

THEORIST'S ANALYSIS TOOL

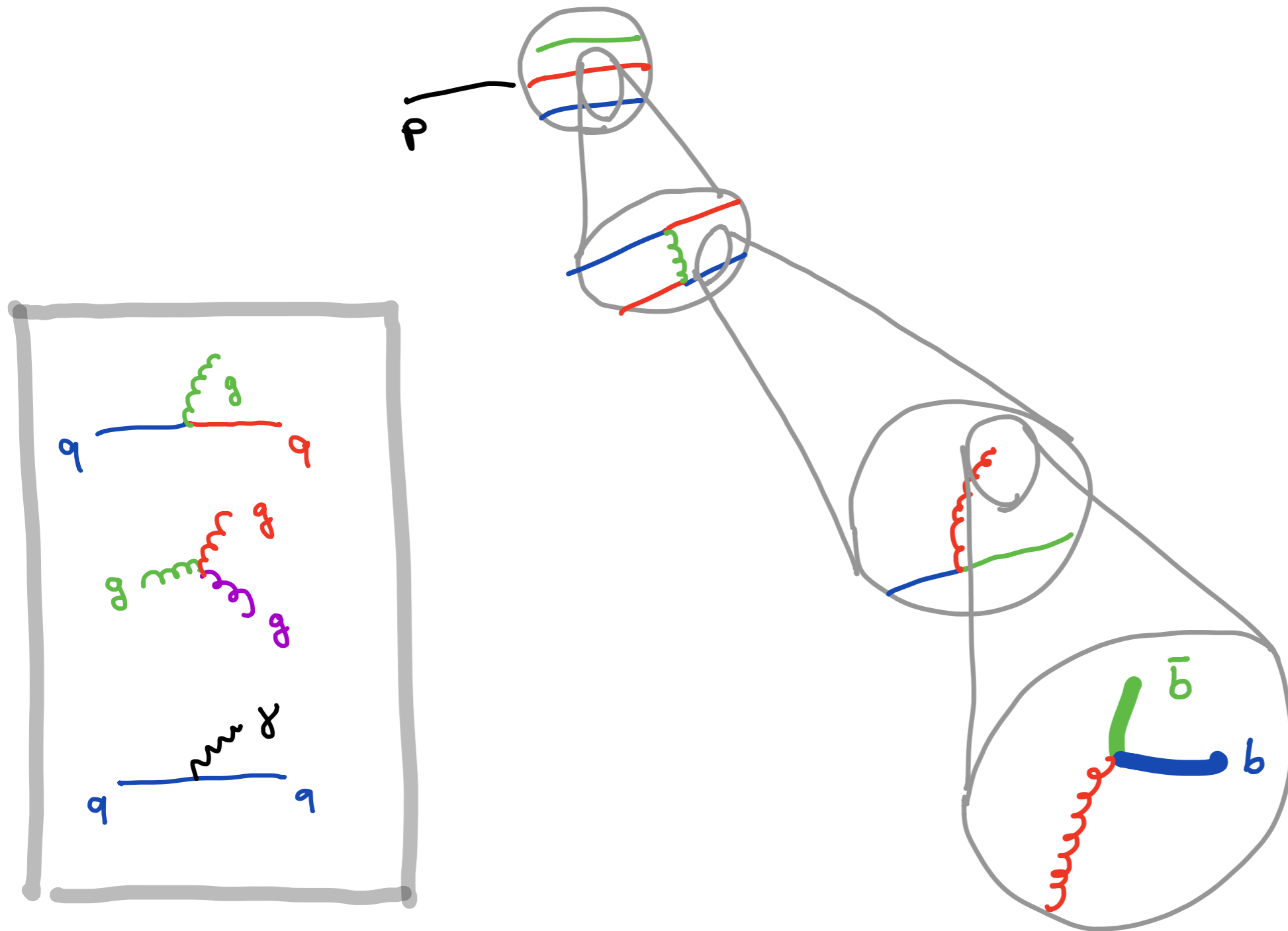
Roberto Franceschini
(franceschini@fis.uniroma3.it Stanza 114)

