Problem Set for Hadron Collider Physics 2015
Prof. Dr. Karl Jakobs, Dr. Karsten Köneke
Problem Set 8
Your solutions have to be handed in by 10:10 am on Tuesday, July 14th 2015.
Please drop them into the mailbox number 1 on the ground floor of the
Gustav-Mie building!

1. **Supersymmetry at the LHC**

   The following exercise is aimed to familiarize you with typical SUSY kinematics and decay chains. Note, however, that some of the hypotheses made here are not necessarily the most common assumptions typically made in LHC SUSY analyses.

   (a) Given the fact that the LHC is a hadron collider, which supersymmetric particles are expected to be produced (if their masses are accessible, given the center-of-mass energy of the machine)? **[2 points]**

   Assume a SUSY particle spectrum such that only one (first or second) squark generation is produced with a cross section of 1 pb. The squark mass is assumed to be 400 GeV, the lightest neutralino mass is 50 GeV, all other SUSY particles have masses of a few TeV.

   (b) The production mechanism is for such a case $pp \rightarrow \tilde{q}\tilde{q}$. How does the $\tilde{q}$ decay? What is the final state? **[2 points]**

   (c) Assume that the two squarks are produced at rest in the transverse plane. A given selection is applied, which requires 2 jets of $p_{\mathrm{T}} > 100$ GeV. Compute the acceptance on the signal of this cut (the signal acceptance being defined as the probability of a signal event to pass the selection). **[2 points]**

   (d) A further cut on the missing transverse momentum is required: $E_{\mathrm{T}}^{\mathrm{miss}} > 150$ GeV. What is the total acceptance of the selection, in the case in which the p_{T} of the jets is at threshold? **[2 points]**

   (e) Make a list of possible Standard Model background processes, mentioning which are expected to be relevant. **[2 points]**

   (f) A total of 10 background events from Standard Model processes are expected per pb^{-1}. According to the numbers given (or computed) above, does one expect to exclude the signal at 95% CL (that is, with a significance of about 2σ) with 100 pb^{-1} of data? **[2 points]**