BSM Event Generators: Status, Prospects, and a New Black Box

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BSM Event Generation: Overview

- Status
  - Will be a ***USER*** point of view...
- Prospects
  - small set

Bulk of Talk

- A New Black Box
  - Soon...

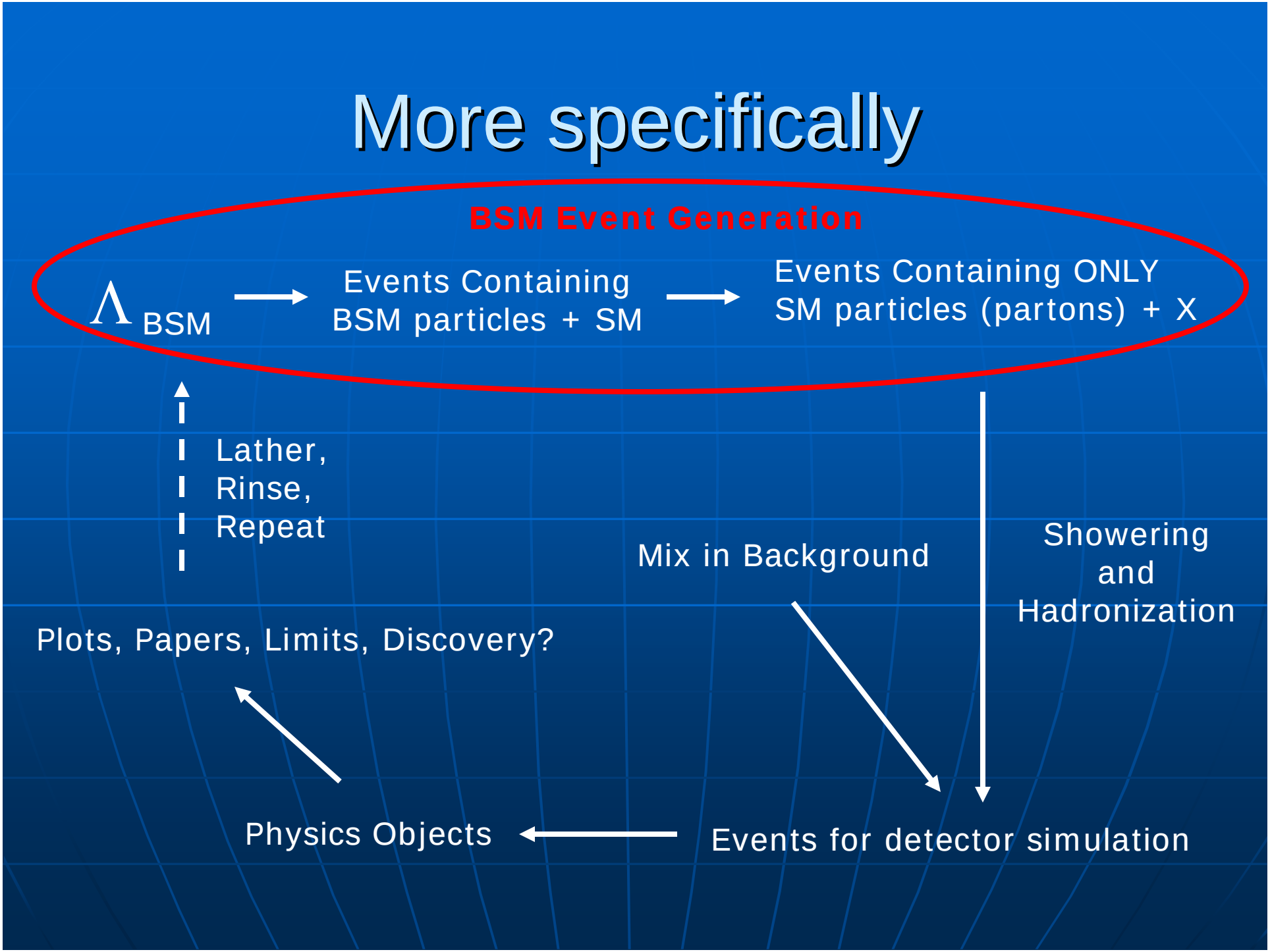
What do I mean by BSM Event Generation?

The steps in between more or less...

Theorist

Experimentalist

More specifically



Sample of BSM Generators

- Comphep/Calchep
- Madgraph/Madevent
- Sherpa
- Pythia
- Herwig
- Grace
- Pandora
- Others...

BSM Event Generation Status

For the most part...

We'd like to upgrade to at least this...

Sample of BSM Generators

- Comphep/Calchep
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- Others...

Drawbacks to some programs:

- Lots of BSM physics not implemented (good reasons)
- Hard to implement new physics
- Can't handle many body final states
- Physics quantities left out
- Lack of documentation
- Good features spread out amongst programs...

