NLO QCD and SMC Algorithms

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Outline

- Parton shower matching
- POWHEG to Pythia interface
- Hardest emission: Pythia vs NLO QCD
- Conclusion

Parton shower matching

- SMC best in soft/collinear regions
- Match NLO matrix elements to existing parton shower generators
- MC@NLO (Frixione, Webber)
  - Subtract approximate NLO SMC terms from exact calculation
  - Generator specific
  - Possibility of negative weighted events

Parton shower matching (contd.)

- POWHEG (Nason; Frixione, Oleari, Ridolfi)
  - Positive Weight Hardest Emission Generator
  - Generate hardest emission (p_T-ordered) using a Sudakov

$$d\sigma = \left(B(v) + V(v) + \int (R(r,v) + C(r,v)) d\Phi_r \right) exp\left(- \int_{p_T} \frac{R(r,v)}{B(v)} d\Phi_r \right)$$

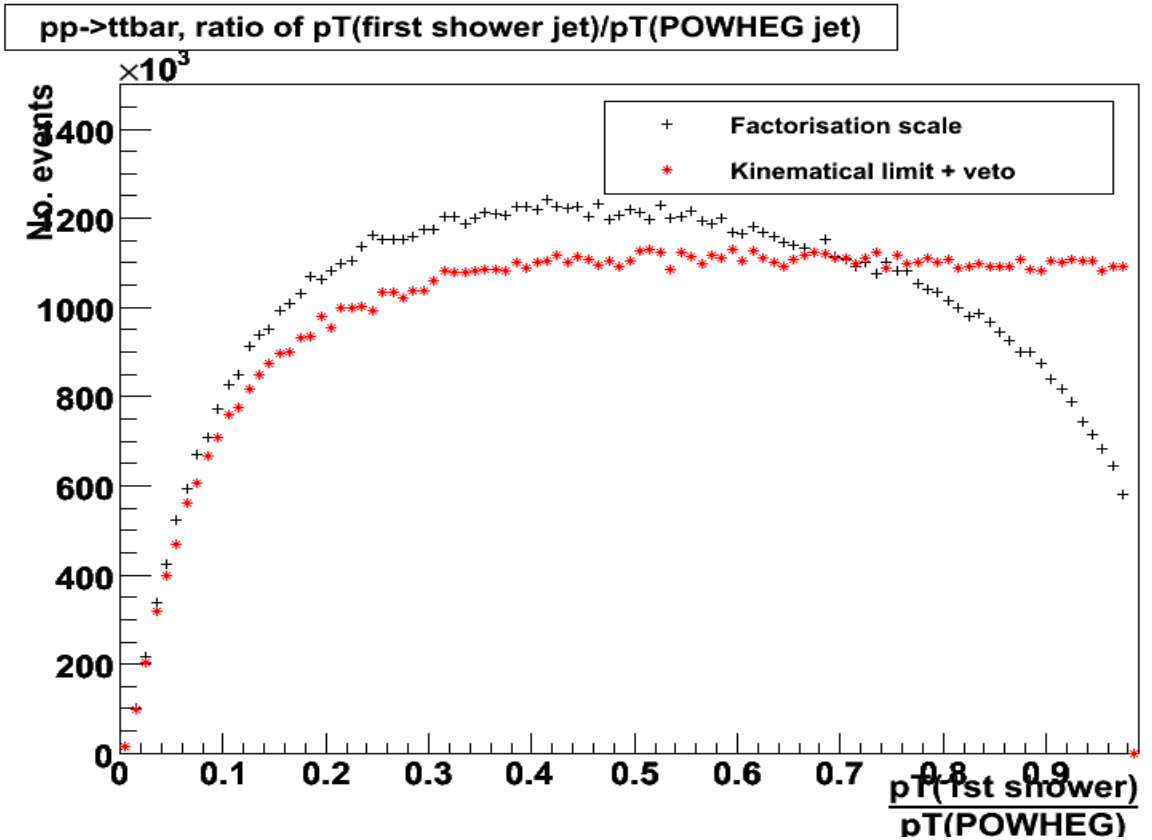
  - Sudakov contains only Born and real terms

