Homework #1

1. Download and install virtualbox and Ubuntu Linux virtual OS;
2. Calculate the scattering of $e^+e^- \to \mu^+\mu^-$ and plot the production cross section as a function of invariant mass of the incoming electron and positron. Please explain the behavior of the curve.
3. Plot the $\cos\theta$ distribution at the $E_{cm} = 10$ GeV (you should set each beam energy to be 5 GeV, i.e. Pcm=5GeV). The θ angle is defined as the open angle between the μ^- and e^-.
4. Plot the $\cos\theta$ distribution at the $E_{cm} = 90$ GeV.
5. What is the difference between $E_{cm} = 90$ GeV and $E_{cm} = 10$ GeV? Why so?
6. You can use generate a Mathematica file of the matrix element square of the scattering process in CalcHEP. The option is in the menu of 'symbolic calculation'. The Mathematica file can be found in the directory of 'Result'. Please read out the matrix element square of $e^+e^- \to \mu^+\mu^-$ and translate it into the Mandelstam variables s, t, u and compare the result with Peskin's QFT textbook.
7. Confirm Eq. (4.61b) on page 97 in our Textbook.
8. Please explain the $\cos\theta$ distribution from the Matrix element square.
9. Plot the transverse momentum (p_T), pseudo-rapdity (η) of μ^- at $E_{cm} = 90$ GeV and $E_{cm} = 10$ GeV.
10. Use CalcHEP to generate Feynman diagrams of the Bhabha scattering (the elastic scattering $e^+e^- \to e^+e^-$). Compare them with Fig. 4.6 on page 92 in Textbook.

Bonus: The argument under Fig. 4.11 in textbook is not correct. What is your comment?

Textbook: "Particles and Fundamental Interactions: An Introduction to Particle Physics", by Braibant, Giacomeeli and Spurio.