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TESLA Damping Wiggler — Improved field roll-off

The magnetic design of the damping wiggler as proposed in the TESLA TDR had not been optimized. Several issues have to be considered for a detailed design study. It has been seen from calculations (W. Decking) that the transversal good-field region is not wide which leads to significant losses enough at the time of injection.

Increasing the pole width will decrease the field roll-off. For a quick estimation of the expected degree of improvement, the pole width has been changed from 40 mm to 60 mm while the overall design has not been changed: The axial and top magnets have been scaled with the increased pole size whereas the side magnets have not been changed. The width of the magnet structure has increased to 220 mm.

It turns out that the field roll-off improves by a factor 10 for the larger poles. The peak field and damping integral only change slightly. On the other hand, the required magnet volume per period increases by ~20% which directly enters into costs. The weight of an undulator segment increases by ~10%.

Comparison		
pole width	**40 mm**	**60 mm**
cross section (magnet structure only)	200×385 mm^2	220×385 mm^2
peak field B_0	1.67 T	1.68 T
trans. homogeneity $\Delta B/B_0$ @ x= ± 1 mm @ x= ± 5 mm @ x=±10 mm	 $3.5\ 10^{-4}$ $9.4\ 10^{-3}$ $\sim 4\ 10^{-2}$	 $3.6\ 10^{-5}$ $1.1\ 10^{-3}$ $5.7\ 10^{-3}$
damping integral I_D	1.37 T^2m per meter	1.45 T^2m per meter
magnet volume: per period total	6120 cm^3 ~6.8 m^3 ≅ 51 tons	7280 cm^3 ~8.0 m^3 ≅ 60 tons
weight per segment (without support)	2.0 tons	2.2 tons

