



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

Kenny Jia

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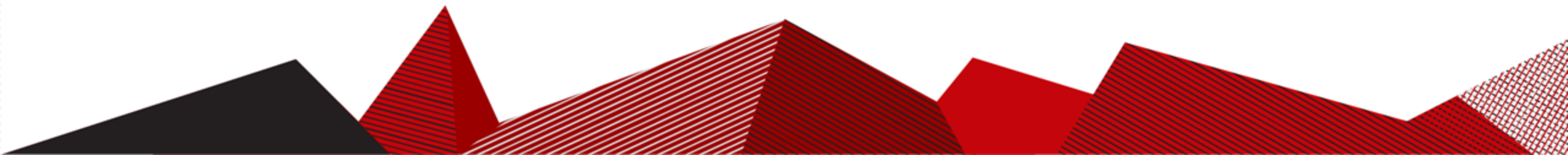




- Signal: $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + H + H$
- Background:
 - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + Z$
 - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + H$
 - $\mu^- + \mu^+ \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + b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



Review on Muon Collider Detector card workflow



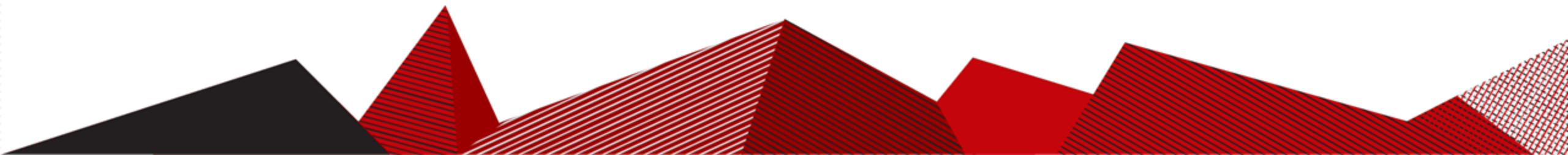


```
#####  
# Energy flow merger  
#####  
  
module Merger EFlowMerger {  
    # add InputArray InputArray  
    add InputArray HCal/eflowTracks  
    add InputArray ECal/eflowPhotons  
