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PHYSICAL KINETICS OF RUNAWAY ELECTRONS DURING THE BREAKDOWN OF GAS-FILLED HIGH-PRESSURE GAPS

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A high-voltage high-pressure discharge with runaway electrons has been intensively studied in recent years [1]. As a result, the level of understanding of the main processes in this phenomenon has increased significantly. If at first only the criterion of the generation of runaway electrons (exceeding the threshold field strength) was used, then the modern kinetic theory of this phenomenon does not need the concept of a threshold field.

The kinetic approach to describing electrons can be effectively integrated into the hydrodynamic theory of streamer breakdown of gas-discharge gaps. Advanced multi-fluid breakdown theory can describe in detail not only one-dimensional, but also two-dimensional discharge gap configurations. If a gap configuration has a direction of spatial symmetry (plane or axis of symmetry), then the kinetic method of describing an ensemble of electrons can be implemented along this direction. The hybrid method makes it possible to bring simplified theoretical models as close as possible to experimental conditions. In this paper, the advantages of the method will be demonstrated with some examples. Figure 1 shows an example of a hybrid simulation.

A complete kinetic approach, unfortunately, we can implement only within the framework of a 1D1V-dimensional model. But even these limited possibilities make a great contribution to our understanding of the key factors that determine the current, the pulse duration, and the energy spectrum of the runaway electron beam.

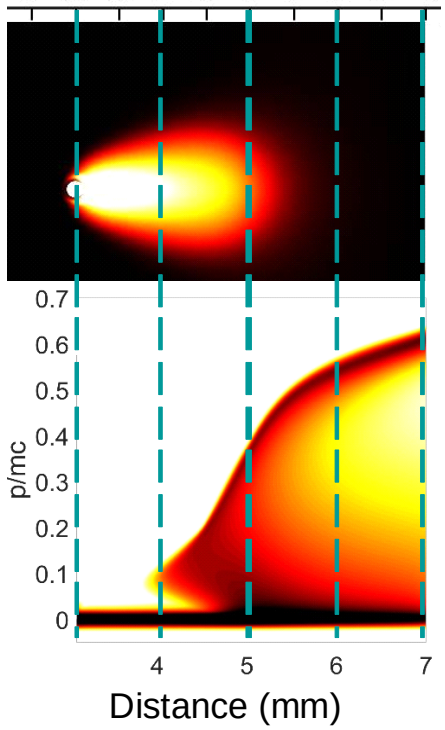

Fig.1. Instantaneous pattern of plasma number density distribution, $n(x,z)$ (top) and space-momentum distribution function of the electron ensemble, $f(z,p,t_0)$ (bottom) at time point of t_0=330 ps after applying a voltage pulse with amplitude of 140 kV to the 4 mm gap "200 μm diameter wire - plane anode" filled with nitrogen at 1 atm.

REFERENCES

[1] Generation of Runaway Electron Beams and X-Rays in High Pressure Gases. Volume 2: Processes and Applications / Edited by Victor F. Tarasenko. – USA, NY: Nova Science Publishers, 2016. – 331 p.