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

Bob Weggel
Particle Beam Lasers, Inc.
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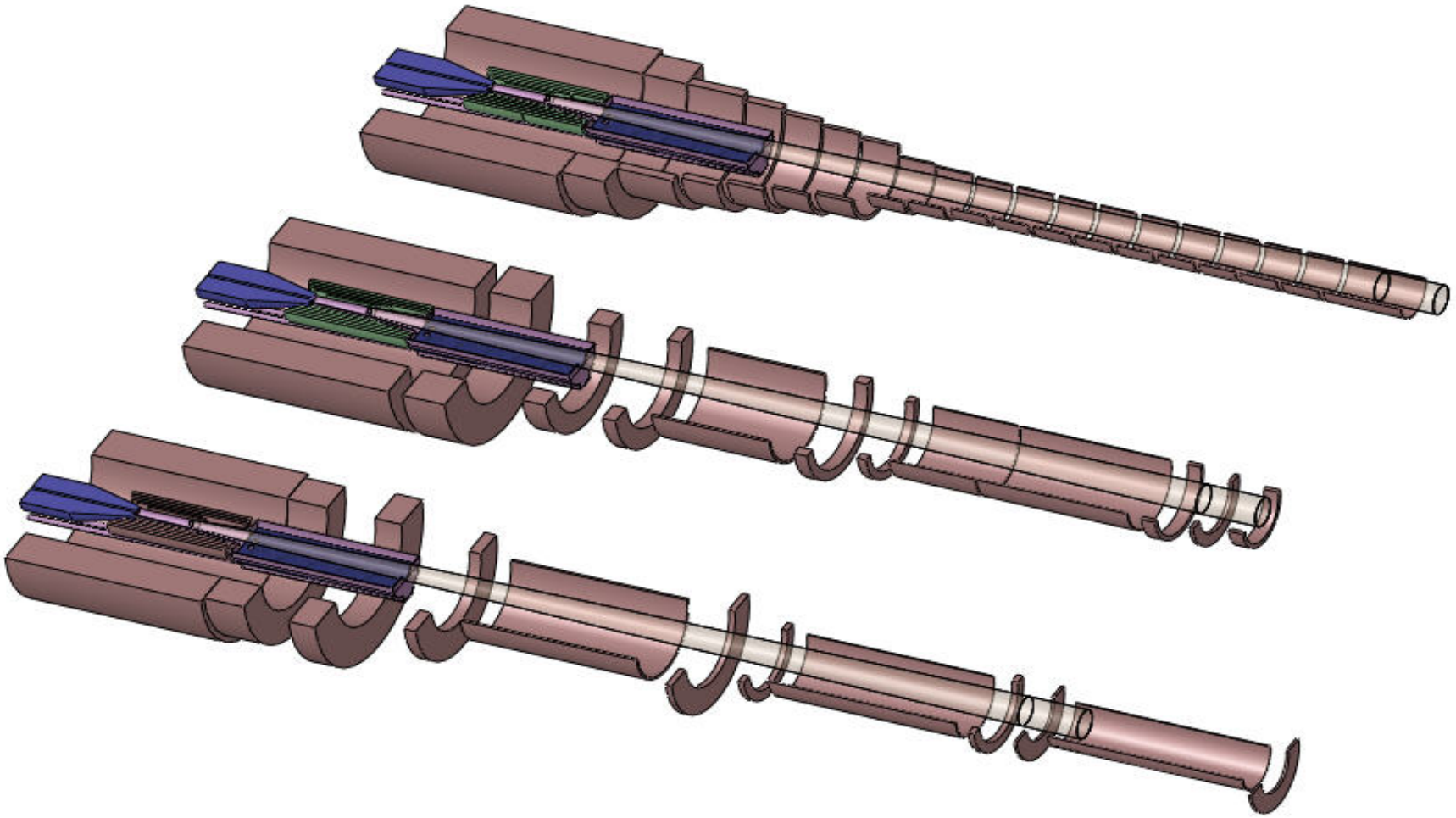
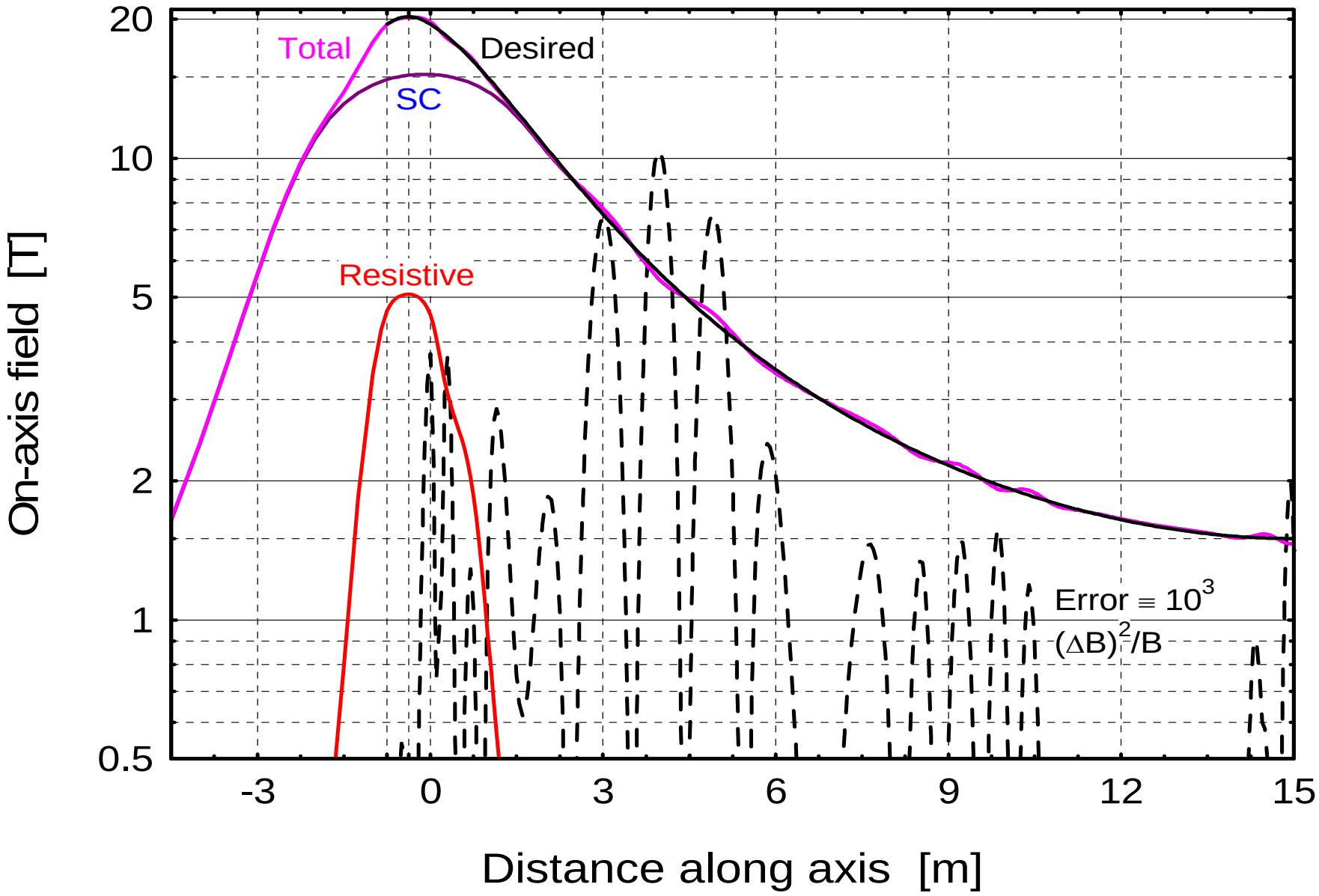
Topics to be Covered

- 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

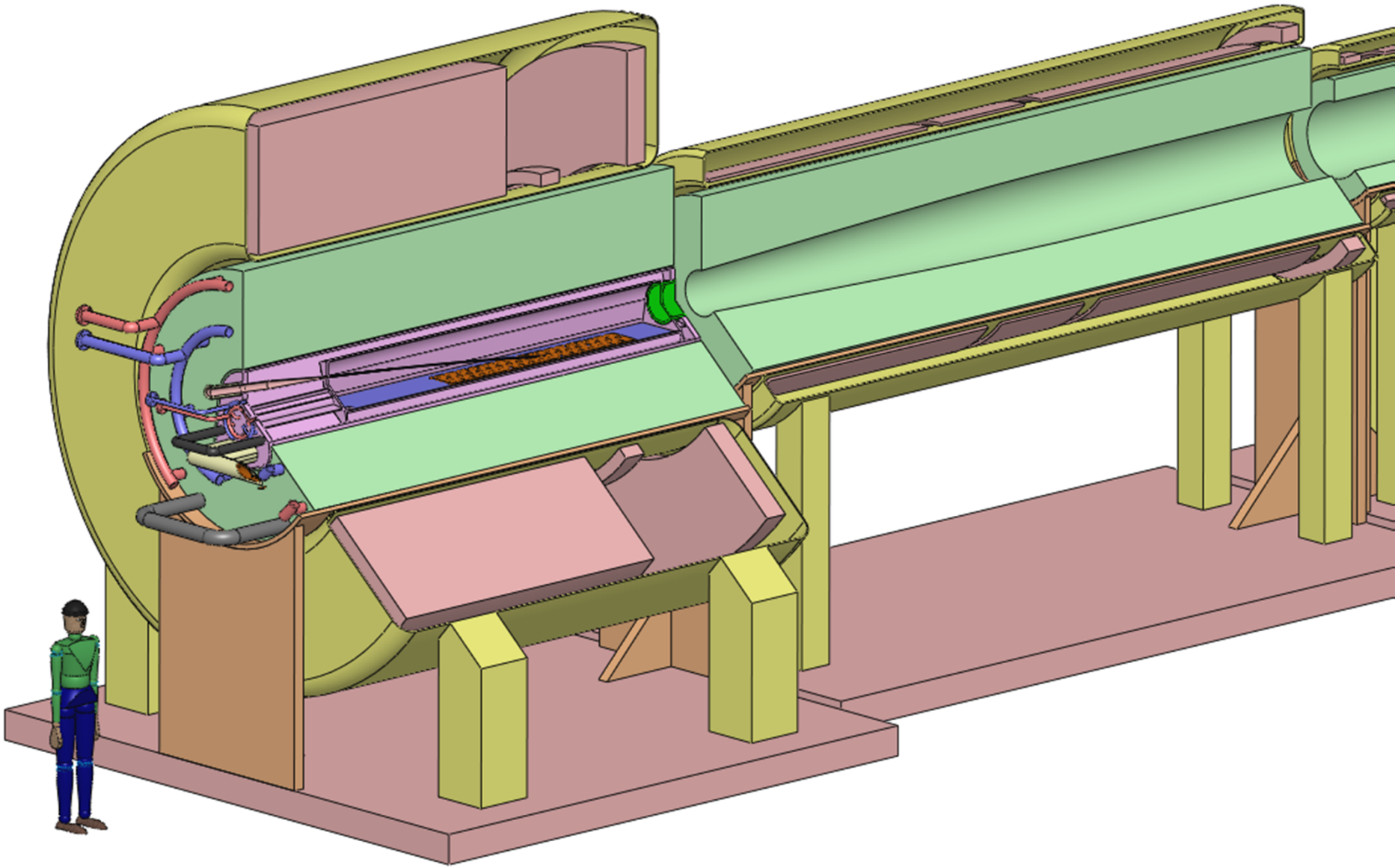


Magnets with B(z) ramping from B_0 to B_{min} as $B_0/[1+\beta\zeta^2(3-2\zeta)]$, where $\beta=B_0/B_{min}-1$, $\zeta=(z+\Delta)/(L+\Delta)$, L=15m, Δ=37.5cm.

