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Study of the jet transport coefficient at the Large Hadron Collider energies using Color String Percolation Model

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Based on : arXiv:2104.02328

Introduction

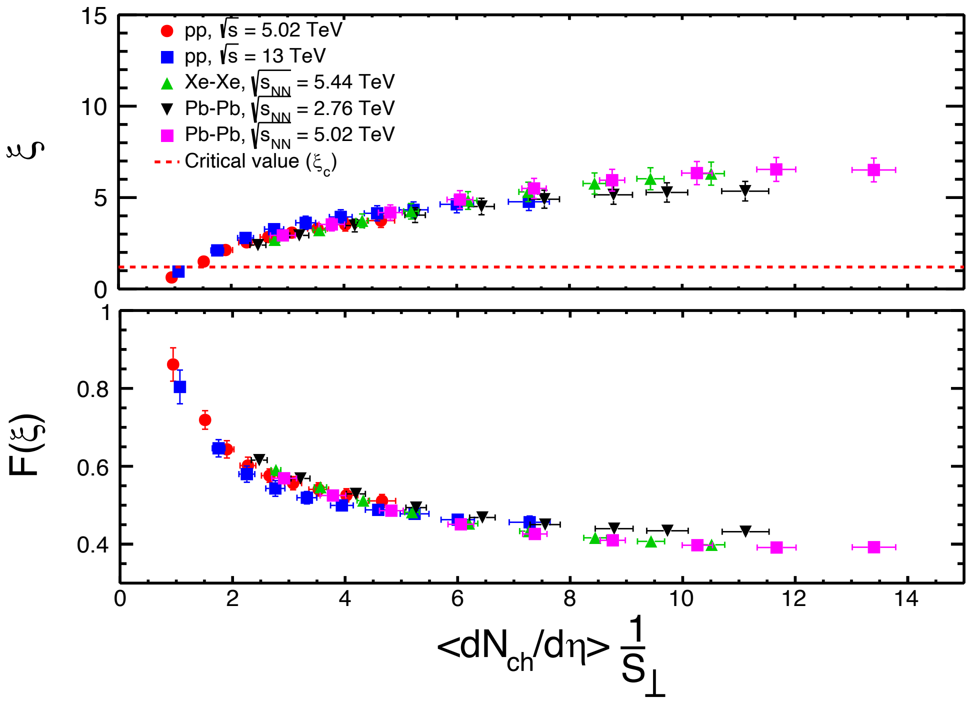
- Jet quenching is an important signature of Quark-Gluon Plasma
- Jets are collimated beams of multitude of hadrons originating from the hard partonic scattering
- They lose their energy through medium-induced gluon radiation and collisional energy loss, because of which we observe suppression of high transverse momentum particles (jet quenching)
- We have estimated the jet quenching parameter ($\hat{q}$) within Color String Percolation Model (CSPM) framework
- CSPM is an established model inspired by Quantum Chromodynamics (QCD)
- In CSPM we assume color strings to be stretched between the projectile and target which may decay into quark-antiquark pairs and subsequently hadronize to produce the final state particles
- These color strings can be viewed as small discs in the transverse plane filled with color field created by colliding partons

- We fit the following function and extract the fitting parameter ($F(\xi)$) which is the color suppression factor,

$$\frac{d^2N_{ch}}{dp_T^2} = \frac{a}{(p_0\sqrt{1/F(\xi)^{mod}} + p_T)^{\alpha}}$$

Where, $F(\xi) = \sqrt{\frac{1-e^{-\xi}}{\xi}}$

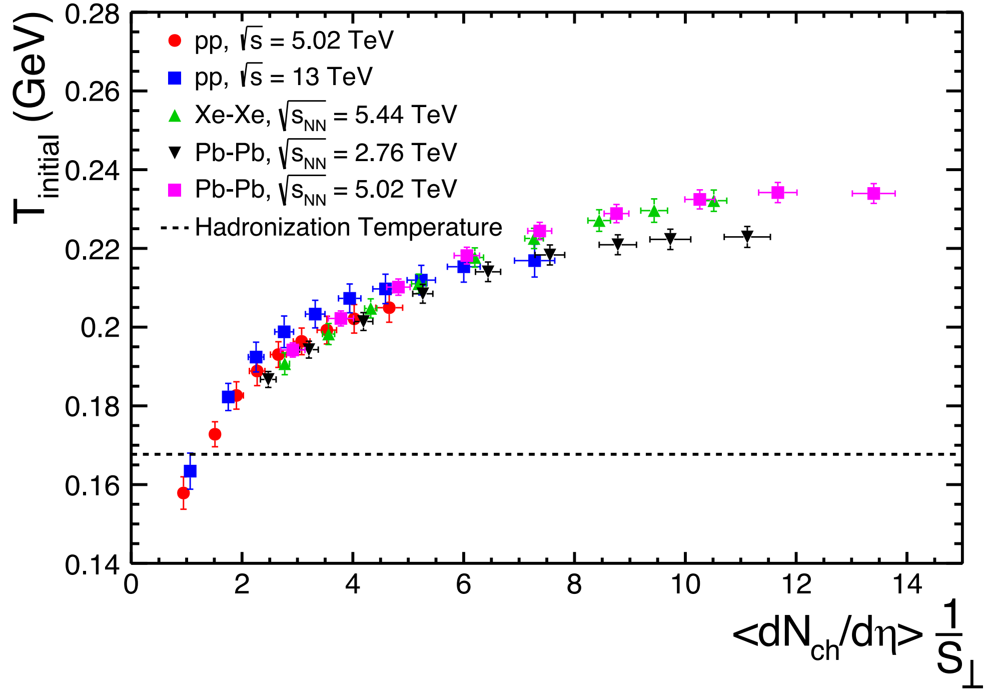
and, ξ is the dimensionless percolation density parameter.



