Exclusive production of dijets at the Tevatron (and at the LHC)

Jean-René Cudell

Interactions Fondamentales en Physique et en Astrophysique (IFPA), AGO Dept., Université de Liège

with Alice Dechambre, Oscar Hernández and Igor Ivanov

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Outline

1. Interest
2. Ingredients
3. Uncertainties and IR region
4. LHC and Higgs
5. Conclusions

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3 UNCERTAINTIES AND IR REGION
4 LHC AND HIGGS
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EXCLUSIVE PRODUCTION

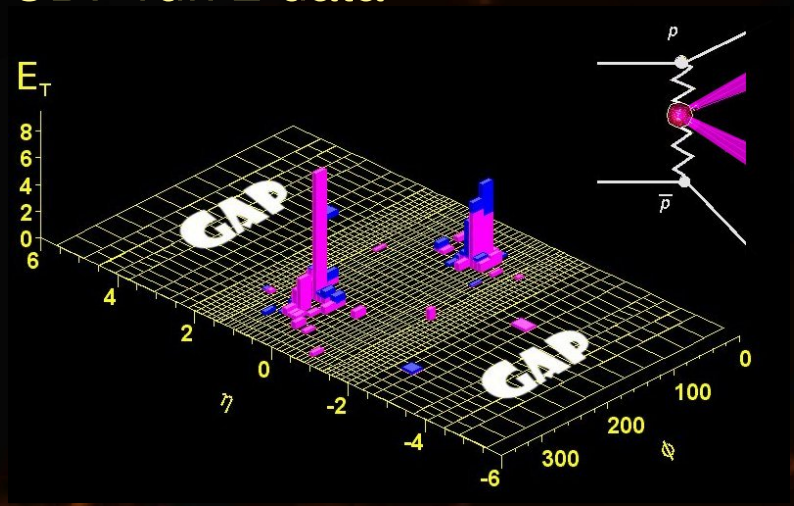
Embedding of a hard process into pomeron exchange $\rightarrow$

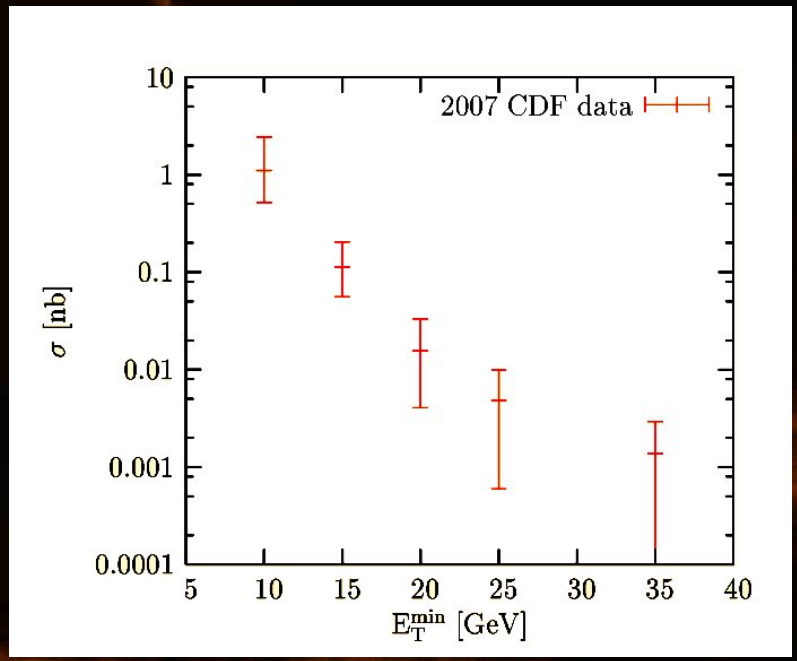
- no underlying event
- little background if sharp resonance and measurement of the hadronic energy
- discovery tool for new physics decaying into hadrons

But is the rate sufficient?

