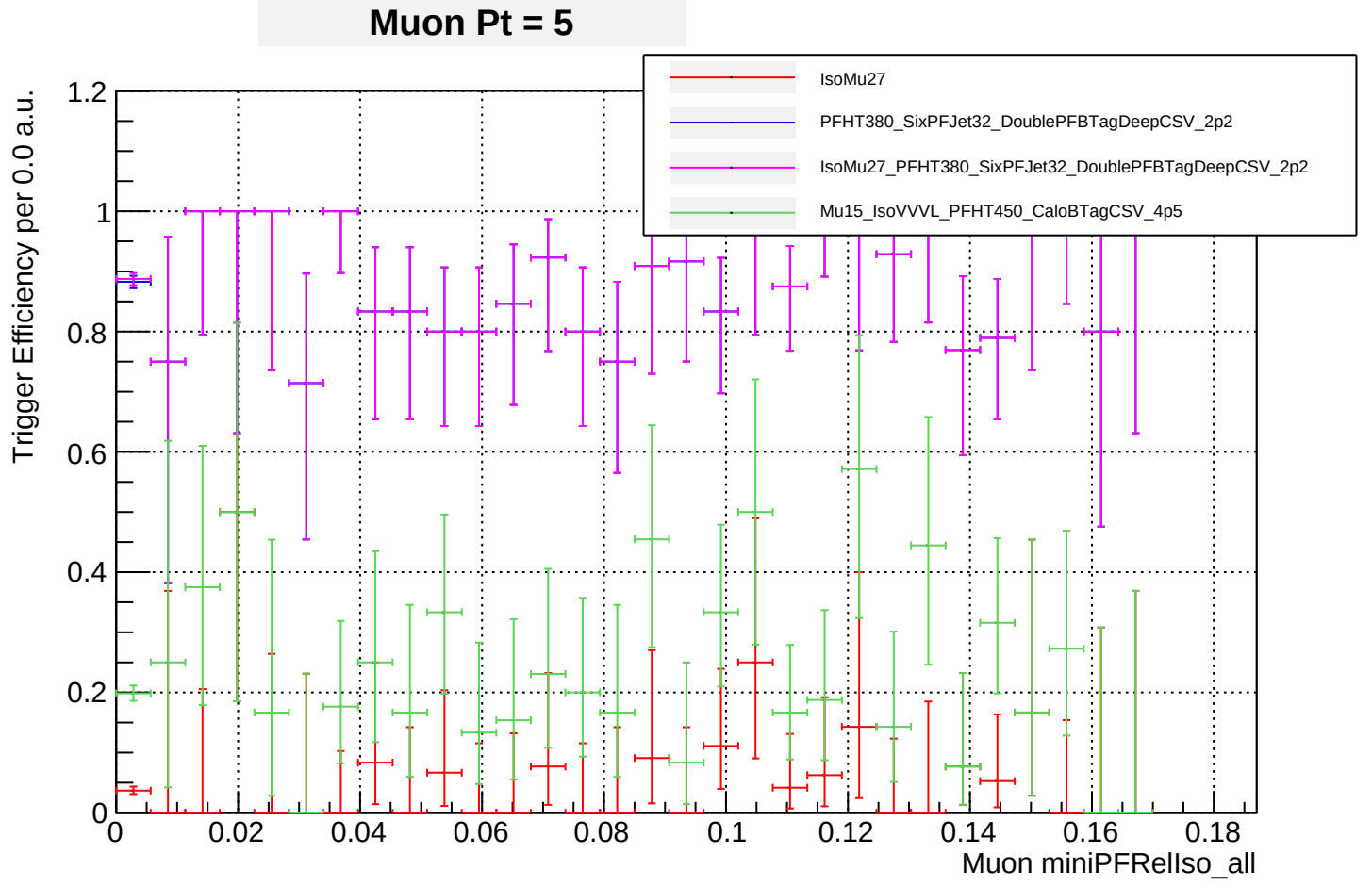
On-line (pre-)selection Requisites for:

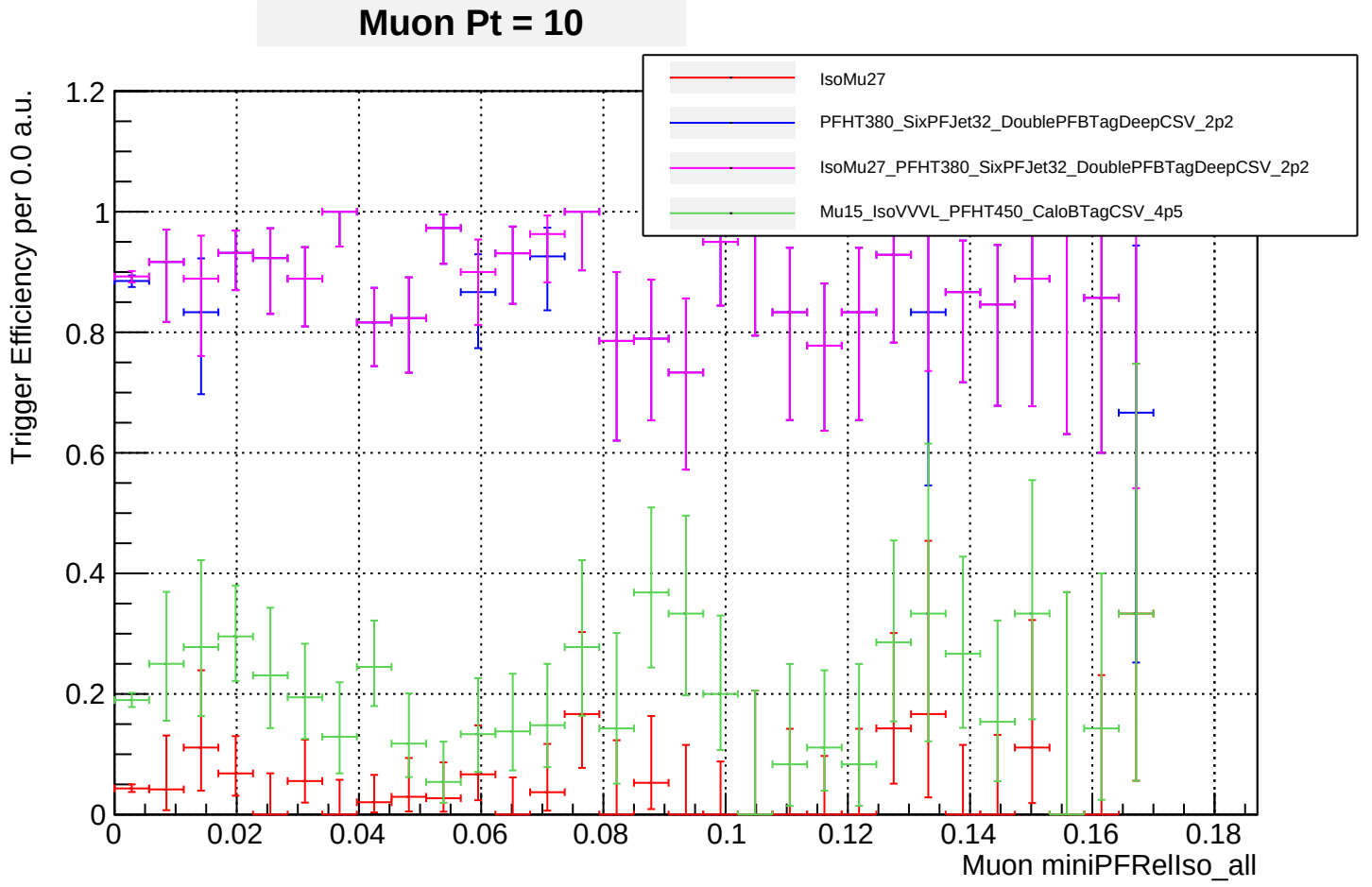
- **Jets:** number > 5
- **Muons plus Electrons:** number > 0

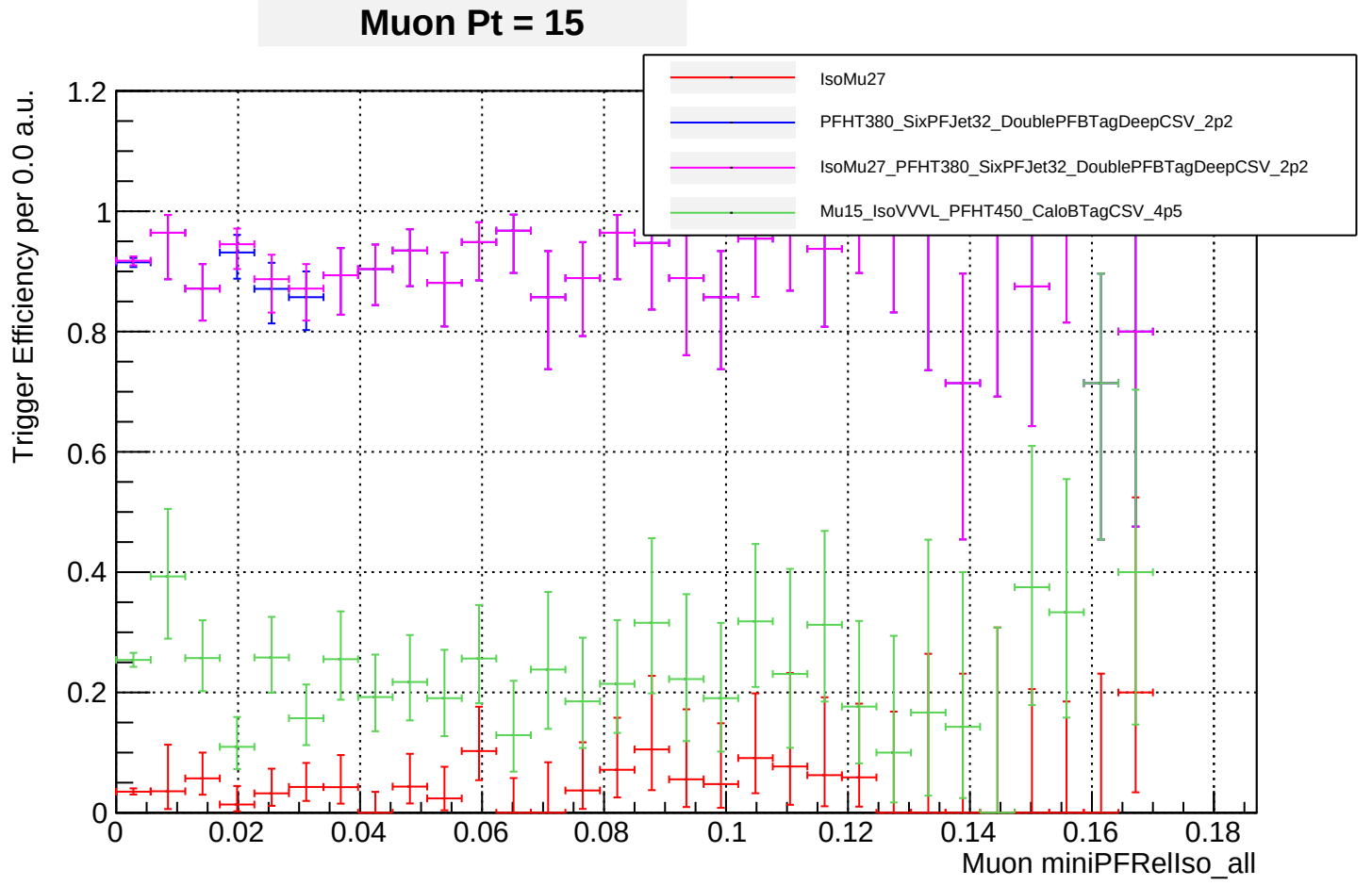
Event Limit: None (see last page)

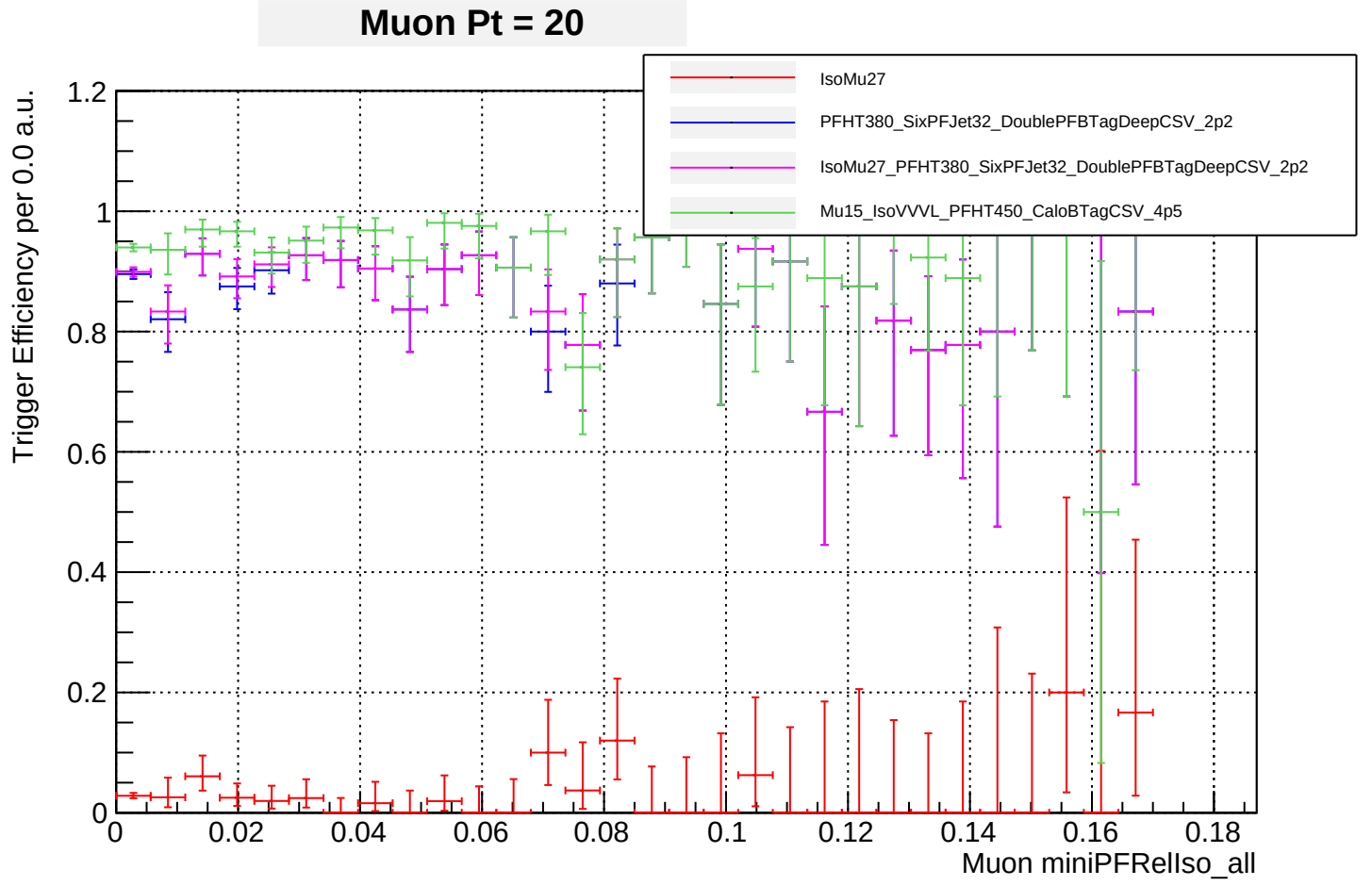
Off-line (post-)selection Requisites for:

