Trigger Efficiency Measurements

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Eric Torrence
University of Oregon

Efficiency Motivation

Why measure trigger efficiency at all?

Physics

- Typically need product $\varepsilon(trig) \times \varepsilon(reco)$
- Sometimes need $\varepsilon(reco)$ alone
- Never (?) need $\varepsilon(trig)$ alone

Can factorize and measure $\varepsilon(trig) / \varepsilon(reco)$

Trigger Understanding

- Trigger must be understood/commissioned before first "real" taus are seen

Both need $\varepsilon(trig)$ dependence on key variables

Trigger Efficiency Methods

$Z \rightarrow \tau\tau$

- Direct measurement (accurate), but low statistics
- Trigger measurement direct extension of offline studies

Di-jet fakes

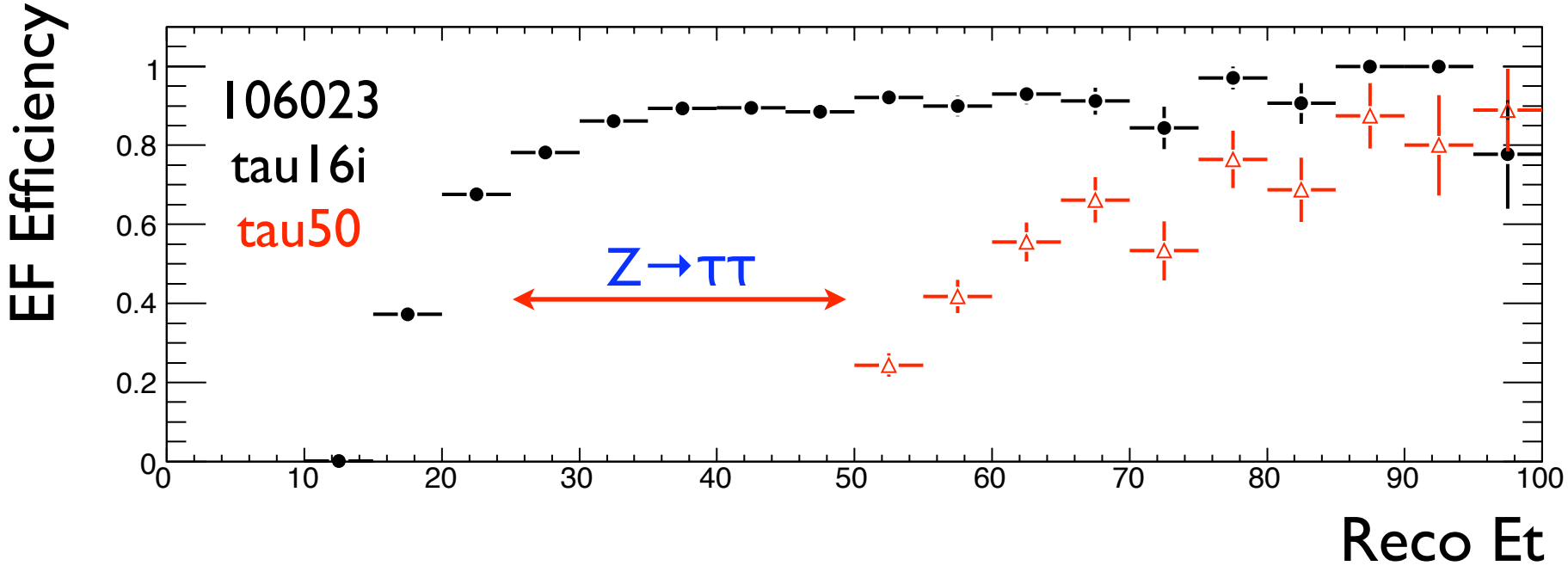
- Use tight offline (fake) taus and measure how often these pass the trigger
- Higher statistics, lower accuracy (calibrate scale w/ $Z \rightarrow \tau\tau$?)

ttbar

- Useful in future for higher E_T ranges, dense environment

All require well defined offline reference
Need consistent definition!

E_T Ranges



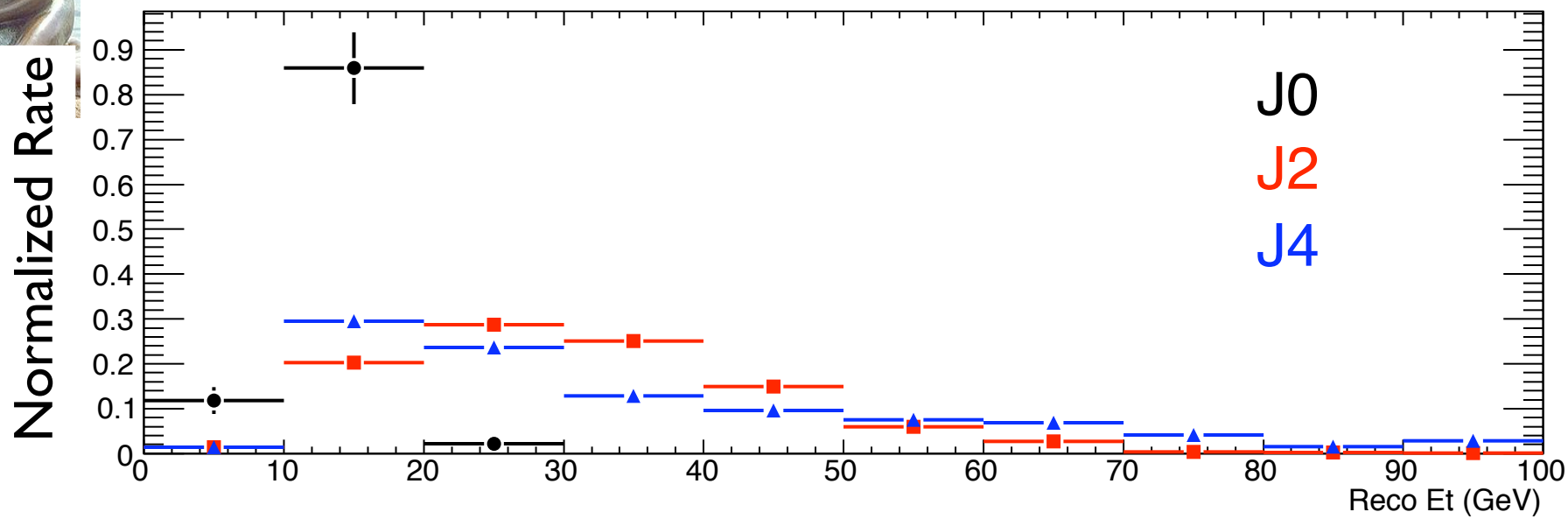
$Z \rightarrow \tau\tau$ can measure plateau, but turn-on at low E_T difficult
Must factorize (or ignore) dependence on other variables

