§ 24. Impurity Accumulation Control by Magnetic Island Formation in LHD Long Pulse Discharges

Nakamura, Y., Takeiri, Y., Komori, A., Peterson, B.J., Narihara, K., Kawahata, K., Noda, N., LHD Experimental Group

In order to realize steady state operation with a high performance plasma, it is of great importance to reduce the impurity concentration or prevent impurities from penetrating into the core plasma. In previous LHD experiments [1], the influence of magnetic islands on impurity behavior was observed by using external perturbation coils, which produce an $n/m = 1/1$ magnetic island near the plasma edge. Therefore, impurity control by magnetic island formation was attempted in long pulse discharges with impurity accumulation as described in Ref. [2]. The long pulse discharge with the perturbation field is shown in Fig. 1, where both discharges with and without the perturbation field are indicated. The perturbation field is applied at 10 s and increased linearly until 28 s. A drastic change of impurity behavior was observed 3 s after the application of the perturbation field. The central radiation decreases on a large scale and a significant increase of the central electron temperature is observed. At that time, magnetic islands with the width of around 7 cm appear clearly in both O point regions as seen in the temperature profile (Fig. 2(c)). The peaked radiation profile returns to a hollow one and the peaked density profile to flat one by applying the perturbation field (Fig. 2(a) and 2(b)). The impurities in the core plasma may diffuse out by the reduction of the impurity influx due to the formation of a magnetic island. However, further experimental and theoretical investigation would be required for understanding the physical mechanism for the impurity pump-out. Another important feature in this discharge is the change of particle transport caused by the application of the perturbation field. As seen in Fig. 1(b), a large difference in the gas puffing rate with and without the perturbation field is observed and the gas fueling rate is very low for the discharge with impurity pump-out by means of magnetic island formation. The particle transport seems to be closely connected with the impurity transport.

As described above, impurity control using the perturbation field has been clearly demonstrated during long pulse discharges, in which the intrinsic impurity accumulation is observed. This method of controlling impurity accumulation with perturbation fields could be applied to long pulse operation in the future.

Reference
[1] Komori, A. et al., Phys. Plasmas **8** (2001) 2002
[2] Nakamura, Y. et al., PPCF **44** (2002) 2121

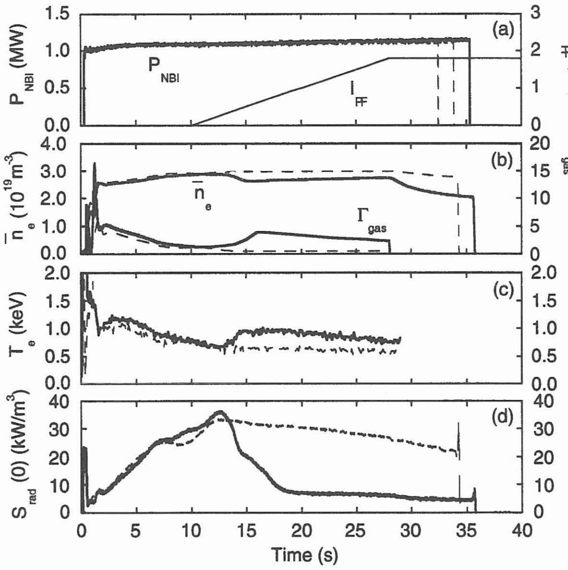

Fig. 1. Impurity accumulation control by the application of a perturbation field. A magnetic island is produced by the perturbation coil current (I_{PF}). The solid and broken lines indicate the discharges with and without a perturbation field, respectively.

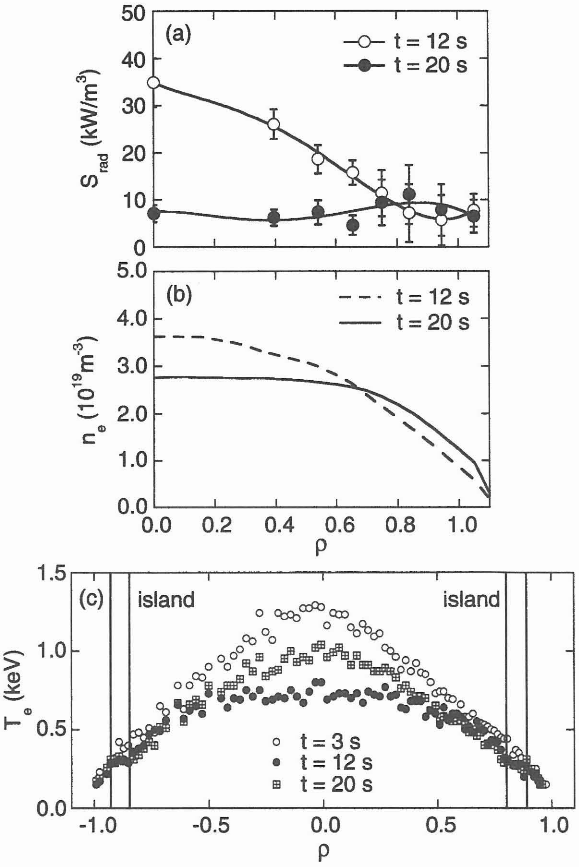

Fig. 2. Temporal variation of (a) radiation, (b) electron density and (c) electron temperature profiles for the discharge with a perturbation field.