

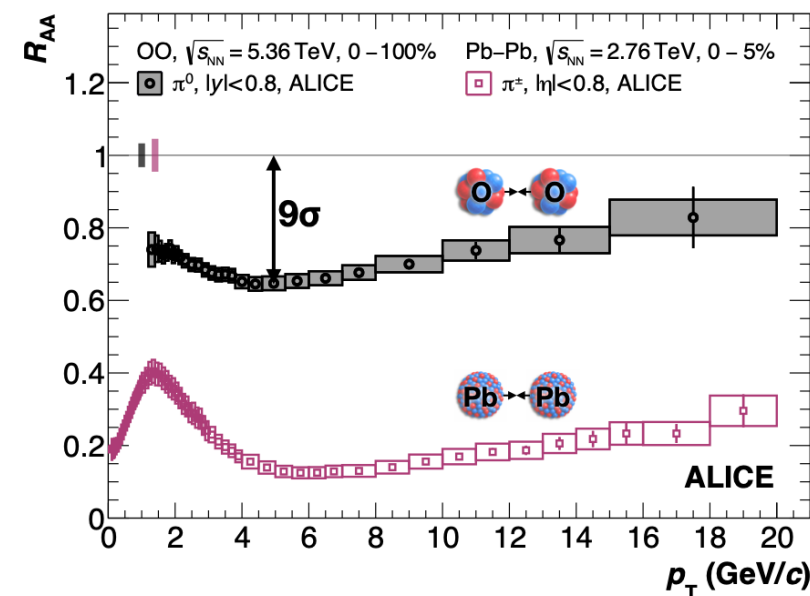
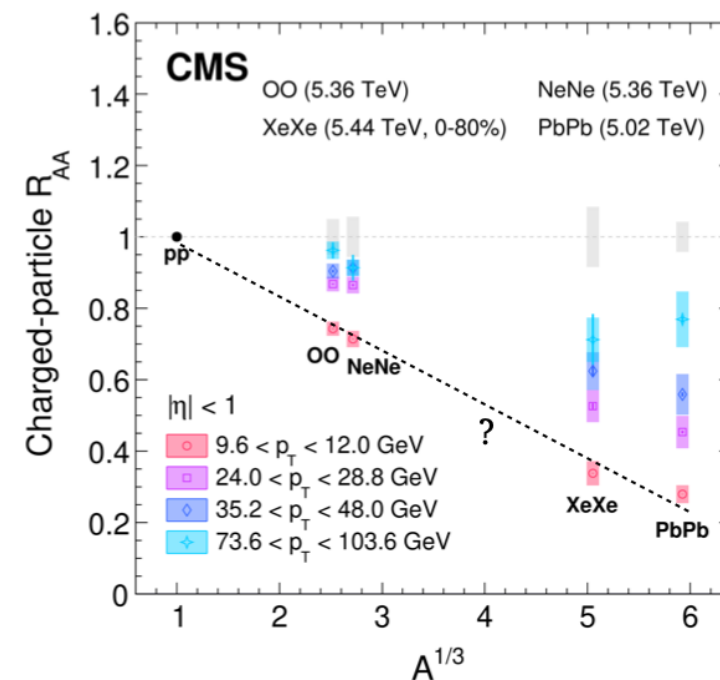
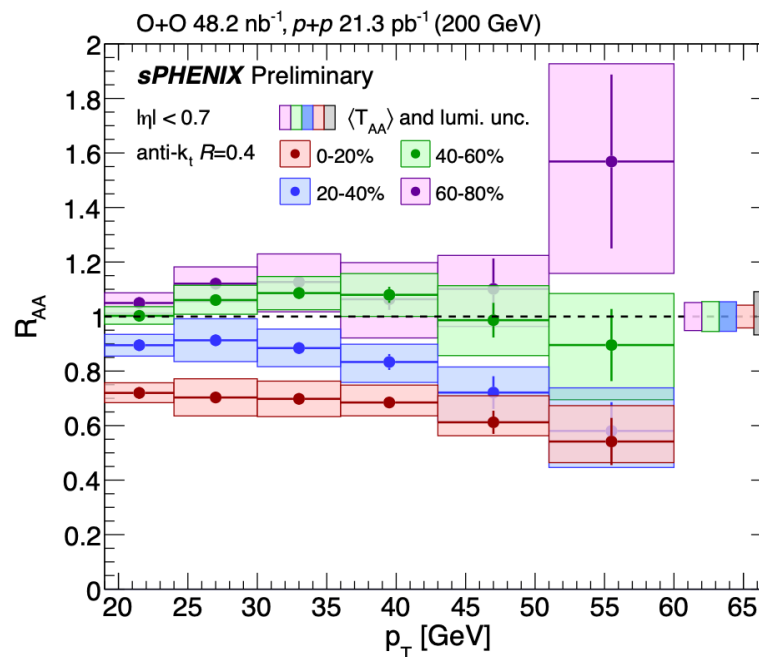
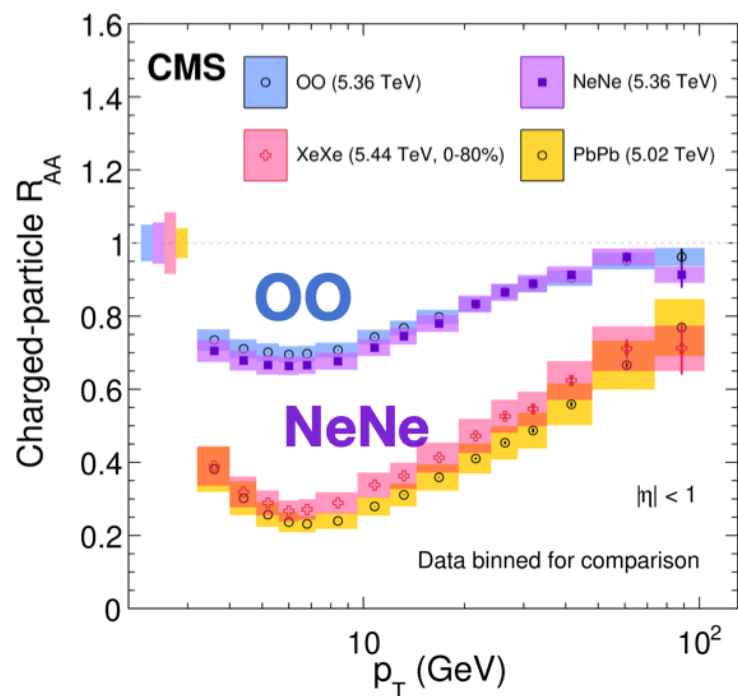
Discussion

