Study of plasma current relaxation phenomena in locally driven FRC-plasma

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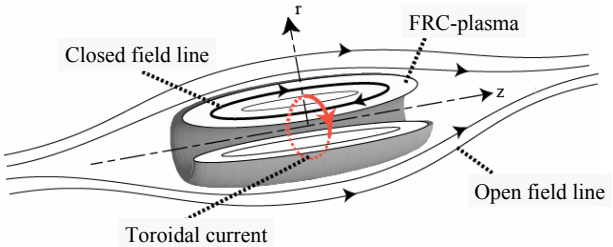
Background

FRC-plasma Confinement Concept

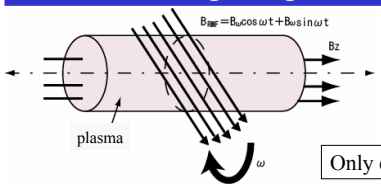


Toroidal current forms closed field line.

Field configuration disappears with time.

Current drive by RMF regularly maintains FRC.

RMF:Rotating Magnetic Field

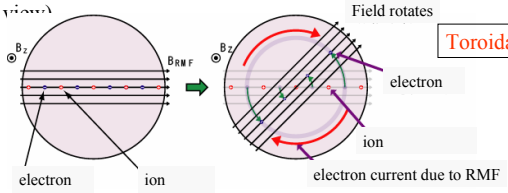


Field is rotated with $\omega_{ci} < \omega < \omega_{ce}$

Only electrons co-rotate with RMF

Toroidal current drive

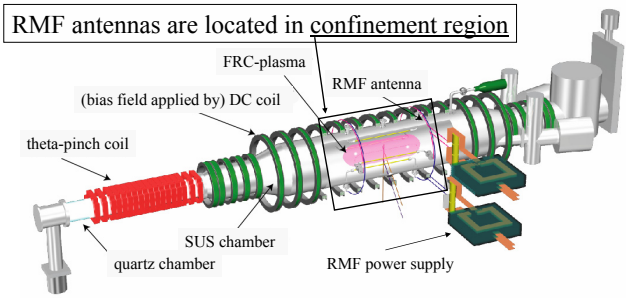
Principle of toroidal current drive by RMF (Side view)



Principle of toroidal current drive by RMF (Cross-section view)

FIX:FRC-plasma Injection eXperiment

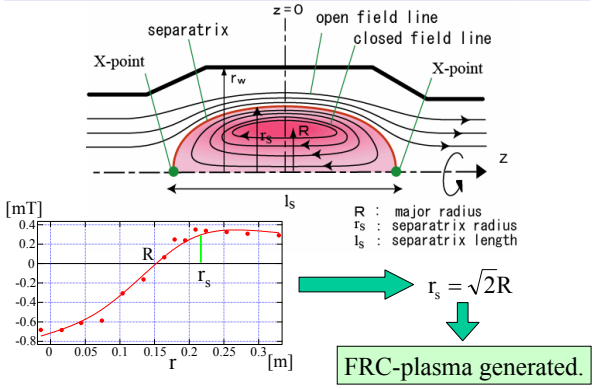
RMF antennas are located in confinement region



RMF applies locally.

Plasma current relaxation phenomena can be observed.

Diameter direction measurement

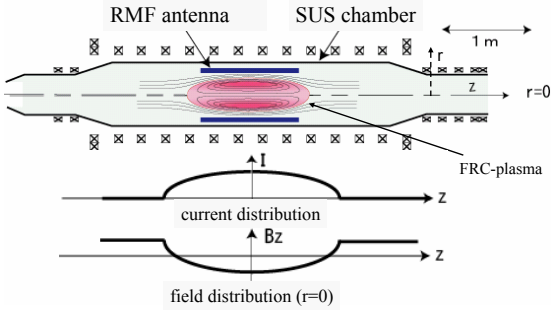


$r_s = \sqrt{2}R$

FRC-plasma generated.

Experiment purpose

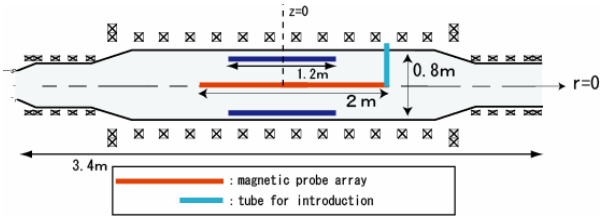
Observation of axial distribution of driven current



Measurement of axial field distribution (r=0)

Measurement Method and Experimental Conditions

Measurement with magnetic probe array
(same frequency response:10Hz~100kHz)

