

Latest results on anomalous J/ψ suppression

S. Ramos – LIP-Lisbon

for the

NA50 Collaboration

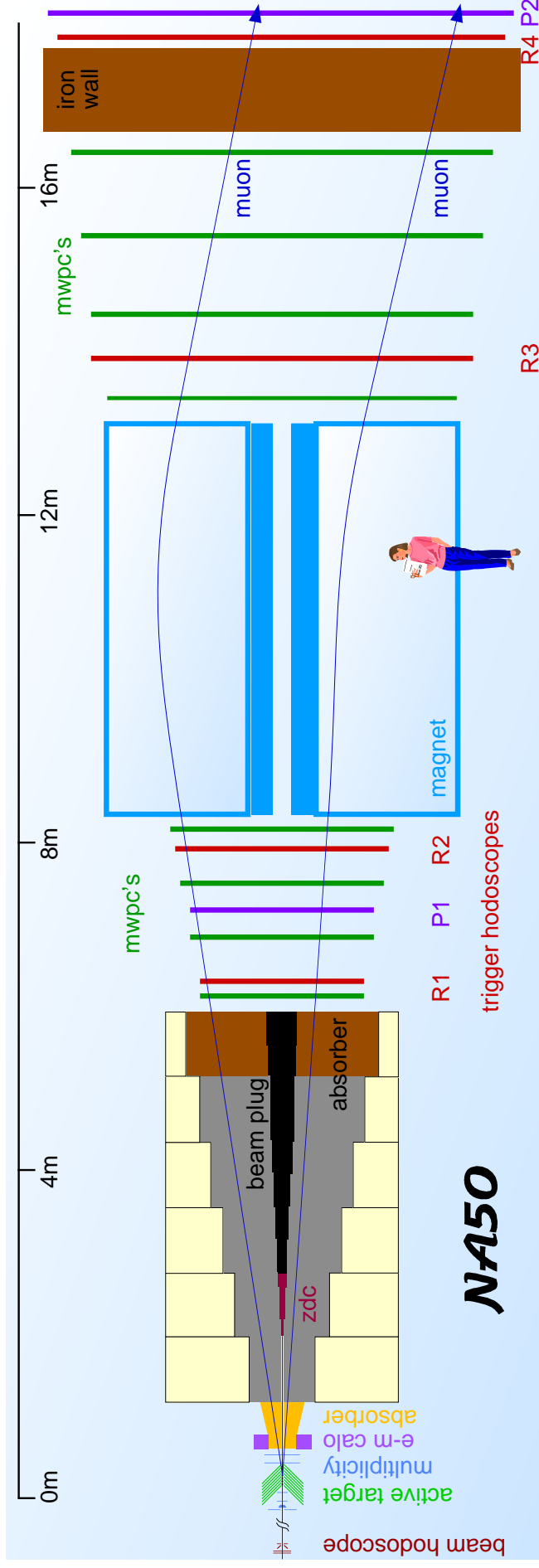
*Alessandria, Annecy, Aubière, Bucharest, Cagliari, CERN,
Lisbon, Moscow, Orsay, Palaiseau, Torino, Villeurbanne, Yerevan*



