PHENIX Dimuon Mass Plot from 10k Data

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1 Introduction

The expected dimuon mass spectrum for 1 RHIC year at blue-book luminosity from Central Au-Au events has been simulated using the PISA/PISORP [1] package. The HIJING event generator was used to produce Central Au-Au events, and the events from charm, Drell-Yan, and the ϕ, J/ψ and ψ' vector mesons were produced using various event generators that will be described below. The PISA package was used to determine the detector hits produced by tracks from central events and from signal events. The PISORP package was used to reconstruct signal tracks and to determine whether a track would pass a set of muon identification cuts. The tracks that survived these cuts were kept to produce the final dimuon mass plot. When the combinatorial mass spectrum from the Central events was combined with the normalized signal events, the resulting signal to background ratios for the vector mesons in the North muon arm were 6.95 for the J/ψ, 0.38 for the ψ', and 0.004 for the ϕ.

2 Event Generation

3 The PISA/PISORP Package

The PHENIX PISA simulation package was used to simulate the muon detector geometry and record the detector hits from background and signal

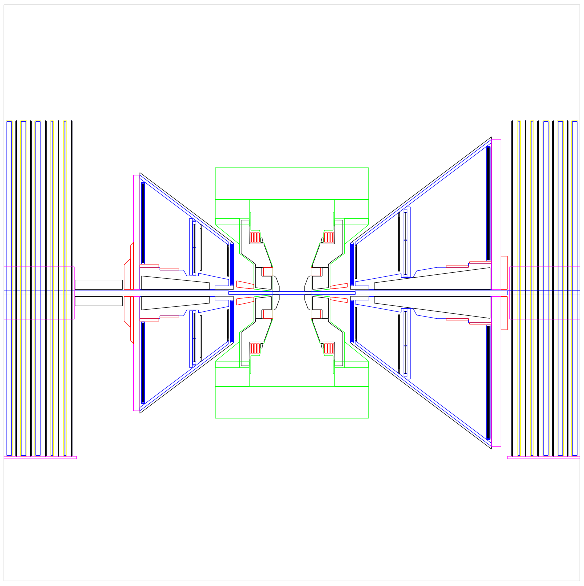

Figure 1: The PHENIX detector geometry in the PISA simulation package.

events. The geometry that was used for this study is shown in Figure 1.

For vector meson events, the full PISORP analysis package was used, which simulates the full detector response of the muon tracking chambers and reconstructs the tracks using the positions measured by the chambers. The reconstructed tracks and the hit positions in the muon identification system were then written to an NTUPLE and an NTUPLE analysis was used to apply muon identification cuts to the tracks. Tracks were kept from the NTUPLE if they passed the following cuts

- Track passed through at least 7/9 tracking chambers
- Track reached at least the 3rd plane of the muon identification system.
- The hits in the first 2 items fell within the active volume of the detectors.
- The depth the muon reached in the muon identification system and the momentum of the track were consistent with a muon.
- The momentum vector at Station 1 pointed to within 20 cm of the true vertex.

- The hits in the muon identfication planes would pass a trigger cut

The depth cut was applied by requiring that the momentum in the tracking chambers be less than a momentum cut which was dependent on the last plane that the track reached in the muon identification system. This momentum cut was 0.0, 1.0, 1.3, 1.7, 2.2 and 200 for planes 1-6, respectively.

The trigger cut required that the hits in the muon identification would pass a "steered" trigger road that is expected to be used for triggering in the muon identification system.

All dimuons that passed the above cuts were combined to form a mass plot, using the reconstructed track momenta.

For the central event background tracks, the PISORP muon identification cuts were used to determine whether a track was kept or not, but the full track reconstruction was not used since the momentum resolution would not affect the dimuon mass plot from combinatorial events, and the cpu time required is much less if the full reconstruction is not used. The momentum for mass calculations was taken to be the true momentum that the event generator produced.

4 1 RHIC year

The spectra below will all be normalized to 1 RHIC year of blue-book luminosity running, which is taken to be $2\text{x}10^{26}$ cm^{-2}s^{-1} for 3000 hours ($1.08\text{x}10^{7}$ sec) which gives an integrated luminosity of $2.16\text{x}10^{33}$cm^{-2}.

