Properties of QCD matter at high energy densities are studied in heavy-ion collisions. The energy density of the medium can be deduced from the transverse energy measured by the tracking detectors or the electromagnetic calorimeter (K_{0}E_{T}).

The systematic error on this correction is determined by comparing the simulated and reconstructed K_{0}E_{T} distributions. The ALICE Collaboration has measured K_{0}E_{T} in Pb-Pb collisions at 200 GeV and compared these results with models that were cited in the reference [12]. Several models (e.g., Albacete [14]) which agreed with E_{T} of the reconstructed K_{0}E_{T} from HIJING. Figure 5, showing that the shape as a function of E_{T} from HIJING is consistent with the experimental data. The results with models that were cited in the reference [12] are also shown in Figure 5, showing a similar shape as a function of E_{T} from HIJING.

Three approximations are made:

\[ E_{T} = E_{T}^{\text{had}} + E_{T}^{\text{em}} = E_{T}^{\text{had}} + E_{T}^{\text{em}} \]

With these approximations:

\[ E_{T}^{\text{had}} = k_{0}E_{T}^{\text{had}} + E_{T}^{\text{em}} \]

\[ E_{T}^{\text{em}} = k_{0}E_{T}^{\text{em}} + E_{T}^{\text{had}} \]

In addition, baryon enhancement has been observed for both strange [8] and non-strange [9] particles in AA collisions, along with strangeness enhancement (10, 11). To take these effects into account, pi-dependent factors to match the RHIC data (until LHC/ALICE data are available) were applied to the spectra to determine the impact of baryon and strangeness enhancement. The value of \( f_{\text{had}} \) for pp collisions and the value of \( f_{\text{em}} \) for baryon and strangeness enhancement applied were averaged and defined as the difference as the systematic error, giving \( f_{\text{had}} = 0.69 \pm 0.05 \). With the assumption that \( E_{T}^{\text{had}} = E_{T}^{\text{em}} \), and using Monte Carlo generators to determine that 91% of K_{0}E_{T} is in \( f_{\text{had}} \), the correction factor is \( E_{T}^{\text{had}}/E_{T} = 0.55 \pm 0.02 \).

2.3 Particle Identification \( f_{\text{had}} \)

Particles are identified using the diE/dx particle bands from the TPC, shown in Figure 2, in momentum regions where the bands do not overlap, and are assigned as \( E_{T}^{\text{had}} \). The number of particles misidentified using this algorithm is negligible. The correction for the assumption that particles that are not K_{0}E_{T} are electrons is determined by Monte Carlo simulations and was considered as in Section 2.2 to determine the systematic error, giving \( f_{\text{had}} = 0.976 \pm 0.022 \).

2.4 Background \( f_{\text{bg}} \)

Decay daughters from \( \Lambda \), \( \bar{\Lambda} \), and K_{0}E_{T} misidentified as primary particles and conversion electrons contribute to a background in E_{T}^{\text{had}}. PYTHIA simulations are used to determine the background contribution from 1/2\( \Lambda \) daughters, rescaling the data by factors to match the data at \( \sqrt{s} = 5.02 \) and 7 TeV (13). In addition, factors to determine the effects of baryon enhancement are applied. The average is used as the nominal value and the range is applied as a systematic error. The values from HIJING simulations are contained in this range. An example showing the contribution to the background as a function of \( E_{T}^{\text{had}} \) is shown in Figure 3.

The correction from conversion electrons is also determined using Monte Carlo simulations and the systematic errors on this contribution are determined by varying the material budget by 10%. These effects lead to a systematic error of 0.8% due to the background correction.

2.5 Efficiency \( f_{\text{eff}} \)

The correction here is determined using HIJING simulations. The systematic error on this correction is determined by varying the material budget by 10%, leading to a systematic error of 1%.

2.6 Monte Carlo Cross Check

Tracks are not reconstructed efficiently in the TPC below 150 MeV/c. A correction for this effect is determined using HIJING simulations. To determine the systematic error on this cut-off, two scenarios are considered, the case where all particles below the cut-off have a momentum of zero and the case where all particles below the cut-off have a momentum of E_{T}^{\text{had}}. The results are: \( f_{\text{had}} = 0.971 \pm 0.006 \).

2.1 Momentum acceptance \( f_{\text{had}} \)

Neutrals \( f_{\text{had}} \) corrects for particles included in the definition of E_{T}^{\text{had}} but not directly measured by the TPC. This is dominated by \( \Lambda \), \( \bar{\Lambda} \), K_{0}, and \( \bar{K}_{0} \). Models dramatically underpredict the contribution from \( \Lambda \) and \( \bar{\Lambda} \) even for pp collisions [6], so Monte Carlo generators cannot reliably be used to determine this correction, which instead is determined by calculating the B_{K} from data in pp collisions at \( \sqrt{s} = 900 \text{ GeV} \) using fits to the Lefevre function in [6, 7].

Cross checks were performed using HIJING with \( f_{\text{had}} \) determined from HIJING. Figure 4 shows the difference between the simulated and reconstructed E_{T}^{\text{had}} as a function of E_{T}^{\text{had}} \( f_{\text{had}} \), demonstrating that the method effectively reconstructs E_{T}^{\text{had}}.

References


