Collision energy dependence of high transverse momentum R_{CP} for charged hadrons in STAR

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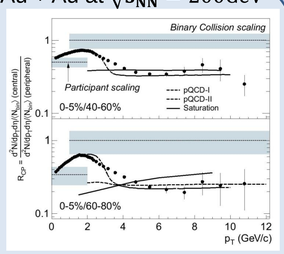
Abstract

Possible signatures of de-confinement have been measured at top RHIC and LHC energies. One such signature is the suppression of high transverse momentum particles as measured with R_{AA} and R_{CP}. The beam energy scan at RHIC was designed to explore the phase diagram for the hot and dense medium produced in heavy ion collisions. Among STAR's goals for the beam energy scan was to determine whether these signatures disappeared at reduced beam energies. The versatility of RHIC has allowed for collisions to be carried out at beam energies ranging from 7.7 – 200GeV, and the efficiency corrected R_{CP} measurements from these energies are shown here.

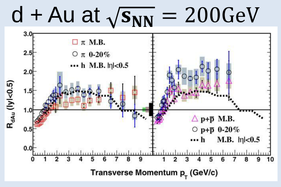
Motivation

- Previous measurements of suppression at $\sqrt{s_{NN}} \geq 200\text{GeV}$ have been attributed to a strongly interacting medium (Top plot) [1]
- Possible cold nuclear matter contributions were investigated in d + Au collisions (Bottom plot)[2]
- d + Au has enhancement (Cronin Effect)
- This study looks for the $\sqrt{s_{NN}}$ where suppression "turns off"

Au + Au at $\sqrt{s_{NN}} = 200\text{GeV}$



d + Au at $\sqrt{s_{NN}} = 200\text{GeV}$



Data

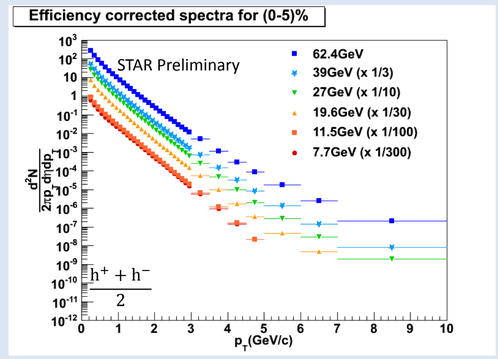
$\sqrt{s_{NN}}$(GeV)	Year	N_{Ev} MB
7.7	2010	3.7M
11.5	2010	7.3M
19.6	2011	33M
27	2011	64M
39	2010	116M
62.4	2010	62M

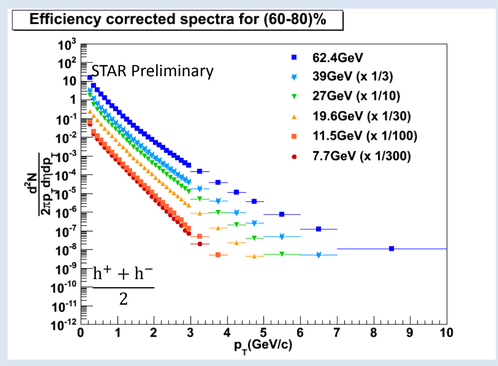
Method

- Charged tracks with |η|<0.5 are used
- Spectra are produced for each centrality of each $\sqrt{s_{NN}}$ as shown to the right
- The spectra exhibit strong centrality dependence and some dependence on $\sqrt{s_{NN}}$
- Single particle tracking efficiencies from embedding are applied
- The scaled ratio of central to peripheral spectra is R_{CP}

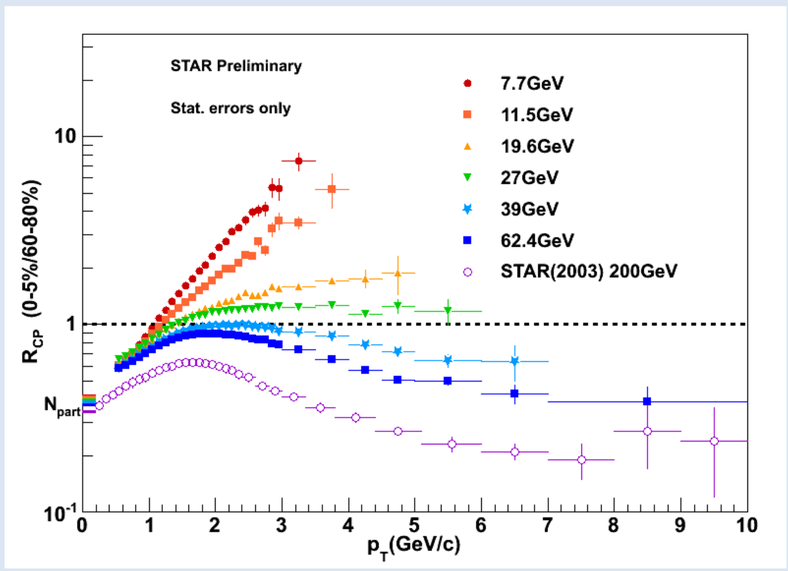
$$R_{CP} = \frac{(N_{Bin})_P}{(N_{Bin})_C} \times \frac{\left(\frac{d^2N}{p_T dp_T d\eta}\right)_C}{\left(\frac{d^2N}{p_T dp_T d\eta}\right)_P}$$

