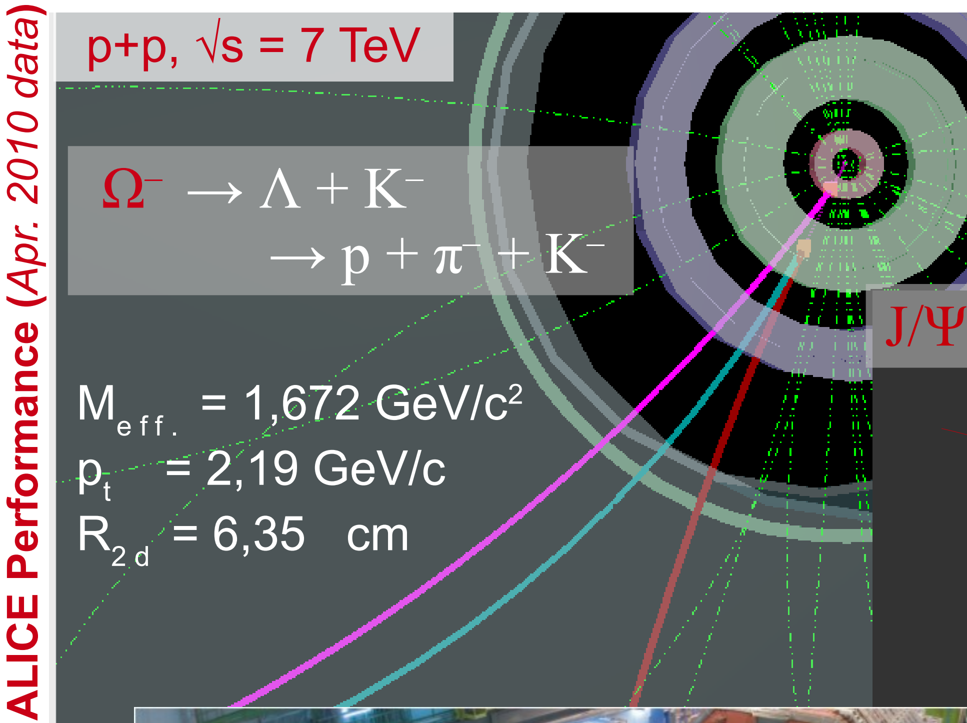
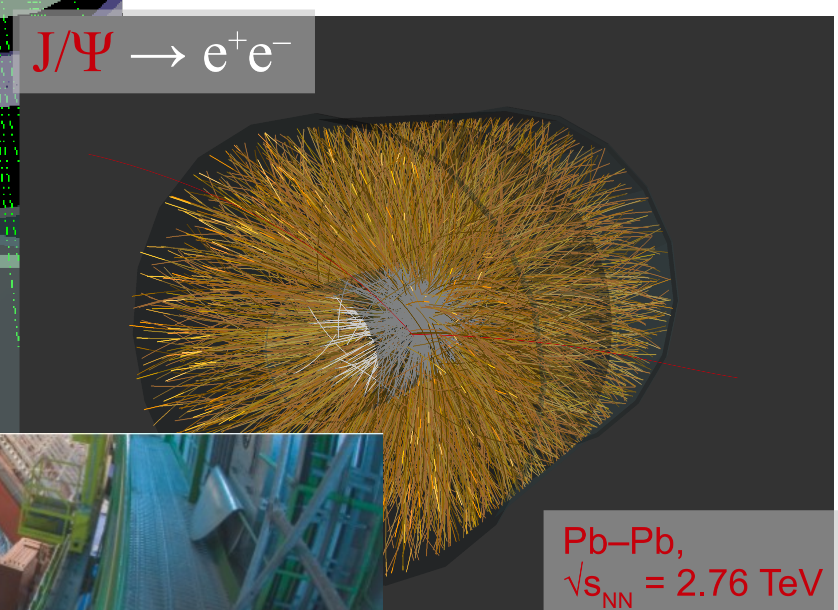
Antonin MAIRE – P.I. Heidelberg, ALICE group

Strangeness and charm in pp and Pb–Pb collisions at the LHC

studies through
multi-strange baryons ($\Xi^{\pm}$, $\Omega^{\pm}$)
and J/Ψ mesons





Outline

I. Introduction : QGP, QCD, pp and A–A

Part A - Strangeness : Ξ^-, $\overline{\Xi}^+$, Ω^-, $\overline{\Omega}^+$

II. Context : *strangeness, ALICE, cascade reco.*

III. (Ξ^- + $\overline{\Xi}^+$) spectrum in pp at $\sqrt{s}$ = 0.9 TeV

IV. Ξ^-, $\overline{\Xi}^+$, Ω^-, $\overline{\Omega}^+$ spectra in pp at $\sqrt{s}$ = 7 TeV

V. Azimuthal correlations ($\Xi^\pm$ - $h^\pm$) and ($h^\pm$ - $\Xi^\pm$)

VI. Ξ^-, $\overline{\Xi}^+$, Ω^-, $\overline{\Omega}^+$ in Pb–Pb at $\sqrt{s_{NN}}$ = 2.76 TeV

Part B - Charmonium : J/Ψ

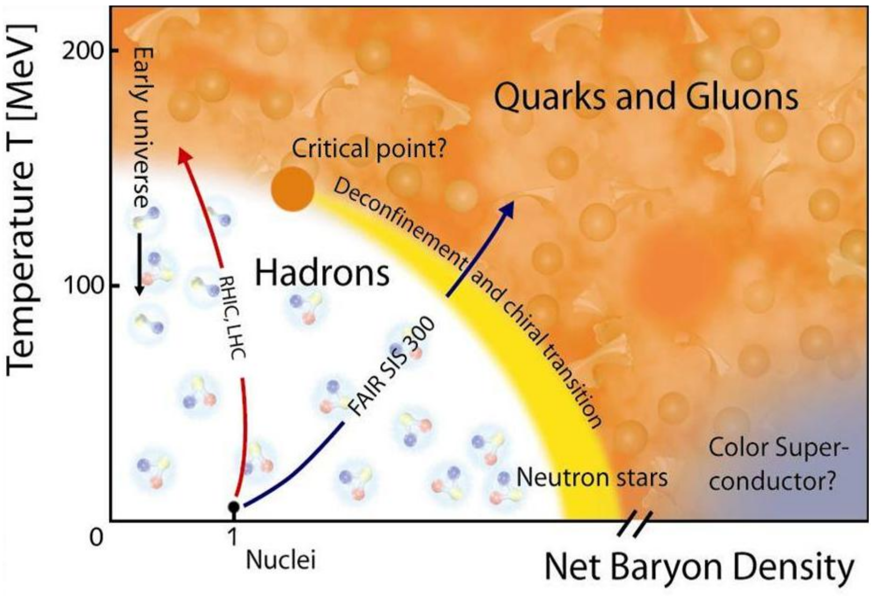
VII. Context : charmonium stakes

VIII. Measurement status of J/Ψ

IX. Conclusion (*3 points towards the exit*)

(Introduction)

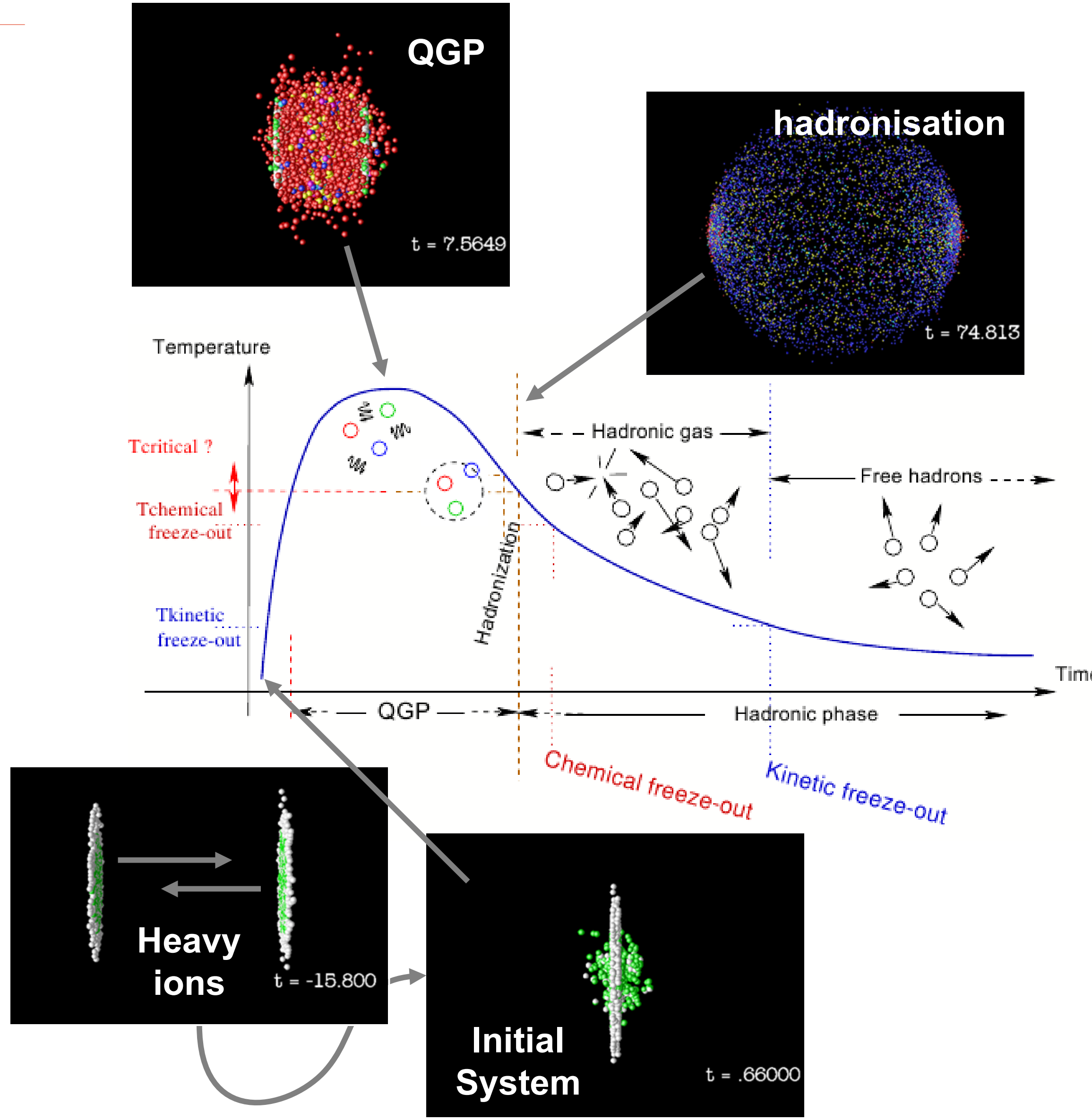
I.1 - Intro. : QGP and AA



Hadrons (confined)

↓

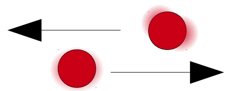
New phase of partons
deconfined and *thermalised*
(internal thermodynamical eq.)

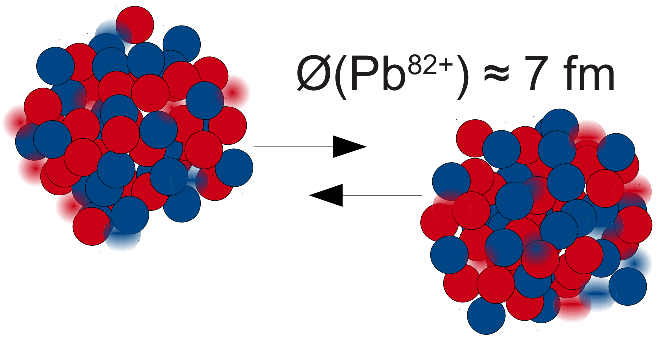


I.2 – Intro. : pp vs. AA, different physics ?

$p+p\left({}^{1}_{1}H\right)$

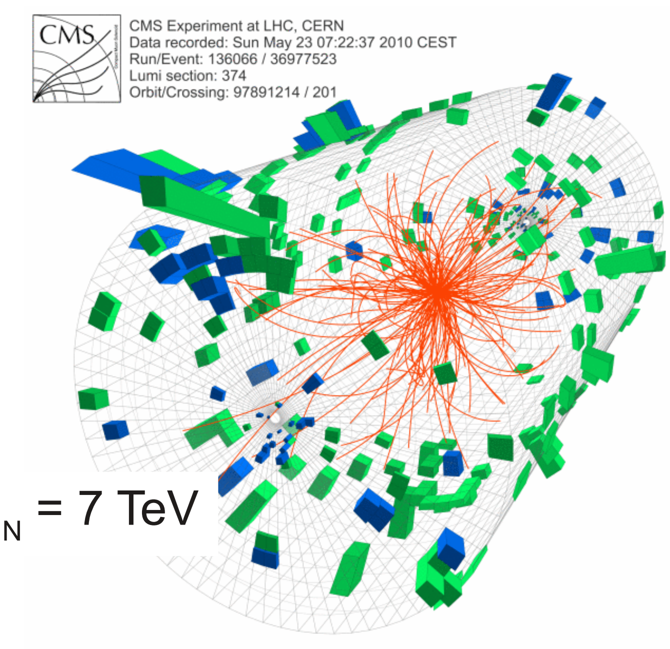
Ø(H⁺) ≈ 1 fm



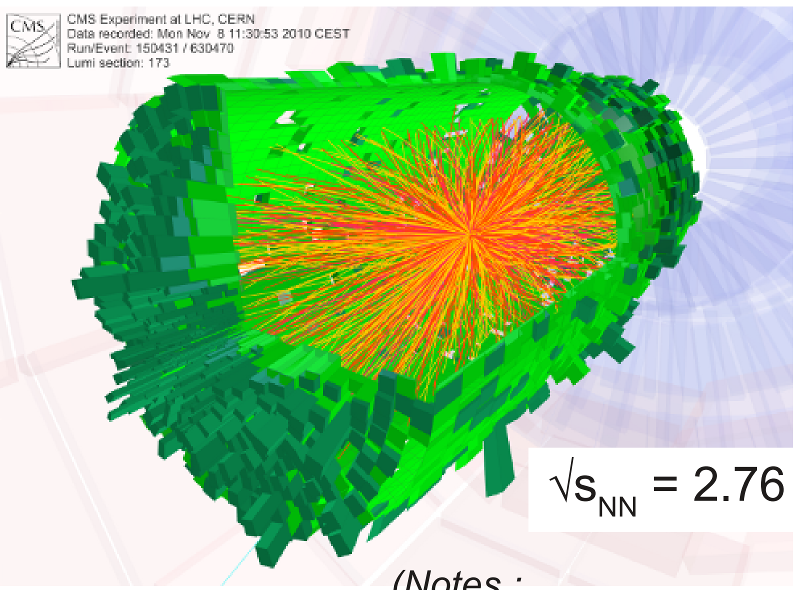


Ø(Pb^{82+}) ≈ 7 fm

$Pb+Pb\left({}^{208}_{82}Pb\right)$



$\sqrt{s_{NN}}$ = 7 TeV



$\sqrt{s_{NN}}$ = 2.76 TeV

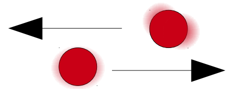
(Notes :
1. the "NN" → √s < 575 TeV
2. the achievable energy density)

At the same $\sqrt{s_{NN}}$, the question is :

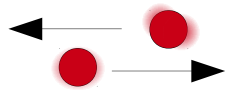
(pp) x 208 ≈ 1 x (Pb–Pb) ?

I.3 – Intro. : pp, AA, continuum of physics ?

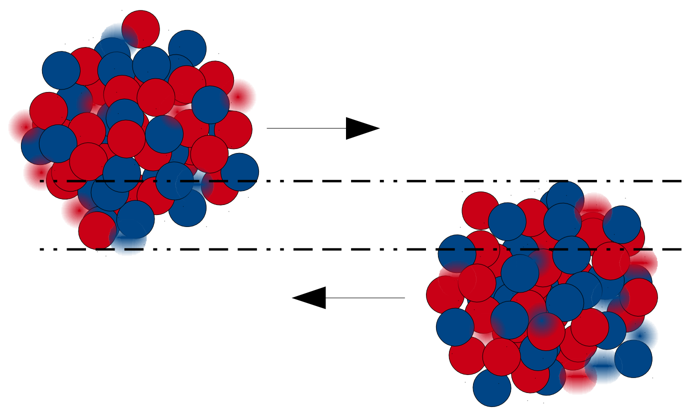
1. pp, Min. Bias



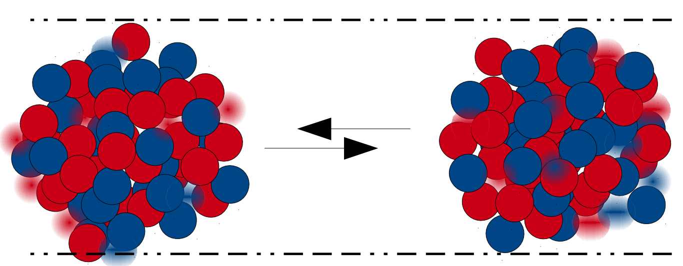
2. pp, High Multilplicity

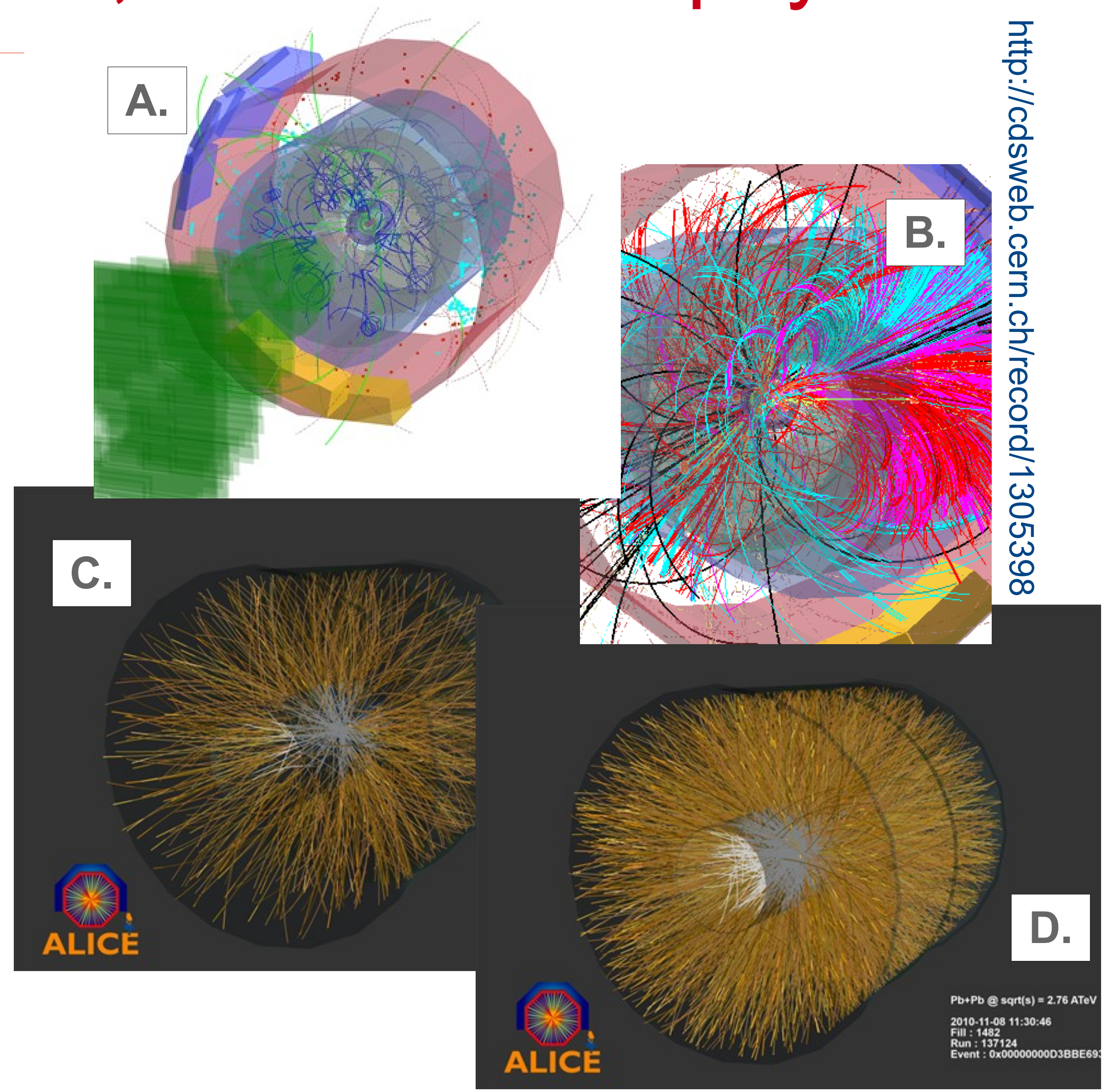


3. Pb–Pb, low centrality



4. Pb–Pb, most central events





http://cdsweb.cern.ch/record/1305398

I.4 – Intro. : defining some notions...

