Effect of p_T broadening on J/ψ mass resolution

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Introduction

Ever since it became possible to create the conditions of producing Quark - Gluon Plasma (QGP) in relativistic heavy ion collisions, numerous signals were proposed to probe the characteristics of such an exotic state of matter. In this context Satz and Matsui [1] have suggested that production of heavy quark resonances (J/ψ) would be suppressed as a result of colour Debye screening in a hot and dense system of quarks, anti-quarks and gluons. This suppression could be detected experimentally through the dileptonic decays of these resonances. ALICE Dimuon Spectrometer [2] is dedicated to look for this type of signal. However, it is a daunting task to disentangle the contributions of the heavy quarkonia states to muon spectrum due to the background from several other sources, for example, Drell-Yan, semileptonic decay of open heavy flavoured mesons ($D\bar{D}, B\bar{B}$), etc. Low energy muons from kaons and pions also constitute a large background.

In the present work we have attempted to estimate the mass resolution of J/ψ taking into account initial state momentum broadening: Cronin Effect [3] and the survival probability in the hot and dense medium.

Formalism

We use the CDF - scaled p_T distribution of J/ψ to estimate the mass resolution of charmonium taking into account the detector effects as per the ALICE Dimuon Spectrometer.

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The p_T distribution is given by:

$$\frac{dN}{dp_T} = \frac{p_T}{[1 + (p_T/p_{T_0})^2]^n} \quad (1)$$

where p_{T_0} and n are constants taken from CDF - scaled parameterization defined in AliRoot framework.

Following distribution is used [4] for inclusion of broadening and survival probability:

$$\frac{dN}{dp_T} = \int d^2k_T\, e^{-(p_T-k_T)^2/\langle p_T^2\rangle} S(k_T) \frac{dN}{dk_T} \quad (2)$$

The enhancement of p_T - width due to nuclear effects can be written as (see [5] for details):

$$\langle k_T^2\rangle_{pA} = \langle k_T^2\rangle_{pp} + \delta^2(Q^2)[\nu_A(b) - 1] \quad (3)$$

where $S(k_T)$ is the the survival probability of the quarkonium [6].

Simulation and Analysis

In order to study the variation of mass resolution of J/ψ with p_T, 10000 parametrized CDF scaled J/ψ, coming from muon combinations, were generated at various p_T values (from 0.5 GeV/c to 12 GeV/c) by using the PARAM event generator in the AliRoot framework.

Results

Fig. 1 shows the variation of mass resolution with p_T for CDF - scaled parameterized J/ψ. The p_T distribution for J/ψ obtained using a theoretical model [7] is depicted in Fig. 2 and fitted by second order polynomial. The fit parameters are used in the AliRoot framework to observe the variation of mass resolution with p_T with Cronin Effect included in p_T distribution.

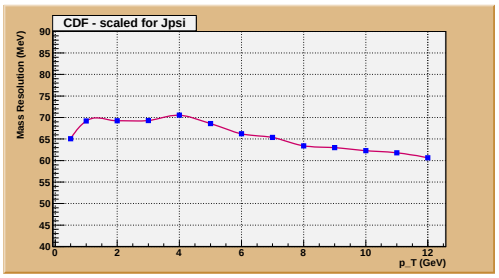

FIG. 1: Variation of mass resolution of J/ψ with p_T from CDF - scaled parameterization.

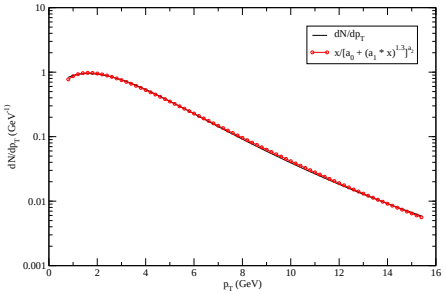

FIG. 2: p_T distribution of J/ψ using the theoretical model.

The Cronin Effect on mass resolution of J/ψ with p_T observed in the AliRoot framework is displayed in Fig. 3.

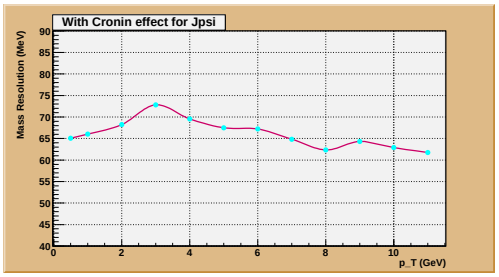

FIG. 3: Variation of mass resolution of J/ψ with p_T including Cronin Effect.

The survival probability is plotted for J/ψ and fitted with fifth order polynomial.

The observed mass resolution for J/ψ with brodening and survival probability included in the p_T distribution is exhibited in Fig. 4.

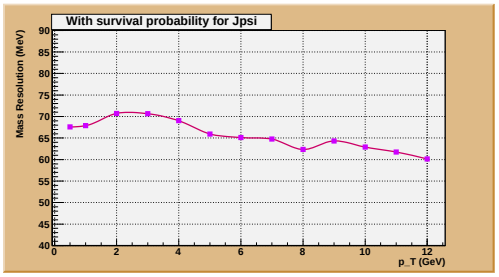

FIG. 4: Variation of mass resolution of J/ψ with p_T with brodening and survival probability included.

Summary

It is observed that the variation of mass resolution of J/ψ with increasing values of p_T with CDF - scaled parameterization is almost the same as the one observed with momentum brodening. The mass resolution is not having much different pattern with taking into account the broadening and survival probability.

Hence, it can be conlcluded that the p_T brodening is not having any discernible effect on the mass resolution observed for J/ψ.

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