WEAK CORRECTIONS TO HADRON + HADRON TO JETS

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LOW X MEETING
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- Why are weak interaction corrections important?
- What results are expected at large p_T?
- Corrections in certain partonic sub- processes.
- Tevatron results.
- What do we expect at LHC.

Weak Interaction Corrections can be Important

$$\alpha_S(1\,TeV) \;=\; 0.09$$

$$\alpha_W(1\,TeV) \;=\; 0.03$$

$\alpha_W \gg \alpha_s^2$ - one-loop weak corrections will dominate NNLO corrections.

Logarithmically enhanced corrections, e.g.

$$\alpha_W \ln\left(\frac{s}{M_W^2}\right), \quad \alpha_W \ln\left(\frac{s}{M_W^2}\right)^2$$

do NOT cancel between virtual and real W/Z emission, because initial/final states are not singlets of flavour.

Weak interaction effects can give rise to observable parity violations, or significantly enhance forward-backward asymmetries.

NNLO QCD corrections in

$$p + p(\bar{p}) \rightarrow \text{jets}$$

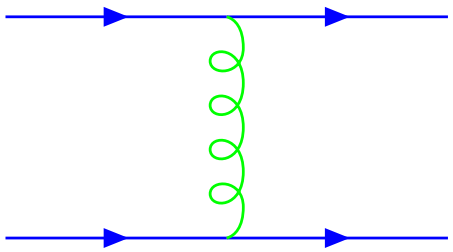
are almost complete

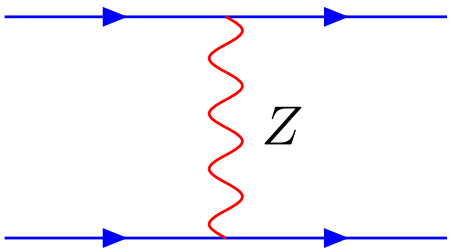
All ingredients have been calculated - the components must now be pieced together in such a way as to cancel the IR divergences - progress made by Frixione and Grazzini - hep-ph/0411399

Expect Weak corrections ($\mathcal{O}(\alpha_s^2 \alpha_W)$), to be at least as important as NNLO QCD corrections at Tevatron and to dominate at LHC. - especially at large p_T

Tree level interferences ($\mathcal{O}(\alpha_s \alpha_W)$), calculated Bourelly, Soffer, et.al - 1998).

One loop corrections are expected to be very large





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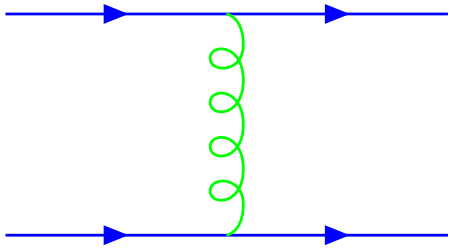
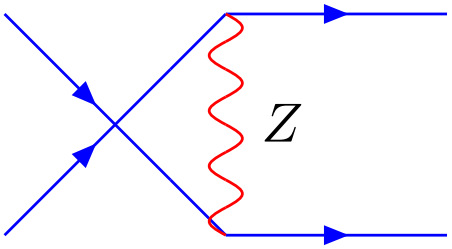
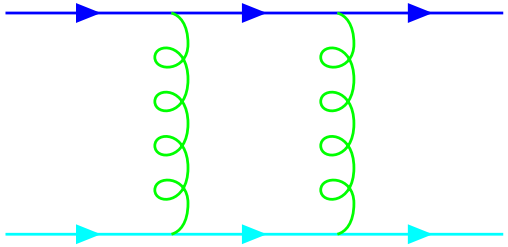


