Heavy ion quarkonia and heavy flavor results from ALICE and LCHb

g.j.kunde@lanl.gov

For LHCb and ALICE

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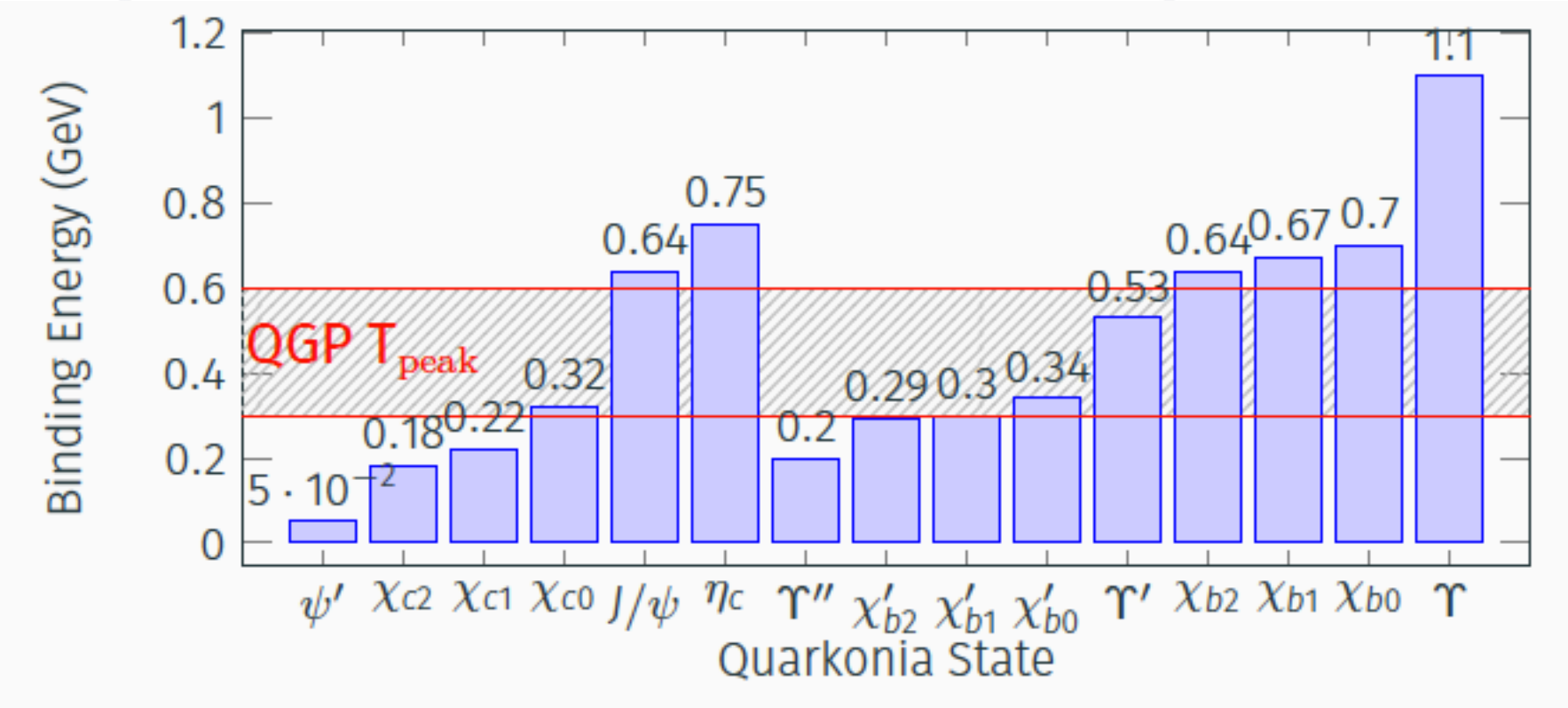
Roadmap to Heavy Ion Studies

- p-p Baseline (cross sections)
- p-A Cold Matter and Initial State Effects
- A-A Two tools presented:
  - Nuclear Modification Factor $R_{AA} = \frac{\text{yield in A+A}}{N_{\text{coll}}(\text{yield in p+p})}$
  - Azimuthal Asymmetries $\frac{dN}{d\phi} \propto 1 + 2\sum_{n=1}^{\text{inf}} v_n \cos n\,(\phi - \Phi_{RP})$

