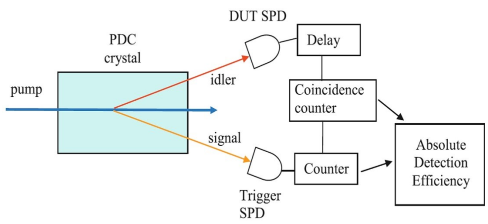
Problem 1

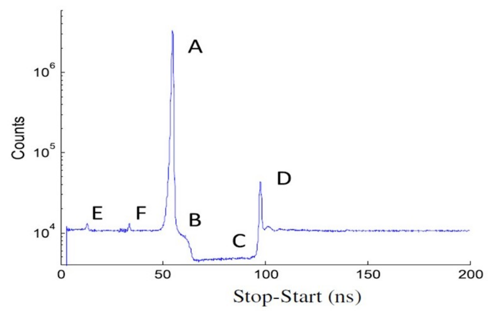
- An avalanche photodiode, consisting of p^+ipn^+ doped semiconductors, is operating under reverse bias voltage for the detection of single photons using an avalanche effect. Discuss the operation mechanism and plot the electric field along the different regions and show where the impact ionisation is very high?
- After the detection of the first photon the avalanche must be stopped for the second detection event. Plot the circuit diagram of simple passive quenching circuit required to stop the avalanche effect. Can you approximate the dead time of the detector using the circuit parameters?

Problem 2

A single photon detector (detector under test, DUT) is calibrated using the photon pairs produced by spontaneous parametric down conversion as shown in the experimental setup in figure (a). Discuss how the measurement will be performed?. The coincidence measurement is shown. Can you discuss what are A, B, C, D, E and F in figure (b)?



(a)



(b)

Problem 3

- Consider the interaction of an atom with classical electromagnetic field given by

$$E(t) = E_0 \cos(\omega t)$$

Drive an expression for the probability for the atom to make a transition from state $|i\rangle$ to state $|f\rangle$ in time t?

- What will be the transition probability from state $|i\rangle$ to state $|f\rangle$ and vice versa for $E_o = 0$, are the solutions physically meaningful?

Problem 4

- Consider the interaction of the atom (the same atom as in question 3) with a quantized field given by

$$\hat{E} = i\Big(\frac{\hbar\omega}{2\epsilon_0 V}\Big)^{1/2} e[\hat{a} - \hat{a}^\dagger]$$

Drive an expression for the probability for the atom to make a transition from state $|i\rangle$ to state $|f\rangle$ in time t?

- What will be the transition probability when there are no photons ($n = 0$), discuss its difference from the case in question 3?