Jet-like heavy-flavour particle correlations in ALICE

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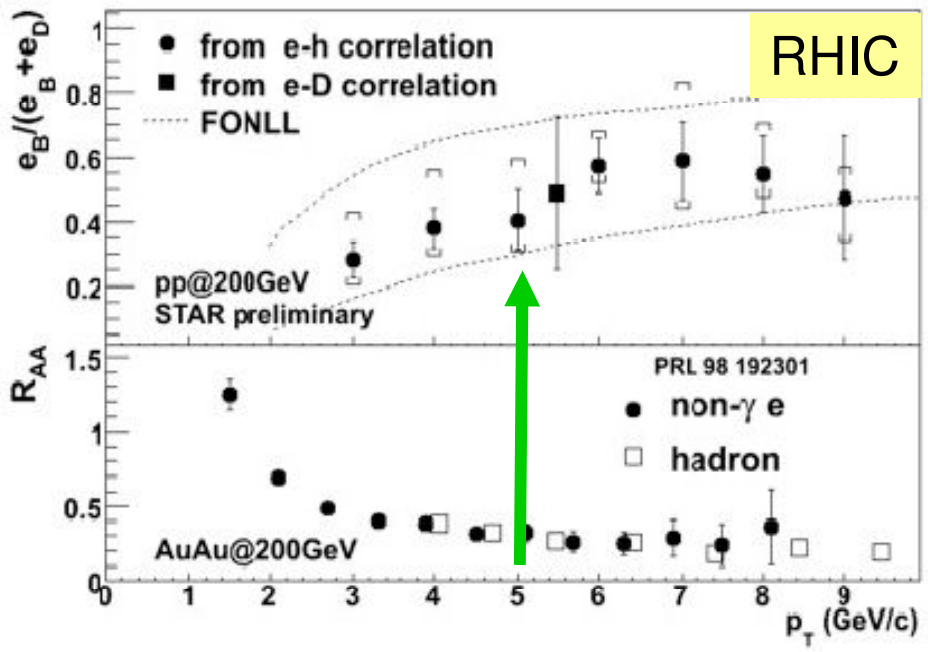
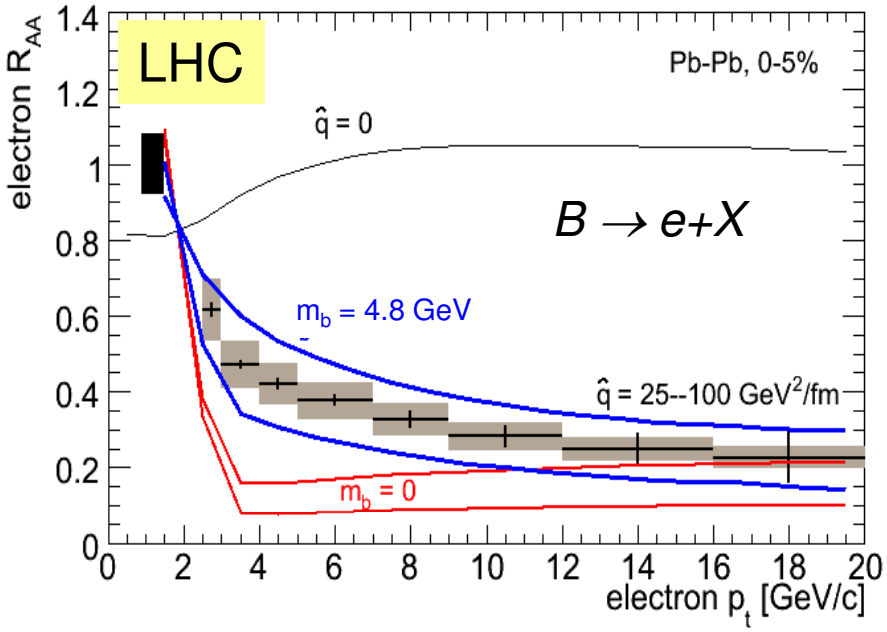
Outline

- Motivation
- Correlation technique
- Detector setup
- Results from PYTHIA simulations
- Summary and conclusions

Motivation

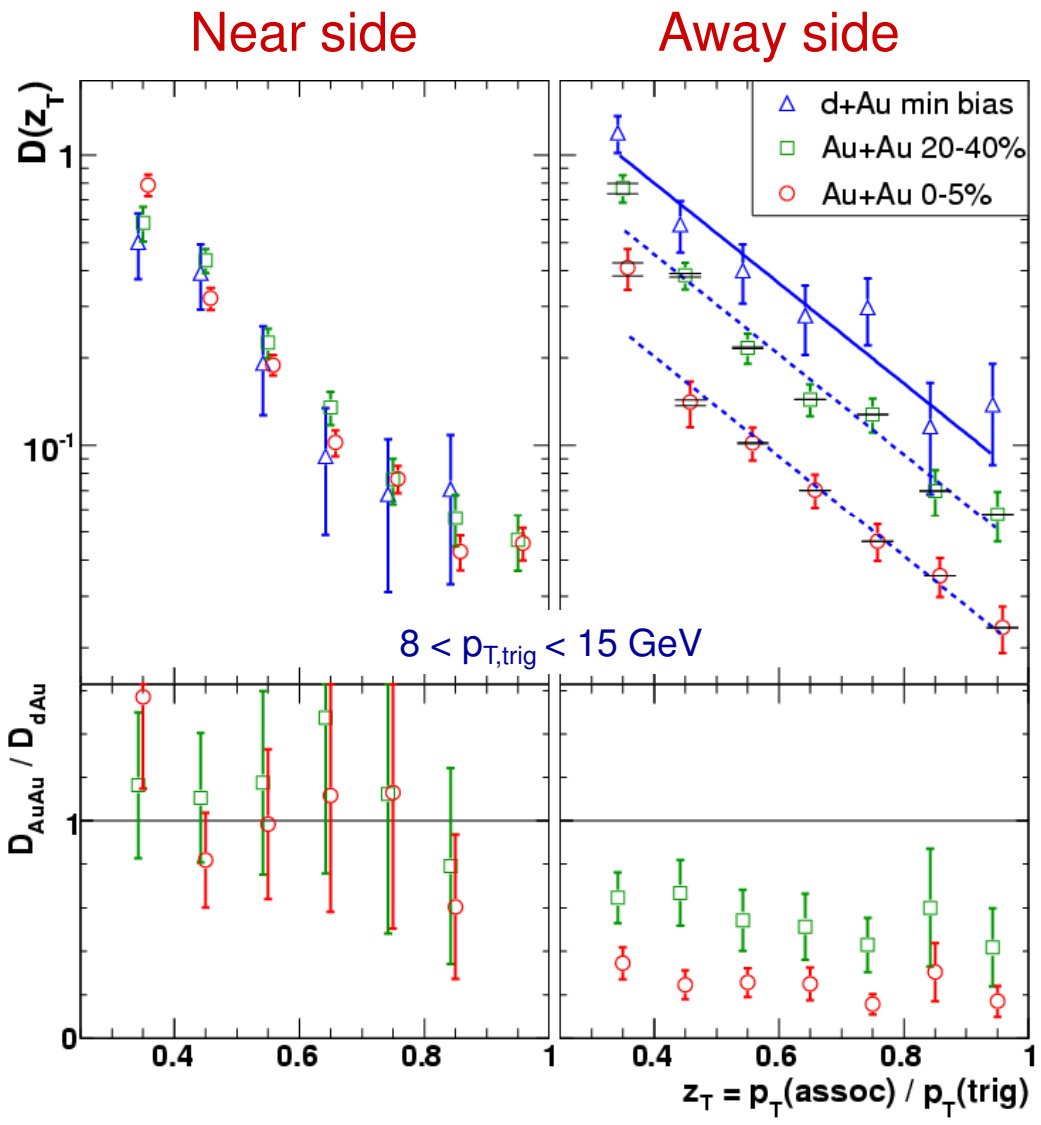
STAR, PRL 98 (2007) 192301, PHENIX, PRL 98 (2007) 172301





- RHIC: single electrons are strongly suppressed to the same level as observed for light-quark hadrons – in contradiction to expectations from dead-cone-effect
- Up to now, model calculations do not describe the RHIC data sufficiently well
- Relative bottom contribution has large error bars – direct reconstruction of c and b hadrons necessary

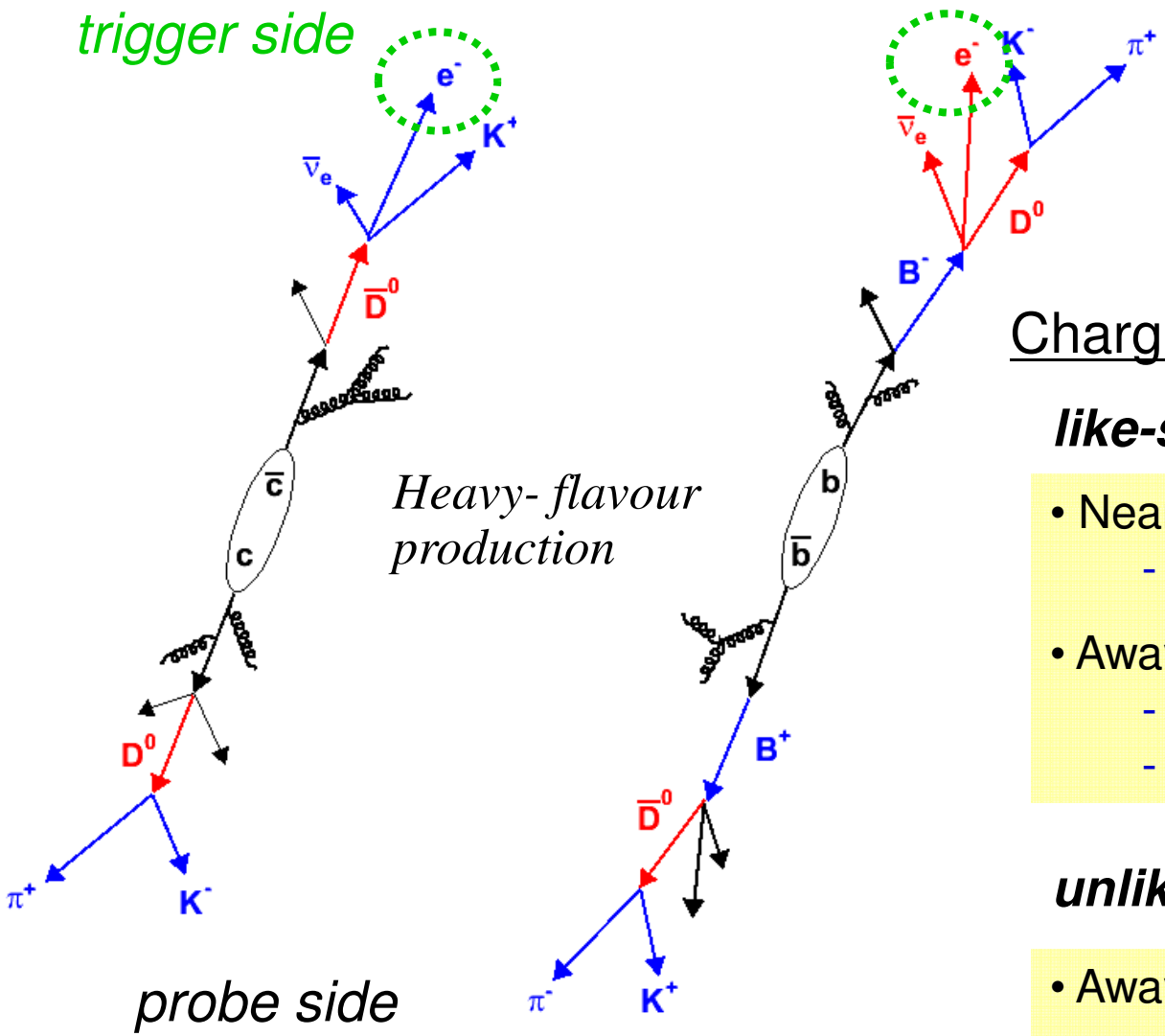
Towards HF fragmentation function



- $m_c \approx 260\ m_{u,d}$
  $m_b \approx 3.5\ m_c$
- Measurement of charm and bottom fragmentation functions
- Dynamical properties of the QCD

