



Feasibility Study of Measuring the Higgs Self-coupling Using the Muon Collider

Kenny Jia

July 15th, 2021

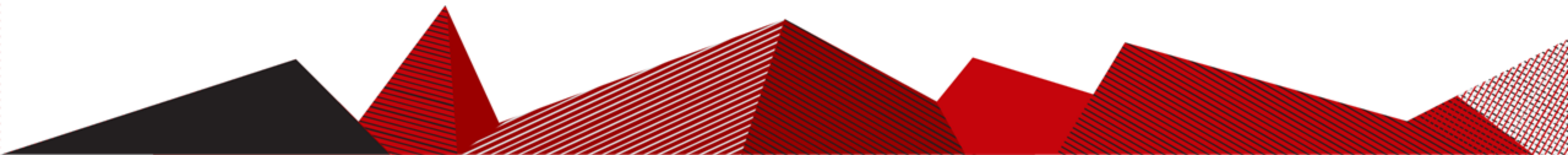




- Signal: $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + H + H$
- Background:
 - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + Z$
 - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + H$
 - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + b + \bar{b}$



Review on Muon Collider Detector card workflow





```
#####  
# Energy flow merger  
#####  
  
module Merger EFlowMerger {  
  # add InputArray InputArray  
  add InputArray HCal/eflowTracks  
  add InputArray ECal/eflowPhotons  
  add InputArray HCal/eflowNeutralHadrons  
  add InputArray MuonMomentumSmearing/muons  
  set OutputArray eflow  
}
```

Add muon to Eflow tracks

```
#####  
# Jet finder KT  
#####  
  
module FastJetFinder FastJetFinderKt {  
  # set InputArray Calorimeter/towers  
  set InputArray EFlowMerger/eflow  
  
  set OutputArray KTjets  
  
  # algorithm: 1 CDFJetClu, 2 MidPoint, 3 SIScone, 4 kt, 5 Cambr  
  idge/Aachen, 6 antikt, 7 anti-kt with winner-take-all axis (for N-  
  subjettiness), 8 N-jettiness, 9 Valencia  
  set JetAlgorithm 4  
  set ParameterR 0.5  
  
  set JetPTMin 20.0  
}
```

Changing GenJet algorithm to anti-kt

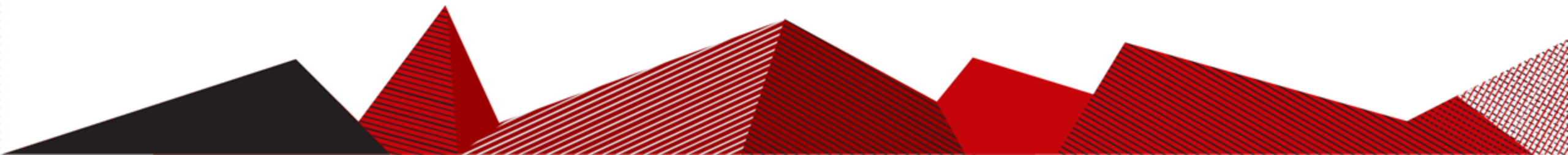


```
#####  
# Jet finder AKT  
#####  
  
module FastJetFinder FastJetFinderAKt {  
  # set InputArray Calorimeter/towers  
  set InputArray EFlowMerger/eflow  
  
  set OutputArray AKTjets  
  
  # algorithm: 1 CDFJetClu, 2 MidPoint, 3 SIScone, 4 kt, 5 Cambr  
  idge/Aachen, 6 antikt, 7 anti-kt with winner-take-all axis (for N-  
  subjettiness), 8 N-jettiness, 9 Valencia  
  set JetAlgorithm 6  
  set ParameterR 0.5  
  
  set JetPTMin 20.0  
}
```