POWHEG to Pythia Interface

- Pythia shower evolution in lightcone p_T

$$p_T^2 = (1-z)Q^2 - \frac{Q^4}{m_{ar}^2} < (1-z)Q^2 = p_{Tevol}^2$$

- Start shower at kinematical limit with veto on p_T
- Small correction

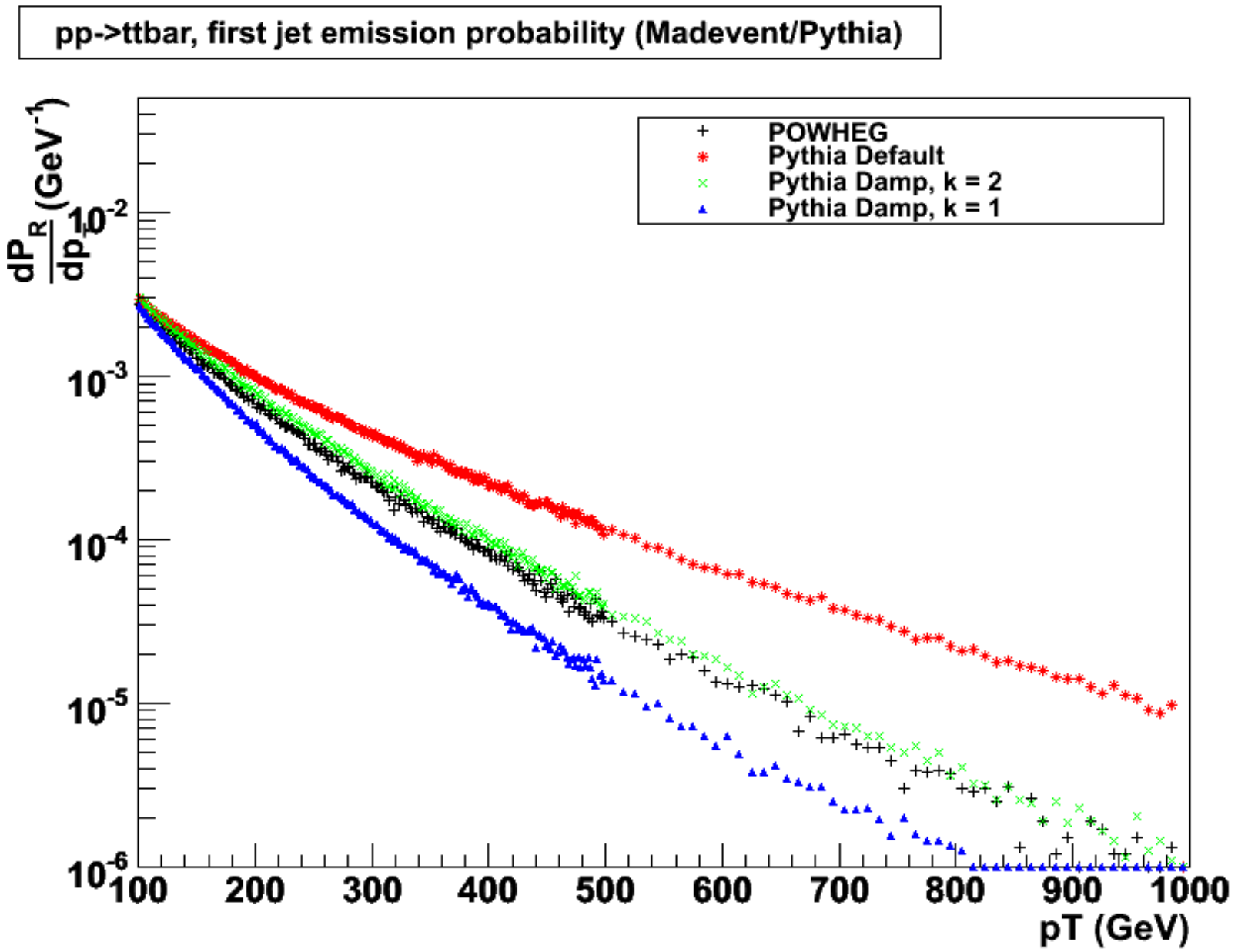


Pythia vs NLO QCD

- Shower behaviour (and single W/Z): $dP \sim \frac{dp_T^2}{p_T^2}$
- t-channel g exchange (for $p_T > p_{Thard}$): $dP \sim \frac{dp_T^2}{p_T^4}$
- Something in between? Guess:
  - No colour in final state
    - Shower behaviour to kinematical limit
  - Colour final state
    - Coherence between ISR and FSR
    - Damp shower emissions by factor:

$$\frac{k^2Q^2}{p_T^2 + k^2Q^2}$$

Pythia vs NLO QCD (contd.)

