Simulations of the GEM-TPC response *

A. Prochazka[1], F. Garcia[2], R. Janik[3], V. Kleipa[1], J. Kunkel[1], C. Nociforo[1], M. Pikna[3], B. Sitar[3], P. Strmen[3], E. Tuominen[2], R. Turpeinen[2], B. Voss[1], and the FAIR@GSI Division[1]

[1]GSI, Darmstadt, Germany; [2]HIP, University of Helsinki, Finland; [3]FMFI, Comenius University Bratislava, Slovakia

The GEM-TPC detector response to 1GeV/u $^{197}\mathbf{Au}$ projectile was simulated.

The GEM-TPC detector [1] is proposed to be a standard tracking detector for the Super-FRS [2]. The requirements for the GEM-TPC detectors are: a high rate capability(1MHz), a low amount of material in active volume and a large dynamic range(proton-Uranium). The GEM-TPC consists of the drift volume($20x8x7cm^3$) filled with a gas and uniform electric field, GEM foil stack located under the drift volume and the strip readout plane. A schematic view of the GEM-TPC is shown in Fig. 1(top).

For better understanding of the GEM-TPC design and its further improvements simulations were perfomed. The following simulation codes were used: Garfield++[3] to calculate drifts of the electrons through the drift volume, GEM stack and induction gap, ELMER software[4] to calculate electric field maps of the drift volume and the GEM foil using the finite element method(FEM).

In the first step the primary electrons from ^{197}Au beam at 1 GeV/u and their drift tracks inside the drift volume were calculated. The drift volume filled with P10 gas at normal pressure and temperature and $400V/cm$ electric field was assumed. The electrons position and time distributions at the top GEM foil were obtained.

In the second step a passing of the electrons through the GEM stack was simulated. The following parameters of the GEM foils were used: hole outer radius = $35\mu m$, hole middle radius = $15\mu m$, kapton thickness = $50\mu m$, hole pitch = $140\mu m$, copper thickness = $8.0\mu m$. The unit cell from which whole GEM foil was constructed is shown in Figure 1(bottom). The electric field between the GEM foils was set to 3kV/cm and the voltage over the GEM foil was set to 300V. The gain of the GEM stack and the position distribution after the stack was calculated.

In the third step the induced charge on the readout plane strips was calculated using the Shockley-Ramo theorem [3]. The weighting fields of the electrodes and electric field map were calculated using the FEM method. The electric field in the induction gap was set to 3kV/cm. The initial position of the electrons in the induction gap were taken according to the results from previous steps of the simulation. As an example the cluster size from ^{197}Au projectile and relative induced charges on the different strips (0.4mm wide, 0.5mm pitch, perpendicular to x axis) are shown in Figure 2. Other characteristics such as spatial and time resolution of the GEM-TPC will be studied with this method which can help in understanding the results of the test of the prototypes [1].

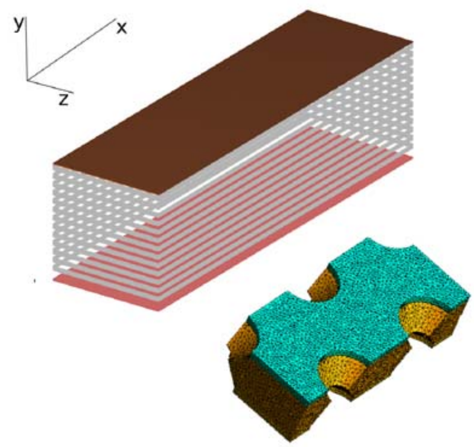

Figure 1: Top-left: Schematic view of the GEM-TPC drift volume showing the cathode (brown) and the field-cage strips (gray) forming an uniform electric field in y-direction. The beam is parallel to z axis. Bottom-right: the GEM cell unit used to construct the GEM foil showing hole positions, copper part(blue) and kapton part(orange).

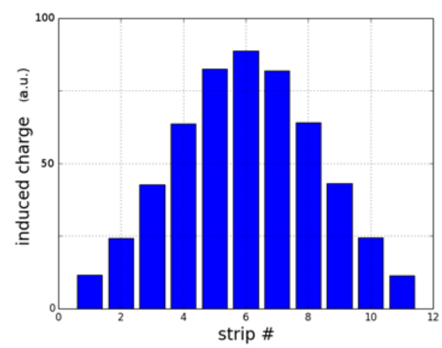

Figure 2: The cluster size and relative induced charge on the strips from ^{197}Au.

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References

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