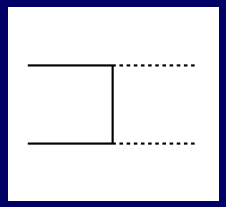
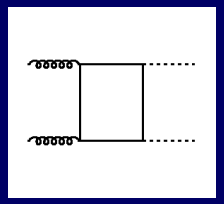
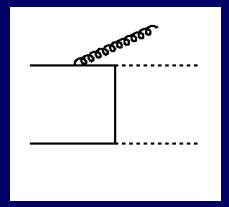
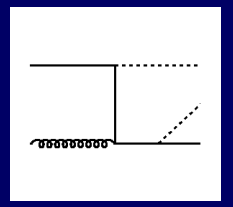
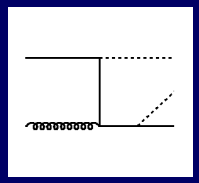
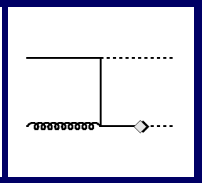
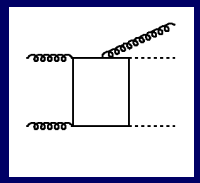
Experimental needs: Summary

Presentations:

- G. Unal: Experiences with NLO programs for the pp $\rightarrow \gamma\gamma$ channel
- V. Drollinger : HO effects in ttH $\rightarrow$ lνqqbbbb - searches at LHC
- S. Paganis : tt production studies using various MCs
- A. Schälicke : Merging of ME and PS at LO
- S. Frixione : MC@NLO
- D. Soper : NLO QCD with parton showers

G. Unal : $pp \rightarrow \gamma\gamma$

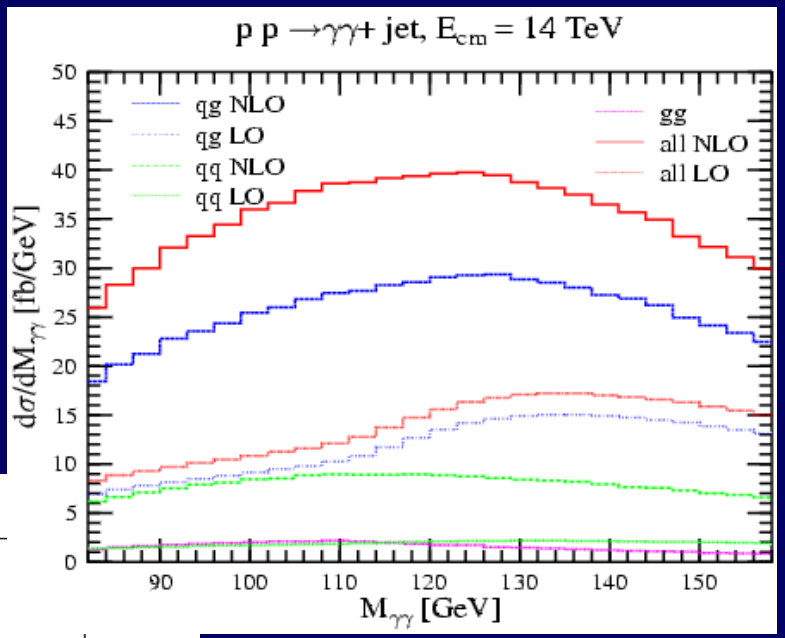
- Contributions:  +   
- Calculations used :
  - DIPHOX:   Higher orders + fragmentation effects
  - Analytical calculation by Bern, Dixon, Schmidt for NLO contributions to box 

NLO traps:

Separating background into different contributions:

