Search for Higgs Boson to Muon Decays

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Motivation

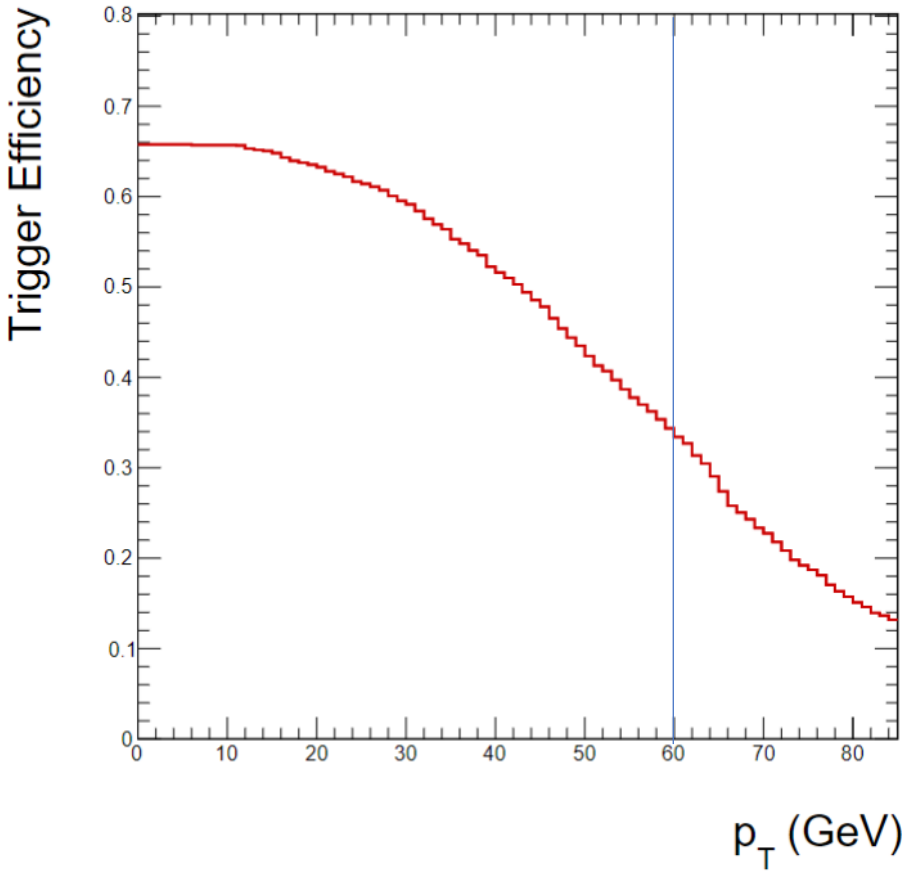
- Long-lived Particles predicted by many theoretical models: including R-parity-violating SUSY, split SUSY, hidden sectors, etc.
- Some theories (hidden sectors) could have low mass LLP, so we need high trigger efficiency at lower masses (standard model Higgs)
- LLPs travel some measurable distance before decaying within ATLAS detector
- i.e. Higgs Bosons from these exotic processes could travel ~10-1000 mm and decays into opposite-sign muons
- Muons have tracks that start some distance away from the beamline creating displaced vertices
- Dataset used: long-lived Higgs with standard model mass with 100 mm lifetime that decay into muon pairs

The Triggers

- Focusing on muon channel, so trigger on muons
- Displaced vertices, cannot use inner detector track information, Muon Spectrometer only (MSonly)
- Original Trigger *HLT_mu60_0eta105_msonly*:
  - 1 muon, MSonly data, 60 GeV pT requirement, high trigger rate, restricted to only the barrel region (0<eta<1.05)
- First additional trigger *HLT_mu80_msonly_3layersEC*:
  - 1 muon, MSonly data, 80 GeV pT requirement, require 3 hits in the endcap (EC) region (1.05<eta<2.4)
- Second additional trigger *HLT_2mu50_msonly*:
  - 2 muons, MSonly data, 50 GeV pT requirement, NO geometric or endcap hit requirements

