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# Transverse Energy Fluctuations

# the Pattern of $J/\psi$ Suppression in Pb–Pb Collisions

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Phys. Rev. Lett. **85** (2000) 4012

## Topics

- The model
- Transverse Energy Fluctuations
- Fit to NA50 Data
- Variations of $\langle\ p_T^2\ \rangle$
- Predictions for RHIC and for smaller systems

# The model (1)

- Nuclear absorption (Glauber model)

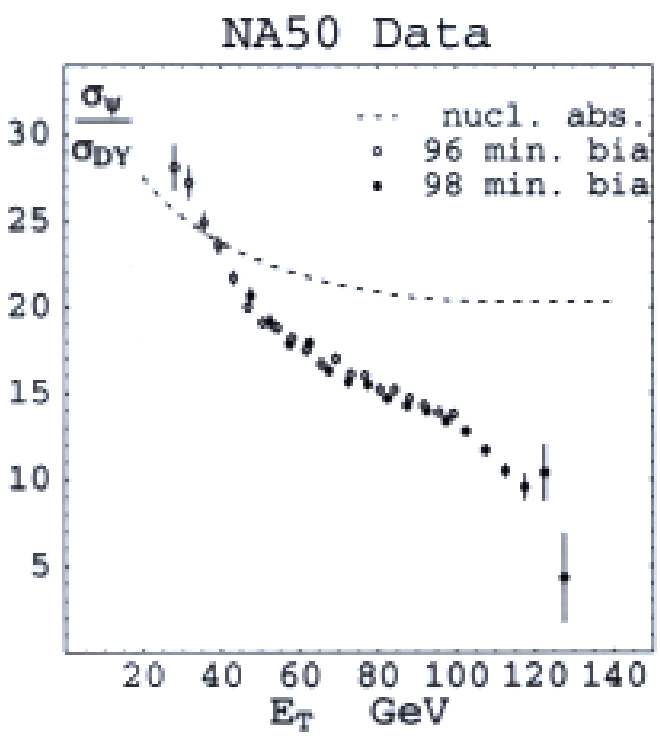
  → good fit of $J/\psi$ production to

  p–p collisions
  p–A
  O–Cu, O–U, S–U

Capella *et al.*, Phys.Lett. **B206** (1988) 354
Gerschel and Hüfner, Z.Phys. **C56** (1992) 171
Kharzeev *et al.*, Z.Phys. **C74** (1997) 307

- In Pb–Pb collisions, anomalous suppression observed.

