

# Update on MCPLOTS

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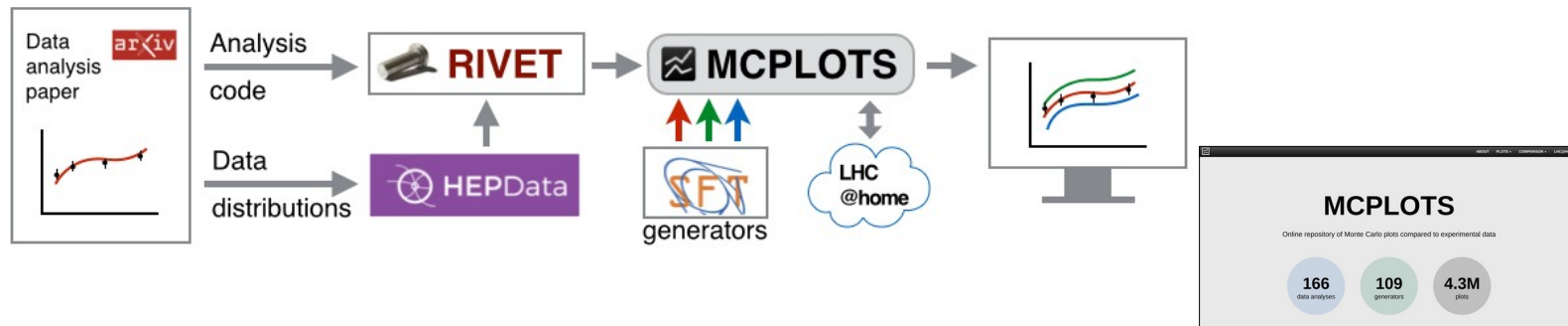
<sup>2</sup> Monash University

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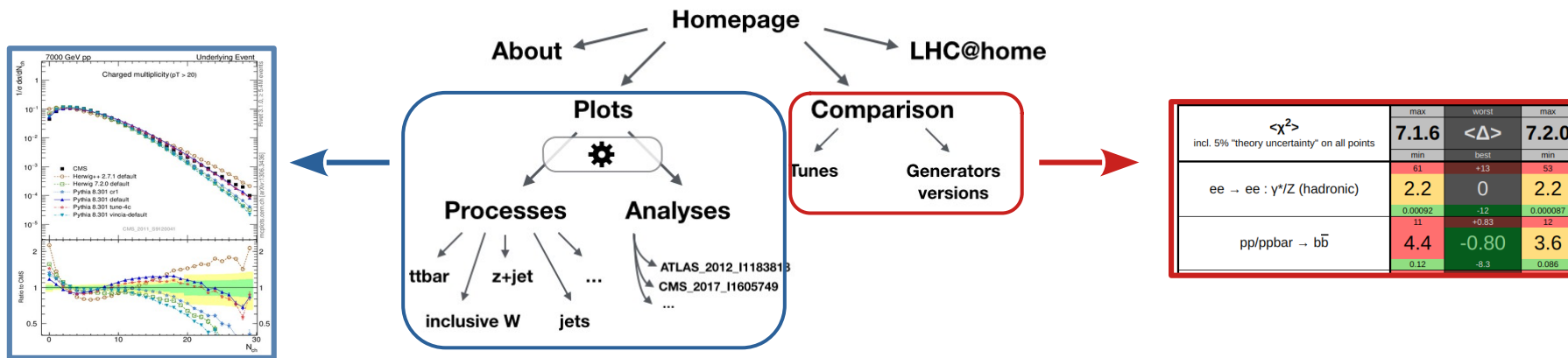
Monash Warwick Alliance in Particle Physics meeting

