Target Magnets & Shielding

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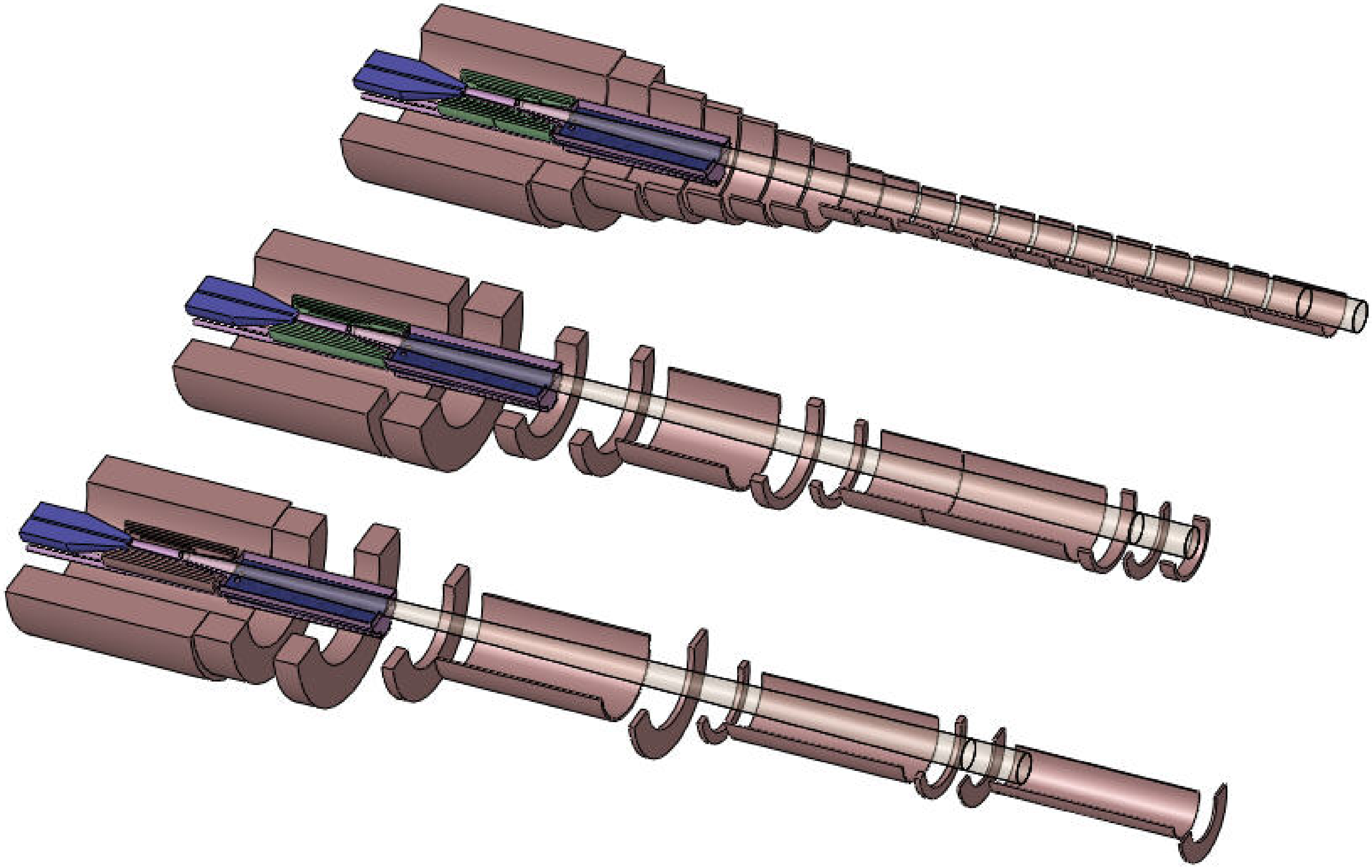
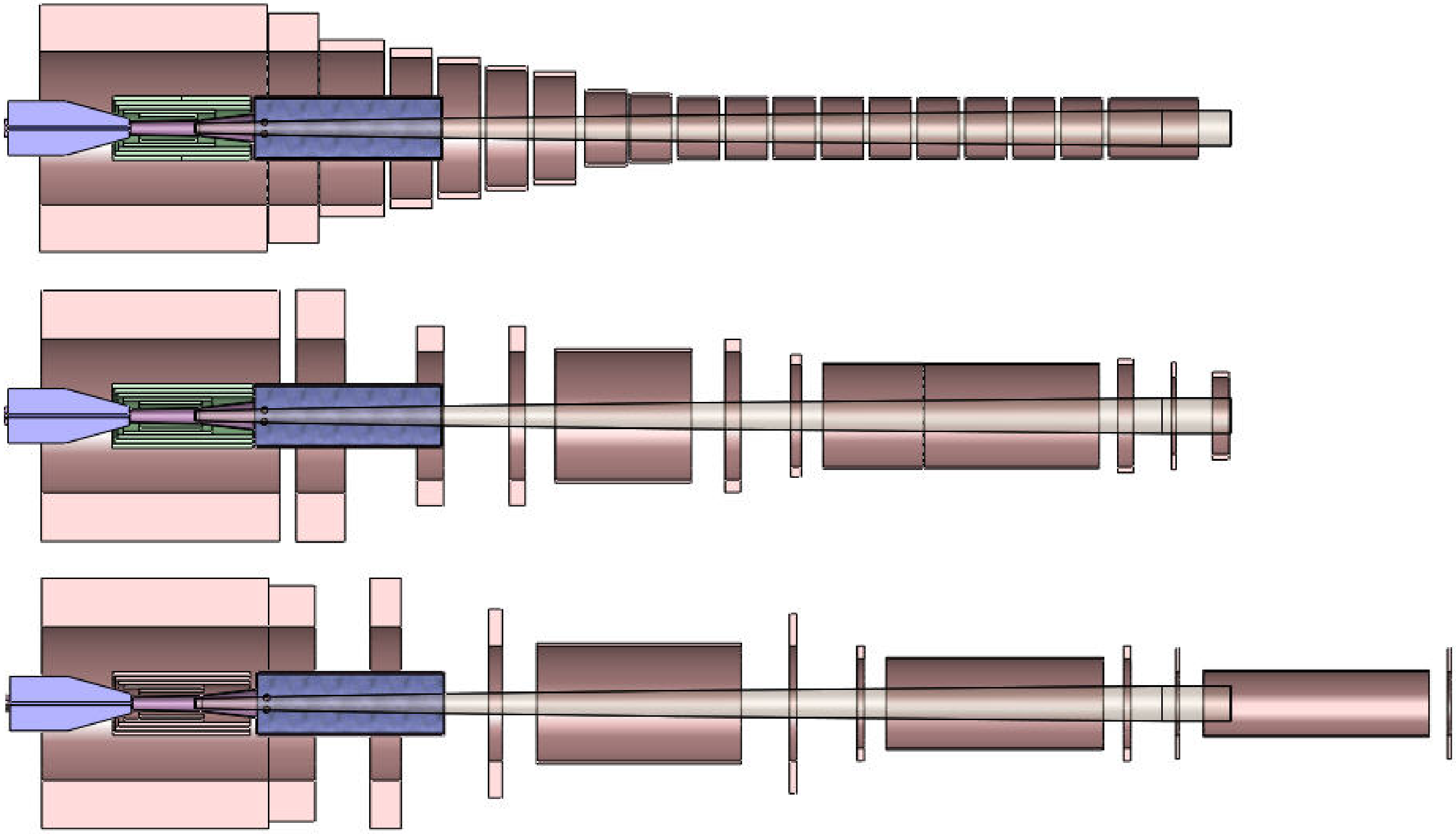
Isometric View of Three Target-Magnet Designs



Design IDS120h (top), IDS120i (middle) & IDS120j (bottom) [courtesy Van Graves]

Cross Sections of Target-Magnet Designs [courtesy Van Graves]