Discussion Question

- What do we learn from the system-size dependence of hard probes? Which observables are most informative?

Nuclear Modification

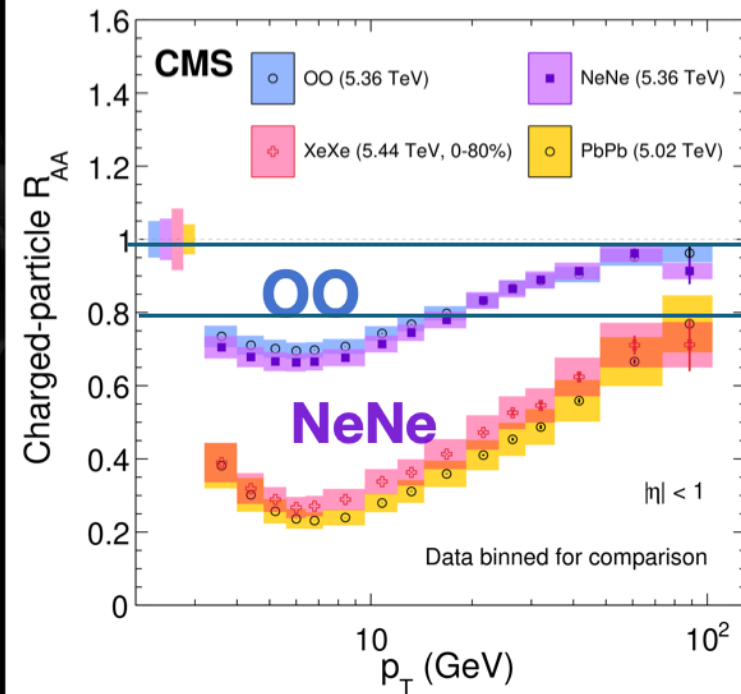
We can definitively say that we see a partonic energy loss due to hot matter in systems $\geq$ O+O at both RHIC and the LHC $\rightarrow$ “Smallest droplet of QGP?”