NA50, Phys.Lett. **B410** (1997) 337
NA50, Phys.Lett. **B477** (2000) 28

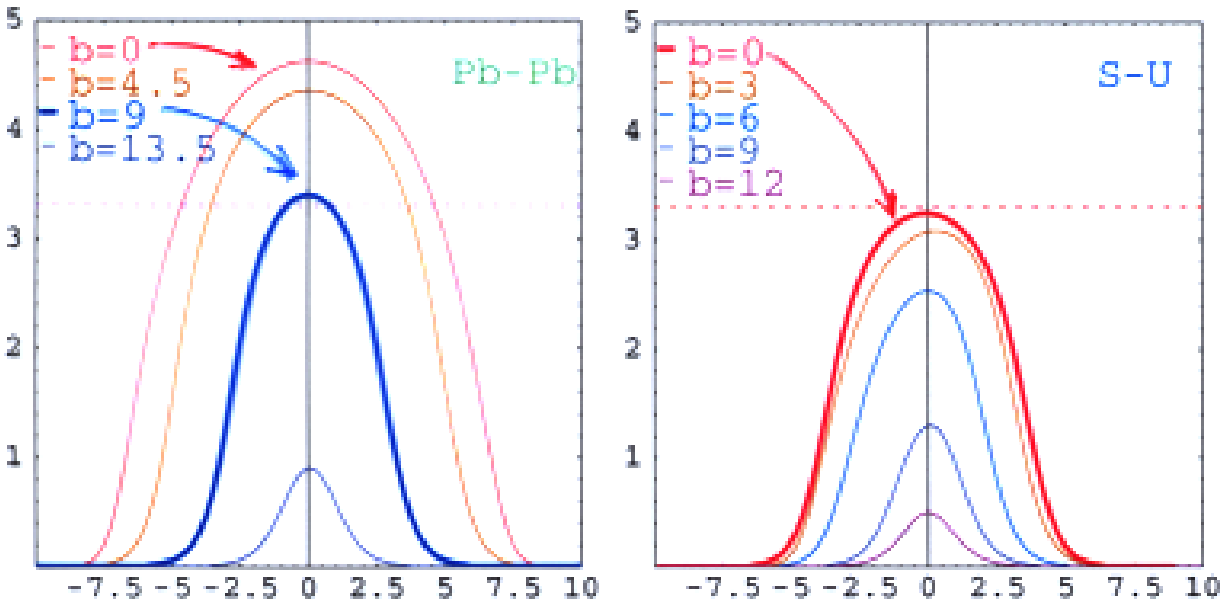


# The model (2)

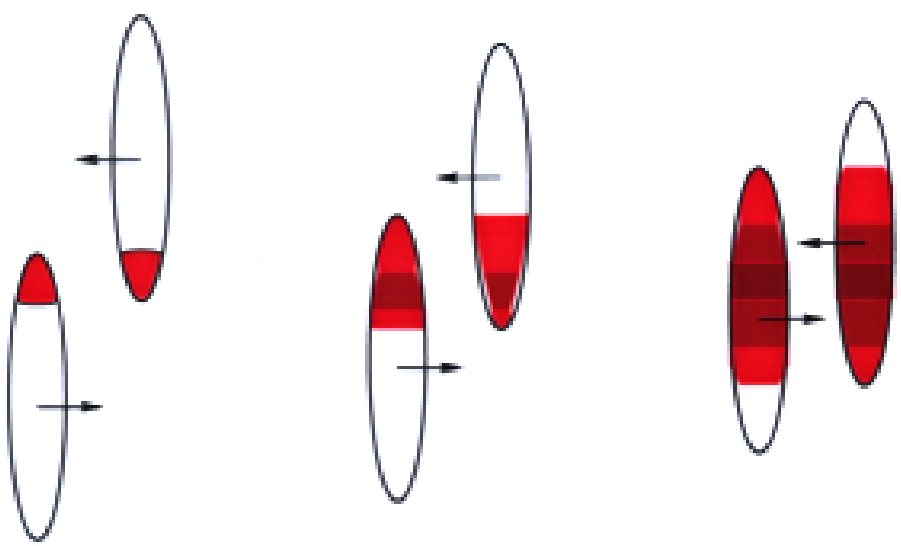
- Distinctive feature of Pb–Pb collisions

  Higher local energy density $\epsilon$

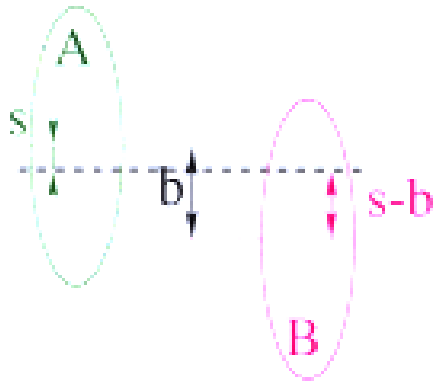
  (or density of participants)




- Geometry of the collision: $\epsilon \nearrow$ when $\mathbf{b} \searrow$



# The model (3)

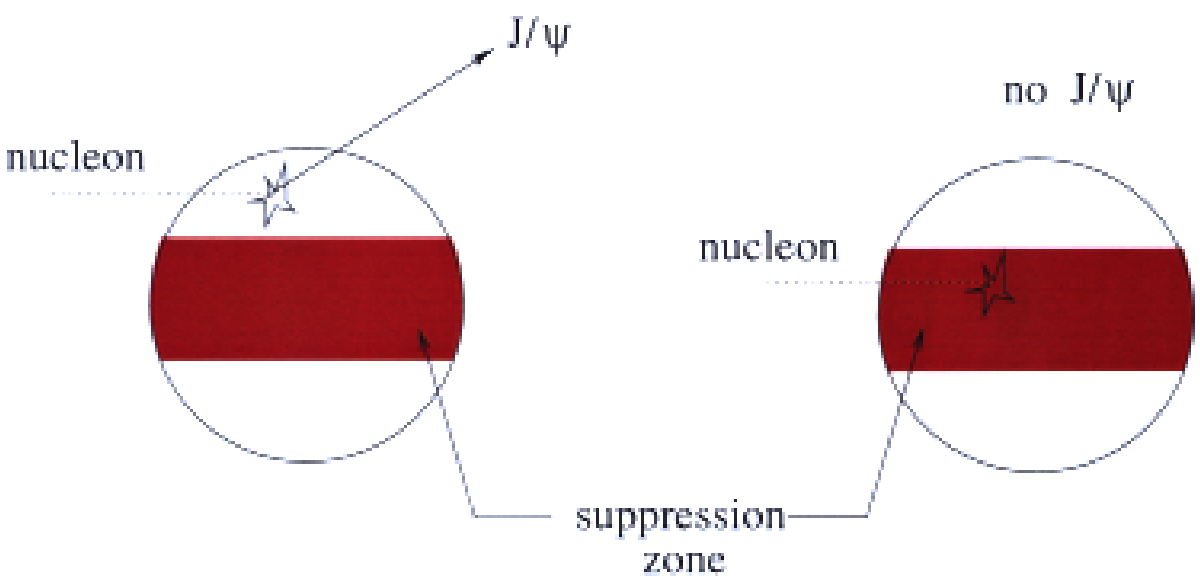



Basic assumption: $\epsilon \propto n_p(\mathbf{s}, \mathbf{b})$

density of participants per surface

$\Rightarrow$ $J/\psi$ suppressed when $\epsilon > \epsilon_c$

Blaizot and Ollitrault, PRL **77** (1996) 1703



# Transverse Energy Fluctuations (1)

- Previous models of suppression:

  without $E_T$ fluctuations

  $\longrightarrow$ only geometrical considerations

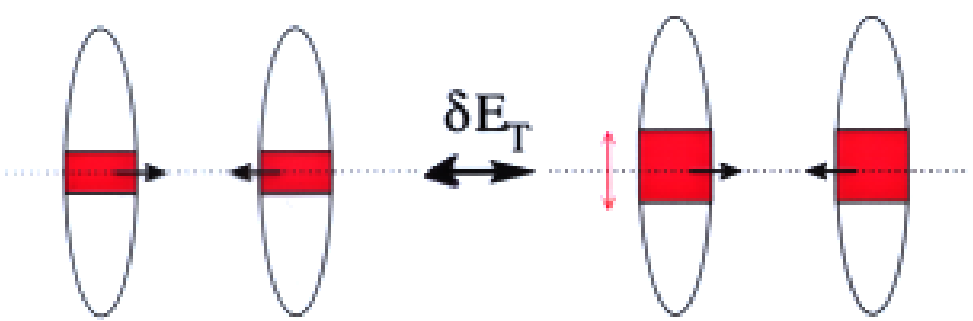
  $\Rightarrow$ Saturation at high $E_T$ Nardi & Satz, PLB 442 (1999) 14

  central collisions $\quad b = 0$

- BUT $E_T$ fluctuates ! Capella et al., PRL 85 (2000), 2080; Armesto et al., Phys. Rev. C59 (1999) 395

  $\rightarrow$ local energy density $\epsilon \propto E_T$

  $\rightarrow$ $\delta E_T$ evenly distributed in collision zone phase space




For a fixed geometry

$\delta E_T > 0 \Rightarrow$ more suppression

# Transverse Energy Fluctuations (2)

$E_T$ distribution $\longrightarrow$ gaussian $\quad \mathcal{P}(E_T|\mathbf{b})$

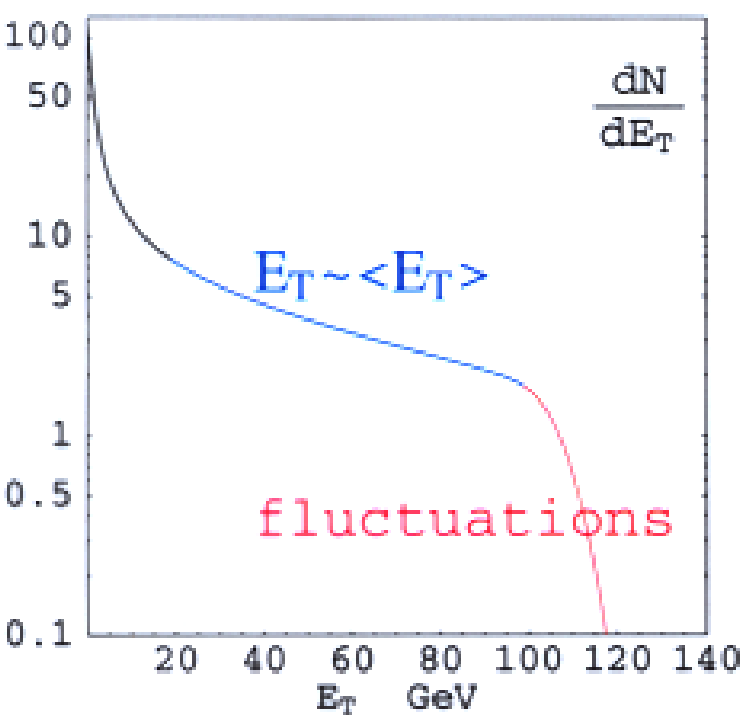
- mean value $\langle E_T \rangle(\mathbf{b}) = q\ N_p(\mathbf{b})$

  $q$: average $E_T$ per participant, $q = 0.274$ GeV (NA50)

  $N_p(\mathbf{b})$: total number of participants at $\mathbf{b}$

- dispersion $\sigma = a\ q^2\ N_p(\mathbf{b})$

  $\hookrightarrow$ dimensionless $\quad$ a=1.27 $\quad$ (NA50)




Fluctuations taken into account

$$\epsilon \propto \frac{E_T}{\langle E_T \rangle(\mathbf{b})}\ n_p(\mathbf{s}, \mathbf{b})$$

