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

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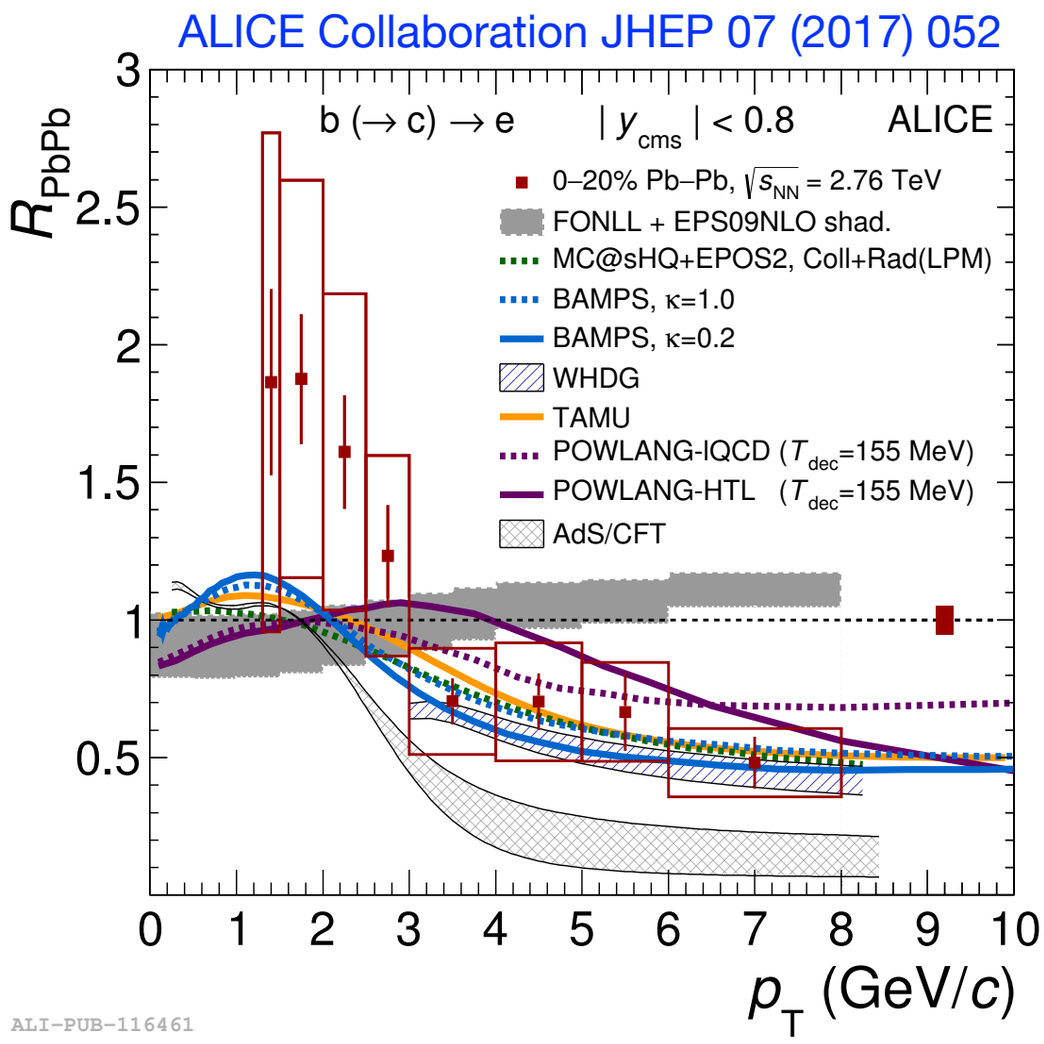
Physics Motivation

- ALICE aims at investigating the properties of the quark-gluon plasma (QGP)
- Heavy quarks (charm & beauty)
  - Created in the early stage of the collisions
  - Experience the full evolution of the medium
- In-medium energy loss
  - Lose their energy via collisions and radiations
  - Expected to depend on color charge and mass

$$\Delta E_g > \Delta E_{u,d,s} > \Delta E_c > \Delta E_b$$

- Evaluate the medium effects by

$$R_{AA} = \frac{1}{\langle T_{AA} \rangle} \frac{dN_{AA}/p_T}{d\sigma_{pp}/p_T}$$



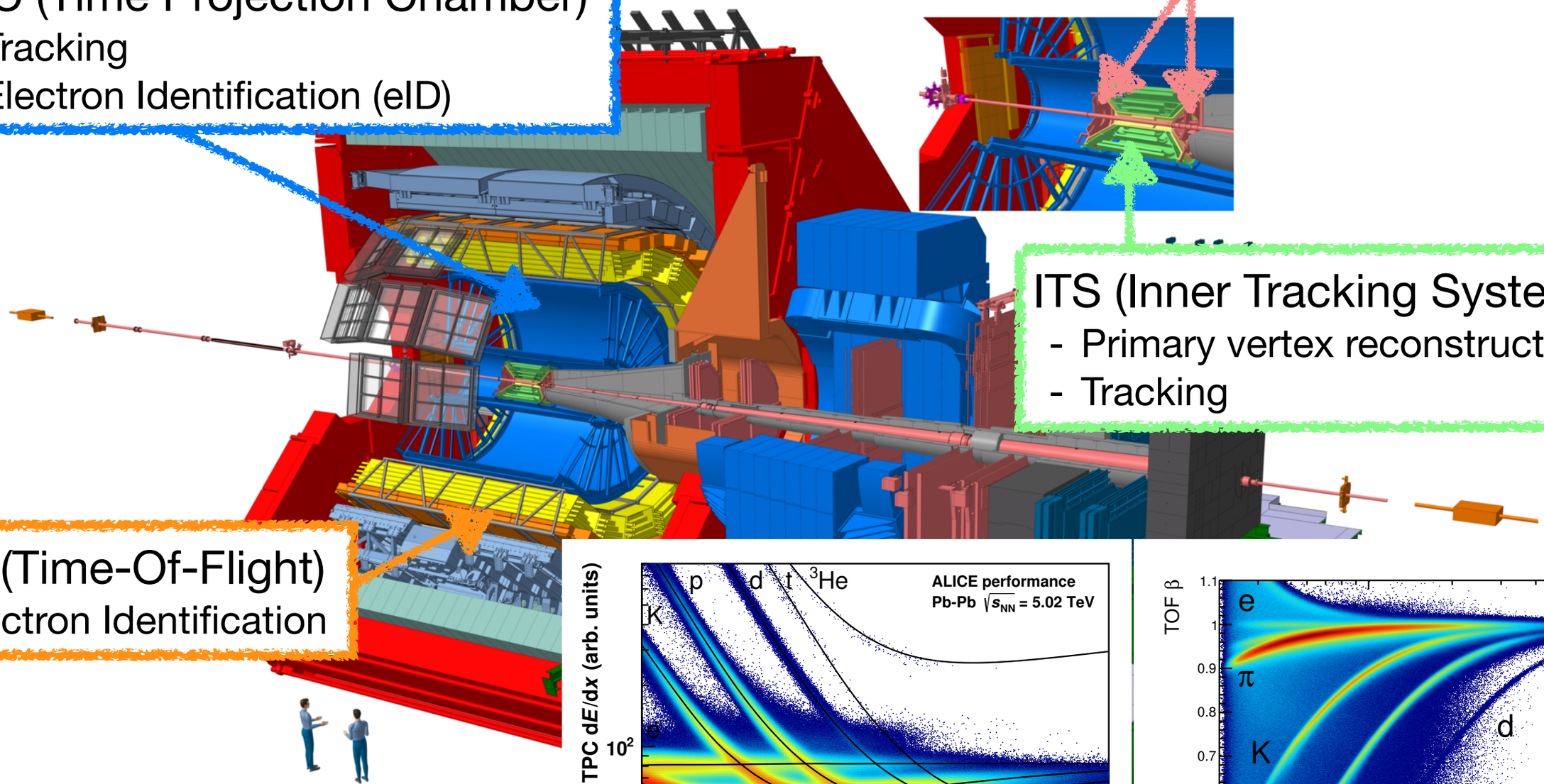
Hint of the mass dependence of the in-medium energy loss by comparison of R_{AA} between charm and beauty

