Latest results on anomalous J/ψ suppression

S. Ramos – LIP-Lisbon

for the

NA50 Collaboration

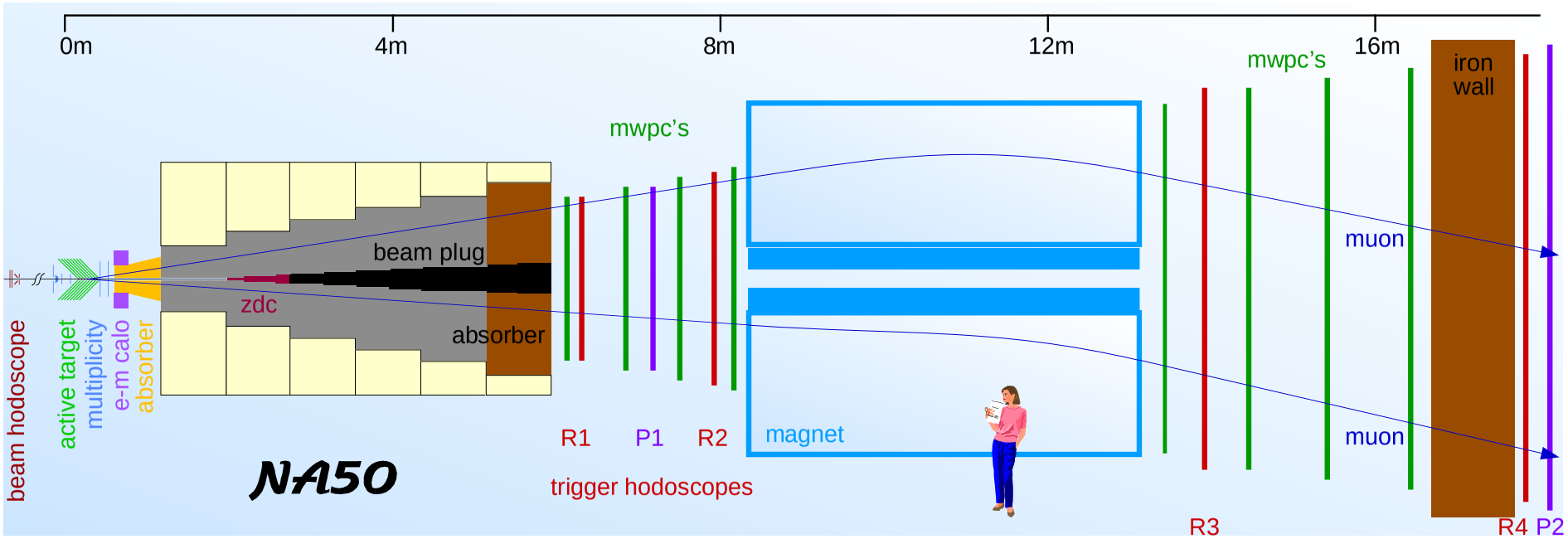
Alessandria, Annecy, Aubière, Bucharest, Cagliari, CERN,
Lisbon, Moscow, Orsay, Palaiseau, Torino, Villeurbanne, Yerevan

Mumbai, January 2003

Outline

- **The NA50 apparatus and its kinematical domain**
- **The reference: the Drell-Yan process for standard J/ψ analysis**
- **The baseline: J/ψ normal nuclear absorption**
- **The anomalous J/ψ suppression as a function of two centrality variables: E_T and E_{ZDC}**
- **Conclusions**

