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PS1-06: Asymmetry in Generation of Near-surface X-rays by 33 MeV Electrons at Grazing Interaction with Thin Si Plate in Magnetic Field

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The effect of asymmetric near-surface X-rays generation, observed recently at a grazing interaction of 33 MeV electrons with a 56 μm Si plate placed along the electron beam in a goniometer into the betatron chamber in a magnetic field, is presented. The evolution of the angular patterns of X-rays generated when changing the orientation of the Si plate relative to the electron beam showed preferential generation of the radiation on the surface of the Si plate, which was outside with respect to the center of the accelerator. At grazing incidence of electrons on this surface of the Si plate, the additional radiation emitted along the surface in the cone, which is several times narrower than that of ordinary bremsstrahlung, was observed. At grazing interaction of electrons with the Si plate surface, facing towards the center of the accelerator, the generation of the near-surface radiation was not observed.

In the formation of the observed effect the surface effects for photons and electrons (such as photon emission, reflection and diffraction, as well, the electron diffraction and/or channeling) together with the influence of the magnetic field of the accelerator on the electron motion may be responsible. That influence may create on the outer surface of the Si plate a specific periodic "jumping" motion of electrons because the magnetic field can return back the electrons reflected from the Si plate. At the surface facing towards the center of the accelerator such a quasiundulator motion of electrons is impossible because the electrons reflected from the Si plate are immediately deflected from this surface by the magnetic field of accelerator.

In [1] it was shown that such a magneto-crystalline undulator can be realized with periodicity until micron region. The frequency and intensity of radiation from the magneto-crystalline undulator can be estimated using the corresponding formulas of the theory of radiation generated in ordinary magnetic undulator, which takes into account the Doppler effect and the coherent summation of radiation from different parts of the particle trajectory formed by magnetic field and by the average fields of the atomic planes or axis. In the case of high-energy electrons or positrons and strong enough magnetic field the radiation generated in magneto-crystalline undulator can be in the range of X-rays. But, in our case of 33 MeV electrons the radiation by this mechanism is very soft and such magneto-crystalline undulator can give additional components in the overall distribution of X-rays only due to multiple interactions of returning electrons with crystal surface.

The comparison of the magneto-crystalline undulator, a deformed crystal undulator [2] and a multicrystal undulator [3] consisted of a periodic set of ultrathin crystals with thicknesses of half period of trajectories of channeling particles is carried out.

References

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