Measurement of electrons from heavy-flavour hadron decays in Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV and in Xe-Xe collisions at $\sqrt{s_{\rm NN}} = 5.44$ TeV

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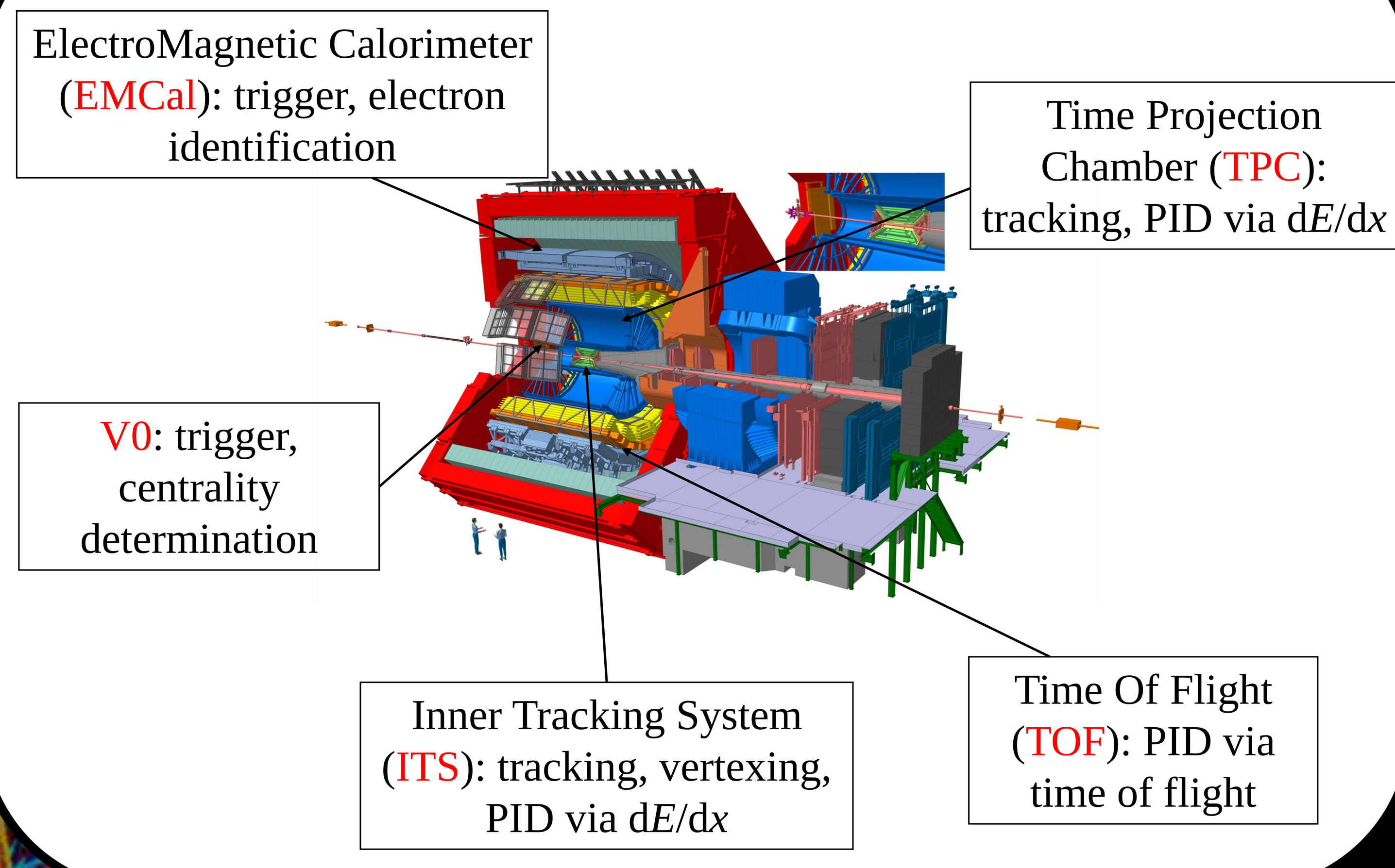
Physics motivation

