



# Azimuthal angular correlations between heavy flavour decay electrons and charged hadrons in pp collisions at $\sqrt{s} = 2.76$ TeV with the ALICE experiment



Deepa Thomas for the ALICE collaboration  
ERC Research Group QGP – ALICE, Institute of Subatomic Physics  
Utrecht University, The Netherlands  
Email : dthomas@uu.nl

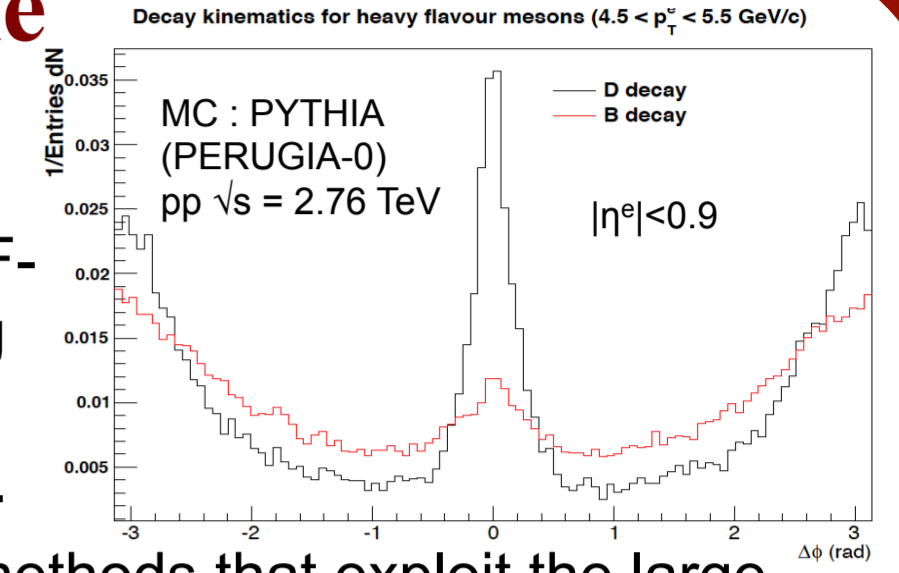


## 1. Motivation

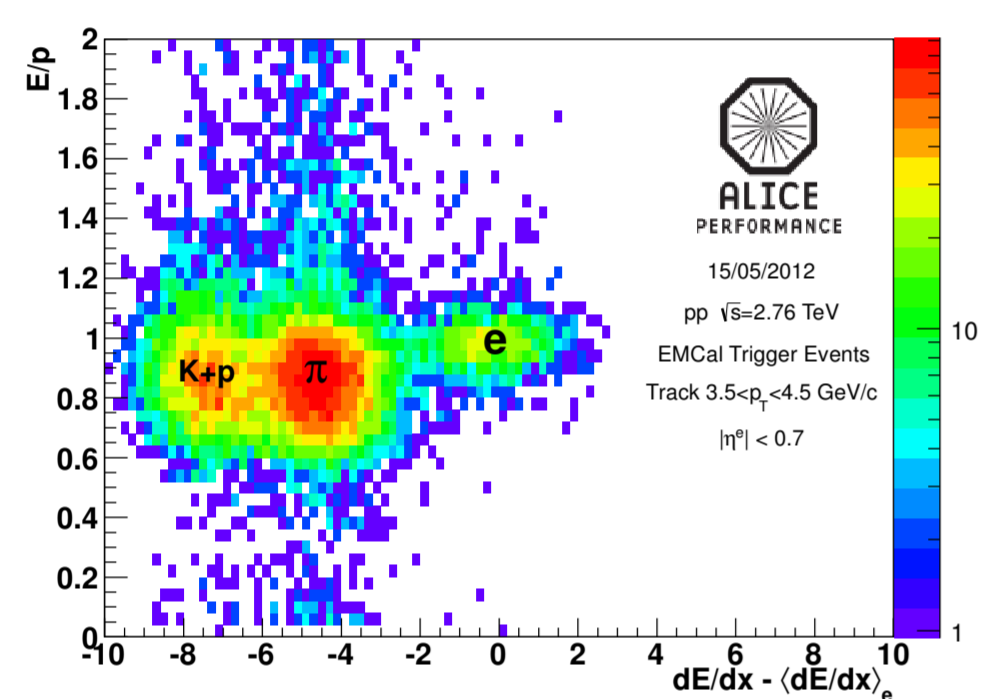
- Heavy flavour (HF) quarks
  - Produced in hard scattering processes.
  - Sensitive probe of QCD matter produced in heavy ion collisions.
  - In pp collisions:
    - Test for perturbative QCD calculations.
    - Reference for HI measurements.
- Heavy quarks can be studied using electrons from semi-leptonic decay of HF mesons.
- Need to separate electrons from D and B decays to study the expected mass dependence of heavy quark energy loss.
- Azimuthal angular correlations of HF decay electrons and charged hadrons  $\rightarrow$  relative beauty contribution (section 2).
- In Pb-Pb collisions, azimuthal angular correlation of HF decay electrons and charged hadrons can be used to study
  - Energy loss of heavy flavour partons.
  - Possible modification of jet fragmentation in QCD medium.

