

Muon Isolation dependency on pileup

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Outline

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Qualification task

Title: Optimisation of isolation WPs in Run3

Description

- Distinguish muons from prompt sources from non-prompt and fake ones.
- Improve robustness against higher pile-up while maintaining good performance for prompt muon selection.
- explore possible dependencies on event topology such as $Z \rightarrow \mu\mu$ process and $t\bar{t}$ events.

OTP task ID: 532774 sub-task ID: 556633.

Proposed beginning of qualification: 01/02/2026

<https://its.cern.ch/jira/browse/ATLASMCP-295>

Introduction

In this presentation, I worked on section 8, "Muon Isolation" from the documentation:
ATLAS Note reference: [ATL-COM-PHYS-2025-020](#)

Variables

- We measure the isolation efficiency of muons from $Z \rightarrow \mu^+ \mu^-$ decays as a function of the average number of interactions per crossing ($\langle \mu \rangle$).
- We measure the efficiency of muons from $t\bar{t}$ decays as a function of transverse momentum (p_T).
- Distributions of the dimuon invariant mass $m_{\mu\mu}$, muon transverse momentum p_T , muon pseudorapidity η , and angular distance ΔR between a muon and its closest jet.
- **Working points:** Loose, Tight, PFlowLoose, PFlowTight.

Technical details

- Software: AnalysisBase,25.2.89
- ROOT Version: 6.36.04
- MC23d, r15530, DAOD_MUON1 format, DSID: 601190, 601229.
- Generator:Pythia ,Sherpa
- Data23, [Run number](#): 451094, [Stream](#): physics_Main, physics_BphysDelayed, calibration_BphysPEB [Period](#): 2023 F.
- Package:[fastMuonChecker](#)

Isolation efficiencies for prompt and non-prompt muons

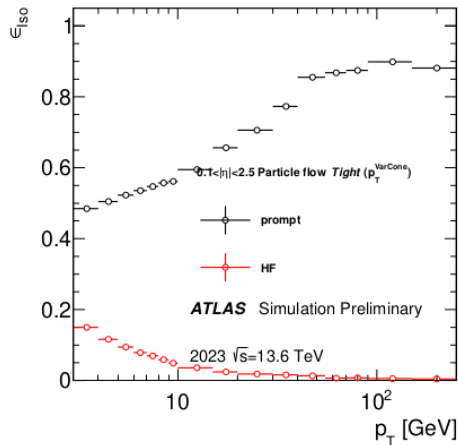


Figure: Original plot

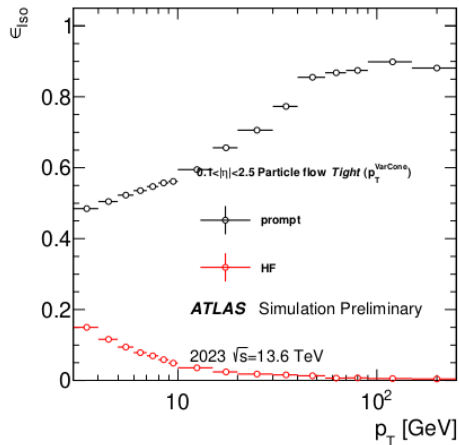


Figure: Reproduced plot

Isolation efficiencies for prompt and non-prompt muons

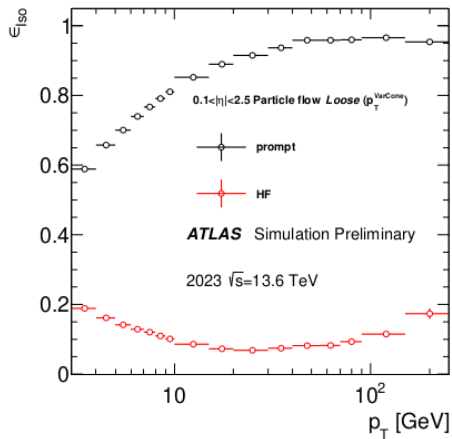


Figure: Original plot

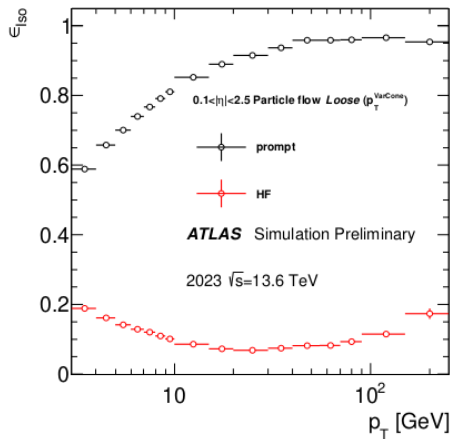


Figure: Reproduced plot

Isolation efficiency for interactions muons satisfying the PFlowTight isolation criteria

