Cross section for quasi-real photo-production of $h^{\pm}$ with high p_T in μ-d scattering

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on behalf of the COMPASS Collaboration

Hadron 2011, Munich

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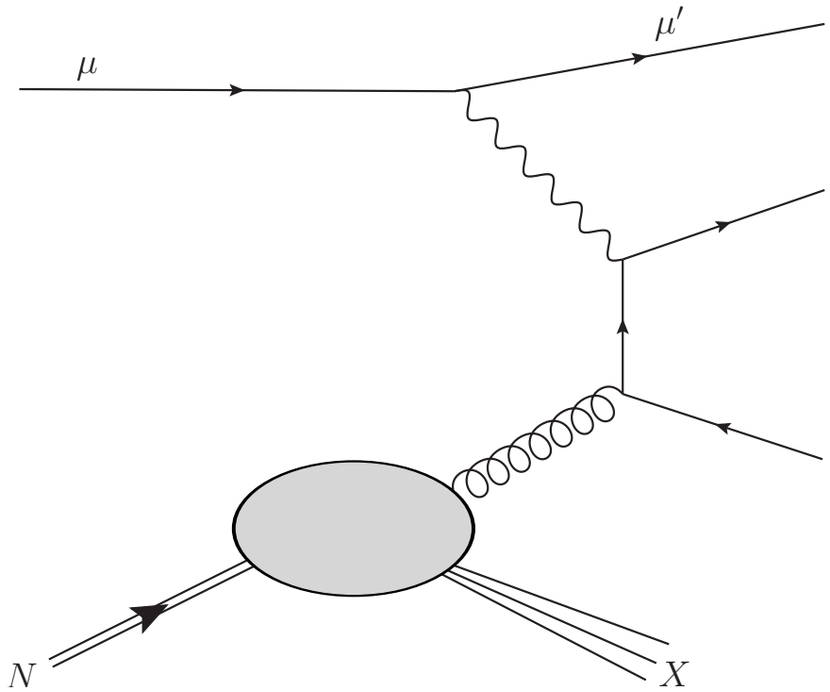
Outline

- Motivation for hadron production cross section measurement
- The COMPASS experiment at CERN
- Luminosity determination, check with structure function F_2
- Cross section for high-p_T hadrons at low Q^2
- Conclusion and outlook

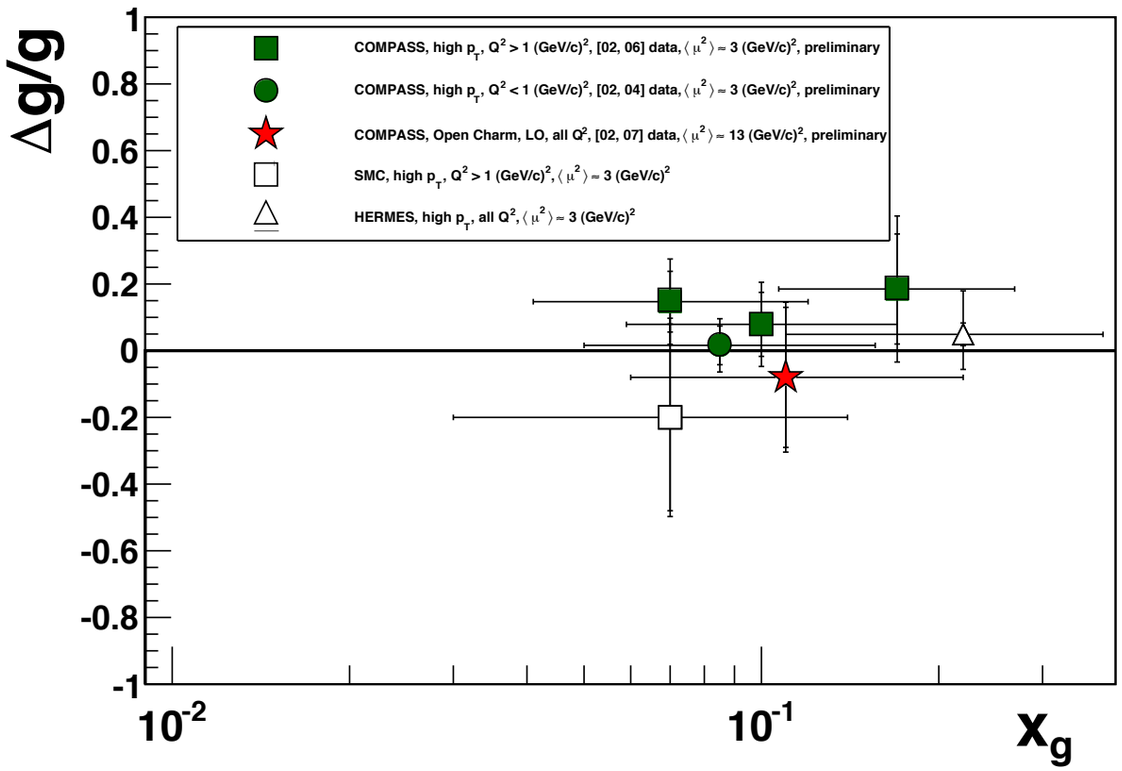
Measuring gluon polarization in DIS

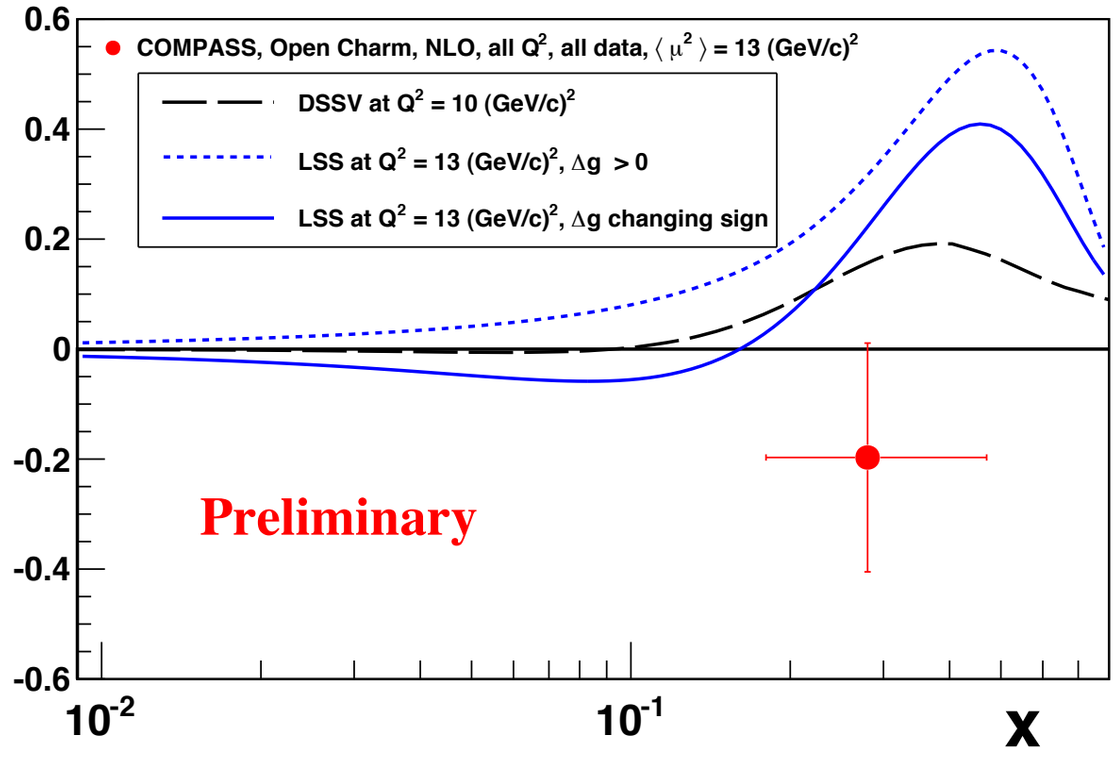
- Photon-gluon fusion



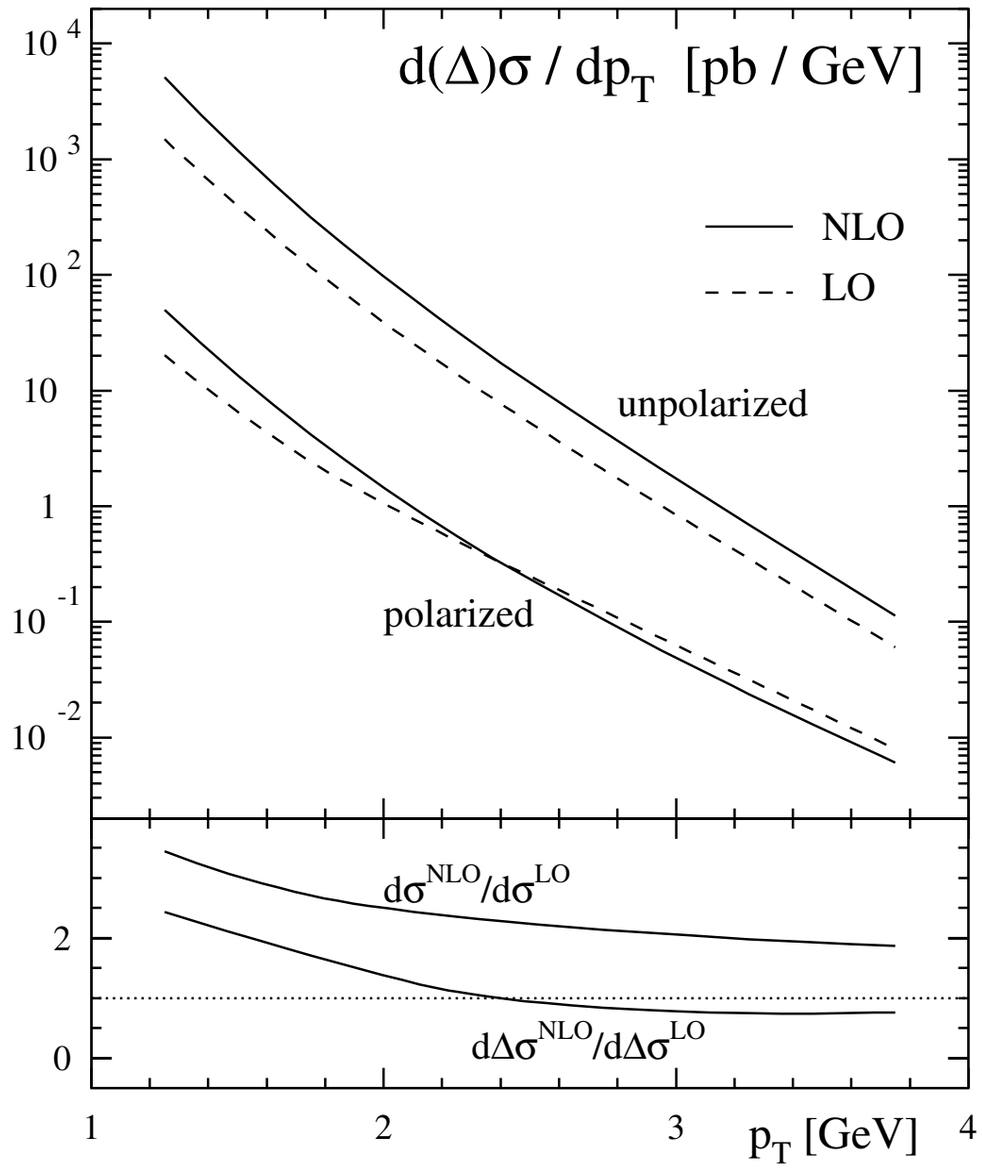
- Dominates cross section for open-charm production
- Considerable contribution to inclusive production of high-p_T hadrons or hadron pairs
- Double spin asymmetries of these processes should be sensitive to gluon polarization

