Production of 2 jets and W/Z in kt-factorization

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DESY

in collaboration with
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Motivations and Introductions

- Improved parton model

Motivations and Introductions

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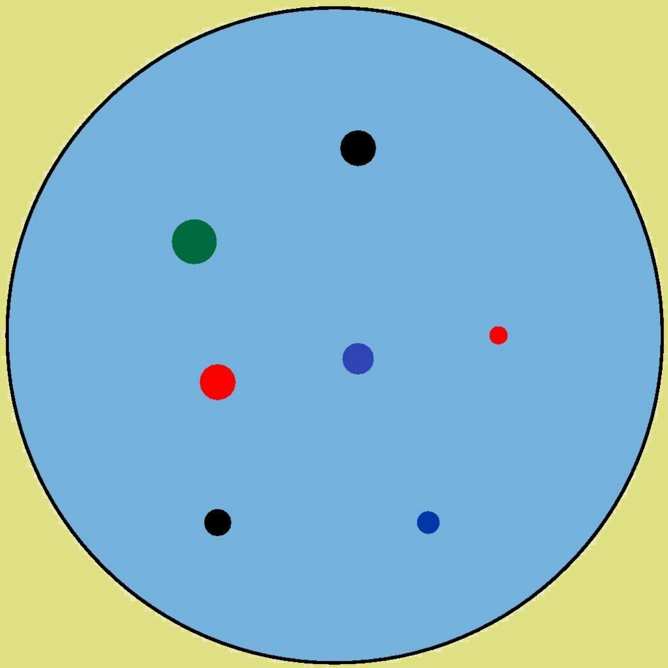
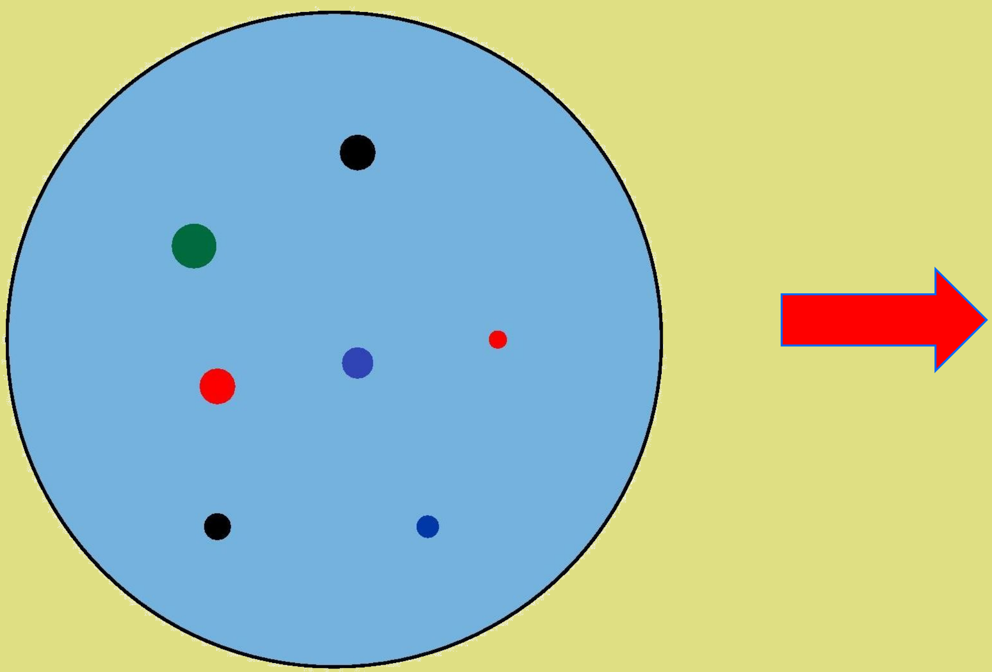


Motivations and Introductions

- Improved parton model



Motivations and Introductions

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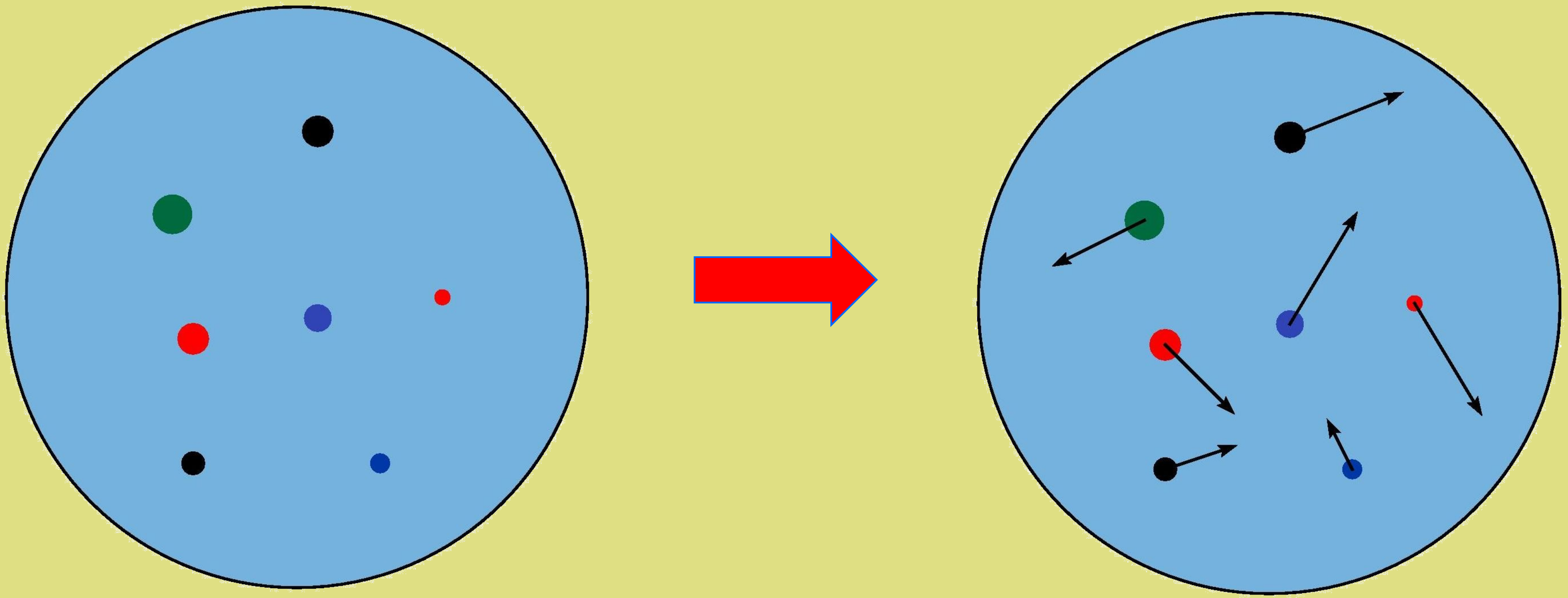

