



Muon Isolation Optimisation Studies for Run-3 in ATLAS

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Introduction

- This work is part of my ATLAS MCP qualification task, focusing on muon isolation studies.
- The goal is to optimise muon isolation working points for Run-3 conditions.
- As a first step, we aim to reproduce the results from the ATLAS Run-2 note using Monte Carlo samples.
- The study is based on:
 - DAOD_MUON1 format
 - fastMuonChecker framework
 - Run-2 MC samples (Pythia and Sherpa)
- Key validation distributions include:
 - $m_{\mu\mu}, p_T^\mu, \eta^\mu$
 - $\Delta R(\mu, \text{jet})$
- This validation step is essential before moving to Run-3 optimisation studies.

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Qualification task



Title: Muon Isolation Optimisation with the Run-3 dataset

Description:

- Optimise muon isolation working points (WPs) as a function of ΔR with respect to nearby jet(s), on top of the usual momentum dependence, using Run-3 data.
- Study MC generator and topology dependence of the isolation performance (Pythia, Herwig, Sherpa; $Z \rightarrow \mu\mu$ and $t\bar{t}$ topologies).
- Work performed within the Isolation and Fake Forum subgroup, with feedback from the Efficiency subgroup and MCP plenary meetings.
- Use standard MCP tools; improvements and documentation to be made available to the Collaboration.

OTP task ID: 532774 sub-task ID: 556633

JIRA ticket : <https://its.cern.ch/jira/browse/ATLASMCP-296>

Proposed beginning of qualification: 01/02/2026



Technical details

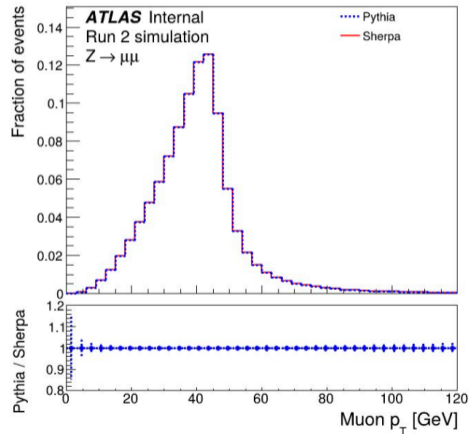
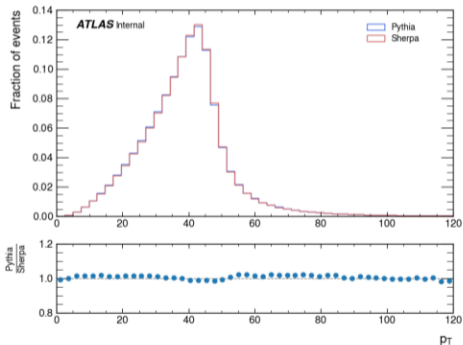


- **Software** : AnalysisBase
- **Release** : 25.2.88
- **ROOT version** : 6.36.02
- **Package** : [fastMuonChecker](#)
- **DAOD_MUON1 format.**
- **Datasets** : Run-2 MC (validation stage)
- **MC generators** : Pythia, Sherpa ($Z \rightarrow \mu\mu$)

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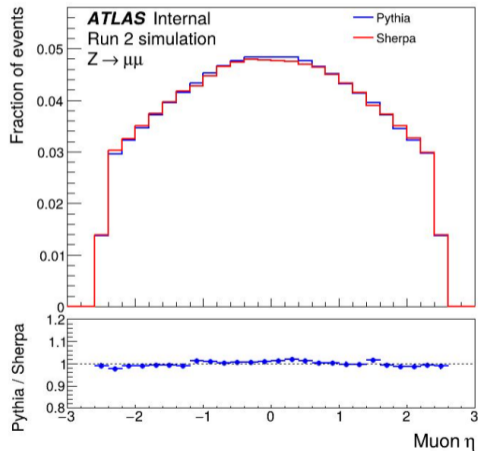
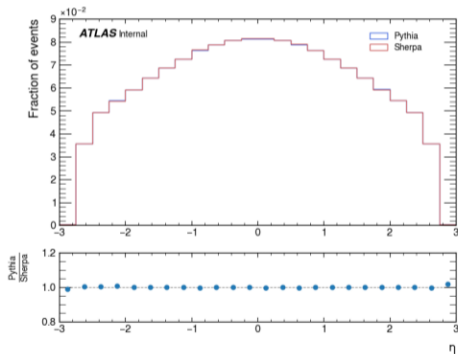
Comparison with ATLAS Note: p_T^μ

NB: lift plots: ATLAS note — Right plots: My work.



