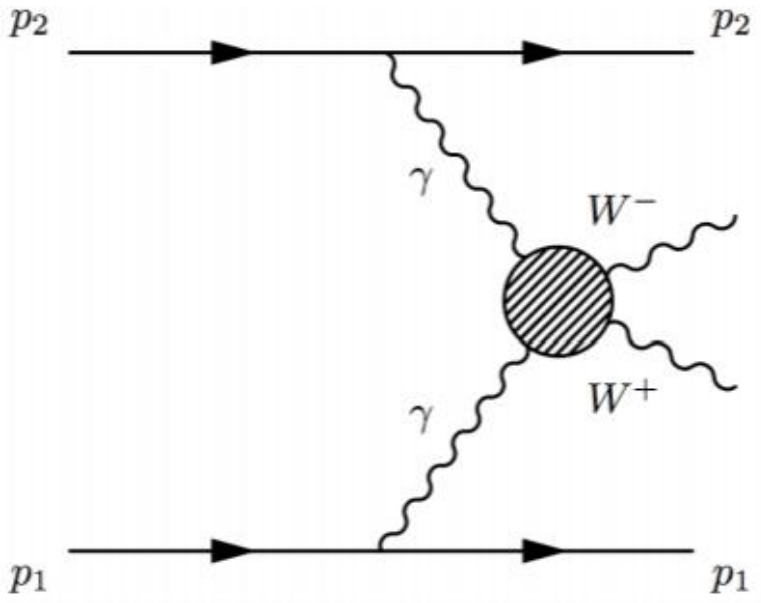
Exclusive WW

- Study is to simulate the effectiveness of track algorithm on signal/background discrimination
- Constrain SM and BSM



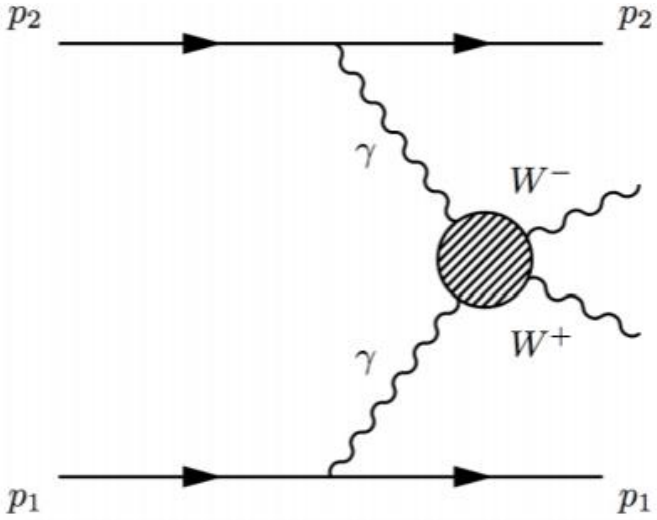
Robert Garbutt, Simone Pagan-Griso, Aleksandra Dimitrievska,

Patrick McCormack

Exclusive WW

$\gamma\gamma \rightarrow W^+W^- \rightarrow \mu^{\mp}\, \nu_\mu\, e^{\pm}\nu_e$

No additional track production

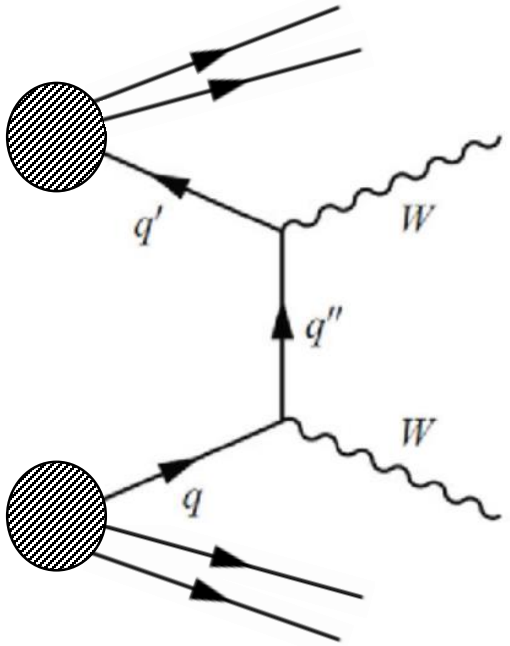


Inclusive WW

Same final state, but produces tracks

1,000 times more likely than ExclWW

Primary e/μ background

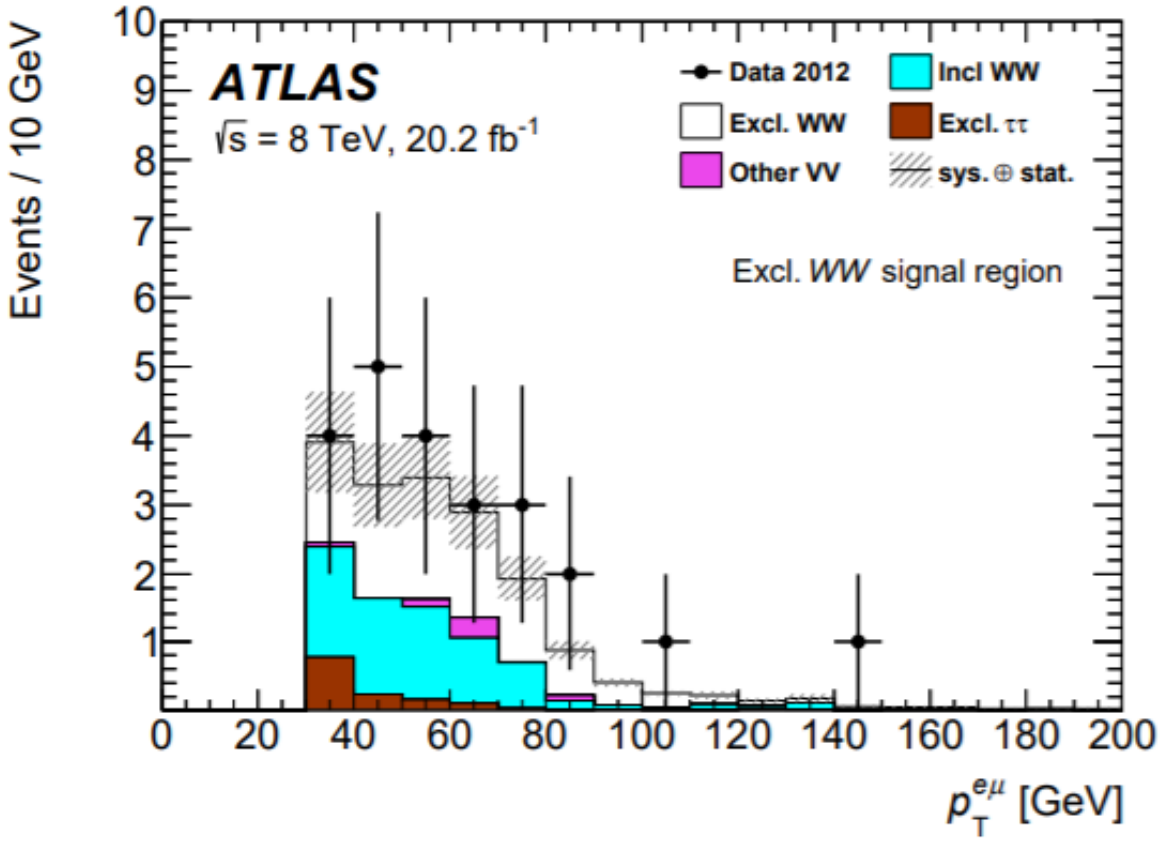


Previous results

- e/μ only
- Min Track p_T of 400 MeV
- N_{data} = 23
- N_{Signal} = 9.3±1.2, $N_{Background}$ = 8.3±2.6
- Predicted S/B = 1.2 ± 0.4

$$\sigma(\gamma\gamma \to W^+W^- \to \mu^{\mp}\, e^{\pm}) = 6.9 \pm 2.2(\text{stat.}) \pm 1.4(\text{sys.})\text{fb}$$