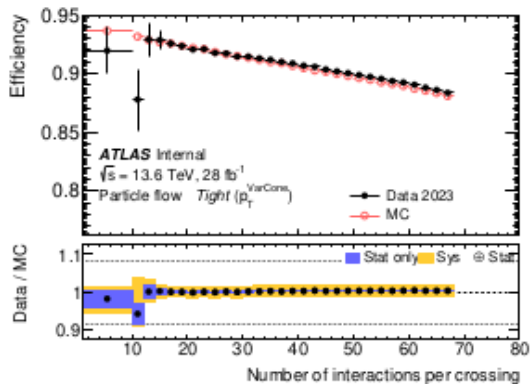


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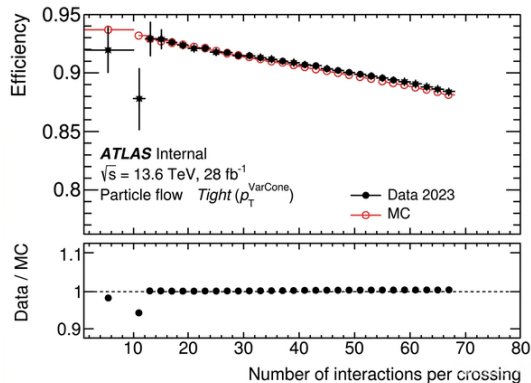


Figure: Reproduced plot without systematics

Isolation efficiency for interactions muons satisfying the Tight isolation criteria

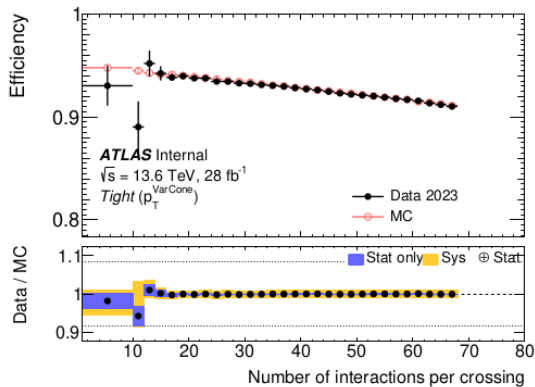


Figure: Original plot

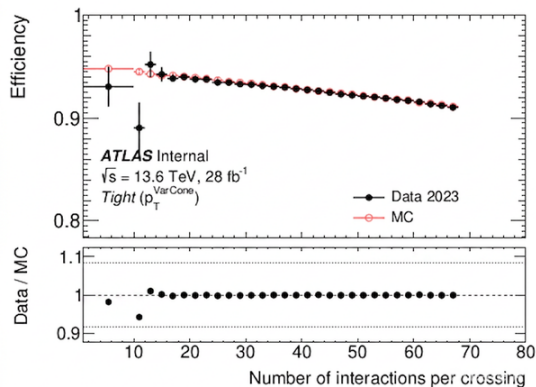


Figure: Reproduced plot without systematics

Isolation efficiency for interactions muons satisfying the PFlowLoose isolation criteria

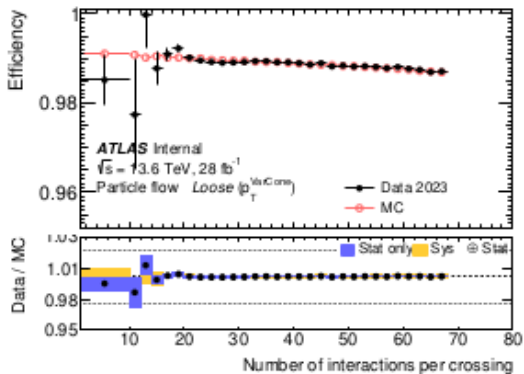


Figure: Original plot

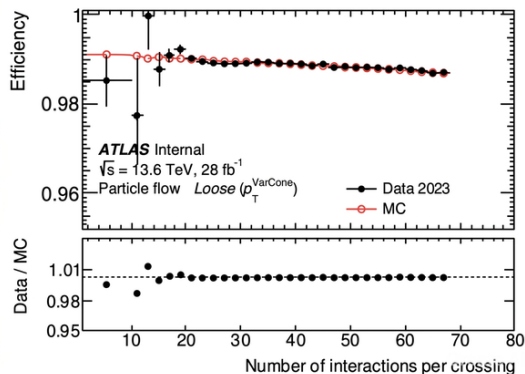


Figure: Reproduced plot without systematics

Isolation efficiency for interactions muons satisfying the Loose isolation criteria