Markus Tischer (-2923) markus.tischer@desy.de Geb. 25f / Zi. 151

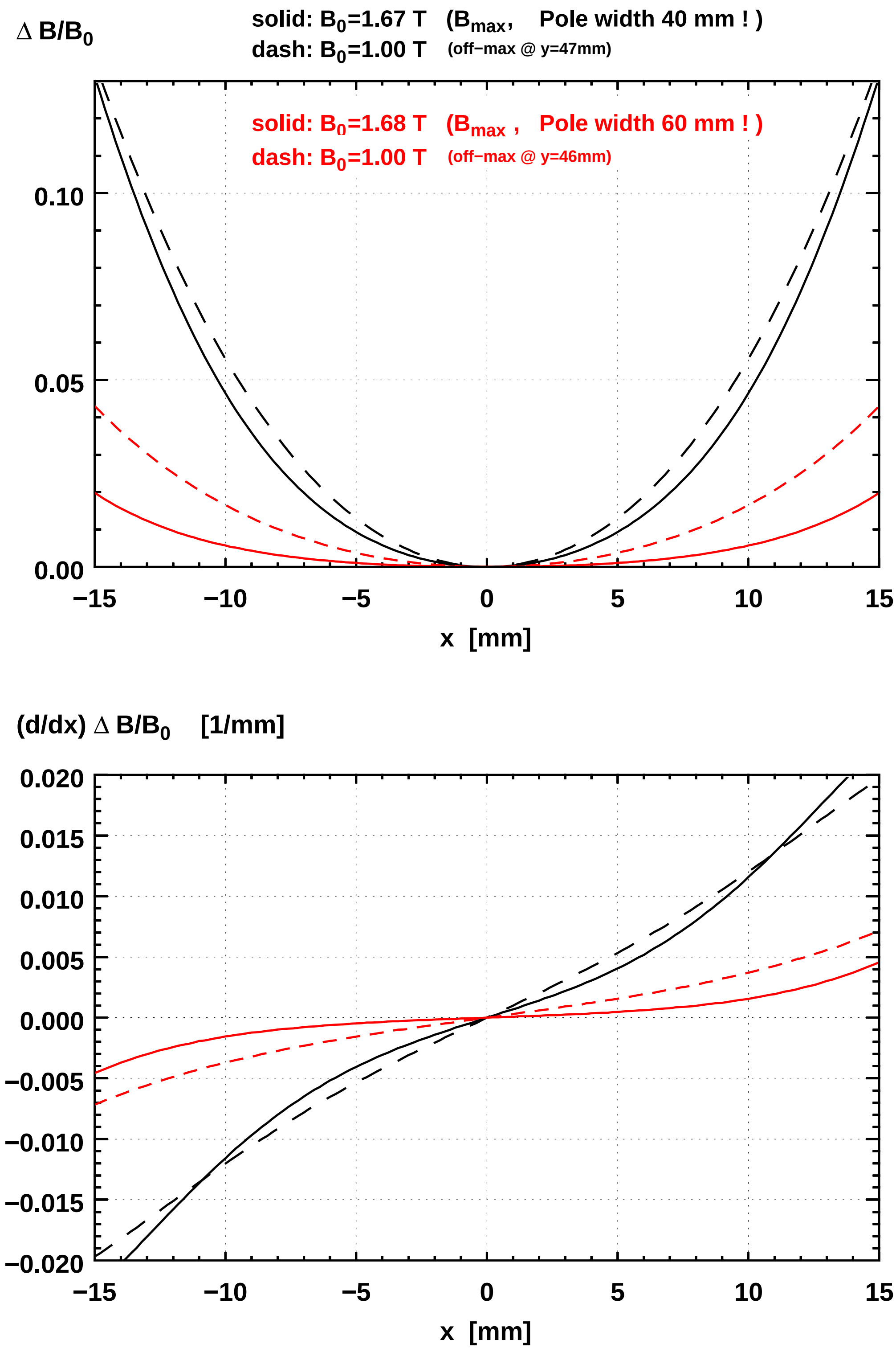

Fig. 1: Relative change of the peak field in transversal direction for different longitudinal positions: at the pole center corresponding to the peak field (solid) and at a shifted position corresponding to a field of 1.0 T.

Markus Tischer (-2923) markus.tischer@desy.de Geb. 25f / Zi. 151

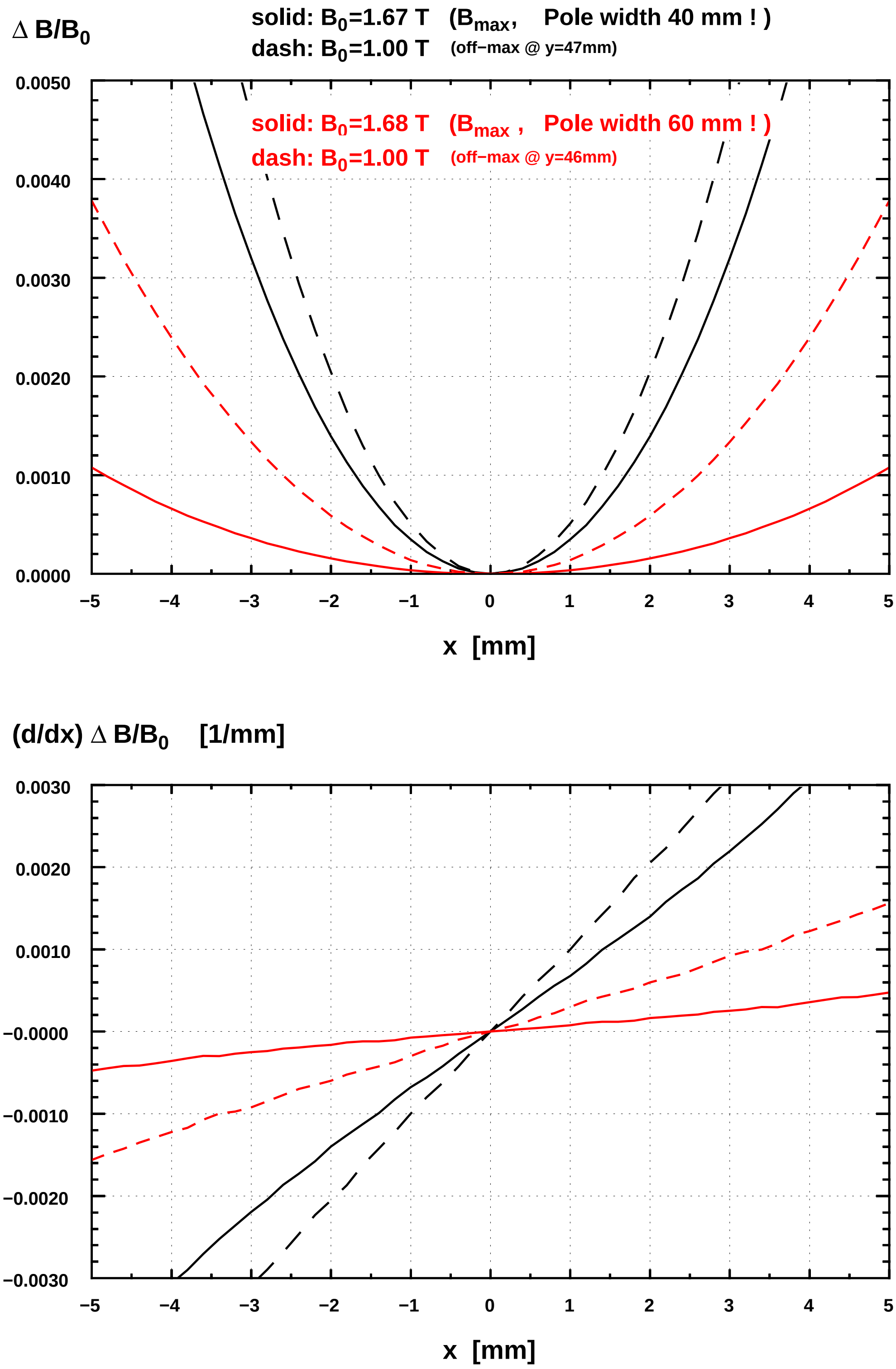

Fig. 2: Zoom in of Fig.1.

Markus Tischer (-2923) markus.tischer@desy.de Geb. 25f / Zi. 151