- Heavy quarks (charm and beauty) are produced in the early stages of heavy-ion collisions, carrying information on the full evolution of the hot and dense plasma of quarks and gluons (QGP) created in such collisions.
- At low $p_{\rm T}$, the binary scaling of the production of heavy quarks in heavy-ion collisions can be tested and information about hadronisation mechanism and the influence from initial state effects can be investigated.
- Because of their large masses, heavy-quarks are expected to lose less energy than light quarks and gluons. They thus provide a unique test of parton energy loss models, especially at high $p_{\rm T}$.

The ALICE detector*

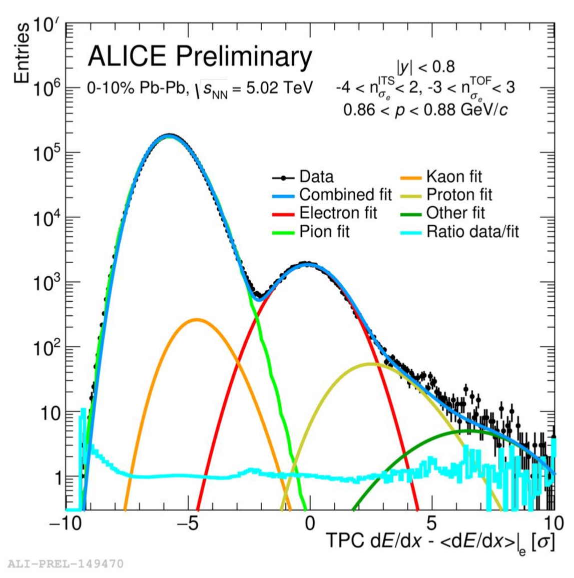
*: the system used in the analysis is described



Data samples

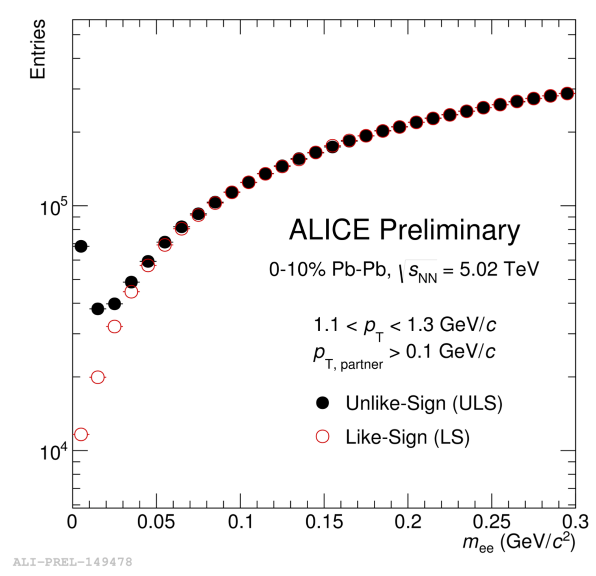
1. **Pb-Pb** collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV recorded in 2015 with ALICE
   → Centrality classes: **0-10%** (~ 6× 10^6 events), **30-50%** (~12× 10^6 events)
2. **Xe-Xe** collisions at $\sqrt{s_{\rm NN}} = 5.44$ TeV recorded in 2017 with ALICE
   → Centrality classes: **0-20%**, **20-40%** (~1.5 × 10^6 events, flat in centrality)

Electron identification



- PID selection applied:
  → $-3 \le {\rm n}^{\rm TOF}_{\sigma,e} < 3$
  → $-4 \le {\rm n}^{\rm ITS}_{\sigma,e} < 2$
  → $0 \lesssim {\rm n}^{\rm TPC}_{\sigma,e} < 3$ (Pb-Pb)
  → $-1 \le {\rm n}^{\rm TPC}_{\sigma,e} < 3$ (Xe-Xe)
- Different functions used to describe the species abundances
- Electron purity for $p_{\rm T} > 3$ GeV/c increased with PID selections in the EMCal (i.e.: E/p)
- Hadron contamination evaluated in different momentum bins and statistically subtracted from the sample of candidate electrons

