

**Introduction:** This study presents the design of an electron gun that could be employed for vacuum tubes operating in the THz range. Since we have a two-way coupling between space charge and electric field, Particle Tracing and Electrostatics analysis have been computed simultaneously.

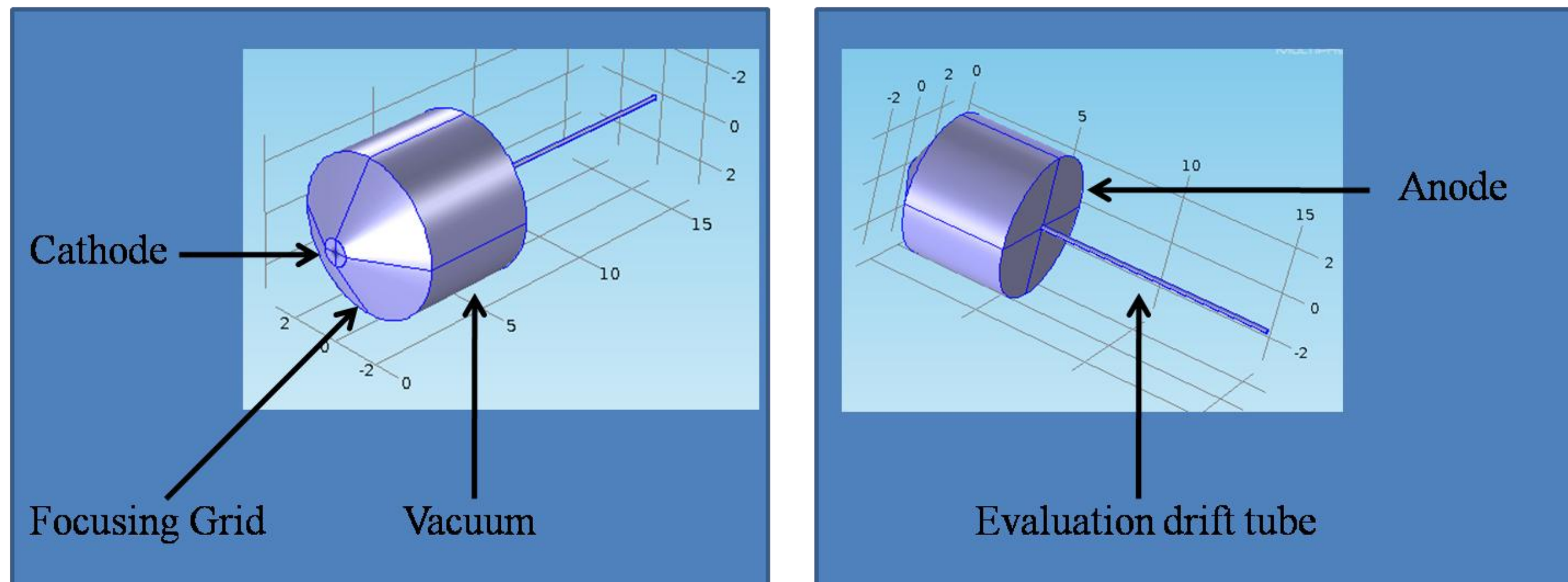


Figure 1. The Electron Gun Geometry.

**Computational Methods:** The initial velocity is related to the initial energy by (1). Since the current density is constant in time and on the cathode surface, a charge release discretization is given by (2).

$$V_y = \sqrt{\frac{2U_0}{m_0}} \quad (1) \quad N = \frac{Js\Delta t}{e} \quad (2)$$

Where  $U_0$  is the design initial potential energy,  $J$  and  $s$  are respectively the cathode current density and surface, and  $\Delta t$  is the time interval between releases. In order to decrease computational cost, the number of particle per release  $N$  has been decreased and a charge multiplication factor  $n$  has been employed, as shown in figure 2.

