QCD Multijet Event Generation

MLM prescription for the removal of event double counting

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- Matrix element
- Parton shower
- MLM matching
- Comments

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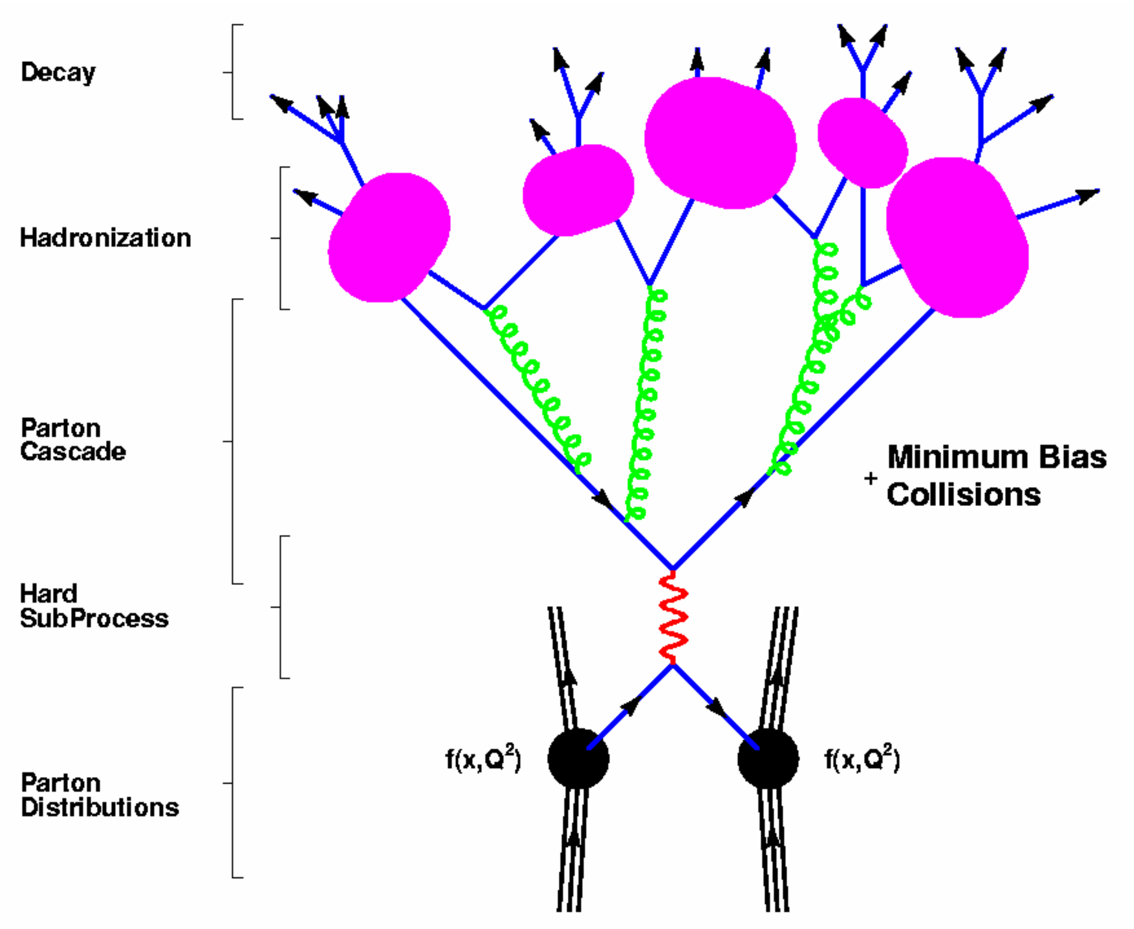
Parton generation

parton shower (PS)

matrix elements (ME)



