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New Linear Microfocus Bremsstrahlung Source Based on Compact Betatron With Light and Heavy Narrow Targets inside

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The paper presents the results obtained in the study of the properties of bremsstrahlung generated at the grazing incidence of 18-MeV betatron electrons with narrow targets, 50 μm and 8 μm thick Si crystals and 13 μm thick Ta foil with a length of 4 mm along the electron beam, mounted in an internal goniometer inside the betatron chamber.

The results show strong changes in the angular distribution of radiation at the variation of the target orientation that is not observed in the case of normal incidence of electrons on the surface of a thin target. It is also shown that a light or heavy target enables generation of radiation with its predominant contribution to the x-ray or γ -ray spectral regions, respectively. The 18-MeV betatron-based linear microfocus source generates bremsstrahlung with a spectrum up to the electron energy, while microfocus X-ray tubes widely used for various purposes have so far attained the photon energy of 750 keV.

Radiation beams generated in the targets were used to obtain magnified images of a microstructure of 50 Pt and 8 W wires and of an object that consisted of four steel bars with 10 μm gaps between them mounted in an external goniometer. The images indicate high absorption and edge-phase contrasts of their components due to a small horizontal size of the radiation source, the width of which in the cases of Si crystals and Ta foil was 30-, 187- and 115-fold smaller than the diameter of the electron beam, respectively.

The obtained results attest to high quality of the radiation generated by the new microfocus source that can also be used in a laboratory physical experiment, for example, in materials science and x- and γ -optics.

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