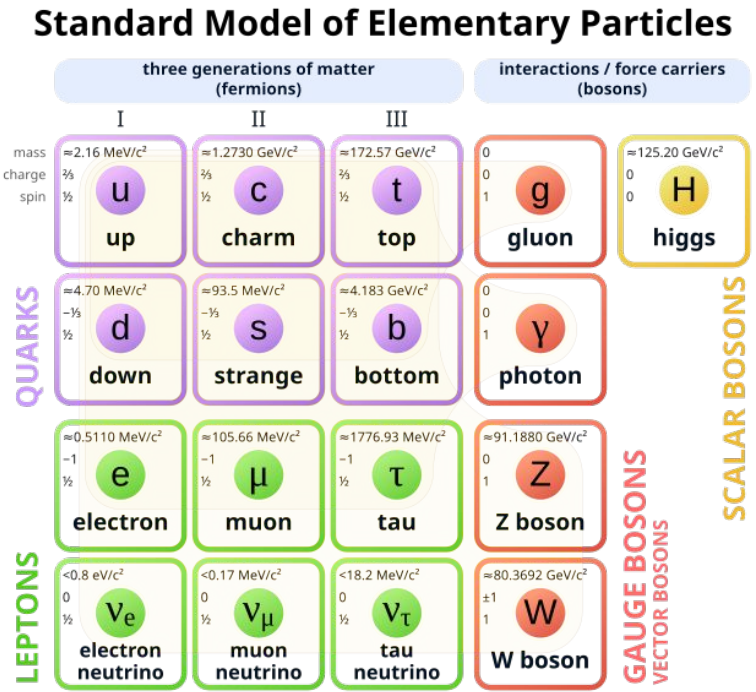
Searching for right-handed neutrinos

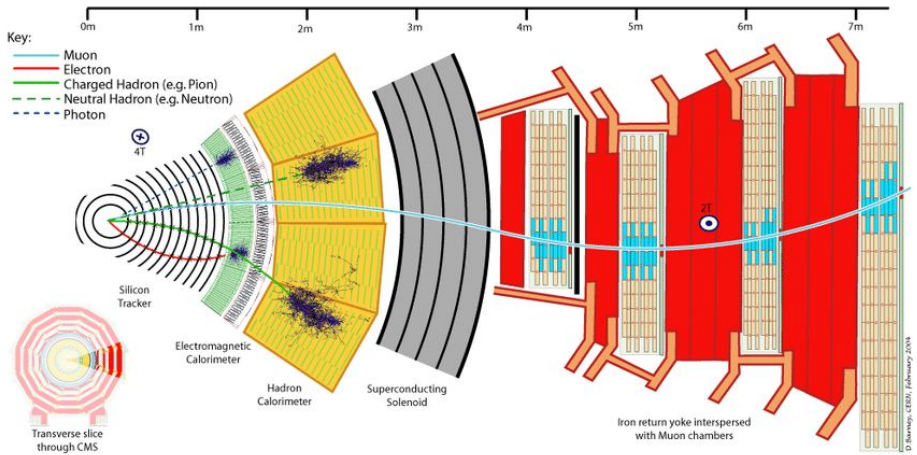
Niveditha Warrier
Advisor: Prof. Sourabh Dube

Right-handed neutrinos



- All observed neutrinos are left-handed
- Right handed neutrinos (if any), must be different from left-handed ones
- Could they be of a higher mass?

Particle Detector

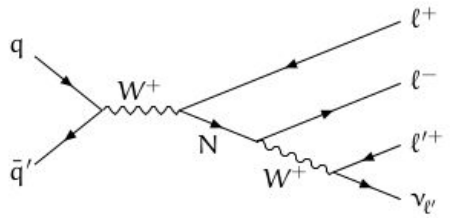


Different SM particles interact differently with the detector.

Only some particles can be detected directly; others have to be inferred from some combination of the ones that *can* be detected

Final States

Proposed Feynman diagram:



Signal (what we're looking for)
Right Handed Neutrinos: final state - 3 leptons (electrons or muons)

Background
A bunch of other processes that could also have the same final state of 3 leptons - WZ, ZZ, ttbar, etc.

What next?