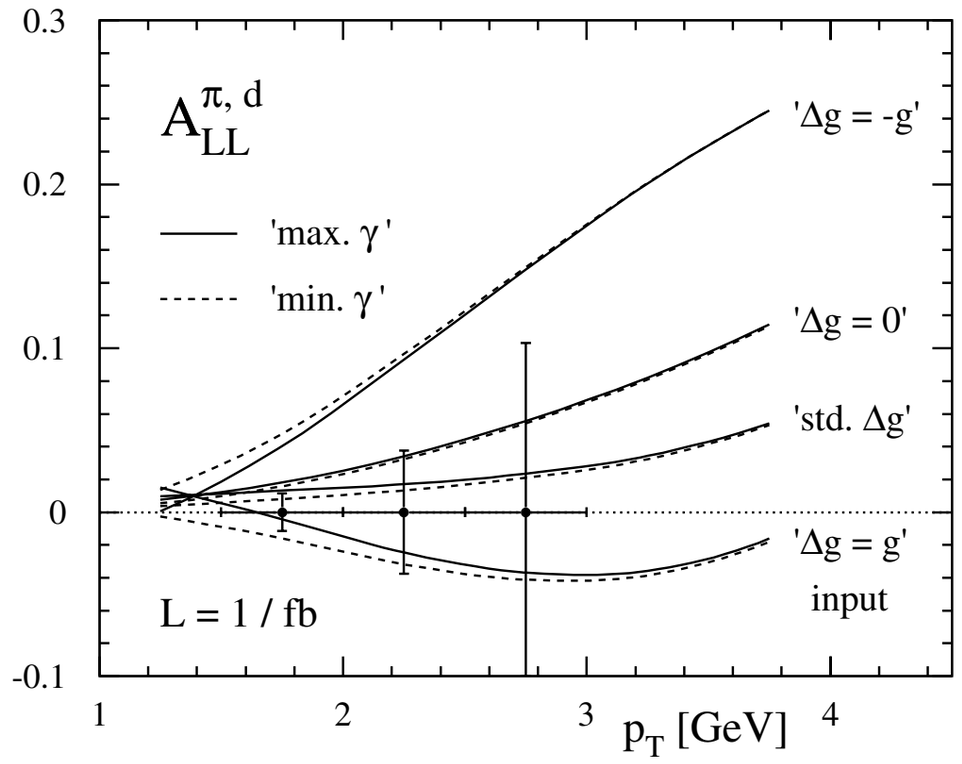
$\Delta g/g$ from DIS





Gluon polarization from quasi-real photo-production of inclusive high-p_T hadrons at COMPASS

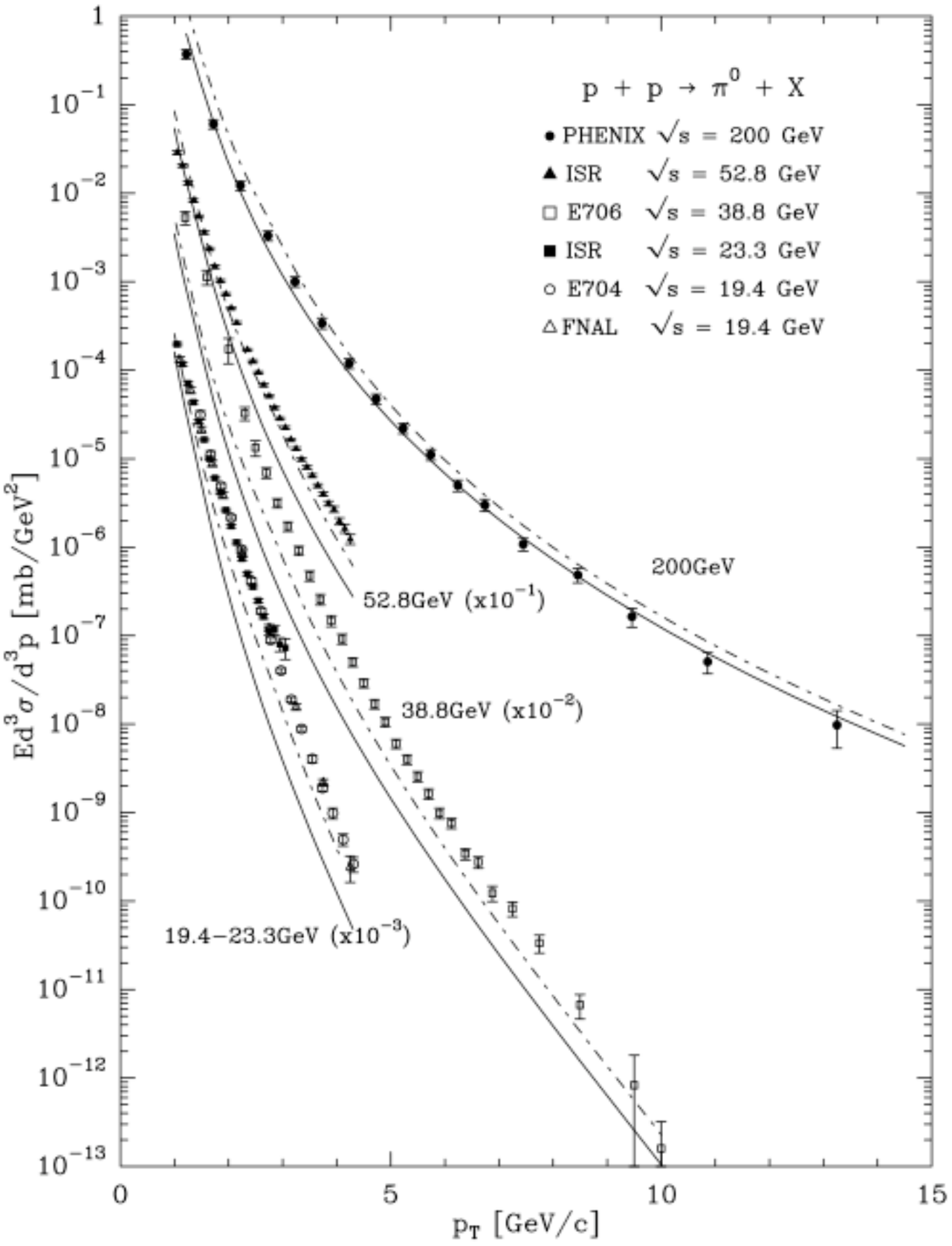




B. Jäger et al., Eur. Phys. J. C **44,** (2005) 533

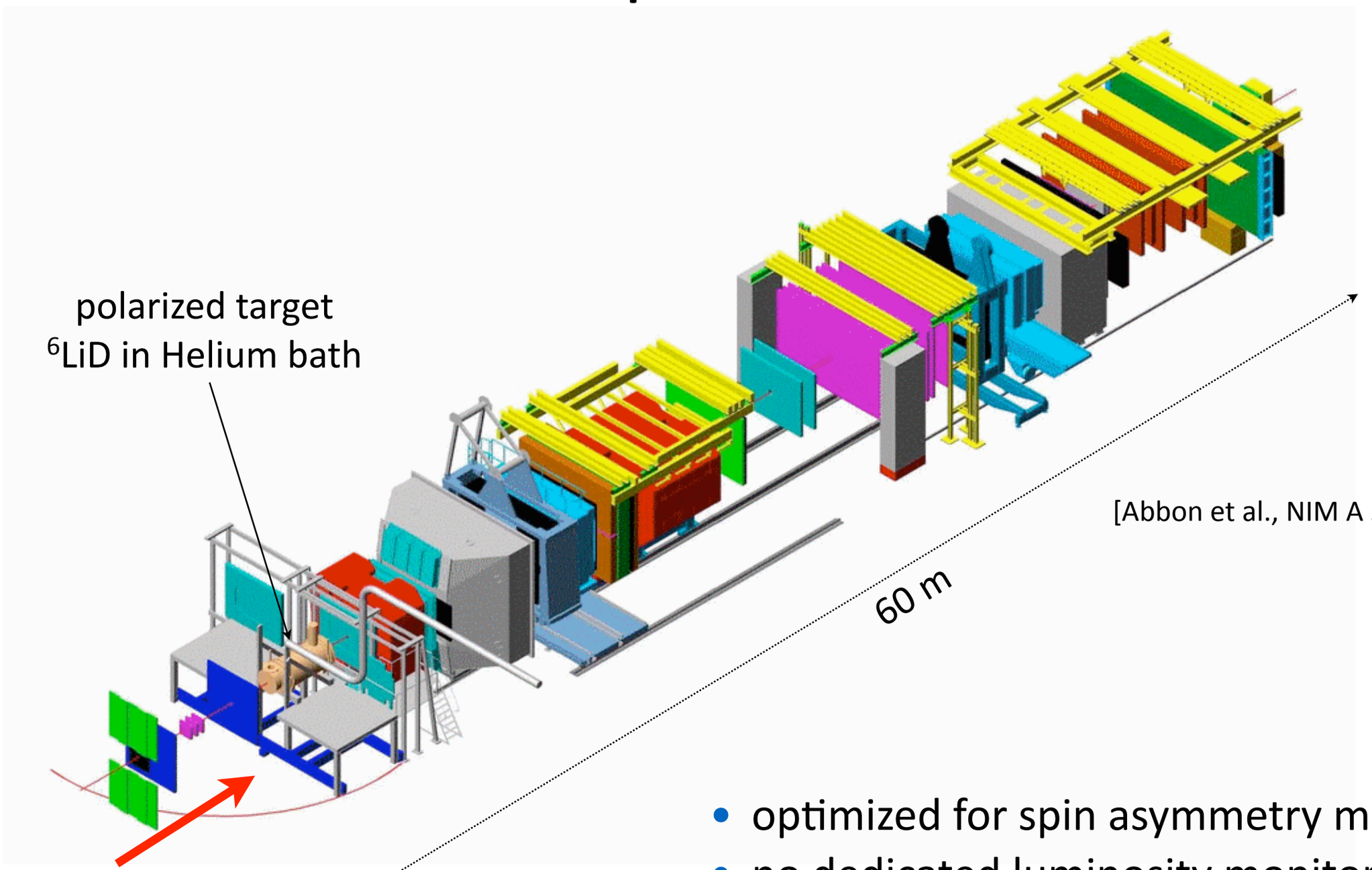
Cross sections as benchmarks for pQCD

- Before spin observables can be extracted from polarized cross sections with confidence, theory has to correctly reproduce unpolarized cross section
- Unpolarized PDFs are much better known
- At collider energies (RHIC p-p) benchmark works well
- Concept is still to be proven at fixed target energies
- Does it work for quasi-real photo-production in lepton-nucleon scattering?



C. Bourrely & J. Soffer, Eur. Phys. J. C **36,** (2004) 371

The COMPASS Experiment at CERN SPS (2004)



[Abbon et al., NIM A 577 (2007), 455-518]

- optimized for spin asymmetry measurements
- no dedicated luminosity monitor

Luminosity

- Selection of good spills
- Flat top of beam is selected in each spill
- Luminosity is determined with direct measurement of beam flux on target in each spill
- Dead times due to trigger and DAQ are corrected in each spill
- Resulting luminosity (30% of 2004 data): 142.4 pb^{-1}
- Luminosity is checked with extraction F_2 from our data -> comparison with literature

Luminosity

NMC parameterization:
M. Arneodo et al. (NMC Collaboration), Physics Letters B **364,** (1995) 107

