§34. Bootstrap Transition to $\beta = 1$ Plasma Confinement by Surface Magnetic Field

Watanabe, T., Takayama, K., Tonegawa, A.,
Kawamura, K. (Tokai University),
Hojo, H. (Plasma Research Center, Univ. Tsukuba)

A new plasma confinement method is proposed to sustain high temperature core plasma in surface magnetic field. Magnetic field is zero in core plasma region (complete $\beta = 1$ plasma). The bootstrap current driven by

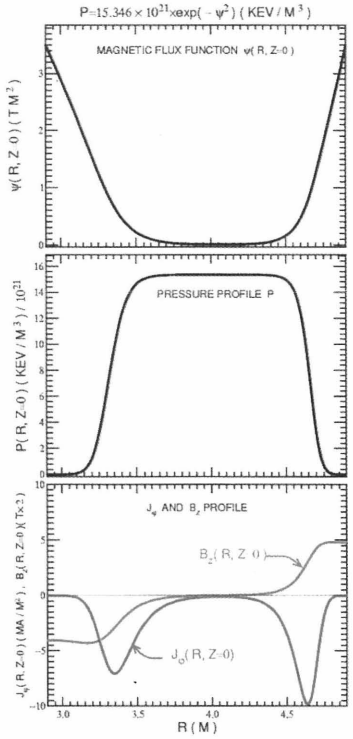

Figure 1: Numerical solution of the Grad-Shafranov equation in the case of strong confinment of complete $\beta = 1$ plasma by surface magnetic field. Distributions of flux function, plasma pressure, magnetic field and current density on $z = 0$ plane are expressed. Horizontal axis represents the major radius R.

the pressure of plasma generates the magnetic field in an outside area of the plasma column. The magnetic field plays the role as the surface magnetic field to confine plasma. In addition, in an outside area of external coils, the magnetic field cancel the magnetic field produced by the external coils. It is possible, therefore, to be decreased the total energy of the system by the confinement of high beta plasma. Then, bootstrap transition to the complete β =1 plasma confinement configuration is possible if plasma is heated by sufficient power level. We have pointed out that this situation is very similar to the appearance of the Meissner effect in the superconductor, physically. The possibility is confirmed by the energy computation of the magnetic field under the cylindrical coil group model. In addition, it was shown numerically by the one dimensional transport calculation, that the threshold power (lower bound) exist in the heating input to plasma for the bootstrap transition to the complete β =1 plasma confinement configuration. Moreover, detailed structure of the complete $\beta = 1$ plasma confinement configuration is shown by the equilibrium calculation of an axisymmetric configuration(Fig.1). The stability boundary for the complete $\beta = 1$ configuration is derived based on the energy computation of simplified model(Fig.2). It is proposed that the LHD magnetic field

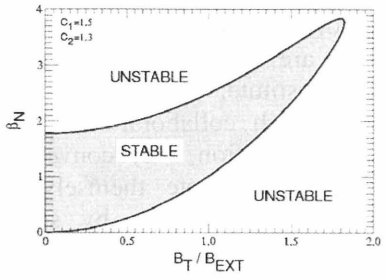

Figure 2: Stability boundary for complete $\beta = 1$ plasma confinement by surface magnetic field. Stability window is present for toroidal field stregth B_T and nomalized plasma beta value $\beta_N \left(= 2\mu_0 n T / B_{EXT}^2\right)$. B_{EXT} is the poloidal magnetic field strength produced by external coils. Parameters c_1, and c_2 are the normalized device size indexes.

configuration be suitable for complete $\beta = 1$ plasma confinement(Fig.3).

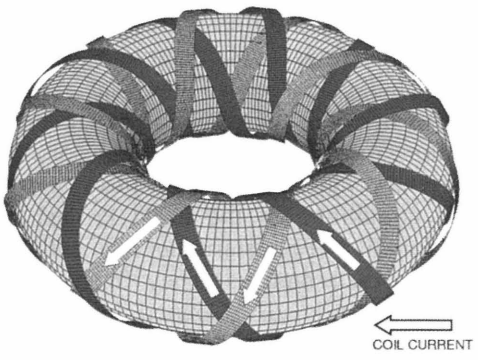

Figure 3: Coil system for confinement of complete $\beta = 1$ plasma with surface magnetic field without no troidal magnetic field.