Colour Reconnection within Herwig++

7th MCnet Meeting

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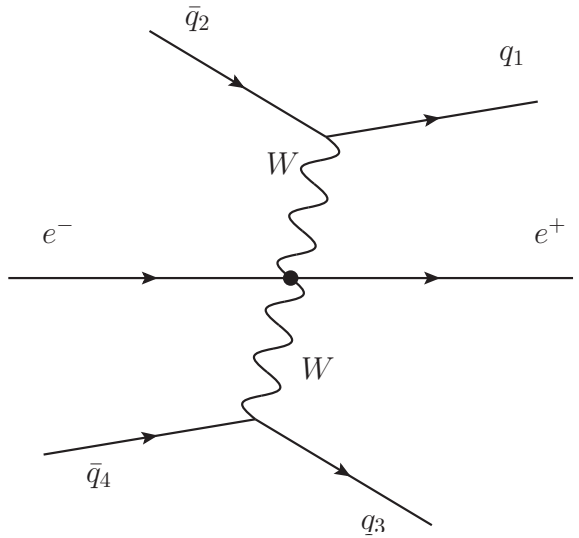
Outline

- Motivation
- Colour Reconnection
- Status Quo

Motivation

Example:
$e^+e^- \longrightarrow WW \longrightarrow (q_1\bar{q}_2)(q_3\bar{q}_4)$
(as done at LEP-2)



- Two colour singlets $q_1\bar{q}_2$ and $q_3\bar{q}_4$
- Usually treated independently (by parton shower and hadronization models)

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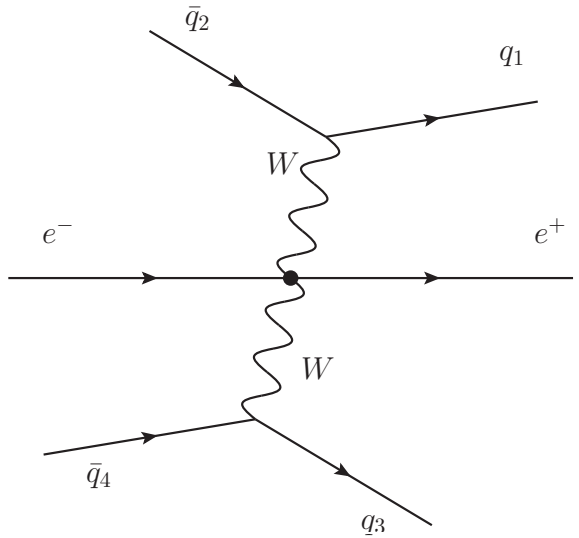
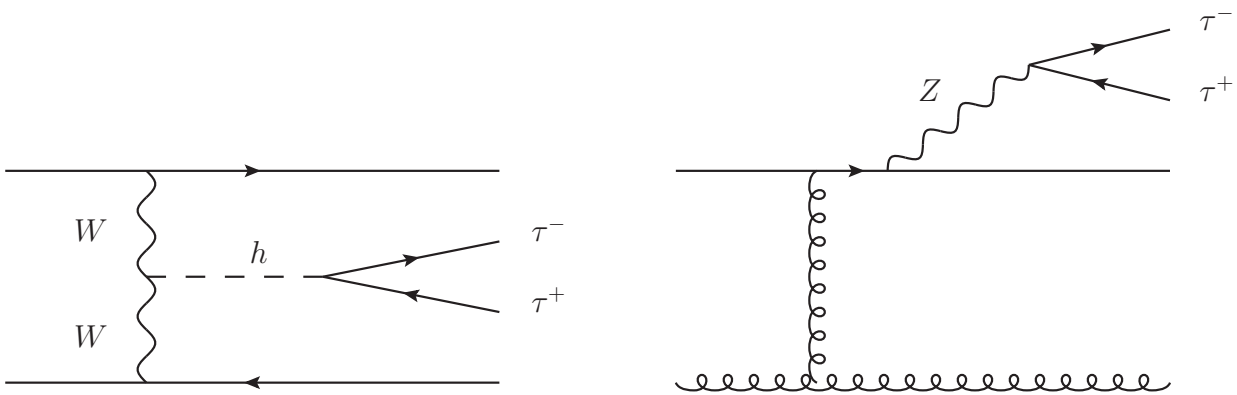


- Two colour singlets $q_1\bar{q}_2$ and $q_3\bar{q}_4$
- Usually treated independently (by parton shower and hadronization models)
- But: products of the W decays may overlap in space-time
- Soft gluon exchange between the two systems possible during hadronization
- Gives rise to Colour Reconnection models
- Particle flow sensitive to this effect ("twice the semileptonic decay $\neq$ fully hadronic decay")

Motivation

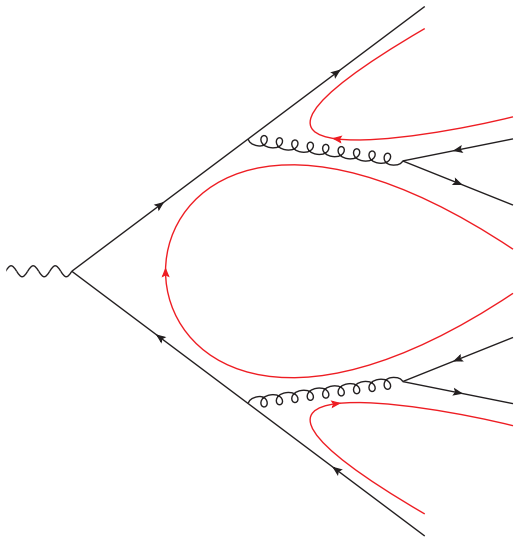
CR yields better simulation of the Underlying Event

