Streamlining ATLAS Monte-Carlo Generator Validation with PAVER

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CHEP 2024

1 Introduction

- Monte-Carlo (MC) simulations are crucial in high-energy physics and continuously evolve.
- Periodic validation is essential to ensure reliable and reproducible results.
- Development of an automated and centralized validation system PAVER (PMG Architecture for Validating Evgen with Rivet) [1].
- This allows the detection of possible issues in MC samples before large-scale production, ensuring low-cost and sustainable MC production in ATLAS.
- Accessible via the PAVER website jem.cern.ch, requiring CERN SSO authentication.

2 PAVER Process Flow

MC Production

- Produce validation samples in the official ATLAS production system.
- Typically 7 samples are generated for each new version of MC generators covering various scenarios like different physics processes (e.g. $t\bar{t}$, W+jets, SUSY).
- Samples usually have the same DSID but different e-tags.

Histogram Filling

- Validation runs automatically using RIVET [2].
- Select 10...20 RIVET analyses for each sample.
- Get 200...400 histograms with a few clicks.
- Can be run on the PAVER website or the Worldwide LHC Computing Grid.

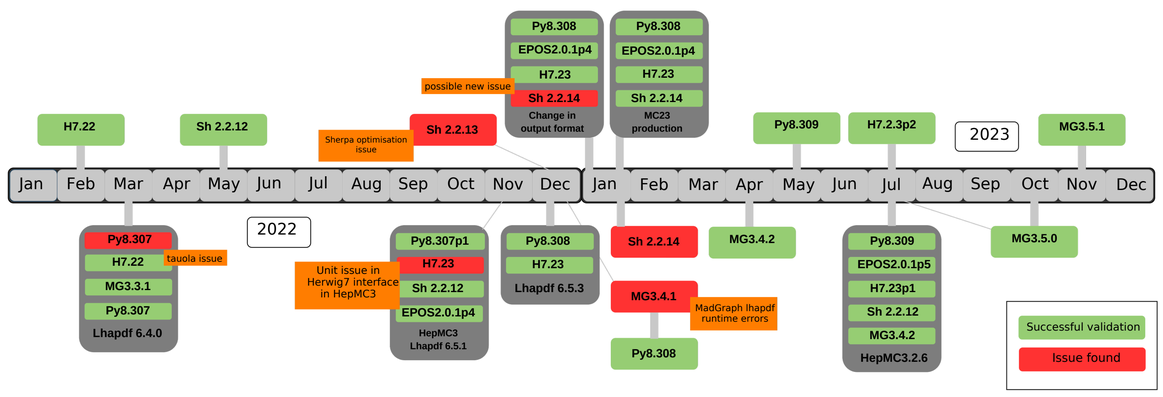
Generator Validation

- Adding the new YODA files to the PAVER database.
- Each new sample is compared to a reference file.
  - (usually the last validated version of the generator/process).
- Show the validation results on the PAVER website
  - A large set of checks and comparisons between reference and new samples.
    - Many sorting and filtering features are available.
    - Statistical tests like χ^2 and Kolmogorov-Smirnov are available.
    - The color code is based on the p-value.
  - The results are directly shared with the generator experts and discussed in regular round-table discussions between ATLAS members and generator authors.

ATLAS MC Production in 2023
~80 billion official production events
~0.5 billion validation events

