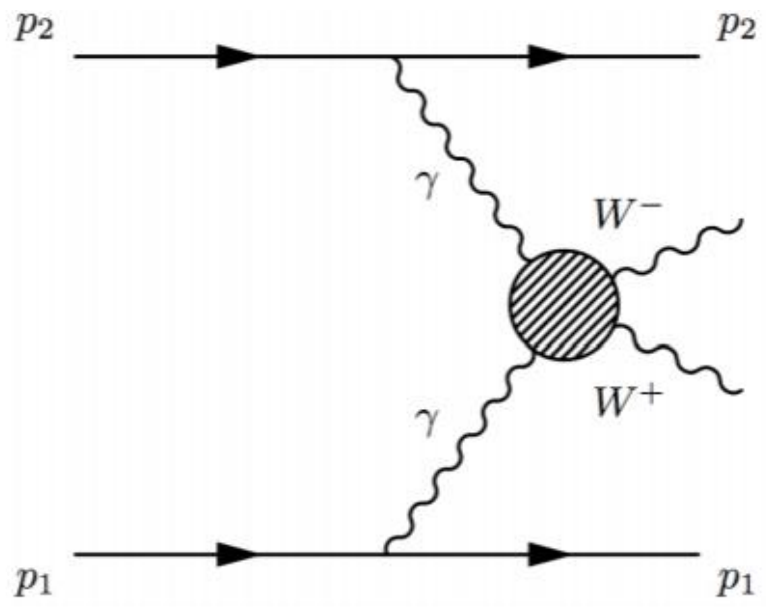
Exclusive WW

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



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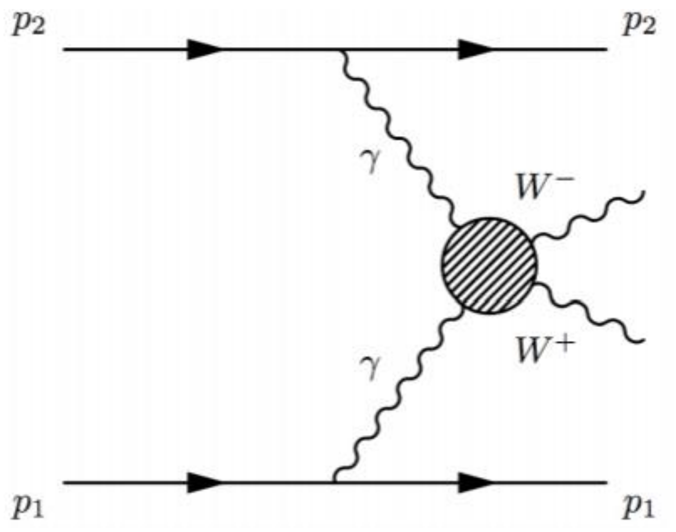
Patrick McCormack

Purpose

- Apply corrections to previous study in order to make predictions more realistic.
- Consider the effects of low pT tracking to determine the viability of same flavor analysis relative to the conventional opposite flavor.
- Previous presentation: https://indico.physics.lbl.gov/event/1141/contributions/4749/attachments/2189/2839/ExclusiveWW_1.pdf