5 Combinatorial Background from Central Events

The combinatorial background for central Au-Au events was simulated using 9105 events that were run through the PISA package followed by the muon identification portion of the PISORP package. The normalization of the combinatorial mass spectrum was determined by combining all pairs of muon-like tracks that passed the PISA/PISORP analysis and were contained in the same event. The resulting number of dimuons divided by 9105 gives the

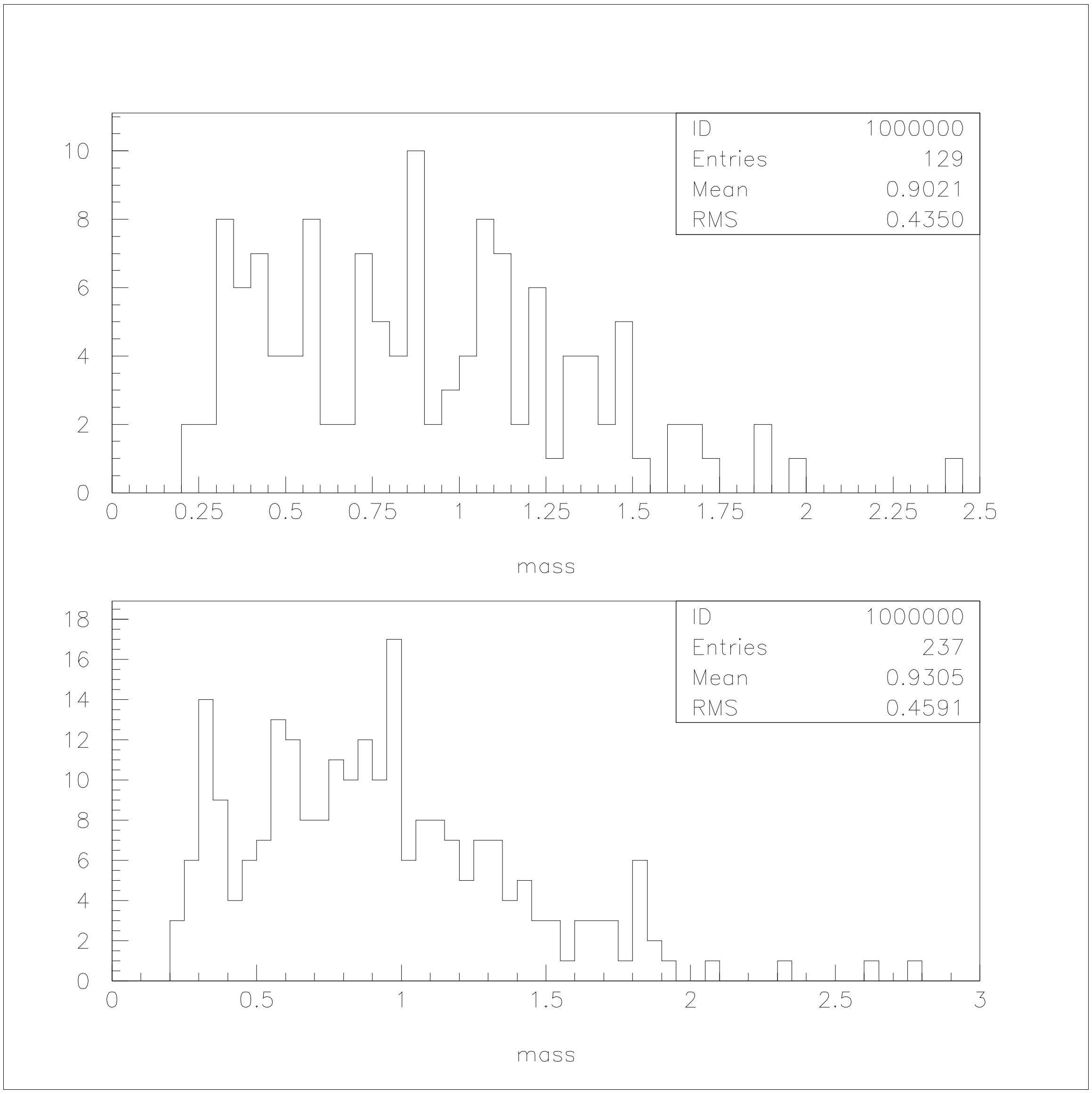

Figure 2: The dimuon events in the North and South muon arms that pass all the PISA/PISORP analysis cuts. 9105 Central events were used to produce the spectra.

