

# Monte Carlo Tutorial

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Welcome to three afternoons of Monte-Carlo tutorials!

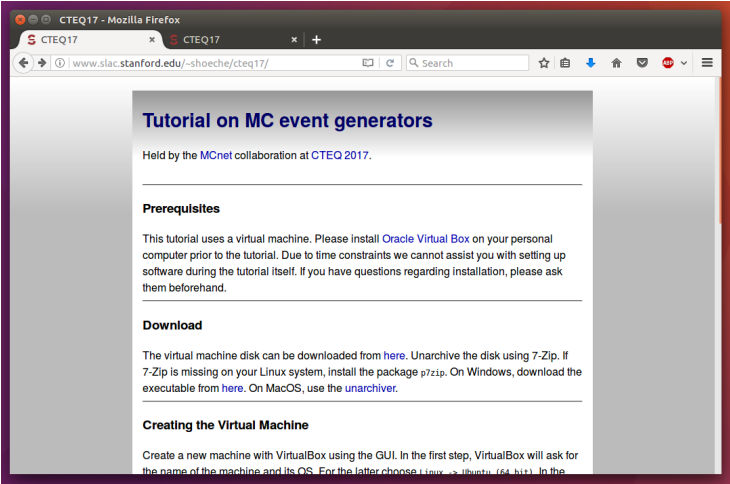
**Aim:** Get a deeper understanding of event generators, look inside these black boxes and understand their physics, *by developing and running code.*

**How?**

Two days to write a parton shower.

One day to get familiar with HERWIG, PYTHIA or SHERPA.

Tutorials use VM from <http://www.slac.stanford.edu/~shoeche/cteq17/>



The screenshot shows a Mozilla Firefox browser window with the address bar displaying [www.slac.stanford.edu/~shoeche/cteq17/](http://www.slac.stanford.edu/~shoeche/cteq17/). The page content is as follows:

## Tutorial on MC event generators

Held by the [MCnet](#) collaboration at CTEQ 2017.

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### Prerequisites

This tutorial uses a virtual machine. Please install [Oracle Virtual Box](#) on your personal computer prior to the tutorial. Due to time constraints we cannot assist you with setting up software during the tutorial itself. If you have questions regarding installation, please ask them beforehand.

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### Download

The virtual machine disk can be downloaded from [here](#). Unarchive the disk using 7-Zip. If 7-Zip is missing on your Linux system, install the package `p7zip`. On Windows, download the executable from [here](#). On MacOS, use the [unarchiver](#).

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### Creating the Virtual Machine

Create a new machine with VirtualBox using the GUI. In the first step, VirtualBox will ask for the name of the machine and its OS. For the latter choose Linux -> Ubuntu (64 bit). In the

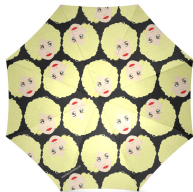
You should have downloaded the VM. Else, ask for a USB stick.

## Days 1& 2: Implementing parton showers

Parton showers are a crucial piece of event generation. They approximate multiparton states by performing a cascade of splittings.

Uncertainties in how parton showers are constructed are among the dominant theory issues at colliders. To understand these issues better, the tutorial will guide you in **writing your own parton shower** code, complete with

- ...splitting probabilities and splitting phase space
- ...matrix element corrections and NLO matching
- ...on-the-fly renormalization scale uncertainties



The programming language will be PYTHON. You should form groups of **three** for the first two days.

## Day 3: LHC generators

On day 3, we learn how to use the common LHC event generators. You will first learn basic usage. Then, you should assess specific uncertainties for  $t\bar{t}$  production at the LHC:



HERWIG

UE and non-perturbative uncertainties



PYTHIA

Shower scale- and kernel uncertainties



SHERPA

Hard process scale uncertainties

Form groups of **three or six** for the third day. Pick one generator. Make sure that each generator is represented once/twice in your group.

At the end, you should have comparisons ready, to discuss in the night cap session.

## More technicalities

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You can find the instructions online at  
<http://www.slac.stanford.edu/~shoeche/cteq17/ws/> (possibly outdated!)  
or better on the VM:

```
/home/student/tutorials/introduction.pdf  
/home/student/tutorials/ps/tutorial.pdf  
/home/student/tutorials/mc/sherpa/  
/home/student/tutorials/mc/pythia/  
/home/student/tutorials/mc/herwig
```

The login/password for the VM are student/2017.  
The first thing you should do every time you start the VM is

```
student@cteq:~tutorials$ svn up
```

Questions anyone? Don't hesitate to ask at any time!

Useful links:

<http://www.slac.stanford.edu/~shoeche/cteq17/>

## Even more technicalities

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For easy file access, it is often convenient to have a shared folder between your VM and the host system. This may be achieved by

- ▶ In your running VM, go to the menu `Devices -> Shared folders` (or something similar) and click "Add" or the "+" symbol
- ▶ Select a folder on your HOST computer.  
Call this folder (in the dialog window!) `share_host`.  
Tick the "automount" and "make permanent" boxes.  
Close with "OK".
- ▶ Then, open the terminal and go to `/home/student`.  
Execute the command

```
mkdir -p share  
sudo mount -t vboxsf share_host share
```

Your shared folder is now available under `share`.