Open heavy flavour in heavy-ion collisions - Experiment -

INFN

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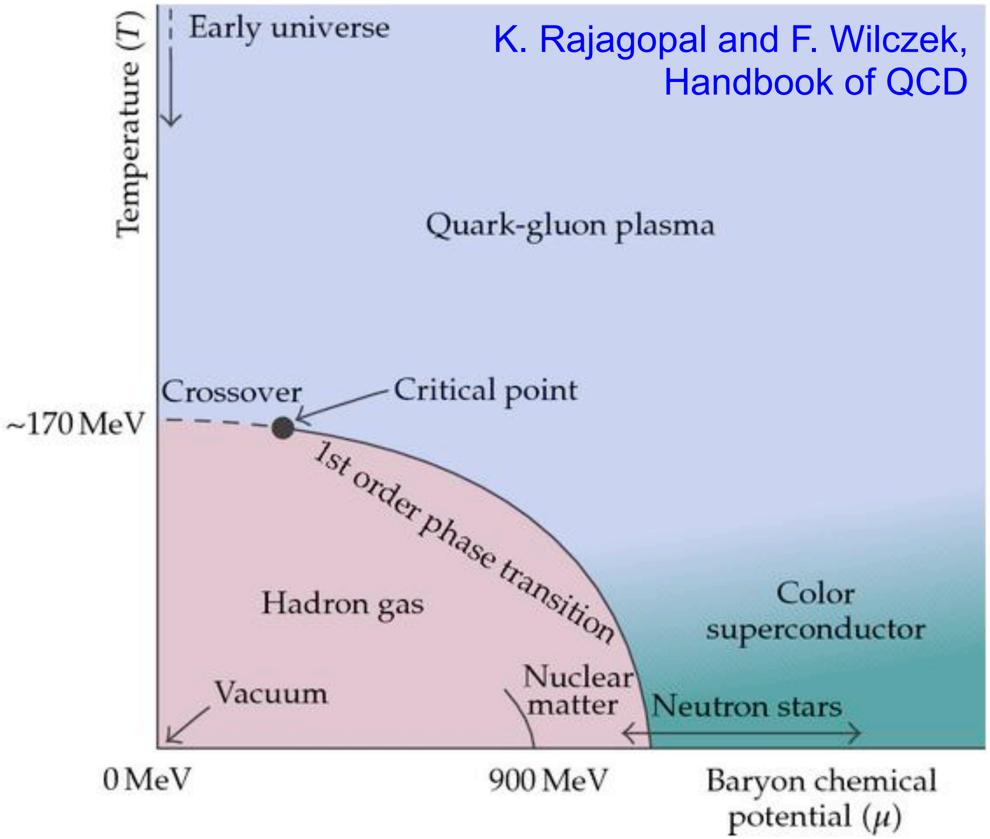
Outline

- Heavy-ion collisions and Heavy Flavour
- HF reference measurements in pp collisions
- HF production in nucleus-nucleus and proton-nucleus collisions at RHIC and LHC:
  - Effects of hot and cold nuclear medium
  - HF azimuthal anisotropy
- Conclusions and Outlook

Phase diagram of strongly-interacting (QCD) matter



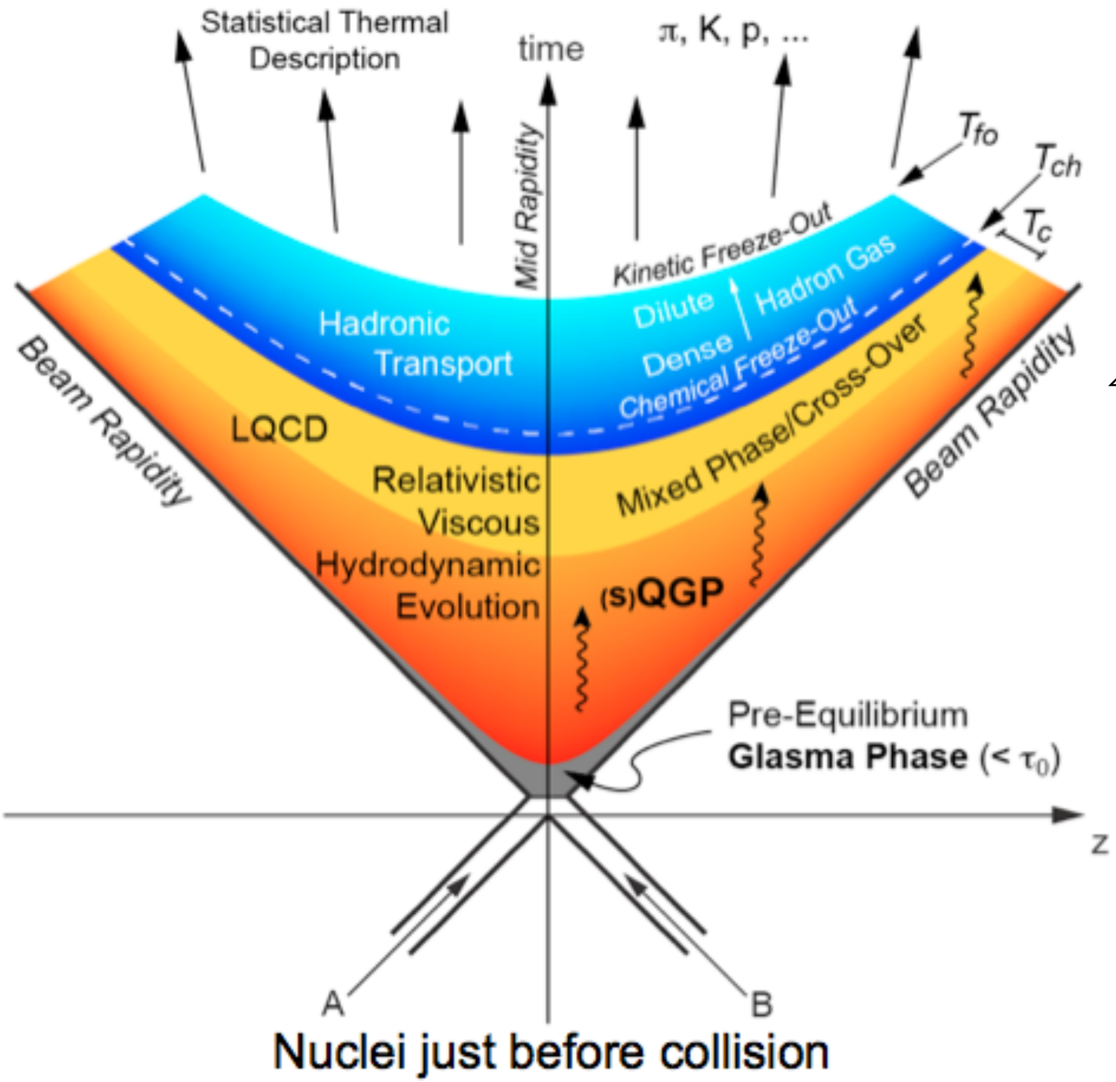
[~ Density of baryons – anti-baryons]

At high energy density ε (high temperature and/or high density) hadronic matter undergoes a phase transition to the *Quark-Gluon Plasma (QGP)*

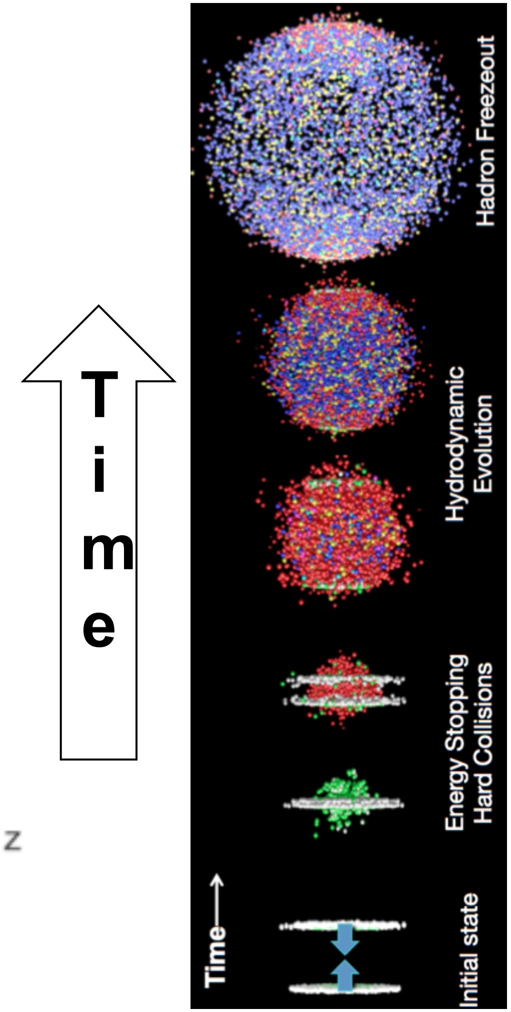
- *a state in which colour confinement is removed*
- *and chiral symmetry is approximately restored*

critical energy density $\varepsilon_c \sim 1$ GeV/fm^3 $\sim 10\ \varepsilon_{nucleus}$

Evolution of a high-energy nuclear collisions



Courtesy B.Hippolyte



Heavy Quarks as probes of the QGP

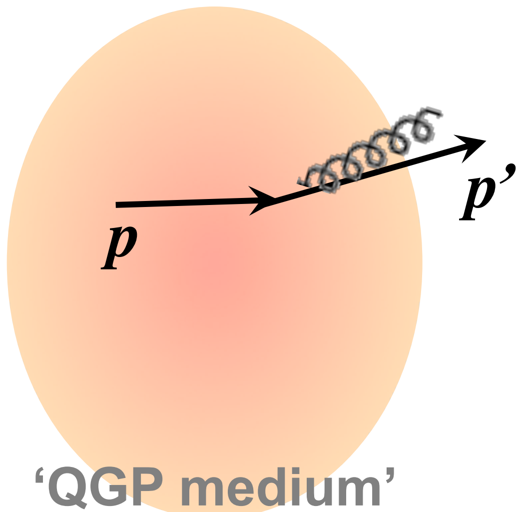
- Large mass (m_c~1.5 GeV, m_b~5 GeV) → produced in large virtuality processes at the initial stage of the collision with short formation time $\Delta t < 1/2m_Q \sim 0.1$ fm $<< \tau_{QGP} \sim 5\text{-}10$ fm
- Production in QGP expected to be ~negligible (<<10% at LHC)
- (Strong) Interactions with QGP conserve flavour

→ Uniqueness of heavy quarks: “see” full system evolution

- **Effective probes of:**
  - **The mechanisms of quark-medium interaction: energy loss (and gain)**
  - **The strength of the collective expansion of the system**

Parton energy loss

→M.Nahrgang



Parton Energy Loss by

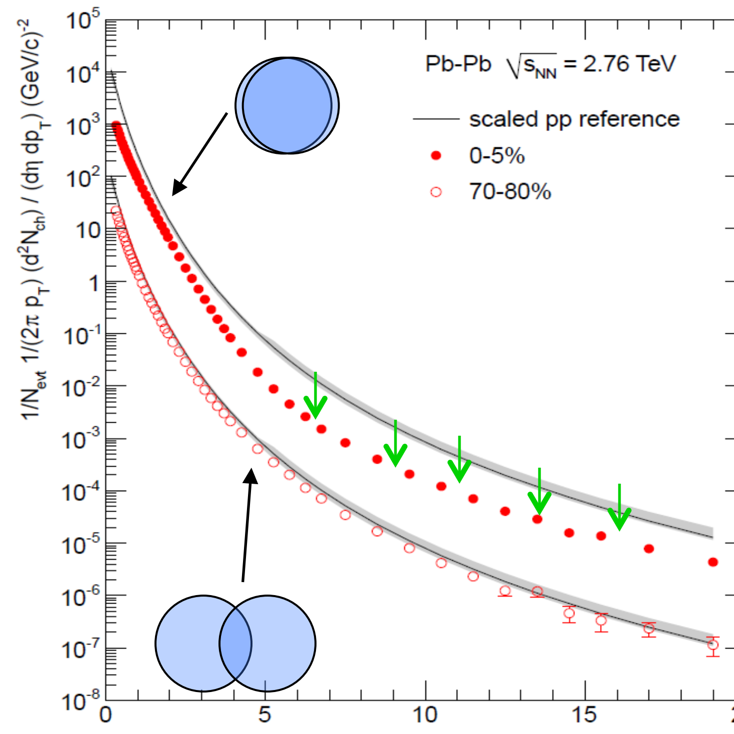
- medium-induced gluon radiation
- collisions with medium gluons

$$p' = p - \Delta E(\varepsilon_{medium})$$

Nuclear modification factor:

$$dN_{AA}/dp_T \;<\; \langle N_{coll}\rangle dN_{pp}/dp_T$$

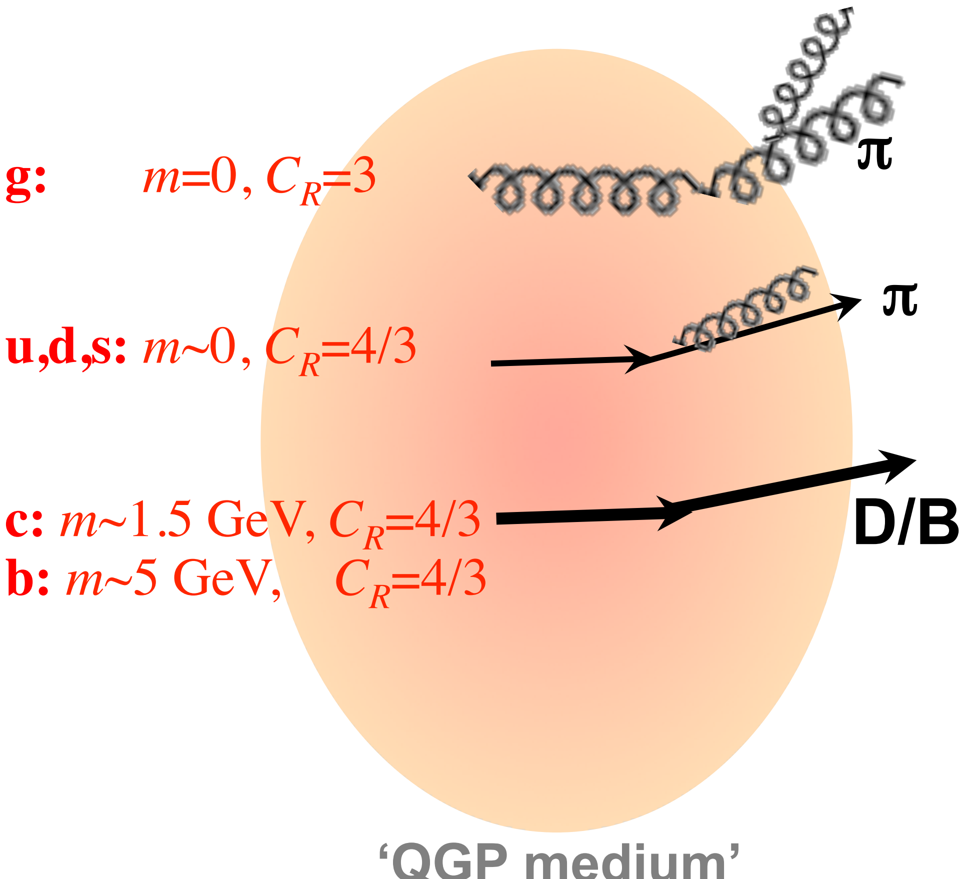
$$R_{AA}(p_T) = \frac{1}{\langle N_{coll}\rangle}\frac{dN_{AA}/dp_T}{dN_{pp}/dp_T} < 1$$



ALICE, PLB 696, 30 (2011)

Heavy Flavour energy loss

Heavy Quarks (charm and beauty): a tool to characterize the properties of the parton-medium interaction



Parton Energy Loss predicted to depend on:

- Color charge C_R (larger for gluons)
- Mass m (larger for heavy quarks)

$$\Delta E(\varepsilon_{medium}; C_R, m)$$

pred: $\Delta E_g > \Delta E_{c \approx q} > \Delta E_b$

→ $R_{AA}^{\pi} \leq R_{AA}^{D} < R_{AA}^{B}$

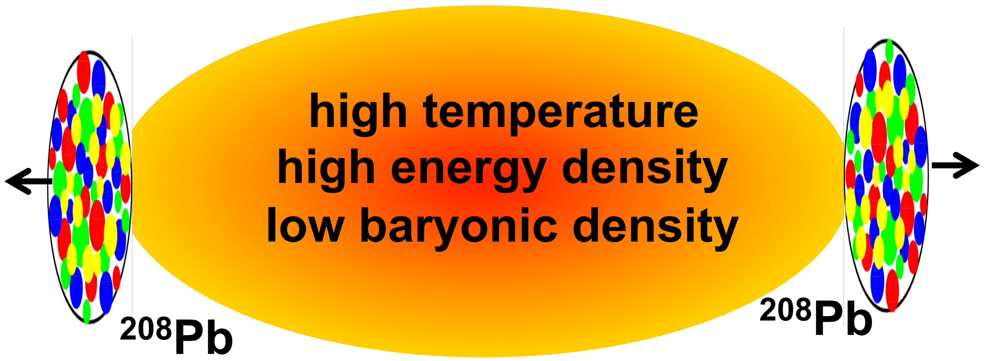
Recall:

$$R_{AA}(p_T) = \frac{1}{\langle N_{coll} \rangle} \frac{dN_{AA}/dp_T}{dN_{pp}/dp_T}$$

See e.g.:
Dokshitzer and Kharzeev, PLB 519 (2001) 199. Armesto, Salgado, Wiedemann, PRD 69 (2004) 114003.
Djordjevic, Gyulassy, Horowitz, Wicks, NPA 783 (2007) 493.

The role of proton-nucleus collisions

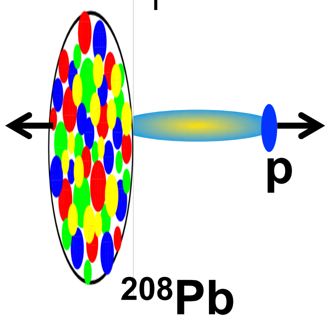
- In **high-energy nucleus-nucleus** collisions, **large energy density** (> 1 GeV/fm^3) over **large volume** (>> 1000 fm^3)



$R_{AA} < 1$

- Control experiment: **high-energy proton-nucleus** collisions, **large energy densities** (?) in a **very small volume**

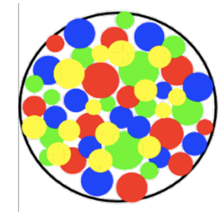
Control experiment:



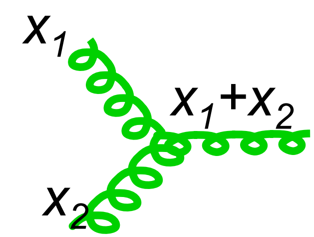
$R_{pA} = 1$?

Initial-state effects?

Initial-state effects:
Gluon Saturation at small $x_{Bjorken}$



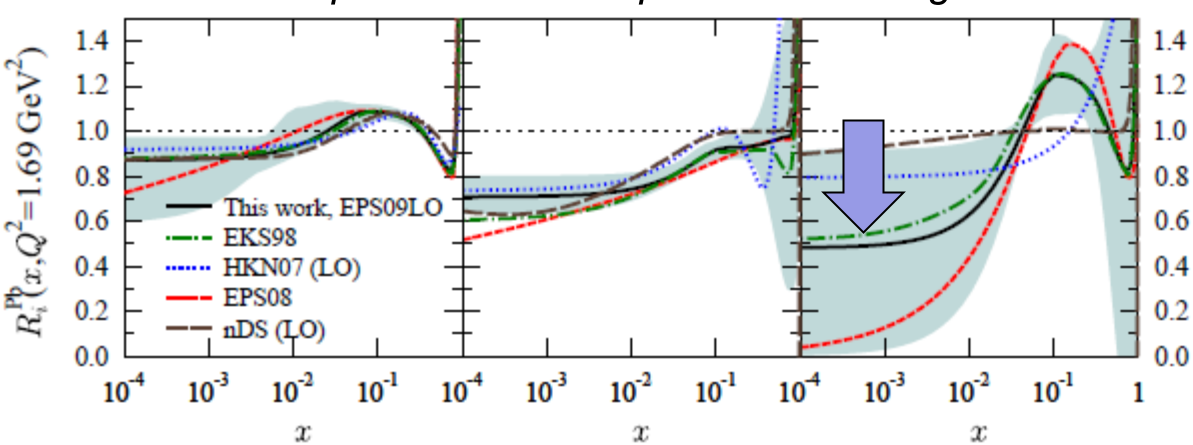
- Saturation: when gluons are numerous enough (low-x) & extended enough (low-Q^2) to overlap
- Enhanced in Au/Pb nuclei: factor $A^{1/3}$ ($\approx$6) more gluons per unit transverse area



Effective reduction of the parton flux (shadowing)
→ also described with nuclear-modified PDFs

- Shadowing factor for PDFs: $xG_A(x,Q^2) = A\,xg(x,Q^2)\,R_G^A(x,Q^2)$

valence quarks *sea quarks* *gluons*



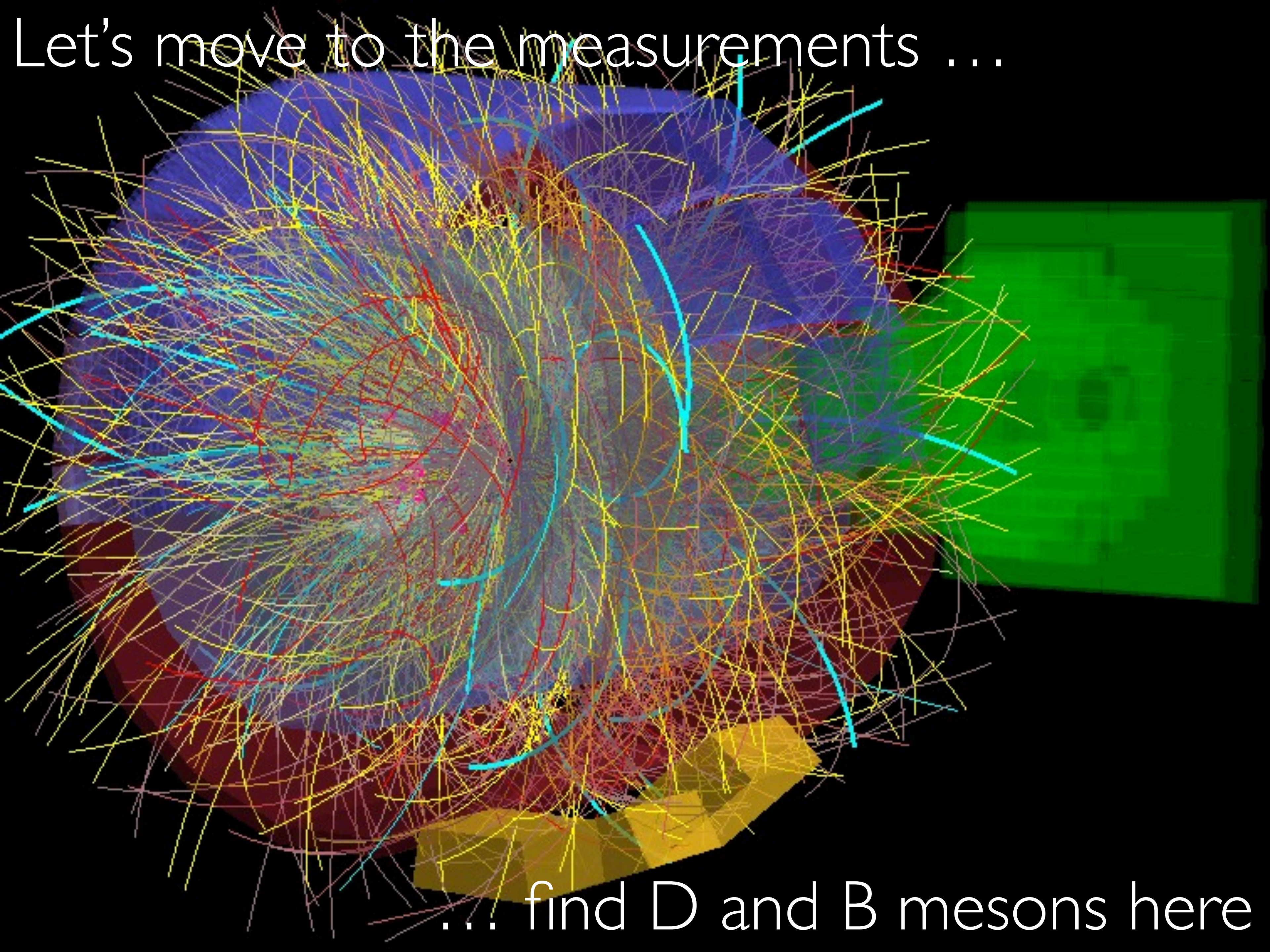
→ $R_{AA} < 1$

(when "small" x is probed)