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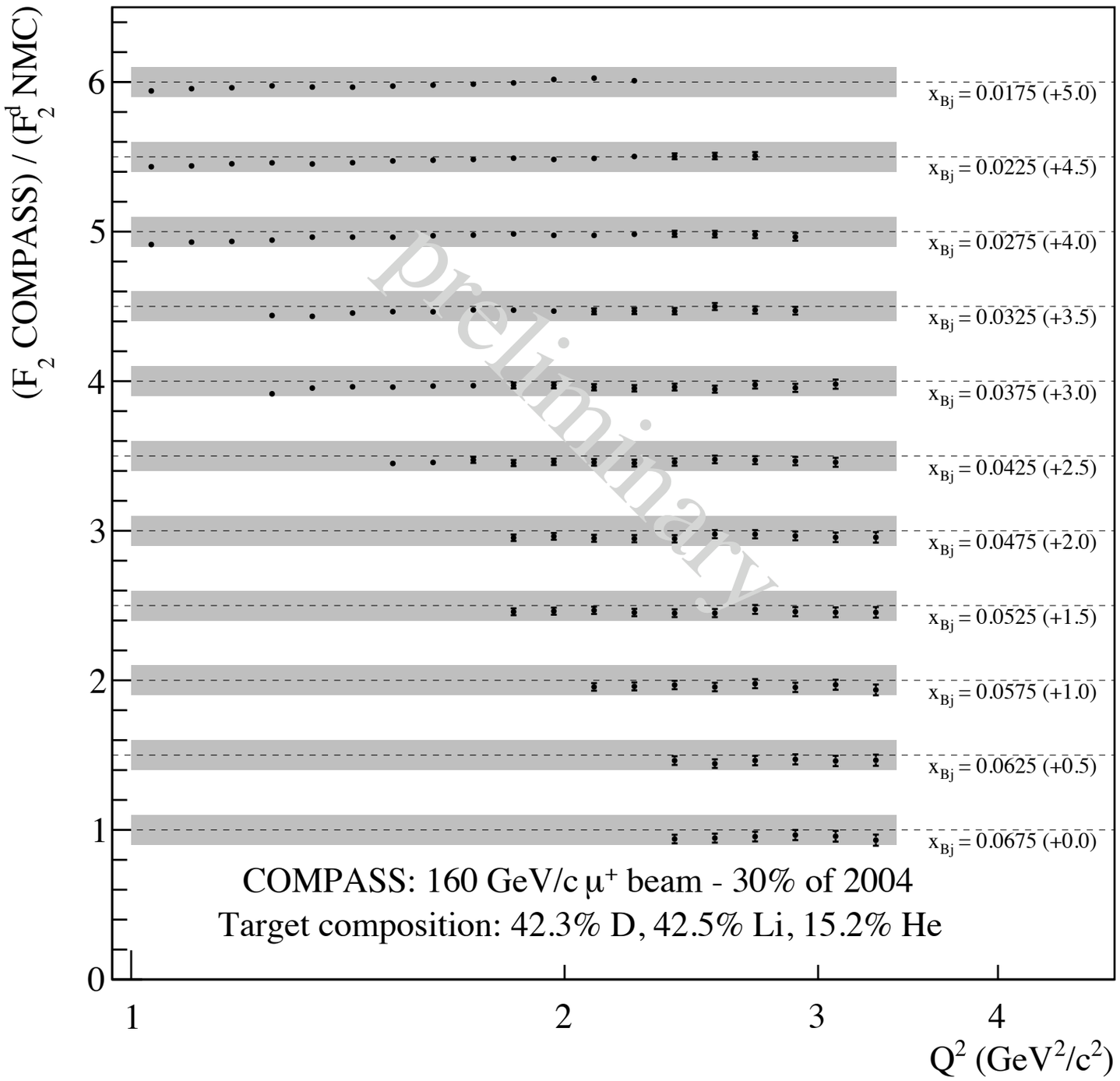
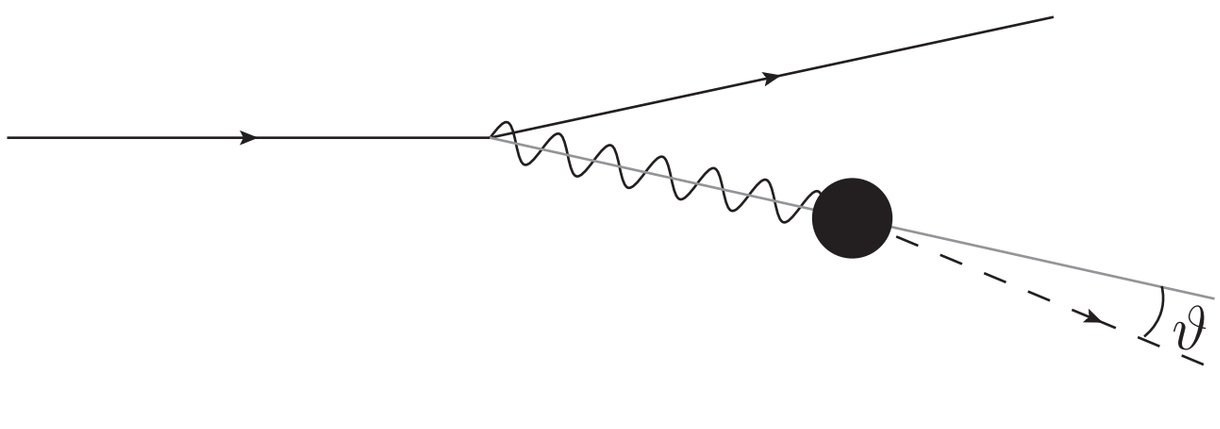
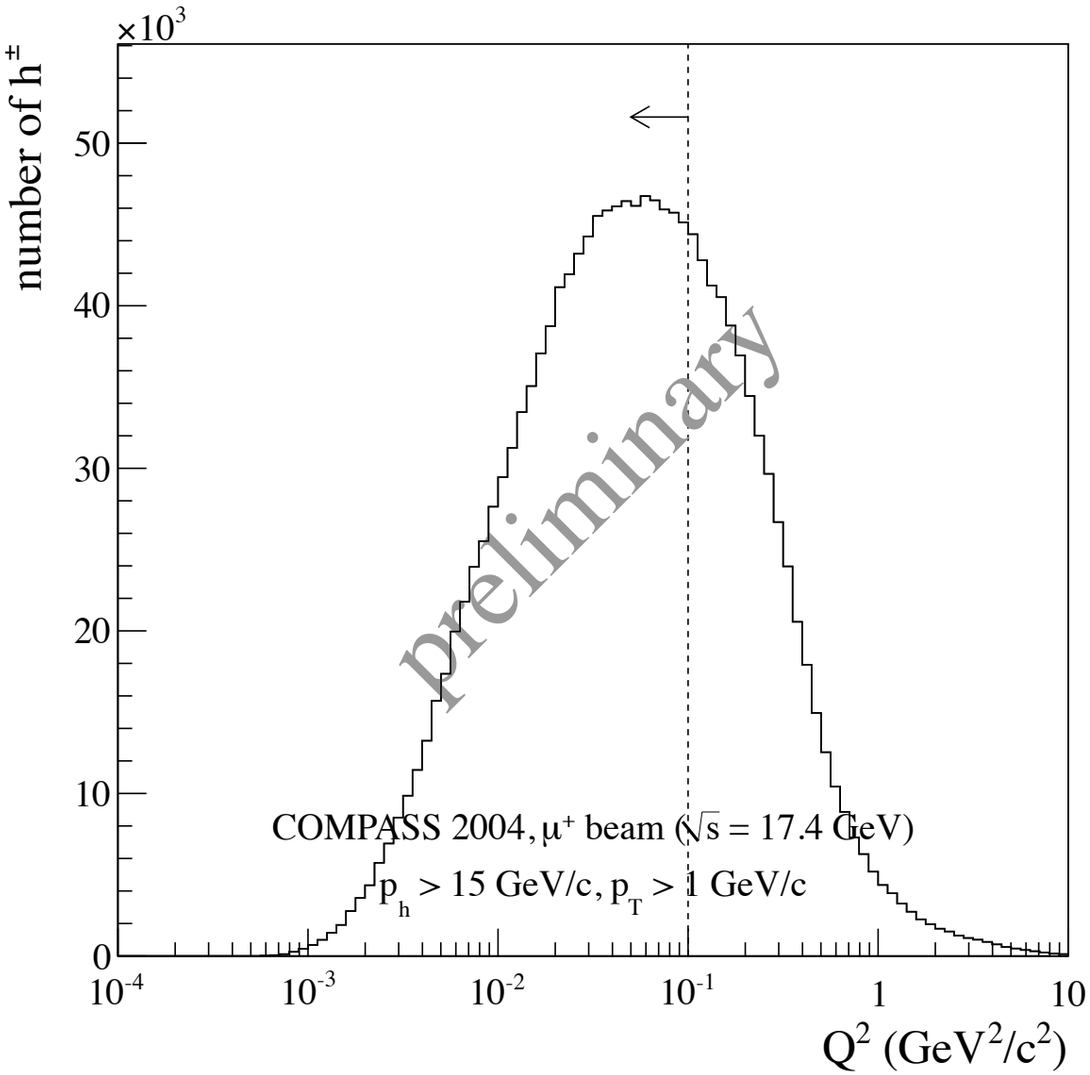


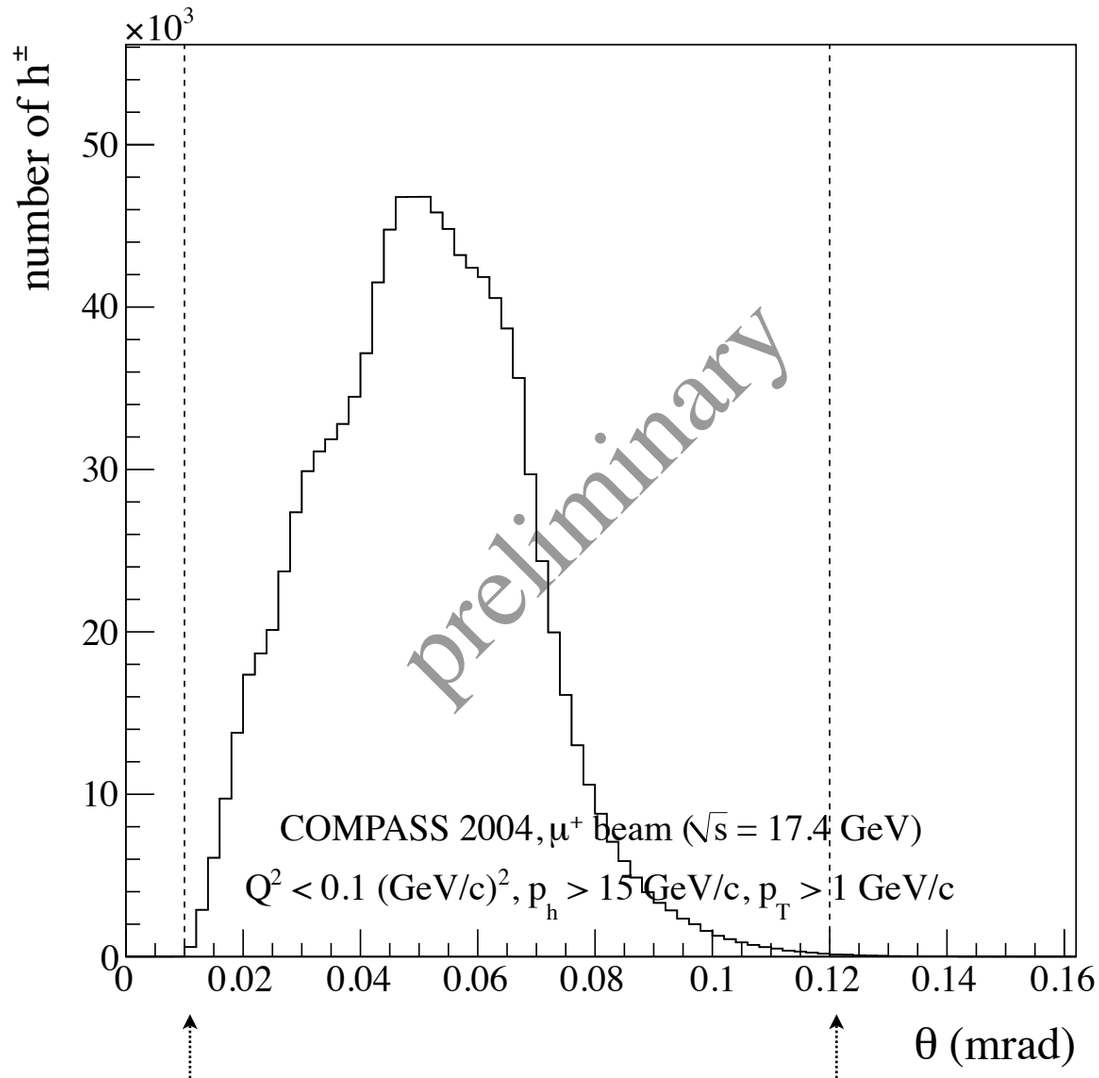
Experimental cuts for high-p_T hadron selection

- Two low-Q^2 triggers: Energy loss of muon and energy deposit in HCAL
- Primary vertex in fiducial target volume (as used for luminosity)
- $Q^2 < 0.1$ (GeV/c)^2
- $y \in [0.2,0.8]$ $\quad y = \frac{E - E'}{E} = \frac{\nu}{E}$
- Hadron candidate cuts:
  - must hit hadronic calorimeter and p > 15 GeV/c
  - $z \in [0.2,0.8]$ $\quad z = \frac{E_h}{\nu}$
  - $\vartheta \in [10$ mrad, 120 mrad$]$