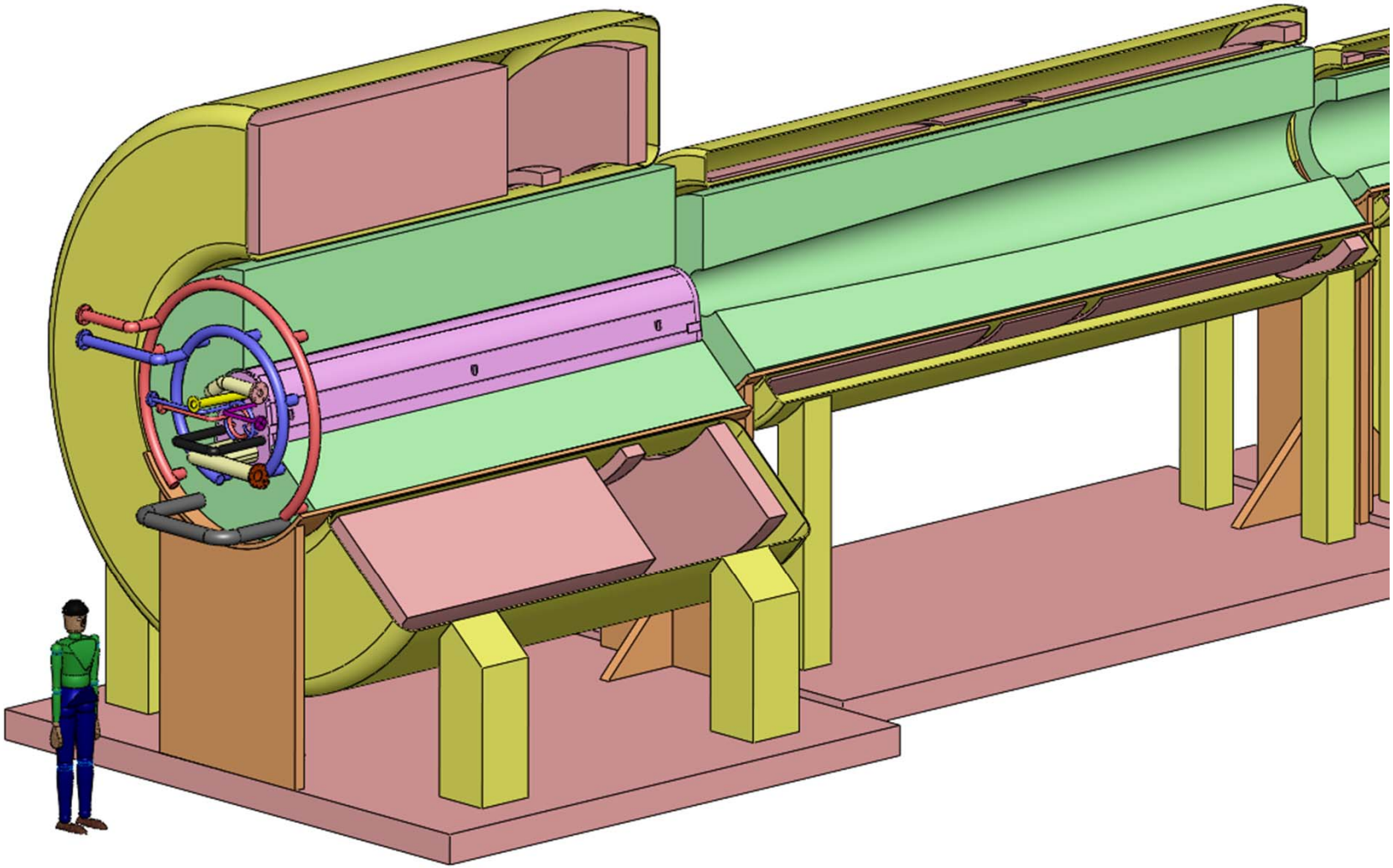


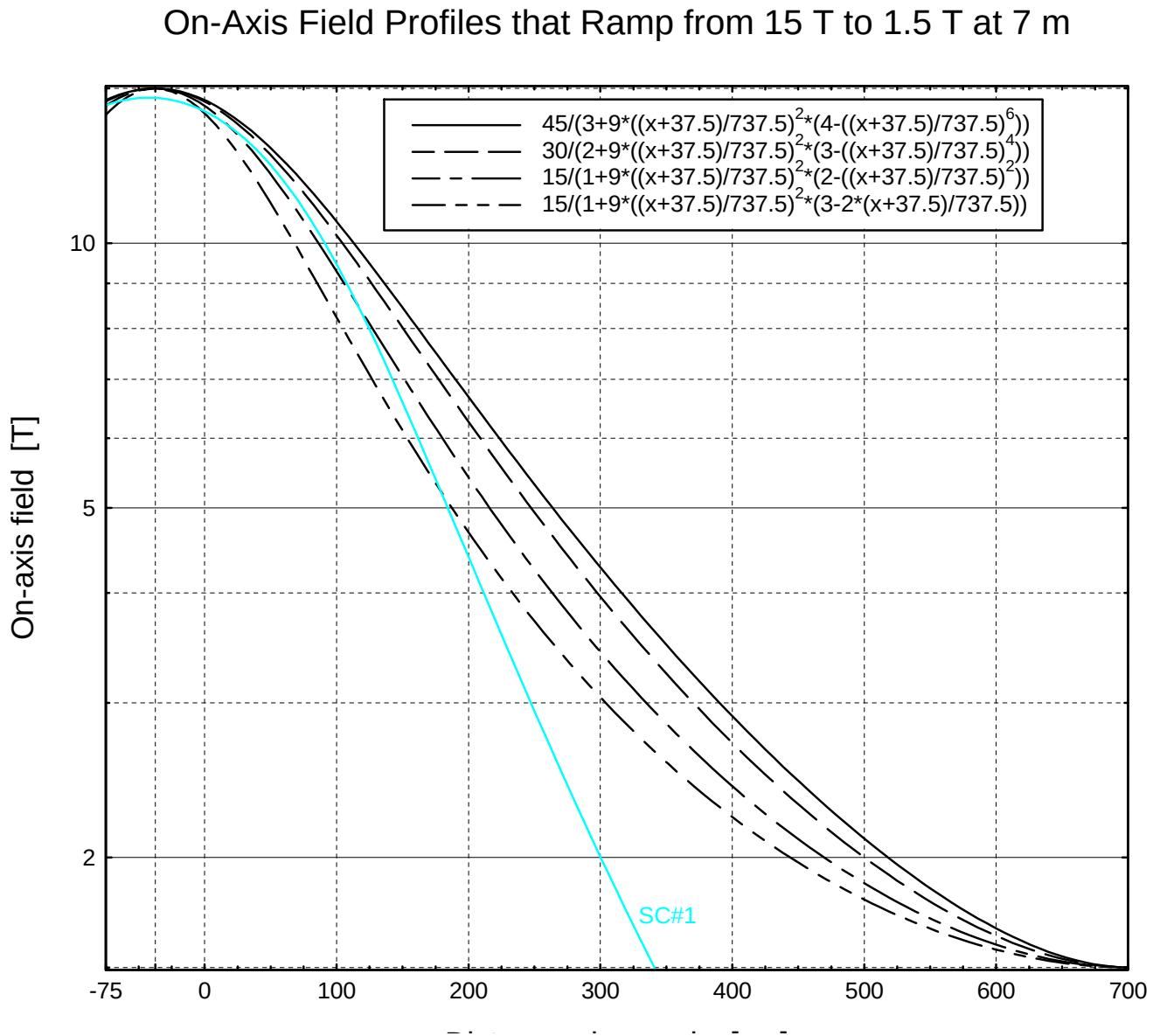
Field profiles of resistive, superconducting & total magnet.

