Single inclusive suppression and intra-jet correlations @ LHC

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Extrapolating from RHIC to LHC

- The matter is denser
- $T_{\text{init}} \, @\, \text{LHC} \sim 2 \, T_{\text{init}} \, @\, \text{RHIC}$
- More flow!
- Will ideal Hydro work?
- Lots of jets for sure!
- Very high energy jets
- Multi-particle analysis
Baseline
A factorized approach for hard jets

\[ x_a = \frac{p_a}{P} \]

\[ x_b = \frac{p_b}{P} \]

\[ z_1 = \frac{p_{T1}}{p_c} \]

\[ \frac{d \sigma^{h_1}}{dy dp_{T1}} \sim \int dx_a dx_b \ G(x_a) \ G(x_b) \ \frac{d \hat{\sigma}}{d \hat{t}} \ D_q^{h_1}(z_1) \]
Exploring RHIC and UA2 with a $K=2$, LO calculation,

Good control over predictions
Factorized approach for hard jet modification

\[ x_a = \frac{p_a}{P} \]

\[ x_b = \frac{p_b}{P} \]

\[ z_1 = \frac{p_{T1}}{p_c} \]

\[ \frac{d \sigma_{h_1}^{T_1}}{dy dp_{T_1}} \sim \int dx_a dx_b G(x_a) G(x_b) \frac{d \hat{\sigma}}{d \hat{t}} D_q^{h_1}(z_1) \]
**Generalized factorization**

\[ AF(p/p_h) d\sigma_{e^-+q\to q+e^-} \]

\[ L\int dt \left\langle F^\alpha(t)\nu_\alpha F^\beta(0)\nu_\beta \right\rangle \]

\[ \sigma_T \propto \frac{A^{1/3} \mu_H^2}{Q^2} \]

\( \hat{q} \) is a multidimensional object

\[
\hat{q} = \frac{p_\perp^2}{\zeta} = \frac{2 \pi^2 \alpha_s C_R}{N_c^2 - 1} \int dt \left\langle F^{\mu \alpha}(t) v_\alpha F^\beta_\mu(0) v_\beta \right\rangle
\]

\[
\hat{q}^{\mu \nu} = \hat{q}_0 \, f^{\mu \nu}(x, y, z, t, y_{flow}; \mu^2, p_{jet})
\]

Medium parameters

Jet parameters

Need to make up models for the space time dependence
How does the jet see the medium

How does $\hat{q}$ depend on the bulk properties of medium

$\hat{q} \sim \varepsilon^{3/4}$

$\hat{q} \sim T^3$

$\hat{q} \sim \frac{dN}{dy}, s$

$\hat{q}$  In deconfined phase  vs.  $\hat{q}$  In hadronic phase

Need a dynamical model of the medium to get the evolution of bulk properties
Model for qhat!

\[ \hat{q} = \frac{p_{\perp}^2}{\zeta} = \frac{2 \pi^2 \alpha_s C_R}{N_c^2 - 1} \int dt \langle F^{\mu \alpha}(t) v_\alpha F^\beta_\mu(0) v_\beta \rangle \]

1) A functional form:
\[ \hat{q}(\zeta) = \hat{q}_0 \frac{\zeta_0}{\zeta} \rho(\vec{r} + \zeta) \]

\[ \rho(\vec{r}) \quad \text{From a Wounded nucleon model for } N_{\text{part}} \]

2) Use a Hydro space-time output
\[ \hat{q}(\zeta) = \hat{q}_0 \frac{\gamma_{\perp}(\vec{r} + \zeta, t=\zeta) T^3(\vec{r} + \zeta, t=\zeta)}{T^3_0} \]
$R_{AA}$ with a functional form

Keep the same space-time profile for medium, increase $q_0$ by a factor of 6

@ RHIC

$\hat{q}_0 (\text{quarks}) = 0.57 \text{ GeV}^2 / \text{fm}$

@ LHC

$\hat{q}_0 (\text{quarks}) = 3.5 \text{ GeV}^2 / \text{fm}$
$R_{AA}$ with 3-D hydrodynamics

\[ \hat{q}(\zeta) = \hat{q}_0 \frac{T^3(\vec{r} + \vec{\xi}, t = \zeta)}{T_0^3} \]

hold the two constants at their RHIC values

@ RHIC

\[ \hat{q}_0(\text{quarks}) = 0.6 \text{ GeV}^2/\text{fm} \]

@ LHC
Little difference between hydro profiles at the same time 0.7 fm/c

Partially Quenched jets feel this region

Extrapolations to LHC deviate from...
Near side associated yield

Small momentum difference
Need Dihadron fragmentation function

Total yield includes 2 components

Consistency check for the formalism

A. Majumder, X. N. Wang,
PRD70:014007,2004;

Large momentum difference
perturbative calculation,
single fragmentation function
Integrated associated yield

Results using a functional form and 6 times RHIC qhat
The structure of the near side Ridge
See M. Strickland, QM2006
Conclusions (incomplete)

- Medium at LHC probably similar to that at RHIC
- Very high energy jets will pass through medium
- Less surface bias, more near side energy loss
- Enhancement in near side yield increased
- Most of the yield sits in the jet cone at high energy