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Simulation of the simplest reactor model of the dynamics of runaway electron avalanches in thunderclouds

Daria Zemlianskaya
Egor Stadnichuk

zemlianskay.d@phystech.edu

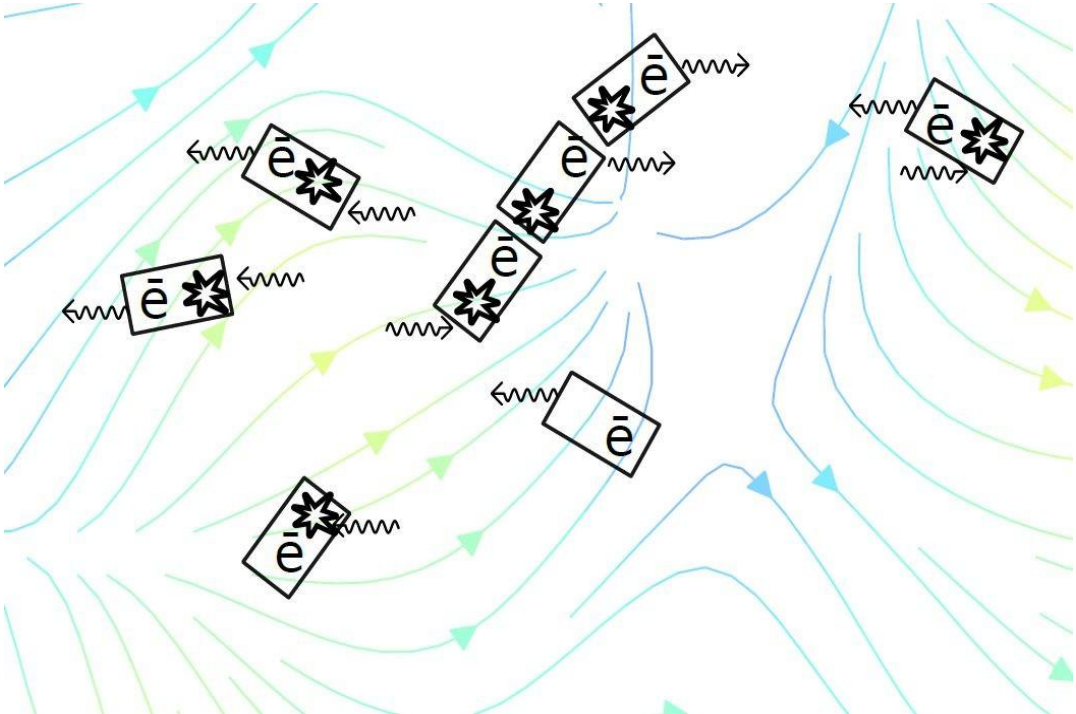
MIPT NPM INR

Reactor model

The models assume the dynamics of electron avalanches inside regions with a uniform electric field.

Infinite feedback in a cell, that is, when the movement of particles in such a cell does not die out, creates a cycle that triggers the generation of TGF and communication between cells in the cloud.

Infinite feedback can appear in a system with a large number of separate fields - cells with a uniform field.



