

ALICE Status Report

106th LHCC meeting - Open session

Andrea Rossi, on behalf of the ALICE
collaboration



ALICE publications in pp collisions

- Multiplicity & distributions
 - 900 GeV; EPJC: Vol. 65 (2010) 111
 - 900,2.36 TeV; EPJC: Vol. 68 (2010) 89
 - 7 TeV EPJC: Vol. 68 (2010) 345
- pbar/p ratio (900 GeV & 7 TeV) PRL: Vol. 105 (2010) 072002
- Momentum distributions (900 GeV) PLB: Vol. 693 (2010) 53
- Bose-Einstein correlations (900 GeV) PRD: Vol. 82 (2010) 052001
- Strangeness ($K_0, \Lambda, \Xi, \Omega, \phi$) at 900 GeV EPJC: Vol: 71, (2011) 1594
- Identified charged particle spectra (900 GeV)
 - <http://arxiv.org/abs/1101.4110> accepted by EPJC
- Pion Bose-Einstein correlations at 0.9 and 7 TeV
 - <http://arxiv.org/abs/1101.3665v1> submitted to Phys. Rev. D
- **J/ Ψ production at 7 TeV :**
 - <http://arxiv.org/abs/arXiv:1105.0380> submitted to Phys. Lett. B

**In this talk,
focus on PbPb
results**



ALICE Talks at



Plenary:

ALICE overview: J. Schukraft
Global properties: A. Toia
HBT: A. Kisiel
Flow: R. Snellings
 R_{AA} : H. Appelshaeuser
Identified Particles: M. Floris
Correlations (I_{AA}): Jan Fiete GO
J/Psi: G. Martinez Garcia
Heavy Flavour: A. Dainese

Correlations & Fluctuations

Elliptic flow: A. Bilandzic
Triggered dihadrons: A. Adare
Untriggered dihadrons: A. Timmins
Dihadrons pp: Y. Mao
pT fluctuations: S. Heckel
HBT: J. Mercado
HBT K_0^s pp: T. Humanic

Identified hadrons

PID methods: A. Kalweit
 $\pi/K/p$ in pp: M. Chojnacki
 π^0, η in pp: K. Reygers
Resonances: A. Pulvirenti
 Λ/K^0 : I. Belikov
 Ξ, Ω pp Pb: D. Chinellato
 $R_{AA} \Lambda/K^0$: S. Schuchmann
 ρ, ω, ϕ pp: A. de Falco

Heavy Flavour

HF μ : X. Zhang
HF e: S. Masciocchi
J/ Ψ pp: R. Arnaldi
J/ Ψ Pb: P. Pillot
D mesons R_{AA} : A. Rossi

Jets

Jet reconstruction: C. Klein-Boesing
 R_{AA} charged: J. Otwinowski
 $R_{AA} \pi^0$: G. Conesa Balbastre

Experiments

Upgrades: T. Peitzmann
cross section pp: K. Oyama

Global & Collective

N_{ch} , centrality: C. Loizides
'strong CP viol': P. Christakoglou
directed flow v_1 : I. Selyuzhenkov
elliptic flow high p_t : A. Dobrin
elliptic flow PID: M. Krzewicki
Ultra-peripheral: C. Oppedisano
Diffraction pp: M. Poghosyan

**In this talk:
focus on
highlights of
PbPb results**

2011 runs

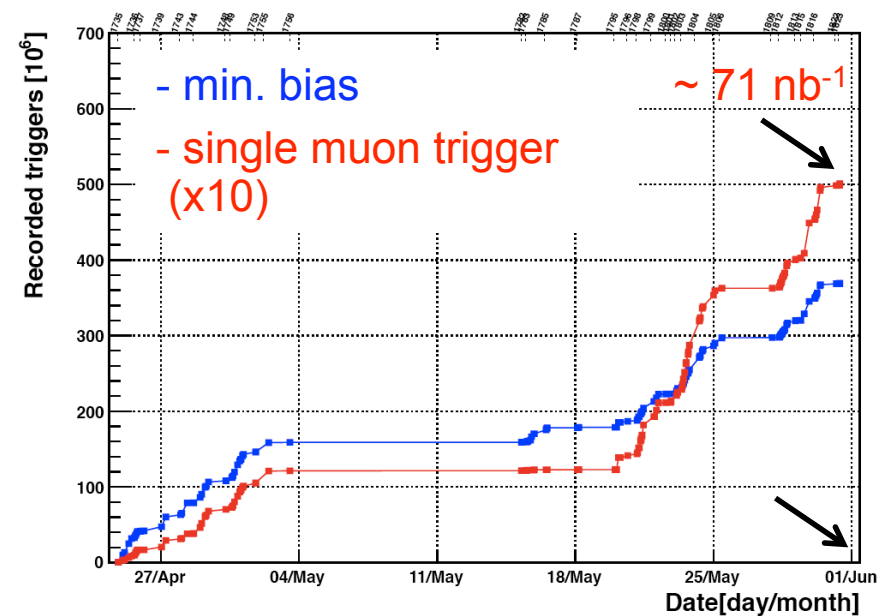
2.76 TeV pp run statistics

- 2.76 TeV pp run: ... not only a fundamental reference for PbPb analyses

System	Energy ($\sqrt{s_{NN}}$)	Trigger	Integr. Lum.
pp	2.76	Min. Bias*	1.37 nb ⁻¹
pp	2.76	Muon SPD high mult. EMCal	20 nb ⁻¹

*w/o SDD (0.65 nb⁻¹ w/ SDD)

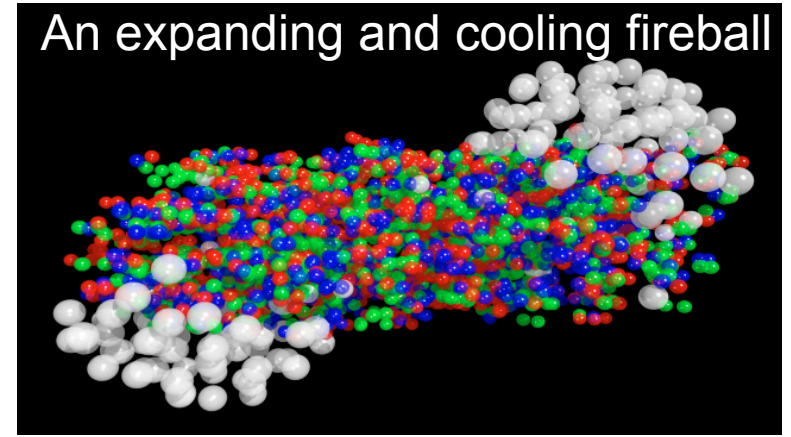
- ongoing 7 TeV pp run
 - now $L_{int} > 400 \text{ nb}^{-1}$ with unlike sign muon pair trigger



Study of the QGP expanding fireball

HIC complex system of strongly interacting matter

- Extended size
- Local thermodynamical equilibrium



25 years experimental research to answer fundamental questions like:

How does the system evolve?

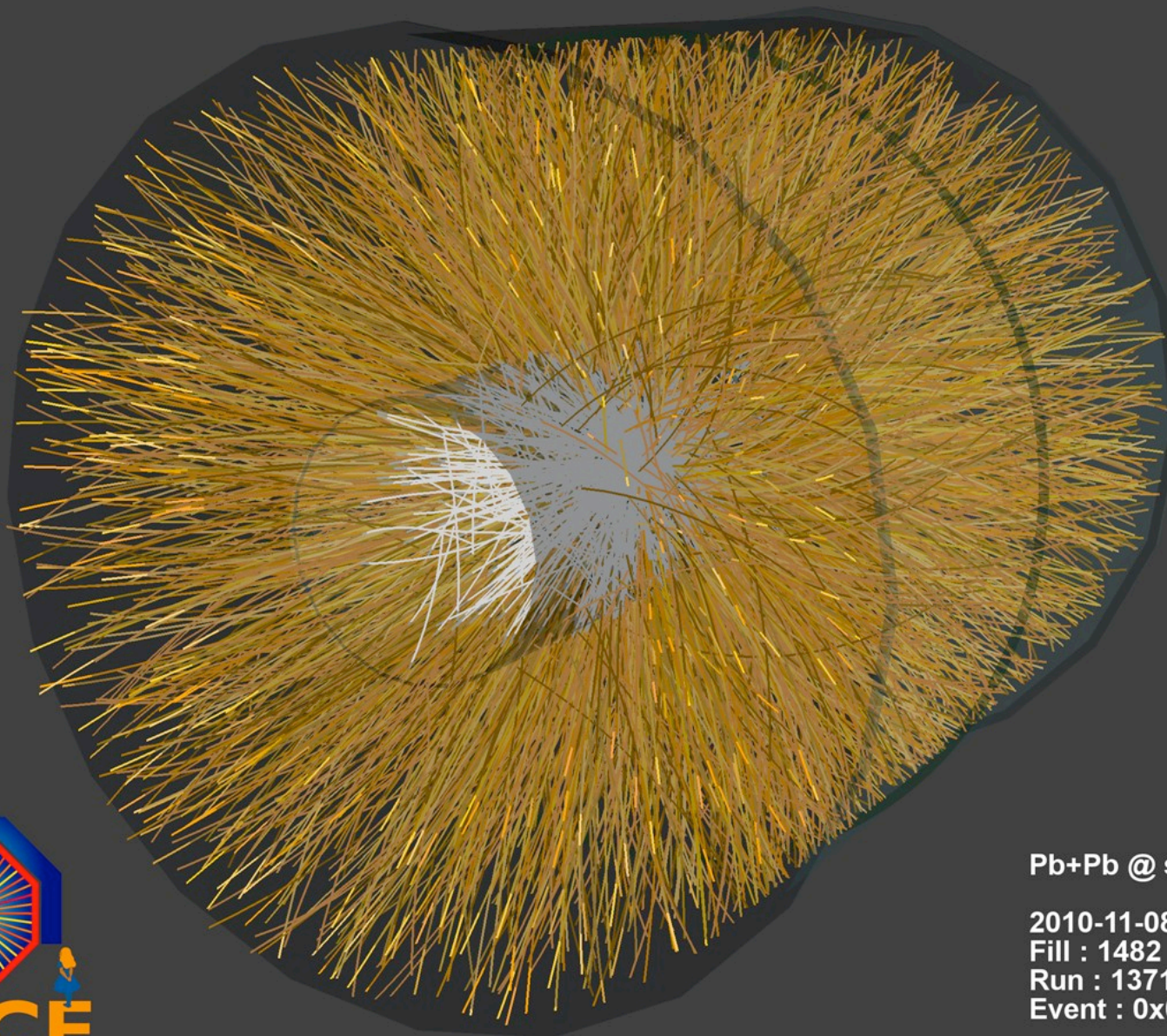
How does the collision geometry manifest itself and what can we learn from it?

Can we access medium global properties (energy density, temperature, size)?

How is particle production modified?

How do high energetic partons interact with the medium?

A challenging environment!



Pb+Pb @ \sqrt{s} = 2.76 ATeV

2010-11-08 11:30:46

Fill : 1482

Run : 137124

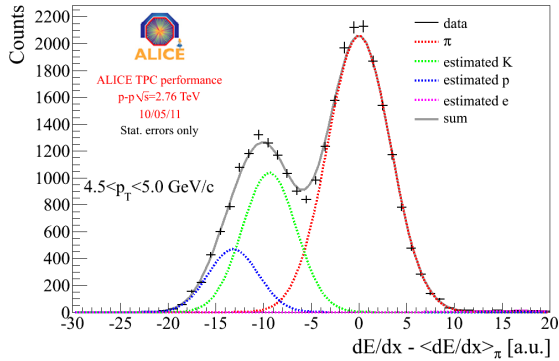
Event : 0x00000000D3BBE693

Particle Identification

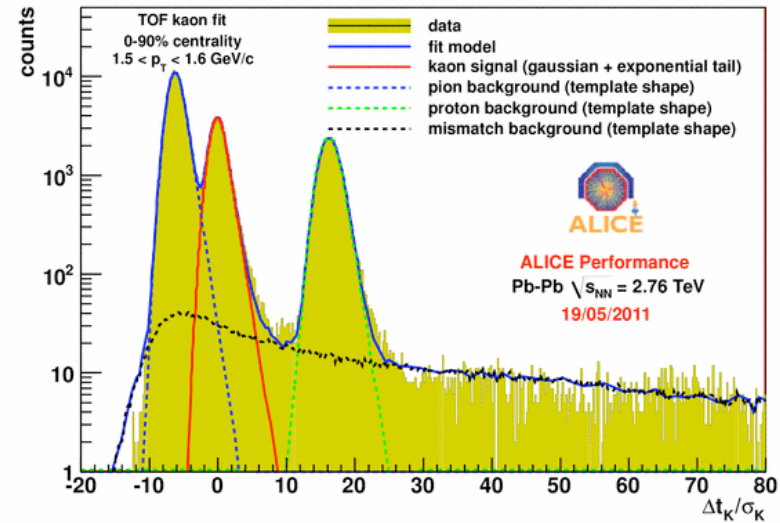
TPC dE/dx



ALI-PERF-3849



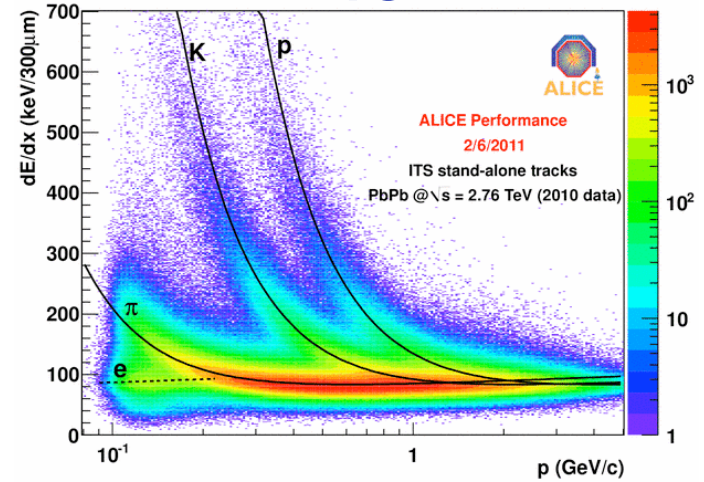
Time Of Flight



ALI-PERF-4539

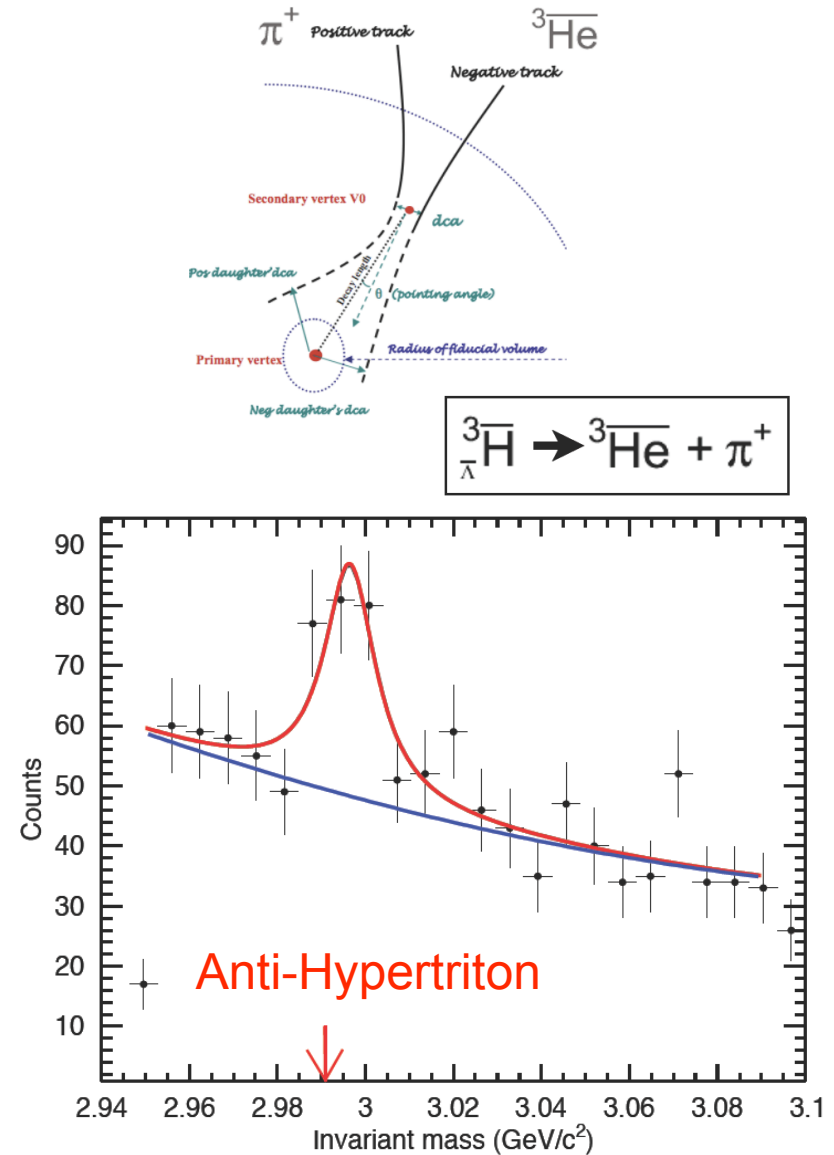
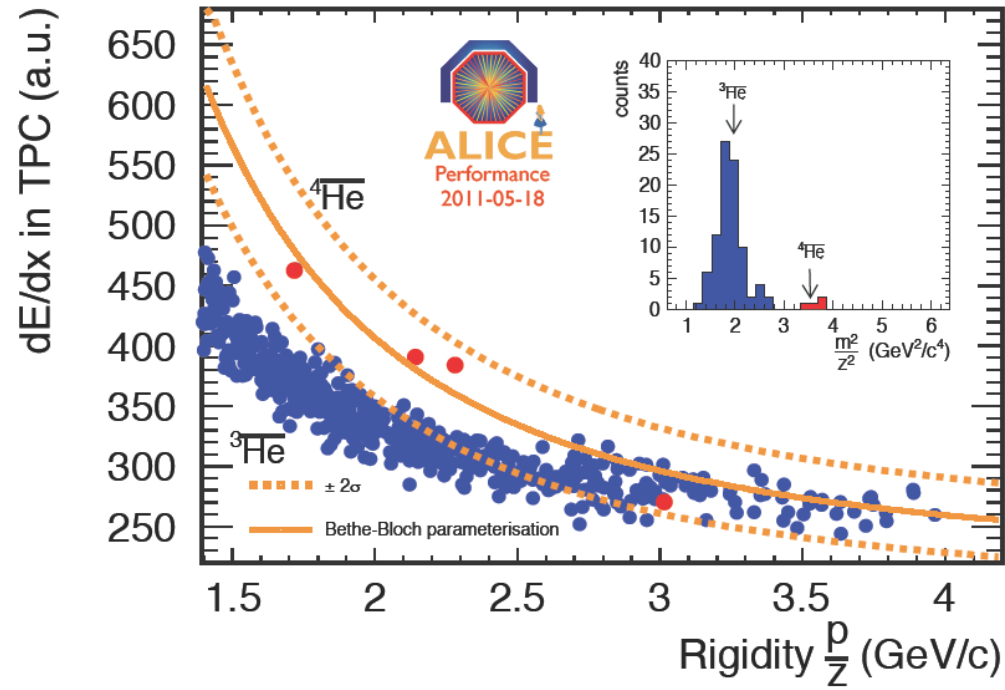
expected separation (nc)

ITS



ALI-PERF-8369

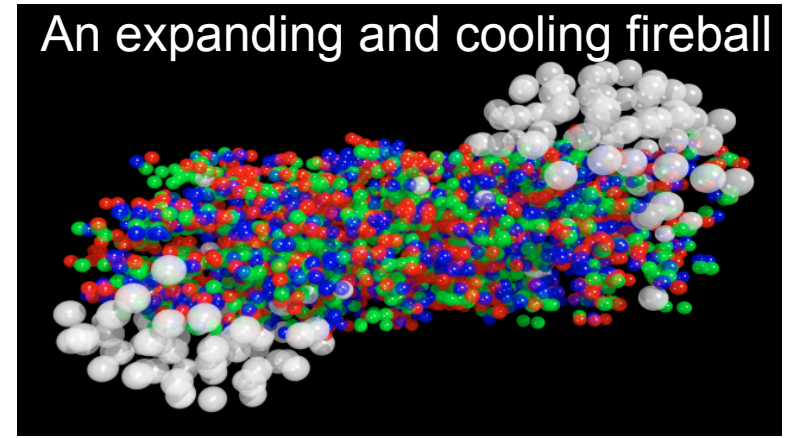
Anti-Matter PID



Study of the QGP expanding fireball

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How do high energetic partons interact with the medium?

One of the main highlights
at Quark Matter 2011

Triggered Azimuthal Correlations

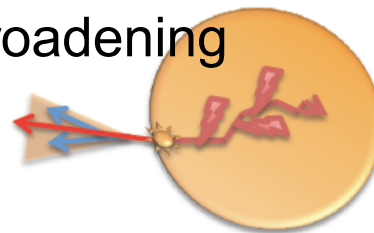
- Triggered correlations: choose a particle from one p_T region ("trigger particle") and correlate with particles from another p_T region ("associated particles") where $p_{T,assoc} < p_{T,trig}$ in bins of $p_{T,trig}$ and $p_{T,assoc}$

- Lower p_T

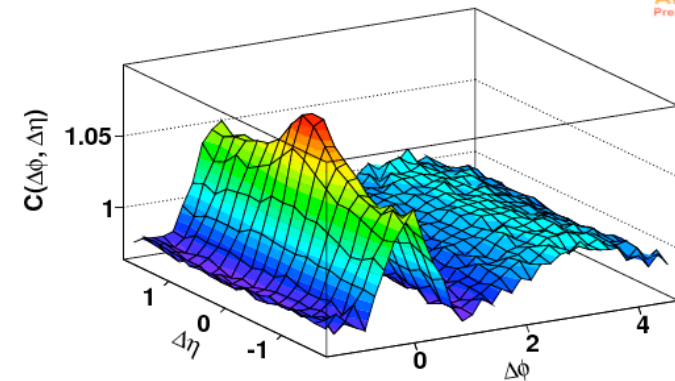
- Assess the bulk of the correlations
- Dominated by hydrodynamics and flow
- Ridge

- Higher p_T

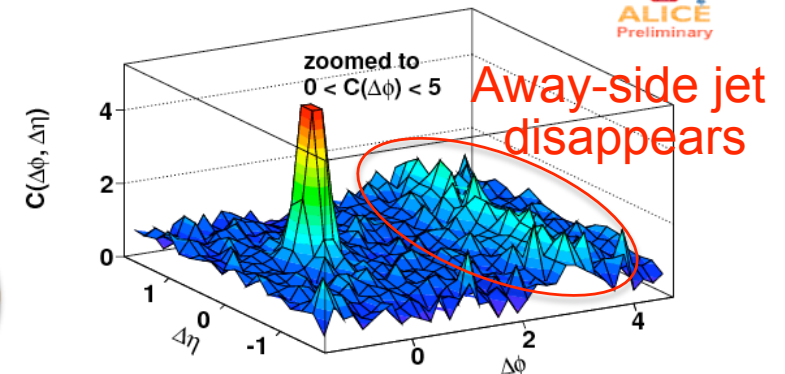
- Dominated by jets
- Quenching/suppression, broadening



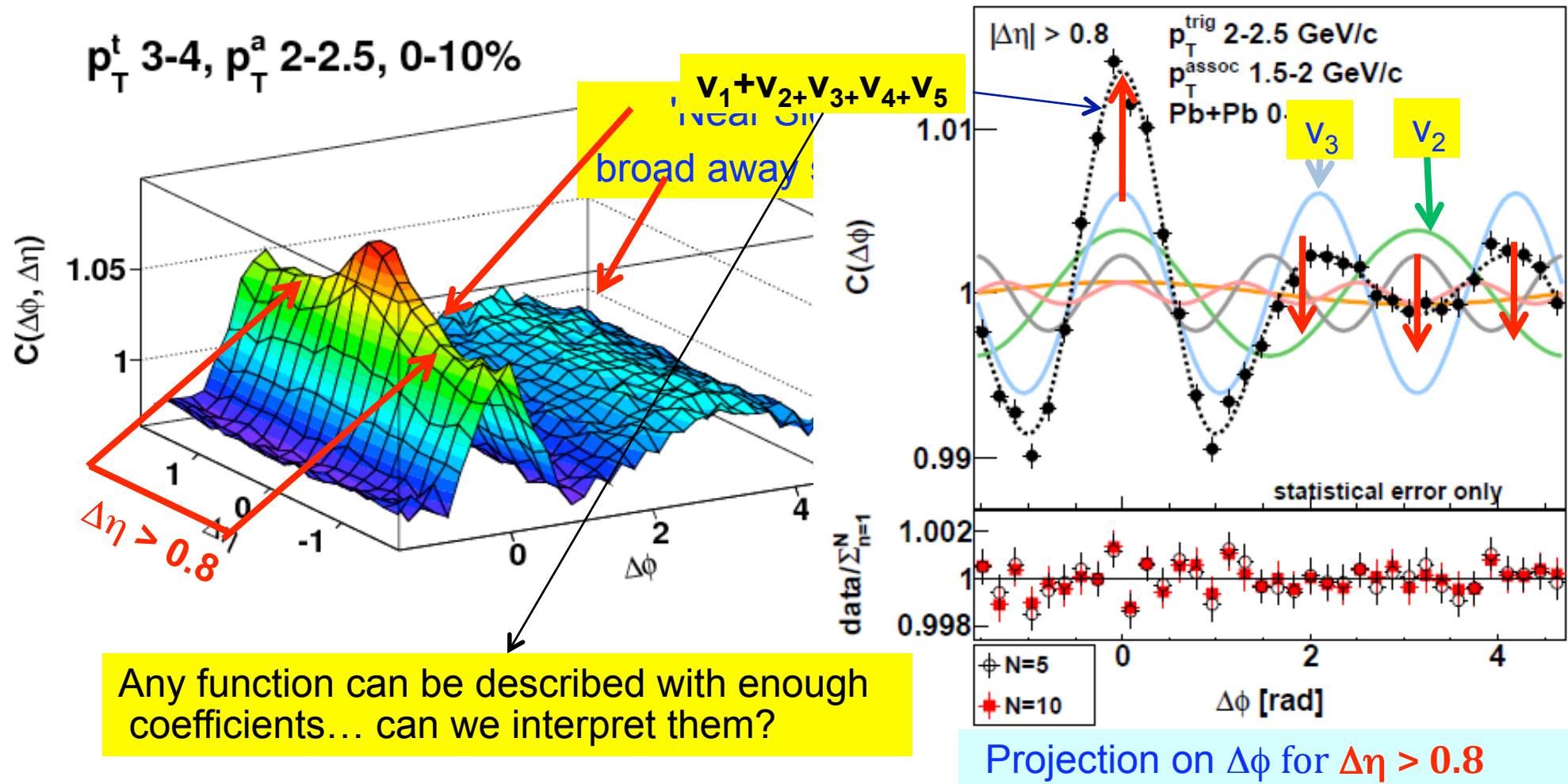
p_T^t 3-4, p_T^a 2-2.5, 0-10%



p_T^t 8-15, p_T^a 6-8, 0-20%



Triggered Azimuthal Correlations



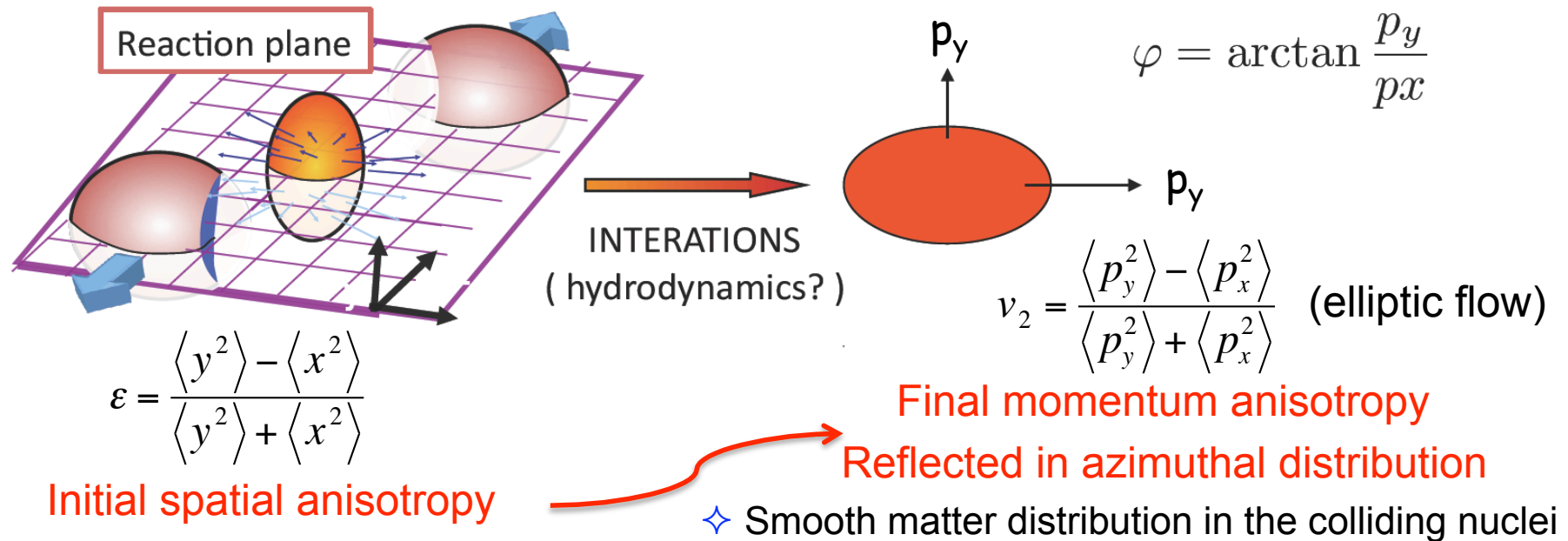
Clean double Hump (aka 'Mach Cone') appears for ultra-central (without any flow subtraction !)

