

# BREMSSTRAHLUNG FROM A NEW TYPE OF TARGET: INCREASED INTENSITY AND AVERAGE ENERGY, AND REDUCED DIVERGENCE

B.Bogdanovich, V.Kudinov, A.Nesterovich, Yu.Pomasan, E.Tsygankov, V.Janenko,  
Moscow Physics Engineering Institute, 115 409 Kashirskoe shosse, 31, Moscow, Russia

The purpose of the present work is the study of increase opportunity of electron bremsstrahlung in narrow bodily angle at forward direction.

Main factor, influencing on bremsstrahlung intensity for electron fixed energy and target material, is target thickness. During electron interaction with substance two competitive processes are observed: bremsstrahlung photons' generation, the number of which is increased with growth of thickness, and photons' absorption and scattering in target material. For all target materials there is such thickness (so named "optimum thickness"), at which maximum significance of bremsstrahlung intensity is observed. Optimum thickness for various materials of targets usually satisfies to thickness close to  $(0.1-0.3)$  radiating lengths [1,2].

The angular distribution width increase of bremsstrahlung with target thickness growth is stipulated, mainly, electrons multiple scattering in target material.

Therefore one of ways of bremsstrahlung output increase in narrow bodily angle at forward direction can lay in electrons angular divergence reduction.

Such way can be realized by means of beam repeated passage method through the thin target. At this method photons' absorption is practically eliminated, the electrons' energy will be realized completely, i.e. the way, that electrons pass, corresponds to its run, that, in turn, will cause bremsstrahlung output increase.

Characteristic researches of the electrons' bremsstrahlung generated by multiple beam passage through thin target were conducted at experimental stand based on electron linear accelerator with travelling waves. Accelerator (see figure) has following parameters of a accelerated beam: energy 3 - 6 MeV, average current 0 - 60  $\mu\text{A}$ , current pulse duration 0.5-2.0  $\mu\text{s}$ . The beam parameters were received at klystron pulse power about 12 MW.

Electron beam, leaving accelerator, has some angular divergence, therefore narrow directed beam was formed by collimator with 30 mm length and aperture diameter of 8 mm. Aluminium was used as the collimator material. Such choice is connected that aluminium has small bremsstrahlung output energy, that, in turn, permits to provide a small level of background radiation, arising as a result of electrons' interaction with collimator material. Electron beam formed by collimator fell into electron-

guide fabricated from iron, which executed a role of the magnetic screen. After electron-guide leaving the electron beam gets into magnetic field. Adjusting magnetic field strength in magnet, it is possible to transform electrons' trajectory in circular orbit. The sizes of the area with uniform magnetic field of this magnet permit to provide circular orbit of electrons with energy 4.5 MeV on the diameter about 120 mm. Maximum magnetic field at median plane of electron beam rotating area was equalled 2830 gauss.

The bremsstrahlung registration expediently to execute under a corner  $90^\circ$  with respect to the beam motion direction in accelerator, since in this direction background minimum level. Such background always takes place in accelerating structure of linac because of small beam waste in it. On this basis target unit is placed on distance, equal quarter of circle length, describing electron orbit, from place of beam entry into magnetic field

Target unit consists from thin aluminium foil by the size 50-20 mm, fixed on ceramic pillar and electrically insulated from the chamber. This construction has allowed to execute beam current control, dropping on the target. The aluminium target thickness makes 100  $\mu\text{m}$ , i.e.  $\sim 1.1 \cdot 10^{-3}$  radiative length. The electron energy was defined from passage curve in aluminium, measured with help multi-plate Faraday cylinder. Electron energy has made 4.5 MeV.

Electron current, measured from the conversional target at magnetic field value provided circular electron orbits in the chamber, makes 1  $\mu\text{A}$ .

Analyzing received data, it is possible to generalize that use of method of electron repeated passage through conversional target increases bremsstrahlung output in 1.9 times in comparison with use of the optimum thickness target.

## REFERENCES

- [1] Kovalev V.P. Secondary Radiation of Electron Accelerators.-Moscow, Atomizdat, 1979, 200 pp. (In Russian).
- [2] Dickinson W.C. Lent E.M. Calculation of Forward Bremsstrahlung Spectra from Thick Targets. - UCPL - 50 442, 1968.

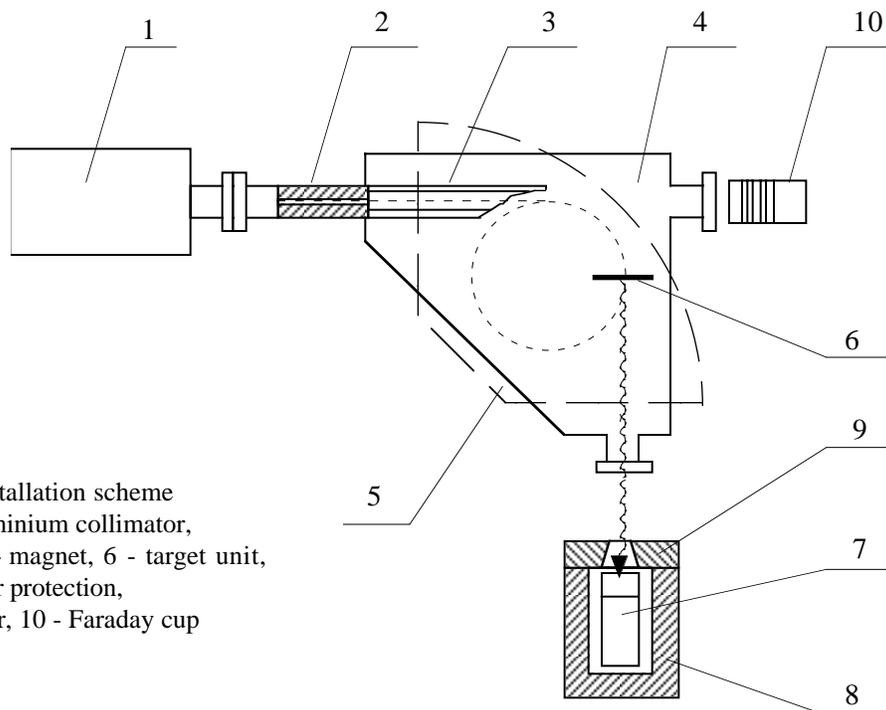


Fig. Experimental installation scheme  
 1 - accelerator, 2 - aluminium collimator,  
 3 - magnetic screen, 5 - magnet, 6 - target unit,  
 7 - detector, 8 - detector protection,  
 9 - plumbum collimator, 10 - Faraday cup