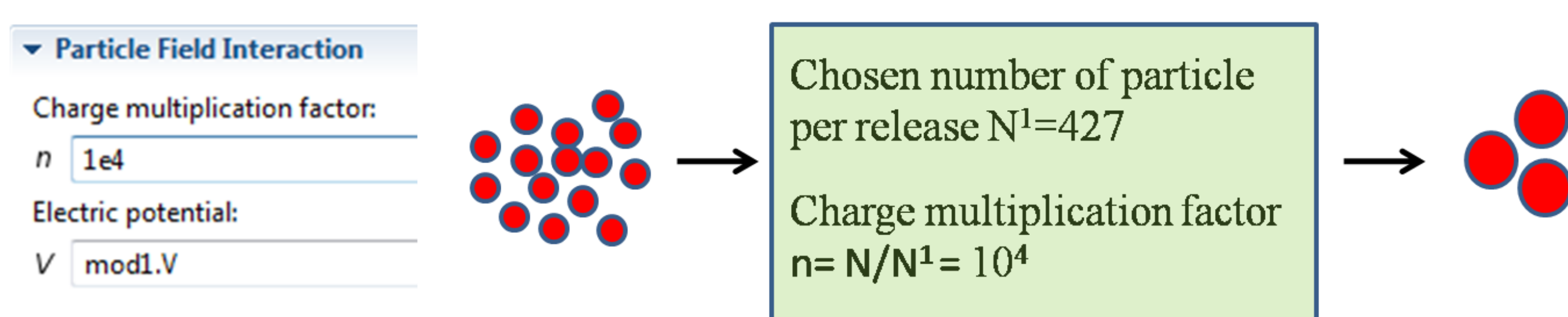


Figure 2. Particle field interaction.

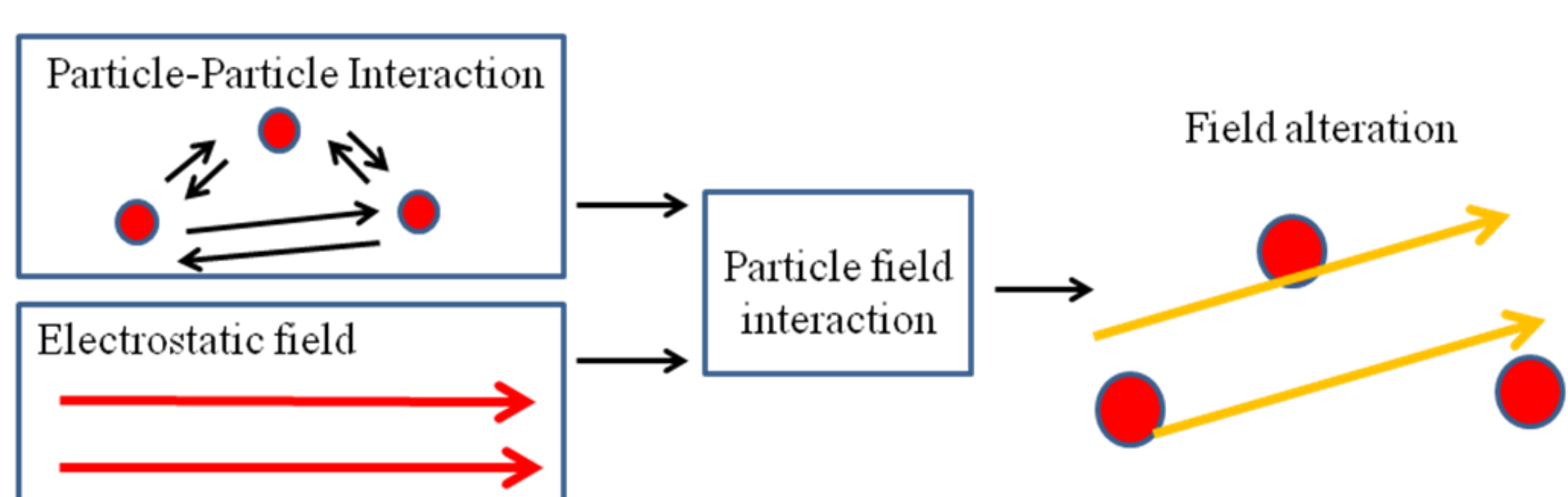


Figure 3. Particle-Particle and Particle Field interactions.