THE BIG PICTURE

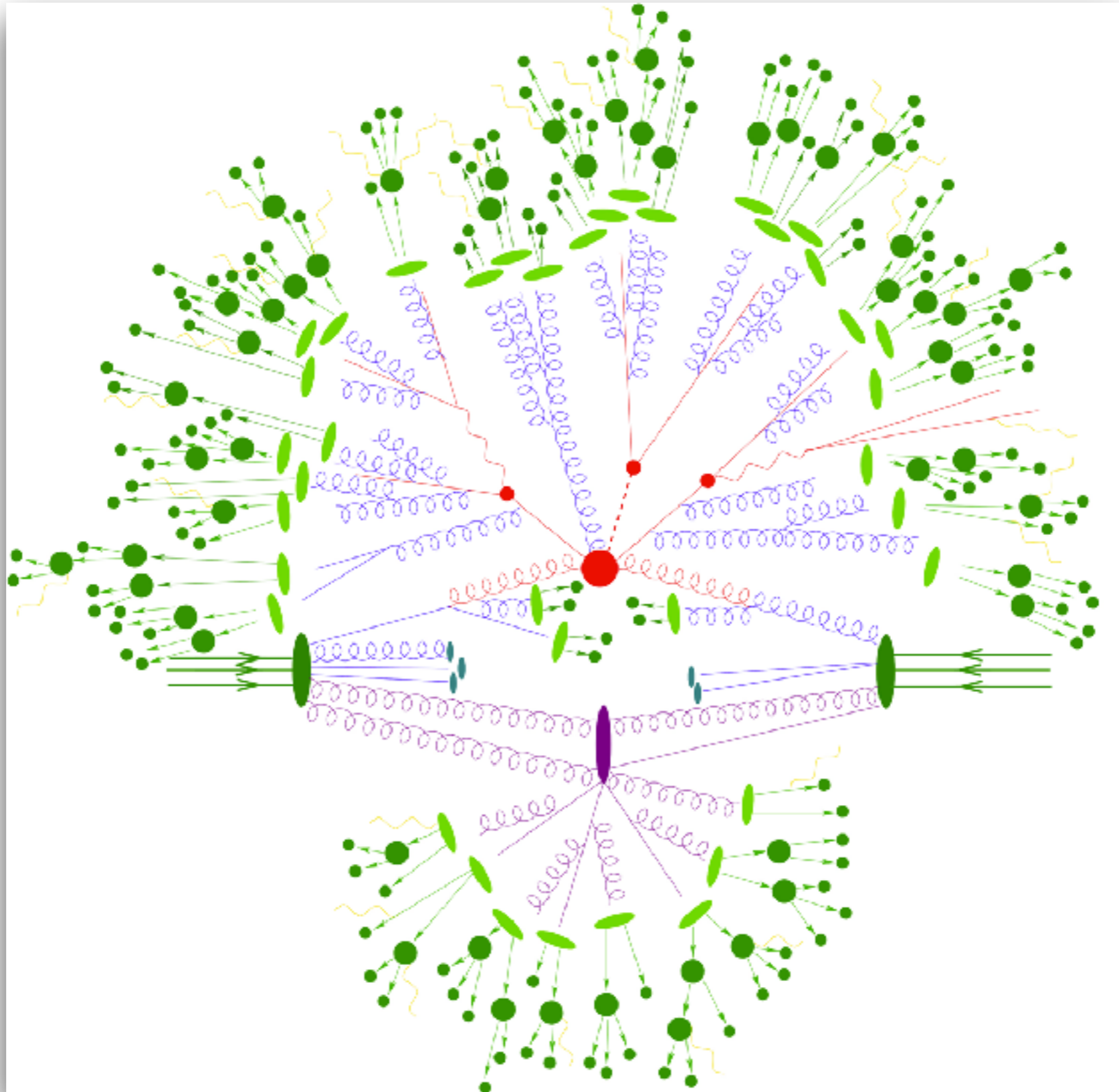
.....
Separation of scales



DIFFERENT PHENOMENA HAPPEN AT DIFFERENT TIME-SCALES



DIFFERENT PHENOMENA HAPPEN AT DIFFERENT TIME-SCALES



DIFFERENT PHENOMENA HAPPEN AT DIFFERENT TIME-SCALES

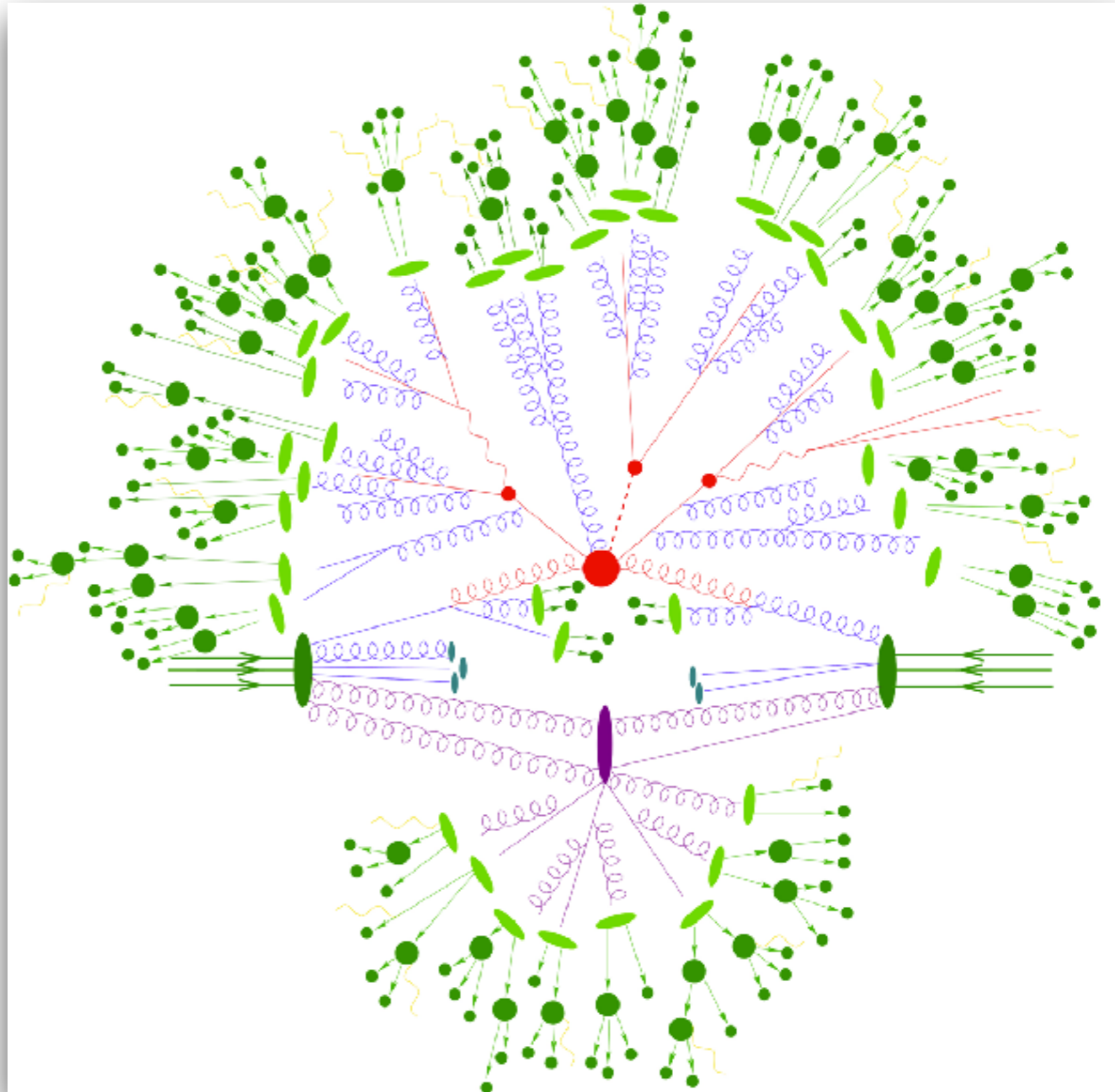
Red: Hard Scattering

Blue: Parton Shower

Purple: softer Underlying Event

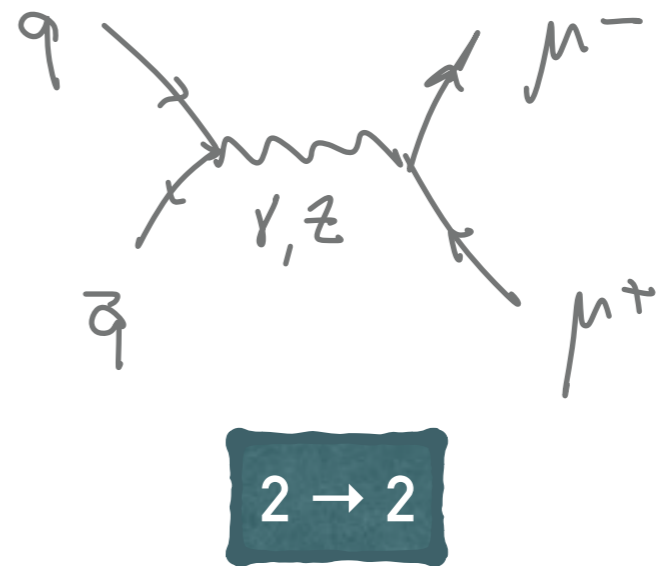
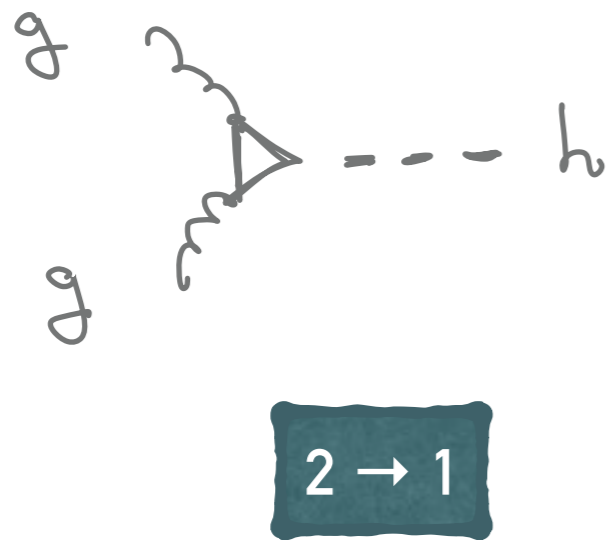
Green: Hadronization

Dark Green: Hadron Decays