    add InputArray HCal/eflowNeutralHadrons  
add InputArray MuonMomentumSmearing/muons  
    set OutputArray eflow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

Muon removed from the inputs of Eflow tracks

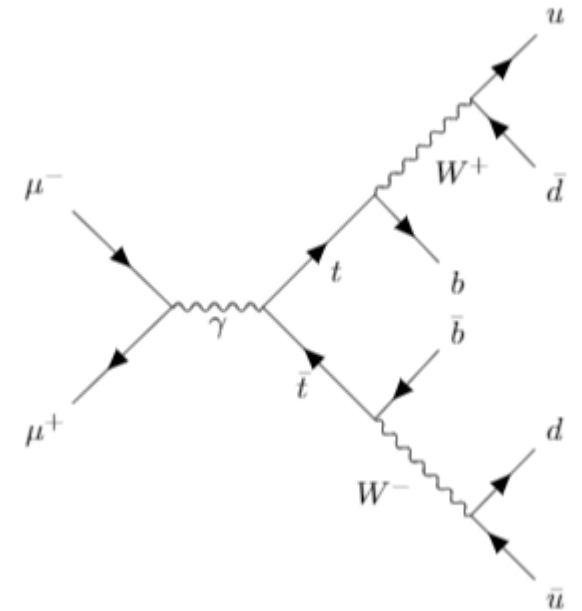


Jets Calibration





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



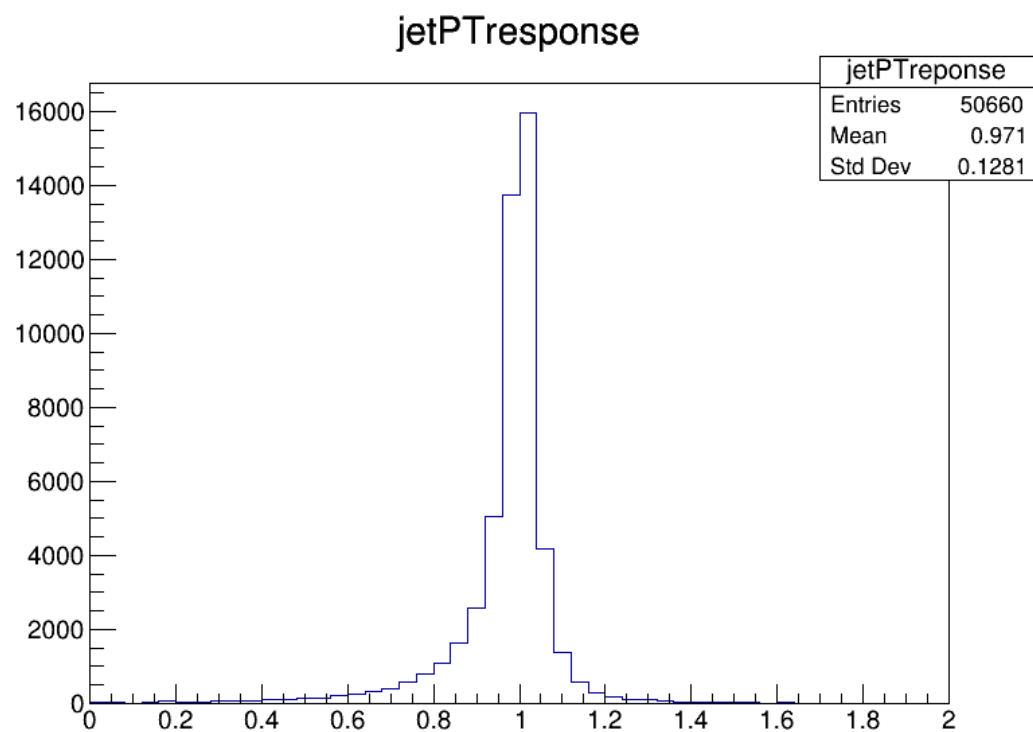


