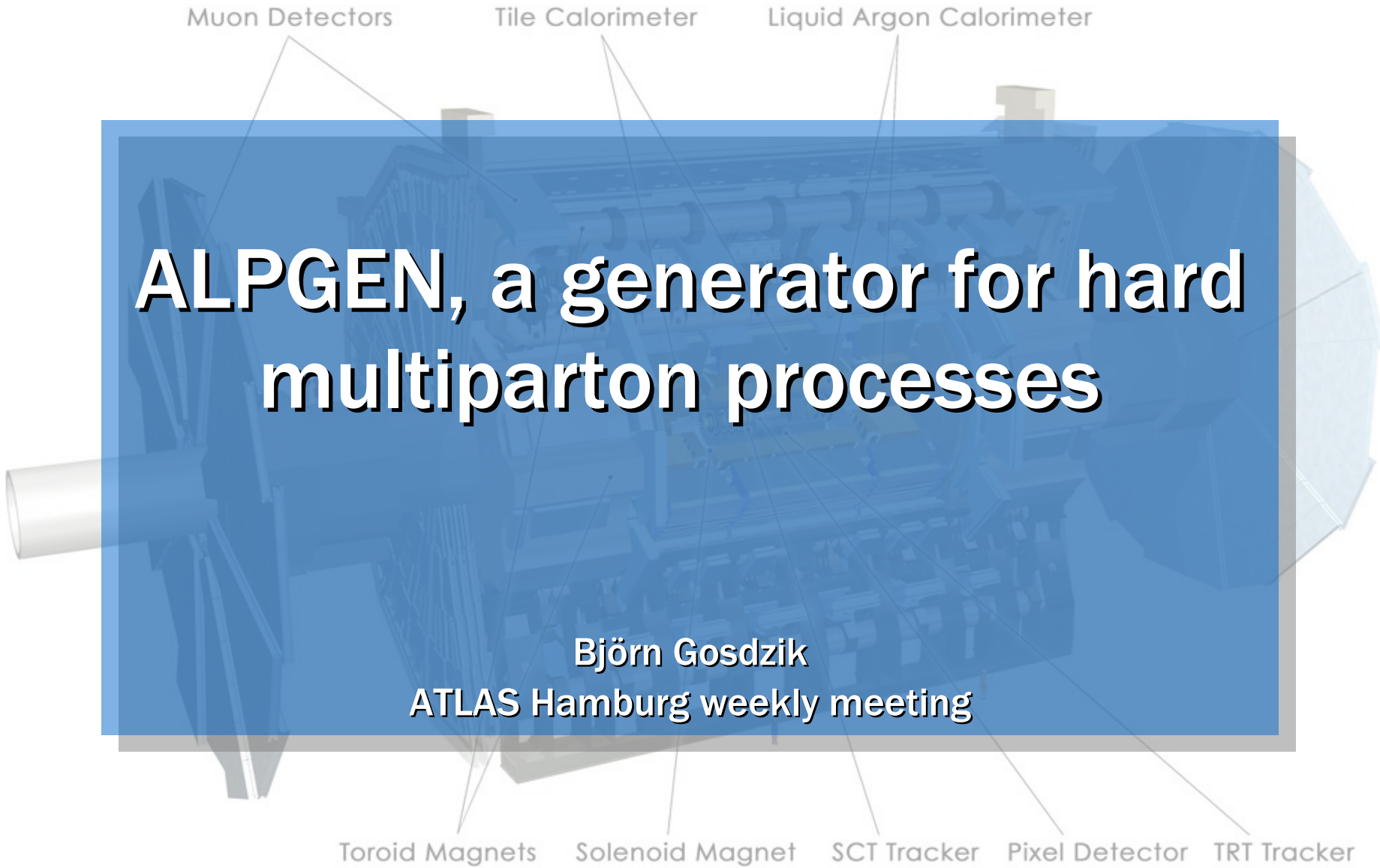

ALPGEN, a generator for hard multiparton processes

Björn Gosdzik

ATLAS Hamburg weekly meeting

Overview

- Why a new event generator?
- Structure
- Available hard processes
- Conclusion

- Important role of multi-jet final states in high-energy collisions
- Provide interesting signatures for several phenomena
  - SM: e.g. top-pair production
  - Beyond SM: e.g. multi-jet decays of supersymmetric particles such as gluinos and squarks
- Good understanding of large multi-jet QCD background