ALICE detector

Central Barrel Coverage : |η| < 0.9

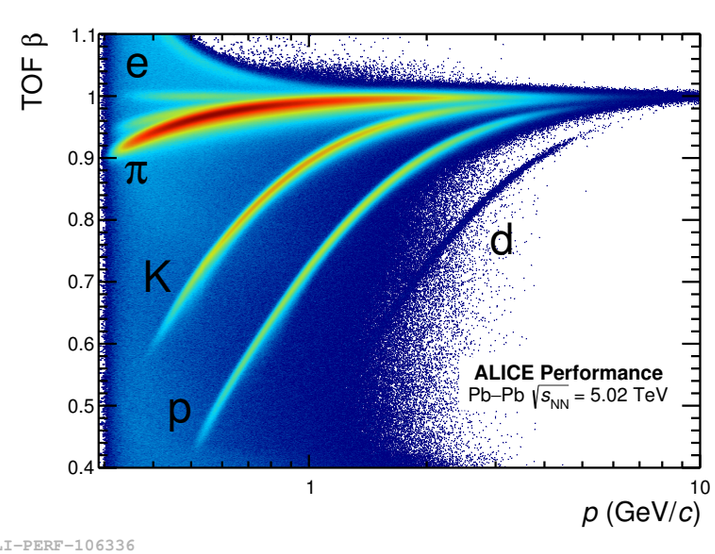
V0
- Triggering
- Centrality estimation

TPC (Time Projection Chamber)
- Tracking
- Electron Identification (eID)



ITS (Inner Tracking System)
- Primary vertex reconstruction
- Tracking

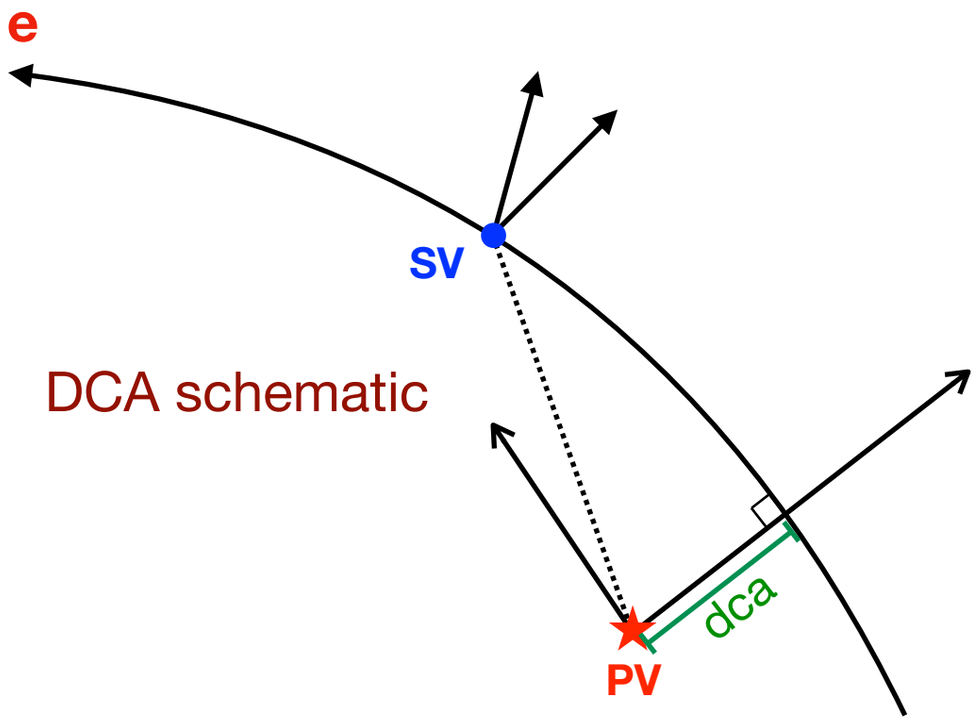
TOF (Time-Of-Flight)
- Electron Identification



Electrons from beauty hadrons

- Study beauty quark production via electrons from open beauty-hadron decays
  - Substantial branching ratio : B→e + *X* (~10%), B→D→e + *X*
- Use specific characteristic of the beauty hadrons
  - Large decay length of beauty hadrons : $c\tau \approx 500\,\mu\mathrm{m}$
  - Wide distribution of IP (impact parameter)