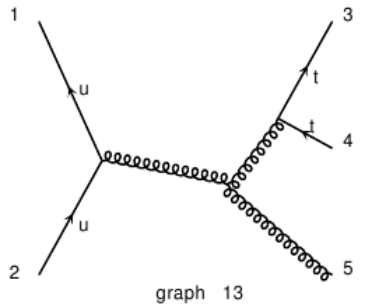


Pythia vs NLO QCD (contd.)

- Use Madgraph/Madevent to get rough idea of corrections for other processes
- Generate probability of emission as:

$$\frac{d\sigma_R}{\sigma_0}\, exp\left(-\int \frac{d\sigma_R}{\sigma_0}\right)$$

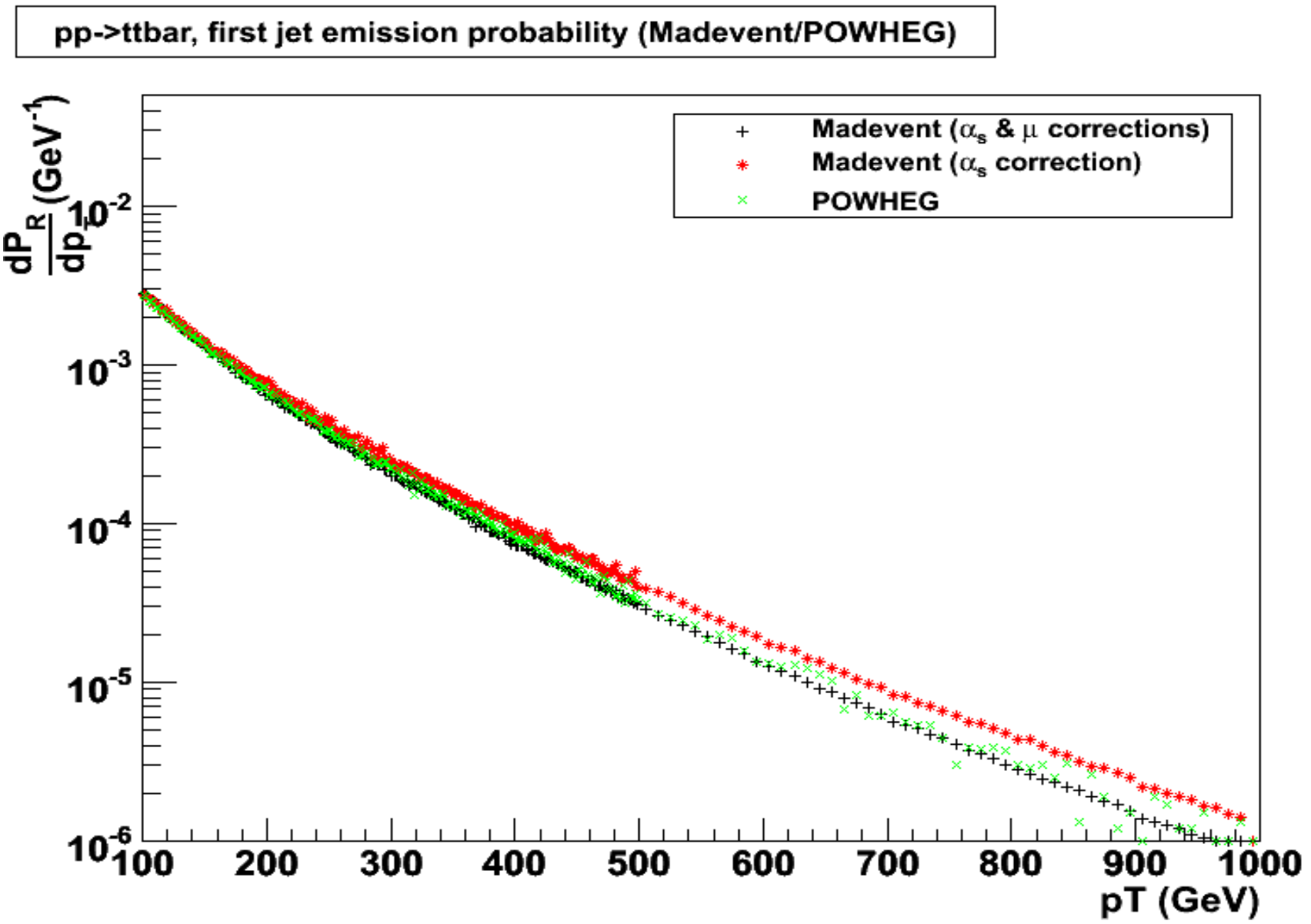
- Not differential in rapidity and no NLO pre-factor
- Watch out for:
  - Unwanted graphs