- From Schwinger's mechanism of particle production the color suppression factor and temperature are related as,

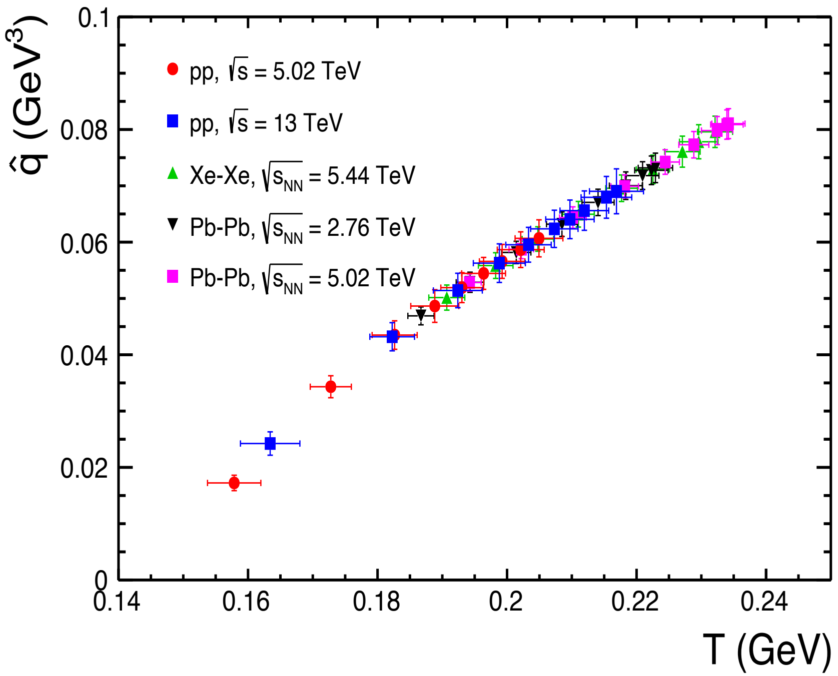
$$T(\xi) = \sqrt{\frac{\langle p_T^2 \rangle_1}{2F(\xi)}}$$

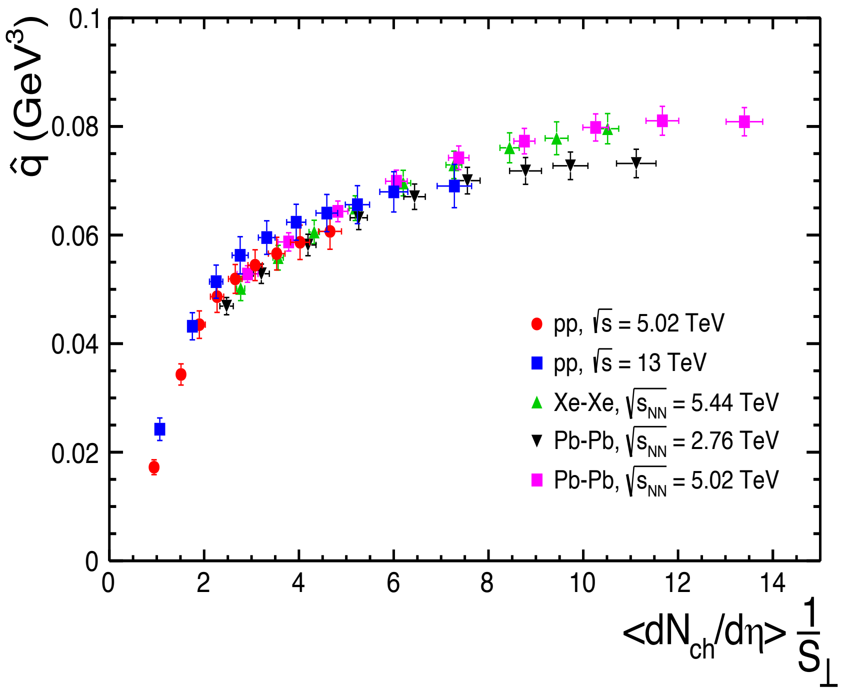
Where, $\langle p_T^2 \rangle_1$ = 207.2 $\pm$ 3.3 MeV is the single string average transverse momentum calculated at the critical percolation density ξ_c = 1.2 with the universal hadronization temperature T_h= 167.7 $\pm$ 2.6 MeV.