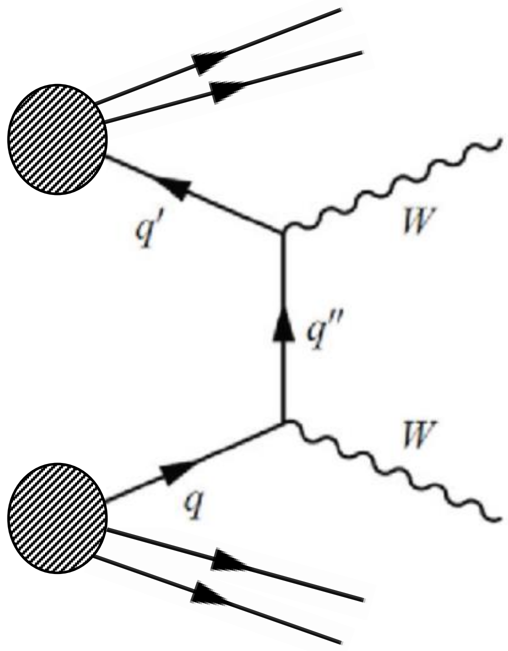
Exclusive WW



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

No HS track production

Inclusive WW



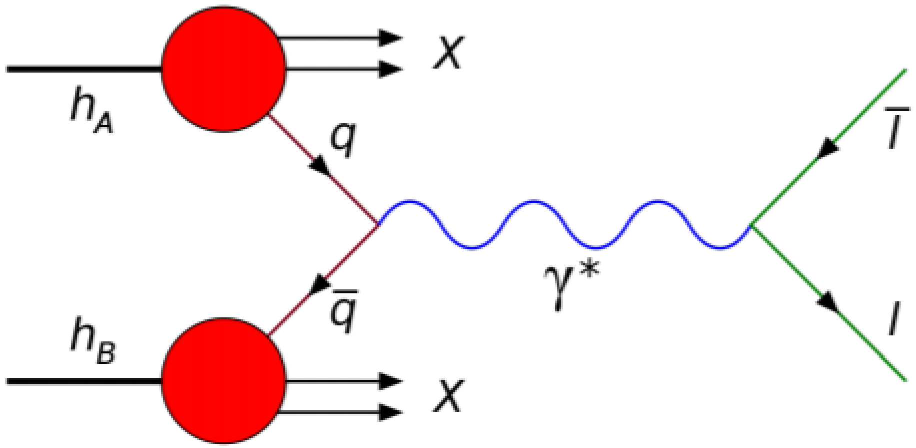
Same final state, but produces tracks

1,000 times more likely than ExclWW

Primary opposite flavor background

Drell-Yan

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



Assumptions/Selections

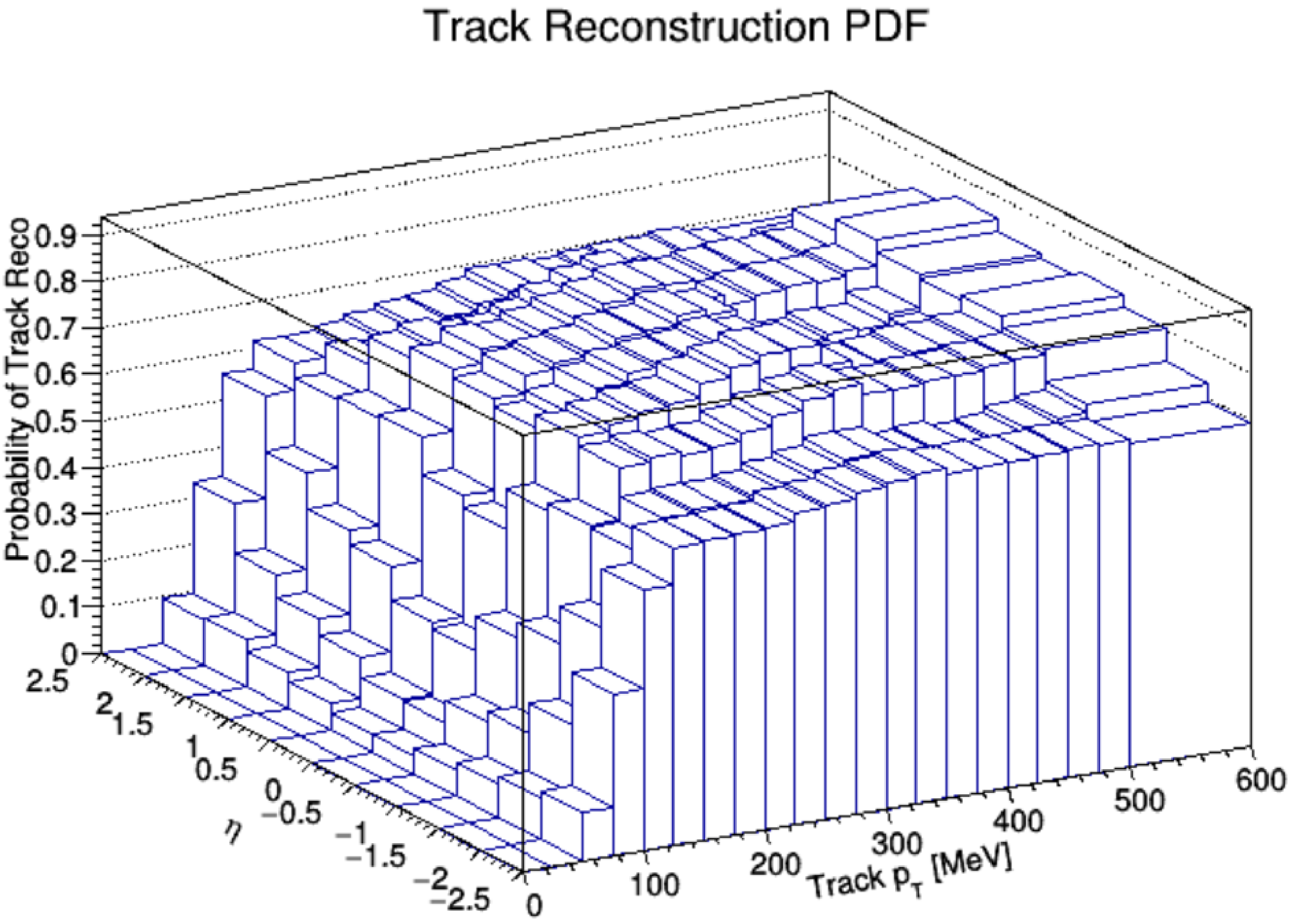
- $\sqrt{s}$ =13 TeV, L = 150 fb^{-1}
- Fast simulation to predict expected signal and background events in full run 2 dataset
- Perform 70 GeV < m(ll) < 110 GeV cut for same flavor due to Z-resonance.

Selections

Trigger	Criteria
lepton 1 pT	> 27 GeV
lepton 2 pT	> 20 GeV
Lepton's |η|	< 2.5
p_T(ll)	> 30 GeV
m(ll)	> 20 GeV
Track |η|	< 2.5
Signal requires 0 tracks	

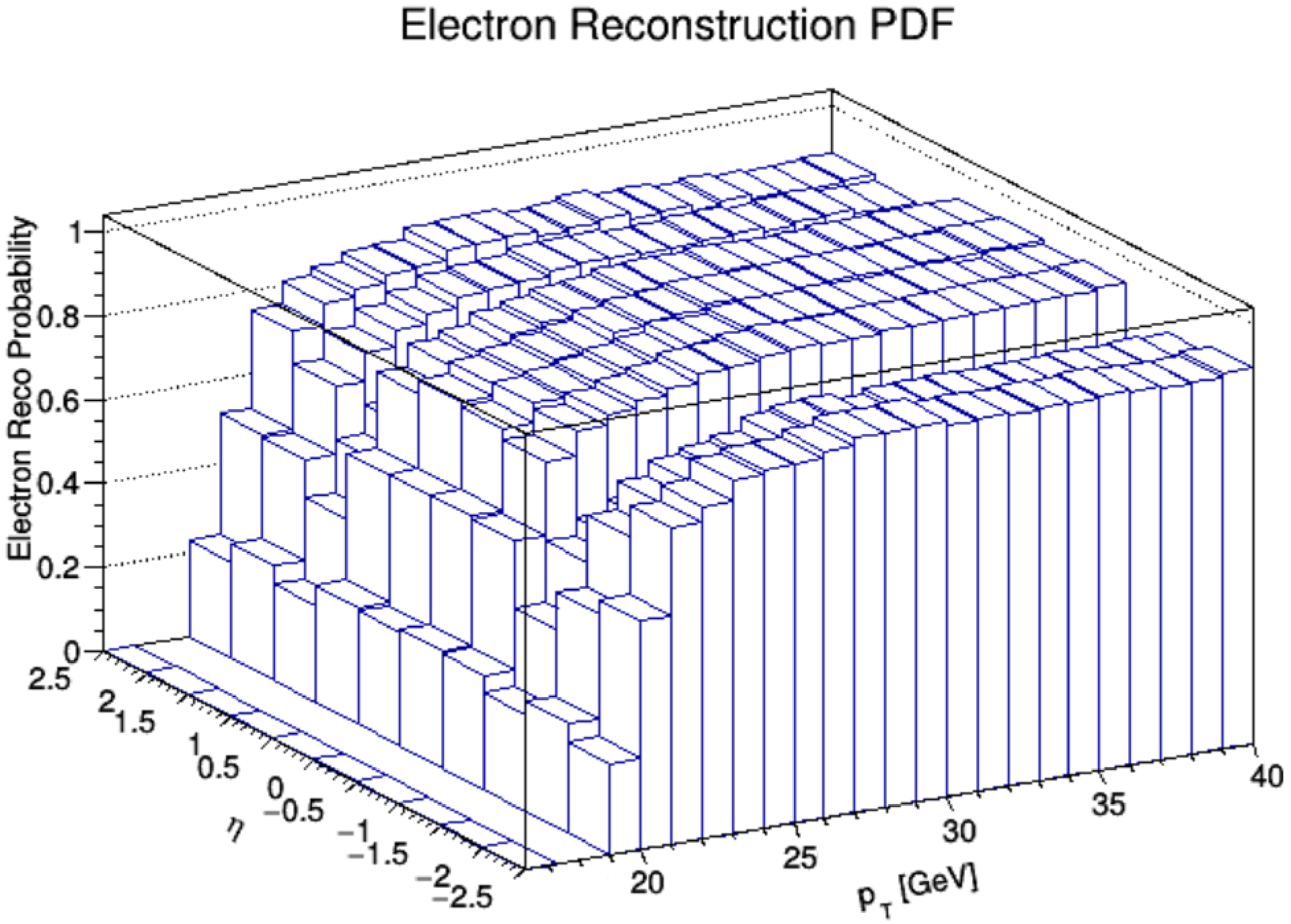
2D tracking efficiency

- Track reconstruction is dependent upon both the track pT and its pseudorapidity.
- Expect a minor and equivalent change in the expected yields for both signal and background



