

J/ψ photoproduction in ultra-peripheral heavy ion collisions with the ALICE experiment

M. Rodríguez Cahuantzi^a for the ALICE Collaboration

¹Faculty of Physics and Mathematics, BUAP, P. O. Box 1152, Puebla, Pue. 72000, México

Abstract. During the 2011 Pb-Pb run, dedicated triggers were used by the ALICE Collaboration to enrich ultra-peripheral collisions (UPC) to measure the J/ψ production cross section and its rapidity dependence at a centre of mass energy of 2.76 TeV per nucleon pair. In this article, the ongoing studies on J/ψ photoproduction in UPC events are presented.

1 Introduction

The suppression of J/ψ in heavy ion collisions at high energies has been reported by several experiments [1,2,3]. Although the results seem to be robust, the interpretation in terms of QGP dynamics requires a deep understanding of cold nuclear matter effects, such as nuclear absorption and nuclear gluon shadowing. The last one has large uncertainties since the gluon structure function in nuclei is poorly known, in particular at low Bjorken x . One promising method to study the nuclear gluon shadowing is to measure the heavy vector mesons production in the so called ultra-peripheral collisions (UPC). The physics of ultra-peripheral collisions is reviewed in [4], [5].

Two-photon and photonuclear interactions at unprecedentedly high energies can be studied in UPC events at the LHC. In these collisions the nuclei are separated by impact parameters larger than the sum of their radii and therefore hadronic interactions are strongly suppressed (see figure 1). The cross sections for photon induced reactions is large because the electromagnetic field of the protons in the nucleus work coherently to produce the intense virtual photon flux, which grows as Z^2 , where Z is the charge of the nucleus. The virtuality of the photons is restricted by the nuclear form factor to be of the order $1/R \approx 30 \text{ MeV}/c$ (R is the radius of the nucleus).

The ALICE experiment allows the study of J/ψ photoproduction in Pb-Pb collisions. The rapidity dependence of such process can be obtained and compared with the different theoretical estimates [6], [7], [8].

In the central region, leptons can be reconstructed and identified with the TPC, while the muon spectrometer can reconstruct J/ψ vector mesons produced at forward rapidities through its muonic decay ($2.5 < y < 4.0$). The neutron production in coherent events can be studied using the zero degree calorimeters. In this paper, we will focus on results obtained at forward rapidity ¹.

^ae-mail: mrodrigu@mail.cern.ch

¹B. Abelev, et al. [ALICE Collaboration], <http://arxiv.org/pdf/1209.3715v1.pdf>, Submitted to Phys. Lett. B.

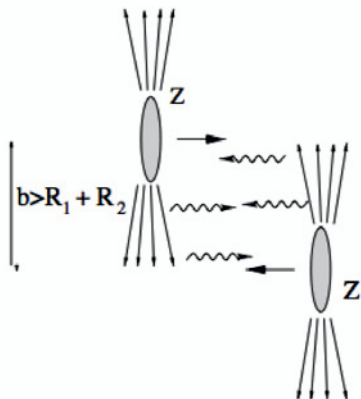


Figure 1. A fast moving nucleus with charge Ze is surrounded by a strong electromagnetic field. This can be viewed as a cloud of virtual photons. These photons can often be considered as real. In the collision of two ions, these photons can collide with each other and with the other nucleus. For ultra-peripheral collisions, this is useful for $\gamma - \gamma$ and $\gamma - nucleus$ collisions [9].

2 Experimental layout

The detectors used in this analysis are the VZERO and the Forward Muon Spectrometer (FMS). The VZERO system consists of two detectors VZERO-A and VZERO-C, located at 330 cm and 90 cm from the interaction point, respectively. Each detector is composed by an array of 32 cells of plastic scintillator arranged in four rings forming an eight sectors disk. The time resolution of the VZERO system is better than 1 ns. It also provides charge and time information. The FMS is made of 5 RPC tracking chambers, a dipole magnet and two trigger chambers located after an iron absorber. Muons with momentum larger than 1 GeV/c are triggered and reconstructed by the FMS in the pseudorapidity range of $-4 < \eta < -2.5$. The J/ψ meson is measured down to zero transverse momentum with a 70 MeV/c² invariant mass resolution [1].

3 Event selection and analysis of data

Two UPC dedicated triggers were used during the 2011 Pb-Pb run. The first one selected events in the central region ($|\eta| < 0.9$). It required a TOF hit multiplicity between 2 and 6, no signals from both VZERO detectors, and at least 2 hits in the SPD.