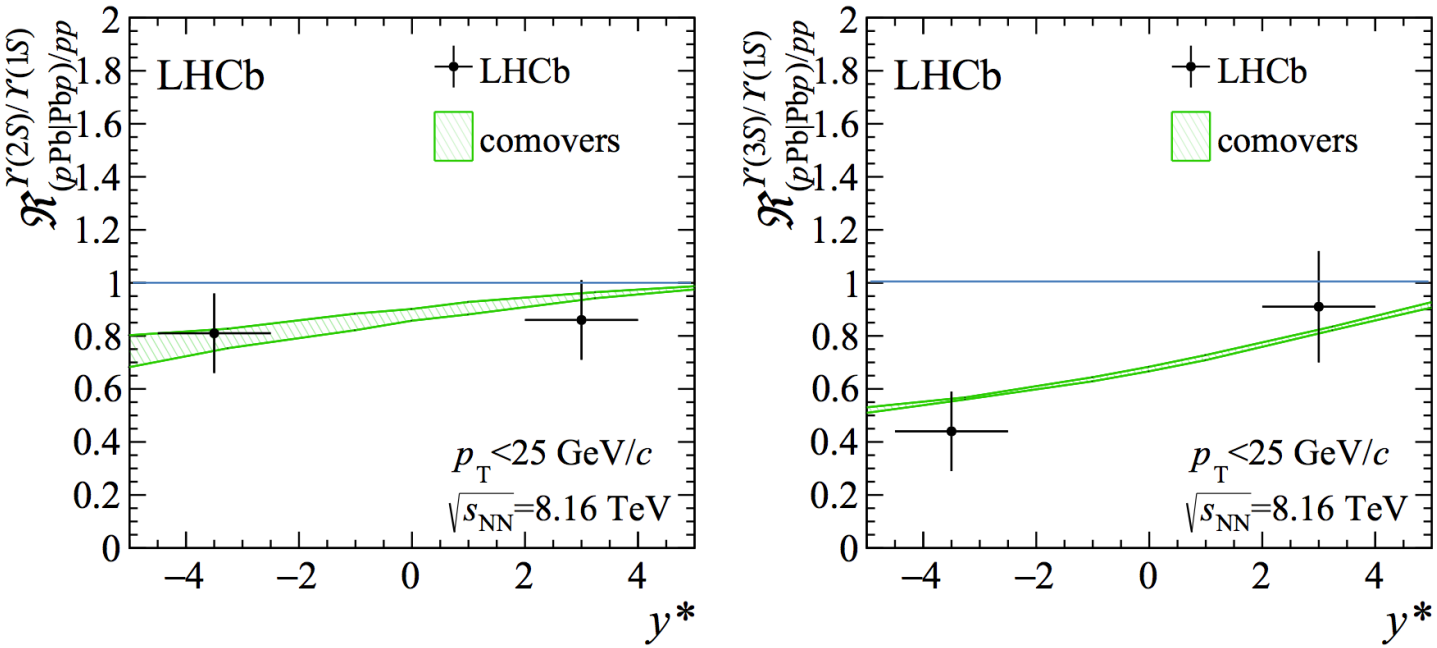
Quarkonia

QGP Temperature



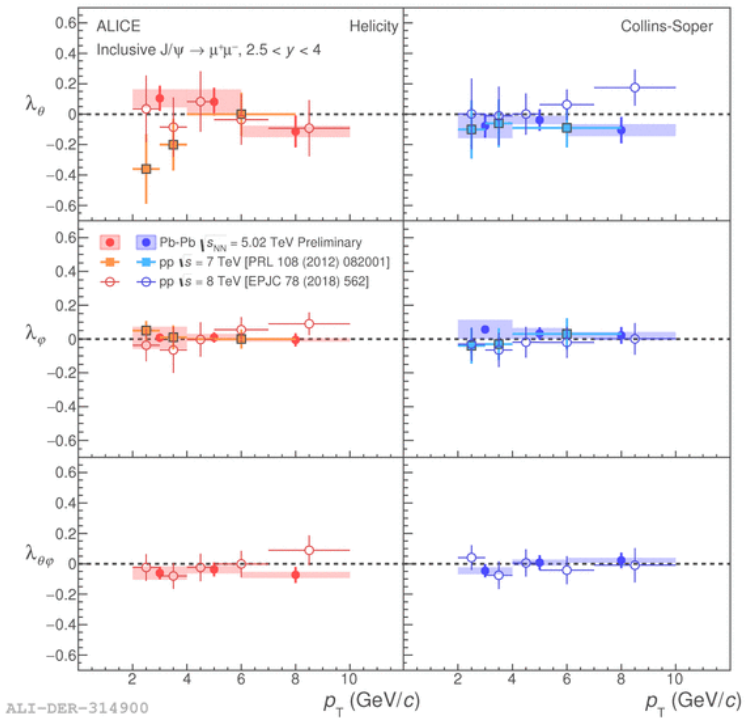
Comovers calculation: JHEP 10 (2018) 094 , PLB 749 (2015) 98

p-Pb Quarkonia "Breaking"



- Relative nuclear modification of Υ_{2S}, Υ_{3S} over Υ_{1S}
- Data reproduced by comover calculations without QGP

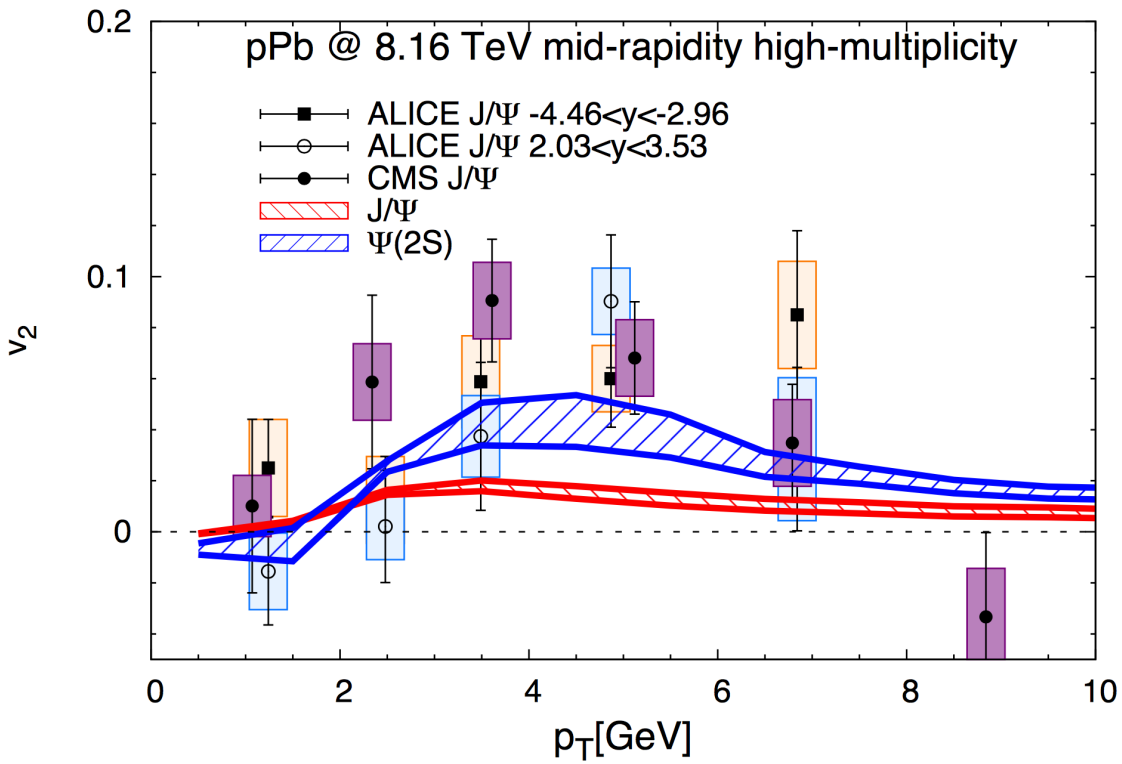
Pb-Pb J/ψ Polarization Studies



$$W(cos\theta,\varphi) \propto \frac{1}{3+\lambda_\theta}\cdot(1+\lambda_\theta\cos^2\theta+\lambda_\varphi\sin^2\theta\, cos2\varphi+\lambda_{\theta\varphi}sin2\theta cos\varphi)$$