number of dimuons per event for Central Au-Au events. The dimuon spectra for the North and South arms is shown in Figure 2

This gives 0.014 dimuons/event in the North arm and 0.025 dimuons/event in the South arm. If the Central event cross section is taken to be 612 mbarns, this gives a yield per RHIC year of $(0.612\text{x}10^{-24})(2.16\text{x}10^{33})(0.014)$ $= 1.85\text{x}10^{7}$ combinatorial dimuons/year in the North muon arm.

A dimuon mass spectrum with better statistics was then produced by "mixing" the muons from the 9105 events, and then normalizing the spectrum to produce a total of $1.85\text{x}10^{7}$ combinatorial dimuons.

6 Acceptance of Charm Events

The yield of uncorrelated dimuon charm events was calculated assuming a p-p cross section of 200 μbarns for single charm events, scaling to Central Au-Au events, and multiplying by the branching ratimuons and the acceptance of the PISA/PISORP analysis. The Central Au-Au yield for 1 RHIC year is calculated as:

$$CentralAu - AuCharmEvents = (L)(\sigma(p-p))(A^{\frac{4}{3}}) = 4.95x10^{8} \qquad (1)$$

Dimuons were generated for the North muon arm analysis by mixing single charm muons and saving the dimuons that fell into the angular acceptance of $\theta = (5{,}45)$ degrees. This angular acceptance plus the muon BR produce a dimuon acceptance of 0.0027.

10,000 of these uncorrelated dimuon charm events covering the entire mass spectrum were then run through the PISA/PISORP package and 185 survived in the North arm, giving a PISA/PISORP acceptance of 0.0185. This gives a yield for a RHIC year that is then $(4.95\text{x}10^{8})(0.0027)(0.0185) =$ $2.5\text{x}10^{5}$/RHIC year.

7 Acceptance of Drell-Yan Events

The yield of Drell-Yan events was calculated assuming a p-p cross section of 29.95 nbarns for M>1 GeV, a k factor of 2, scaling to Central Au-Au events, and multiplying by the acceptance of the PISA/PISORP analysis. The Central Au-Au yield for 1 RHIC year is calculated as:

$$CentralAu-AuDrell-YanEvents = (L)(k)(\sigma(p-p))(A^{\frac{4}{3}}) = 1.5x10^5 \quad (2)$$

Dimuons were generated for the North muon arm analysis by selecting dimuons that fell into the angular acceptance of $\theta = (5,45)$ degrees. This cut produces a dimuon acceptance of 0.112.

10,000 of these Drell-Yan events were then run through the PISA/PISORP package and 876 survived in the North arm, giving a PISA/PISORP acceptance of 0.0876. The entire yield for a RHIC year is then (1.5x10^5)(0.112)(0.0876) = 1.47x10^3/RHIC year.

8 Acceptance of Vector Meson Events

The yield of J/ψ events for 1 RHIC year was calculated from:

$$J/\psi Events = (L)(BR\sigma)(PISA/PISORPaccept) = 1.88x10^5/RHICyear \quad (3)$$

The yield of ϕ events is:

$$\phi Events = (L)(BR\sigma)(PISA/PISORPaccept) = 1.8x10^4/RHICyear \quad (4)$$

The yield of ψ' events is:

$$\psi' Events = (L)(BR\sigma)(PISA/PISORPaccept) = /RHICyear \quad (5)$$

9 Normalized Mass Spectra

Figure 3 shows the normalized spectra from ϕ, J/ψ and ψ' dimuons, dimuons from uncorrelated charm decay and dimuons from Drell-Yan. If you are viewing the spectrum without color, the charm can be identified as the dominant contiuum spectrum at low mass.