HARD SCATTERING

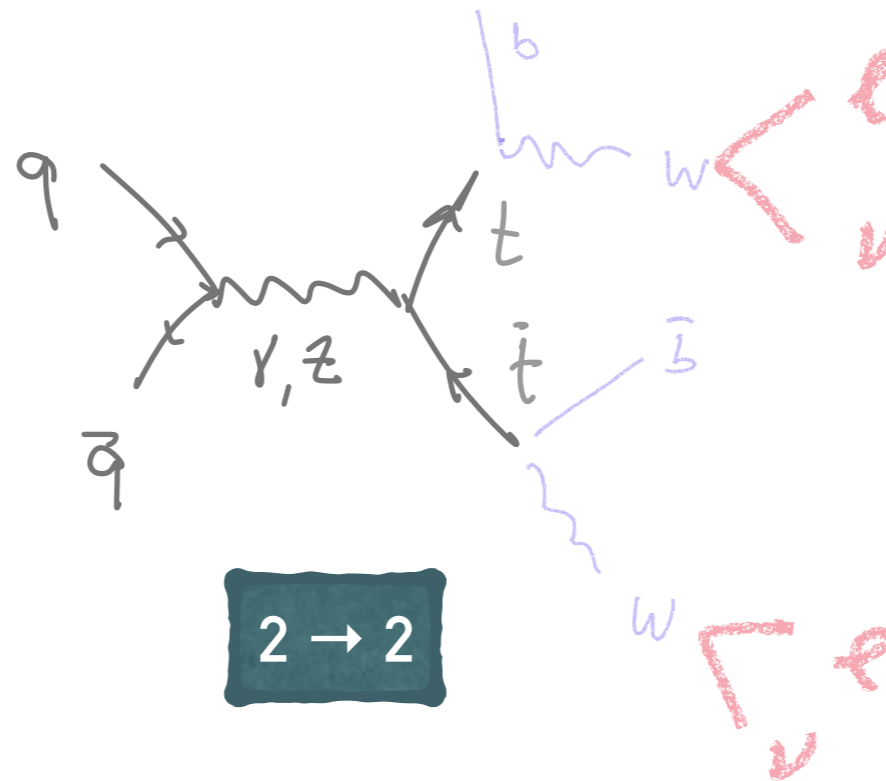
Typically a $2 \rightarrow 1$ or $2 \rightarrow 2$ process



$\sigma_{n\text{-bodies}} \sim \alpha^n \Rightarrow$ start considering process with lowest number of interactions

HARD SCATTERING

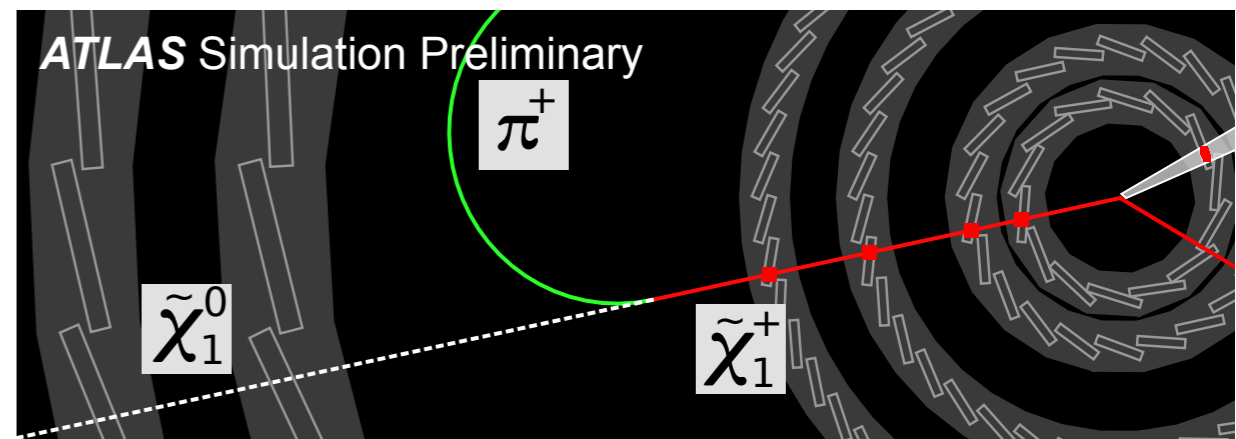
Typically a $2 \rightarrow 1$ or $2 \rightarrow 2$ process



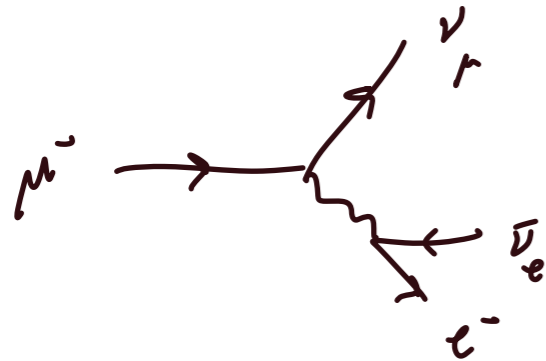
$\sigma_{n\text{-bodies}} \sim \alpha^n \Rightarrow$ start considering process with lowest number of interactions