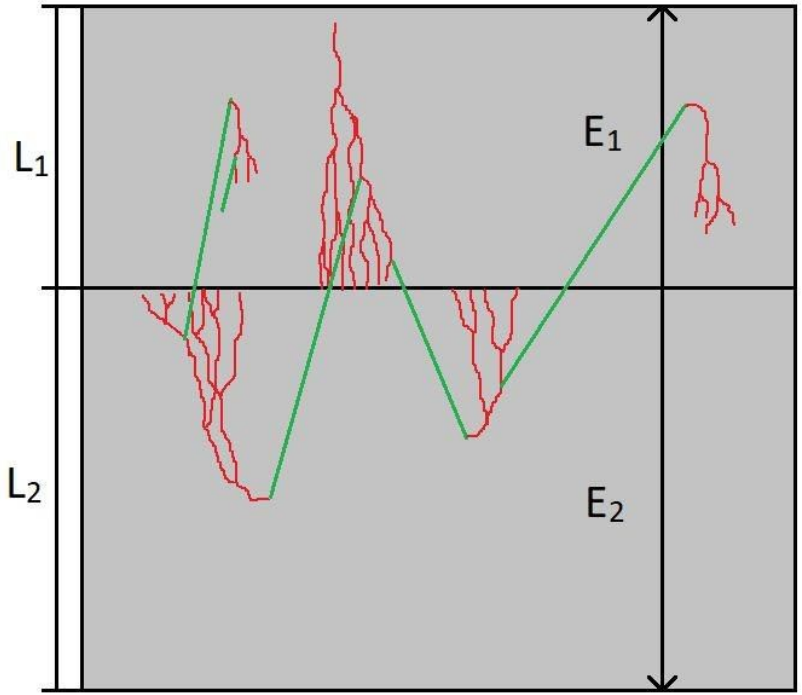
zemlianskay.d@phystech.edu

The simple reactor

In this case, an infinite amplification of the process due to the exchange of gamma rays is possible.

Gamma radiation will make an overwhelming contribution to the feedback.

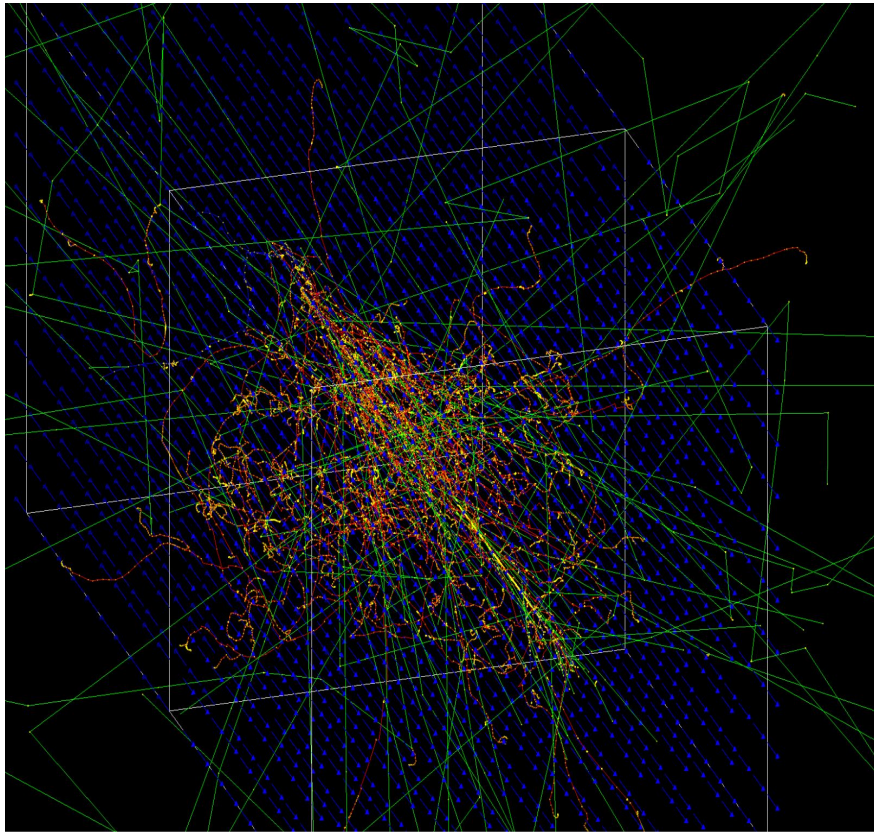
The contribution from the electrons of the primary avalanche can be neglected.

