Flavor content of initial state cascades

H. Jung, DESY
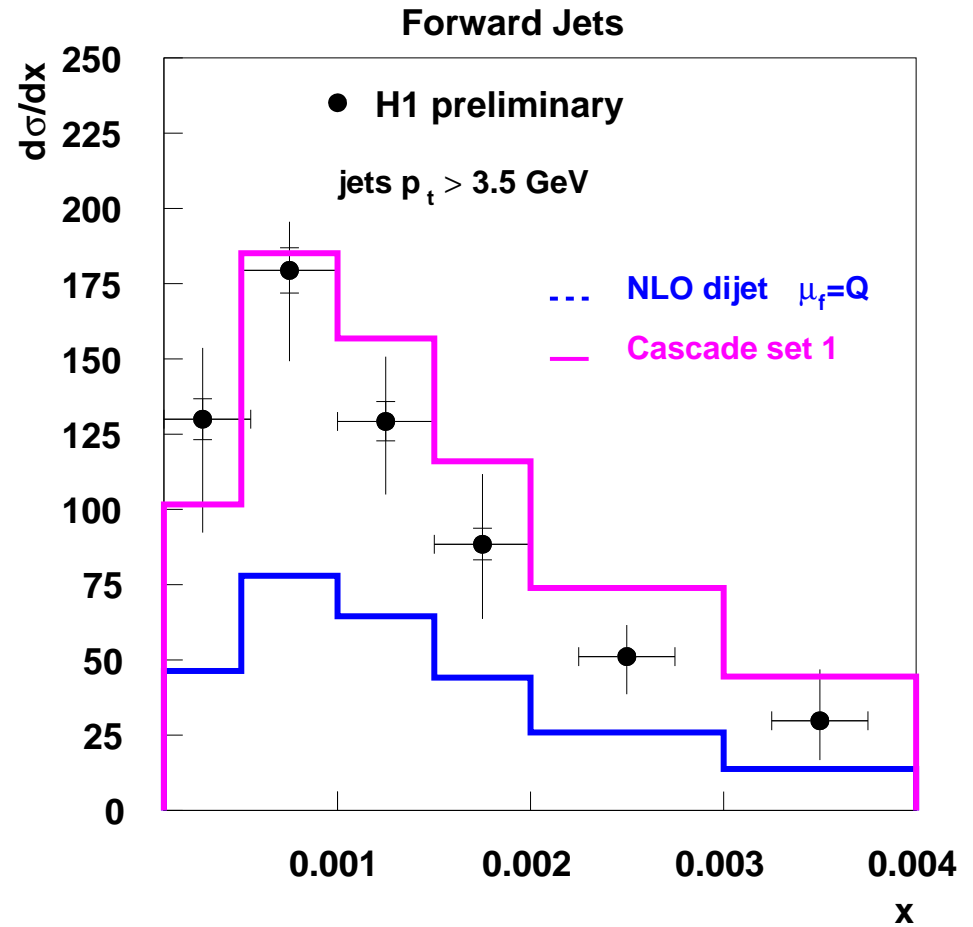
- the problem: fwd-jets and fwd-pions at HERA
- unintegrated gluons and unintegrated quarks
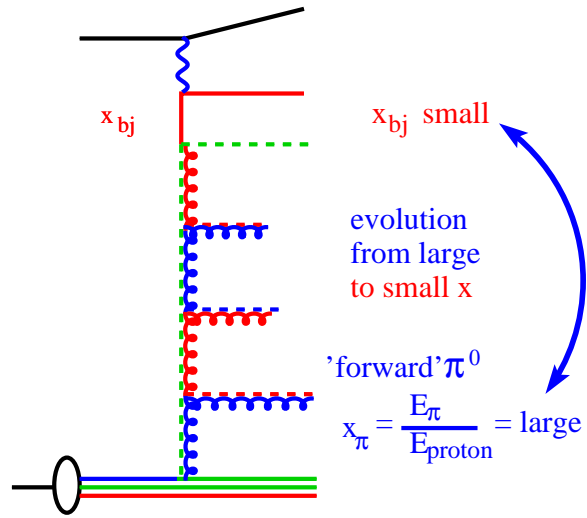- relevance for HERA and LHC

