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J/ψ suppression in Pb-Pb collisions at 158 A·GeV/c

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for the NA50 Collaboration

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OUTLINE

J/ψ suppression versus centrality in Pb-Pb

$\frac{J/\psi}{DY}$

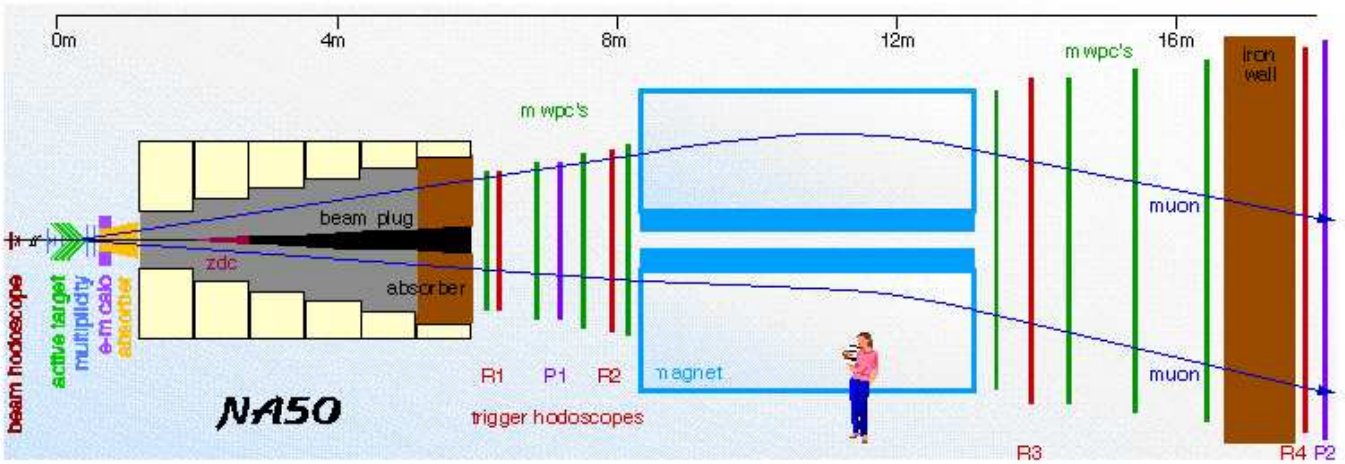
- 1996 DATA: Final Results
  (*Physics Letters B 450(1999) 456*)
- 1998 DATA: Preliminary Results

$\frac{J/\psi}{MB}$

Estimation of DY events from a Minimum Bias trigger sample

- 1996 DATA: Final
- 1998 DATA: Preliminary

EXPERIMENTAL SETUP



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

- Dimuon spectrometer

$0 < y_{CM} < 1 \quad (2.92 < y_{LAB} < 3.92) \quad |\cos\theta_{CS}| < 0.5$

Acceptance	J/ψ	13.5%
	DY$(2.9-4.5)$	15.1%
	DY $(2.9-8.0)$	15.4%

- Active target (Cherenkov counters)

- Centrality detectors

  - E.m. calorimeter $(1.1 < \eta_{lab} < 2.3)$
  - Multiplicity detector $(1.5 < \eta_{lab} < 3.5)$
  - Zero Degree Calorimeter $(\eta_{lab} > 6.3)$

1996 Pb-Pb data taking

1995,1996 and 1998 very similar setup except for the target

Active target: 30%λ_I in 7 subtargets (17%λ_I in 1995)

High statistics: 190000 J/ψ, 2100 Drell-Yan events
Access to peripheral collisions

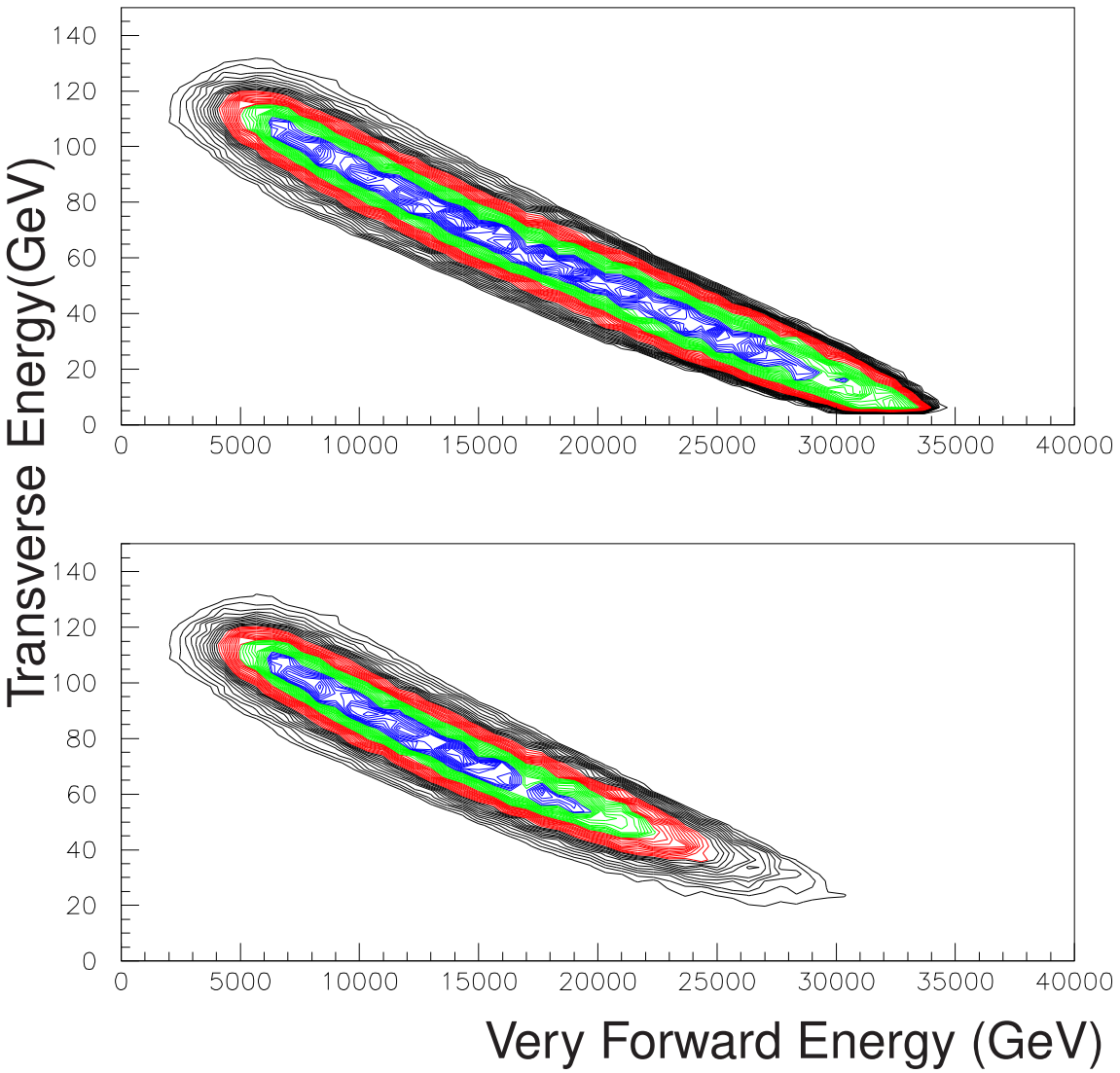
Event selection

Clean sample of dimuon events originating in the target

1. Dimuon trigger
2. Pile-up and beam halo events are rejected, as well as events coming from interactions in the beam hodoscope
3. Target identification (Cherenkov counters) and correlation $E_T - E_{ZDC}$
4. Severe cuts on the muon track quality

Identification of Pb-Pb interactions

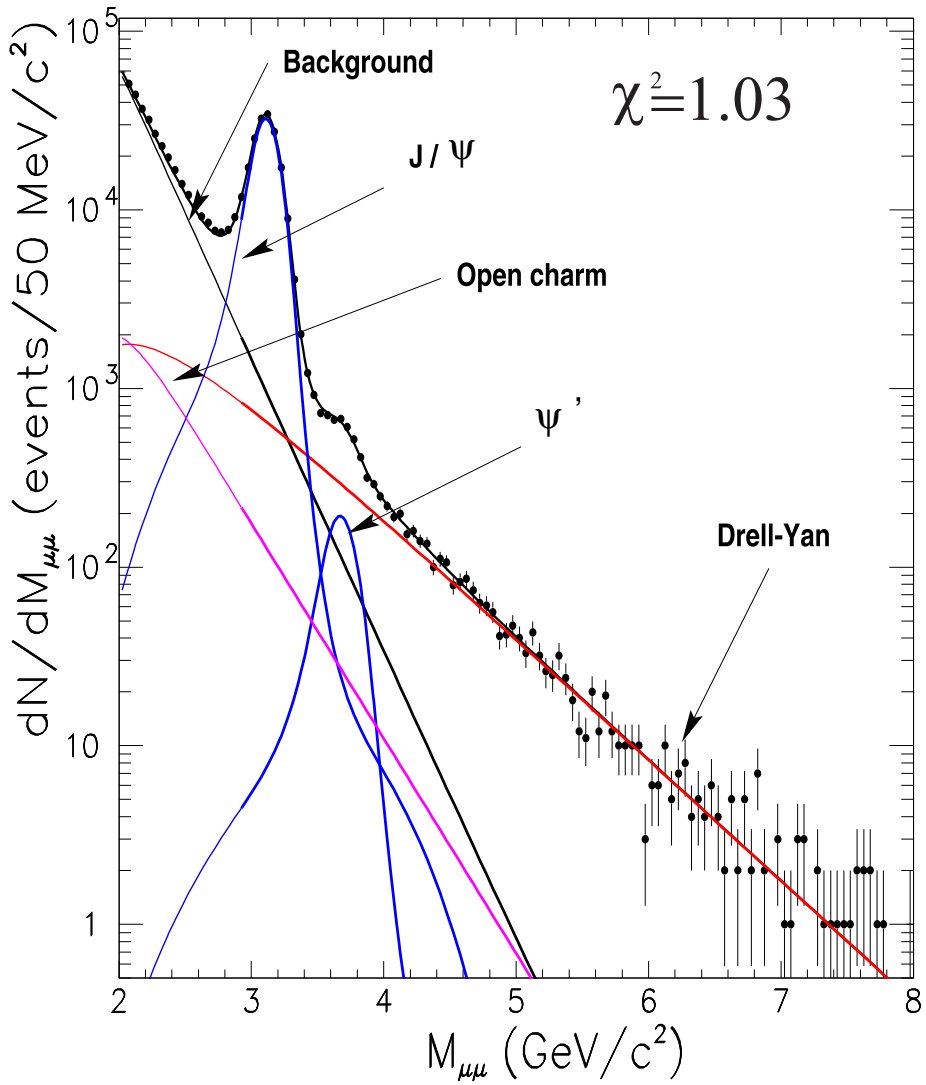
Target Algorithm based on Quartz Cherenkov counters



Contour cut on the E_T - E_{ZDC} correlation: increase the statistics for peripheral events.

Fit to the mass spectrum

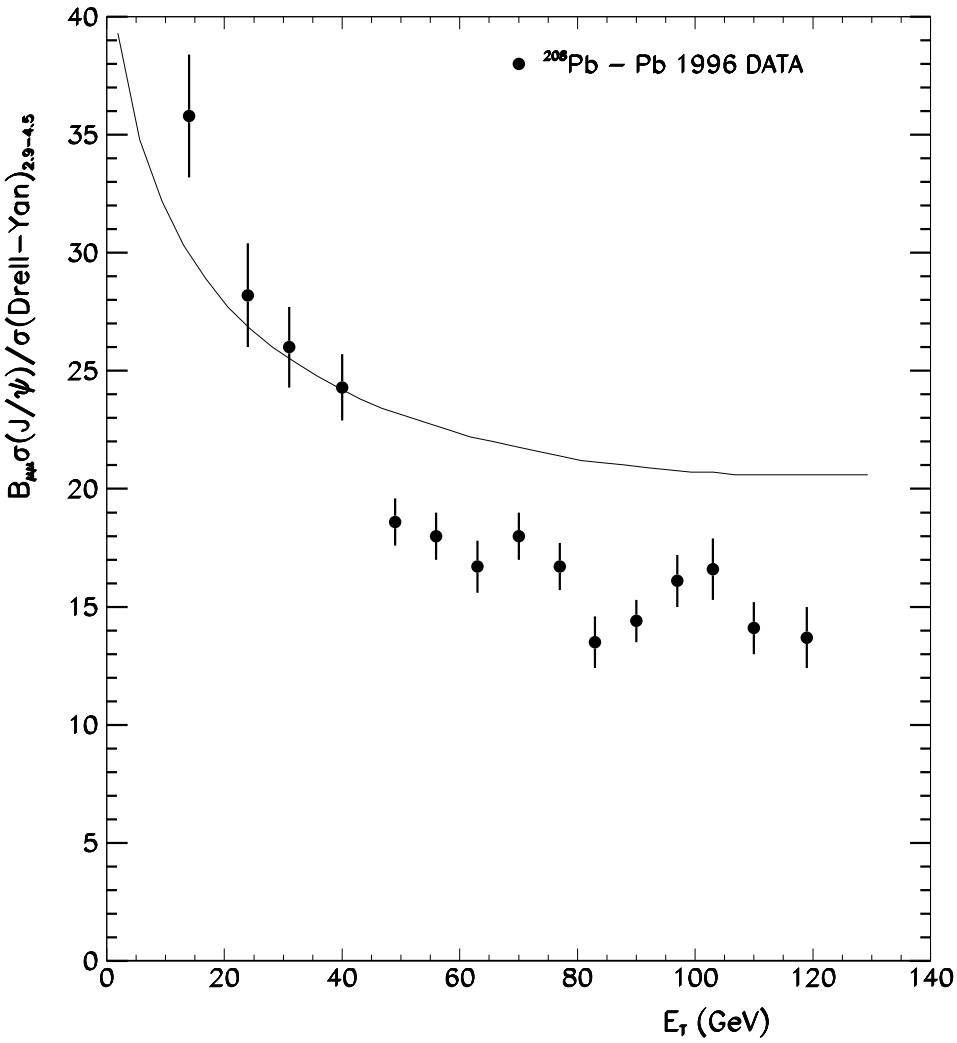
$$\frac{dN}{dM} = A_{J/\psi}\frac{dN_{J/\psi}}{dM} + A_{\psi'}\frac{dN_{\psi'}}{dM} + A_{DY}\frac{dN_{DY}}{dM} + \frac{dN_{D\bar{D}}}{dM} + \frac{dN_{BG}}{dM}$$