→R.Vogt this afternoon

see e.g. Eskola et al. JHEP0904(2009)065

Let’s move to the measurements …



… find D and B mesons here

HF "detection" channels

AA

	PHENIX	STAR	ALICE	ATLAS	CMS
HF electrons	✔	✔	✔		
HF muons	✔		✔	✔	
D^0, D^+, D^{*+}		✔	✔		
D_s^+			✔		
$B \to J/\psi$			✔		✔
B jets					✔
B electrons			✔		

Originally compiled by Z. Conesa dV

p(d)A

	PHENIX	STAR	ALICE	ATLAS	CMS	LHCb
HF electrons	✔		✔			
HF muons	✔		✔			
D^0, D^+, D^{*+}		✔	✔			
D_s^+			✔			
$B \to J/\psi$						✔
B jets					✔	
B electrons			✔			
B					✔	

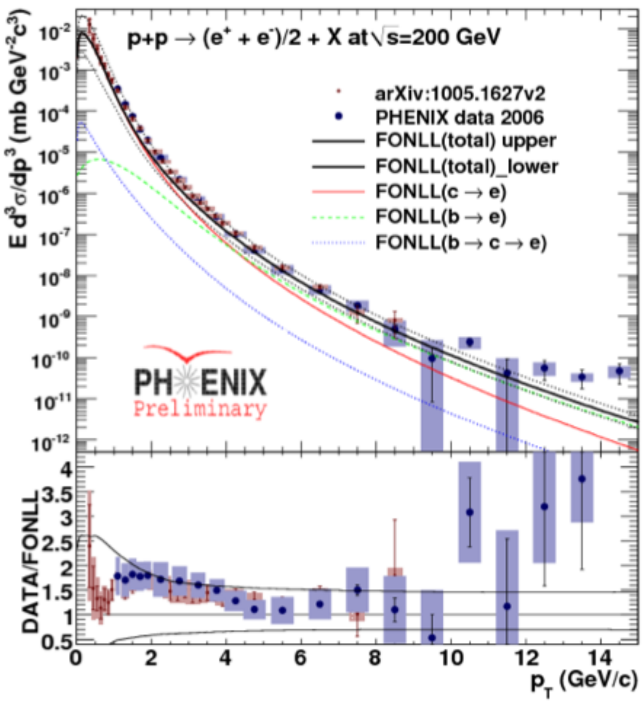
Only a selection in this talk!

see also →C.Bianchin, S.LaPointe this afternoon

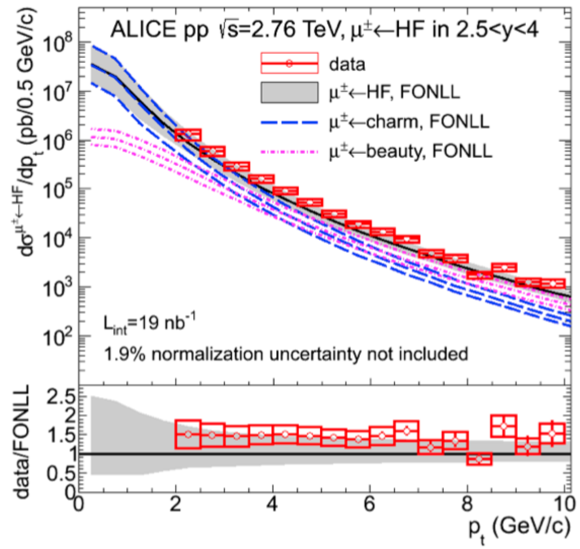
pp "reference": pQCD calculations vs data

HF-decay lepton p_T-differential cross section

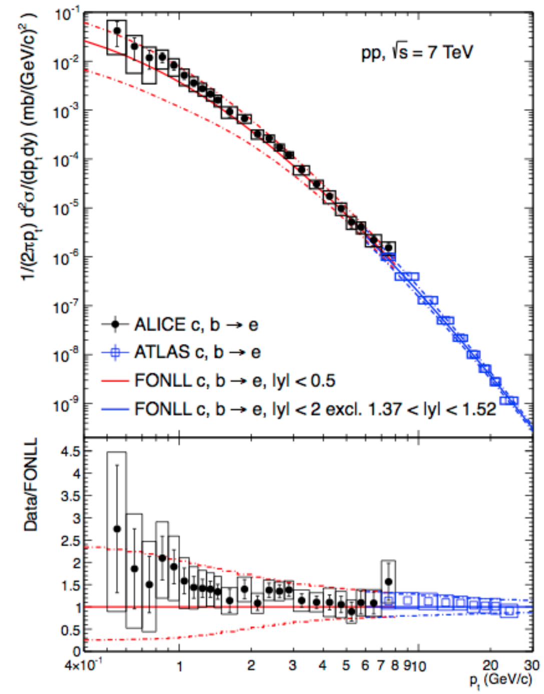
$e^{\pm}$ 200 GeV | **$\mu^{\pm}$ 2.76 TeV** | **$e^{\pm}$ 7 TeV**



PHENIX, PRC84 (2011) 044905
S. Lim (QM2014)



ALICE, PRL 109 (2012) 112301



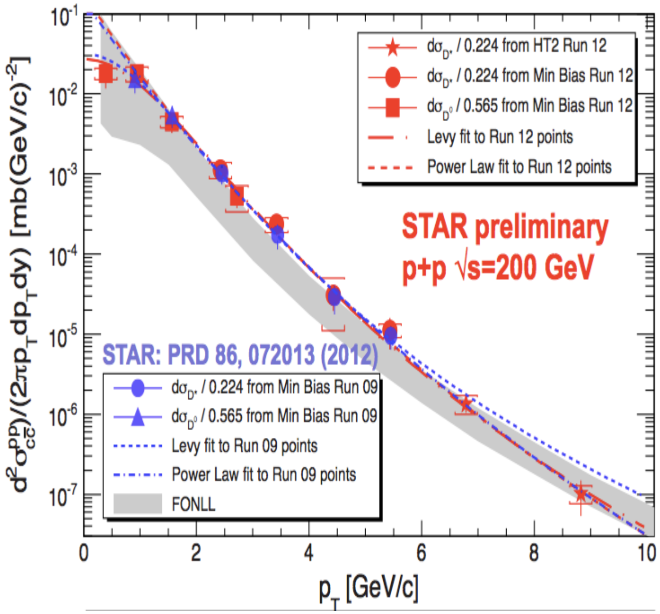
ALICE, PRD86 (2012) 112007
ATLAS, PLB707 (2012) 438

- HF-decay electrons and muons at central and forward y
- FONLL: "b > c" for p_T > 4 (5) GeV/c at RHIC (LHC)

pp "reference": pQCD calculations vs data

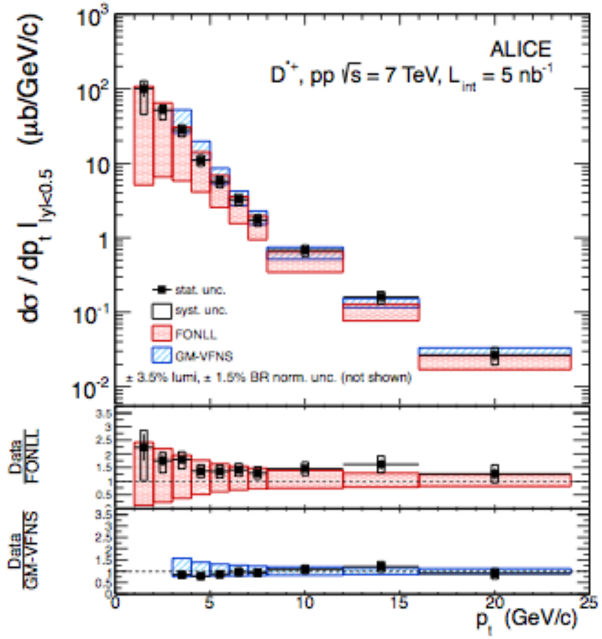
Charm and beauty p_T-differential cross section

D 200 GeV



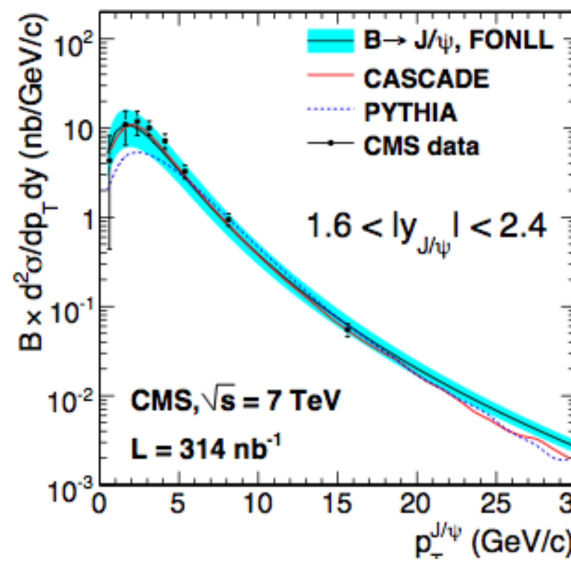
STAR, PRD 86 (2012) 72013 (200 GeV)
Z. Ye (QM2014)

D 7 TeV



ALICE, JHEP01 (2012) 128

N.p. J/ψ 7 TeV

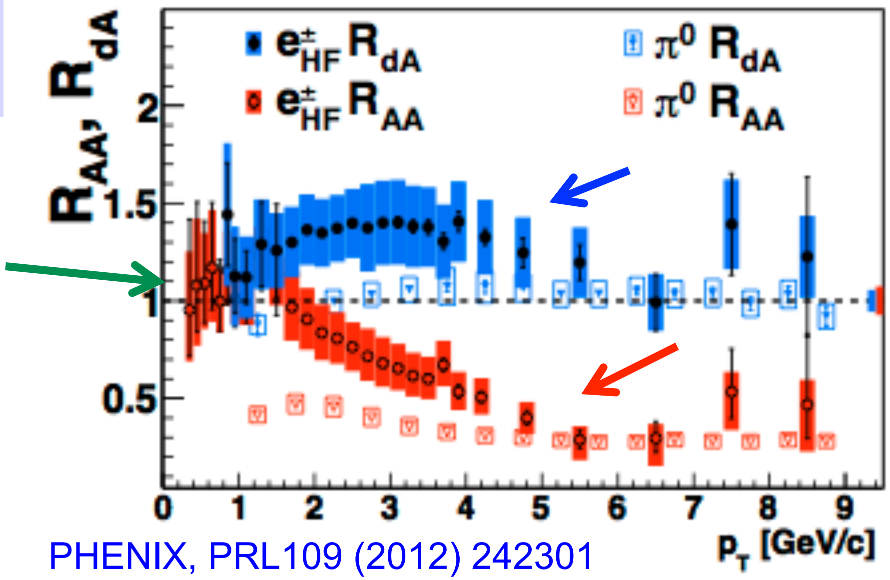


CMS, EPJC71 (2011) 1575

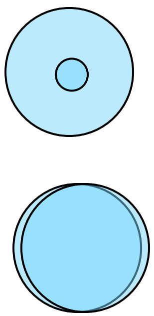
- Charm production described within uncertainties
  - "Consistently" at upper limit of FONLL band from 0.2 to 7 TeV
- Beauty production described by FONLL central value

HF-decay electrons at RHIC

$$R_{AA}(p_T) = \frac{1}{\langle N_{coll} \rangle} \frac{dN_{AA}/dp_T}{dN_{pp}/dp_T}$$

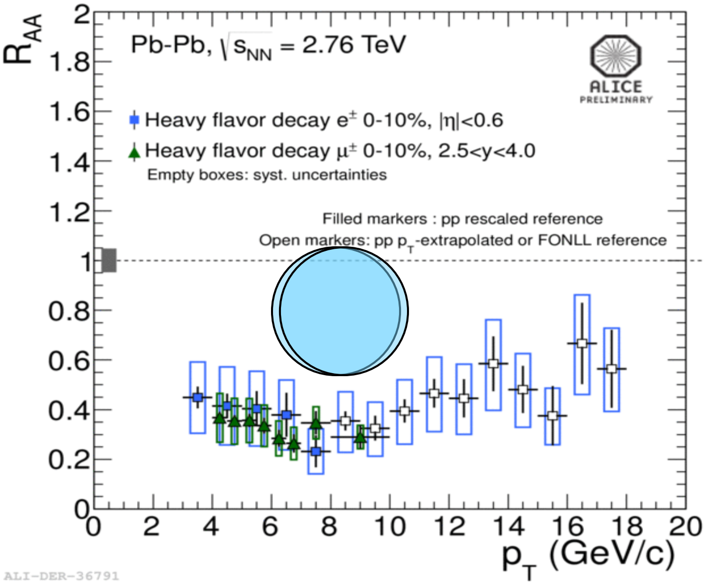


PHENIX, PRL109 (2012) 242301



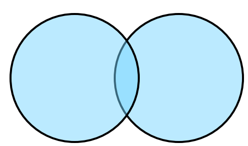
- "Total" yield compatible with binary scaling (R_{AA} ~ 1 ± 0.3) ←
- Large suppression above 3 GeV/c
  - Same as for pions above 5 GeV/c ←
- R_{dA}≥1 → Au-Au high-p_T suppression is a hot medium effect ←

HF-decay $e^{\pm}$ and $\mu^{\pm}$ at LHC

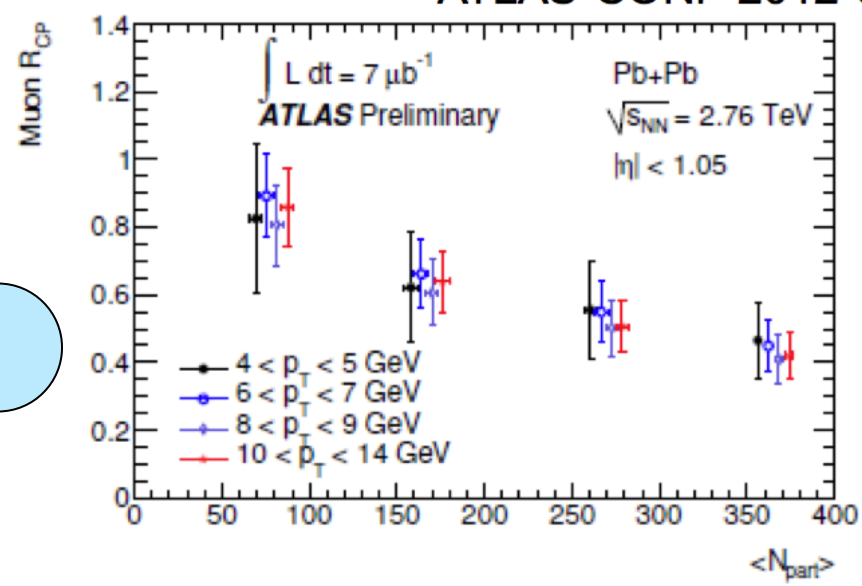


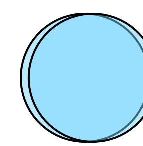
- Pb-Pb: comparable suppression at central and forward rapidity
  - Note1: dominated by B mesons at high p_T^{lepton}
  - Note2: p_T^{hadron} ~2 p_T^{lepton} → p_T^B up to ~35 GeV/c

- Suppression vanishes when going to peripheral collisions

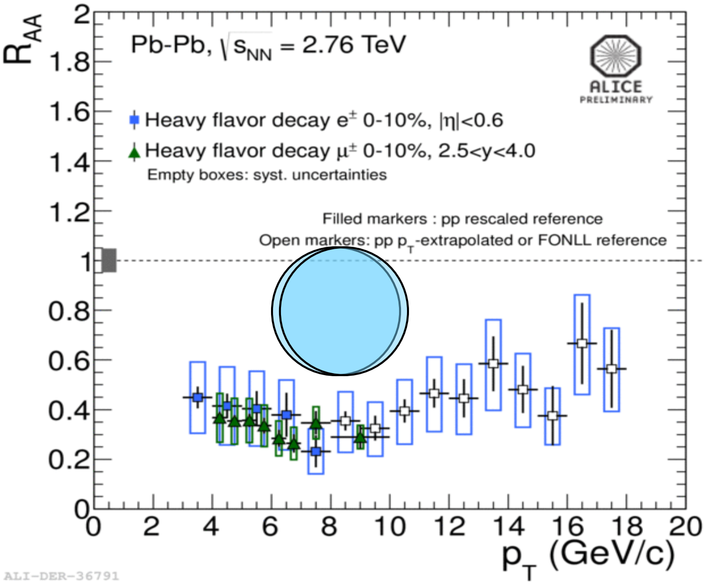


ATLAS-CONF-2012-081



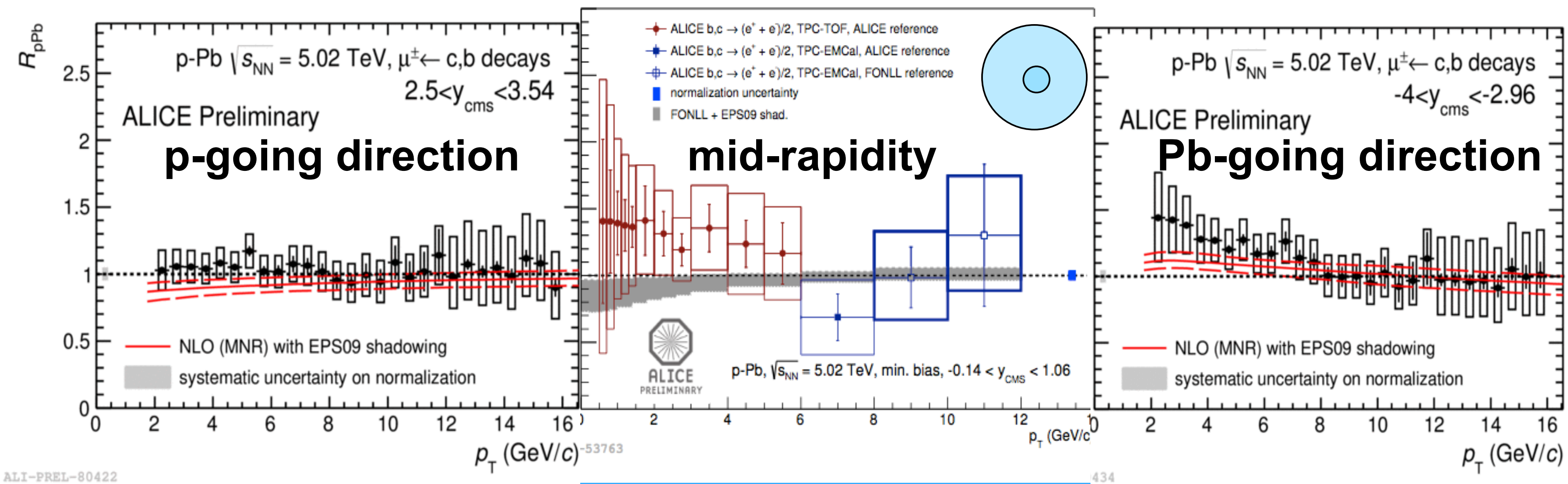


HF-decay e and μ at LHC



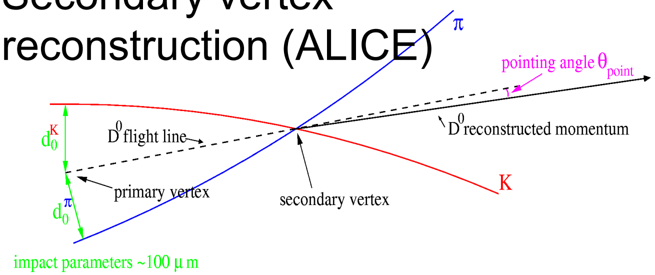
- Pb-Pb: comparable suppression at central and forward rapidity
  - Note1: dominated by B mesons at high p_T^{lepton}
  - Note2: p_T^{hadron} ~2 p_T^{lepton} → p_T^B up to ~35 GeV/*c*
- R_{pPb} ~ 1
  - Described by calc. with nuclear PDFs

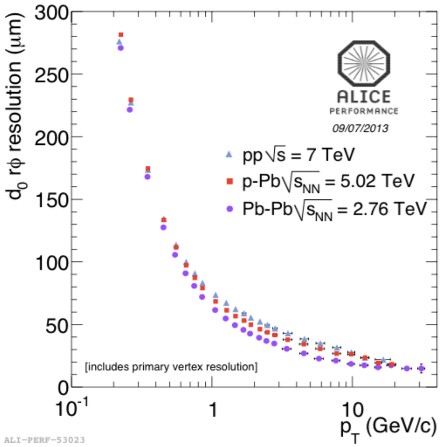
→Suppression in Pb-Pb is a final-state effect