## The suppression factor

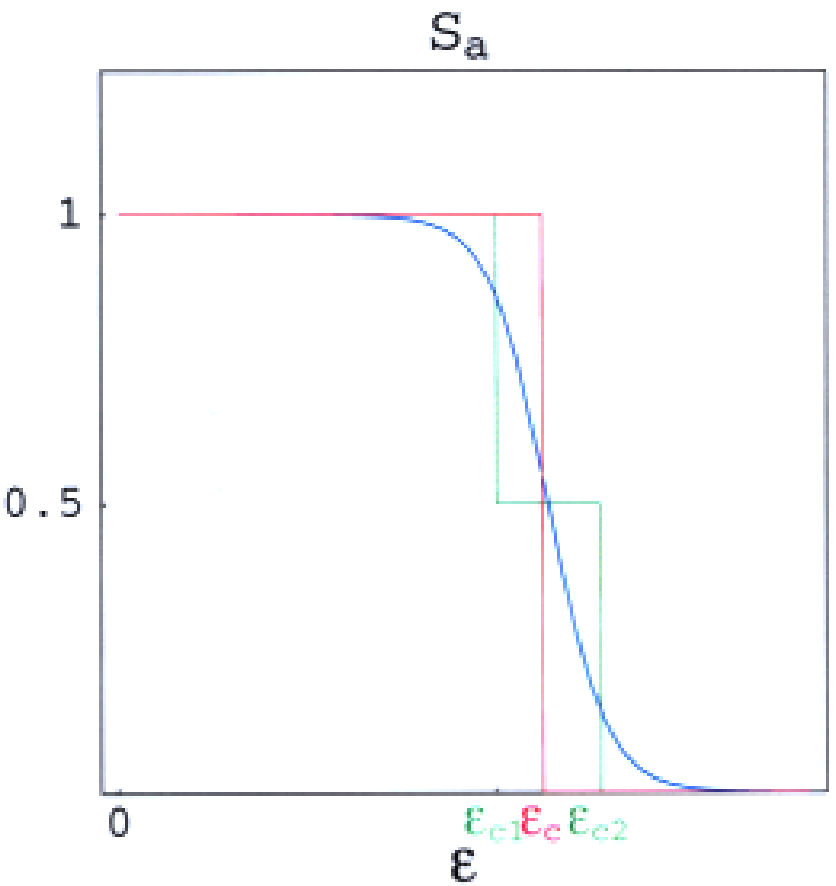
- $J/\psi$ production

  $\longrightarrow$ Suppression factor *locally*

$$S_a = \frac{\text{anomalous suppression (with nucl. abs.)}}{\text{nuclear absorption only}}$$

