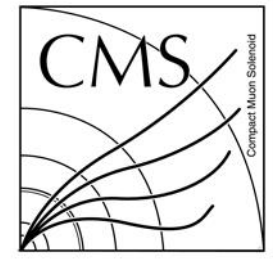




First Results Training p_T with Data

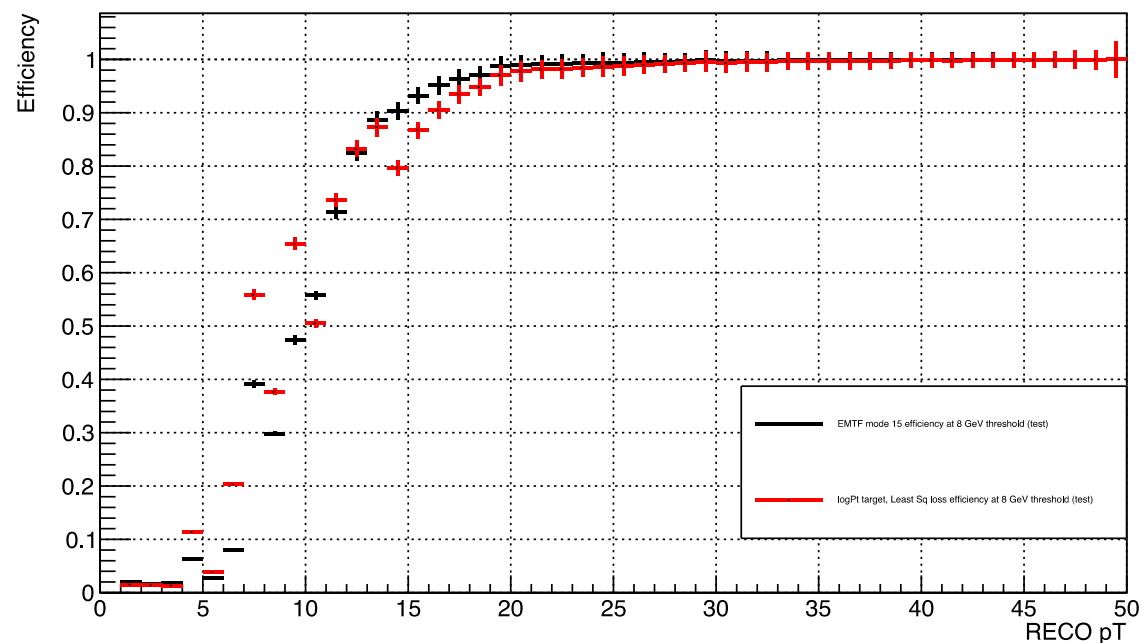
Wei Shi



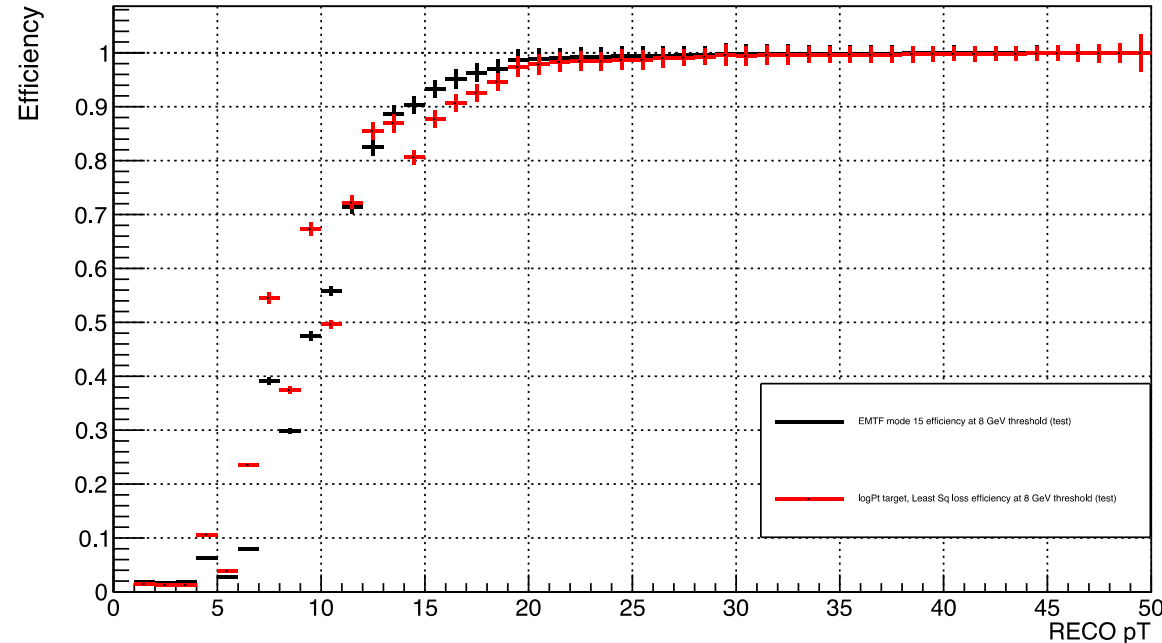
Basics

- Train 87,584 muons
 - SingleMu Ntuple with trigger matching using 2018 dTh4
 - NTuple_SingleMuon_FlatNtuple_Run_306154_2018_05_07_SingleMu_2018_emul_dTh4.root
 - NTuple_SingleMuon_FlatNtuple_Run_306154_2018_05_07_SingleMu_2017_emul.root
 - EMTF track uniquely matched to RECO muon + 2017 BDT pT as input
 - Removed bias in SingleMu data
 - Removed events: nRecoMuonsTrig==1 && nRecoMuonsTrigCen==0
- Test 207,572 muons
 - SingleMu data (uniquely matched) + ZeroBias
 - NTuple_ZeroBias1_FlatNtuple_Run_306091_2018_05_07_ZB1_2018_emul_dTh4.root
 - NTuple_ZeroBias1_FlatNtuple_Run_306091_2018_05_07_ZB1_2017_emul.root
- Settings
 - Compare 100 trees and 400 trees in case of overtraining
 - Compare 2018 dTh4 and 2017 setting
 - logPt target, 1/pT weight, Least Square loss function

