Dubna, September 29 – October 4,2008

Extraction of Gluon Distribution Functions from ALICE Experimental Data

XIX INTERNATIONAL BALDIN SEMINAR ON HIGH ENERGY PHYSICS PROBLEMS

"RELATIVISTIC NUCLEAR PHYSICS AND QUANTUM CHROMODYNAMICS"

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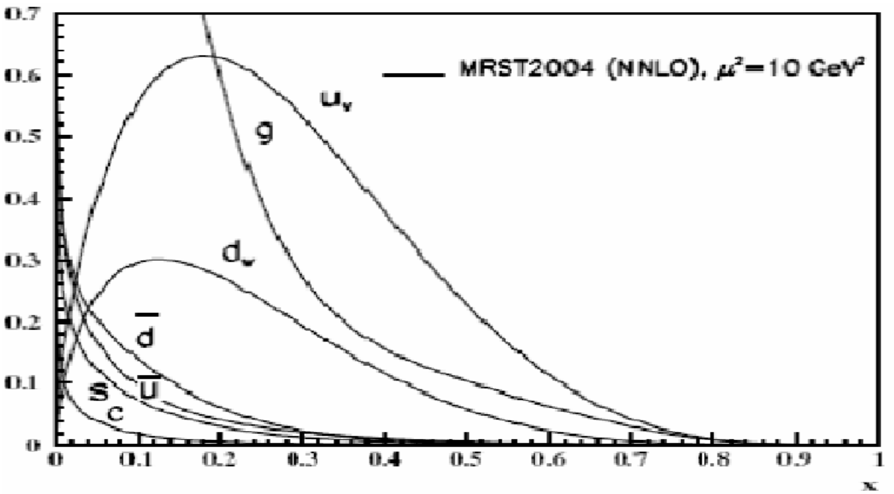
PDF definition



In the inelastic collision of a nucleon with a particle, the Bjorken x is the fraction of the nucleon momentum carried by parton that enters the hard scattering process. The distribution of x for a given parton type is called Parton Distribution Function (PDF) and it gives probability to pick up a parton with momentum fraction x from the nucleon.

LHAPDF – PDF library, containing different parameterization sets (CTEQ, GRV, MRST, Alekhin…).

Existing PDF parameterizations.