Mumbai, January 2003

- 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



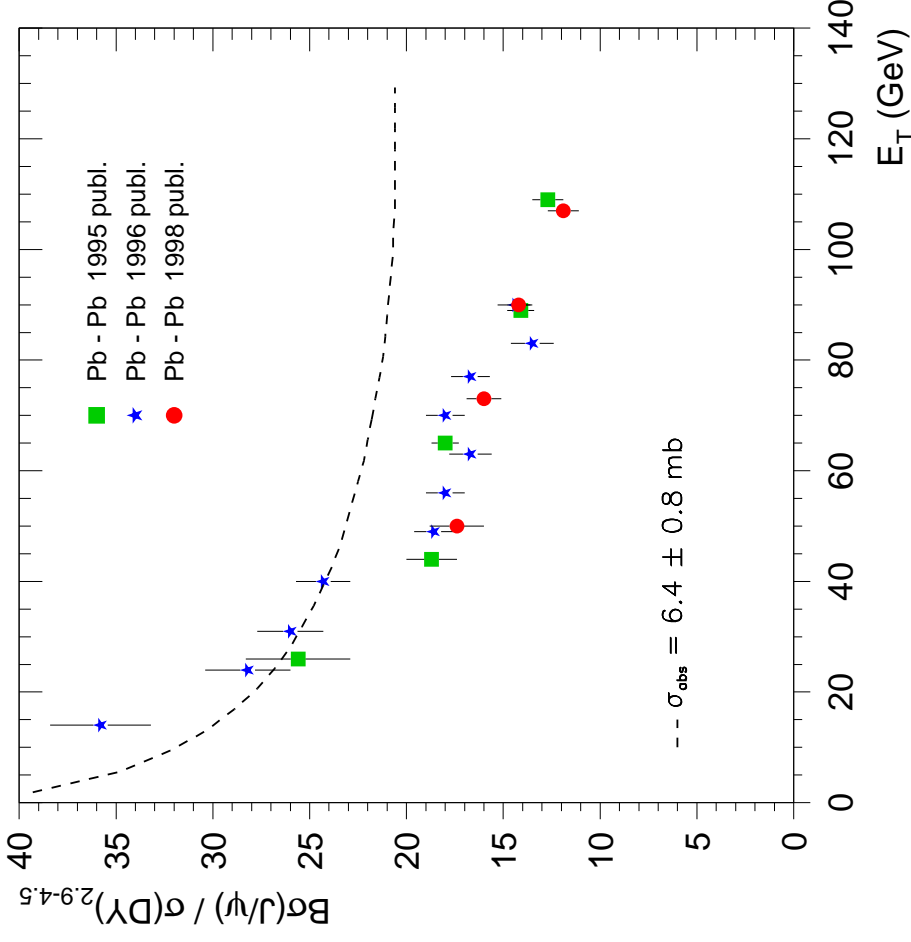
The J/ψ is detected via its decay into muon pairs

- Dimuon spectrometer: $0 < y_{CM} < 1$ ($2.92 < y_{Lab} < 3.92$) $|\cos\theta_{CS}| < 0.5$
- Centrality detectors:
 - ▷ Electromagnetic 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: $J/\psi/DY$

