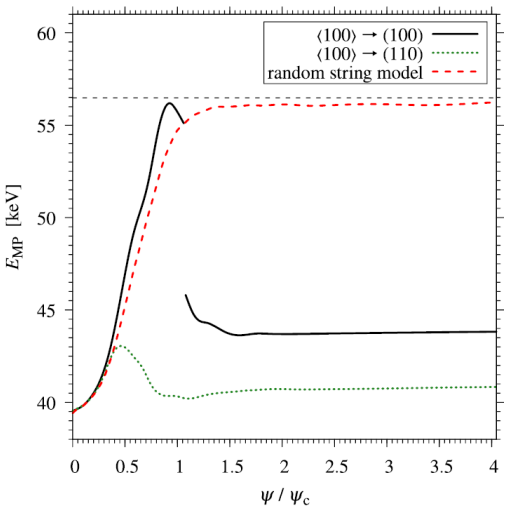
IONIZATION LOSS AND CHARACTERISTIC RADIATION OF HIGH-ENERGY PARTICLES IN ORIENTED CRYSTALS

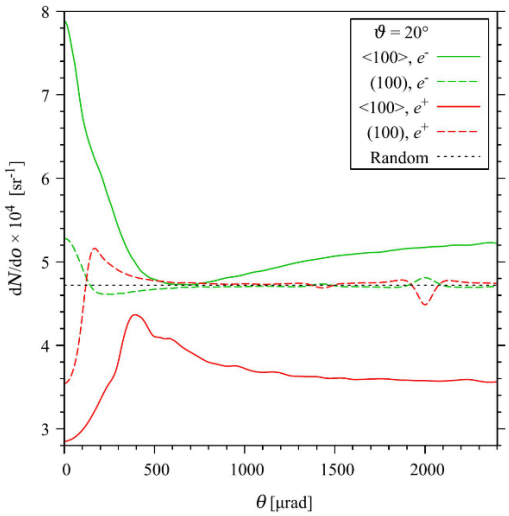
S.V. Trofymenko[1,2], I.V. Kyryllin[1,2]

[1]*National Science Center "Kharkiv Institute of Physics and Technology", Kharkiv, Ukraine*
[2]*V.N. Karazin Kharkiv National University, Kharkiv, Ukraine*

Methods of computer simulation of atomic K-shell ionization, characteristic X-ray radiation (CXR) and the ionization energy loss of high-energy particles in oriented crystals are developed. The ionization energy loss distributions (spectra) of high-energy protons and positrons in oriented silicon crystals are obtained. For protons, evolution of the spectra with the change of the angle between the particle momentum and the crystal (110) plane is investigated. For positrons, such evolution is studied for the case when the crystal orientation changes from the axial ⟨100⟩ to the planar (100) and (110). It is shown that both the most probable E_{MP} and average E_{AV} energy losses in these cases change non-monotonically, while E_{MP} may change even discontinuously. These variations of E_{MP} and E_{AV} are correlated with the change of the particle motion regime. The evolution of the angular distribution of CXR from the upstream surface of the crystal with changes in the angle between the incident electron/positron momentum and the crystal ⟨100⟩ axis or (100) plane, as well as with changes in particle energy in the range of 1–1000 GeV, is investigated. A new method for measuring the dechanneling length of high-energy electrons in a crystal and the dependence of this length on the particle energy by registering CXR is proposed.



Dependence of the most probable energy loss of 3 GeV positrons in a silicon crystal of 200 μm thickness on the angle between the incident particle momentum and the ⟨100⟩ crystal axis. Dashed horizontal line – E_{MP} for a non-oriented crystal.



Dependence of the angular density of the number of CXR photons emitted from the upstream surface of the crystal on the angle between the atomic axis/plane and the momentum of the 1 GeV particles incident on the crystal.

1. Trofymenko S.V., Kyryllin I.V. Eur. Phys. J. C. 2024. Vol. 84. P. 1207.

2. Trofymenko S.V., Kyryllin I.V. Eur. Phys. J. C. 2025. Vol. 85. P. 682.

3. Trofymenko S.V., Kyryllin I.V. arXiv:2511.13407.