Full correlation structure described by Fourier Coefficients v_1, v_2, v_3, v_4, v_5 (for $|\eta| > 0.8$)

v_3 very visible, indeed, $v_3 \approx v_2$ for very central

'Mach Cone' & 'Near Side Ridge' shapes evolve smooth with magnitude of v_2 and v_3

Anisotropic transverse flow

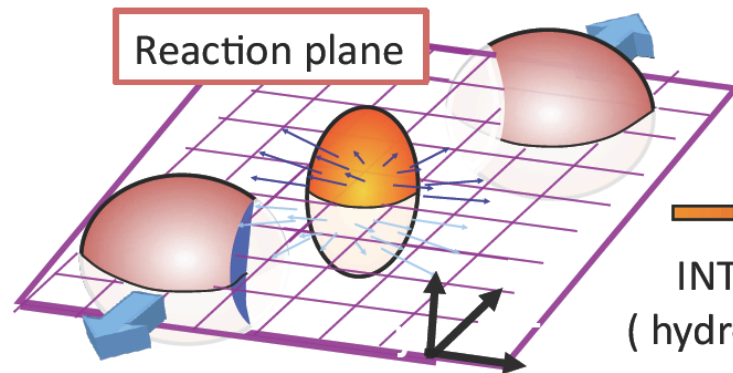


$$\frac{dN}{d(\varphi - \psi_n)} \propto 1 + 2 \sum_{n=1} v_n \cos(n[\varphi - \psi_n])$$

$$v_n = \langle \cos(n[\varphi - \psi_n]) \rangle$$

- $\Psi_n = \Psi_{RP}$
- $v_{2n+1} = 0$ by symmetry

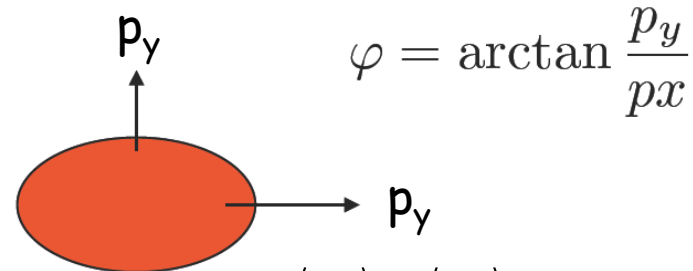
Anisotropic transverse flow



$$\varepsilon = \frac{\langle y^2 \rangle - \langle x^2 \rangle}{\langle y^2 \rangle + \langle x^2 \rangle}$$

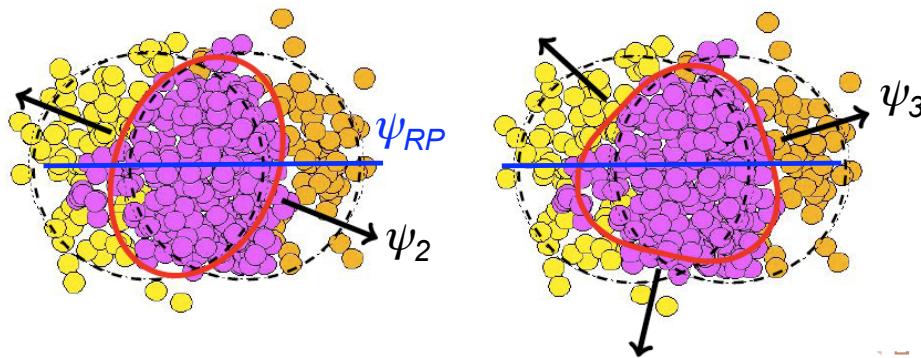
Initial spatial anisotropy

INTERACTIONS
(hydrodynamics?)



$$v_2 = \frac{\langle p_y^2 \rangle - \langle p_x^2 \rangle}{\langle p_y^2 \rangle + \langle p_x^2 \rangle} \quad (\text{elliptic flow})$$

Final momentum anisotropy
Reflected in azimuthal distribution



✦ Smooth matter distribution in the colliding nuclei

- $\Psi_n = \Psi_{RP}$
- $v_{2n+1} = 0$ by symmetry

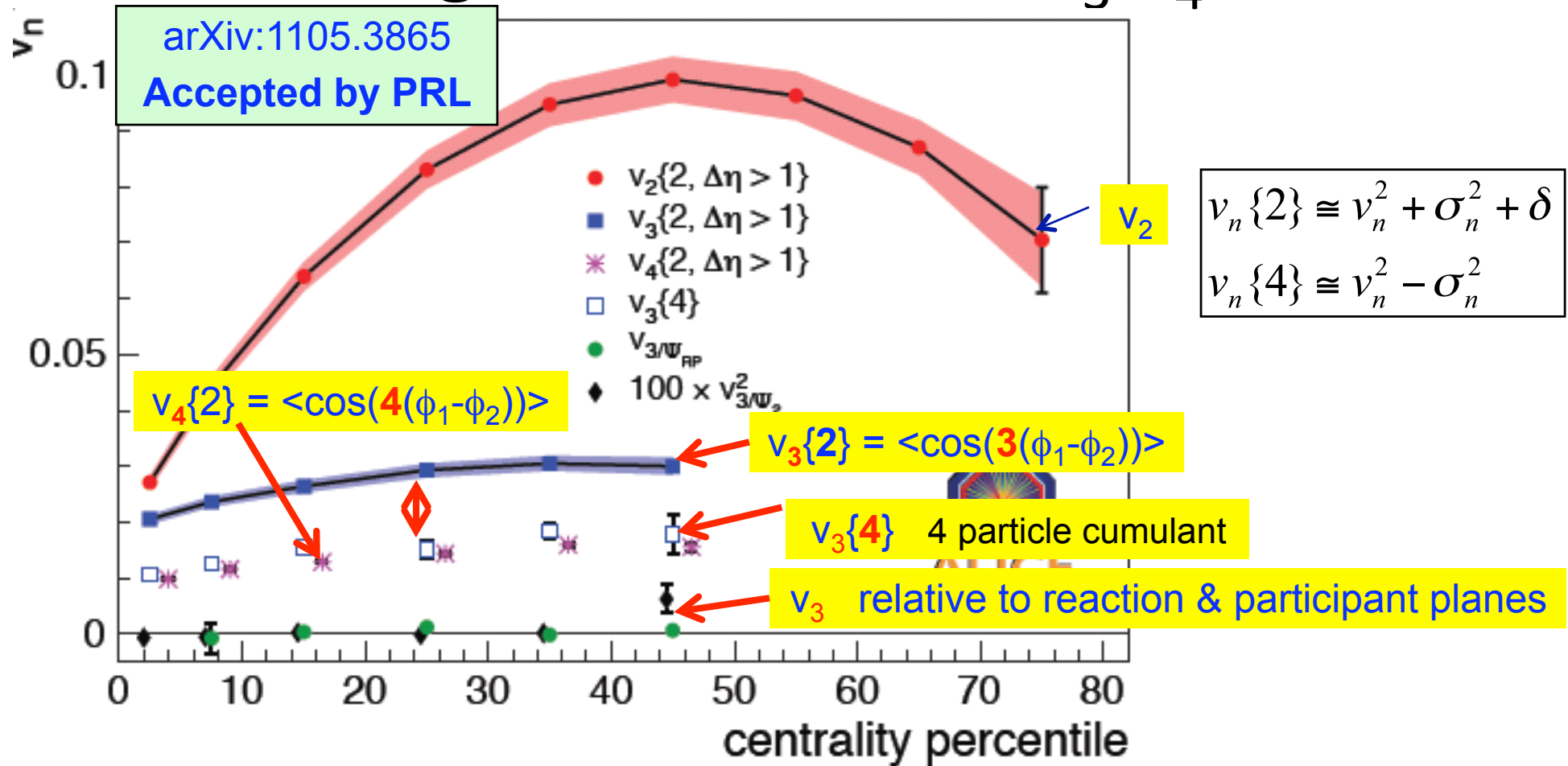
✦ Fluctuations in the matter distribution

→ event by event fluctuation of the plane of symmetry around Ψ_{RP}

→ non negligible odd harmonics

✦ v_3, v_5, \dots magnitude regulated by shear viscosity to entropy density ratio (η/s)

Higher Order Flow v_3, v_4, \dots



V_3 :

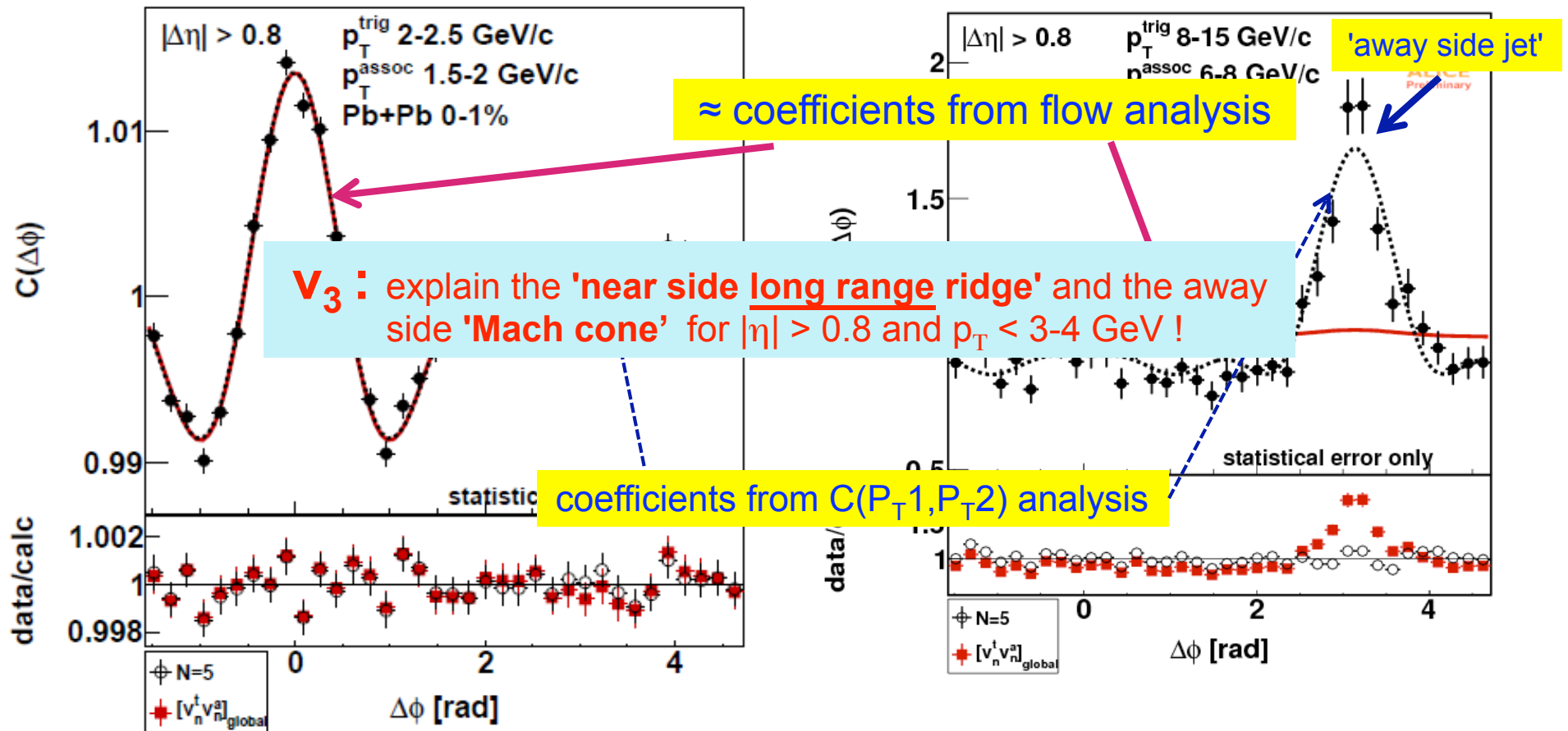
small dependence on centrality

$v_3\{4\} > 0 \Rightarrow$ not non-flow

$v_3\{4\} < v_3\{2\} \Rightarrow$ geometry fluctuations !

$V_3\{\Psi_{RP}\} \approx 0 \Rightarrow \Psi_3$ indep. fluctuations w.r.t. Ψ_{RP}

Flow & Triggered Correlations



Any function can be described with enough coefficients

- But not if we impose factorization $C(p_T^{\text{trig}}, p_T^{\text{assoc}}) = v(p_T^{\text{trig}}) * v(p_T^{\text{assoc}})$ (or take coefficients from flow analysis).

Correlations ($|\eta| > 0.8$) can be described consistently with 'collective flow' hypothesis

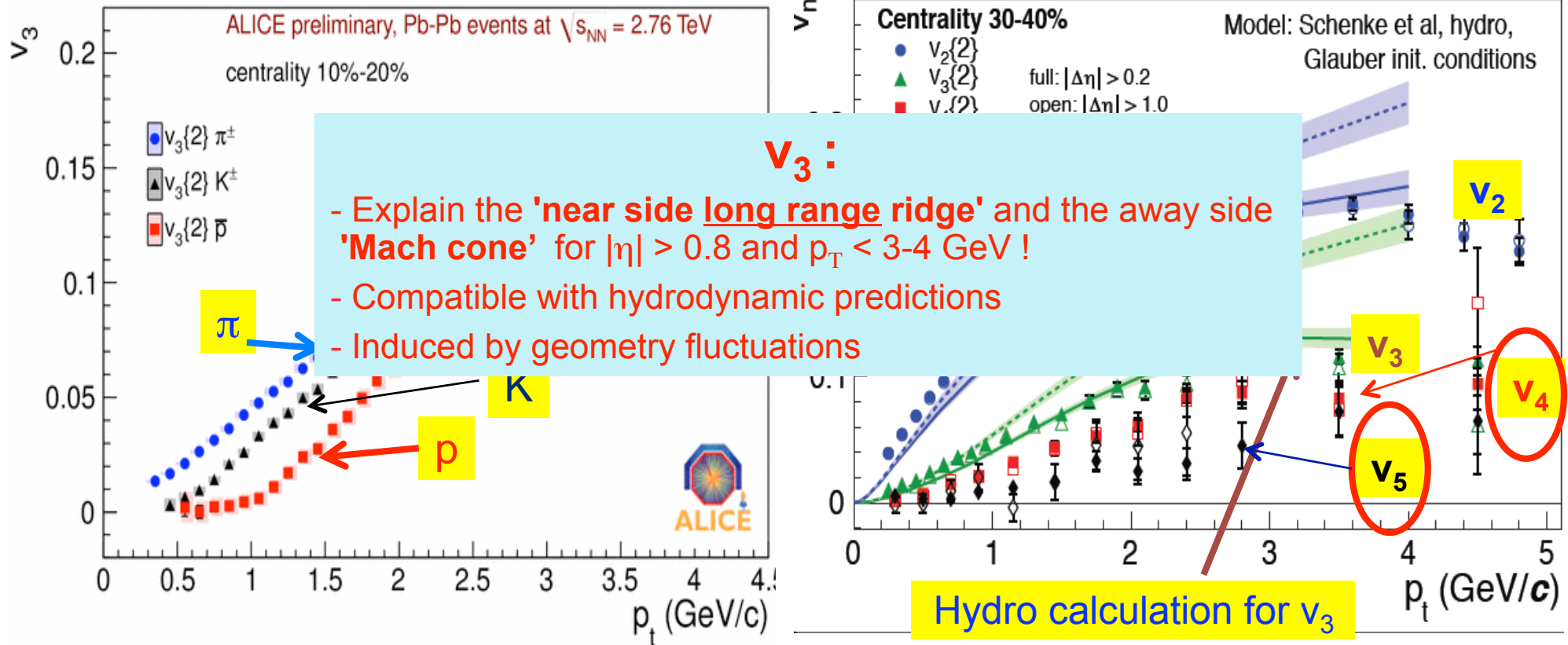
for $p_T < 3-4 \text{ GeV}$ (consistent with 'collectivity')

only partially or not at all for $p_T > 5 \text{ GeV}$

Triangular Flow v_3

v_3 for $\pi/K/p$

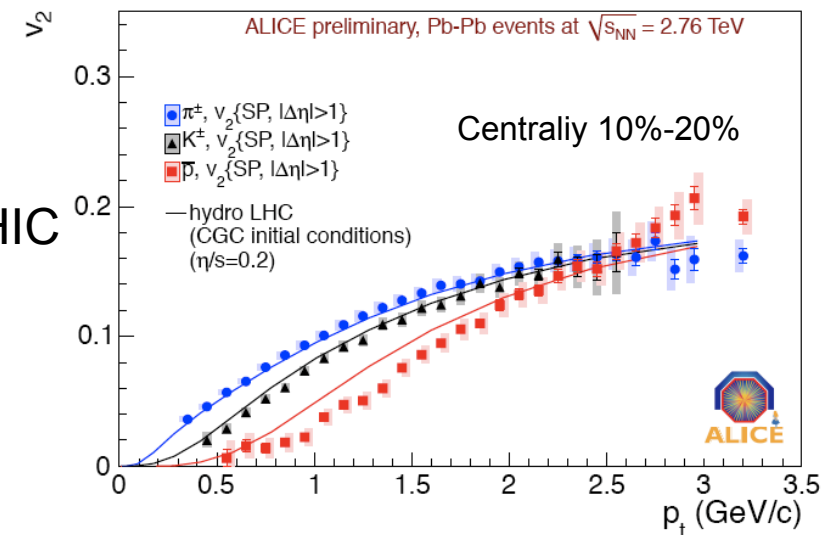
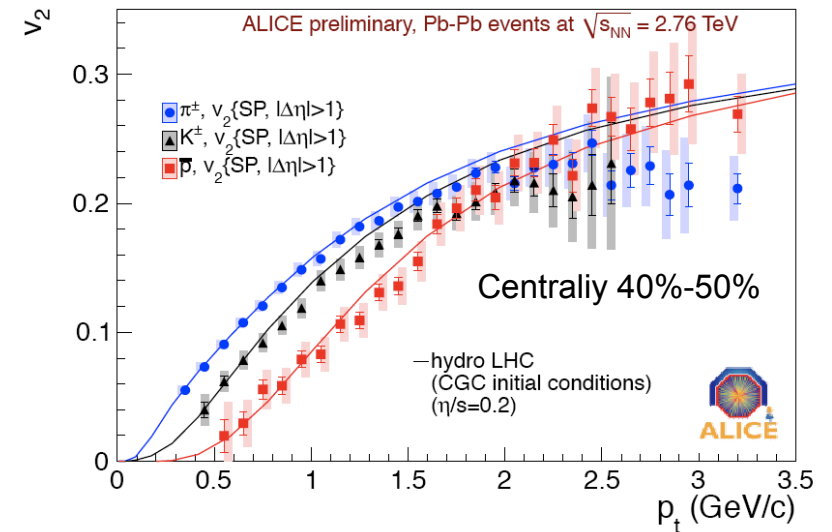
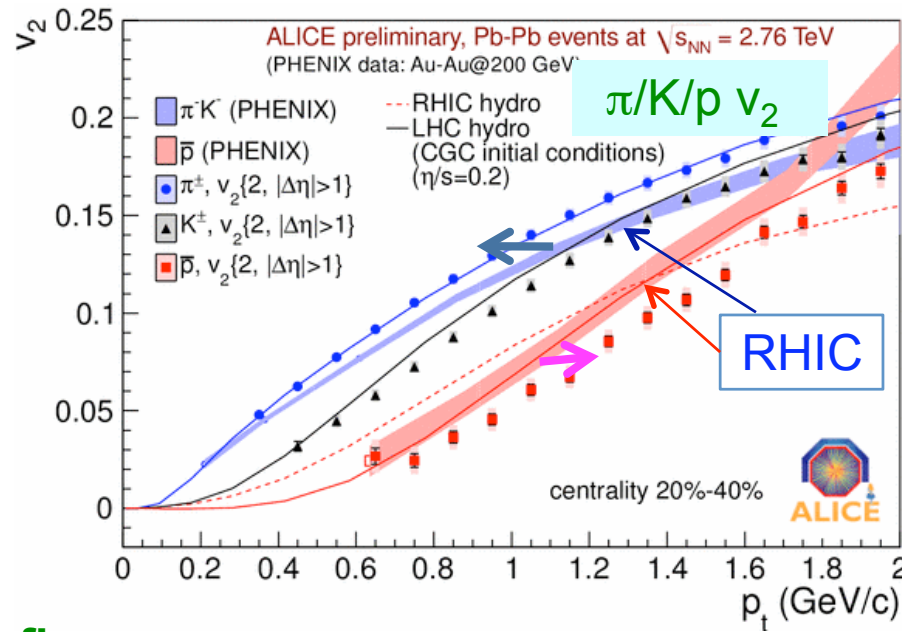
v_3 v_4 v_5 versus p_T



v_3 shows **mass splitting** expected from hydro flow

Has the **magnitude (and p_T dependence)** expected from geometry fluctuations
(and has different sensitivity to η/s than v_2)

More on v_2 : identified particle flow



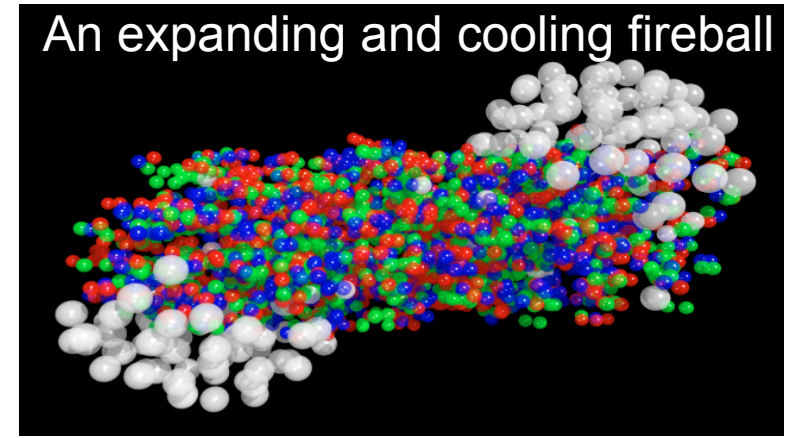
PID flow:

- Mass splitting and ordering \approx hydro
- π and \bar{p} are 'pushed' further compared to RHIC \approx expected from hydro (with larger radial flow)
- π and K flow well described by hydro
- \bar{p} flow not well described by hydro in more central collisions

Study of the QGP expanding fireball

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25 years experimental research to answer fundamental questions like:

How does the system evolve?

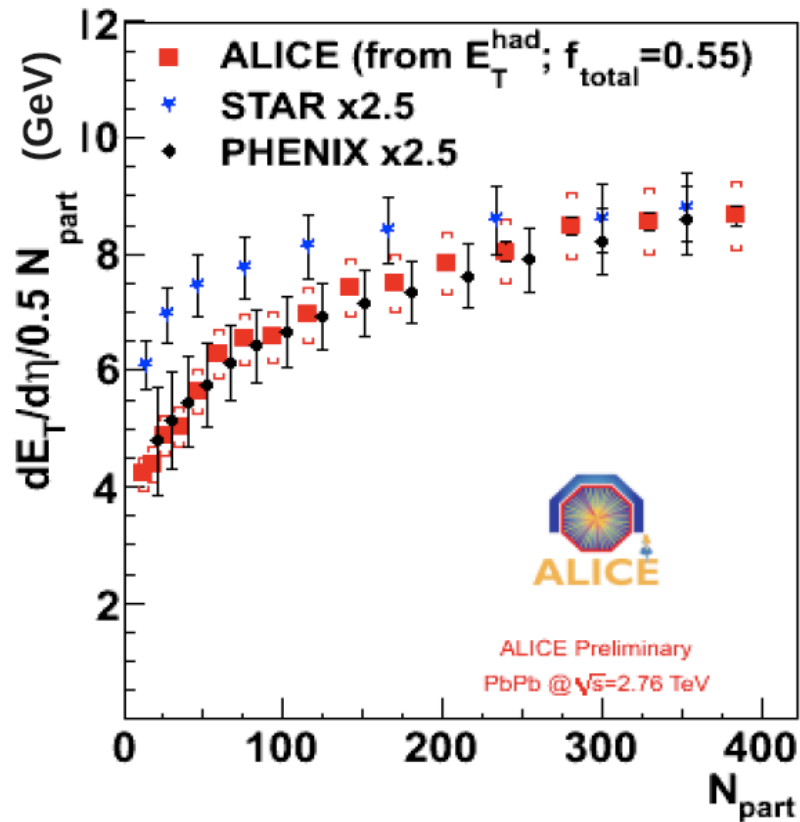
How does the collision geometry manifest itself and what can we learn from it?

Can we access medium global properties (energy density, temperature, size)?

How is particle production modified?

How do high energetic partons interact with the medium?

Transverse energy & energy density



Energy density (Bjorken)

$$\varepsilon = \frac{1}{\pi R^2 \tau} \frac{dE_T}{dy}$$

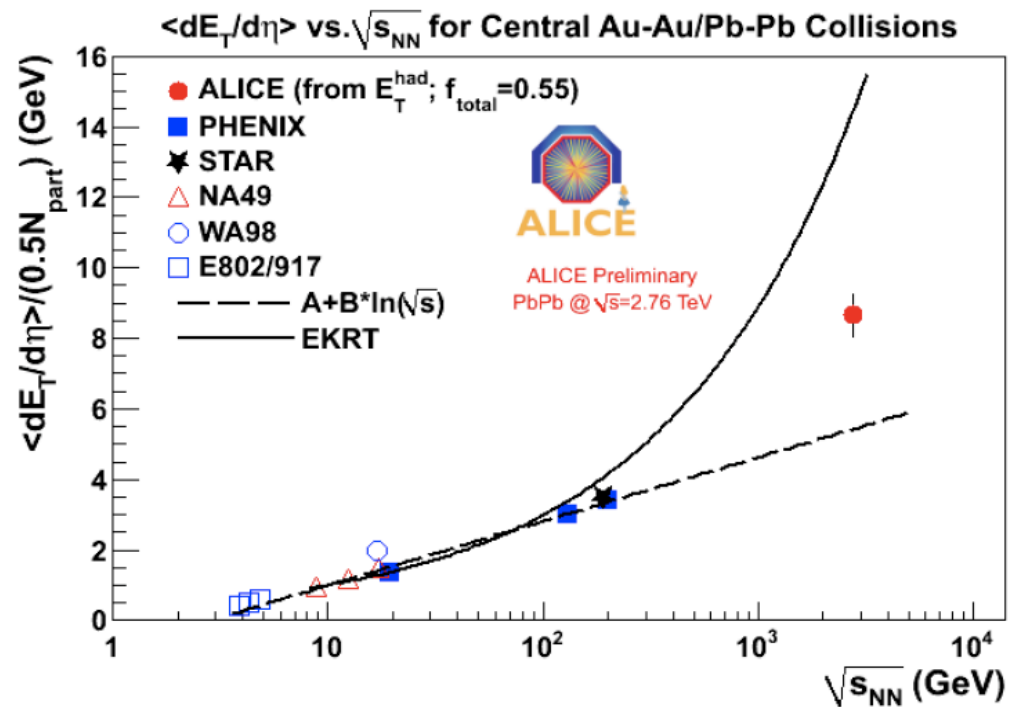
$$R = 1.12 A^{1/3} \text{ fm}$$



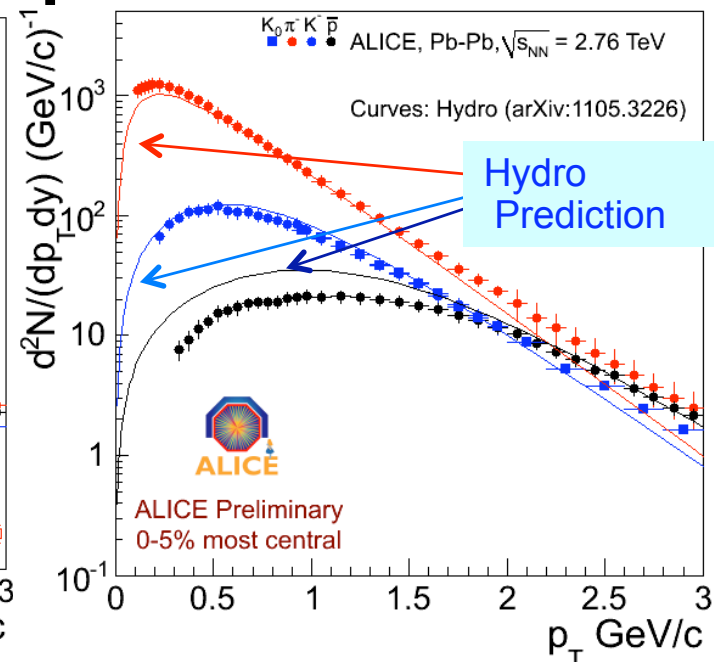
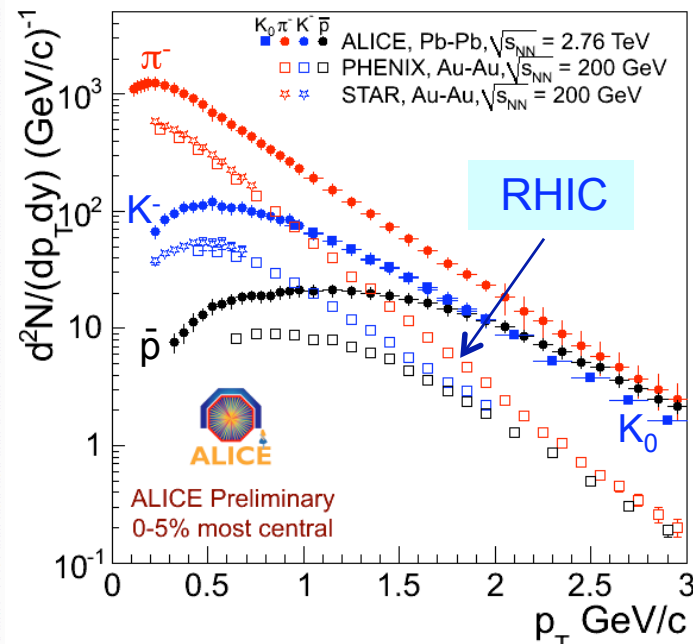
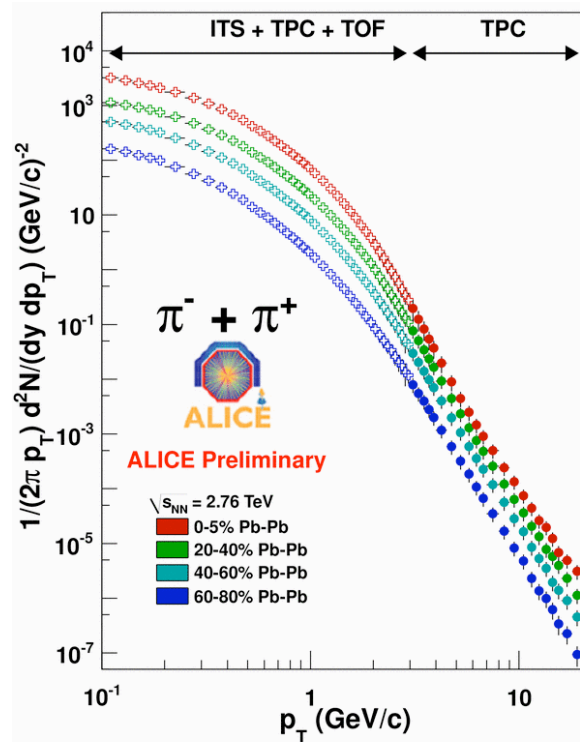
$$\varepsilon \tau \approx 16 \text{ GeV}/(\text{fm}^2 c)$$

factor 2.7 larger than RHIC

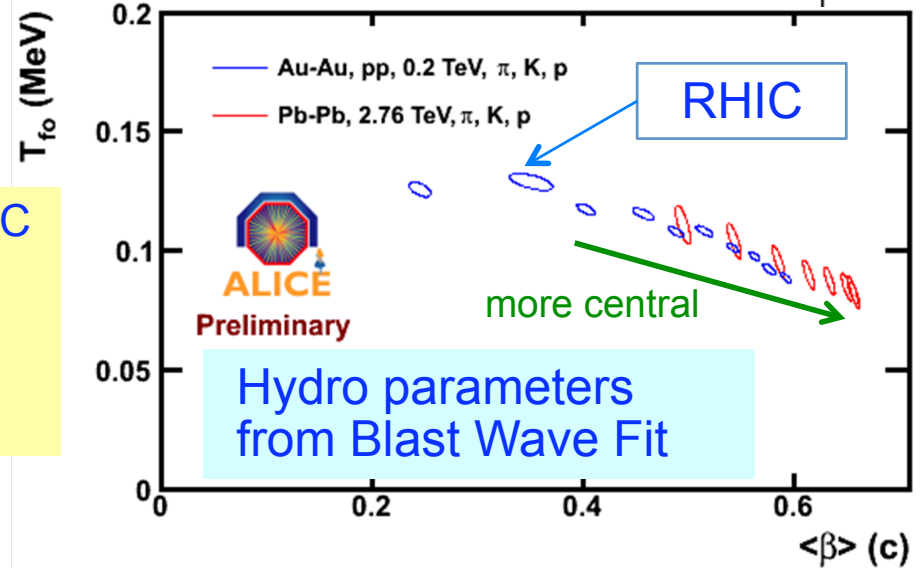
Grow with power of CM system energy faster than simple logarithmic scaling extrapolated from lower energy (similar trend than $dN_{ch}/d\eta$)



