§7. Kinetic Effect of Beam Ion in a High-beta Region by Equivalent NBI Technique

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One of common important issues of magnetic confinement fusion is to resolve the behavior and effect of a high-energy fusion product particle (*e.g.* alpha particle) on MHD characteristics of a fusion reactor core plasma. Non-ideal MHD characteristics (*e.g.* ion kinetic effects) have an important role for the plasma stability. It is expected to be more significant in a burning state of high-temperature plasma. A field-reversed configuration (FRC) plasma has an extremely high-beta value of nearly 100% even in the current stage of experiments. Also, a FRC can be translated into a quasi-static field region with and without background neutral gas with super Alfvenic velocity. Then significant amount of high-energy particle is injected into a core FRC plasma with relative velocity between translated FRC and background particles.

It has been expected from theoretical works that the mentioned non-ideal MHD characteristics are effective on a FRC stability. Several experimental results, which show non-ideal MHD effects, have also been obtained. For example, translated plasma with large normalized Lamor radius does not show an interchange instability with toroidal mode number of n=2, which is the most dangerous macro instability in a conventional theta-pinch FRC.

Experiments has been conducted on a field-reversed theta-pinch (FRTP) device of NUCTE–III device (Fig.1). The device has a formation region and quasi-static confinement region. Plasma diagnostics consist of an ion Doppler spectoroscopy (IDS), a 3.39 μm He-Ne interferometer, 60-channel of near-UV - near-infrared tomographic measurement system, and magnetic measurements.

Typical plasma parameters of presented experiment are electron density n_e: 2×10^{21} m^{-3}, temperature T_i: 190 eV, radius $r_s(0)$: 0.06 m in the formation region. The FRC plasma is injected into confinement region with approximately 130km/s of translation velocity.

Global behavior of translated FRC has been observed with optical methods. As possible effect of injected background particles, delay of an on-set time of rotational instability has been observed. Also, prolonged particle confinement time and flux decay time have been indicated. Relation between global instability and confinement property has never been clarified yet, however, delay of growth of the instability would potentially be caused by stabilization by a finite Larmor radius effect or so. 1)

Self spin-up reaching Alfvenic velocity has also been investigated experimentally. 2) An IDS measurement indicates rapid spin-up of plasma column and its velocity shear. This also potentially has a stabilization effect on global behavior of FRC. This mechanism will be continuing to investigate in detail.

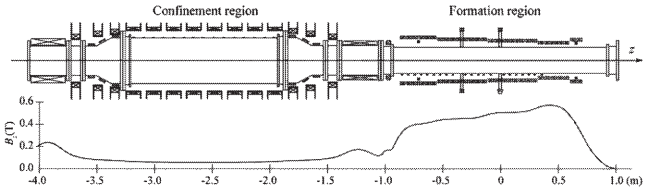

Fig. 1. Schematic of experimental device, NUCTE-III/T and profile of vertical magnetic field.

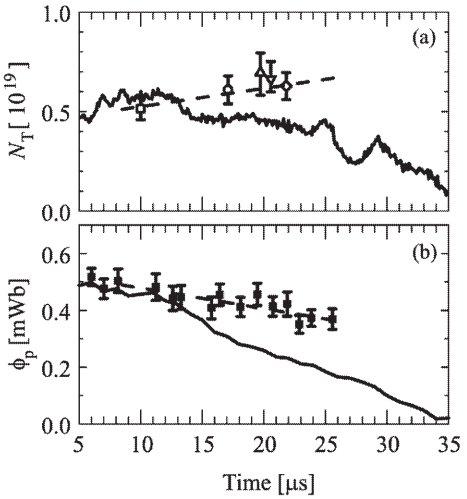

Fig. 2. Time evolution of total particle inventory and torapped poloidal flux with and without translation.

1) Matsuzawa, Y., Asai, T., Takahashi, T. *et al.*, Physics of Plasmas **15** (2008) 082504.

2) Yamamoto, N., Asai, T., *et al.*, in 7th international conference on Open Magnetic System for Plasma Confinement , Daejeon, 2008 (OS 2008).