Invariant Yield of Inclusive Pions and Mesons in difference Centrality of Au + Au Collisions at sqrt(_{NN})= 200 GeV

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Introduction

The production of hadrons carrying heavy flavor, i.e. charm or bottom quarks, serves as a crucial proving ground for quantum chromodynamics (QCD), the theory of strong interaction [1]. Hadron spectra reflect conditions late in the reaction, as well as the integrated effects of expansion from the beginning of the collision. We are generating an electron cocktail to subtract background from an electron spectrum in order to estimate the heavy flavor cross section through the semi-leptonic decay channel.

Cocktail calculations

The cocktail calculation discussed below have several major improvement compared to the previous versions [2]. In this calculation neutral as well as charged pion data are incorporated to parameterize the pion spectra, which are the most important cocktail ingredients. Neutral and charged pions data are fitted simultaneously. This fitting is based on the assumption that the neutral pion spectrum is the same as the average charged pion spectrum. This additional input will significantly improves the quality of the electron cocktail at low p_T (<1.5 GeV/c). Figure 1 shows the transverse momentum distributions for pions in Au + Au collisions at $\sqrt{s_{NN}}$ = 200 GeV in 20-30% centrality region. The pion spectra have a concave shape at low p_T where many of the pions may come from the decay of resonances of Δ, ρ, etc. In addition, we determine the ratio of pionic electrons, i.e. electrons from π^0 Dalitz decays and conversions of photons from π^0's 2γ decays, to photonic electrons and to the full electron cocktail. These ratios are important ingredients for the e-γ correlation analysis and can only be determined via a cocktail calculation.

Data Analysis

The parameterization of the π^0 invariant yield spectra is crucial because it is the dominant source of electrons. Other light meson spectra were determined using the parameterization of π spectra and m_T scaling. In this calculation the Au + Au data for π^+, π^- and π^0 were taken from Ref. [3, 4]. Spectrum of invariant yield as function of p_T has been plotted for different centralities starting from (0-10%) to (80-92%). These spectra were fitted using the fitting function that is a modified Hagedorn Parameterization, which is given below:

$$F(x)= c / [\exp (-a*x - b*x*x+x/p0)]^m, \quad (1)$$

where a, b, c, p0 and m are the fit variables and the variable x is nothing but p_T. A summary of above mentioned fitted parameters for each centrality region are tabulated in Table 1.

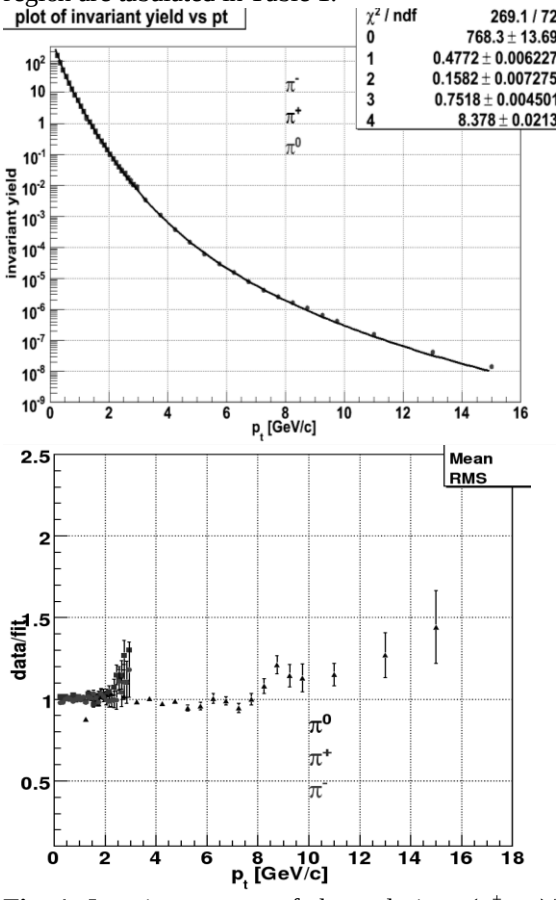

Fig. 1: Invariant spectra of charged pions ($\pi^+ + \pi^-$)/ 2 measured in Run-4 Au + Au collisions at 200 GeV [3] at 20-30% centrality (shown in square) and neutral pions measured in Run-8 Au + Au collisions [4] (shown in circle) fitted with a modified Hagedorn function (upper panel). The ratio of data to fit demonstrates the excellent quality of the parameterization (lower panel).

To check the quality of fitting i.e. whether the input parameters and the Hagederon function perfectly fit our data or not, we plotted data/fit versus p_T for each centrality region.

