Measurement of the deuteron coalescence probability in and out of jets with ALICE

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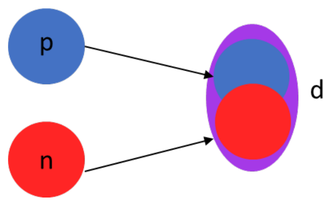
1. Physics Motivation

- Baryon coalescence[1] → phenomenological model that describes the formation of bound states
- State-of-the-art implementations describe this formation as the overlap between the phase-space distribution of point-like nucleons and the Wigner density of the bound state[2]



- Coalescence parameter B_A proportional to the coalescence probability

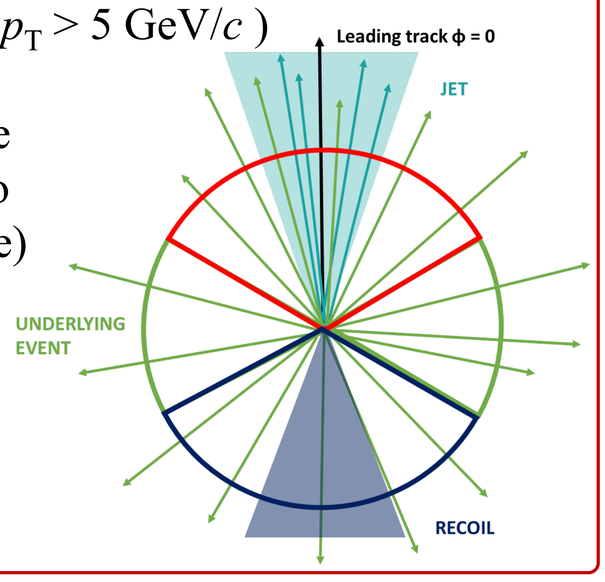
$$B_A = \frac{\frac{1}{(2\pi)p_T^A}\left(\frac{d^2N}{dydp_T}\right)_A}{\left(\frac{1}{(2\pi)p_T^p}\left(\frac{d^2N}{dydp_T}\right)_p\right)^A}$$

- To constrain the coalescence model, the production of (anti)nuclei is studied in regions where the nucleons are close, using a novel technique

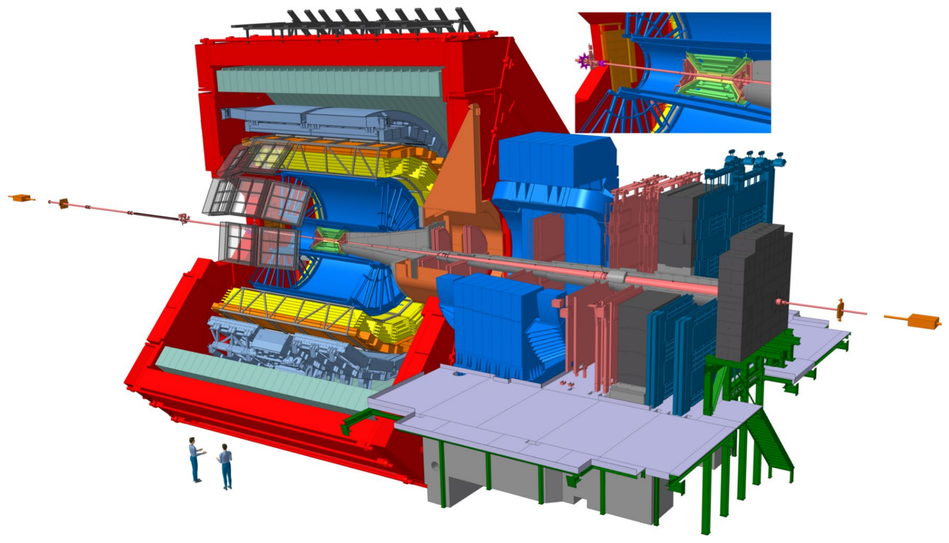
[1] S. T. Butler et al., Phys. Rv. 129 (1963) 836
[2] M. Mahlein et al., Eur. Phys. J. C 83 (2023) 804

2. In-jet and underlying event

- Leading particle (highest p_T and $p_T > 5$ GeV/c) used as a proxy for the jet axis
- Transverse plane divided in three azimuthal regions with respect to the leading track (CDF technique)
- Transverse region dominated by the Underlying Event (UE)
- Jet = Toward (jet + UE) - Transverse (UE)

