# $\tau$ reconstruction at the Muon Collider: Cross section measurement of the H→$\tau\tau$ process

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# Samples characteristics

**15000 $\tau$** events generated:

- $0 \leq \varphi \leq 2\pi$ rad
- $10° \leq \theta \leq 170°$
- $20 \leq pT \leq 320$ GeV/c

**15000** $\mu^+\mu^- \rightarrow Z\nu_\mu\bar{\nu}_\mu,\ Z \rightarrow q^+q^-$
**15000** $\mu^+\mu^- \rightarrow Z\nu_\mu\bar{\nu}_\mu,\ Z \rightarrow b^+b^-$

**100 000** $\mu^+\mu^- \rightarrow H\nu_\mu\bar{\nu}_\mu,\ H \rightarrow \tau^+\tau^-$
**100 000** $\mu^+\mu^- \rightarrow Z\nu_\mu\bar{\nu}_\mu,\ Z \rightarrow \tau^+\tau^-$
**100 000** $\mu^+\mu^- \rightarrow \tau^+\tau^-\mu^+\mu^-$

Search cone: DeltaR <= 0.05
Isolation cone: 0.05 < DeltaR < 0.45
No Dynamic cone

# Fake rates Jets

We define the efficiency as: $$\varepsilon_{\text{Jets}} = \frac{N_{\tau}^{\text{reco}}}{N_{\text{jets}}}$$

Cuts: jet do not contains gen-level $\tau$s, $p_T$ > 20 GeV, $|\eta|$<2.3 (jets); # of charged tracks != 2 & 4, $M_{inv}$< 3 GeV, # of reconstructed particles composing the $\tau_h$ candidate <8 ($\tau$-Id), EMF<1.0

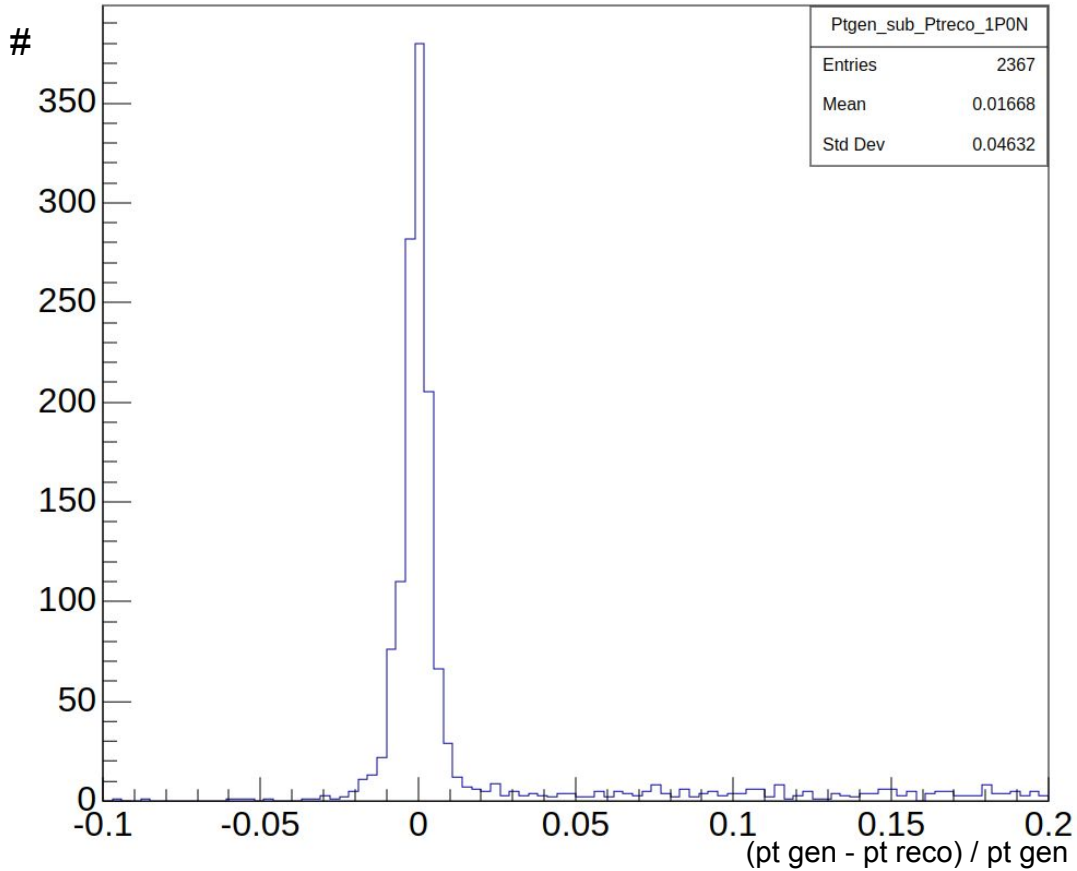
The number of jets ($N_{jets}$) is calculated with the number of quarks in the hepmc files passing the requirements pt > 20; $|\eta|$ < 2.3:

| Physical objects | (u, s, d) jets | $b$-jets | $\tau_h$ |
|---|---|---|---|
| kinematics | 19.4% | 12.9% | 69% |
| kin. + $E_{iso} < 3$ GeV | 0.7% | 0.13% | 63% |
| kin. + $E_{iso}/p_T^{lead} < 0.1$ | 0.8% | 0.13% | 66% |

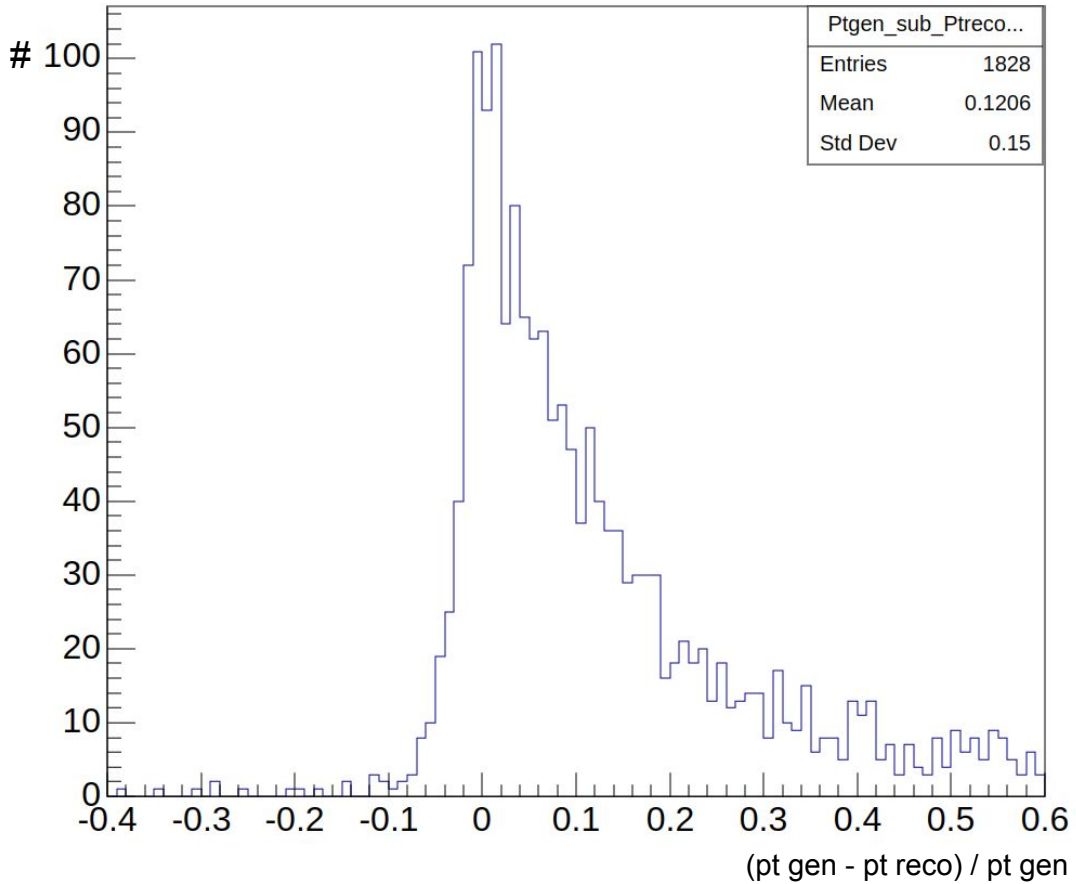
If we don't put requirements on generated level:

| Physical objects | (u, s, d) jets | $b$-jets | $\tau_h$ |
|---|---|---|---|
| kinematics | 12% | 8% | 65% |
| kin. + $E_{iso} < 3$ GeV | 0.4% | 0.08% | 60% |
| kin. + $E_{iso}/p_T^{lead} < 0.1$ | 0.5% | 0.08% | 62% |

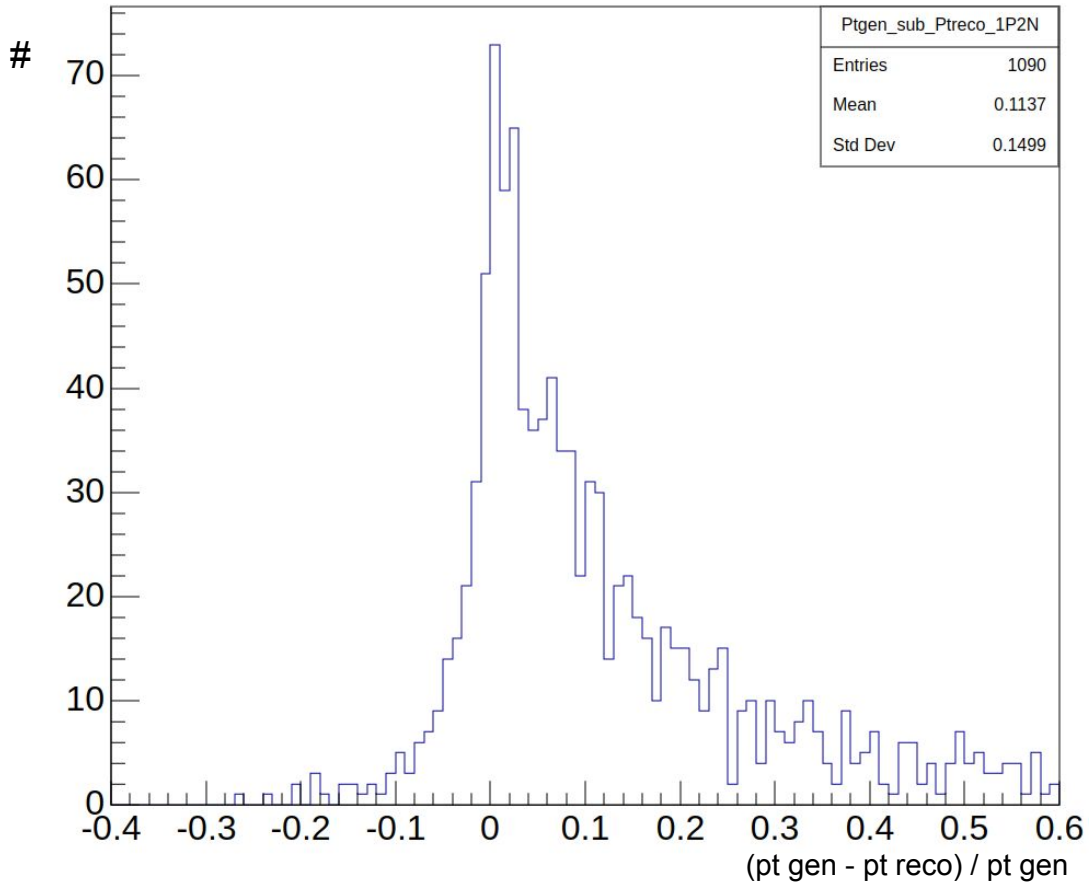
# (Pt gen - Ptreco) / Pt gen 1P0N



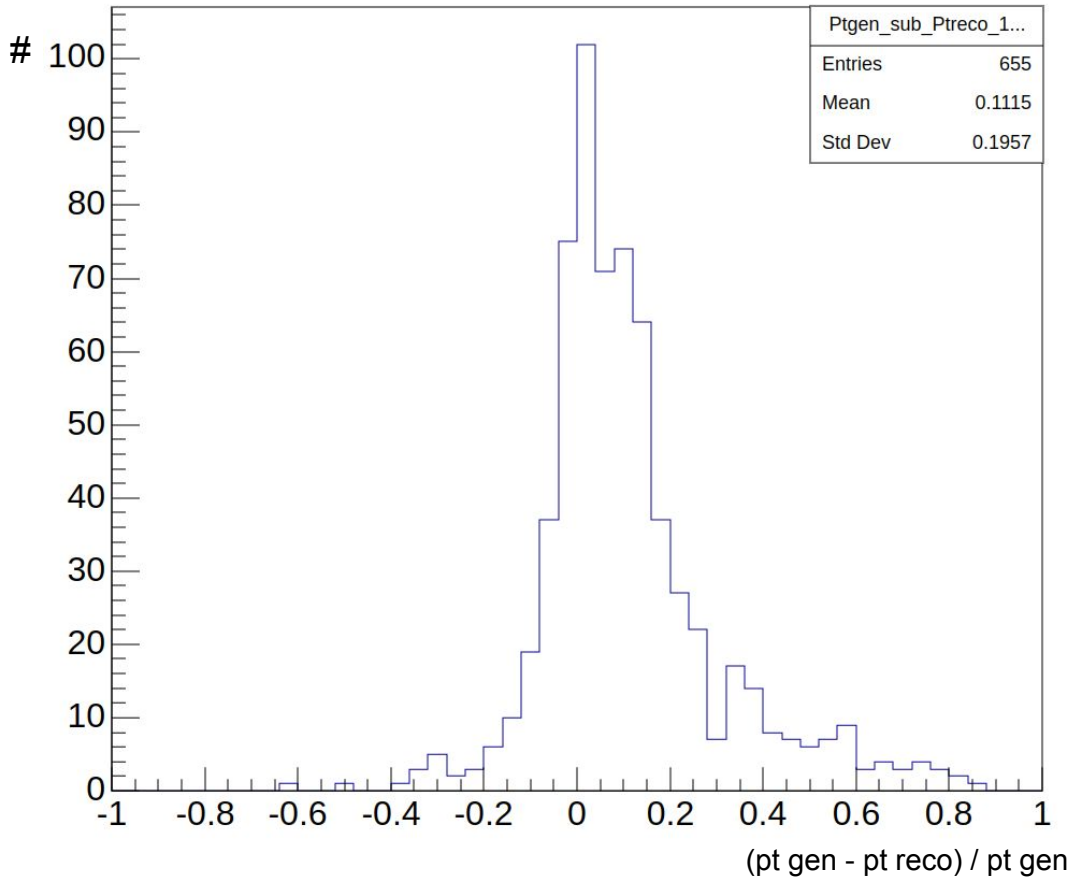