- e.g. important for Higgs physics



- or for BSM physics

Cluster Hadronization in Herwig++



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- $\Rightarrow$ colour of gluons represented by a colour dipole

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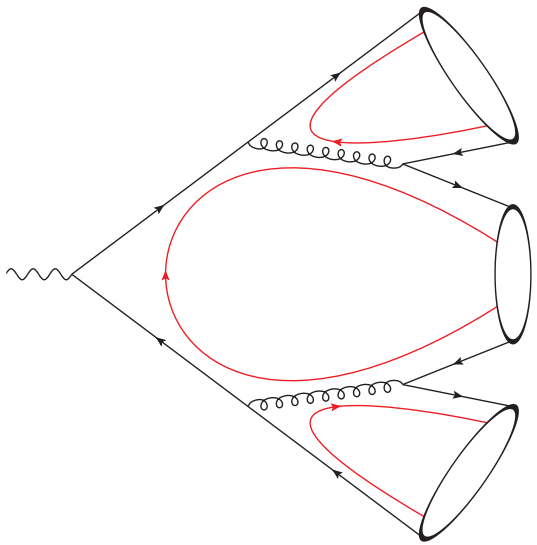

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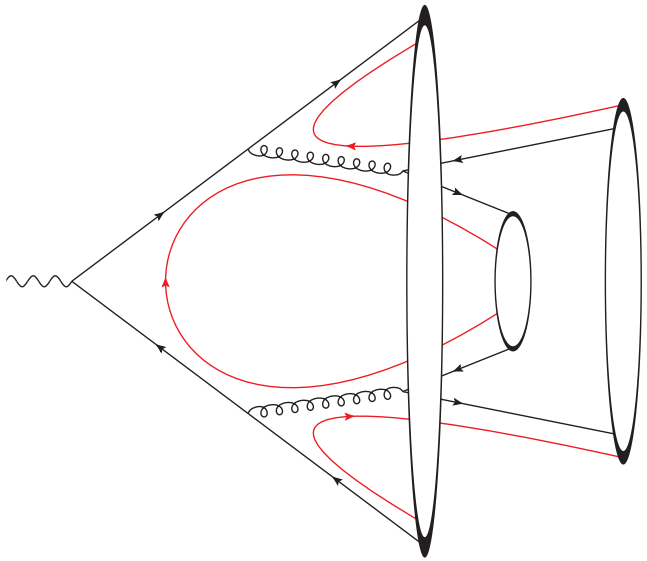
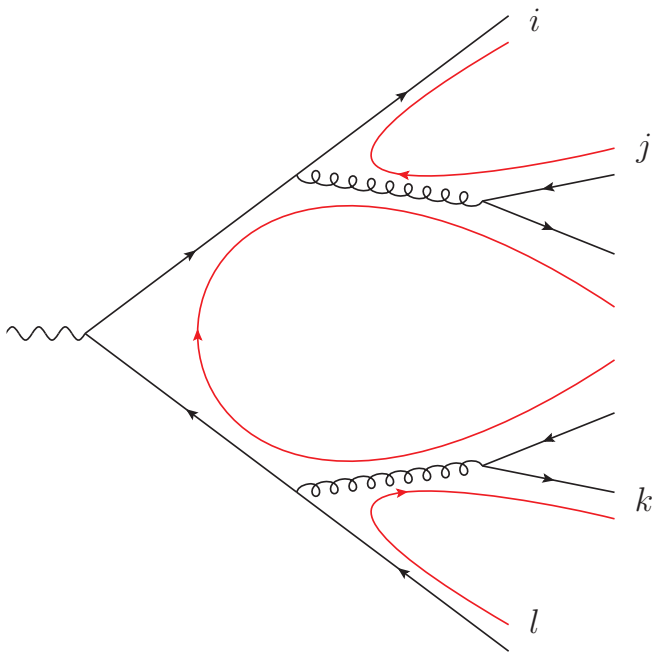


- $N_C \to \infty$ limit
- $\Rightarrow$ colour of gluons represented by a colour dipole
- at the end of the parton shower: every colour carrier has a **unique** anticolour partner (and vice versa) $\Rightarrow$ these pairs form clusters
- allow *reconnection* of colour-anticolour pairs

The Colour Reconnection model (as implemented in HERWIG 5.9+)

d_{ij} denotes the space time distance of the production points of a cluster's constituents q_i and $\bar{q}_j$ (the cluster's "spatial size").



1. Check if a rearrangement with this cluster would lower the sum of the clusters' spatial sizes:

$$|d_{il}|^2 + |d_{kj}|^2 < |d_{ij}|^2 + |d_{kl}|^2$$

2. Accept with user defined probability (default: $\frac{1}{9}$).

B. Webber, arXiv:9708463 [hep-ph] (1997)

Status Quo

So far:

- implementation of a space-time model in Herwig++ that generates the space-time points of the partons' production vertices
- implementation of space-time based colour reconnection model

To do:

- code debugging
- validation and tuning against LEP-2 data ($e^+e^- \rightarrow WW \rightarrow 4j$)
- look at other observables, e.g. $< p_T > (N_{\mathrm{ch}})$ (measured by CDF)