

## S21. Magnetic Axis Dependability over the Ideal MHD Instability of LHD Plasma

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The low- $n$  ideal MHD analysis is performed to the LHD plasma using TERPSICHORE code[1]. TERPSICHORE code solves the linearized ideal MHD equation in variational form for 3-D equilibrium.

Here, the difference of characteristics of stability about magnetic axis  $R_{ax}$  is discussed.

The analyzed result is shown in Fig.1. The position of the magnetic axis are (a) $R_{ax}=3.5m$ , (b) $3.6m$ , and (c) $3.75m$  respectively. The adopted pressure profile is  $p=p_0(1-\rho^2)$ . Here  $p_0$  and  $\rho$  are the pressure at the magnetic axis and normalized minor radius respectively. The solid and dotted lines are the Mercier criteria  $D_I$  and rotational transform  $\iota/2\pi$  respectively. The interval of the contour of  $D_I$  is 0.2. The contour line of  $\iota/2\pi$  corresponds to the resonance surface of these modes. The modes of  $n/m=1/1, 1/2, 2/3, 2/5, 3/4, 3/5,$  and  $3/7$  stabilities are shown in each figures by some symbols. The opened and closed symbols describe the stable and unstable to low- $n$  mode respectively.

In case of  $R_{ax}=3.5m$ , the Mercier unstable domain widely lies. The Mercier mode is unstable over all  $\rho$  at the range of  $1.2\% < \langle \beta \rangle < 2.2\%$ . The low- $n$  modes are almost unstable except for 1/1 mode at the peripheral region. Especially all the low- $n$  modes shown here are unstable in  $\langle \beta \rangle \simeq 1.9\%$ .

In case of  $R_{ax}=3.6m$ , the Mercier unstable region lies in the core region at  $\langle \beta \rangle < 1.5\%$  and peripheral region at  $\langle \beta \rangle > 1.5\%$  region. It is found that there is a second-stability region ( $\langle \beta \rangle > 1.5\%$ ,  $\rho < 0.8$ ). The low- $n$  unstable region moves outward ( $\rho=0 \rightarrow 1$ ) with increasing the beta. In the low beta region, the mode of  $n/m=2/5, 3/7,$  and  $1/2$  are unstable. On the other hand, in the high beta region, the mode of  $n/m=3/5, 2/3,$  and  $3/4$  are unstable.

In case of  $R_{ax}=3.75m$ , the narrow Mercier unstable region is seen around  $\rho \simeq 0.9$  and  $\langle \beta \rangle \simeq 1.7\%$ . Any low- $n$  modes are stable.

In the viewpoint of ideal MHD, the case of  $R_{ax}=3.75m$  is a desirable configuration for the LHD plasma. However, in the actual experiment, the plasma produced at  $R_{ax}=3.6m$  has the good performance and the serious MHD instabilities are not observed.

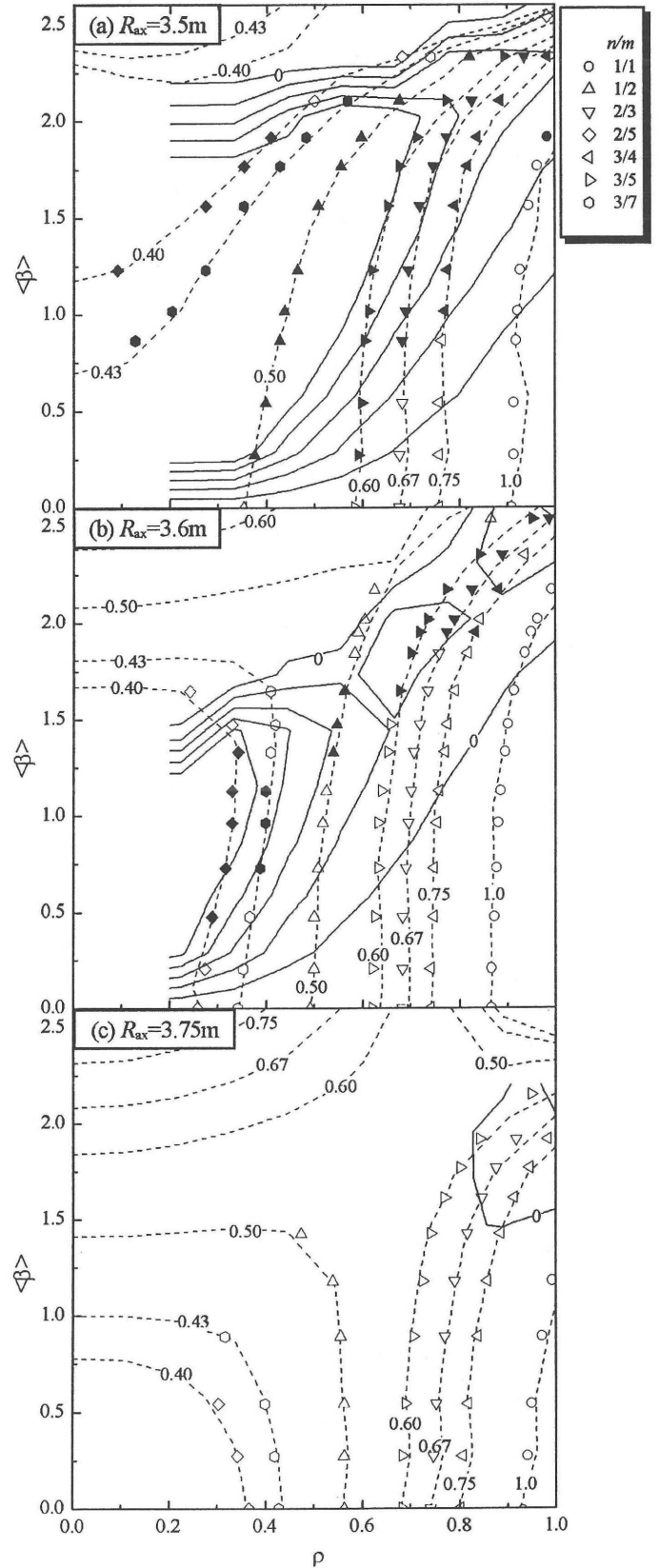


Fig. 1: Contour plot of Mercier criteria and rotational transform at (a) $R_{ax}=3.5$ , (b) $3.6$ , and (c) $3.75m$

### Reference

1) W. A. Cooper, Plasma phys. and Controlled Fusion 34, (1992) 1011