J/ψ and ψ' production in 450 GeV p-A interactions

Absolute cross sections
Rapidity dependence

- ✓ **Introduction**
- ✓ **Description of NA50 experiment**
- ✓ **Results**
- ✓ **Summary**

Introduction

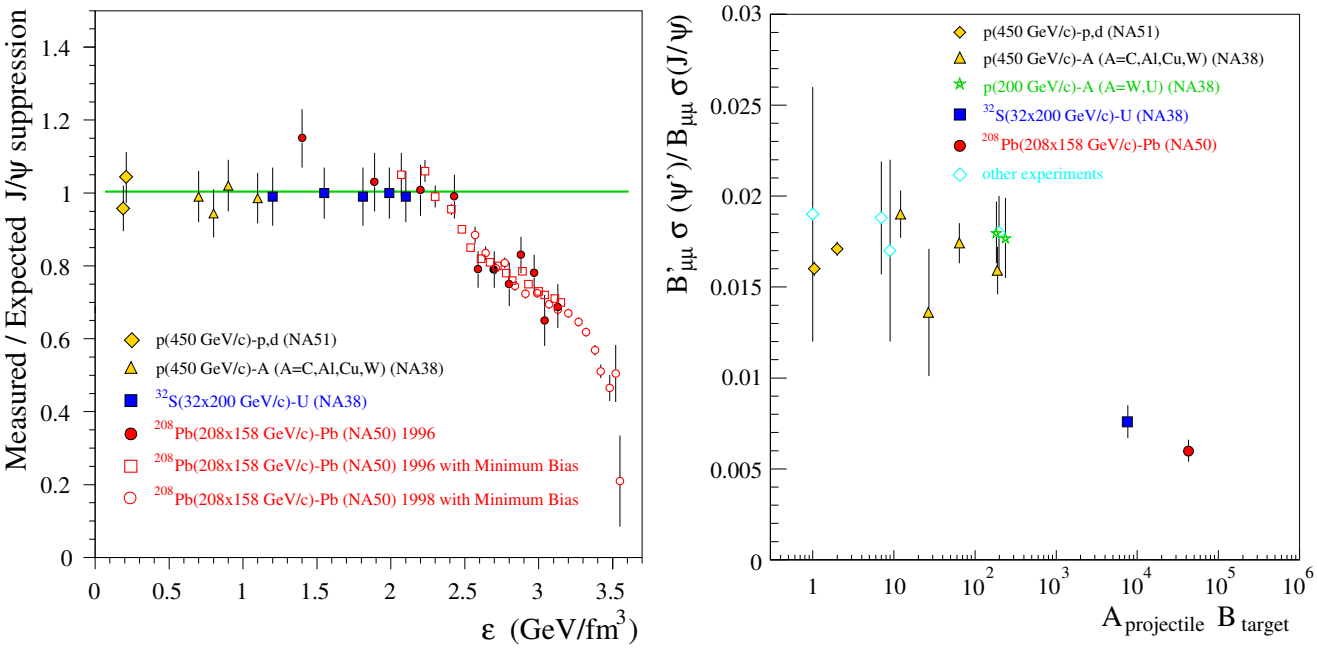
✓ **Charmonia suppression was predicted as a signature of QGP formation in nucleus-nucleus collisions**

✓ **But even in normal nuclear matter charmonia production is suppressed due to hadronic interactions.**

✓ **NA50 observed in 158 AGeV/c PbPb collisions an anomalous suppression of J/ψ. Its two-step pattern suggest initial melting of χ_c states at the onset of QGP (T~T_c,) with subsequent melting of the J/ψ at higher temperatures.**

✓ **The ψ'/ψ ratio was observed to be constant in pA : indicates formation of preresonant state with considerable formation time to final meson.**

