

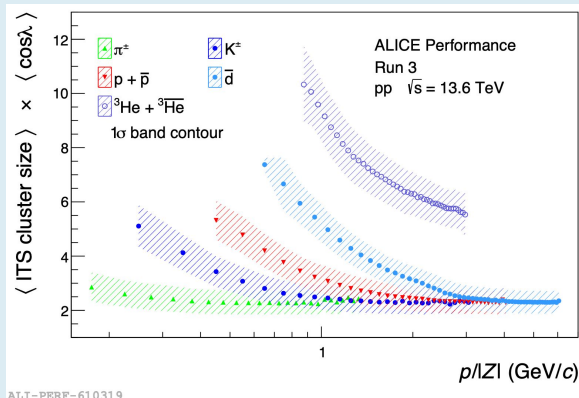
Physics motivation

- (Anti)(hyper)nuclei have an important role in astrophysics
- Antinuclei: golden channel for indirect dark matter searches^[1]
 - Probing the interaction among the constituents of hypernuclei can help in solving the *Hyperon puzzle*^[2]

- At the LHC (anti)(hyper)nuclei are abundantly produced
- Coalescence mechanism:** nuclei formed by nucleons emitted close in phase space
 - Nuclear wave function

- Large datasets and a clean identification of nuclei required
- How to select these candidates with **high purity** preserving **high efficiency**?

^[1] ALICE Collaboration, Nat. Phys. 19, 61 (2023)
^[2] Vidana et al., Eur. Phys. J. A 61 (2025)



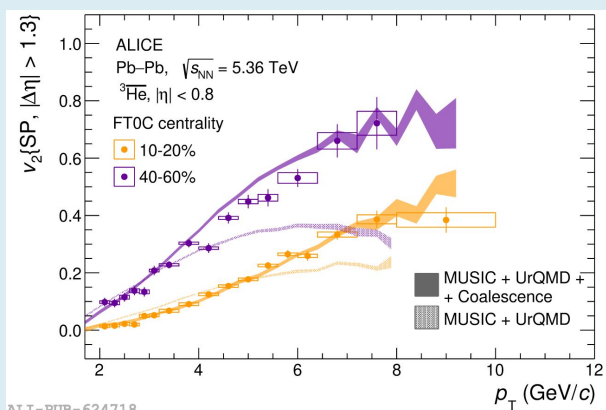
Particle identification (PID) with a digital sensor

- Nuclei with Z=2 separated** in the whole momentum range
- Z=1 hadrons separated at low momentum**
 - Identification of *fake matches*
 - Suppression of π background in proton identification

Measurement of the elliptic flow (v_2) of ^3He and $^3_\Lambda\text{H}$

- Anisotropy in the collision geometry $\rightarrow$ anisotropy in the momentum distribution
 - Sensitive to the production mechanism** of nuclei
- Differential measurement** in centrality and in p_T
- The observed trend is only reproduced by models that account for the coalescence mechanism

$$\frac{dN}{d(\phi - \Psi_{RP})} = \frac{\mathcal{N}}{2\pi} \left(1 + 2 \sum_{n=1}^{\infty} v_n \cos[n(\phi - \Psi_{RP})] \right)$$

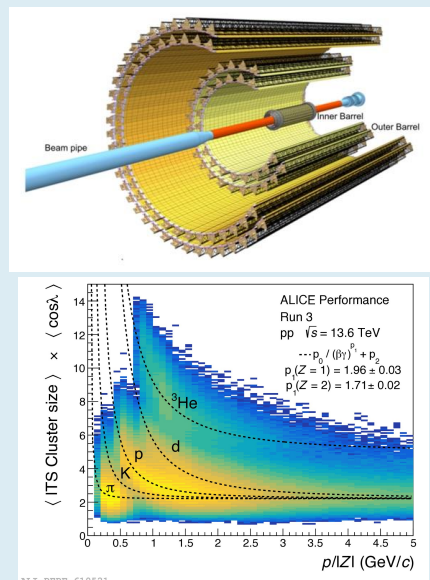


ALICE Collaboration, arXiv:2603.19398

Inner Tracking System (ITS)

Full-silicon sensors

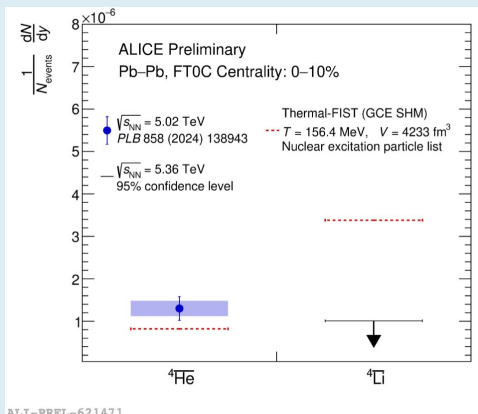
- Based on MAPS
- Position resolution: 5 μm**
- 7 cylindrical layers (radii from 2.3 cm to 40 cm)
- Material budget
 - 0.36% X_0 (inner barrel)
 - 1.1% X_0 (outer barrel)
- Binary readout**
 - Cluster size:** number of pixels turned on by a single charged particle
 - Proxy of the dE/dx
 - Depends on track inclination λ



Upper limit on the production of ^4Li

- Resonant state, not observed yet
 - $^4\text{Li} \rightarrow ^3\text{He} + p$
- Unknown radius
- Lifetime $\tau \sim 10^{-22}$ s
 - Relies on PID of daughters**
- Predicted abundance depends on the production mechanism^[3]

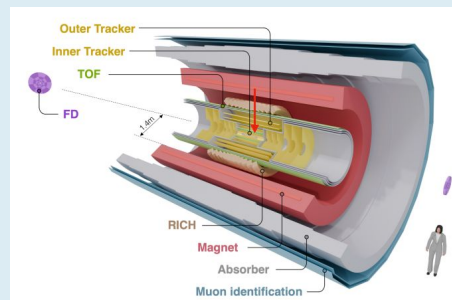
^[3] S. Bazak et al., Eur. Phys. J. A 56, 193 (2020)



Outlook: ALICE 3

New experiment that will replace ALICE in LHC Run 5

- 11 cylindrical silicon layers + forwards disks
 - Tracking, vertexing and PID of nuclei
- 2 layers of TOF detector
 - CMOS LGAD technology, 20 ps resolution



Improved vertex and PID resolution and enhanced statistics will allow for the search of more exotic states

- c-deuteron searches:
 - $c_d \rightarrow d + K + \pi$
- $^3\text{He} \leftarrow \Lambda_b$