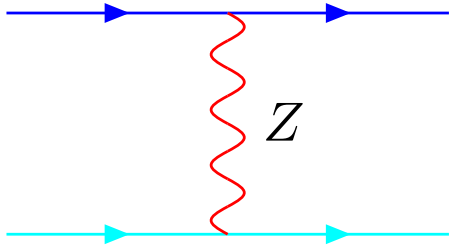


flavours must be equal

But at one loop

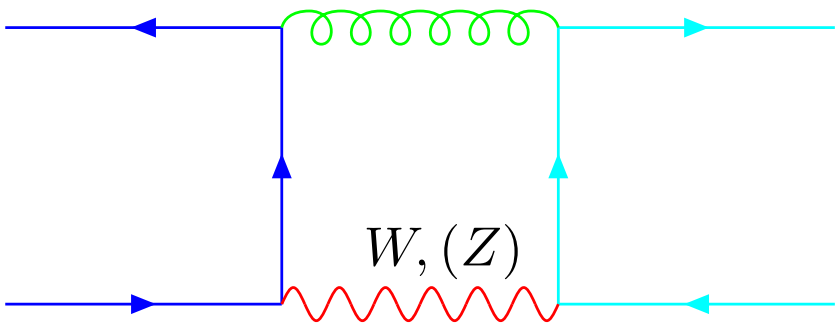


etc.



allowed for any flavour

Assuming that real W or Z emissions can be vetoed experimentally,
we might initially have expected the one-loop weak corrections to be negative at high p_T



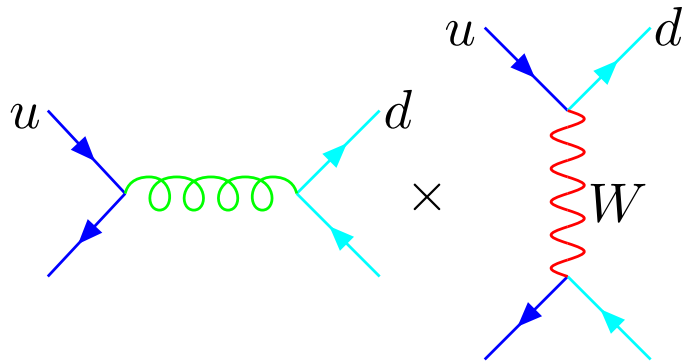
gives Sudhakov contribution at high p_T

$$\sim -\frac{\alpha_W}{\pi} \ln^2 \left(\frac{p_T^2}{M_W^2} \right) \times \text{tree-level QCD contribution}$$

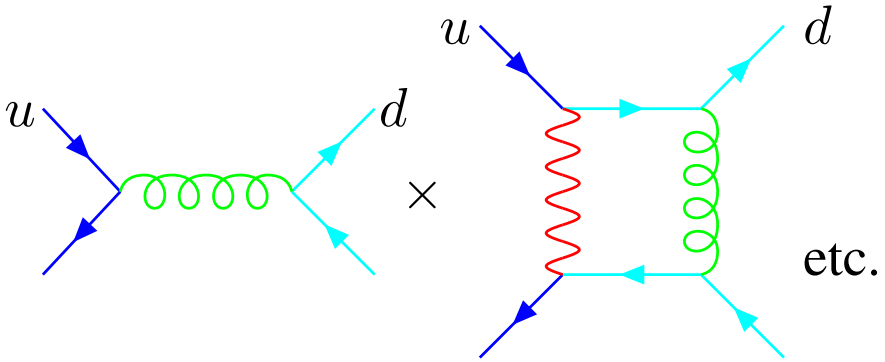
But the reality is more complicated

Interference between QCD and Weak Interaction tree-level graphs can be negative

e.g.

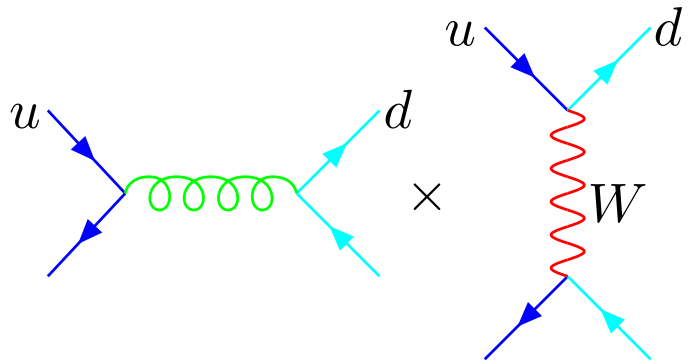


$\mathcal{O}\left(\alpha_s^2 \alpha_W\right)$ corrections - e.g.



