CONVERSION OF THE PLASMA CURRENT MAGNETIC ENERGY INTO THE KINETIC ENERGY OF RUNaway ELECTRONS DURING TOKAMAK disruptions [[1]](#footnote-1)\*)

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One of the many damage causes to the first wall of the tokamak vacuum chamber is a large flux of thermal energy locally ejected onto the wall by runaway electrons (REs) during disruptions. Studies show [1, 2] that the accumulated RE energy can reach 100 MJ at the ITER, and the surface area of the chamber wall on which the energy is released is quite small. The conditions for the establishing of a regime in which electrons accumulate high energy are currently not fully understood [1–3].

In this paper, within the framework of a model that includes a plasma column, a vacuum gap, and a tokamak chamber wall, the process of conversion of the plasma current magnetic field energy into the kinetic energy of REs at the termination of discharge disruption is studied. Following the works [1, 2], the energy transferred from the magnetic field to the REs is expressed by the formula:

 (1)

Here *a* is the small radius of the tokamak, *σp* is the plasma conductivity, *EC* is the critical field, *Jp* and *JRE* are the total plasma current and RE current, respectively. Integration is performed over the plasma volume and over the time of the process under consideration (termination).

Providing that there is no displacement of the plasma column and the current density is uniform over the plasma cross section, the time dependences of the currents are found from the system of differential equations of the first order, taking into account Ohm's law [4]:

 (2)

Here *Jw* is the current in the chamber wall, *Rp* is the plasma resistance, *Lp* и *Lw* are the plasma and wall inductances, respectively, is the flux function of external currents at the plasma boundary,  is the time constant.

With a constant flux function of external currents for the standard parameters of the discharge at the ITER tokamak used in [1, 2], the value of 66.47 MJ obtained for the field energy converted into REs kinetic energy almost coincides with the corresponding value in [1] (~ 70 MJ) and several times less than the value indicated in [2] (~270 MJ). This may be due to taking into account in the presented paper the finite resistivity of the chamber wall (a significant part of the runaway electron current at the termination is converted into a current in the wall, which leads to significant energy losses in it), as well as taking into account in [2] the generation of runaway electrons due to avalanche mechanism (enhancing the conversion), which is not considered in this work.

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/CI-Savin.docx) [↑](#footnote-ref-1)