## 2. Method and data sample

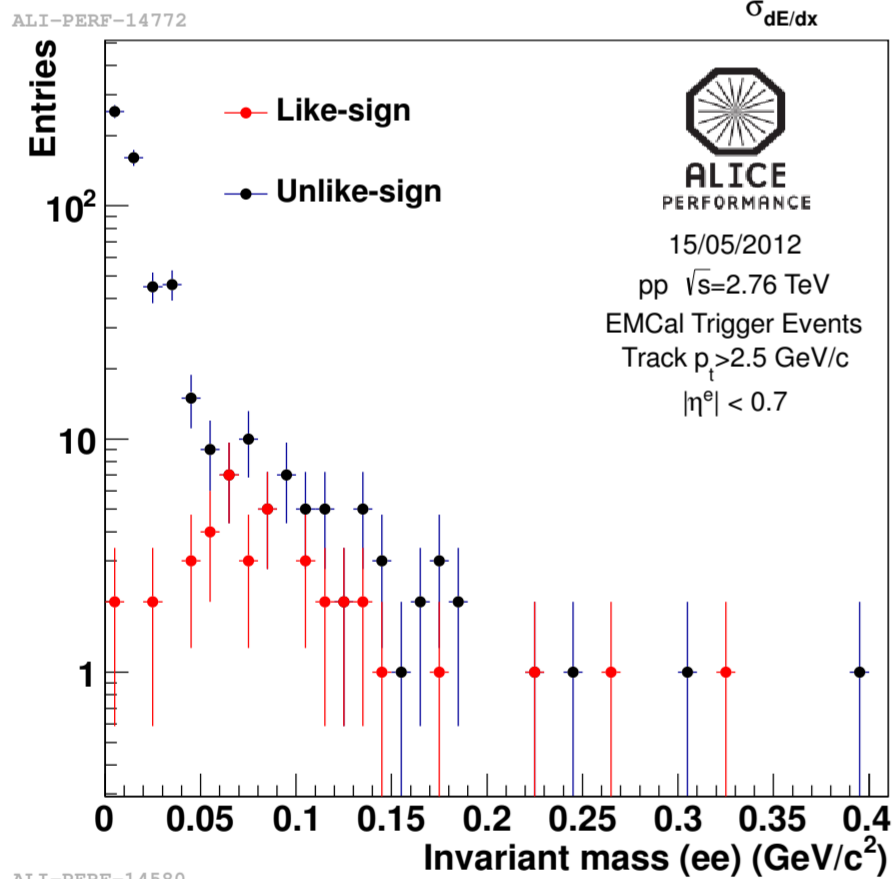
- Exploit different decay kinematics of D and B mesons.
- The relative beauty contribution to the HF-decay electron yield is extracted by fitting the correlation distribution with MC (PYTHIA + detector response) templates.
- The method is complementary to direct methods that exploit the large displacement of electrons from B decays.
- Using relative beauty contribution and inclusive cross section of HF-decay electrons, the cross sections of beauty-decay and charm-decay electrons can be computed separately.
- Dataset:
  - EMCal triggered events: L0 trigger (2x2 towers), cluster energy threshold  $>3$  GeV.
  - Detectors : Inner Tracker System ( $|\eta| < 0.9, 0 < \phi < 360$ ), Time Projection Chamber ( $|\eta| < 0.9, 0 < \phi < 360$ ), Electromagnetic calorimeter ( $|\eta| < 0.7, 80 < \phi < 180$ ).
  - Statistics :  $6.2 \times 10^5$  events,  $L_{int} = 14.6 \text{ nb}^{-1}$ .



