

## POSSIBILITY OF AN ELECTRON BREMSSTRAHLUNG OUTPUT INCREASE BY USE OF A CONVERSION TARGET PLACED IN A FOCUSING MAGNETIC FIELD

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### Abstract

The dependences of bremsstrahlung output at electron energy about 100-300 MeV on multi-layer target, placed in a focusing magnetic field, thickness are presented. The system suggested is intended for an intensive bremsstrahlung flow formation on objects, which are removed from radiator on significant distance. Such radiator, in particular, can be used at monitoring the Earth atmosphere from space and at sounding planets with the help of space vehicles. It is shown, that the bremsstrahlung output from 10-layer copper target, placed in a focusing magnetic field, exceeds the one from an optimum target at registration cone of  $1^\circ$  in 3 times. The magnetic field influence on bremsstrahlung angular distribution width is investigated.

The method of a narrow-angle electron bremsstrahlung flow formation by use of a multi-layer conversion target is resulted in [1]. In the report given to estimate limiting parameters of electron bremsstrahlung flow, which can be achieved using a multi-layer target method, the electron bremsstrahlung characteristics were calculated for such a case, when the electron beam on an input of each subsequent target layer became monodirected. In other words, it was supposed such magnetic field in an interval between a target layers, which completely would cancel angular electrons divergence, arising from their passage through the previous a target layer.

The power and angular characteristics of bremsstrahlung for electron energy 30 - 300 MeV and various target materials were calculated by a Monte-Carlo method. Thus the calculation model of fast electron transfer, based on the "condensed" trajectories method with inclusion so-called "catastrophic" collisions, was used. Such collisions change the size of elementary pieces, at crossing which the effects of multiple scattering and electron energy losses are taken into account. The effects concerning the large energy losses caused by secondary delta - electron formation and generation of high-energy bremsstrahlung quanta are considered as "catastrophic" events.

To estimate the quality of electron bremsstrahlung characteristics calculation model given, calculation results were compared with the literary data.

In a Figure 1 the calculated energy distributions of 25 MeV electron bremsstrahlung, falling on a tantalum target by thickness of 4,06 mm and experimental data from [2] are submitted. Experimental data of [2] were obtained with use of measurement method based on deuteron

photodisintegration, so we defined the bottom bound of a bremsstrahlung spectrum, as value about 4 MeV. The rather good coincidence of our calculated data and experimental one is observed. The comparison analysis of our calculated data, to the characteristics, available in the literature, shows a high degree validity of data obtained by method suggested.

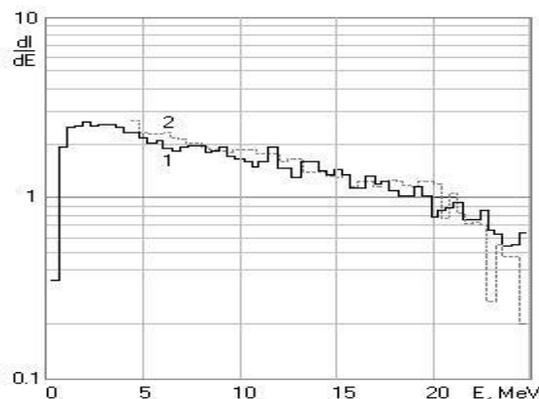


Figure 1: The calculated energy distributions of 25 MeV electron bremsstrahlung for a tantalum target with thickness of 4,06 mm (trace 1) and experimental data from [2] (trace 2).

In a Figure 2 - 4 the dependences of electron bremsstrahlung photons number output with energy 100, 200 and 300 MeV from a copper multi-layer target at a registration cone  $\theta = 1^\circ$  are given at presence of a focusing magnetic field in space between layers. Traces 2, 3, 4, 5, 6, 7 are corresponding to 2, 3, 4, 5, 7, 10 number of target layers.

In the same figures the monolayer target output curve (trace 1) is represented. As well as it was necessary to expect, the bremsstrahlung output depends on number of target layers and, for example, for electron energy 300 MeV, the maximal output from a ten-layer target exceeds an output from a "optimum" monolayer target in 3 times. Thus the one layer thickness of ten-layer target is equal to 0,05 rad. length.

In a Figure 5 the 300 MeV electron bremsstrahlung energy distribution for a registration cone of  $1^\circ$  for monolayer, five-layer and ten-layer targets of "optimum" thickness is shown.

In a Figure 6 the angular distributions, and in a Figure 7 relative angular distributions of 300 MeV electron bremsstrahlung from monolayer, five-layer and ten-layer targets of "optimum" thickness are given. It is visible, that if number of layers increase, semi width of angular

distribution becomes less. Such situation is caused by fact that, to obtain the maximal output, when increase target layers number each separate layer becomes thinner.

