Setting Chamber HV – v1.0

Daniel S. Carman
Department of Physics, Ohio University
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♢ First Order Thoughts:

1). Set the sense wire high voltage (HV) such that the electric field at the surface of the sense wire is roughly E_s=300 kV/cm to obtain an avalanche multiplication factor (or gas gain) $\mathcal{G}$ of a few times 10^4.

2). Set the field wire high voltage (HV) such that the electric field at the surface of the field wire is roughly $E_f \leq 20$ kV/cm to stay away from conditions that:

- lead to electron emission from the field wires and,
- could lead to deposits on the field wires.

♢ Second Order Thoughts: (From Mac Mestayer)

1). Choose the sense wire high voltage (HV) such that the electric field ∼30 μm away from the sense wire is roughly E_s=100 kV/cm.

> *(i).* For a typical chamber gas, it requires roughly 20 eV to ionize a gas molecule.
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> *(ii).* The mean free path (mfp) in a typical chamber gas for creation of an electron-ion pair is roughly 2 μm.
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> *(iii).* This ratio of 20 eV/ 2 μm ⇒ E=100 kV/cm.
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> *(iv).* This field defines when the electron avalanche occurs, or the electric field threshold where the electron avalanche begins.
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> *(v).* The charge doubles every mean free path once the ionization avalanche begins.
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> *(vi).* The avalanche multiplication factor or gas gain $\mathcal{G}$ goes as $2^{N_{mfp}}$, where N_{mfp} is the number of mean free paths from where the avalanche begins to the surface of the sense wire.
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> *(vii).* For $\mathcal{G}=5\times10^4$, we would require that there be 16 mean free paths (i.e. N_{mfp}=16) from where the avalanche begins to the surface of the sense wire. This amounts to a distance of roughly 30 μm.

2). Using GARFIELD, set the field wire high voltage and the cathode plane high voltage such that the number of field lines terminating on each is roughly equal. This is important for efficient charge collection at the cathode and to optimize the field configuration for the drift time measurement in the plane of the wires.

> **Note:** This will be an iterative procedure. E_s at 30 μm will change as the field wire and cathode plane high voltage values are changed.

3). Require E_f <60 kV/cm at 8 μm from the surface of the field wire. This is a less stringent requirement than the value for electric field at 20 kV/cm at the surface of the field wire as suggested in the "first order thoughts" above. The distance of 8 μm is chosen as this would represent 4 mean free paths. Thus with the field well below that necessary for avalanche multiplication, we stay away from conditions that are sufficient for field wire emission and can cause field wire deposits. Mac strongly feels that the value of 20 kV/cm is *far* too conservative.

4). Other thoughts on the matter:

(i). For a scenario with grounded cathode planes, the electric field at the surface of the cathode should be relatively low.

(ii). With the cathode planes at ground potential, we should expect to find our operational criteria (laid out above) are met under the condition where V_s = -2V_f.