MPI

Multiple Partonic Interactions

I – New experimental aspects

C. Sen

II – More theoretical predictions

A. Szczurek, M. Luszczak,R. Maciula,: 4-jets,double charm pairs …

III – Multiparton correlations

A. Stasto : double gluon distribution

IV – DPS and gluon saturation

V. Gonçalves, F. Navarra

V – More theory

L. Szymanowski

7th International Workshop on
Multiple Partonic Interactions
at the LHC
23 - 27 November 2015
Miramare, Trieste, Italy

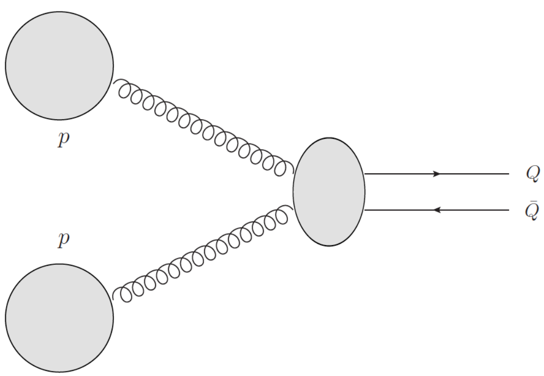
Double parton scattering (DPS) in pp collisions

Two partons from the target scatter with two partons from the projectile

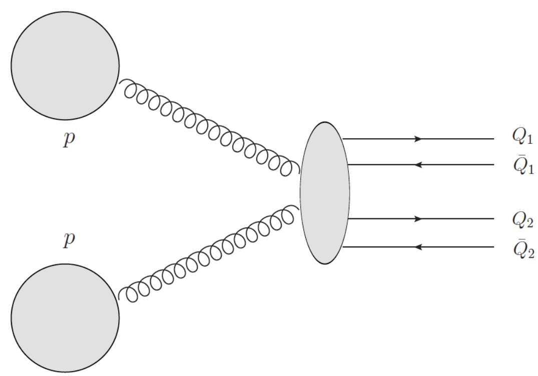
Landshoff, Polkinghorne, PRD (1978) → M. Diehl, arXiv:1306.6059

Single parton scattering (SPS)

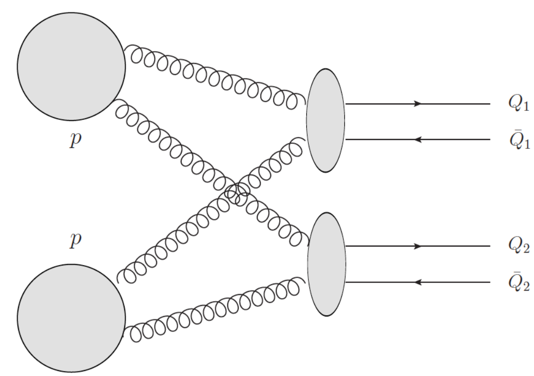
Double parton scattering (DPS)