Trigger	Lepton p_T criteria [GeV]
Single electron	$p_T^e > 24$
Single muon	$p_T^\mu > 24$
Symmetric dielectron	$p_T^{e_1} > 12,\ p_T^{e_2} > 12$
Asymmetric dimuon	$p_T^{\mu_1} > 18,\ p_T^{\mu_2} > 8$
Electron-muon	$p_T^e > 12,\ p_T^\mu > 8$



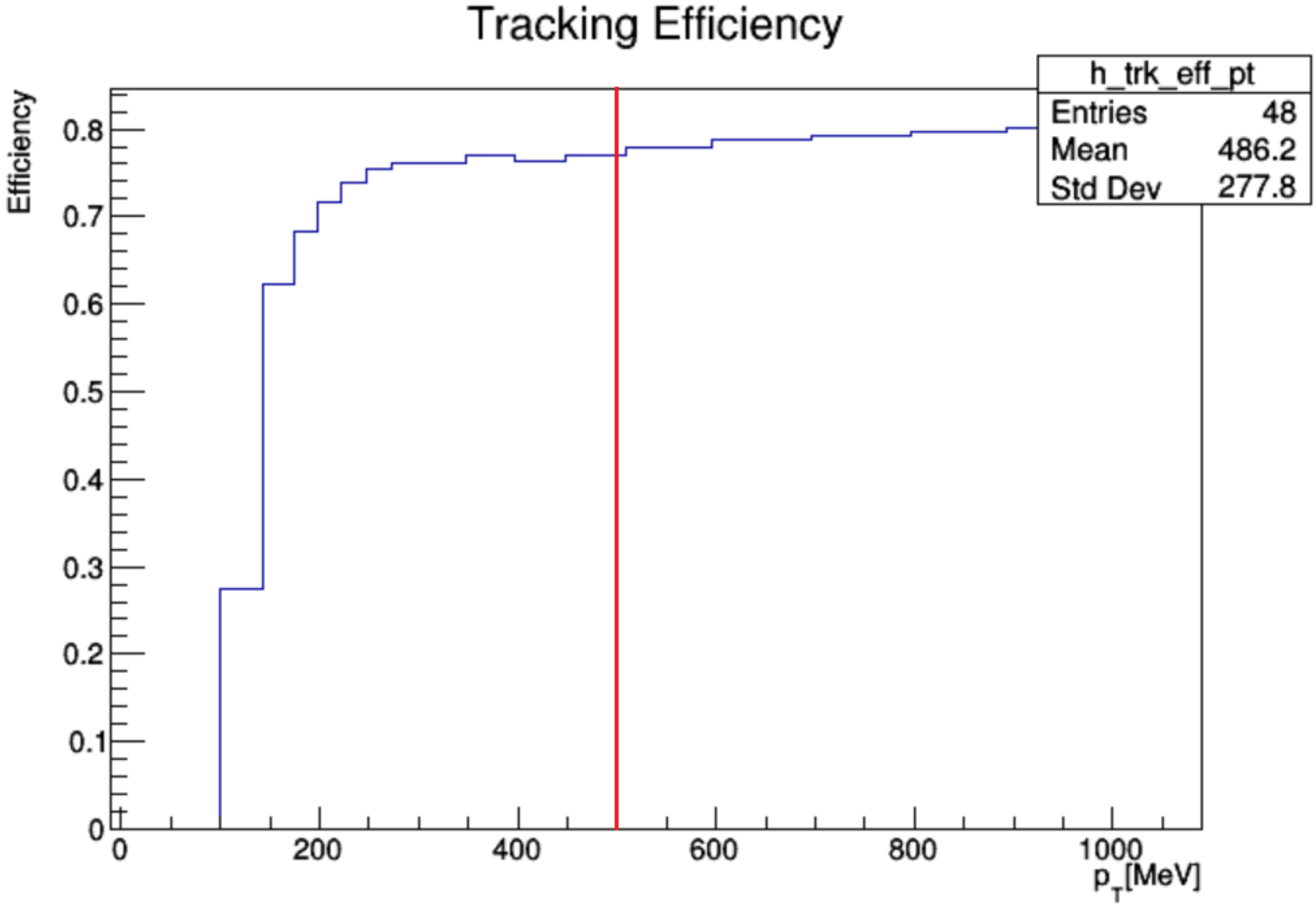
Purpose

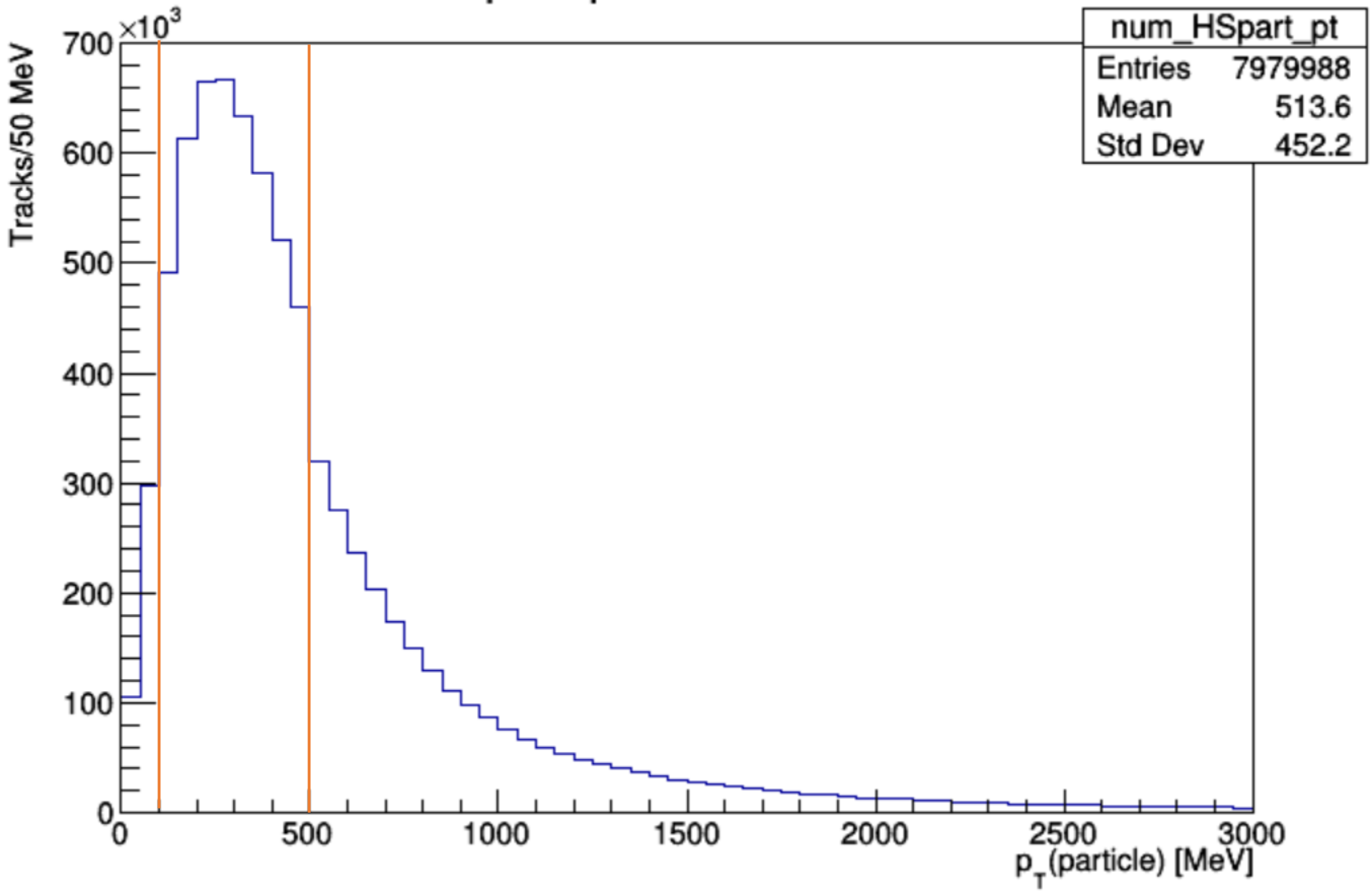
- Explore the effects of reducing the minimum track p_T threshold on the ratio of signal to background
- Investigate if we can successfully increase the total number of detected events by opening up μμ/ee analysis.