Motivations and Introductions

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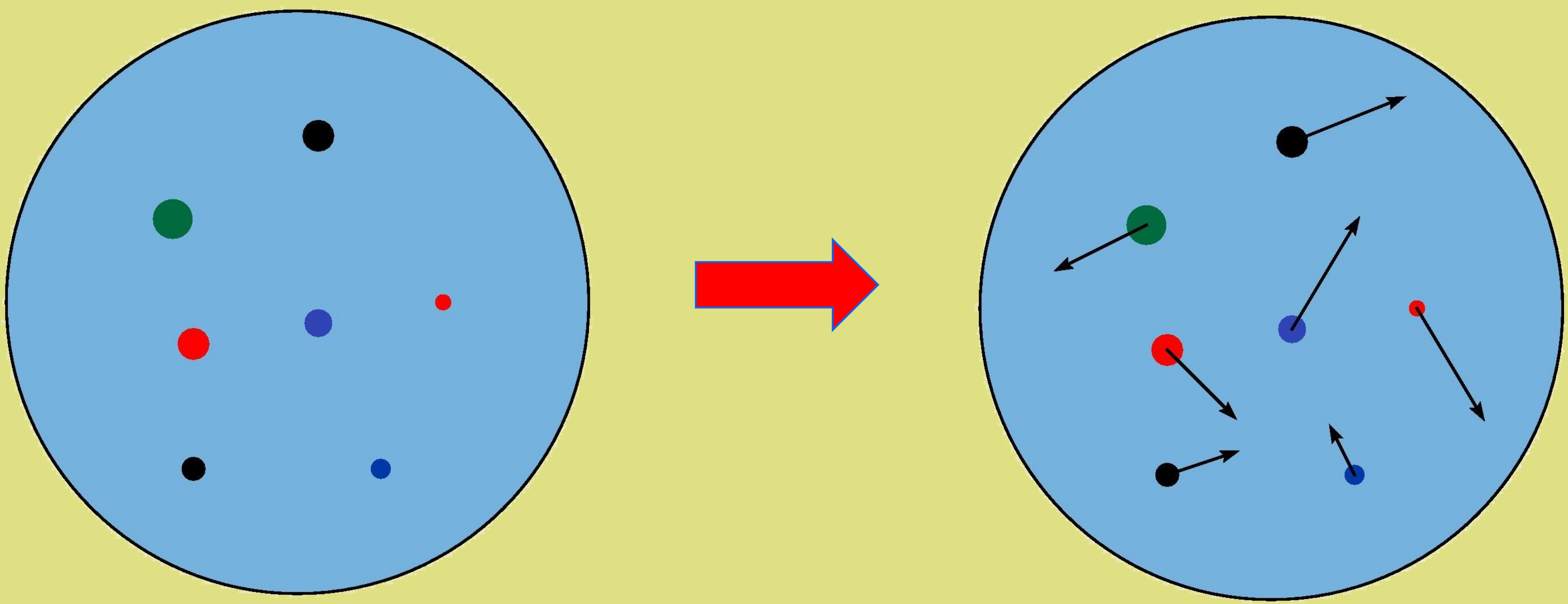
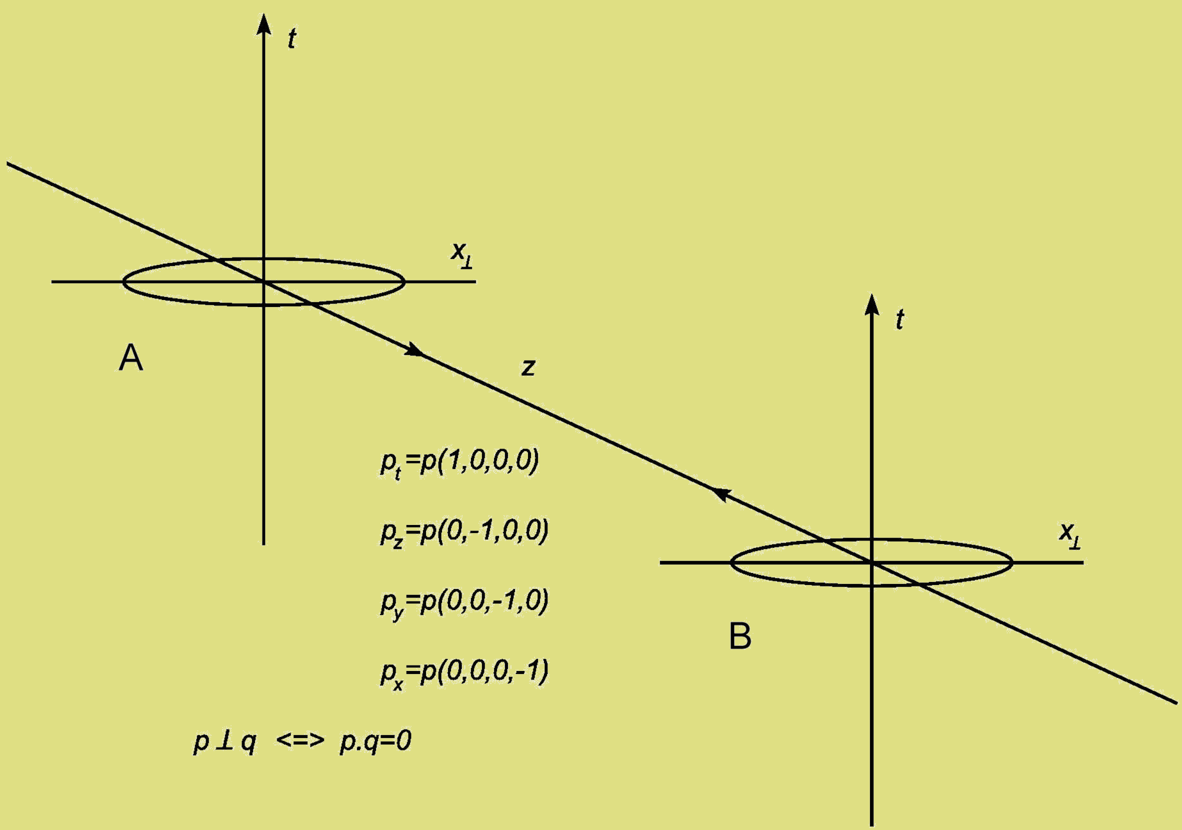


collinear approach
based on DGLAP evolution, PDFs

kt-factorisation
BFKL, CCFM, uPDFs (HERA)

W or Z and 2 jets Motivations and Introductions

- Kinematics (Introduction)



$$p_A = \left(\frac{\sqrt{s}}{2}, \frac{\sqrt{s}}{2}, 0, 0 \right)$$

$$p_B = \left(\frac{\sqrt{s}}{2}, -\frac{\sqrt{s}}{2}, 0, 0 \right)$$

$$p_A p_B = \frac{s}{2}, \quad p_A^2 = 0, \quad p_B^2 = 0$$

$$\forall \ k_\perp : p_A k_\perp = 0, \quad p_B k_\perp = 0$$

$$k_\perp = (0, 0, k_y, k_x)$$

$$\vec{k}_\perp = (k_x, k_y)$$

$$k_\perp^2 = -\vec{k}_\perp^2$$

Motivations and Introductions

- Kinematics better treated

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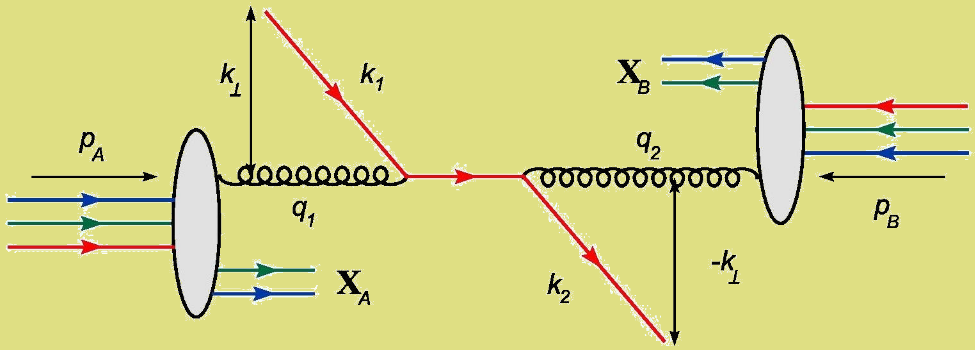

