Target Magnets that Ramp from 20 T to 1.5 T at 7, 6 or 5 m

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Figure 1, from 4/14/2013, plots the on-axis field profile of each component of Target Magnet IDS120L20to1.5T7m, whose field ramps from 20 T at z = −0.375 m to 1.5 T at z = 7 m. The components are: 5-T, 9.8-MW resistive magnet (red); superconducting coil #1 (turquoise); 15-T superconducting magnet (blue); total field (magenta); and desired field (black). The field error is defined as ΔB/B [%] but plotted as 2ΔB/B to shift the curve upwards on the graph. The maximum percentage discrepancy is 4.9% in the ramp region (at z = 70 cm) and 1.6% in the decay region (at 1,320 cm).

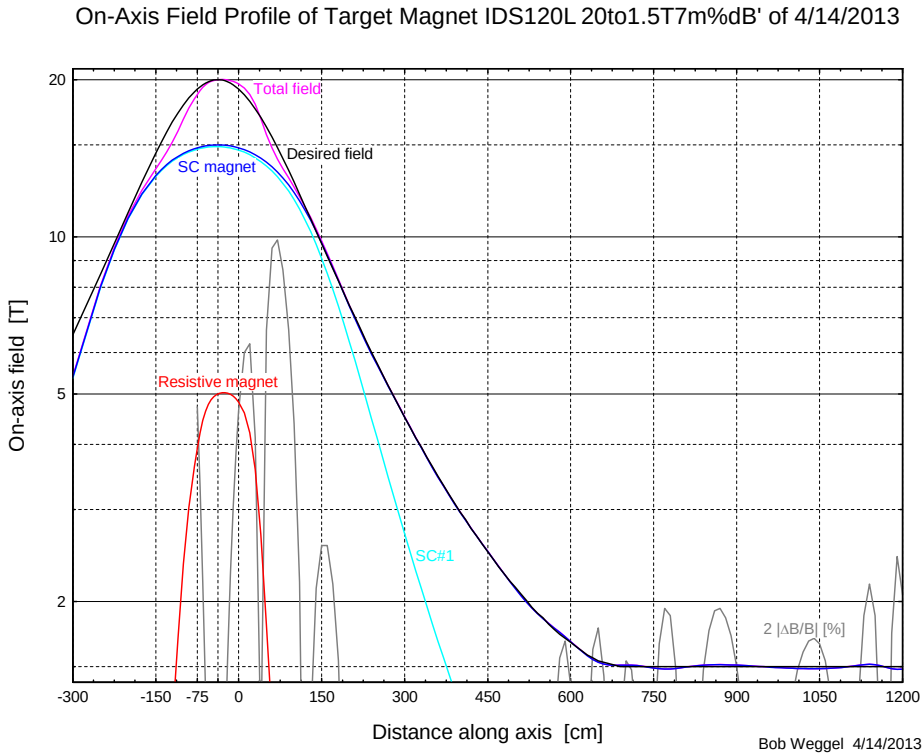

Fig. 1. On-axis field profile of Target Magnet IDS120L20to1.5T7m: 5-T, 9.8-MW resistive magnet (red); superconducting coil #1 (turquoise); 15-T superconducting magnet (blue); total field (magenta); and desired field (black). The field error (grey), plotted as 2|ΔB|/B, is 4.9% at z = 70 cm and 1.2% at 1,190 cm.

Figure 2 plots corresponding field profiles for a magnet in which the ramp bottoms out 1 m sooner, at z = 6 m. The field quality is even better than in Fig. 1, with a maximum error in the ramp region of 4.3% (at z = 60 cm) and, in the decay region, 1.1% at 1,220 cm. Figure 3 plots field profiles for a magnet in which the ramp bottoms out at z = 5 m. The maximum error in the ramp region is 5.0% (at 140 cm) and, in the decay region, 1.4% at 1,120 cm.

To achieve a rapid rampdown of the field requires superconducting coil #1 and the resistive coils to be short—respectively 242 cm and 118 cm for Fig. 3, compared to 387 cm and 143 cm for Fig. 1. An attendant benefit is a reduction in power consumption of 13%. An attendant penalty is that the peak-to-peak field homogeneity over the target region −75 cm <z < 0 is ~7% instead of the 3% typical of designs that ramp to 1.5 T at 15 m. Will this poorer field quality excessively distort the mercury jet?