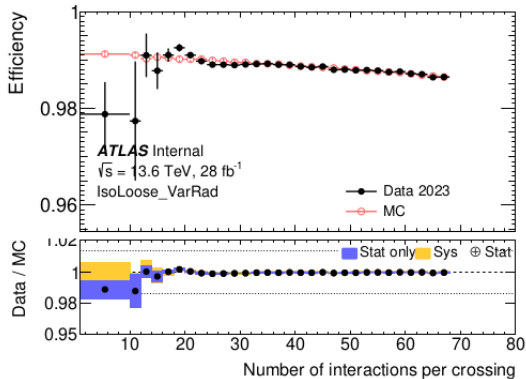


Figure: Original plot

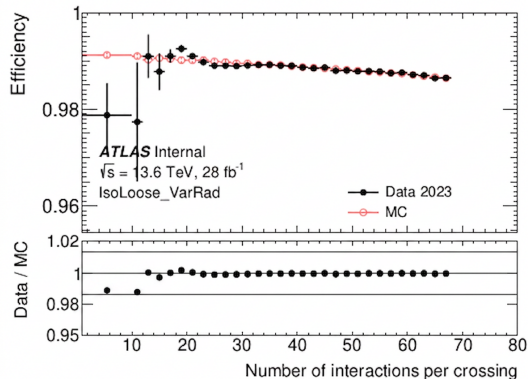


Figure: Reproduced plot without systematics

Distributions for the dimuon mass

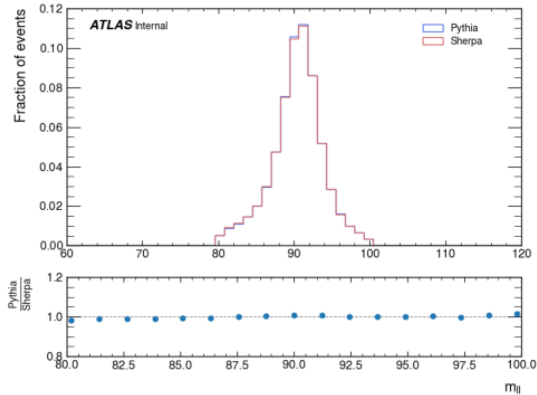


Figure: Original plot

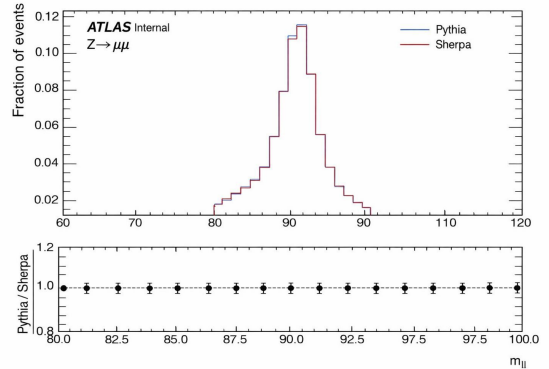


Figure: Reproduced plot

Distributions for muon transverse momentum

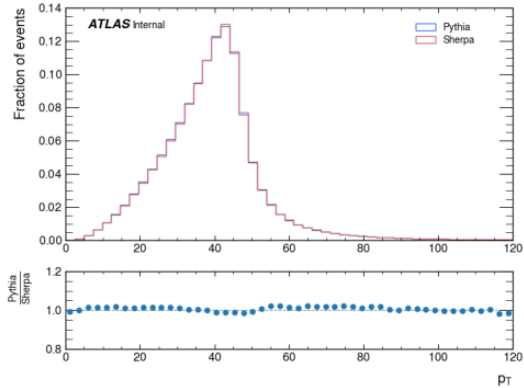


Figure: Original plot

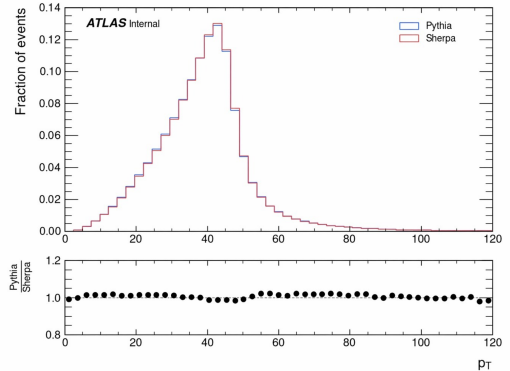


Figure: Reproduced plot

Distributions for muon pseudorapidity

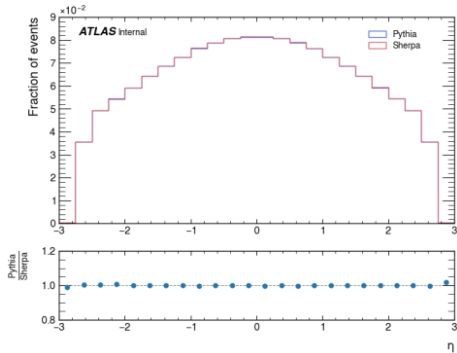


Figure: Original plot

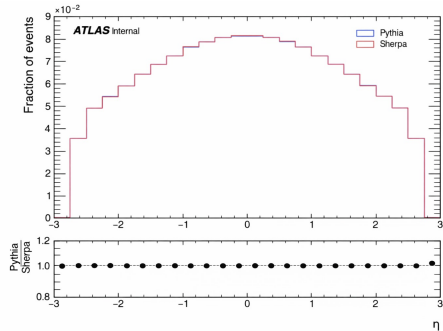


Figure: Reproduced plot