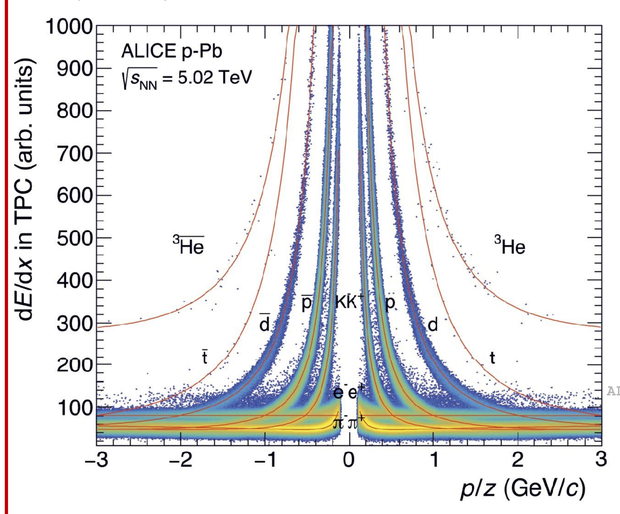


3. Particle identification with ALICE

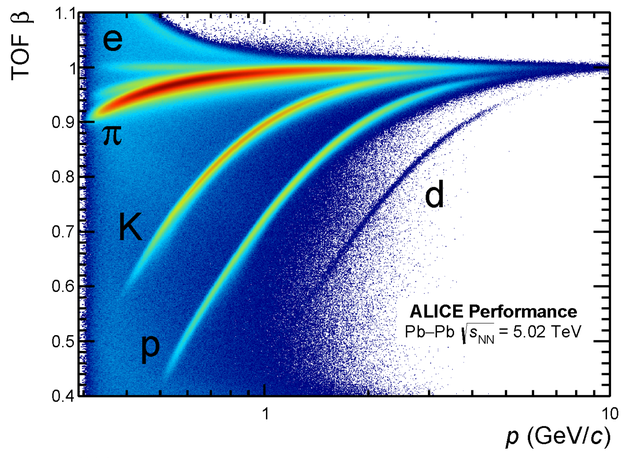


- Excellent PID capabilities in a broad transverse momentum range
- Most suited LHC experiment to study light (anti)nuclei

Low p_T: dE/dx measured by the Time Projection Chamber (TPC)

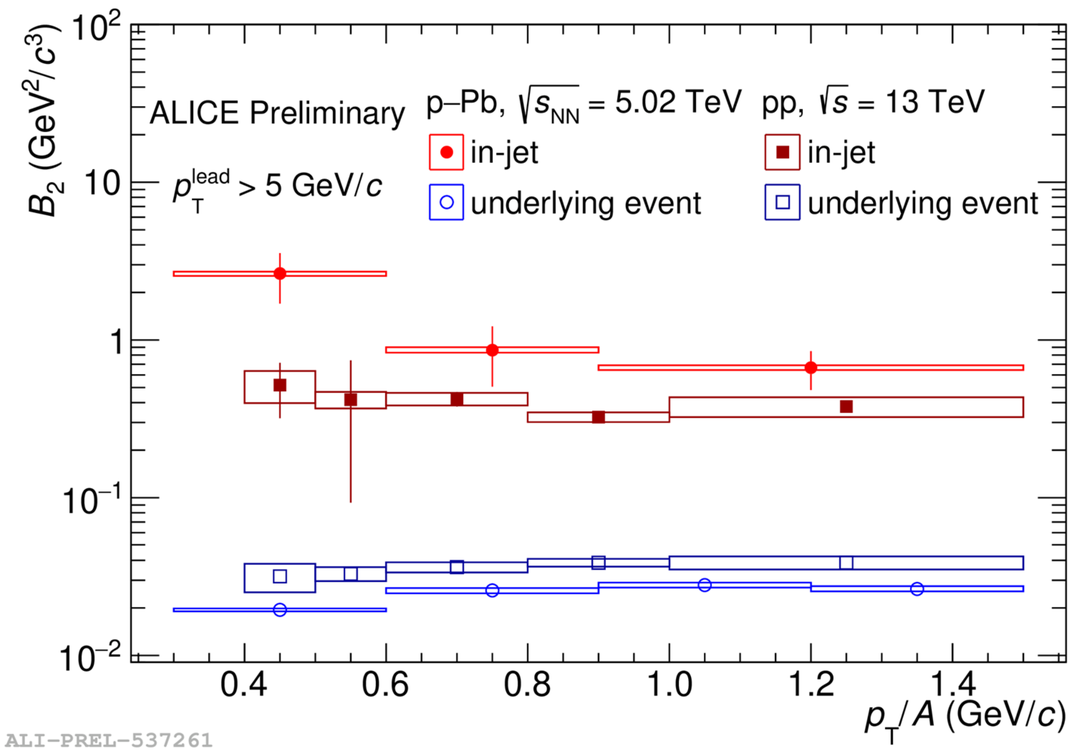


Phys.Lett. B800 (2020) 135043



High p_T: β measured with Time-Of-Flight detectors (TOF)