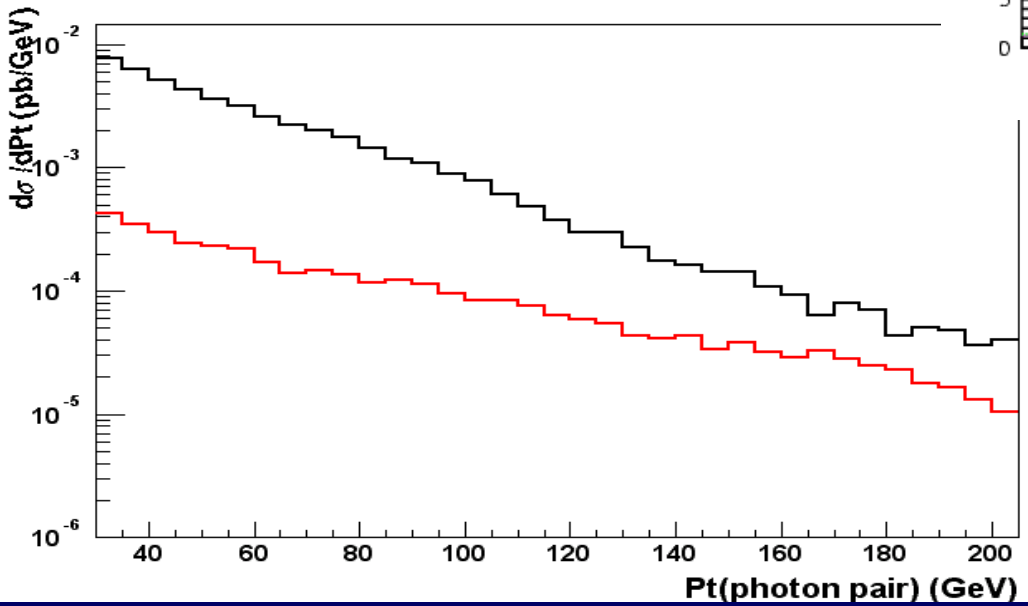
Bremsstrahlung = direct+fragmentation, only sum is meaningful

Pt(γ) > 40 GeV, Pt(jet seen)>40 GeV, Isolation in 0.4 cone



Cut on Pt(pair) ⇒ improves S/B (by ~3-5)

worse S/√B (by ~0.6)



NLO changes the shape !!!
No universal K-factor

Consequences:

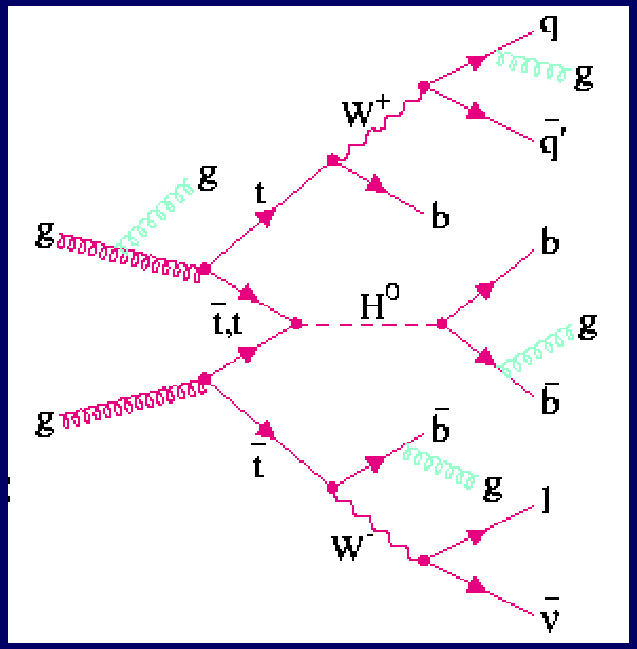
1. Intrinsic limitations of fixed order matrix element computations:
« Low » Pt part not well described => Resummation
Up to which Pt are these effects important ?