Distributions for angular distance between a muon and its closest jet

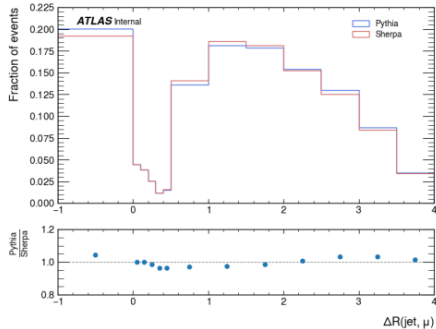


Figure: Original plot

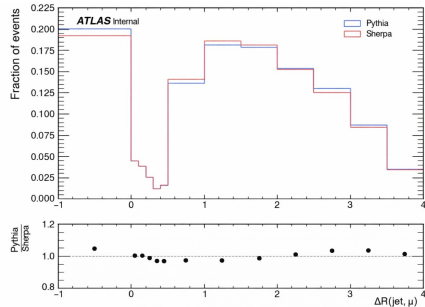


Figure: Reproduced plot

Distributions for the isolation variables divided by the muon p_T

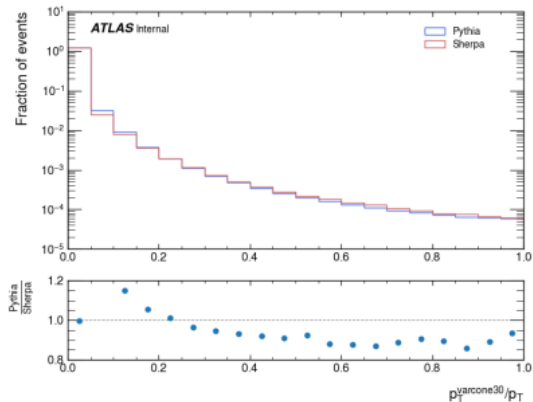


Figure: Original plot

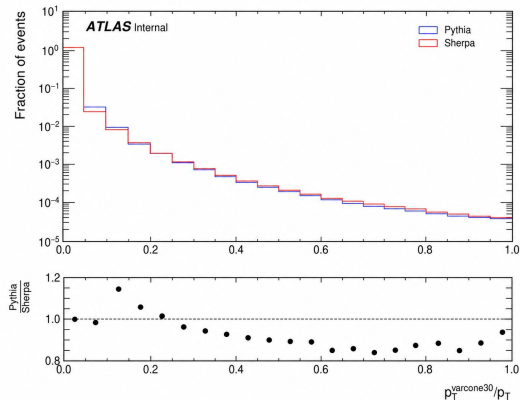


Figure: Reproduced plot

Distributions for the isolation variables divided by the muon p_T

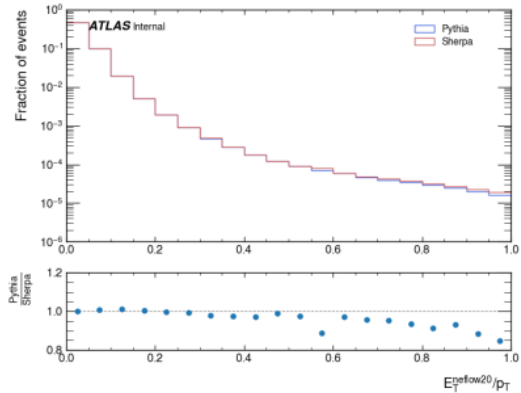


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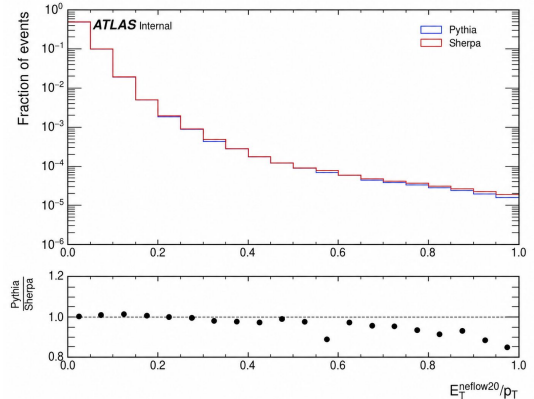


Figure: Reproduced plot

Conclusion

