Elliptic flow and nuclear modification factors of D-mesons at FAIR*

T. Lang[1], *H. van Hees*[1], *J. Steinheimer*[2], *and M. Bleicher*[1]
[1]FIAS, Frankfurt, Germany; [2]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

The CBM experiment at FAIR will provide new possibilities for D-meson observables in heavy-ion collisions at low collision energies and high baryon densities. To predict D-meson observables in this environment we apply a Langevin approach for the transport of charm quarks in the UrQMD hybrid model [1]. Due to the inclusion of event-by-event fluctuations [2] and a full (3+1) dimensional hydrodynamical evolution, the UrQMD hybrid approach provides a realistic evolution of the matter produced in heavy ion collisions. As drag and diffusion coefficients for the Langevin approach we use a resonance model for elastic heavy-quark scattering [3] and assume a decoupling temperature of the charm quarks from the hot medium of 130 MeV, which has already been successfully applied at RHIC and LHC energies [4]. The hadronization of charm quarks to D-mesons is included by a coalescence mechanism. To account for the high baryon chemical potential at FAIR-energies we use fugacity-factors in our calculation. Therefore we multiply the anti-charm drag- and diffusion-coefficients by $e^{\mu_B/T}$ and the charm coefficients by $e^{-\mu_B/T}$. Here μ_B is the baryon chemical potential of the surrounding quarks and T is the local temperature of the medium.

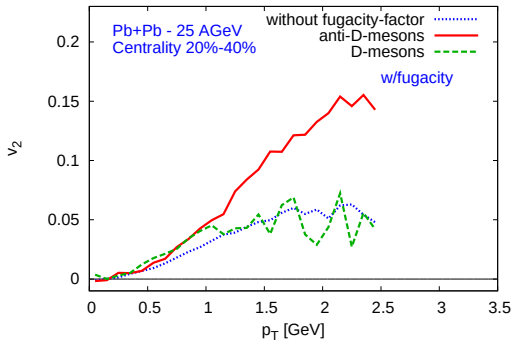

Figure 1: v_2, of D-mesons and $\bar{D}$-mesons in Pb+Pb collisions at 25 AGeV using fugacity-factors. We use a rapidity cut of $|y| < 0.35$.

Fig. 1 shows our results for the elliptic flow and Fig. 2 for the nuclear modification factor, both in Pb+Pb collisions at 25 AGeV Our calculation shows a strong difference between D-mesons and $\overline{\text{D}}$-mesons. The elliptic flow of $\overline{\text{D}}$-mesons reaches up to 15% and that for D-mesons

* Work supported by H-QM, HIC for FAIR, GSI Helmholtzzentrum, Office of Nuclear Physics in the US Department of Energy's Office of Science under Contract No. DE-AC02-05CH11231, Bundesministerium für Bildung und Forschung (BMBF) grant No. 06FY7083

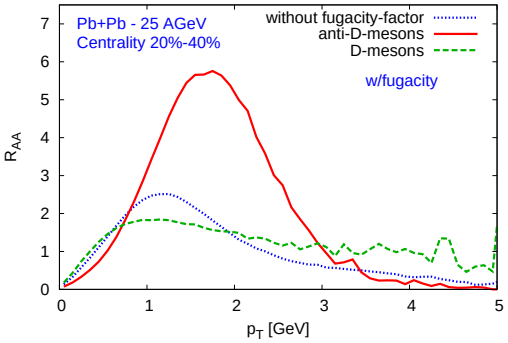

Figure 2: R_{AA} of D-mesons and $\bar{D}$-mesons in Pb+Pb collisions at 25 AGeV using fugacity-factors. We use a rapidity cut of $|y| < 0.35$.

about 5%. If we have a look on the difference between the D-mesons and the calculation neglecting fugacity-factors we realize that the difference is much smaller than for $\overline{\text{D}}$-mesons. This small difference is not due to a small difference of the coefficients used, but to the role of the coalescence mechanism that accounts for the overwhelming fraction of the flow of D-mesons if the coefficients are small. The medium modification in our calculation is considerably stronger than at RHIC and LHC energies [4]. We relate this to the very soft initial momentum distribution of the charm-quarks and the slower bulk medium evolution at FAIR energies compared to RHIC and LHC energies. In the R_{AA} this results in a strong suppression at low p_T due to a "heating-up" of the charm quarks.

We should mention that the difference seen between D-mesons and $\overline{\text{D}}$-mesons is sensitive to the model used to calculate the drag- and diffusion-coefficients. In case of the T-Matrix approach applied [5] this difference should not arise. Therefore D-meson measurements at FAIR can provide an excellent test for a confirmation or rejection of different heavy-quark-coupling mechanisms to the QGP.

References

[1] H. Petersen, J. Steinheimer, G. Burau, M. Bleicher and H. Stocker, Phys. Rev. C **78** (2008) 044901

[2] S. A. Bass, A. Dumitru, M. Bleicher, L. Bravina, E. Zabrodin, H. Stoecker and W. Greiner, Phys. Rev. C **60** (1999) 021902

[3] H. van Hees and R. Rapp, Phys. Rev. C **71** (2005) 034907

[4] T. Lang, H. van Hees, J. Steinheimer and M. Bleicher, arXiv:1211.6912 [hep-ph].

[5] H. van Hees, M. Mannarelli, V. Greco and R. Rapp, Phys. Rev. Lett. **100** (2008) 192301