Meson-induced Drell-Yan process and the partonic structure of mesons

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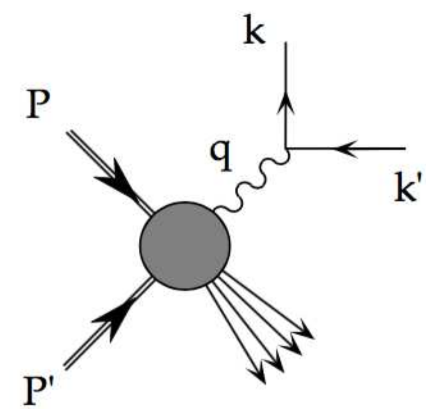
Based on F.A.C., A. Courtoy, S. Noguera and S. Scopetta, EPJ C78 (2018) no.8, 644

The Drell-Yan process: motivation



- Drell-Yan pair production is the only process for which factorization is theoretically proven to all orders in hadronic collisions.
- DY cross sections are known to high accuracy in perturbation theory for a wide number of observables.
- Measurements differential in DY mass and rapidity allow the study of longitudinal meson parton distribution
- DY q_T-spectrum at low q_T, exploiting perturbative resummation techniques, allows the study of non perturbative model of the meson transverse structure.
- Therefore meson-nucleus induced DY process is an ideal laboratory to study the longitudinal and transverse partonic structure of pions (✓) or kaons (x).

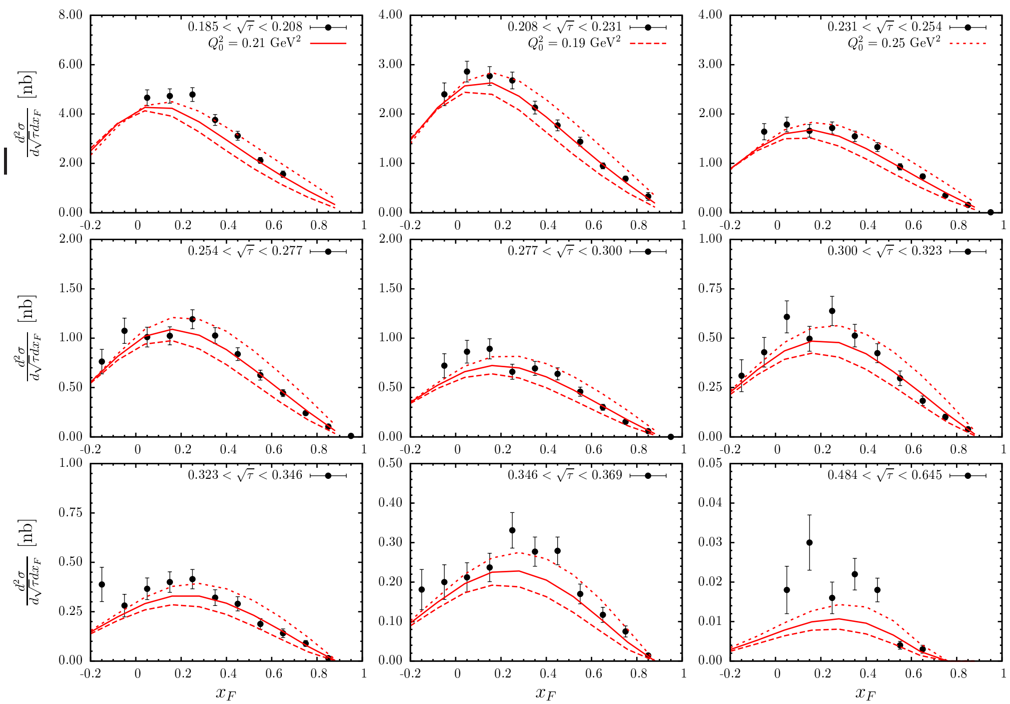
DY and the longitudinal structure of NJL pion

- Exp : E615 $\pi^- W$ at $p_{lab} = 252$ GeV. DY x-sections differential in $\sqrt{\tau}$ and y, Conway '89

- The hadronic scale Q_0 of the NJL model not determined $\rightarrow$ tune theory to data

- Theo: NLO $\overline{\text{MS}}$, Sutton '92
  - NLO pion pdf's from NJL, evolved with QCDNUM, Botje '11
  - NLO nuclear pdf's from CTEQ10

- Results: we find good agreement at large x_F, *i.e.* valence quark in the pion, where NJL is expected to work better.



- The tuning gives $Q_0^2 = 0.21$ GeV^2 with $\chi^2/dof \sim 2$

DY and the transverse structure of NJL pion

- At small $q_\perp$ the cross section reads

$$\frac{d\sigma}{dq_T^2 d\tau dy} = \sum_{a,b} \sigma_{q\bar{q}}^{(LO)} \int_0^\infty db \frac{b}{2} J_0(b\, q_T)\, S_{PT}(Q,b)\, S_{NP}^{h_1 h_2}(b) \cdot$$

$$\cdot \Big[\left(f_{a/h_1} \otimes C_{qa}\right) \left(x_1, \frac{b_0^2}{b^2}\right) \left(f_{b/h_2} \otimes C_{\bar{q}b}\right) \left(x_2, \frac{b_0^2}{b^2}\right) + q \leftrightarrow \bar{q} \Big] .$$