$$\propto \alpha_s^2 G^2(x, \mu^2)$$



$$\propto \alpha_s^4 G^2(x, \mu^2)$$

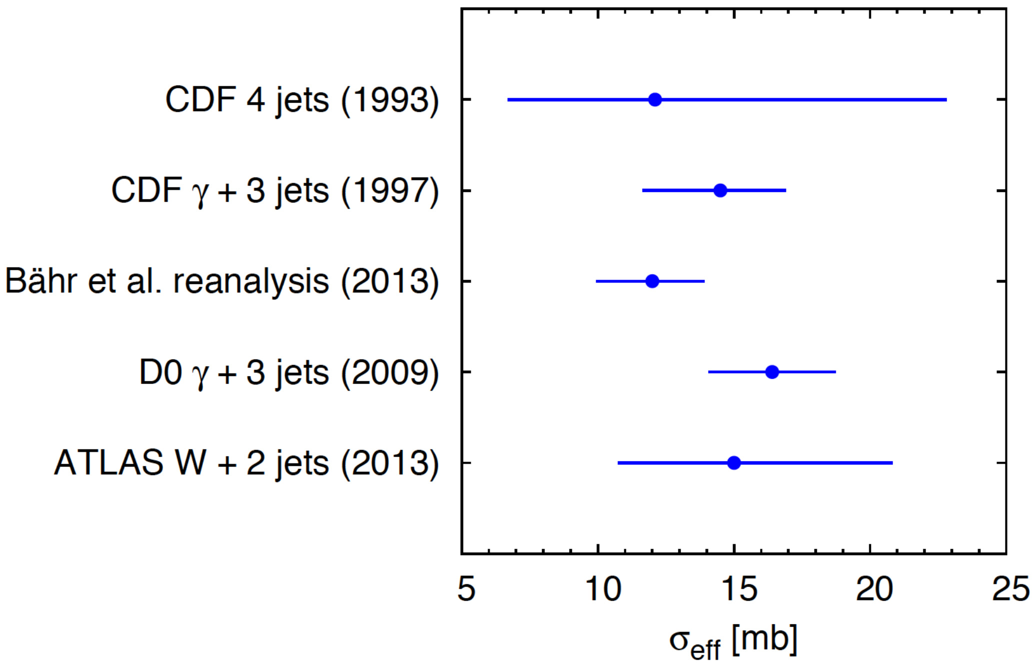


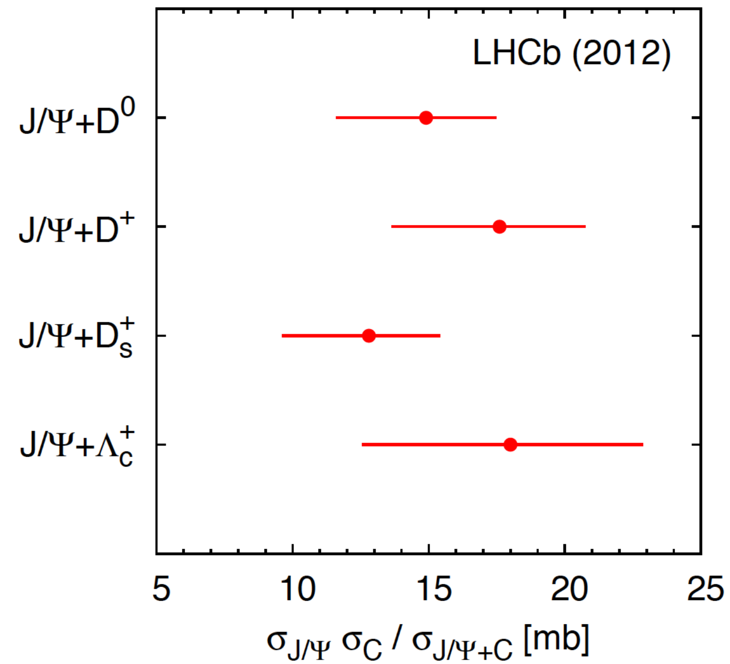
$$\propto \alpha_s^4 G^4(x, \mu^2)$$

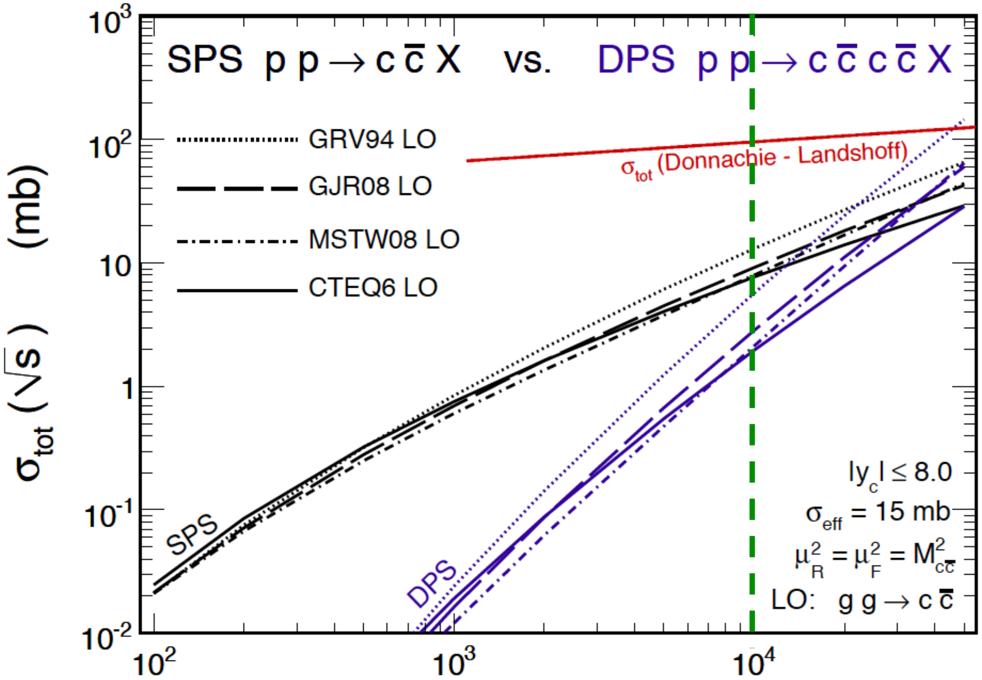
Double charm production in pp collisions

- uncorrelated partons
- independent scatterings