2018 dTh4 Efficiency @ 8GeV

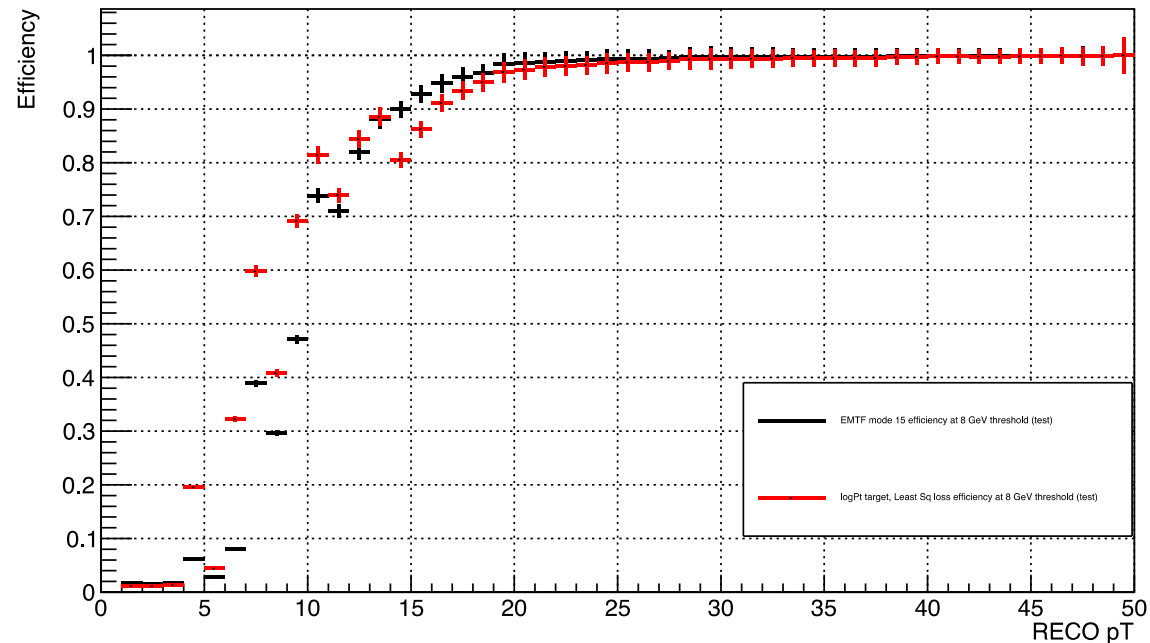


400 Trees

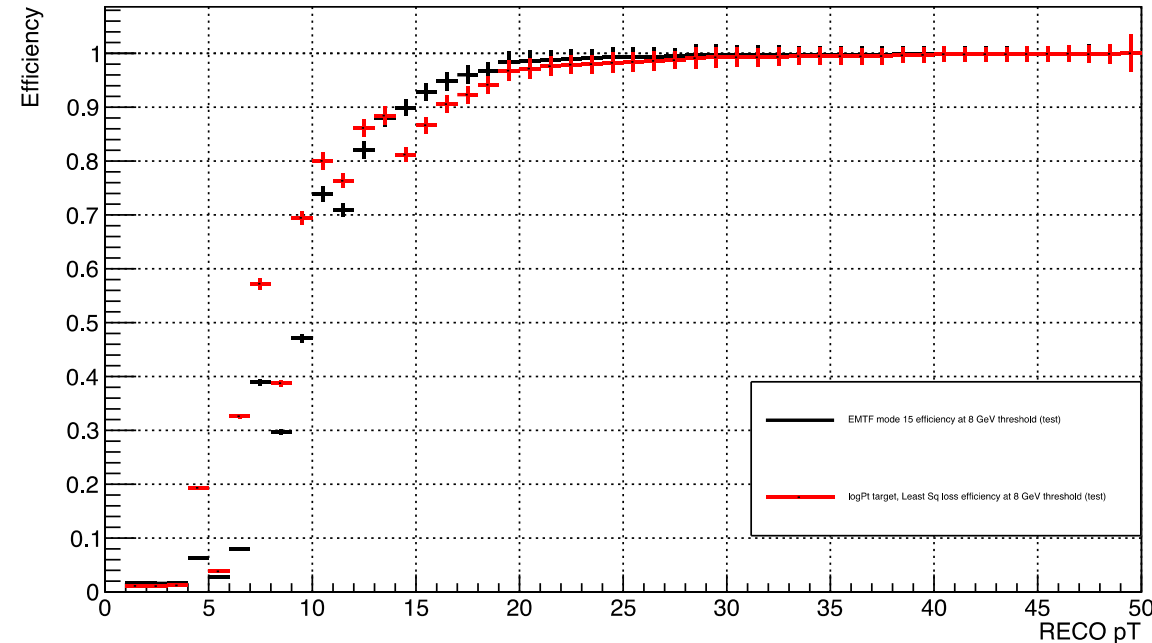


100 Trees

2017 Efficiency @ 8GeV

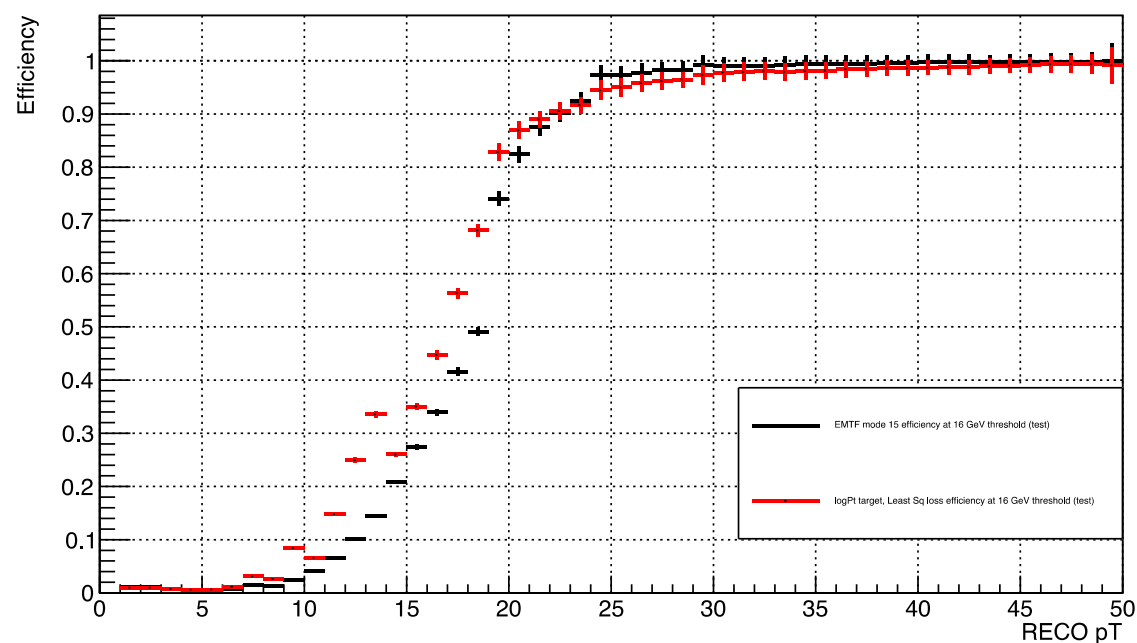


400 Trees

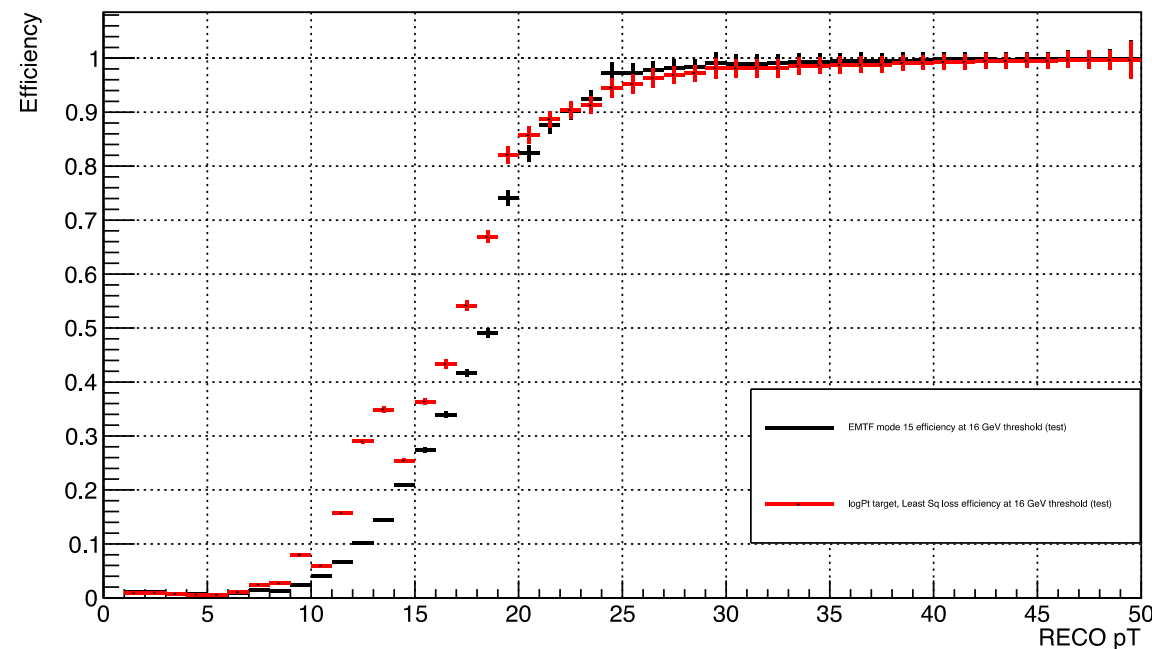


100 Trees

2018 dTh4 Efficiency @ 16GeV

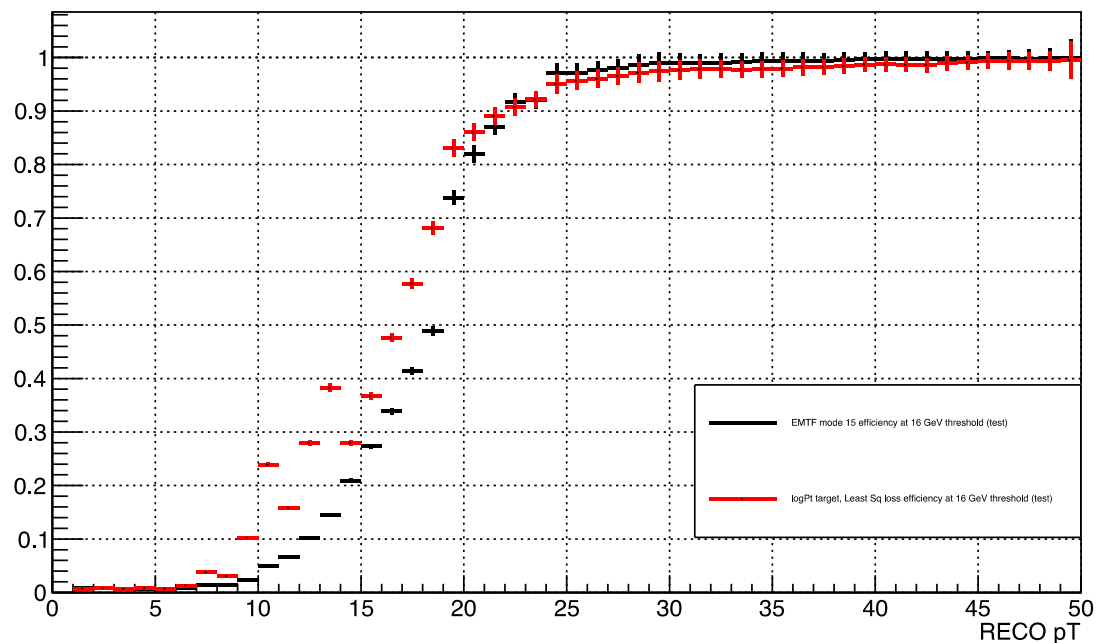


400 Trees

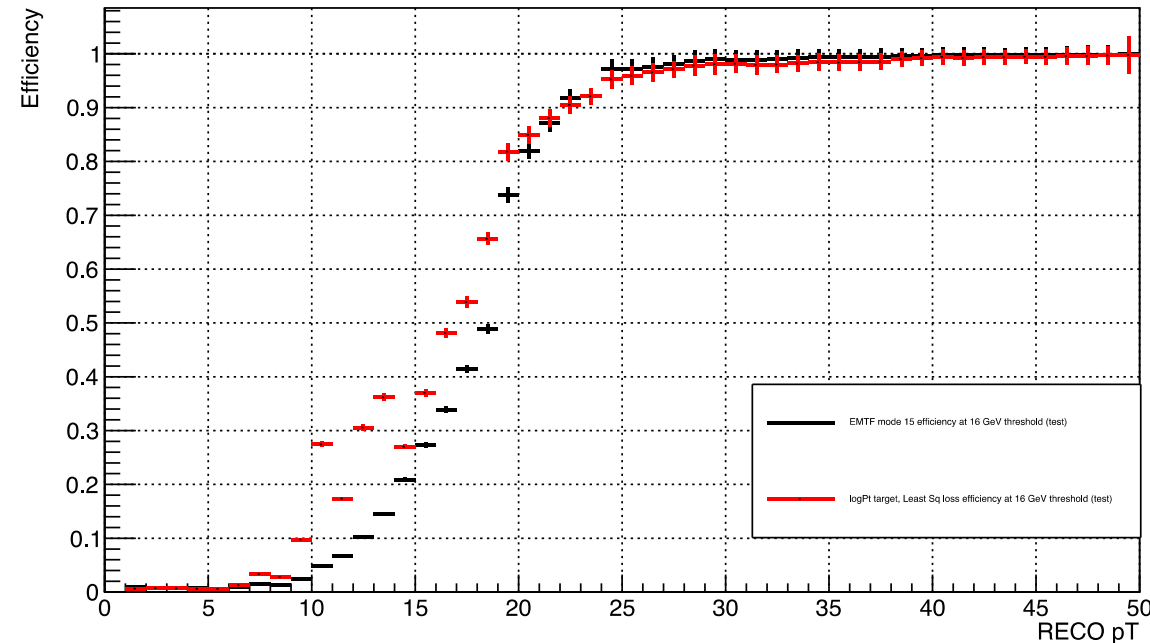


100 Trees

2017 Efficiency @ 16GeV

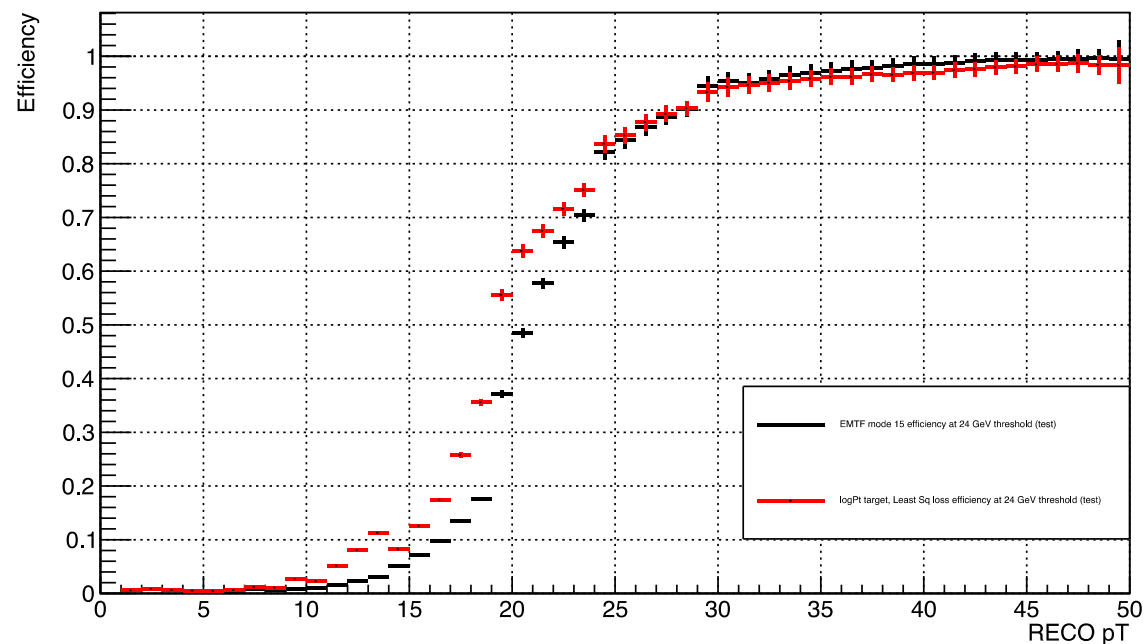


400 Trees

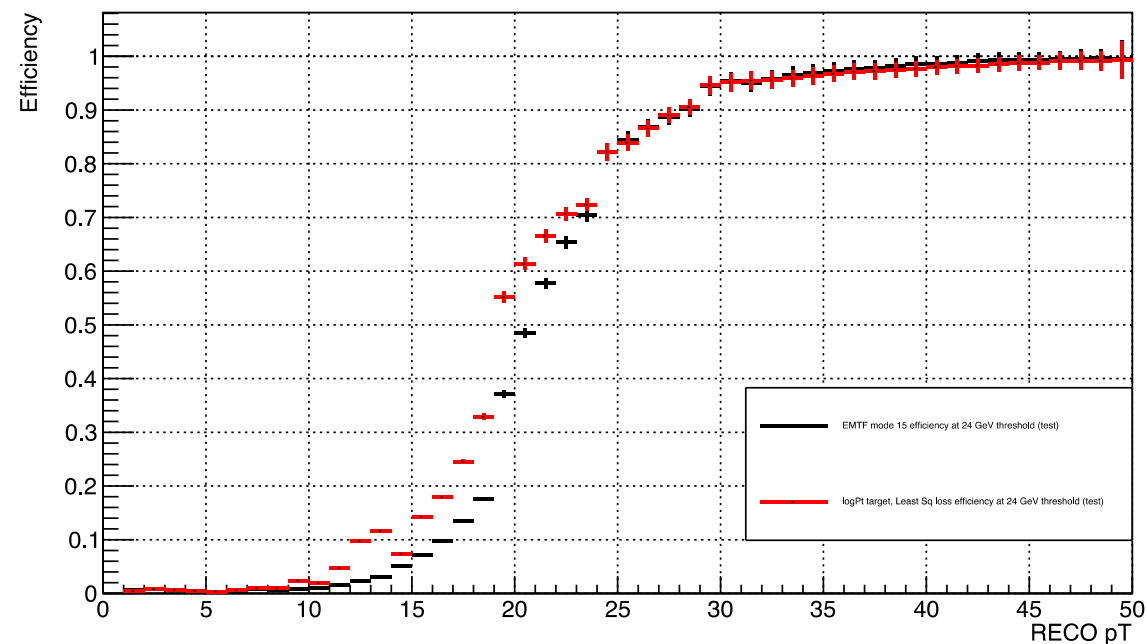


100 Trees

2018 dTh4 Efficiency @ 24GeV

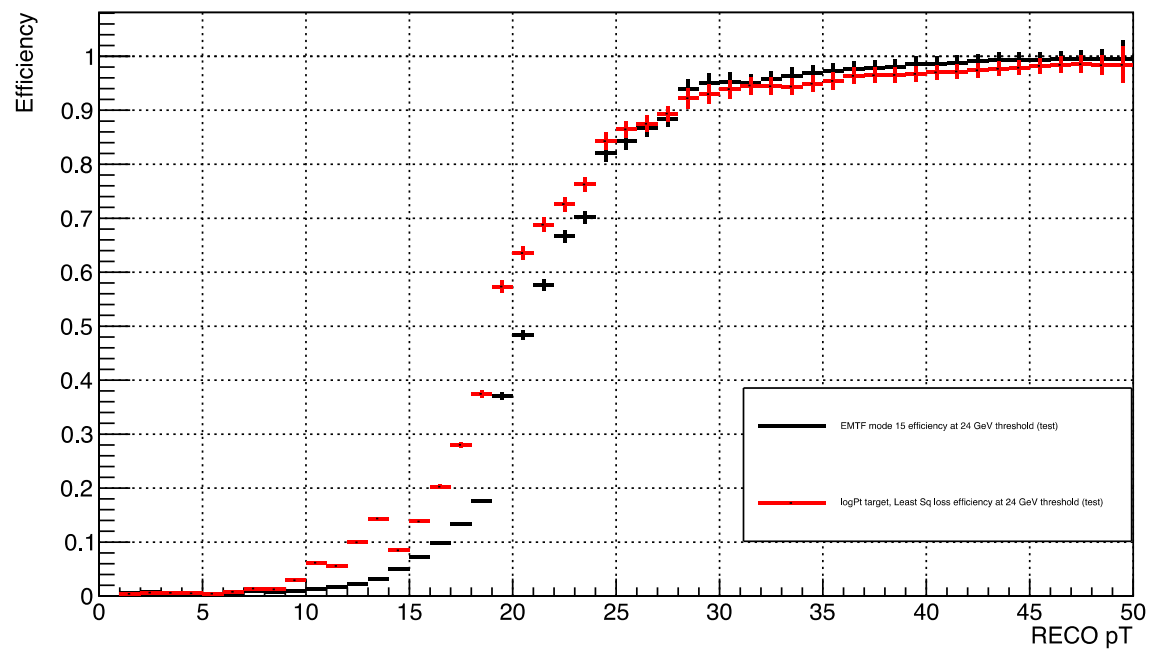
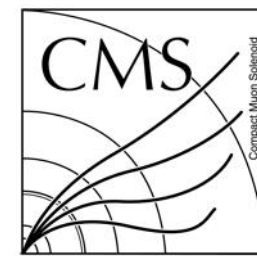


