Letter: non perturbative Sudakov

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PB evolution equation

- Evolution equation for parton density (not momentum weighted)

$$f_a(x,\mu^2) = \Delta_a^S(\mu^2)\ f_a(x,\mu_0^2) + \sum_b \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \frac{\Delta_a^S(\mu^2)}{\Delta_a^S(\mu'^2)} \int_x^{z_M} \frac{dz}{z}\ P_{ab}(\alpha_s(\mu'^2),z)\ f_b\left(\frac{x}{z},\mu'^2\right)$$

- Sudakov form factor

$$\Delta_a^S(\mu^2,\mu_0^2) = \exp\left(-\int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \int_0^{z_M} dz P_{ab}(\alpha_s(\mu'^2),z)\right)$$

- For transverse momentum dependent pdfs:

$$\mathcal{A}_a(x,\mathbf{k},\mu^2) = \Delta_a^S(\mu^2)\ \mathcal{A}_a(x,\mathbf{k},\mu_0^2) + \int \frac{d^2\mathbf{q}'}{\pi\mathbf{q}'^2} \frac{\Delta_a^S(\mu^2)}{\Delta_a^S(\mathbf{q}'^2)}\ \Theta(\mu^2-\mathbf{q}'^2)\ \Theta(\mathbf{q}'^2-\mu_0^2) \times \left[\int_x^{z_M} \frac{dz}{z}\ P_{ab}(\alpha_s(\mathbf{q}'^2),z)\ \mathcal{A}_a\left(\frac{x}{z},\mathbf{k}+(1-z)\mathbf{q}',\mathbf{q}'^2\right)\right]$$

- Splitting function

$$P_{ab}(\alpha_\mathrm{s}, z) = d_a(\alpha_\mathrm{s})\delta(1-z) + k_a(\alpha_\mathrm{s})\frac{1}{1-z} + R_{ab}(\alpha_\mathrm{s}, z)$$

- Sudakov, with virtual term

$$\Delta_a^S(\mu^2, \mu_0^2) = \exp\left(- \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \left[\int_0^{z_M} dz \frac{k_q}{1-z} - d_q \right] \right)$$

- split this into different pieces

$$\begin{aligned} \Delta_a^S(\mu^2, \mu_0^2) &= \exp\left(- \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \left[\int_0^{z_{dyn}} dz \frac{k_q}{1-z} - d_q \right] \right) \\ &\times \exp\left(- \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \int_{z_{dyn}}^{z_M} dz \frac{k_q}{1-z} \right) \end{aligned}$$

The $q_T \geq q_0$ region

- "perturbative region"

$$\Delta_a^S(\mu^2, \mu_0^2) = \exp\left(- \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \left[\int_0^{z_{dyn}} dz \frac{k_q}{1-z} - d_q \right] \right) .$$

- leads to CSS Sudakov structure

$$\begin{aligned} \log \Delta_a^S(\mu^2, \mu_0^2) &= -\int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \left[\int_0^{z_{dyn}} dz \frac{k_a}{1-z} - d_a \right] \\ &= -\int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \left[\frac{1}{2} k_a \log\left(\frac{\mu'^2}{q_0^2} \right) - d_a \right] \\ &= -\frac{1}{2} \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \left[\log\left(\frac{q_0^2}{\mu'^2} \right) A + B \right] \end{aligned}$$