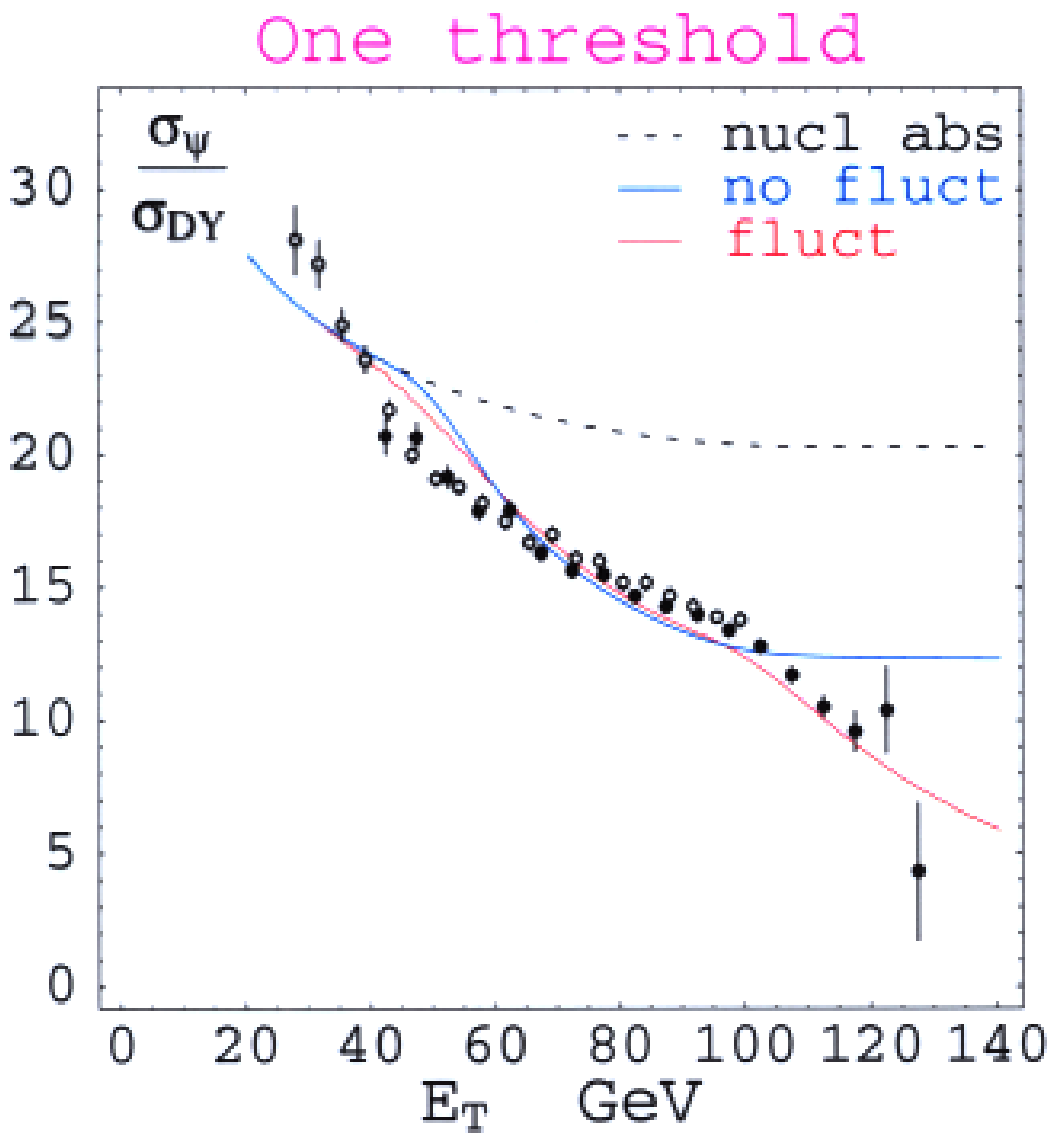
- Three scenarios

  One threshold
  Two thresholds
  Gradual suppression



# Fit to NA50 Data (1)

Blaizot, Dinh and Ollitrault PRL **85** (2000) 4012



# Predictions for RHIC (1)

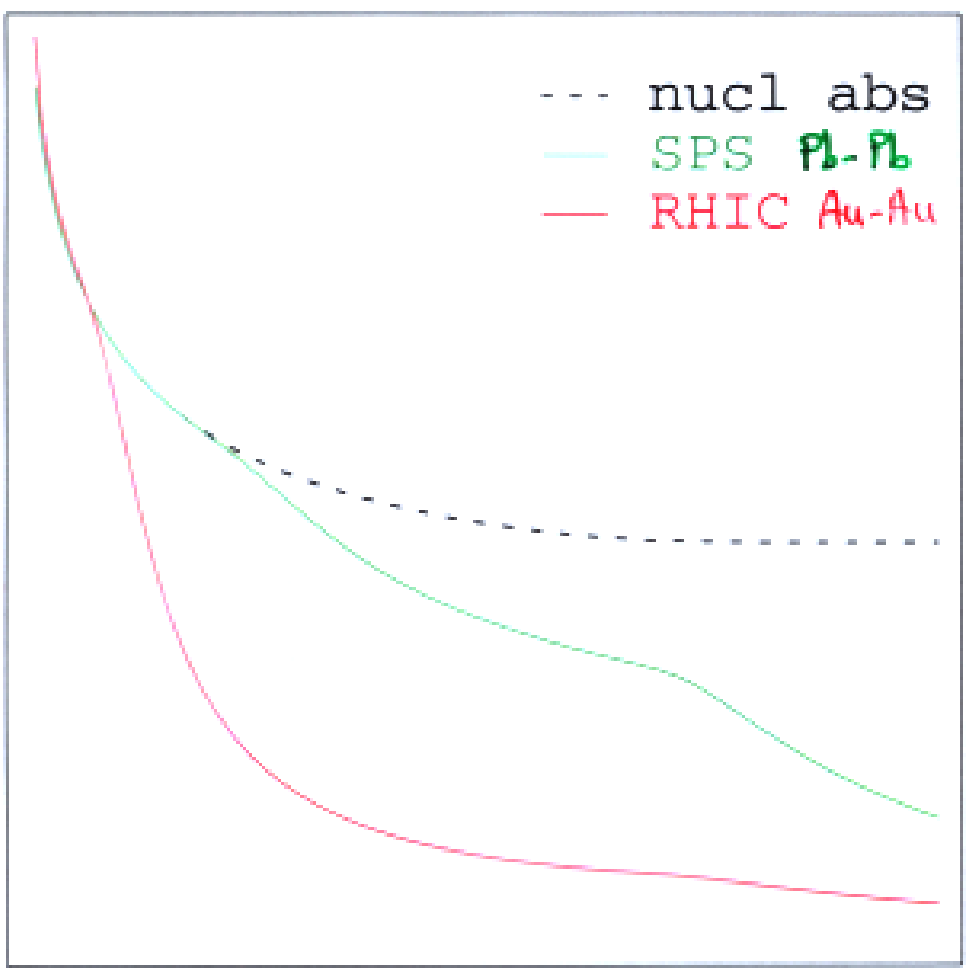
Assumption

energy density 70 % higher than at SPS

Phobos, PRL **85** (2000) 3100

$$\Rightarrow \quad n_c \text{ at SPS} \quad \longrightarrow \quad \frac{n_c}{1.7} \text{ at RHIC}$$