# (Pt gen - Ptreco) / Pt gen 1P1N



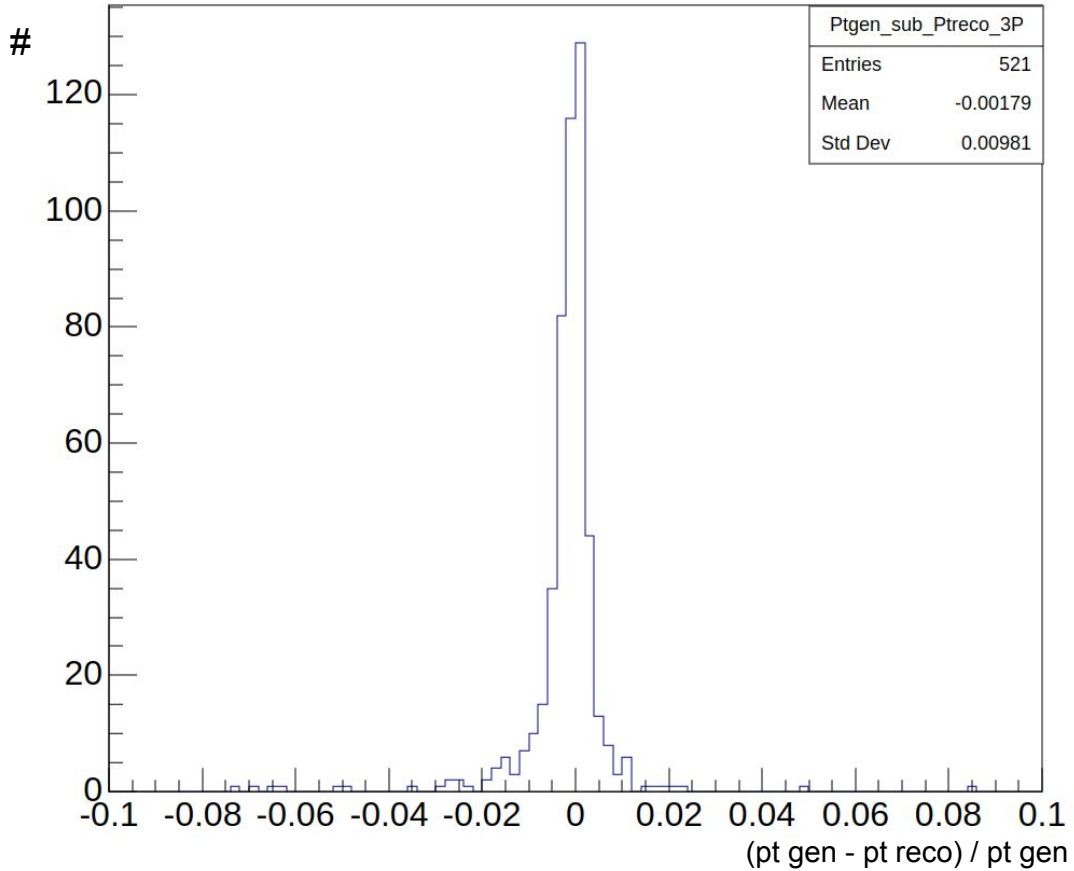
# (Pt gen - Ptreco) / Pt gen 1P2N



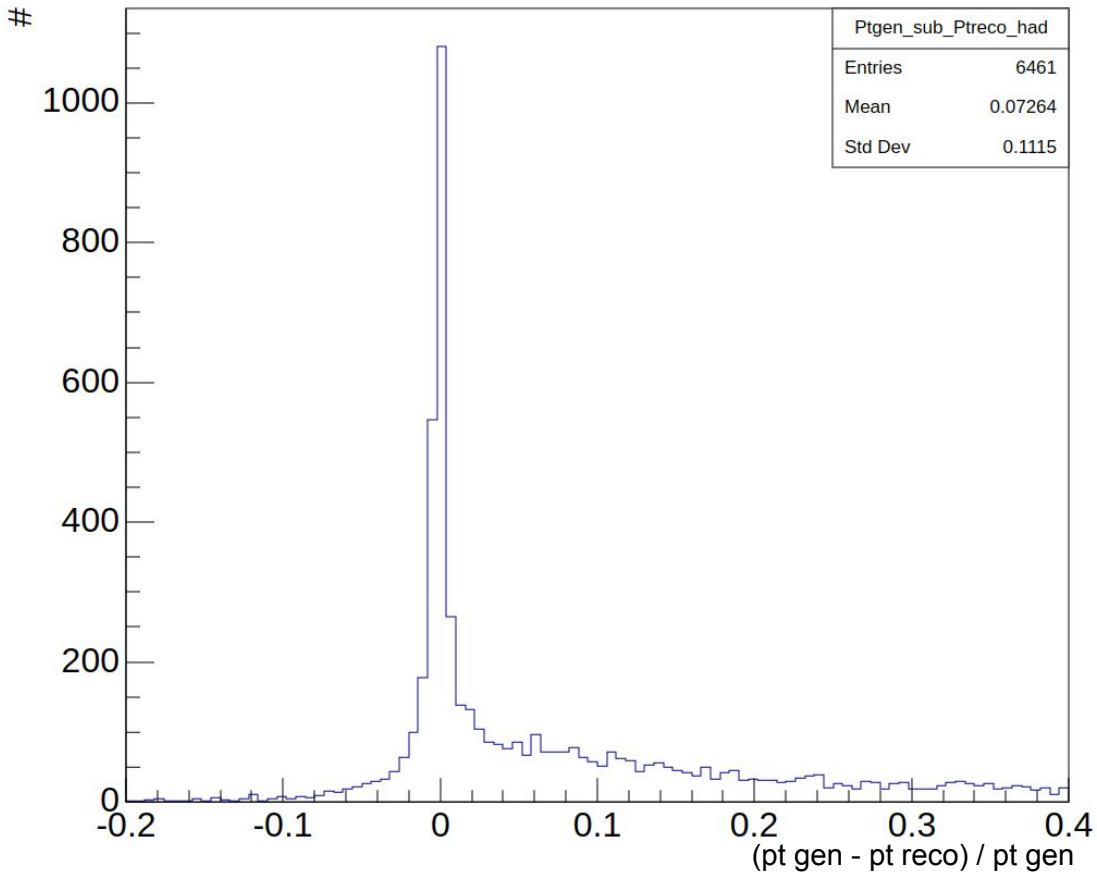
# (Pt gen - Ptreco) / Pt gen 1P3N+



# (Pt gen - Ptreco) / Pt gen 3P

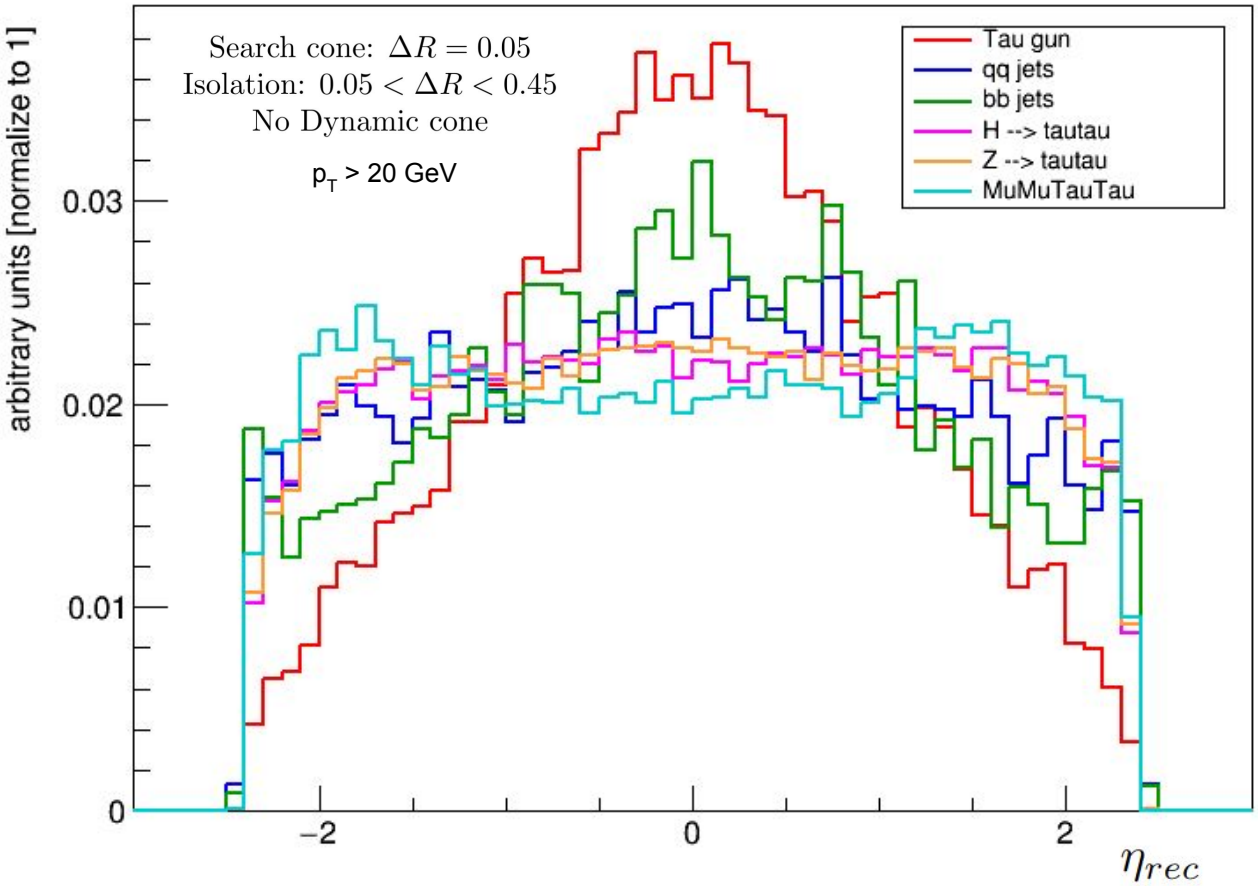


# (Pt gen - Ptreco) / Pt gen hadronic

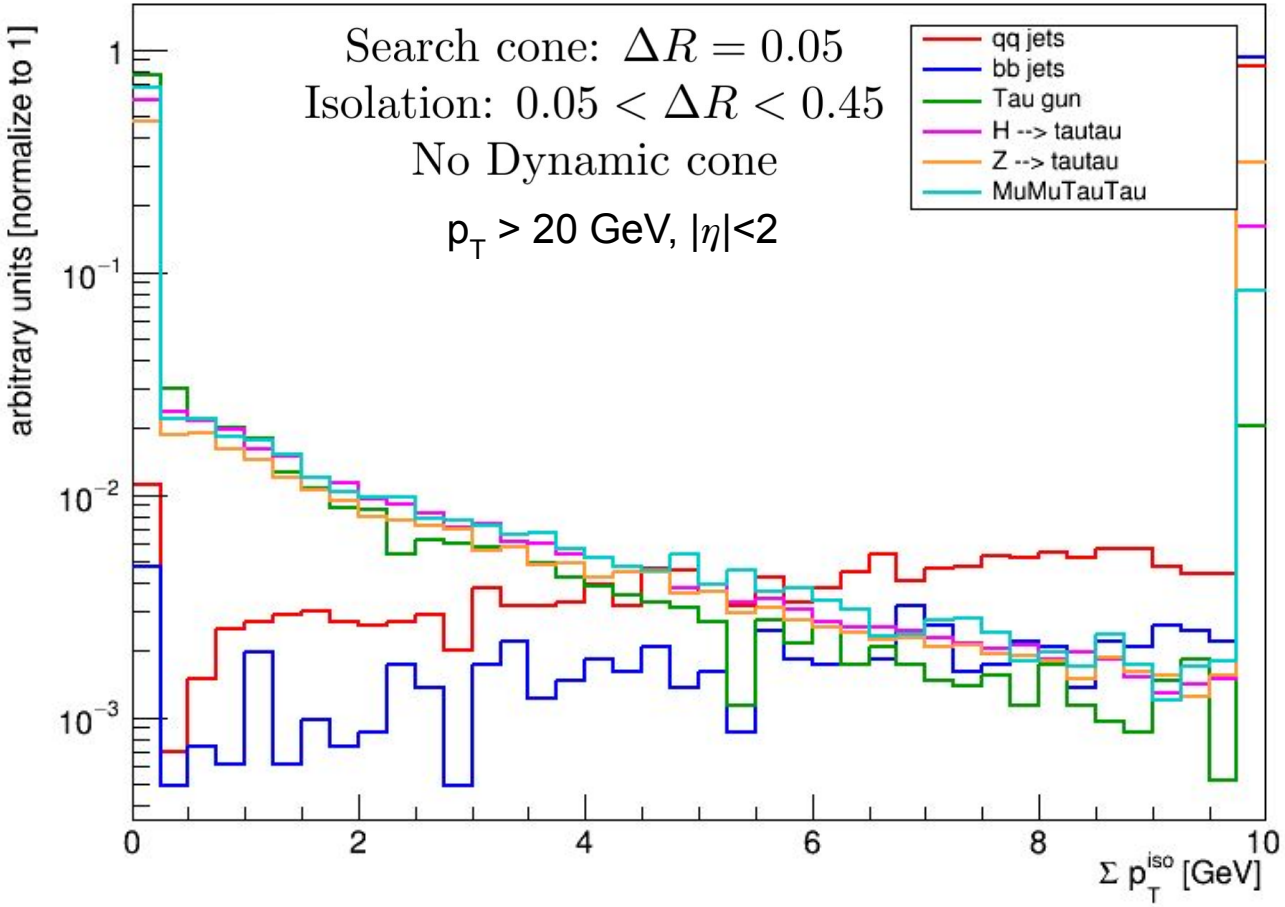


