Progress update on tracking efficiencies

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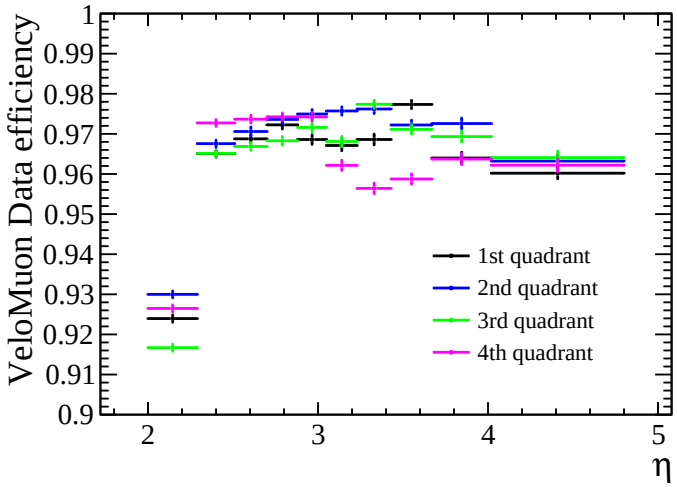
Current progress

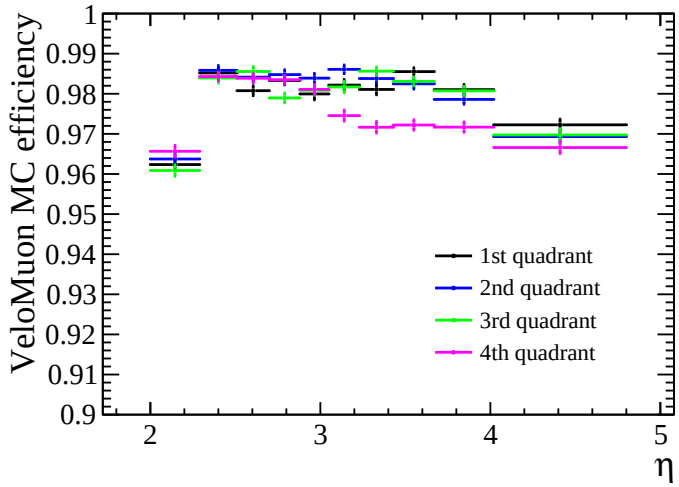
Current progress on tracking efficiencies:

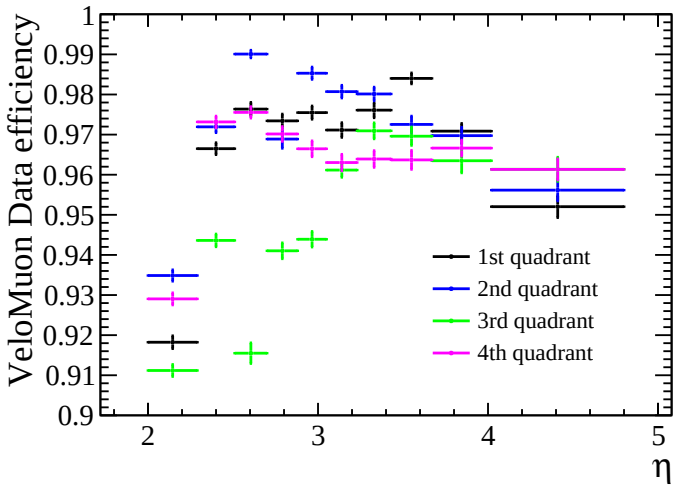
- Recap from last time:
  - Tracking efficiencies produced for blocks 1, 5, 6, 7, 8
  - Only 1D binning in p and η ready
- What's new today?
  - MC for 2024 block 2 and pp ref run produced
  - AP over block 2, pp ref and 2025 pre-TS data/MC done
  - Tracking efficiencies in 1D produced for these datasets
  - Comparison between block 1a and block 1b MC ready
  - Preliminary results for 2D binning available for some blocks
  - Prepare to present results in WP4

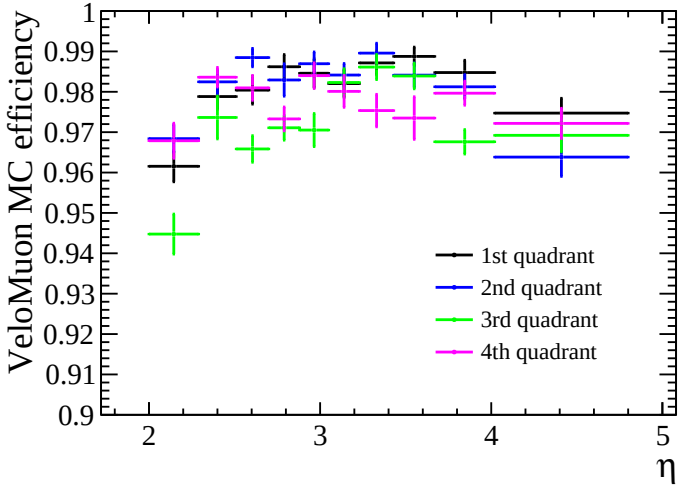
Block 1a vs 1b

Block 1a (fills 9982–10012, top) vs 1b (fills 10017–10056, bottom)





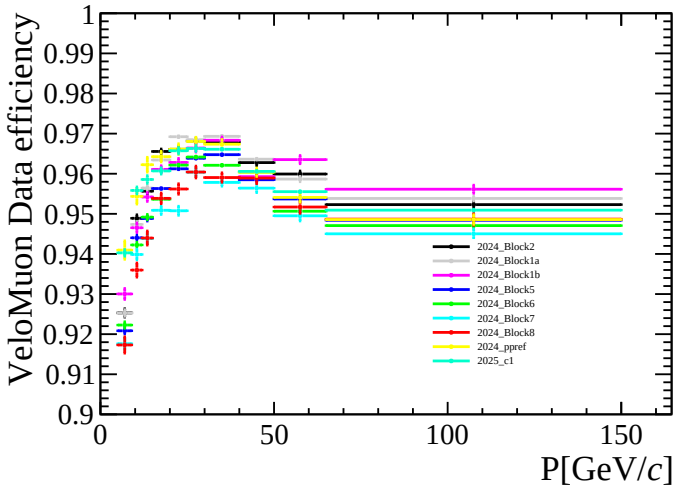


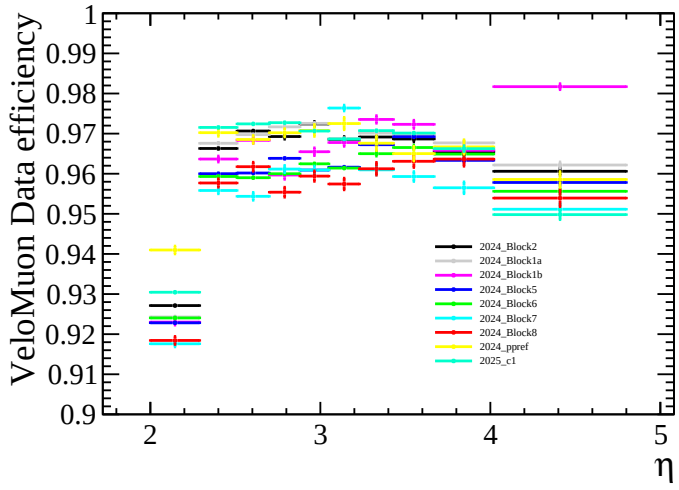


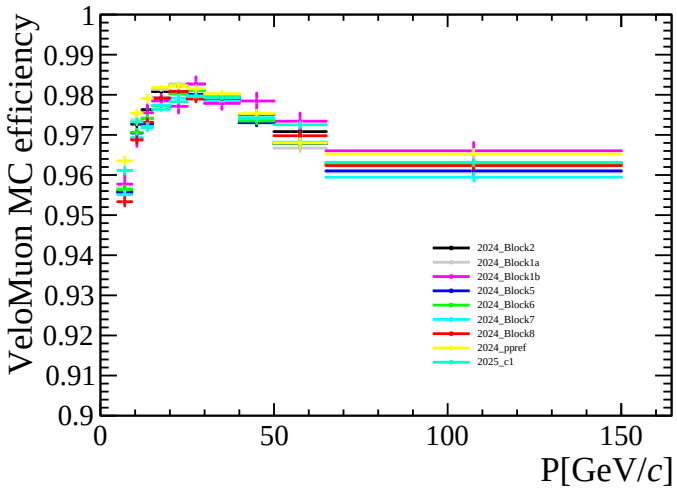
SciFi T2L0Q0M1H0 FE was excluded on 17th August