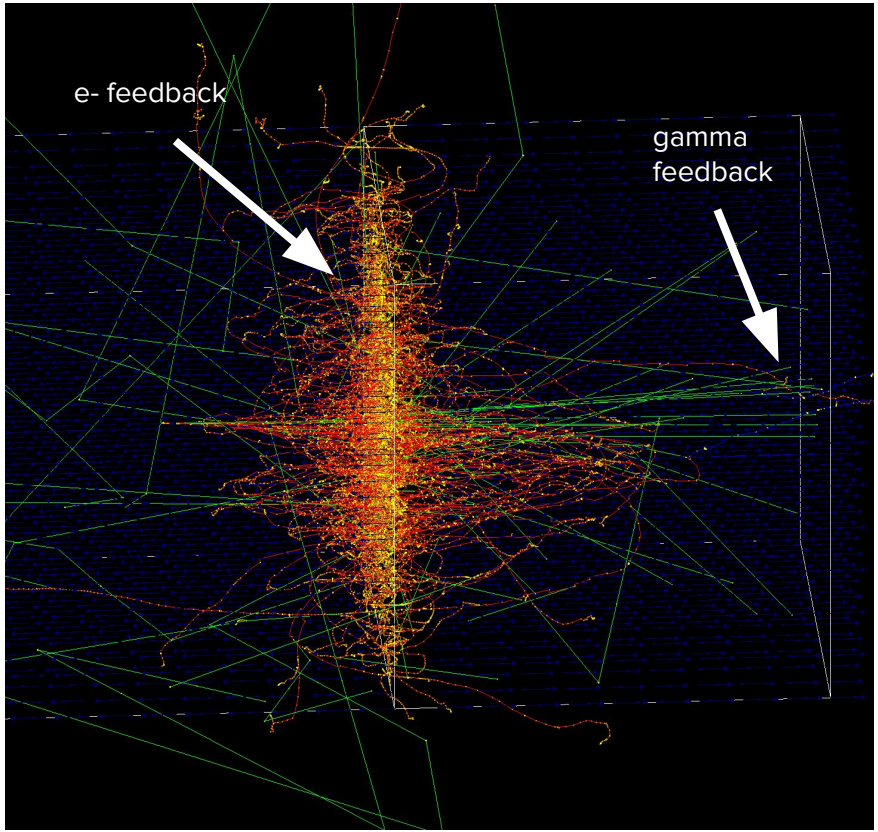


Red - e-, green - gamma

The simple reactor

Geant4 simulation





red - e- green - gamma

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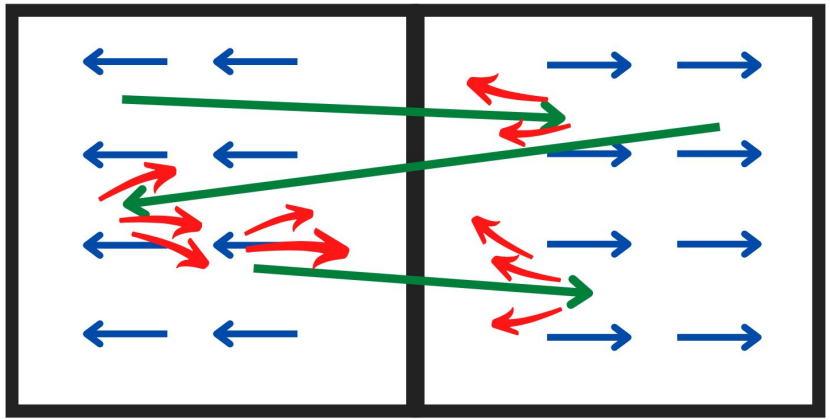
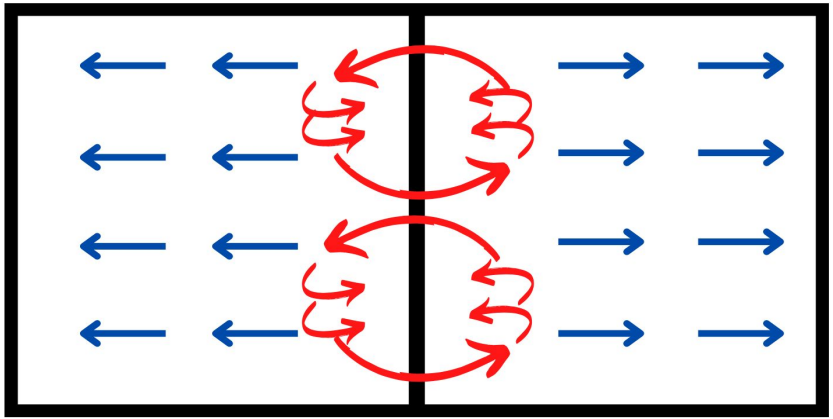
Feedback between reactor cells

