Cold Nuclear Matter effects on heavy quark production in PbPb collisions at $\sqrt{s_{NN}}$=2.76 TeV and 5.0 TeV.

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Introduction

The heavy ion collisions at high energy are carried out to study the properties of Quark Gluon Plasma(QGP). The first PbPb collisions at LHC are done at energy $\sqrt{s_{NN}}$=2.76 TeV and are planned at 5.0 TeV. The heavy quarks produced in initial hard collisions and while propagating the hot matter (QGP) loose energy and are thus a very good probe of opacity of QGP. The opacity of the medium is reflected in heavy quark Nuclear Modification Factor (R_{AA}). The R_{AA} is also modified due to cold nuclear matter effects due to modification of Parton Distribution Function (PDF) in the nucleus, thus one has to study the contribution due to cold matter to understand the properties of QGP.

Heavy Quark Production

Heavy quarks (charm and bottom) production is dominated by the following processes:
(1) Fusion of light quarks: $q\bar{q} \to Q\bar{Q}$.
(2) Fusion of gluons: $g\bar{g} \to Q\bar{Q}$.
The differential cross-section for production of heavy quarks is given by [1],

$$\frac{d\sigma}{dp_T dy} = \int_{x_{min}}^{1} dx_a \; f_a(x_a, {\mu_F}^2) \; f_b(x_b, {\mu_F}^2) \; 2p_T \; \frac{x_a x_b}{x_a - \frac{m_T e^y}{\sqrt{s}}} \; \frac{d\sigma}{dt}(ab \to Q\bar{Q}) \quad (1)$$

The production cross section for the process ($ab \to Q\bar{Q}$) where a,b refers to partons is defined as

$$\frac{d\sigma}{dt} = \frac{|\mathcal{M}|^2}{16\pi \hat{s}^2} \quad (2)$$

In the present work we take into account only leading order diagrams for the production.

PDFs and Shadowing

The functions $f(x, {\mu_F}^2)$ are the PDFs of the partons within the nucleons, obtained by deep inelastic scattering (DIS) of leptons off nucleus. We use CTEQ6.6 set of PDFs in our calculations. The PDFs for a free nucleon are different from those of a nucleon inside a nucleus. This effect is called **Shadowing** and/or **anti-Shadowing**. We use NLO set of EPS09 parametrization for obtaining the nuclear PDFs (nPDFs). The bound nucleon PDFs, $f_i^A(x, Q^2)$ for each parton flavor i can then be written as [2],

$$f_i^A(x, Q^2) = R_i^A(x, Q^2) f_i^{CTEQ6.6}(x, Q^2) \quad (3)$$

where $R_i^A(x, Q^2)$ is the nuclear correction to the free nucleon PDF $f_i^{CTEQ6.6}(x, Q^2)$.

Results and discussions

Figure 1 shows the p_T dependence of R_{AA} for charm and bottom quarks due to nPDFs in PbPb collisions at $\sqrt{s_{NN}}$=2.76 TeV. We can notice the effect of shadowing is more in case of charm quark than for bottom quark. Figure 2 is the same for the future collisions at $\sqrt{s_{NN}}$=5.0 TeV. By comparing these figures it is clear that the effect of shadowing increases at higher collision energy. Figures 3 and 4 give the rapidity dependence of R_{AA} due to shadowing for two windows of p_T. The R_{AA} due to nPDF effects is smaller in mid-rapidity and is more at forward rapidities. Moreover the lower p_T window shows more suppression of

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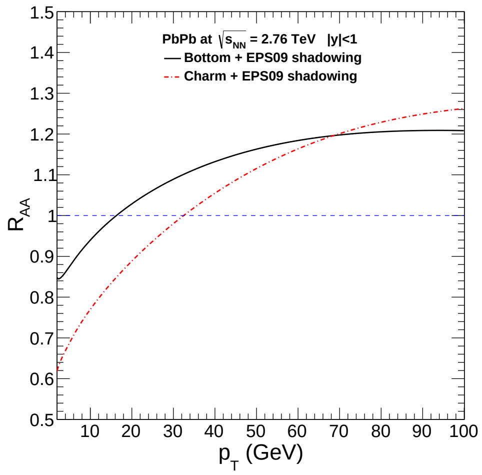

FIG. 1: R_{AA} as a function of p_T

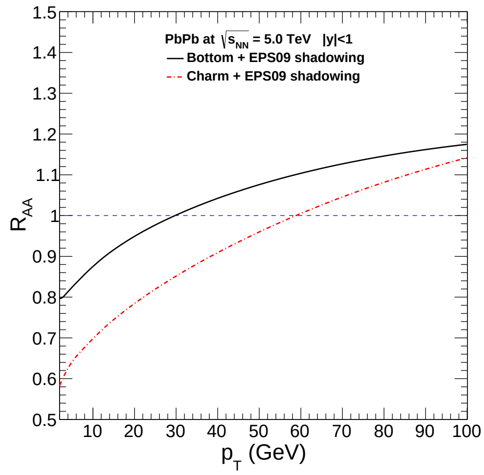

FIG. 2: R_{AA} as a function of p_T

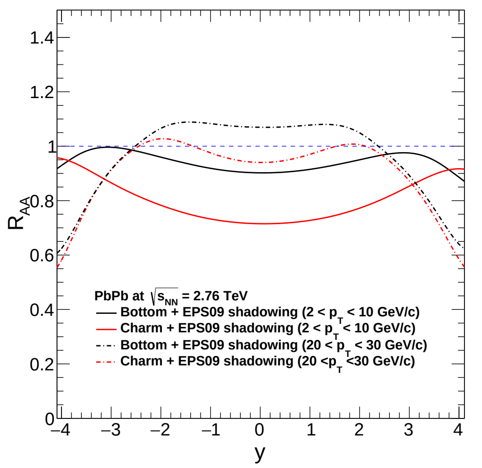

FIG. 3: R_{AA} as a function of y

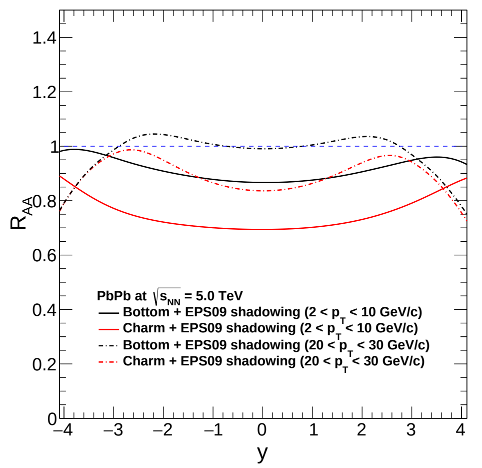

FIG. 4: R_{AA} as a function of y

R_{AA}. At higher energy the central rapidity region is flatter as compared to the lower energy. The charm and bottom quarks are fragmented in D and B mesons which are then detected in the experiment. Inclusion of fragmentation functions in the calculations are in progress.

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References

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