IDS120_15-1.5T7m3+4 Cryo1-2 Iso Cut

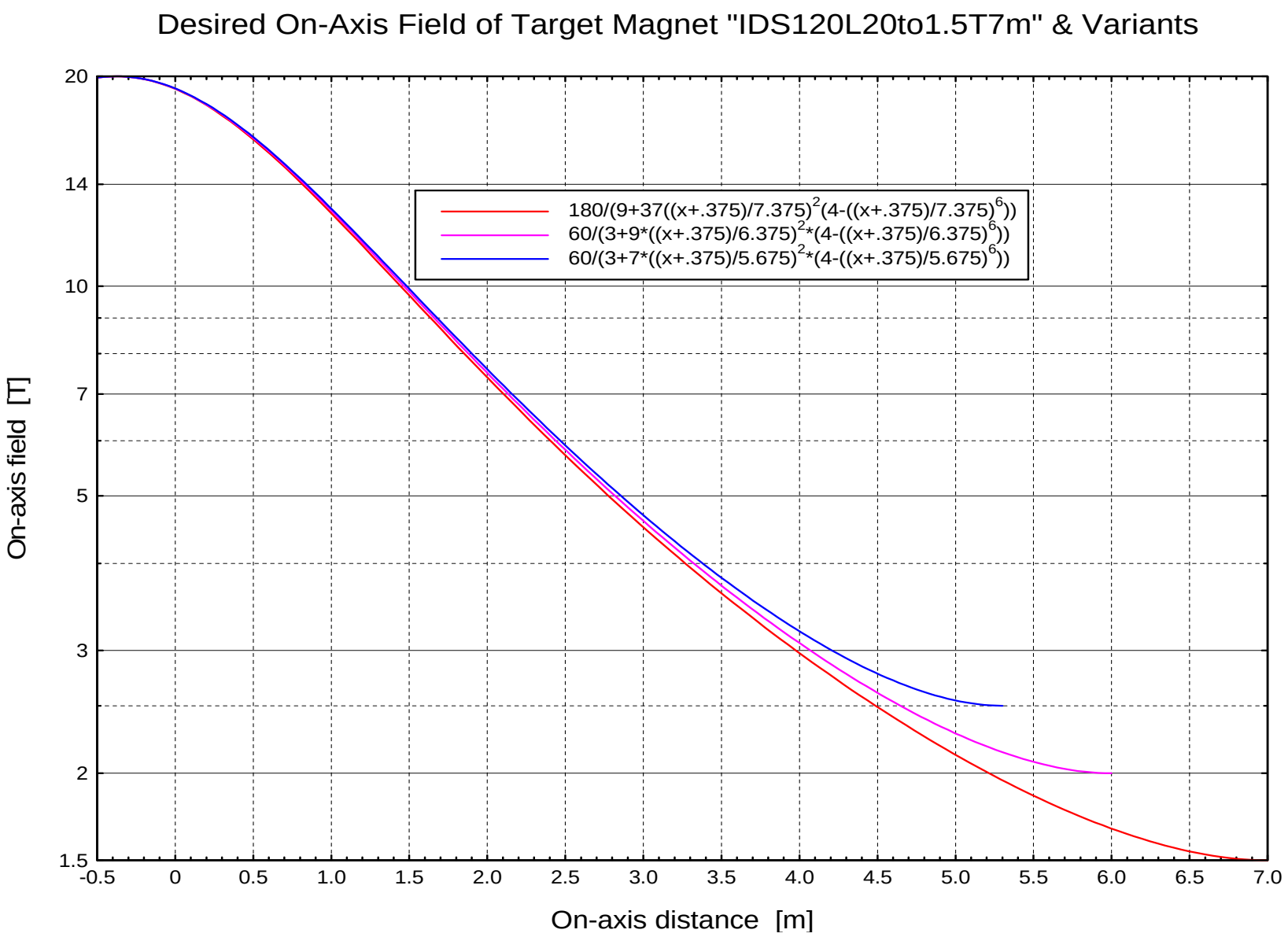


IDS120_15-1.5T7m3+4 Cryo1-2 With Uncut Target Module

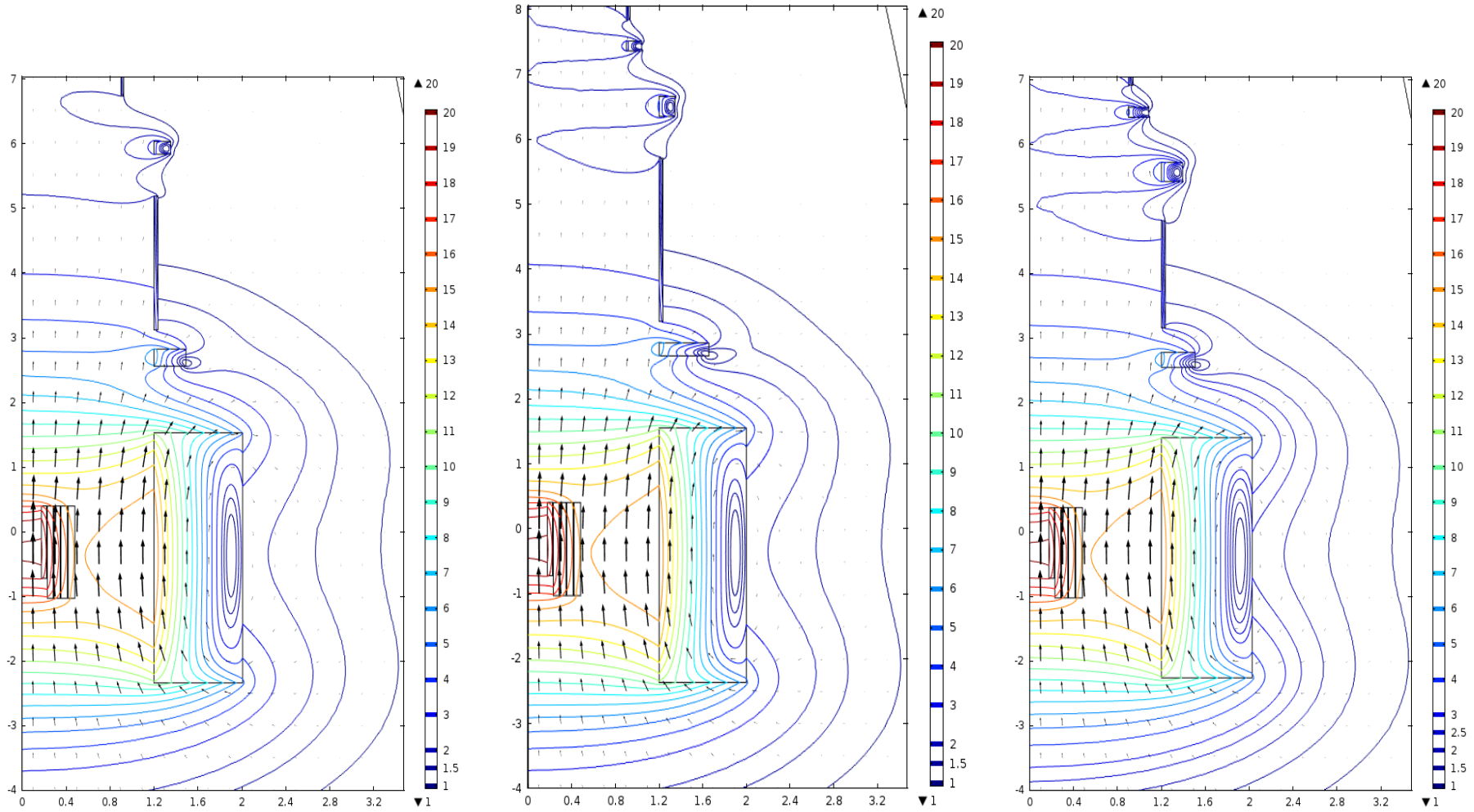




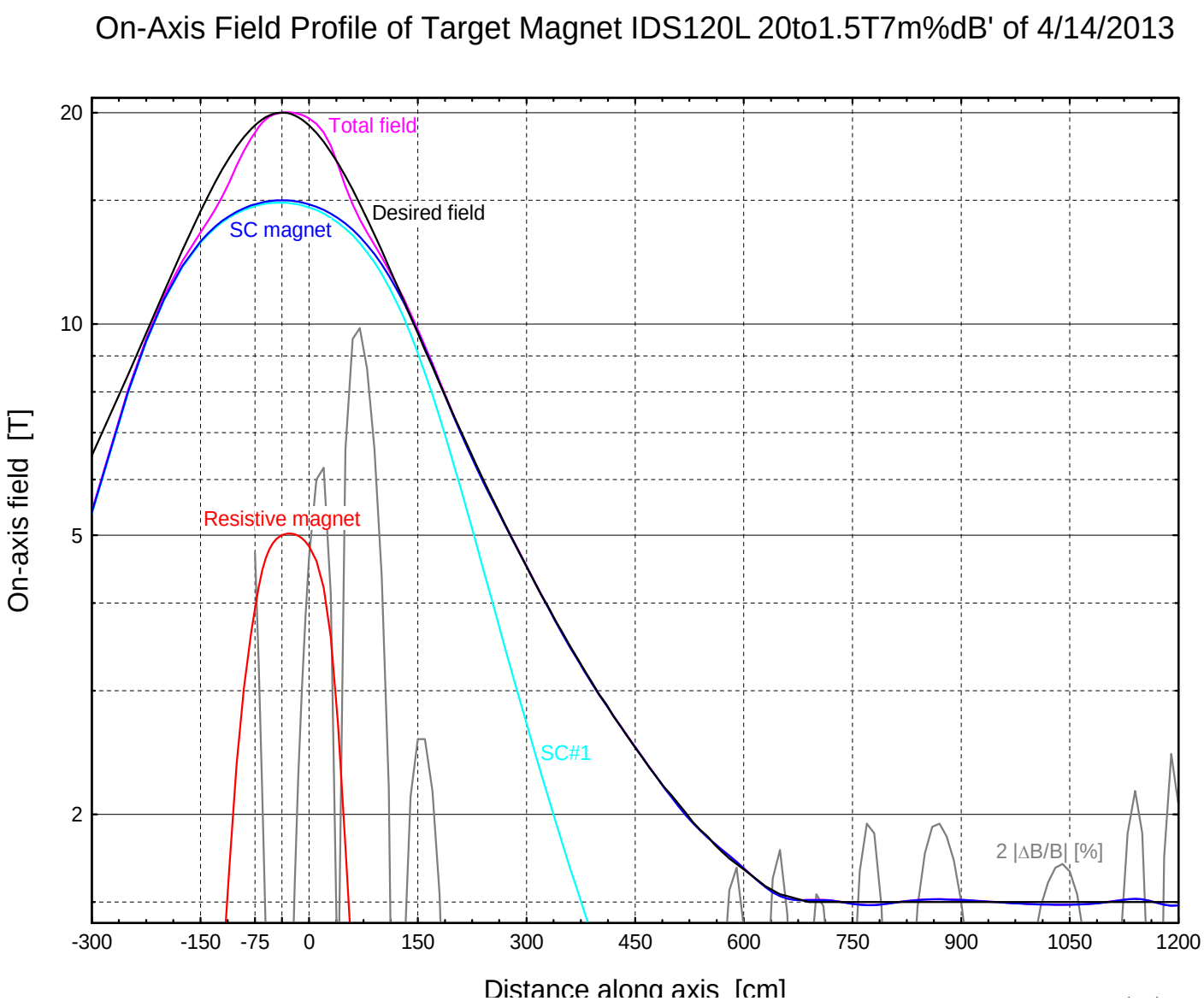
Field profiles B(z) that ramp from 15 T to 1.5 T at 700 cm.