The alteration of the electric field, due to the particle - particle Coloumbian interaction has been considered.

**Results:** We have checked the self consistency of the proposed model by observing the cathode current density. The following results have been obtained.

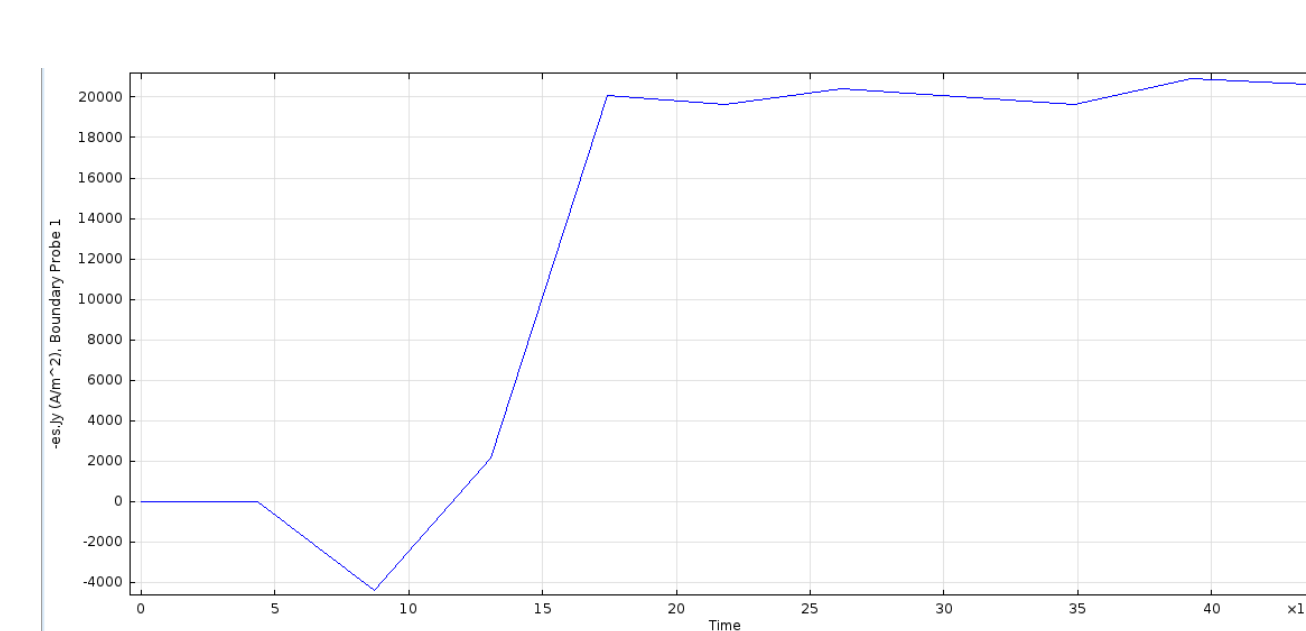


Figure 4. Current density.