Combinatorial background: due to π and K decays.
Estimated from like-sign pairs: $N_{BG} = 2\sqrt{N^{++}N^{--}}$

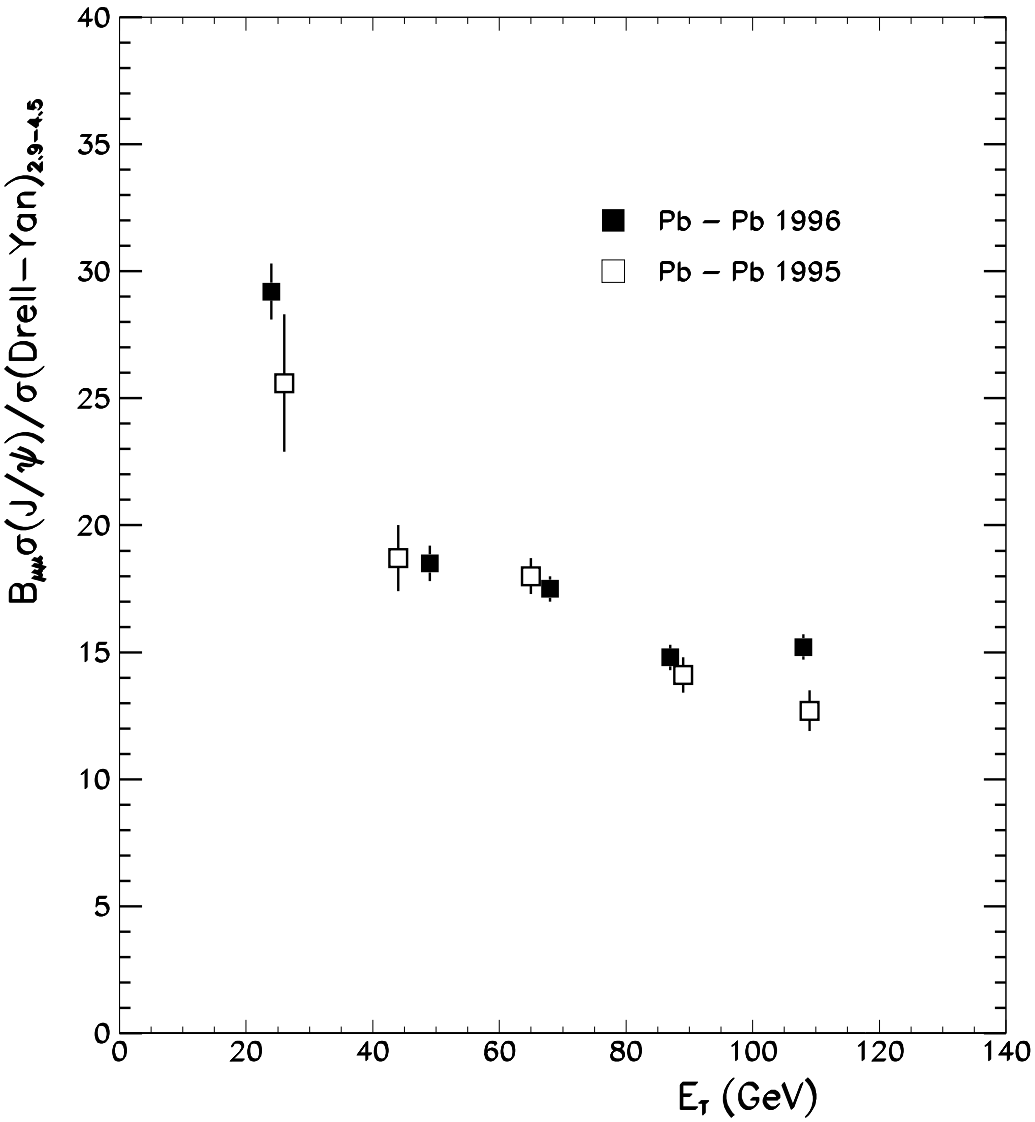
J/ψ,ψ', open charm and Drell-Yan shapes: Monte Carlo.

J/ψ/DY vs E_T 96 data



The curve accounts for an ordinary nuclear absorption with $\sigma_{abs} = 6.4$ mb, as obtained from p-A and S-U data.

Compare 95 and 96 Data



Difference at high E_T probably due to reinteraction events in 96 data

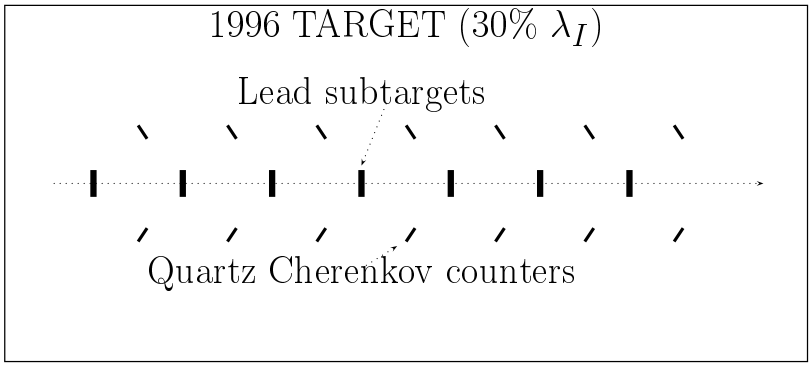
98 data taking

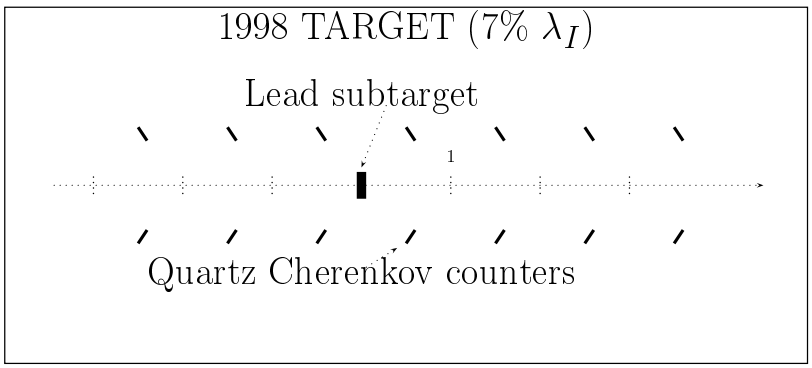
Single active target 3 mm thick ($7\%\lambda_I$) $\rightarrow$ less reinteraction events

Statistics: $\approx$ 40000 reconstructed J/ψ events

Severe cuts on the Cherenkov counters of the active target to avoid interactions in air

Transverse energy range limited to $E_T > 40$ GeV





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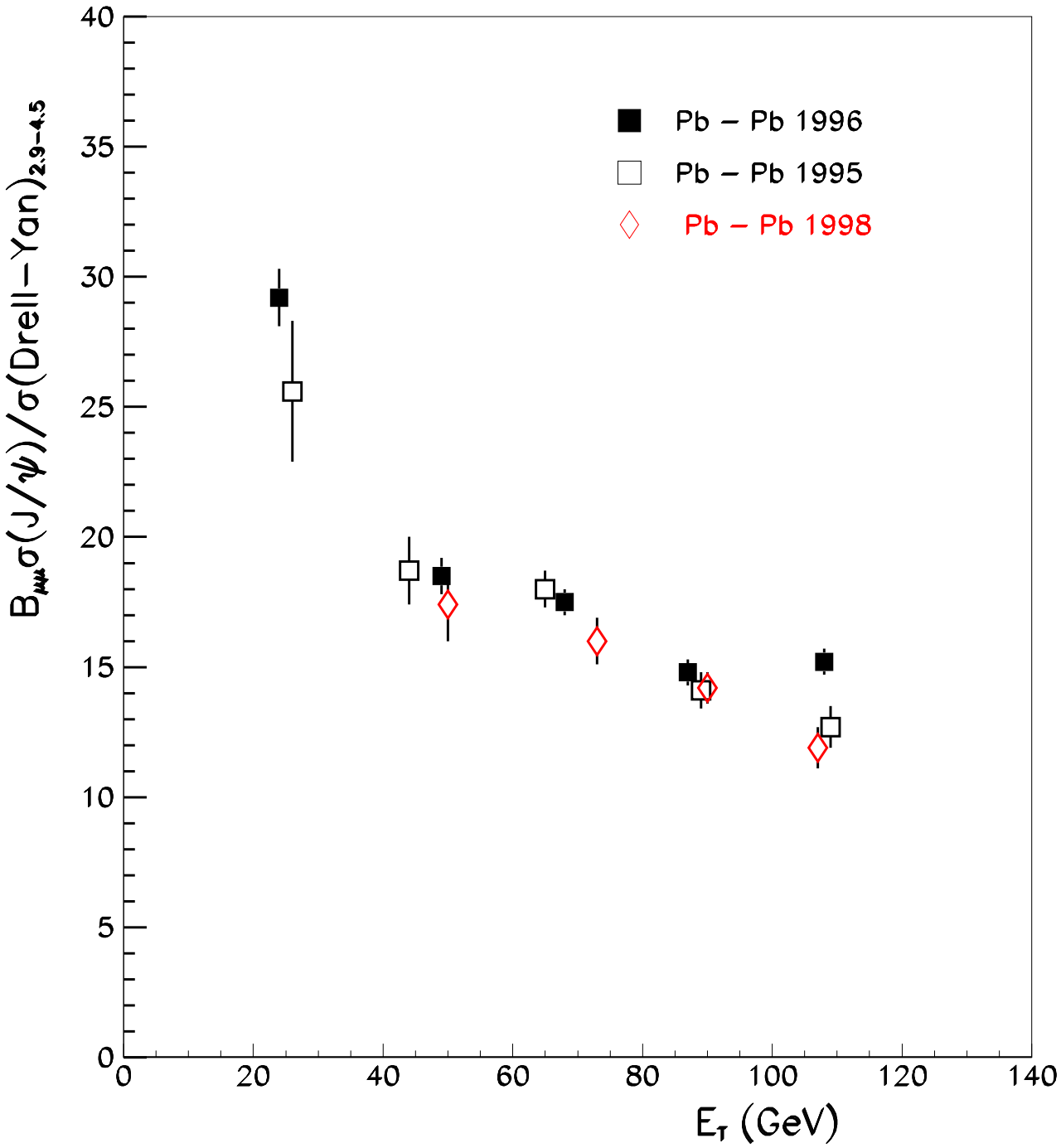
J/ψ/DY

Comparison between 95, 96 and 98 data



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"Minimum bias" analysis

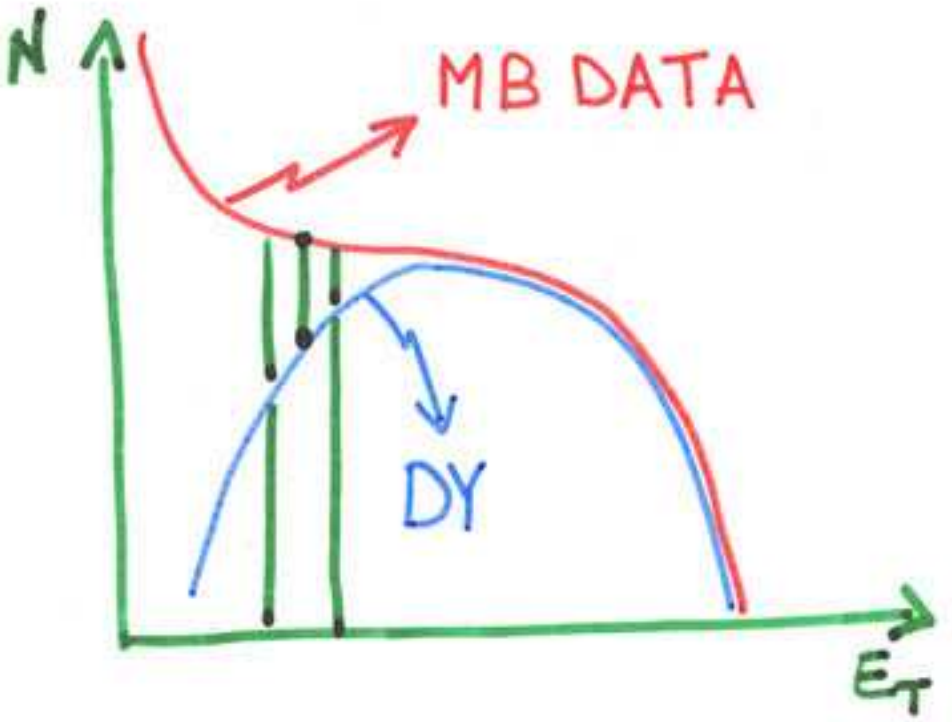
Using the sample of events collected with a "minimum bias" (ZDC) trigger as an estimator for the Drell-Yan in the ratio $J/\psi/DY$.