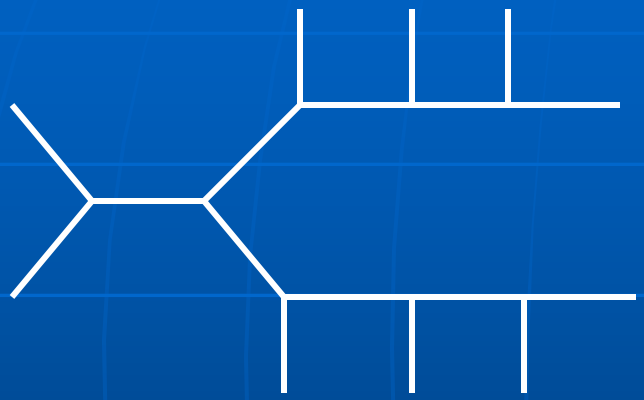
BSM Wish List Examples

- Idea to plots in a few minutes
  - Doubtful…
- “More realistic” example:

  Spin correlations (see exhortation by A. de Roeck MC4BSM)
- One integrated system
  - Easy to implement models
  - Can carry out large number of particle final states

Your wish list may differ based on point of view

Theorists role in collider pheno?

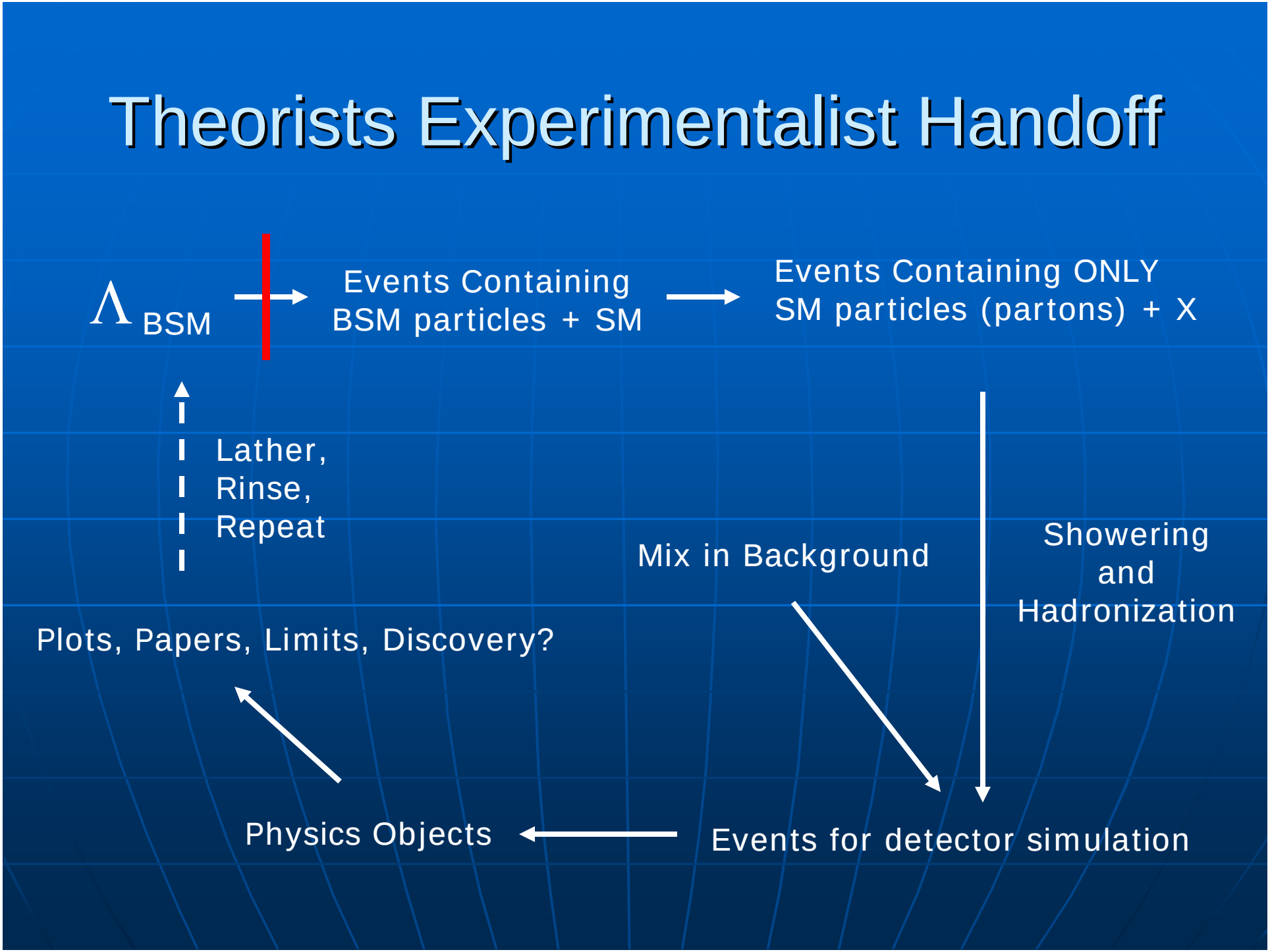


σ (2->2) Br(x->ab) Br(y->cd) ...

Multiply by luminosity declare victory based on counts versus background

What if we want to go further?