400 Trees

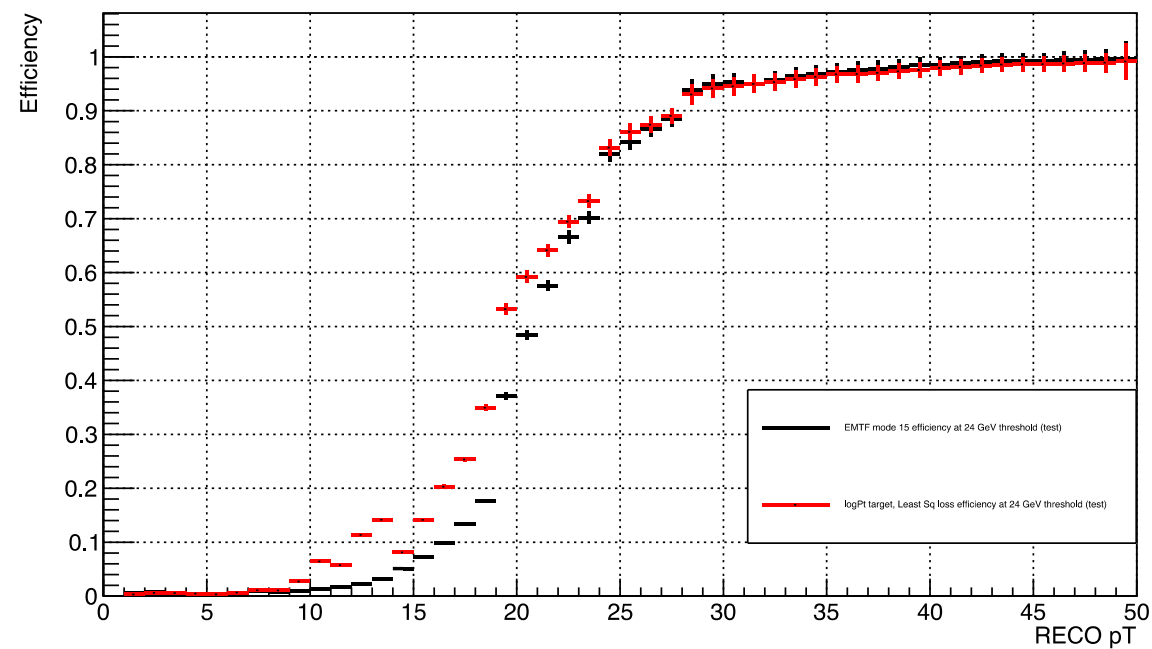


100 Trees

2017 Efficiency @ 24GeV

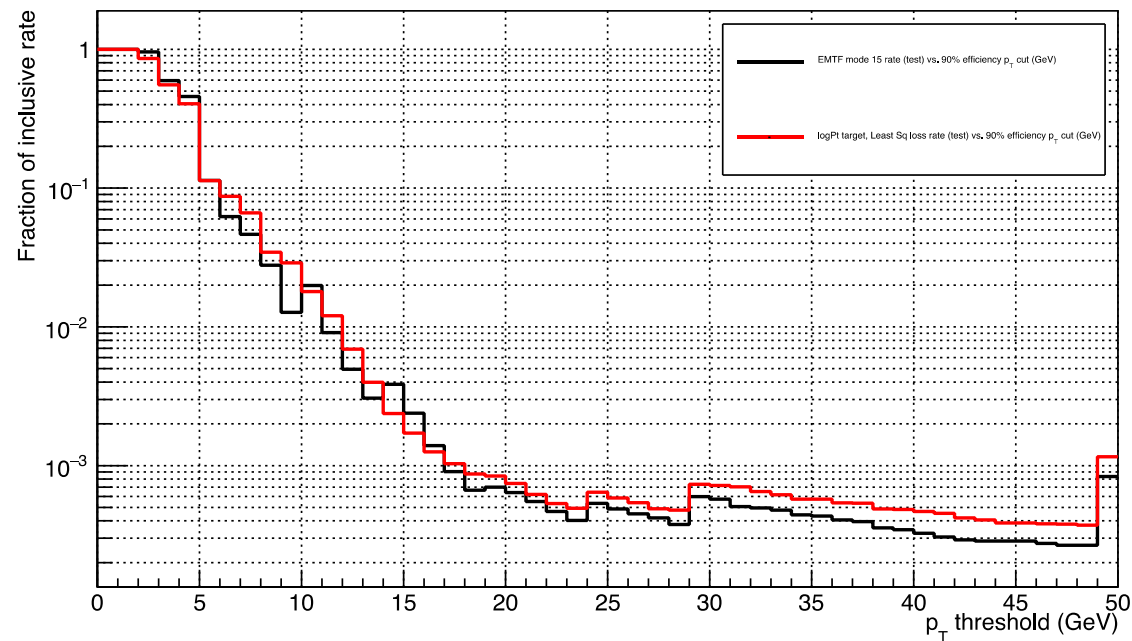


400 Trees

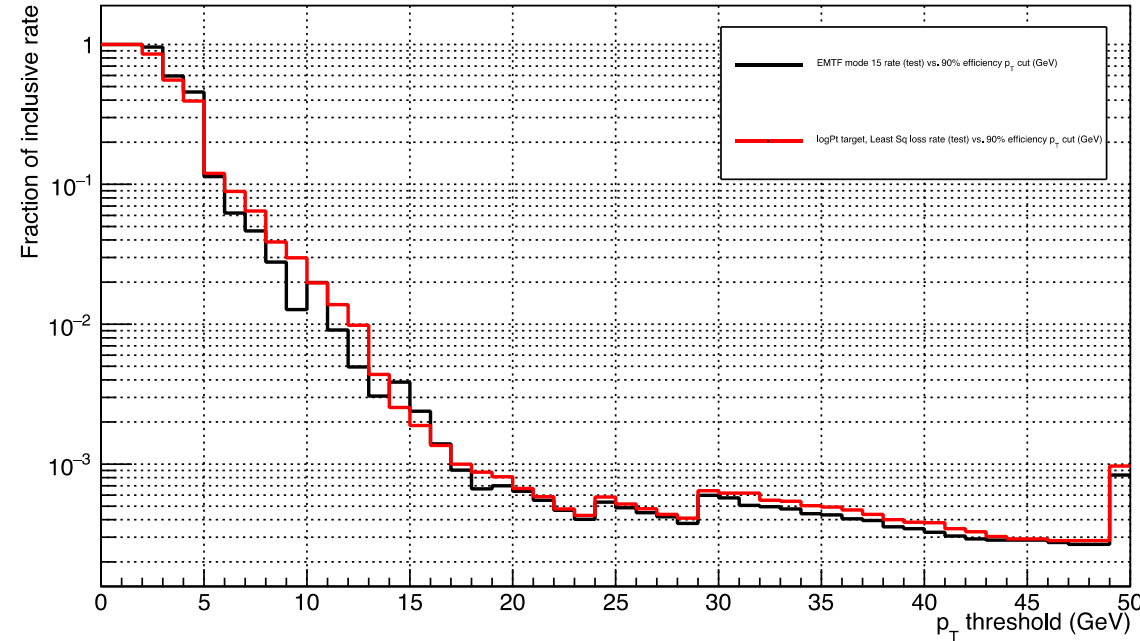


100 Trees

2018 dTh4 setting: Rate

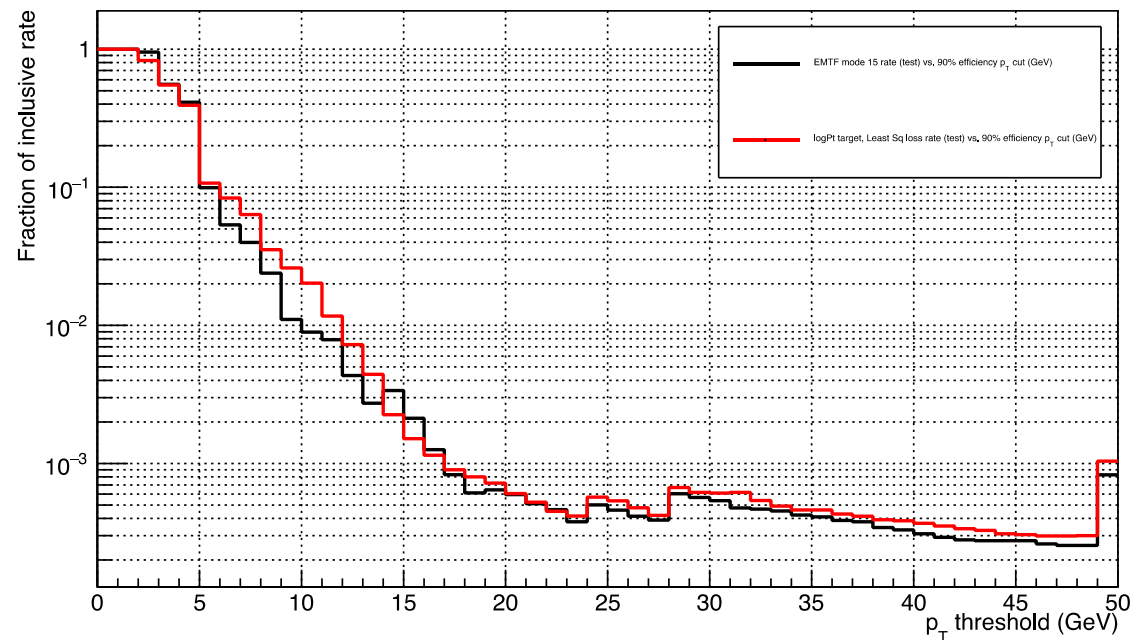


400 Trees

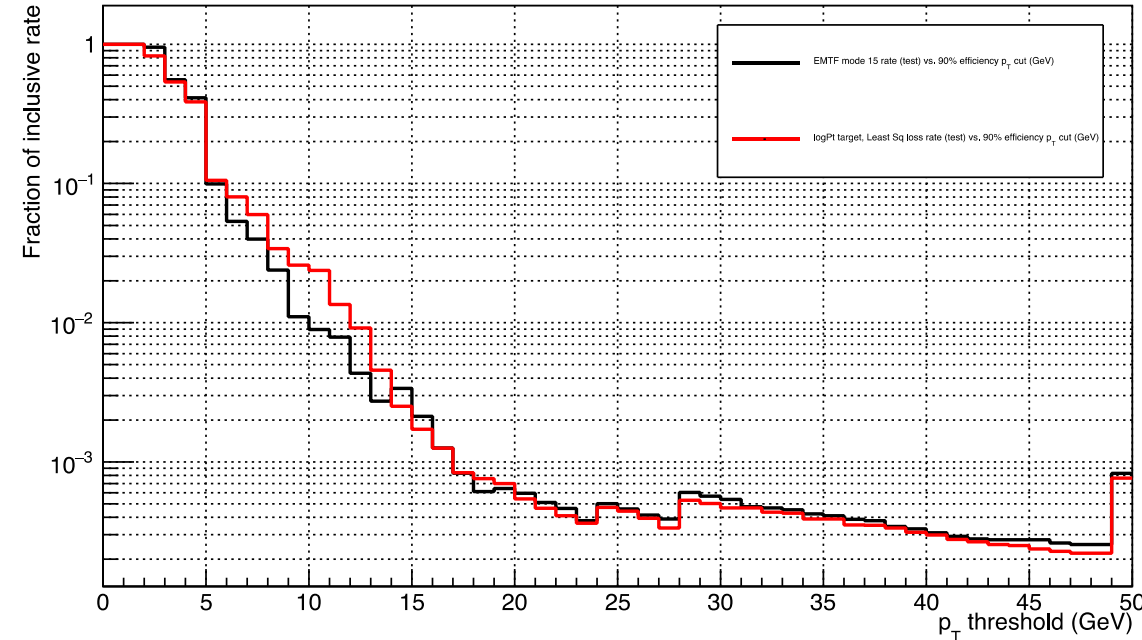


100 Trees

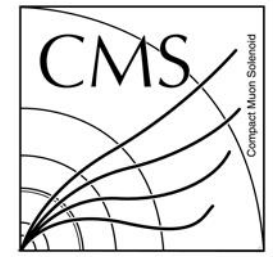
2017 setting: Rate



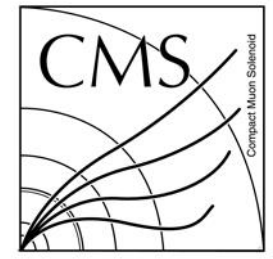
400 Trees



100 Trees



Back Up



Basics

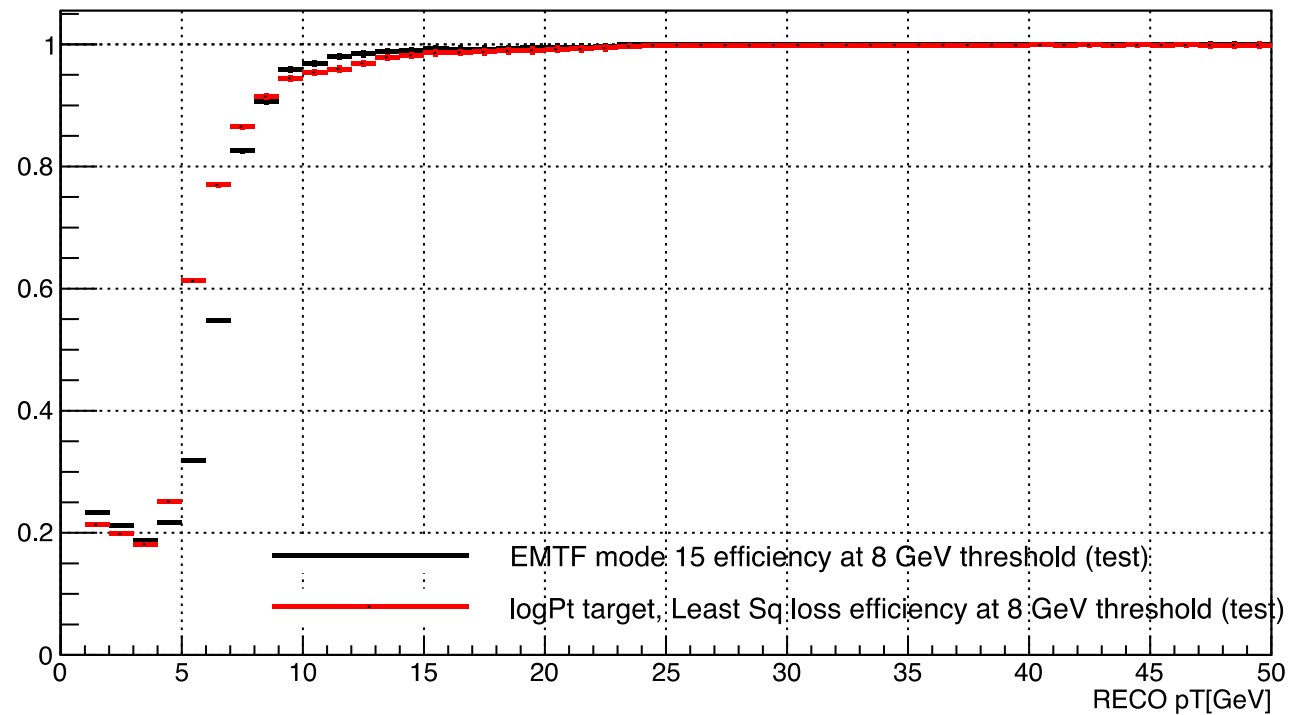
- Train 85,265 muons
 - SingleMu data
 - EMTF track uniquely matched to RECO muon + **2017 BDT pT as input**
 - Removed bias in SingleMu data ^[1]
 - Removed events with only 1 EMTF muon in endcap ^[2]
- Test 7,017,799 muons
 - SingleMu data (uniquely matched) + ZeroBias
- Settings
 - logPt target, 1/pT weight, Least Square loss function
 - Other BDT parameters same to 2017 BDT setting

[1] Slide 6, https://twiki.cern.ch/twiki/pub/CMS/EMTFAnalyzer/EMTF_Studies_on_Reco_Muons.pdf

[2] <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/PtRegression2018.C#L412-L432>

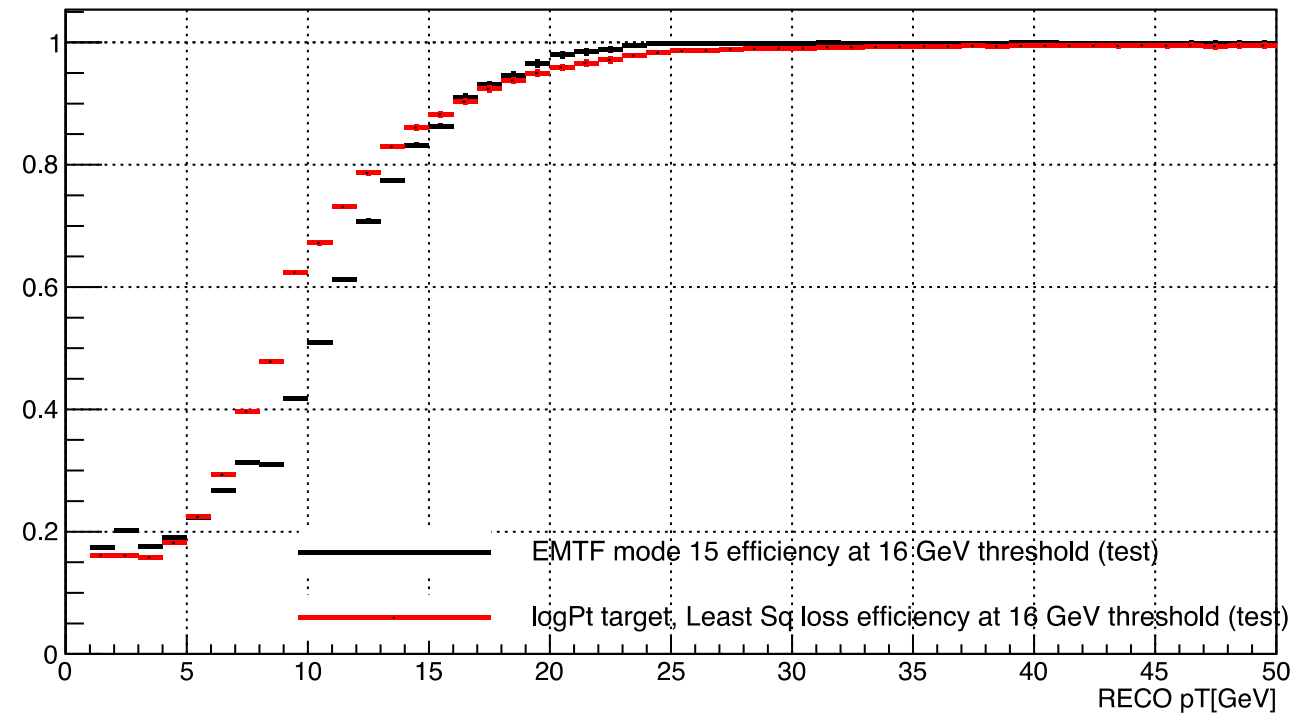
Efficiency @ 8GeV

EMTF mode 15 efficiency at 8 GeV threshold (test)



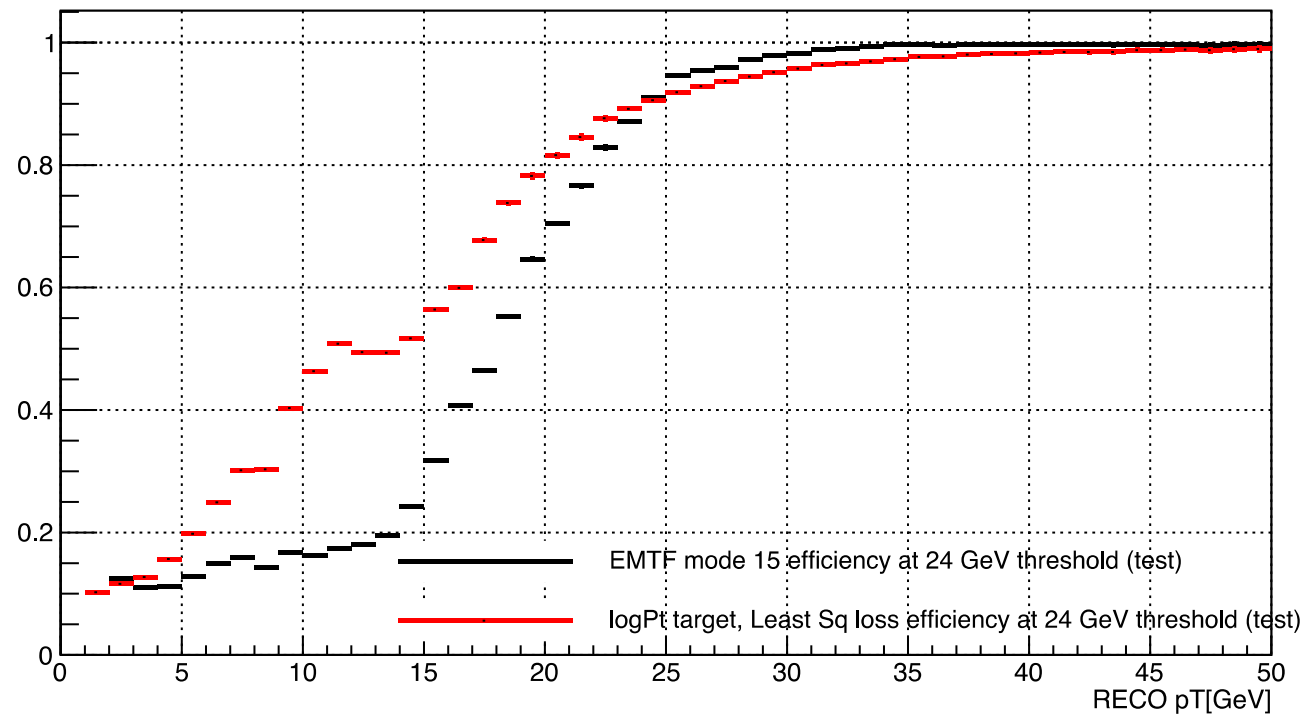
Efficiency @ 16GeV

EMTF mode 15 efficiency at 16 GeV threshold (test)

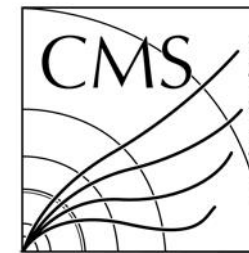


Efficiency @ 24GeV

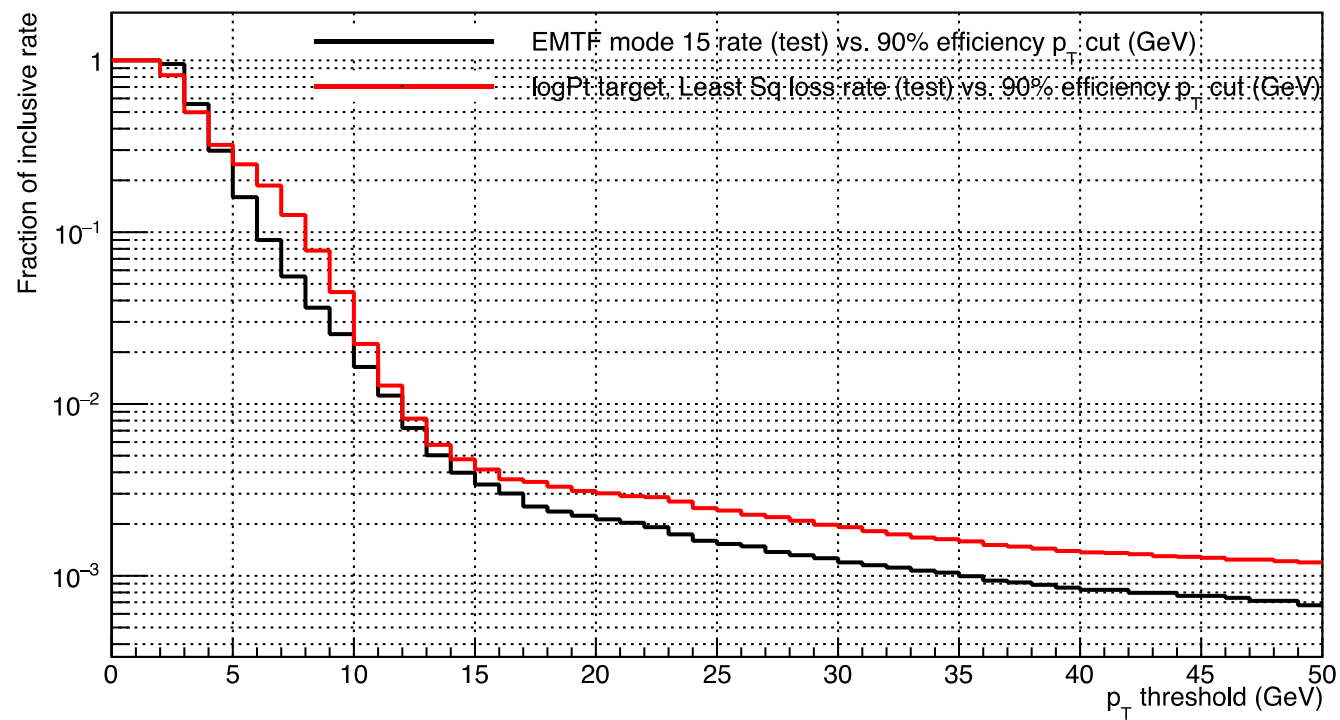
EMTF mode 15 efficiency at 24 GeV threshold (test)



Rate



EMTF mode 15 rate (test) vs. 90% efficiency p_T cut (GeV)





