In linear vacuum tubes (klystron, TWT) as the operation frequency increases up to THz range, the required beam current density into the interaction structure drastically increases up to 100-1000 A/cm² [1], leading to a required beam dimension in the order of few tenths of micron [2]. As consequence of these requirements, an intense effort has to be made to shrink the electron gun dimensions. When the geometrical size of the electron gun parts, such as the focusing grid or the anode, are in the range of few millimeter or less, the realization and assembly tolerances, in the order of some tenths of micron, could become unacceptable.

In this work the variations of the electron beam characteristics and electron gun performances, such as anode current losses, were studied in order to extrapolate the minimum manufacturing tolerances in the design of electron gun for THz vacuum tubes. The study was performed using the electromagnetic particle in cell simulation tool MAGIC.

An electron gun with a beam current of 10 mA and a beam radius of 40 µm was designed in order to be used in a THz vacuum device. Accordingly with both cold [3] and thermionic cathode [4] an emitting current density of 8 A/cm² was used. A fabrication tolerance of ± 50 µm was considered. A parametrical analysis was then performed changing the main geometrical parameters. In particular the variation of concentricity between cathode and focusing grid and between cathode and anode were considered. Furthermore variation of the focusing grid shape and vertical position respect to the ideal case were analyzed. As output results of this study the anode current losses, the beam waist position, and the output beam current density distribution will be shown as dependence of the possible manufacturing defects.