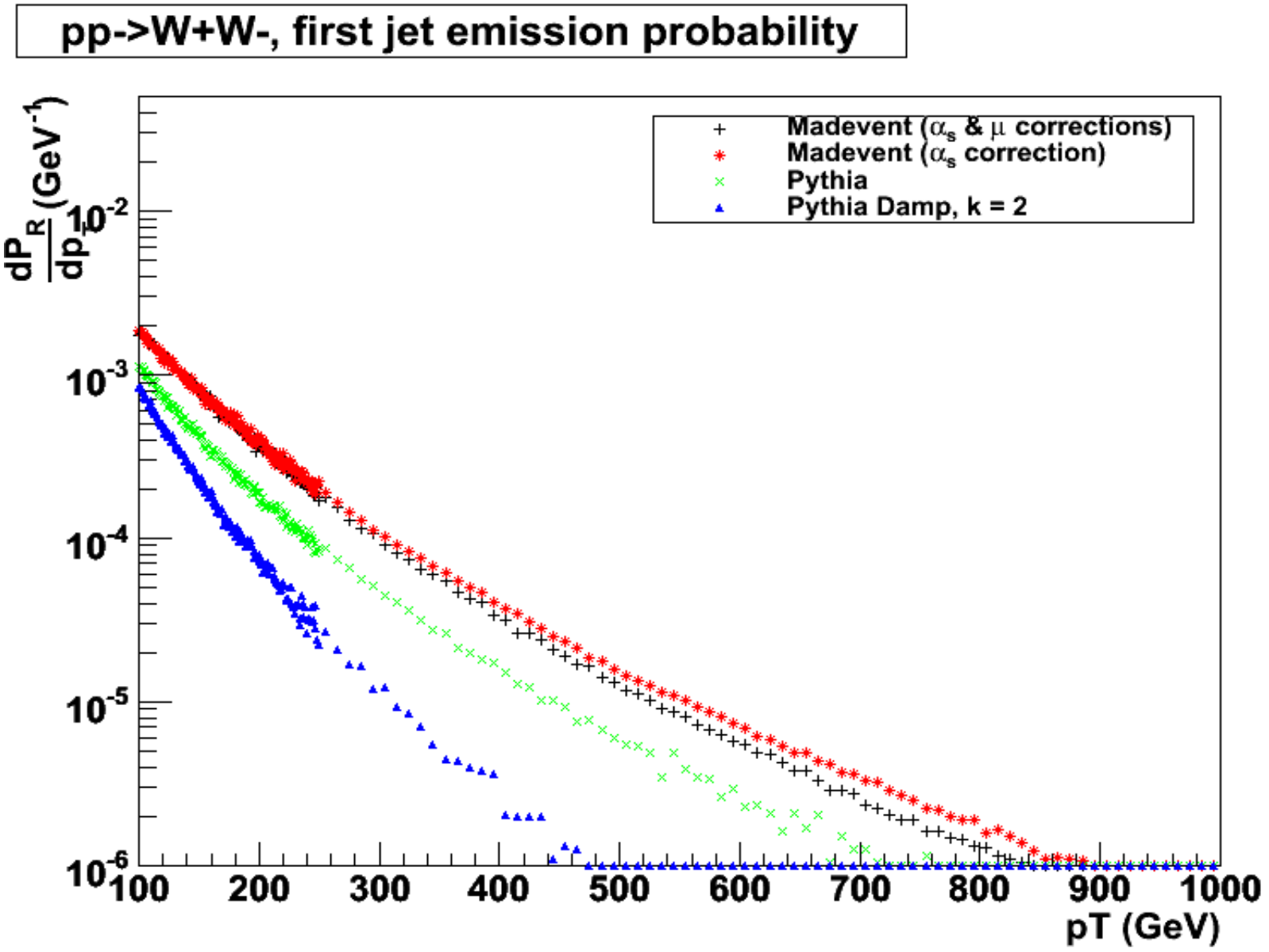
  - α_s and PDFs

$$exp\left(-\int_t^{t_{max}} dt' \int dz \frac{\alpha_S(t')}{2\pi} P_{a\to bc}(z) \frac{x' f_a(x',t')}{x f_b(x,t')}\right)$$

Pythia vs NLO QCD (contd.)



Pythia vs NLO QCD (contd.)



Conclusion

- When no matching to higher orders available - possible set of processes for which an appropriate dampening factor may improve high p_T tail of parton shower
- Initial W^+W^-/Z^0Z^0 results appear to follow original guess – dampening not needed
- SUSY processes still to come (squark/gluino production)