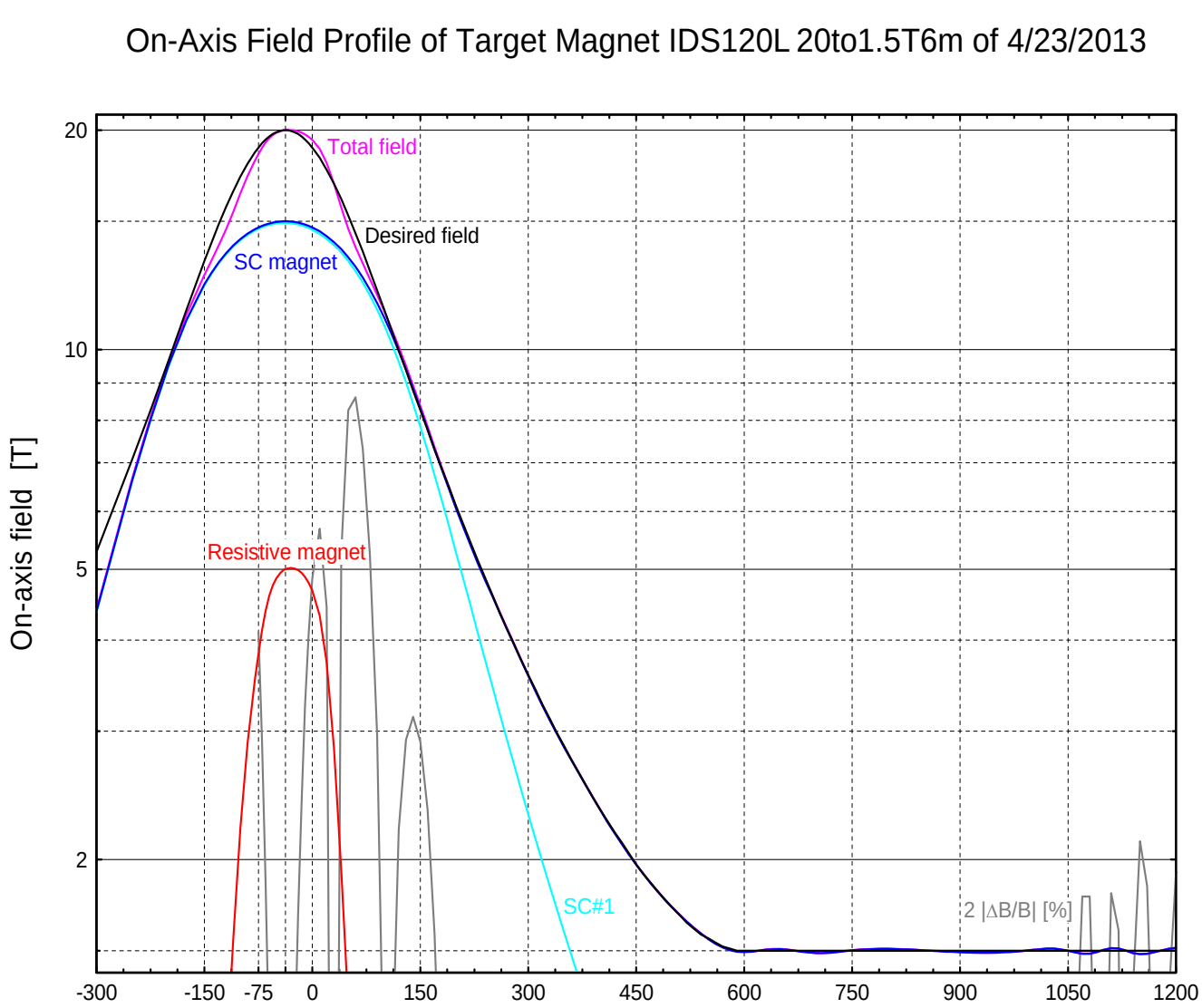
B(z) ramps to 1.5 T at 7 m, 2.0 T at 6 m, or 2.5 T at 5.3 m.



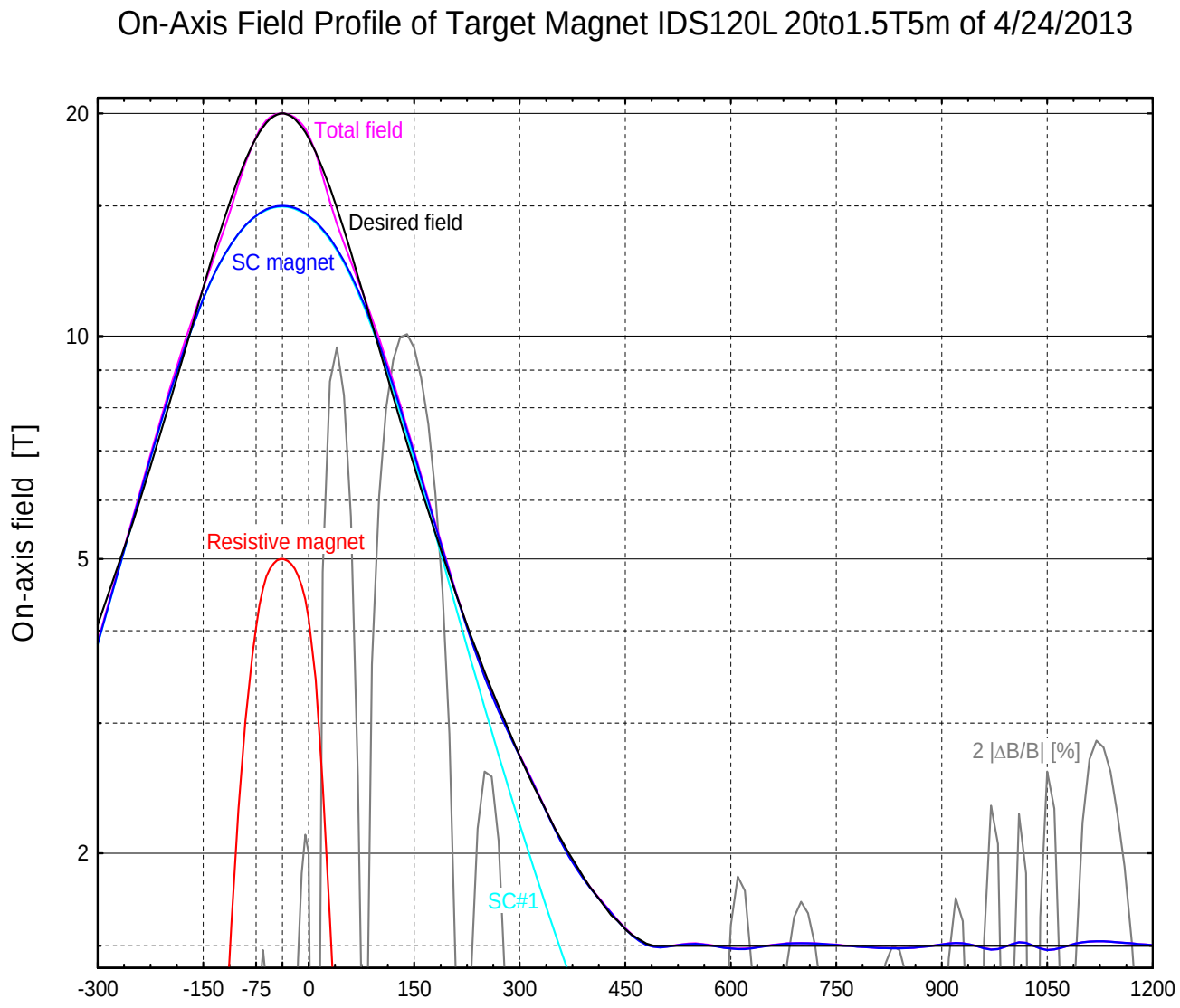
Field direction & magnitude of magnets with field ramp from 20 T to (left to right) 1.5 T at 7 m, 2.0 T at 6 m or 2.5 T at 5 m.



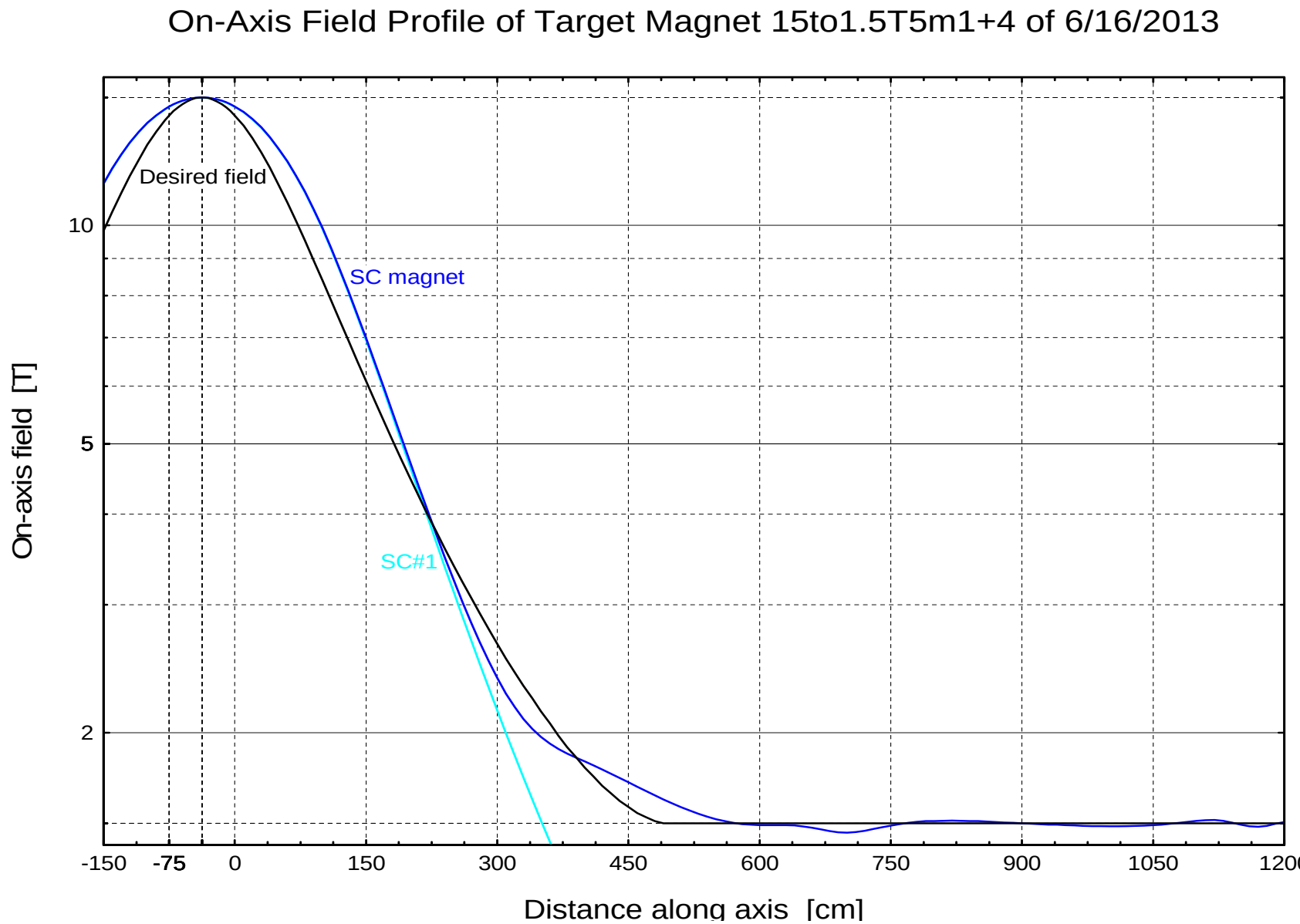
B(z) of IDS120L20to1.5T7m, with 5-T, 9.8-MW resistive magnet; field error ΔB/B is 4.9% at 70 cm & 1.2% at 11.9 m.