17 March 2025

# MCPLOTS : reminder



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



# Infrastructure

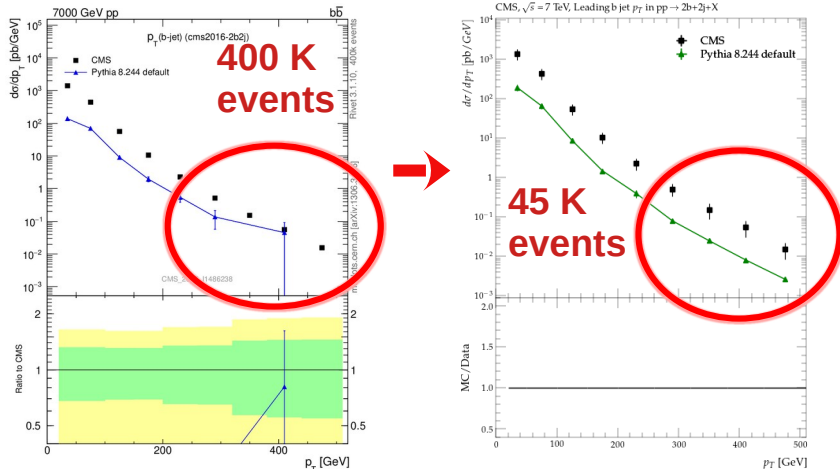


Change in the data storage format :

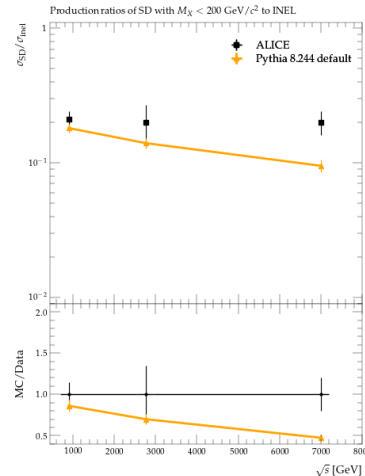
native `.yoda` Rivet format instead of the MCplots' own `.dat` format

The most important profit : **rivet native histogram merging** for both statistics accumulation (equivalent merging) and **multirun distributions**

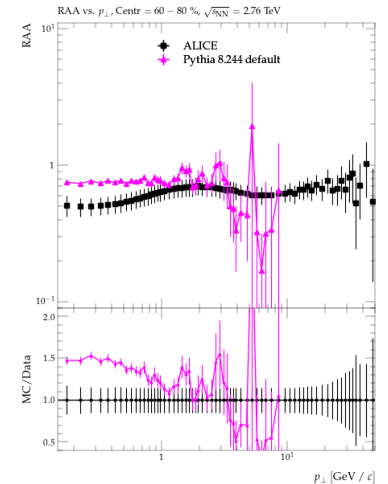
Fill in the high-pt tails of distributions