Muon-in-jet situation

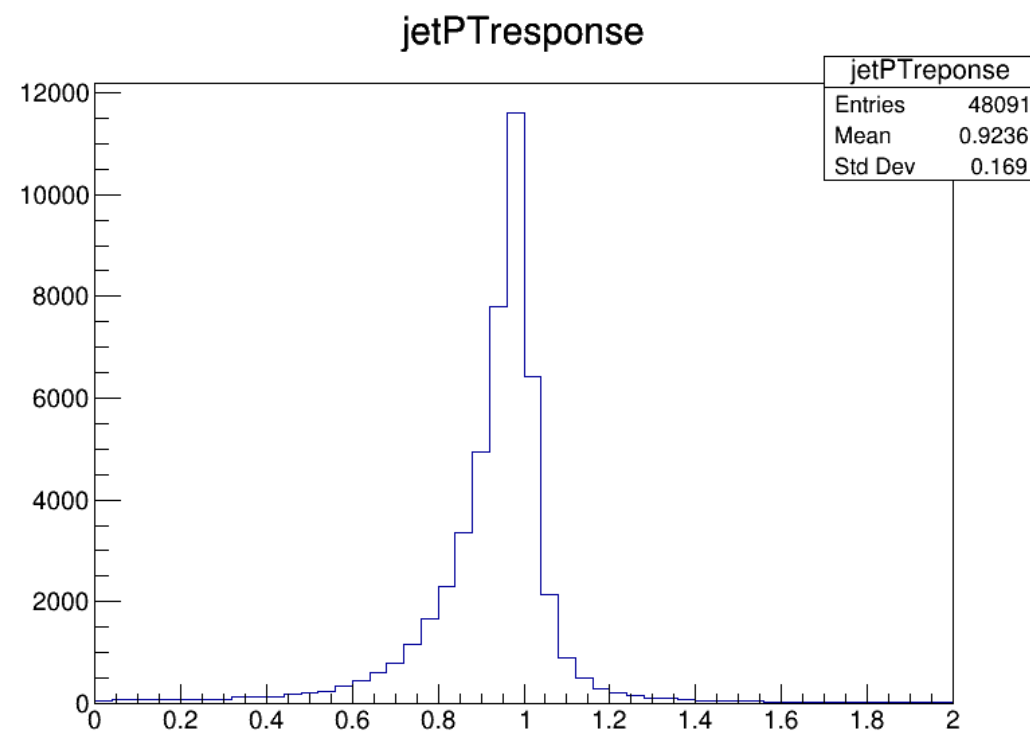
1. Create Muon-tagging:
 - Matching gen muon with gen jet
2. Compare result using EflowTrack and Calorimeter towers



Eflow Tracks



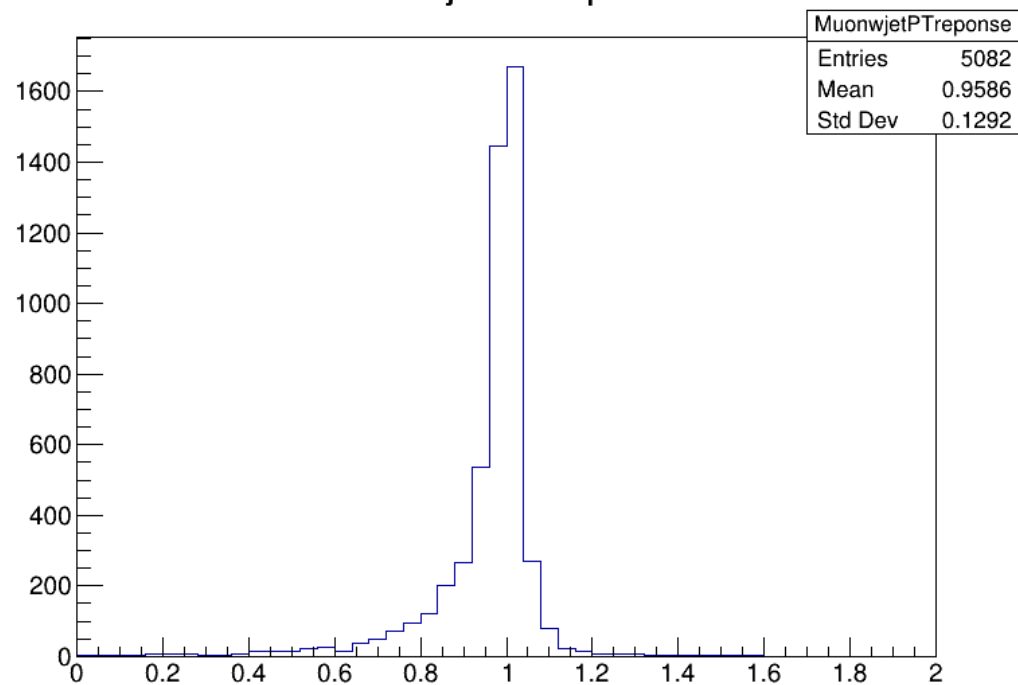
Calorimeter





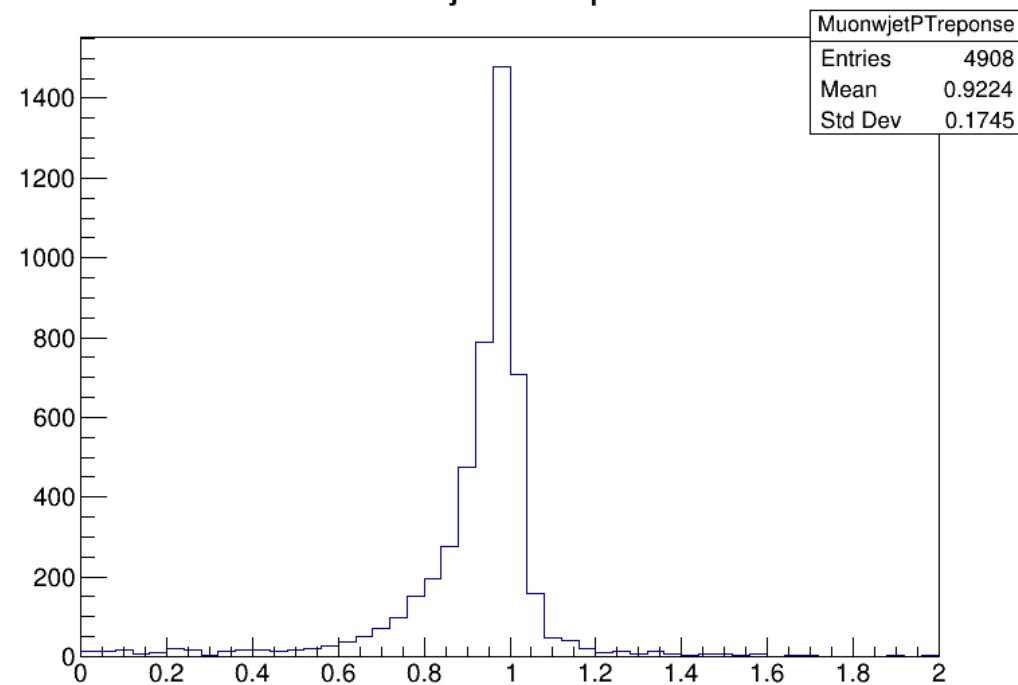
Eflow Tracks

MuonwjetPTresponse



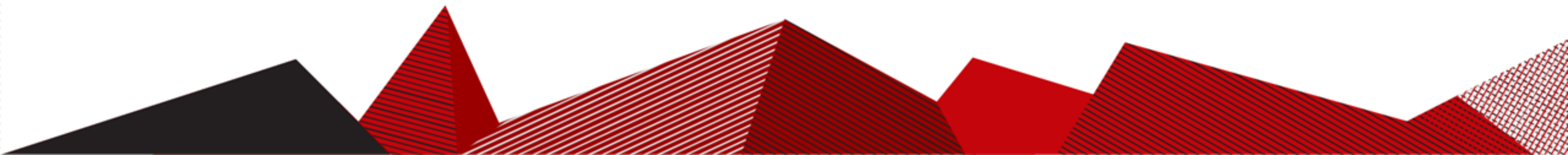
Calorimeter