## 3. HF-decay electron identification

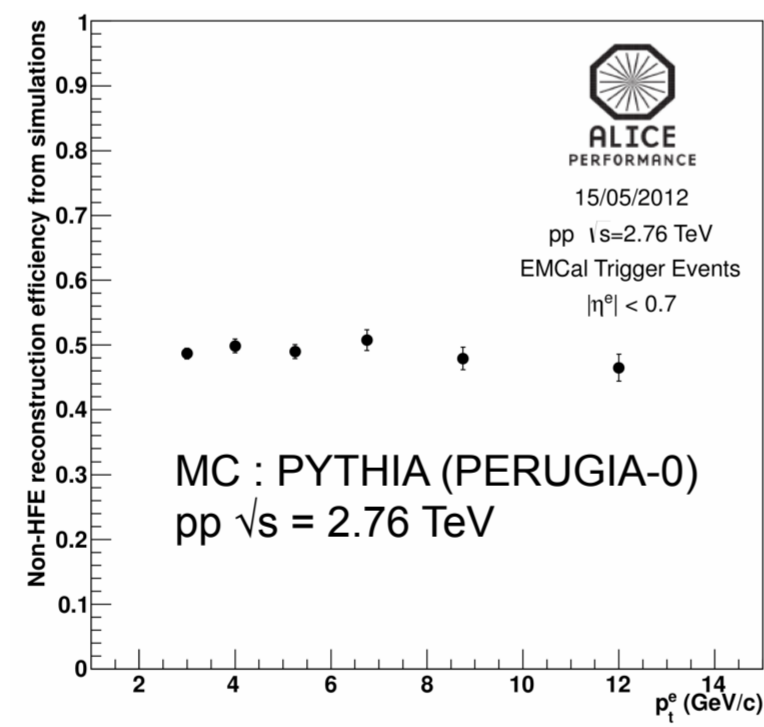


- Electron identification
  - TPC and EMCAL
- Electron track selection
  - $-\sigma < \text{TPC } dE/dx < 3\sigma$
  - $0.8 < E/p < 1.2$
- Non-heavy-flavour electron (Non-HFE)
  - Main sources :  $\gamma$  conversion,  $\pi^0$  and  $\eta$  Dalitz decay.
  - Identified using  $e^+e^-$  invariant mass.
  - Invariant mass cut of 50 MeV/c<sup>2</sup> is applied.
  - Efficiency for Non-HFE identification -  $\sim 50\%$ .

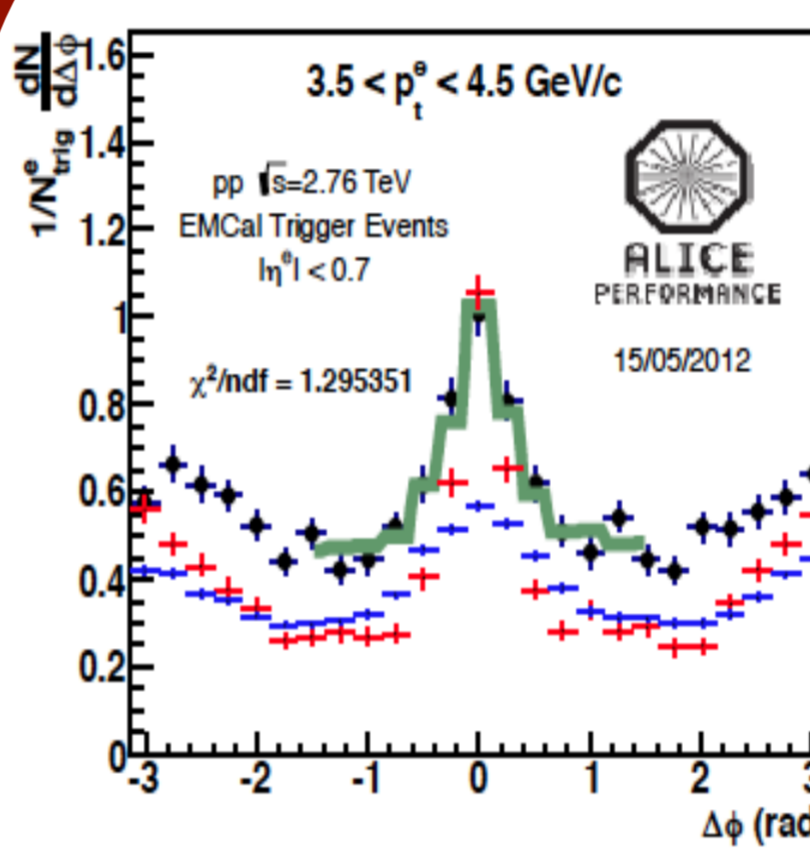


Azimuthal angular correlation between HFE and charged hadrons is calculated using inclusive electrons, reconstructed Non-HFE (Reco-NonHFE) and not reconstructed Non-HFE (using efficiency) as :

