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Application of particle beams from accelerators and cooled tungsten windings in the production of high magnetic fields

Abstract

This paper concern projects of two innovative methods of generating of high magnetic fields. The first part concerns the application of charged-particles packets, accelerated by an accelerator, to produce high-impulse fields. Two types of bunches – proton bunches in the accumulative ring of the LHC with an energy of 7 TeV, and electron bunches in the accumulative ring of the Solaris accelerator with an energy of 1.5 GeV – are taken into consideration in the paper. Presented is also a new approach of calculating the magnetic field induction via the Lorentz transformation of the electric field intensity taken from the bunch's reference frame to the sample's frame. According to the performed calculations, it is possible to obtain magnetic fields of induction 4.6-56.0 T at the distance of 5 mm from the bunch axis and of the duration of 10^{-12}-10^{-13} s in both cases. Described is additionally a project for a special chamber, designed for the remote exchange and control of researched samples, during the accelerator's operation. The latter focuses on the usage of tungsten, cooled with liquid helium to the temperature 1 K, as a material of windings producing constant magnetic fields. Using this method, we may significantly reduce the resistivity and the power consumption. A coil is proposed, with an innovative geometry and with a longitudinal eccentric channel. The calculations for this coil and a Bitter magnet, made from this material, proved them to be able to obtain constant magnetic fields of induction of 32-56 T in a volume of several dm^3 given the consumed power in the order of 1 kW.