AN EXAMPLE

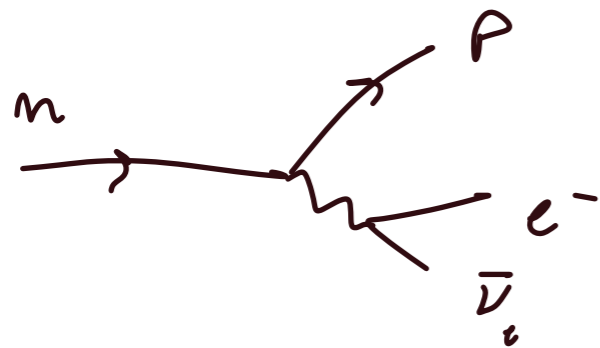
A heavy muon



MUON AND NEUTRON LIFE-TIME

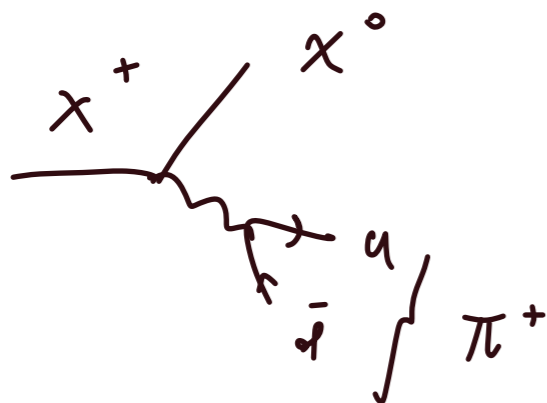


$$\tau \sim 10^{-6} \text{ s}$$



$$\tau \sim 900 \text{ s}$$

$$\Gamma \sim 1/\tau \sim G_F(m_n - m_p)^5$$

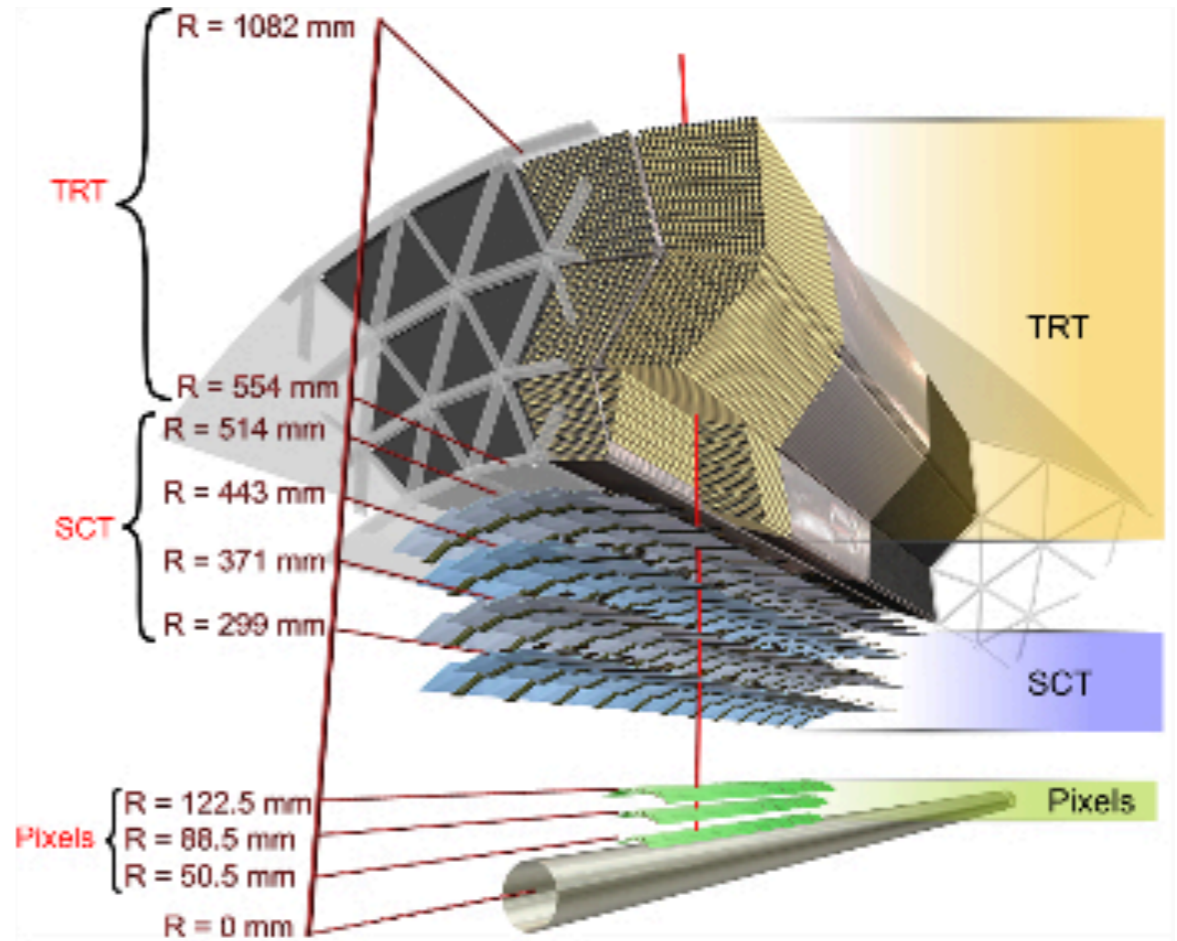
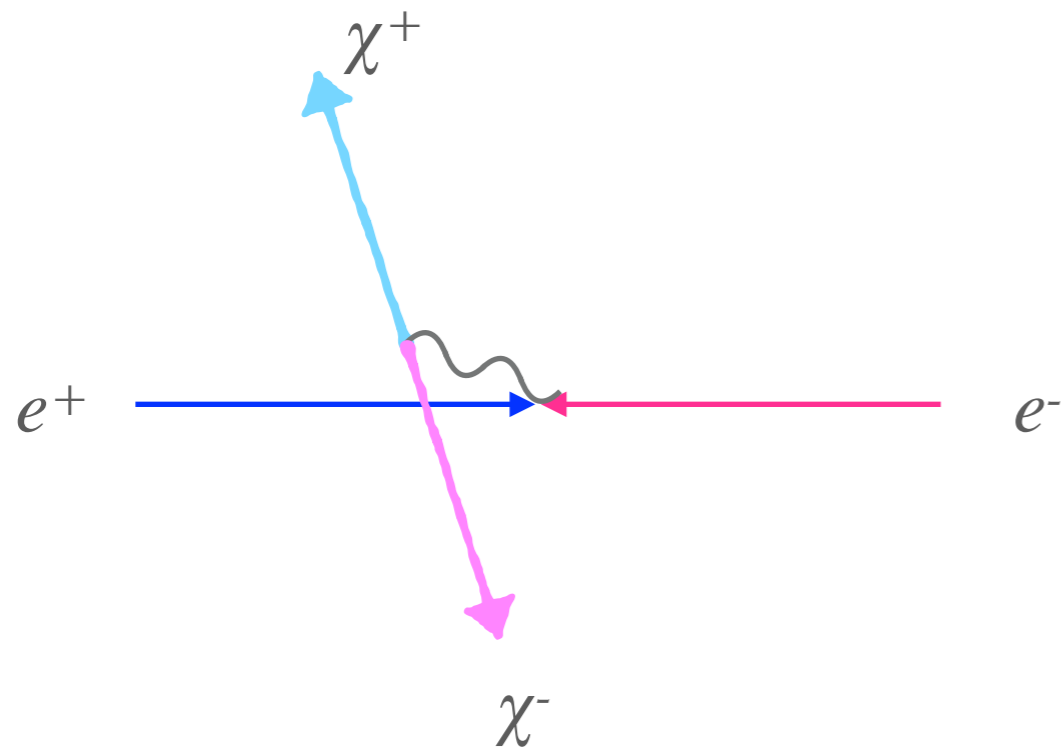


