§4. Fast Potential Change Measured by HIBP at Sawtooth Oscillations

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The periodic clashes of the central electron temperature called sawtooth oscillations are a common feature of the tokamak plasmas. After the decays the flattening of the pressure thoughout the q=1 surface is observed. Kadomtsev proposed the theoretical model of the resistive reconnction. The theory, however predicted the flattening of the q-profile as well as the pressure inside q=1 surface, in contradiction with the recent measurements of the current density in tokamak plasmas.

We observed for the first time by a heavy ion beam probe, the fast change of the electrostatic potential is induced during the decay of the electron temperature. By the detailed study of this effect, we found that this potential is mainly due to the formation of the so-called barrier potential induced by the interaction of the hot and cold plasmas during the fast loss of the energy from the central part of the plasma. Figure 1 shows trajectories of 450 kV thallium beams at 3 Tesla toroidal field and points of measurement (sample volume) conducted in this experiment, well inside, near and outside the inversion radius of the sawtooth.(q=4.5) and in order to increase the inversion radius, some additional heating due to IBW and NBI heating is performed.

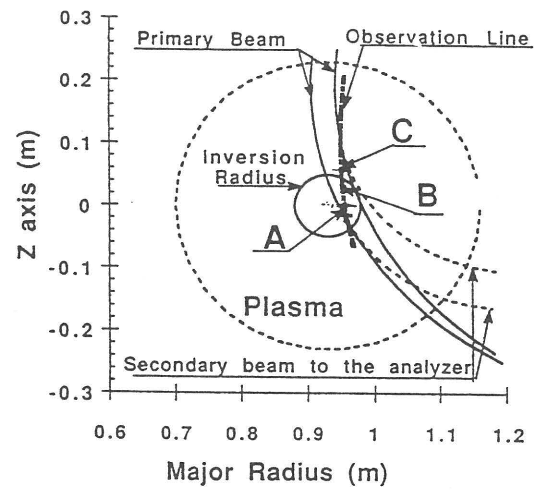

Fig 1. Trajectories of primary and secondary beam detected by the analyzer, and position of sample volume where measurements are conducted.

In Fig.2a, vey sharp positive changes are observed when the sample volume is at the position A in Fig.1c well inside the inversion layer of ECE and soft x-ray . When the sample volume is near the inversion layer (position B in Fig.1), the mixture of positive and negative potential pulse are observed as shown in Fig.2b. When sample volume is outside the inversion layer (position C), the negative potential pulses are observed in Fig.2c.

In case of C, the delay time of the potential from the sawtooth clashes are observed as is shown in ECE and soft x-ray measurement. In case of B, the polarity of the change of the potential depends on the direction of the fast movement of the hot core. If the core moves towards the point of measurement at the clash, the postive change is observed. When the movement is inwards, the negative potential is observed. The fast change of the potential can be interpretated by the interaction of hot and cold plasmas at the sautooth. The electrons of the hotter plasma travel faster through the destroyed magnetic surfaces and enter the region of region of cold plasma, producing the potential. The hotter region will become positive and cold region will be negative in accordance with the experiment. The amplitude of the change of the potential is about 100-200 V and is approximately the same with change of the electron temperature measured by the YAG Thomson scattering and ECE measuremnt, since $\Delta T_{e,ECE}(0)/T_{e,ECE}(0) = 0.1$, and $T_{e,YAG}(0) = 1.2$ keV.

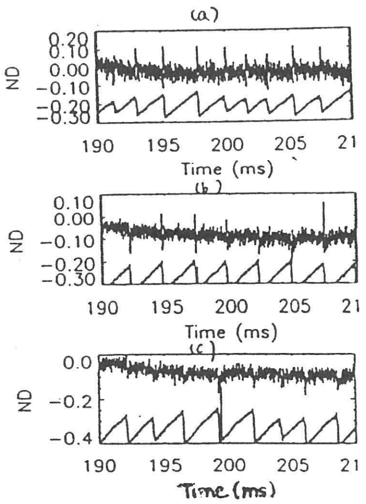

Fig. 2. Typical change of ND (the difference of to the upper and lower detector currents, normalized by the sum) at various postion of sample volume in sawtooth clashes. The conversion from ND to the plasma potential is about 1 kV/1.0ND.