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

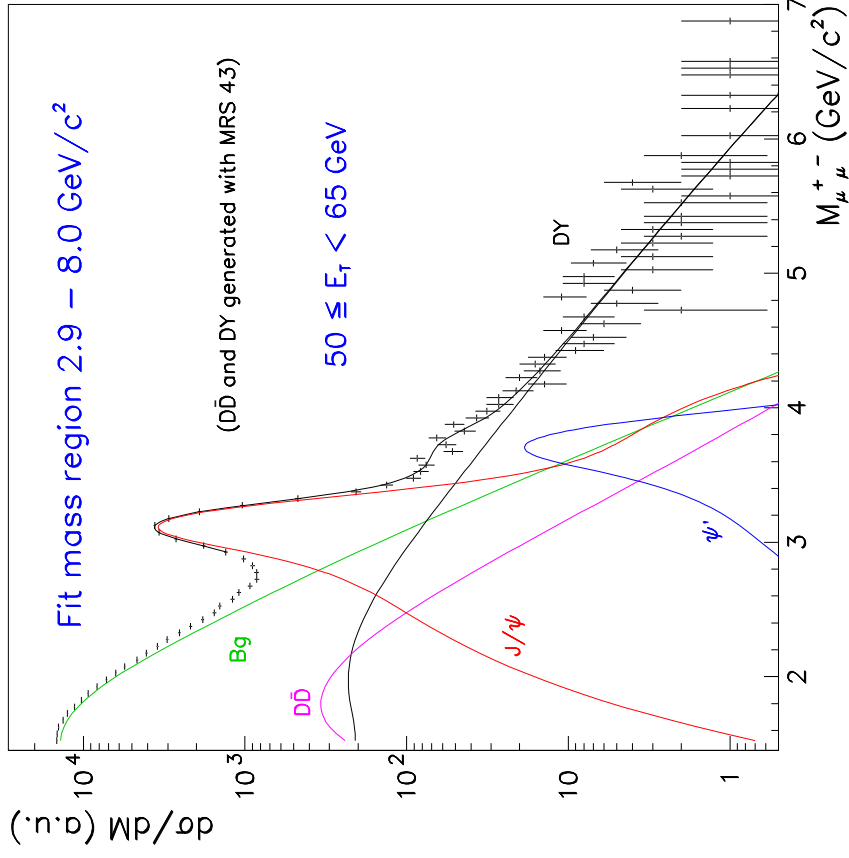
NA50 Pb-Pb data

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)

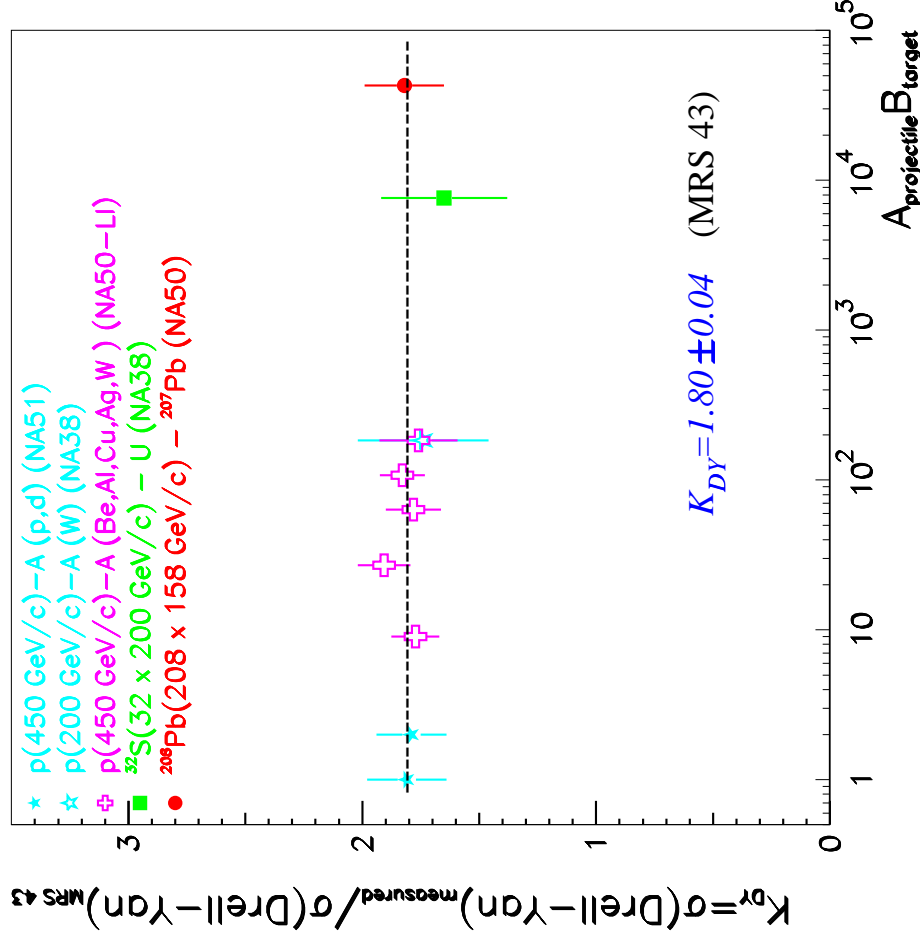
Mass spectrum and fit method

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



- **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 $A \cdot B$, that is, it scales as expected:

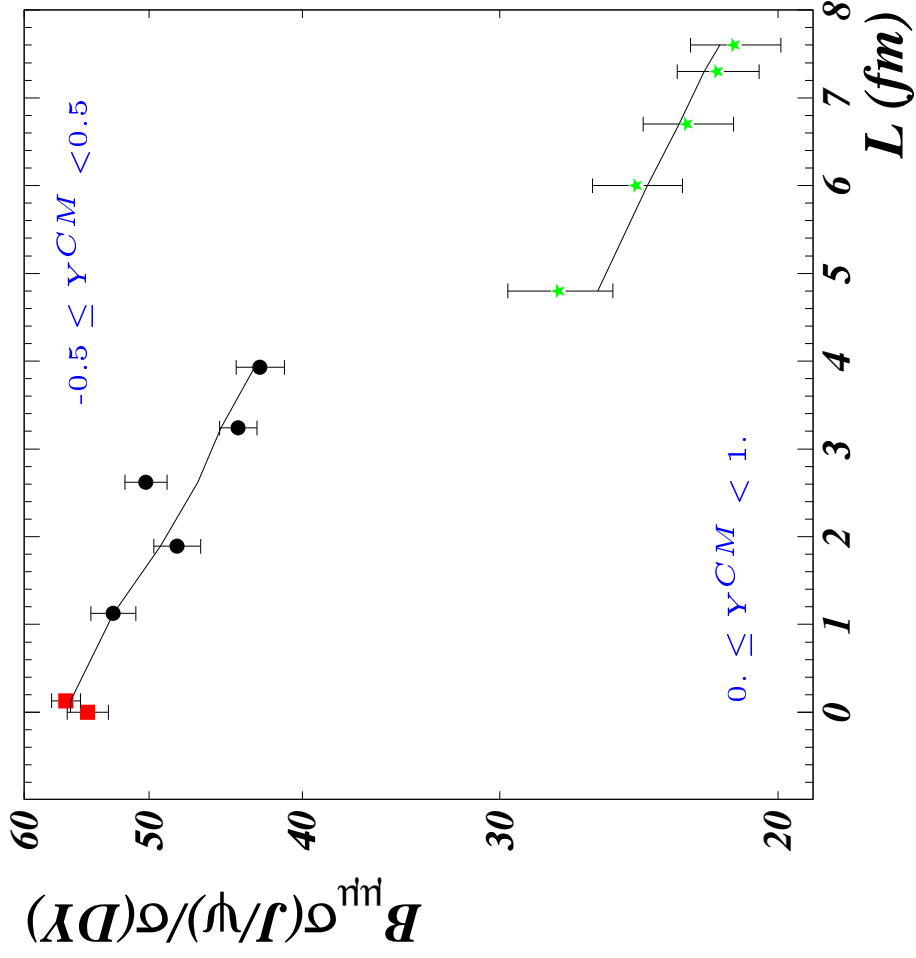
$$\sigma^{DY} \propto (A B)^\alpha \quad \text{with} \quad \alpha = 1$$