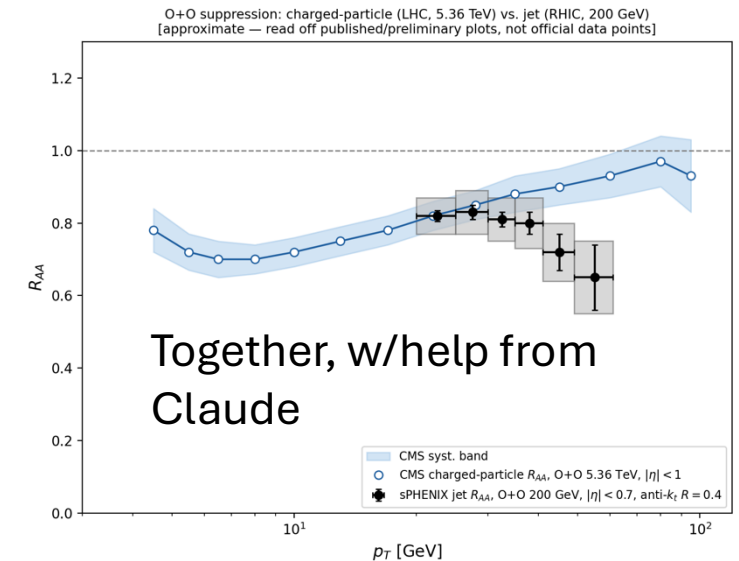
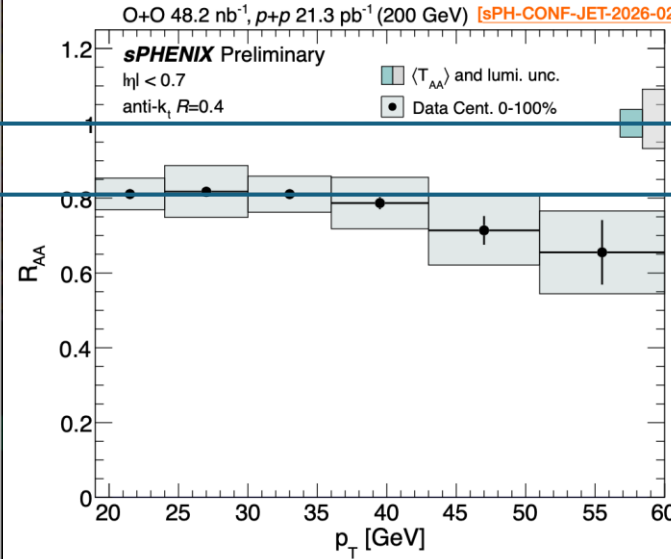
PRL 136 (2026) 162301
PLB 880 (2026) 140679

Nuclear modification seems very similar from RHIC $\rightarrow$ LHC

Jets vs hadrons? Convolutes a lot of effects, from fragmentation to spectral shapes



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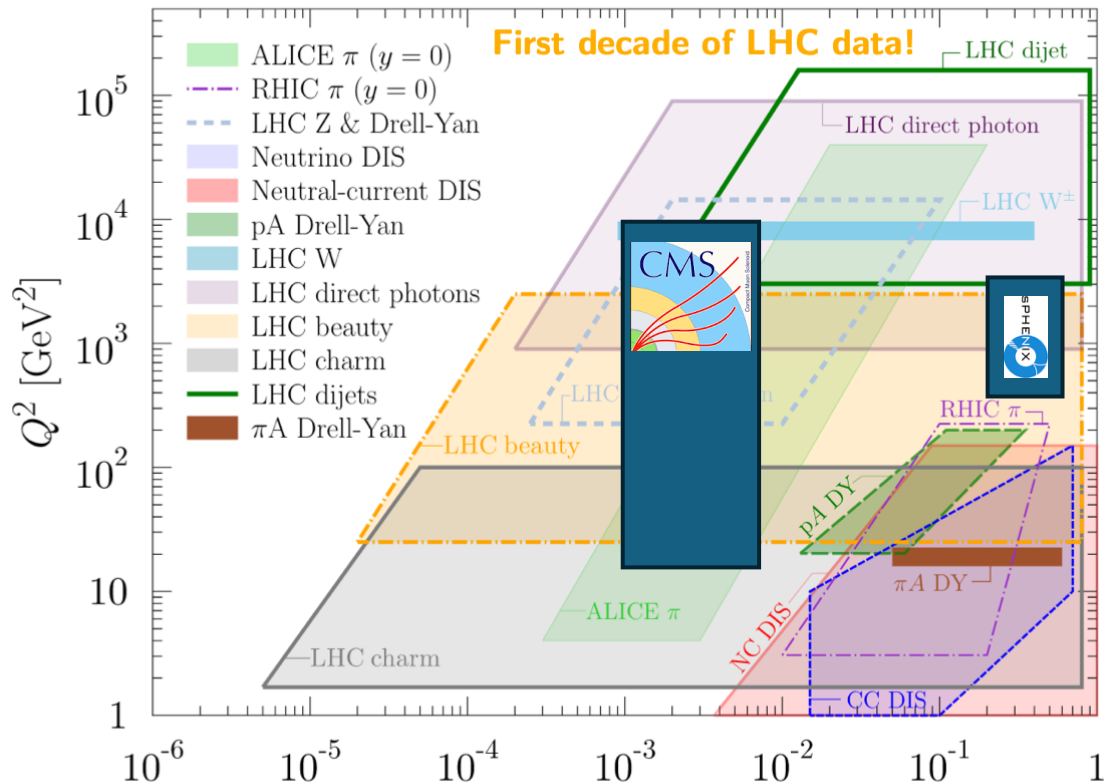


