Dijet momentum imbalance - Determination of the energy loss

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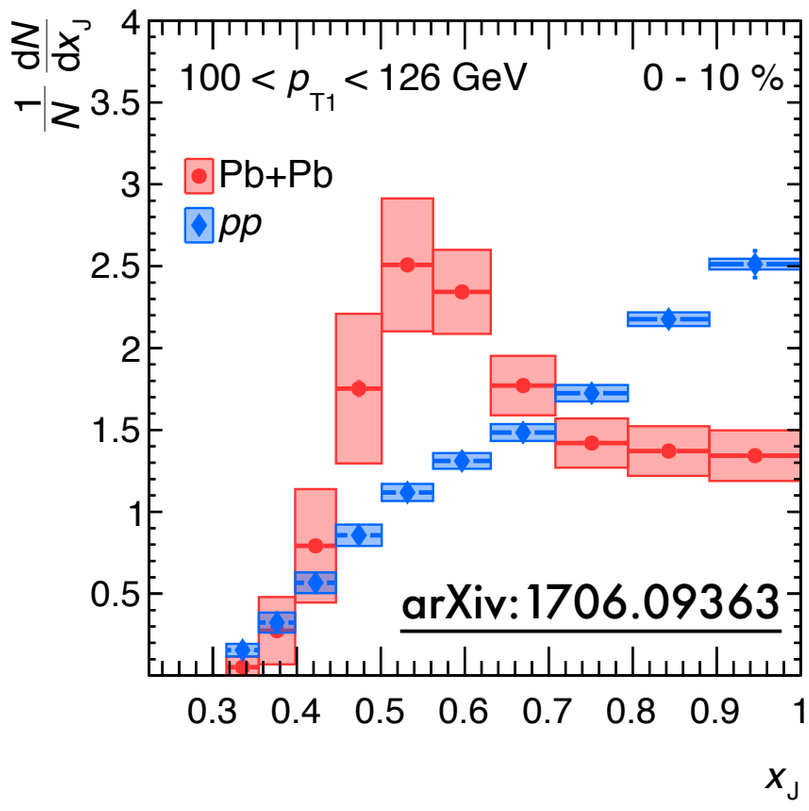
Overview

- Jets loss energy when traversing the medium of quark-gluon plasma (QGP) → critical evidence for QGP

- Measurements of di-jet events with Pb-Pb collisions observed the transverse momentum (p_T) imbalance, indicating that the two jets from hard scattering suffer from different amounts of energy loss ΔE

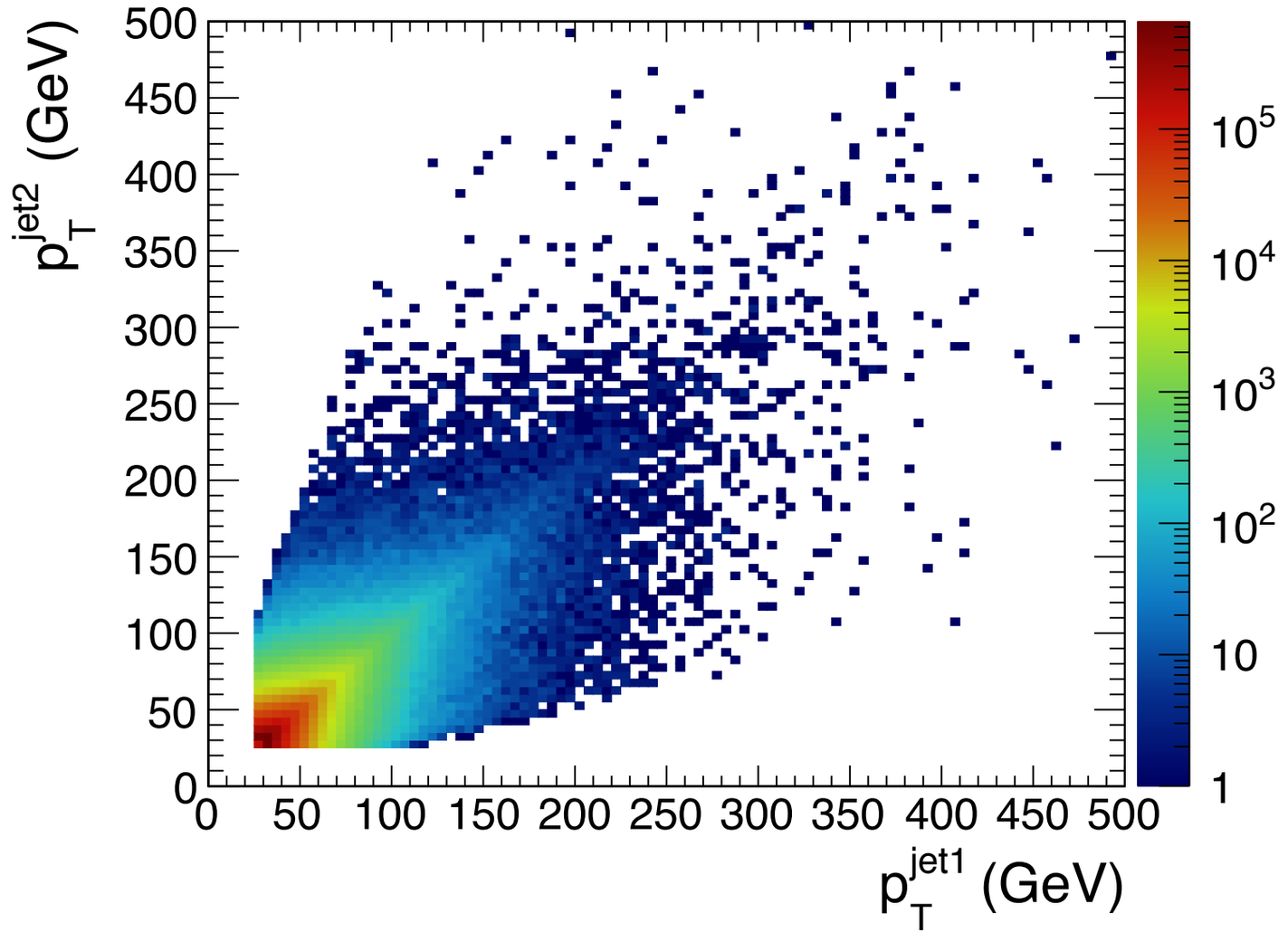
  - (Right figure) ATLAS results of $x_J \equiv p_T^{jet2}/p_T^{jet1}$ using PbPb and pp data. For PbPb data, the distribution flattens toward high x_J value and develops a peak around $x_J \sim 0.5$