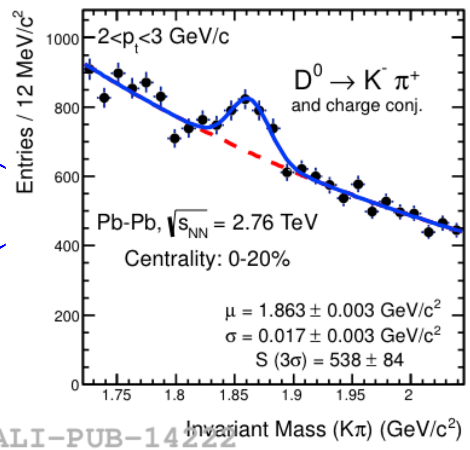
Charm: D mesons in Pb-Pb at LHC

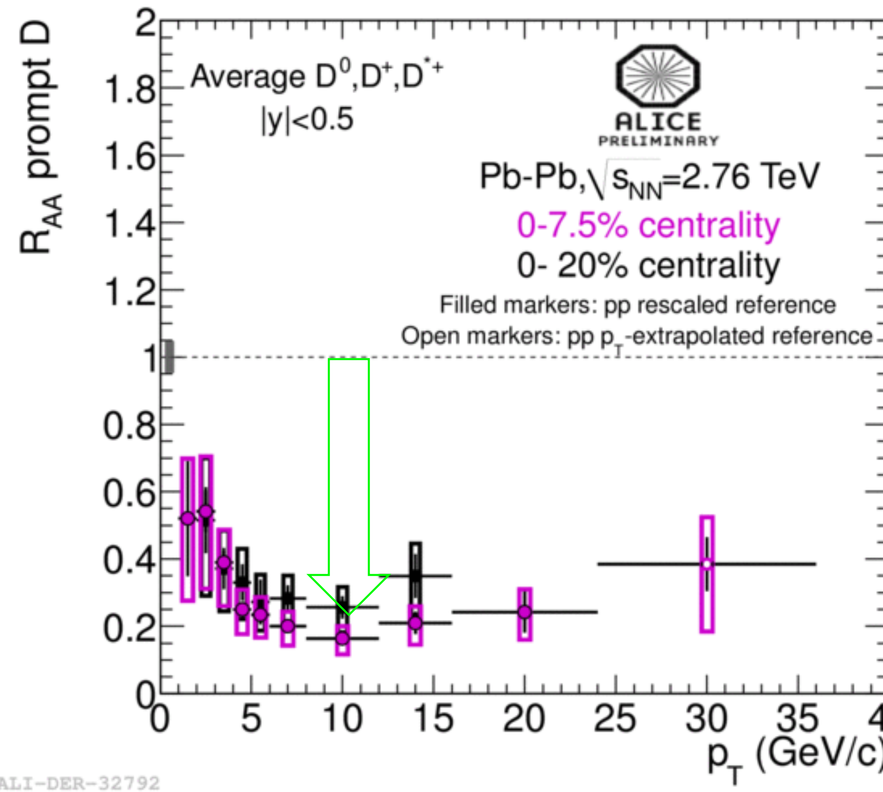
Secondary vertex reconstruction (ALICE)





JHEP1209(2012)112

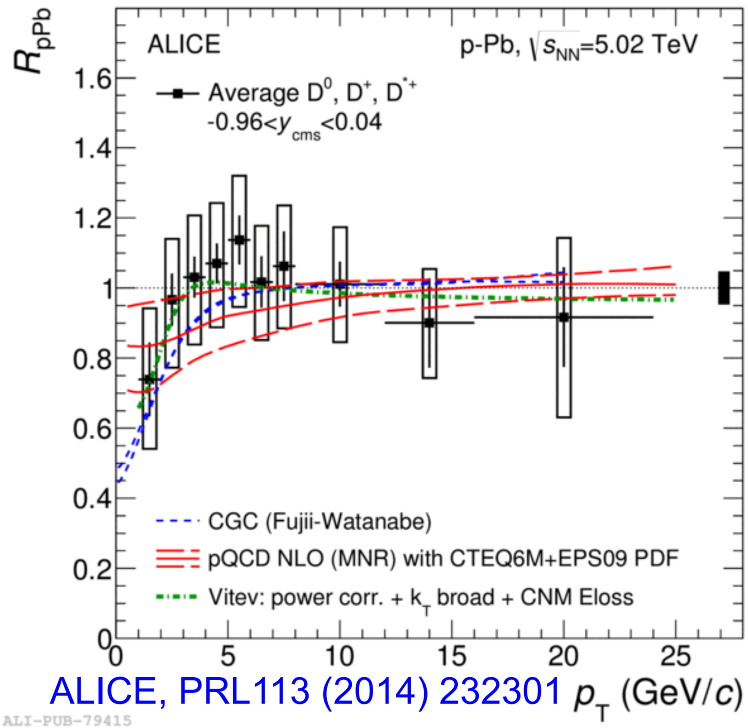




- First D R_{AA} measurement with data from LHC 2010 run
- Extended with LHC 2011 run, from 1 to 30 GeV/c: factor ~5 suppression at ~10 GeV/c in 0-7.5% centr.

ALICE, JHEP 09 (2012) 112 Z.Conesa (QM2012)

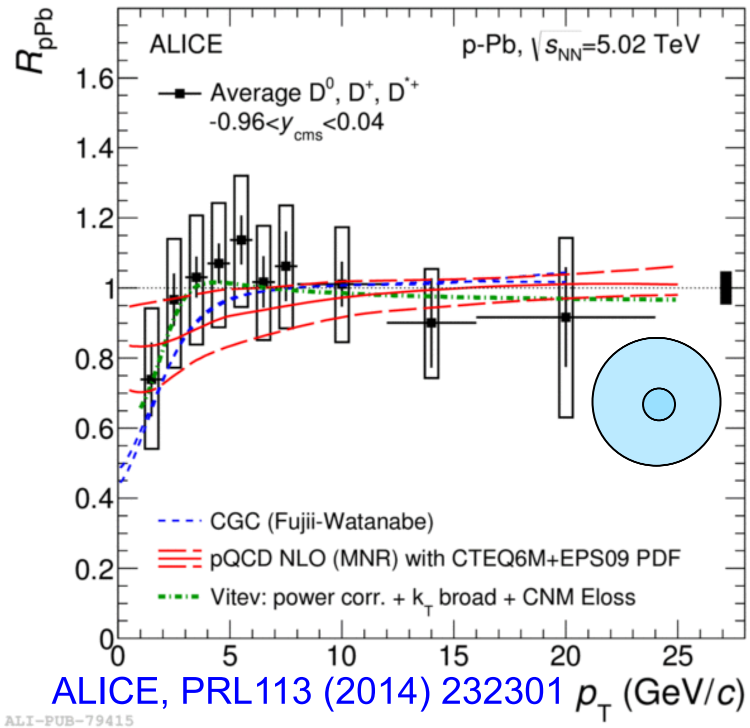
Charm: D mesons in p-Pb at LHC



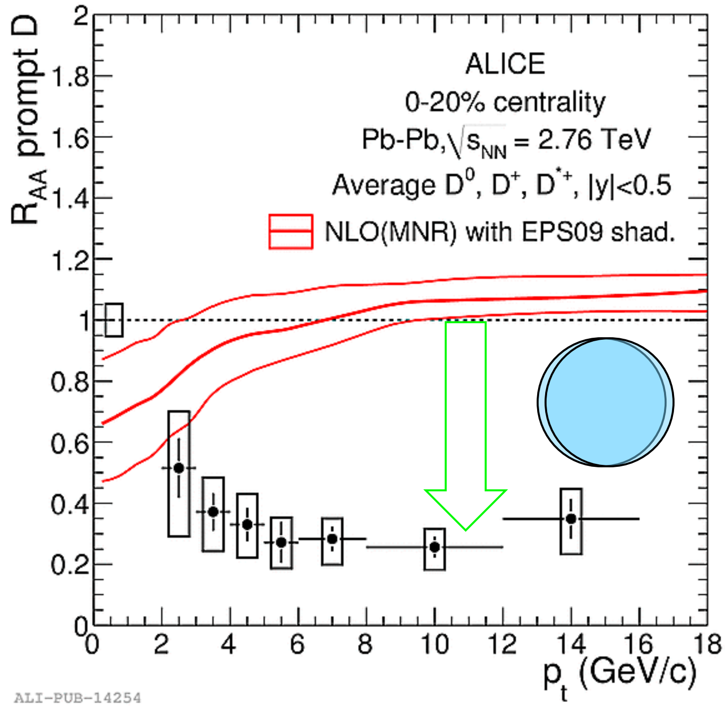
ALICE, PRL113 (2014) 232301

- D meson R_{pA} consistent with unity
  - Calculations with nuclear PDFs describe the data

Charm: D mesons in p-Pb at LHC



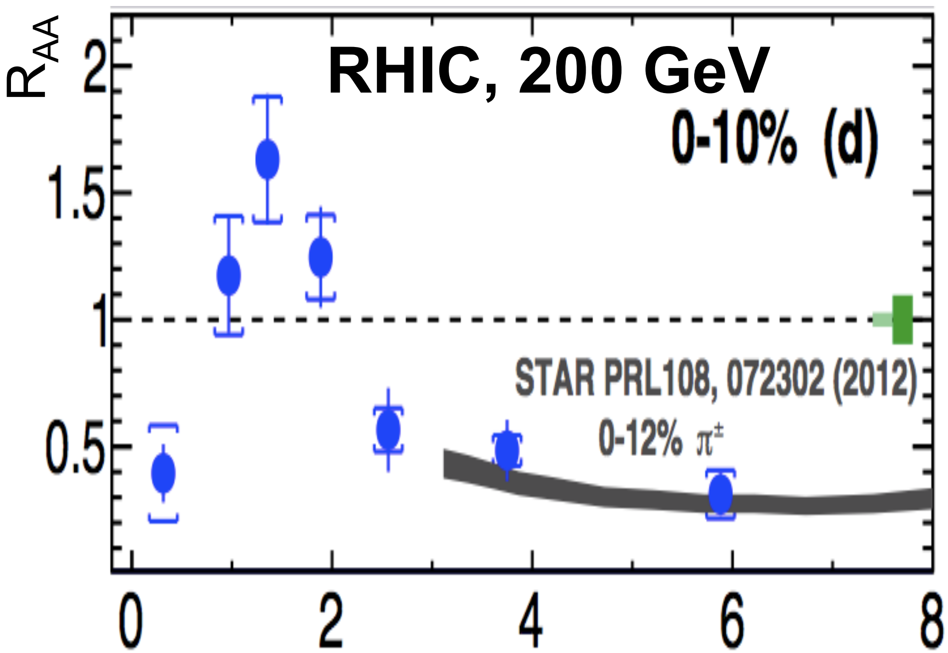
ALICE, PRL113 (2014) 232301



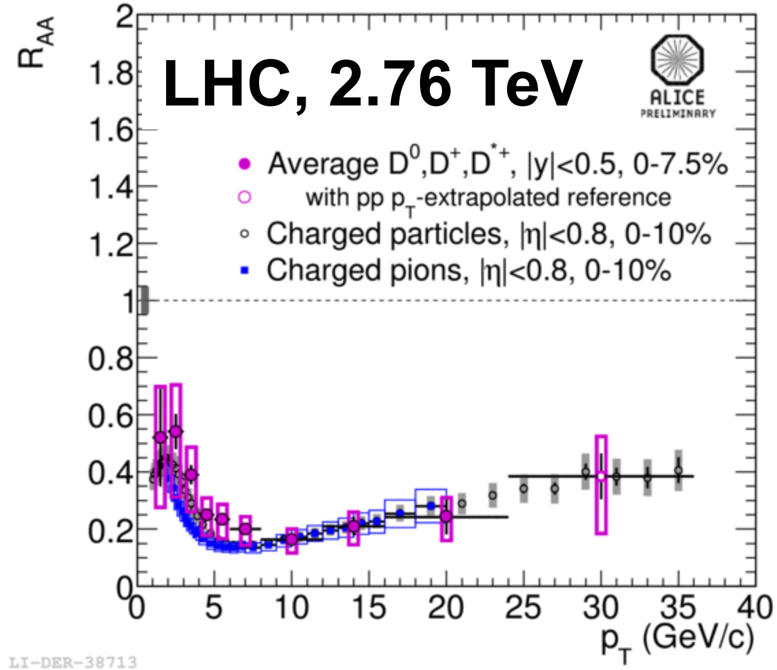
- D meson R_{pA} consistent with unity
  - Calculations with nuclear PDFs describe the data
  - Shadowing not expected to contribute to suppression in Pb-Pb above ~5 GeV/c

→ Pb-Pb high-p_T suppression is a final state effect

Colour charge dependence of energy loss: D mesons vs. pions

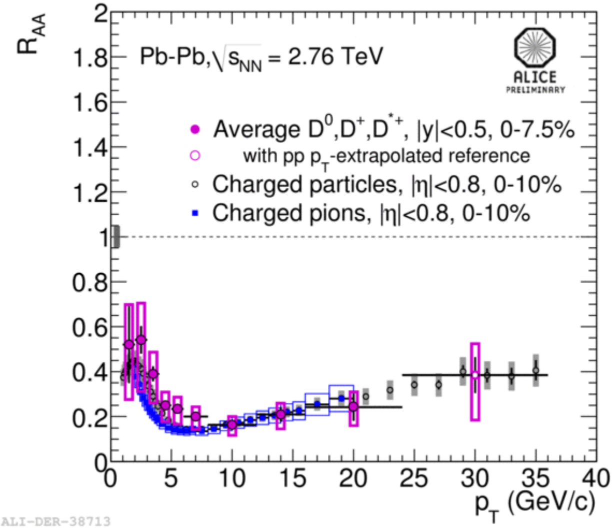


STAR, PRL 113 (2014) 142301

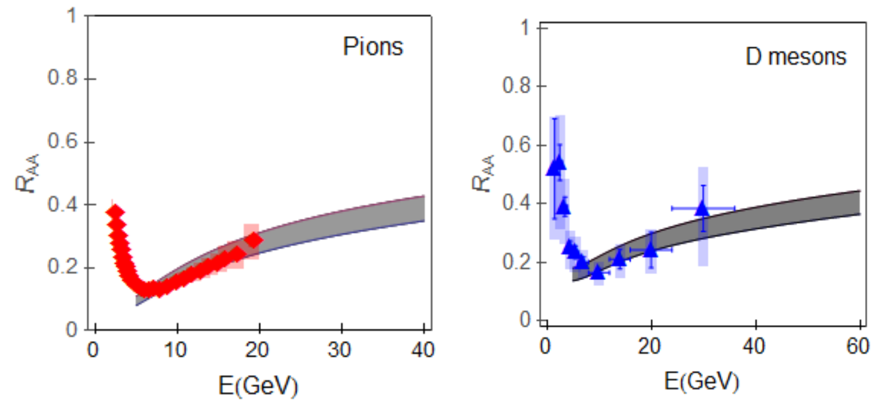


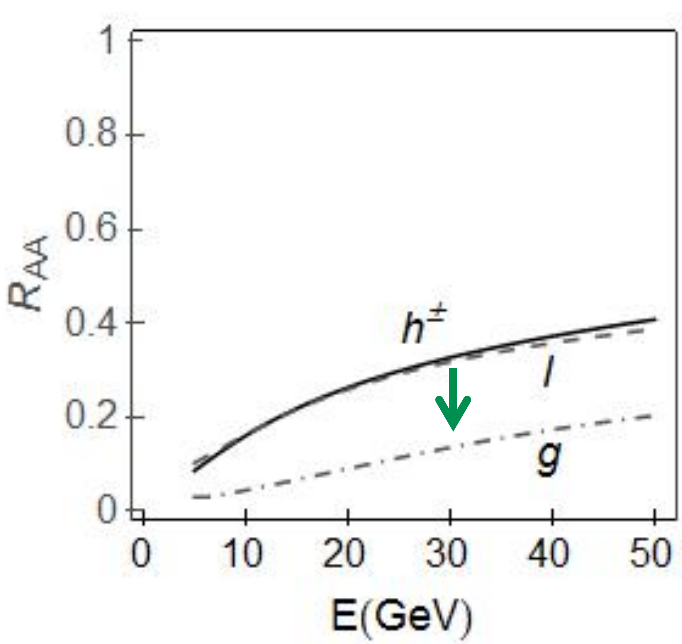
- D R_{AA} at RHIC: x3 suppression at high p_T, similar to LHC
- R_{AA} of D and π consistent within current uncertainties, both RHIC and LHC
  - Is it consistent with the colour charge dependence of energy loss in the hot medium?

Colour charge dependence: theory



- Calculation by M. Djordjevic (rad+coll energy loss) can describe both R_{AA}
- Shows strong colour charge effect in partonic R_{AA} (gluon vs. quark)



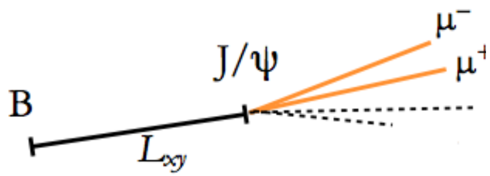


Suggests that colour charge effect helps to describe the observed $R_{AA}^{D} \sim R_{AA}^{\pi}$

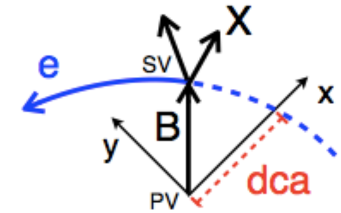
M. Djordjevic and M. Djordjevic, PRL112 (2014) 042302

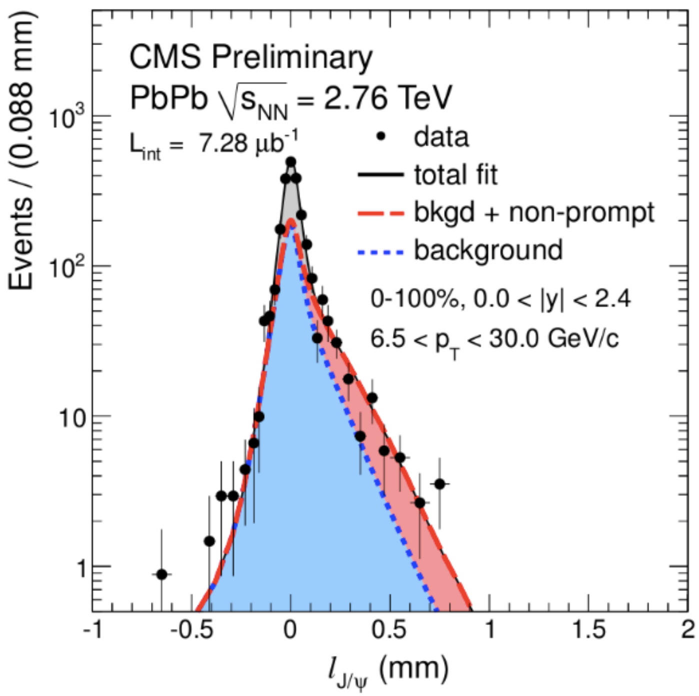
Beauty in Pb-Pb at LHC

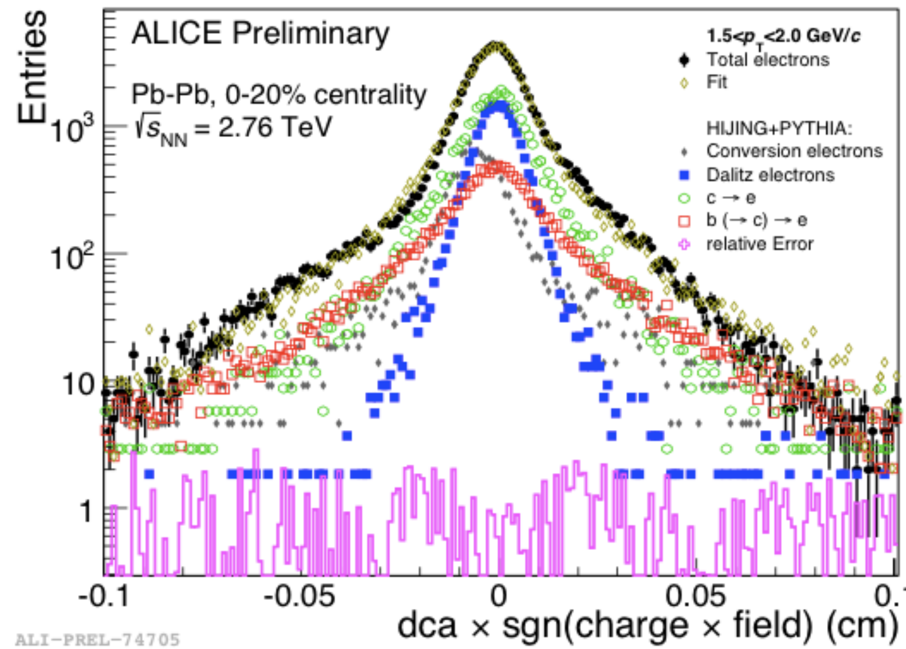
- CMS:



- ALICE:





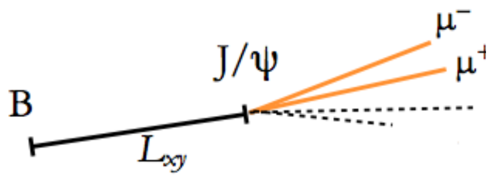


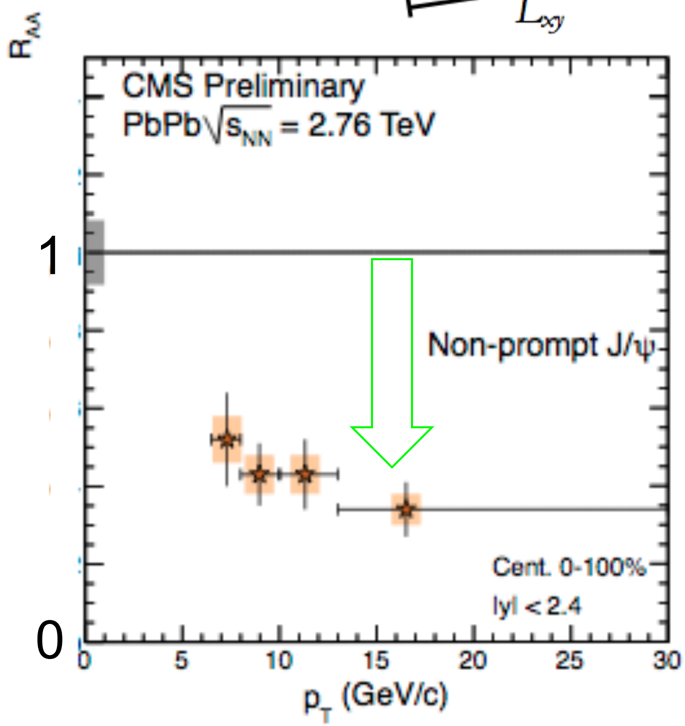
CMS-PAS-HIN-12-014

A. Festanti (QM2014)

Beauty in Pb-Pb at LHC

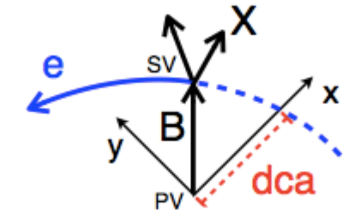
- CMS:

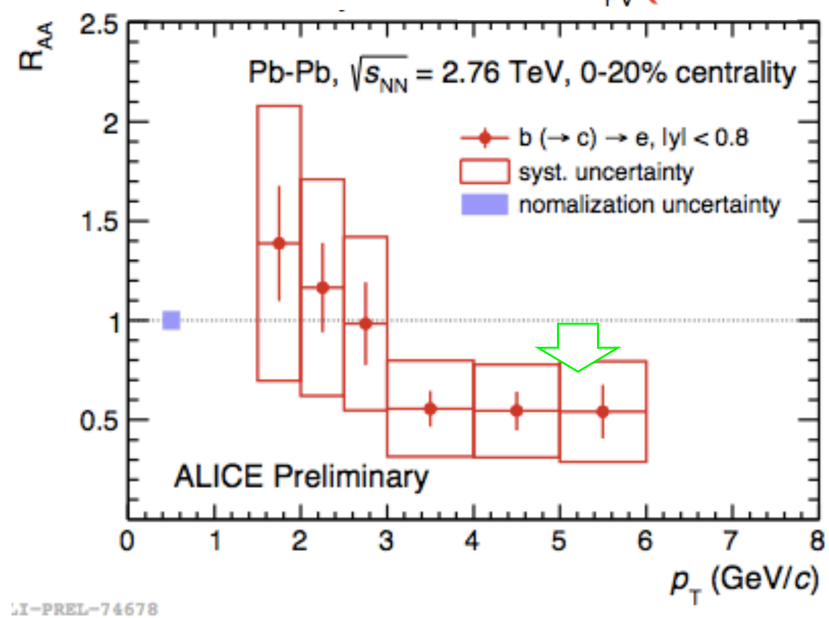




  - Large suppression at high p_T
  - Dependence on collision centrality in next slide