STAR results for high-pT triggered light-quark hadrons
PRL 97 (2006) 162301

Decay kinematics



Charge sign cut on decay kaons

like-sign: *q(ele) = q(K)*

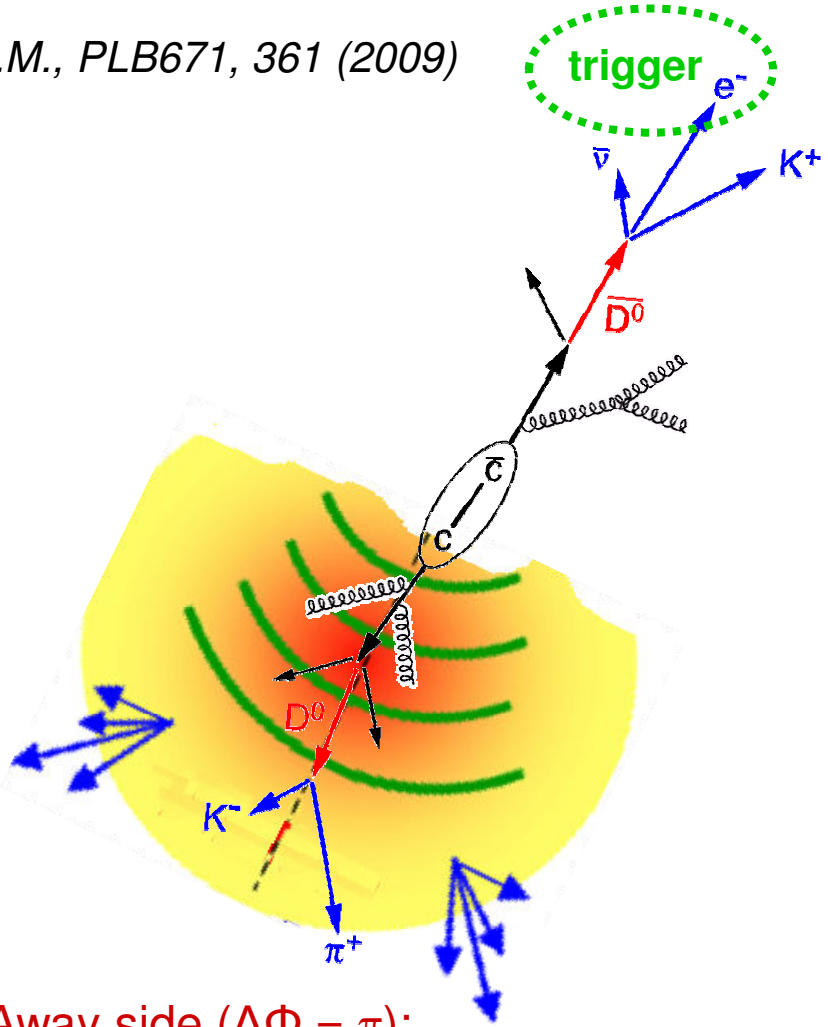
- Near-side
  - B decays (dominant)
- Away-side
  - charm flavour creation (dominant)
  - small B contribution

unlike-sign*: q(ele) ≠ q(K)*

- Away-side
  - B decays (dominant)
  - small charm contribution

Correlation technique

A.M., PLB671, 361 (2009)

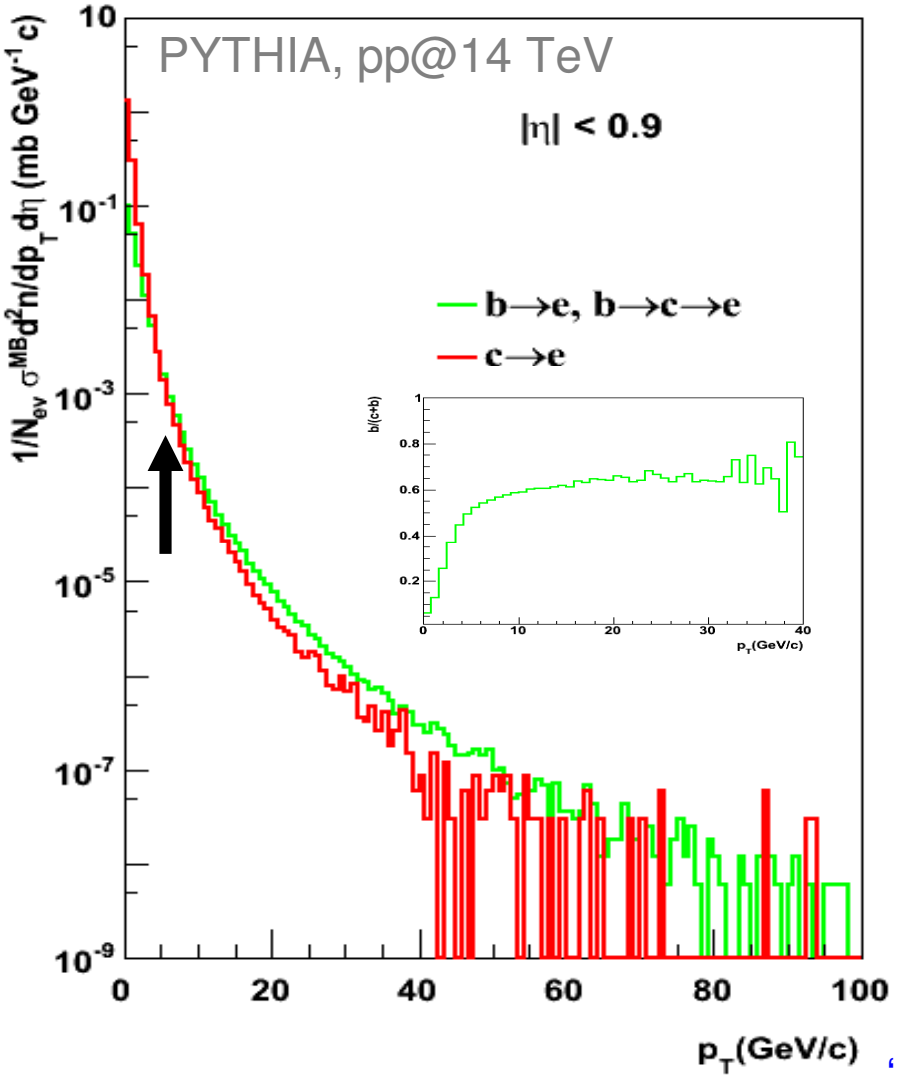


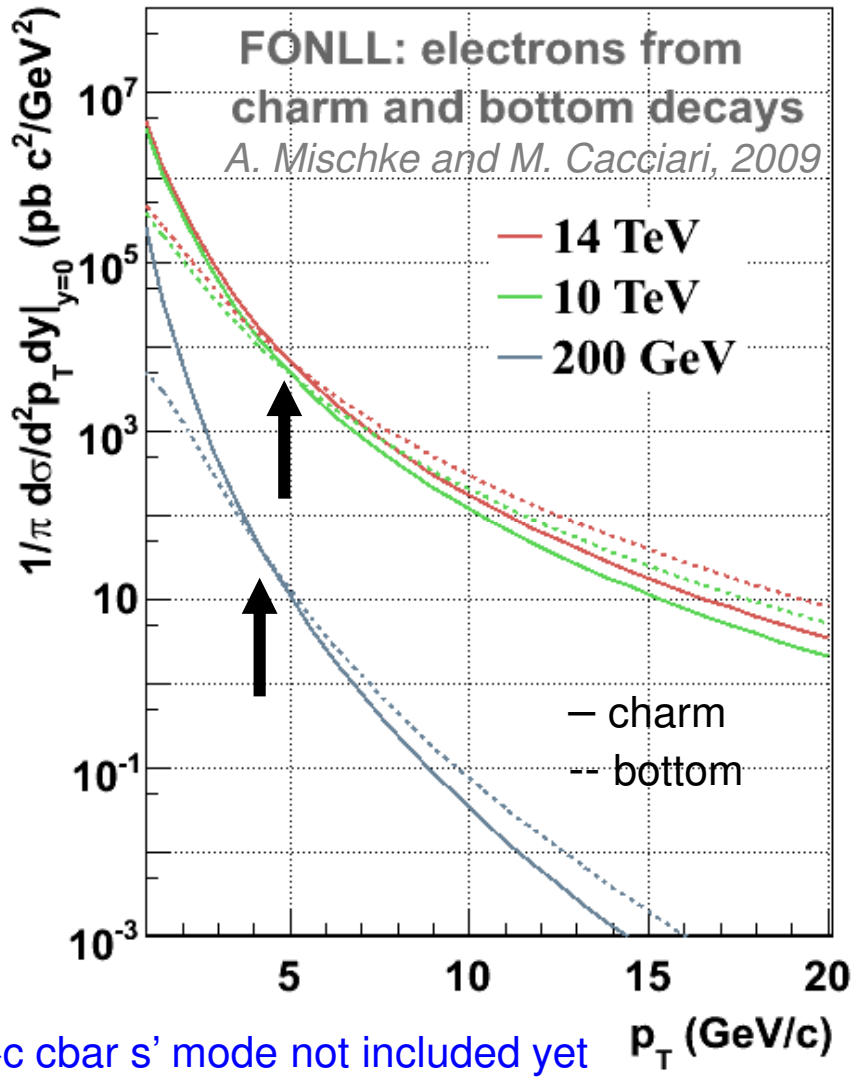
Away side ($\Delta\Phi = \pi$):