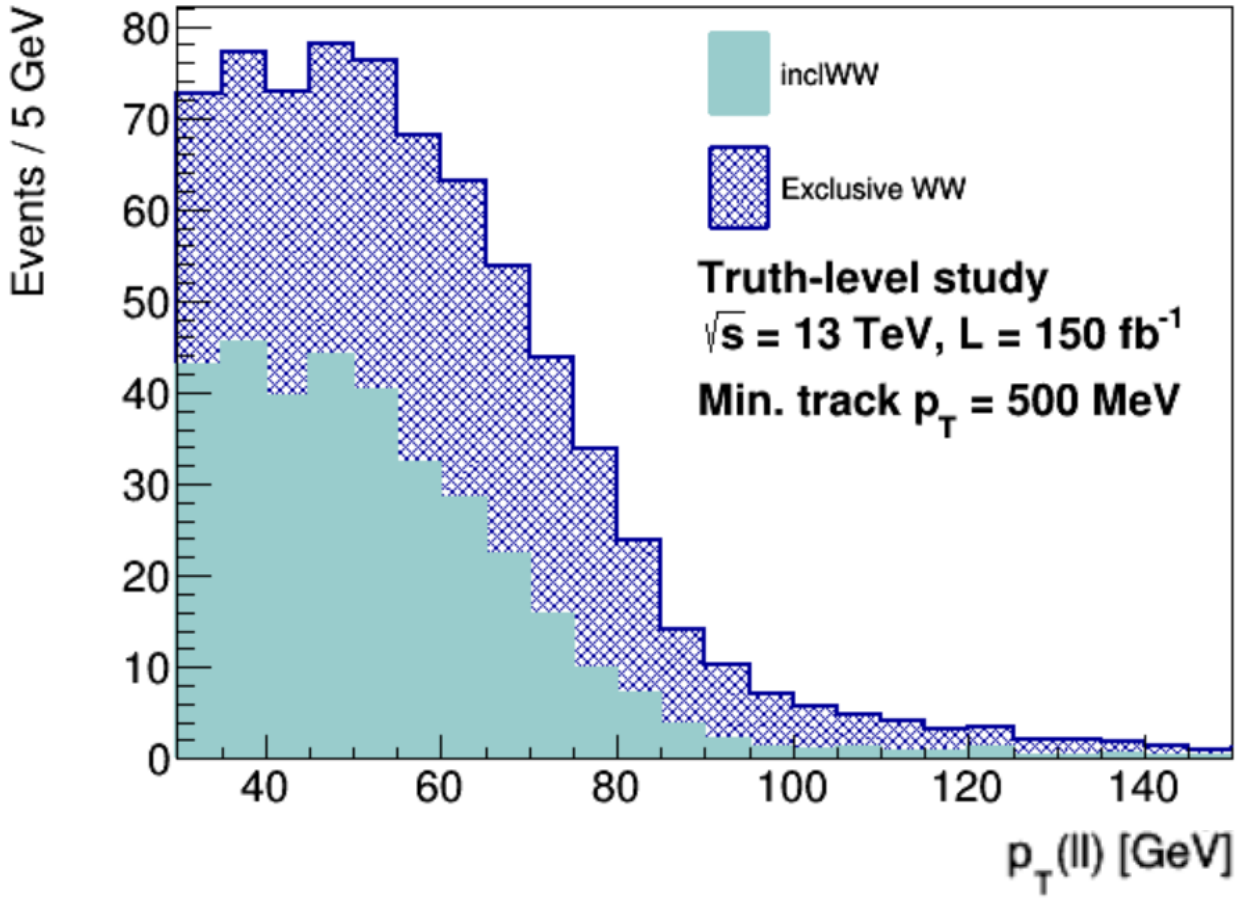
Assumptions/Exclusivity

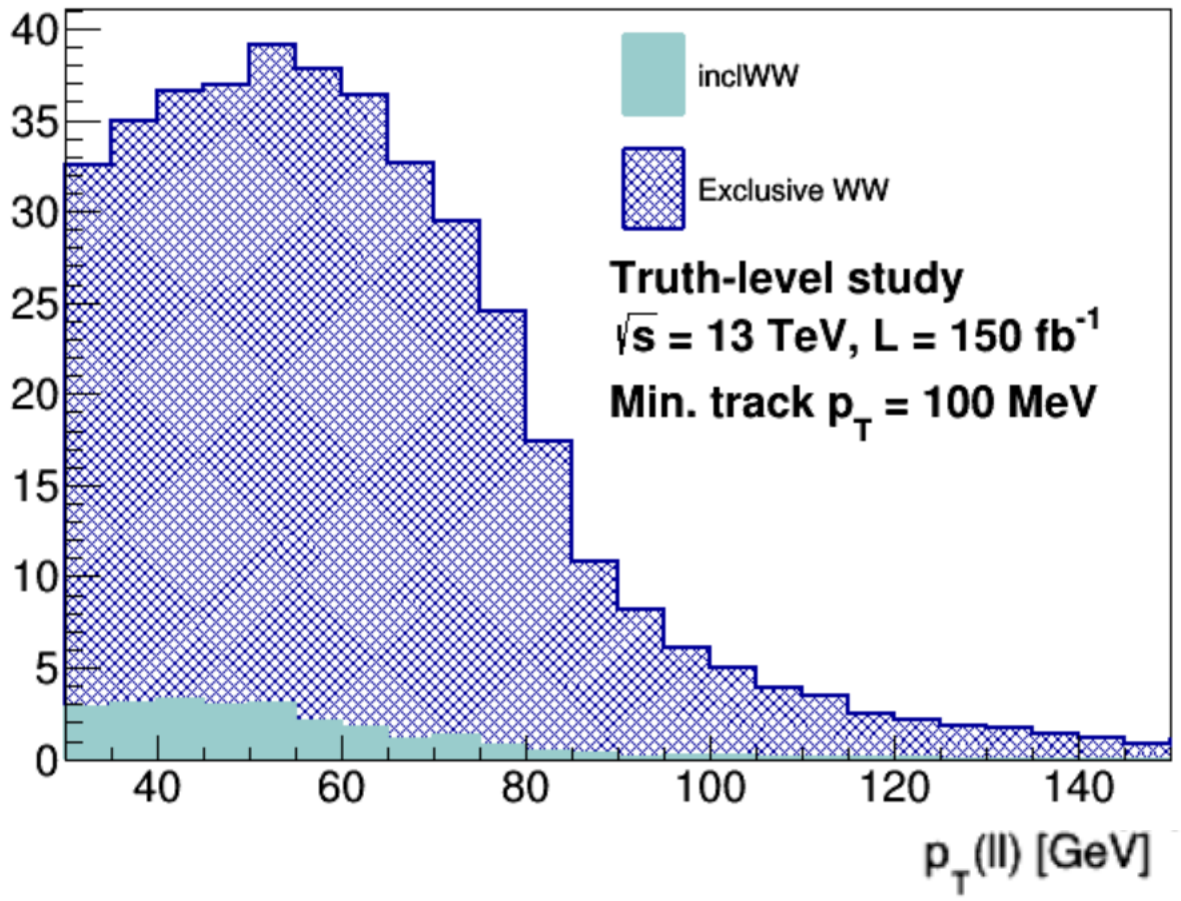
- Fast simulation to predict expected signal and background events in full run 2 dataset
- $\sqrt{s}$ =13 TeV, L = 150 fb^{-1}
- Track reconstruction efficiency
- Do not consider fakes or pileup so far

Trigger	Criteria
lepton 1 pT	> 25 GeV
lepton 2 pT	> 20 GeV
Lepton 1&2 η	< 2.5
p_T(ll)	> 30 GeV
m(ll)	> 20 GeV
Track η	< 2.5
Signal requires no tracks	


Tracking Efficiency
