Search for Heavy Neutral Leptons in K+ Decays

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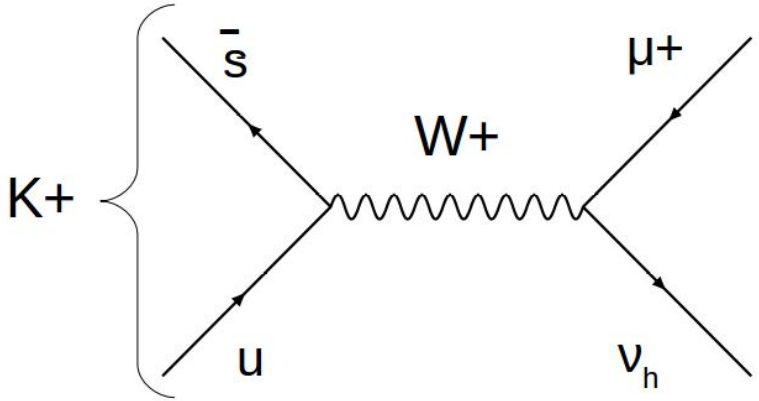
Physics Motivation

- Many Standard Model extensions involve heavy neutral leptons (HNLs)
- Neutrino Minimal Standard Model (vMSM)
  - predicts 3 HNLs which explain:
    - dark matter
    - baryon asymmetry
    - low mass of SM neutrinos
  - implies lepton number violation

HNL in Kaon Decay

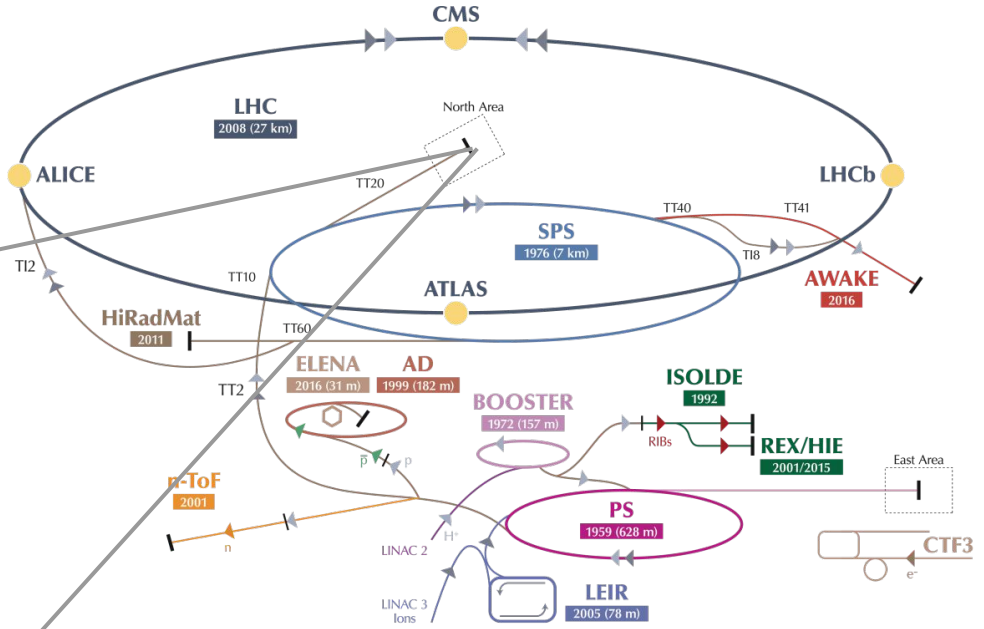


Background processes:

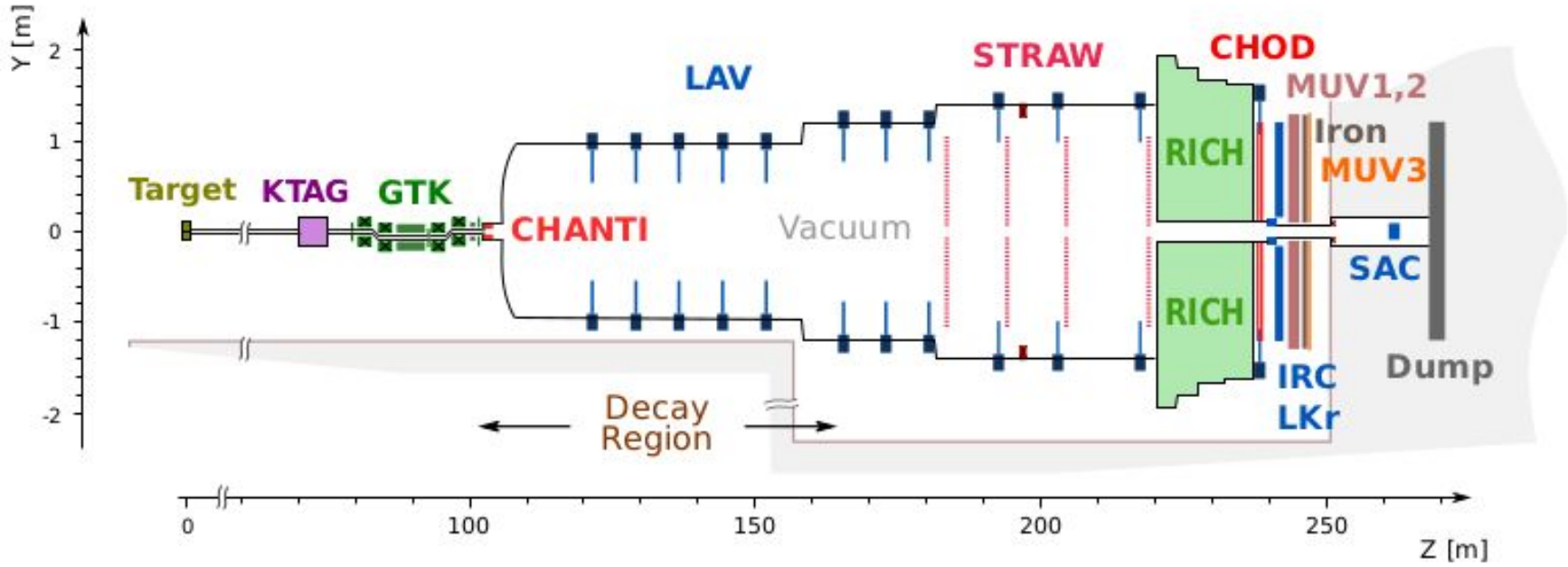
- $K^+ \rightarrow \mu^+ \nu(\mu)$ (~63 %)
- $K^+ \rightarrow \pi^0 \mu^+ \nu(\mu)$ (~3 %)
- hadronic (Pions) (~30 %)
- photons involved

