

## §7. Time Dependence of Ablation Characteristics with the Off-Axis Ice Pellet Injection in the JIPP T-IIU Tokamak

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In order to carry out various basic investigation of toroidal plasmas by pellet injection, the degree of freedom concerning the pellet injection is considered to be a very important and essential factor. Recently a new scheme of injection system, "the injection-angle controllable system", has been developed and installed to the JIPP T-IIU tokamak. [1]

The arrangements of an injection-angle controllable system, CCD cameras, a high speed framing photograph (IMACON), and a heavy ion beam probe (HIBP) in the JIPP T-IIU tokamak are shown in Fig. 1. The pellet injection-angle has been varied poloidally from  $-6$  to  $6$  degree by changing the angle of the last stage drift tube of the injector. This situation makes it possible for pellets to aim at from about  $r = -2a/3$  to  $2a/3$  of the plasma.

In the case of an injection angle ( $\theta$ ) larger than a certain value ( $\theta \geq 4^\circ$ ), a pellet penetrates straightly through the plasma with a trace of straight ablation cloud, which has been expected from usual theoretical consideration. On the other hand, a long helical rotation ("tail") of ablation light has been observed in the case of the angle smaller than the certain value ( $\theta \leq 4^\circ$ ). In addition to the measurements by CCD cameras[2], the time-dependent flow characteristics of the ablation cloud have been observed by using the high speed framing photograph as shown in Fig. 2. Here, the direction of the toroidal field is counter-clockwise (CCW) and the plasma current direction is clockwise (CW). As clearly seen here, the direction of helical tail is independent to that of the total magnetic field lines of the torus. In order to examine the tail direction, experiments has been carried out as to four conditions with the combination of two (CW and CCW) toroidal field directions and two plasma current directions. These results show that the tail seems to rotate to the electron diamagnetic direction poloidally, and to the opposite to plasma current direction toroidally as to the almost all conditions of injection angles, but with  $|\theta| \leq 4^\circ$ .

Only in the case of pellet injection-angle to be parallel to the electron diamagnetic direction in poloidal plane (i.e., in the case of so-called

downward injection in this situation of the tokamak), it has been observed that the ablation cloud first rotates to the same direction with other cases, but at a certain time later it seems to decelerate and stay at the same location, or sometimes even to flow back to the reverse direction.

Consideration on various cross sections shows that the charge exchange equilibrium of hydrogen ions and neutrals at high density may exist in the tail structure. The phenomena may also have a close connection with the plasma potential and rotation.

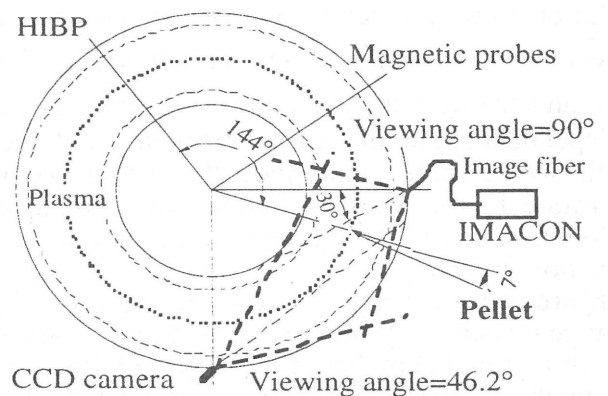


Fig. 1. Arrangements of the pellet injector ("injection-angle controllable system"), CCD cameras, a high speed framing photograph (IMACON), and a heavy ion beam probe (HIBP) in the JIPP T-IIU tokamak in planar view.

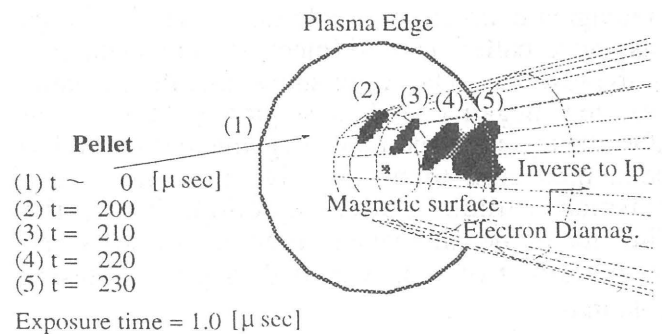


Fig. 2. Time-resolved framing photographs of the ablation cloud with the off-axis "upward" pellet injection by an image convertor camera. (The exposure time =  $1.0 \mu\text{sec}$ ) The viewing angle is essentially tangential.

### References

- 1) Sato, K.N., et al.: International Conference on Plasma Physics **1**, 93 (Iguacu, 1994)
- 2) Sakakita, H., et al.: Ann. Rep. of NIFS (Apr. 1993 - Mar. 1994) p. 157