- ALICE:





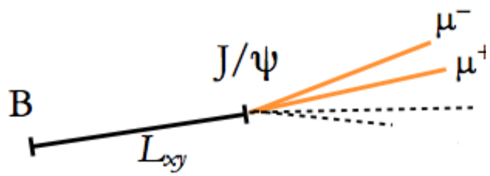
  - Large uncertainties
  - Indication of R_{AA}<1 for electron p_T>3 GeV/c

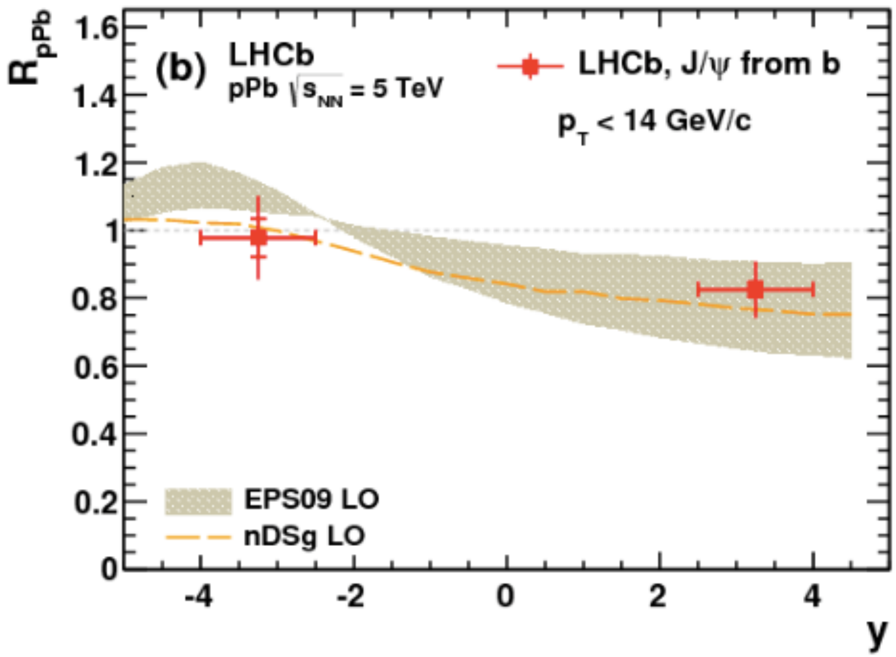
CMS-PAS-HIN-12-014

A. Festanti (QM2014)

Beauty in p-Pb at LHC

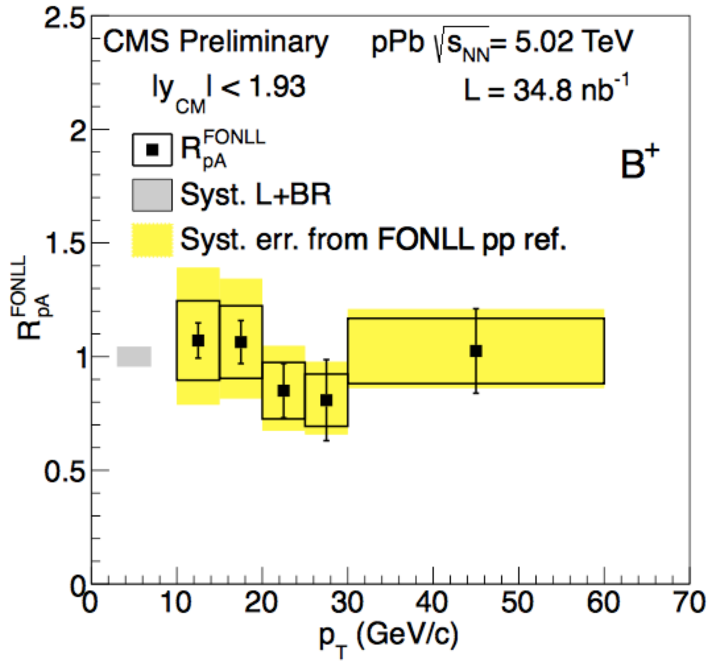
- **LHCb:**





- From p_T=0
- Consistent with mild modification, described by nuclear PDFs

- **CMS: fully-reco B^0, B^+, B_s**
  - Using J/ψ + hadron channels



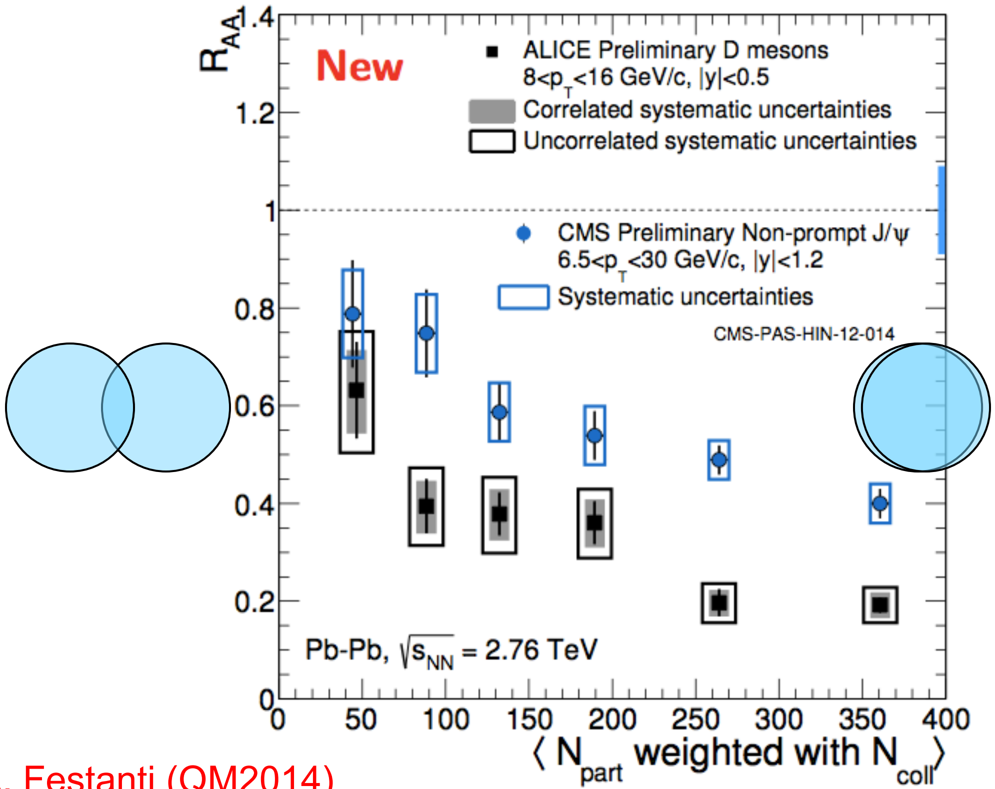
- Limited to high p_T (>10)
- Consistent with unity within 20-30% uncertainties

LHCb, JHEP 1402 (2014) 072

CMS-HIN-14-004

Mass dependence of HQ energy loss: R_{AA} of D and B at LHC

- D mesons (ALICE) and J/ψ from B decays (CMS)



A. Festanti (QM2014)

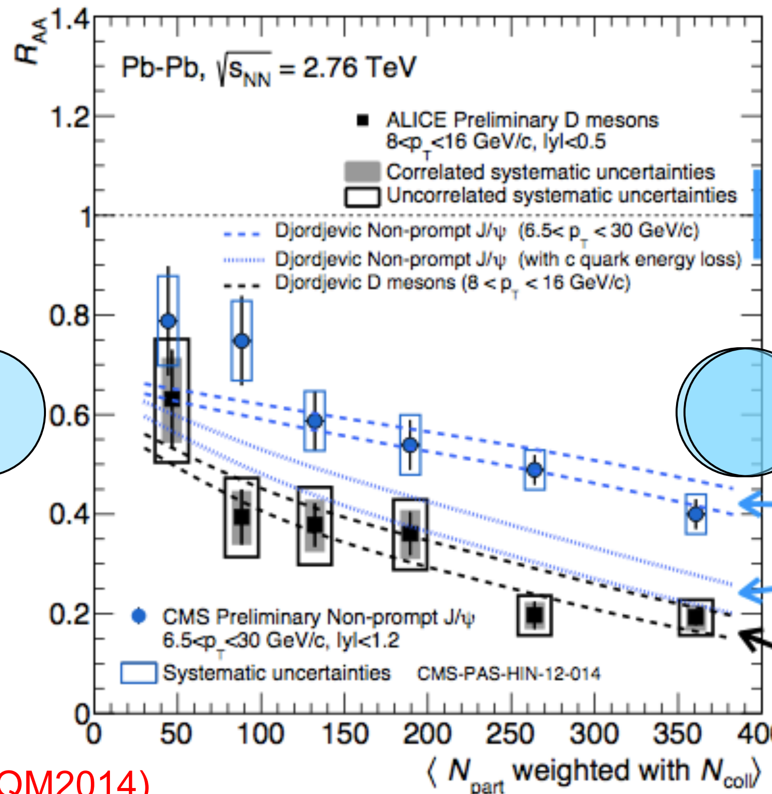
Similar $<p_T>$ for B and D:

- B $<p_T>$ ~ 11 GeV (FONLL +EvGen)
- D $<p_T>$ ~ 10 GeV

- First clear indication of: $R_{AA}^{B} > R_{AA}^{D}$

Mass dependence: theory

- D mesons (ALICE) and J/ψ from B decays (CMS)



A. Festanti (QM2014)

Similar $<p_T>$ for B and D:

- B $<p_T>$ ~ 11 GeV (FONLL +EvGen)
- D $<p_T>$ ~ 10 GeV

✓ Djordjevic: non-prompt J/ψ R_{AA} considering for energy loss
- b quark mass
- c quark mass

} to test the mass dependence

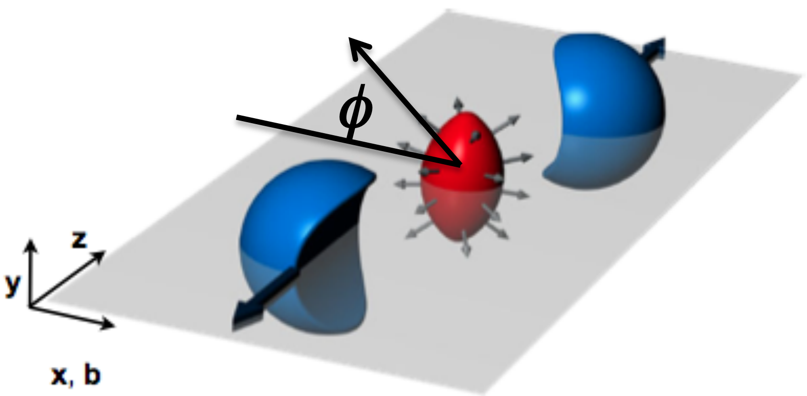
✓ Djordjevic: D meson R_{AA}

M. Djordjevic et al., PRL112 (2014) 042302

- Described by model calculations with $\Delta E_c > \Delta E_b$
  - Also other models (WHDG, Nantes, Vitev, TAMU, Duke)

Azimuthal anisotropy: collective flow

→M.Nahrgang



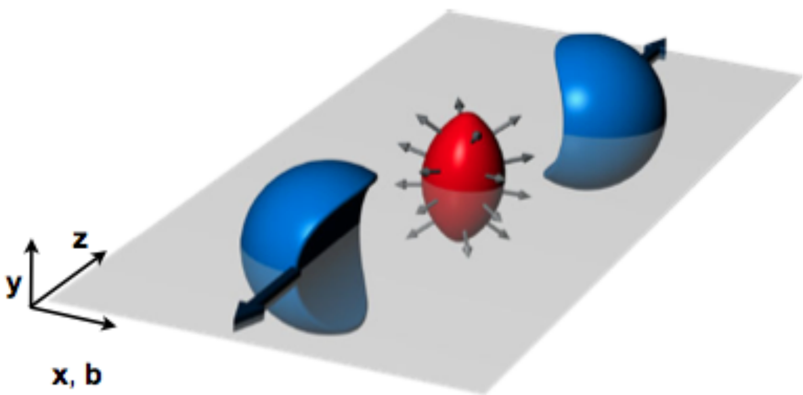
- System geometry asymmetric in non-central collisions
- Expansion under azimuth-dep. pressure gradient results in azimuth-dep. momentum distributions
- Measured by the elliptic flow parameter v_2

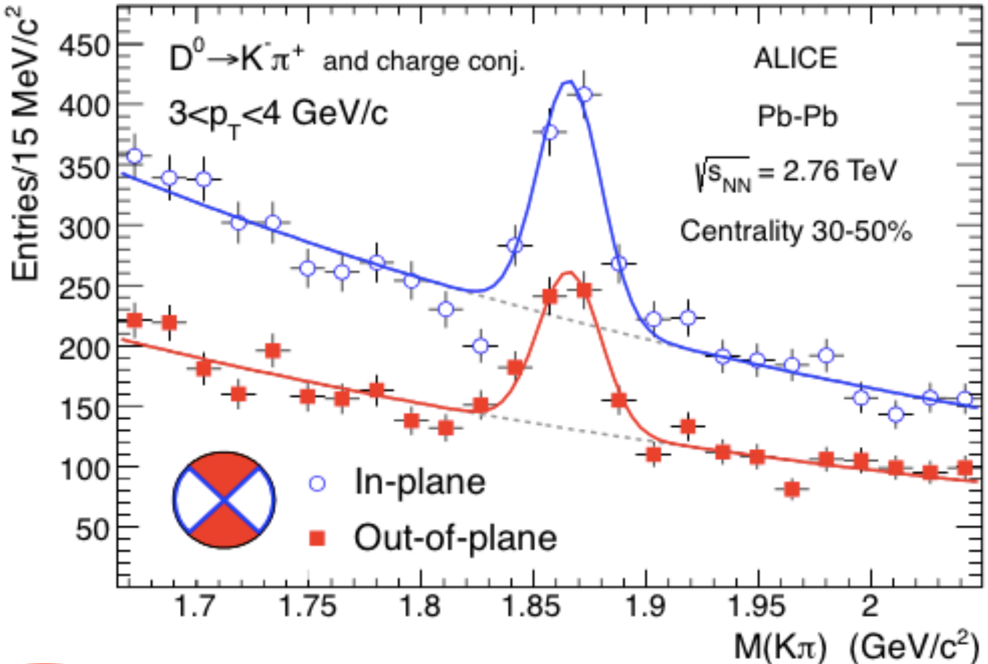
$$\frac{dN}{Nd\phi} \sim 1 + 2v_2 \cos\left(2(\phi - \Psi_{RP})\right) + \textit{higher harmonics } (v_3, v_4, \ldots)$$

- v_2 provides a measure of strength of collectivity (mean free path of outgoing partons)
- To what extent do heavy quarks take part in the collective expansion?
  - Probe of the interaction mechanism
  - Sensitive to medium viscosity

D meson anisotropy at LHC

- The v_2 coefficient can be measured by comparing the production yield in two orthogonal directions wrt estimated reaction plane

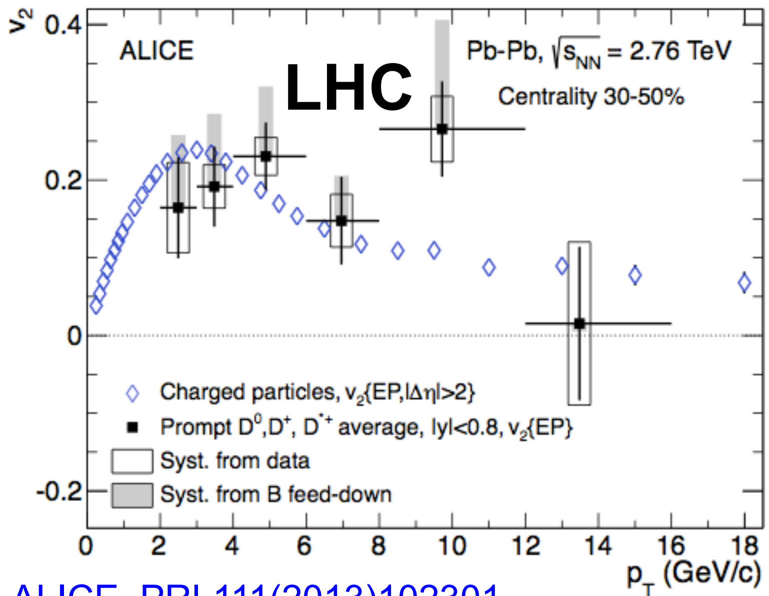




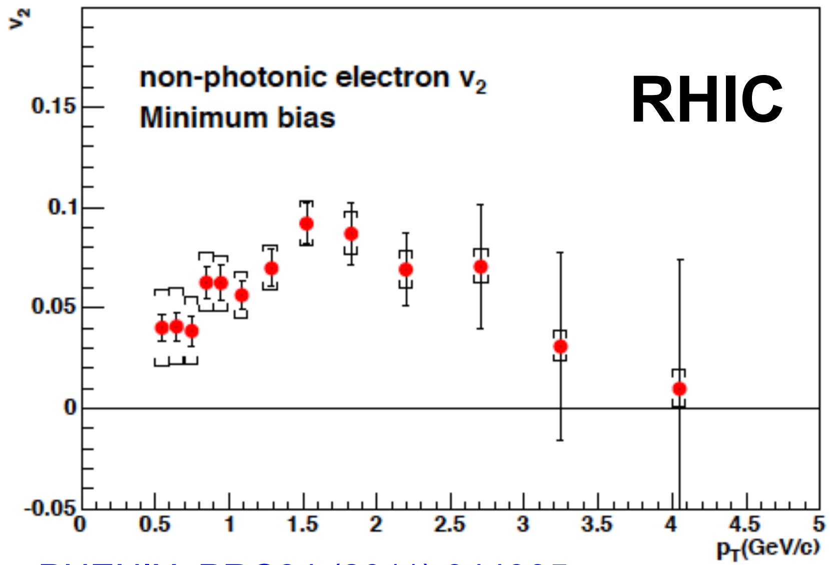
ALICE, PRL111(2013)102301

$$v_2 = \frac{1}{R_2}\frac{\pi}{4}\frac{N_{\text{in-plane}} - N_{\text{out-of-plane}}}{N_{\text{in-plane}} + N_{\text{out-of-plane}}}$$

Heavy Flavour v_2 at LHC and RHIC



ALICE, PRL111(2013)102301



PHENIX, PRC84 (2011) 044905
See also: STAR, arXiv:1405.6348

- D meson v_2 ~0.2 in 2-6 GeV/c at LHC (ALICE)
  - Comparable with charged particle v_2
- Electrons from HF show a v_2 of up to 0.10 at RHIC (PHENIX, STAR)
- What is the origin of this v_2? c quark flow induced by multiple elastic interactions? recombination with light quarks from medium?

→M.Nahrgang

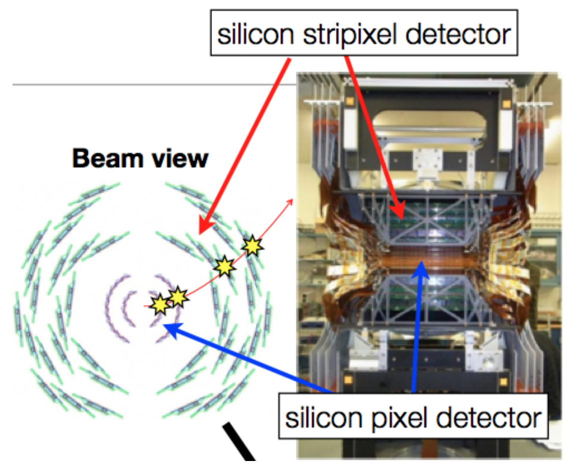
Conclusions

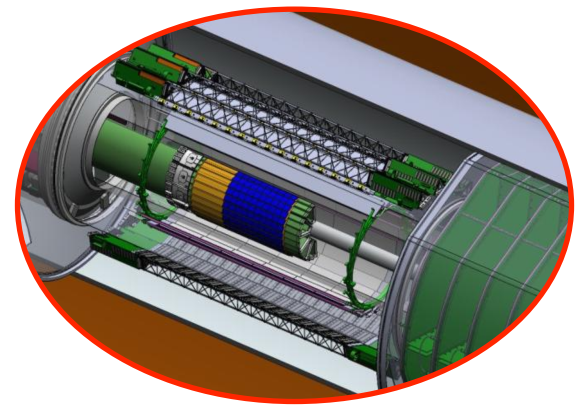
- Heavy Flavour probes now accessible using several (>6) "detection" channels and by all (6) experiments
- HF energy loss:
  - Large suppression in AA in all channels at p_T > 5 GeV/c
  - It is a final state effect (R_{pA}~1)
  - D $R_{AA} \sim \pi\ R_{AA}$ → described by charge-dep. E loss
  - B R_{AA} > D R_{AA} (at 10 GeV/*c*) → described by m_Q-dep. E loss
- HF azimuthal anisotropy:
  - Significant v_2 suggests that collisional processes in "collective medium", and maybe recombination, play a role at intermediate/low p_T
- More direct and precise measurements needed to solidify these conclusions and address the open questions
  - Experiment upgrades! (see next slide)

Outlook: upgrades at RHIC and LHC

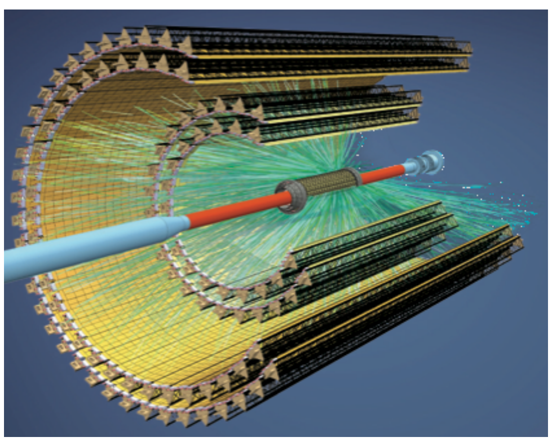
- Heavy flavour: a central topic for upgrades of all HI experiments!
  - %-level precision!
  - c/b decay leptons
  - Low-p_T D, D_s, B
  - HF baryons
  - HF correlations
  - …

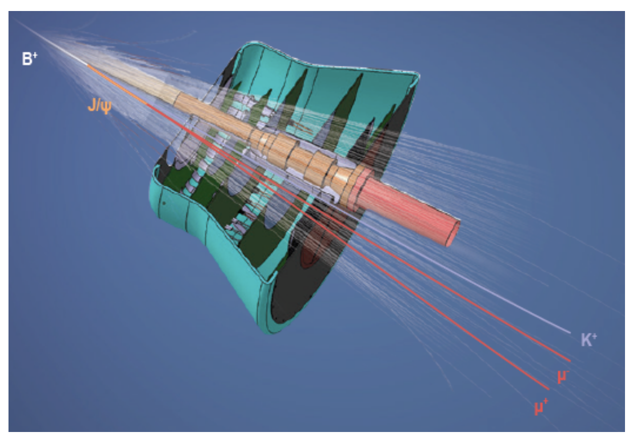
Already online: PHENIX VTX, STAR HFT





Scheduled for 2018-19: ALICE new ITS and MFT





Also:
STAR MTD,
ATLAS, CMS,
LHCb tracker
upgrades,
sPHENIX

Thank You !