- Consistent with zero in all frames

p-Pb J/ψ Elliptic Flow

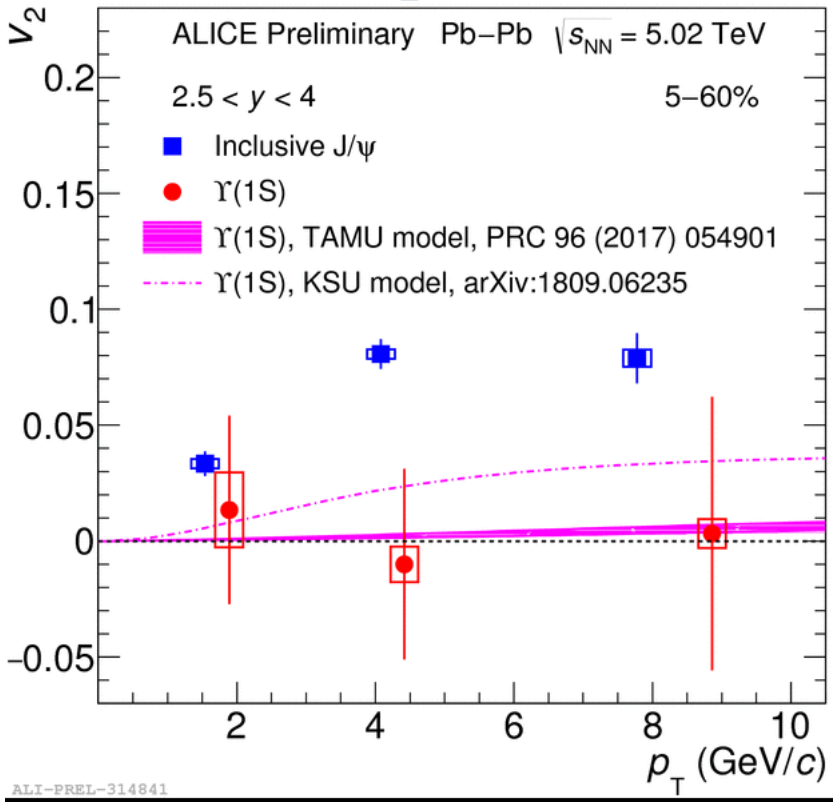


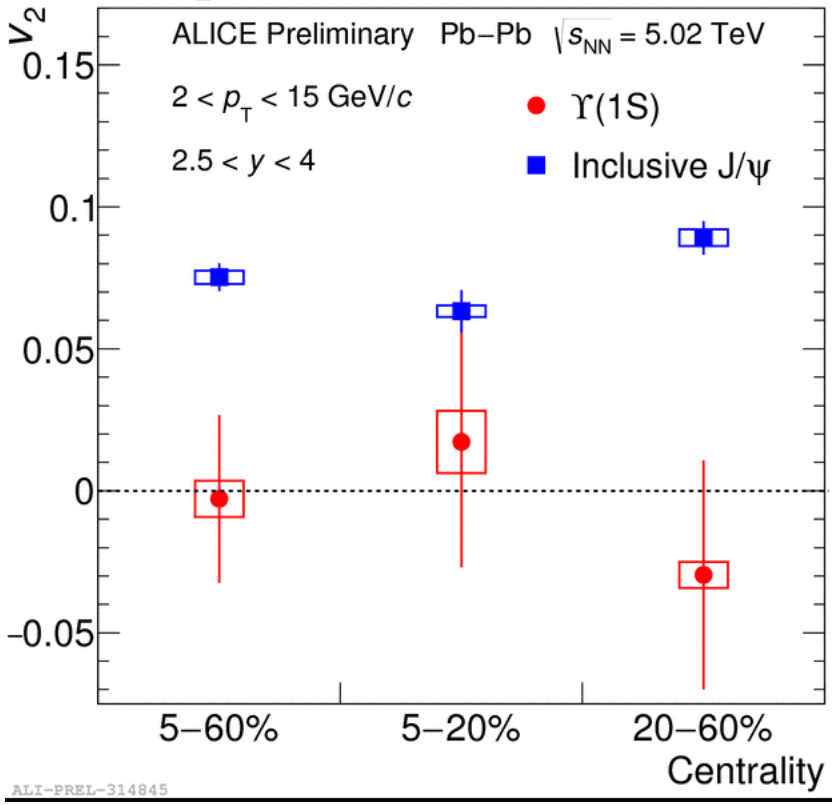
arXiv:1808.10014v2

In-Medium Charmonium Production in p+Pb Collisions

- Same model describing J/ψ R_{pA} using transport in-medium cannot describe v_2
- Coalescence/Hydro in small systems ?