Analysis setup

- **Goal**: find a parametric model of $\langle \Delta E \rangle = f(p_T^{jet}, R)$, where R is the length of the jet traversing through the QGP, that can reproduce the ATLAS x_J distribution

- Simulated di-jet events
  - Jet selections (following arXiv: 1706.09363)
    - $p_T^{jet}>25GeV$
    - $|\eta_{jet}|<2.1$
    - $|\Delta\Phi| > 7\pi/8$
  - $p_T^{jet1}>100GeV$ for x_J distributions



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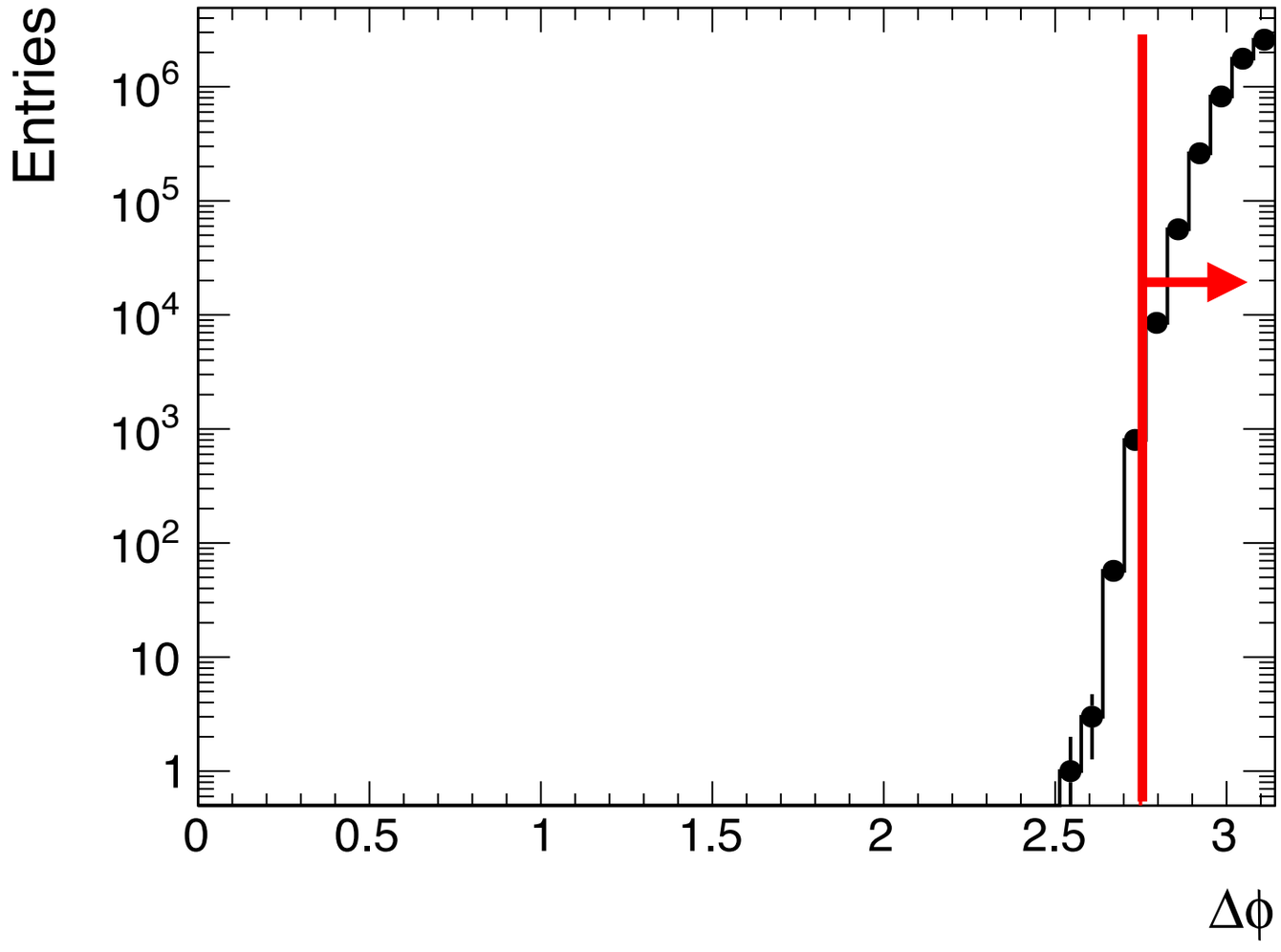