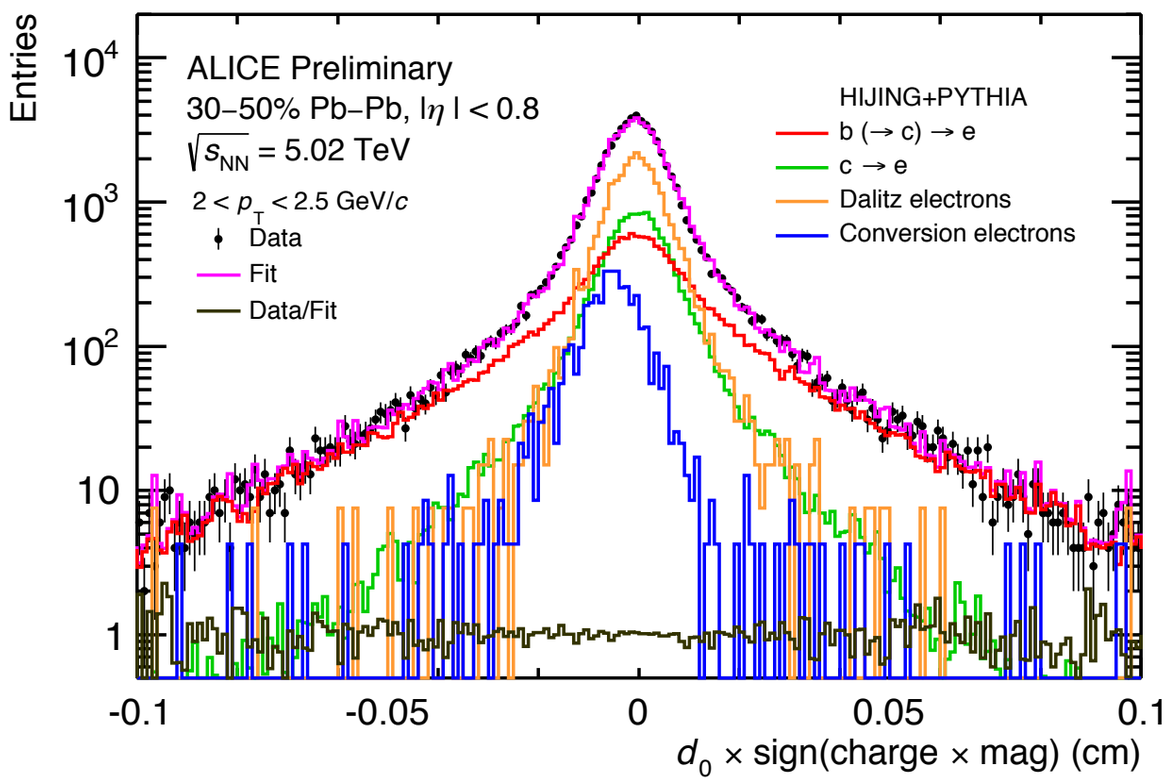
    IP : DCA (distance of closest approach) in the plane perpendicular to the beam direction



Analysis Strategy

Steps

- Select electron candidates passing track quality cuts and eID cuts
- Fit the IP distribution of the inclusive electrons in data using templates from Monte Carlo (MC) simulation
- Apply efficiency correction obtained from MC

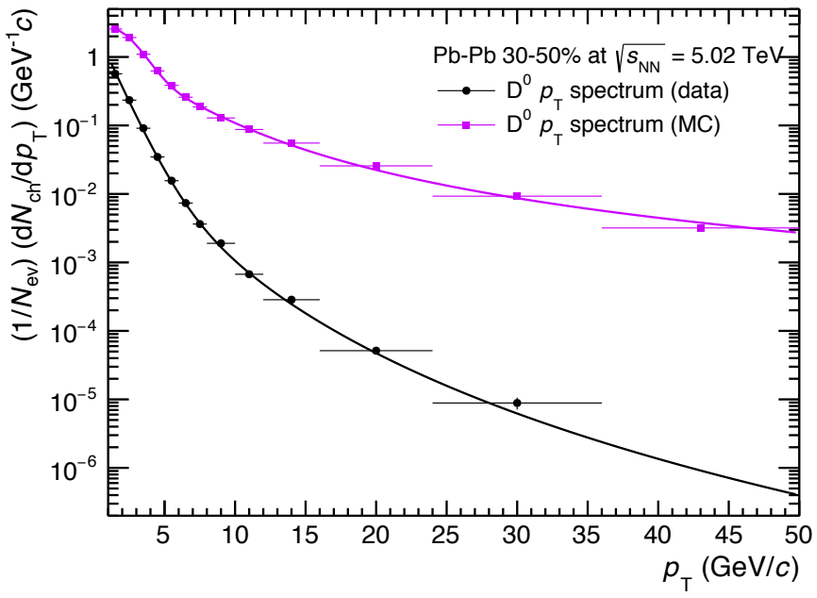


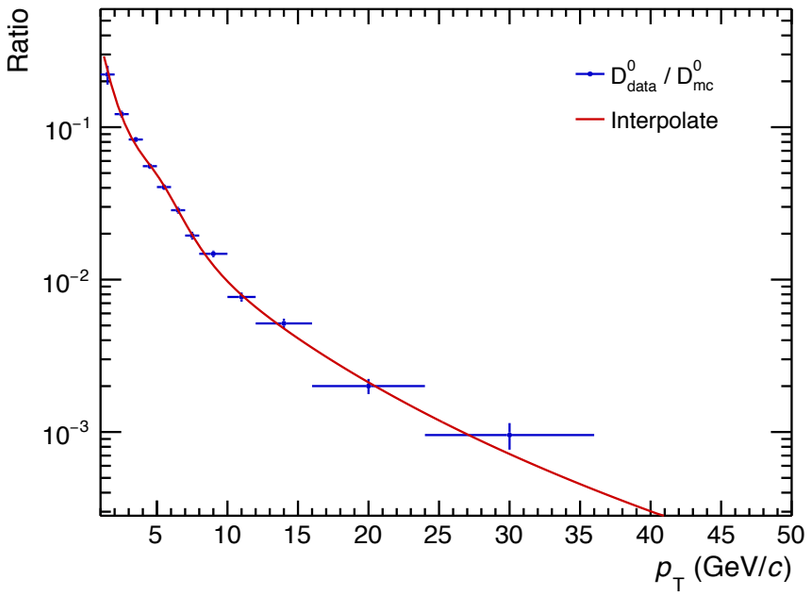
Template fit method

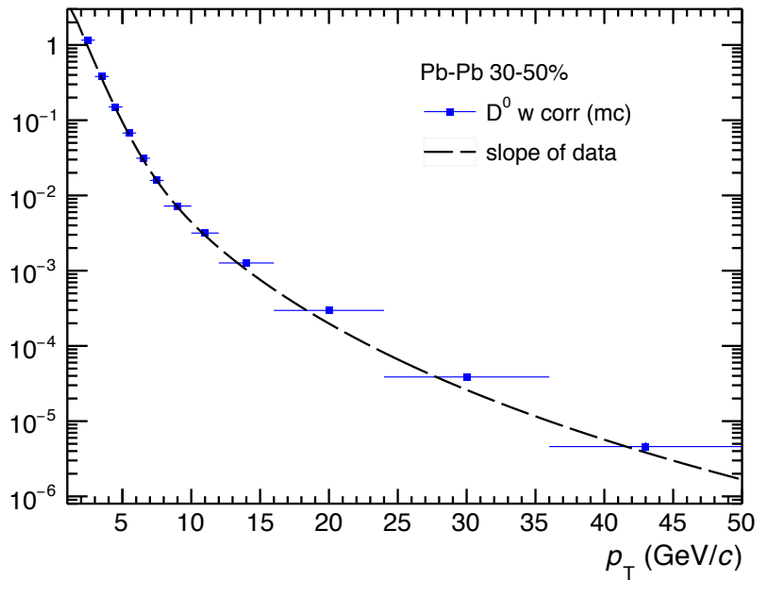
- Based on maximum likelihood approach
- Templates obtained from MC (HIJING+PYTHIA)
  Beauty, Charm, Dalitz, Conversion
- All templates are corrected to have realistic IP distributions
  - IP mean and resolution correction [backup]
  - p_T correction for hadrons decaying into electron
  - Charm hadron yield correction

