Sensitivity of jet quenching to the initial geometry in Pb+Pb collisions with ATLAS

Motivation:
- Jets are known to lose energy while traversing the Quark Gluon Plasma in ways sensitive to the initial state geometry
- The transverse momentum balance of di-jet pairs in Pb+Pb can provide direct insight on the path-length dependence to energy loss
- Path-length dependent energy loss can cause higher jet yield in-plane vs. out-of-plane, creating a positive $v_2$
- Jet $v_{n>2}$ can give insight into the role of initial state fluctuations

Di-jet Measurement[1]:
- Directly measure the two-dimensional leading, subleading transverse momentum ($p_{T,1}, p_{T,2}$) distribution of the leading di-jet pair with $\Delta \eta > 7\pi/8$ and both $|\eta_{1}|$ and $|\eta_{2}| < 2.1$
- Two dimensional Bayesian unfolding accounts for migration in both the leading and sub-leading jet $p_T$
- The unfolded ($p_{T,1}, p_{T,2}$) distribution projected to the di-jet momentum balance: $x_j = \frac{p_{T,2}}{p_{T,1}}$

Jet $v_n$ measurement[2]:
- Measure the $R = 0.2$ jet yield as a function of $\eta\Delta\phi_{ij} = |\eta_j - \phi|$ in bins of centrality and jet $p_T$
- For $n = 2, 3, 4$
- Yields are unfolded in $p_T$ and $\Delta\phi_{ni}$, and fit to extract $v_n$

Di-jet Momentum Balance: Centrality Dependence
- $158 < p_T^1 < 178$ GeV in central Pb+Pb is consistent with flat $x_j > 0.5$
- Peripheral Pb+Pb is consistent with $pp$ above $p_{T,1} = 251$ GeV
- Central Pb+Pb has clear modification from $pp$ out to $p_{T,1} = 562$ GeV

Di-jet Momentum Balance: Theory Comparison
- PYTHIA8 tune used in LIDO[3] over-predicts symmetric jets in $pp$
- LIDO predictions observe agreement across both centrality and $p_{T,1}$
- Significant modification in central Pb+Pb compared to $pp$ collisions extends through $p_{T,1} = 562$ GeV
- New, high $p_T$, information to constrain the role of fluctuations and path-length dependence in energy loss

Jet $v_2$
- Observe positive $v_2$ on the order of 3-4% for $R=0.2$ jets with $71 < p_T < 251$ GeV in 40-60% events
- Decreases to order 1% for 0-10% central events
- No observation of significant $p_T$ dependence

Jet $v_3$ and $v_4$
- No evidence for non-zero $v_3$ and $v_4$ in Pb+Pb collisions

Conclusions
- ATLAS sees significant modification of the momentum balance of di-jet pairs in Pb+Pb collisions compared to $pp$ collisions for leading jet $p_T$ up to 562 GeV, evidence of path-length dependent energy loss within the QGP.
- A strong non-zero $v_2$ is observed for $R = 0.2$ jets which decreases to ~1% for central Pb+Pb, and is independent of $p_T$ between 71 and 251 GeV
- ATLAS first measurement of $v_2$, $v_3$, and $v_4$ for zero $R$ are consistent with zero

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