uPDFs: Direct simulation of Δ_{ns}/z in CCFM evolution

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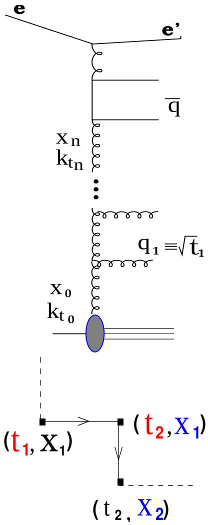
CCFM evolution



- Initial distributions: $g(x) = \frac{3(1-x)^5}{x}$, $x_{min} = 10^{-6}$, intrinsic k_T generated by a gauss(0,0.7)

- Sudakov form factor $\Delta_s(q_i, z_i q_{i-1}) =$

$$\exp\left\{-\int_{(z_{i-1}q_{i-1})^2}^{q_i^2} \frac{dq^2}{q^2}\int_0^{1-Q_0/q} dz \frac{\bar{\alpha}_s(q^2(1-z)^2)}{1-z}\right\},$$

  $R = \Delta(t_1, t_2)$ - analytical calc. + bisection method

  $q_i = \frac{p_{ti}}{1-z_i}$, $\bar{\alpha}_s(\mu) = \frac{6}{11-\frac{2}{3}n_f} \cdot \frac{1}{\ln\frac{\mu}{\Lambda}}$,

  $Q_0 = 1$ GeV, $\Lambda_{QCD} = 0.2$ GeV and $n_f = 4$

- $\int_\epsilon^z dz \frac{\alpha_s}{2\pi}\tilde{P}_{gg} = R\int_\epsilon^{1-\epsilon} dz \frac{\alpha_s}{2\pi}\tilde{P}_{gg}$

$$\tilde{P}_{gg}(z, q_t, k_t) = \bar{\alpha}_s(k_t^2)\frac{\Delta_{ns}(z,k_t,q_t)}{z} + \frac{\bar{\alpha}_s(q_t^2(1-z)^2)}{1-z},$$

  if $\frac{g_1}{g_{tot}} < R \Rightarrow$ z generated according to second term (analytical calculation)

  else z generated according to first term (next slide) .

Direct method of Δ_{ns}/z generation

Non-Sudakov form-factor

General expression of the non-Sudakov form factor includes some additional parameter z_0:

$$\ln \Delta_{ns}(z, z_0, k_t, q) = -\bar{\alpha}_s(k_t^2) \ln \frac{z_0}{z} \ln \frac{k_t^2}{z_0 z q^2},$$

where (Kwiecinski1995)

$$z_0 = \begin{cases} 1\,, & \text{if } 1 \leq \frac{k_t}{q}\,, \\ \frac{k_t}{q}\,, & \text{if } z \leq \frac{k_t}{q} < 1\,, \\ z\,, & \text{if } \frac{k_t}{q} < z < 1\,. \end{cases} .$$

Introducing the variable t

$$t \equiv \ln \frac{z_0}{z} + C\,,$$

$$C \equiv \ln \frac{k_t}{z_0 q} \;\rightarrow\; z = z_0 e^{C-t},$$

$$\frac{\Delta_{ns}}{z} = \frac{e^{\bar{\alpha}_s (C^2 - t^2)}}{z_0 e^{C-t}} =$$

$$\frac{1}{z_0} e^{-\bar{\alpha}_s t^2 + t + \bar{\alpha}_s C^2 - C} = \frac{e^{\bar{\alpha}_s (C - t_0)^2}}{z_0} e^{-\bar{\alpha}_s (t - t_0)^2},$$

$$t_0 \equiv \frac{1}{2\bar{\alpha}_s}.$$

Gaussian distribution of Δ_{ns}/z

Function $\frac{\Delta_{ns}}{z}(t)$ is the Gaussian with

$$\mu = t_0$$

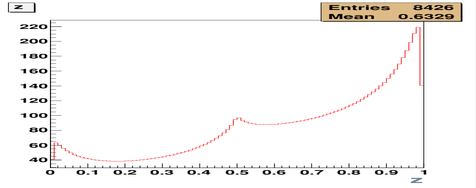
$$\sigma = \frac{1}{\sqrt{2\bar{\alpha}_s}} = \sqrt{t_0}.$$

