Unravelling Medium Effects in Heavy Ion Collisions with Zeal

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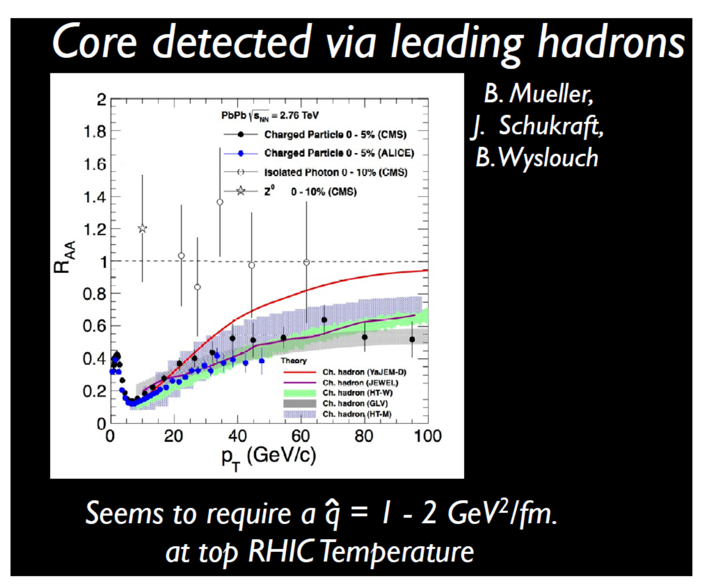
Summary

- A new jet observable zeal [1]
- Less sensitive to cone radius R
- Capable of distinguishing models

Introduction

Models have been very successful in predicting the quenching (R_{AA}) of the leading particle but differ in details. Differ in physical characterizations of the medium ($\hat{q}$).



The original vision [2], quenching of the jet, now accesible thanks to the LHC.

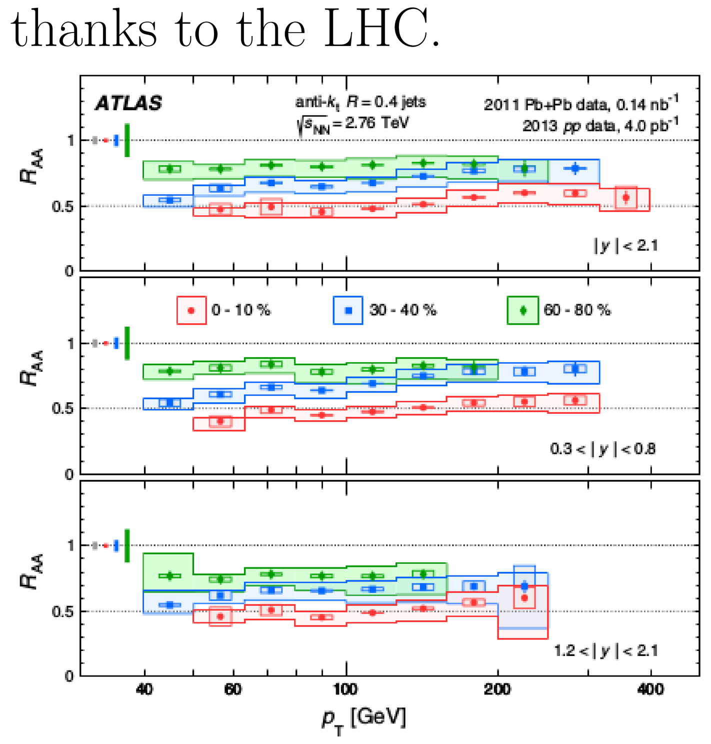
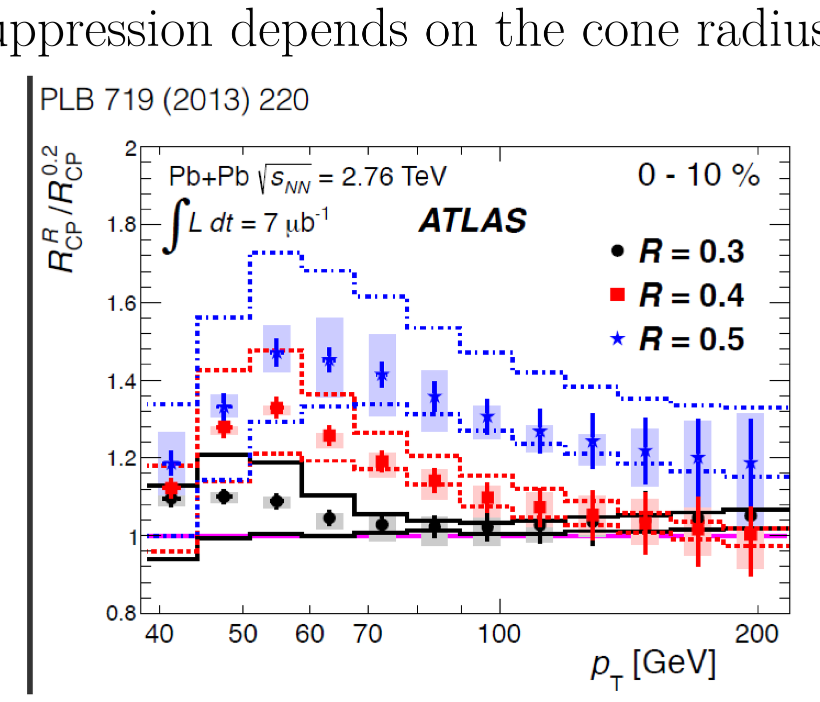


Figure 1: Jet R_{AA} (ATLAS hep-ex/1411.2357)

The suppression depends on the cone radius.



