Test of Nuclear Effecs in pA Collisions at RHIC and LHC

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The Importance of the Asymmetric High-Energy Nucleus-Nucleus Collisions

High energy nuclear modifications can be measured by the nuclear modification factor (NMF), defined as,

$$R_{dAu} \equiv \frac{1}{\langle N_{coll}\rangle}\frac{d^2N^{d+Au}/dp_T d\eta}{d^2N^{p+p}_{inel}/dp_T d\eta} \quad \text{or} \quad R_{AA}(p_T) = \frac{d^2N^{AA}_{ch}/dp_T d\eta}{\langle T_{AA}\rangle\, d^2\sigma^{NN}_{ch}/dp_T d\eta}$$

which factor measures the nuclear effect on a linear scale, comparing $\langle N_{coll}\rangle$ normalized hadron spectra in proton-nucleus (pA) or in nucleus-nucleus (AA) collisions to the spectra obtained from proton-proton (pp) at the same kinematic conditions, such as: c.m. energy, rapidity regions, centrality.

In asymmetric high-energy nuclear collisions (*pA, AA'*) the rapidity asymmetry factor, $Y_{Asym}(p_T)$ carry more information on the backward/forward dependent nuclear effects, but in connection with the $R_{AA}(p_T)$,

$$Y^h_{Asym}(p_T) = E_h\frac{d^3\sigma^h_{AB}}{d^3p_T}\Big|_{\eta<0} \Big/ E_h\frac{d^3\sigma^h_{AB}}{d^3p_T}\Big|_{\eta>0} \quad \text{or} \quad Y^h_{Asym}(p_T) = R^h_\eta(p_T) = \frac{R^h_{dAu}(p_T,\eta<0)}{R^h_{dAu}(p_T,\eta>0)}$$

These quantities can help us to understand the physical origin of the cold nuclear (initial state) effects, such as: Cronin enhancement, shadowing at low- and high-x values). A solid baseline/control measurement is necessary in order to test parameters of final state effects in nucleus-nucleus (AA) collisions – in a more complex case. See more in Refs [1-4].