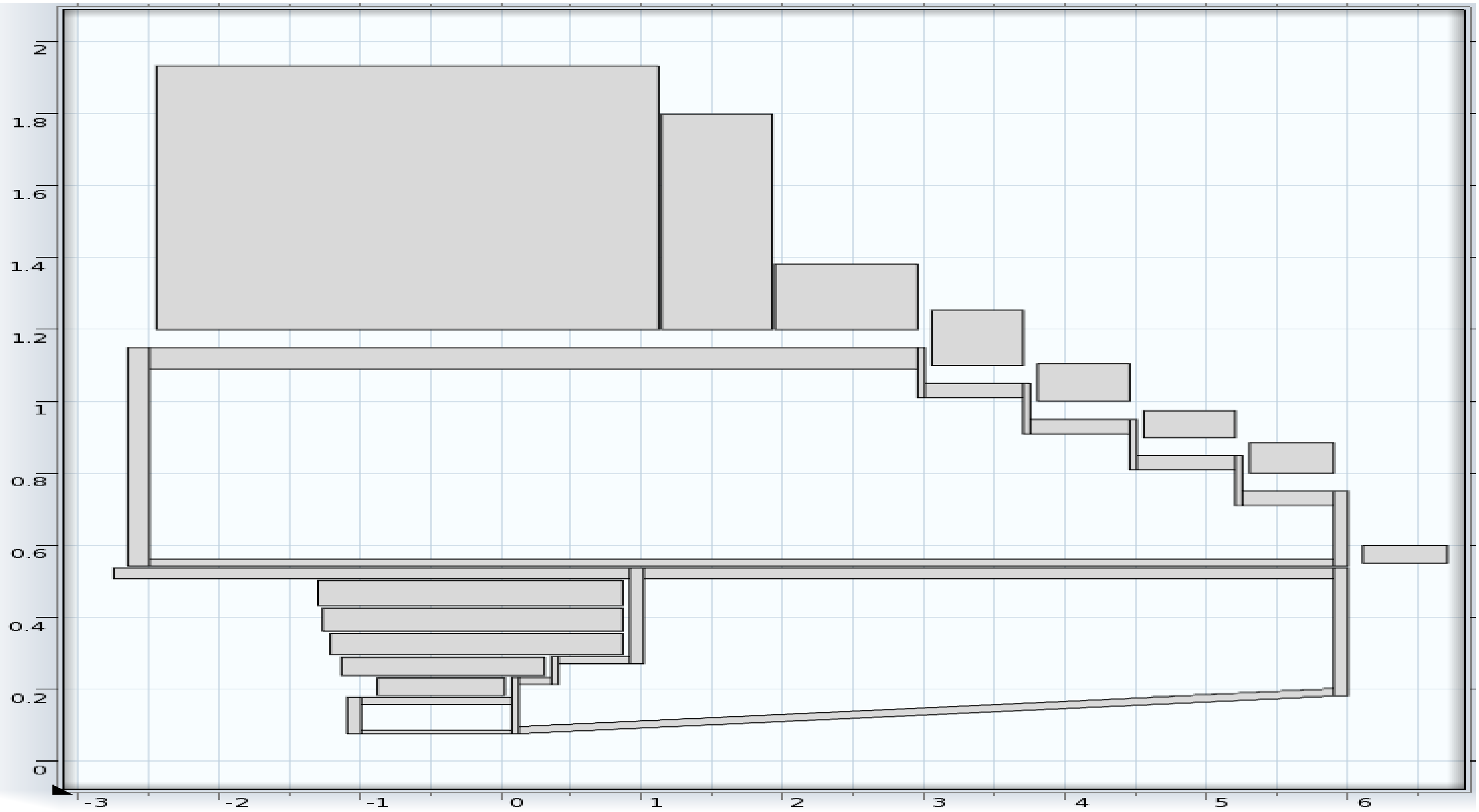


IDS120h: I.R.'s step down gradually from 120 cm to 45 cm; minimal gaps between coils

IDS120i: Large gaps between cryostats; I.R.'s = [120, 100, 80, 60] cm; gaps at [3, 9, 15] m

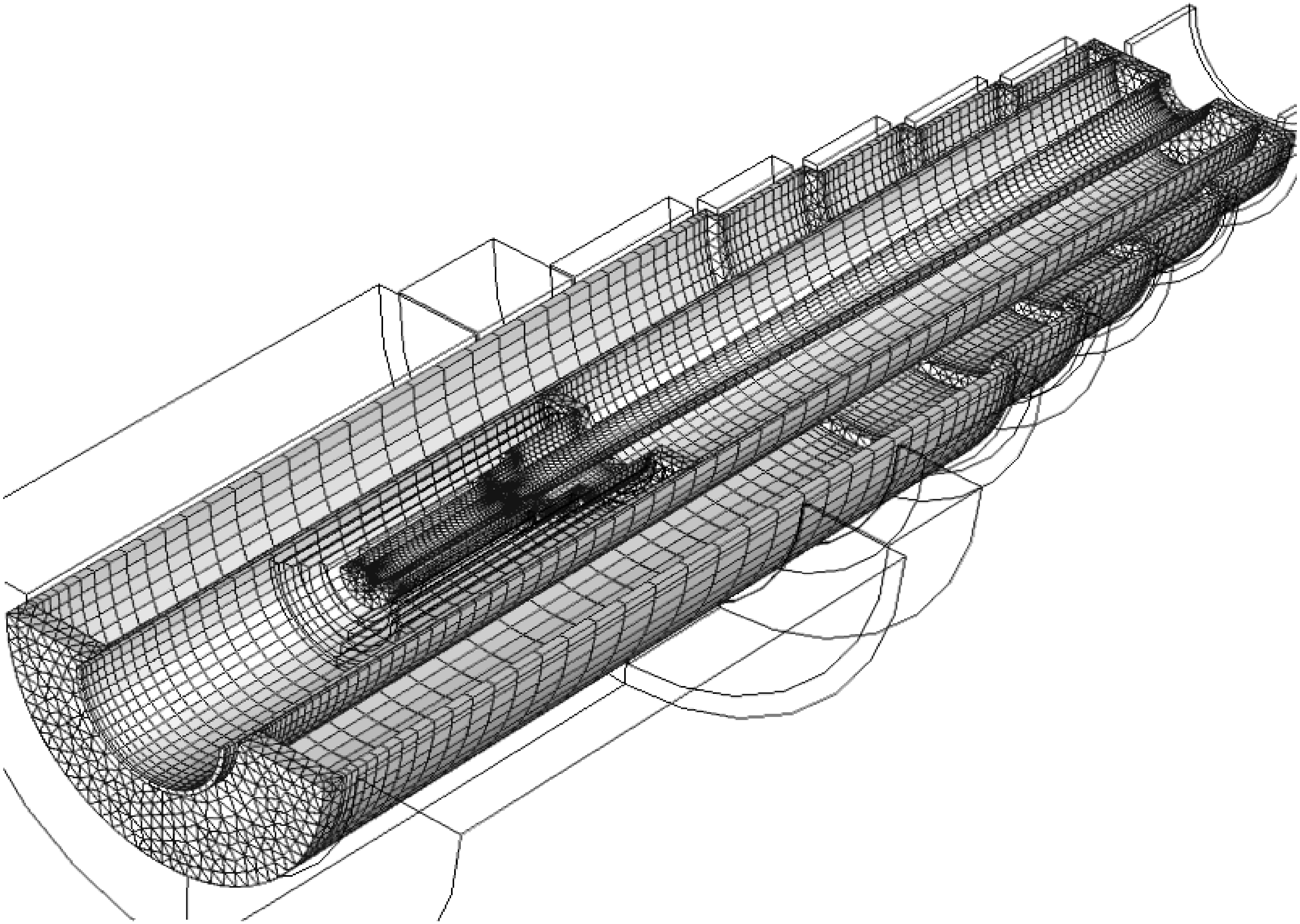
IDS120j: 3 coils per cryostat; I.R.'s = [120, 90, 70, 50] cm; gaps at [4,10,15] m; z_{max} = 20 m