The problem at small x: Forward Jets I

x_{bj}

x_{bj} small

evolution
from large
to small x

'forward' jet

$x_{jet} = \dfrac{E_{jet}}{E_{proton}} = $ large
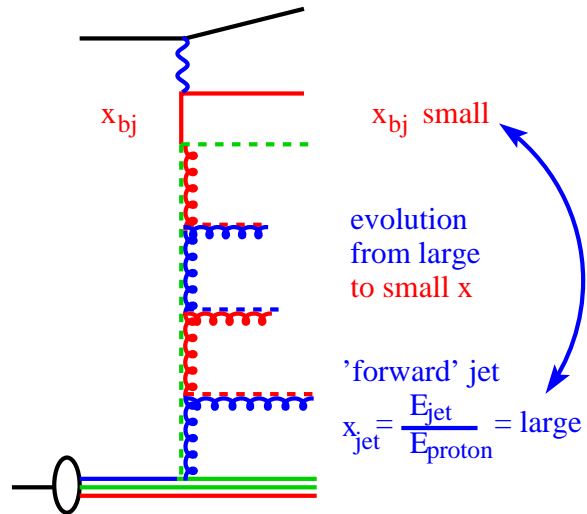
DIS : $5\ \text{GeV}^2 < Q^2 < 75\ \text{GeV}^2$
forward jet (incl. k_t algorithm)
$7.0^o < \theta_{jet} < 20.0^o$
$x_{jet} > 0.035$
$0.5 < \dfrac{p^2_{t\ jet}}{Q^2} < 2$

Forward Jets

$d\sigma/dx$

- **H1 preliminary**

jets p$_t$ > 3.5 GeV

... **NLO dijet μ_f=Q**

— **Cascade set 1**

x

DGLAP too small, need for
k_t factorisation with BFKL or CCFM ???

The problem at small x: Forward π^0 I

x_{bj}

x_{bj} small

evolution from large to small x

'forward' π^0

$x_\pi = \dfrac{E_\pi}{E_{proton}} = \text{large}$

DIS : forward π^0 (instead of jet)

$5^o < \theta_\pi < 25.0^o$

$x_\pi > 0.01$

DGLAP too small, need more:

- **CCFM too small at small x !?!**
- **WHY ?!?**

$d\sigma_\pi/dx$ [nb]