JET DATA

CDF run 2 data





- $\bar{p}$ measured, p reconstructed by Monte Carlo

- E_T from 10 to 35 GeV
- $\sigma =$ 1 nb to 1 pb
- M_{jj} up to 135 GeV $\approx M_H$

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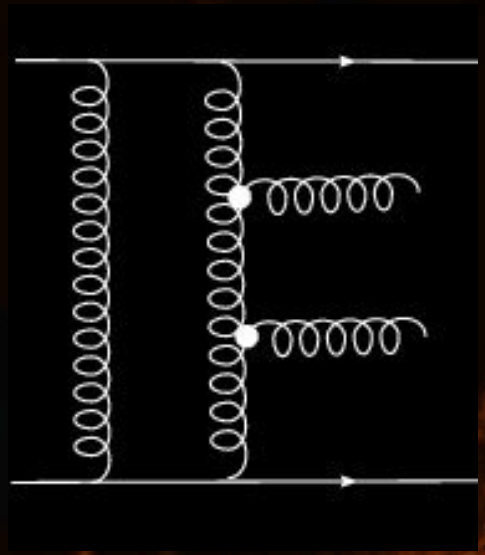
BASIC INGREDIENTS

- Partonic singlet exchange:
  - $qq \to q + gg + q$
- Embed in hadrons:
  - $p\bar{p} \to p + gg + \bar{p}$
- Large vertex corrections
- Large screening corrections
- Make jets:
  - $p\bar{p} \to p + JJ + \bar{p}$

Collins-Berera



- fully calculable
- exact kinematics in $\perp$ plane
- $\sigma = \infty$ (IR divergence)

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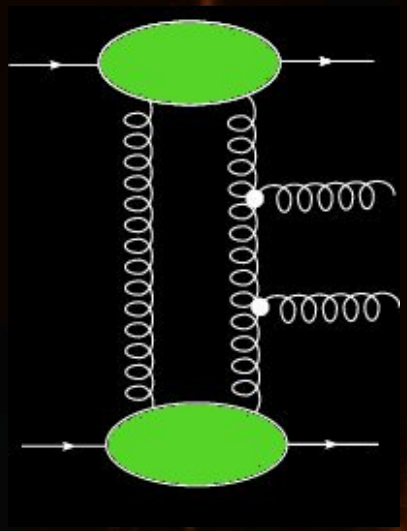
Cheng-Wu, Soper-Gunion



- regulates IR region
- changes the mass dependence
- $\sigma(E_T > 10\ \mathrm{GeV}) \approx 600$ nb

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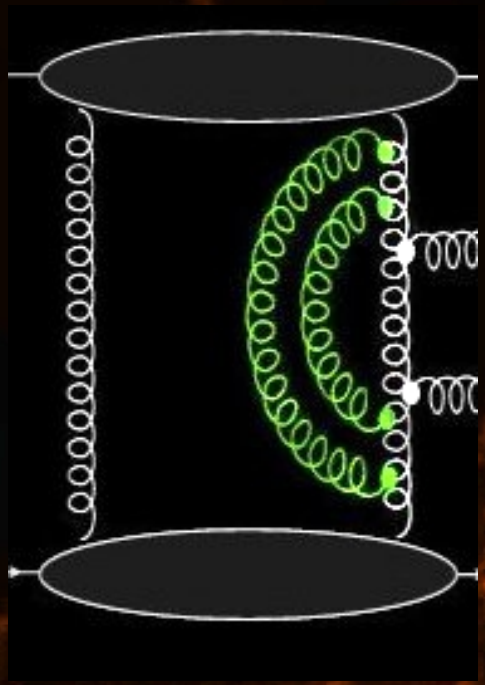
Diakonov-Dokshitzer-Trojan, Kaidalov-Khoze-Martin-Ryskin



- very large correction
- double logs fully known
- $\sigma(E_T > 10\ \mathrm{GeV}) \approx 25$ nb

Basic ingredients

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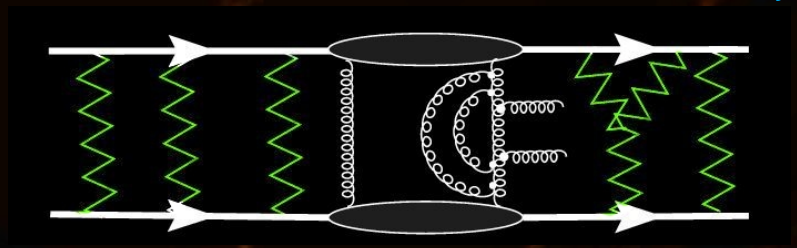
Bjorken