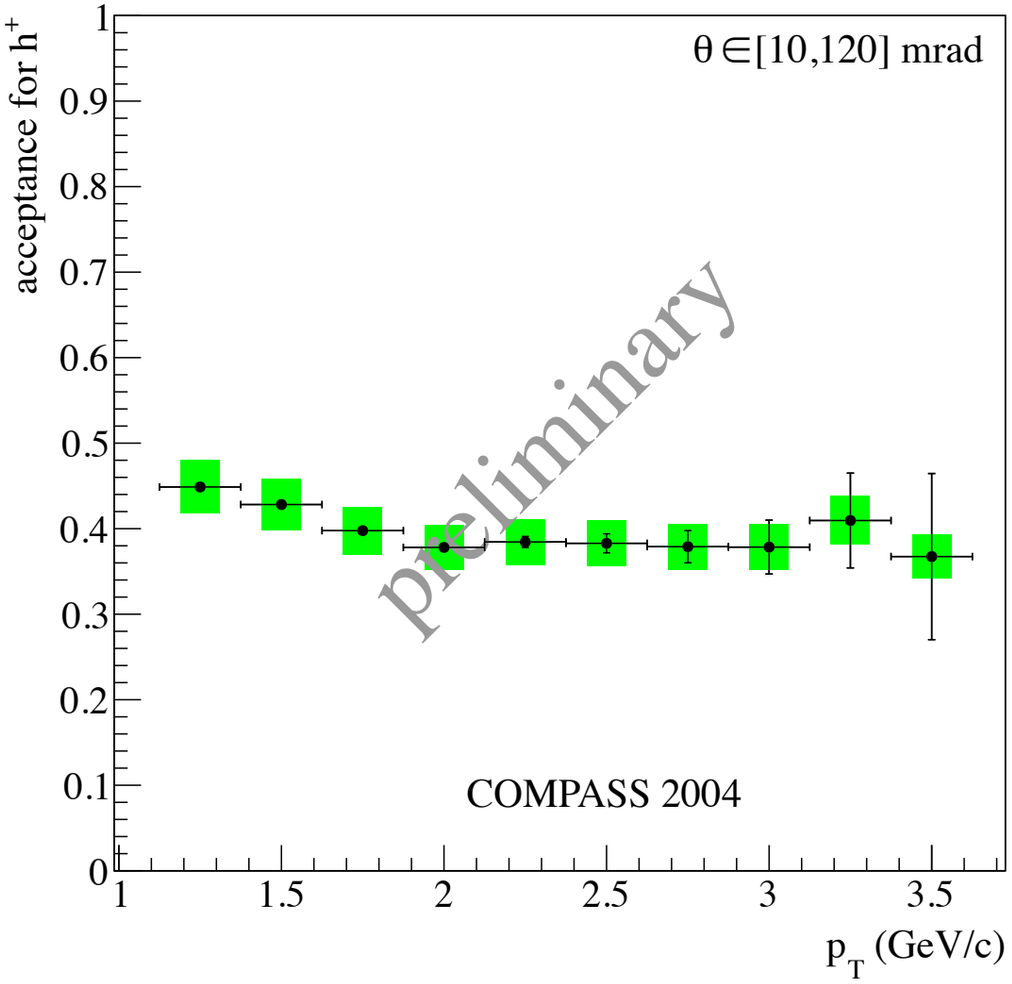
Kinematical distributions

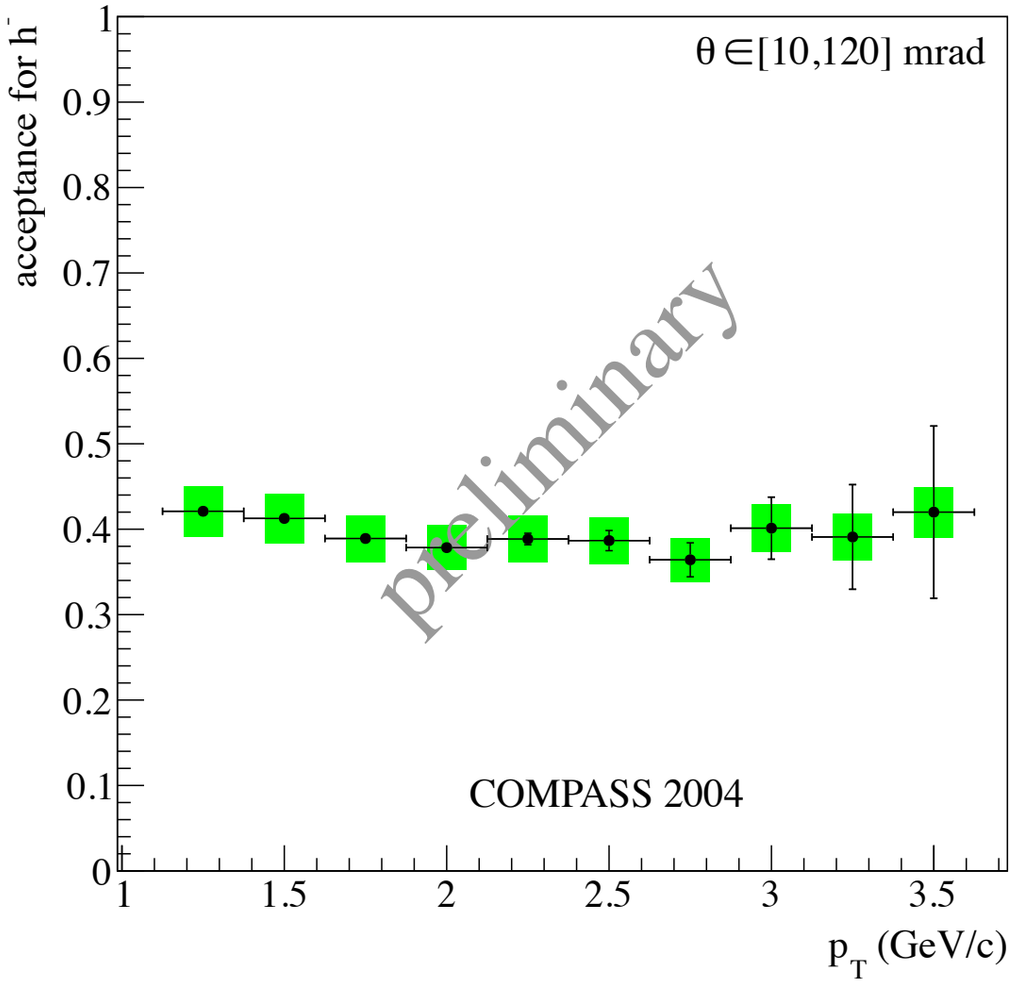




$\eta_{c.m.s.} = 2.38$ $\eta_{c.m.s.} = -0.1$

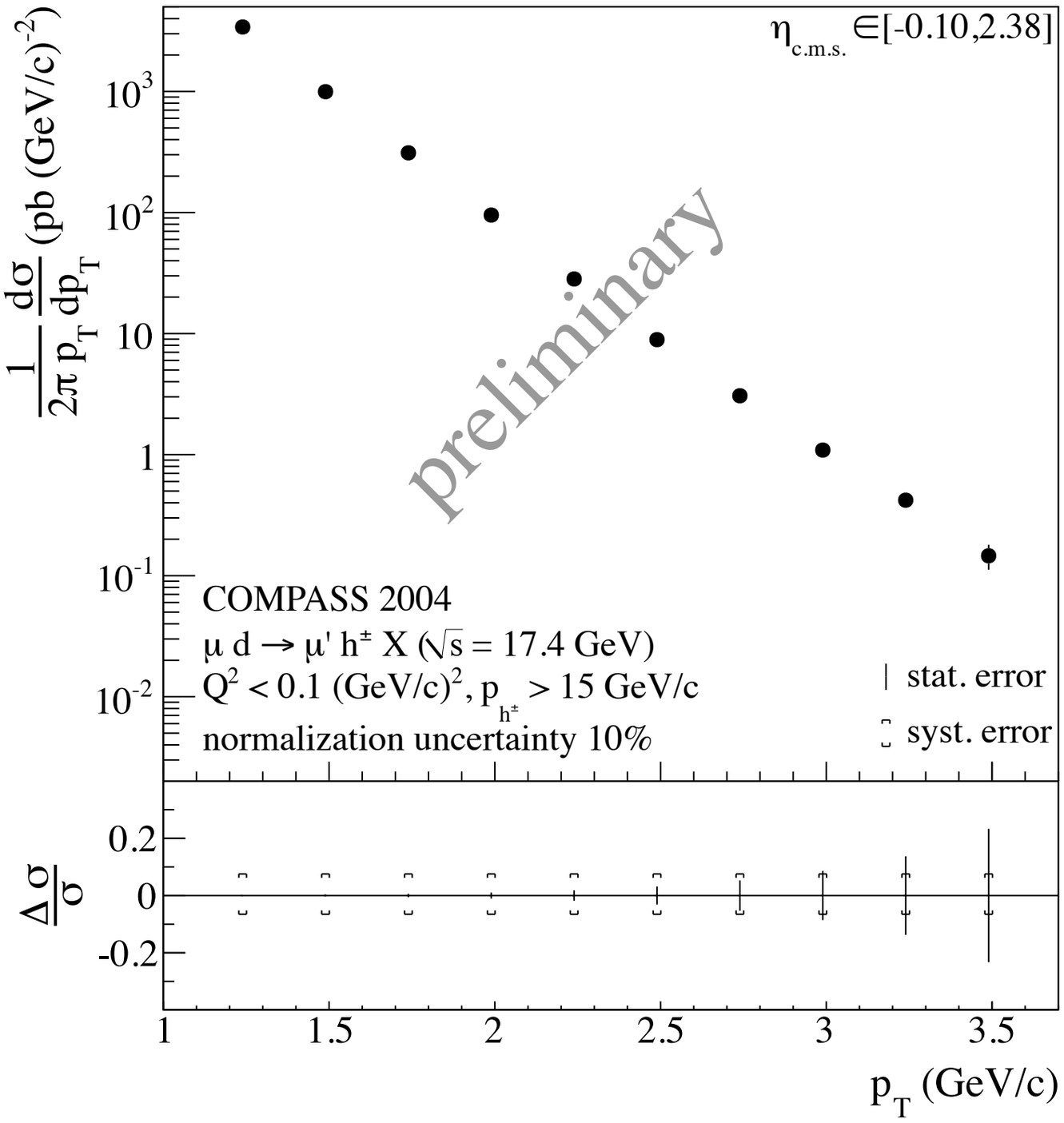
Acceptance correction



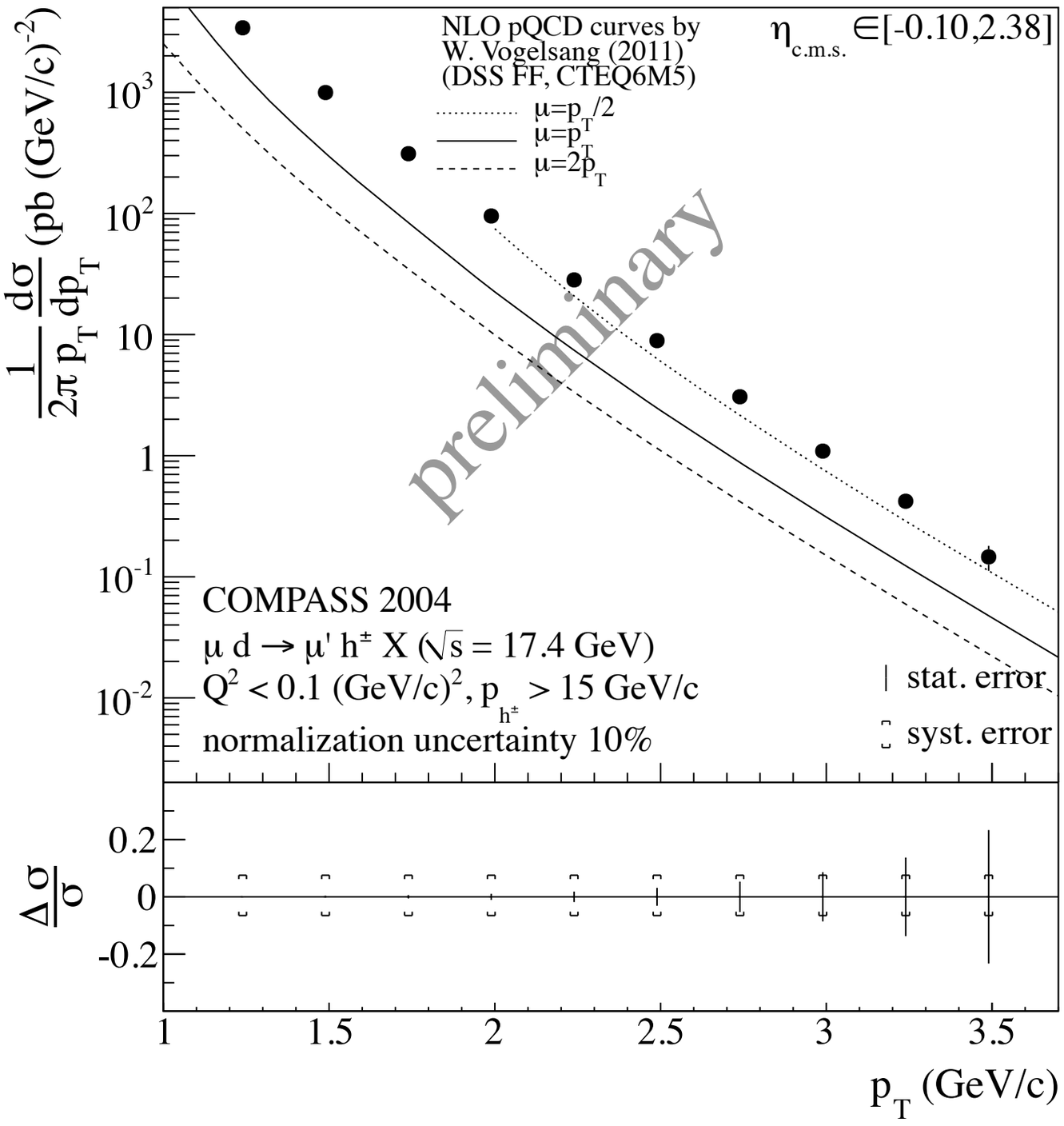


- Generated and reconstructed $2.3 \cdot 10^9$ events
- Software chain: PYTHIA6, GEANT3, COMPASS reconstruction
- Systematic error: 7%
  - Background from secondary hadrons
  - Multidimensional acceptance

