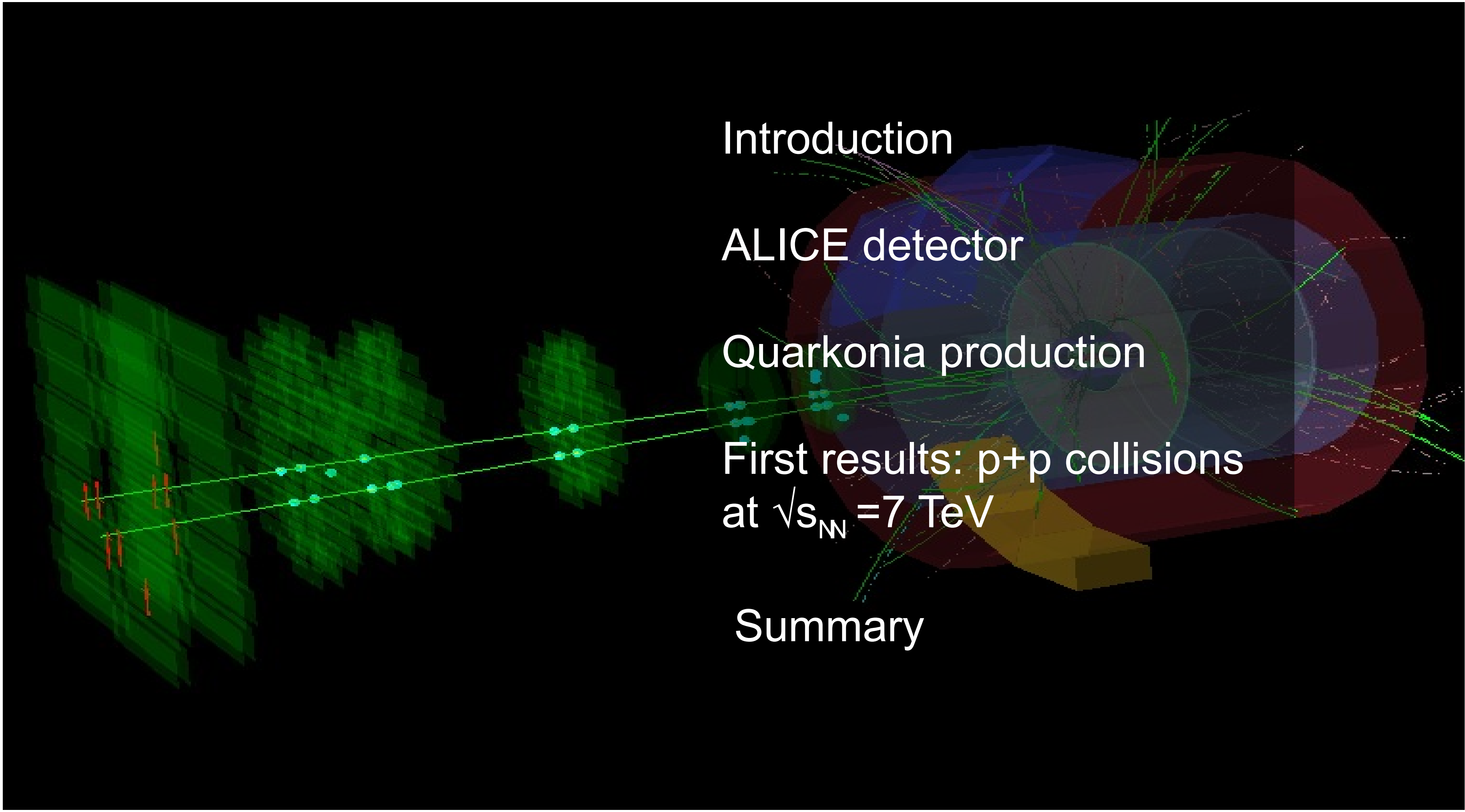
J/ψ production at LHC energies

Dr. Daniel Tapia Takaki

CERN &
IPN Orsay -Université Paris XI, CNRS

Benemérita Universidad Autónoma de Puebla
Cuerpo Académico de Partículas Campos y Relatividad General

Plan of this talk



Introduction

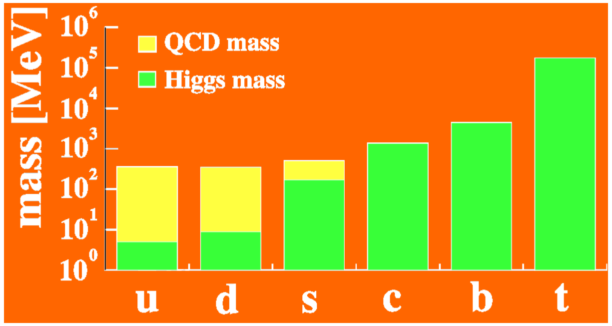
ALICE detector

Quarkonia production

First results: p+p collisions at $\sqrt{s_{NN}}$ =7 TeV

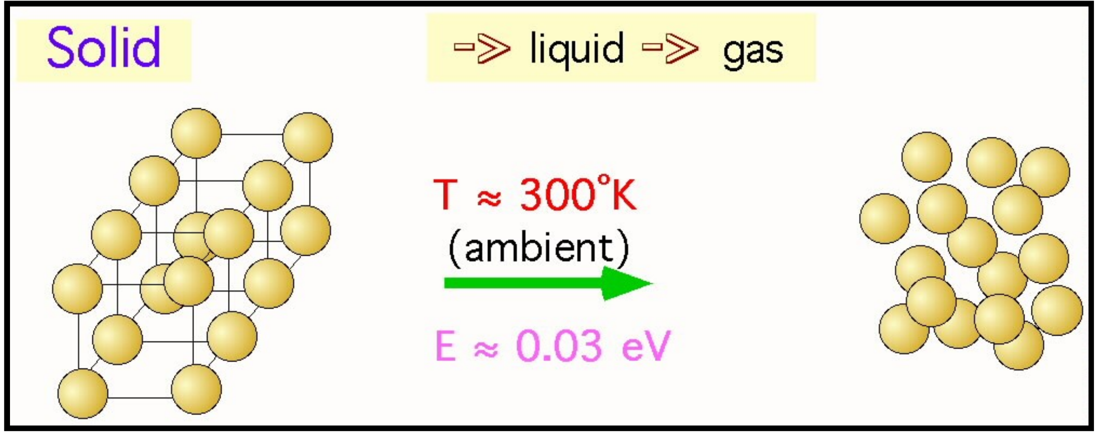
Summary

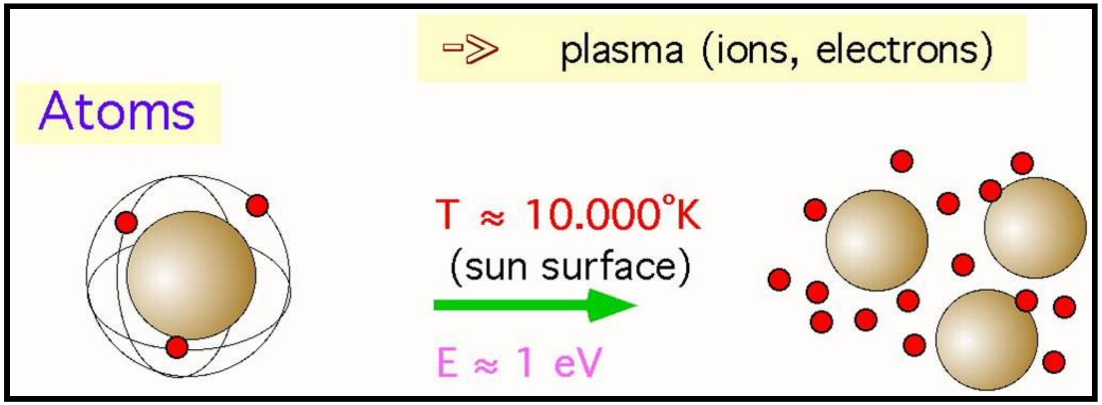
Hadronic matter

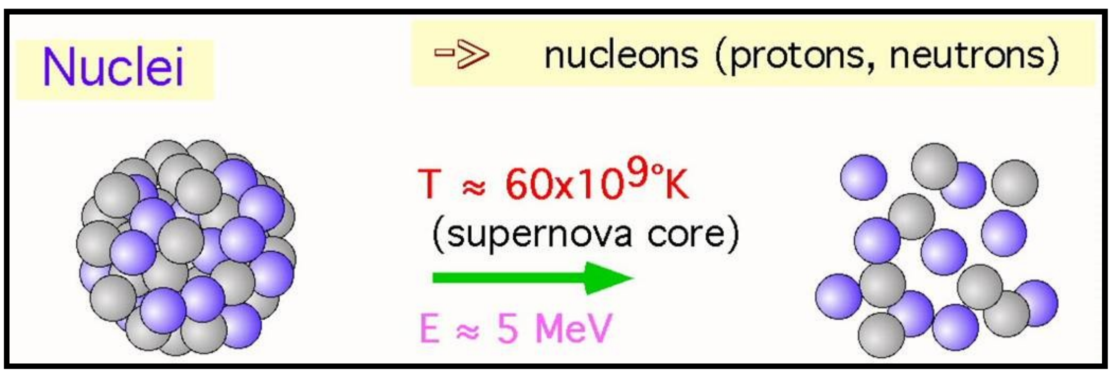


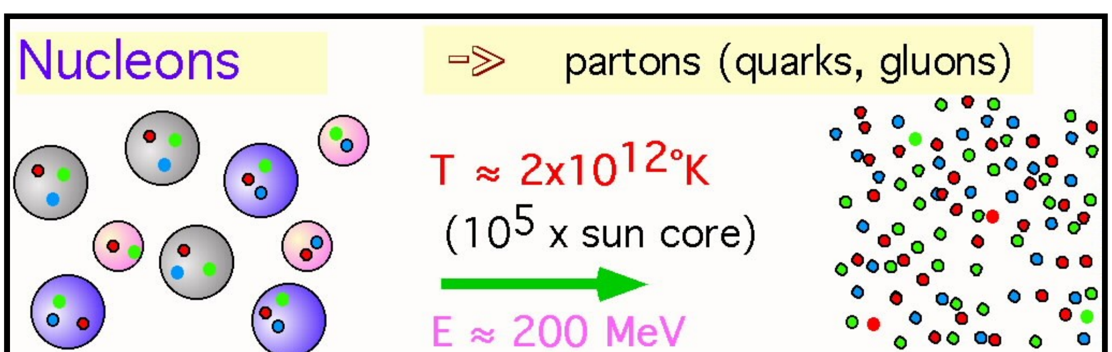
- Hadronic matter can be subdivided into:
  - Baryons (qqq) bound together
  - Mesons (qq) by gluons
- Under normal conditions it is not possible to observe 'free' quarks, antiquarks and gluons
- However under extreme conditions hadronic matter undergoes a phase transition into a Quark-Gluon Plasma: the state of deconfined strongly interacting matter.
- Furthermore quarks reduce to their bare masses
  - → A further test of QCD

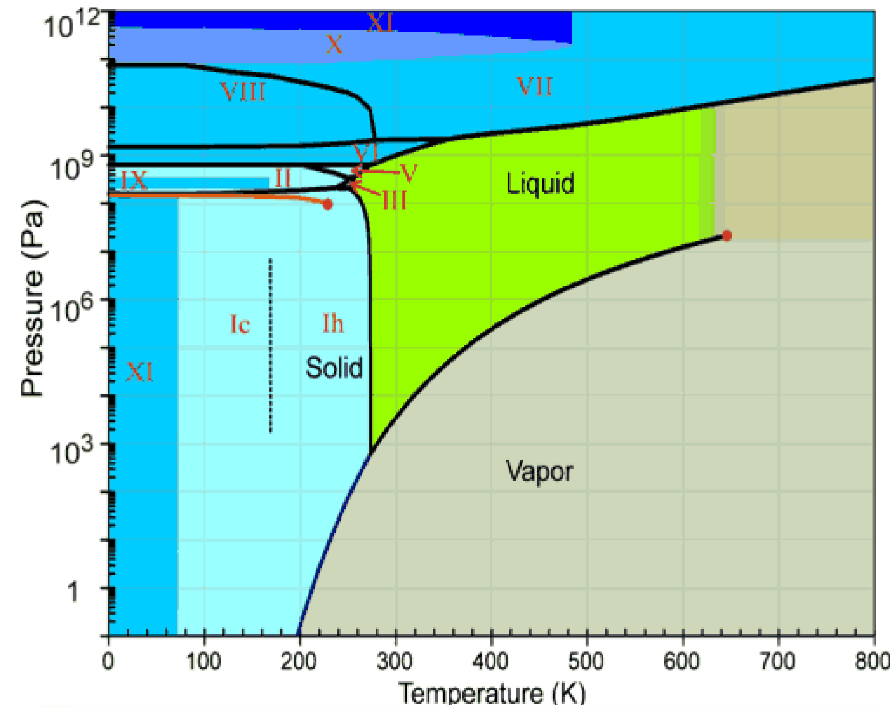
Melting Matter

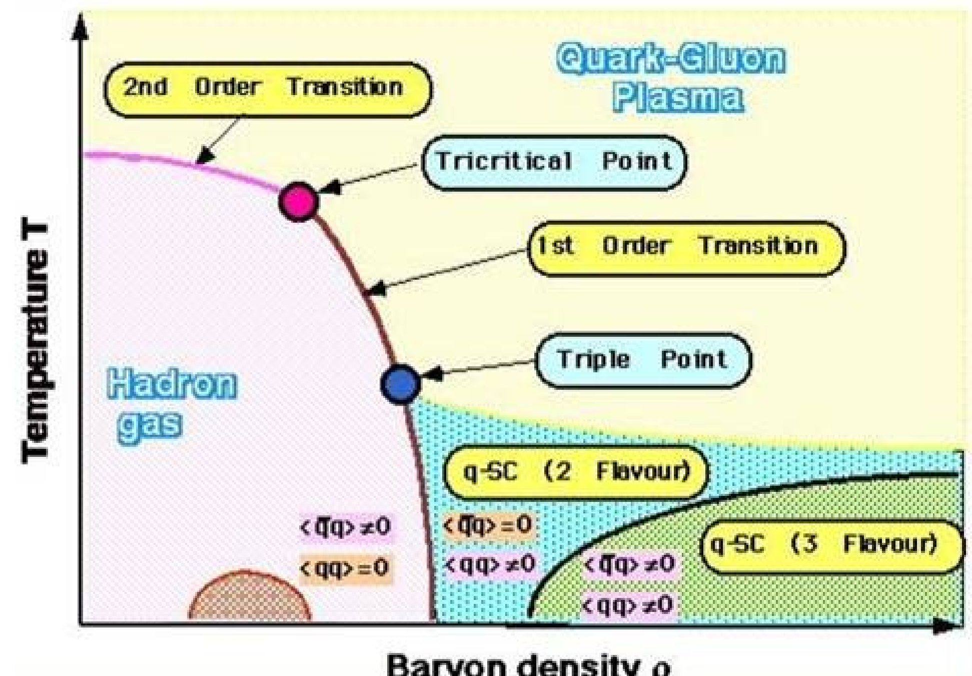




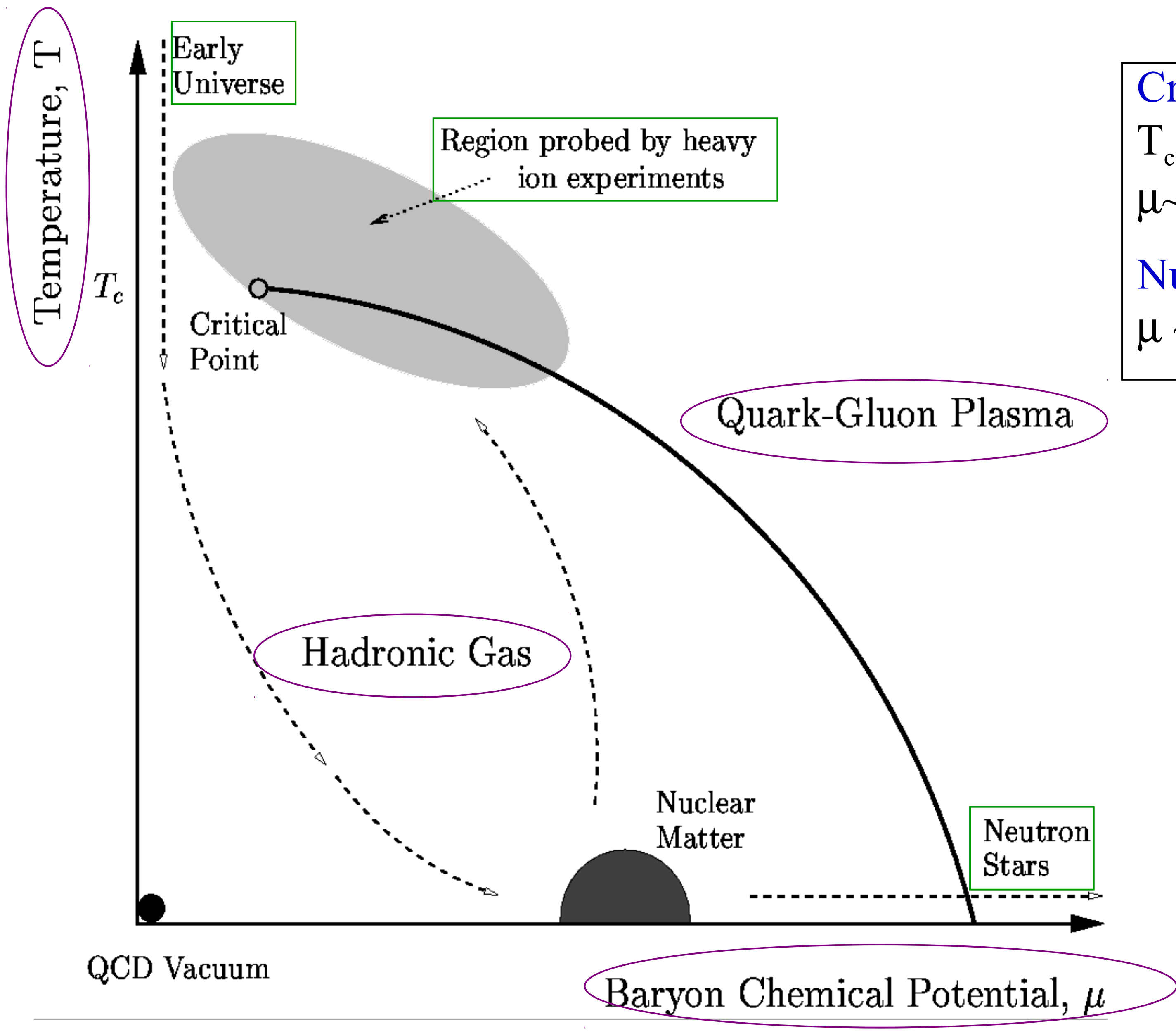








The Phase Diagram



Critical Point:

$T_c \sim 170$ MeV

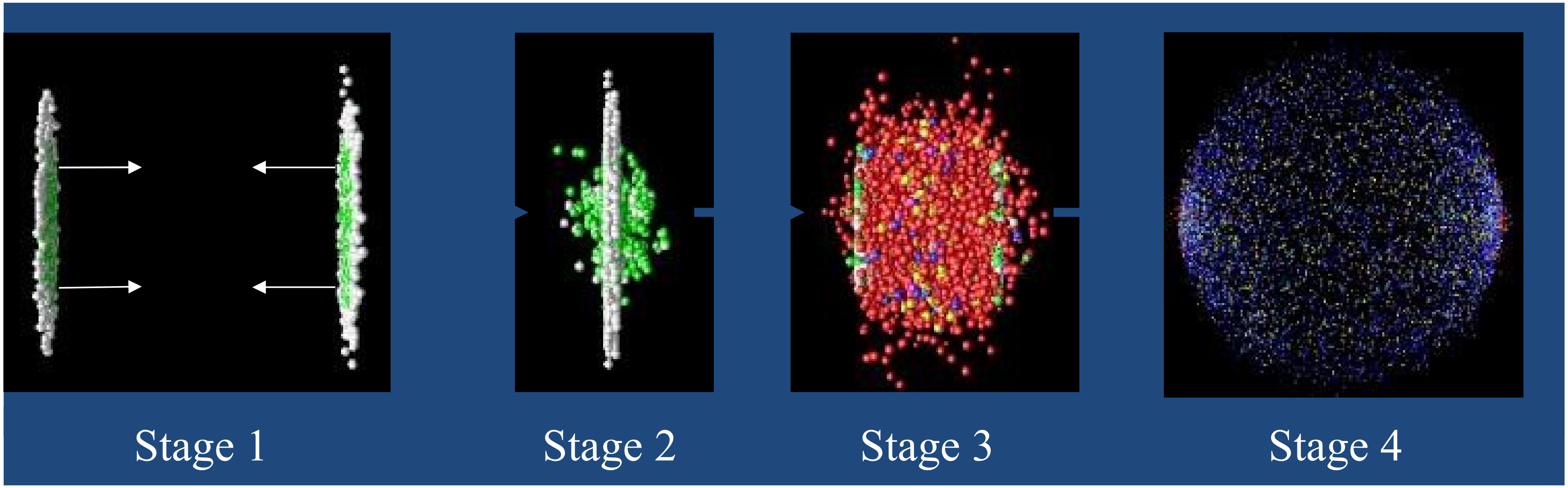
$\mu \sim 0.3$ GeV

Nuclear Matter:

$\mu \sim 1$ GeV

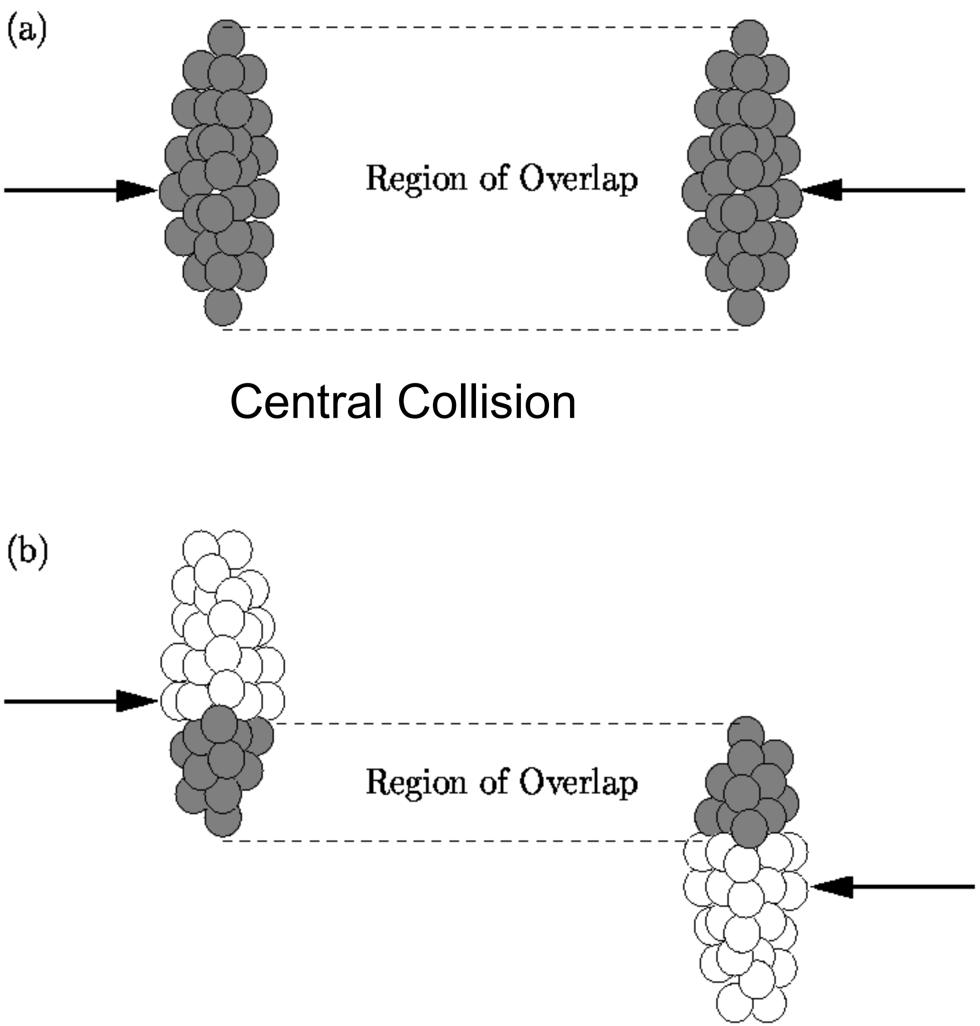
Heavy Ion Collisions

- **Why collide heavy ions?**
  - So as to pack enough energy into a large enough volume to create a macroscopic ultra-hot (10^{12} K) fireball within which matter enters the QGP phase



A typical Heavy Ion Collision

Terminology



Central Collision

Peripheral Collision

- **Collision Centrality**
  - Describes the overlap of two incoming ions at the point at which they collide
  - The more central the collision, the greater number of participating nucleons (N_{part} or N_{wound})
  - Energy of system increases with collision centrality
- **Multiplicity**
  - Number of charged particles produced in the collision

Terminology (2)

- Rapidity, y, is defined:

$$y = \frac{١}{٢} \mathit{ln}\left(\frac{E + P_L}{E - P_L}\right)$$

- Useful for HEP experiments as the rapidity distribution, measured in the lab frame, is unaffected by a longitudinal Lorentz boost and so easy to convert to centre of mass frame
- The rapidity of a particle is a measure of where in the collision it has come from.

Signatures of the QGP

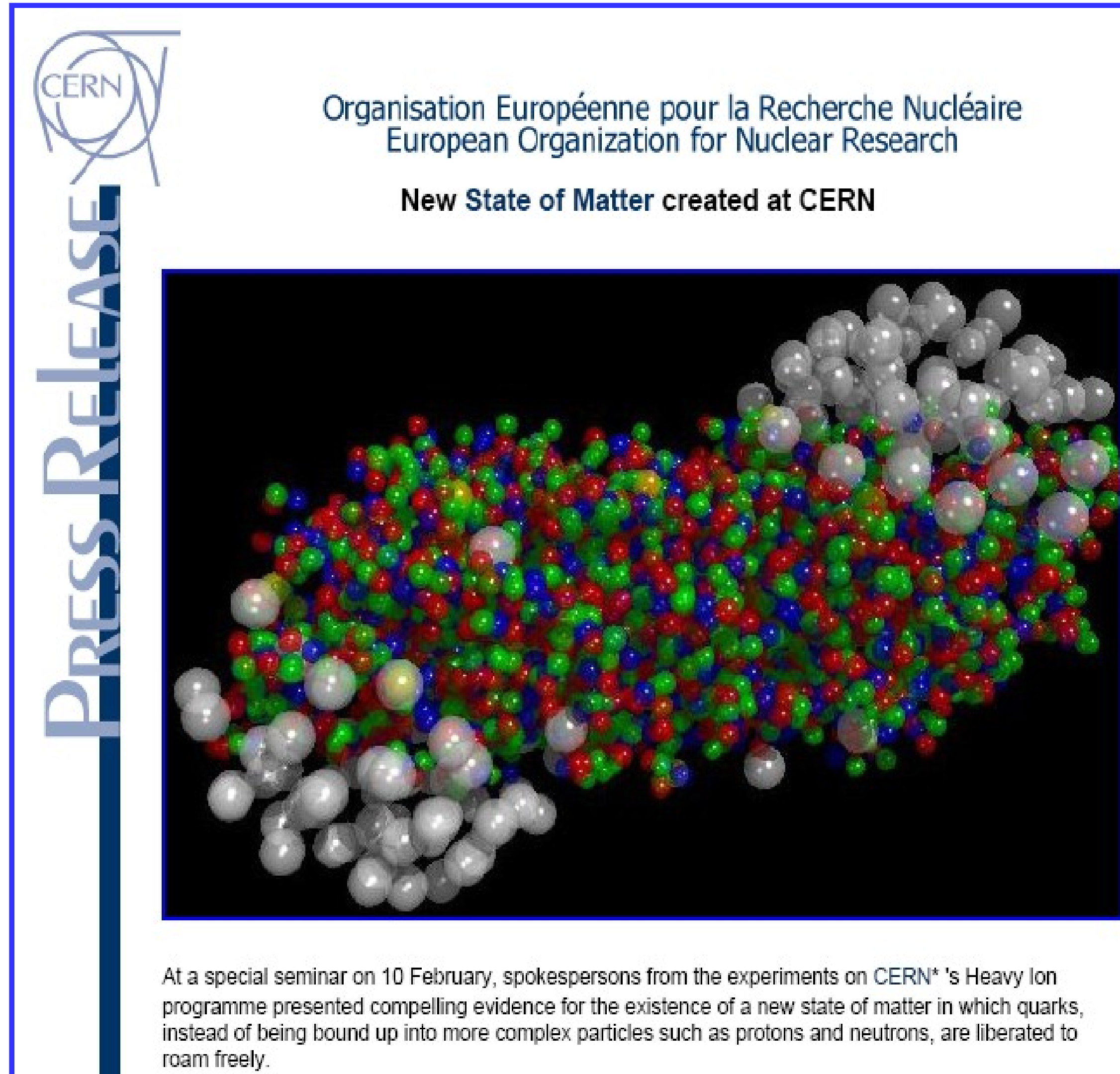
- It is not possible to observe a QGP directly, instead we look for predicted signatures
- The more commonly used signatures include:
  - Strangeness Enhancement
  - **J/ψ Suppression**
    - Dilepton Pairs
    - Direct Photons
  - High p_T Suppression and Jet Quenching

Refs (for example): J. Letessier & J. Rafelski, *Hadrons & Quark-Gluon* Plasma, CUP (2002)
JW Harris and B Müller, **Annu. Rev. Nucl. Part. Sci. 46** (1996) 71

From SPS, RHIC to the LHC

- SPS
  - Observed many of the signatures predicted for QGP formation
  - CERN announced a new state of matter in 2000.

