# §6. Improvements in Experiment Technique for the Study of Nonlocal Ion Heat Transport in LHD

Tamura, N., Ida, K., Yoshinuma, M., Inagaki, S. (Kyushu Univ.),
Sudo, S.

In LHD, a sudden rise of core ion temperature $T_i$, which is measured using a charge exchange spectroscopy (CXS) with toroidal viewing sightlines (toroidal CXS), in response to an edge cooling induced by a TESPEL injection has been observed[1]. This phenomenon would be considered as so-called "nonlocal transport phenomenon", which has been observed in the electron heat transport so far. It should be noted here that when a $C^{5+}$ ion plume, which is derived from the ablation cloud of TESPEL (it consists of a polystyrene, -$CH(C_6H_5)CH_2$-) in this case, cuts across viewing chords of the toroidal CXS, the $T_i$ measured with such a diagnostics, especially in the core region, will be underestimated. Thus, in order to study precisely the initial response of the nonlocal behavior of ion heat transport, the influence of $C^{5+}$ ion plume on the $T_i$ measurement should be reduced as much as possible. One of the techniques for eliminating such an offending impact on the $T_i$ measurement is the use of the CXS with poloidal viewing sightlines (poloidal CXS). A simultaneous background measurement at another toroidal location for the poloidal CXS allows us to eliminate such an influence. Figure 1(b) shows a temporal evolution of the $T_i$ measured using the poloidal CXS in the plasma exhibiting the nonlocal transport phenomenon on ion heat transport. As a reference, the $T_i$ measured simultaneously using the toroidal CXS is shown in Fig. 1(a). Conditions of the discharge (LHD pulse #103678) for Fig. 1(a, b) are as follows; magnetic axis position of 3.5 m, toroidal magnetic field strength of 2.705 T, port-through power of negative-ion based tangential NBI of 9.7 MW, port-through power of positive-ion based perpendicular NBI of 6.4 MW, injected ECH power of 2.3 MW. The line-averaged electron density just before the TESPEL injection is 0.63 x $10^{19}$ $m^{-3}$ and the TESPEL deposition zone is estimated to be outside $\rho \sim 0.85$. As can be easily recognized from Fig. 1(b), the core $T_i$ measured even using the poloidal CXS is increased abruptly just after the TESPEL injection. Its response time is found to be less than the time resolution, 5 milliseconds, of the poloidal CXS.

Another approach for the detailed study of the initial response of the nonlocal transport phenomenon on ion heat transport is using the CXS with higher time resolution. Figure 1(c) shows an example of this approach, temporal evolution of the $T_i$ measured using the toroidal CXS with higher time resolution in the same plasma as Fig. 1(a, b). Here, the $T_i$ data is obtained at 1 millisecond interval and each plotted point is produced by a four-point average (thus, the effective time resolution is 4 milliseconds). As can be seen in Fig. 1(c), a further improvement in the S/N ratio in the CXS diagnostics is required for discussing further details (e.g. delay) in the response time of the core $T_i$ rise to the edge cooling.

1) N. Tamura et al.: Ann. Rep. NIFS (2007 – 2008) 21.

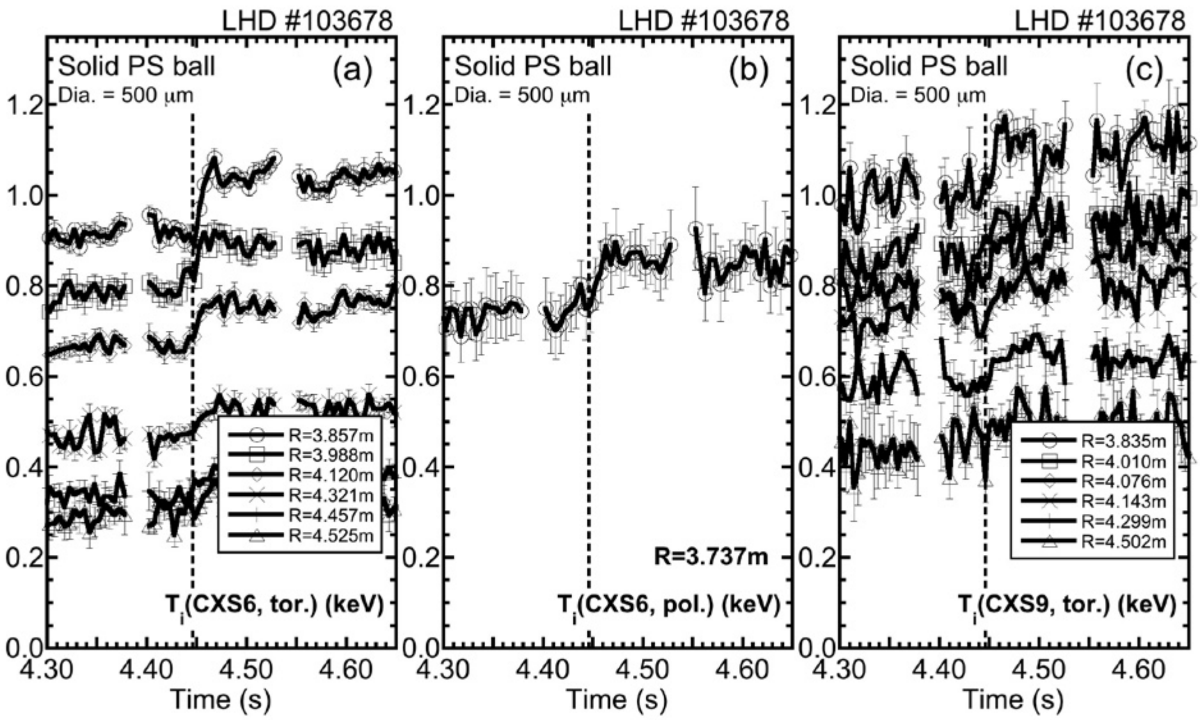


Fig. 1. Temporal evolutions of the ion temperature measured using a fast charge exchange spectroscopy (a) with toroidal viewing sightlines and (b) with poloidal viewing sightline. Each data point is plotted at 5 millisecond interval. (c) Temporal evolution of the ion temperature measured using an ultrafast charge exchange spectroscopy with toroidal viewing sightlines. Here, the ion temperature data is obtained at 1millisecond interval and each plotted point is produced by four-point average. All the data is obtained at the LHD pulse #103678 (the line-averaged electron density = 0.63 x $10^{19}$ $m^{-3}$ just before an edge cooling (t = 4.44 s). The vertical dashed lines represent the times of the TESPEL injection for the edge cooling.