Photonic background estimation ($N^{\rm phot}(p_{\rm T})$)



- Main background, referred to as photonic electrons, comes from:
  ○ $\pi^0, \eta \to \gamma e^+ e^-$ (Dalitz decays);
  ○ $\gamma \to e^+ e^-$ (photon conversions).
- Background is estimated using invariant mass of ee pairs .
- The reconstructed amount of photonic electrons is

$$N^{\rm phot}_{\rm reco}(p_{\rm T}) = N^{\rm ULS}(p_{\rm T}) - N^{\rm LS}(p_{\rm T})$$

  within $m_{\rm ee} \le 140$ MeV/c^2.
- The total photonic yield is obtained by correcting for tagging efficiency calculated using Monte-Carlo simulations:

$$\varepsilon^{\rm tag}(p_{\rm T}) = \frac{N^{\rm true}_{\rm ULS}(p_{\rm T}^{\rm rec})}{N^{\rm true}_{\rm phot,incl}(p_{\rm T}^{\rm gen})}$$

Nuclear modification factor ($R_{\rm AA}$)

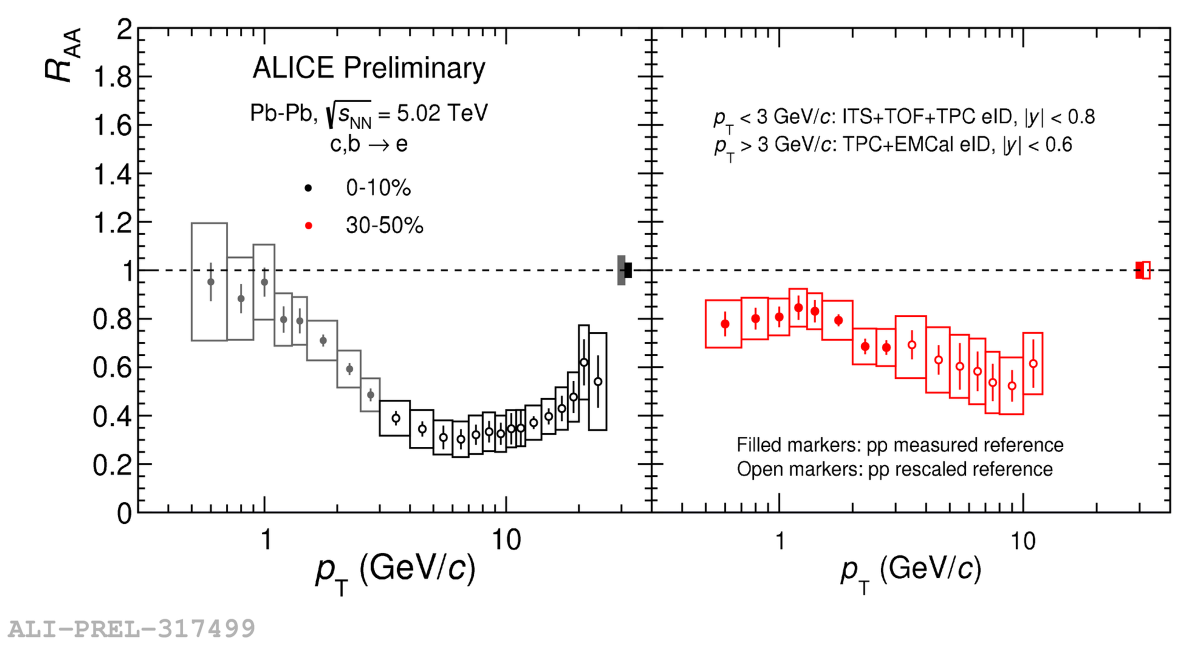
The modification of the p_T-differential yield in heavy-ion collisions with respect to pp result at the same centre-of-mass energy is quantified by the nuclear modification factor ($R_{\rm AA}$), defined as