Different jets are different, comparisons w/different R are always fraught

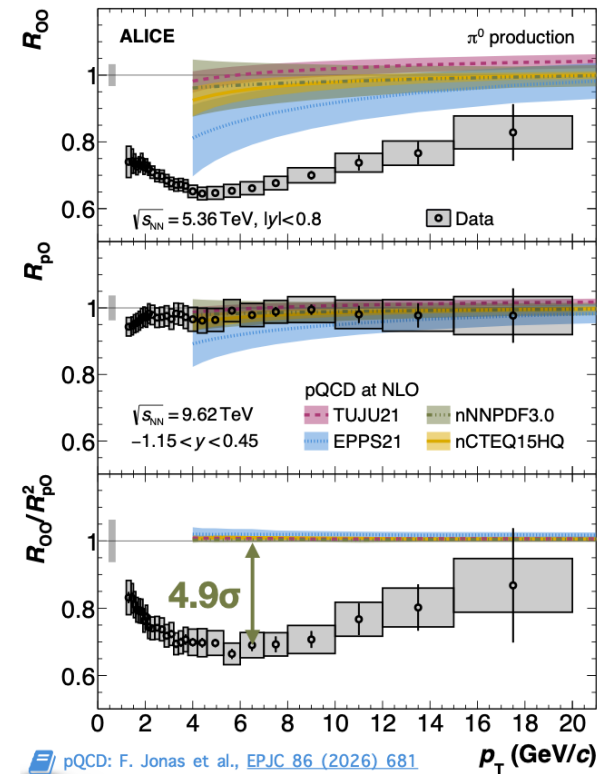
Cold Nuclear Matter Effects

- Can we quantify the impact of CNM on our results?