h_trk_eff_pt
Entries 48
Mean 486.2
Std Dev 277.8
Efficiency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
200
400
600
800
1000
p_T [MeV]

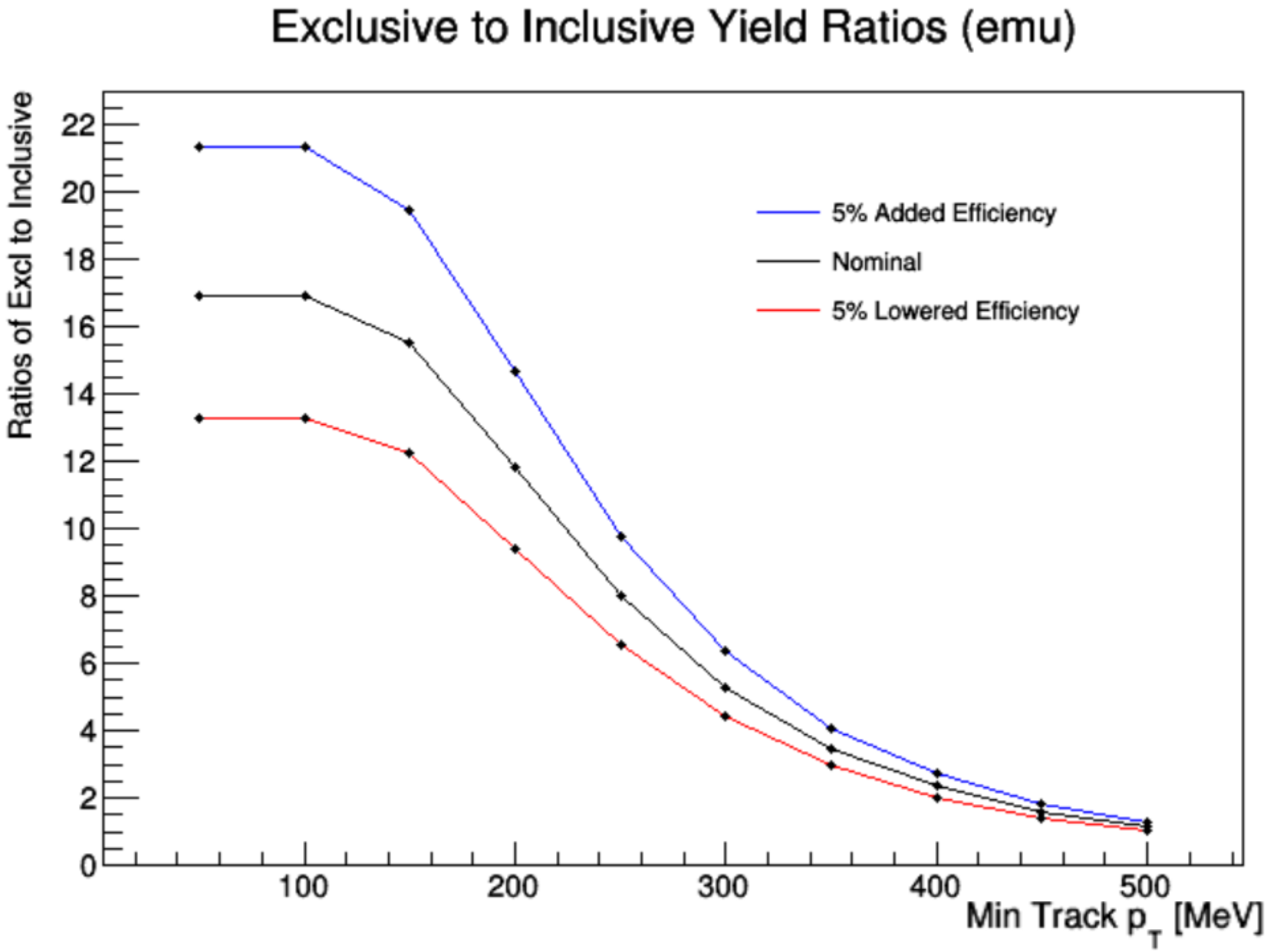

Num. non-lepton particles from Hard Scatter
num_HSpart_pt
Entries 7979988
Mean 513.6
Std Dev 452.2
Tracks/50 MeV
×10^3
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
p_T(particle) [MeV]





	ExclWW	Background	Ratio
500 MeV Yield	393.85	342.37	1.15
100 MeV Yield	393.85	23.25	16.94