The $q_T \leq q_0$ region

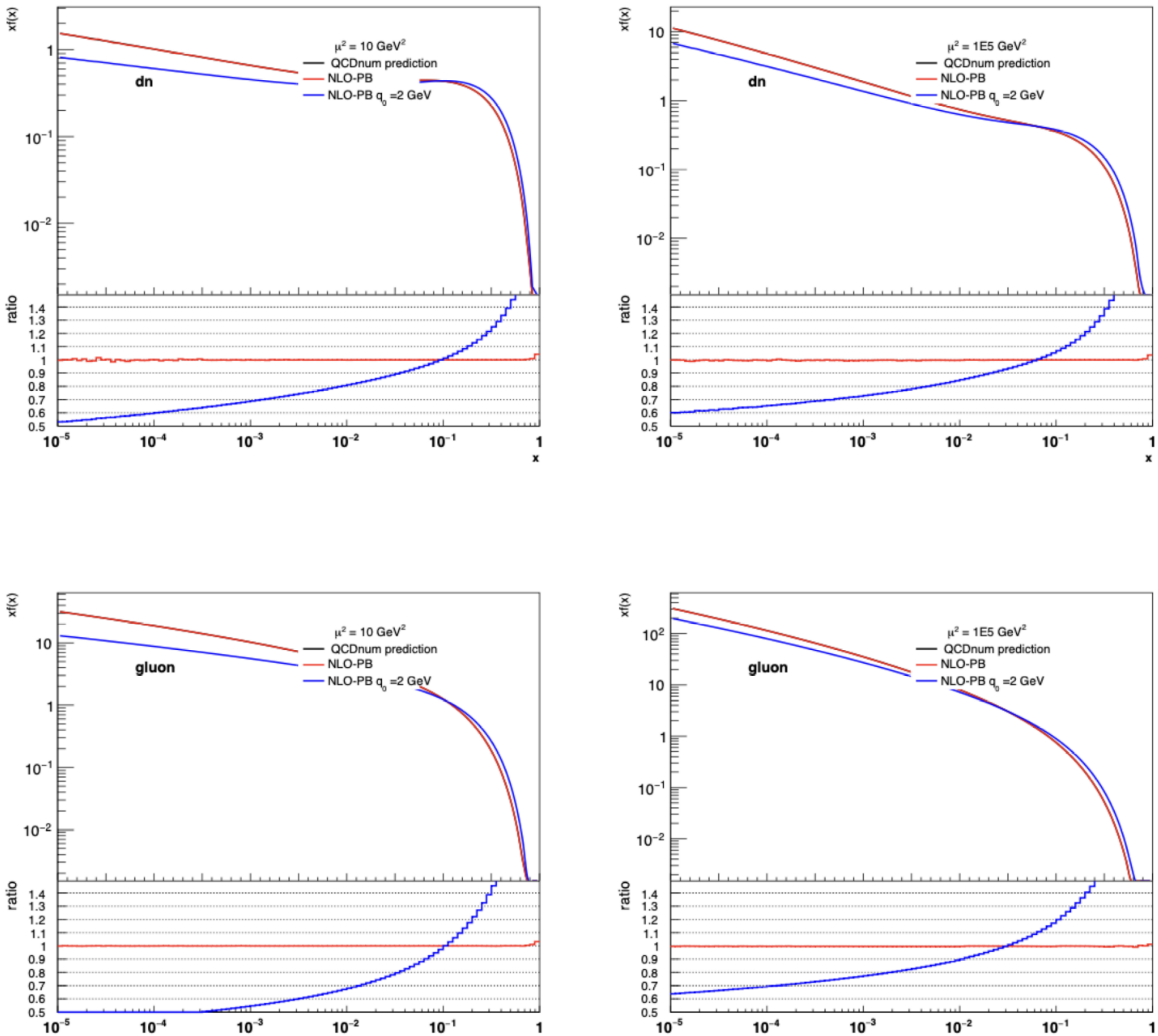
- "non-perturbative" region (very large z)

$$\Delta_a^{non-pert.}(\mu, \mu_0) = \exp\left(- \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \int_{z_{dyn}}^{z_M} dz \frac{k_q}{1-z} \right)$$