1. - Spectra : $\frac{1}{N_{evt}} \frac{d^2N}{dp_T\,dy} = f(p_T)$

2. - Yields : $1/N_{evt} \quad dN/dy$

} To be considered in pp or A–A

3. $R_{AA}(p_T) = \frac{(1/N_{evt}^{AA}) \; d^2N^{AA}/dp_T\,dy}{\langle N_{part} \rangle \; (1/N_{evt}^{pp}) \; d^2N^{pp}/dp_T\,dy}$

} "(pp) x 208 ≠ 1 x (Pb–Pb) ?" ...

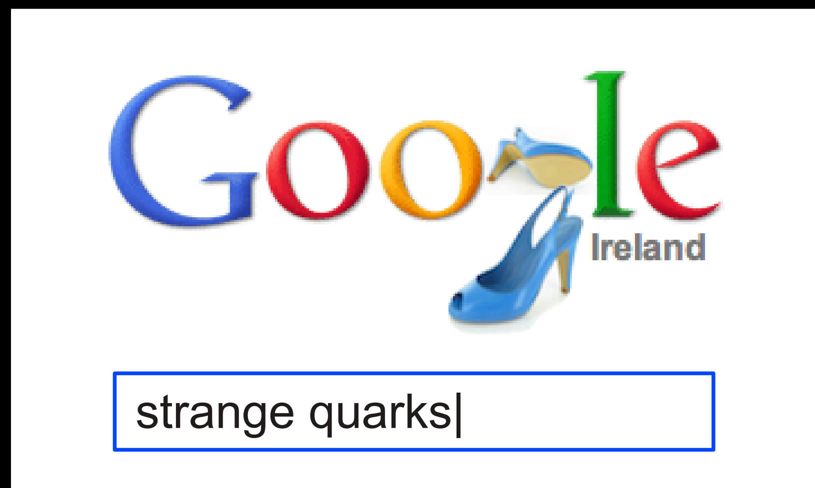
Notes :

→ $R_{AA} = 1$, nothing special in A–A ..
e.g. photons, $W^{\pm}$, Z^0.

→ $R_{AA} > 1$, enhancement in the A–A system
e.g. strange hadrons at low momenta (p_T < 3 GeV/*c*)

→ $R_{AA} < 1$, suppression in the A–A system
e.g. light flavour quarks at mid/high p_T (p_T > 3 GeV/*c*)

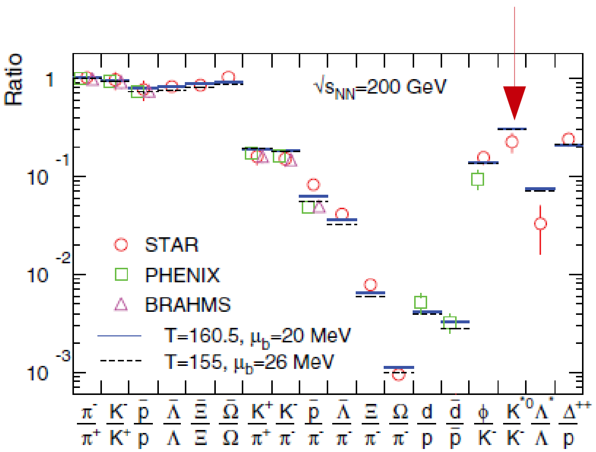
Part A – strangeness with ALICE



II.1 – Strange. : QGP, strangeness

1. *s* quarks seem thermalised as *u*,*d* quarks
→ *s* obey bulk physics ...

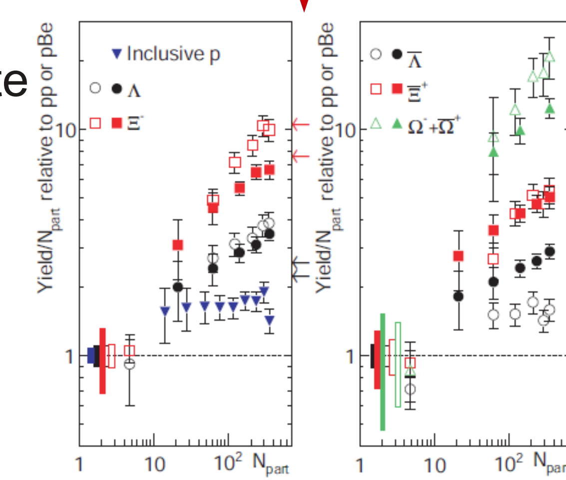
Nucl.Phys.A772:167(2006)



2. Historical signature : "*strangeness enhancement*"
= Gluon fusion : **gg** → **s$\bar{\text{s}}$**
from Rafelski & Müller, Phys.Rev.Lett 48 : 1066 (1982)…

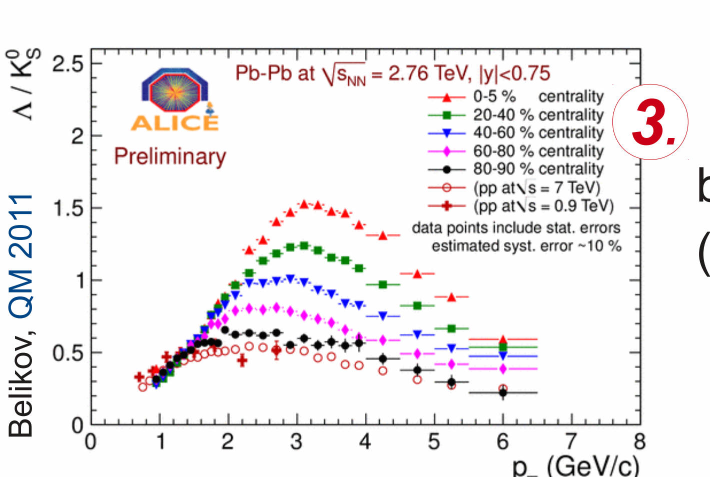
Experimental results : NA57, STAR

→ complex phenomenon,
leading to long-standing debate
(ex. : *a*. Normalisation to pp, pA
b. Canonical suppression,
c. Centrality dependence ...)



STAR, PhysRevC.77.044908

Belikov, QM 2011



3. Other aspect :
baryon/meson at intermediate p_T,
(like p/π)

→ Coalescence picture ?

All need proper study of the benchmark system : **pp** ...

II.2 – **Strange.** : p+p, strangeness

- Physical incentives :

Strangeness in p+p = benchmark for heavy-ion physics …
+ interest in itself = strangeness production mechanisms :

pQCD (*high* p_T)

vs.

soft interaction (*low* p_T)

→ understand the *soft part* of the event + its interplay with the *hard part*,
→ constrain the phenomenology (*Multi-Parton Interaction ? … ?*) of QCD-inspired models (*PYTHIA, EPOS, Sherpa …*)

- Measurement status : (p+p) or (p+$\bar{p}$) measurements at high energies :

√s	Experiment(s)	Collisions	Particles	Ref./Link
0.2 TeV	(UA5) + STAR	(p+$\bar{p}$) + p+p	K^0s, Λ, $\Xi^{\pm}$, $\Omega^{\pm}$	STAR
0.9 TeV	UA5	p+$\bar{p}$	K^0s, Λ, Ξ^-	UA5
1,96 TeV	CDF Run II	p+$\bar{p}$	Λ, $\Xi^{\pm}$, $\Omega^{\pm}$	CDF

→ LHC : 0.9, 2.76, 7 TeV ?

(NB : *CMS paper (0.9 + 7 TeV)*, in preparation ATLAS, in PLHC 2010 ...)

II.3 – Strange. : strangeness, ALICE

- Experimental paths : **A.** Strangeness via *detector-PID* = $K^{\pm}$

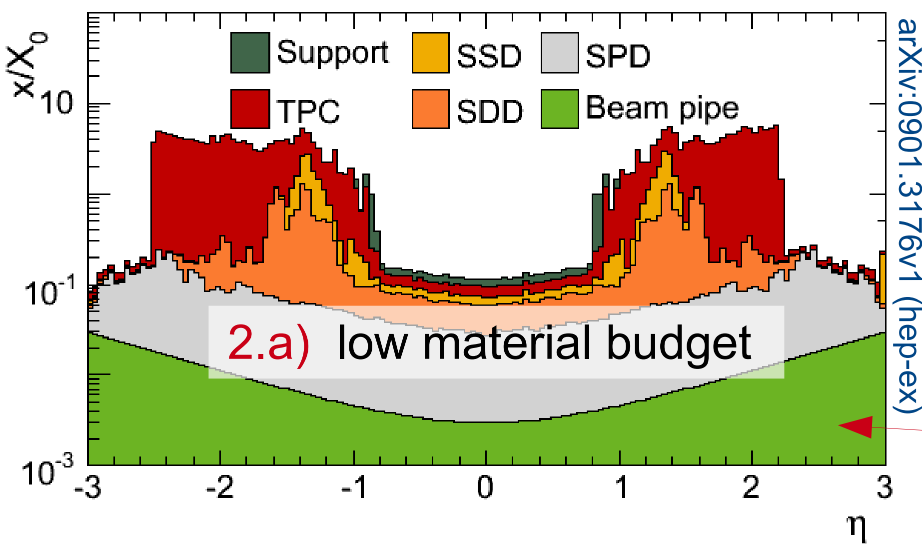
  B. Strangeness via *topology* =

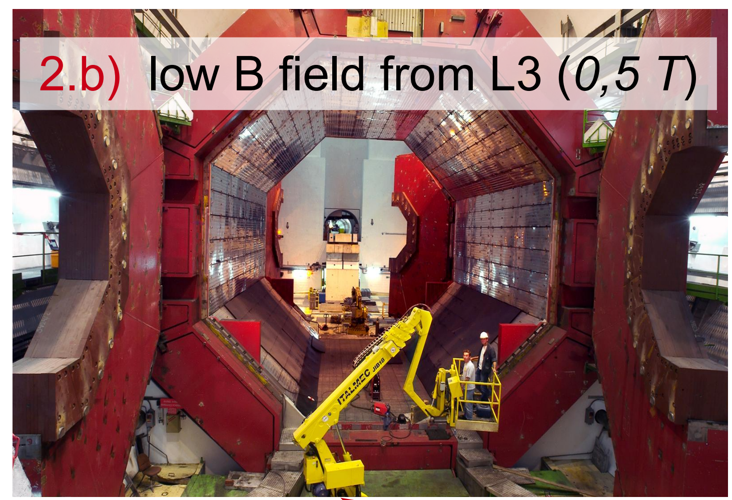
  $s = 0$ (*φ meson*)
  \+ $s = 1$ (*K^0s, Λ neutral hadrons*)
  \+ $s \geq 2$ (***multi-strange baryons***)

  NB : identification from low p_t (~*0.2 GeV/c*) to high p_t (~10 GeV/c)

- ALICE designed for it : good identification capabilities at mid-rapidity

  1. < very good detector-PID capabilities (ITS, TPC, TRD, TOF, HMPID)

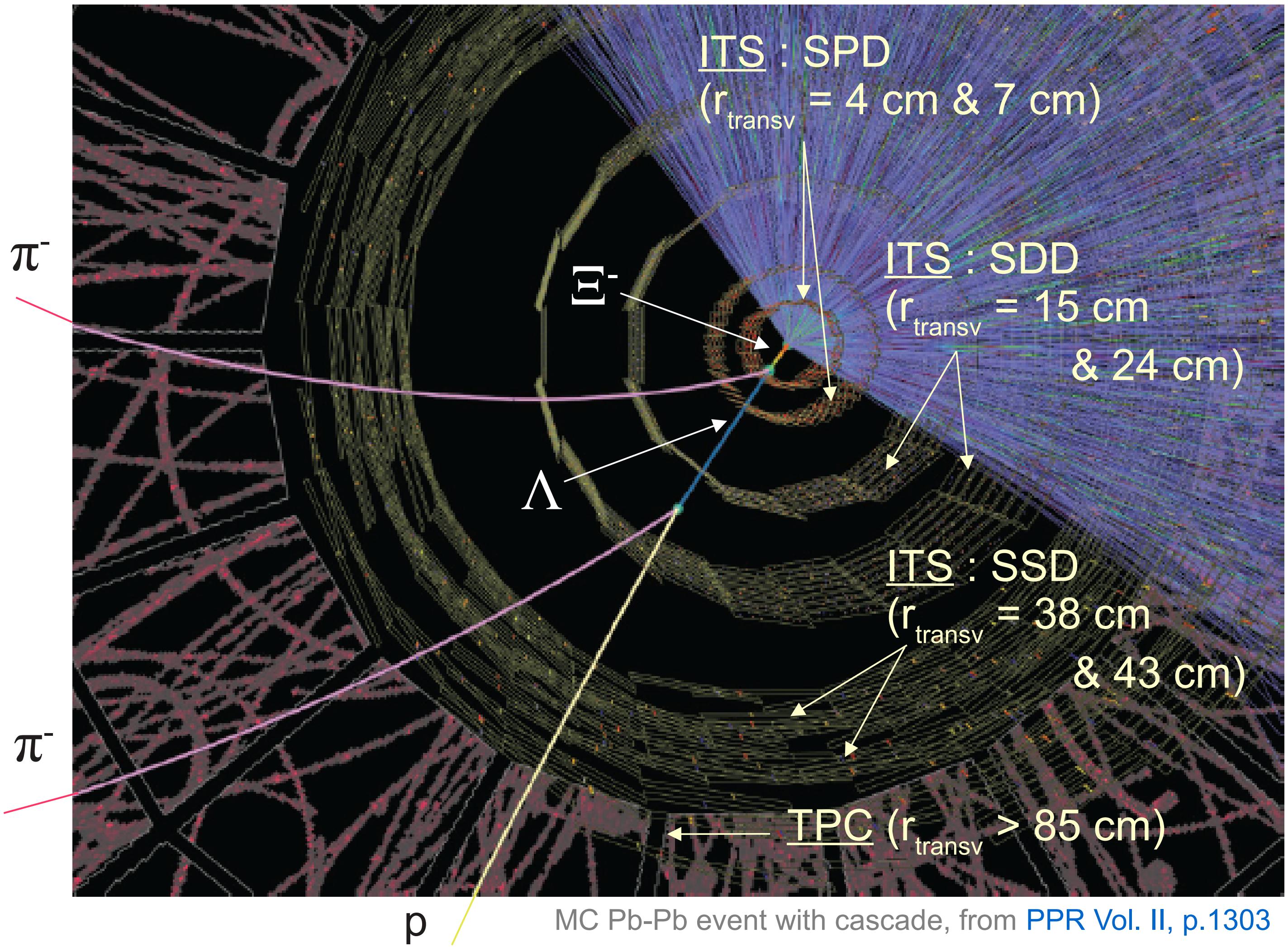




2. < low pt cut-off

II.4 – **Strange.** : ALICE, multi-strange baryons

ALICE (in 2009-11) : – pp collisions at 0.9 TeV,
(at 2.36 TeV), at 2.76 TeV,
at 7 TeV,
– Pb-Pb collisions at 2.76 TeV



MC Pb-Pb event with cascade, from PPR Vol. II, p.1303

Charged multi-strange baryons :

$\Xi^-(dss)$ $\overline{\Xi}^+(\overline{d}\overline{s}\overline{s})$
$\Omega^-(sss)$ $\overline{\Omega}^+(\overline{s}\overline{s}\overline{s})$

Sub-detectors needed :

1. Inner Tracking System
2. Time Projection Chamber

What we detect from $\Xi^-, \overline{\Xi}^+, \Omega^-, \overline{\Omega}^+$:

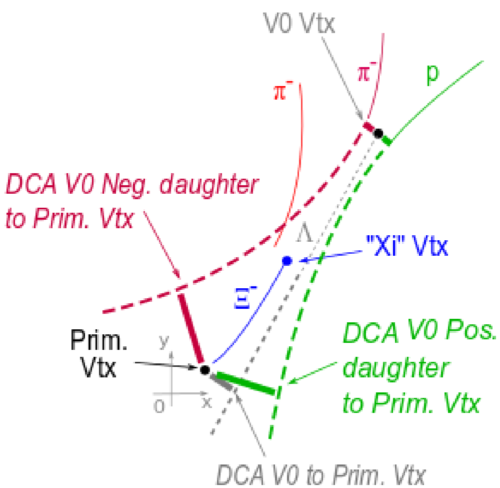
- bachelor,
- V0 daughters.

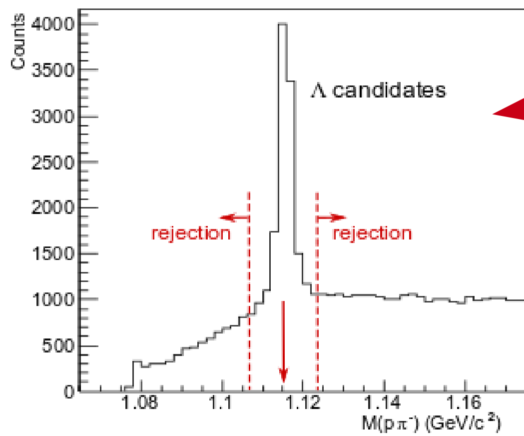
II.5 – **Strange.** : cascade reconstruction

- Decay channel :

Ξ^- (dss) (m_{PDG} = **1.322** GeV/c^2 ; $c\tau$ = 4.91 cm) → Λ(uds) + π^- → p + π^- + π^- (B.R. = 63.6 %)

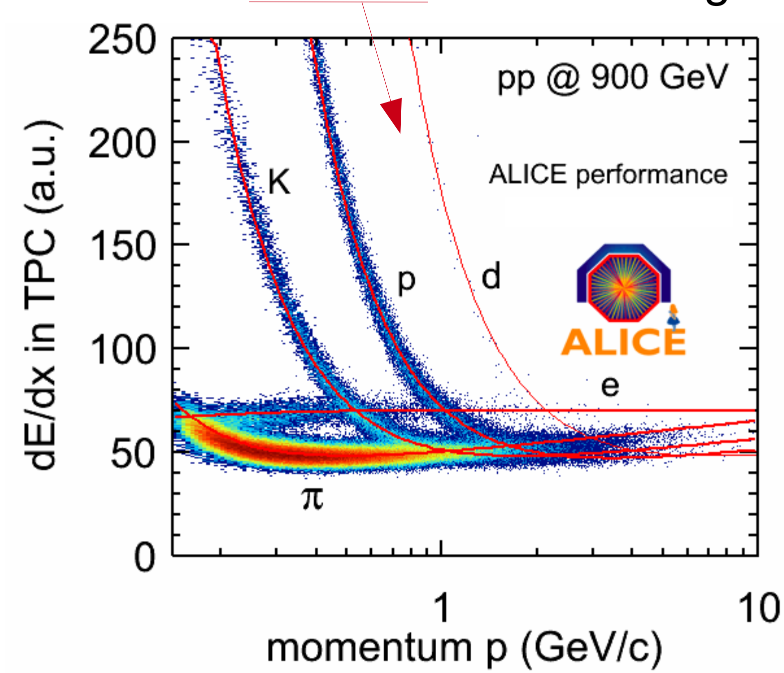
$\overline{\Omega}^+$ ($\bar{s}\bar{s}\bar{s}$) (m_{PDG} = **1.672** GeV/c^2 ; $c\tau$ = 2.46 cm) → $\overline{\Lambda}(\bar{u}\bar{d}\bar{s})$ + K^+ → $\bar{p}$ + π^+ + K^+ (B.R. = 43.3 %)

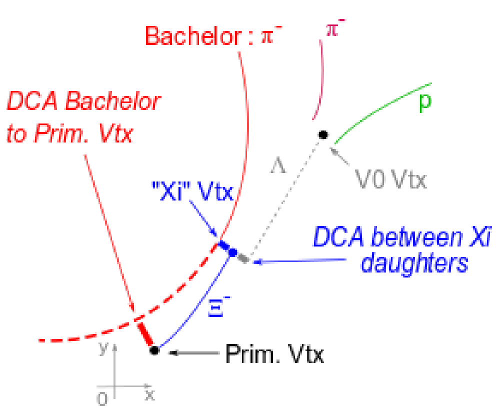


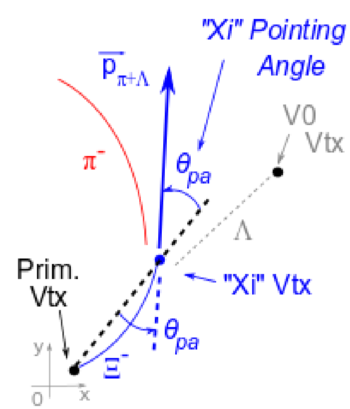


- Identification based on three 2dary tracks, within a fiducial volume, + "Cascade *topology*"

