

# Update on MCPLOTS

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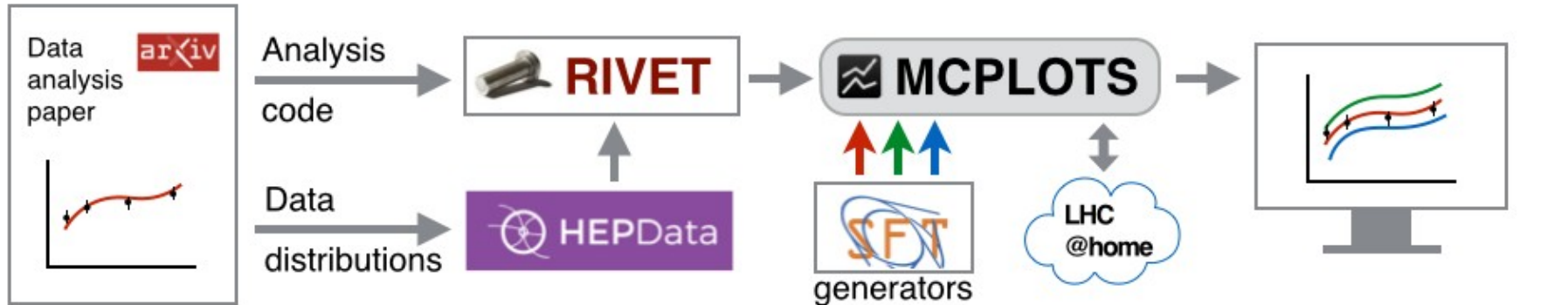
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Monash Warwick Alliance in Particle Physics meeting

13 March 2024

# MCPLOTS : overview



<http://mcplots.cern.ch/>

<https://rivet.hepforge.org/>

<https://ep-dep-sft.web.cern.ch/>

<https://www.hepdata.net/>

<https://lhathome.web.cern.ch/>

# MC PLOTS : overview

## MC PLOTS workflow

**Jobs** are distributed to volunteers

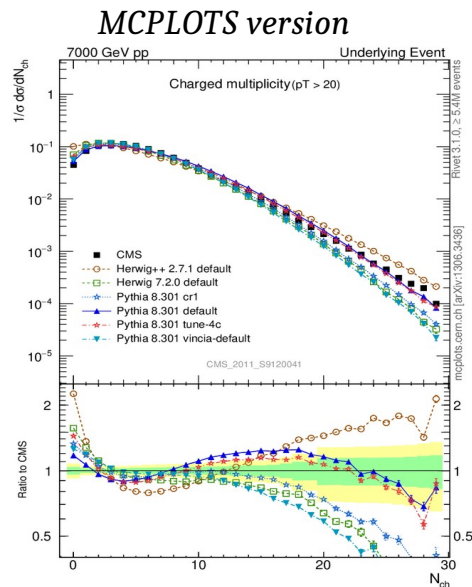
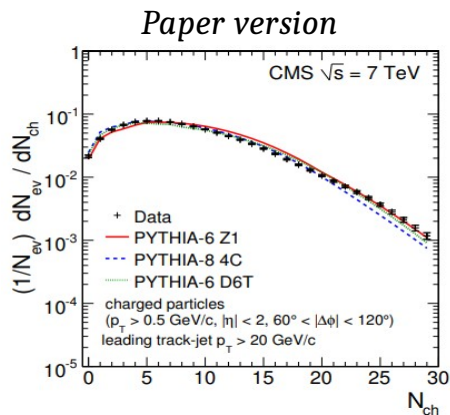
**Completed ones** are stored on the **server**

Their descriptions – in the **database**

The website operates with **queries** to this DB

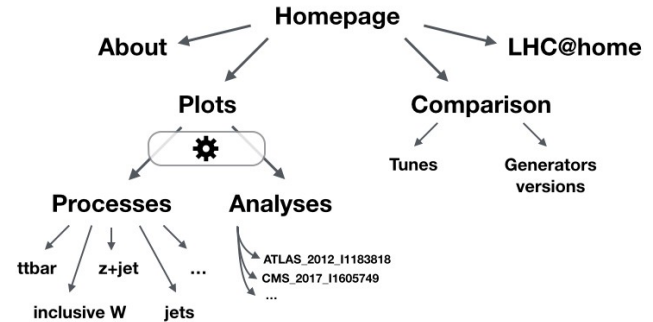
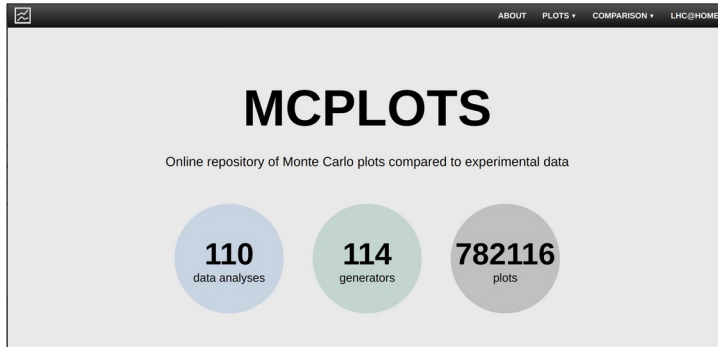