EXTRA SLIDES

Heavy flavour production in pp

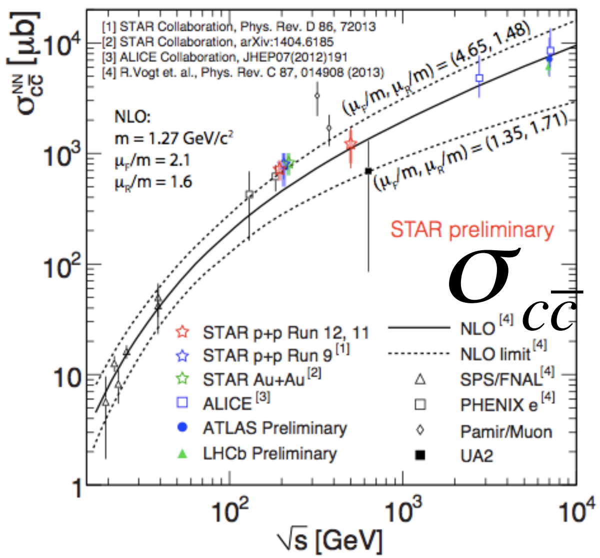
- Example pQCD calculation: Fixed Order Next-to-Leading Log

$$\frac{d\sigma}{dp_T} = A(m)\,\alpha_s^2 + B(m)\,\alpha_s^3 + G(m,p_T)\left[\alpha_s^2 \sum_{i=2}^{\infty} a_i [\alpha_s \log(\mu/m)]^i + \alpha_s^3 \sum_{i=1}^{\infty} b_i [\alpha_s \log(\mu/m)]^i\right]$$

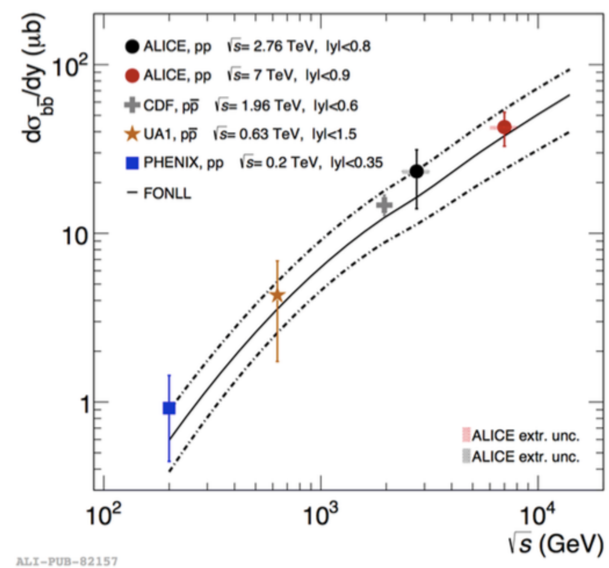
$\mu \approx p_T$

FONLL: Cacciari, Frixione, Mangano, Nason and Ridolfi, JHEP0407 (2004) 033

[coincides with NLO for low p_T (total cross section); more accurate at high p_T]



from Z. Ye (QM2014)



from arXiv:1405.4144

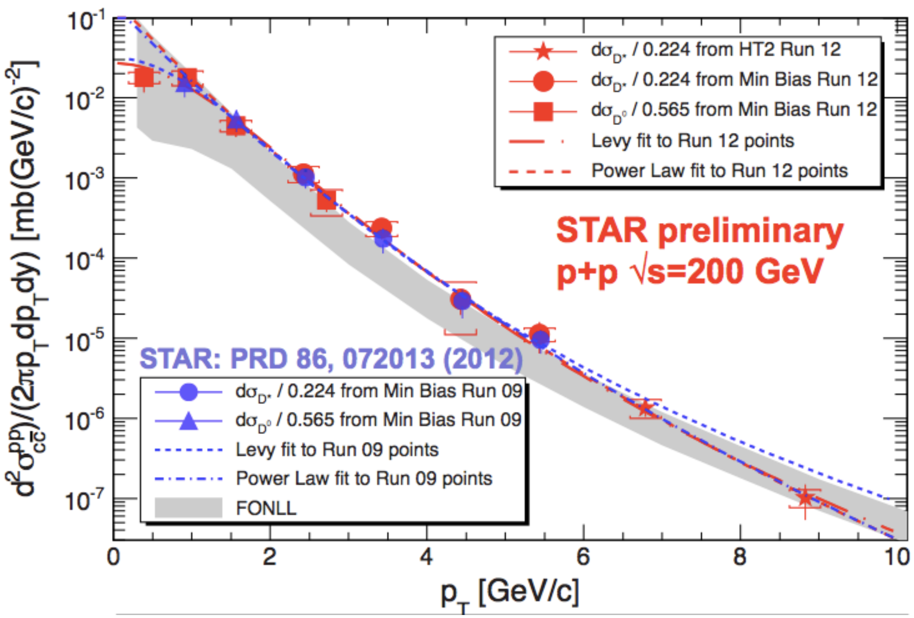
- Describes consistently energy dependence of total cross sections
- Charm (beauty) x10 (100) from 0.2 to 2.76 TeV

pp: pQCD calculations vs data

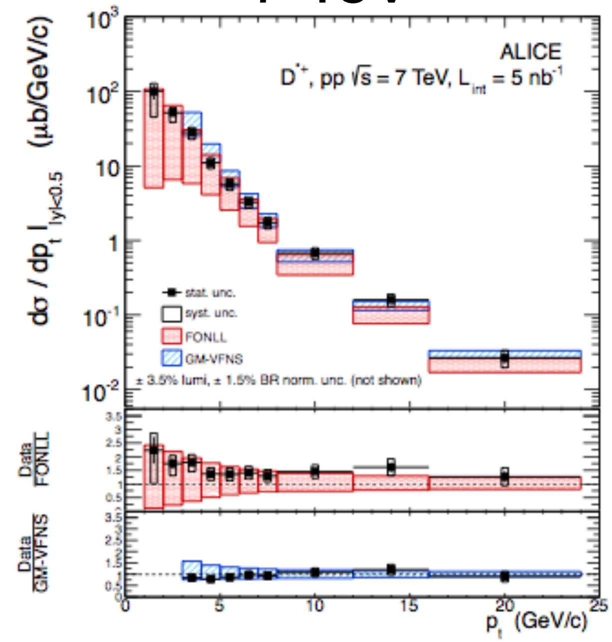
Charm p_T-differential cross section

INFN

200 GeV



7 TeV



STAR, PRD 86 (2012) 72013 (200 GeV)
Z. Ye (QM2014)

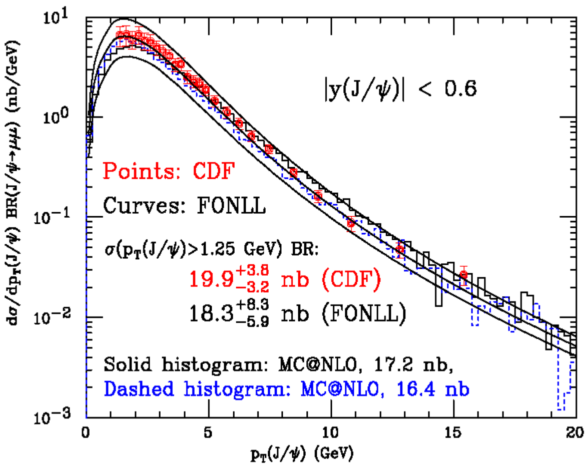
ALICE, JHEP01 (2012) 128

- Charm production described within uncertainties
- Consistently at upper limit of theoretical band from 0.2 to 7 TeV
  - also at 0.5, 1.96 and 2.76 TeV (not shown)
  - deviation below 1 GeV?

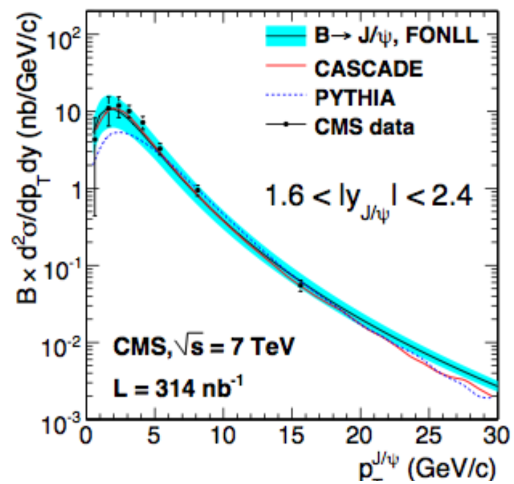
pp: pQCD calculations vs data
Beauty p_T-differential cross section

1.96 TeV

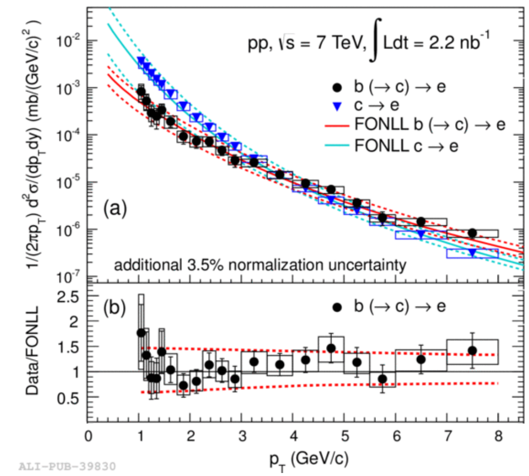
7 TeV



CDF, PRD71 (2005) 032001



CMS, EPJC71 (2011) 1575



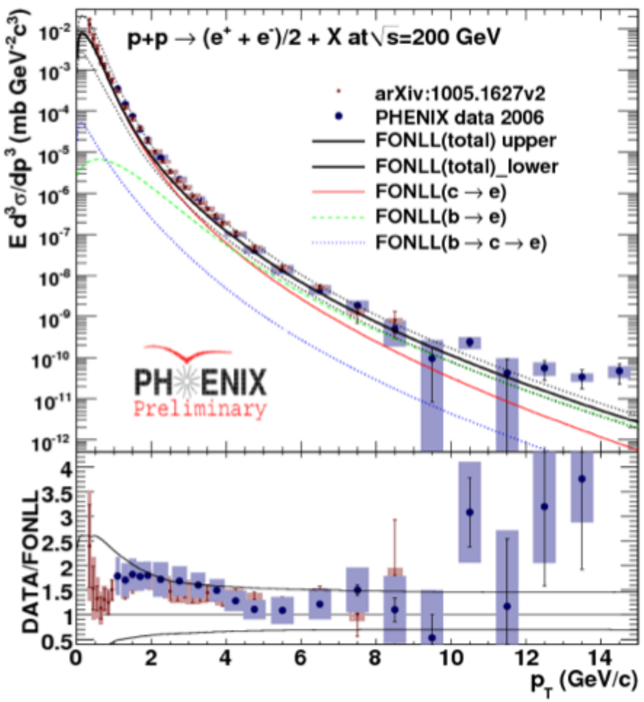
ALICE, PLB721 (2013) 13

- Beauty production described very well by central value of calculation

pp: pQCD calculations vs data

HF-decay lepton p_T-differential cross section

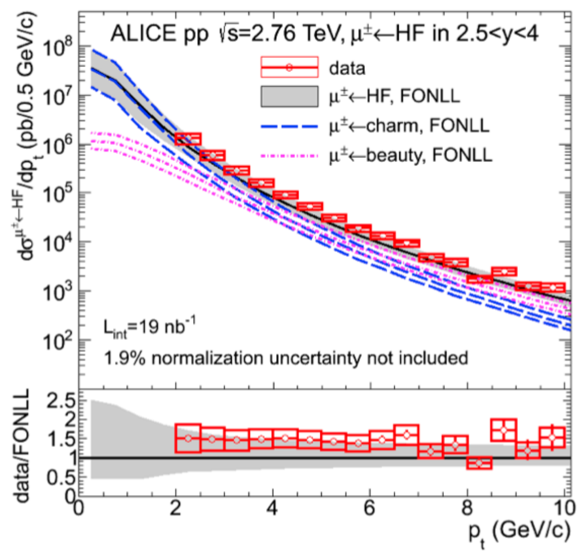
200 GeV



PHENIX, PRC84 (2011) 044905

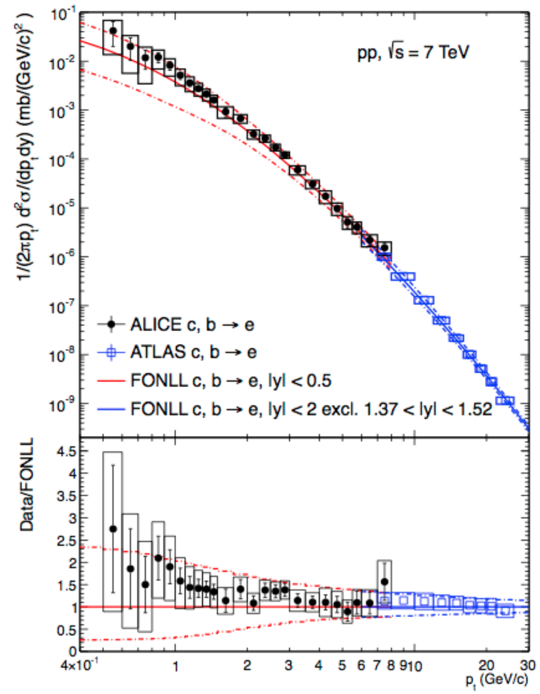
S. Lim (QM2014)

2.76 TeV



ALICE, PRL 109 (2012) 112301

7 TeV

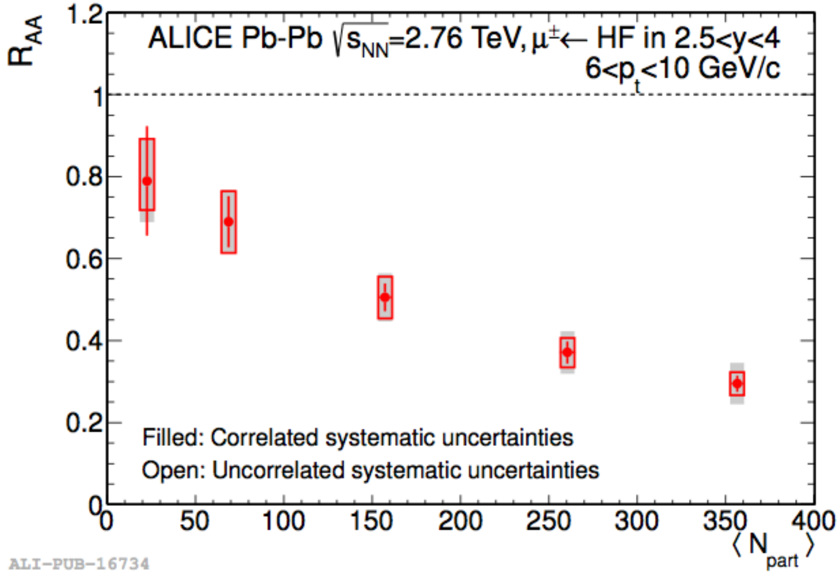


ALICE, PRD86 (2012) 112007

ATLAS, PLB707 (2012) 438

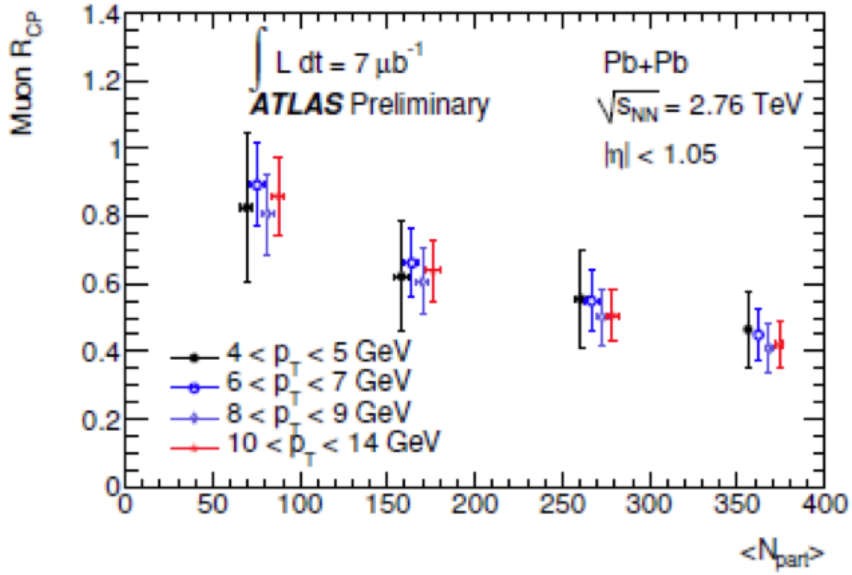
- HF-decay electrons and muons at central and forward y
- FONLL: "b > c" for $p_T > 4$ (5) GeV/c at RHIC (LHC)

HF-decay μ at LHC vs. centrality



PRL 109 (2012) 112301

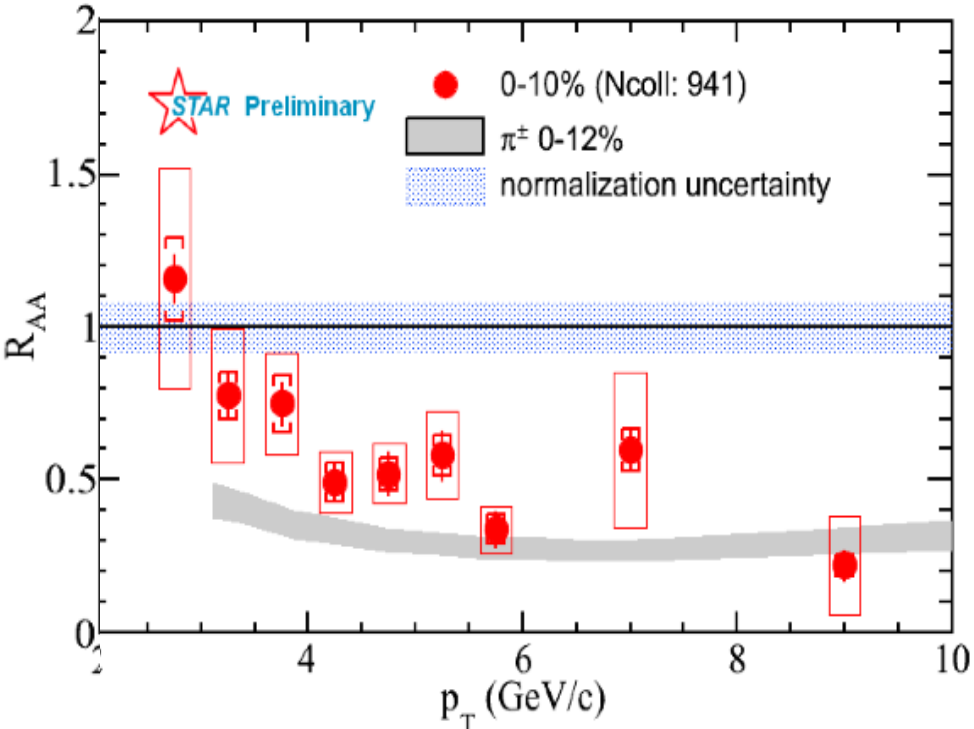
ATLAS-CONF-2012-081



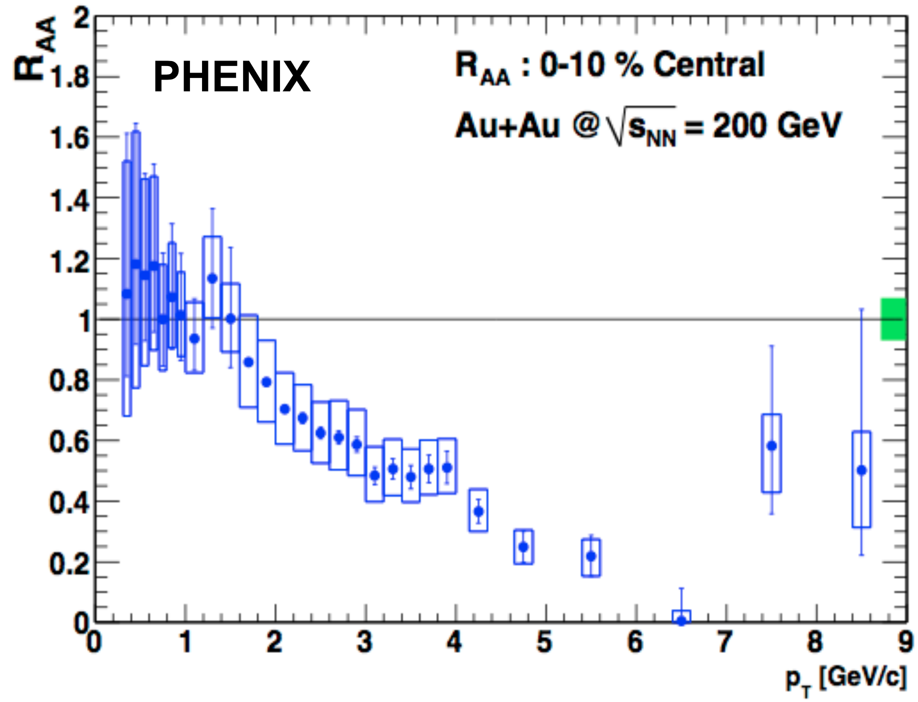
- Clear and consistent centrality dependence for
  - R_{AA} of muons at forward rapidity (ALICE)
  - R_{CP} of muons at central rapidity (ATLAS)
- No sign of p_T dependence from 4 to 12 GeV/c

HF-decay electrons at RHIC (200 GeV)

- Inclusive measurement (c+b) using non-photonic electrons



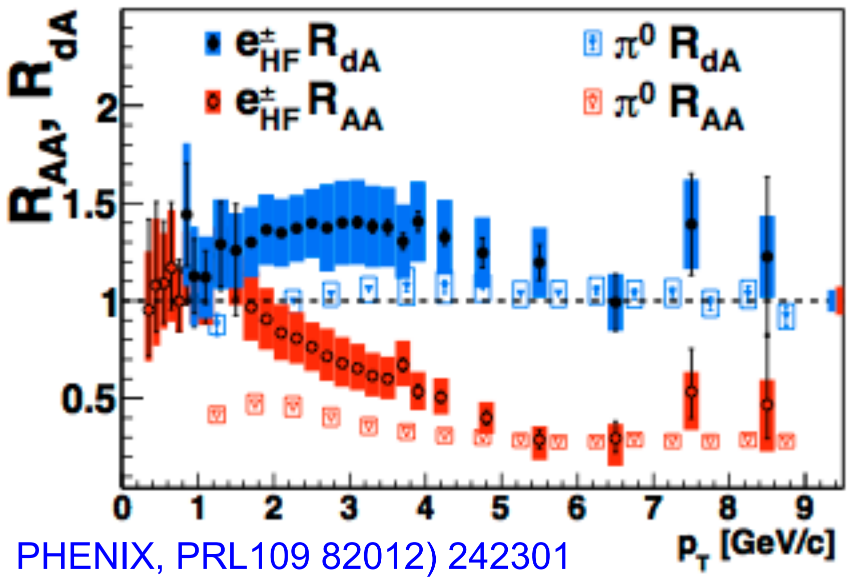
W. Xie (QM2012)
see also Phys. Rev. Lett. 98, 192301 (2007)