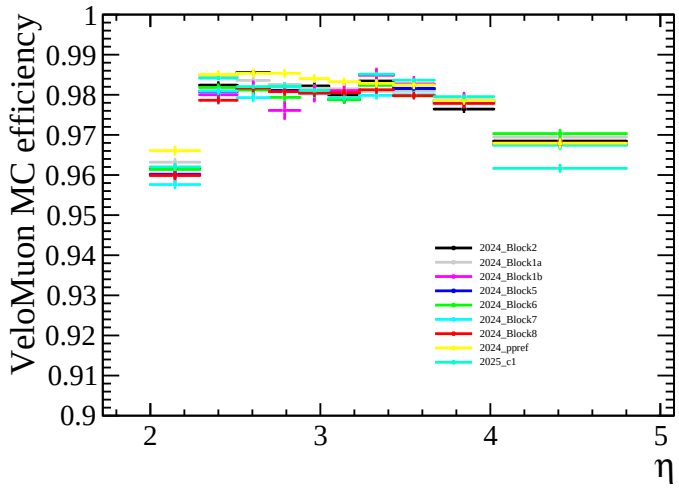
Efficiency comparisons

Comparison of tracking efficiencies in all data blocks





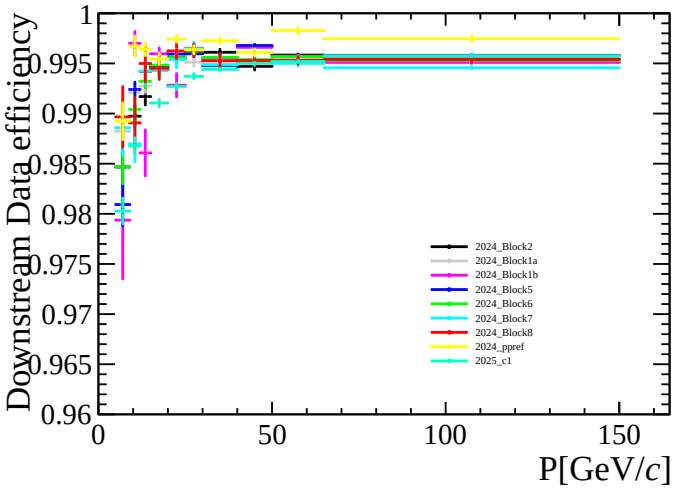


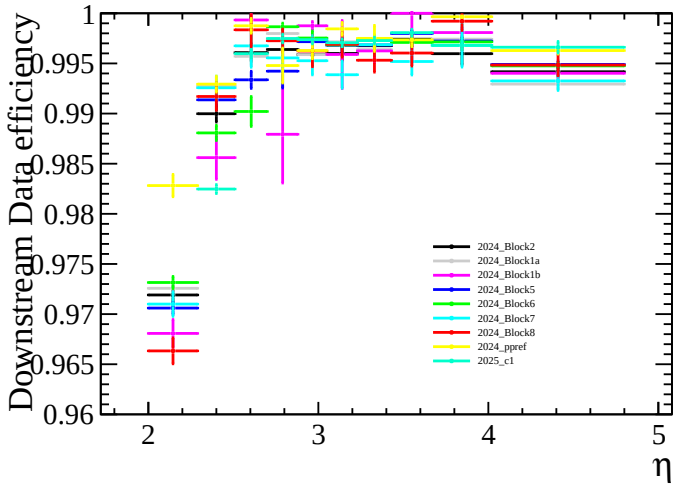


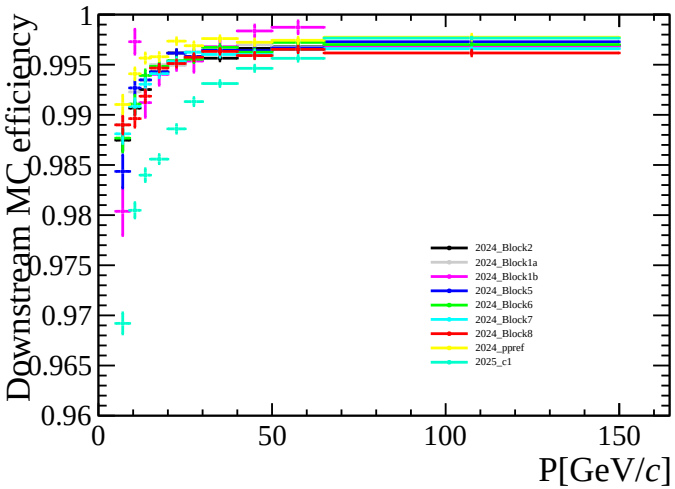
VeloMuon track efficiencies

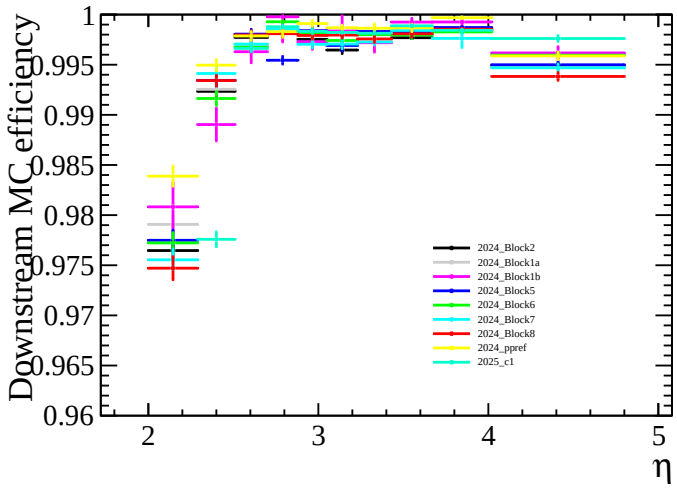
Efficiency comparisons

Comparison of tracking efficiencies in all data blocks





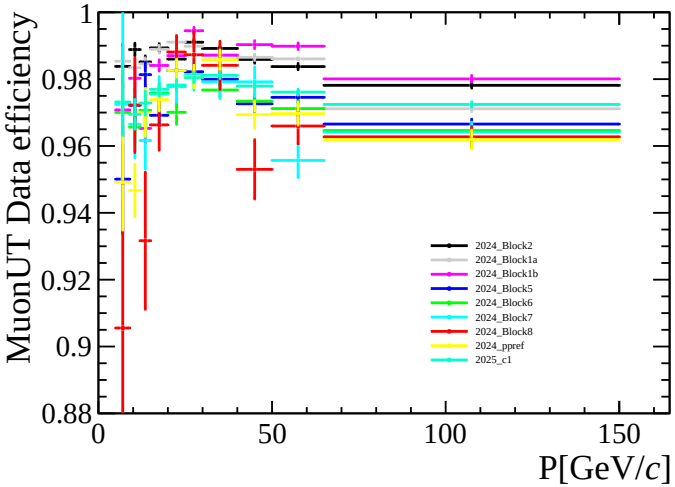


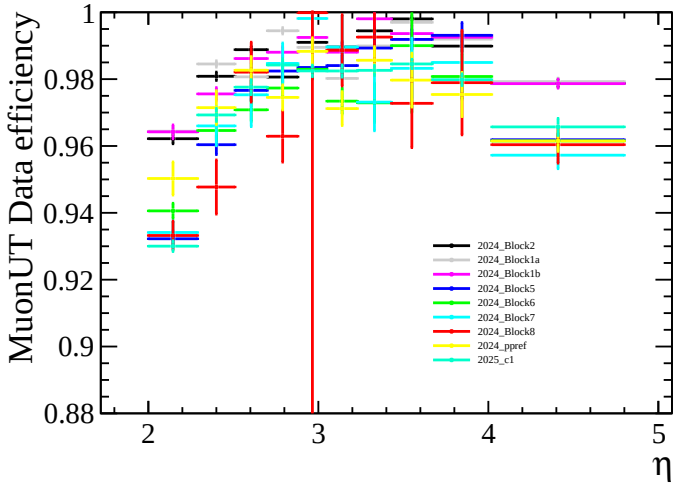


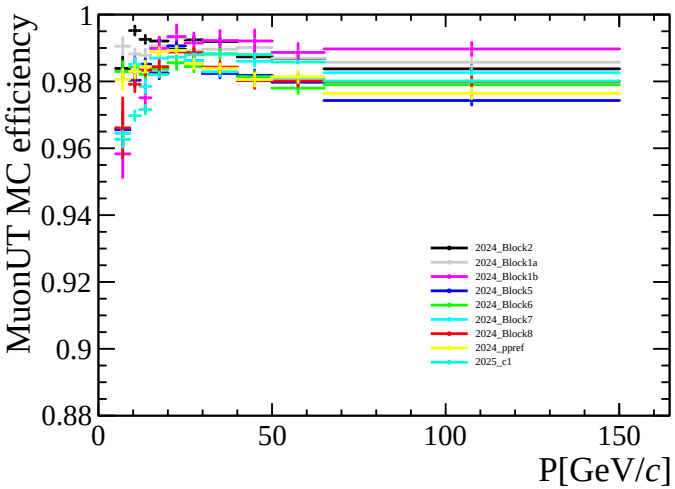
Downstream track efficiencies

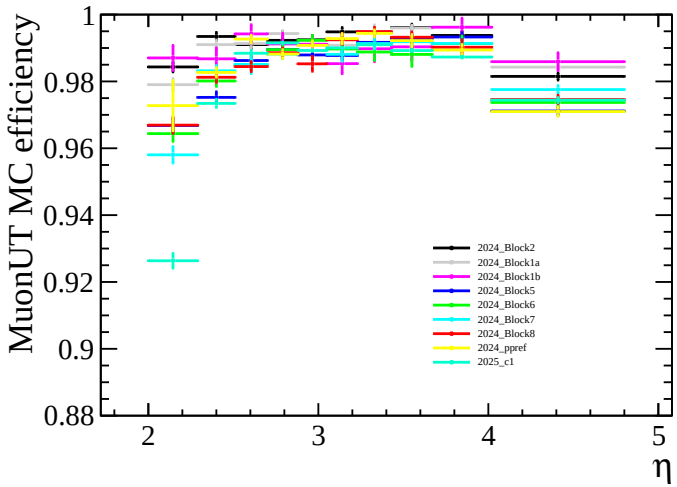
Efficiency comparisons