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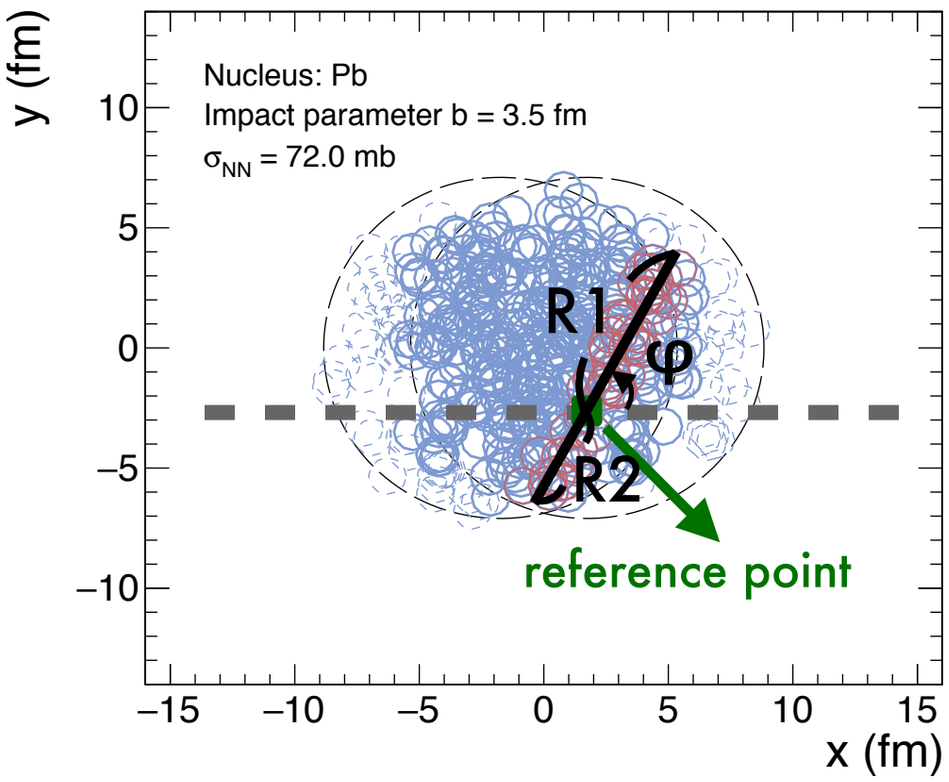
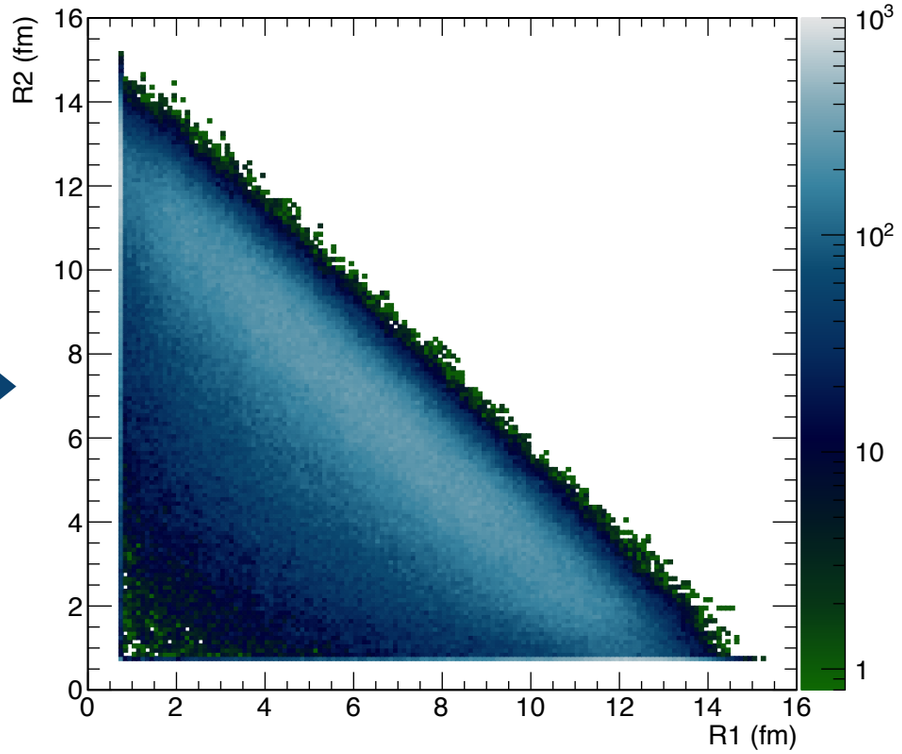
- Glauber Monte-Carlo to simulate (1) the point where the hard process takes place (2) the correlation of path lengths between the two jets





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Di-jet events
di-jet p_T

Glauber MC
(R1, R2)

Try simple forms of

1. $\langle \Delta E \rangle = C \times (p_T^{jet})^a \times R^b$

2. $\langle \Delta E \rangle = C \times \ln(p_T^{jet}) \times R^b$

(a and b are integers, C is the constant term)

A Poisson distribution with mean value at $\langle \Delta E \rangle$ is sampled to obtain ΔE

