Generator Issues

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Summary

- Most of the work done by the event generator authors has been in the context of the other groups.
- I'll briefly mention some of this and the more MC specific things.
  - Parton Shower and Matching
  - SLHA2
  - New Physics

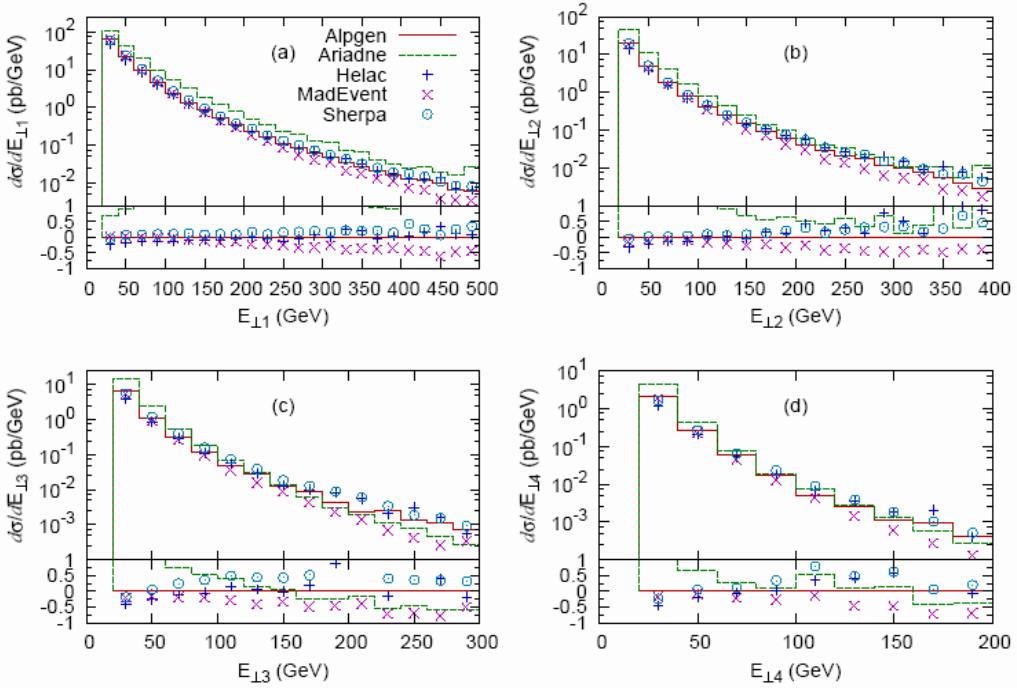
Matching

- So we had an all day session on parton shower physics.
- This followed the all day session on matching we had with the NLM group in the last session.
- Some new things presented, should go into the proceedings with the stuff from the previous session.

Comparing CKKW and MLM Approaches arXiv:0706.2569

Comparing CKKW, L-CKKW, MLM @ LHC

- the jet-E_T spectra @ LHC (reference curve in lower panels is Alpgen)

