LUND UNIVERSITY

uPDF uncertainties for exclusive Higgs

- Higgs à la Khoze, Martin, Ryskin
- Uncertainties in the uPDF
- LDC
- Results

Manchester
2003.12.15
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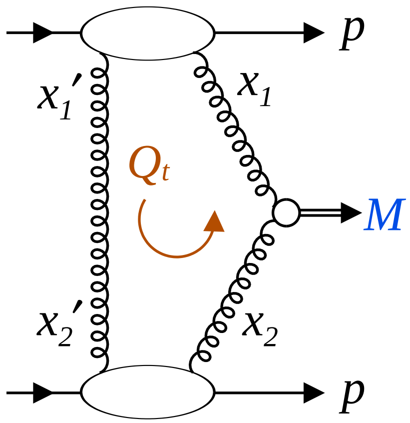
Exclusive Diffractive Higgs



$$\frac{d\sigma_M^{\text{excl}}}{d(lnM^2)dy} = \frac{d\mathcal{L}}{d(lnM^2)dy}\hat{\sigma}_{gg\to M}(M^2)$$

$$M^2\frac{d\mathcal{L}}{dM^2dy} = S^2L$$

$$L = \left(\frac{\pi}{(N_c^2-1)b}\int\frac{dQ_t^2}{Q_t^4}f_g(x_1,x_1',Q_t^2,M^2/4)f_g(x_2,x_2',Q_t^2,M^2/4)\right)^2$$

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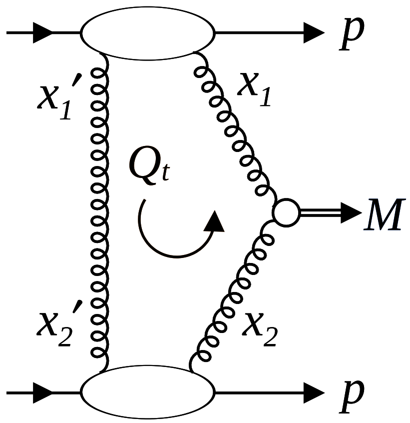

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f_g is the amplitude related to the un-integrated, off-diagonal gluon density.

S^2 is a soft survival probability

b comes from the approximation of the probability for a proton to remain intact $\int_0^\infty \exp(b(p_f-p_i)^2)d(p_f-p_i) = \frac{1}{b}$

For $x' \approx \frac{Q_t}{\sqrt{s}} \ll x \approx \frac{M}{\sqrt{s}} \ll 1$:

$$f_g(x, x', Q_t^2, M^2/4) = R_g \frac{\delta}{\delta ln(Q_t^2)} \left[\sqrt{T(Q_t, M/2)} xg(x, Q_t^2) \right]$$

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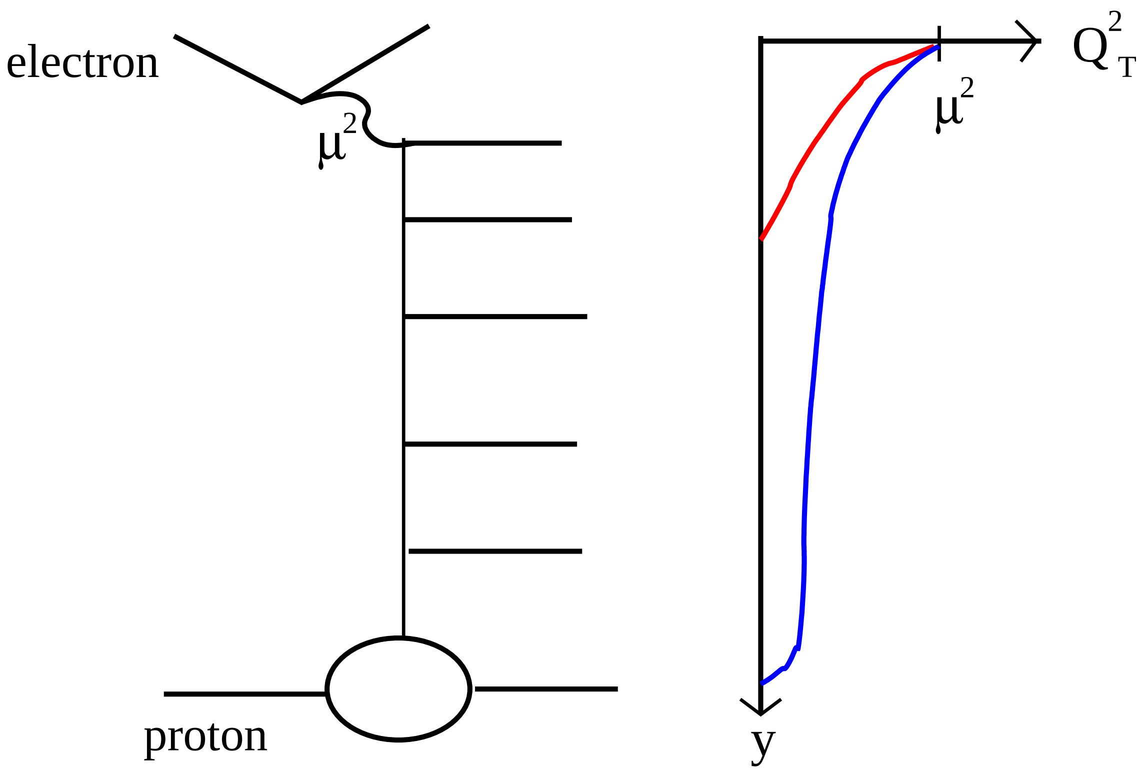
$R_g(x, Q_t^2) \approx 1 + (0.82 + 0.56\lambda)\lambda$, $\lambda = d\ln(xg(x, Q_t^2))/d\ln(1/x)$

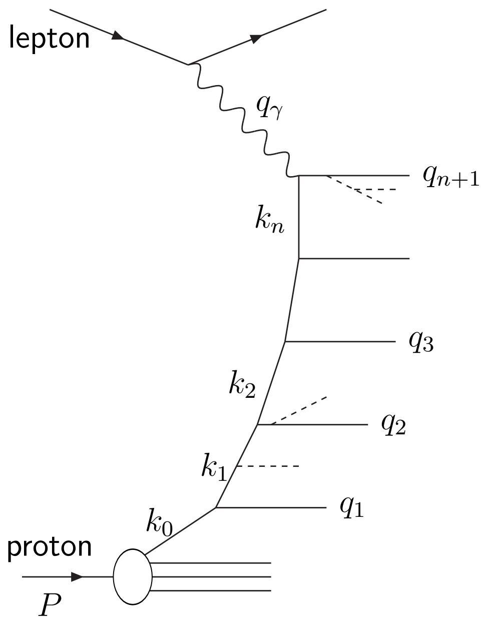
$\langle R_g \rangle \approx 1.2(1.4)$ at LHC (Tevatron)

$T(Q_t, M/2)$ is the Sudakov form factor, hard survival probability (Square root since only one gluon couples to the Higgs at large scale.)