$2 < Q^2 < 4.5$ GeV^2

- H1 preliminary

CCFM (CASCADE)
DGLAP

$4.5 < Q^2 < 15$ GeV^2

$15 < Q^2 < 70$ GeV^2

$p_{T,\pi}^* > 2.5$ GeV

$5^o < \theta_\pi < 25^o$

x
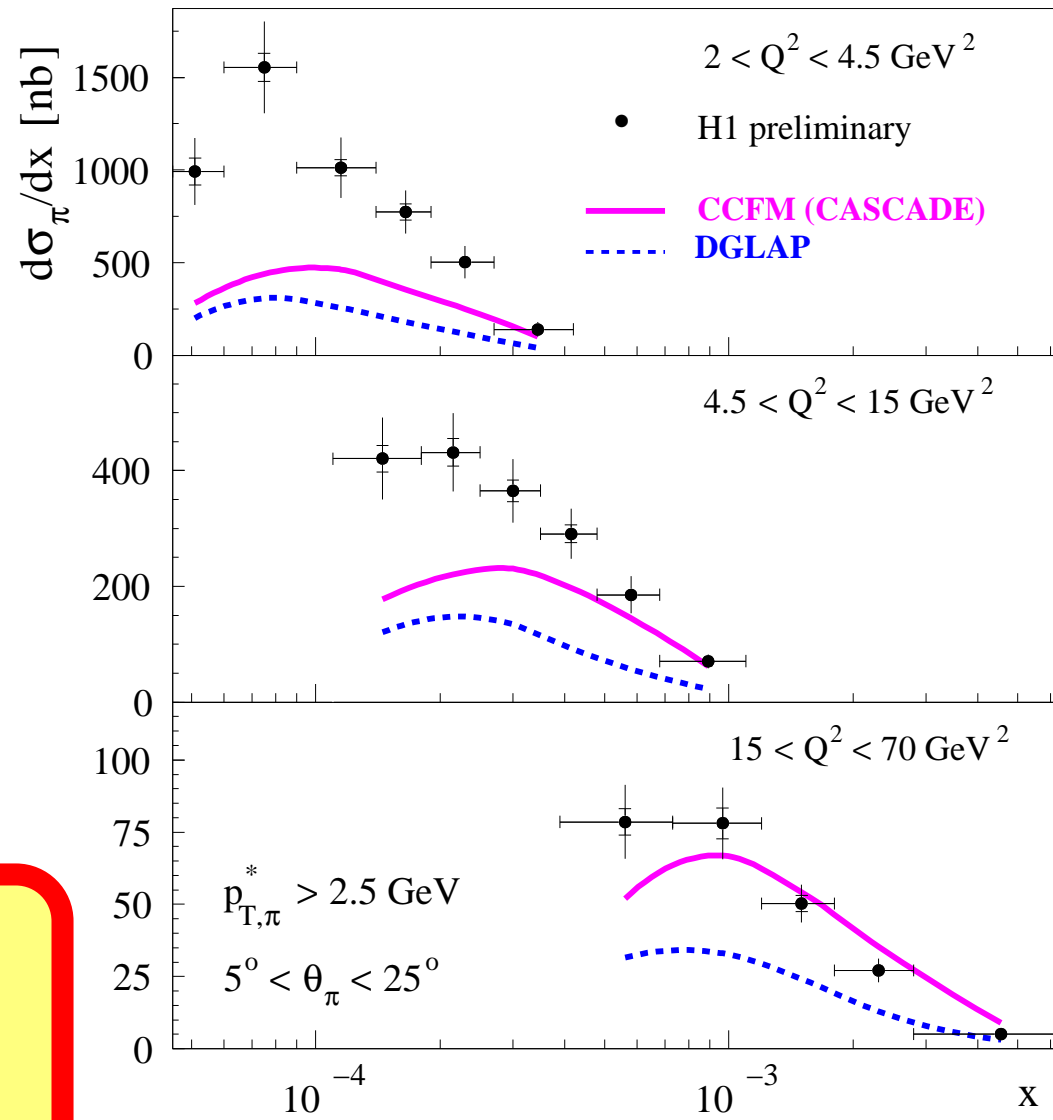
The model - CCFM and CASCADE

- **CCFM in MC generator CASCADE ... only gluons**
- **initial state CCFM cascade with strict angular ordering**
- **gluons only might be ok for jets....**
- **but ... different fragmentations for pions**
- **quarks in unintegrated pdfs...... important for pions**
- **different splitting functions**
- **different scale behavior....**

How to measure it ???

Relevance for LHC ???

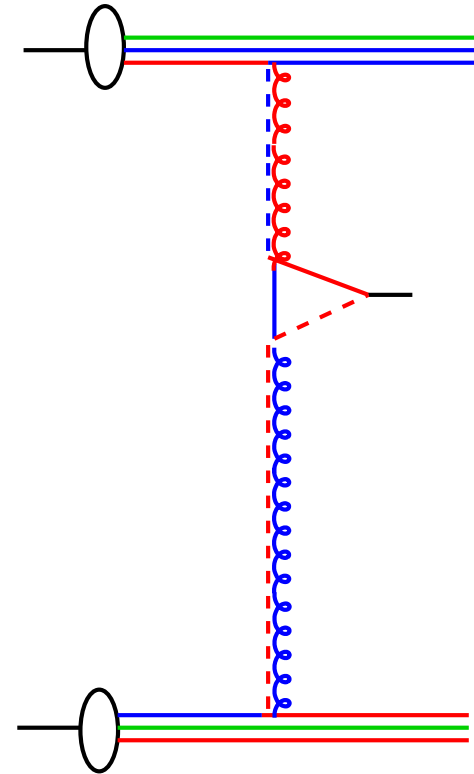# Differentiate unintegrated density quarks and gluons

