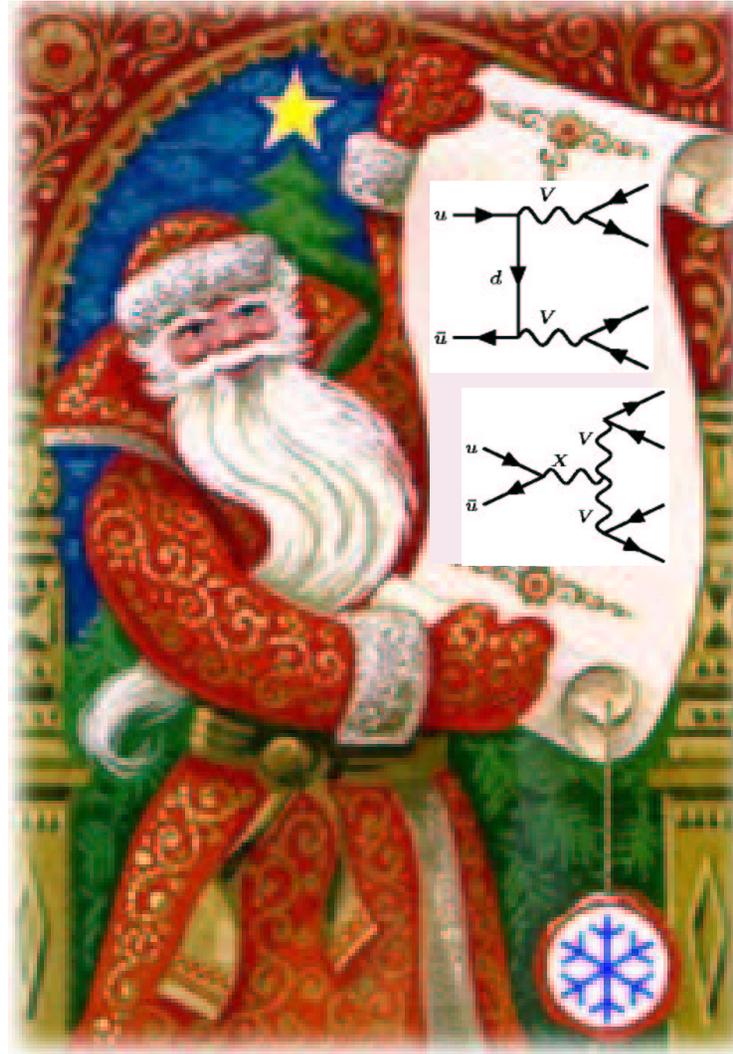


A Monte Carlo Wishlist

1. Incremental
2. Global



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Introduction

My wishlist:

Single boson	Diboson	Triboson	Heavy flavor
$W^+ \leq 5j$	$WW^+ \leq 5j$	$WWW^+ \leq 3j$	$t\bar{t} \leq 3j$
$W + b\bar{b} \leq 3j$	$WW + b\bar{b} \leq 3j$	$WWZ^+ \leq 3j$	$t\bar{t} + \gamma^+ \leq 2j$
$W + c\bar{c} \leq 3j$	$WW + c\bar{c} \leq 3j$	$W\gamma\gamma^+ \leq 3j$	$t\bar{t} + W^+ \leq 2j$
$Z^+ \leq 5j$	$ZZ^+ \leq 5j$	$Z\gamma\gamma^+ \leq 3j$	$t\bar{t} + Z^+ \leq 2j$
$Z + b\bar{b} \leq 3j$	$ZZ + b\bar{b} \leq 3j$	$WZZ^+ \leq 3j$	$t\bar{t} + H^+ \leq 2j$
$Z + c\bar{c} \leq 3j$	$ZZ + c\bar{c} \leq 3j$	$ZZZ^+ \leq 3j$	$t\bar{b} \leq 2j$
$\gamma^+ \leq 5j$	$\gamma\gamma^+ \leq 5j$		$b\bar{b} \leq 3j$
$\gamma + b\bar{b} \leq 3j$	$\gamma\gamma + b\bar{b} \leq 3j$		
$\gamma + c\bar{c} \leq 3j$	$\gamma\gamma + c\bar{c} \leq 3j$		
	$WZ^+ \leq 5j$		
	$WZ + b\bar{b} \leq 3j$		
	$WZ + c\bar{c} \leq 3j$		
	$W\gamma^+ \leq 3j$		
	$W\gamma^+ \leq 3j$		
	$Z\gamma^+ \leq 3j$		
	$Z\gamma^+ \leq 3j$		