In the luminosity function the Sudakov hits you at small Q_T and the $1/Q_T^4$ at large. $\langle Q_T \rangle \approx 2-3$ GeV.

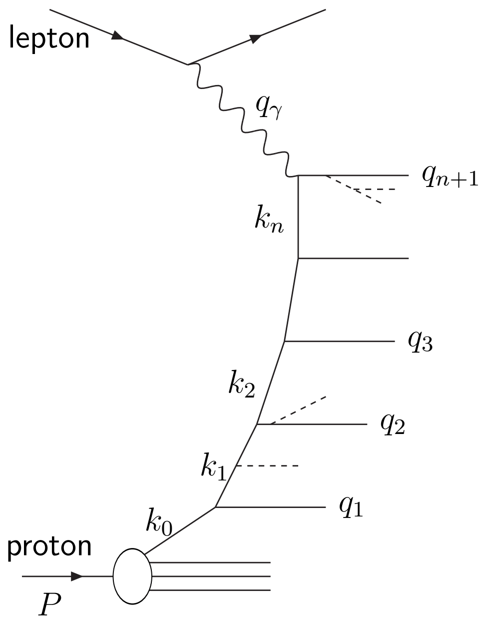


Linked Dipole Chain Model



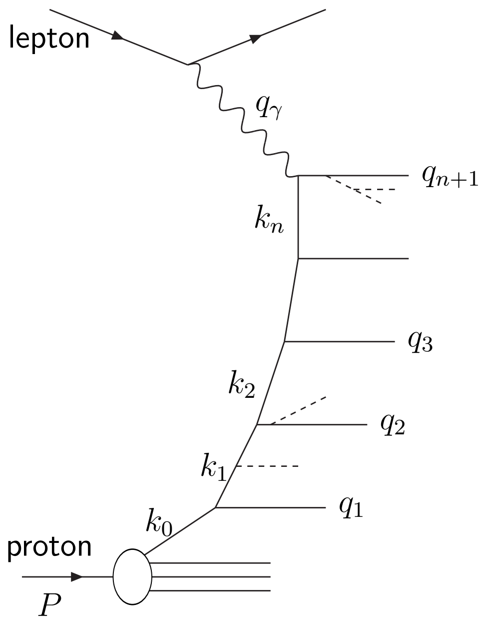
- Reformulation of CCFM suitable for Monte Carlo

Linked Dipole Chain Model



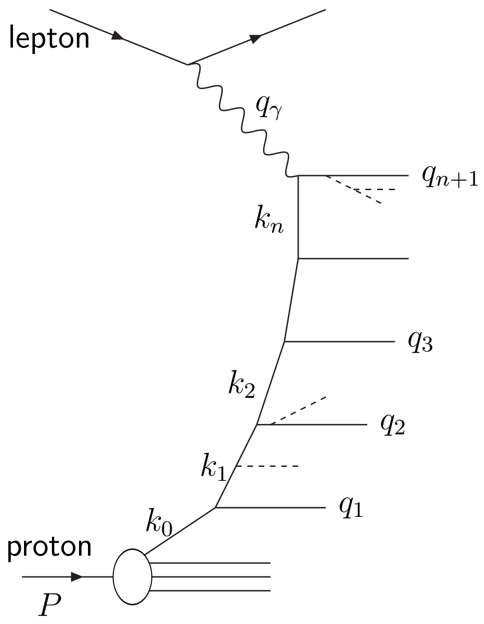
- Reformulation of CCFM suitable for Monte Carlo
- Straight forward to add quarks and non-singular terms

Linked Dipole Chain Model



- Reformulation of CCFM suitable for Monte Carlo
- Straight forward to add quarks and non-singular terms
- Easy to compare with less inclusive quantities

Linked Dipole Chain Model



- Reformulation of CCFM suitable for Monte Carlo
- Straight forward to add quarks and non-singular terms
- Easy to compare with less inclusive quantities
- Generates the unintegrated densities directly

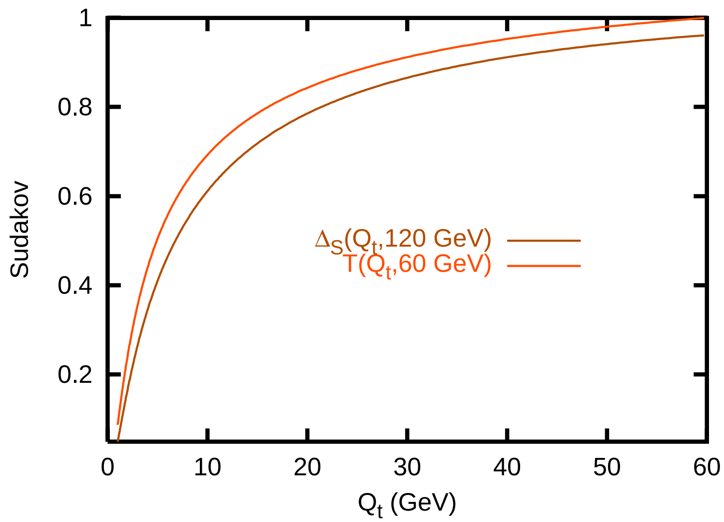
LDC needs a cutoff, $k_{\perp 0}$, below that we use non-perturbative input densities.