NA62-Beamline

- 400 GeV/c protons from SPS
- Interaction with fixed Be-Target
- Secondary positive hadron beam (75 Gev/c)



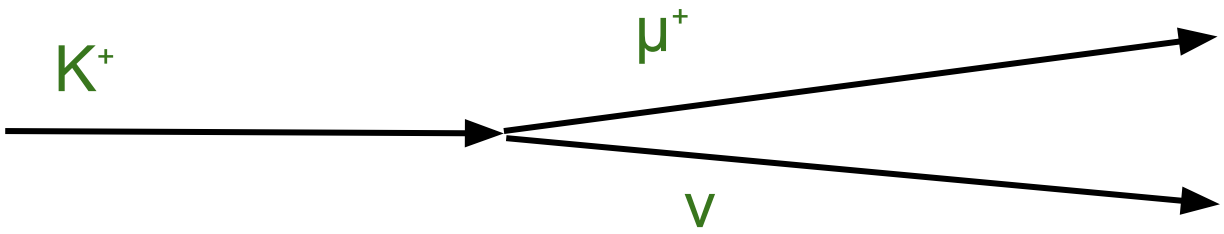
NA62-Detector



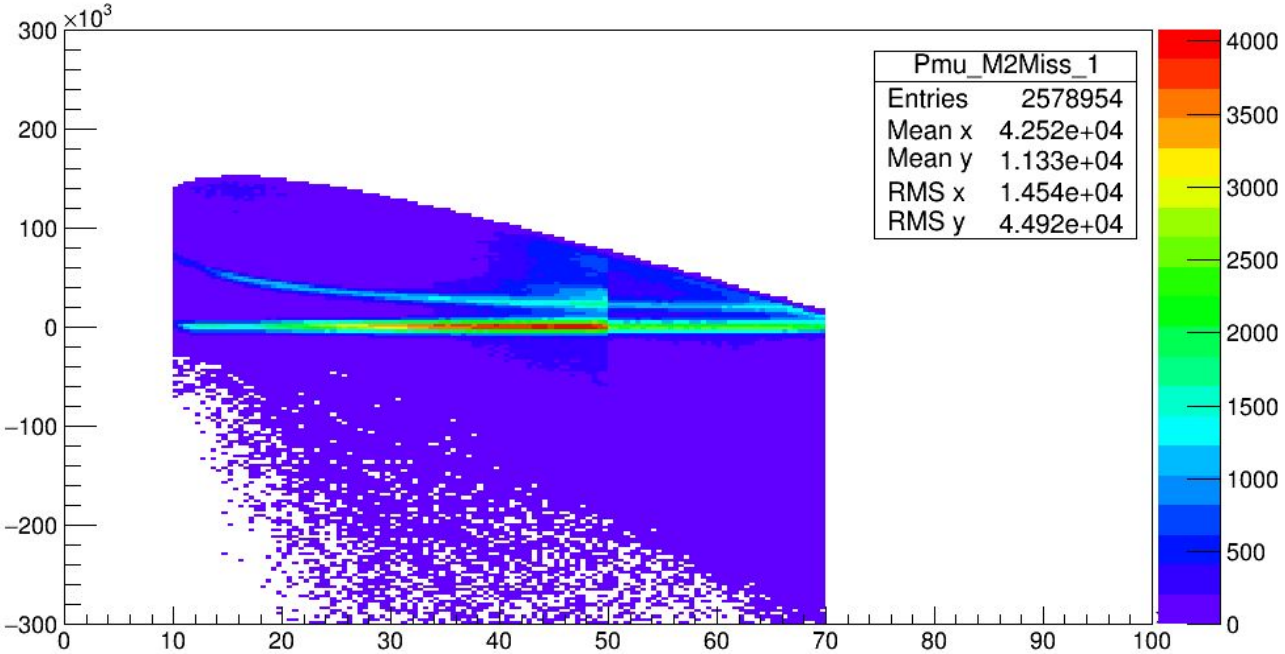
Neutrino Reconstruction

- GTK → Kaon Momentum
- STRAW → Muon Momentum
- Masses are known (particle data group)