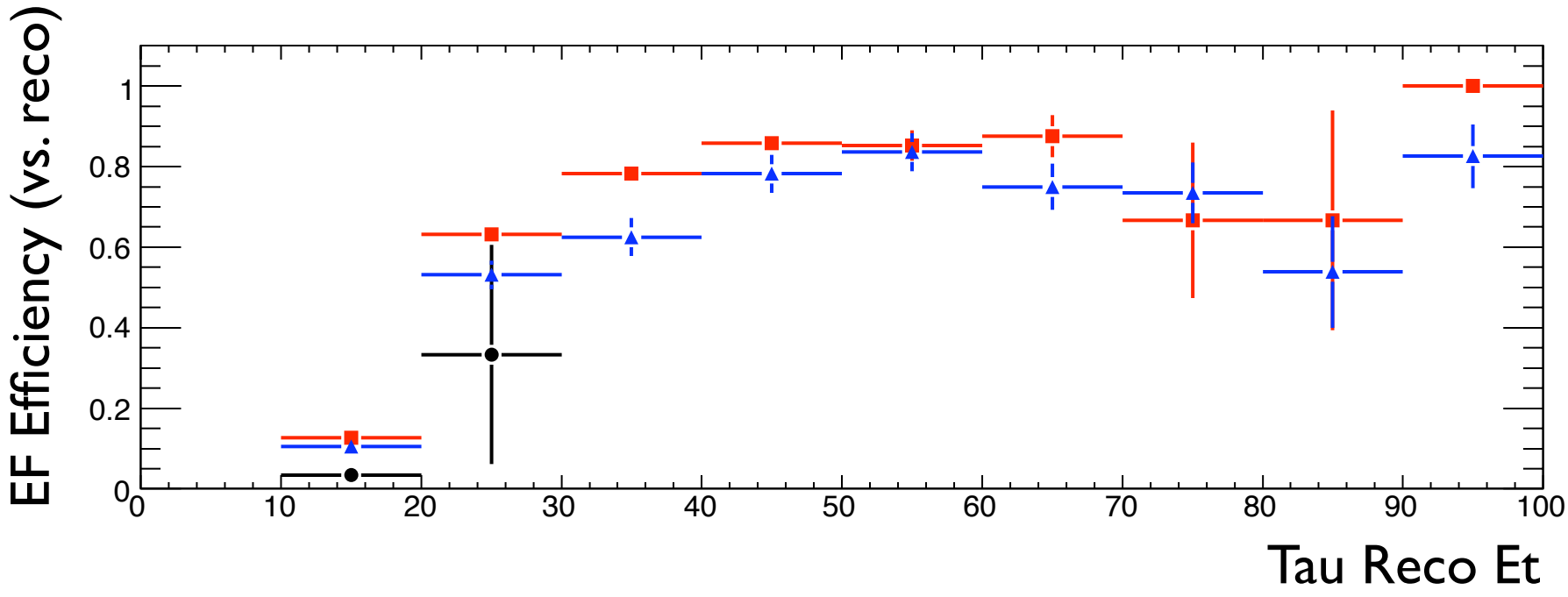
Extrapolate to lower E_T using dijet fakes or MC

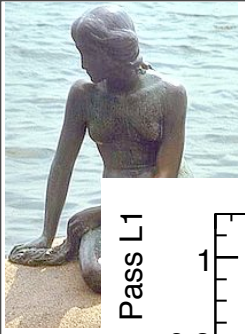
tau50 above range where $Z \rightarrow \tau\tau$ has reasonable statistics
use ttbar, MC, or possibly dijets here also?

What is the offline E_T efficiency range?