Pb-Pb Υ Flow

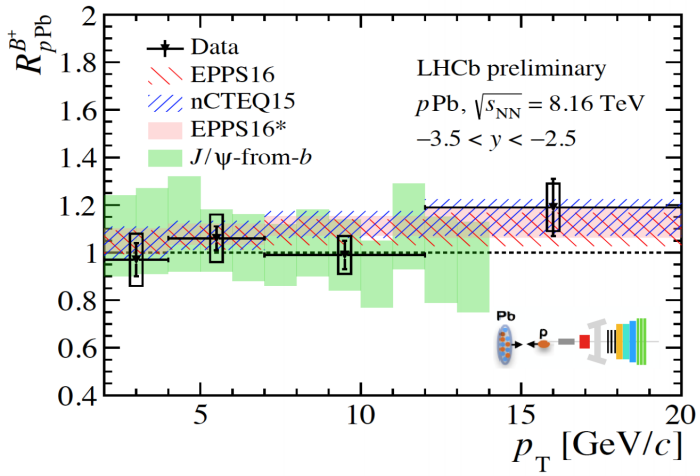


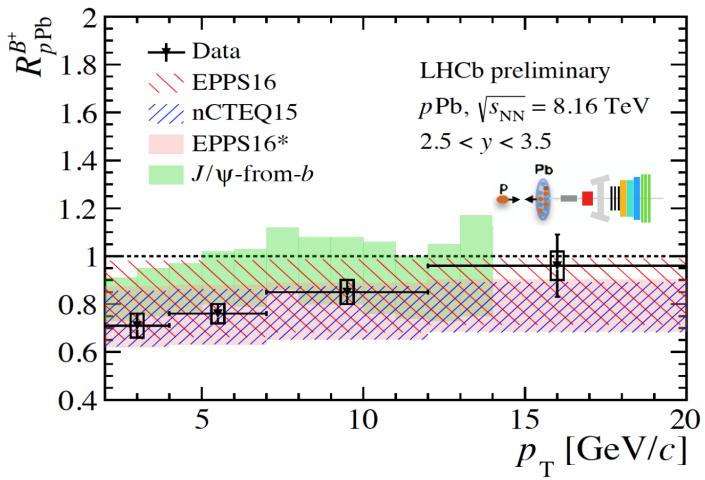


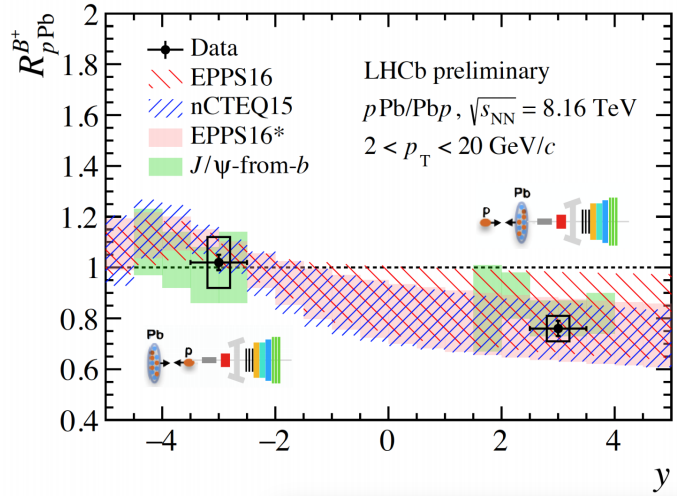
- "No flow" result
- Bottomonia should not be produced by coalescence (small number)

Heavy Quarks

p-Pb Beauty Production @ 8.16 TeV

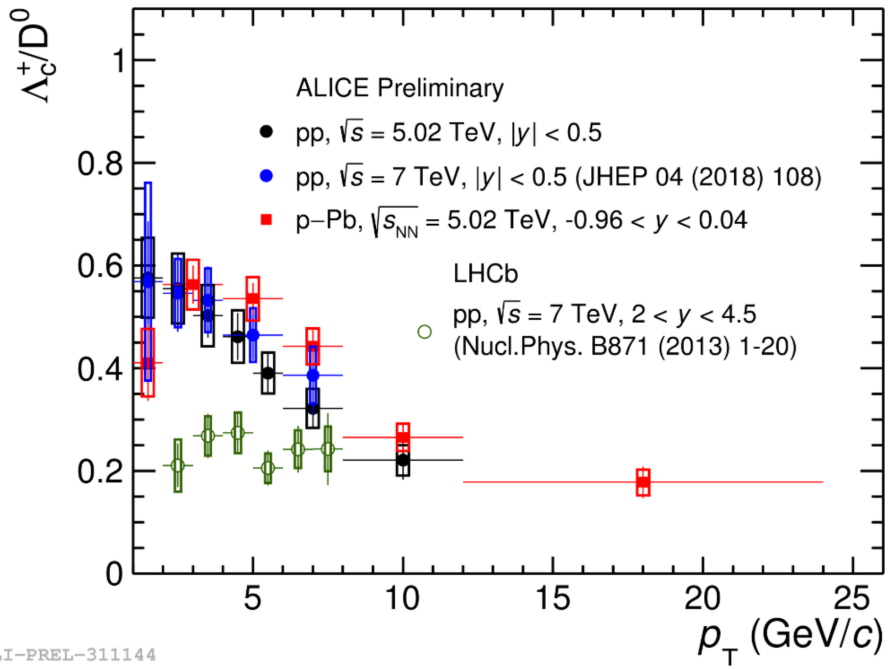


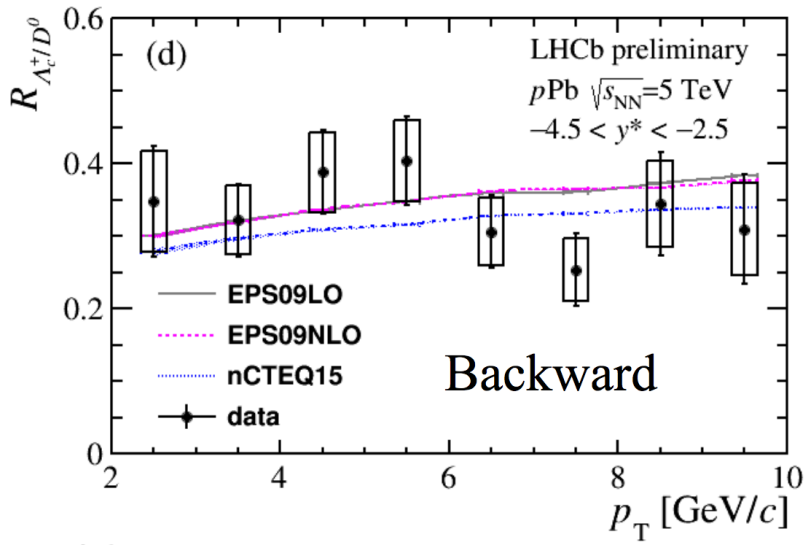


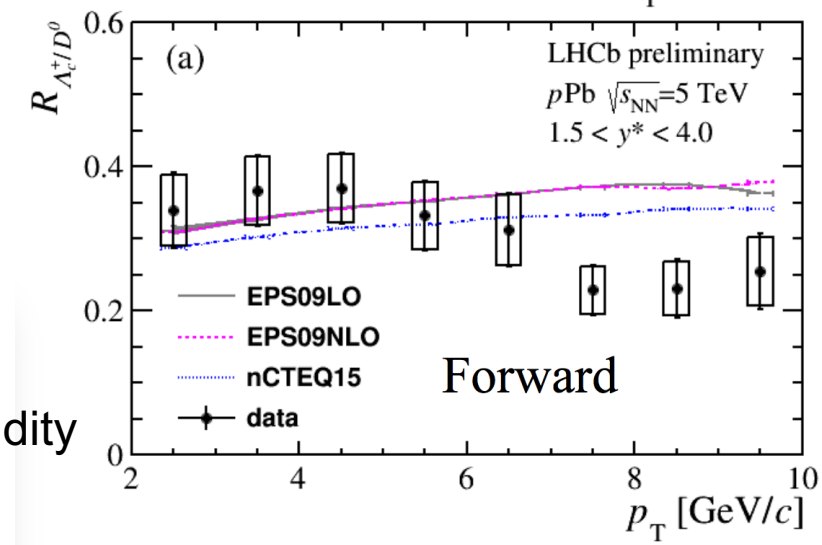


- Benchmark data
- At large Q^2 agreement with nPDFs (smaller uncertainties)