SPS heavy ion programme
1986 with Oxygen ions
1987 - 1993 Sulphur ions
1994 - 2000 Lead ions

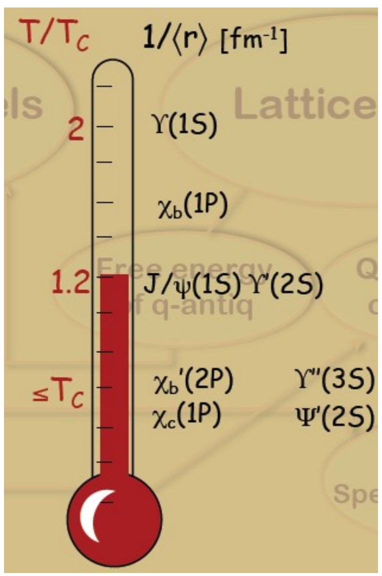

CERN
PRESS RELEASE
Organisation Européenne pour la Recherche Nucléaire
European Organization for Nuclear Research

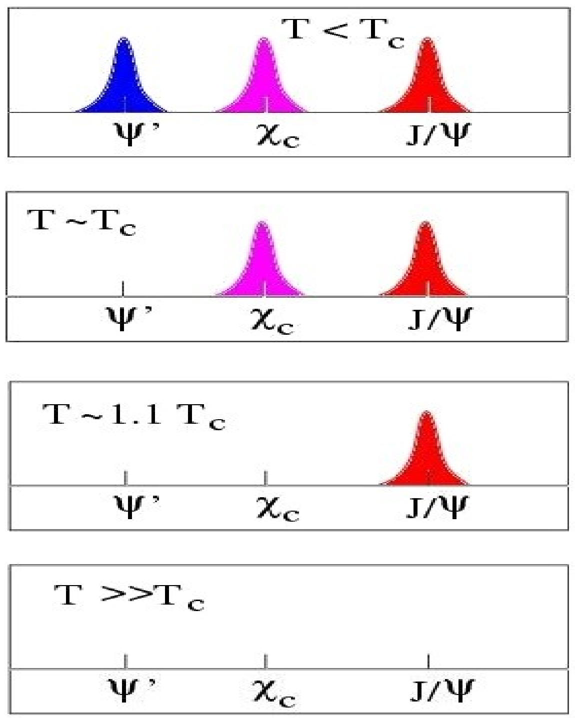
New State of Matter created at CERN

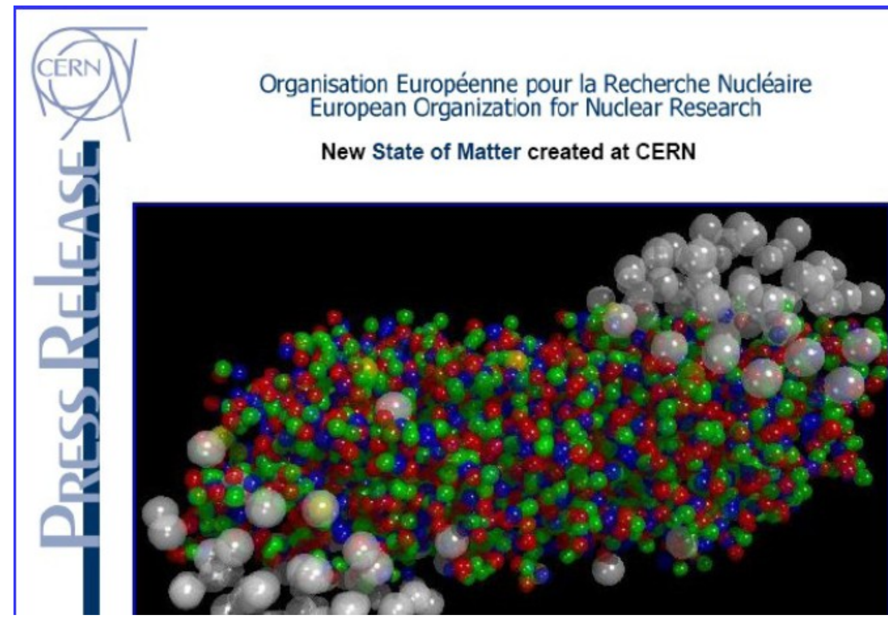
At a special seminar on 10 February, spokespersons from the experiments on CERN* 's Heavy Ion programme presented compelling evidence for the existence of a new state of matter in which quarks, instead of being bound up into more complex particles such as protons and neutrons, are liberated to roam freely.

Quarkonia in heavy-ions

Quarkonia suppression was one of the main pieces of evidence for CERN's claim to have produced a QGP phase at SPS energies





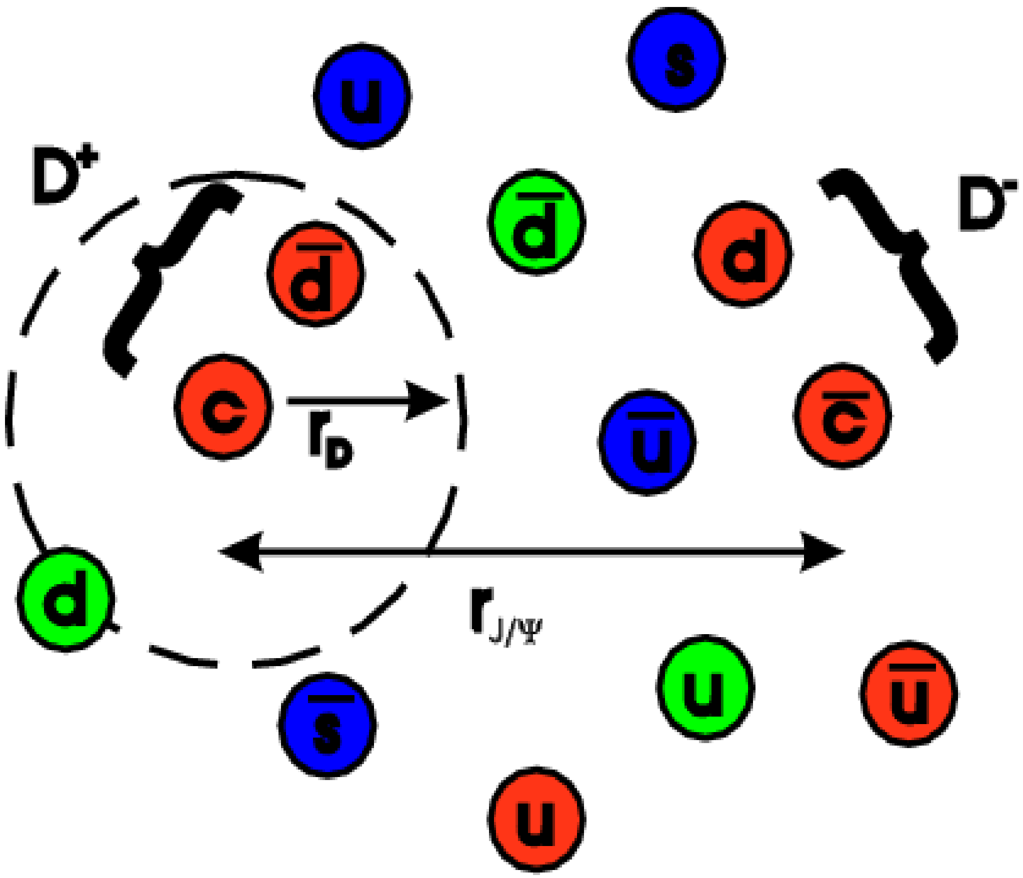


Debye screening predicted to destroy J/ψ's in a QGP with other states "melting" at different temperatures due to different sizes or binding energies

Different lattice calculations do not agree on whether the J/ψ is screened or not

measurements will have to tell!

J/ψ Suppression



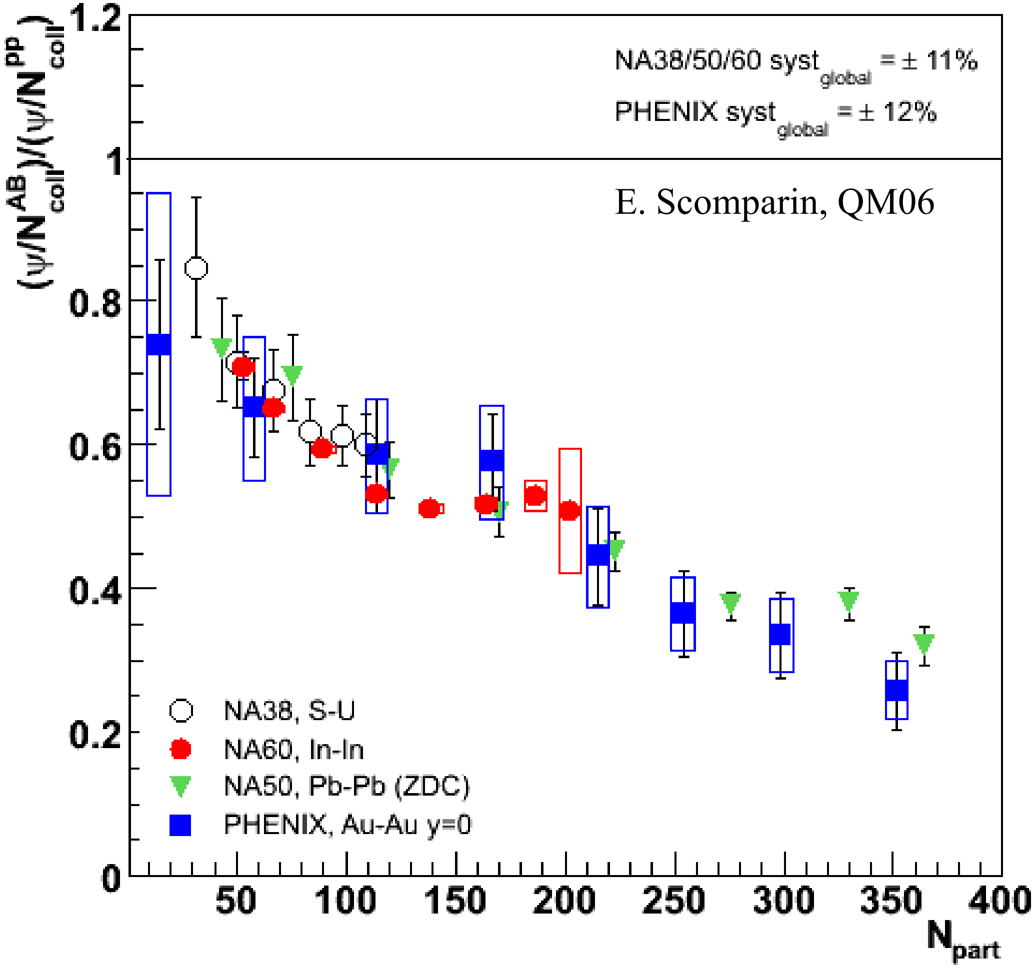
Colour screening in QGP: Screening radius < size of J/ψ (~0.5 fm)

So $c\bar{c}$ bound state cannot survive in QGP.
Seen at SPS energies

At LHC energies, colour screening could be strong enough to break-up ϒ ($b\bar{b}$) or maybe just ϒ' or ϒ''.

Anomalous suppression SPS and RHIC

J/ψ yield vs N_{part} , normalised to collision scaling expectations



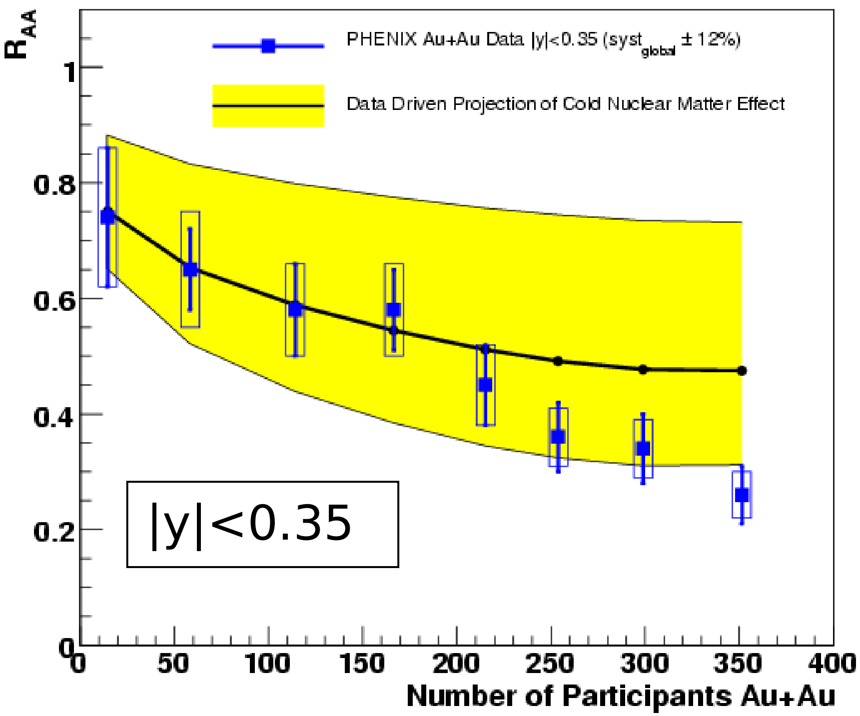
Peripheral collisions exhibit a J/ψ yield in agreement with the normal nuclear absorption pattern derived from pA collisions.

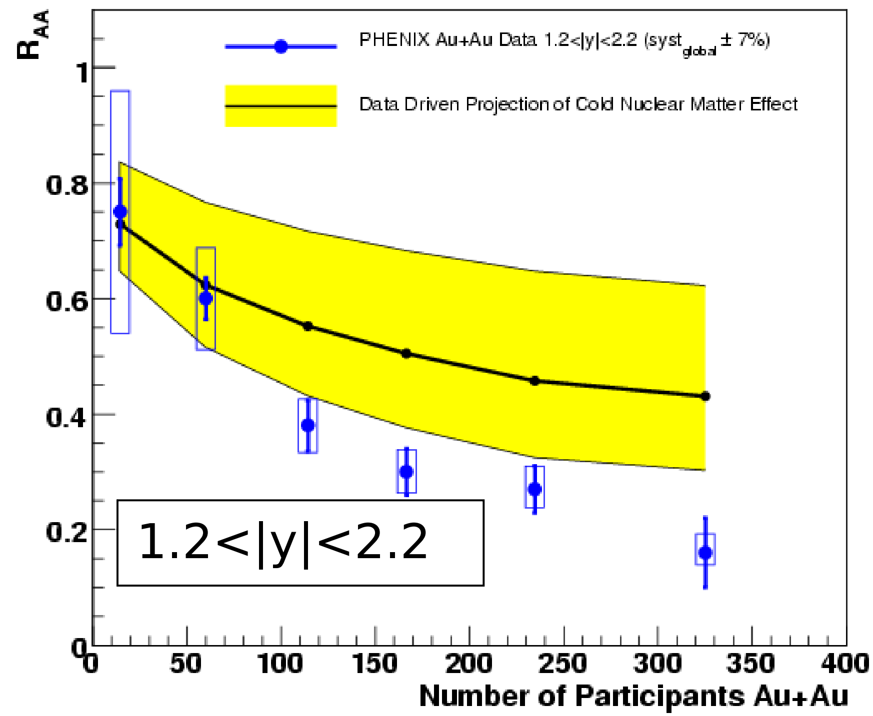
As the centrality of the collision increases → the J/Ψ yield decreases: **anomalous J/ψ suppression**

Suppression patterns are surprisingly similar at SPS and RHIC!

Suppression at RHIC

J/ψ Nuclear modification factor





Results from AuAu collisions at 200 GeV show that:

- more suppression at forward than at mid-rapidity
- suppression is beyond CNM effects: **anomalous suppression**

CNM effects include shadowing + absorption

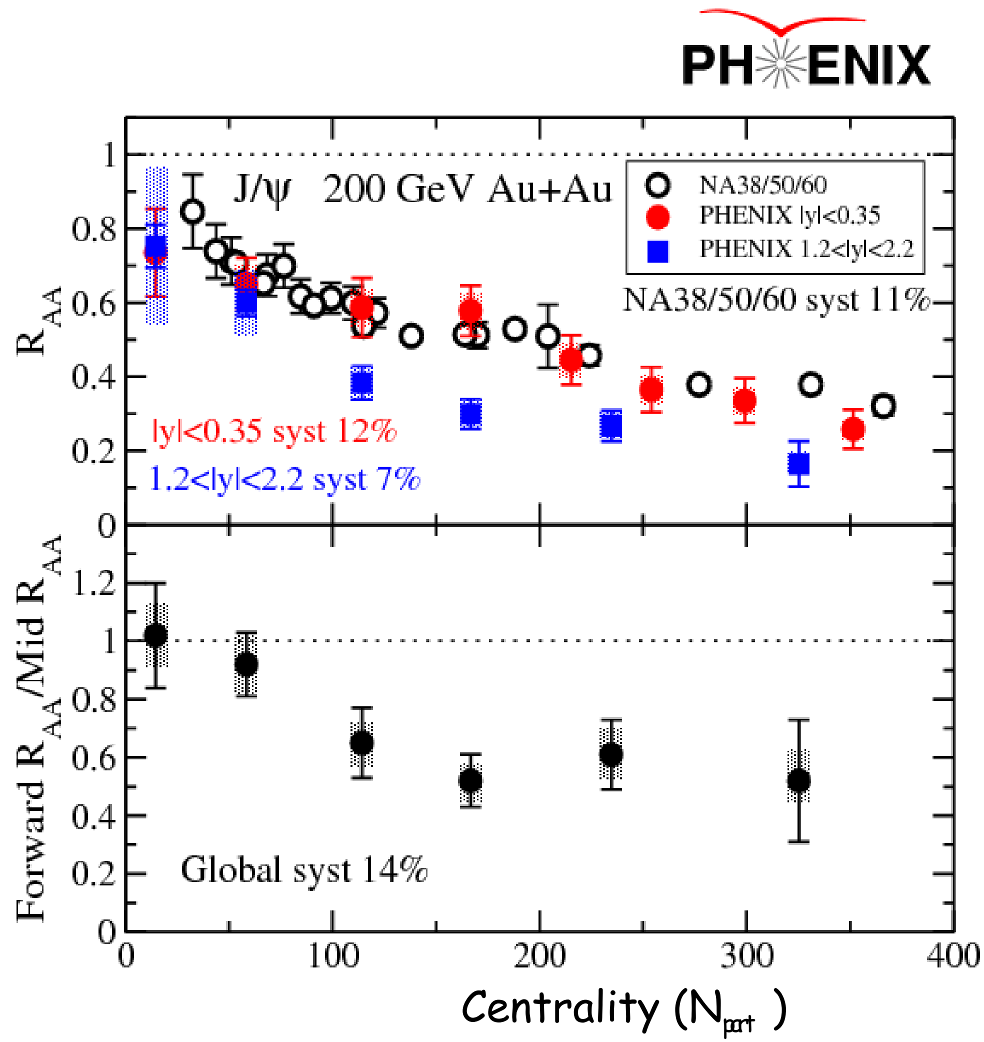
PHENIX A+A Data and Features

PHENIX Au+Au data shows suppression at mid-rapidity about the same as seen at the SPS at lower energy

- but stronger suppression at forward rapidity.
- Forward/Mid R_{AA} ratio looks flat above a centrality with N_{part} = 100

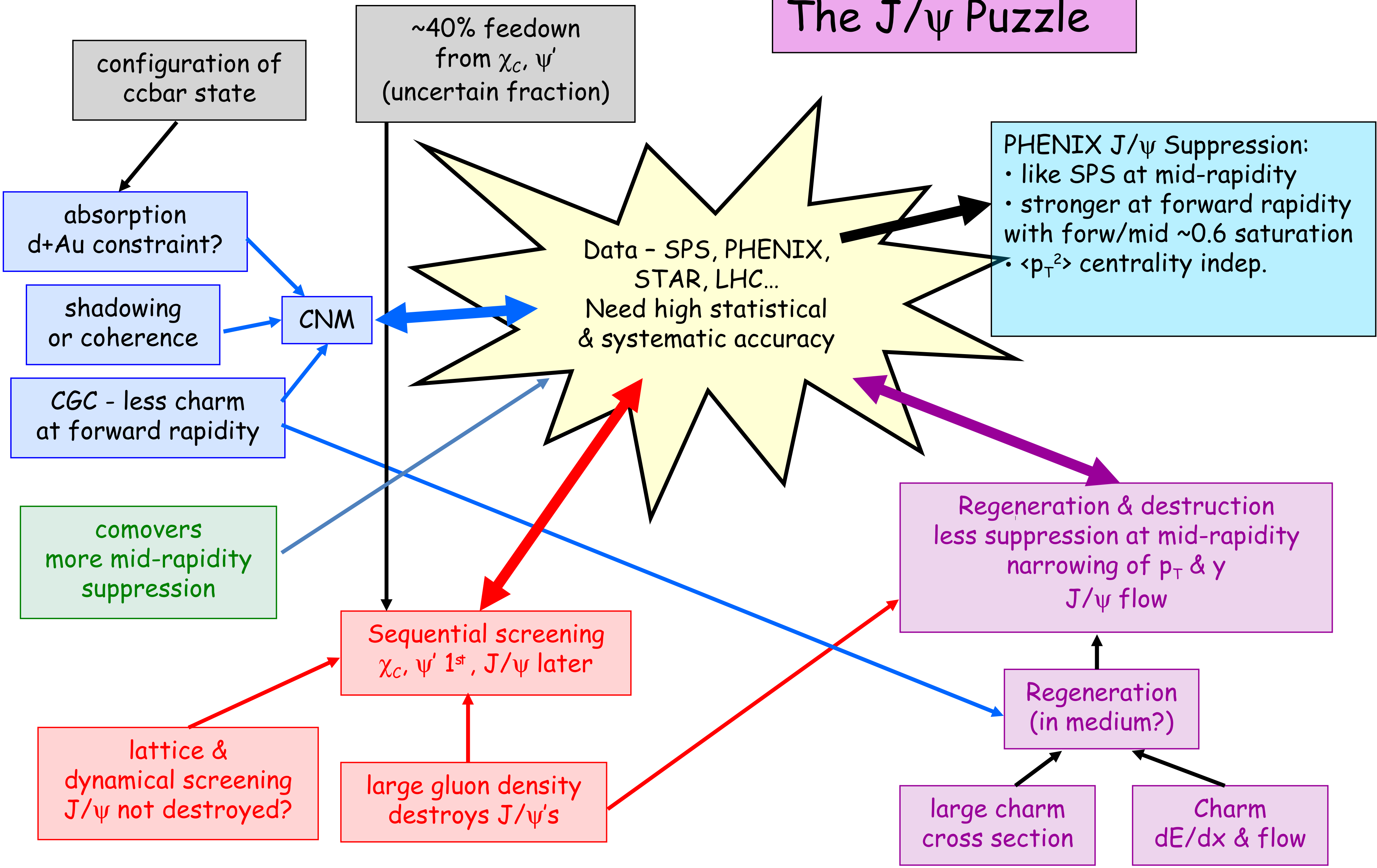
Several scenarios may contribute:

- Cold nuclear matter (CNM) effects
  - important, need better constraint
- Sequential suppression
  - QGP screening only of χ_c & ψ' - removing their feed-down contribution to J/ψ at both SPS & RHIC
- Regeneration models
  - give enhancement that compensates for screening