Experimental Setup

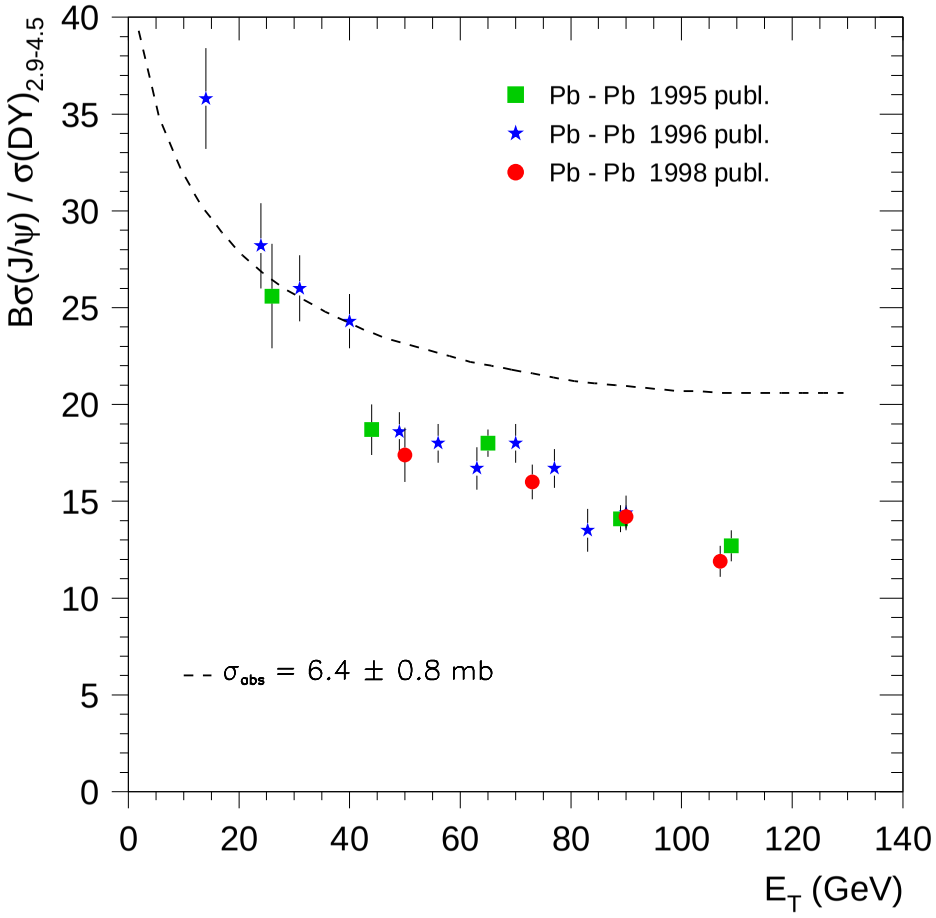


The J/ψ is detected via its decay into muon pairs

- **Dimuon spectrometer:** $0 < y_{CM} < 1$ $\quad (2.92 < y_{Lab} < 3.92)$ $\quad |\cos\theta_{CS}| < 0.5$
- **Centrality detectors:**
  - ▷ Electomagnetic calorimeter $(1.1 < \eta_{lab} < 2.3)$
  - ▷ Zero Degree Calorimeter $(\eta_{lab} > 6.3)$
  - ▷ Multiplicity detector $(1.9 < \eta_{lab} < 4.2)$
- **Target region:** Beam Hodoscope, Anti-Halo Counters, Active Target with Čerenkov counter blades

NA50 standard published analysis: J/ψ/DY

Observation of anomalous J/ψ suppression



- **A threshold effect followed by steady decrease for central Pb-Pb collisions**
- **Clear departure from normal nuclear absorption curve**
  But:
  - **Peripheral Pb-Pb interactions have some contamination from Pb-air background**