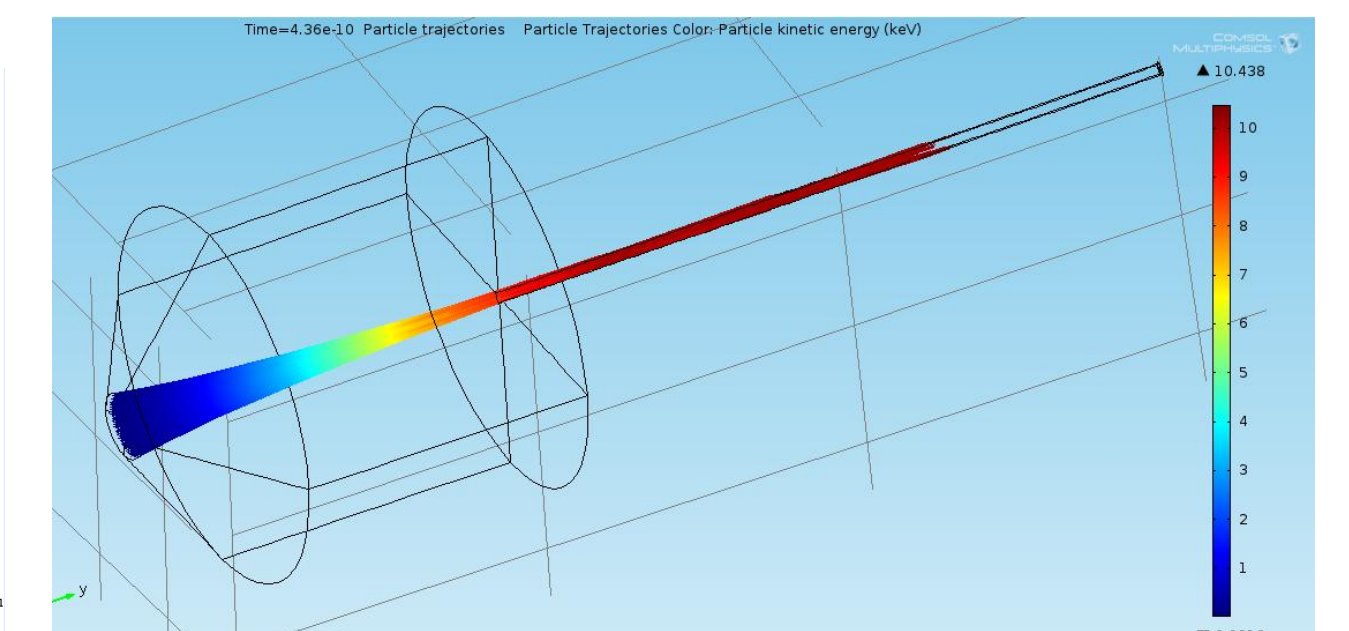


Figure 5. Energy.

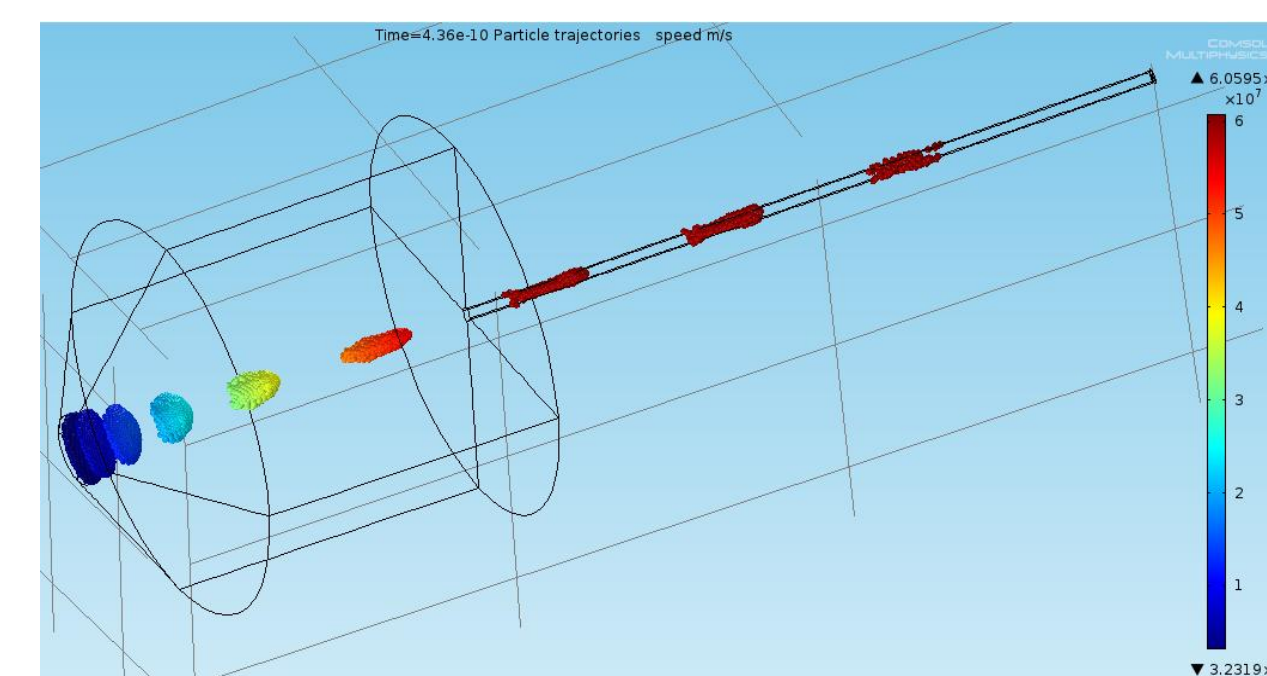


Figure 6. Velocity.