# Thank you for your attention

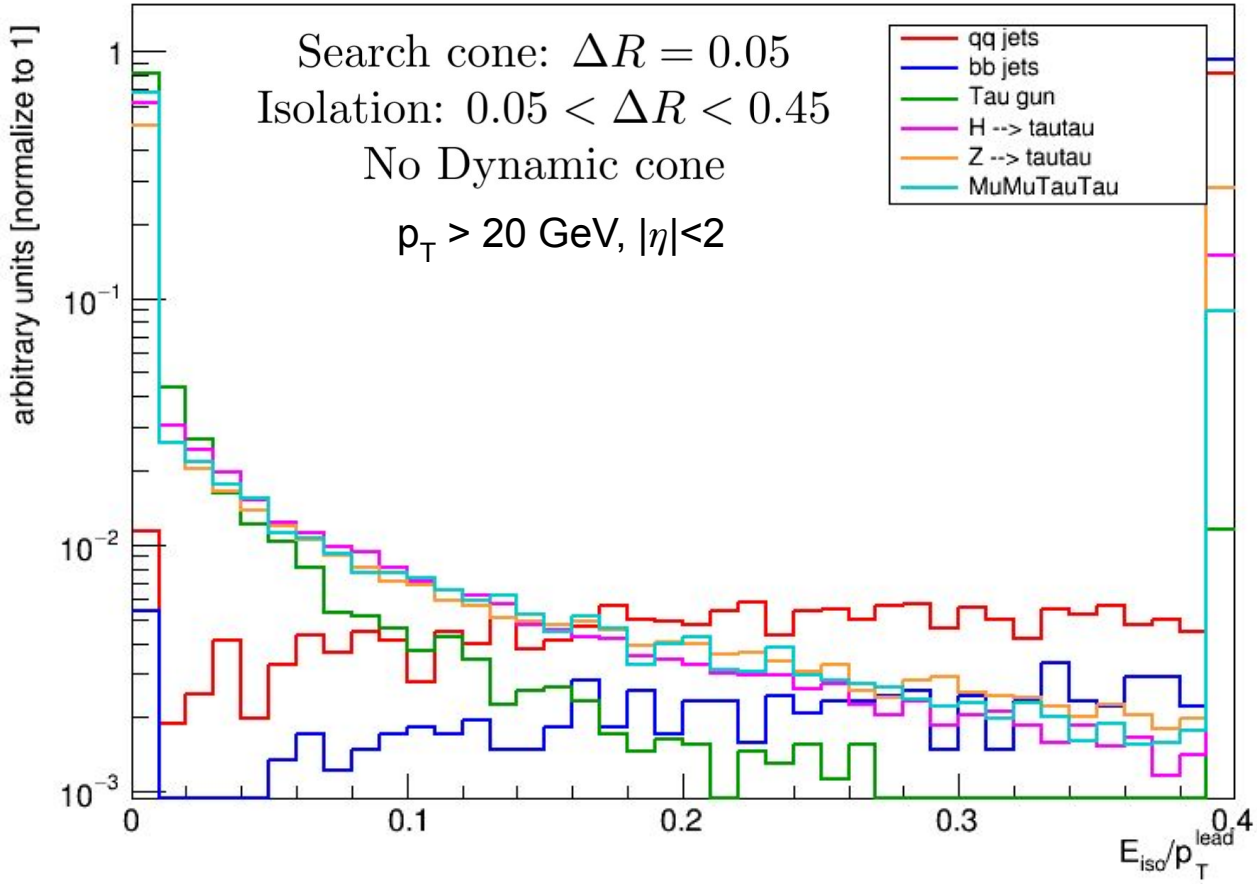
# Eta distribution



# Isolation Energy



# Isolation energy over Leading Pfo pt of the tau



# Tau mis-identification efficiency

**Jets: 15000 Z→qqjets & 15000 Z→bbjets**

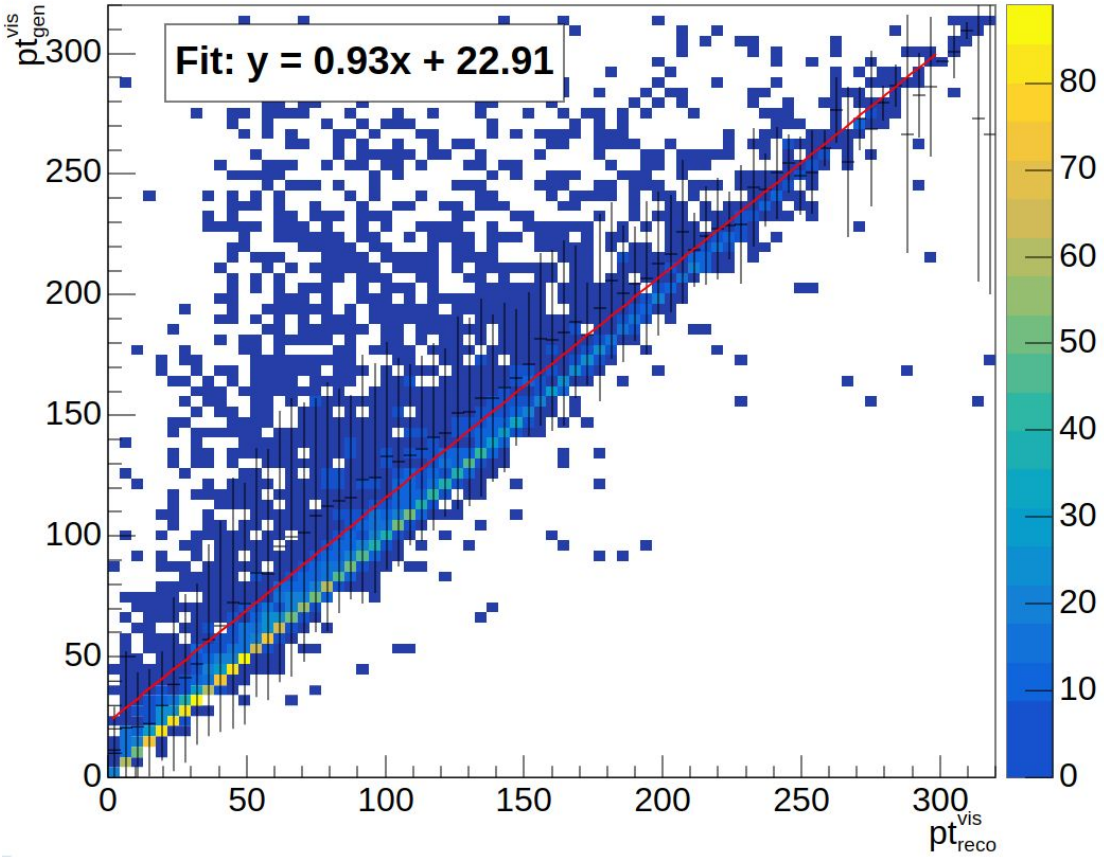
We define the efficiency as: $\varepsilon_{\text{Jets}} = \frac{N_\tau^{\text{reco}}}{N_{\text{jets}}}$

Kinematic requirements: jet do not contains gen-level $\tau$s, pT > 20 GeV, $|\eta|$<2 (jets); # of charged tracks != 2 & 4, Minv< 3 GeV, # of reconstructed particles composing the $\tau$h candidate <8 ($\tau$-Id), EMF<1.0

The number of jets ($N_{jets}$) is calculated with the number of quarks in the hepmc files passing the requirements pt > 20; $|\eta| < 2$

