XXIV QUARK MATTER
DARMSTADT 2014

Performance for the reconstruction of Λ_b baryon with the ALICE Inner Tracker upgrade

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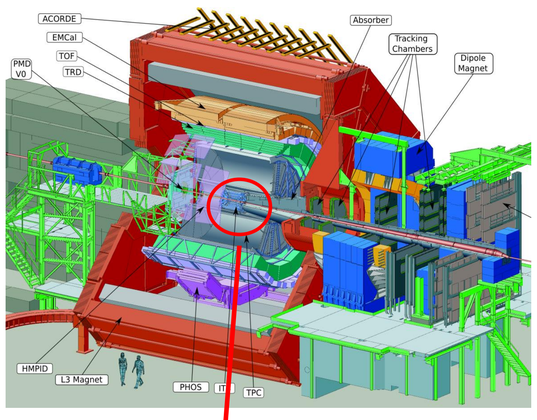
ALICE experiment and heavy-flavour probes of the QGP

Investigate properties of strongly interacting matter under extreme conditions of compression and temperature in Pb-Pb collisions at the LHC
→ **Characterization of the Quark-Gluon Plasma (QGP)**



Measurements of heavy flavour transport parameters in QGP via the probe-medium interaction
- Heavy Flavour azimuthal anisotropy (v_2) and nuclear modification factor R_{AA} down to low p_T
- Mass dependence of energy loss

Study of heavy flavour hadronization mechanism
- Heavy-flavour baryon R_{AA} and v_2
- Heavy-flavour baryon-to-meson ratio

The production of ***charm*** and ***beauty baryons*** has a relevant interest to understand the thermalization and the mechanism of hadronization of heavy flavour in the medium

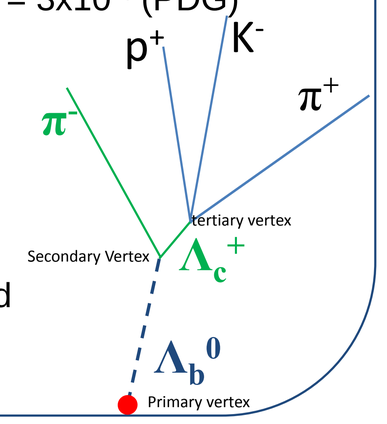
Reconstruction of heavy-flavour hadrons

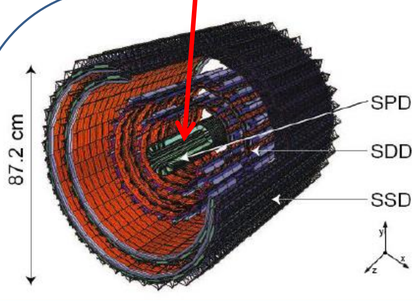
Charm and beauty mesons and baryons in Pb-Pb collisions:
D^0, D_s, D^*, D^+, Λ_c, Λ_b, B
- decays within few hundred microns
- very small signal-over-background ratio

Signal to background separation:
- via topological selection of secondary decay vertices
- PID to reduce background

Beauty Baryon $\Lambda_b \rightarrow \Lambda_c\pi$ ($\Lambda_c \rightarrow pK\pi$)

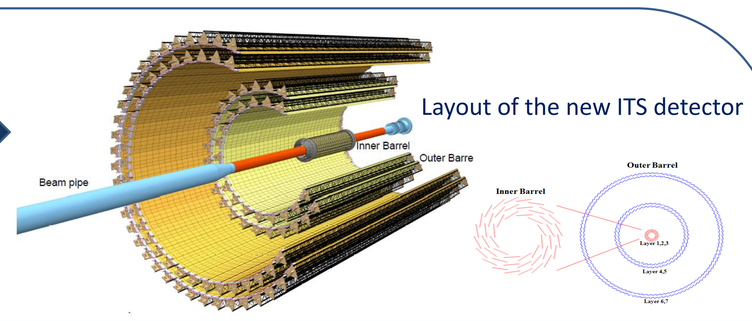
- M= 5621.19 GeV/c^2; cτ=417μm (cτ(Λ_c)=59μm) B.R. = 3×10^{-4} (PDG)
- Expected Production Yield= 0.5 Λ_b/(central collision) in Pb-Pb at 5.5 TeV (estimated applying N_{coll} binary scaling to FONLL prediction)
  2×10^{-5} ($\Lambda_b \rightarrow \Lambda_c\pi$)/central collision in $|\eta|<0.9$
- Not accessible with current ALICE set up due to the present resolution in vertex separation and to the small production yield
  Higher precision and statistics needed!





