



Kinematical correlations: from RHIC to LHC

Antoni Szczurek

INSTITUTE OF NUCLEAR PHYSICS

POLISH ACADEMY OF SCIENCES

IFJ PAN

AND

UNIVERSITY OF RZESZOW



Plan of the first part



Nonphotonic electrons – coincidences

Recent results of PHENIX and STAR
(see M. Luszczak talk for inclusive distributions)



Nonphotonic electrons

- 1) Heavy quark-antiquark production

$$gg \rightarrow c\bar{c} \text{ or } gg \rightarrow b\bar{b}$$

$$q\bar{q} \rightarrow c\bar{c} \text{ or } q\bar{q} \rightarrow b\bar{b}$$

k_t -factorization approach, Kwiecinski UPDFs here.

- 2) Fragmentation

$$c \rightarrow D \text{ and } \bar{c} \rightarrow \bar{D}$$

$$b \rightarrow B \text{ and } \bar{b} \rightarrow \bar{B}$$

Peterson fragmentation functions.

- 3) Semileptonic decays

$$D \rightarrow e^+ \text{ and } \bar{D} \rightarrow e^- \text{ (see CLEO data)}$$

$$B \rightarrow e^- \text{ and } \bar{B} \rightarrow e^+ \text{ (see BBAR data)}$$

fit of the decay function to the decay data.

- 4) Drell-Yan dielectron production



Simultaneous fragmentation of Q and \bar{Q}

From heavy quarks/antiquarks to heavy mesons:

$$\frac{d\sigma(y_1, p_{1t}^M, y_2, p_{2t}^M, \phi)}{dy_1 dp_{1t}^M dy_2 dp_{2t}^M d\phi} \approx \int \frac{D_{Q \rightarrow M}(z_1)}{z_1} \cdot \frac{D_{\bar{Q} \rightarrow \bar{M}}(z_2)}{z_2} \cdot \frac{d\sigma(y_1, p_{1t}^Q, y_2, p_{2t}^Q, \phi)}{dy_1 dp_{1t}^Q dy_2 dp_{2t}^Q d\phi} dz_1 dz_2 \quad (1)$$

where: $p_{1t}^Q = \frac{p_{1t}^M}{z_1}$, $p_{2t}^Q = \frac{p_{2t}^M}{z_2}$,

$z_1 = (0, 1)$ and $z_2 = (0, 1)$.