Cross section of Coils & Shielding Vessels of IDS120h

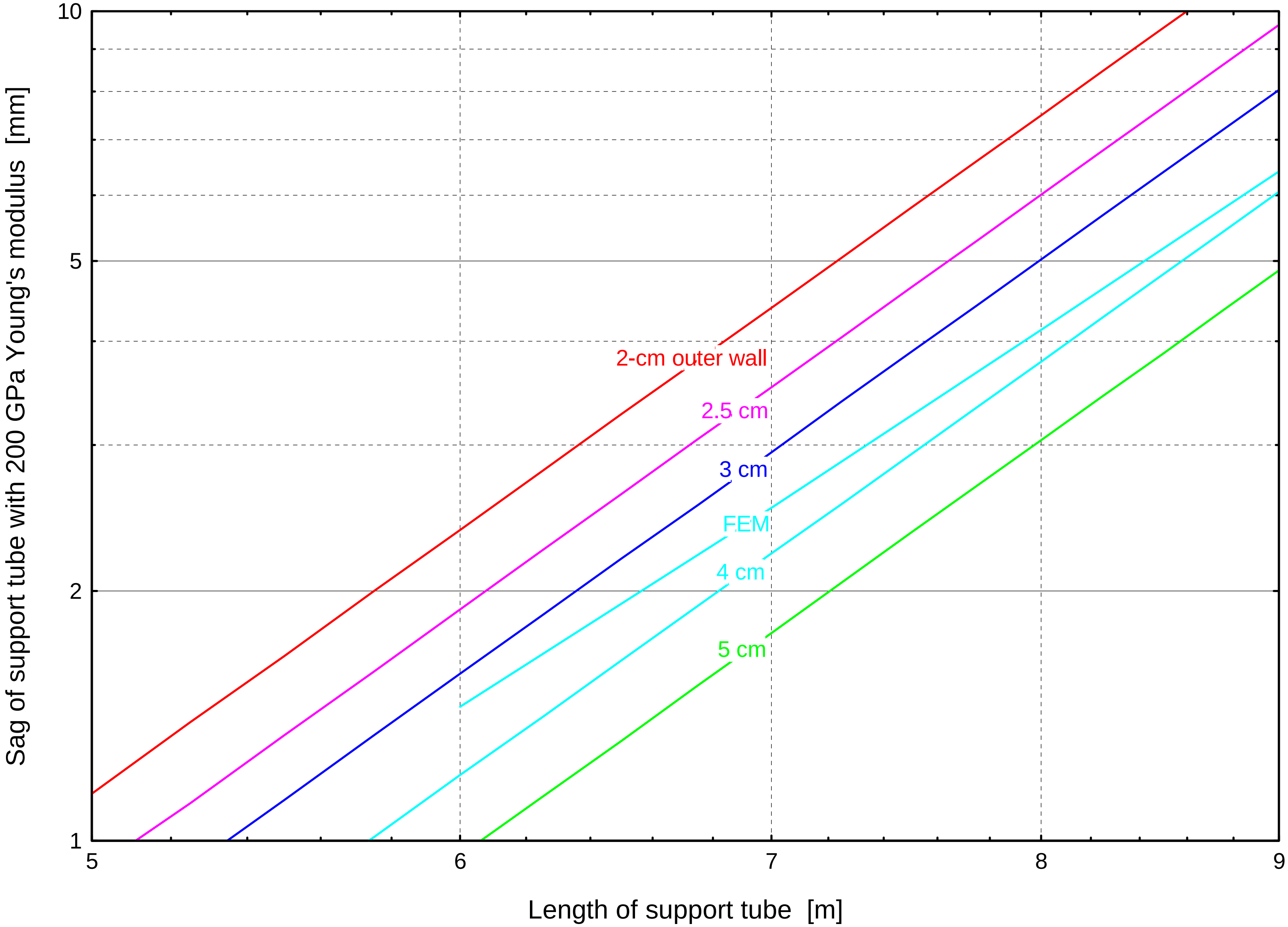


Tubes & flanges: = 7.85 g/cm^3; shielding = 10 g/cm^3; Outer ≈ 30 tons/m; Inner ≈ 8 tons/m.

Isometric View of Meshed Shielding Vessels of IDS120h



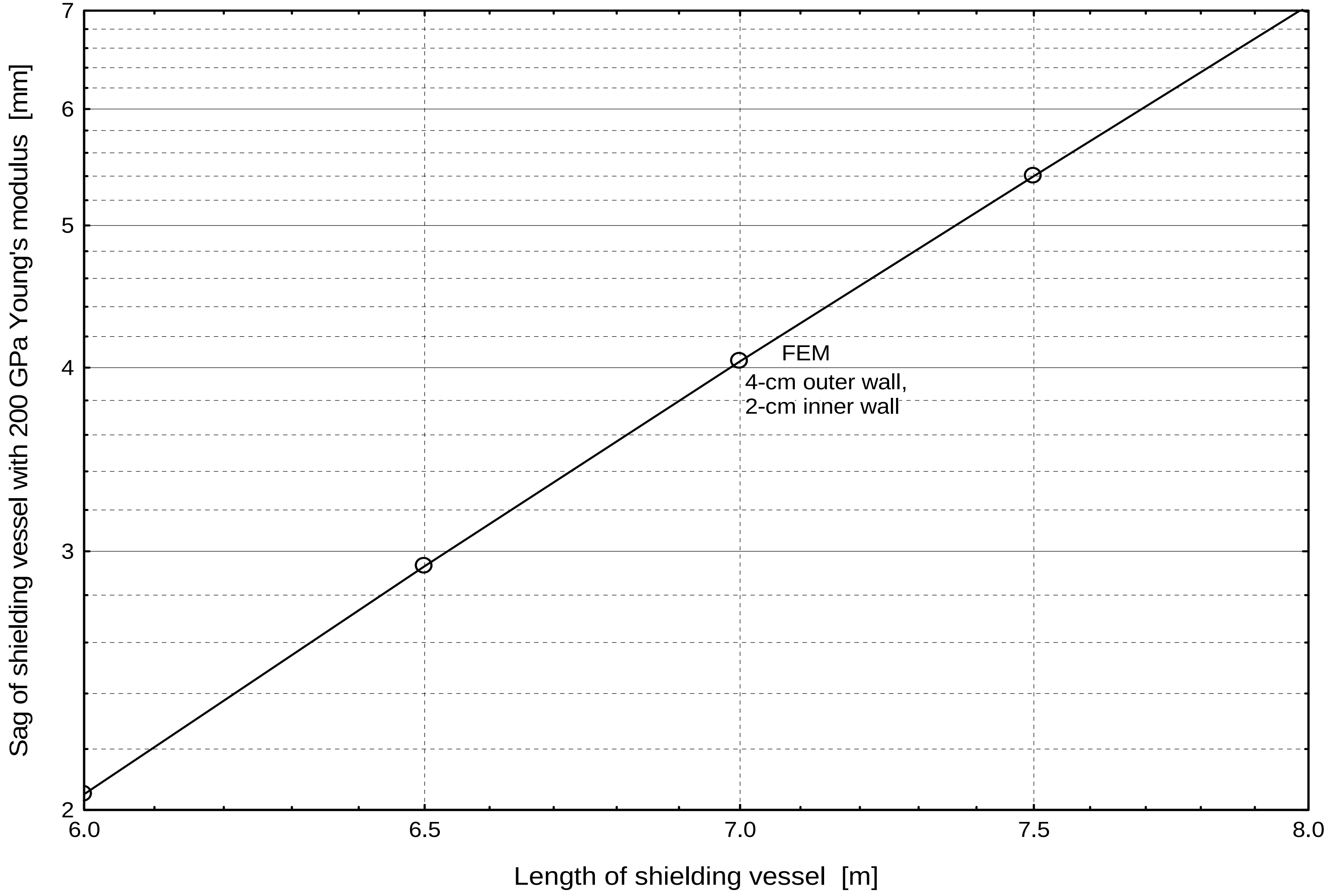
Sag of Shielding Vessel vs. Length *L* & Wall Thickness *t*



O.R.$_{max}$ = 114 cm; I.R.$_{min}$ = 60 cm; γ = 7.85 g/cm^3; $\gamma_{shielding}$ = 10 g/cm^3; $t_{in} = ½t_{out}$; ~30 tons/m.