MuonwjetPTresponse



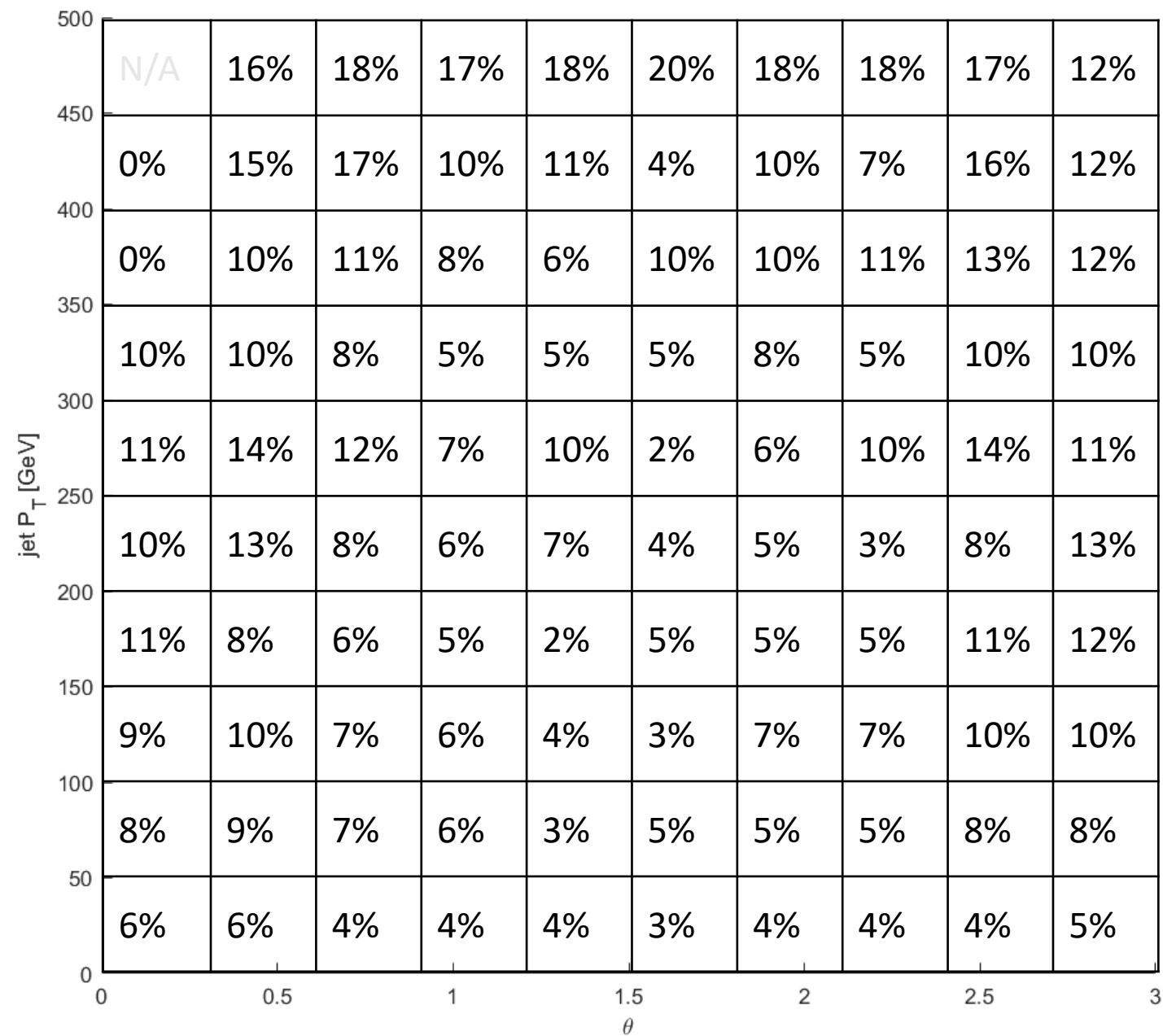


For ETrack



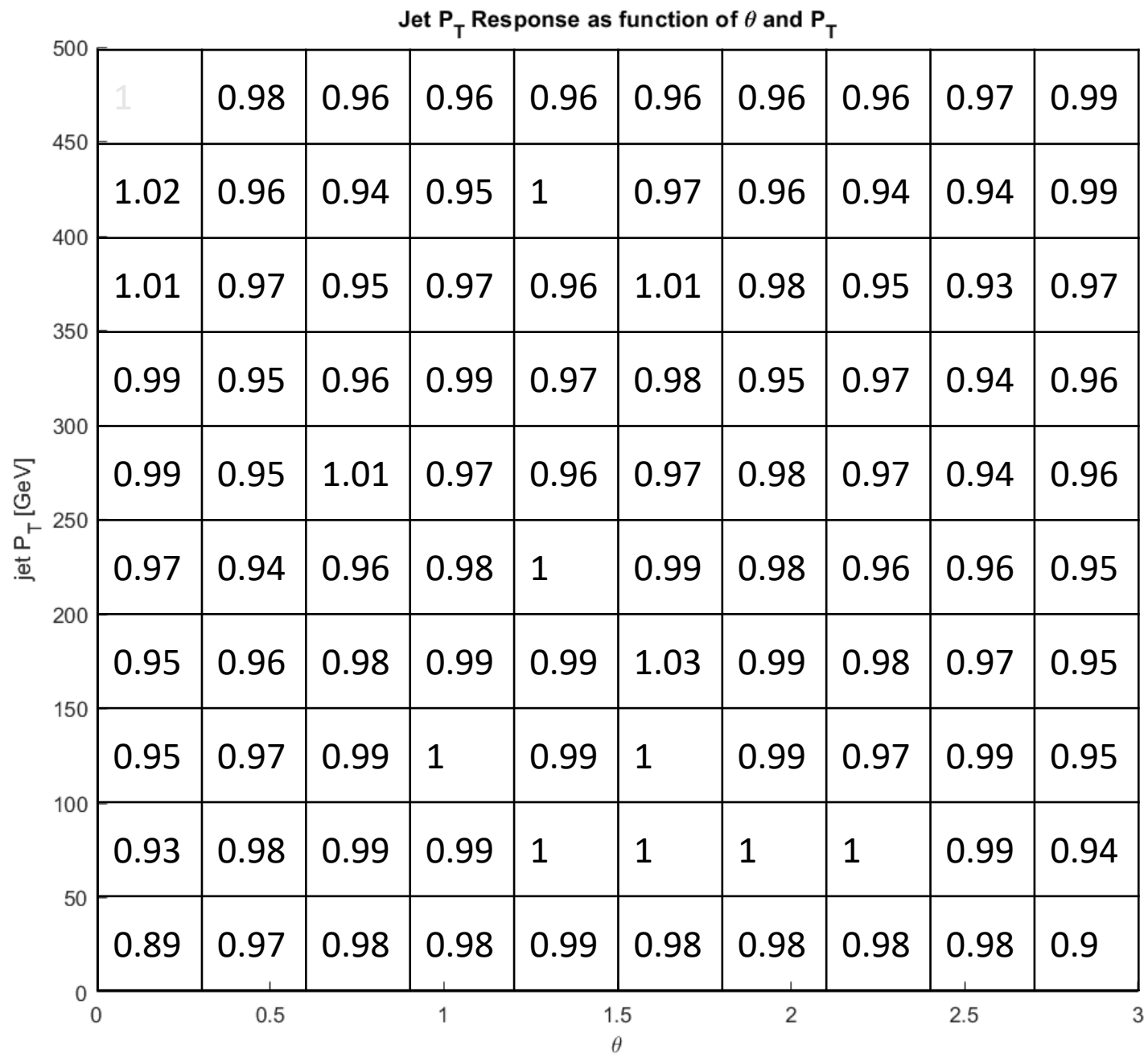


Percent of jet's
matched with a
GenJet with a muon
inside



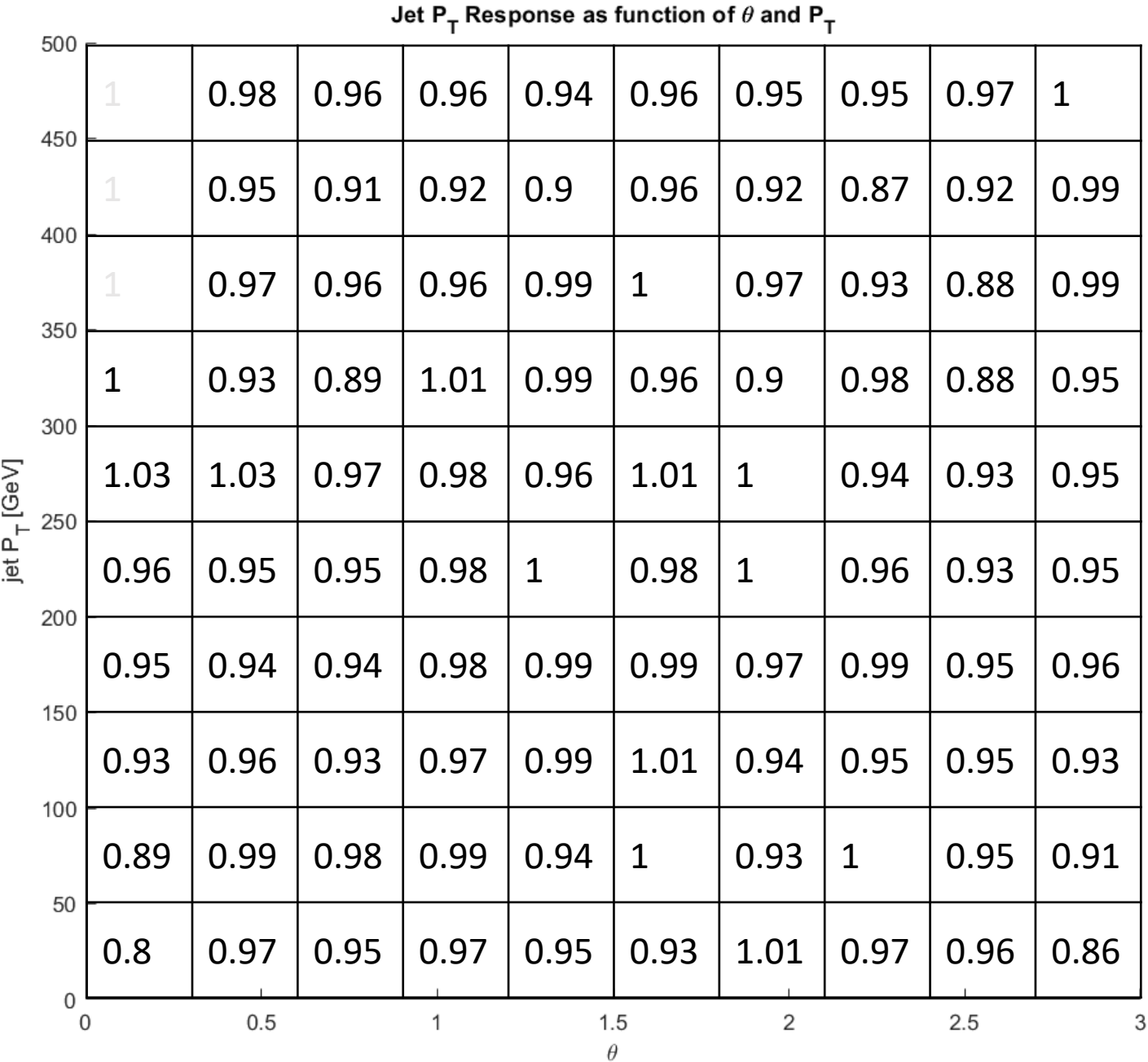


All jets



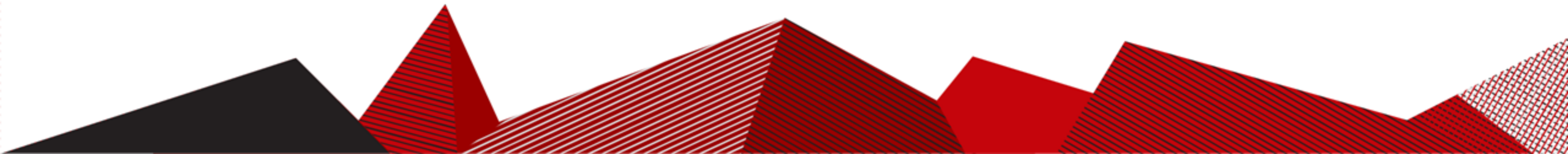


Muon-tagging = true





Program Structure





Combining Calibration and Pairing algorithm

