Oponentský posudek na doktorskou disertační práci Tomáše Koseka

This is a referee report on the doctoral thesis "Analysis of data from heavy-ion collisions at the ATLAS experiment" by Mr. Tomáš Kosek.

Evaluation:

Which of the results can be referred as a new scientific result?

> All the results presented in Chapters 5 and 6 are new: those of Chapter 5 of more technical nature, those of Chapter 6 related to the physics of heavy-ion collisions

What is the importance of them for the area?

> The technical results are hugely important, because they make possible to pose experimental questions regarding our understanding of Nature. The results of Chapter 6 provide a very precise data set to contrast against models of the interaction of colour probes with the hot-medium created in the collisions. The importance for the community is reflected in the fact that these results either form a crucial part of several publications or, for the results of Chapter 6, form the core of one high quality publication.

What are the applications to other areas?

> The results of Chapter 5 are of use to any analysis using jets. Jets are used as tools in many different studies (top physics, searches for new physics, determination of the strong constant, jet quenching, …). The results of Chapter 6 will be useful to the theory and phenomenology communities as well as to other collaborations as benchmark and cross check.

Does the thesis prove the ability of the author for creative scientific work?

> Yes, it does.

Organization of the work:

The thesis is organised in 7 chapters. In the first chapter a very brief introduction to the topic treated in the thesis is offered. This chapter also contains a statement on the contributions of the author to the measurements discussed in the work. The second chapter provides a short description of a Glauber calculation in the context of centrality determination. Chapter 3 has a concise review of experimental results related to probes of the QGP in Pb-Pb collisions. The ATLAS experiment Is briefly introduced in Chapter 4. The main doctoral work is described in Chapter 5, covering the subtraction of the underlying event and the energy calibration of jets, and Chapter 6, describing the measurement of jet fragmentation functions. The last chapter presents a brief summary of the work.

Comments:

I have two comments. The first rewards the quality of the English language. The thesis is well written, and the occasional mistakes do not disturb the flow of the reading, but if the author wants in the future to write himself high quality scientific articles, his use of the language has to be improved a little bit. Particularly, he should improve the use of articles (sometimes missing, sometimes the wrong type used), be more consistent with spelling (sometimes American sometimes British spelling is used in the text) and try to avoid some (few) awkward constructions that obscure the meaning of the sentence. The second comment is with respect to the length of the thesis. All chapters seemed to me extremely short. This seems to be a conscious decision by the author, but I am used to (and like better) thesis where details are

discussed in larger detail than in the corresponding scientific publications. The questions below reflect a bit this comment.

Questions to the author:
Reading the thesis, I found that I had some questions that could not be answered based only on the text of the thesis. This is something normal and should not be taken as criticism. Nonetheless, if possible, it would be nice to have the answers.

- Did the author participate in any ATLAS community service (beyond that described in Chapter 5), particularly related either to hardware or to outreach?
- In Chapter 2, Figure 2.3: how is the model histogram computed, i.e. how does ATLAS go from Glauber variables to FCal variables? Details are welcomed.
- In Chapter 3, in Sec. 3.1 a bit of QCD is discussed. I did not find any comment about fragmentation functions, which are, according to the author 'The main physical result' of his work. Could the author introduce fragmentation functions from the point of view of pQCD, and briefly mention the current status in the field (both in pp and AA collisions)?
- The description of the ATLAS experiment in Chapter 4 misses some crucial information for the analyses presented in Chapters 5 and 6. Could the author explain how the triggering and readout proceeds in ATLAS, both in general and for the samples used in Chapter 5 and 6? Could the author say a few words about the resolution of the calorimeters (at the cell level!) and how it was determined? Some words about the calibration would also be welcomed. Could the author add information about the track reconstruction from the trackers' space points and about the track resolution?
- In Chapter 5, it is mentioned that the anti-kt algorithm is used to measure jets. Can the author briefly describe it and lists its advantages with respect to other algorithms? Here it is also stated that only calorimeter information is used to build jets. What is the minimum momentum that a particle needs to reach the calorimeter in ATLAS?
- In Eq. 5.1: which detectors are used to determine Ψ_2? How it is determined?
- In Sec. 5.1 one can read the following sentence "Because jets can influence the estimated transverse energy density, the iterative procedure is used to exclude jet areas from the ρ estimation". This sentence cannot be understood with the information available in the text. Can the author elaborate in detail how this works?
- In Sec. 5.2. How is pT truth computed? Using the same jet algorithm with the same value for R? Which particles are then included?
- What is the physics motivation of using the functional form given in Eq. 5.2? What is the correlation between the a_i parameters obtained from the fits?
- I do not understand the third paragraph of Sec. 5.2.2. If you use signal-only jets, what is pT truth? Am I missing something?
- Fig. 5.1: is the width of the Gaussian distribution used somehow later on for the calibration or only the mean (and its error) play a role?
- Section 6.3: With this selection, what is the fraction of tracks from K0s and Lambda decays and how it is estimated? (I guess that this fraction depends strongly on centrality)
- Section 6.4: Could the author provide some examples of pT-spectra for particles in pp jets, as well as pT-spectra of particles in Pb+Pb jets before and after UE subtraction?
- Section 6.6: why was Bayesian unfolding selected? Were there other methods tested?
- Second point in p.54. How many more bins?

- Chapter 6. The measurements are beautiful, but I miss a comment on what do we learn from them in the pQCD context or what do we need from experiment/pheno/theory to be able to learn something from these measurements. Could the author comment on this? I also miss a comparison to measurements from other collaborations. Could the author comment on this?
- Chapter 7. I miss an outlook: what is next for this kind of studies in ATLAS (e.g., are there plans to measure fragmentation functions for jets having a Z boson produced back-to-back to the jet? Same measurements at a new energy? New ideas?) and in the community (both theory and experiment) in particular with respect to the data to be collected in Run 3 and Run 4 (with the possible inclusion of other nuclei, as in the test run with Xe+Xe collisions). Can the author comment on this?

Prague, August 20, 2018

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J. G. Contreras