QGP tomography with ebe-DREENA framework

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МИНИСТАРСТВО ПРОСВЕТЕ,
НАУКЕ И ТЕХНОЛОШКОГ РАЗВОЈА

DREENA framework

- **D**ynamical **R**adiative and **E**lastic **EN**ergy loss **A**pproach

- fully optimized numerical procedure capable of generating high $p_\perp$ predictions
- includes:
  - parton production
  - multi gluon-fluctuations
  - path-length fluctutations
  - fragmentation functions
- keeping all elements of the state-of-the art energy loss formalism, while introducing more complex temperature evolutions:
  - DREENA-C: constant temperature medium
    D. Z., I. Salom, J. Auvinen, M. Djordjevic and M. Djordjevic, J. Phys. G **46**, no. 8, 085101 (2019).
  - DREENA-B: Bjorken expansion
    D. Z., I. Salom, J. Auvinen, M. Djordjevic and M. Djordjevic, Phys. Lett. B **791**, 236 (2019).
  - DREENA-A: smooth (2+1)D temperature evolution
    D. Z, I. Salom, J. Auvinen, P. Huovinen and M. Djordjevic, arXiv:2110.01544 [nucl-th].
  - ebe-DREENA: event-by-event fluctuating hydro background

ebe averaging

- cummulants: $v_n\{2\}$, $v_n\{4\}$

  A. Bilandzic, R. Snellings and S. Voloshin, Phys. Rev. C **83**, 044913 (2011).

- event plane: $v_n\{EP\}$

  Y. He, W. Chen, T. Luo, S. Cao, L. G. Pang and X. N. Wang, [arXiv:2201.08408 [hep-ph]].

- scalar product: $v_n\{SP\}$

  C. Andres, N. Armesto, H. Niemi, R. Paatelainen and C. A. Salgado, Phys. Lett. B **803**, 135318 (2020)

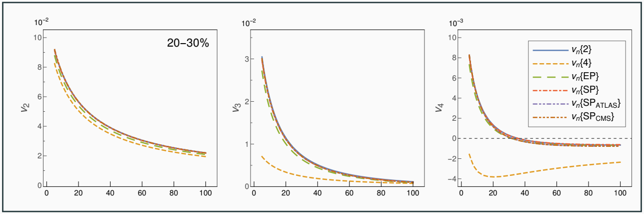
  Y. He, W. Chen, T. Luo, S. Cao, L. G. Pang and X. N. Wang, [arXiv:2201.08408 [hep-ph]]

- scalar product - ATLAS: $v_n\{SP_{ATLAS}\}$

  M. Aaboud *et al.* [ATLAS], Eur. Phys. J. C **78**, no.12, 997 (2018)

- scalar product - CMS: $v_n\{SP_{CMS}\}$

  A. M. Sirunyan *et al.* [CMS], Phys. Lett. B **776**, 195-216 (2018)

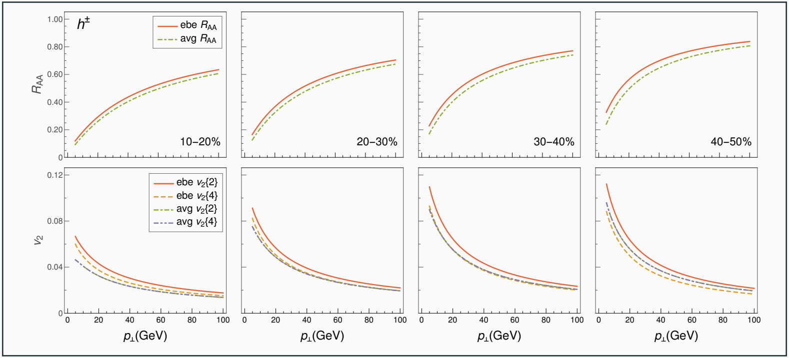


all methods, other than $v_n\{4\}$ agree with each other

no need for rapidity correlations!

ebeDREENA

- high-p_T energy loss: ebe fluctuation vs smooth hydro background

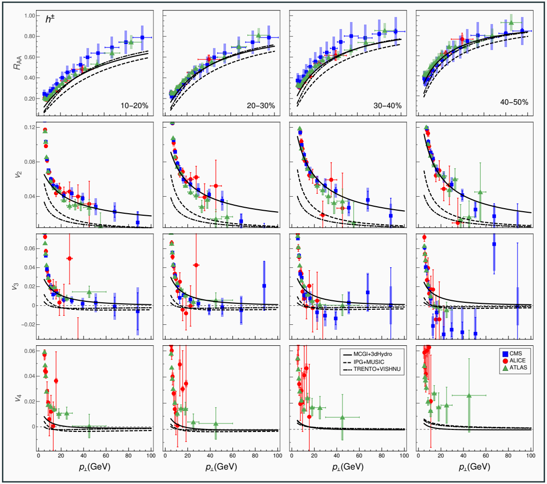


R_{AA} differences small $\sim 7\%$ and no centrality dependence

$v_2\{2\}$ differences from 14% in 40-50% up to 32% in 10-20%
also $p_\perp$ dependence of the differences

ebe-DREENA

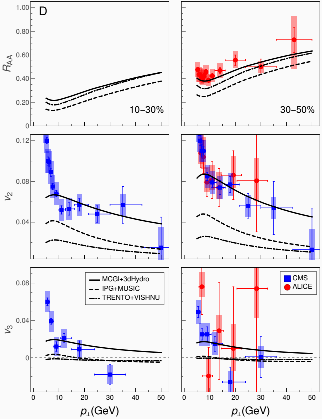
- charged hadrons, $Pb + Pb$, $\sqrt{s_{NN}} = 5.02\,TeV$

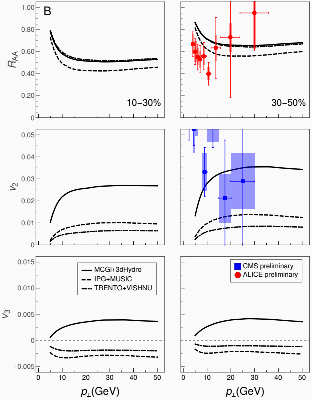


we can distinguish between different models with high-p_T energy loss

ebe-DREENA

- heavy flavour, $Pb + Pb$, $\sqrt{s_{NN}} = 5.02\,TeV$





we can distinguish between different models with high-p_T energy loss on heavy flavour as well

Conclusion

- high p_T energy loss can distinguish between different initial condition and hydro models
- ebe-DREENA has no energy loss fitting parameters
  all parameters are from initial conditions and hydro (binary collisions, temperature evolution,...)
- obtained notable sensitivity and the fact that there are no additional fitting parameters shows that high-$p_\perp$ theory/data can indeed be used to further constrain QGP properties
- high luminosity LHC $\rightarrow$ precision QGP tomography