# $R_{AA}$ of electrons from open beauty-hadron decays in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE

**Jonghan Park[1] on behalf of the ALICE collaboration**

1. Inha university, Incheon, South Korea (jonghan@cern.ch)

10th International Conference on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions

## Physics Motivation

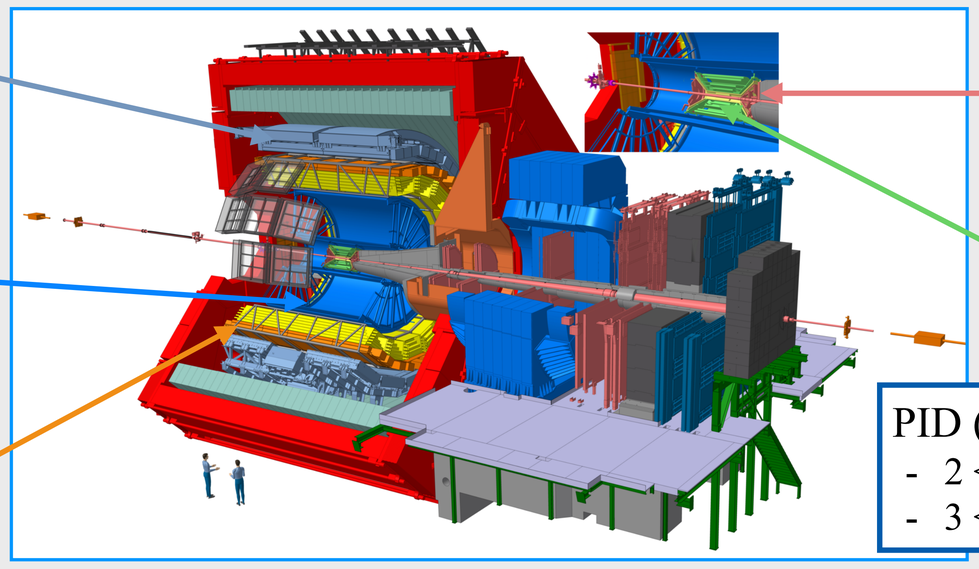
Heavy quarks (charm and beauty) are effective tools to investigate the properties of hot and dense QCD matter, in which quarks and gluons are de-confined (quark-gluon plasma, QGP) [1] since they are mainly produced in initial hard partonic scattering processes due to their large mass. Therefore, they can experience the full evolution of the QGP. While traversing the medium, partons lose their energies via elastic (collisional) and inelastic (radiative) scatterings. The in-medium energy loss is expected to depend on mass and color charge, such as $\Delta E_g > \Delta E_{u,d,s} > \Delta E_c > \Delta E_b$ [2]. The energy loss can be studied by means of the nuclear modification factor ($R_{AA}$). The comparison of charm and beauty $R_{AA}$ provides insights into the mass dependence of the in-medium energy loss.

## ALICE detector

EMCal (Electro Magnetic Calorimeter)
- PID via energy deposited in the EMCal per track momentum

TPC (Time Projection Chamber)
- Tracking and PID using specific energy loss in the gas