- Reduce statistical error
- Independent sample
- Target algorithm selection for all the events
- Counting technique: no fits to the mass spectra

Different systematic effects:

- Minimum bias trigger based on ZDC
- No selection on the muon tracks
- Empty target contamination at low E_T

Minimum bias: the method



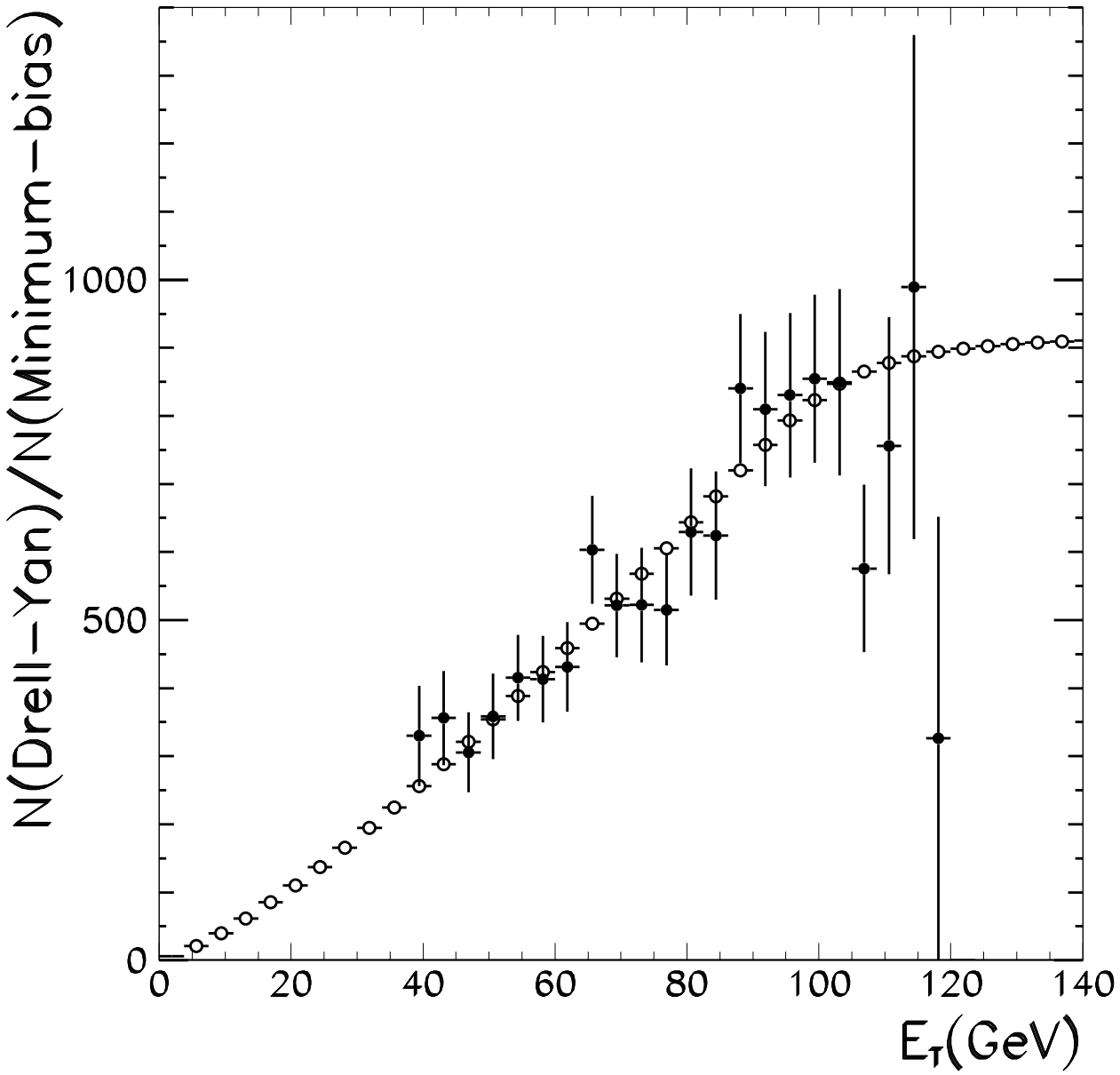
$N_{AB}(b)$: number of collisions for a given b (Glauber model)

$$\frac{N_{DY}(E_T)}{N_{MB}(E_T)} \sim N_{AB}(E_T)$$

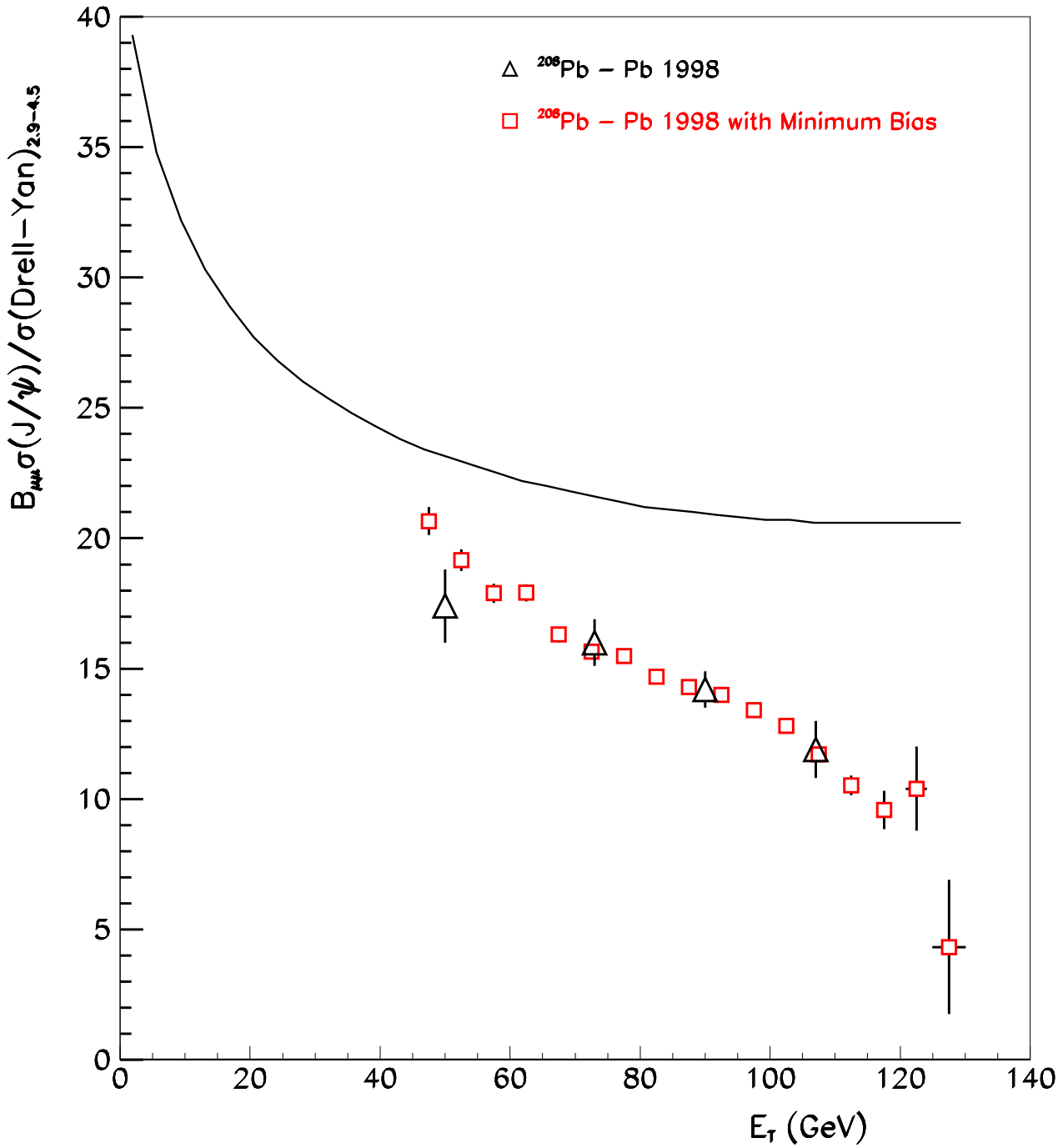
$$N_{DY^\star}(E_T) = N_{MB}^{exp}(E_T) \times N_{AB}(E_T)$$

$$\frac{N_\psi(E_T)}{N_{MB}(E_T)} \rightarrow \frac{N_\psi(E_T)}{N_{DY}(E_T)}$$

N_{AB} vs E_T 98 sample



J/ψ/DY vs E_T 1998



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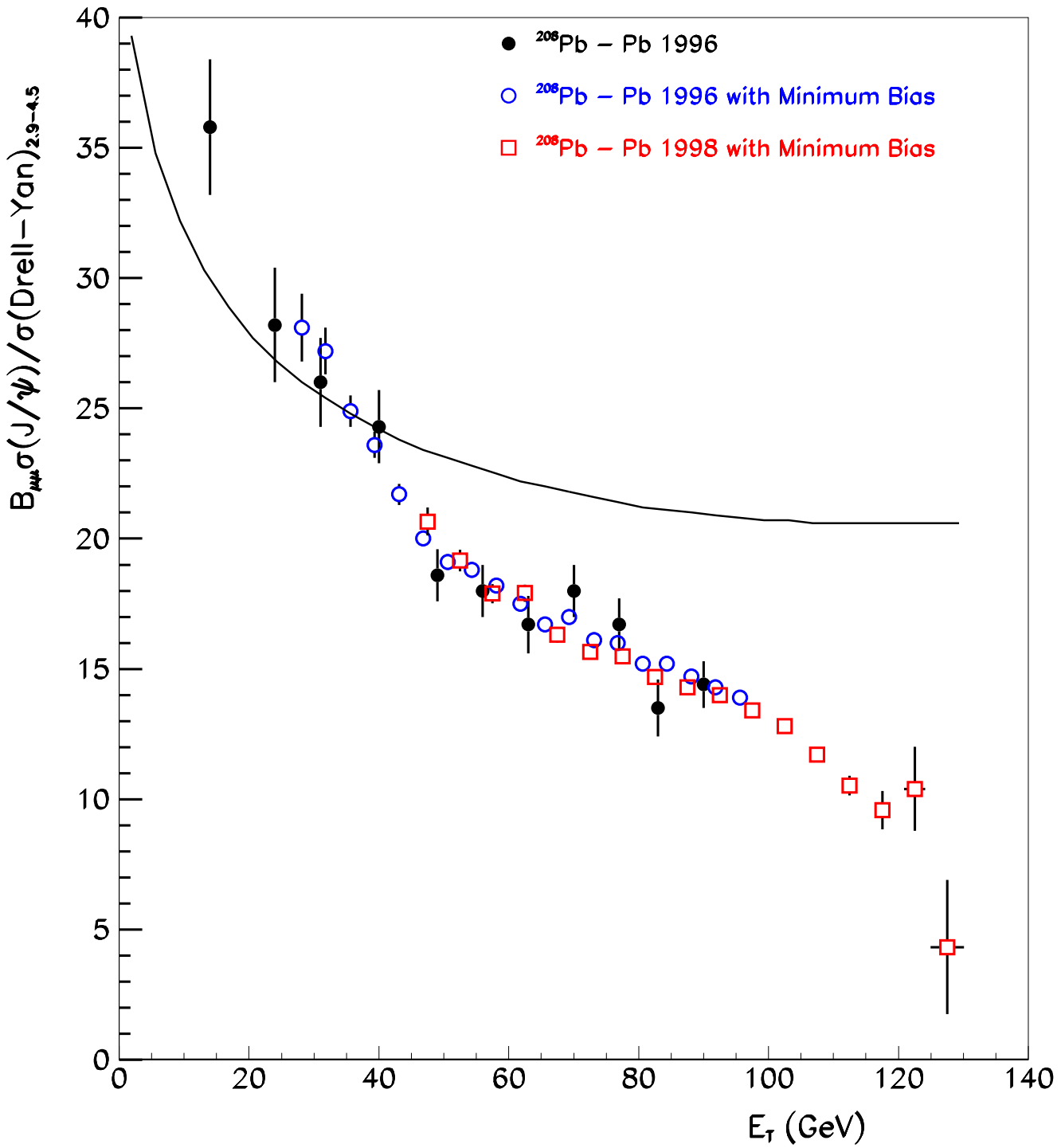
^{208}Pb – Pb 1996
^{208}Pb – Pb 1996 with Minimum Bias
^{208}Pb – Pb 1998 with Minimum Bias
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
E_T (GeV)
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120
140