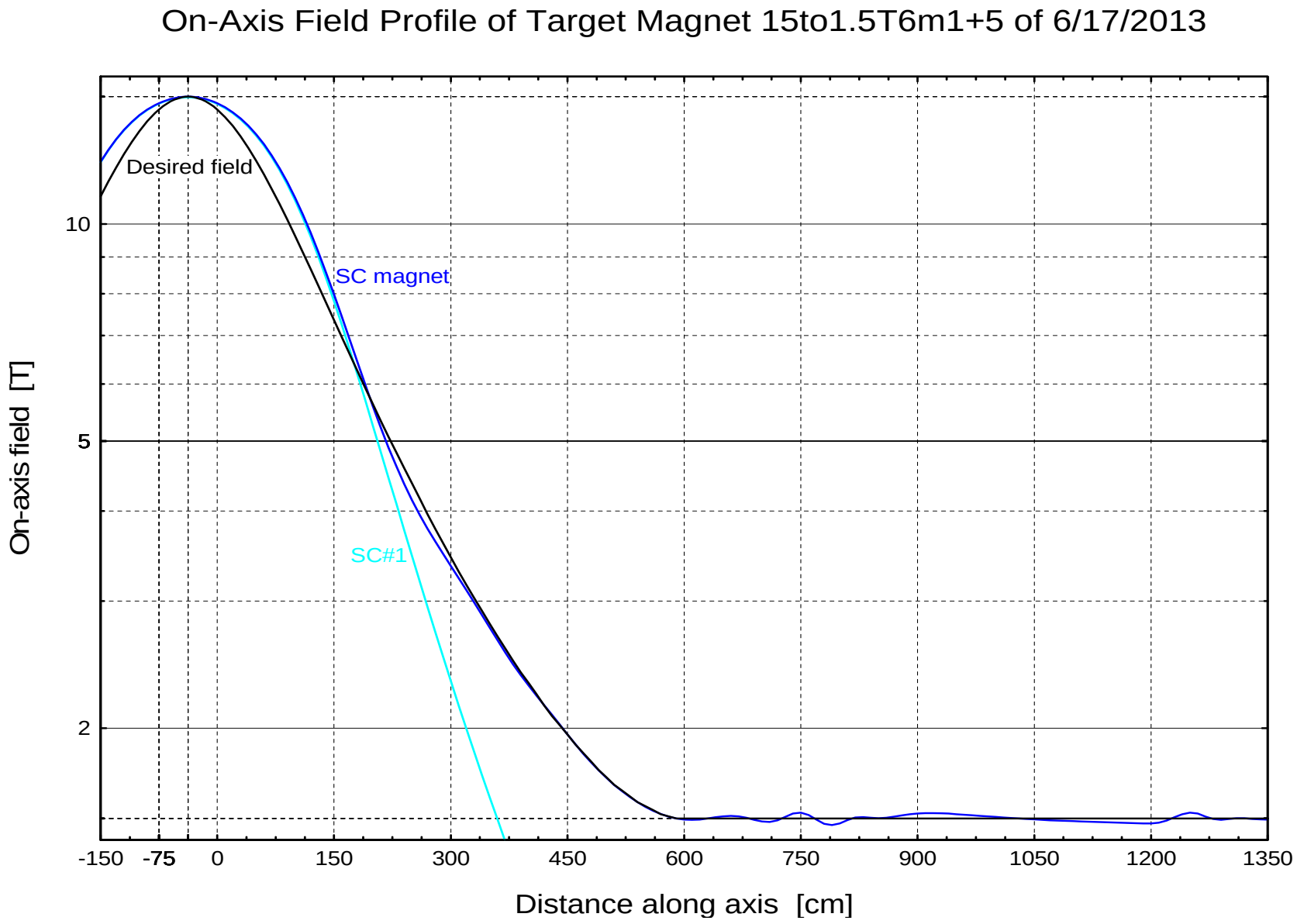
B(z) of IDS120L20to1.5T6m: with 9.2-MW resistive magnet.
ΔB/B is 4.3% at 60 cm & 1.1% at 12.2 m.



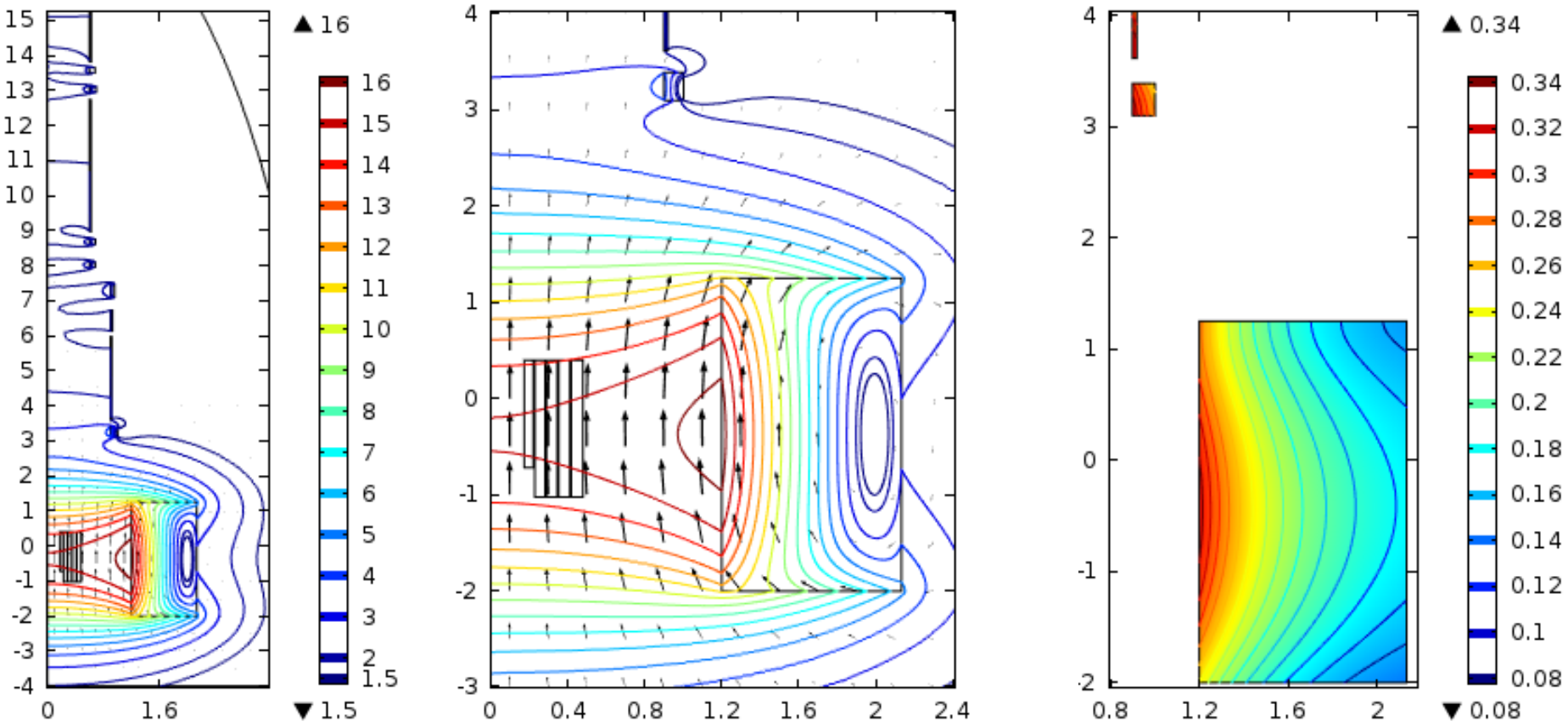
B(z) of IDS120L20to1.5T5m, with 8.5-MW resistive magnet.
ΔB/B is 5.0% at 140 cm & 1.4% at 11.2 m.



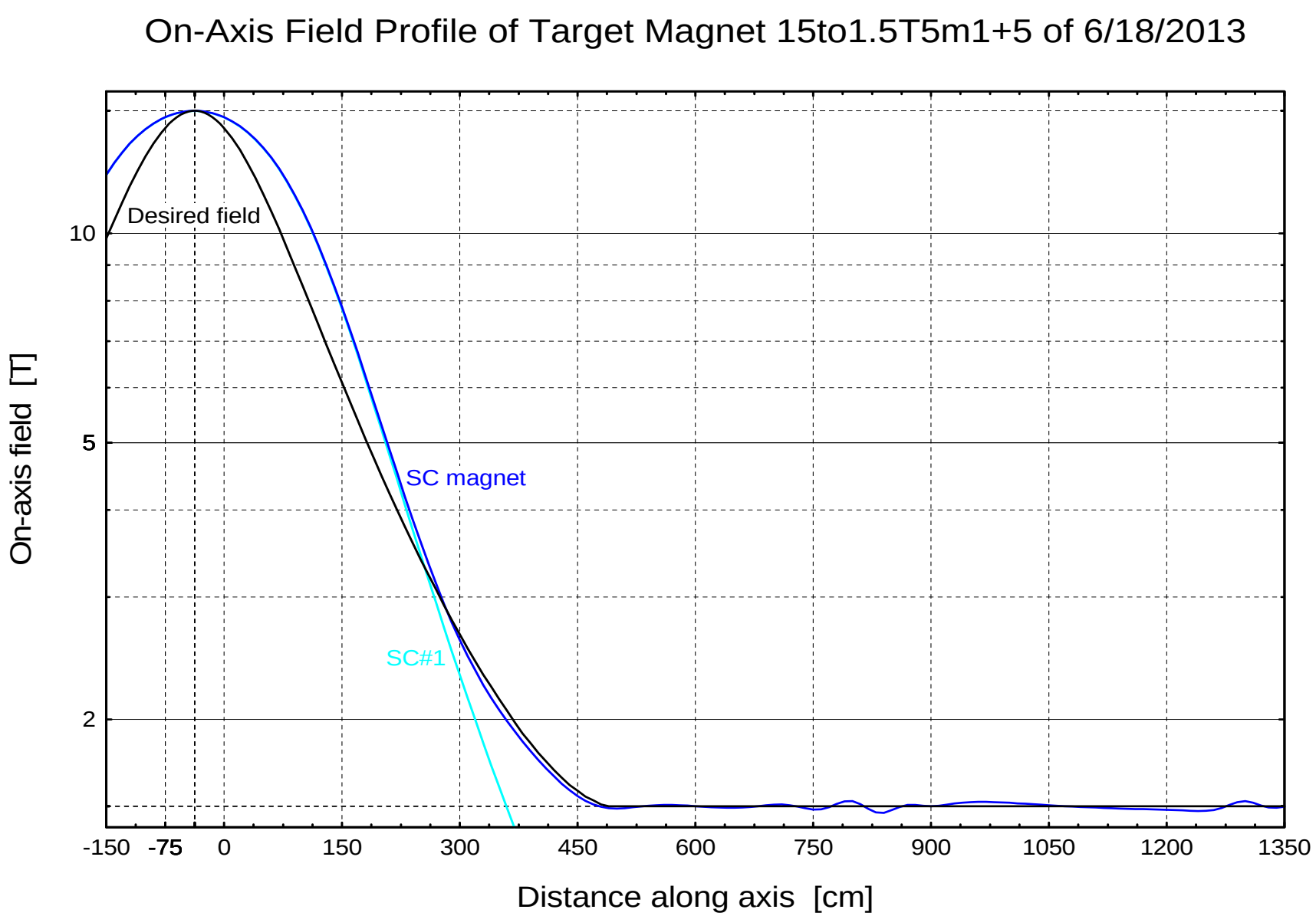
B(z) ramps from 15 T to 1.5 T at ~5.6 m; 210-cm gap after SC #1.