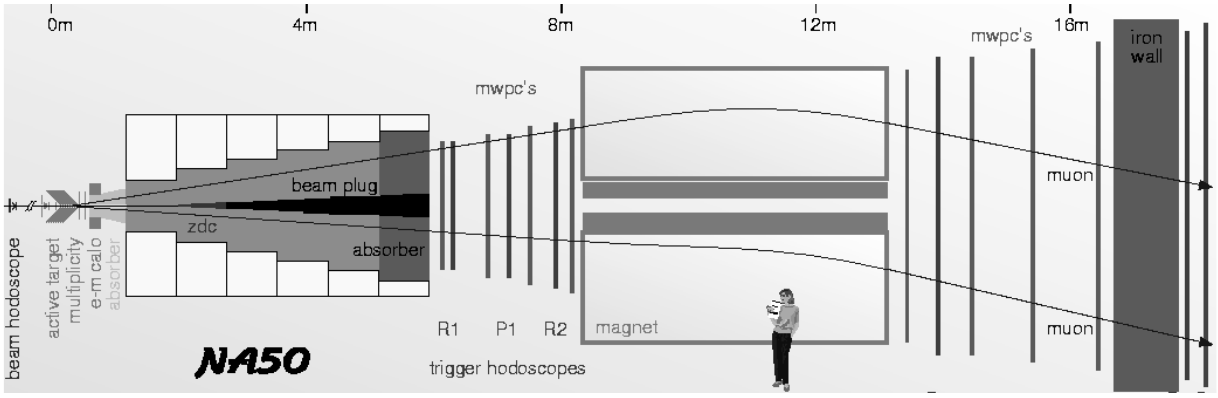
✓ **Its decrease in AB collisions was attributed to ψ' absorption by secondaries from the nuclear collision.**



✓ **The E866 Fermilab collaboration observed a stronger suppression of the ψ' compared with the J/ψ in interactions of 800 GeV/c protons on Be, Fe and W targets.**

✓**The motivation of the present study is to look for similar effects in the NA50 pA data.**

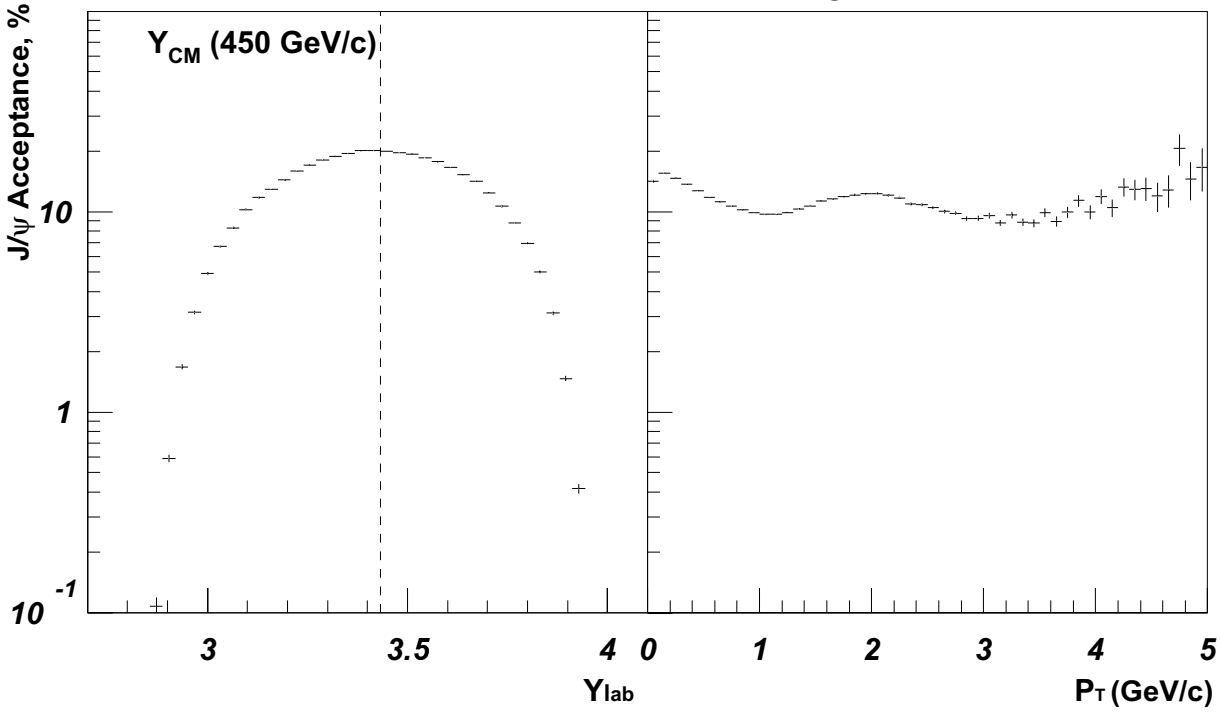
NA50 Experiment (pA setup)



Muon Spectrometer (8 MWPC) with air-core toroidal magnet separated from target region by Hadron Absorber.

Targets used for present analysis: Be, Al, Cu, Ag and W

Acceptance at 450 GeV/c : -0.5< y_{CM}<0.5; |cos(θ)|<0.5



Two types of data samples were collected for each target: with Low (LI) and High (HI) Intensity beams. Results on LI data (integrated over the NA50 acceptance) were presented by E. Scomparin at QM2001.

