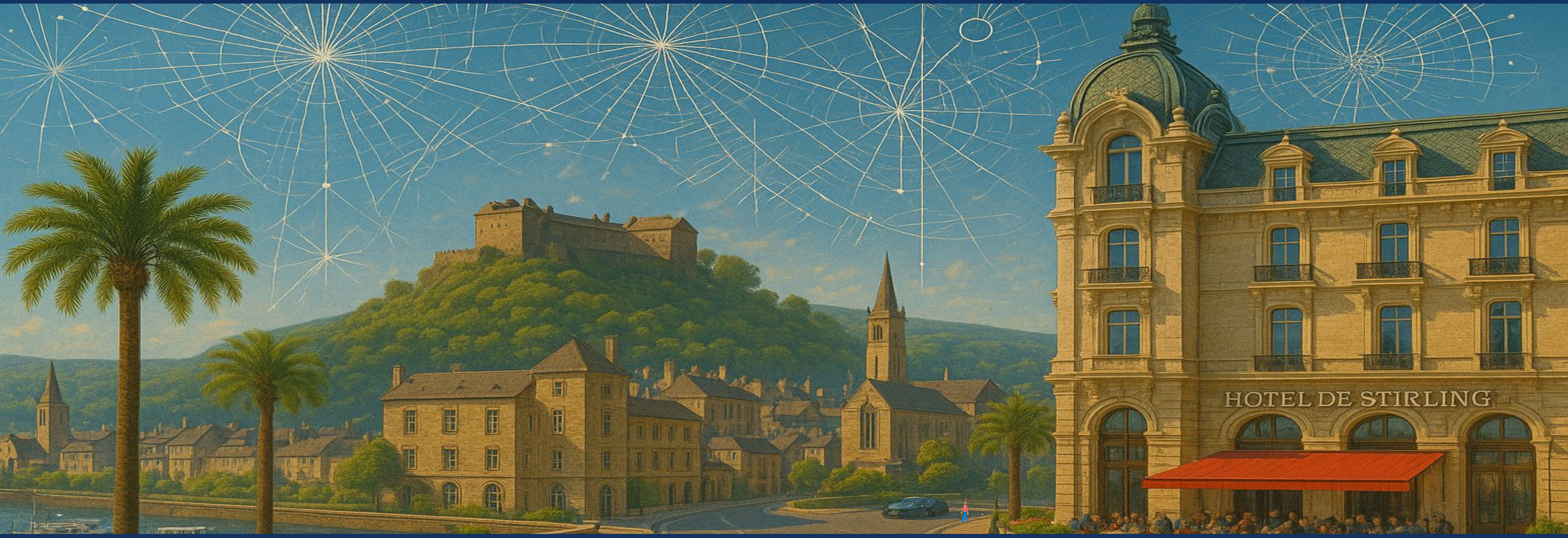
Tutorial — MG5 to Contur

From Theory to Exclusion



MadGraph5

Daniele Massaro (CERN)

Ramon Winterhalder (UniMi)

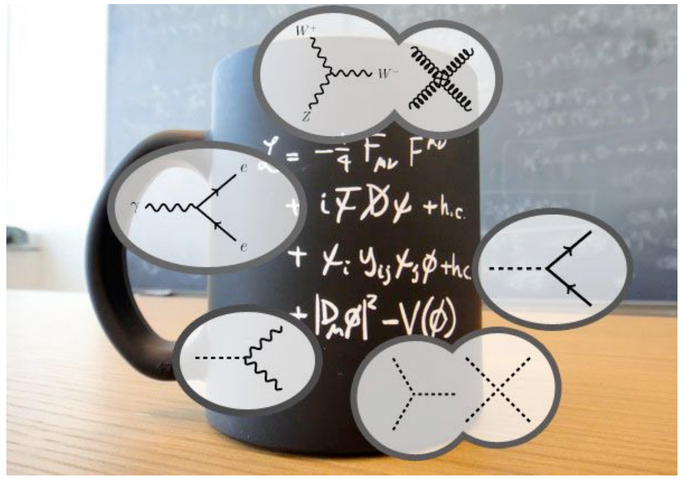
Rivet+Contur

Martin Habedank (Glasgow)