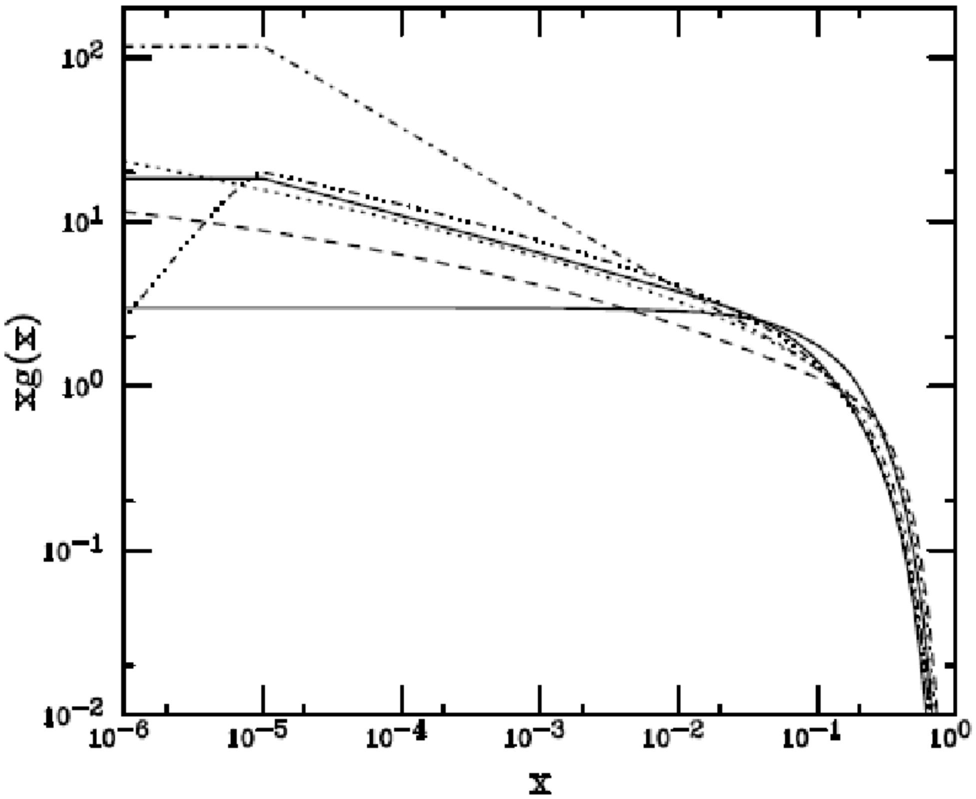


Fig. 10: Gluon distribution functions in the proton at the scale of the charmonium calculations. The lower solid curve is the scale independent $(1-x)^5$, the other solid curve employs the MRST HO distributions with $\mu = 2.4$ GeV, the dashed, GRV 98 HO with $\mu = 1.3$ GeV, the dot-dashed, MRSD-′ with $\mu = 2.4$ GeV, the dotted, GRV HO with $\mu = 1.3$ GeV and the dot-dot-dot-dashed, CTEQ 5M with $\mu = 2.4$ GeV.

ALICE capability to study low-x area

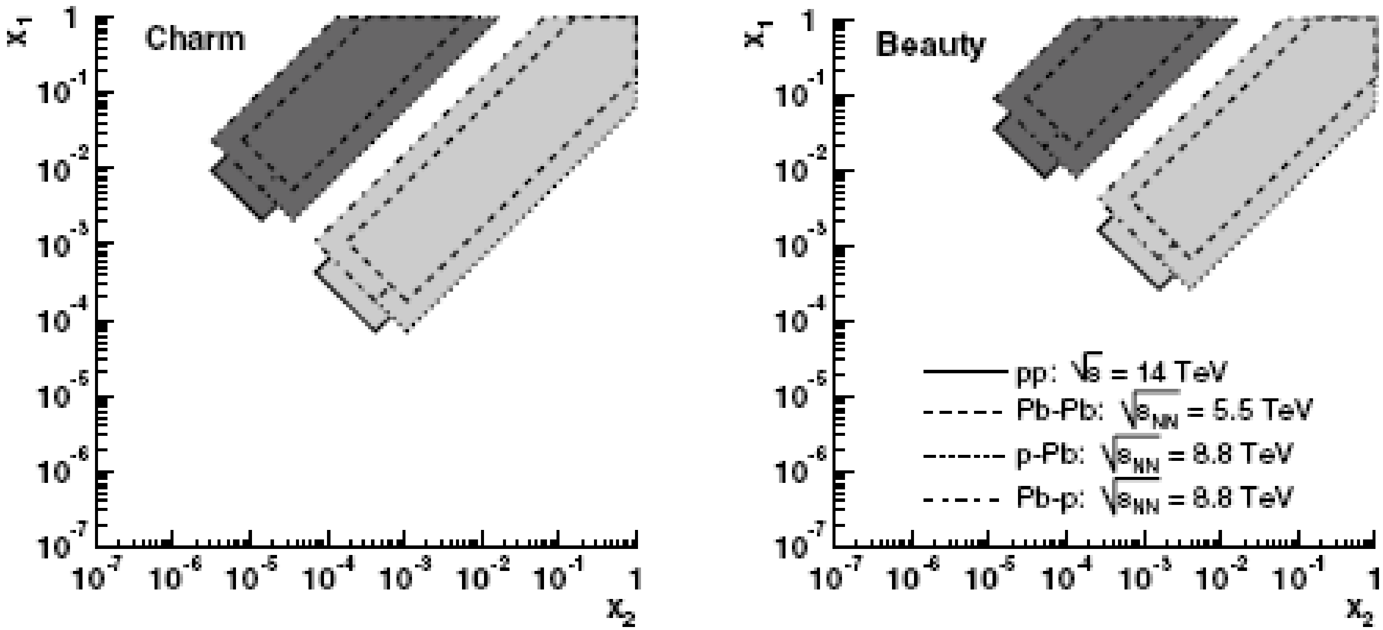


Figure 6.258. ALICE acceptance in the (x_1, x_2) plane for charm (left) and beauty (right) at 5.5, 8.8 and 14 TeV.