Mike Leitch

The J/ψ Puzzle



Parton Distribution Functions in nuclei

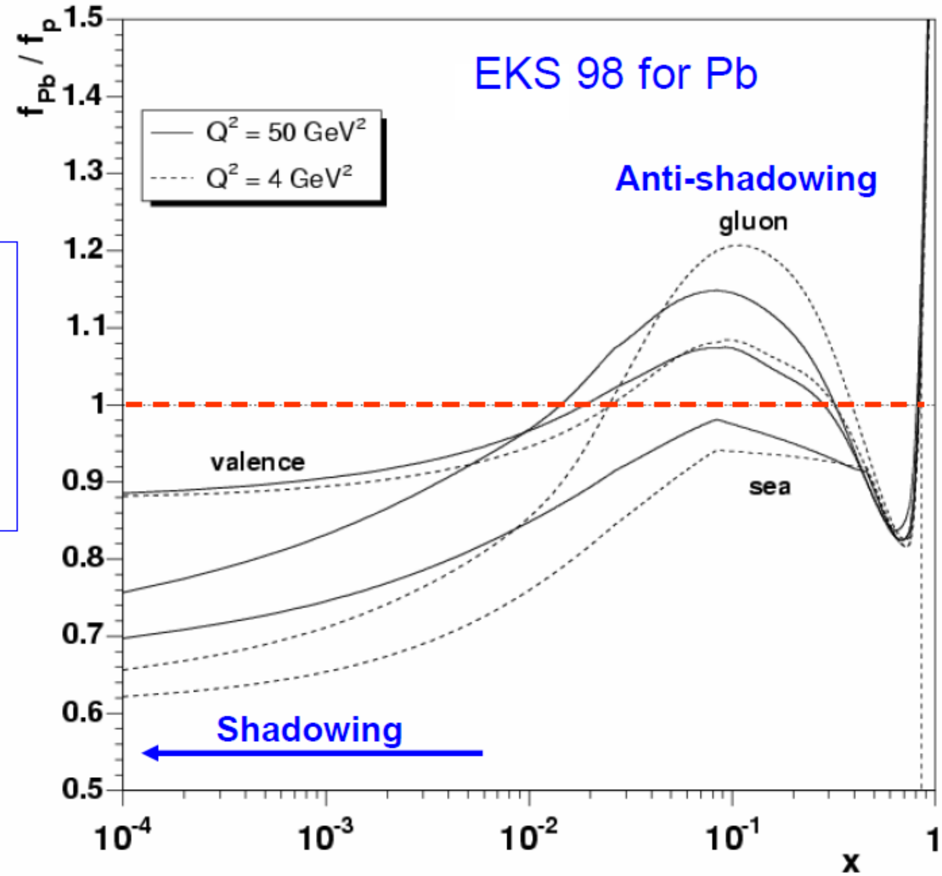
Is a free proton the same as a proton inside a nucleus?
No! Some "nuclear effects" modify the probabilities of finding partons of given *x* when the proton is inside a nucleus
The "EKS 98 model" (among others) provides the ratio between the PDFs in a "proton of a nucleus of mass number A" and in a "free proton"

$$R_i^A(x,Q^2) = \frac{f_i^A(x,Q^2)}{f_i^p(x,Q^2)}$$

<u>"Shadowing" or "anti-shadowing":</u>

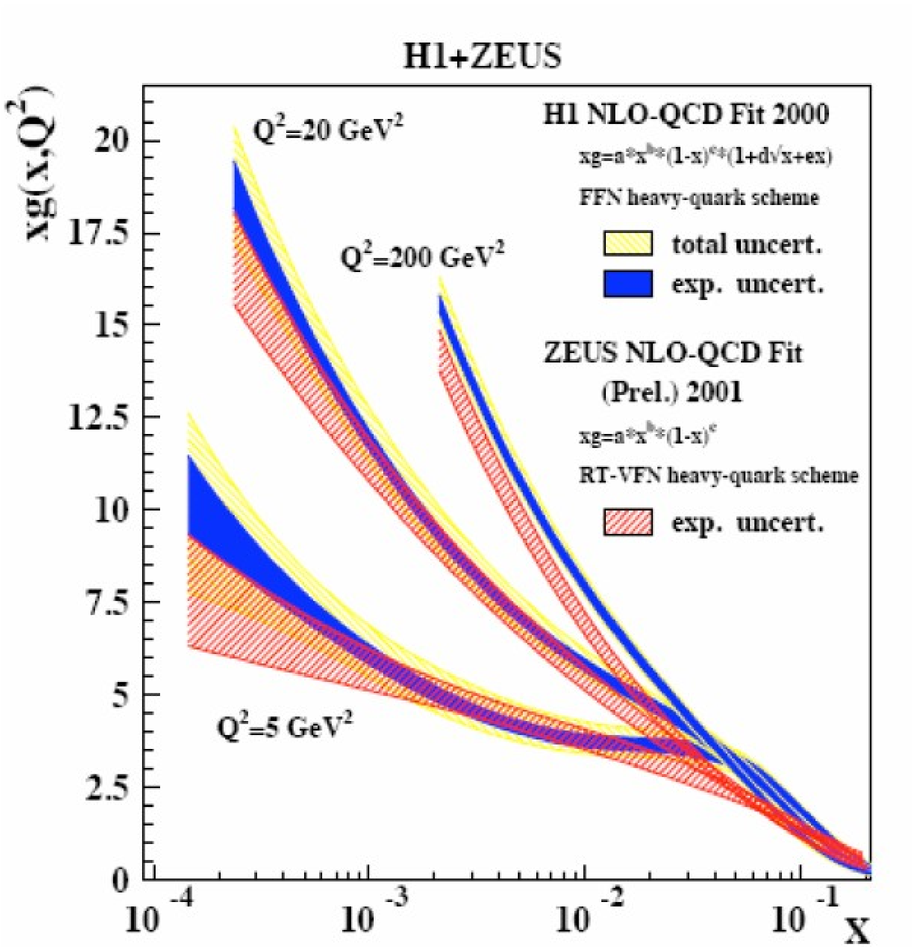
Decrease or increase of the parton's density in the nucleus, in a certain kinematic range…

For a given collision energy and a given produced mass, the *x* values depend on the rapidity range where the measurement is made

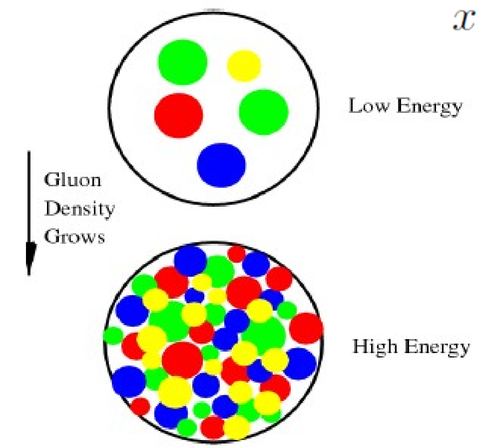


(Shadowing means that some of the partons are obscured by virtue of having another parton in front of them. For hard spheres, for example, this would result in a decrease of the scattering cross section relative to what is expected from incoherent independent scattering.)

Small-x physics and non-linear evolution



$x = E_{\text{constituent}} / E_{\text{hadron}}$

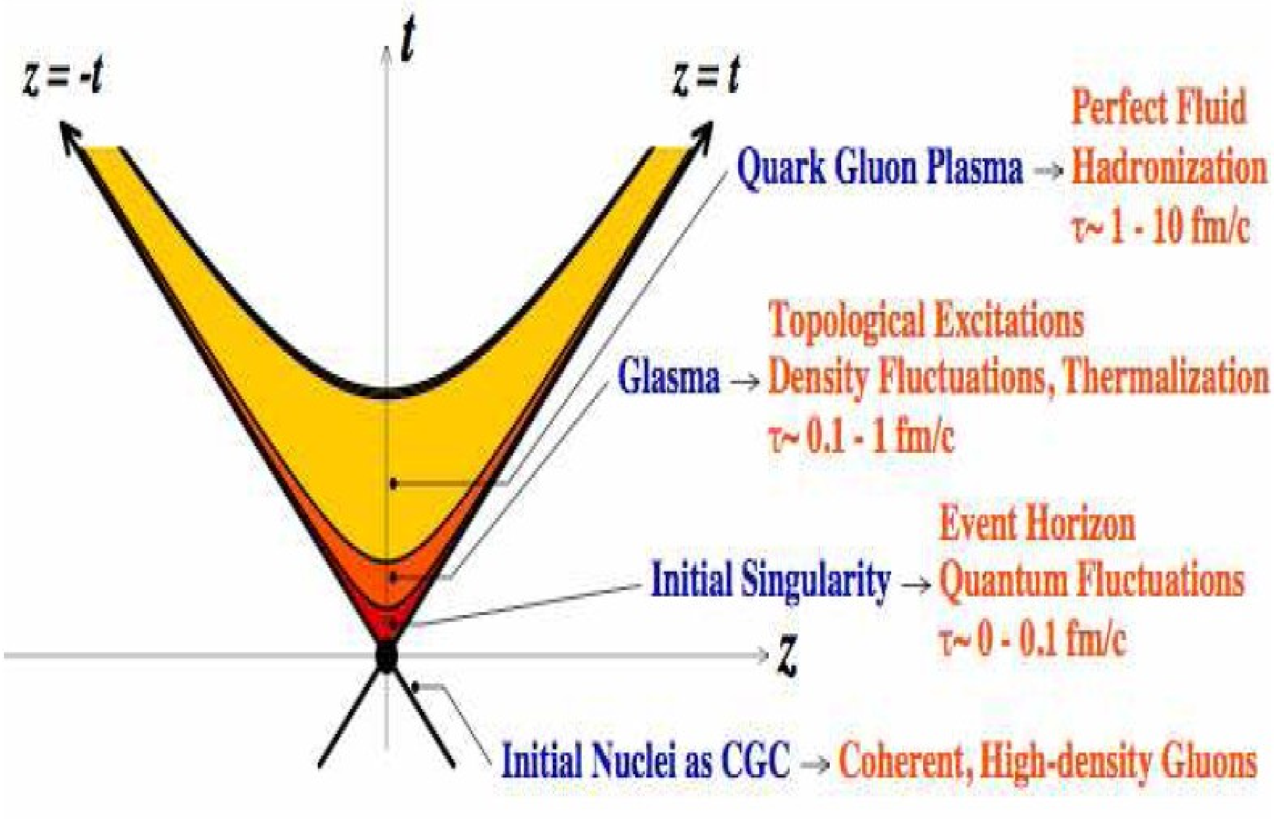


$y \sim \ln(1/x).$

- At low x, there must be a regime (at $q^2 < Q_s^2$) where partons overlap. Here, the increase in the number of small x partons becomes limited by gluon fusion.
- *Saturation scale* Q_s^2 (x) to be determined experimentally.

This is the quantum evolution of the hadron
wavefunction. Because the saturation momentum is larger in nuclei than it is in protons, it is more difficult to produce glue at small x. Therefore as one goes to smaller values of x, there should be fewer particles at small x relative to the expectation from incoherent scattering.... L.M.

Heavy-ion collisions

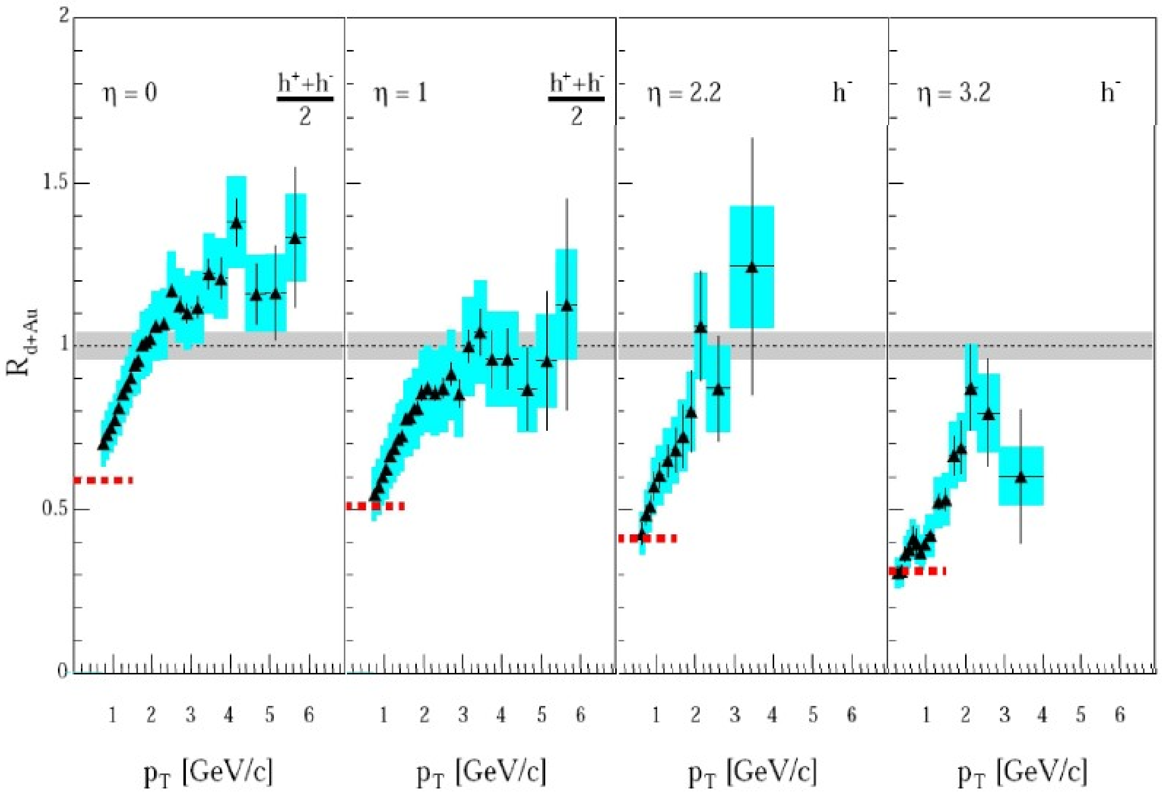


The CGC provides a framework to describe nucleus-nucleus collisions up to a time of

$$\tau \sim Q_s^{-1}$$

Nuclear modification factor at RHIC

BRAHMS data



$$R_{dAu} = \frac{1}{N_{coll}} \frac{\left(\frac{dN}{dP_T d\eta}\right)_{dAu}}{\left(\frac{dN}{dP_T d\eta}\right)_{pp}}$$

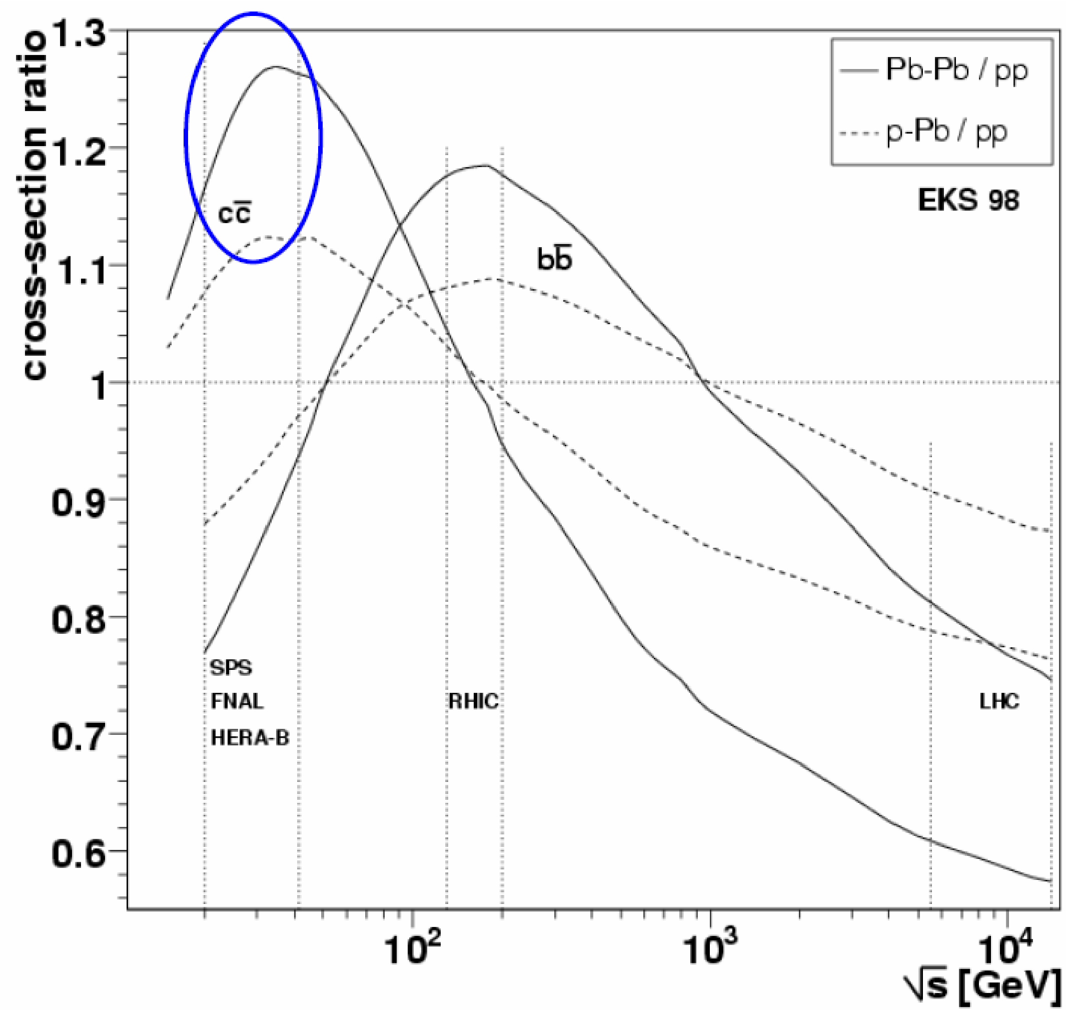
- Albacete, Armesto, Kovner, Salgado, Wiedemann ('03)
- Kharzeev, Levin, McLerran ('03)
- Iancu, Itakura, Triantafyllopoulos ('04)

Experience from SPS and RHIC

- **We have learnt that understanding less complex systems (p+p and p+A) is a must**
  - Cold Nuclear Matter effects (CNM) are not trivial.
- Measurements in p+A are needed.
- Vital to measure p+p and p+A at same $\sqrt{s}$ (or above and below) than that in A+A

Are nuclear PDFs important?

The EKS98 nuclear PDFs give a 20-25% *higher* charm production cross section in Pb-Pb collisions at the SPS and a ~40% *lower* value at the LHC, as compared to a linear extrapolation from pp collisions



Remarks:

If the pp and Pb-Pb collisions are collected at different energies, the corrections for the nuclear effects are non trivial

We cannot *directly* compare heavy-ion and pp data

This influences the analysis of the J/ψ suppression data and the comparisons between the SPS and RHIC data sets

Central to Peripheral Modification Factor (R_{CP})

$$R_{CP}(p_T) = \frac{\langle N_{coll} \rangle_P}{\langle N_{coll} \rangle_C} \times \frac{d^2 N_C / dp_T dy}{d^2 N_P / dp_T dy}$$

C and P are two centrality classes, Central and Peripheral
N_{coll} are the average number of nucleon-nucleon (N-N) collisions for nucleus-nucleus (A-A) collisions in a given centrality class

- Expect $R_{CP} = 1$ if the A-A collision were merely a superposition of N_{coll} independent N-N collisions

Ref: F Antinori *et al.* (NA57 Collaboration), **Phys. Lett. B 623** (2005) 17

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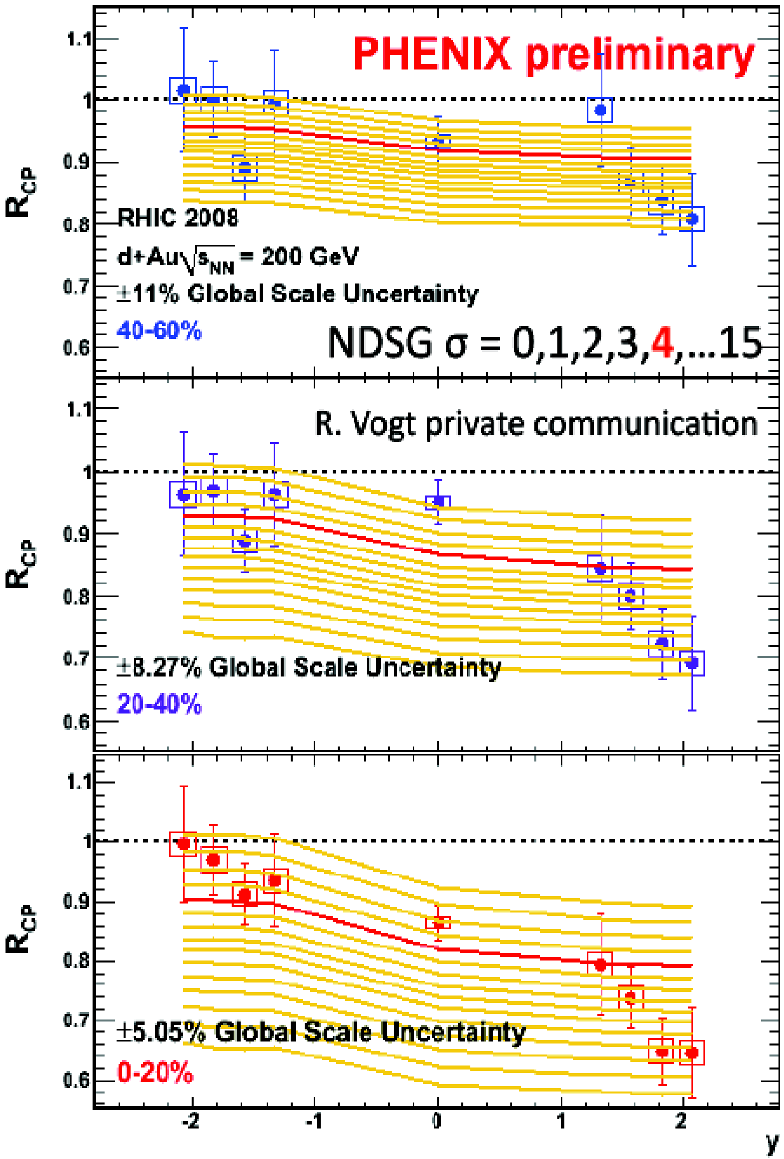
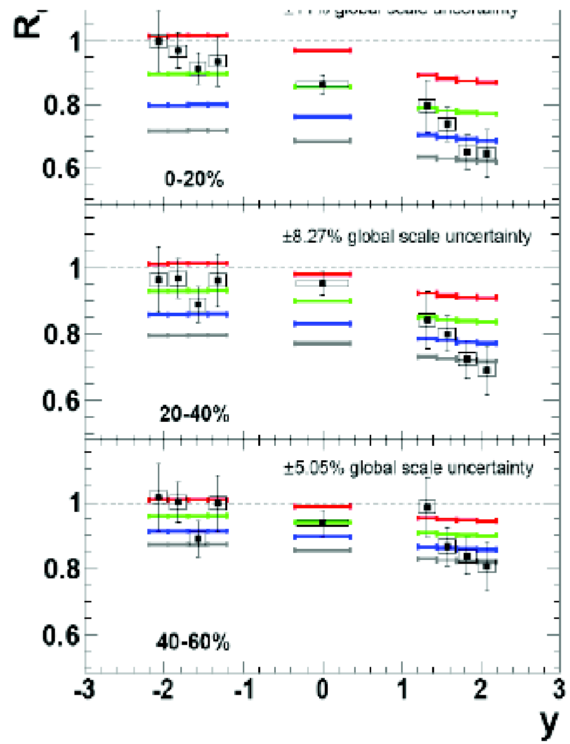
J/ψ CNM effects

pA might be crucial to understand the AA data at LHC energies

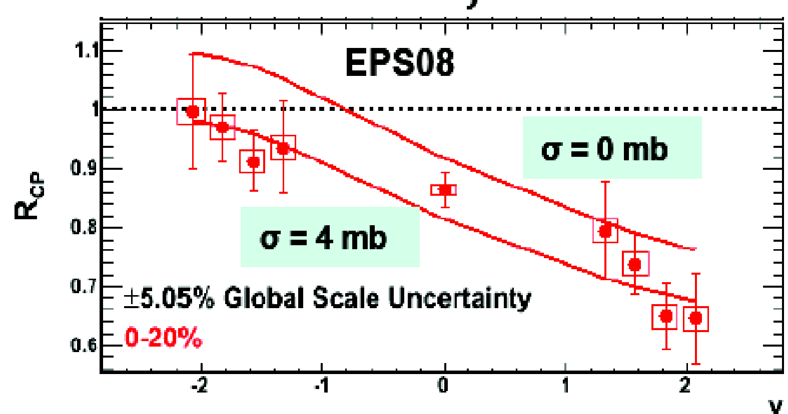




arXiv:0912.4498

At PHENIX, CNM effects (EKS shadowing + dissociation from fits to d+Au data, with R. Vogt calculations) give large fraction of observed Au+Au suppression, especially at mid-rapidity

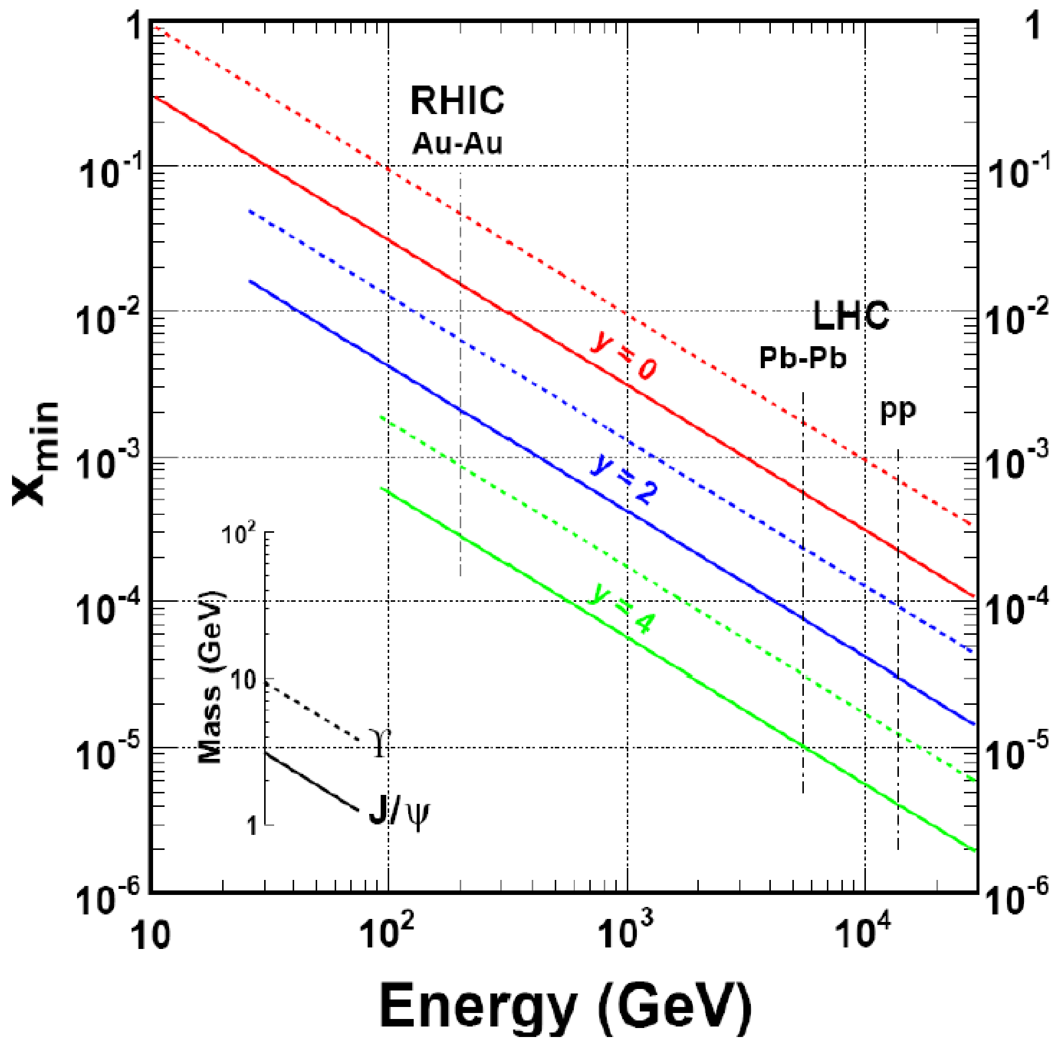
Bottom line:
CNM could explain the mid-forward rapidity difference



L. Levy @ ICHEP 2010

High statistics data provides a strong test of CNM models

The small-*x* regime



From RHIC to LHC

x_{min} ↘ ~ 10^{-2}

- factor 1/30 due to energy
- factor 1/3 larger rapidity

With J/ψ at rapidity 4

- Pb+Pb collisions $x_{min} \sim 10^{-5}$
- p+p collisions $x_{min} \sim 3\times10^{-6}$

The LHC: p+p, **p+A** and A+A collider

J. M Jowett – CERN LHC project

- Heavy ion programme (ALICE PPR Vol I) foresees 1 year p+Pb run
- The LHC has a single magnet ring with two beams aperture.
  - Pb-beam momentum (Z/A) x p_p = 2.8 TeV
  - **Peaked at 8.8 TeV for p+Pb. For p_p =4.4 TeV, $\sqrt{S}$ = 5.5 in p+Pb**
  - Physics conditions involve **a central rapidity shift of 0.47 in p+Pb**
  - d+Pb is more interesting because of a shift of 0.1 (same acceptance than Pb+Pb) but technically difficult (an additional injection source will be needed)

$$L = 1.5 \times 10^{29} cm^{-2} s^{-1}$$

$$\sqrt{s} = \sqrt{\frac{Z_1 Z_2}{A_1 A_2}} p_p$$

$$\Delta y = 0.5 \ln\left(\frac{Z_1 Z_2}{A_1 A_2}\right)$$

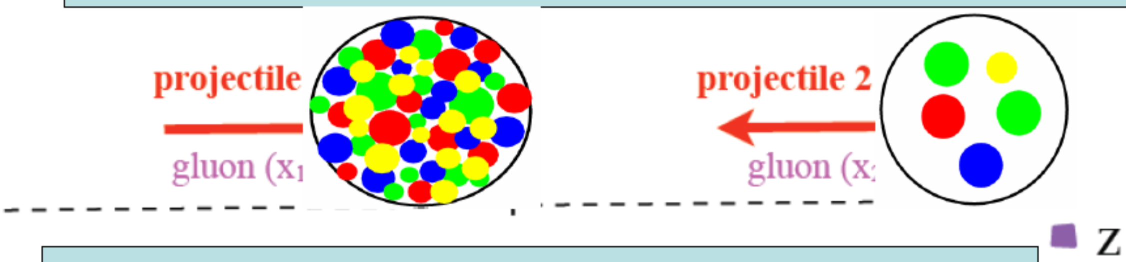
HQ pair cross-section in p+A

$$\frac{dN_Q^{pPb}}{dy d^2 P_T} = f_g^{(p)}(x_1) \otimes \varphi(x_2) \otimes \frac{dN^{sat}_{gluons \to Q\bar{Q}}}{dy d^2 P_T}$$

1. **Gluon distribution in the proton** (CTEQ)
2. **Gluon distribution in a saturated nucleus**
   (BK evolution equation + initial condition on x_2 from the McLerran-Venugopalan model)
3. **Heavy quark spectrum**
   (gluon fusion with rescattering effects)

Describing *this* CGC

- **Description by Fujii, Gelis and Venugopalan**
- Initial condition at $x_0 = 10^{-2}$ McLerran-Venugopalan model.