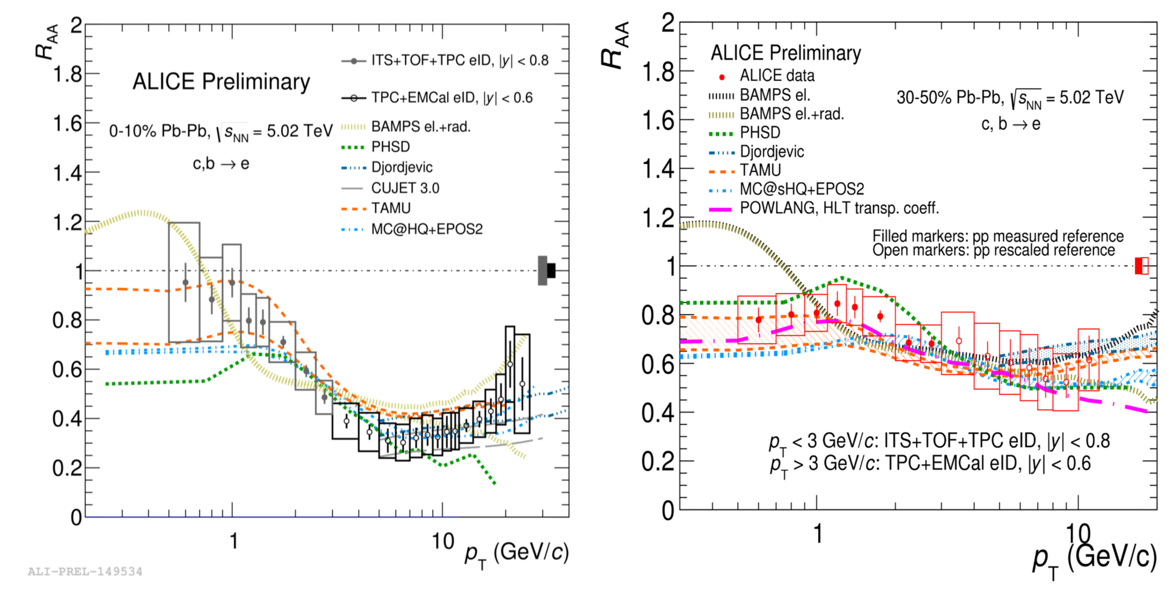
$$R_{\rm AA} = \frac{{\rm d}N_{\rm AA}/{\rm d}p_{\rm T}}{\langle T_{\rm AA}\rangle\, {\rm d}\sigma_{\rm pp}/{\rm d}p_{\rm T}}$$

where the average of nuclear overlap function $\langle T_{\rm AA}\rangle$, is defined as the average number of binary collisions among nucleons $\langle N_{\rm coll}\rangle$ over the inelastic nucleon-nucleon cross section

- Invariant yield measured down to $p_{\rm T} = 0.2$ GeV/c thanks to the low magnetic field used in ALICE during the data taking (B = 0.2 T)
- The reference for the $R_{\rm AA}$ measurement is obtained from the measured cross section in pp collisions at $\sqrt{s} = 5.02$ TeV performing a rescaling ($p_{\rm T} > 0.5$ GeV/c) and an extrapolation ($p_{\rm T} < 0.5$ GeV/c) employing FONLL predictions
- The measured $R_{\rm AA}$ is well described by Djordjevic [4] and PHSD [3] models in the intermediate $p_{\rm T}$ region