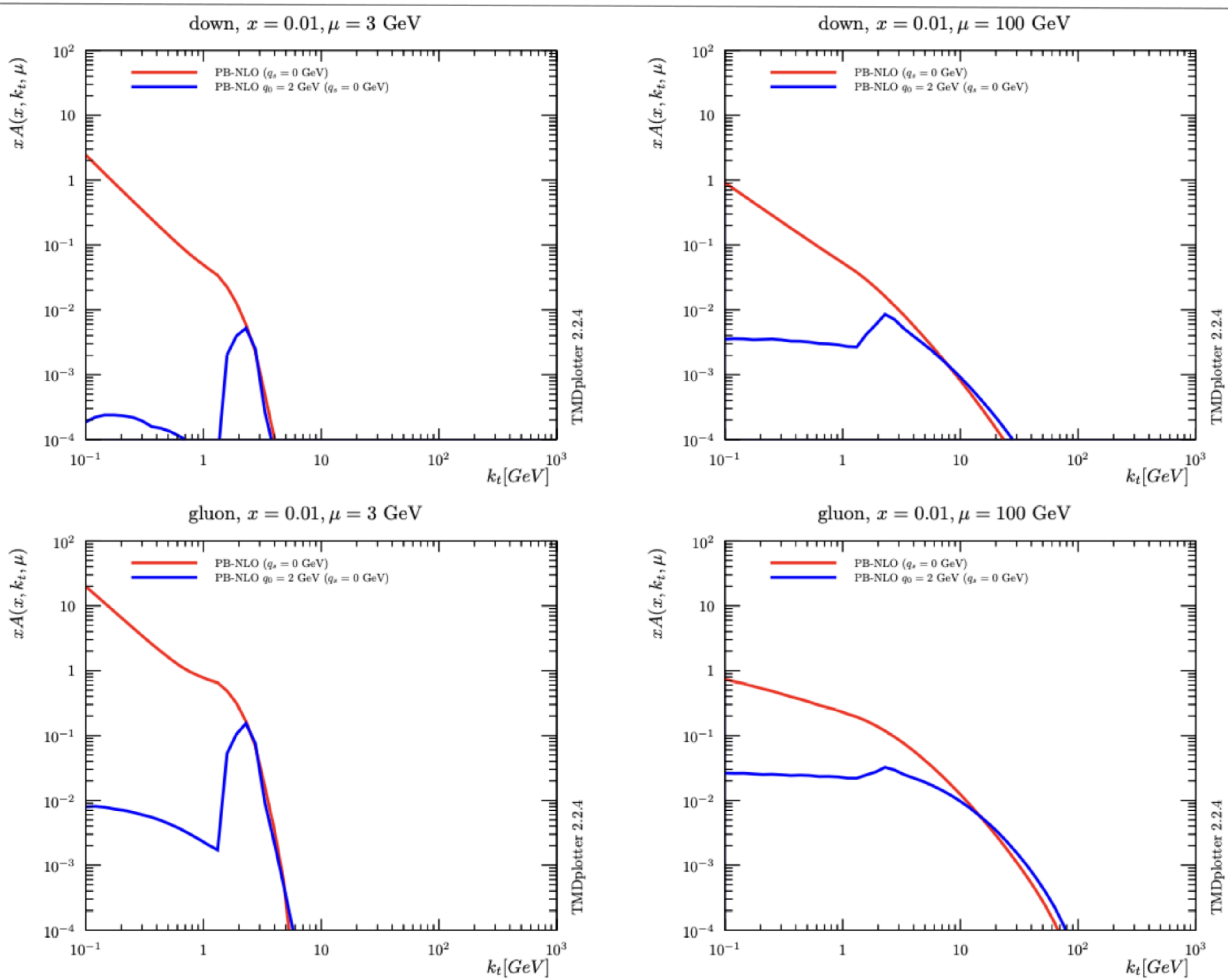
$$\begin{aligned} \log \Delta_a^{non-pert}(\mu^2, \mu_0^2) &= - \int_{\mu_0^2}^{\mu^2} \frac{d\mu'^2}{\mu'^2} \frac{1}{2} k_q \log\left(\frac{q_0^2}{\mu'^2 \epsilon^2} \right) \\ &= - \log\left(\frac{\mu^2}{\mu_0^2} \right) g_1(\alpha_s, q_0) \end{aligned}$$

- gives a structure as CSS "non-pert" Sudakov

Numerical results: integrated distributions



Numerical results: TMD distributions



- Effect of z_dyn clearly visible

Conclusion

- Introduction of z_dyn allows to recover CSS structure in PB Sudakov Form Factor
- z_dyn makes an important effect on inclusive and TMD distributions
- Integral z> z_dyn is calculable, although non-perturbative, gives the same structure as CSS NP factor
    - comes automatically from PB

AOB

- Further news ?