# Doctoral thesis review by the supervisor

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| Thesis title: | Proton structure studies using hard exclusive processes at COMPASS experiment |
| Institution: | Faculty of Mathematics and Physics, Charles University |
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The thesis describes the analysis of the data taken by COMPASS experiment at CERN in 2016 with a 160 GeV $\mu^{\pm}$ beam and liquid hydrogen target. It aimed at extracting the cross section of the exclusive neutral pion production $\mu p \to \mu' p' \pi^0$. The pion was reconstructed from its decay to two photons. If the transferred four-momentum $Q^2$ is large, the reaction can be interpreted in terms of generalised parton distributions (GPDs), which describe the nucleon structure in the longitudinal momentum fraction, transverse position and spin degrees of freedom.

In Chapter 1, a detailed introduction in the formalism of GPDs is given. Then the experimental setup is described, with the emphasis on the parts most relevant for the measurement: the recoil proton detector and the electromagnetic calorimeters (ECALs). These chapters are not original work, but summarize numerous original articles and reviewes, which are properly cited and their at times differing conventions are made coherent.

Chapter 3 describes the ECAL calibrations. Several layers of calibrations were used and the author contributed to some of them and dealt with all of them both during her work as COMPASS production manager and during the analysis. That included identifying problems and investigating their origin. In the cases of calibration steps done by other students their theses are cited.

Chapter 4 describes the event selection and kinematic fit. Although the researcher initially followed the recipe defined in the published 2012 pilot run analysis, later she optimised some of the selections, and also expanded the kinematic range thanks to a better coverage of the 2016 setup. Thanks to a better description of both the apparatus and the physics process of interest in the Monte Carlo simulation, the background was significantly lowered. In Chapter 5 the author explains how the cross section is calculated from the selected events, presents the results and estimates systematic uncertainties in numerous tests. The last two chapters contain a large amount of original and careful work. The author collaborated with another doctoral student, Karolína Lavičková from Czech Technical University. They were responsible for different parts of the analysis and systematic tests, which is made clear in the thesis. Both of them performed independently the whole analysis chain, fulfilling the COMPASS collaboration rule requiring a cross check of all released results.

The formal level of the thesis is high, the typesetting, notations, references, citations etc. make the text clear. In some figures the text is too small. However, these are mostly either taken from references or they are technical plots presented in large numbers, creating the need for a trade-off between the space and readability. Perhaps, the selections which plots to show could have been a bit stricter. I have not noticed plots without axis titles or not clear in another ways. The graphical level of important plots is very high. The English is also very good, as far as I can tell.

The methods used to obtain the results are sound. The results have been presented at conferences relevant in the field and a publication is being finalised. They are awaited by several groups of theorists, showing they are interesting for the scientific community. A bit more space could have been dedicated to comparison with other experiments and to the interpretation of the results.

To conclude, in my opinion the thesis meets very well the requirements for a doctoral thesis.

Prague, September 4, 2024
Jan Matoušek, Ph.D.