Corrections for charm template

- p_T spectra of hadrons containing heavy quark have harder shape than the measured one (or theory)
  - Since heavy quarks are enhanced to increase statistics
- Weighting factor for D mesons : $w_D = p_{T,D^0}^{data} / p_{T,D^0}^{mc}$
  - Slope of spectrum of other D mesons are similar with D^0 spectrum
- The weight makes p_T shape in MC as one in data
- Λ_c correction is done with the same way (backup)



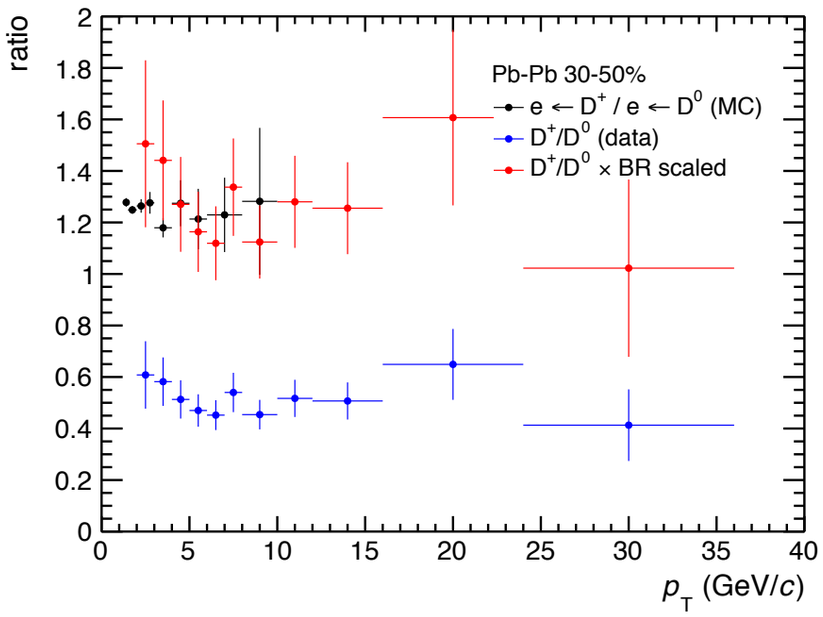


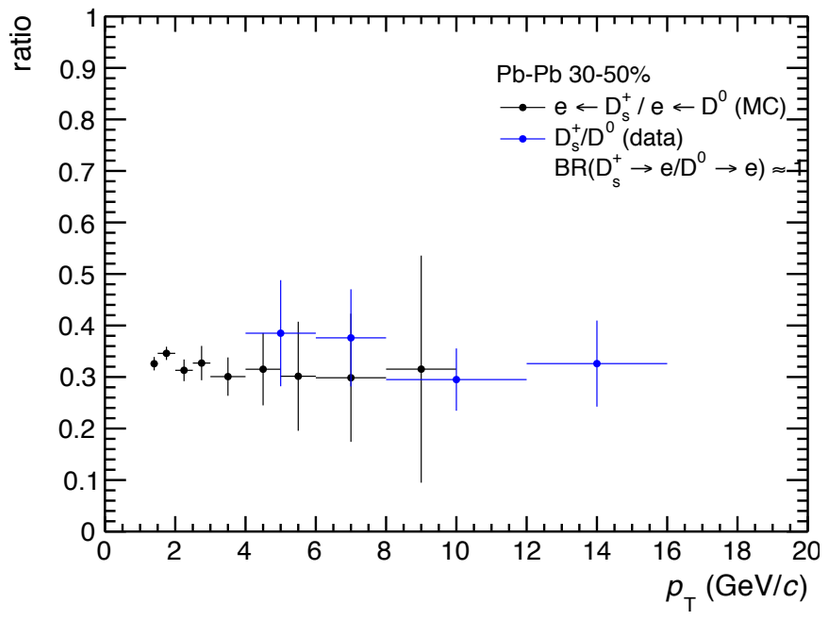


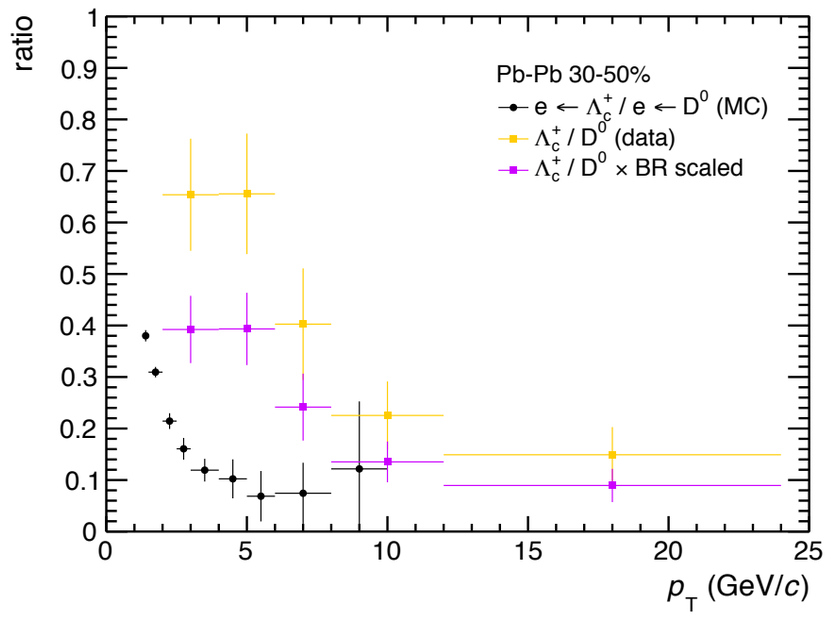
Corrections for charm template

- Different charm species have different decay length
  - Different fraction makes incorrect templates
  - Need to correct the amount of each hadrons
- Use fraction of D^+, D_s, Λ_c w.r.t D^0 measured in data
- Since we make electron templates, branching ratio should be considered
- Each fractions are well matched with data after p_T correction
  - In case D_s/D^0, artificial factor is applied to match the ratio in data