⇒ 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

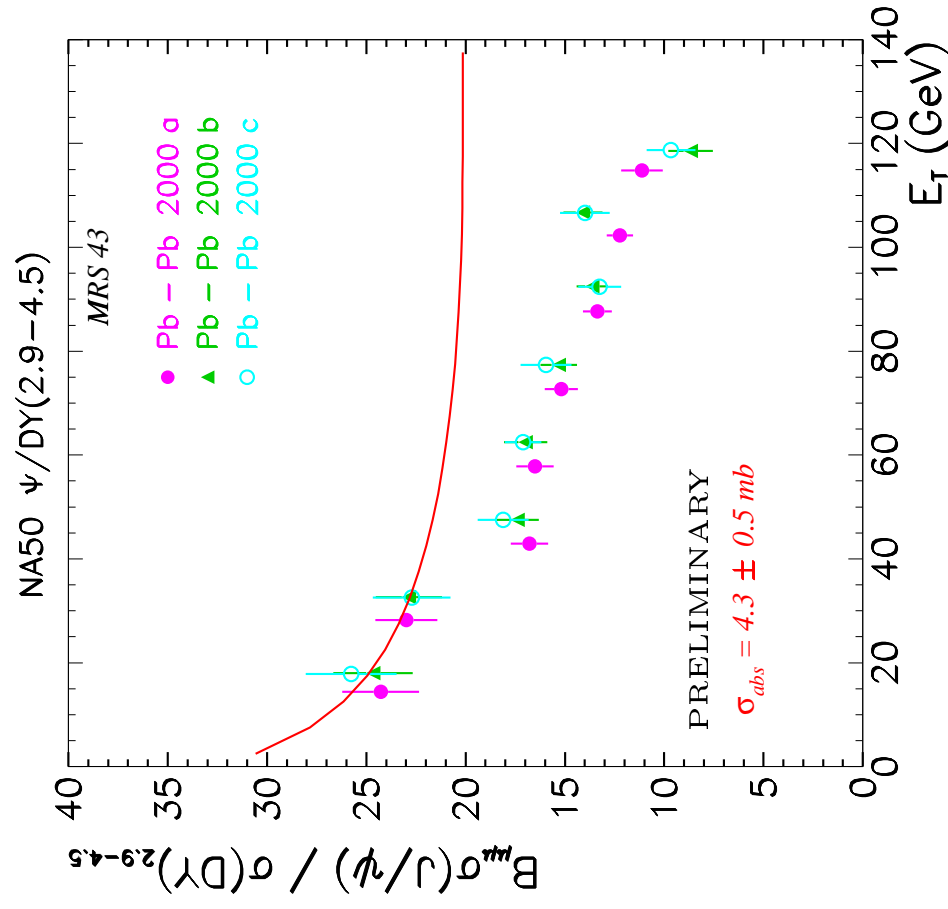
SU Goncalo MRS43



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

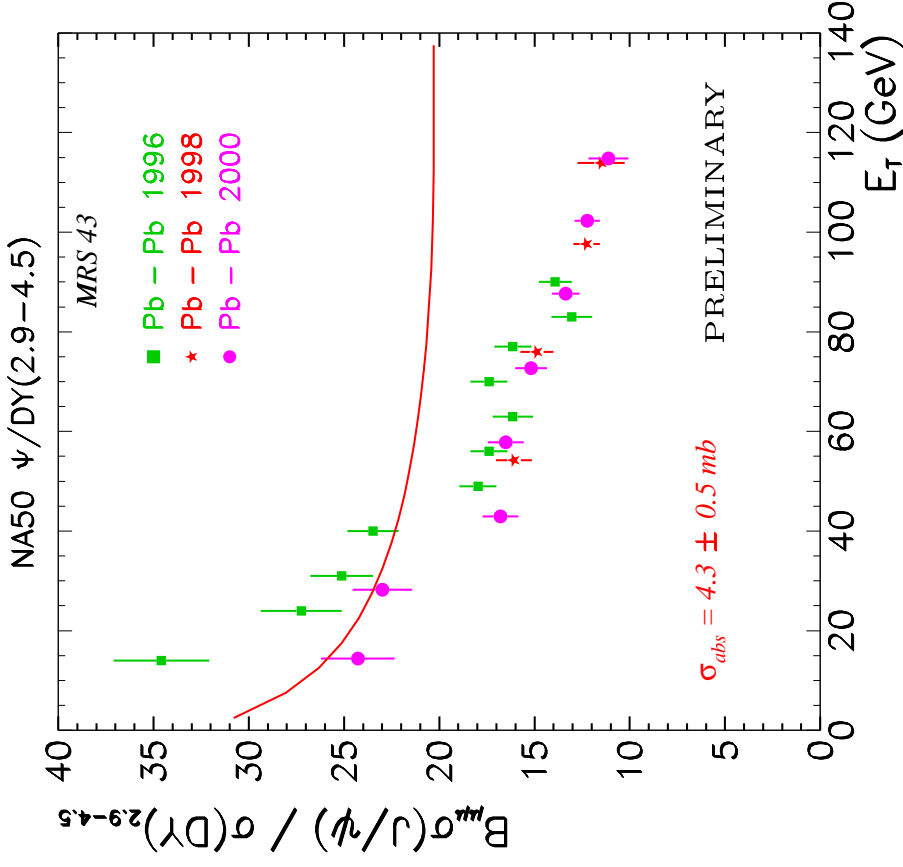
Pb-Pb 2000 results vs. E_T

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 %

