

Designing and recasting LHC analyses with MADANALYSIS 5

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What is MADANALYSIS 5?

MADANALYSIS 5 is a public program that allows high-energy physicists (theorists and experimentalists) to efficiently design and recast LHC analyses. Phenomenologists can, in this way, investigate their favorite models, and determine whether the LHC is sensitive to a given signature by either conducting a novel analysis or by recasting existing CMS or ATLAS studies.

Tightly associated with MadGraph 5, MADANALYSIS 5 is now able to read the output of any Fortran Carlo generator (at leading order or next-to-leading order QCD accuracy). Analyzing event samples consists in histogramming distributions of observables, applying some selection cuts and building a cut-flow chart. All results are summarized into a HTML, PDF or ROOT report.

According to the wishes of the user, MADANALYSIS 5 can process the events before analysing them. In particular, a jet-clustering algorithm or a detector simulation can be used efficiently. Besides processed events can be saved in output files.

Main concepts

A unique framework
 The MADANALYSIS 5 package [1] allows one to design/recast in a same way phenomenological investigations at any step of the generation (parton, hadron and reconstructed object level) for any file format (STHEDER, HEPVLC, LHE, LHCO, ROOT).

User-friendly
 The user designs her/his analysis by interacting with a Python console. Settings and analyses can be written with the help of a metalinguage designed to be intuitive. Tab completion and in-line help facilitate the life of the user.

Efficient
 The Python console exports the analysis encoded using the MADANALYSIS 5 metalinguage to a dedicated C++ program ready to be compiled and executed.

Flexible
 MADANALYSIS 5 is shipped with a series of common built-in observables that includes sophisticated variables such as n or l/n . Operations between four-momenta are also available. For more complicated selections, the user can directly write the analysis in C++ (the so-called expert mode) and design her/his own observables.

Multi-interface
 MADANALYSIS 5 is interfaced to several packages: Ge4 ROOT, Fastjet, FastSim, Darkjet. Installation of these packages can be done easily from the Python console. It is also distributed with Ceasim-1403una, a modified version of Ceasim.

Program summary

Current release: MADANALYSIS v1.1.12
 Platforms: Linux, Mac OSX
 Programming language: Python, C++
 Requirements: Ge4, Python, MySQL, ROOT
 Software license: GNU General Public License
 Official web-site: <http://ma5.hepforge.net/madanalysis5/>
 YouTube: <https://www.youtube.com/watch?v=be-fuik1t0p0c>
 Physics Analysis Database: <https://madanalysis5.hepforge.net/physicsanalysis5database>

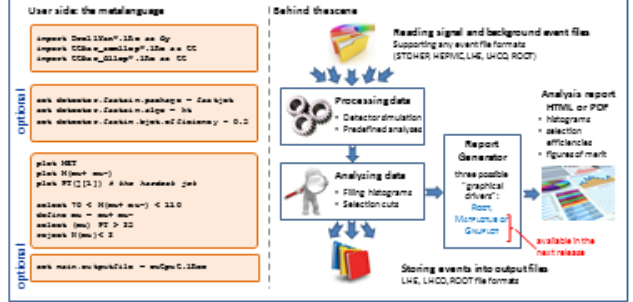
References

- [1] E. Conte, B. Fuks, G. Smet, CPC 184 (2013) 022
- [2] E. Conte, B. Dumont et al, submitted to PRD, arXiv:1405.5802
- [3] M. Ciccolini, G. S. Gouni, S. Jozsa, PRD 79 (2013) 1850
- [4] D. Favareto et al., JHEP 01 (2014) 057
- [5] B. Dumont, B. Fuks et al, submitted to PRD, arXiv:1407.2276
- [6] A. Buckley, J. R. Smithey et al, CPC 184 (2013) 2903
- [7] A. Abou, M. Frank, JHEP 1310 (2013) 092