Comparing results using EflowTrack/Calorimeter as input of reco jet algorithm

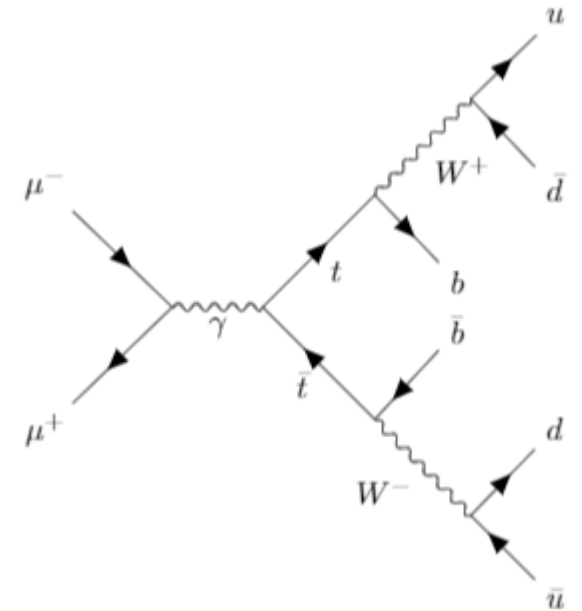


Jets Calibration





- 100k events of $\mu^- + \mu^+ \rightarrow t + \bar{t}$
 - Hadronic decay of $W^\pm$ with two b jets and four other jets from quark