$$x_J = \frac{p_T^{jet1} - \Delta E(jet1)}{p_T^{jet2} - \Delta E(jet2)}$$

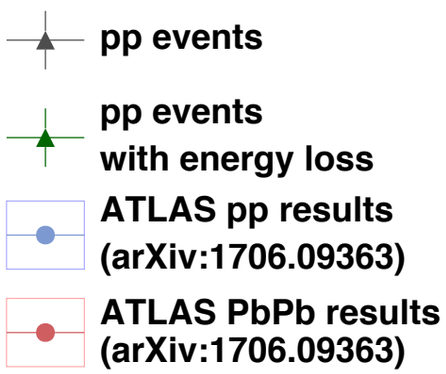
Results

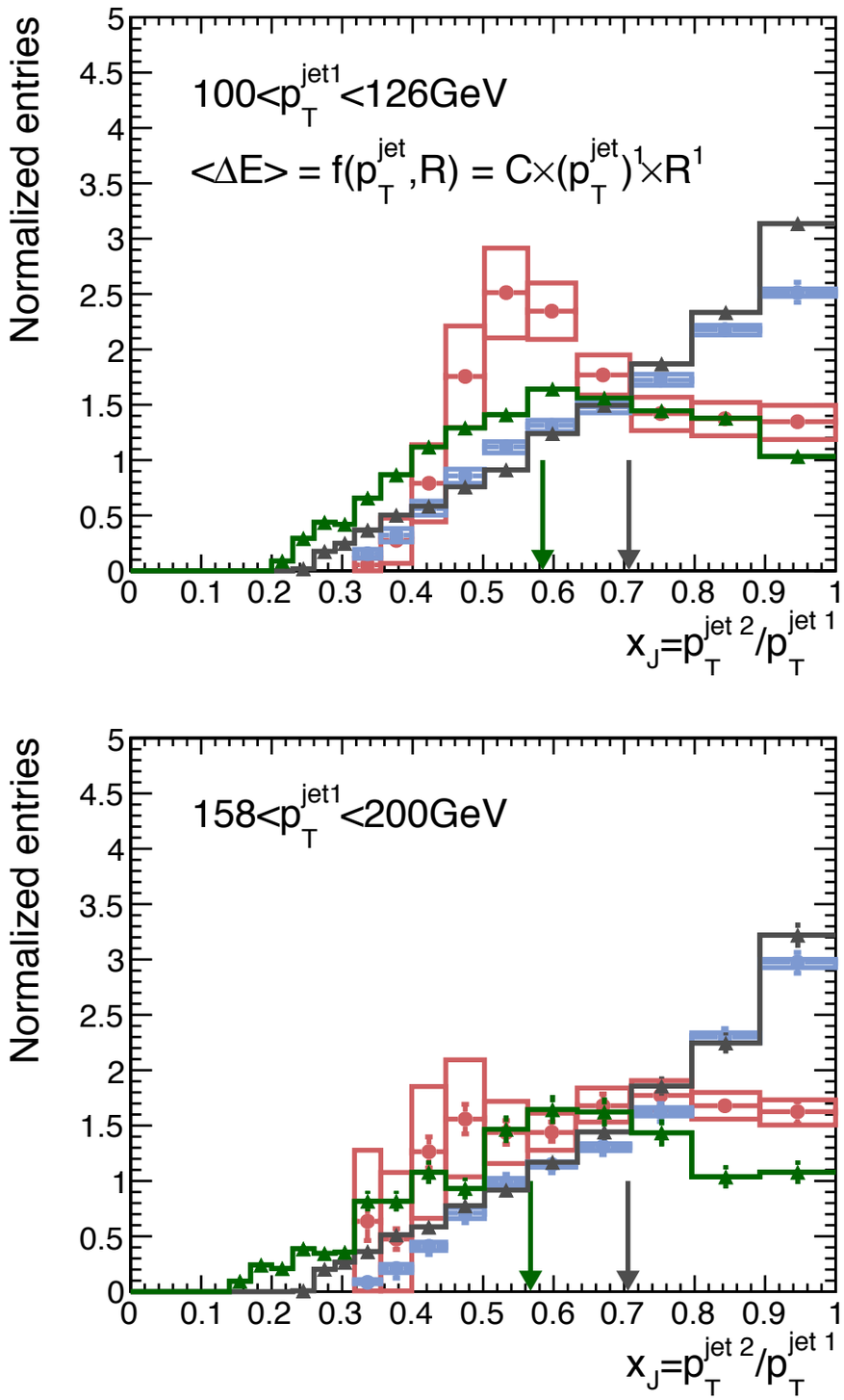
- Several combinations of a and b were tested, none of which can reproduce the peak structure as what ATLAS observed…
  - For parametrization of $\langle \Delta E \rangle = C \times (p_T^{jet})^a \times R^b$, only results of (a,b)=(1,1) and (1,2) will be shown
  - For parametrization of $\langle \Delta E \rangle = C \times \ln(p_T^{jet}) \times R^b$, only results of b=1 and 2 will be shown
- In this study, only statistical uncertainty is quoted in the results. No systematic uncertainty is evaluated and assigned

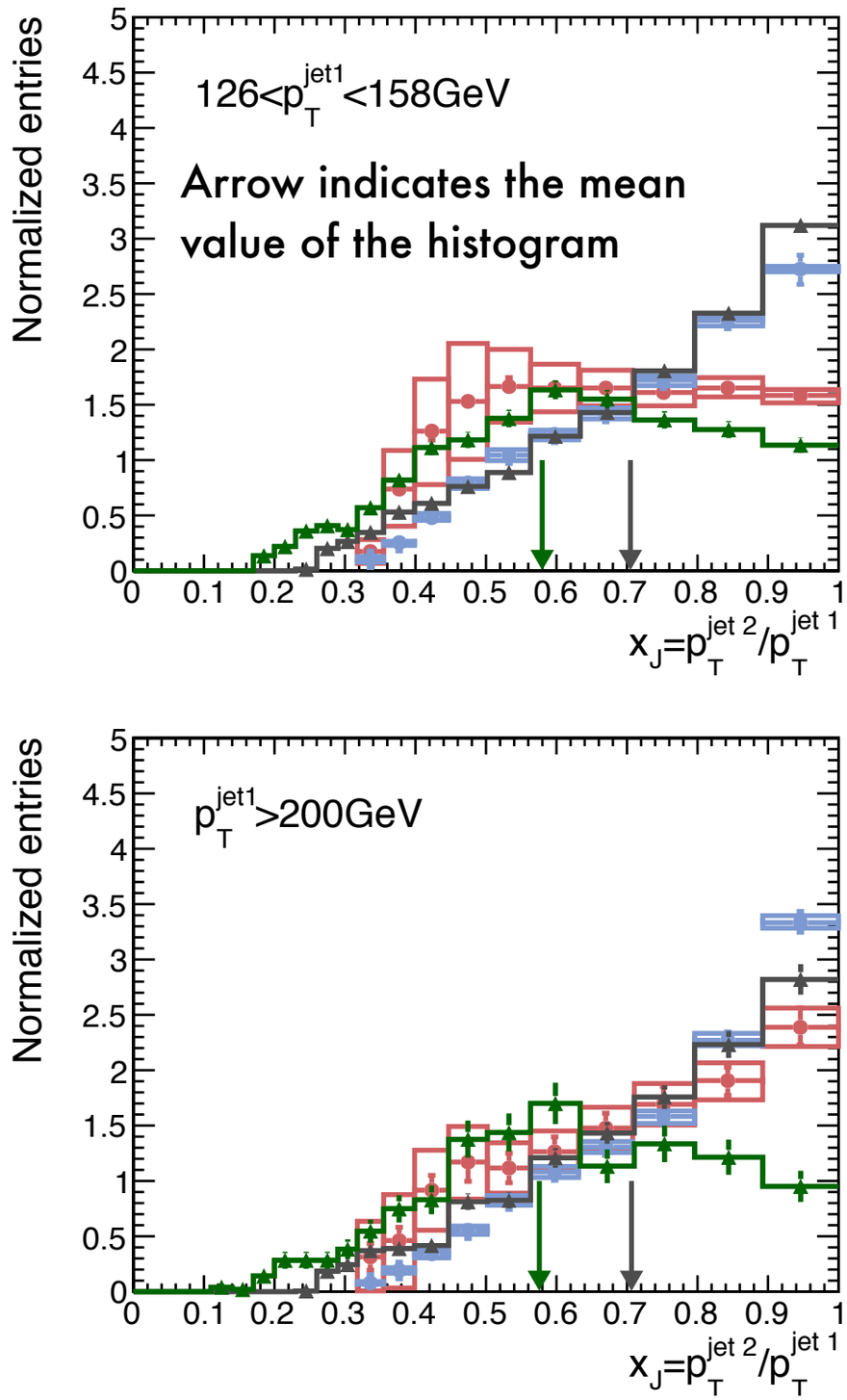
Results

$\langle \Delta E \rangle = C(p_T^{jet})^a R^b$

(a, b) = (1, 1)