→ Four-Vector (Neutrino) = Four-Vector (Kaon) - Four-Vector (Muon)



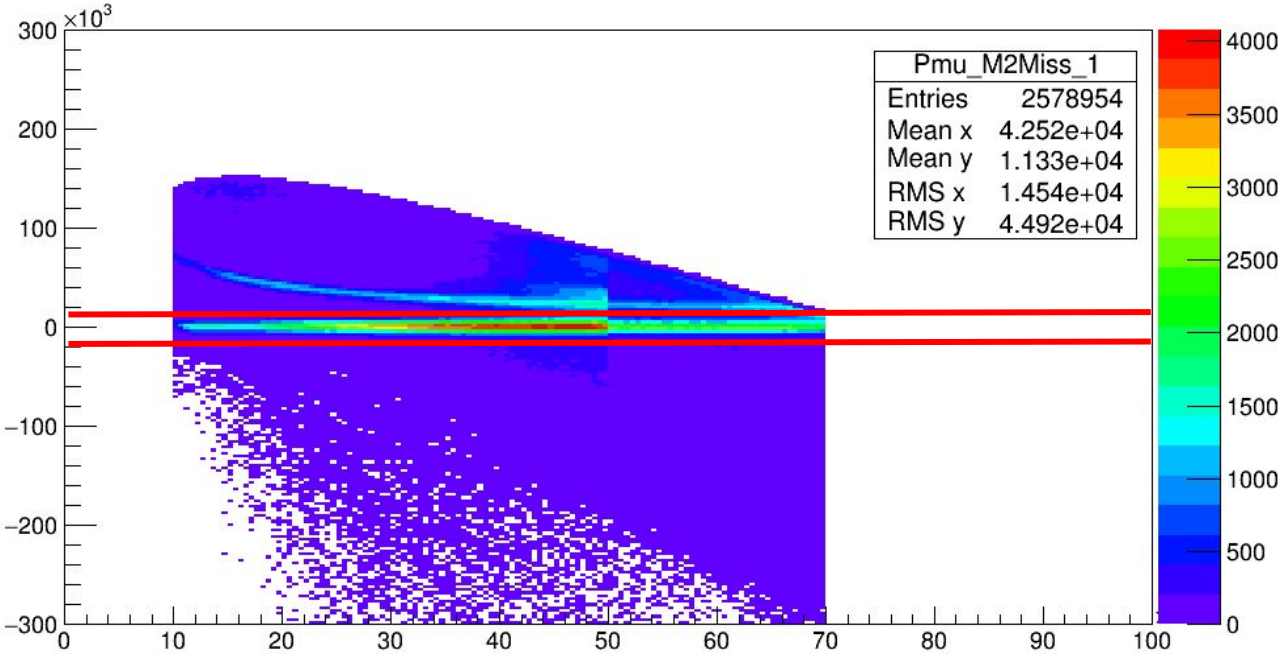
Before (complete) Selection



X: P(μ) (GeV/c)

Y: M²Miss (MeV/c²)