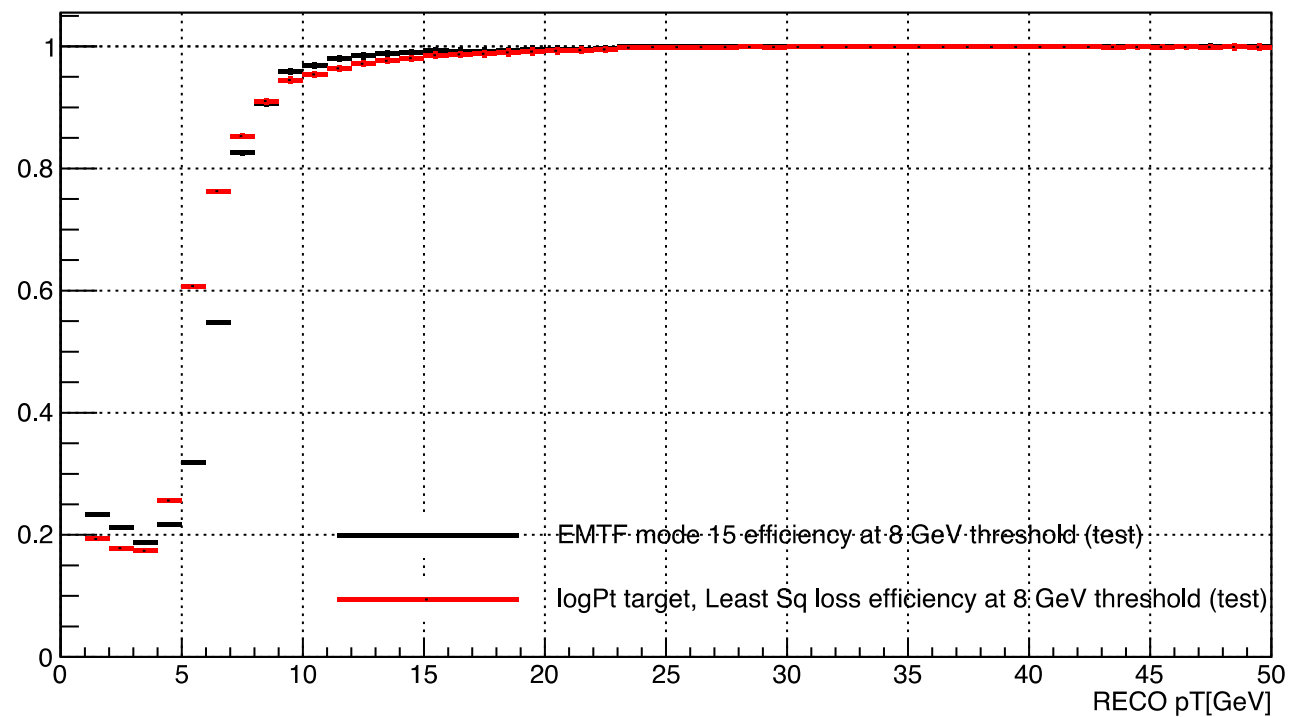
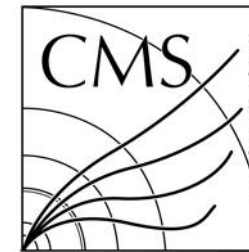
Basics

- Train 85,265 muons
 - SingleMu data
 - EMTF track uniquely matched to RECO muon
 - Removed bias in SingleMu data ^[1]
 - Removed events with only 1 EMTF muon in endcap ^[2]
- Test 7,017,799 muons
 - SingleMu data (uniquely matched) + ZeroBias
- Settings
 - logPt target, 1/pT weight, Least Square loss function
 - Other BDT parameters same to 2017 BDT setting

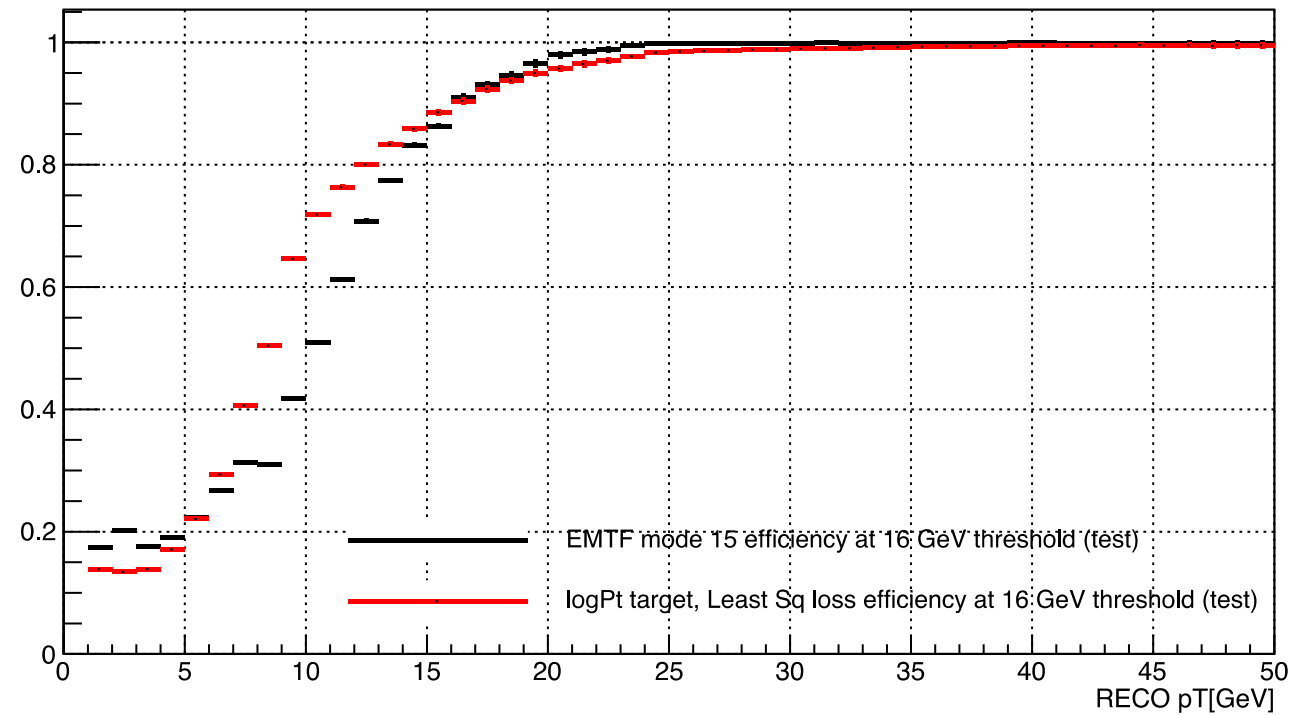
[1] Slide 6, https://twiki.cern.ch/twiki/pub/CMS/EMTFAnalyzer/EMTF_Studies_on_Reco_Muons.pdf

[2] <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/PtRegression2018.C#L412-L432>

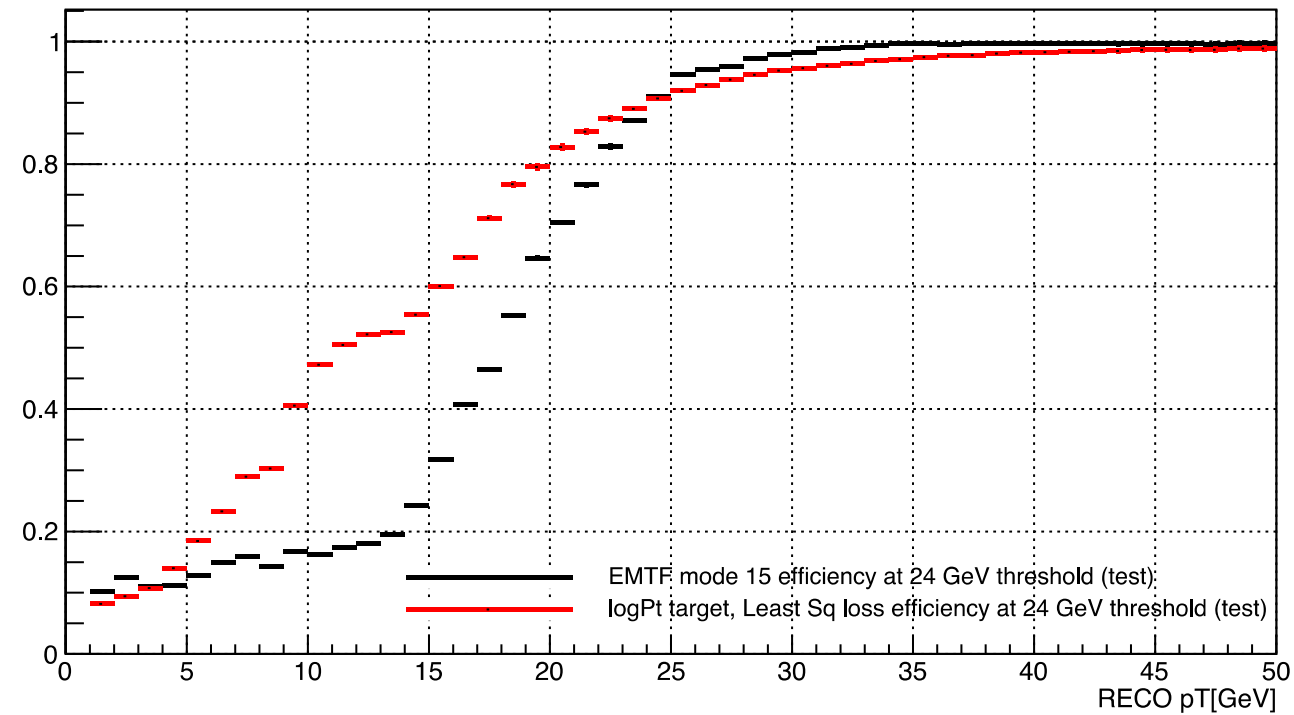
Efficiency @ 8GeV



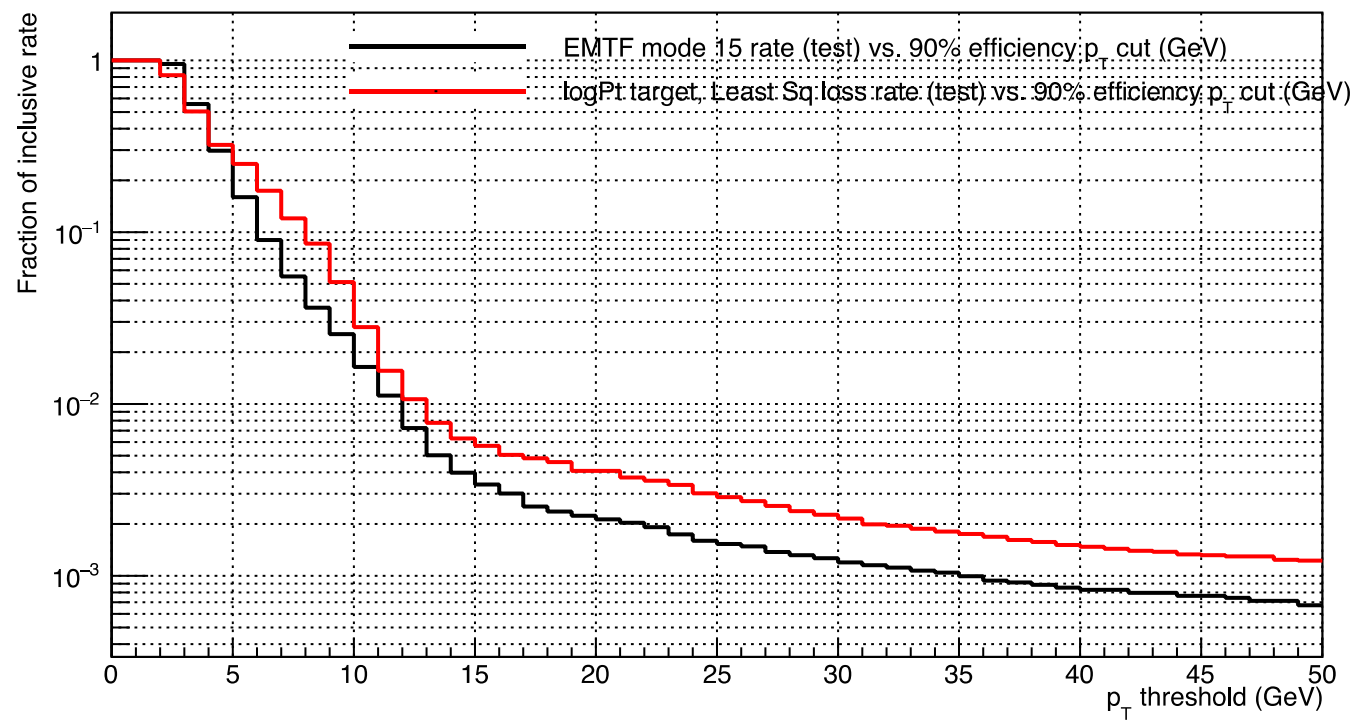
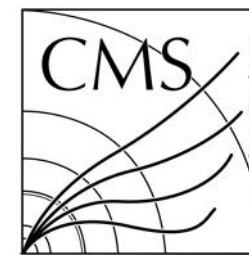
Efficiency @ 16GeV



Efficiency @ 24GeV



Rate





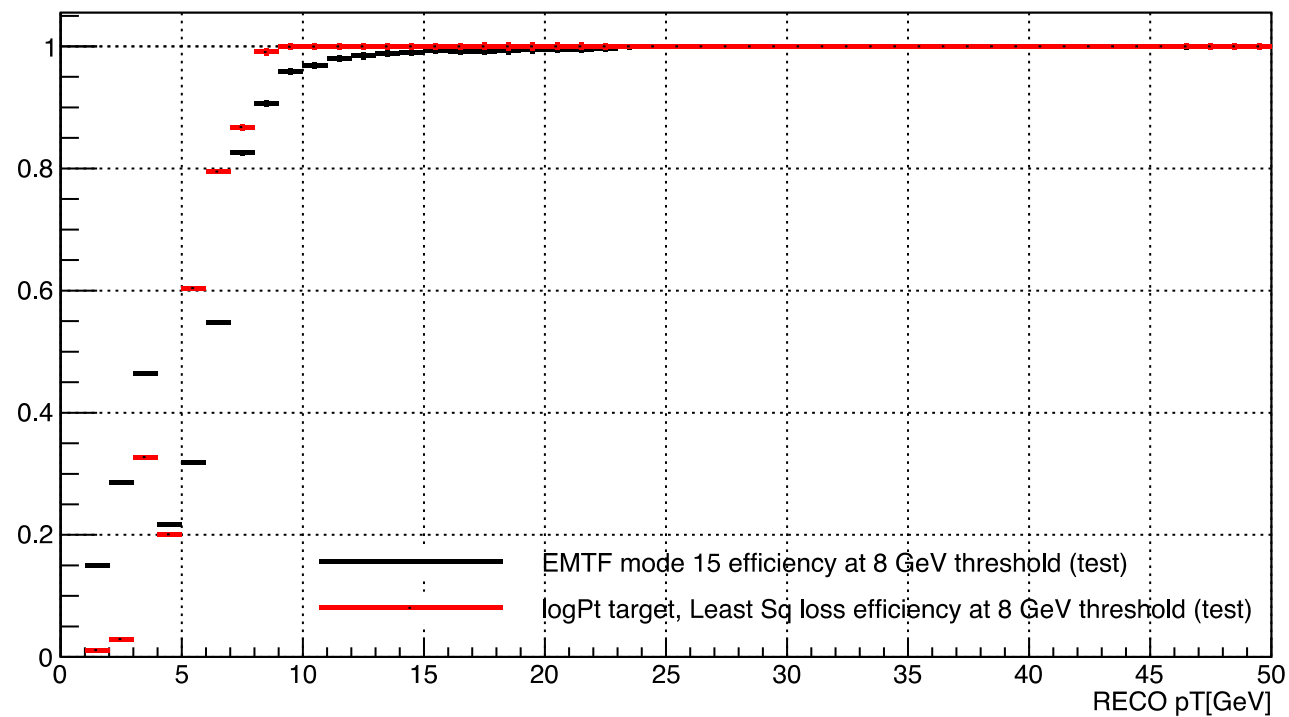
Basics

- Train 249,290 muons
 - SingleMu data
 - EMTF track uniquely matched to RECO muon + **Not Uniquely matched (assign uGMT default pT to RECO muon)**
 - Removed bias in SingleMu data ^[1]
 - Removed events with only 1 EMTF muon in endcap ^[2]
- Test 10,670,100 muons
 - SingleMu data + ZeroBias
- Settings
 - logPt target, 1/pT weight, Least Square loss function
 - Other BDT parameters same to 2017 BDT setting