$$L = \left[\frac{\pi}{(N_c^2-1)b} \left(\int_{k_{\perp 0}^2}^{M^2} \frac{dQ_t^2}{Q_t^4} R_g^2 \mathcal{G}(x, Q_t^2, Q_t^2) \mathcal{G}(x, Q_t^2, Q_t^2) \Delta_S(Q_t^2, M^2) \right.\right.$$
$$\left.\left. + \; R_g^2 g_0(x, k_{\perp 0}^2) g_0(x, k_{\perp 0}^2) \Delta_S(k_{\perp 0}^2, M^2)/k_{\perp 0}^2 \right) \right]^2$$

$$f_g(x, x', Q_t^2, M^2) = R_g \sqrt{\Delta_S(Q_t^2, M^2)}\, \mathcal{G}(x, Q_t^2, Q_t^2)$$

$$\ln T(Q_t, M/2) = -\int_{Q_t^2}^{M^2/4} \frac{\alpha_s(k_\perp^2)}{2\pi} \frac{dk_\perp^2}{k_\perp^2} \int_0^{\frac{M}{M+2k_\perp}} \left[zP_{gg}(z) + n_f P_{qg}(z)\right] dz$$

$$\ln \Delta_S(Q_t^2, M^2) = -\int_{Q_t^2}^{M^2} \frac{\alpha_s(k_\perp^2)}{2\pi} \frac{dk_\perp^2}{k_\perp^2} \int_0^{1-k_\perp/M} \left[zP_{gg}(z) + n_f P_{qg}(z)\right] dz$$



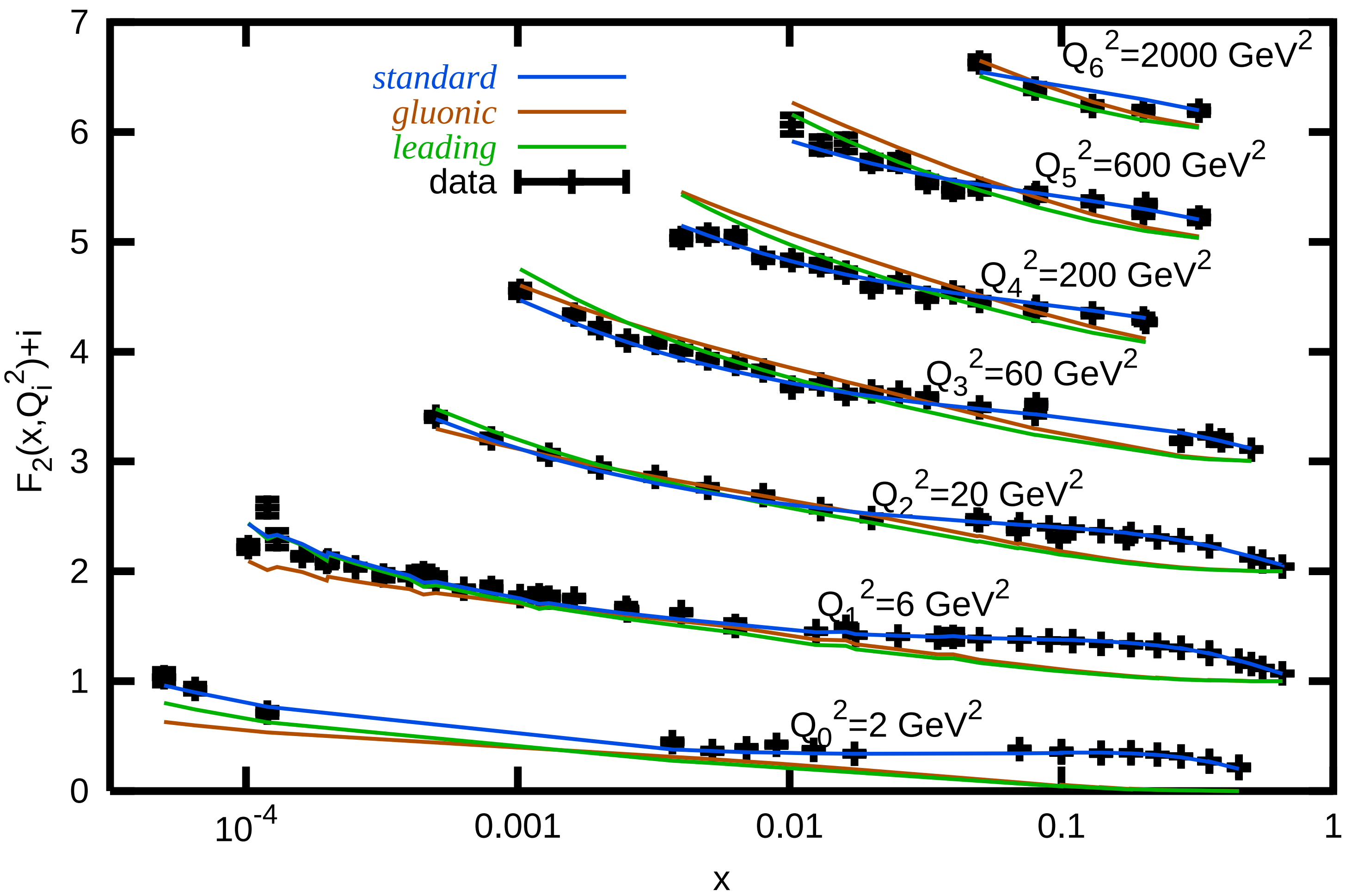
To estimate the uncertainties from the unintegrated structure function we have used three different LDC unintegrated gluon distributions which differs in the treatment of non-leading terms.