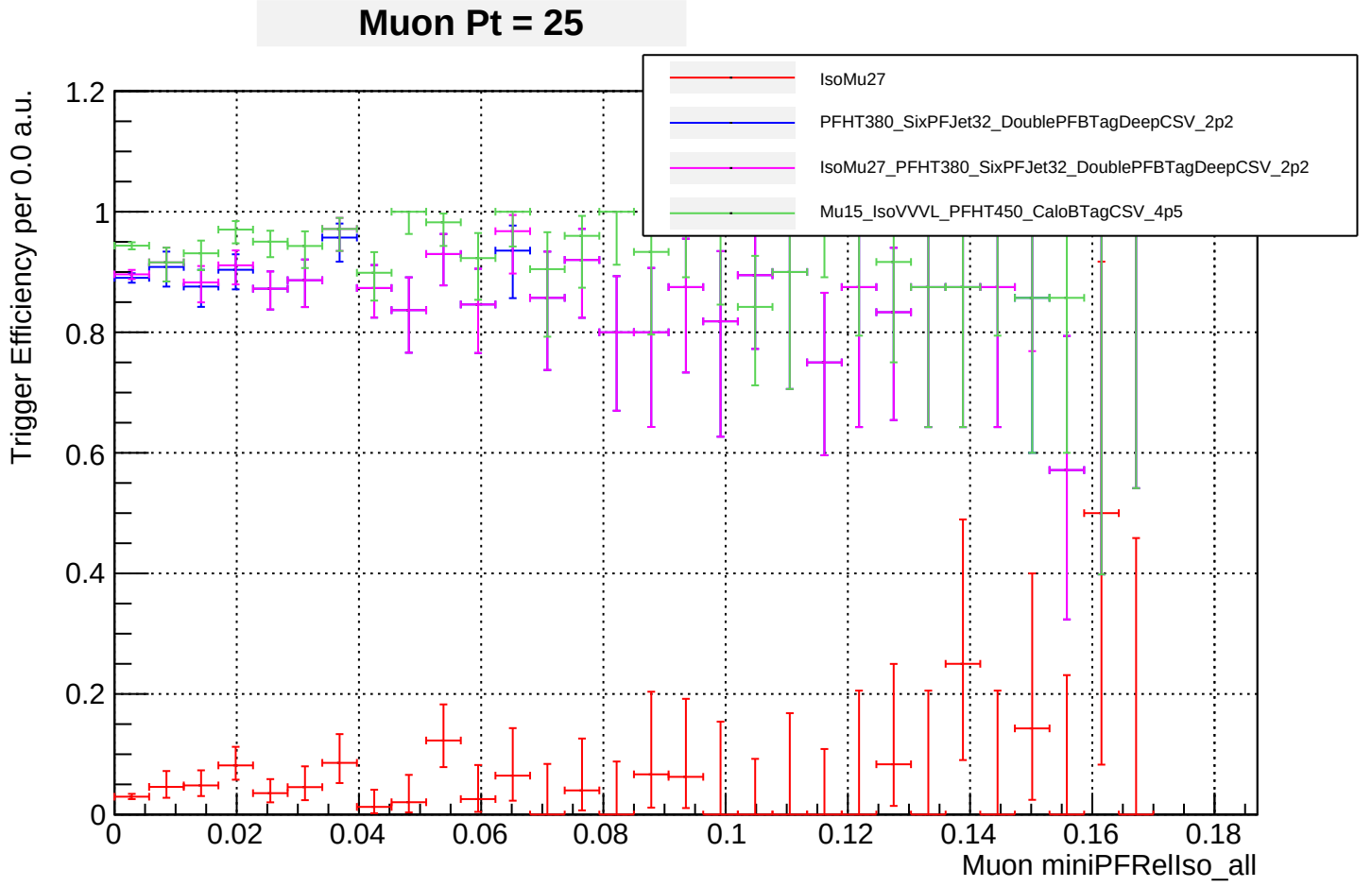
- **Jets:** jetId > 2 , p_T > 30 and |η|<2.4 (for at least 6 jets)
  btagDeepFlavB > 0.7489 (for at least one jet)
- **Muons:** has tightId, |η|<2.4 and PFRelIso_all<0.15 (for at least 1)

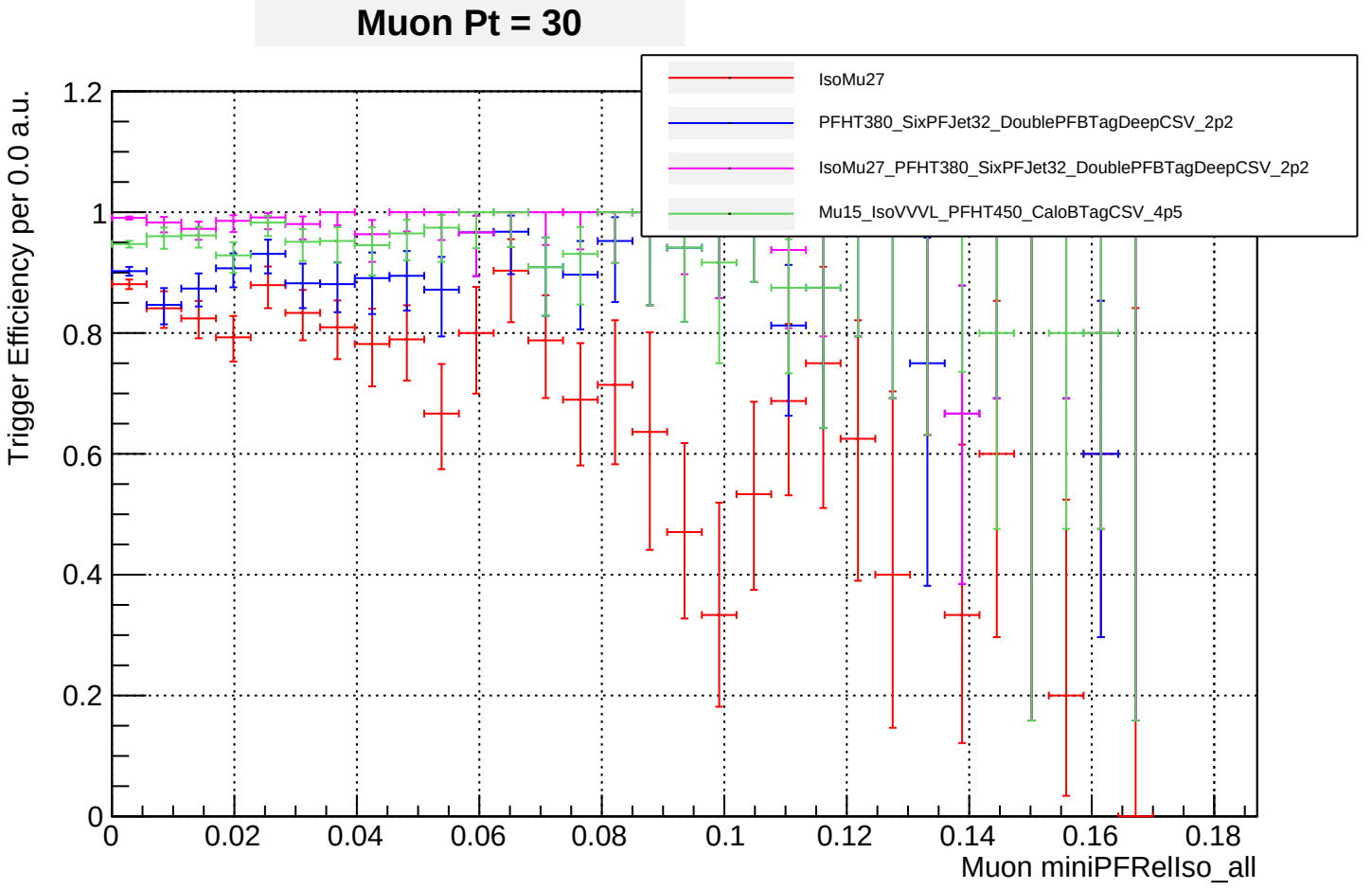

Muon Pt = 5
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

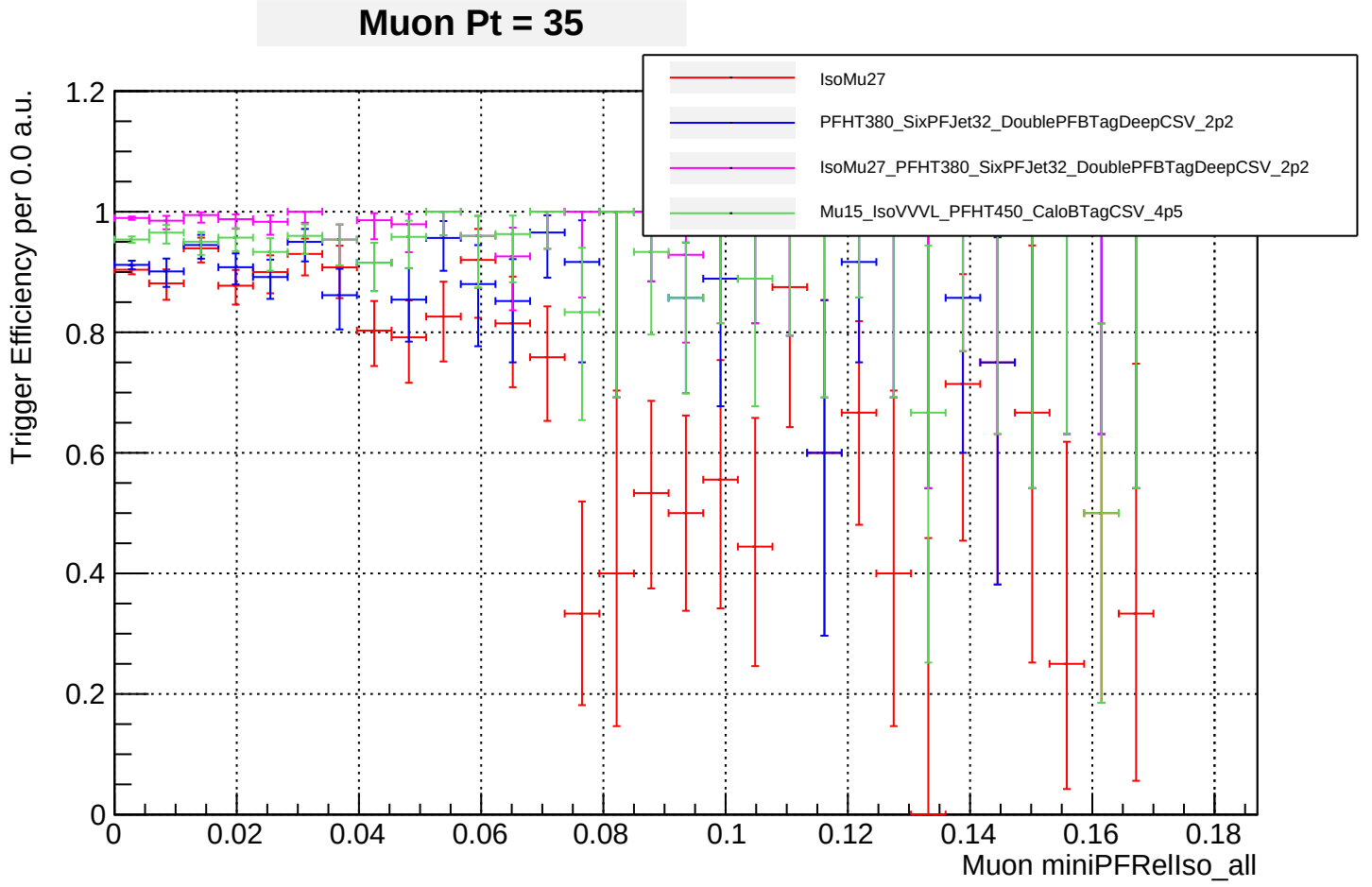

Muon Pt = 10
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

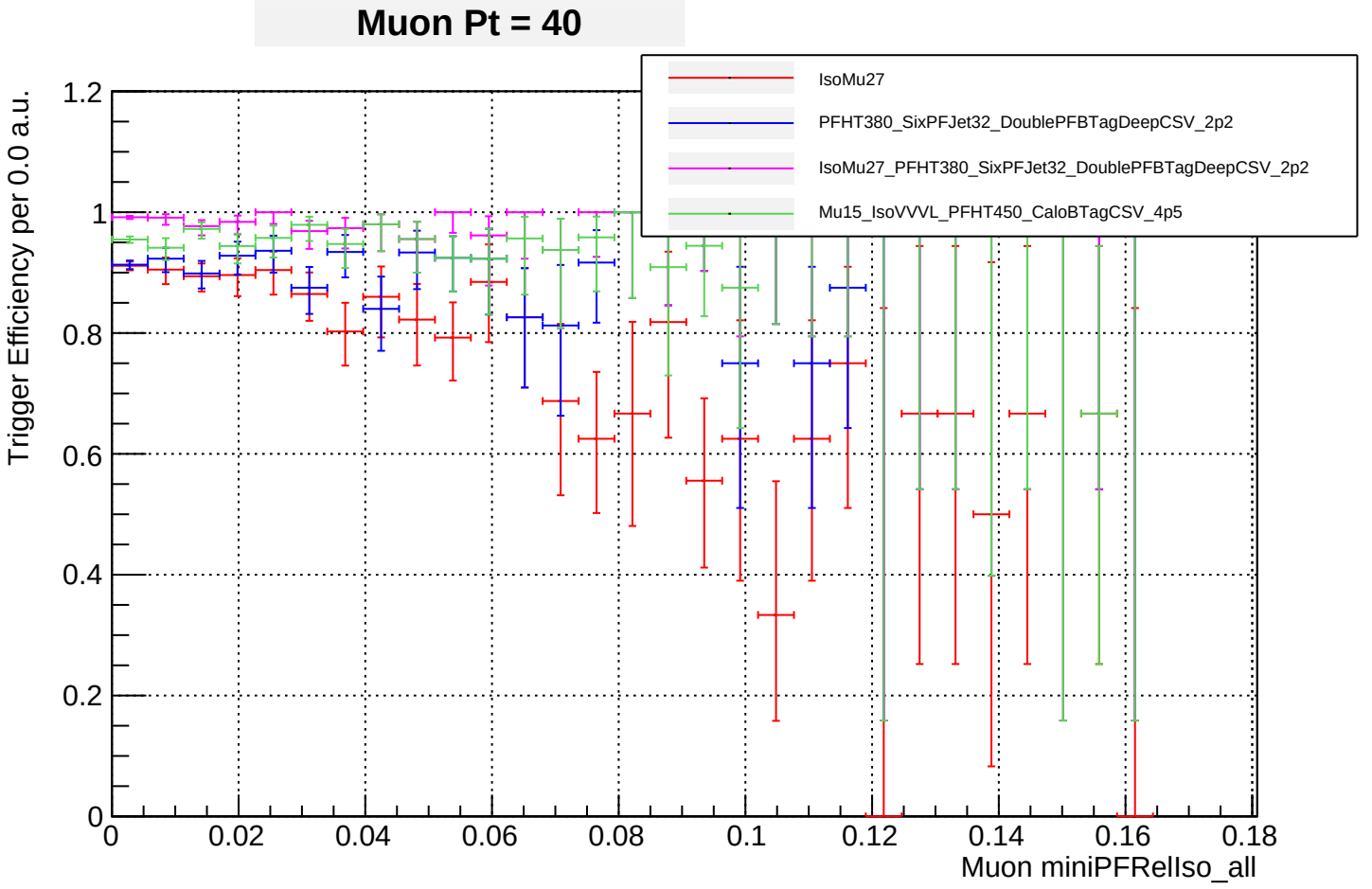

Muon Pt = 15
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

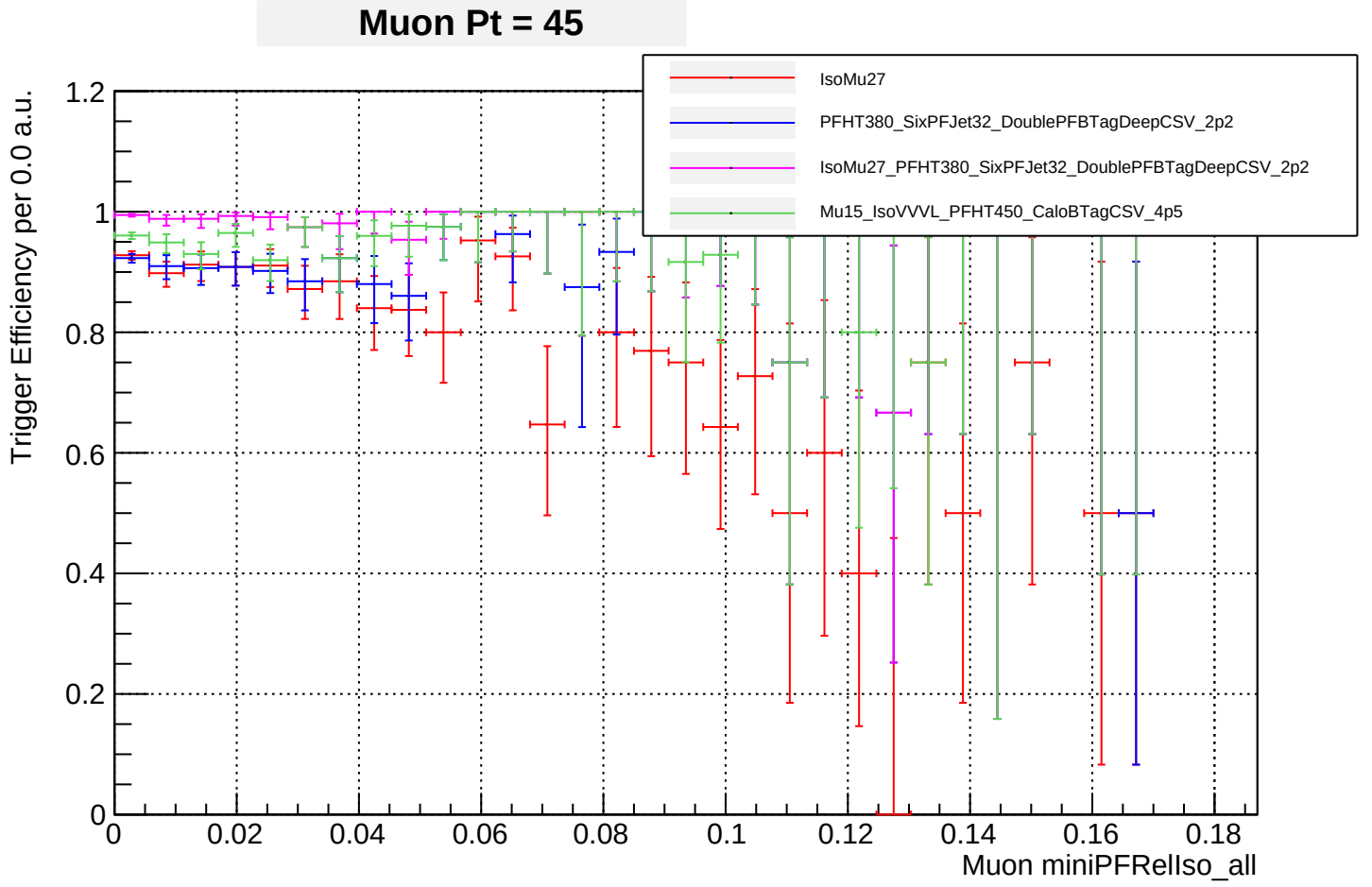

Muon Pt = 20
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
1.2
1
0.8
0.6
0.4
0.2
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
Muon miniPFRelIso_all