Before (complete) Selection



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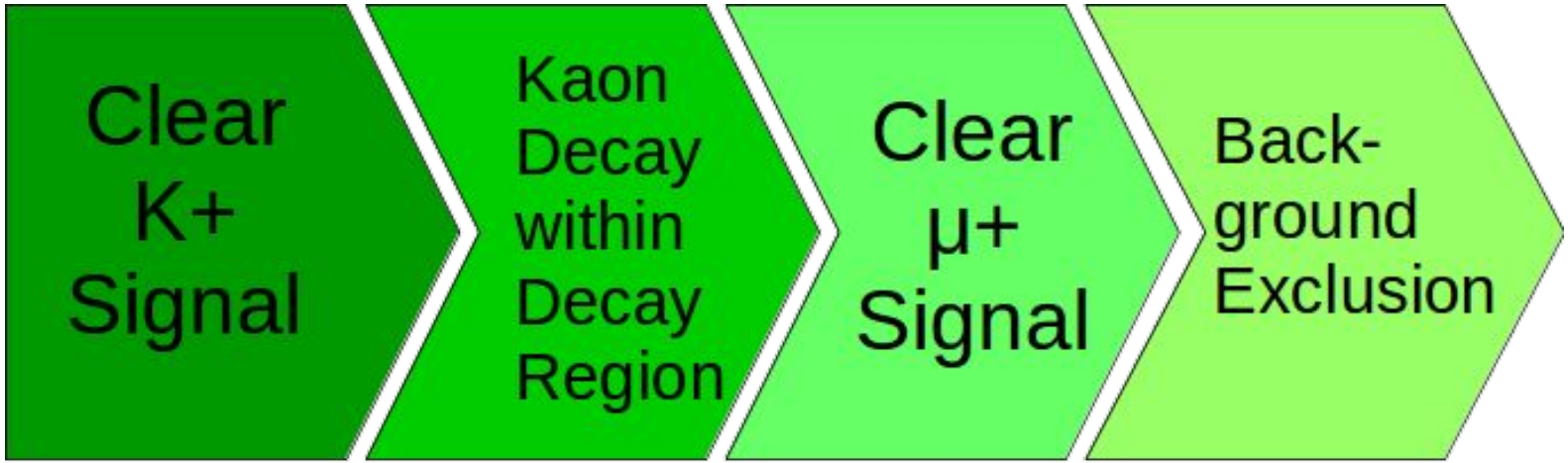
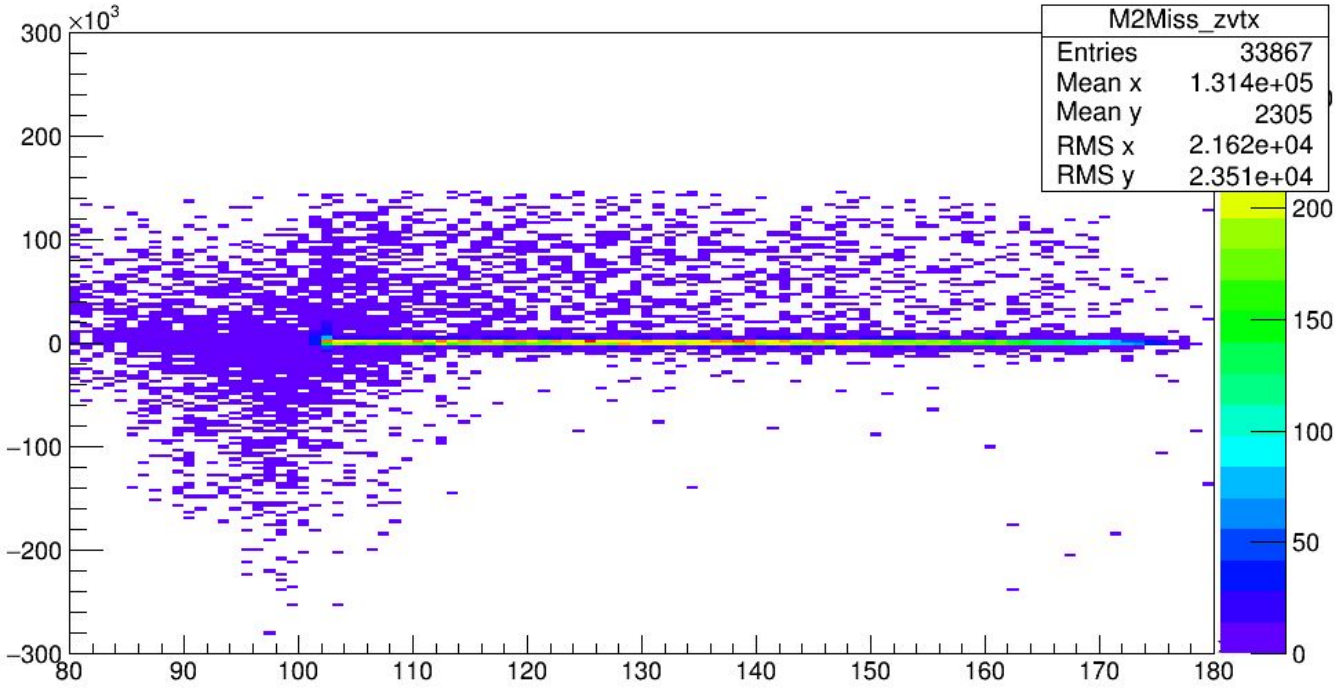
Event Selection



