

Review of the thesis „Study of photoproduction at ALICE” by Tomáš Herman

The dissertation thesis by Tomáš Herman is dedicated to the study of the photoproduction of J/Ψ meson in ultra-peripheral collisions of Pb+Pb at 5.02 TeV. The thesis analyzes the data collected by the ALICE experiment in the 2018 run. The analysis delivers the photonuclear J/Ψ cross-section as a function of rapidity, allowing to probe the internal degrees of freedom of the nucleus over a broad range of momentum fractions x . Cross-section is also delivered for different neutron emission classes, quantifying the degree of dissociation of lead ion connected with the level of coherence of the photon emission (coherent vs incoherent). This is shown to have a significant discriminating power with respect to theoretical modeling. Calculations based on impulse approximation are then used to deliver the nuclear suppression factor, which directly quantifies the presence of dynamical QCD effects such as shadowing and saturation. While at low photon-target c.m.s. energies (high x), no need for a presence of dynamical QCD effects is seen; at high energies (low x), models incorporating shadowing or saturation allow for a decent description of the data. Besides this analysis, the author also presents the data quality control system used to monitor the muon forward tracker in ALICE, which he helped to develop.

The thesis is well written. It provides a useful introduction to the topic of photoproduction of vector mesons. It summarizes both the theory and previous results in an accessible way. The description of the muon forward tracker and its data quality control is thorough and may serve as a good tool for other physicists working with the same detector. The description of the analysis of J/Ψ photon-nuclear production is detailed and complete. From the formal point of view, there is a negligible number of typos (for completeness, I'm giving them here: typo in Eqs. (1.15), (1.16), page 56: Figure Fig.; it would be nice to have units on Fig. 3.50; ZNA and ZNC not defined).

The results obtained by Tomáš Herman represent important progress in the experimental understanding of J/Ψ photonuclear production. The results have a significant impact on constraining the presence of dynamical QCD phenomena in nuclei. The amount of work done by Tomáš Herman is substantial, both on the side of the analysis and technical tasks.

Despite the clear quality of the thesis, I have a few questions which I would like to be addressed by the author during the defense of the thesis:

- a) On page 104, you say that “PDF fit templates are available”, but you do not give any reference. Did you build the fit model used in Fig. 4.8, or did you inherit it, please? Related to that, what is the mean p_t of the coherently produced J/Ψ in Fig. 4.8? Is it extracted (or fixed) to be 60 MeV, as stated in the introduction on page 12? My understanding from the introduction is that p_t of 60 MeV is given by the uncertainty principle. How is the mean p_t of coherently produced J/Ψ

from $\Psi(2S)$ decay determined?

b) Figure 4.2 shows luminosity as a function of run number. Do you also evaluate luminosity normalized yields as a function of run number? This represents an example of important cross-checks for a cross-section measurement. I'm asking also because I'm still thinking if (the lack of) the difference between forward and barrel in Fig.1.10 can be due to some detector effects.

c) Section 4.11. In principle, you could evaluate $\sigma_{\gamma pb}$ also directly using Eqs. (1.8)-(1.11) from known photon fluxes and differential cross-sections instead of fitting. Did you perform such a check to e.g. see if there are no outliers?

d) On page 104, you say that you fix the value of power in the power law. In general, the power in a phenomenological description of spectra usually evolves with the center of mass energy. Isn't it a problem to keep it fixed and not vary it, at least as a part of the evaluation of systematic uncertainties?

e) On page 96, you say that $p_t < 0.25$ GeV cut is applied on dimuons. This seems inconsistent with the information on page 94, where you quote a cut of 200 MeV. I assume page 96 is correct, and 94 is a typo. Is that correct?

Irrespective of these questions, I judge the thesis to be of high quality, and I fully recommend it as a valid dissertation thesis.

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