New observable: Zeal

We define,

$$Z = -[\log(\sum_i \exp[-p_T/(\hat{n}_T \cdot \vec{p}^i)])]^{-1} \quad , \qquad (1)$$

To generate events, we partition the energy E into partons carrying a fraction $x = \exp(\xi)$ chosen randomly according to a probability distribution function which is identical to the predicted distribution function of partons given in Ref. [3] (see Fig. 4 in Ref. [3]).

Results

We plot the histogram of zeals obtained for 200, 000 events. In Fig. 2 (3), we plot zeal distributions for jets with $p_T = 10$ (100)GeV. Different colors indicate different values of $\hat{q}L$.

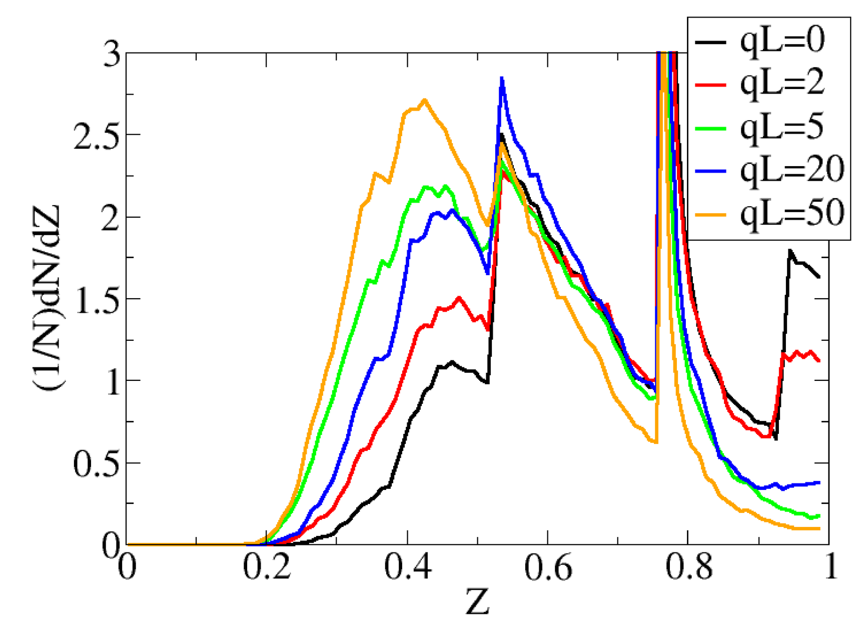


Figure 2: Zeal distribution for jets with $p_T = 10$GeV

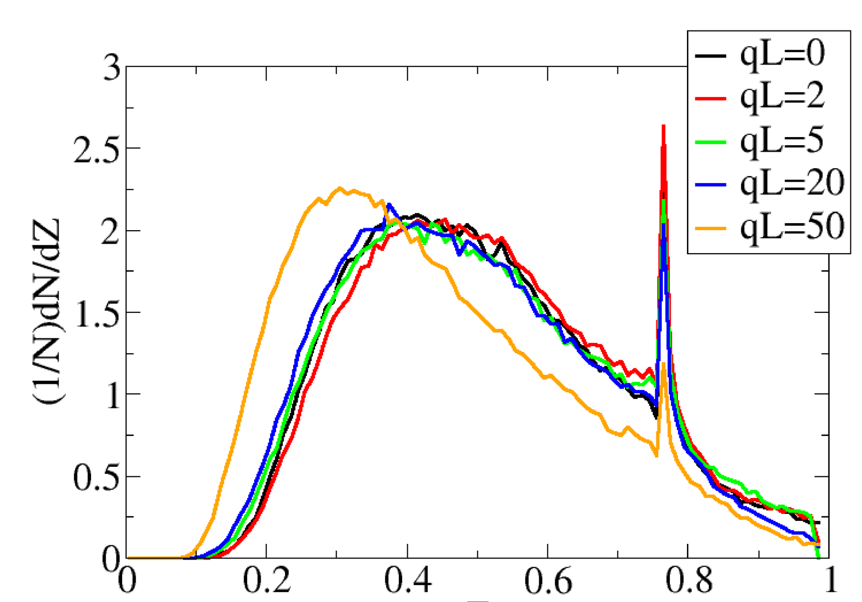


Figure 3: Zeal distribution for jets with $p_T = 100$GeV

One can clearly see that increasing $\hat{q}L$ shifts the zeal distribution to smaller values.