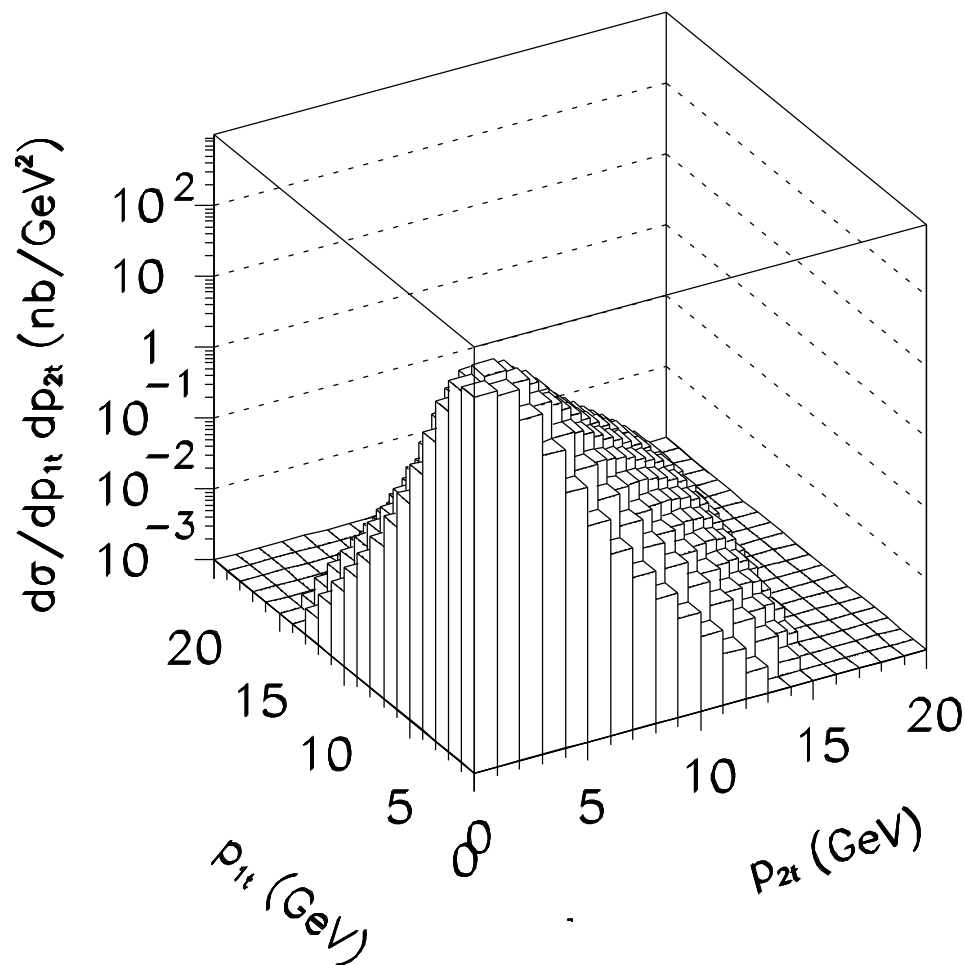
$D_{Q \rightarrow M}(z_1)$, $D_{\bar{Q} \rightarrow \bar{M}}(z_2)$ – Peterson fragmentation functions.

Approximation:

y_1, y_2, ϕ – unchanged in the fragmentation process (reasonable for heavy quarks/antiquarks).



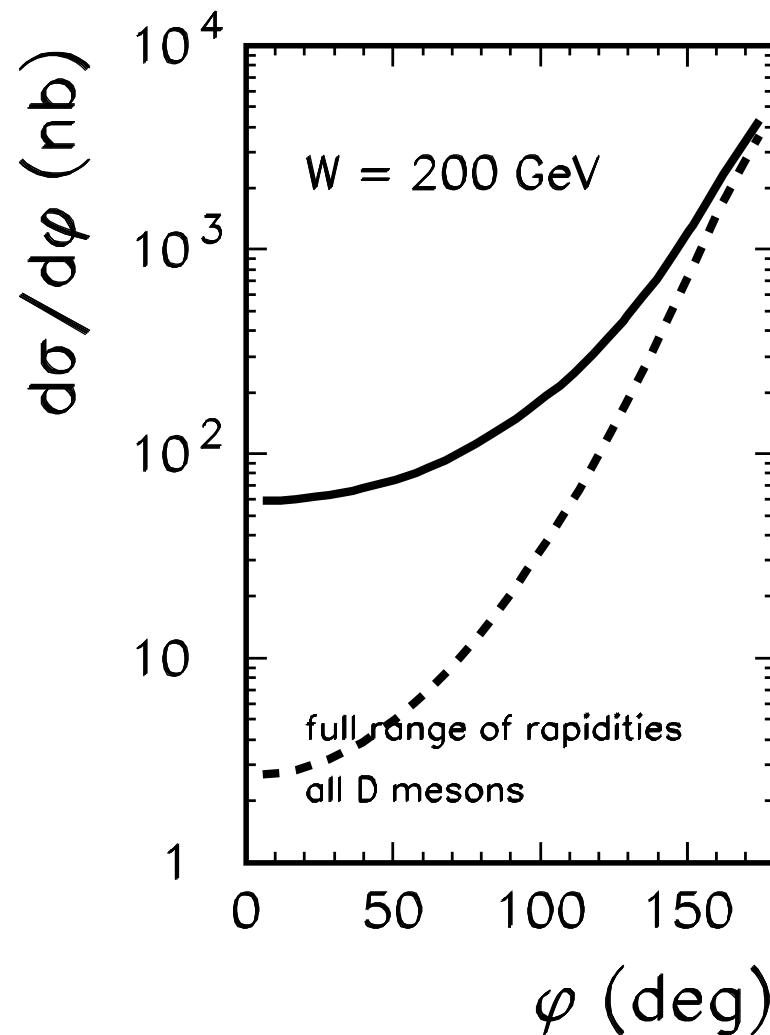
$D - \bar{D}$ correlations in transverse momenta