- `void JetEnergyFix(Double_t AKTjeteta, Double_t AKTjetPt, Double_t JER[10][10]) { // Double_t MuonwJER[10][10], Double_t MuonwoJER[10][10], bool MuonTagging){`
 - Rescale the jet pT for given jet pT and eta
 - Called inside the pairing up algorithm,
 - }
- `void Calibration(const char *inputFile, const char *outputFile, Double_t JER[10][10]) { // Double_t MuonwJER[10][10], Double_t MuonwoJER[10][10]{`
 - For given input file for calibration, calculate JES then saved into 10 by 10 2d array for later use
 - }
- `void Pairing_w_JES(const char *inputFile, const char *outputFile, const char *inputFileForJES, const char *outputFileForJES) {`
 - Call Calibration
 - Pairing (call JetEnergyFix)
 - **Truth-matching**
 - Plotting
 - }



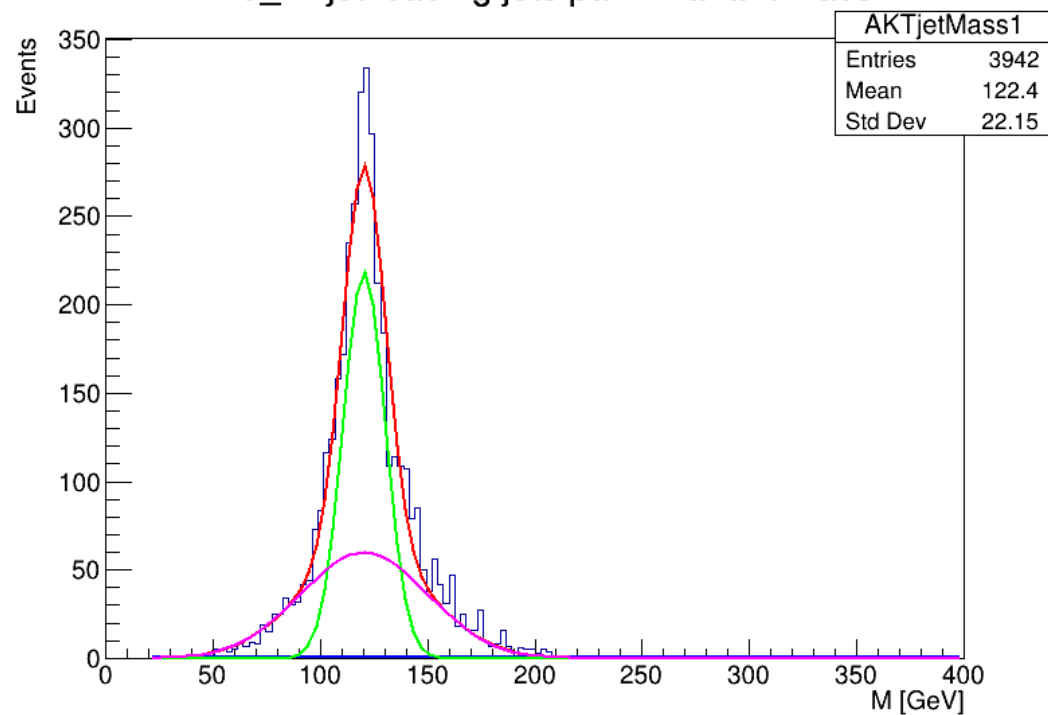
