Studies of reconstructed jets within a partonic transport model*

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One method for determining the energy loss of a high-p_t parton traversing a heavy-ion medium and thereby studying the properties of the created hot and dense matter is "jet reconstruction". Initial hard scattered back-to-back partons decrease their virtuality in splitting processes, which lead to particle showers with a broad angular and momentum distribution, which is enhanced by in-medium radiation processes. In order to develop a description of the energy loss of the partons, jet reconstruction algorithms are used that combine the single shower particles to a common "reconstructed jet" based on their distance in the $\eta - \phi$ plane.

When studying reconstructed jets in central $\sqrt{s_{NN}} = 2.76\,\text{TeV}$ Pb + Pb collisions, the experiments at the LHC [1, 2, 3, 4] have seen an enhancement of dijet events with asymmetric transverse momenta in comparison with p + p-collisions. This momentum asymmetry can be expressed by

$$A_J = \frac{p_{\text{t;Leading}} - p_{\text{t;Subleading}}}{p_{\text{t;Leading}} + p_{\text{t;Subleading}}}, \qquad (1)$$

where $p_{\text{t;Leading}}$ ($p_{\text{t;Subleading}}$) is the transverse momentum of the reconstructed jet with the highest (second highest) transverse momentum. The additional enhancement of asymmetric events in heavy-ion collisions is assumed to be caused by the different in-medium path lengths of the non-centrally produced initial parton pair and thereby different energy loss of the jets within the created bulk medium.

Here we want to show our result on this momentum imbalance A_J simulated within the partonic transport model BAMPS [5], which allows the simulation of multiple in-medium scattering processes and the 3+1D medium evolution in one common framework, while providing the configuration and phase space information of every particle at every timestep.

For the momentum spectra of the initial partons we use a distribution based on parton distribution functions. In order to properly reproduce the p + p data [2] we model the initial vacuum splitting processes by shower routines of the event generator PYTHIA. Because the medium modification of the parton showers is evaluated within the BAMPS framework it is necessary to terminate the vacuum splitting processes prematurely. The initial spatial production point of the parton pair is determined by a Glauber modeling based on a Woods-Saxon density profile.

The created parton showers are subsequently evolved within an offline recorded BAMPS background event, in which at every timestep the shower particles may interact with medium particles which then become shower particles themselves and may scatter further inside the medium. One difficulty which emerges while reconstructing jets in heavy-ion collisions is the subtraction of the underlying event contribution to the momenta of the reconstructed jets. For considering this, we sort the shower particles as well as an appropriately sampled background medium into "calorimeter cells" to obtain an calorimetric event comparable to experimental events. By doing this we can use common experimental background subtraction methods to remove the medium contribution in the reconstructed jets.

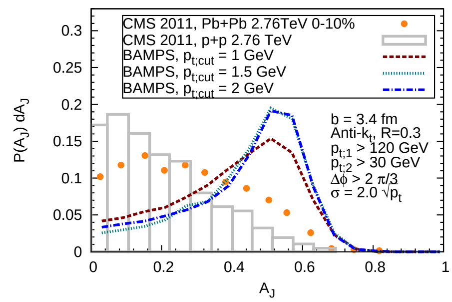

Figure 1: Momentum imbalance A_J in central Pb + Pb collisions at the LHC. The evolution of the shower particles is stopped when reaching $p_{t;cut}$. After background subtraction, the distribution is shown independent from $p_{t;cut}$.

Fig. 1 shows the calculated A_J distribution for central (0-10%) $\sqrt{s_{NN}} = 2.76\,\text{TeV}$ Pb + Pb collisions in comparison with experimental data[2]. For that comparison, trigger conditions as used by CMS are chosen. For an effective modeling of the detector response a Gaussian smearing of the reconstructed jet momenta based on the comparison between our initial shower and p + p data by CMS is used.

At present the calculated momentum imbalance of reconstructed jets within BAMPS is too strong which is in qualitative agreement with other energy loss studies within BAMPS, e.g. R_{AA} of gluons and light quarks[6, 7].

References

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