(all at NLO)

1. Incremental (Run IIa)

2. Global

Much nice work has been done implementing new physics in Monte Carlos . . .

But the focus now should be on Standard Model backgrounds

How does one find new physics?

By demonstrating conclusively that it isn't old physics!

Monte Carlos of new physics are almost useless for this

I will talk only about Standard Model backgrounds

1

Decays of τ 's:

Incorporate Tauola into Pythia/Herwig/Isajet

Decays of b's:

Incorporate QQ or EvtGen into Pythia/Herwig/Isajet

2

More interaction between experiments and Monte Carlo authors for tuning of fragmentation and underlying event

3

Common output

Can we agree on a standard?



Easy interface

Doesn't need to be fancy!

5

Z/γ^* interference:

Can we get this into Vecbos?

In any Monte Carlo process that produces a Z , having the full interference would be useful

6

Tree-level generators (e.g., MadGraph, CompHEP):

Quark-level process:

$$u\bar{u} \rightarrow Wgg$$

Real-life process:

$$p\bar{p} \rightarrow Wjj$$

Can we systematically sum over the parents of jets?

7

Can we specify an easy interface from any tree-level Monte Carlo into an arbitrary fragmentation program?

Can we do this in a way that gets color flows \approx right?



Generating a process through two different programs
allows for a certain degree of checking



9

W/Z + jets is a background to everything under the sun

Currently Vecbos ($LO, W^{+\leq 4j}, Z^{+\leq 3j}$) is the standard

Is there an alternative that produces events with unit weight?

10

MadGraphII can generate diagrams for up to 8 final state particles

8 final state particles is probably sufficient for much of what we will wish to do in Run IIa

Can we perform the integration of these matrix elements?
Where does CompHEP stand?

Are there other tools that adopt this systematic approach?

RunIIa outlook

I envision Herwig and Pythia as being our two primary fragmentation programs in Run II.

I would like for the systematic approach of MadGraph and CompHEP to become LO standards
(Other leading order MCs will remain in demand until this happens)

Ad hoc (K-factor) corrections will still need to be implemented piecemeal from NLO calculations for individual processes

1. Incremental

2. Global (Run IIb)

The global plan (Run IIb) addresses two problems:

Systematic NLO calculations

Implementation of NLO into fragmentation programs

Systematic NLO calculations

There are a number of ways that we could go about doing this

At this point these are just ideas

(But no "no-go" theorems yet)

- Numerical

Can we do everything numerically?

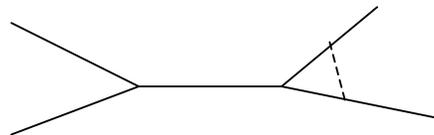
Yes, if we could figure out how to handle infinities . . .