Coverage of lepton-A, pion-A and proton-A data in nPDFs



M. Klasen & H. Paukkunen
Ann.Rev.Nucl.Part.Sci. 74 (2024) 1, 49-87

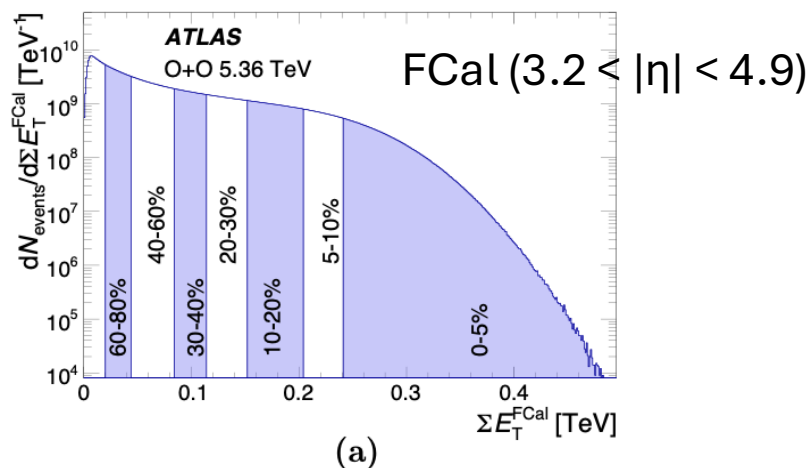
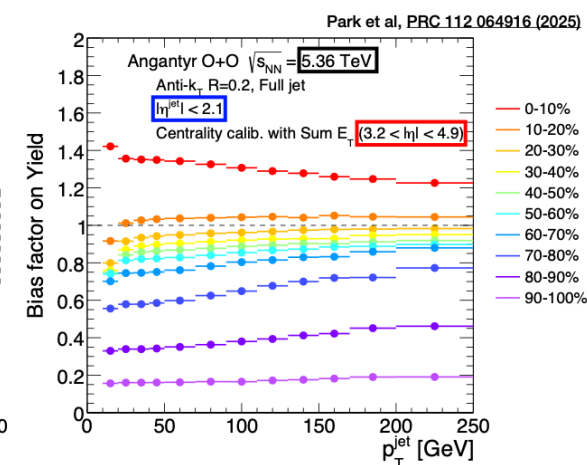
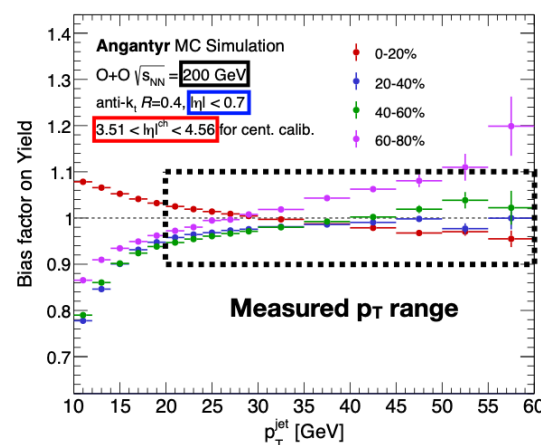
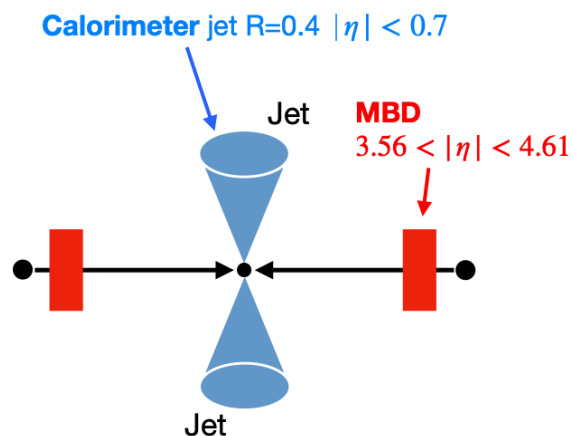
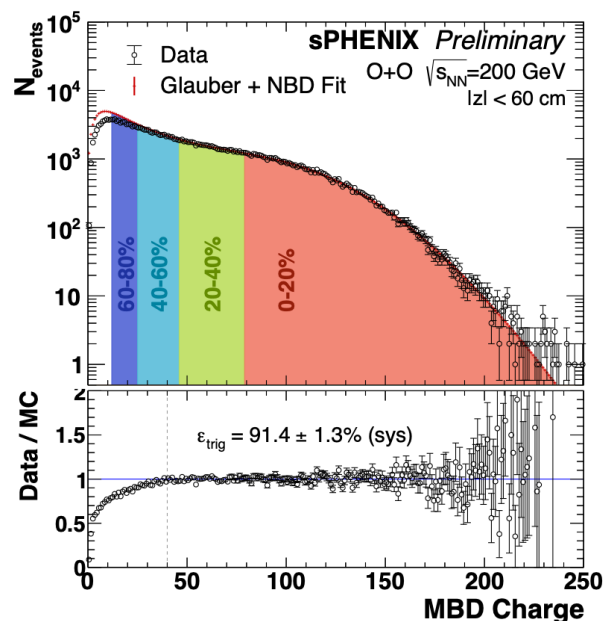