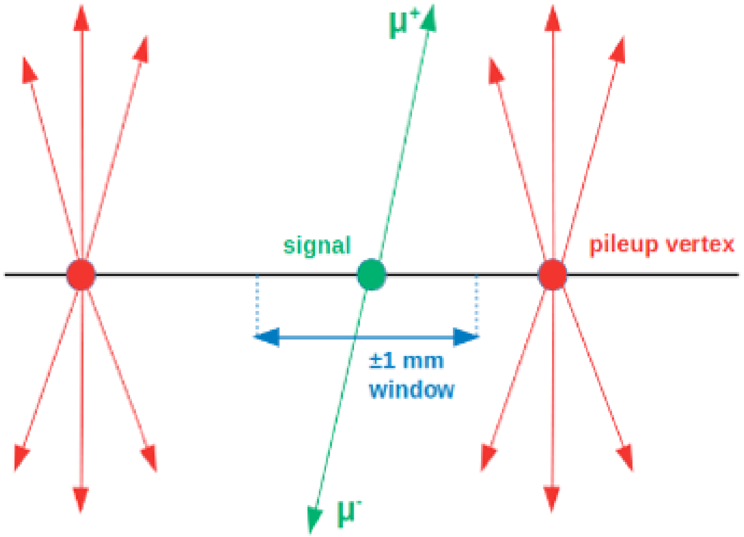
Lepton reconstruction

- Only some fraction of the final state leptons will be properly detected, which is dependent upon the flavor, pT, and pseudorapidity.
- Expect equivalent decrease in the yield of both signal and background

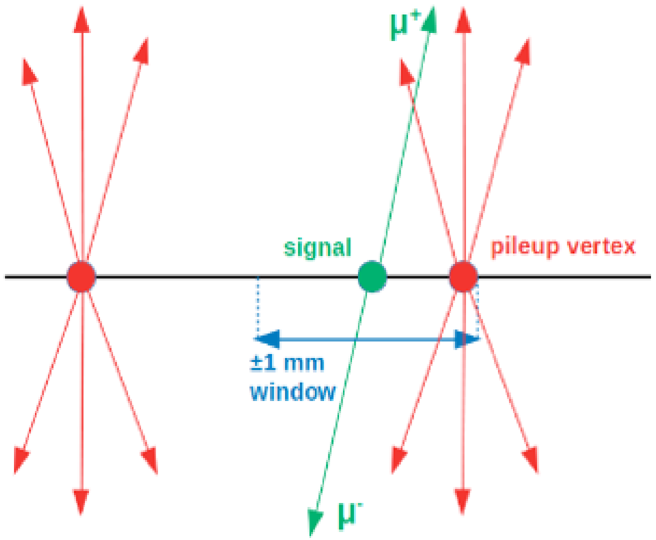


Pileup

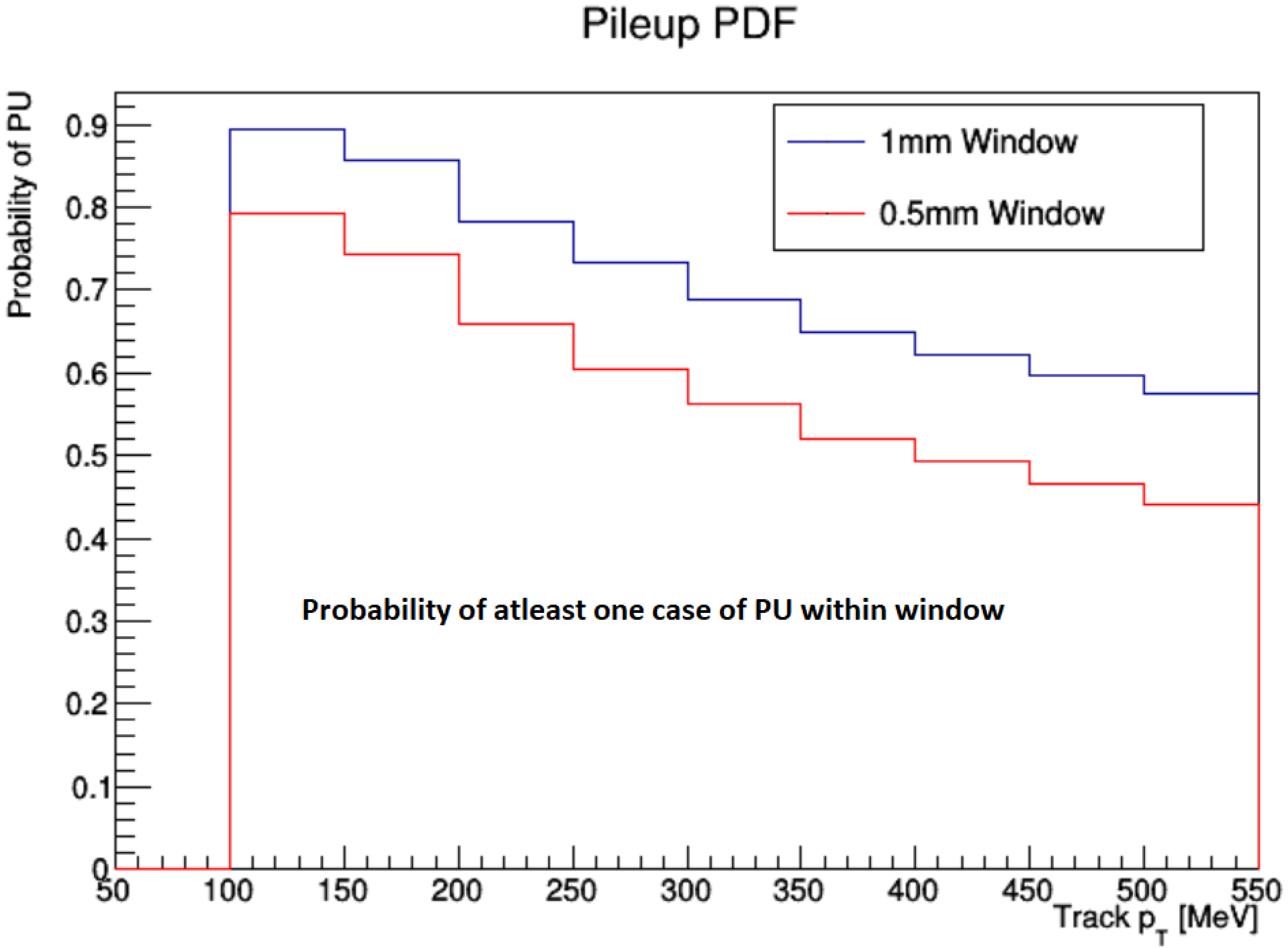
- Interaction simulations do not consider the presence of nearby events.
- Signal may be improperly associated with nearby background events.
- Can reduce the presence of pileup by considering longitudinal windows in the detector.
- Investigate 1mm and 0.5mm windows.