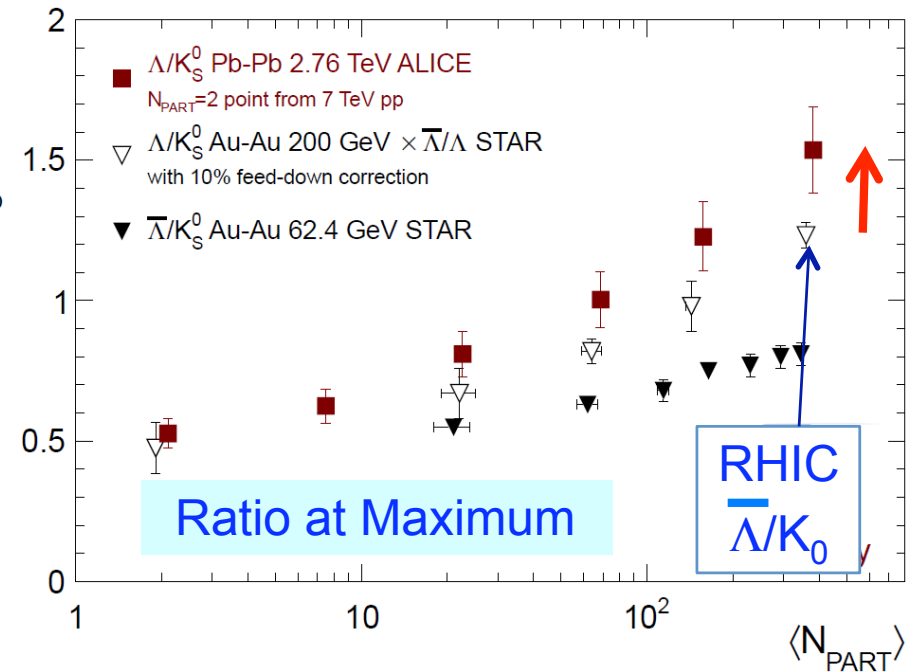
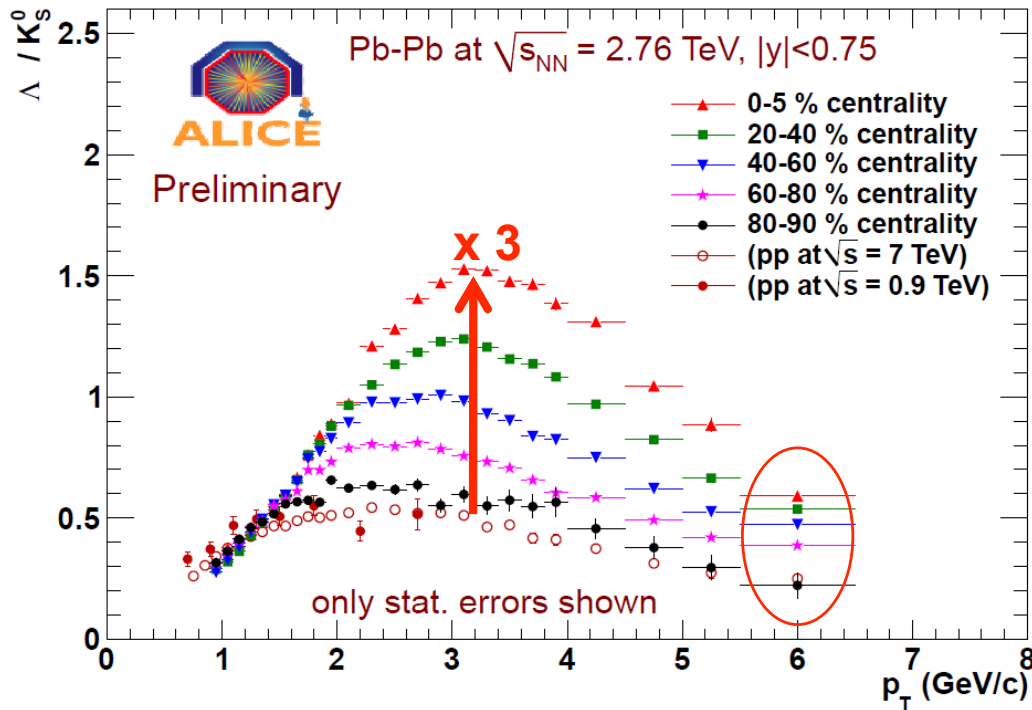
Identified Particle spectra



Very significant changes in slope compared to RHIC
 Most dramatically for protons
Very strong radial flow, $\beta \approx 0.66$
 even larger than predicted by most recent hydro



'Baryon anomaly': Λ/K^0



Baryon/Meson ratio still strongly enhanced

x 3 compared to pp at 3 GeV

- Enhancement slightly larger than at RHIC 200 GeV

- Still present at 6 GeV/c

- Maximum shift very little in p_T compared to RHIC

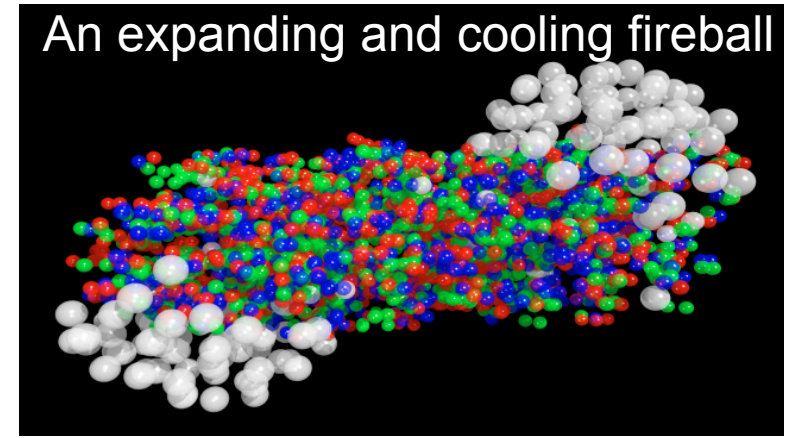
despite large change in underlying spectra !

Recombination + Radial flow?

Study of the QGP expanding fireball

HIC complex system of strongly interacting matter

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25 years experimental research to answer fundamental questions like:

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How is particle production modified?

How do high energetic partons interact with the medium?

→ in-medium partonic energy loss

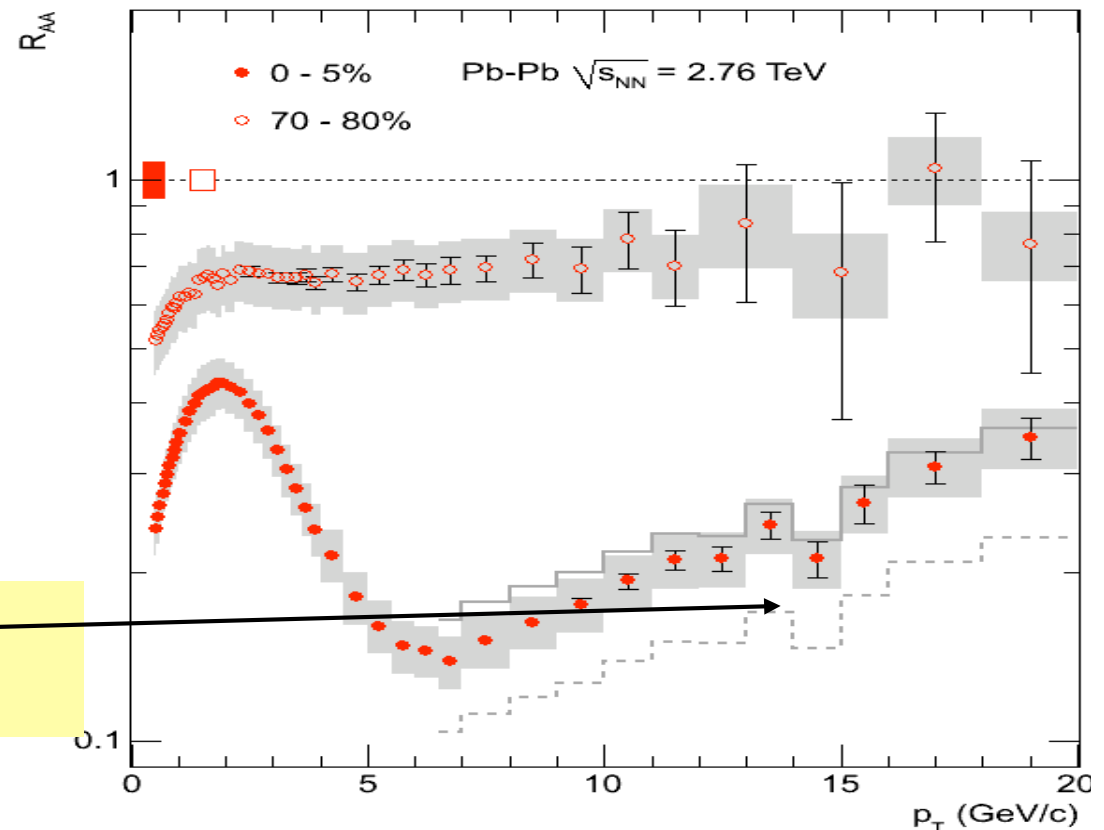
→ parton nature (quark/gluon), mass dependence?

Charged particle nuclear modification factor (R_{AA})

$$R_{AA} = \frac{\text{\# particle observed in Pb - Pb collisions}}{(\text{\# particle observed in pp collisions}) \times \text{number of binary collisions}}$$

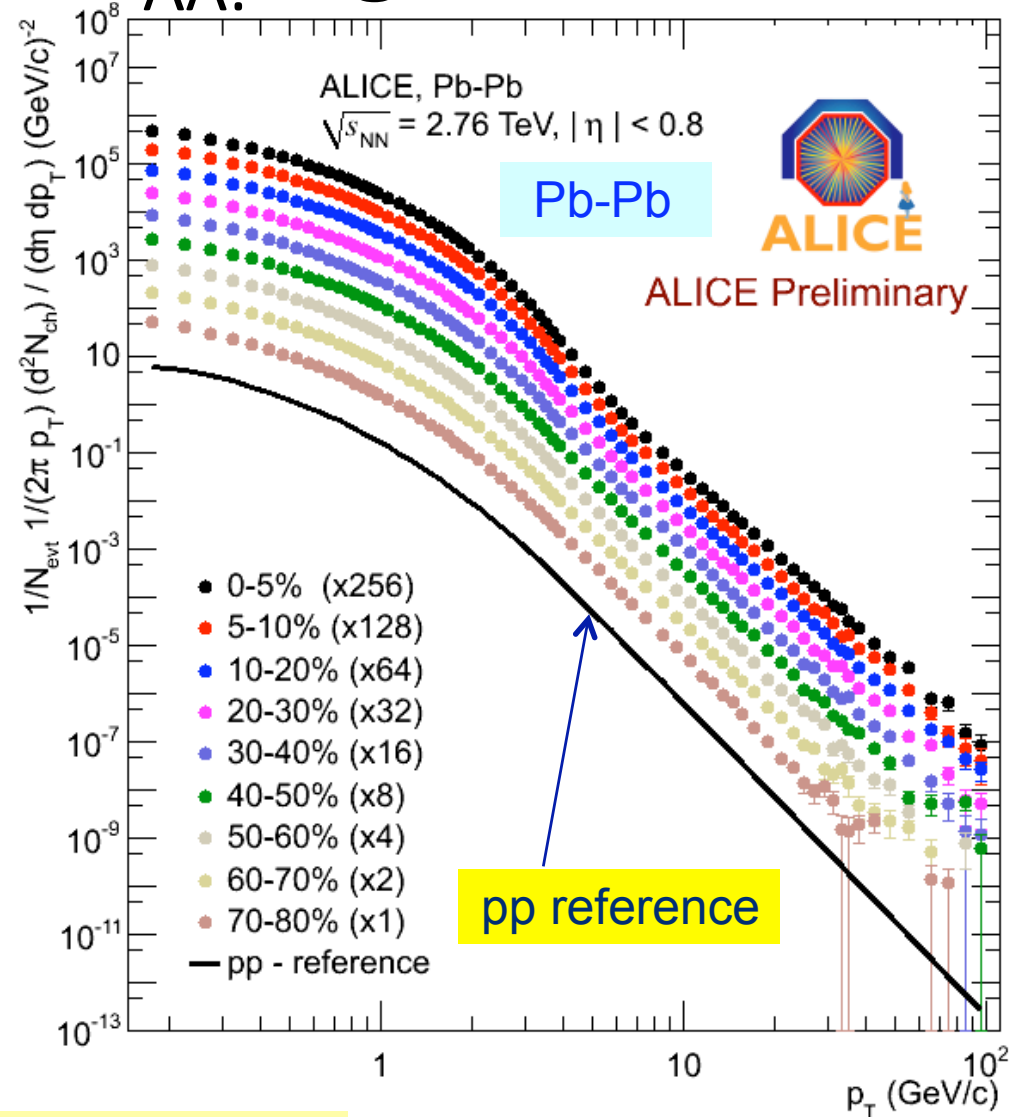
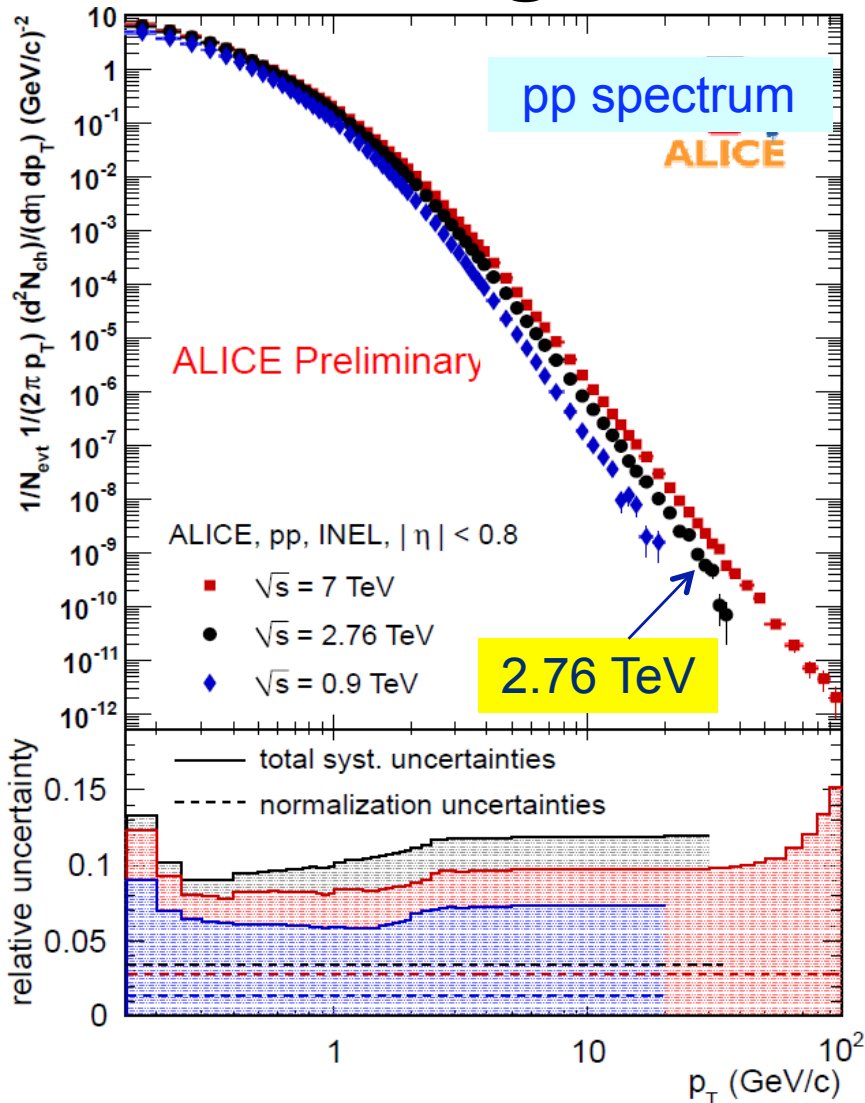
$$R_{AA}(p_t) = \frac{d^2 N_{ch}^{AA} / d\eta dp_t}{d^2 N_{ch}^{pp} / d\eta dp_t \times \langle N_{coll} \rangle}$$

PLB 696 (2011) 30-39



Extrapolated reference
=> large syst. error

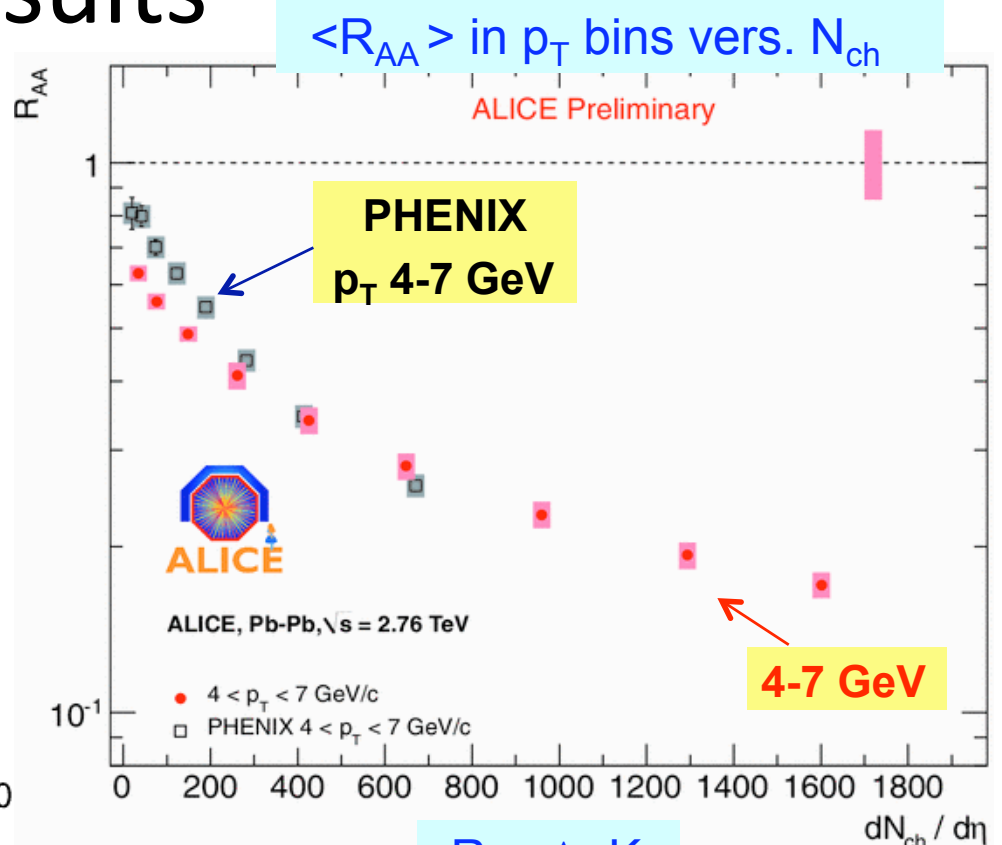
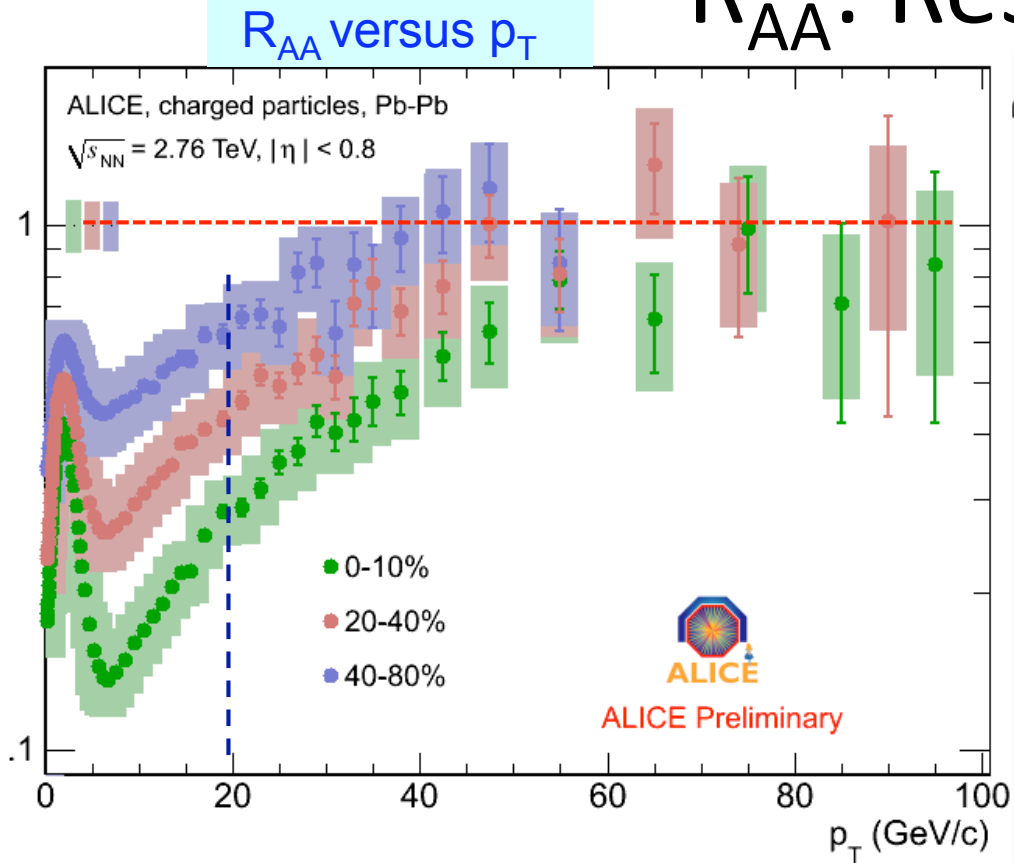
Charged Particle R_{AA} : Ingredients



Measured reference, still needs extrapolation for $p_T > 30$ GeV
(but not in $\sqrt{s} \Rightarrow$ smaller syst. error)

Note: measured spectrum somewhat different than previous extrapolation
(R_{AA} goes down, but stays well within old systematic error bands)

R_{AA} : Results



Rise continues beyond 20 GeV

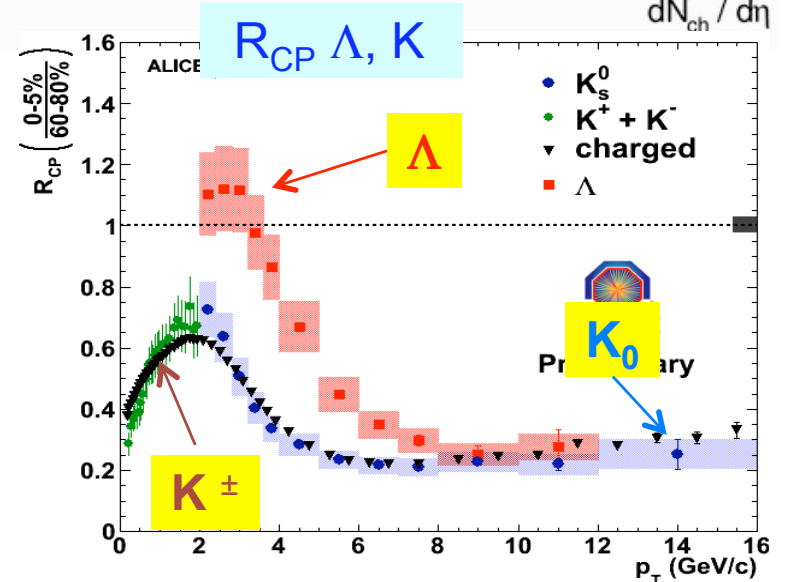
Gradual change of slope above 30-40 GeV

Note: centrality dependence is independent of reference spectrum !

Identified particle $R_{AA}(K/\Lambda)$:

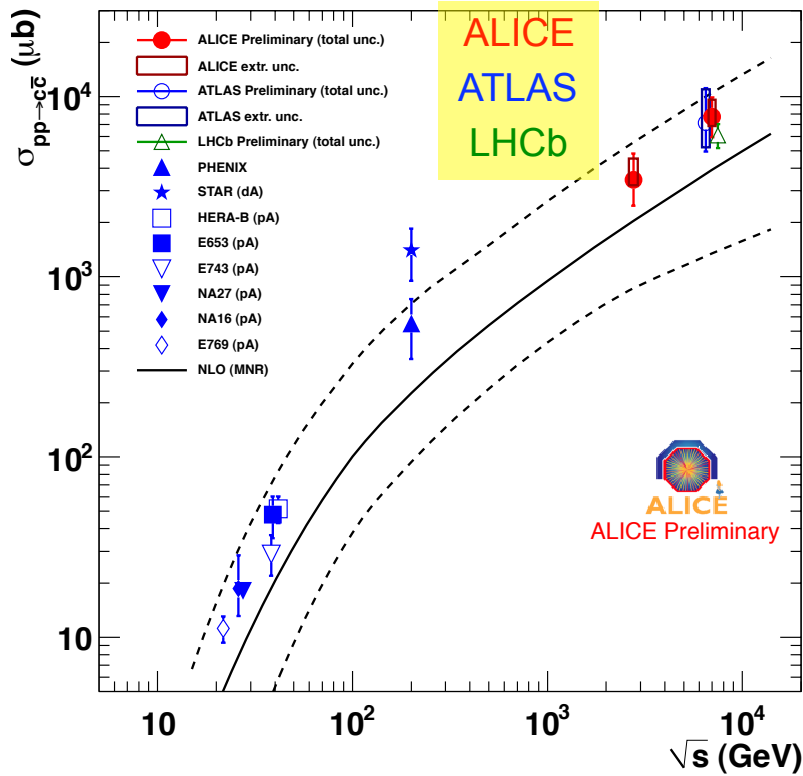
- Interesting differences < 6 GeV

- R_{AA} universal > 6 GeV



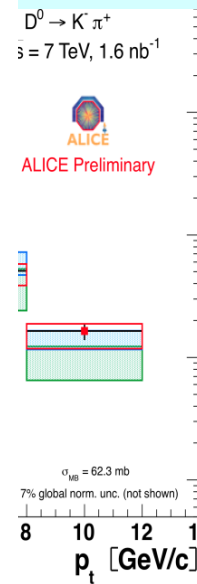
Charm R_{AA} : Ingredients

Total Charm cross section

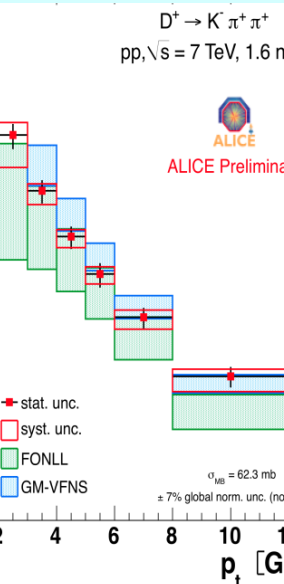


- charm in pp @ 7 TeV
- subtract B feed down
- absolute cross section
- scale (FONLL) to 2.76 TeV
- check with CDF & data @ 2.76 TeV
- compare with other expts

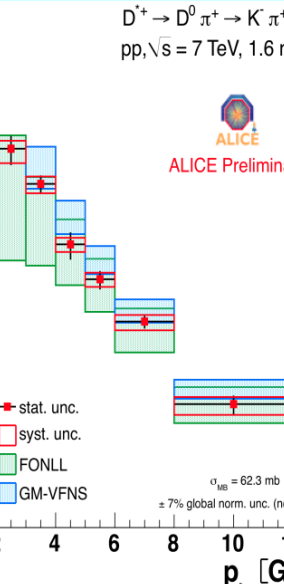
$D^0 \rightarrow K^- \pi^+$



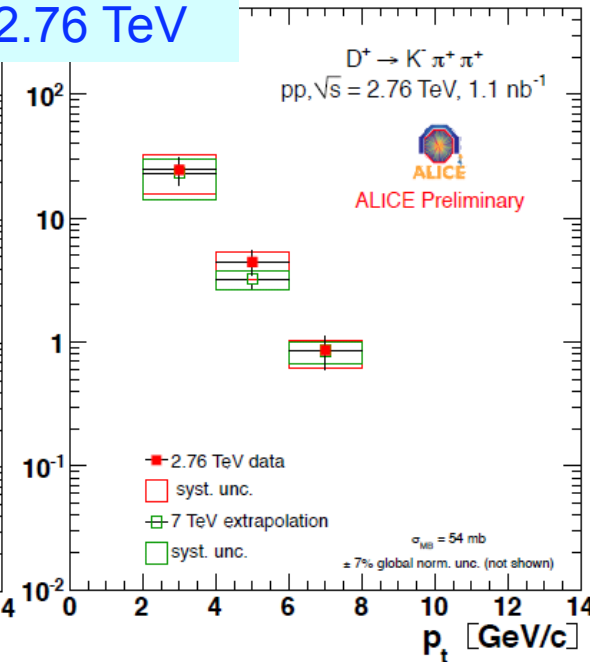
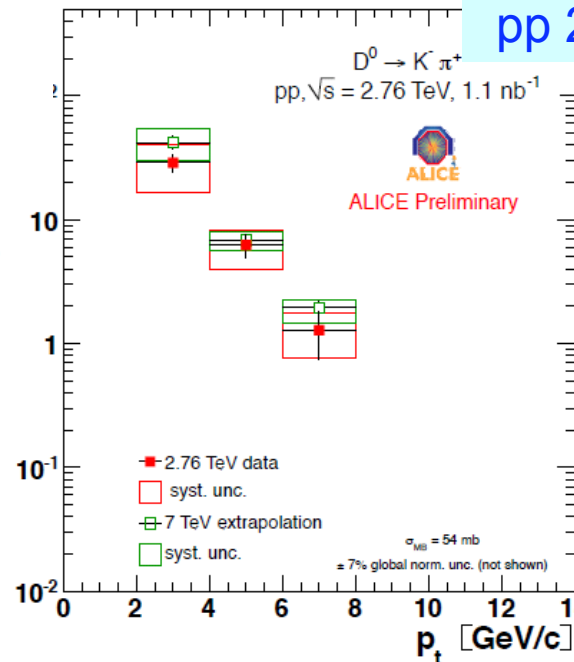
$D^+ \rightarrow K^- \pi^+ \pi^+$