p-Pb Λ_c Production

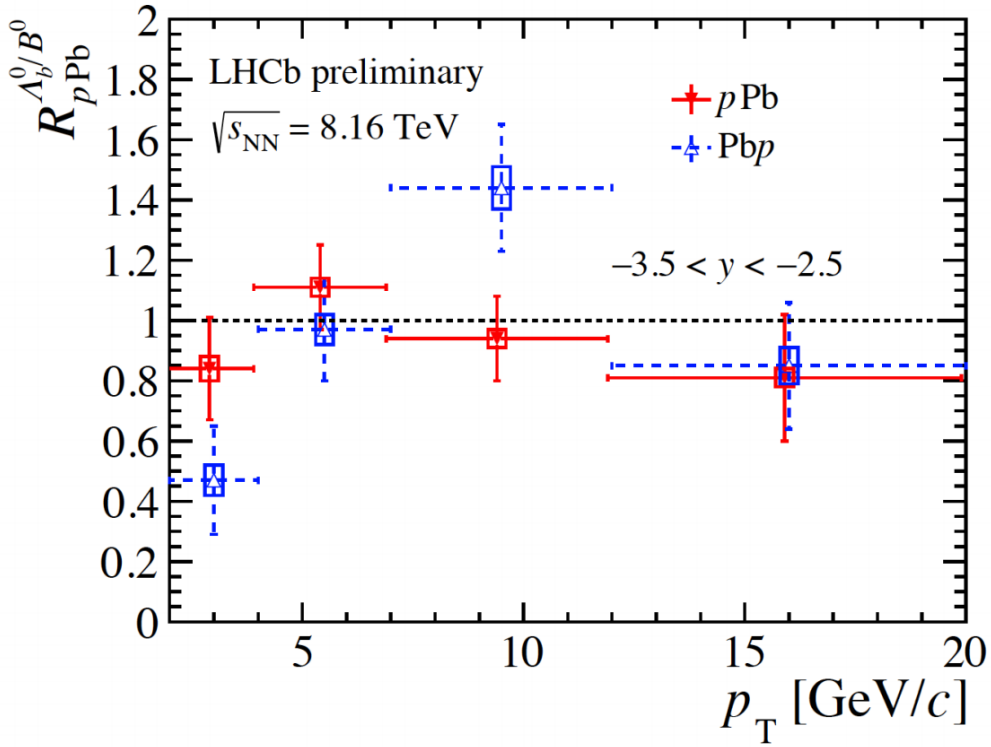






- Ratio larger larger than those measured previously in different colliding systems
- Ratio at mid-rapidity larger than forward-rapidity

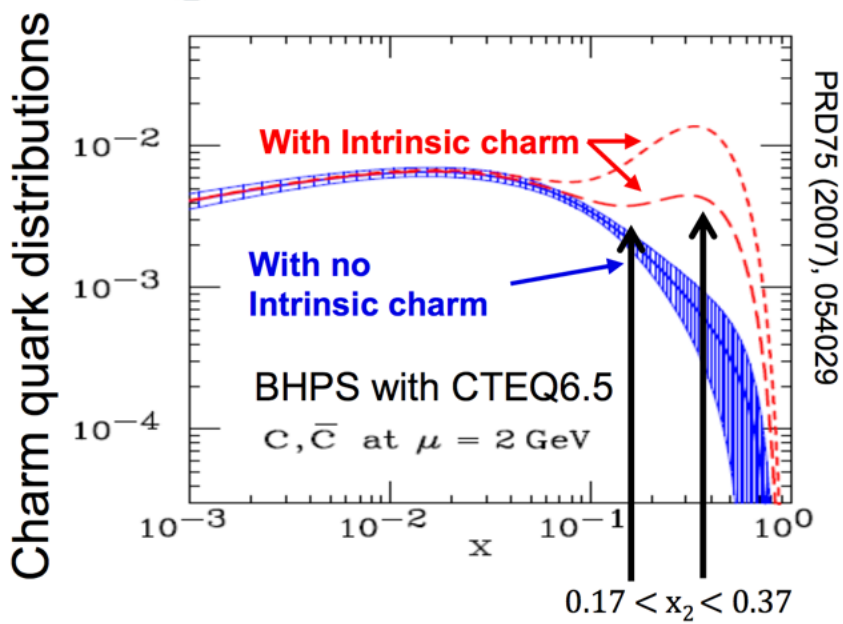
p-Pb Baryon/Meson Ratio @ 8.16 TeV

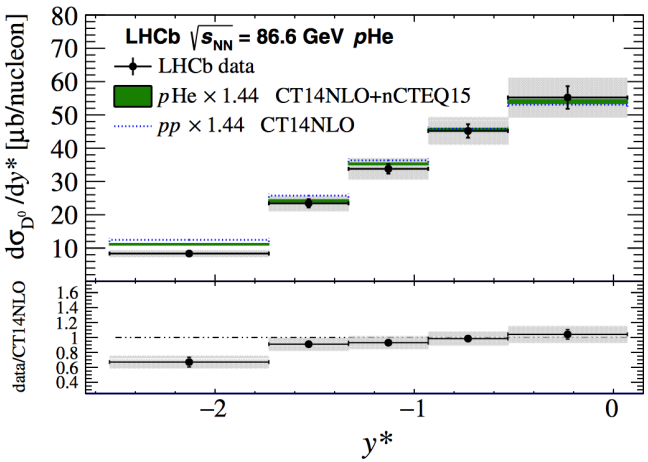


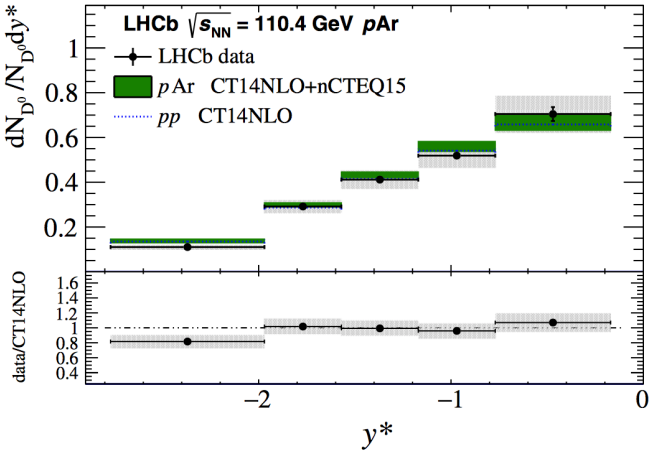
- Baryon/meson ratio same as p+p at forward rapidity
- Large fluctuation at backward rapidity