gamma feedback



e- feedback

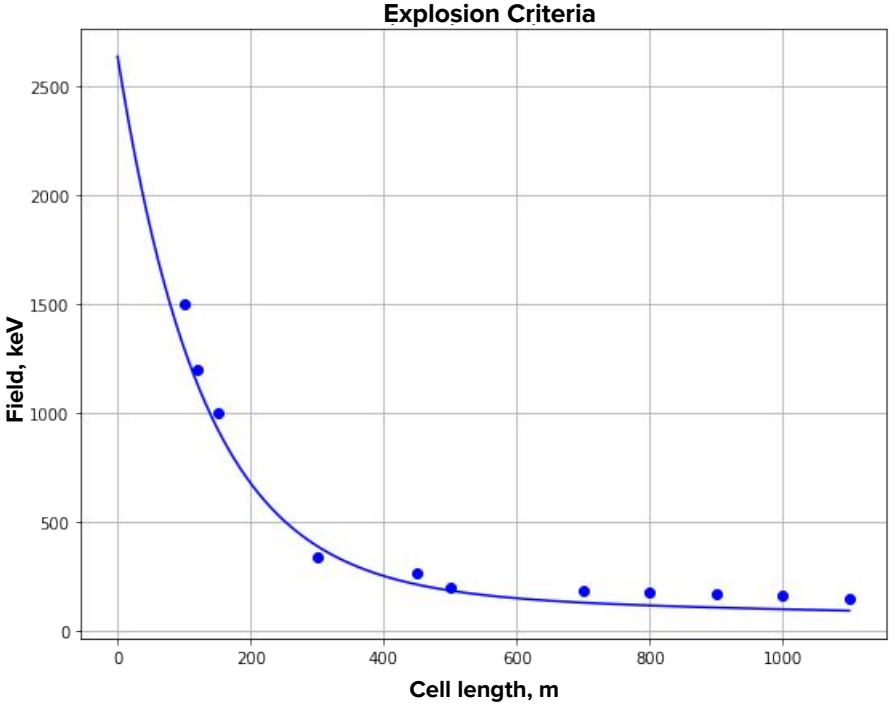


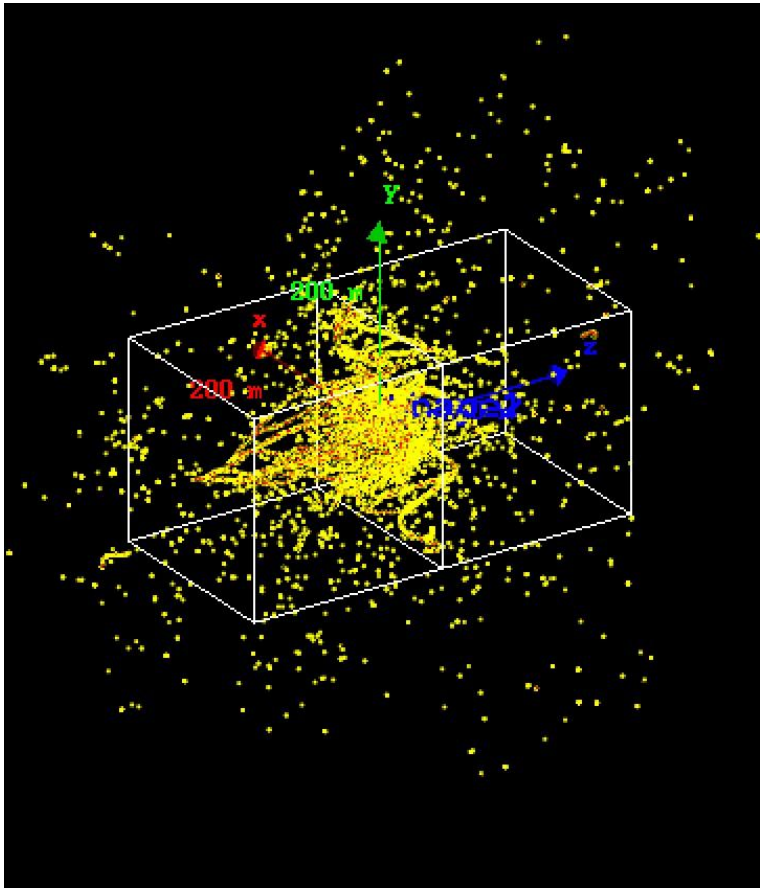
Gamma propagate over long distances and give rise to an avalanche of runaway electrons, which can also give birth to a gamma, which will loop the process.

Electrons circulate around the cell interface and at the same time give rise to new avalanches, which also begin to circulate over short distances (about 100 m), which maintain the connection between the cells, despite the force of friction against the air in the cell.