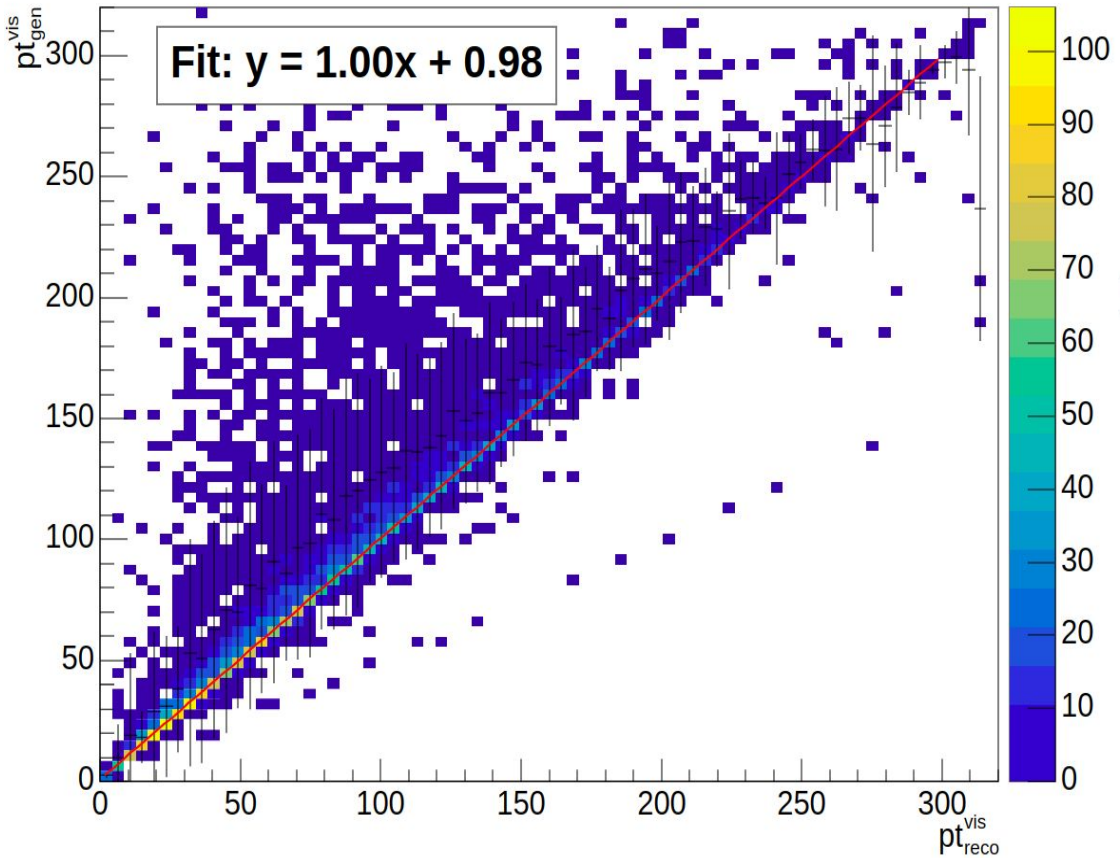
| Physical objects | (u, s, d) jets | $b$-jets | $\tau_h$ |
|---|---|---|---|
| kinematics | 20% | 14% | 69% |
| kin. + $E_{iso} < 3$ GeV | 0.6% | 0.11% | 63% |
| kin. + $E_{iso}/p_T^{lead} < 0.1$ | 0.7% | 0.11% | 66% |

# Tau energy corrections




Search cone: $\Delta R = 0.05$
Isolation: $0.05 < \Delta R < 0.45$
No Dynamic cone

# Tau energy corrections

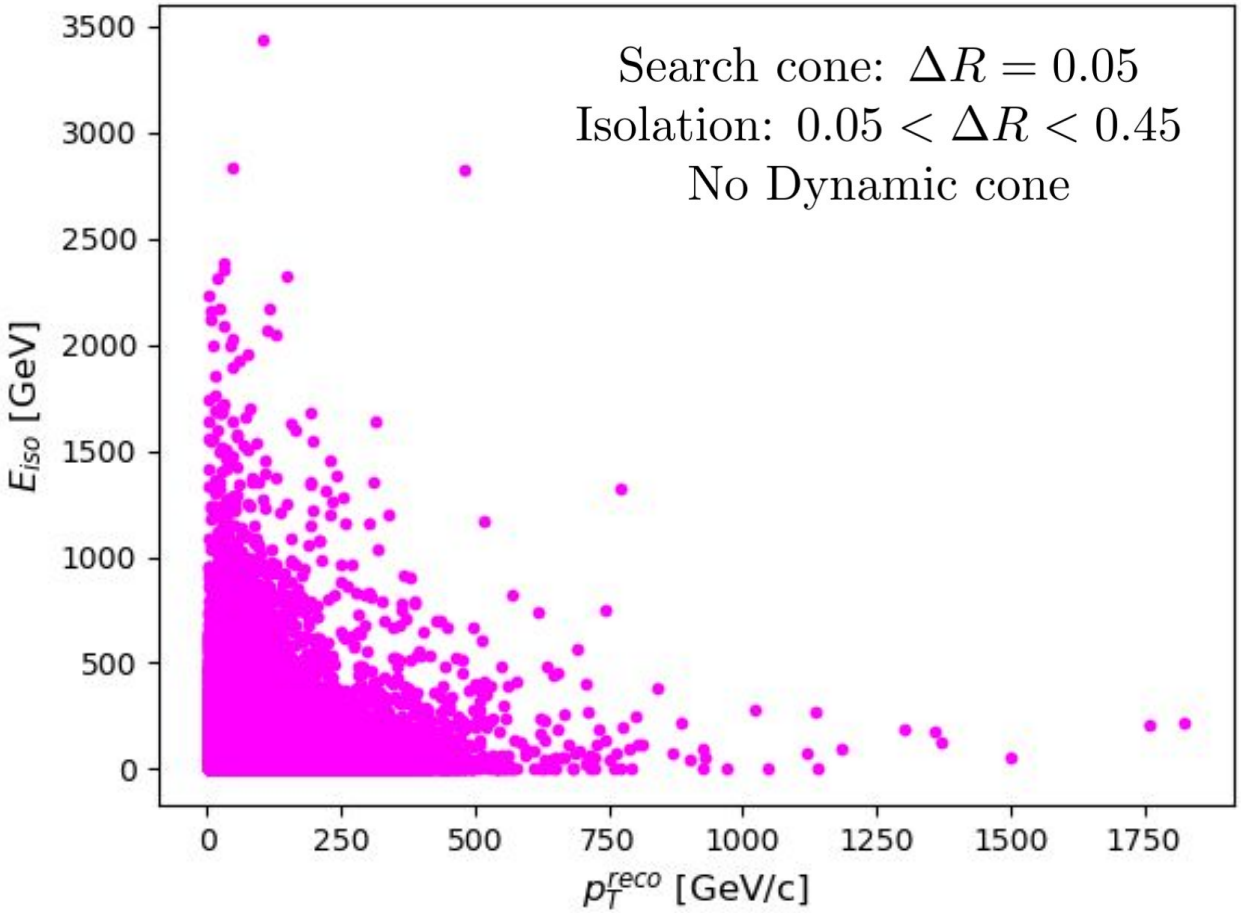



Isolation: $0.15 < \Delta R < 0.35$

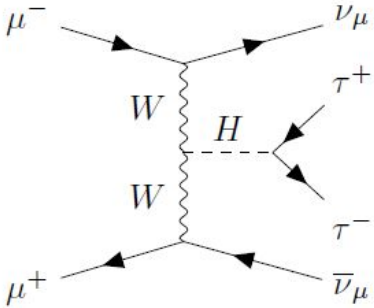
Dynamic Cone

$$\begin{cases} 0.6 & p_T \leq 10 \\ \frac{6}{p_T} & 10 < p_T < 120 \\ 0.05 & p_T \geq 120 \end{cases}$$