Comparison of tracking efficiencies in all data blocks





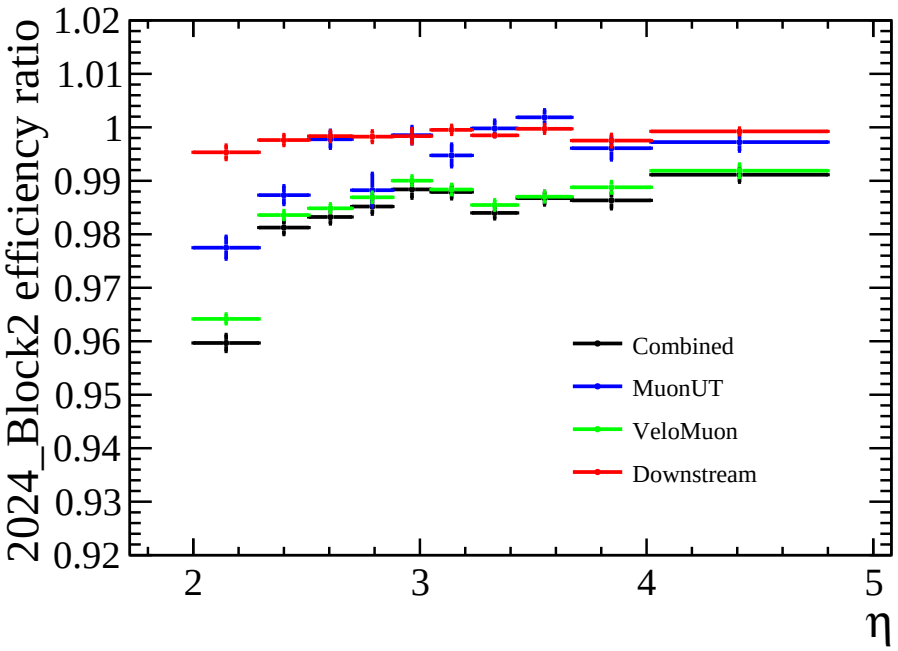


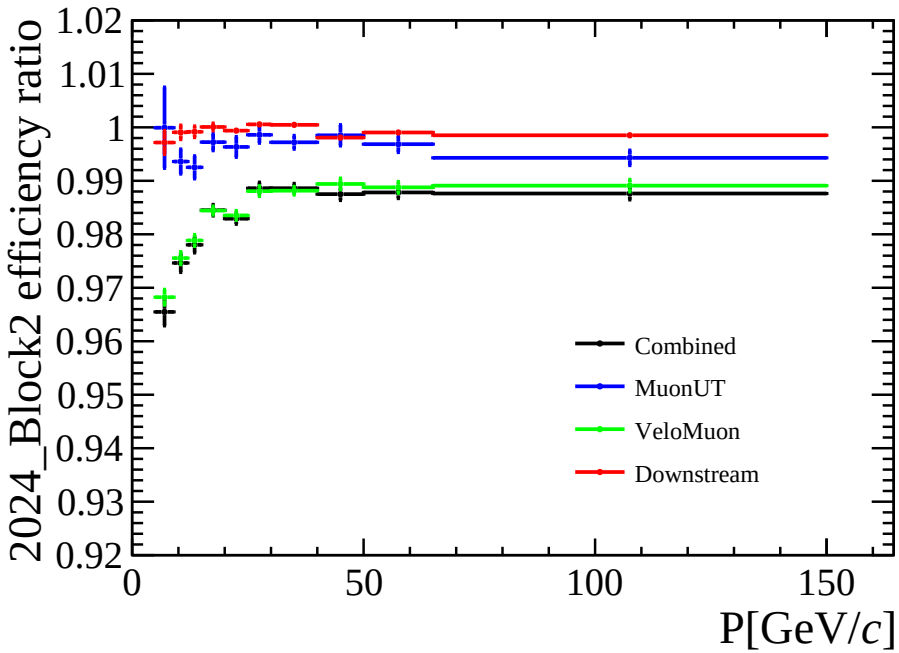


MuonUT track efficiencies

Tracking efficiency data/MC ratio

Data/MC ratio

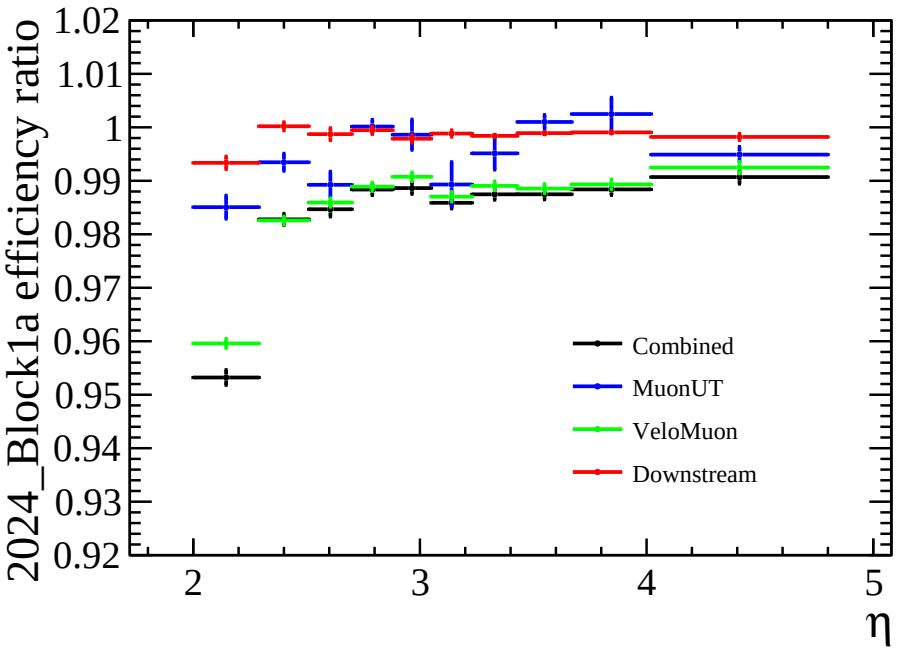


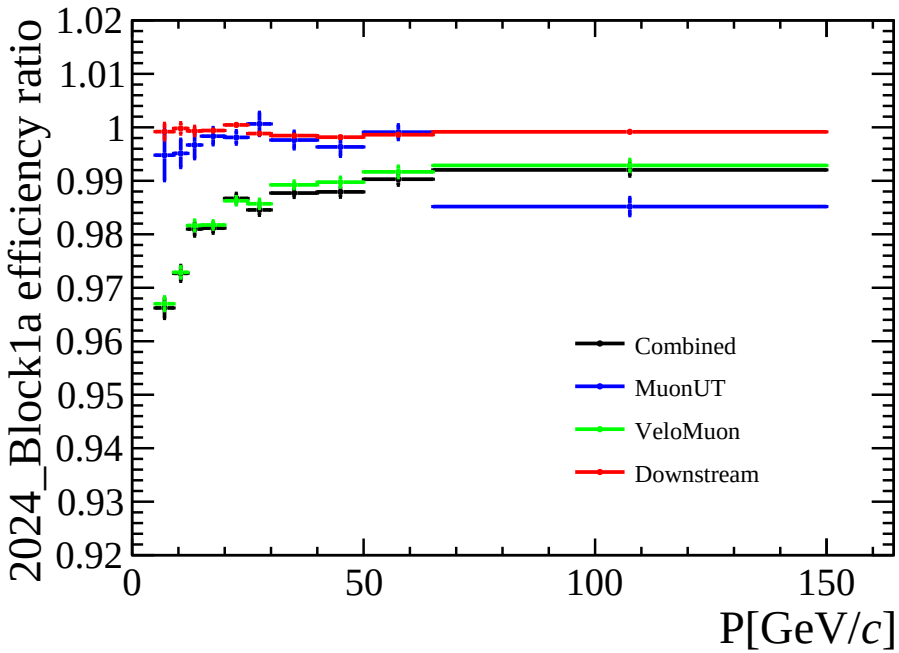


Data/MC ratio for Combined/MuonUT track efficiencies block 2

Tracking efficiency data/MC ratio

Data/MC ratio

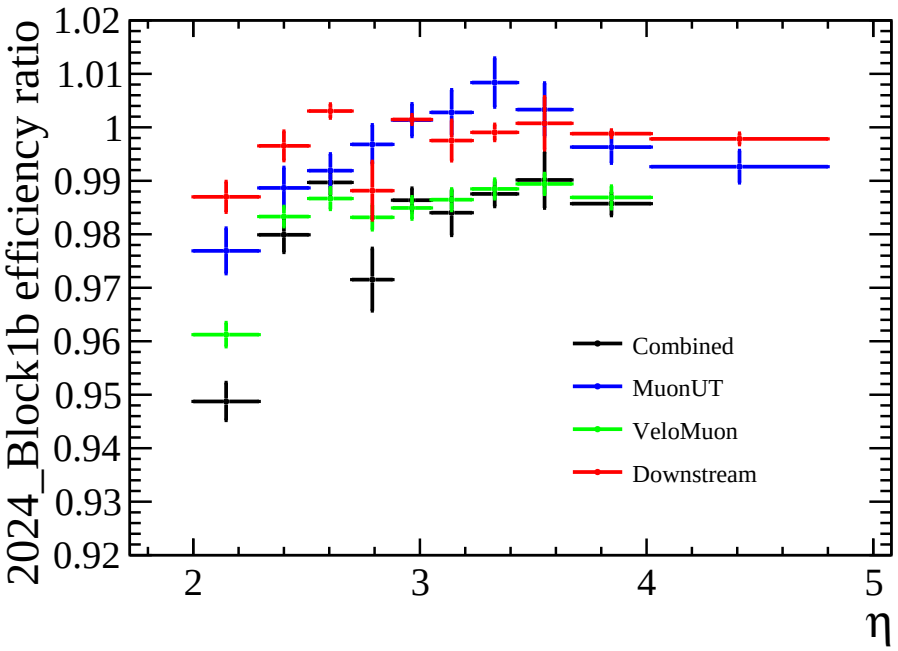


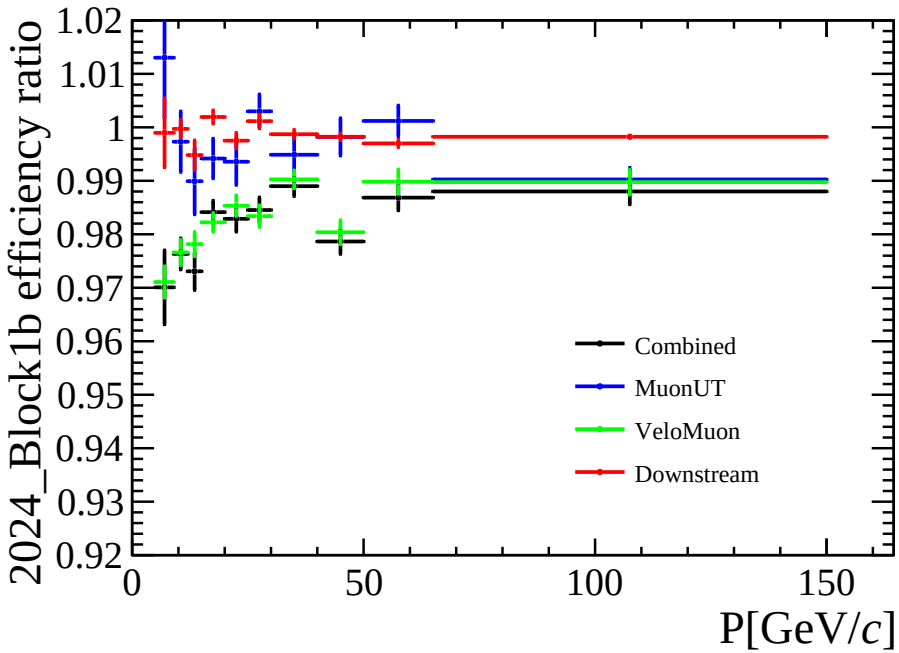


Data/MC ratio for Combined/MuonUT track efficiencies block 1a

Tracking efficiency data/MC ratio

Data/MC ratio

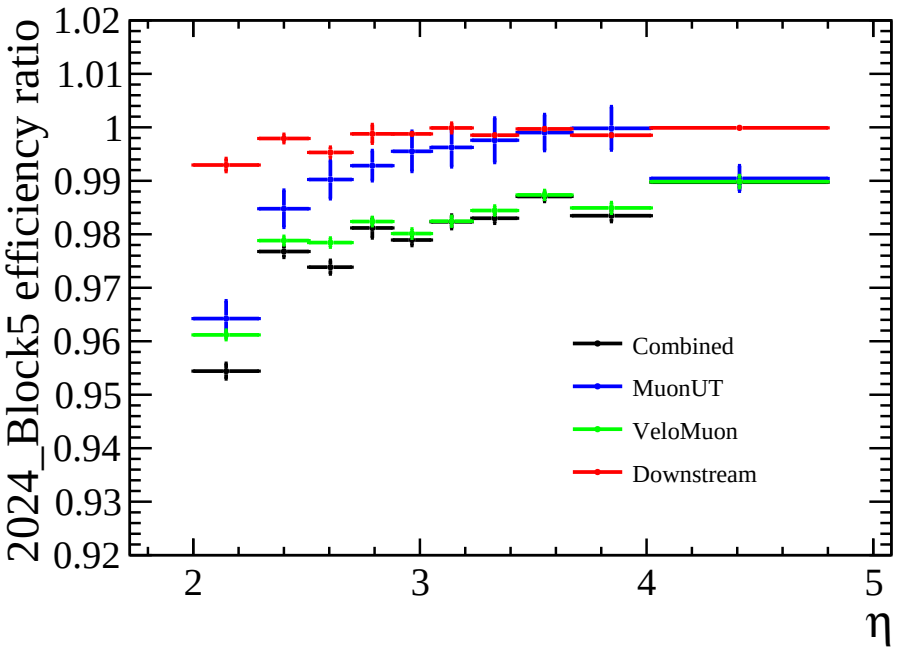