Phys. Rev. Lett. **122**, 132002

p-He/p-Ar D^0 Production Fixed Target

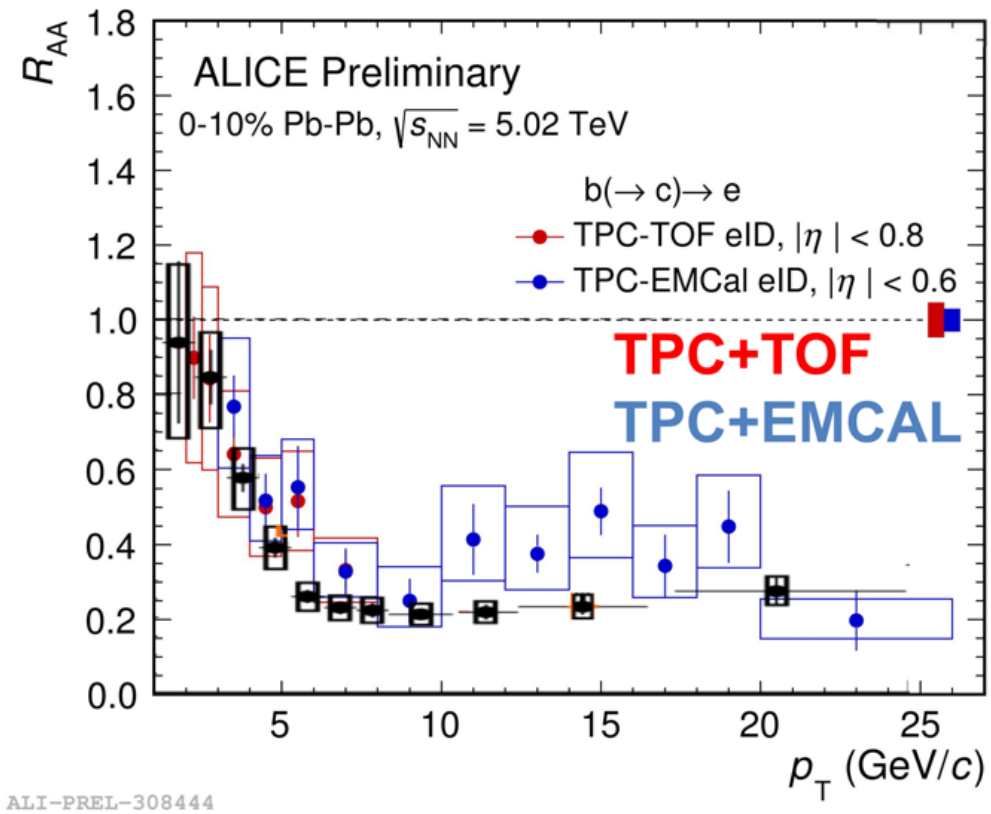






- No evidence for strong charm enhancement predicted by intrinsic charm estimation
- More data will allow a better exploration of x_2

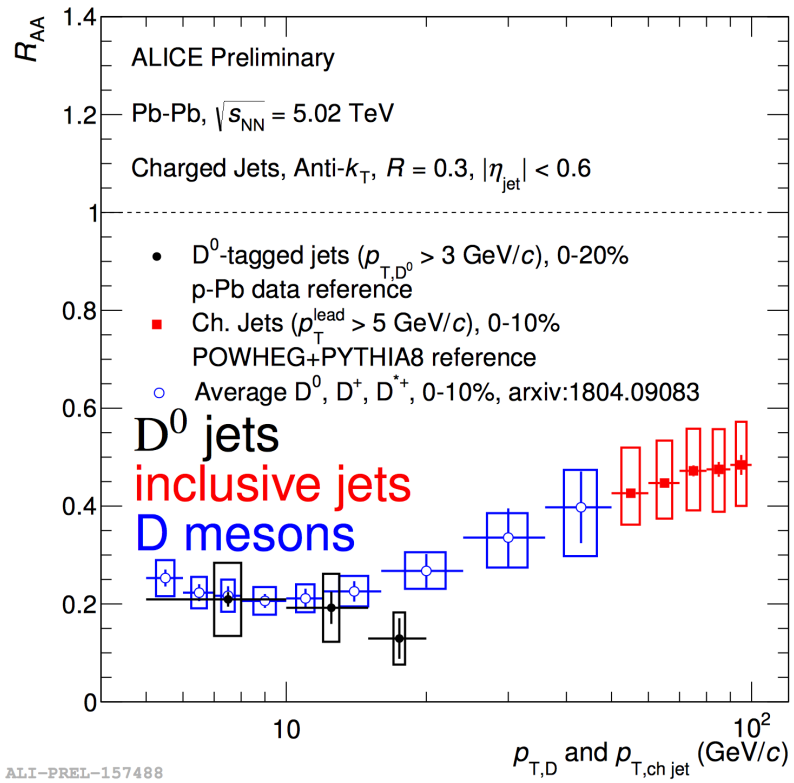
Pb-Pb Semi-leptonic Decays of Beauty



Average D^0,D^+,D^{*+} from JEHP 1810 (2018) 174

- Electron impact parameter selection
- Hint of maller suppression of b-quarks ?
- Caveat: B-meson p_T vs. electron p_T

Pb-Pb D-Meson Tagged Jets



- Inclusive and D-meson tagged jets R_{AA} similar
- No radial profile modification for higher D-meson p_T

