Delphes Simulation Studies on Higgs Pair Production in Muon Collider

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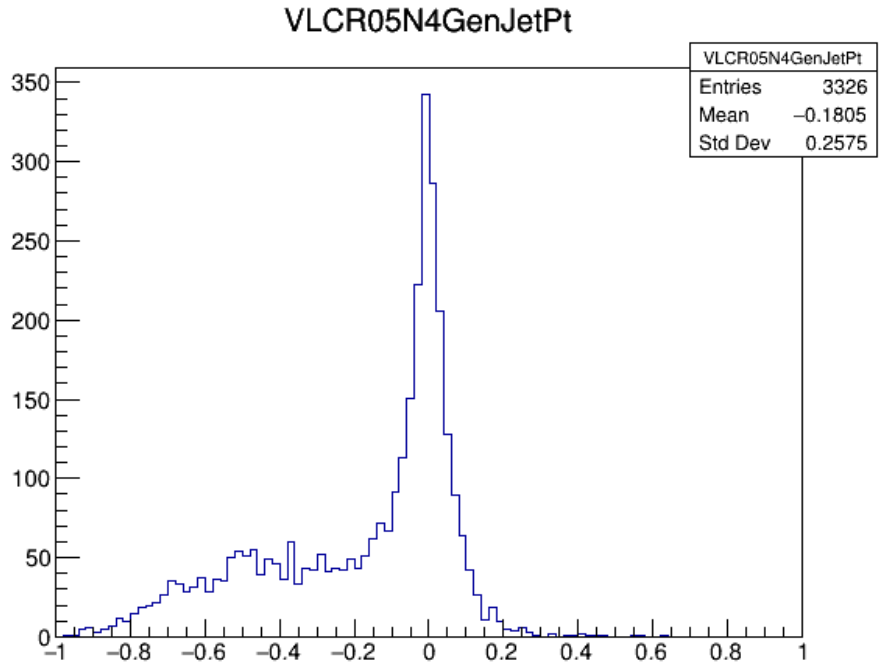
- Signal: $\mu^+ + \mu^- \rightarrow \nu_\mu + \bar{\nu}_\mu + H + H$
- Background:
  - $\mu^+ + \mu^- \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + Z$
  - $\mu^+ + \mu^- \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b} + H$
  - $\mu^+ + \mu^- \rightarrow \nu_\mu + \bar{\nu}_\mu + b + \bar{b}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

Reconstructing two Higgs bosons

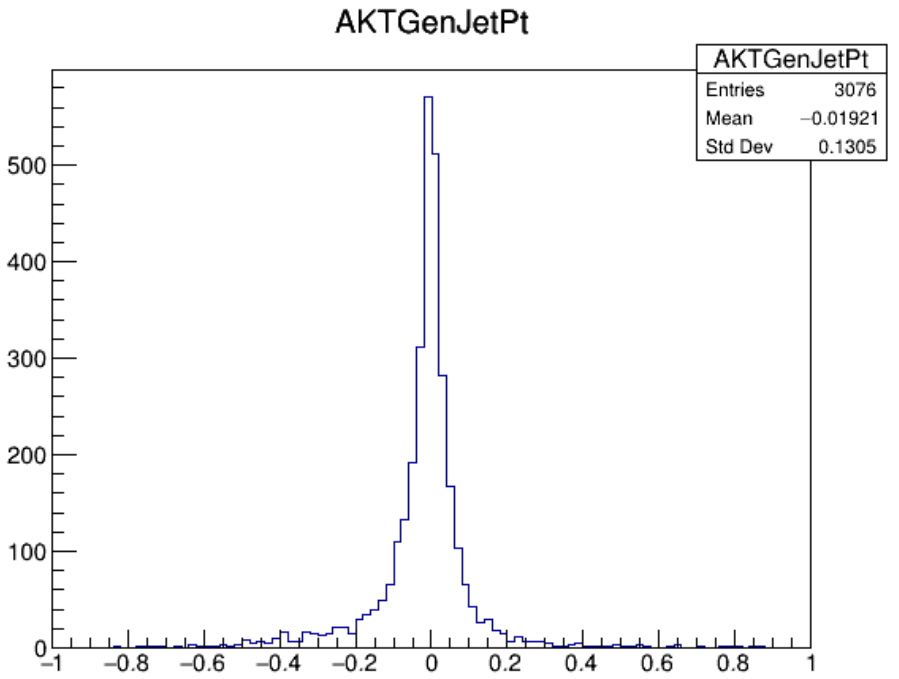
- Valencia Jets:
  - Choosing the pair with invariant mass closest to 125GeV to be the leading pair, rest two be the sub-leading pair. Then truth matching with GenJet and check the eta. 52% pass check
  - Invariant mass of sub-leading jets pair 63.57GeV: I think it might be caused by the problem of reconstructing p_T.