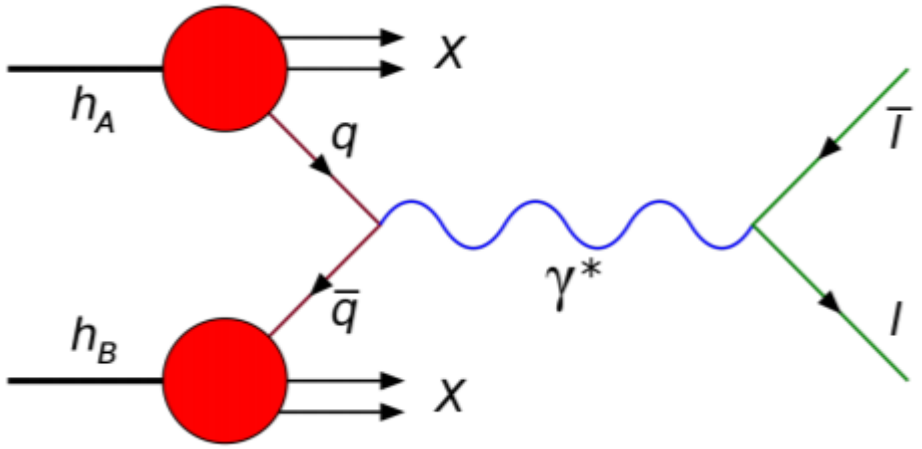
S/B: 1.15 -> 16.94

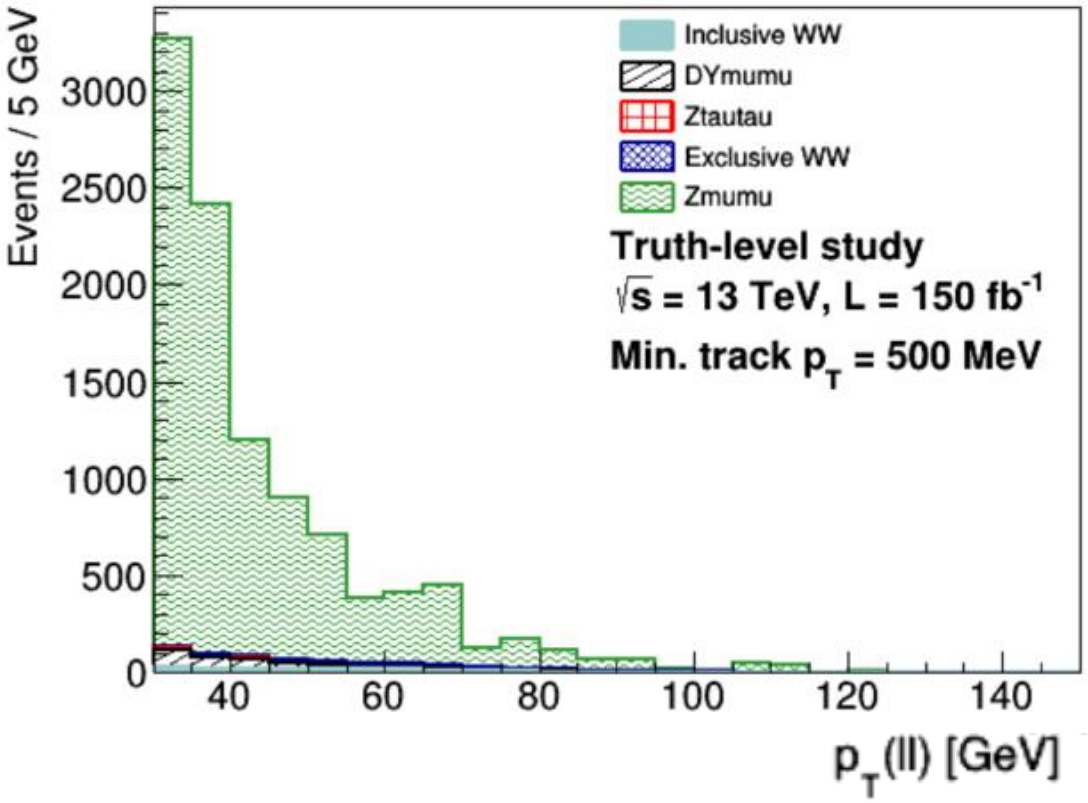

Exclusive to Inclusive Yield Ratios (emu)
Ratios of Excl to Inclusive
0
2
4
6
8
10
12
14
16
18
20
22
100
200
300
400
500
Min Track p_T [MeV]
5% Added Efficiency
Nominal
5% Lowered Efficiency

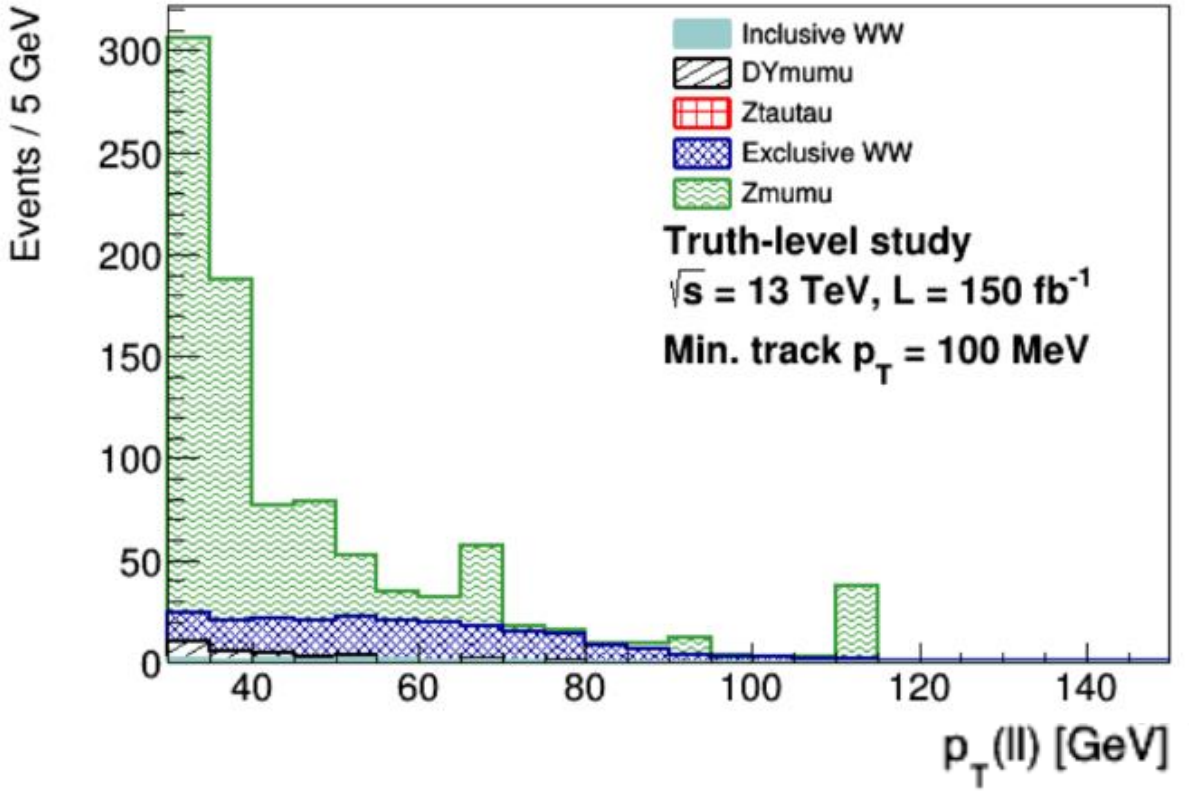
- Success of e/ μ analysis suggests investigating same flavor.
- Background now includes both the Drell-Yan process and Inclusive WW