$Q^2_{s,p}$ =0.33 GeV^2

$Q^2_{s,A}$ = 1.93 GeV^2

α_s fixed at 0.15

m_c = 1.2 GeV/c

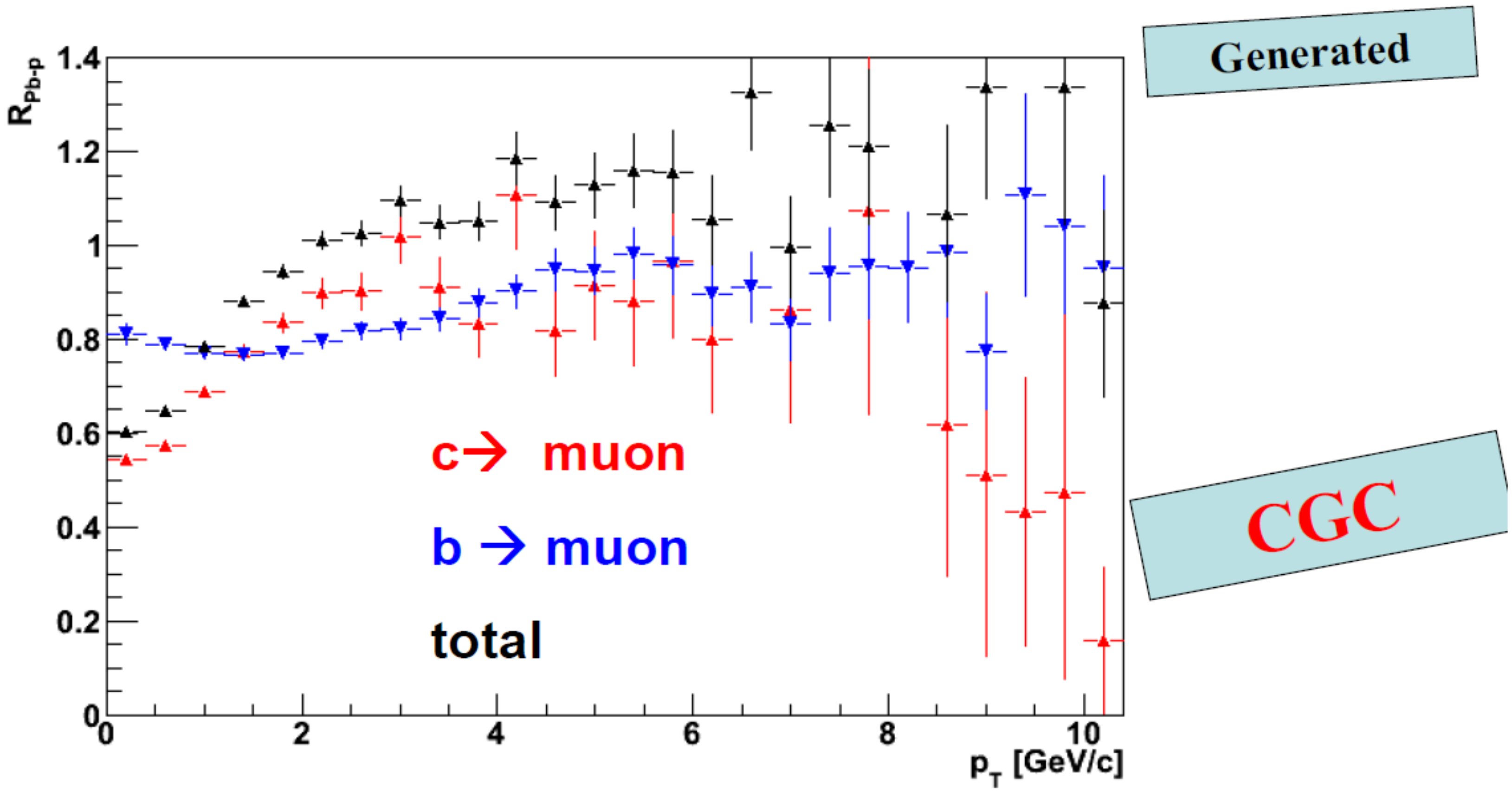
ALICE Muon reference frame

-4.0 < y < -2.5

Projectile 1: *A dense system* described at a given Q2s,A. Only the most central collisions are considered here.

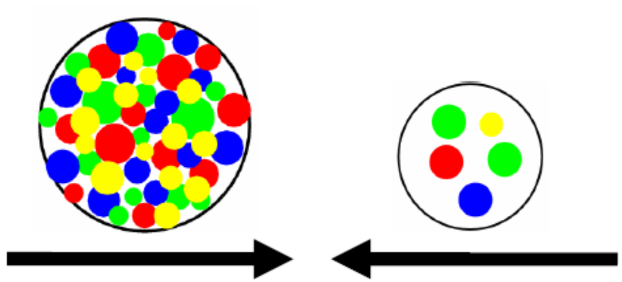
Projectile 2: *A Dilute system*. PDFs by CTEQ6

Nuclear modification factor- CGC



The J/Ψ: Suppression

numerical calculations at 8.8 TeV



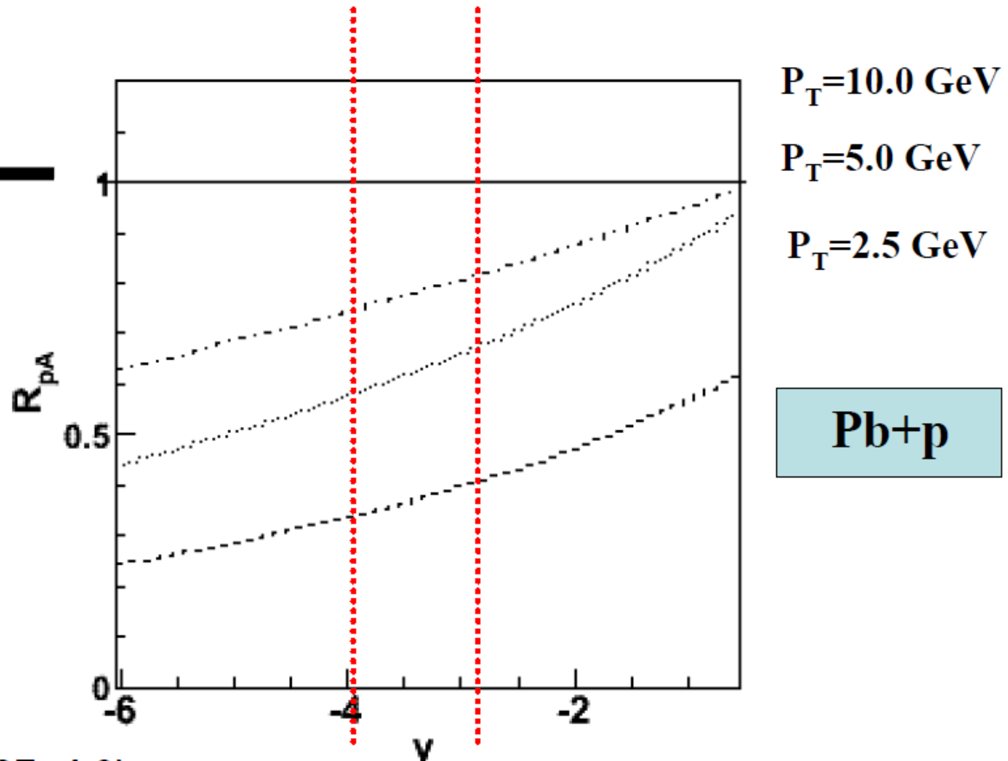
$Q^2_{s,p}$ =0.17 GeV^2

$Q^2_{s,A}$ = 2.0 GeV^2

α_s fixed at 0.15

m_c = 1.2 GeV/*c*

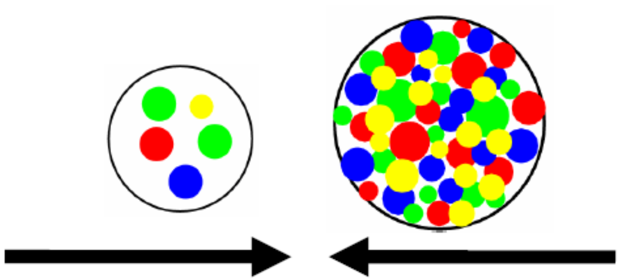
***c.f.* with EPS09.**
R_{pA}=0.7 within the ALICE muon Acc



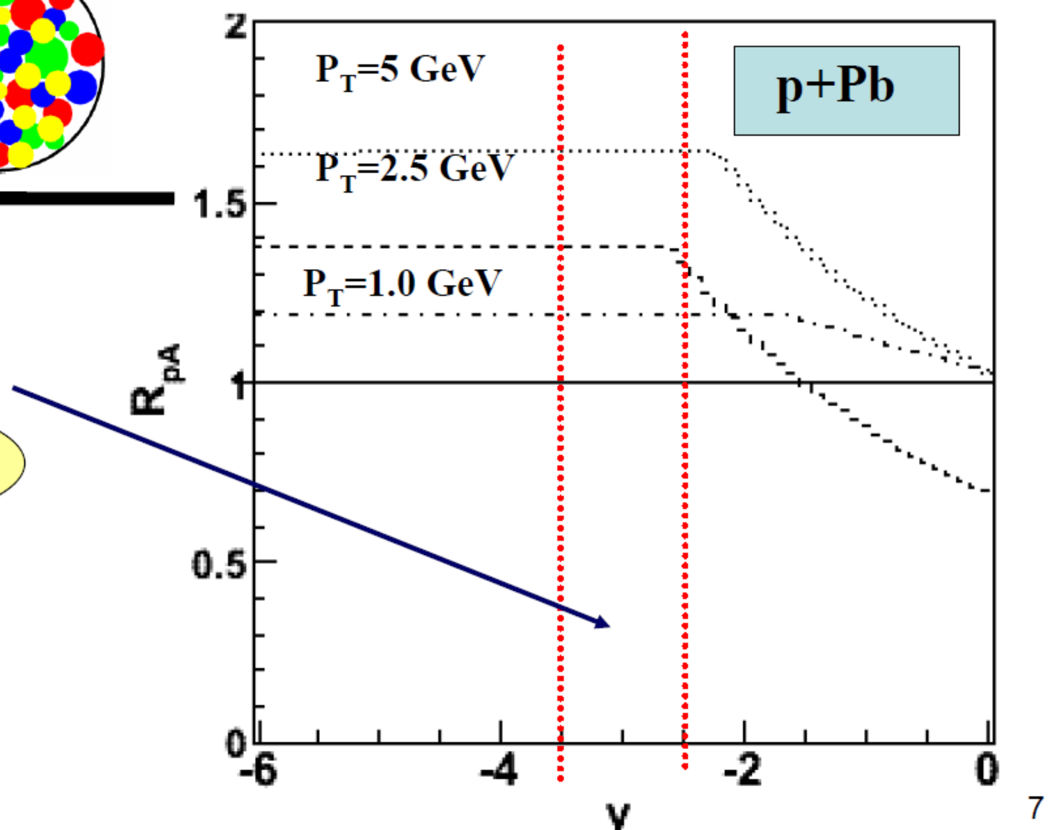
(-2.97,-4.0)

The J/Ψ: multiple scattering

numerical calculations at 8.8 TeV

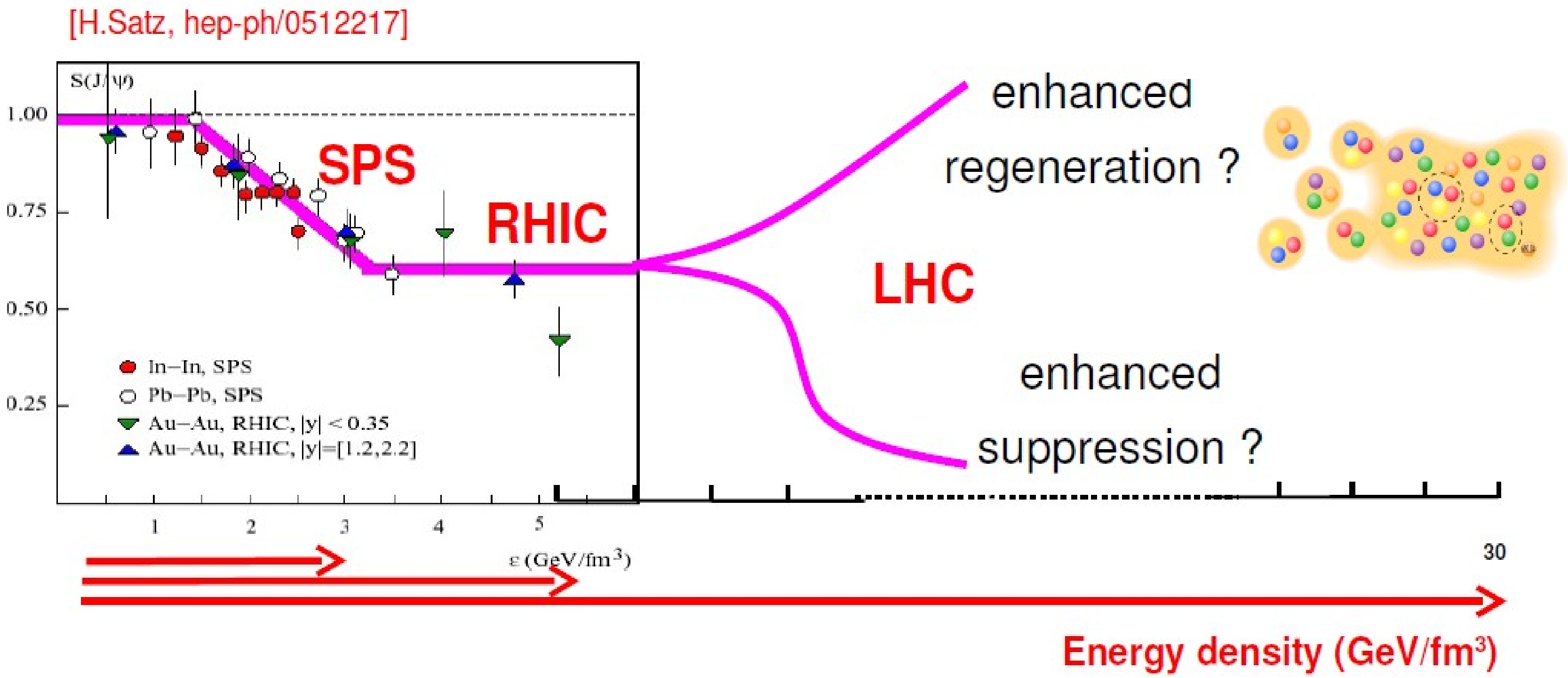


$x_2(A) > 0.01$



(-2.5,-3.53)

Quarkonia in heavy-ions



The long standing unambiguous signature of deconfined quark matter has somehow become ambiguous :Suppression pattern "anomalously" comparable at SPS and RHIC.

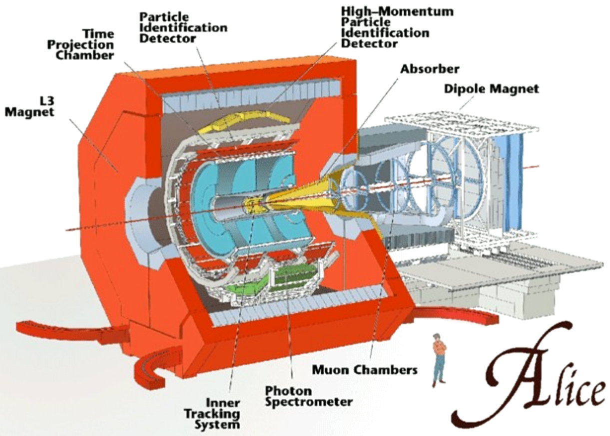
Rapidity dependence

Different CNM/shadowing effects

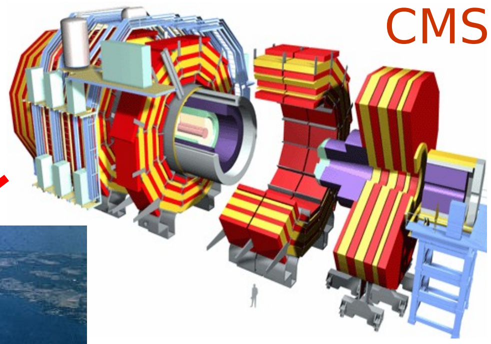
Sequential melting : ψ', χ_C only

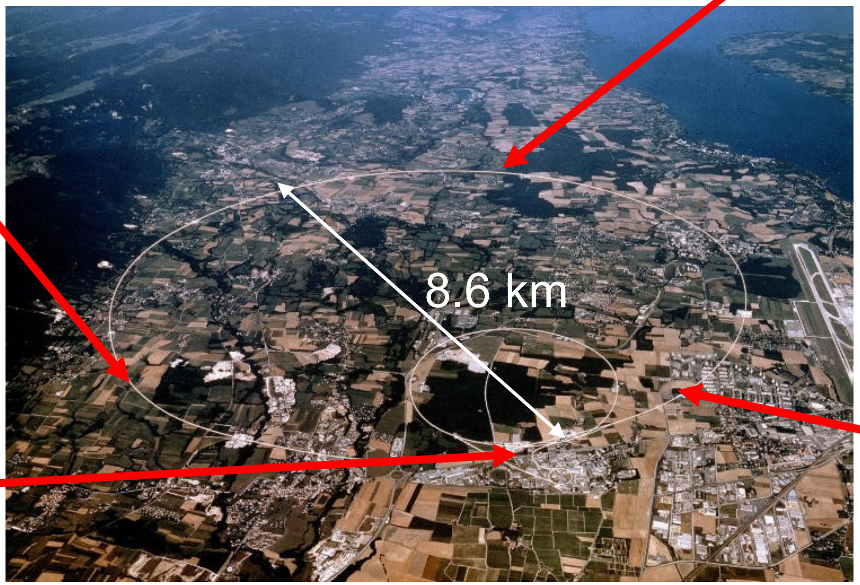
Statistical hadronisation : a possible scenario motivated by the large production of charm in Pb+Pb collisions

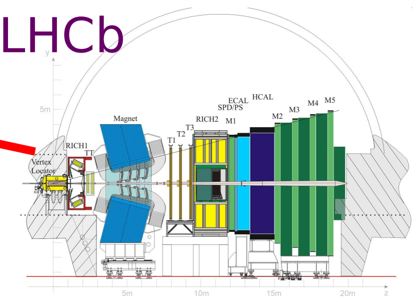
The CERN's LHC

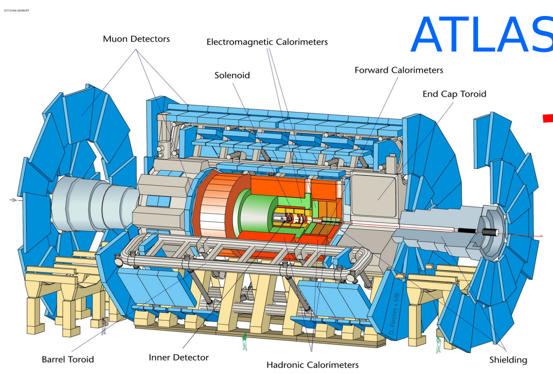


Large Hadron Collider



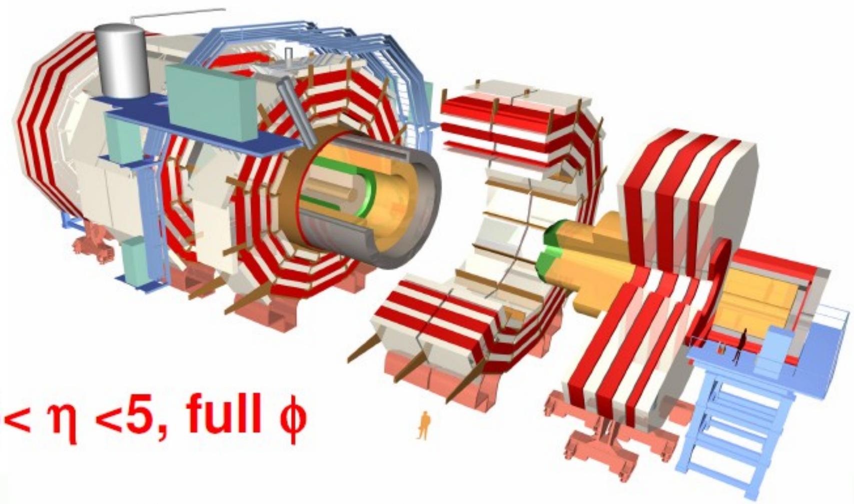




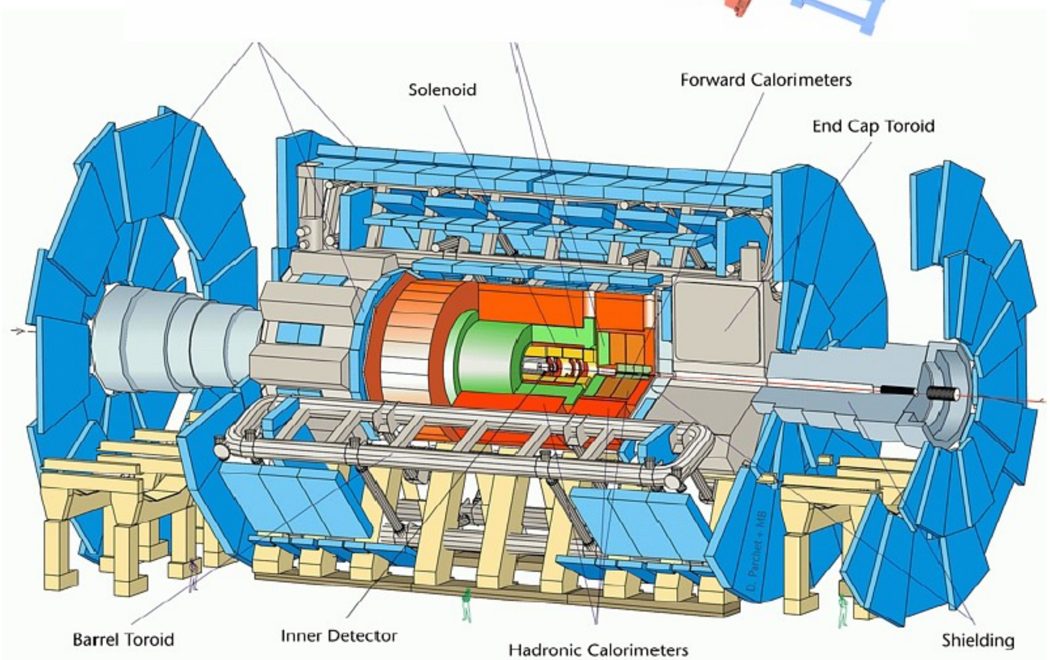


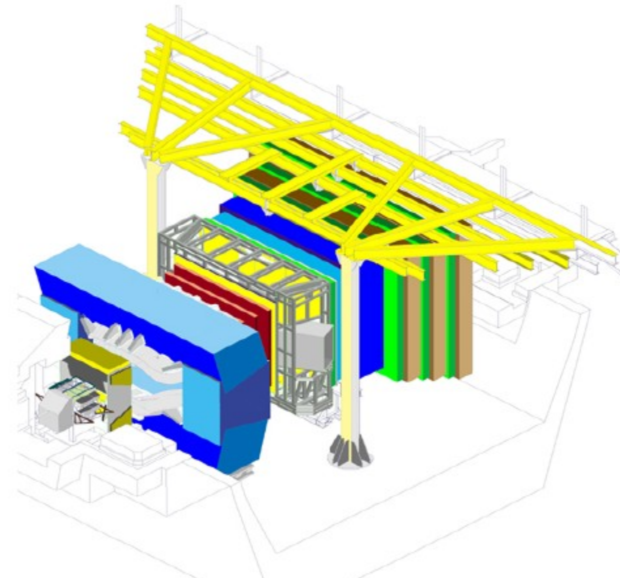
- 2 concentric rings with 27 km circumference
- counter-rotating beams of ions from p to Pb
- max. center-of-mass energy:
  PbPb 5.5 ATeV, pp 14 TeV
- **first heavy ion run: November 2010**

ATLAS, CMS & LHCb detectors



-5< η <5, full φ



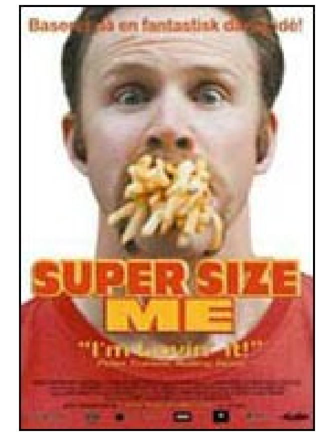


2< η <5, full φ

The ALICE experiment at the LHC

From SPS, RHIC to the LHC

	SPS	RHIC	LHC
$\sqrt{s_{NN}}$ (GeV)	17	200	5500
dN_{ch}/dy	500	850	1500-4000
τ^0_{QGP} (fm/c)	1	0.2	0.1
T/T_c	1.1	1.9	3-4
ε (GeV/fm^3)	3	5	15-60
τ_{QGP} (fm/c)	≤2	2-4	≥10
τ_f (fm/c)	~10	20-30	30-40
V_f (fm^3)	few 10^3	few 10^4	Few 10^5