- under control if jet production at small distances
- otherwise depends on unitarisation scheme
- $\sigma(E_T > 10\ \mathrm{GeV}) \approx 3$ nb

Basic ingredients

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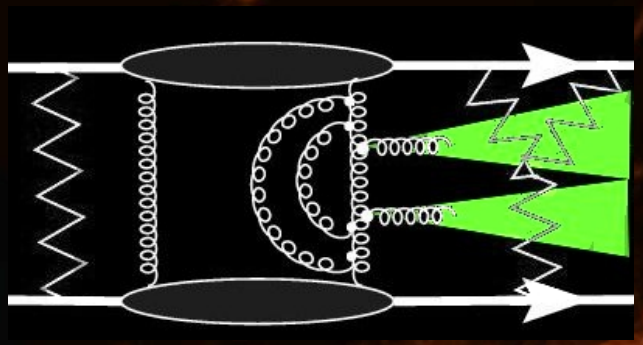
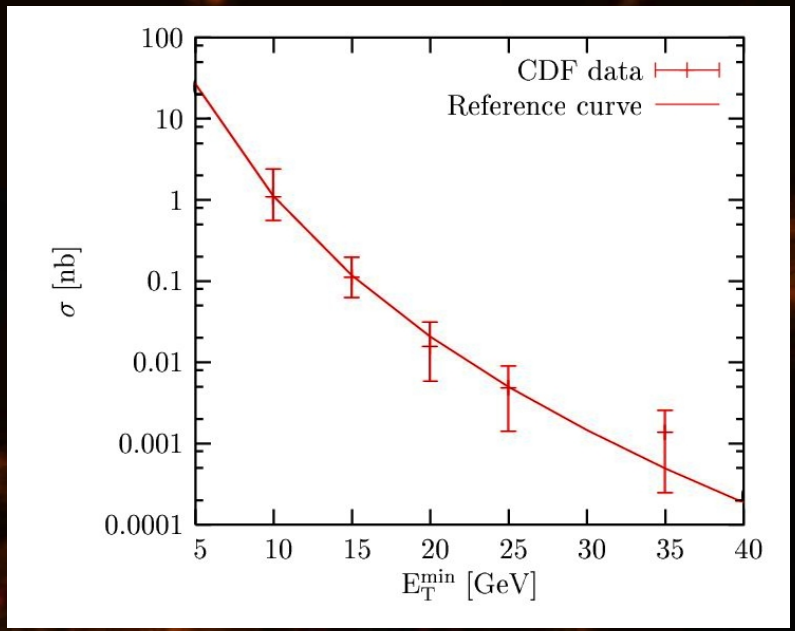
Kaidalov-Khoze-Martin-Ryskin, Salam



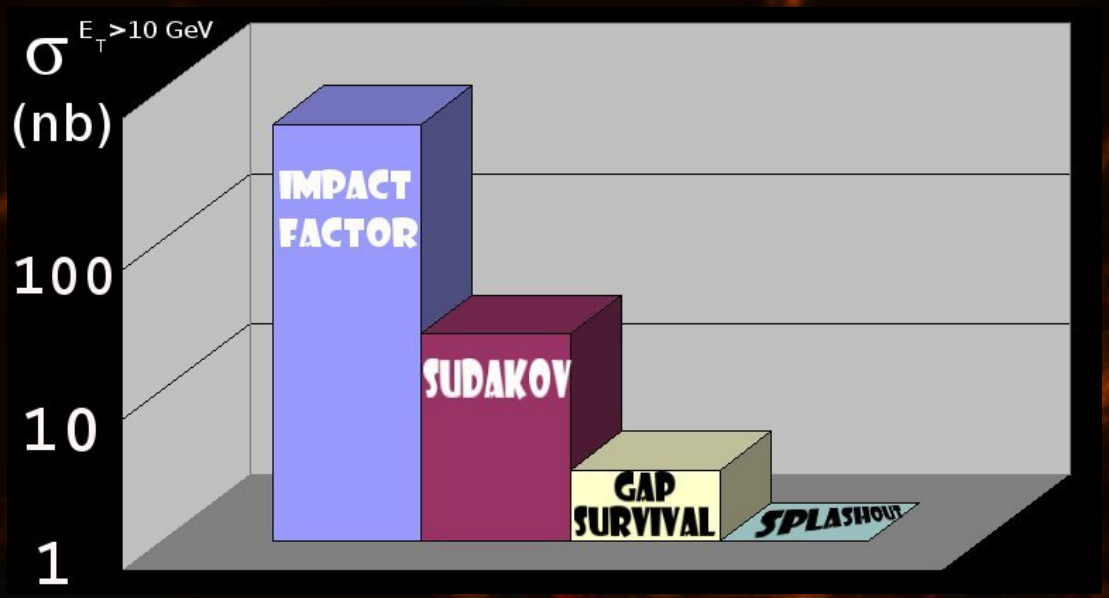
- several parametrisations
- $\sigma(E_T > 10\ \mathrm{GeV}) \approx 1$ nb