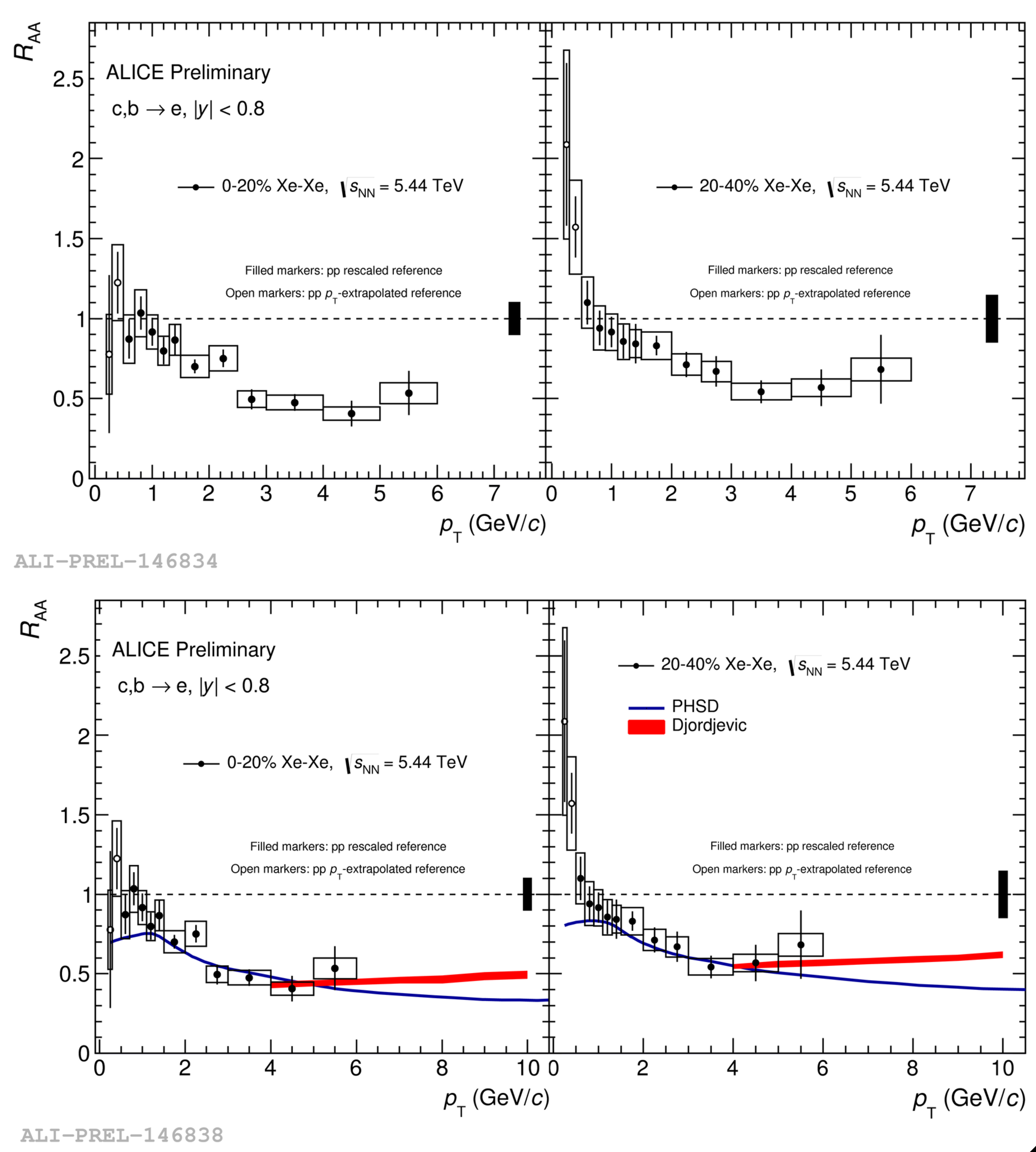
Pb-Pb results



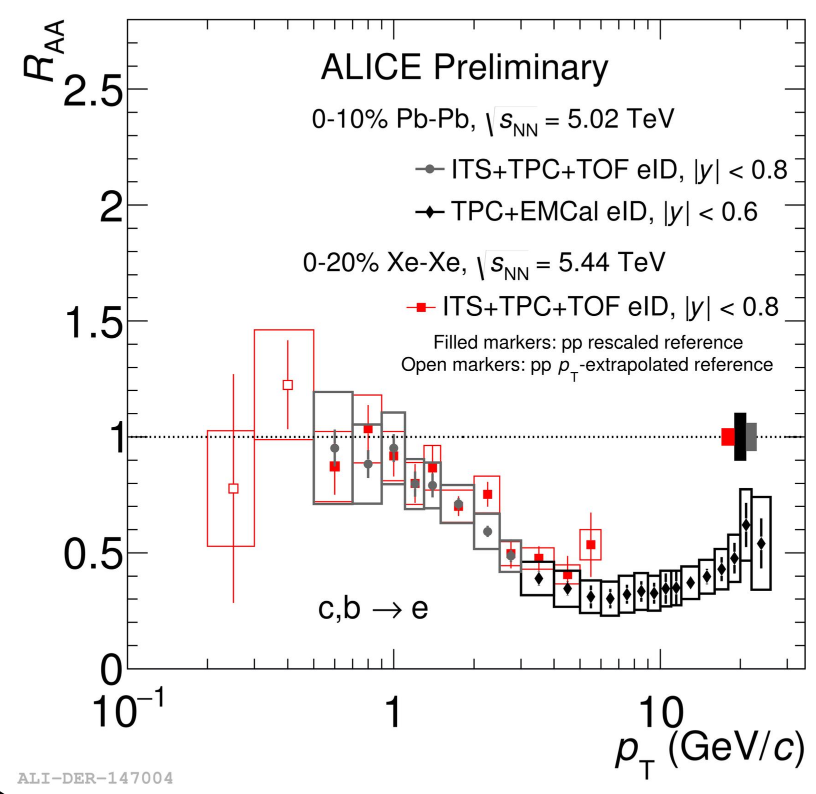


- The invariant cross section measured in pp collisions at $\sqrt{s} = 5.02$ TeV is used as reference for $R_{\rm AA}$ measurement
- Heavy quarks undergo energy loss in central Pb-Pb collisions, and the suppression increases until $\sim 7-8$ GeV/c
- The result is compared to theoretical predictions [1-7]
  → At $p_{\rm T} < 3$ GeV/c, the measured result (central value) is compatible with TAMU [5] prediction ⟹ energy lost mainly due to elastic collisions
  → At higher $p_{\rm T}$, the measurement agrees with Djordjevic [4] and CUJET 3.0 [1] models ⟹ radiative energy loss becomes relevant
  → As also observed at $\sqrt{s_{\rm NN}} = 2.76$ TeV, the data do not favor $R_{\rm AA} > 1$ at low $p_{\rm T}$, supporting the presence of shadowing and the necessity of including nuclear PDF in the models.

Xe-Xe results



Pb-Pb vs. Xe-Xe



- Comparison of $R_{\rm AA}$ measurements at different $N_{\rm part}$ or $N_{\rm ch}$ may add sensitivity to probe the path-length dependence of in-medium parton energy loss
- Similar $R_{\rm AA}$ is observed in Xe-Xe and Pb-Pb collisions when compared at similar $\langle dN_{\rm ch}/d\eta\rangle$
  → Possibility to further constrain the model calculations

References: [1]: JHEP 1602 (2016) 169; [2]: J. Phys. G42 no. 11, (2015) 115106; [3]: Phys. Rev. C 93, 034906 (2016); [4]: Phys. Rev. C 92, 024918; [5]: Phys.Lett. B735 (2014) 445–450; [6]: Phys. Rev. C 89, 014905 (2014); [7]: Eur. Phys. J. C75 no. 3, (2015) 121