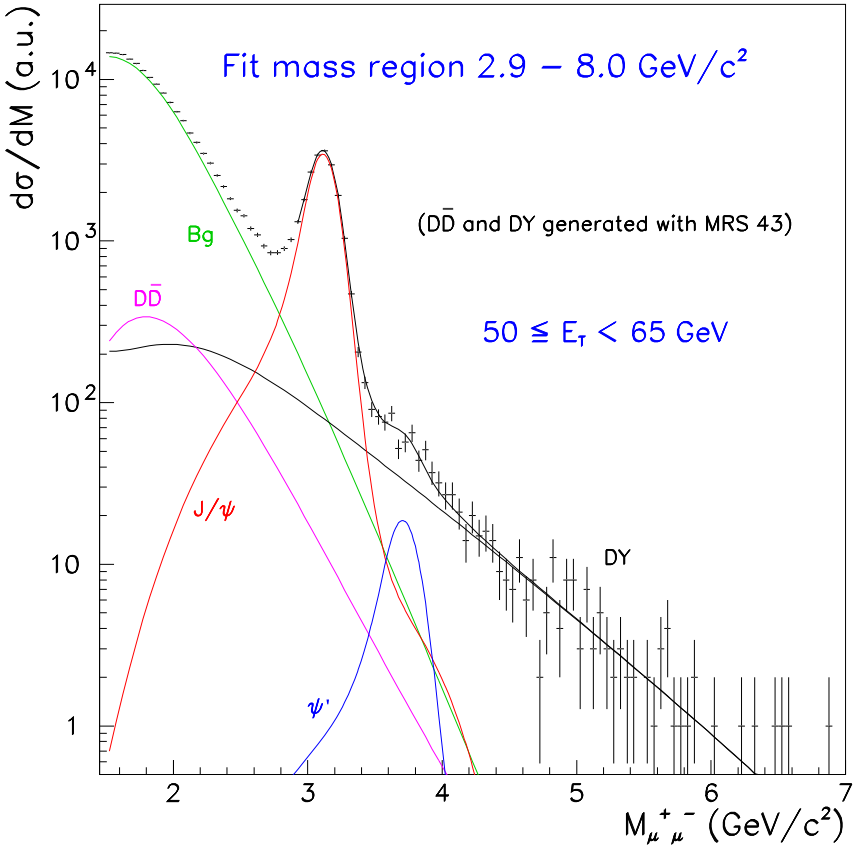
NA50 Pb-Pb data

Data period	total target thickness	subtargets	target region	beam intensity (ions/burst)	J/ψ number
1995	17% λ_I	7	air	3×10^7	50000
1996	30% λ_I	7	air	5×10^7	190000
1998	7% λ_I	1	air	5.5×10^7	40000
2000	9.5% λ_I	1	vacuum	7×10^7	120000

- **In 2000 the target region was placed under vacuum up to the pre-absorber**
- **New high statistics p-A data allows for better precision in the measurement of normal nuclear absorption curve, used as baseline (as defined from p-A and S-U results from NA50, NA51 and NA38 – all using the same spectrometer)**

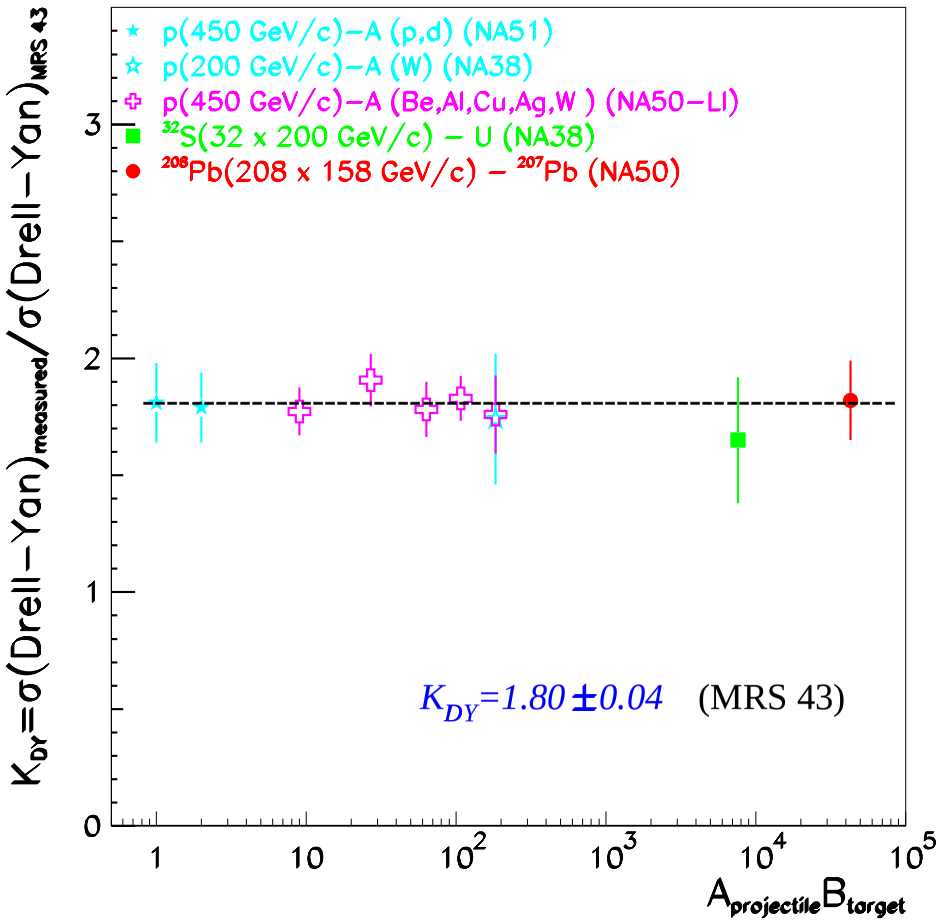
Mass spectrum and fit method

$$\frac{dN}{dM} = A_{J/\psi}\frac{dN_{J/\psi}}{dM} + A_{\psi'}\frac{dN_{\psi'}}{dM} + A_{DY}\frac{dN_{DY}}{dM} + \frac{dN_{D\bar{D}}}{dM} + \frac{dN_{Bg}}{dM}$$



