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BENT CRYSTALS FOR BEAM STEERING IN ACCELERATORS

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One of the important problems of accelerator physics is the problem of deflecting the direction of motion of high-energy charged particles. One of the options for solving this problem is to use thin bent crystals, passing through which the particles change their direction of motion. This occurs when the particles enter the crystal at a small angle to one of the main crystallographic axes or planes. In this case, the impact parameter of the particle interaction with neighboring crystal atoms changes slowly and coherent effects appear in the scattering of the particle by these atoms. Due to this coherence, it is possible to achieve deflection of the particle in a given direction through interactions with atomic strings or planes. The bending of the crystal in certain cases significantly increases the deflection angles of particles. In particular, if a particle moves in a bent crystal in the planar channeling mode [1,2], it can be deflected by an angle significantly exceeding the critical angle of planar channeling [3]. In addition to planar channeling, there are two other mechanisms for deflecting charged particles in a bent crystal: volume reflection of particles [4], when particles perform above-barrier motion relative to atomic planes in a bent crystal, and the Greenenko-Shul'ga mechanism [5], in which particles enter the crystal at a small angle to one of the crystal axes and move in above-barrier mode in the field of the crystal atomic strings.

All three mentioned mechanisms for deflecting high-energy charged particles using bent crystals have been successfully confirmed experimentally, including at CERN. In particular, the deflection of protons with energies around 7 TeV using planar channeling in a bent crystal was successfully demonstrated in experiments at the Large Hadron Collider [6,7]. This report analyzes the feasibility of using bent crystals for collimating charged particle beams in accelerators and for extracting part of the beam into separate channels.

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