TOF (Time-Of-Flight)
- PID using time-of-flight measurement

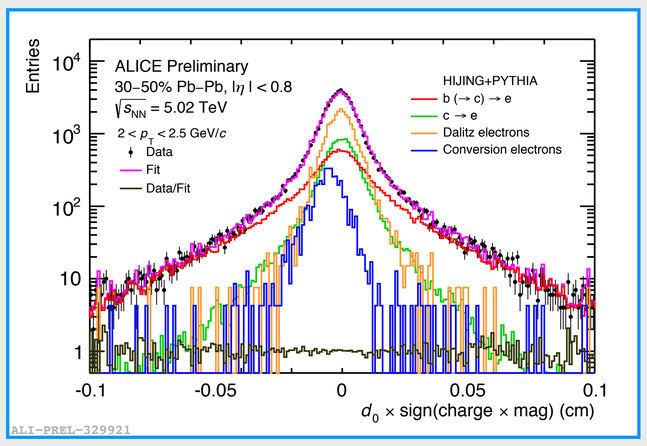


V0
- Event trigger and centrality estimation

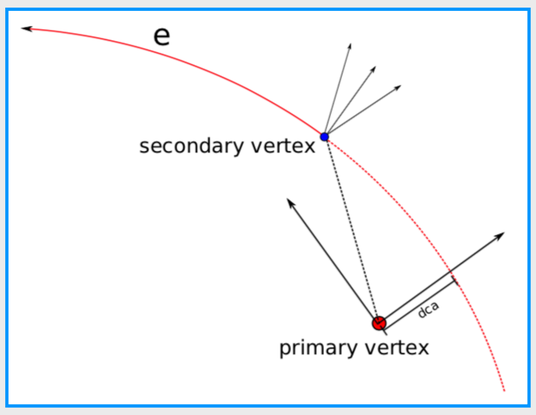
ITS (Inner Tracking System)
- Tracking and Vertexing

PID (particle identification)
- $2 < p_T < 8$ GeV/$c$ with TPC+TOF
- $3 < p_T < 26$ GeV/$c$ with TPC+EMCal

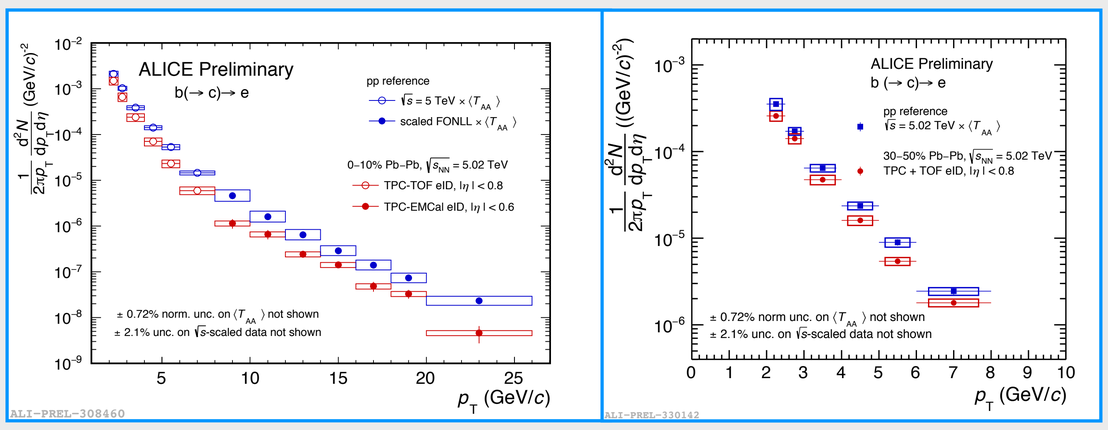
## Signal Extraction




- Beauty-decay electrons are extracted according to the template fit method, based on maximum likelihood approach which takes into account finite statistics of templates [3].
  - The idea of the fit method is to make use of large decay length of beauty hadrons ($c\tau \approx 500\mu$m) which leads to large impact parameter defined as distance of closest approach in the transverse plane.
- The templates are obtained from Monte Carlo (HIJING+PYTHIA) simulations and are corrected for having realistic $p_T$ shape based on measurements, since the impact parameter depends on $p_T$ of electron sources.