M_T-scaling & Normalization

The other light mesons contributing to the inclusive electron spectrum via their decays are the η, ρ, ω, φ, η' and ϕ mesons. However, only the η meson contributes a sizeable fraction of decay electrons, in particular at high p_T. The p_T spectra of mesons (except π^0) are equivalent to that of $\pi^{\pm}$ spectra at higher p_T region. That's why to get the spectra of other mesons, p_T has been replaced by $\sqrt{(m_T^2 - m_{\pi 0}^2)}$, where $m_T^2 = p_T^2 + (M_{meson})^2$. For each above mentioned mesons including π^0, dN/dy value has been derived by integrating the invariant yield as function of p_T. In the used approach for cocktail calculation, the ratios h/π^0 is constant at high p_T as shown in figure 2. The ratio of dN/dy for different mesons to π^0 has also been calculated for different centralities. The relative normalization to the π is given by the ratios meson-to-pion up to high p_T (15 GeV/c). The used values of ratios are better for the relative normalization [5]: ρ/π^0=1.0±0.06, ω/π^0=1.0 ±0.06, η/π^0=0.55±0.076, η'/π^0=0.25±0.007, φ/π^0= 0.47±0.009 for 20-30% centrality. While all higher mass mesons except for η are essentially irrelevant in terms of their contribution to the inclusive electron spectrum, it is important to demonstrate that the chosen parameterization is reasonable for the η meson. The contribution to the electron spectrum from η decays is increasing with increasing p_T. While at low p_T, η decays are irrelevant relative to π^0 decays. The η contribution increases and saturates towards high p_T (8 GeV/c) as shown in figure 3. Similar results will be presented for the other centralities. The value of all considered mesons and neutral pions in different centralities are summarized in Table 2.

Centrality	a $(GeV/c)^{-2}$	b $(GeV/c)^{-1}$	c $(GeV/c)^{-2}$	p0 (GeV/c)	m
0-10%	1331.0	0.5678	0.1945	0.7429	8.348
10-20%	1001.0	0.5260	0.1610	0.7513	8.345
20-30%	450.3	0.4930	0.1530	0.7478	8.299
30-40%	535.3	0.4534	0.1325	0.7525	8.333
40-50%	364.5	0.4335	0.1221	0.7385	8.261
50-60%	231.2	0.4220	0.1027	0.7258	8.220
60-70%	118.1	0.4416	0.0559	0.7230	8.163
70-80%	124.9	0.4392	0.0441	0.7277	8.145
80-92%	51.1	0.2470	0.0619	0.7101	8.123

Table 1: Summary of the fit parameters for the π^+, π^- and π^0 combined invariant p_T distributions according to Eq. 1.

Mesons centrality	π^0	ρ	ω	η	ή	φ
0-10%	236.74	15.37	14.53	35.51	7.61	6.08
10-20%	170.04	10.62	10.04	24.72	5.26	4.21
20-30%	122.71	07.15	06.76	16.77	3.55	2.84
30-40%	084.75	04.57	04.31	10.82	2.26	1.18
40-50%	054.77	02.72	02.56	06.55	1.33	1.07
50-60%	033.54	01.51	01.42	03.71	0.73	0.58
70-80%	009.28	00.32	0.307	0.823	0.15	0.104

Table 2: Summary of dN/dy values for different mesons in different centralities regions.

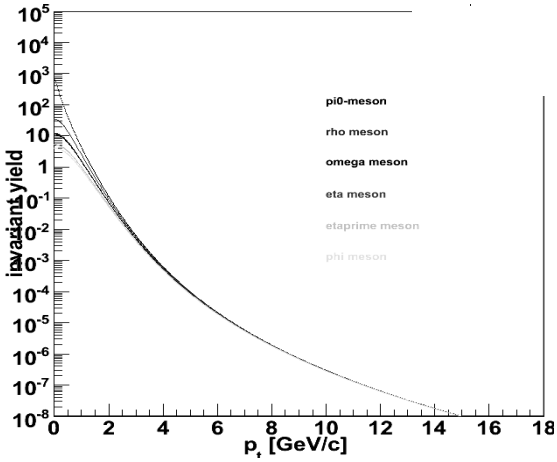

Fig. 2: Distribution of invariant yield for different mesons as function of p_T.

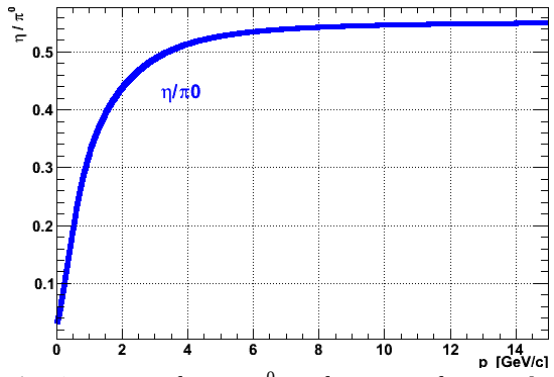

Fig. 3: Ratio of η to π^0 as function of p_T in the current cocktail calculation.

A detailed study of cocktail calculation and its input parameter determination will be presented.

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