- The non perturbative form factor, $S_{NP}^{h_1 h_2}(b)$, encodes the transverse structure of both the colliding hadrons. The latter is either:
  - fixed by comparison with data or
  - parametrized with the help of hadronic models, as we shall do in this analysis.
- In our case we take the proton structure from the literature
- The pion structure entirely extracted from NJL model

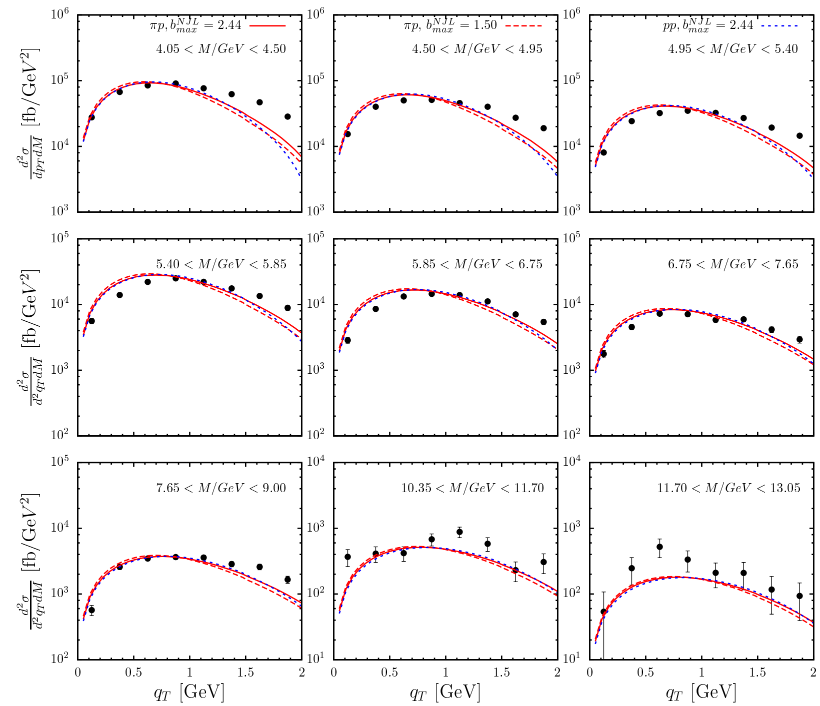
DY q_T spectrum vs M

- Exp : E615 $\pi^- W$ at $p_{lab} = 252$ GeV.
  DY differential q_T-sections integrated over $0 < x_F < 1$ and given mass intervals (Conway '89)

- The quality of the description slight improves moving to higher masses.
  Increased effect of PT Sudakov

- More in detail:
  - theory slight overshoots data at small q_T
  - theory undershoots data at larger q_T

- Stability:
  - Theory almost insensitive to b_{max} choices on NJL side.
  - if NJL pion substituted with KN05 proton: theory similar, b-profiles similar at small b at $M = 4$ GeV



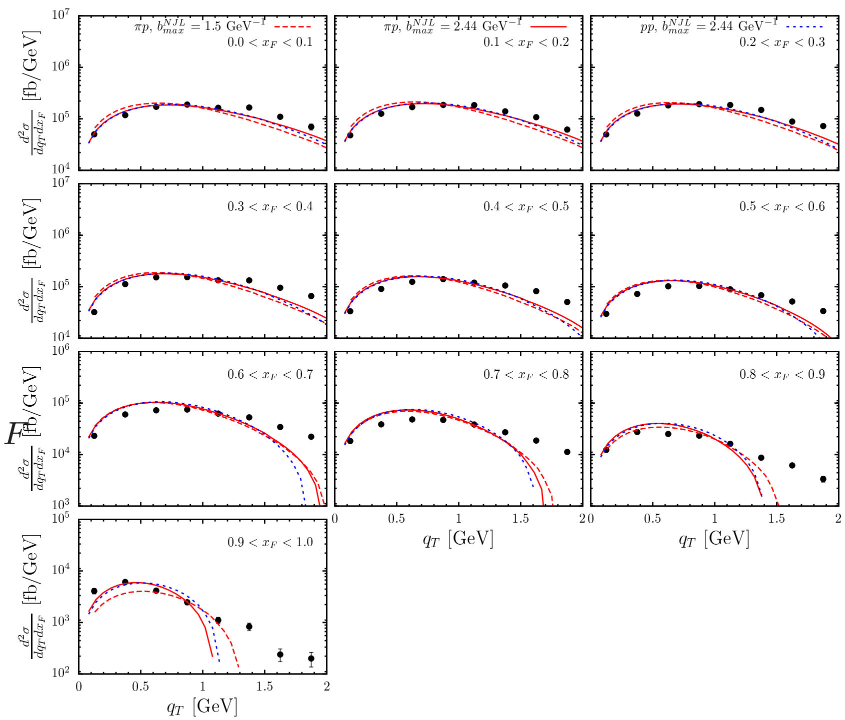
DY q_T spectrum vs x_F

- Exp : E615 $\pi^- W$ at $p_{lab} = 252$ GeV.
  DY differential q_T-sections integrated over $4 < M/GeV < 8.55$ and given x_F intervals (Conway '89)

- The quality of the description deteriorates with increasing x_F

- More in detail:
  - theory slight overshoots data at small q_T at all x_F
  - theory undershoots data at larger q_T, this trend is more pronounced as x_F increases : large x partons in the projectile (pion).

- q_T-sections in x_F-bins are extremely useful to explore eventual x-dependence of NP and PT Sudakov form factor



- Overall, NJL gives a reasonbly good description of data (say, up to $q_T \sim 1$ GeV)