WW Benchmark – TauFinder

February 17, 2019

Introduction

– used Marlin Reco TauFinder processor on τ/μ signal sample
  – `https://github.com/iLCSoft/MarlinReco/tree/master/Analysis/TauFinder`

– documentation:
  – `https://github.com/iLCSoft/MarlinReco/blob/master/doc/TauFinder/TauFinderLCDNote.pdf`

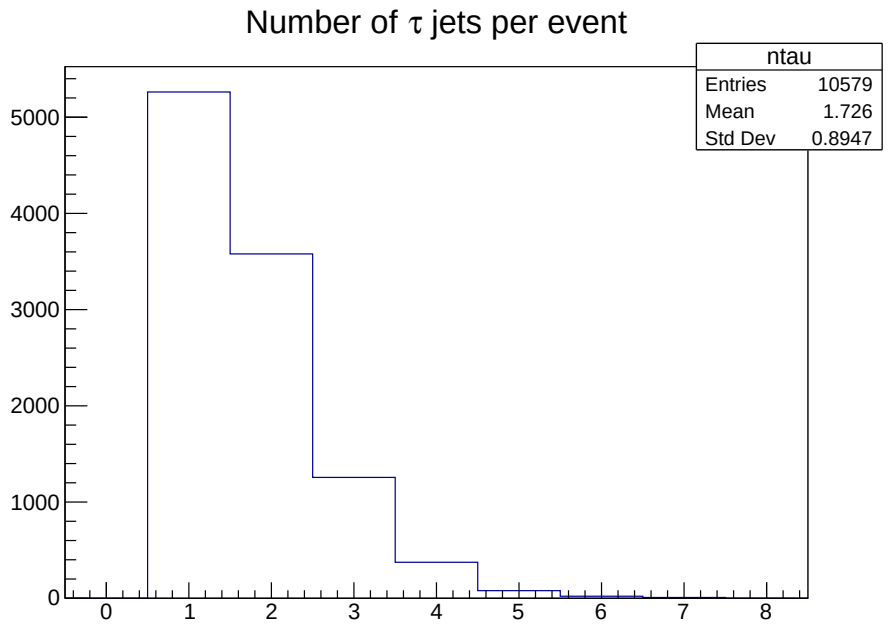
Processor designed specifically for WW in 3 TeV environment at CLIC

- documentation uses low statistics samples
- could be useful for 500 GeV ILD

Basic operating cuts used:

```
86                              std::string("Signal.root") ) ;
87
88    registerProcessorParameter( "pt_cut" ,
89                              "Cut on pt to suppress background"  ,
90                              _ptcut ,
91                              (float)0.2) ;
92     registerProcessorParameter( "cosT_cut" ,
93                              "Cut on cosT to suppress background"  ,
94                              _cosTcut ,
95                              (float)0.99) ;
96
97     registerProcessorParameter( "searchConeAngle" ,
98                              "Opening angle of the search cone for tau jet in rad"  ,
99                              _coneAngle ,
100                             (float)0.05) ;
101
102    registerProcessorParameter( "isolationConeAngle" ,
103                             "Outer isolation cone around search cone of tau jet in rad (relativ to cone angle)"  ,
104                             _isoAngle ,
105                             (float)0.02) ;
106
107    registerProcessorParameter( "isolationEnergy" ,
108                             "Energy allowed within isolation cone region"  ,
109                             _isoE ,
110                             (float)5.0) ;
111
112    registerProcessorParameter( "ptseed" ,
113                             "Minimum tranverse momentum of tau seed"  ,
114                             _ptseed ,
115                             (float)5.0) ;
116
117    registerProcessorParameter( "invariant_mass" ,
118                             "Upper limit on invariant mass of tau candidate"  ,
119                             _minv ,
120                             (float)2.0) ;
121 }
```

First run



- a τ jet is found for nearly event (w/o acceptance cuts)
- τ jet candidates are found for both τ and μ channels

