28E17P

RELAXプラズマの高性能化シナリオ
A Scenario for High-Performance RFP Plasmas in RELAX

政宗貞男[1]，三瓶明希夫[1]，出口和明[1]，中木聖也[1]，田中裕之[1]，西村香苗[1]，比村治彦[1]，
川端一男[2]，秋山毅志[2]，永田正義[3]，菊池祐介[3]
S. Masamune[1], A.Sanpei[1], K. Deguchi[1], S. Nakaki[1], H. Tanaka[1], K. Nishimura[1], H. Himura[1],
K. Kawahata[2], T. Akiyama[2], M. Nagata[3], Y. Kikuchi[3]

[1]京都工繊大，[2]核融合科学研究所，[3]兵庫県立大
[1]Kyoto Institute of Technology, [2]NIFS, [3]University of Hyogo

The reversed field pinch (RFP) is a compact, high-beta magnetic confinement concept. The great advantage of the RFP is that it requires weak external toroidal magnetic field. Recent RFP research has revealed two scenarios for confinement improvement. One is the plasma current profile control, and the other is the quasi-single helicity (QSH) scenario which allows only a single dominant mode to grow. As an extreme case, the Single Helical Axis (SHAx) state has emerged as a new self-organized helical RFP state.

An equilibrium analysis has shown that the aspect ratio *A* (=*R*/*a*) is an important parameter for optimization of the RFP configuration because the *q* profile is closely connected to *A* in the self-organized state. Furthermore, some theories show that the pressure-driven bootstrap current increases as *A* is lowered to less than 2.

RELAX is a RFP machine (*R*=0.5m/*a*=0.25m: *A*=*R/a*=2) to explore the plasma characteristics in low-*A* regime. The RFP configuration is often discussed in (Θ, *F*) space, where the pinch parameter Θ is the ratio of edge poloidal field *B*p(*a*) to the average toroidal field <*B*t>, and the field reversal parameter *F* is the ratio of the edge toroidal field *B*t(a) to <*B*t>. Experimentally achieved wide discharge regions in (Θ, *F*) space in RELAX have already been discussed. In shallow reversal plasmas, the discharge tends to transit to the QSH state, or helical Ohmic equilibrium state which is essentially the same as the SHAx state. Experimental internal field profiles of *B*r, *B*p, and *B*t showed good agreement with the theoretical helical Ohmic equilibrium state.

The MHD behavior of RELAX plasmas has been studied in detail in the current region from 40 kA to 80kA as shown in Fig.9, where two possible improved confinement regions were suggested: QSH-dominated shallow-reversal region and deep-reversal region with low magnetic fluctuation level. In both regions, further improvement of confinement can be expected with higher *S* because quality of the QSH is improved more at higher *S*, and magnetic fluctuation level decreases with increasing *S* in the RFP. In order to improve plasma performance we have started optimization of high current operation.

At present, poloidal flux consumption is higher in high pressure discharges in shallow reversal regions, where it is easier to attain QSH discharges. As a result, plasma lifetime is determined by the available poloidal flux in high-current QSH regions. On the other hand, we have attained low-resistance, high current RFP plasmas in low pressure discharges in deep reversal regions. When we look at the discharge resistance and amplitude of the dominant m=1/n=4 mode in these two regions (high pressure, shallow reversal and low pressure, deep reversal regions), the trend merges at Ip~125kA, as shown in Fig.1. Therefore, we are preparing for the following discharge scenario for high-performance low-A RFP plasma; current startup to ~100kA at low pressure, followed by fast gas puff together with toroidal field reversal control to attain QSH state at high-current, high S regions. Additional control scheme such as helicity injection will also be discussed.

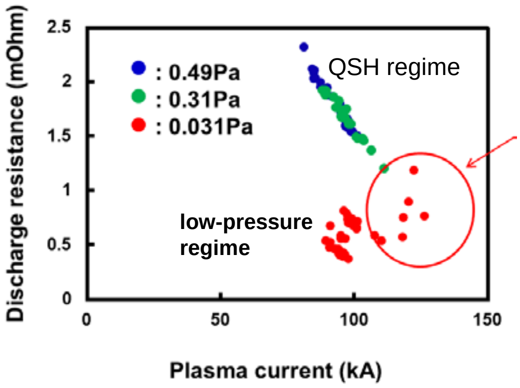

Fig.1.Discharge resistance vs. plasma current.