Coil Configurations for the Target/Front End of a Muon Collider or Neutrino Factory

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Topics to be Covered

• 1) Illustrative Target-Magnet geometries

• 2) B(z): 15-20 T, ramping to 1.5-2.5 T in 5-15 m

• 3) Coil cross sections; off-axis fields; stresses

• 4) Operating temperature vs. deposited power
Magnets with $B(z)$ ramping from $B_0$ to $B_{\text{min}}$ as $B_0/[1+\beta\zeta^2(3-2\zeta)]$, where $\beta=B_0/B_{\text{min}}-1$, $\zeta=(z+\Delta)/(L+\Delta)$, $L=15m$, $\Delta=37.5cm$. 
Field profiles of resistive, superconducting & total magnet.
IDS120 15-1.5T7m3+4 Crvo1-2 Iso Cut
IDS120_15-1.5T7m3+4 Cryo1-2 With Uncut Target Module
Field profiles $B(z)$ that ramp from 15 T to 1.5 T at 700 cm.
$B(z)$ ramps to 1.5 T at 7 m, 2.0 T at 6 m, or 2.5 T at 5.3 m.
Field direction & magnitude of magnets with field ramp from 20 T to (left to right) 1.5 T at 7 m, 2.0 T at 6 m or 2.5 T at 5 m.
On-Axis Field Profile of Target Magnet IDS120L 20 to 1.5 T 7 m

\[ B(z) \text{ of IDS120L20to1.5T7m} \]

with 5-T, 9.8-MW resistive magnet; field error \( \Delta B/B \) is 4.9% at 70 cm & 1.2% at 11.9 m.
$B(z)$ of IDS120L 20to1.5T6m: with 9.2-MW resistive magnet. 
$\Delta B/B$ is 4.3% at 60 cm & 1.1% at 12.2 m.
$B(z)$ of IDS120L20to1.5T5m, with 8.5-MW resistive magnet. 
$\Delta B/B$ is 5.0% at 140 cm & 1.4% at 11.2 m.
B(z) ramps from 15 T to 1.5 T at ~5.6 m; 210-cm gap after SC #1.
B(z) ramps from 15 T to 1.5 T at 6 m; 185-cm gap after SC #1.
Field direction & magnitude (left & center) and hoop strain (right) of magnet with field that ramps from 15 to 1.5 T in 6 m.
B(z) ramps from 15 T to 1.5 T at 5 m; 189-cm gap after SC #1.
Field direction & magnitude (left) and hoop strain (right) of magnet with field that ramps from 15 to 1.5 T in 5 m.
Mass, power consumption, and amortization, running & total cost of hollow-conductor magnets for 1.5-T chicane 50 m long.
M$/yr of Amortization & Refrigeration for 1.5-T Chicane Magnets of NbTi, Nb\textsubscript{3}Sn, MgB\textsubscript{2} or YBCO
Field magnitude & direction of 50-cm section of 1.5-T chicane. $B(0,z)$ varies only 2% peak-to-peak; $B_{\text{max}} = 2.17$ T.
$B(r=43\text{cm, } z)$ magnitude & direction. $B_{\text{max}} = 2.17 \text{ T}; \theta_{\text{max}} = 27^\circ$. 
Left: von Mises stress, 7.6 to 11.0 MPa.
Right: Deformation (amplified 500 fold), 37 to 41 μ.m.
ΔT with uniform $w_v = 500 \text{ kW}/7.5 \text{ m}^3 = 66 \text{ mW/cm}^3$.

Left: Cooled only from outer radius; $\Delta T_{\text{max}} = 0.75 \text{ K}$.

Right: Cooled from inner & outer radii; $\Delta T_{\text{max}} = 0.24 \text{ K}$. 