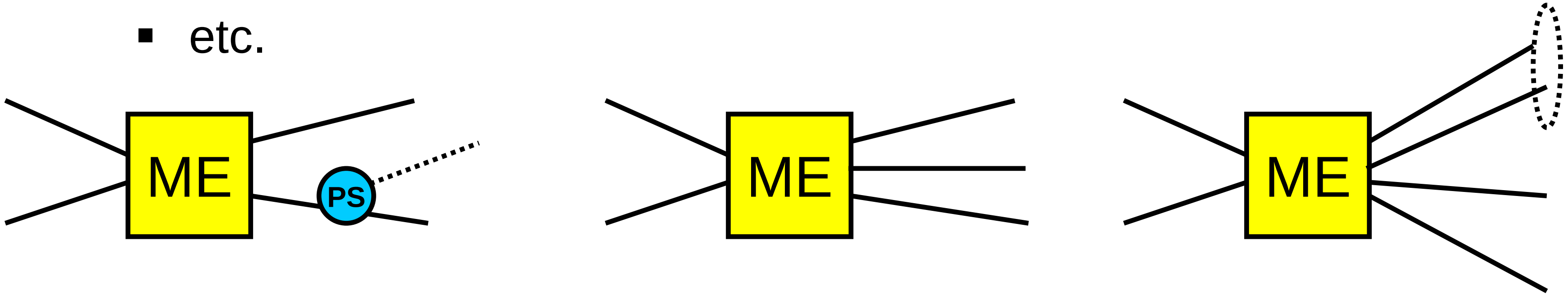
M. Dobbs and J.B. Hansen, Comput. Phys. Commun. 134 (2001) 41.

Parton generation

- Analytical calculation of gluon radiation has divergences that make it impossible to calculate ME for the complete $N_{partons}$ phase space. Furthermore, calculation are calculated to a fixed perturbative order.
  - e.g. Alpgen
- Generators solve this problem through parton shower models that add gluon radiation to the output of the ME calculation
  - e.g. Herwig, Pythia

Double counting

- Consider a 3-(hard)parton final state, before hadronization
  - it can come from a 2 parton ME and one parton from PS
  - it can come from a 3 parton ME
- Consider a 3-jet final state
  - it can also come from a 4 parton ME of which two partons are reconstructed as one jet
  - etc.



- Introduce a convention that decides which part of the 3-jet phase space is generated by ME, and which part of phase space is generated by PS.

Jets and Partons

- ME Partons
  - they come from the matrix elements calculation
- PS Partons
  - they come from the parton shower model

often just called “partons”

- Parton Jets
  - they come from an algorithm run on all ME+PS partons before hadronization
- Reconstructed Jets
  - they come from an algorithm run on stable particles or on detector signatures

often just called “jets”

MLM Matching Prescription

- Generate parton level configurations from ME with N_{partons} constrained by
  - $p_T > p_{T\min}$ and $\Delta R_{\text{parton-parton}} > R_{\min}$
- Perform parton shower
- Process the showered event before hadronization with a cone jet algorithm defined by
  - $E_{T\min}$ and R_{jet}
- Match N_{partons} ME partons and (parton)jets
  - for each ME parton
    - select the jet with minimum $\Delta R_{\text{jet-parton}}$
    - if $\Delta R_{\text{jet-parton}} < R_{\text{jet}}$ then the ME parton and this jet are matched
  - if a jet is matched to more than one ME parton, reject event
- Inclusive sample
  - if all N_{partons} ME partons are matched keep the event, otherwise reject.
  - then $N_{\text{jet}} \geq N_{\text{partons}}$
- Exclusive sample
  - if all N_{partons} ME partons are matched and $N_{\text{jet}} = N_{\text{partons}}$ keep the event

Final Multijet Sample

- for $N_{jet} < N_{max}$
  - produce exclusive N_{jet} samples
- for $N_{jet} = N_{max}$
  - produce inclusive N_{jet} sample
- Combined all these samples to produce an inclusive sample with all jet multiplicities
  - add cross sections, not events!

Comments

- The choice of a cone algorithm for the production of parton-jets is arbitrary: it is a topological criterion to classify events and ensure the absence of double counting.
- The physics obtained from the final inclusive sample should not depend on the generation cuts (p_{Tmin}, R_{min}) nor on the matching parameters (E_{Tmin}, R_{jet}). Different jet definitions can be used on the final reconstructed jets.
- The extent to which results depend on the generation cuts and matching parameters is a measure of the success of the matching prescription.
- It it not necessary that $E_{Tmin} = p_{Tmin}$ or $R_{jet} = R_{min}$. The matching ensures limited dependence on this choice.