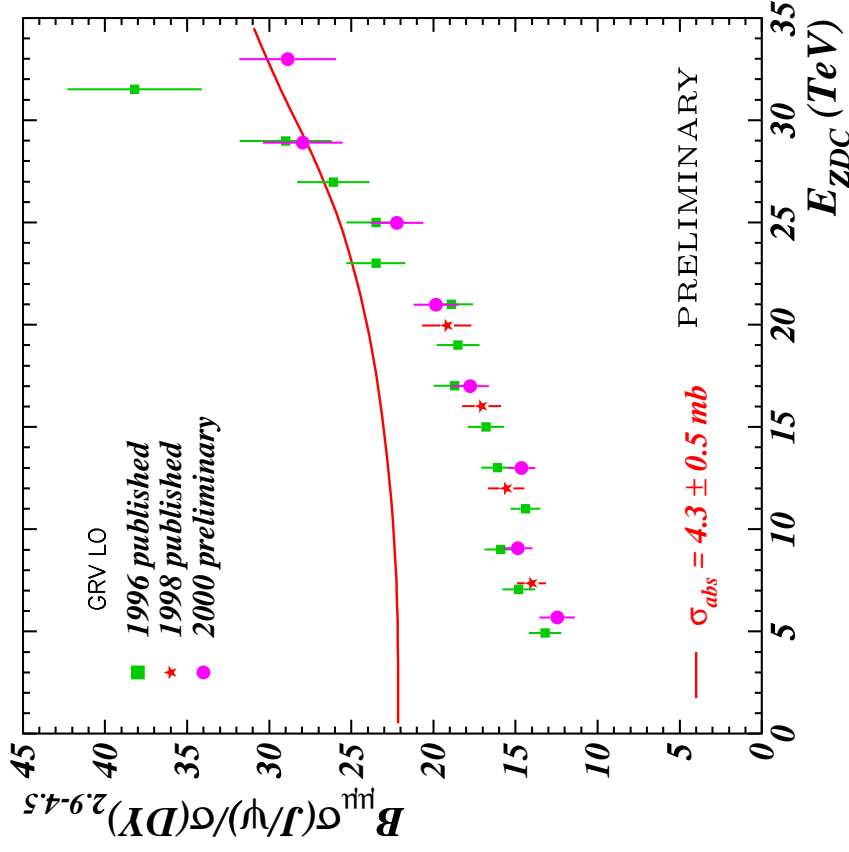
Pb-Pb results vs. E_T : Comparison of several data takings



- 1998 published data re-analysed 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 $\simeq 40 \text{ GeV}$**
 - ★ **No saturation at high E_T**