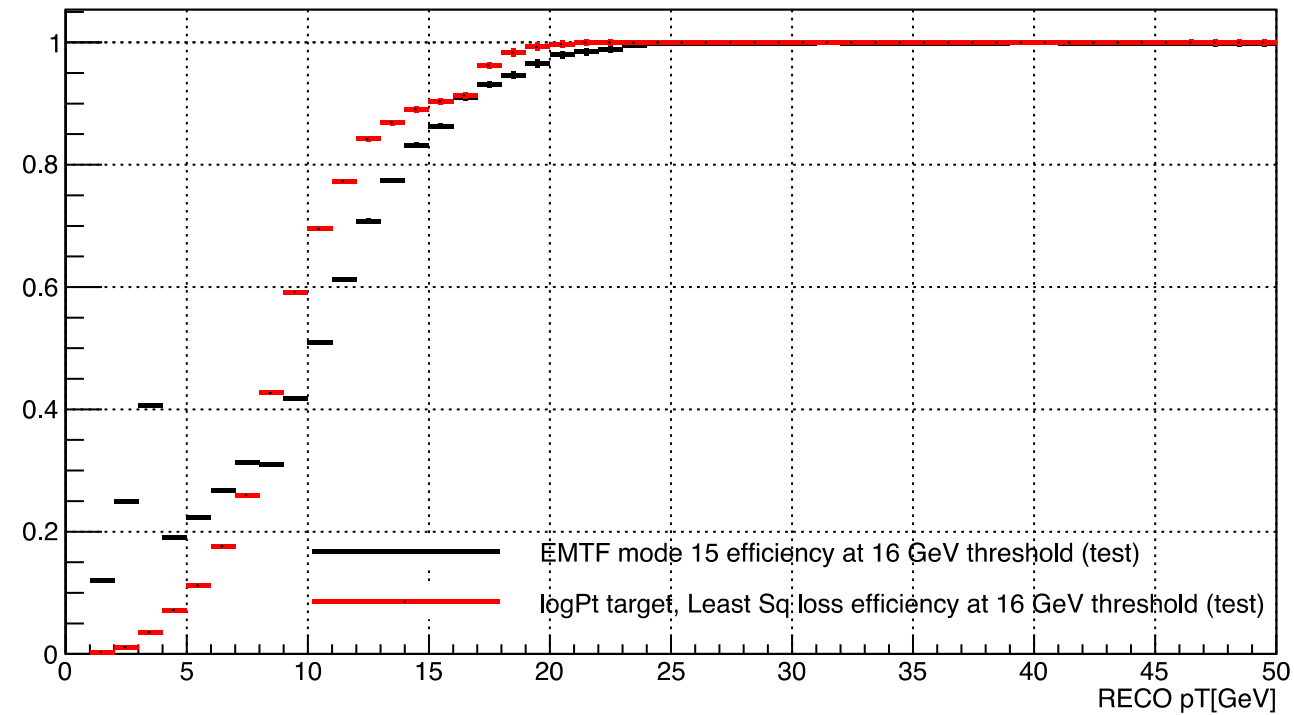
[1] Slide 6, https://twiki.cern.ch/twiki/pub/CMS/EMTFAnalyzer/EMTF_Studies_on_Reco_Muons.pdf

[2] <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/PtRegression2018.C#L412-L432>

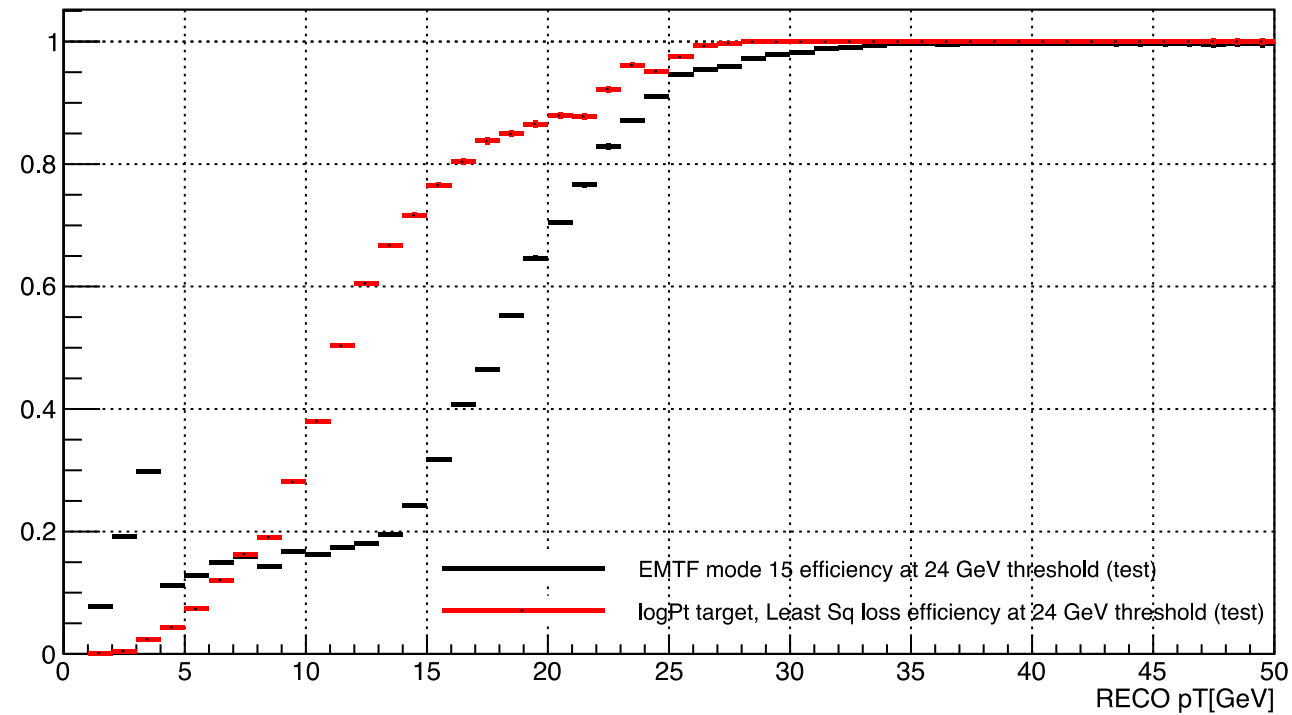
Efficiency @ 8GeV



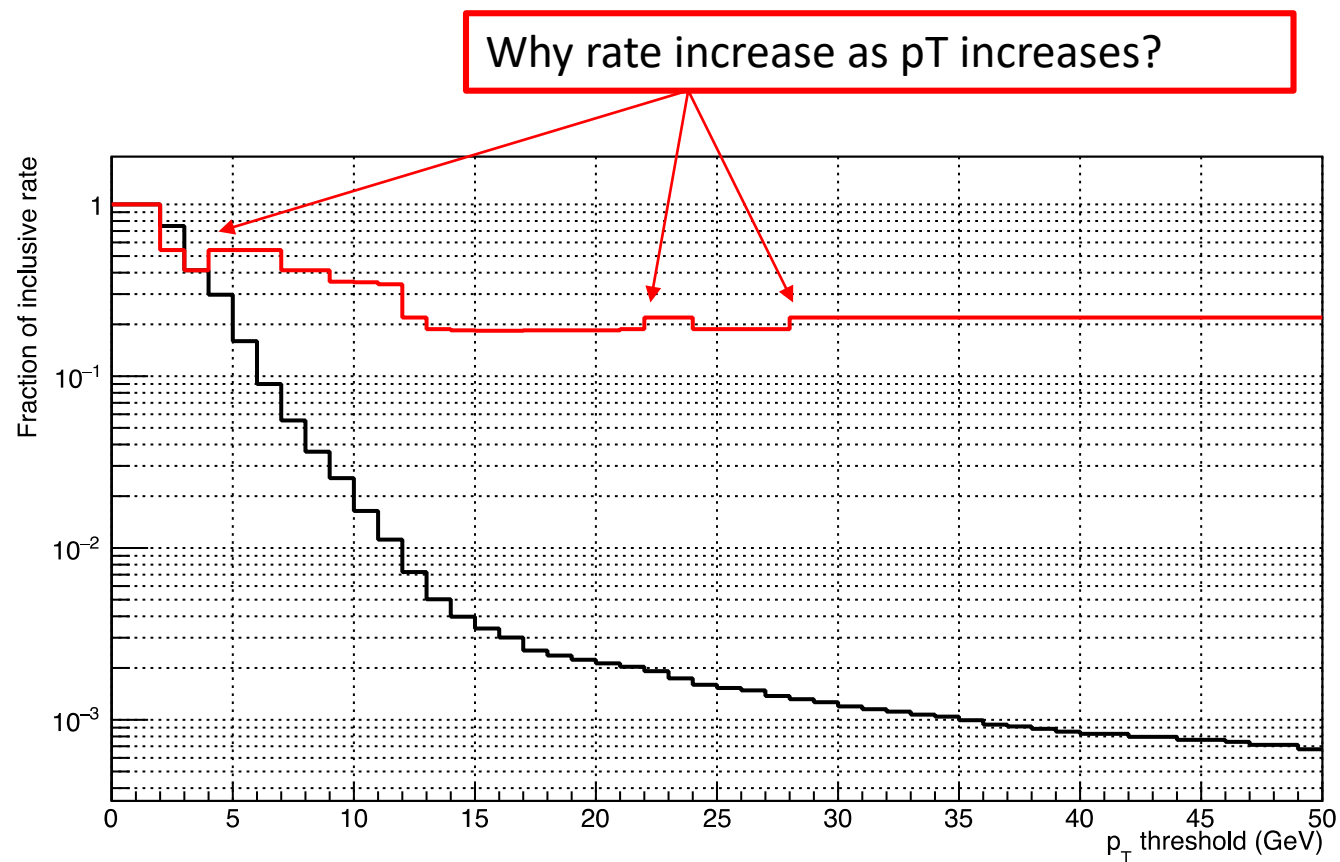
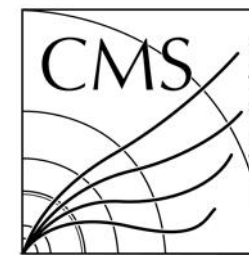
Efficiency @ 16GeV



Efficiency @ 24GeV

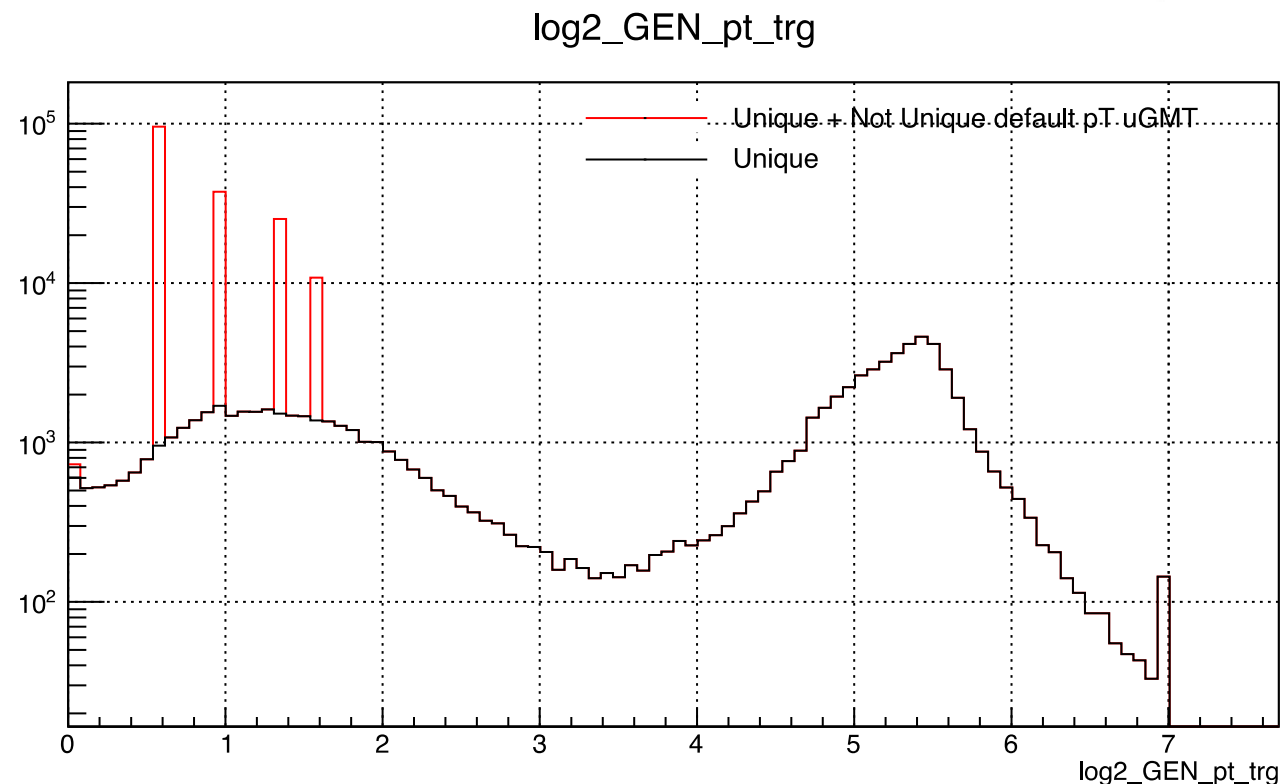


Rate



Compare Target

- Current default pT setting for not uniquely matched tracks (from uGMT [1-2])
 - $\text{mu_eta} = \text{emtf_eta_int} * 0.010875;$
 - $\text{gmt_pt} = 10 - (\text{abs}(\text{emtf_eta_int}) / 32);$
 - $\text{mu_pt} = (\text{gmt_pt} \leq 0) ? 0 : (\text{gmt_pt} - 1) * 0.5;$
- Four discrete peaks at low pT
 - Due to emtf_eta_int is “int” type

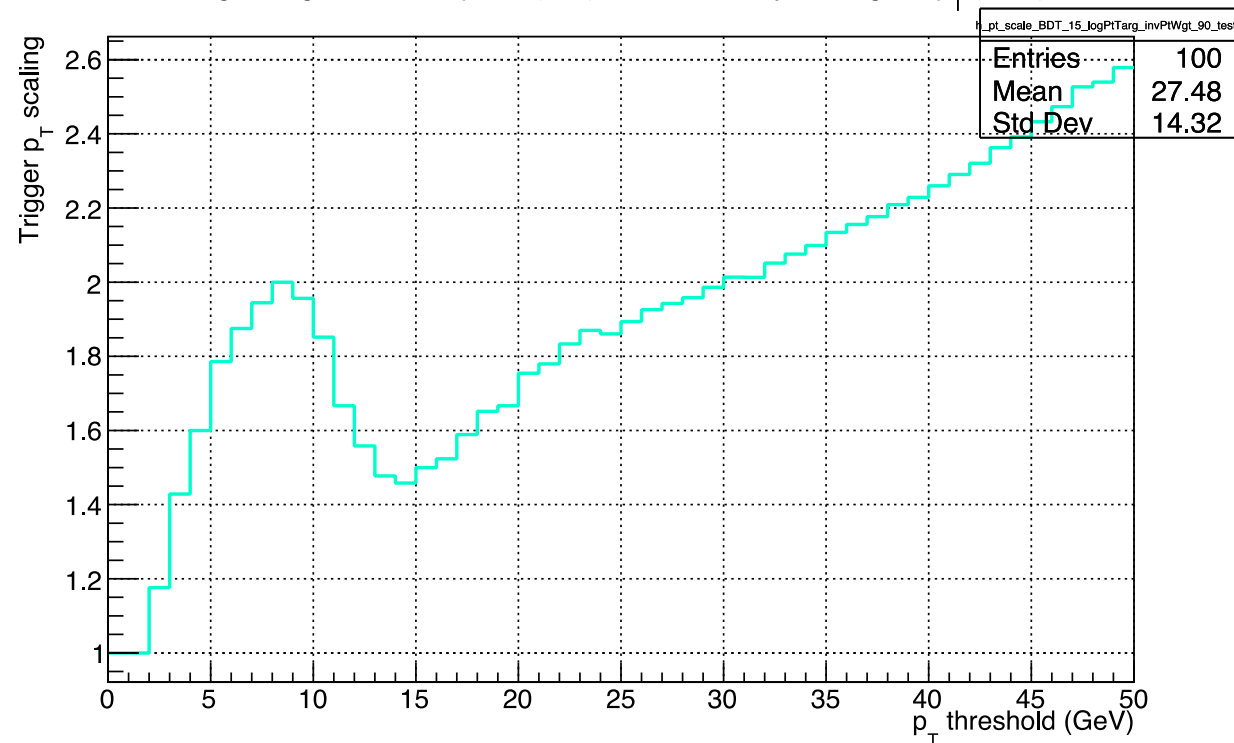


[1] <https://github.com/cms-sw/cmssw/blob/master/L1Trigger/L1TMuonEndCap/src/PtAssignment.cc#L86-L89>

[2] <https://github.com/cms-sw/cmssw/blob/master/L1Trigger/L1TMuonEndCap/interface/TrackTools.h#L77-L81>

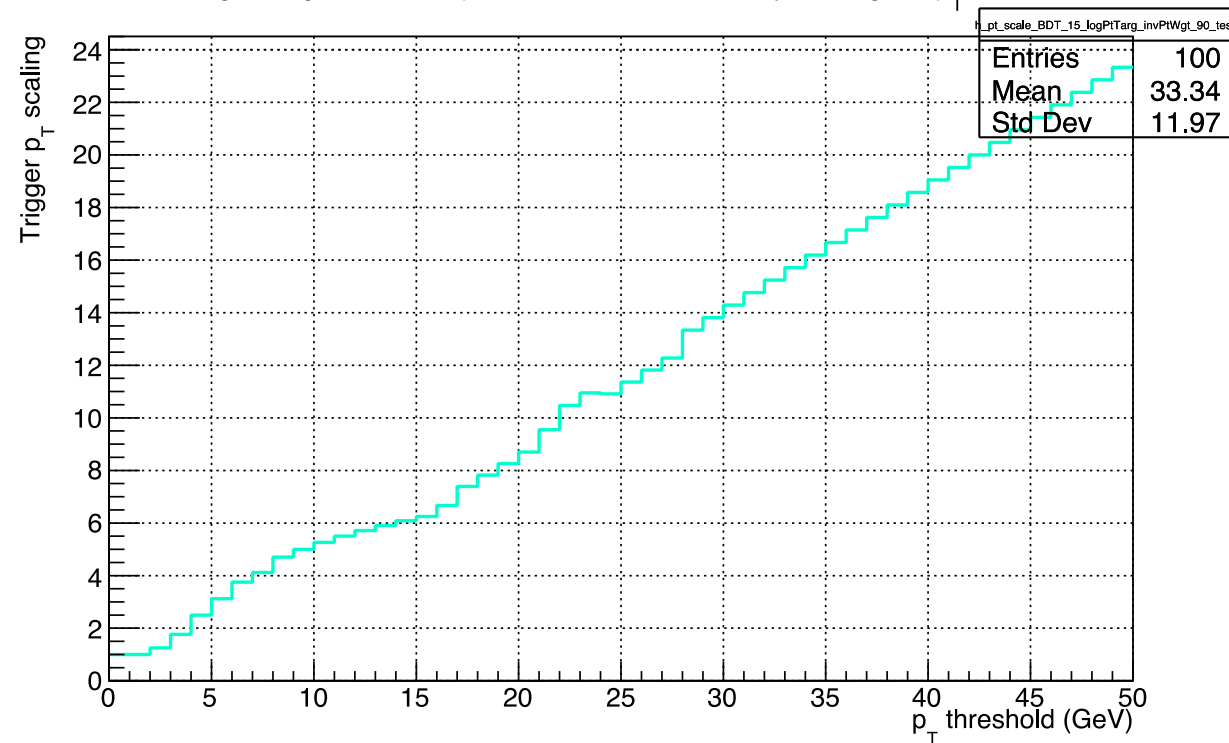
Compare pT Scale

logPt target, Least Sq loss (test) 90% efficiency scaling vs. p_T (GeV)