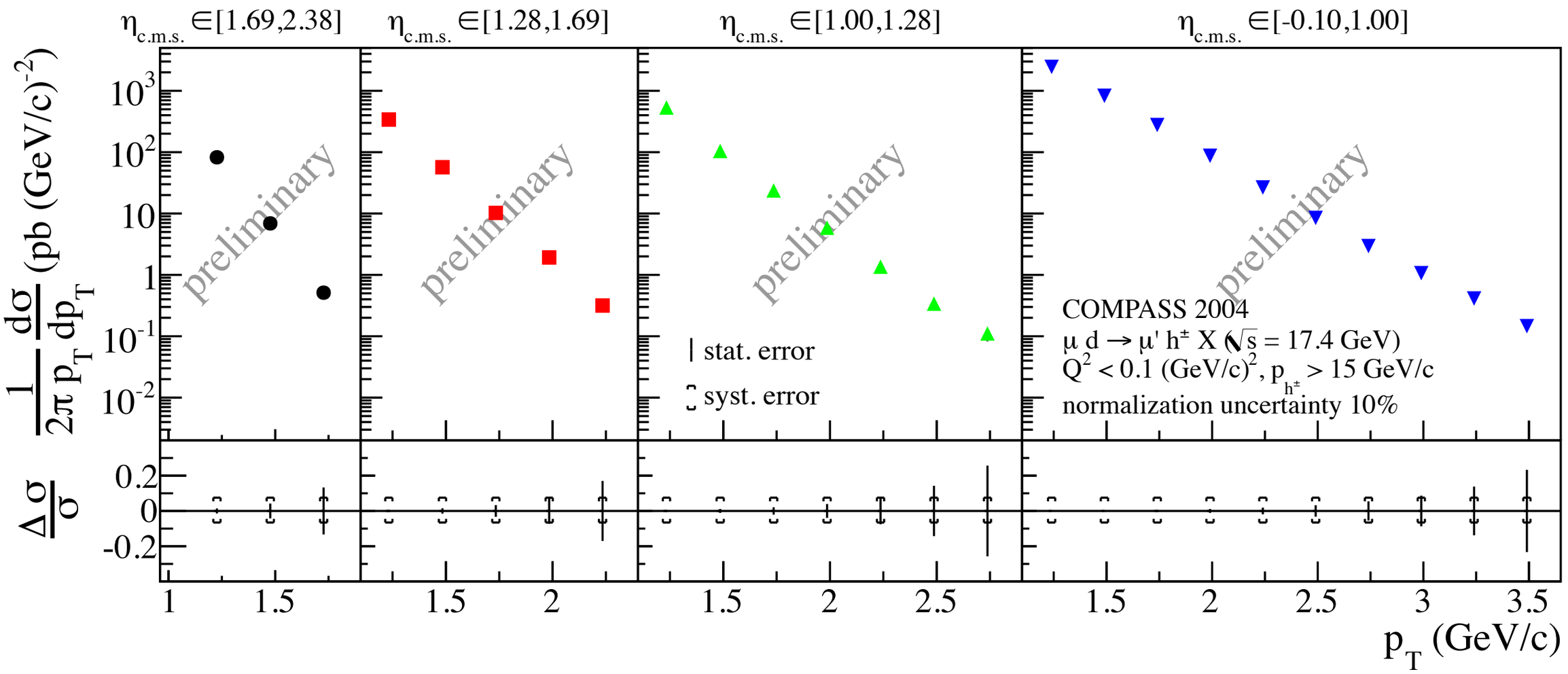
Cross section



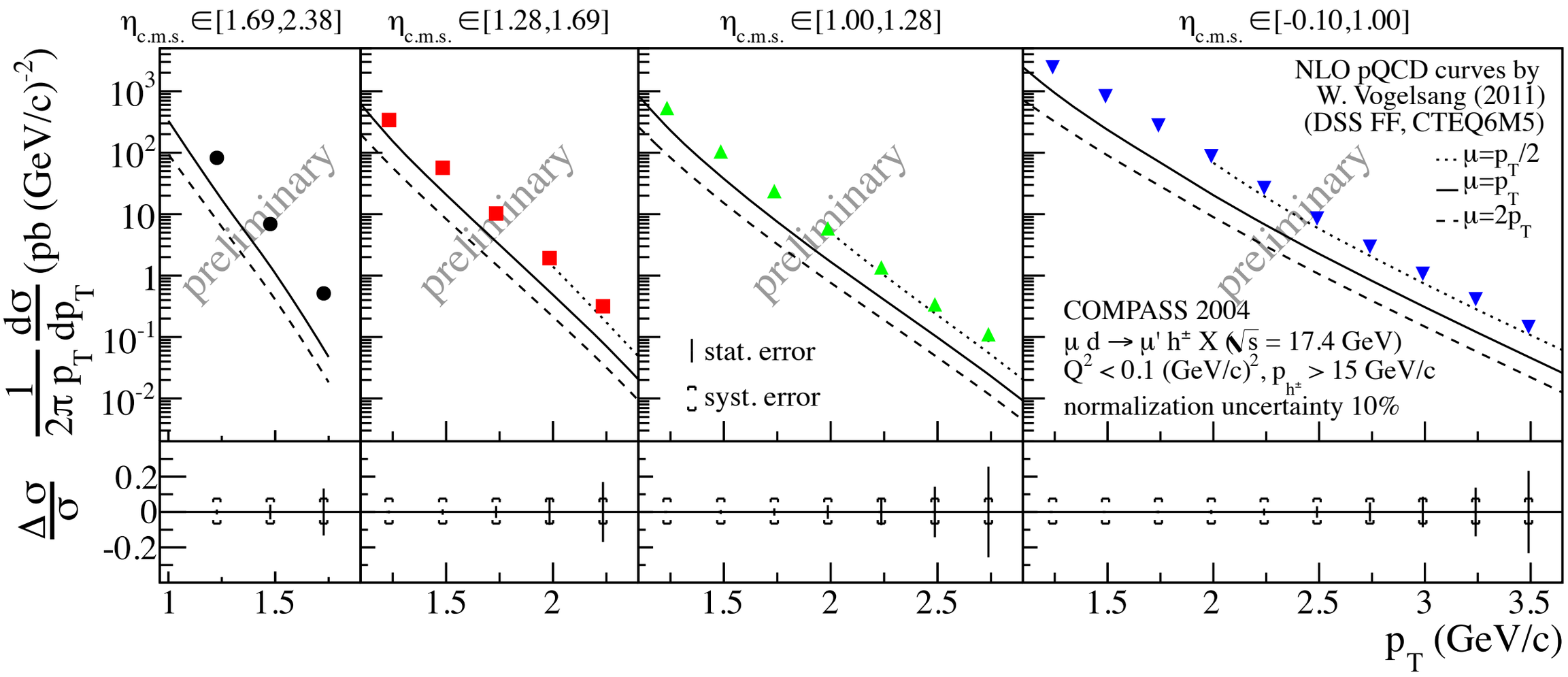
Cross section



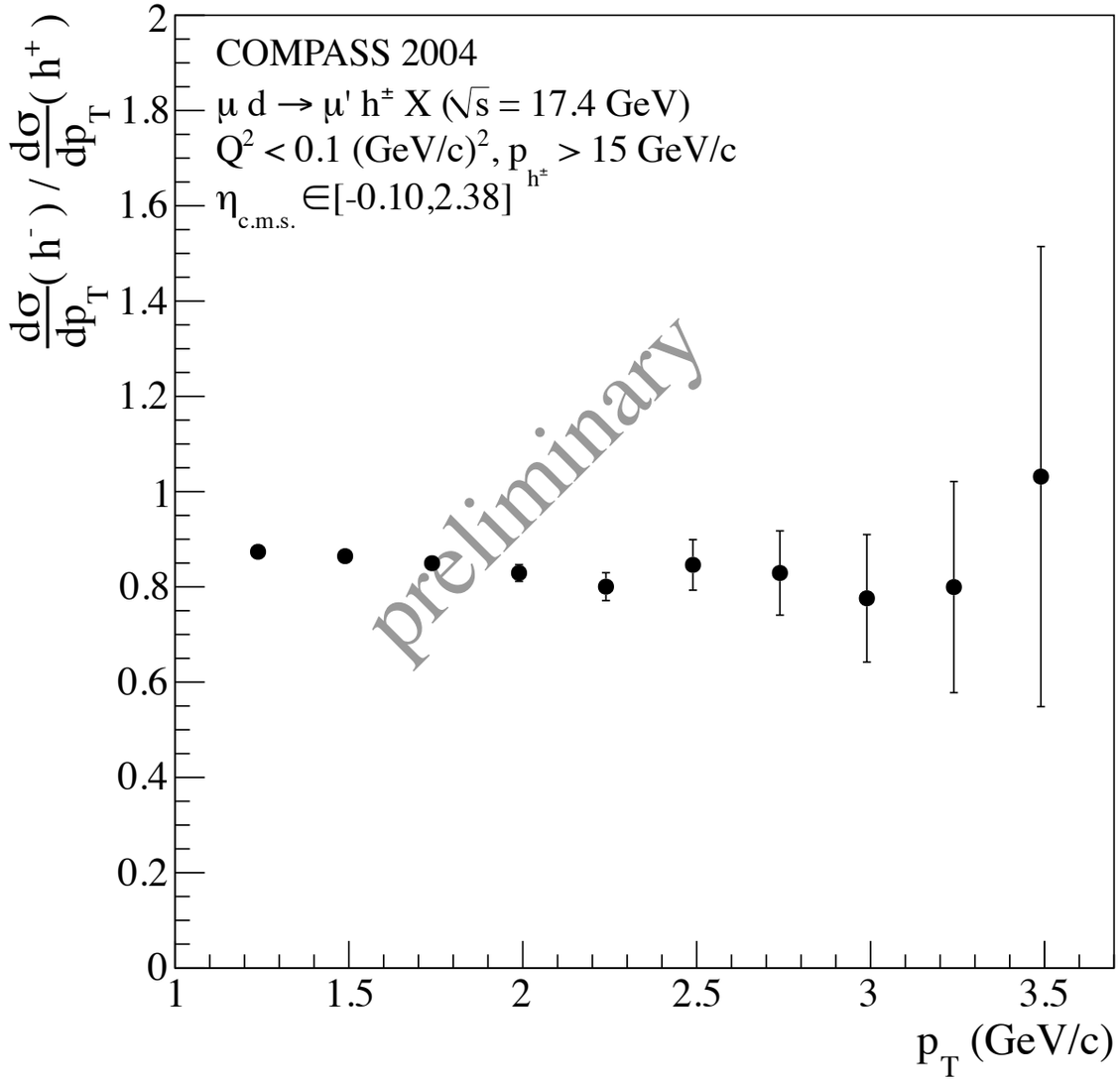
Cross section in rapidity bins

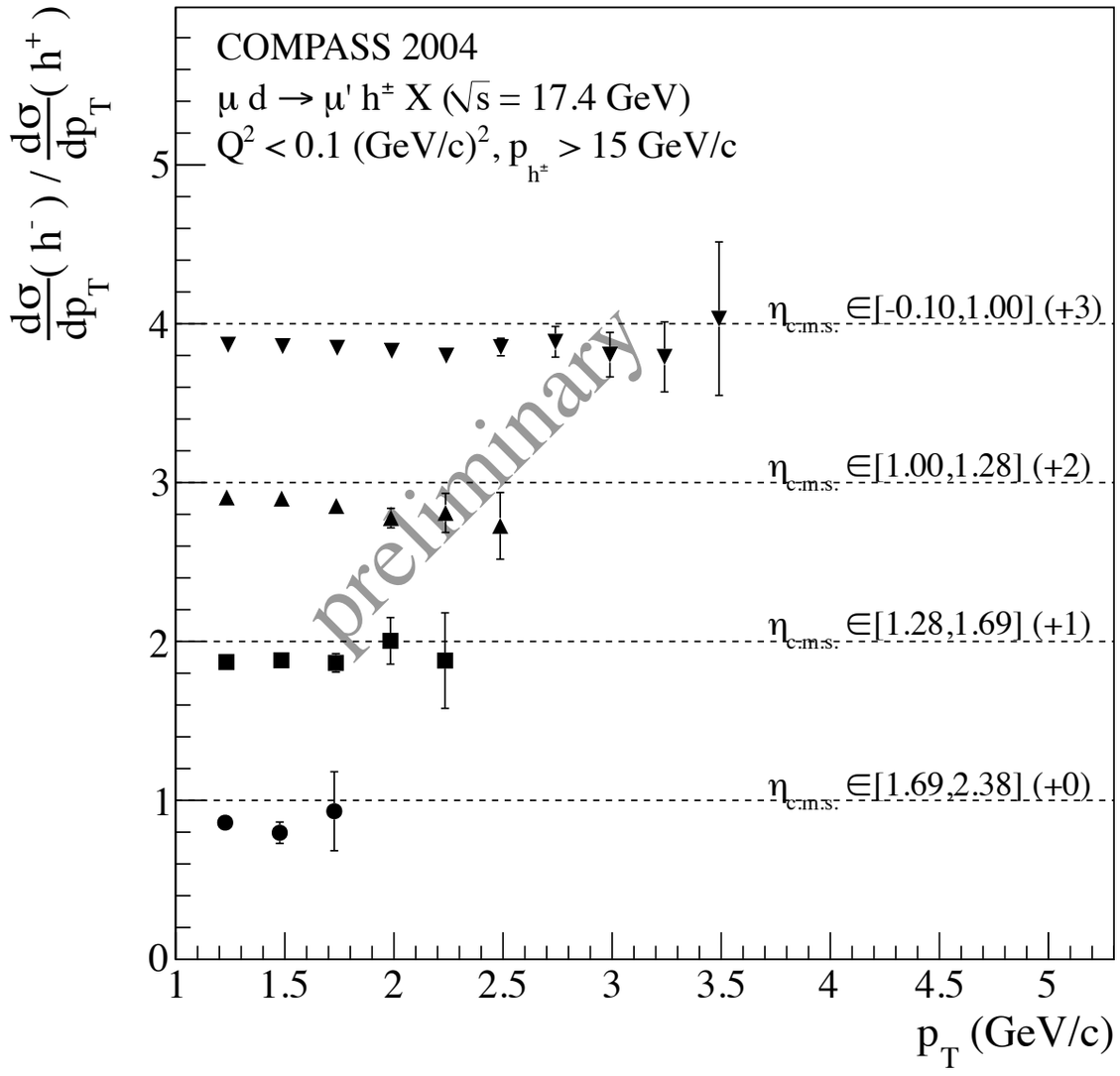


Cross section in rapidity bins



Charge ratio of cross section