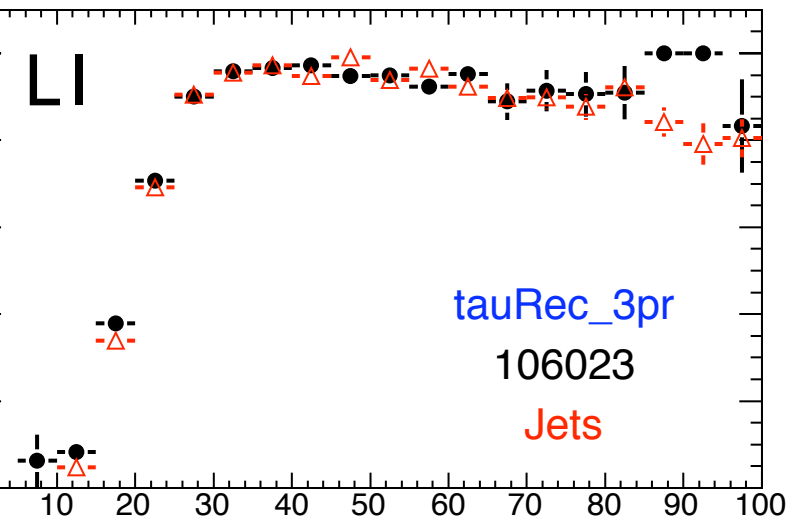
Jn Fakes Comparison

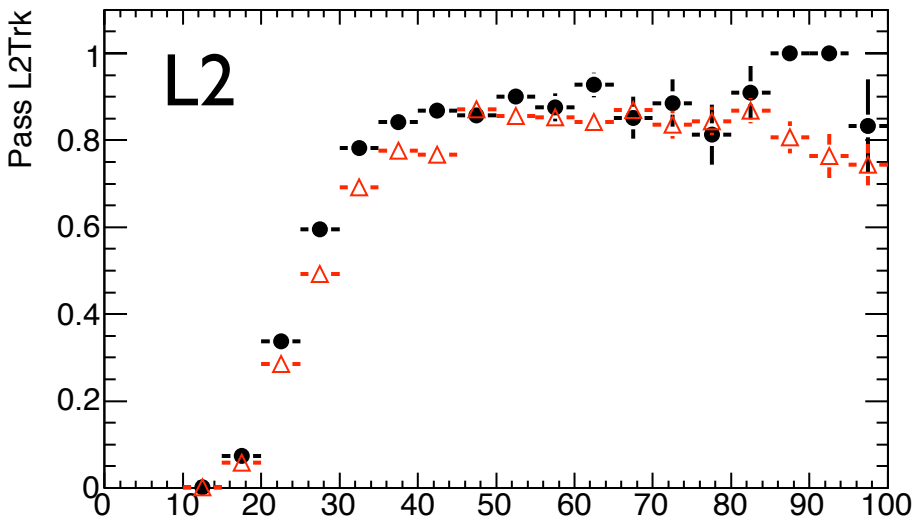


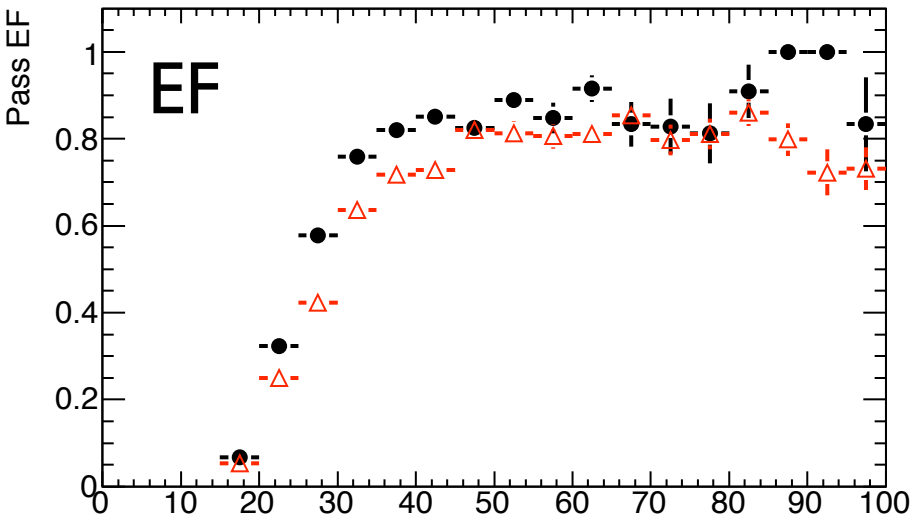




Fake 3pr taus



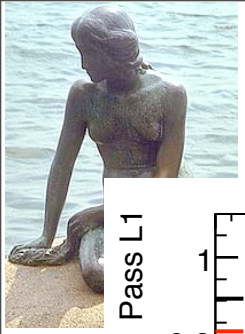




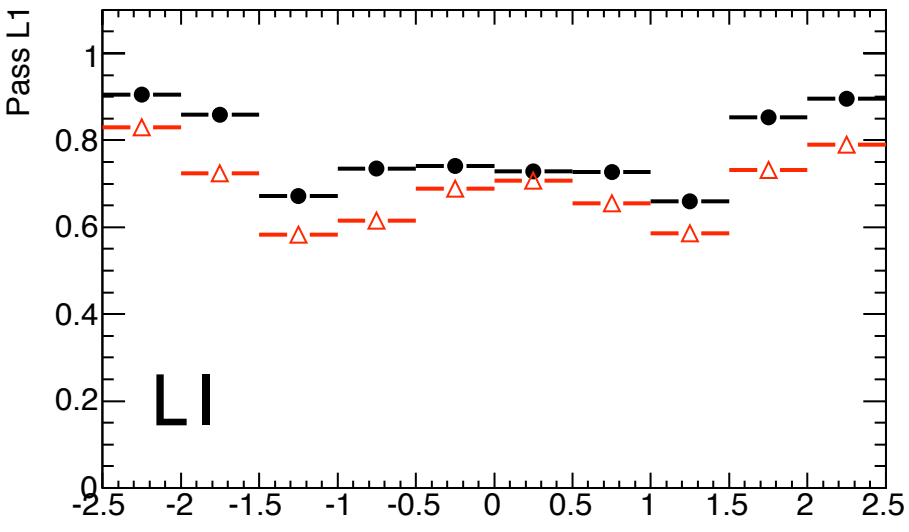
10 TeV $W \rightarrow \tau\nu$ vs.
J0-J4 unweighted

