Impact of wrong matching on tracking efficiencies

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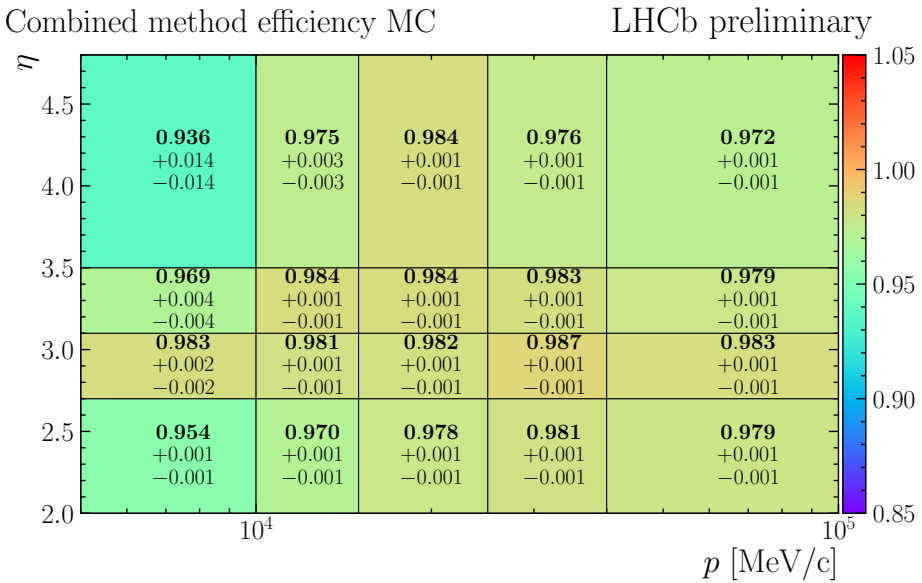
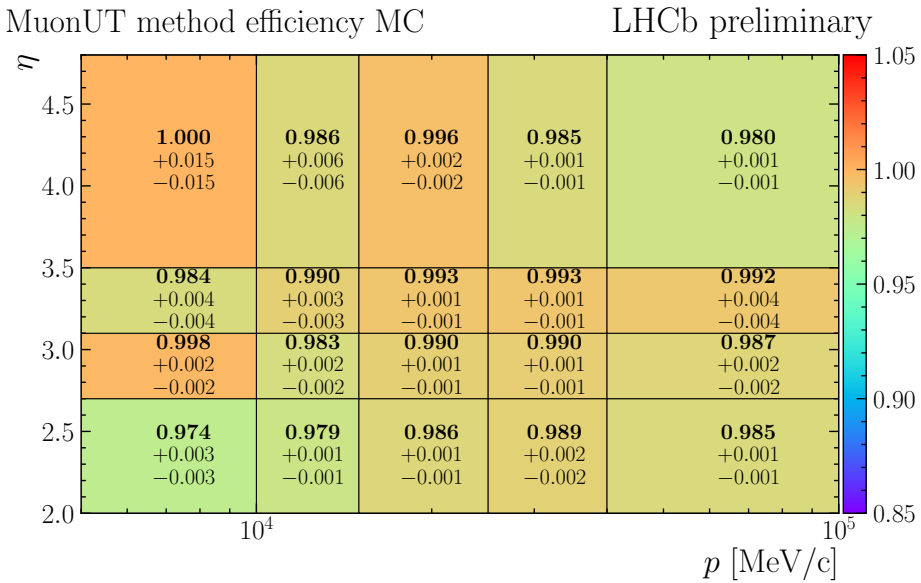
Introduction

Recap from previous presentations:

- Tracking efficiencies with VeloMuon, Downstream, MuonUT methods
  - Combined: VeloMuon $\times$ Downstream
  - Cross check: MuonUT
- A long-standing issue is a discrepancy between the two methods
  - Efficiencies from MuonUT method are consistently higher than those from the combined method
  - Data/MC ratios also show discrepancies