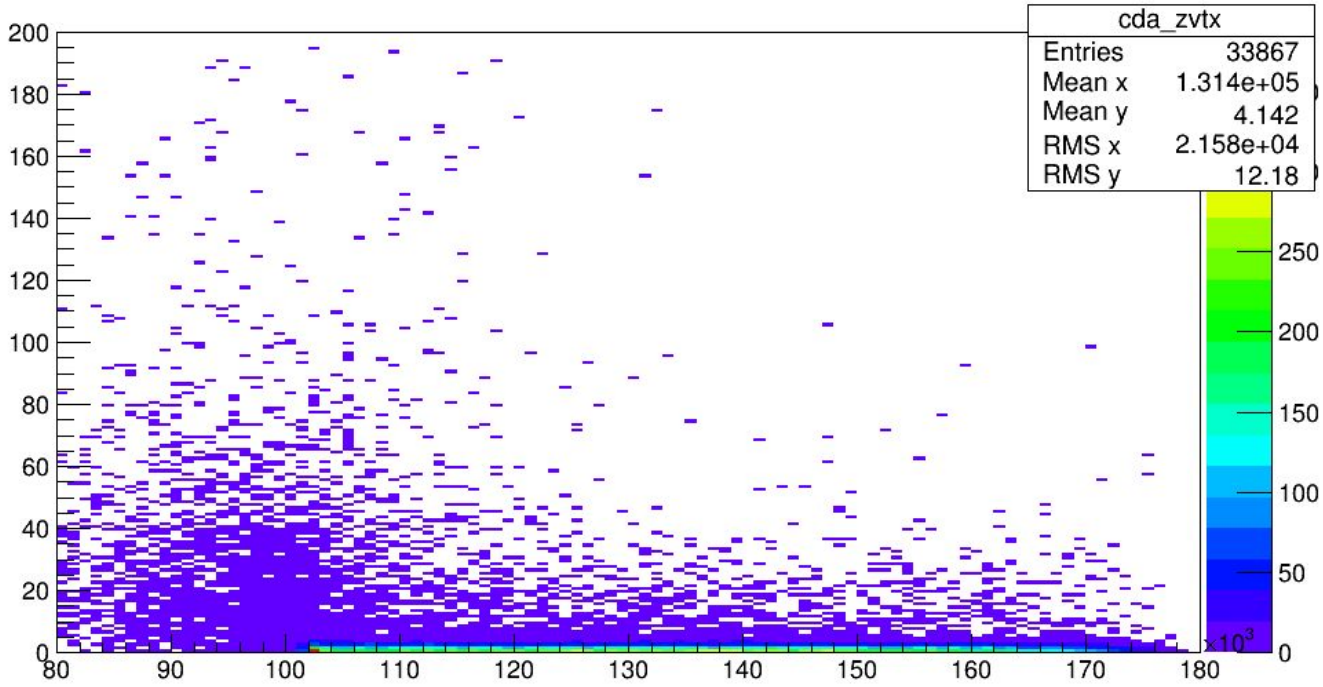
Cut Example: Vertex



X: z-Position Vertex

Y: Missing Mass²

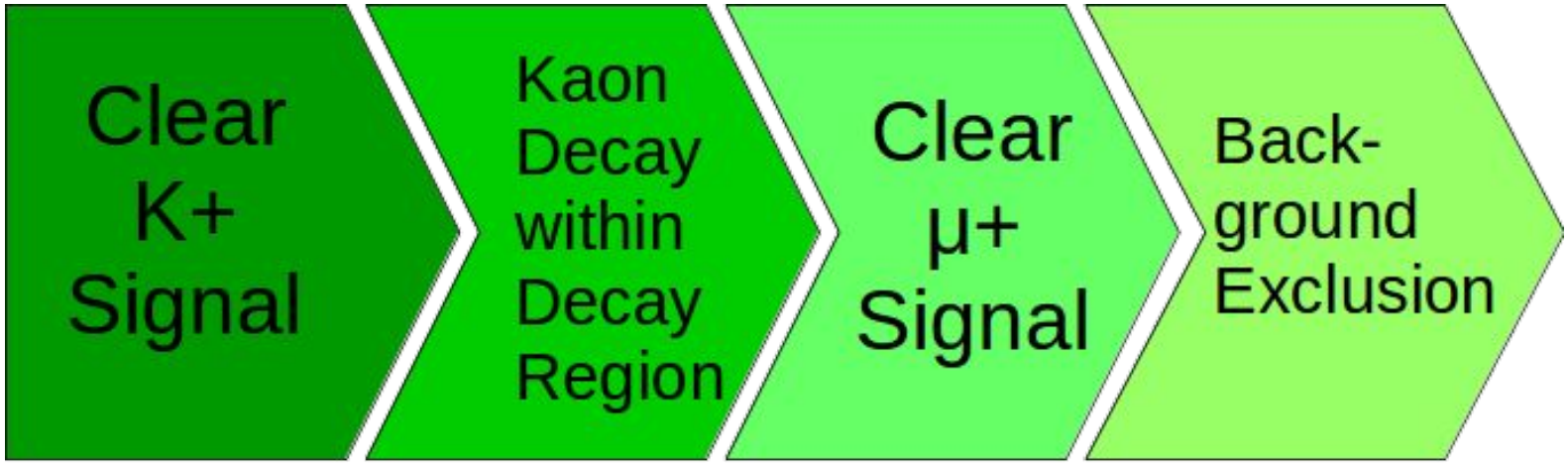
Cut Example: Closest Distance of Approach