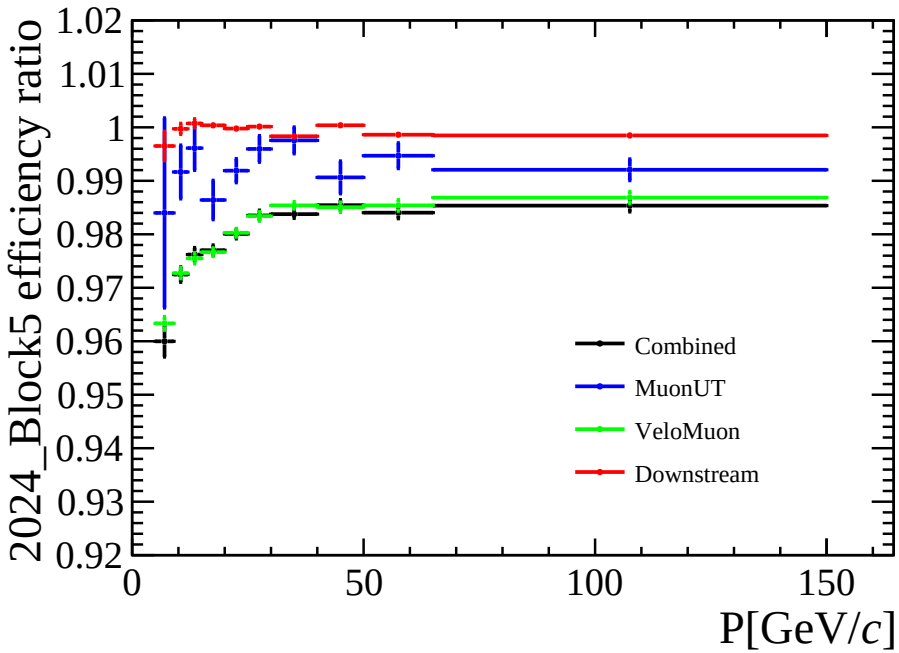


Data/MC ratio for Combined/MuonUT track efficiencies block 1b

Tracking efficiency data/MC ratio

Data/MC ratio

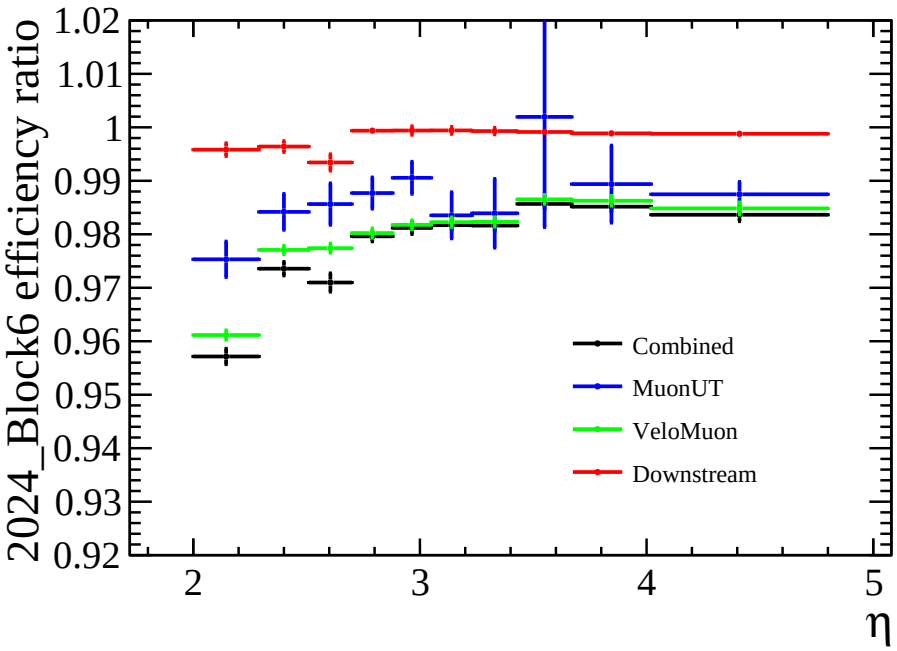


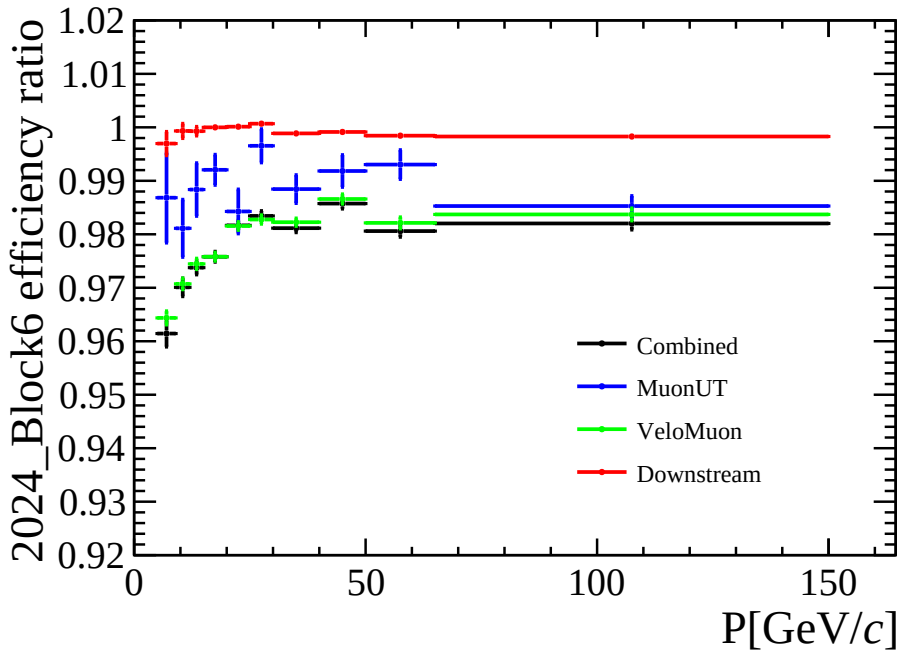


Data/MC ratio for Combined/MuonUT track efficiencies block 5

Tracking efficiency data/MC ratio

Data/MC ratio

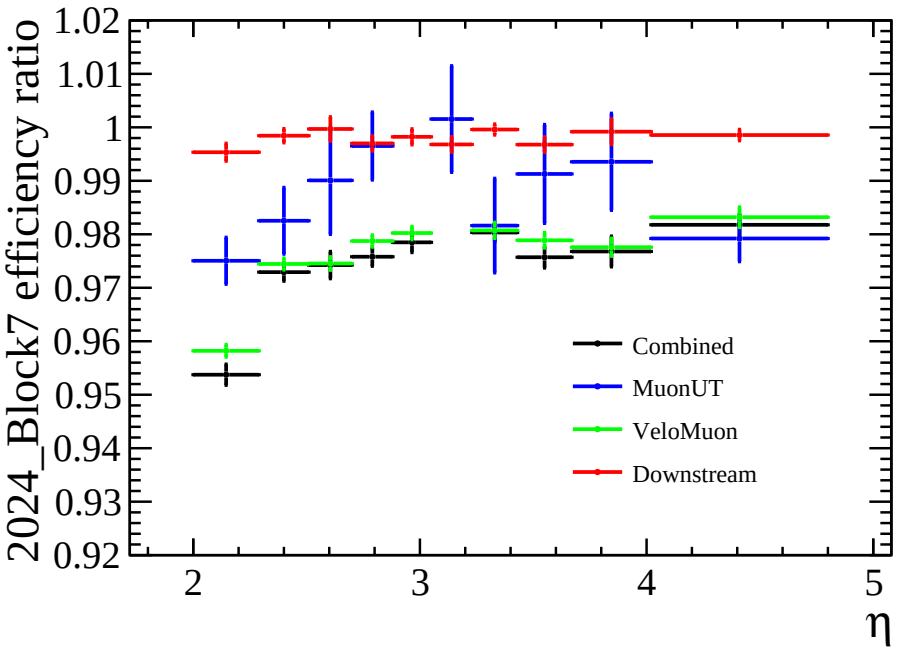


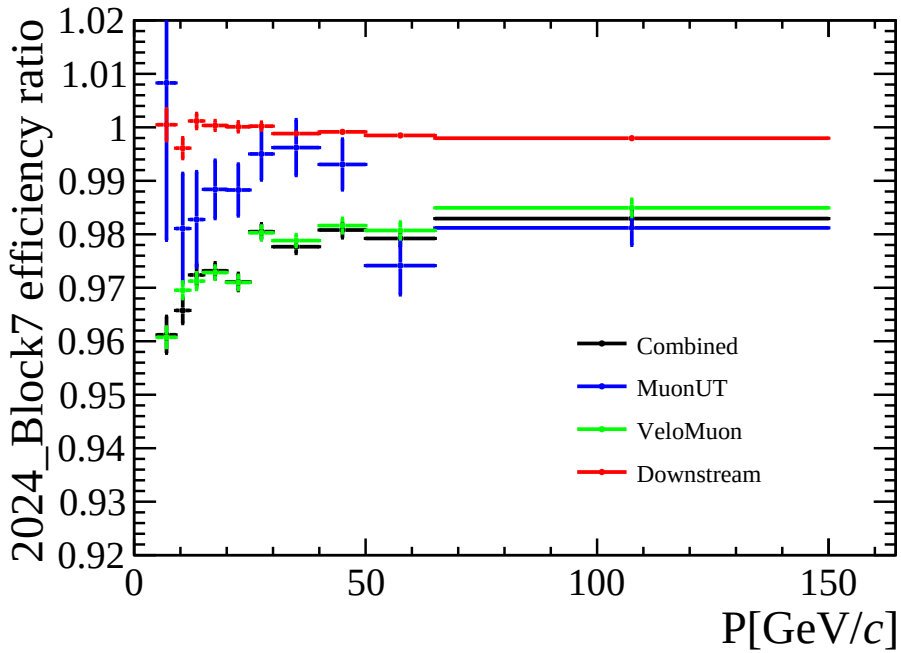


Data/MC ratio for Combined/MuonUT track efficiencies block 6

Tracking efficiency data/MC ratio

Data/MC ratio

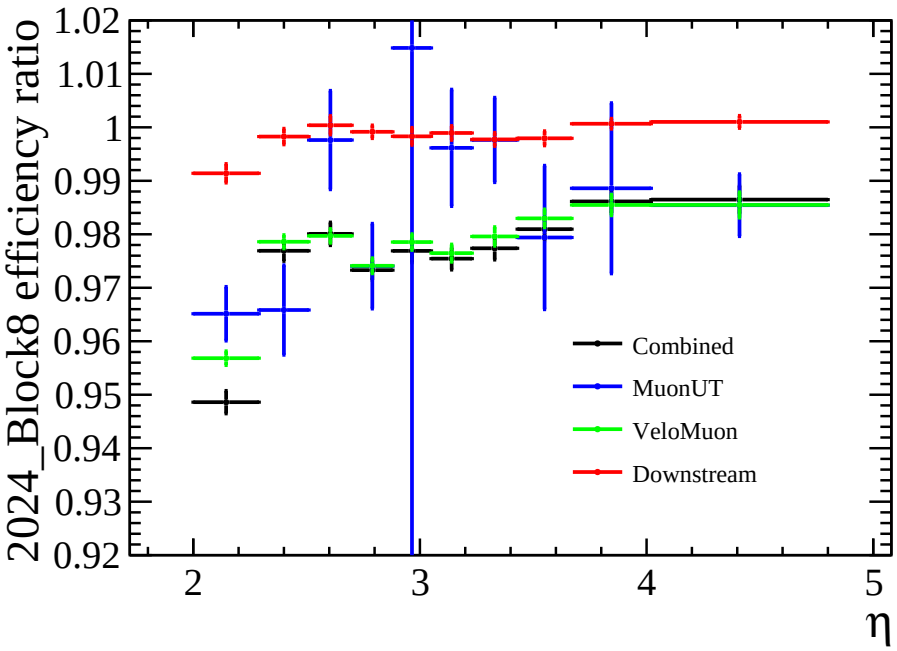


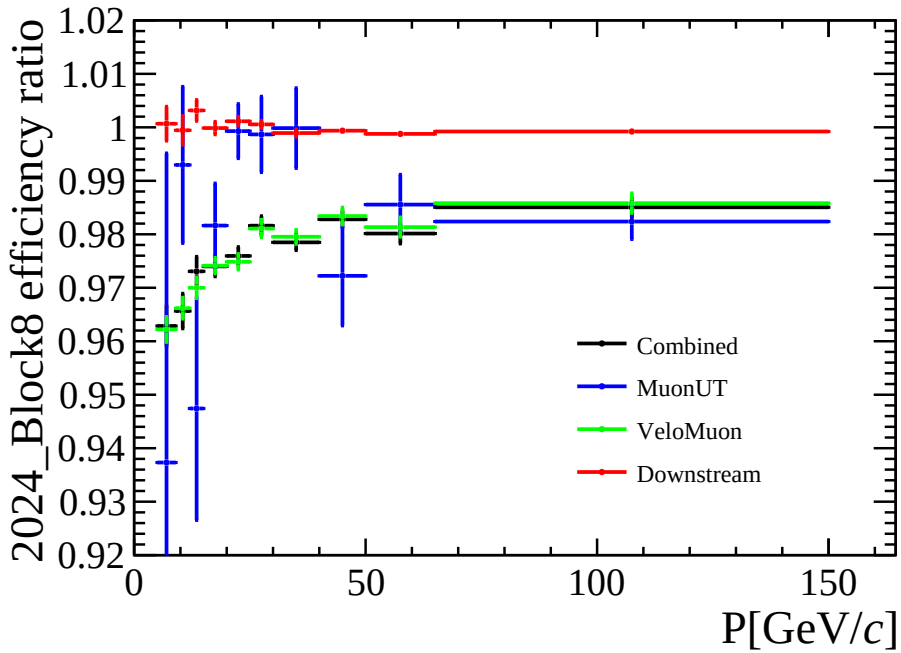