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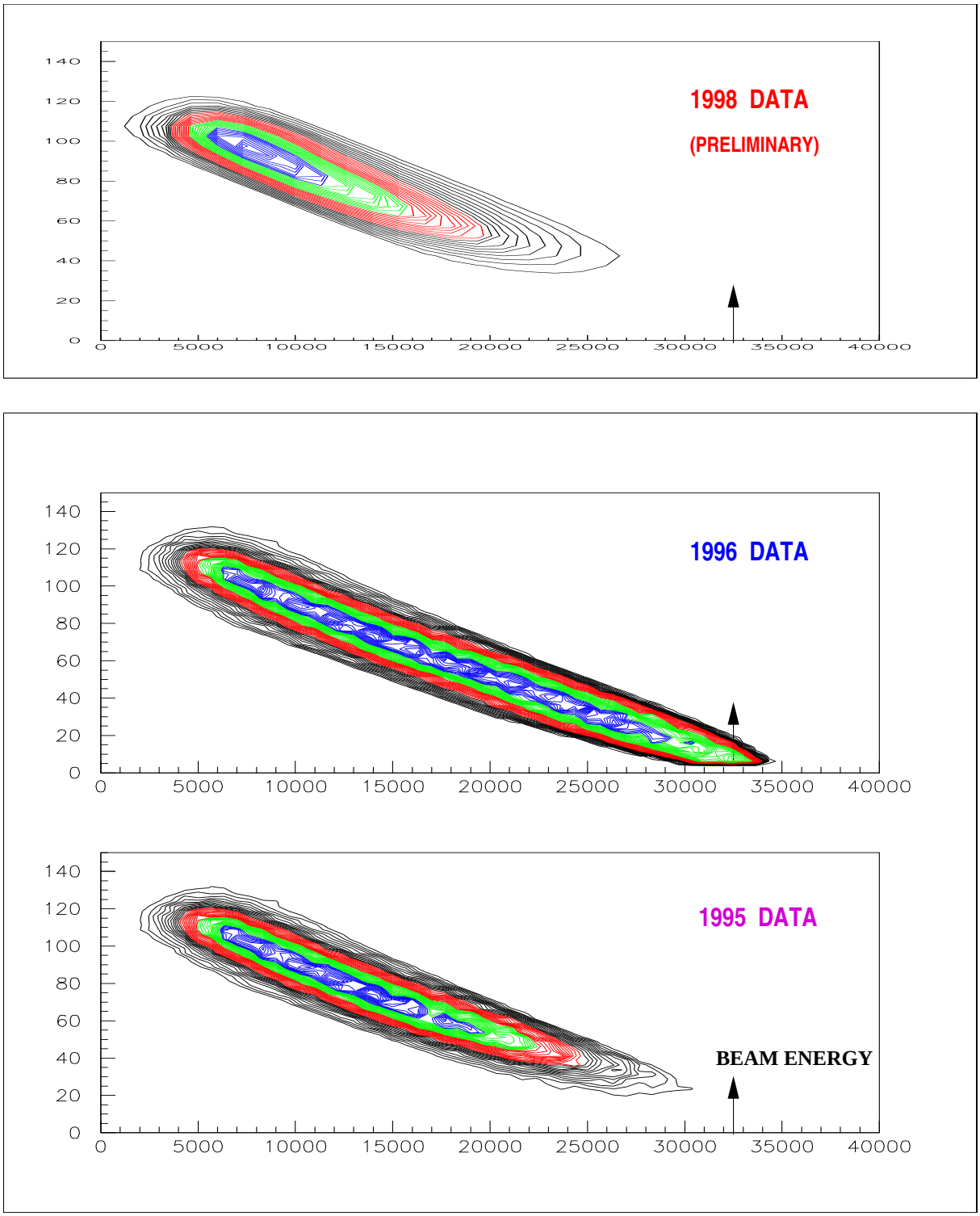
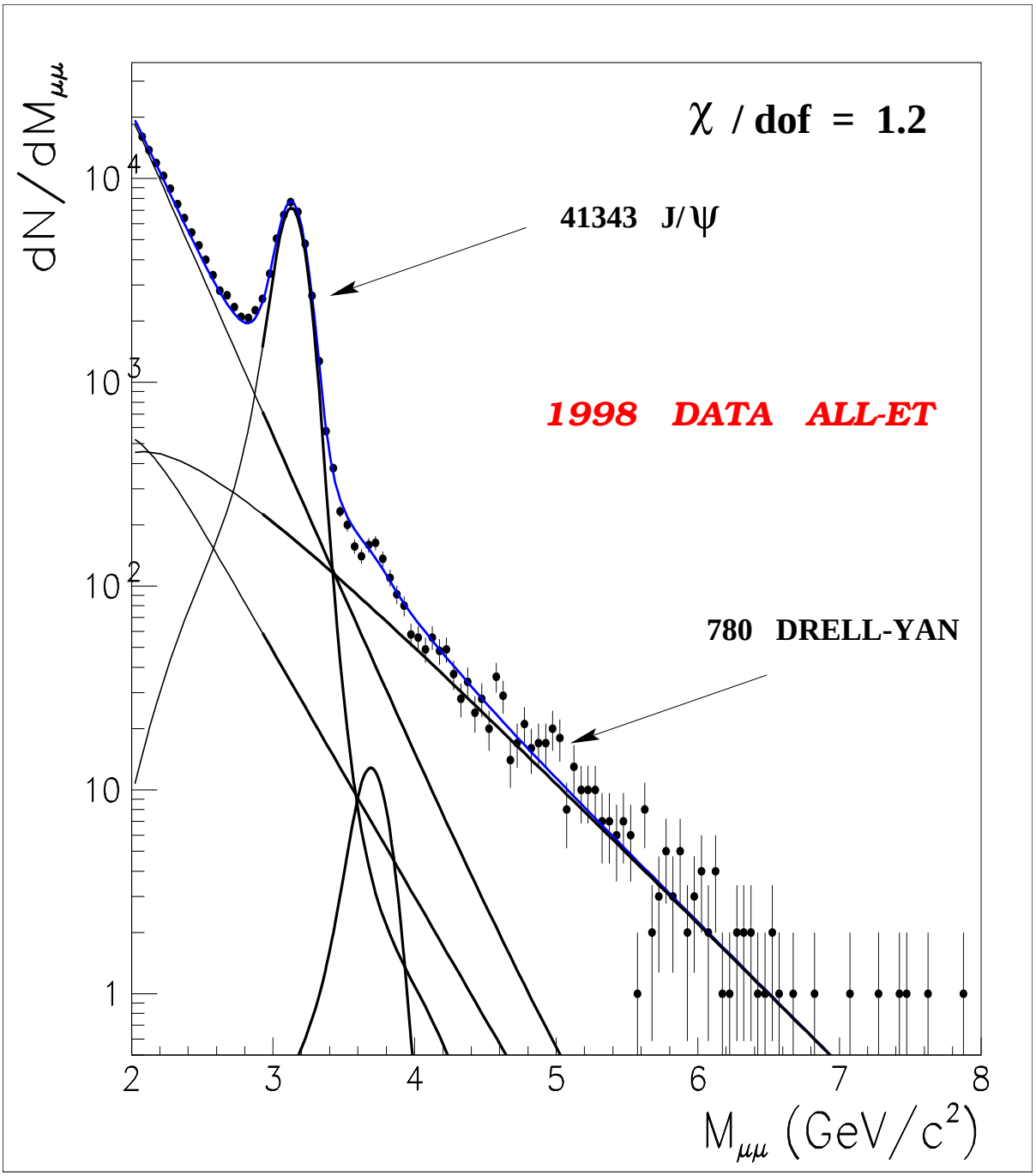
95 96 98 contour cut