POSSIBLE RESULT

	parameter	value
hard	scale of α_S	s_{gg}
	$\Lambda^{(5)}_{QCD}$	200 MeV
Sudakov	scale of α_S	loop momentum
	$\lhd$ ordering	yes
	terms	$\log^2 + \log$+constant
	lower scale	external off-shellness
	upper scale	$k_T^2/2$
impact factor	unitegrated gluon density	fitted to F_2
gap survival	$\langle S^2 \rangle$	15%
splash-out	$E_T^{jets}/E_T^{partons}$	0.8



Huge correction factors:



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Uncertainties

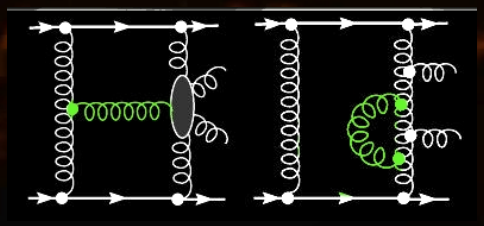
parameter	uncertainty (highest/lowest)
Sudakov	20
Impact factor	3
Gap survival	3
Splash-out	2
Total	$\sim$ 400

Example: Sudakov form factor

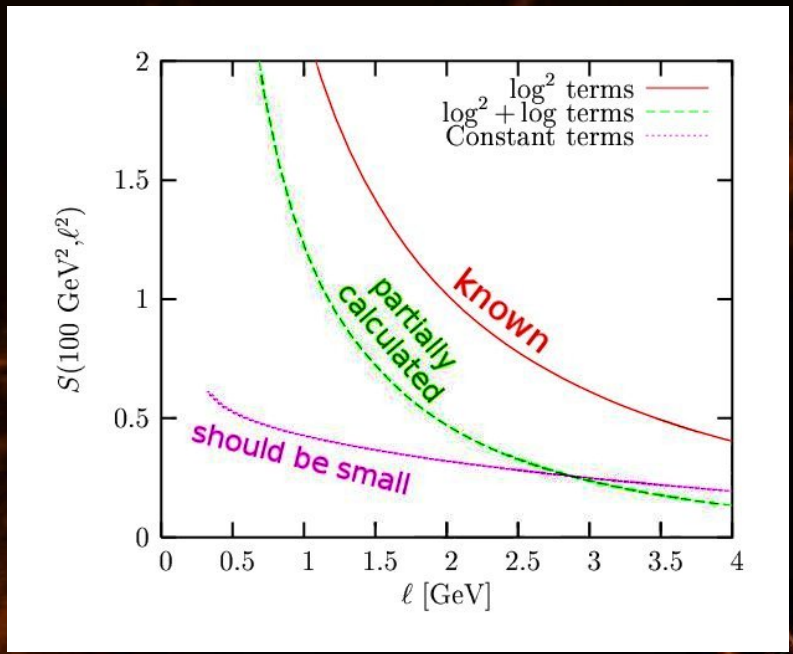
$$T(\mu^2,\ell^2)=\exp\left[-S(\mu^2,\ell^2)\right]\,,\quad S(\mu^2,\ell^2)=\int_{\ell^2}^{\mu^2}\frac{d\mathrm{q}^2}{\mathrm{q}^2}\frac{\alpha_s(\mathrm{q}^2)}{2\pi}\int_0^{1-\Delta}dz\,\left[zP_{gg}+N_fP_{gq}\right]$$