Color Evaporation Model

Quarkonium production cross section:

-Fraction Fc of all $Q\bar{Q}$· pairs below $H\bar{H}$ threshold; $F_c = 0.03654$

- No constraints on the color or spin of final state;

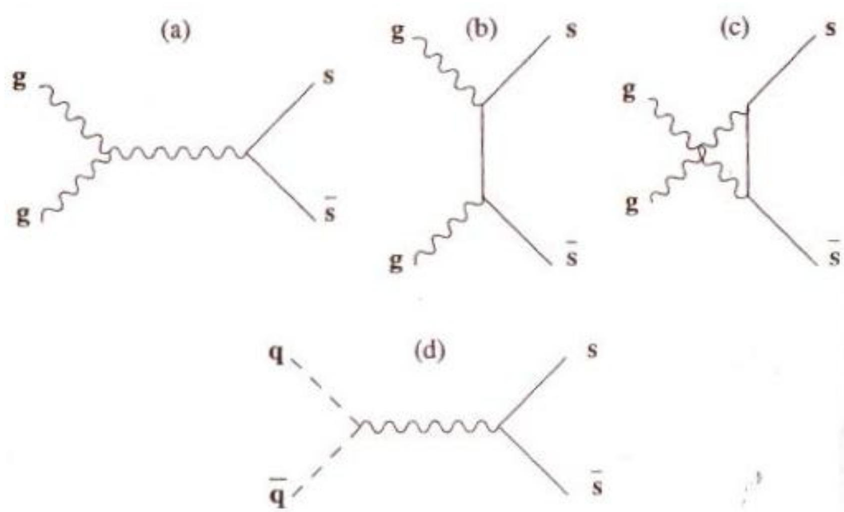
-Neutralization of color by the interaction with collision-induced color field – "color evaporation".

At leading order, the production cross section of quarkonium state C in an AB collision is:

$$\sigma_C{}^{CEM} = F_C \sum_{i,j} \int_{4m_Q^2}^{4m_H^2} d\hat{s} \int dx_1 dx_2 f_{i/A}(x_1, \mu^2) f_{j/B}(x_2, \mu^2) \hat{\sigma}_{ij}(\hat{s}) \delta(\hat{s} - x_1 x_2 s)$$

Color Evaporation Model

Subprocess cross section can be obtained through the evaluation of the lowest–order Feynmann diagrams:



$$\hat{\sigma}_{gg\to f\bar{f}}(s) = \frac{\pi\alpha_s^2}{3s}\left[\left(1+\frac{4m_f^2}{s}+\frac{m_f^4}{s^2}\right)\ln\left(\frac{1+\omega(s)}{1-\omega(s)}\right)-\left(\frac{7}{4}+\frac{31m_f^2}{4s}\right)\omega(s)\right]$$

$$\omega(s) = \sqrt{1-\frac{4m_f^2}{s}}$$

Color Evaporation Model

$$\sigma_C{}^{CEM} = F_C \sum_{i,j} \int_{4m_Q^2}^{4m_H^2} d\hat{s} \int dx_1 dx_2 f_{i/A}(x_1,\mu^2) f_{j/B}(x_2,\mu^2) \hat{\sigma}_{ij}(\hat{s}) \delta(\hat{s} - x_1 x_2 s)$$

Assumptions:

-the main term is ij=gg, we neglect other terms;