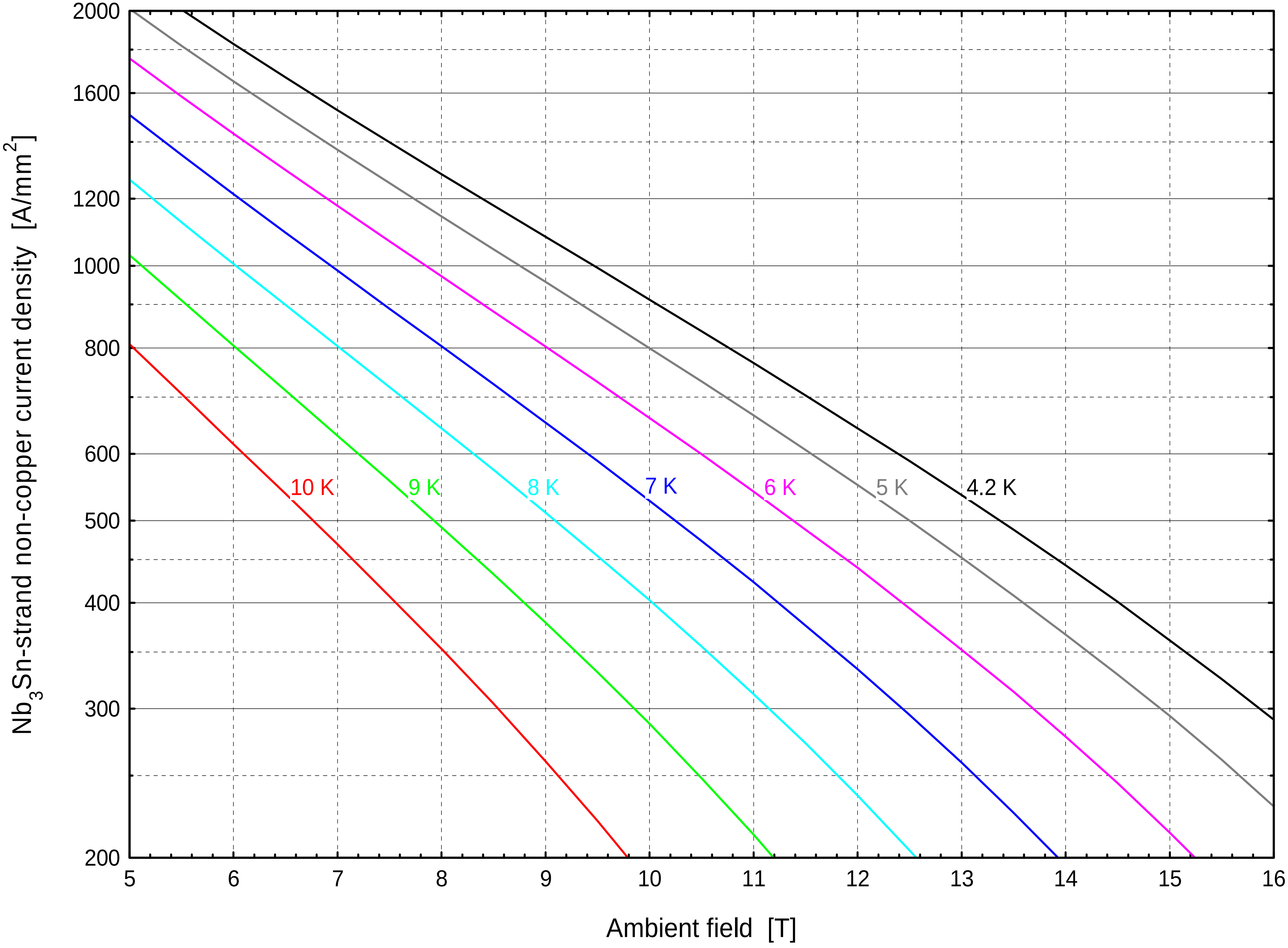
With t_{out} = 4 cm, t_{in} = 2 cm & *L* = [6, 7, 8, 9] m, sag$_{FEM}$ = [1.5, 2.5, 4.1, 6.4] mm→ Limit *L* to 8 m.

Sag of Shielding Vessel vs. Length *L* & Wall Thickness *t*

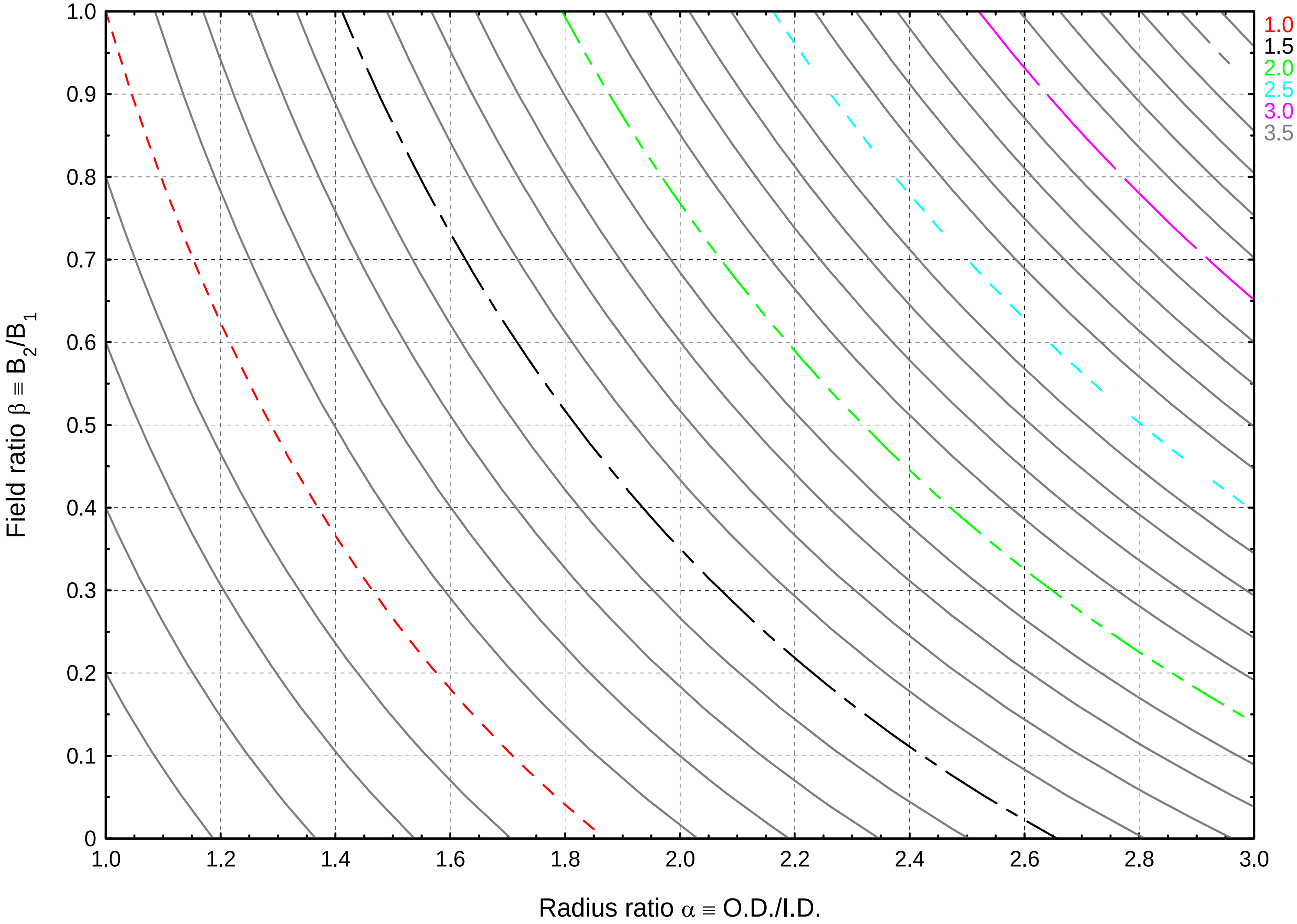


O.R.$_{max}$= 58 cm; I.R. $_{min}$ = 16 cm; t_{out} = 4 cm; t_{in} = 2 cm; γ = 7.85 g/cm^3; $\gamma_{shielding}$ = 10 g/cm^3; ~8 tons/m. When *L* = [6, 6½, 7, 7½, 8] m, sag = [2.0, 2.9, 4.0, 5.4, 8.0] mm → Limit *L* to 7 m.