$\sigma_\psi / \sigma_{DY}$ for Pb-Pb and Au-Au

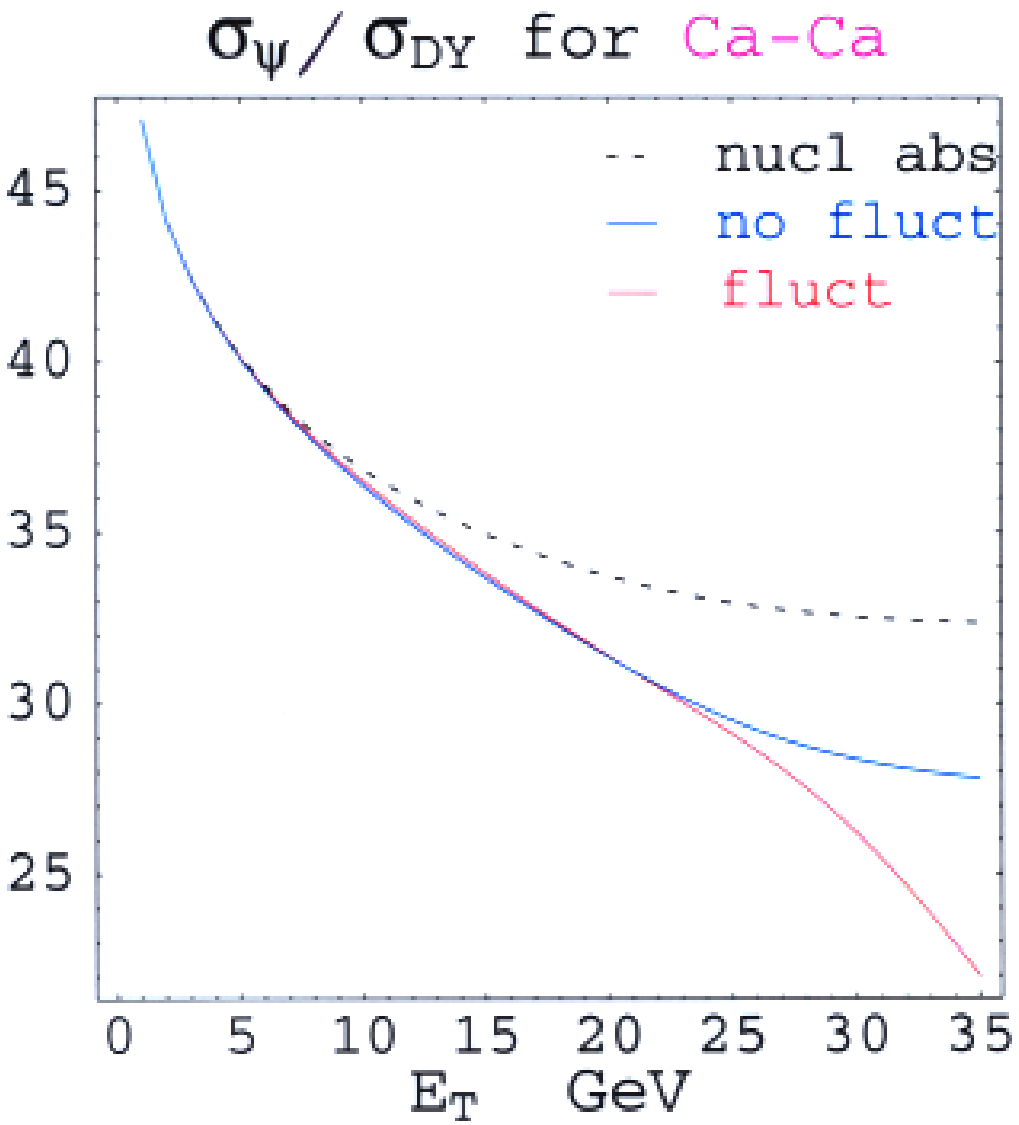


# Predictions for RHIC (2)

Another possible system
instead of Pb–Pb with $n_c/1.7$

Au - Au

$$\Rightarrow A = \frac{208}{1.7^3} = 42 \quad \longrightarrow \quad \text{Ca–Ca}$$