The present analysis use HI data (together with HI+LI average) in 4 equidistant bins in –0.5< y_{CM}<0.5.

Parametrizations of Charmonia Suppression

Glauber Model

Mesons are produced in binary nucleon-nucleon interactions with cross section σ_0 and absorbed in nuclear matter with cross section σ_{abs}

$$\sigma_{pA} = \frac{\sigma_0}{\sigma_{abs}} \int d^2\vec{s} \left[1 - T_A(\vec{s})\sigma_{abs}\right]^A$$

$T_A(s)$ - nuclear thickness function at impact vector s.

<ρL> parametrization

Mesons are absorbed with cross section σ_{abs}, seeing in average <ρL> amount of matter from its production point to exit from nucleus:

$$\sigma_{pA} = \sigma_0 A \exp\left(-\sigma_{abs} < \rho L >\right)$$

(from expansion of Glauber formula: $< \rho L >= \frac{A-1}{2} \int d^2\vec{s}\, T_A^2(\vec{s})$ **)**

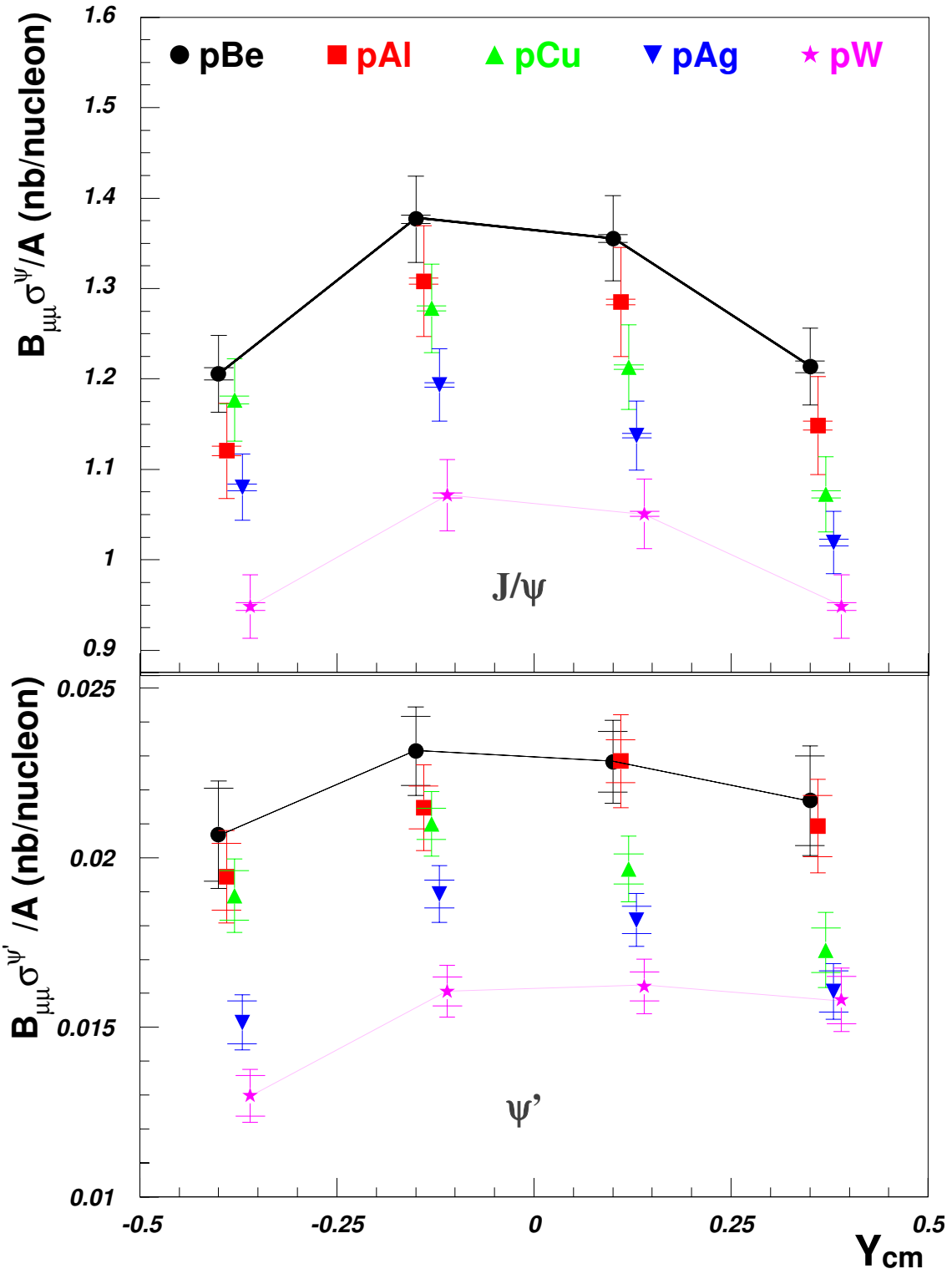
A^α parametrization

Widely used but rough parametrization

$$\sigma_{pA} = \sigma_0 A^\alpha$$

Connected with previous formulae as $\alpha \approx 1 - \sigma_{abs} \frac{< \rho L >}{\ln A}$

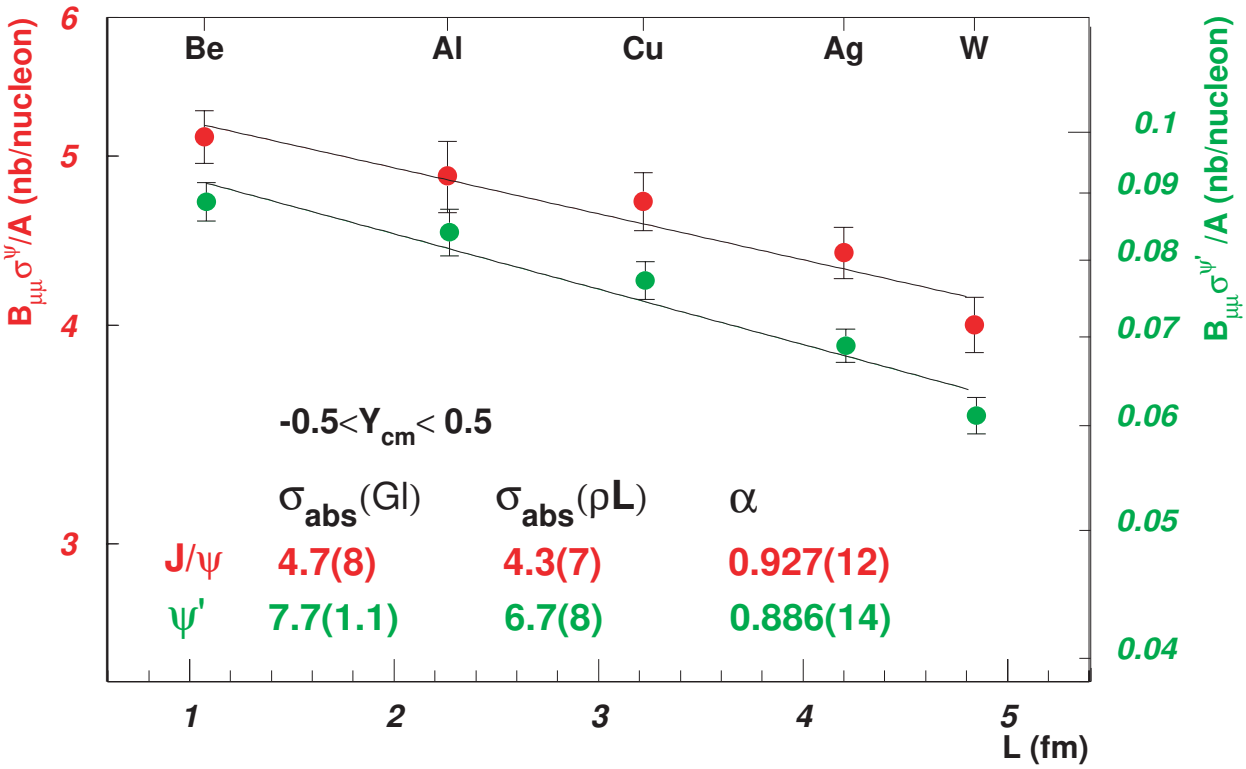
J/ψ and ψ' absolute cross sections (HI)



