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Study of production of electrons from beauty-hadron decays in pp collisions at $\sqrt{s}$ = 13 TeV and Pb–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV with ALICE

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Heavy quarks, charm and beauty, are expected to be effective probes for the hot and dense medium (QGP) produced in high-energy heavy-ion collisions. They are produced in the early stage of the collision, almost exclusively in hard partonic scattering, and therefore they experience the full evolution of the QGP allowing to study the in-medium partonic energy-loss. In particular, the medium-induced parton energy loss is expected to depend on the parton mass and colour charge. This results in a reduction of beauty-quark energy loss compared to charm-quark energy loss. Therefore the separate measurement of the beauty-quark production from charm-quark production allows us to test various parton energy loss models. In addition, the measurement in pp collisions provides a crucial testing ground for perturbative QCD calculations and provides a mandatory baseline for corresponding studies in Pb-Pb collisions. In this paper, the measurements of beauty-hadron decay electrons in Pb–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV comparing with one at $\sqrt{s_{\rm NN}}$ = 2.76 TeV is reviewed, and the status of the same study in pp collisions at $\sqrt{s}$ = 13 TeV is shown.

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1. Introduction and analysis method

Heavy quarks, charm and beauty, are mainly produced by the hard partonic scattering process in the early stage of the collision due to their large masses with short formation time [1]. Since they experience the full evolution of the medium, they allow to investigate the energy-loss mechanism of the partons in the QCD medium. The QCD medium effect can be quantified by the nuclear modification factor, $R_{\rm AA}$,

$$R_{\rm AA} = \frac{1}{\langle T_{\rm AA} \rangle} \frac{{\rm d}N_{\rm AA}/{\rm d}p_{\rm T}}{{\rm d}\sigma_{\rm pp}/{\rm d}p_{\rm T}} \quad , \tag{1}$$

where $\langle T_{\rm AA} \rangle = \langle N_{\rm coll} \rangle / \sigma_{\rm inel}^{\rm AA}$ is the nuclear overlap function, $N_{\rm AA}$ is the particle yield in Pb–Pb collisions and $\sigma_{\rm pp}$ is the inelastic cross-section in pp collisions. The analysis is performed using the Inner Tracking System, Time Projection Chamber and Time-Of-Filght in ALICE [2] to identify the electrons and investigate the beauty production via electrons from beauty-hadron decay. The electrons coming from beauty-hadron decays are statistically separated from background electrons using the impact parameter (d_0) distribution of tracks which is wider for the beauty-decay electrons due to its long lifetime ($c\tau \approx 500\,\mu$m) [3, 4].

2. Summary and outlook

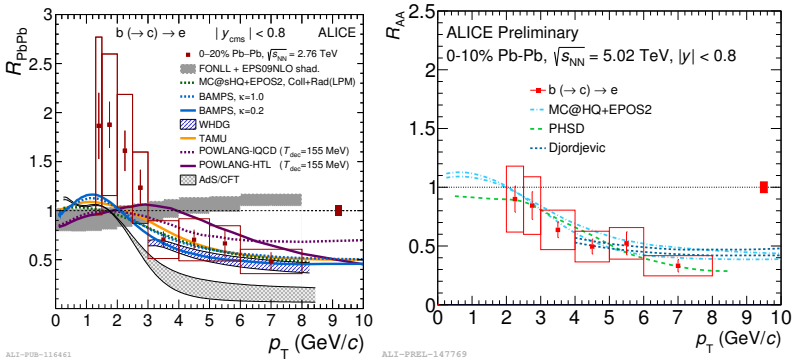

Figure 1: $R_{\rm AA}$ of electrons from beauty hadrons in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV (left) [4] and 5.02 TeV (right)

The $R_{\rm AA}$ of beauty-hadron decay electrons in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV and 5.02 TeV, measured as a function of $p_{\rm T}$, is shown in Fig 1. The measured $R_{\rm AA}$ is described by theoretical models of beauty-quark energy loss in the QGP within uncertainties. The suppression of beauty-hadron decay electrons in $p_{\rm T} > 3$ GeV/c can be understood as an effect of the hot and dense medium created in Pb-Pb collisions. Additionally, the Pb–Pb 2018 statistics will allow to reduce the uncertainties. In addition, the same study with same method in pp collisions at $\sqrt{s} = 13$ TeV has been studying and the spectrum would be compared with pQCD calculations (FONLL) [5].

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