$$\sigma^{DPS}_{h_1 h_2 \to Q_1 \bar{Q}_1 Q_2 \bar{Q}_2} = \frac{\sigma^{SPS}_{h_1 h_2 \to Q_1 \bar{Q}_1} \sigma^{SPS}_{h_1 h_2 \to Q_2 \bar{Q}_2}}{\sigma_{eff}}$$



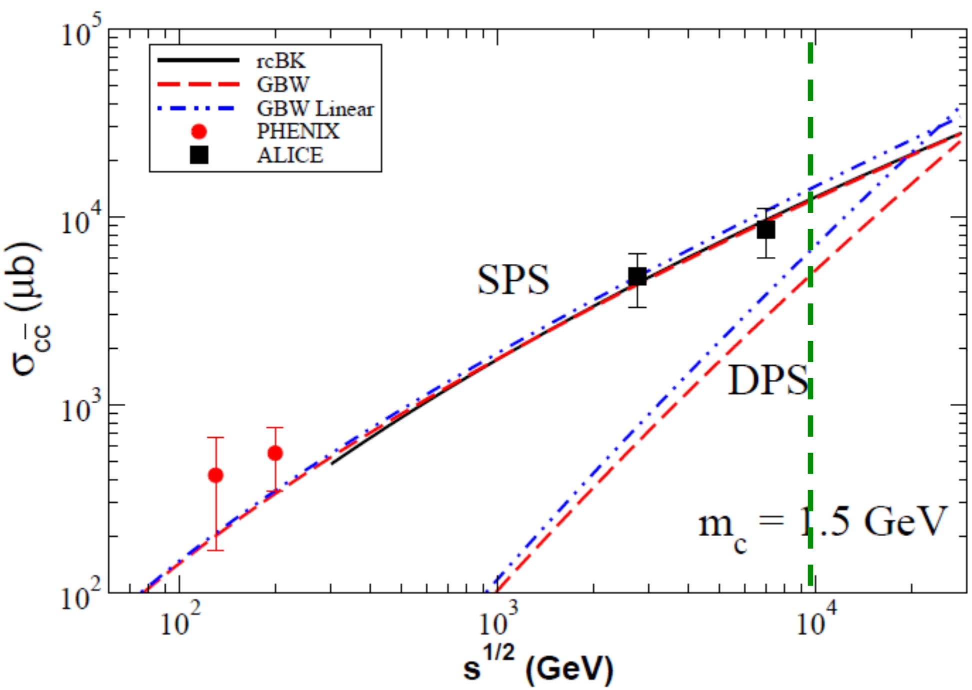




without saturation effects

Luszczak, Maciula, Szczurek,
PRD 85 (2012) 094034

LHC: DPS = SPS !!!