Universal connection and cut

$$z = \frac{k_t}{q} e^{-t}\,, \qquad t \geq \ln \frac{k_t}{q}$$

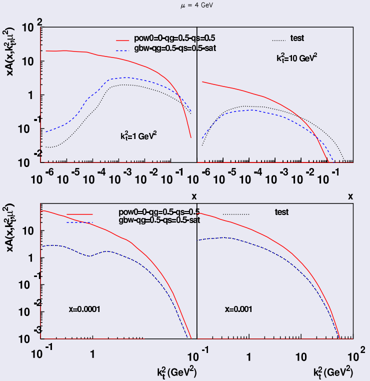
gives for Gaussian distributed variable t:

$$\begin{cases} 1 \leq \frac{k_t}{q} \rightarrow t \geq \ln \frac{k_t}{q} \geq 0 \rightarrow 0 < z = \frac{k_t}{q} e^{-t} \leq 1 \\ \frac{k_t}{q} < 1 \rightarrow \left(\begin{array}{l} t \geq 0 \rightarrow 0 < z = \frac{k_t}{q} e^{-t} \leq \frac{k_t}{q} \\ \ln \frac{k_t}{q} \leq t < 0 \rightarrow \frac{k_t}{q} < z = \frac{k_t}{q} e^{-t} \leq 1 \end{array} \right. \end{cases} .$$

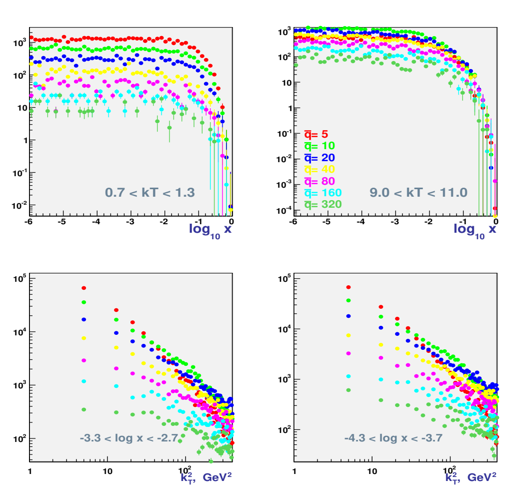


Evolved x- and k_T- distributions. $x_{min} = 10^{-6}$

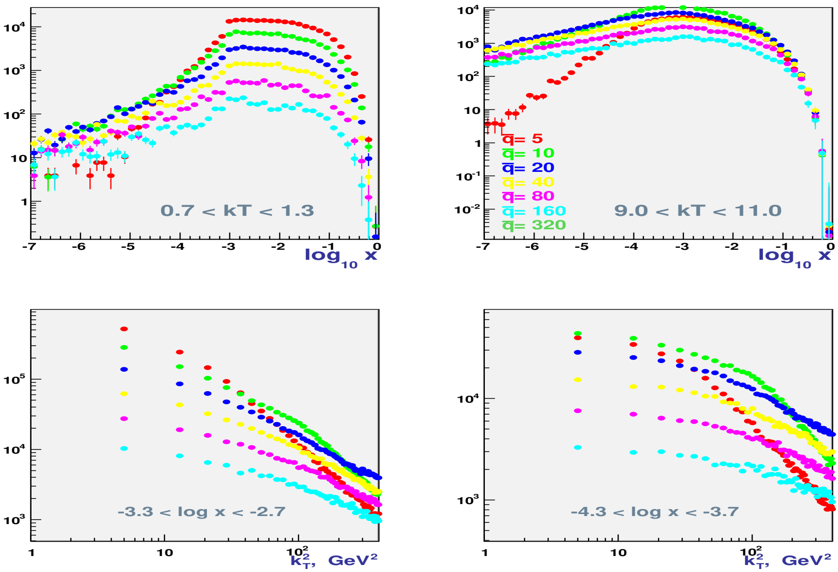
Hannes distributions



My first distributions



$x_{min} = 10^{-3}$ plots



Summary

- It is shown that Δ_{ns}/z term in gluon-gluon splitting function is distributed, as function of $t = \ln \frac{k_T}{zq}$, according to Gauss, which allows its direct simulation (without using some majorants) ;
- First simulations of evolved x- and k_T-distributions at various scales $\bar{q}$ are performed .