- **identify quarks (heavy quarks or jets)** reconst. 4 jets

- **measure** $\cos\theta^*$ ... **test propagator in initial state cascade** !!!
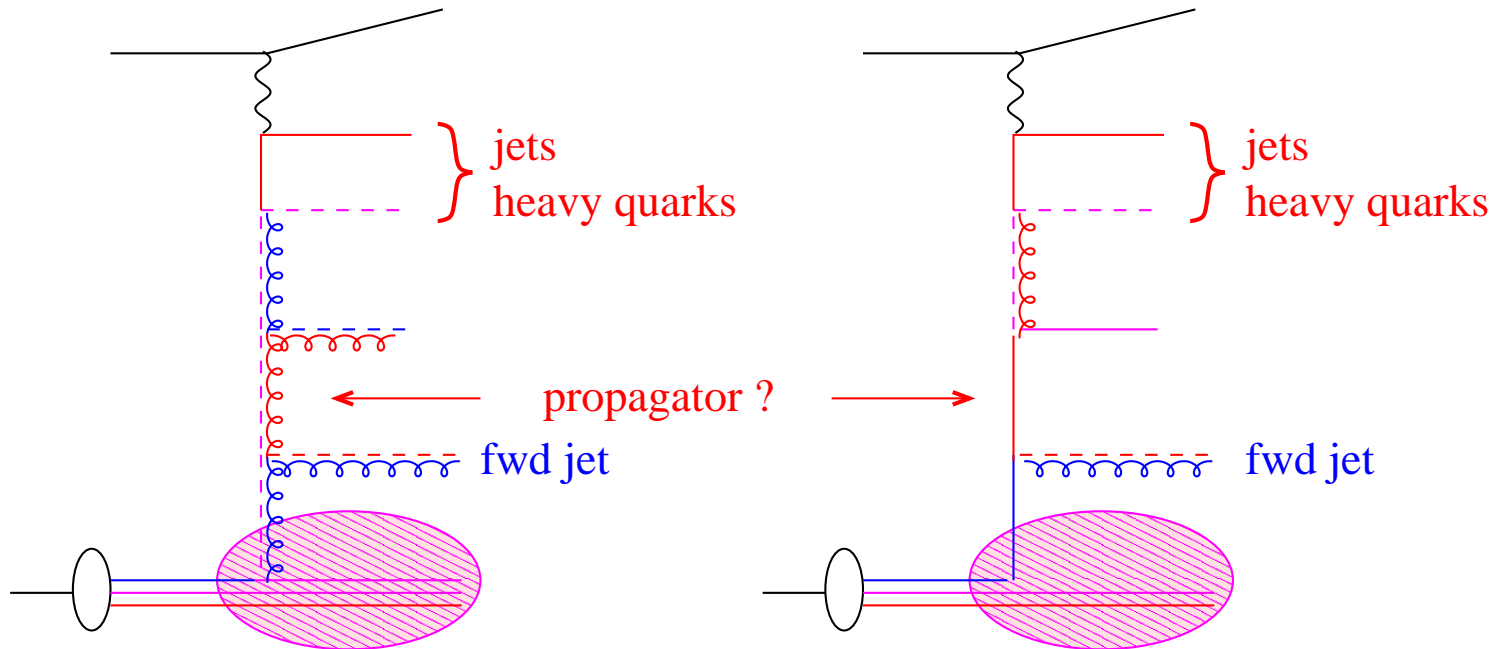
- **measure contribution of quark initiated fwd-jet production**
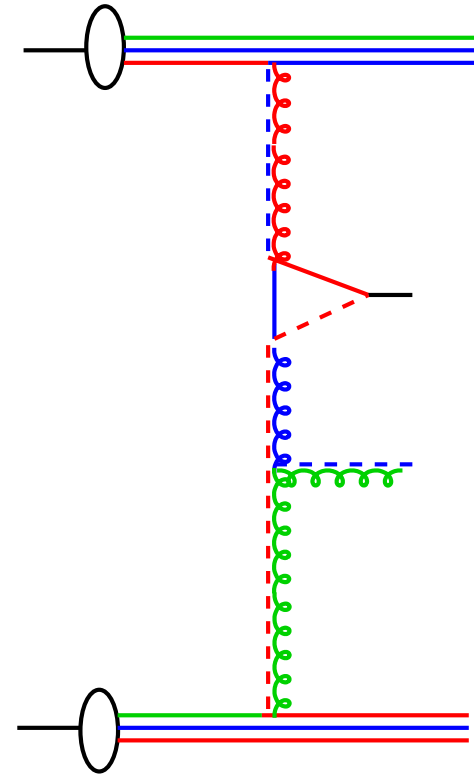
- **measure unintegrated quark density ????....**

