

## Evaluation Report on the PhD Thesis submitted by Mgr. Jan Matoušek:

### Nucleon spin structure studies in Drell-Yan process at COMPASS

The doctoral thesis is focused on the study of nucleon spin structure in the experiment COMPASS at the accelerator SPS at CERN. This fundamental topic is extraordinarily important. There are also other laboratories in which the related problems are studied, at present mainly at the collider RHIC (BNL) and the Jlab (Jefferson laboratory), both in USA. The study of spin structure is tightly interconnected with the questions of intrinsic motion of quarks and gluons inside the nucleons. So there is a broader set of hot unsolved questions to be solved in both, experiment and theory.

The Prague COMPASS team takes a part in the experiment since its proposal. Therefore the team has contributed to obtaining of the most important results like for example the quark and gluon contributions to the proton spin  $\Delta\Sigma$  and  $\Delta g/g$ . Very important share is also in a demanding construction of the polarized target representing a very important pillar of the equipment. In fact it is just the option of polarized collisions, what makes the experiment COMPASS quite exceptional.

The thesis is divided in a well arranged way into six sections. In a general introduction, the scope of work is defined and a historical context is mentioned shortly. Then the Sect. 1 follows, where the related theoretical formalism is introduced and explained. Its basic tools are represented by the transverse momentum dependent distributions of quarks and gluons (TMD). A central role is played by the Sivers function, its extraction and analysis from the SIDIS (semi-inclusive deep inelastic scattering) a Drell-Yan process is the main objective of the thesis. The section is well arranged and proves that author has managed theoretical background into appropriate depth. The Sect. 2 is devoted to the description and explanation of all the parts of the equipment COMPASS. A special attention is paid to the polarized target, author of the thesis is the key co-author of the software tools for the complex monitoring of the target operation. In Sect. 3 the general method of the measuring of transversal asymmetries is explained. Sect. 4 describes in more details the method and some results of the Sivers asymmetries from the collisions  $\mu+p$  (proton is transversely polarized) with the production  $J/\psi$  decaying to muon pair. Analysis of the Drell-Yan in  $\pi^+p$  with extraction of the weighted asymmetries is the subject of Sect. 5. The results of this section are discussed and interpreted in Sect. 6, where the final results on the Sivers functions are presented. The results are summarized in the last section in context with the results obtained in other experiments or by other methods.

In summary, my impression is very good, the author has done a very important piece of useful work. The thesis contains valuable results obtained by analysis of the COMPASS data, in particular results extracted by the method of weighted asymmetries. The author's work is a part of common work of the whole collaboration COMPASS. Therefore I suppose the author will define more specifically his contribution to the common results, his work during shifts, his involvement in hardware and software works.

Finally, I have a few small questions:

1) I understand there is a slight difference between weighted Sivers asymmetries and those obtained by the standard way. In general, different methods can give different results,

however one should try to understand why. I wonder, if these differences could be checked more systematically by some Monte-Carlo simulation?

2) I cannot find a definition of parameters  $\sigma_i$  in equation 4.5.

3) In text to fig.2 it is stated that Sivers asymmetry is positive within one standard deviation. Is this deviation evaluated with accounting for systematic errors?

A few misprints can be tolerated. Some figure captions (figs. 1.13, 1.14, 5.6) refer to colour marks, however the figures are black-and-white.

To conclude, there is no doubt the author applied a lot of very good ideas in the analysis of the topic. The thesis contains the new original scientific findings, applied methods were adequate. The arrangement of thesis corresponds to the required standards. The thesis achieved a its goal, the author proved his ability to carry out the independent scientific work.

Prague, 8th March 2018

Mgr. Petr Závada CSc., DSc.