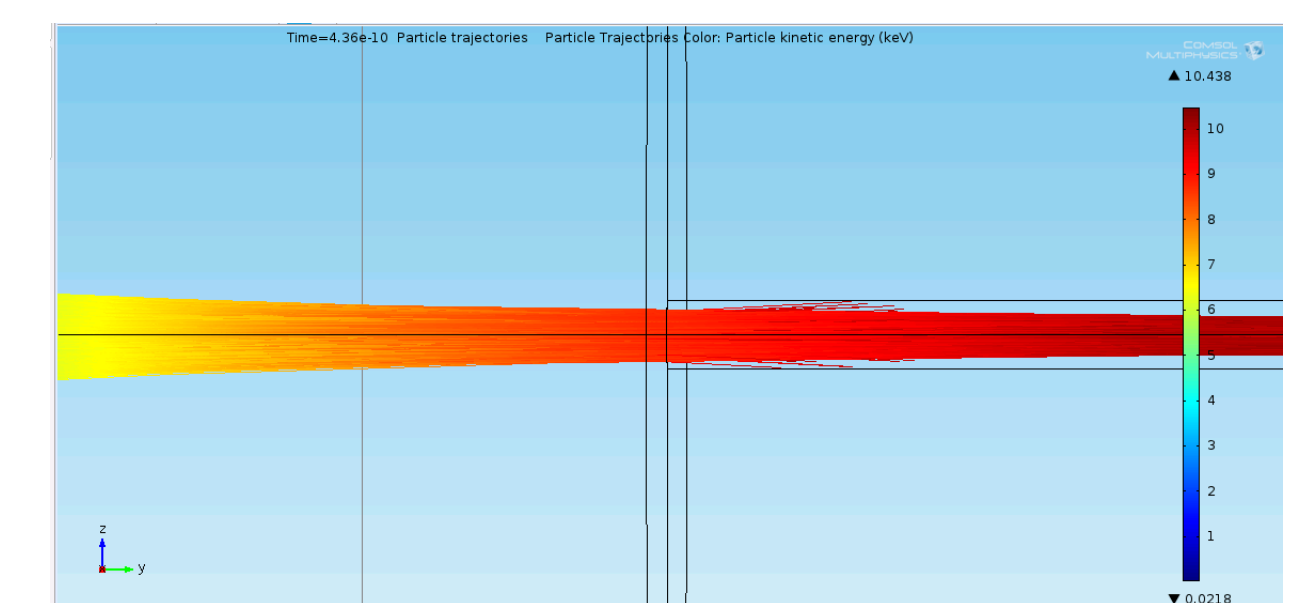


Figure 7. Beam Waist.