    lost ~18% comparing to GenJet

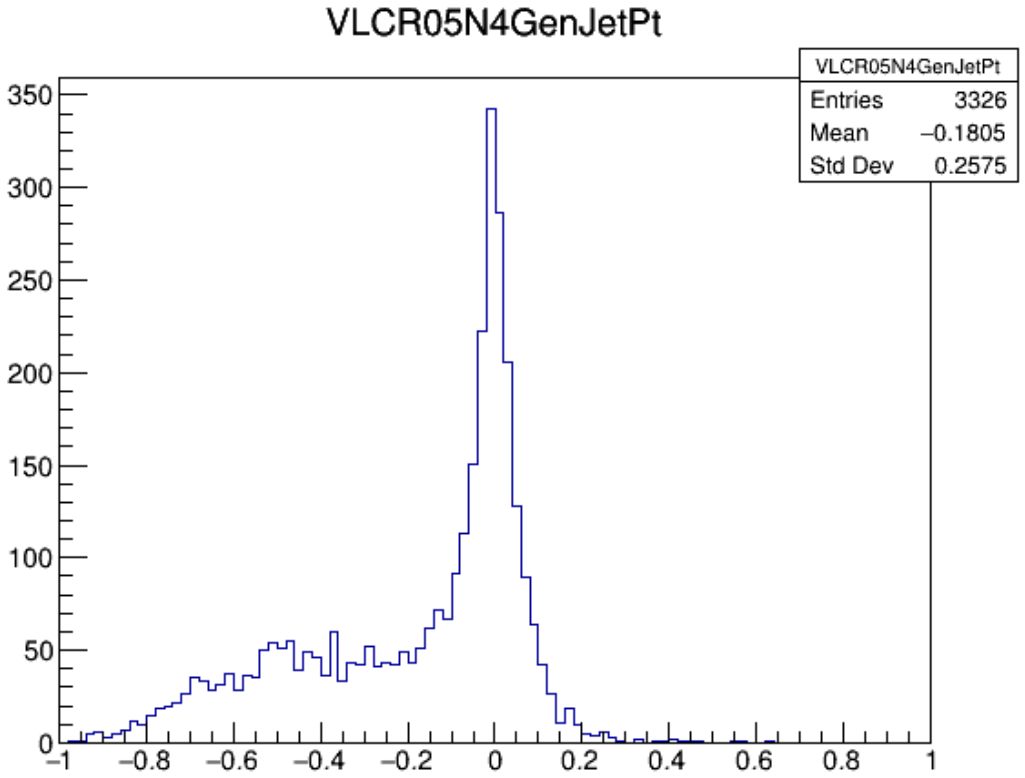


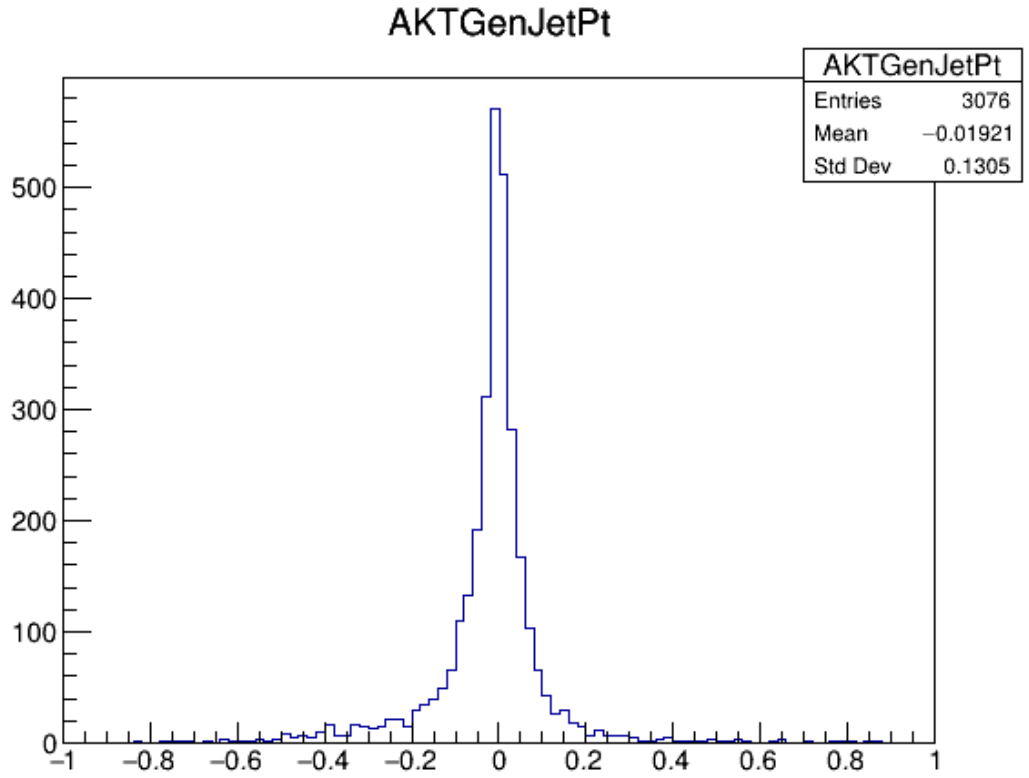
Reconstructing two Higgs bosons

- Anti-k_t Jets:
  - Only studied the events with at least 4 jets (or exactly 4), ordering the leading and sub-leading jets pair by distance to 125GeV. Then truth matching with GenJet. 30% pass check
  - Invariant mass of sub-leading jets pair 78.39GeV