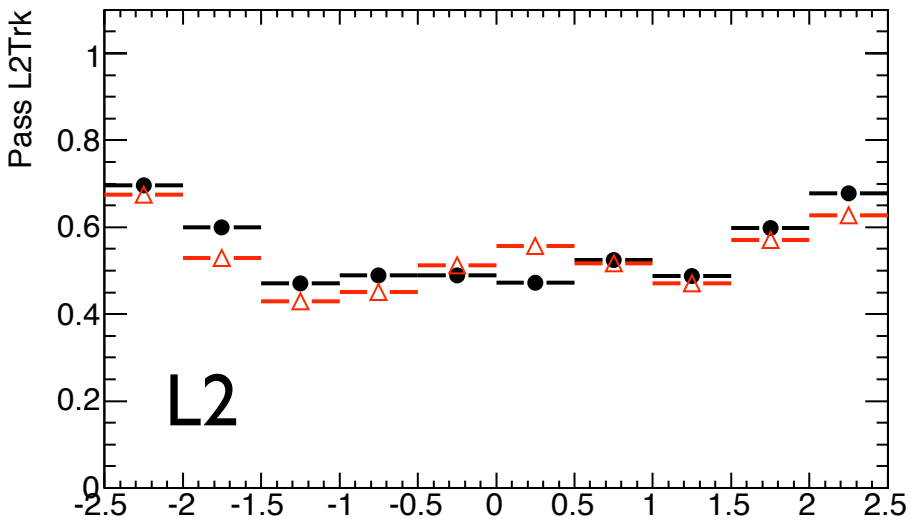
tauRec L>5

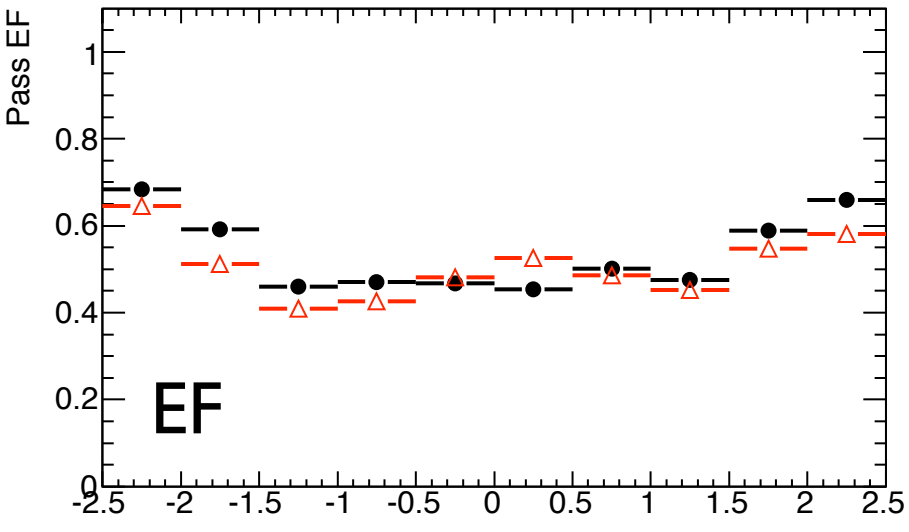
Good to ~5%



Fake 3pr taus







10 TeV $W \rightarrow \tau\nu$ vs.
J0-J4 unweighted

tauRec L>5

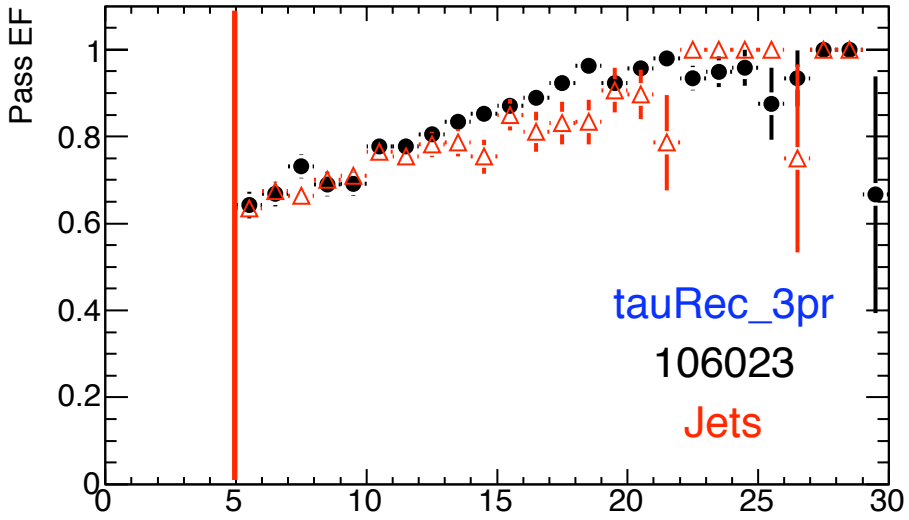
3pr Reco Discriminant

Trigger efficiency can/does depend on offline tau definition

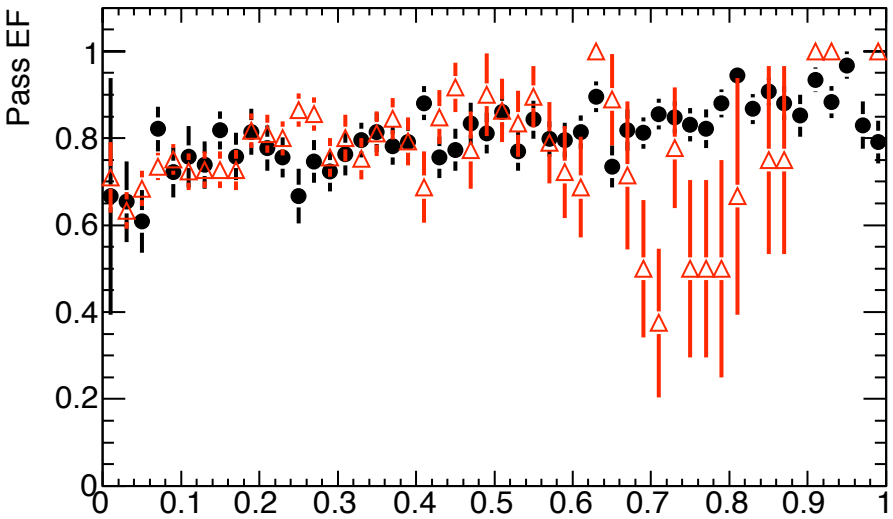
Need to define offline reference

Must be tight enough to avoid lots of junk

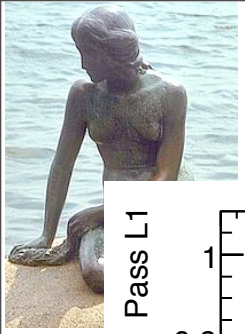