τ Finding Performance

TauFinder Processor basic performance

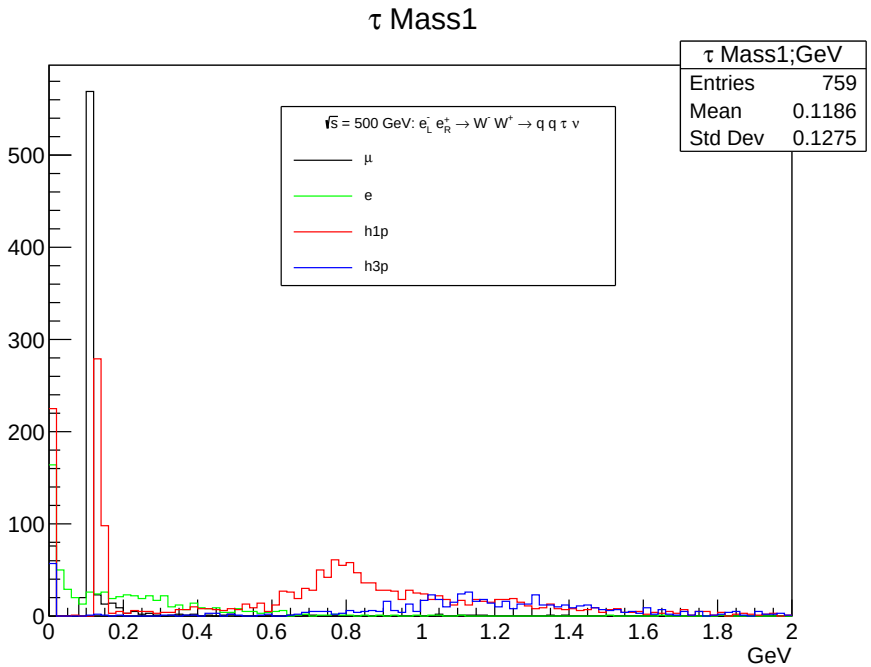
—	Inclusive	μ	e	h1p	h3p	Other
True τ's	5073	892	962	2445	767	7
$cos\theta < 0.995$	4690	842	895	2235	711	7
$\psi < 100$ mrad	4001	759	779	1845	616	2
ϵ	0.853 ± 0.005	0.901 ± 0.010	0.870 ± 0.011	0.826 ± 0.008	0.867 ± 0.012	0.29 ± 0.17

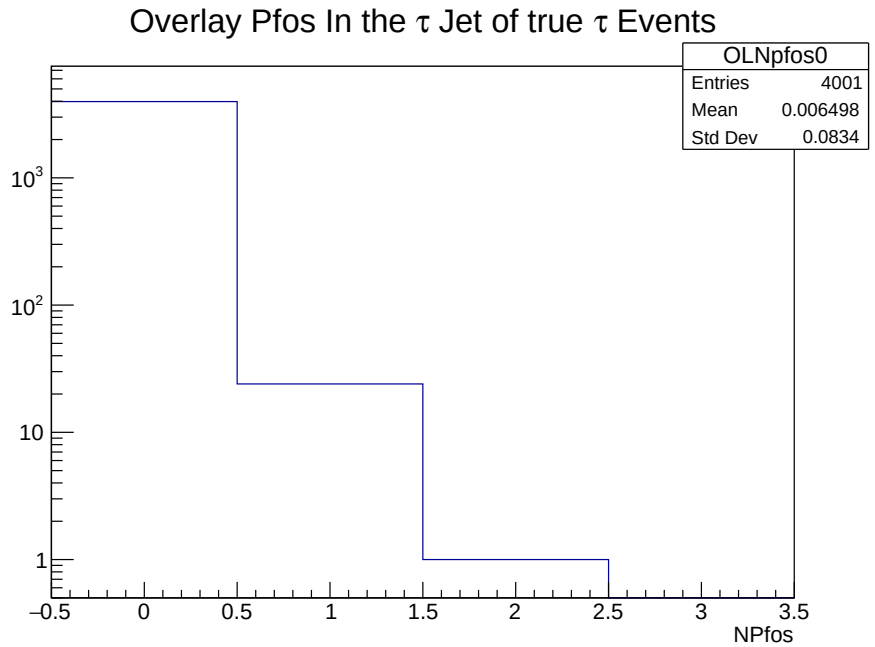
$cos\theta < 0.995$ - visible MC fermions fall within detectable range
$\psi < 100$ mrad - event has at least 1 measured τ within 100 mrad of true τ

$$\epsilon = \frac{(\#\ of\ measured\ \tau\ that\ pass\ acceptance + MCTag)}{(\#\ of\ true\ \tau\ that\ pass\ acceptance)}$$

τ quality

Can assess the quality of the MC tagged τ jets by looking at how much overlay is picked up and basic mass distributions per channel