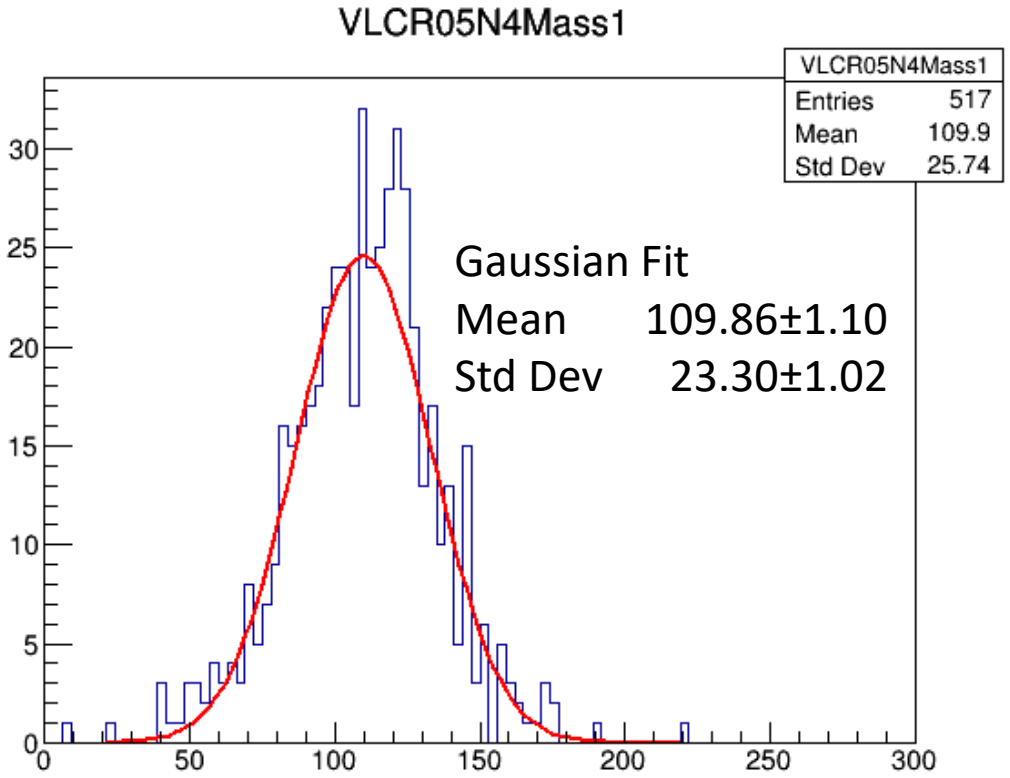


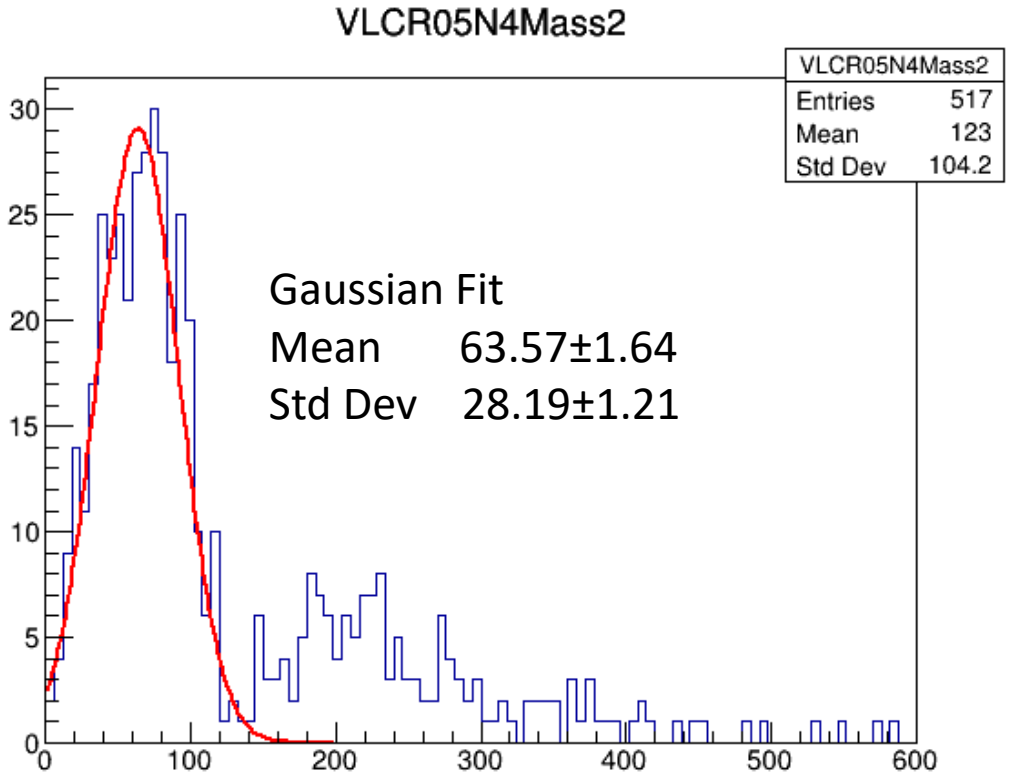
Comparison between Valencia and anti-k_t



