§20. Formation and Sustainment of High-beta Spherical Tokamak like Field-reversed Configuration

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Because of its high-beta nature, effective additional heating technique for a FRC is primarily limited to a neutral beam injection. However, the FRC formed by a field-reversed theta-pinch (FRTP), the most effective formation technique of FRC, may not have enough poloidal flux to capture tangentially injected fast beam ions.

Since an FRC is a simply-connected configuration, it can be translated axially along a gradient of the external magnetic field and trapped in a confinement region with quasi-static external magnetic field. The translated plasmoid initially has a modest amount of toroidal flux, as observed in the FRX-C/T, FIX and TCS facilities. The TCS experiment demonstrated self-organization by the translated FRC, converting it into a spherical tokamak (ST) like magnetic configuration.

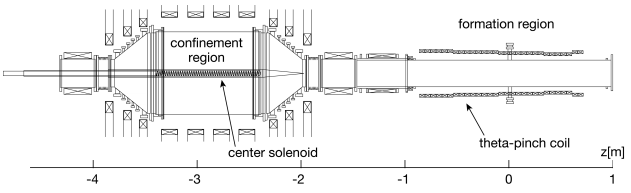

Fig. 1. Schematic view of FAT facility with a center solenoid and conductor.

Studies have been performed on the FAT-ICD facility (Fig. 1) at Nihon University, to study the FRC-ST transition and to demonstrate poloidal refluxing, i.e. transient toroidal current drive by a center solenoid (CS) on a translated FRC. Table I shows the basic specifications of the chamber.

The FAT-ICD has vacuum vessels made of transparent quartz tube both on the formation and confinement regions. A FRTP formed FRC is translated at

Table 1 Geometrical specifications of FAT-ICD

		Diameter (mm)
Coil	theta-pinch	300 - 360
	Mirror	256 - 900
	Confinement	1030
Vacuum vessel (Transparent quartz)	Formation	256
	Confinement	800

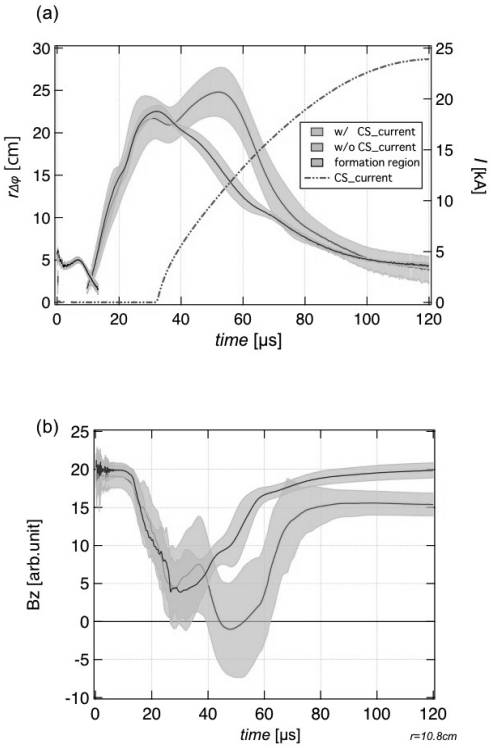

Fig.2 Time evolutions of (a) plasma radius (z = 0.30 m) and input current on a center solenoid and (b) poloidal magnetic field (z = 0, r = 0.108 m).

100 – 200 km/s into the confinement region along the external guide magnetic field. Then, the FRC is pierced at its geometric axis by a center structure housing an inner solenoid. Each coil bobbin is made of stainless steel plate with a toroidal cut. In the confinement region, conductive copper shell is installed on the inner wall of coil bobbin.

An FRTP-generated FRC is translated without any disruptive perturbation on its structure. The FRC with 10^{21} m^{-3} of electron density and about 40 eV in ion temperature is translated into the confinement region with a CS installed. The range of translation velocity is between 150 – 200 km/s. The stainless steel exoskeleton layer holds the translated FRC without any adverse impact.

Inductive current drive by the CS has been conducted. Figure 2 (a) shows time evolution of separatrix radius and input current on a CS. By exciting the CS, the separatrix radius is temporarily increased. Figure 2(b) shows temporal change of poloidal magnetic field B_z measured by internal magnetic probe at midplane of confinement region. It indicates induced reversed component of magnetic flux by driven CS current.

This study was supported by NIFS under contract No. NIFS15KBAP026.