Higgs production at LHC

- search for Higgs ...

- basic process:
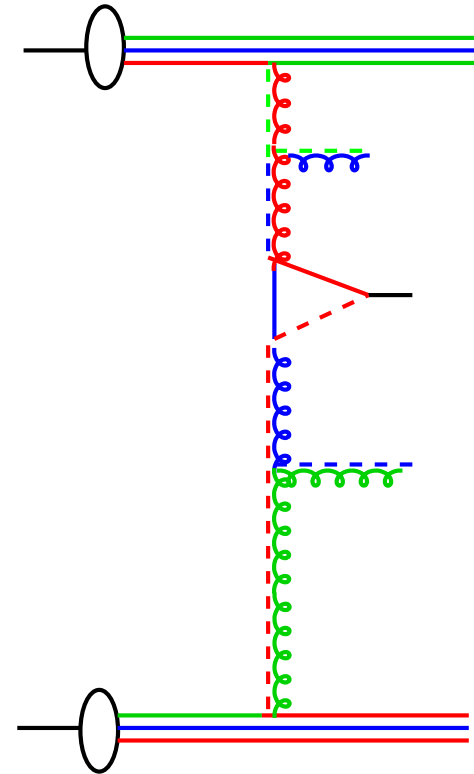 LO $\mathcal{O}(\alpha_s^2)$ gg $\rightarrow$ Higgs

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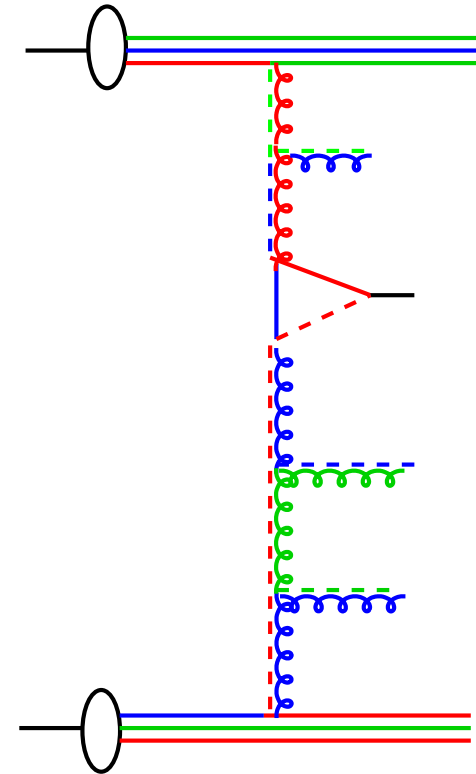
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- available only: NLO + NNLL resummation....
 Bozzi et al (PLB 564 (2003) 65, hep-ph/0302104)

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- calculate gg $\to$ Higgs in k_t factorisation

- small x approximation and for for $m_t \to \infty$
  F. Hautmann, PLB 535 (2002) 159

- obtain NNLO correction to gluon-gluon
  x-section for $x \ll 1$

- estimate higher order corrections ...