# Variations of $\langle\ p_T^2\ \rangle$

Assumptions

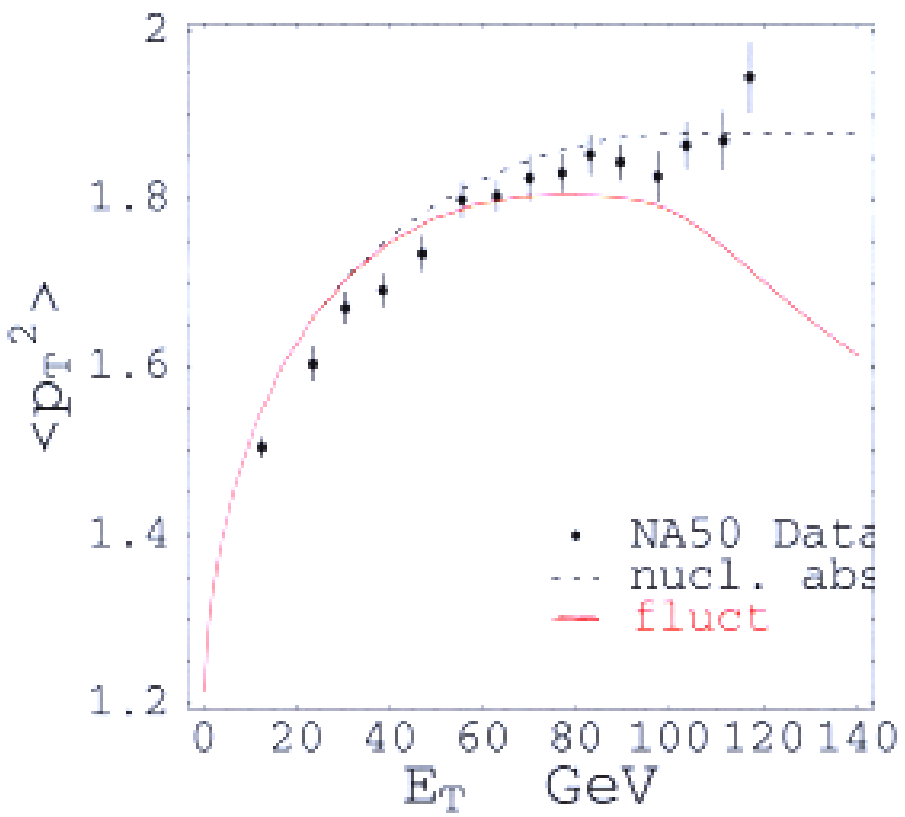
- Initial state scattering

$$\langle\ p_T^2\ \rangle_{AB} = \langle\ p_T^2\ \rangle_{pp} + a\langle L \rangle$$

length of crossed matter $\hookleftarrow$

NA50, CERN-EP-2000-141 Nov 2, 2000
Kharzeev *et al*, Phys. Lett. **B405** (1997) 14

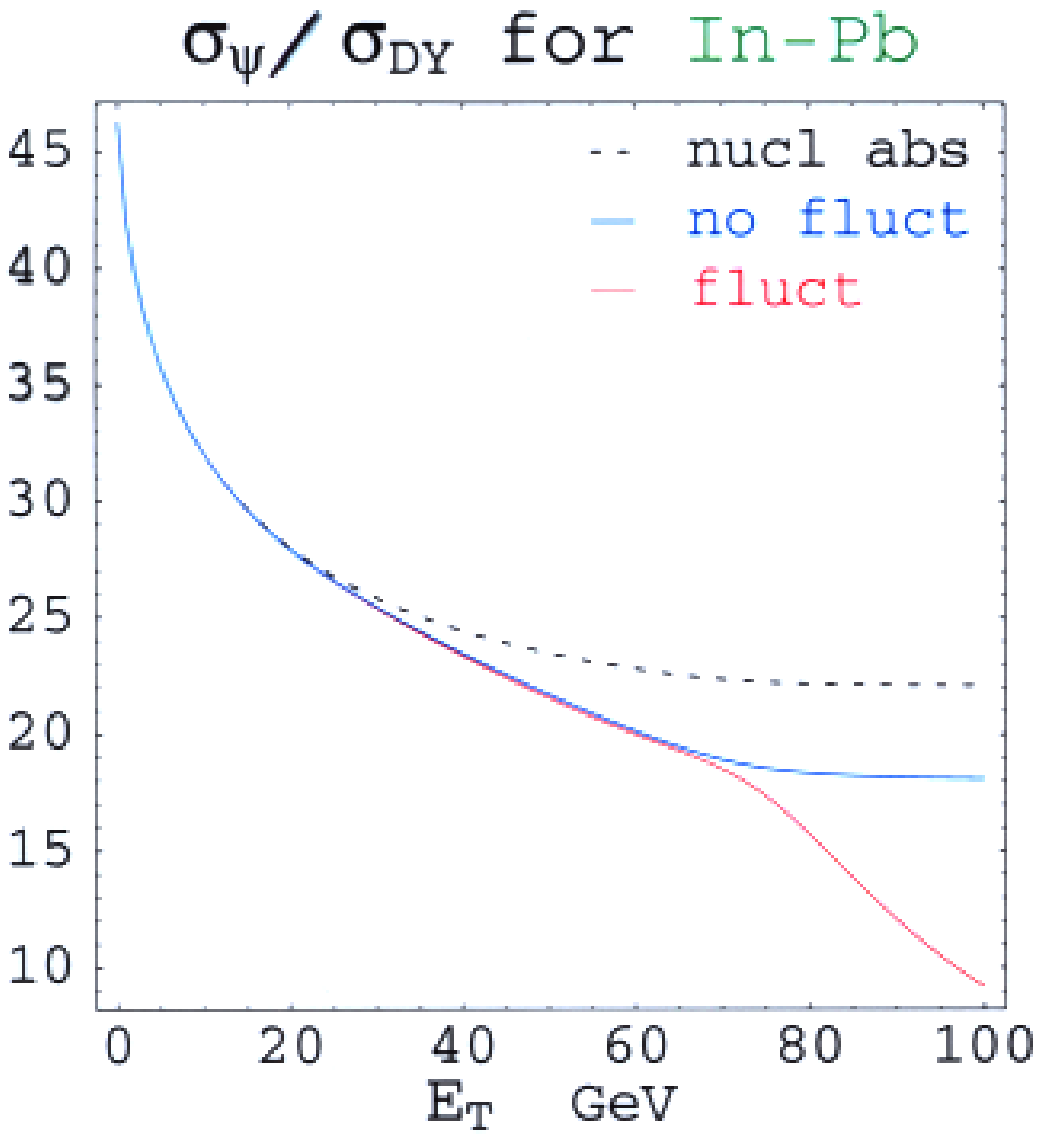
- Anomalous suppression taken $p_T$–independent