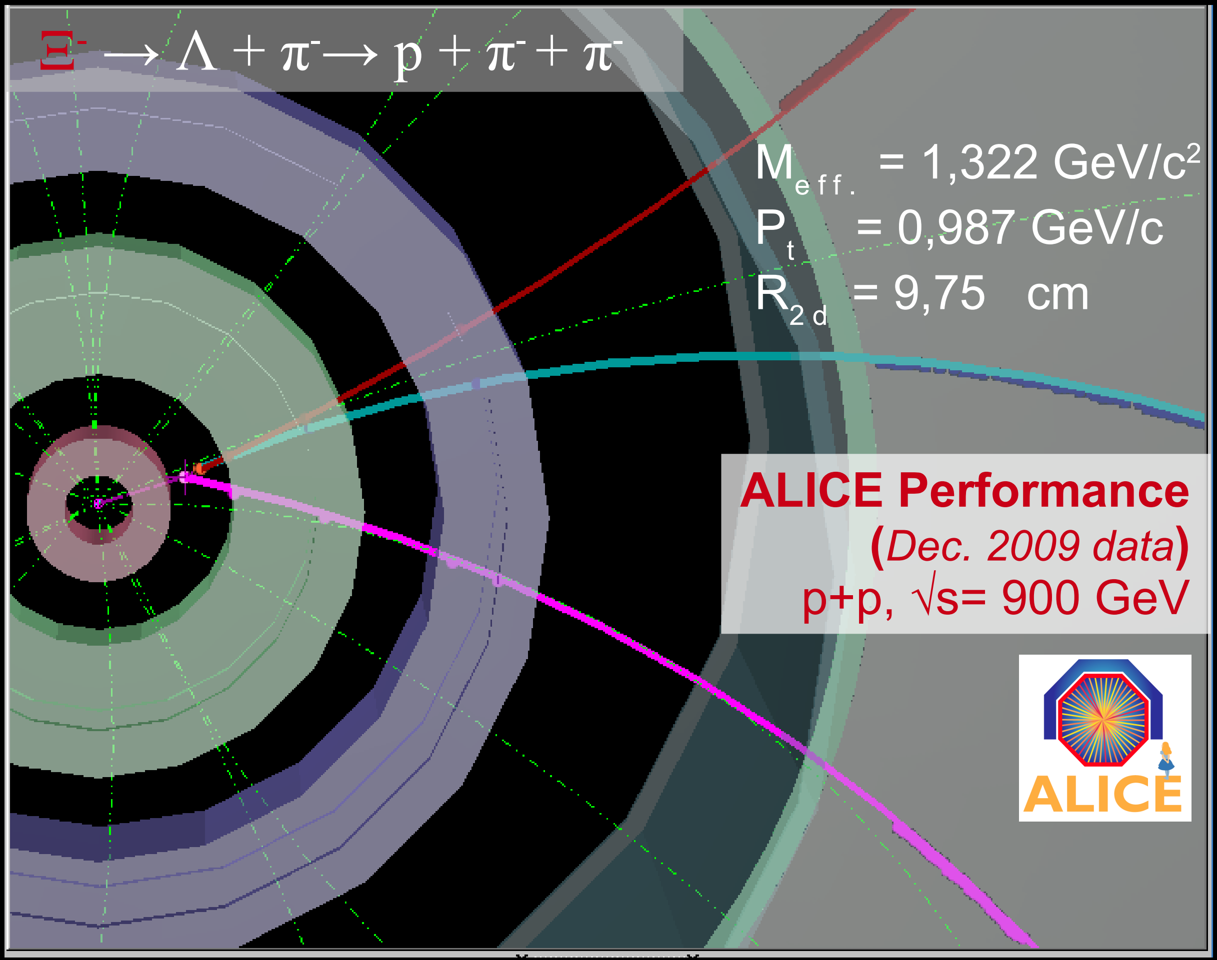
+ *TPC PID* on each daughter







Part A.a – 900 GeV : Cascades, $\Xi^{\pm}$



Pass4 - Run 09000104892 / Chunk 020.30 / Event 108

- Data :

December 2009
p+p, 900 GeV

~ 250 x 10^3 evts

III.1 – 900 GeV : signal extraction principle

Talk A.Maire, Physics@LHC 2010

1. Definition of the S and B areas :

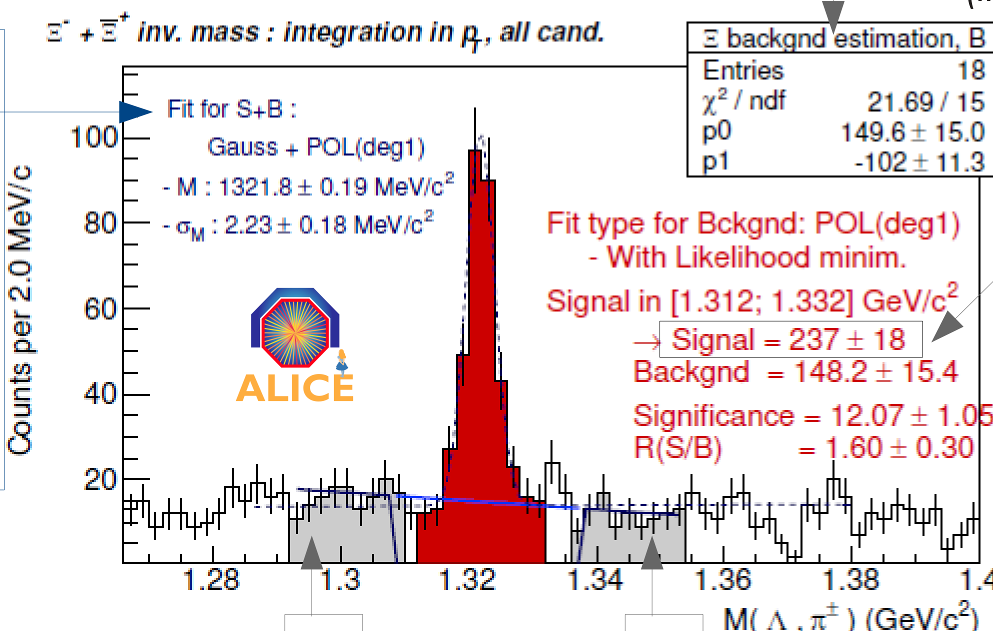
S = $\mu_m \pm 4\sigma$
ΔB = 7σ
B, 6σ away

2.

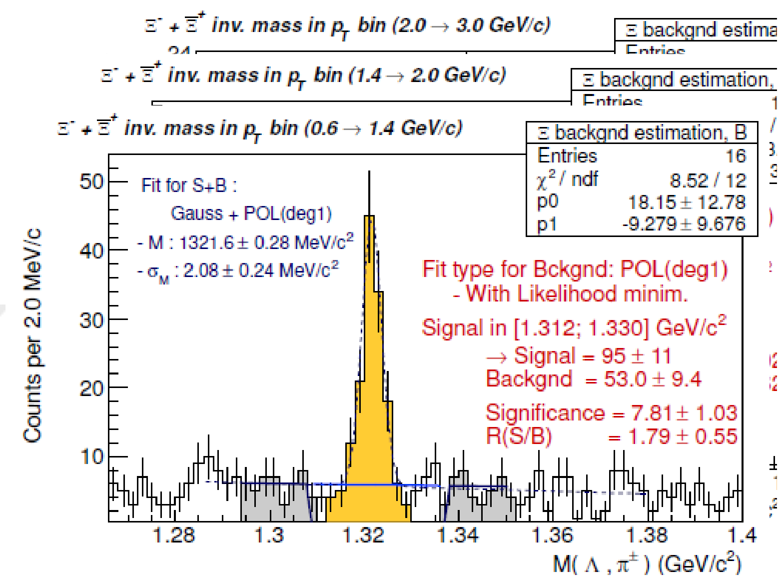
Overall signal (integrated in p_T)

$S_{casc,raw}$ = $(S+B)_{counted}$ - $B_{interpolated}$

3.



Signal in p_T bin



Building a corrected spectrum :

$$\frac{1}{N_{\mathrm{evt}}(\mathrm{INEL})}\frac{\mathrm{d}^2 N_{casc}}{\mathrm{d}p_{\mathrm{T}}\,\mathrm{d}y}(p_{\mathrm{T}})=\frac{\varepsilon_{PhySel}}{N_{\mathrm{evt,PhySel}}}\frac{1}{\Delta y}\left(\frac{S_{casc,raw}}{\varepsilon_{reco}}\frac{1}{\Delta p_{\mathrm{T}}}\right)_{p_{\mathrm{T}}\ bin\ i}$$

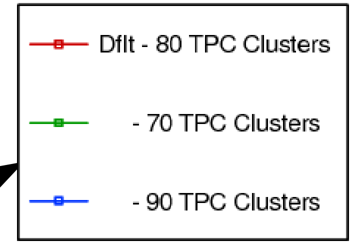
3 points, up to 3,0 *GeV/c*

III.2 – 900 GeV : systematics, summary

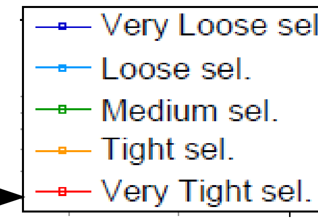
Eur.Phys.J.C71:1594,2011

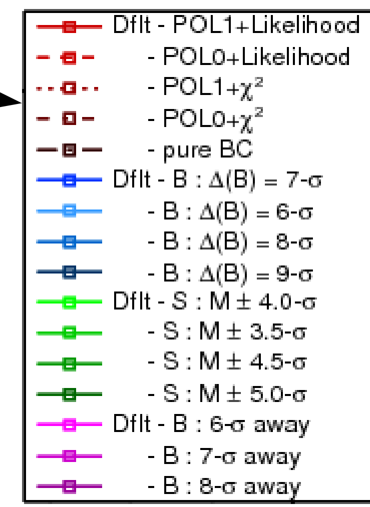
$\Xi^-+\bar{\Xi}^+$ – Syst. uncertainties (%)

p_T bin (GeV/c)	0.6 – 1.4	1.4 – 2.0	2.0 – 3.0
Selections			
tracks	*negl.*	5.4	*negl.*
topological	6.8	11.6	13.9
Signal extraction	5.6	*negl.*	2.5
TPC dE/dx		– *negl.* –	
Efficiency			
material budget	2.7	1.5	3.6
$\bar{p}$ cross-section		– 2 –	
Normalisation		– 2 –	



x11 selections





Signal loss
due to TPC PID

Over-estimation of
$\bar{p}$ cross-section
in Geant3/4
→ syst. correction

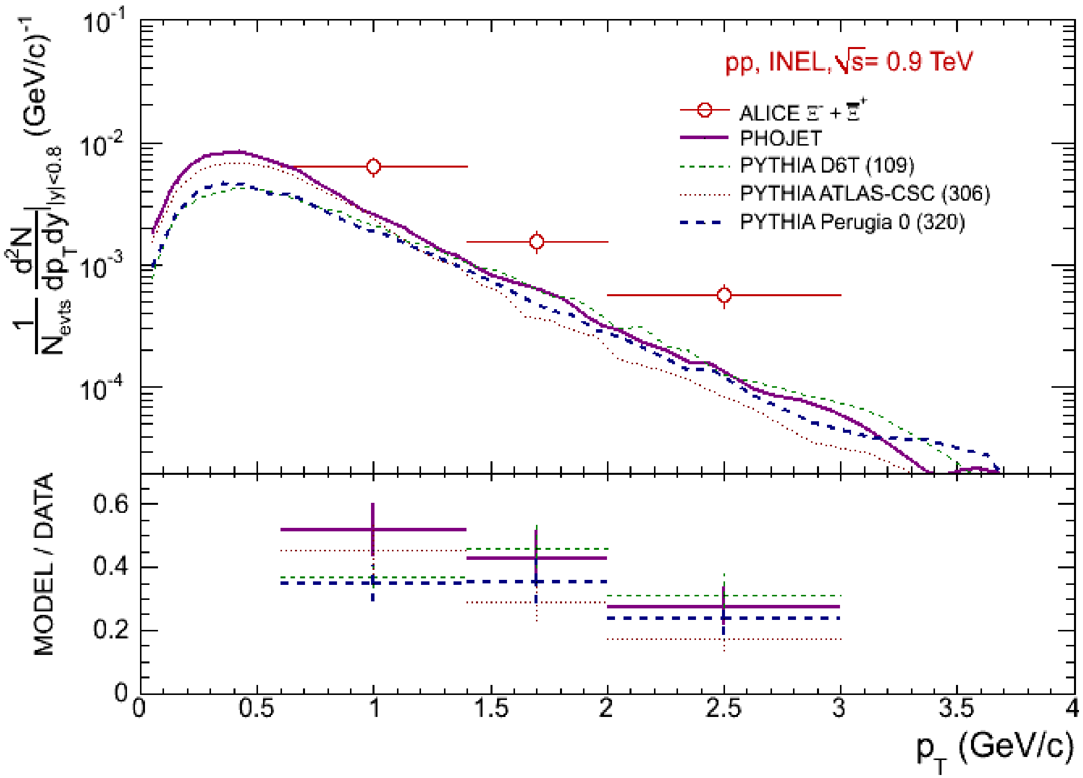
– PYTHIA D6T
(– Phojet)
– PYTHIA D6T
+ 20 % mat. budget

All these syst. studies
= significant part
of the PhD work...

III.3 – 900 GeV : corrected spectra

1. All MC models tested = under data ~ factor 3-5

2. In terms of data :
- d*N*/d*y* compatible with the ones from UA5 and CMS
- CMS spectrum in accordance with ALICE one
- Spectrum in accordance with ALICE 2010 data ...

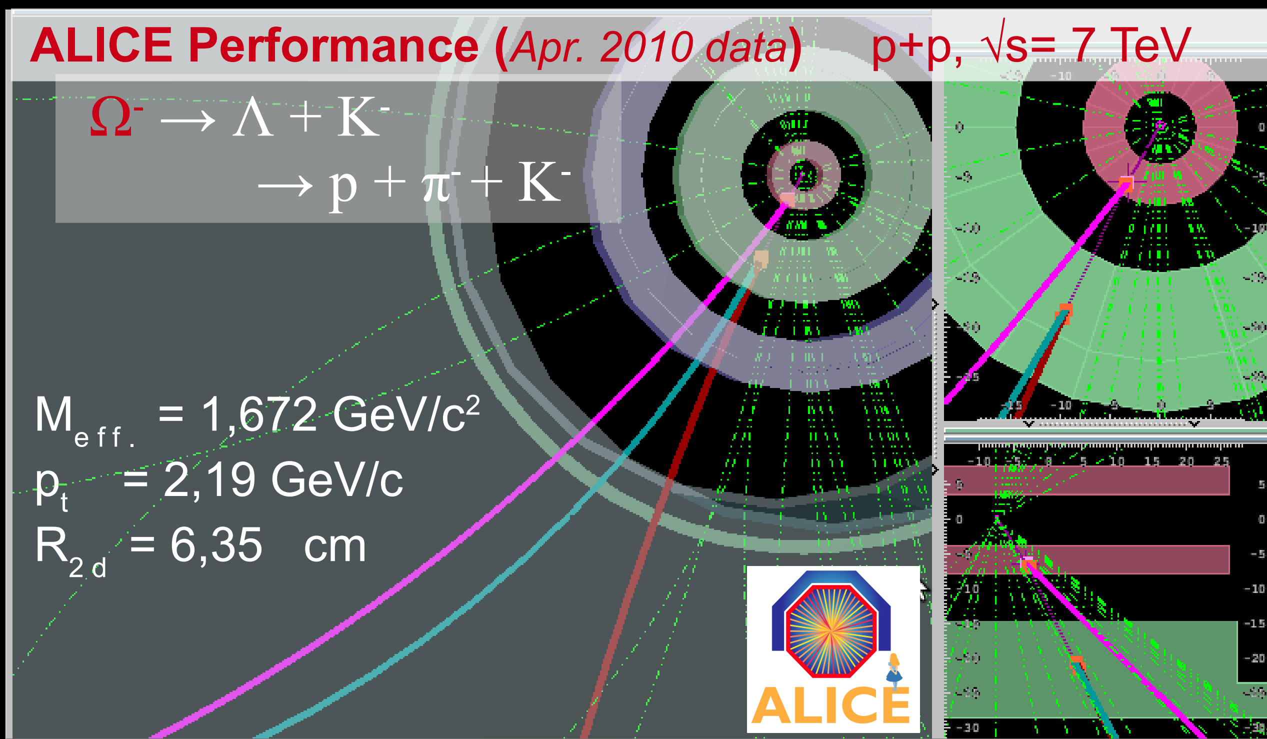


Eur.Phys.J.C71:1594,2011

Table 6. Rapidity and p_T ranges, $\langle p_T \rangle$, corrected yields and extrapolated fraction at low p_T using the Lévy function (2).

Particles		$\|y\|$	p_T range (GeV/c)	$\langle p_T \rangle$ (GeV/c)	dN/dy	Extrapolation (%)
Mesons	K^0_S	< 0.75	[0.2 – 3.0]	$0.65 \pm 0.01 \pm 0.01$	$0.184 \pm 0.002 \pm 0.006$	$12 \pm 0.4 \pm 0.5$
	ϕ	< 0.60	[0.7 – 3.0]	$1.00 \pm 0.14 \pm 0.20$	$0.021 \pm 0.004 \pm 0.003$	$48 \pm 18 \pm 7$
Baryons	Λ	< 0.75	[0.6 – 3.5]	$0.86 \pm 0.01 \pm 0.01$	$0.048 \pm 0.001 \pm 0.004$	$36 \pm 2 \pm 4$
	$\overline{\Lambda}$	< 0.75	[0.6 – 3.5]	$0.84 \pm 0.02 \pm 0.02$	$0.047 \pm 0.002 \pm 0.005$	$39 \pm 3 \pm 4$
	$\Xi^- + \overline{\Xi}^+$	< 0.8	[0.6 – 3.0]	$0.95 \pm 0.14 \pm 0.03$	$0.0101 \pm 0.0020 \pm 0.0009$	$35 \pm 8 \pm 4$

Part A.b – 7 TeV : Ξ^-, $\overline{\Xi}^+$, Ω^-, $\overline{\Omega}^+$



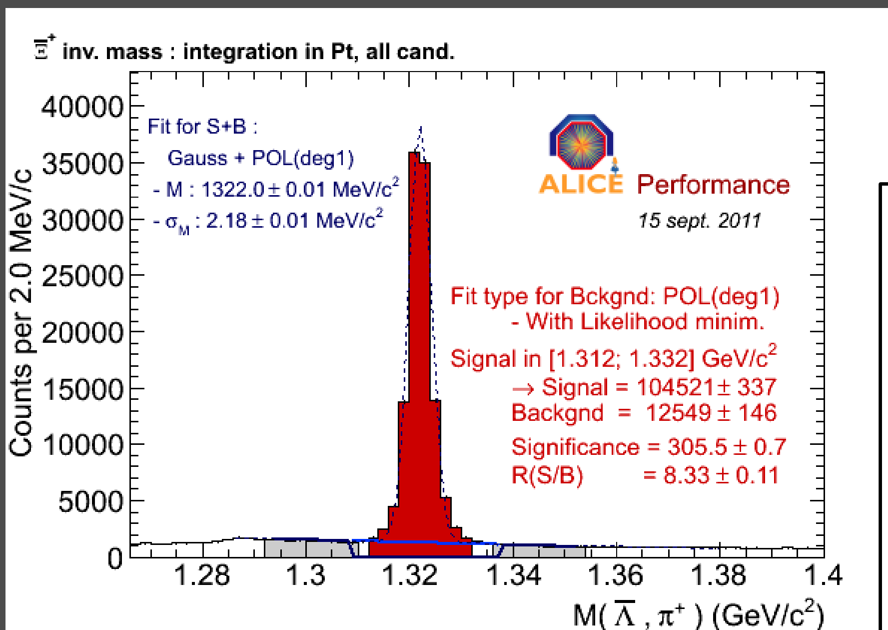
Pass1 - Run 10000115322 / Chunk 029.150 / Event 2428