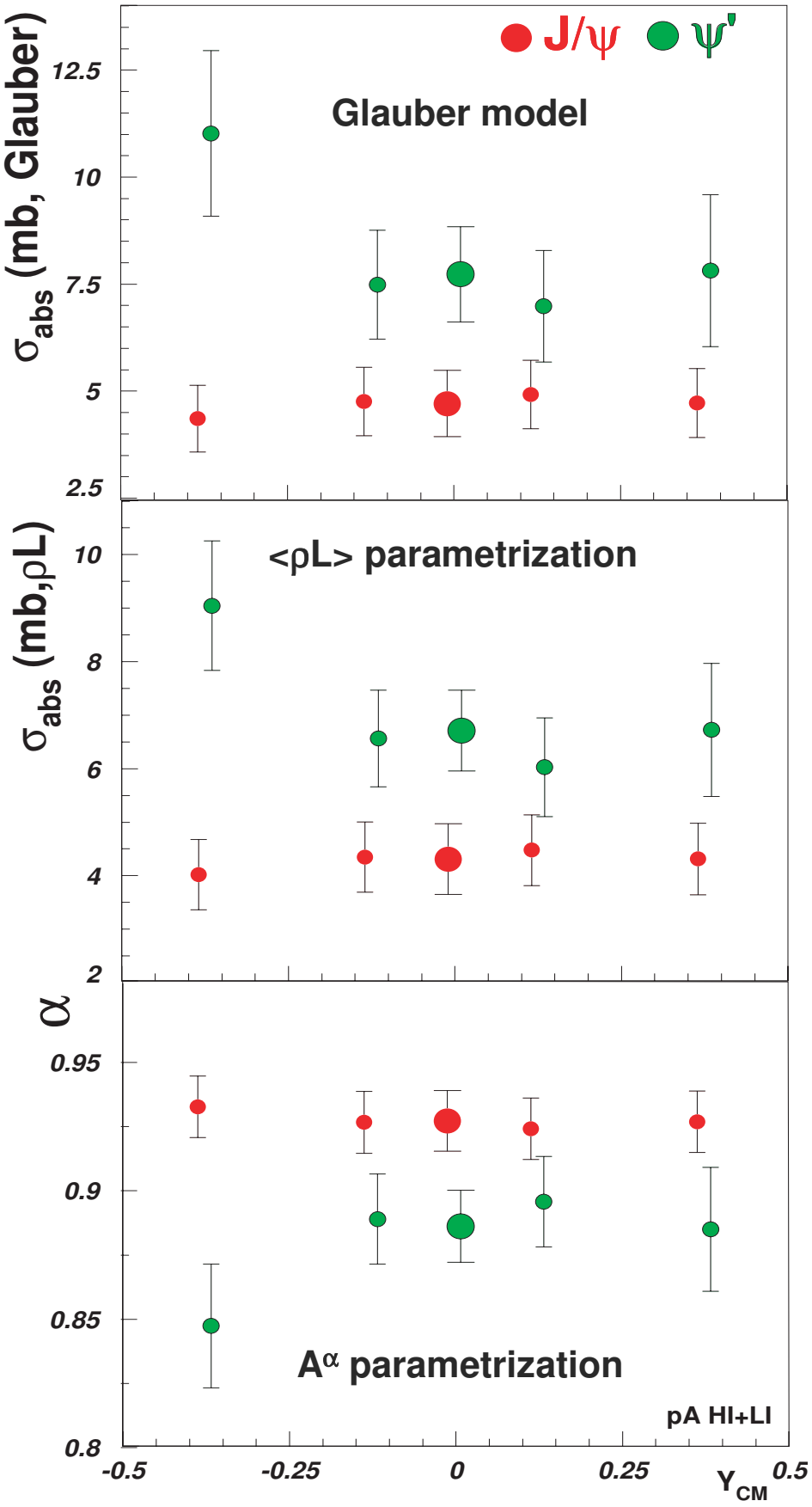
✓ψ' distributions are more asymmetric with respect to y_{cm}

(Large error bars reflect uncertainty in absolute normalization =>do not affect the shapes)

Absorption parameters from absolute cross sections (integrated over rapidity)