$$q_1 = x_1 p_A$$

$$q_2 = x_2 p_B$$

$$k_{1\perp} + k_{2\perp} = 0$$

Motivations and Introductions

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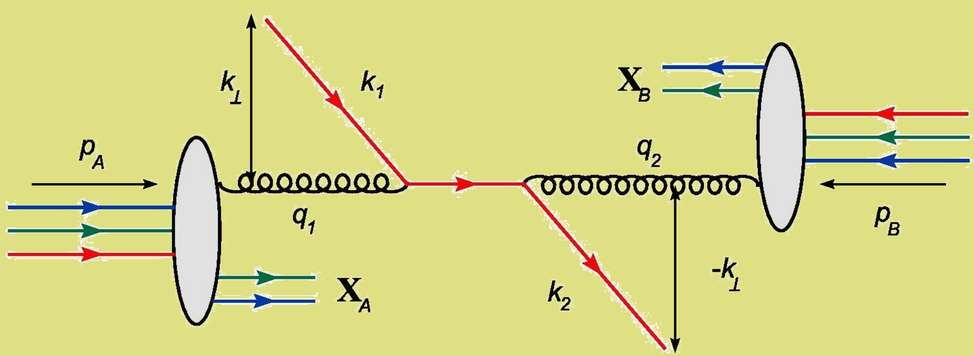

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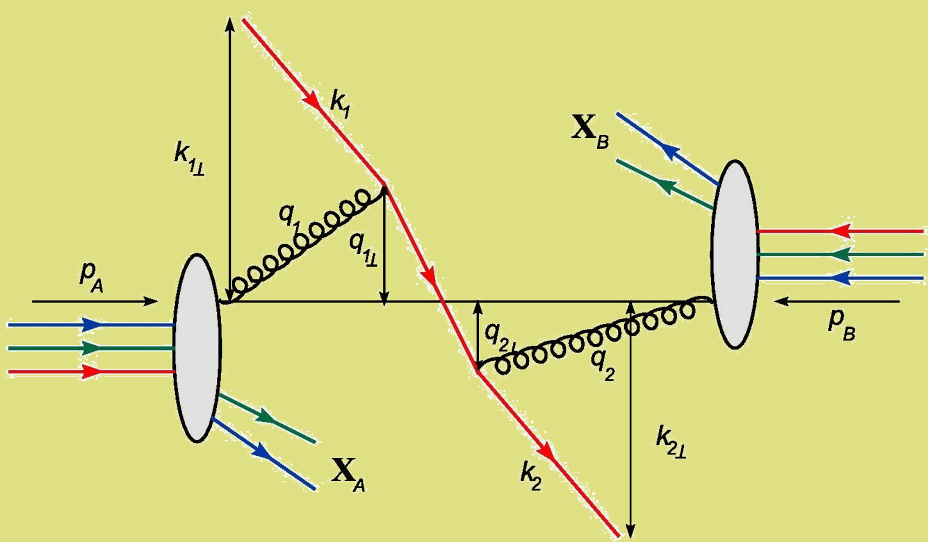

$$q_1 = x_1 p_A + q_{1\perp}$$
$$q_2 = x_2 p_B + q_{2\perp}$$
$$k_{1\perp} + k_{2\perp} \neq 0$$

Motivations and Introductions

- Offshell partons expected - interacting

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  1. collinear partons

$$q_1^2 = \left(x_1 p_A\right)^2 = x_1^2 p_A^2 = x_1^2 m_A^2 \approx 0$$

Motivations and Introductions

- Offshell partons expected - interacting

1. collinear partons

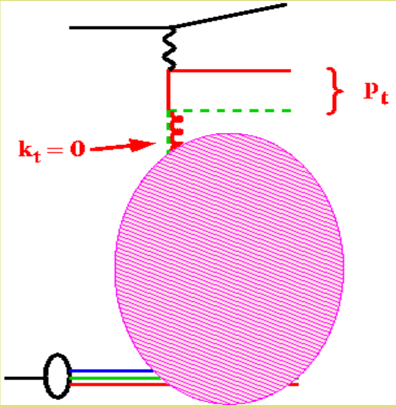
$$q_1^2 = \left(x_1 p_A\right)^2 = x_1^2 p_A^2 = x_1^2 m_A^2 \approx 0$$

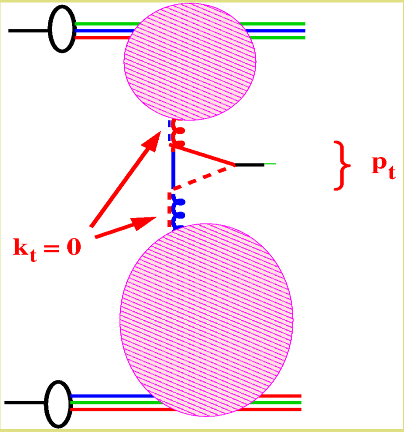
2. partons with transversal components of momenta

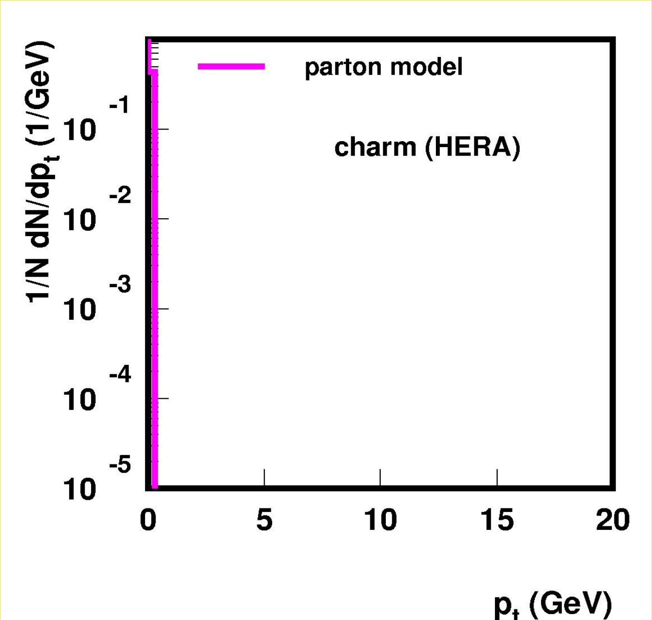
$$q_1^2 = \left(x_1 p_A + q_{1\perp}\right)^2 = \left(x_1 p_A\right)^2 + 2x_1 p_A . q_{1\perp} + q_{1\perp}^2$$
$$= x_1^2 p_A^2 + 0 + q_{1\perp}^2 = x_1^2 m_A^2 + q_{1\perp}^2 \approx -\vec{q}_{1\perp}^{\,2} < 0$$

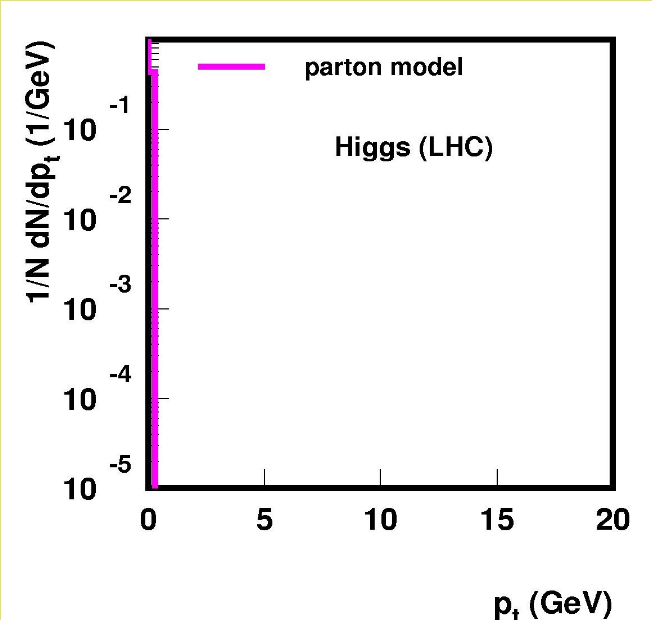
Motivations and Introductions

- Examples of usual results (without parton showers)





