# Comparison of Internal Magnetic Structure during Field-Reversed Configuration Merging Process with Resistive MHD Simulation

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Internal magnetic measurements during the collisional merging formation process of field-reversed configurations (FRCs) have been conducted on the FRC amplification via translation-collisional merging (FAT-CM) device at Nihon University.[1] An FRC is a magnetically confined plasma, characterized by the highest beta (~1) and is categorized as a compact torus. A single FRC state can be formed through the collision and merging of FRC-like plasmoids at super Alfvénic/sonic speed.[1,2] Despite the disruptive perturbation experienced by the plasmoids during the collision and merging phases, the plasmoid, after merging, relaxes into the FRC-like equilibrium state within several tens of microseconds. This phenomenon suggests the robustness of FRC.

The two-dimensional axisymmetric resistive magnetohydrodynamics (MHD) simulation[3] of the collisional merging formation of FRCs has been attempted to obtain the detailed internal magnetic structure of plasma during the collision and merging phase. The simulation successfully reproduced major quantities and global behaviors of the plasmoid, such as density, temperature, volume, and translation speed.[4] Figure 1 shows the radial profile of the magnetic field in the $x$, $y$, and $z$ directions, as observed by the internal magnetic probe array, around the midplane of the device. Comparable contour maps generated from the simulation result are shown in Fig. 2. Note that this MHD model does not incorporate a toroidal field (represented as $B_x$). In the experiments, the magnetic field was locally perturbated to the extent that it disturbed the FRC-like reversed field structure during the timeframe in which the plasma radius expanded due to the collision of plasmoids ($t \sim$ 15–30 µs), as shown in Fig. 1. A similar perturbation was also observed in the simulation as shown in Fig. 2. On the other hand, fast oscillation due to plasma bouncing was not observed experimentally. Furthermore, the slower oscillation, which induces radial expansion, decays significantly faster in the experiment allowing the plasmoid to relax into the FRC-like equilibrium state more quickly. Though the inserted internal magnetic probe array may have an invasive effect, oscillations on the plasma radius were not observed even without the probe. Therefore, a mechanism might exist to expedite the decay of these oscillations, which cannot be solely explained with this MHD model, and it may facilitate the rapid merging of the FRC. More detailed analyzed results will be reported in future work.

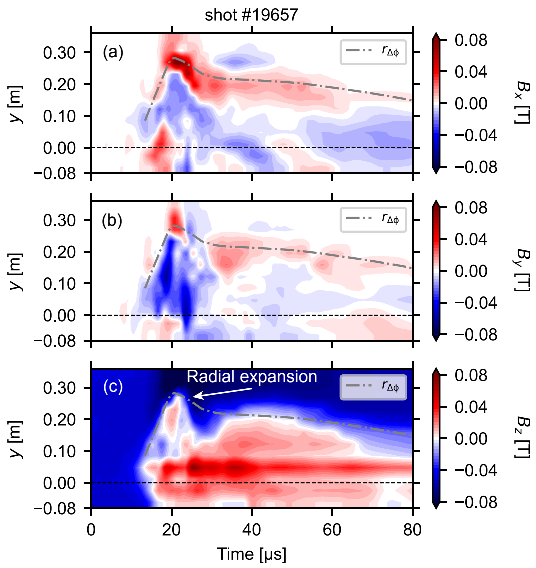


**Figure 1**. Radial magnetic profile of FRC observed by the internal magnetic probe array in the experiment. Grey dashed line denotes the plasma radius.

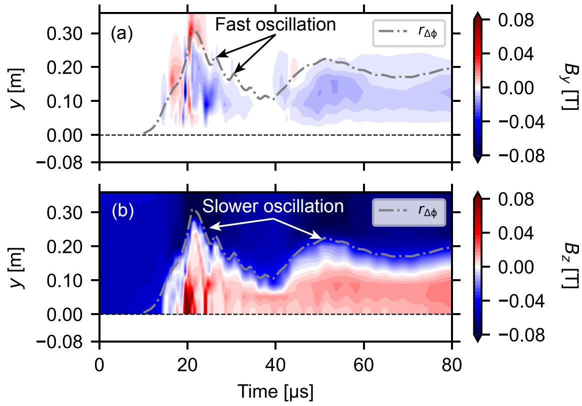


**Figure 2**. Radial magnetic profile of FRC obtained from the simulation. Grey dashed line denotes the plasma radius. Note that, there is no $B_x$ in this simulation result.

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