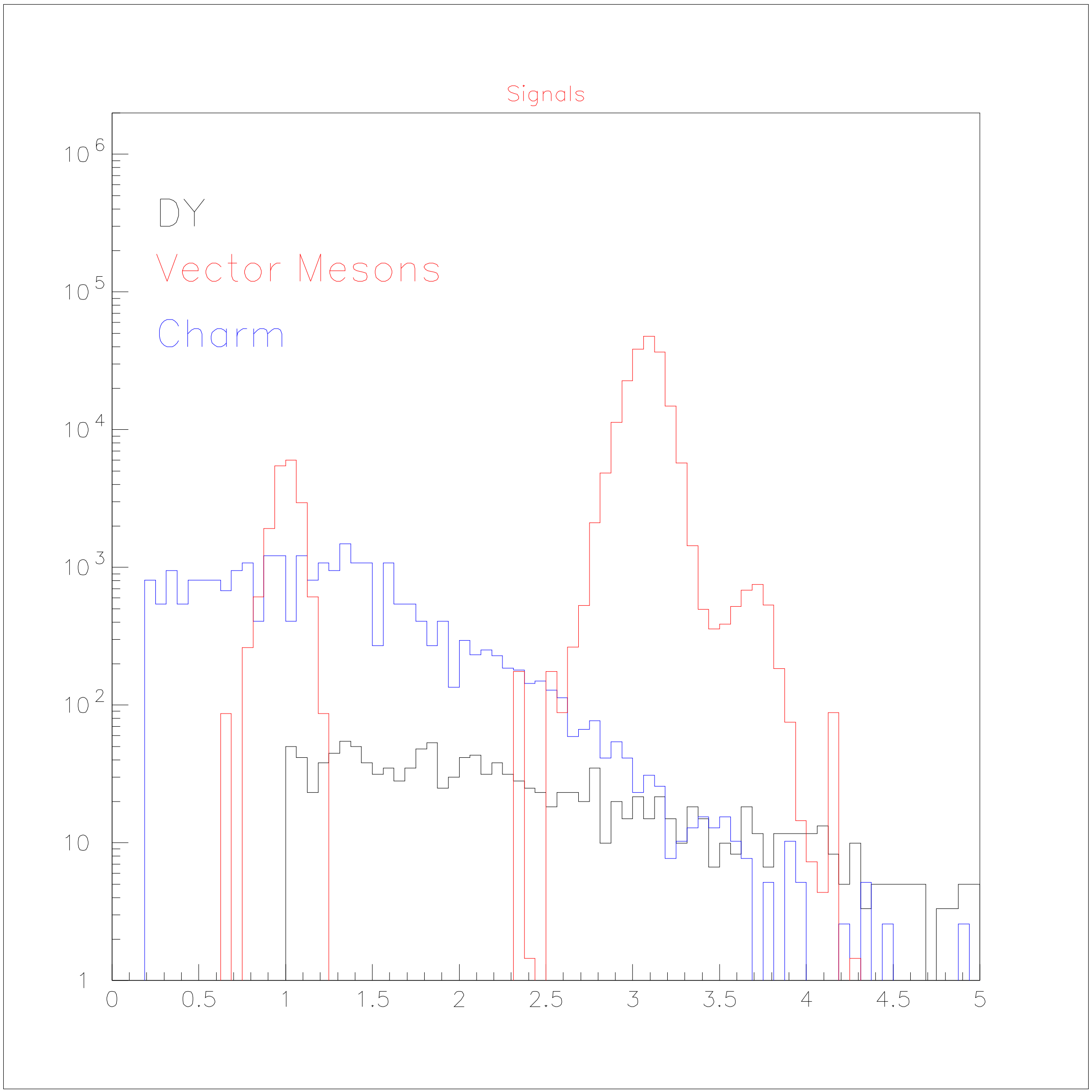

Figure 3: Normalized dimuon events from ϕ, J/ψ and ψ' vector mesons, uncorrelated charm decay and Drell-Yan. The total yields correspond to 1 RHIC-year of running.

Figure 4 shows the sum of the signals in figure 3 along with the normalized combinatorial mass spectrum from Central Au-Au events. If the combinatorial mass spectrum is integrated below the vector meson peaks, you obtain a signal:background of roughly 6.95 for the J/ψ, 0.38 for the ψ', and 0.004 for the ϕ.

References

[1] http://rsgi01.rhic.bnl.gov/export1/phenix/WWW/SIMULATION/simulation.html.