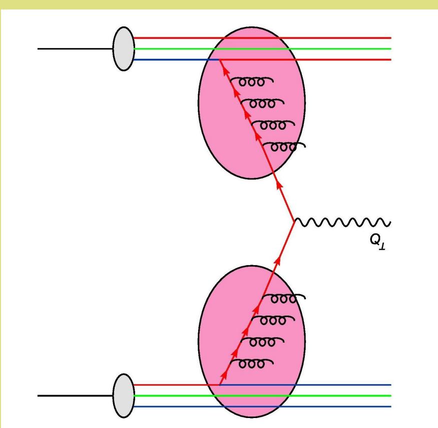


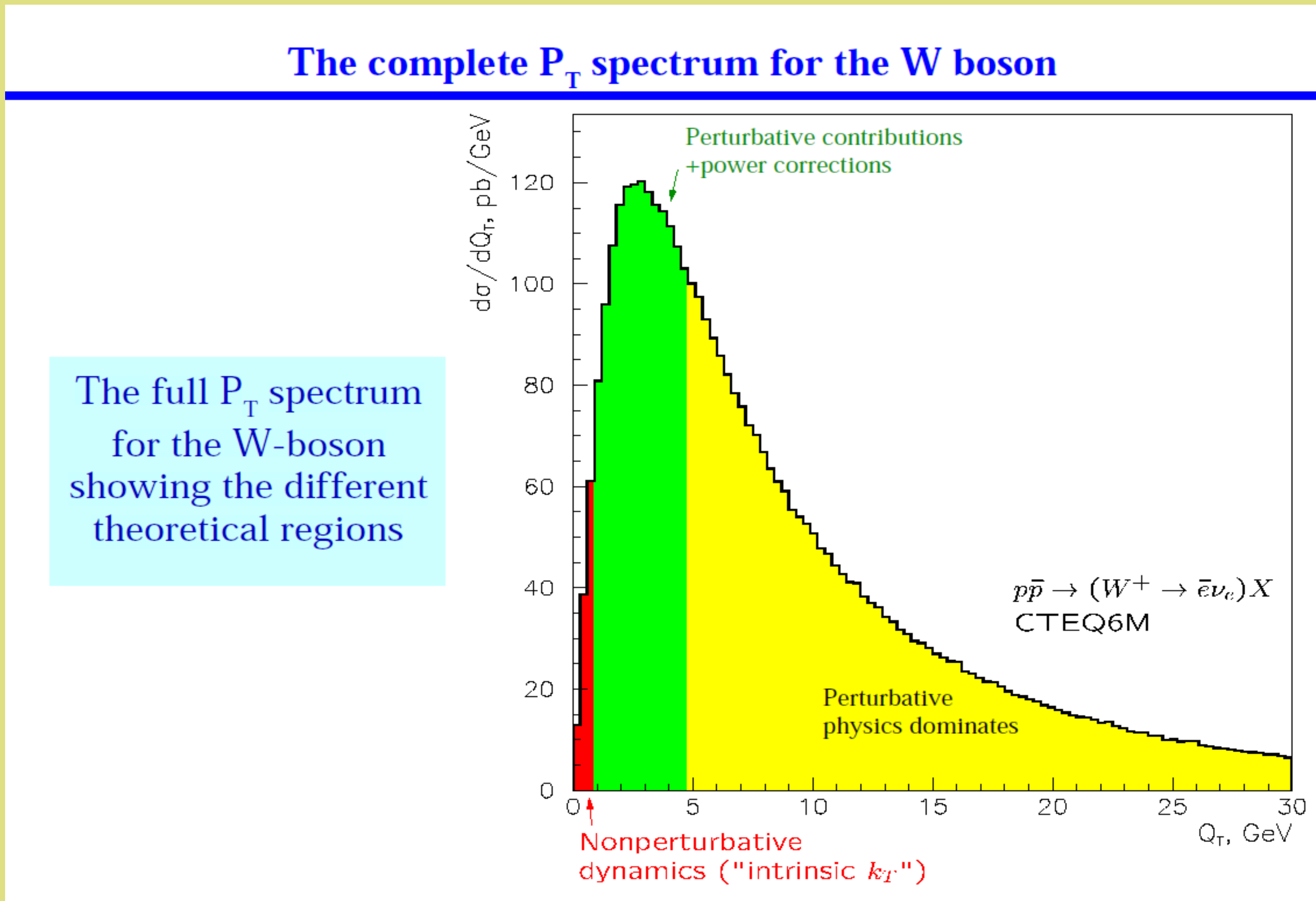


Motivations and Introductions

- Usual approach

Collins, Soper, Sterman, Nucl. phys. B250:199,1985

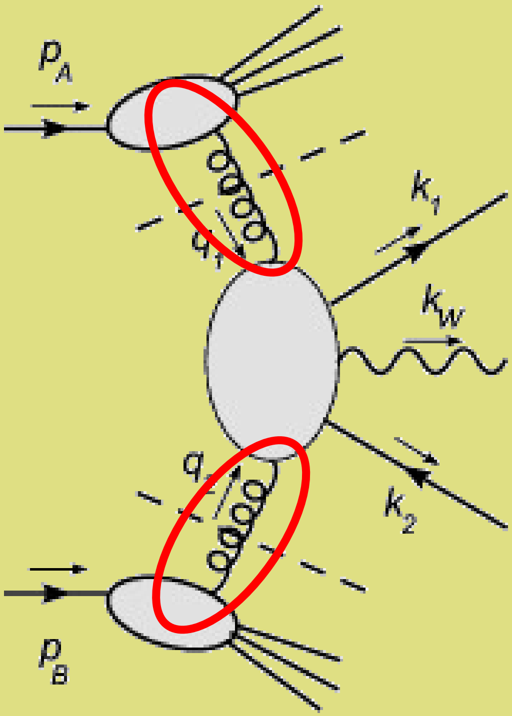




Fred Olness, CTEQ summerschool 2003

BFKL formalism (kt-factorisation)

- kinematic regime: $s >> |t|$
- small x
- rapidity ordering follows



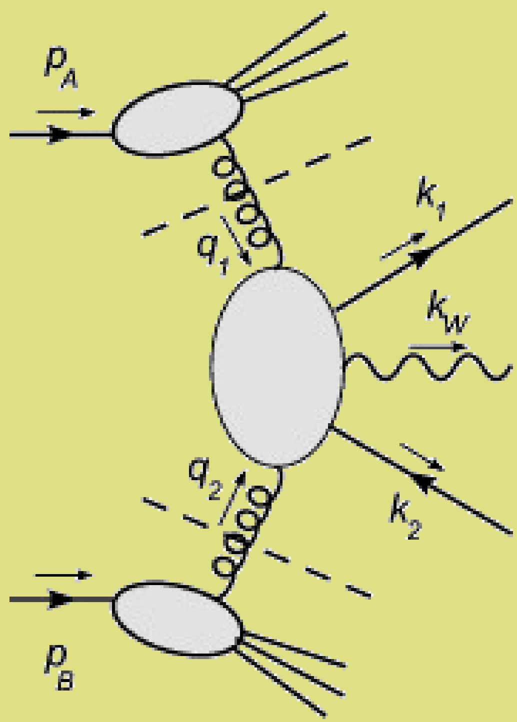
$$q_1 = x_1 p_A + \xi_1 p_B + q_{1\perp}$$
$$q_2 = \xi_2 p_A + x_2 p_B + q_{2\perp}$$

$$x_1 >> \xi_1,\ x_2 >> \xi_2$$

BFKL formalism (kt-factorisation)

