Beauty measurement prospects with ALICE 3

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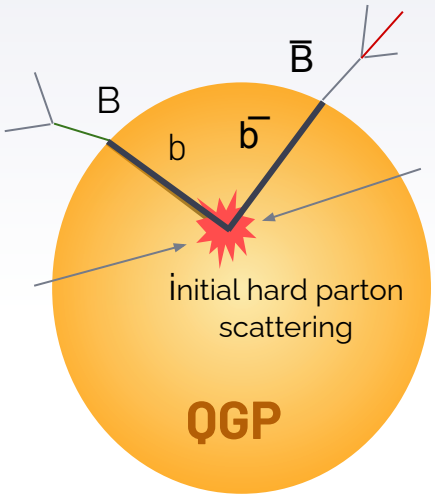
Poster Session
Quark Matter 2022, Krakow

Beauty production: physics motivation

- **pp collisions**: crucial for testing **perturbative QCD** (pQCD) calculations.
- **p-Pb collisions**: isolate impact of **cold-nuclear matter** effects.
- **Heavy-ion collisions**: heavy quarks are probes of the **QGP**, investigate mass dependence of **energy loss**.

  → **Beauty quarks** are not expected to fully thermalize:

  ➢ qualitative test for **heavy quark transport**,
  ➢ study **hadronization** away from equilibrium.

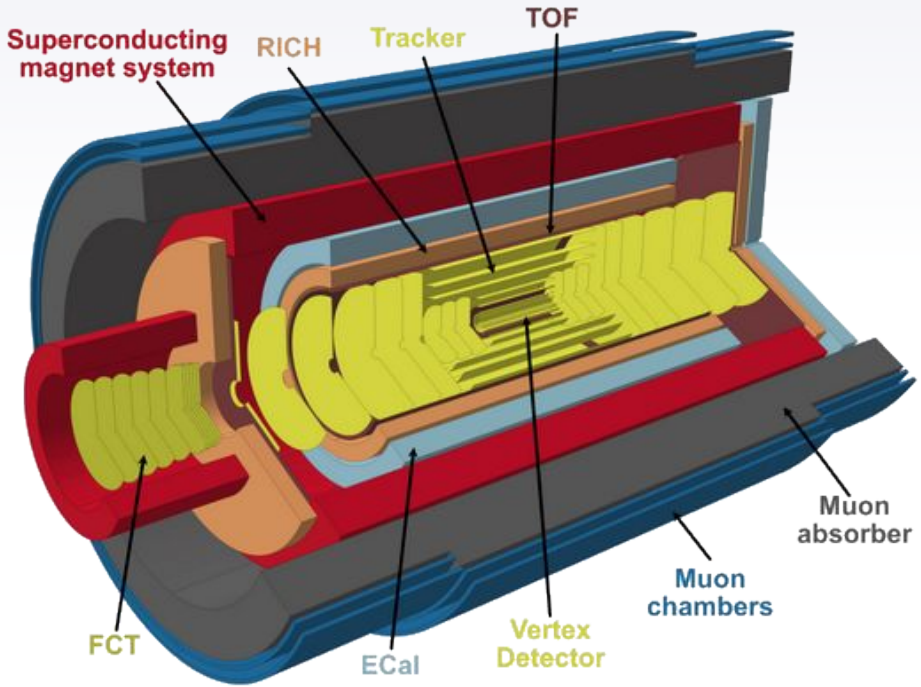


- In Runs 3 and 4 of the LHC, ALICE will perform measurements of **open beauty hadrons**[1]
  → expected precision to be limited, not enough to constrain ***transport coefficients***.

ALICE 3 would allow **high-accuracy measurements** of **production of beauty hadrons down to $p_T = 0$** to study their participation in the ***collective dynamics of the system***.

ALICE 3

ALICE 3 is a next-generation multipurpose detector at the LHC, featuring unprecedented tracking and vertexing capabilities.



- Ultra-lightweight silicon tracker
- Extensive Particle Identification over wide momentum range
- Kinematic range down to very low p_T
- Large acceptance
  → Barrel detectors + end caps $\Delta\eta = 8$

Detectors for beauty hadronic decays analysis:
- Inner and outer tracker based on MAPS
- TOF + RICH for PID

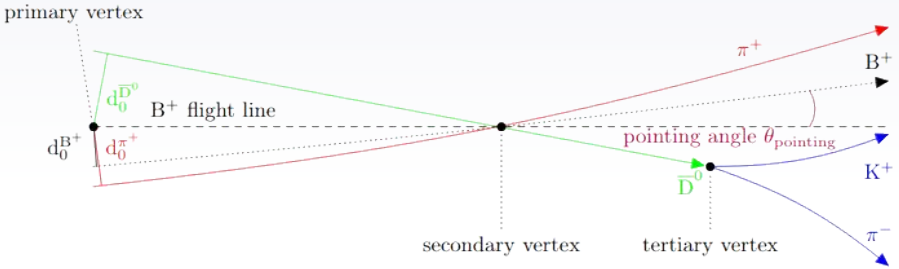
Reconstruction of beauty channels

Thanks to very precise and accurate identification of secondary vertices, the **full kinematic** of **beauty hadrons** reconstructed through **hadronic decay channels** is easily accessible.