## Invariant yield and $R_{AA}$ of beauty-decay electrons

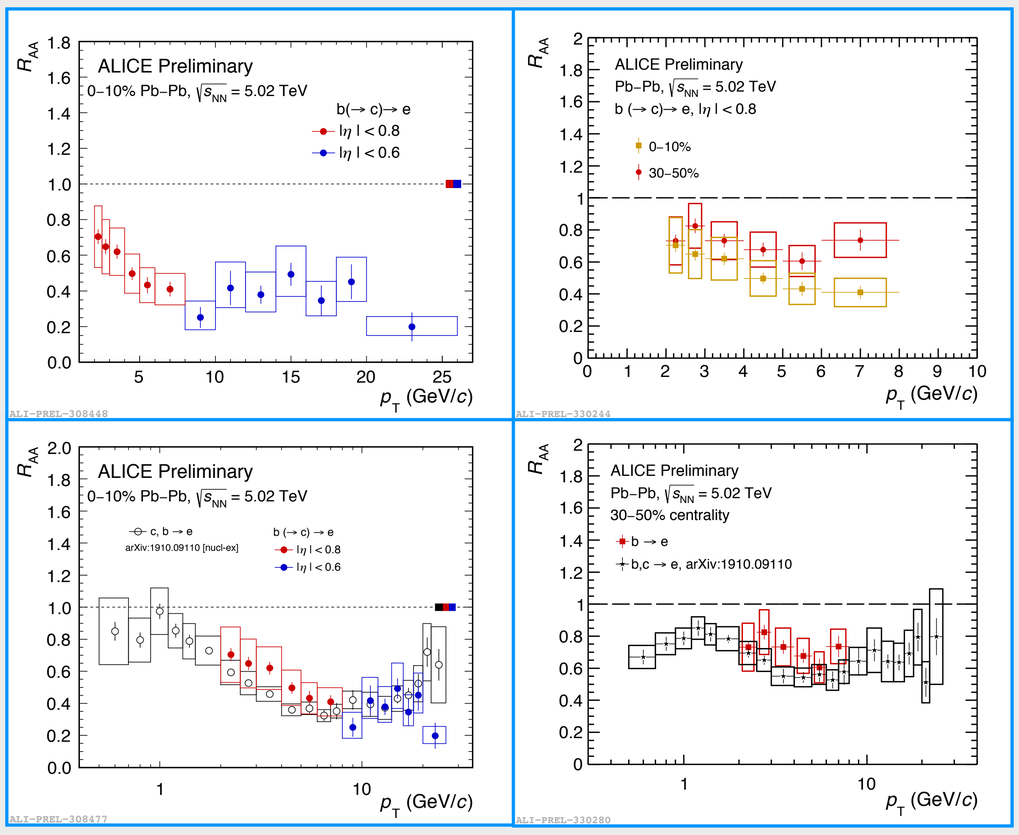



- Invariant yields of electrons from beauty-hadron decays in 0–10% (left) and 30–50% (right) Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV are shown.
- They are compared with pp references at 5.02 TeV from data up to 8 GeV/$c$ and from FONLL calculations up to 26 GeV/$c$ (blue). The references are scaled by the nuclear thickness function, $\langle T_{AA}\rangle$ (23.05 for 0–10% and 3.89 for 30–50%).

- A suppression of spectra in Pb-Pb is observed with respect to the scaled pp reference.
- Effects due to the presence of the nuclear medium have been evaluated by means of the **nuclear modification factor $R_{AA}$**:

$$R_{AA} = \frac{dN_{AA}/dp_T}{\langle T_{AA}\rangle d\sigma_{pp}/dp_T}$$

- $R_{AA}$ of the beauty-decay electrons is less than unity for $p_T > 2$ GeV/$c$ in both central and semi-central collisions → the beauty quarks are suppressed in the medium.
- Compared with $R_{AA}$ of electrons from heavy-flavor hadron decays measured in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV [4].
  - At low $p_T$, the $R_{AA}$ of beauty-decay electrons is systematically higher than that of heavy-flavor decay electrons → beauty quarks lose less energy than charm quarks in the medium.
  - At high $p_T$, the two $R_{AA}$ merge since the beauty contribution becomes dominant [5].




## Outlook

- The measurements for 30–50% centrality class will be extended to higher $p_T$ using the EMCal detector for high $p_T$ electron identification
- Compute the $R_{CP}$ to cancel correlated systematic uncertainties in the different centrality classes

## References

[1] A. Andronic et al., Eur. Phys. J. C76 no.3, (2016) 107
[2] Y. Dokshitzer and D. Kharzeev, Phys. Lett. B 519 (2001) 199
[3] R. Barlow and C. Beeston, Comput. Phys. Commun. 77, 2 (1993) 219-228
[4] ALICE Collaboration, Phys. Lett. B 804 (2020) 135377
[5] ALICE Collaboration, Phys. Lett. B 721 (2013) 13-23