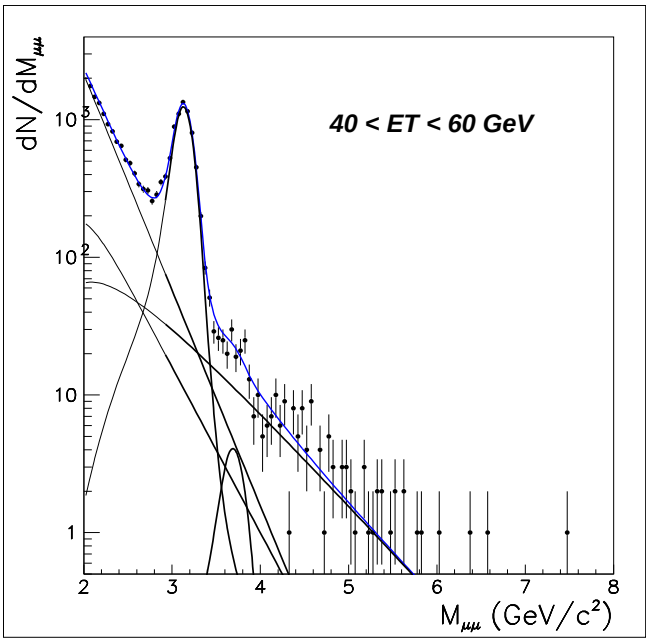


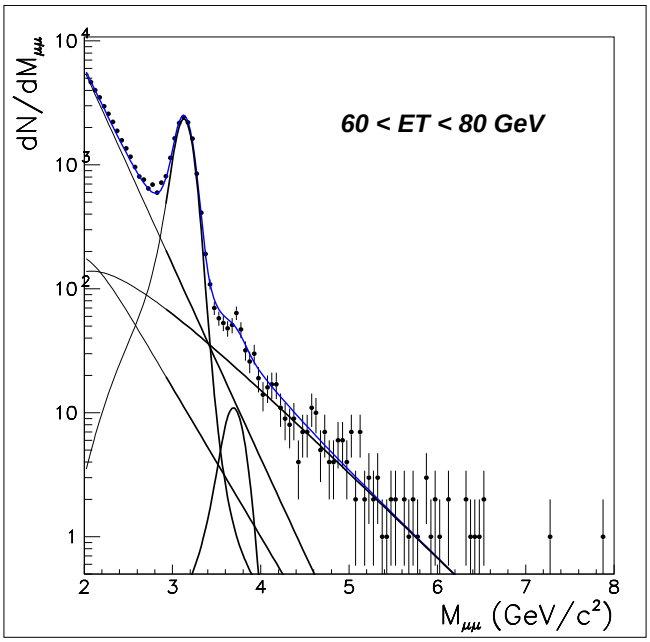
Mass spectrum 1998 sample

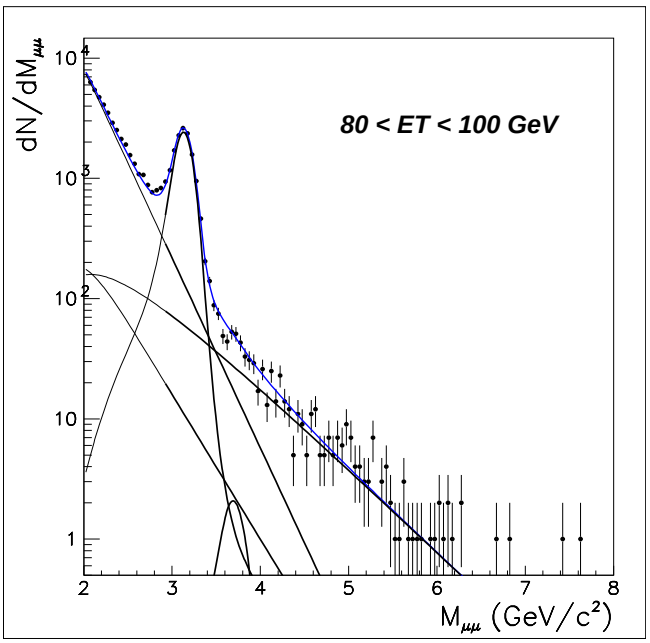


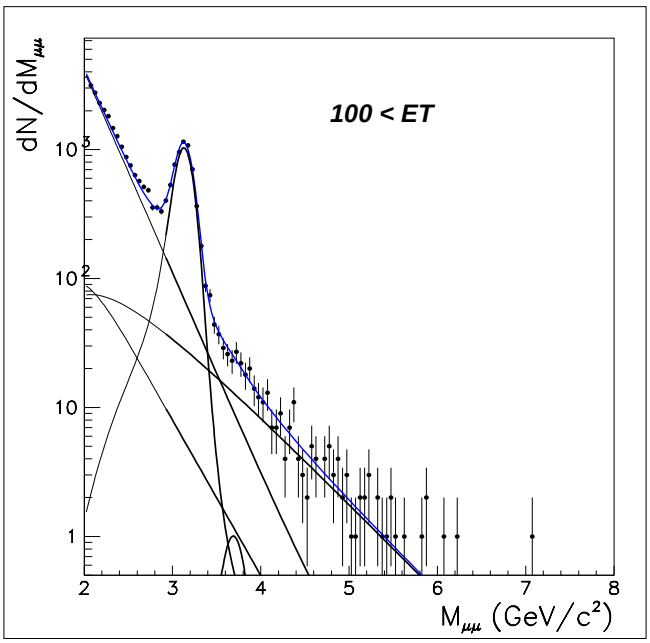
Mass for different E_T bins

1998 DATA versus CENTRALITY

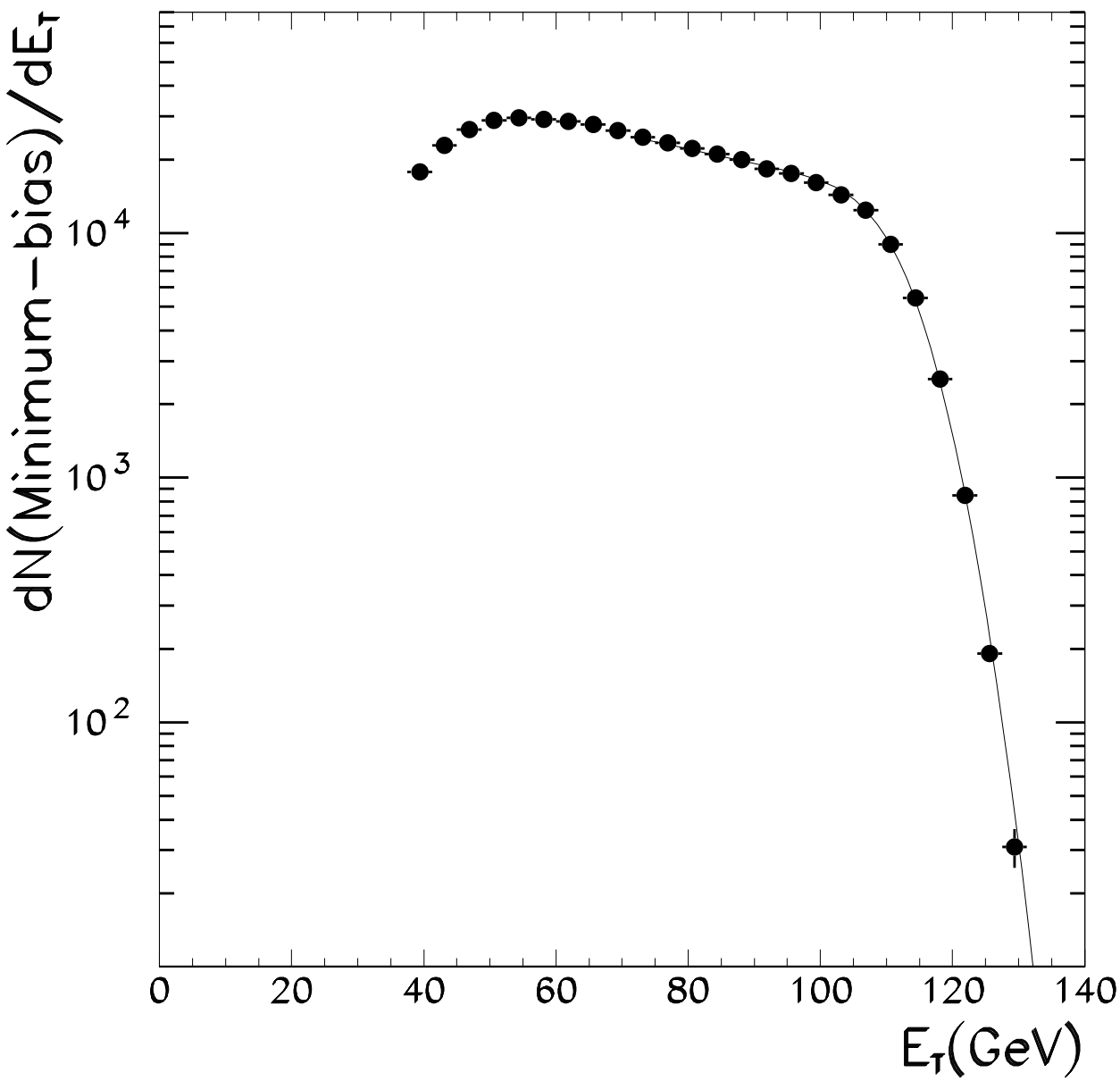




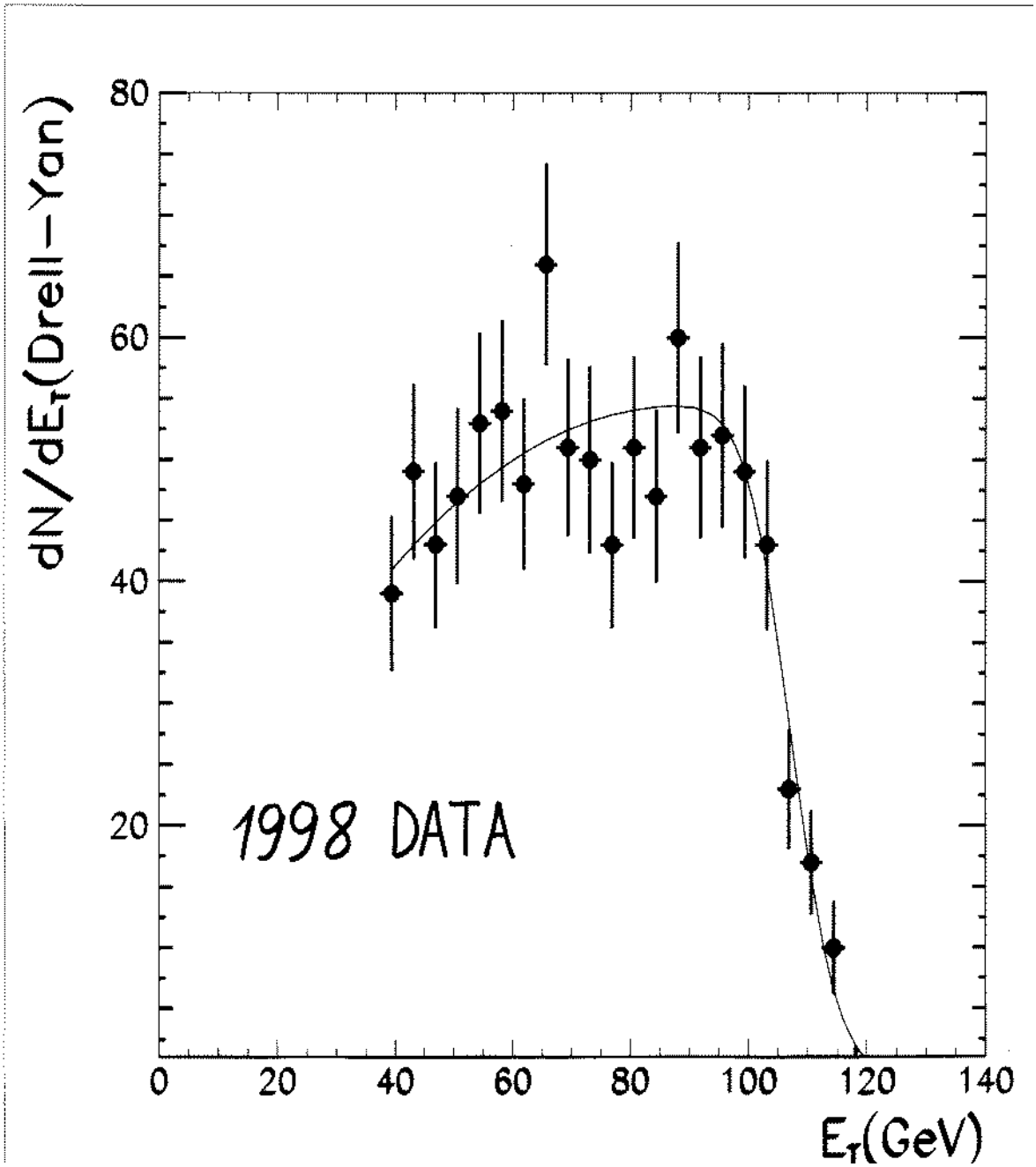




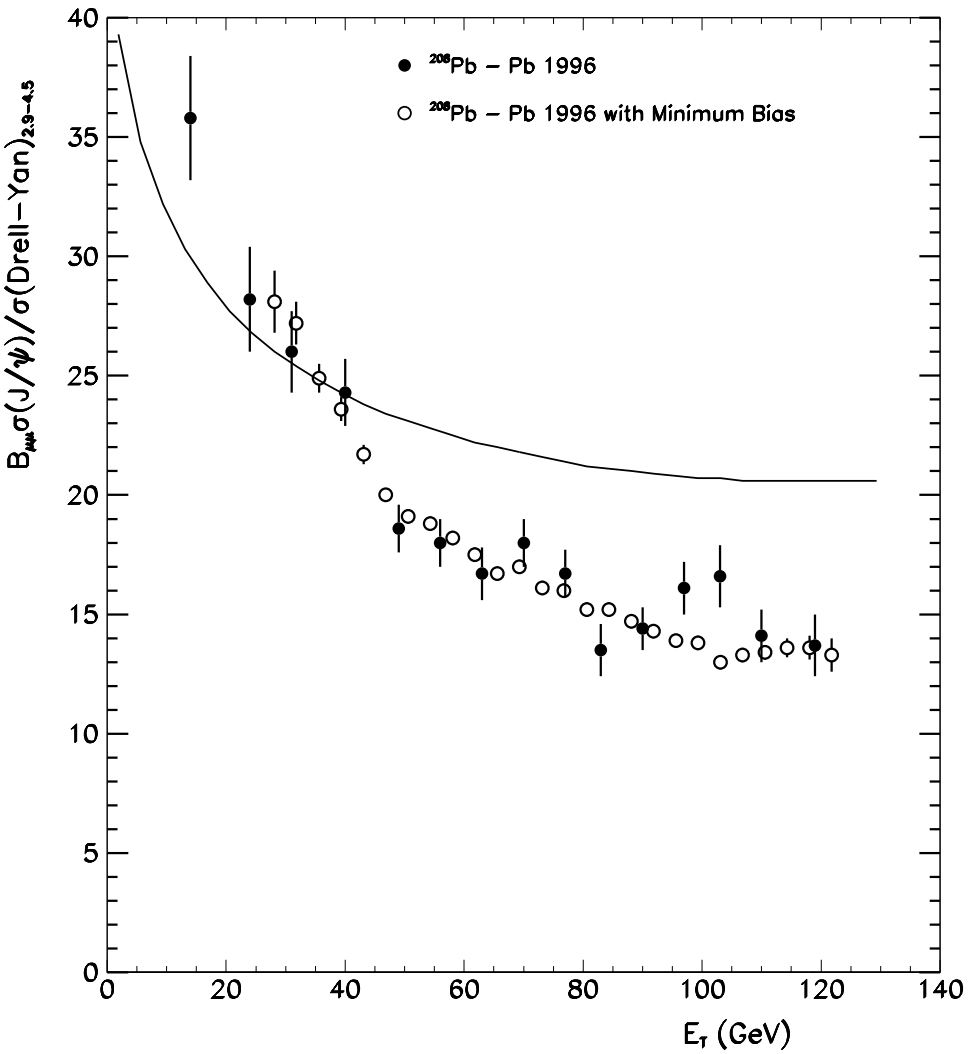
E_T distribution for Minimum Bias events



E_T distribution for Drell-Yan events



J/ψ/DY vs E_T 1996



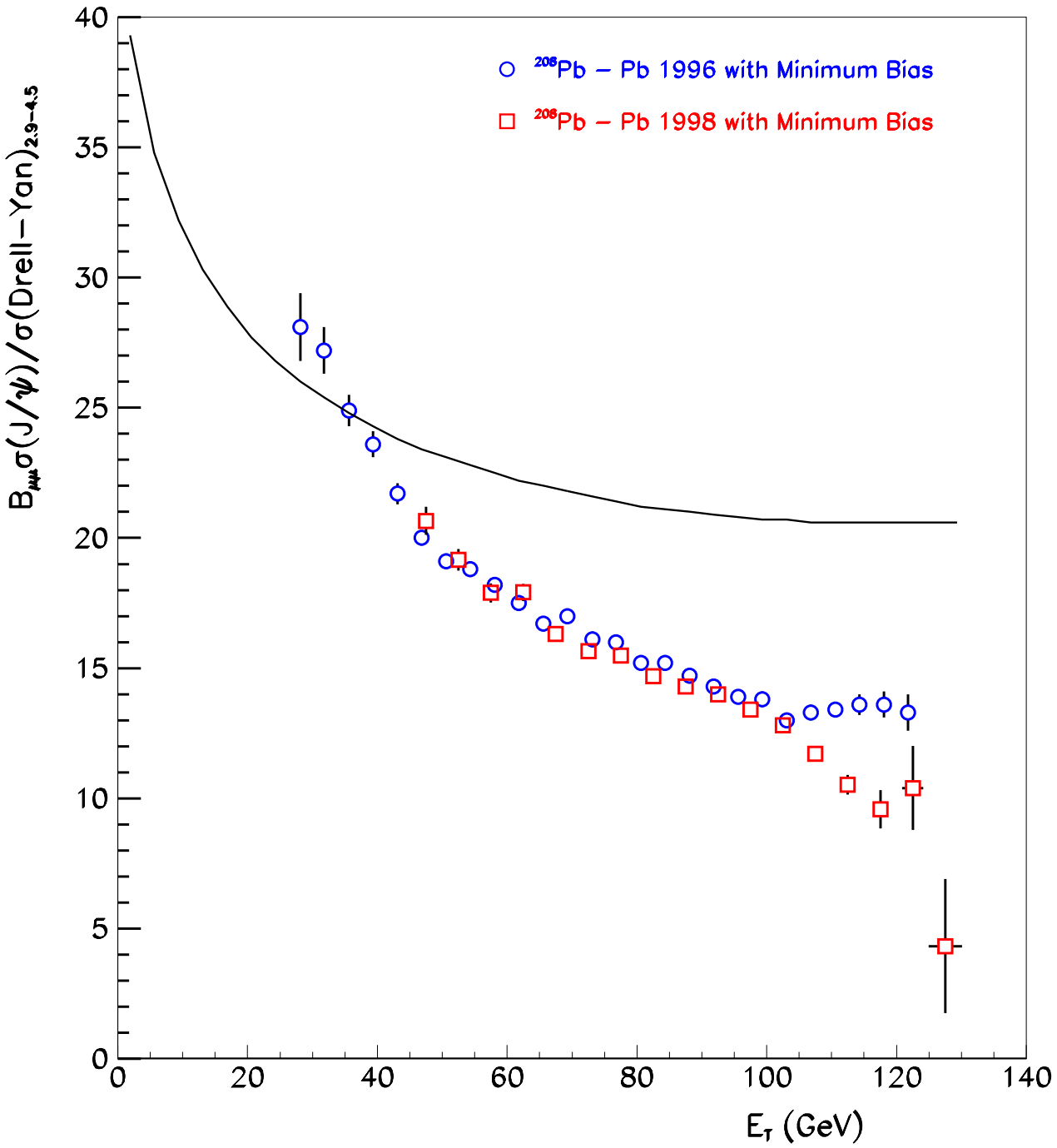
Normalization for MB: $55 < E_T < 75$

Cut at $E_T < 26$ GeV (contamination from off-target events, evaluated with target out runs)