Results

$\langle \Delta E \rangle = C(p_T^{jet})^a R^b$

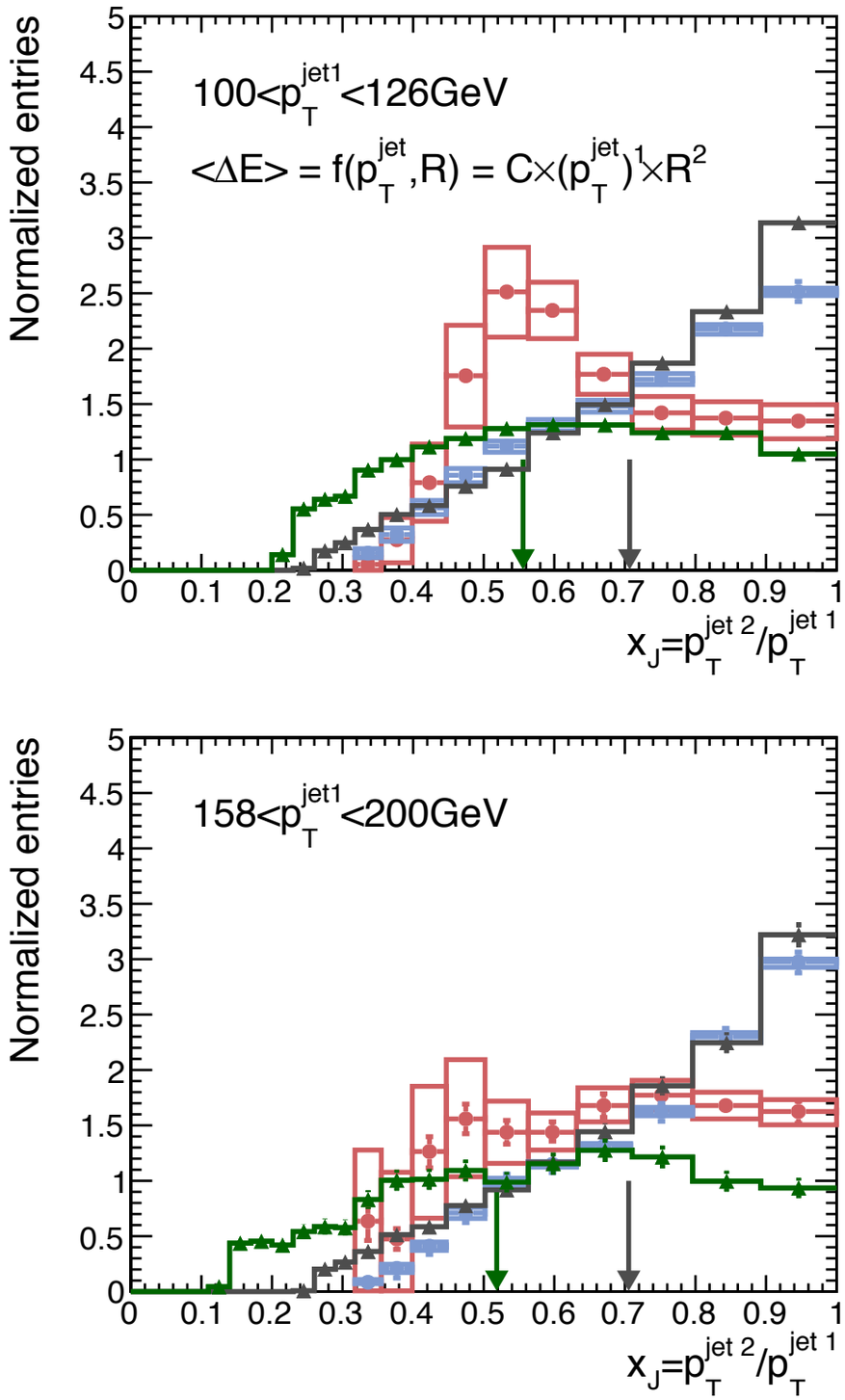
(a, b) = (1, 2)