- **Combinatorial background**, due to π and K decays, is estimated from like-sign pairs: $N_{BG} = 2\sqrt{N^{++}N^{--}}$
- J/ψ, ψ', $D\bar{D}$ and Drell-Yan shapes from simulation and reconstructed chain
- $D\bar{D}$ and **Drell-Yan** are generated using both **GRV LO** or **MRS 43** PDF

Drell-Yan: the reference for J/ψ analysis



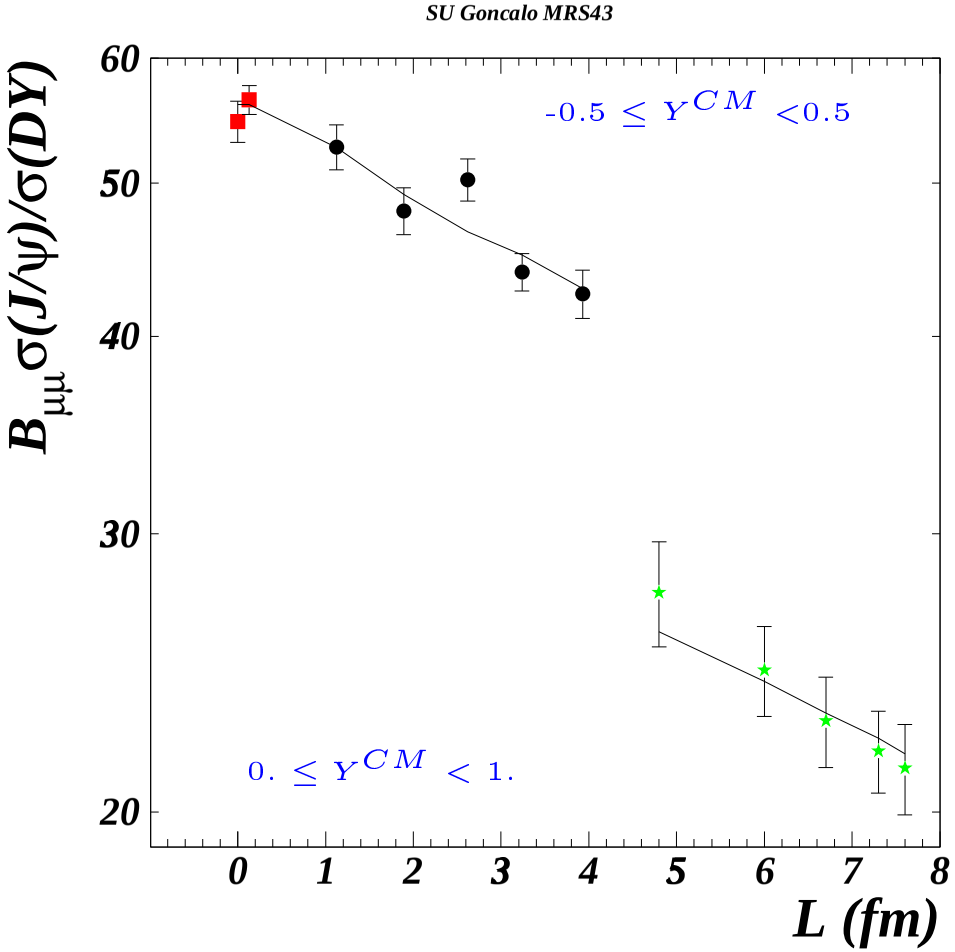
Drell-Yan is **proportional** to the **number of collisions A·B**, that is, it **scales** as expected:

