Windings Volume of Magnet with ΔB/B of 1-4% over 75-100 cm

Bob Weggel Magnet Optimization Research Engineering (M.O.R.E.), LLC Nov. 3, 2013

The graph below suggests that one should incur only a modest penalty in cost to lengthen the region of field homogeneity beyond L =75 cm. For example, consider the turquoise curve, for which the field homogeneity is 2% (i.e., the field at each end of the region, ±L/2, is 98% that at its center). The conductor volume of 35.3 m^3 for L = 100 cm is only 9.1% greater than the 32.3 m^3 for L = 75 cm.

For simplicity, this study models the Target Magnet by a single coil symmetric about the target region, optimizing its length and outer diameter to minimize the conductor volume. The current density is 18 A/mm^2, as for Superconducting Coil #1 in Design "Target15to1.5T5m1+5.xlsx" of 6/18/2013. If ΔB/B ≥ 3.2% (or [ΔB/B = 2.5%, L ≤ 90 cm]; or [ΔB/B = 2.0%, L ≤ 80 cm]) the minimum-volume magnet is a simple solenoid whose length increases with increasing L and decreasing ΔB/B.

The remaining designs achieve the desired field homogeneity more efficiently by means of a midplane notch (region of zero current density) of optimized length and outer diameter.