$$\tau \sim 0.1 \text{ ns} \Rightarrow c\tau = 3 \text{ cm}$$

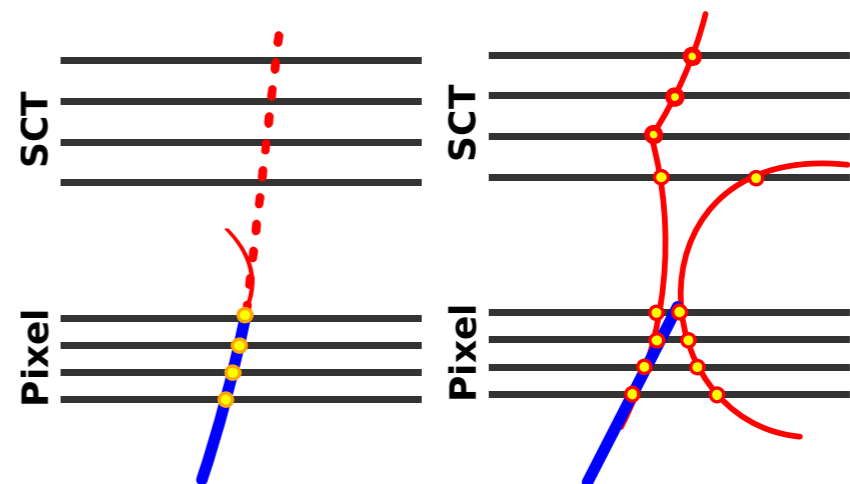
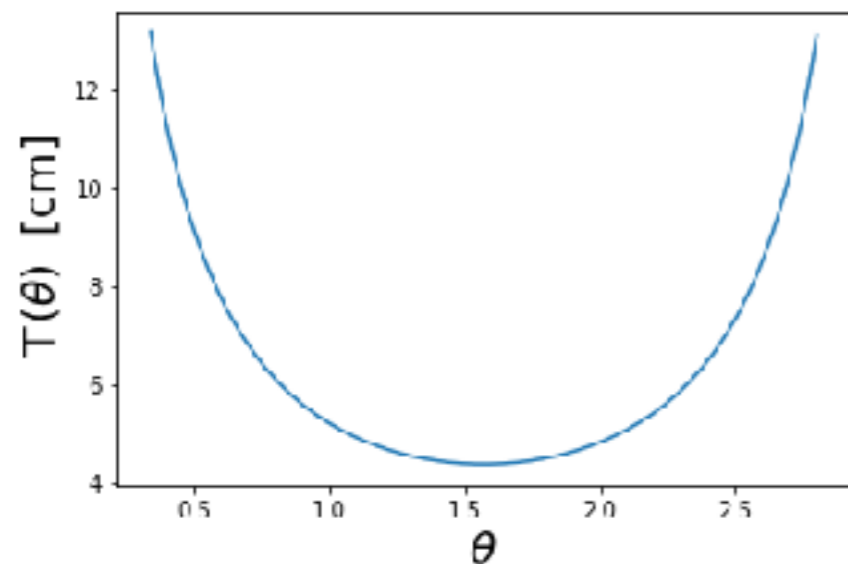
$$\text{Mass of } \chi^+ \sim 100 \text{ GeV} - 1 \text{ TeV}$$

HOW TO SEARCH FOR IT?

ELECTRON-POSITRON COLLISION



$$c\tau = c\tau_0\gamma > \tau(\theta) = 4.4 \text{ cm} / \sin\theta$$



EVENT GENERATION

<https://launchpad.net/mg5amcnlo>



HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

- `qsub -I -l host=wn-01-01-01.cluster.roma3`
- `wget https://launchpad.net/mg5amcnlo/2.0/2.6.x/+download/MG5_aMC_v3.0.0.beta.tar.gz`
- `tar zxf MG5_aMC_v3.0.0.beta.tar.gz`
- `python -V` #check python version is 2.7
- `cd MG5_aMC_v3_0_0`
- `./bin/mg5_aMC`

HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

- MG5_aMC> **tutorial**
- MG5_aMC> **help import**
- MG5_aMC> **import model MSSM_SLHA2**
- MG5_aMC> **display particles x1 +**

Particle x1+ has the following properties:

```
{  
  'name': 'x1+',  
  'antiname': 'x1-',  
  'spin': 2,  
  'color': 1,  
  'charge': 1.00,  
  'mass': 'mdl_Mch1',  
  'width': 'mdl_Wch1',  
  'pdg_code': 1000024,  
  'line': 'straight',  
  'propagator': '',  
  'is_part': True,  
  'self_antipart': False,  
  'type': '',  
  'counterterm': {}  
}
```

HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

- MG5_aMC> generate e+ e- > x1+ x1-
- MG5_aMC> launch

The following switches determine which programs are run:

<i>/===== Description =====</i>	<i>/===== values =====</i>	<i>/===== other options =====</i>	<i>\</i>
<i> 1. Choose the shower/hadronization program</i>	<i> shower = Not Avail.</i>	<i> Please install module</i>	<i> </i>
<i> 2. Choose the detector simulation program</i>	<i> detector = Not Avail.</i>	<i> Please install module</i>	<i> </i>
<i> 3. Choose an analysis package (plot/convert)</i>	<i> analysis = Not Avail.</i>	<i> Please install module</i>	<i> </i>
<i> 4. Decay onshell particles</i>	<i> madspin = OFF</i>	<i> ON/onshell</i>	<i> </i>
<i> 5. Add weights to events for new hypp.</i>	<i> reweight = OFF</i>	<i> ON</i>	<i> </i>

\=====

HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

Do you want to edit a card (press enter to bypass editing)?

```
/-----\  
| 1. param : param_card.dat |  
| 2. run   : run_card.dat   |  
\-----/
```

BLOCK MASS #

...