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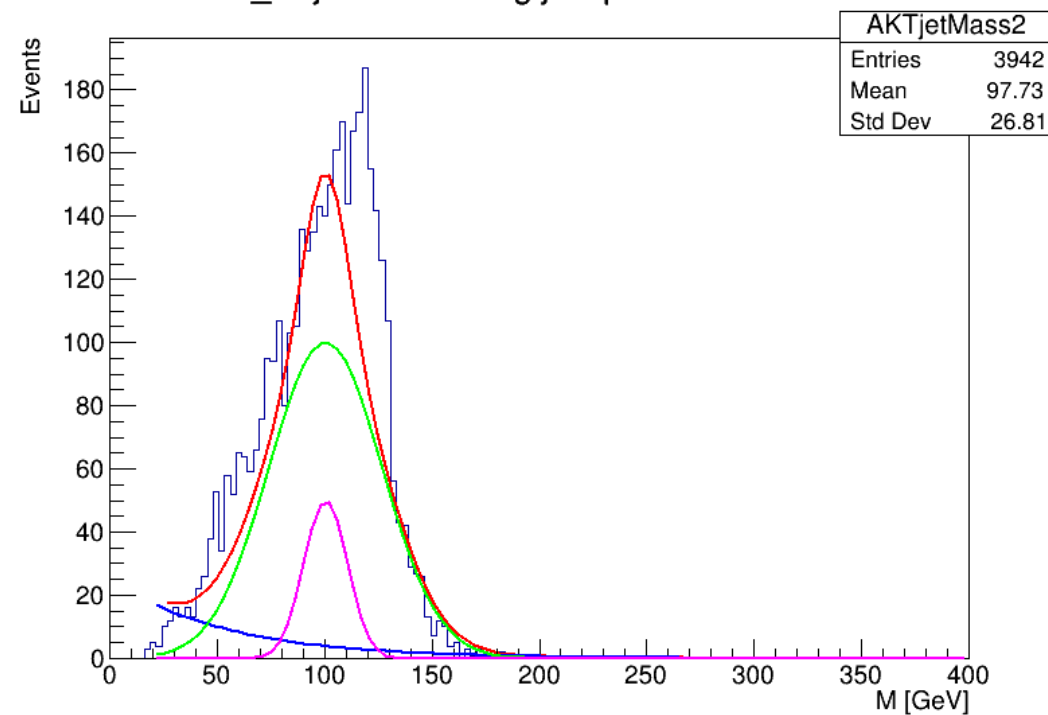


With Calibration

Anti_KTjet leading jets pair invariant mass



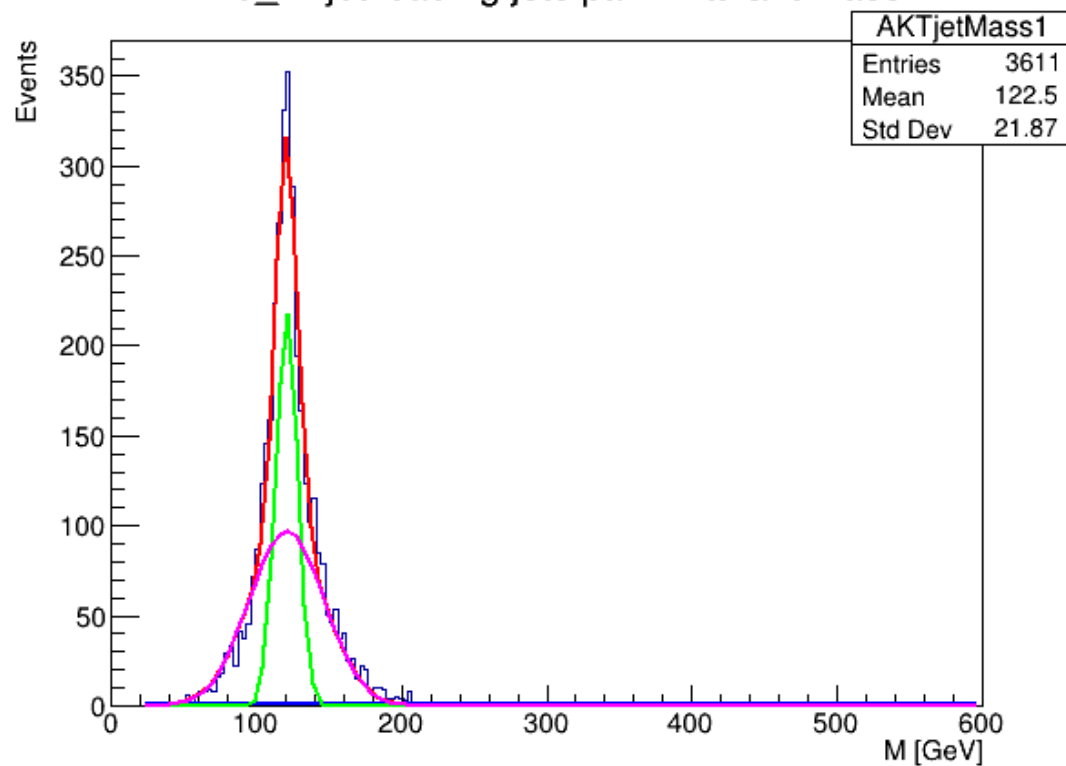
Anti_KTjet sub-leading jets pair invariant mass





w/o Calibration (truth-matching Valencia GenJet)

Anti_KTjet leading jets pair invariant mass



Anti_KTjet sub-leading jets pair invariant mass