**Result:** dozens of G-V-T combinations for each data distribution are available; they are plotted on the fly by a user's request



# Website

New version moved to the usual address → <http://mcplots.cern.ch/>

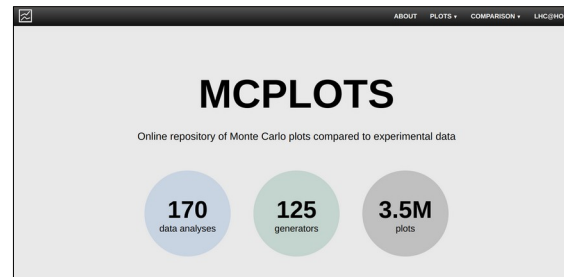


## New production

New generators and data analyses have been implemented  
We are preparing a new production  
Number of **plots** to be increased by **more than 4x**

Test version

<http://mcplots-dev.cern.ch/>



# Paper

The first paper was published ~10 year ago :

## MCPLOTS: a particle physics resource based on volunteer computing

<https://doi.org/10.1140/epjc/s10052-014-2714-9>

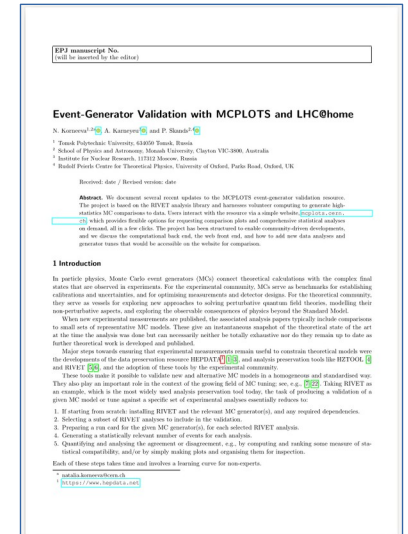
The second one : **January 2024**

## Event-Generator Validation with MCPLOTS and LHC@home

in arXiv : <https://arxiv.org/abs/2401.10621>

submitted to EPJ+

- Full description of the updated repository and database structure
- Comprehensive user's guide (the website functionality)
- Developer's guide : how to implement
  - ➔ a new data analysis
  - ➔ a new generator (version)
  - ➔ a new generator tune
- Detailed phase-space cuts discussion



MCPLOTS source code :

<https://gitlab.cern.ch/MCPLOTS/mcplots>

# Phase-space cuts

*For many modern analyses using high- $p_T$  jets we have to populate a corresponding phase-space region which is impossible without a generator-level hard-process cut*

Example: CMS\_2013\_I1265659 / Probing color coherence effects in pp collisions at  $\sqrt{s}=7$  TeV

Event selection: 3-jets events with  $p_{T1} > 100$  GeV

MCPLOTS implementation :

| [beam] | [proc] | [Ecm] | [par] | [analysis histogram]          | [obs]   | [cuts]  |
|--------|--------|-------|-------|-------------------------------|---------|---------|
| pp     | ttbar  | 13000 | ?     | CMS_2013_I1265659_d01-x01-y01 | jj.beta | cms-coh |

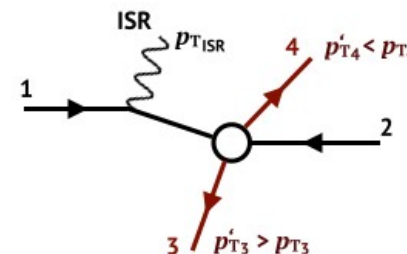
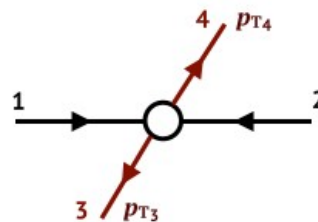
**Data analysis cut** : physical **particle-level** final state