signal kept

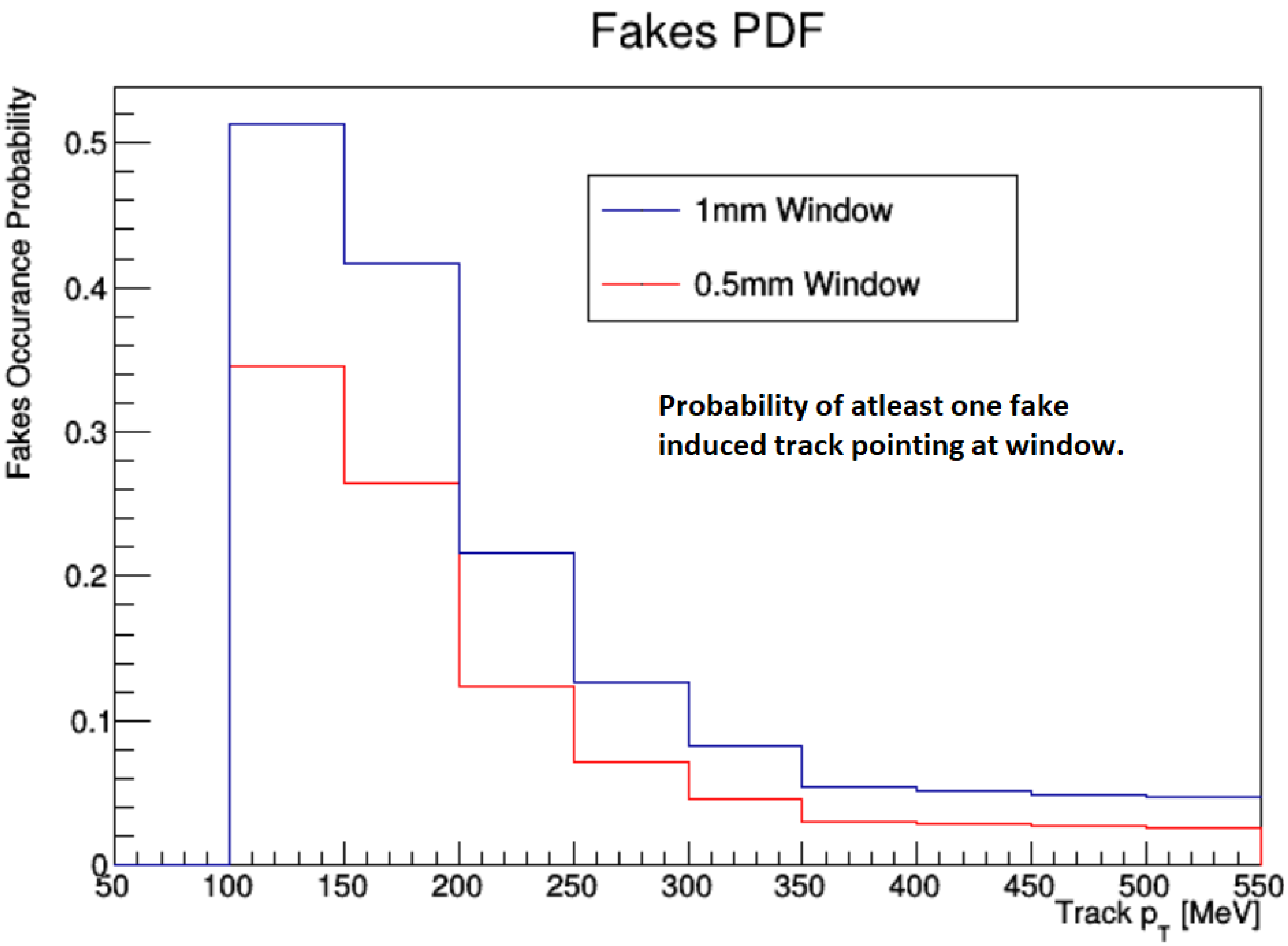


signal rejected


Pileup PDF
Probability of PU
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
50
100
150
200
250
300
350
400
450
500
550
Track p_T [MeV]
1mm Window
0.5mm Window
Probability of atleast one case of PU within window

Fakes

- When track reconstruction occurs, some detector hits are incorrectly associated with nearby hits from separate particles.
- Lower min track pT increases the likelihood of fakes.