Kwiecinski UGDF with $\mu^2 = 4m_c^2$ and $b_0 = 1 \text{ GeV}^{-1}$



$D - \bar{D}$ azimuthal correlations



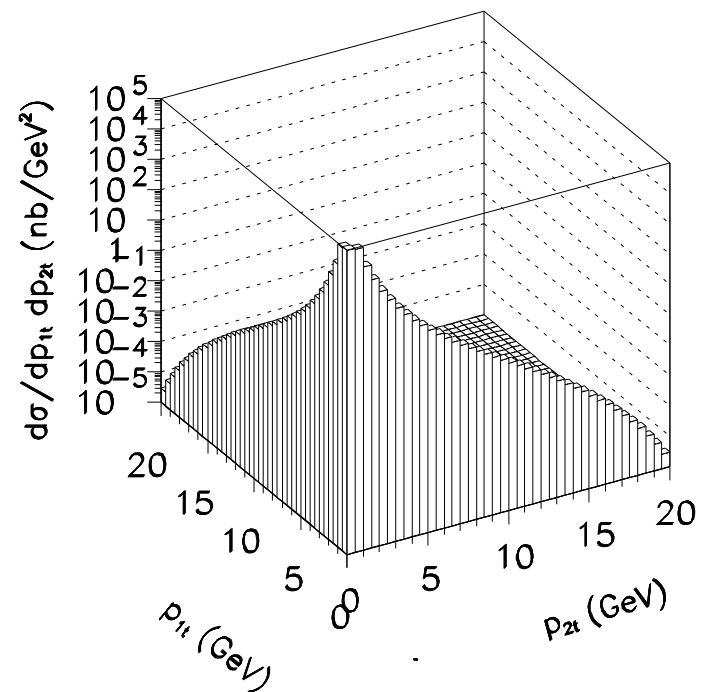
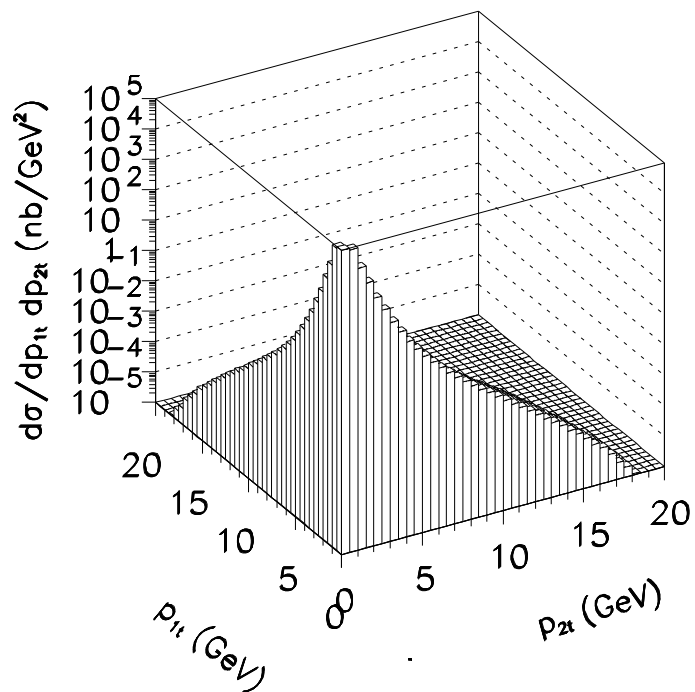
dashed: $p_{1t}^D, p_{2t}^{\bar{D}} > 0.5$ GeV.