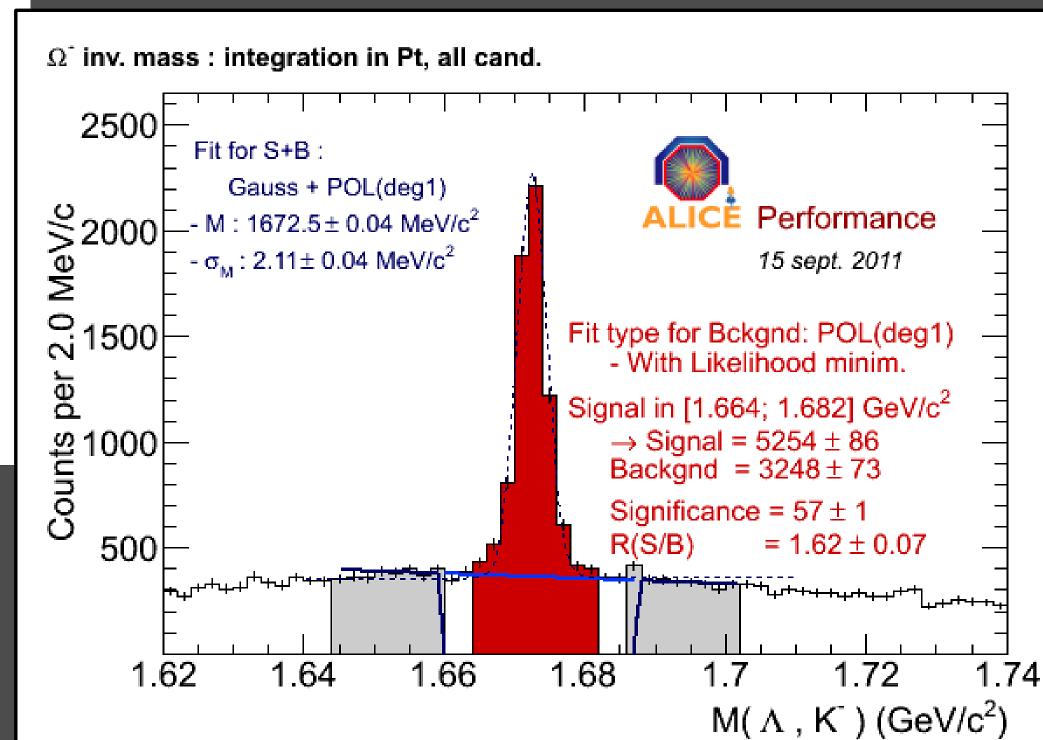
- Data :

Summer 2010
(LHC10d)
p+p, 7 TeV

≈ 165 x 10^6 evts

IV – Min. Bias p_t spectra at $\sqrt{s}$ = 7 TeV





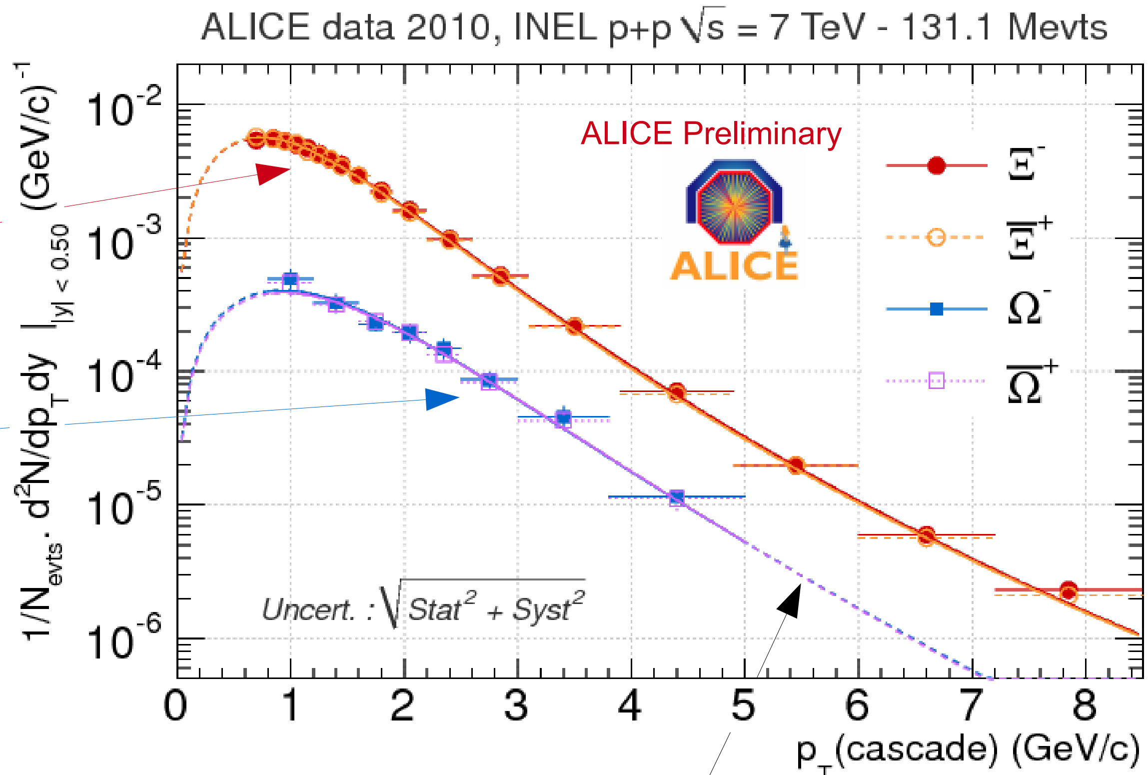
IV.1 – MinB spectra : Ξ^-, $\overline{\Xi}^+$, Ω^-, $\overline{\Omega}^+$

$S_{TOT}(\Xi^-) \sim S_{TOT}(\overline{\Xi}^+) \sim 105$ k

1st pt bin : **0.6** - 0.8 GeV/c
Last pt bin : 7.2 - **8.5** GeV/c

$S_{TOT}(\Omega^-) \sim S_{TOT}(\overline{\Omega}^+) \sim 5$ k

1st pt bin : **0.8** - 1.2 GeV/c
Last pt bin : 3.8 - **5.0** GeV/c



Extrapolation (low p_T) :

- ~ 22 % for Ξ,
- ~ 26 % for Ω.

Lévy-Tsallis fit function

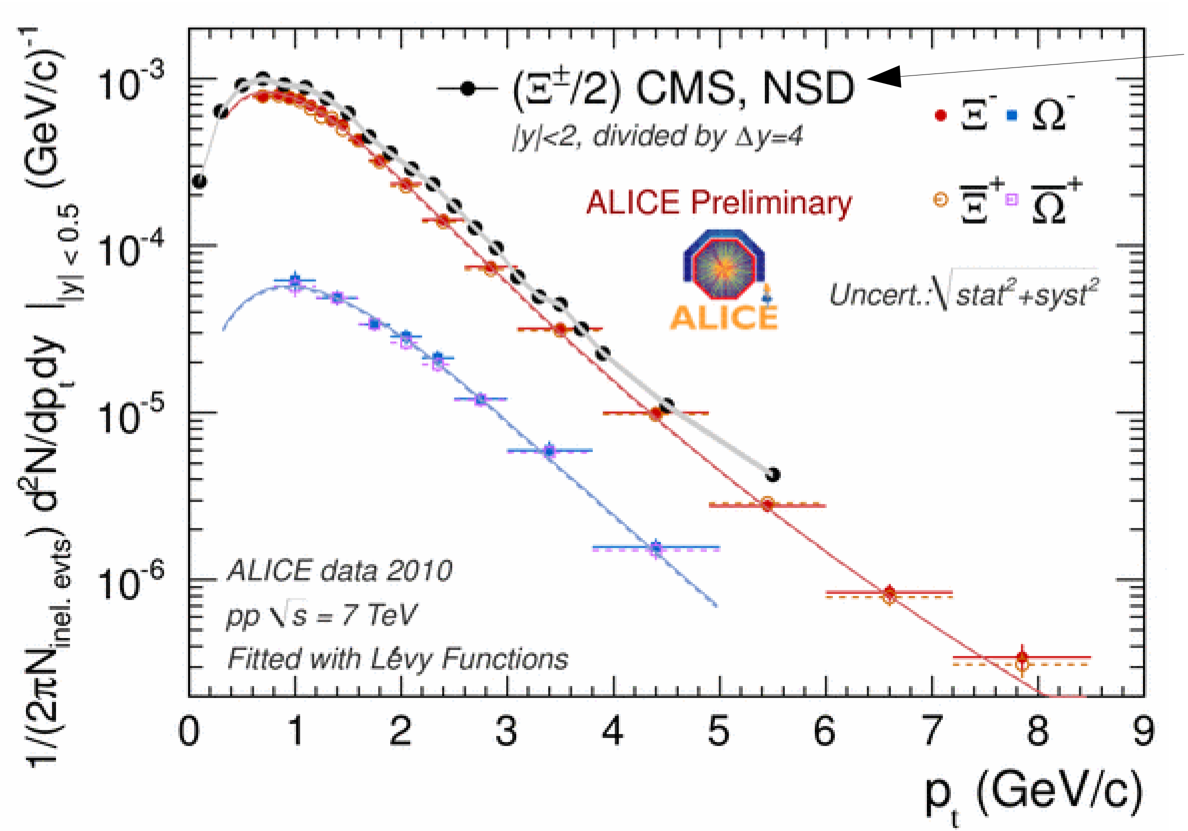
$$\frac{d^2N}{dp_T dy} = \frac{dN}{dy}\, p_T\, \frac{(n-1)(n-2)}{nT_t[\,nT_t + m(n-2)\,]} \left(1 + \frac{m_T - m}{nT_t}\right)^{-n}$$

$1/N_{INEL}$ dN/dy :

– 1 Ξ^- ($\overline{\Xi}^+$) every **130** evts
– 1 Ω^- ($\overline{\Omega}^+$) every **1500** evts

Talk A.Maire, SQM 2011

IV.2 – Comparison : ALICE and CMS



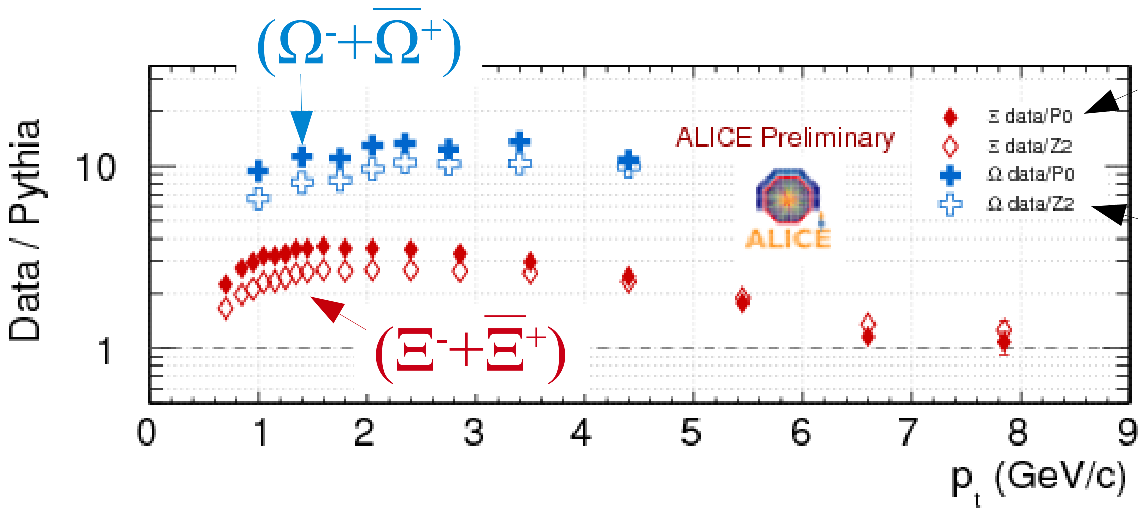
CMS : Strangeness in pp 0.9 and 7 TeV
→ 10.1007/JHEP05(2011)064

CMS data :

1. $(\Xi^- + \overline{\Xi}^+)$ spectrum
2. from p_t = 0 to 6 GeV/c
3. normalisation to NSD
   (ALICE, to INEL)
   → hence the difference
4. no Ω^-, $\overline{\Omega}^+$ or $(\Omega^- + \overline{\Omega}^+)$...

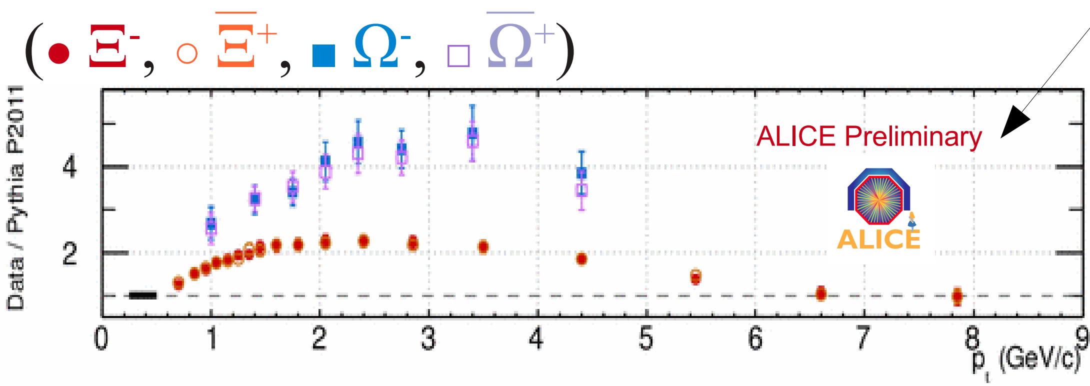
→ good agreement between the two experiments
(provided the INEL/NSD difference...)

IV.3 – Comparison : PYTHIA tunes



Different tunes :

- PYTHIA ***Perugia 0*** (♦ ✚) :
  focus on Multi-Parton Interaction
  for UE description,
- PYTHIA ***Z2*** (◊ ✚) :
  extension of reference tune D6T
- PYTHIA ***Perugia 2011*** (●○■□) :
  update of Perugia 0

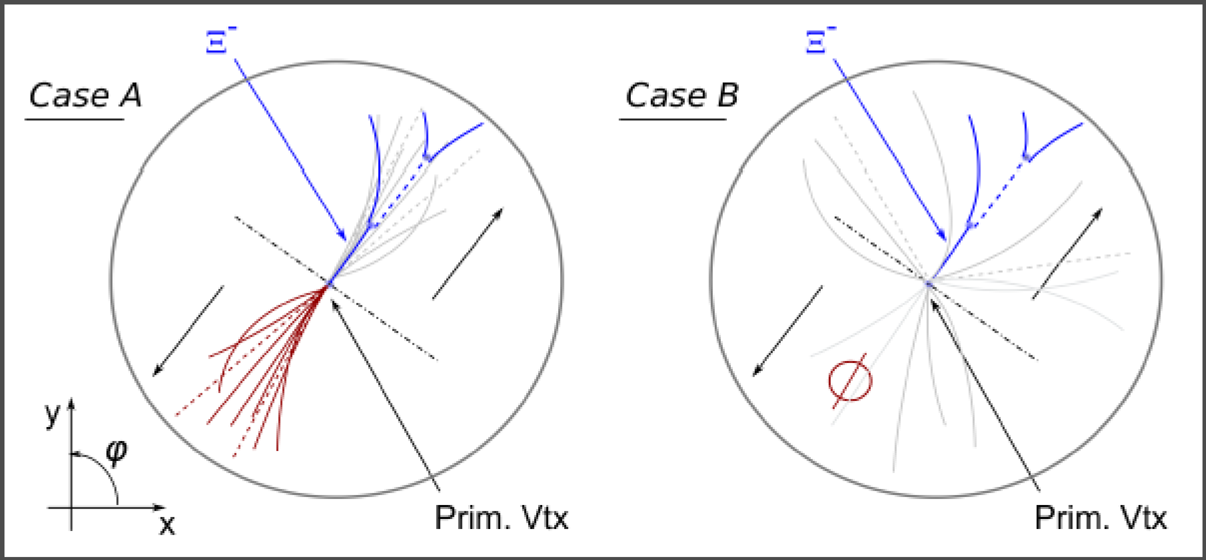


Z2 + *P2011* = adapted to recent LHC measurements,
i.e. multiplicity + unID. p_t spectra at $\sqrt{s}$ = 0.9 and 7 TeV

P2011 : + special care for strangeness...

→ PYTHIA tune with the highest yields = still well below the data, at intermediate p_t
(*NB* : Perugia 2011 looks ok for Ξ^- and $\overline{\Xi}^+$ at p_t > 6 GeV/c...)

V – Azimuthal Correlations

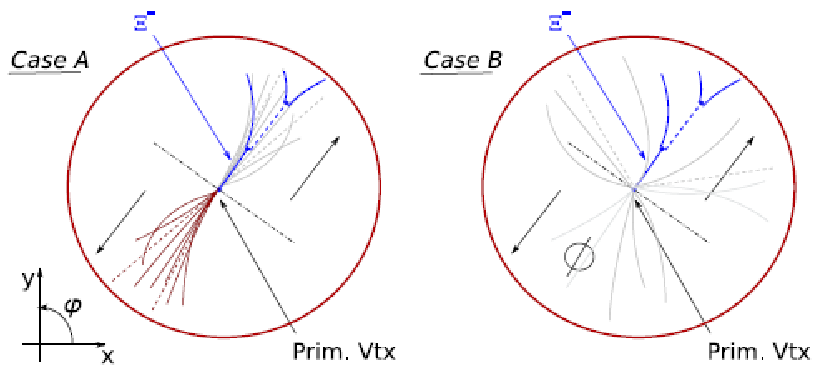


V.1 – Correlations : (Cascade – h±)

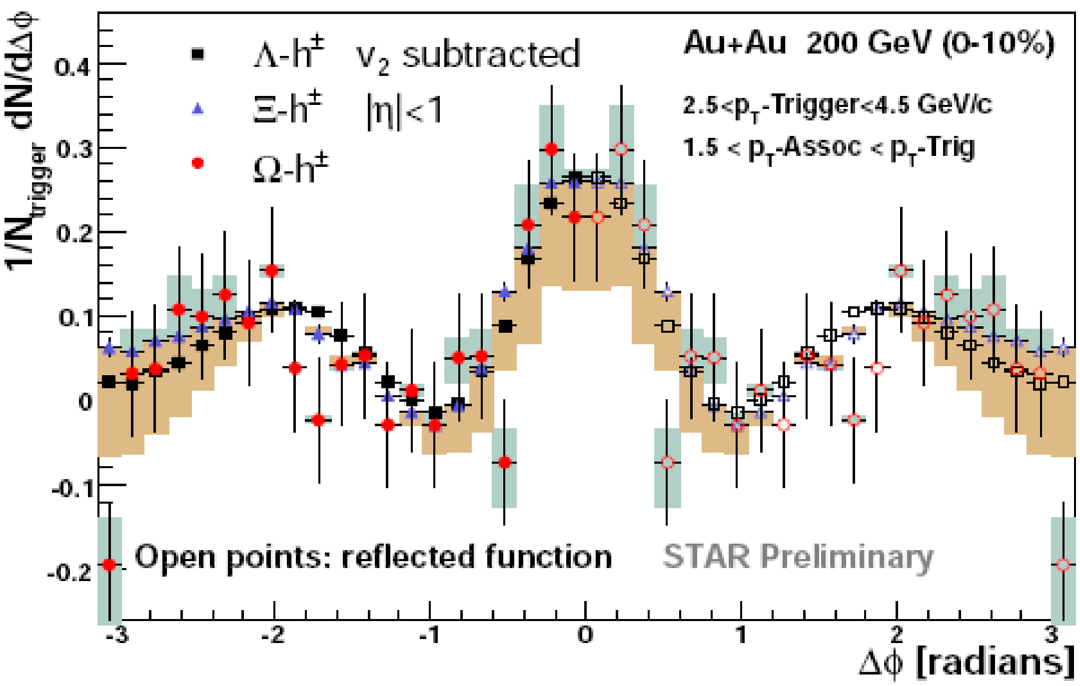
- *Soft* or *hard* hadronisation ?

(→ in Pb–Pb, coalescence vs fragmentation ?)