- study in-medium D/B energy loss - conical emission as observed for light quark hadrons?
- modification of fragmentation function

- Heavy quarks are produced in pairs
- Separation of charm or bottom production events using their decay topology and azimuthal angular correlation of their decay products
  - single electrons are used to trigger on high-pT c-cbar/b-bbar pairs
  - associated D^0 are reconstructed through their hadronic decay channel (probe)
- Study two-particle azimuthal angular correlations
- Efficient electron trigger

Single electron spectra



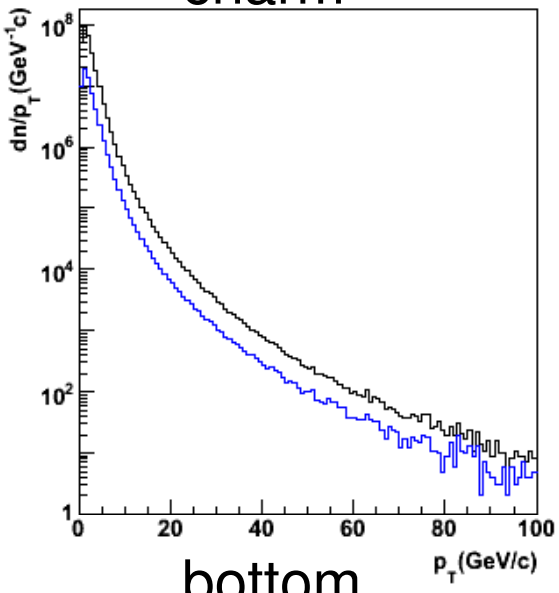


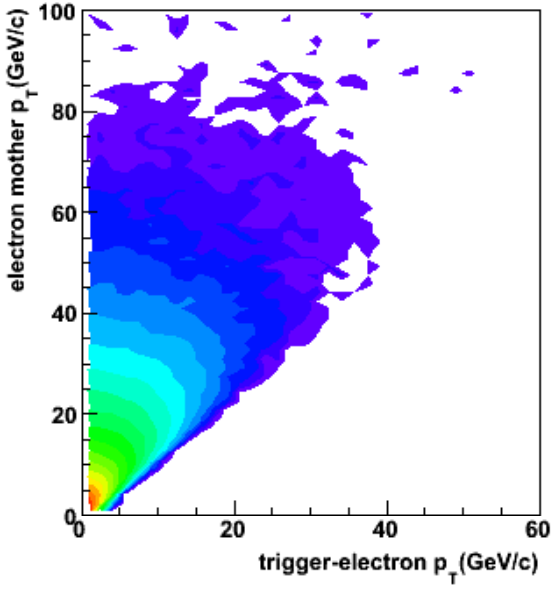
'b→c cbar s' mode not included yet

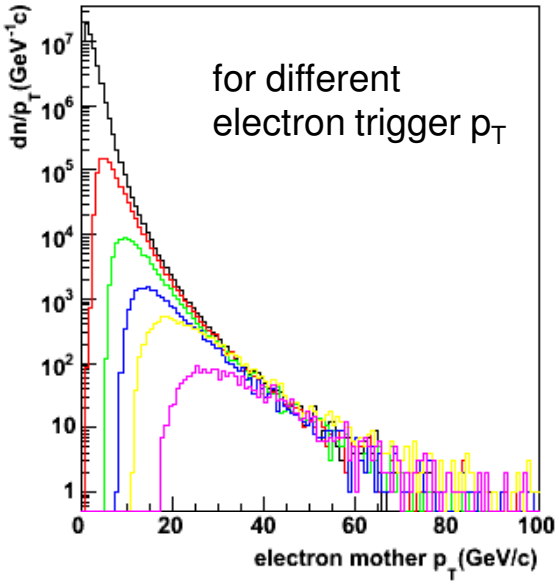
D→e/B→e crossing point around the same p_T for RHIC and LHC