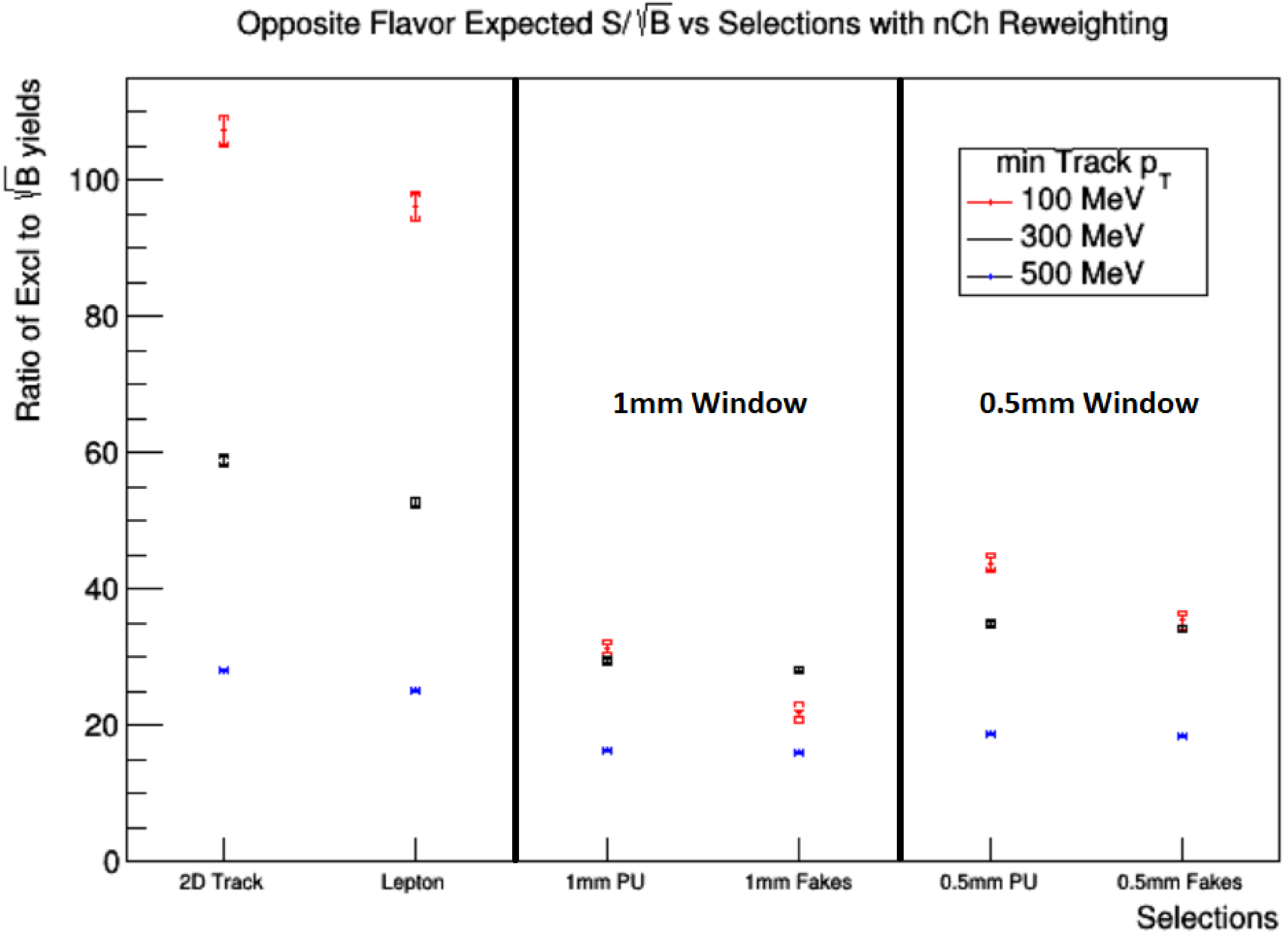


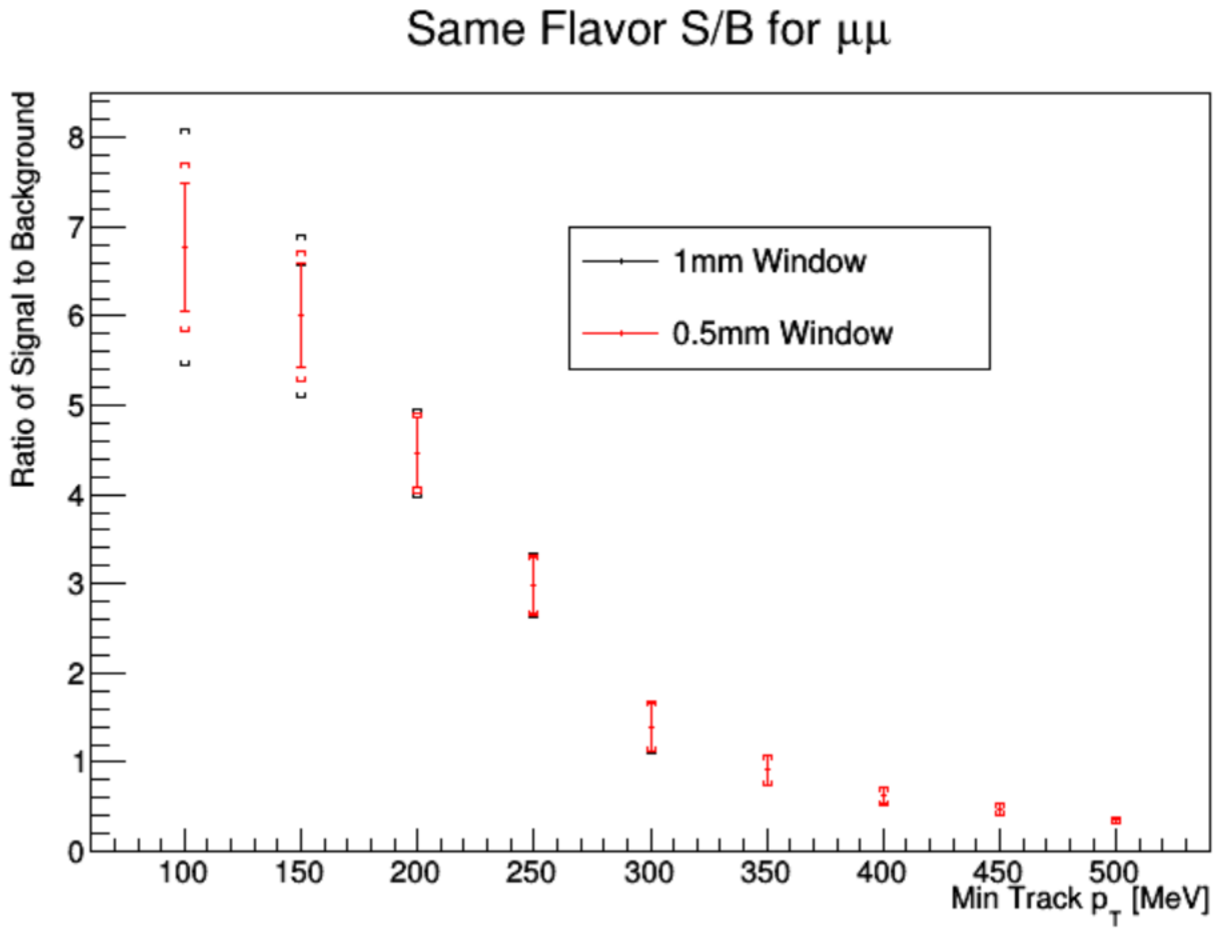
Nch reweighting

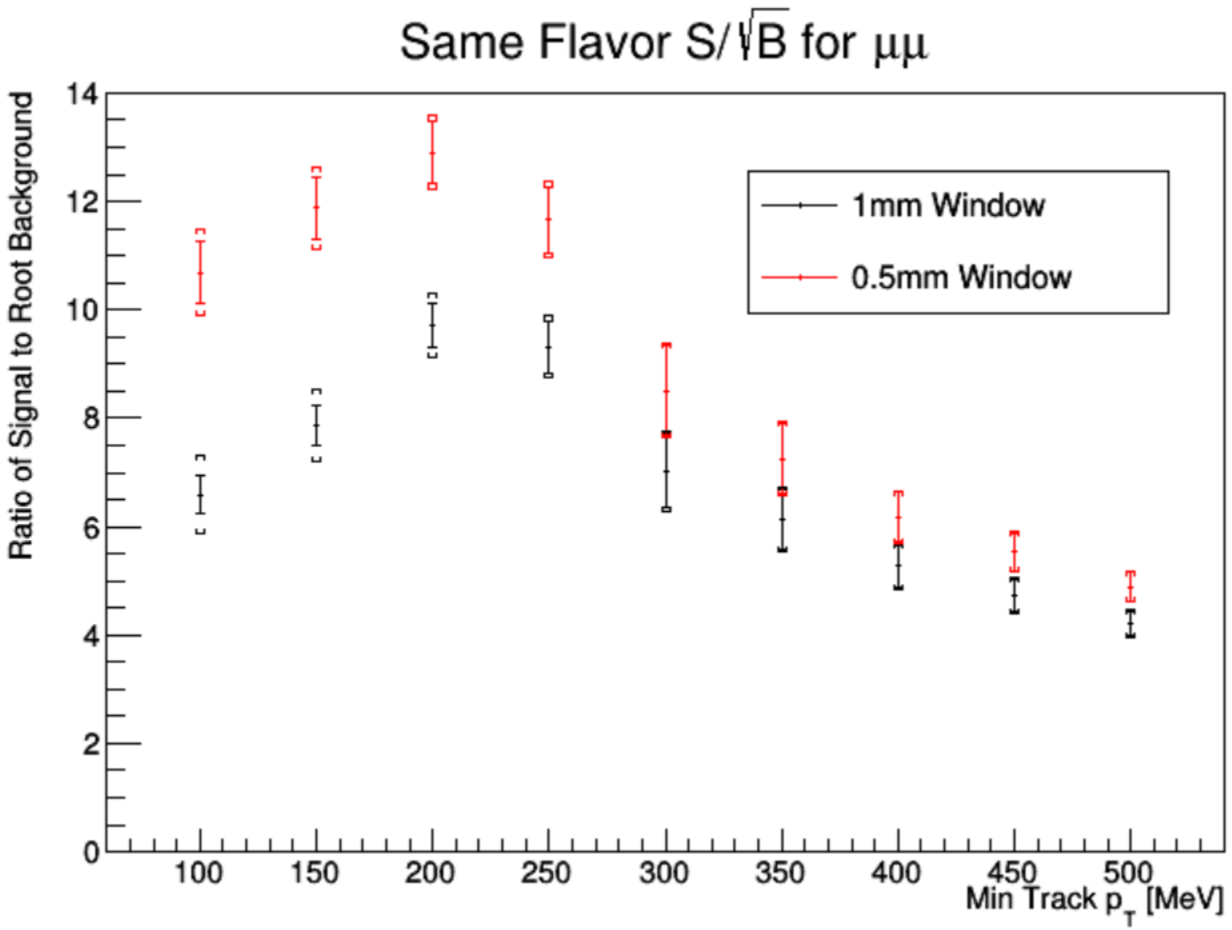
- Simulations overpredict the yield of background due to charged particle activity.
- Corrections factor is used to properly scale down background in order for result to conform to experiment.
- Results in scaling the background yields by a factor of 0.447.

Uncertainty

- Statistical uncertainty arises from propagating the uncertainty of the Monte Carlo expected yields by the various correction weights. Represented in the following plots via bars.
- We consider systematic error in the number of events with zero reco’d tracks due to track reconstruction. We determine this error by varying each bin in the track reco PDF by ± 5%. Represented by brackets.