<u>Tool :</u> azimuthal correlations
with 2 particles, as a 1st step



B.Abelev (STAR) / arXiv:0705.3371

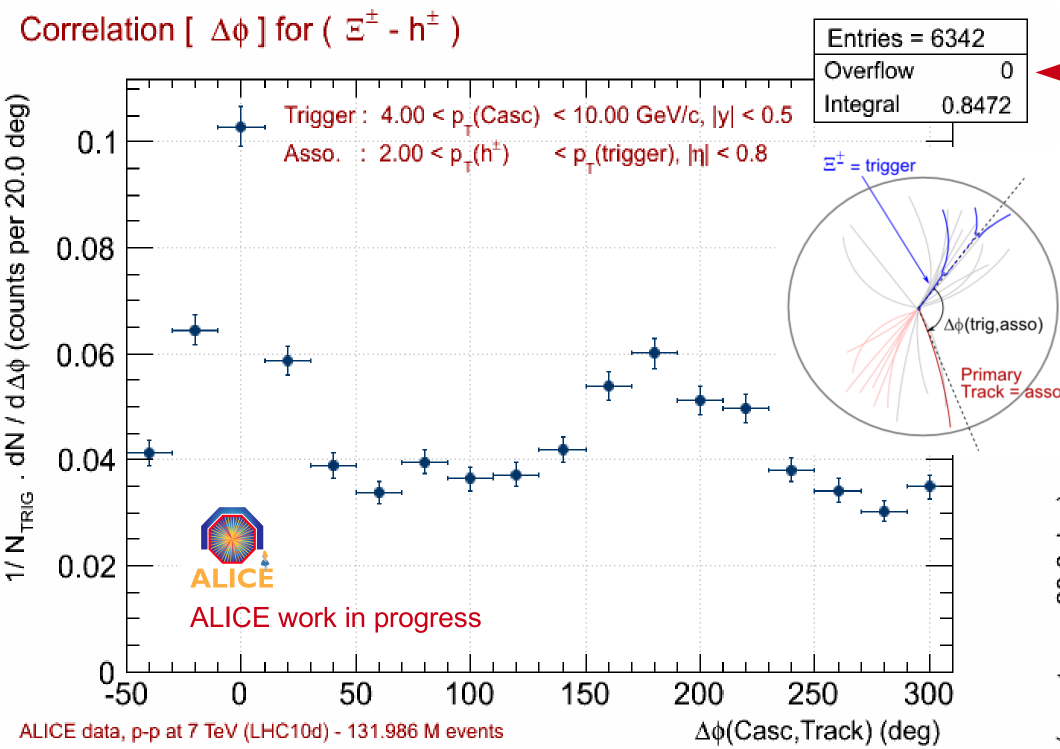


→ Correlation study led at RHIC
in *Au-Au*, for $\Xi^{\pm}$ - $h^{\pm}$ and $\Omega^{\pm}$ - $h^{\pm}$
in *d-Au*, for $\Xi^{\pm}$ - $h^{\pm}$
in *pp*, … missing stat …

See also the jumping-off point :
- J. Bielcikova (STAR) / arXiv :0701047
- R. Hwa (Th) / arXiv: nucl-th/0602024

- Question :
correlation in pp at LHC ?

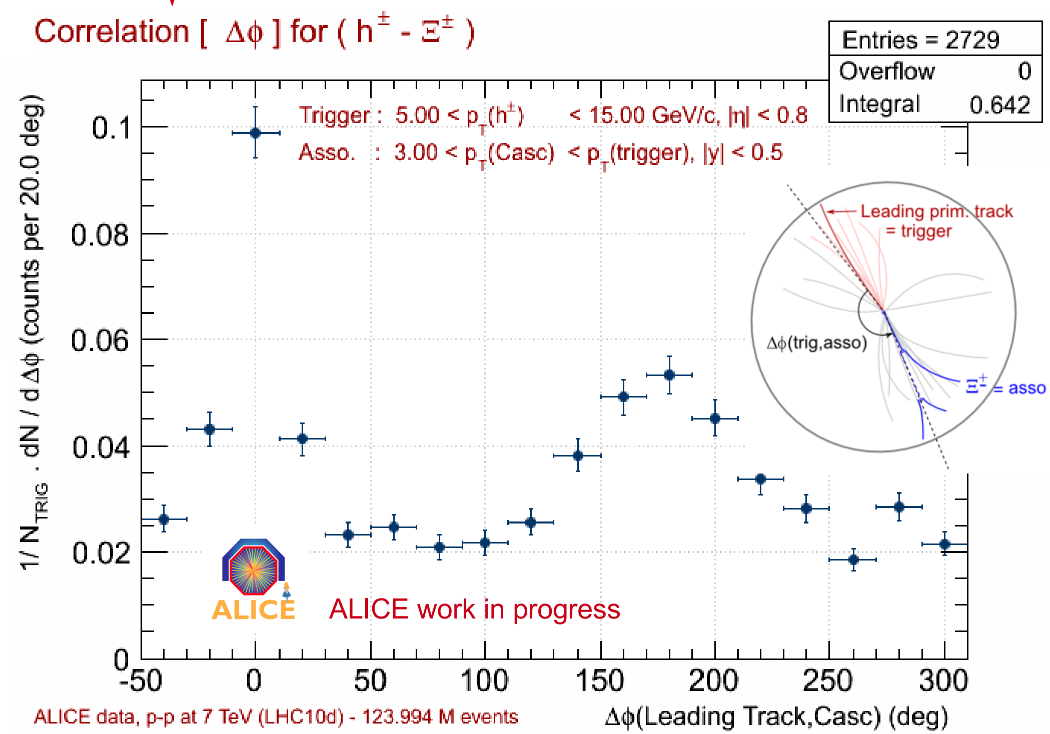
V.2 – Correlations : results



Correlation options :

A. Trigger : cascade
Associated : primary tracks

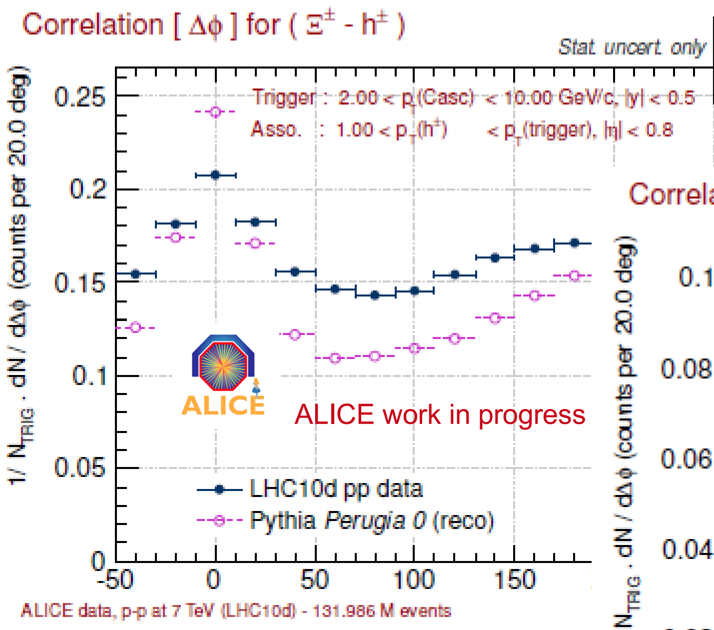
B. Trigger : leading track
Associated : cascades

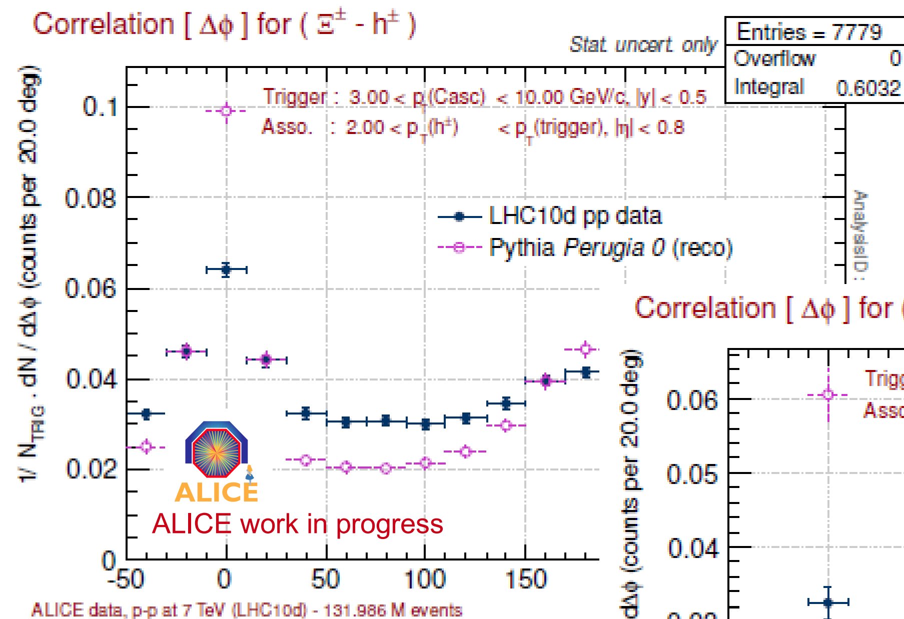


Hypotheses :

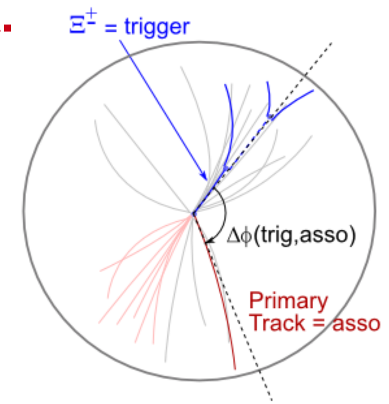
A. 1ry tracks ≠ cascade daughters
B. Purity S/(S+B) > 90% for any p_T
C. p_T(asso) < p_T(trigger)
D. ~ correction for efficiency (...)

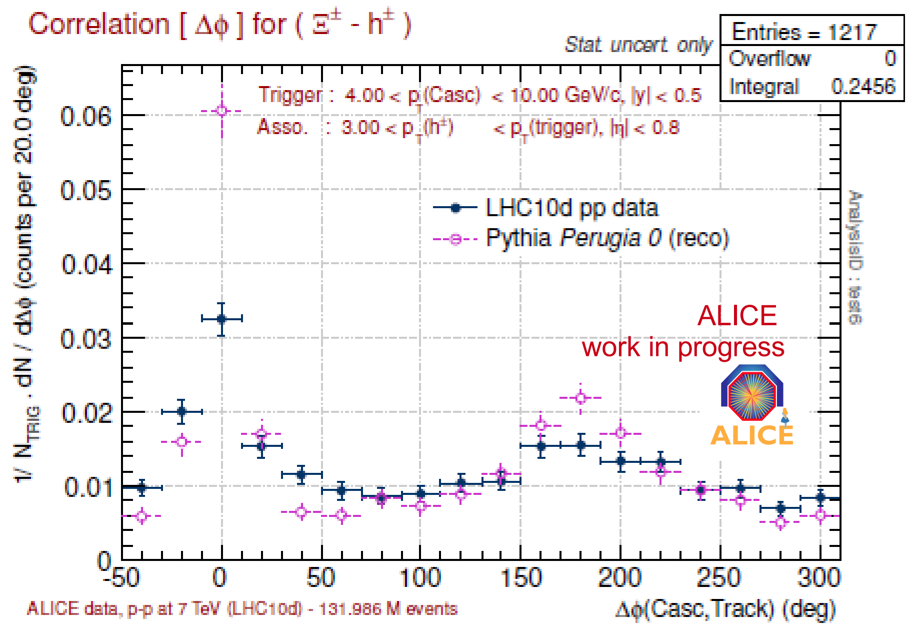
V.3 – Correlations : qualitative results





Option **A.**

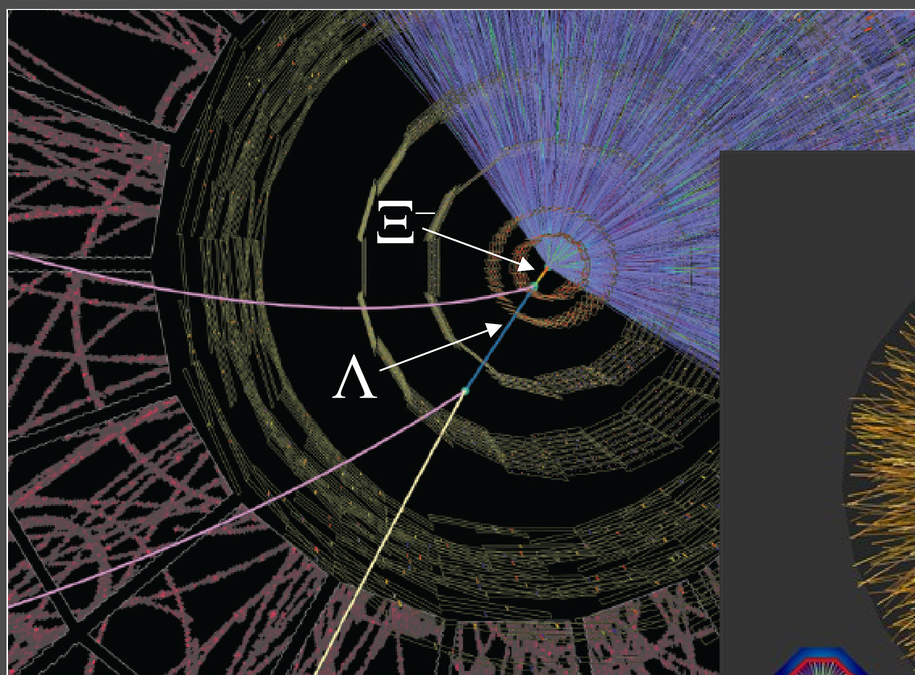


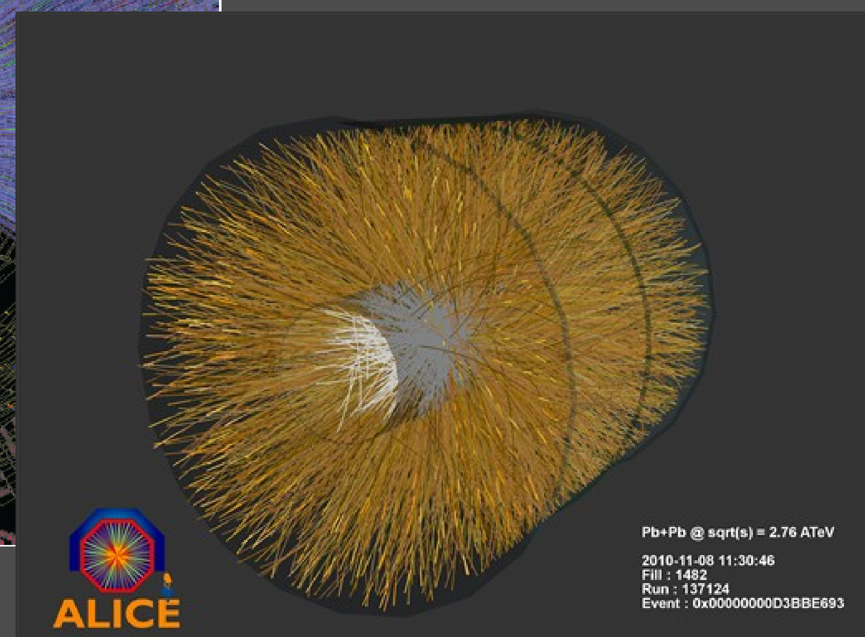


1. More and more correlations,
with increased p_t for trigger and associated

2. PYTHIA Perugia 0 tends to overestimate
the data correlations

VI – Cascades in Pb–Pb

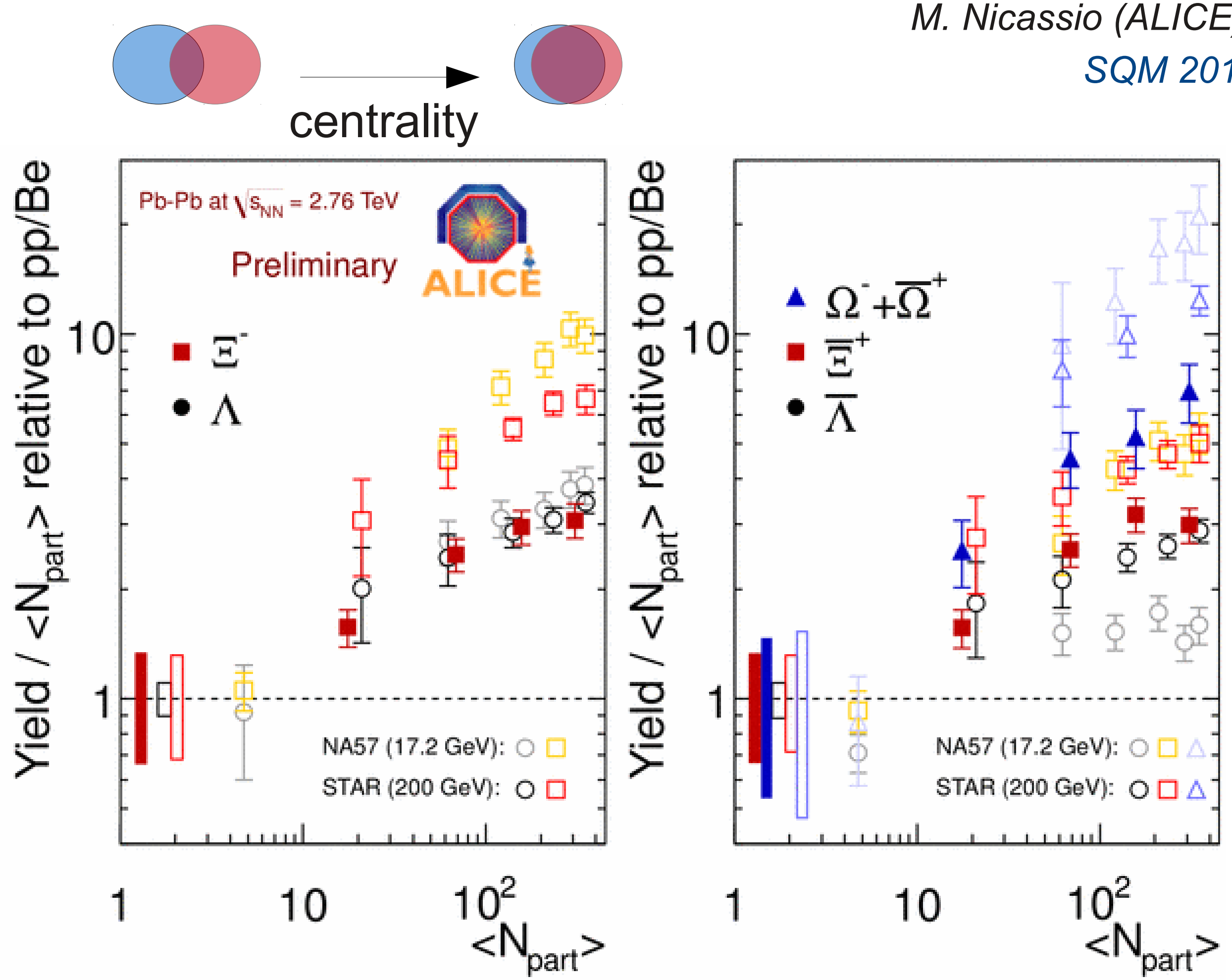




VI.1 – In Pb–Pb : enhanced production ...