Field and Temperature Dependence of Current Density of Nb_3Sn Strands

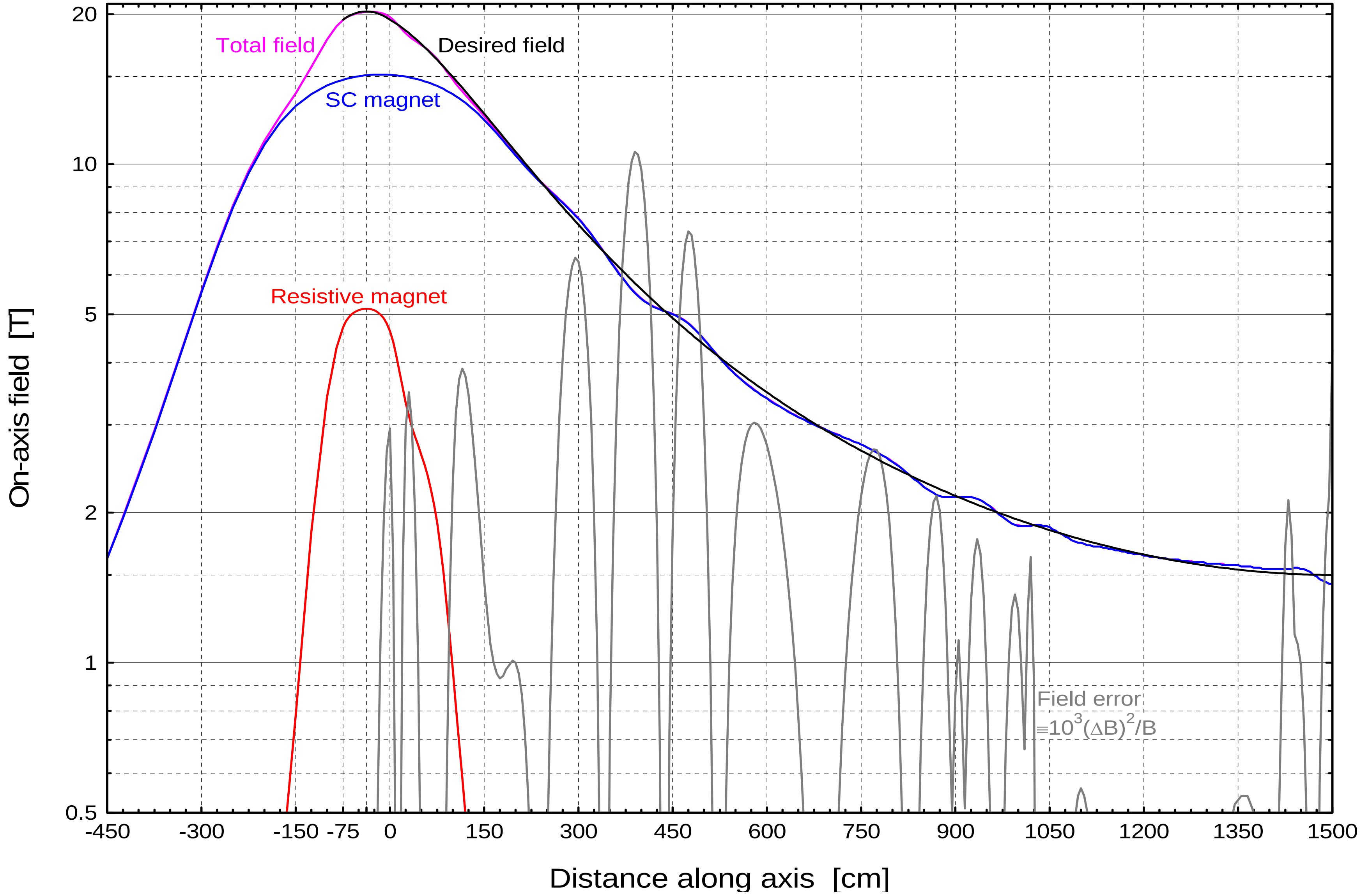


Normalized Maximum Hoop Stress $\sigma^* \equiv \sigma_{max} / (B_1 j_1 a_1)$



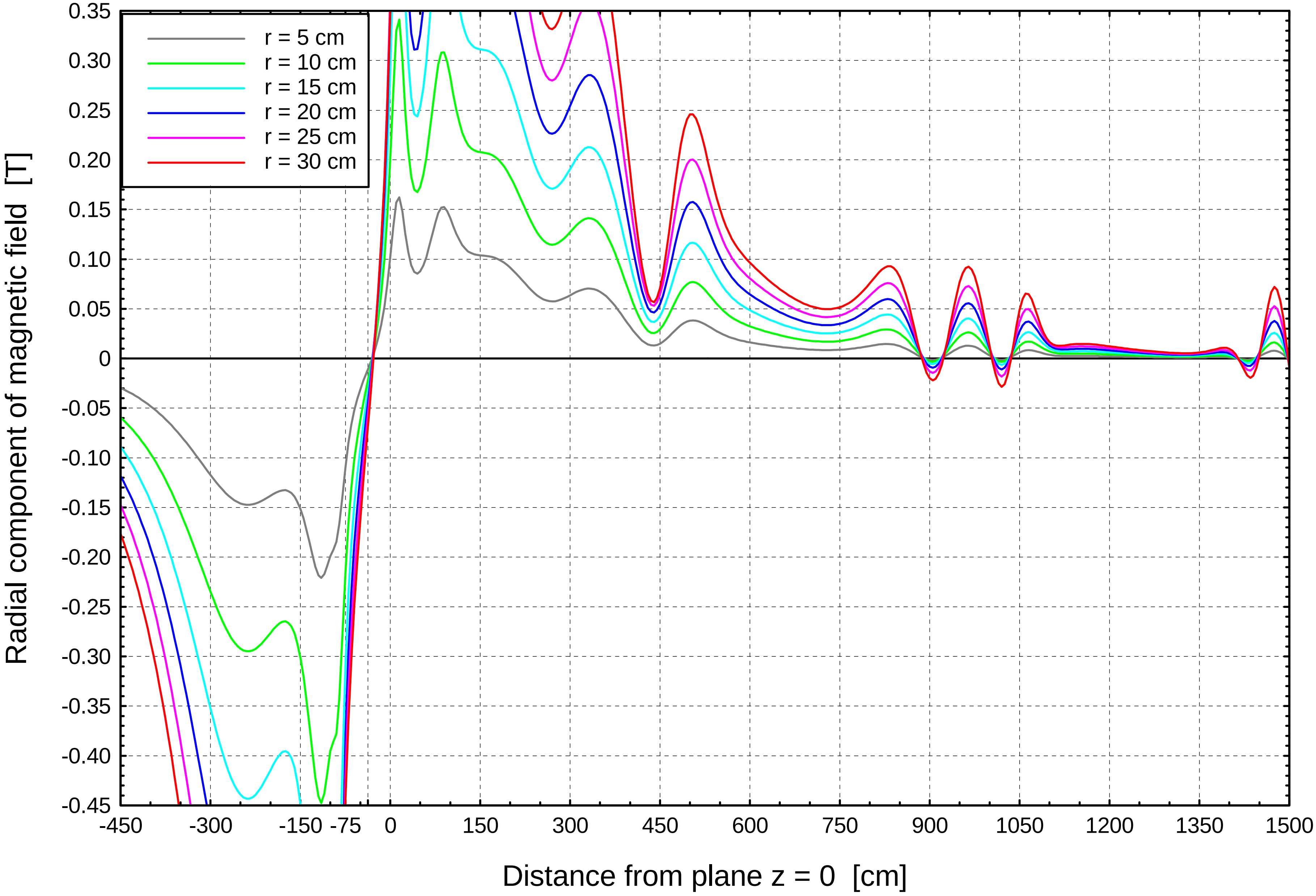
a_1 ≡ I.R. of coil; a_2 ≡ O.R. of coil; $B_1 \equiv B(r=a_1)$, $B_2 \equiv B(r=a_2)$; j_1 ≡ current density