Electron mother

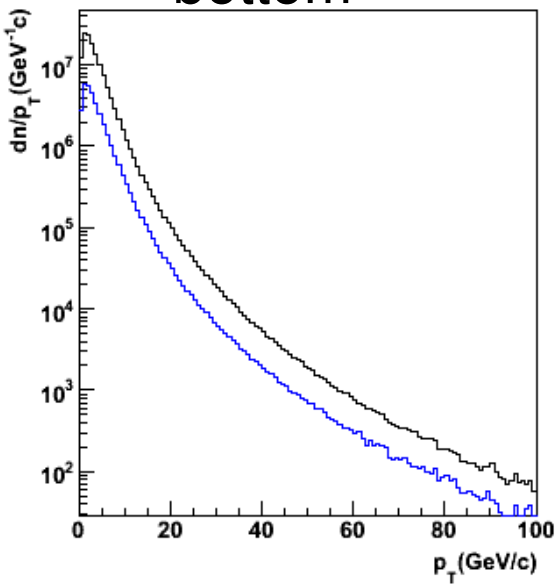
charm

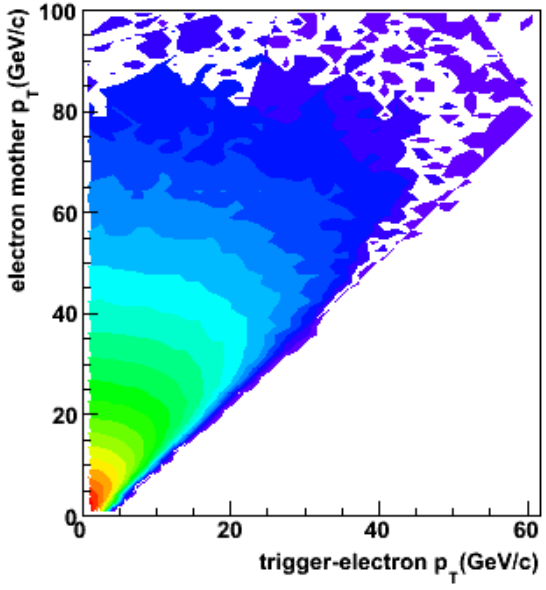


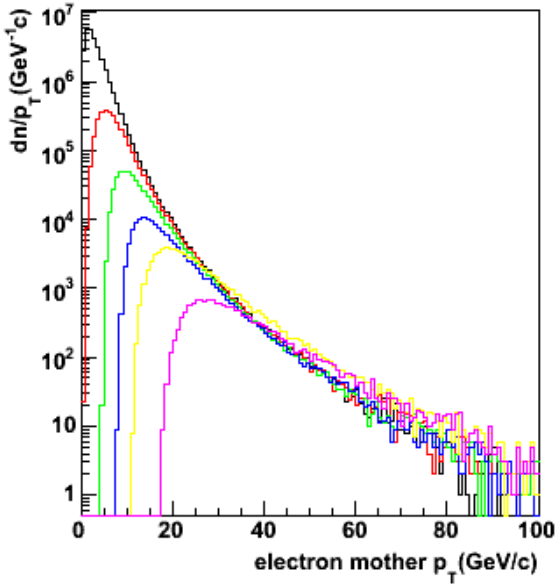




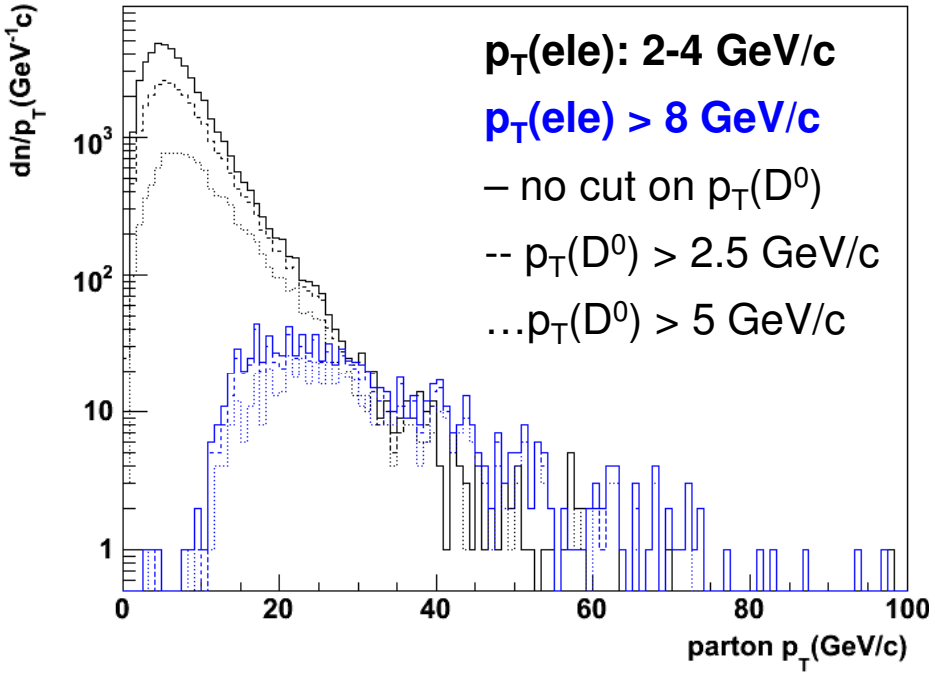
bottom



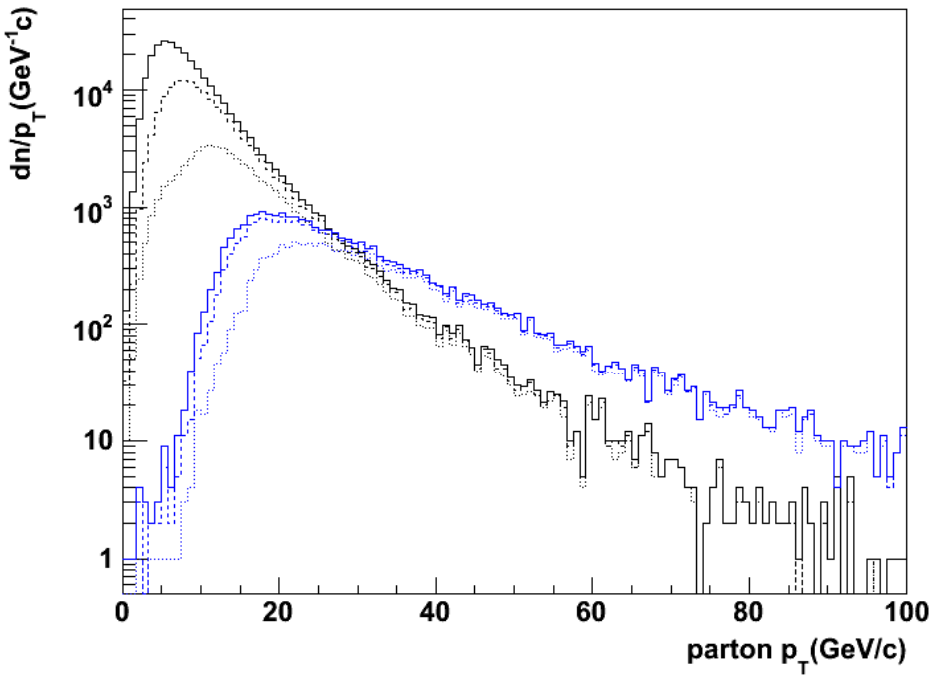




Parton p_T

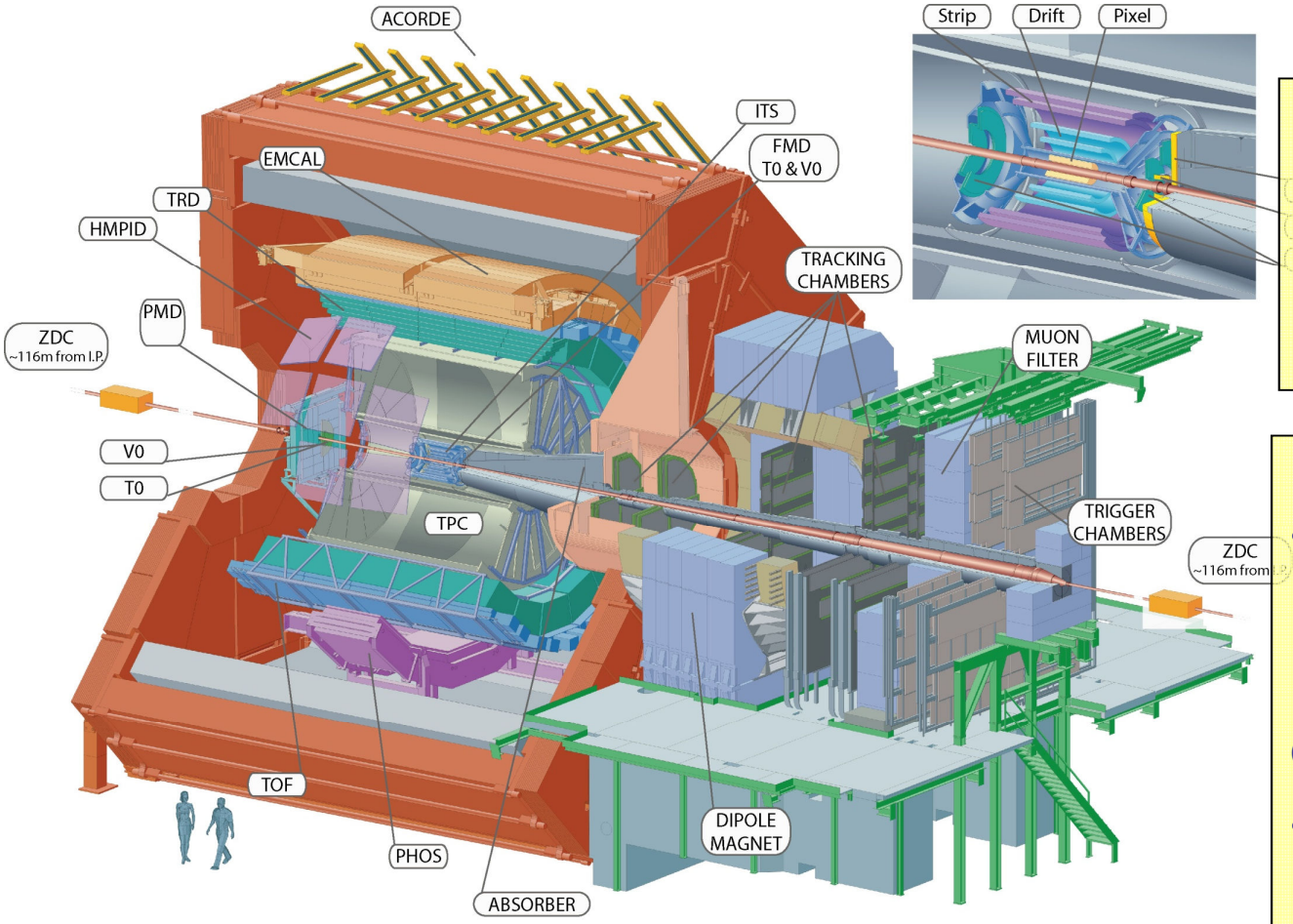


c→e



b→e

The ALICE detector



Electrons

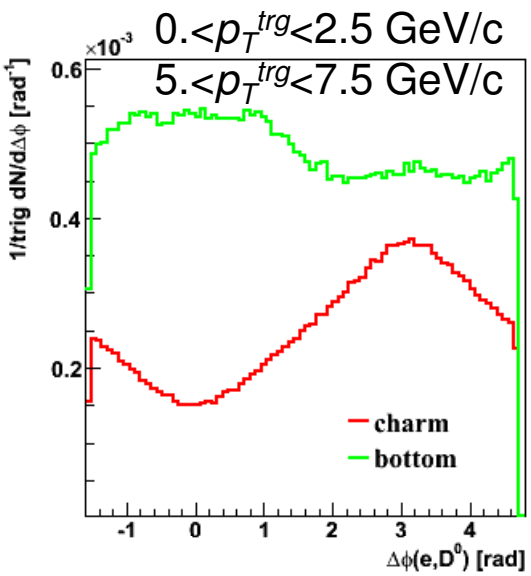
- ***EMCal***
  - $|\eta| < 0.7$
  - $dE/E < 10\%/\sqrt{E}$
- ***TRD***

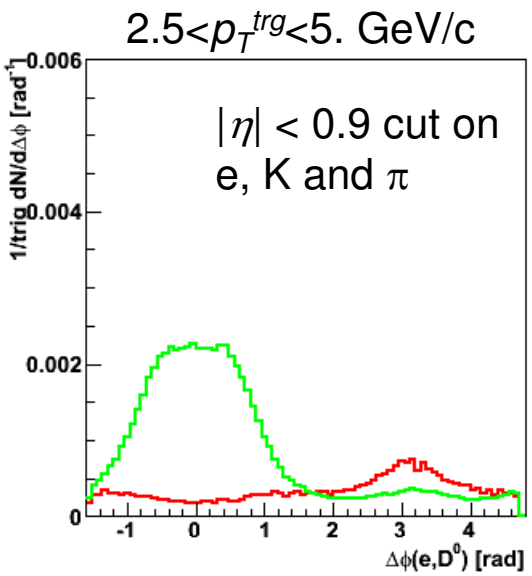
D^0 decay products

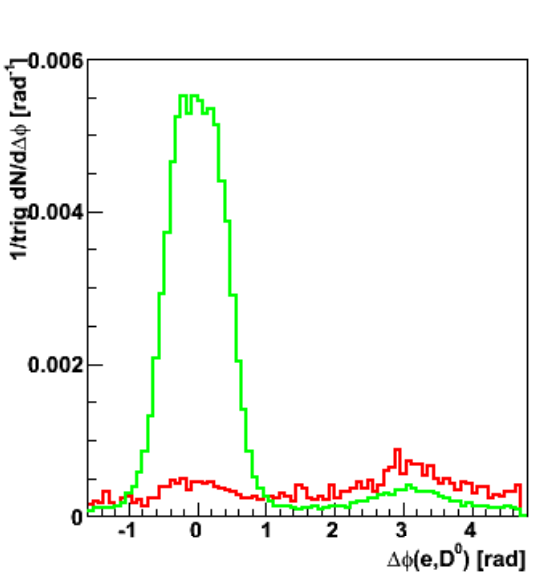
- ***ITS***
  - material budget ~8% X_0
  - impact parameter res. < 50μm for p_T>1.5 GeV/c
- ***TPC***
  - $\Delta p/p$ = 5% at 100 GeV/c
  - $\sigma_{dE/dx}/dEdx < 6\%$
- ***ToF***
  - 50-100ps

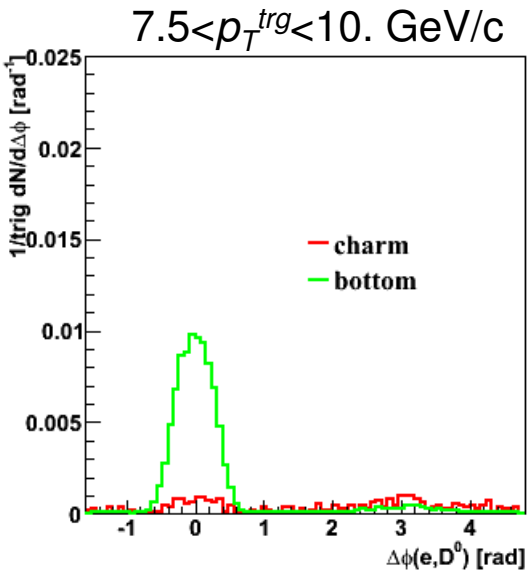
- PID from ~100 MeV/c to above 30 GeV/c
- large acceptance in azimuth
- mid-rapidity coverage ($|\eta| < 0.9$) and $-4 < \eta < -2.5$ in forward region

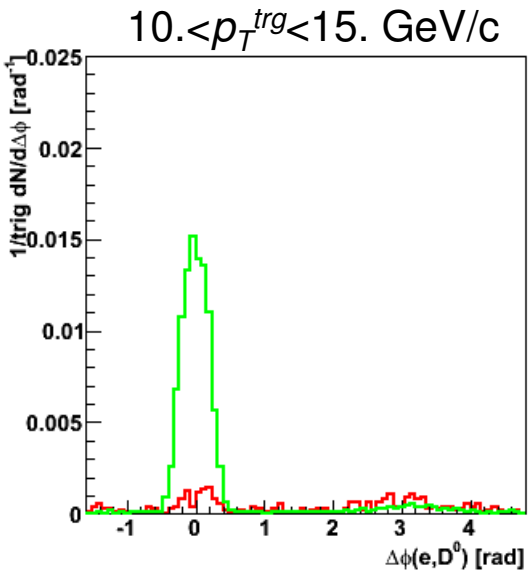
$\Delta\phi(e,D^0)$ distribution for like-sign pairs