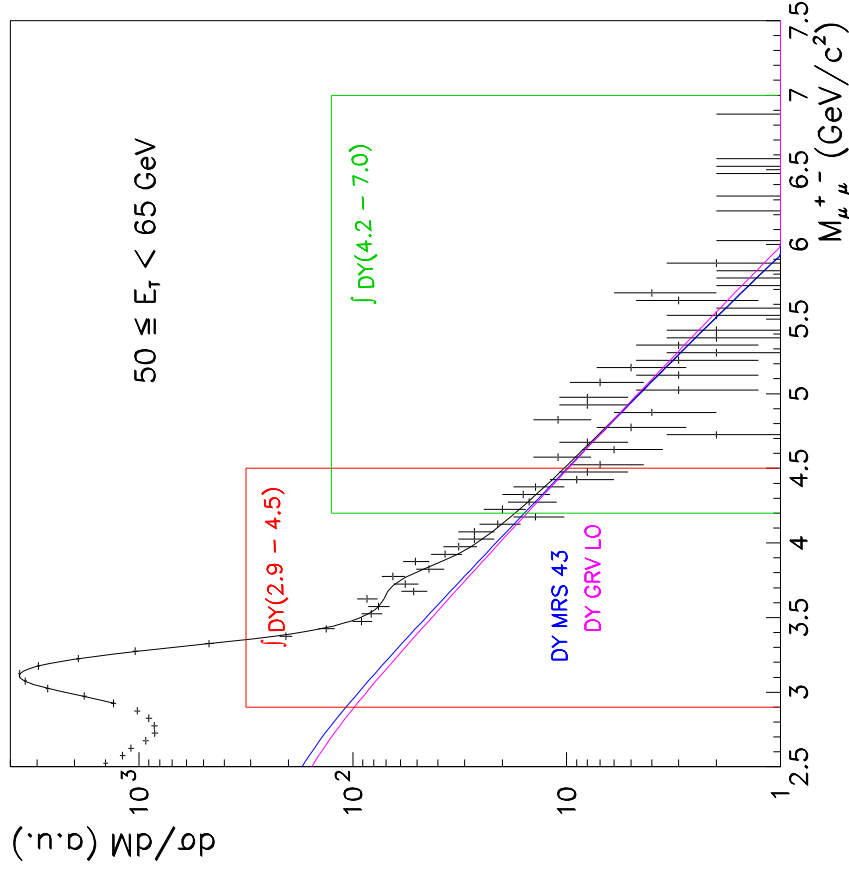
Pb-Pb 2000 results vs. E_{ZDC} . Comparison w/ previous results

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



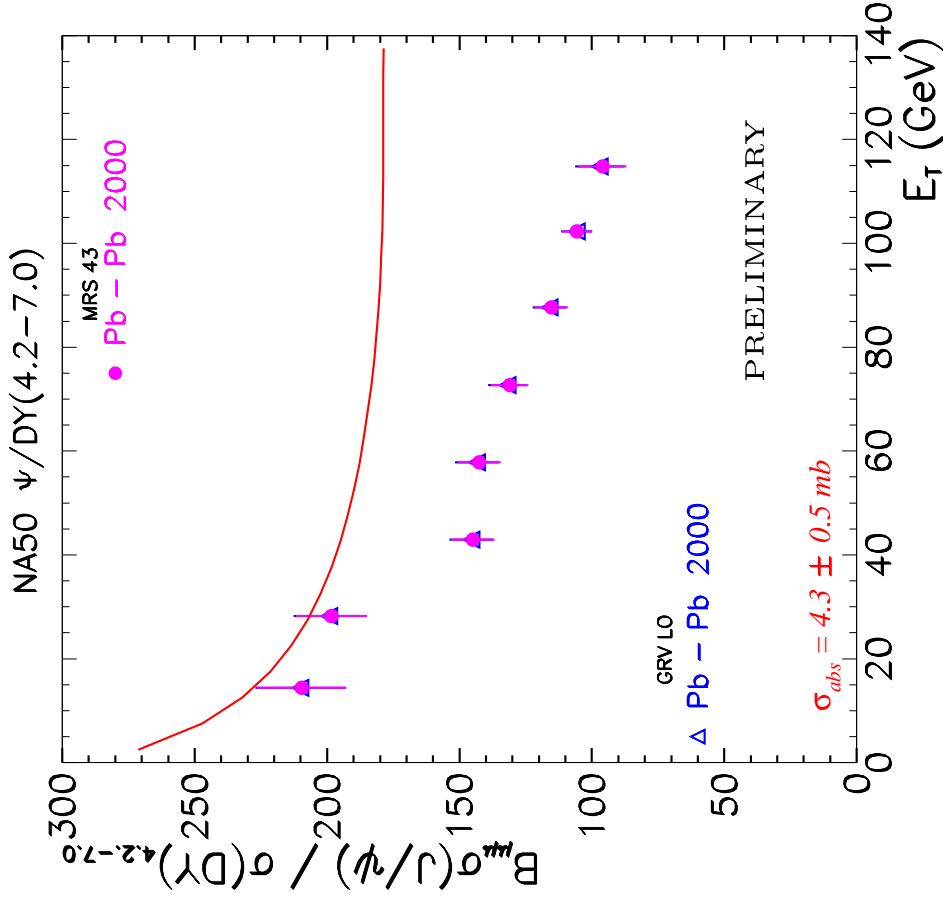
- The $J/\psi/\text{DY}(2.9-4.5)$ Pb-Pb 2000 analysis, as a function of E_{ZDC} , shows **good agreement** with 1996 and 1998 published results
- It exhibits the **same features** as the Pb-Pb analysis as a function of E_T :
 - ★ Departure from absorption curve at mid-centrality
 - ★ No saturation at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