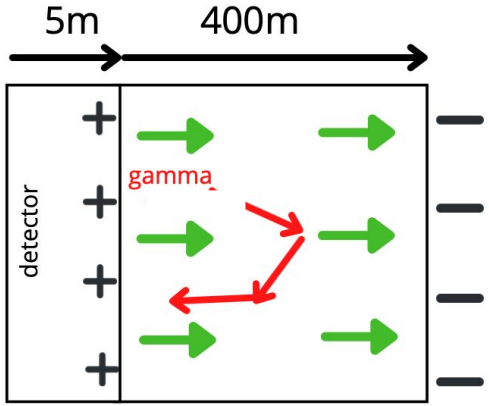
Critical values

100 gamma rays with an energy of 5 MeV are launched. The air density corresponds to 10 km.

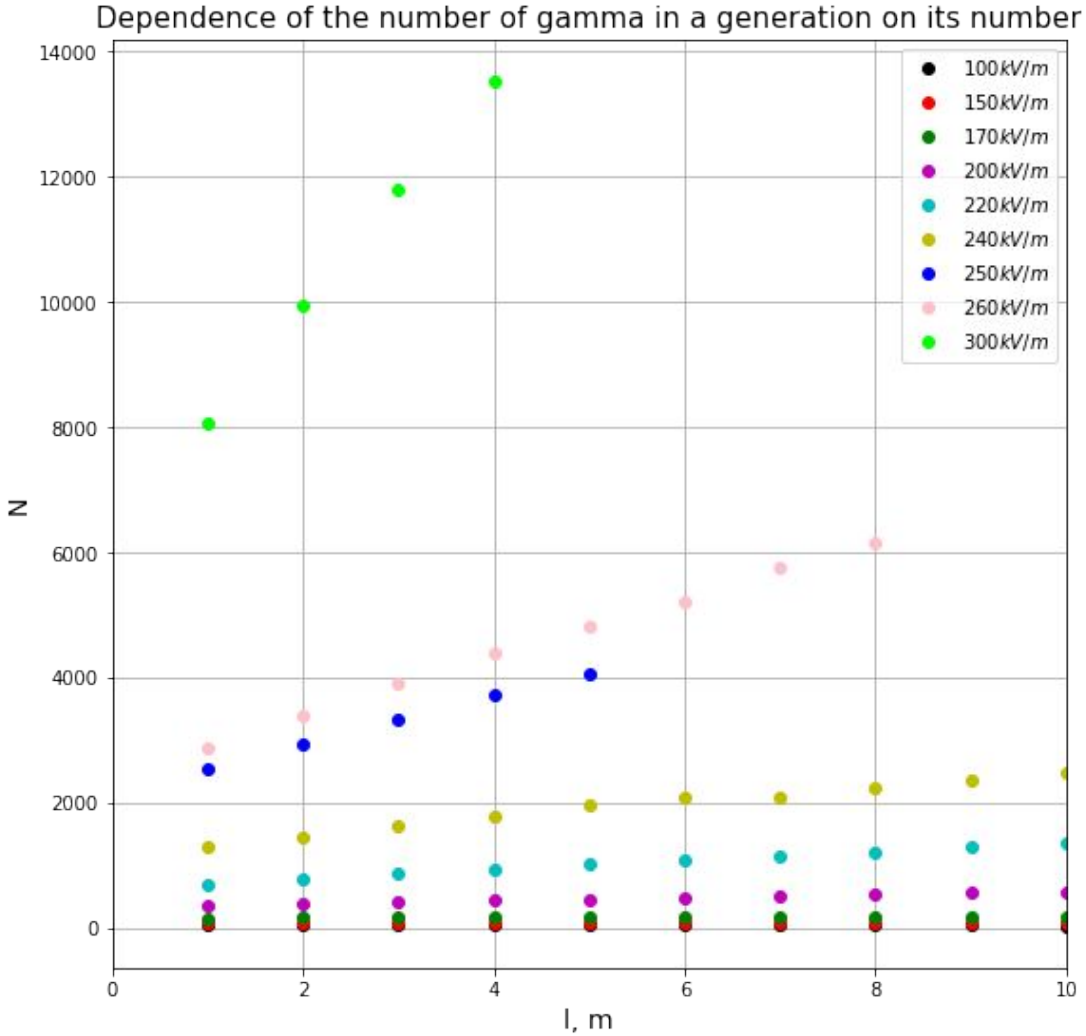




Consideration of generations



Here we divide the simulation stages into stages by considering only one cell and restarting the emitted particles (this can be done due to the symmetry of the system)



Thank you for your attention!