Start using "safe" variables



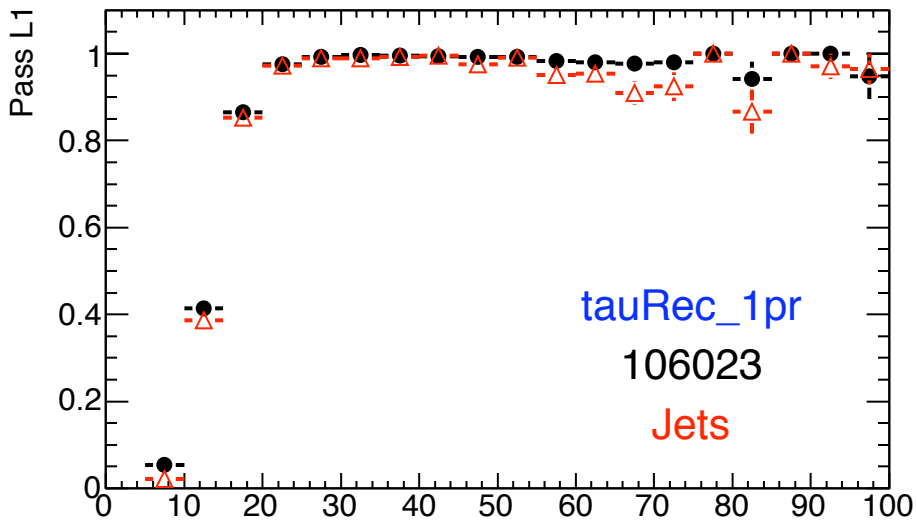
tauRec Likelihood

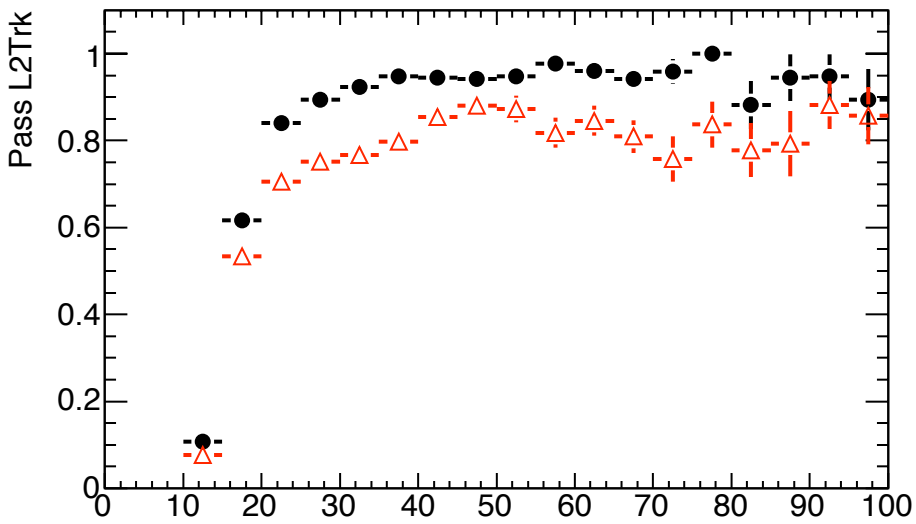


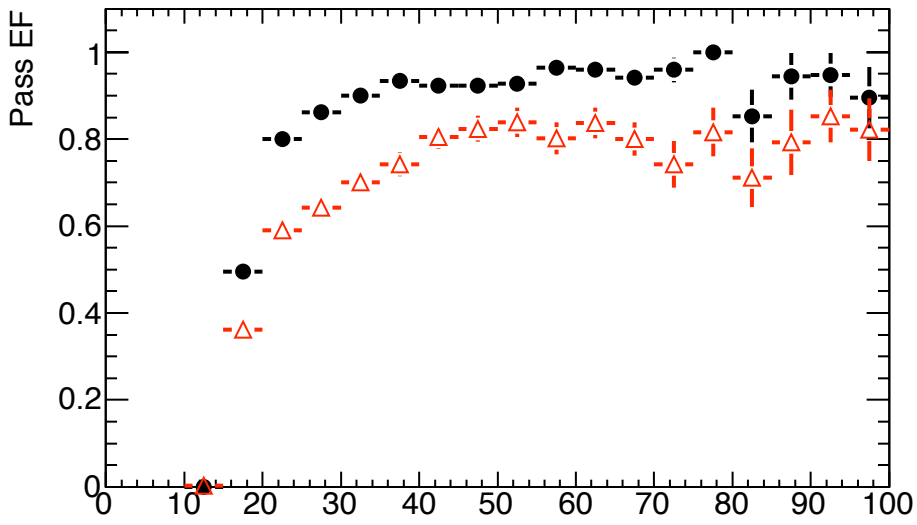
tau1p3p efficNN



Fake 1pr taus





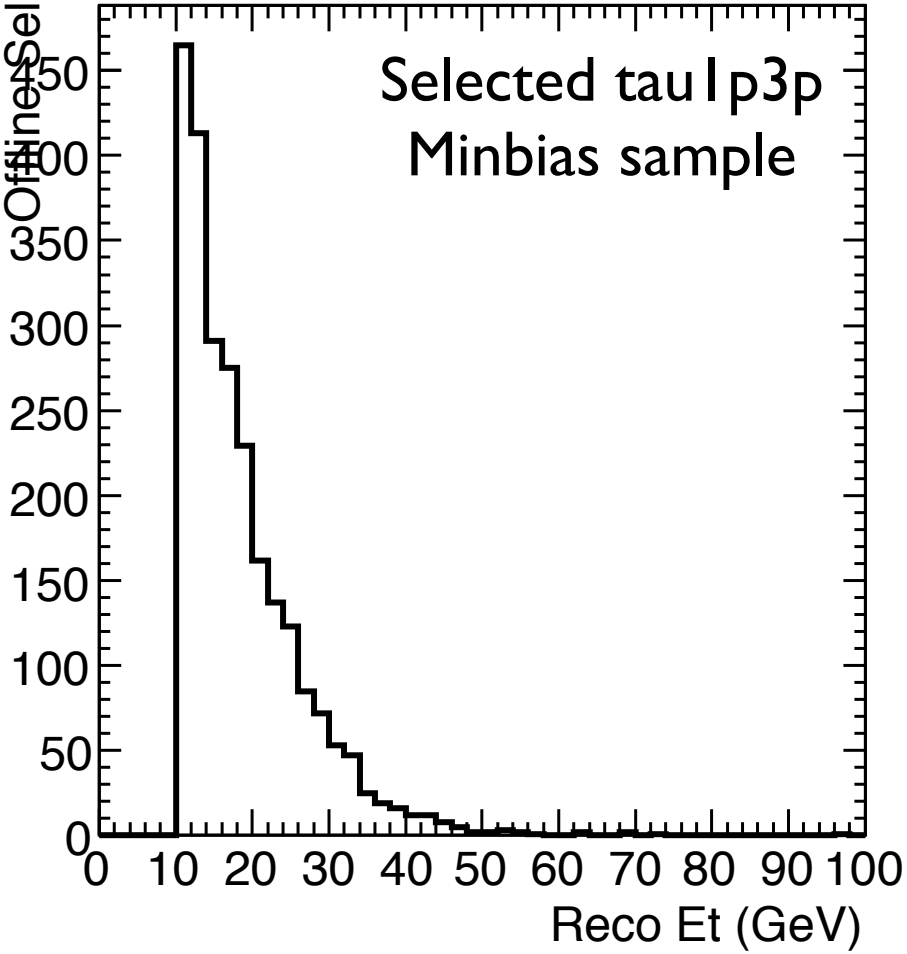


10 TeV $W \rightarrow \tau\nu$ vs.
J0-J4 unweighted

tauRec L>5

Good to ~10%

Minbias Statistics



Need some unbiased trigger to provide sample.

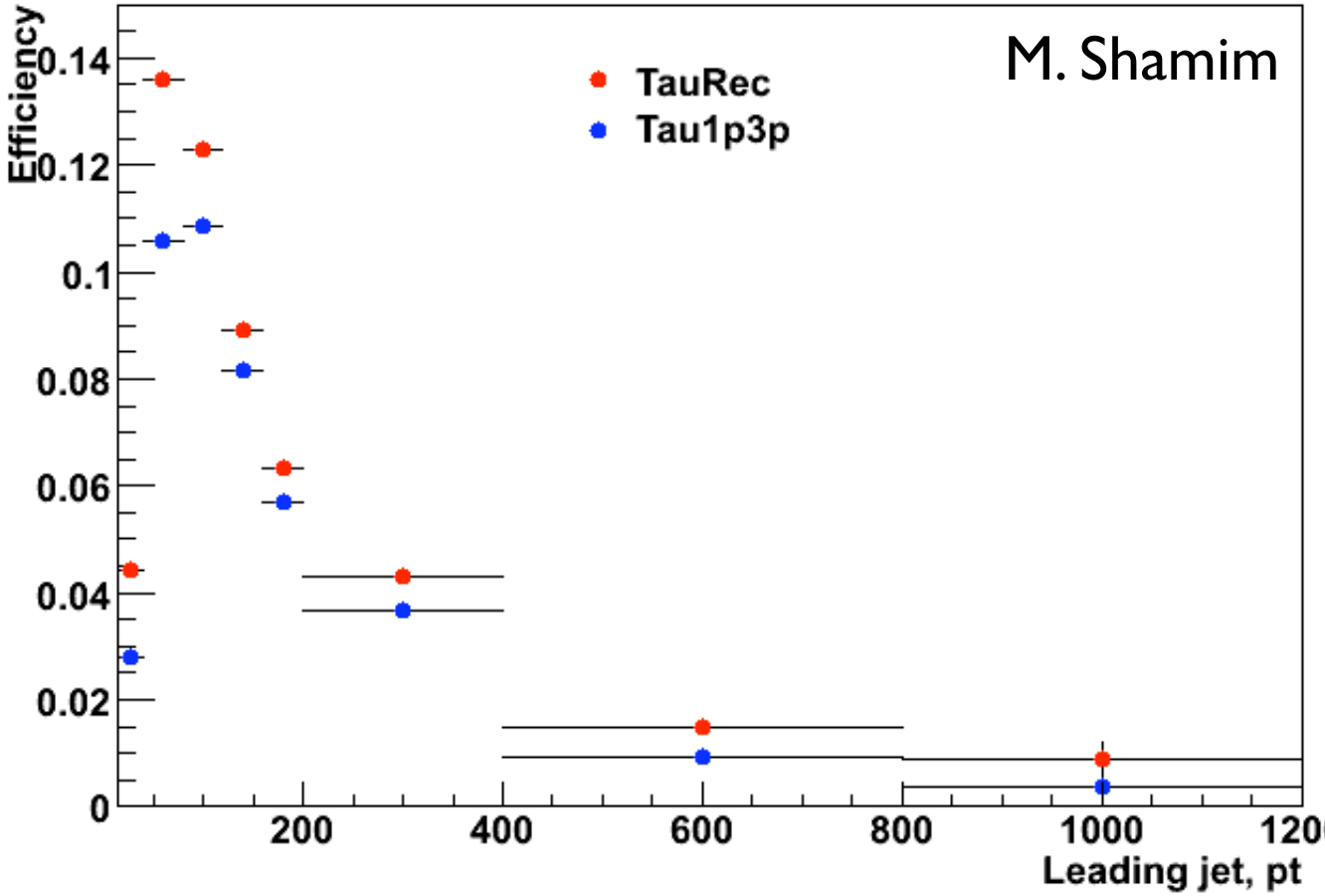
Use Minbias trigger?