Drell-Yan

- Produces $l\bar{l}$ pairs without neutrinos
- Produces tracks
- Primary same flavor background

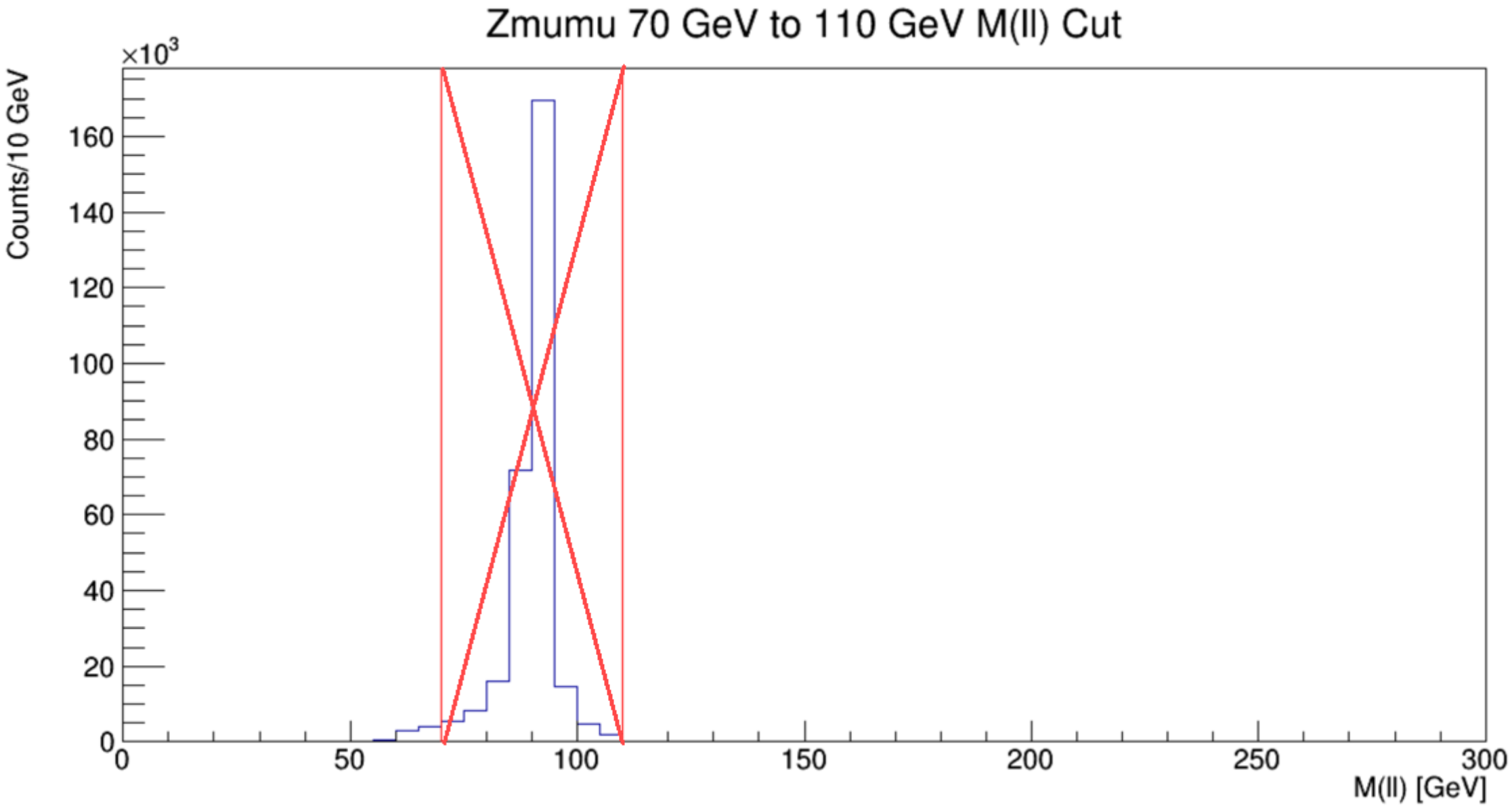


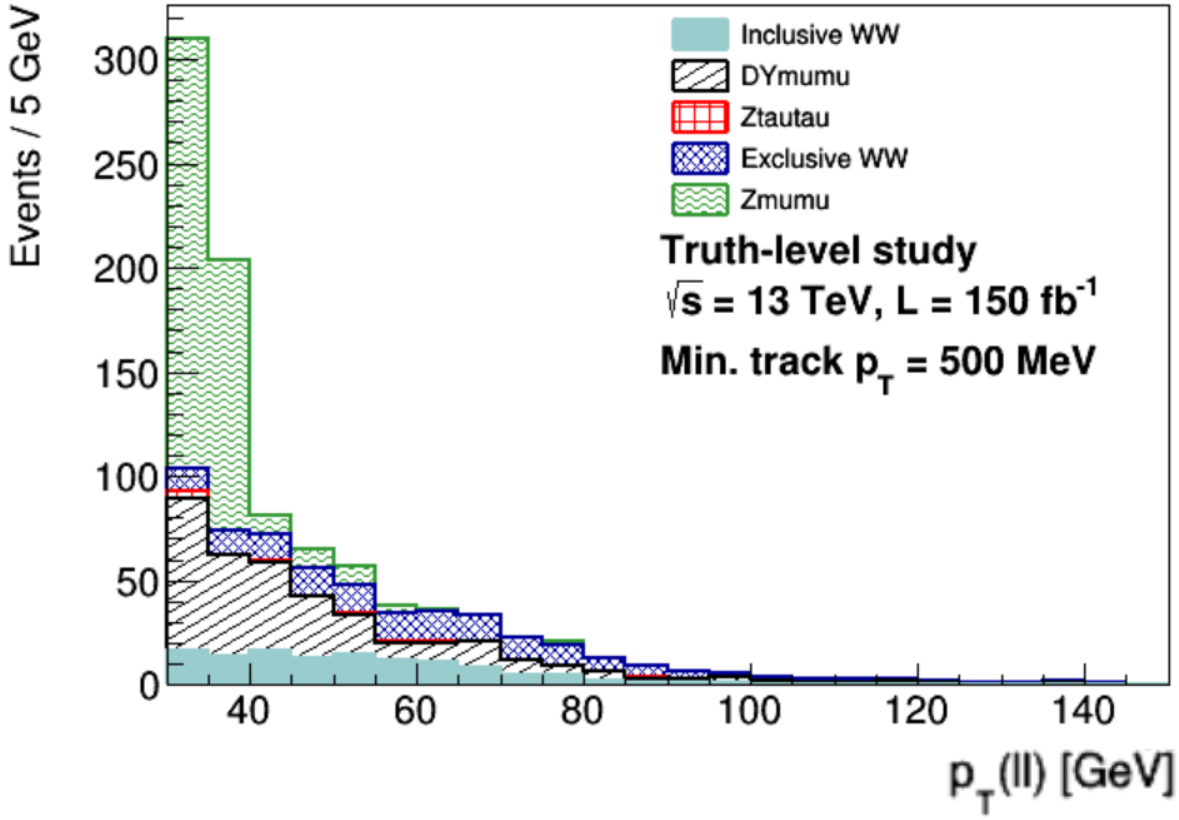


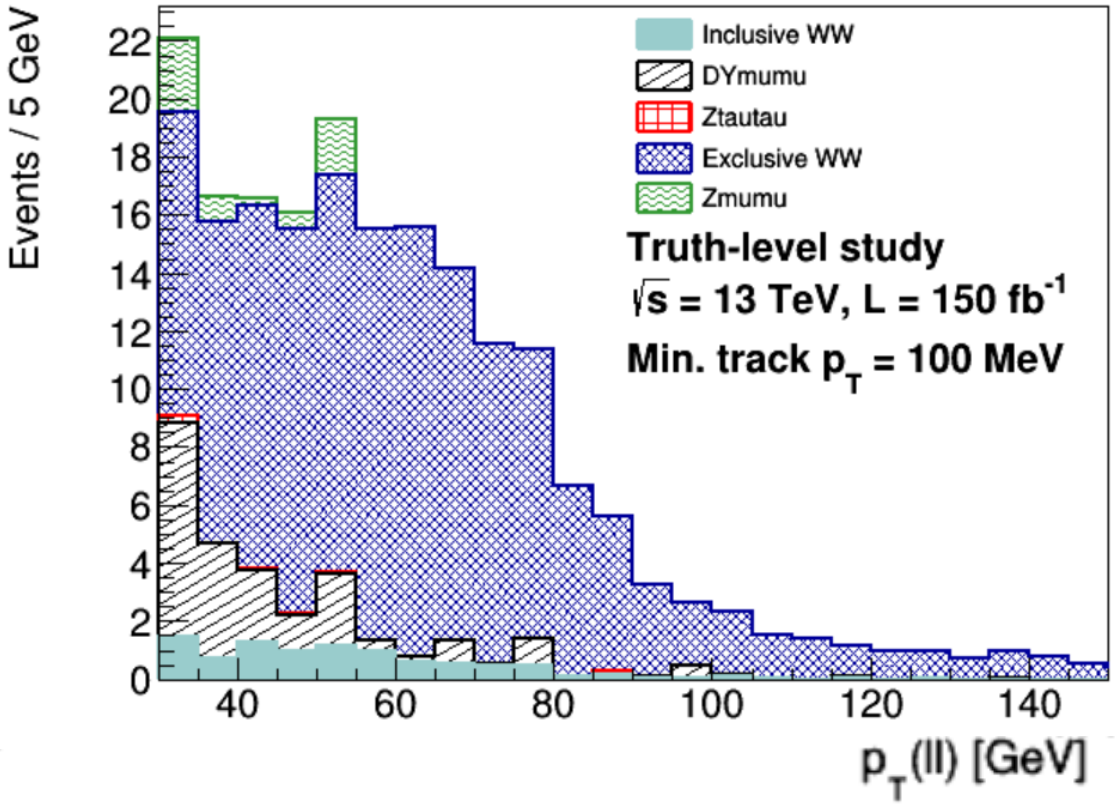


	ExclWW	Background	Ratio
500 MeV Yield	203.4	10267.3	0.0198