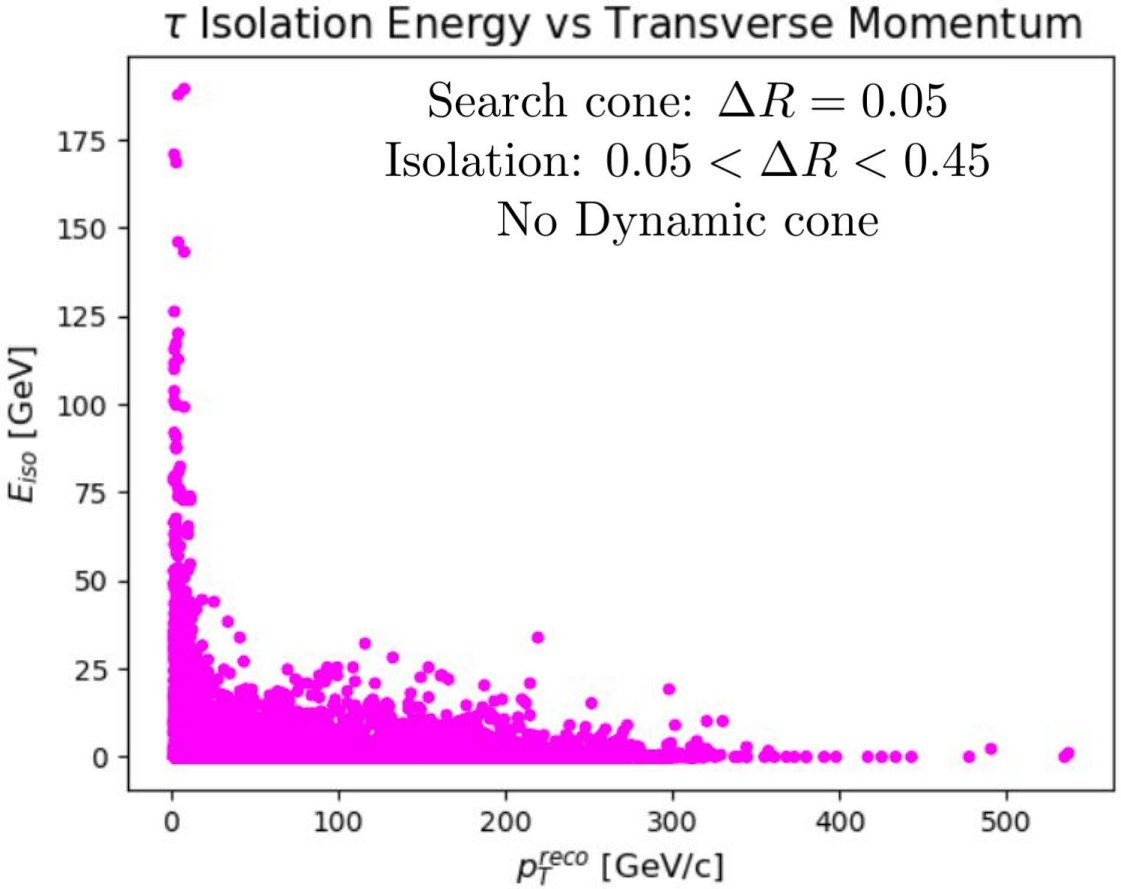
# Reconstructed tau Isolation energy vs Tau Pt