1000024 1.816965e+02 # mch1

Running parameters

...

1500.0 = ebeam1 ! beam 1 total energy in GeV

1500.0 = ebeam2 ! beam 2 total energy in GeV

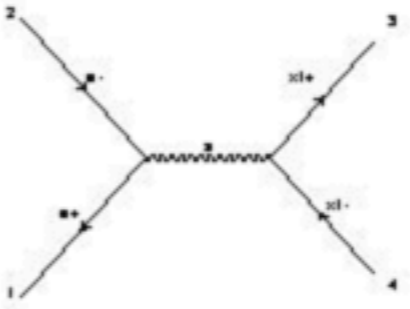
more information in /storage/DATA-05/gridrm3/franceschini/Particelle/MG5_aMC_v3_0_0/HardScattering/index.html

HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

file:///Users/roberto/ssh_local/Particelle/MG5_aMC_v3_0_0/HardS... Search Google

MadEvent Card for $e^+ e^- \rightarrow x1^+ x1^-$

Created: Unknown

<p>Process: $e^+ e^- \rightarrow x1^+ x1^-$ Model: MSSM_SLHA2</p>	
<p>Links</p> <p>Process Information</p> <p>Code Download</p> <p>On-line Event Generation</p> <p>Results and Event Database</p>	<p>Status</p> <p>Generation Complete</p> <p>Available</p> <p>Only available from the web</p> <p>2 runs available</p>
<p>Notes:</p>	

Last Update: Sun May 27 13:06:12 CEST 2018

HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

file:///Users/roberto/ssh_local/Particelle/MG5_aMC_v3_0_0/HardS... Search Google

[Postscript Diagrams for e+ e- -> x1+ x1- WEIGHTED<=4 @1](#)

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diagram 1 QCD=0, QED=2

diagram 2 QCD=0, QED=2

HOW TO RUN THE HARD SCATTERING EVENT GENERATOR

file:///Users/roberto/ssh_local/Particelle/MG5_aMC_v3_0_0/HardS... Search Google

Results in the MSSM_SLHA2 for e+ e- > x1+ x1-

Available Results

Run	Collider	Banner	Cross section (pb)	Events	Data	Output	Action
run_01	e+ e- 500.0 x 500.0 GeV	tag_1	0.1314 ± 0.00021	10000	parton madevent	LHE	<input type="button" value="remove run"/> <input type="button" value="launch detector simulation"/>
run_02	e+ e- 1500.0 x 1500.0 GeV	tag_1	0.02086 ± 2.4e- 05	10000	parton madevent	LHE	<input type="button" value="remove run"/> <input type="button" value="launch detector simulation"/>

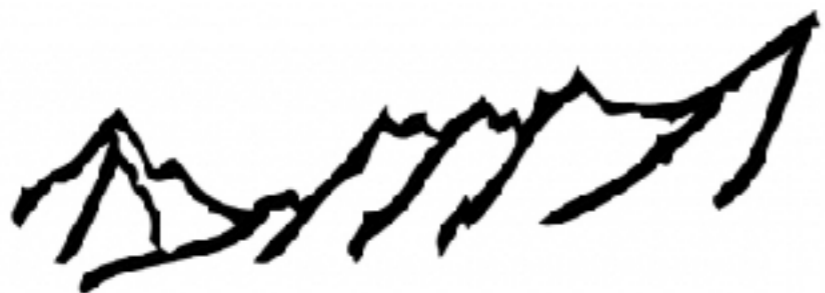
[Main Page](#)

GOODIES

- `cat /proc/cpuinfo` *#to see how many cpu you have on the node*
- `w` *#to see how many computing resources are used in the node*
- `ssh -fnNT -L 2022:ui-01.roma3.infn.it:22
USERNAME@amaldi.fis.uniroma3.it` *#to open a ssh tunnel*
- `sshfs -p 2022
USERNAME@127.0.0.1:PATH_YOU_WANT_TO_ACCESS ~/ssh_local` *#to mount locally the remote folder accessible only from ui-01,
you need to install sshfs*
- `open -a Google\ Chrome.app /Users/roberto/ssh_local` *#if you
use Chrome on Mac OS X*
- <https://twiki.cern.ch/twiki/bin/view/CMSPublic/MadgraphTutorial>

LES HOUCHES FILE FORMAT

.....
hep-ph/0609017 - A standard format for Les Houches Event Files
<http://arxiv.org/abs/hep-ph/0609017>



LHEF LIBRARIES

- <http://home.thep.lu.se/~leif/LHEF/> for C++
- <https://github.com/lukasheinrich/pylhe> for Python
- <http://pdg.lbl.gov/2017/reviews/rpp2017-rev-monte-carlo-numbering.pdf>

2) Event information, repeated as many times as there are events

a) one line with common event information:

NUP IDPRUP XWGTUP SCALUP AQEDUP AQCDUP

b) NUP lines, one for each particle I in the range 1 through NUP

**IDUP(I) ISTUP(I) MOTHUP(1,I) MOTHUP(2,I) ICOLUP(1,I)
ICOLUP(2,I) PUP(1,I) PUP(2,I) PUP(3,I) PUP(4,I) PUP(5,I)
VTIMUP(I) SPINUP(I)**

LHEF EVENTS

2) Event information, repeated as many times as there are events

a) one line with common event information:

NUP IDPRUP XWGTUP SCALUP AQEDUP AQCDUP

b) NUP lines, one for each particle I in the range 1 through NUP

**IDUP(I) ISTUP(I) MOTHUP(1,I) MOTHUP(2,I) ICOLUP(1,I)
ICOLUP(2,I) PUP(1,I) PUP(2,I) PUP(3,I) PUP(4,I) PUP(5,I)
VTIMUP(I) SPINUP(I)**