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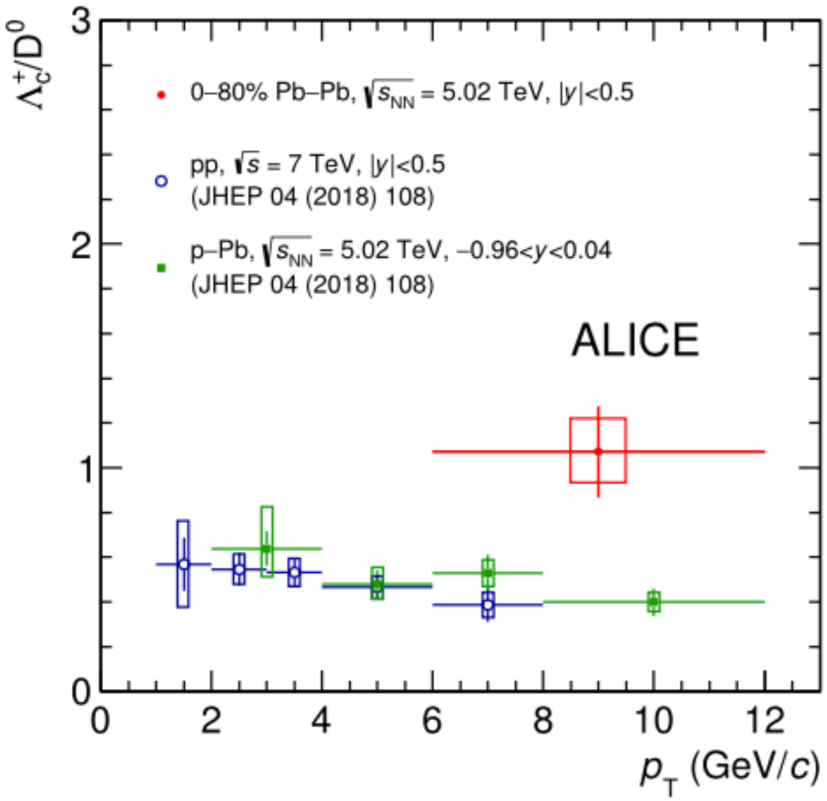
Pb-Pb Λ_c Production



- ALICE results consistent with charm coalescence in medium

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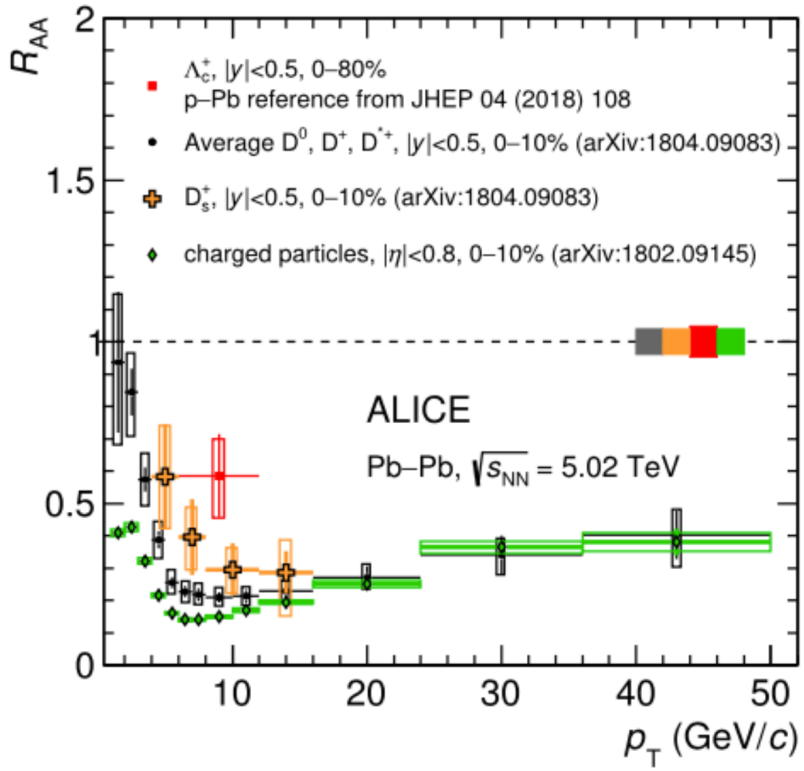
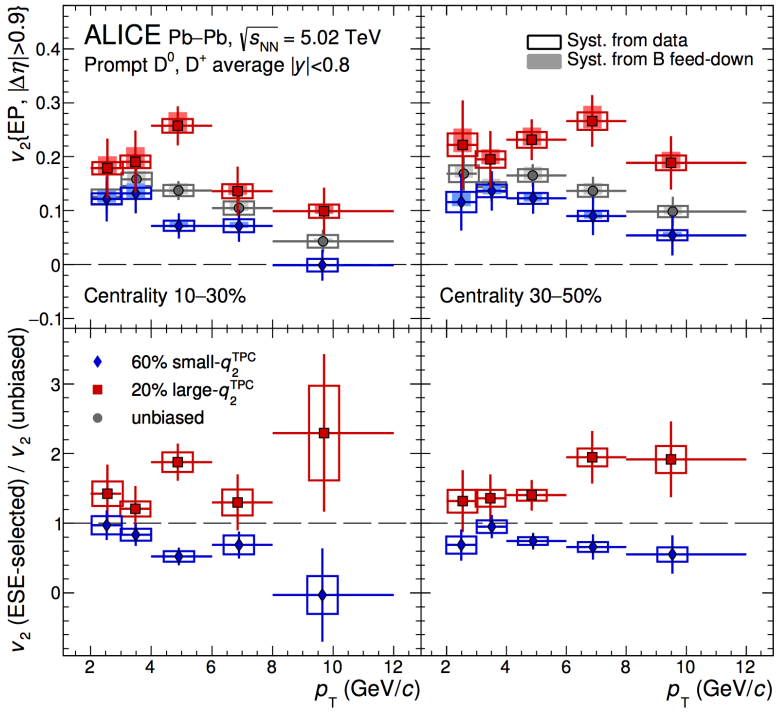
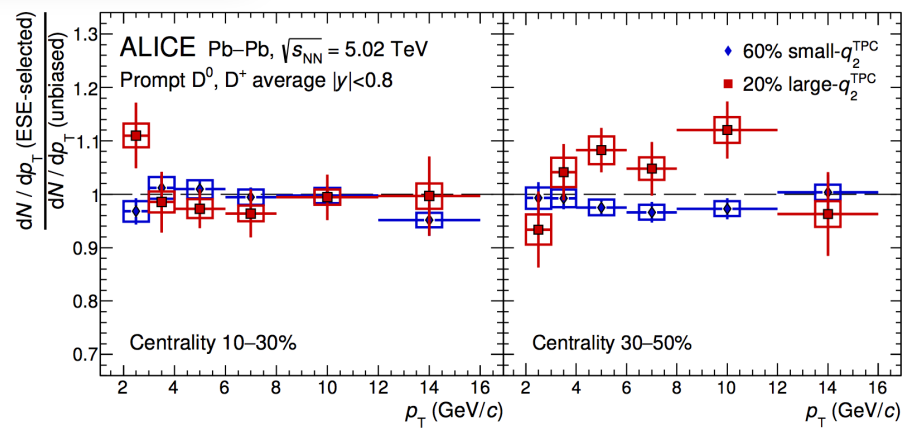
Pb- Pb Λ_c Ratios

