Electrical Field Simulation of an Ionization Chamber of Parallel Plates and Graphite Collecting Electrode

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1. INTRODUCTION

An ionization chamber was developed at the Calibration Laboratory of IPEN/CNEN for use in electron beams of linear accelerators. The ionization chamber body is made of acrylic and the collecting electrode is painted with graphite powder mixed with nail polish. The Maxwell 2D software was used to simulate the electric field of the ionization chamber.

2. MATERIALS AND METHODS

The Maxwell 2D software was used to simulate the electric field of the ionization chamber. This ionization chamber presents simple construction. The sensitive volume of the ionization chamber is 0.34 cm^3 and the collecting electrode diameter is 1.7 cm. The geometry was based in an ionization chamber already developed and is shown at Figure 1. All dimensions and materials of the simulated device are the same of the real ionization chamber. Only a 2D plane was considered, because of the symmetry of the ionization chamber. The applied electric potential between the electrodes was 300V. The simulation was repeated considering that the guard ring is inactive (without polarizing voltage).

Figure 1. The homemade ionization chamber

3. RESULTS

The ionization chamber simulated can be observed in Figure 2.

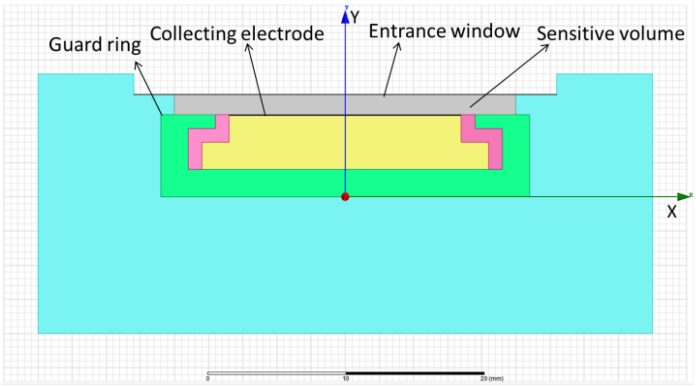

Figure 2. Scheme of the ionization chamber designed by Maxwell 2D software .The acrylic is represented by the colors: pink, yellow and blue; air is represented by the gray color; the graphite guard ring is represented by the green color.

The electric field was simulated by the Maxwell 2D software, and it can be observed at Figure 3without the guard ring and at Figure 4 with the guard ring. The polarization voltage used at the simulation was 300V.

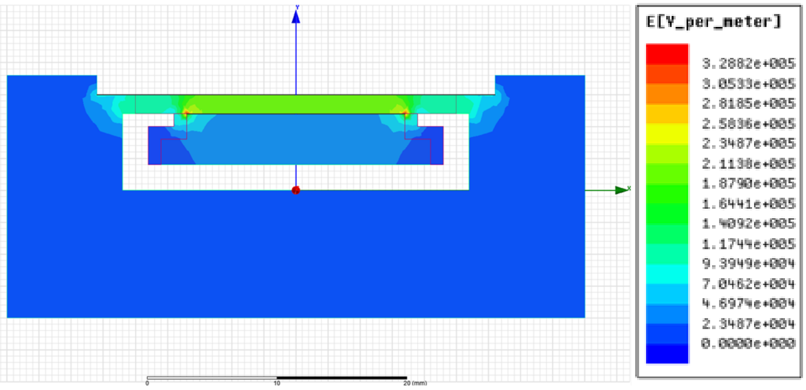

Figure 2.The electric field simulated by Maxwell 2D software. In this case the guard ring is not considered in the simulation (no polarization voltage). The colors represent the magnitude of the electrical field.

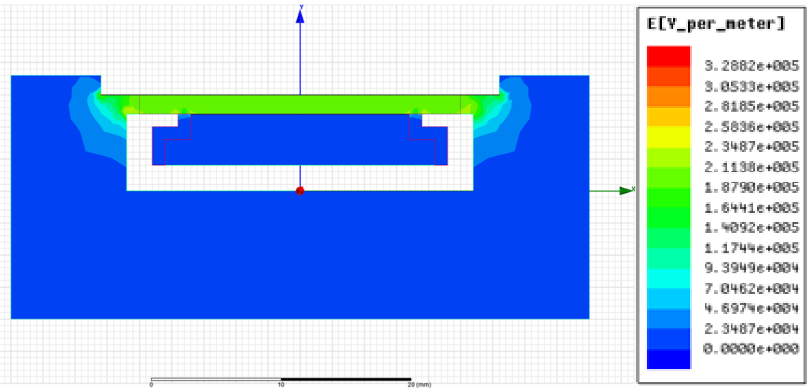

Figure 3. The electric field simulated by Maxwell 2D software. In this case the guard ring was included with the same polarization voltage of the collecting electrode. The colors represent the magnitude of the electrical field.

Figure 2 and Figure 3 show the guard ring importance. Without this part, the electrical field inside the sensitive volume is less uniform. Therefore, the boundary effect (that distorts the electrical field in the sensitive volume) is eliminated, ensuring a uniform region where the charges are collected. It can also be seen that outside the space between the plates there is a residual electrical field that can interfere in a signal transmitted by a bare wire, that is present in this developed ionization chamber.

4. CONCLUSIONS

The ionization chamber was developed with the expected performance according to the Maxwell 2D software. The simulations show that without a guard ring, the electric field is irregular, specially at the collecting electrode extremes; the guard ring as designed in this work also guarantees that outside the sensitive volume there is no residual electric field that could interfere on the signal transmitted by a bare cable inside the ionization chamber. Further simulations with the Maxwell 2D software can also provide (with the Hetch formula) a simulated saturation curve that can be compared with an experimental saturation curve. For this additional result, a radiation transport simulation will also be necessary to estimate the charges created inside the sensitive volume. In this kind of simulation, the MCNP5 will be employed.

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