UPGRADE: new Inner Tracking System

And High Rate Upgrade: 50 kHz (Pb−Pb) $L_{int}>10nb^{-1}$
Installation during Long Shutdown in 2018-2019



Current ITS

Capability to separate primary and secondary vertex of heavy flavour hadrons
- 6 layers of silicon detectors (pixels, drift, strips)
- PID (drift and strips)
- Low material budget: 7.2% of X_0 for whole ITS

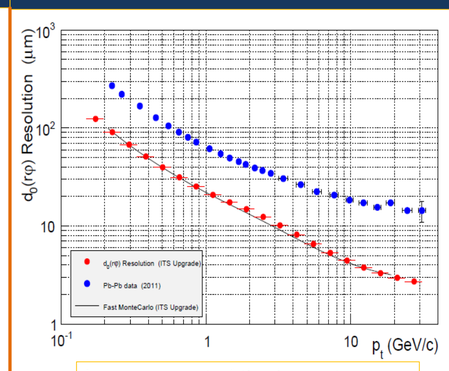
Impact parameter resolution
σ_{d0}>60 μm for p_T<1GeV/c
→ *not sufficient for Λ_c analysis* (cτ=59μm)
Λ_c studies impossible in Pb-Pb

How To Upgrade → new detector

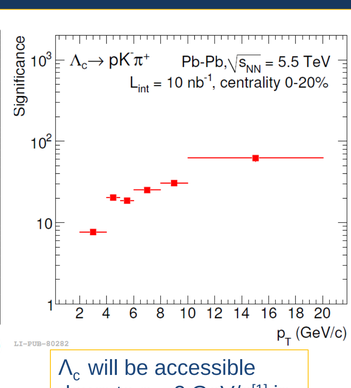
❑ Improve impact parameter resolution
- Get closer to IP
  Smaller Beam pipe radius: r =18.4 mm (presently 29.8 mm)
  First layer at 22 mm (presently 39 mm)
- Reduce pixel size (rφ, *z*): 20-30 (presently: 50 x 425 μm)

❑ High standalone tracking efficiency and p_T resolution
- Increase granularity pixels resolution 4 or 6 μm
- Increase number of layers 7 instead of 6
- smaller material budget 0.3% of X_0 in the three innermost layers, thickness = 50 μm (presently 1.1% of X_0 in each layer)

Performance



Improvement of the impact parameter resolution in *r–φ* for the new ITS[1]



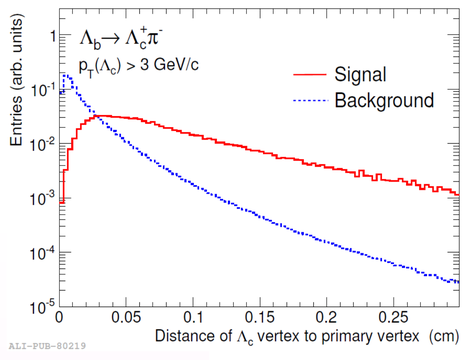
Λ_c will be accessible down to p_T=2 GeV/c[1] in central Pb-Pb collisions (see Poster from R. Romita)

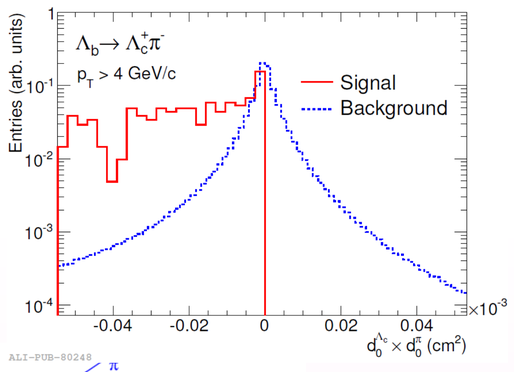
Λ_b Signal Extraction

Once Λ_c analysis is feasible → we can start looking at Λ_b

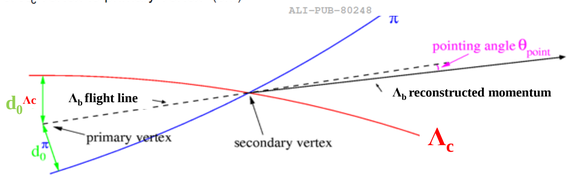
Simulations sample:
- Pb-Pb collisions at 5.5 TeV
- ITS Upgrade simulation and reconstruction