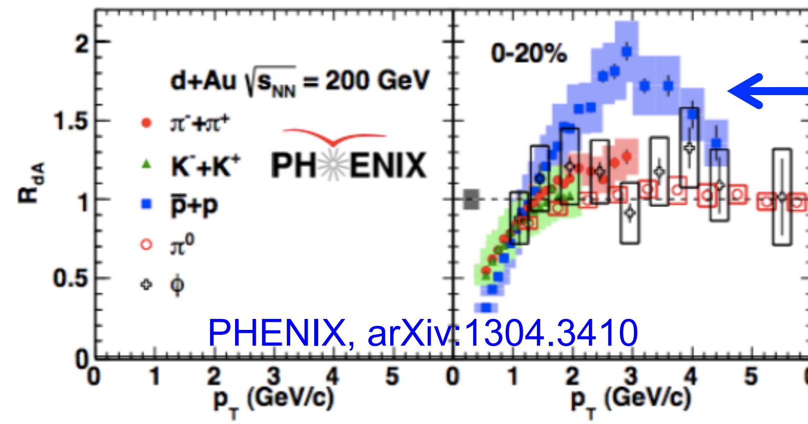
Phys. Rev. C 84, 044905 (2011)

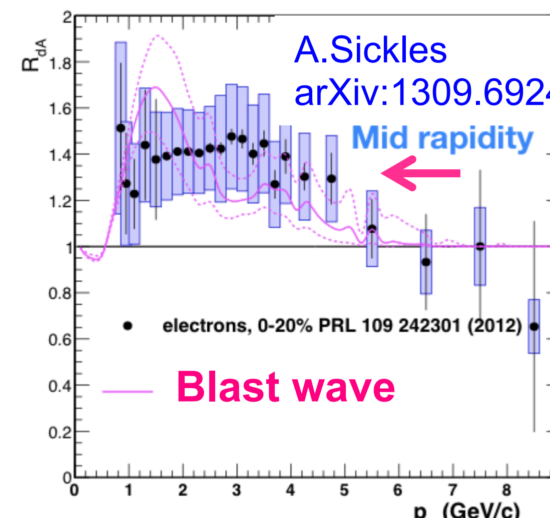
- Same suppression as for light-flavour hadrons above 5 GeV/*c*
- Smaller suppression at 2-3 GeV/c, but cannot conclude on mass effects

HF-decay e at RHIC



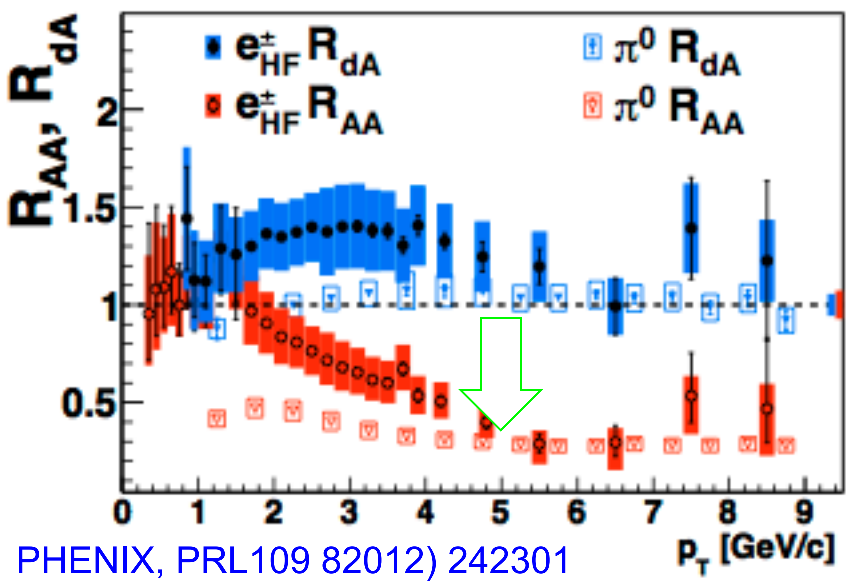
PHENIX, PRL109 82012) 242301



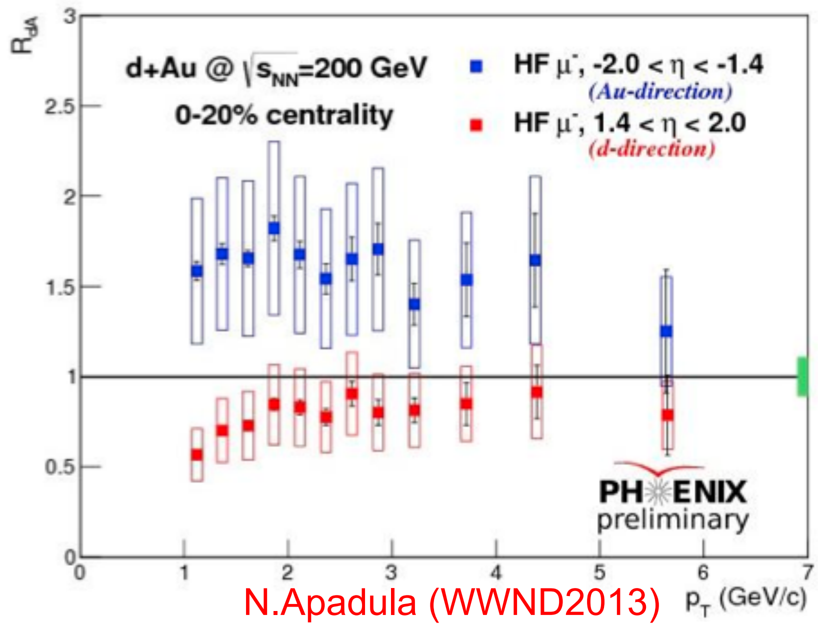


- Low-p_T electrons at mid-y (and muons at backward y): R_{dA}>1
- This "Cronin peak" is very interesting!
  - Not seen in pions, but seen in protons
  - More "enhanced" than expected from anti-shadowing?
  - Consistent with radial flow?
    - Larger effect expected for D mesons!

HF-decay e and μ in d-Au at RHIC



PHENIX, PRL109 82012) 242301

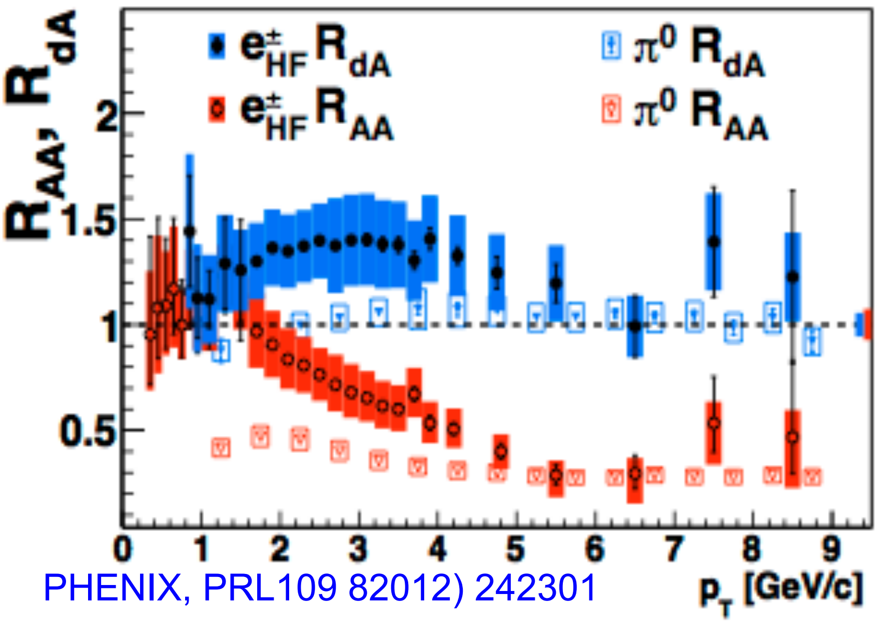


N.Apadula (WWND2013)

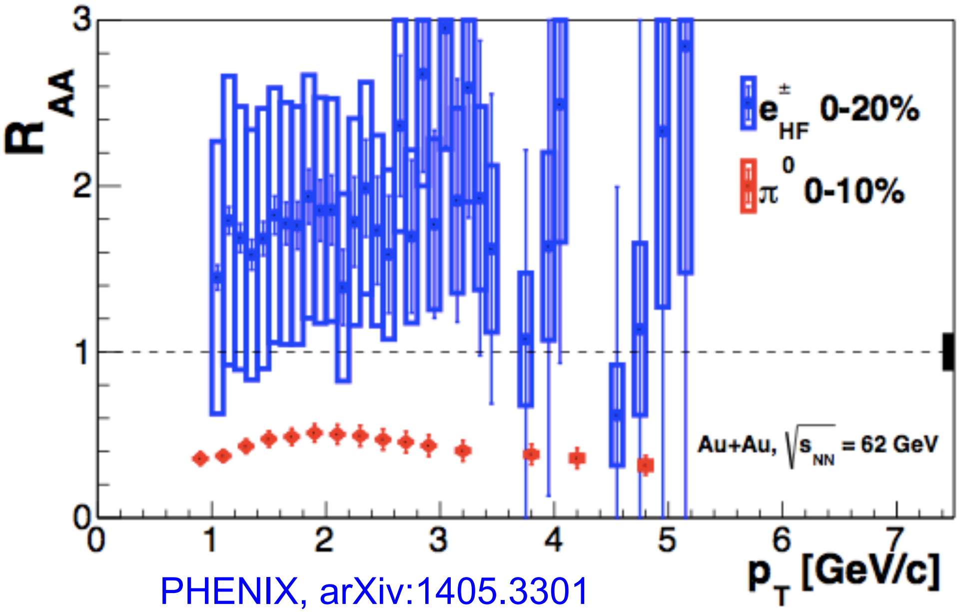
- Low-p_T electrons (mid-y) and muons (backward y) largely enhanced
  - More than expected from anti-shadowing?
  - Significant role of (mass-dependent?) k_T broadening?

→ Au-Au high-p_T suppression is a final state effect

HF-decay electrons at RHIC (62 GeV)



PHENIX, PRL109 82012) 242301



PHENIX, arXiv:1405.3301

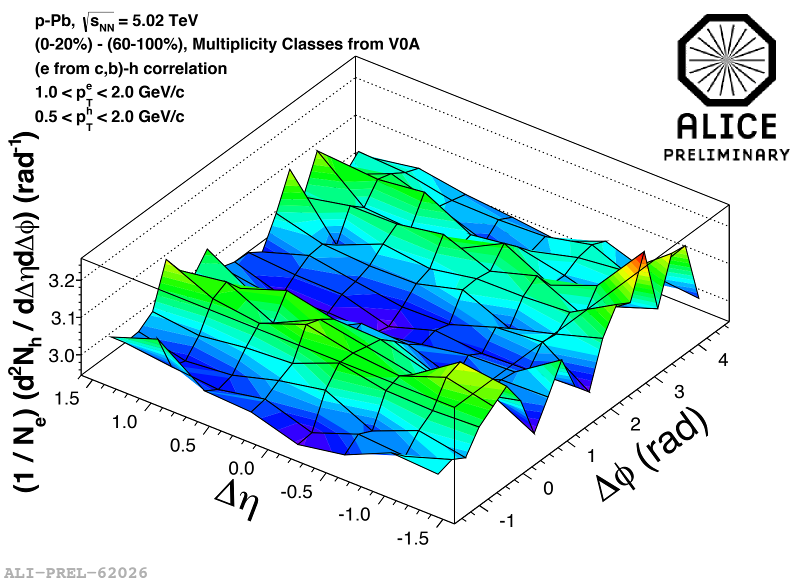
- Lower energy RHIC runs give the unique opportunity to study the onset of the suppression
- R_{AA} at 62 GeV obtained with reference data from ISR
- Large uncertainties show the need for a high-stat RHIC pp run at 62 GeV

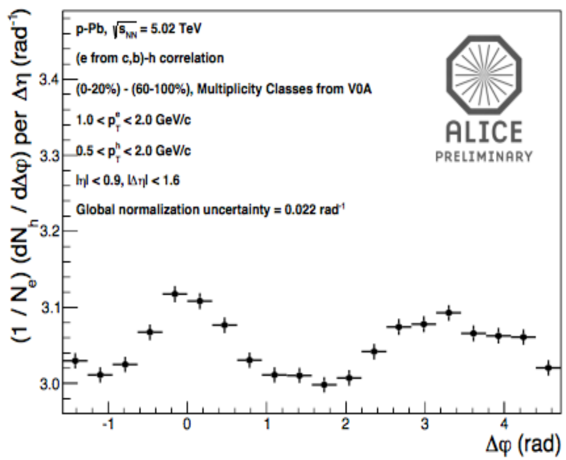
p-Pb at LHC: more than a control experiment?

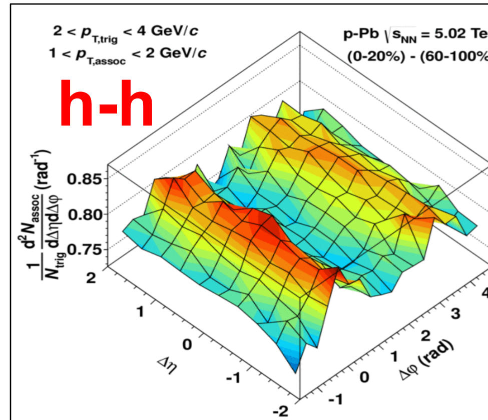
e-h correlations in high-mult collisions

- Correlation between HF-decay electrons and hadrons in (high-mult) – (low-mult) p-Pb collisions: a “double ridge” similar to what observed for hadron-hadron

HFe-h





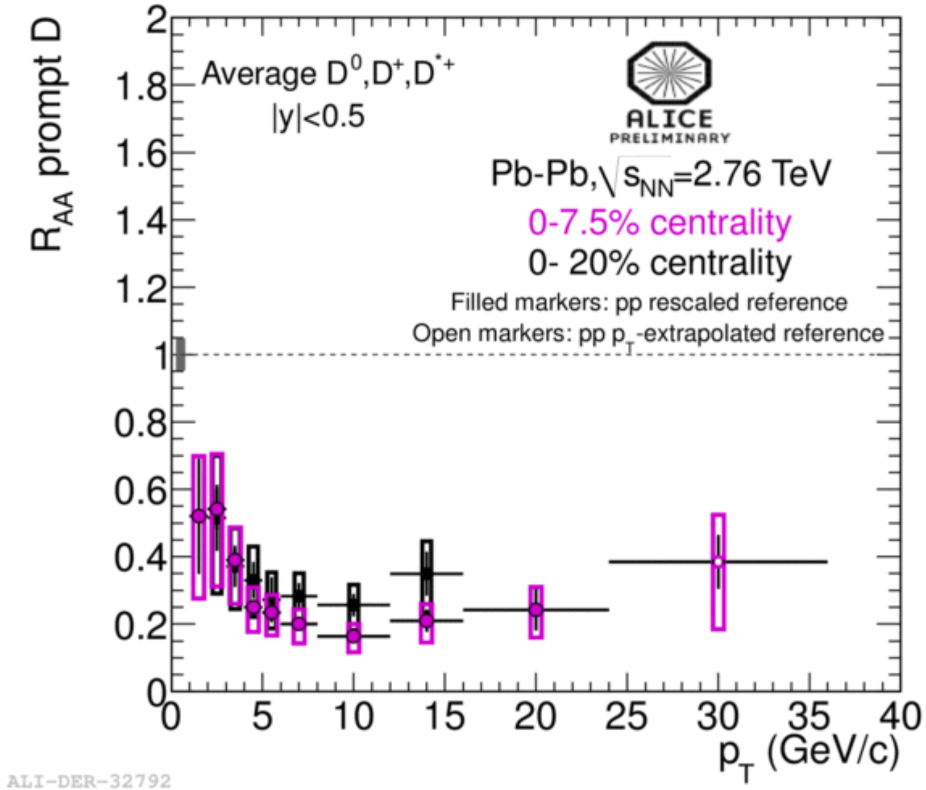


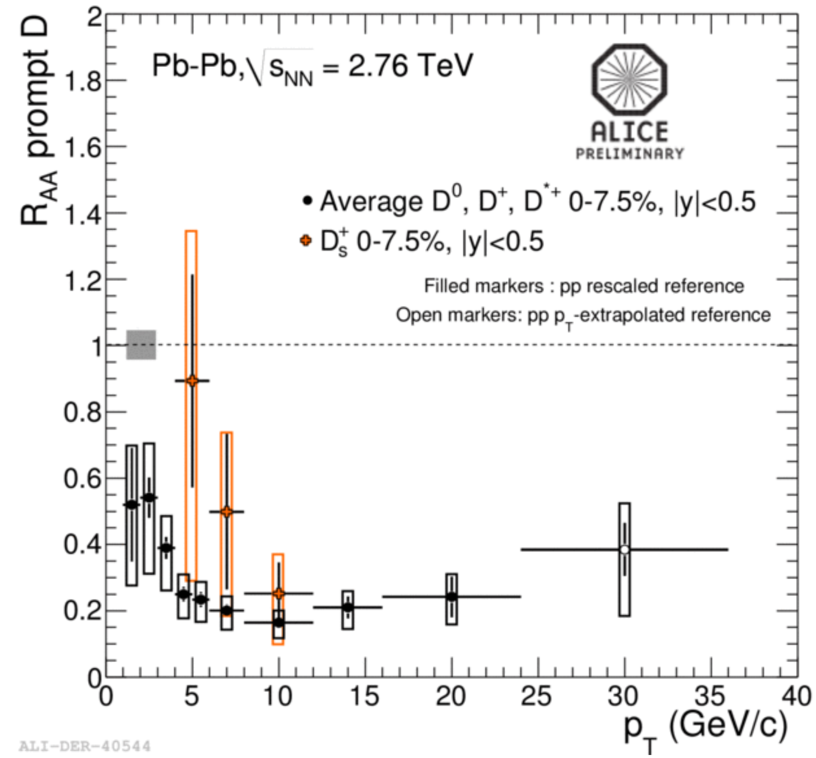
ALICE, PLB719 (2013) 29

E. Pereira, HP2013

- Resembles the structure that in AA is interpreted in terms of collective flow

Charm: D mesons in Pb-Pb at LHC

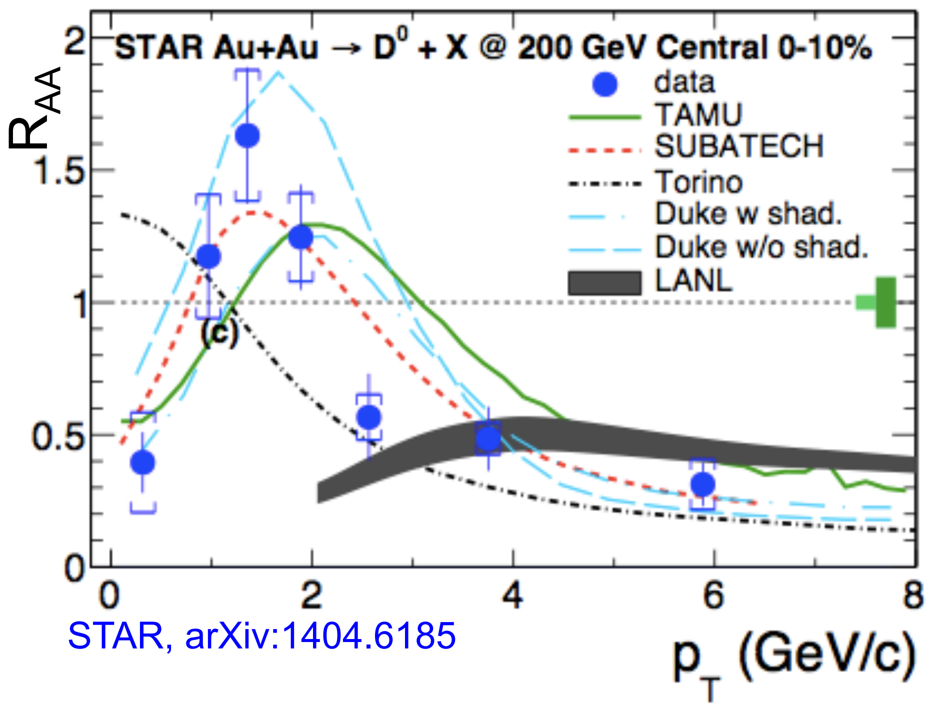




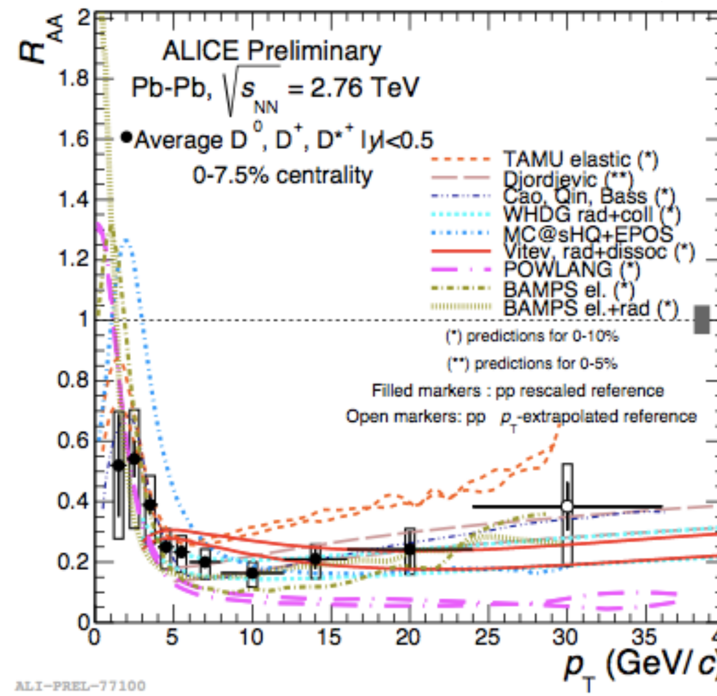
- First D R_{AA} measurement with data from LHC 2010 run
- Extended with LHC 2011 run, from 1 to 30 GeV/c: factor ~5 suppression at ~10 GeV/c in 0-7.5% centr.
- First R_{AA} of D_s: suggestive of $c\bar{s}$ recombination at low p_T ?