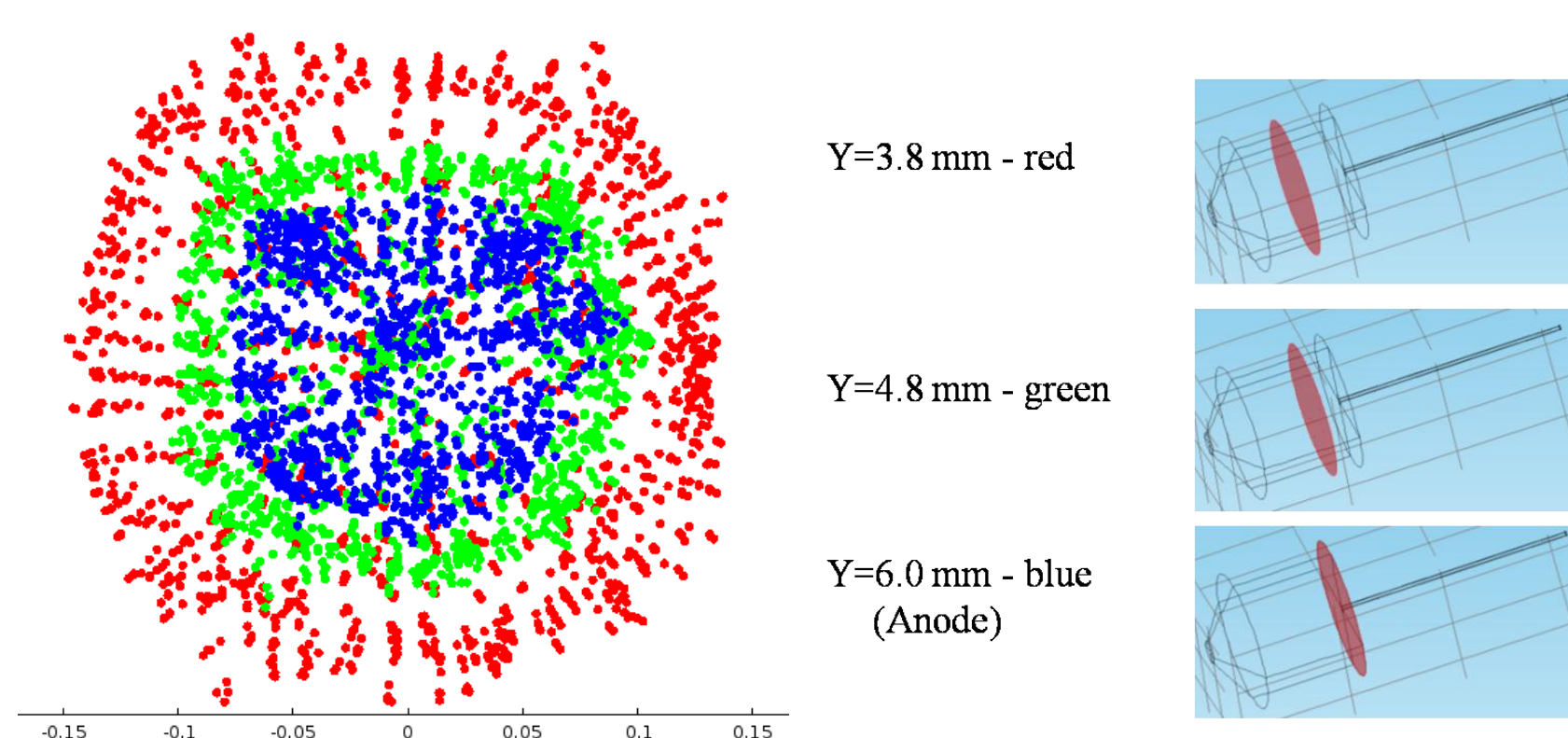


Figure 8. Beam spatial distribution.

**Conclusions:** An Electron Gun has been designed and characterized. Without any magnetic field we have obtained a Beam Waist of 0.1 mm and a beam area compression factor of 100.

## References:

1. A. Di Carlo et al, "The European project OPTHER for the development of a THz tube amplifier," *International Vacuum Electronics Conference*, pp. 100 - 101, 2009.
2. Kenneth B. K. Teo et al, "Microwave devices: Carbon nanotubes as cold cathodes," *Nature*, 437, 2005.
3. J. Tucek et al. "A compact, high power, 0.65 THz source," *International Vacuum Electronics Conference*, pp. 16 - 17, 2008.
4. G. Ulisse, F. Brunetti, A. Di Carlo, "Study of the influence of transverse velocity on the design of cold cathode based electron guns for THz devices" *IEEE Transactions on Electron Devices*, Vol. 58, Iss. 9, pp. 3200-3204, 2011.
5. *COMSOL Particle Tracing Module Users Guide, Version 4.3*, 2012
6. *COMSOL AC/DC Module Users Guide Version 4.3*, 2012.