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



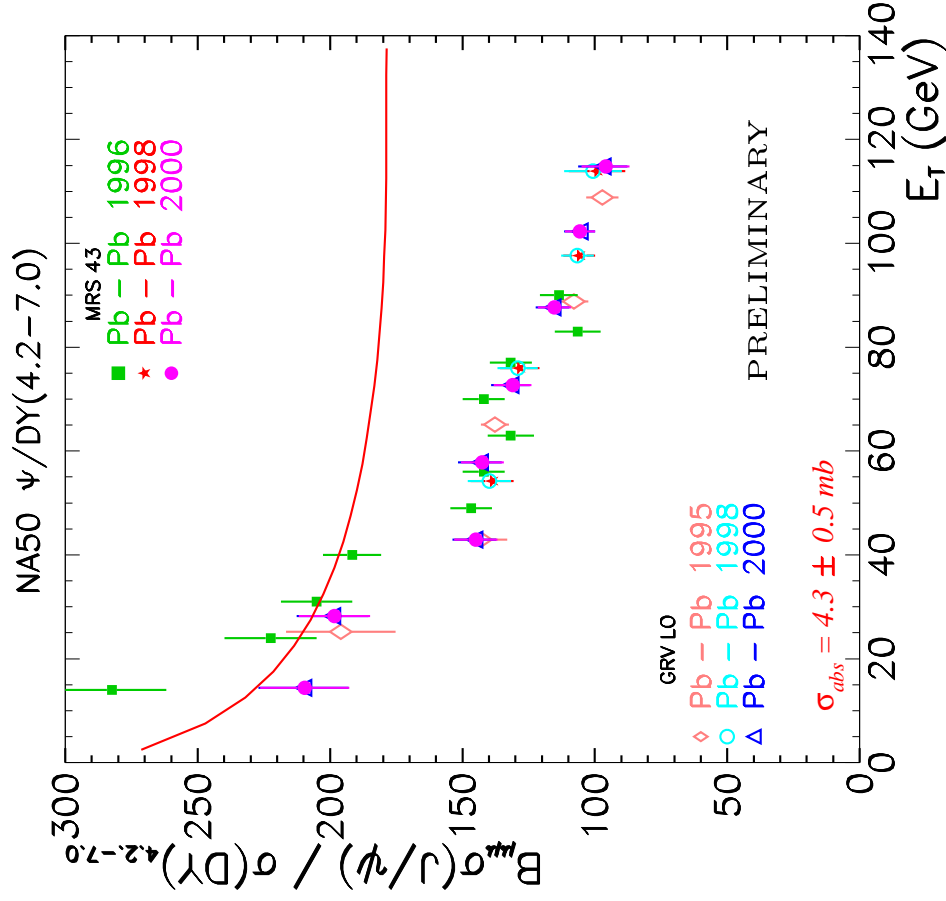
- σ_{DY} (2.9-4.5) depends on extrapolation from the measured mass region: 4.2 - 7.0 GeV/c²
 \Rightarrow Using MRS 43 or GRV LO a 10% difference is found
- Using as reference the directly measured σ_{DY} (4.2-7.0) obtains a unique result

Pb-Pb 2000 results: $J/\psi/DY(4.2-7.0)$



The **Drell-Yan** reference being evaluated where it is **directly measured**, i.e., in the region **4.2-7.0 GeV/c²**, the **$J/\psi/DY$** 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):
 - ⇒ 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 collisions follow the normal nuclear absorption pattern