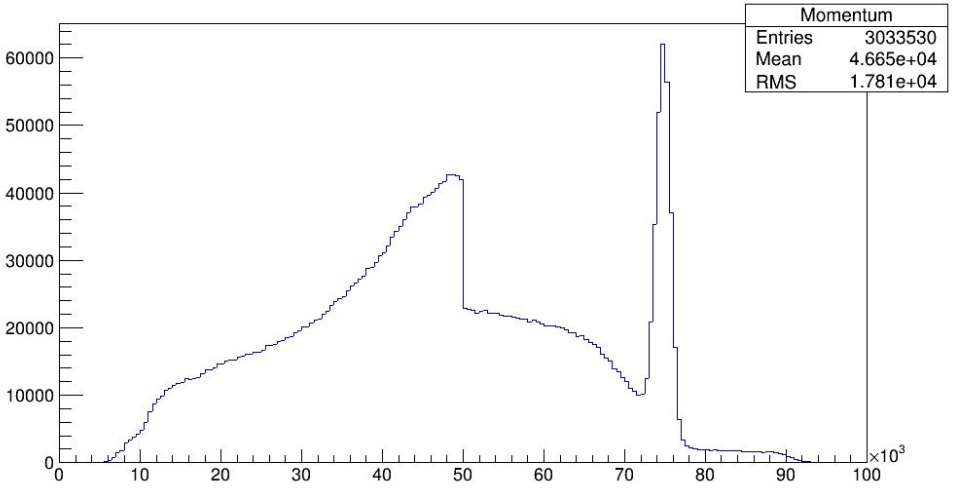
X: z-Position Vertex

Y: cda

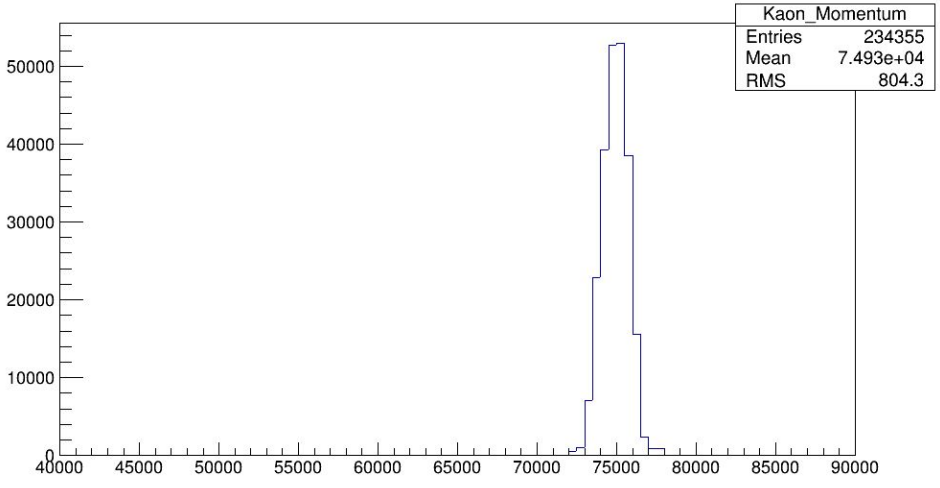
Event Selection



Cut Example: Muon Momentum

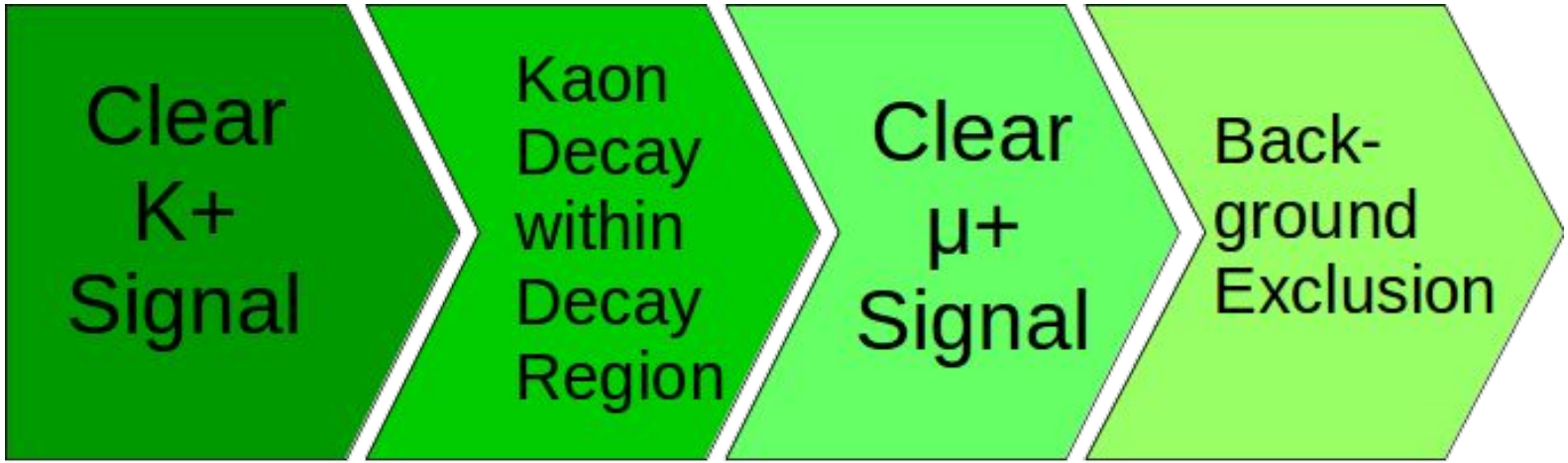


Muon Momentum (MeV/c)



Kaon Momentum (MeV/c)