The **ALICE 3** performance have been evaluated through the decays: $\Lambda_b^0 \to \Lambda_c^+ \pi^- \to (pK^-\pi^+)\pi^-$

$B^+ \to \overline{D^0}\pi^+ \to (K^+\pi^-)\pi^+$

B decay topology and reconstruction strategy:



D^0 candidate: definition and selection

Topology: *CPA*, *DecayLength*, *DCA*, ...

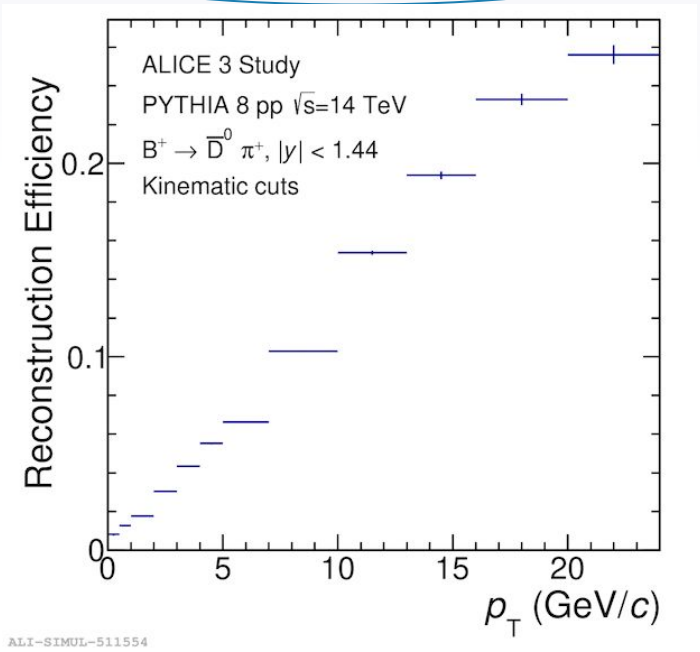
PID: TOF and RICH

↓ Adding a charged track and extrapolating B^+ decay vertex

B^+ candidate: definition and selection

Topology: *CPA*, *DecayLength*, *DCA*,...