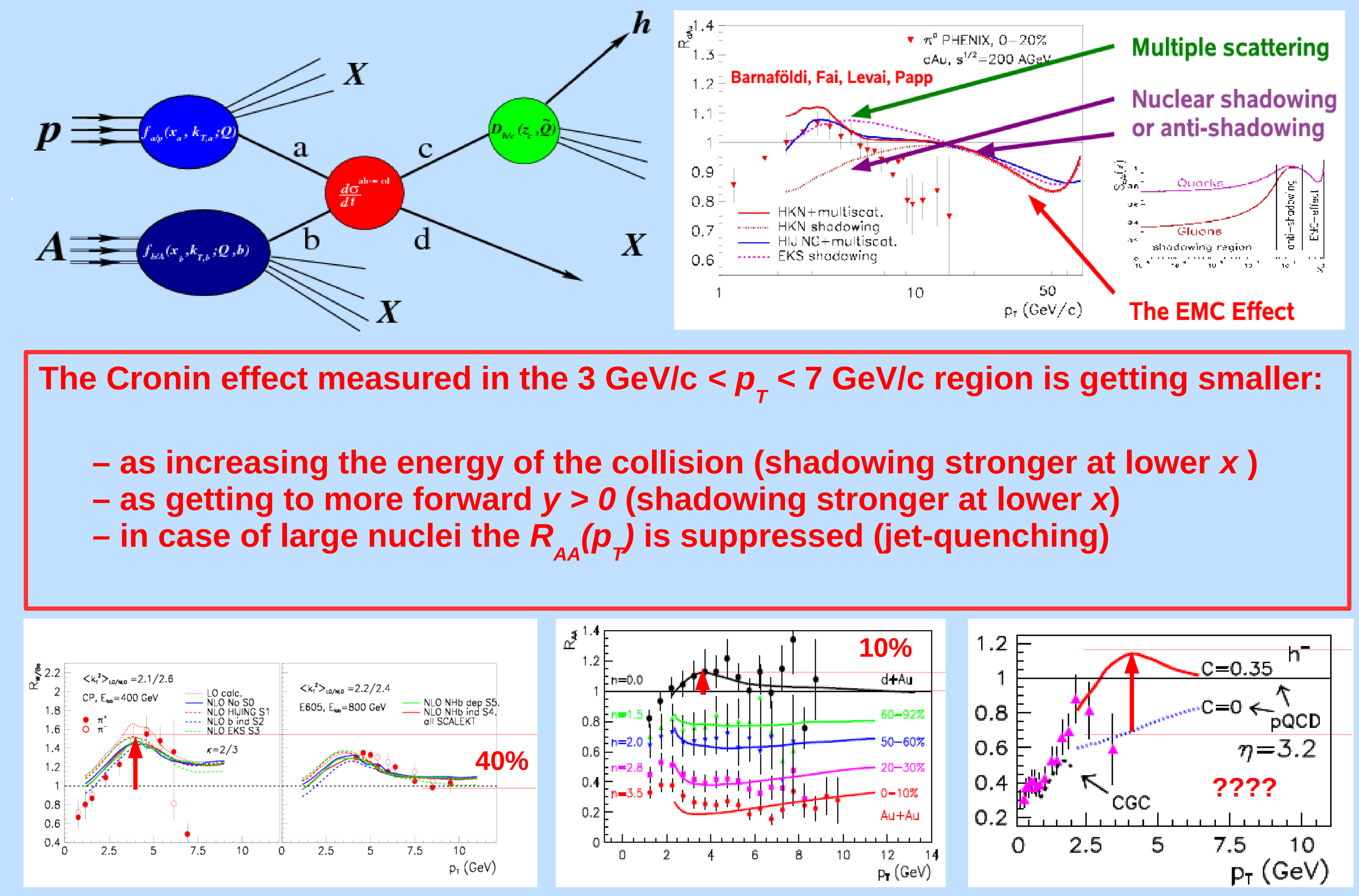


Figure 1: The nuclear modification factor, $R_{AA'}(p_T)$ in asymmetric nucleus-nucleus collisions from SPS to RHIC energies at y=0 and y>0.

Model I: HIJING/BB 2.0

The HIJING/BB 2.0 is a modified version of the original HIJING Monte Carlo simulator, which was developed to study hadron production in proton-proton, proton-nucleus and nucleus-nucleus collisions [5]. Essentially this is a two component model, which describe the production of hadron jets and the soft interaction between nucleon remnants. In the code of HIJING/BB 2.0 minijet cutoff and string tension has been modified by a center-of-mass energy, *s* and nuclear size, *A* dependent term,

$$p_0(s,A) = 0.416\,\sqrt{s}^{0.191}\,A^{0.128}\ \text{GeV}/c \quad \text{and} \quad \kappa(s,A) = \kappa_0\,(s/s0)^{0.06}\,A^{0.167}\ \text{GeV/fm}.$$

with parameters $p_0=3.1$ GeV/c and $\kappa_0=2.9$ GeV/fm respectively. Calculations presented on Fig 2. were done with GRV parton distribution functions adding HIJING 2.0 shadowing parameterization. Hadonization is given by the PHYTIA and the HIJING minijet fragmentation. We presented our results on charged hadron production at midrapidity ($|y|<0.8$) and to the forward ($y=6$) direction in pPb collisions at 4.4 ATeV c.m. energy. Both minimum bias ('MB', $N_{coll}=6.5$) and central ('Central', $N_{coll}=12$) collisions were considered. It was found, strong $R_{pPb}(p_T)=0.7$ suppression is expected in pPb collision applying only a leading twist shadowing.