give positive contribution to scattering cross-section

One-loop corrections can have either sign



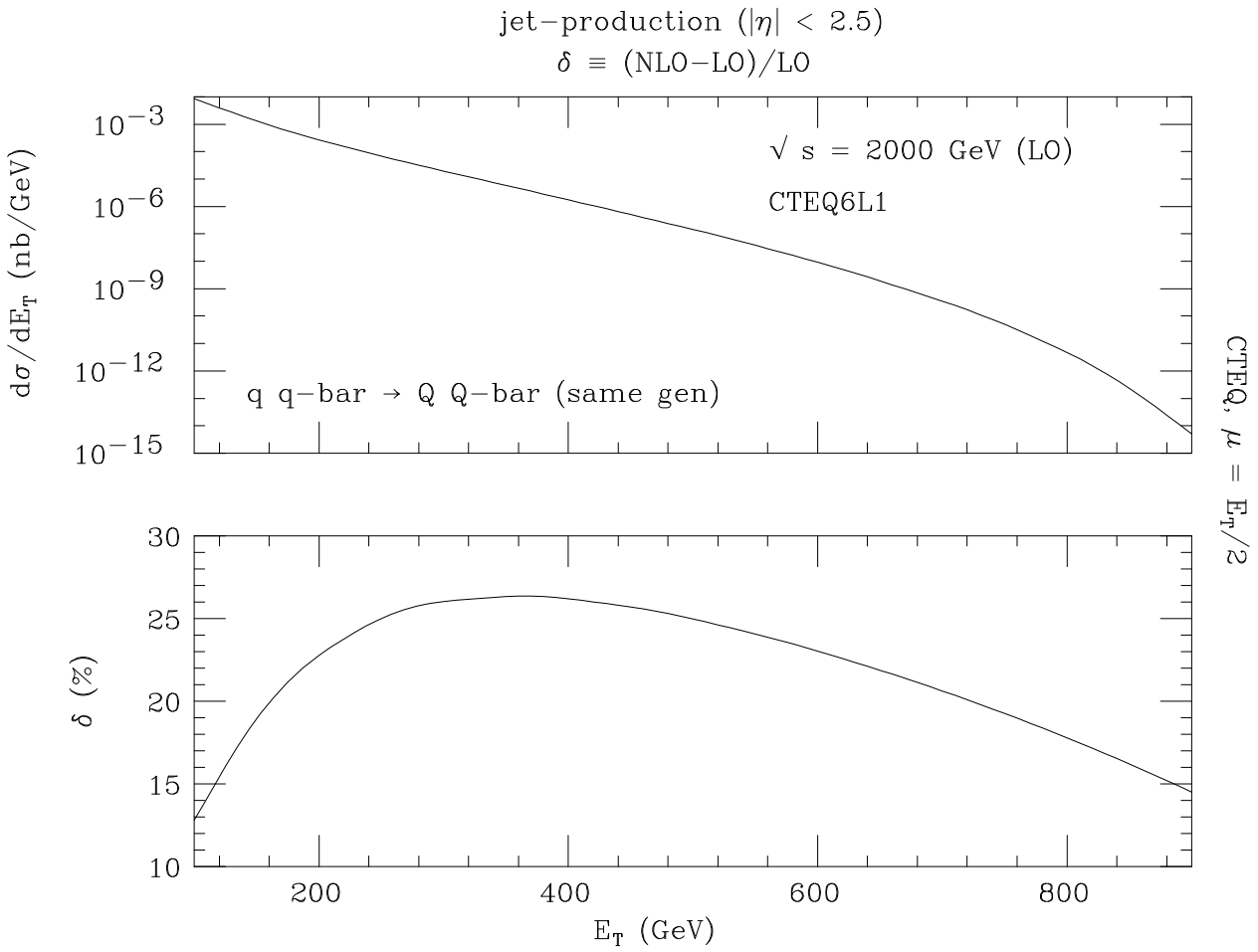
Can give rise to abnormally large weak corrections also at low p_T, near Coulomb singularity at small t.