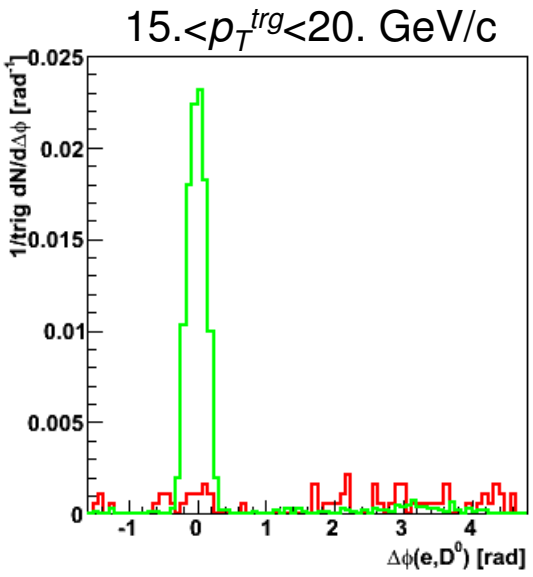






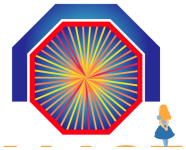


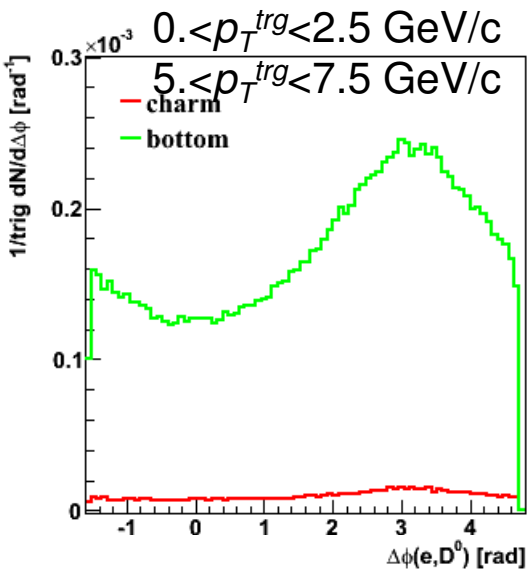


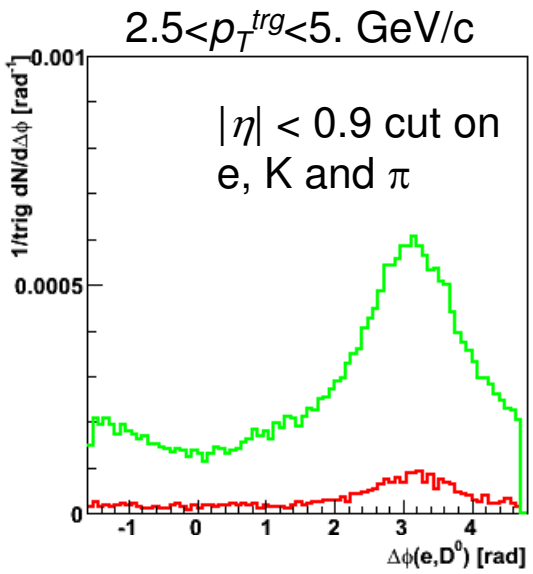


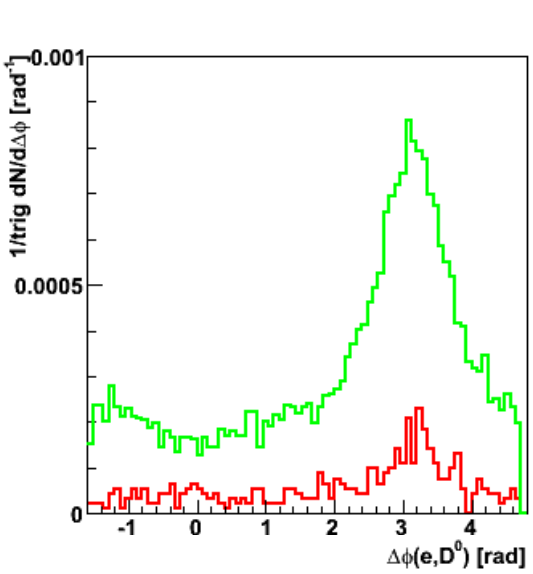
pp @ $\sqrt{s}$ = 14 TeV

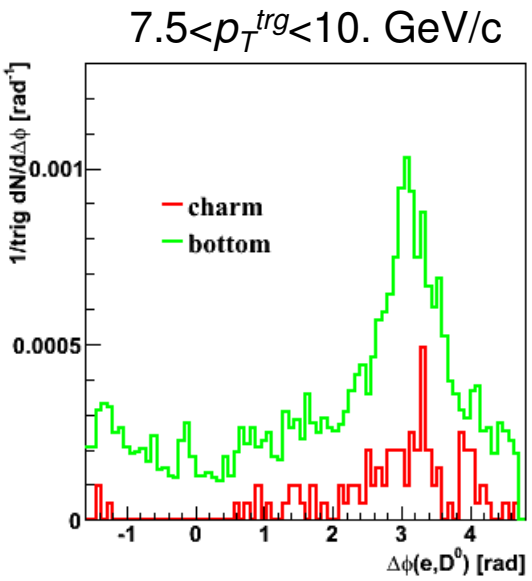
$\Delta\phi(e,D^0)$ distribution for unlike-sign pairs