Data/MC ratio for Combined/MuonUT track efficiencies block 7

Tracking efficiency data/MC ratio

Data/MC ratio

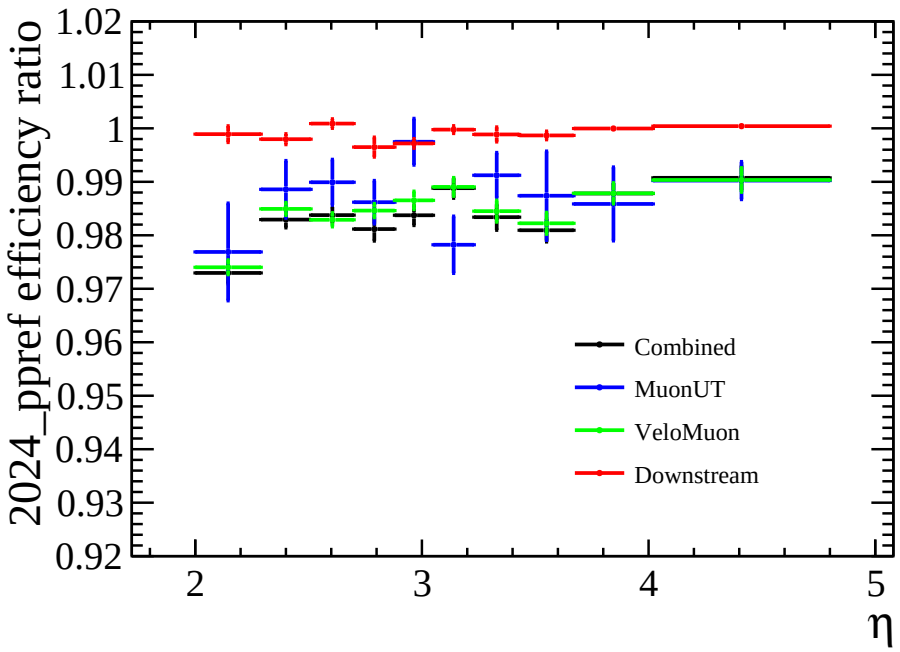


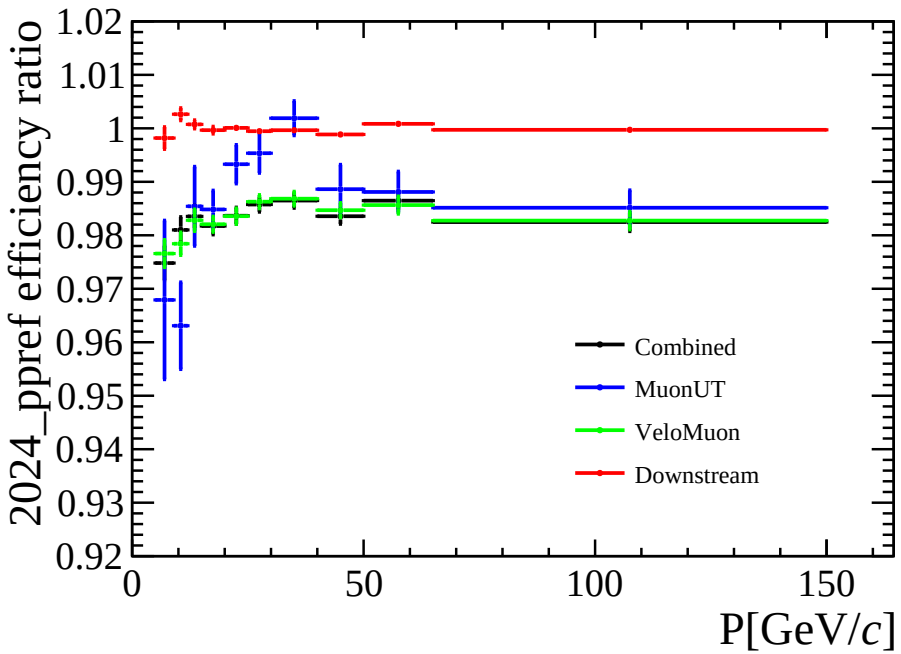


Data/MC ratio for Combined/MuonUT track efficiencies block 8

Tracking efficiency data/MC ratio

Data/MC ratio

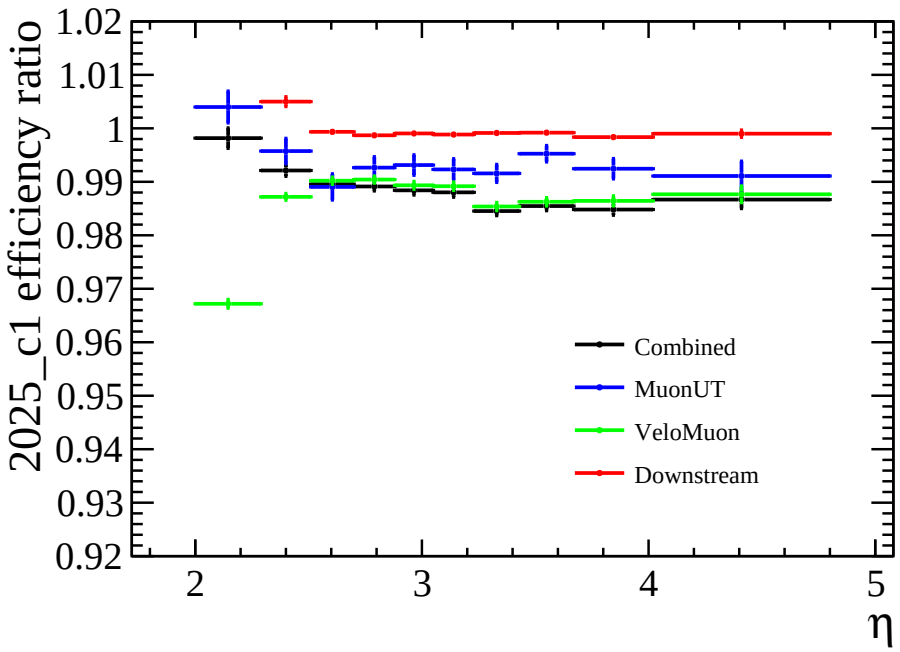


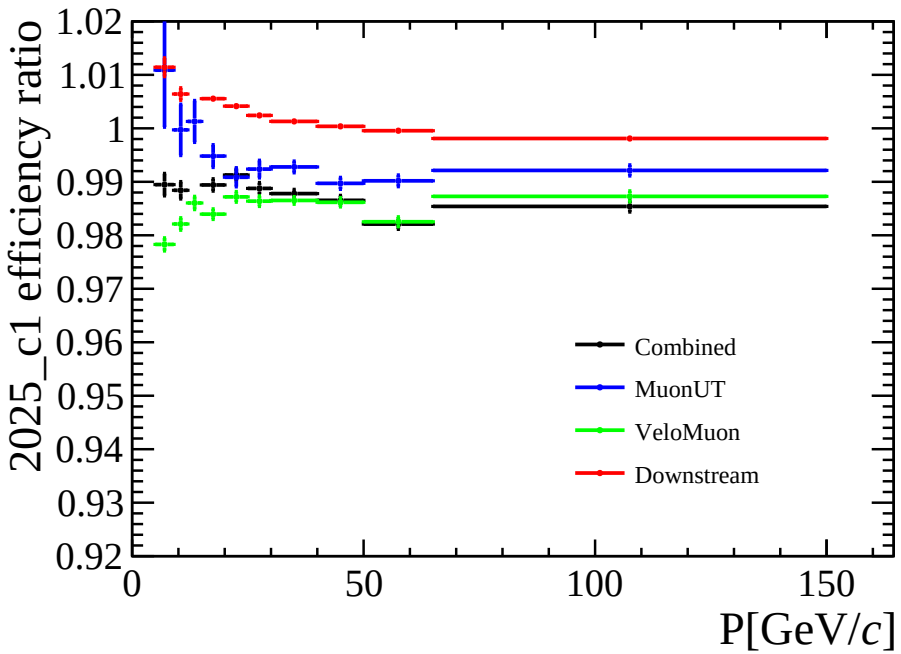


Data/MC ratio for Combined/MuonUT track efficiencies *pp* ref run

Tracking efficiency data/MC ratio

Data/MC ratio





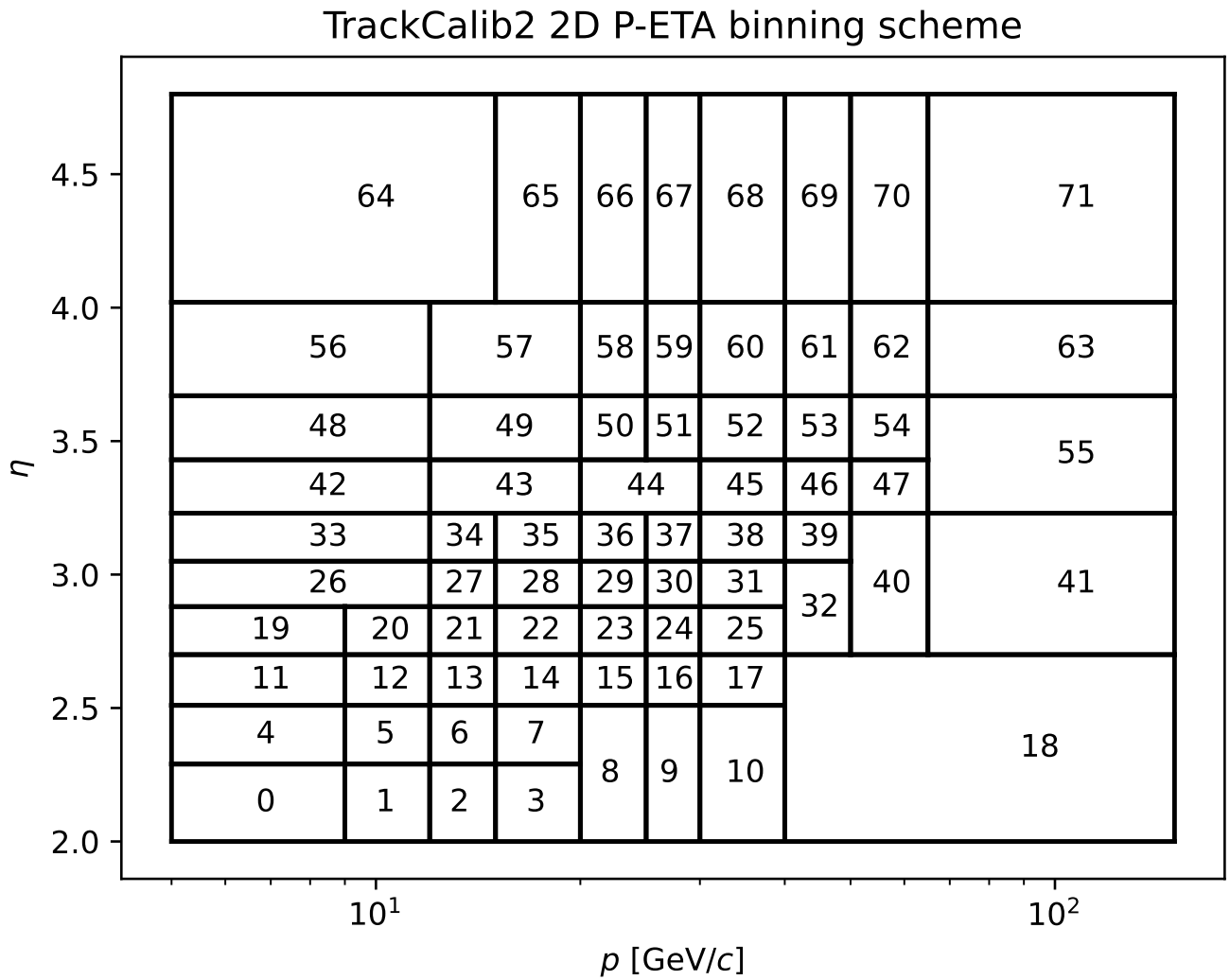
Data/MC ratio for Combined/MuonUT track efficiencies 2025 pre-TS

2D binning

- Currently we have 1D bins in p and η with 10 bins each
- Using 10×10 2D bins is impossible
  - Insufficient statistics at high (low) p and low (high) η
  - But most bins do have sufficient statistics
- Strategy: Start with 10×10 bins and merge bins
  - Only consider MC, which is important for constraining the fit shape
  - Only consider VeloMuon yields, as Downstream efficiencies are close to 100% anyway and MuonUT is only used as a cross check
  - Try to merge bins along η at high p and vice versa
  - Aim for roughly $\gtrsim 100$ matched candidates in each bin

2D binning

Final 2D binning in p vs η with 72 bins:

