EXPERIMENTAL AND NUMERICAL STUDY OF DAMAGE TO CONSTRUCTION MATERIALS INTENDED FOR THE FIRST WALL OF POWERFUL PLASMA UNITS BY A HIGH-CURRENT RELATIVISTIC ELECTRON BEAM [[1]](#footnote-1)\*)

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1,3,4Kazakov E.D., 1Bobyr N.P., 1Krutikov D.I., 1Orlov M.Yu., 1,3Smirnova A.R., 1Spitsyn A.V., 1Strizhakov M.G., 2Sunchugashev K.A.

1NRC "Kurchatov Institute", Moscow, RF
2RUDN University, Moscow, RF
3MIPT, Dolgoprudny, Moscow region, RF
4NRU MPEI, Moscow, RF

In the event of emergency situations at powerful plasma installations, plasma flows or beams of charged particles can hit the wall of the vacuum chamber, leading to its damage [1]. In this work, we studied samples of polycrystalline tungsten (Goodfellow) and ferrite-martensitic corrosion-resistant steel EK-181 (Rusfer). Preliminary experiments carried out at the Kalmar high-current electron accelerator demonstrated that repeated exposure to an electron beam with an energy of about 100 J eads to significant melting of steel and cracking of the surface of tungsten samples [2].

A new series of experiments is intended to assess the difference between a powerful single exposure and a series of moderate exposure. Also, a numerical simulation of the deceleration of electrons in the samples was carried out.

The simulation of the effect of relativistic electron beam on the sample under study was carried out using the "Cascade" program (hereinafter referred to as the Program), which implements the Monte Carlo method. The program is designed to calculate the linear characteristics of the fields of electrons, positrons and gamma-quanta in a general inhomogeneous medium, which is a cylinder, divided into zones of uniform composition of different radii and thicknesses. The program combines two main methods for calculating electron fields by the Monte Carlo method: the segment model [3] and the catastrophic collision model [4]. The Program implements algorithms for grouping small energy transfers for electrons and positrons and analog simulation for gamma quanta in the energy range 0.01 - 105 MeV to simulate the paths between catastrophic collisions. The production of secondary charged particles and gamma quanta is modeled in the same way as in the model of catastrophic collisions [5]. The calculation results were: the depth of electron ranges inside the targets, the depth of energy release, and the energy of bremsstrahlung.

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References

1. Savrukhin P.V., Shestakov E.A., Borshegovsky A.A. // VANT. Ser. Thermonuclear synthesis, 2017, vol. 40, no. 4. P. 50–62.
2. Bobyr N.P., Kazakov E.D., Krutikov D.I., et al. // Laser, plasma research and technologies LAPLAZ-2021 Collection of scientific papers VII International conference. Moscow, 2021 S. 399-401.
3. Berger M. J. Monte Carlo calculation of the penetration and diffusion of fast charged particles // Methods in Computational Physics. – 1963. – Т. 135.
4. Akkerman A.F., Nikitushev Yu.M., Botvin V.A. Solution by the Monte Carlo method of problems of the transfer of fast electrons in matter // Alma-Ata: Nauka. - 1972 .-- S. 166.
5. Plyashnikov A. V., Kolchuzhkin A. M. Calculation of radiation fields of a point mono-directional source of fast electrons by the Monte Carlo method. - 1976.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Pt/ru/GW-Kazakov.docx) [↑](#footnote-ref-1)