Hotter

Denser

Longer

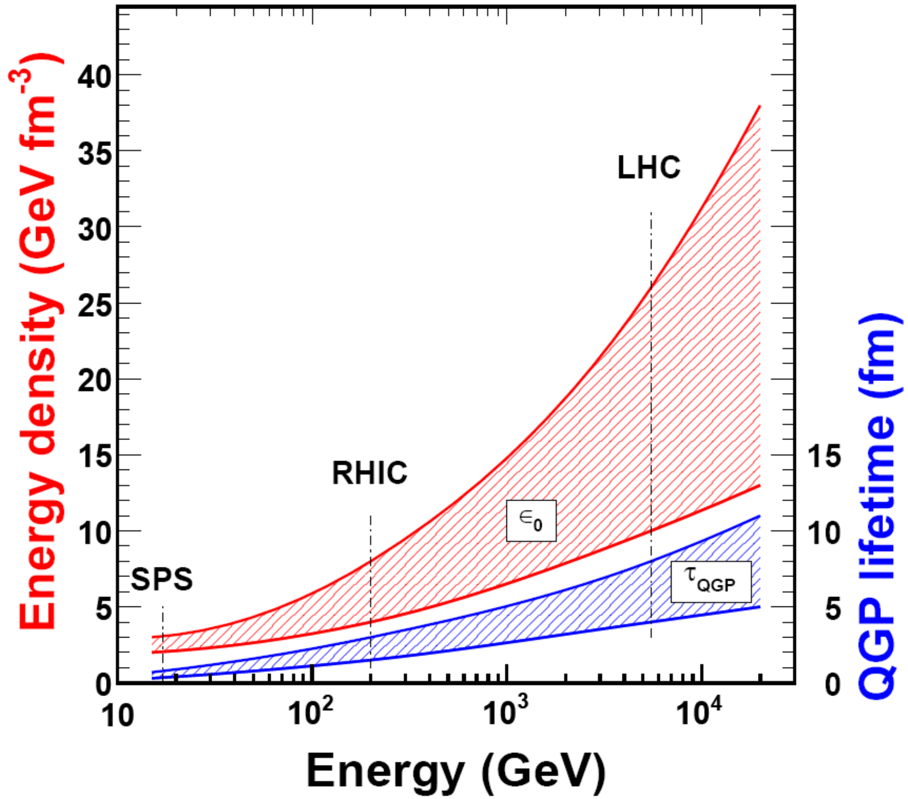
Bigger

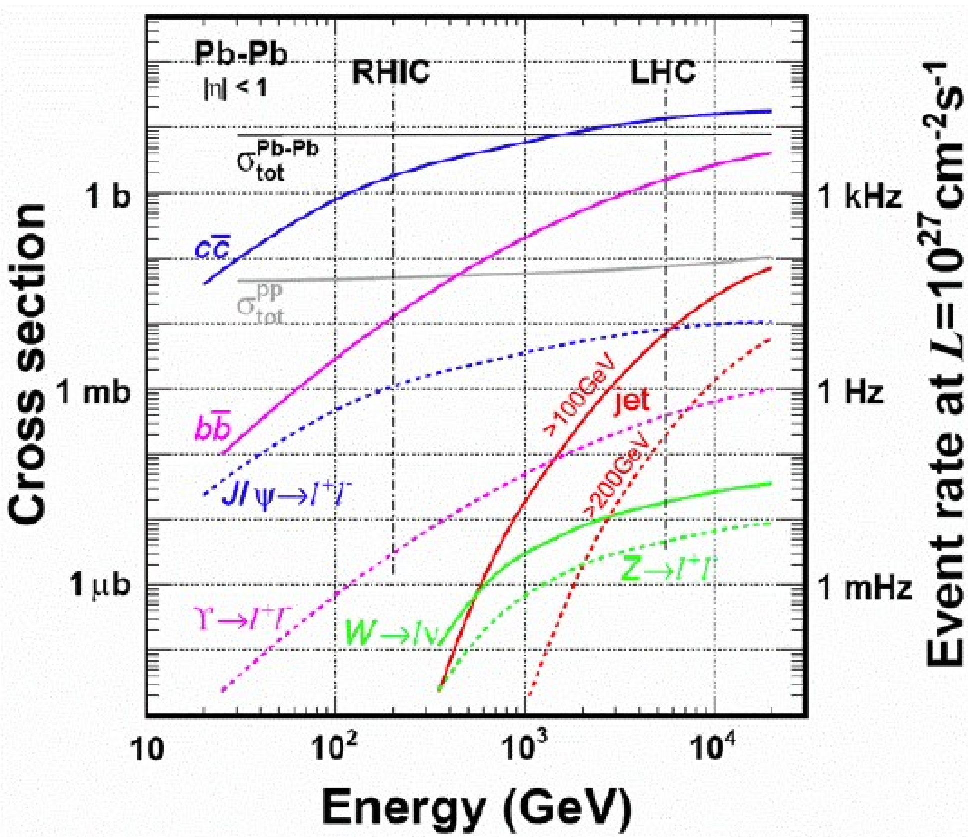
1 GeV ≈ mass of proton
1fm (Fermi) =10-15m ≈ radius of proton

Physics motivation

- A big step in $\sqrt{s_{NN}}$
  - (SPS x 13 = RHIC) x 28 = LHC
  - Energy density well above the expected phase transition (hotter,bigger,longer)

→ Hard probes as new probes





Heavy Quarks, abundantly produced in the first instant 0.03-0.1 fm/c, will probe QGP/medium over its whole lifetime (~ 10 fm/c)

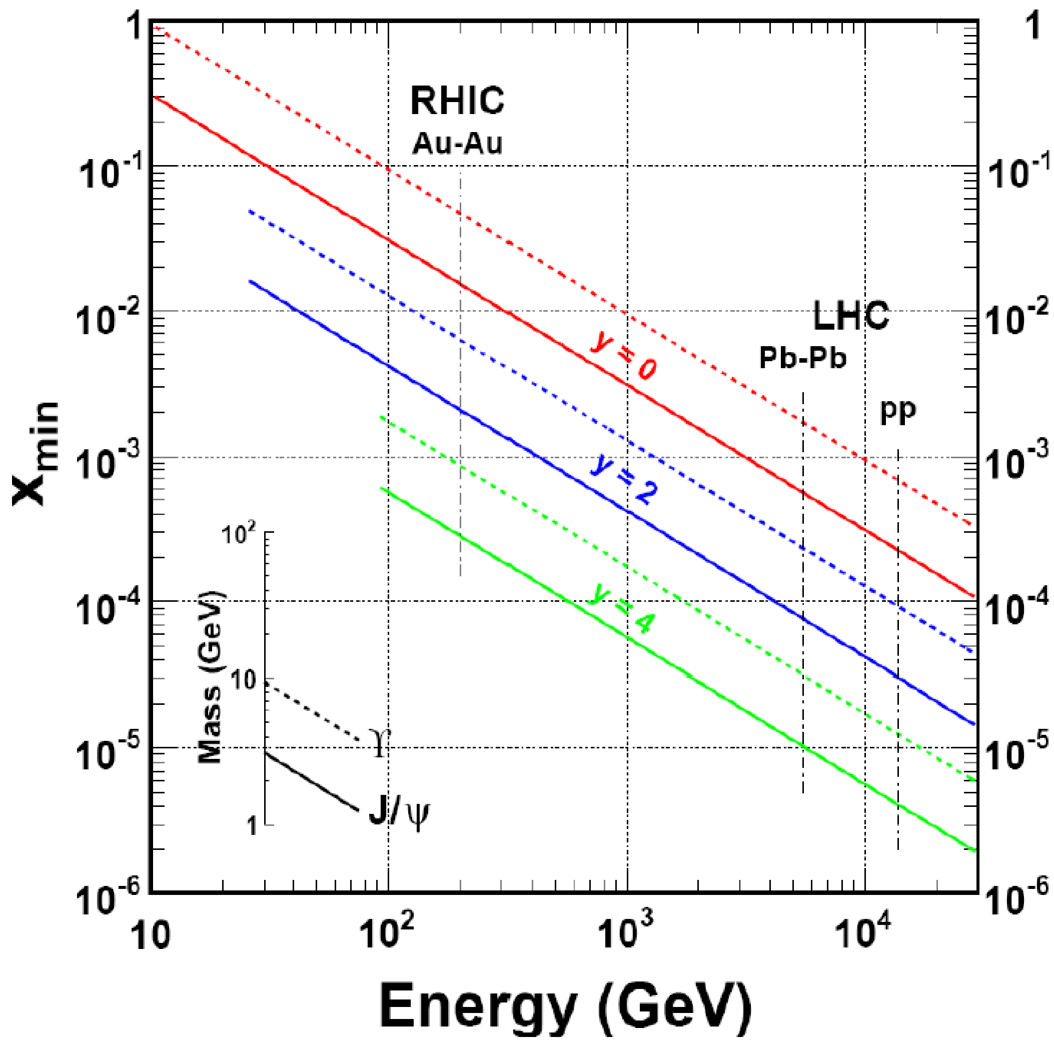
Open beauty and charm physics

J/ψ, ψ’ and Y,Y’,Y’’ as medium thermometer

Important B-hadron decays to charmonia yields

See talk by Serhiy Senyukov

The small-*x* regime



From RHIC to LHC

x_{min} ↘ ~ 10^{-2}

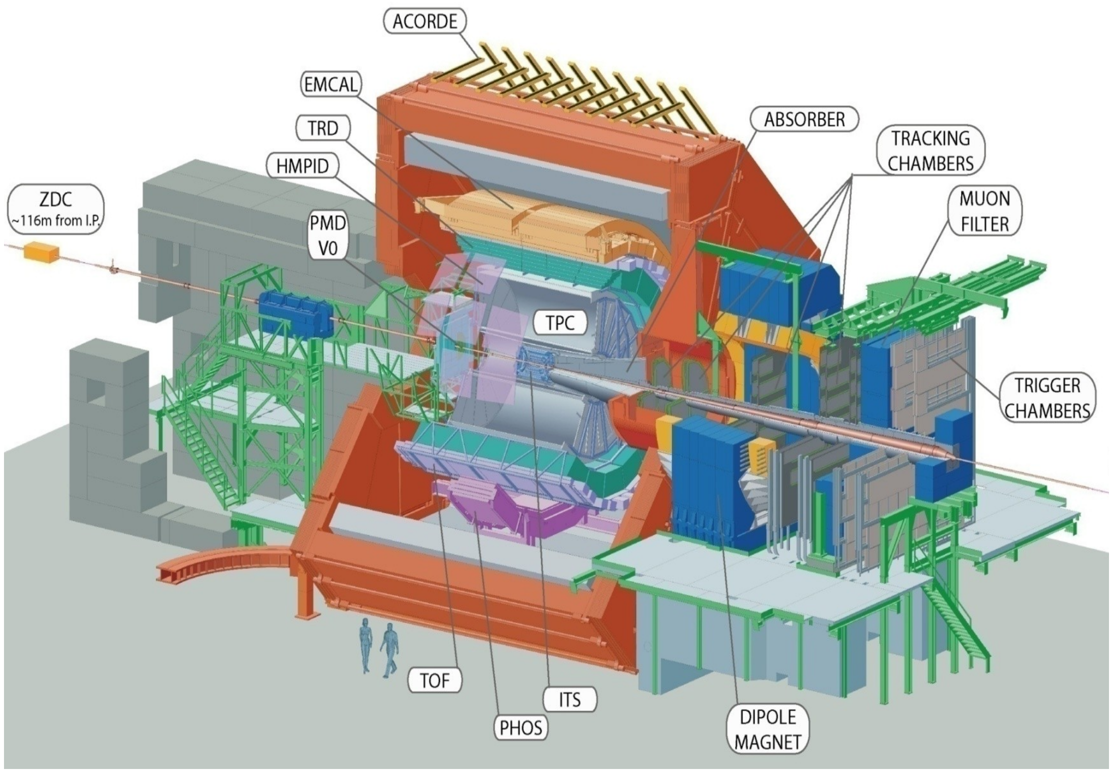
- factor 1/30 due to energy
- factor 1/3 larger rapidity

With J/ψ at rapidity 4

- Pb+Pb collisions $x_{min} \sim 10^{-5}$
- p+p collisions $x_{min} \sim 3\times10^{-6}$

The ALICE experiment

- **Tracking (B=0.2-0.5 T):**
  - Inner Tracking System (ITS) – pixels (SPD),drift (SDD),strips (SSD)
  - Time Projection Chamber (TPC)
  - Transition Radiation Detector (TRD)
- **Particle Identification (PID):**
  - TPC
  - TRD
  - Time Of Flight (TOF)
  - High Momentum PID (HMPID)
- **Muons:** dimuon arm
- **Calorimetry:**
  - PHOton Spectrometer (PHOS)
  - Electromagnetic Calorimeter (EMCAL)
  - Zero Degree Cal (ZDC)
- **Trigger:**
  - Central Trigger Processor
  - SPD
  - scintilator array (V0)
  - cerenkov array (T0)
  - TOF,…



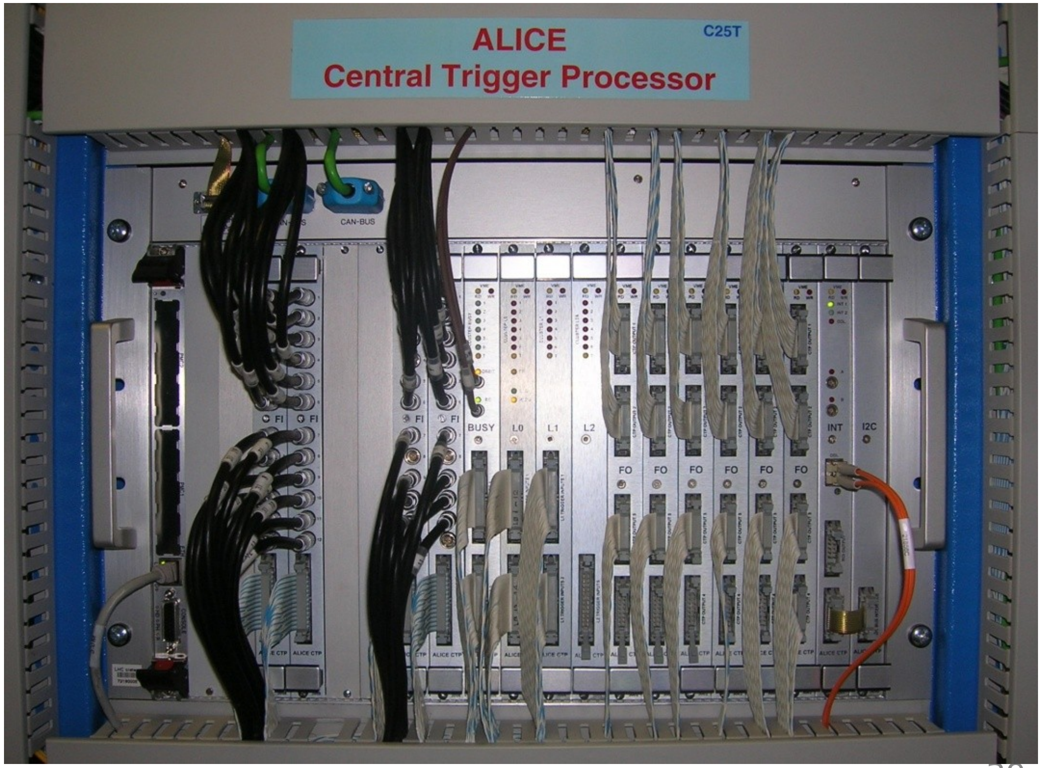
ALICE Central Trigger Processor

Collision system	$\sqrt{s_{NN}}$ (TeV)	L_0 ($cm^{-2}s^{-1}$)	Run time (s/year)	σ_{inel} (b)	$Rate_I$ (kHz)
pp	14.0	10^{31}	10^{7}	0.07	700
PbPb	5.5	10^{27}	10^{6}	7.7	7.7

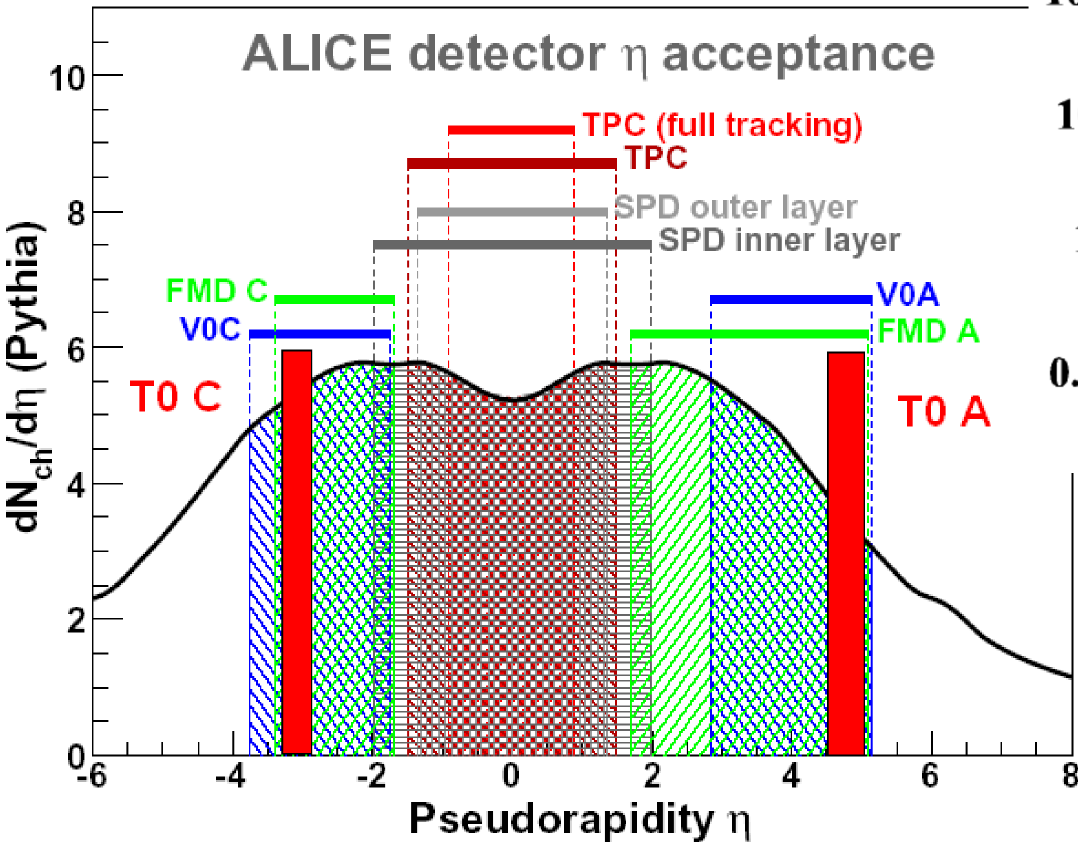
<= MAX
Optimal = MAX/100

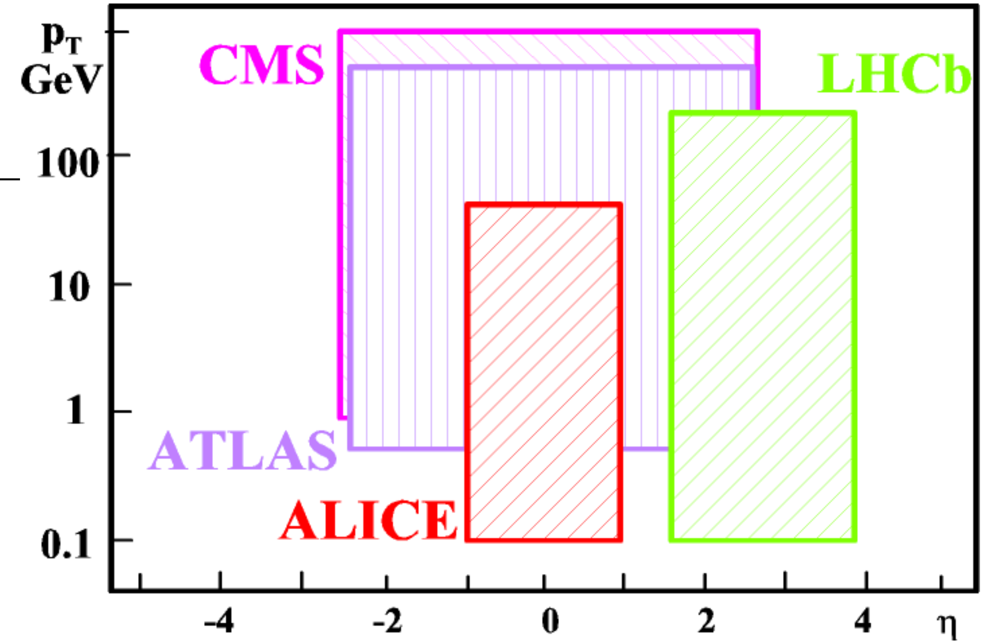
CTP features:

- 3 Levels (L0,L1,L2 ~ 1μs, 6μ, 88μs)
- Generally no pipelining
- Partitioning of detectors into independent groups
  – e.g. muon arm and central barrel
- Pile up (past-future) protection
  – tens of interactions in TPC drift time



ALICE Detector Acceptance





V0: $2.8 < \eta < 5.1$
$-3.7 < \eta < -1.7$

Central tracking: $-1<\eta<1$
Muon arm: $2.4<\eta<4$

ALICE detector

ALICE unique features:

☺ **acceptance at low p_T** (~ 0.2GeV/c)

⇒ relatively low field (0.5T)

⇒ low material budget (total X/X0=7%)

☺ **excellent PID capabilities**

⇒ dE/dx (TPC/ITS), TRD,

TOF, HMPID, PHOS, (EMCAL)

☹ **limited in luminosity, but pile-up is not a big issue**

Particle Identification

Stable hadrons (π, K, p): 100 MeV < p < 5 GeV (few 10 GeV)

dE/dx in silicon (ITS) and gas (TPC) + Time-of-Flight (TOF) + Cerenkov (RICH)

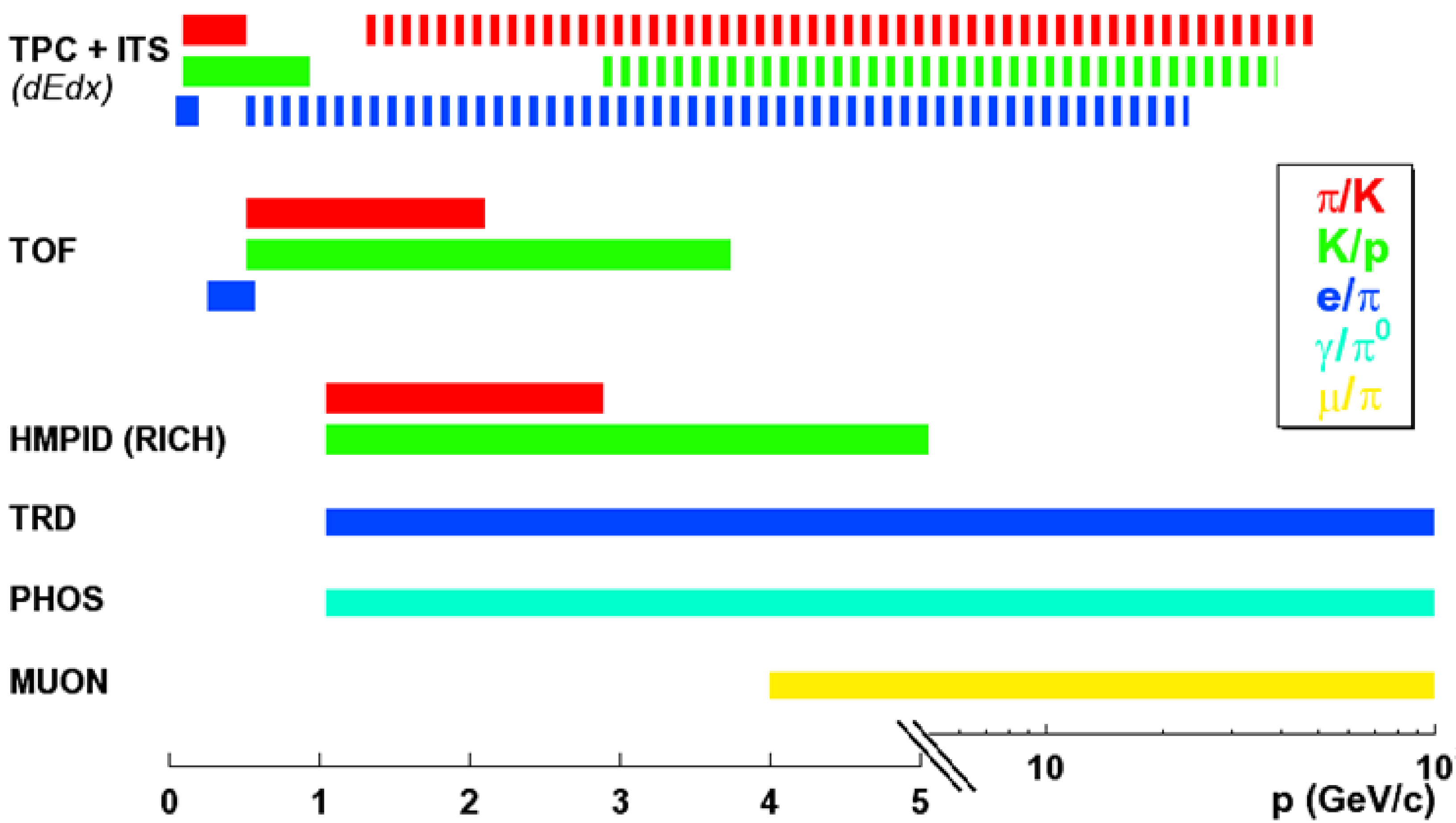
Decay topology (K^0, K^+, K^-, Λ)

K and Λ decays up to at least 10 GeV

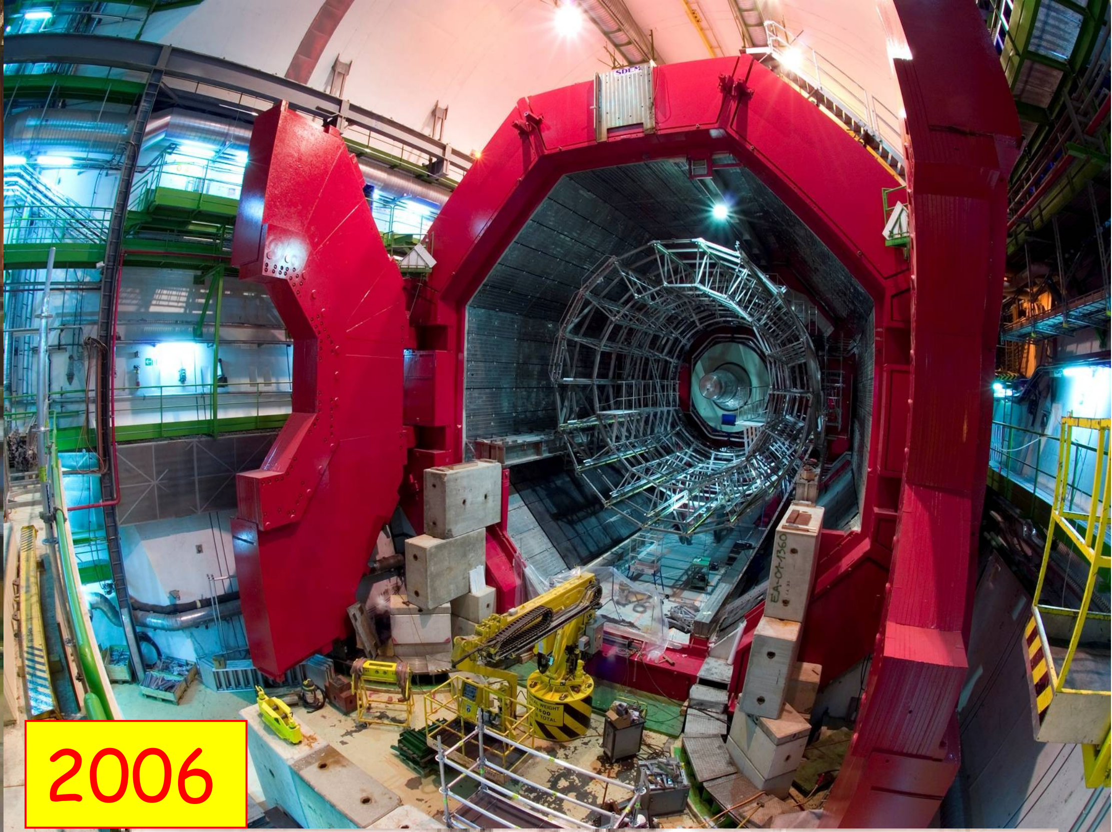
Leptons (e, μ), photons, π^0, η

electrons in TRD: p > 1 GeV, muons: p > 5 GeV, π^0 in PHOS: 1 < p < 80 GeV

Alice uses ~ all known techniques!

