Heavy Flavor Decay Muon Production in proton-proton collisions at √s = 13 TeV

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Introduction

The Quark Gluon Plasma (QGP), a state of deconfined quarks (antiquarks) and gluons, is expected to be produced at extremely high temperature and/or density in heavy-ion collisions at ultra-relativistic energies. The study of the properties of such a state is being carried out using Relativistic Heavy Ion Collider (RHIC) at BNL, USA and Large Hadron Collider (LHC) with ~ 30 times higher energy density at CERN laboratory of Geneva, Switzerland. In such high energy experiments, it is expected that the heavy quarks (charm and beauty, M >1 GeV) are produced in the initial hard scattering processes. Heavy quarks are widely recognized as the excellent probes of QGP. These heavy quarks pass through the hot and dense medium and lose energy by radiative and collisional processes and which can be estimated using perturbative QCD calculations. The energy loss vis a vis the nuclear modification factor (R_{AA}) can be estimated through the decay of heavy flavoured mesons (HFM) to single muon from which the nature of the medium produced in heavy ion collisions can be inferred. The single muon measurement is done using the Muon Spectrometer (MS) of ALICE detector, where A Large Ion Collider Experiment (ALICE) is one of the experiments going on deploying LHC accelerator. As mentioned, one of the signatures of QGP can be identified by measuring R_{AA} which is the ratio of the production yield in heavy-ion (AA) collision to that measured in proton-proton (pp) collision at the same energy normalised by the number (N_{coll}) of binary nucleon-nucleon collisions in AA collisions. Hence the measurement in pp collision serves as the baseline for AA collision.

The production of heavy flavor mesons (D and B) at relativistic high energy can be studied through the semileptonic decays of D- and B-meson.

Simulation of Single Muons decay from Heavy Mesons

The study of the production of heavy mesons (charm and bottom) can be simulated using PYTHIA event generators. This production is to be tuned to reproduce Fixed-Order Next-to-Leading Logarithm (FONLL) calculations for the production of bottom and charm quarks. The initially produced charm and bottom quarks hadronize into D- and B-meson respectively through fragmentation [1]. The final hadronized heavy-flavor mesons may undergo further decay to electron or muon through their semileptonic decay mode. In this paper, we have shown the production cross-section of single muons from the decay of heavy-flavor mesons in pp collisions at $\sqrt{s} = 13$ TeV using PYTHIA simulation.

Study of Heavy Flavor Decay Muons at $\sqrt{s}$ =13 TeV

In this work, we study for the single muons from heavy-flavor mesons (D & B) using PYTHIA event generator at $\sqrt{s} = 13$ TeV for proton-proton collisions. Here we study the semi-muonic decay of D-mesons (D^+, D^0, D_s^+ and their charge-conjugate) and B-mesons (B^+, B^0, B_c^+, B_s^0 and their charge conjugate). We have looked into the muons from quarkonia group i.e. J(ψ), ψ(2S), ϒ(1S) and ϒ(2S) which are originated from B-meosn and considered the muons from D-mesons actually decaying from B-mesons also. The Fig.1 shows the heavy flavor meson decay muon production in forward rapidity range (-4.0 < y < -2.5) within the ALICE -MS acceptance at $\sqrt{s}$ =13 TeV.

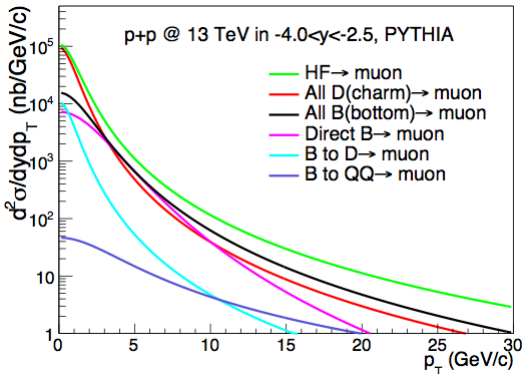

Fig. 1 The p_T -differential production cross-section of muons from Heavy Flavor decays in forward rapidity (-4.0 < y < -2.5).

Fig.1 shows that the total bottom production is well dominated over charm at higher p_T ranges.

The HFM production along with their heavy-flavor contributions in the mid-rapidity region is shown in Fig.2 also. Hence, the production of charm and bottom at mid-rapidity zone complies the same study for forward rapidity region.

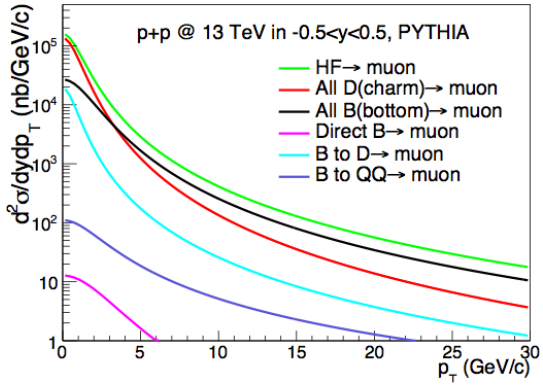

Fig. 2 The p_T -differential production cross-section of muons from Heavy Flavor decays in mid-rapidity (-0.5 < y < 0.5).

The Fig. 3 shows a comparison of the HFM production at two LHC energies pp@7 TeV and pp@13 TeV.

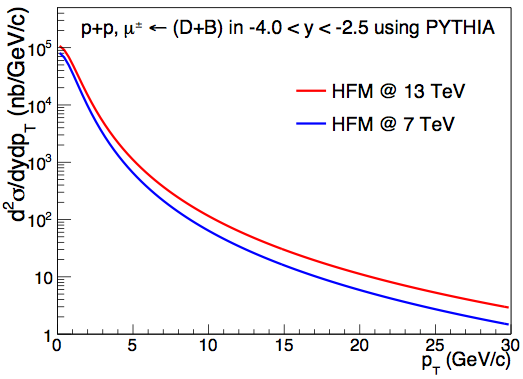

Fig. 3 The p_T -differential production cross-section of muons from Heavy Flavor decays in forward rapidity (-4.0 < y < -2.5) at $\sqrt{s}$ =7 TeV and $\sqrt{s}$ =13 TeV for proton-proton collisions.

We will compare the results obtained from PYTHIA with the FONLL calculations. The analysis of the experimental results for HFM production for pp @ $\sqrt{s}$ =7 TeV has been done already [2]. The work on the interpretation of experimental data for for pp @ $\sqrt{s}$ =13 TeV with the simulation study is in progress.

Reference

[1] Taesoo Song, Hamza Berrehrah, Phys. Rev. C 96, 014905 (2017).
[2] Phys. Lett. B 708, 265 (2012).