Species	$c\tau$ (μm)
D^+	311.8
D^0	122.9
D_s	151.2
Λ_c	60.7

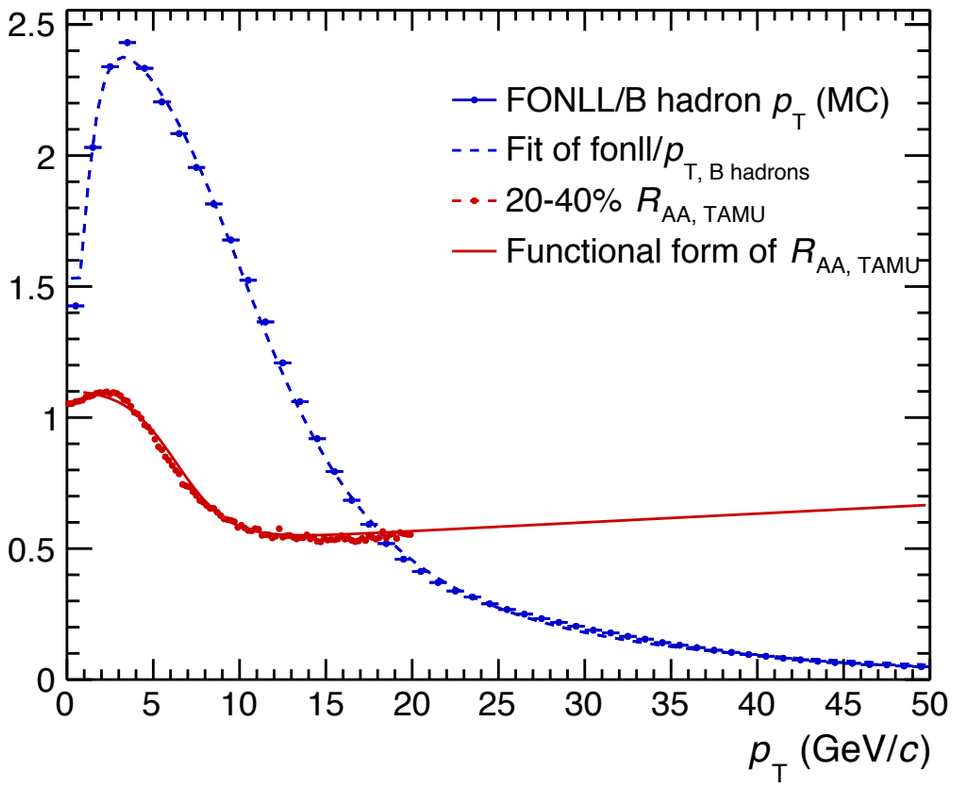






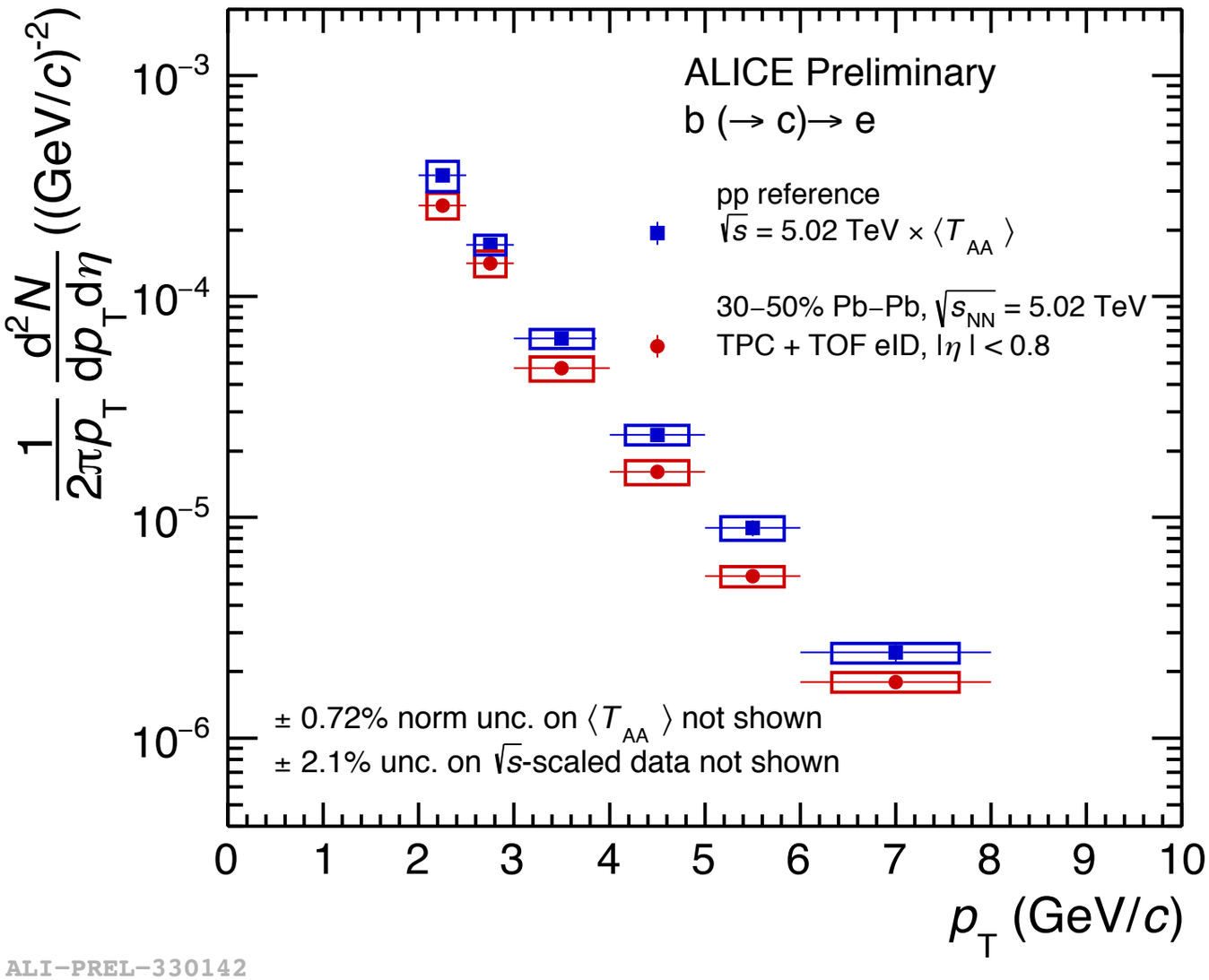
Corrections for beauty template

- Not possible to use the same approach for beauty hadrons
  - Beauty decay electrons provide the information of the beauty quark/hadron p_T distribution
  - Not available prior to the measurement
- Instead, use theoretical calculations for the references
  - In this analysis, adopted FONLL and TAMU model
- Weighting factor for B hadrons : $w_B = \mathrm{FONLL}/p_{T,B}^{mc} \times R_{AA}^{TAMU}$
- No additional fraction correction since all beauty hadrons have similar decay length