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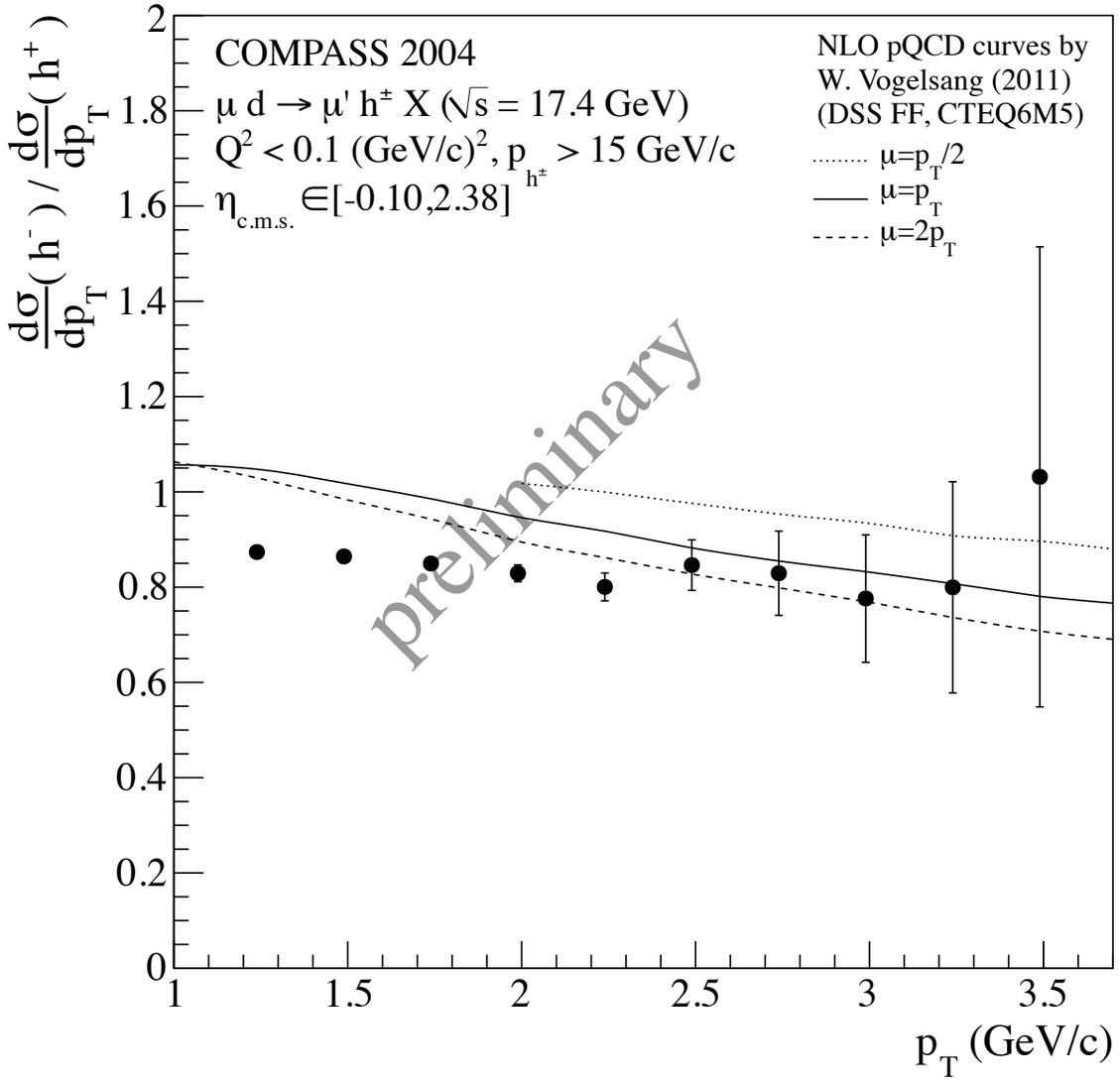
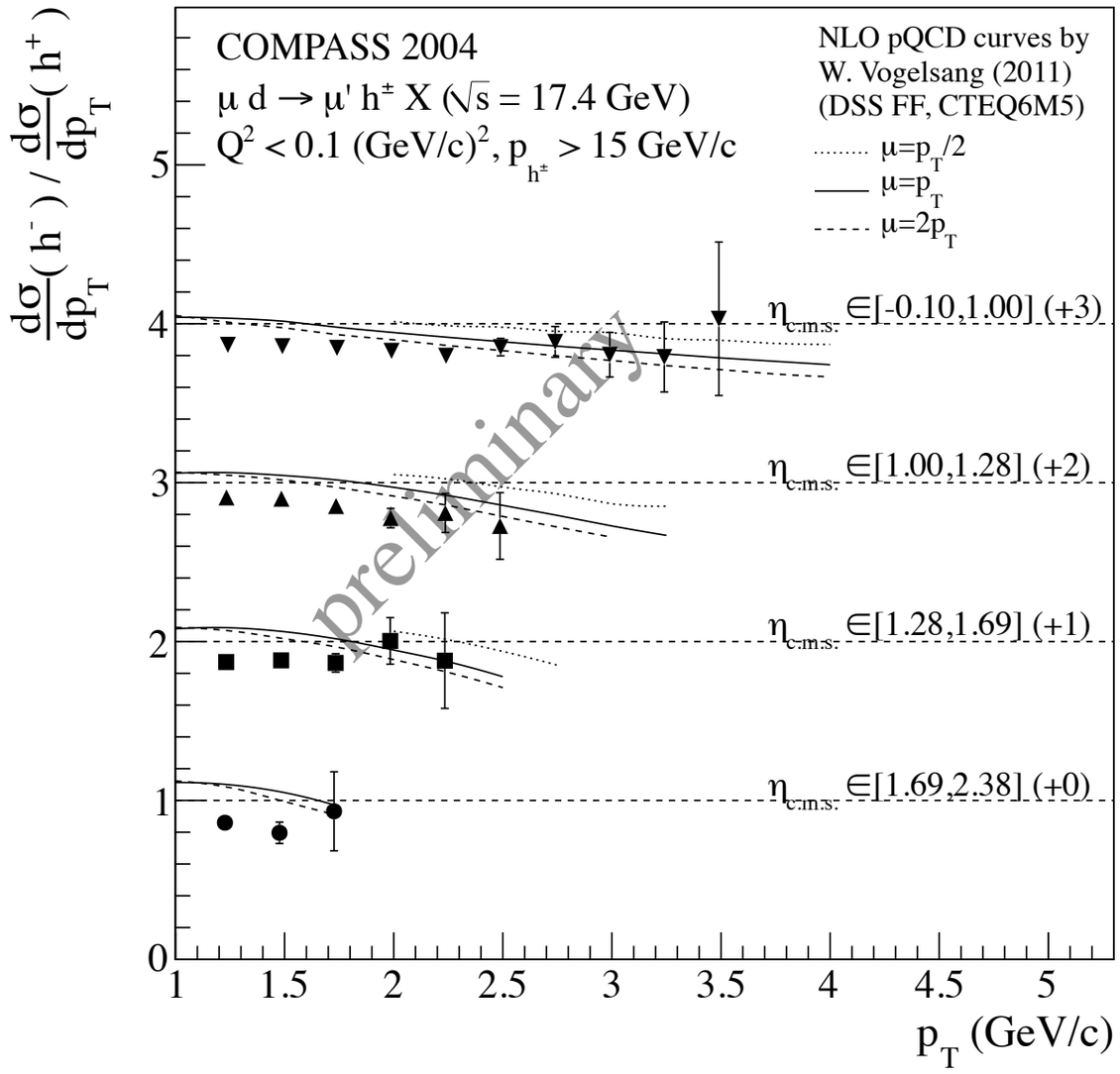




Conclusion and outlook

- Measurements of single-inclusive particle production cross sections provide an important benchmark for pQCD methods
  (especially at fixed-target energies)