Kwiecinski UGDF with $\mu^2 = 4m_c^2$ and $b_0 = 1$ GeV⁻¹

CDF has studied: $D^0 - D^{*-}$ and $D^+ - D^{*-}$ correlations.



Dielectron correlations $(p_{1t}(e^+), p_{2t}(e^-))$

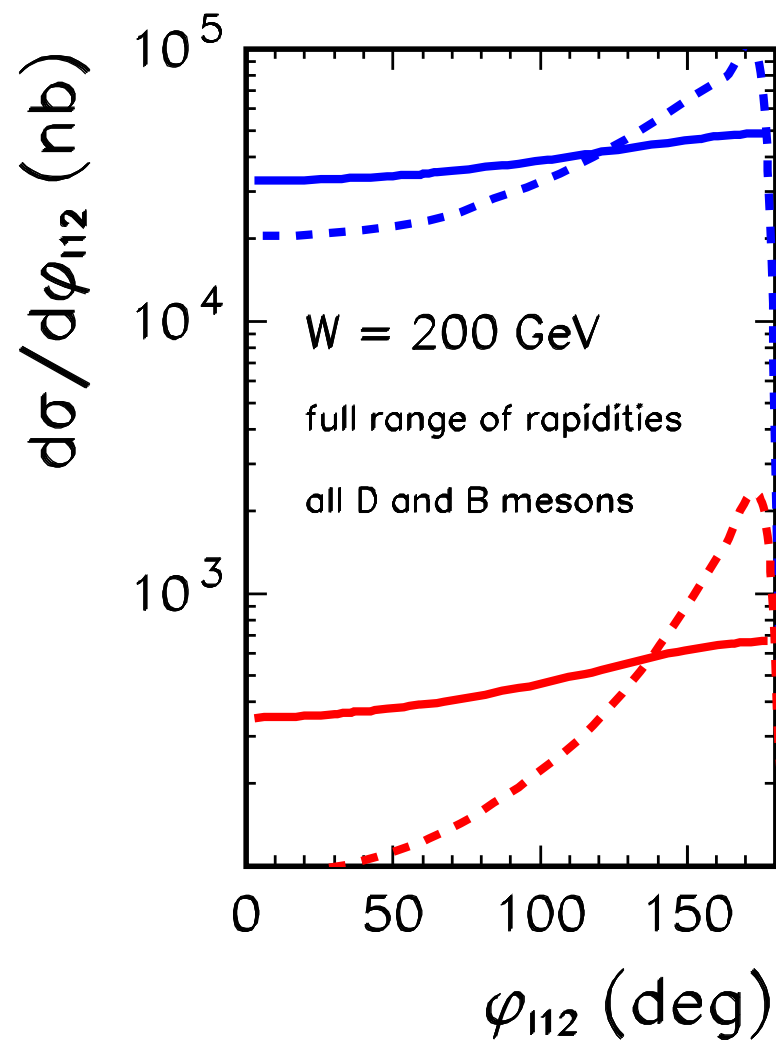


full range of rapidities

Kwecinski and Kharzeev-Levin UGDFs

