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Channeling of Relativistic Electrons in Half-Wave Silicon Crystal and Corresponding Radiation

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Synopsis The new experiments on channeling of 255 MeV in a 0.7 μm silicon half-wavelength crystal were performed at SAGA LS facility. Both experimental and simulated electron angular distribution after the crystal and corresponding radiation spectra reveal the number of peculiarities.

Suggestion that the straight half-wavelength crystal (HWC) may serve for particles deflection, due to effect of particle "mirroring" was made first in [1]. HWC means, that the channeled particle experiences only one collision with crystallographic plane. Recently, the authors of Ref. [2] experimentally demonstrated that planar channeled 2 MeV protons were successfully mirrored by a thin silicon HWC. In our works [3-4] we performed the detailed experimental investigation and computer simulations of channeling of 255 MeV electrons in the 1 μm thickness silicon HWC. This thickness is slightly greater than the thickness of a half wavelength crystal which is determined by the formula [1]

$$\lambda/2 = \pi \frac{d_p}{2\theta_c}, \quad \theta_C = \sqrt{\frac{2U_0}{E}},$$

where d_p is the distance between channeling planes, θ_c is the critical channeling angle, U_0 is the maximal value of potential energy of the particle in the field of continuous potential for planar channeling, E is the energy of the particle. Due to this fact the effect of mirroring [3-4] was not brilliant.

Recently, the new experiments on channeling of 255 MeV in a 0.7 μm silicon HWC were performed at SAGA LS facility. Here we present the results of the new experiments and comparison with computer simulation. Now, the thickness of the crystal (0.7 μm) was closer to the necessary for 255 MeV electrons value of HWC thickness, therefore the angular distribution of electrons after the HWC crystal revealed the number of peculiarities.

The specifics of trajectories as well as very small crystal thickness should effect on the channeling radiation spectra of relativistic electrons in a HWC. In this work we calculated radiation spectrum from electrons channeled in a HWC and performed the comparison with radiation spectrum of electron moving in an arc [4] (never studied experimentally).

Further perspectives for experimental and theoretical studies of channeling and radiation in a HWC are discussed, too.

References

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