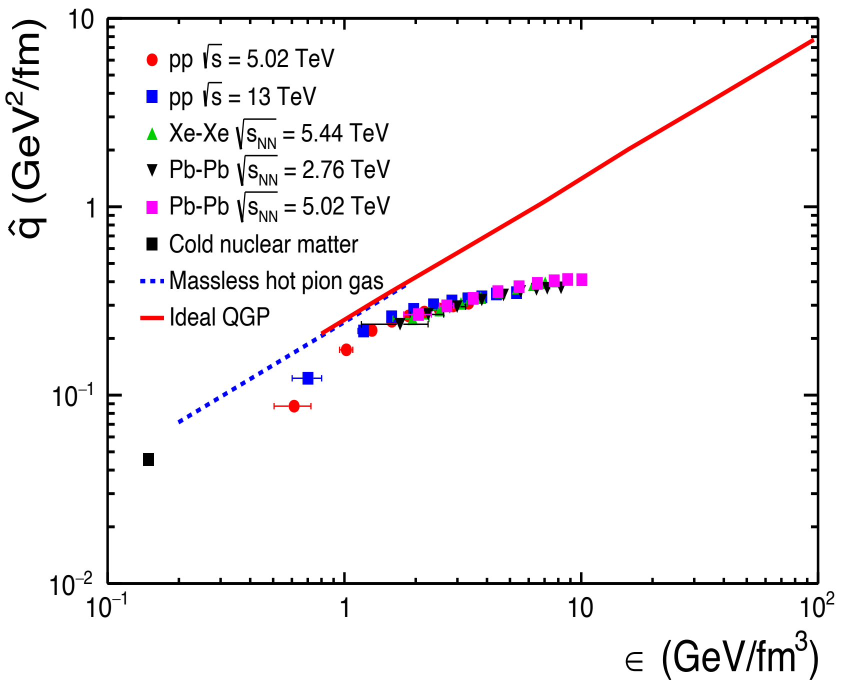


*Figures are from A. N. Mishra, D. Sahu, R. Sahoo [arXiv:2104.02328]

- In kinetic theory framework, $\hat{q}$ can be estimated by the formula, $\hat{q} = \rho \int d^2q_\perp \, q_\perp^2 \frac{d\sigma}{d^2q_\perp}$, where ρ is the number density of the medium and $d\sigma/d^2q_\perp$ is the differential scattering cross-section of the particles in the medium
- The jet transport parameter and the shear viscosity to entropy density ratio are related as, $\frac{\eta}{s} \approx \frac{3}{2}\frac{T^3}{\hat{q}}$
- In CSPM, $\frac{\eta}{s} = \frac{TL}{5(1-e^{-\xi})}$, where L is the length of a string ~1 fm
- So, finally we have the expression, $\hat{q} \approx \frac{3}{2}\frac{T^3}{\eta/s} \approx \frac{15}{2}\frac{T^2(1-e^{-\xi})}{L}$