pQCD: F. Jonas et al., EPJC 86 (2026) 681

Using RpO is clever, but not all observables have this possibility

RHIC will not have pO data and at a very different x range

Centrality, Geometry and Bias

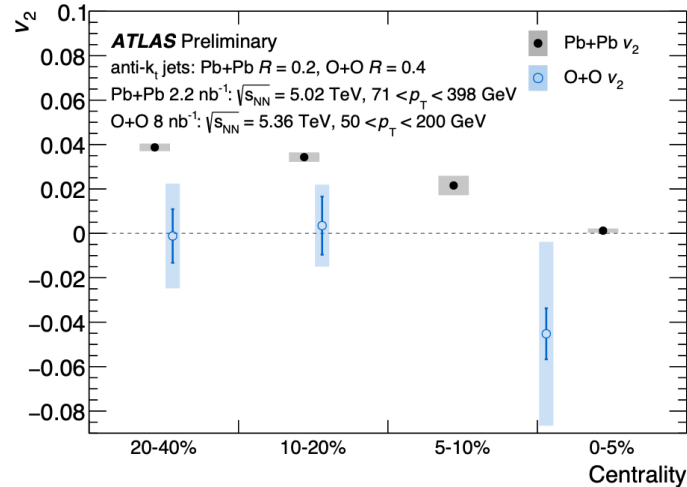


Is there a chance to see the effect of geometry above the effect of fluctuations

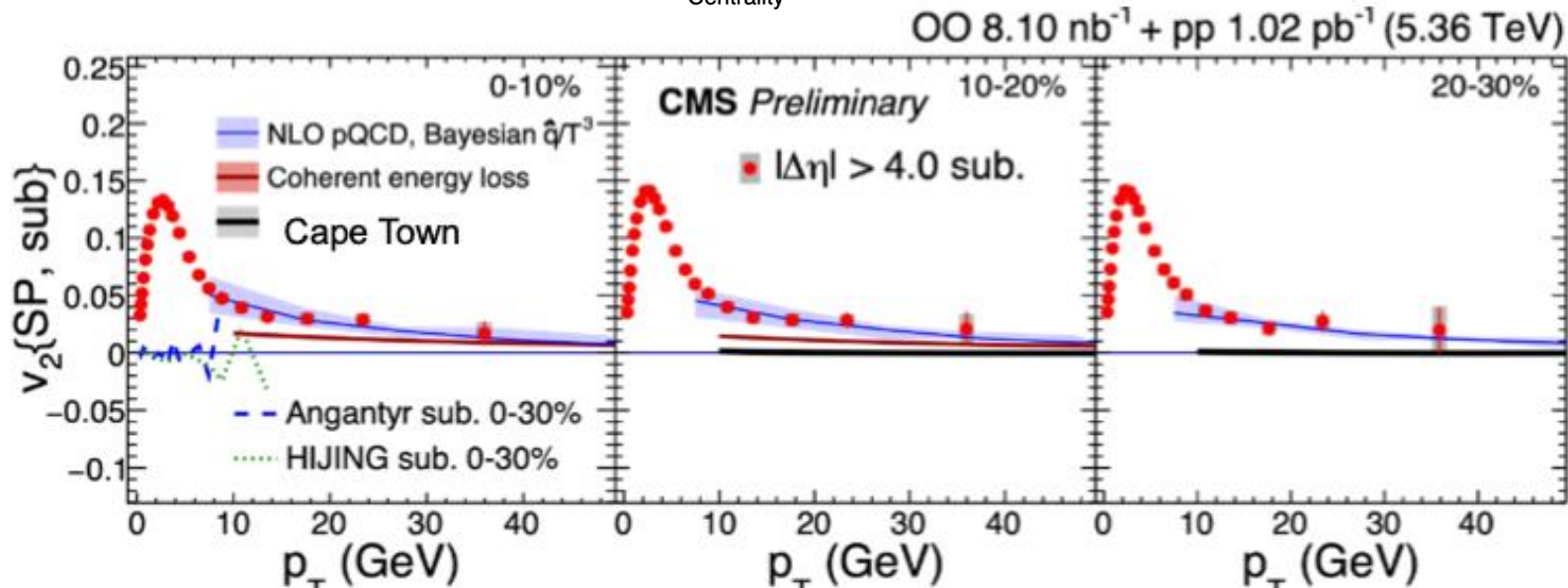
- RHIC vs LHC
- Centrality could matter (smaller system $\rightarrow$ more dominated by fluctuations)
- Determination of centrality/geometry can be more biased in small system collisions w/hard probe

Path-length dependent Eloss?

Is the geometry small enough that it is completely fluctuation driven?



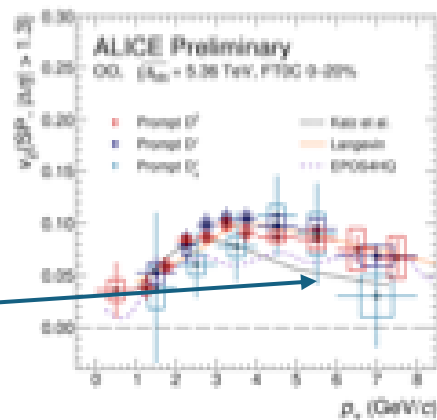
In terms of p_T range, the CMS v_2 trend seems to agree with Atlas
No overlap in p_T ?



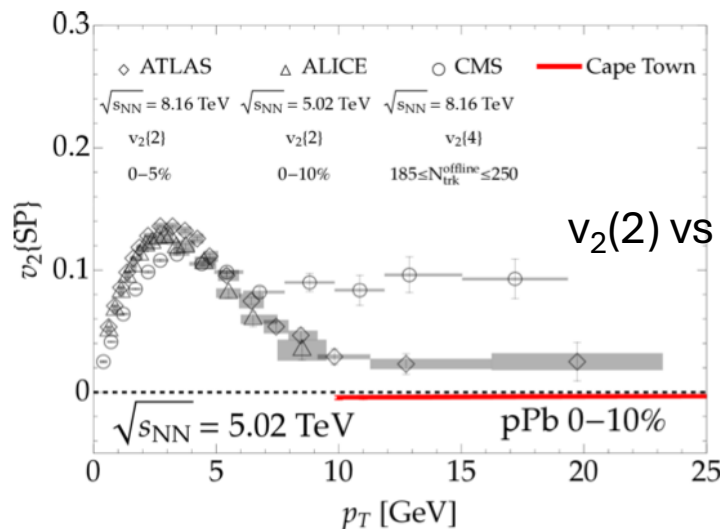
Path-length dependent Eloss?

