

# Exploring tomorrow's Monte-Carlo generators: MC Validation in ATLAS with PAVER

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## Introduction

- Monte-Carlo (MC) simulations play a key role in high energy physics
- MC generators evolve continuously  
→ Periodic validation is indispensable for obtaining reliable and reproducible physics results
- Development of an automated and central validation system: **PMG Architecture for Validating Evgen with Rivet (PAVER)**  
→ Possible issues in simulated samples can be detected before generating large samples for the collaboration  
→ Crucial for a **sustainable** and **low-cost** MC production procedure in ATLAS
- Can be accessed via nice webpage: [jem.cern.ch](http://jem.cern.ch) (CERN SSO necessary)



- Produce **validation samples** in **official ATLAS production system** (not using PAVER)
- Set of  $\sim 7$  samples for each generator
- Cover different scenarios
  - Physics processes: e.g.  $t\bar{t}$ ,  $W$ +jets, SUSY
  - Matching schemes
- New samples for **each new version** (usually same DSID, different e-tag)



official ATLAS MC production  
→ 80 billion events in 2023

Validation sample  
→ 0.5 billion events in 2023

### Run automatically using RIVET [1]

[1] A. Buckley et al., *Rivet user manual*, Comput. Phys. Commun. **184** (2013) 2803, arxiv: 1003.0694 [hep-ph]

### Select set of $\sim 10-20$ RIVET analyses for each sample

⇒ Get  $\sim 200-400$  histograms with just a few clicks

### Can be run on PAVER website or on Worldwide LHC Computing Grid

MC production

Fill histograms

Validation

### Add the new YODA files to the PAVER database

### Each new sample is compared to a reference file

⇒ Usually the **last validated version** of this generator/process

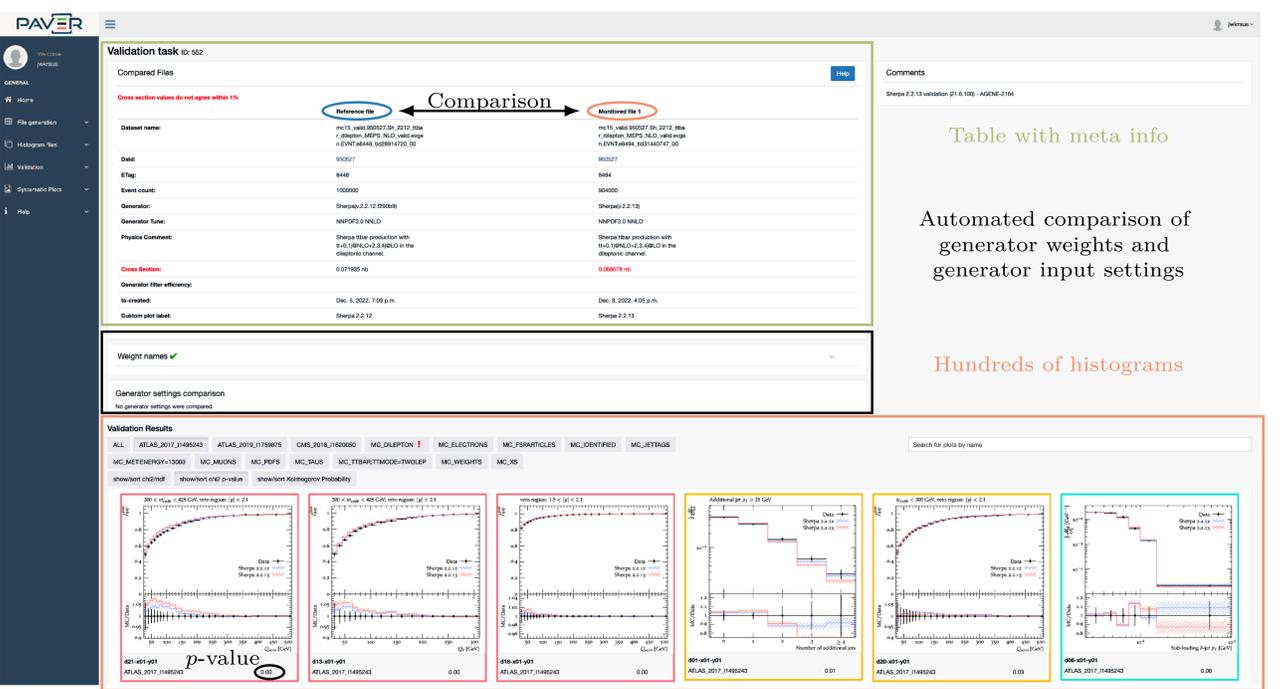
### Show validation results on the PAVER webpage

⇒ Large set of **checks and comparisons** between reference and new samples

- Many sorting and filtering features
- Statistical tests:  $\chi^2$  and Kolmogorov-Smirnov
- Color code based on  $p$ -value

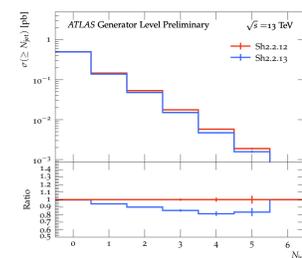
⇒ Can be shared directly with e.g. generator experts

## The PAVER webpage - example of a results page

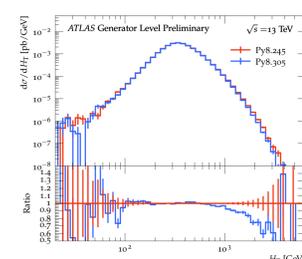


## Validation successes

- Inclusive jet multiplicity differs for Sherpa 2.2.12 and Sherpa 2.2.13  
→ Performance improvement made in 2.2.13 had an **unforeseen side effect** on physics results



- Issue with CKKW-L merging was found in Pythia8 validation



⇒ Identifying these issues **before** large-scale MC production campaigns significantly **reduced computing effort** ✓

## Validation program

- Massive validation program over the last years
- Many **successfully** validated generator (or software) updates, some **issues** were found

