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BFKL studies of heavy quark and jet production with modified Pythia

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Introduction

- High energies \Rightarrow small- x regime dominates
- Small- x regime \Rightarrow important large $(\alpha_S \ln(1/x))$ -terms
- GLAPD (Gribov, Lipatov, Altarelli, Parisi & Dokshitzer) equation resums only $(\alpha_S \ln(Q^2/\Lambda^2))$ -terms
- LL (leading log) BFKL (Fadin, Kuraev, Lipatov & Balitsky) resums $((\alpha_S \ln(1/x)))$ -terms in all orders of perturbation theory
- NLL (next-to-leading log) BFKL (includes also GLAPD) recently established

- Introduction
- Available BFKL-based MC generators
- Incorporation of BFKL effects to Pythia
- Preliminary results with modified Pythia
- Summary

Currently available MC event generators

- GLAPD-based (without BFKL-evolution):
 - Pythia
 - Herwig
 - Isajet

• BFKL-based:

- Cascade: k_\perp -factorization
- Ariadne: Linked Dipole Chain (LDC) model

Disadvantages of Cascade:

- Designed only for heavy quark production
- Not designed for jet production:
 $g^* g^* \rightarrow gg$ matrix element is not available

- No guarantee for correct predictions in other processes (gauge invariance of k_\perp -factorization?)

Disadvantages of Ariadne(LDC):

- only deep inelastic lepton-nucleon process included

Incorporation of BFKL-evolution to Pythia

Standard Pythia GLAPD-evolution kernel for parton shower:

$$\frac{\partial(xf_b(x, \mu^2))}{\partial \ln \mu^2} = \sum_a \frac{\alpha_S}{2\pi} \int_x^1 dz \frac{x}{z} f_a \left(\frac{x}{z}, \mu^2 \right) P_{a \rightarrow bc}(z)$$

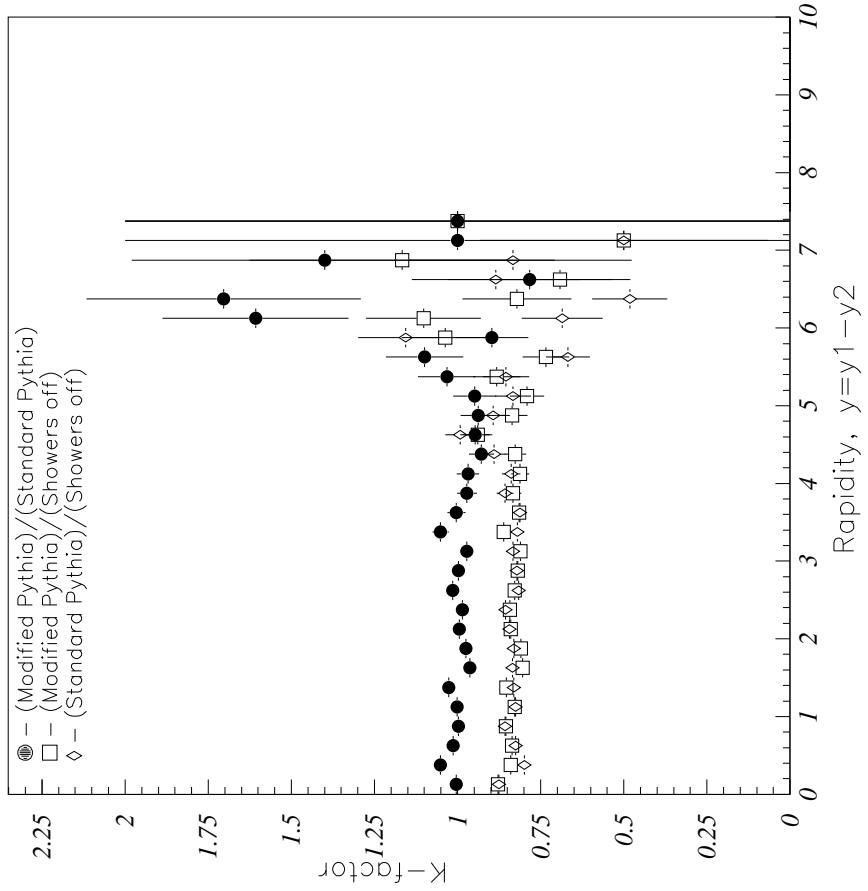
Modified Pythia (LL BFKL + GLAPD)-evolution kernel for parton shower:

$$\begin{aligned} \frac{\partial(xg(x, \mu^2))}{\partial \ln \mu^2} &= \frac{\alpha_S}{2\pi} \int_x^1 dz \left\{ \bar{P}(z) \frac{x}{z} g \left(\frac{x}{z}, \mu^2 \right) - z P(z) x g(x, \mu^2) \right\} \\ &+ \frac{\alpha_S}{2\pi} 2N_C \int_x^1 dz \frac{d_z}{z} \left\{ \frac{x}{z} g \left(\frac{x}{z}, q_0^2 \right) \right. \\ &+ \left(\int_{q_0^2}^{(\mu-\lambda)^2} - \int_{(\mu+\lambda)^2}^{\infty} \right) \frac{dk_{\perp}^{\prime 2} \mu^2}{(\mu^2 - k_{\perp}^{\prime 2})^2} \frac{x}{z} \frac{\partial g(\frac{x}{z}, k_{\perp}^{\prime 2})}{\partial k_{\perp}^{\prime 2}} \\ &\left. + \frac{x}{z} \mu^2 \frac{\partial g(\frac{x}{z}, \mu^2)}{\partial \mu^2} \ln \left(\frac{\lambda^2}{\mu^2} \right) \right\}, \text{ for } x \leq 0.01 \end{aligned}$$