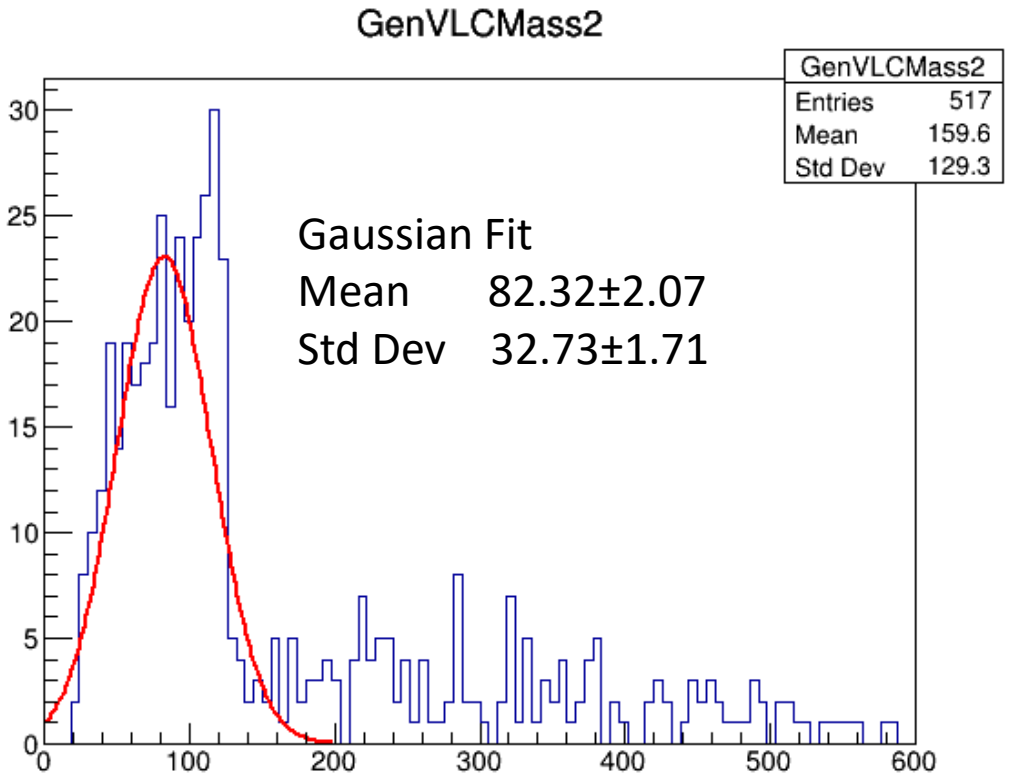


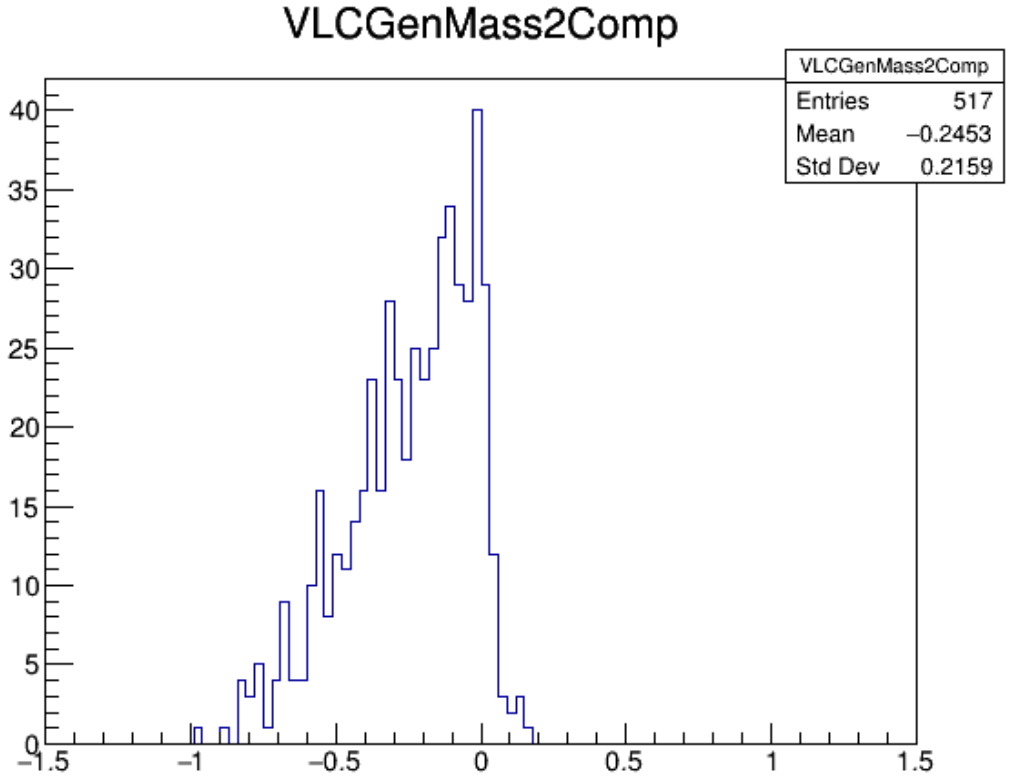
Valencia jet



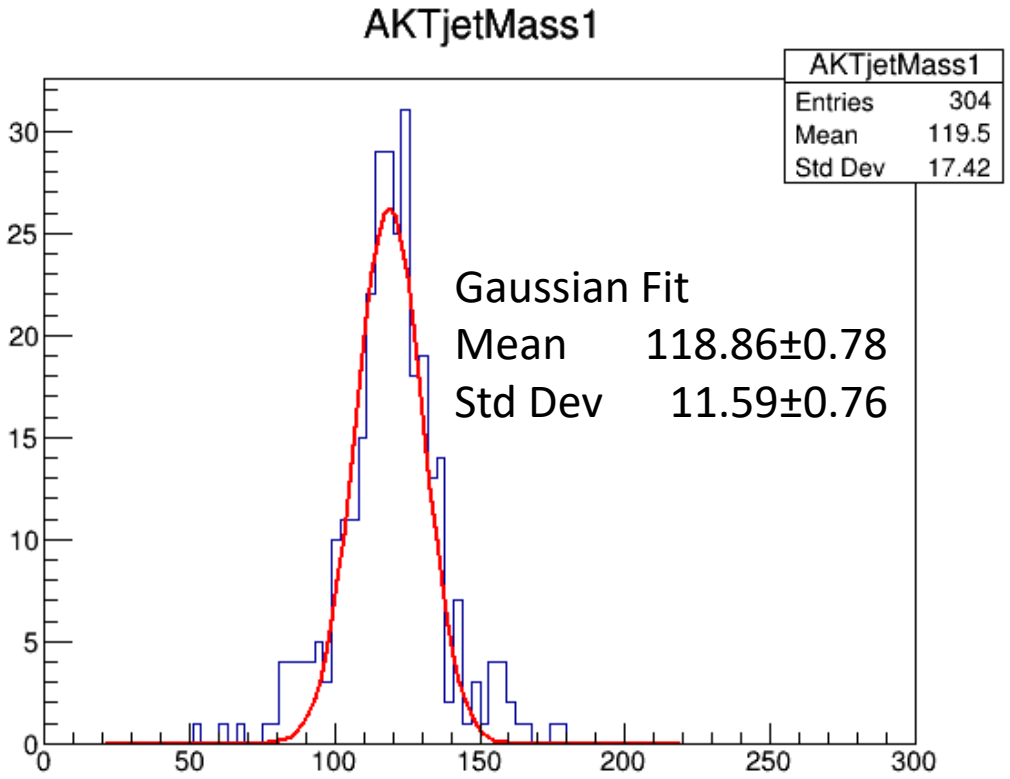