- Unpolarized cross section for quasi-real photo-production
  of high-p_T charged hadrons at $\sqrt{s} = 17.4\,\mathrm{GeV}$ has been measured

- Less negative hadrons than positive hadrons, ratio almost independent of p_T

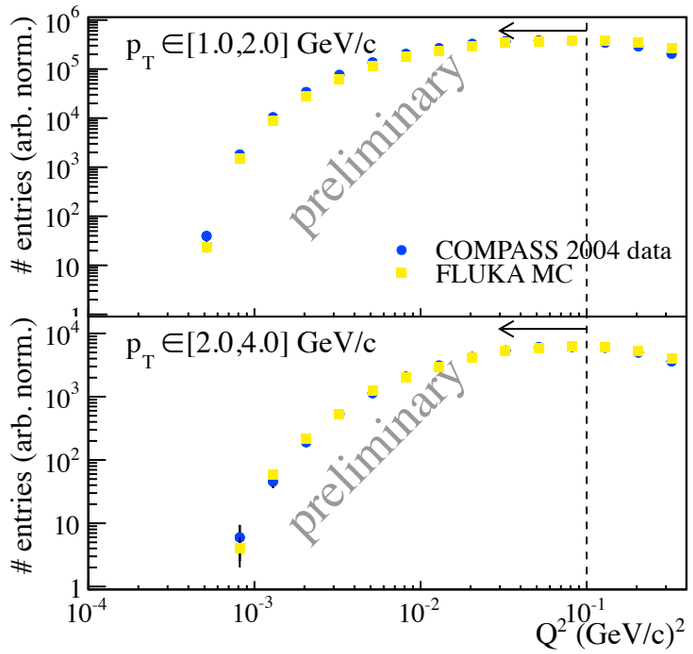
$$\sigma(\mathrm{h}^-)/\sigma(\mathrm{h}^+) < 1$$

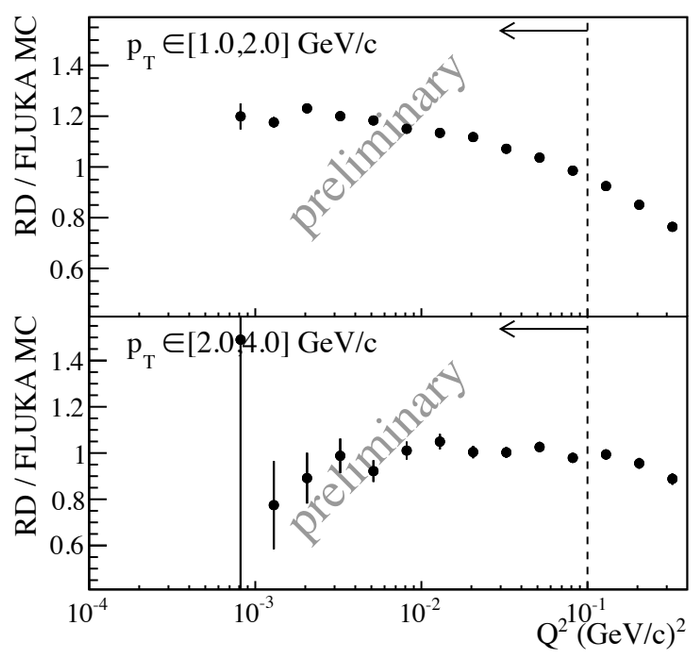
- Comparison to NLO pQCD:
  - Experimental cross section is higher than pQCD (-> resummations?)
  - p_T dependence of charge ratio from pQCD not confirmed
    (-> fragmentation function?)

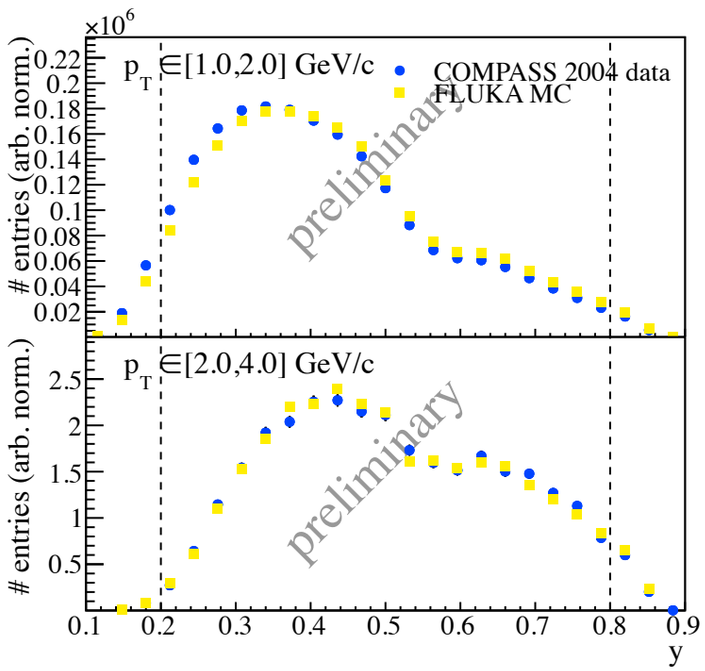
- Polarized high-p_T hadron production cross section at low Q^2 has potential to constrain gluon polarization