- Replace proton by a quark
- Special example production of Z/W + 2 jets
- Measurment of luminosity, background for beyond

  SM processes, only way to have Z/W in kt-factorisation, uPDFs



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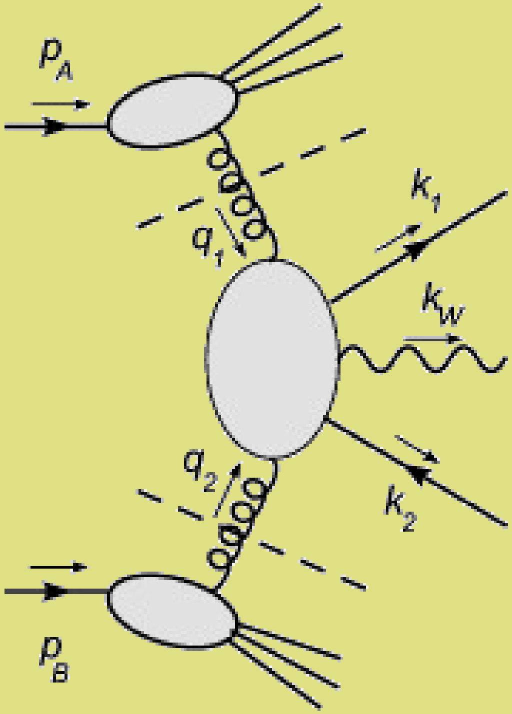

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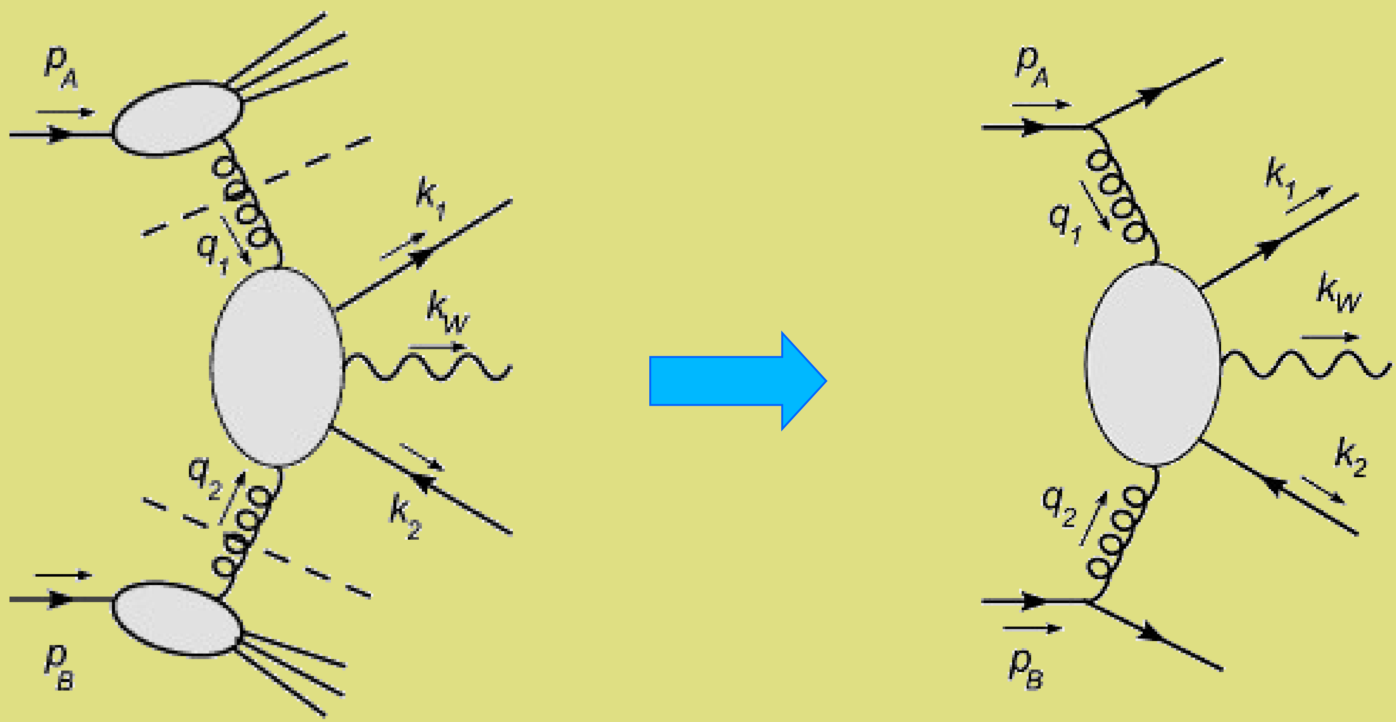
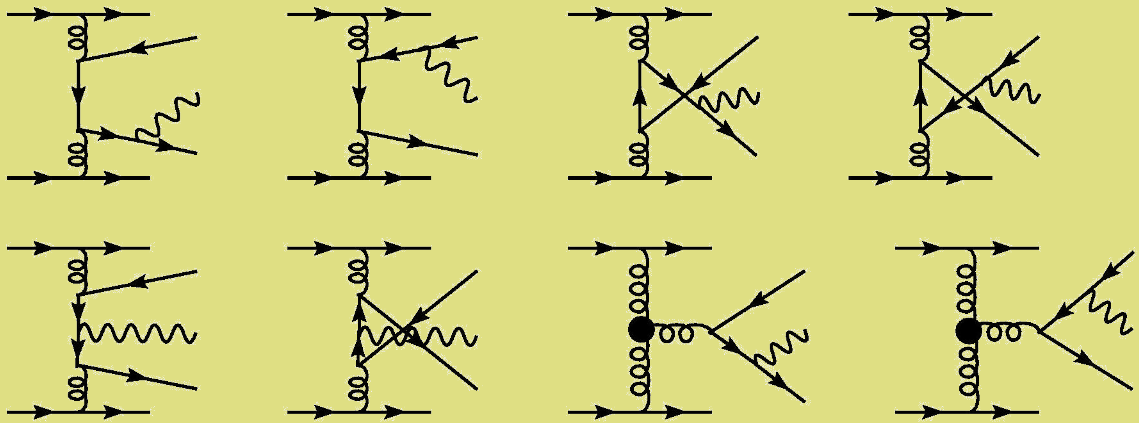
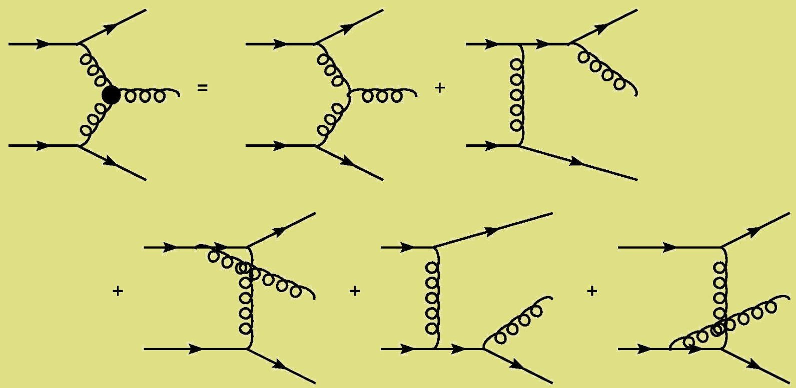