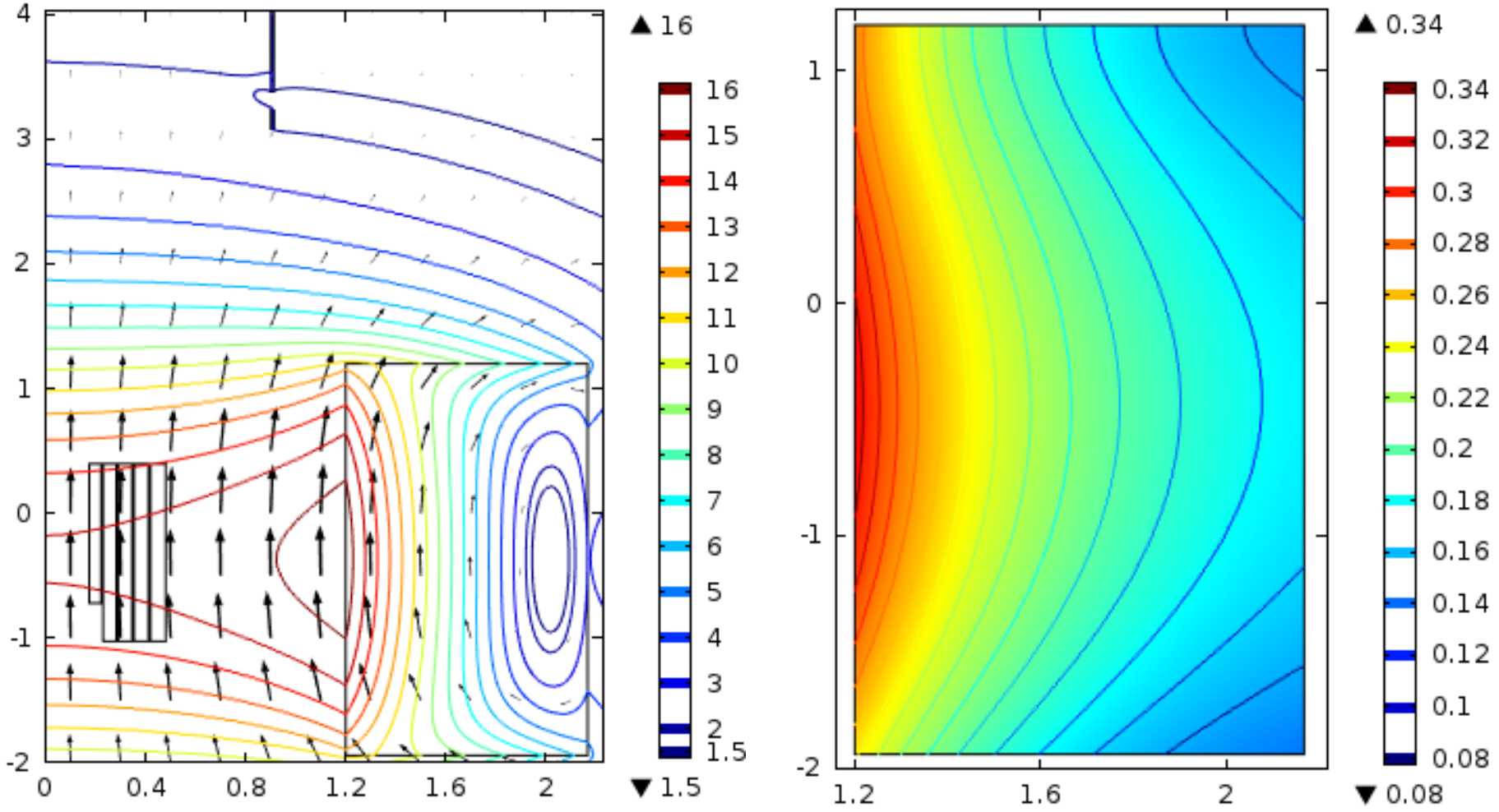
B(z) ramps from 15 T to 1.5 T at 6 m; 185-cm gap after SC #1.



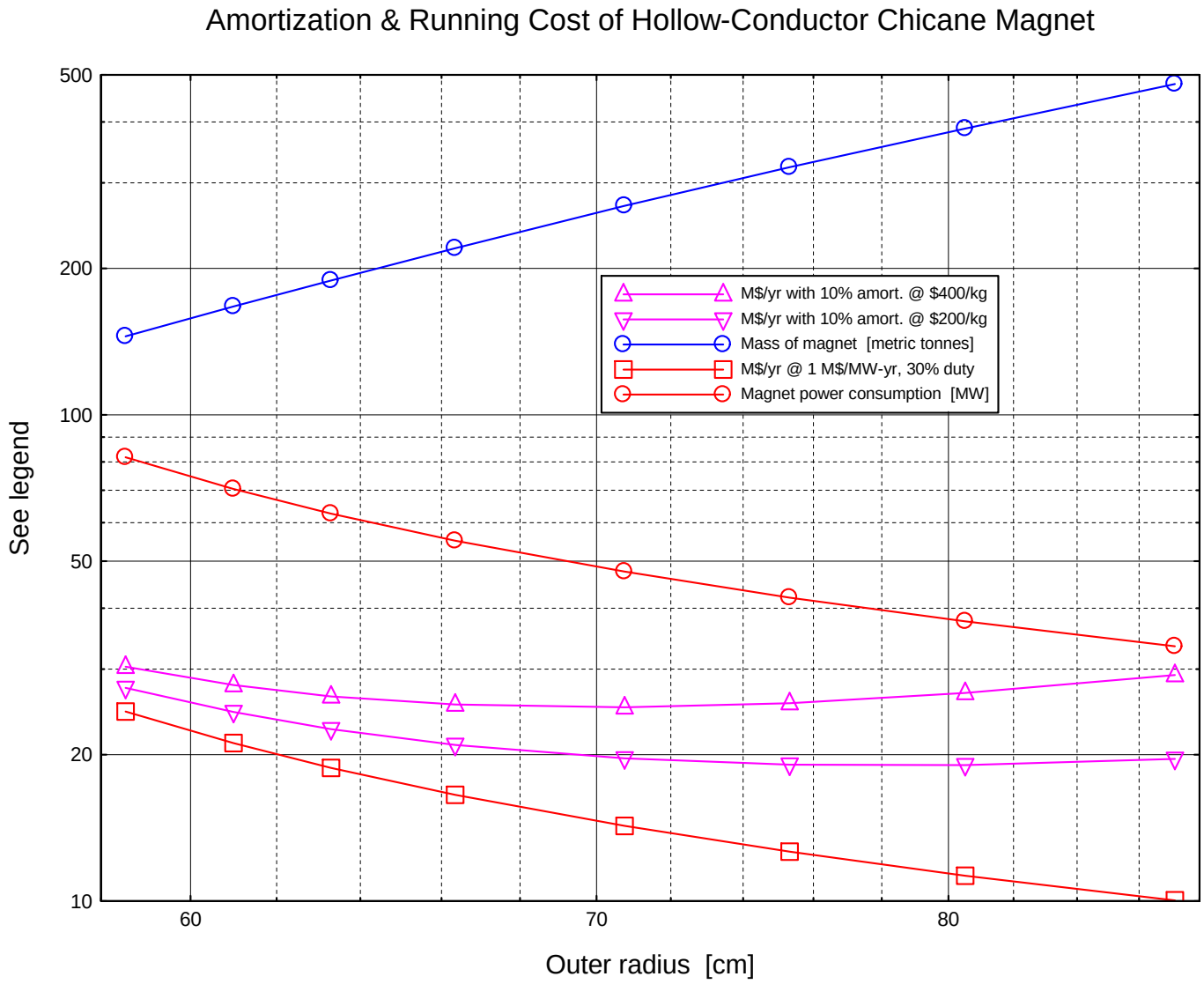
Field direction & magnitude (left & center) and hoop strain (right) of magnet with field that ramps from 15 to 1.5 T in 6 m.