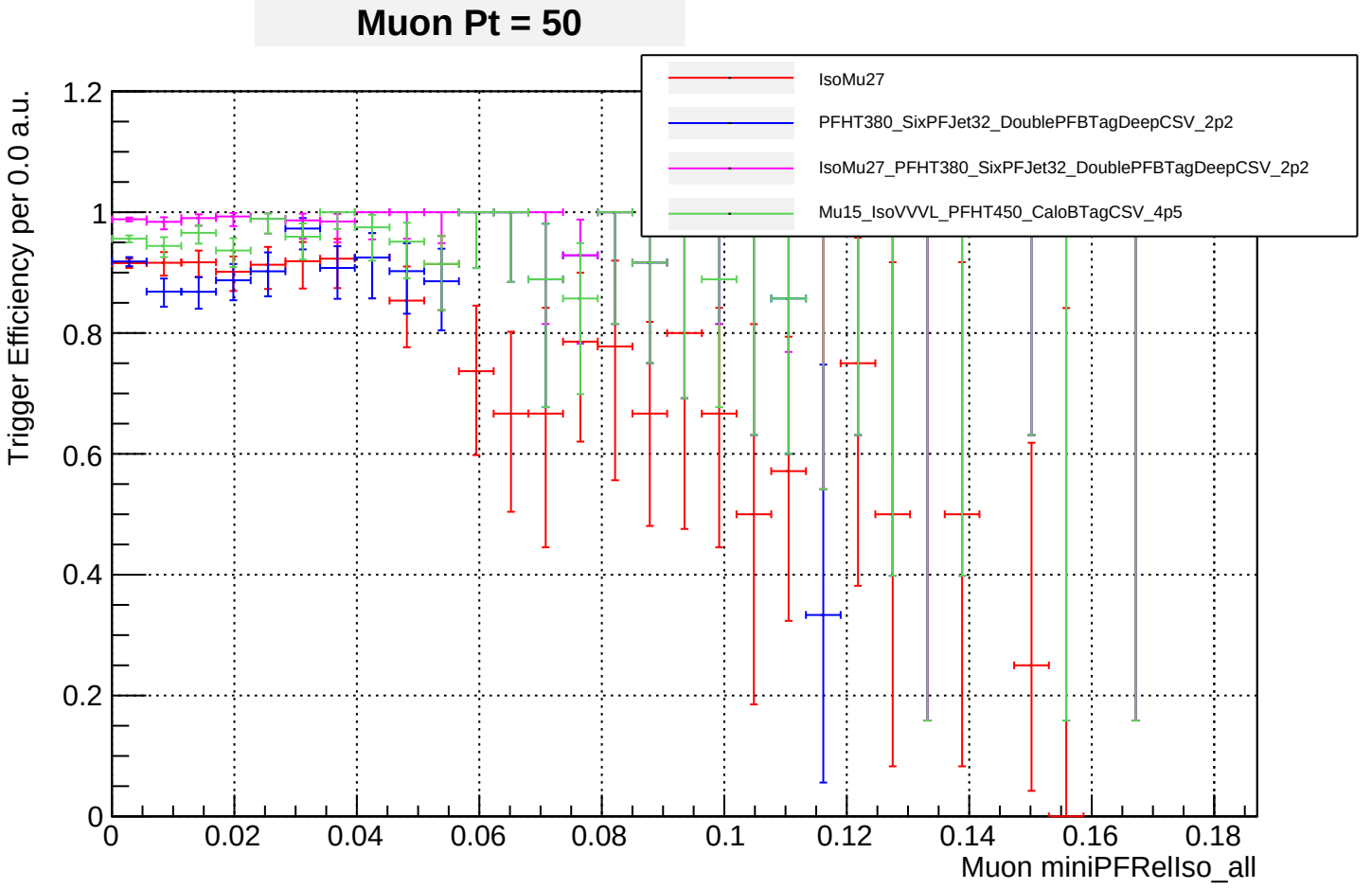

Muon Pt = 25
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

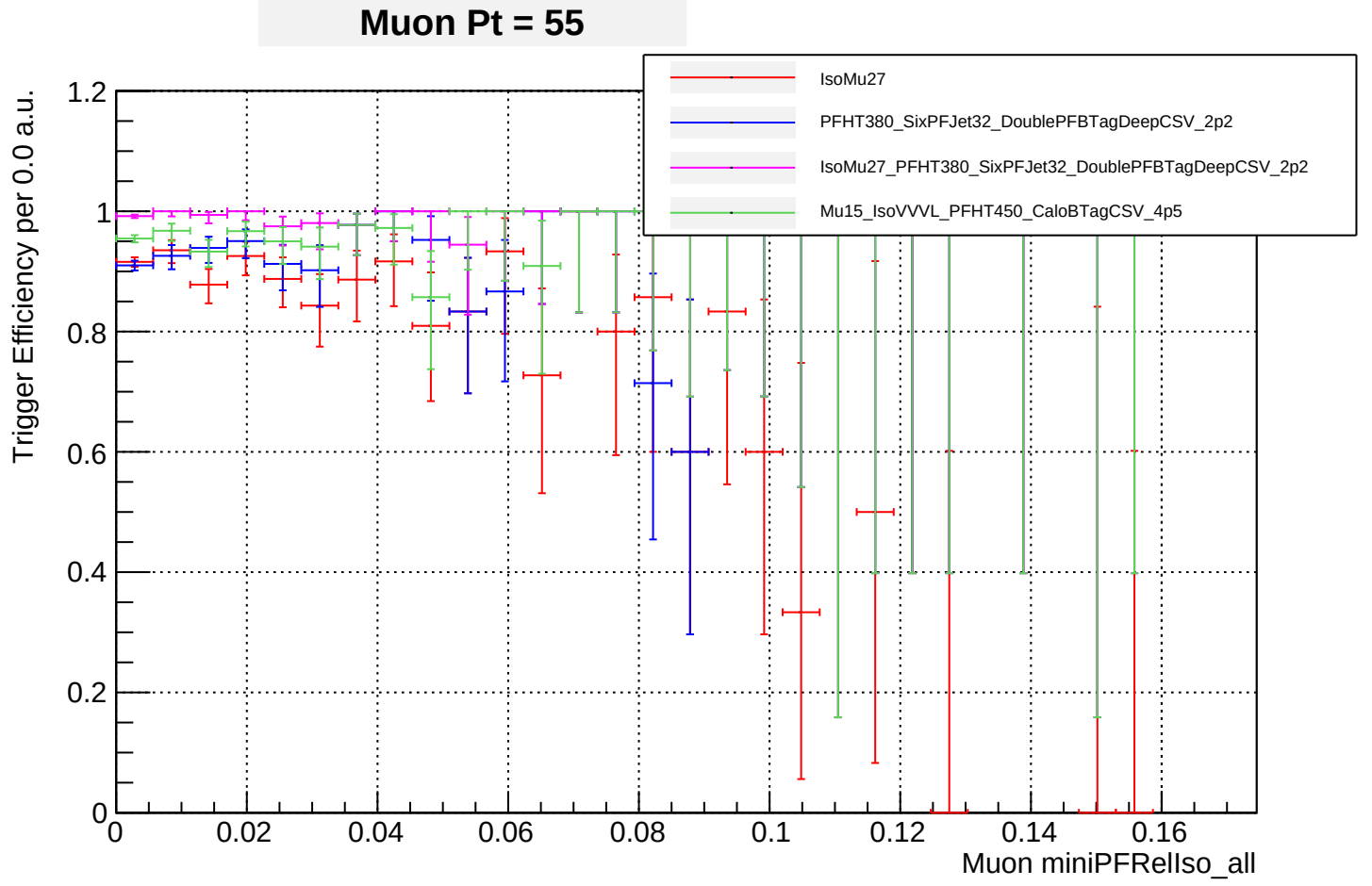

Muon Pt = 30
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

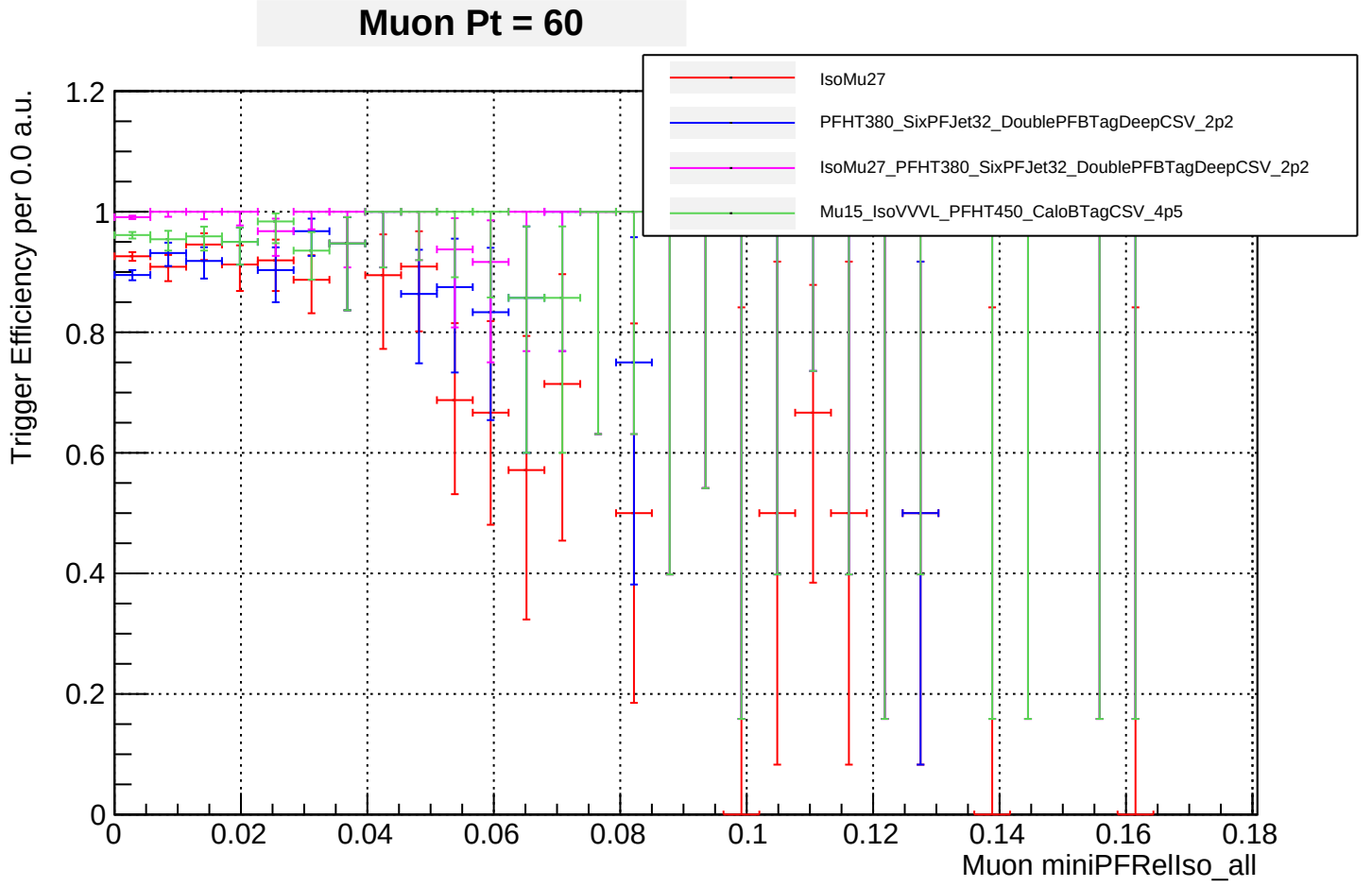

Muon Pt = 35
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

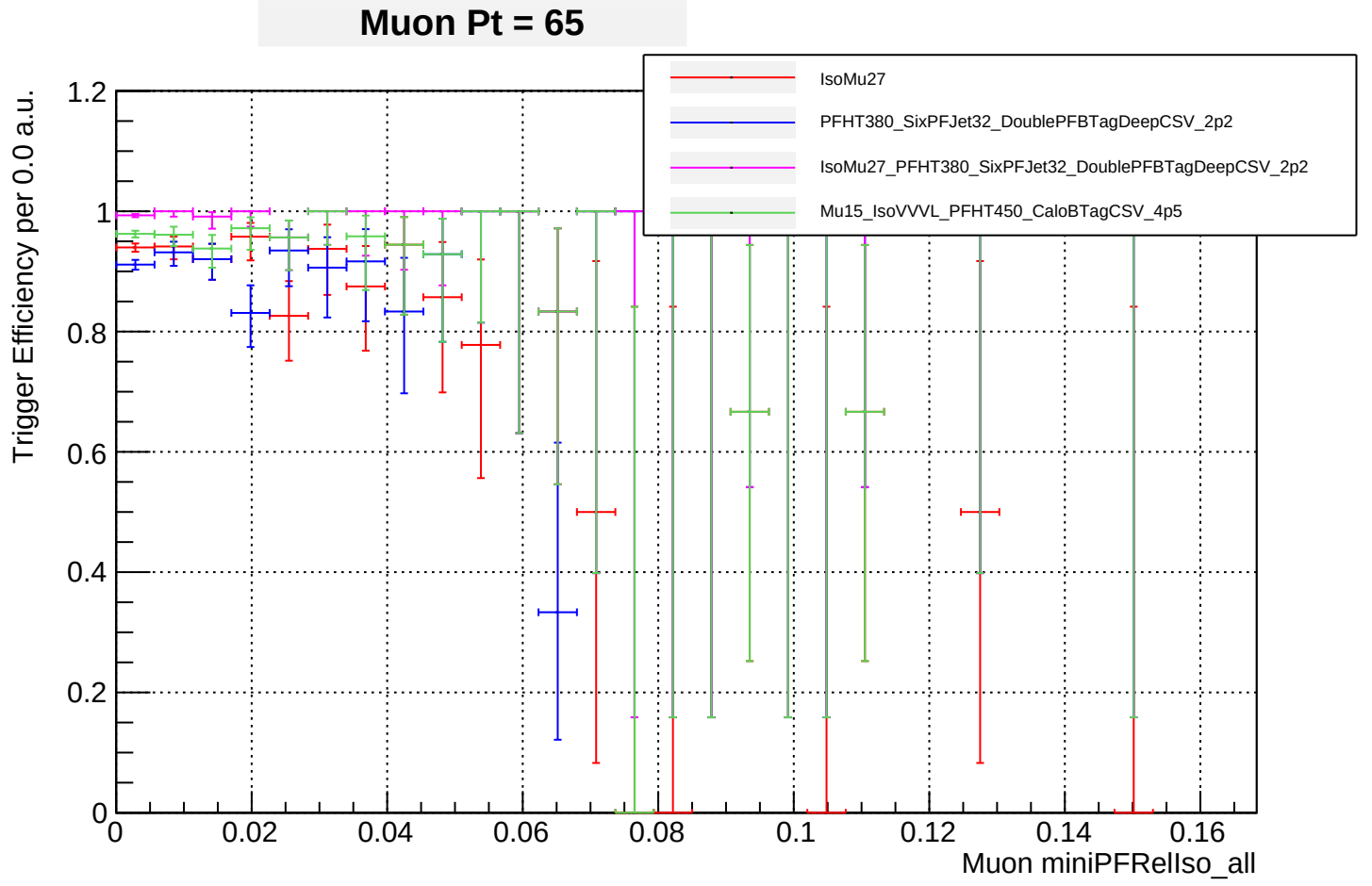

Muon Pt = 40
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