M. Nicassio (ALICE)
SQM 2011

R_{AA} integrated in p_T
as measured by ALICE
in Pb–Pb at $\sqrt{s_{NN}}$ = 2.76 TeV

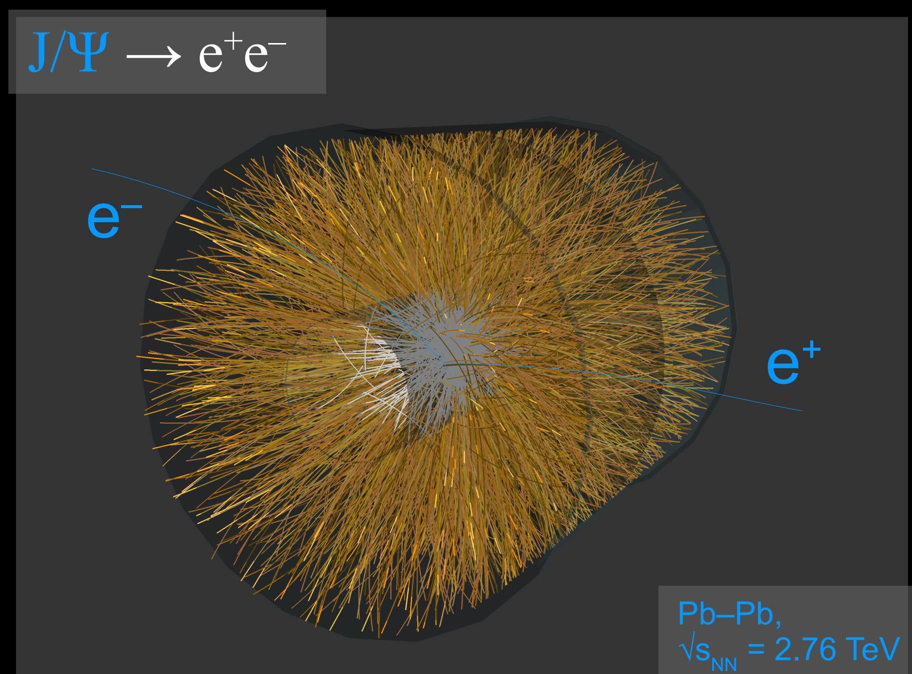


Status :

- corrected spectra,
- for Ξ^-, $\overline{\Xi}^+$, Ω^-, $\overline{\Omega}^+$
- in different centrality bins,
- strangeness enhancement
  = seen...
  i.e. larger enhancement
  for Ω than Ξ,
  + enhancement increasing
  with centrality

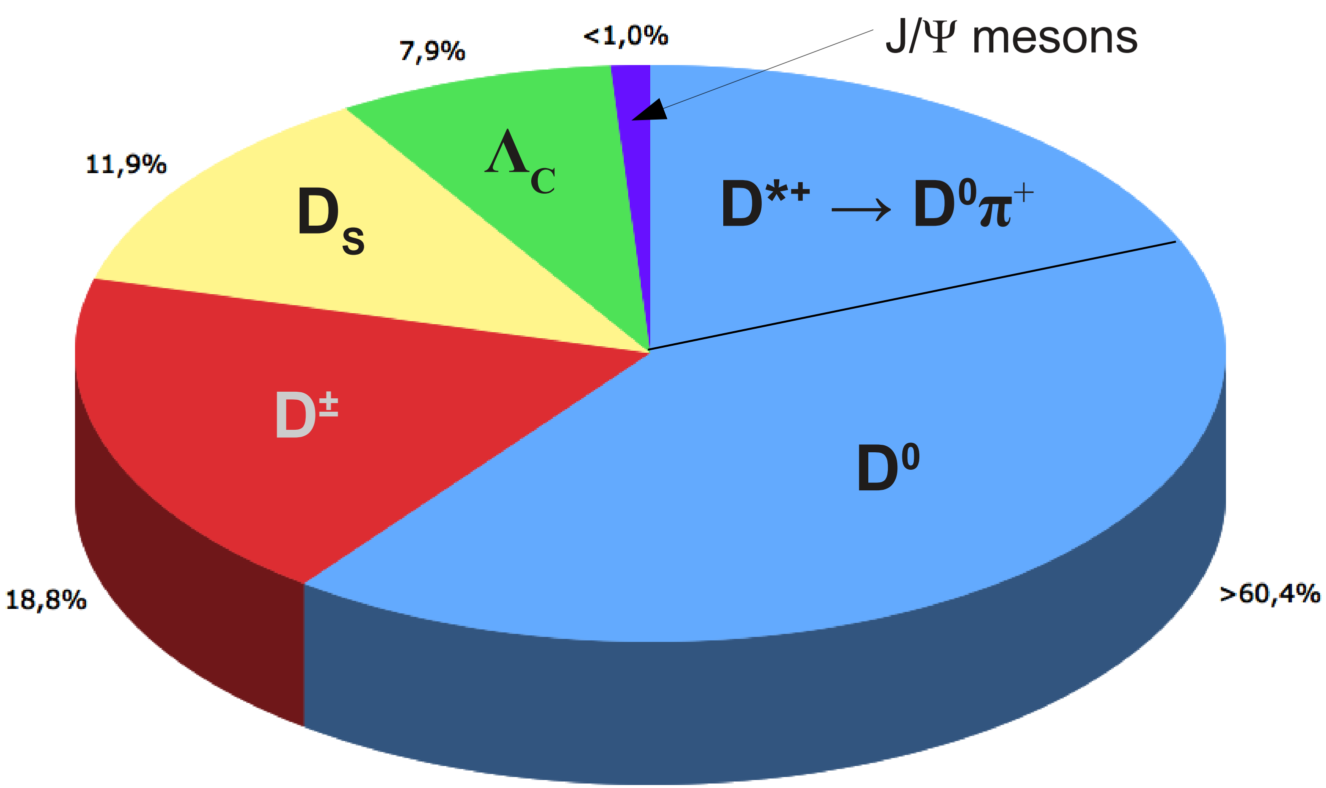
→ "Strangeness enhancement" decreases from SPS to LHC...

Part B – Charmonium ($J/\Psi[\bar{c}c]$)



VII.1 – Intro. : charmed hadrons, J/Ψ *et al.*

Total charm cross section and distribution
expected at the LHC in pp



Courtesy of A. Mischke

J/Ψ(1S) ($c\bar{c}$)

m_{PDG} = 3.0969 GeV/c^2

__*Note :*__

→ Open charm (D mesons) ~ 90 % of the charm cross-section.

→ Charmonium does not stand for most of the charm cross section … but still, hidden charm...

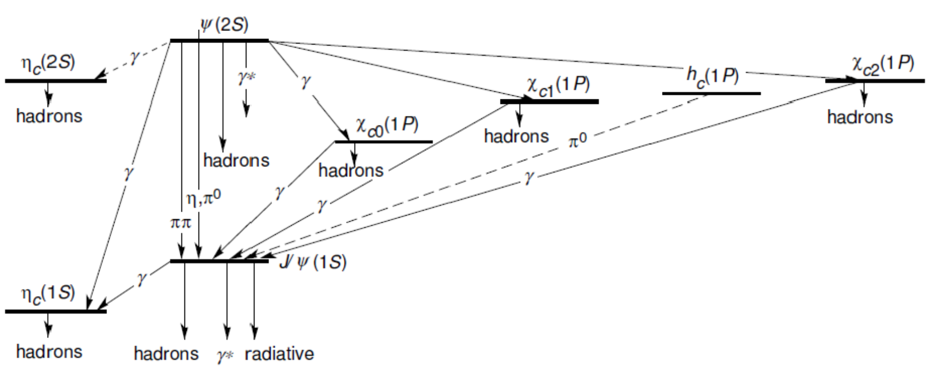
VII.2 – Intro. : cumulative difficulties of J/Ψ

- In pp

1. - understand production mechanisms
2. - understand polarisation

e.g. Colour singlet model,
Colour octet model, NRQCD,
Colour evaporation model, ...

3. - *prompt* J/Ψ include decay from
higher mass resonance states



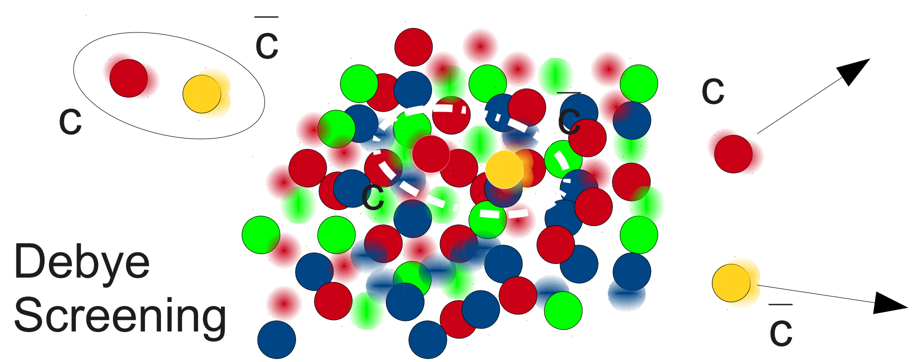
4. - *non-prompt* J/Ψ
i.e. from b hadron decays

- In pA

...
5. - Cold nuclear matter effects
(nPDF, absorption)

- In A–A

...
6. - suppressed production (Matsui & Satz, 1986)

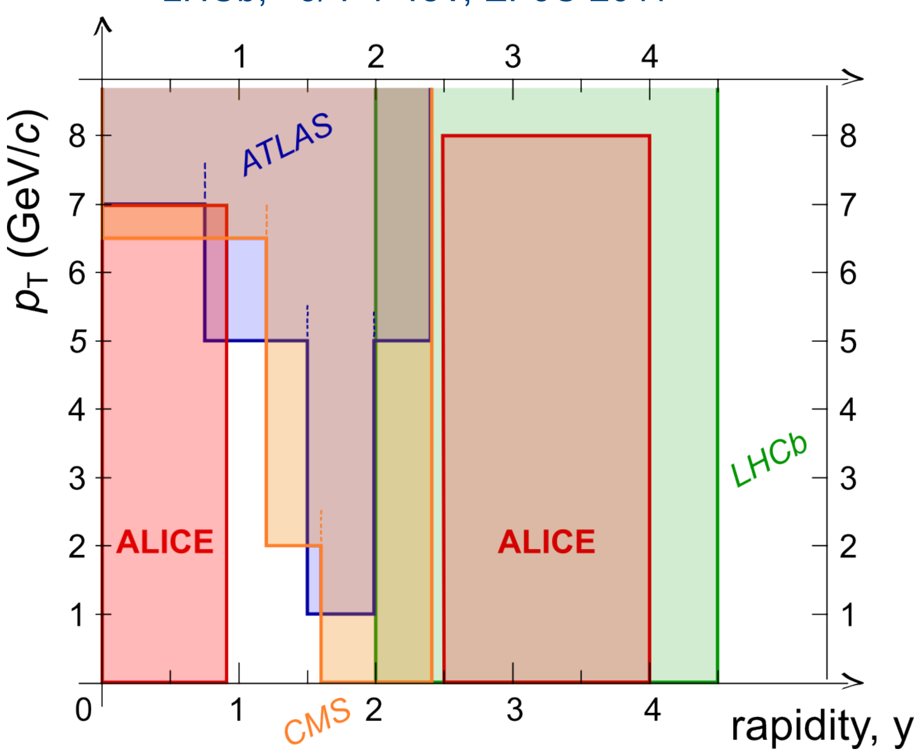


7. - enhanced production at LHC ?
($q\bar{q}$ coalescence)

VIII.1 – Charmo. : phase space at the LHC

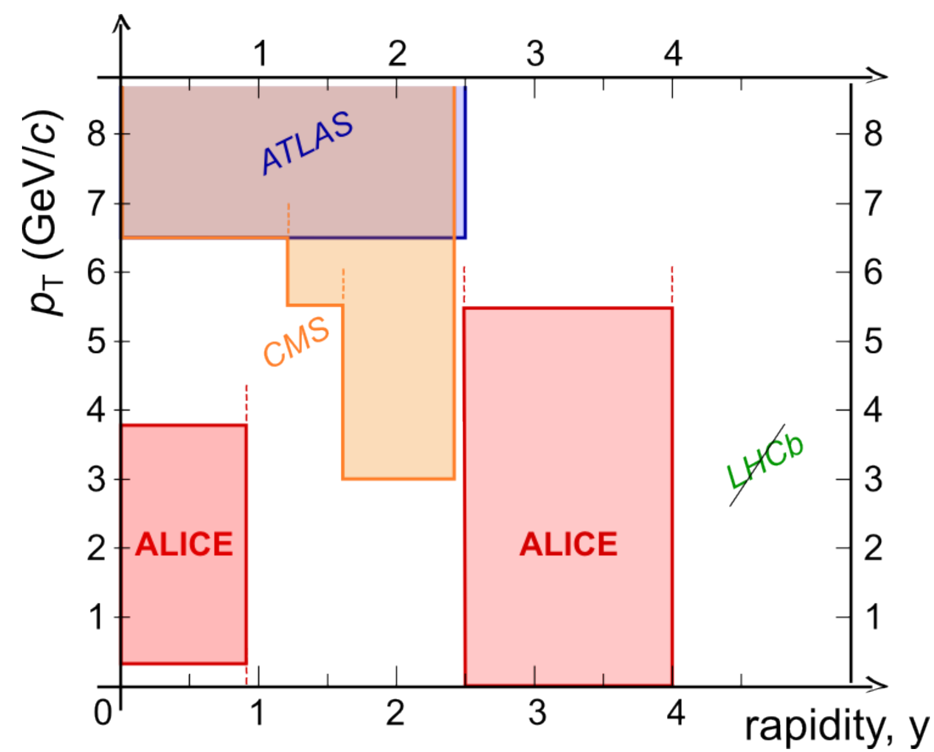
- In pp

– ALICE, J/Ψ 7 TeV, PLB 2011
– ATLAS, J/Ψ 7 TeV, Nucl. Phys B 2011
– CMS, J/Ψ 7 TeV, EPJC 2011
– LHCb, J/Ψ 7 TeV, EPJC 2011



- In A–A

– ALICE, J/Ψ Raa Fwd, PRL 2012
– ATLAS, J/Ψ Rcp, PLB 2011
– CMS, J/Ψ Raa, JHEP 2012



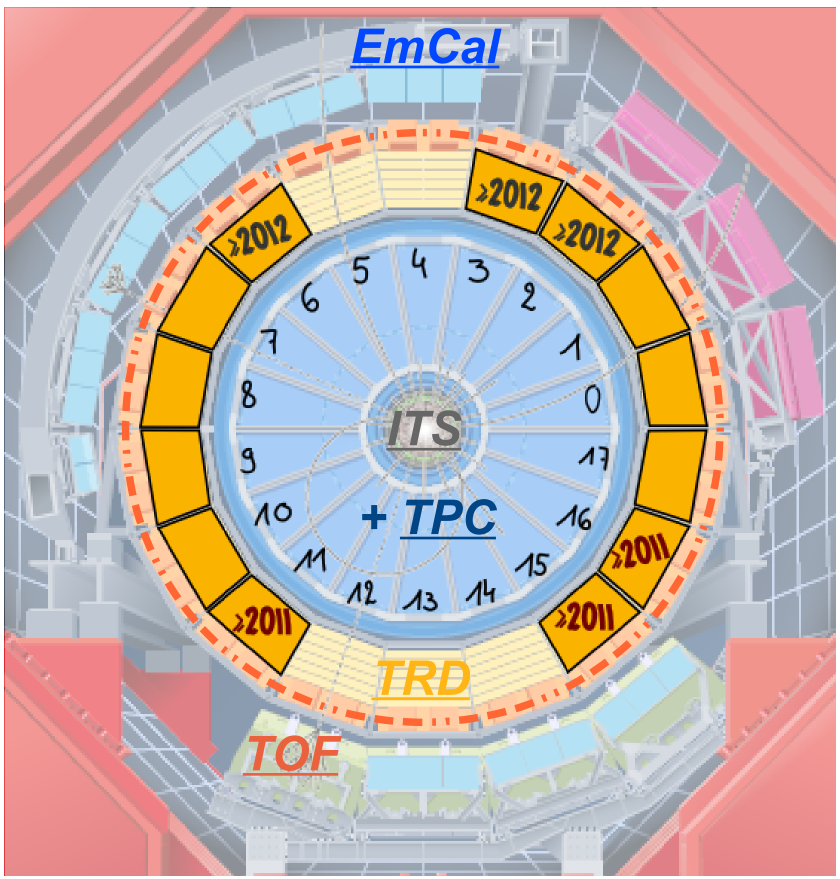
ATLAS, **CMS**, **LHCb** : higher luminosity, access to very high p_T ; down to $p_T = 0$ (LHCb)

ALICE : key potential at (mid-rapidity + low p_T) + alone at forward rapidity in A–A …

VIII.2 – Charmo. : J/Ψ detection at the LHC

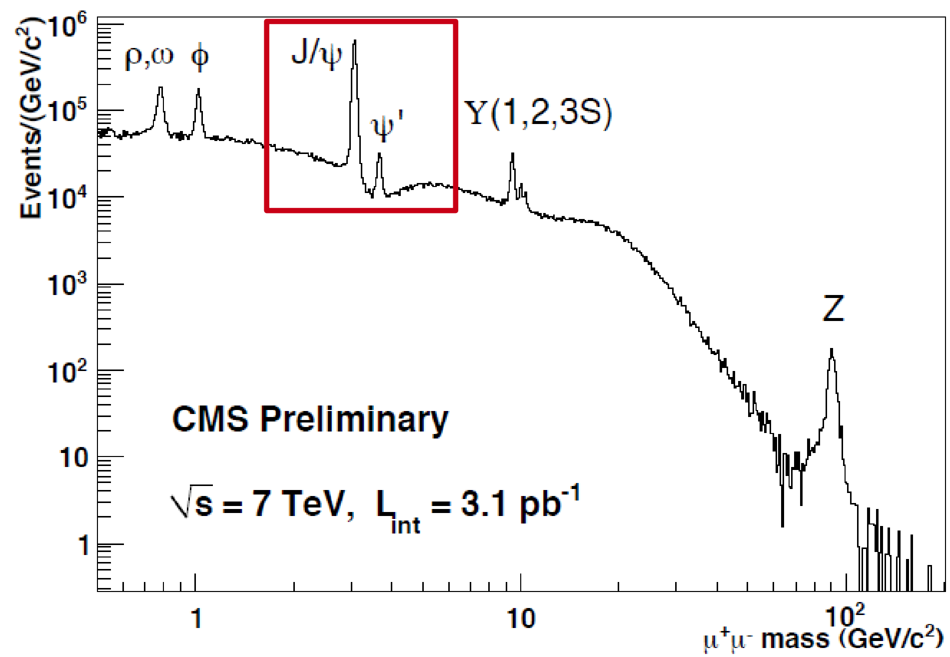
- $J/\Psi \rightarrow e^+e^-$

ALICE (mid-rapidity)