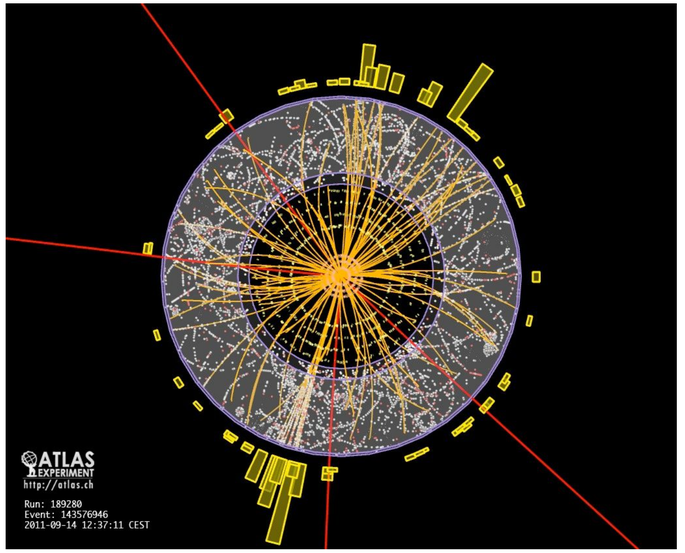
From Theory to Exclusion

Introduction

From Theory to Exclusion



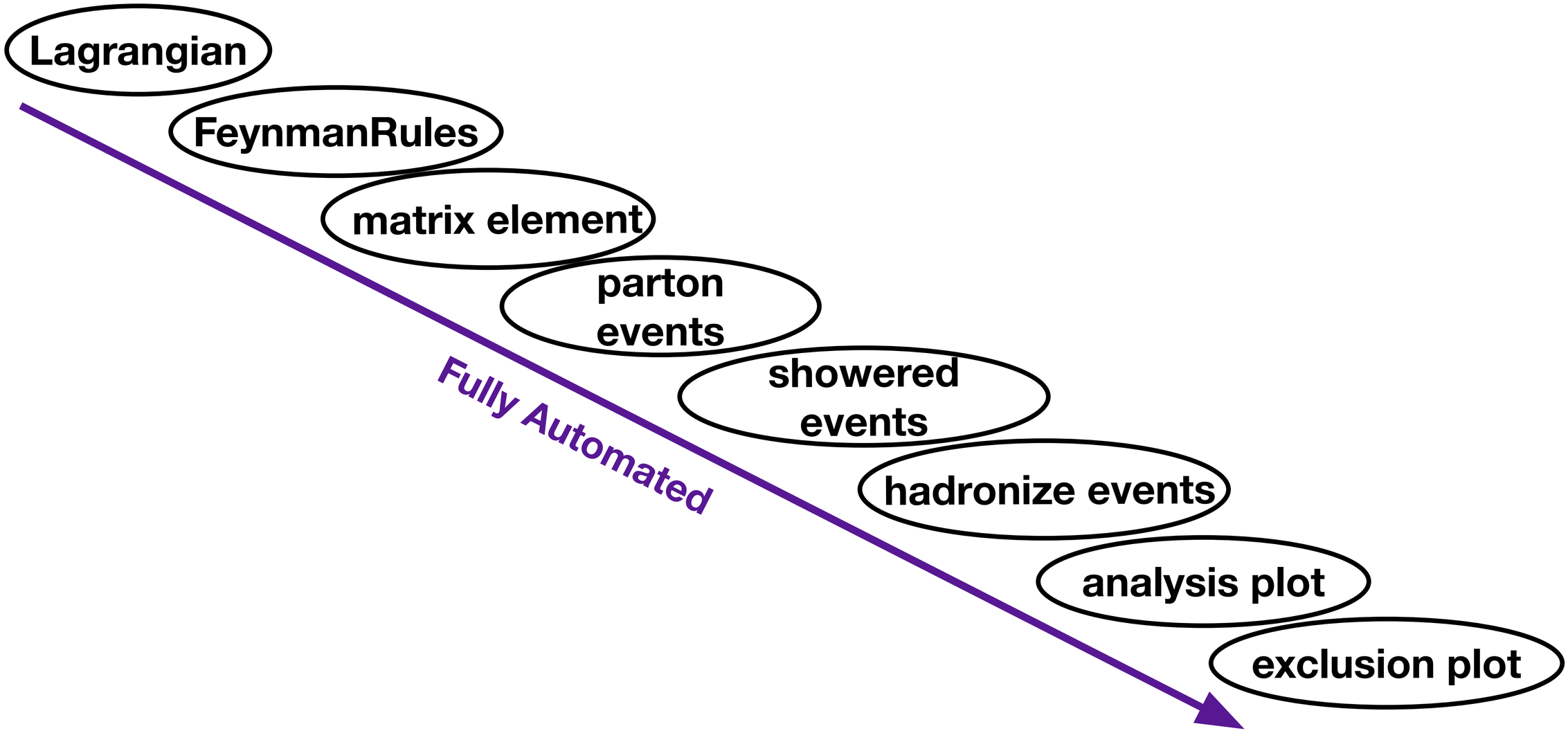
Monte-Carlo Physics



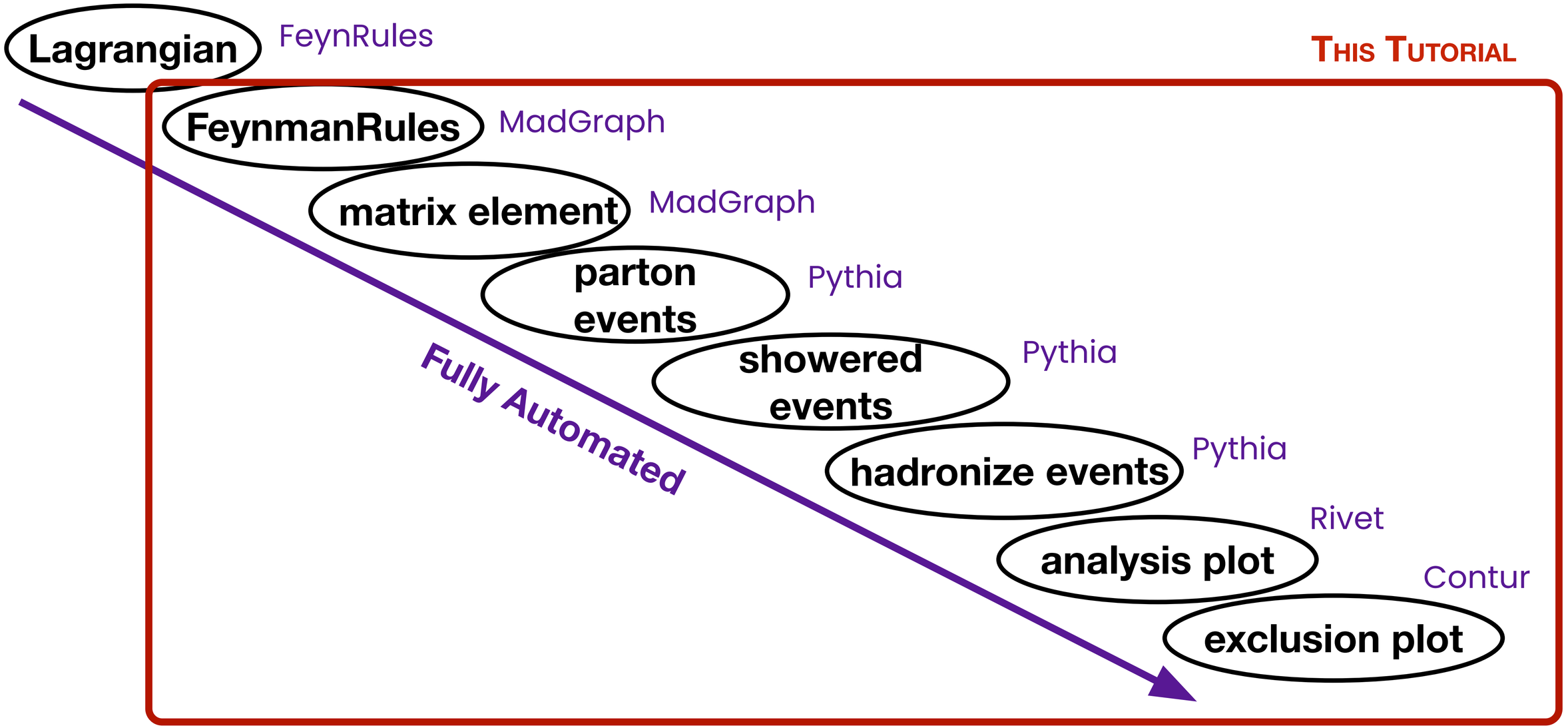
Our goal

- Cross section
- Differential cross section
- Unweighted events

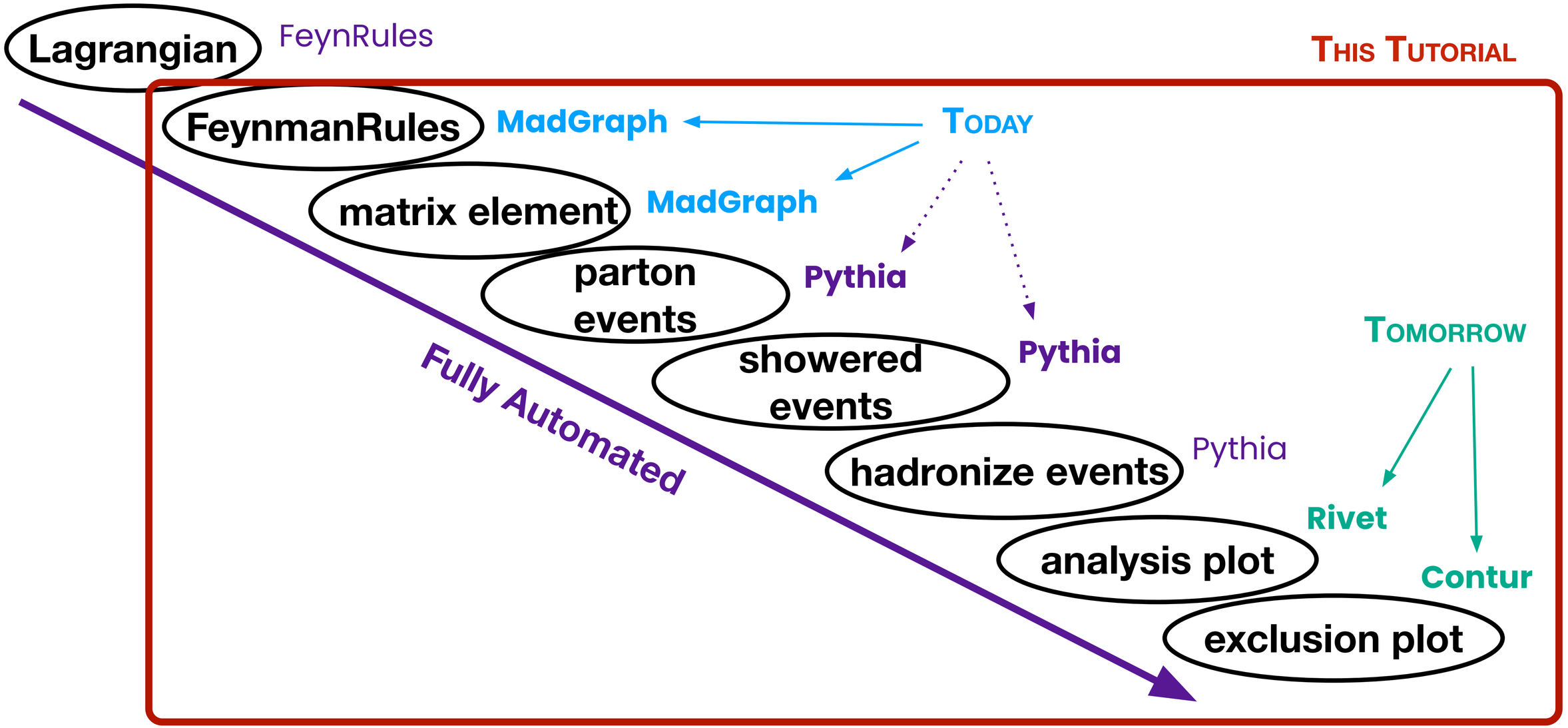
From Theory to Exclusion



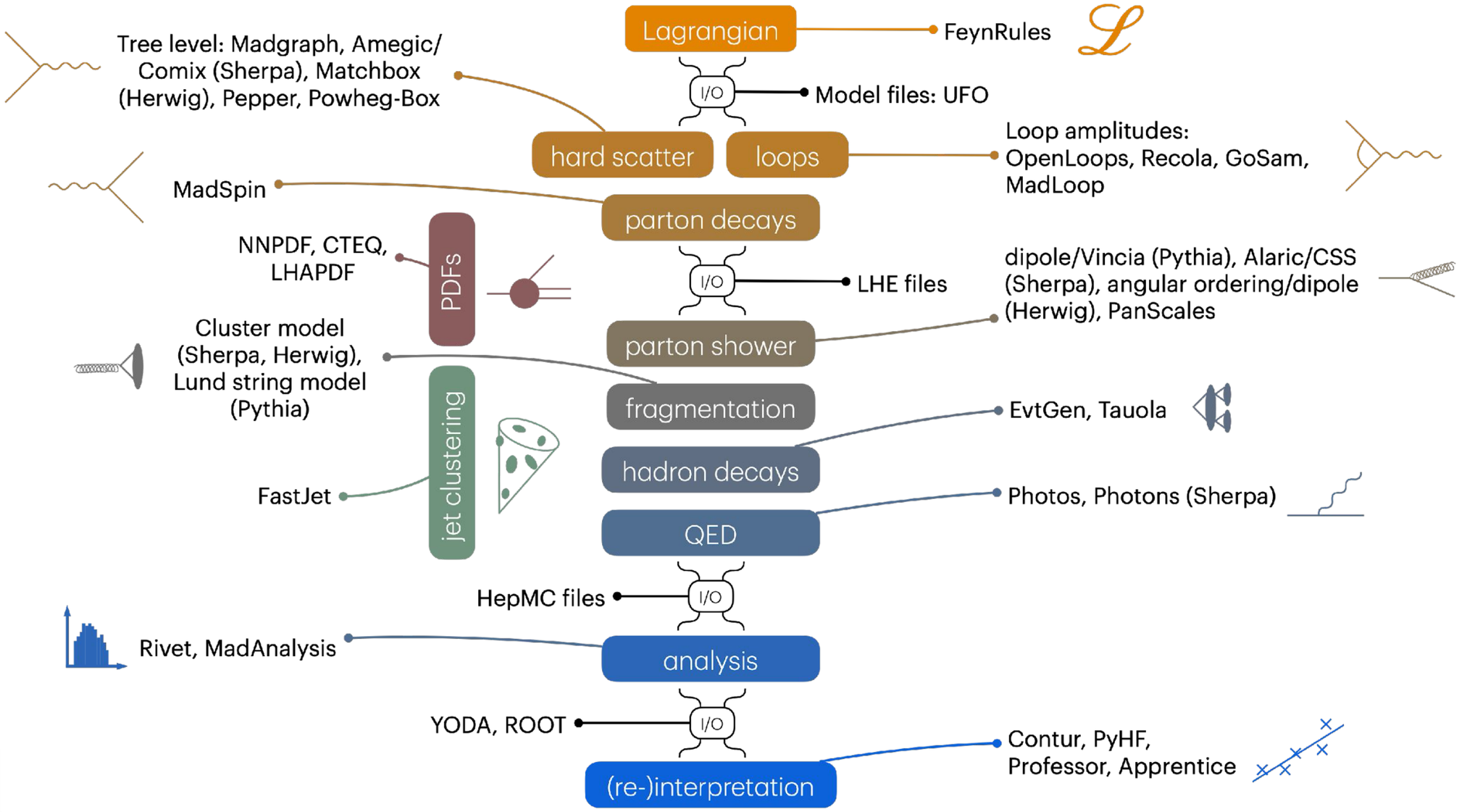
From Theory to Exclusion



From Theory to Exclusion



The devil is in the details



MCnet

MadGraph5 Tutorial

Ramon Winterhalder (UniMi)
Daniele Massaro (CERN)

Getting the code