Shapes compatible

Agreement at low E_T

J/ψ/DY vs E_T



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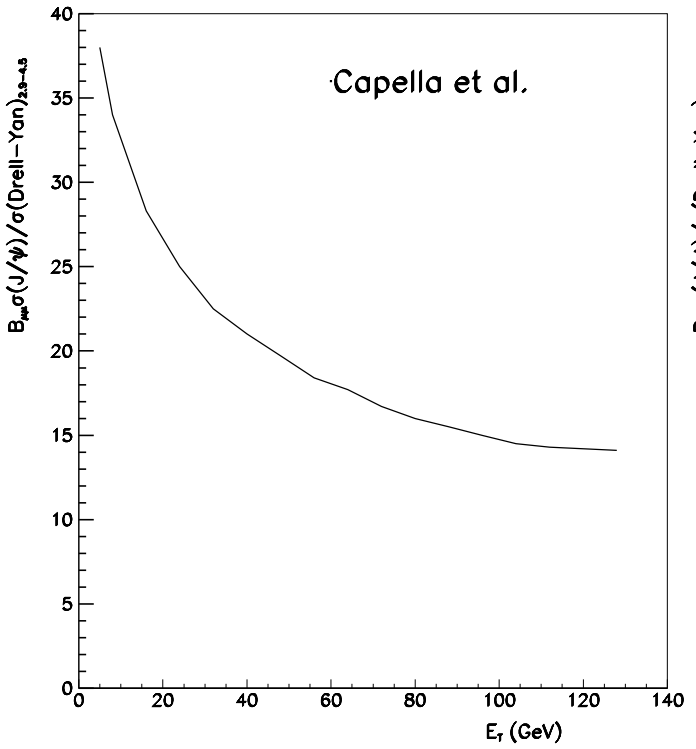
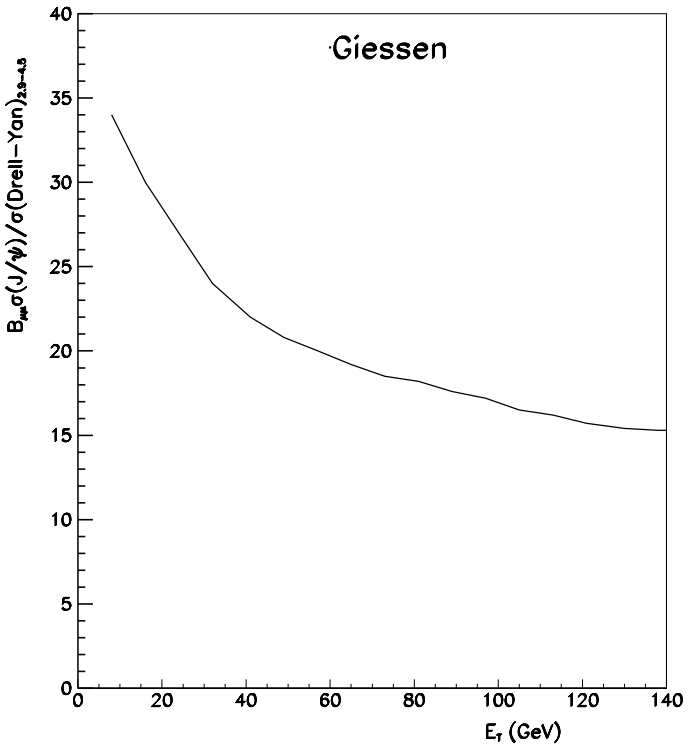
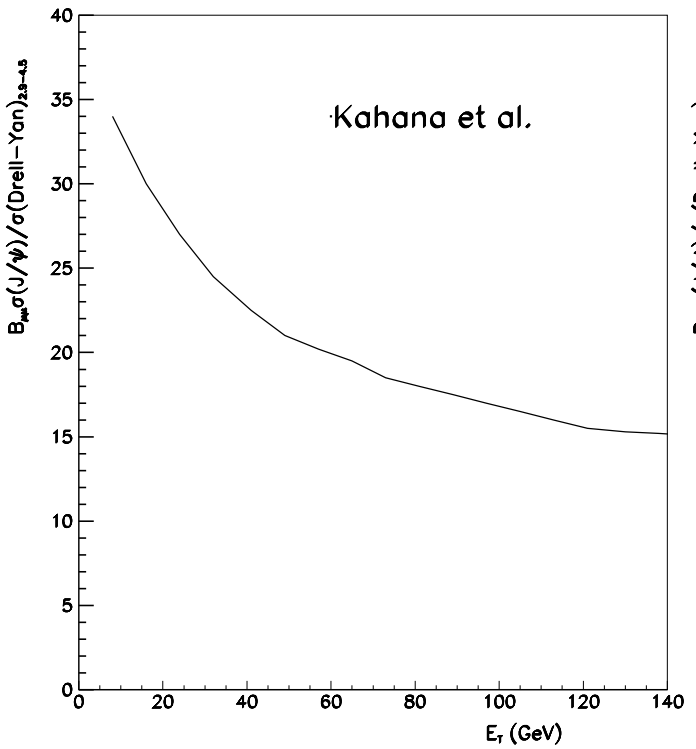
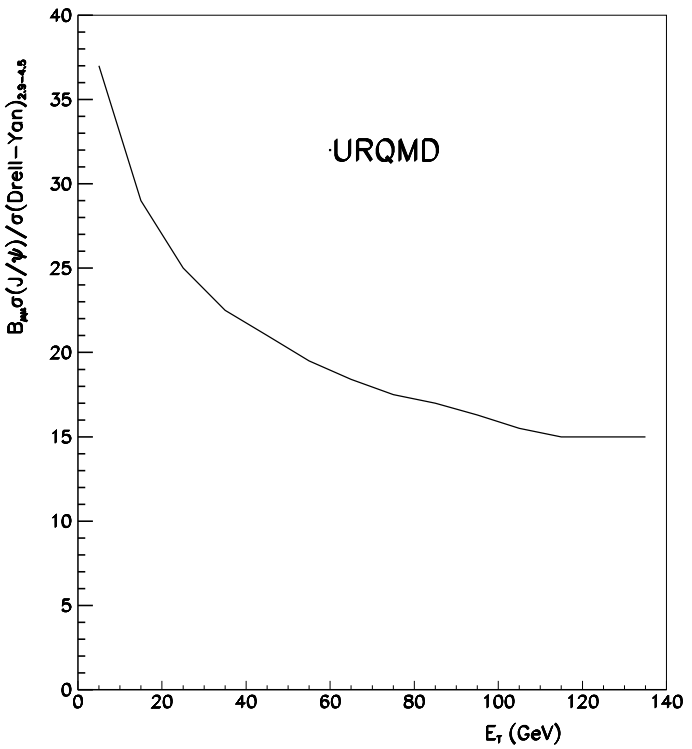
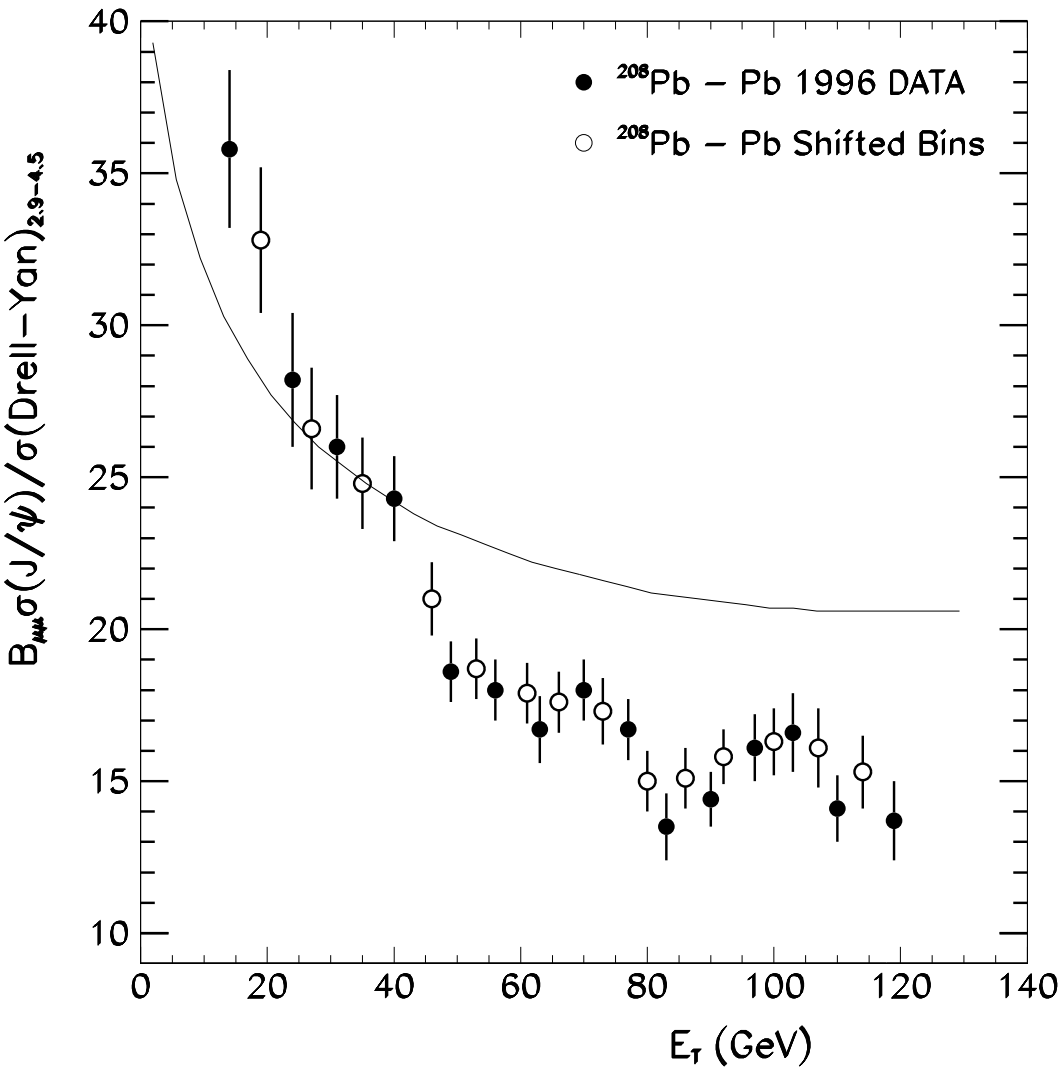

Capella et al.
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
E_T (GeV)


Giessen
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
E_T (GeV)


Kahana et al.
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
E_T (GeV)