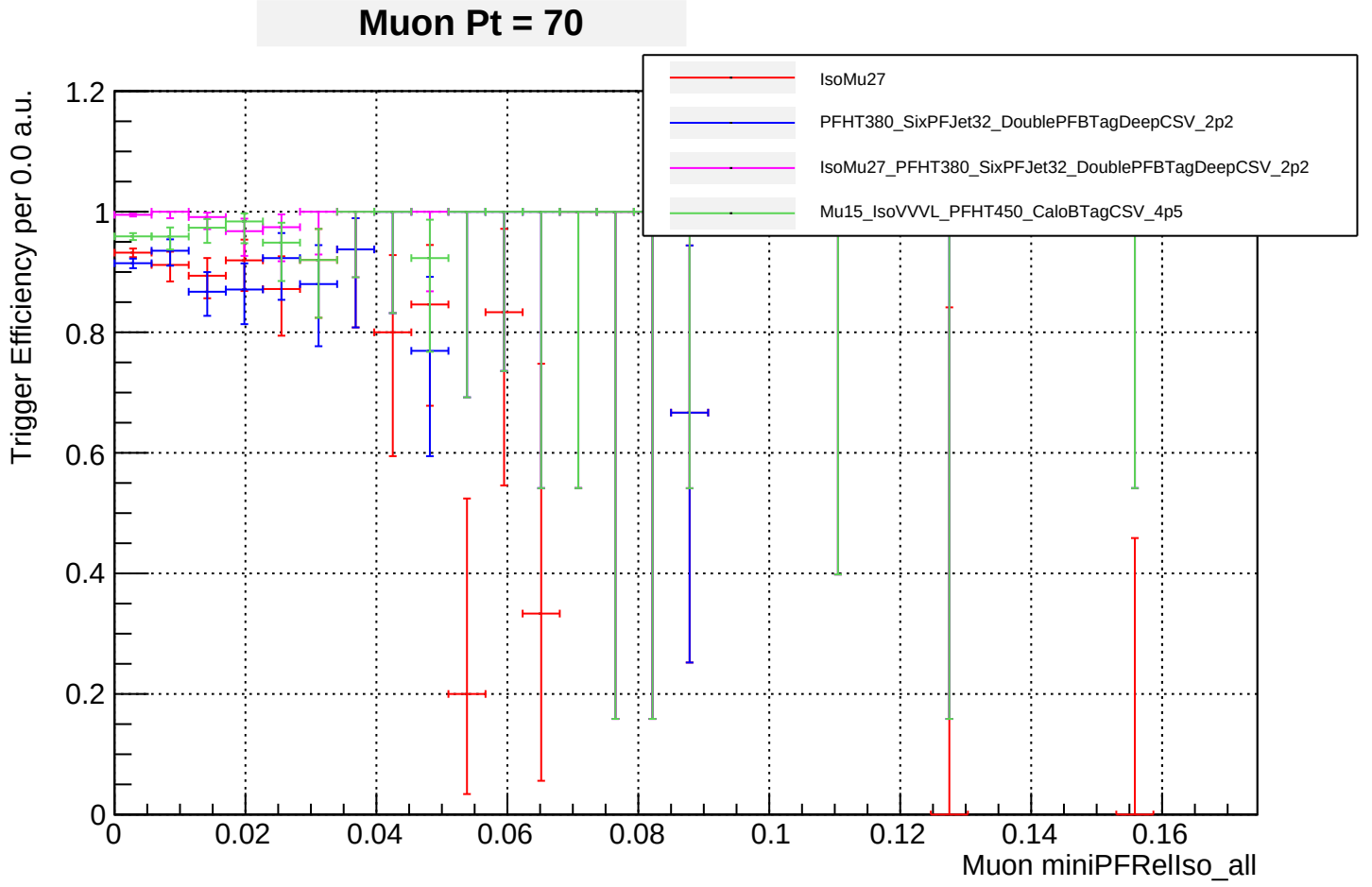

Muon Pt = 45
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

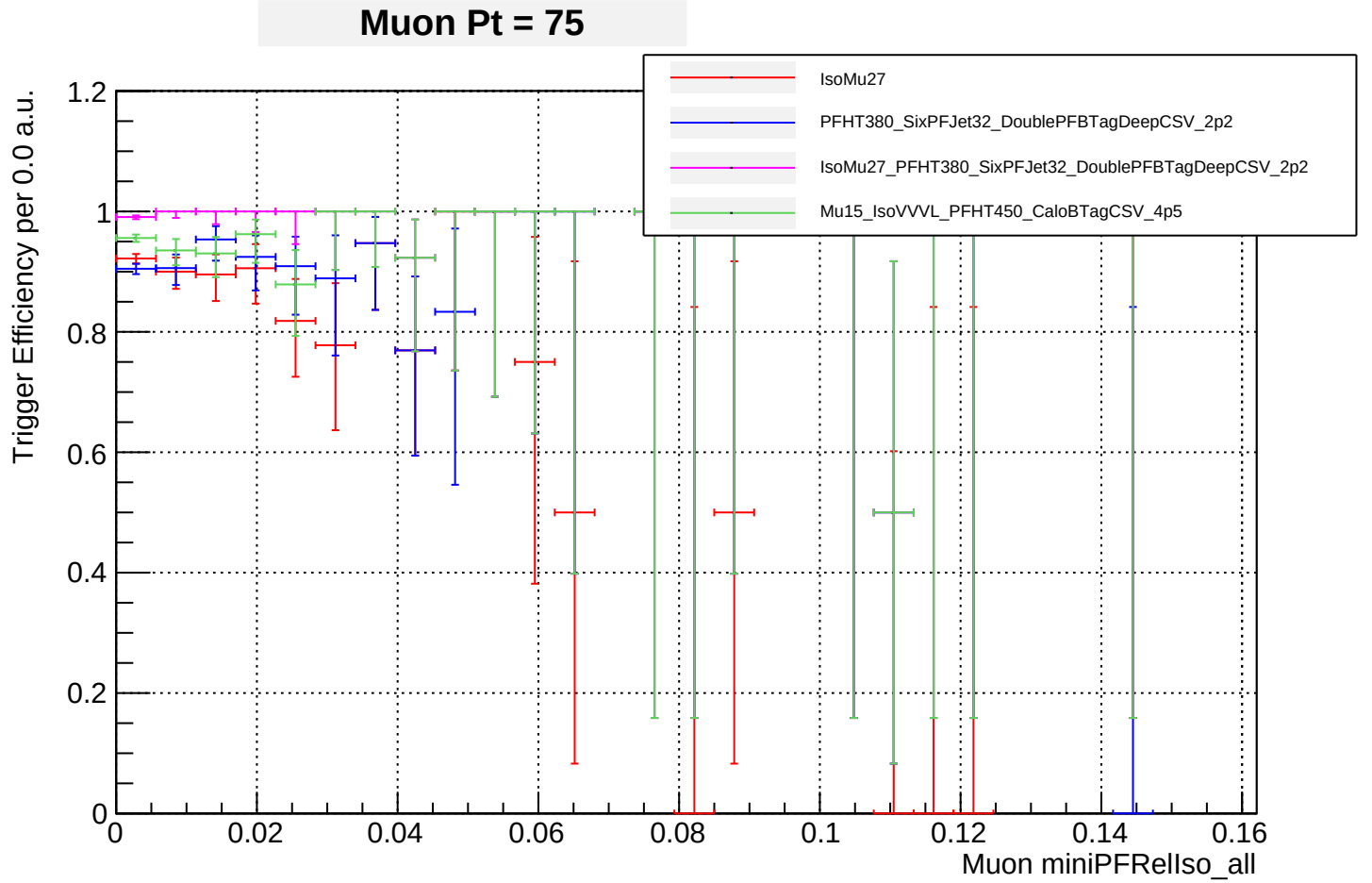

Muon Pt = 50
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

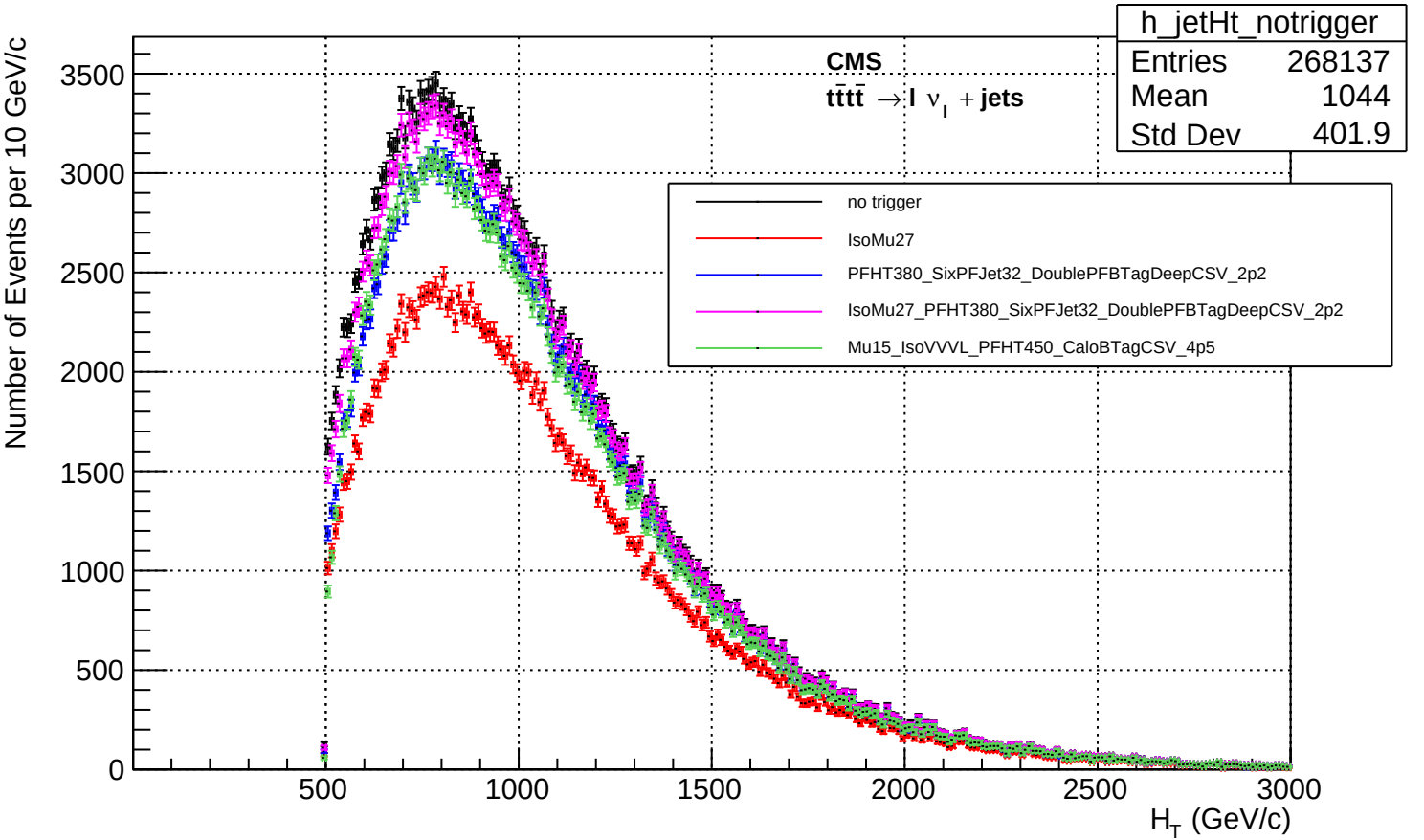

Muon Pt = 55
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
1.2
1
0.8
0.6
0.4
0.2
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Muon miniPFRelIso_all