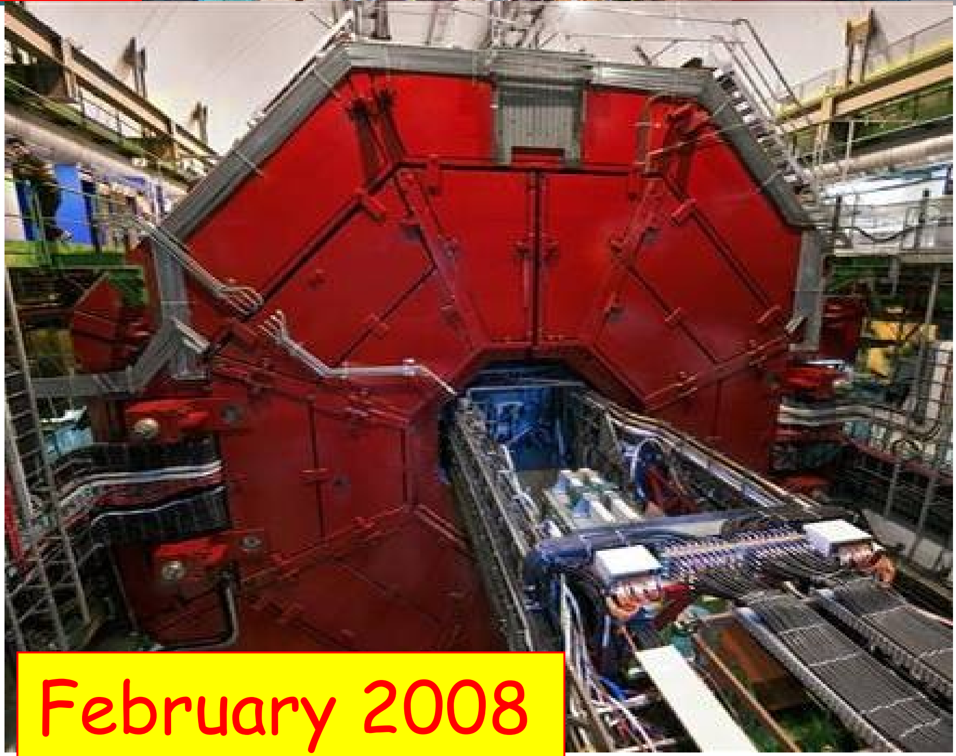


2002



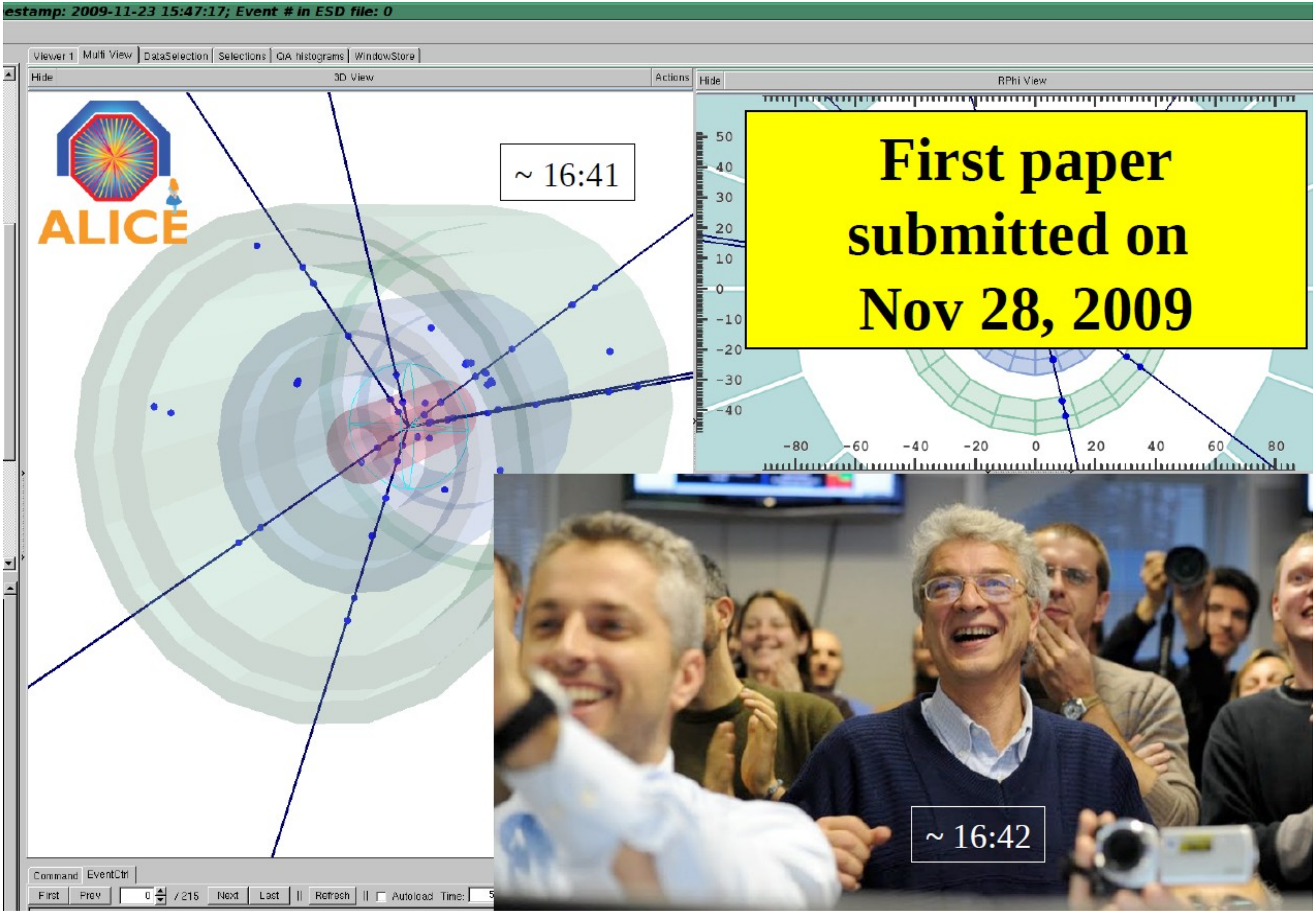
2006

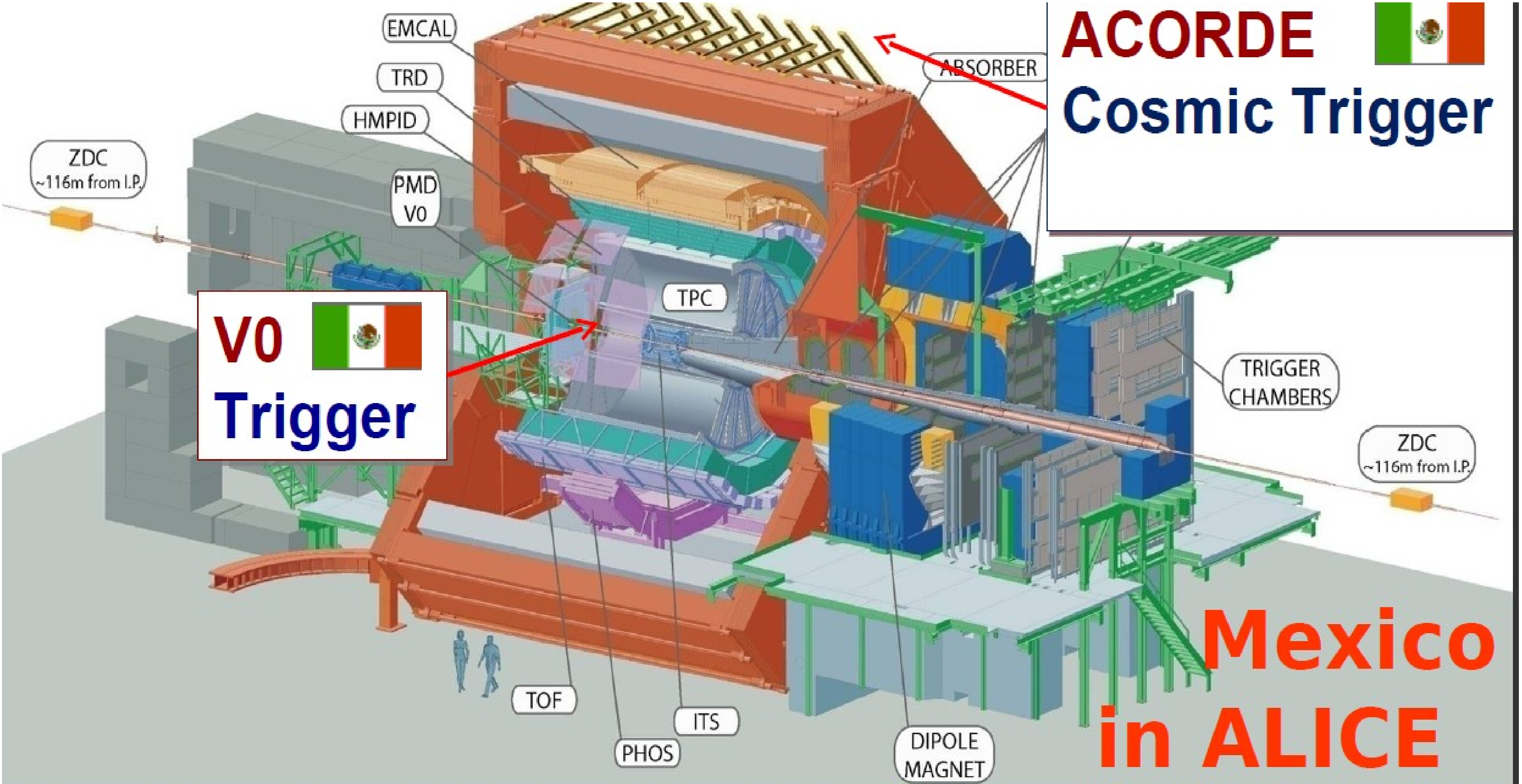
October 2007



February 2008

First p+p collisions – 23 Nov 2010





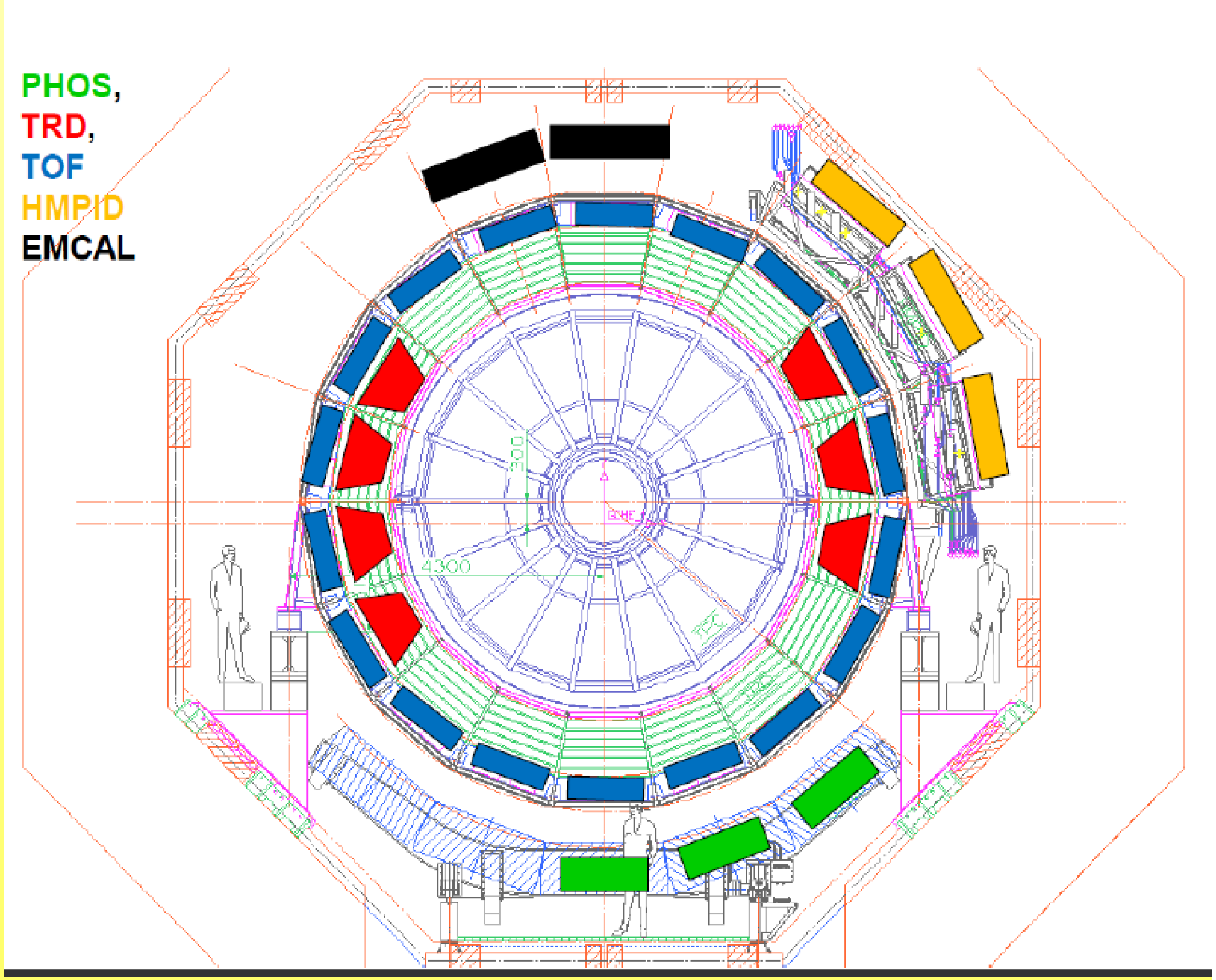
- at the core of the detector, two 100% Mexican projects:
  - ⇨ **V0L :**
    - ⇨ trigger, vital element of the first analysis!
  - ⇨ **ACORDE:**
    - ⇨ Cosmic ray trigger for calibrations and Cosmic Ray Physics
  - ⇨ **+ UPGRADES: VHMIPD, AD**

- at the core of the Physics, leading role in three key fields:
  - ⇨ **Jets/ Event Structure**
  - ⇨ **Cosmic Ray Physics**
  - ⇨ **Diffractive Physics**

+ Computing ….

ALICE 2010

- ITS, TPC, TOF, HMPID, MUON, V0, T0, FMD, PMD, ZDC (100%)
- TRD* (7/18)
- EMCAL* (4/12)
- PHOS (3/5)



*upgrade to the original setup

The ALICE experiment

Central barrel ($|\eta|<0.9$)

Tracking: ITS+TPC+TRD
PID: TPC+TRD+TOF
Secondary vertexing: ITS

→ Open heavy flavour
- hadronic channel
- semi-leptonic decays ($e^{+/-}$)

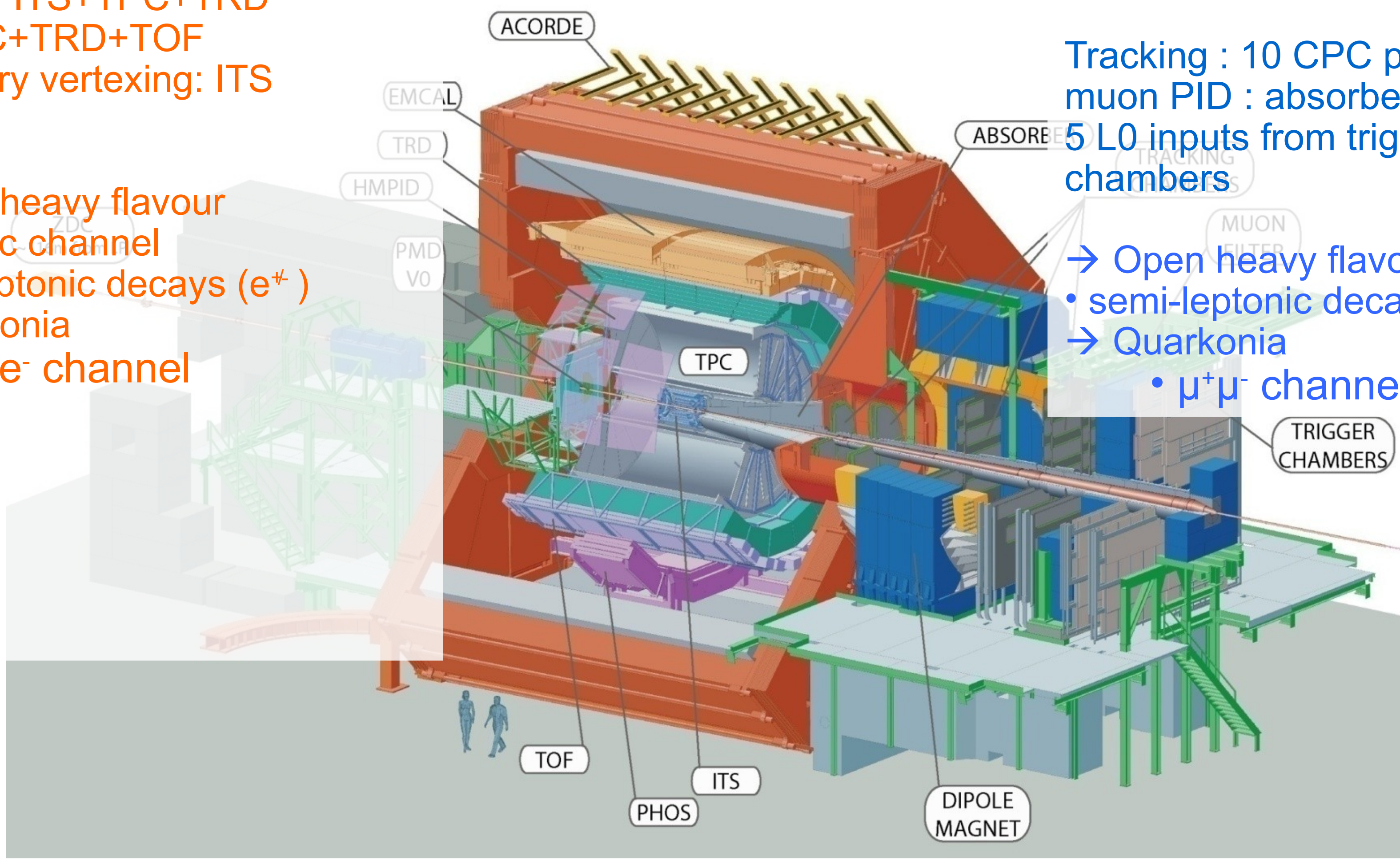
→ Quarkonia
  - e^+e^- channel

Muon spectrometer ($-4.0<\eta<-2.5$)

Tracking : 10 CPC planes
muon PID : absorbers
5 L0 inputs from trigger chambers

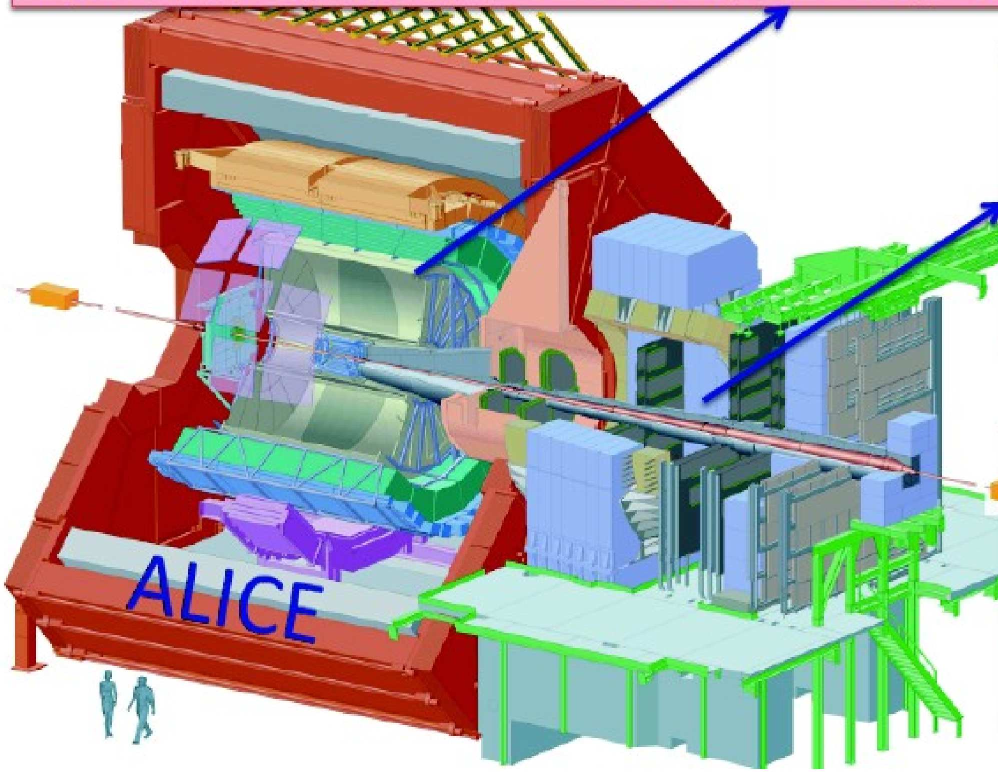
→ Open heavy flavour
- semi-leptonic decays ($\mu^{+/-}$)

→ Quarkonia
  - $\mu^+\mu^-$ channel



Quarkonium Detection in ALICE

Central Barrel $|y|<0.9$; ITS+TPC+TRD+TOF; electron ID and μm vertex.
1) J/ψ, ψ', Υ, Υ', Υ'' -> e^+e^-; 2) B-> J/ψ+X->e^+e^-; 3) χ_c->γ+e^+e^- in pp;



Forward muon spectrometer $2.5<|y|<4.0$; Muon trigger and tracking; J/ψ, ψ', Υ, Υ', Υ'' -> $\mu^+\mu^-$;

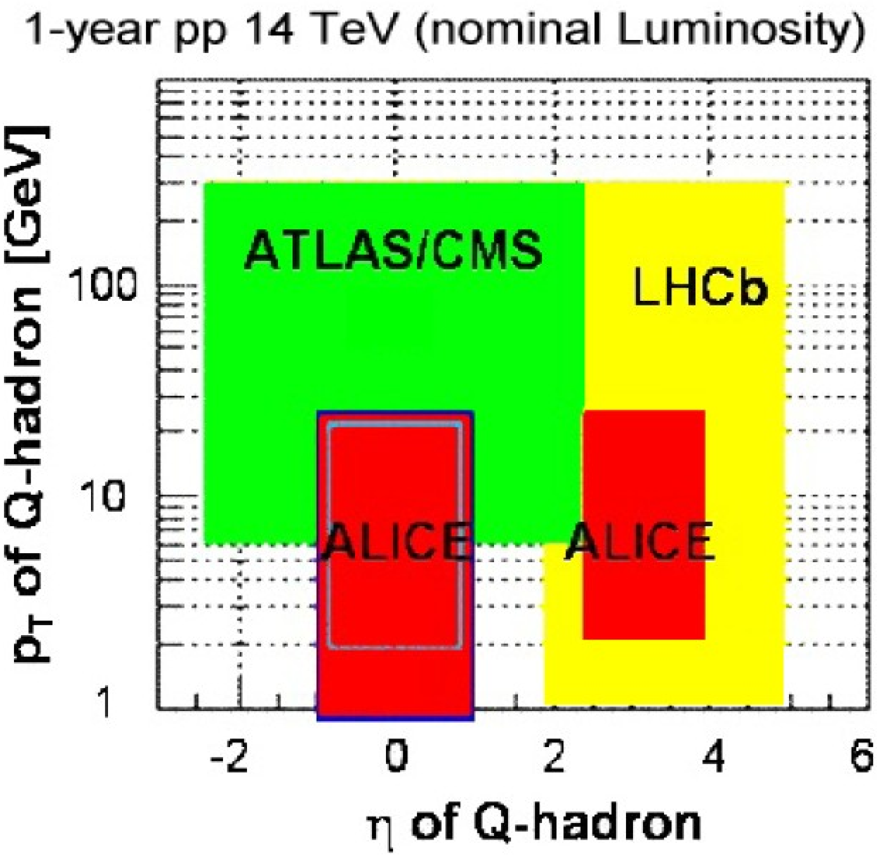
D-hadron & B-electron measurements in $|y|<0.9$; B-muon and B-dimuons in $2.5<|y|<4.0$;

Quarkonia challenges at the LHC

- $J/\psi, \Upsilon \rightarrow \ell^+\ell^-$ measurements require $\mu^\pm$, $e^\pm$, secondary-vertex detectors
  - ✓ ATLAS/CMS within $-2.5 < \eta < 2.5$, full ϕ
  - ✓ LHCb within $2 < \eta < 5$, full ϕ

$B \rightarrow J/\psi$ (20%)contribution

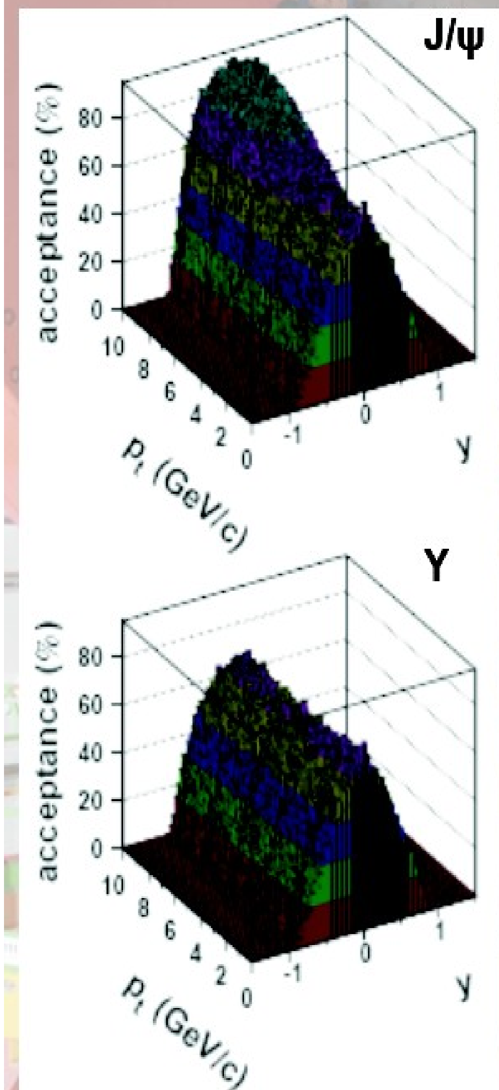
- Focus on dimuons at moderately high-p_T (ATLAS/CMS), low-p_T (LHCb)
- Dielectron channels accessible but more difficult: large X_0/X in front of ECALs (ATLAS/CMS).
- Early measurements (low lumi, dedicated low-thresh. triggers):
  ATLAS/CMS: p-p & Pb-Pb studies
  LHCb: p-p studies only