$\sqrt{s}$  distributions



HI RAA distributions

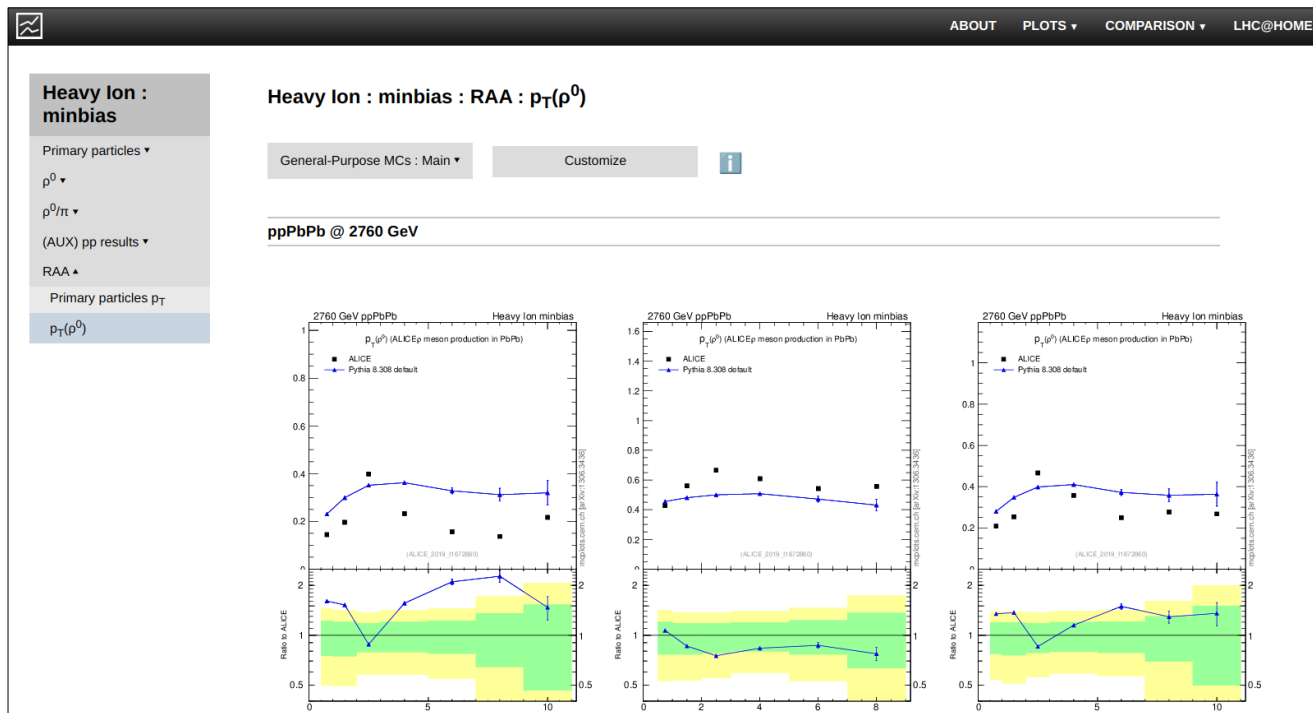


# Heavy ion section

- Particularity : PbPb beam runs require calibration files / produced separately on Ixbatch /
- First multirun results combining PbPb and pp beams / RAA /

*Recently added  
to the website*  
[mcplots-dev](https://mcplots-dev.github.io)

*ALICE interest  
for validation*  
[talk](#)



# Matching / merging

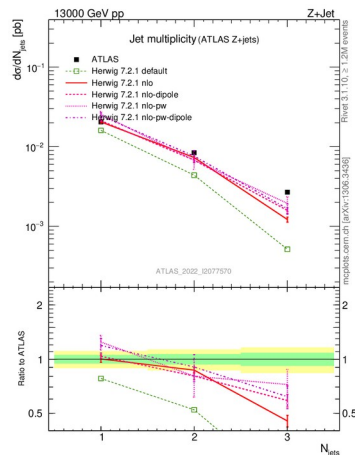
- Herwig 7 NLO configurations :

MC@NLO angular-ordered shower  
 MC@NLO dipole shower  
 Powheg angular-ordered shower  
 Powheg dipole shower

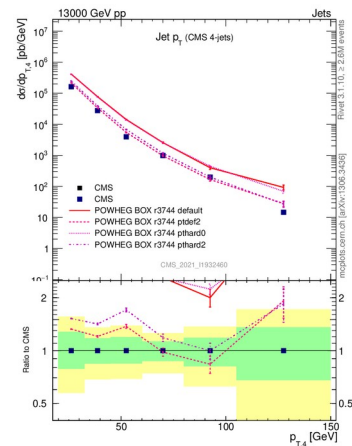
- Powheg-Box-Pythia matching parameters

*default* :  $p_{Tdef} = 1$   $p_{Thard} = 1$

*3 new tunes* :  $p_{Tdef} = 2$  ;  $p_{Thard} = 0$  ;  $p_{Thard} = 2$



*Highly resource-demanding configurations*  
*Need optimizer*



# Other updates

- implementation of new tunes and generator versions and removal of outdated ones
  - *latest update: reduction of the number of MC configurations from 203 679 to 139 809*
- express production of custom distributions
  - *main production is on hold*
  - *quick gain in stats for the distributions of interest / **first results in 24 hours***
  - *switch back to the main production*
- adding new analyses
  - *0 statistics in recent LHCb analyses when using Pythia8*
    - LHCB\_2012\_I1097092  $B_c^+ \rightarrow J/\psi (\mu\mu) \pi^+ [\pi^+ \pi^-]$
    - LHCB\_2012\_I1114753  $\Lambda_b^* \rightarrow \Lambda_b^0 \pi^+ \pi^-$
    - LHCB\_2015\_I1401225  $D^0 \rightarrow K^- \pi^+ \mu^+ \mu^-$
    - ...
  - ***EvtGen** is used for heavy-flavour decays*