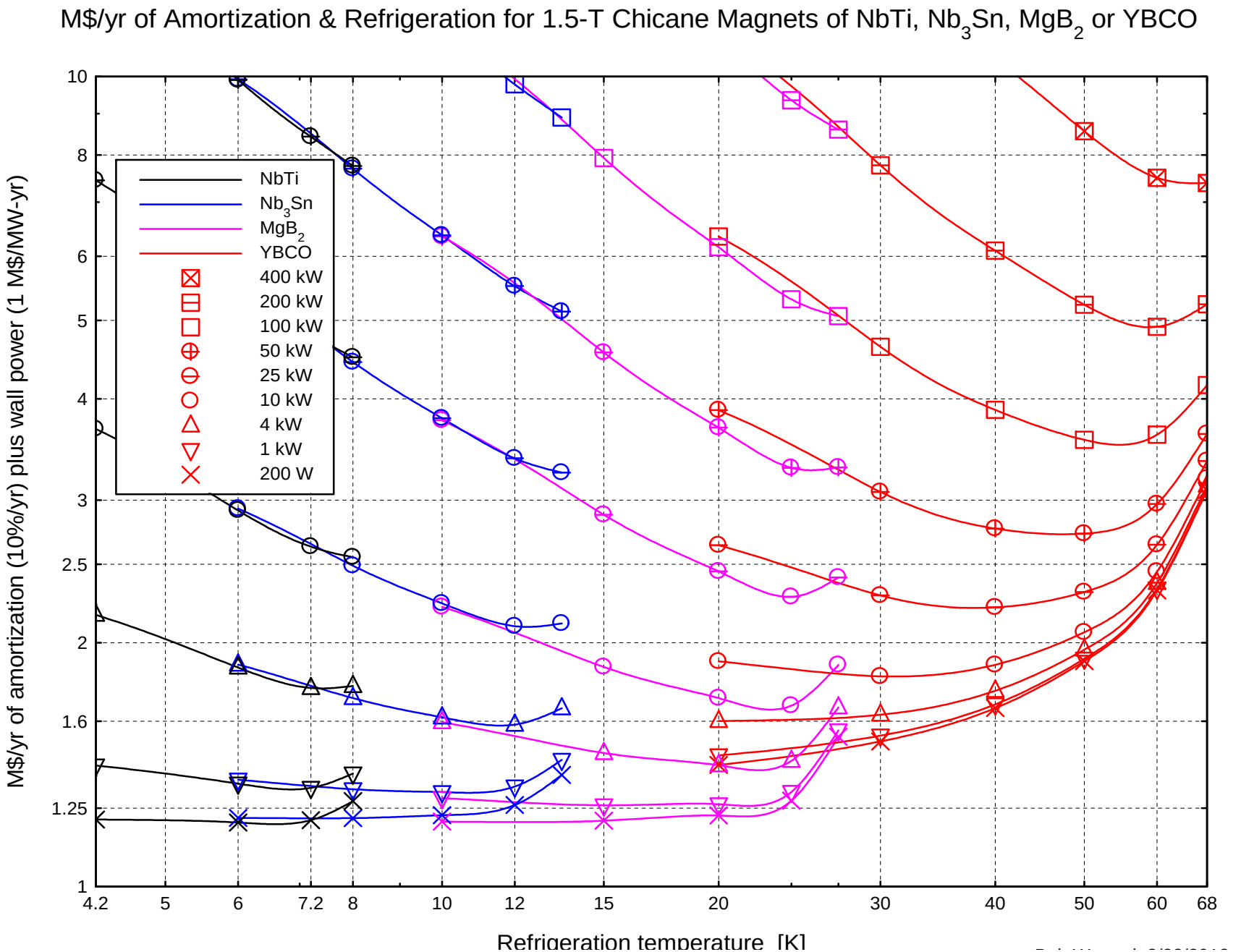
B(z) ramps from 15 T to 1.5 T at 5 m; 189-cm gap after SC #1.



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$/yr of Amortization & Refrigeration for 1.5-T Chicane Magnets of NbTi, Nb3Sn, MgB2 or YBCO
M$/yr of amortization (10%/yr) plus wall power (1 M$/MW-yr)
Refrigeration temperature [K]
NbTi
Nb3Sn
MgB2
YBCO
400 kW
200 kW
100 kW
50 kW
25 kW
10 kW
4 kW
1 kW
200 W
10
8
6
5
4
3
2.5
2
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12
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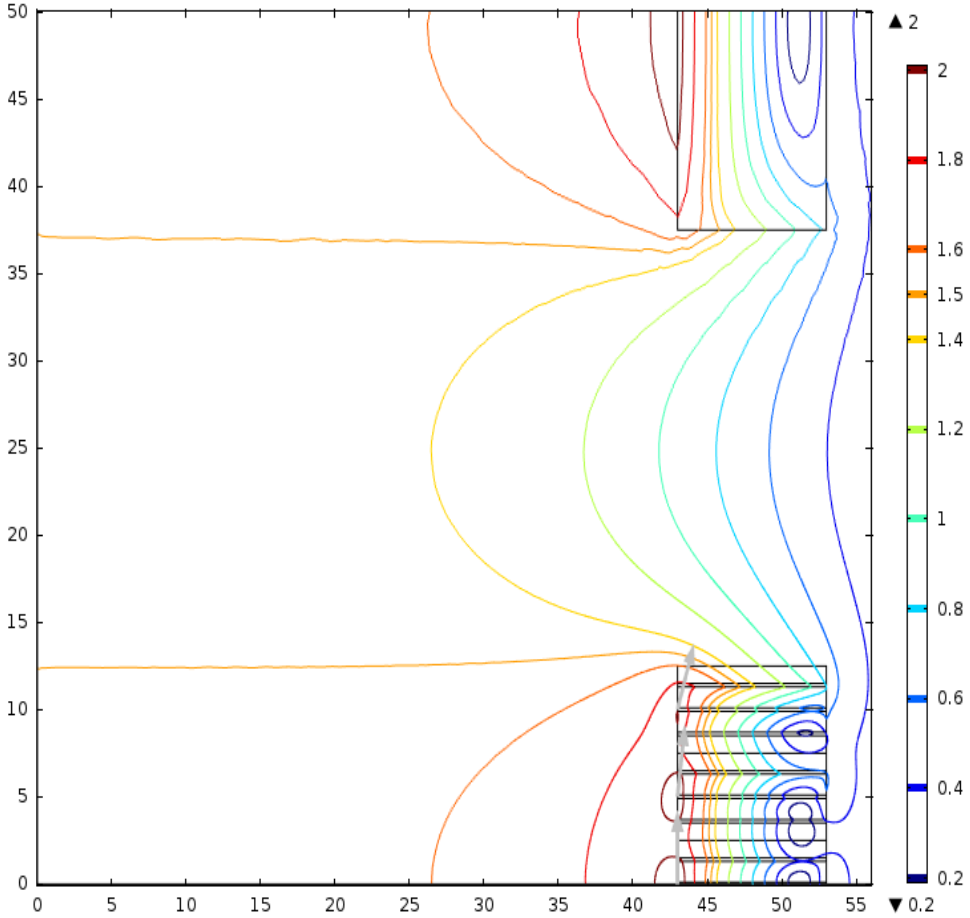
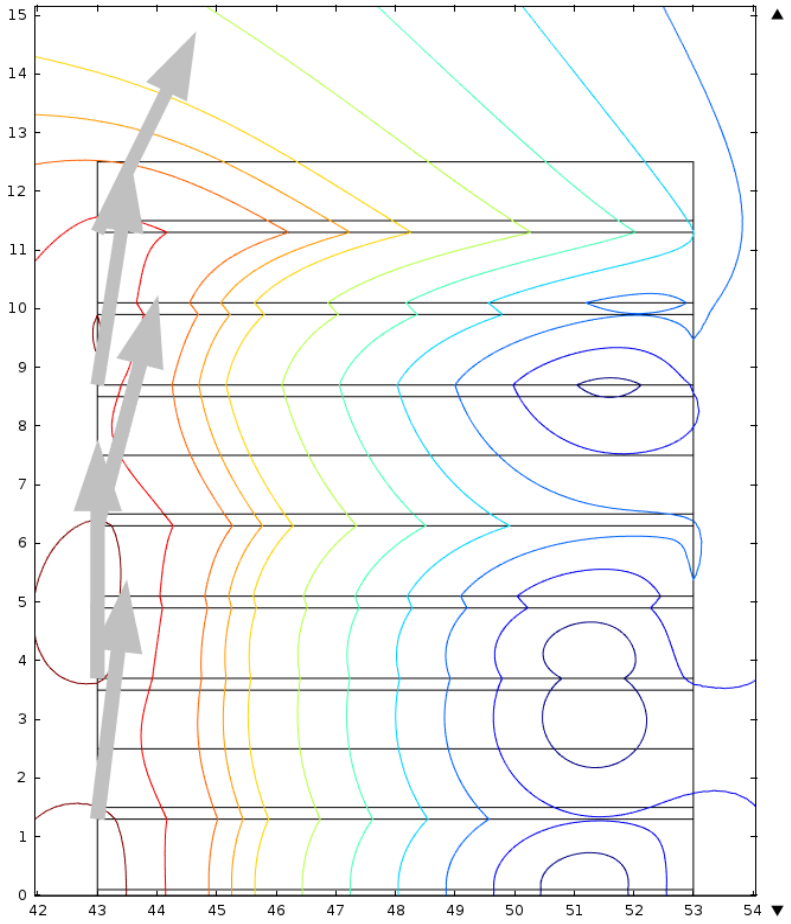
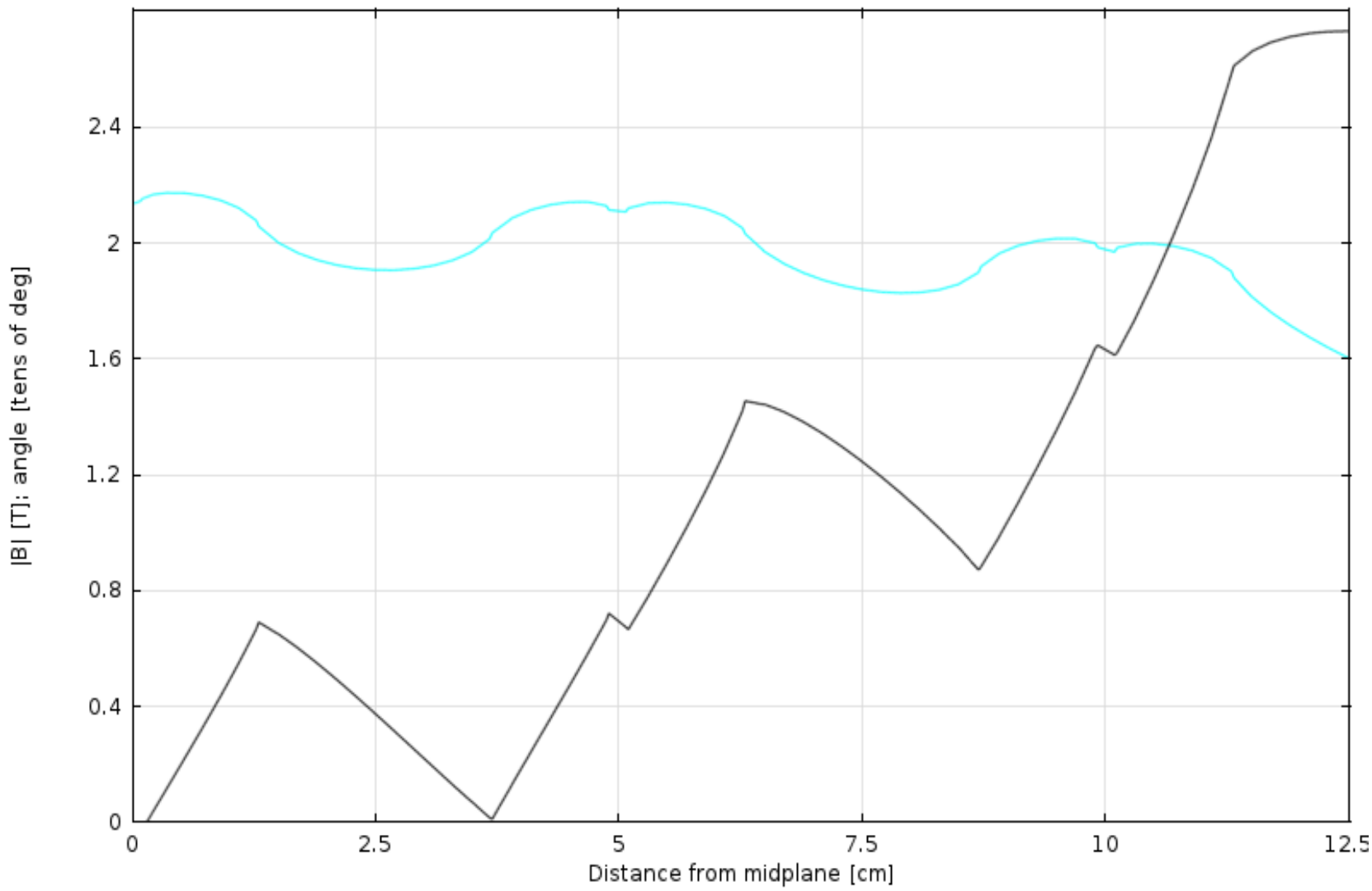
50
60
68