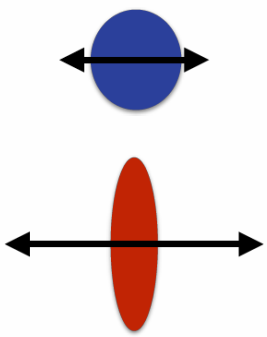


- Sensitive to the charm quark hadronisation mechanisms in the medium
- Two standard deviation difference between p-Pb and Pb-Pb – coalescence ?

Pb-Pb Event-Shape-Engineering with D Mesons







60% smallest q_2^{TPC}

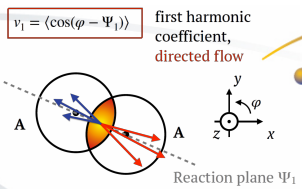
$\langle v_2 \rangle_{\text{small}-q_2} < \langle v_2 \rangle_{\text{unb}}$

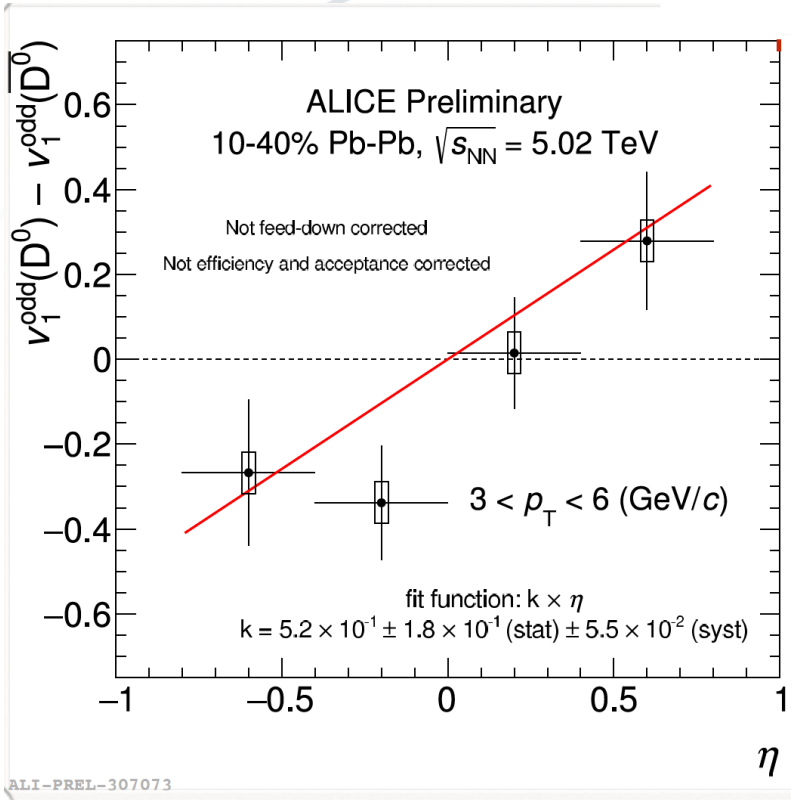
20% largest q_2^{TPC}

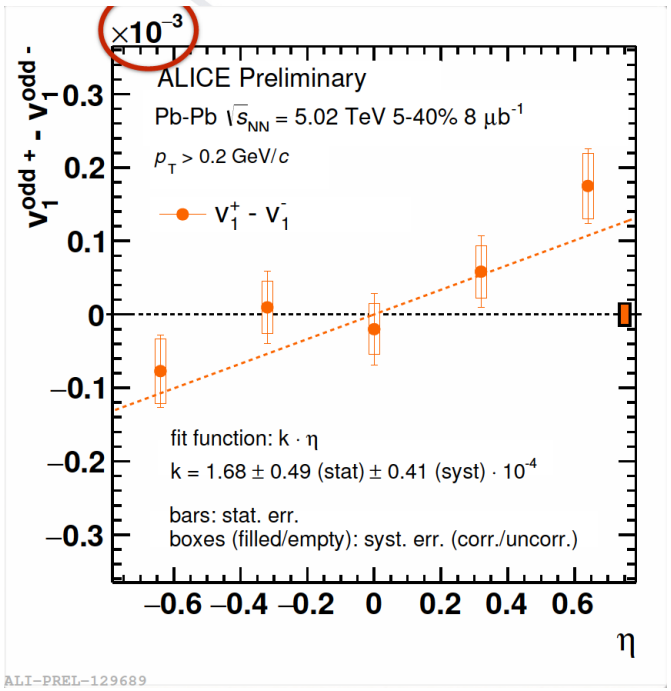
$\langle v_2 \rangle_{\text{large}-q_2} > \langle v_2 \rangle_{\text{unb}}$

- Correlation of flow for D-meson and light hadron
- Similar eccentricities

Pb-Pb Initial Magnetic Fields ?







- Charge asymmetry of direct flow v_1 is a signature for the initial magnetic field in the collision
- Effect depends on the quark mass and formation time, charm should be more sensitive than light quarks

Summary of Highlights

- No intrinsic charm in fixed target mode
- Stronger suppression of excited quarkonia states
- Azimuthal asymmetry for J/ψ in pPb - coalescence unlikely
- Large regeneration of charm hadrons and perhaps in bottom hadrons
- More observations of J/ψ flow attributed to charmonium coalescence
- Υ shows no azimuthal asymmetry confirming that bottomonium coalescence is small
- Exciting new measurement of direct flow of D-mesons indicating a sensitive probe for initial magnet fields

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