BFKL formalism → Calculation

- Happily draw all the diagrams (note only gluon channel) of Z/W + 2 jets



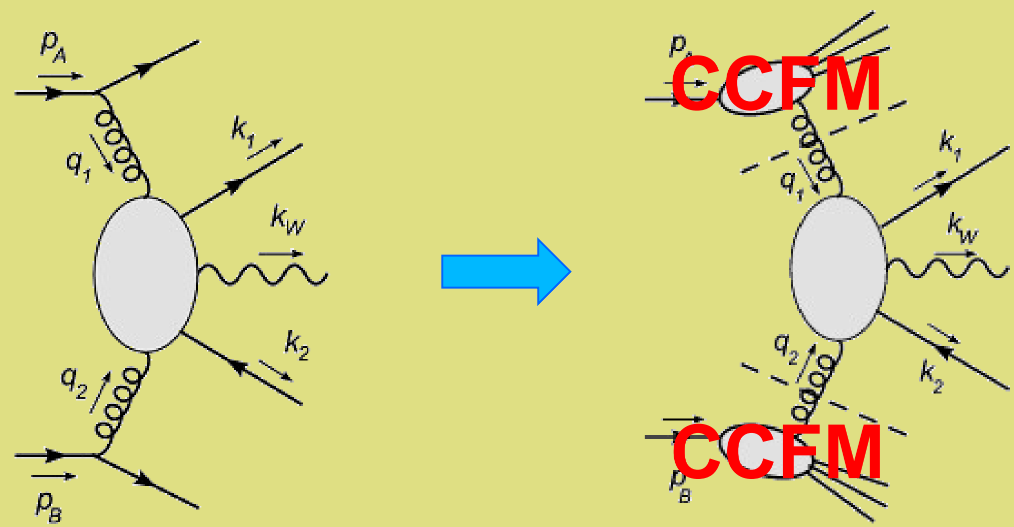
- Effective vertex:



Lipatov,
Sov. J. Nucl. Phys. 23, 338 (1976)

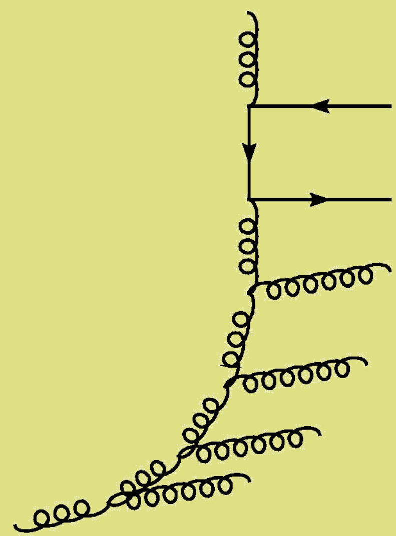
Calculation

- Getting back to proton



Jung,
Comput. Phys. Commun.143, 100 (2002)
[hep-ph/0109102]
Jung, Salam,
Eur. Phys. J. C19, 351 (2001)
[hep-ph/0012143]

- CCFM is implemented in CASCADE
- Implementation of matrix element of $gg \to W/Z + q_i\bar{q}_j$

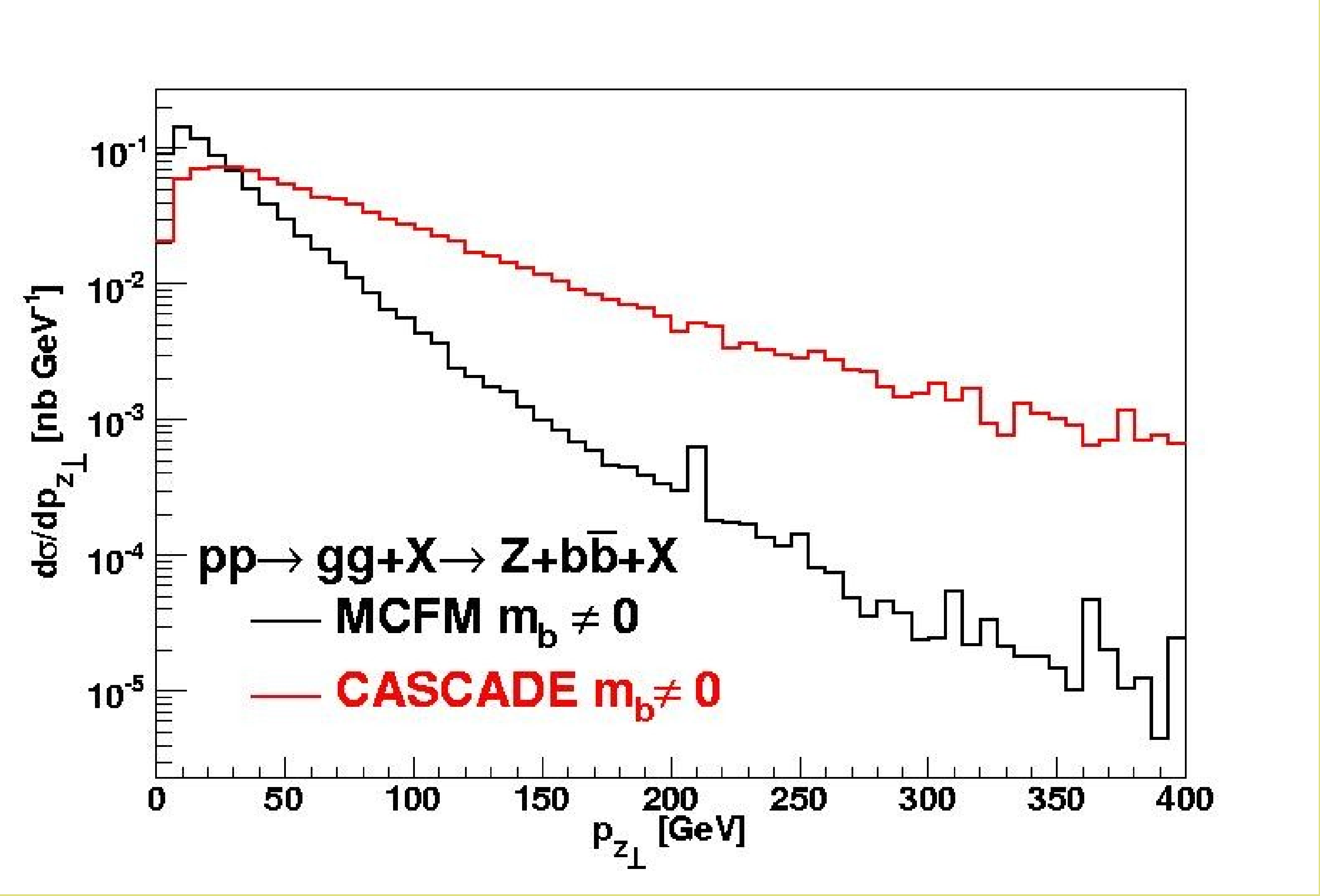


CCFM

Ciafaloni,
Nucl. Phys. B296 (1988) 49;
Catani, Fiorani, Marchesini,
Phys. lett. B234 (1990) 339;
Nucl. Phys. B336 (1990) 18;
Marchesini,
Nucl. Phys. B445 (1995) 49
[hep-ph/9412327]