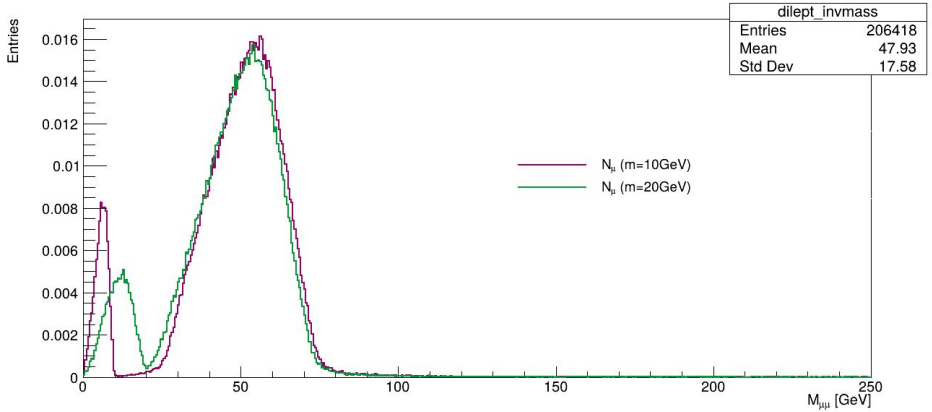
- Make simulations of different masses of RHNs
- Plot different quantities with simulated data and study their properties
- See how it can be differentiated from background

Simulations of several hypothetical masses of RHNs of both muon-type and electron-type were used

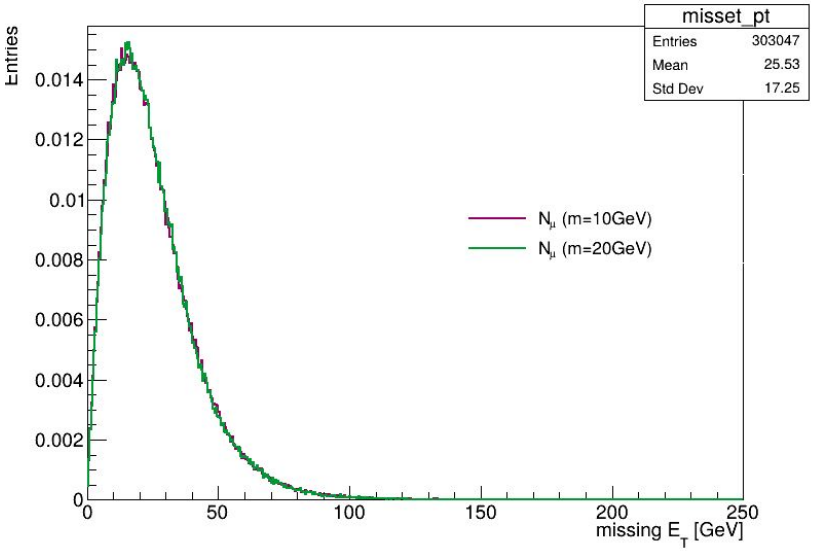
Masses: 10 GeV, 20 GeV, 200 GeV

Similarity between N_μ (m = 10 GeV) and N_μ (m = 20 GeV)