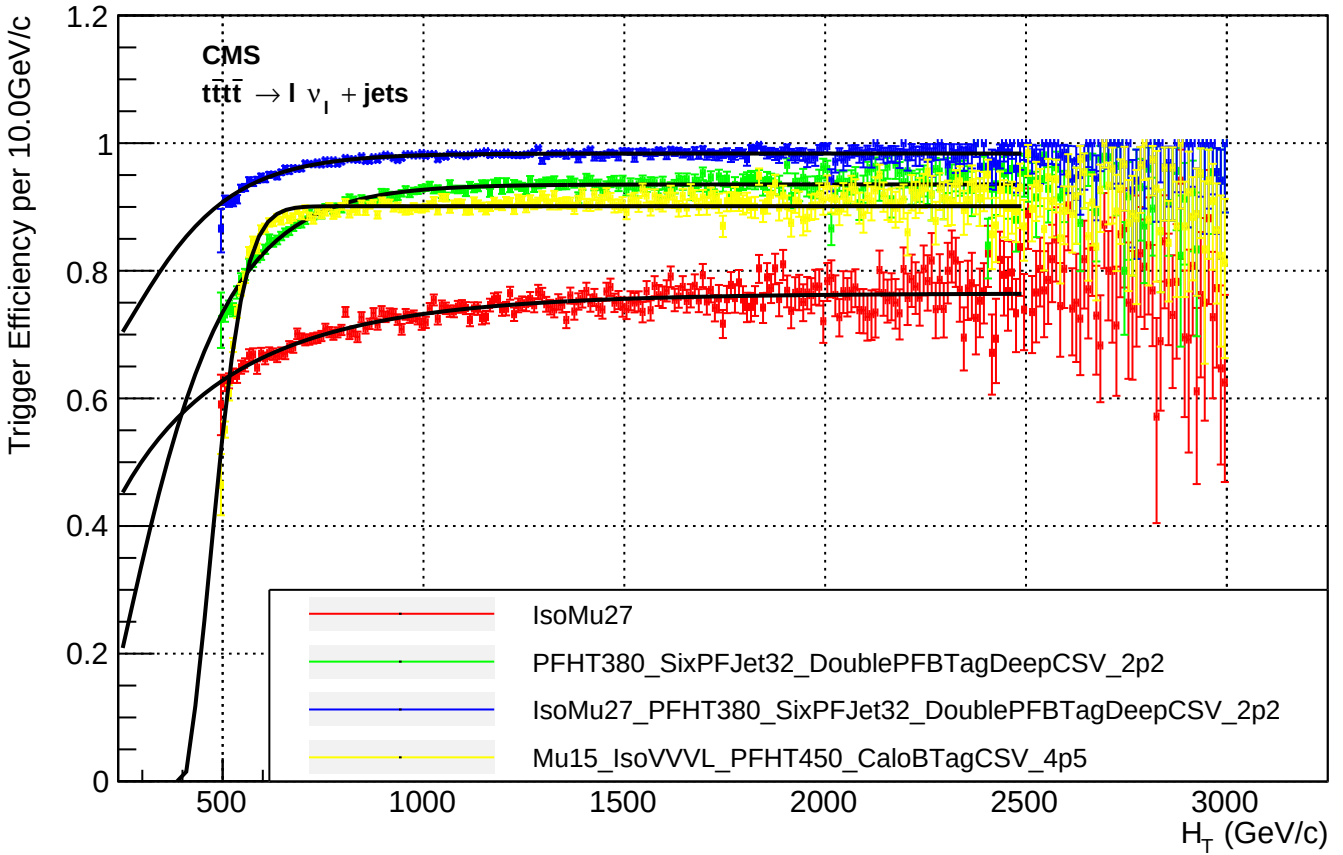

Muon Pt = 60
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18

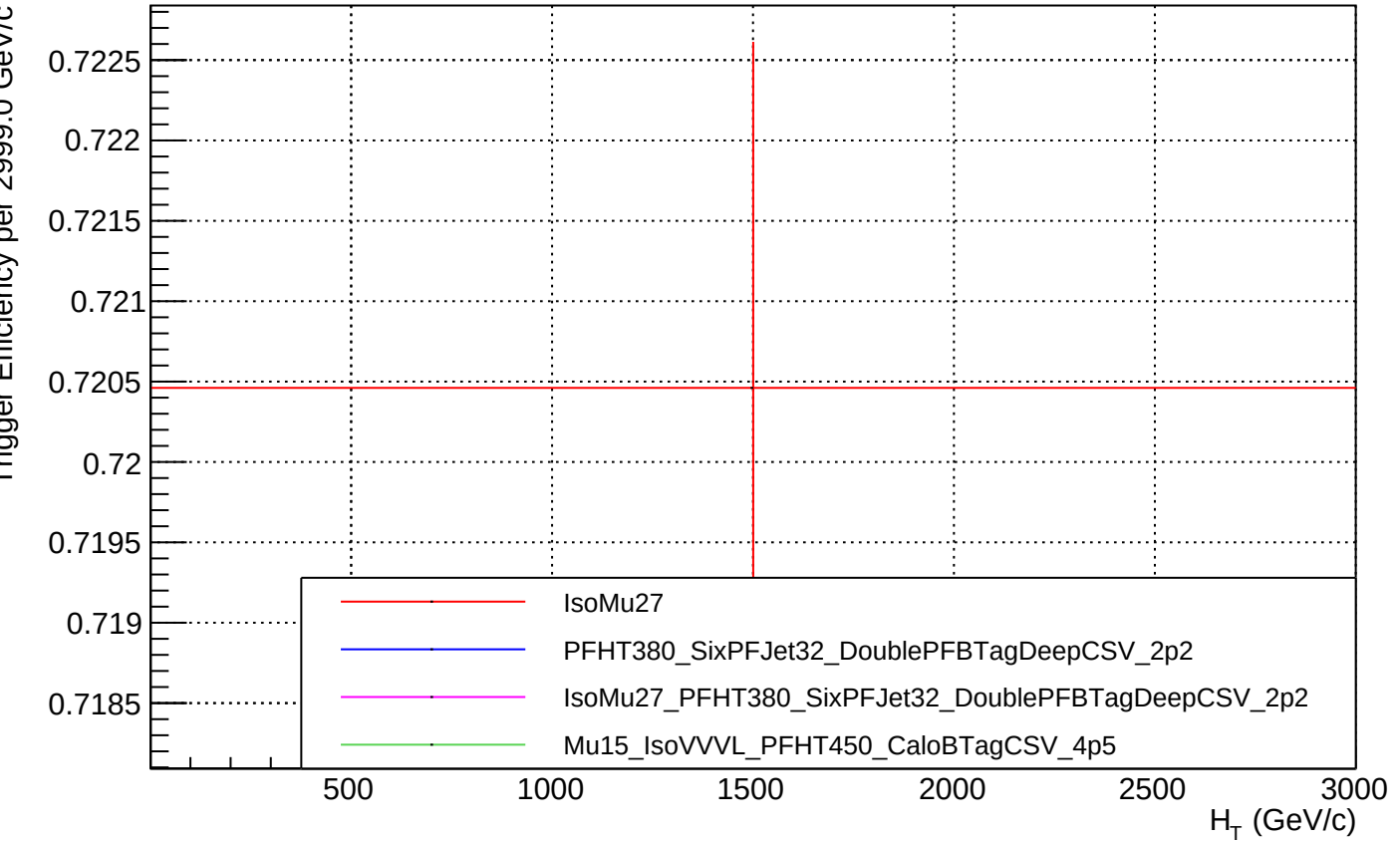

Muon Pt = 65
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
1.2
1
0.8
0.6
0.4
0.2
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Muon miniPFRelIso_all

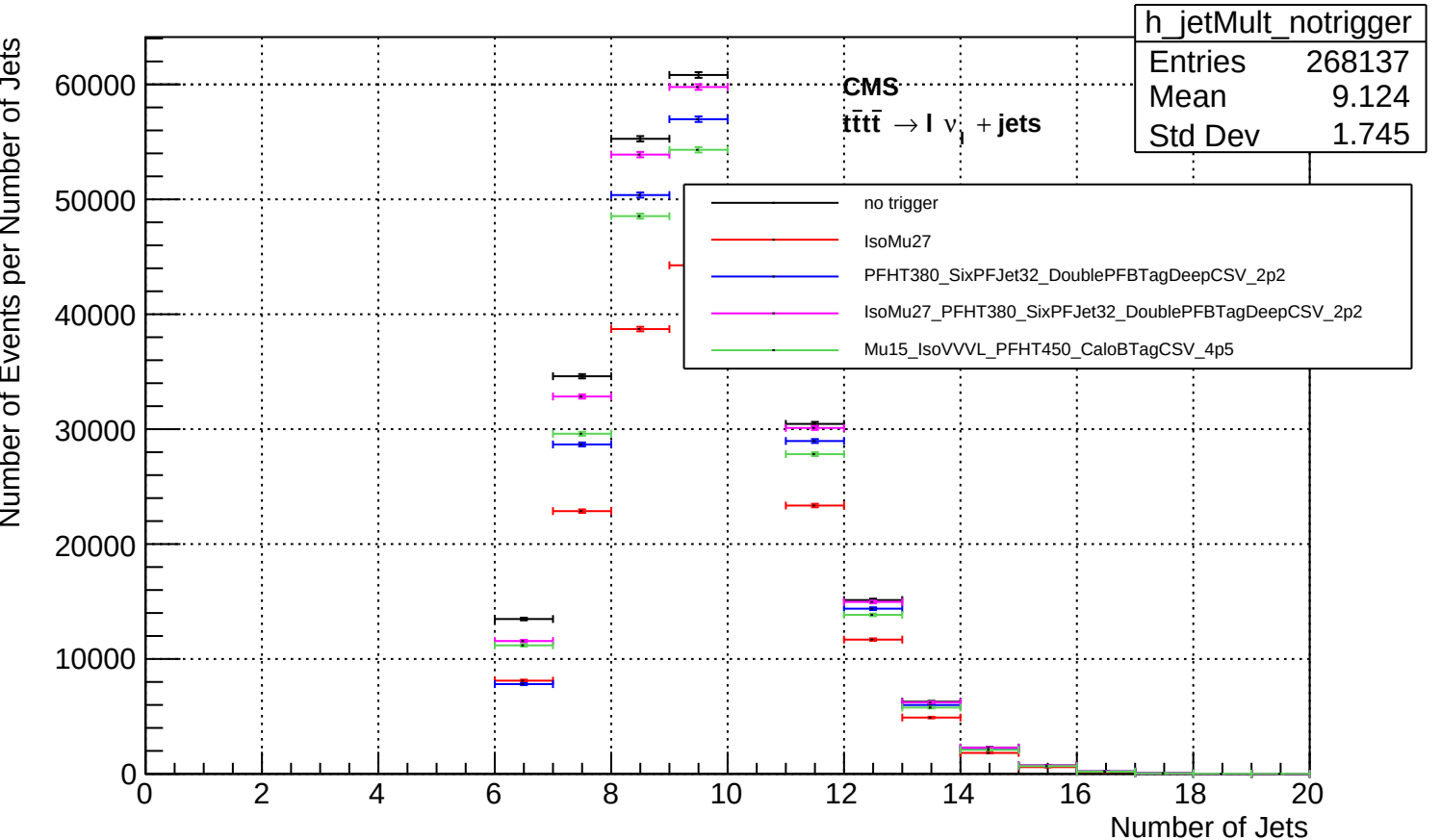

Muon Pt = 70
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

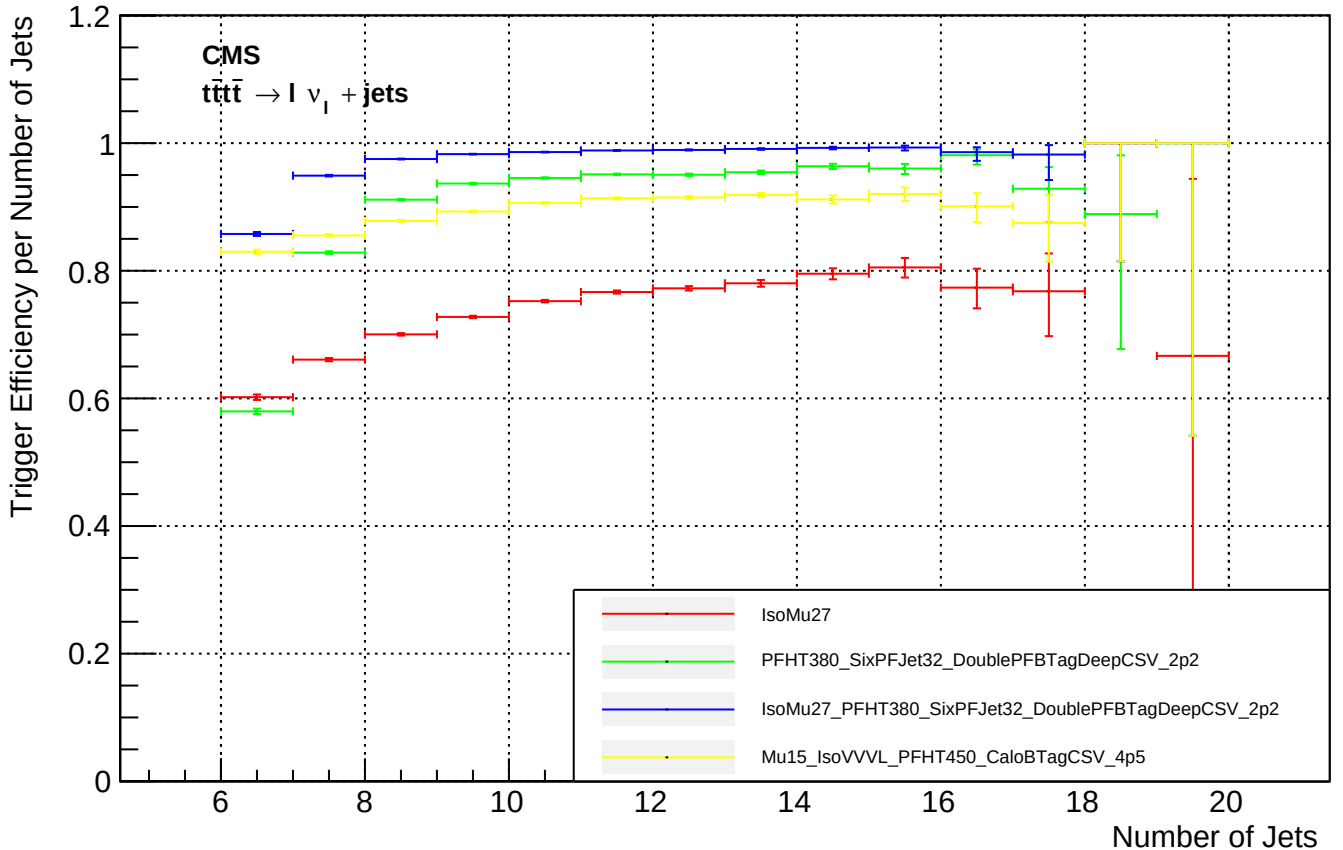

Muon Pt = 75
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Trigger Efficiency per 0.0 a.u.
Muon miniPFRelIso_all
0
0.2
0.4
0.6
0.8
1
1.2
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

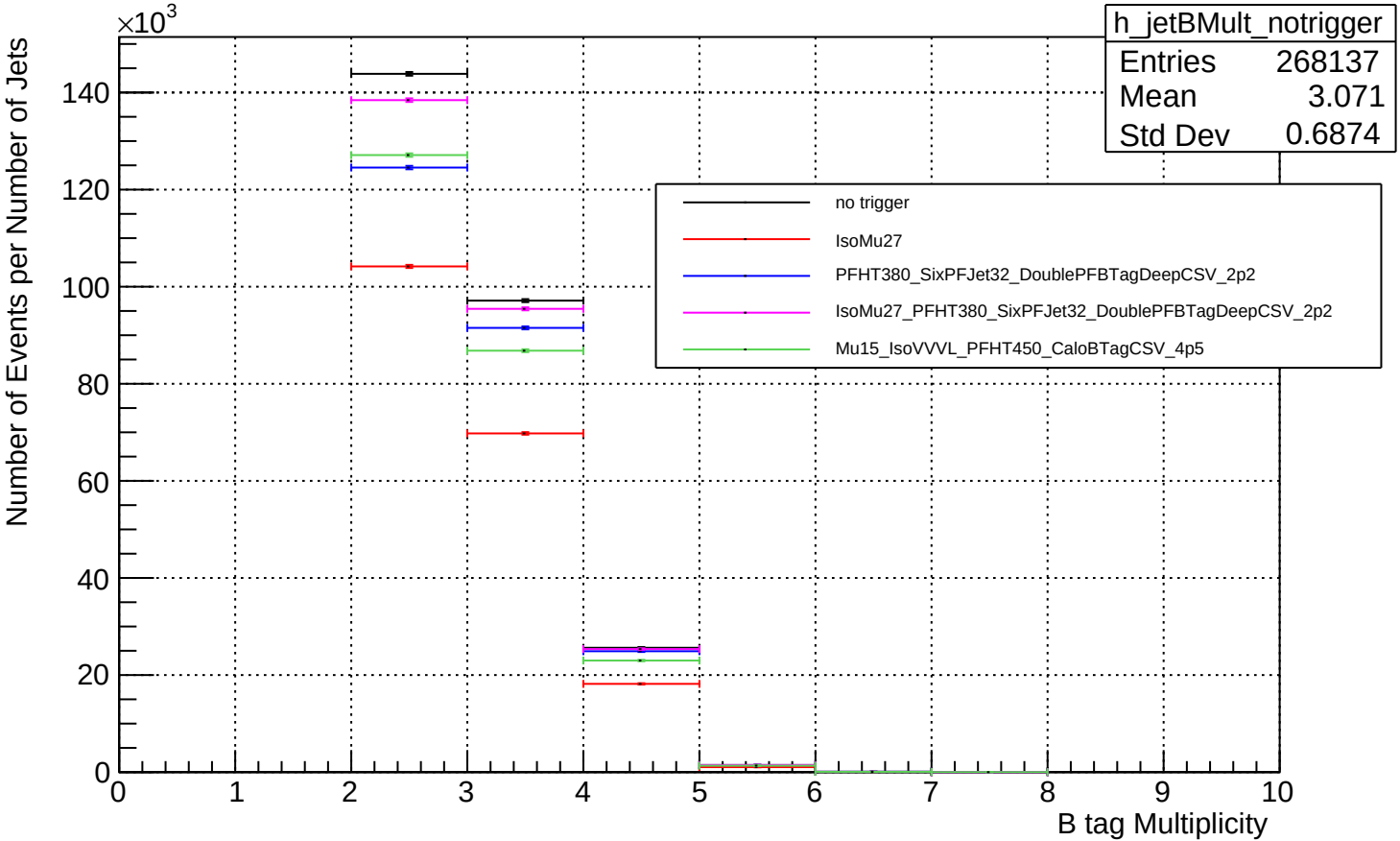

h_jetHt_notrigger
Entries 268137
Mean 1044
Std Dev 401.9
CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l$ + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per 10 GeV/c
H_T (GeV/c)
0
500
1000
1500
2000
2500
3000
3500

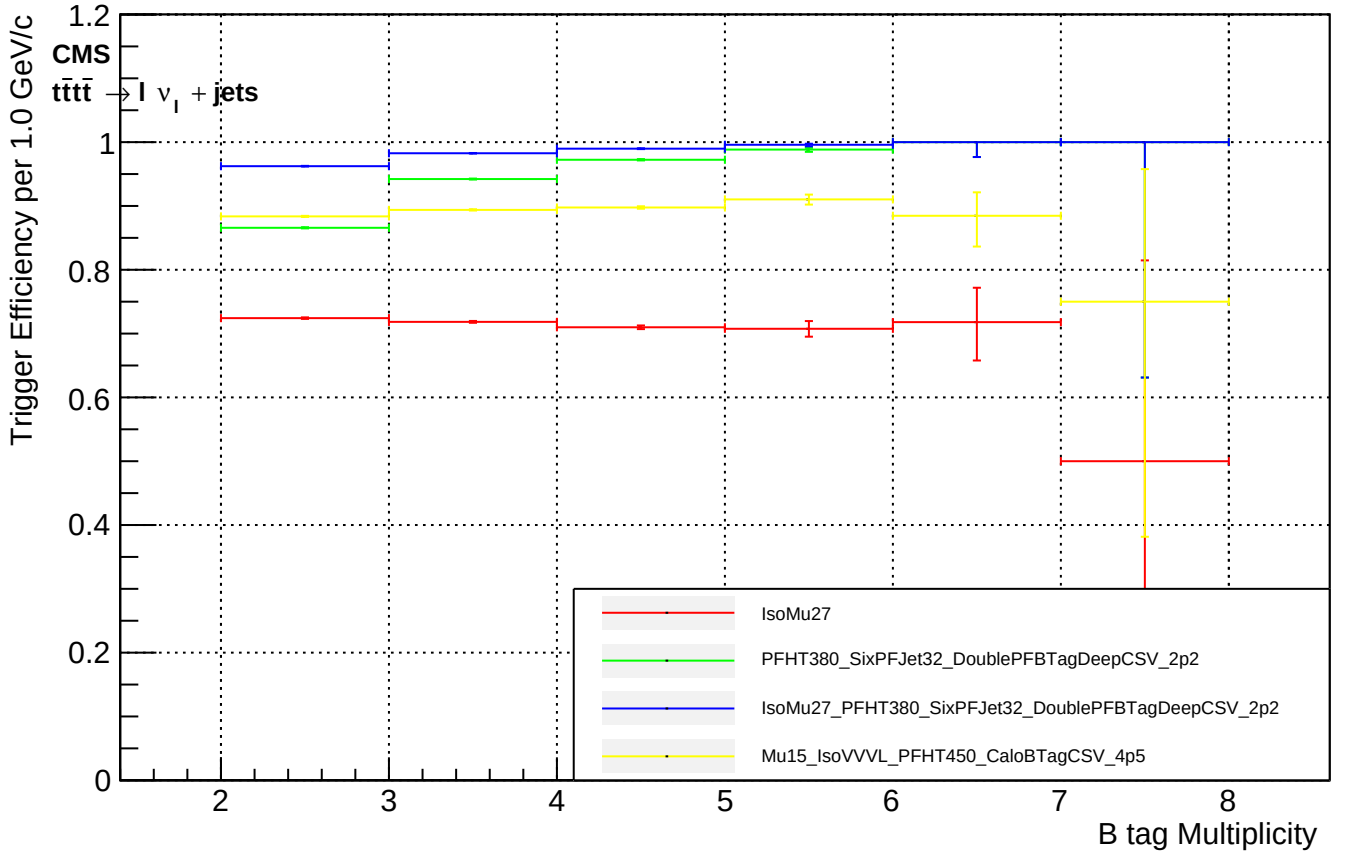

CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l + jets$
Trigger Efficiency per 10.0GeV/c
H_T (GeV/c)
0
0.2
0.4
0.6
0.8
1
1.2
500
1000
1500
2000
2500
3000
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5