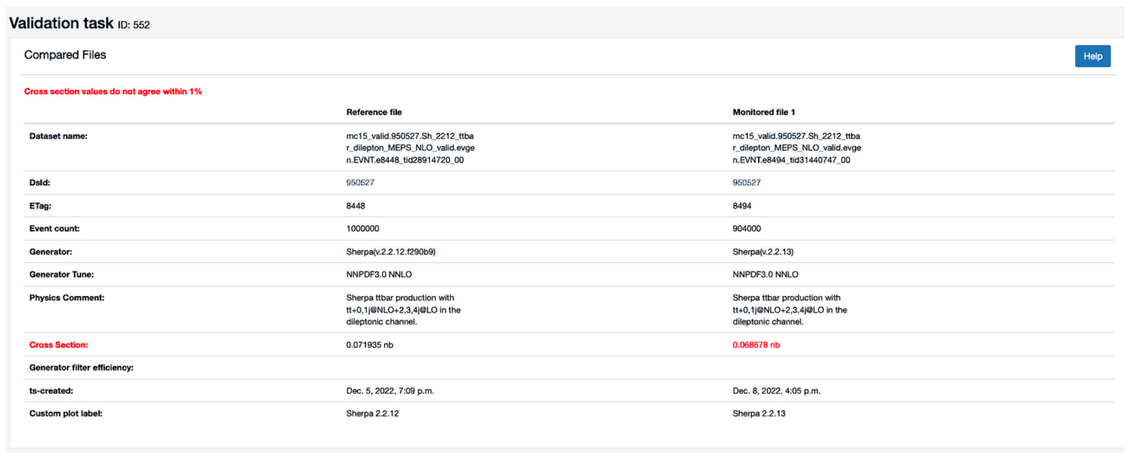
3 Validation Program

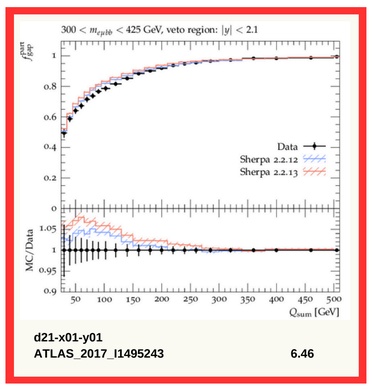
- Massive validation of many MC generator versions during the past years
  - Many successfully validated generator/software updates.
  - Some versions show issues and were not validated.

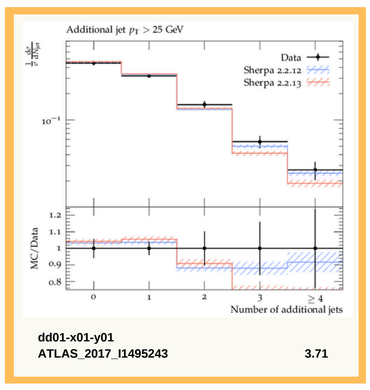


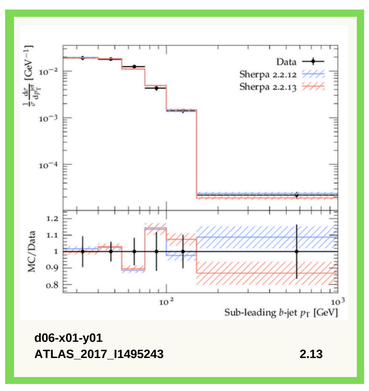
4 PAVER Website

- Showing table with meta info about the monitored and reference samples.
- Automatically creating hundreds of histograms including color codes.



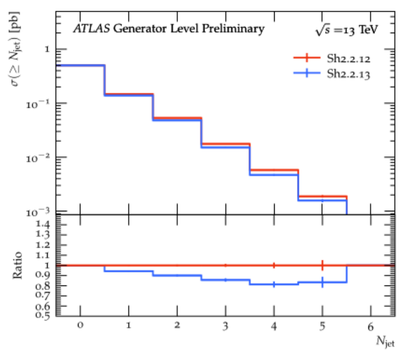


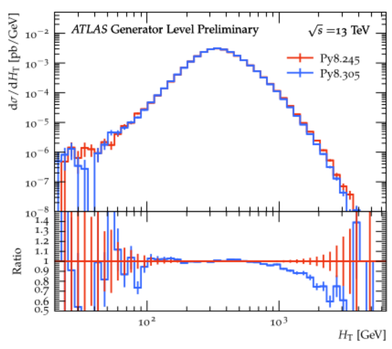




5 Validation Impact

- Inclusive jet multiplicity differs for Sherpa 2.2.12 and Sherpa 2.2.13.
  - Performance improvement in 2.2.13 had an unforeseen side effect on physics results.
- An issue with CKKW-L merging was found in Pythia8 validation.
- Identifying these issues before large-scale MC production campaigns significantly reduced computing effort.





6 References

[1] ATLAS Collaboration, Monte Carlo Validation in ATLAS with PAVER, ATL-PHYS-PUB-2024-013, url: http://cds.cern.ch/record/2904943

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

ATLAS EXPERIMENT

FSP ATLAS Erforschung von Universum und Materie

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