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On the effect of close-fitting magnetic (high permeability normal and superconducting) shields on the coil-factor of a solenoid

J. Mygind¹, M. Aaroe¹, A. Gordeeva¹, R. Monaco² and V.P. Koshelets³

¹DTU Physics, B309, Technical University of Denmark, DK-2800 Lyngby, Denmark

²Istituto di Cibernetica del CNR, 80078, Pozzuoli, Italy and Unit`a INFM Dipartimento di Fisica, Universit`a di Salerno, 84081 Baronissi, Italy†

³Institute of Radio Engineering and Electronics, Russian Academy of Science, Mokhovaya 11, B7, 125009, Moscow, Russia

Abstract

A combination of superconducting and high-permeability magnetic shields are commonly used in cryogenic measurements to suppress DC and high frequency external electromagnetic interference. In order to investigate the magnetic properties of a given device usually the control magnetic field is supplied from one or more solenoids installed inside the shields. We show that an error of almost an order of magnitude can occur in the coil-factor in realistic configurations of a solenoid and a superconducting shield. The reason is that the coil-factor is determined not only by the geometry of the solenoid, but also by its nearby magnetic environment. This has important consequences for reported as well as coming experiments such as the determination of the parameters of Josephson junctions, as well as other cryogenic devices. We propose to solve the problem by inserting a thin sheet of high-permeability material. The results are tested both experimentally and numerically.