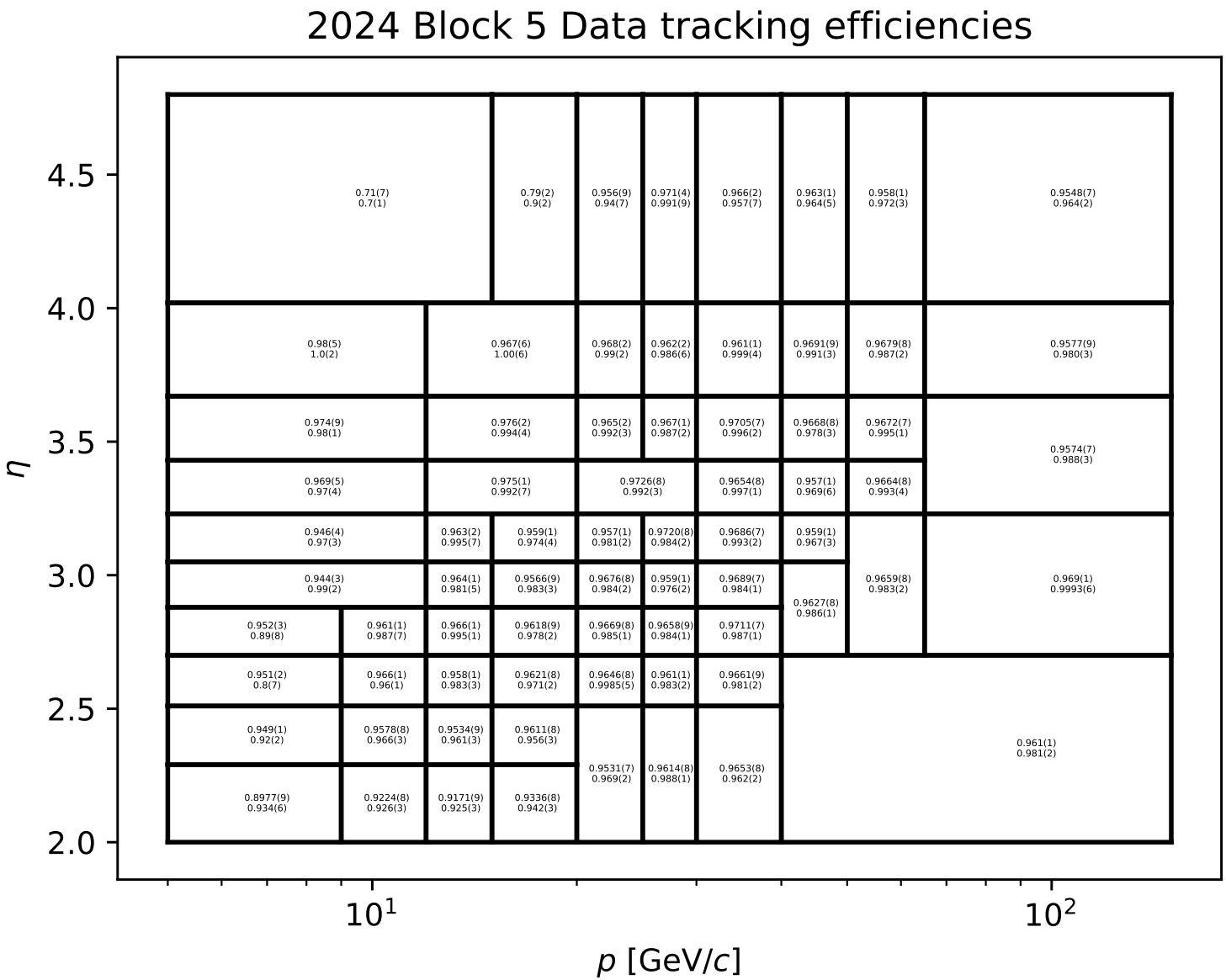


2D binning

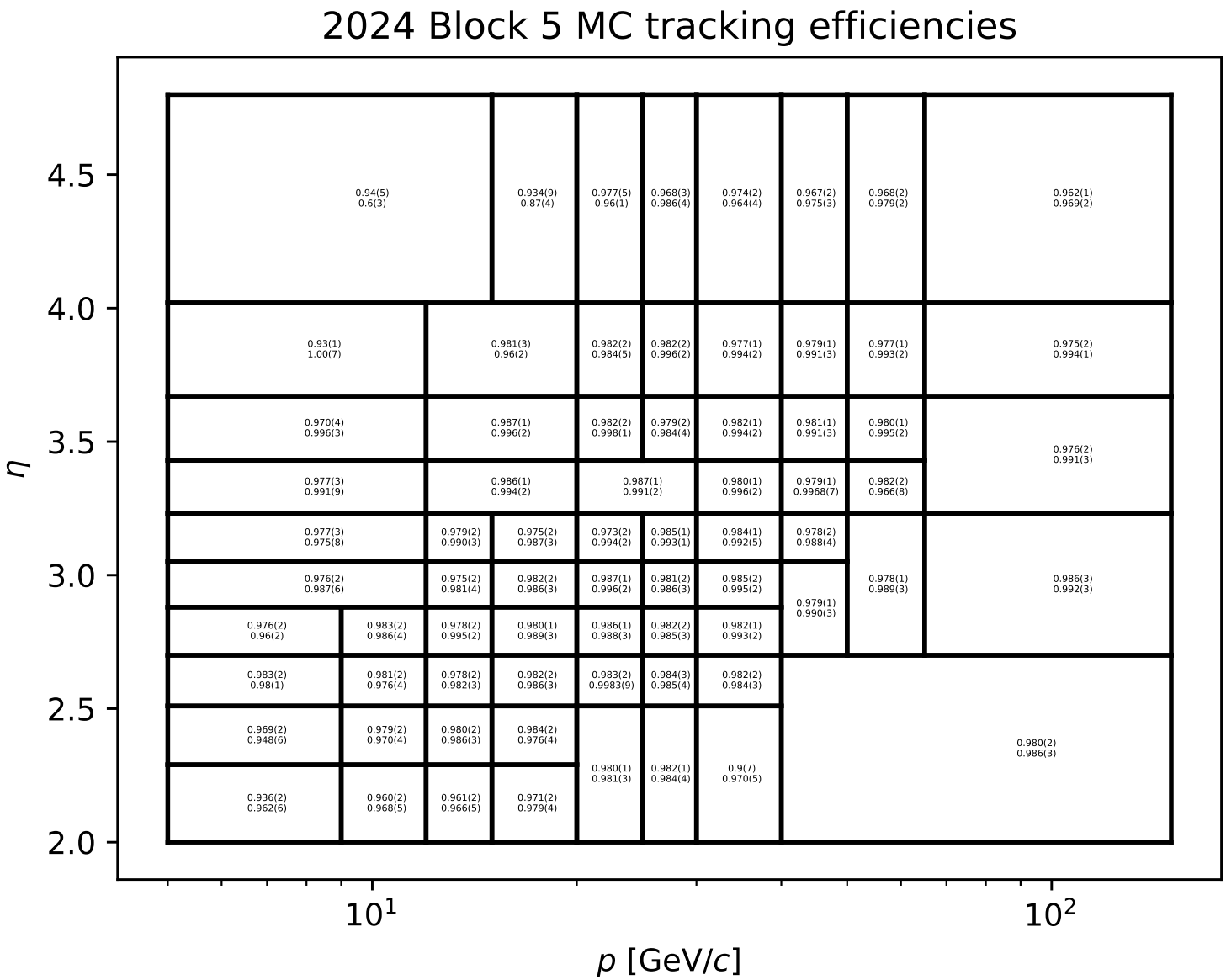
Some caveats:

- In some rare cases a fit might fail...
  - ... but I have now implemented single-bin fits in TrackCalib2, so one can vary the start parameters for a specific dataset and rerun the fit in that bin
  - Still needs to be done by hand, but it's relatively quick
- Tracking efficiency tables need to be provided as JSON files...
  - ... but I'll attempt to make some plots as well

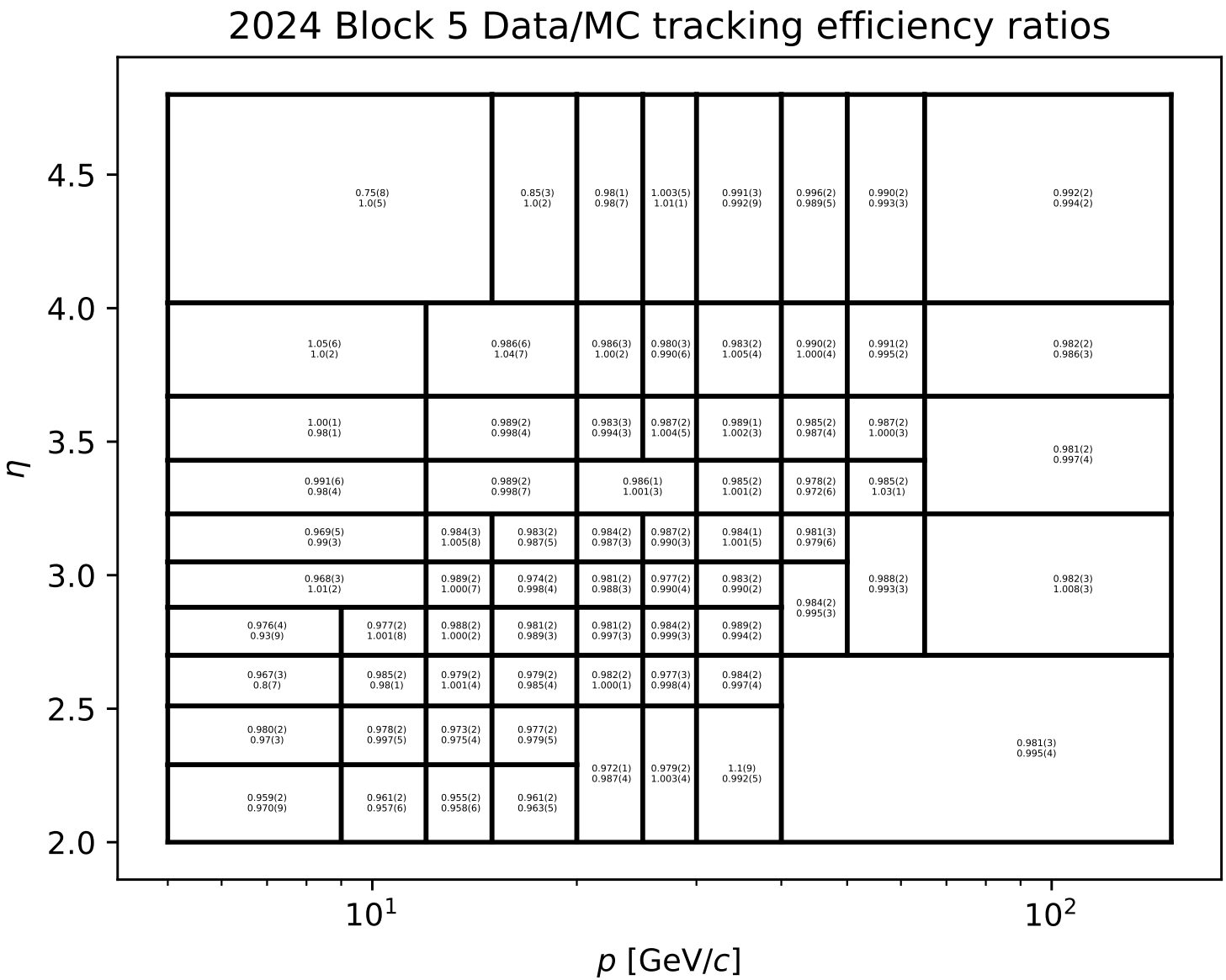
2D binning


2024 Block 5 Data tracking efficiencies
0.71(7)
0.7(1)
0.79(2)
0.9(2)
0.956(9)
0.94(7)
0.971(4)
0.991(9)
0.966(2)
0.957(7)
0.963(1)
0.964(5)
0.958(1)
0.972(3)
0.9548(7)
0.964(2)
0.98(5)
1.0(2)
0.967(6)
1.00(6)
0.968(2)
0.99(2)
0.962(2)
0.986(6)
0.961(1)
0.999(4)
0.9691(9)
0.991(3)
0.9679(8)
0.987(2)
0.9577(9)
0.980(3)
0.974(9)
0.98(1)
0.976(2)
0.994(4)
0.965(2)
0.992(3)
0.967(1)
0.987(2)
0.9705(7)
0.996(2)
0.9668(8)
0.978(3)
0.9672(7)
0.995(1)
0.9574(7)
0.988(3)
0.969(5)
0.97(4)
0.975(1)
0.992(7)
0.9726(8)
0.992(3)
0.9654(8)
0.997(1)
0.957(1)
0.969(6)
0.9664(8)
0.993(4)
0.946(4)
0.97(3)
0.963(2)
0.995(7)
0.959(1)
0.974(4)
0.957(1)
0.981(2)
0.9720(8)
0.984(2)
0.9686(7)
0.993(2)
0.959(1)
0.967(3)
0.944(3)
0.99(2)
0.964(1)
0.981(5)
0.9566(9)
0.983(3)
0.9676(8)
0.984(2)
0.959(1)
0.976(2)
0.9689(7)
0.984(1)
0.9627(8)
0.986(1)
0.9659(8)
0.983(2)
0.969(1)
0.9993(6)
0.952(3)
0.89(8)
0.961(1)
0.987(7)
0.966(1)
0.995(1)
0.9618(9)
0.978(2)
0.9669(8)
0.985(1)
0.9658(9)
0.984(1)
0.9711(7)
0.987(1)
0.951(2)
0.8(7)
0.966(1)
0.96(1)
0.958(1)
0.983(3)
0.9621(8)
0.971(2)
0.9646(8)
0.9985(5)
0.961(1)
0.983(2)
0.9661(9)
0.981(2)
0.949(1)
0.92(2)
0.9578(8)
0.966(3)
0.9534(9)
0.961(3)
0.9611(8)
0.956(3)
0.9531(7)
0.969(2)
0.9614(8)
0.988(1)
0.9653(8)
0.962(2)
0.961(1)
0.981(2)
0.8977(9)
0.934(6)
0.9224(8)
0.926(3)
0.9171(9)
0.925(3)
0.9336(8)
0.942(3)
4.5
4.0
3.5
3.0
2.5
2.0
η
10^1
10^2
p [GeV/c]