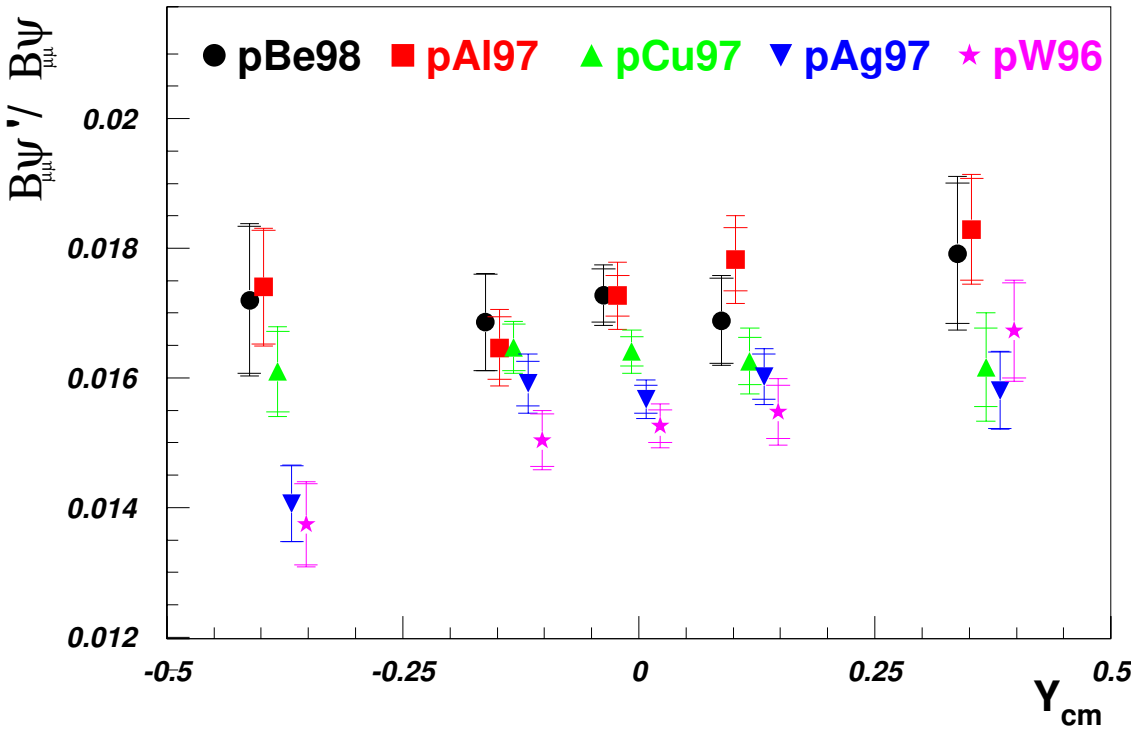
Absorption parameters from absolute cross sections

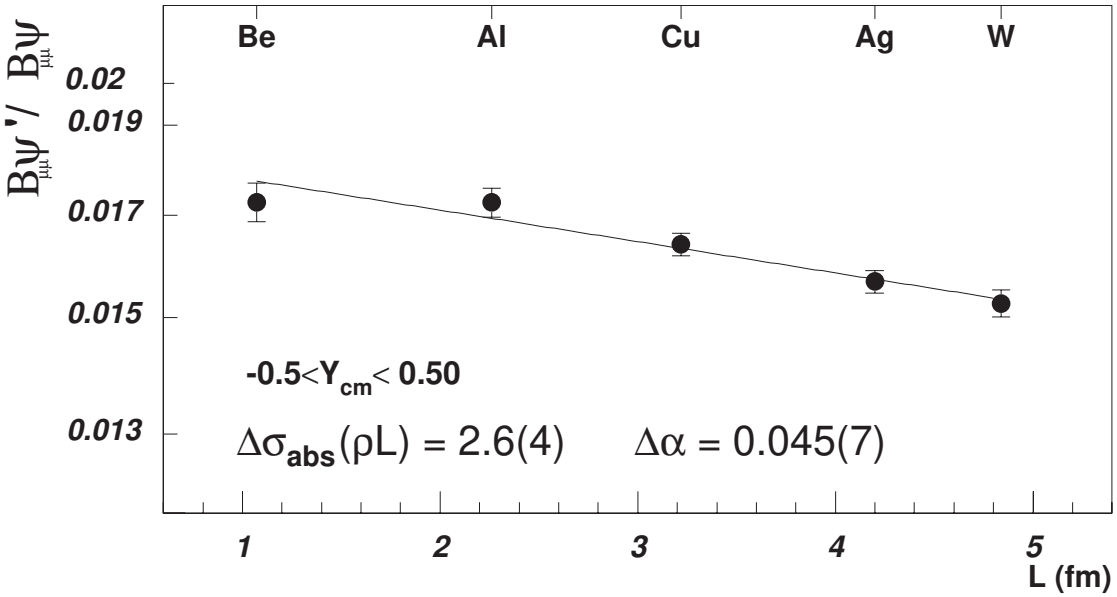


Large symbols in the center are integrated values.