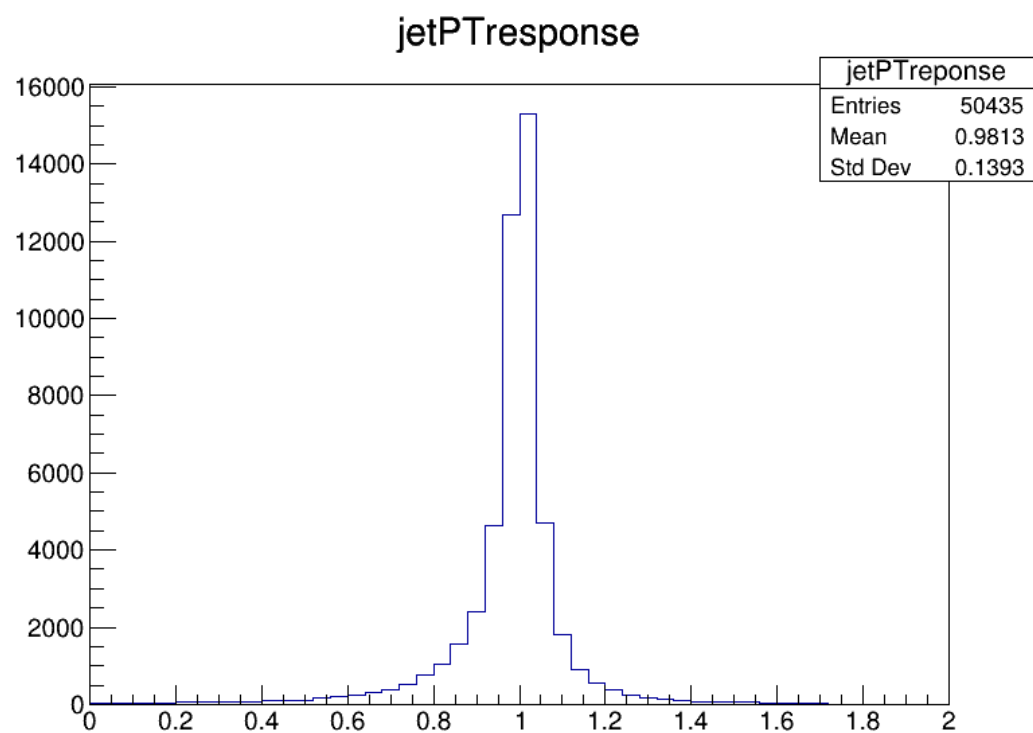


Muon-in-jet situation

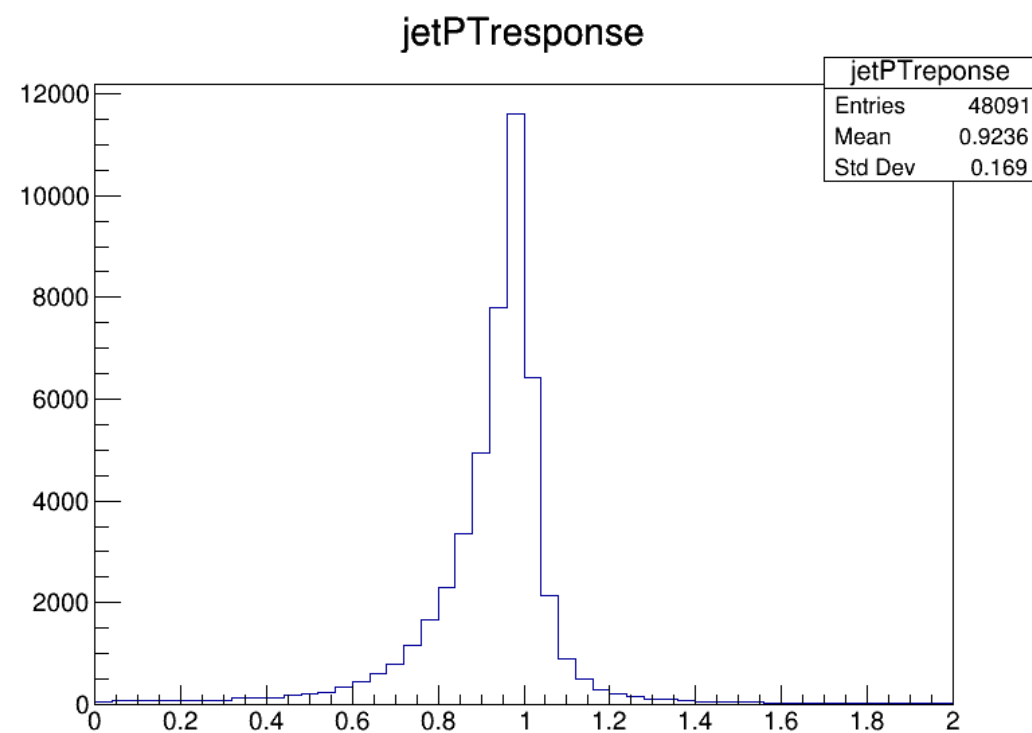
1. Create Muon-tagging:
 - Matching gen muon with gen jet
2. Compare result using EflowTrack and Calorimeter towers



