Physics 198, Spring Semester 1999 Helmuth Spieler
Introduction to Radiation Detectors and Electronics

Problem Set 9: Due on Tuesday, 6-Apr-99 at begin of lecture.
Discussion on Wednesday, 7-Apr-99 at 12 – 1 PM in 347 LeConte.
Office hours: Mondays, 3 – 4 PM in 420 LeConte

1. A planar detector is made of a semiconductor material that is semi-insulating, i.e. it behaves like very high resistivity material, so thick detectors can be made with a uniform field throughout the detector. Assume a detector thickness of 1 cm. A drawback of the material is that holes are trapped after moving an average distance of 1 mm, whereas electrons can traverse the full thickness without significant losses.

   a) A photon is absorbed in the middle of the sensitive volume, i.e. 5 mm from the positive electrode, forming 1000 electron-hole pairs. After all carrier motion has ceased, how much charge (expressed in electrons) is induced on the electrodes?

   b) How much charge is induced when a photon is absorbed 1 mm from the positive electrode?

   c) How much charge is induced when a photon is absorbed 1 mm from the negative electrode?

2. A detector is made of high-purity germanium using a coaxial geometry as shown in V.5., p. 10 (lecture on 04-Mar-99). The inner electrode is *n*-type with 10 mm diameter and the outer diameter is 50 mm. The detector is operated at 77 K with 5 kV bias voltage, so one can assume substantial overbias.

   a) What is the field distribution within the detector?

   b) What is the maximum collection time for holes and electrons? At 77 K electrons and holes in Ge have the same mobility μ= 40,000 cm^2/Vs.

   c) Assume 100 keV deposited at a radius of 10 mm. The ionization energy in Ge at 77 K is 3.0 eV. What is the induced signal current vs. time for the electrons, the holes, and for the total signal?

   d) What are the current pulse shapes for 100 keV deposited at a radius of 22.5 mm?