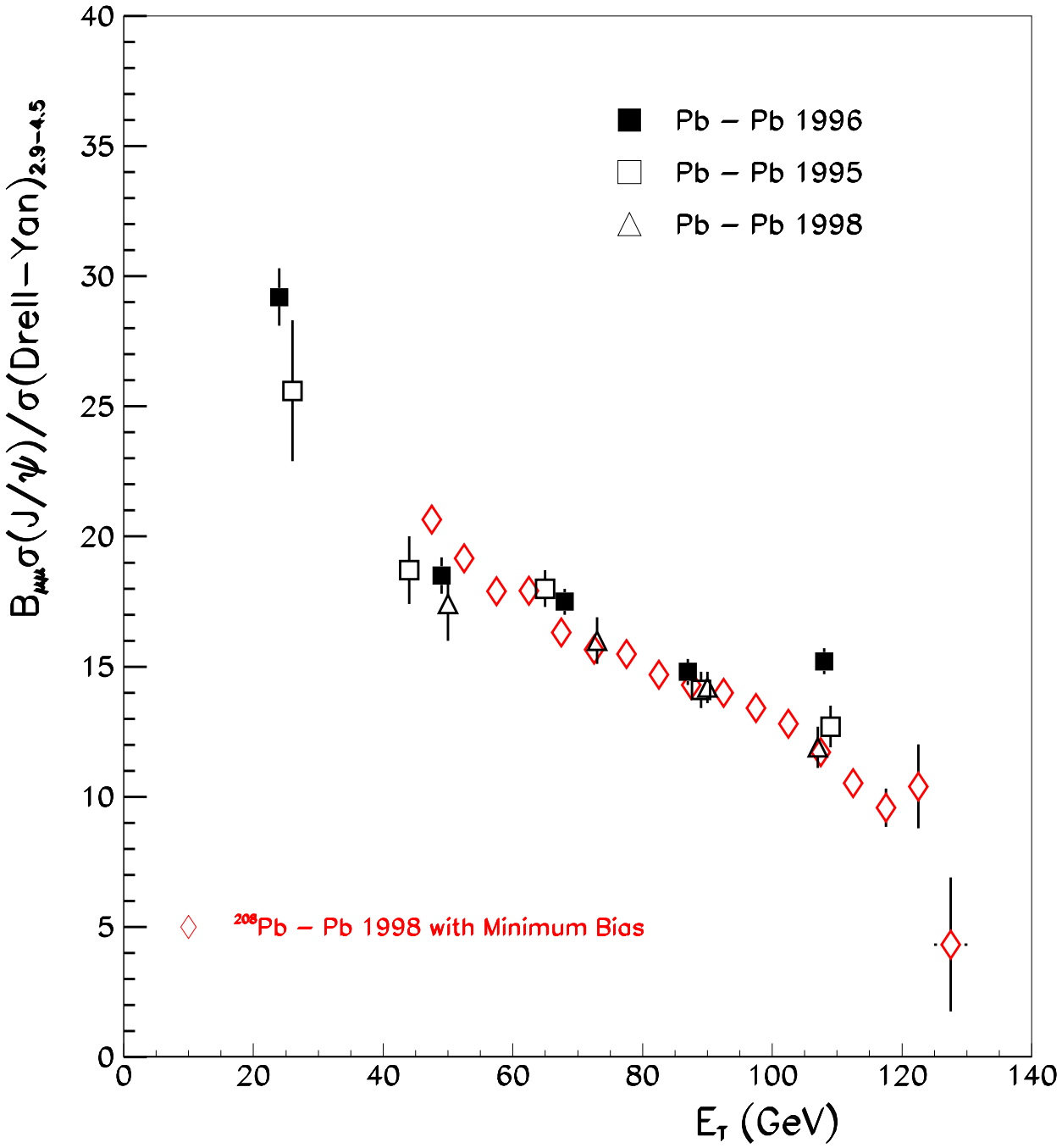

URQMD
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
E_T (GeV)

J/ψ/DY vs E_T 96 data



Stability check: different binning in E_T

J/ψ/DY vs E_T



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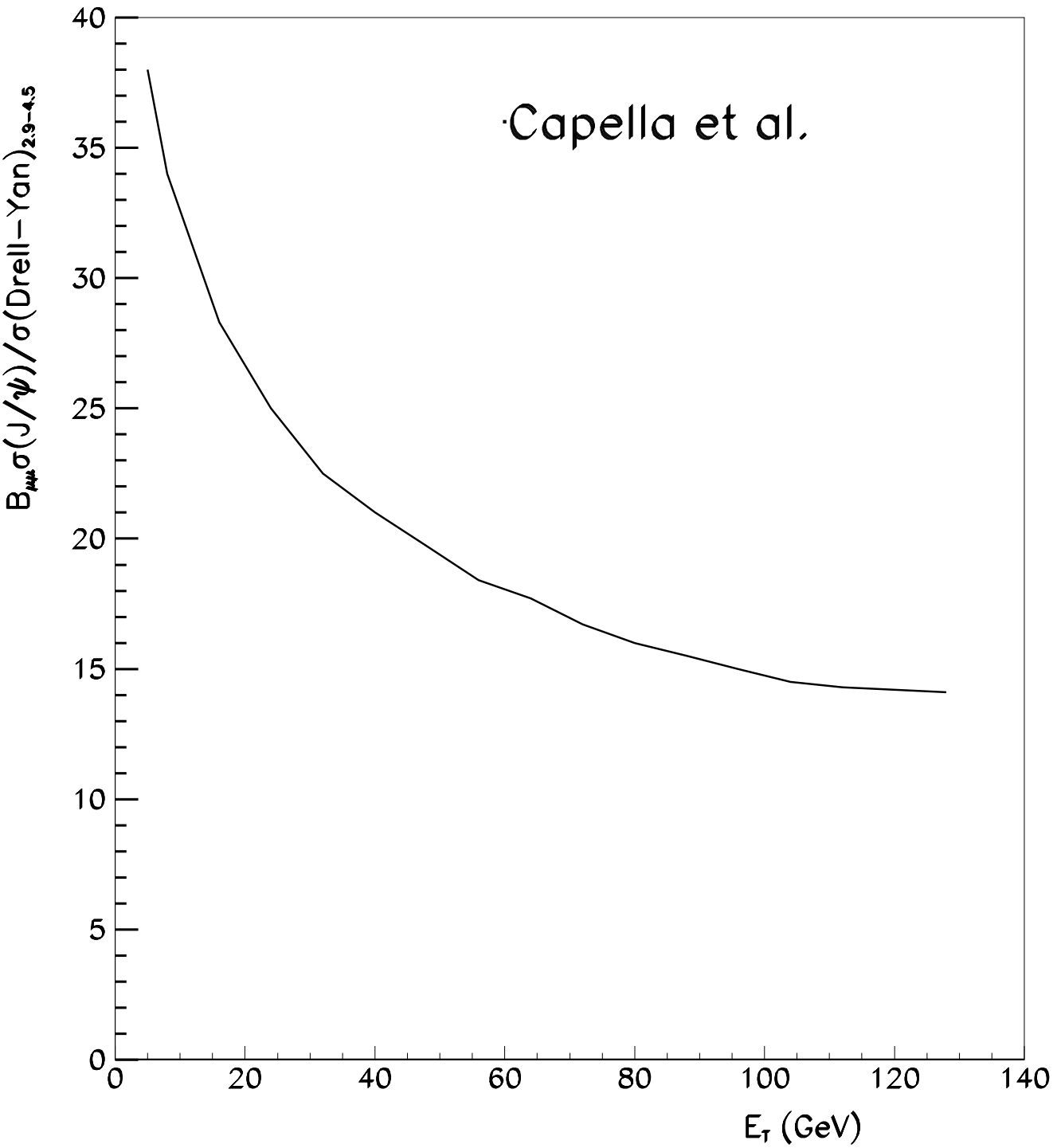
Capella et al.
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
0
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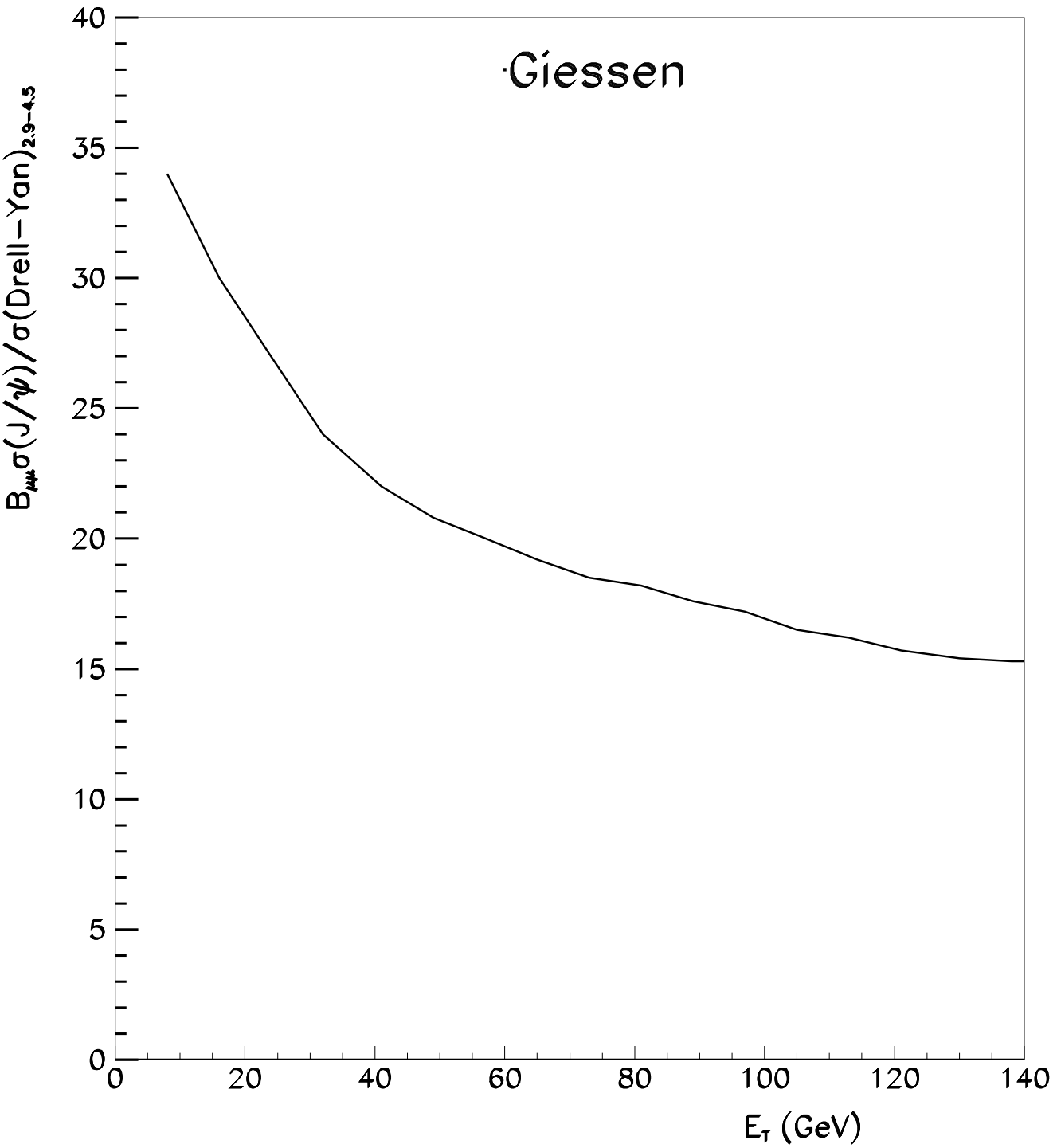
140
E_T (GeV)


