Posudek školitele na doktorskou disertační práci

Prague, February 20, 2022

Doctorand:
Martin Krivoš
Title of dissertation:
Study of production of jets and dijets in Xe+Xe and Pb+Pb collisions at the ATLAS experiment
Recommendation:
The work fulfils all the requirements to be defended as a doctoral thesis

The work is organised in 5 chapters, accompanied by an introduction, conclusions, one appendix, and an adequate bibliography. The first three chapters introduce the main concepts needed to understand, and to put in context, the work presented in the last two chapters.

Chapter 1 discusses quantum chromodynamics, and introduces the concept of jets and the algorithms used to define a jet. The second chapter presents the basic ideas of heavy-ion collisions, the determination of centrality, and the phenomenon of jet quenching. The observable that is the main topic of the thesis, namely the dijet balance, is also presented in this chapter. Chapter 3 describes briefly the experimental set-up.

The contributions from the doctorand are the subject of Chapter 4 and 5. The former describes the calibration of jets in the context of the ATLAS detector. Chapter 5 describes the measurement of the dijet balance in Xe-Xe collisions. The analysis procedure is presented as well as the strategy to extract the observables from the raw measured data. This chapter also introduces the Monte Carlo data samples used in the analysis. Special attention is devoted to the unfolding formalism and how the corresponding parameters are chosen. The final section of this chapter, Sec. 5.6, presents the results of the measurement.

The thesis is in general well written. The text is structured and presented in a clear an logical way. The use of the English language, except for the use of articles, is good and the final product is easy to read. I would have expected a bit more care on the editorial side. In particular, in the version of the thesis I got, there were two editorial issues that should not have happened: (1) in page 30, just below Fig. 3.1, there is a sentence at the end of the paragraph "with a [...] 25 ns" that do not belong there; (2) in page 35, the paragraph 'LAr [...] interactions." is a repetition of a paragraph in the previous page. Nonetheless, all-in-all I consider the thesis to be good from the editorial point of view.

The subject of the thesis is topical and the text explains the key parts of the analysis adequately. As someone who is not a member of the ATLAS collaboration, I would have welcomed a bit more experimental and technical details, but this is mainly a matter of taste, so I do not consider it a problem of the work. The results themselves are very interesting and the final precision that was achieved is quite impressive.

I have some questions that I hope the student can answer (briefly!) the day of the defence. The first three questions address the customary issue of the contribution of the author. The next four questions request some more details about the analysis itself, while the last question is to give the opportunity to the candidate to put his results in a wider context, and discuss their potential impact in more detail than what was done in the thesis.

1. I would welcome more detail on the amount of work that the jet calibration took. Did the candidate work on it for six months? two years? what exactly was done by the candidate himself and what as part of a group working in jet calibration?

2. In the same context: the candidate mentions six papers where the calibration framework was used. Could a bit more detail be provided? Which results or techniques described in Chapter 4 were used in the papers? How were they adapted to the particular needs of each analysis? What about unfolding (described in Chapter 5), was it used in the the second listed paper that also uses dijets?
3. Did the candidate participated in any work closer to instrumentation? (detector/ trigger/...). Did the candidate participated in shifts and similar activities?
4. Could the candidate discuss a bit more the need for symmetrisation? In Sec. 5.1 it is mentioned that this addresses the possibility that the leading and sub-leading jets are swapped due to the resolution of the detector. If I understand correctly, the symmetrisation is applied to all bins; is the resolution that bad? For example, is it really needed to account for the possibility that a 100 GeV jet is the leading jet when in the event a 200 GeV jet is measured? I have the feeling that I did not understand fully the motivation and application of this method, so further clarification is welcomed.
5. In Sec. 5.5 you mentioned that the uncertainty is taken as the full difference between the nominal and the value obtained when considering a potential systematic effect. Why do you take the full difference and not the difference divided by sqrt(2), which is the standard recommendation?
6. In Fig. 5.27, for the bin 10-20% and 158-199 GeV the uncertainty from closure is huge at small xJ. Can you please comment?
7. I was surprised that in many bins in Fig. 5.32 the uncertainty band in Xe-Xe is smaller than for Pb-Pb, particularly for central collisions. Can you discuss this a bit quantitatively?
8. The last sentence of the thesis states that 'these results should bring a better understanding [...]", but in the thesis there was no discussion at all about models of jet energy loss. Can you briefly comment on how the results may impact our understanding? For example, you mention the role of path-length. What do models say about path-length? what are the differences amongst the models and would the precision of your data be able to have an impact? I know that a detailed discussion is outside the scope of your work, but some brief discussion and your thoughts about these issues would be welcomed.

In summary: I find the thesis clear and well written; the results are very interesting and topical; and the contribution of the author to the results is at the level expected from a good Ph. D. student. For these reasons, I consider that this work fulfils without a doubt the requirements for a Ph. D. thesis and recommend that the candidate is allowed to defend it.

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