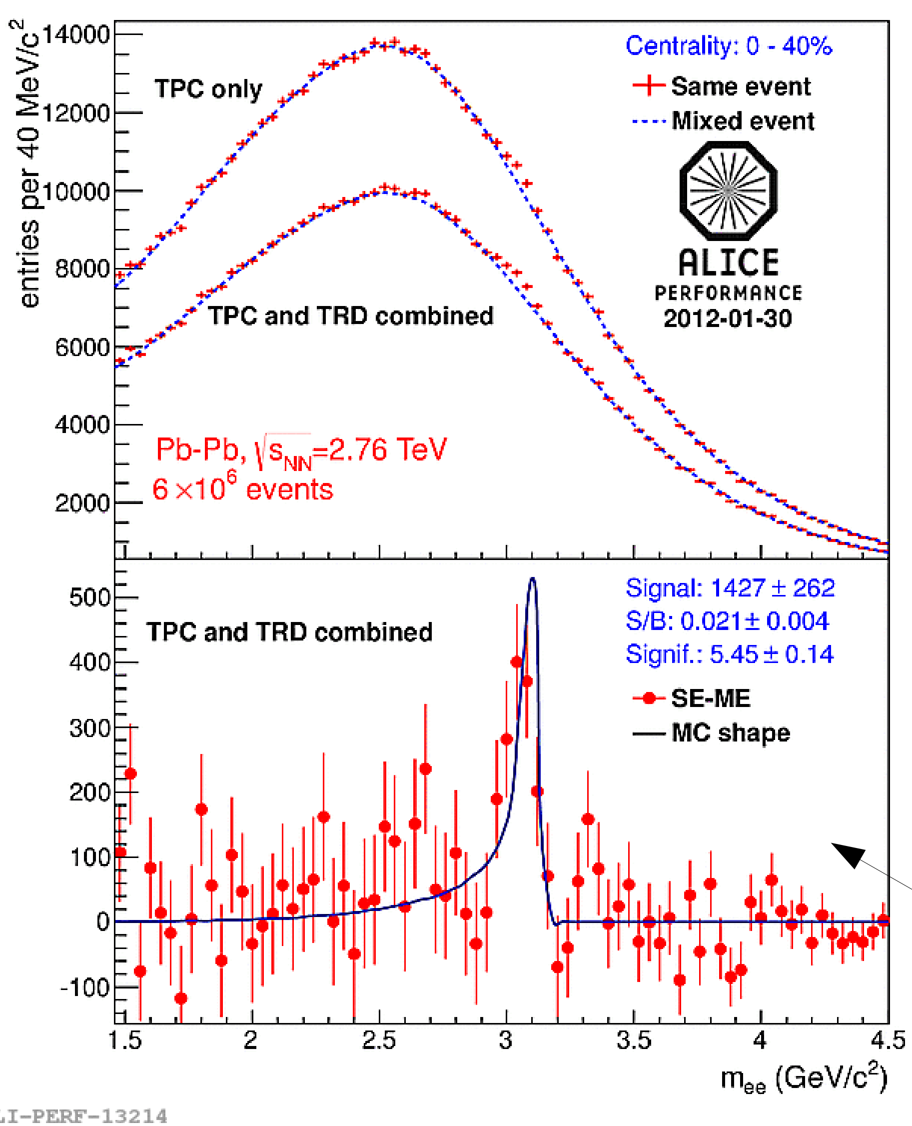


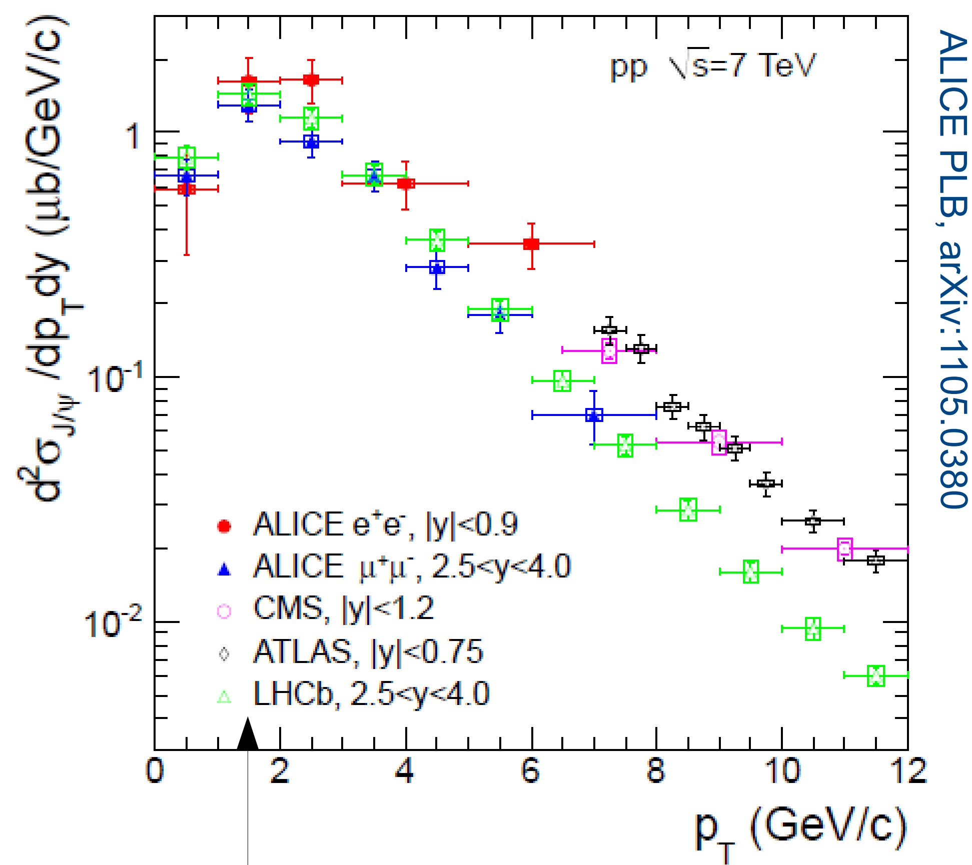
- $J/\Psi \rightarrow \mu^+\mu^-$

ALICE (forward rapidity)
ATLAS
CMS
LHCb



VIII.3 – Charmo. : J/Ψ measurement status





- in pp at $\sqrt{s}$ = 7 TeV
- in Pb–Pb at $\sqrt{s_{NN}}$ = 2.76 TeV

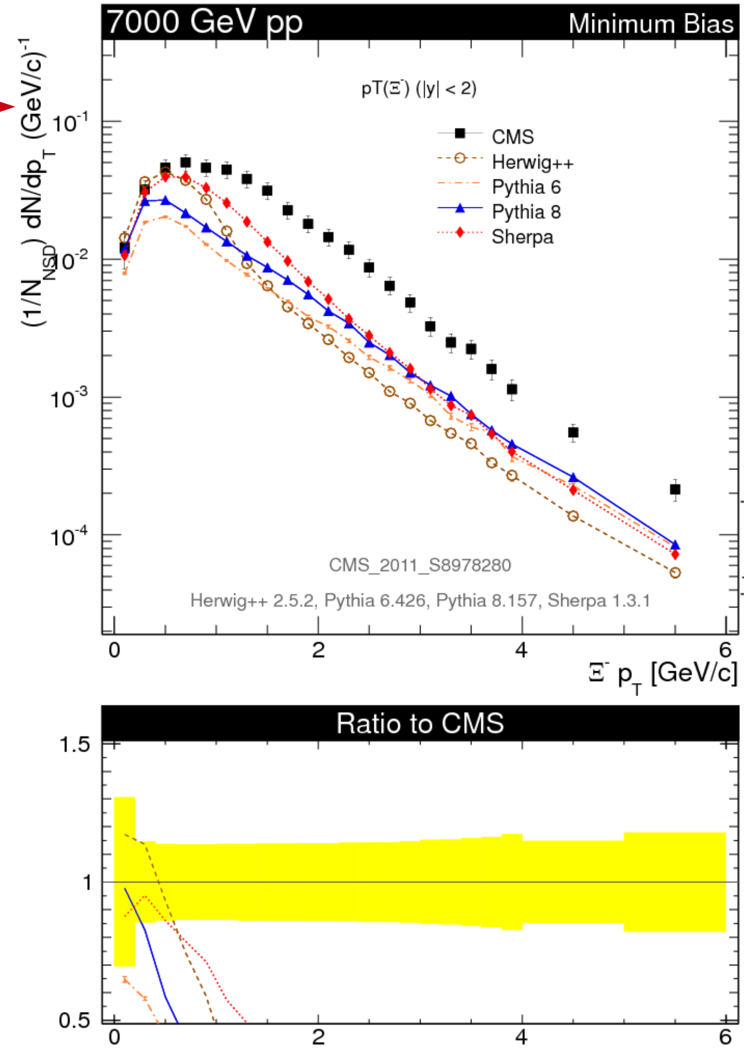
(Conclusion) :

charm and strangeness

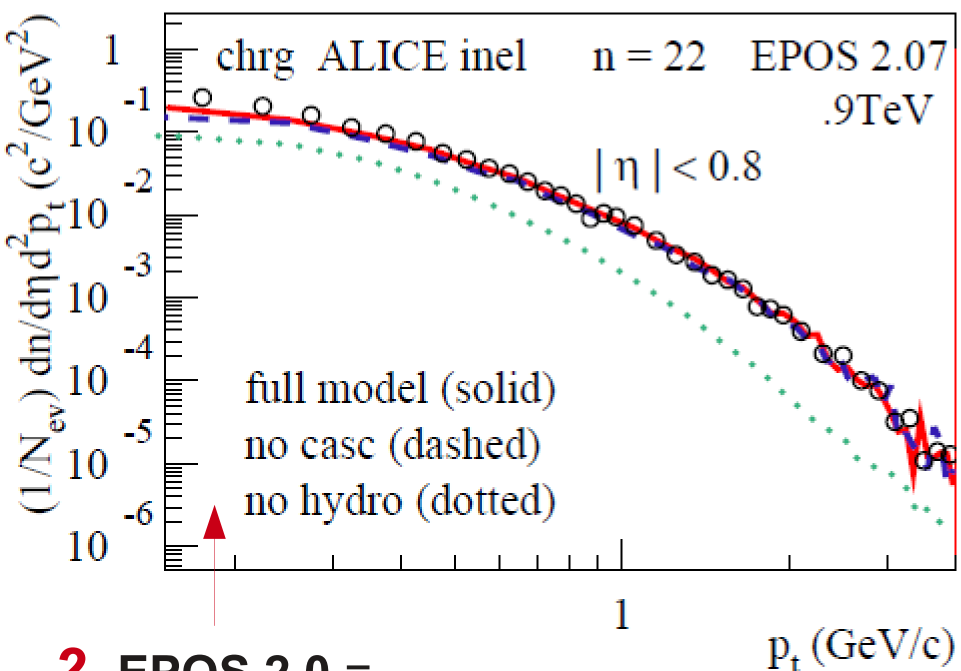
as pieces
of a wide
puzzle

Ccl°.1 – Puzzle : PYTHIA and EPOS

1. MC models (e.g. **PYTHIA**)
~ constrained by CDF data (at the TeV scale)
= via *unidentified* particles, essentially.
LHC may have a say … = join *MCplots/Rivet* effort !



MCplots

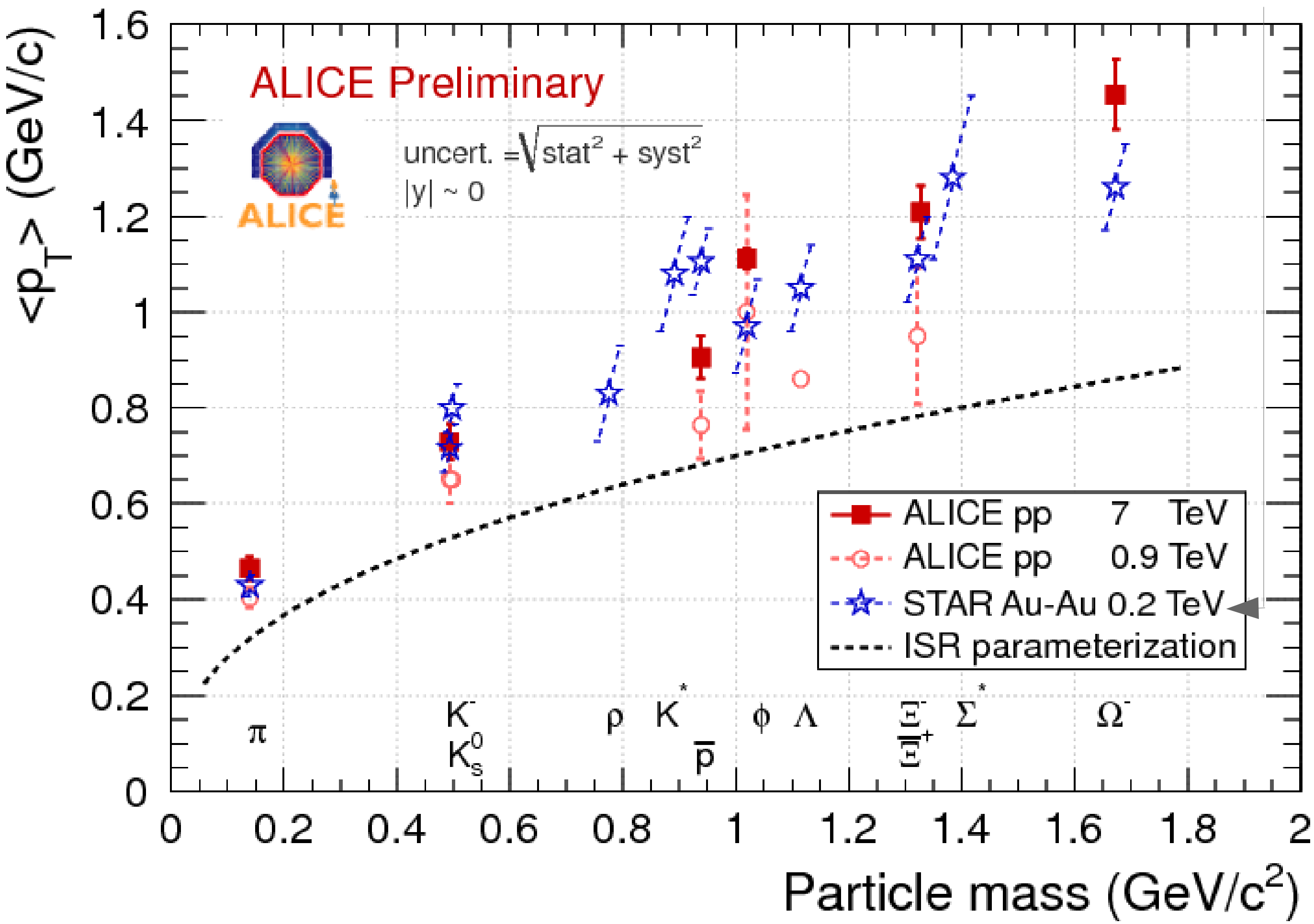


K.Werner, MPI@LHC 2010 + 2011

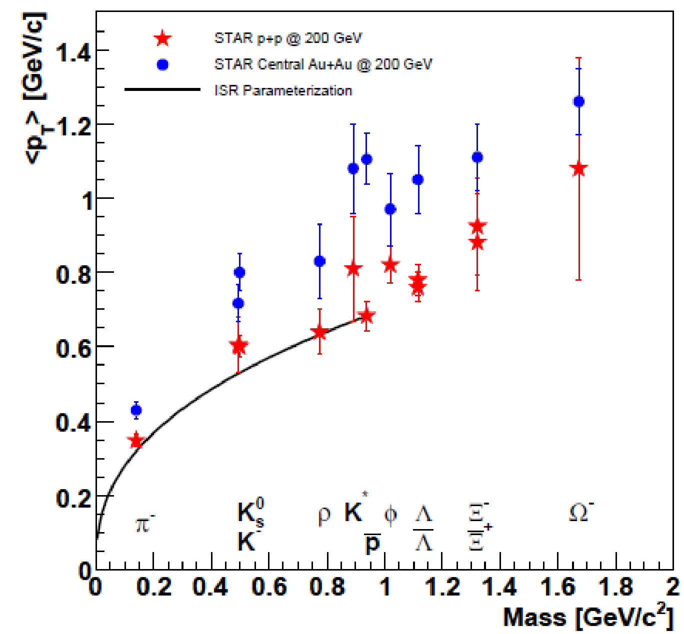
2. **EPOS 2.0** =
multiple scattering + Core/Corona + Hydro
Put it to the test : description of strange hadrons ? w/o hydro, w/o mini-plasma, … ?

Ccl°.2 – Puzzle : Au-Au vs pp ‹p_T›

STAR, 10.1103/PhysRevC.75.064901



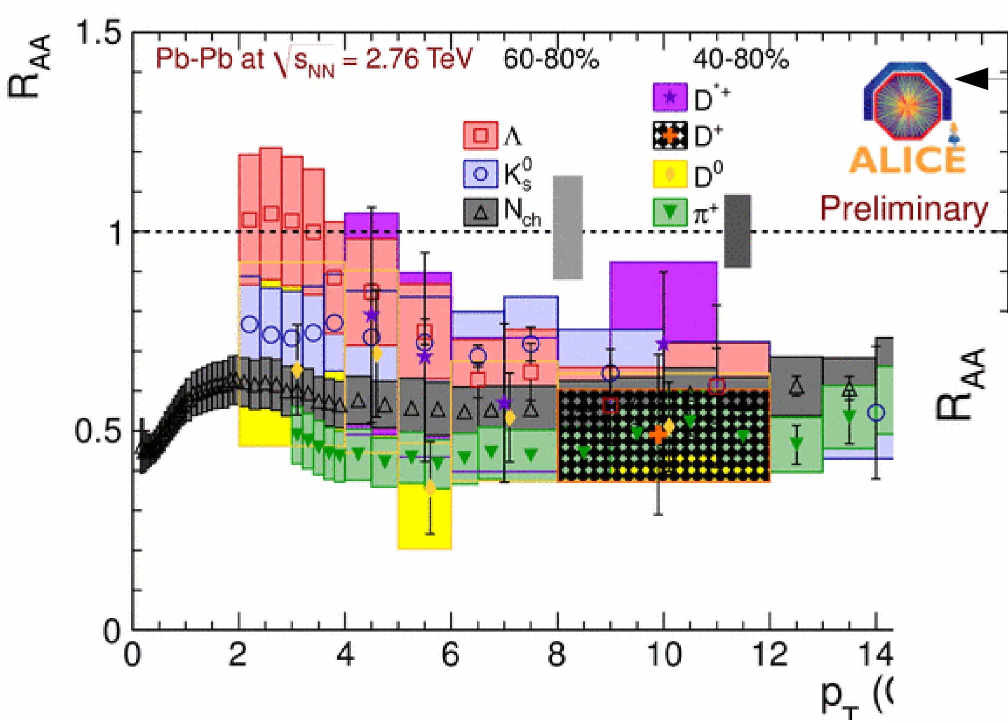
‹p_T› in pp 7 TeV comparable with or higher than STAR data in central Au-Au at $\sqrt{s_{NN}}$ = 200 GeV

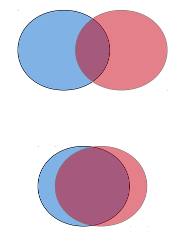


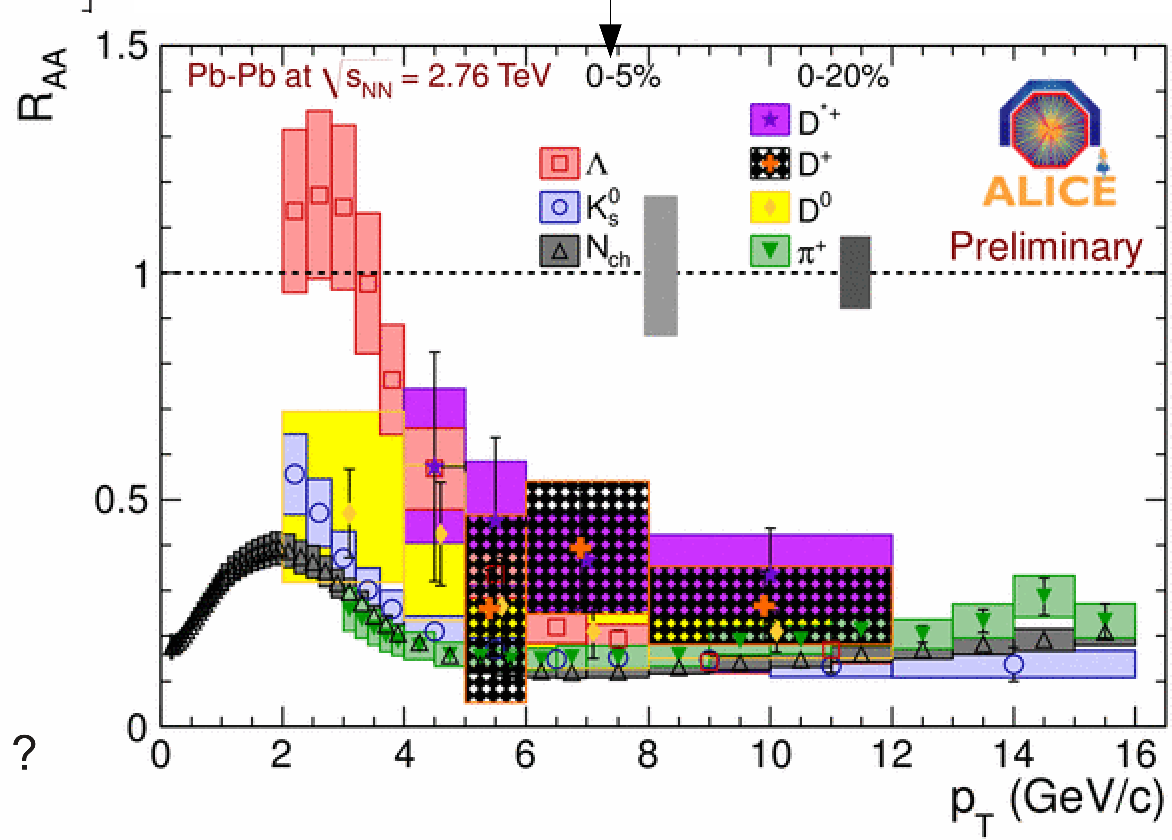
→ What is about ‹p_T› in Pb-Pb at $\sqrt{s_{NN}}$ = 2.76 TeV ?

Talk A.Maire, SQM 2011

Ccl°.3 – **Puzzle** : some other R_{AA} ...







Charmed D mesons

1. … suppressed (R_{AA} < 1)
2. .. to a level close to π suppression level...

Does it mean *c* behave like *u,d* quarks ?

B. Hippolyte (ALICE)
SQM 2011

Ccl°.4 – Conclusion : map of flavour physics.

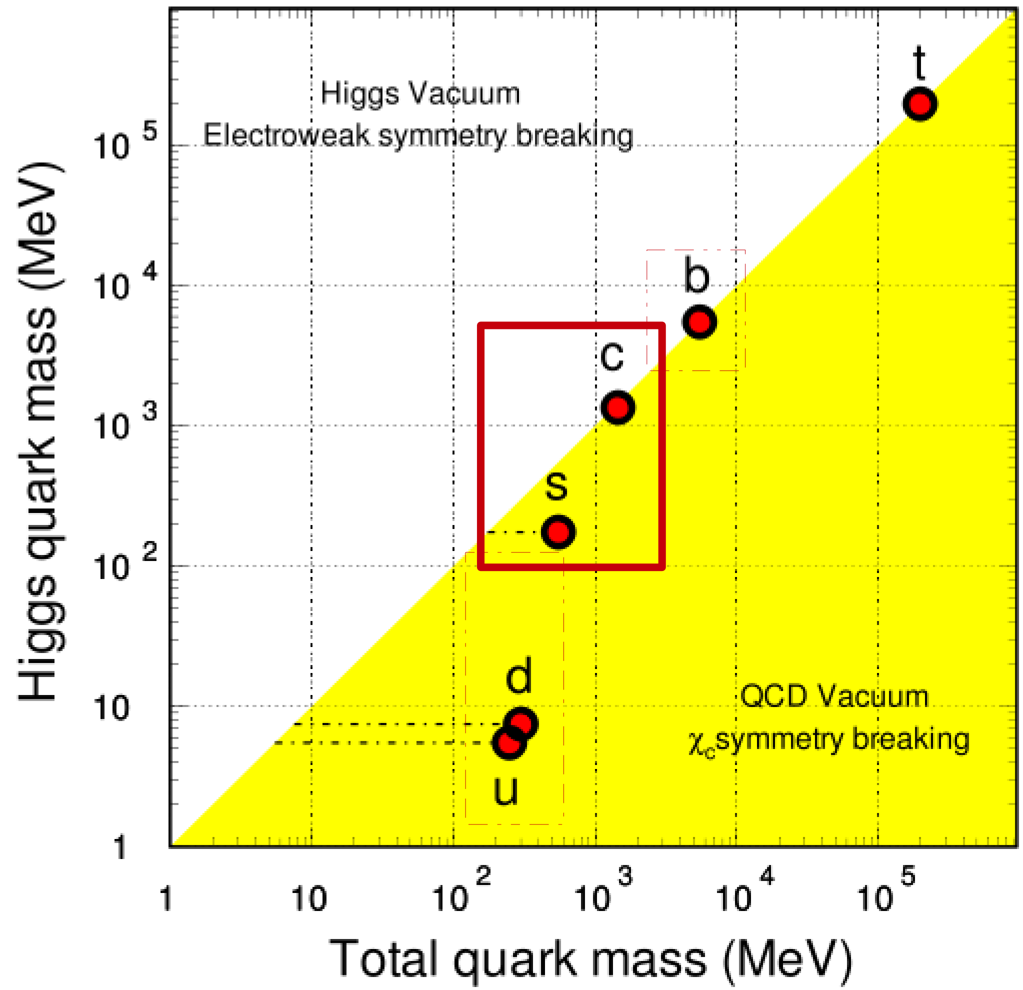
Completing the picture :

1. - **Particle wise ...**

– strangeness related :
 K^+, K^0s, Λ
 + resonances $\varphi(1020)$, $\Lambda(1520)$, $\Sigma^*(1385)$, Ξ^* etc
– charm related :
 D meson, charmed baryon...