Fake rate = 0.1%

10 Hz minbias trigger
→ 430 events/12 hours

Limited to low E_T

Jet Selection



- Motivated by offline fake rate study (Sylvie B.)
- Select "good" dijets
- "Tag" with high mult.
- "Probe" with offline/trigger taus
- Mansoora implemented in HLTOfflineMon

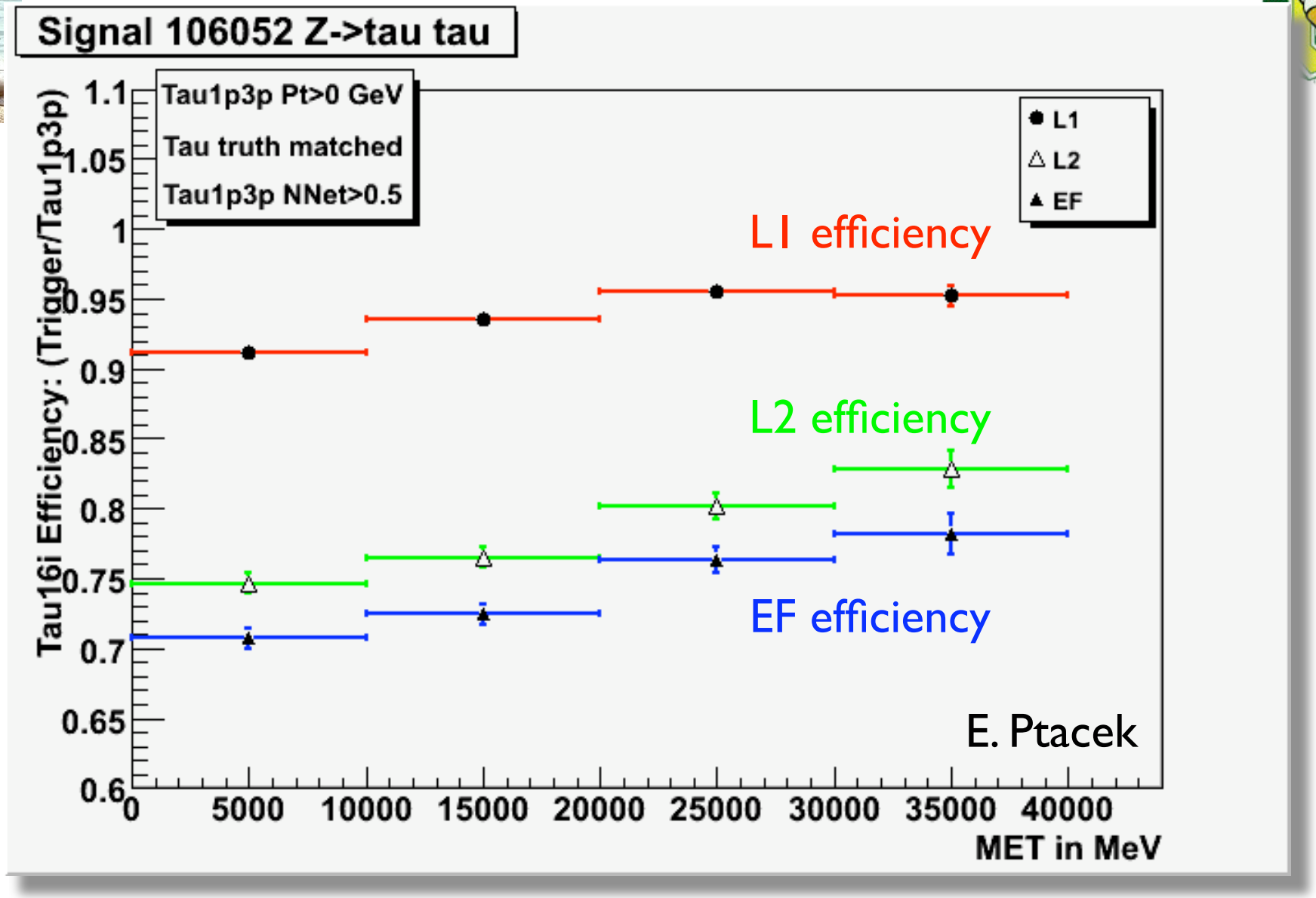
Jet rates prescaled to ~0.5 Hz, J10, J50, J80, ...
Comparable selected rates to minbias sample, higher E_T range
Need to check biases carefully...

$Z \rightarrow \tau\tau$ studies

- Originally motivated by offline studies (Caterina, et. al.)
- Extend to measure trigger vs. offline efficiency
- Statistics limited: expect ~ 250 events in 100 pb^{-1}
  - OK for plateau efficiency
  - No real binning possible
- Moving to DPD-based analyses (Uppsala, Oregon),
  - integrate this with offline efforts
- Looking at selection bias