Eflow Tracks



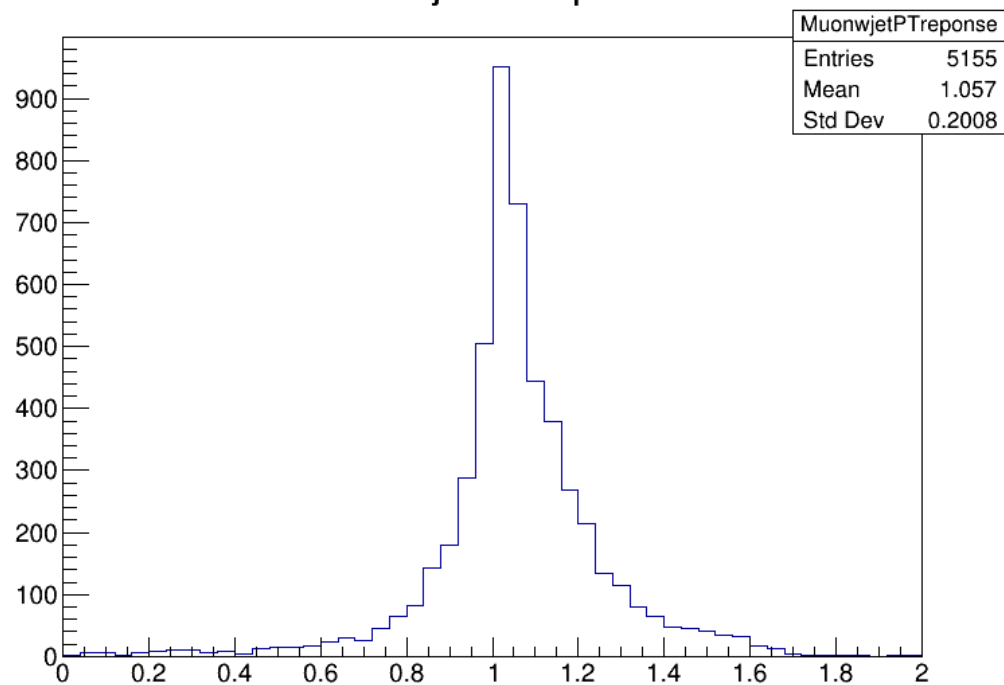
Calorimeter





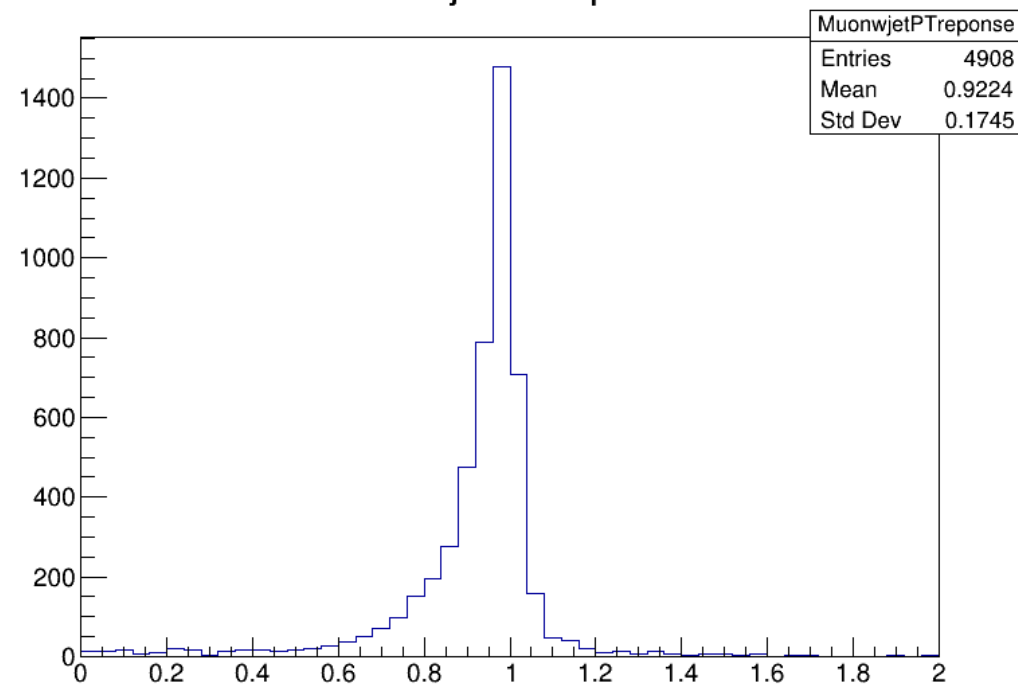
Eflow Tracks

MuonwjetPTresponse