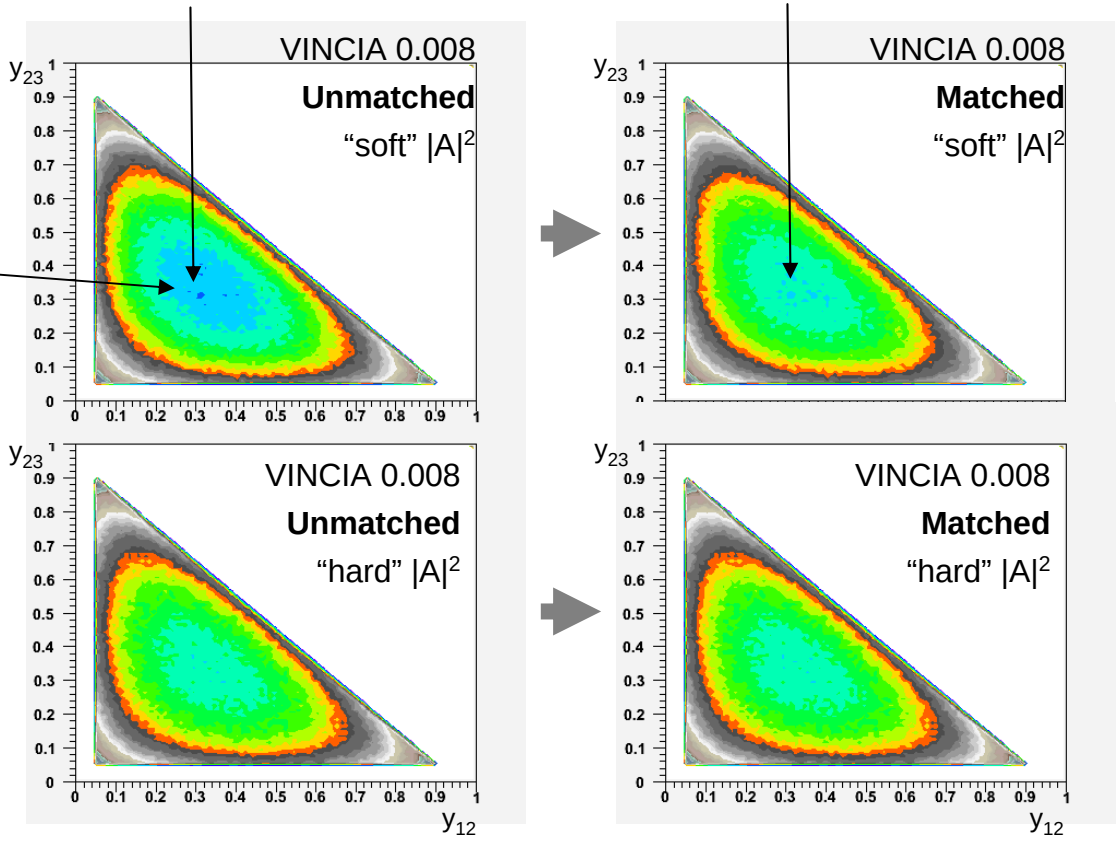


VINCIA Example: H → gg → ggg

Giele, Kosower, PS : FERMILAB-PUB-07-160-T

- First Branching ~ first order in perturbation theory
- Unmatched shower varied from “soft” to “hard” : soft shower has “radiation hole”. Filled in by matching.

radiation hole in high-p_T region



Outlook:

Immediate Future:

Paper about gluon shower

Include quarks → Z decays

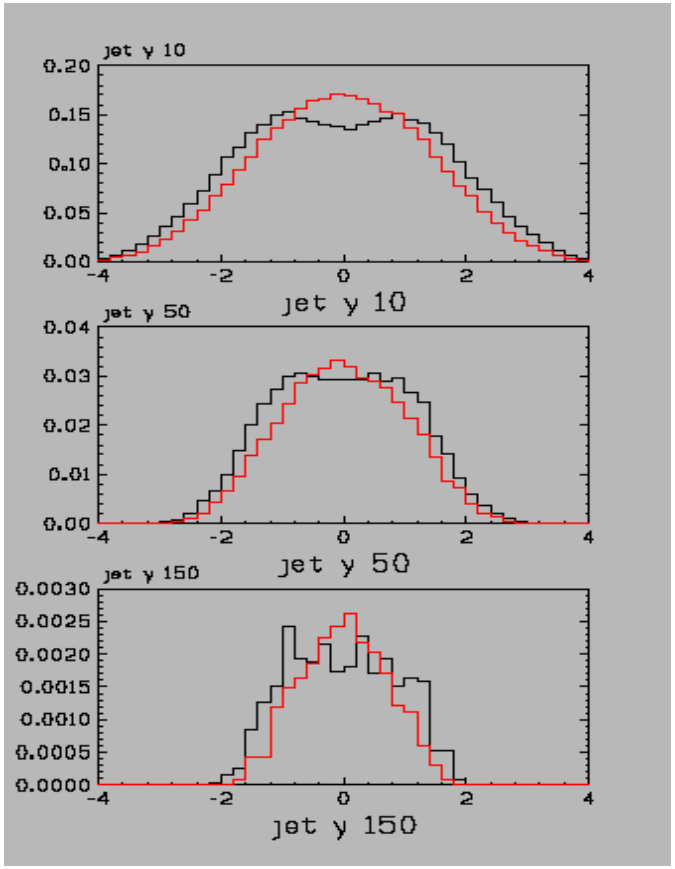
Automated matching

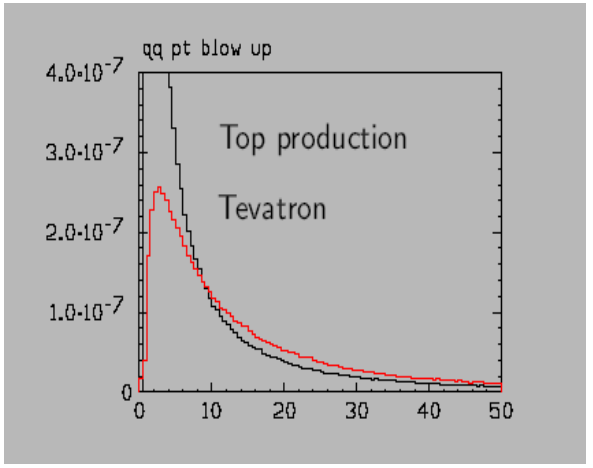
Then:

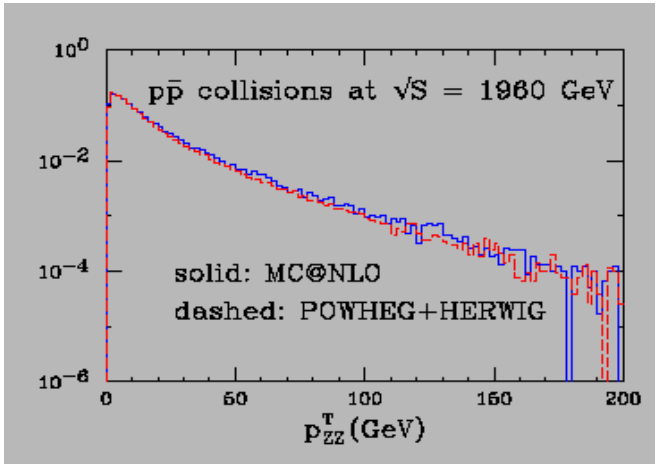
Initial State Radiation

Hadron collider applications

POWHEG-Nason, Frixione, Oleari







Figures taken from P. Nason's talk to 3rd MC workshop Frascati Oct. 06.

Matrix Element programs

- We also had presentations on two matrix element generators.
- HELAC–PHEGAS Papadopoulos
- PHANTOM Maina

HELAC–PHEGAS Papadopoulos

Current Status

- Single process mode: all SM processes. Only limitation memory and CPU cost ! to be judged by the user. Experience with as many as 10 particles in the final state.
- Summation over processes mode: all SM processes with fl_{ini} and fl_{fin} flavors for 'jets'. Only limitation memory and CPU cost ! to be judged by the user. Parallelism !
- Complete generation for pp and $p\bar{p}$ collisions, including all sub-processes. We do not exclude any processes!
- Interfacing with Pythia, including CKKW-like reweighting and use of `UPVETO` à la MLM.
- Extra version with HG^n and $H\gamma^n$ couplings

HEP - NCSR Democritos

Phantom

Ballestrero, Belhouari,Bevilacqua,E.M.