Theorists Experimentalist Handoff



Tools to Accommodate All

- My take is that we want to go as far as possible as to convince experimentalist to redo the analysis
- Whether you are a bottom upper or top downer (or an in betweener) if we have the tools it's your responsibility

An Example: Madgraph/Madevent

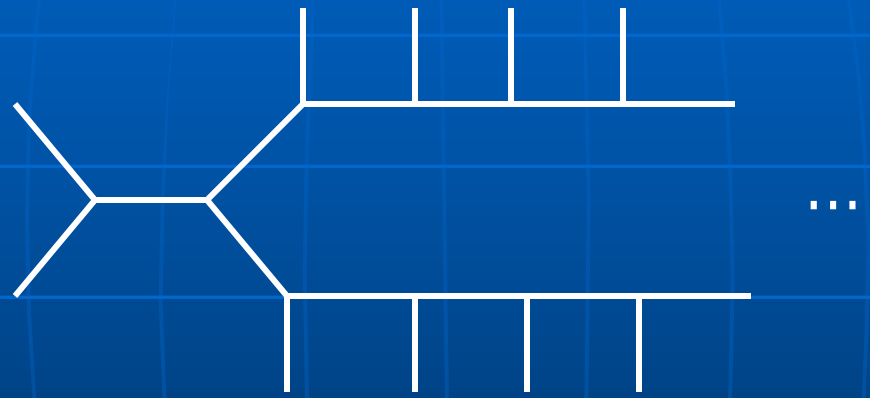
- Madgraph: from a set of particles and interactions sets up helicity amplitudes (HELAS) for a requested process
- Madevent: Carries out integration using VEGAS to get cross sections and events
  - •Can handle large number of final states
  - •Relatively easy to implement new models

Drawbacks:

- 2->N, N>6ish
- Have to calculate widths in new model beforehand

Prospects (an example)

- Let's just try to deal with new models and large final states to make ourselves "useful"



Want to eventually get to Pythia let's say

How to attack?

Madgraph almost only tool but computationally prohibitive

Pythia needs to know about new particles…

Prospects

This you really need an expert or at least multiple people involved in this to give you a comprehensive view…

SAMPLING OF NEW THINGS/PROSPECTS…

- Q-numbers in Pythia (6.326 update notes)
- Madgraph
  - New model template v4.0
  - Simplifying longer decay chains in progress
  - New HELAS routines can be incorporated in a straightforward manner
- BRIDGE for Madgraph

A **BRIDGE** to BSM Event Generation

Branching **R**atio **I**nquiry / **D**ecay **G**enerated **E**vents

PM, M. Reece

(WORK IN PROGRESS)

Generic problem of calculating widths in madgraph given a new model

Simple solution:

BRI

- Loop over all particles find 2 body (or more) decays available from set of particles and interactions
- Construct appropriate HELAS amplitudes and integrate with VEGAS to find widths
- Spit out table that can be read by Madgraph

Can in principle account for loop decays other “exotics”
Can use to check other decay programs

Now you can blissfully go about calculating in any model

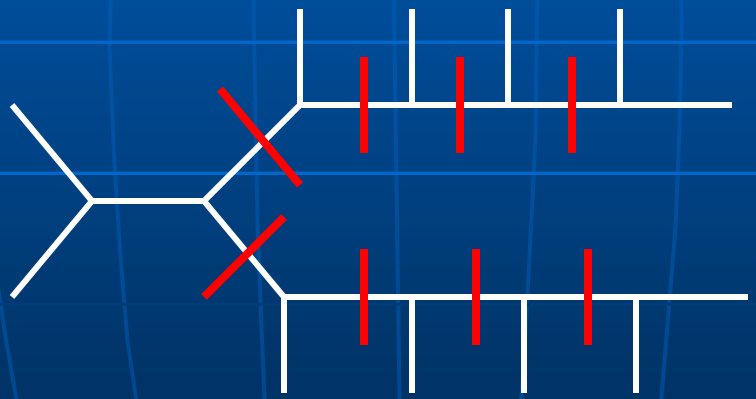
Branching **R**atio **I**nquiry / **D**ecay **G**enerated **E**vents

Problem: Getting down long decay chains to SM particles

Simple solution:

DGE

- Generate events at a lower level see below
- Build up decay chains iteratively
- Use VEGAS grids from getting widths
- Boost particle to rest frame decay boost back with appropriate weight change



Not a perfect solution but moving forwards

BRIDGE

- Use Madgraph for any model off the shelf quickly
- Take care of long decay chains
- Spin correlation kept to some degree
- Can expand on this framework not in principle married to Madgraph but stand alone
- C++ not fortran
- Feel free to offer suggestion/***help***/encouragment…

A New Black Box

C. Csaki, PM, P. Onyisi, M. Perelstein,
M. Reece, C. Spethmann + X

Thinking outside the box to make a box…

Hopefully no analogy to this will be found by you all

New Black Box

COMING SOON!

HINTS:

- There is a model…
- The model doesn't exist in any current generator
- The box is generated in madgraph-pythia-PGS
- There is a lot going on…
- Don't forget the hope of the TeV scale

  (try to understand as much as you can about EWSB)

GOOD LUCK!