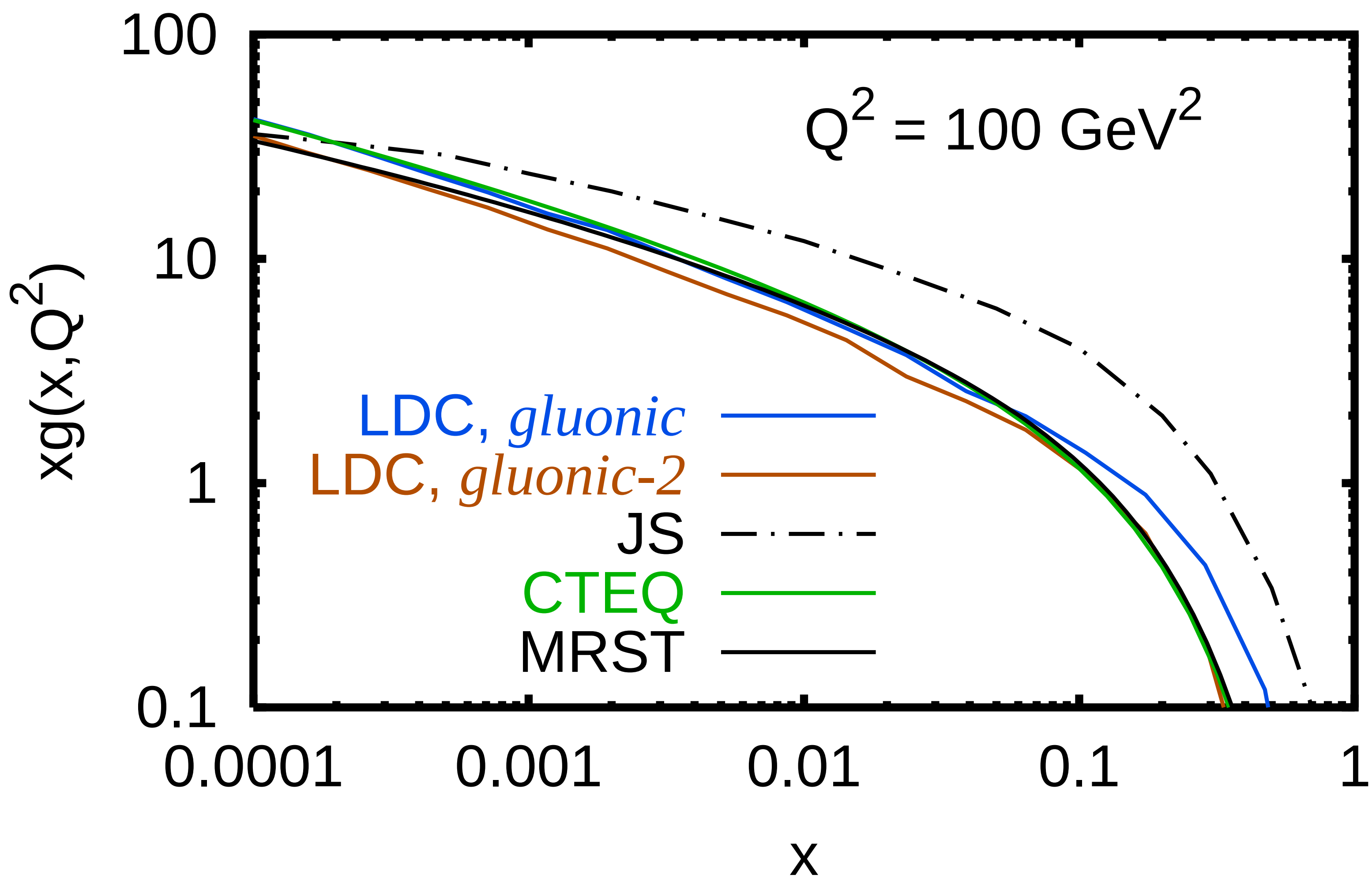
standard uses quark and gluon evolution with full splitting functions. Gives a good description of F_2.

gluonic uses only gluons with full splitting function. Gives a good description of the integrated gluon.

leading uses only gluons with only singular terms in the splitting function. Gives a good description of forward jets and b-production at the Tevatron.

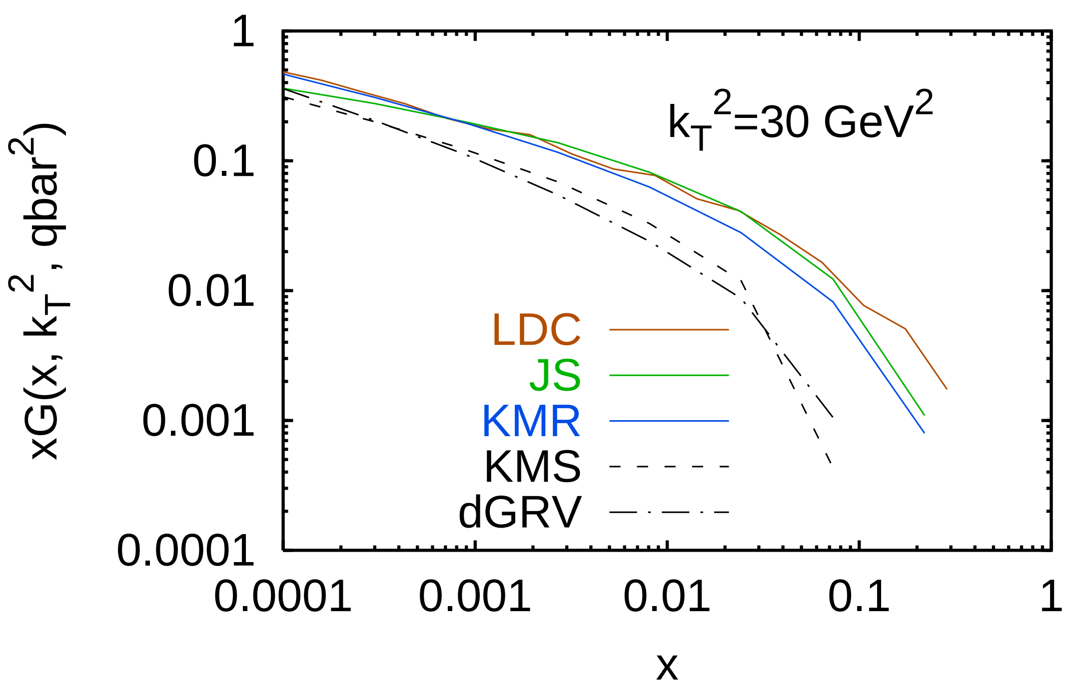
They are all extracted from generating a large number of DIS events with LDCMC and sampling the gluon density in bins of x and $k_\perp$.