- get resummation to all orders
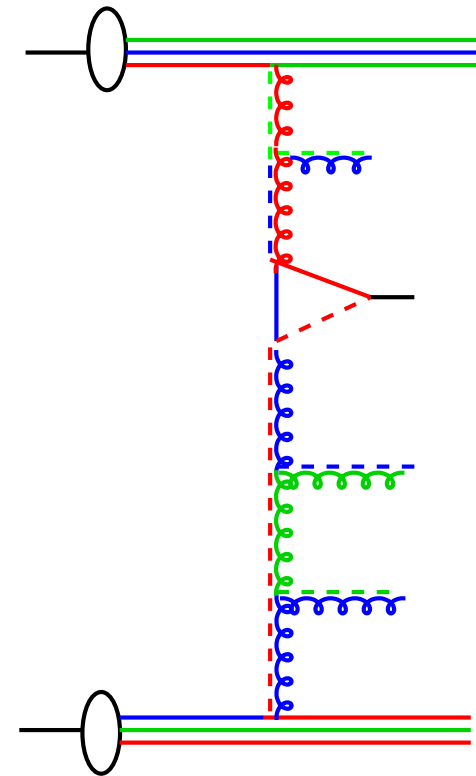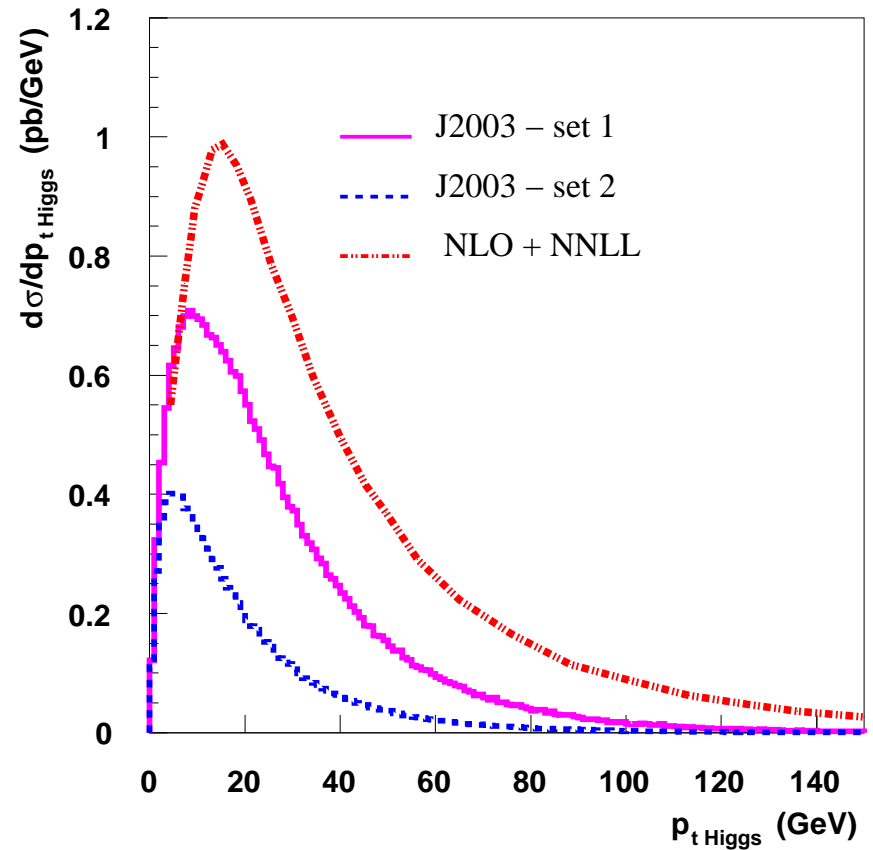
Higgs production at LHC

