Université catholique de Louvain
Center for Particle Physics and Phenomenology - CP3

# LHC phenomenology with MadGraph

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A six-hour PhD course at University of Milan

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# Abstract

One of the top priorities of the high-energy physics community is to discover how masses of the fundamental constituents of matter arise and are stabilized. Data collected both through accelerator experiments in the last thirty years and, more recently, also from cosmological observations, point to the presence of new particles and interactions at an energy scale of Tera-electronVolt (TeV). This region will be systematically explored with the Large Hadron Collider (LHC) at CERN started last year, in 2009. At this collider, spectacular events takes place and mulijet final states in association with leptons or missing energy will constitute the most interesting data samples. The quest for the Higgs boson(s) and/or for supersymmetric particles will rely on our ability of predicting both the signal and the standard model processes which are the backgrounds of these searches.

In this framework, Monte Carlo simulations will play a primary role, both at the descriptive and predictive levels.

# Goals

The goals of the course are:

- to introduce the basics concepts of Monte Carlo simulation of events at hadron colliders starting from the Lagrangian of the Standard Model to the final state description of in terms of hadrons and leptons.

- to learn by hands-on sessions how to generate events for both signal and backgrounds with MadGraph (and Pythia).

The course is aimed at Ph.D. students, both theorists and experimentalists in HEP.

# Program

The course is organized in three 1h+1h hour theory and exercises sessions:

I **TH :** Introduction to event simulation at the LHC: Motivations, Anatomy of an event at hadron-hadron colliders. High-$Q^2$ processes: matrix element generators.
**EX:** Matrix element generation with MadGraph: Introduction, code generation from the Web. Case studies.

II **TH :** Basics of Monte Carlo techniques, event generation.
**EX:** Cross section evaluation and parton-level event generation with MadGraph. Case studies: Higgs, top, jets,...

III **TH :** Towards a realistic simulation: The physics of parton showers and hadronization models. Full event simulation with MadGraph + Pythia. Beyond the Standard Model simulations.
**EX:** Full simulation: case studies. Challenge: solving Black Boxes.

The lectures will be supported by material and tools available from the web (slides, references, Wiki pages, event database, MadGraph server and clusters). See, for instance, `http://cp3wks05.fynu.ucl.ac.be/twiki/bin/view/Main/MadLectures`.