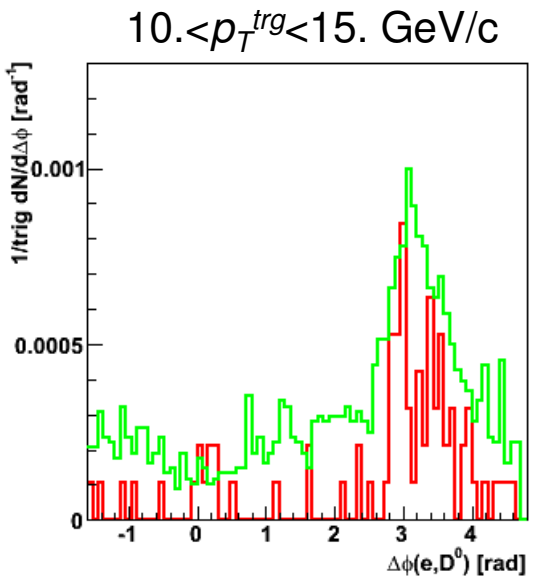


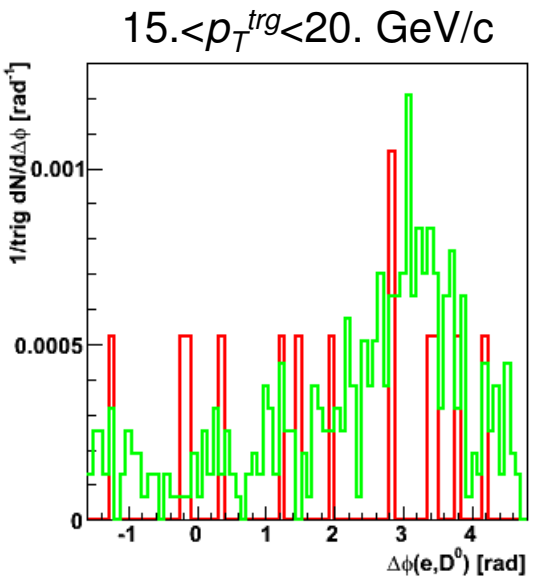








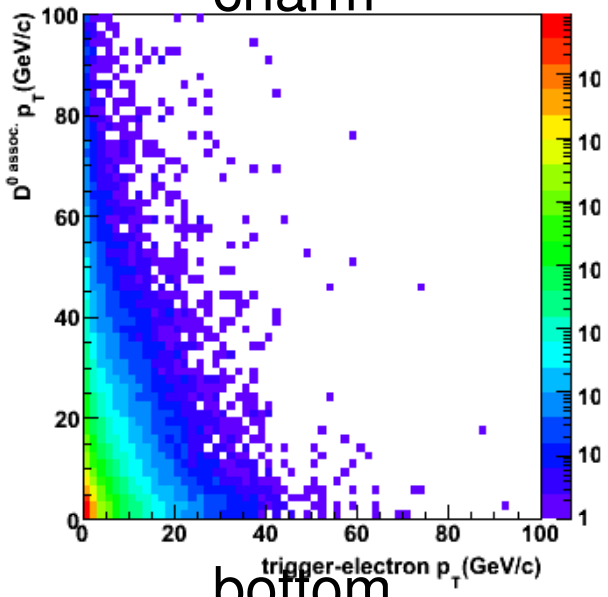


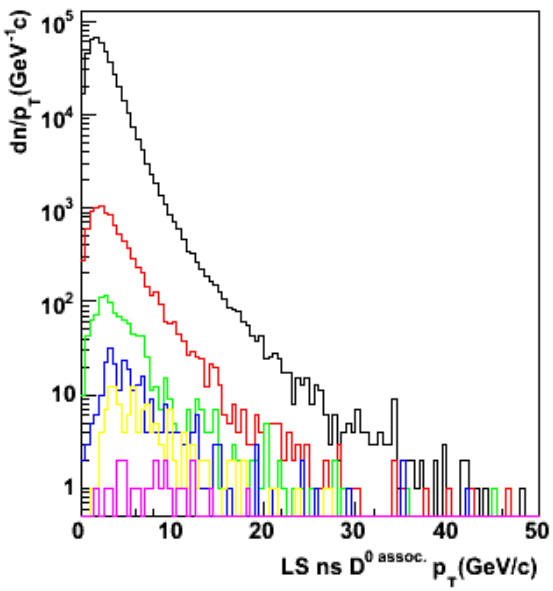


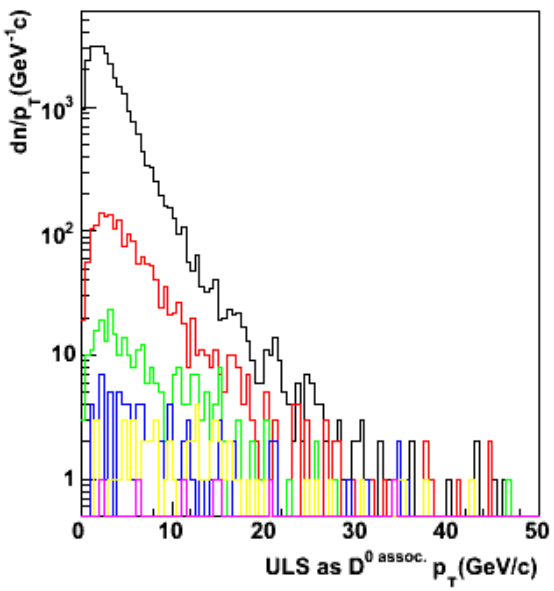
pp @ $\sqrt{s}$ = 14 TeV

Associated D^0 spectra

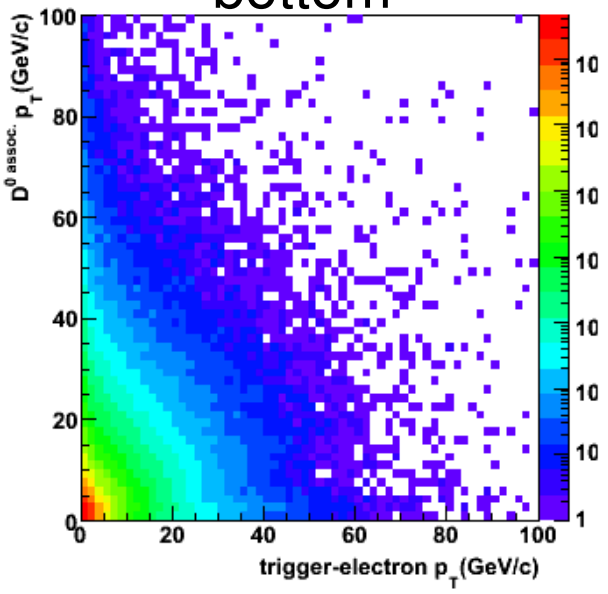
charm

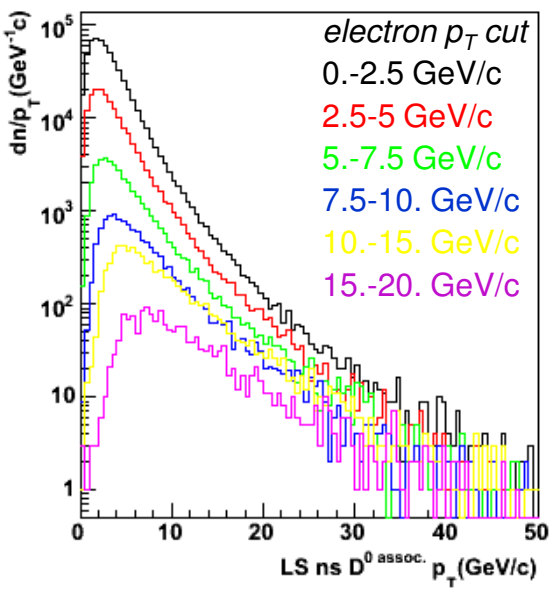


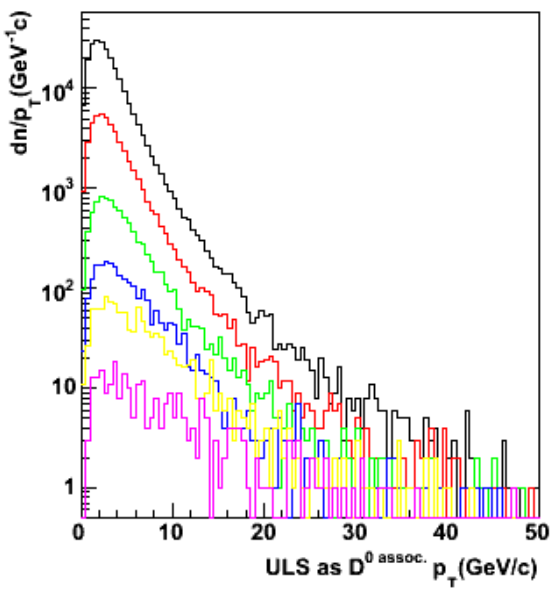




bottom

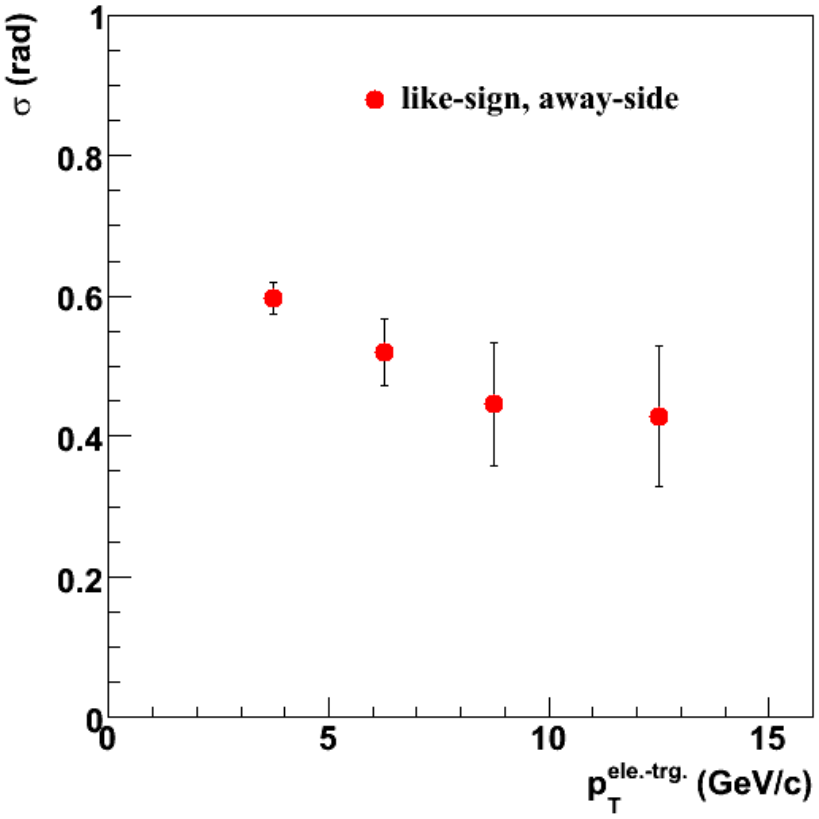




