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低周波振動磁場へのFRCプラズマの応答
Response of a field-reversed configuration plasma to applied low-frequency magnetic field

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A field-reversed configuration (FRC) is a compact toroid with mostly poloidal magnetic field, which is generated by a plasma current, and it has simply-connected geometry. So, it has an extremely high beta value and it can be translated axially[1]. Therefore, it is expected as a core plasma for advanced fuel (D-^{3}He and p-^{11}B) fusion reactor. However, an additional heating technique is limited because of the characteristics of the FRC, such as the high beta nature and simply-connected geometry. In the FAT-CM (FRC Amplification via Translation – Collisional Merging) device[2] at Nihon University, it has been proposed to excite a low-frequency wave in a collisional merging FRC as an additional heating technique.

In the FAT-CM device, a merged FRC, which is excluded flux radius ~0.14 m, a length ~1.5 m, the volume ~0.08 m^3 and an average electron density ~8.0×10^{19} m^{-3} at quiescent equilibrium phase, is produced in a central confinement section by a collisional merging method. A low-frequency wave is excited in the merged FRC by the loop antennas. The antennas consist of two half-turn coils and can generate an oscillating magnetic field. Also, the antennas are placed on the planes at z = 0.9 and -0.9 m of the confinement section symmetrically with respect to the geometrical axis and the mid plane. The frequency of the oscillating magnetic field is lower than an ion cyclotron frequency ~110 kHz at a separatrix of the FRC because frequencies, which are higher than the ion cyclotron frequency and lower than a electron plasma frequency ~80 GHz are resonant or reflected outside of a separatrix of the FRC and cannot reach FRC core.

Figure1 shows an antenna current and B_z probe signals at the inner wall of the confinement chamber. In this case, a magnetic flux density was ~0.05 T on a center of the coil and the frequency of the antenna current was 91 kHz. The set of antennas was triggered at 100 μs after the main reversal time. Although the oscillatory wave was not observed on some B_z probe which are part of the antennas in a vacuum shot, the oscillatory wave was observed on all B_z probe signals. Also, it is inferred that the wave propagated in the axial direction because of a phase shift between probe signals. The propagation speed is ~ 160 – 240 km/s which is faster to compare with the Alfvén velocity ~130 km/s.

In this presentation, the response of the FRC to the applied low-frequency wave will be reported with a result of internal and external magnetic field measurement.

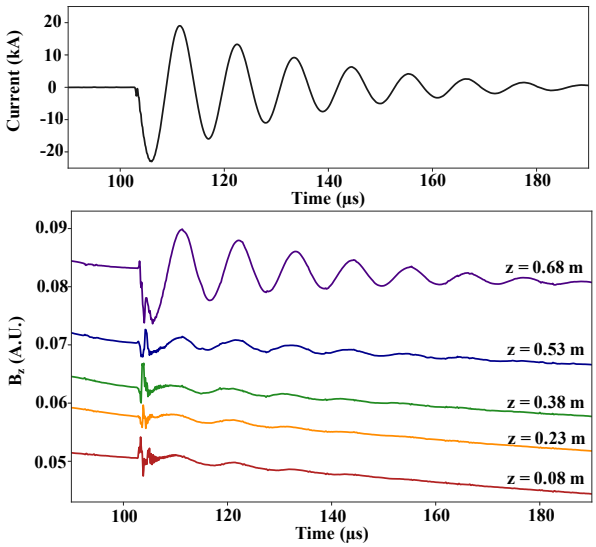

FIG.1 Time evolutions of the antenna current (top) and B_z probe signals in the confinement section (bottom). B_z probes are arranged axially on the inner wall of the confinement vessel at the interval of 0.15 m.

[1] M.Tuszewski, Nucl. Fusion **28**, 2033 (1988)
[2] T. Asai, et. al, in 27th IAEA-FEC 2018, Gandhinagar, India (2018) EX/P7-20