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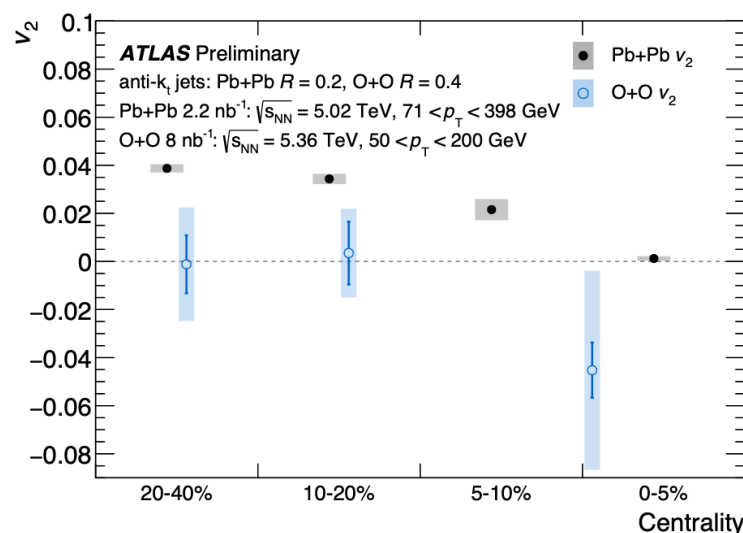
O+O, July 2025: ALICE sees finite D -meson v_2



Is this still soft?



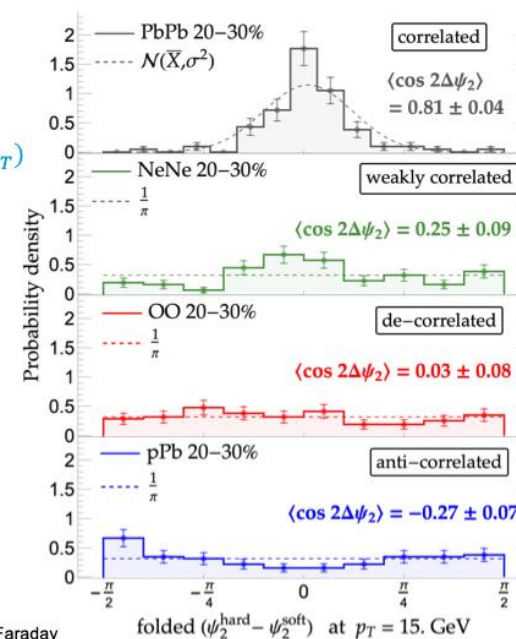
$v_2(2)$ vs $v_2(4)$?



Why is $v_2 \approx 0$?

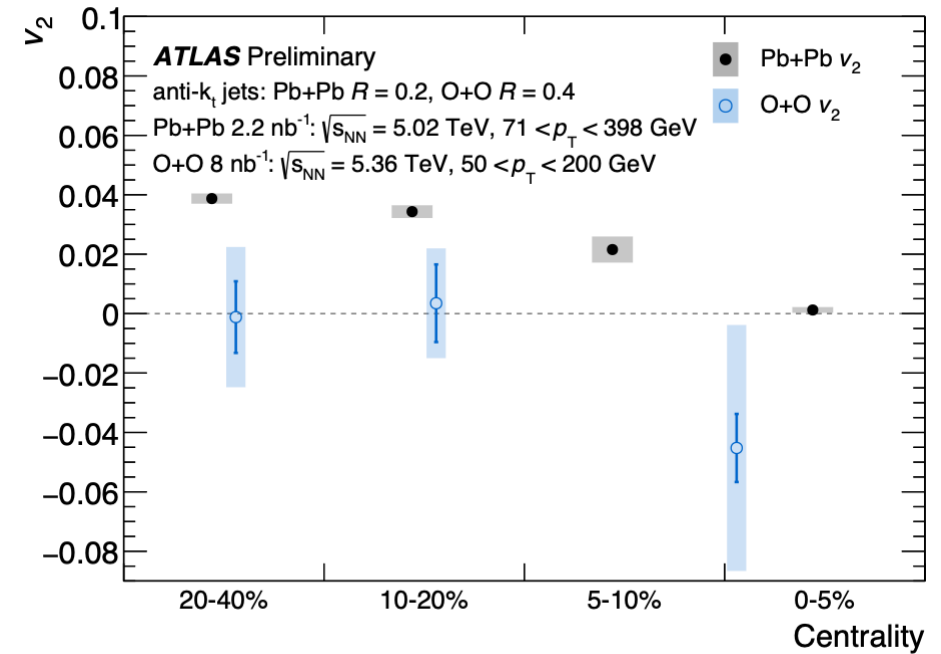
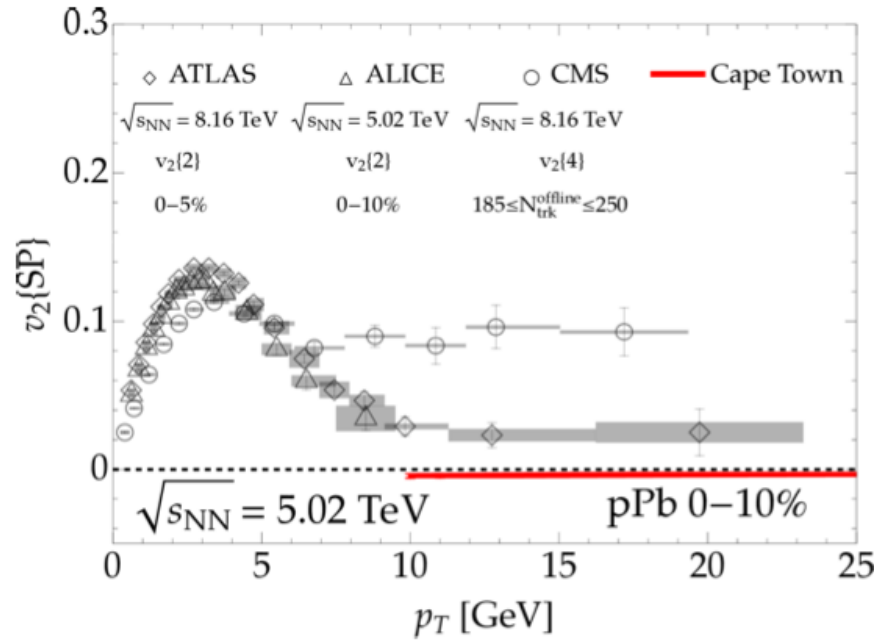
$$v_n\{SP\}(p_T) \propto \cos[n(\psi_n^{\text{hard}}(p_T) - \psi_n^{\text{soft}})] v_n^{\text{hard}}(p_T)$$