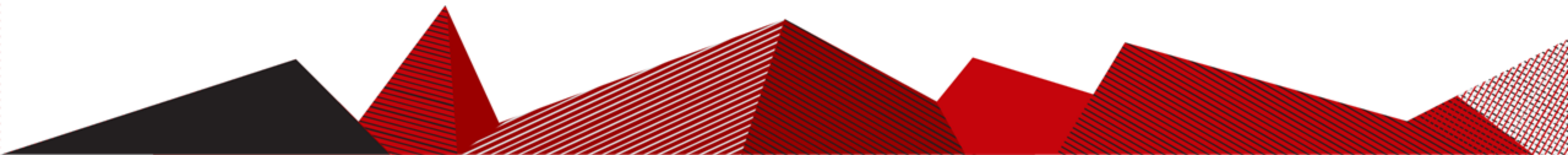
Calorimeter

MuonwjetPTresponse





For ETrack



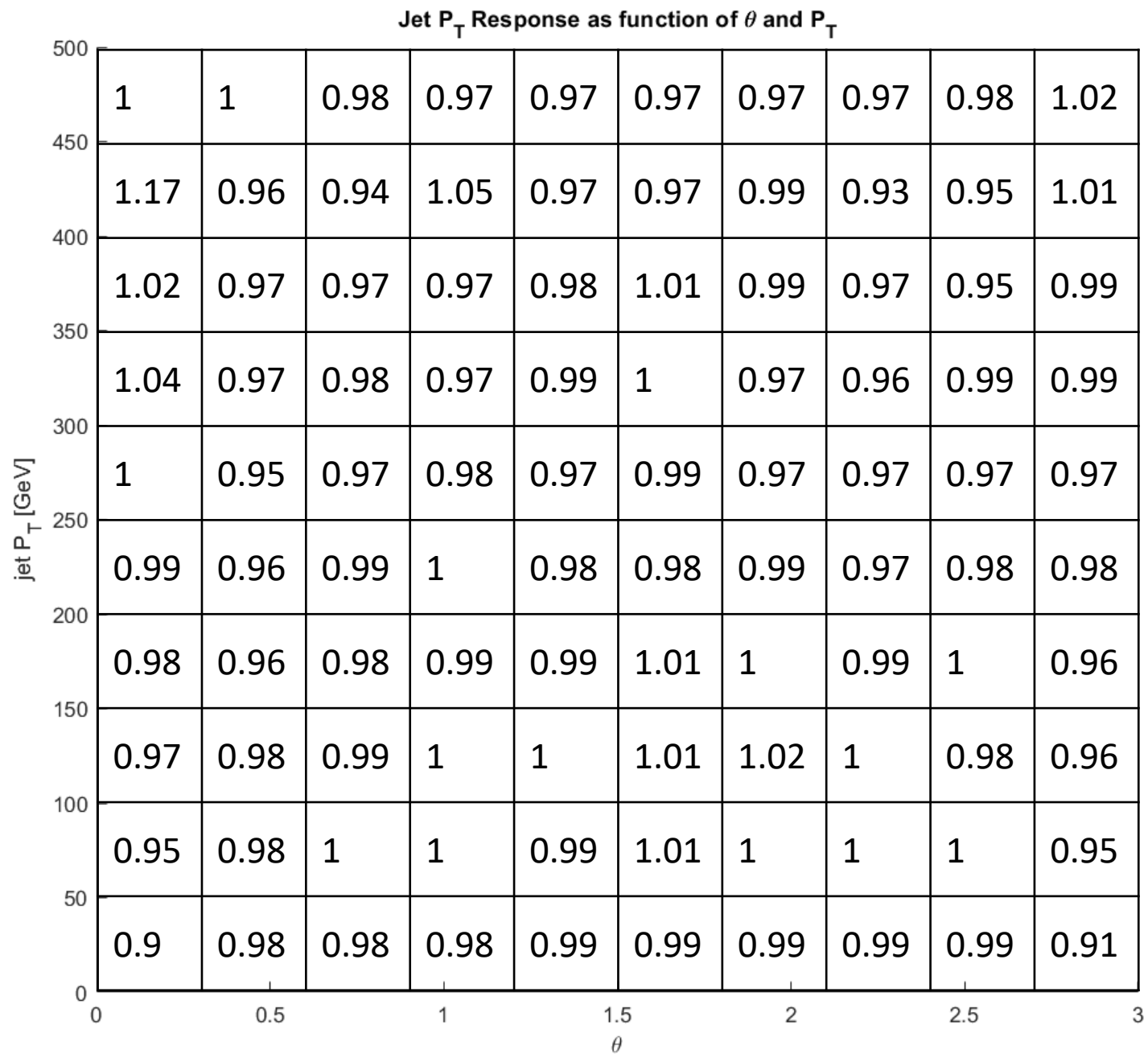