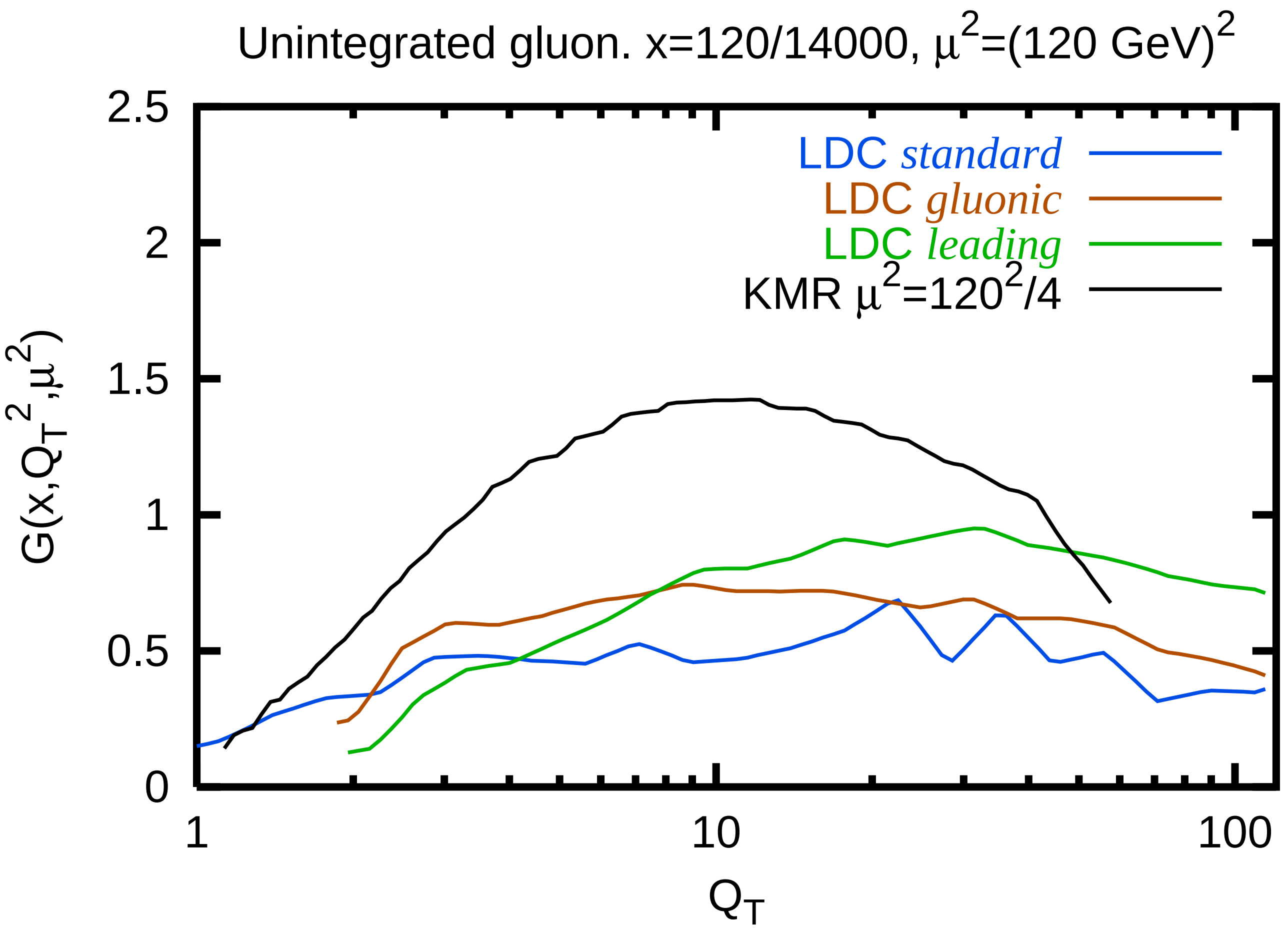

standard
gluonic
leading
data
Q_6^2=2000 GeV^2
Q_5^2=600 GeV^2
Q_4^2=200 GeV^2
Q_3^2=60 GeV^2
Q_2^2=20 GeV^2
Q_1^2=6 GeV^2
Q_0^2=2 GeV^2
$F_2(x,Q_i^2)$+i
x
0
1
2
3
4
5
6
7
10^{-4}
0.001
0.01
0.1
1



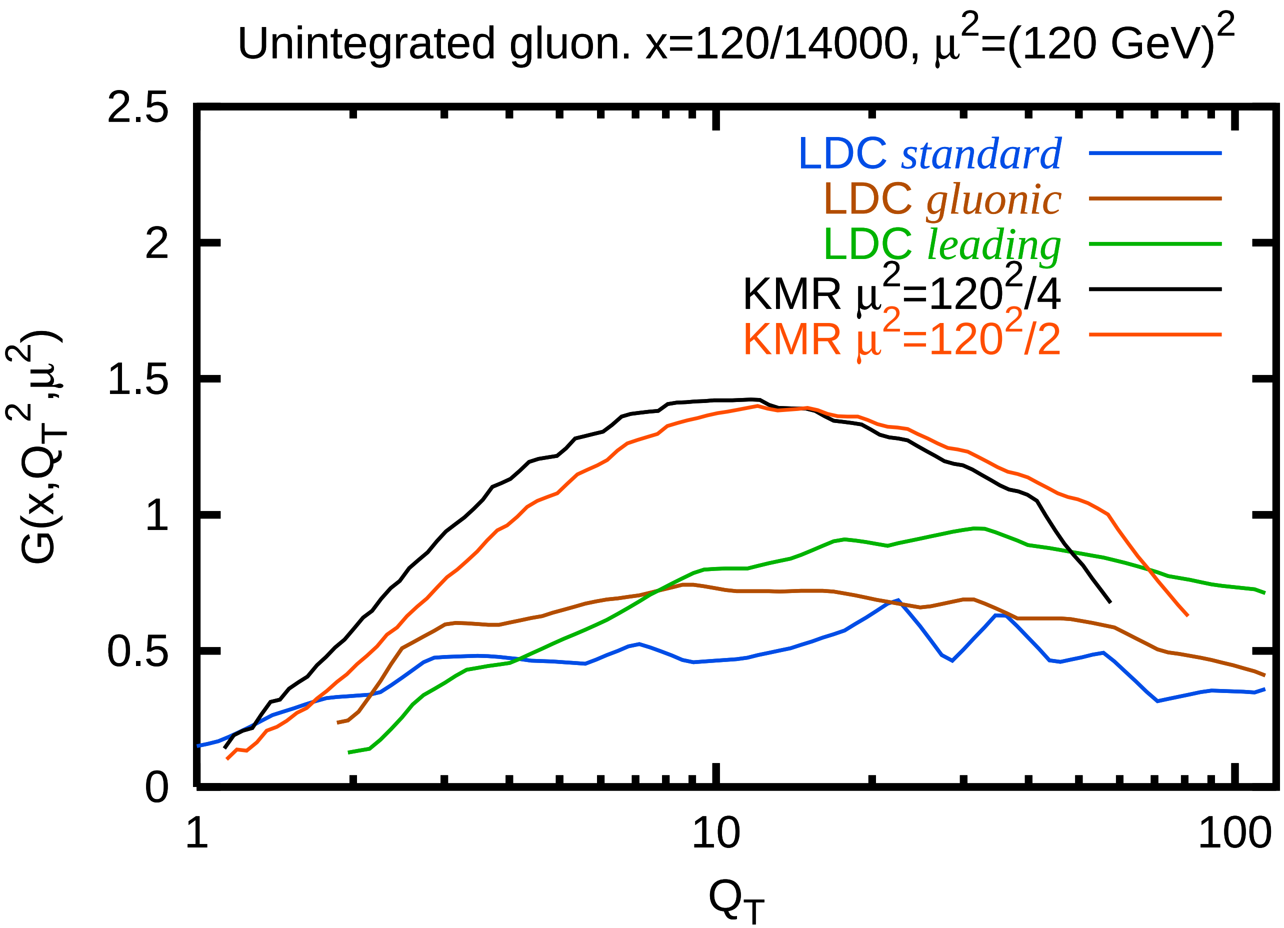
100
10
1
0.1
0.0001
0.001
0.01
0.1
1
x
xg(x,Q²)
Q² = 100 GeV²
LDC, gluonic
LDC, gluonic-2
JS
CTEQ
MRST