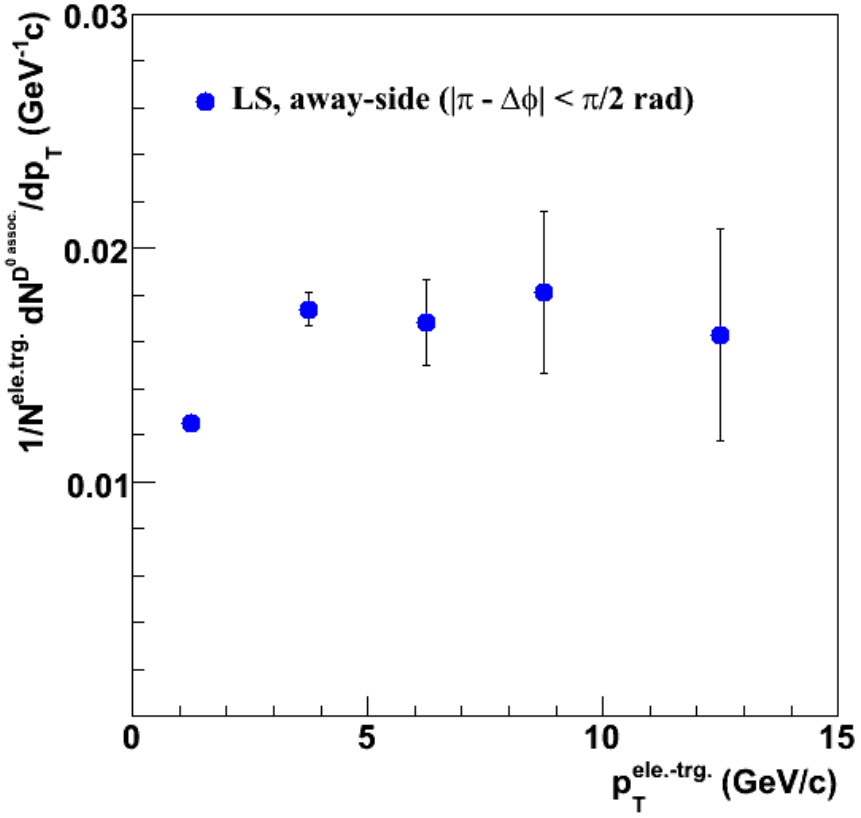


Charm: away-side peak

width*



yield**

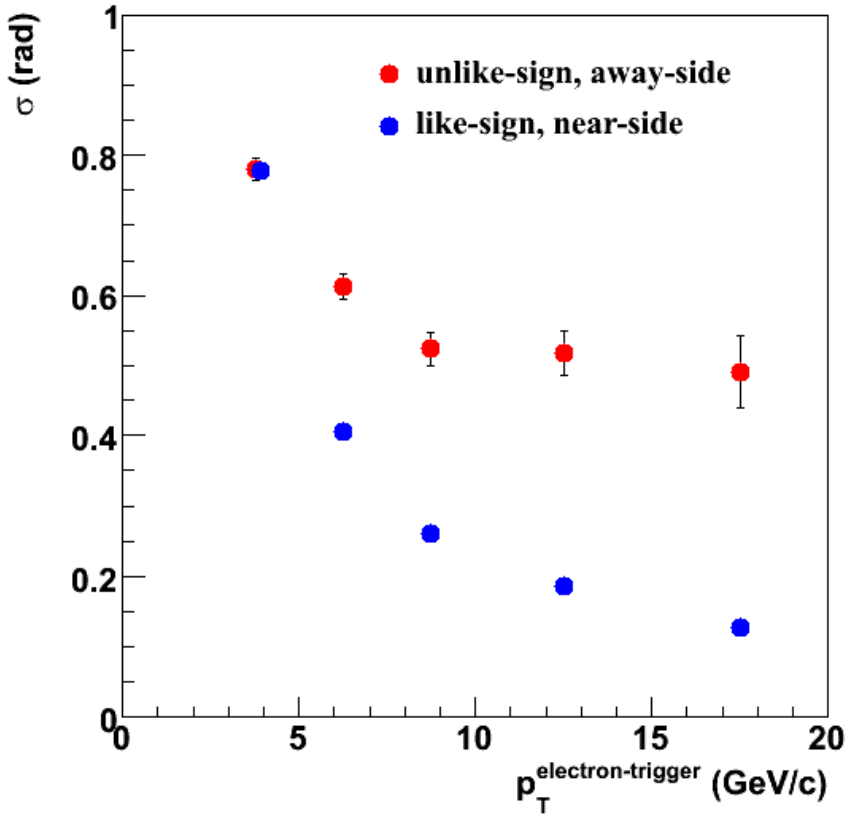


* using Gaussian fit

** integral in the indicated range

Bottom: near- and away-side peaks

width



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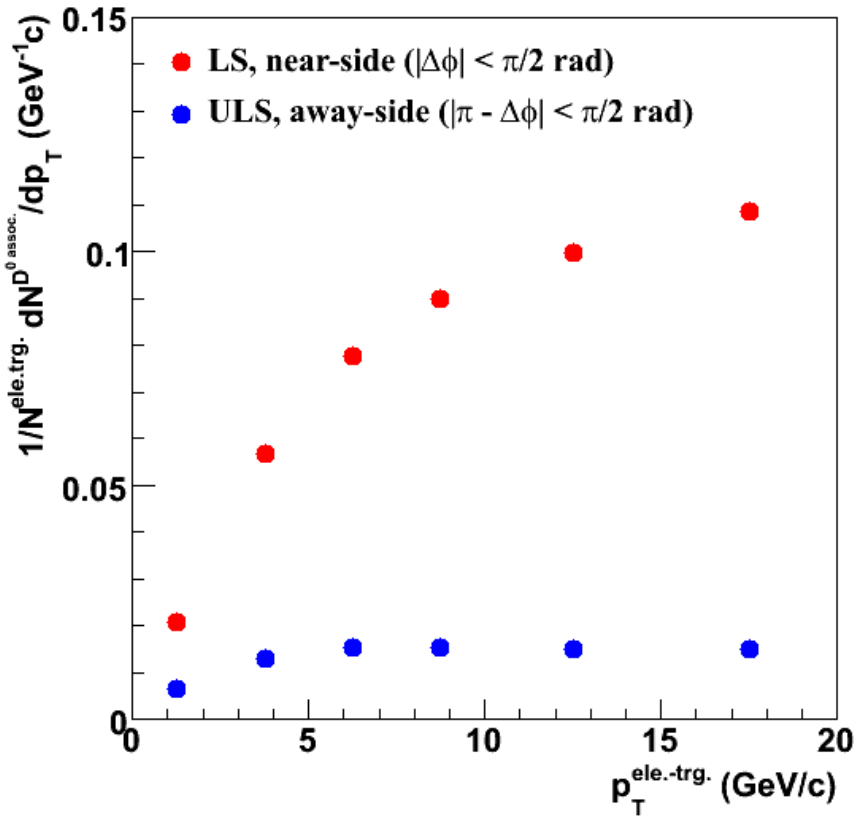
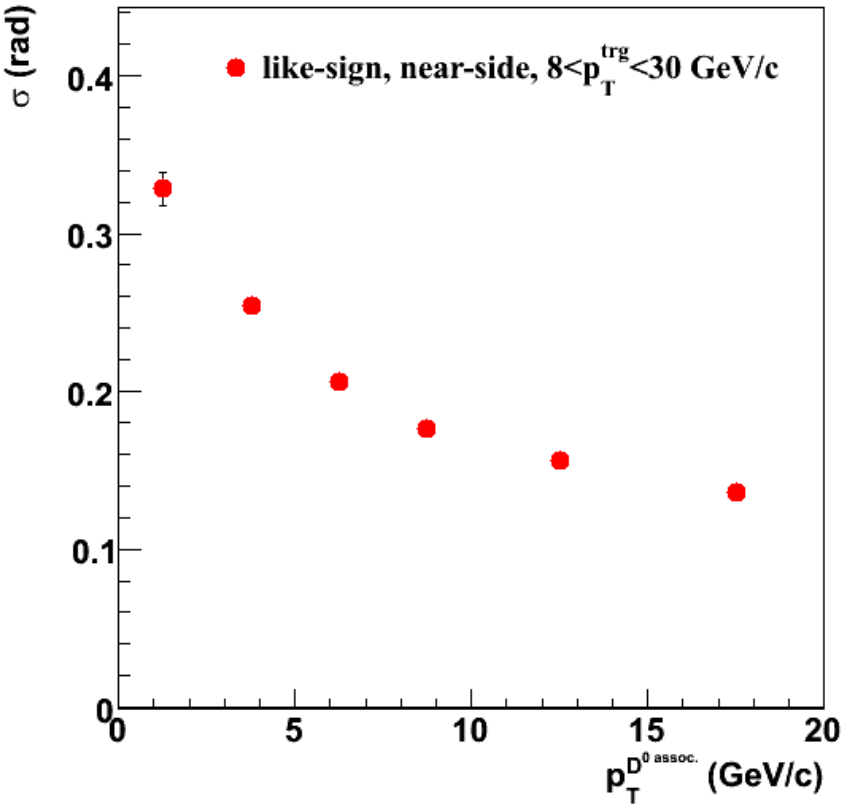
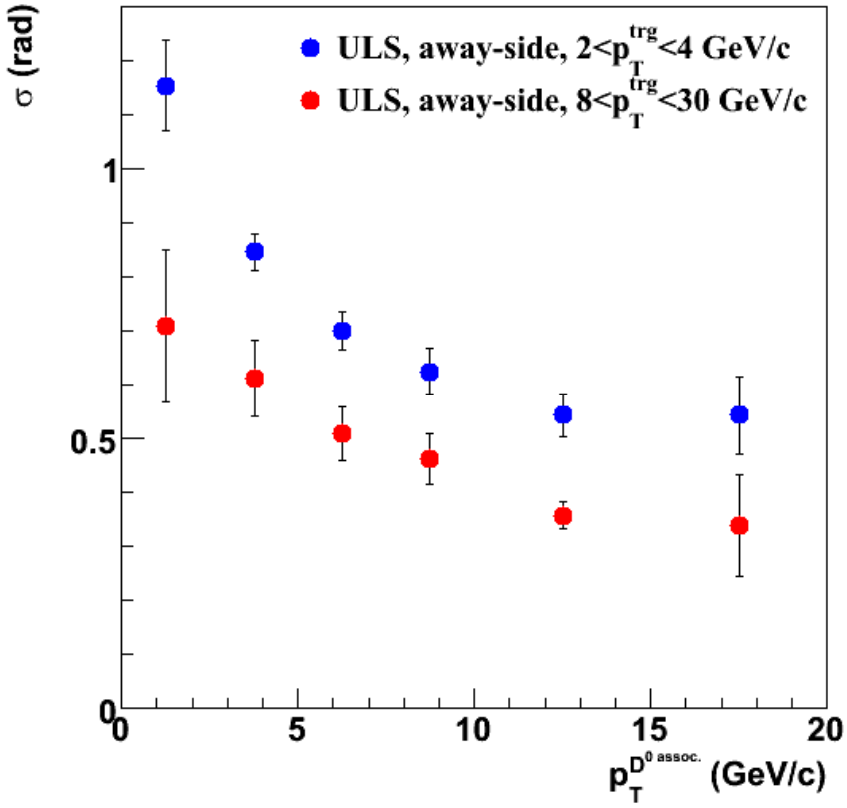


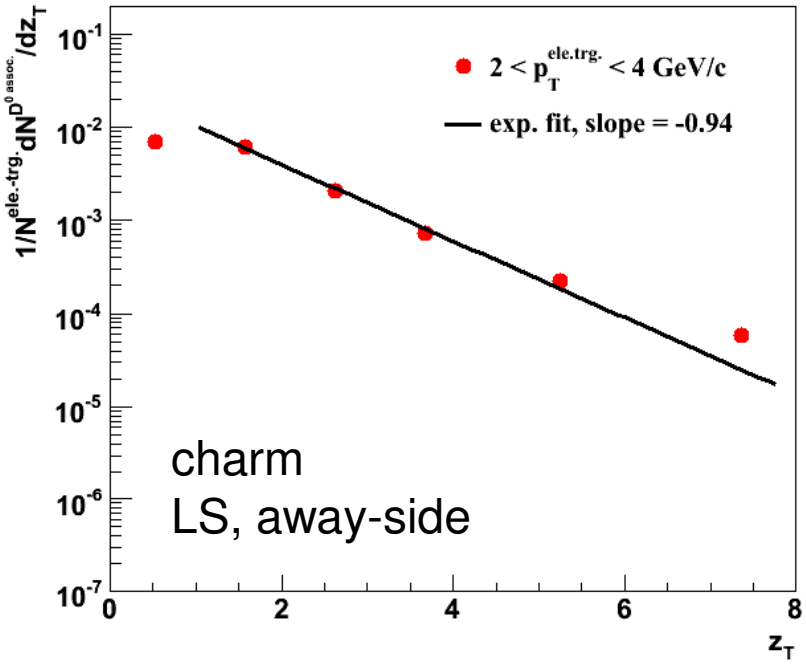
Bottom: peak width versus $p_T^{D0assoc}$