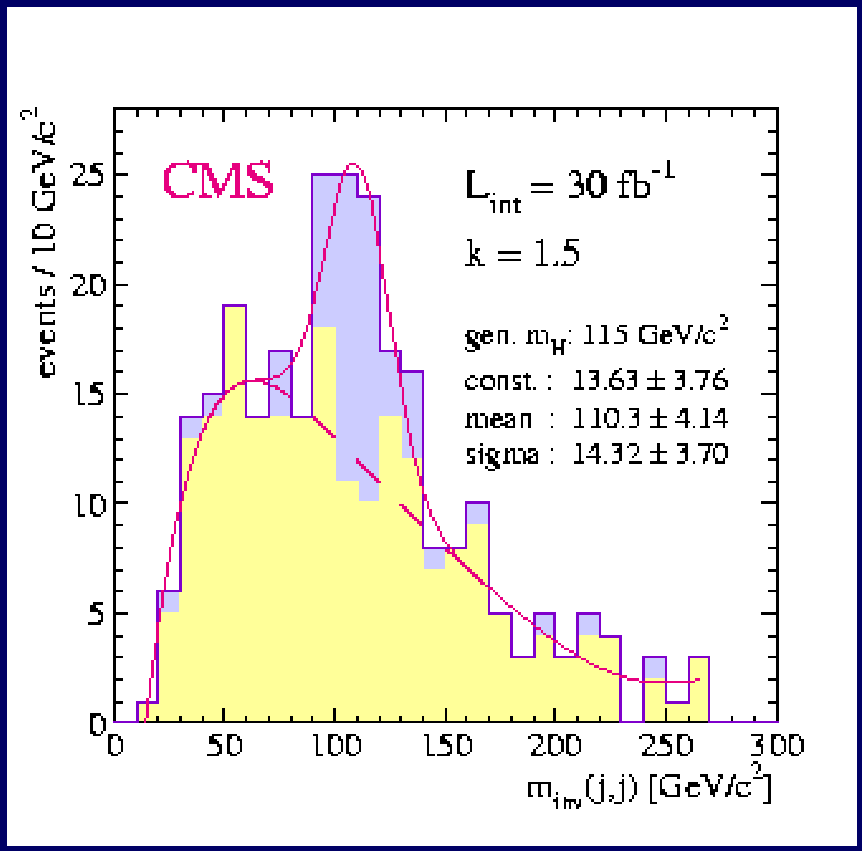
2. Parton level limitations: Isolation cut « crudely » modelled.
Would need fragmentation+underlying event +… to do a better job

3. Put NLO into parton shower program ?
   -Fix (at least partially) low pt part
   - Isolation better described

V. Drollinger: ttH → lνqqbbbb

- Signal calculated with ME generator (CompHEP), used Pythia to generate radiation.
- "Flat peak" over complicated background (+combinatorical), not clear how to extract background from data.





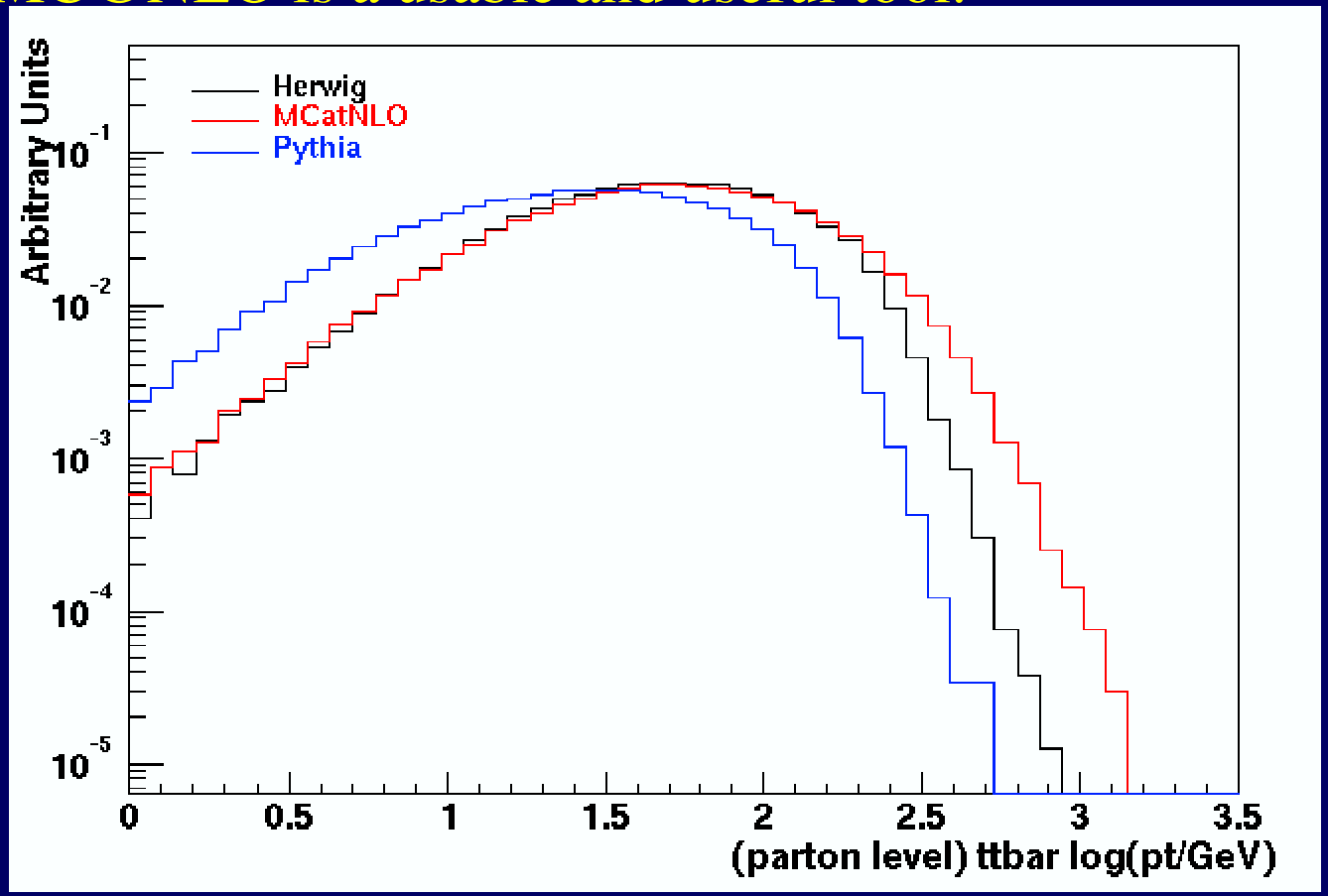
Consequences:

1. Need for multi-particle production matrix element generators + a merging to parton showers, fragmentation, etc. .

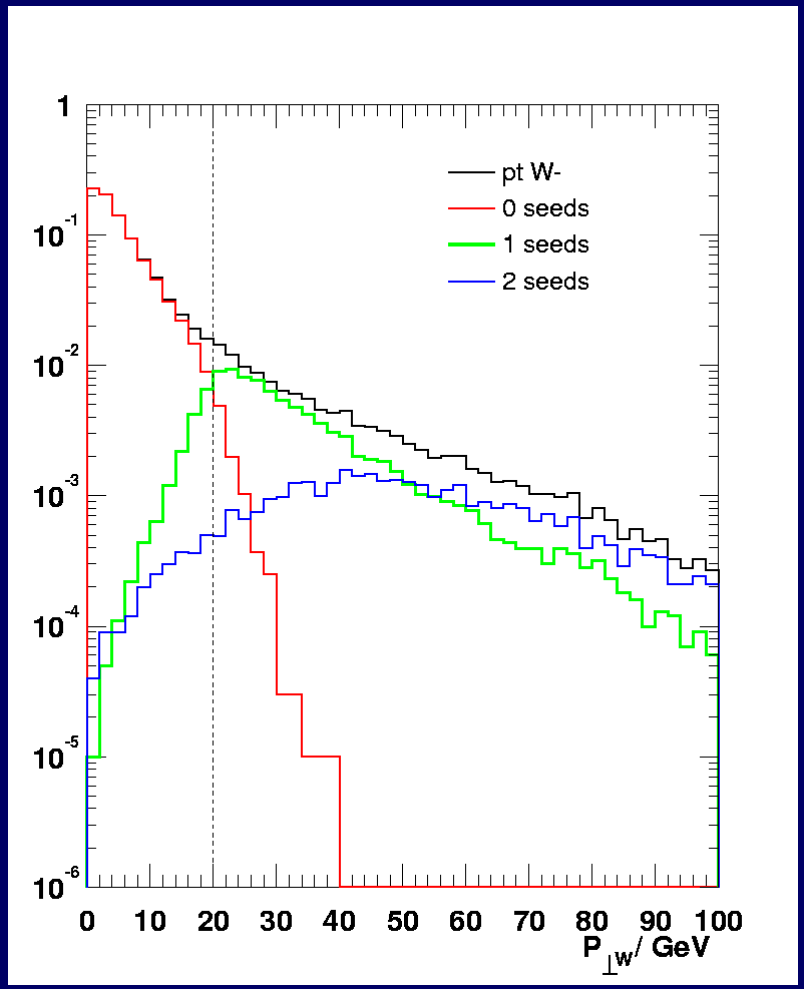
2. If higher (i.e. loop) order is needed the idea would be to have MC@NLO for individual pieces + spin correlations for the decays.