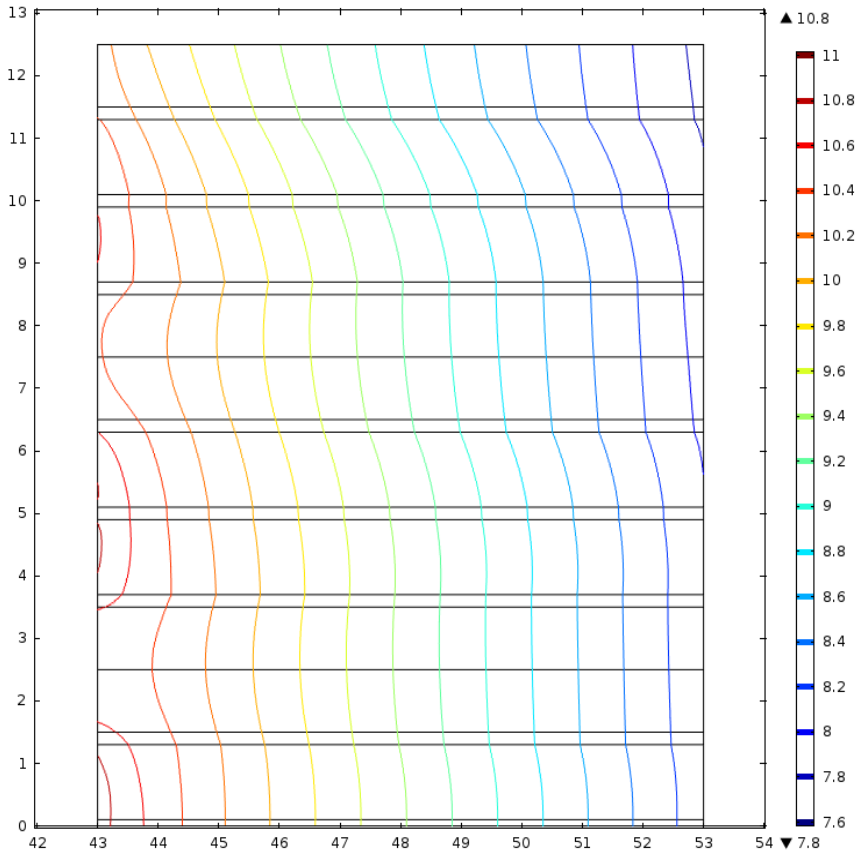


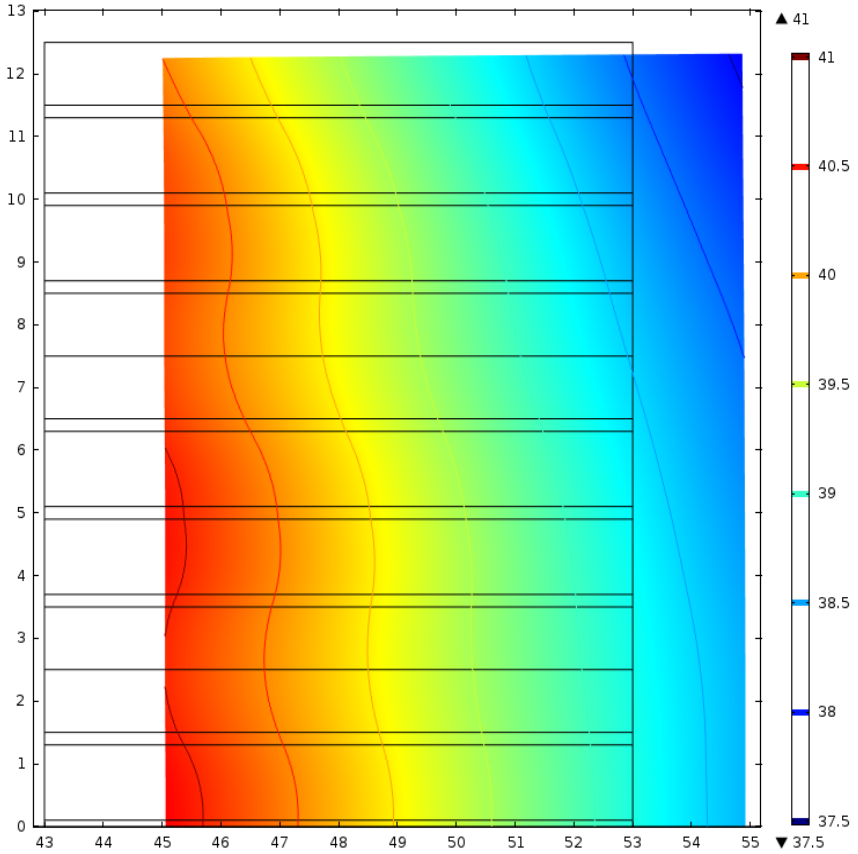


Field magnitude & direction of 50-cm section of 1.5-T chicane. B(0,z) varies only 2% peak-to-peak; B_{max} = 2.17 T.



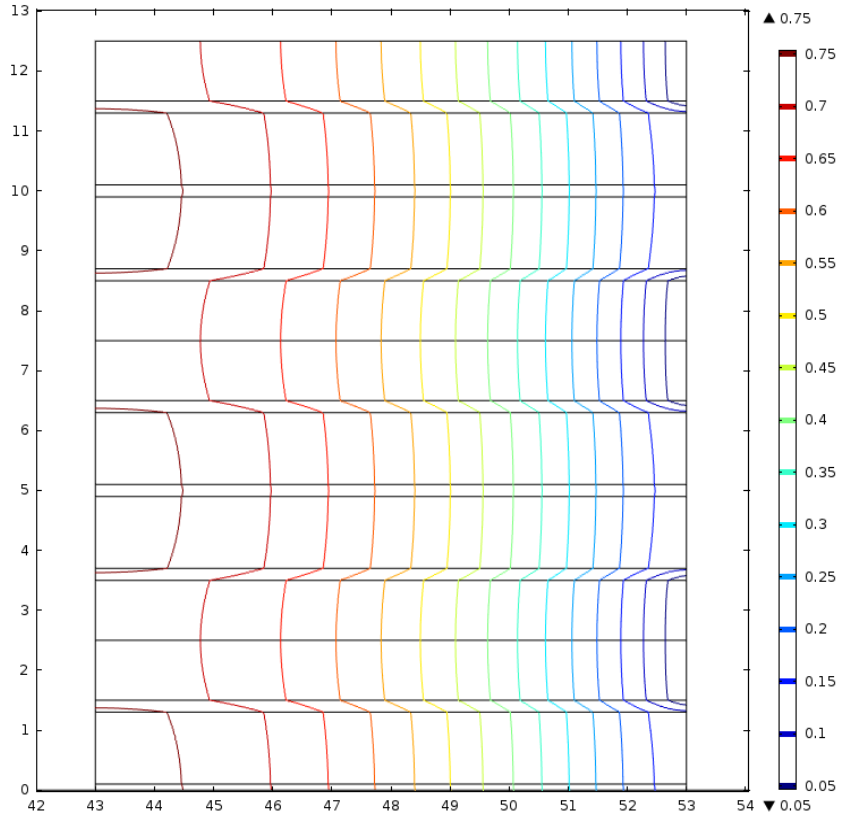
B(r=43cm, z) magnitude & direction. B_{max} = 2.17 T; θ_{max} = 27°.

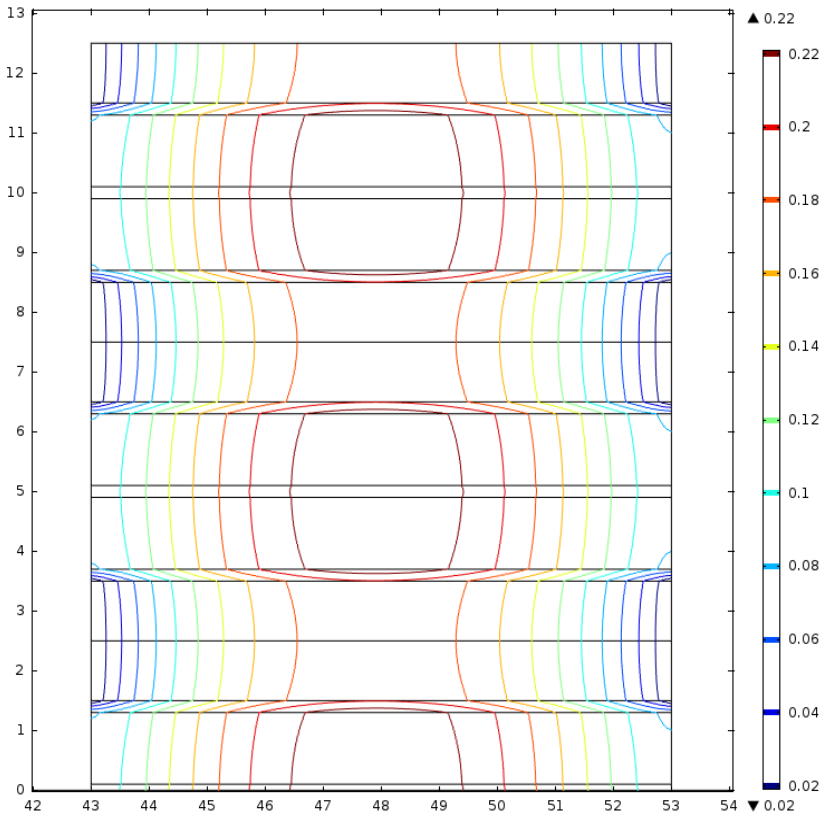




Left: von Mises stress, 7.6 to 11.0 MPa.

Right: Deformation (amplified 500 fold), 37 to 41 µ.m.





ΔT with uniform w_v = 500 kW/7.5 m^3 = 66 mW/cm^3.

Left: Cooled only from outer radius; ΔT_{max} = 0.75 K.

Right: Cooled from inner & outer radii; ΔT_{max} = 0.24 K.