How well do we know the un-integrated gluon density?
$(\mathcal{L} \propto density^4)$





In the luminosity function the Sudakov hits you at small Q_T and the $1/Q_T^4$ at large. $\langle Q_T \rangle \approx 2 - 3$ GeV.



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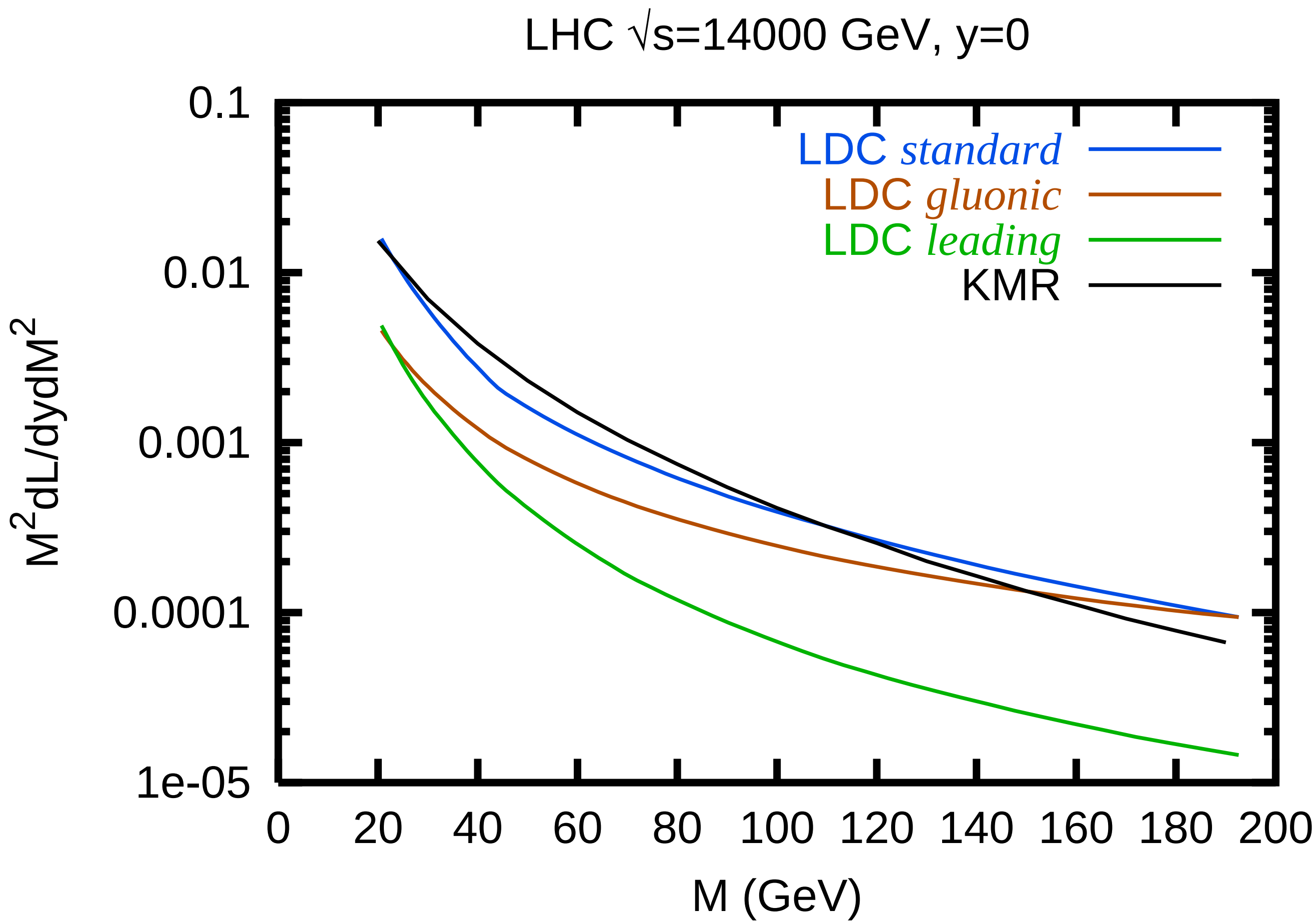
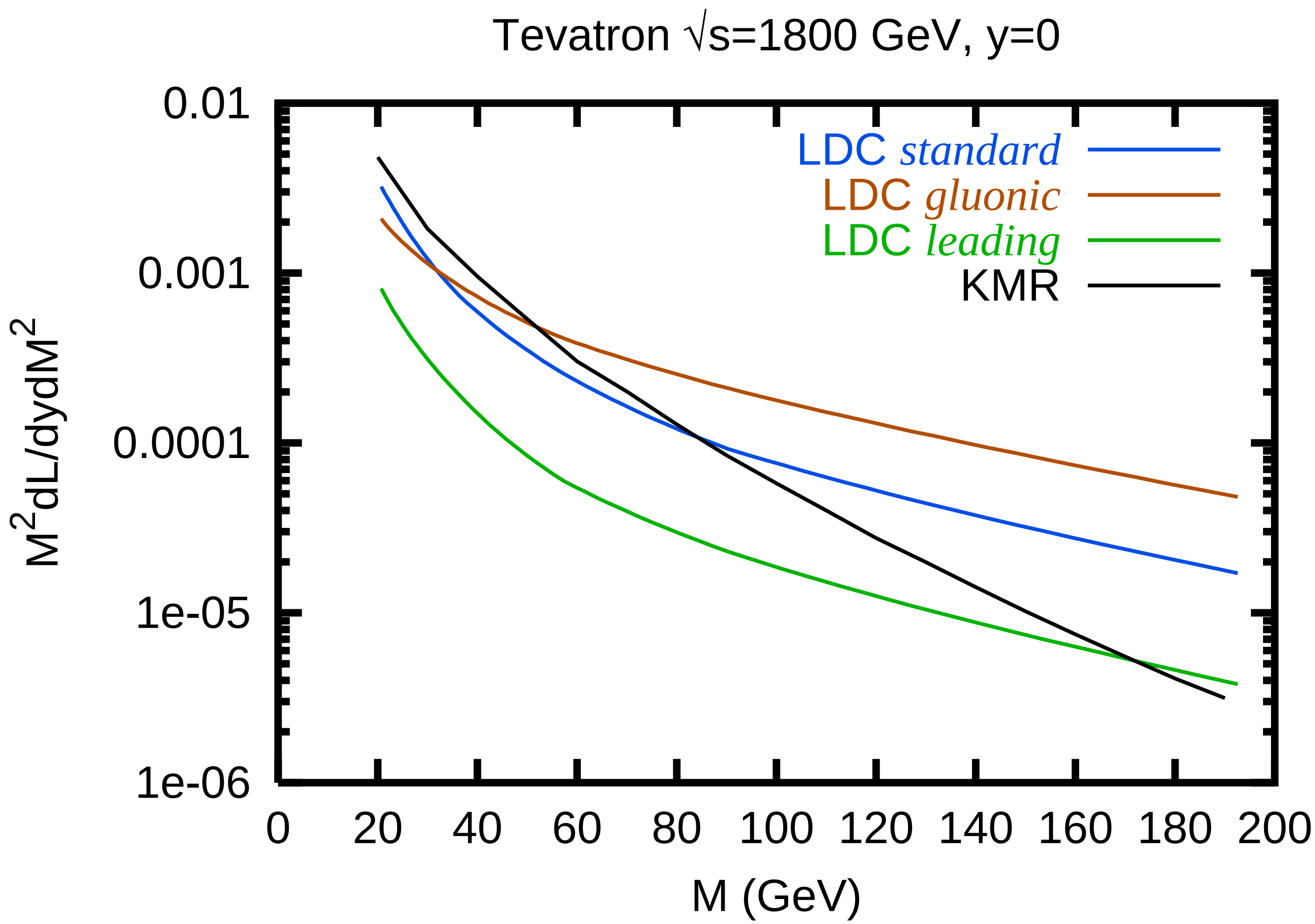
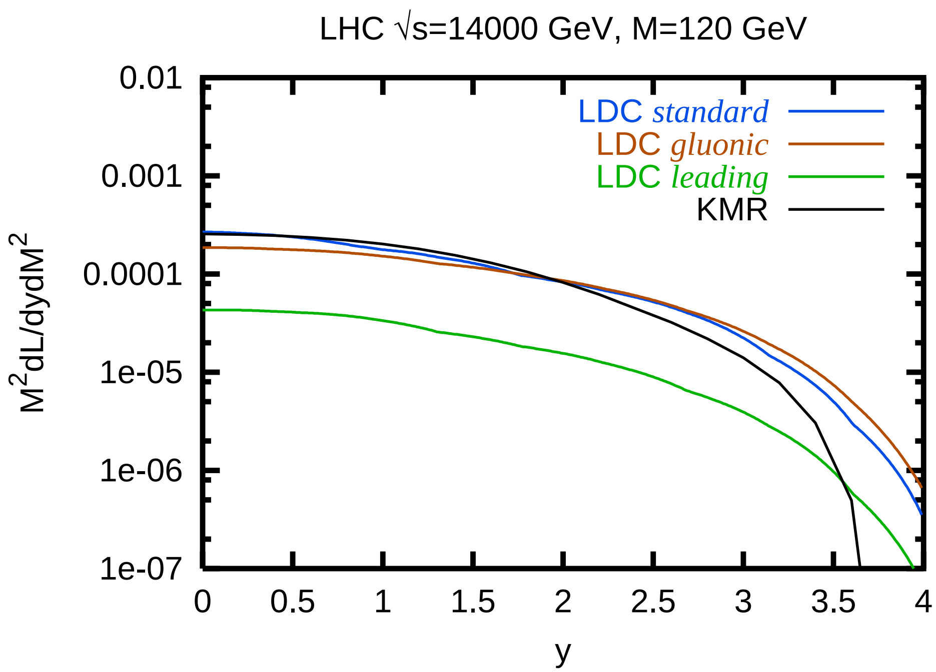
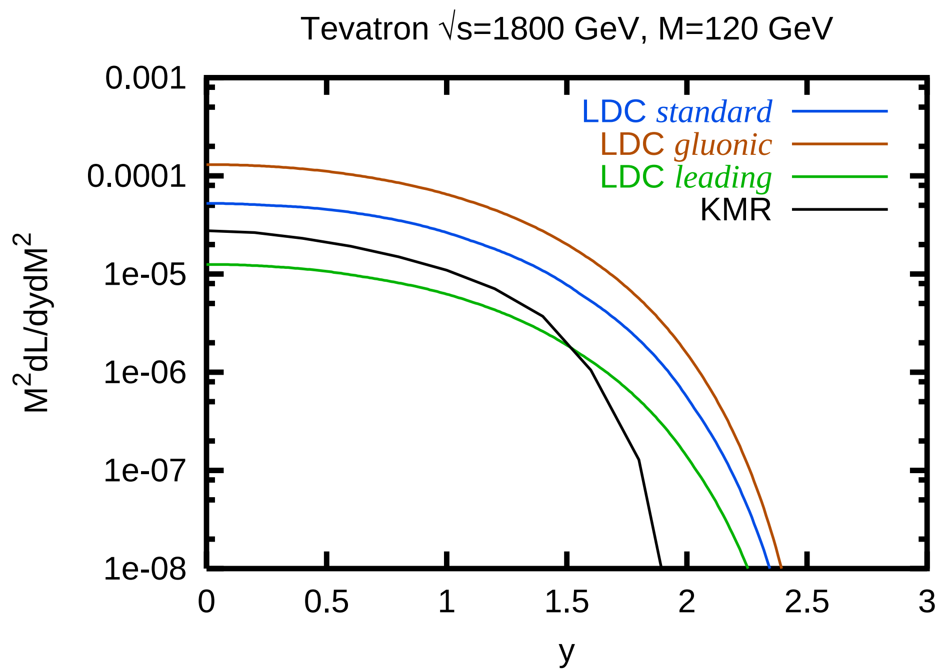
Results