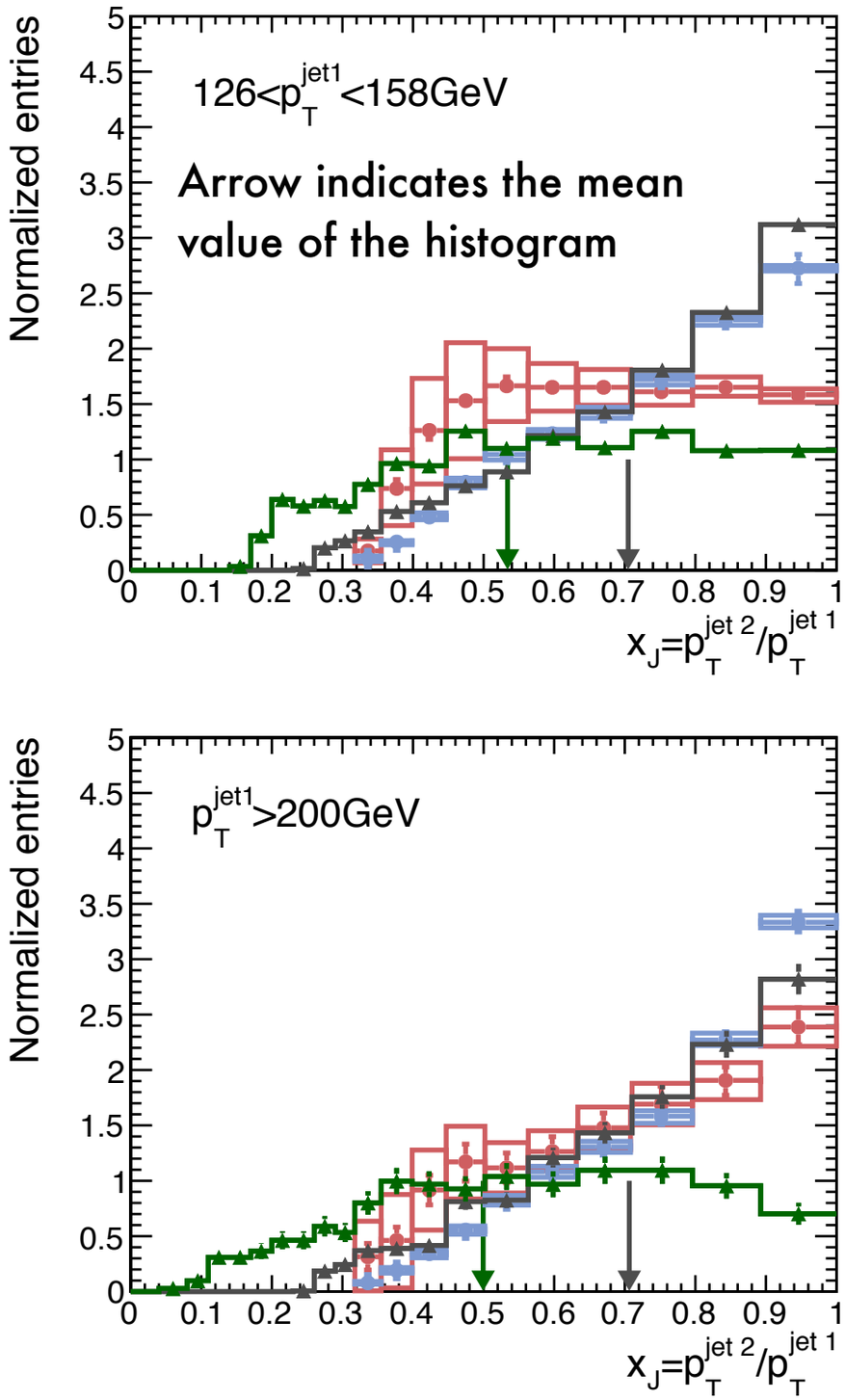
pp events

pp events with energy loss

ATLAS pp results (arXiv:1706.09363)

ATLAS PbPb results (arXiv:1706.09363)

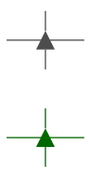




Results

$\langle \Delta E \rangle = C \ln(p_T^{jet}) R^b$

b = 1



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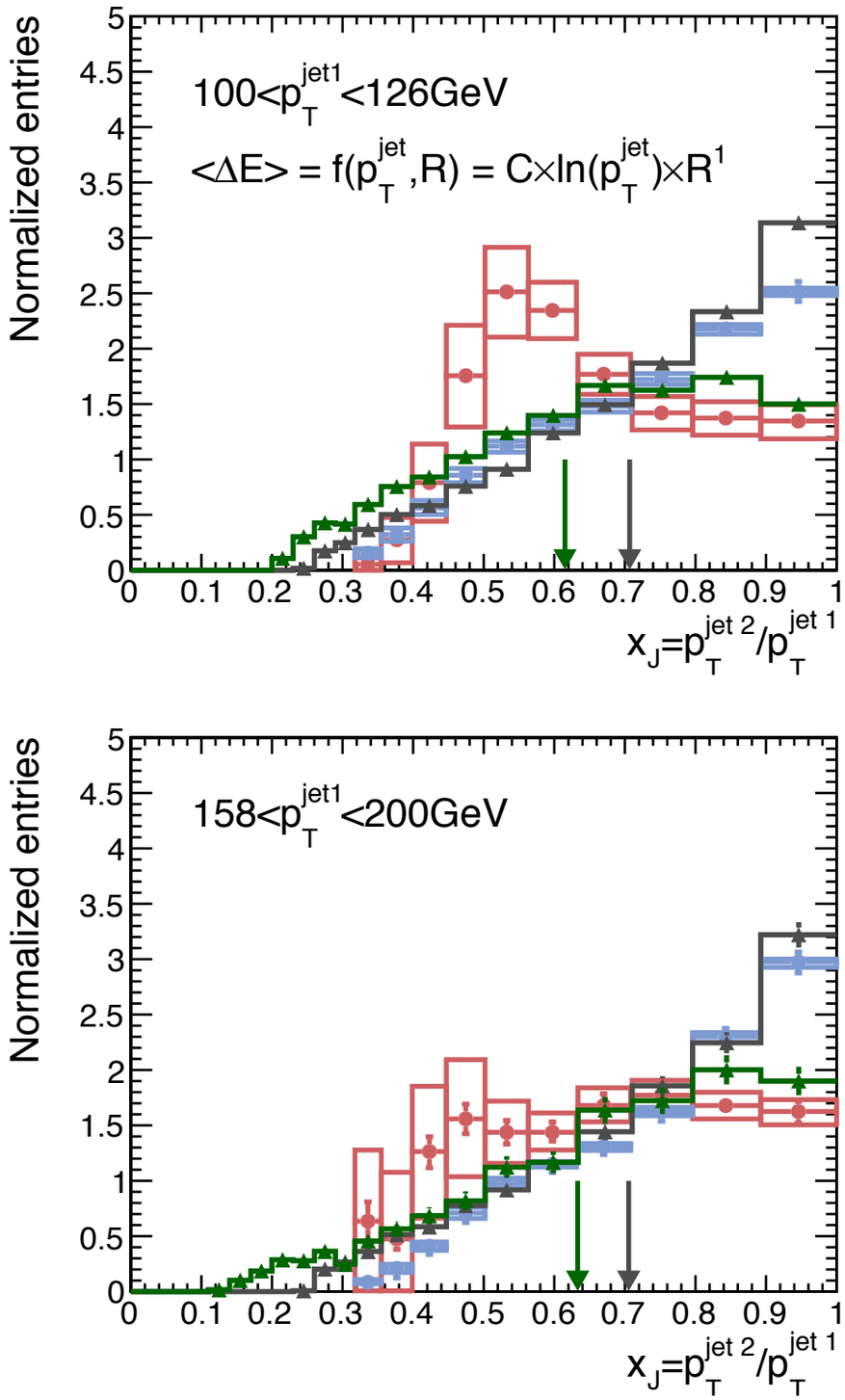