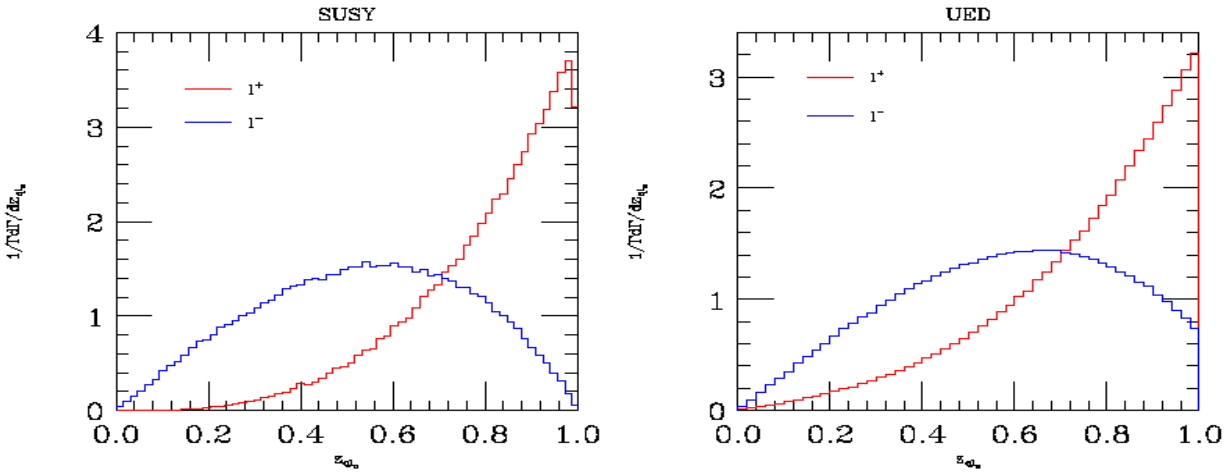
- Dedicated event generator
- Complete $2\to6$ $O(\alpha^6)+O(\alpha^4\alpha_s^2)$
- p-p, p-pbar, e^+e^-
- Complete set of reactions up to pp → 4l2j, ee → 2l4j
- At LHC: $q_1q_2\to f_1f_2\ f_3\ f_4\ f_5f_6$ $O(\alpha^6)+O(\alpha^4\alpha_s^2)$

  $gg \to f_1f_2\ f_3\ f_4\ f_5f_6$, $gq\to gq\ f_1f_2\ f_3\ f_4$, $qq\to gg\ f_1f_2\ f_3\ f_4$
- Exact matrix elements. No production⊗decay or EVBA
- Fast
- One-shot: generates unweighted events for all processes simultaneously
- Efficient: good mapping of phase-space
- Multichannel + Vegas

BSM

- Only had one talk (Gigg on Herwig++)
- Lots of useful discussion and collaboration on projects needing simulations.
- Should see simulations of future non-SUSY BSM models as a result.
- Also agreement to make adding new particles to the event generators easier.

Plots



A (double) BSM Accord: 1

Informal agreements, so far including at least: HERWIG++ (Gigg, Richardson), CalcHEP (Pukhov), CompHEP (Boos), MadGraph (Herquet), PYTHIA (Skands), (more? …)

- First problem
  - My MC generator doesn't know how to decay my favourite particle A in my favourite channel B! ☹
    - Partly addressed in SLHA1: decay tables
    - For exotic states, generator still needs to know quantum numbers, for colour flow, showering, charge conservation checks, …
    - ➔ New SLHA-like block: QNUMBERS (quantum numbers), specifies particle properties (+ SLHA1 MASS and DECAY as usual)

```
BLOCK QNUMBERS 1234567 # new_guy : [“PDG code” # name]
         1 0  # 3 times electric charge
         2 2  # number of spin states (2S+1)
         3 1  # colour rep (1: singlet, 3: triplet, 8: octet)
         4 0  # Particle/Antiparticle distinction (0=own anti)
BLOCK MASS  # Mass Spectrum
   1234567  3.1415926535E+02  # new_guy: mass [GeV]
DECAY   1234567   1.000000E+00 # new_guy: total width [GeV]
#   Branching  NDA Daughter1 Daughter2
   1.0000E-00    2        22        22 # Br(new_guy -> gamma gamma) = 1.0
```

A (double) BSM Accord: 2

Informal agreements, so far including at least: HERWIG++ (Gigg, Richardson), CalcHEP (Pukhov), CompHEP (Boos), MadGraph (Herquet), PYTHIA (Skands), (more? …)