LHC √s=14000 GeV, y=0
0.1
0.01
0.001
0.0001
1e-05
0
20
40
60
80
100
120
140
160
180
200
M (GeV)
M2dL/dydM2
LDC standard
LDC gluonic
LDC leading
KMR


Tevatron √s=1800 GeV, y=0
LDC standard
LDC gluonic
LDC leading
KMR
0.01
0.001
0.0001
1e-05
1e-06
0
20
40
60
80
100
120
140
160
180
200
M (GeV)
M2dL/dydM2


LHC √s=14000 GeV, M=120 GeV
LDC standard
LDC gluonic
LDC leading
KMR
M²dL/dydM²
y
0.01
0.001
0.0001
1e-05
1e-06
1e-07
0 0.5 1 1.5 2 2.5 3 3.5 4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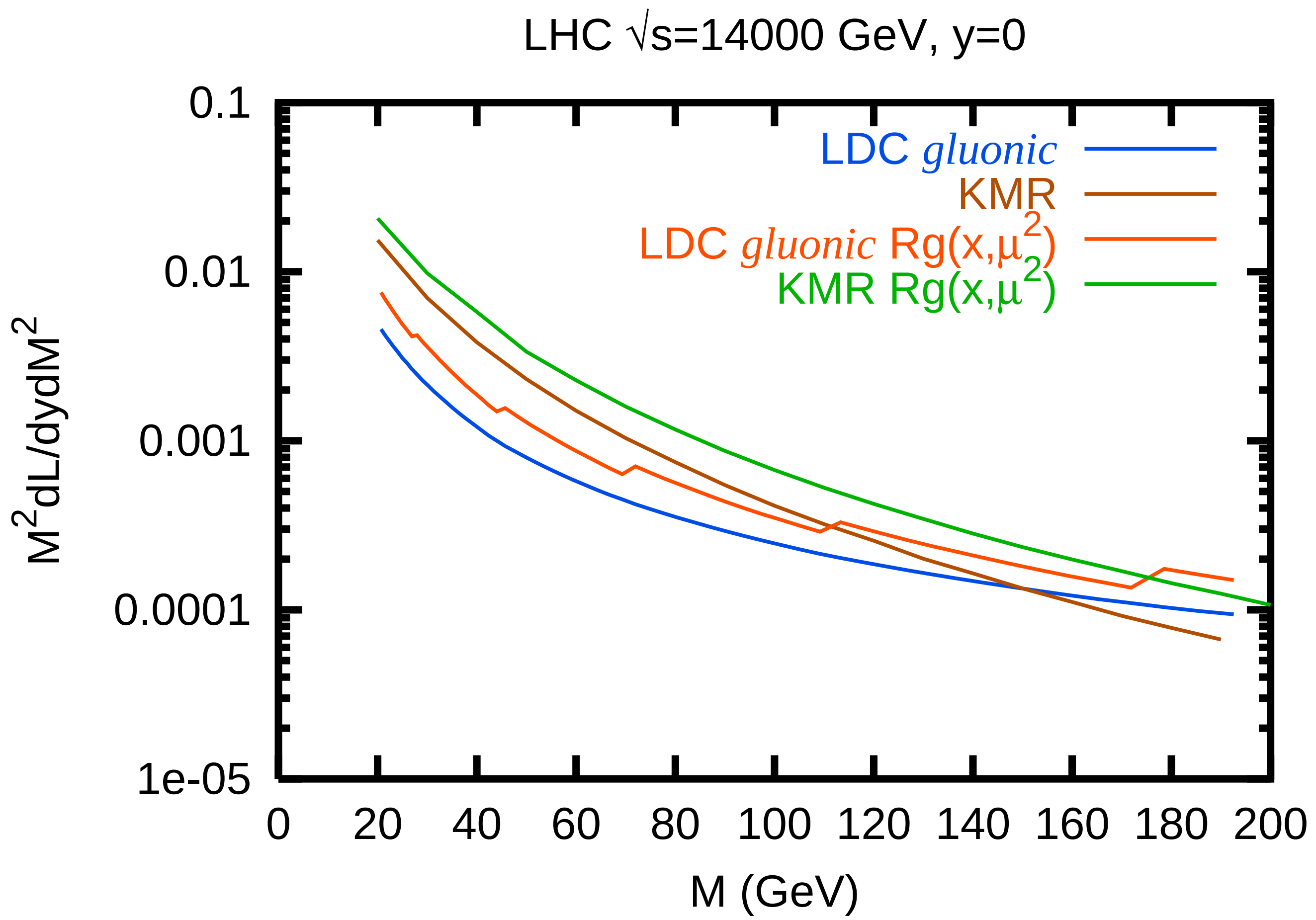
LDC gluonic
LDC leading
KMR
M²dL/dydM²
y
0.001
0.0001
1e-05
1e-06
1e-07
1e-08
0 0.5 1 1.5 2 2.5 3


LHC √s=14000 GeV, y=0
0.1
0.01
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0.0001
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20
40
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80
100
120
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180
200
M (GeV)
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LDC gluonic
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LDC gluonic Rg(x,μ2)
KMR Rg(x,μ2)

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- Sensitive to the k_t dependence of the uPDF at around $k_t = 2 - 3$ GeV
- The k_t-dependence is poorly constrained experimentally
- More studies are needed

Questions

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- What angular ordering condition should we use in the Sudakov?
- How should we treat the R_g-factor?