**Generation cut** : hard **partonic** process ;

it should be **broader** than the analysis cut

**low enough** so as not to lose events that can pass the data-analysis cut after a PS

**high enough** to ensure the population of the desired phase-space region



2 generic methods to determine an optimal generation cut

# Phase-space cuts

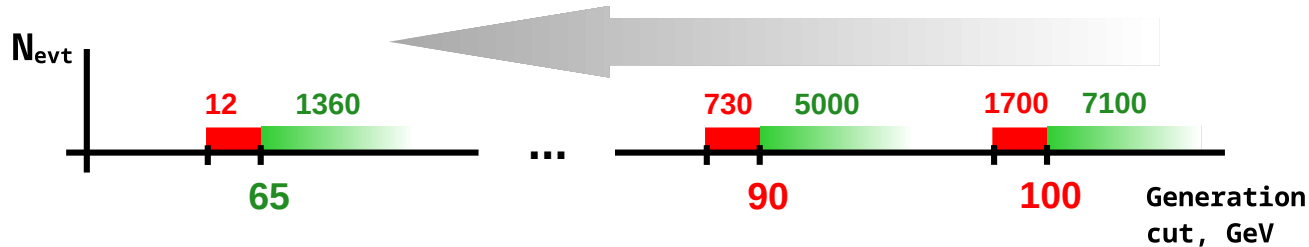
## 2 methods to determine an optimal generation cut

**Illustration** : CMS\_2013\_I1265659 / Probing color coherence effects in pp collisions at  $\sqrt{s}=7$  TeV

Event selection : 3-jets events with  $p_{T1} > 100$  GeV

1. Estimation of  $\frac{N_{\text{lost}}}{N_{\text{test}}}$

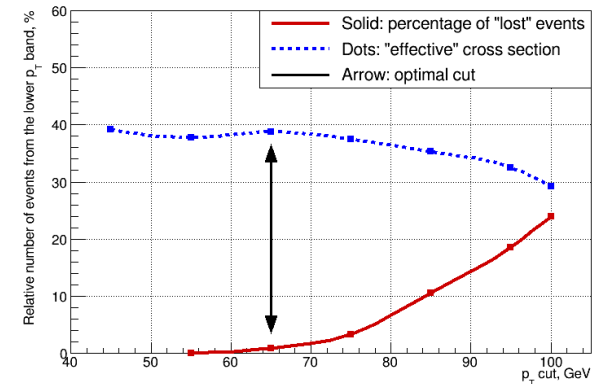
$N_{\text{lost}}$  : number of event that would not satisfy the given generation cut but which would pass the analysis cut



*Should not exceed a fraction of a percent*

2. Estimation of the « effective » cross section  $\sigma \cdot N_{\text{test}}$

*Should be stabilised*



# Development

110

data analyses

114

generators

782116

plots

**Implemented generators** : Alpgen, Epos, Herwig++ and Herwig7, MadGraph, Pythia6 and Pythia8, Sherpa, Vincia

**110 data analyses** with **1146 data distributions** implemented so far refer mostly to the *ee* and *pp* **HEP collider experiments**: ATLAS, CMS, D0 etc.

**We'd be happy to expand the coverage !**



unified frontend to generators  
used for cosmic-ray studies

- MCPLOTS was presented to people from astroparticle community ([Wuppertal Jan'24](#))
- proposal from the [CHROMO](#) team to integrate it into MCPLOTS
- in process of discussing the possibility of installing CHROMO in CERN (with Gloria Corti, LHCb and Hans Dembinski, CHROMO)

**NLO+PS**  
matching



POWHEG-BOX

+



Pythia



Herwig7



# Summary

- Updated website: <http://mcplots.cern.ch/>
  - a bunch of new plots is coming
- MCLOTS paper <https://arxiv.org/abs/2401.10621>
  - phase-space cuts discussion, relevant not only for MCLOTS
- Comparison of various matching schemes/parameters
- Possible extension to astroparticle physics