- Second problem
  - A proliferation of ASCII files: model files, card files, event files, SLHA files, … there was recently an agreement on a common format for Les Houches Event Files ☺
    - Format includes a freely specifiable header
    - E.g. MadGraph puts SLHA blocks etc in the header of the event file.
  - Propose to adopt this as common standard:
    - SLHA files (or just QNUMBERS+MASS+DECAY for general BSM) should be put in the header of the Les Houches event file whenever possible.
      - SLHA read/write in event generators can be adapted to check for such information automatically when reading event files

      → in conjunction with QNUMBERS: Event file by itself contains all the information necessary for further processing → complete (if primitive) general BSM interface from production to hadronization
      - Event File + SLHA → one file → ASCII reduction

Overview

- Most MC projects as part of other groups.
- Some work on
  - Colour Coherence effects
  - Intrinsic p_T
  - Underlying Event
  - Adding some new BSM models.

Les Houches Guidebook

- Plan to update the 2003 Les Houches guidebook.
- Include the new generation of simulations.
- Improvements in matching and underlying event modelling

Les Houches Guidebook to Monte Carlo Generators for Hadron Collider Physics

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Abstract
Recently the collider physics community has seen significant advances in the formalisms and implementations of event generators. This review is a primer of the methods commonly used for the simulation of high energy physics events at particle colliders. We provide brief descriptions, references, and links to the specific computer codes which implement the methods. The aim is to provide an overview of the available tools, allowing the reader to ascertain which tool is best for a particular application, but also making clear the limitations of each tool.

Compiled by the Working Group on Quantum ChromoDynamics and the Standard Model for the Workshop "Physics at TeV Colliders", Les Houches, France, May 2003.
May 23, 2006

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BSM

- One project with the BSM group on off-shell effects.
- Other major issue is SHLA2, useful discussion which should be ready for the proceedings.

hep-ph/07mmnnn
FERMILAB-PUB-07-036-T

SUSY Les Houches Accord 2

B.C. Allanach, C. Balázs, G. Bélanger, F. Boudjema, D. Choudhury, K. Desch, U. Ellwanger, P. Gambino, R. Godbole, J. Guasch, M. Guchait, S. Heinemeyer, C. Hugonie, T. Hurth, S. Kraml, S. Kreiss, J. Lykken, M. Mangano, F. Moortgat, S. Moretti, S. Penaranda, T. Plehn, W. Porod, A. Pukhov, P. Richardson, M. Schumacher, L. Silvestrini, P. Skands, P. Slavich, M. Spira, G. Weiglein, P. Wienemann

List of affiliations.

June 18, 2007

Abstract

The SUSY Les Houches Accord provides a common interface that conveys spectral and decay information between various computer codes used in supersymmetric analysis problems, such as spectrum calculators, decay packages, Monte-Carlo programs, dark matter evaluators, and SUSY fitting programs. Here, we propose extensions of the conventions of the first SUSY Les Houches Accord to include various generalisations: violation of CP, R-parity and flavour as well as the simplest next-to-minimal supersymmetric standard model (NMSSM).

1 Introduction

Supersymmetric extensions of the Standard Model rank among the most promising and well-explored scenarios for New Physics at the TeV scale. Given the long history of supersymmetry and the number of both theorists and experimentalists working in the field, several different conventions for defining supersymmetric theories have been proposed over the years, many of which have come into widespread use. At present, therefore, there is not one unique definition of supersymmetric theories that prevails. Rather, different conventions are adopted by different groups for different applications. In principle, this is not a problem. As long as everything is clearly and completely defined, a translation can always be made between two sets of conventions, call them A and B.

However, the proliferation of conventions does have some disadvantages. Results obtained by different authors or computer codes are not always directly comparable. Hence, if author/code A wishes to use the results of author/code B in a calculation, a consistency check of all the relevant conventions and any necessary translations must first be made – a tedious and error-prone task.

To deal with this problem, and to create a more transparent situation for non-experts, the original SUSY Les Houches Accord (SLHA1) was proposed [1]. This accord uniquely defines a set of conventions for supersymmetric models together with a common interface between codes. The most essential fact is not what the conventions are in detail (they largely

1

Summary

- There have been a lot of useful discussions and hopefully a lot of projects started here will produce useful results.