Invariant yield of beauty-decay electrons

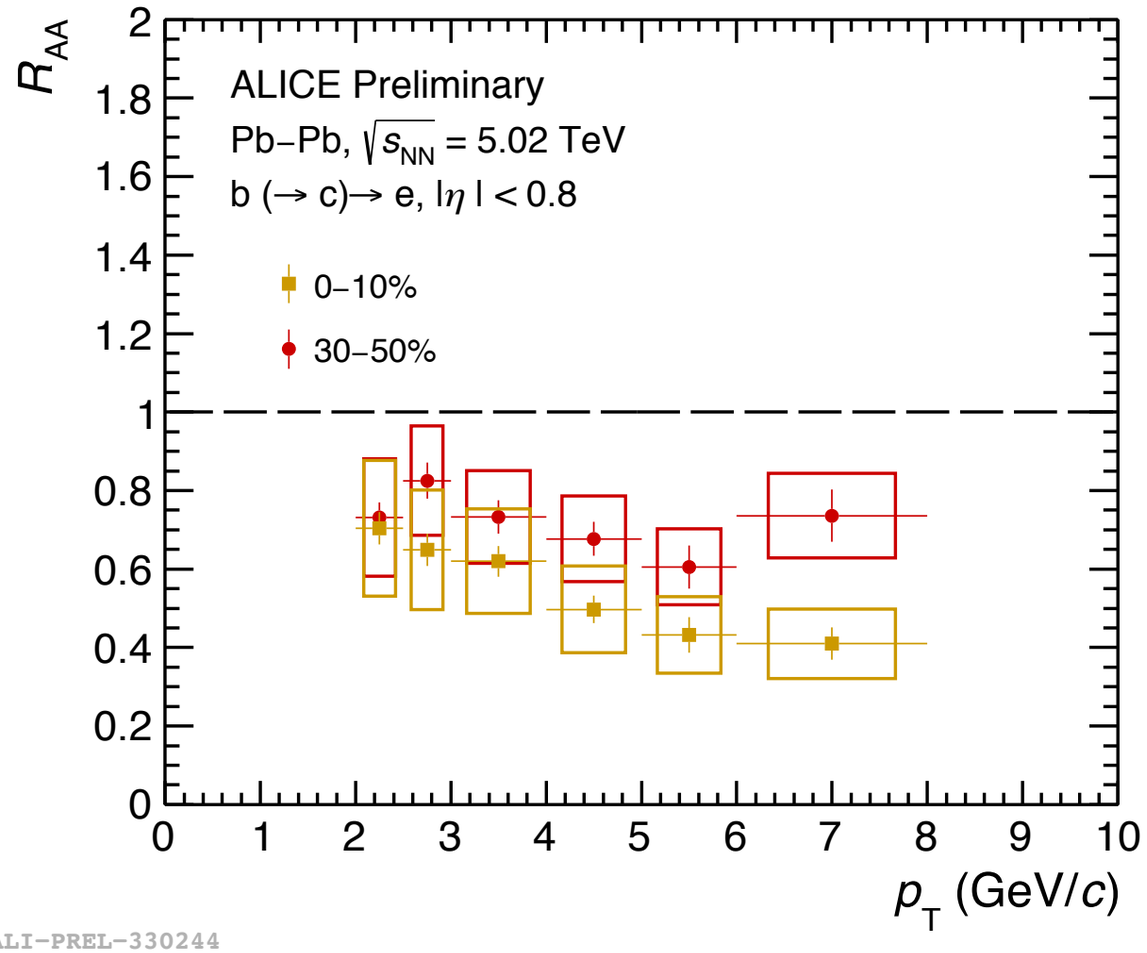
- Electrons from beauty-hadron decays in pp and 30-50% Pb-Pb at 5.02 TeV
  - Measured p_T range : $2 < p_T < 8$ GeV/c
  - pp reference multiplied by $\langle T_{AA} \rangle$: nuclear thickness function
  - Observed suppression in Pb-Pb collisions above 2 GeV/c



ALI-PREL-330142

R_{AA} of beauty-decay electrons

- R_{AA} of beauty decay electrons in 30-50% Pb-Pb collisions at 5.02 TeV
- Compared with 0-10% result (left) and HFe R_{AA} (right)



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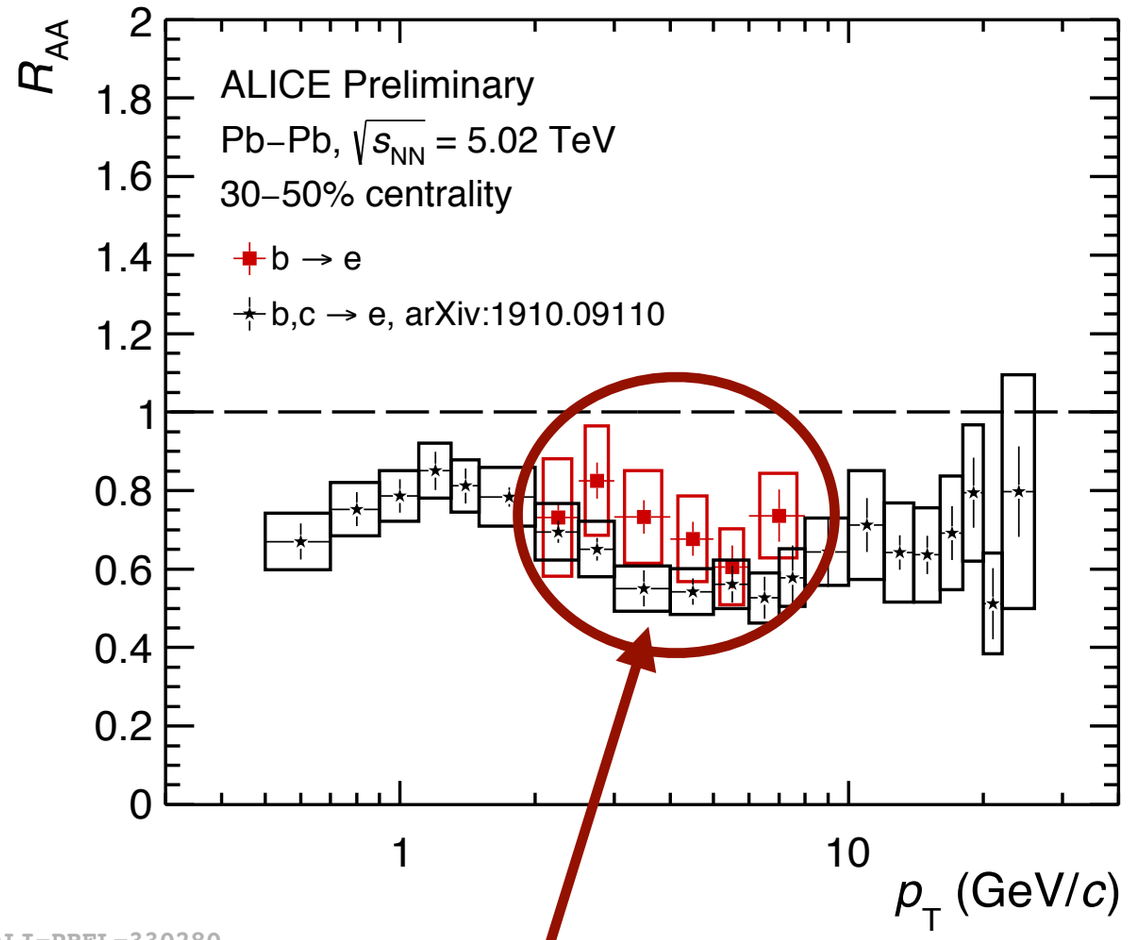