Two types of divergences: **ultraviolet** and **infrared**

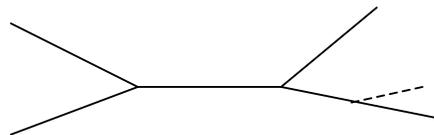
ultraviolet divergences can be renormalized (no problem)

infrared divergences cancel between two types of diags:

Virtual



Real emission



Achieving this cancelation analytically requires a bag of tricks

- Numerical

But buggier the analytic result

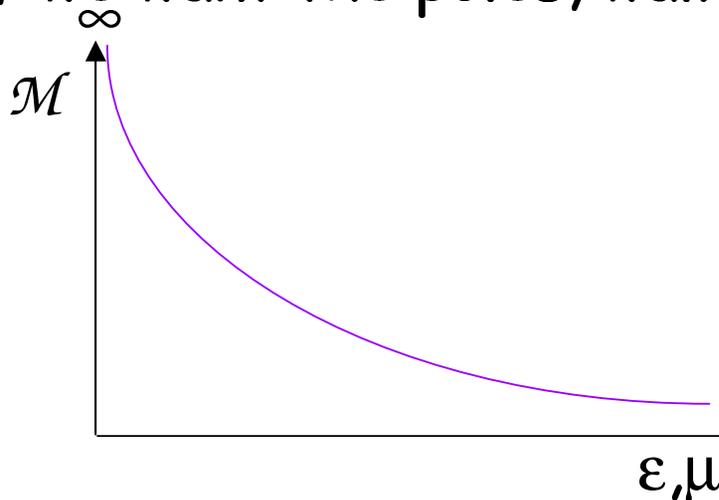
(which is generally lengthy and un insightful)

Could we do this numerically?

Go to $4-2\epsilon$ dimensions, and set $\epsilon = 0.0001$

Or introduce masses, and set them small

If we want the poles, walk $\epsilon, \mu \rightarrow 0$, and fit to



$$\frac{a_2}{\epsilon^2} + \frac{a_1}{\epsilon} + a_0$$

or

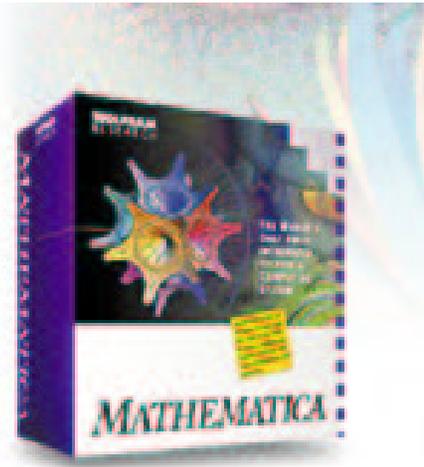
$$a_2 \log^2(\mu^2) + a_1 \log(\mu^2) + a_0$$

- Analytic

Can we algorithmatize the bag of tricks that are employed to obtain analytic results?

A question of pattern matching . . .

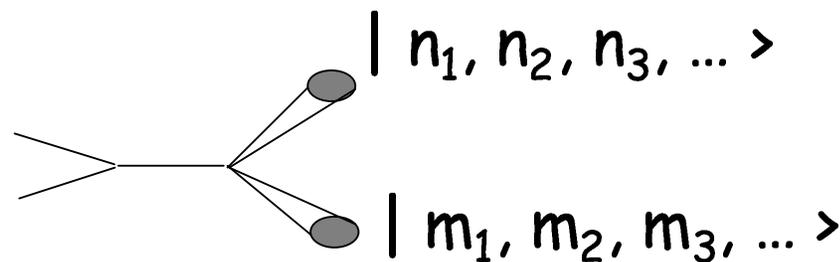
Can we extend symbolic manipulation tools that already exist?



- Rephrase the problem
(After all, our detectors handle the infinities just fine)

We are trying to compute individual amplitudes for final states that we never observe

Can we figure out a formalism that allows us to consider incoming and outgoing states as coherent Fock states, rather than as well-defined quarks and gluons?



Implementation of NLO into fragmentation programs

How does one do this and avoid double-counting?

Conclusions

- We need more complete Monte Carlos in Run II
- The emphasis should be on Standard Model backgrounds
- This can be tackled in two prongs:
 - **Incremental** — let's get what we have working well
 - This is largely a matter of sitting down and doing it
 - **Global** — let's prepare a systematic attack on NLO
 - This is a real intellectual effort needing real resources
- Serious work on these fronts could have a huge impact on Run II physics