Download the code

```
$ wget https://github.com/mg5amcnlo/mg5amcnlo/archive/refs/tags/v3.6.2.tar.gz
$ tar xzf v3.6.2.tar.gz
$ cd mg5amcnlo-3.6.2
$ ./bin/mg5_aMC
```

Outline of the Tutorial

I. Built-in MG5 tutorial

II. Understanding the cards

III. Understanding the syntax

IV. BSM process and mass scan (bonus)

V. Generate hepMC files for the **Rivet+Contur Tutorial**

Where to find help?

- Ask us

  Use the command “`help`” / “`help XXX`”

  “`help`” tells you the next command that you can do

- Launchpad:

  https://answers.launchpad.net/madgraph5

  FAQ: **https://answers.launchpad.net/madgraph5/+faqs**

Exercise I — Built-in Tutorial

- Launch the code
  - ➡ `$ ./bin/mg5_aMC`

- Type “`tutorial`”
  - ➡ Follow instructions!

Exercise II — Parameters and Cards

- Compute the LO cross-section for our BSM background (see later)
  - `generate p p > mu+ mu-`
- Check
  - What is the Z mass?
  - Are there any cuts? (Do we need cuts?)
  - Beam energy
- Useful cards to check are

  param_card: **model parameters**

  run_card: **beam/run parameters and cuts**

Exercise III — Syntax

- Generate the cross-section **and the distribution** (invariant mass) for
