THE DOSE FIELD OF NANOSECOND PULSE SOURCE OF BREMSSTRAHLUNG X-RAY RADIATION

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The bremsstrahlung spectrum of the nanosecond electron accelerator on the basis of the vacuum diode supplied by the high-voltage nanosecond generator SINUS – 150 [1,2] with the coaxial forming line combined with the transformer has been monochromatizated by a tungsten crystal under the Bragg – geometry ($\theta_B = 45^0$) (see fig. 1).

In [3] it was shown that by combining a crystal target and a 10 MeV linac bremsstrahlung source, it was possible to construct a tunable gamma-ray source producing monochromatic gamma-ray beams with ranging from 75 keV up to one MeV. We tested the similar technique for high-current low energy electronbeam.

The high-current (2 kA) electric beam created by the "blade" metallodielectric cathode (Fig.2).

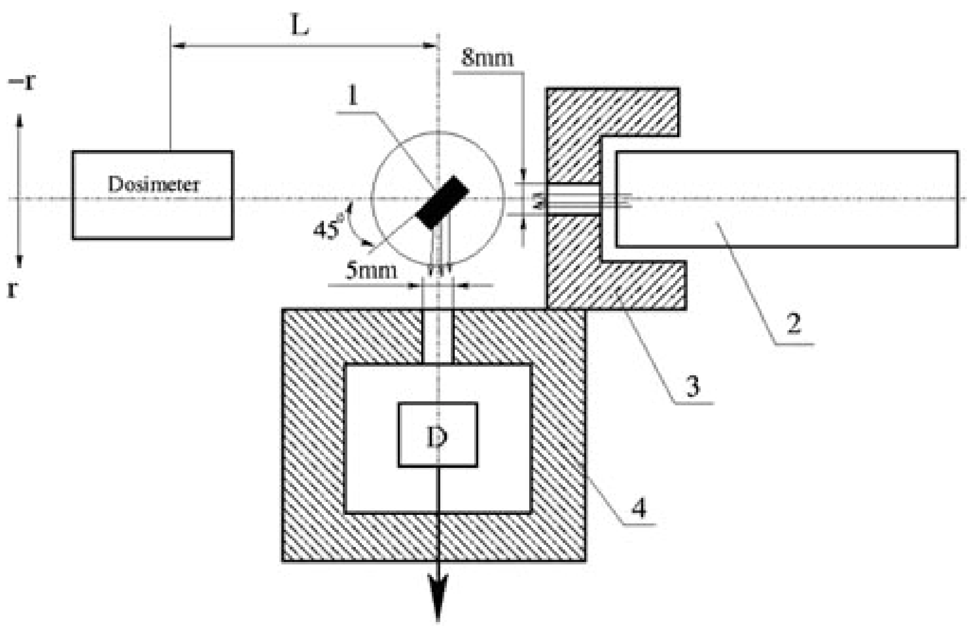

Figure 1: Geometry of experiment: 1. tungsten target; 2. accelerator; 3,4. Pb-sheet; D – detector

Figure 2: "Blade" metallodielectric cathode 100мм diameter.

The cathode resource can achieve 10^8 pulses. The cathode diameter is 20mm. The planar vacuum diode construction and converter are shown in fig.3. The accelerated electrons at the collector 3 from the stainless steel 1mm in thickness have generated a bremsstrahlung spectrum with suppressed low energy part. The collector is cooled by the running water. The top frequency of pulse repetition is about 100Hz and is limited by the cathode overhead and, consequently, by its resource reduction. The accelerator parameters: the voltage on the cathode is 310kV, the beam current is 2,7kA, the pulse duration at the half-height is 4ns.

The SINUS accelerators are the direct operation accelerators and are used for electron forming in the plane diodes and in the diodes with the coaxial electron beam in the magnetic field. The accelerating voltage is given on the vacuum diode cathode. The accelerating pulse front duration is 3÷20ns, that supplies the condition for the explosive electron emission rise on the cathode. In this case the electron are emitted from the plasma rising on the cathode surface, that allows the electron flows to be formed with the particle density of $10^{14}÷10^{17}cm^{-3}$.