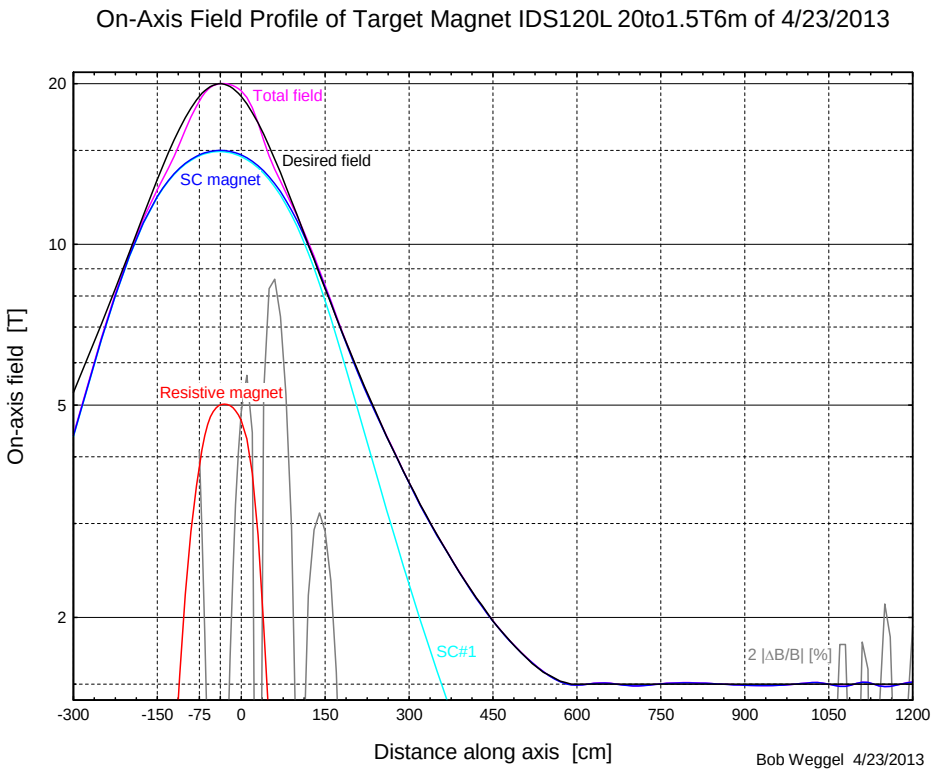

Fig. 2. Field of IDS120L20to1.5T6m: 5-T, 9.2-MW resistive magnet (red); SC #1 (turquoise); 15-T superconducting magnet (blue); total field (magenta); & desired field (black). |ΔB|/B (grey) is 4.3% at 60 cm & 1.1% at 1,220 cm.

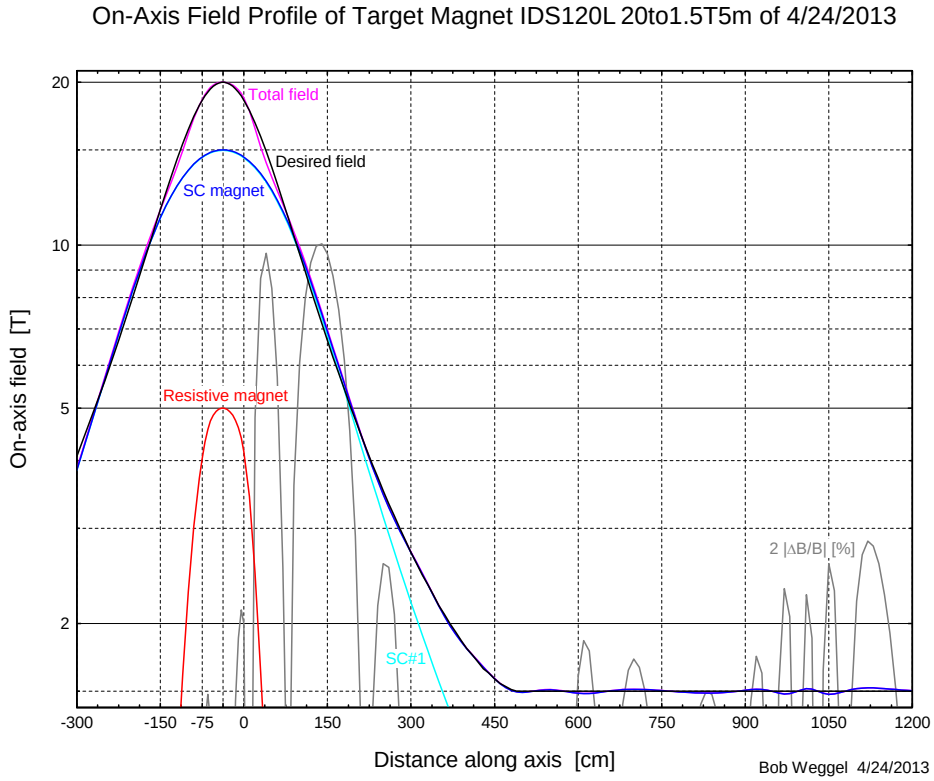

Fig. 3. Field of IDS120L20to1.5T5m: 5-T, 8.5-MW resistive magnet (red); SC #1 (turquoise); 15-T superconducting magnet (blue); total field (magenta); & desired field (black). |ΔB|/B is 5.0% at 140 cm & 1.4% at 1,120 cm.