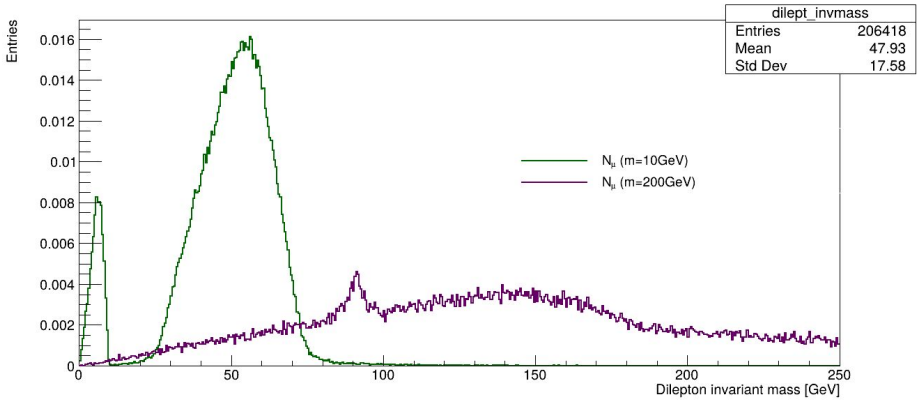
Dilepton invariant mass

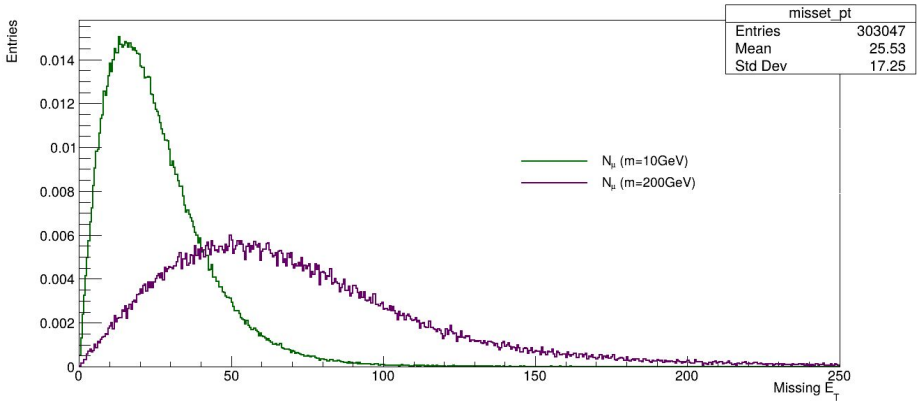


Missing E_T



Difference between N_μ (m = 10 GeV) and N_μ (m = 200 GeV)