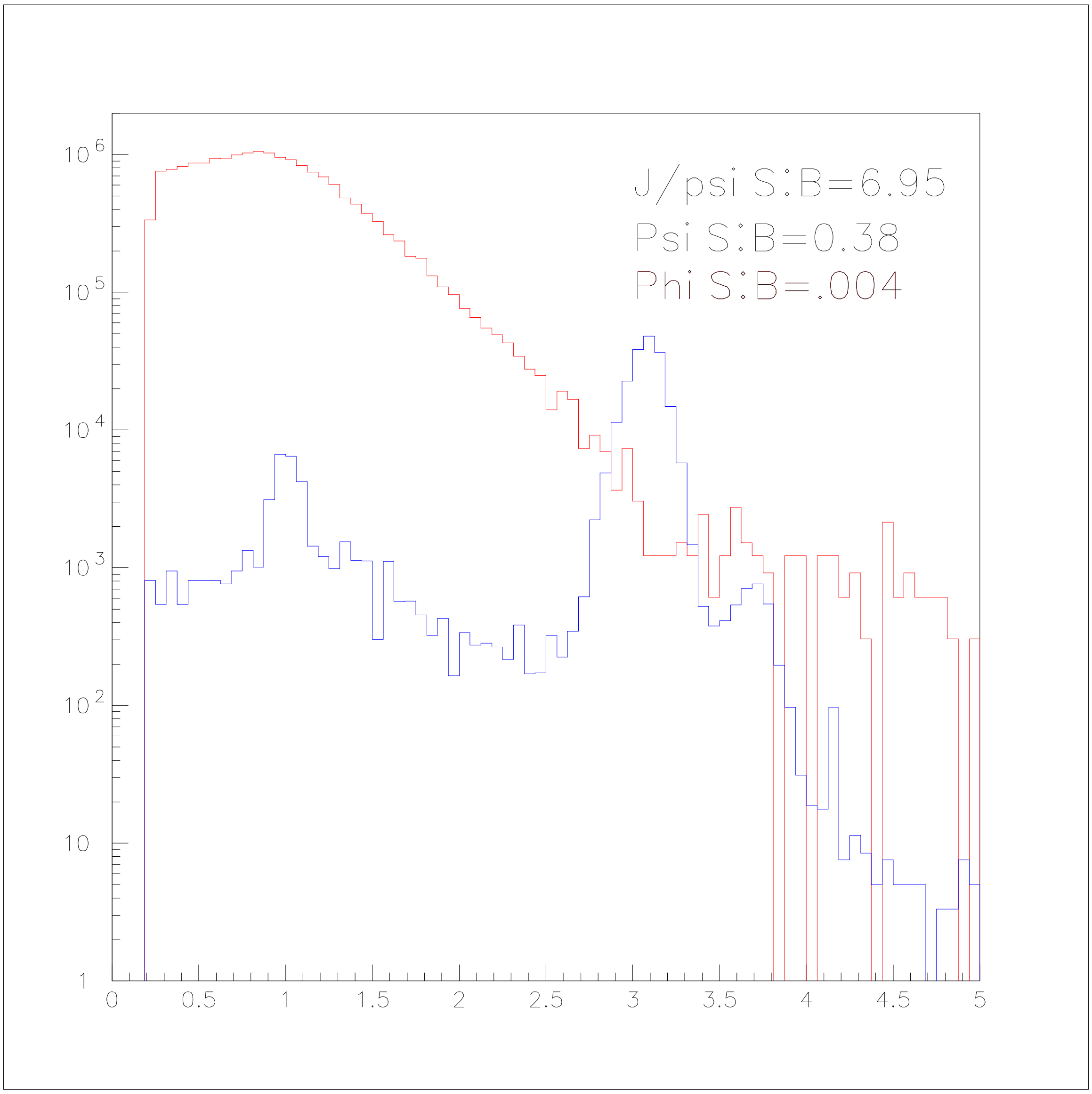

Figure 4: Normalized dimuon events from ϕ, J/ψ and ψ' vector mesons, uncorrelated charm decay and Drell-Yan (in blue) and from combinatorial events (red). The total yields correspond to 1 RHIC-year of running.