Uniquely matched Only

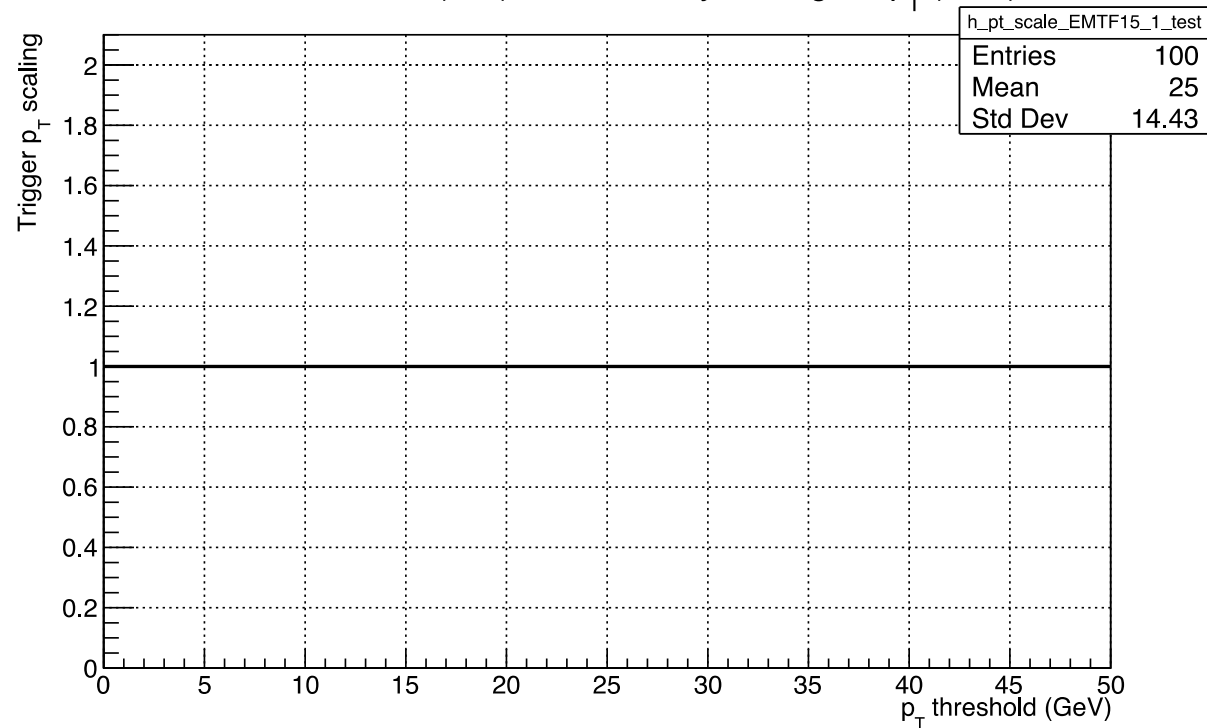
logPt target, Least Sq loss (test) 90% efficiency scaling vs. p_T (GeV)



Include not uniquely matched

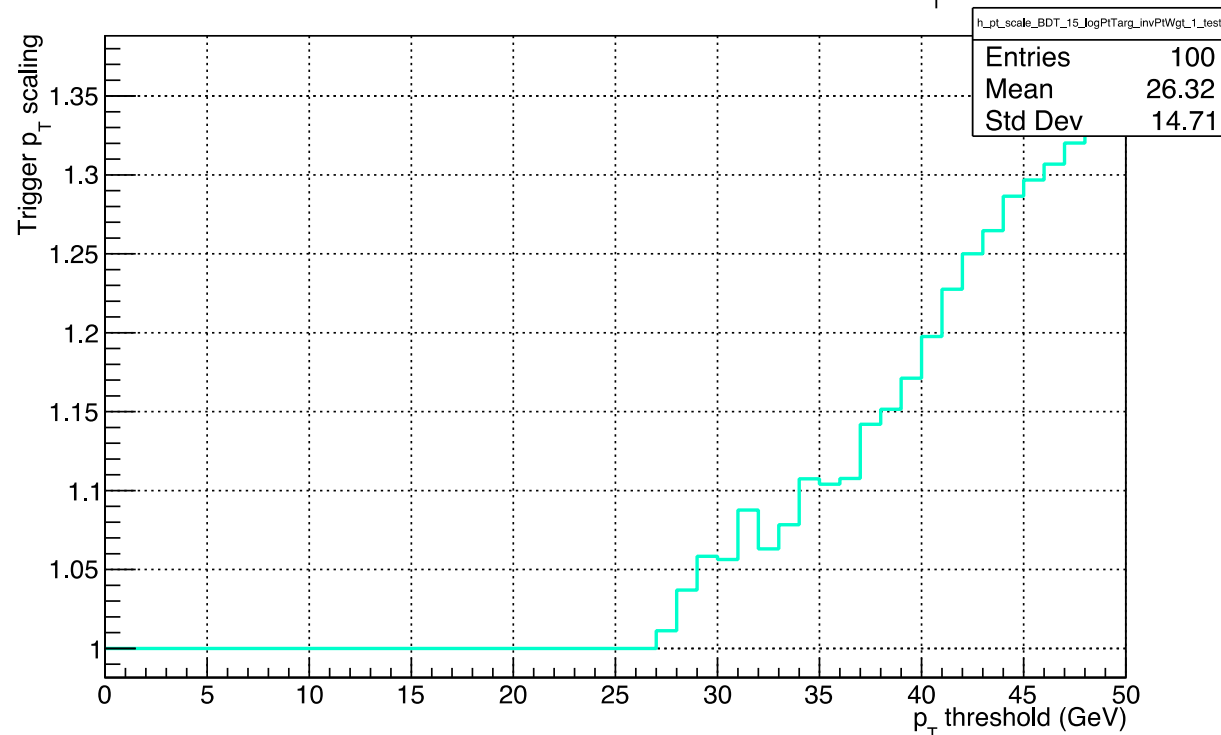
pT Scale @1% efficiency

EMTF mode 15 (test) 1% efficiency scaling vs. p_T (GeV)



EMTF

logPt target, Least Sq loss (test) 1% efficiency scaling vs. p_T (GeV)



New BDT: Include not uniquely matched



Basics

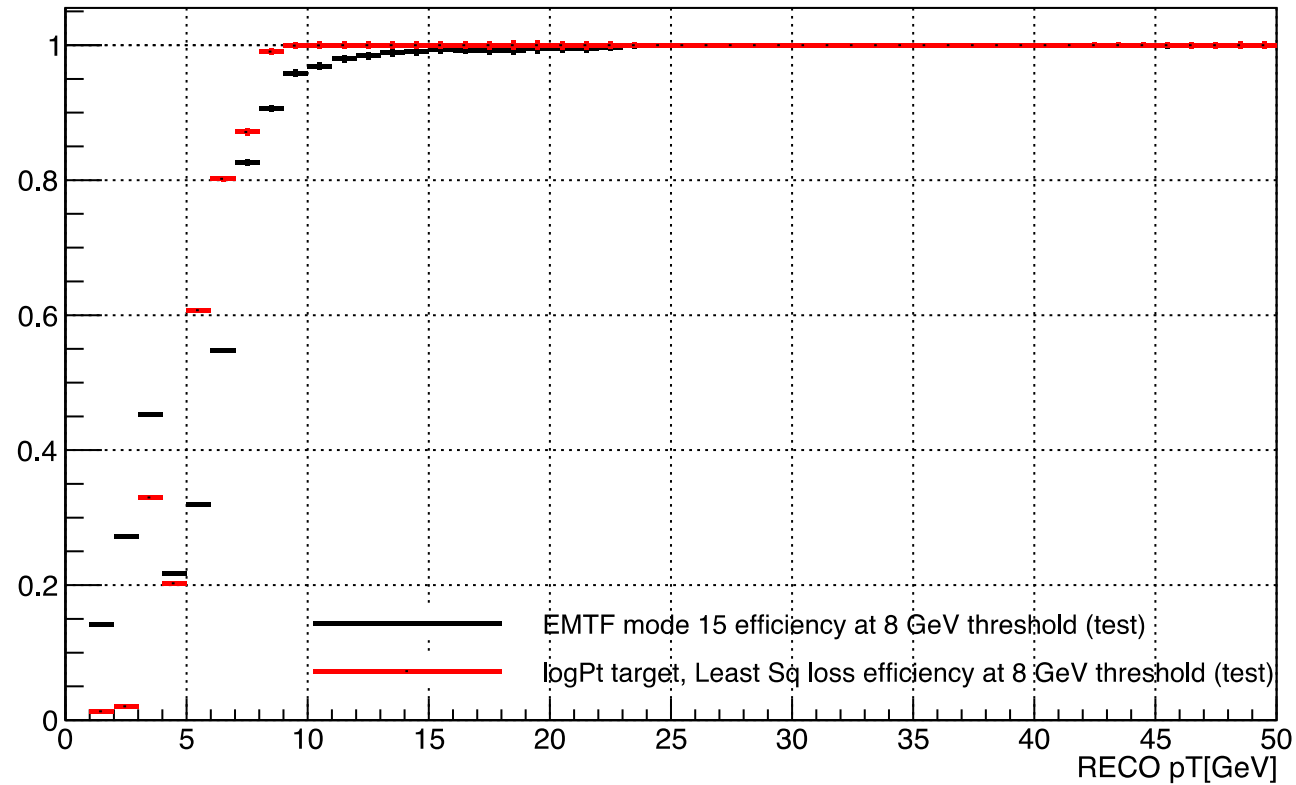
- Train 246,738 muons
 - SingleMu data
 - EMTF track uniquely matched to RECO muon + **No RECO match (assign uGMT default pT to RECO muon)**
 - Removed bias in SingleMu data ^[1]
 - Removed events with only 1 EMTF muon in endcap ^[2]
- Test 10,549,360 muons
 - SingleMu data + ZeroBias
- Settings
 - logPt target, 1/pT weight, Least Square loss function
 - Other BDT parameters same to 2017 BDT setting

[1] Slide 6, https://twiki.cern.ch/twiki/pub/CMS/EMTFAnalyzer/EMTF_Studies_on_Reco_Muons.pdf

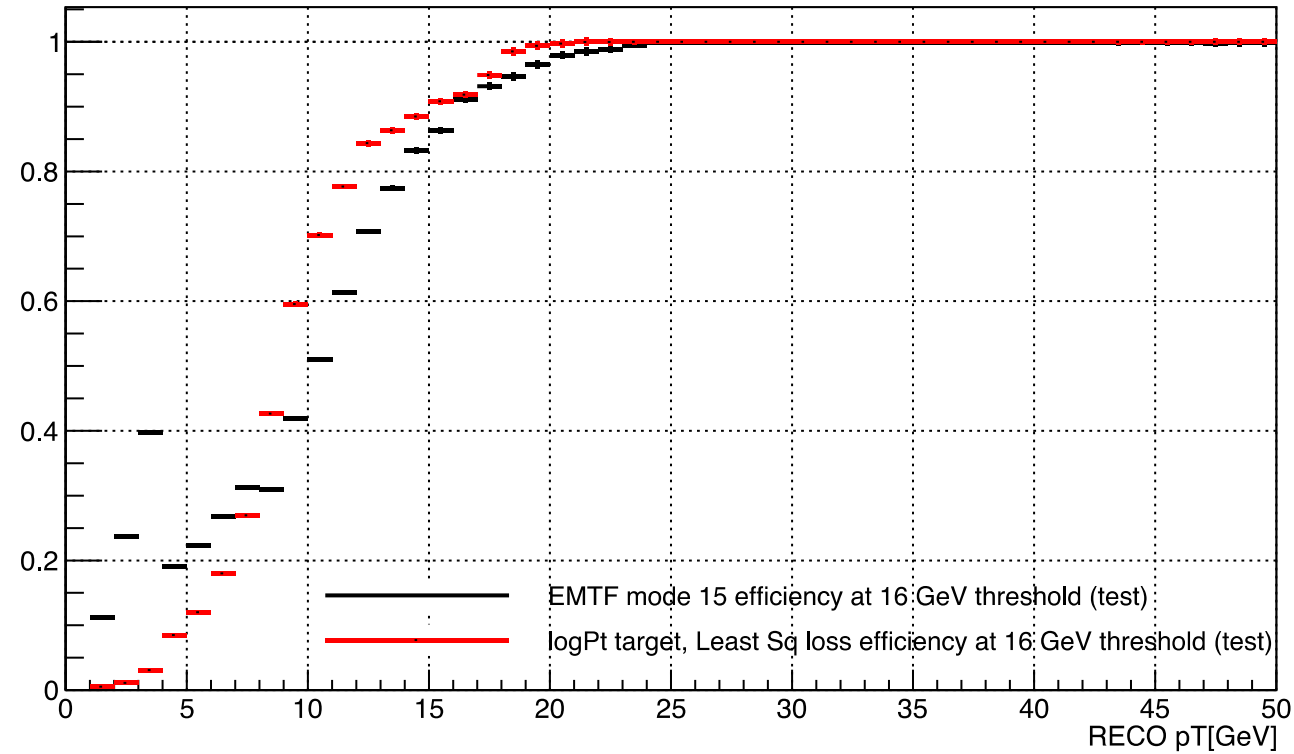
[2] <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/PtRegression2018.C#L412-L432>

Efficiency @ 8GeV

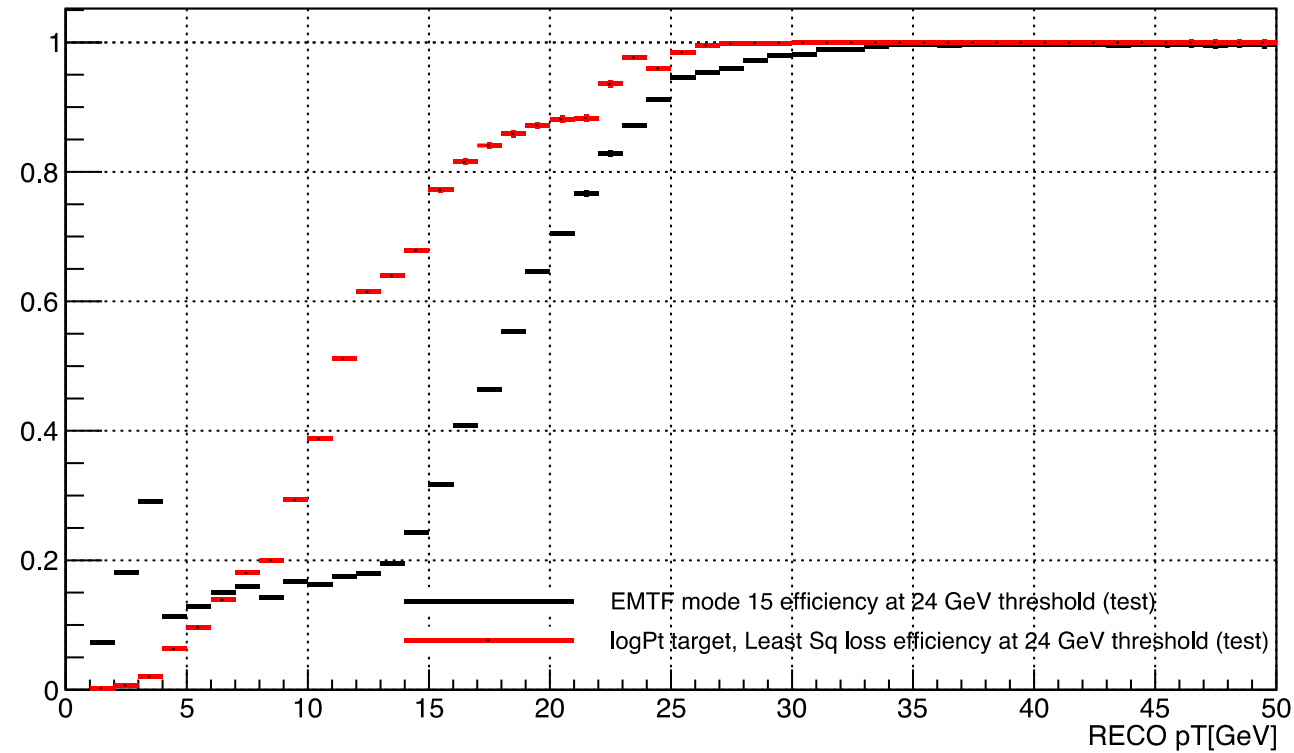
EMTF mode 15 efficiency at 8 GeV threshold (test)