***Need help with  
generator cards***

# Development

- Enhancement of the matching / merging section
  - more Powheg-Box/Pythia processes
  - faster Herwig7 NLO calculations
  - possibility of adding NNLO results
- Update to Rivet 4
  - as soon as it is available on BOINC
- Including and organizing multirun results
  - $\sqrt{s}$  distributions and high-pt tails in addition to heavy ion RAA
- Promotion of MCplots as a generator cards library

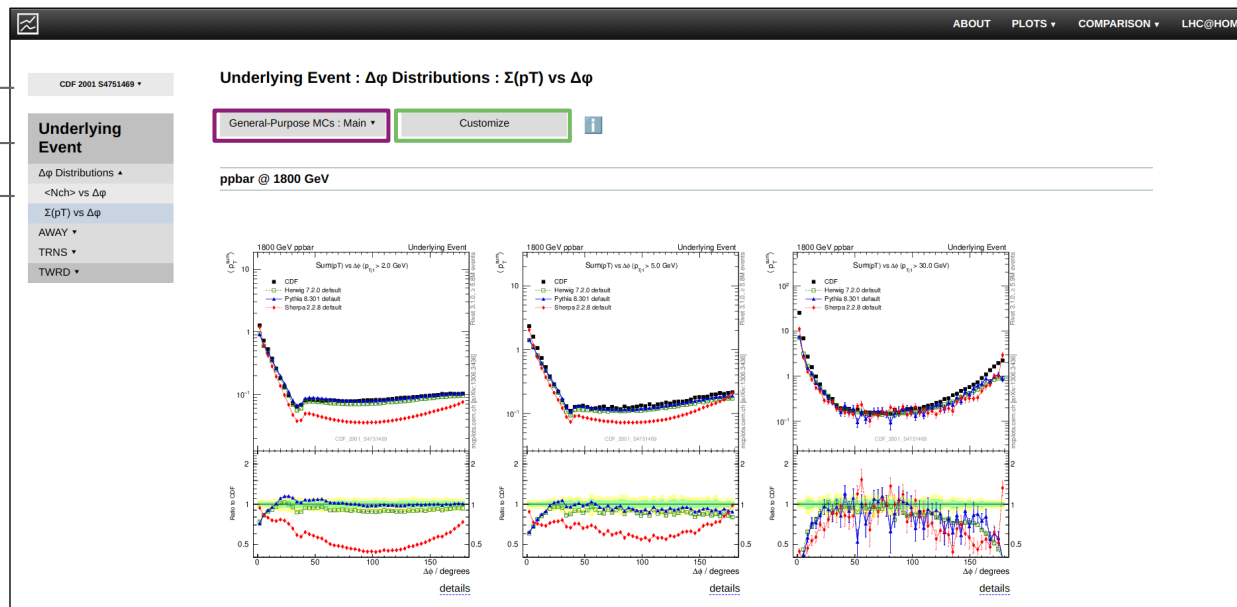
# BACKUP

# 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 : comparison

ABOUT PLOTS ▾ COMPARISON ▾ LHC@HOME

**Generator / tune**

- alpgenpythia6 ▾
- 350-CTEQ5L
- 351-CTEQ5L
- 352-CTEQ5L
- 356-CTEQ6L1
- pro-q20-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

	max		word	max	
	2.1.3e_6.426		< $\Delta$ >	2.1.4_6.426	
$\langle \chi^2 \rangle$ incl. 5% "theory uncertainty" on all points					
	min			min	
pp/ppbar → Jets	1.2	+4.8	+0.20	1.4	-3.5
	0.0019		-6.5	0.0017	
	1.4			1.2	
pp/ppbar → W	0.92		-0.34	0.58	
	0.60		-0.75	0.32	

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	$\chi^2_{+5\%}$ (2.1.3e_6.426)	$\Delta$	$\chi^2_{+5\%}$ (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*

# MCPLOTS production cycle

Fix mc configurations to be used and start the production

Initial accumulation of statistics

*2-3 weeks*

Update the website with new plots

Calculation of  $\chi^2$  values

*3 days*

Accumulation of statistics and development stage

Implementation of new Rivet routines  
new generators/versions/tunes

*several months*

...

Switch to the latest Rivet version  
Fix the updates

*Express productions  
of custom distributions*

Fix mc configurations to be used and start a new production

# 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

<https://doi.org/10.1140/epjp/s13360-024-05353-2>

- 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
- Phase-space cuts discussion