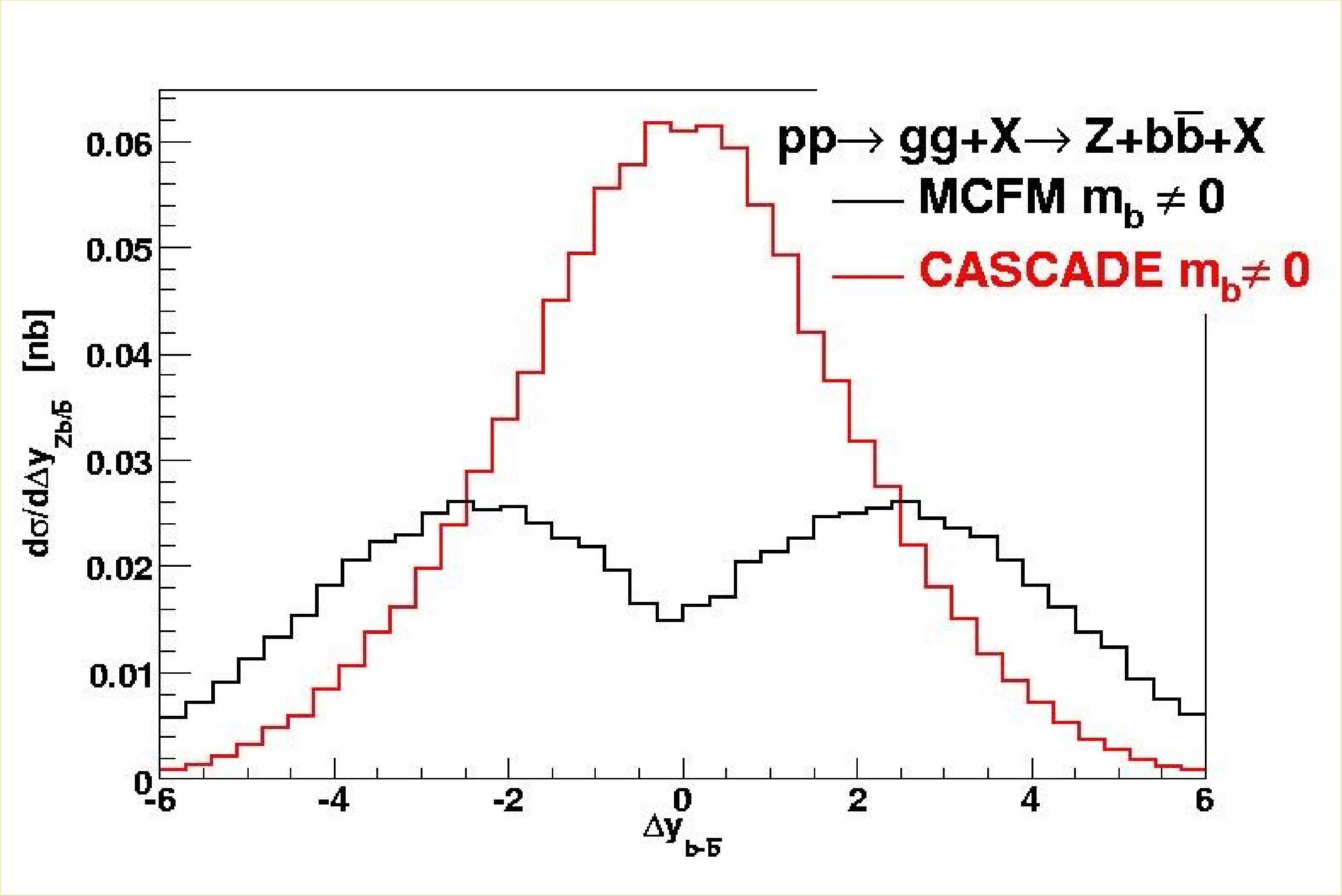
Results

- pt distribution of *Z* (comparison with MCFM LO)



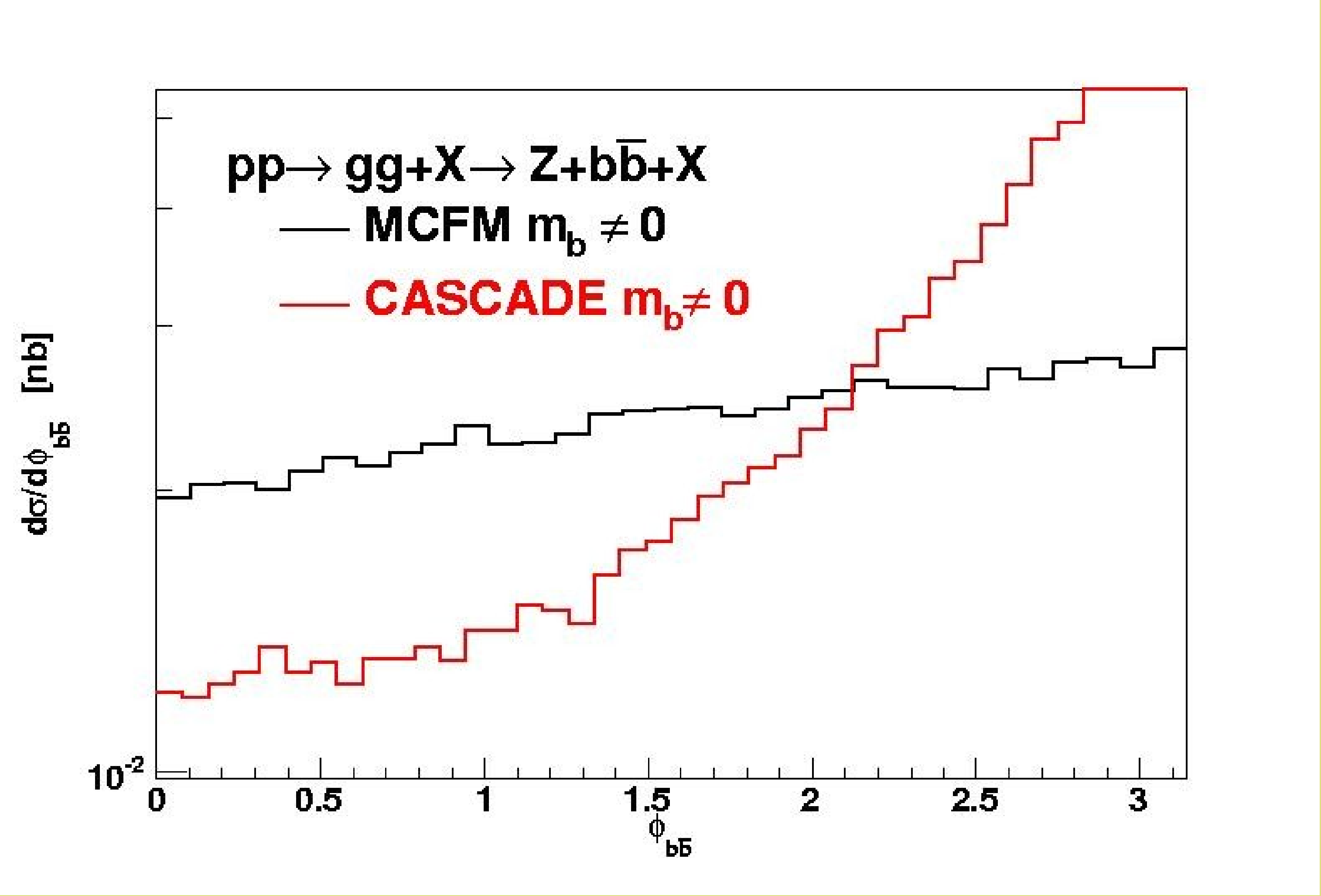
Results

- Difference of rapidities of quark and antiquark (comparison with MCFM LO)