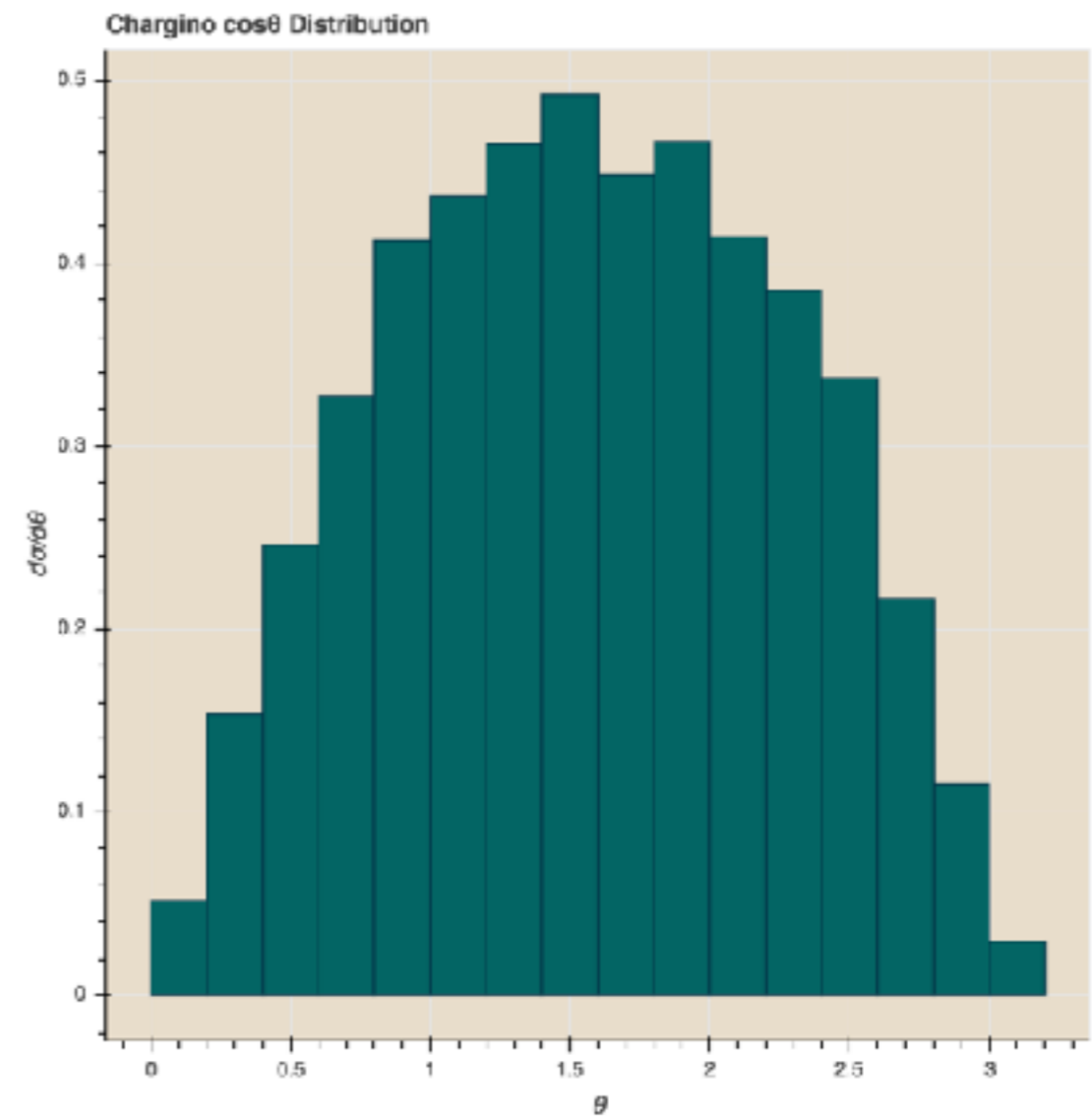
<event>

<i>ID</i>	<i>status</i>	<i>p_x</i>	<i>p_y</i>	<i>p_z</i>	<i>E</i>	<i>m</i>					
1	1	+2.1222900e-01	6.00000000e+02	7.81653100e-03	9.20023900e-02						
-11	-1	0	0	0	+0.0000000000e+00	+0.0000000000e+00	+3.0000000000e+02	3.0000000000e+02	0.0000000000e+00	0.0000e+00	1.0000e+00
11	-1	0	0	0	-0.0000000000e+00	-0.0000000000e+00	-3.0000000000e+02	3.0000000000e+02	0.0000000000e+00	0.0000e+00	-1.0000e+00
1000024	1	1	2	0	-3.5774676505e+01	+6.6624747301e+01	+1.0668324877e+02	3.0000000000e+02	2.7000000000e+02	0.0000e+00	1.0000e+00
-1000024	1	1	2	0	+3.5774676505e+01	-6.6624747301e+01	-1.0668324877e+02	3.0000000000e+02	2.7000000000e+02	0.0000e+00	-1.0000e+00