- Possible improvement
  consider less suppression at high $p_T$

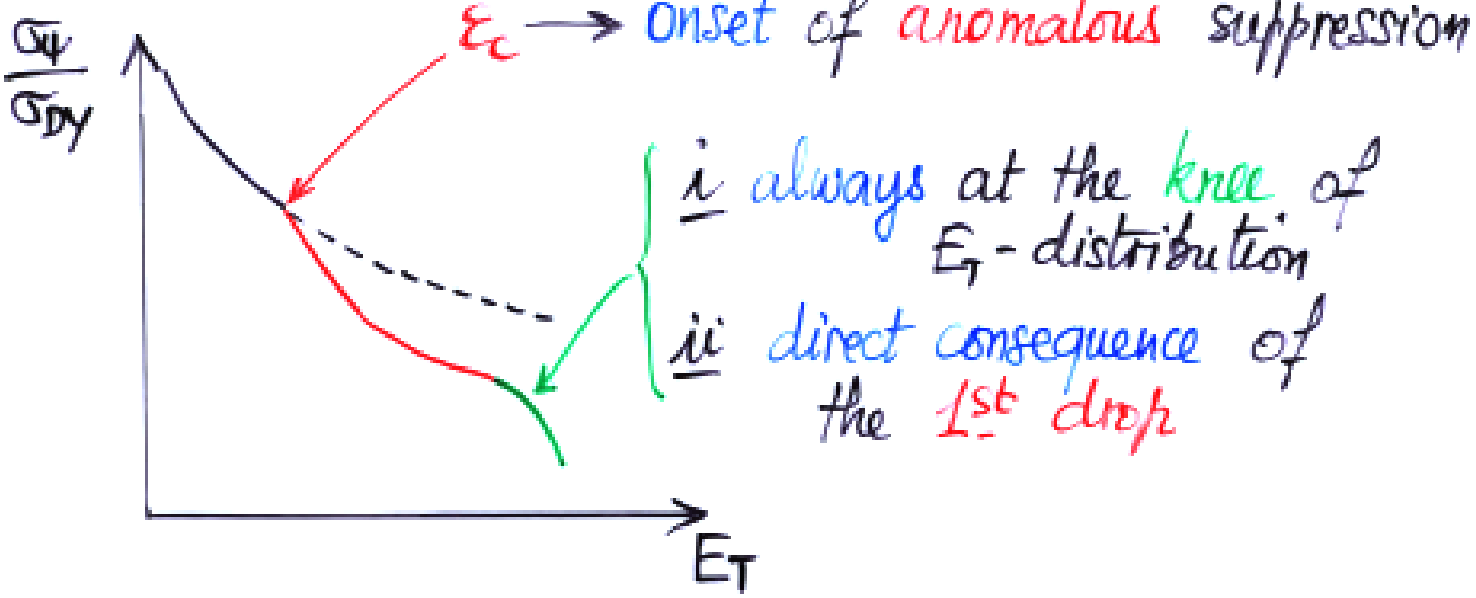
# Prediction for smaller systems

No free parameter !



# Summary

- J/ψ suppression at SPS
  - → NA50 interpretation
    & successive meltings, χ then J/ψ
  - → Our interpretation
    both suppressed simultaneously




- Increasing of $\langle p_T^2 \rangle$ with centrality
  ↔ hint of $p_T$-dependent suppression

- at SPS ↔ at RHIC
  $\varepsilon_c$ for Pb-Pb ↔ $\frac{\varepsilon_c}{1.7}$ for Ca-Ca