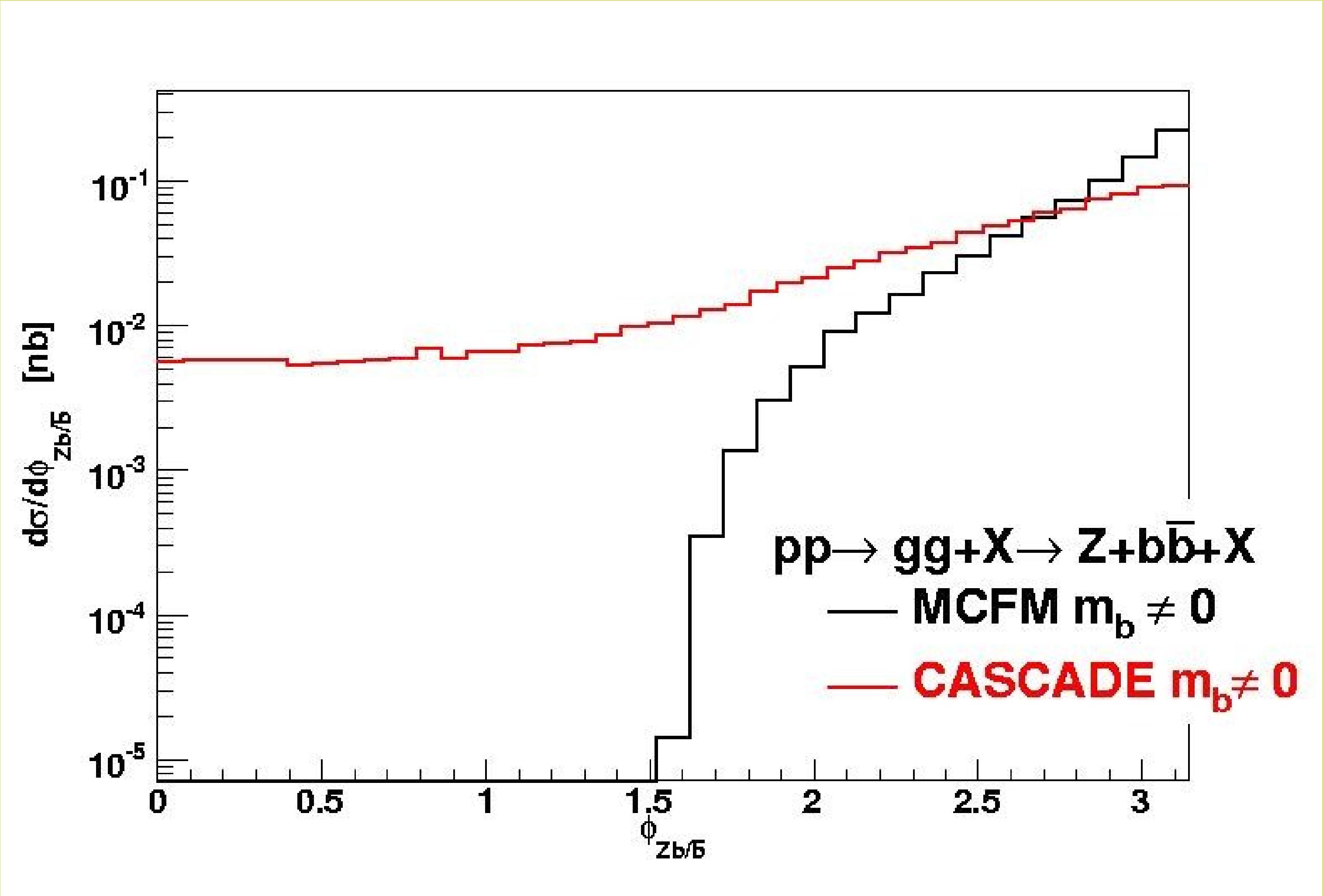
Results

- Polar angle between quark jets (comparison with MCFM LO)



Results

- Polar angle between higher pt quark jet and Z (comparison with MCFM LO)

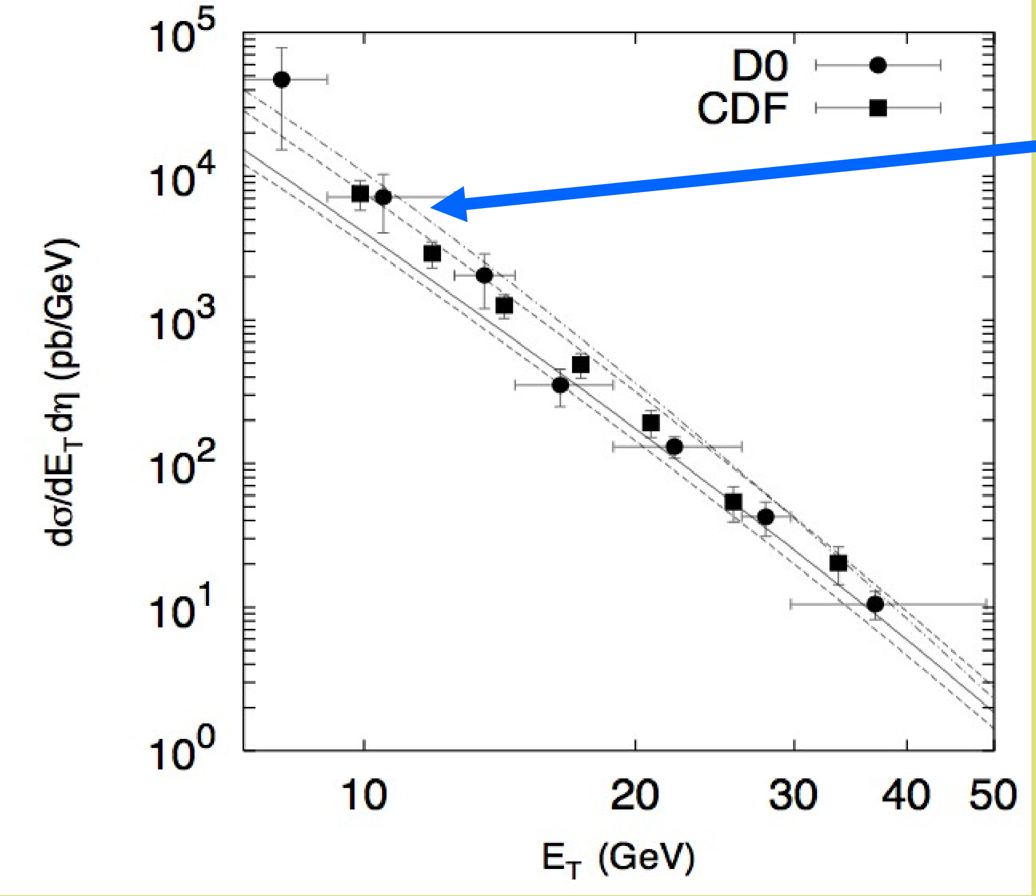


Summary

- The need for unintegrated parton densities was explained
- Usual approach vs. BFKL formalism – kt-factorisation
- One example of their application was shown
- Harder distributions of transversal momenta of produced particles than in usual approach

Motivations and Introductions

- Example of comparison of kt-factorisation result and usual approach – prompt photon at Tevatron



kt-factorisation result - CCFM

Baranov, Lipatov, Zotov, [hep-ph/0708.3560]