Current Single Muon Barrel Trigger

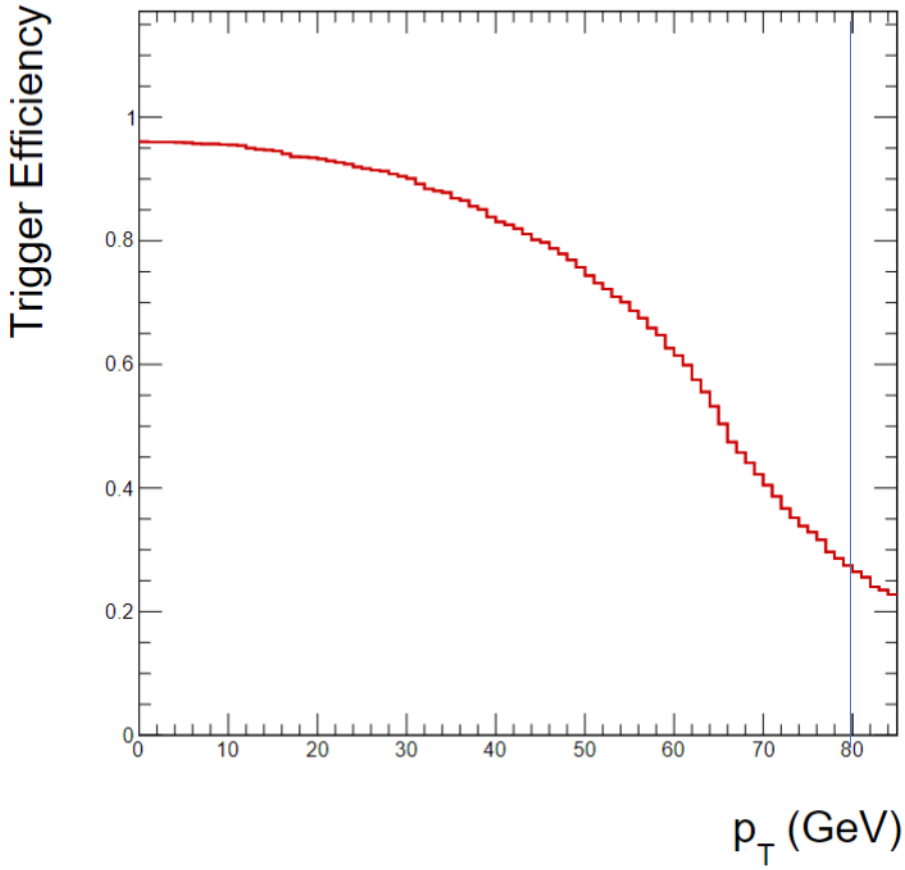
Trigger Acceptance of Single Muon Trigger vs. pT Requirement



HLT_mu60_0eta105_msonly
Efficiency: 34.35%

Additional Single Muon End Cap Trigger

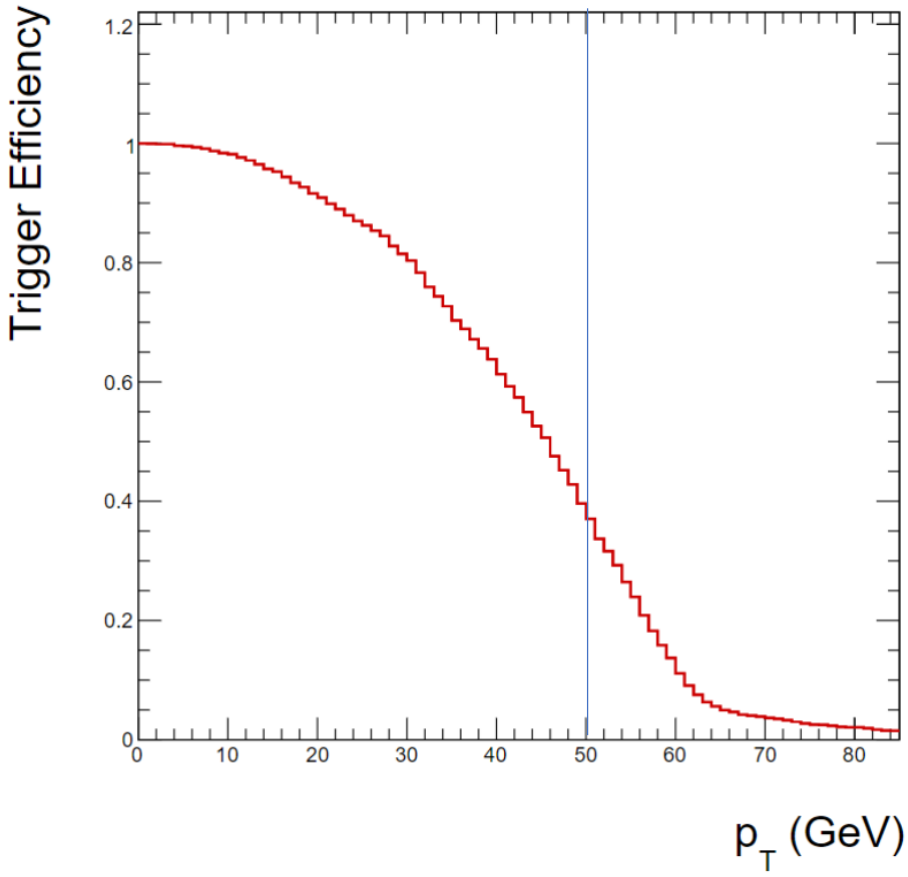
Trigger Acceptance of Single Muon Trigger vs. pT Requirement