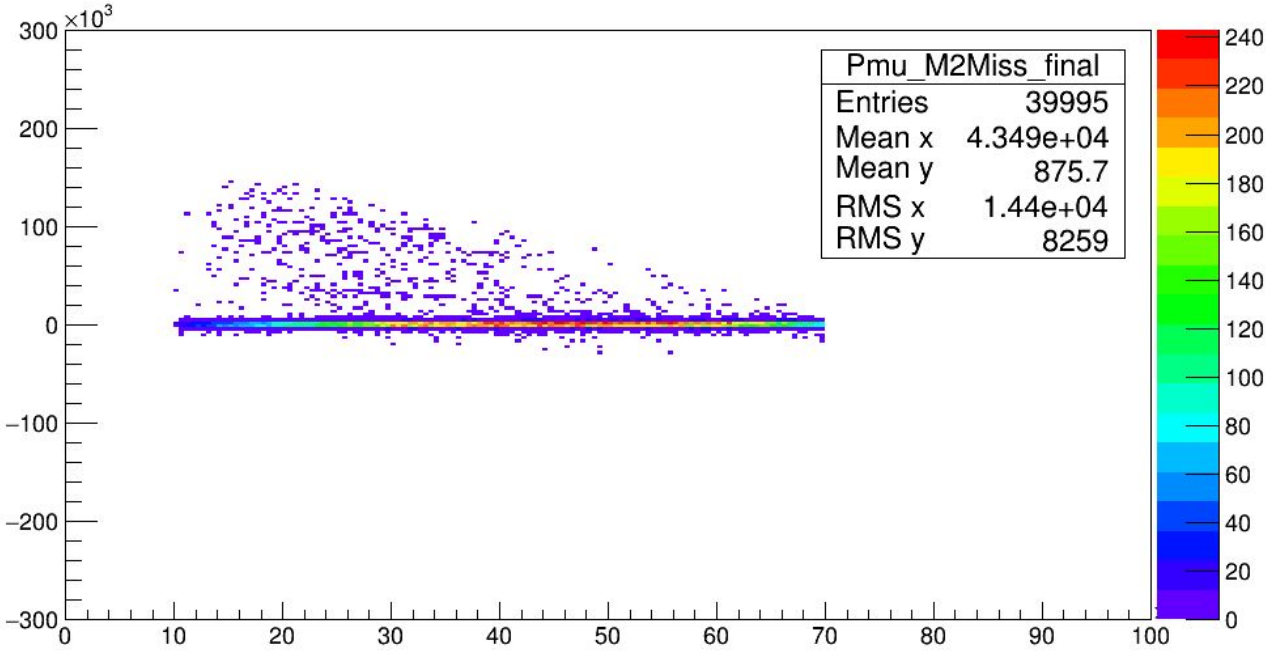
Event Selection



leftover Backgrounds:

- $K^+ \rightarrow \mu^+ \nu$ (~63 %)
- $K^+ \rightarrow \pi^0 \mu^+ \nu$ (~3 %)

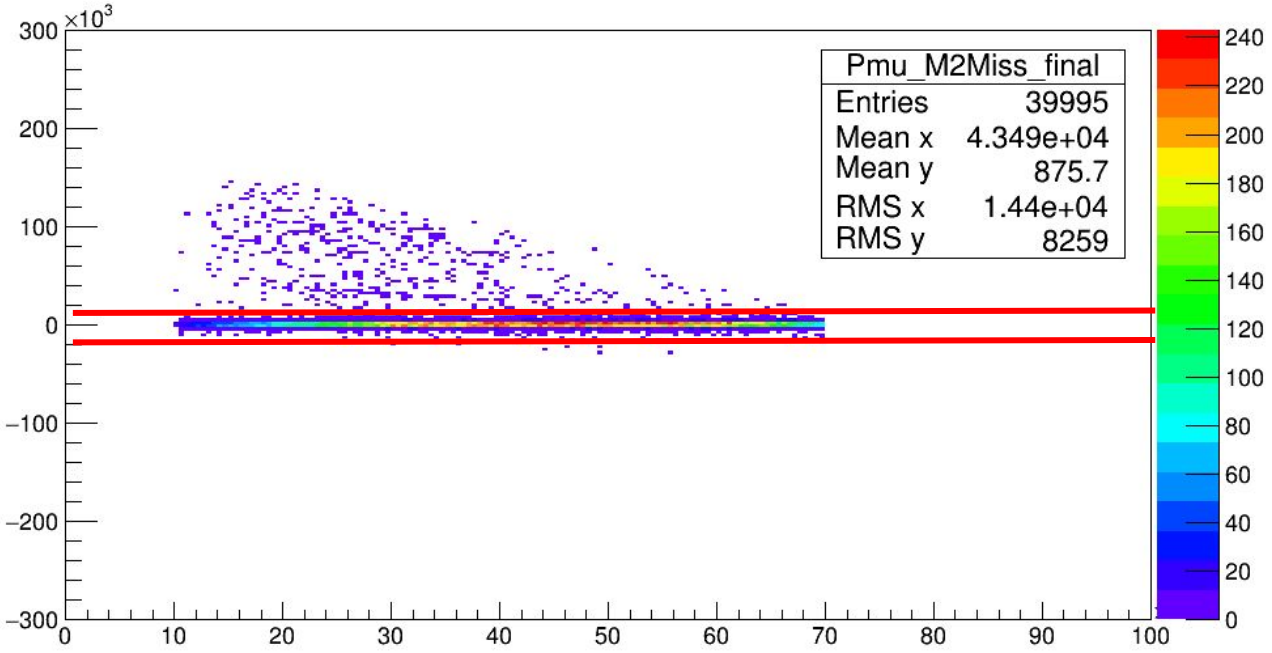
After Selection



X: P(μ) (GeV/c)

Y: M²Miss (MeV/c²)