$$\sigma^{DY} \propto (A\ B)^{\alpha} \qquad with \qquad \alpha = 1$$

$\Rightarrow$ **it is used as a reference to study the J/ψ production**

The baseline: J/ψ normal nuclear absorption

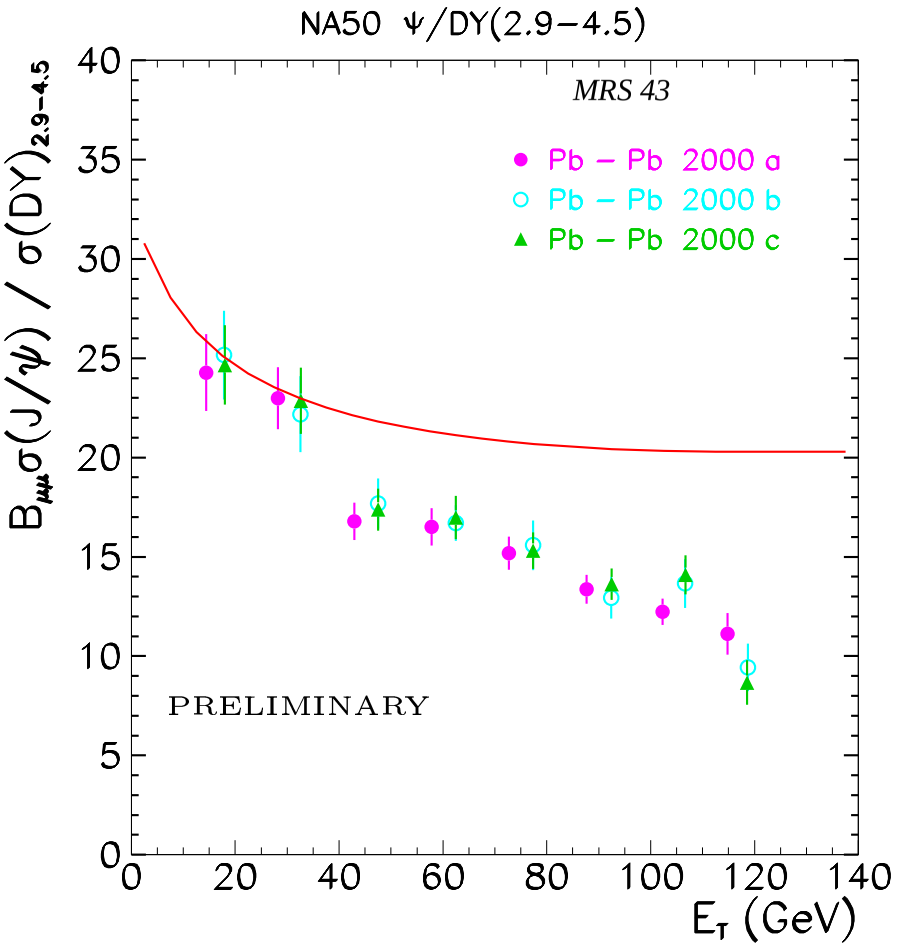
Normal nuclear absorption of charmonia states in dense media is measured with the same spectrometer: present NA50 high statistics p-A, and previous NA51 p-p, p-d and NA38 S-U data



Using a Glauber model fit, the J/ψ absorption cross-section obtained is $\sigma_{abs} = 4.3 \pm 0.5$ mb

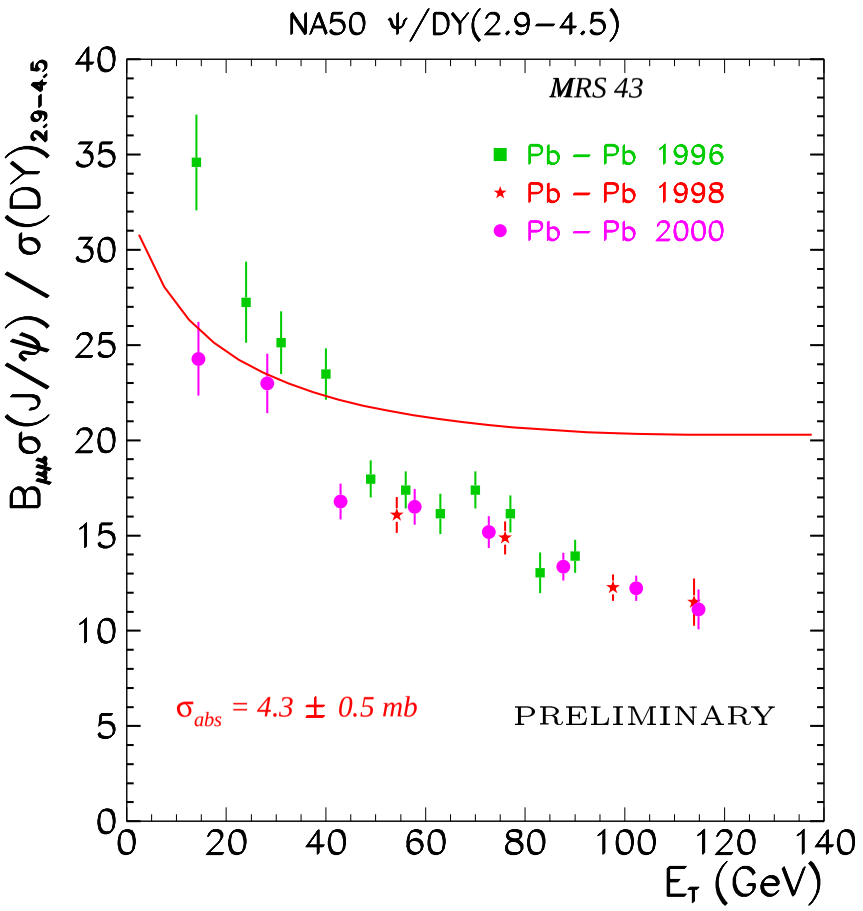
Pb-Pb 2000 results vs. E_T

Transverse energy E_T used as the collision centrality estimator



3 independent analyses, performed in 3 different Laboratories (different data selections and fit methods) are consistent within a few %