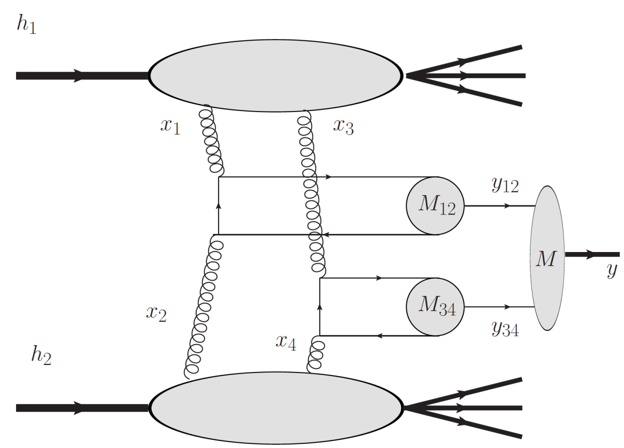
with saturation effects

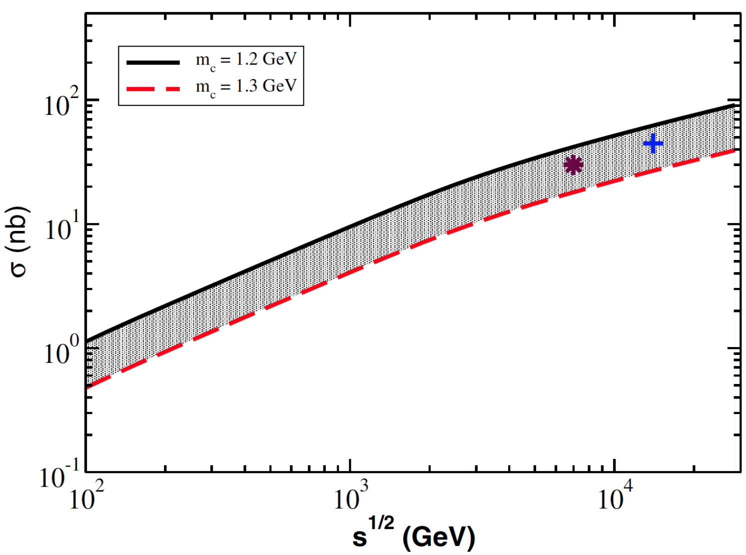
Cazaroto, Goncalves, FSN,
PRD 88 (2013) 034005

Production of T_{4c} ($c\bar{c}c\bar{c}$) and X(3872)

Carvalho, Cazaroto, Goncalves, FSN, Phys. Rev. D93, 034004 (2016)

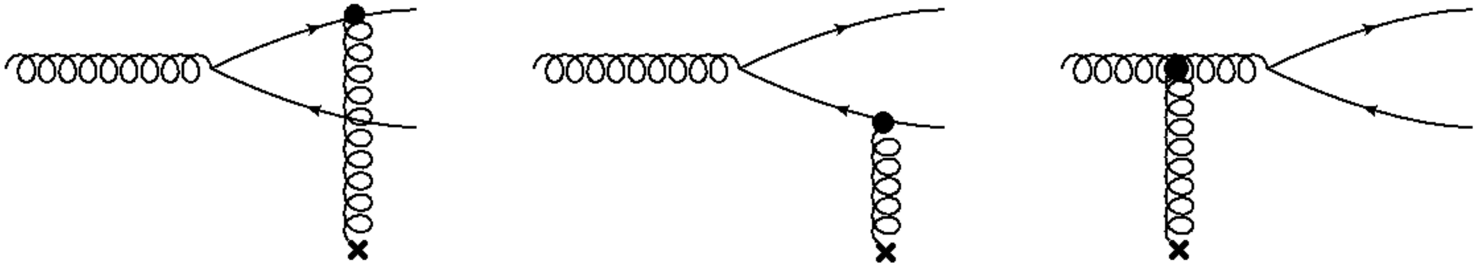
$$\sigma_{\rm DPS} = \frac{F_{T_{4c}}}{\sigma_{\rm eff}} \left[\int_0^1 dx_1 \int_0^1 dx_2 g(x_1,\mu^2) g(x_2,\mu^2) \sigma_{g_1 g_2 \to c\bar{c}} \right] \times \left[\int_0^1 dx_3 \int_0^1 dx_4 g(x_3,\mu^2) g(x_4,\mu^2) \sigma_{g_3 g_4 \to c\bar{c}} \right] \times \Theta(1 - x_1 - x_3)\Theta(1 - x_2 - x_4) \times \Theta(M_{12}^2 - 4m_c^2)\Theta(M_{34}^2 - 4m_c^2) \times \delta(y_{34} - y_{12}),$$