Trick: virtual corrections $\sim$1-brehmstrahlung

- true for $\log^2$
- true for *some* log

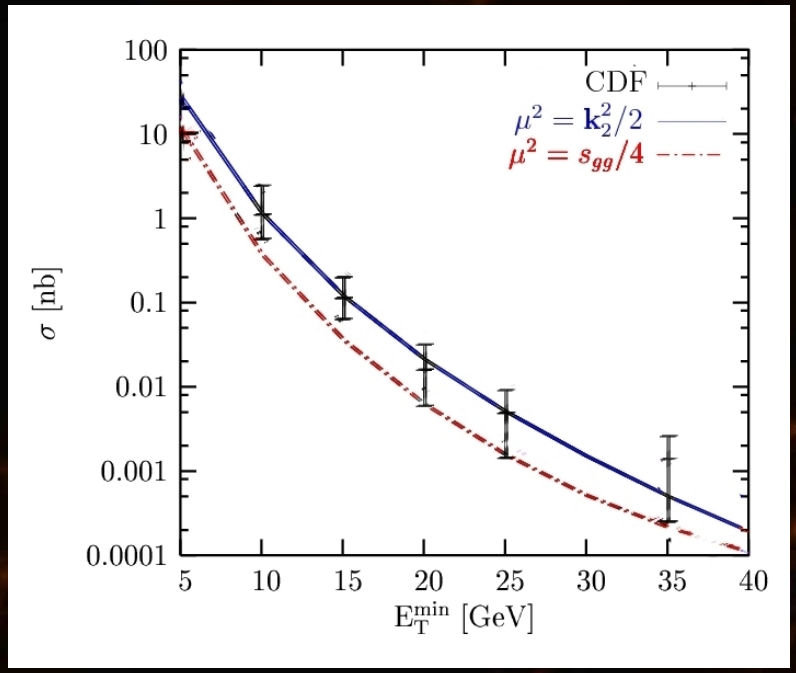


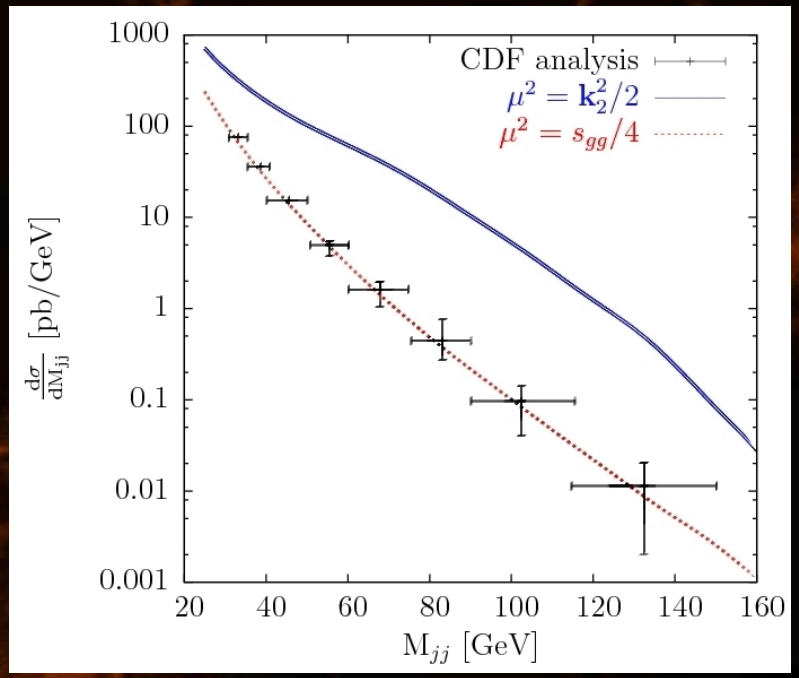
- not true for constant terms



Consequences

Two curves fitting the E_T distribution can produce very different mass distributions