On-Axis Field Profile B(z)of Target Magnet IDS120j

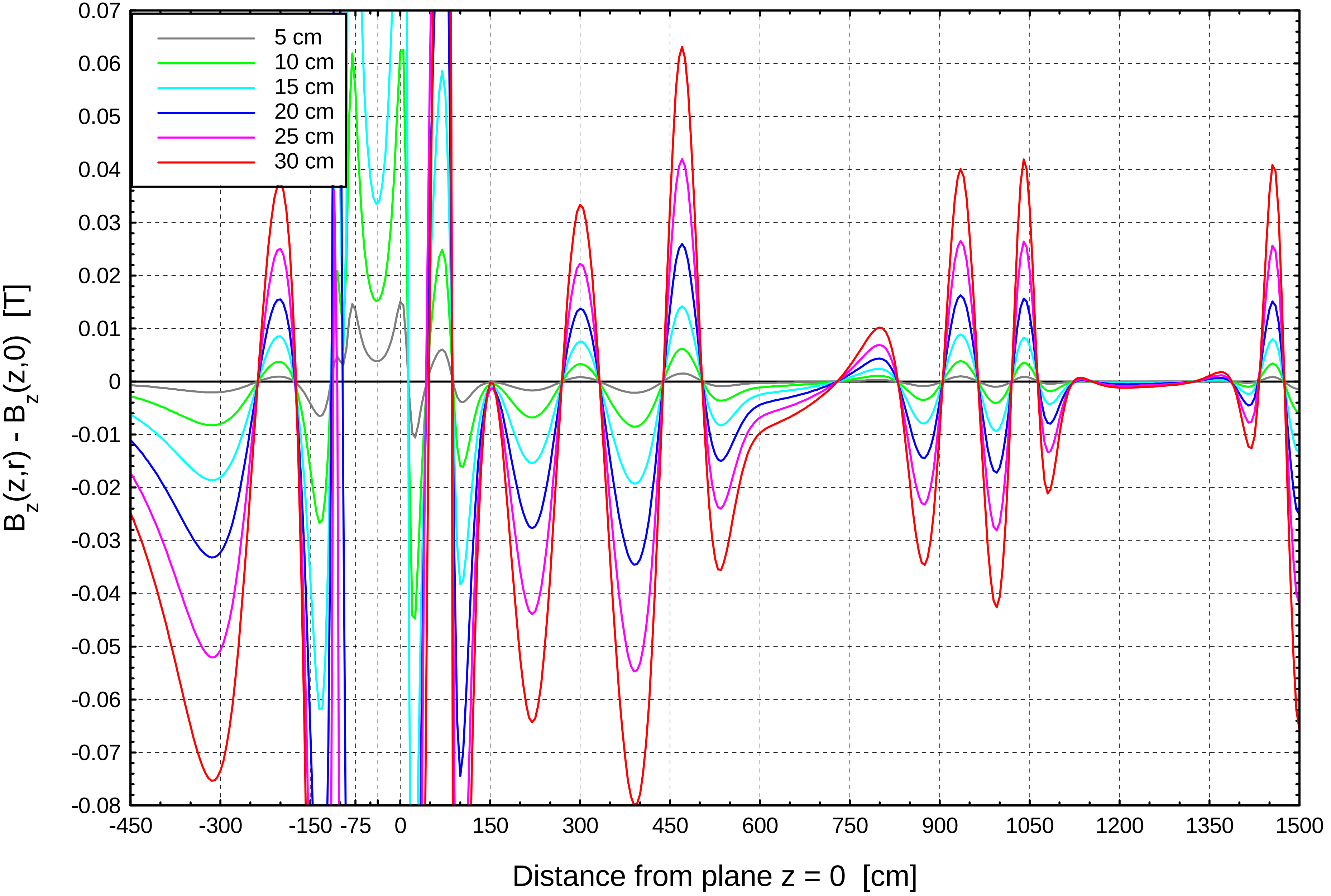


<B(z)> = 20 T over the 75-cm length centered at z = −37.5 cm. B(z=15 m) ≈ 1.5 T.

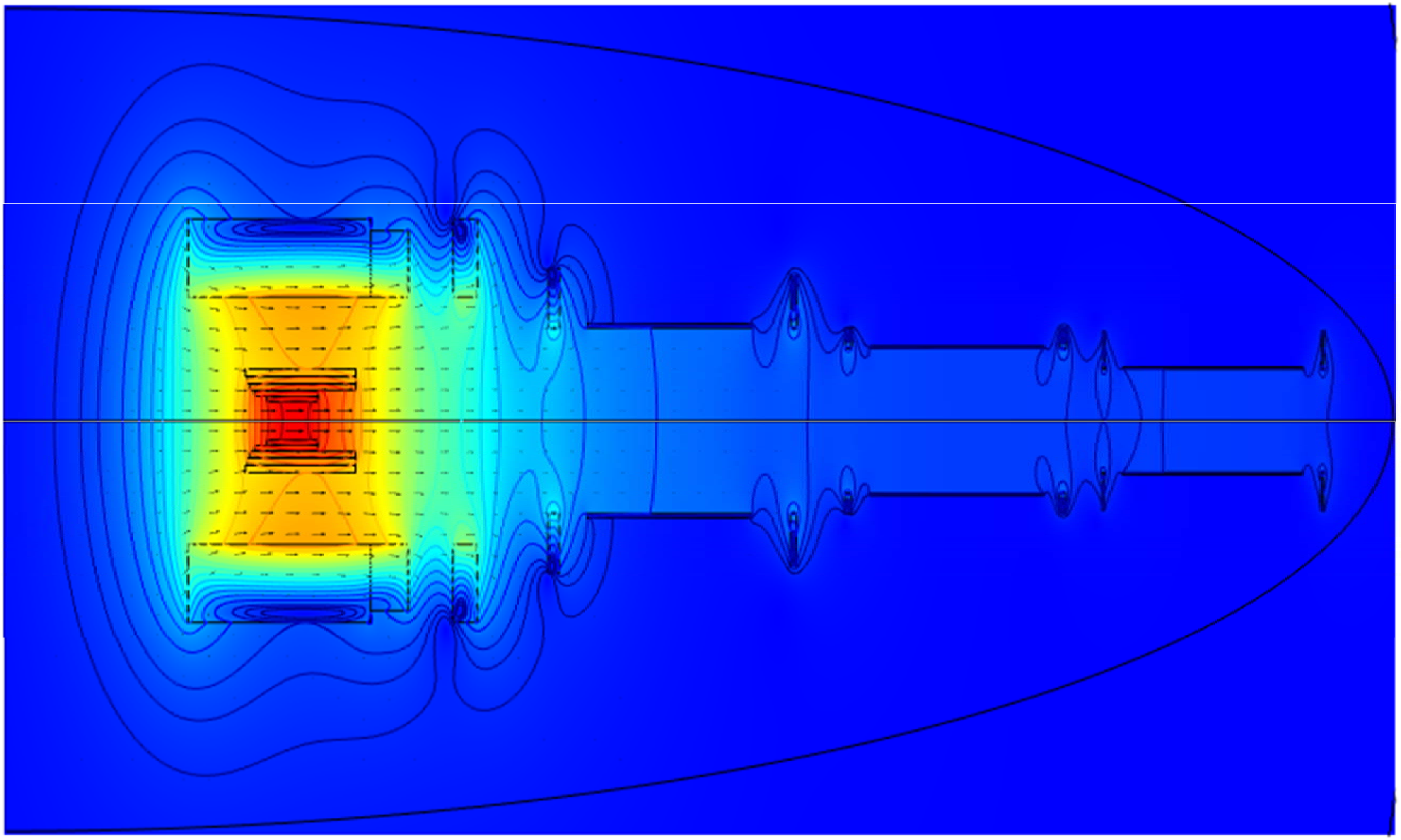
Radial Component of Off-Axis Field of Target Magnet IDS120j