  - `p p > mu+ mu-`
  - `p p > z, z > mu+ mu-`
  - **`p p > mu+ mu- $ z`** **(warning set sde_strategy=1 in the run_card)**
  - `p p > mu+ mu- / z`

Hint: To plot automatically distributions

```
mg5> install MadAnalysis5
```

Exercise IV — BSM Model

Get a new model (in mg5)

```
./bin/mg5_aMC
set auto_convert_model T
import model VPrime_NLO
```

Check the model

```
./bin/mg5_aMC
import model VPrime_NLO
check p p > mu+ mu-
display particles zp
```

Exercise IV — Mass Scan

- Compute the cross-section for
  - `p p > zp`
    - **For zp mass 500 GeV, 1 TeV, 1.5 TeV, 2 TeV**

      Trick you can use: `scan:[500,1000,1500,2000]`
    - Does the cross section decrease/increase (why should it)?
  - `p p > zp , zp > mu+ mu-`
    - **For zp mass 500 GeV, 1 TeV, 1.5 TeV, 2 TeV**
    - Does the cross-section decrease/increase (why should it be)?
    - What is the relation to the previous cross section?
    - Compute the branching ratio

Prerequisite for Contur/Rivet

Extra - showering w/ Pythia

- First of all, install pythia through the MadGraph interface:

```
MG5_aMC>install pythia8
   You are installing 'pythia8', please cite ref(s): arXiv:1410.3012.
```