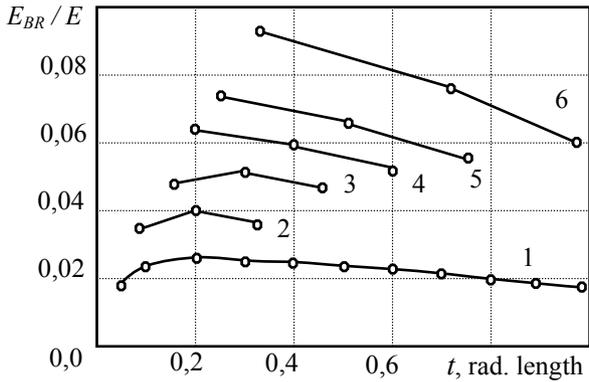


Figure 2: the dependences of 100 MeV electron bremsstrahlung photons number output  $E_{BR}/E$  on a total target length  $t$  at registration cone of  $1^0$

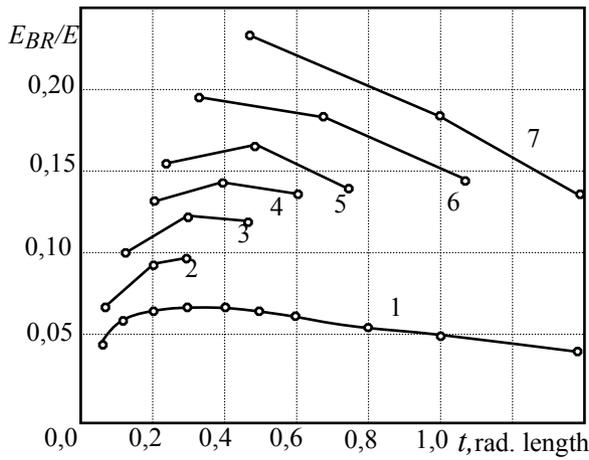


Figure 3: the dependences of 200 MeV electron bremsstrahlung photons number output  $E_{BR}/E$  on a total target length  $t$  at registration cone of  $1^0$

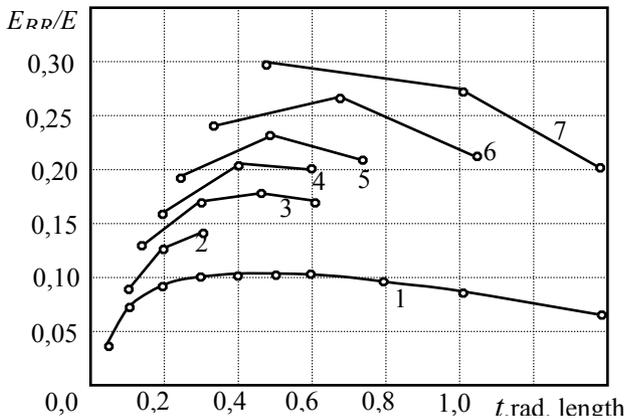


Figure 4: the dependences of 300 MeV electron bremsstrahlung photons number output  $E_{BR}/E$  on a total target length  $t$  at registration cone of  $1^0$

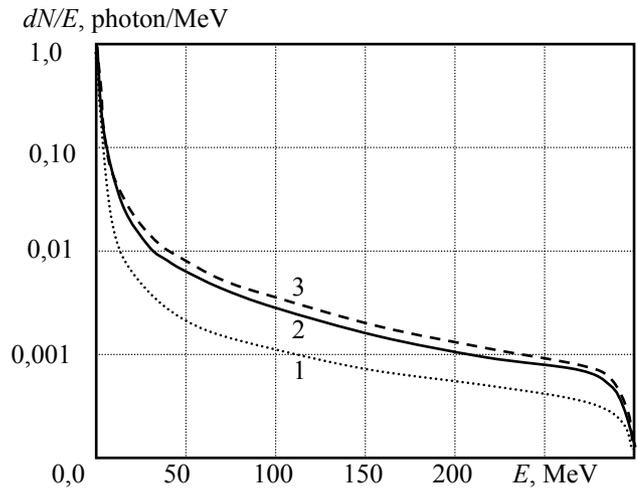


Figure 5: the 300 MeV electron bremsstrahlung energy distribution at a registration cone of 10 for monolayer (1), five-layer (2) and ten-layer (3) targets of "optimum" thickness