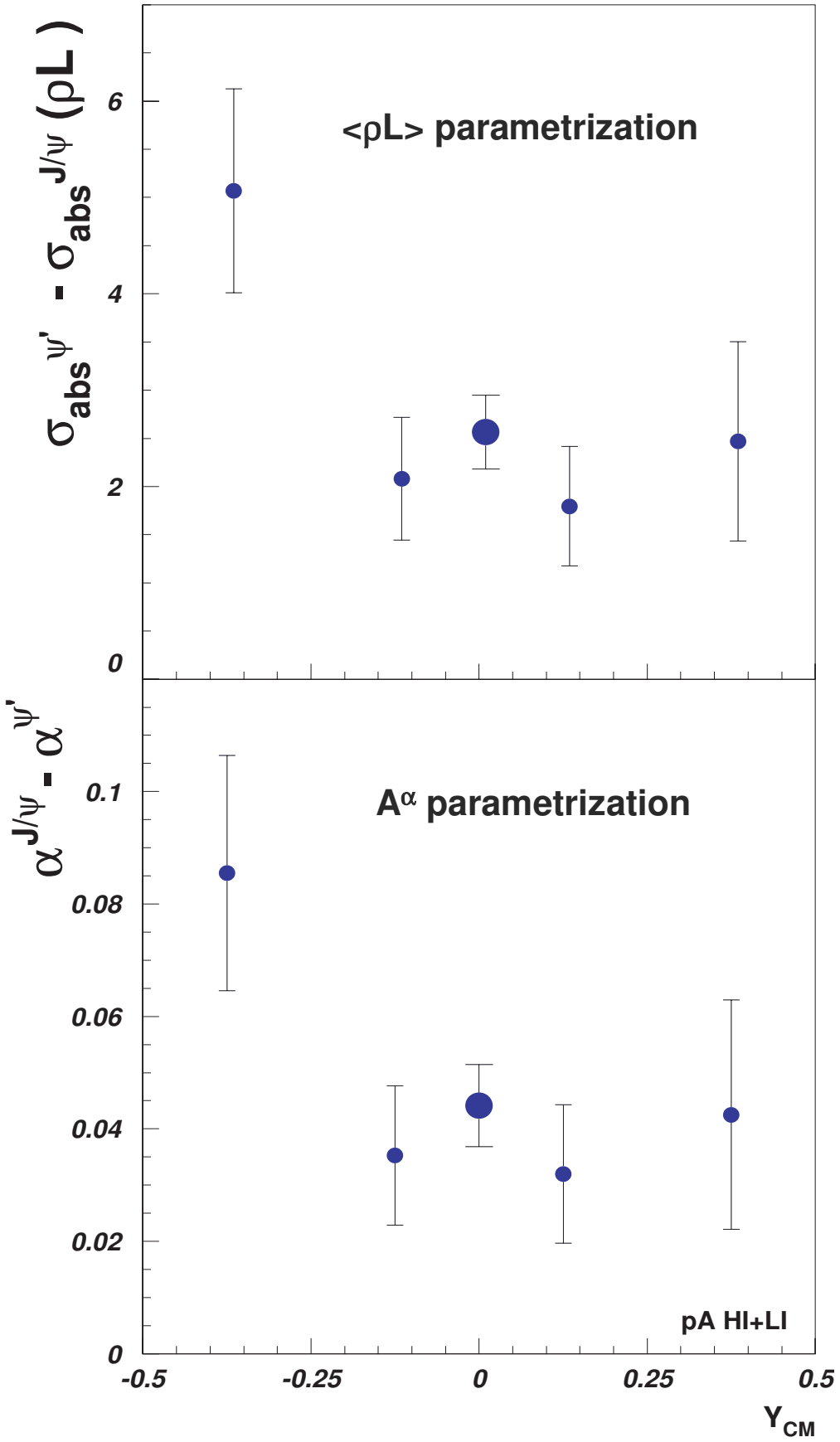
ψ' /ψ ratio

Uncertainty in absolute cross sections is dominated by systematics (mainly beam luminosity normalization)
=> canceled in cross sections ratio