$$\Delta\phi^{\text{HFE}} = \Delta\phi^{\text{InclusiveE}} - \Delta\phi^{\text{Reco-NonHFE}} - (1/\text{Eff} - 1) \Delta\phi^{\text{Non-HFE}}$$

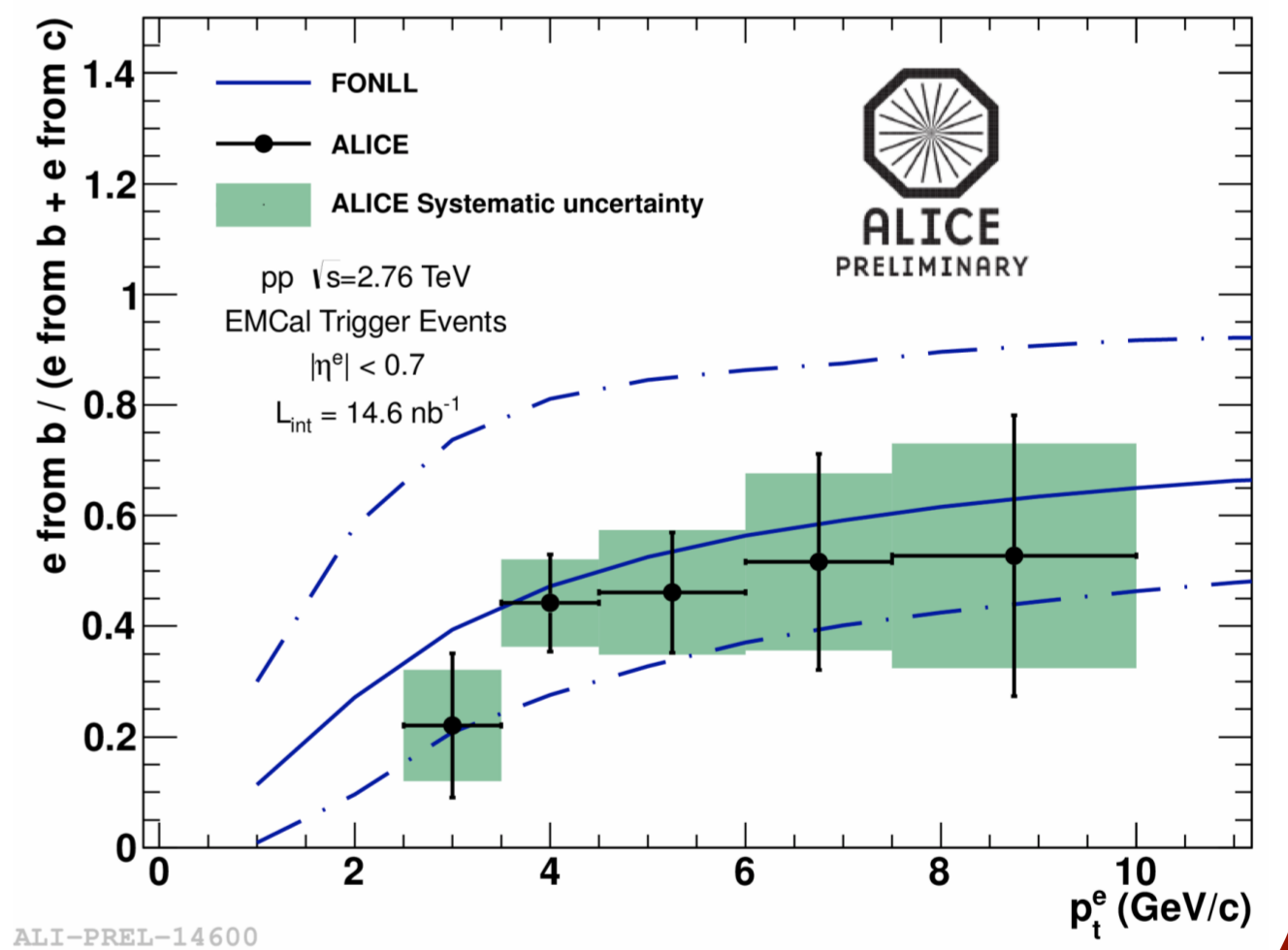


## 4. Fraction of beauty-decay electrons

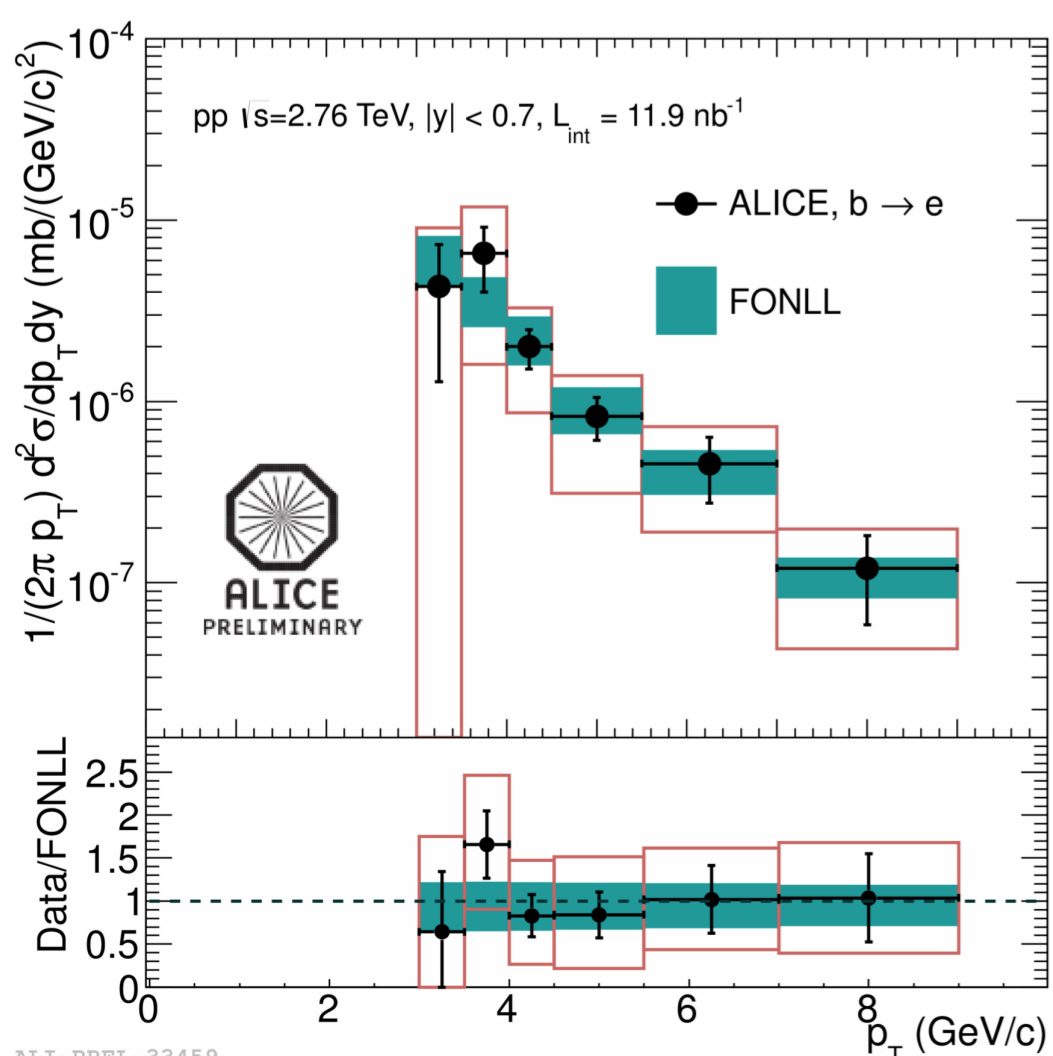


- Azimuthal angular correlation distribution between HFE and charged hadrons is shown.
- Hadron track selection:
  - $p_T > 0.3 \text{ GeV}/c$
  - $|\eta| < 0.9, 0^\circ < \phi < 360^\circ$
- Fit data points using MC template for charm and beauty (PYTHIA + GEANT3).
- Fit function :  $\Delta\phi_{\text{data}} = \text{const} + r_b \Delta\phi_B + (1-r_b) \Delta\phi_D$   
where  $r_b = N_e^B / (N_e^B + N_e^D)$ ,  
const  $\rightarrow$  uncorrelated background.