- While N_{bin} describes high p_T (low cross-section) physics, N_{part} is the proper scaling at low p_T
- Observed enhancement in d + Au collisions (The Cronin Effect) rules out cold nuclear matter effects as the source of suppression

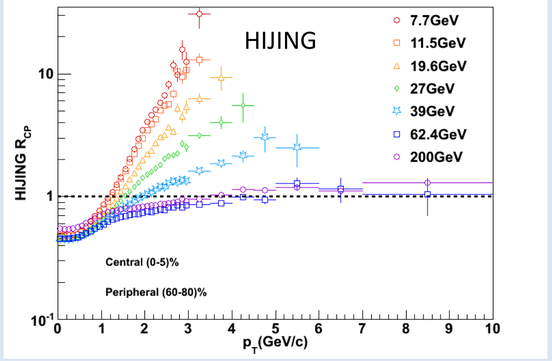




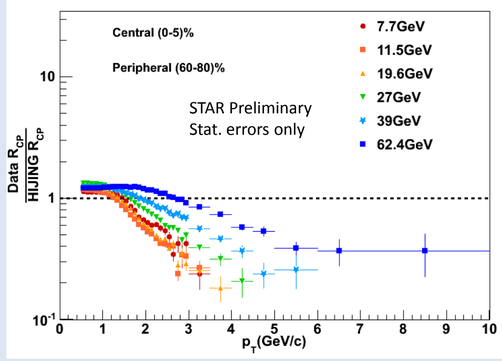
Results



Charged hadron R_{CP} falls below unity for $\sqrt{s_{NN}} \geq 39\text{GeV}$ at high p_T. Note that the Cronin Effect competes with jet suppression such that a result above unity may still include jet quenching.



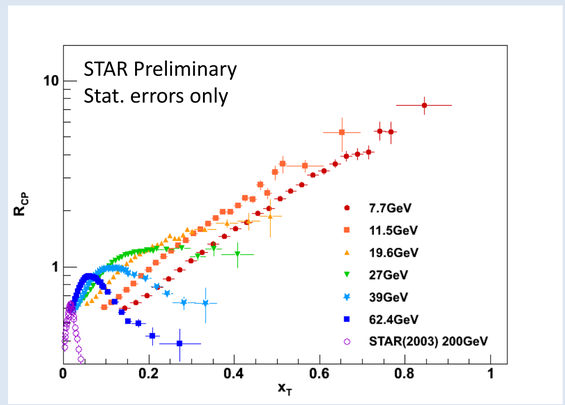
HIJING [3] version 1.35 with jet quenching turned off shows similar trends to data.



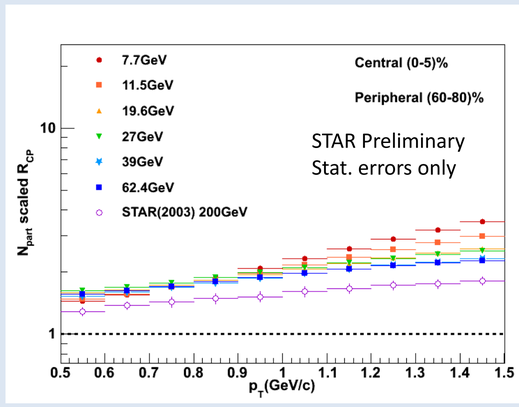
The Ratio Data/HIJING motivates further investigation with additional HIJING tunes as well as other models.

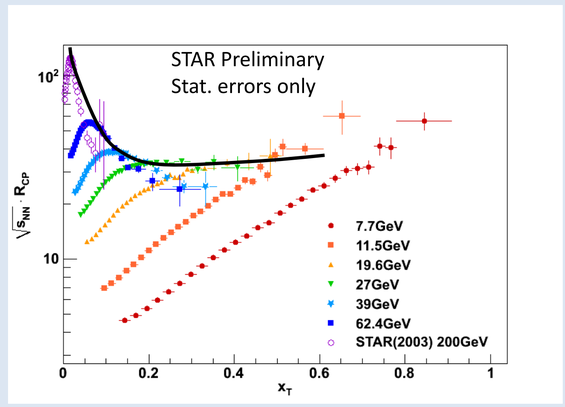
Observations

1) It might be expected that R_{CP} demonstrate x_T scaling. $x_T = \frac{2p_T}{\sqrt{s_{NN}}}$
That is to say, we might expect some beam energy independent trends with the proper scaling and x_T could be considered the most natural. No trends emerge with this scaling (top right). Scaling both axes reveals a possible x_T dependent trend for high p_T tracks(bottom right).



2) N_{part} scaled result at low p_T exhibits very weak energy dependence (bottom left).





Conclusions

- Charged hadron R_{CP} is statistically below unity for 200, 62, and 39GeV data sets
- A clear energy ordering is observed with smooth monotonic dependence on beam energy
- The Cronin effect is seen to dominate the lower beam energies, complicating the interpretation of results
- Suppression at lower energies may also reveal itself as variation from trends, as shown in part 2 of the observations section
- A complimentary study of triggered dihadron correlations will provide an additional tool for extracting medium modification effects

References

[1] STAR Collaboration, Phys. Rev. Lett. 91, 172302 (2003)
[2] STAR Collaboration, Physics Letters B 637 (2006) 161–169
[3] Miklos Gyulassy and Xin-Nian Wang, Comput. Phys. Commun. 83 (1994) 307

The STAR Collaboration: http://drupal.star.bnl.gov/STAR/presentations