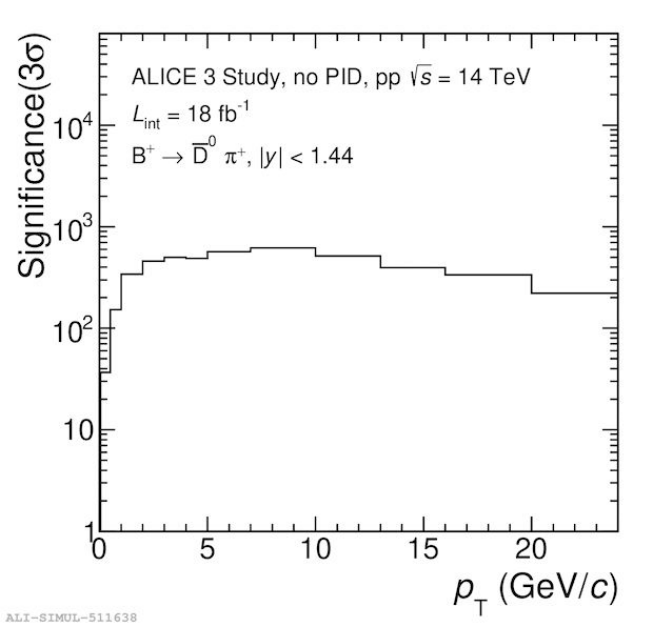
PID: TOF and RICH

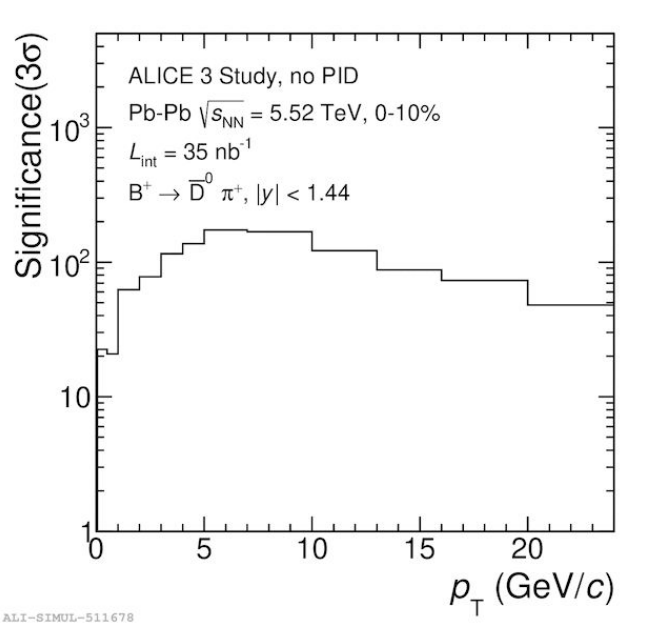


Estimation of significance

A projection of the significance for B^+ signal in $|\Delta y| < 1.44$ is computed using:

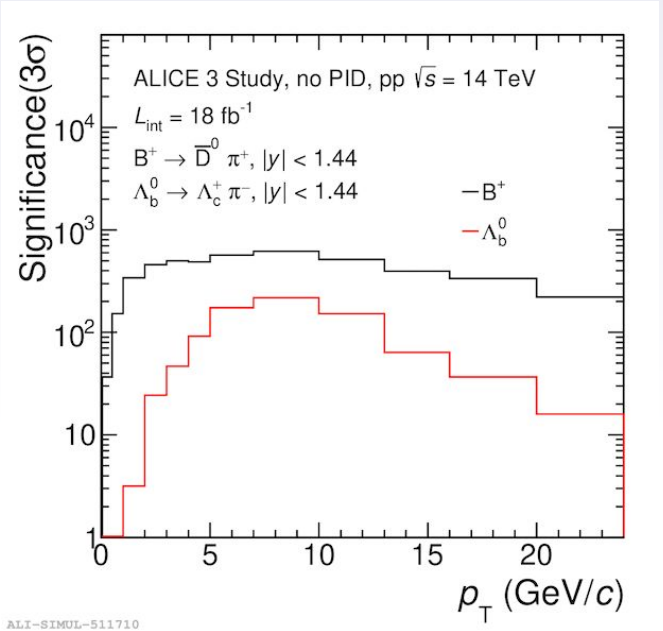
- Signal estimation: $S = \Delta p_{\mathrm{T}} \cdot \Delta \mathrm{y} \cdot (A \times \epsilon) \cdot (d\sigma_{b\bar{b}}^{FONLL}/dp_{\mathrm{T}}) \cdot f(b \to B) \cdot BR$
- Background per event
- Expected integrated luminosity in Run 5 and 6: pp: $L_{\mathrm{int}} = 18\ \mathrm{nb}^{-1}$, Pb-Pb: $L_{\mathrm{int}} = 35\ \mathrm{nb}^{-1}$

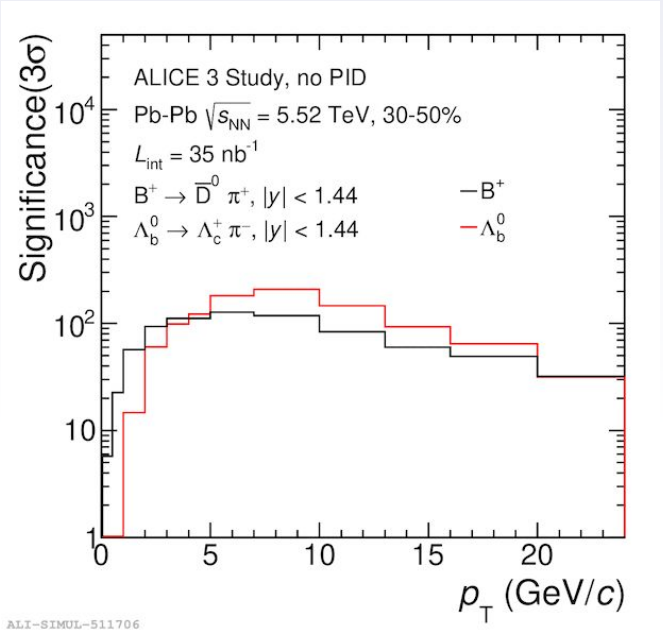




The high luminosity and precise secondary vertex reconstruction allow beauty hadrons to be measured down to $p_{\mathrm{T}} \sim 0$.

Performance for beauty baryons





The projections of the **ALICE 3** results look promising compared to Run 3 and 4 [1], providing excellent performance also in the **low-p_T region** for both **beauty baryons and mesons**:

→ insight into ***thermalisation*** and ***hadronization*** mechanisms (e.g. by looking at **Λ_b/B yield ratios**)

→ in-medium ***energy loss*** and its ***mass dependence*** (R_{AA});

→ in-medium ***transport*** from v_2 measurement.

Reference

[1] 2014 *J. Phys. G: Nucl. Part. Phys.* **41** 087002