- use new matrix element (off-shell)
  F. Hautmann, PLB 535 (2002) 159

- calculate q_T spectrum with CCFM unintegrated gluon:
  two sets, both determined from HERA

- sensitive to trans. mom. of gluons

- **new approach to calculate Higgs prod. at LHC**
- **important for x-section estimate**
- **different result than NLO ...**
- **better constrain unintegrated gluon ...**
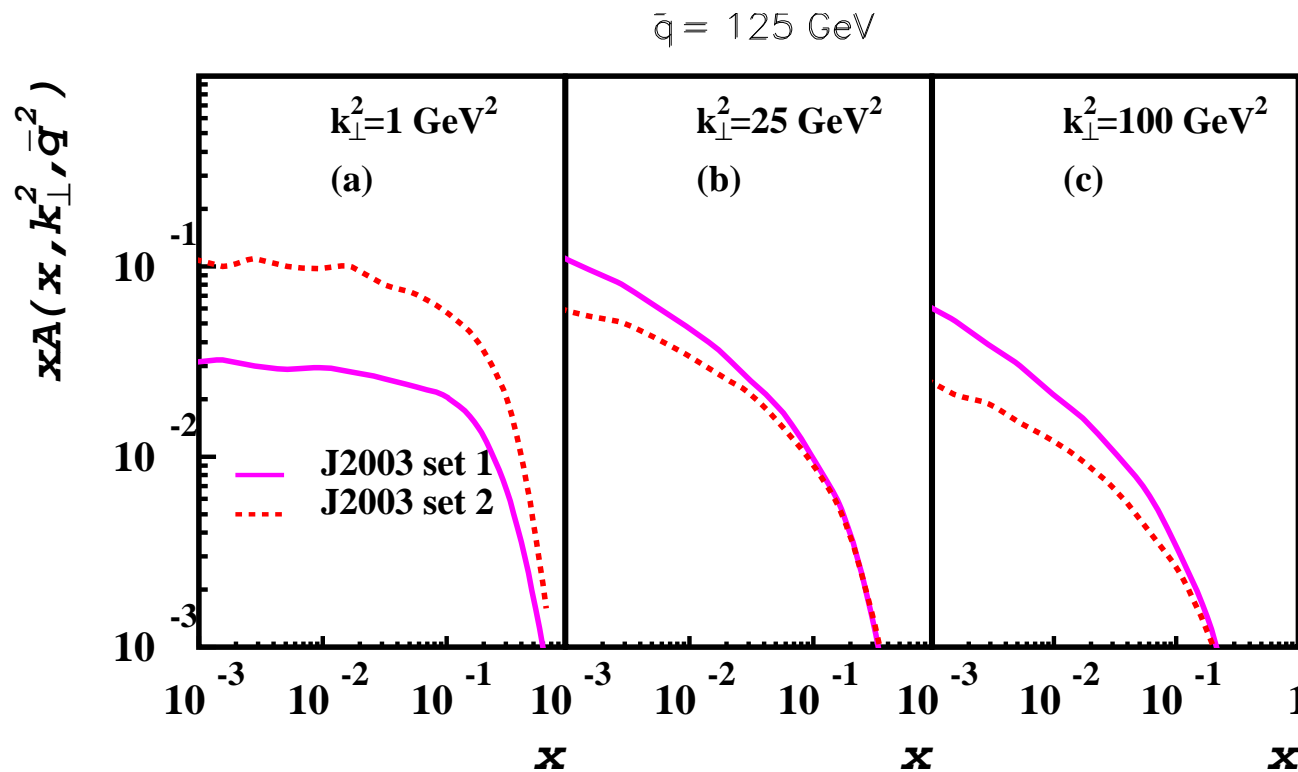
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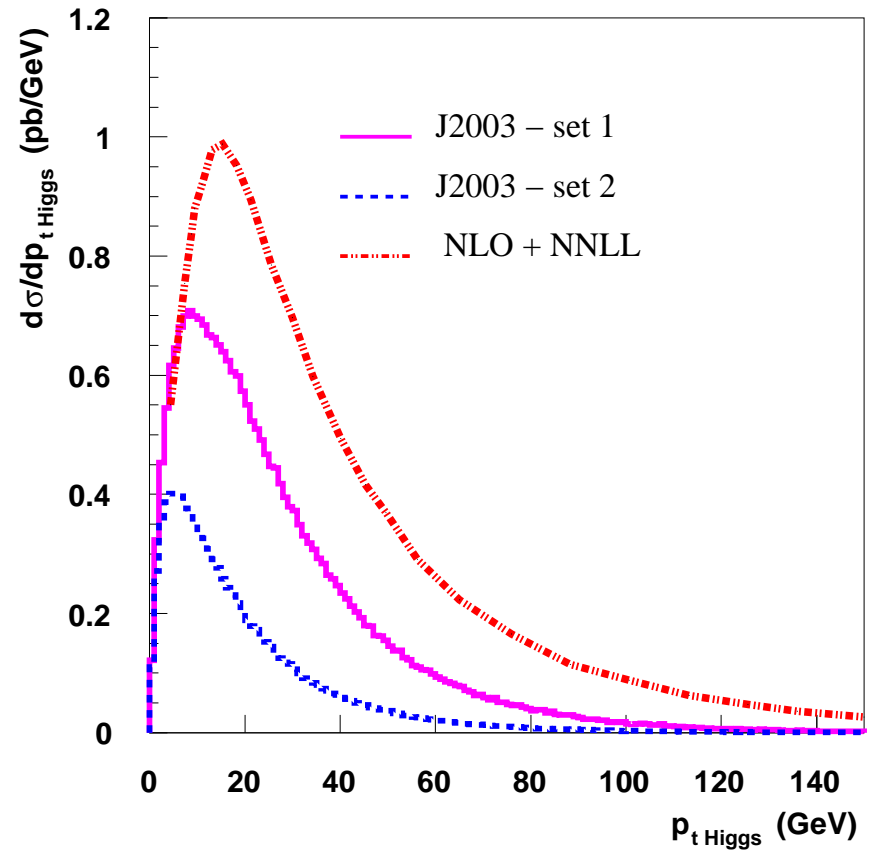
- sensitive to trans. mom. of gluons