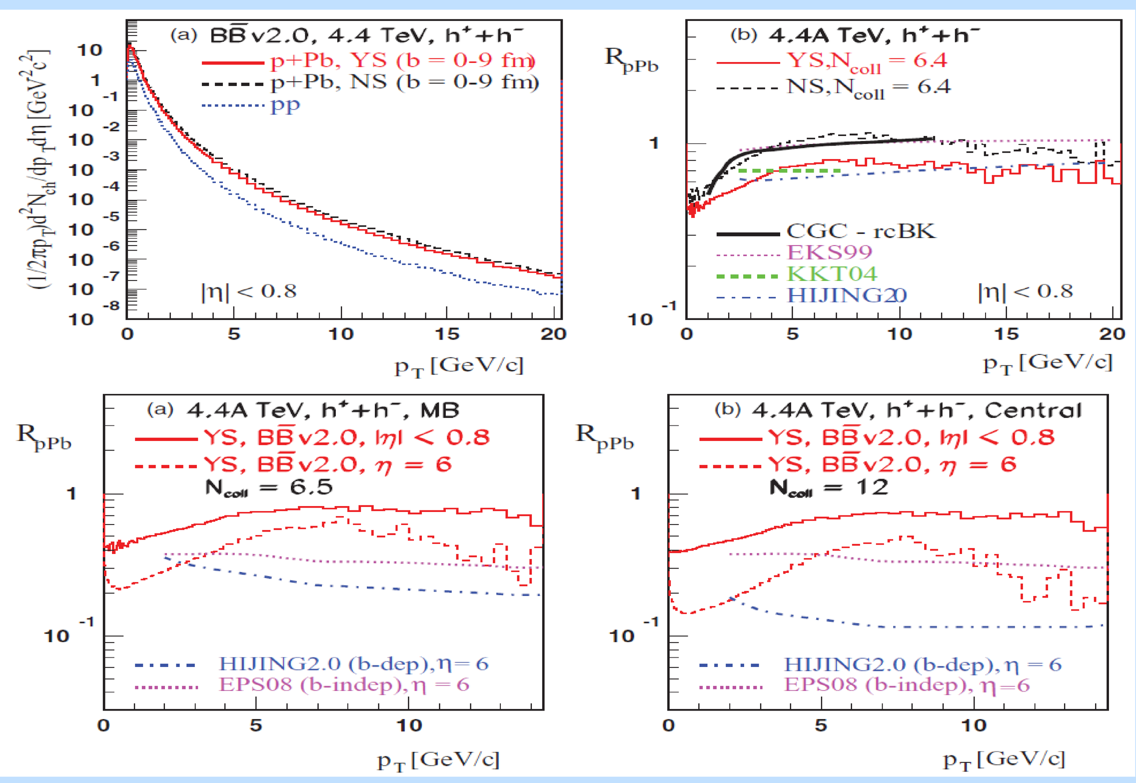
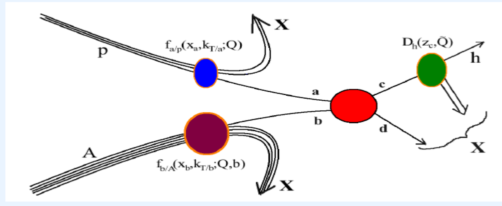


Figure 2: Inclusive spectra and nuclear modification factor, $R_{pA}(p_T)$ generated by HIJING/BB 2.0 in pPb collisions at 4.4A TeV LHC energy [1].

Model II: kTpQCD_v2

The kTpQCD_v2 is a next-to-leading order pQCD-improved based parton model, with an phenomenological parameter the so called intrinsic-k_T. The program calculated the inclusive hadron spectra in proton-proton, proton-nucleus, and nucleus-nucleus collisions,

$$E_\pi\frac{d\sigma_\pi^{dAu}}{d^3p_\pi} = f_{a/d}(x_a,Q^2;\mathbf{k}_{Ta}) \otimes f_{b/Au}(x_b,Q^2;\mathbf{k}_{Tb}) \otimes \frac{d\sigma^{ab\to cd}}{d\hat{t}} \otimes \frac{D_{\pi/c}(z_c,\hat{Q}^2)}{\pi z_c^2}, \qquad (1)$$



with a 1+2 dimensional parton model framework. The code includes the k_T-broadening to model the Cronin effect by a series of *semihard* nucleon-nucleon collision following the hard pQCD one. The model includes most of the shadowing parameterization and the full CERNLib the PDFLib parton distribution functions, $f_{a/A}$ combined with various fragmentation functions, $D_{h/q}$ from the literature [1-4,6]. Here we used all settings for our calculations to compare them with the HIJING/BB 2.0 based model in accordance with Ref. [1,6]. Our results on $R_{pA}(p_T)$ and $Y_{Asym}(p_T)$ for 4.4/8.8 ATeV pPb collisions in are presented on Fig 3.