Giessen
$B_{\mu\mu}\sigma(J/\psi)/\sigma(Drell-Yan)_{2.9-4.5}$
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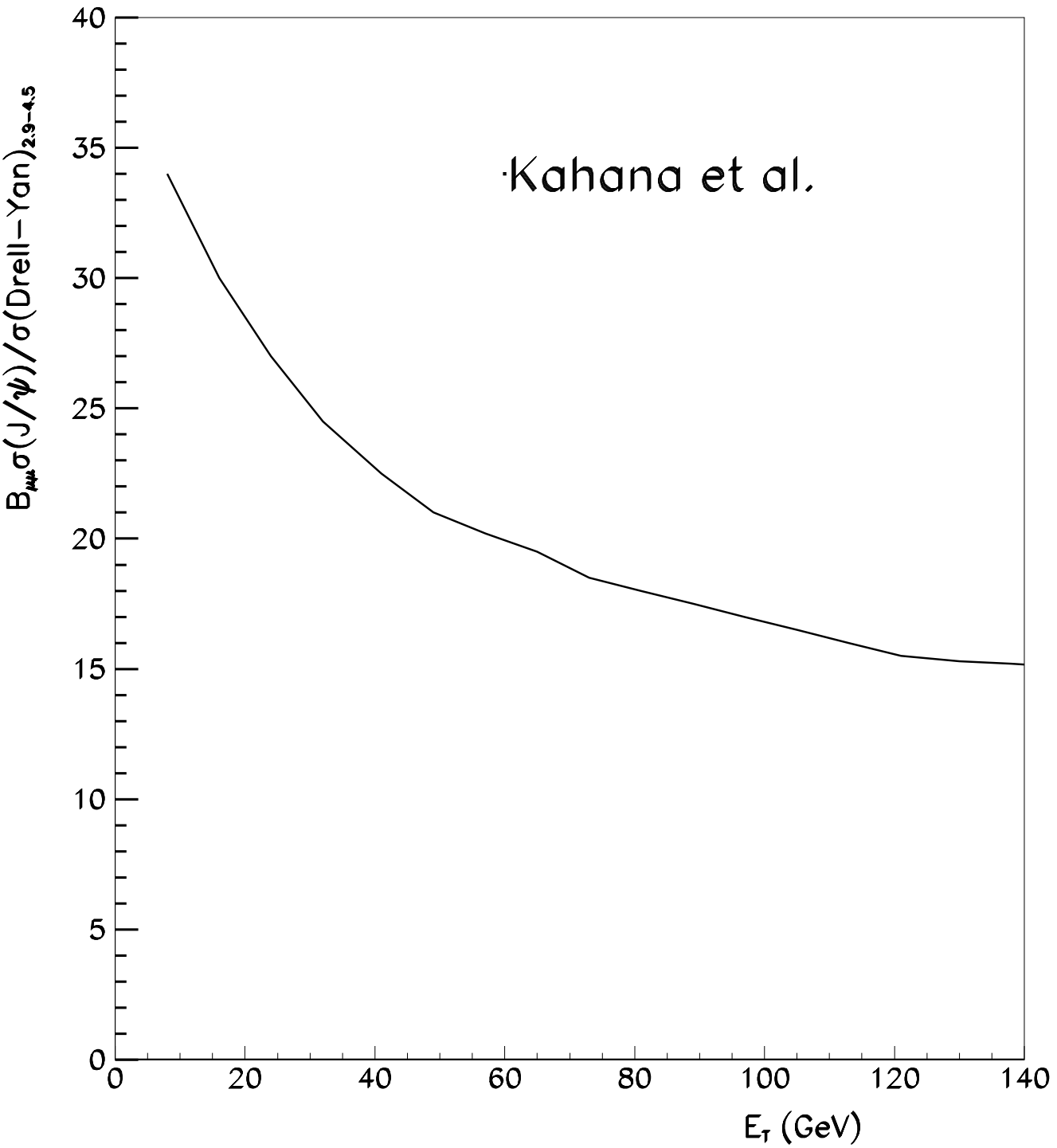
E_T (GeV)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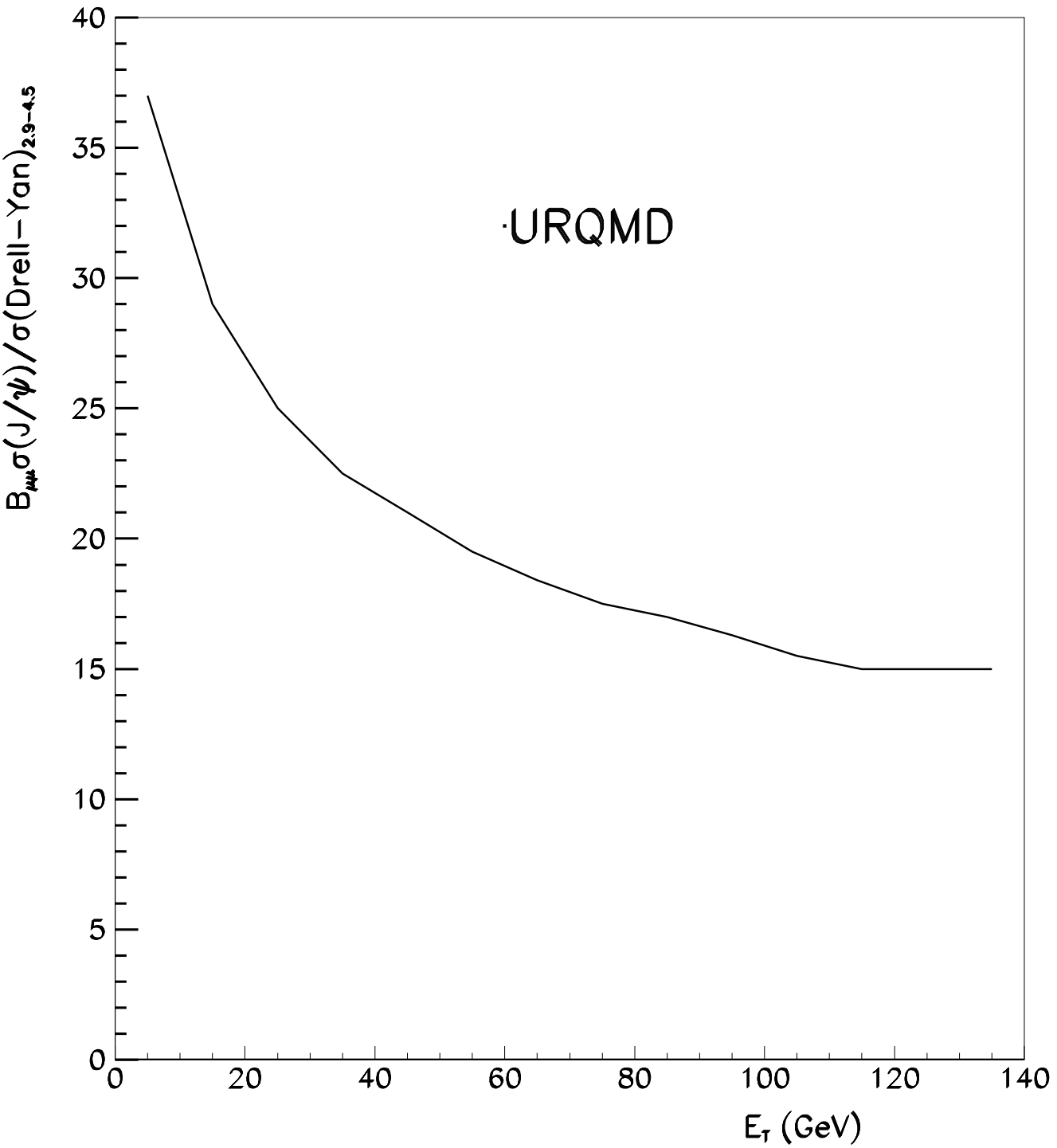
URQMD
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E_T (GeV)
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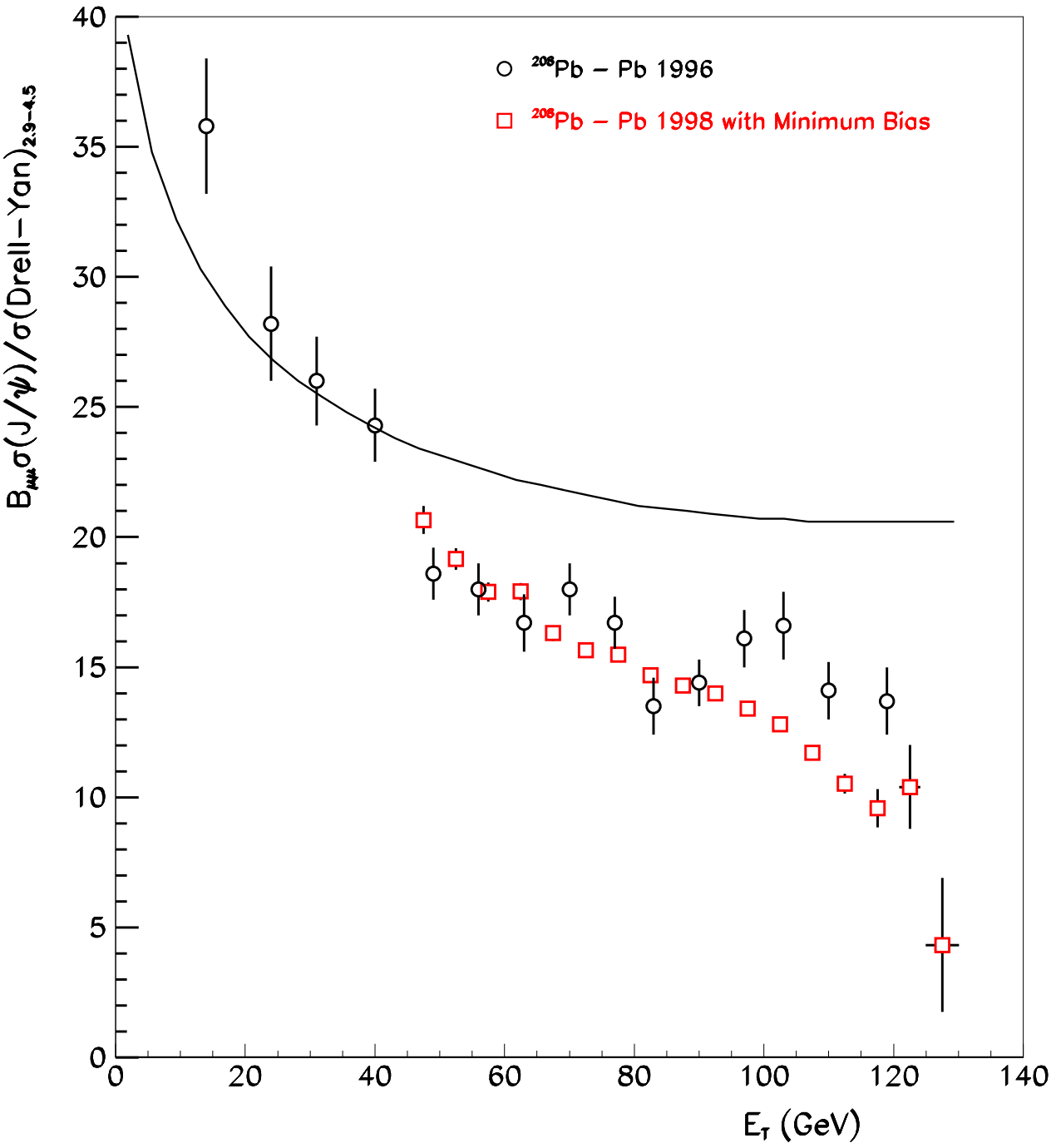
J/ψ/DY vs E_T



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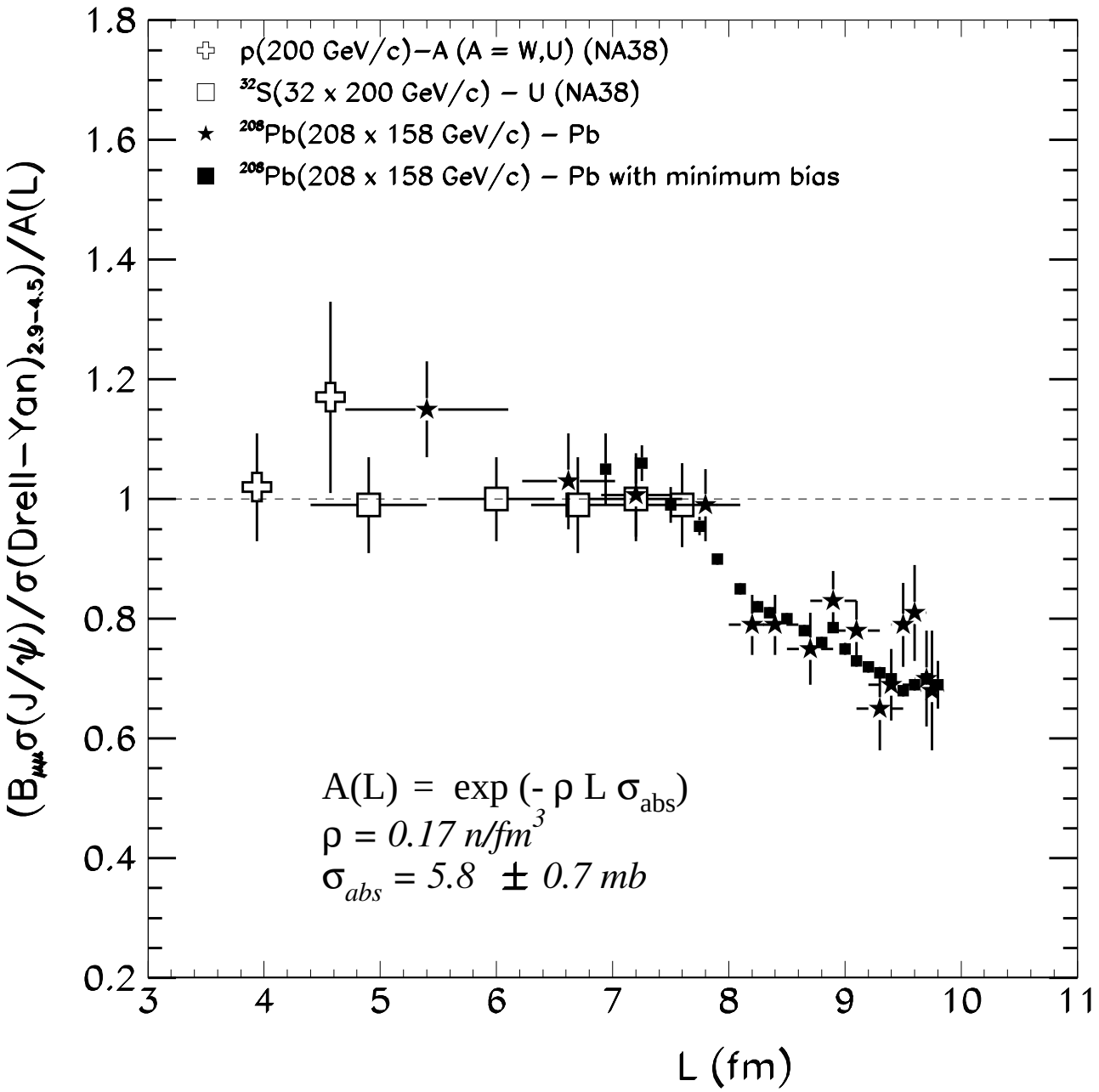
J/ψ/DY vs L


p(200 GeV/c)–A (A = W,U) (NA38)
32S(32 x 200 GeV/c) – U (NA38)
208Pb(208 x 158 GeV/c) – Pb
208Pb(208 x 158 GeV/c) – Pb with minimum bias
$(B_{\mu\mu}\sigma(J/\psi)/\sigma(\text{Drell–Yan})_{2.9-4.5})/A(L)$
L (fm)
A(L) = exp (- ρ L σ_{abs})
ρ = 0.17 n/fm^3
σ_{abs} = 5.8 ± 0.7 mb