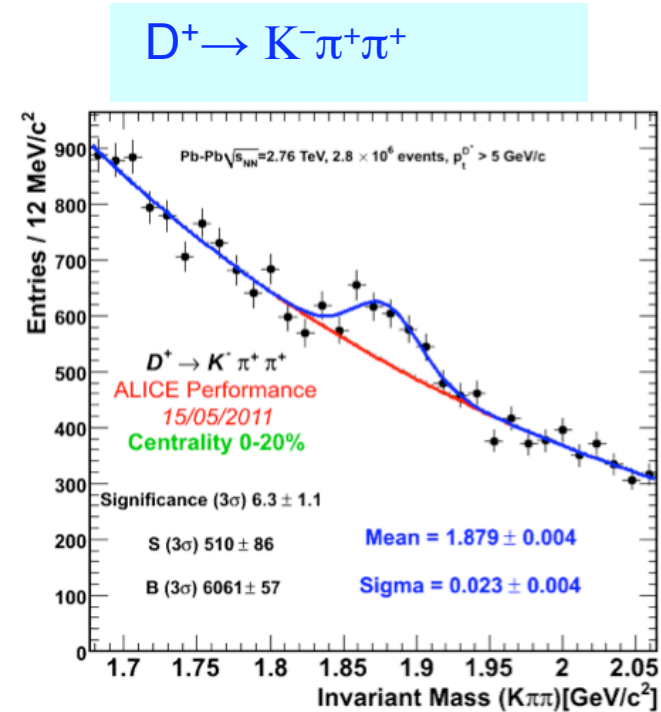
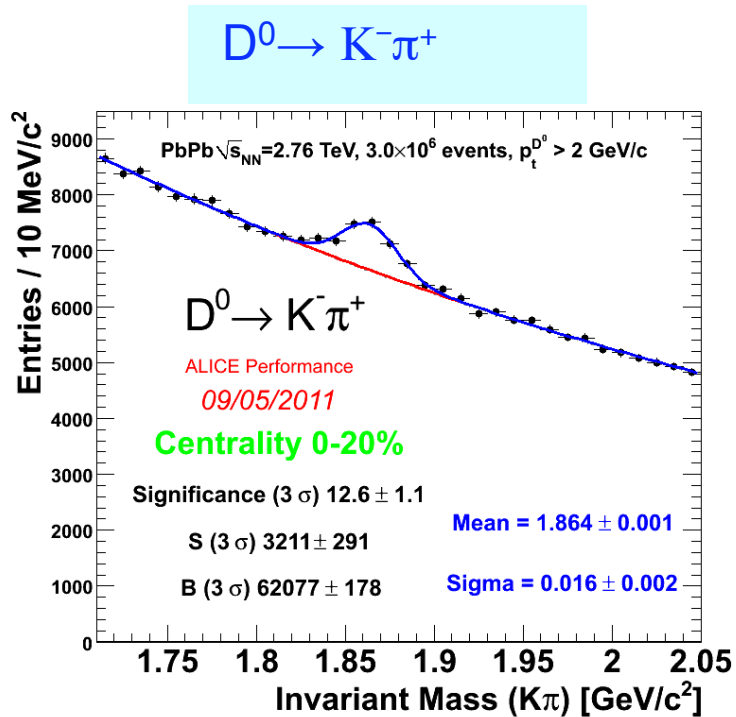
$D^{*+} \rightarrow D^0 \pi^+$



pp 2.76 TeV

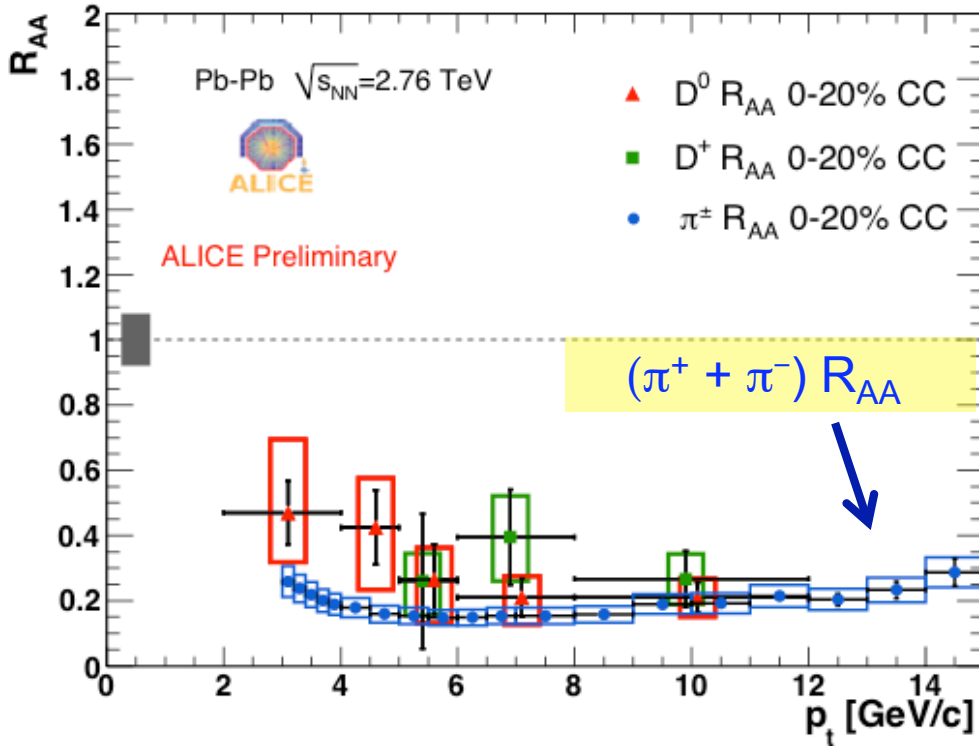


Charm R_{AA} : results

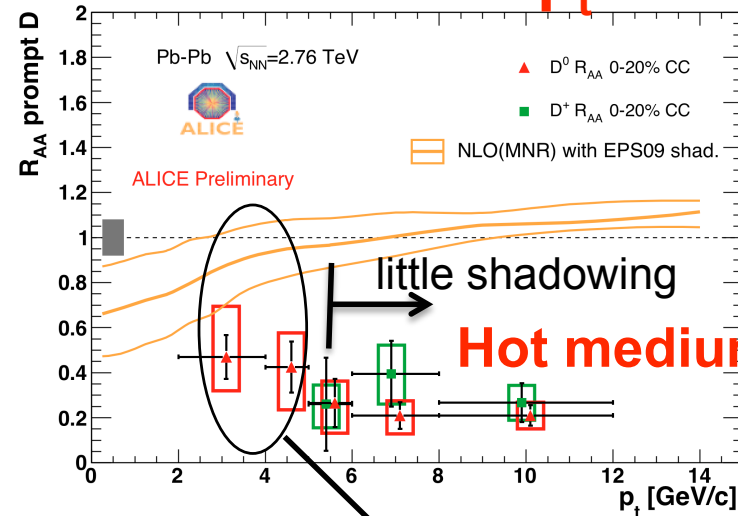


- charm central in Pb-Pb!
- subtract B feed down
- absolute cross section (T_{AA})
- => prompt charm R_{AA} (p_T , centrality)
- check consistency D^0 , D^+

Charm R_{AA} : results



Strong suppression observed in central (0-20%) collisions, factor $\sim 4-5$ for $p_t > 5$ GeV/c



- R_{AA} prompt charm $\approx R_{AA}$ pions for $p_T > 5-6$ GeV
- R_{AA} charm $> R_{AA}$ π for $p_T < 5$ GeV ?

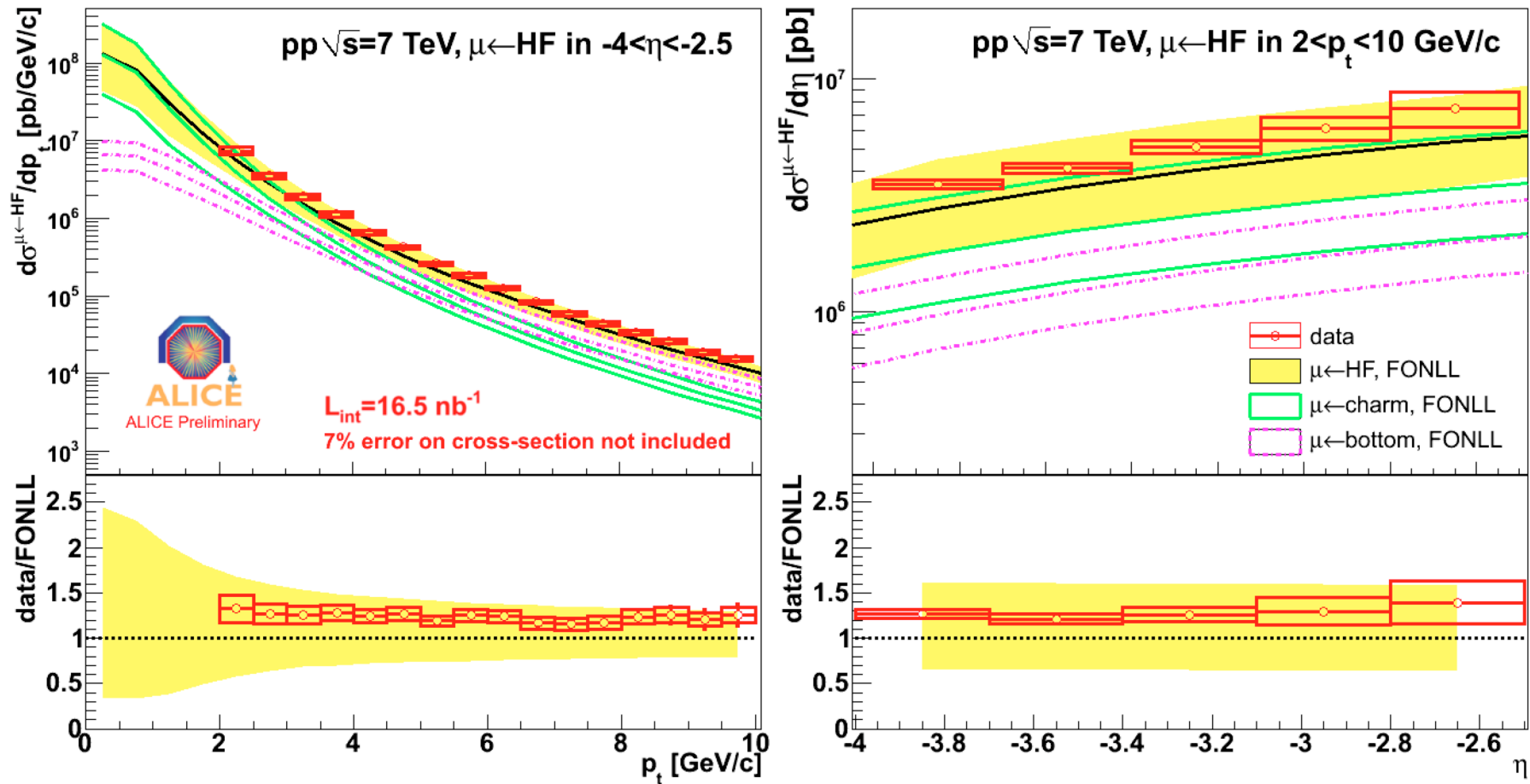
Qualitative expectation: R_{AA} Charm $> R_{AA}$ Mesons

- ΔE gluon $> \Delta E$ quark (**Casimir factor**)
- ΔE massless parton $> \Delta E$ massive quark (**'dead cone'**)

Needs quantitative comparison with quenching calculations

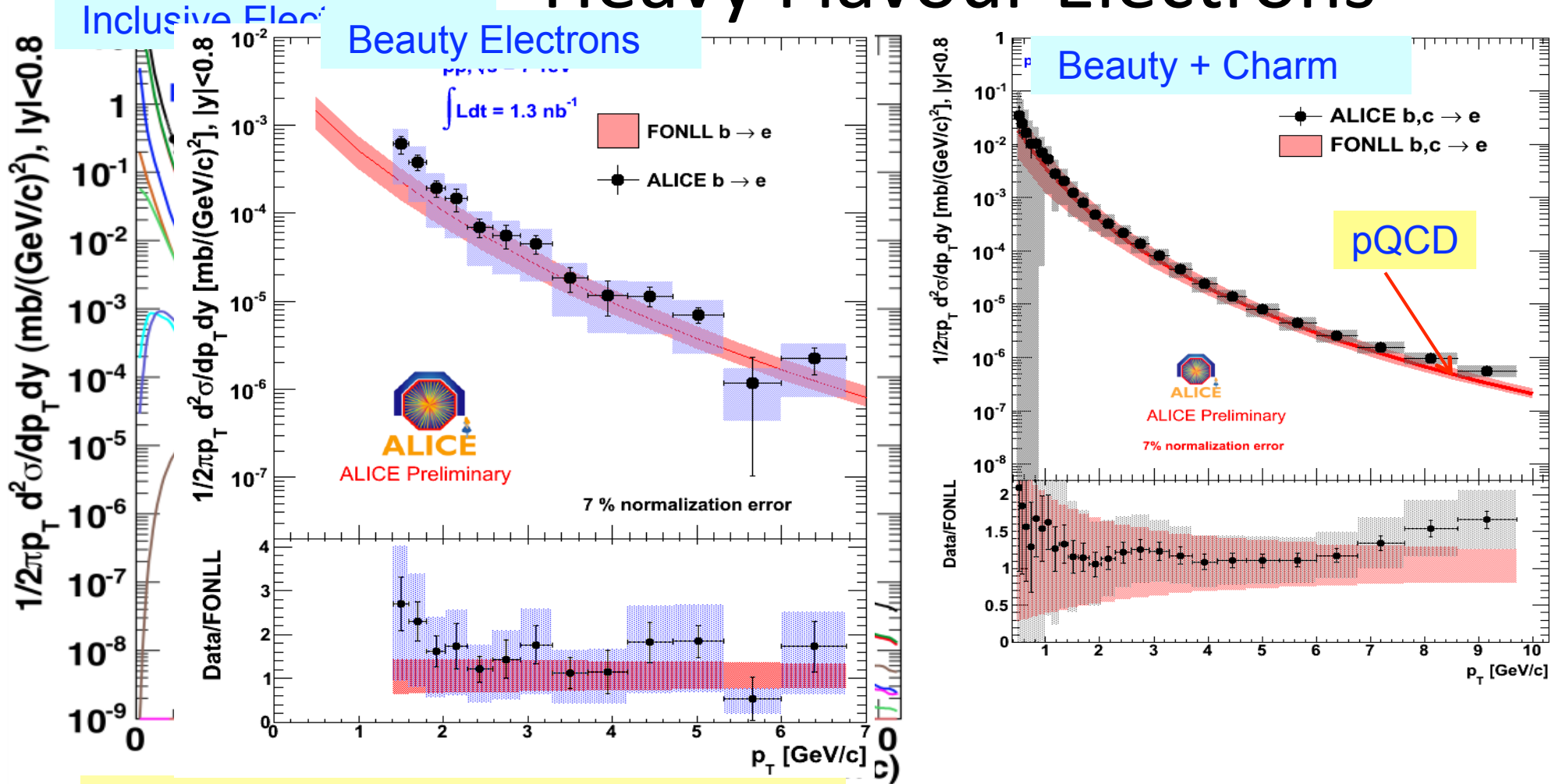
p-Pb run at LHC crucial to understand the low- p_t rise

Heavy Flavour decay muons



- single prompt muon cross section (c,b) pp @ 7 TeV

Heavy Flavour Electrons

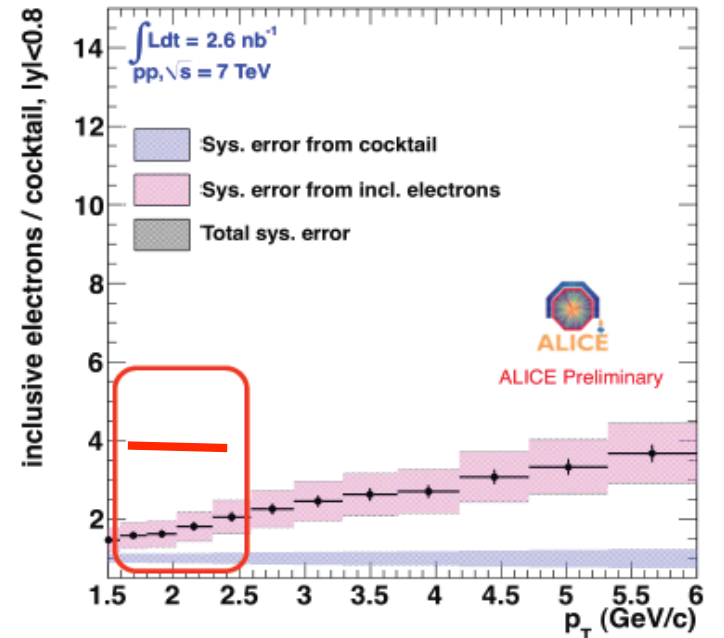
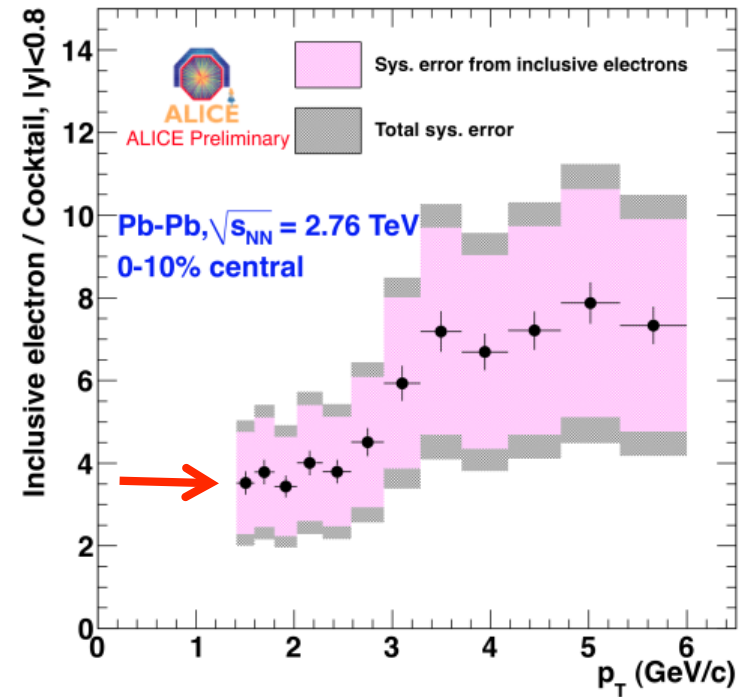
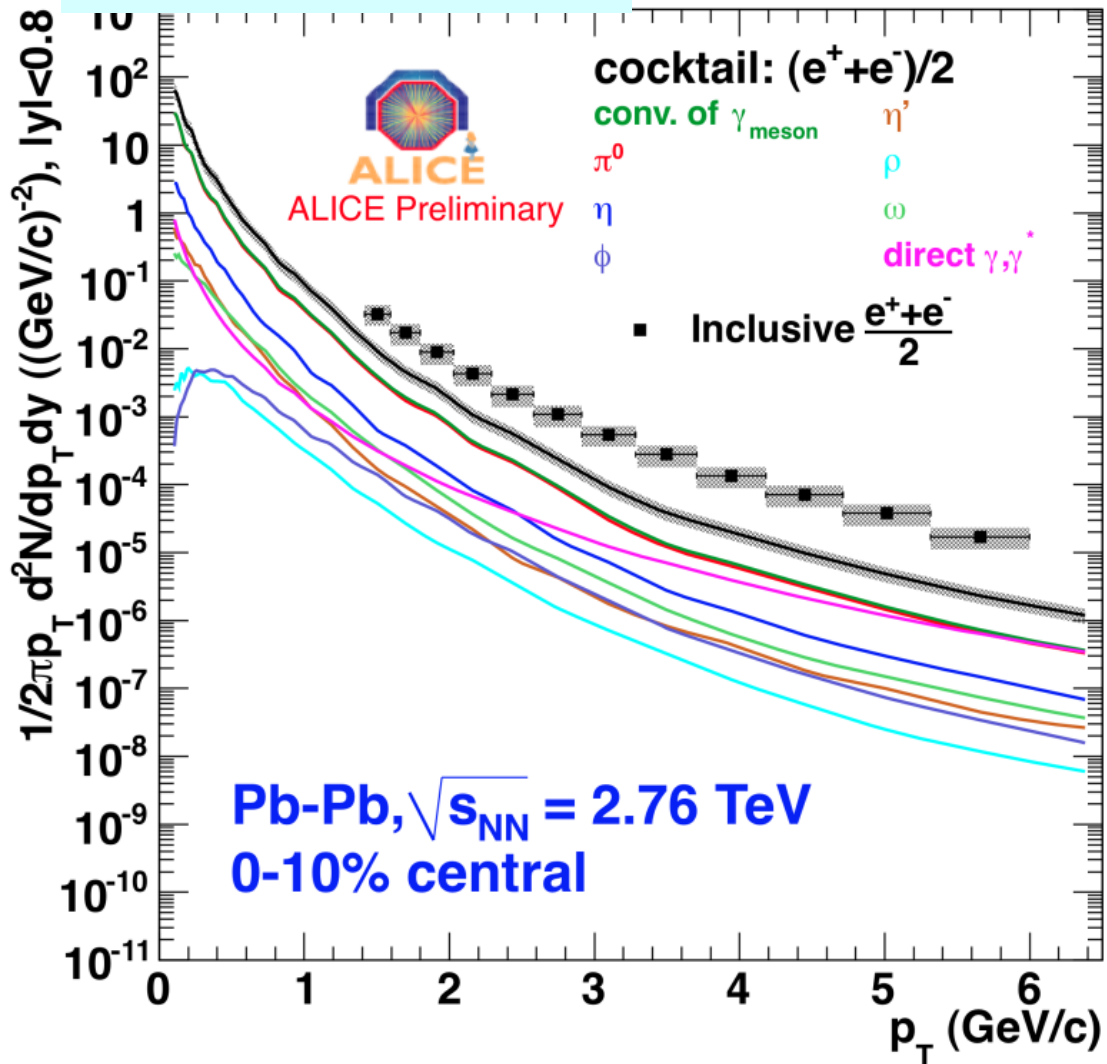


Inclusive electron spectrum **pp 7 TeV**

Background 'cocktail' based on measured π^\pm
 subtract => **heavy flavour electrons (c, b)**
consistent with pQCD (and measured charm!)
 impact parameter cut => **select beauty**
consistent with pQCD

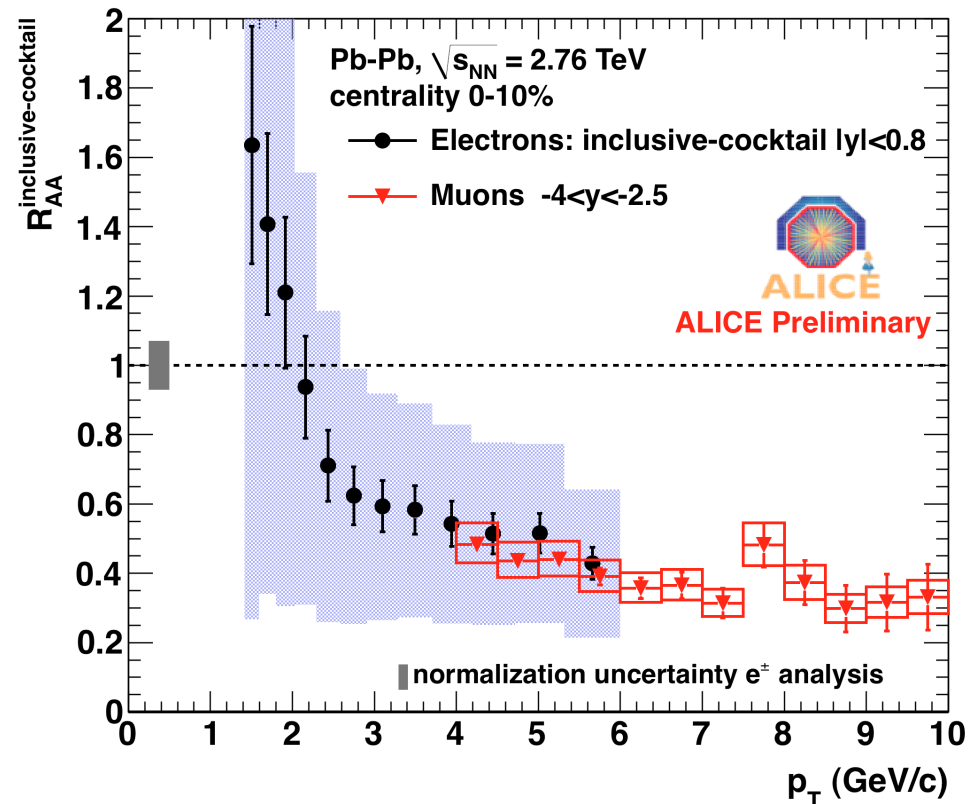
Heavy Flavour decay Electrons

Inclusive Electrons Pb



Data / Background => hint of excess around 2 GeV
interesting region (thermal radiation ? seen at RHIC...)

Heavy Flavour decay Electrons & Muons R_{AA}



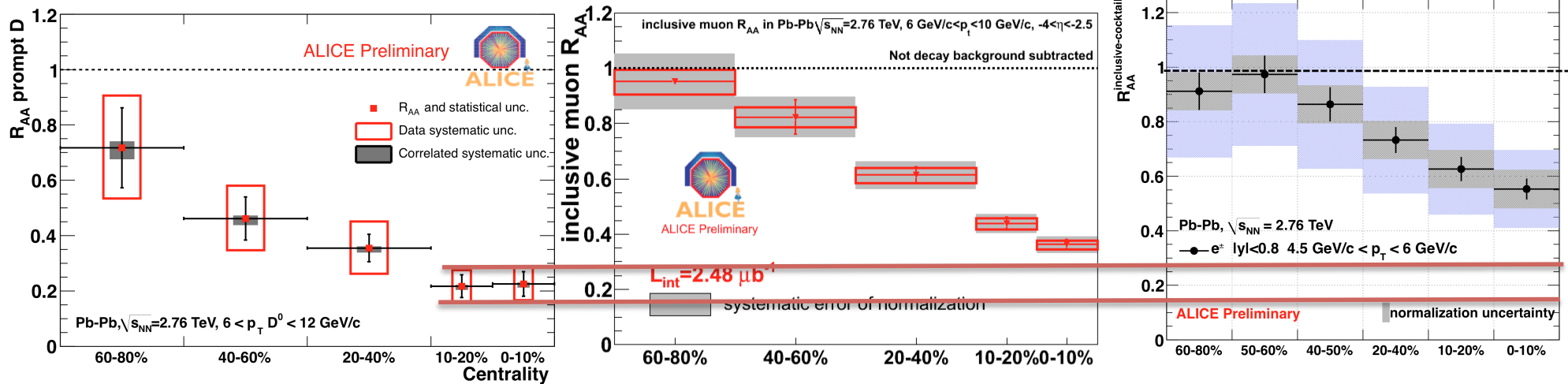
- pp reference: 7 TeV measurement scaled (FONLL) to 2.76 TeV
Resulting $HFe R_{AA}$ consistent with HF_μ for $p_T > 3-4$ GeV

Heavy Flavour R_{AA} Comparison

D^0 $p_t > 6$ GeV/c

μ $p_t > 6$ GeV/c

e $p_t > 4.5$ GeV/c

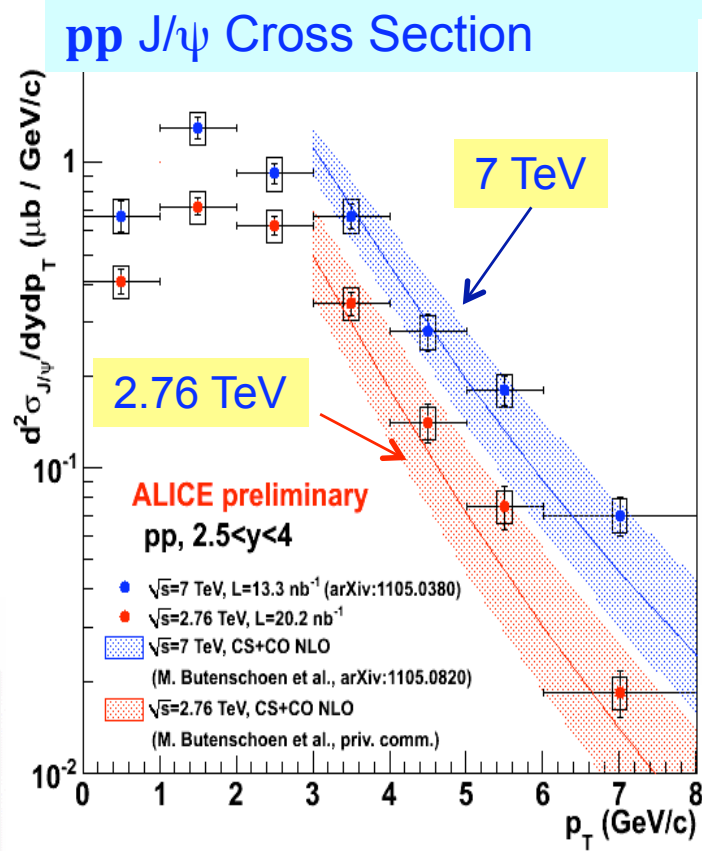
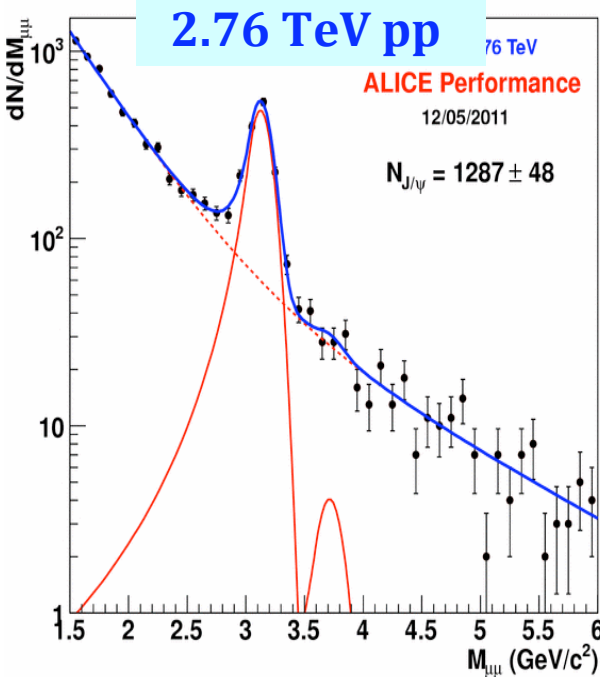
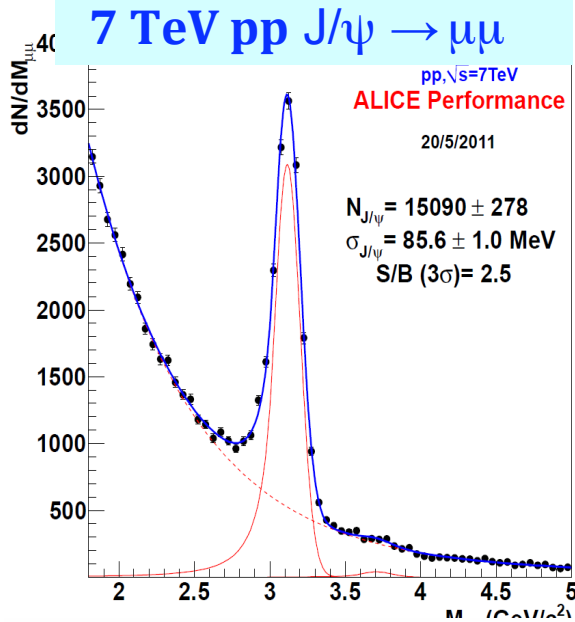