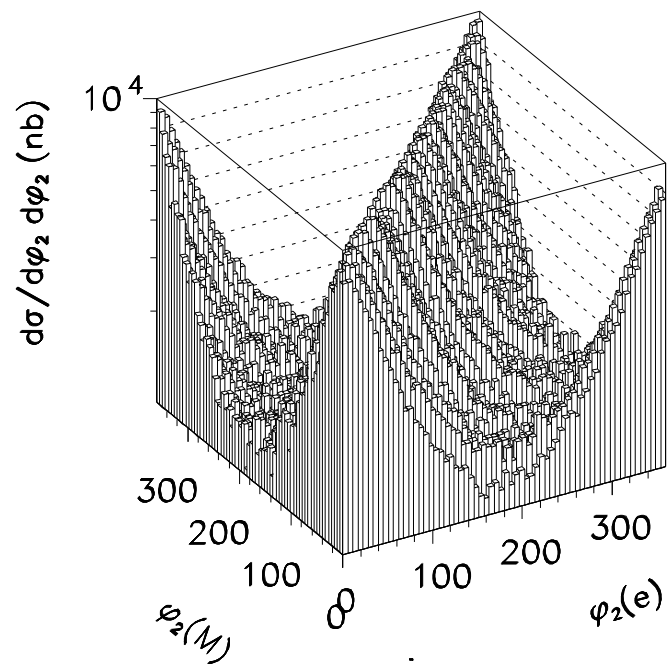
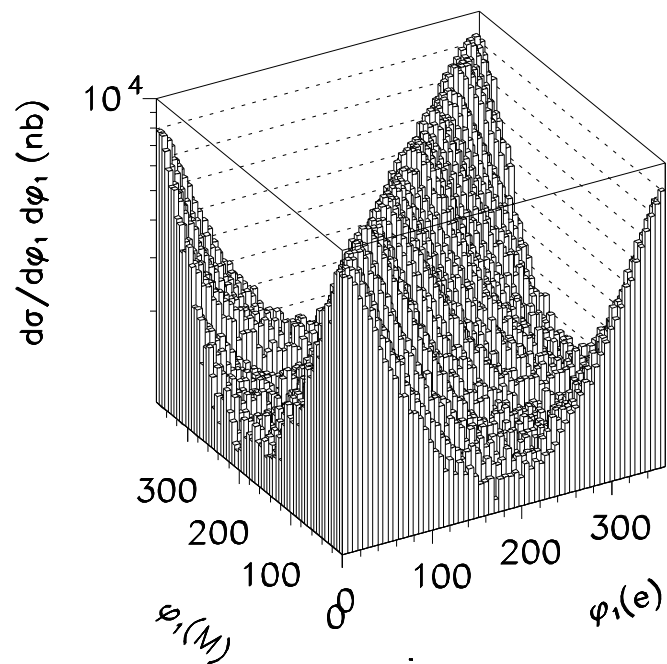


Azimuthal correlations between e^+ and e^-



Decorrelation due to decays

Decorrelation due to semileptonic decays



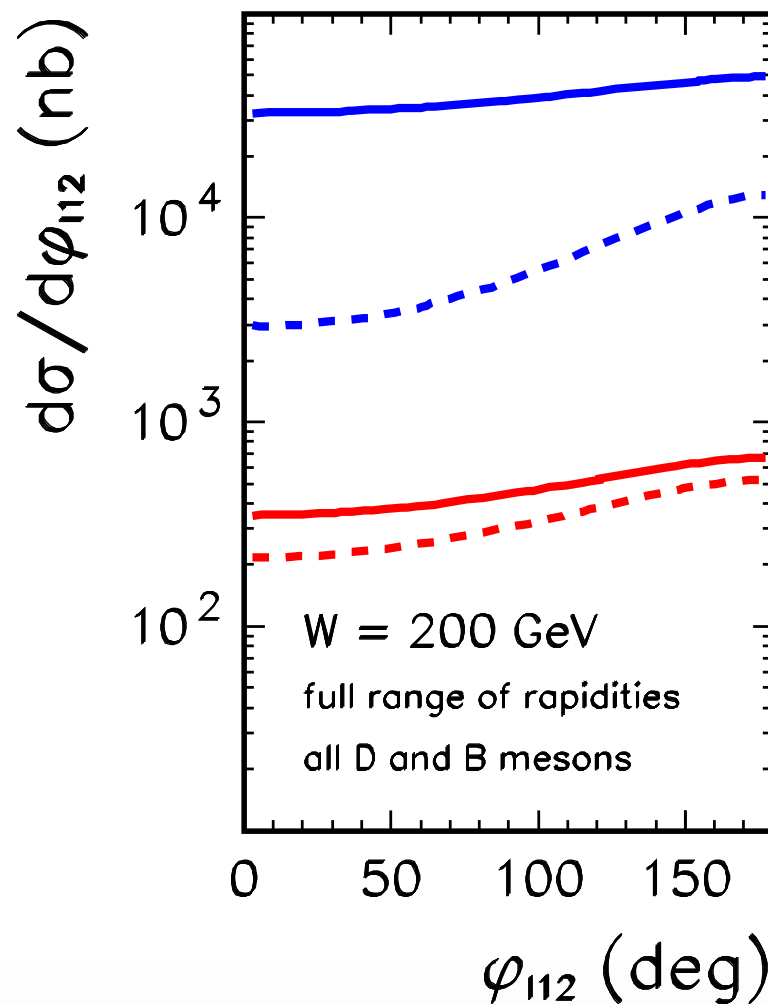
Lost of memory (small transverse momenta)



