§17. Modular Coil Design for CHS-qa

Shimizu, A. (Nagoya Univ.), Okamura, S., Matsuoka, K.,
Watari, T.

In the latest modular coil design for NIFS CHS-qa, the coils in torus are assumed to be 20 in total. However a requirement from technical issues may force to reduce the total number of coils. So the alternate design, in which the coils number is reduced, is examined.

For finding the optimized shape of the modular coils, NESCOIL code developed in Garching for designing coils of Wendelstein VII-X is used. The shape of current carrying surface (CCS) can be represented by Fourier components, and the shape of filaments is also represented by Fourier components on the CCS. These parameters are determined so that normal components of magnetic field on the last closed magnetic surface, which characterizes a magnetic configuration we would like to realize, become minimum by using a numerical minimization routine.

In case that only the normal component of magnetic field is used as optimization parameter, there is the possibility that other properties, such as the rotational transform and the position of magnetic axis, do not well agree with the designed value. NESCOIL code can evaluate these parameters and include in the optimization parameters. The curvatures of filaments and the distances between adjacent coils are important from technical points, and these parameters are also evaluated. Since this code evaluates the sum of (weight) x (realized value - aiming value)^2/(aiming value)^2, adding any other new expanded parameter is very easy.

The configuration of which coils assumed to be 16 in total in torus is shown in Fig.1 (Top view). In this optimization calculation, the normal components of B, the curvatures of filaments and the distances between adjacent coils are used as optimization parameters without using other properties. The curvature and distance are sacrificed to some extent to gain the good agreement with the aiming configuration. So the curvature of filaments is tighter than 20-coils case. This tight curvature may be impossible to attain technical feasibility. The Fourier components of the magnetic field in Boozer coordinates indicate the good

quasi-axisymmetric characteristic as shown in Fig.2. Of course it is predicted that the reducing the total of coils leads to the increasing bumpy ripples produced by discrete coils, so the magnetic error from the aimed configuration becomes larger than for 20-coils case. The evaluation of the error of the magnetic configuration reproduced by technically possible designed coils is now in progress.
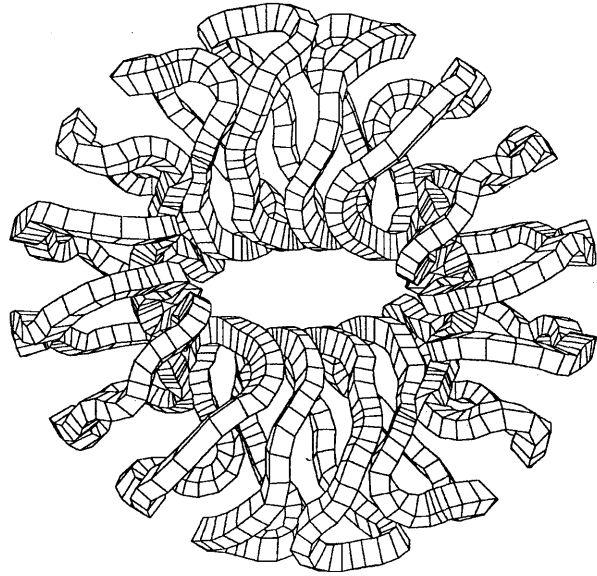

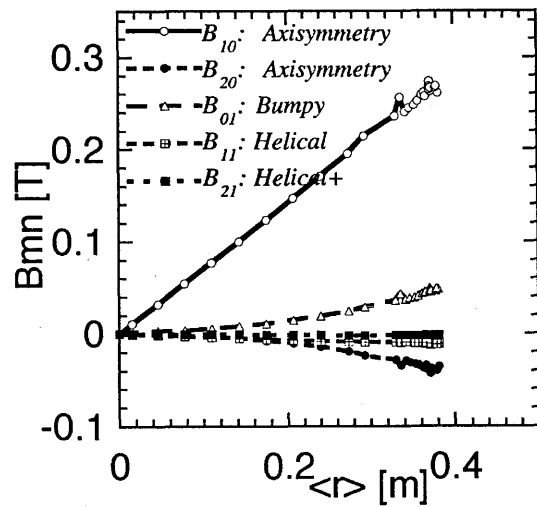Fig.1   Top view of modular coils configuration. The coils total up to 16 in torus.

Fig.2   The Fourier components of magnetic field in Boozer coordinates, of which the magnetic configuration are formed by 16 coils in Fig.1, are shown.