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Experimental investigation on steering of ultrarelativistic particle beams through axially oriented bent crystals

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An investigation into the stochastic deflection of high-energy charged particles in a bent crystal was conducted at the extracted lines of the CERN Super Proton Synchrotron. Specifically, we examined the mechanism of relaxation of axially confined 400 GeV/c protons to planar channeling in a bent crystal. The experimental results were critically compared to computer simulations and analytical estimations, demonstrating a good agreement. We conclusively identified a necessary condition for the utilization of axial confinement or its relaxation for particle beam manipulation in high-energy accelerators. We demonstrated that with a short bent crystal, aligned with one of its main axes to the beam direction, it is possible to realize either a total beam steerer or a beam splitter with adjustable intensity.
We also investigated the deflection efficiency under axial confinement of 120 GeV/c electrons and positrons as a function of crystal orientation, the choice of the bending plane, and the charge sign. In particular, we identified the optimal orientations of the crystal’s bending plane, which enable the deflection of the largest number of charged particles using a bent crystal in axial orientation.

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