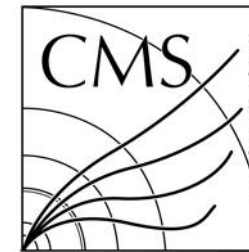
Efficiency @ 16GeV



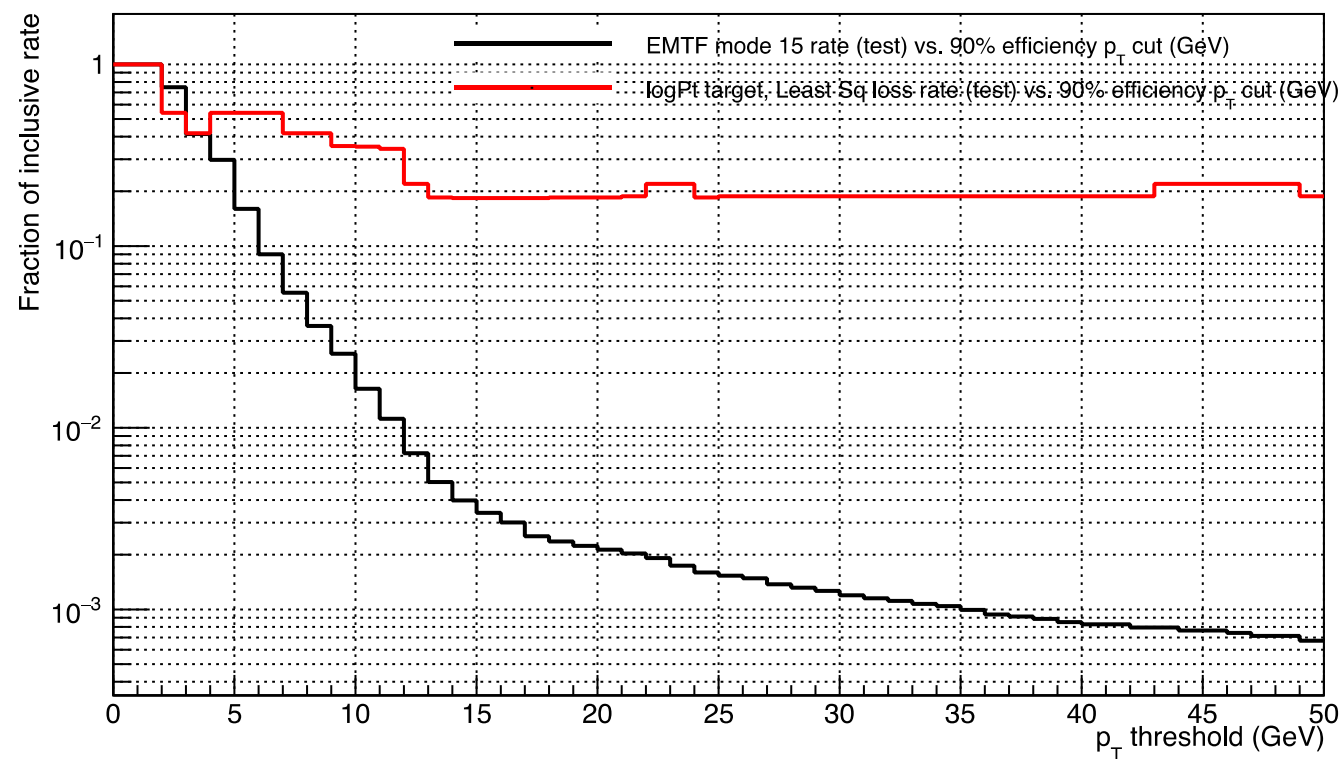
Efficiency @ 24GeV



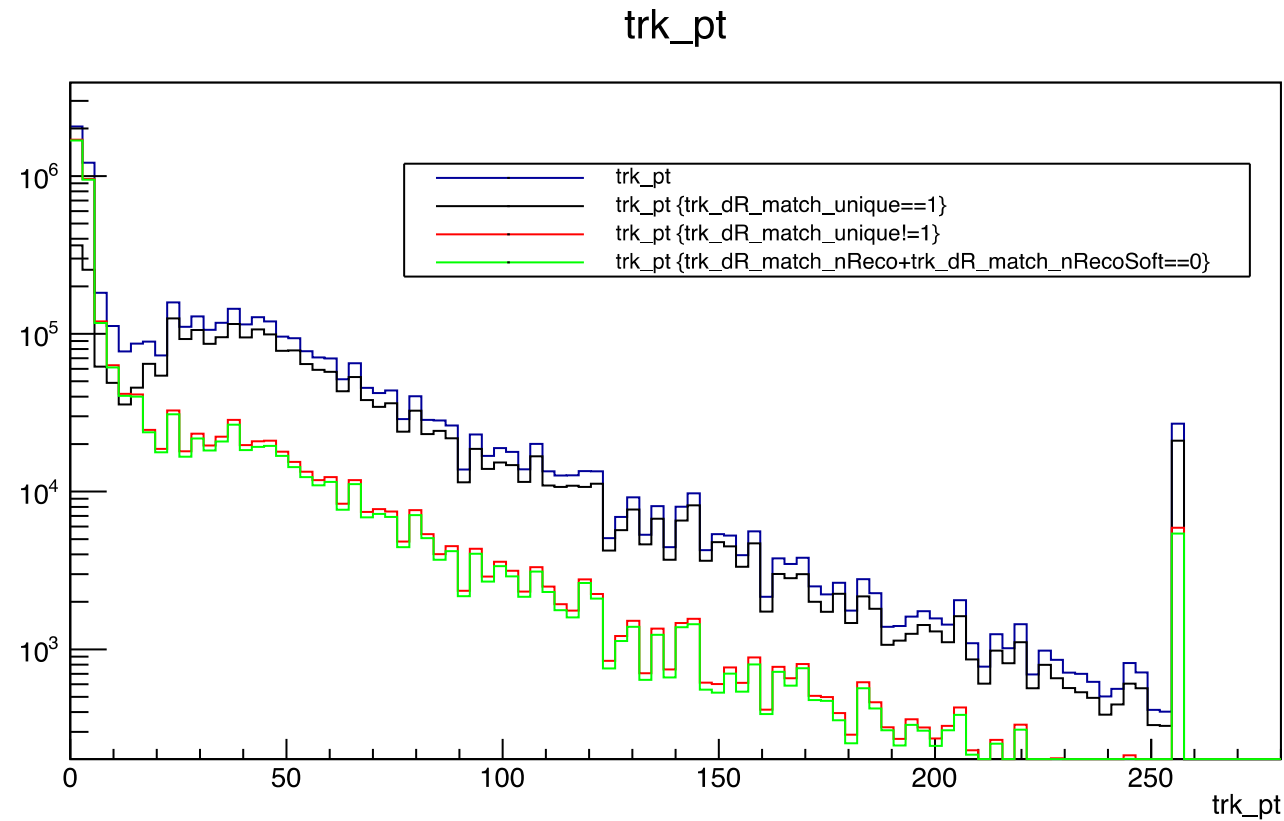
Rate

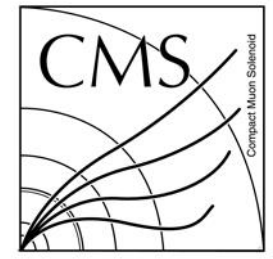


EMTF mode 15 rate (test) vs. 90% efficiency p_T cut (GeV)

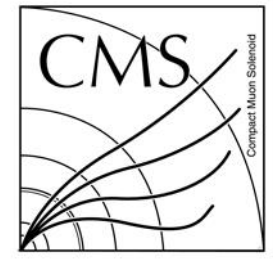


Trk_pT from one SingleMu file





Back Up



Additional Info

- Output Files
 - /eos/user/w/wshi/2018PtTraining
- Training macro
 - <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/PtRegression2018.C>
- RateVsEff macro
 - <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/macros/RateVsEff.C>



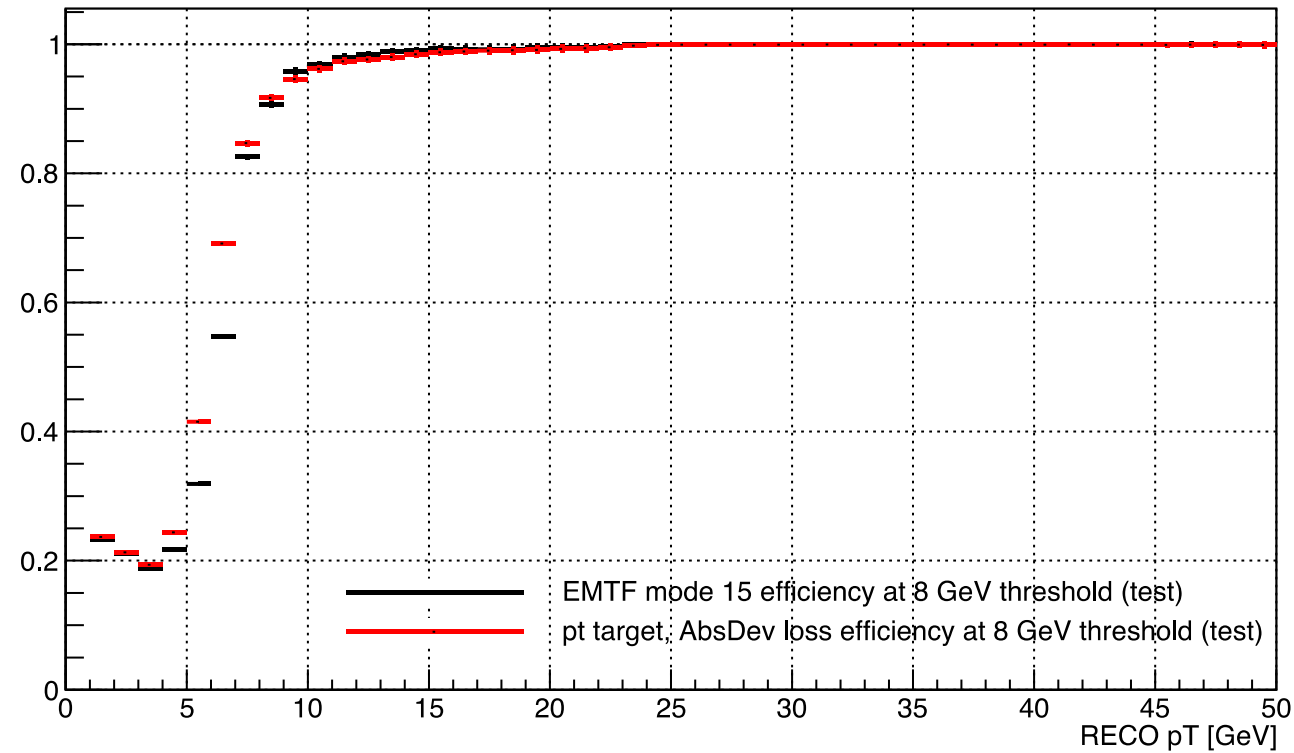
Basics

- Train 85,265 muons
 - SingleMu data
 - EMTF track uniquely matched to RECO muon
 - Removed bias in SingleMu data ^[1]
 - Removed events with only 1 EMTF muon in endcap ^[2]
- Test 7,017,799 muons
 - SingleMu data (uniquely matched) + ZeroBias
- Settings
 - pT target, no weight, Absolute deviation loss function
 - Other BDT parameters same to 2017 BDT setting

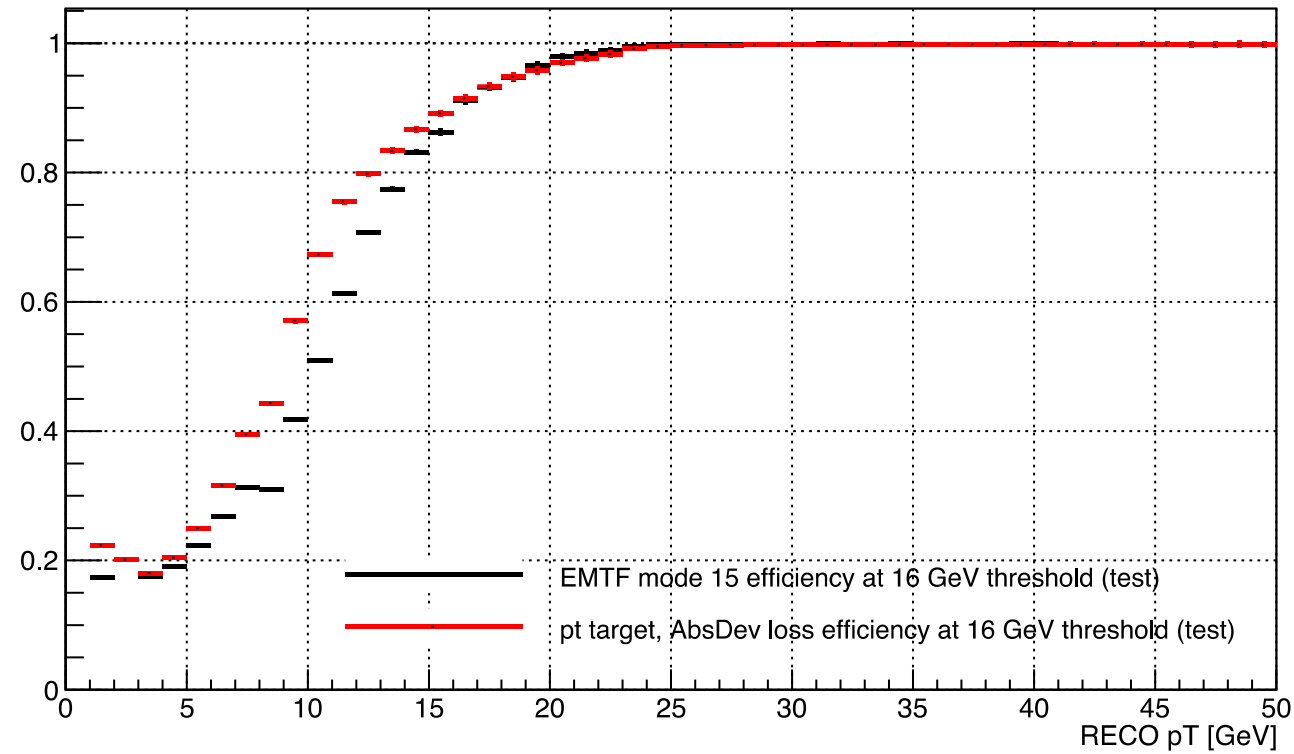
[1] Slide 6, https://twiki.cern.ch/twiki/pub/CMS/EMTFAnalyzer/EMTF_Studies_on_Reco_Muons.pdf

[2] <https://github.com/weishi10141993/EMTFPtAssign2017/blob/test/PtRegression2018.C#L412-L432>