HLT_mu80_msonly_3layersEC
Efficiency: 27.45%

New Dimuon Trigger

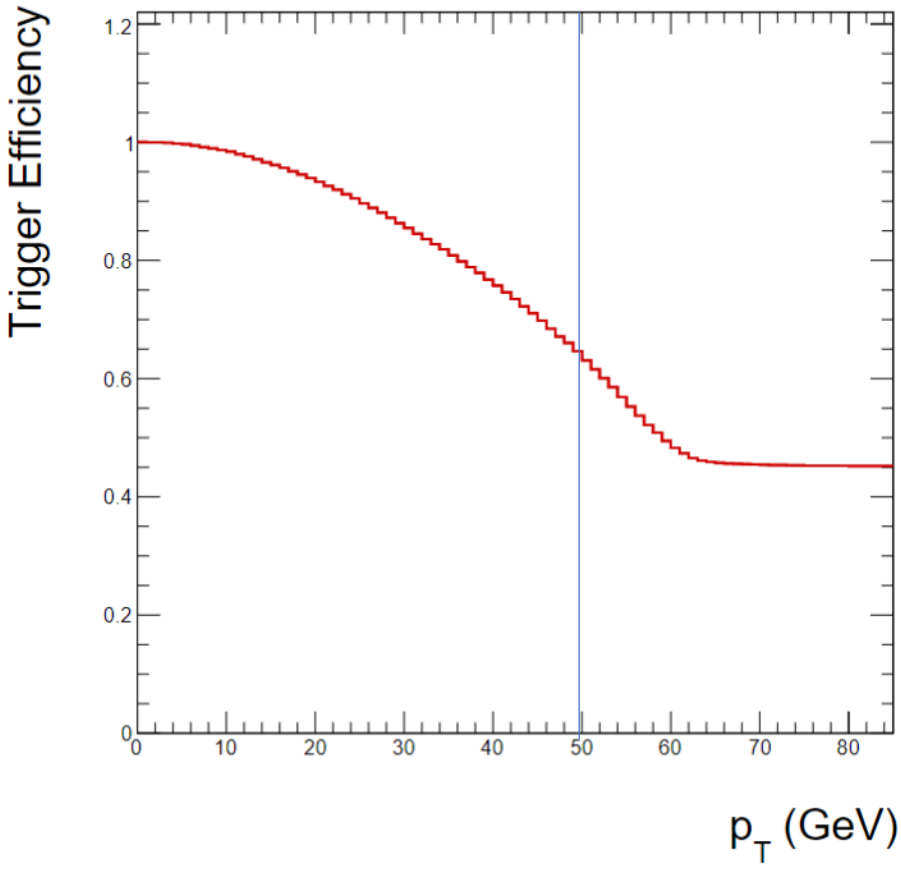
Trigger Acceptance of Dimuon Trigger vs. pT Requirement



HLT_2mu50_msonly
Efficiency: 39.60%

Combination of Triggers

Combined Trigger Acceptance vs. pT Requirement



HLT_mu60_0eta105_msonly
+HLT_mu80_msonly_3layersEC
+HLT_2mu50_msonly
Efficiency: 64.64%

Conclusion

- These three triggers combined increase efficiency from 34.35% to 64.64% as opposed to the original *HLT_mu60_0eta105_msonly trigger.*
- This greatly enhances the physics sensitivity which is necessary for detecting Higgs to Muon decays.
- The increased efficiency would also increase sensitivity for any LLP with mass smaller than the Higgs Boson