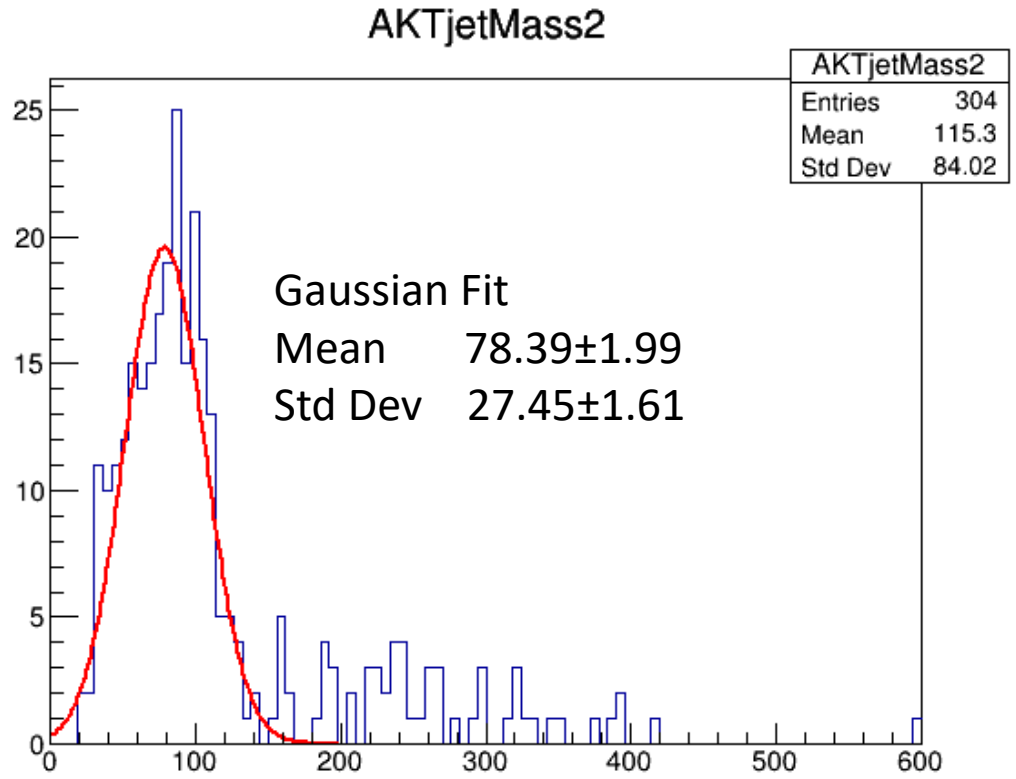
Valencia jet comparison with GenJet under same selection