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Less suppression of beauty quarks than charm quarks at low p_T

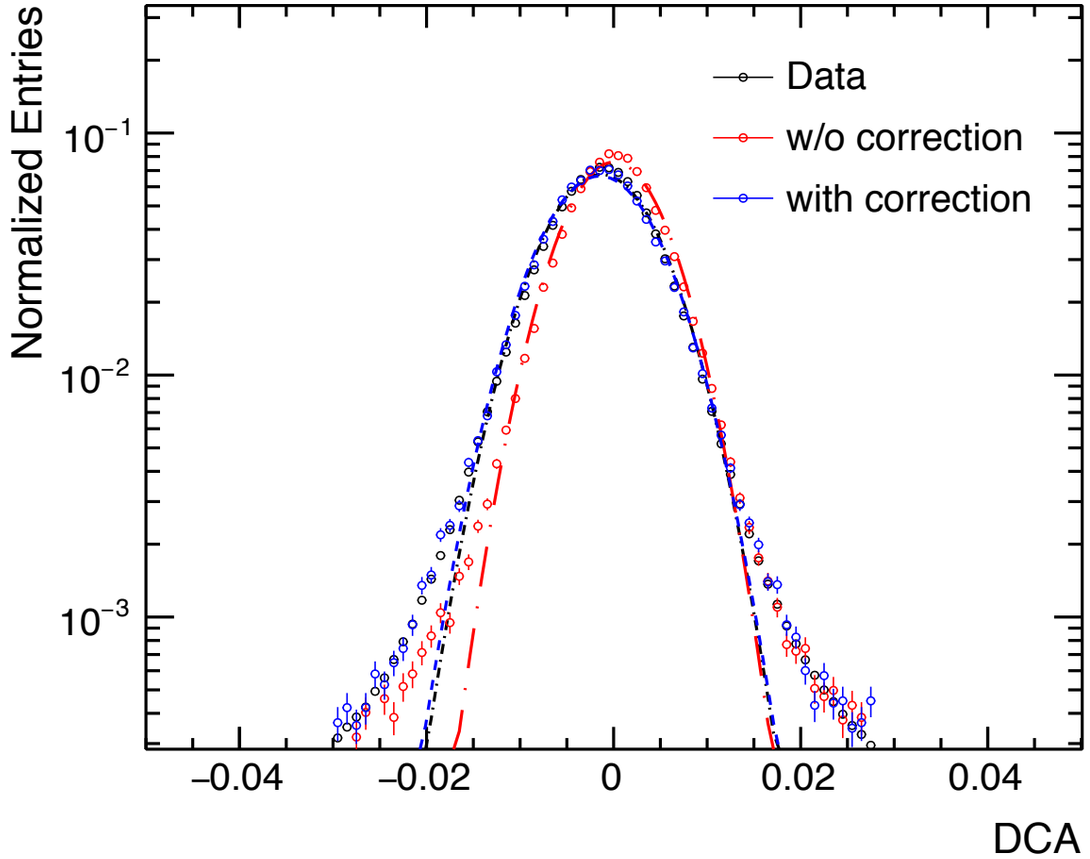
Summary

- Beauty production via electrons from beauty-hadron decays in Pb-Pb collisions at 5.02 TeV with ALICE detector at the LHC
- Signal extraction is done by performing template fit method
  - The templates are corrected to have realistic IP distributions
- Beauty decay electrons are measured from $2 < p_{T} < 8$ GeV/c
- Observed beauty quark suppression in Pb-Pb collisions w.r.t pp reference
- In the RAA comparisons,
  - Less suppression in semi-central case than most central case
  - Beauty quarks are less suppressed than charm quarks