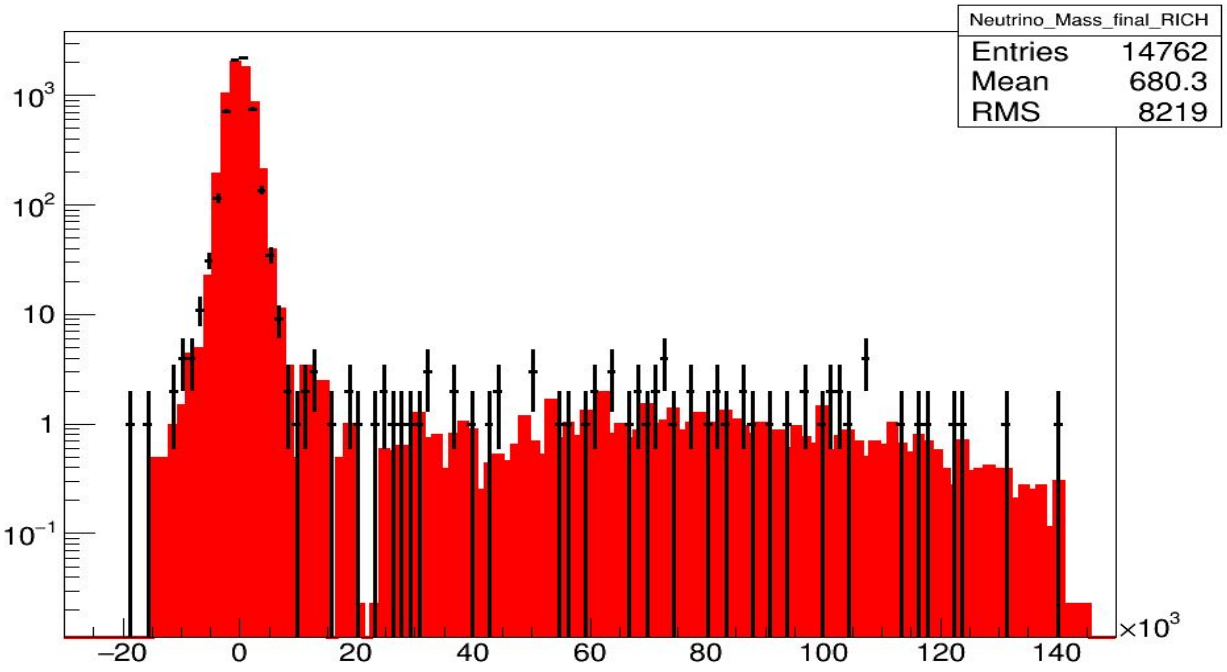
After Selection



X: P(μ) (GeV/c)

Y: M²Miss (MeV/c²)

Comparison: Data - MC



X axis:

Missing Mass²

- red: MC
- black: data

Next Steps

➔ Improve statistics

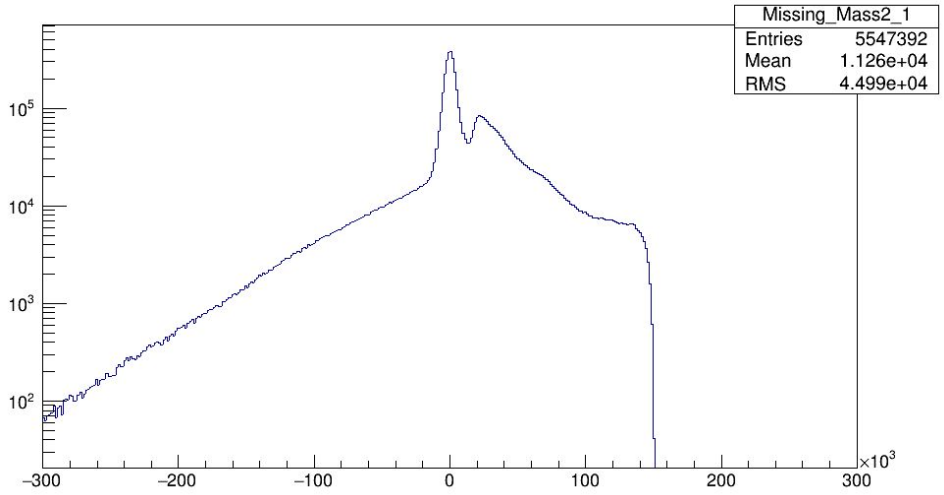
- run on more data files
- run on more MC files

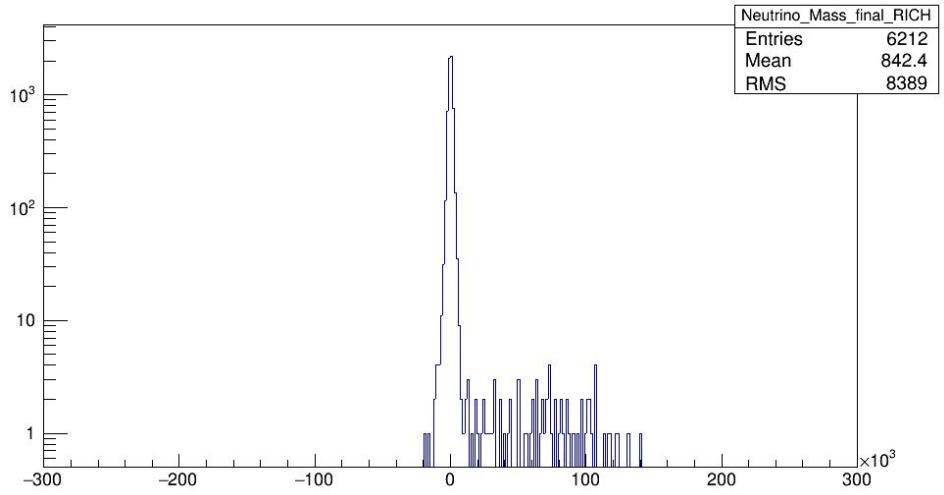
Next Steps

- ➔ Improve statistics
  - run on more data files
  - run on more MC files
- ➔ Never stop learning about particle physics :)

Thank you!

Back-up: Cut





before Cuts

after Cuts

Missing Mass ^2

Back-up: Detector: STRAW