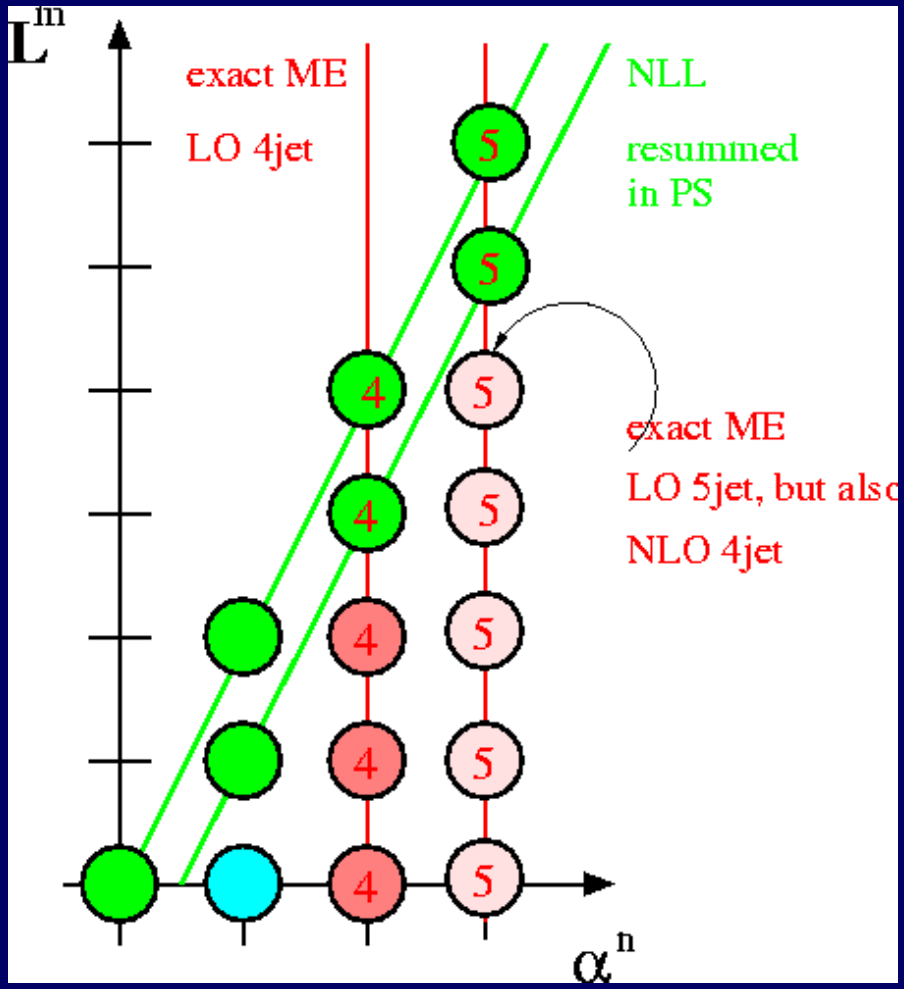
S. Paganis: tt production

- MC@NLO is a usable and useful tool.