→ Consistent centrality dependence

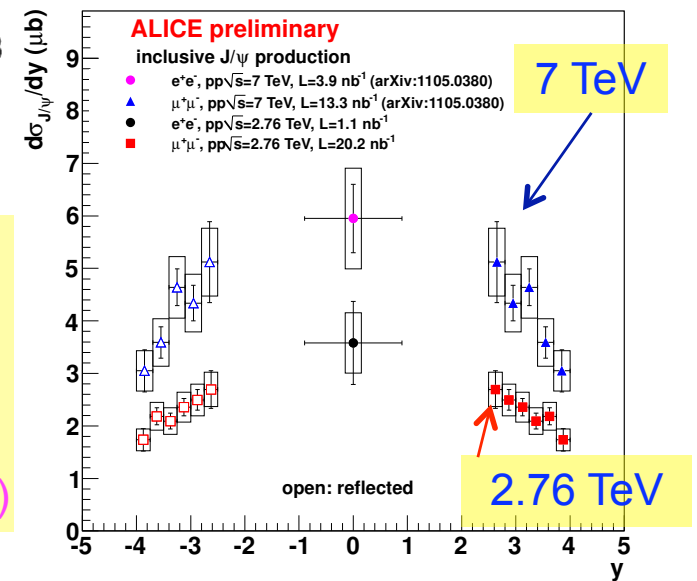
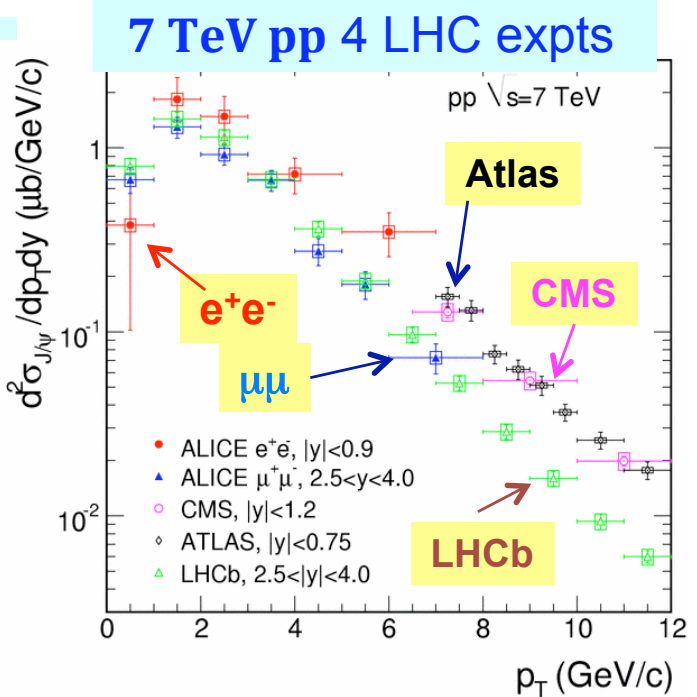
→ Muons ~ Electrons ~ CMS J/ψ from B (QM2011)

→ D mesons clearly lower (charm vs beauty?)

J/ψ suppression: Ingredients

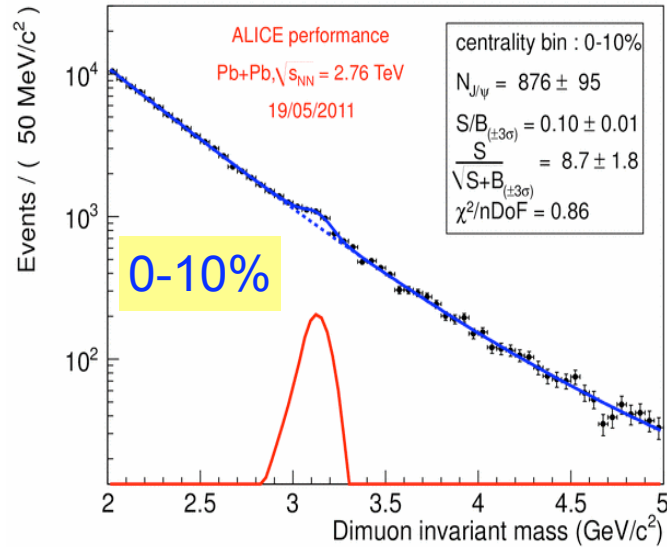


J/ψ cross section $d\sigma/dydp_T$
 7 TeV & 2.76 TeV
 Agreement with pQCD
 Agreement among 4 LHC experiments (in region of overlap)



J/ψ suppression: Results

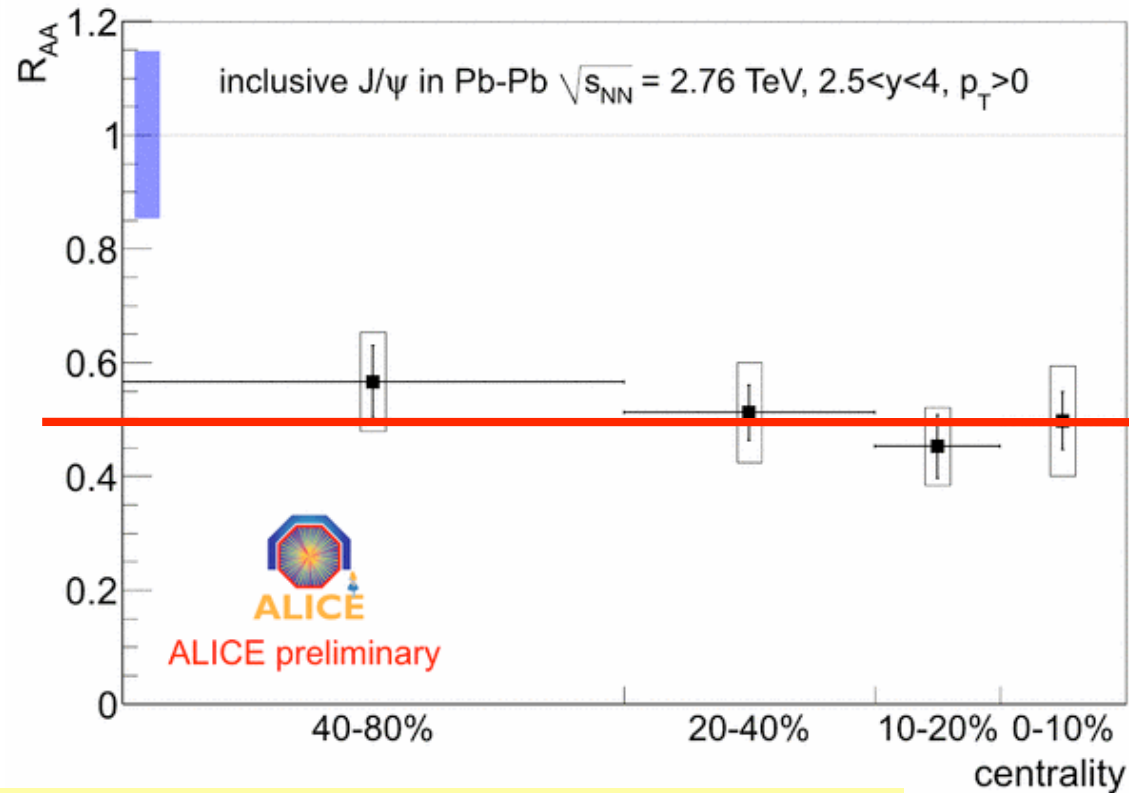
PbPb



ALI-PERF-4502

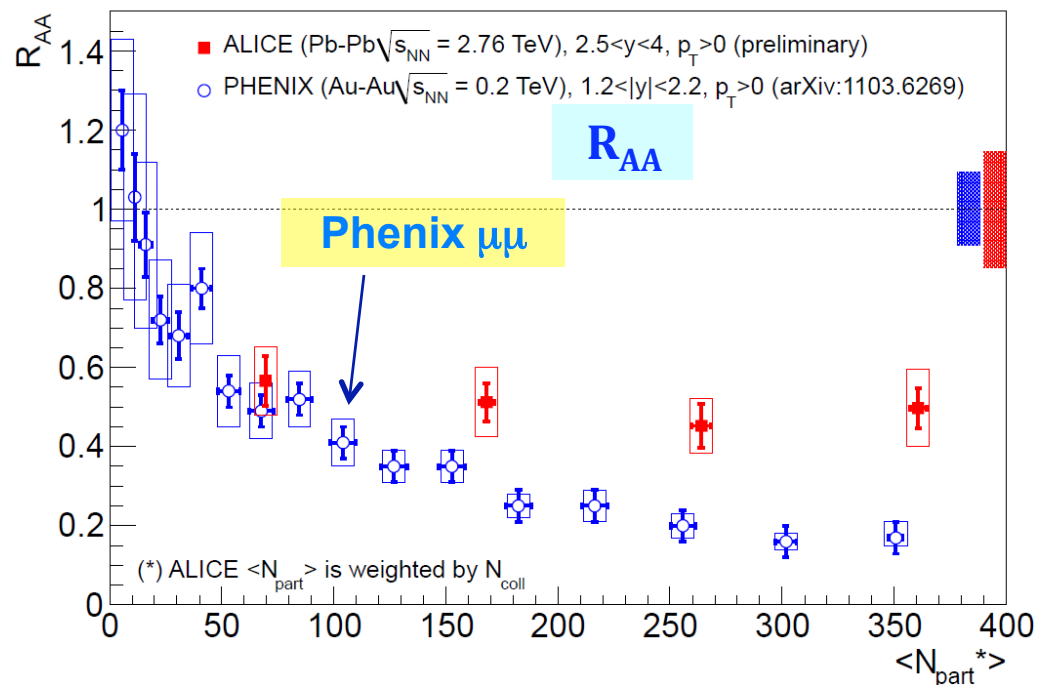
Di-muon channel
 $p_T > 0, 2.5 < y < 4$

Inclusive J/ψ $R_{AA}^{0-80\%} = 0.49 \pm 0.03$ (stat.) ± 0.08 (sys.)



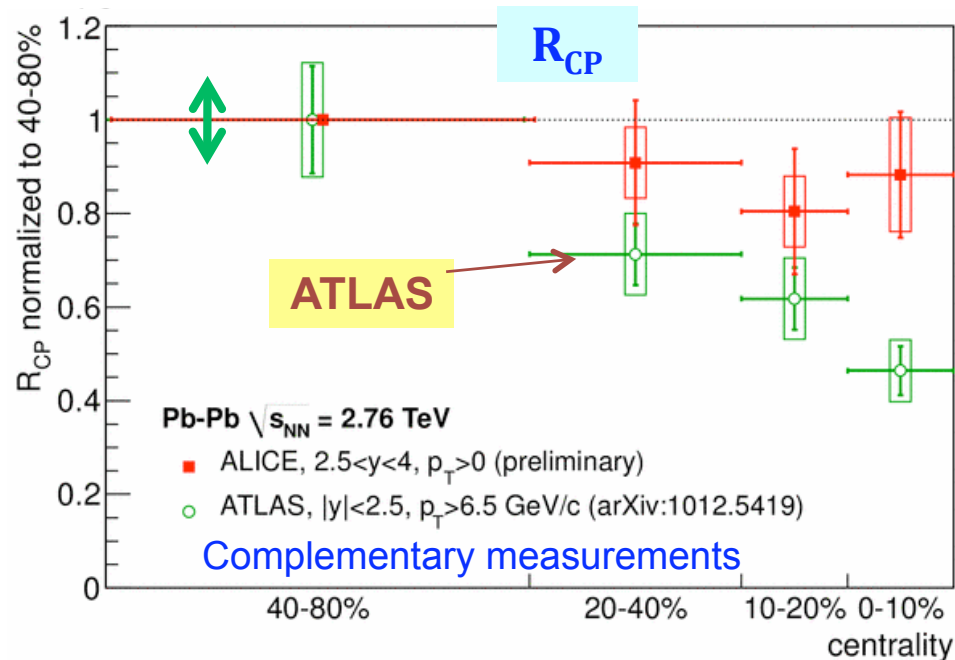
Rather small suppression & centrality dependence

J/ψ suppression: Compared to..



Surprisingly (?) : less suppression than RHIC !

R_{CP} (Alice/Atlas): suppression stronger at high p_T ??



Progressing analyses

pp exclusive analyses:

- Resonances in pp
- Event shape characterization in pp

Pb-Pb exclusive analyses:

- Identified particle
 - Including nuclei and anti-nuclei
- Azimuthal anisotropy
 - V_n
- Chiral magnetic effects
- Event-by-event fluctuations
- HBT vs centrality

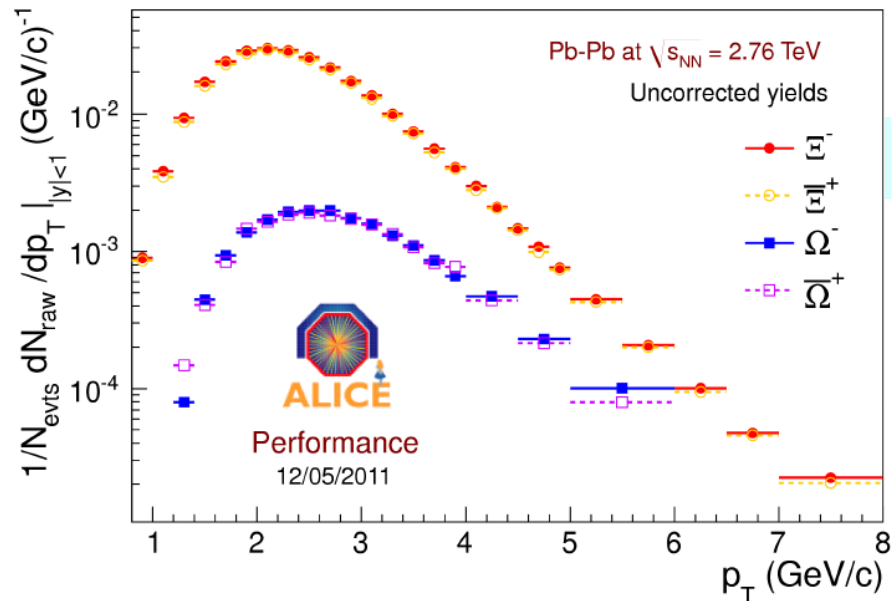
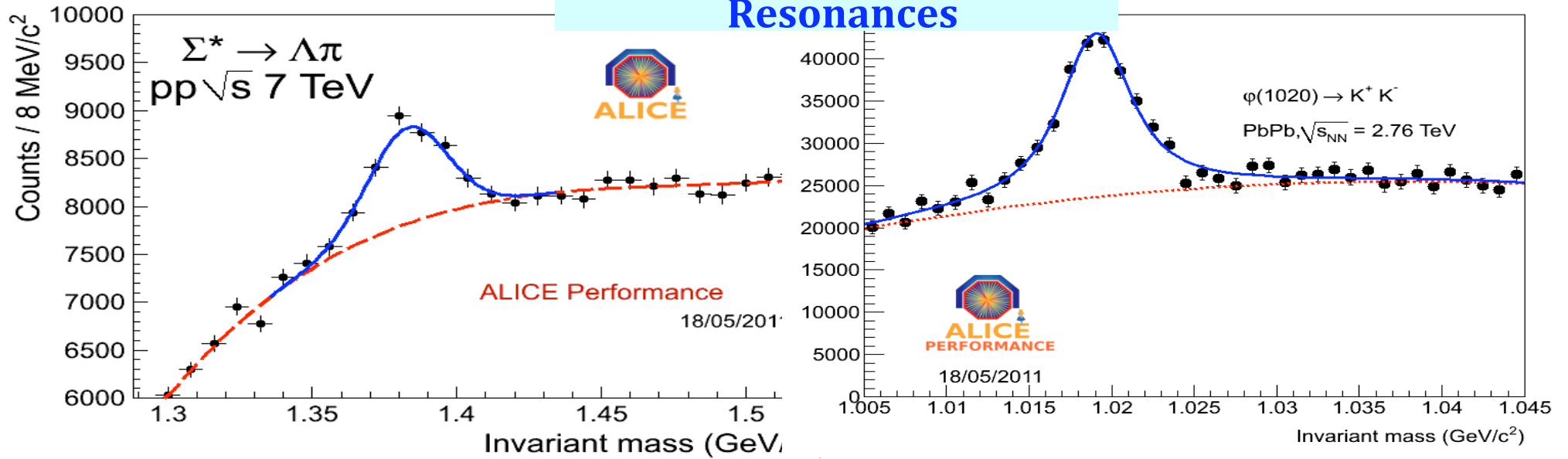
Analyses in both systems:

- R_{AA}
- J/ψ (paper on pp results submitted)
 - study of polarization
- Single electron from heavy-flavor decays
- Single muons
- Open charm
- π^0 production cross-section & R_{AA}
- Azimuthal correlations
- Λ/K_s^0
- Multi-strange particles

Extra slides


Resonances & Hyperons

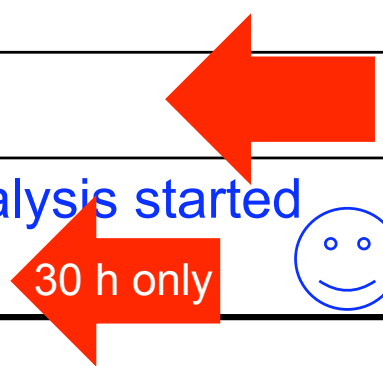
Resonances



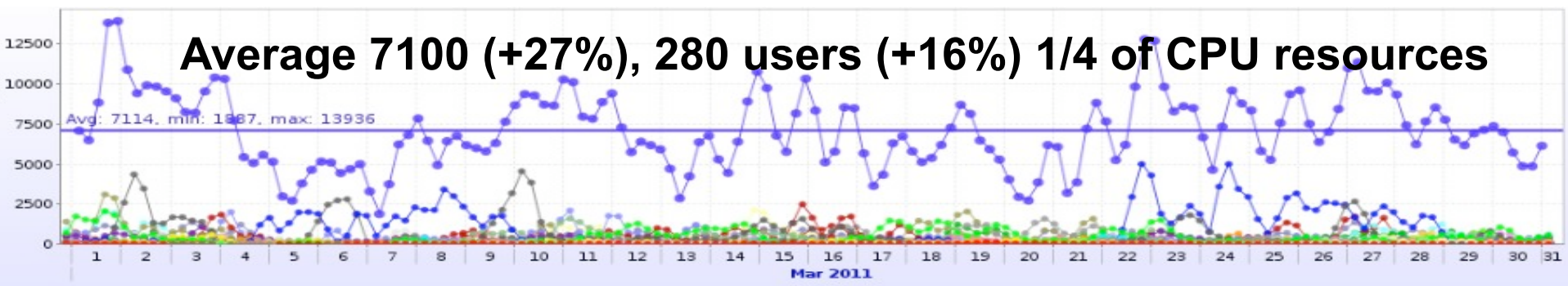
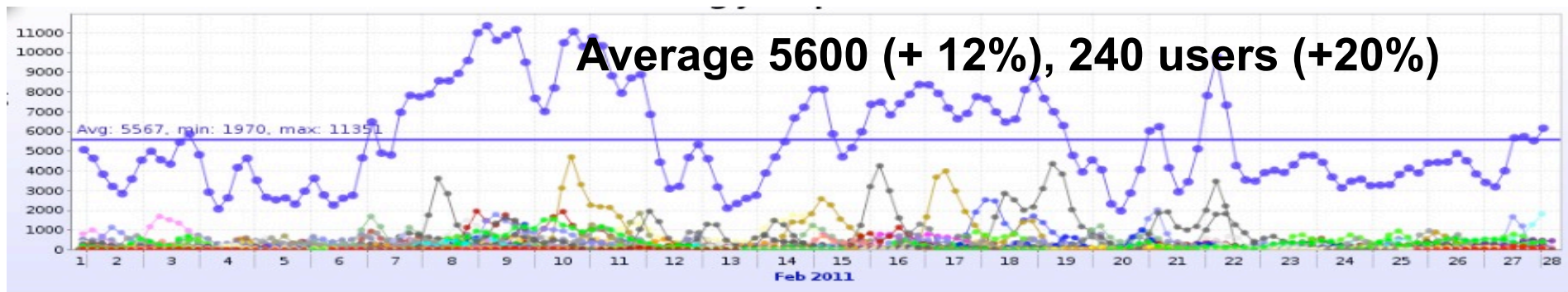
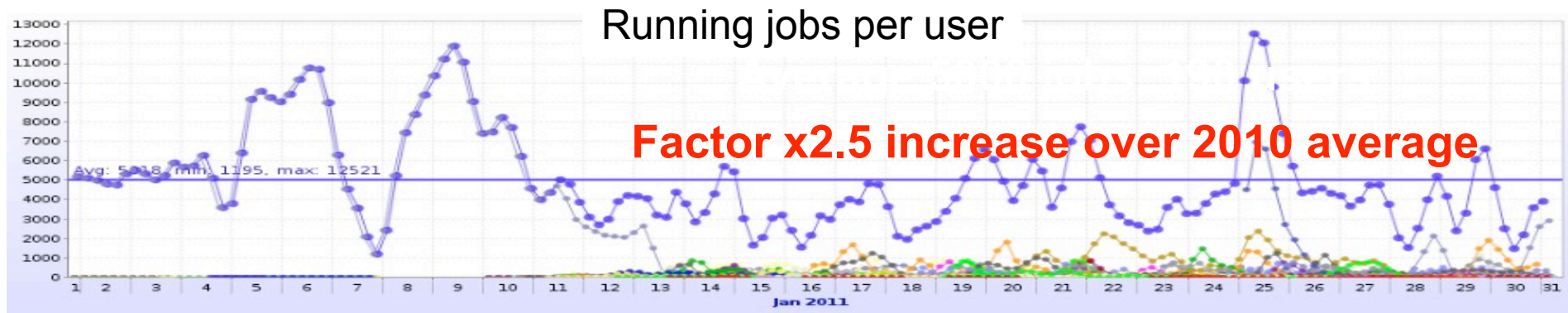
Hyperons

Data Samples

Beam	Energy	# of Events	
pp	900 GeV	300 k MB	2009, analysis finished
pp	900 GeV	~ 8 M MB	2010, partially analyzed
pp	2.36 TeV	~ 40 k MB	2009, only ITS, $dN_{ch}/d\eta$
pp	7 TeV	~ 800 M MB ~ 50 M muons ~ 20 M high N_{ch}	2010
PbPb	2.76 TeV/N	~ 30 M MB	2010
pp	2.76 TeV	~ 70 M MB ~ 20 nb^{-1} (rare triggers)	2011, analysis started 

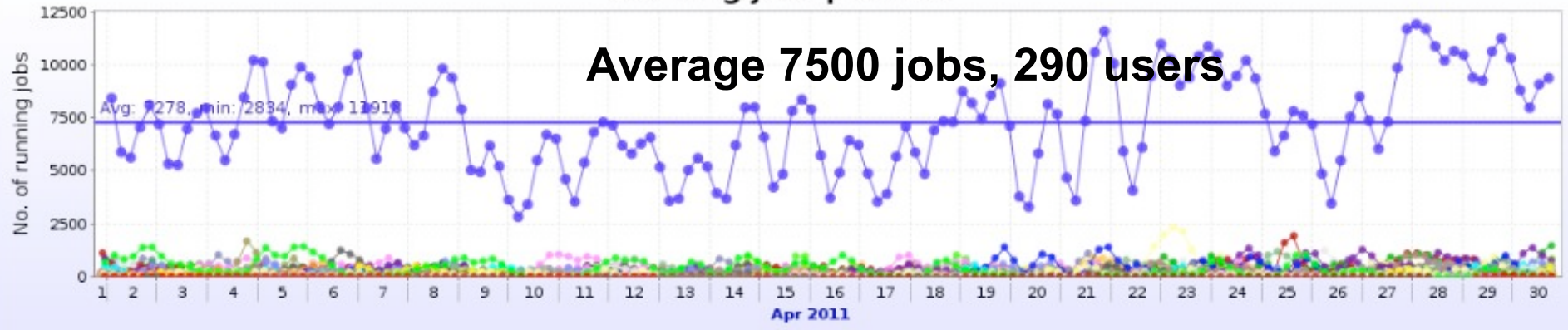


User activity – month on month increase



User activity – month on month increase

Running jobs per user

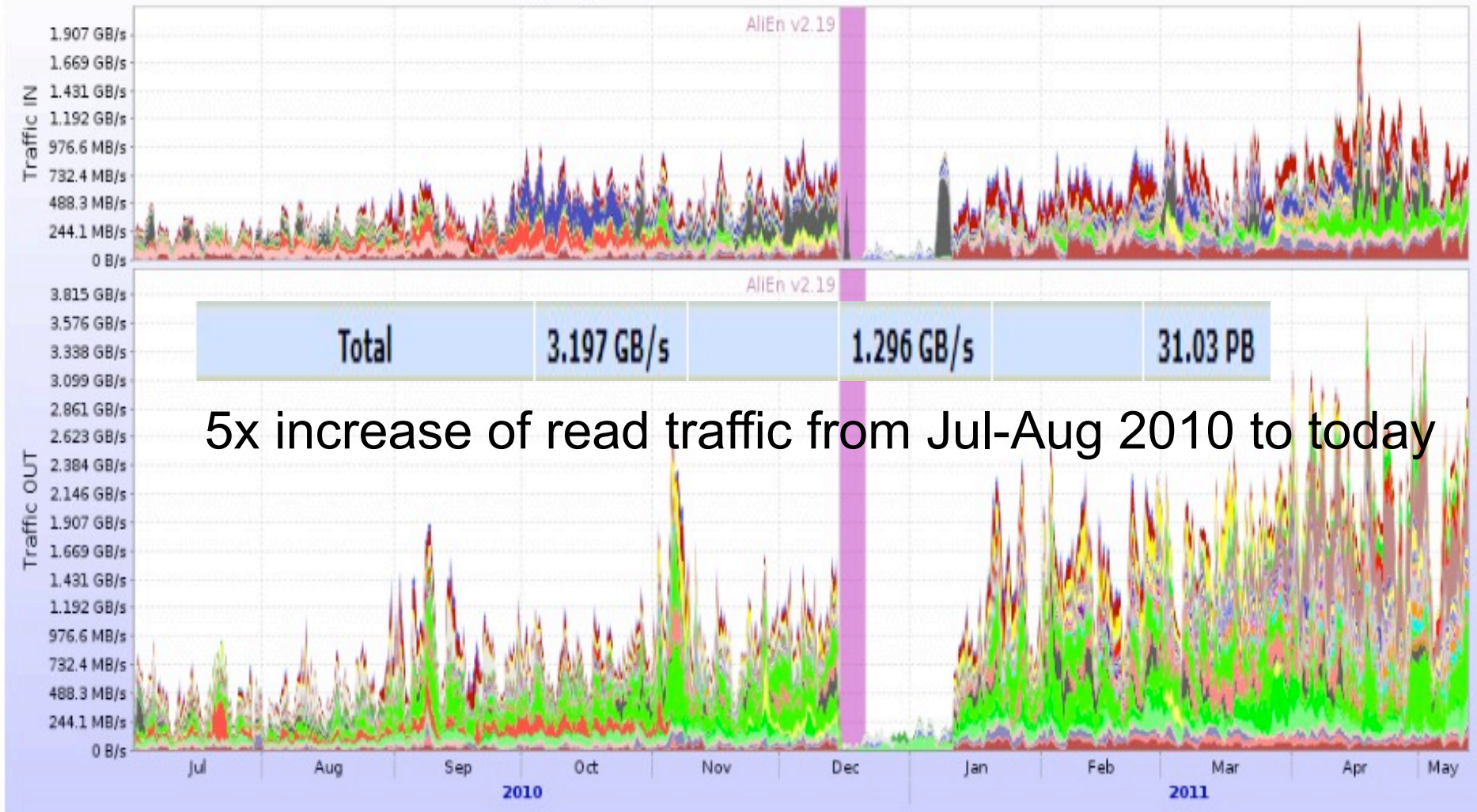


Running jobs per user



Stress-test for the GRID & Offline ...OK!