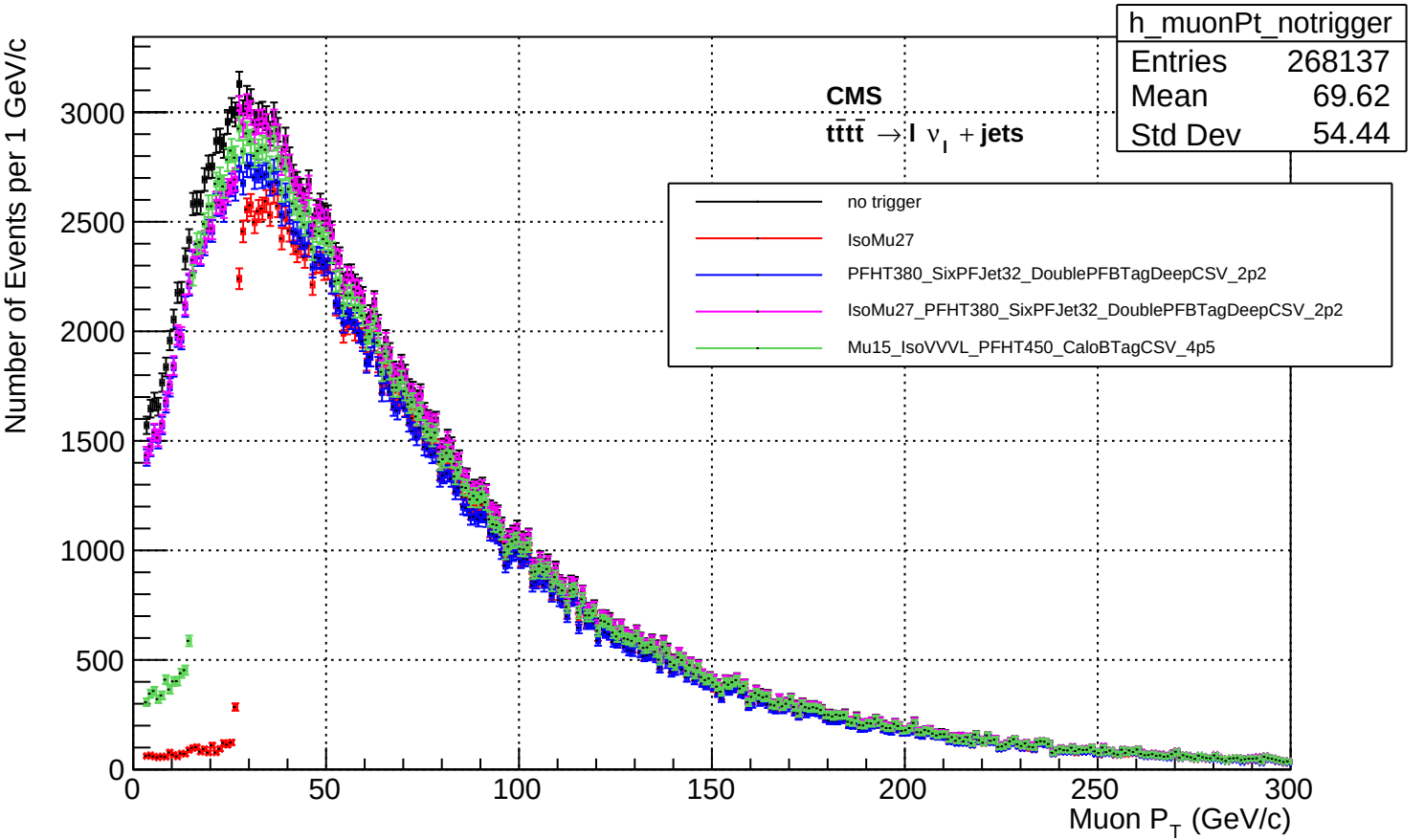

Trigger Efficiency per 2999.0 GeV/c
0.7225
0.722
0.7215
0.721
0.7205
0.72
0.7195
0.719
0.7185
500
1000
1500
2000
2500
3000
H_T (GeV/c)
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5

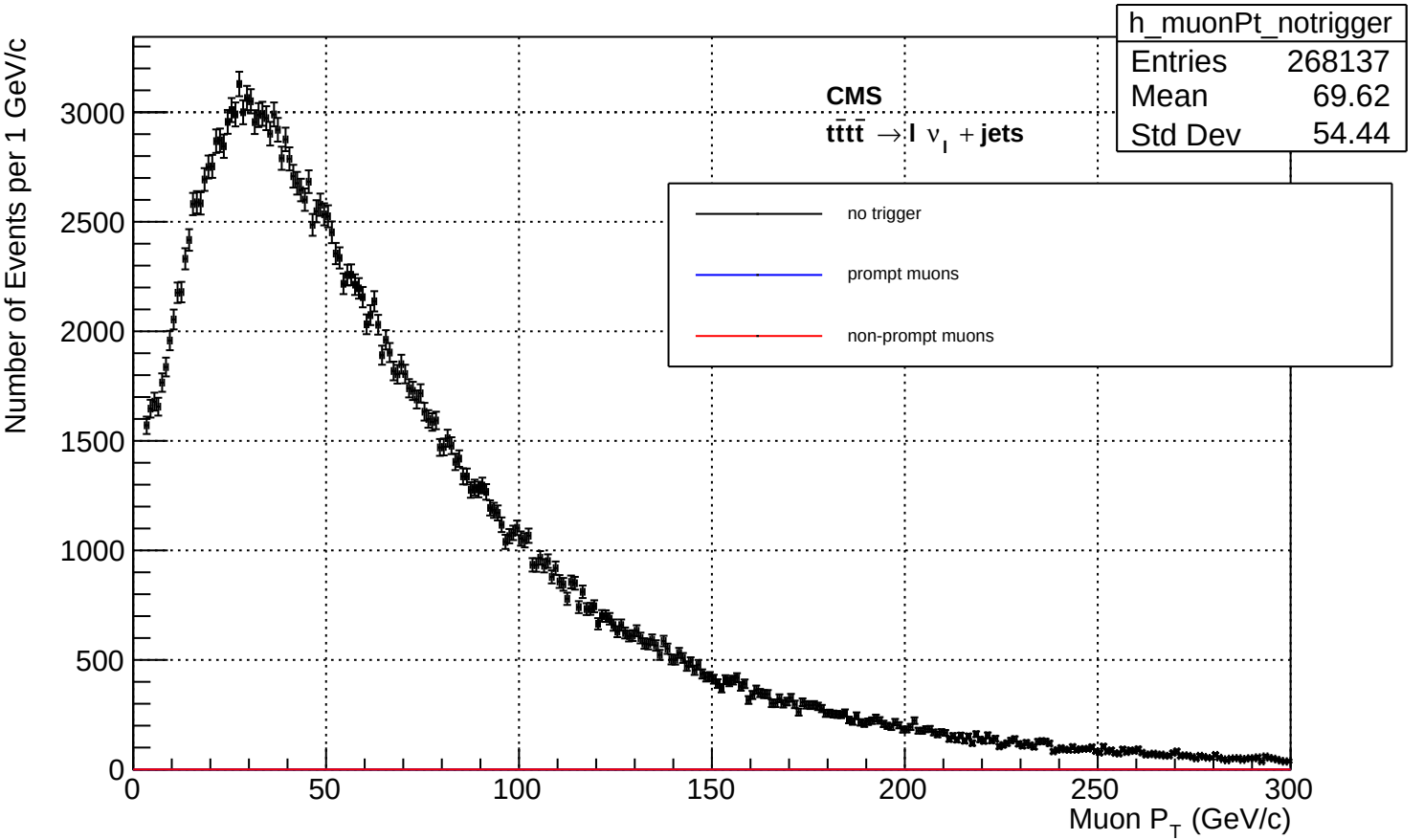

h_jetMult_notrigger
Entries 268137
Mean 9.124
Std Dev 1.745
CMS
tttt → l ν + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per Number of Jets
Number of Jets
0
10000
20000
30000
40000
50000
60000
0
2
4
6
8
10
12
14
16
18
20

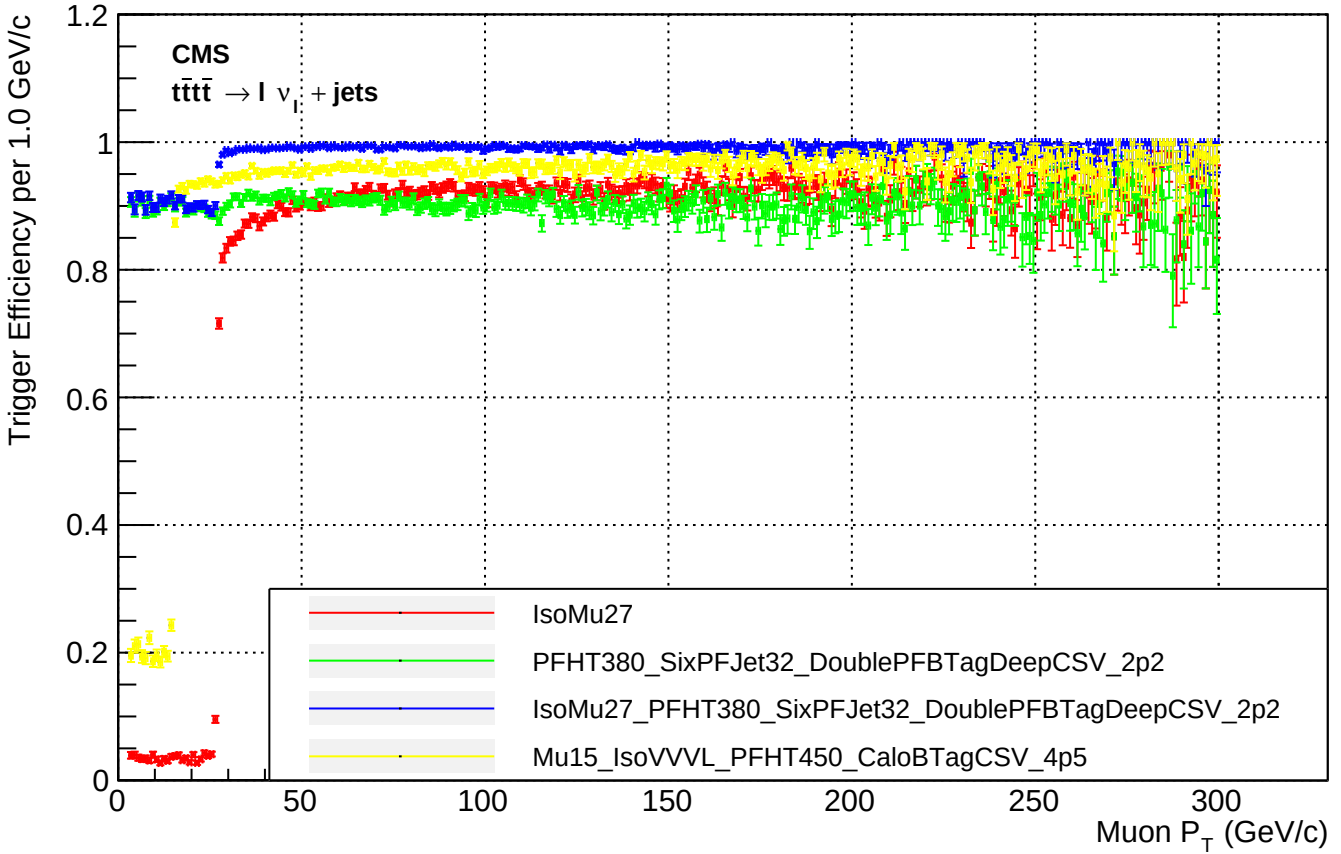

CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l + jets$
Trigger Efficiency per Number of Jets
Number of Jets
0
0.2
0.4
0.6
0.8
1
1.2
6
8
10
12
14
16
18
20
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5

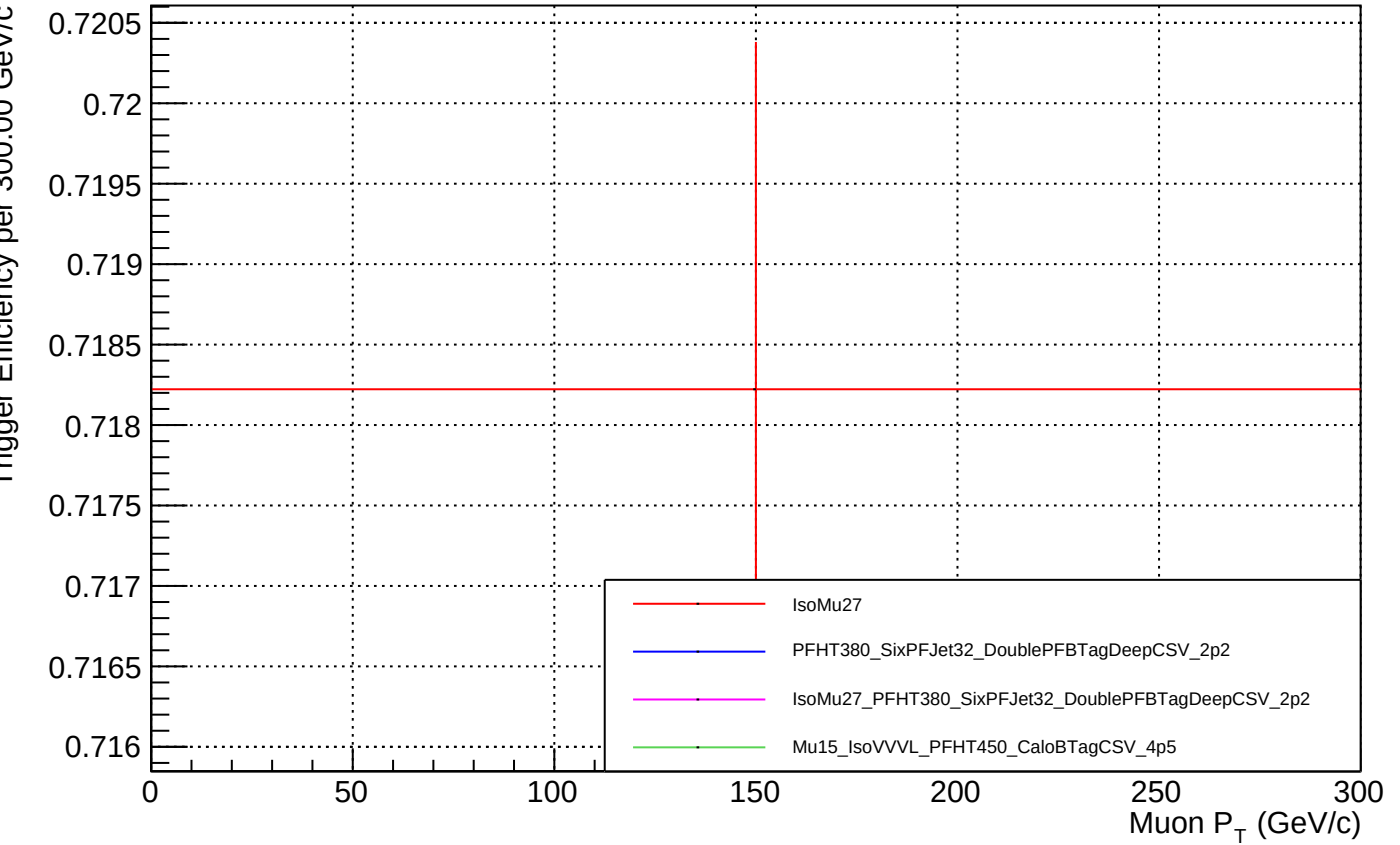

h_jetBMult_notrigger
Entries 268137
Mean 3.071
Std Dev 0.6874
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
×10^3
Number of Events per Number of Jets
B tag Multiplicity
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
7
8
9
10

