

# Homework #10

- A photomultiplier have 14 dynodes and are operated at a total operation voltage of 2000 V, with an amplification factor of 4. Calculate the signal height in Volts for one input electron if the total time of travel is 5 ns and the resistance is 50  $\Omega$ .
- A photomultiplier tube with 25% quantum efficiency detects light from an organic scintillator with a density of 1.15 g cm<sup>-3</sup> and 4x10<sup>3</sup> photons being emitted per MeV of particle energy loss. Only 5% of scintillation photons reach the PMT due to losses in the scintillator and light guide. How thick scintillator layer is required to detect minimum ionizing particles with an efficiency of at least 99%?
- A detector has an efficiency of 95% and a fake rate, i.e. how many times there is a signal without any incoming particle, of 1%. Calculate the efficiency and fake rate of a stack of three such identical detector layers if a signal is defined as (a) a logical OR of the three detector layers; (b) a logical AND of 2 or more layers.
- Derive the formula for the spatial resolution  $\sigma$  (defined as the RMS of the residuals between the measurement and the actual point of impact) in the case of threshold (also called digital) readout of a Silicon detector with a pitch size  $p$ :  $\sigma = p/\sqrt{12}$ .
- How can dark matter be observed by particle physics experiments?