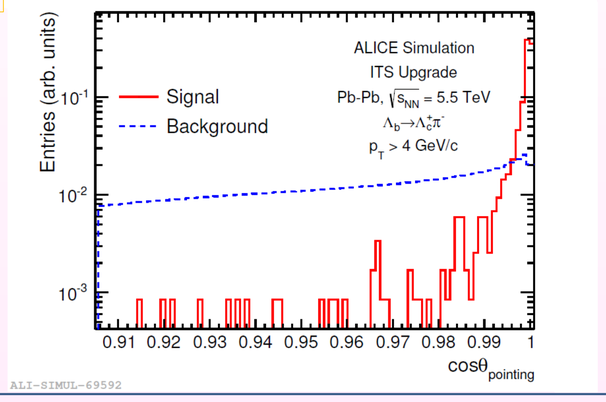
Main Topological and Kinematics cuts to separate Signal from Background



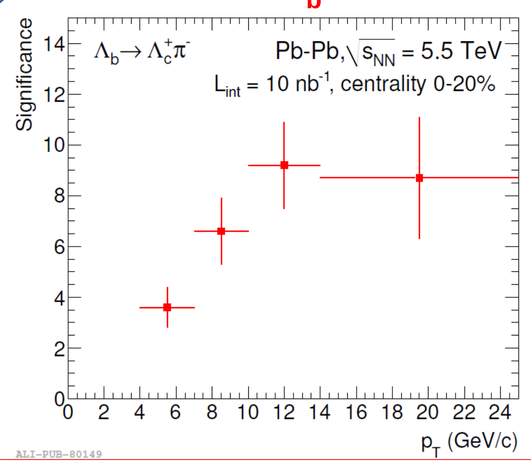


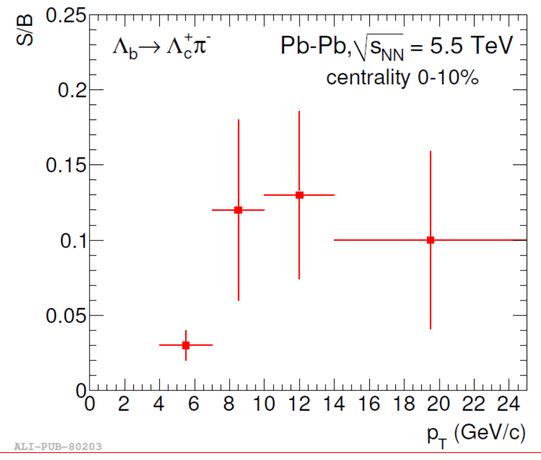
Very tight cuts due to a final 4 prongs state and small yield production





Λ_b Performance with ITS Upgrade

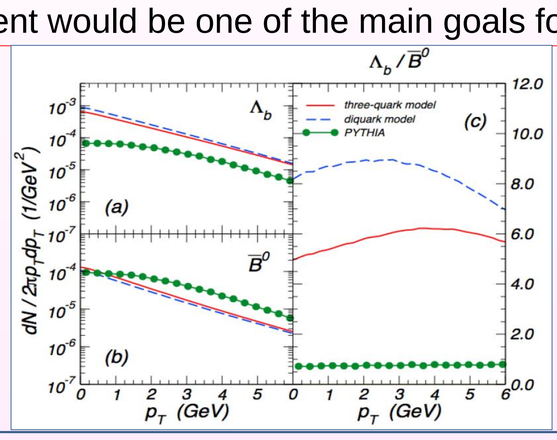




Significance scaled to 1.6×10^9 Pb-Pb events as expected in the 0-20% centrality class for an integrated Luminosity of $10nb^{-1}$
- Error bars include the statistical and the systematic errors
- Systematics errors are due to the background estimation with rotational method

Observation of Λ_b possible from 4 GeV/c with significance > 3

Expected enhancement of the Λ_b/B ratio in central Pb-Pb w.r.t. pp collisions based on two theoretical models[2]
→ This measurement would be one of the main goals for the Upgrade



Theoretical prediction for Au-Au collisions at 200 GeV

[1] ALICE Collaboration, "*Upgrade of the ALICE Inner Tracking System*", CERN-LHCC-2013-024, ALICE-TDR-017 [2] Y. Oh et al. "Heavy baryon/meson ratios in relativistic heavy ion collisions", Phys. Rev. C79, 044905 (2009)