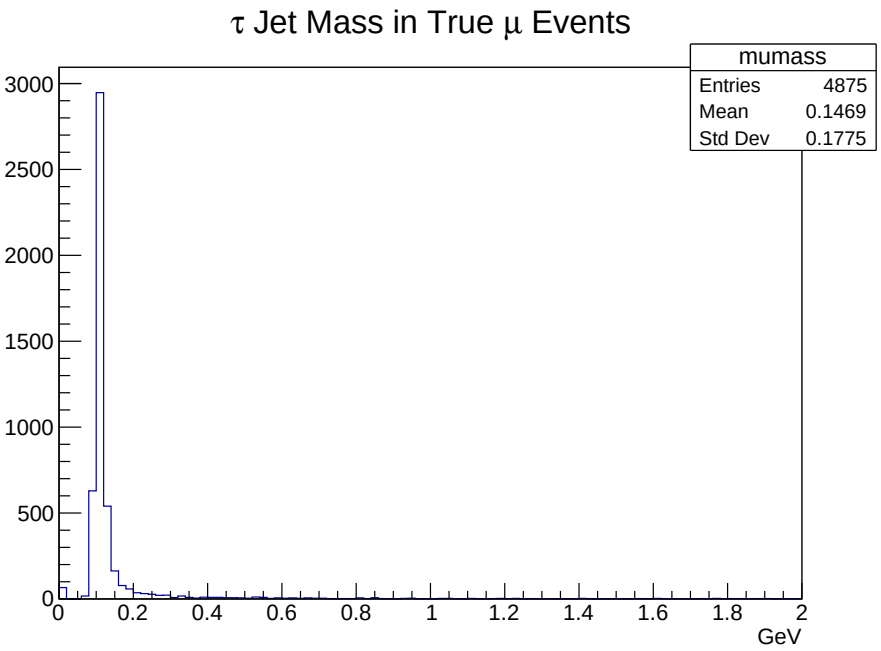
– each decay channel clearly represented in terms of masses

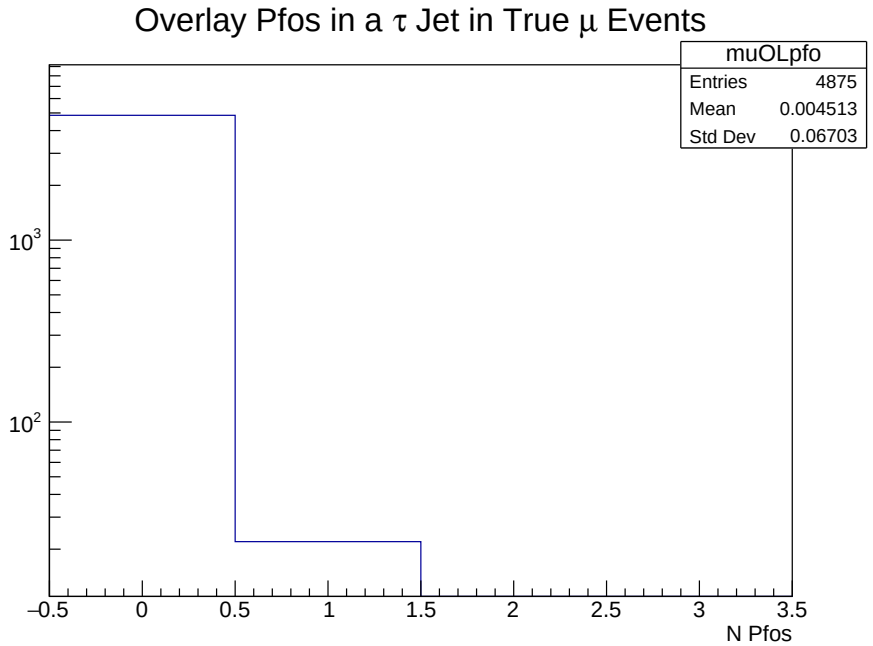
– almost no overlay is present in tau cones

τ jets from true μs

Muon finding performance

–	μ
True μs	5506
$\lvert cos\theta \rvert < 0.995$	5051
$\psi < 0.1$	4875
ϵ	0.965 ± 0.003

