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Equivalent NBI effect onto a translated field-reversed configuration plasma
FRCプラズマ移送実験における等価的NBI効果の検証

Hirotoshi Ando[1)], Jun'ichi Sekiguchi[1)] , Mamiko Arai[1)] , Seri Katayama[2)], Tsutomu Takahashi[2)] , Toshiki Takahashi [3)]and Tomohiko Asai[2)]
安藤宏敏[1)], 関口純一[1)], 荒井真美子[1)], 片山晴理[2)], 高橋努[2)], 高橋俊樹[3)], 浅井朋彦[2)]

[1)]Graduate School of Sience and Technology,Nihon University
[2)]College of Sience and Technology,Nihon University
1-8-14, Kandasurugadai, Chiyoda-ku, Tokyo 101-8303, Japan
[3)]Faculty of Engineering, Gunma Univerdity

[1)]日本大学大学院理工学研究科　〒101-8303　東京都千代田区神田駿河台1-8-14
[2)]日本大学理工学部〒101-8303　東京都千代田区神田駿河台1-8-14
[3)]群馬大学大学院工学研究科　〒376-8515　群馬県桐生市天神町1-5-1

Field-reversed configuration (FRC) formed by a field-reversed theta-pinch method has simply-connected structure. Therefore, it is possible to be translated by the gradient of external magnetic pressure. In this study, mass dependence of equivalent NBI effect has been investigated in the FRC translated into the background gas of hydrogen and deuterium.

1. Introduction

Field-reversed configuration (FRC) formed by a field-reversed theta-pinch method is a magnetized plasmoid which has simply-connected geometrical structure. Therefore, it is possible to be translated along a gradient of external magnetic field. Translation velocity of FRC reaches up to the range of 70 to 130km/s. In this translation process, filled background gas is injected into the translated FRC with relative velocity. Therefore, it make low-energy, large-current axial NBI effect onto the FRC. It is evidenced that this effect increases internal plasma energy and elongate extend configuration lifetime from the past experiment [1,2].

In this study, mass dependence of the equivalent NBI effect has been investigated on a FRC translated into background gas of hydrogen and deuterium.

2. Experimental device

This study has been conducted on a theta-pinch based FRC facility FAT (FRC Amplification via Translation). The FAT facility consists of a theta-pinch type formation region and a quasi-spherical confinement region as shown in figure 1.

The formation region consists of a quartz discharge tube of 2.0m in length and 256mm diameter, a set of theta pinch coil and metal flanges.

The Confinement region consists of a quartz discharge tube of 1.0m length and 0.8m diameter as the central part and two conical metal chambers of 0.4m in length on both ends and a set of quasi-steady field coil.

3. Experimental result

In this section, experimental results of FRC translation into a confinement region with and without deuterium gas.

3.1 *Case 1: translation into a vacuum confinement region*

Figure 2 shows the time evolution of separatrix radius in the case of typical FRC translation. The separatrix radius is about 5cm on the formation region, then expanded to about 10cm in the confinement region. A FRC reflects at the conical metal chamber region to the confinement region

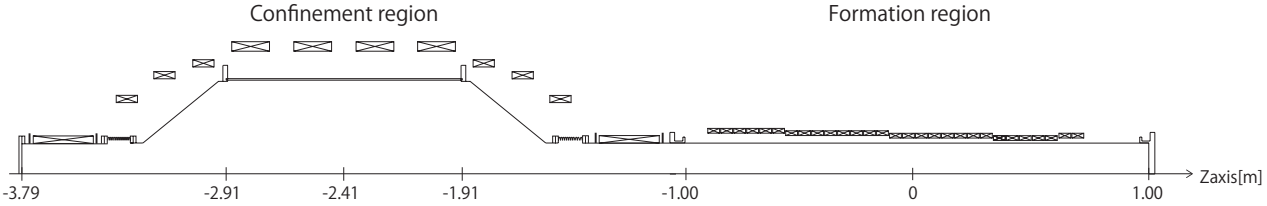

Fig.1 Schematic view of Experimental device.

with a translation velocity of 130km/s after the first pass of the translation process.

When the FRC is translated into the confinement region, the separatrix radius expands 1.8 times and the volume 3.2 times while it keeps a separatrix length. However, any global instability has not been observed even after the translation process.

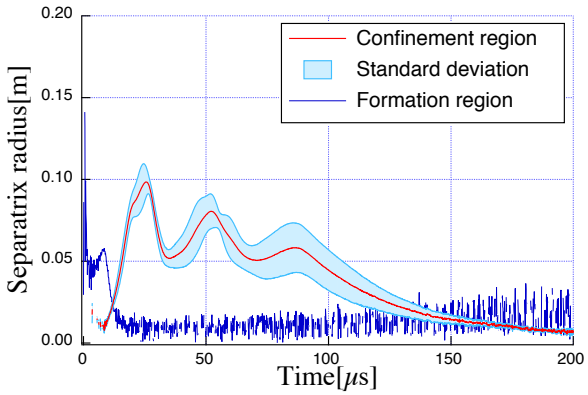

Fig.2. Time evolution of separatrix radius of a FRC translated into a vacuum confinement region

3.2 *Case 2: translation into a deuterium gas.*

Figure 3 shows the time evolution of separatrix radius of a FRC translated into a confinement region filled with deuterium gas. The separatrix radius is about 3cm in the formation region, and then expands to 20cm in the confinement region. In this case, translation velocity is about 70km/s. The separatrix radius expands 6.2 times during the translation process. Reflection at conical metal chamber region was not observed.

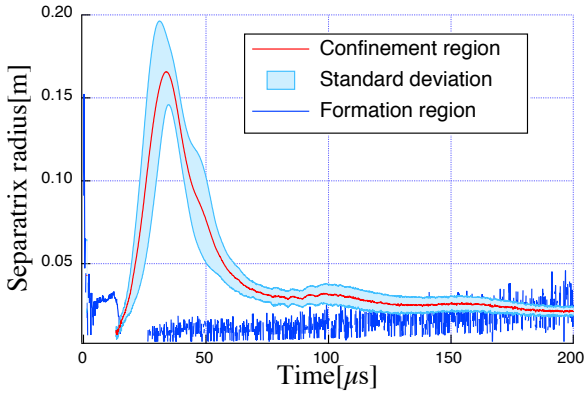

Fig.3. Time evolution of separatrix radius of FRC translated into a deuterium gas.

Conpared to the case1, the translated FRC in this case shows the following characteristics: (1) separatrix radius in the formation region is relatively smaller, (2) expansion rate of separatrix radius is more than 3 times larger, (3) translation velocity is approximately half of vacuum case, and (4) FRC is not reflected at the conical metal chamber.

3. Summary

Decrease of translation velocity is observed in the case of FRC translation into the confinement region filled with deuterium gas. However, the increase of separatrix and volume indicate regeneration of the translation kinetic energy back into the internal energy of FRC same as the energy regenerating mechanism of kinetic energy due to the equivalent NBI effect of background neutral is indicated in the past experiment[1].

On the other hand, filled background gas influences the plasma parameter in the formation region in this experimental setup. Therefore, fast gas-puff valve is necessary to reduce the effect of background gas onto the formation region.

References

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[2] T. Asai, Y. Matsuzawa, N. Yamamoto, K. Takao, H. Tamura, M. Hiyoshi, T. Sasaki, Ts. Takahashi, Y. Nogi, M. Inomoto, To.Takahashi, J. Miyazawa, and Y. Nakamura: J. Plasma Fusion Res. SERIES, Vol.**8**.(2009)