Analysis

Stack all background plots

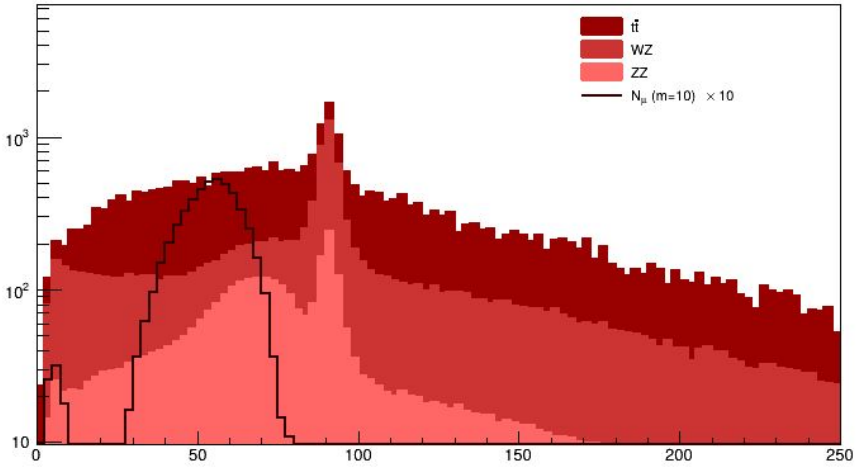
Overlay the signal

See where cuts can be made such that signal is high and background is low

Aim: Improve S/sqrt(B) without compromising on signal efficiency

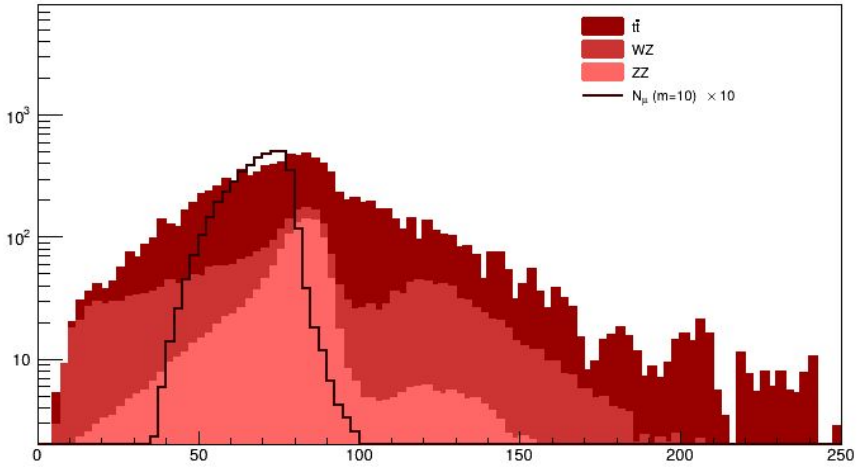
Cuts for low-mass region

Initial S/sqrt(B): 166.291



$M_{ll} < 75$ GeV

S/sqrt(B): 262.514



$35 < M_{lll} < 80$ GeV

S/sqrt(B): 387.761

- Initial S/sqrt(B) = 166.291
- Initial signal efficiency = 0.267909

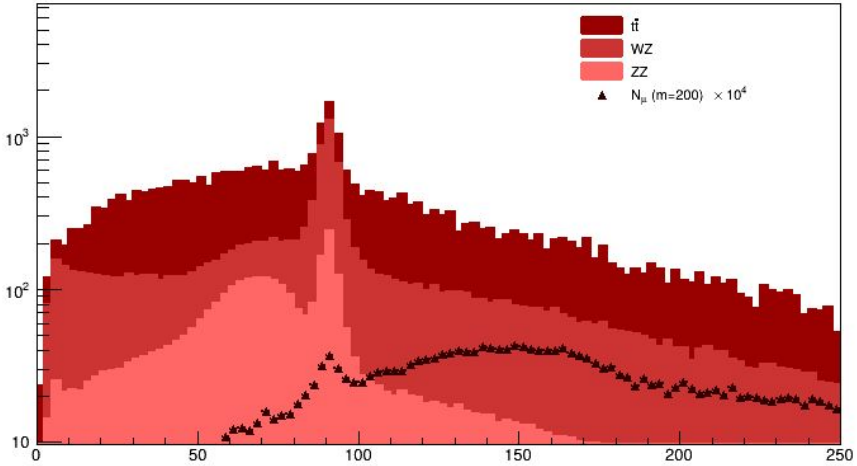
Cuts:

- $p_T(l^0) > 25$ GeV
- $M_{ll} < 75$ GeV
- $35 < M_{lll} < 80$ GeV
- $\Delta R_{L0L1} < 0.4$ or $\Delta R_{L0L1} > 1.8$
- $\Delta R_{L1L2} < 1$ or $1.9 < \Delta R_{L1L2} < 4.2$
- $m_T^0 < 100$ GeV
- $m_T^2 < 50$ GeV
- $\Delta R_{(L1L2 - MET)} < 4$
- $L_T < 90$ GeV
- $\Sigma M_{ll} < 120$ GeV

- Final S/sqrt(B) = 571.903
- Final signal efficiency = 0.203351

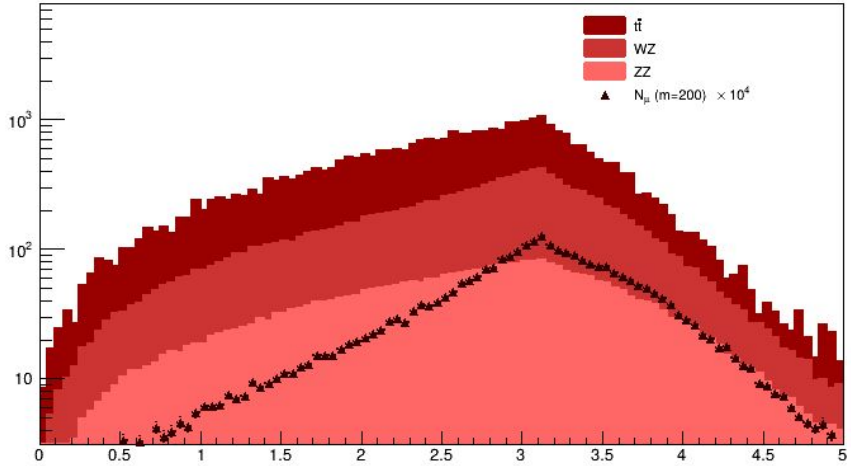
Cuts for high-mass region

Initial S/sqrt(B): 131.861



M_{ll} >110 GeV

S/sqrt(B): 204.08



$\Delta R_{(L0L1 - MET)}$> 0.5

S/sqrt(B): 204.99

- Initial S/sqrt(B) = 131.861
- Initial signal efficiency = 0.605997

Cuts:

- $p_T(l^0) > 50$ GeV
- $p_T(l^1) > 30$ GeV
- $M_{ll} > 110$ GeV
- $1 < \Delta R_{L0L1} < 4.5$
- $\Delta R_{L0L2} < 4.5$ and $\Delta R_{L1L2} < 4.5$
- $\Delta R_{(L0L1 - MET)} > 0.5$
- $\Delta R_{(L1L2 - MET)} < 4$
- $L_T + MET > 200$
- $\Delta\phi_{(L0 - L1L2)} > 0.7$

- Final S/sqrt(B) = 234.705
- Final signal efficiency = 0.436236

Thank You!