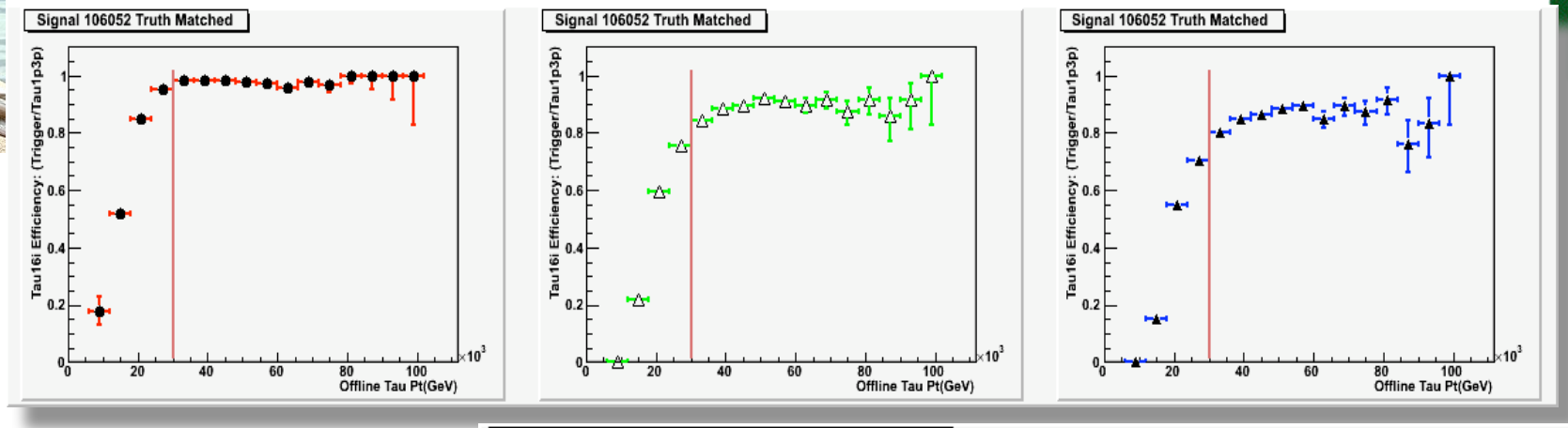
MET Bias

tau16i Efficiency



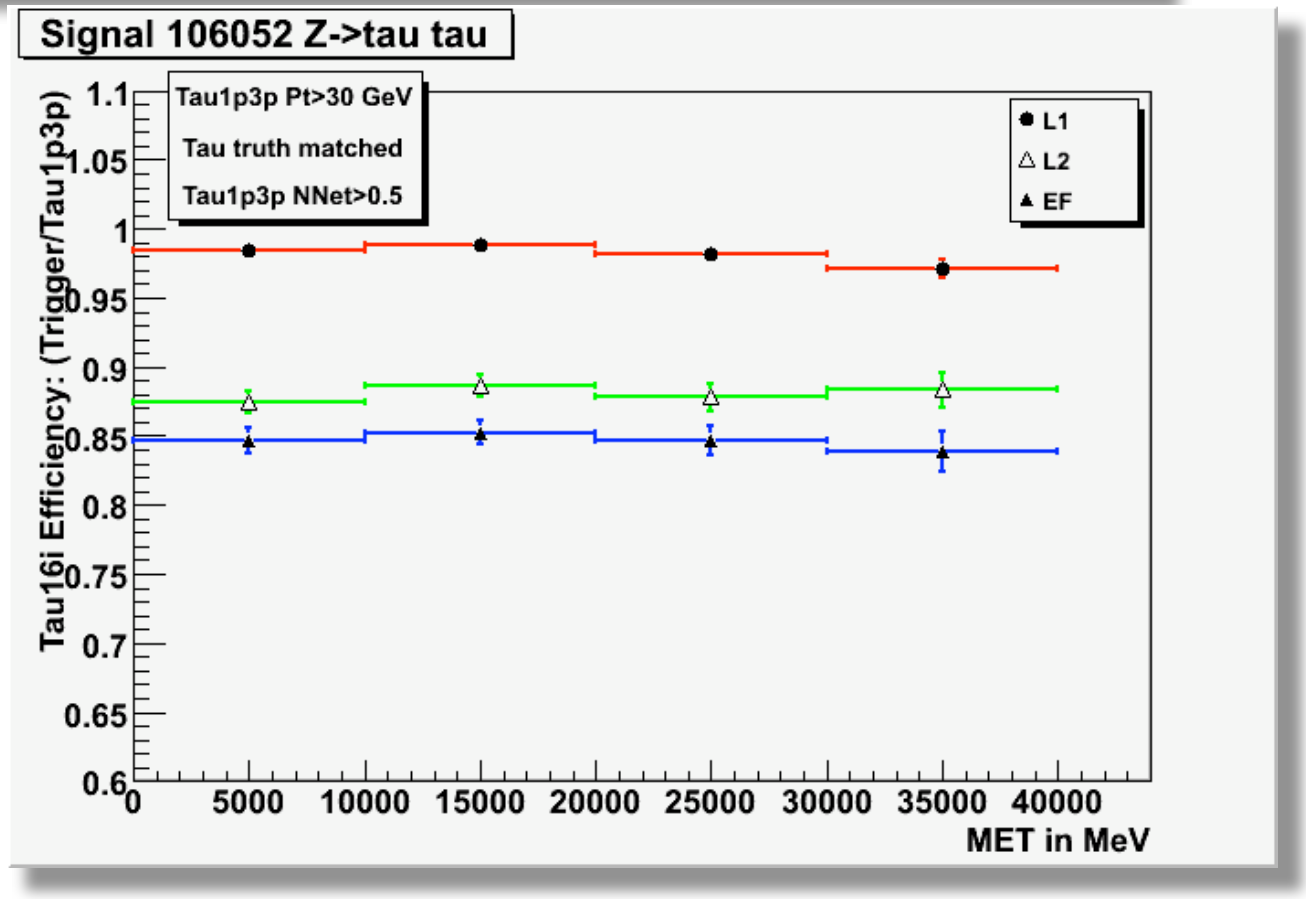
Clear bias, but MET correlated to tau E_T