Pb-Pb results vs. E_T : Comparison of several data takings

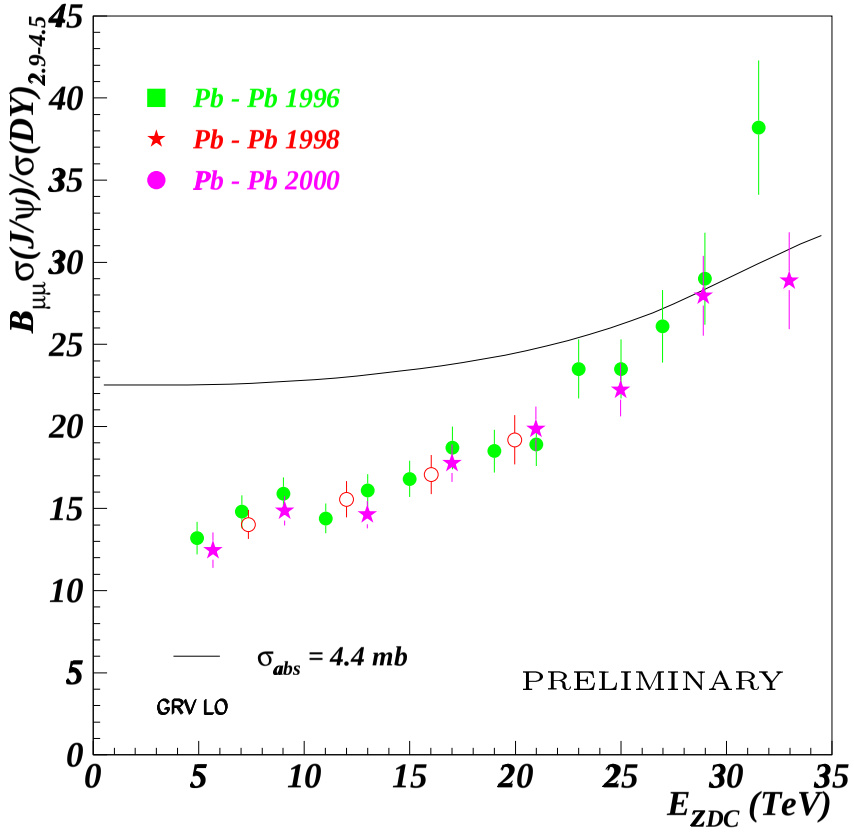


- **1998 published data re-analised with 2000 analysis criteria.**
- **1996 published data rescaled by 3.5% to meet new analysis conditions.**
- **New normal nuclear absorption curve as measured by NA51(p-p, p-d), NA38(S-U), NA50(new high stat. p-A)**

  ⇒ All data sets show agreement within a few %
- **Features:**
  - ⋆ **Departure from absorption curve at $\simeq$ 40 GeV**
  - ⋆ **No saturation at high E_T**