Percent of jet's been tagged



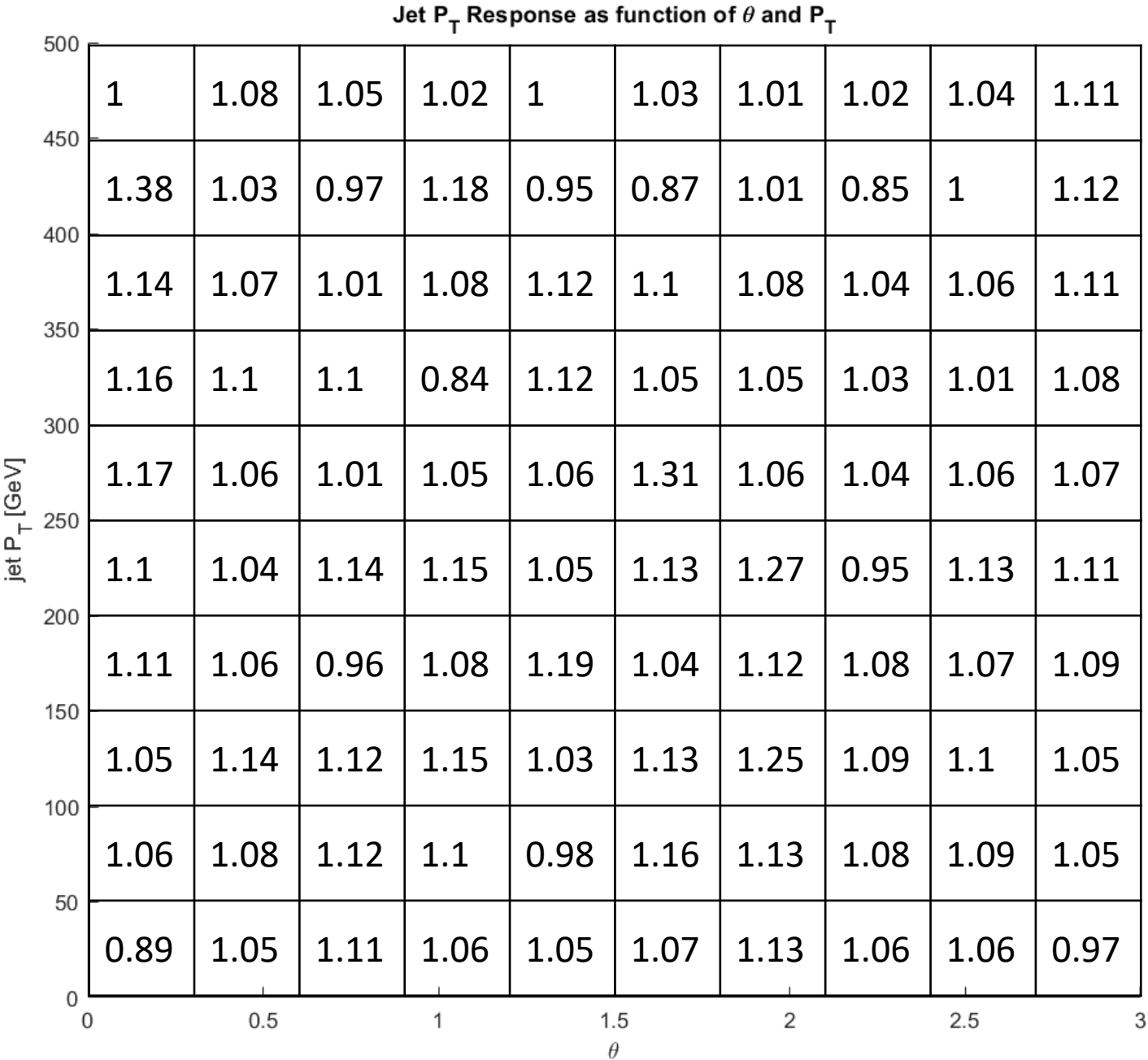


All jets



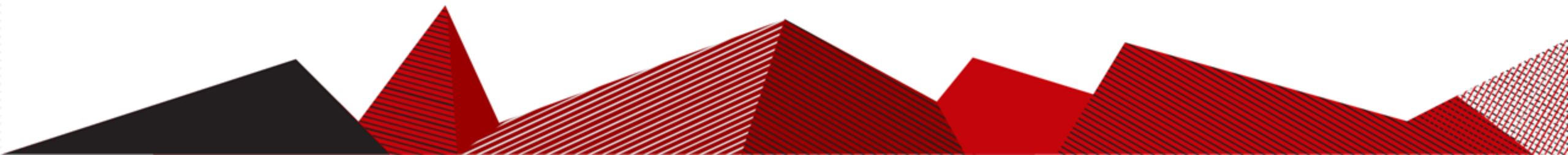