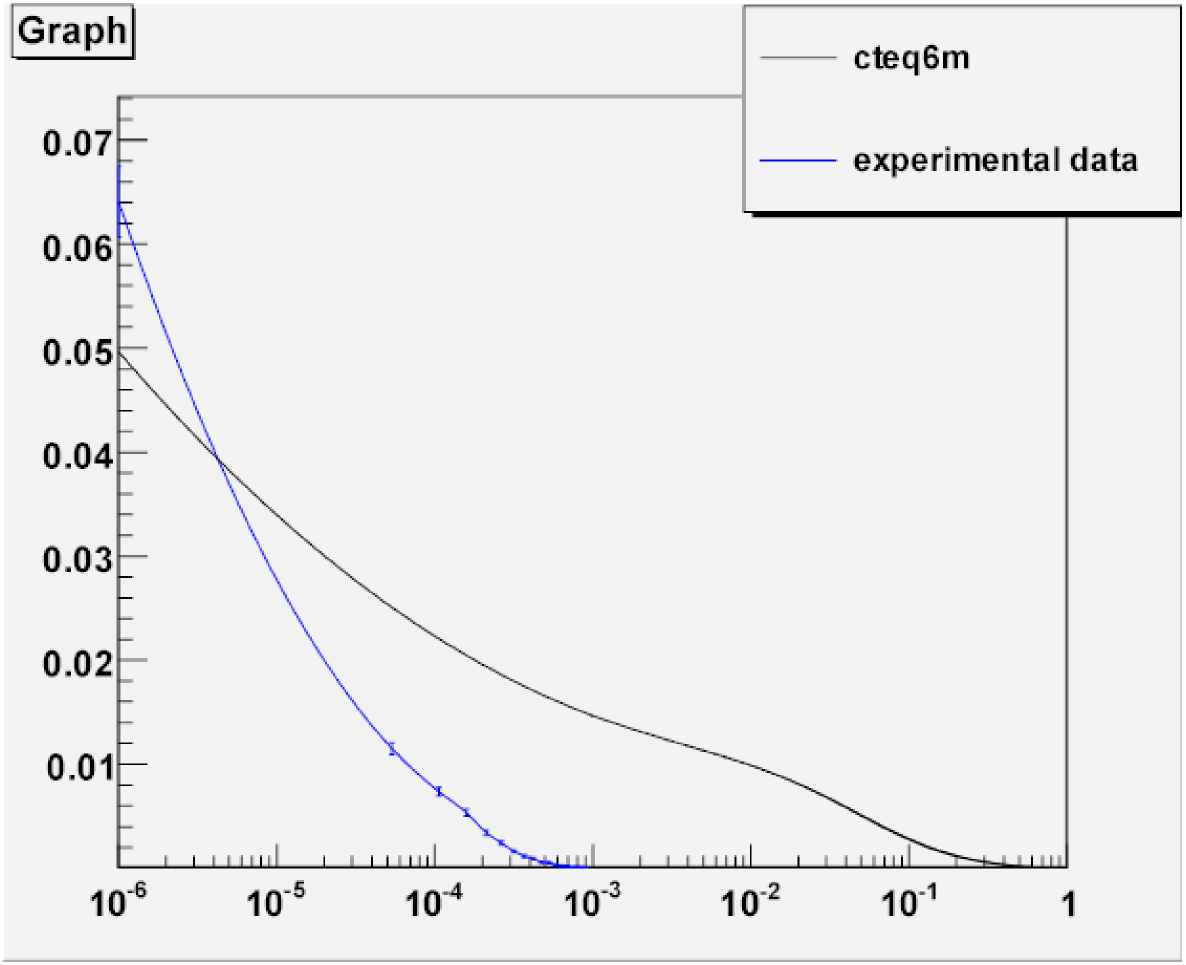
-leading order of charmonia production cross section;

-PDF are taken from parameterizations, here **CTEQ6m** is used.

$$x_1 \cdot f_{i/A}(x_1,\mu^2) = x_1 \frac{\partial \sigma_C{}^{CEM}}{\partial x_1} \frac{1}{F_C} \left(\int_{4m_Q^2}^{4m_H^2} d\hat{s} \frac{x_2 \cdot f_{j/B}(x_2,\mu^2)}{\hat{s}/s x_1} \hat{\sigma}_{ij}(\hat{s}) \right)^{-1}$$

Simulated distribution of charmonia cross section

Results



Graph
cteq6m
experimental data
0.07
0.06
0.05
0.04
0.03
0.02
0.01
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1

Conclusions

- Results are preliminary;
- Only statistical errors are taken into account;
- Systematic errors are not studied yet;
- The detector response and acceptance window could influence the experimental results;
- The behavior of curves is right.

Literature:

- arXiv:hep-ph/0311048 v1
- “Hadrons and Quark-Gluon Plasma” J.Letessier, J.Rafelski, Cambridge University press, 1998.