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MAGNETICS CALCULATIONS FOR AN ELMO BUMPY SQUARE*

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Advanced ELMO Bumpy Torus (EBT) concepts have been studied in an effort to determine the potential for new and different concepts as confinement experiments or as reactors. Several magnetic configurations based on the EBT confinement concept were developed including the ELMO Bumpy Square (EBS).[1] The EBS was selected as a possible candidate for near-term study because of its potential for resolving critical EBT issues, for its desirability as a reactor, and for anticipated contributions to the physics and technology of fusion. This paper summarizes magnetics calculations that were carried out in support of studies to assess the merits of an EBS.

The EBS configuration consists of four linear arrays of simple mirrors that are joined by 90° sectors of a high field toroidal solenoid that generates a field with negligible ripple. The EBS studied here is a reconfiguration of the EBT-1/S device constructed using the existing EBT-1/S mirror coils to form the straight sides of the square and incorporating eight new design half-size EBT 1/S coils to form each corner. The corner coils are displaced from the axisymmetric mirror coils by 2.5 cm (in the outward direction) to symmetrize the mod-B in the midplane of the transition sector with respect to the field lines. The transition sector is the region between the linear sector coil and the first corner coil. This is done to permit rings to form in the transition sector on the same flux lines on which they are formed in the linear coil train.

In the EBS model studied here, the mirror sector length is 40 cm, the transition sector length is 42 cm, and the corner coils have a major radius of 44.2 cm. All of the coils have an inner radius of 16.36 cm. The side coils have a cross-sectional area of 10.16 x 7.30 cm^2 and carry a current of 7777 A in 44 turns. The corner coils carry 9000 A in 22 turns and the cross-sectional area is 5.08 x 7.30 cm^2.

The calculations reported here were made using the computer code EFFI.[2] Field-line/mod-B contours, $\oint d\ell$, $\oint d\ell/B$, and the magnetic forces acting on the coils were calculated for the EBS configuration described above, and also for a similar configuration including trim coils. The data were obtained to assess the vacuum magnetic parameters of the EBS and to provide information to aid in the mechanical design of the mirror and transition cavity structures, turning coil assembly, and structural support and containment for the coils.

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The results of this study show that favorable magnetic performance can be achieved in the EBS. The calculated forces acting on the coils due to the magnetic fields are comparable in magnitude with those found in the EBT-1/S and no extraordinary structural design is required to support either the side coils or turning coils. The outward displacement of the corner coils from the axis of the side mirror coils leads to a significant improvement of the ring formation in the transition sector compared to the case where the corner coils are on the mirror coil axis.

Fluctuations in the field line/mod-B contours introduced by drifts in the current flow in the side and mirror coils are readily restored by applying current to circular trim coils that are located in the center of the transition sector coaxial with the mirror coil axis. Trim coils having an inner radius of 32.76 cm and a cross-sectional area of 2.6 x 2.6 cm^2 will restore the magnetic field configuration for $\pm$15% variations in the coil current.

REFERENCES

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