Block 5 tracking efficiencies





- Effect is worse in data
- Does not seem to cancel in data/MC ratio

Checks performed

Current work: Try to understand why this discrepancy exists in MC, and whether or not it could explain some of the discrepancy in data

- Different kinematics?
  - Finer bins still show discrepancies
- MuonUT charge asymmetry bug?
  - Fits split by charge consistent with charge integrated results
- Bad fit model or counting bias?
  - Truth matched MC still shows discrepancies
- Problem must be somewhere further upstream...
  - ... so I looked into how the matching is performed

Checks performed

Matching is performed by compared hits in each subdetector

Method	Velo	UT	SciFi	Muon
VeloMuon	0.4	–	–	0.4
Downstream	–	–	0.4	0.4
MuonUT	–	–	–	0.4

- Probe track is perhaps matched to a random long track
- Especially for MuonUT, which only has 4 hits in the Muon system, this effect should be checked
- Strategy: Copy Rowina's AP on MC and add long track truth info
  - Compare `TRUEKEY` between probe track and long track
- Warning: Results from local testjob have limited statistics
  - AP was submitted yesterday and still running

Tracking efficiencies on truth matched yields

Calculate tracking efficiencies on truth matched yields (no fitting)

Method	Charge	N_{pass}	N_{fail}	ϵ
VeloMuon	μ^+	594 ± 24	15 ± 4	0.975 ± 0.006
Downstream	μ^+	400 ± 20	6.0 ± 2.4	0.985 ± 0.006
Combined	μ^+	–	–	0.961 ± 0.009
MuonUT	μ^+	97 ± 10	1.0 ± 1.0	0.990 ± 0.010
VeloMuon	μ^-	625 ± 25	21 ± 5	0.967 ± 0.007
Downstream	μ^-	428 ± 21	6.0 ± 2.4	0.986 ± 0.006
Combined	μ^-	–	–	0.954 ± 0.009
MuonUT	μ^-	77 ± 9	2.0 ± 1.4	0.975 ± 0.018

Fraction of wrongly matched tracks

How often is the matched long track wrong?

Method	Charge	N_{pass}	$N_{\text{pass}}^{\text{wrong}}$	Correction
VeloMuon	μ^+	594 ± 24	0	1
Downstream	μ^+	400 ± 20	11.0 ± 3.3	0.972 ± 0.008
MuonUT	μ^+	97 ± 10	4.0 ± 2.0	0.959 ± 0.020
VeloMuon	μ^-	625 ± 25	0	1
Downstream	μ^-	428 ± 21	5.0 ± 2.2	0.988 ± 0.005
MuonUT	μ^-	77 ± 9	3.0 ± 1.7	0.961 ± 0.022

Correction factor: $(N_{\text{pass}} - N_{\text{pass}}^{\text{wrong}})/N_{\text{pass}}$

Corrected tracking efficiencies on truth matched yields

Multiply tracking efficiencies with correction factors

Method	Charge	ϵ
VeloMuon	μ^+	0.975 ± 0.006
Downstream	μ^+	0.958 ± 0.010
Combined	μ^+	0.934 ± 0.011
MuonUT	μ^+	0.949 ± 0.022
VeloMuon	μ^-	0.967 ± 0.007
Downstream	μ^-	0.975 ± 0.008
Combined	μ^-	0.943 ± 0.010
MuonUT	μ^-	0.937 ± 0.027
Combined	$\mu^\pm$	0.939 ± 0.007
MuonUT	$\mu^\pm$	0.944 ± 0.017

Summary and next steps

- Matching to the wrong long track occurs more often with MuonUT method, potentially leading to biased tracking efficiencies
- After correcting for this using MC truth information, discrepancy seems to be gone, but uncertainties are currently large
- AP with more MC is currently running
- Next steps:
  1. With more statistics, study effect in kinematic bins
  2. Figure out if this effect cancels in the data/MC ratio?

Thanks for listening!