

Übungen zu Physik an Hadron-Collidern SS 2013  
Prof. Karl Jakobs, Dr. Iacopo Vivarelli, Francesca Ungaro  
Übungsblatt Nr. 7

**Die Lösungen müssen bis 11 Uhr am Mittwoch, 19.6.2013 in die Briefkästen  
im Erdgeschoss des Gustav-Mie-Hauses eingeworfen werden!**

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1. *W* cross section at the LHC

In this exercise, we discuss the first *W* and *Z* cross section measurement at the LHC by the ATLAS collaboration:

<http://arxiv.org/pdf/1010.2130v1> (see also web page of the lecture)

Without pretending the understanding of the full paper, here are a few questions that you are required to answer as quantitatively as possible.

- Figure 1b shows the  $E_T$  spectrum of the electrons as measured in the data. There is a huge contribution arising from jet production from QCD processes. Briefly discuss the different reasons why QCD-jet events enter into this plot with such a large contribution.
  
- Focusing on Fig. 2a: The contribution from QCD-jet events dominates in the region of low missing transverse energy. Why? What are the possible sources of missing transverse energy in QCD-jet events? [**2 points**]
  
- Still on the same figure, why has  $Z \rightarrow \tau\tau$  a harder contribution than  $Z \rightarrow ee$  (i.e., on average the missing transverse energy is larger)? [**2 points**]
  
- On Figs. 3a and 3b: Explain the shape of the  $m_T$  distribution for the  $W \rightarrow e(\mu)\nu$  component. [**2 points**]
  
- The selection for the electron channel is  $E_T^{miss} > 25$  GeV,  $m_T > 40$  GeV. What is the minimum allowed transverse momentum of the electron? To what angle between the electron and the missing transverse momentum does this correspond? [**2 points**]
  
- In Table 4 an estimate (after background subtraction) of about 600  $W^+ \rightarrow e^+\nu$  and 400  $W^- \rightarrow e^-\bar{\nu}$  events is given. How significant is the excess of  $W^+$  events if only statistical uncertainties are assumed (quote a probability that the two numbers actually correspond to equal production cross sections from  $pp \rightarrow W^\pm + X$ )? If the excess is significant, could you explain the difference qualitatively? [**3 points**]