Signal: H → $\tau\tau$

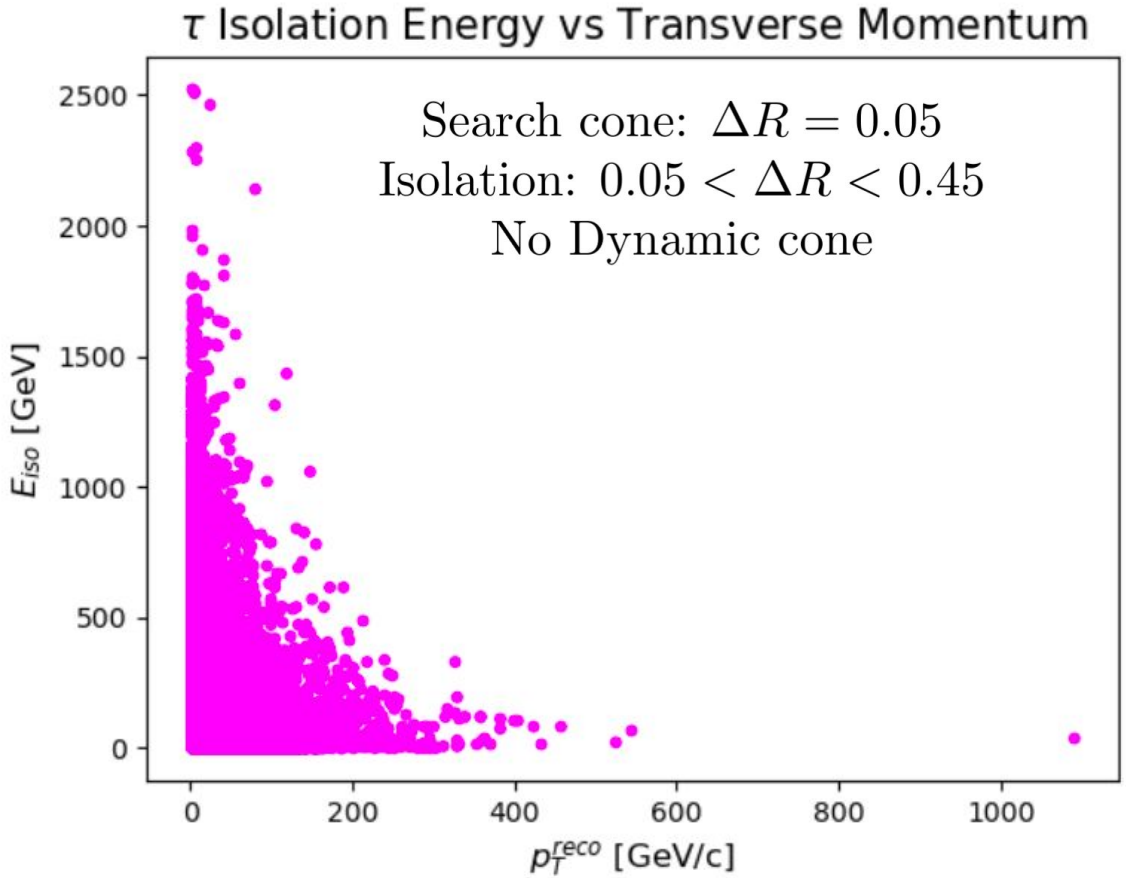


# Reconstructed tau Isolation energy vs Tau Pt



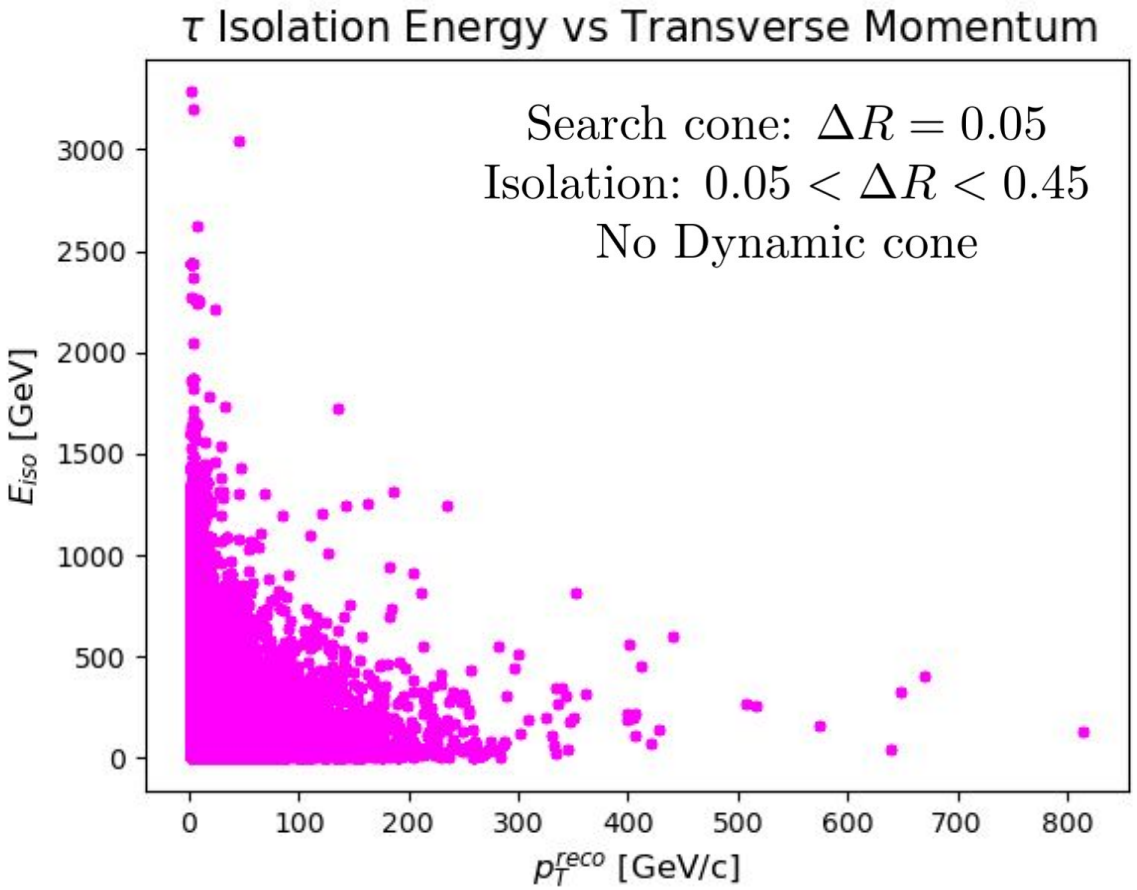

**Tau gun**

# Reconstructed tau Isolation energy vs Tau Pt

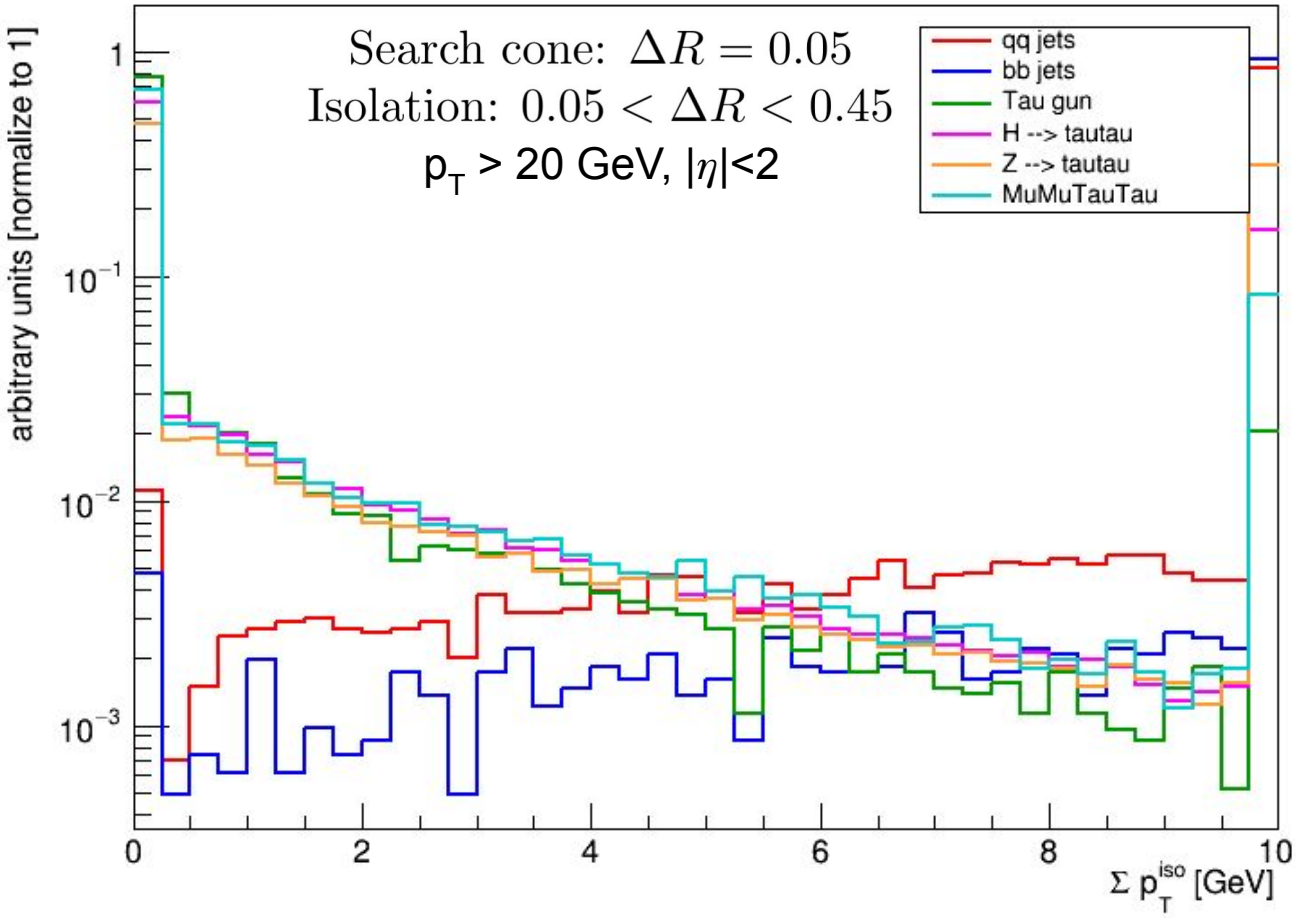



**Z →qq jets**

# Reconstructed tau Isolation energy vs Tau Pt




**Z →bb jets**


Search cone: $\Delta R = 0.05$
Isolation: $0.05 < \Delta R < 0.45$
$p_T$ > 20 GeV, $|\eta|$<2
qq jets
bb jets
Tau gun
H --> tautau
Z --> tautau
MuMuTauTau
arbitrary units [normalize to 1]
1
$10^{-1}$
$10^{-2}$
$10^{-3}$
0
2
4
6
8
10
$\Sigma\ p_T^{iso}$ [GeV]