MET Bias II



Restrict E_T > 30 GeV
No residual bias observed

Cut on MET safe, as long as ET dependence is taken into account

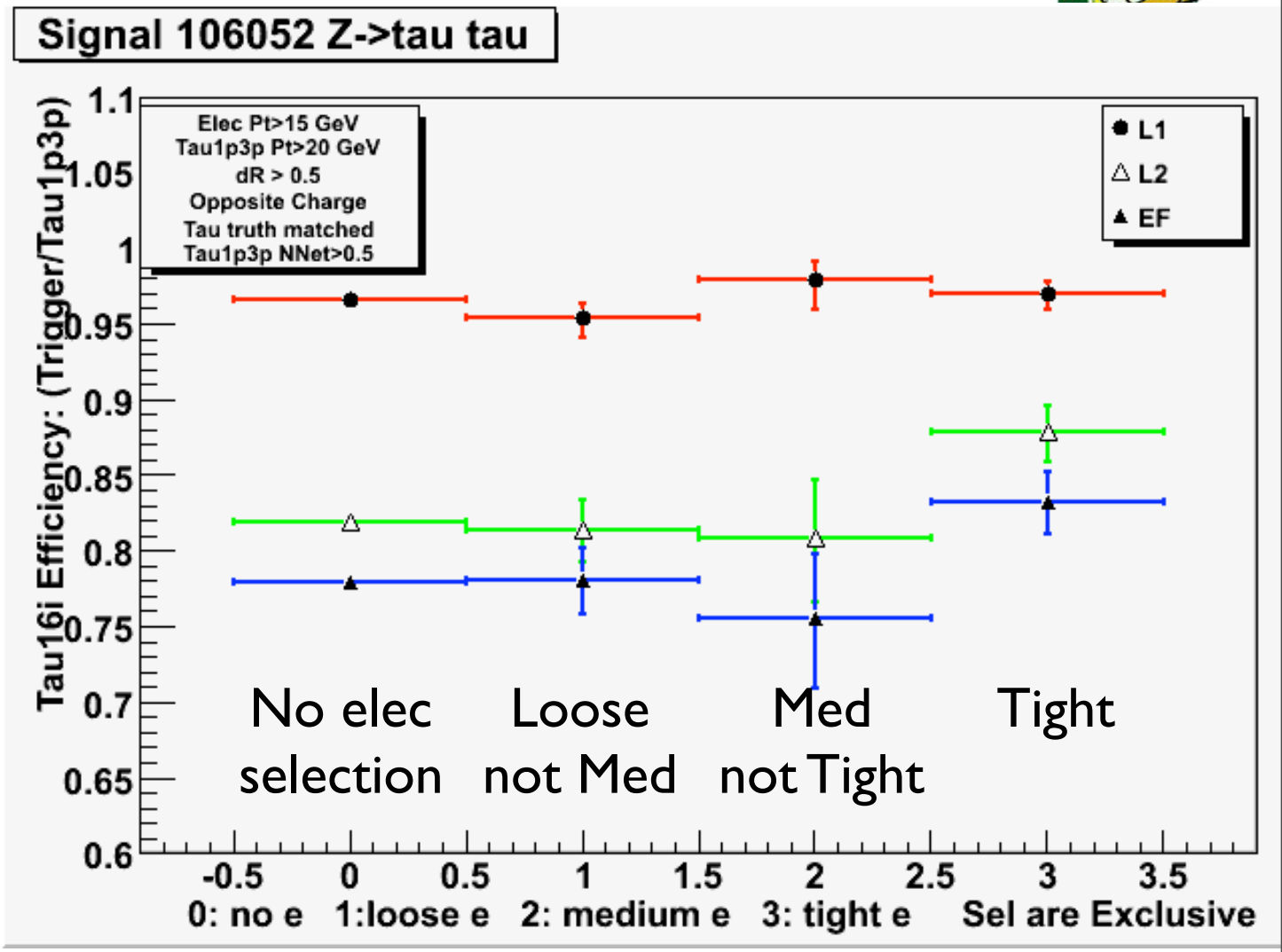


Electron Bias

Tau Efficiency vs Electron Selector

Persists with tau truth match, e-tau dR, e and tau min E_T

Not obviously correlated with tau E_T

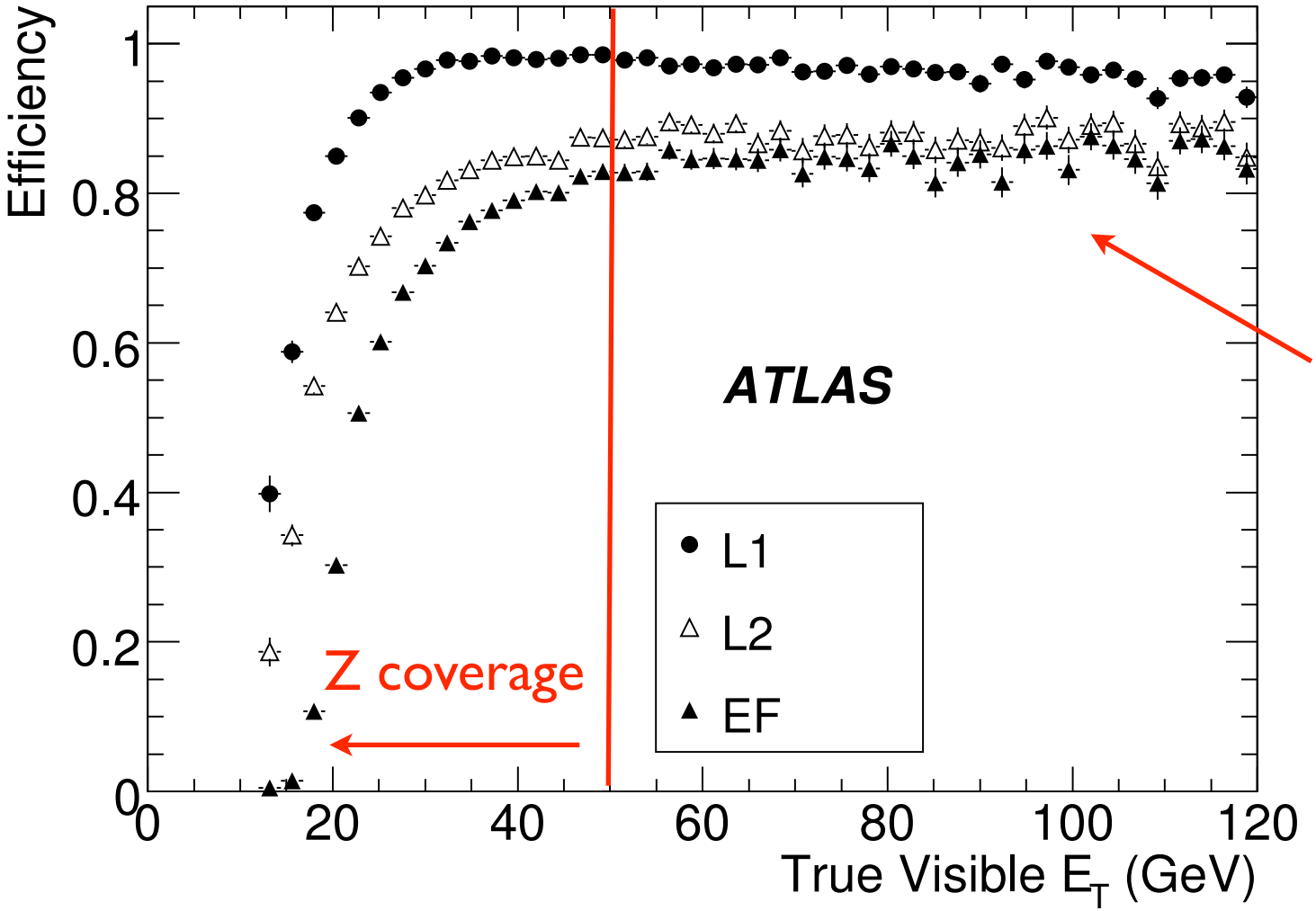


Not huge effect (~5%), but unexpected

Still trying to understand root cause here

Clean electron correlated with clean tau, similar in offline?

Higher E_T ranges



How do we measure this?

ttbar can help here, but also limited statistics

Likely rely on extrapolation from $Z \rightarrow \tau\tau$

Use Monte Carlo, or possibly fakes from jets

Need uniform (or tighter) cuts to higher E_T

HLT algorithms

- Trigger efficiency studies rely on independent trigger to provide unbiased sample
- Currently, HLT algorithms are only run for un-prescaled chains

Minbias triggers will not have tau ROIs processed
Electron/Muon triggers will not have tau ROIs processed

Some Possibilities

- Run all HLT algorithms for all events
  - probably OK, will be tested (soon?) (but for how long???)
- Define special chains with "tag" selection and "probe" algorithms run, but no cuts
- Re-run HLT offline and believe results

Summary

- Trigger efficiency measured with respect to offline
  Must ensure offline efficiency is also measured...

- Need to combine multiple techniques to cover E_T range, provide adequate statistics for functional dependence (ET, eta, 1pr - 3pr, ...)

- $Z \rightarrow \tau\tau$ provides best absolute normalization (plateau), must be extrapolated using MC, dijet fake taus
  First commissioning/understanding/measurements will come from fakes. Real taus come later...

- Other channels potentially interesting (ttbar, $W \rightarrow \tau\nu$?)