100 MeV Yield	203.4	746.2	0.272

S/B: 0.0198 -> 0.272

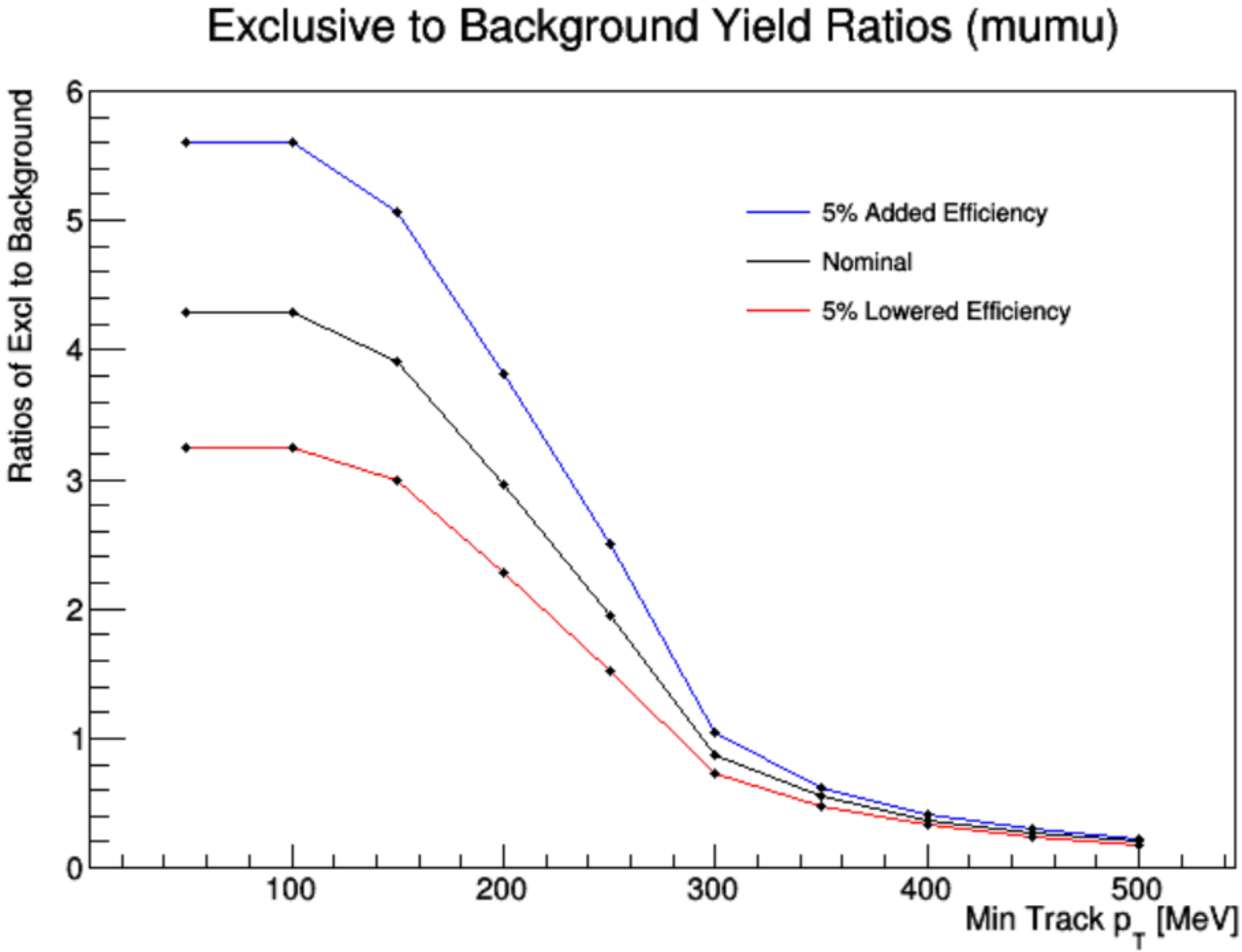

Zmumu 70 GeV to 110 GeV M(ll) Cut
×10^3
Counts/10 GeV
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
M(ll) [GeV]





	ExclWW	Background	Ratio
500 MeV Yield	156.4	771.89	0.203
100 MeV Yield	156.4	36.41	4.294