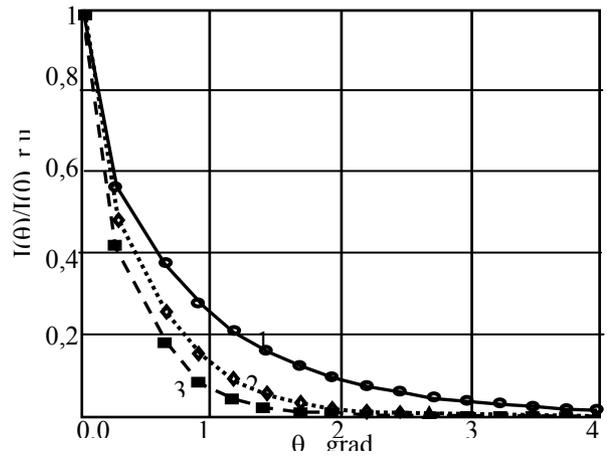


Figure 6: the angular distributions of 300 MeV electron bremsstrahlung from monolayer (1), five-layer (2) and ten-layer (3) targets of "optimum" thickness

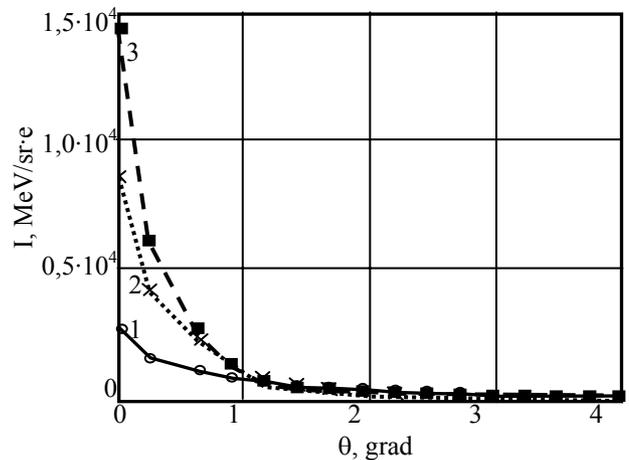


Figure 7: relative angular distributions of 300 MeV electron bremsstrahlung from monolayer (1), five-layer (2) and ten-layer (3) targets of "optimum" thickness

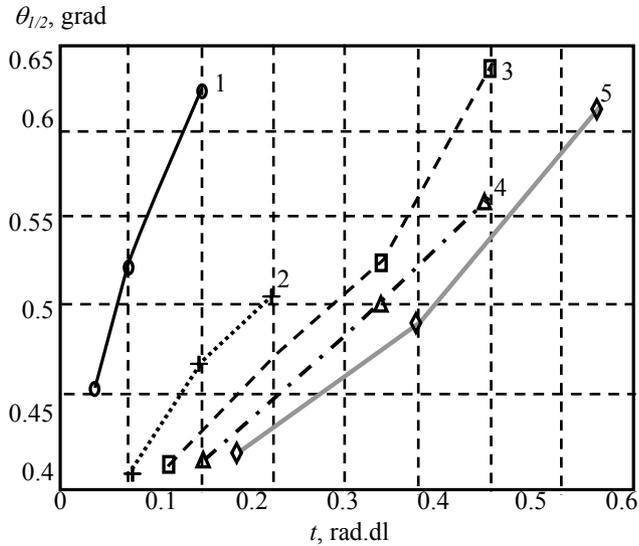


Figure 8: the dependence of 300 MeV electron bremsstrahlung angular distribution semi width on thickness of two - , three - , four - and five- layer copper targets with a focusing magnetic field in space between layers (traces 2, 3, 4, 5, 6 accordingly) and monolayer target (trace 1)

In a Figure 8 the dependence of electron bremsstrahlung angular distribution semi width on thickness of two -, three -, four - and five-layer a copper targets at energy 300 MeV is presented. It is necessary to

note, that semi width of electron bremsstrahlung angular distribution at energy 300 MeV for "optimum" ten-layer copper target is equal to  $0,5^{\circ}$ .

Thus, the research carried out has shown, that use of multi-layer target placed in a focusing magnetic field, increases an electron bremsstrahlung output, and, the more is number of layers, the more is output. So, for example, for ten-layer target the output, in comparison with monolayer "optimum" target, grows at electron energy 300 MeV in 3 times, and at 100 and 200 MeV - almost in 4 times. Thus, semi width of bremsstrahlung angular distribution becomes less, than one of monolayer "optimum" target.

## REFERENCES

- [1] Formation of Bremsstrahlung Flow with Small Divergence at Linac Output for Planet Surface Sounding with Interplanetary Space Stations. Auth.: B. Bogdanovitch, V.Kudinov, S.Minaev, A.Nesterovitch, Yu.Pomazan. Proceedings of the 1999 Particle Accelerator Conference, New York, 1999, p.1291-1293.
- [2] Lambert R.P., Jury J.W., Sherman N.K. Measurement of Bremsstrahlung Spectra from 25 MeV Electrons on Ta as a Function of Radiator Thickness and Emission Angle, Nucl.Insfr. and Meth., 214, 1983, pp.349-360.