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Simulation of High-Energy Particles Channeling Using Mathematica©

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Experiments with high-energy particle beams using straight and bent crystals is a popular recent trend in high-energy accelerator physics. The strong electrical field of the crystal planes allows steering of particle trajectories. Recently, experiments on the bent crystal channelling of 6.5-TeV protons were performed at the Large Hadron Collider in CERN toward the future beam collimation [1,2]. The studies on bent crystal channelling have also been carried out using sub-GeV and several GeV electrons at MAMI (855 MeV) [2] and SLAC [3]. Besides studies of basic properties of high-energy electron channelling, several applications of bent crystal channelling of electrons have been discussed: beam splitters, beam collimation [4] and so-called crystalline undulators as powerful γ-ray sources [5].

Here we present a computer code which allows calculating the trajectories of relativistic charged particles channelled in aligned crystals using Mathematica© code. It is a specific separate part of the BCM-2.0 code [6]. The simulation procedure takes into account multiple scattering and angular spread of the particle beam. The computer code allows calculate the flux dynamics and angular and spatial distributions of relativistic particles passing through straight and bent crystals, including mirroring. Simulations were validated against experimental data obtained at SAGA LS Linac for 255 MeV electrons channelled in the thin Si crystals [7,8].

We present also the results of simulations for another energies and another crystals than in [7,8] both for electrons and positrons, and make a comparative analysis and suggest further perspectives.

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Summary

Here we present a computer code which allows calculating the trajectories of relativistic charged particles channelled in aligned crystals using Mathematica© code. It is a specific separate part of the BCM-2.0 code. The simulation procedure takes into account multiple scattering and angular spread of the particle beam. The computer code allows calculate the flux dynamics and angular and spatial distributions of relativistic particles passing through straight and bent crystals, including mirroring. Simulations were validated against experimental data obtained at SAGA LS Linac for 255 MeV electrons channelled in the thin Si crystals.

We present also the results of simulations for another energies and another crystals than in both for electrons and positrons, and make a comparative analysis and suggest further perspectives.

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