- up to now only gluon initiated cascades

- BUT, what about quark initiated cascades?

- new approach to calculate Higgs prod. at LHC
- important for x-section estimate
- different result than NLO ...
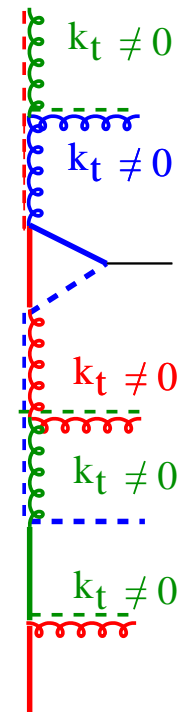- better constrain unintegrated gluon ...

Higgs production at LHC

- gluon density at $\bar{q} = m_{\text{higgs}}$

- only gluon chains included

$\bar{q} = 125$ GeV

- $k_\perp^2 = 1$ GeV^2 (a)
- $k_\perp^2 = 25$ GeV^2 (b)
- $k_\perp^2 = 100$ GeV^2 (c)

J2003 set 1
J2003 set 2

$xA(x, k_\perp^2, \bar{q}^2)$

- gluon densities different at large scales ....
- include also quark chains ???

- what about ?

$k_t \neq 0$

- unintegrated quarks ?

Conclusions

- k_t-**factorisation applied to** ep **and** $p\bar{p}$
- **at present only gluon chains included....**
- ☞ **need also quark chains, for high scales like Higgs prod.**
- **sensitive to flavor contents of parton cascade**
- **Higgs at LHC ... promising, but also x-sects, shapes ???**
- **new attempt to calculate higher order contributions**

detailed measurement and calculation of

unintegrated pdfs needed !!!

use it (in CASCADE) for

heavy quarks ... and Higgs ... !!!