Home exam on gaseous and semiconductor detectors

1. A cylindrical proportional tube has an anode wire radius of 0.003 cm and a cathode radius of 2cm. It is operated with an applied voltage of 2kV. If a minimum electric field of 1 MV/m is required to initiate gas multiplication, what fraction of the internal volume of the tube corresponds to the multiplication region?

2. How much charge is deposited by a minimum ionising particle in fully depleted 300 μm Silicon and Germanium. Compare the result with charged produced in the proportional chamber in problem 1 filled with Argon-gas at NTP.

3. Calculate the dark current (generation current) for fully depleted 300μm thick Silicon and Germanium.

4. Calculate the depletion voltage for both n-type and p-type (bulk) 300μm thick Silicon sensors when the substrate resistivity, r, is 6 kΩcm. The doping concentration of the substrate is given by:

$$N_{A,D} = \frac{1}{q\mu_{e,h}r} \quad ,$$

where $\mu_{e,h}$ is the mobility for electrons or holes, q the charge of the electron.

5. A Parallel plate ion chamber with 150 pF capacitance is operated in electron sensitive mode. Calculate the pulse amplitude expected from 1000 ion pairs formed 2 cm from the anode, if the total spacing between the plates is 5 cm.