

Teilchenphysik 2 — W/Z/Higgs an Collidern Sommersemester 2019

Exercises No. 6

Discussion on July 9, 2019

Please read the paper:

Observation of Higgs boson decay to bottom quarks by the CMS Collaboration,
Phys. Rev. Lett. 121 (2018) 121801

NB: Access to PRL is only free within the KIT-network. An alternative preprint-version of the paper is available <https://arxiv.org/abs/1808.08242>.

Please prepare answers to the following questions:

- a) What is the goal of the presented analysis?
- b) How many $H \rightarrow b\bar{b}$ events do you expect in total in the analysed dataset, assuming a Standard Model Higgs boson?
- c) Why is VH the most sensitive production process in the search for $H \rightarrow b\bar{b}$ decays at the LHC and the Tevatron? What are the problems with the other channels?
- d) Which final states in which channels does the analysis target? Why these and not other ones?
- e) How is the signal extracted and what is the purpose of the control regions?
- f) What are the main Standard Model background processes and how are they modelled?
- g) What is the benefit of clustering jets from the particle candidates reconstructed with the particle-flow algorithm? Are there further benefits of the particle-flow-based object reconstruction?

- h) During the reconstruction, physics-objects like jets are corrected for energy deposits from pile-up collisions. How?
- i) What are the primary event selection criteria?
- j) How are the V-boson and the Higgs-boson candidates reconstructed?
- k) How is the dijet invariant mass $m(jj)$ of Higgs-boson candidate decays calibrated? Why is the mass not used as final sensitive variable in the analysis?
- l) How are the signal and control regions defined? Which distributions are used in the final binned profile likelihood fit?
- m) What is the signal strength μ and which value is measured with the 2017 data? What do we learn from this value about the properties of the Higgs boson?
- n) What are the dominant systematic uncertainties?
- o) How is the analysis method validated?
- p) Which measurements are combined to achieve the observation of $H \rightarrow b\bar{b}$ decays?
- q) What is the probability that the observed signal is just a statistical fluctuation? What is the difference between the observed and the expected significance?