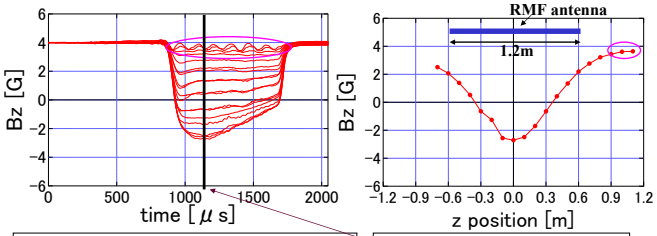


Experimental Conditions

- Enclosed gas pressure Deuterium 4.0×10^{-2}[Pa]
- Bias field strength 1～8[G]
- RMF strength 2～6[G]

Results

Bias field strength 4[G], RMF strength 3[G]

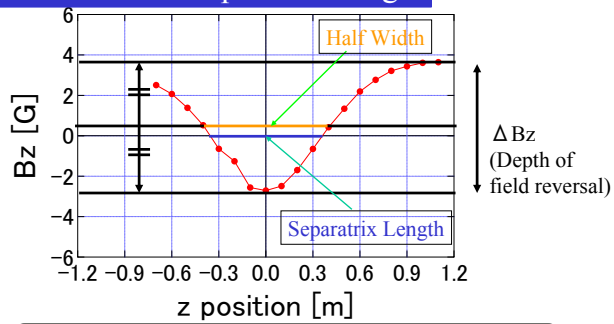


Temporal transition of axial field strength

1134 μs:axial field distribution

- Field is reversed most in center of the antenna (z=0)
- Field strength varies outside the antenna (z>0.6)
- Field oscillates in the edge of measurement (z>0.9)

Half Width and Separatrix Length



Using half width to compare field distribution shape

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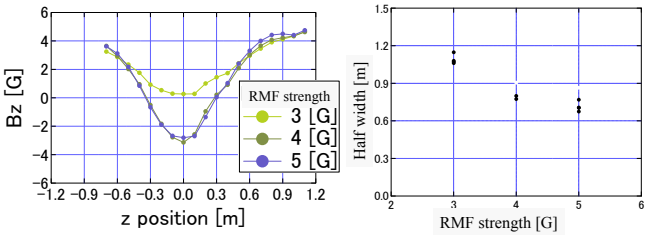
Comparing half width by each parameter

Field Distribution Shape（1）

Bias field strength 5[G]



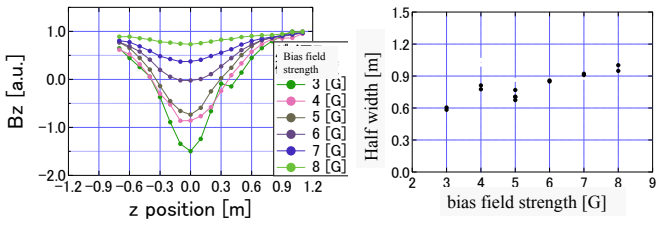
Field reversal becomes deeper when RMF strength is enlarged.

↓

Toroidal current on the center of plasma is higher.

Field Distribution Shape（2）

RMF strength 5[G]



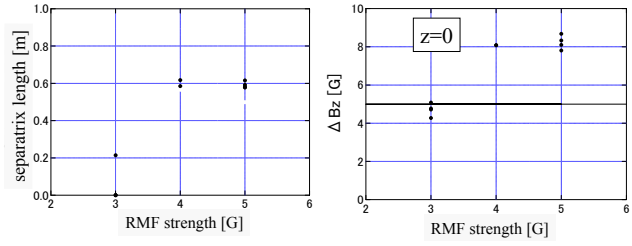
Field reversal becomes deeper when bias field strength is reduced.

↓

Toroidal current on the center of plasma is higher.

Separatrix Length（1）

Bias field strength 5[G]



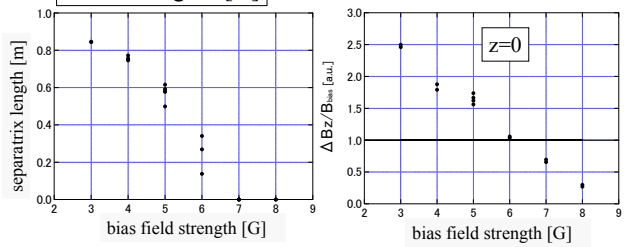
When RMF strength is enlarged,
depth of field reversal and separatrix length grow.

↓

FRC-plasma generated becomes large.

Separatrix Length（2）

RMF strength 5[G]



When bias field strength is reduced,
depth of field reversal and separatrix length grow.

FRC-plasma generated becomes large.

Conclusion

(1) When RMF strength is enlarged or bias field strength is reduced,
(i)FRC-plasma generated becomes large.
(ii)Toroidal current on the center of plasma is higher.
Thus, toroidal current distribution can be controlled.

From field oscillation in the edge of measurement,
(2) It is estimated that the plasma current is discharged at the constant cycle in the region where the RMF antennas are not located.