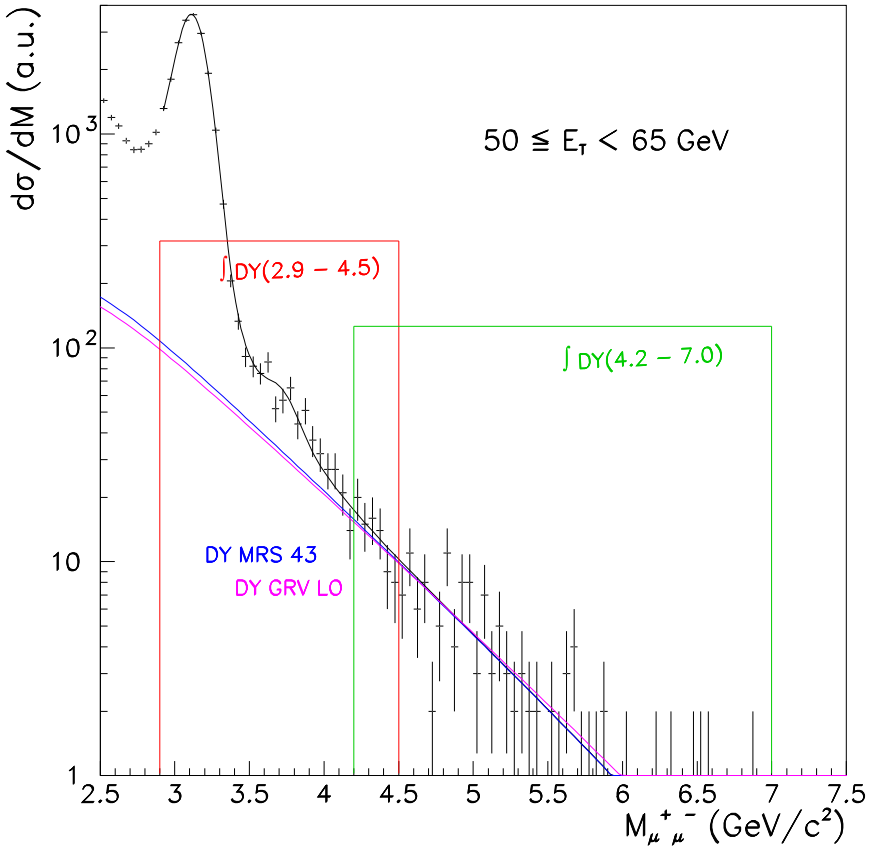
Pb-Pb 2000 results vs. E_{ZDC} . Comparison w/ previous resu

Forward energy E_{ZDC} used as the collision centrality estimator



- The J/ψ/DY(2.9-4.5) Pb-Pb 2000 analysis, as a function of E_{ZDC}, shows good agreement with 1996 and 1998 published results
- It exhibits the same features as the Pb-Pb analysis as a function of E_T :
  - ⋆ Departure from absorption curve at mid-centrality
  - ⋆ No saturation at high centrality

Drell-Yan (4.2-7.0): the new reference for J/ψ analysis

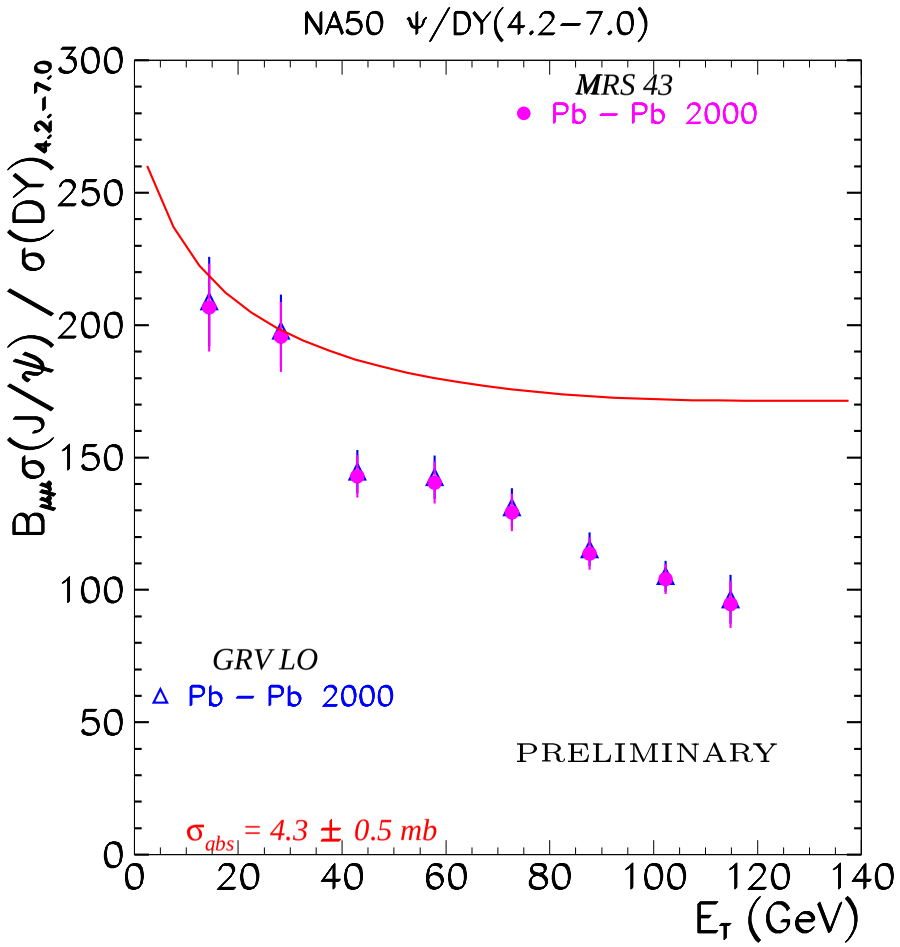


- $\sigma_{\rm DY}$**(2.9-4.5) depends on extrapolation from the measured mass region: 4.2 - 7.0 GeV/c^2**