ALICE, JHEP 09 (2012) 112 Z.Conesa (QM2012)

D R_{AA} at RHIC and LHC

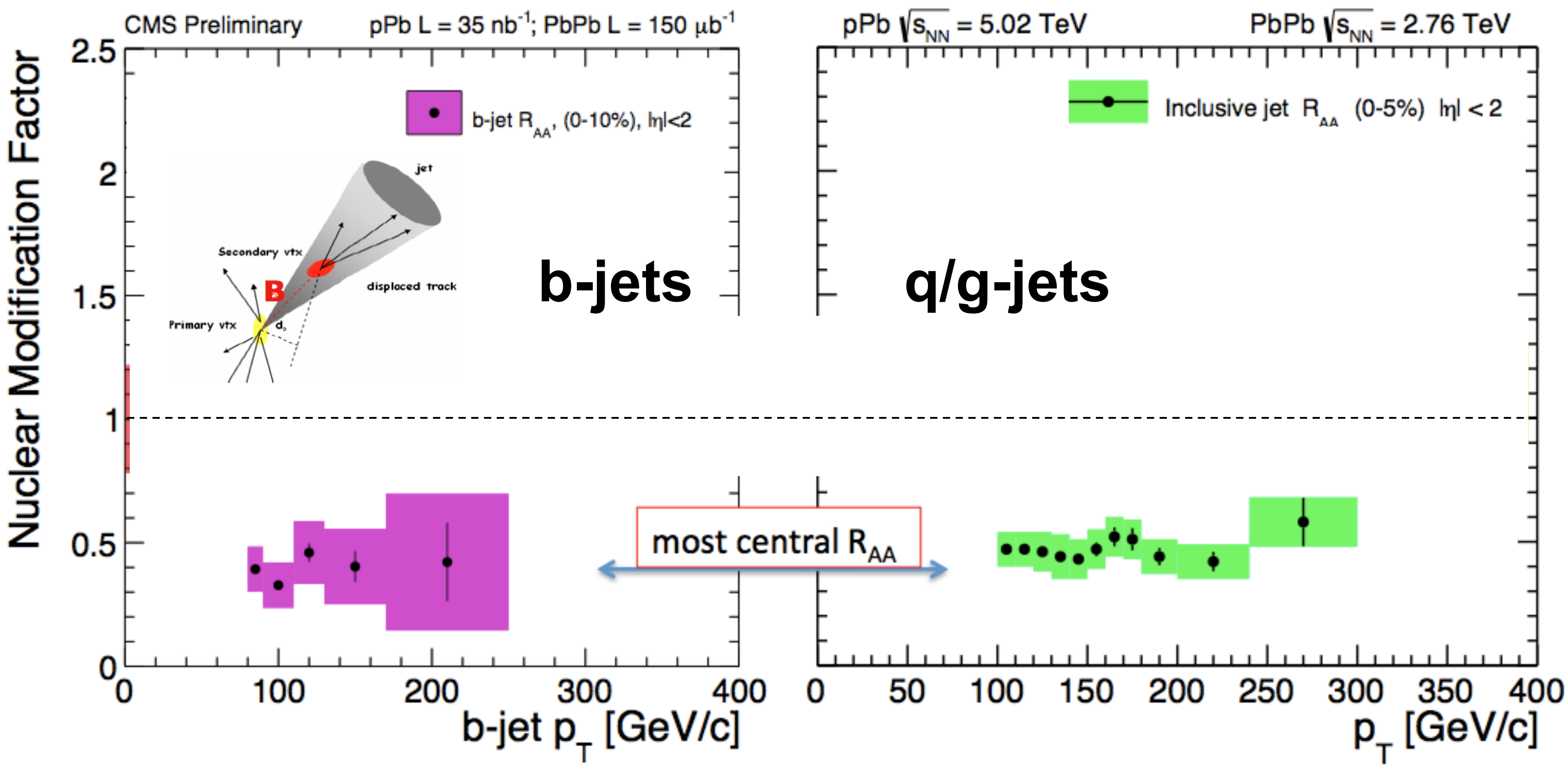


STAR, arXiv:1404.6185



- D R_{AA} similar at RHIC and LHC at 5-6 GeV/c
- Looks quite different at 1-2 GeV/c:
  - Could it be shadowing + recombination + radial flow? (stronger effect at RHIC because of steeper dN/dp_T)
  - Two transport models (TAMU and Duke) with these ingredients predict maximum R_{AA} ~1.3-1.5 at RHIC and ~0.7-0.8 at LHC

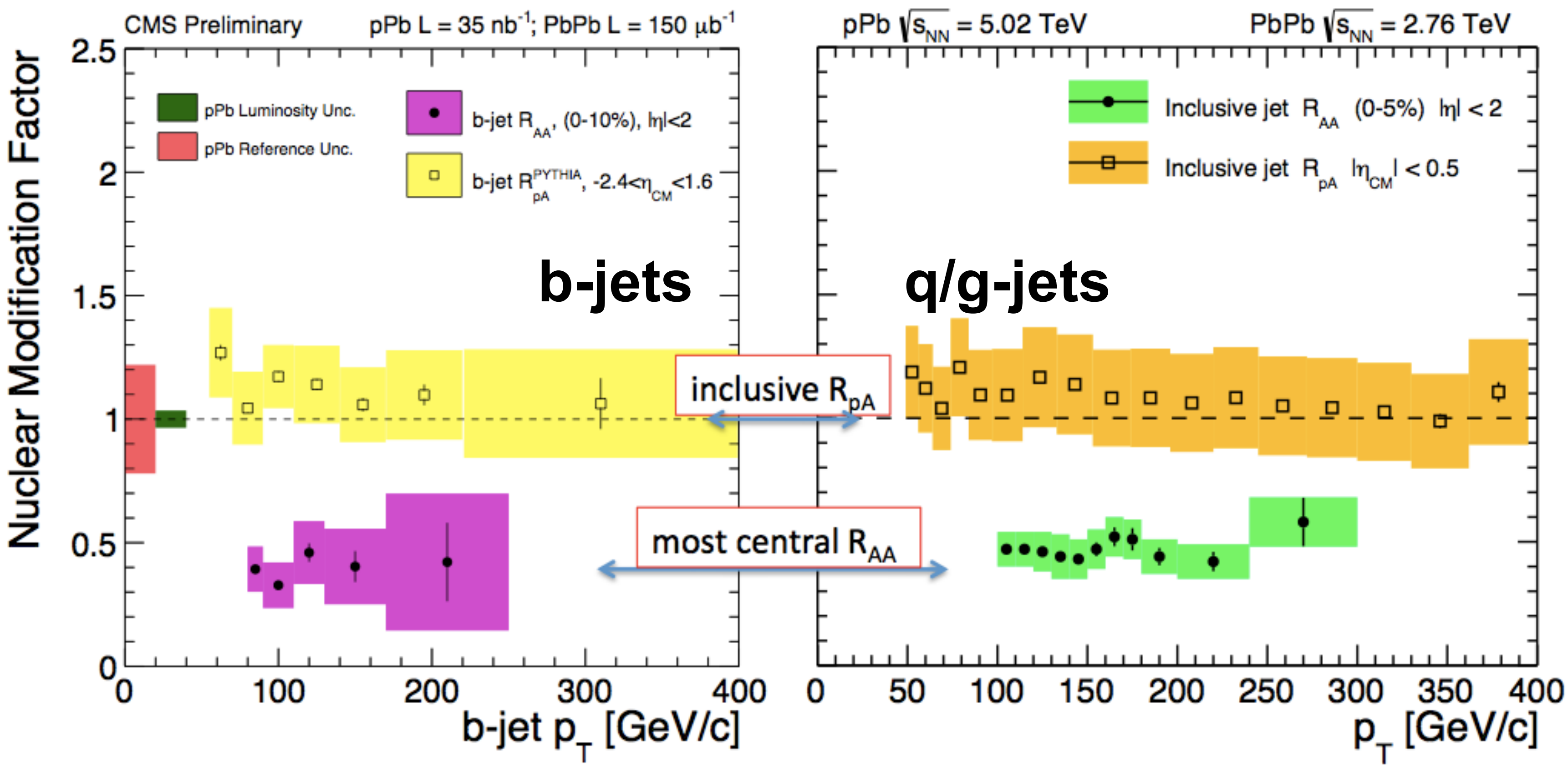
b-jet R_{AA} at LHC



- CMS measured b-jets with p_T>80 GeV/c in Pb-Pb and p-Pb
- Same R_{AA} for b-jets as for q/g-jets, as expected at this p_T

CMS-HIN-12-003, CMS-HIN-14-007

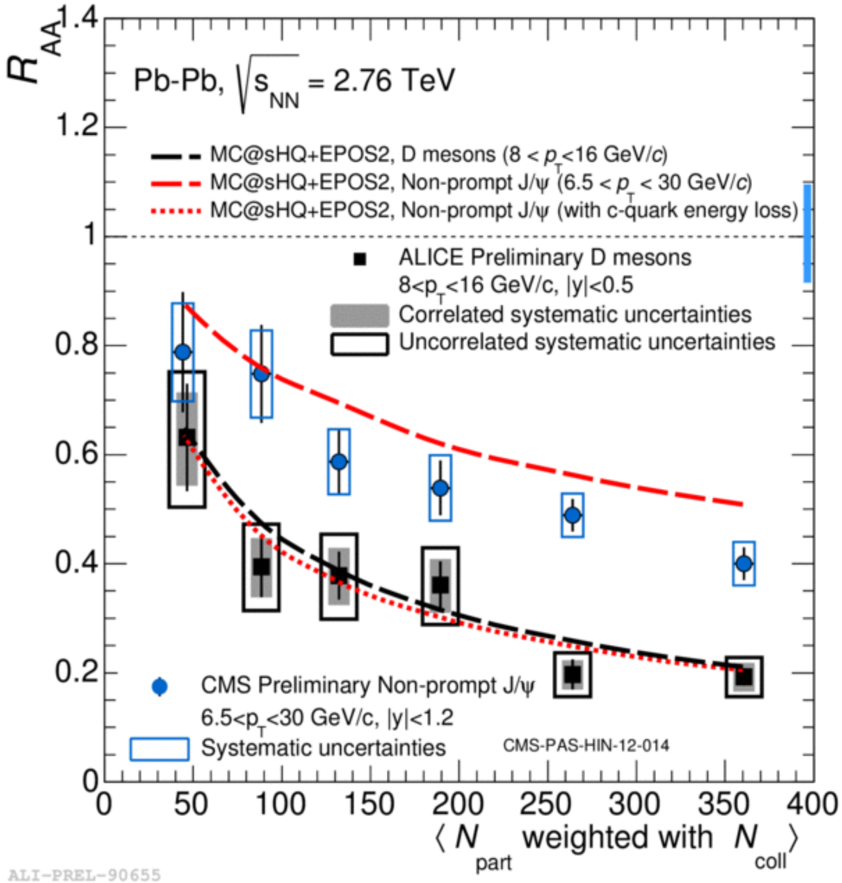
b-jet R_{AA} at LHC

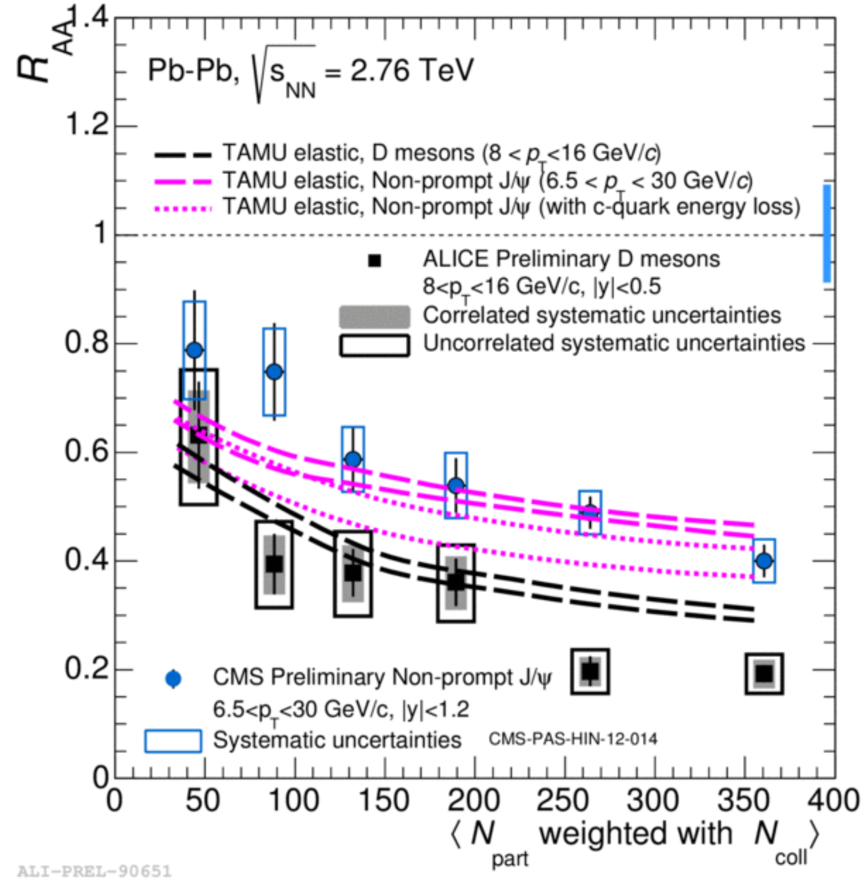


- CMS measured b-jets with p_T>80 GeV/c in Pb-Pb and p-Pb
- Same R_{AA} for b-jets as for q/g-jets, as expected at this p_T
- R_{pA} consistent with unity: no strong initial-state effects

CMS-HIN-12-003, CMS-HIN-14-007

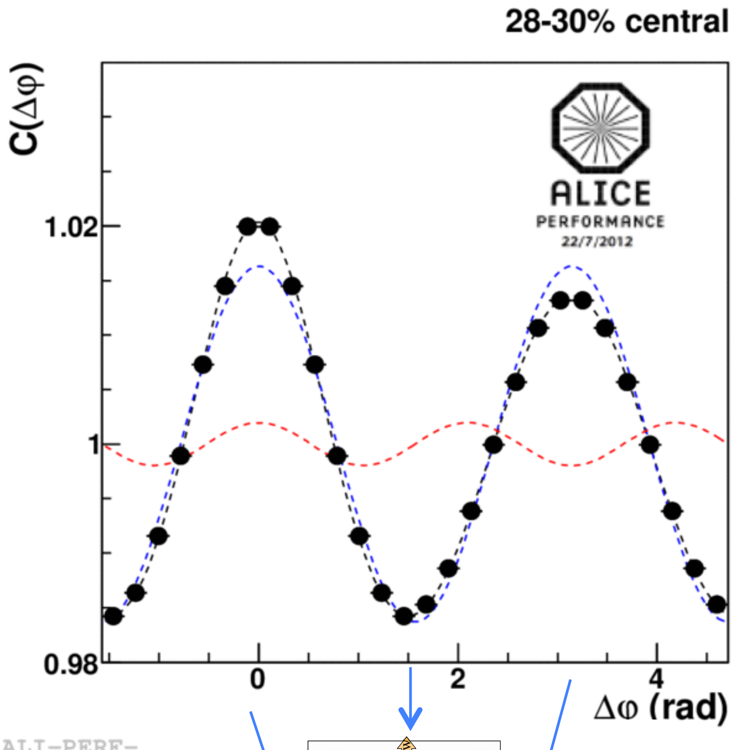
R_{AA} of D and B at the LHC

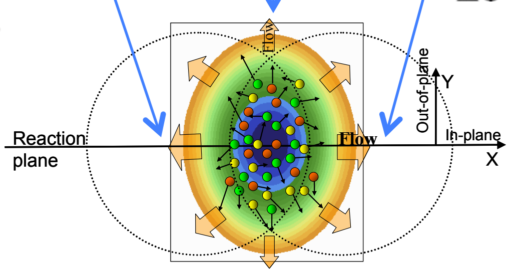




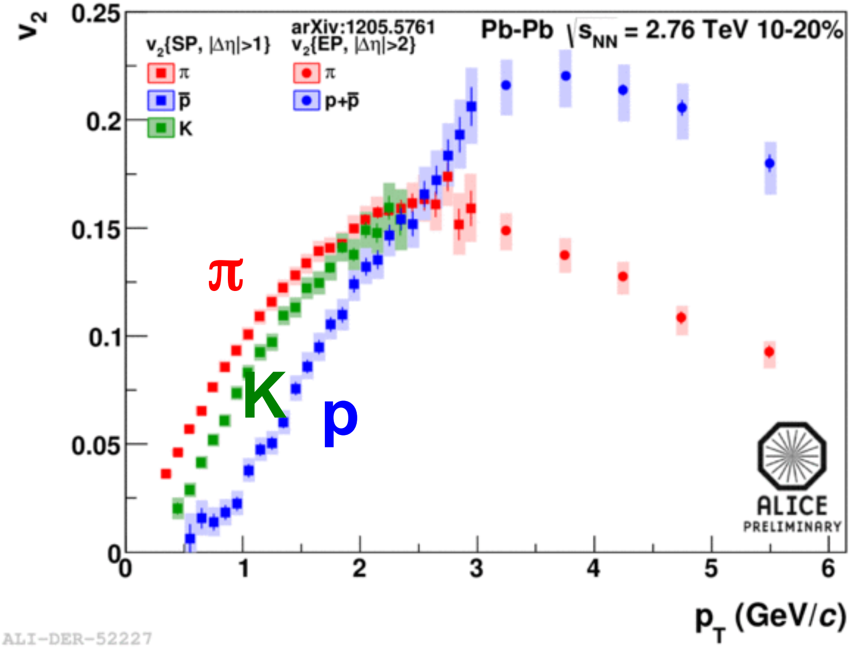
Two-particle Δφ correlations and azimuthal anisotropy in Pb-Pb

Example of azimuthal modulation:





v_2: amplitude of 2[nd] order (elliptic) modulation

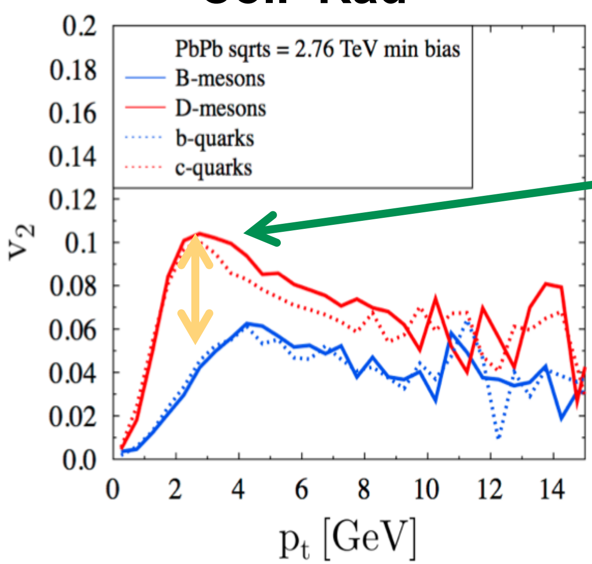


- Particle-species and p_T dependence follow expectations from hydrodynamical models, in which v_2 is built from collective expansion

HF flow

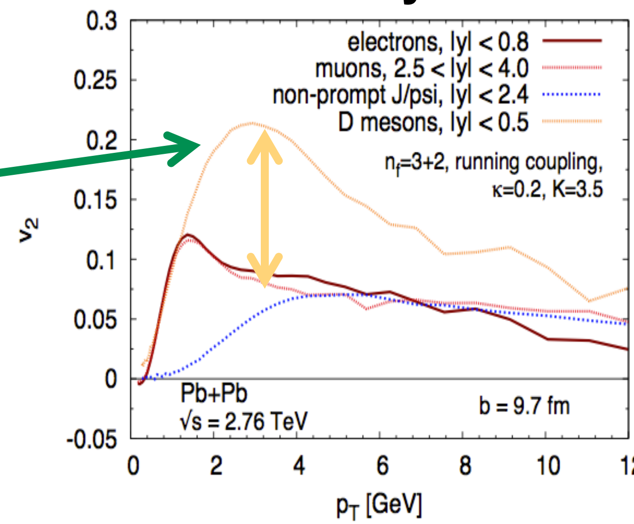
- Do HQs take part in the "collectivity"? → look for radial and elliptic flow
- Information on QGP transport coefficient, role of E loss mechanisms, and hadronization mechanisms
  - Due to their large mass, HQs need frequent interactions with large coupling to build flow (a clear expectation: $v_2^b < v_2^c$) ↔
  - Collisional energy loss gives larger v_2 than radiative ↔
  - Coalescence increases radial and elliptic flow at intermediate p_T ↔

Coll+Rad



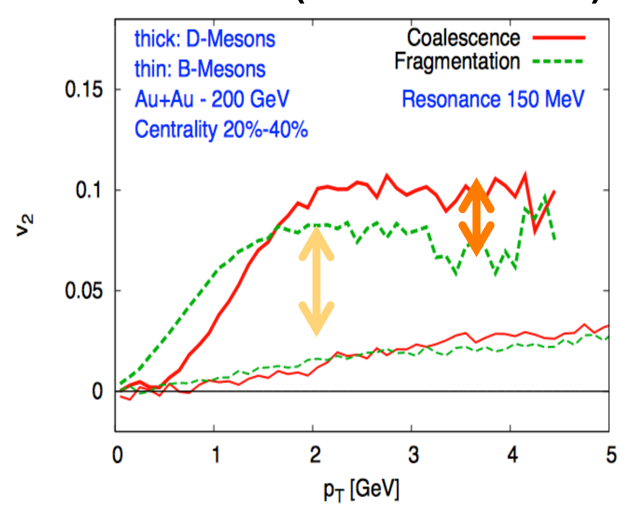
J. Aichelin et al., arXiv:1201.4192

Coll only



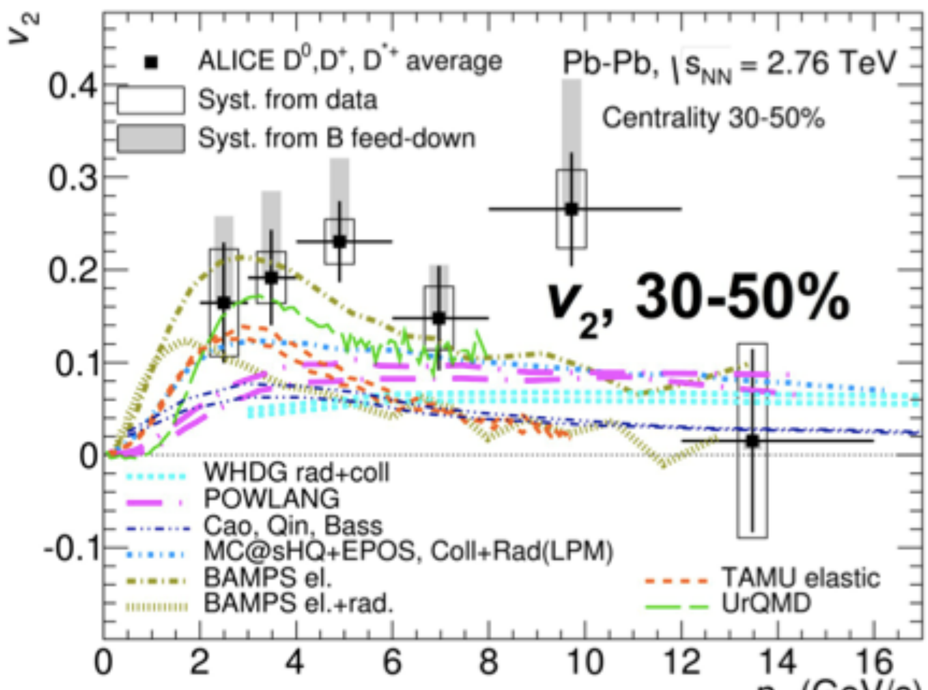
J. Uphoff et al., arXiv:1205.4945

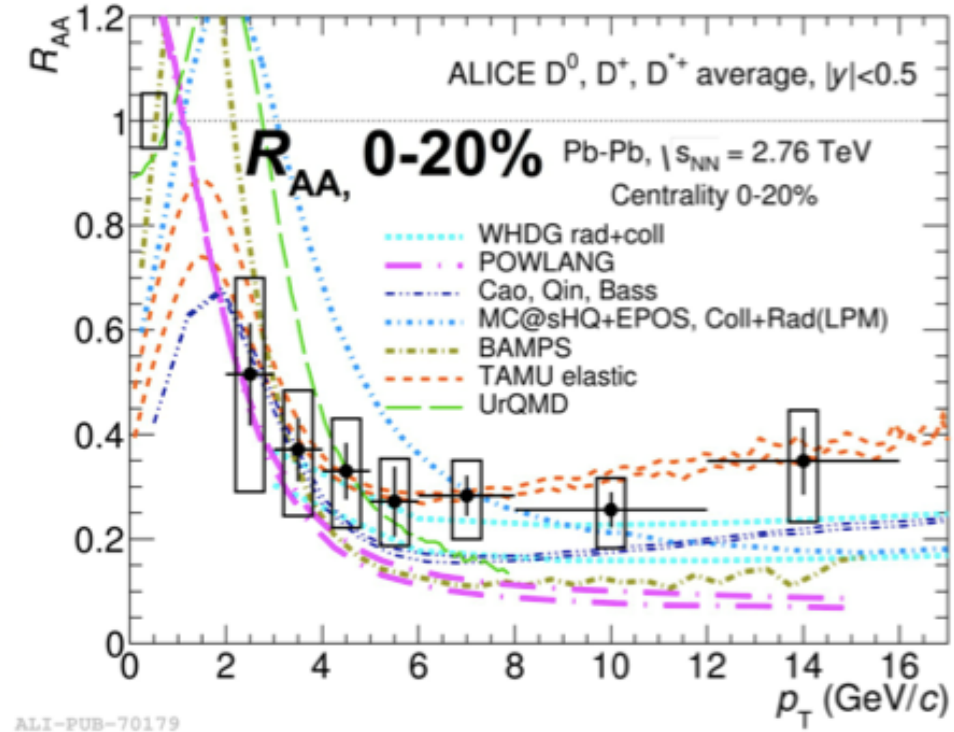
Coll (via resonance)