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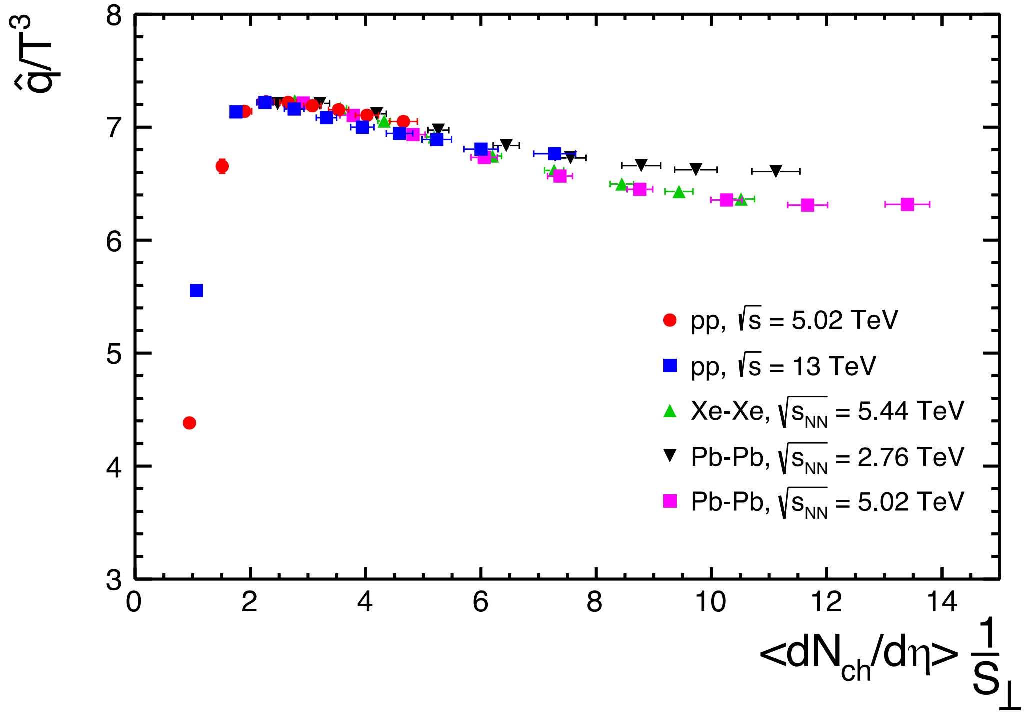
Summary

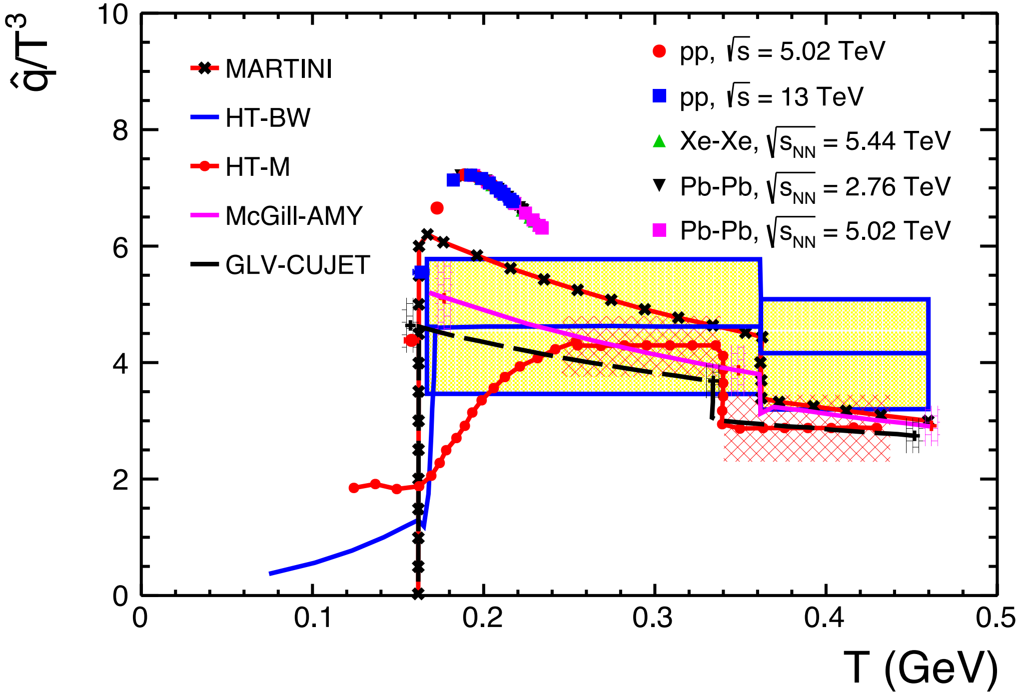
- At very low multiplicity, $\hat{q}$ shows a sharp increase and saturates at high multiplicity (energy density), suggesting that at lower multiplicity the system is not dense enough to highly quench the partonic jets, whereas with increase of multiplicity the quenching of jets becomes more prominent

- In the low energy density regime, the system behaves almost like a massless hot pion gas. As initial energy density increases, $\hat{q}$ values deviate from the ideal QGP values because of the fact that systems produced in high multiplicity events are actually viscous and are not exactly ideal

- $\hat{q}/T^3$ as a function of scaled charged particle multiplicity shows a sudden increase and reaches to a maximum at , $\langle dN_{ch}/d\eta\rangle/S_\perp \sim 2$ then it starts decreasing regardless of the collision system

- The $\hat{q}/T^3$ obtained from CSPM approach as a function of temperature has similar kind of behavior as observed by the JET collaboration





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