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BRILLIANT X-RAY RADIATION FROM A LOW EMITTANCE 855 MeV ELECTRON BEAM*)

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Electron storage rings as synchrotron radiation sources are presently the most powerful x-ray sources in the energy range between 0.53 keV, the "water window" for microscopy of biological molecules, and 33.16 keV, the K-edge of iodine for a possible coronary angiography. However, with the advent of modern electron accelerators delivering high current low emittance electron beams with energies up to a few GeV it was realized that they may present also attractive sources of intense x rays. In this contribution we report on the investigation of resonant transition radiation in the x-ray region (XTR), and parametric x-ray radiation (PXR) as such x-ray sources. The experiments have been performed with the low emittance (3 π nm rad) 855 MeV electron beam of the Mainz Microtron MAMI.

The interference of XTR produced from a periodic stack of four polyimide foils (thickness 7.2 μm, separation 162 μm) [1] and four titanium foils (thickness 6.0 μm, separation 294 μm) was investigated. Transition radiation has been observed in the energy range from 2 to 15 keV. A good energy resolution of 0.8 keV and angular resolution of 0.15 mrad was achieved simultaneously allowing for the first time to quantitatively study the interference pattern. Good agreement with theoretical calculations is found. *The experiments prove that at the K-edge of titanium narrow band transition radiation* is emitted. Calculations show that the spectral brilliance of XTR should reach that of modern synchrotron radiation sources without insertion devices. Peculiarities of such a x-ray beam, as controllable time structure or its high energy bremsstrahlung content, are discussed as well as the status of the x-ray beam project at MAMI.

Parametric x-ray radiation is emitted if a highly relativistic electron beam traverses a crystal. The x-ray energy is tuneable in the interval between some keV to several 10 keV. The radiation has a highly directional angular distribution with a characteristic width in the order of $1/\gamma$, with γ the Lorentz factor. To further investigate the features of PXR we measured the angular distribution at various crystal reflection planes of silicon, the energy width with a critical absorber technique, and the intensity as function of the crystal thickness and electron beam energy (180 to 855 MeV). The results will be compared with the Feranchuk-Ivashin theory of PXR [2].

References

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2) I.E. Feranchuk, A.V. Ivashin, J. Physique 46 (1985) 1981.

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