Muon-tagging = true





For Calo



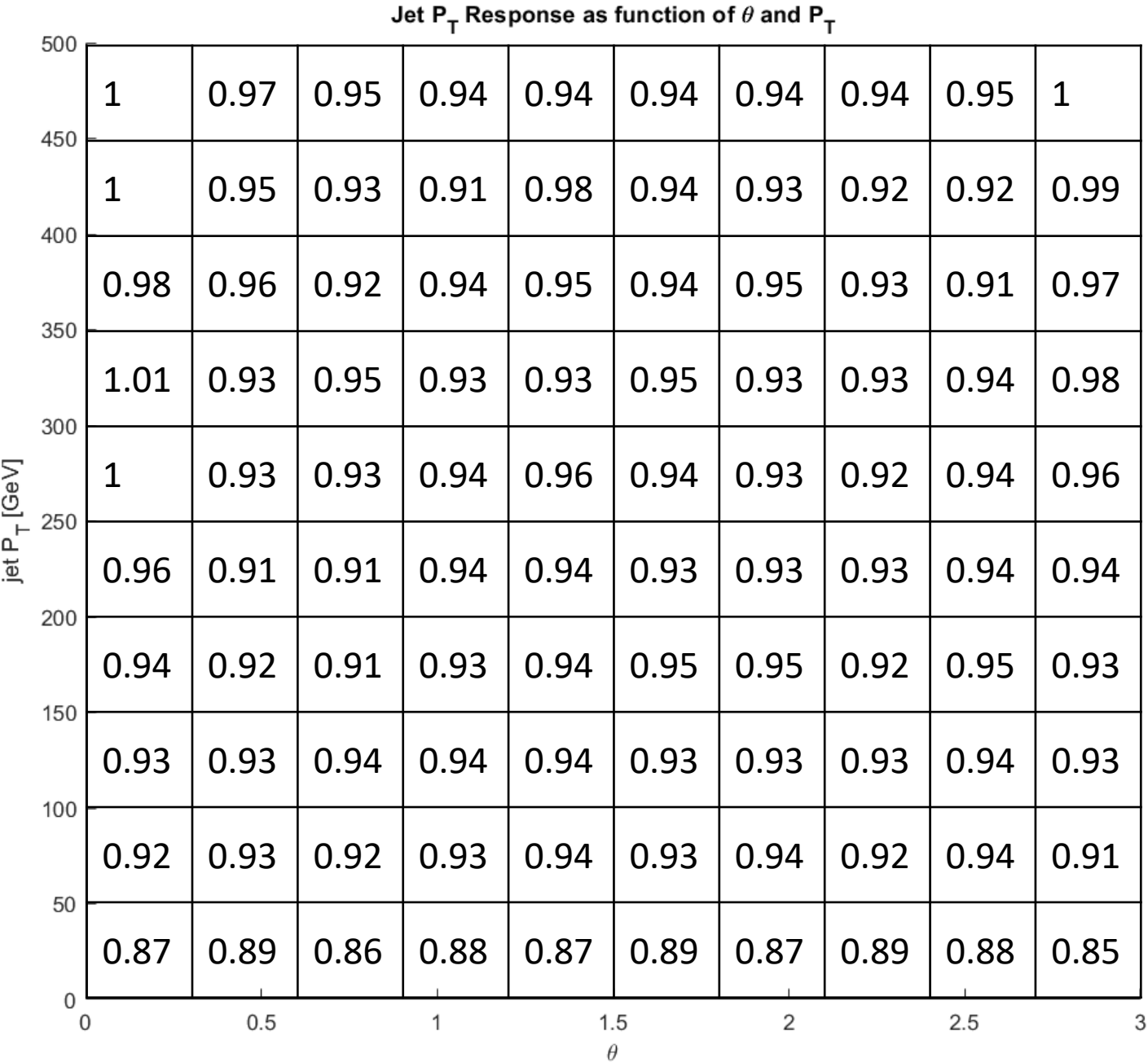


Percent of jet's been tagged





All jets





Muon-tagging = true