S/B: 0.203 -> 4.294


Exclusive to Background Yield Ratios (mumu)
Ratios of Excl to Background
0
1
2
3
4
5
6
100
200
300
400
500
Min Track p_T [MeV]
5% Added Efficiency
Nominal
5% Lowered Efficiency

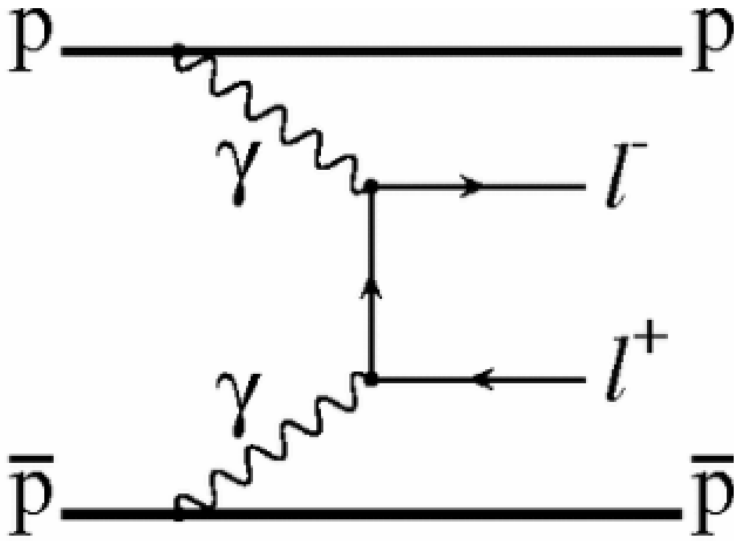
Conclusion

- Reduction in the track min p_T to 100 MeV results in a nominal ratio of signal to background of 17 for e/mu.
- The predicted signal to background ratio of 4 for the same flavor case confirms the viability of using same flavor final states.
- Plan on application of pileup and fakes

Backup

Exclusive Di-lepton

- Initial energy of incoming protons too great to facilitate detection of mimicked signal.
- Initial incoming protons have zero transverse momentum
- Final state dileptons have pT below our cutoff threshold



Full Selection info

Different Flavor

	ExclWW	Background	Ratio
Yield	393.853	342.375	1.15036
Eff	28.57%	0.19%	
Eff-exclus	0.99	0.4236	23.6016

	ExclWW	Background	Ratio
Yield	393.853	23.2531	16.9376
Eff	28.57%	0.19%	
Eff-exclus	0.99767	0.00298	334.602

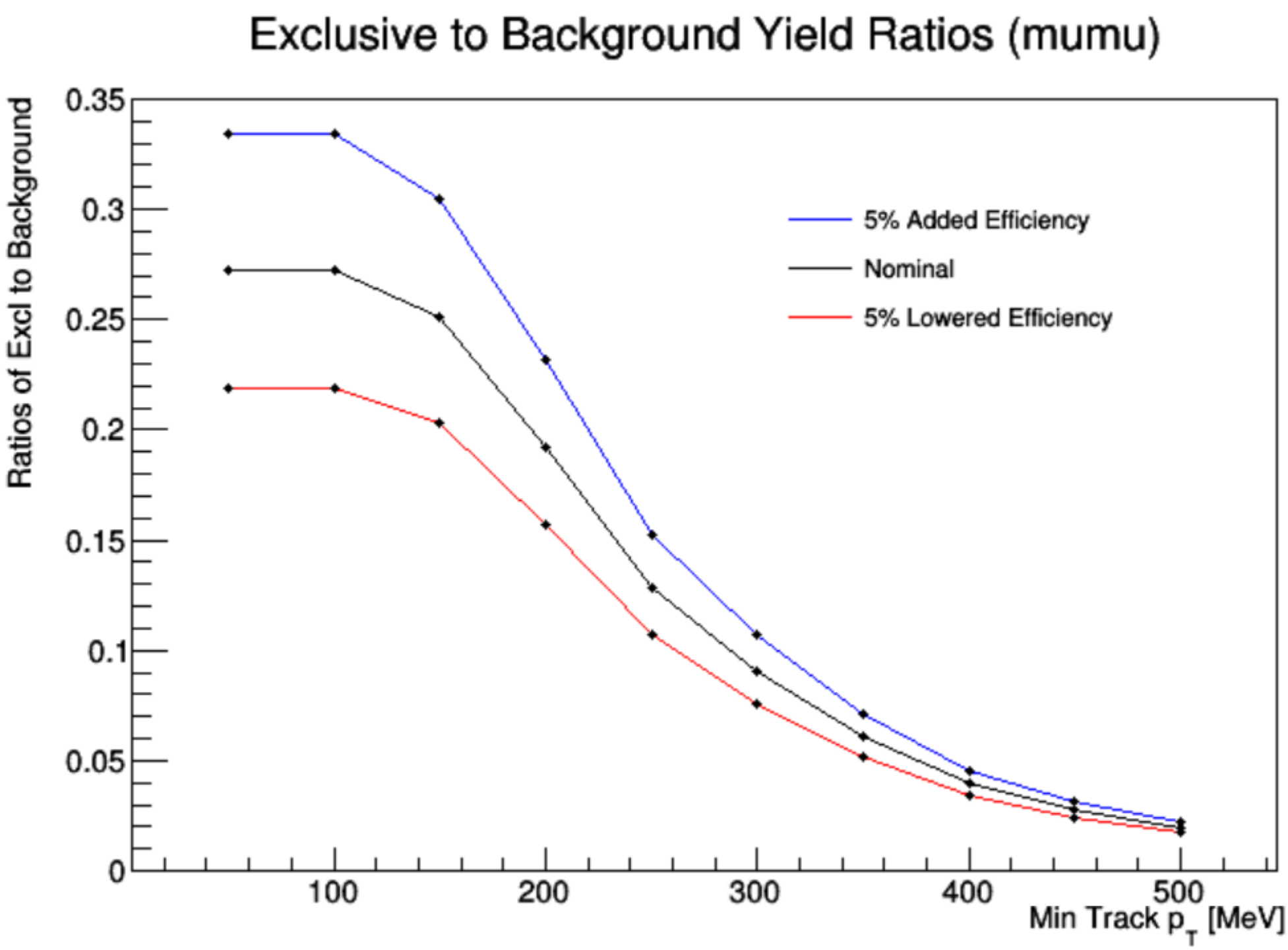
Same Flavor

	ExclWW	Background	Ratio
Yield	203.396	10267.3	0.0198
Eff	14.75%	6.62%	
Eff-exclus	1	0.096	10.4079

	ExclWW	Background	Ratio
Yield	203.396	746.23	0.272
Eff	14.75%	6.62%	
Eff-exclus	1	0.0072	138.744

	ExclWW	Background	Ratio
Yield	156.379	771.886	0.202593
Eff	11.34%	4.05%	
Eff-exclus	1	0.101899	9.81363

	ExclWW	Background	Ratio
Yield	156.379	36.414	4.29441
Eff	11.34%	4.05%	
Eff-exclus	1	0.0057	175.347


Exclusive to Background Yield Ratios (mumu)
Ratios of Excl to Background
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
100
200
300
400
500
Min Track p_T [MeV]
5% Added Efficiency
Nominal
5% Lowered Efficiency