Energy (TeV)	$\sigma_{c\bar{c}}$ (mb)	$\sigma_{\rm inel}$ (mb)	σ_X (nb)
7	8.5 [28]	73.2 [27]	30.0 [9]
14			44.6 ± 17.7

Charm production in the color dipole approach



$$\sigma\{p\,p \to Q\bar{Q}\,X\} = 2 \int_0^{\ln(\sqrt{s}/2m_Q)} d\,y\; x_1\,G(x_1,\mu^2)\;\sigma\{g\,p \to Q\bar{Q}\,X\}$$

Kopeliovich,Tarasov
hep-ph/0205151

$$\sigma\{g\,p \to Q\bar{Q}\,X\} = \int_0^1 d\alpha \int d^2\rho\;|\Psi_{g\to Q\bar{Q}}(\alpha,\rho)|^2\,\sigma_{gq\bar{q}}(\alpha,\rho)$$

$$|\Psi_{g\to Q\bar{Q}}(\alpha,\rho)|^2 = \frac{\alpha_s(\mu^2)}{(2\pi)^2}\{m_Q^2\,K_0^2(m_Q\,\rho) + (\alpha^2+\bar{\alpha}^2)\,m_Q^2\,K_1^2(m_Q\,\rho)\}$$

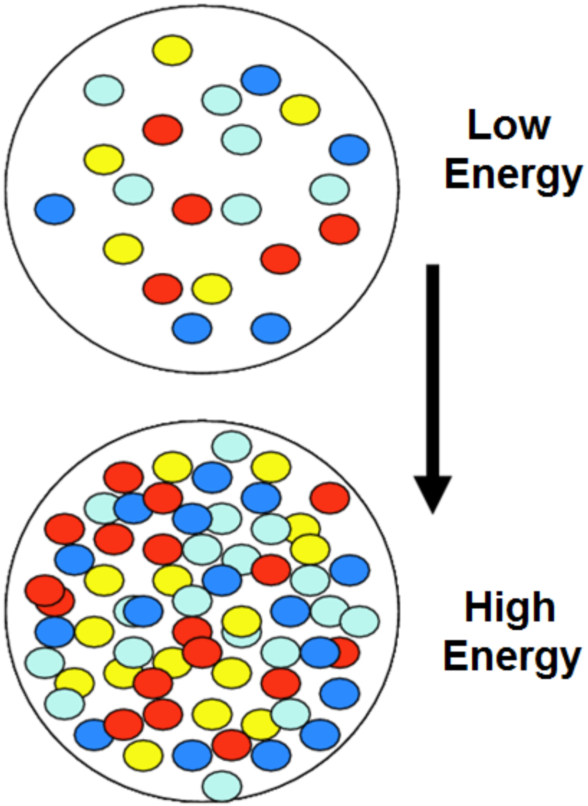
$$\sigma_{gq\bar{q}}(\alpha,\rho) = \frac{9}{8}[\sigma_{dp}(\alpha\rho)+\sigma_{dp}(\bar{\alpha}\rho)] - \frac{1}{8}\sigma_{dp}(\rho)$$

$$x_1 = \frac{2\,m_Q\,e^{y}}{\sqrt{s}}$$

$$x_2 = \frac{2\,m_Q\,e^{-y}}{\sqrt{s}}$$

$$y = \frac{1}{2}\ln(\frac{x_1}{x_2})$$

Gluon saturation



High energies
large number of gluons
gluon recombination

$$g\, g \rightarrow g$$

Gluon recombination at very small x tames the growth of the gluon distribution

Implementation: color dipole approach