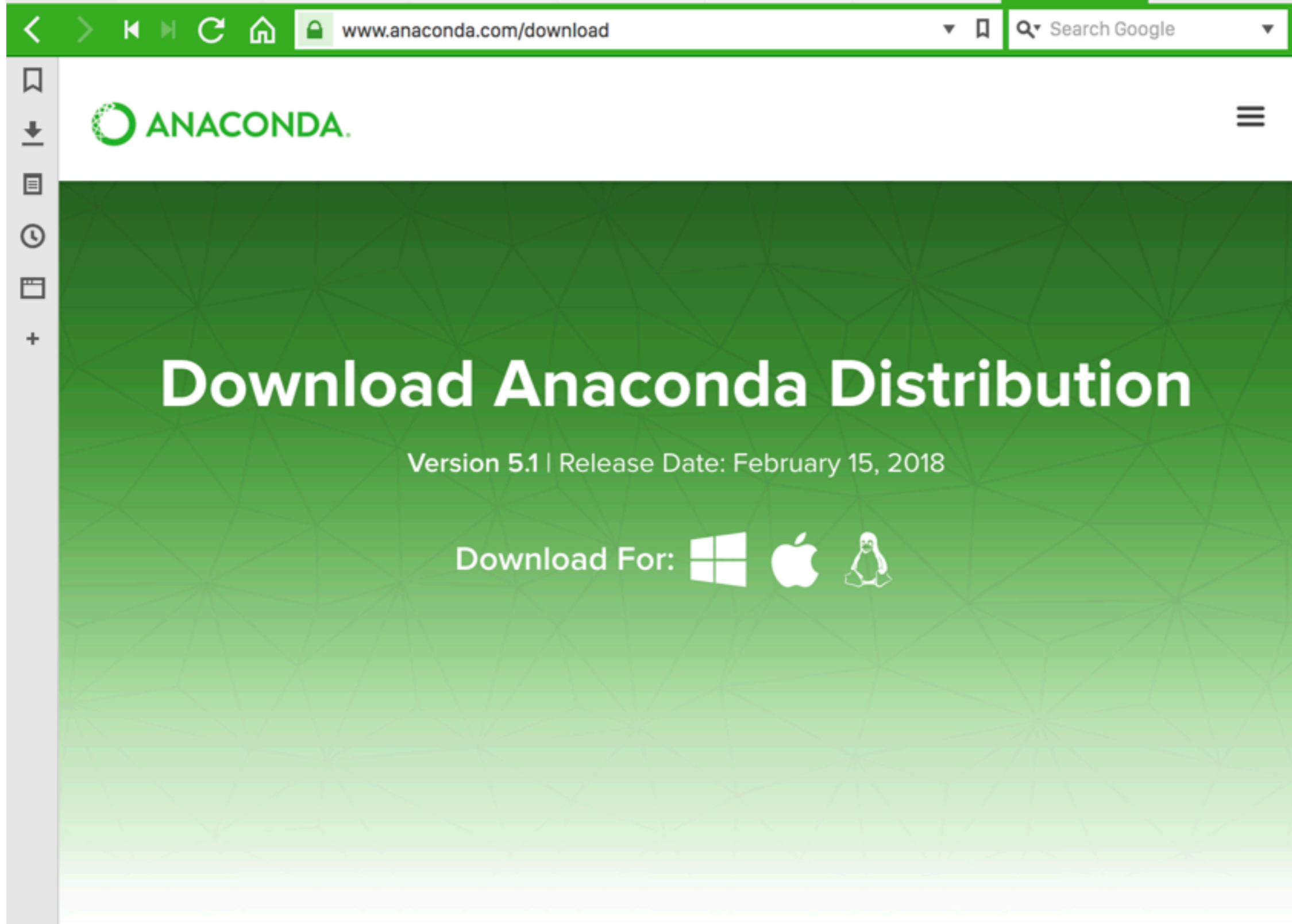
</event>

ANALYSIS

With Jupyter






ALL IN ONE SOLUTION



The image shows a browser window with the URL www.anaconda.com/download. The page features the Anaconda logo in the top left and a hamburger menu in the top right. The main content area has a green background with a geometric pattern and contains the following text:

Download Anaconda Distribution

Version 5.1 | Release Date: February 15, 2018

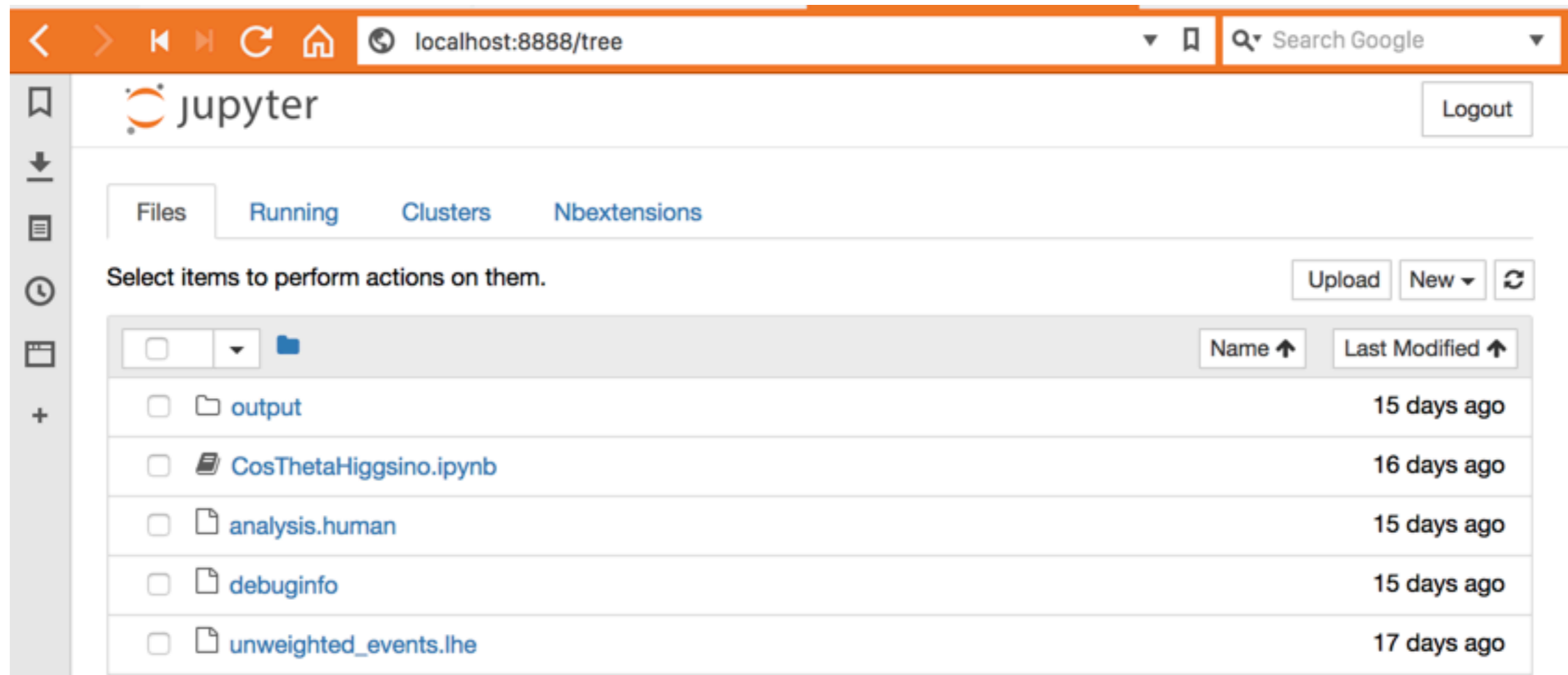
Download For:   

NOTEBOOKS INTERFACE

➤ `jupyter notebook --no-browser`

*Copy/paste this URL into your browser when you connect for the first time,
to login with a token:*

`http://localhost:8888/?token=0c332205b79a1ebdc9cc80b7a890f620b96893abe1c7ffaf`



PHYSICS LIBRARY

- <https://github.com/lukasheinrich/lorentz/>
- <https://github.com/RobertoFranceschini/PyLHEAnalysis>