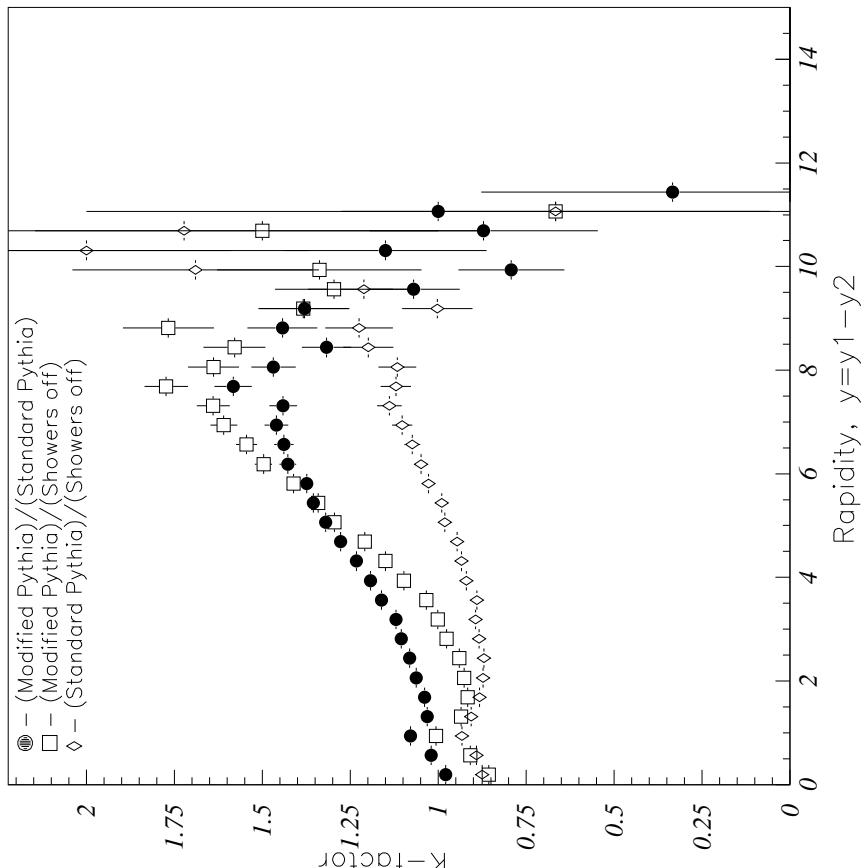
Studies with BFKL-based modified Pythia:

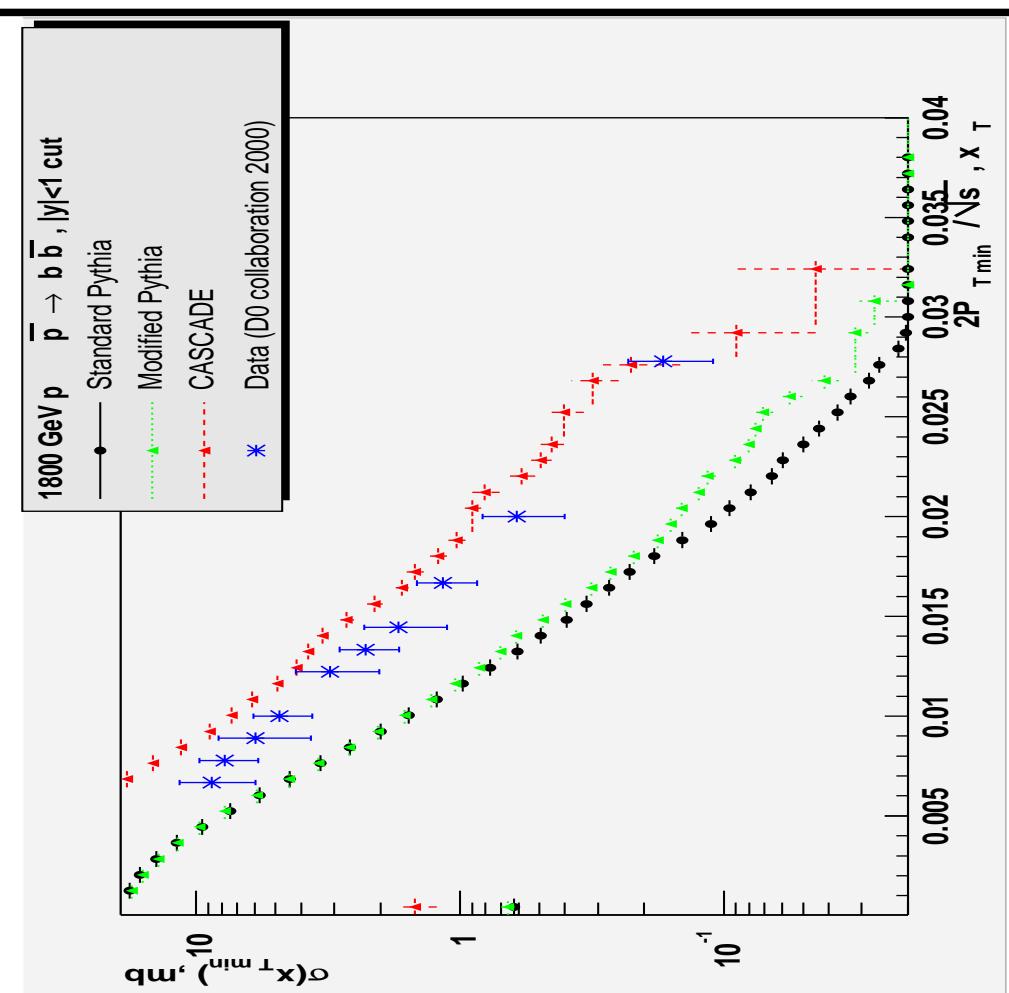
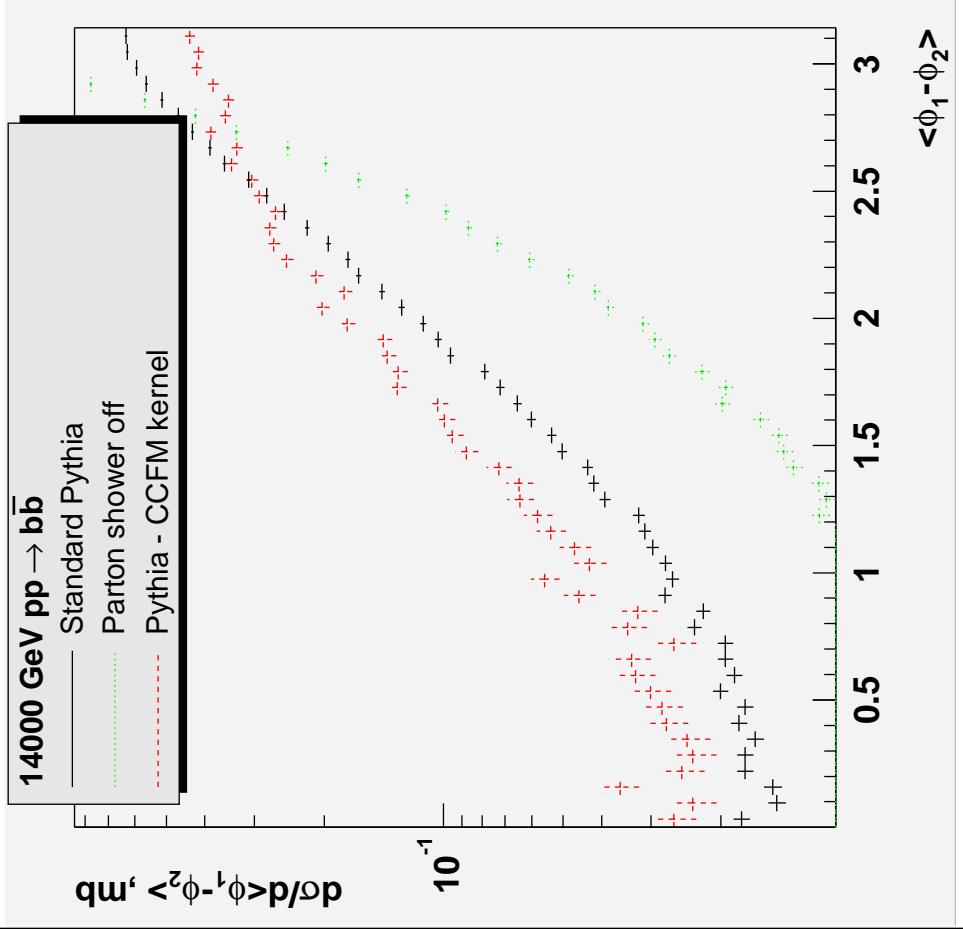
- Inclusive cross sections and K-factors for $b\bar{b}$ - and jet-production
- Azimuthal decorrelation in $b\bar{b}$ and dijets

Inclusive dijet production at Tevatron, Ecm=1.8 TeV, PTmin = 20 GeV



Studies with modified Pythia: Inclusive dijet production at LHC, Ecm=14 TeV, PTmin = 20 GeV





Summary

- The BFKL-based version of Pythia is under development
- Comparison of the modified Pythia with other MC generators and comparison with data ⇒ tuning of BFKL-parameters
- This is an initial stage for further implementation of LL and NLL BFKL evolutions to Pythia for description of small-x processes