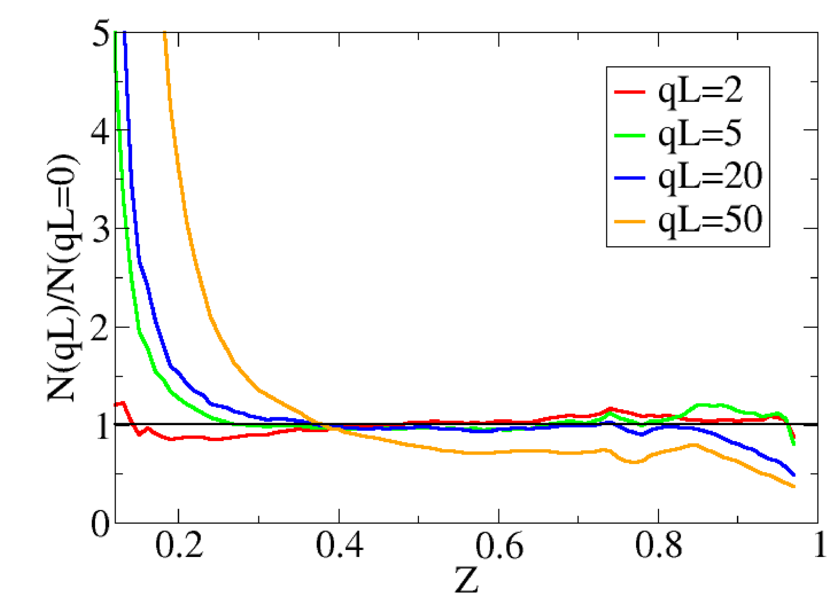


Figure 4: Ratio of zeals to pp for $p_T = 100$GeV jets

Comparing models

gluon distribution given for the models GLV [4], AMY [5], and ASW [6] in Fig. 19 of Ref. [7]. The model parameters chosen such that the value of R_7 — the suppression of a p_T spectrum falling with the power $1/p_T^7$ — is 0.25 when the leading parton traverses a QGP brick of length $L = 5$fm. We generate ensembles of events for the initial injected energy of 20GeV partitioned into partons carrying a fraction x chosen according to the distribution given in Ref. [7]. We find it very satisfying that even when the models are tuned to give the same suppression, the zeal distribution is able to distinguish between them Fig. 5, in particular showing a significant difference between the AMY and the GLV models.

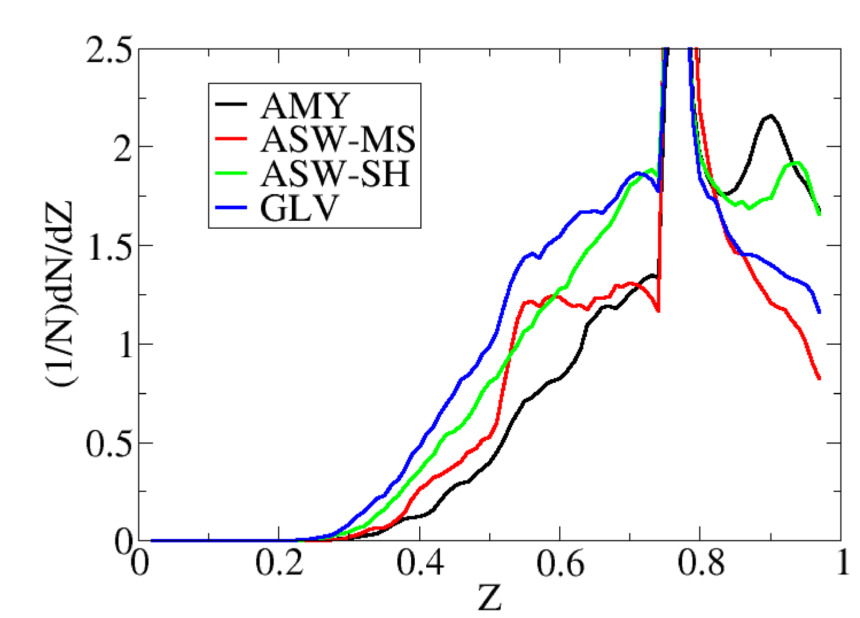


Figure 5: Comparing models

Conclusions

The zeal [Eq. 1] depends on the distribution of particles in the jets and therefore is more discriminating than R_{AA} of the leading partons.

Other jet shape measures like the value of R_{AA} as a function of jet cone radius [8, 9] have also been previously studied to analyze the distribution of partons in jets.

The advantages of the zeal distribution are

- It weighs the energetic partons more heavily and hence is particularly sensitive to the processes that lead to the energy loss of the leading parton.
- One can use large values of jet cone radii r to extract the p_T of the jet. This turns out to be very useful because we expect jets to be wider in AA compared to pp collisions due to broadening and this will reduce the systematics associated with the extraction of the p_T of the jets, and hence the calculation of zeal.

It will be interesting to see how these results are affected by hadronization. We are currently pursuing this study and are planning its application to actual experimental data.

References

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