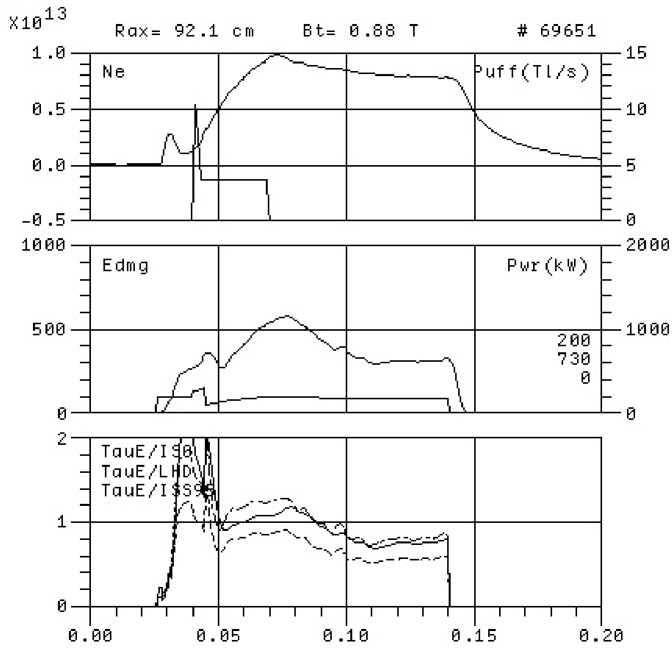

Fig. 2. NBI discharge with deuterium gas puff