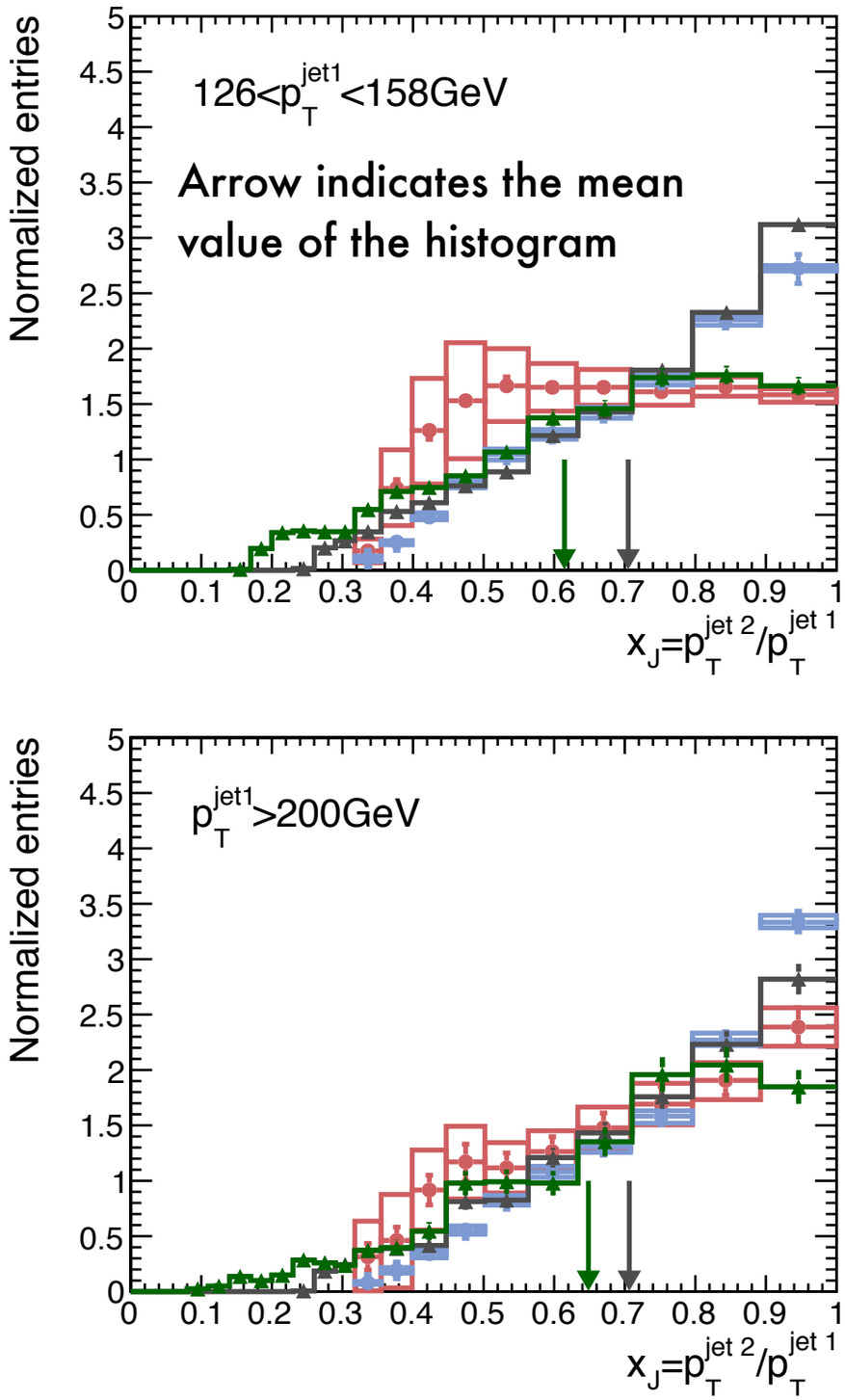

Results

$\langle \Delta E \rangle = C \ln(p_T^{jet}) R^b$

b = 2

pp events

pp events with energy loss

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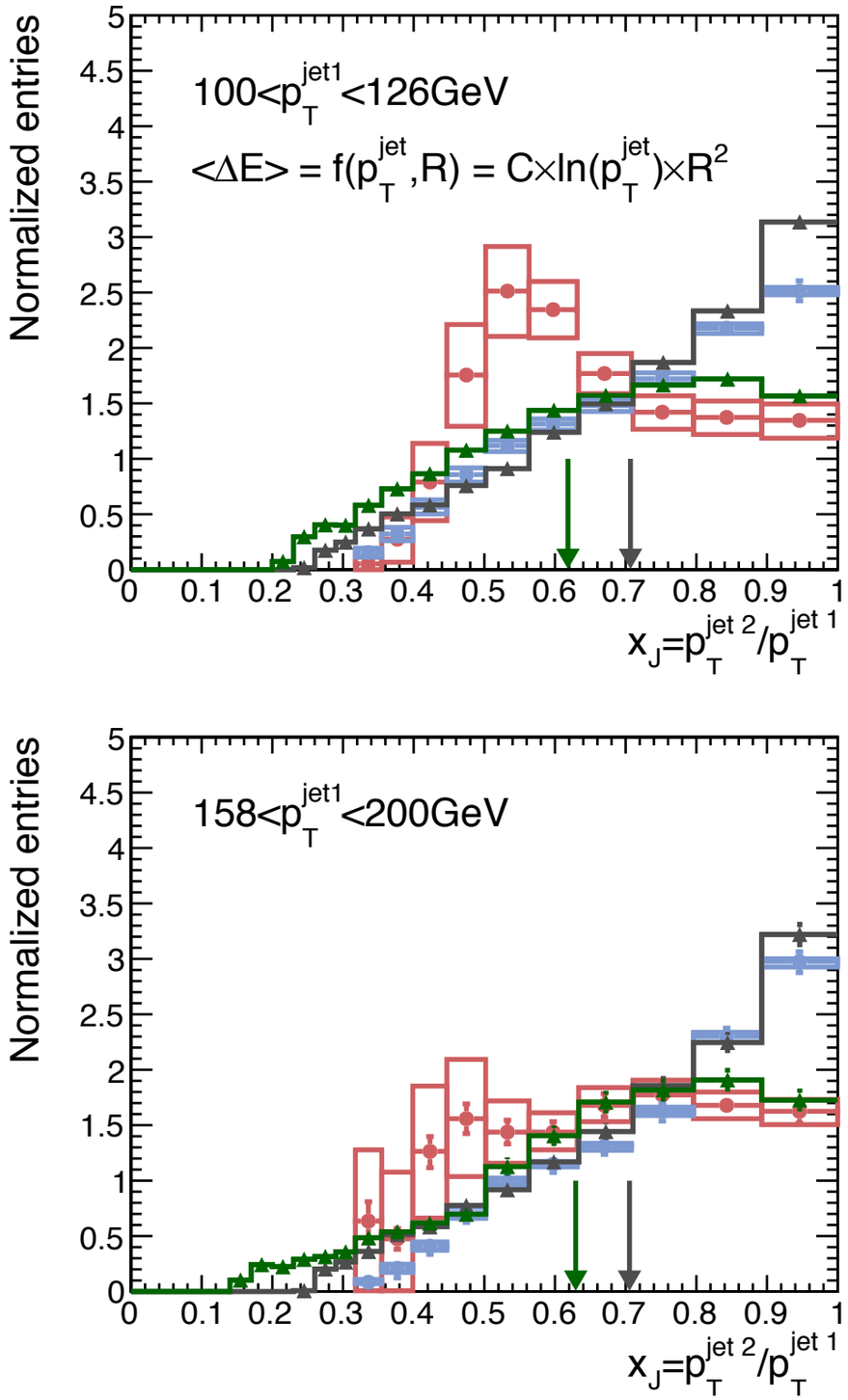
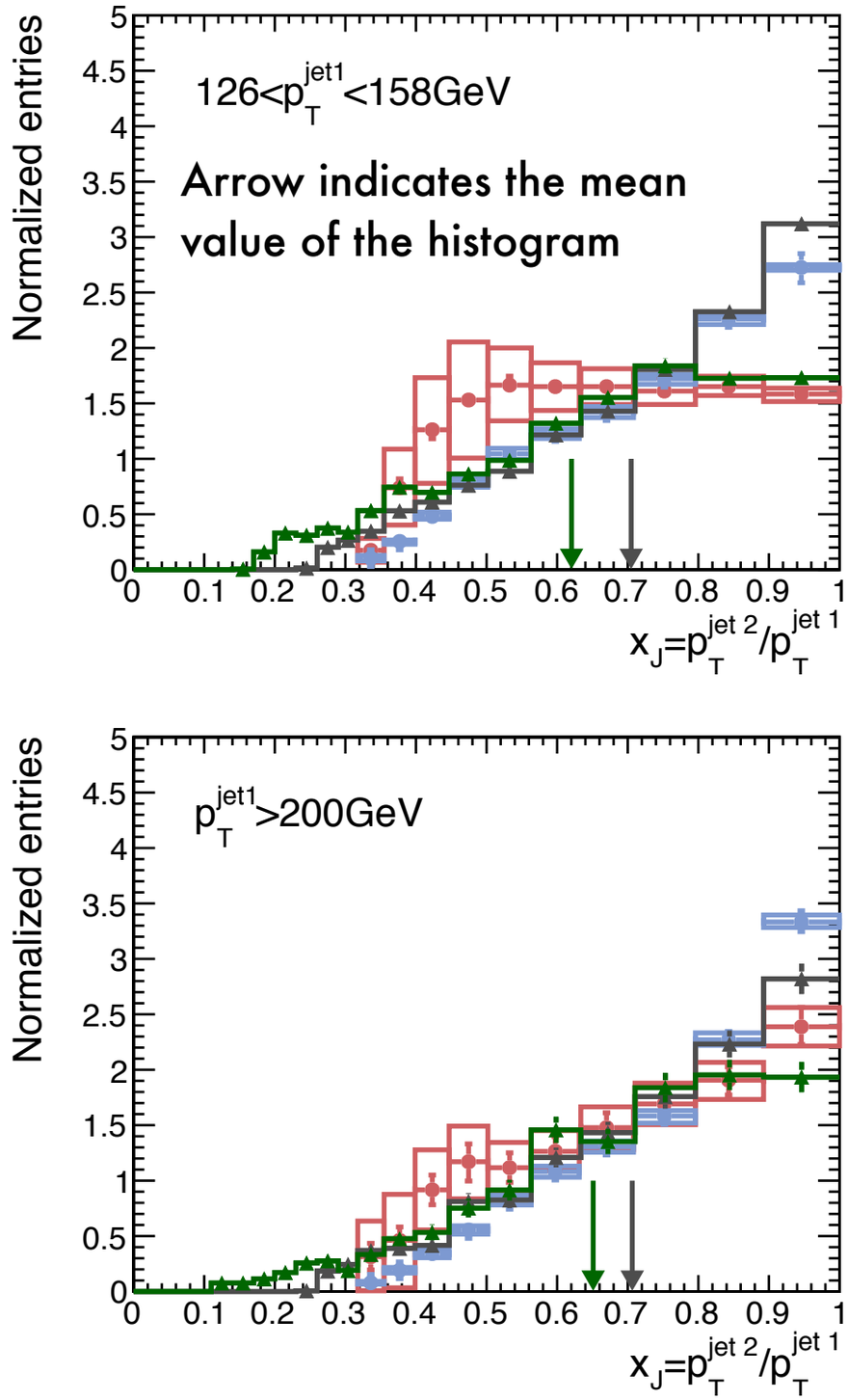
ATLAS PbPb results (arXiv:1706.09363)





Summary

- With simulated dijet events from pp collisions, Glauber Monte-Carlo simulation, and simple forms of energy loss of jet traversing in QGP $\langle\Delta E\rangle = C(p_T^{jet})^a R^b$ and $\langle\Delta E\rangle = C\ln(p_T^{jet})^a R^b$, attempt to reproduce ATLAS results (arXiv:1706.09363) was made. However, none of the tested models work
  - For $\langle\Delta E\rangle = C(p_T^{jet})^a R^b$, results with (a, b)=(1, 1) and (1, 2) are shown; For $\langle\Delta E\rangle = C\ln(p_T^{jet}) R^b$, results with b=1 and 2 are shown.