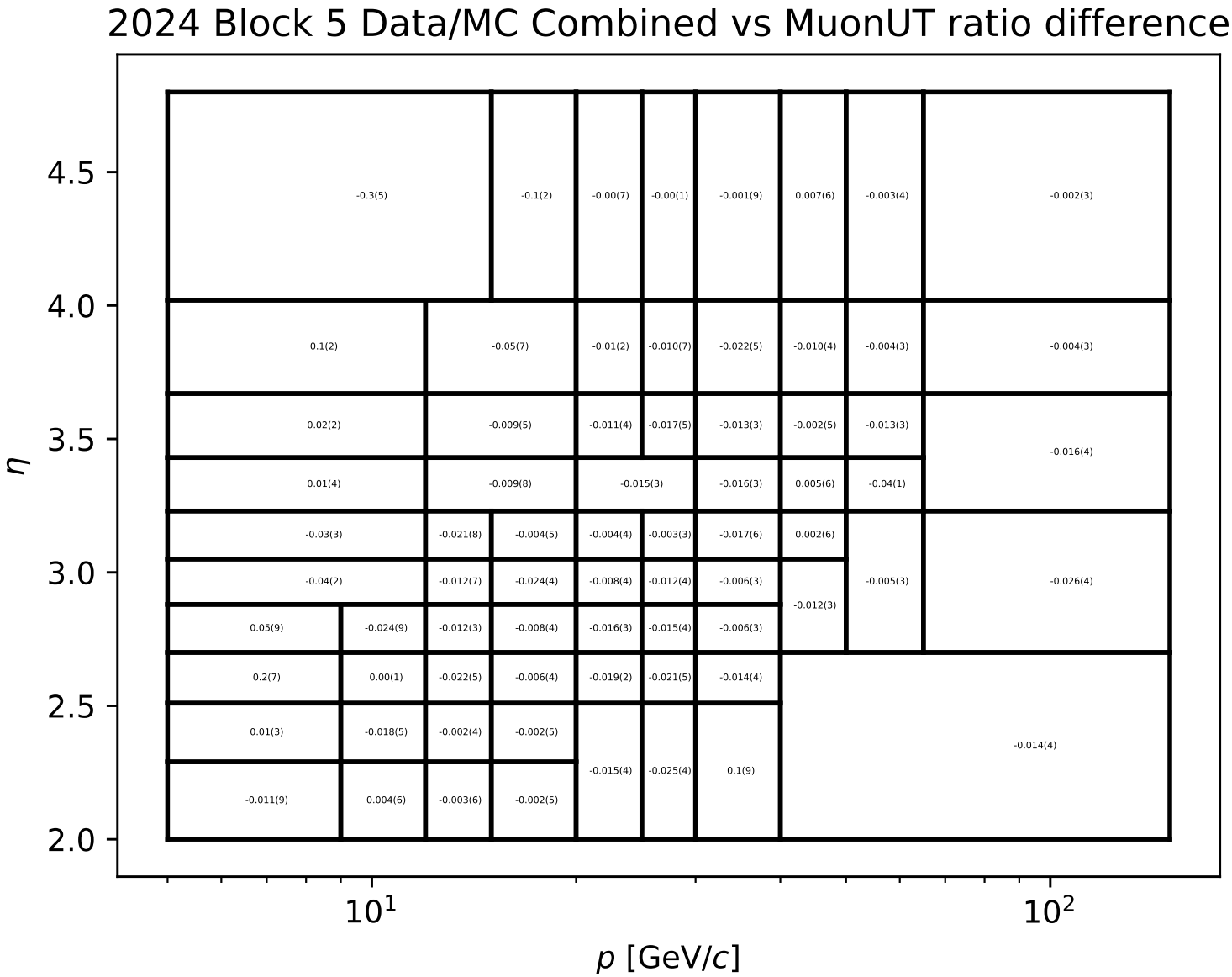
2D binning


2024 Block 5 MC tracking efficiencies
0.94(5)
0.6(3)
0.934(9)
0.87(4)
0.977(5)
0.96(1)
0.968(3)
0.986(4)
0.974(2)
0.964(4)
0.967(2)
0.975(3)
0.968(2)
0.979(2)
0.962(1)
0.969(2)
0.93(1)
1.00(7)
0.981(3)
0.96(2)
0.982(2)
0.984(5)
0.982(2)
0.996(2)
0.977(1)
0.994(2)
0.979(1)
0.991(3)
0.977(1)
0.993(2)
0.975(2)
0.994(1)
0.970(4)
0.996(3)
0.987(1)
0.996(2)
0.982(2)
0.998(1)
0.979(2)
0.984(4)
0.982(1)
0.994(2)
0.981(1)
0.991(3)
0.980(1)
0.995(2)
0.976(2)
0.991(3)
0.977(3)
0.991(9)
0.986(1)
0.994(2)
0.987(1)
0.991(2)
0.980(1)
0.996(2)
0.979(1)
0.9968(7)
0.982(2)
0.966(8)
0.977(3)
0.975(8)
0.979(2)
0.990(3)
0.975(2)
0.987(3)
0.973(2)
0.994(2)
0.985(1)
0.993(1)
0.984(1)
0.992(5)
0.978(2)
0.988(4)
0.976(2)
0.987(6)
0.975(2)
0.981(4)
0.982(2)
0.986(3)
0.987(1)
0.996(2)
0.981(2)
0.986(3)
0.985(2)
0.995(2)
0.979(1)
0.990(3)
0.978(1)
0.989(3)
0.986(3)
0.992(3)
0.976(2)
0.96(2)
0.983(2)
0.986(4)
0.978(2)
0.995(2)
0.980(1)
0.989(3)
0.986(1)
0.988(3)
0.982(2)
0.985(3)
0.982(1)
0.993(2)
0.983(2)
0.98(1)
0.981(2)
0.976(4)
0.978(2)
0.982(3)
0.982(2)
0.986(3)
0.983(2)
0.9983(9)
0.984(3)
0.985(4)
0.982(2)
0.984(3)
0.969(2)
0.948(6)
0.979(2)
0.970(4)
0.980(2)
0.986(3)
0.984(2)
0.976(4)
0.980(2)
0.986(3)
0.936(2)
0.962(6)
0.960(2)
0.968(5)
0.961(2)
0.966(5)
0.971(2)
0.979(4)
0.980(1)
0.981(3)
0.982(1)
0.984(4)
0.9(7)
0.970(5)
4.5
4.0
3.5
3.0
2.5
2.0
η
10^1
10^2
p [GeV/c]

2D binning


2024 Block 5 Data/MC tracking efficiency ratios
0.75(8)
1.0(5)
0.85(3)
1.0(2)
0.98(1)
0.98(7)
1.003(5)
1.01(1)
0.991(3)
0.992(9)
0.996(2)
0.989(5)
0.990(2)
0.993(3)
0.992(2)
0.994(2)
1.05(6)
1.0(2)
0.986(6)
1.04(7)
0.986(3)
1.00(2)
0.980(3)
0.990(6)
0.983(2)
1.005(4)
0.990(2)
1.000(4)
0.991(2)
0.995(2)
0.982(2)
0.986(3)
1.00(1)
0.98(1)
0.989(2)
0.998(4)
0.983(3)
0.994(3)
0.987(2)
1.004(5)
0.989(1)
1.002(3)
0.985(2)
0.987(4)
0.987(2)
1.000(3)
0.981(2)
0.997(4)
0.991(6)
0.98(4)
0.989(2)
0.998(7)
0.986(1)
1.001(3)
0.985(2)
1.001(2)
0.978(2)
0.972(6)
0.985(2)
1.03(1)
0.969(5)
0.99(3)
0.984(3)
1.005(8)
0.983(2)
0.987(5)
0.984(2)
0.987(3)
0.987(2)
0.990(3)
0.984(1)
1.001(5)
0.981(3)
0.979(6)
0.968(3)
1.01(2)
0.989(2)
1.000(7)
0.974(2)
0.998(4)
0.981(2)
0.988(3)
0.977(2)
0.990(4)
0.983(2)
0.990(2)
0.984(2)
0.995(3)
0.988(2)
0.993(3)
0.982(3)
1.008(3)
0.976(4)
0.93(9)
0.977(2)
1.001(8)
0.988(2)
1.000(2)
0.981(2)
0.989(3)
0.981(2)
0.997(3)
0.984(2)
0.999(3)
0.989(2)
0.994(2)
0.967(3)
0.8(7)
0.985(2)
0.98(1)
0.979(2)
1.001(4)
0.979(2)
0.985(4)
0.982(2)
1.000(1)
0.977(3)
0.998(4)
0.984(2)
0.997(4)
0.980(2)
0.97(3)
0.978(2)
0.997(5)
0.973(2)
0.975(4)
0.977(2)
0.979(5)
0.981(3)
0.995(4)
0.959(2)
0.970(9)
0.961(2)
0.957(6)
0.955(2)
0.958(6)
0.961(2)
0.963(5)
0.972(1)
0.987(4)
0.979(2)
1.003(4)
1.1(9)
0.992(5)
η
4.5
4.0
3.5
3.0
2.5
2.0
10^1
10^2
p [GeV/c]

2D binning


2024 Block 5 Data/MC Combined vs MuonUT ratio difference
-0.3(5)
-0.1(2)
-0.00(7)
-0.00(1)
-0.001(9)
0.007(6)
-0.003(4)
-0.002(3)
0.1(2)
-0.05(7)
-0.01(2)
-0.010(7)
-0.022(5)
-0.010(4)
-0.004(3)
-0.004(3)
0.02(2)
-0.009(5)
-0.011(4)
-0.017(5)
-0.013(3)
-0.002(5)
-0.013(3)
-0.016(4)
0.01(4)
-0.009(8)
-0.015(3)
-0.016(3)
0.005(6)
-0.04(1)
-0.03(3)
-0.021(8)
-0.004(5)
-0.004(4)
-0.003(3)
-0.017(6)
0.002(6)
-0.04(2)
-0.012(7)
-0.024(4)
-0.008(4)
-0.012(4)
-0.006(3)
-0.012(3)
-0.005(3)
-0.026(4)
0.05(9)
-0.024(9)
-0.012(3)
-0.008(4)
-0.016(3)
-0.015(4)
-0.006(3)
0.2(7)
0.00(1)
-0.022(5)
-0.006(4)
-0.019(2)
-0.021(5)
-0.014(4)
0.01(3)
-0.018(5)
-0.002(4)
-0.002(5)
-0.014(4)
-0.011(9)
0.004(6)
-0.003(6)
-0.002(5)
-0.015(4)
-0.025(4)
0.1(9)
4.5
4.0
3.5
3.0
2.5
2.0
η
10^1
10^2
p [GeV/c]

Combined vs MuonUT systematic

Combined vs MuonUT systematic strategy? My five cents:

- Clearly depends on kinematics, so we should use 2D binning
- It's a method systematic, so should not depend on dataset
  1. Determine ratio difference for all data sets in each bin
  2. Combine all data sets
  3. For bins with a discrepancy above a threshold (maybe 3σ from zero), assign the difference from zero as a systematic
  4. Systematic will most likely be small in most bins, but a small number of bins might have a 1%–2% systematic
- Could potentially leave out Block 2 and 1 from combination, as the MuonUT method is biased and the discrepancy seems larger in these blocks

Other news

Resprucing of 2024 blocks 7 and 8 running now!

- First validation had a bug in the merging
  - Tupling worked fine, but rerunning reconstruction didn't work
  - Many thanks to Nicole for debugging this!
- Second validation showed no issues
- I need to submit an AP to look at this data soon

Summary and next steps

1. I think we can release a preliminary set of tracking efficiencies to the collaboration
   - 2024 blocks 2, 1 (maybe 1a and 1b), 5, 6, 7, 8
   - 2024 *pp* ref
   - 2025 pre-TS
   - 2025 post-TS with pre-TS MC?
2. Next steps:
   - Show the current results to WP4
   - If no issues are raised, request larger MC samples with PPG permission
   - Reweight `nFTClusters` using work by Maurice
   - Systematics?