The dose field map (fig.4) has been taken by the dosimeter DKD – 01 (Russia) on the basis of the diamond detector in the median acceleration plane. The resulting bremsstrahlung beam divergence was measured by moving the dosimeter along direction r.

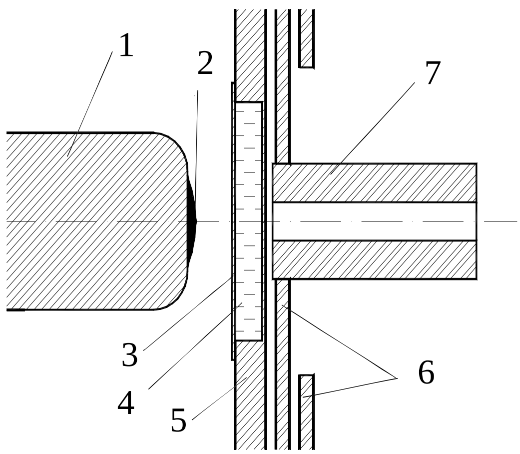

Figure 3: Construction of vacuum diode and X-ray convertor. 1 – catode-keeper, 2 – metallodielectric cathode, 3 – convertor, 4 – water, 5 – anode, 6 – Pb-sheet, 7 – collimator.

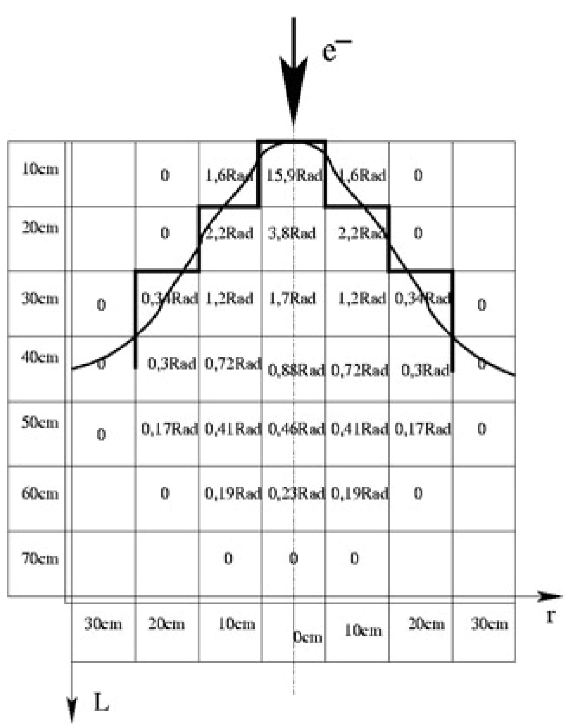

Figure 4: The dose field map.

It has been shown that the maximum dose is 16 rad/s at the distance of 10 cm from the collector, then it falls down proportionally to the square of distance to the level less than 0.1 rad/s at the distance of 1 m (fig.5). To monochromatize the bremsstralung spectra we used tungsten <111> crystalwith thickness 0,5mm and diameter 10mm.

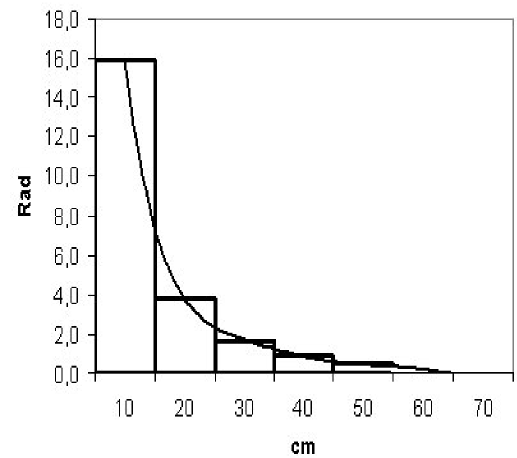

Figure 5: Histogram of fall down dose as a distance from convertor.

