

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

Helmuth Spieler

Problem Set 13: Due on Tuesday, 04-May-99 at begin of lecture.

Discussion on Wednesday, 05-May-99 at 12 – 1 PM in 347 LeConte.

Office hours: Mondays, 3 – 4 PM in 420 LeConte

1. A gas ionization chamber is used to detect 5.9 keV x-rays from an ^{55}Fe source.
 - a) How large is the charge signal provided by the detector?
 - b) What is the statistical fluctuation of the charge signal?
 - c) What is the allowable electronic noise level, if the overall resolution is to be within 10% of the intrinsic resolution of the detector?
 - d) The chamber capacitance is 10 pF. You have an amplifier whose input JFET has a transconductance of 5 mS and an input capacitance of 5 pF. Using a CR-RC shaper, what is the minimum shaping time that will provide the required noise level? Assume that the noise current sources are negligible.

2. An MSGC is to be used as a tracking detector. The gas is CH_4 at standard temperature and pressure (not necessarily the best choice, but it keeps the calculation simple).
 - a) Minimum ionizing particles have a differential energy loss $dE/dx \approx 2 \text{ MeV g}^{-1} \text{ cm}^2$. The drift space where the primary energy is deposited is 4 mm thick. How large is the primary signal charge for a track at normal incidence?
 - b) The anode strip pitch is 200 μm . What is the signal per readout strip for tracks at 45° incidence?
 - c) A bipolar input transistor is used in the preamplifier. The transistor's current gain is 150 and the total capacitance of a readout strip is 10 pF. What is the obtainable noise level?
 - d) How much gas gain is required if a signal-to-noise ratio of 10 is to be achieved at normal incidence? How much gain is required if $S/N = 10$ is to be maintained at track angles up to 45° (relative to normal incidence)?