BACKUP

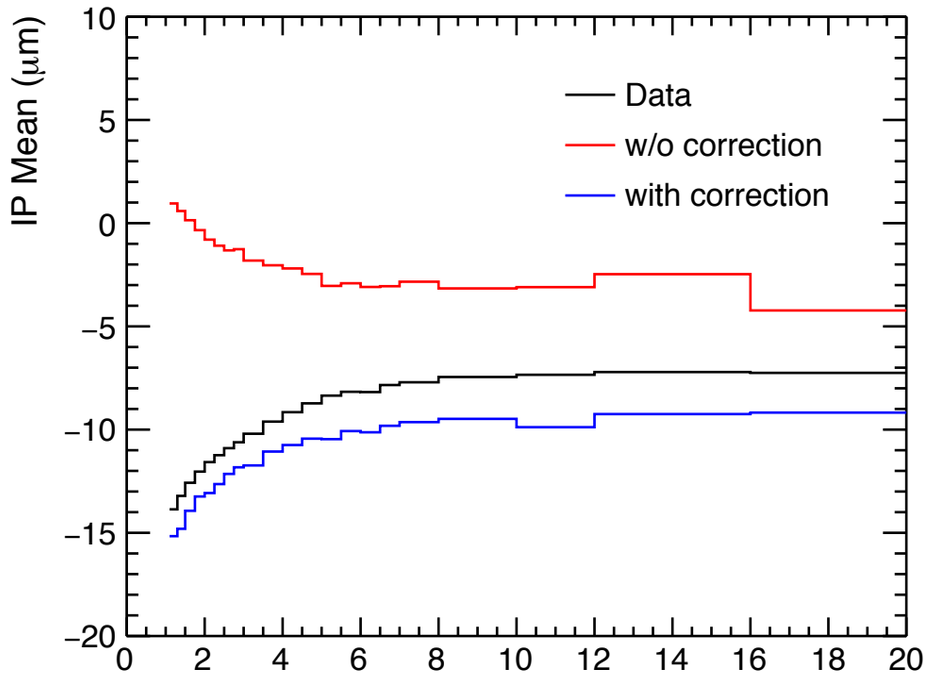
Corrections for impact parameter

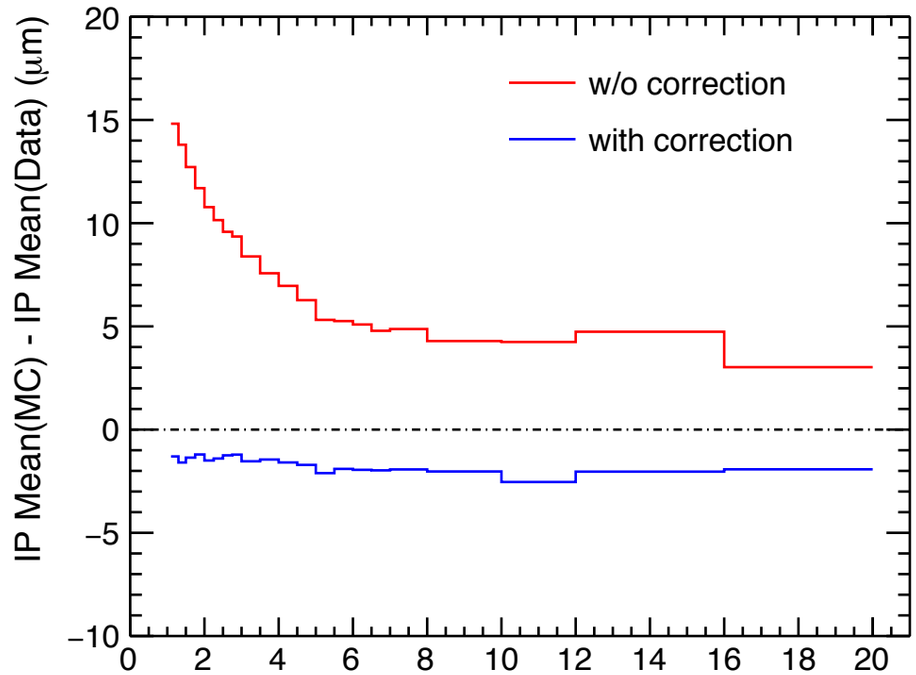
- Observed IP differences between data and MC in Pb-Pb 5.02 TeV
  - First hypothesis is that happens due to mis-alignment during maintenance period
- Check for the IP with charged pion channel
  - Charged pions are mostly coming from the primary vertex
  - Easy to check the impact parameter mean and resolution
- Impact parameter mean and resolution obtained from Gaussian fit parameters



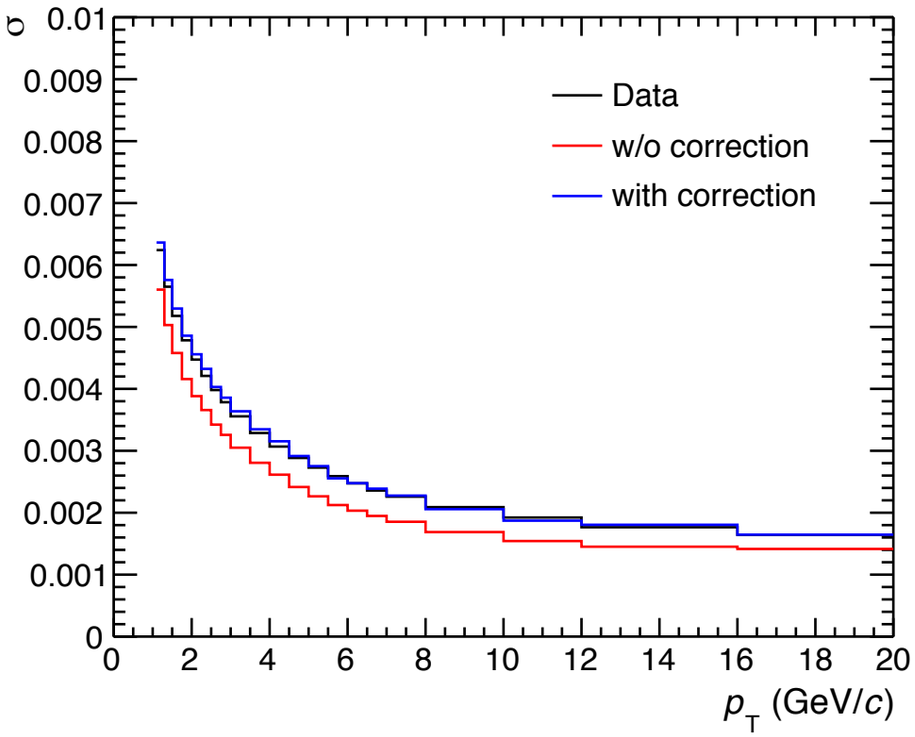
Corrections for impact parameter

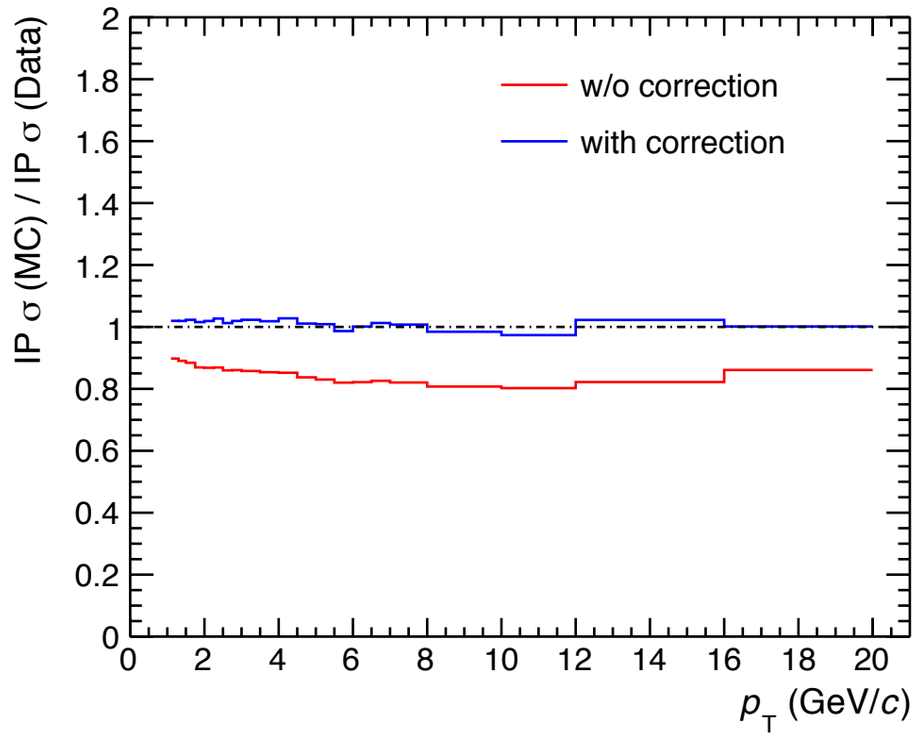
Mean





Resolution





Corrections for charm template

- Weighting factor for Λ_c : $w_{\Lambda_c} = p_{\mathrm{T},\Lambda_c}^{\mathrm{data}} / p_{\mathrm{T},\Lambda_c}^{\mathrm{mc}}$