Aggregated network traffic per SE



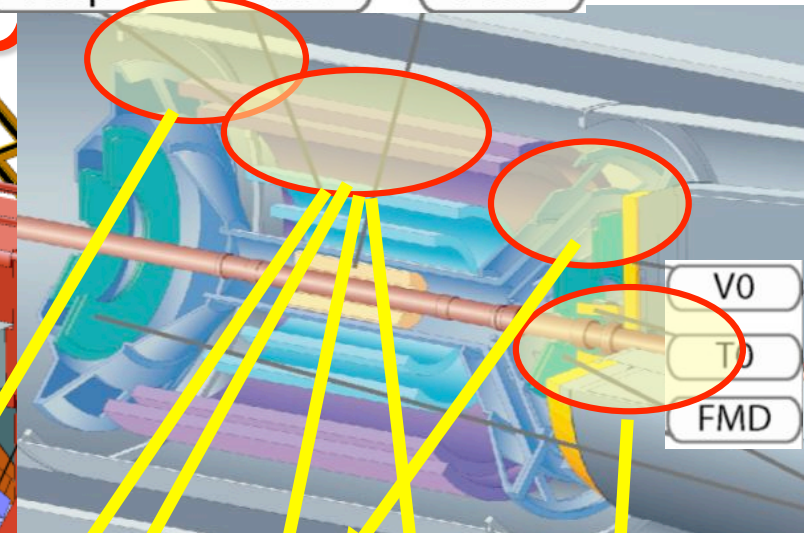
ALICE

Central Barrel
2 π tracking & PID
 $\Delta\eta \approx \pm 1$

Strip Drift Pixel

ACORDE
EMCal
TOF

ACORDE (cosmics)
V0 scintillator centrality
 $|\eta|: 1.7-3.7, 2.8-5.1$
T0 (timing)
ZDC (centrality)
FMD (N_{ch} $-3.4 < \eta < 5$)
PMD (N_{γ}, N_{ch})



Muon Spectrometer
 $2.5 < \eta < 4$

Detector:
Size: 16 x 26 meters
Weight: 10,000 tons

Collaboration:
> 1000 Members
> 100 Institutes
> 30 countries

HMPID

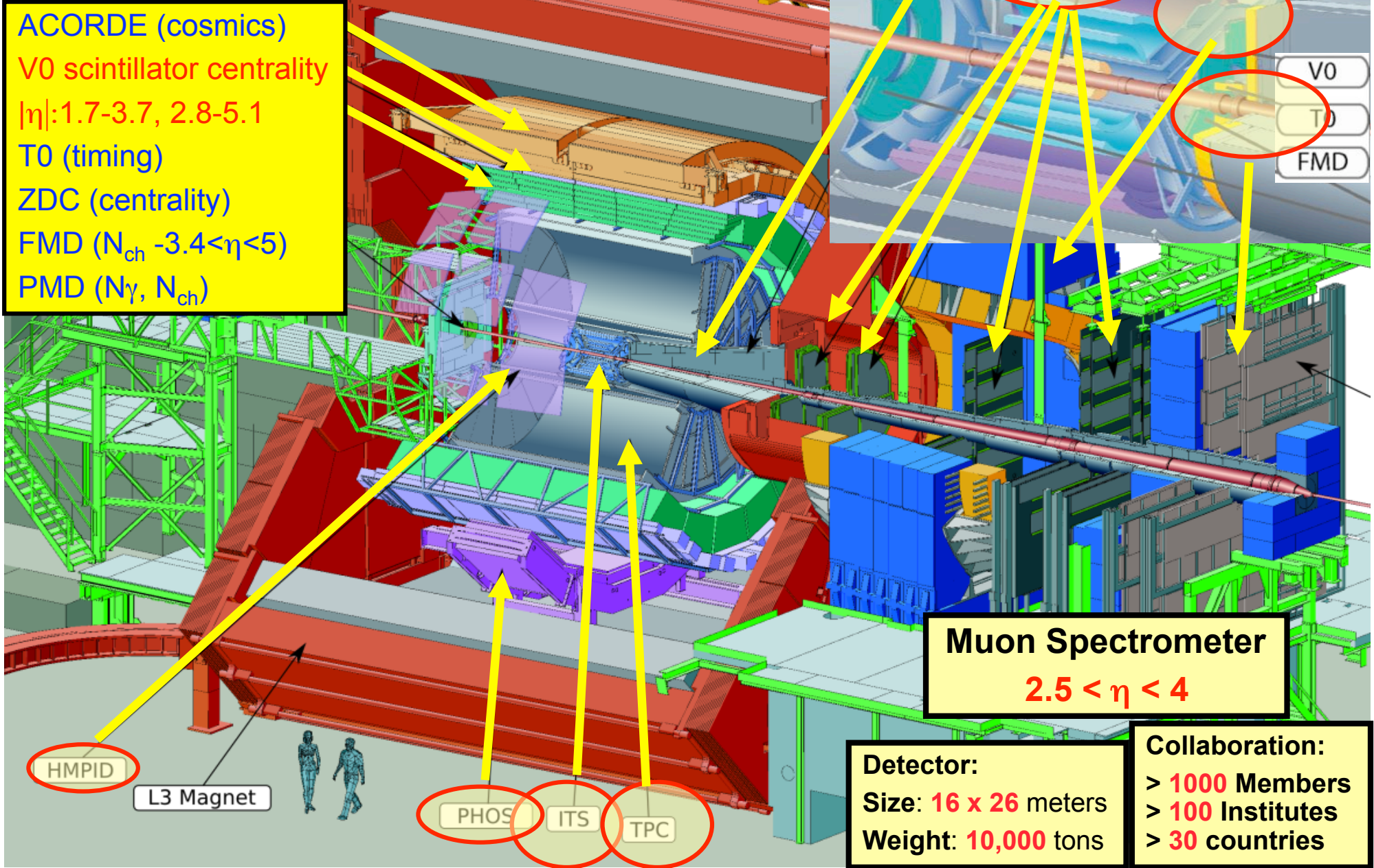
L3 Magnet



PHOS

ITS

TPC



Detector Status

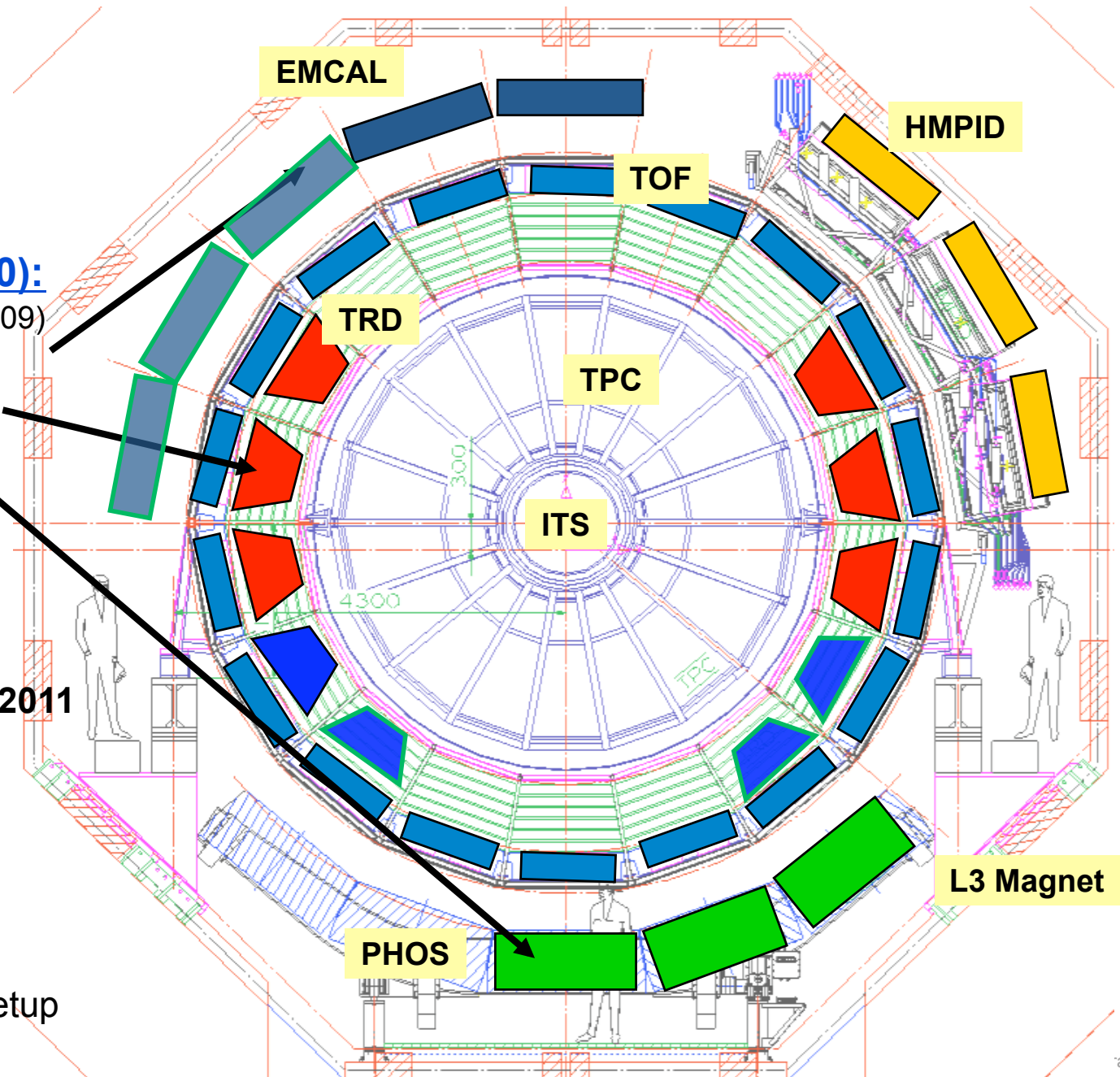
Complete since 2008:
ITS, TPC, TOF, HMPID,
FMD, T0, V0, ZDC,
Muon arm, Acorde
PMD, DAQ

Partial installation (2010):
4/10 EMCAL* (approved 2009)
7/18 TRD* (approved 2002)
3/5 PHOS (funding)

~ 60% HLT (High Level Trigger)

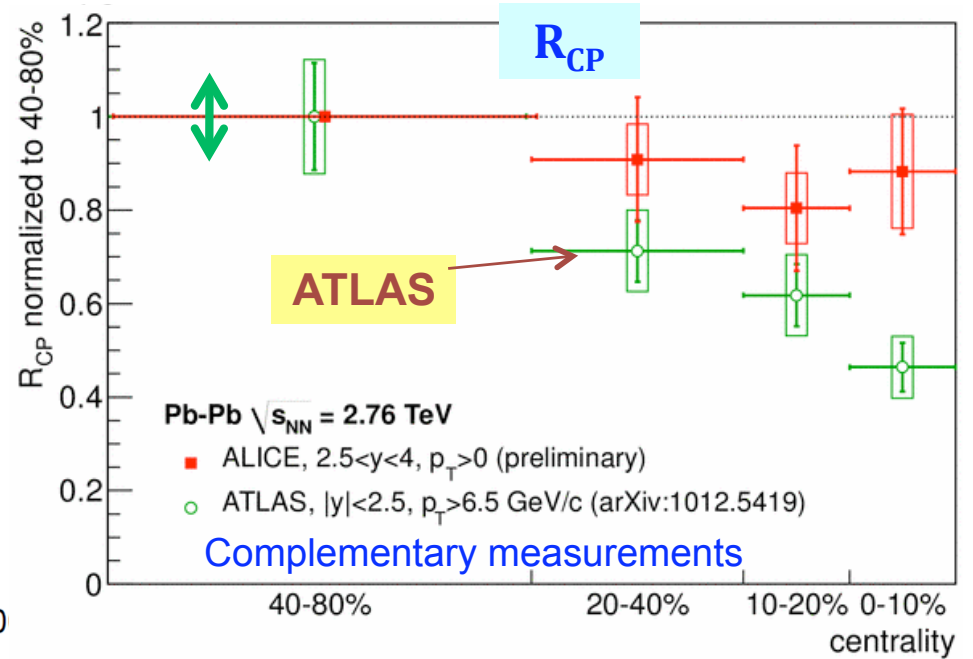
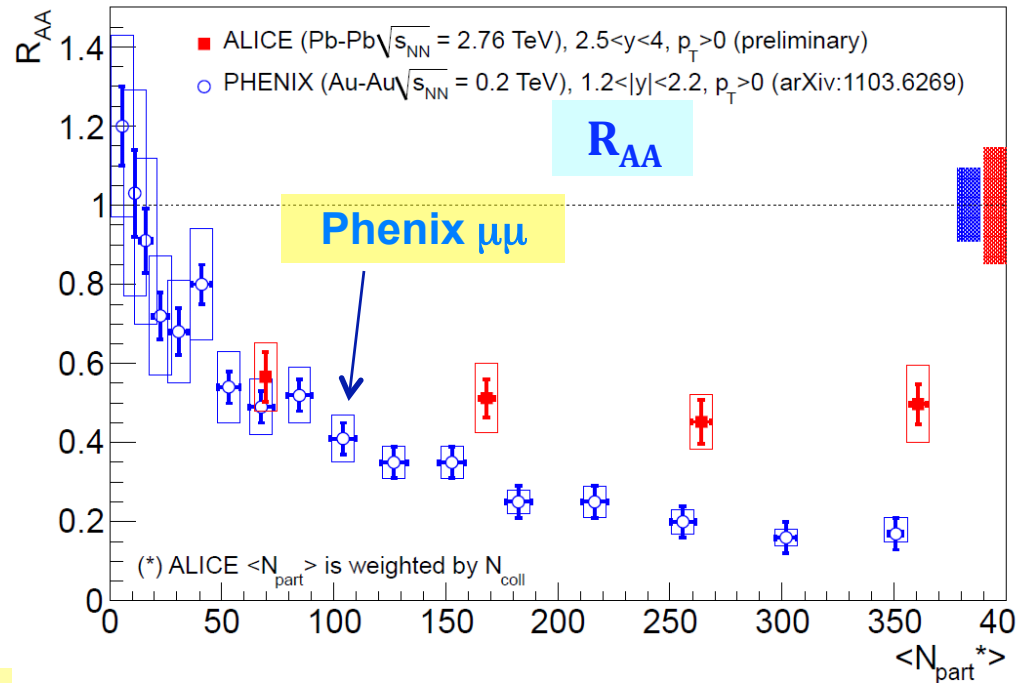
2011
10/10 EMCAL
10/18 TRD

TRD to be completed end 2011



*upgrade to the original setup

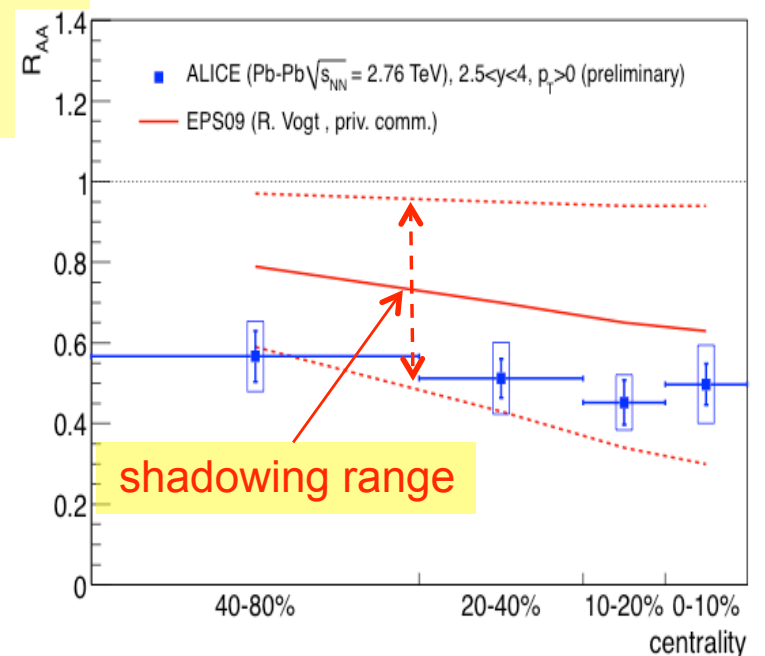
J/ψ suppression: Compared to..



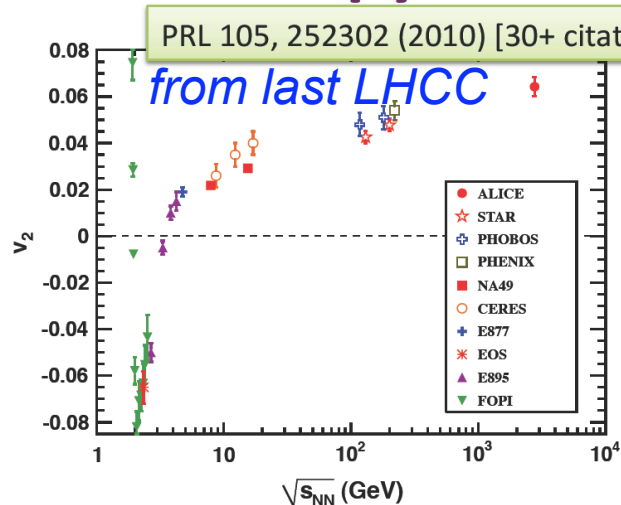
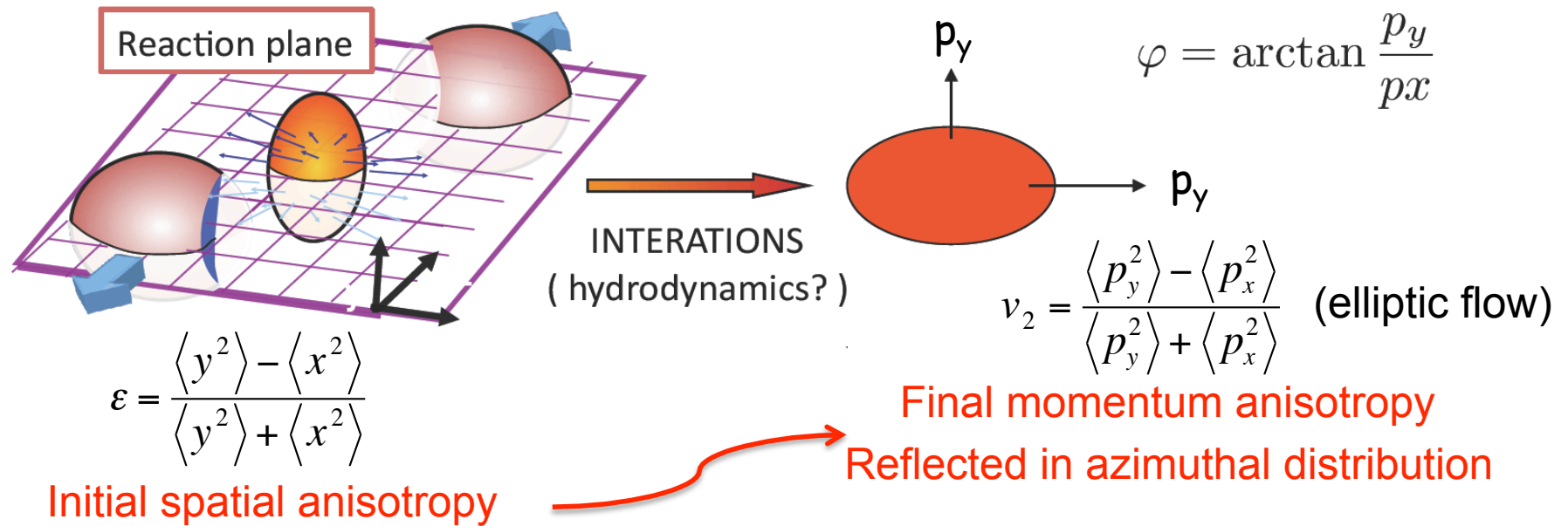
Surprisingly (?) : less suppression than RHIC !
 R_{CP} (Alice/Atlas): suppression stronger at high p_T ??

Caveats:

- J/ψ (B) about 10% (LHCb) => R_{AA} (prompt) lower by ≈ 0.05
- compare to Phenix e^+e^- ? => less difference, still significant
- shadowing(LHC) > shadowing(RHIC) ? => R_{AA} goes up ?
- cold nuclear matter suppression ?



Anisotropic transverse flow



More on v_2

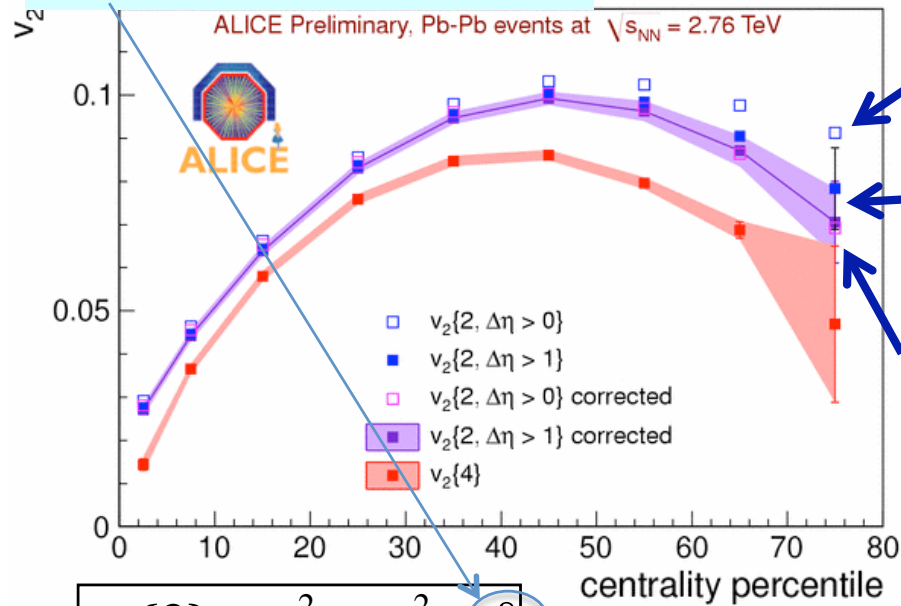
- Non-flow contribution (δ)
- Measure flow fluctuations (σ)
 - different cumulants
- Identified particle flow (sensitive to radial expansion)

$$v_2\{2\} \cong v_2^2 + \sigma_2^2 + \delta$$

$$v_2\{4\} \cong v_2^2 - \sigma_2^2$$

More on v_2

Non-Flow corrections



v_2 no eta gap between particles

v_2 $|\eta| > 1$

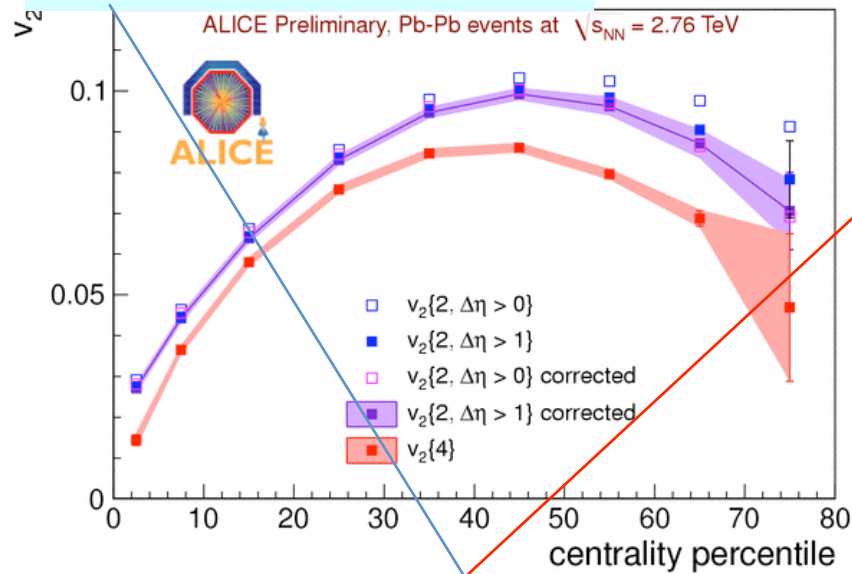
both v_2 corrected for remaining non-flow
(Hijing or scaled pp)

$$v_2\{2\} \cong v_2^2 + \sigma_2^2 + \delta$$

$$v_2\{4\} \cong v_2^2 - \sigma_2^2$$

More on v_2

Non-Flow corrections



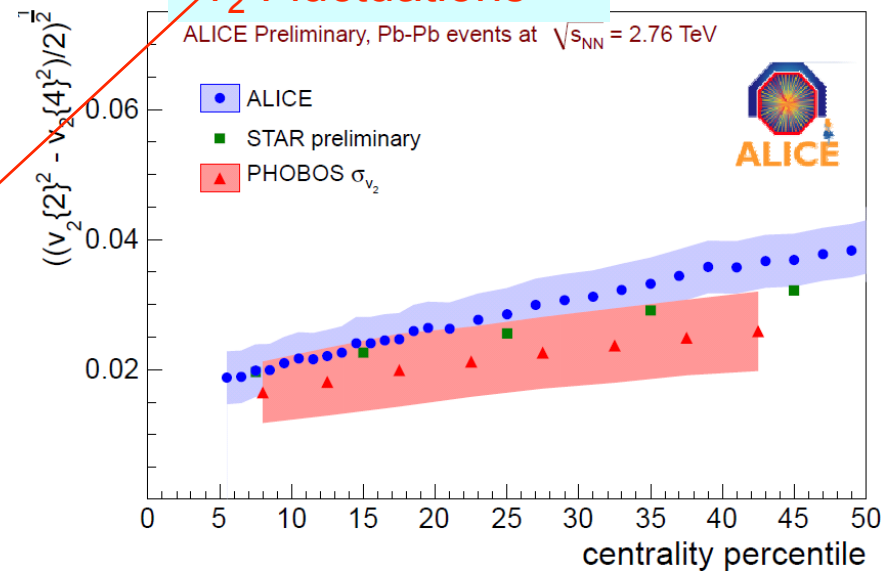
$$v_2\{2\} \cong v_2^2 + \sigma_2^2 + \delta$$

$$v_2\{4\} \cong v_2^2 - \sigma_2^2$$

Flow fluctuations:

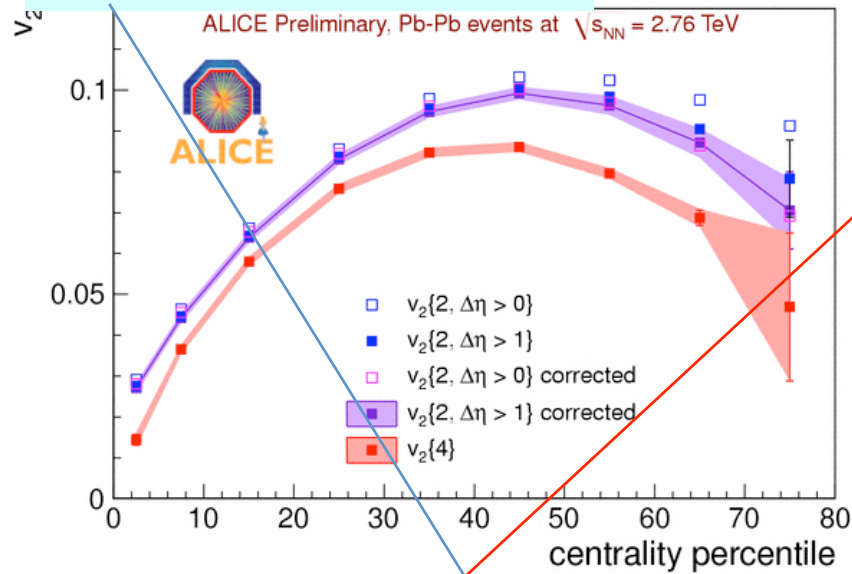
- comparable to RHIC (driven mostly by geometry)

v_2 Fluctuations



More on v_2

Non-Flow corrections



$$v_2\{2\} \cong v_2^2 + \sigma_2^2 + \delta$$

$$v_2\{4\} \cong v_2^2 - \sigma_2^2$$

Flow fluctuations:

- comparable to RHIC (driven mostly by geometry)

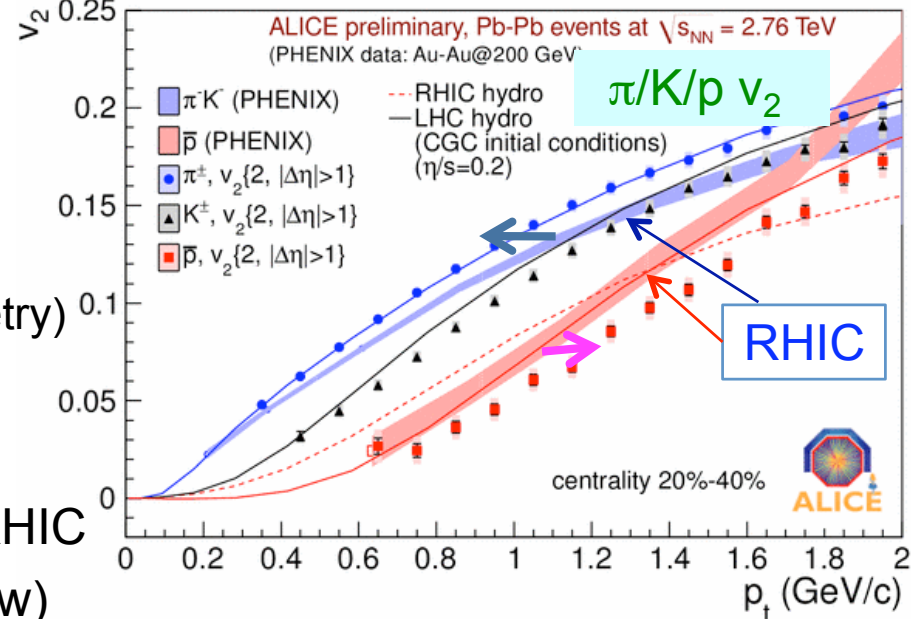
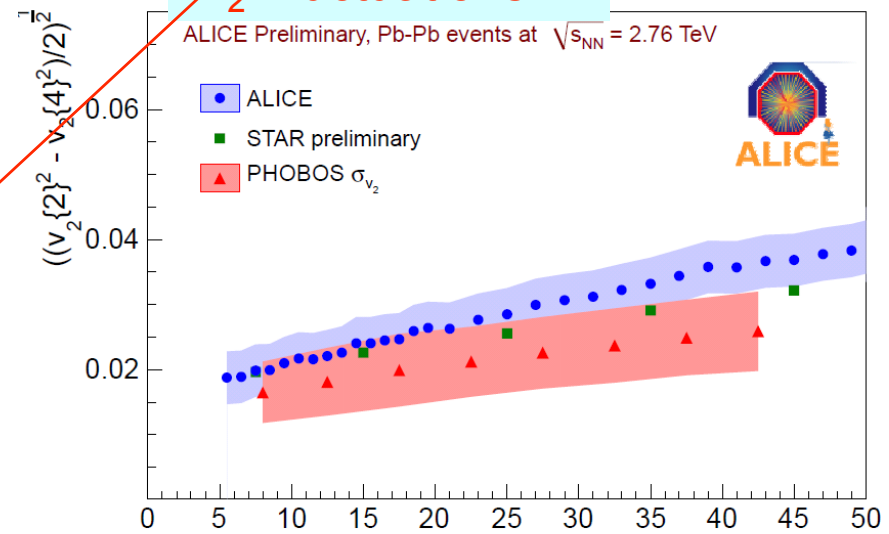
PID flow:

- Mass splitting and ordering \approx hydro

- π and p are 'pushed' further compared to RHIC

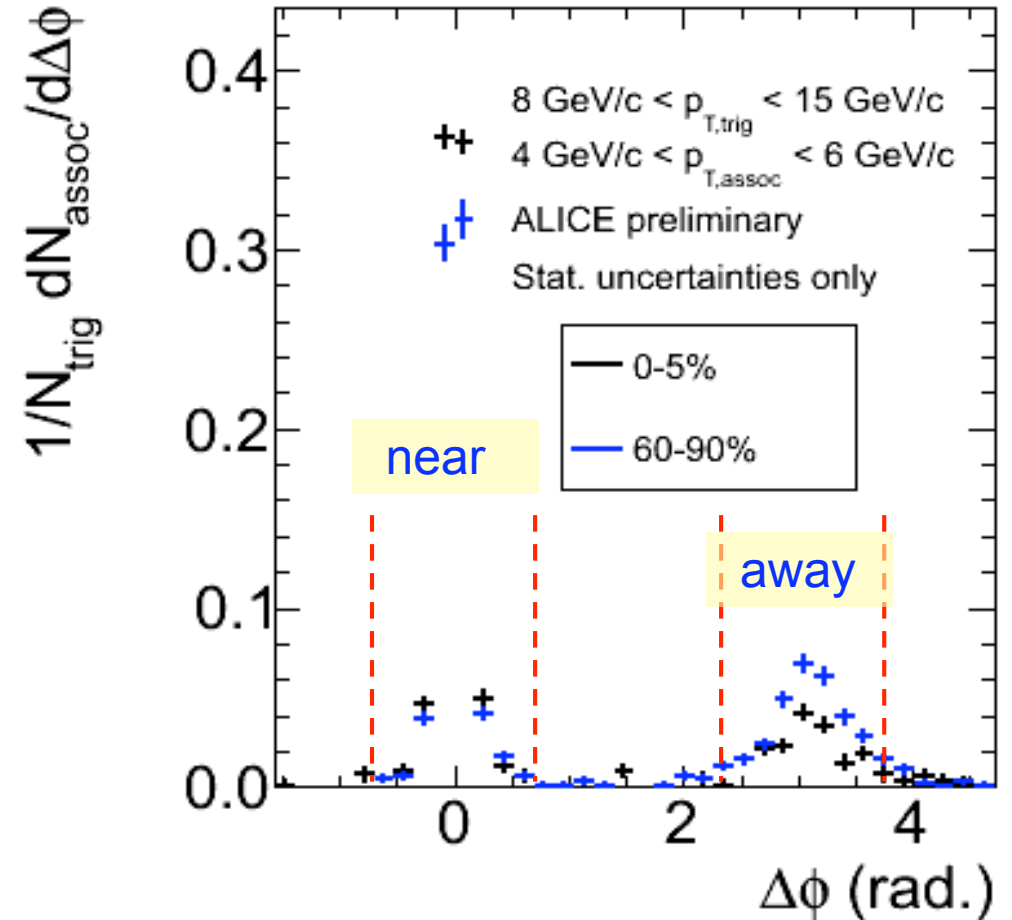
\approx expected from hydro (with larger radial flow)

v_2 Fluctuations

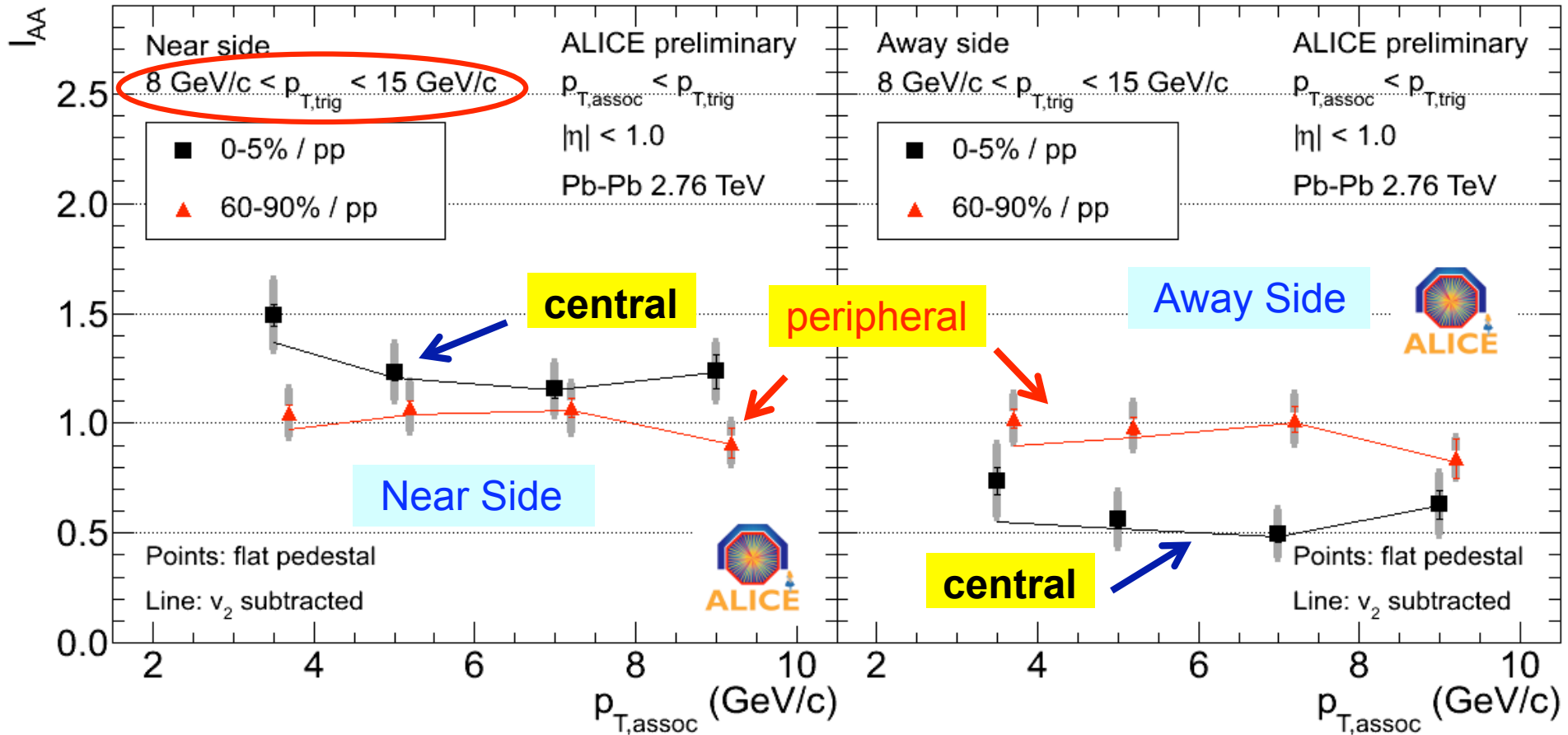


Triggered correlation at high p_t & jets: I_{AA}

- Extract **near** and **away-side** jet yields from per-trigger yields
 - Compare central and peripheral collisions $\rightarrow I_{CP}$
 - **Compare Pb+Pb and pp $\rightarrow I_{AA}$**
- Non-jet component (baseline) needs to be removed (no known assumption-free methods... pedestal at $\pi/2$, ALICE flow...)
- Measure in a region where the signal dominates over pedestal and v_2 modulation
($8 \text{ GeV}/c < p_{T,\text{trig}} < 15 \text{ GeV}/c$)



Triggered correlation at high p_t & jets: I_{AA}



- Near-side of central events slightly enhanced
 $I_{AA} \sim 1.2$... unexpected and interesting
- Away side of central events suppressed:
 $I_{AA} \sim 0.6$... expected from in-medium energy loss

• Peripheral events consistent with unity

Multiplicity & system size

- Multiplicity at central rapidity (Ingredient for many models)

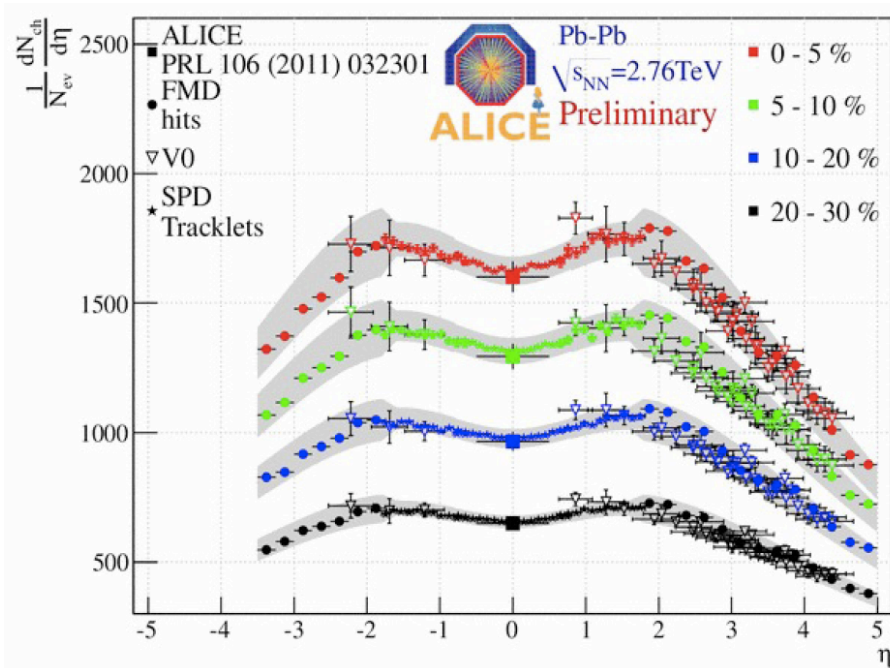
K. Aamodt et al. (ALICE), Phys. Rev. Lett. 105, 252301 (2010)

K. Aamodt et al. (ALICE), Phys. Rev. Lett. 106, 032301 (2011)

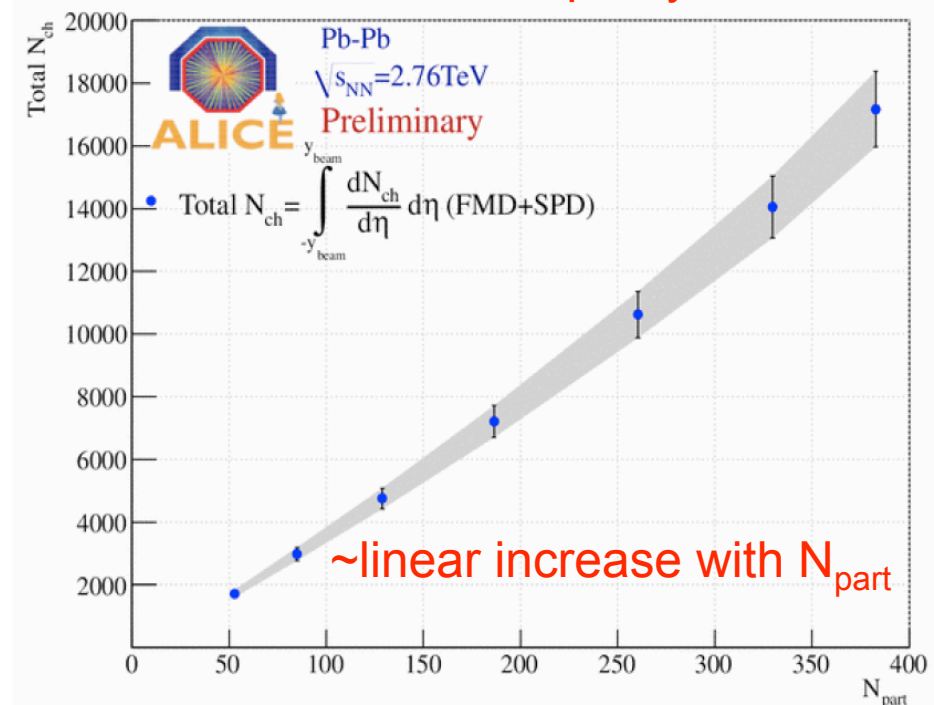
- Study of system “size” at decoupling & decoupling time (within hydrodynamic scenario) via HBT analysis (quantum interference of identical bosons emitted close in phase space from a common source) Phys.Lett.B 696:328-337,2011

} Last LHCC

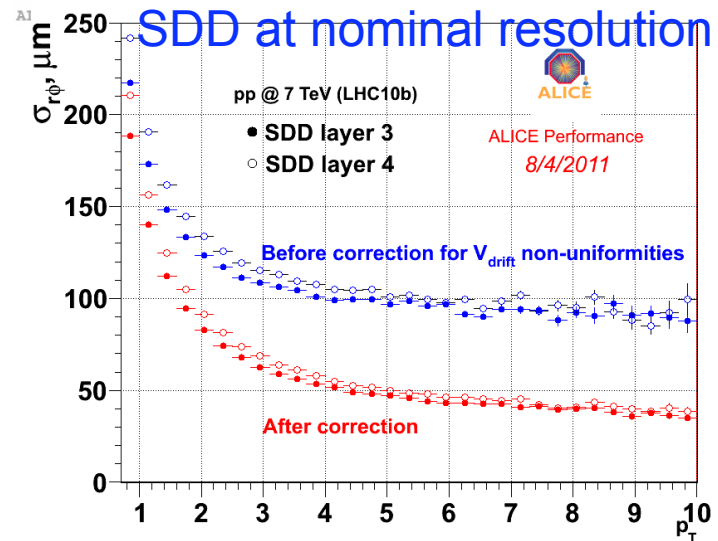
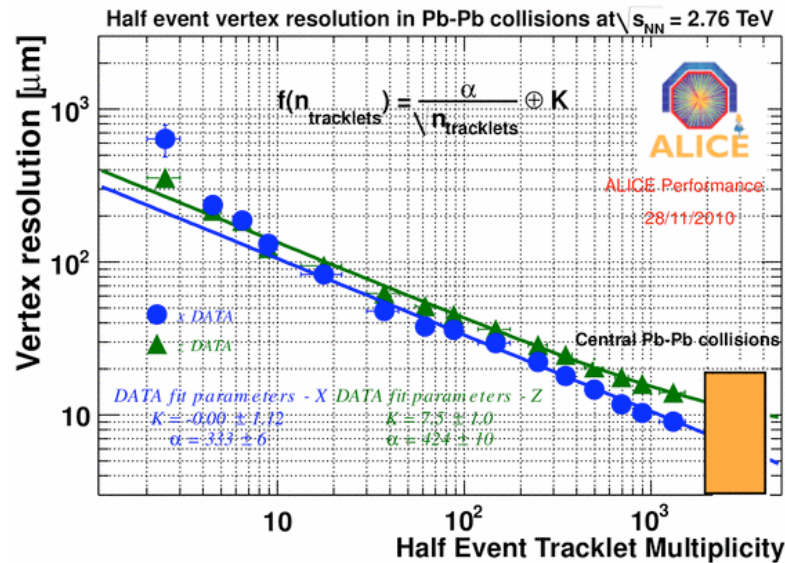
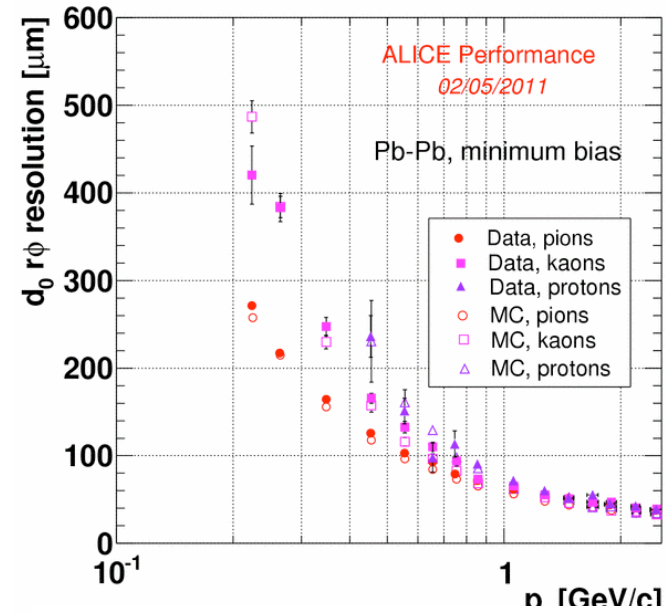
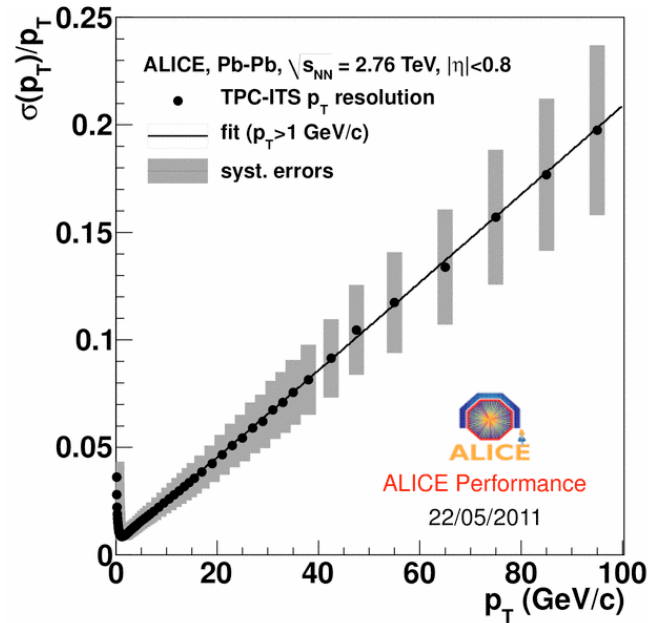
Multiplicity at forward rapidity



Total multiplicity



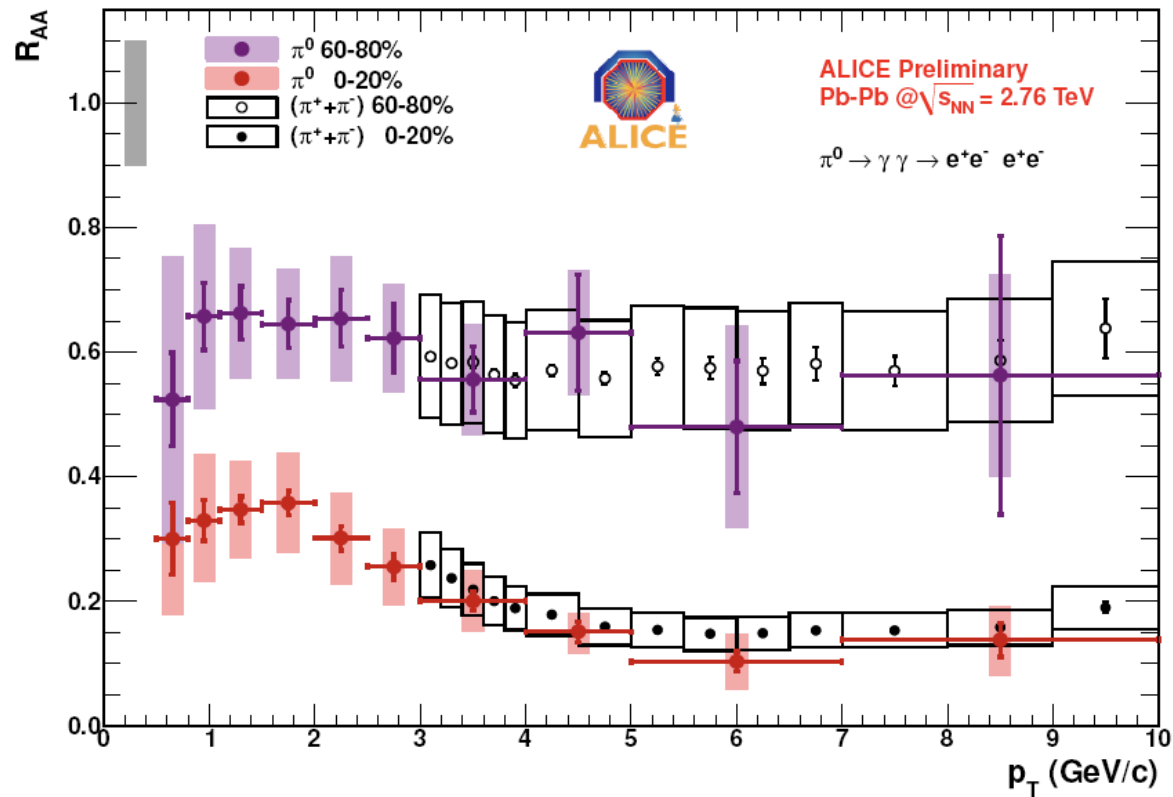
Tracking & Vertexing



$\pi^\pm, \pi^0 R_{AA}$

π^0 from reconstruction of gamma conversions

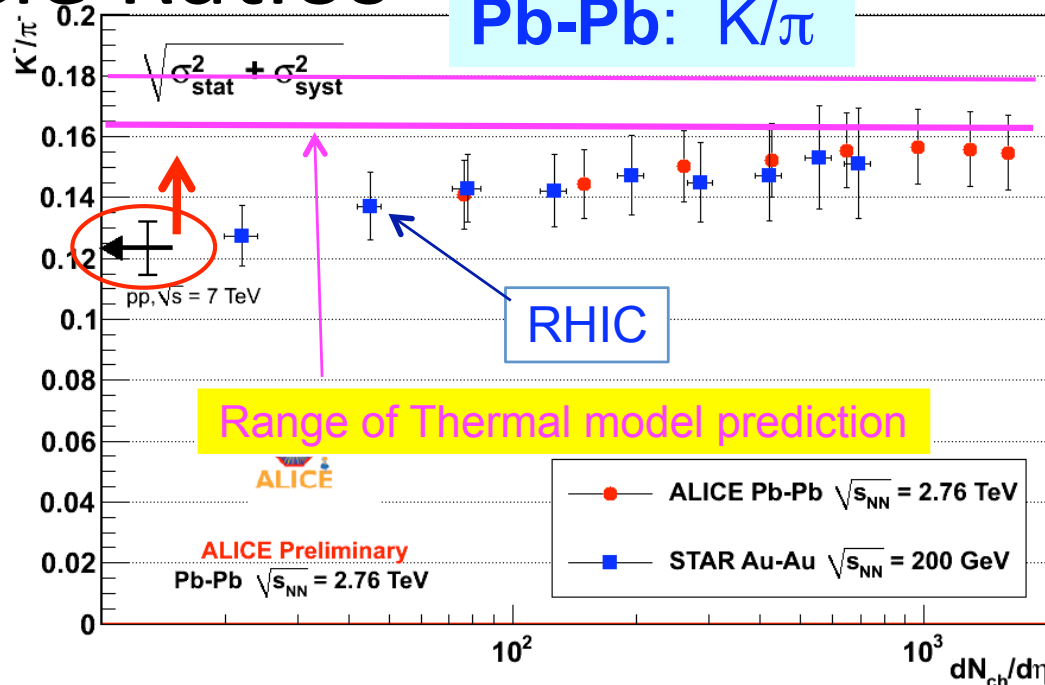
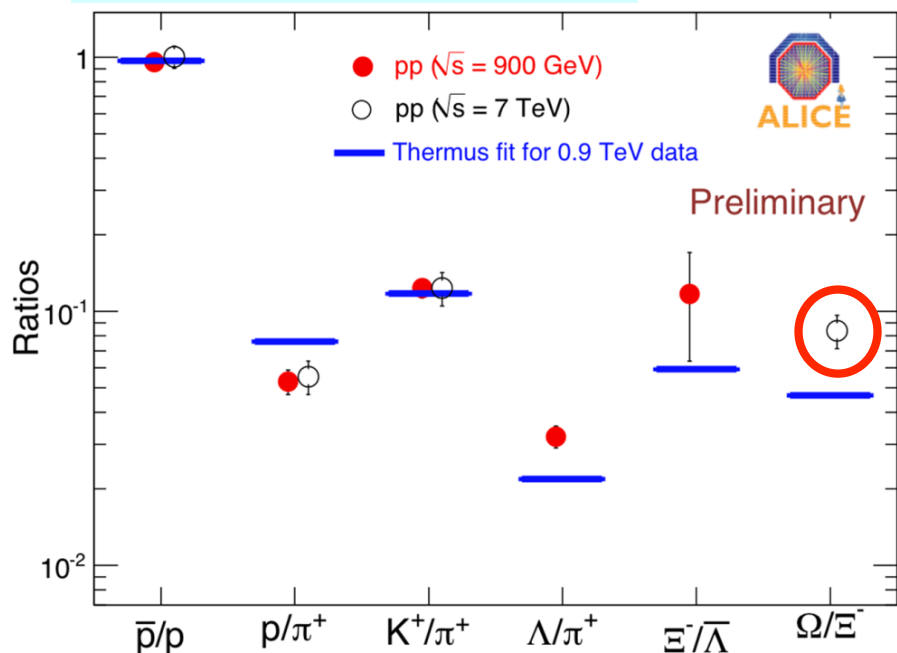
✓ Being cross-checked with π^0 spectra measured with EMCal & PHOS calorimeters



pp: 900 GeV & 7 TeV

Particle Ratios

Pb-Pb: K/π



- pp: Thermus thermal fit rather poor
(wasn't this better for pp at lower energies ??)

- K/π grows slightly from pp value

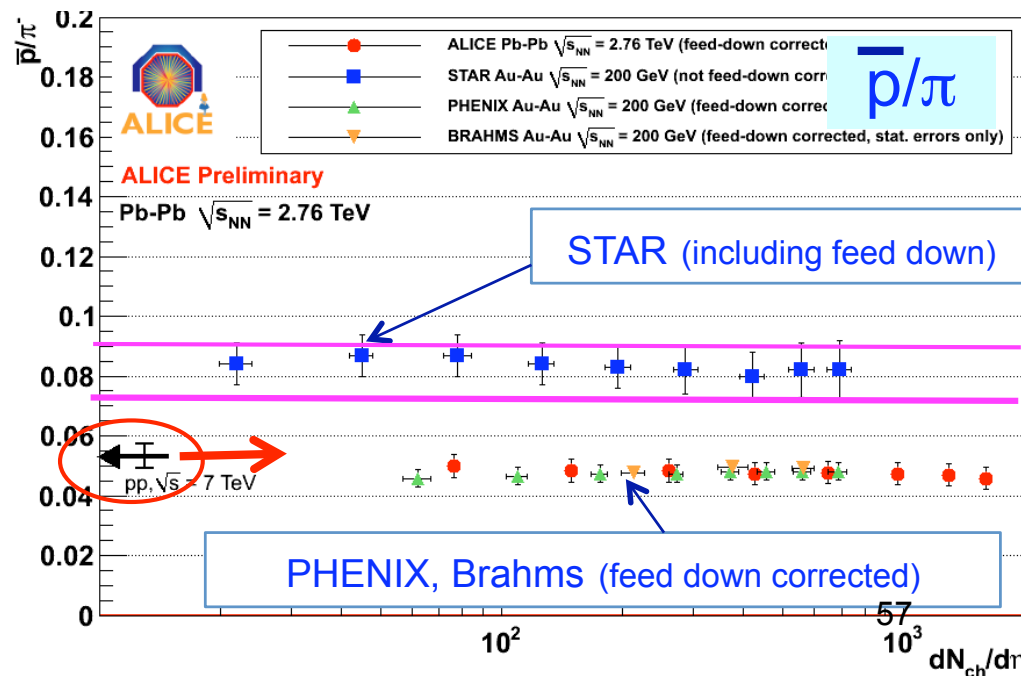
- $p/\pi \approx$ like pp

Pb: p/π off by factor > 1.5
from predictions !

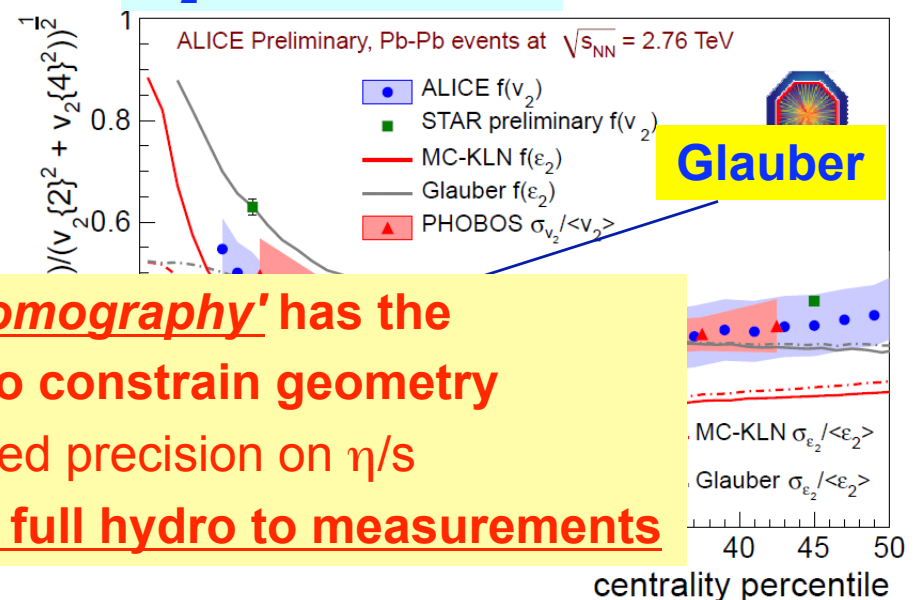
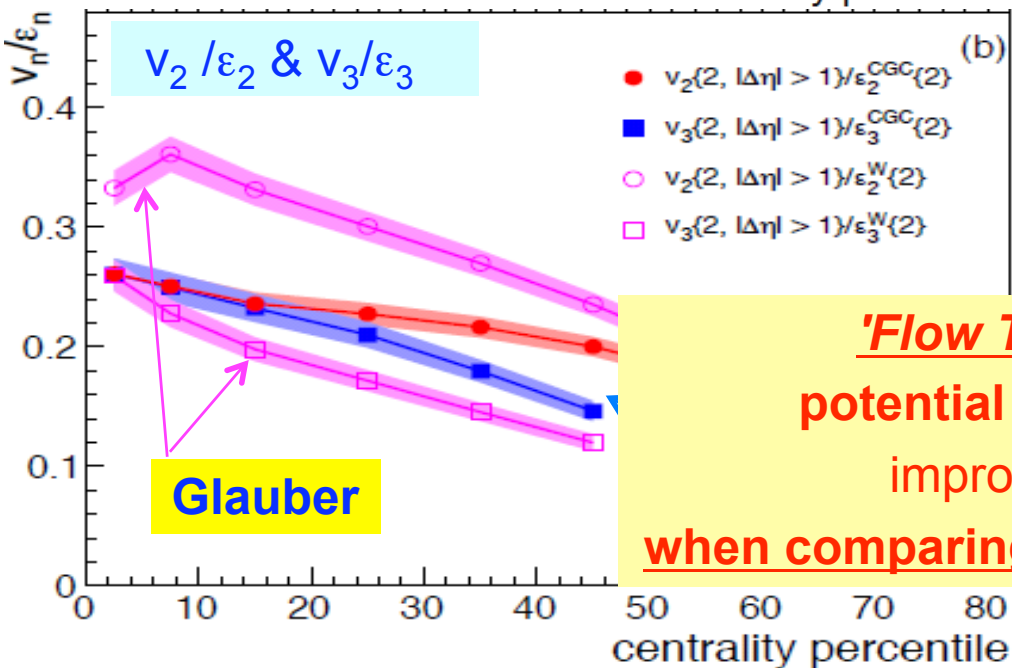
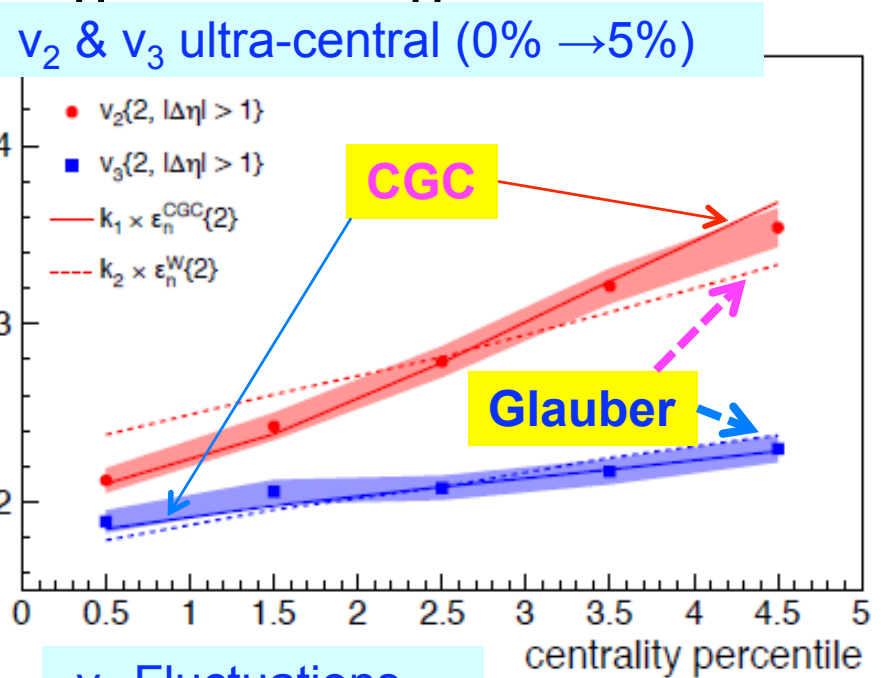
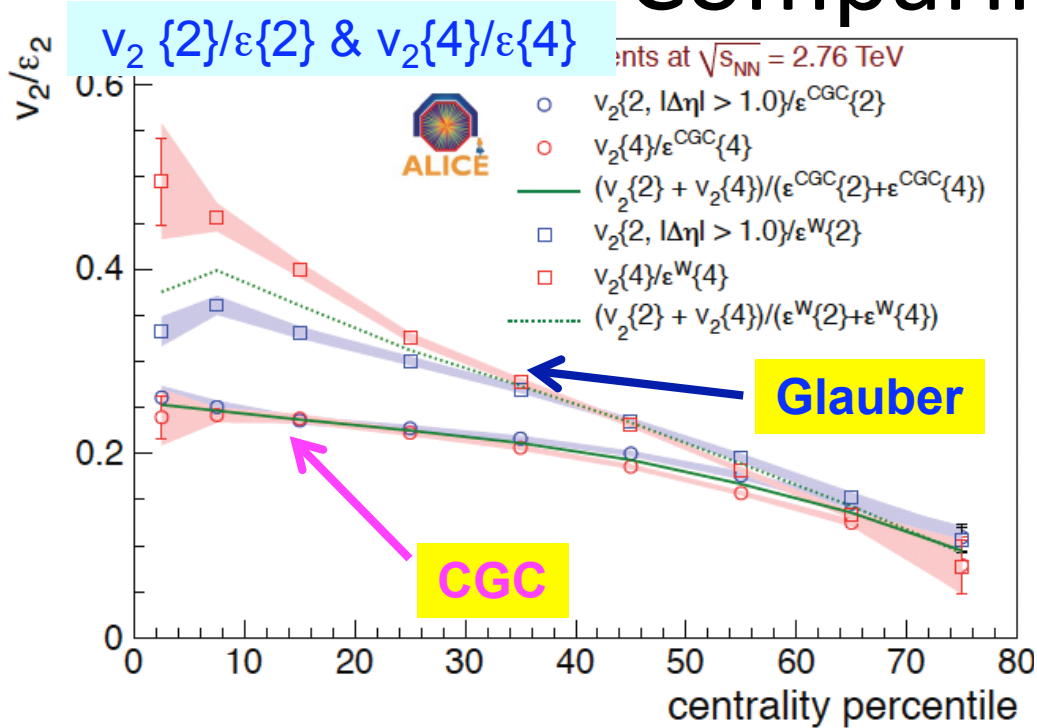
but very compatible with RHIC !!