T. Lang et al., arXiv:1211.6912

Comparison with models at LHC

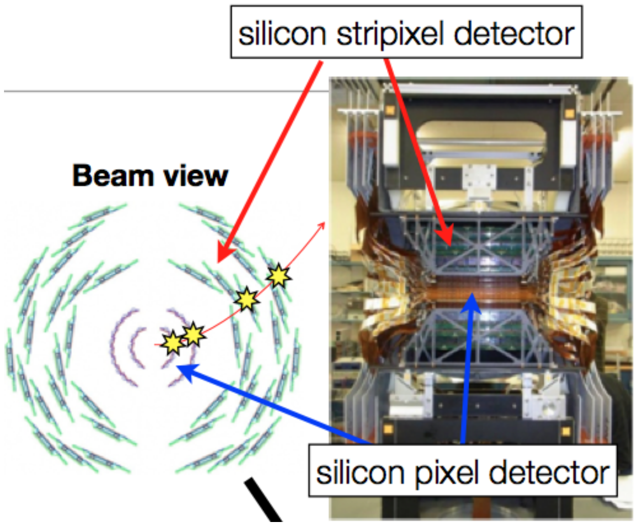




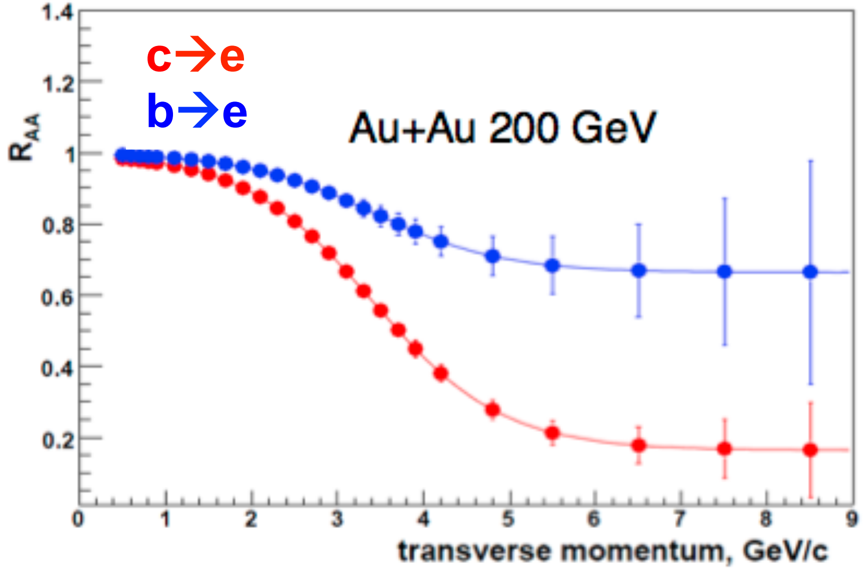
ALICE, PRC90 (2014) 034904

- Models without HQ interactions with *expanding* medium underestimate v_2 (WHDG, POWLANG)
- Max v_2~0.15-0.20 is best described by models that include **collisional energy loss** of heavy quarks in expanding medium (BAMPS, UrQMD, TAMU, MC@sHQ); they also include a component of **recombination**
- Suggests that these mechanisms play a role in HQ-medium interactions

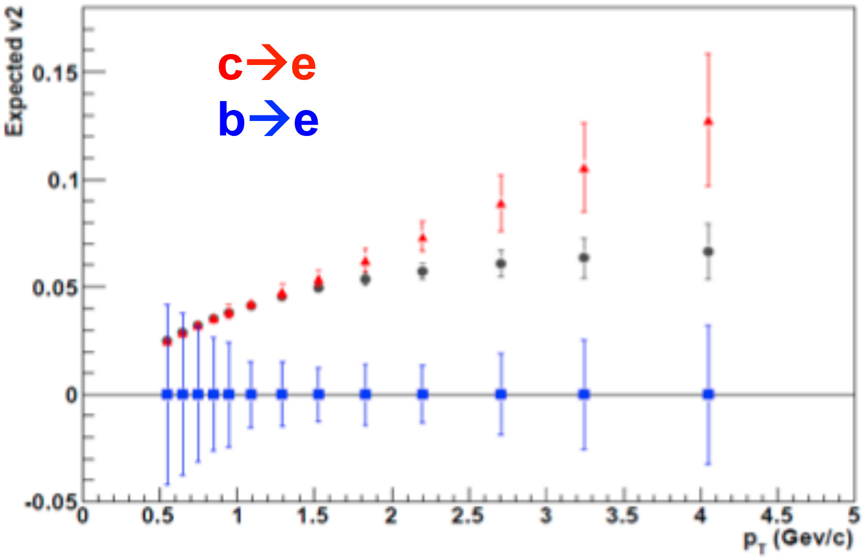
PHENIX: Vertex Tracker (VTX)



Electron R_{AA}

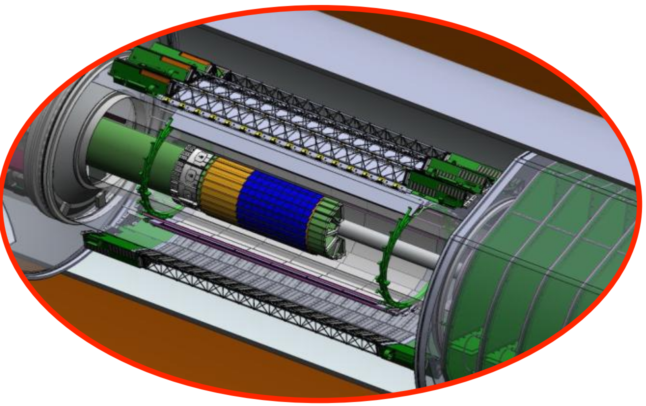


Electron v_2



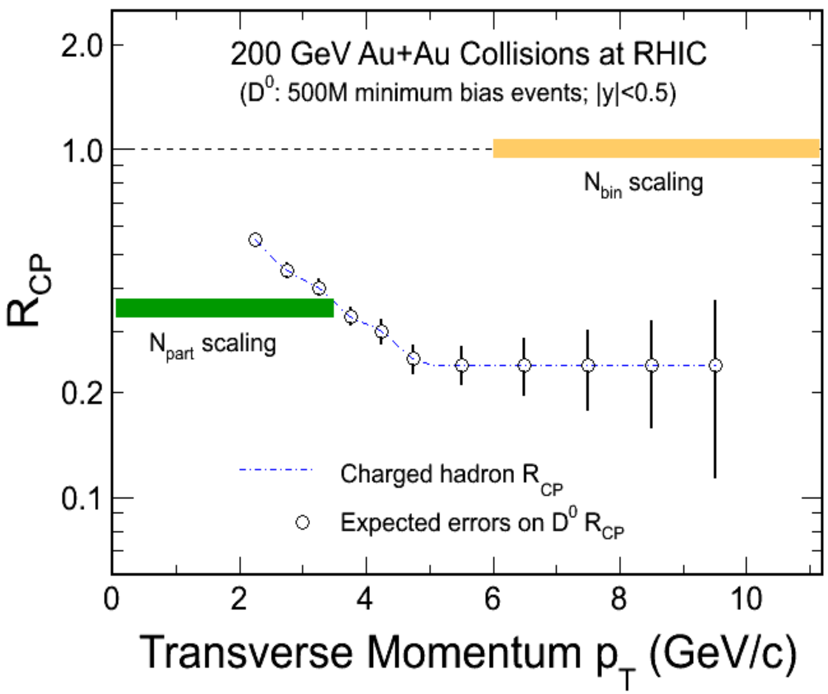
Projections $5x10^9$ evts

M. Rosati, QM2012

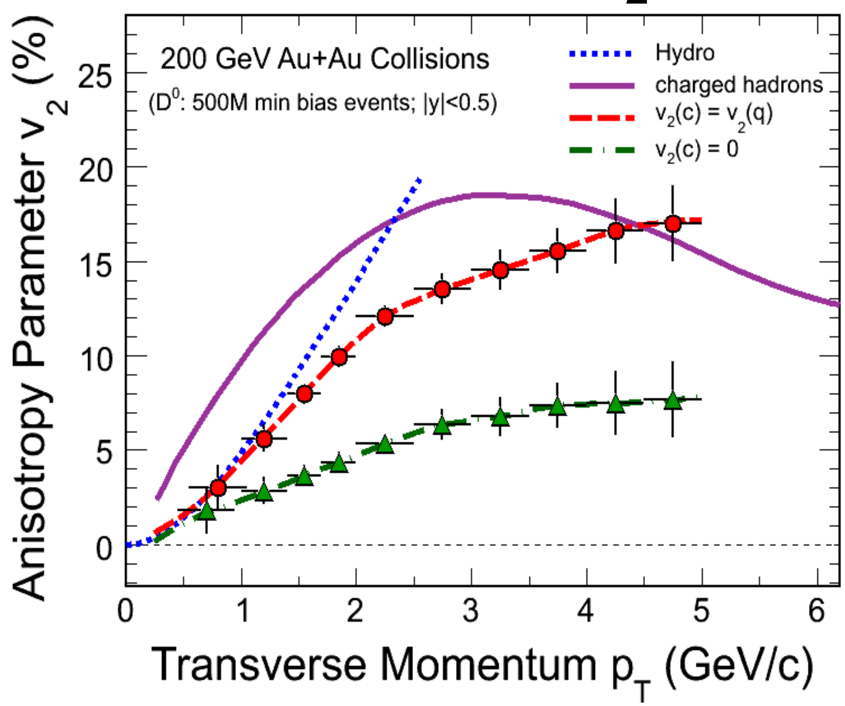


STAR: Heavy Flavour Tracker

D meson R_{CP}



D meson v_2

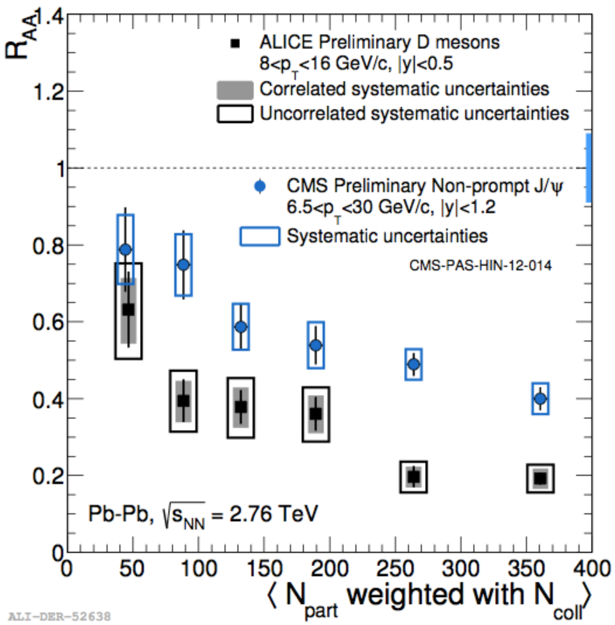


Projections 0.5×10^9 evts

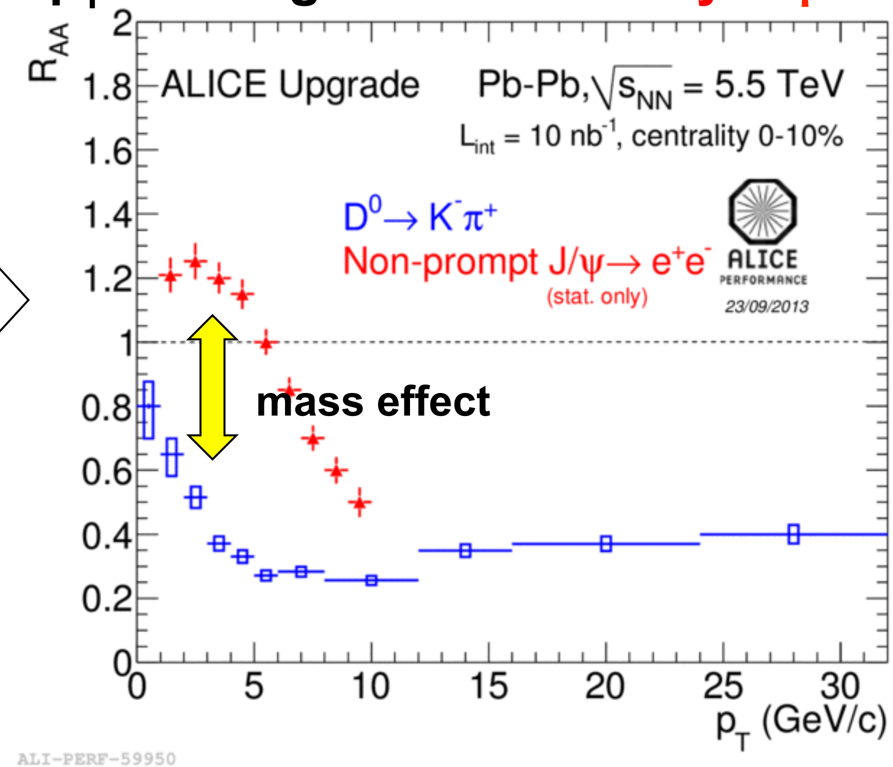
J. Bielcik, Moriond2013

ALICE Upgrade: Heavy flavour R_{AA}

Present data at p_T~10 GeV



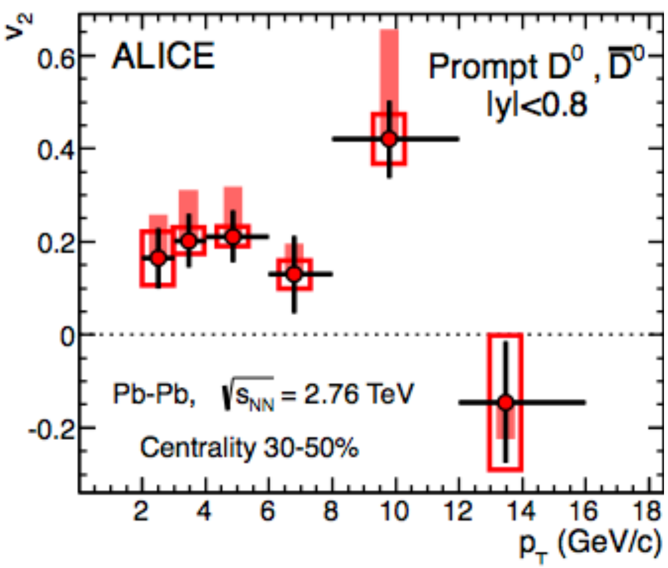
Upgrade: Charm and beauty R_{AA} down to p_T~0 using D^0 and B-decay J/ψ



ALICE, CERN-LHCC-2013-024

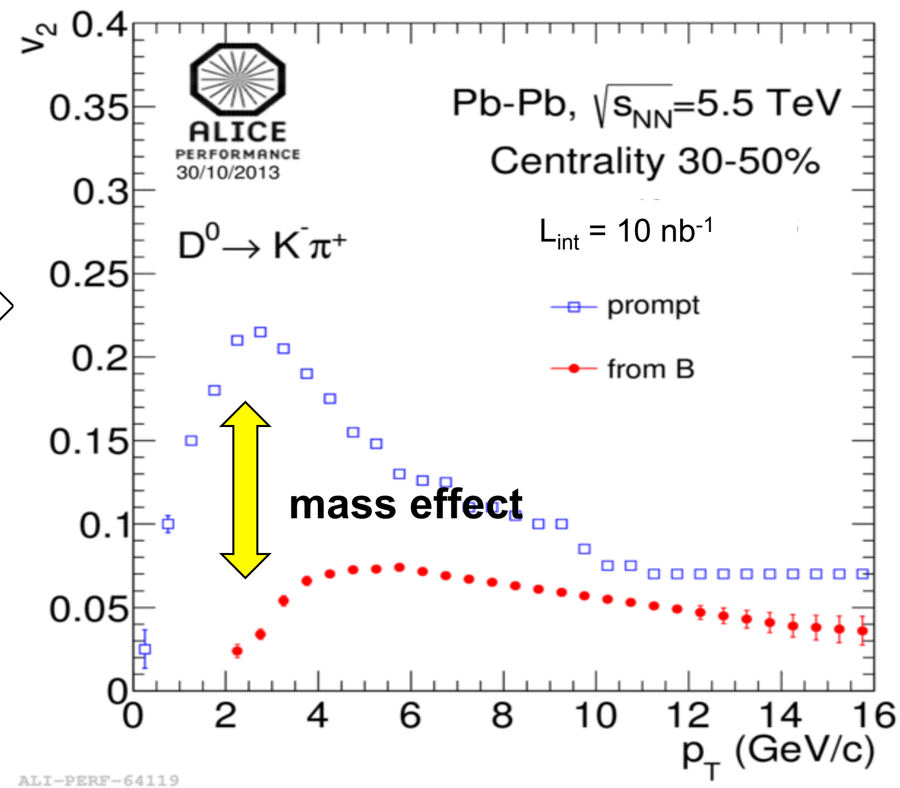
ALICE Upgrade: Heavy flavour flow

Present data on charm v_2



ALICE, PRL 111 (2013) 102301

Upgrade: Charm and beauty v_2 down to p_T~0 using prompt and B-decay D^0



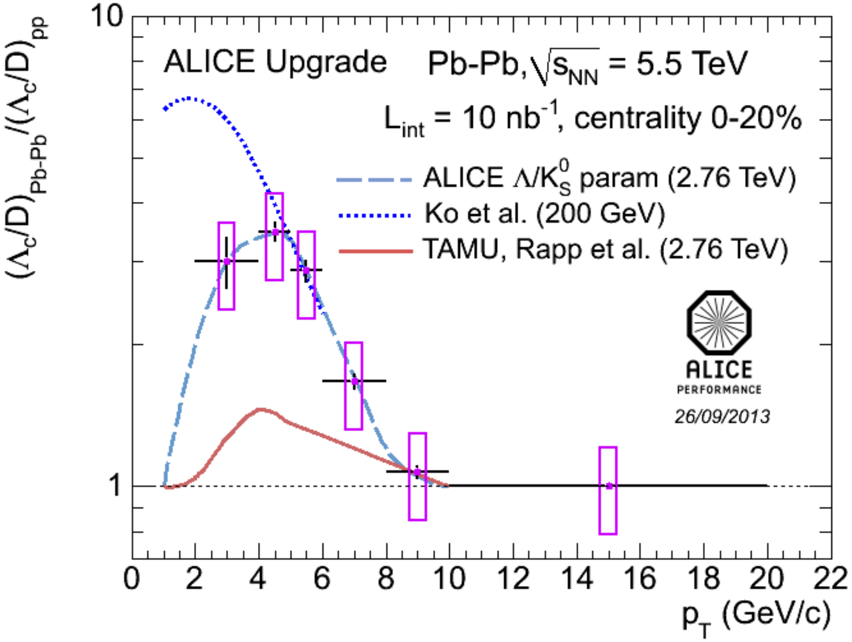
ALICE, CERN-LHCC-2013-024

Input values from BAMPS model:
C. Greiner et al. arXiv:1205.4945

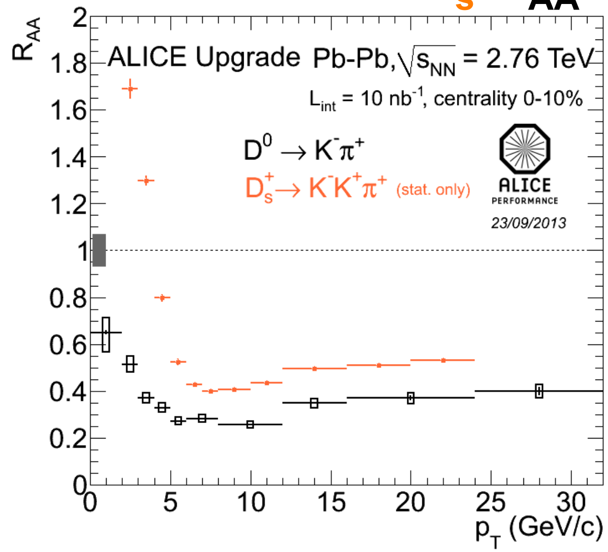
ALICE Upgrade: HF "hadrochemistry"

- $\Lambda_c \rightarrow pK\pi$ and $D_s \rightarrow KK\pi$ ($c\tau$=60 and 150 μm) measured with good precision in ALICE with upgrades and 10/nb

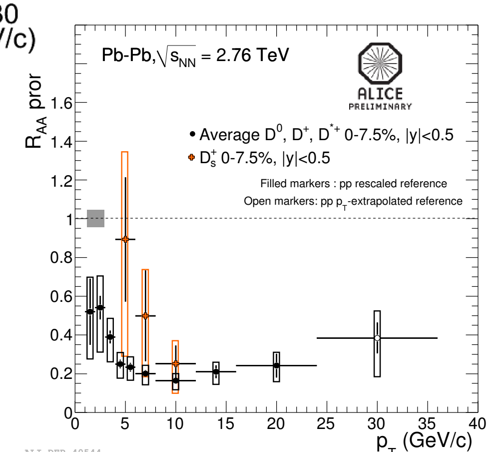
Λ_c/D enhancement
(full detector sim.)



D^0 and D_s R_{AA}



2011 data



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