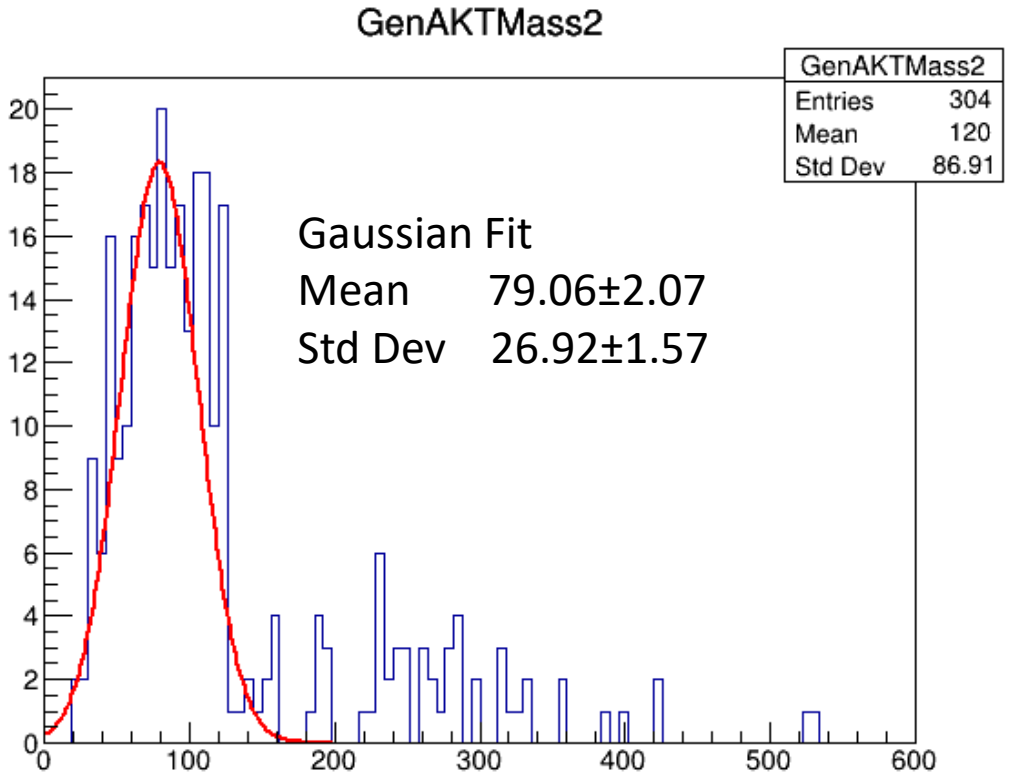


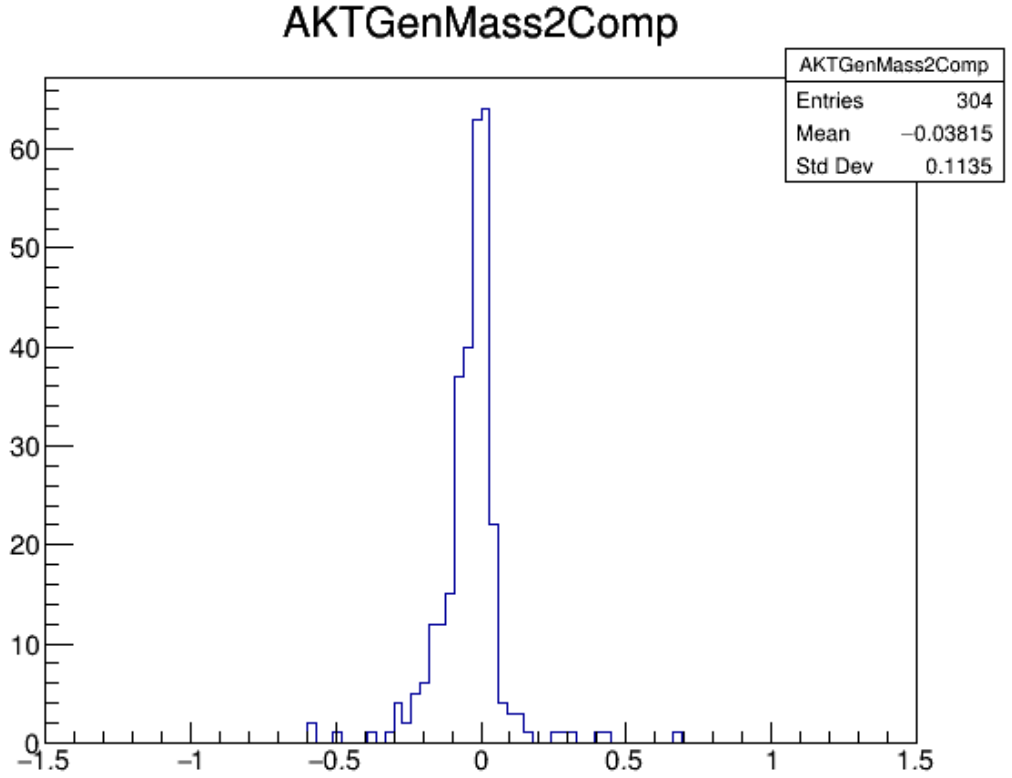
Anti-k_t jet


AKTjetMass1
AKTjetMass1
Entries 304
Mean 119.5
Std Dev 17.42
Gaussian Fit
Mean 118.86±0.78
Std Dev 11.59±0.76
0
5
10
15
20
25
30
0
50
100
150
200
250
300