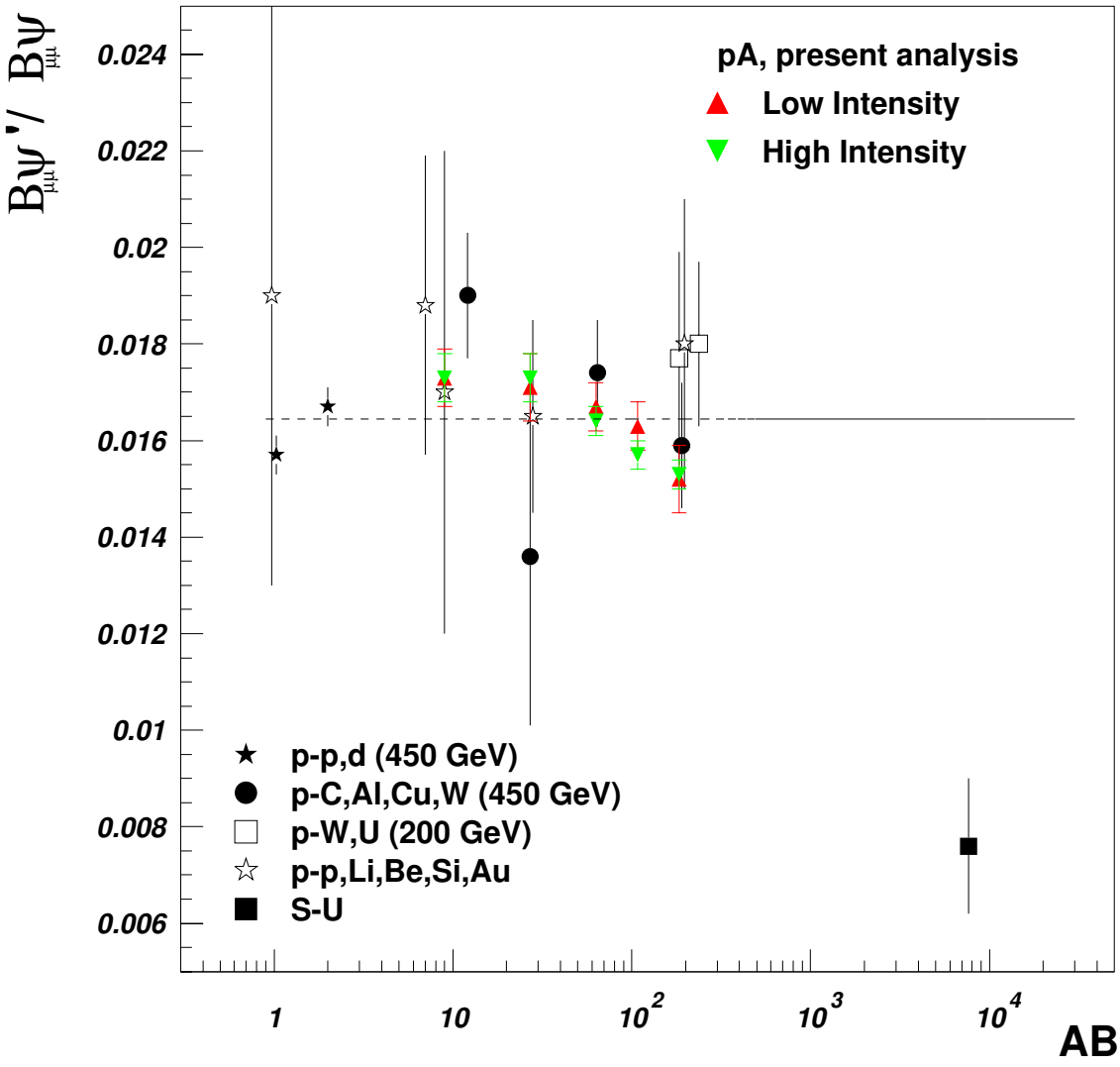




Difference in ψ' and J/ψ nuclear absorption



ψ' /ψ ratio: comparison with previous results



Summary

Results from absolute cross sections

✓ **J/ψ nuclear absorption at $0.5<y_{cm}<0.5$ is consistent with previous results:**

$\alpha^{J/\psi} = 0.927 \pm 0.012$ from A^{α} fit

$\sigma_{abs}^{J/\psi} = 4.7 \pm 0.8$ mb ($\sigma_0 = 5.71 \pm 0.18$ nb) from Glauber fit

$\sigma_{abs}^{J/\psi} = 4.3 \pm 0.7$ mb from $\langle \rho L \rangle$ fit

✓ **ψ' shows stronger suppression than J/ψ :**

$\alpha^{\psi'} = 0.886 \pm 0.014$

$\sigma_{abs}^{\psi'} = 7.7 \pm 1.1$ mb ($\sigma_0 = 105 \pm 4$ pb) from Glauber fit

$\sigma_{abs}^{\psi'} = 6.7 \pm 0.8$ mb from $\langle \rho L \rangle$ fit

Results from cross section ratios (smaller systematic errors)

$\alpha^{J/\psi} - \alpha^{\psi'} = 0.045 \pm 0.007$

$\sigma_{abs}^{\psi'} - \sigma_{abs}^{J/\psi} = 2.6 \pm 0.4$ mb from $\langle \rho L \rangle$ fit

✓ **Indication on stronger absorption of ψ' at small rapidities**