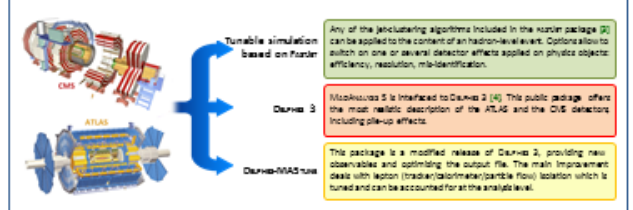
Acknowledgments

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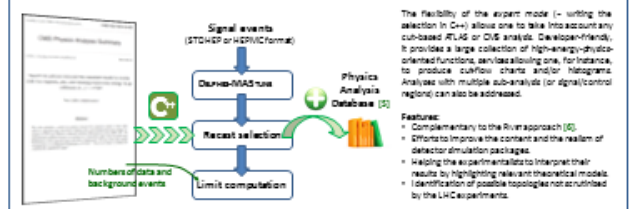
Analysis design based on the MADANALYSIS 5 metalinguage



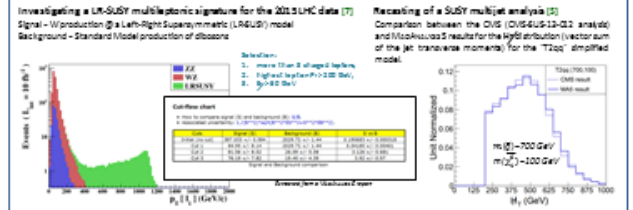
Three available packages devoted to detector fast-simulation



Recasting an existing ATLAS or CMS analysis with the MADANALYSIS 5 expert mode [3]

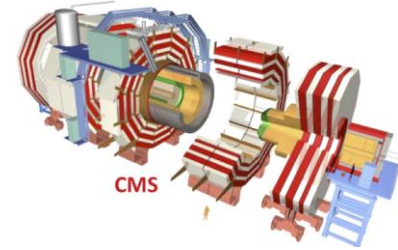


Examples of results



What is MADANALYSIS 5?

*a tool devoted to
phenomenological studies @ LHC*



Relevant features of design

- Universal
- User-friendly
- Flexible
- Efficient
- Multi-interface
(FastJet, Delphes, ...)

Design of a novel
analysis

Recasting of an
existing analysis


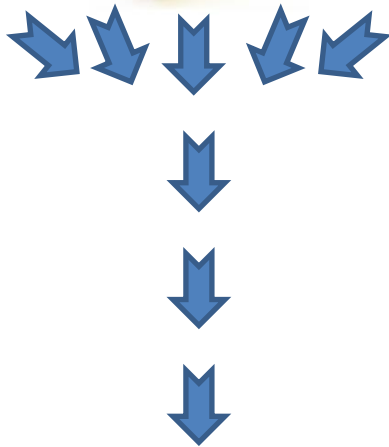
MAD Analysis 5

LHC sensibility to a given
experimental signature

What MADANALYSIS 5 does ...



Reading signal and background event files
Supporting any event file format
(STDHEP, HEPMC, LHE, LHCO, ROOT)



Analyzing data

- Filling histograms
- Selection cuts



Report Generator

three possible
“graphical drivers”:

ROOT,
MATPLOTLIB or
GNUPLOT



Analysis report
HTML or PDF

- histograms
- selection efficiencies
- figures of merit

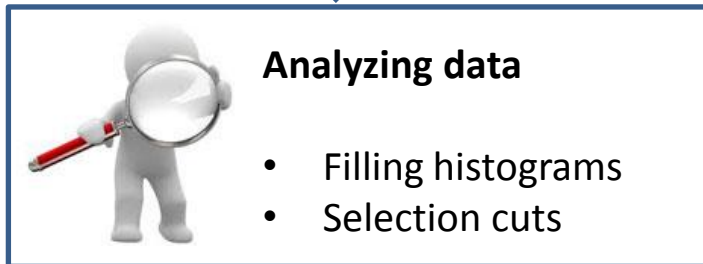
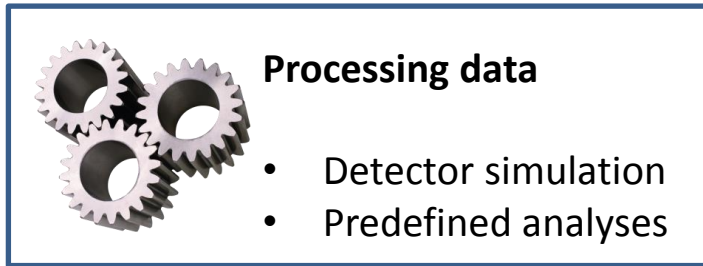


available in the
next release

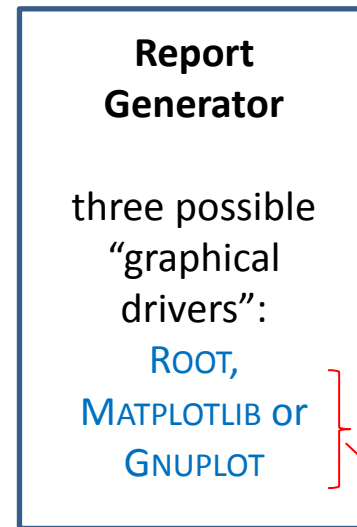
What MADANALYSIS 5 does ...



Reading signal and background event files
Supporting any event file format
(STDHEP, HEPMC, LHE, LHCO, ROOT)



Storing events into output files
LHE, LHCO, ROOT file formats



Analysis report
HTML or PDF

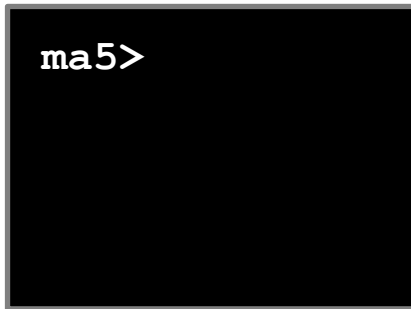
- histograms
- selection efficiencies
- figures of merit



available in the
next release

and what the user needs to do ...

Intuitive metalanguage



User interface in PYTHON

```
import DrellYan*.lhe as dy
import ttbar_semilep*.lhe as tt
import ttbar_dilep*.lhe as tt
```

```
set detector.fastsim.package = fastjet
set detector.fastsim.algo = kt
set detector.fastim.bjet.efficiency = 0.5
```

```
plot MET
plot M(mu+ mu-)
plot PT(j[1]) # the hardest jet

select 70 < M(mu+ mu-) < 110
define mu = mu+ mu-
select (mu) PT > 25
reject N(mu) < 2
```

```
set main.outputfile = output.lhco
```

Recasting an ATLAS or CMS analysis

Available on the CERN CDS information server CMS PAS SUS-12-019

CMS Physics Analysis Summary

Contact: cms-pag-conveners-susy@cern.ch 2014/08/24

Search for physics beyond the standard model in events with two leptons, jets, and missing transverse energy in pp collisions at $\sqrt{s} = 8$ TeV

The CMS Collaboration

Abstract

This note presents a search for physics beyond the standard model in final states with two opposite-sign same-flavor leptons, jets, and missing transverse energy, in a sample of 8 TeV pp collisions collected with the CMS detector at the CERN LHC. The experimental analysis focuses on searches for a kinematic edge in the invariant mass distribution of the opposite-sign same-flavor lepton pair. The size of the data sample corresponds to an integrated luminosity of 19.4 fb^{-1} . We do not observe evidence for a statistically significant signal.

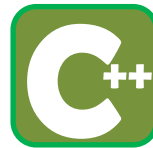
Signal events
(STDHEP or HEPMC format)

DELPHES-MA5TUNE

Recast selection

Limit computation

Physics Analysis Database



Numbers of data and background events