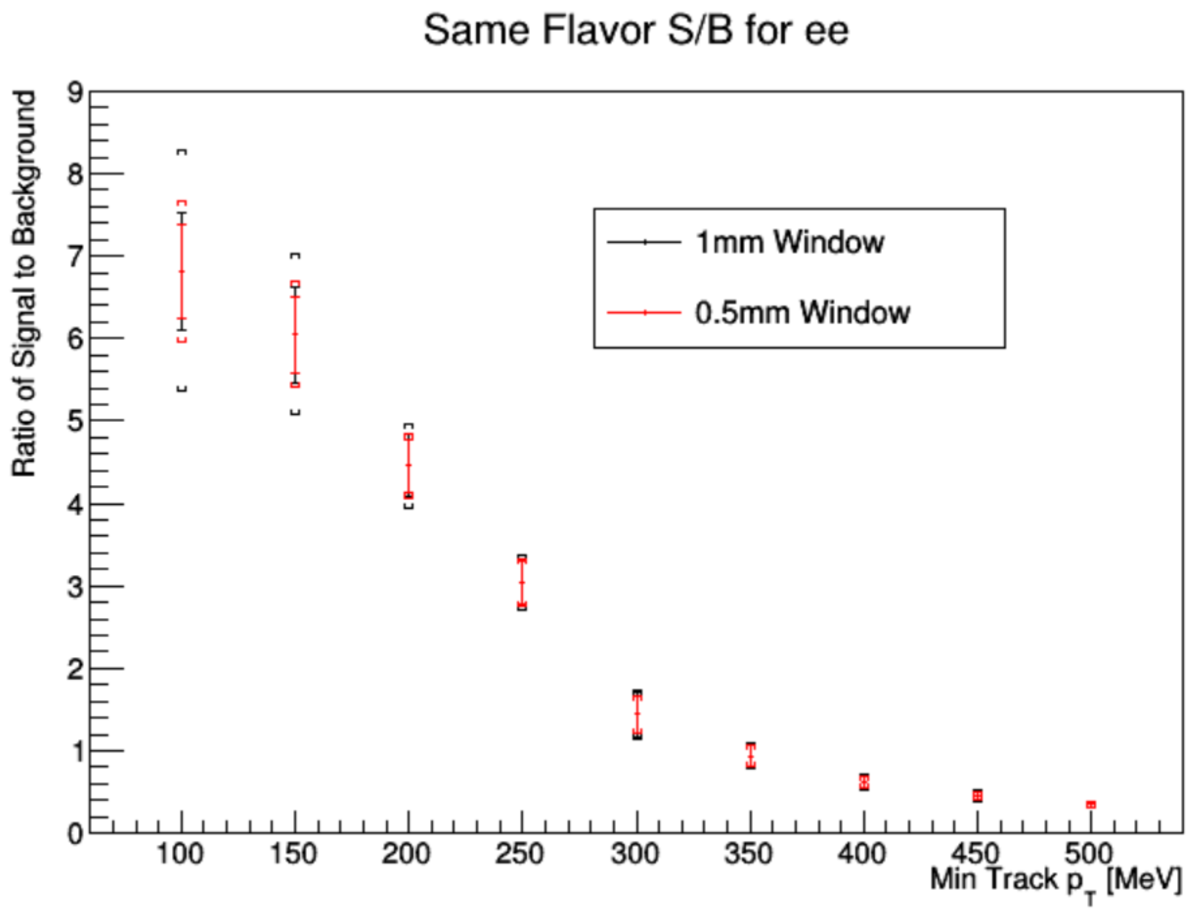

Opposite Flavor Expected S/√B vs Selections with nCh Reweighting
Ratio of Excl to √B yields
0
20
40
60
80
100
1mm Window
0.5mm Window
min Track p_T
100 MeV
300 MeV
500 MeV
2D Track
Lepton
1mm PU
1mm Fakes
0.5mm PU
0.5mm Fakes
Selections

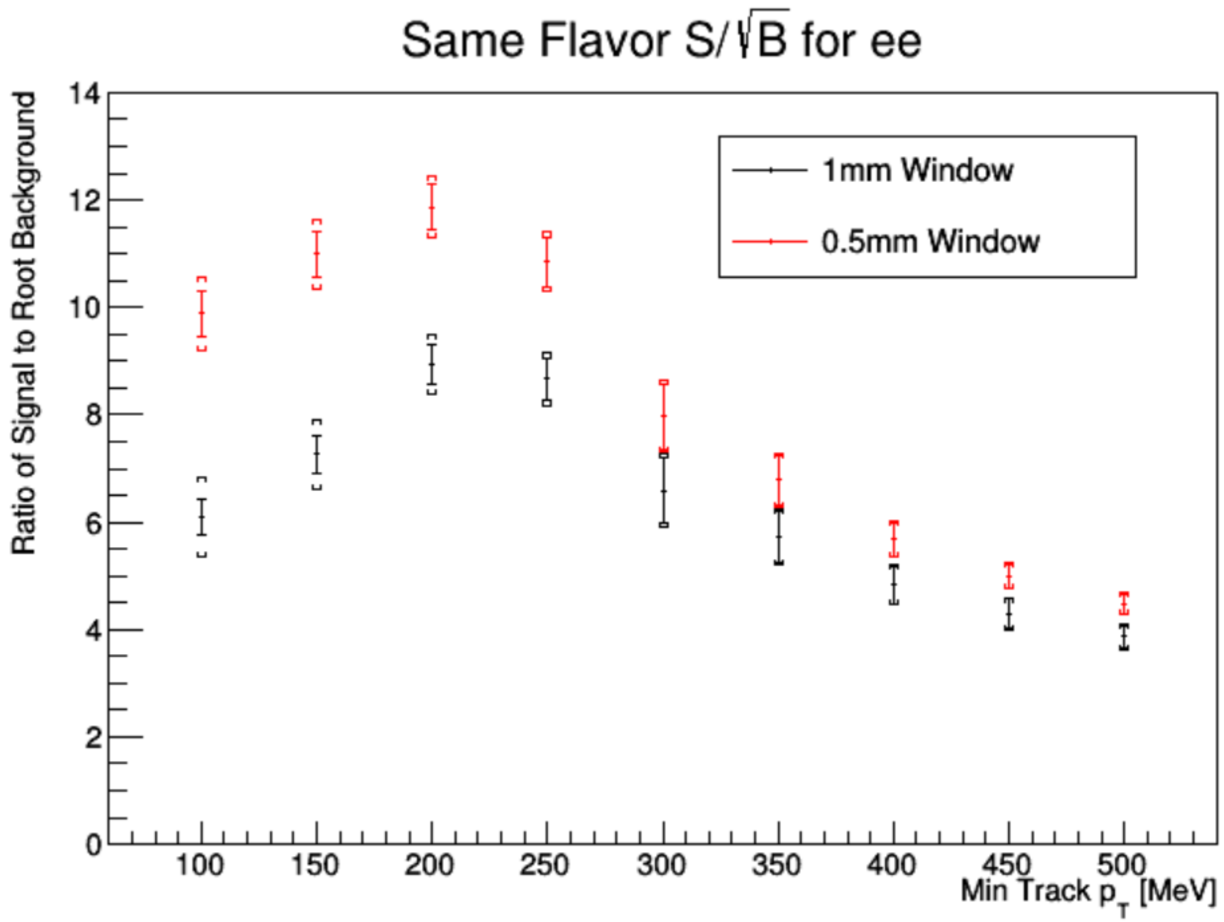




Background for both mumu and ee involve Drell-Yan and Inclusive WW samples. For DY, the considered samples are as follows: Ztautau, Zmumu (60 GeV < m(ll)< 110 GeV), and Dymumu (mll>110GeV).

For ee we did not generate Zee and DYee samples. To compensate, we instead counted the muons in DYmumu and Zmumu as electrons and used the electron lepton reco efficiency.





Summary

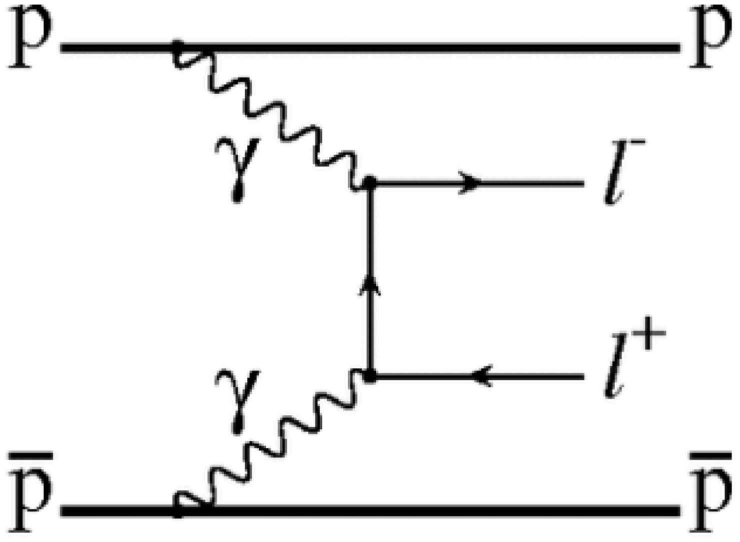
- The increased impact of PU and Fakes on the expected yield of low pT tracking, causes a maximum in S/√B at a min track pT of ≈200 MeV.
- Reduction in the track min p_T to 200 MeV results in a ratio of S/B≈4.5 for both mumu and ee final states.
- The expected ratio of 4.5 is significant enough to consider same flavor final states for determination of the exclusive WW xsec.