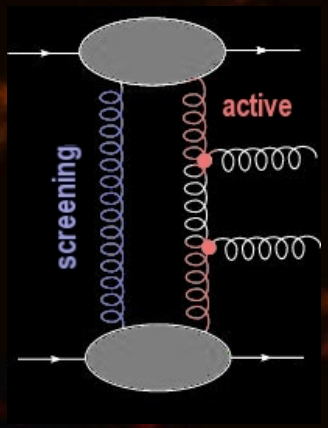


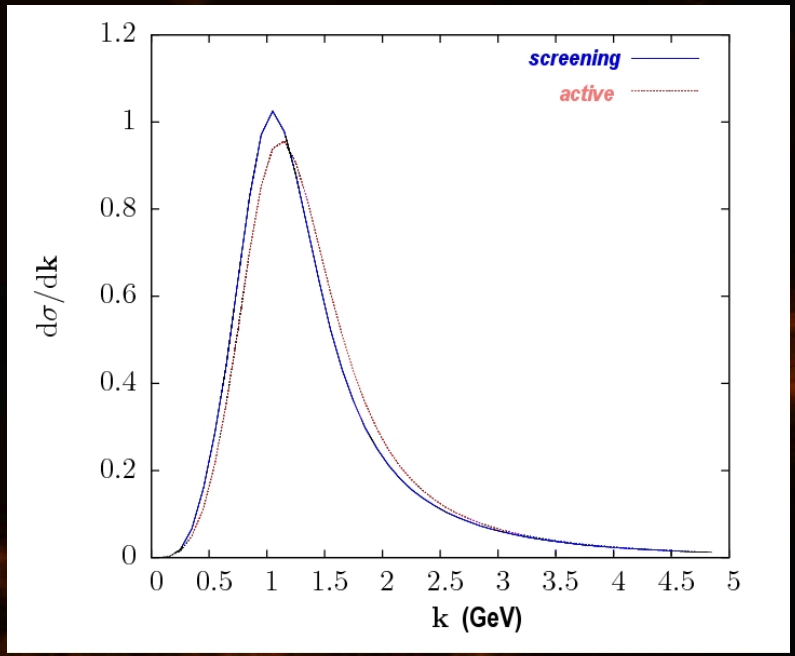


The ExHuMe Monte-Carlo use to analyse the data takes $\mu^2 = s_{gg}/2.62$.

Gluon momentum distribution

- One can write $\sigma = \int dk \frac{d\sigma}{dk}$ with k the (non-measurable) momentum of one of the internal gluons.





- Only 30% of the cross section comes from the phase-space region with all off-shellnesses > 1 GeV.

The calculation is tentative

at best !

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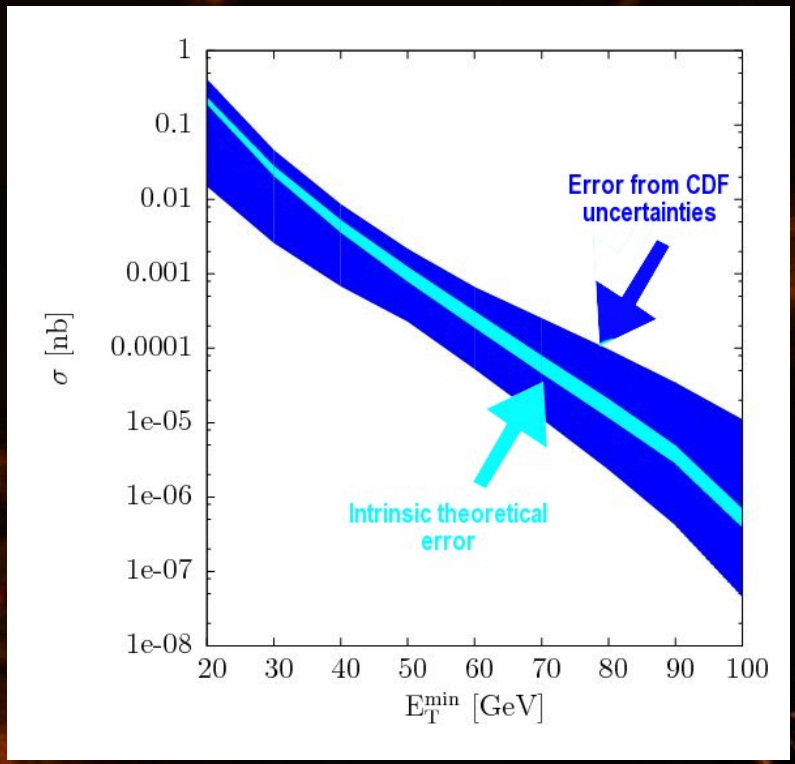
LHC DIJETS