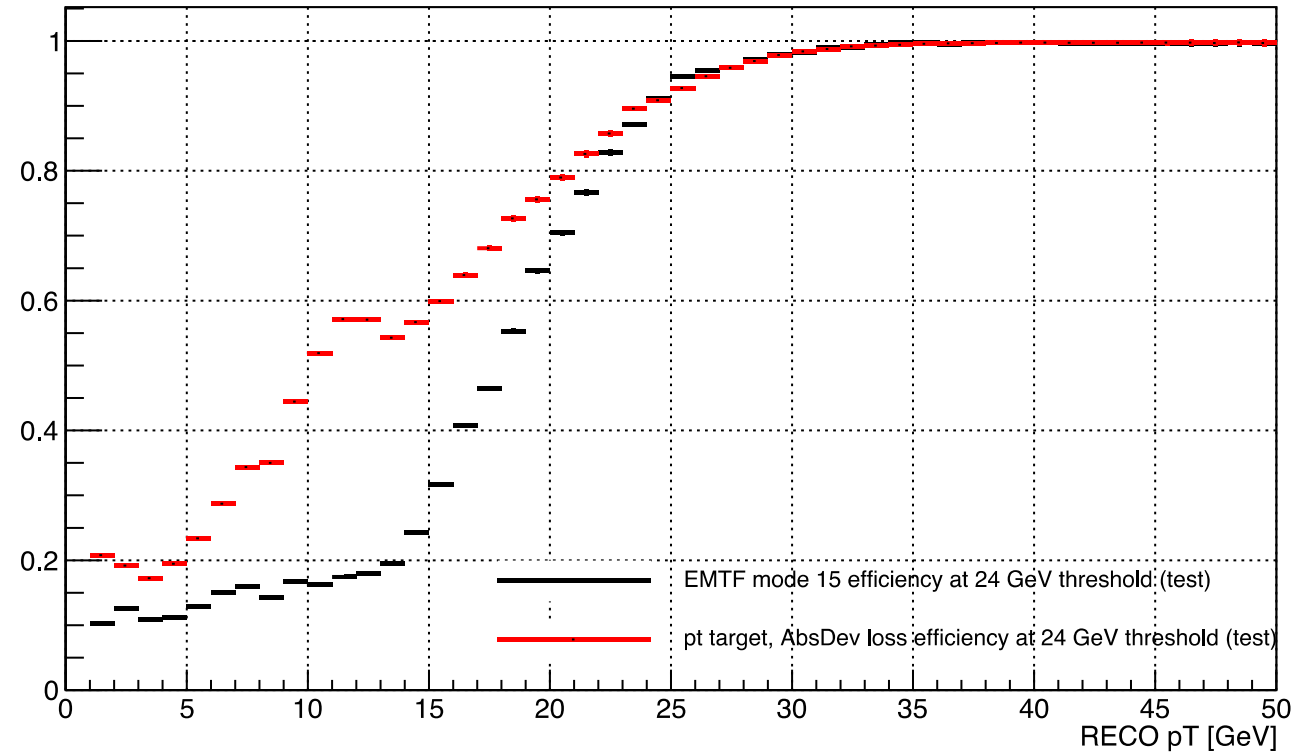
Efficiency @ 8GeV



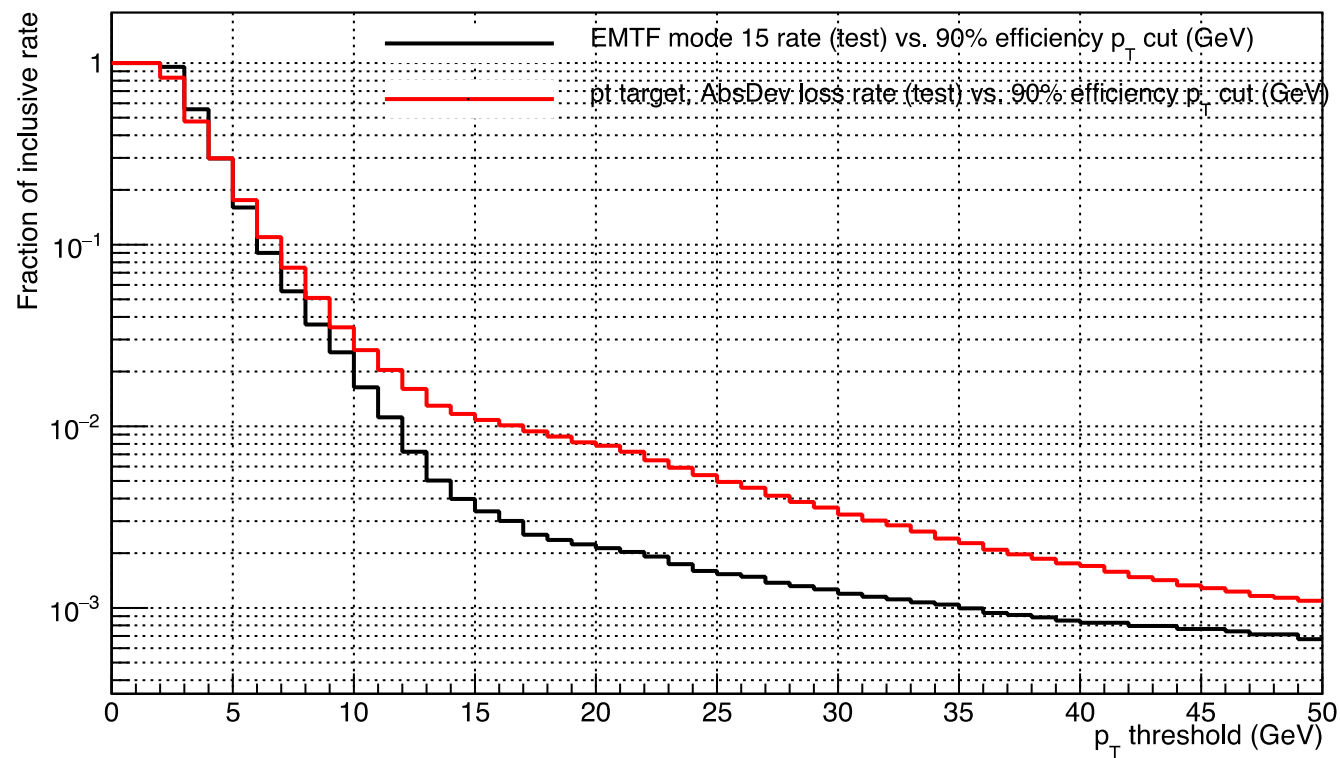
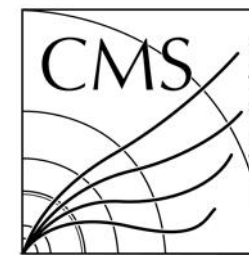
Efficiency @ 16GeV

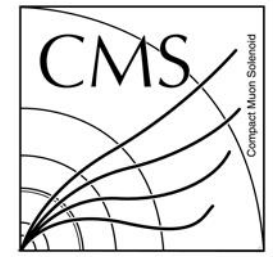


Efficiency @ 24GeV

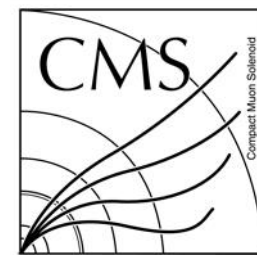


Rate





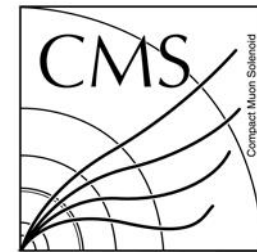
Back Up



Some Useful info from TMVA

Correlation matrix (Regression):

	theta	St1_ring2	dPhi_12	dPhi_23	dPhi_34	dPhi_13	dPhi_14	dPhi_24	FR_1	bend_1	dPhiSum4	dPhiSum4A	dPhiSum3	dPhiSum3A	outStPhi	dTh_14
theta:	+1.000	+0.934	-0.460	-0.117	+0.157	-0.457	-0.431	+0.030	+0.033	-0.150	-0.420	-0.464	-0.001	-0.364	+0.010	+0.140
St1_ring2:	+0.934	+1.000	-0.442	-0.092	+0.144	-0.434	-0.411	+0.035	+0.014	-0.128	-0.399	-0.433	+0.028	-0.324	+0.034	+0.132
dPhi_12:	-0.460	-0.442	+1.000	+0.161	-0.436	+0.970	+0.888	-0.172	+0.030	+0.644	+0.859	+0.980	-0.147	+0.731	-0.107	-0.487
dPhi_23:	-0.117	-0.092	+0.161	+1.000	+0.531	+0.395	+0.559	+0.863	-0.005	-0.072	+0.613	+0.203	+0.595	-0.183	-0.324	+0.132
dPhi_34:	+0.157	+0.144	-0.436	+0.531	+1.000	-0.275	-0.008	+0.886	+0.018	-0.474	+0.036	-0.416	+0.632	-0.649	-0.236	+0.413
dPhi_13:	-0.457	-0.434	+0.970	+0.395	-0.275	+1.000	+0.963	+0.051	+0.027	+0.582	+0.950	+0.962	+0.009	+0.635	-0.179	-0.421
dPhi_14:	-0.431	-0.411	+0.888	+0.559	-0.008	+0.963	+1.000	+0.300	+0.033	+0.473	+0.998	+0.885	+0.186	+0.480	-0.252	-0.322
dPhi_24:	+0.030	+0.035	-0.172	+0.863	+0.886	+0.051	+0.300	+1.000	+0.008	-0.322	+0.356	-0.137	+0.702	-0.487	-0.318	+0.319
FR_1:	+0.033	+0.014	+0.030	-0.005	+0.018	+0.027	+0.033	+0.008	+1.000	-0.024	+0.031	+0.018	-0.019	-0.016	-0.044	-0.024
bend_1:	-0.150	-0.128	+0.644	-0.072	-0.474	+0.582	+0.473	-0.322	-0.024	+1.000	+0.445	+0.642	-0.208	+0.572	+0.061	-0.484
dPhiSum4:	-0.420	-0.399	+0.859	+0.613	+0.036	+0.950	+0.998	+0.356	+0.031	+0.445	+1.000	+0.859	+0.225	+0.442	-0.267	-0.296
dPhiSum4A:	-0.464	-0.433	+0.980	+0.203	-0.416	+0.962	+0.885	-0.137	+0.018	+0.642	+0.859	+1.000	-0.044	+0.785	-0.034	-0.486
dPhiSum3:	-0.001	+0.028	-0.147	+0.595	+0.632	+0.009	+0.186	+0.702	-0.019	-0.208	+0.225	-0.044	+1.000	-0.227	+0.029	+0.211
dPhiSum3A:	-0.364	-0.324	+0.731	-0.183	-0.649	+0.635	+0.480	-0.487	-0.016	+0.572	+0.442	+0.785	-0.227	+1.000	+0.135	-0.467
outStPhi:	+0.010	+0.034	-0.107	-0.324	-0.236	-0.179	-0.252	-0.318	-0.044	+0.061	-0.267	-0.034	+0.029	+0.135	+1.000	-0.097
dTh_14:	+0.140	+0.132	-0.487	+0.132	+0.413	-0.421	-0.322	+0.319	-0.024	-0.484	-0.296	-0.486	+0.211	-0.467	-0.097	+1.000



Some Useful info from TMVA

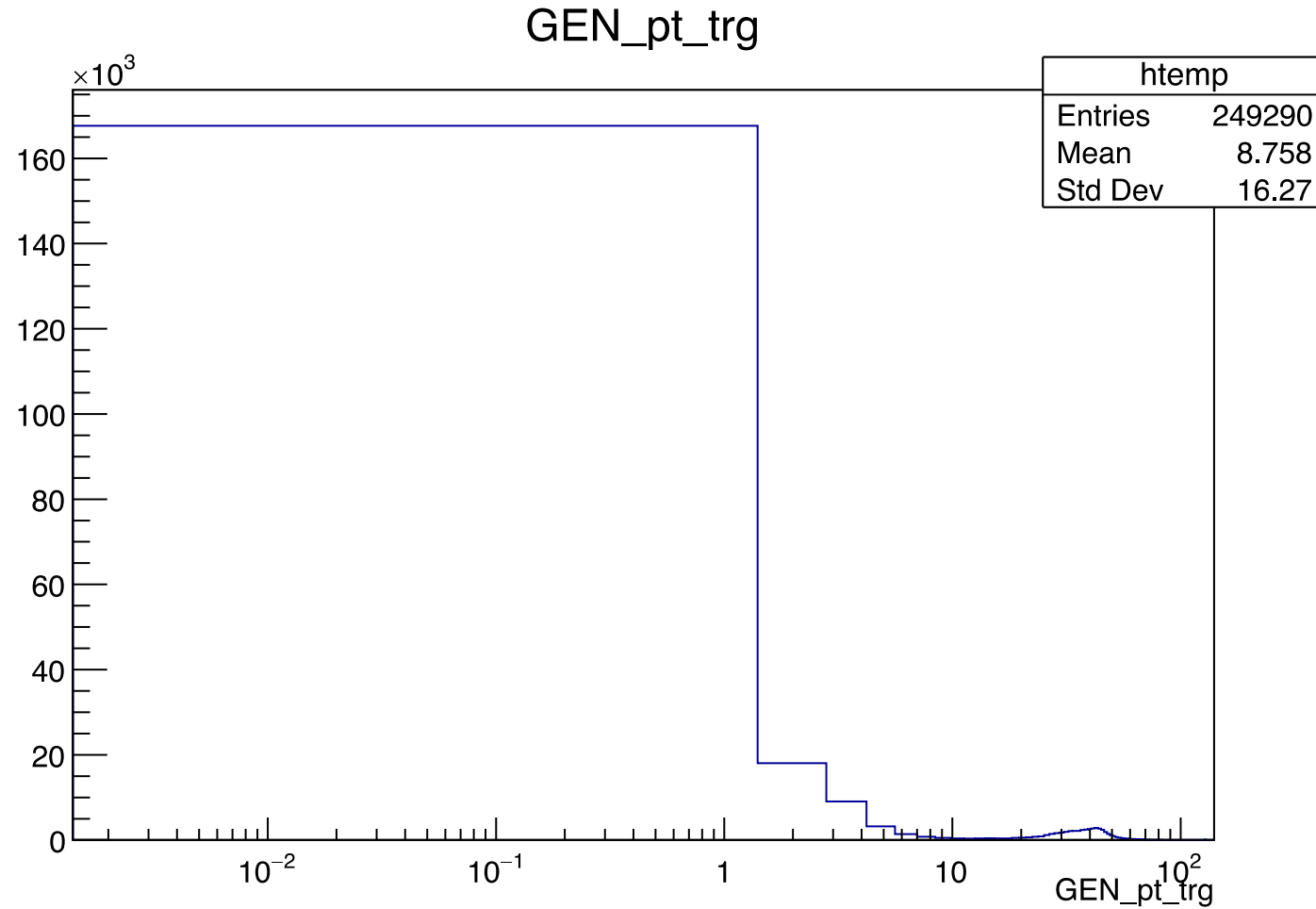
Ranking input variables (method unspecific)...
Ranking result (top variable is best ranked)

Rank : Variable : |Correlation with target|

1	:	dPhiSum4A	:	7.199e-01
2	:	dPhi_12	:	7.035e-01
3	:	dPhi_13	:	6.559e-01
4	:	dPhiSum3A	:	6.373e-01
5	:	bend_1	:	5.951e-01
6	:	dPhi_14	:	5.642e-01
7	:	dPhiSum4	:	5.378e-01
8	:	dTh_14	:	4.479e-01
9	:	dPhi_34	:	4.234e-01
10	:	theta	:	3.526e-01
11	:	St1_ring2	:	3.009e-01
12	:	dPhi_24	:	2.501e-01
13	:	dPhiSum3	:	1.151e-01
14	:	FR_1	:	2.576e-02
15	:	outStPhi	:	2.387e-02
16	:	dPhi_23	:	4.426e-03

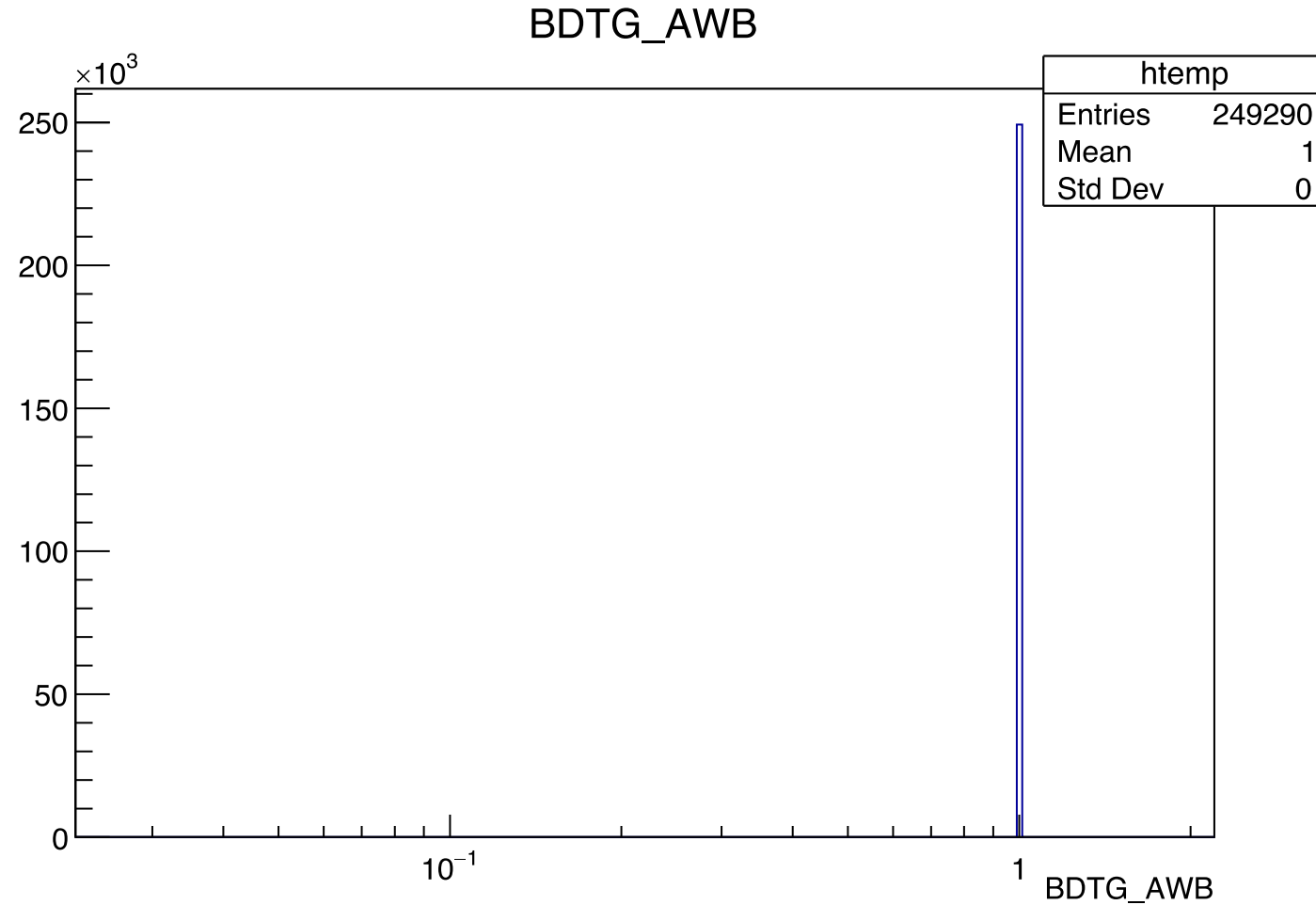
Variable	Mean	RMS	[	Min	Max]
theta:	5.0103	4.5058	[	0.0000	13.000]
St1_ring2:	0.34822	0.47641	[	0.0000	1.0000]
dPhi_12:	106.41	132.85	[	0.0000	470.00]
dPhi_23:	2.0012	35.020	[	-136.00	136.00]
dPhi_34:	-15.304	38.249	[	-136.00	136.00]
dPhi_13:	108.41	142.72	[	-135.00	606.00]
dPhi_14:	93.109	137.20	[	-232.00	674.00]
dPhi_24:	-13.303	64.121	[	-272.00	272.00]
FR_1:	0.49340	0.49996	[	0.0000	1.0000]
bend_1:	1.5546	0.70919	[	0.0000	3.0000]
dPhiSum4:	281.33	432.15	[	-832.00	2158.0]
dPhiSum4A:	393.29	466.04	[	0.0000	2158.0]
dPhiSum3:	-3.0195	91.961	[	-544.00	544.00]
dPhiSum3A:	66.352	88.117	[	0.0000	544.00]
outStPhi:	1.2193	0.73335	[	0.0000	4.0000]
dTh_14:	1.6198	0.77743	[	0.0000	3.0000]
GEN_pt_trg:	23.681	20.874	[	1.0001	128.00]

Include tracks not uniquely matched



- Set RECO pT=1GeV, eta, phi, charge same as EMTF track

Include tracks not uniquely matched



- `/eos/user/w/wshi/2018PtTraining/Mode15PtTargNoWgtAbsDevUniquelyMatched_plus_NotUniquelyMatchedRECO1GeV`