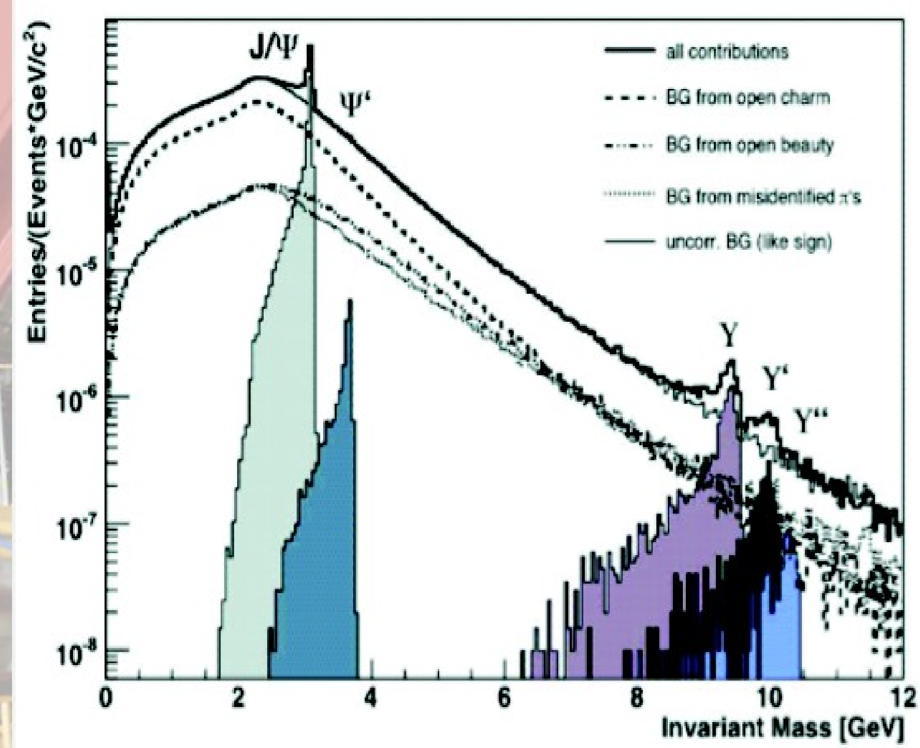


J/ψ in the electron decay channel

Pb+Pb physics performance

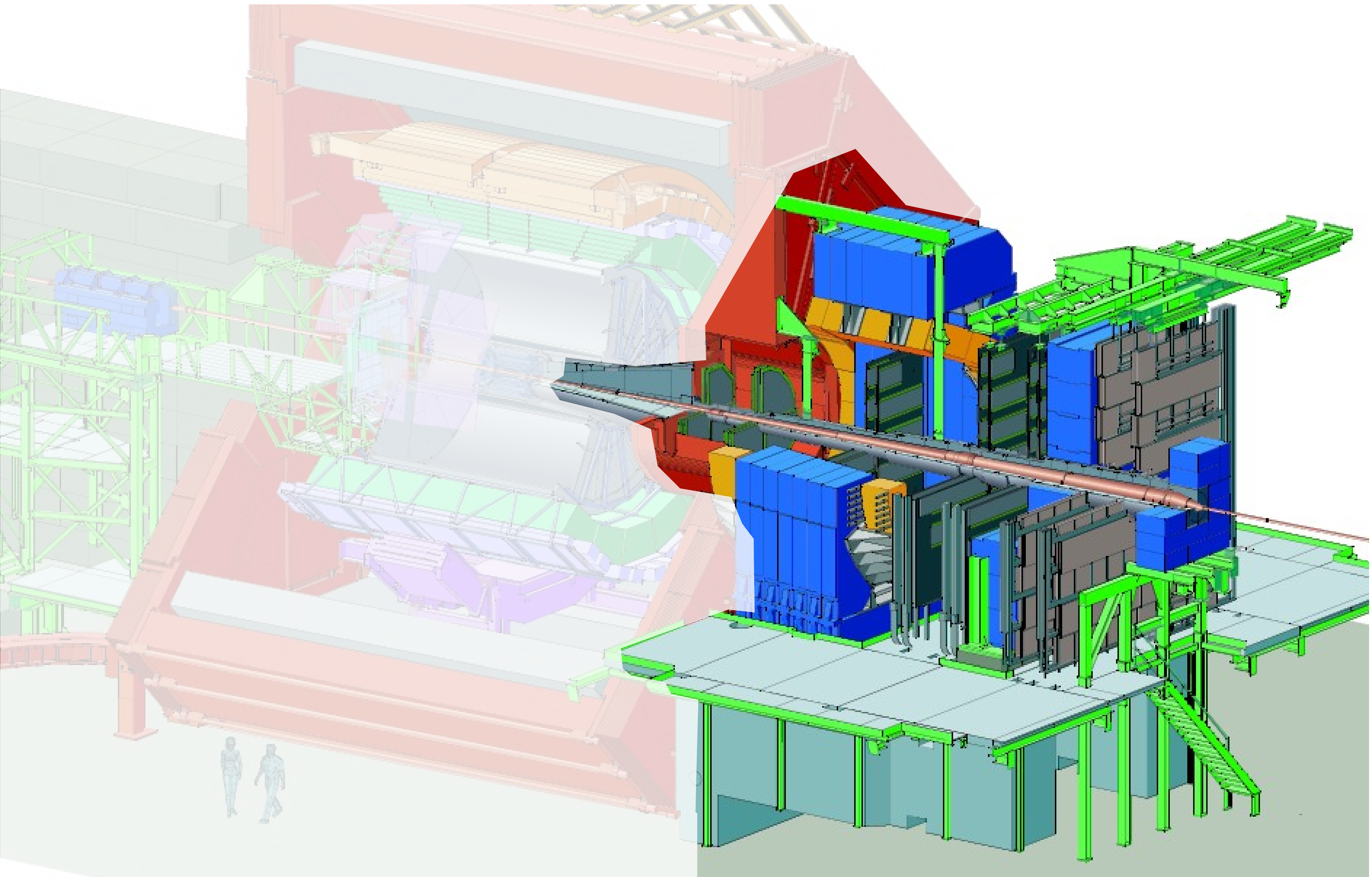
|y|<1 and pt>0



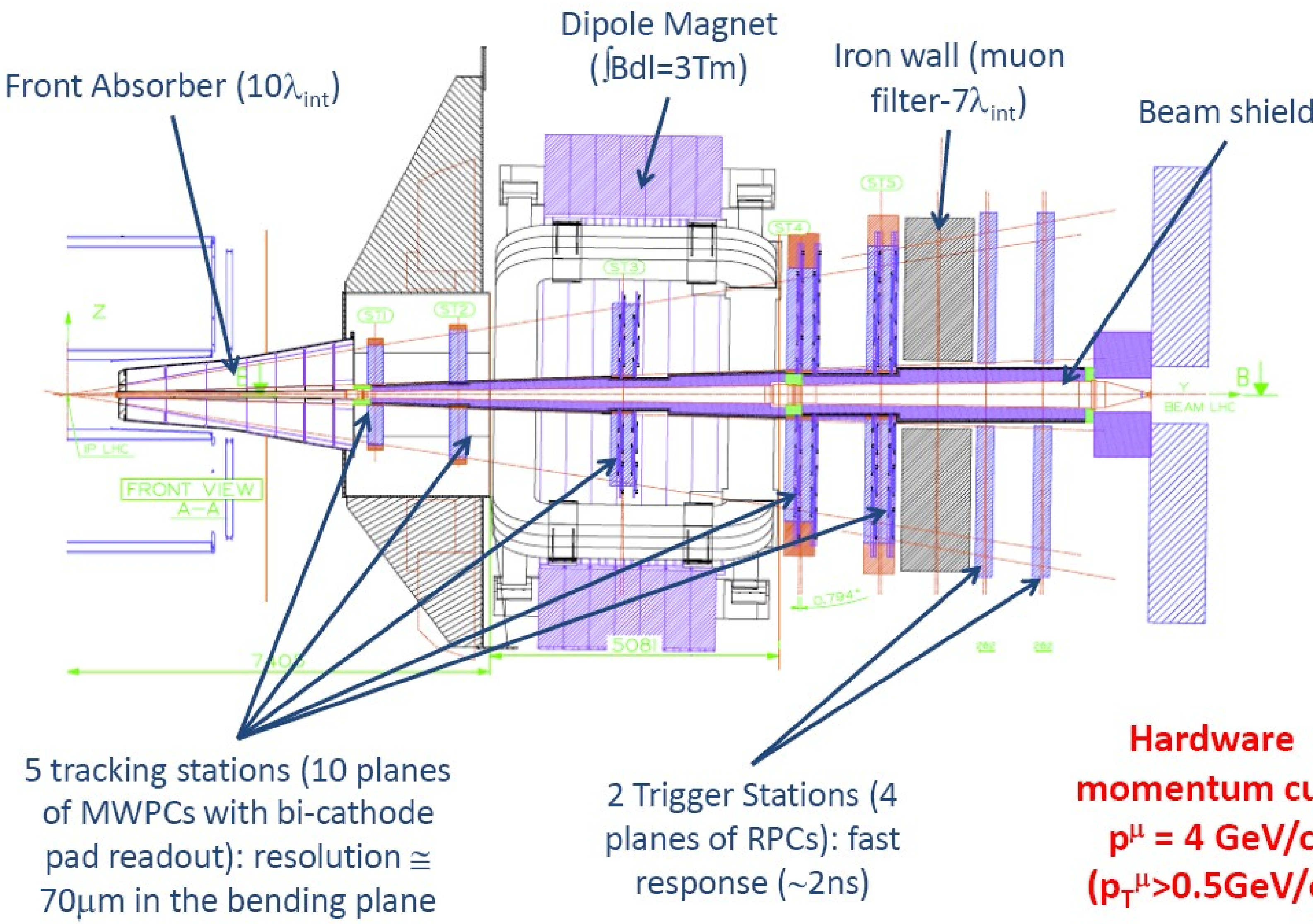


	J/ψ	Υ
Mass resolution	~30 MeV/c^2	~90 MeV/c^2
Signal/Noise	1.2	1.0
Counts (nominal PbPb year) 10%	120k	*900*

ALICE Muon Spectrometer

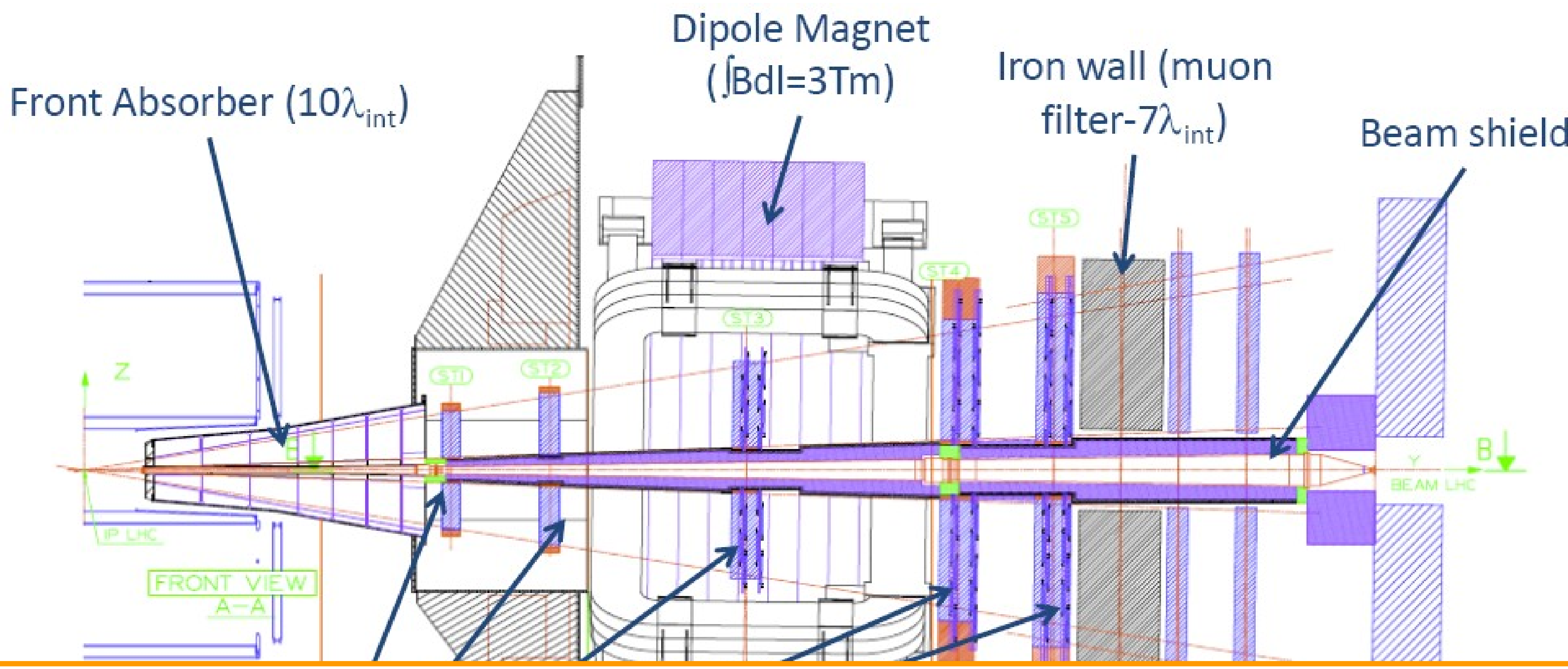


ALICE Muon Spectrometer



Hardware momentum cut:
p^{μ} = 4 GeV/c
(p_T^{μ}>0.5GeV/c)

ALICE Muon Spectrometer



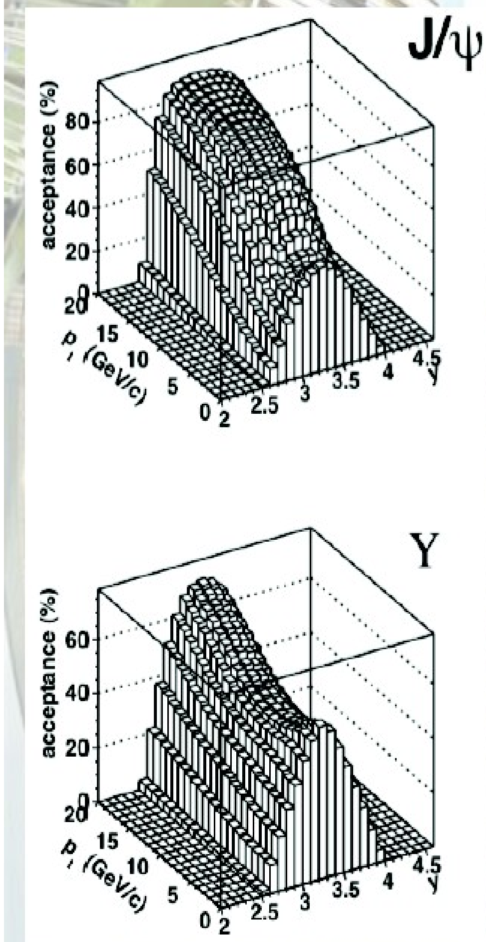
I. **Mass resolution for Υ < 100 MeV/c^2 $\rightarrow$ spatial resol. < 100 μm along y (bending direction)**

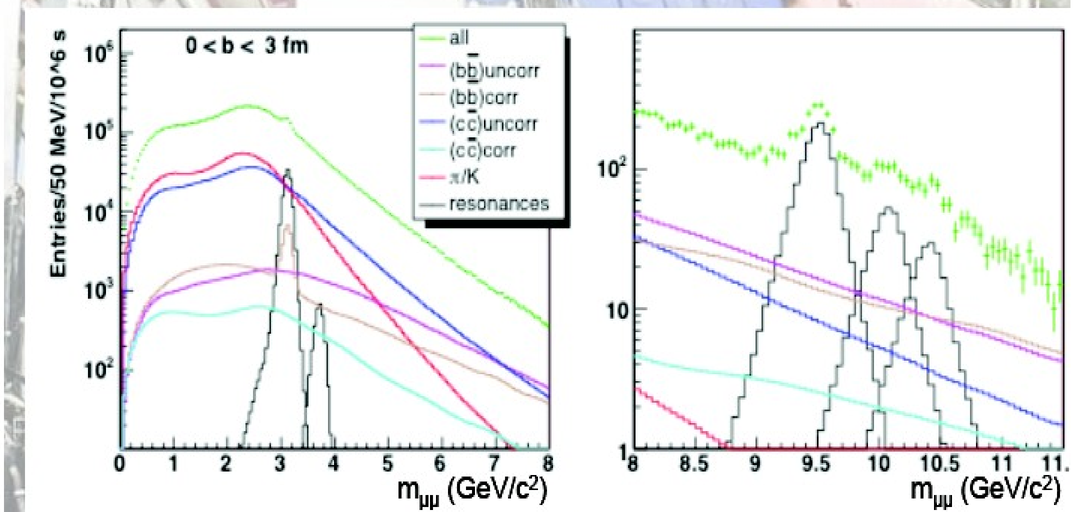
II. **Designed for up to 500 hits/central Pb-Pb collision on the 1st station** (assuming $dN_{ch}/dy|_{y=0}$ = 8000) Today, $dN_{ch}/dy|_{y=0}$ = 2000 would be a more realistic value

III. **Trigger rate < ~1 kHz (DaQ bandwidth for muon)**

- 8 kHz Pb-Pb collisions with L = 10^{27} $cm^{-2}s^{-1}$

J/ψ in the muon decay channel
Pb+Pb physics performance





	J/ψ	*Υ*
Mass resolution	~70 MeV/c^2	~100 MeV/c^2
Signal/Noise	0.3	2.5
Counts (nominal PbPb year) MB	680k	*6000*

J/ψ production in Pb+Pb

The suppression pattern is a thermometer of the QCD matter produced : clear advantage to have a measurement of J/ψ and Y.

Quarkonia production in Pb+Pb in the Muon Spectrometer

$\sqrt{s_{NN}}$ =5.5 TeV [2.76 TeV → 40 to 55 % in σ]

no recombination

central Pb-Pb (0 < b < 3 fm), (MB)

no nuclear effects, $p_\perp$ > 1 GeV/c

Running time : 10^6 s with a Pb-Pb [~90%]

luminosity of 5×10^{26} $cm^{-2}s^{-1}$ [10^{25} $cm^{-2}s^{-1}$]

→ Good statistics for ϒ(1S)

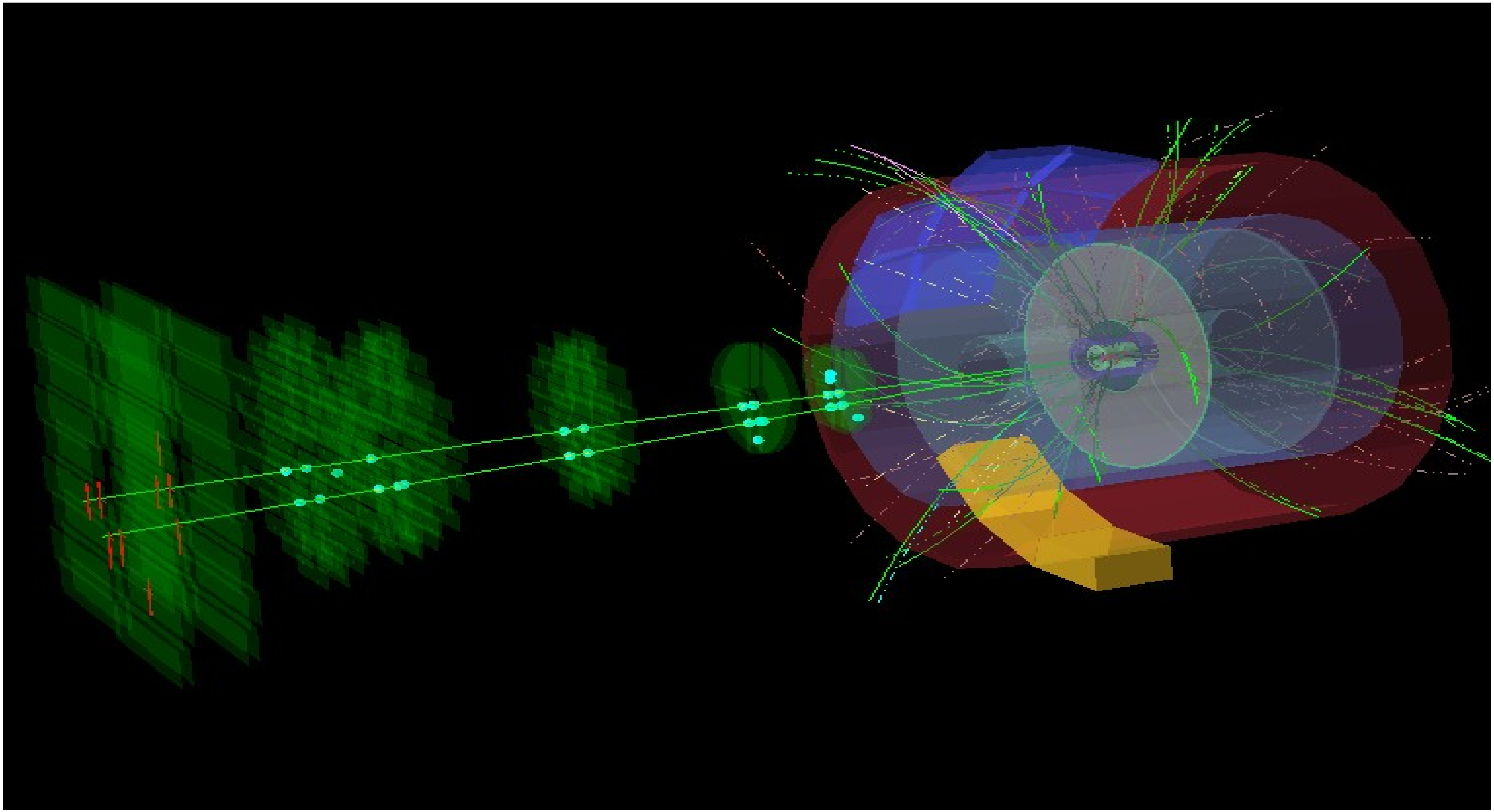
→ ϒ(2S), ϒ(3S) will requires a few runs

J/ψ statistics allows polarization studies

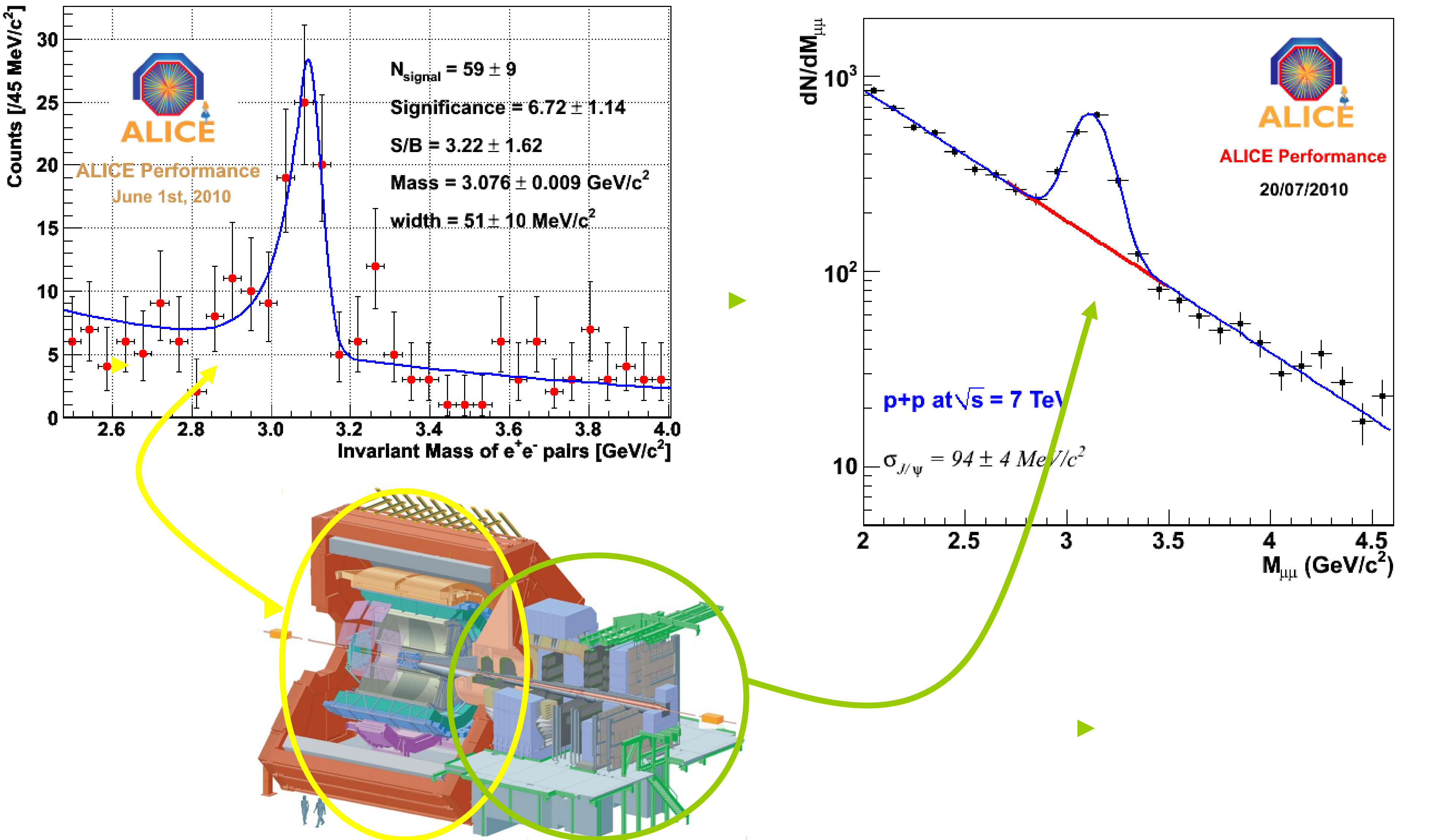
⇒ In fact for the first PbPb run > 1/100

State	S[10^3]	B[10^3]	S/B	$S/(S+B)^{1/2}$
J/ψ	130 (700)	680	0.20	150
ψ’	3.7 (20)	300	0.01	6.7
ϒ(1S)	1.3 (7)	0.8	1.7	29
ϒ(2S)	0.35 (1.8)	0.54	0.65	12
ϒ(3S)	0.20 (1.0)	0.42	0.48	8.1

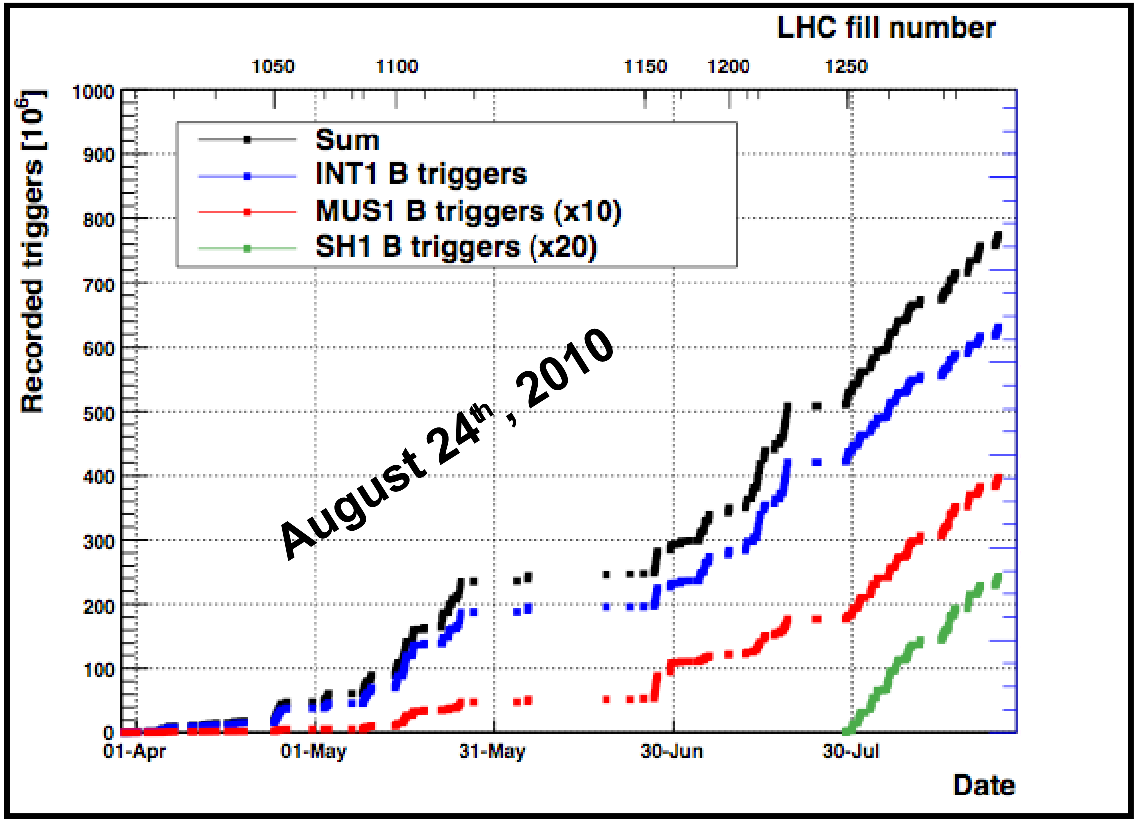
First results in p+p at 7 TeV



Preliminary results on J/ψ



Integrated luminosity at ALICE



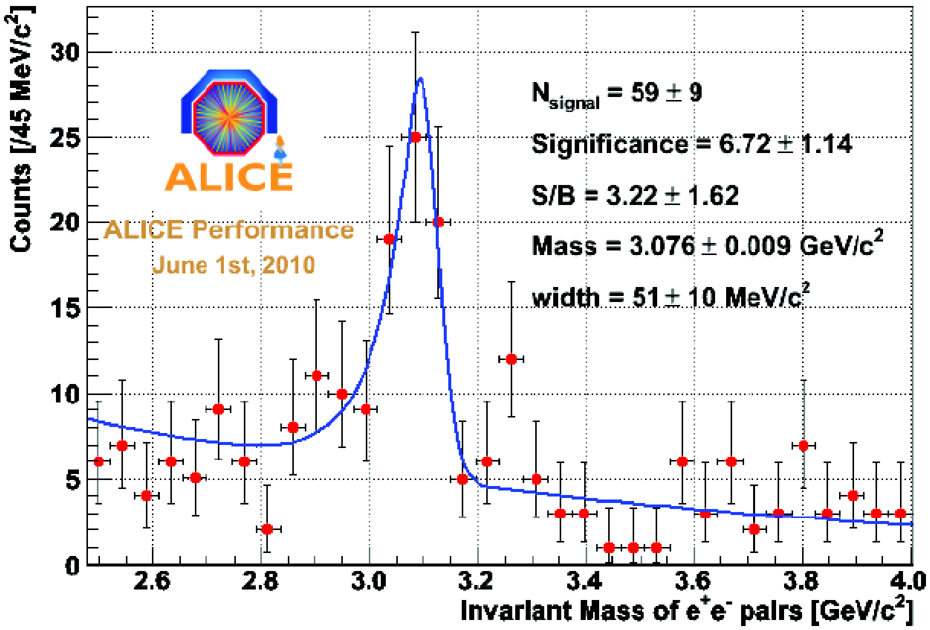
- **INT1-B: minimum bias interaction trigger**
  - **at least one charged particle in 8 η units**
- **MUS1-B: single-muon trigger**
  - **forward muon in coincidence with MB trigger**
- **SH1-B: high multiplicity trigger**

For all these classes, mask (≡ gate) to trigger on the crossing of the colliding bunches.