One can predict the jet LHC cross section using the CDF result to calibrate it

- For typical cuts of FP420

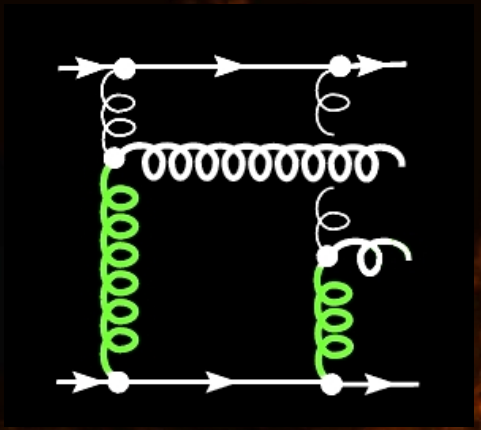
parameter	value
proton fractional momentum loss	0.002-0.02
jet rapidity	<1
mass of jet system	>50 GeV



Standard candle for Higgs production?

Maybe not: there are diagrams in jet production which may be important, and which are not present in Higgs production:

Diagrams negligible at lowest order



- extra propagator
- suppression by factor $1/M_{jj}^2$

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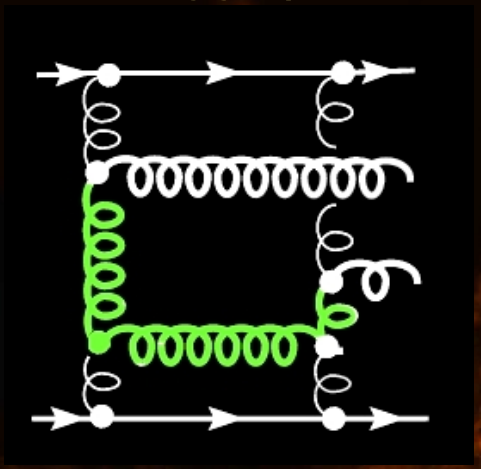

Diagrams negligible at lowest order
correspond to a specific routing of the hard momentum, without double logs

- the hard momentum must be routed outside of the hadron form factor

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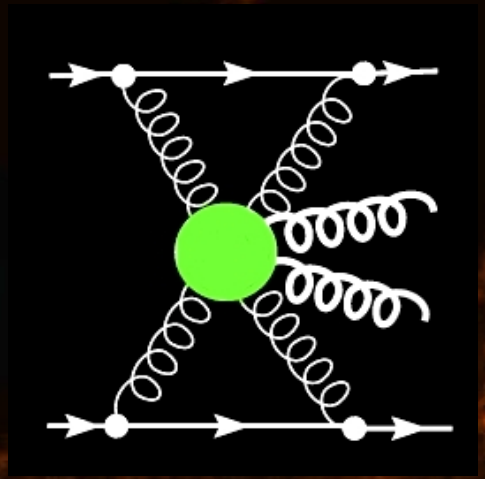

Diagrams negligible at lowest order
correspond to a specific routing of the hard momentum, without double logs
but further corrections to the localised hard momentum will contain double logs

- The localised hard vertex will have double logs

Standard candle for Higgs production?

One knows the contribution to be negative, and the Sudakov corrections to be very different

$$\sim \frac{1}{M_{jj}^2}(1 + C_1\alpha_S \log + C_2\alpha_S^2 \log^3 + C_3\alpha_S^3 \log^5 + ...) \text{ vs.}$$

$$(1 - C\alpha_S \log^2 + \frac{C^2}{2}\alpha_S^2 \log^4 - \frac{C^3}{6}\alpha_S^3 \log^6 + ...)$$

Tuning the theoretical uncertainties on the dijet data would only lead to a lower bound on the Higgs production cross section.

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Conclusions

- Importance of CDF data to test theoretical ideas
- Calculation largely in the nonperturbative domain
- Large uncertainties (factor 20 up or down) due to Sudakov factor (and gap survival)
- Potential problems to relate the dijet production to Higgs boson production