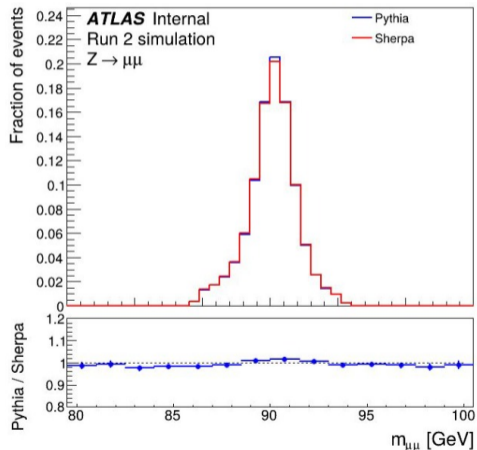
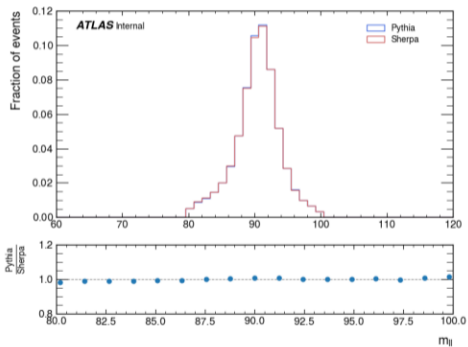
Comparison with ATLAS Note: η

NB: lift plots: ATLAS note — Right plots: My work.



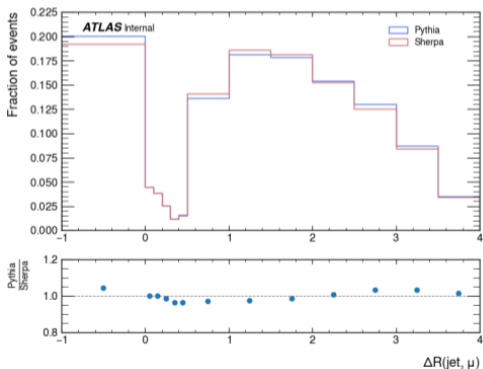
Comparison with ATLAS Note: $m_{\mu\mu}$

NB: lift plots: ATLAS note — Right plots: My work.



Comparison with ATLAS Note: $\Delta R(\mu, \text{jet})$

ATLAS note (reference)



Current issue

The reproduction of this distribution using fastMuonChecker is currently delayed.

Although the jobs are submitted successfully on Panda, the workflow becomes unstable when re-running the code, leading to execution failures.

Ongoing work

- Investigating Panda job failures
- Checking logs and ROOT outputs
- Testing stable configurations

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Progress Status and Workflow

Done

- Setup of ATLAS software environment
- Adaptation of `fastMuonChecker.py`
- First validation with Pythia & Sherpa $Z \rightarrow \mu\mu$
- Reproduction of ATLAS note plots:
 - $m_{\mu\mu}, \eta^\mu, p_T^\mu$

In progress

- $\Delta R(\mu, \text{jet})$

Next steps

- Collecting Run-3 samples (Pythia/Herwig/Sherpa)
- Produce generator-comparison plots on Run-3 samples
- Evaluate isolation WPs (Loose, Tight)
- Efficiency & rejection vs $p_T, \eta, \Delta R(\mu, \text{jet})$
- Compare $Z \rightarrow \mu\mu$ vs $t\bar{t}$ topologies
- Derive optimisation inputs for MCP recommendations

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Conclusion

To summarise:

- Muon isolation plays an important role in ATLAS analyses.
- In this work, I focused on validating my framework and understanding how isolation behaves with Run-2 data.
- The results I obtained show that my setup is working correctly for the main distributions.
- This gives me a solid starting point for the next steps of the project.
- The goal is to improve isolation performance and contribute to future MCP recommendations.

Thank you for your attention!

SOUFIANE KHOULAKI



Back up

Instructions to reproduce the results

setupATLAS

voms-proxy-init -voms atlas

lsetup pyAMI panda rucio

asetup AnalysisBase,25.2.88

Grid Submission Command (prun):

```
1 prun --exec "python fastMuonChecker.py -i %IN --run Run2" \  
2 --inDS "mc20_13TeV.361107.PowhegPythia8EvtGen_AZNLOCTEQ6L1_Zmumu.deriv.DAOD_MUON1.  
   e3601_s3681_r13145_r13146_p6232" \  
3 --outDS "user.skhoulak.pythia_zmumu_run2_t1" \  
4 --outputs "output_tree.root" \  
5 --containerImage "docker://atlas/analysisbase:latest" \  
6 --nJobs 50 --nGBPerJob 4 --noBuild .  
7
```