$B_z(z,r) - B_z(z,0)$ of Off-Axis Field of Target Magnet IDS120j

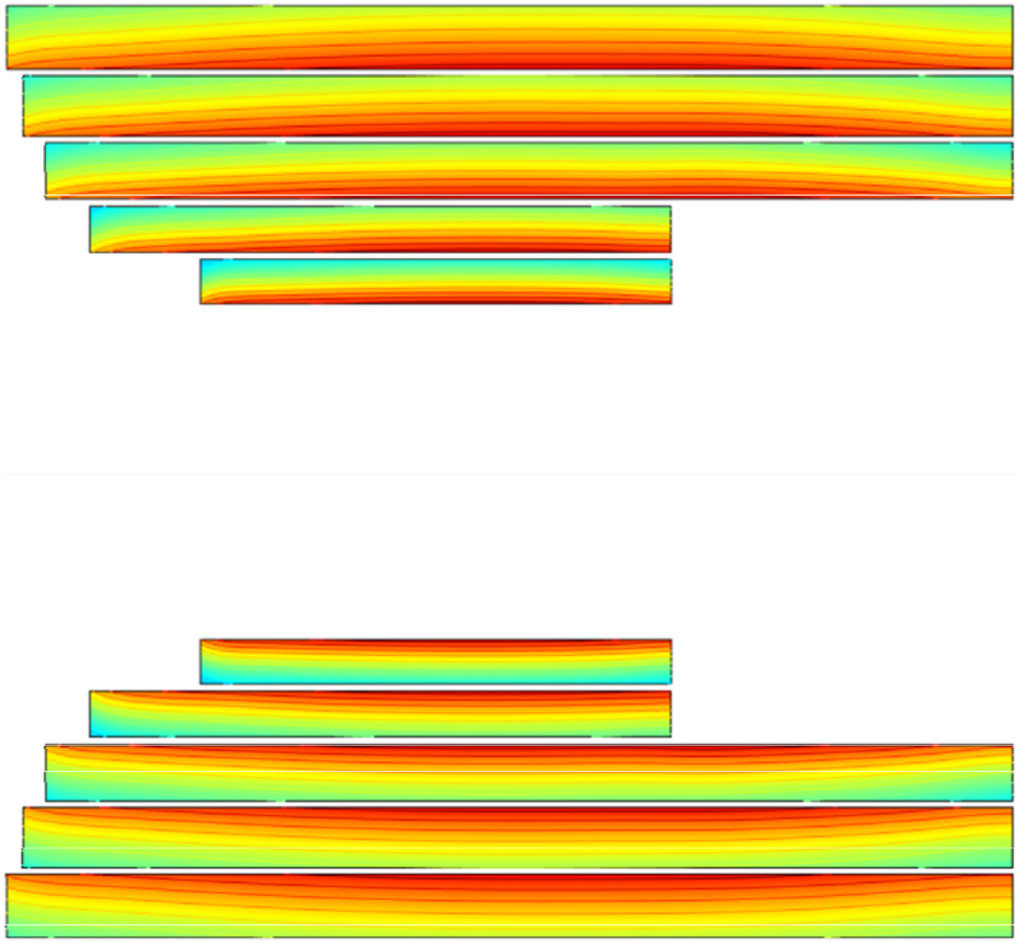


Field Magnitude $|B| \equiv (B_r^2+B_z^2)^{1/2}$ of Target Magnet IDS120j



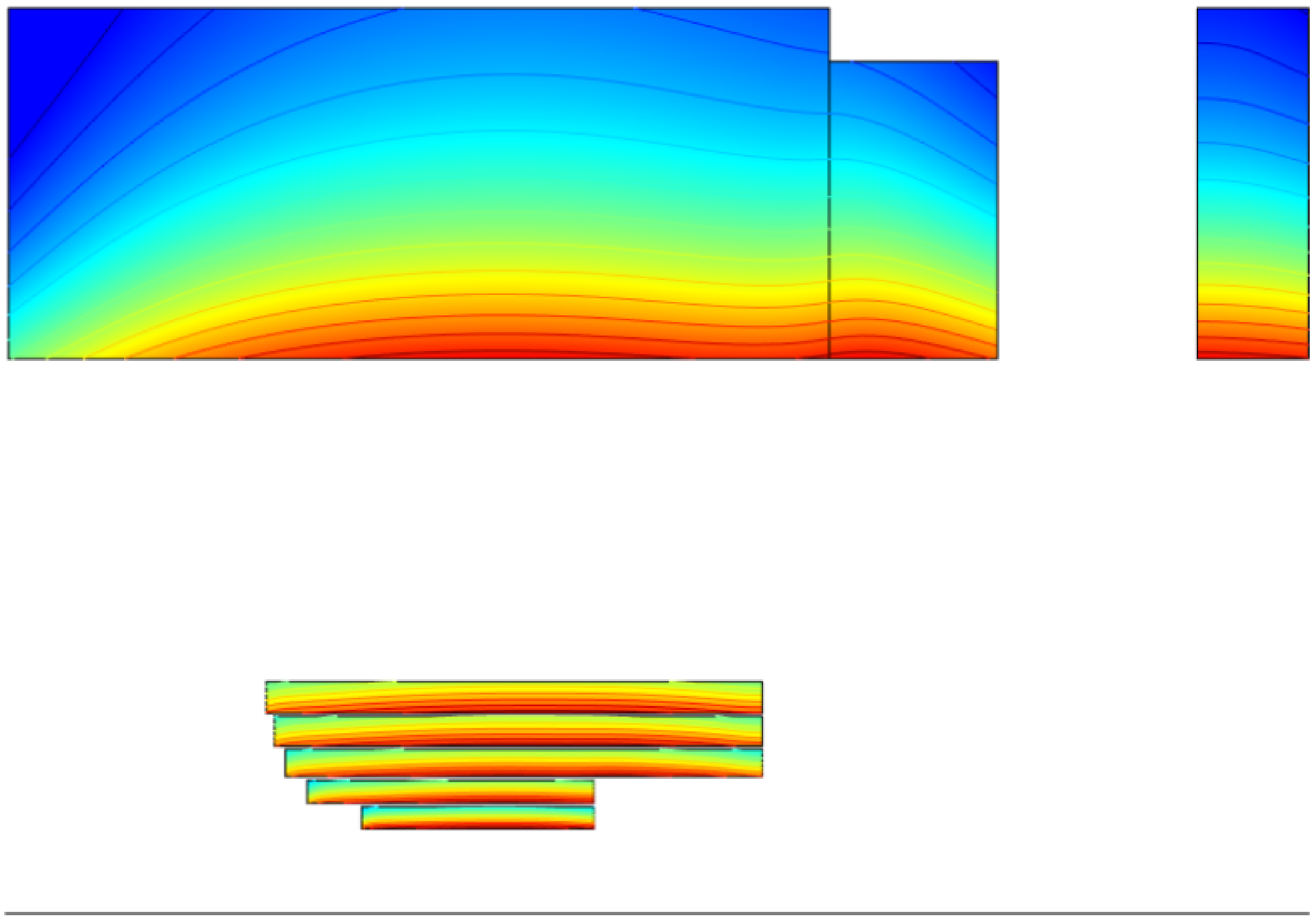
Maximum field = 20.4 T; contours at 1.5 T and integer values from 1 T through 20 T

Hoop Strain σ_{hoop} in Magnet of Copper Hollow Conductor



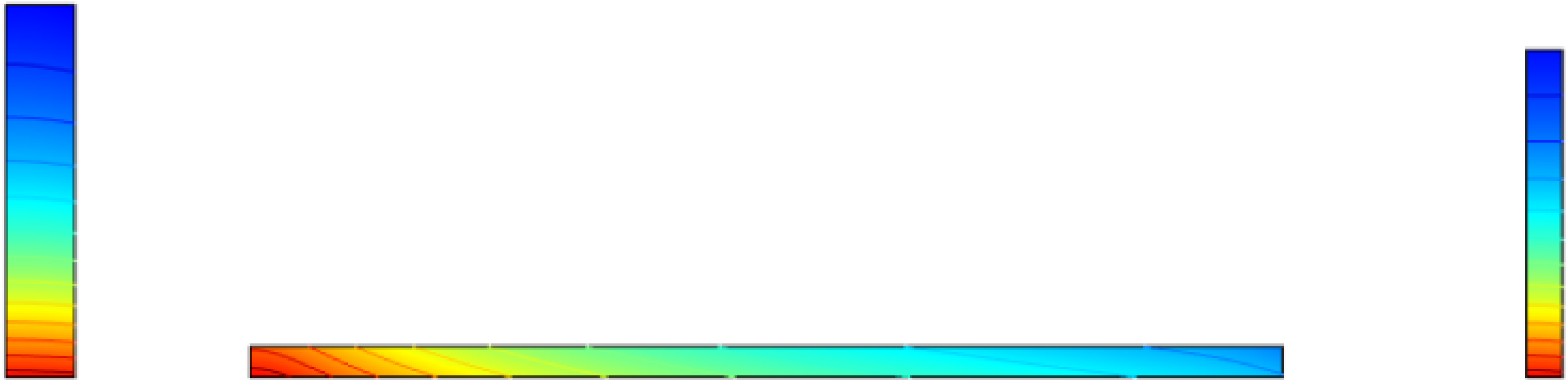
700-MPa coil banding limits σ_{hoop} in each coil to 0.35%; contour interval = 0.02%.