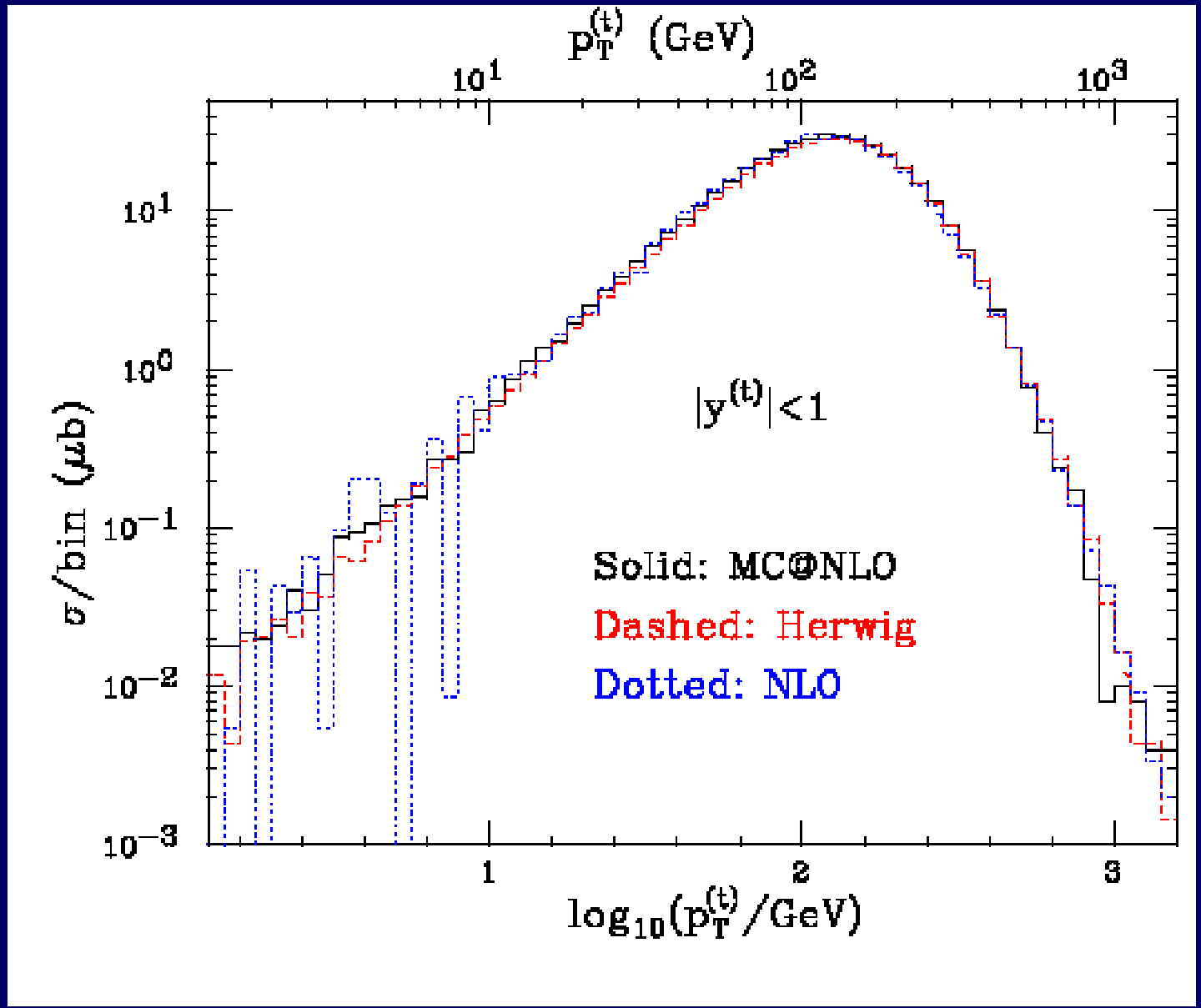
A. Schälicke : ME + PS at LO





S. Frixione: MC@NLO

- Systematic approach to match NLO calculations with a parton shower, inherits the full power of the underlying event generator (Herwig in actual implementation)
- Features :
  - NLO normalization of (incl) cross section
  - PS in soft, extra leg in hard region
  - Available : W(Z)W(Z), tt (yesterday), bb (yesterday), Higgs (soon)
  - Authors ask for further wishes … need manpower !


$p_T^{(t)}$ (GeV)
10^1
10^2
10^3
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
σ/bin (μb)
$|y^{(t)}|<1$
Solid: MC@NLO
Dashed: Herwig
Dotted: NLO
1
2
3
$\log_{10}(p_T^{(t)}/\mathrm{GeV})$

D. Soper: NLO QCD + showers

- Independent approach to add parton showers to NLO calculations.
- Test case: 3 jet production in ee collisions.
- So far no real parton shower model has been attached (duty of the user).

Outcome of the (long) discussion

- Strategy to be implemented:
  - validate the existing tools
  - if not sufficient, you've got an excellent reason for better ones !
  - this can be done only on a case by case basis !
- Examples :
  - W production (cross section for lumi, W mass …) with MC@NLO, check theory uncertainties (PDF, scale, …) and compare with experimental uncertainties, if theory not sufficient, NNLO is a must !
  - Vector boson fusion with ME+PS (tree-level), check jet veto. If theory not sufficient, NLO is a must !