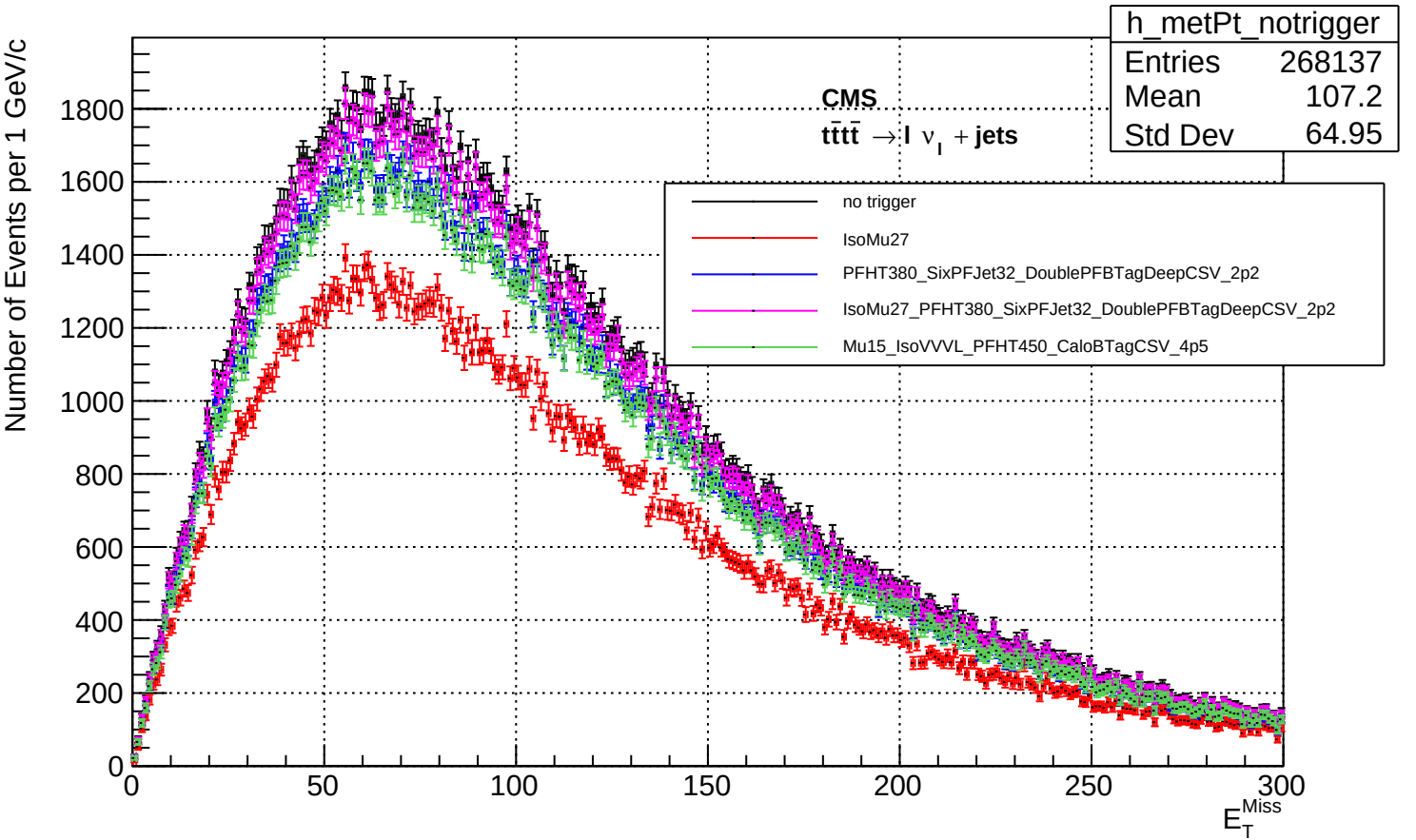

CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l$ + jets
Trigger Efficiency per 1.0 GeV/c
B tag Multiplicity
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5

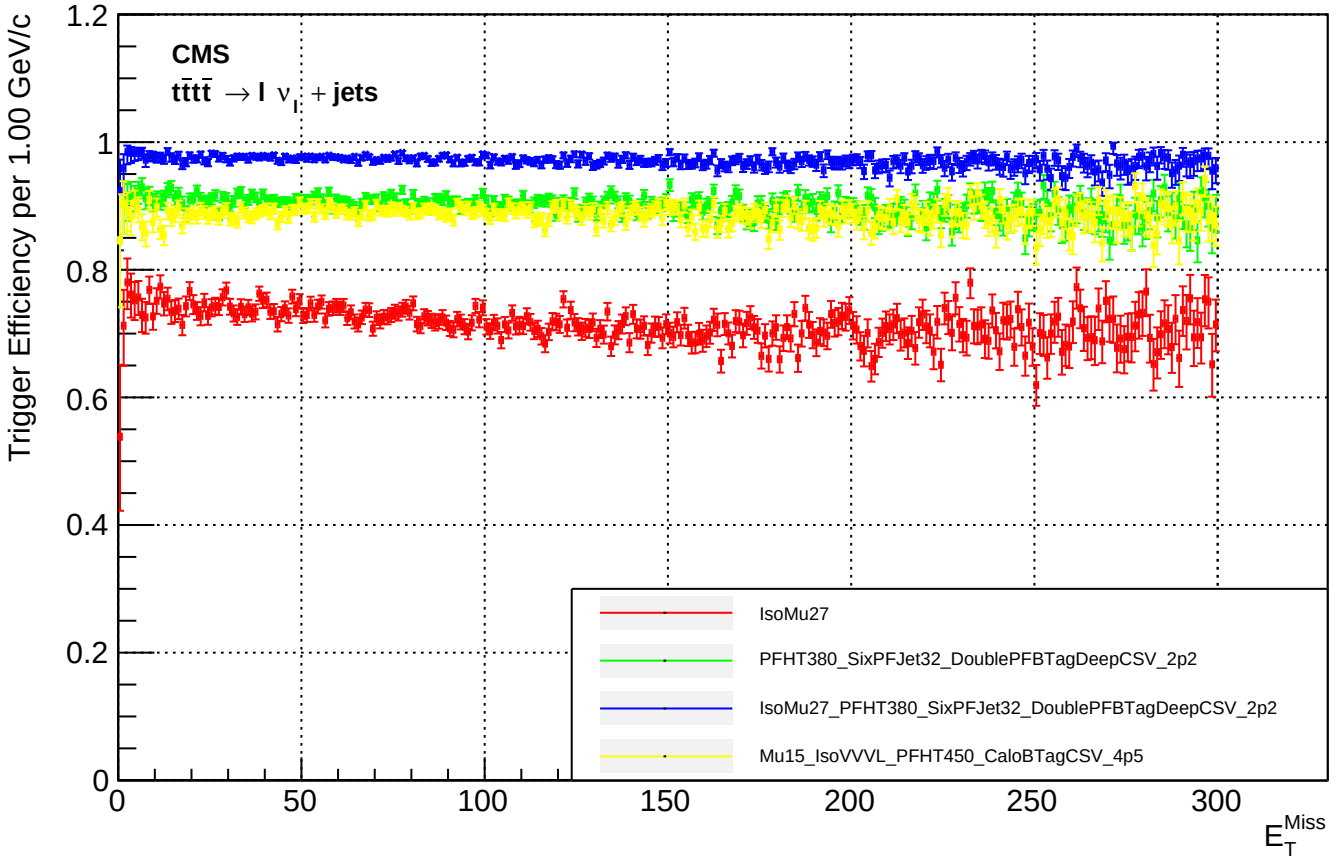

h_muonPt_notrigger
Entries 268137
Mean 69.62
Std Dev 54.44
CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l$ + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per 1 GeV/c
Muon P_T (GeV/c)
0
500
1000
1500
2000
2500
3000
0
50
100
150
200
250
300

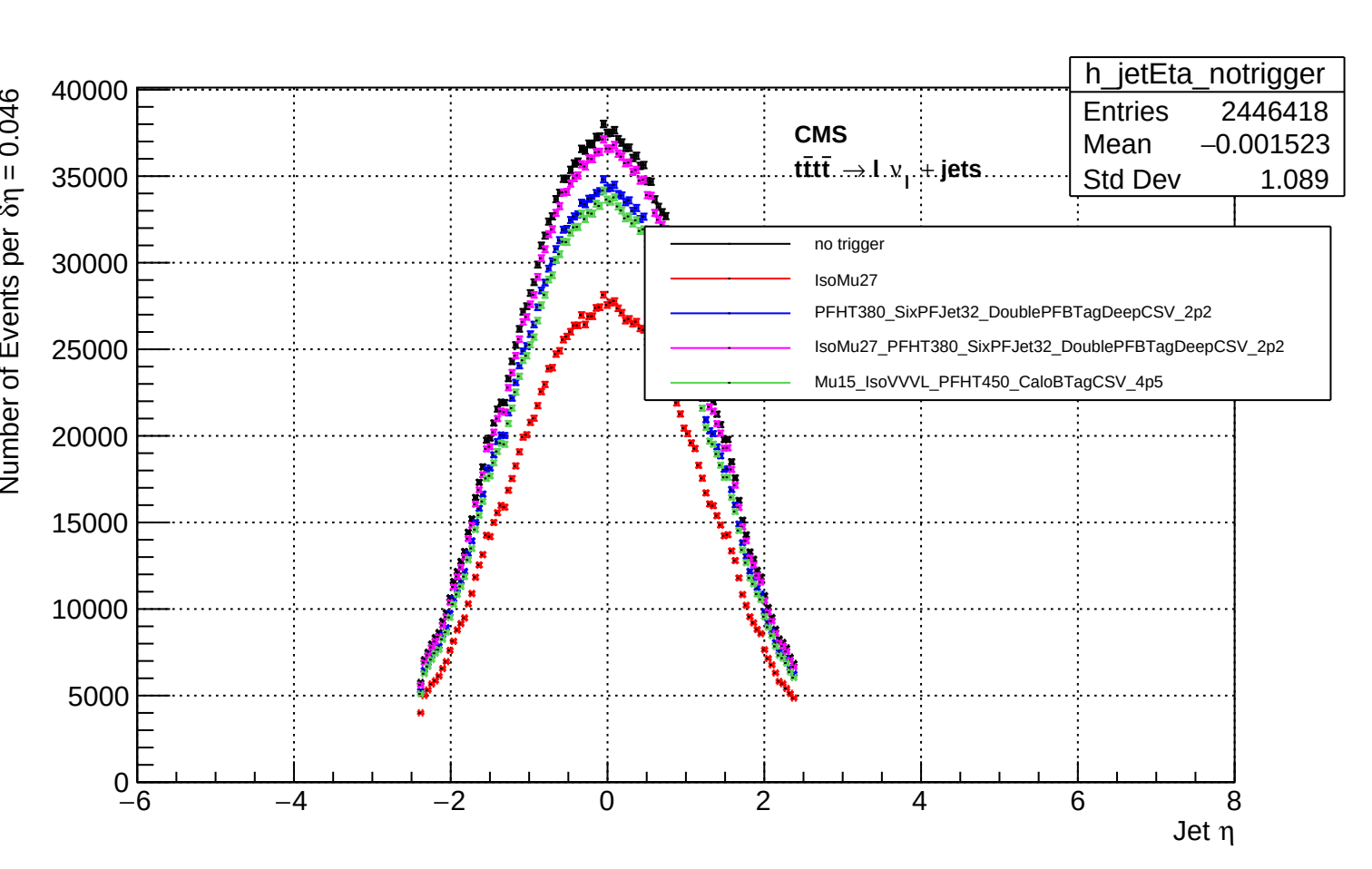

h_muonPt_notrigger
Entries 268137
Mean 69.62
Std Dev 54.44
CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l$ + jets
no trigger
prompt muons
non-prompt muons
Number of Events per 1 GeV/c
Muon P_T (GeV/c)
0
500
1000
1500
2000
2500
3000
0
50
100
150
200
250
300

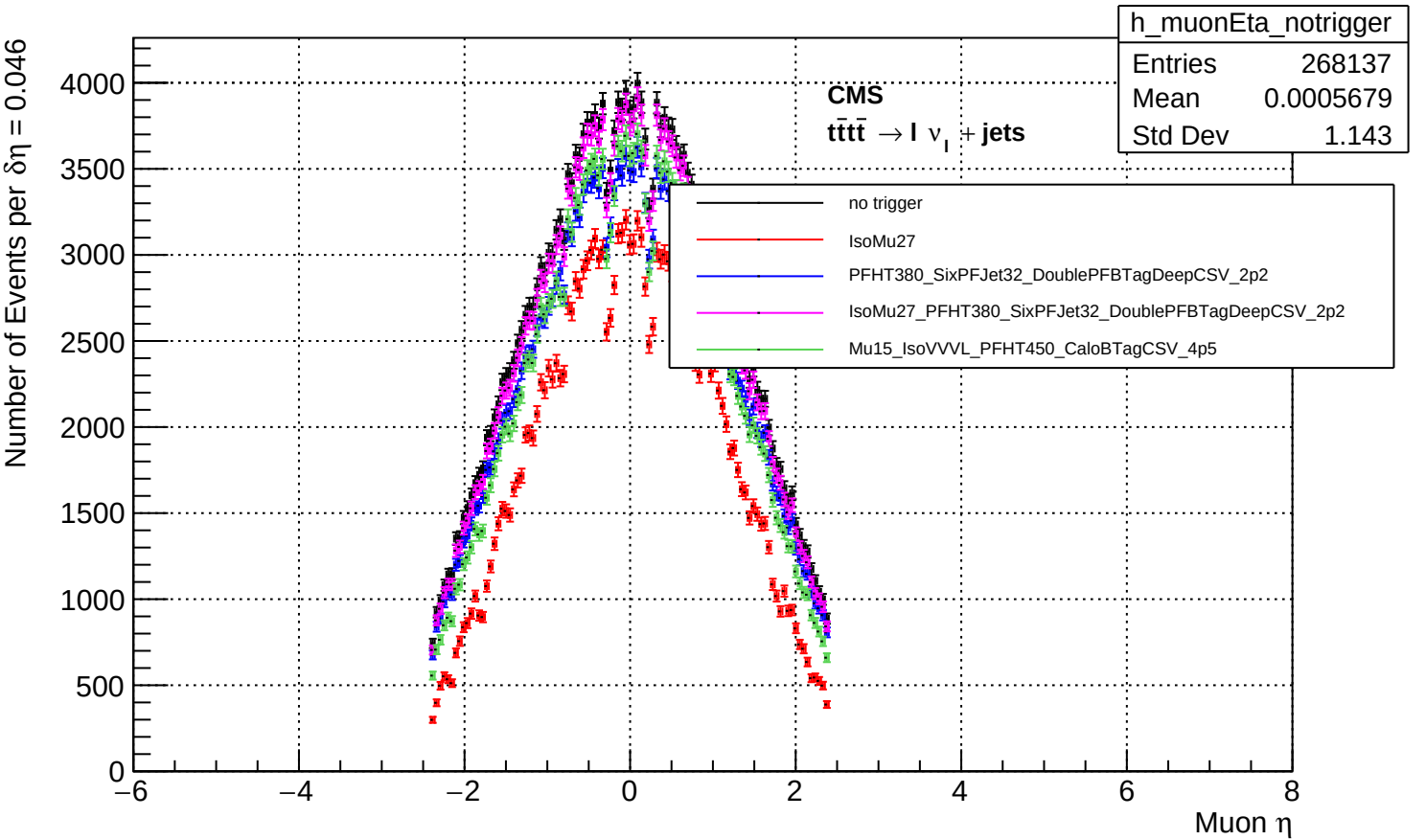

CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l + jets$
Trigger Efficiency per 1.0 GeV/c
Muon P_T (GeV/c)
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
0
0.2
0.4
0.6
0.8
1
1.2
0
50
100
150
200
250
300