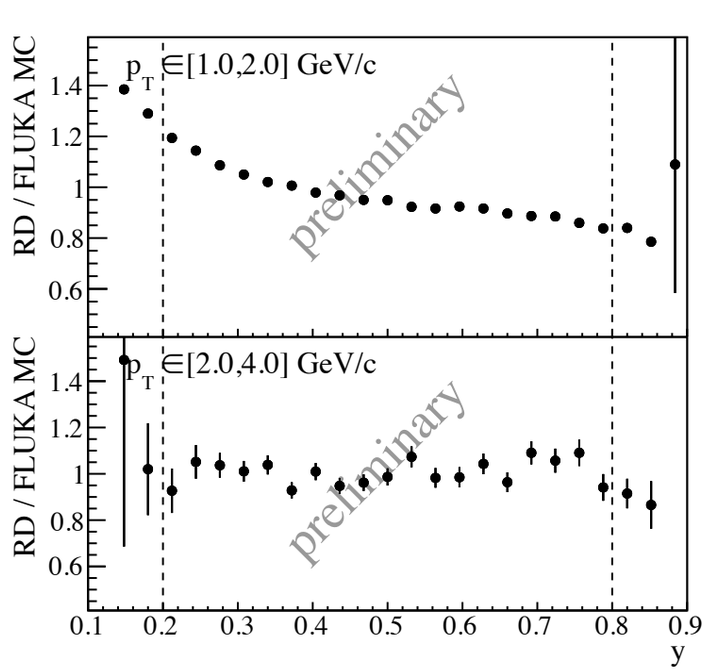
Extra Slides

Comparison of real data and MC









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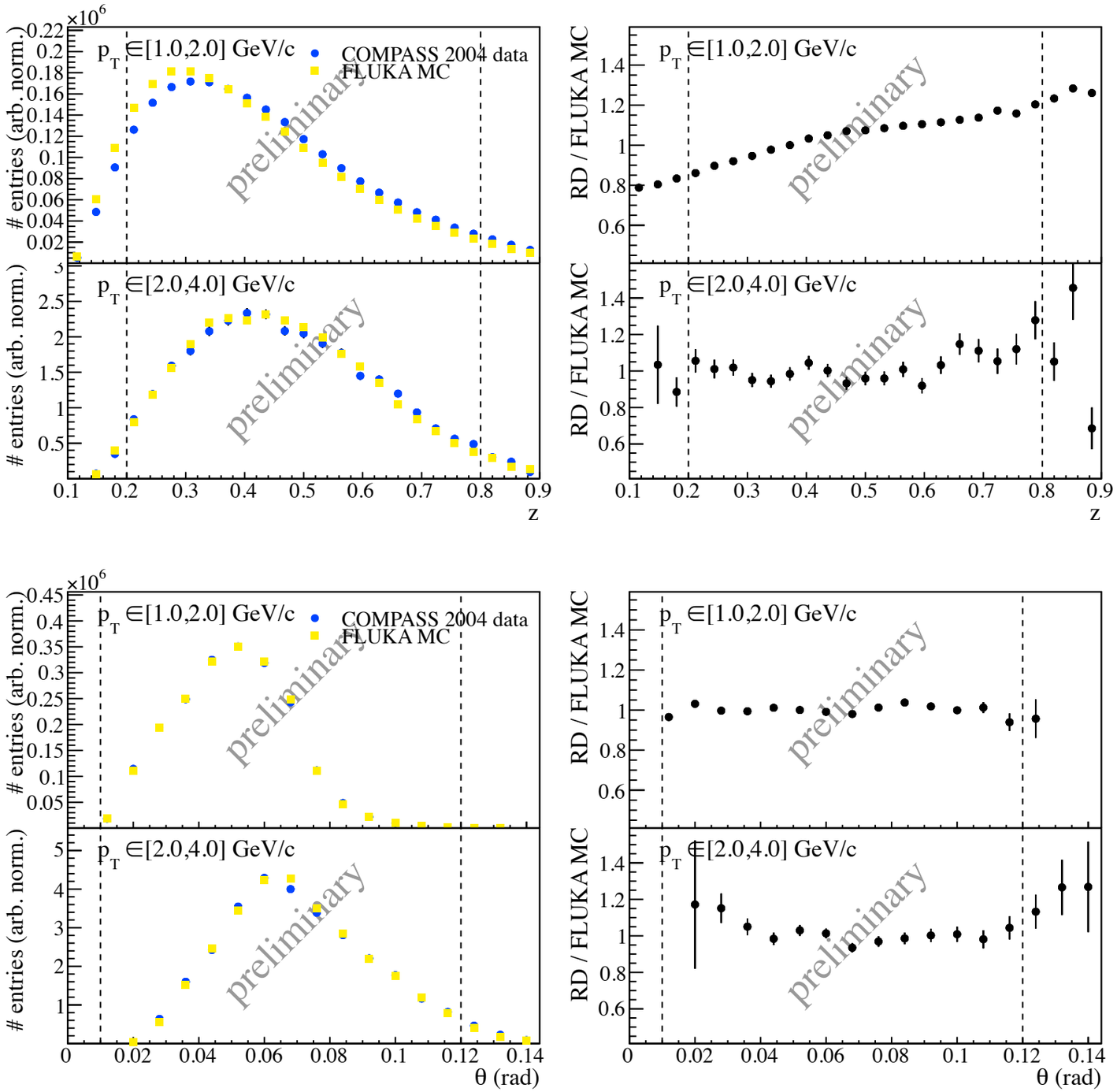
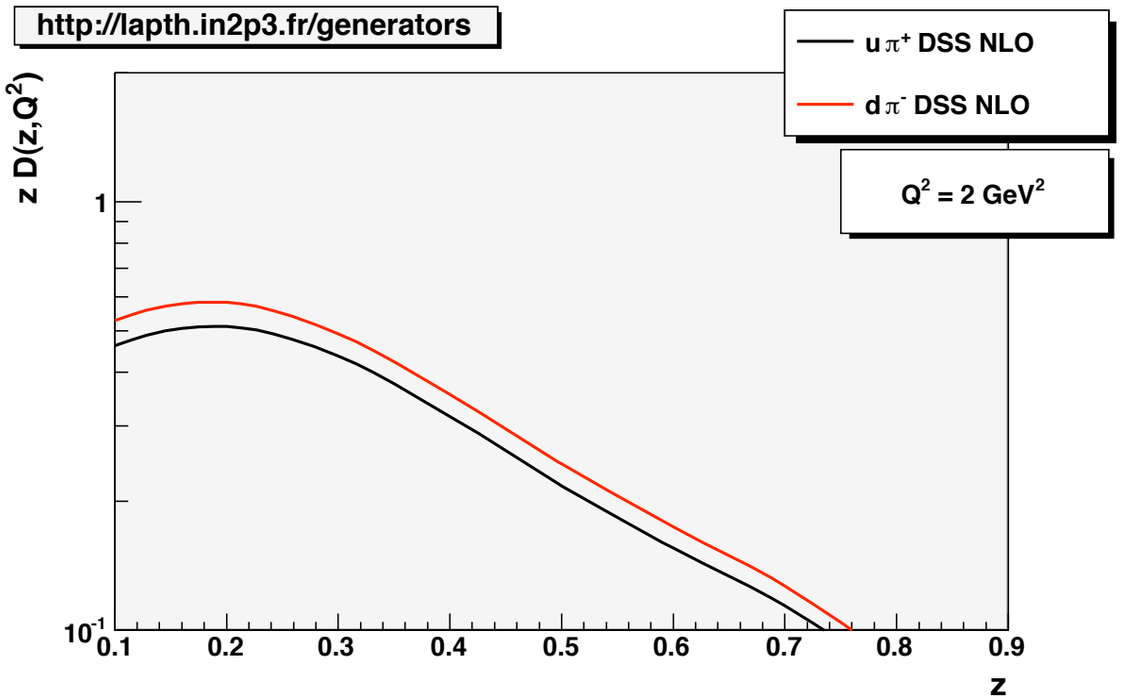
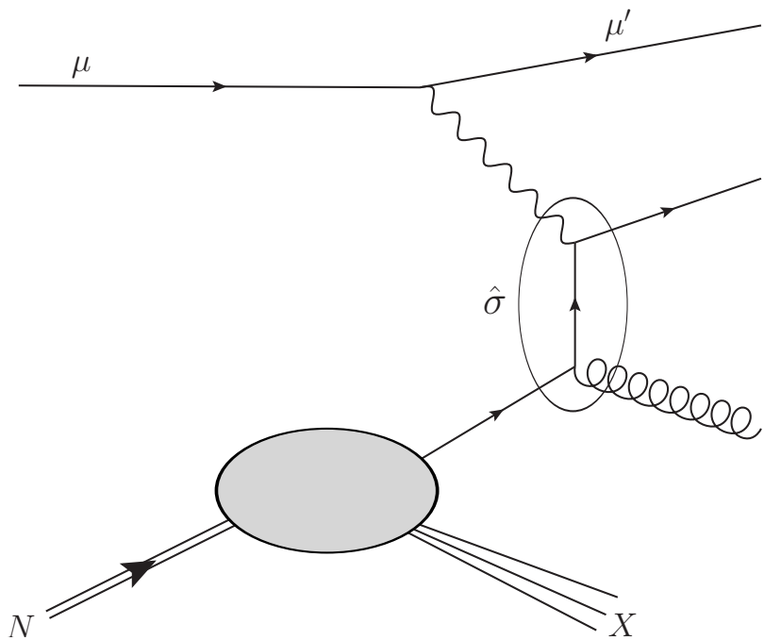
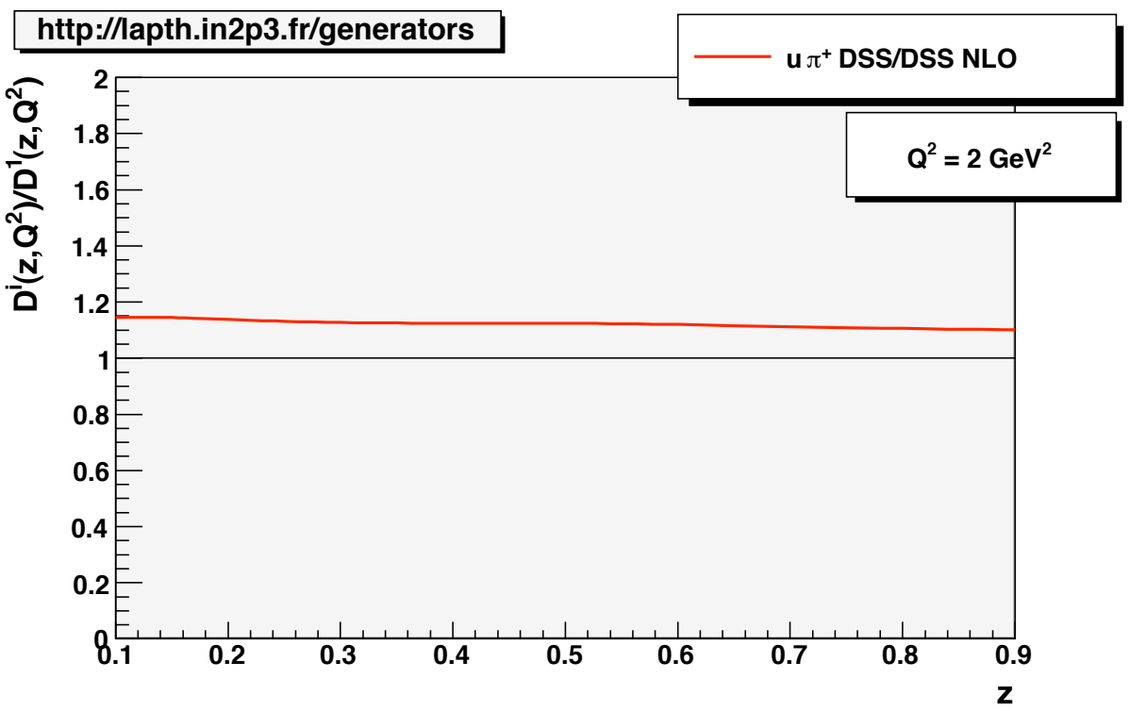
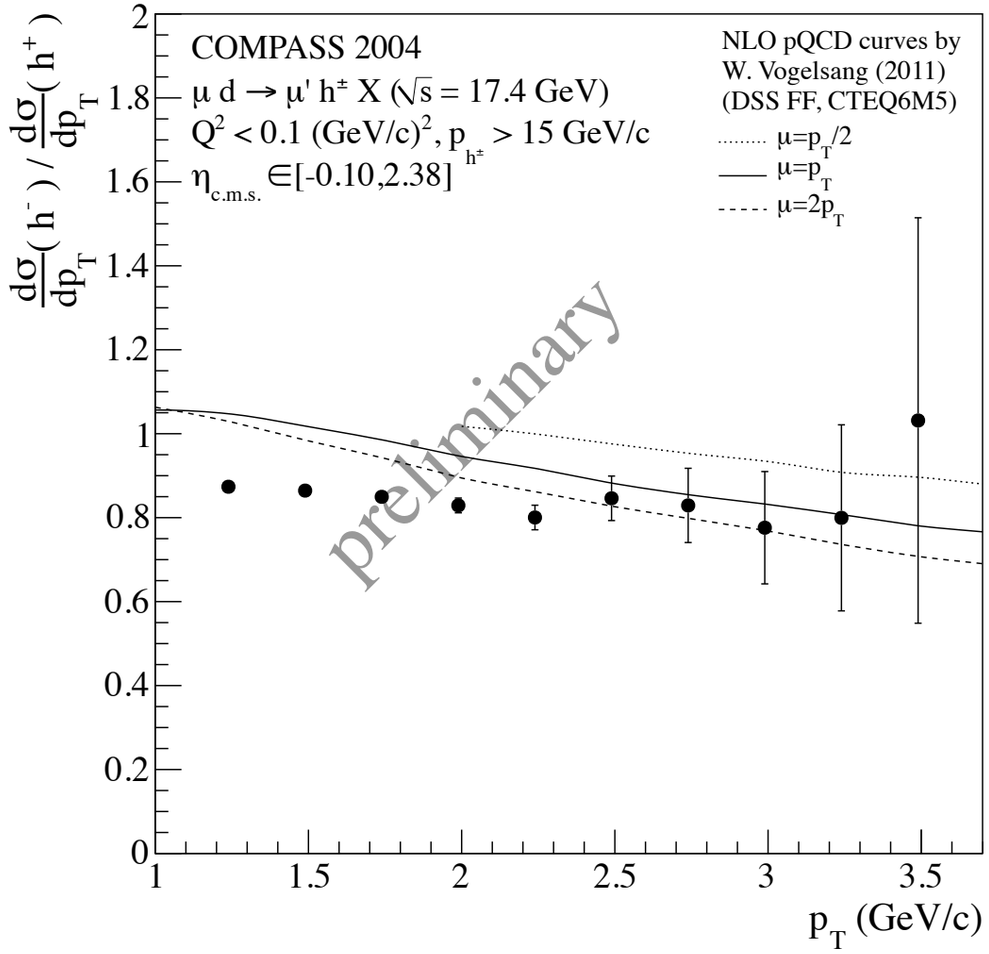


Charge ratio

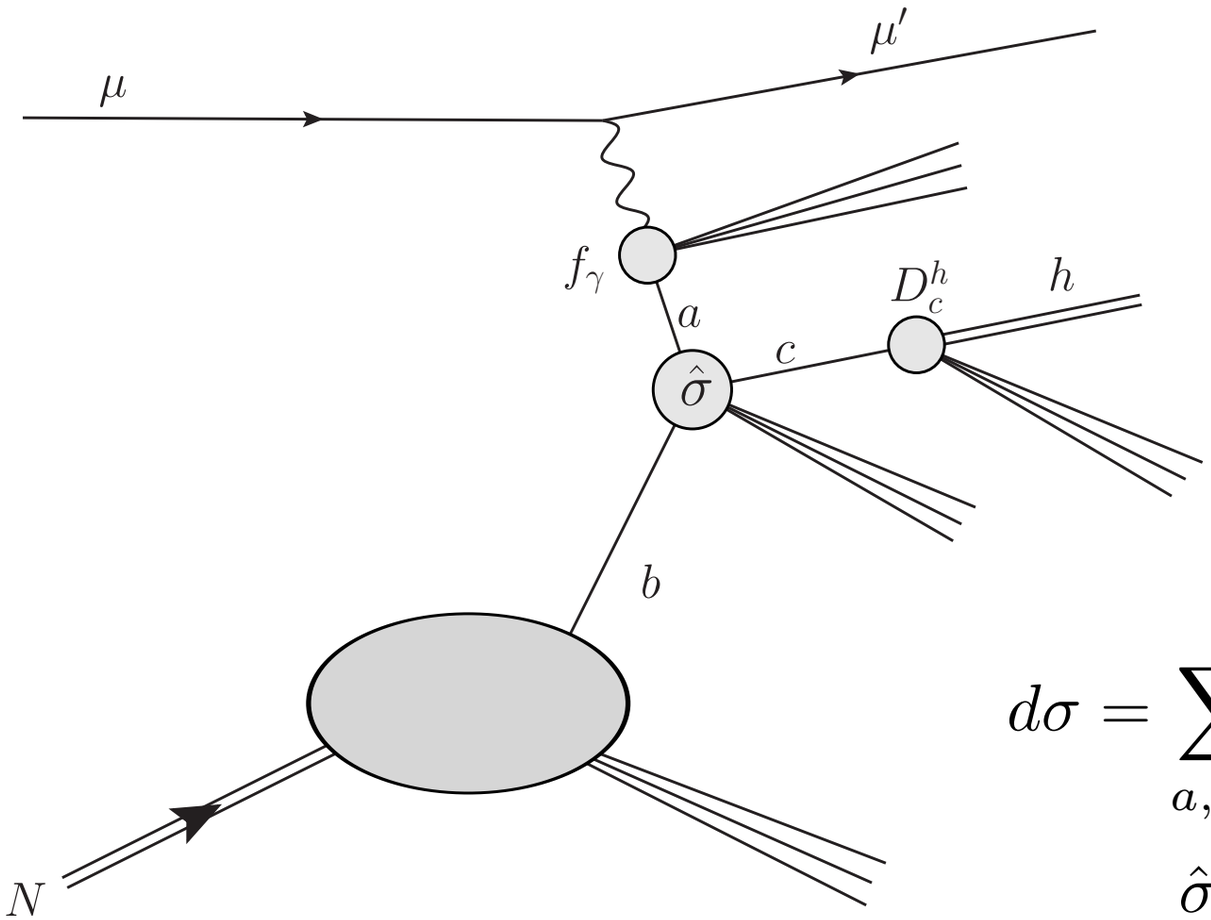








pQCD factorization of hadron production cross section



B. Jäger et al., Eur. Phys. J. C **44,** (2005) 533

$$d\sigma = \sum_{a,b,c} \int dx_a dx_b dz_c f_a^l(x_a, \mu_f) f_b^N(x_b, \mu_f) \times$$
$$\hat{\sigma}(S, x_a, x_b, P_h/z_c, \mu_r, \mu_f, \mu'_f) D_c^h(z_c, \mu'_f)$$

$$f_a(x_a, \mu_f) = \int_{x_a}^1 \frac{dy}{y} P_{\gamma l}(y) f_a^\gamma(x_\gamma = \frac{x_a}{y}, \mu_f)$$