The X-Ray spectrum has been measured by the silicon semi-conductor X-ray spectrometer with energy resolution 280 eV for 5,9 keV.

It has been shown that the two maximum at the spectrum 6,3 and 12,6 keV corresponds the second and third orders of diffraction on (111) planes of tungsten crystal (fig.6). It means that using the flat crystal monochromator one may obtain the tunable X-ray source based on low energy electron accelerator. This work is supported by Grant RFFI-05-08-50244-a.

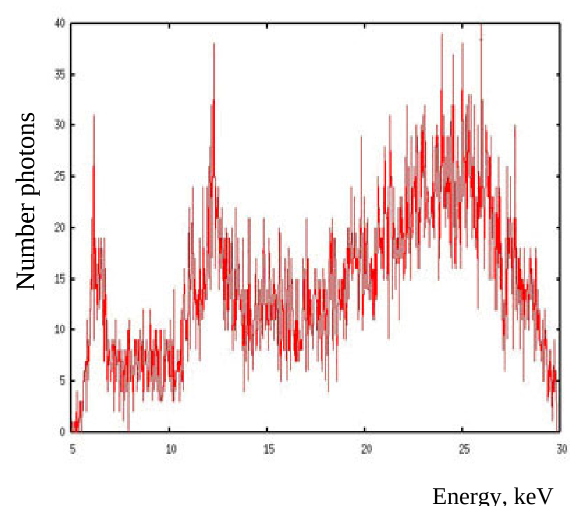

Figure 6: X-ray spectrum from tungsten crystal.

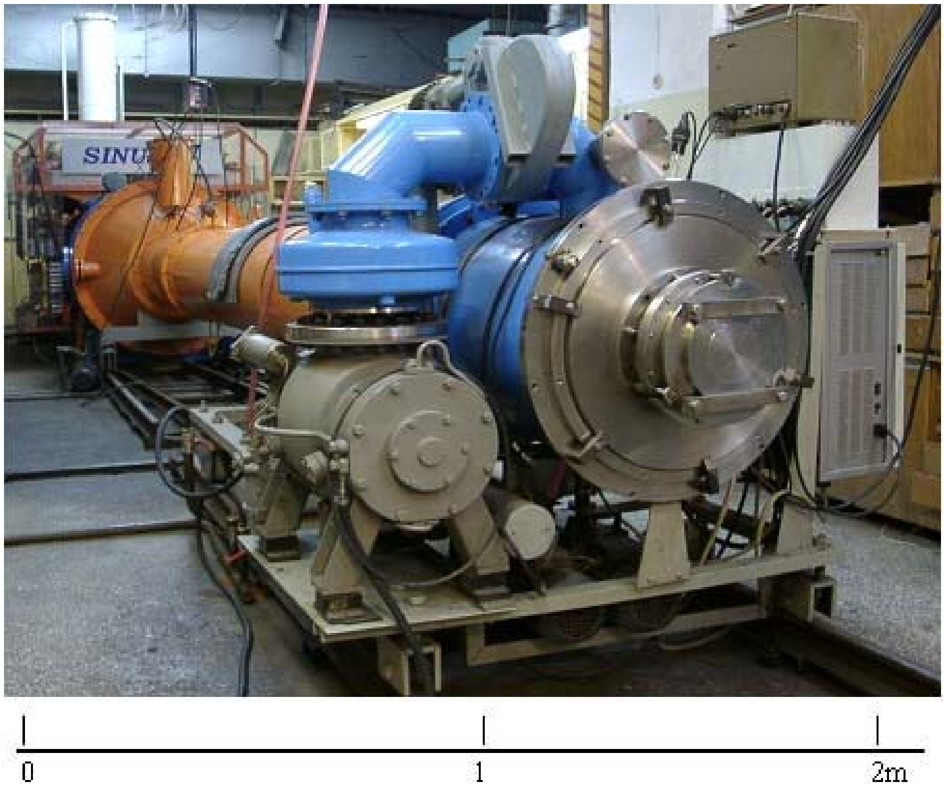

Figure 7: Outword appearance of accelerator.

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