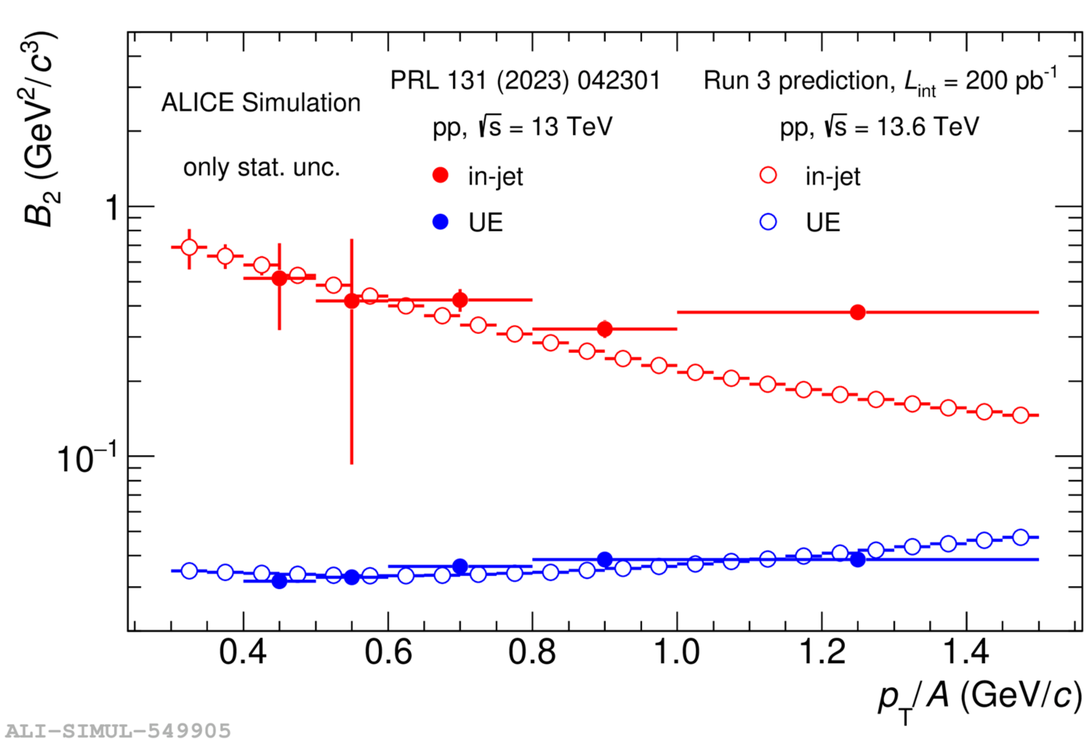
4. Experimental results in Run 2



- **Striking gap** between B_2 ^{jet} and B_2^{UE} → compatible with the coalescence picture
- **Larger gap** in p–Pb with respect to pp collisions[3]
- Statistical uncertainties dominate over the systematic ones in jet and at low p_T
- More measurements are needed to constraint these observations:
  - Hadron chemistry in jet
  - Full reconstruction of jets with jet-finder algorithms
  - Multi-differential studies vs p_T, jet radius and multiplicity

[3] Phys. Rev. Lett. 131 (2023) 042301

5. Prospect for Run 3 measurements



- The measured p_T spectra [3][4] are parametrized and used as inputs for the simulation
- Assumed same efficiency and σ_{inel}[5] of Run 2 (conservative estimate)
- **Promising results**, multi-differential measurements (e.g. vs multiplicity in the transverse region) will be performed
- **Improvement of the statistical uncertainties** of a factor 4 for B_2 ^{jet} and a factor 3 for B_2^{UE}

[4] JHEP 06 (2023) 027
[5] LHCb Collaboration, JHEP 06 (2018) 100