The second UPC trigger was devoted to detect muons in the forward region (called FUPC). This trigger required the coincidence of VZERO-C and the single muon trigger (with a p_t threshold set to 1 GeV/c), while VZERO-A was used as veto. In this period, ALICE collected ~ 3 million of forward muon triggers. The data sample analyzed corresponds to an integrated luminosity of $32.42^{+4.1}_{-2.7} \mu b^{-1}$. Below is the list of the applied cuts used to identify the J/ψ candidates:

- *No. of dimuons is equal to 1:* the events with an extra activity (not expected in UPC events) in the FMS are rejected.
- *Single muon tracks with opposite charges:* for J/ψ and continuum unlike sign dimuon pairs are expected. The remaining background can be estimated when both tracks have the same charge (like sign).

- *At least one of the muon tracks was matched to a trigger track*: events where at least one of the muon track candidates match a trigger track recorded in the muon spectrometer trigger chambers are selected.
- *The dimuon had transverse momentum less than 300 MeV*: this requirement selects coherent events which are expected to have low p_T and also rejects the majority of incoherent events and hadronic background which are produced with higher J/ψ transverse momentum.
- *The dimuon pseudorapidity was in the range $-4.0 < |\eta| < -2.5$* .

In figure 2, the invariant mass distribution of the reconstructed dimuons by the forward spectrometer of ALICE is shown. A clear peak is observed in the J/ψ mass region.

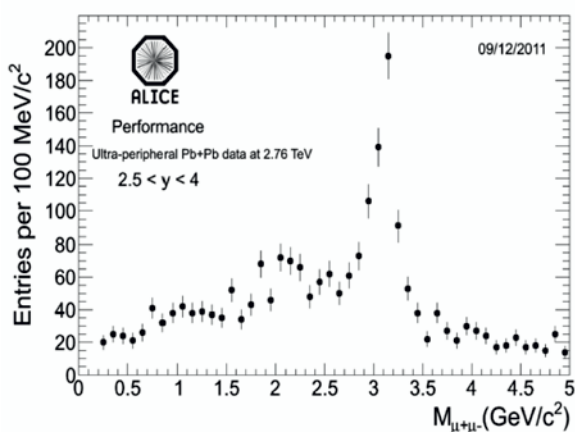


Figure 2. Reconstructed invariant mass of the dimuons collected by the FMS in ALICE. A clear peak around the J/ψ mass region is observed.

4 Summary

The ALICE detector allows the study of UPC events in heavy ion collisions. In particular, the photoproduction of J/ψ vector mesons can be studied via its muonic decay in the forward region. The results presented in this article show an excellent performance of the UPC triggers. Additionally, this study is being carried out for J/ψ events in the central rapidity region where leptons can be reconstructed and identified by the TPC using the dE/dx information.

Acknowledgements

I would like to thank to the conference organizers for they kind invitation to the first ICFP Conference in Crete, Greece. At the same time I want to thank to the Faculty of Physics and Mathematics of the Benemérita Universidad Autónoma de Puebla (FCFM-BUAP), CONACyT (México) and ePlanet program for their financial support as well as all the colleagues involved in this analysis.

Copyright CERN for the benefit of the ALICE Collaboration.

References

- [1] G. Borges, et al. [NA50 Collaboration], J.Phys. **G32**, (2006) S381-S390
- [2] Adare, A. et al. [PHENIX Collaboration], Phys. Rev. **C84**, (2011) 054912
- [3] Abelev, Betty, et al. [ALICE Collaboration], Phys. Rev. Lett. **109**, (2012) 072301
- [4] A. J. Baltz et al. Phys. Rep. **458**, (2008) 1.
- [5] C. A. Bertulani, S. R. Klein and J. Nystrand, Ann. Rev. Nucl. Part. Sci. **55**, (2005) 271
- [6] S.R. Klein and J. Nystrand, Phys. Rev. **C60**, (1999) 014903
- [7] L. Frankfurt, M. Strikman and M. Zhalov, Phys. Lett. **B626**, (2005) 72
- [8] V.P. Goncalves and M.V.T. Machado, Phys. Rev. **C84**, (2011) 011902
- [9] Gerhard Baur, Kai Hencken, and Dirk Trautmann. Phys. Rep. **364**, (2002) 359
- [10] ALICE Collaboration, J. Phys. G: Nucl. Part. Phys. **30**, (2004) 1517