- ψ_2^{hard} and ψ_2^{soft} correlated in Pb + Pb
 - Uncorrelated or even anti-correlated in small systems (!)
- **Not possible** to create $v_2\{2\}$ in small systems from energy loss

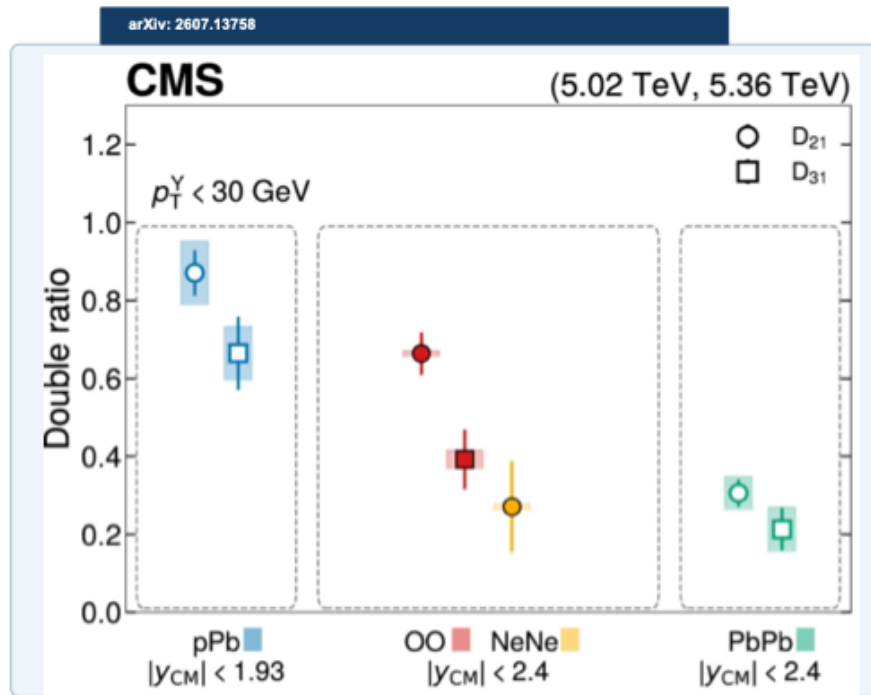


Path-length dependent Eloss?

pPb is confusing



Does the HF sector see the same suppression?



The upsilon seems to indicate that this is the case!

No real p_T dependence (within uncertainties)

Observable (double ratio)

$$D_{nm} = \frac{[\Upsilon(nS)/\Upsilon(mS)]_{AA}}{[\Upsilon(nS)/\Upsilon(mS)]_{pp}} \quad \begin{matrix} n=2,3 \\ m=1,2 \end{matrix}$$