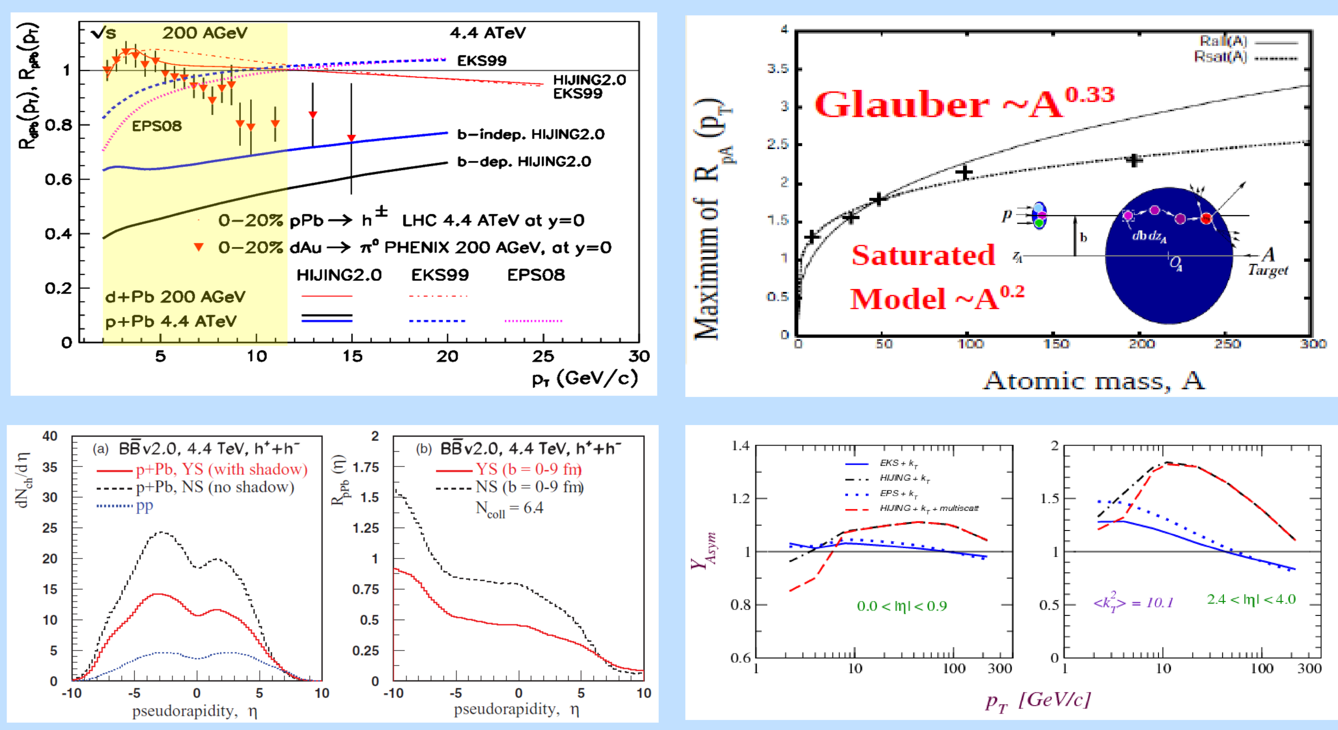


Figure 3: Nuclear modification factor, $R_{pA}(p_T)$ & rapidity asymmetry, $Y(p_T)$ generated by kTpQCDv2 in pPb collisions at 4.4 and (8.8) ATeV LHC energy [1,2].

ACKNOWLEDGEMENTS & REFERENCES

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