Azimuthal correlations between e^+ and e^-

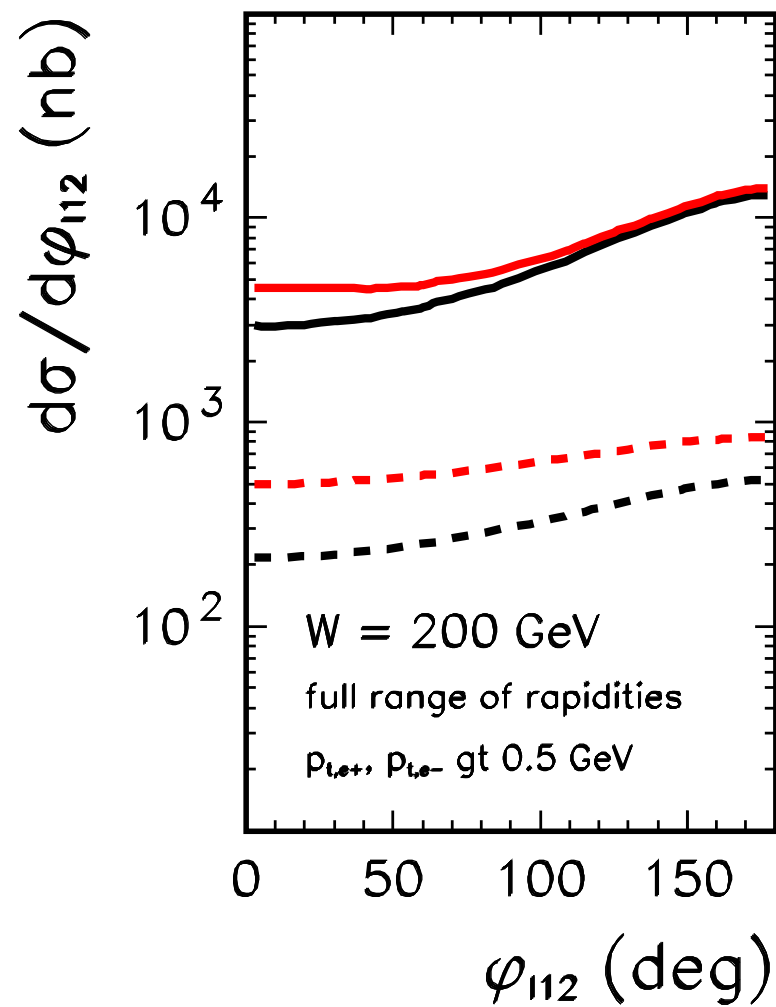
Cut on electron transverse momenta:

$$p_{1t}(e^+), p_{2t}(e^-) > 0.5 \text{ GeV}$$





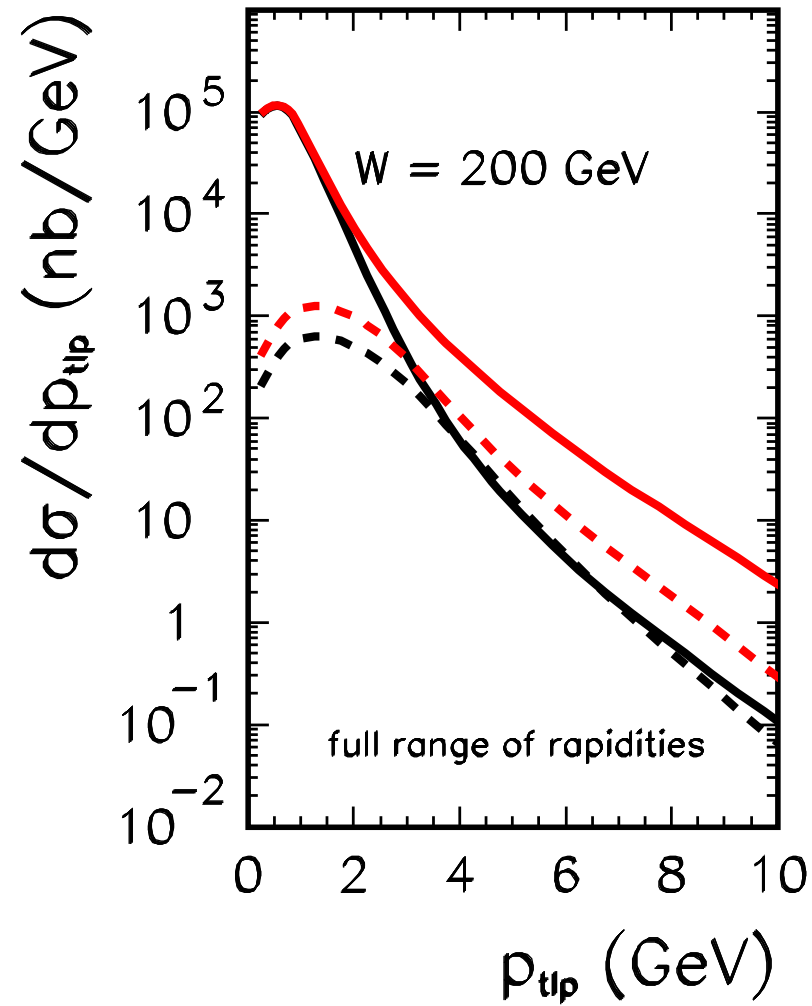
UGDF dependence of azimuthal correlations



Kwiecinski (black), Kharzeev-Levin (red)



Pair transverse momentum distribution



Kwiecinski (black) versus Kharzeev-Levin (red)



Invariant mass distribution

$$\frac{1}{N_{evt}} \frac{dN}{dM_{ee}} = \frac{1}{\sigma_{ine}}$$

$$\begin{aligned} & (BR(D \rightarrow e) \cdot BR(D \rightarrow e) \cdot \frac{d\sigma}{dM_{ee}}(gg \rightarrow c\bar{c} \rightarrow D\bar{D} \rightarrow e^+e^-; cuts) \\ & + BR(B \rightarrow e) \cdot BR(B \rightarrow e) \cdot \frac{d\sigma}{dM_{ee}}(gg \rightarrow b\bar{b} \rightarrow B\bar{B} \rightarrow e^+e^-; cuts) \\ & + \frac{d\sigma}{dM_{ee}}(q\bar{q} \rightarrow e^+e^-; cuts) \end{aligned}$$

$$\sigma_{ine}(W = 200 GeV) = 42.2 \text{ mb}$$

$$BR(D \rightarrow e) \approx 0.1$$

$$BR(B \rightarrow e) \approx 0.1$$

(3)