  $\Rightarrow$ **Using MRS 43 or GRV LO a 10% difference is found**

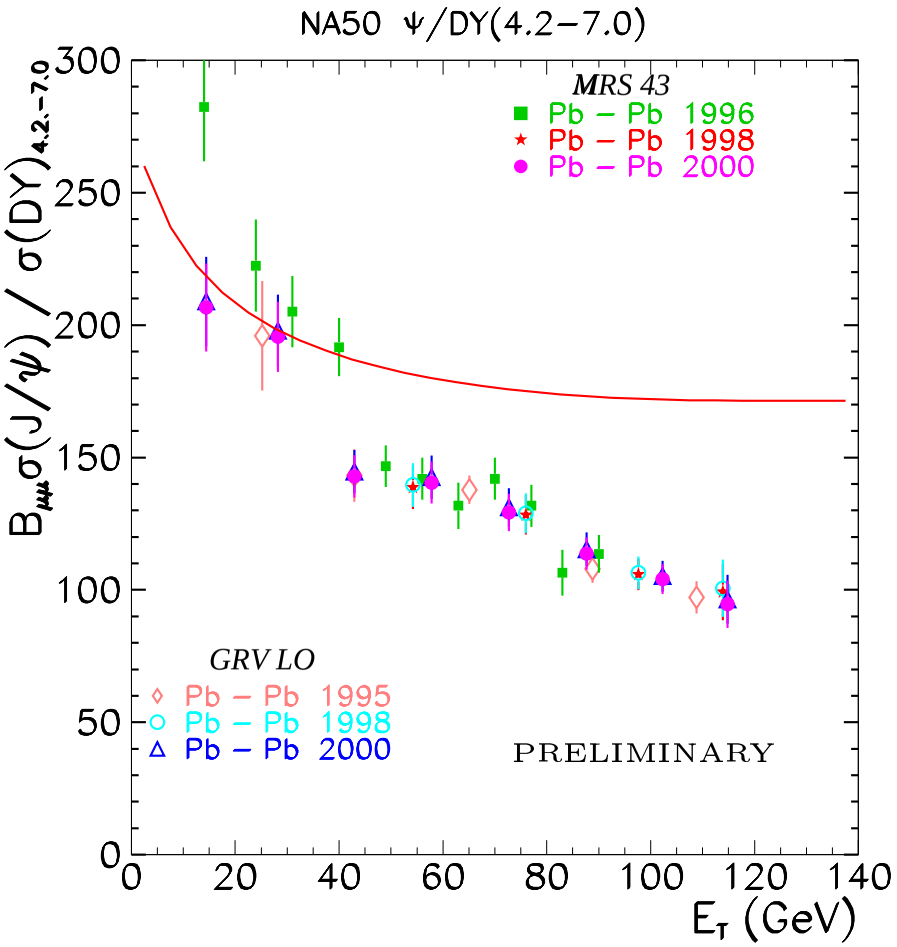
- **Using as reference the directly measured $\sigma_{\rm DY}$(4.2-7.0) one obtains an unique result**

Pb-Pb 2000 results: J/ψ/DY(4.2-7.0)



The Drell-Yan reference being evaluated where it is directly measured, i.e., in the region 4.2-7.0 GeV/c^2, the J/ψ/DY results become independent on the parton distribution function used

Comparison of all NA50 Pb-Pb data: J/ψ/DY(4.2-7.0)



- **J/ψ/DY(4.2-7.0) results are independent on the PDF used for Drell-Yan**
- **Clear stepwise pattern of anomalous J/ψ suppression is seen in all Pb-Pb data**
- **Very good compatibility among different data takings**

Conclusions

Results concerning the 2000 Pb-Pb data with target in vacuum:

- **Agree with analyses from all previous data taking periods (using either E_T or E_{ZDC} as the centrality estimator):**
  $\Rightarrow$ the stepwise pattern of the anomalous J/ψ suppression
- **Confirm the departure at mid-centrality from the normal nuclear absorption curve (as obtained using our p-A and S-U data), which does not saturate at high E_T**
- **Indicate that peripheral collisons follow the normal nuclear absorption pattern**