Neutron Spectra and Correlations from AuAu Collisions at $\sqrt{S_{NN}}$ = 130GeV

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The BRAHMS experiment consists of two movable spectrometers and three detector systems to measure global variables for each event [1]. The spectrometers allow BRAHMS to measure particle yields over a very wide range of p_T and rapidity. The Tile Multiplicity Array measures multiplicity in the pseudorapidity region $|\eta| < 2.2$, while the Beam-Beam covers $3.0 < |\eta| < 3.5$. Finally two zero degree calorimeters (ZDC) at ±18m measure the energy of forward going neutral particles [2]. Almost all of this energy is from non interacting neutrons. They are used for finding the interaction vertex, centrality and luminosity [3].

Peripheral interactions of heavy ions produce intense electromagnetic, EM, fields which may be used to probe the structure of the nucleus. At $\sqrt{S_{NN}} = 130 GeV$ one *Au* nucleus sees the other approaching at a speed corresponding to a lorentz factor of *(* = 9800. The nucleus may absorb several photons and be excited into the giant dipole or even to multi-phonon resonances. As the nucleus equilibrates and cools it may emit several neutrons, protons and photons. In order to study EM interactions we require no hits in either the tiles or the beam-beam counters. From HIJING [4] we estimate that we have a 2% contamination of peripheral nuclear events.

For purely EM events each nucleus interacts independently with the field and therefore one would expect no correlations between fragments from the left and right going nuclei. However for nuclear collisions both nuclei have the same number of "wounded nucleons" and therefore the left and right spectra should be correlated. This effect can be quantified using the correlation function

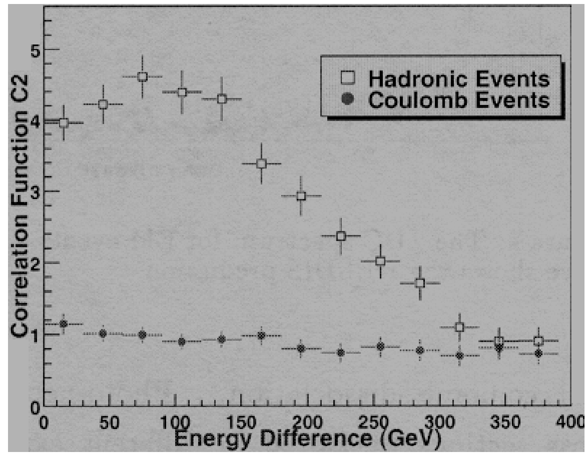

Figure 1: Neutron Correlation function C_2 versus *dE* for EM ● and nuclear □ events.

$$C_2\left(E_{Left}, E_{Right}\right) \equiv \frac{P(E_{Left}, E_{Right})}{P(E_{Left}) \cdot P(E_{Right})}$$

where $P(E_{Left}, E_{Right})$ is the joint probability to measure energies E_{Left} and E_{Right} while $P(E_{Left})$ and $P(E_{Right})$ are the corresponding single probabilities. Figure I shows C_2 as a function of the energy difference $dE \equiv \left|E_{Right} - E_{Left}\right|$ for our EM and nuclear data sets. As expected the correlation function is flat for EM events but peaked at $dE = 0$ for nuclear ones.

Figure 2 shows the energy spectrum in the right ZDC and the spectrum from the RELDIS[5] model after smearing with the experimental resolution. RELDIS extends the Weizsacker-Wiffiams method to mutual coulomb dissociation. Photo-neutron cross sections measured in different experiments are

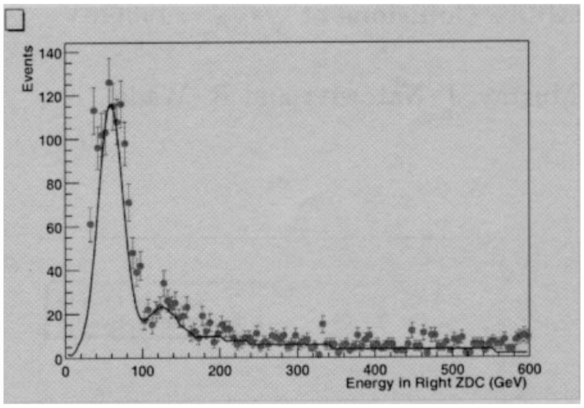

Figure 2: The ZDC spectrum for EM events. The curve shows that RELDIS prediction.

used as input for the calculations of dissociation cross sections. The excited nuclei reach thermal equilibrium and then decay according to the statistical evaporation-fission-multifragmentation model, (the SMM model) [6]. The data and model have been normalized at the one neutron peak. Above this peak the real spectrum is consistently higher than the model's prediction.

Figure 3 shows the ratio of two to one neutron cross sections as a function of $\sqrt{s_{NN}}$. The probability to emit 2 neutrons rises with $\sqrt{s_{NN}}$ because more energy is absorbed and the multi-phonon resonances are more likely to be excited. A strong correlation between the excitation energy of a compound nucleus and the neutron multiplicity has been observed in CuAu collisions at a beam energy of 35A MeV, [8]. For EM collisions the RELDIS model gives a reasonable description of the neutron spectrum at zero degrees. In this model the EM breakup of two nuclei is mainly due to multi-photon exchange. The data show that as the beam energy increases the neutron multiplicity in electromagnetic interactions increases.

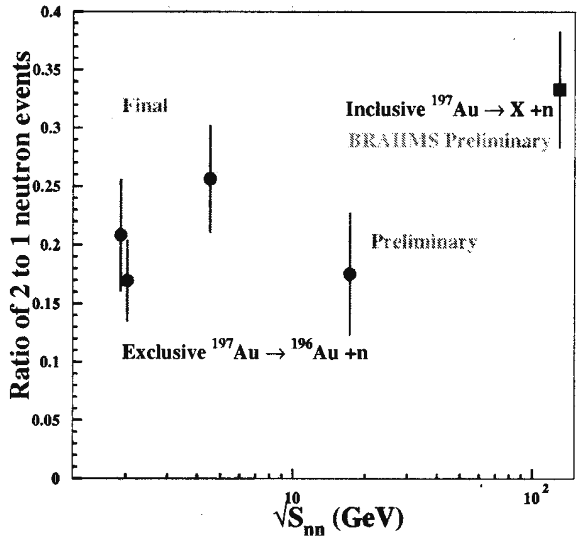

Figure 3: Ratio of 2 to 1 neutron yields versus energy. The lower energy data are from [7].

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