# Opponent's evaluation of doctoral thesis

**Title of thesis:** Ultra-Peripheral Collisions at ALICE – Looking inside lead ions
**Author of thesis:** Ing. Roman Lavička
**Opponent:** doc. Mgr. Martin Spousta, Ph.D.

The thesis by Roman Lavička consists of seven chapters. The first and second chapter provide the introduction and an overview of the relevant parts of the ALICE experiment, respectively. Third chapter provides basic introduction to the problem of luminosity determination. Fourth chapter introduces the problem of the unfolding and presents basic mechanisms of methods that are used to perform this procedure. Fifth chapter presents the analysis of the cross-section of the coherent photo-production of J/Psi in ultra-peripheral Pb+Pb collisions at the energy of 5.02 TeV. The resulting cross-section is presented in sixth chapter. Chapter seven is the summary.

The main topic of the thesis which is the measurement of photo-production of J/Psi in ultra-peripheral collisions is an important part of the physics program being pursued by LHC experiments and, as shown in the thesis and published articles, it has a very good potential to improve our knowledge of the internal structure of nuclei. Specifically, it can improve our understanding of the behavior of parton distribution functions of gluons at low-x. The thesis clearly documents the work done by the author which is of a high quality and importance for the field. The work by the author is an essential part of one article published in a high-profile journal and another article which was also submitted to a high-profile journal.

The thesis is well written with only very little typos and small number of subtle grammatical issues. There are no formal problems except for minor issue of using abbreviations prior their definition in some places (e.g. ITS, SSD) or an issue of forward referencing (e.g. the author speaks about an equation but only later the equation is presented). There are few places where the text could be improved, for example page 6: "To study the kinematics … it is useful to define kinematic variables." or "s-channel represents the square of the total energy"... These are however minor issues.

In some part of the thesis I would appreciate to read more details, since without details it is hard to explain. I'll include all of them here: 1) Chapter 1: it would be nice to the reader to explain the term pomeron and provide derivations of some of the basic relations (such as the relation between $Q^2$ and mass of J/Psi or x and s and y – this could be included in an appendix). 2) Section 2.4.1 – is this section complete? It carries very little information. 3) Equations in Sec. 3 are sometimes hard to follow – it would help the reader to have little more text saying how they were derived or provide actual derivations (it could be included in an appendix). 4) Section 5.2: it would be useful to discuss formulae for the fit model in this place and not only in section on systematics. All of this can be found in the literature and what I wrote does not mean that the thesis is incomplete. It is meant to provide a subjective feed-back, hopefully useful, for a future work of the author.

Then I have few questions, please. I'd kindly ask the author if he can respond them during the defense of the thesis:

a) The acceptance times efficiency is very low, around 4%. This implies a large correction. What is the uncertainty on acceptance times efficiency, please? Is such an uncertainty present in systematics? I don't see it. Given the size of the correction, I'd expect this to be one of important uncertainties.

b) Fig. 5.10: Why there is no signal at |t|~0.18 in the upper plot and why there is no signal at several pT^2 values in the lower plot, please?

c) page 73: How much do you vary alpha and n in the alternative fit model? This is an important information to define your systematics.

d) page 75: I'm a bit surprised that the systematic uncertainty on luminosity has only two components. I'm used to see more than twenty sources of that uncertainty. I can name e.g. uncertainties on: length-scale calibration, satellite correction, beam position jitter, bunch-by-bunch consistency, beam-beam effects, scan curve fit model, etc (please search for public documents on luminosity determination from other experiments). Can you comment, please?

e) page 77: I'm a bit surprised that the only uncorrelated uncertainty is the uncertainty on signal extraction. To me this would mean that e.g. the unfolding or tracking should not depend on pt. I have a hard time to believe that. It would mean that e.g. the unfolding could be done using a trivial multiplicative correction . Can you comment, please?

f) You don't discuss the correlated vs uncorrelated systematics for the rapidity dependent measurement. Why? Are all of them correlated?

And a few less important questions:

g) On the choice of the number of iterations: You could also plot sqrt( (statistical error)^2 + (difference from change of iterations)^2 ) and search for a minimum – this would make the choice more quantitative. Did you try, please?

h) page 74, section "Unfolding". You mention you use MC not used to train the response matrix. Which MC is that, please?

i) page 23: 0STG trigger – why there is such a big difference in the requirement on the opening angle?

I should repeat that the work presented in the thesis is of a high quality and that the thesis nicely presents non-trivial original results. Consequently, I fully recommend the thesis being accepted as the doctoral thesis.

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