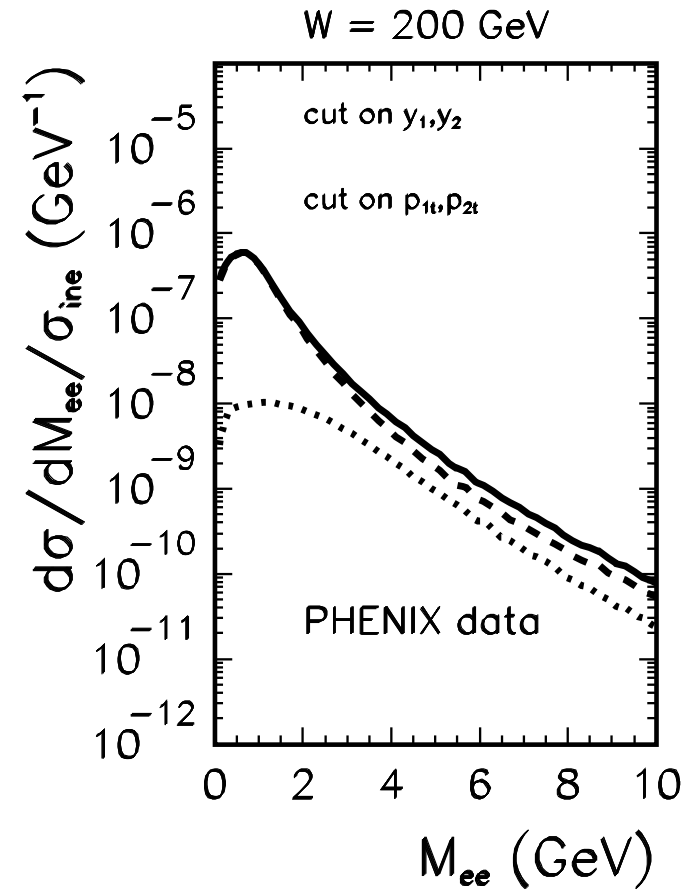
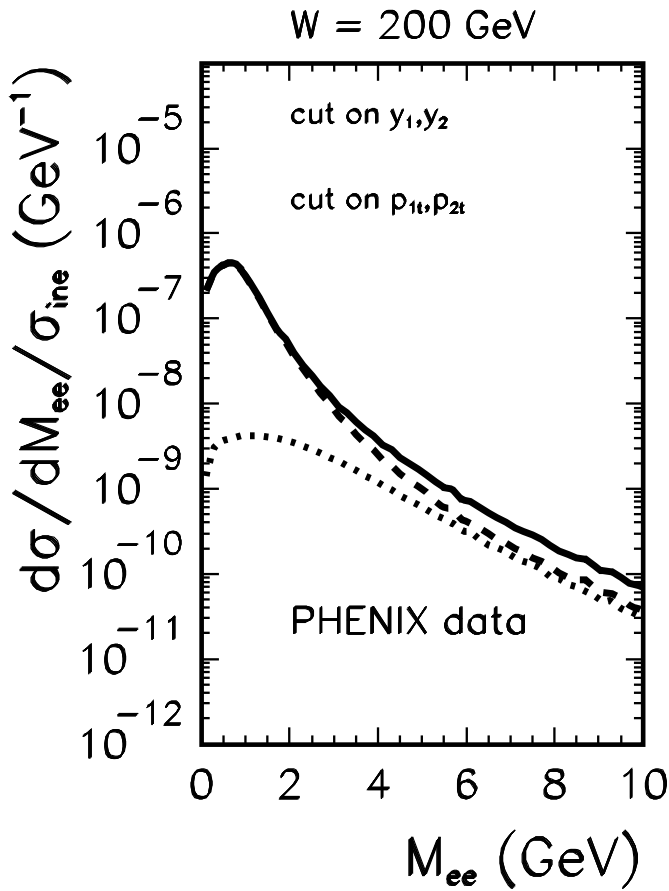
PHENIX experimental cuts:

$$-0.35 < y(e^+), y(e^-) < 0.35,$$

$$p_{1t}(e^+), p_{2t}(e^-) > 0.2 \text{ GeV} .$$



Comparison with recent PHENIX data



Kwiecinski and Kharzeev-Levin UGDFs