- The exercise of producing the plots in Section 8 of the ATLAS note has been completed successfully.
- As an outlook, what would be the recommended next step?

Back Up



Comparison of the charged particle based isolation variable $p_T^{\text{varcone30}}$ for reconstructed muons and inner detector tracks

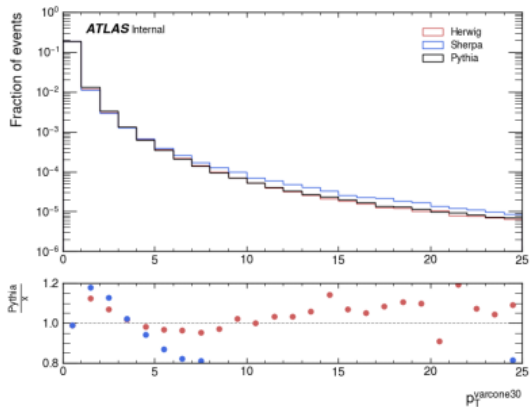


Figure: Original plot

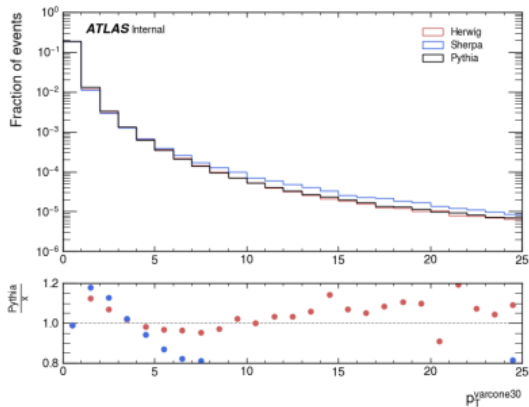


Figure: Reproduced plot

Comparison of the charged particle based isolation variable $p_T^{\text{varcone30}}$ truth particles

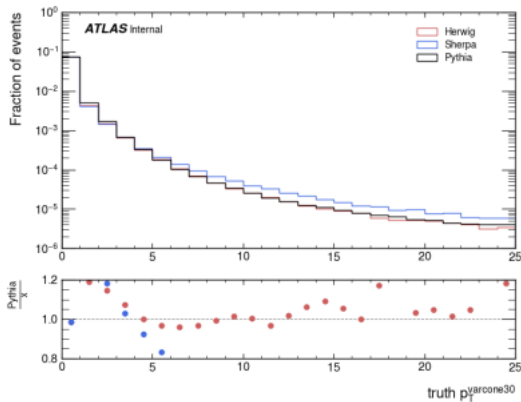


Figure: Original plot

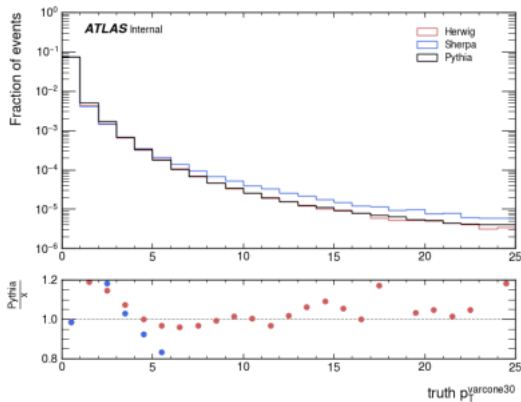


Figure: Reproduced plot