Heavy quark energy loss and heavy meson spectra in pPb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV

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Introduction

At very high temperature or baryon density, QCD predicted a deconfined state of the quarks and gluons, which is known as the Quark Gluon Plasma (QGP). The heavy ion collisions (AuAu, CuCu, XeXe and PbPb) at relativistic energuies are performed to create and characterize QGP. The properties of QGP are studied through variety of probes accessible in STAR, PHENIX, CMS, ATLAS and ALICE experiments. Heavy quarks are the best tools to prope the QGP. Due to their large mass, heavy quarks are mostly produced in early phase of collisions when parton momenta are very high before the formation of QGP and the production of heavy quarks is small making them special as a probe for QGP. When heavy quarks travels in the QGP medium, they loose energy either due the collisions with the plasma partons or by radiating gluons. Some models are available to calculate the collisional and radiative energy loss. These energy loss models are used to calculate the nuclear modification factor $R_{\rm AA}$.

In this article, we study the transverse momentum ($p_{\rm T}$) spectra, energy loss and $R_{\rm AA}$ spectra of the heavy quark in proton - lead (pPb) collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV.

Methodology

The differential cross - section of the heavy mesons in proton - proton (pp) collision is calculated using pQCD approach which is described in the Ref.[1]. In this calculation, we use the LHAPDF6.2.1 (CT14NLO) sets [2] to obtain the parton distribution functions (PDFs). The EPPS16 package [3] is used for the modification of PDFs inside the nucleus. Peterson fragmentation function is used for the fragmentation of the heavy quarks into the heavy mesons. The generalised dead cone approach (Present) [4] and reactor operator formalism (DGLV) [5] are used to calculate the radiatve energy loss while Peigne and Peshier (PP) formalism [6] is used to calculate the collisional energy loss. The energy gain due to the chromoelectric field fluctuation (CMT) is calculated using the Ref.[7]. The path length and initial temperature is obtained using the evolution model [1, 8].

Results and discussions

Figure 1 shows the pQCD LO calculation of $d\sigma/dp_{\rm T}$ of B mesons as a function of $p_{\rm T}$ in pp collision at $\sqrt{s} = 5.02$ TeV compared with the CMS measurements [9].

Figure2 shows the energy loss of bottom auark as a function of quark energy in pPb collision at $\sqrt{s_{\rm NN}} = 5.02$ TeV calculated using PP, DGLV, Present and CMT formalisms. The radiative energy loss calculatedby present approach is larger than that by DGLV. The collisional energy loss calculated by PP formalism is less than the radiative energy loss calculation. CMT calculation is very less compared to the other calculations.

Figure3 shows $R_{\rm AA}$ of B mesons as a function of $p_{\rm T}$, obtained by including shadowing energy loss (DGLV, Present, PP+DGLV and PP+Present calculations) in pPb collisions $\sqrt{s_{\rm NN}} = 5.02$ TeV. The calculations are compared with the CMS data [9]. The radiative energy loss by DGLV formalism describes the CMS data without adding collisional energy loss at high $p_{\rm T}$. The other calculations such as PP, Present, PP + Present and PP + DGLV are below the CMS measurements.

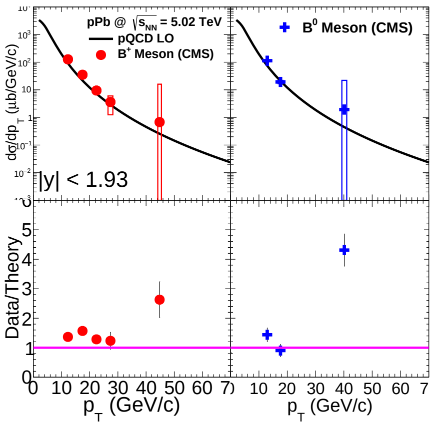

FIG. 1: $d\sigma/dp_{\mathrm{T}}$ of B as a function of p_{T}.

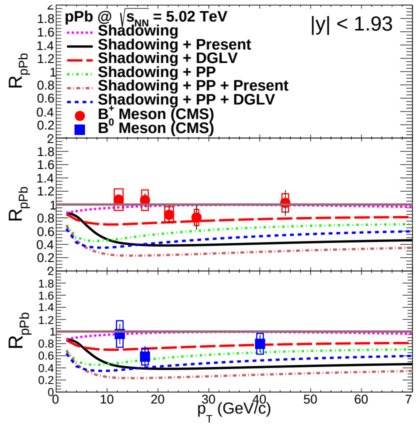

FIG. 3: R_{AA} of B as a function of p_{T}.

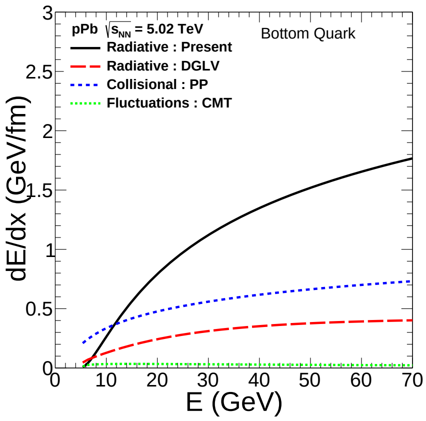

FIG. 2: dE/dx of Bottom as a function of E_{T}.

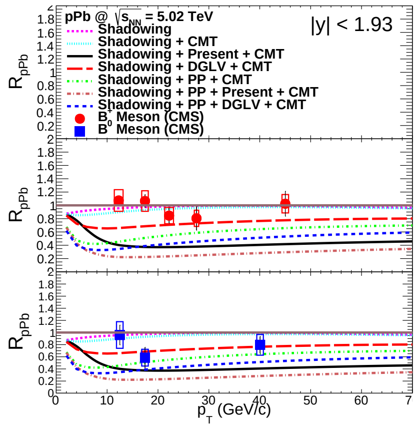

FIG. 4: R_{AA} of B as a function of p_{T}.

Figure4 is same as Figure3 but it includes the CMT formalism.

Conclusion

We find that the radiative energy loss from DGLV formalism alone is sufficient to produce B meson R_{AA} at high p_{T}. The other calculations with or without including CMT are below the CMS measurements. The study of the energy loss and R_{AA} of D meson in pPb collisions is under process.

Acknowledgemnet

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References

[1] Nucl. Phys. A **961**, 169 (2017).
[2] Eur. Phys. J. C **75**, 132 (2015).
[3] Eur. Phys. J. C **77**, 163 (2017).
[4] Nucl. Phys. A **943**, 83 (2015).
[5] Nucl. Phys. A **784**, 426 (2007).
[6] Phys. Rev. D **77**, 114017 (2008).
[7] Phys. Rev. C **75**, 064908 (2007).
[8] Phys. Rev. C **92**, 024908 (2015).
[9] CMS-PAS-HIN-14-004.