σ_{hoop} in Copper & Nb_3Sn Magnets (Most-Upstream Cryostat)



Maximum hoop strain in each coil is 0.35%; contour interval = 0.02%.

σ_{hoop} in Coils of Cryostat #2 (NbTi Conductor)



Maximum hoop strain in each coil is 0.35%; contour interval = 0.02%.

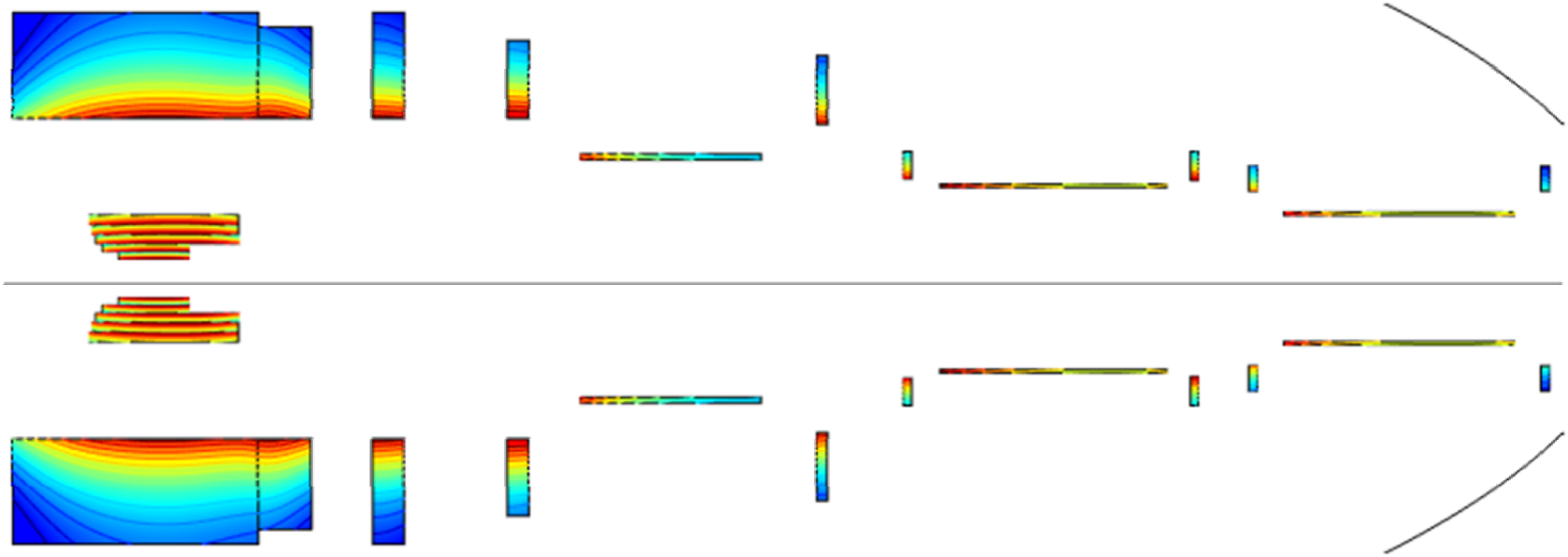
σ_{hoop} in in Coils of Cryostat #3 (NbTi Conductor)

Maximum hoop strain in each coil is 0.35%.

σ_{hoop} in Coils of Cryostat #4 (NbTi Conductor)

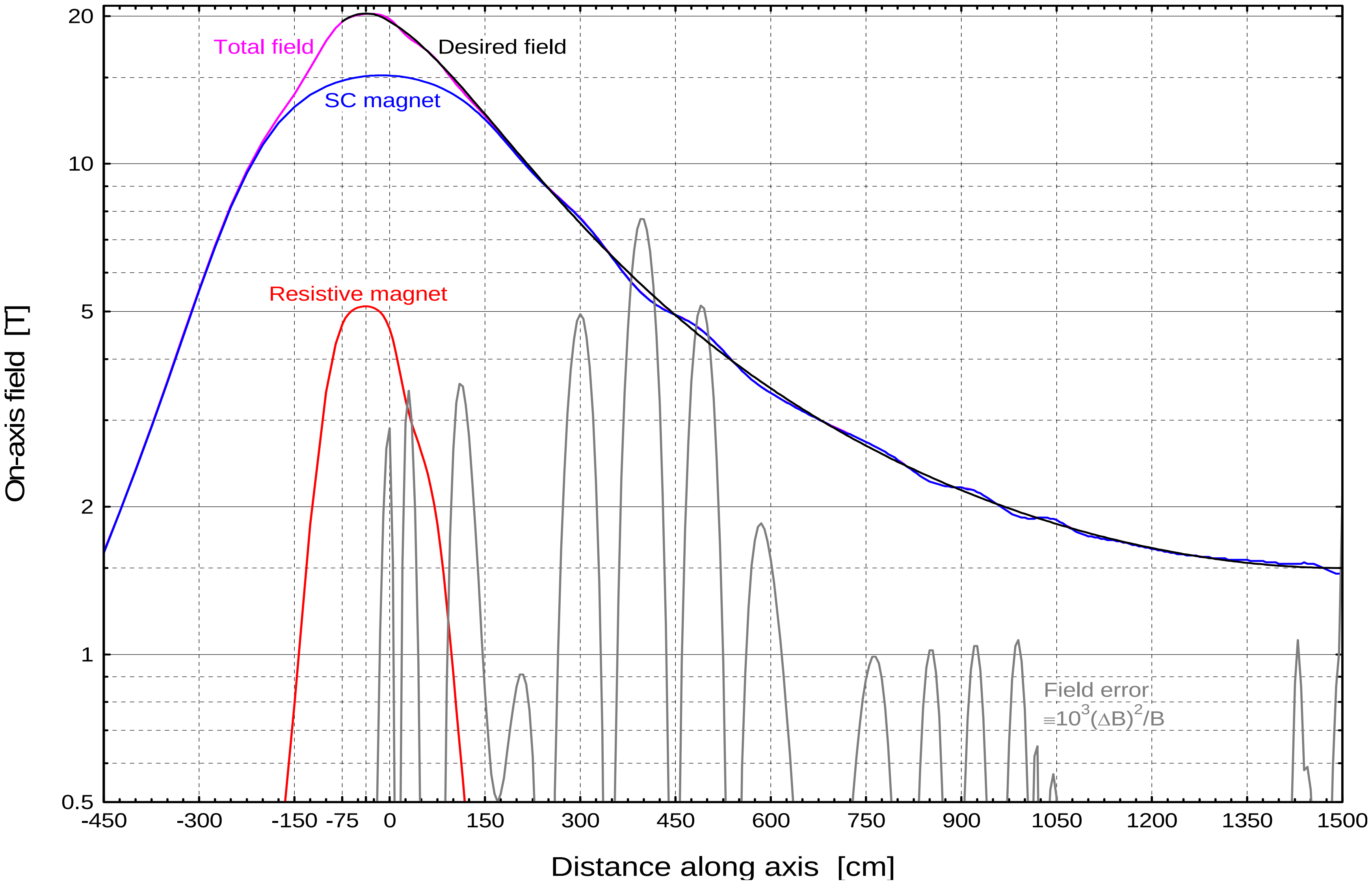
Maximum hoop strain in two upstream coils = 0.35%; max.(σ_{hoop}) in downstream coil also is 0.35% if one adds an identical set of coils downstream.

Target Magnet “DS120j5”: Optimized I.R. of Flanking Coils



I.R.’s of coils in cryostats #2-#4 are [120, 90, 116] cm, [76, 70, 75] cm & [67, 50, 67] cm.

On-Axis Field Profile B(z)of Target Magnet IDS120j5



Maximum field error is nearly 30% less than in design IDS120j.