§9. Ion Energy Spectrum in ICRF Experiment

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The ion energy spectrum was measured by the fast neutral particle energy analyzer (FNA) during all series of ICRF experiments. Since the analyzer is of electro-static type, it is not possible to distinguish different ion species. Although the system is movable to measure ions with different pitch angles, data presented here are all from the measurement with perpendicular pitch angles. As the energy ratio for the highest and lowest energy channels is 2.66, data were compiled for identical discharges to obtain a full spectrum.

Figure 1 shows a typical ion energy spectrum for the ICRF discharges in CHS. The diamagnetic energy was 1.2 kJ (Bt = 1.7 T) with 240 kW coupled ICRF power. The density was $2.5 \times 10^{13}\,cm^{-3}$ sustained by a deuterium gas puff. The measurement of Hα/Dα ratio showed the hydrogen minority was less than 20 % (hydrogen came out from the wall) which is necessary condition for the ion heating in two-ion hybrid scheme of ICRF heating. Bulk and tail ion temperature are calculated from the linear regression in two different energy ranges indicated by the small triangles on the bottom line of the figure.

Time variations of bulk and tail ion temperatures are plotted in Fig. 2 as well as the density ratio of the tail component to the bulk. The plasma density was increasing from 1.5 (at 50 ms) to $3.3 \times 10^{13}\,cm^{-3}$ (at 90 ms) during the discharge. While the ratio of the tail component decreased gradually, the tail temperature was almost constant during the discharge.

Figure 3 is another example of the ion energy spectrum measured in ICRF heating experiments. In this discharge, the diamagnetic energy was 1.9 kJ with 600 kW ICRF power input at the density $2.5 \times 10^{13}\,cm^{-3}$. No tail component was observed in the spectrum. The ICRF hardware setting was almost the same as the previous case (Fig. 1) but the mixture of ion species was different. Hydrogen minority was about 40 % of deuterium ions. Usual ICRF theory does not give ion heating in such condition.

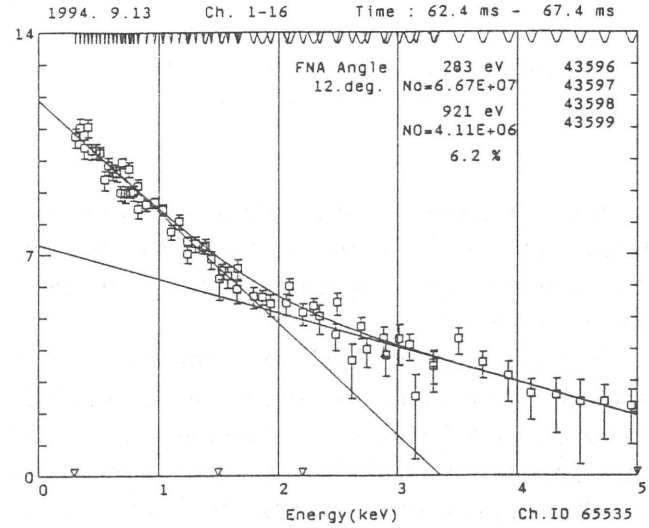

Fig. 1 Ion energy spectrum for low H/D ratio.

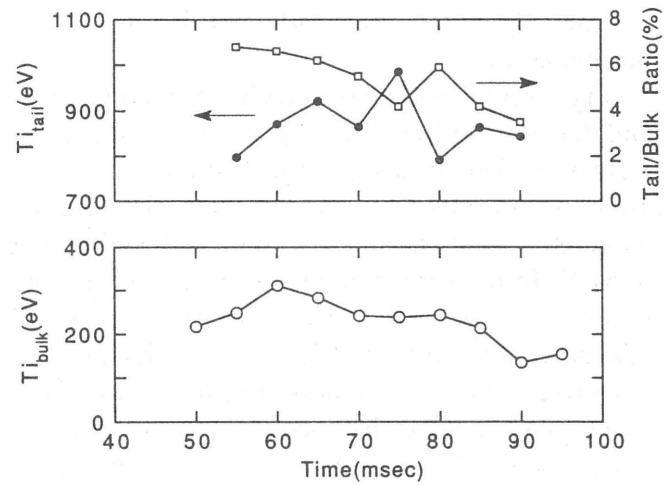

Fig. 2 Time variation of bulk & tail components.

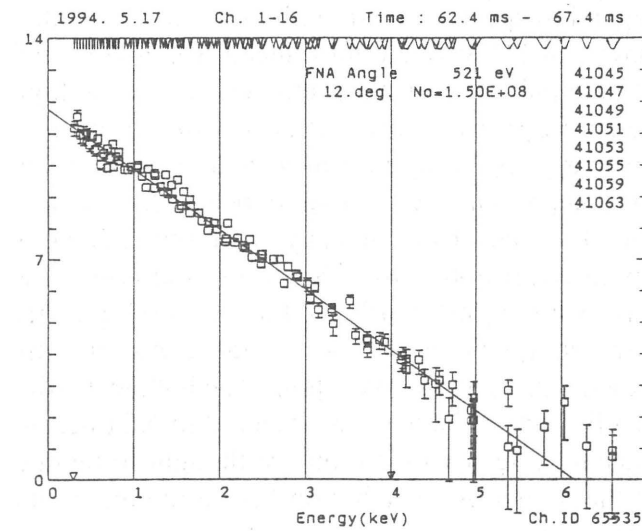

Fig. 3 Ion energy spectrum for high H/D ratio.