- Relative beauty fraction as a function of  $p_T^e$ .
- At  $\sim 5 \text{ GeV}/c$  the beauty contribution is equivalent to charm  $\rightarrow$  Similar results obtained at RHIC <sup>2,3</sup> at  $\sqrt{s} = 200 \text{ GeV}$ .
- Consistent with FONLL pQCD calculation<sup>1</sup>.



## 5. Beauty-decay electron cross section at $\sqrt{s} = 2.76 \text{ TeV}$



- Using HFE-decay cross section\* and relative beauty contribution to the heavy flavour electron yield, the beauty to electron cross-section can be calculated.
- $(1/(2\pi p_T) d^2\sigma/dp_T dy)_{b \rightarrow e} = r_b \times (1/(2\pi p_T) d^2\sigma/dp_T dy)_{b+c \rightarrow e}$
- Beauty-decay electron cross section in pp collision at 2.76 TeV is shown.
- Consistent with FONLL pQCD calculation<sup>1</sup>.

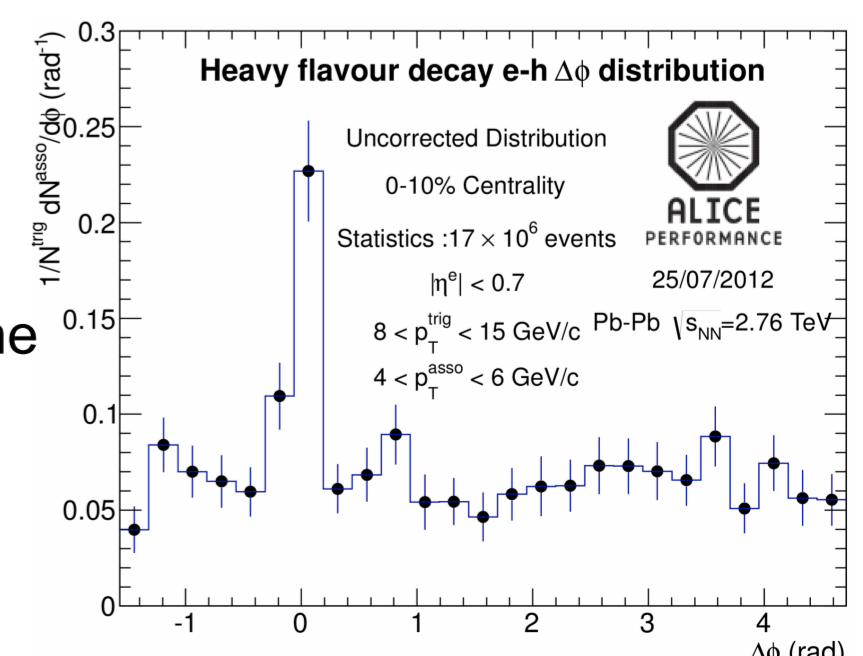
\*Details on HFE cross-section in pp collisions at 2.76 TeV  $\rightarrow$  refer Poster by Bernard Hicks

## 6. Conclusions and Outlook

- Relative beauty contribution to the heavy flavour decay electron yield is measured in pp collisions at 2.76 TeV with the ALICE detector using an EMCAL trigger.
- HFE data are well described by pQCD calculations at FONLL and agree with previous measurements from RHIC at 200 GeV.
- Beauty decay electron cross section is calculated in pp collisions at 2.76 TeV.
- The measured cross section is consistent with pQCD calculations at FONLL.

### Outlook:

- Azimuthal angular correlation of heavy flavour decay electrons and charged hadrons at 2.76 TeV Pb-Pb collisions (see uncorrected distr. at the right).
- Study the energy loss and modified fragmentation of heavy quarks in the QCD medium.



<sup>1</sup>M. Cacciari et al., JHEP 0103, 006 (2001) and private communication (2012).  
<sup>2</sup>STAR Collaboration, Phys. Rev. Lett. 105, 202301 (2010).  
<sup>3</sup>PHENIX Collaboration, Phys. Rev. Lett. 103, 082002, (2009).