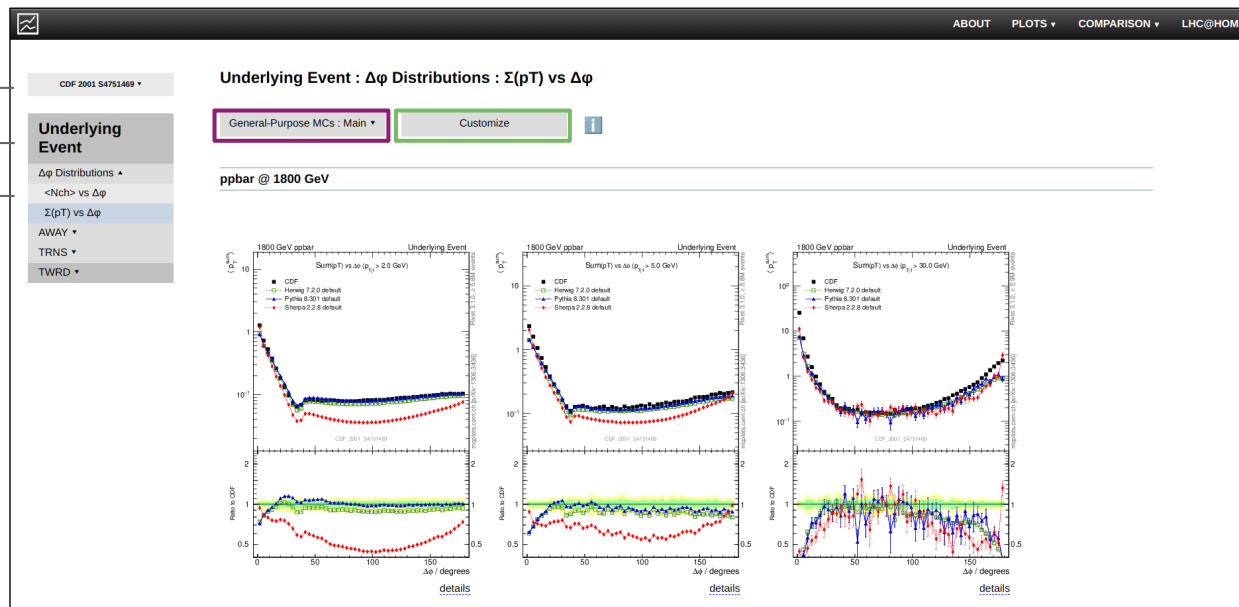
# BACKUP

# Website : plots

Analysis filter (if used)

Hard process

Individual distributions



Possibility to choose what to plot either from **a pre-defined preset** or from **all MCs**

General-Purpose MCs : Main ▾

- General-Purpose MCs ▸ Main
- Soft-Inclusive MCs ▸ Herwig vs Pythia
- Matched/Merged MCs ▸ Pythia 6 vs 8
- Herwig ▸ All C++ Generators
- Pythia 8 ▸
- Pythia 6 ▸
- Sherpa ▸

7.2.0  default  softTune

madgraph5amc

- 2.4.3.atlas  lo  lo1jet  lo2jet
- 2.5.5.atlas  lo  lo1jet  lo2jet
- 2.6.0.atlas  lo  lo1jet  lo2jet  nlo  nlo1jet  nlo2jet
- 2.6.1.atlas  lo  lo1jet  lo2jet  nlo  nlo1jet  nlo2jet
- 2.6.2.atlas  lo  lo1jet  lo2jet  nlo  nlo1jet  nlo2jet
- 2.6.5.atlas  lo  lo1jet  lo2jet  nlo  nlo1jet
- 2.6.6.atlas  lo  lo1jet  lo2jet  nlo  nlo1jet  nlo2jet
- 2.6.7.atlas2  lo  lo1jet  lo2jet  nlo  nlo1jet
- 2.7.2.atlas3  lo  lo1jet  lo2jet  nlo  nlo2jet

pythia6

- 6.423  a  d6t  default  dw  dwt  p0  p2010  p6  pnc
- 6.424  a  ambt1  d6t  default  dw  dwt  p0  p2010  p6
- 6.425  350  351  352  353  354  355  356  357  358