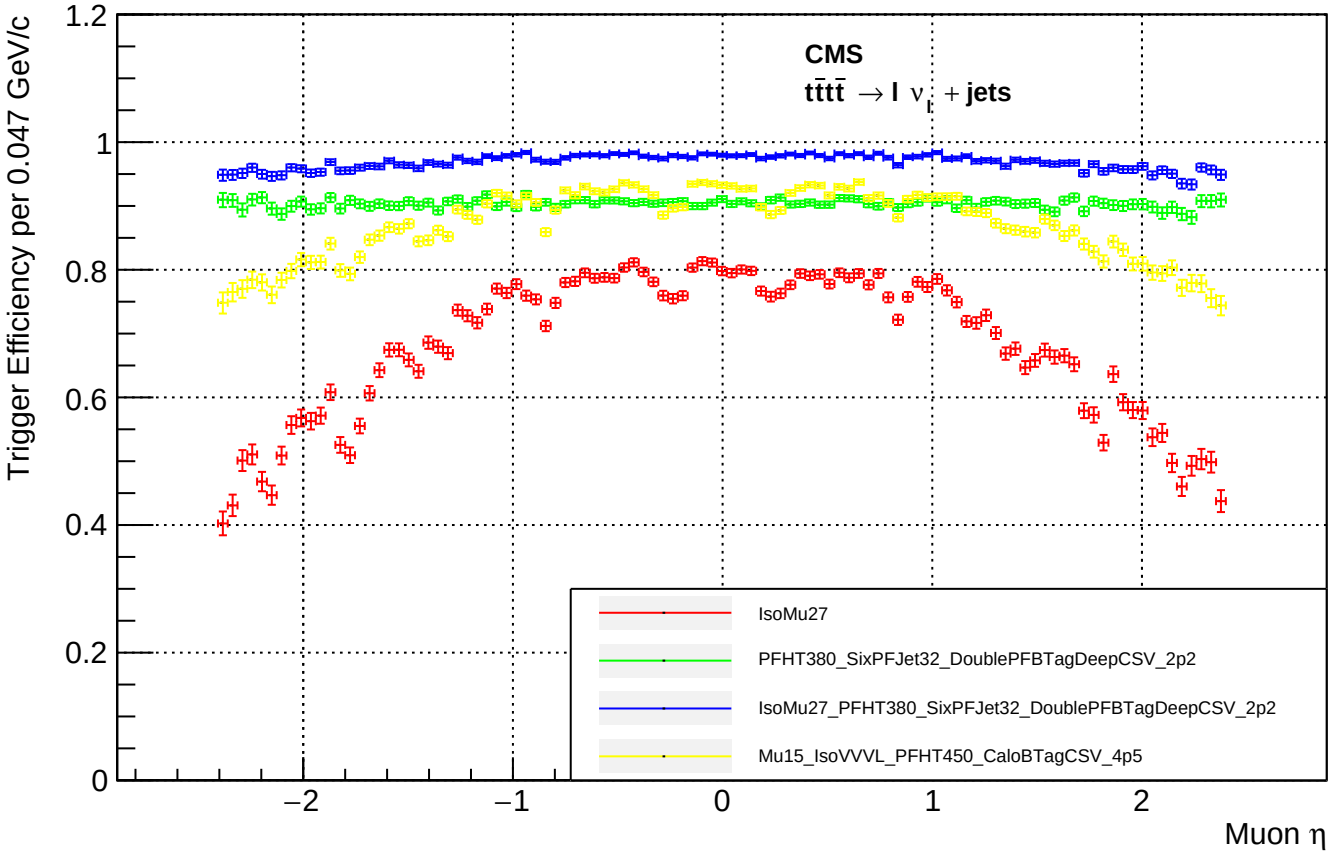

Trigger Efficiency per 300.00 GeV/c
0.7205
0.72
0.7195
0.719
0.7185
0.718
0.7175
0.717
0.7165
0.716
0
50
100
150
200
250
300
Muon P_T (GeV/c)
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5

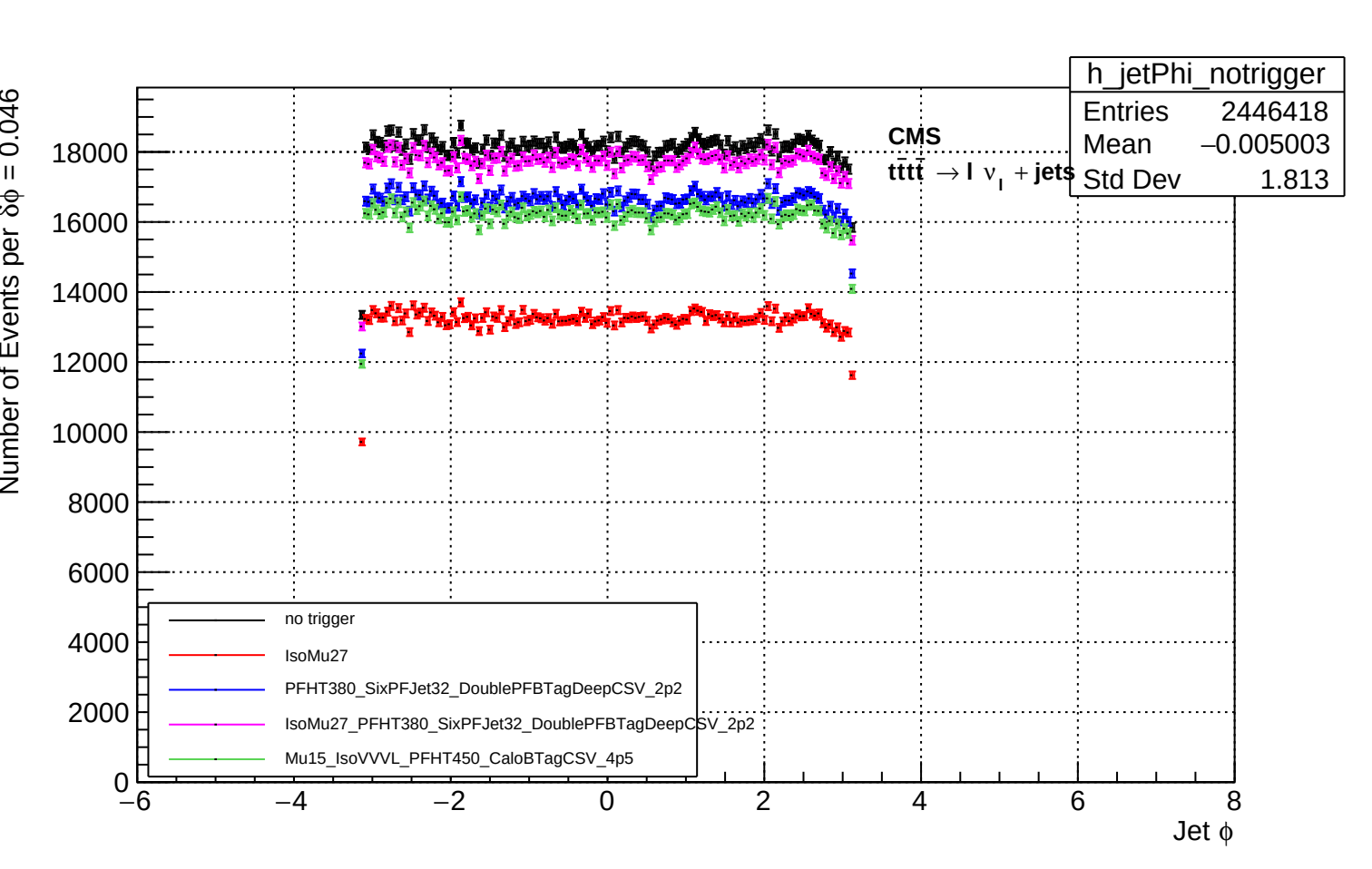

h_metPt_notrigger
Entries 268137
Mean 107.2
Std Dev 64.95
CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l + jets$
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per 1 GeV/c
0
200
400
600
800
1000
1200
1400
1600
1800
0
50
100
150
200
250
300
E_T^{Miss}

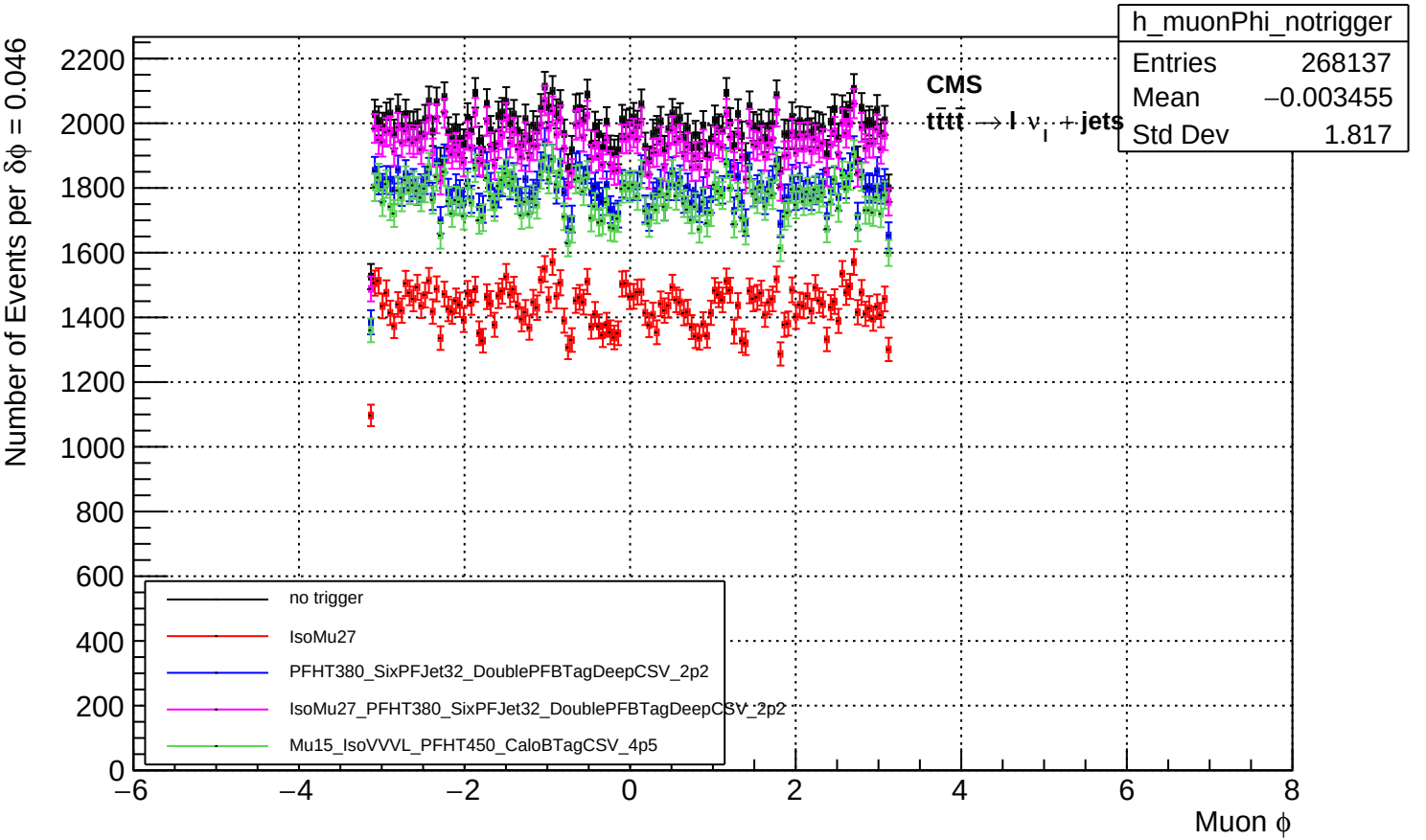

CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l + jets$
Trigger Efficiency per 1.00 GeV/c
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
E_T^{Miss}
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5

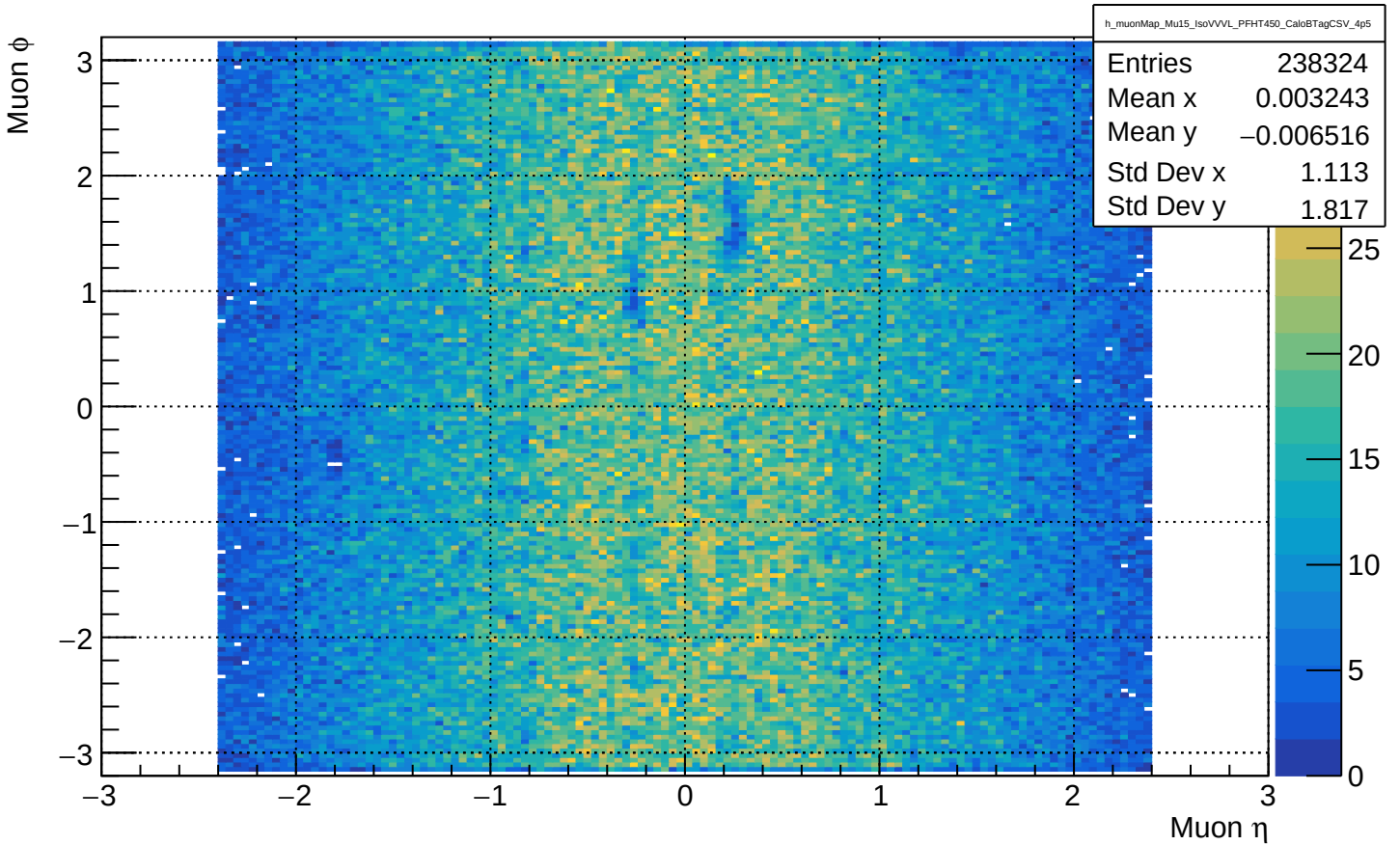

h_jetEta_notrigger
Entries 2446418
Mean −0.001523
Std Dev 1.089
CMS
$t\bar{t}t\bar{t} \rightarrow l\,\nu_l$ + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per δη = 0.046
Jet η
0
5000
10000
15000
20000
25000
30000
35000
40000
−6
−4
−2
0
2
4
6
8


h_muonEta_notrigger
Entries 268137
Mean 0.0005679
Std Dev 1.143
CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l$ + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per δη = 0.046
Muon η
0
500
1000
1500
2000
2500
3000
3500
4000
−6
−4
−2
0
2
4
6
8


CMS
$t\bar{t}t\bar{t} \rightarrow l\ \nu_l + jets$
Trigger Efficiency per 0.047 GeV/c
Muon η
1.2
1
0.8
0.6
0.4
0.2
0
−2
−1
0
1
2
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5


h_jetPhi_notrigger
Entries 2446418
Mean −0.005003
Std Dev 1.813
CMS
tttt → l ν_l + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per δφ = 0.046
Jet φ
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
−6
−4
−2
0
2
4
6
8


h_muonPhi_notrigger
Entries 268137
Mean −0.003455
Std Dev 1.817
CMS
tttt → l ν_l + jets
no trigger
IsoMu27
PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
IsoMu27_PFHT380_SixPFJet32_DoublePFBTagDeepCSV_2p2
Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Number of Events per δϕ = 0.046
Muon ϕ
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
−6
−4
−2
0
2
4
6
8


h_muonMap_Mu15_IsoVVVL_PFHT450_CaloBTagCSV_4p5
Entries 238324
Mean x 0.003243
Mean y −0.006516
Std Dev x 1.113
Std Dev y 1.817
Muon ϕ
Muon η
3
2
1
0
−1
−2
−3
25
20
15
10
5
0