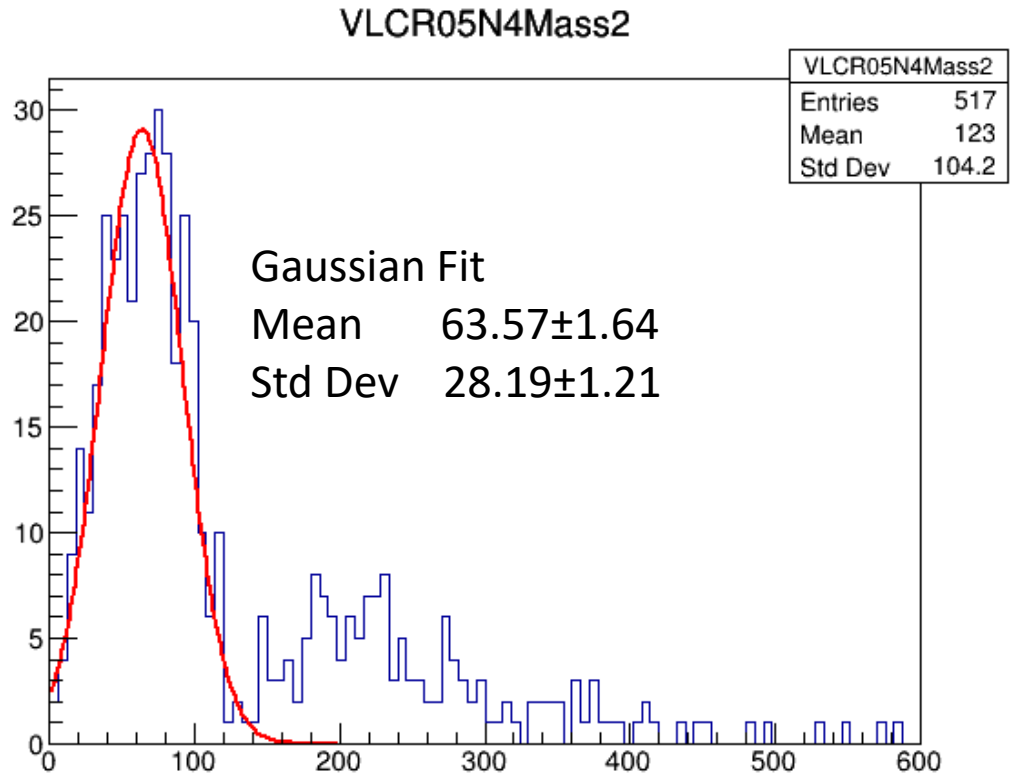

AKTjetMass2
AKTjetMass2
Entries 304
Mean 115.3
Std Dev 84.02
Gaussian Fit
Mean 78.39±1.99
Std Dev 27.45±1.61
0
5
10
15
20
25
0
100
200
300
400
500
600

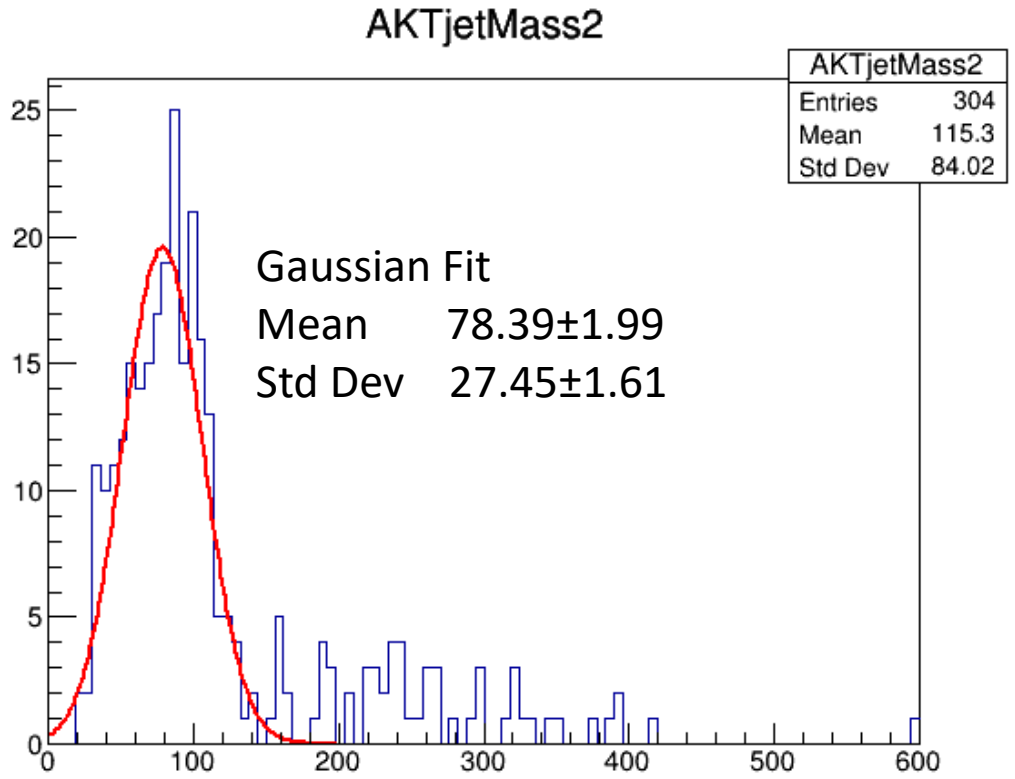
Anti-k_t jet comparison with GenJet under same selection





Comparison on the sub-leading jets pair





Appendix: data card for run anti-k_t jet algo

```
1633  ###############
1634  # Jet finder AKT
1635  ###############
1636
1637  module FastJetFinder FastJetFinderAKt {
1638      #  set InputArray Calorimeter/towers
1639      set InputArray EFlowMerger/eflow
1640
1641      set OutputArray AKTjets
1642
1643      # algorithm: 1 CDFJetClu, 2 MidPoint, 3 SIScone, 4 kt, 5 Cambridge/Aachen, 6 antikt
1644      set JetAlgorithm 6
1645      set ParameterR 0.5
1646
1647      set JetPTMin 20.0
1648  }
```

Appendix B: Uncut GenJet sub-leading jet pair