- Then, use `shower=pythia8` when running the event generation.

```
The following switches determine which programs are run:
/================== Description ==================|============= values =============|======== other options ========\
| 1. Choose the shower/hadronization program       |        shower = OFF             |     Pythia8                    |
| 2. Choose the detector simulation program        |      detector = Not Avail.      |     Please install module      |
| 3. Choose an analysis package (plot/convert)     |      analysis = Not Avail.      |     Please install module      |
| 4. Decay onshell particles                       |       madspin = OFF             |     ON|onshell|full           |
| 5. Add weights to events for new hypp.           |      reweight = Not Avail.      |     Please install module      |
\=================================================================================================================/
Either type the switch number (1 to 5) to change its setting,
Set any switch explicitly (e.g. type 'shower=Pythia8' at the prompt)
Type 'help' for the list of all valid option
Type '0', 'auto', 'done' or just press enter when you are done.[60s to answer]
>shower=pythia8
The following switches determine which programs are run:
/================== Description ==================|============= values =============|======== other options ========\
| 1. Choose the shower/hadronization program       |        shower = Pythia8         |     OFF                        |
| 2. Choose the detector simulation program        |      detector = Not Avail.      |     Please install module      |
| 3. Choose an analysis package (plot/convert)     |      analysis = Not Avail.      |     Please install module      |
| 4. Decay onshell particles                       |       madspin = OFF             |     ON|onshell|full           |
| 5. Add weights to events for new hypp.           |      reweight = Not Avail.      |     Please install module      |
\=================================================================================================================/
```

Extra - showering w/ Pythia

- You can also modify some of the pythia parameters later

```
Do you want to edit a card (press enter to bypass editing)?
/------------------------------------------------------------\
|  1. param    : param_card.dat                              |
|  2. run      : run_card.dat                                |
|  3. pythia8  : pythia8_card.dat                            |
\------------------------------------------------------------/
 you can also
   - enter the path to a valid card or banner.
   - use the 'set' command to modify a parameter directly.
     The set option works only for param_card and run_card.
     Type 'help set' for more information on this command.
   - call an external program (ASperGE/MadWidth/...).
     Type 'help' for the list of available command
 [0, done, 1, param, 2, run, 3, pythia8, enter path][90s to answer]
>3
```

```
...t/mg5amcnlo/3.6.1/my_proc/Cards/pythia8_card.dat
!
! Pythia8 cmd card automatically generated by MadG>
! For more information on the use of the MG5aMC / >
!    https://cp3.irmp.ucl.ac.be/projects/madgraph/>
!
! ==================
! General parameters
! ==================
!
Main:numberOfEvents      = -1
!
! ------------------------------------------------>
! Specify the HEPMC output of the Pythia8 shower.  >
!   hepmc       : MG5aMC will automatically place  >
!   hepmc.gz    : Same as 'hepmc', but also will c>
!   hepmcremove : MG5aMC will automatically remove>
!                 (usefull when running with Delph>
!   hepmc@<hepmc_path> :
!                 User defined path where the HEPM>
!                 therefore not be placed in the r>
!                 specified path, if not absolute,>
!                 the Event/run_<i> directory of t>
!   /dev/null : to turn off the HEPMC output.
!   fifo      : to have MG5aMC setup the piping of>
!               analysis tools such as MadAnalysis>
!   fifo@<fifo_path> :
!              Same as 'fifo', but selecting a cu>
!              fifo pipe. (useful to select a mou>
!              fifo). Note that the fifo file ext>
! ------------------------------------------------>
!
HEPMCoutput:file         = hepmc.gz
!
                  [ Read 87 lines ]
^G Help      ^O Write Out^W Where Is  ^K Cut
^X Exit      ^R Read File^\ Replace   ^U Paste
```

Extra - script MadGraph

- Create text file and write the commands you would write on the prompt

Example: `generate.txt`

```
import model VPrime_NLO
generate p p > mu+ mu-
# comments work as well
output my_proc
```

Pass as first command line argument

```
$ ./bin/mg5_aMC generate.txt
$ ./bin/mg5_aMC launch.txt
```

Example: `launch.txt`

```
launch my_proc
shower=pythia8
set mzp scan:[500,1000,1500,2000]
# python syntax works too
# set mzp scan:[500*i for i in range(1,5)]
```

In case of prompt questions, default is accepted if no valid answer is found.

Rivet+Contur Tutorial

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