MC simulation of the RPR trap in DRIFT-IIb. Part II

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In this report results from MC simulations of the RPR trap are presented. RPR trap has been constructed by placing additional rows of (gating) wires on both sides of the central cathode wires. Studies, as a function of the wires voltage and the wire pitch were performed on the Po decay events were Pb recoil was fully stopped in the gas and alpha fully in the wire.

1. Description of the RPR trap

Simulated RPR trap consists of a central cathode wires and additional rows of wires (called gate wires) placed symmetrically on its both sides. Different voltages applied to the cathode and gate wires creates electrostatic focusing of drift lines on the cathode wires. Due to this effect all positive charges created in the drift volume are collected by the cathode wires while only part of negative charges created near the cathode wires comes back to the drift volume. Remaining part of negative charges is collected by the gating wires. The aim of the proposed RPR trap is to maximise the efficiency of the negative charge collection by the gating wires.

2. Description of the MC simulation

The main part of the simulation contains drifting of 100 equally spaced negative charges created in 3D along a straight line with a random direction and starting point at the cathode wire. Geometrical requirements for the event with Pb recoil stopped in the gas and alpha in the wire are described in Part I of this report. For each event negative charges passing the gate wires are summed and histogrammed.

3. Results

Fig. 1(a) shows drift lines near the cathode wires in DRIFT IIb. With applied negative voltage of 31900 V, the electric field on the cathode wires surface and at the distance \(l=2\times\text{radius}\) is 37 kV/cm and 18.5 kV/cm, respectively which is not high enough to trigger gaseous avalanche in 40 Torr CS\(_2\). These values of the electric field are the reference for the RPR trap simulation.

Fig. 1(b) shows the distribution of NIPs that go into the drift volume. It is clear that in the absence of the gating wires for all Pb recoils, 100 generated NIPs/track drift to the drift volume. This distribution changes with gating wires added to the detector.
3.1. Gate wires: configuration 1

Configuration 1 of the gating wires and created drift lines are shown in figs 1(a/b). 200 μm diameter cathode and gating wires with a pitch of 2 mm are 1 cm apart and staggered by half pitch. Different magnitude of the electrostatic focusing is shown for different voltages applied to the gating wires. Fig 1(a/b) show drift lines for negative voltages on cathode 31900 V and gating wires: 30500 and 25500 V respectively. Corresponding NIPs distributions are shown in figs. 3(a/b) As one can clearly see stronger electrostatic focusing increase the efficiency of the NIPs collected by gating wires. This is illustrated as a function of the gating wire voltage in fig. 4(b). Electric field on the cathode wires surface and at the distance l=2*r is shown in fig. 4(a).

3.2. Gate wires: configuration 2

Configuration 2 of the gating wires and created drift lines are shown in fig. 5(a) where 200 μm diameter cathode and gating wires with a pitch of 2 mm are aligned and 1 cm apart.

3.3. Gate wires: configuration 3

Configuration 3 of the gating wires and created drift lines are shown in fig. 6(a) where 200 μm diameter cathode with a pitch of 2 mm and gating wires with a pitch of 1 mm are 1 cm apart.

3.4. Gate wires: configuration 4

Configuration 4 of the gating wires and created drift lines are shown in fig. 7(a) where 200 μm diameter cathode with a pitch of 2 mm and two rows of gating wires with a pitch of 1 mm are 1 cm apart. Gating wires are staggered by half pitch.

4.

As can be seen, introducing gating wires changes drift lines configuration. With a proper voltage difference, gating wire pitch and the number of gates one can significantly reduce the number of NIPs collected by the MPWC.
Figure 1. Drift lines near cathode wires in DRIFT IIb (a). Distribution of number of NIPs drifting to drift volume (b).
Figure 2. Trap configuration 1: Drift lines near cathode ($V=-31900$) and gating wires with voltages $V=-30500$ (a) and $V=-25500$ (b).
Figure 3. Distribution of number of NIPs drifting to drift volume in gating configuration 1 and voltages $V = -30500$ (a) and $V = -25500$ (b).
Figure 4. Electric field on the cathode wires surface and at the distance $l=2r$ as a function of the voltage on gating wires (a). Fraction of events in which all NIPs drift to the MPWC (b).
Figure 5. Trap configuration 2: Drift lines near cathode and gating wires. Distribution of number of NIPs drifting to drift volume (b).
Figure 6. Trap configuration 3: Drift lines near cathode and gating wires. Distribution of number of NIPs drifting to drift volume (b)
Figure 7. Trap configuration 4: Drift lines near cathode and gating wires. Distribution of number of NIPs drifting to drift volume (b)