2. - **Analysis wise ...**

– in pp :
 azimuthal correlations,
 studies in multiplicity,
 Underlying Event vs. jet...
– in A–A :
 elliptic flow,
 polarisation



arXiv:hep-ph/0604178v2

Appendices

A.3 – Comparison : Perugia 2011

– The default suppression of strangeness in association with popcorn mesons (PARJ(6) and PARJ(7)) was removed to help improve Ξ and Ω yields at LEP [104]. (Note, however, the consequences of this on particle-particle correlations have not been checked.)

Parameter	Type	Perugia 0	Perugia 2010	Perugia 2011 (All)
MSTP(5)	Tune	310	327	350 — 359
MSTJ(11)	HAD	5	5	5
PARJ(1)	HAD	0.073	0.08	0.087
PARJ(2)	HAD	0.2	0.21	0.19
PARJ(3)	HAD	0.94	0.94	0.95
PARJ(4)	HAD	0.032	0.04	0.043
PARJ(6)	HAD	0.5	0.5	1.0
PARJ(7)	HAD	0.5	0.5	1.0
PARJ(11)	HAD	0.31	0.35	0.35
PARJ(12)	HAD	0.4	0.35	0.40
PARJ(13)	HAD	0.54	0.54	0.54
PARJ(21)	HAD	0.313	0.36	0.33
PARJ(25)	HAD	0.63	0.63	0.63
PARJ(26)	HAD	0.12	0.12	0.12
PARJ(41)	HAD	0.49	0.35	0.35
PARJ(42)	HAD	1.2	0.9	0.80
PARJ(45)	HAD	0.5	0.5	0.55
PARJ(46)	HAD	1.0	1.0	1.0
PARJ(47)	HAD	1.0	1.0	1.0

Table 5: Hadronisation Parameters of the Perugia 2011 tunes compared to Perugia 0 and Perugia 2010. Parameters that were not explicitly part of the Perugia 0 and Perugia 2010 tuning but were included in Perugia 2011 are highlighted in blue. For more information on each parameter, see [14].

Tuning Monte Carlo Generators: The Perugia Tunes
http://arxiv.org/abs/1005.3457

[14] *PYTHIA 6.4 Physics and Manual*
http://arxiv.org/abs/hep-ph/0603175

PARJ(6) : (D = 0.5) extra suppression for having a $s\bar{s}$ pair shared by the B and $\overline{B}$ of a $BM\overline{B}$ situation.

PARJ(7) : (D = 0.5) extra suppression for having a strange meson M in a $BM\overline{B}$ configuration.

A.4 – After comparison : Z1C ?

PARJ(1) : (D = 0.10) is $\mathcal{P}(\mathrm{qq})/\mathcal{P}(\mathrm{q})$, the suppression of diquark-antidiquark pair production in the colour field, compared with quark–antiquark production.

PARJ(2) : (D = 0.30) is $\mathcal{P}(\mathrm{s})/\mathcal{P}(u)$, the suppression of s quark pair production in the field compared with u or d pair production.

PARJ(3) : (D = 0.4) is $(\mathcal{P}(\mathrm{us})/\mathcal{P}(\mathrm{ud}))/(\mathcal{P}(\mathrm{s})/\mathcal{P}(\mathrm{d}))$, the extra suppression of strange diquark production compared with the normal suppression of strange quarks.

PARJ(4) : (D = 0.05) is $(1/3)\mathcal{P}(\mathrm{ud}_1)/\mathcal{P}(\mathrm{ud}_0)$, the suppression of spin 1 diquarks compared with spin 0 ones (excluding the factor 3 comin

PARJ(5) : (D = 0.5) parameter determining relative oc $BM\overline{B}$ and by $B\overline{B}$ configurations in the simple p roughly $\mathcal{P}(BM\overline{B})/(\mathcal{P}(B\overline{B}) + \mathcal{P}(BM\overline{B}))$ = PA subsequent baryon parameters are modified in see section 14.3.1.

PARJ(6) : (D = 0.5) extra suppression for having a $\mathrm{s\overline{s}}$ pair shared by the B and $\overline{B}$ of a $BM\overline{B}$ situation.

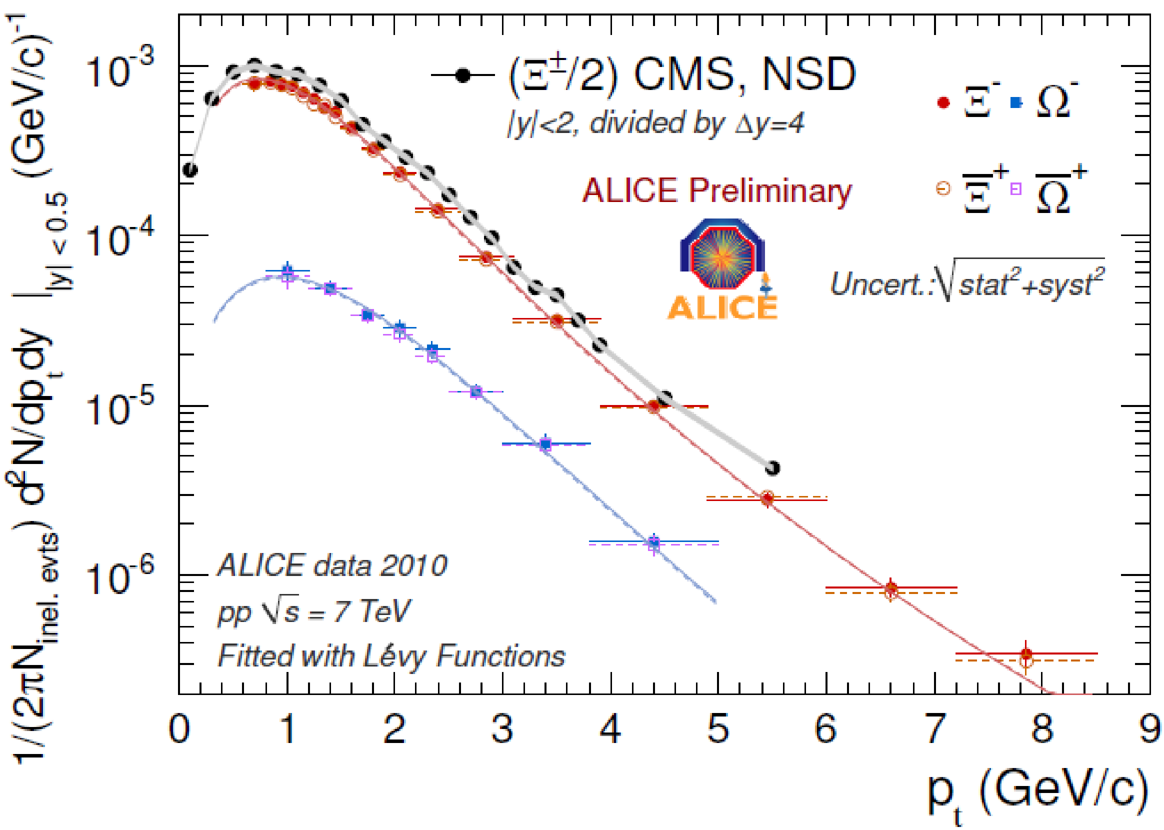
PARJ(7) : (D = 0.5) extra suppression for having a strange meson M in a $BM\overline{B}$ configuration.

Z1C Rick Field (CDF, CMS) :
Z1 tune +
PARJ(1) = 0.12
PARJ(3) = 0.8
→ MB & UE working group (June, 17th 2011)

B – 7 TeV analyses :

three comparisons

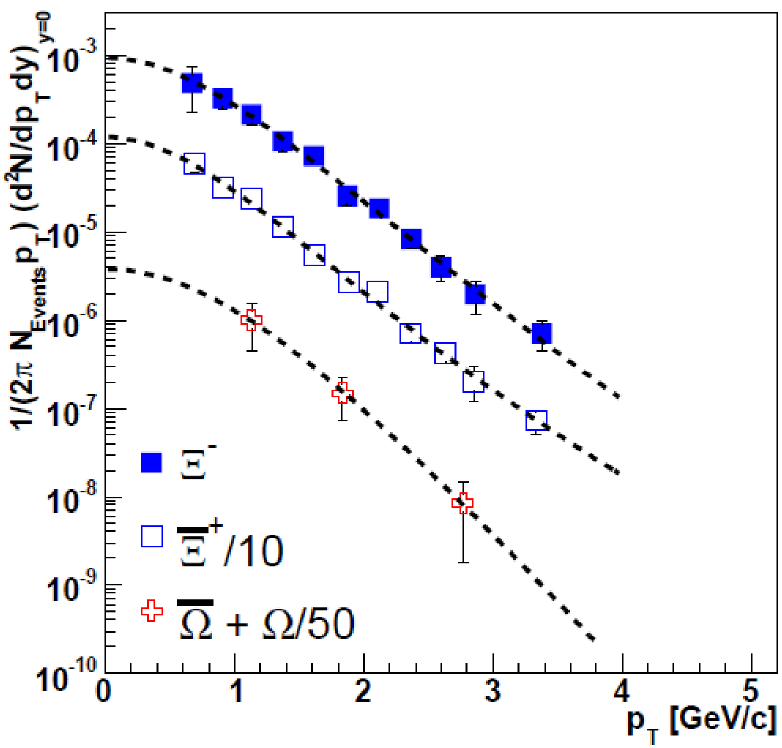
B.1 – Comparison : ALICE, CMS, STAR



ALICE+CMS

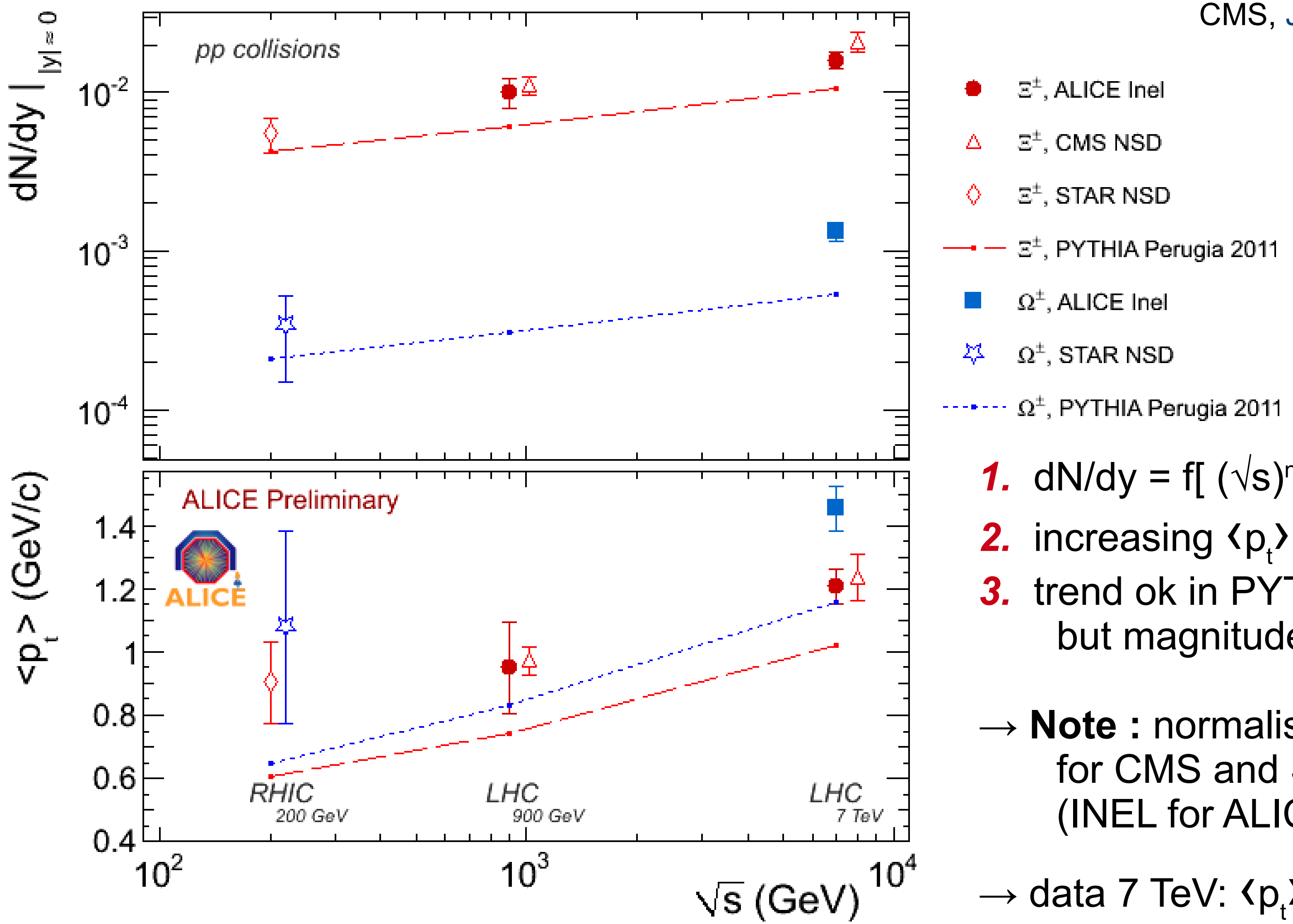
→ *In pp collisions ...*

STAR, nucl-ex/0607033



B.2 – Comparison : dN/dy, ‹p_t› = f(√s)

STAR, Phys.Rev.C75:064901(2007),
CMS, JHEP 05 (2011) 064,

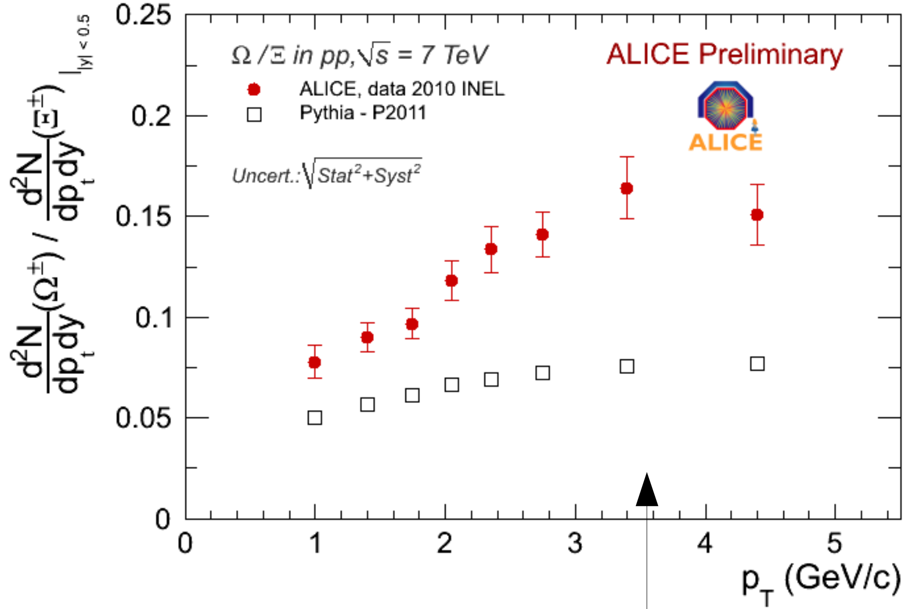


1. dN/dy = f[$(\sqrt{s})^n$]
2. increasing ‹p_t› with (√s)
3. trend ok in PYTHIA tunes …
   but magnitude ≠ ok

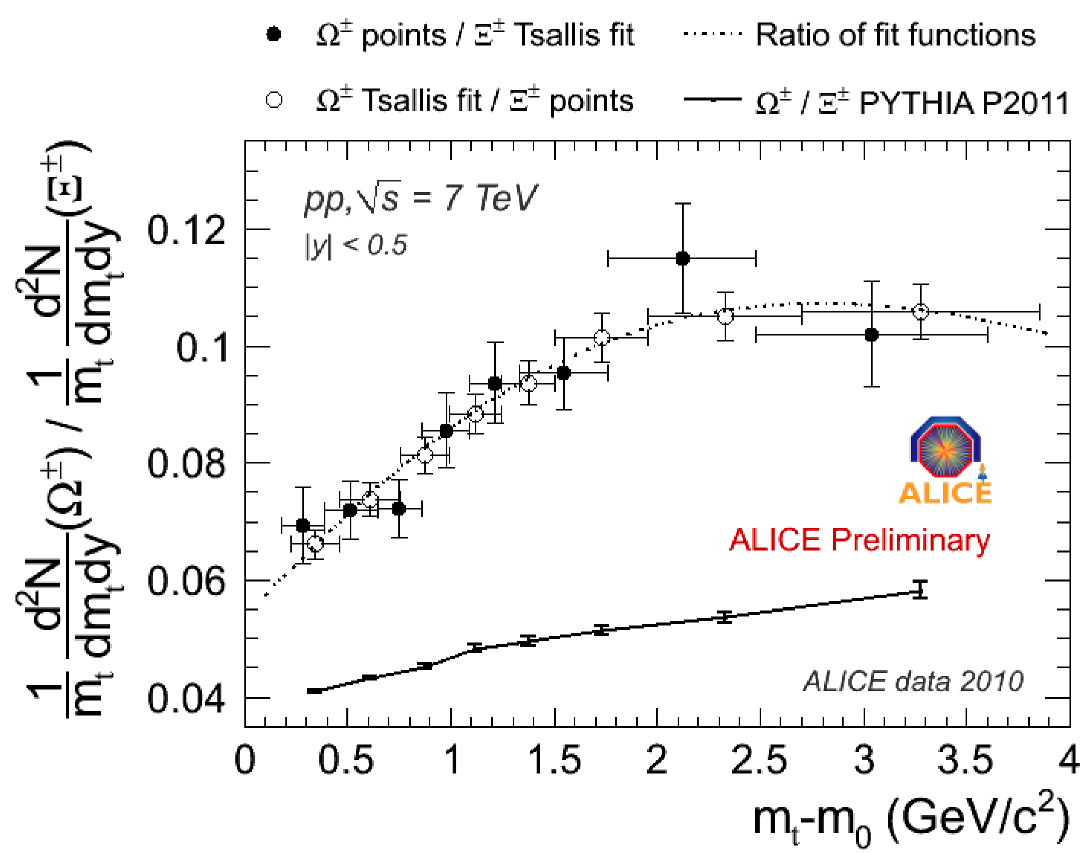
→ **Note :** normalisation to NSD
for CMS and STAR
(INEL for ALICE)

→ data 7 TeV: ‹p_t›($\Omega^{\pm}$) = 120% ‹p_t›($\Xi^{\pm}$)

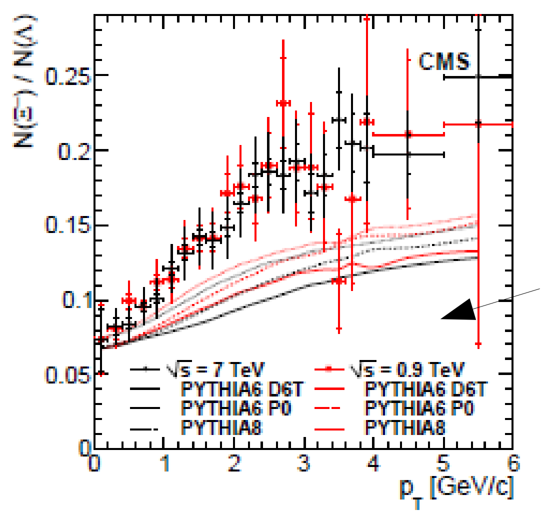
B.3 – Comparison : $(\Omega^{\pm} / \Xi^{\pm}) = f(p_t)$



Cost of adding *one* strange quark to a *baryon* ?
= easier at high p_t / more difficult at low p_t ?



CMS, arxiv:1102.4282v2



$\Omega^{\pm} / \Xi^{\pm} = f(p_t)$

$\Xi^{\pm} / \Lambda = f(p_t)$

$\Lambda / p = f(p_t)$

to get a complete picture...
ratios quite difficult to reproduce clearly in MC ...