# Website : plots

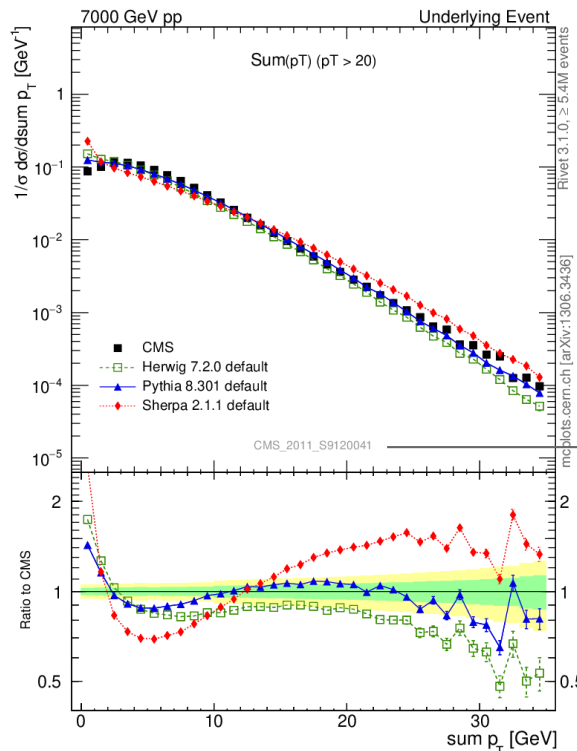
Beam parameters



Generator-version-tune for each MC curve



Steering files and results for each MC curve



details

Download as: [.pdf](#) [.eps](#) [.png](#) [.script.tgz](#) #  
 CMS experiment: [data](#) | [article paper](#)  
 Herwig 7 (Def): [data](#) | [generator card](#)  
 Pythia 8 (Def): [data](#) | [generator card](#)  
 Sherpa (Def): [data](#) | [generator card](#)

Hard process



RIVET version and # of MC events



RIVET reference



Plot in higher resolution



Data distribution and article paper



# Website : comparison

ABOUT PLOTS ▾ COMPARISON ▾ LHC@HOME

**Generator / tune**

- alpgenpythia6 ▾
- 350-CTEQ5L
- 351-CTEQ5L
- 352-CTEQ5L
- 356-CTEQ6L1
- pro-q2o-CTEQ5L
- z1-CTEQ5L
- z2-CTEQ6L1
- z2-lep-CTEQ6L1
- epos ▾
- herwig++ ▾
- herwig++powheg ▾
- herwig7 ▾
- madgraph5mc ▾
- pythia6 ▾
- pythia8 ▾
- sherpa ▾
- vincia ▾

**Alpgen + Pythia 6 (356:C) versions validation**

Versions:  2.1.3e\_6.426  2.1.4\_6.426

| $\langle \chi^2 \rangle$<br>incl. 5% "theory uncertainty" on all points | max          |       | word                     | max         |      |
|---|--------------|-------|--------------------------|-------------|------|
|   | 2.1.3e_6.426 |       | $\langle \Delta \rangle$ | 2.1.4_6.426 |      |
| pp/ppbar → Jets   | 1.2          | +4.8  | +0.20                    | -6.5        | 1.4  |
| pp/ppbar → W  | 0.92         | -0.34 |                          |             | 0.58 |

Legend:  $\chi^2 < 1$  /  $1 \leq \chi^2 < 4$  /  $4 \leq \chi^2$

(click on number in the table cell to see individual observables)

The page data is based on 402 histograms.

Generator (tune) name

Available versions to compare

$\chi^2$  for individual observables

Number of distributions used to calculate  $\langle \chi^2 \rangle$

## Details for Alpgen + Pythia 6 (356:C) v.2.1.3e\_6.426 vs. v.2.1.4\_6.426

### pp/ppbar → Jets

| Observable         | Cut                | Energy | $\chi^2_{+5\%}$<br>(2.1.3e_6.426) | $\Delta$ | $\chi^2_{+5\%}$<br>(2.1.4_6.426) |
|--------------------|--------------------|--------|-----------------------------------|----------|----------------------------------|
| 23-jet Correlation | CMS 2013 (Forward) | 7000   | 5.2                               | -3.8     | 1.4                              |
|                    | CMS 2013 (Central) | 7000   | 5.1                               | -3.8     | 1.3                              |
| ET(J1)             | CDF 1994           | 1800   | n/a*                              | -        | n/a*                             |
| ET(J2)             | CDF 1994           | 1800   | n/a*                              | -        | n/a*                             |
| Transverse Minor   | CMS 90 < pT < 125  | 7000   | 0.41                              | +0.49    | 0.90                             |
|                    | CMS 125 < pT < 200 | 7000   | 0.99                              | -        | n/a*                             |
|                    | CMS pT > 200       | 7000   | n/a*                              | -        | n/a*                             |
| Transverse Thrust  | CMS 90 < pT < 125  | 7000   | 0.72                              | +0.88    | 1.6                              |
|                    | CMS 125 < pT < 200 | 7000   | 0.72                              | -        | n/a*                             |
|                    | CMS pT > 200       | 7000   | 1.1                               | -        | n/a*                             |