- Improved algorithms for calculation of cross-sections for complicated processes (final states with over 10 jets) within reasonable amounts of computer time
- Calculation of parton-level matrix elements with evaluation of the full hadronic structure of the final state
  - for study of both signal and background
  - for complete comparison between theory and data
- Involves consistent merging of the matrix-element computation with parton-shower evolution
  this problem has not been considered in previous tools

- ALPGEN consists of several building block
  - Defining the overall infrastructure
    - Implementing the logical sequence of operations
      - Algorithm needed for the evaluation of the matrix element
      - The evaluation of the parton densities
  - Each hard process has a separate set of code elements, specific to it
    - Process initialization
    - Phase-space generation
    - Extraction of flavour and colour structure
    - Default analysis routines
- Interface to HERWIG and PYTHIA

Parton-level generation and cross section evaluation

- Parameters required to define the hard process are passed to the code
  - Selection of jet multiplicity
  - Mass of possible heavy quarks
  - Rapidity and transverse momentum cuts
  - etc.
- A first phase-space integration cycle is performed to explore how the cross-section is distributed in phase-space
  - One subprocess is selected (randomly)
  - A point in phase-space is selected (randomly)
  - Initial-state parton luminosity is evaluated for chosen subprocess
  - Spin and colour for each parton are assigned (randomly)
  - Matrix element is evaluated (using the ALPHA algorithm)

Parton-level generation and cross section evaluation

- Map of the cross-section distribution among different subprocesses and in phase-space is available at the end of the first integration iteration
- Optimised integration grids are stored in a file after the completion of a series of warm-up integration cycles
- PDF sets and Electroweak parameters are controlled by variables
  - PDF parameterization (CTEQ4M, CTEQ4L,... MRST99-1, MRST01-1,...) and corresponding $\alpha_s(m_Z)$
  - EW parameters with following inputs:

$$m_W = 80.419 \qquad m_Z = 91.188 \qquad \sin^2\theta_W = 0.231$$

$$\alpha_{em}(m_Z) = 1/128.89 \qquad G_F = 1.16639 \cdot 10^{-5}$$

List of hard processes

$WQ\bar{Q}+jets$

$Z/\gamma\, Q\bar{Q}+jets$

$W+jets$

$W+c+jets$

$Z/\gamma+jets$

$nW+mZ+j\gamma+lH+kjets$

$Q\bar{Q}+jets$

$Q\bar{Q}Q'\bar{Q}'+jets$

$Q\bar{Q}H+jets$

$N\ jets$

$m\gamma+jets$

$nH+jets$

$Single-top$

$W+\gamma+jets$

$W+\gamma+Q\bar{Q}+jets$

$Q\bar{Q}+m\gamma+N\ jets$

Conclusion

- MC tool for generation of complex, high-multiplicity hard final states
- Large fraction of processes have never been calculated before to the level of jet multiplicities
- Evaluation of the matrix elements
- Possibility to carry out the shower evolution and hadronization of the final states

Literature:

M.L Mangano, M. Moretti, R. Pittau, ALPGEN, a generator for hard multiparton processes in hadronic collisions, CERN-TH/2002-129, [hep-ph/0206293]

F. Caravaglios, M.L. Mangano, M. Moretti and R. Pittau, A new Approach to Multi-Jet Calculation in Hadron Collisions, Nucl. Phys. B **539** (1999) 215, [hep-ph/9807570]