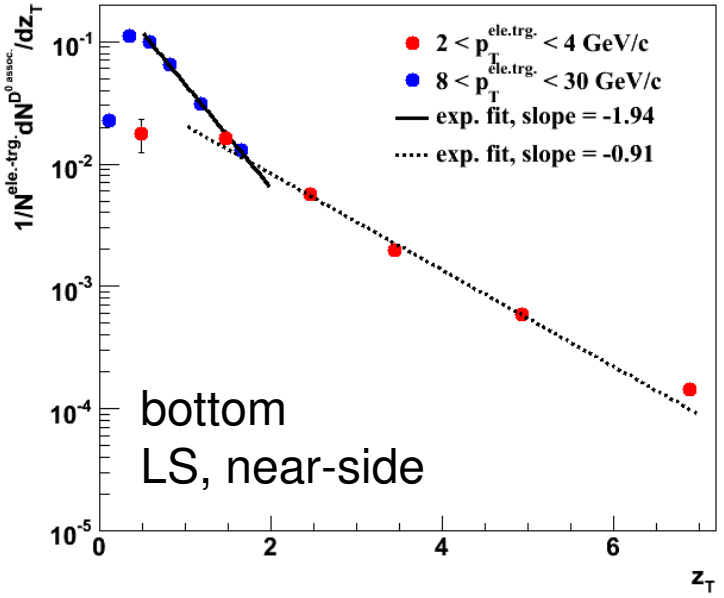


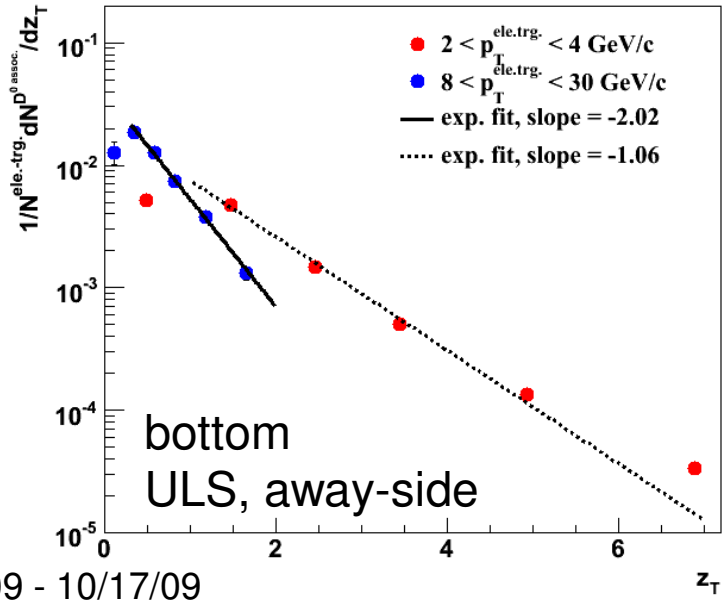


Correlation peaks get narrower with increasing $p_T^{D0assoc}$

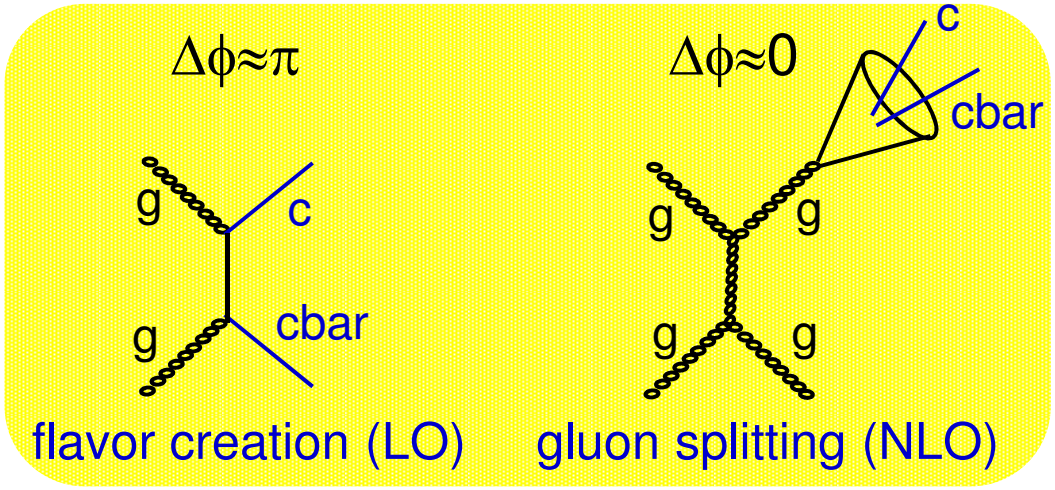
D^0 fragmentation functions



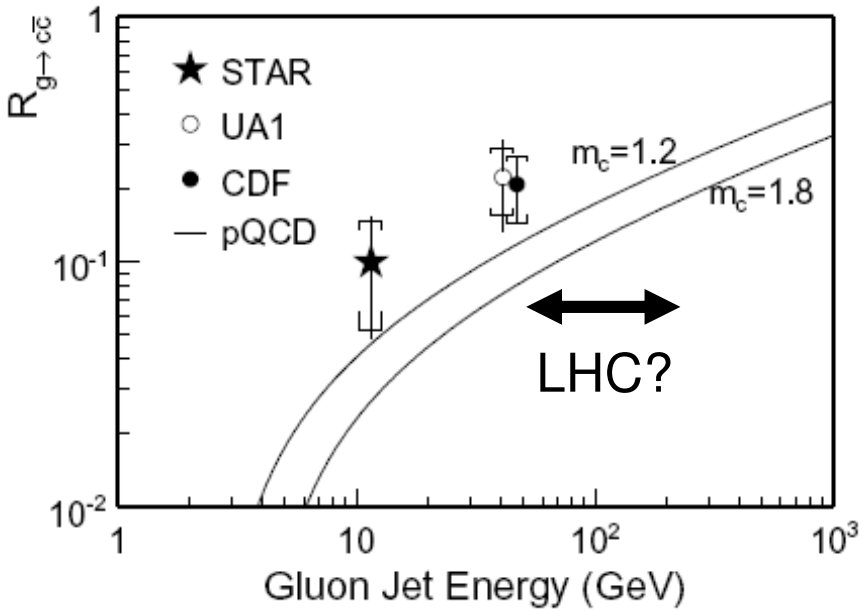


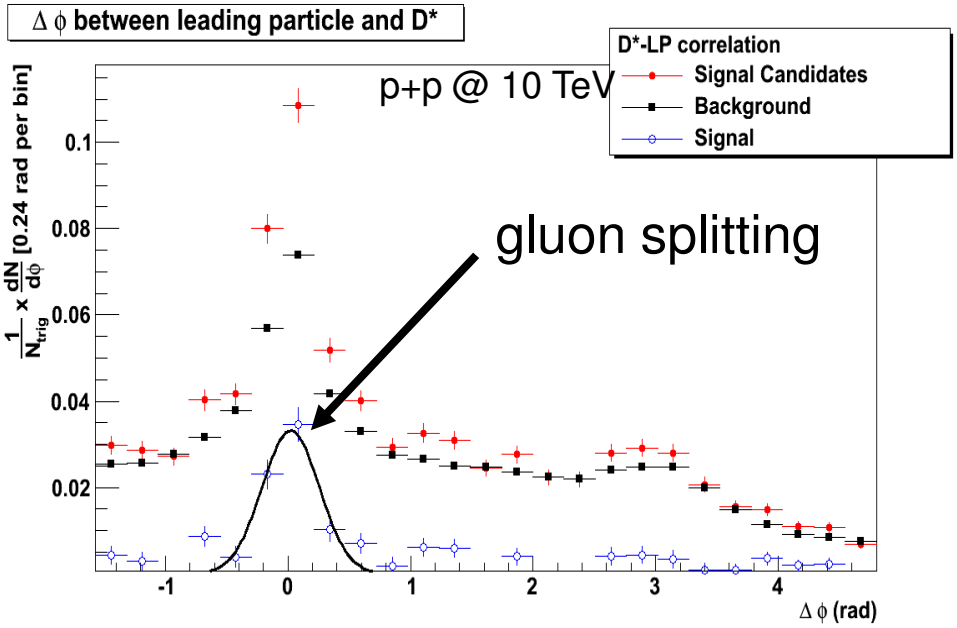


Gluon splitting contribution



- At LHC the contribution from gluon splitting might be as big as the one from flavour creation
- **D* in jet** measurement
- Soft charm FF in gluon jet





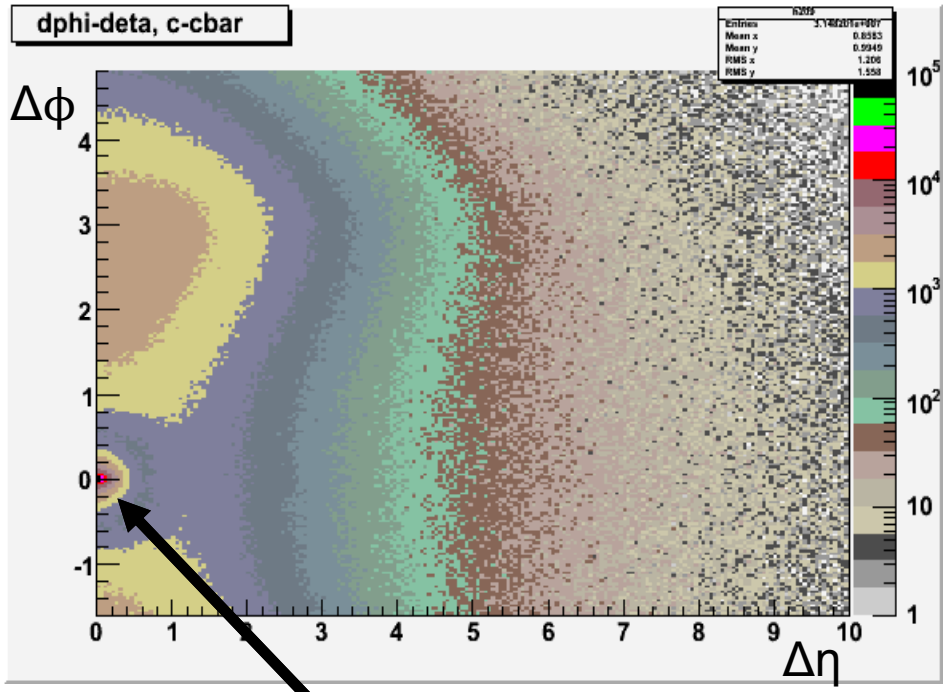
Summary and conclusions

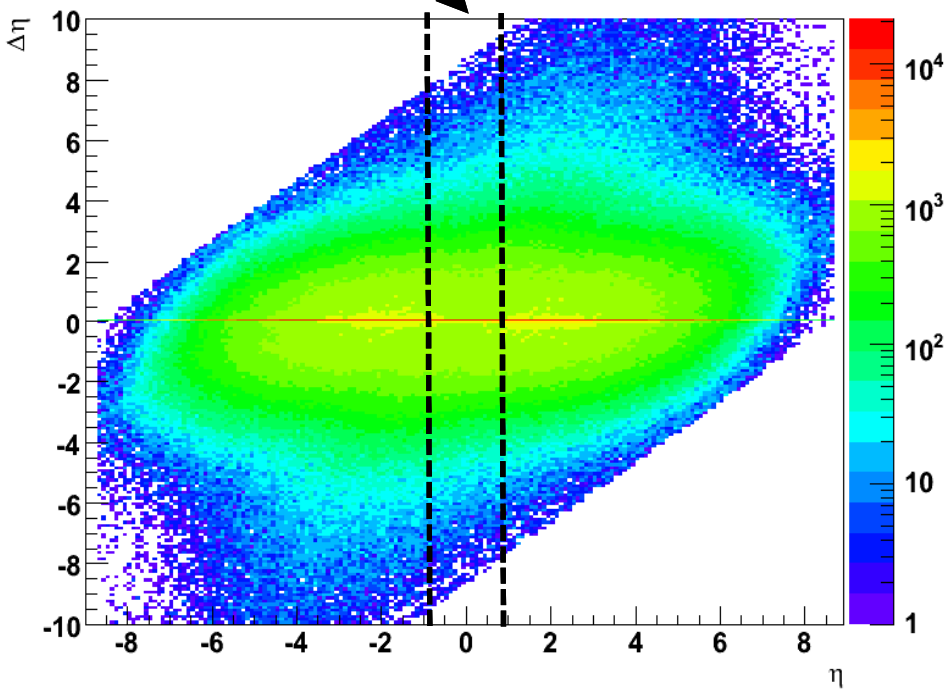
- First studies on azimuthal angular correlations between single electrons and D^0 mesons were reported using PYTHIA simulations
- Sensitive to the underlying production mechanism using second charm particle
- Robust electron trigger to study energy loss of heavy quarks at really high p_T (>20 GeV/c)
- Next
  - refine studies using NLO computations
  - study charm/bottom fragmentation function in the medium

Backup slides

Kinematics for ccbar pairs

ALICE (central barrel) acceptance





Gluon splitting

PYTHIA parameter settings

- Version: 6.222
- CTEQ5L PDF
- p+p at $\sqrt{s}$ = 14 TeV
- m_c = 1.3 GeV/c^2 and m_b = 4.5 GeV/c^2
- $\langle k_T \rangle$ = 1.5 GeV/c
- k factor = 3.5
- D/D* spin factor = 0.594

- Event statistics: 1.5B and 320M events for charm and bottom, respectively
- Cross-sections: ~43mb and ~1.9mb for for charm and bottom, respectively