Advanced Options for Modular Stellarator Magnets

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There have been investigations of stellarator magnets that incorporate conventional magnet construction with state-of-the-art materials. The purpose of this paper is to investigate the options for stellarator magnets that utilize extrapolation of present day technology, utilizing high performance superconductors, structure and insulation, as well as aggressive design approaches.

Evaluation of the use of high temperature superconducting materials, in particular highly anisotropic YBCO, on the magnet thickness, shield and cooling requirements, is performed. In addition to YBCO, other high Tc materials will be discussed, including BSCCO 2212 and MgB_2. The status of radiation damage on the performance of the high Tc superconductor is also described. This has impact on the required shielding for the survivability of the superconductor and insulator, as well as the cooling requirements.

The impact of magnet protection on high Tc designs will be discussed. As opposed to low temperature superconductors, it will be difficult to measure the occurrence of quench due to the very low speed of propagation of normal zones. Options for protection and implications for the magnet thickness will be discussed.

Conventional react and wind techniques present difficult obstacles for magnet construction with high performance low Tc superconductors because of the complex nature of the magnets. NbTi has good mechanical properties, but it is limited to low fields unless it is operates temperatures lower than 4 K.. Options of using high Tc and intermediate Tc superconductors capable of react and wind will be presented. Wind and react techniques will be very difficult to implement.

Monolithic windings, using high Tc superconductors, will be presented as an aggressive, speculative means of fabricating the magnets. It offers the potential advantage of ease of manufacturing using rapid prototyping techniques and incorporation of a ceramic insulation during the construction process. In such monolithic magnets the superconductor is rigidly supported, minimizing the required space for structural support in the region where the conductor lies and thus increasing the local current density.

Magnet design options that decrease the coil centroid to plasma distance will be explored. The impact of conductor, structure and overall arrangement choices on this distance will be discussed.