Contribution from the process

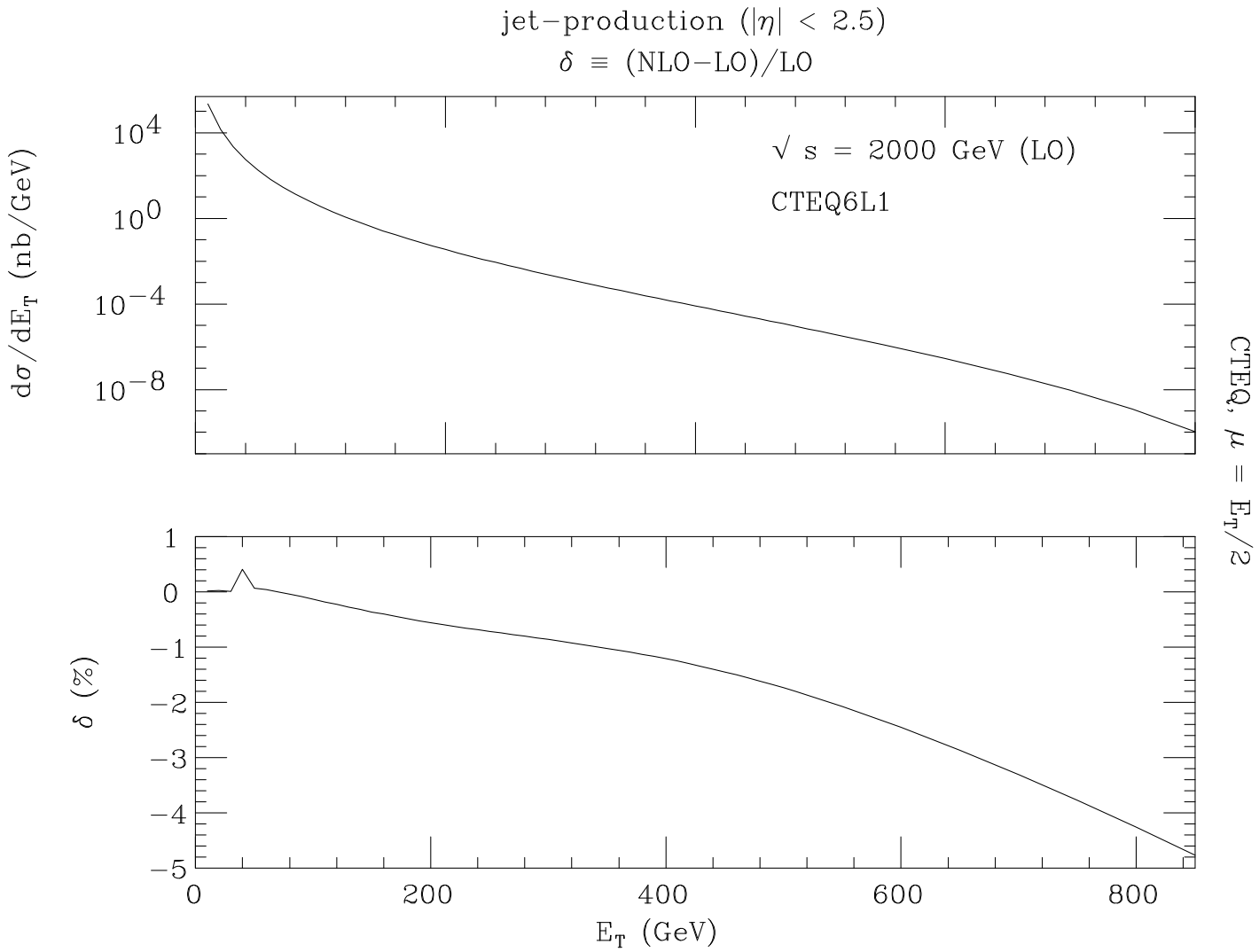
$$u + \bar{u} \rightarrow d + \bar{d}$$

or

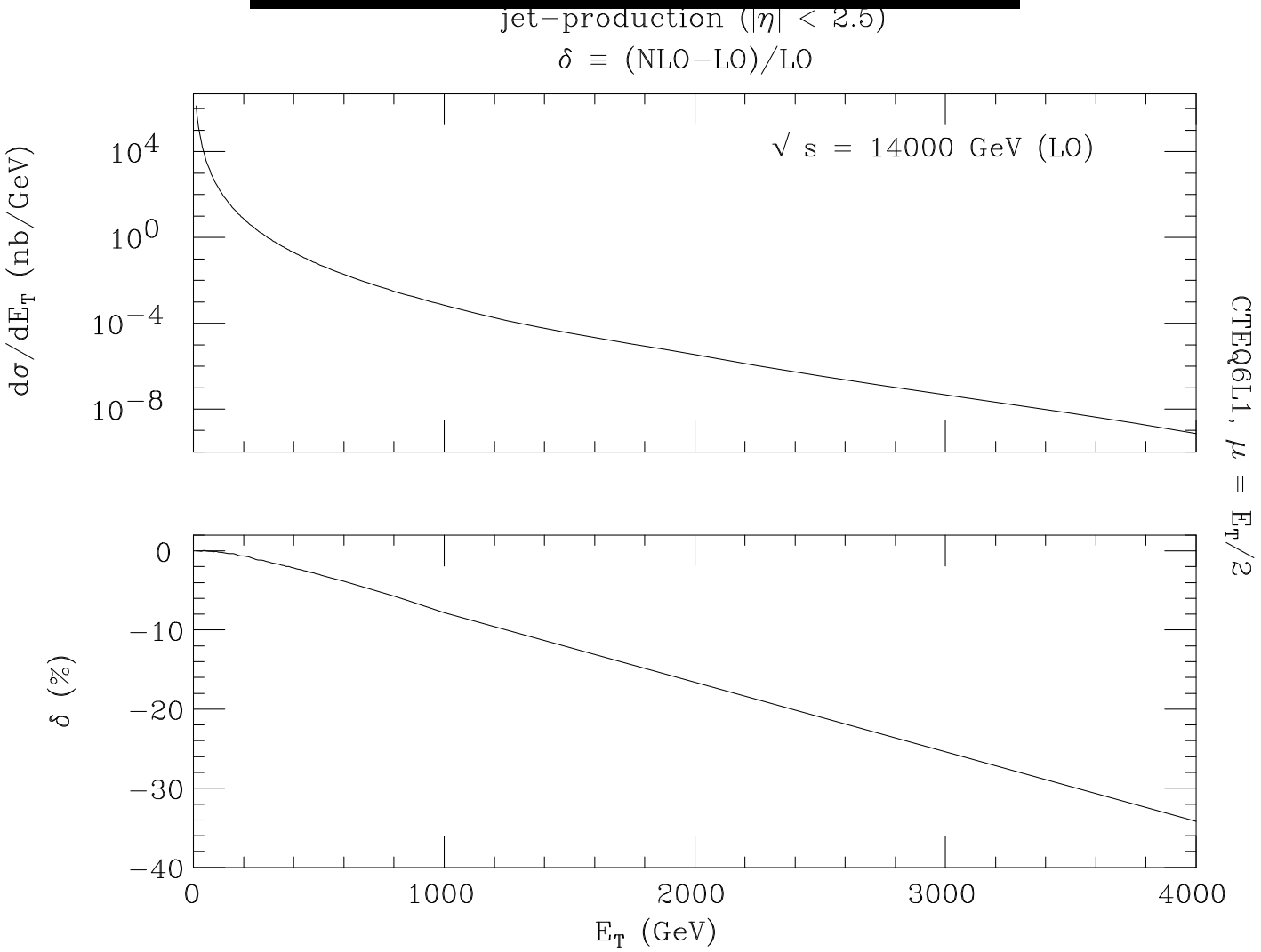
$$d + \bar{d} \rightarrow u + \bar{u}$$



RESULTS FOR TEVATRON



What we can expect from LHC



SUMMARY

- Weak Interaction Corrections are at least as important as NNLO QCD corrections.
- One loop corrections involving weak interactions can make a large difference
- The sign of the one-loop correction cannot be determined *a priori* since the the tree-level interference between strong and weak interactions can take any sign
- The net result for two-jet events at Tevatron is a modest reduction in the differential cross-section at high p_T
- We expect this effect to be considerably greater at LHC