Before we can conclude anything
we need more particle species..

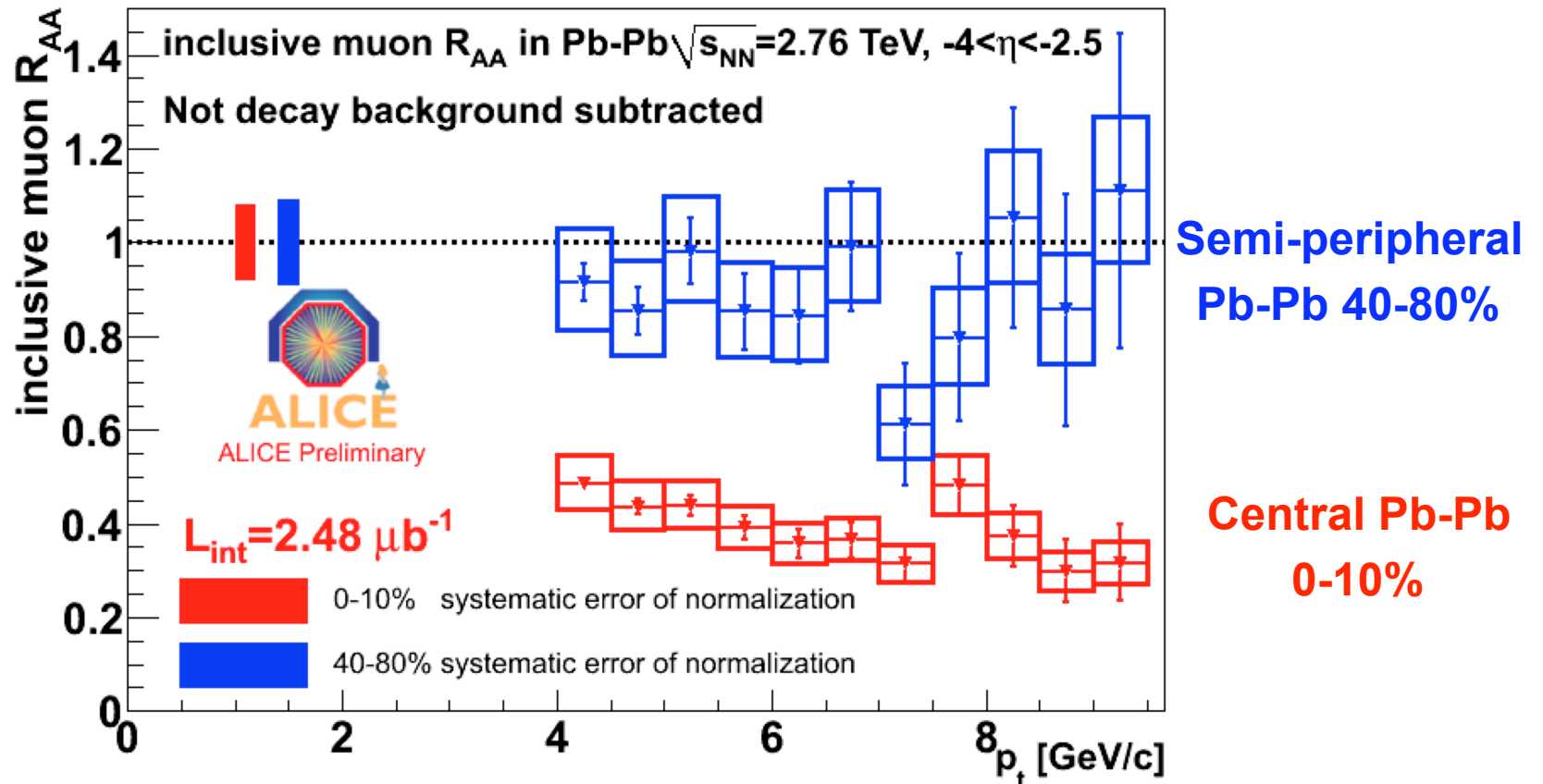


Comparing v_n with ϵ_n



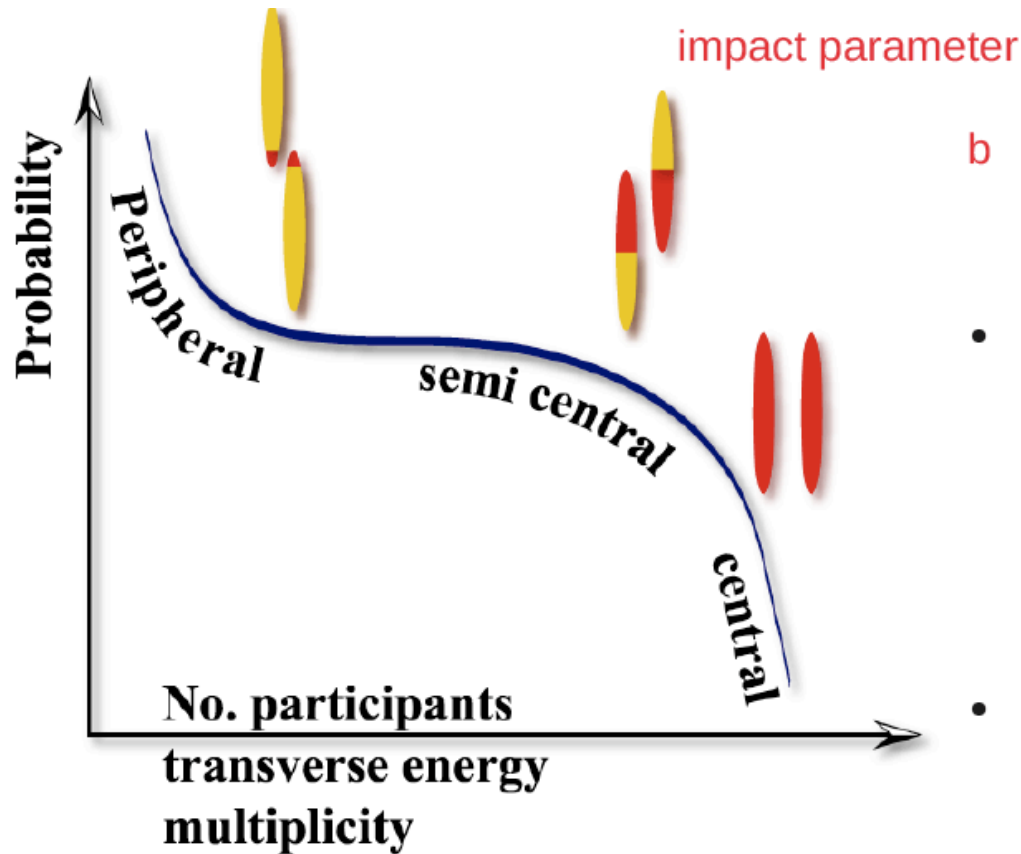
'Flow Tomography' has the potential to constrain geometry improved precision on η/s when comparing full hydro to measurements

Heavy Flavour decay muons



- single prompt muon cross section (c,b) pp @ 7 TeV
- scaled (FONLL) to 2.76 TeV
- R_{AA} (p_T , centrality) with inclusive muons

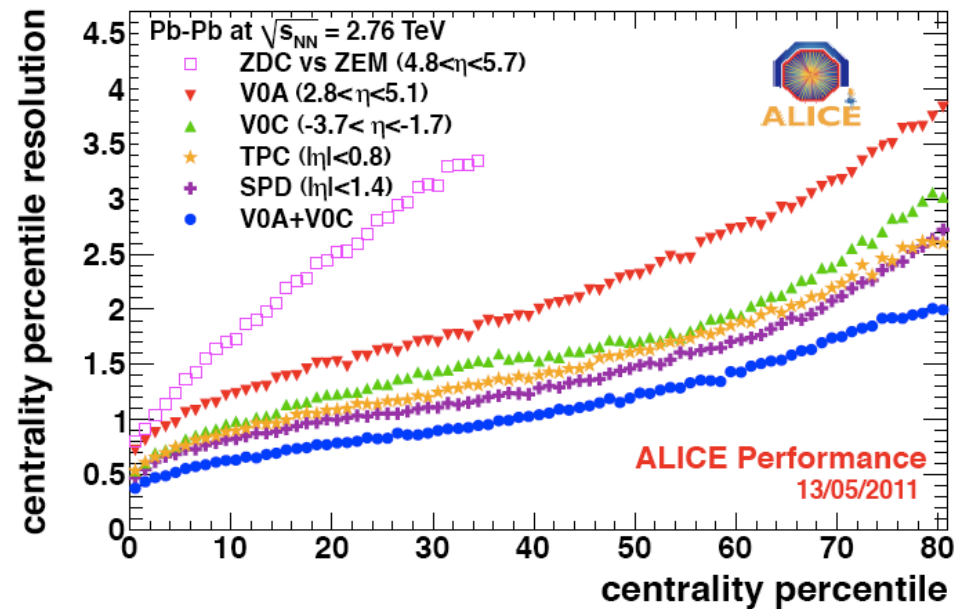
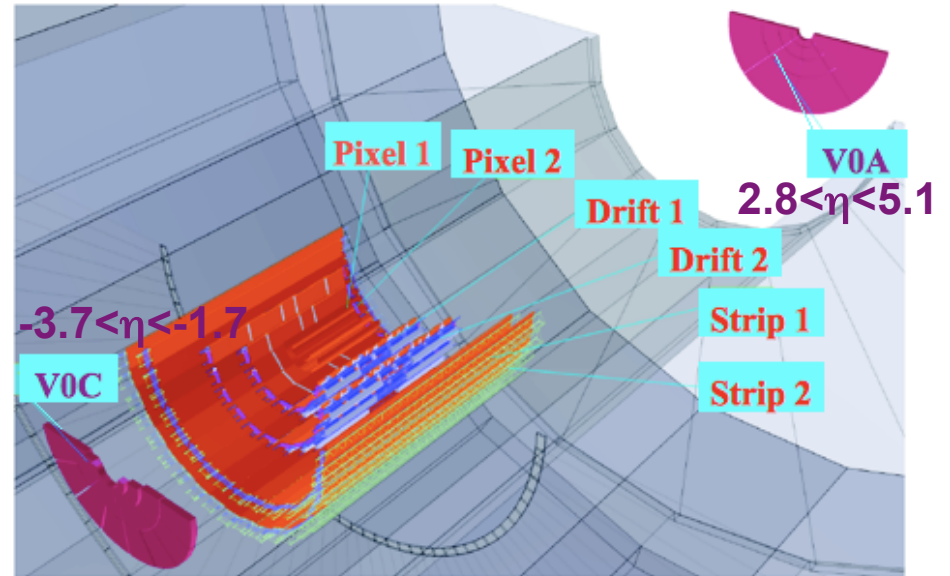
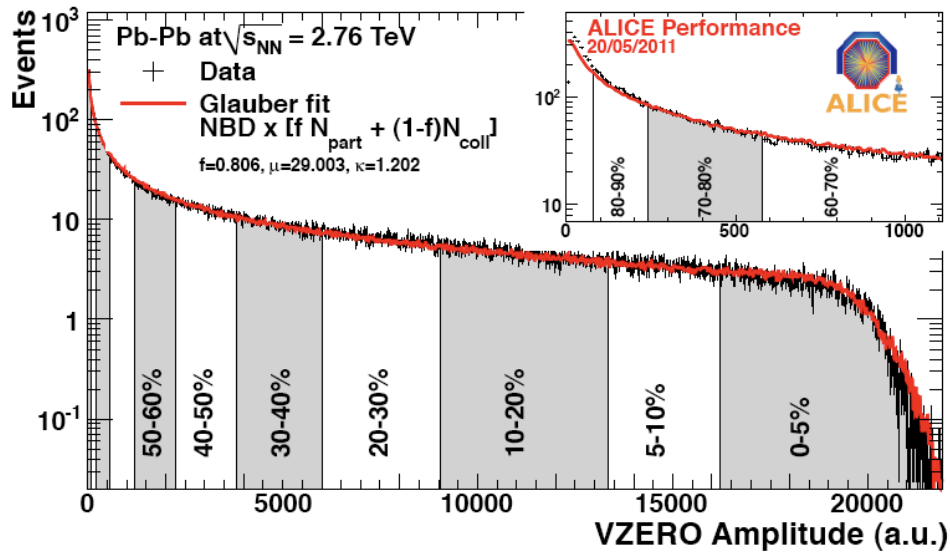
Geometry of AA collisions



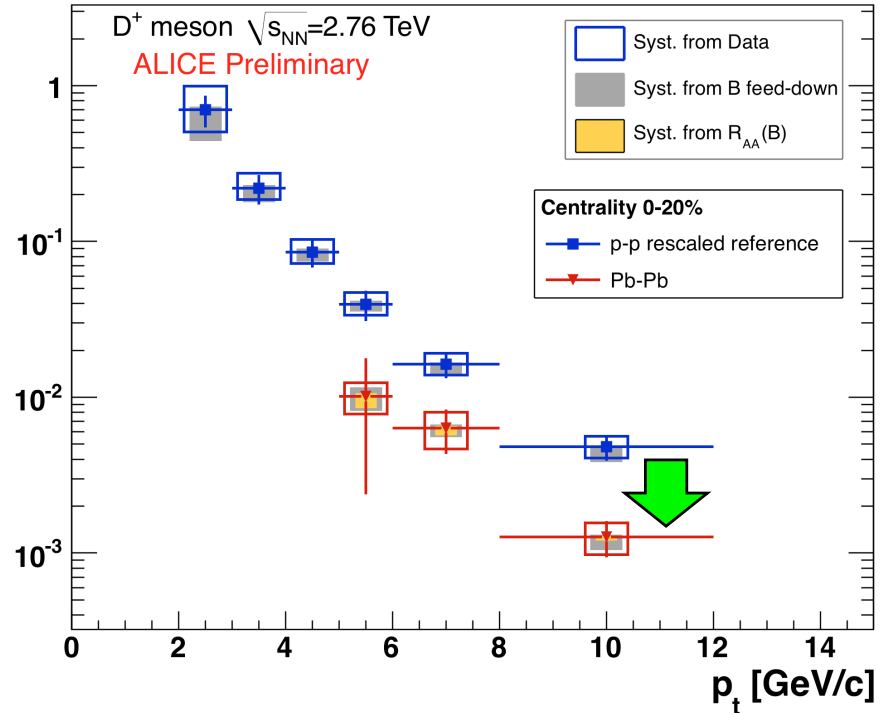
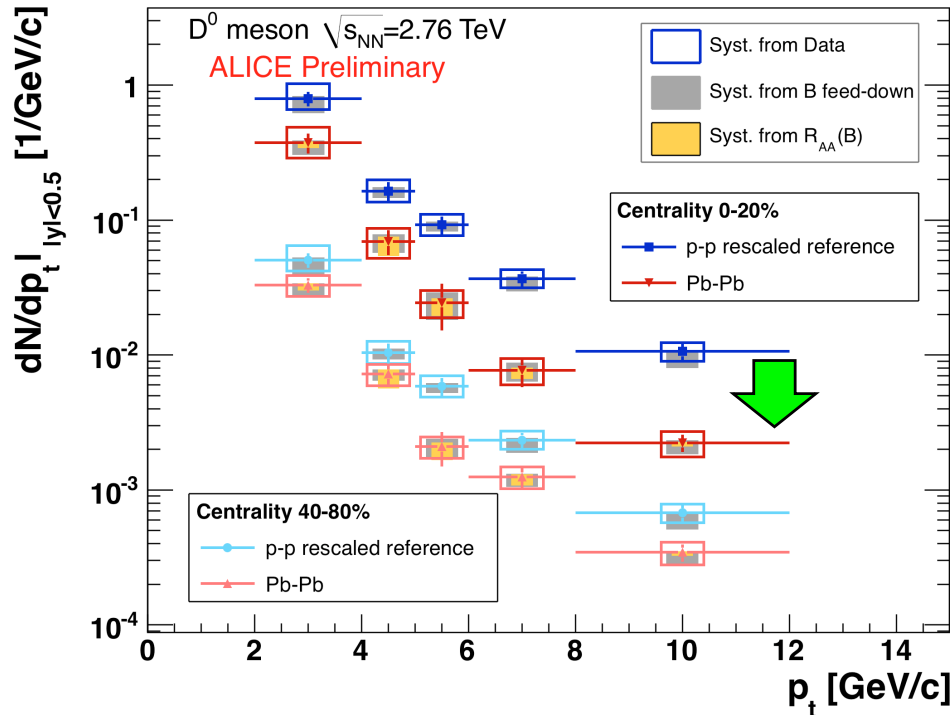
- small impact parameter ($b \sim 0$)
 - high energy density
 - large volume
 - large number of produced particles
- measured as:
 - fraction of cross section "centrality"
 - number of participants
 - number of nucleon-nucleon collisions

From a Glauber Monte Carlo calculation

Centrality



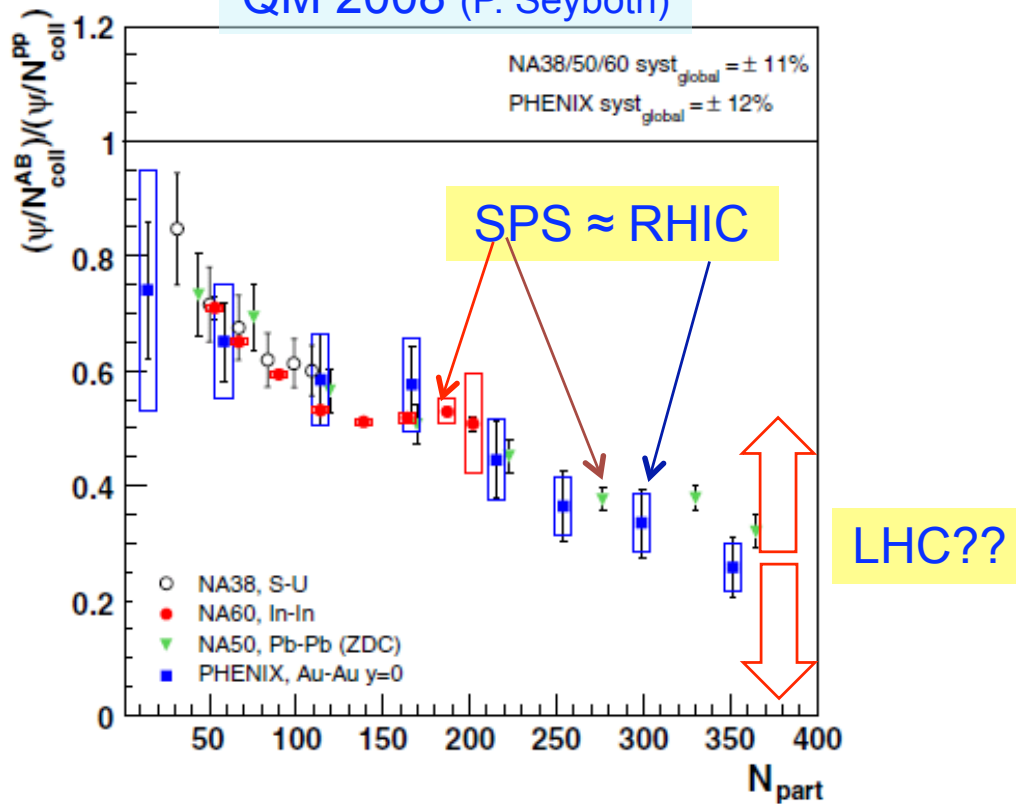
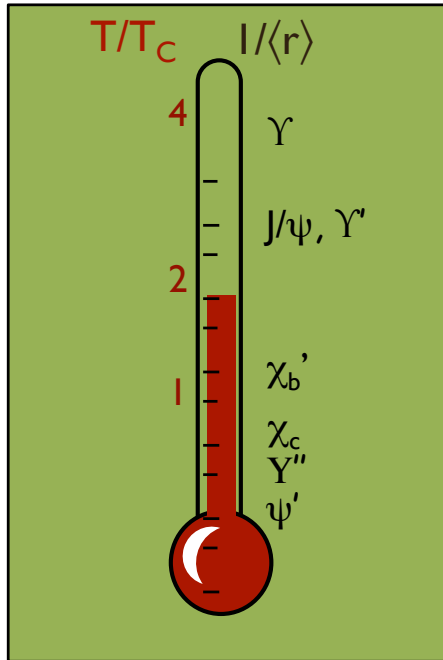
Charm R_{AA} : results



- ❖ Strong suppression observed in **central collisions (0-20%)** wrt T_{AA} -scaled pp reference
- ❖ Significant suppression also in **semiperipheral (40-80%)** wrt T_{AA} -scaled pp reference

J/ψ Suppression

QM 2008 (P. Seyboth)



- Can LHC solve the puzzle (measuring J/ψ and Y families) ?

	ψ'	χ	Y''(3S)	Y'(2S)	J/ψ	Y
T_d/T_c	1-1.2	1-1.2	1.1-1.3	1.2-2	1.5-2.5	3-5

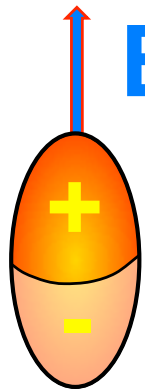
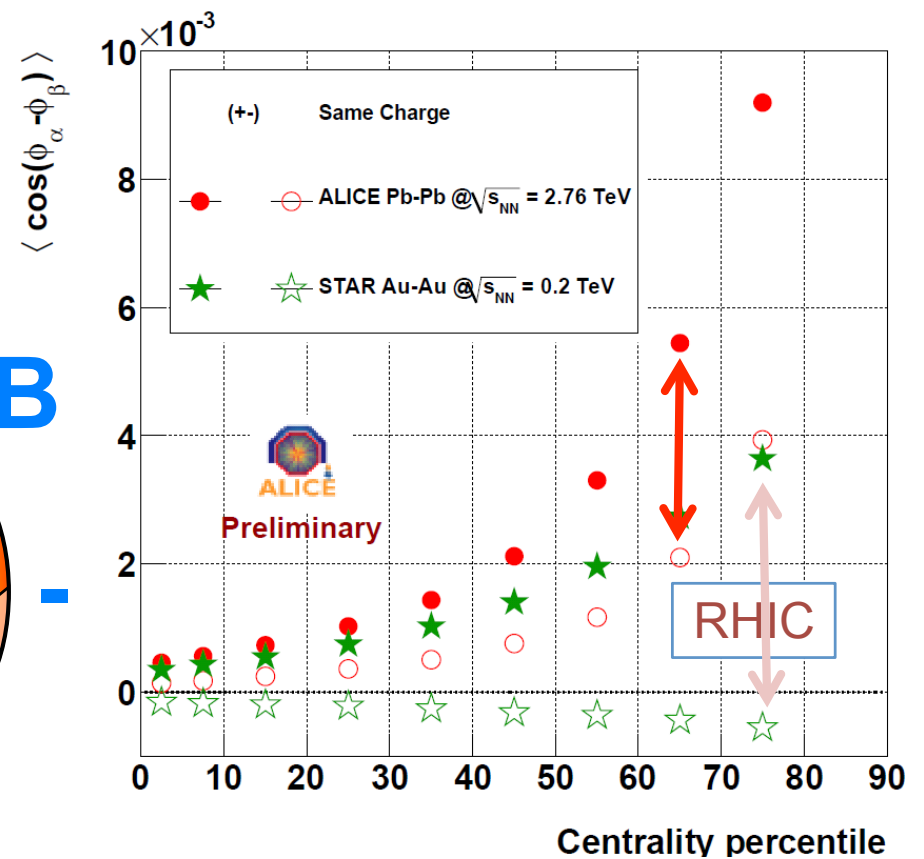
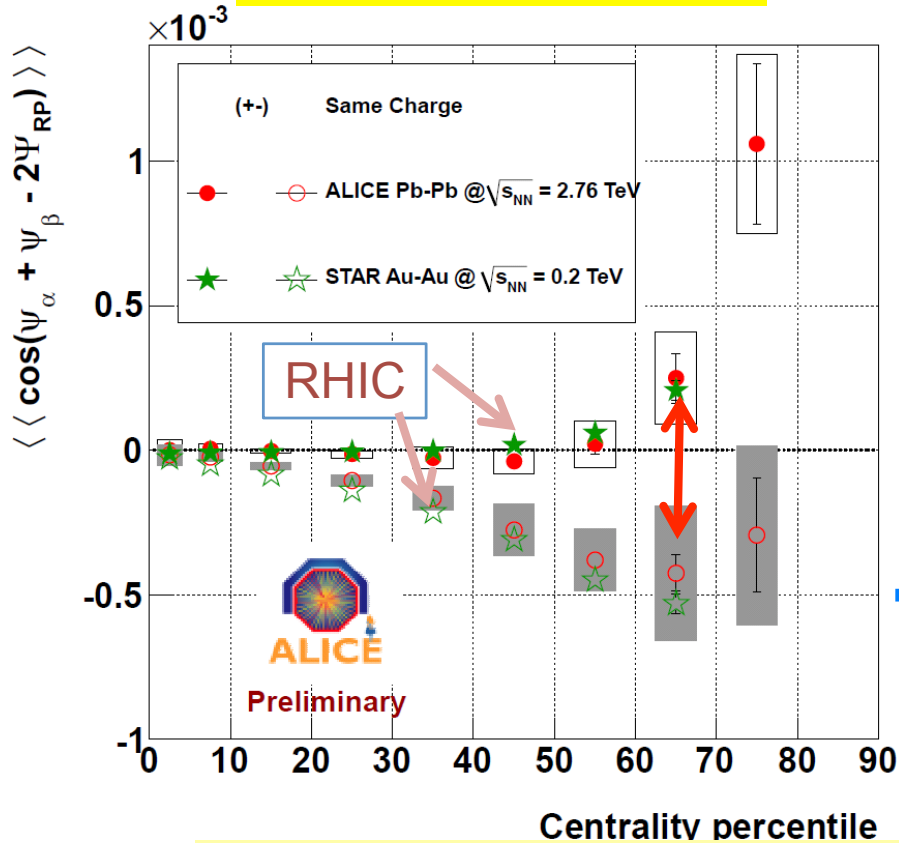
Lattice QCD based predictions of 'melting' temperature T_d (a bit dated..)

- **suppression** only: suppression for $Y'(2S) \approx \psi'$, $Y''(3S) \approx J/\psi$
- **suppression + recombination:** $Y', Y'' \sim$ unaffected, J/ψ less suppression than @ RHIC

Chiral Magnetic Effect ('strong parity violation')

$$\langle \cos(\varphi_\alpha + \varphi_\beta - 2\Psi_{RP}) \rangle$$

$$\langle \cos(\varphi_\alpha - \varphi_\beta) \rangle$$



Same charge correlations **positive**

Opposite charge correlations **negative** RHIC : (++) , (+-) different sign and magnitude

RHIC \approx LHC

LHC : (++) , (+-) same sign, similar magnitude

Local Parity Violation
in strong magnetic Field ?
may decrease with \sqrt{s}