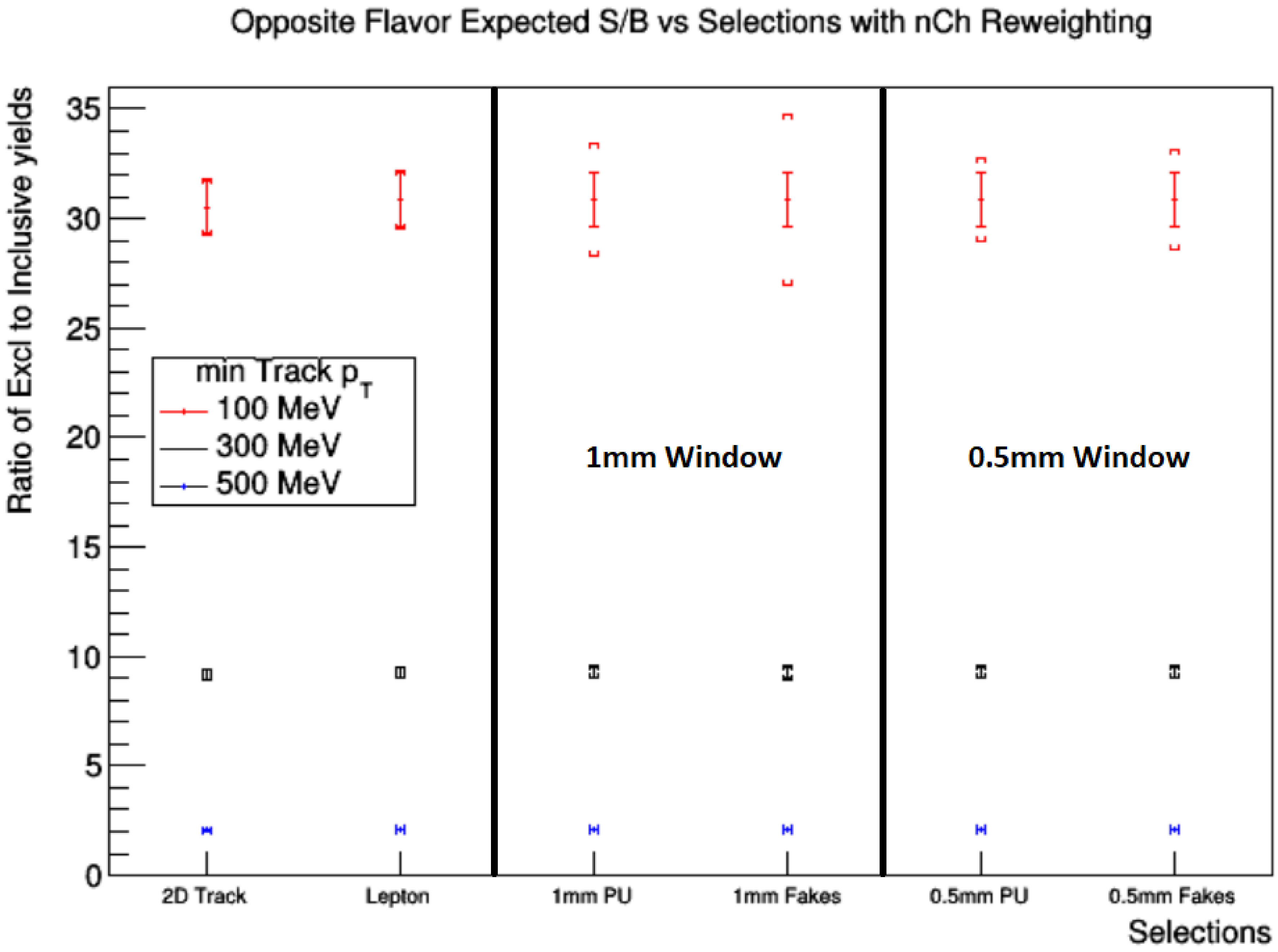
Expected Yields with all Corrections in 0.5mm Window for Opposite Flavor and Same Flavor								
min Track pT	500 MeV				200 MeV			
	OF (emu)	SF (mumu)	SF (ee)	SF (mumu+ee)	OF(emu)	SF (mumu)	SF (ee)	SF (mumu+ee)
S	162.9±0.4	67.7±0.3	57.5±0.3	125.1±0.4	89.5±0.2	37.2±0.1	31.6±0.1	68.8±0.1
B	77.5±2.2	192±21	165±13	357±25	4.4±0.3	8.3±0.7	7.1±0.5	15.4±0.8
S/B	2.10±0.06	0.35±0.04	0.34±0.03	0.35±0.02	20.2±1.4	4.483±0.4	4.5±0.3	4.5±0.2
S/√B	18.5±1.0	4.885±1.1	4.5±0.7	6.6±0.9	42.7±5.8	12.9±2.2	11.9±1.7	17.5±1.8

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




Opposite Flavor Expected S/B vs Selections with nCh Reweighting
Ratio of Excl to Inclusive yields
35
30
25
20
15
10
5
0
min Track p_T
100 MeV
300 MeV
500 MeV
1mm Window
0.5mm Window
2D Track
Lepton
1mm PU
1mm Fakes
0.5mm PU
0.5mm Fakes
Selections

Expected Yields with all Corrections in 1mm Window for Opposite Flavor (eμ) and Same Flavor (μμ)								
min Track pT	500 MeV		300 MeV		200 MeV		100 MeV	
	OF (eμ)	SF (μμ)	OF (eμ)	SF(μμ)	OF (eμ)	SF(μμ)	OF (eμ)	SF (μμ)
S	121.3±0.3	50.4±0.2	85.3±0.2	35.5±0.1	50.8±0.1	21.1±0.1	15.41±0.04	6.41±0.02
B	58±2	143±15	9.2±0.5	25±5	2.5±0.2	4.7±0.4	0.50±0.04	0.9±0.1
S/B	2.09±0.07	0.35±0.04	9.3±0.5	1.4±0.3	20.3±1	4.5±0.4	31±2	7.1±0.8
S/√B	15.9±0.3	4.2±0.2	28.2±0.8	7.0±0.7	32±1	9.7±0.4	21.8±0.9	6.6±0.3