Estudiante de verano Gibraham Napoles trabajo en un proyecto relacionado con estimar la luminosidad integrada

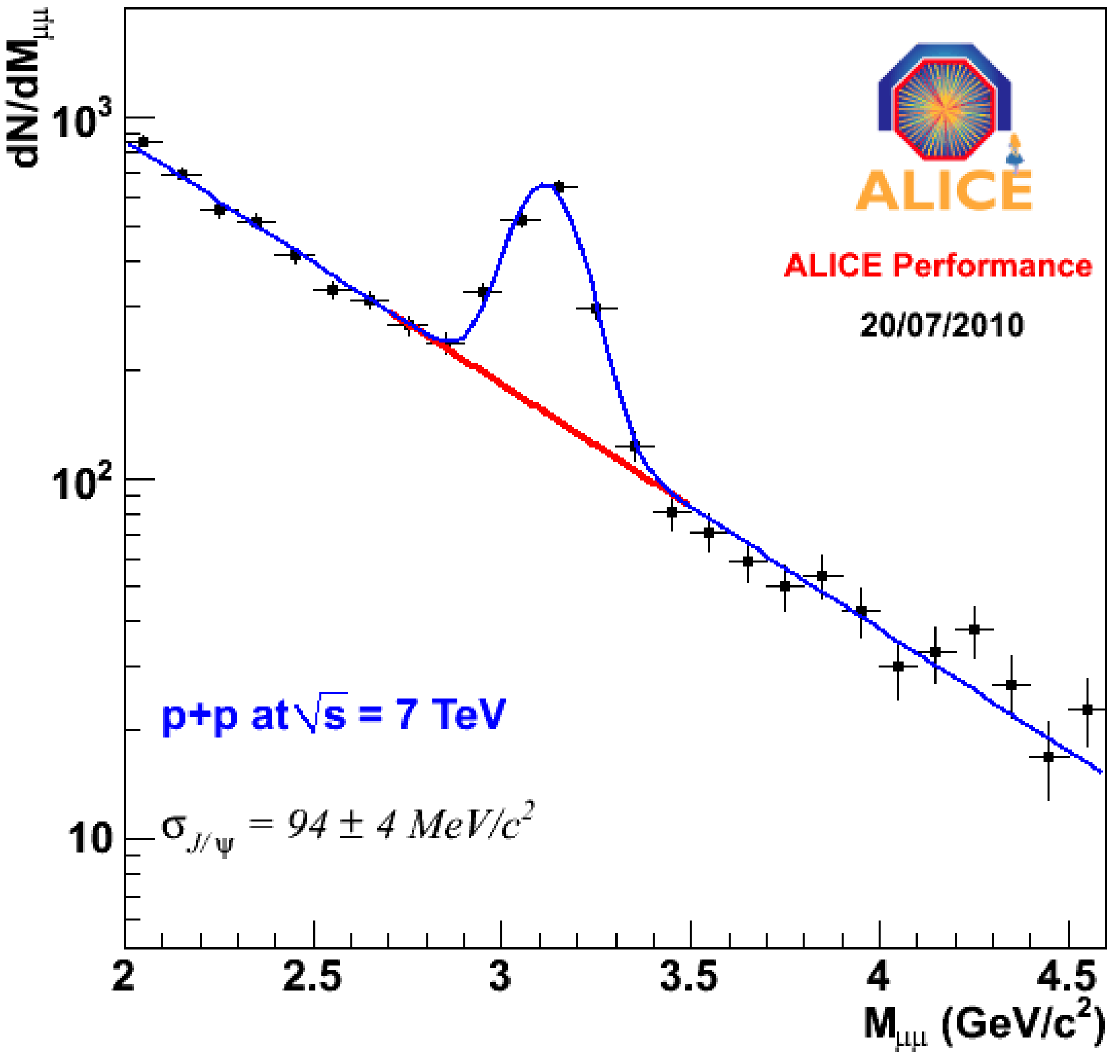
J/ψ in the electron decay channel
First p+p results at 7 TeV

- 110M p-p events at 7 TeV
  - 1/3 of available statistics
- Track reconstruction
  - TPC + ITS
- Electron identification (and pion rejection)
  - TPC
  - TRD could be included later
- Fit with a Cristal Ball function
- |η|<0.9



110 M events

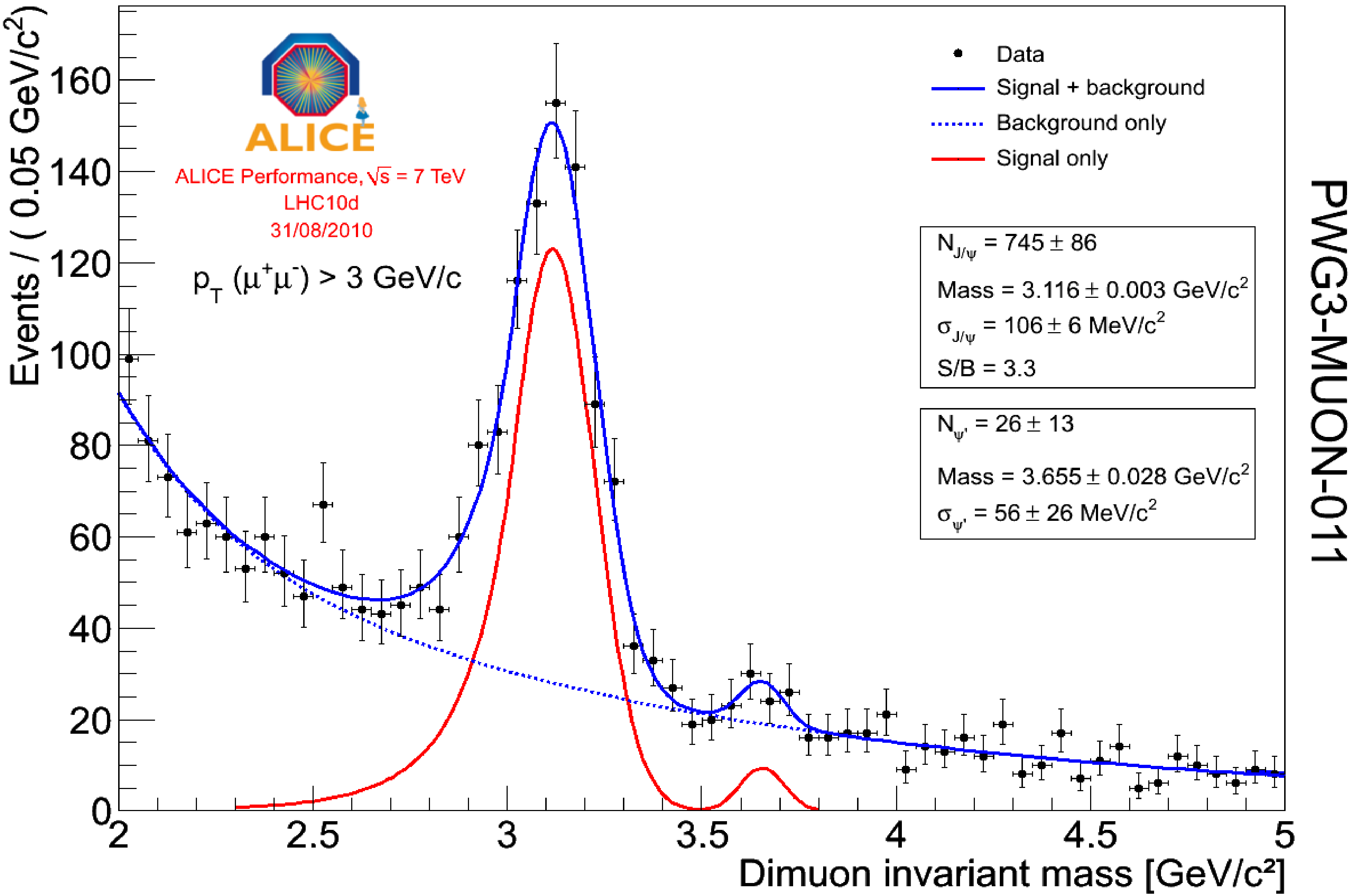
J/ψ in the muon decay channel



- detector performance close to nominal
    - efficiency
    - mass resolution 94 MeV/c^2 (target is 70 MeV/c^2)
- data/analysis flow works well
- recent changes in trigger strategy allows to accumulate more statistic

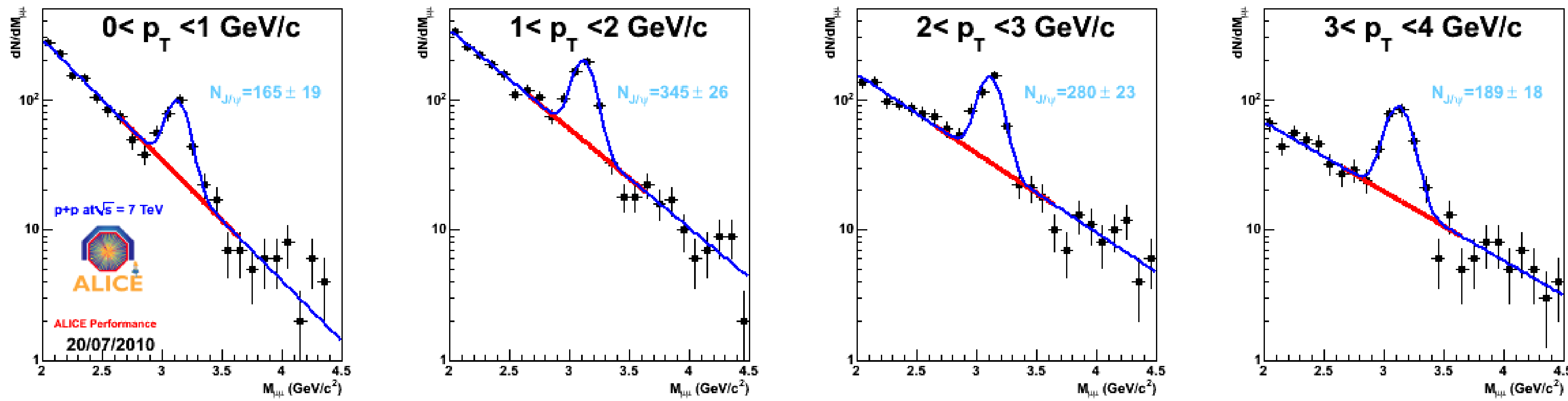
So far ~ 6000 J/ψ recorded.

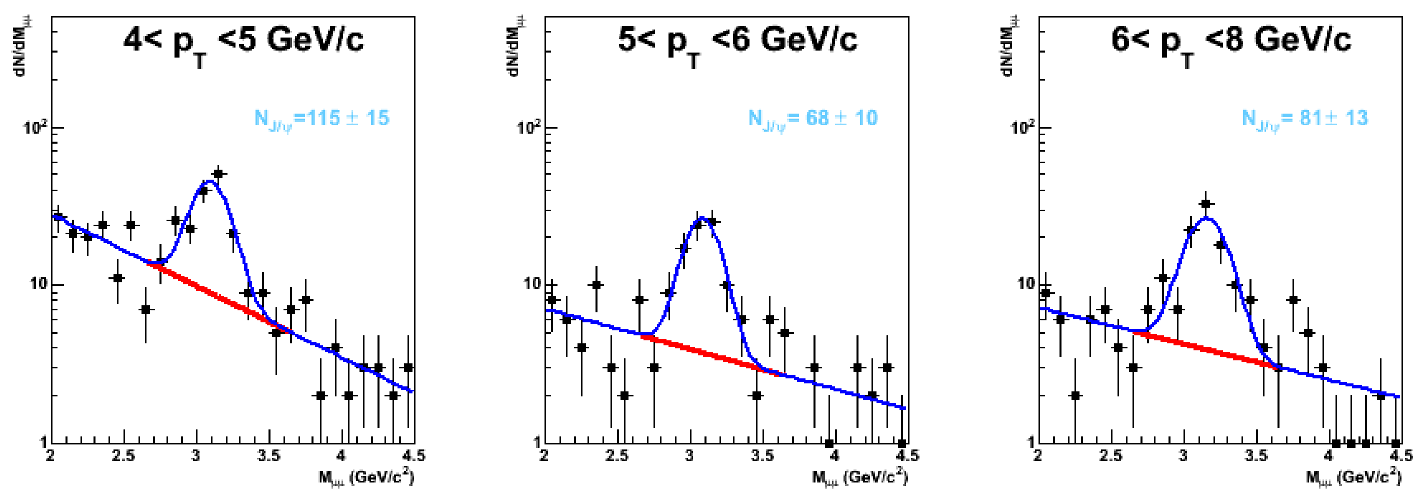
ψ' shows up

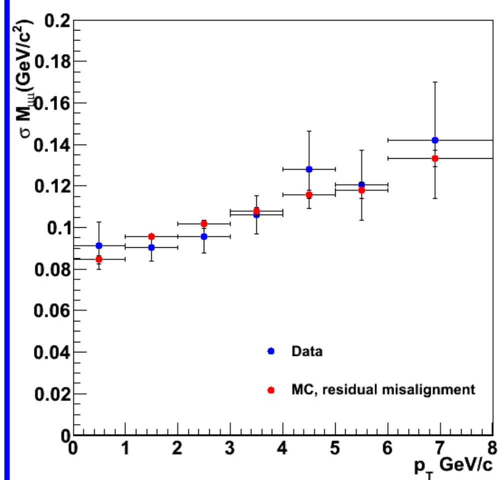


Estudiante de verano Nayeli Rodriguez trabajo en un proyecto relacionado con entender ruido de fondo

J/ψ's transverse momenta

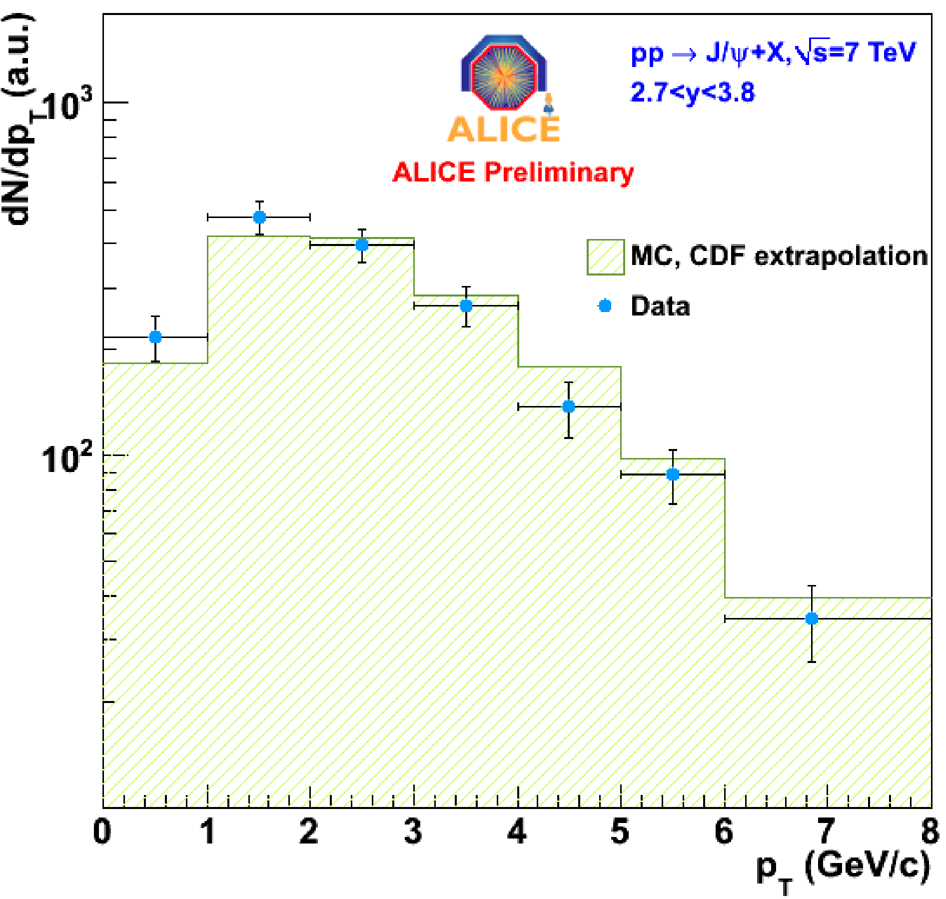


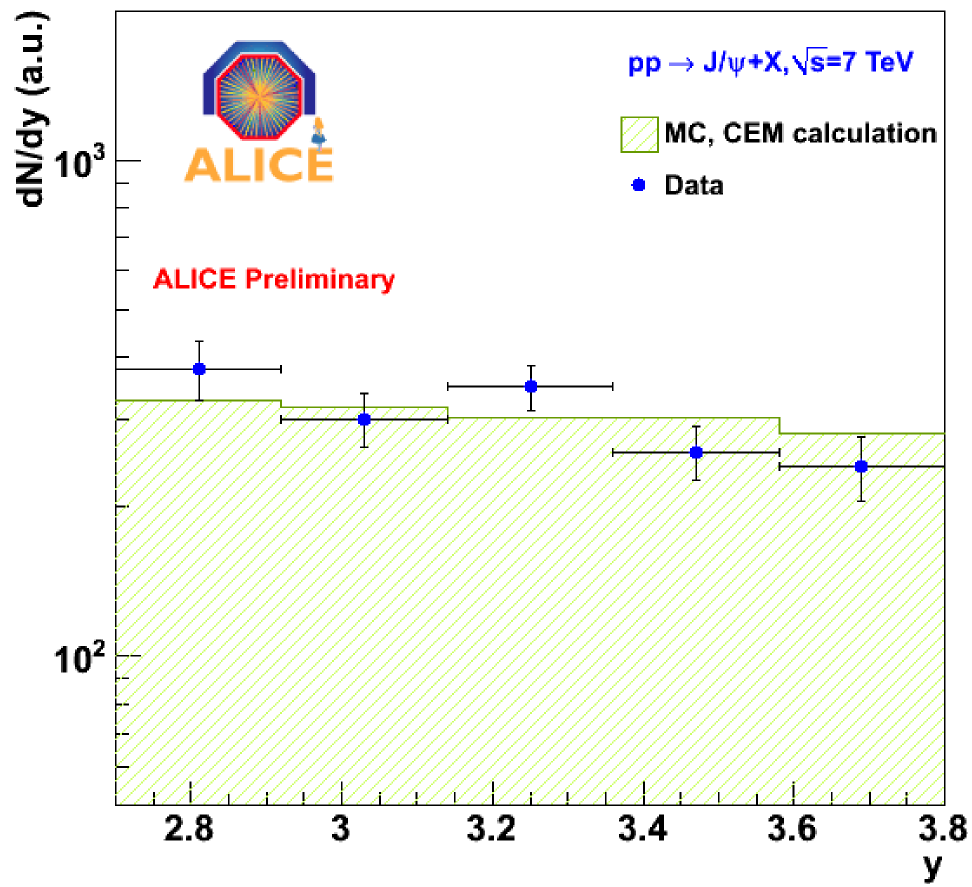




J/ψ peak width well reproduced by the MC

Comparing results to the MC





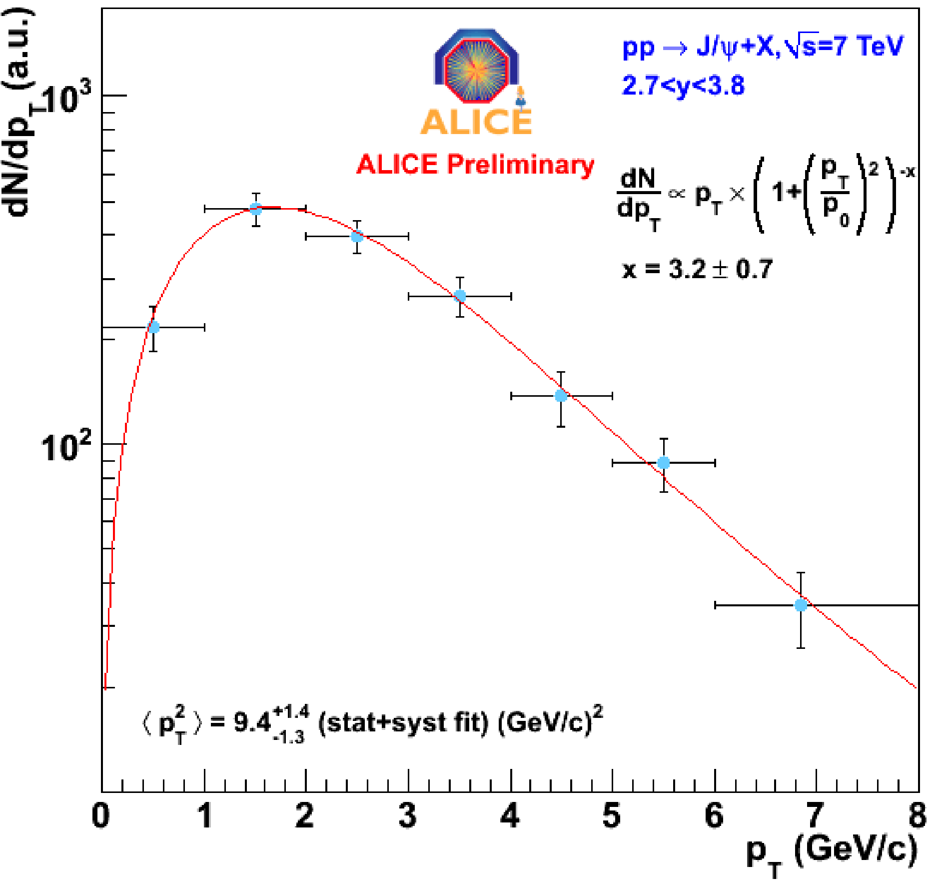
Data corrected for acceptance and efficiency

- data slightly softer than MC

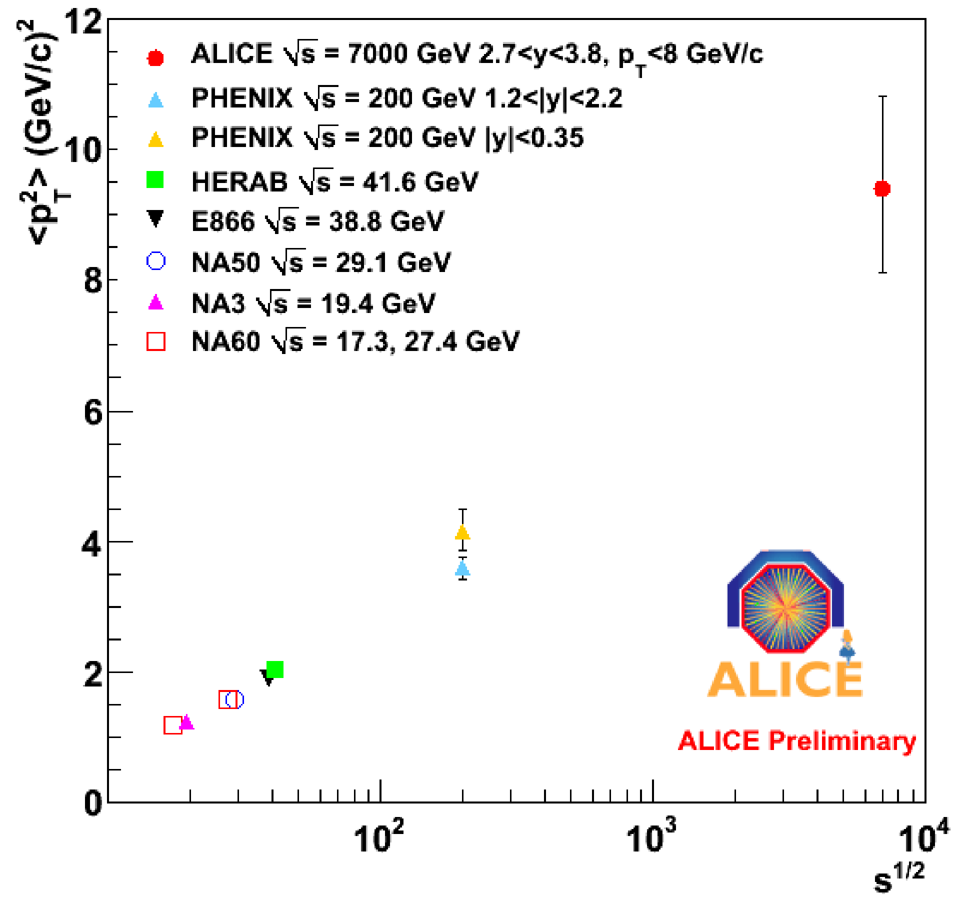
Generated MC distribution “CDF pp 7TeV”

- p_T extrapolated from CDF results, y obtained from CEM calculations, no polarisation

J/ψ's transverse momenta



$<p_T^2>$ is extracted with the fit function first proposed by Yoh et al., PRL 41 (1978) 684 (also used by previous experiments)



Quoted uncertainties include systematics from the fit function. Full systematic uncertainties are being evaluated

Summary

The ALICE experiment has successfully started the study of Inclusive quarkonia production in p+p interactions at $\sqrt{s_{NN}}$ = 7 TeV

- J/ψ's rapidity and transverse momentum distribution were presented

- Next: J/ψ's production cross section
  → Top priority : J/ψ analysis to be used as a reference for Pb+Pb

This is only the very beginning...
Pb+Pb collisions ....next!