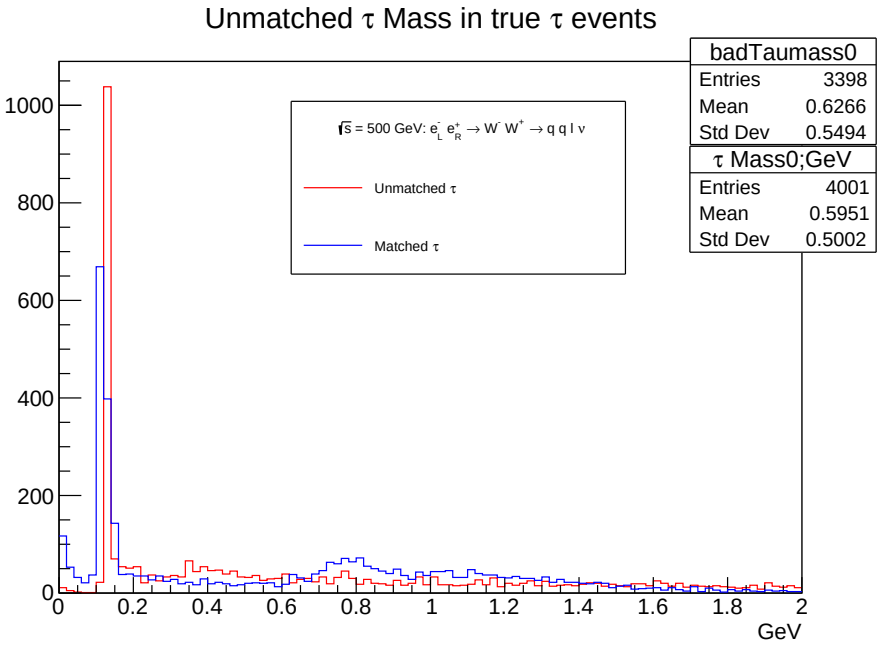


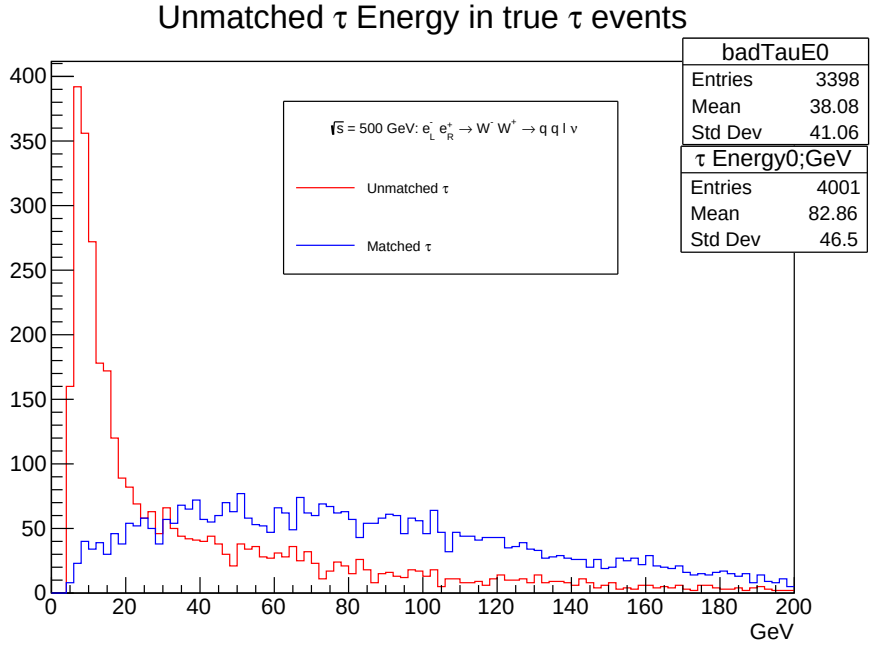


unmatched τ – true τ case

Main issue becomes how to choose the correct τ for events with $> 1\,\tau$ jets

– Here are Mass and energy distributions of τ jets not matched to true lepton

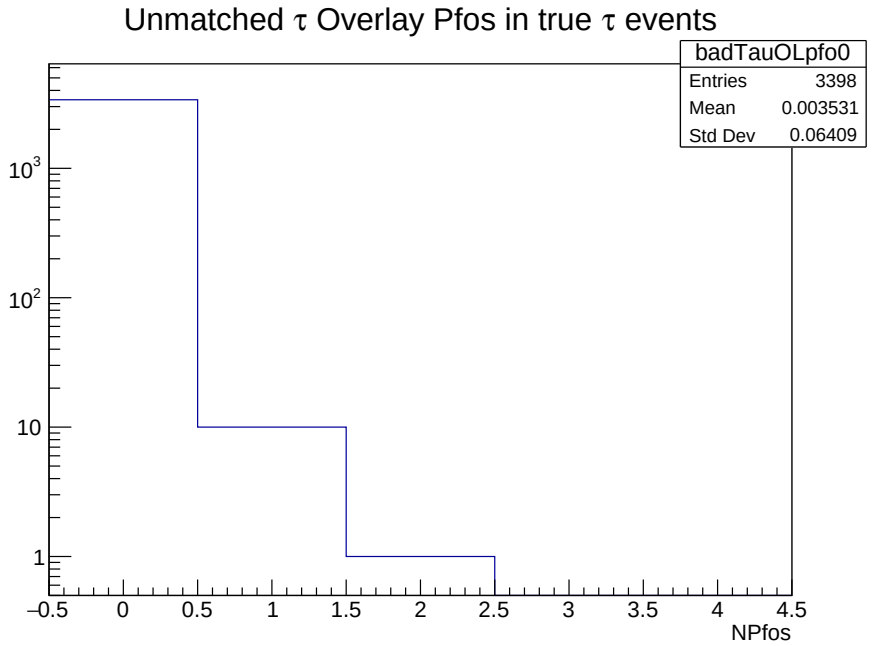




Junk τ tend to have similar mass with the matched candidate

Distinct low energy signature for unmatched τ

unmatched w/ overlay – true τ case

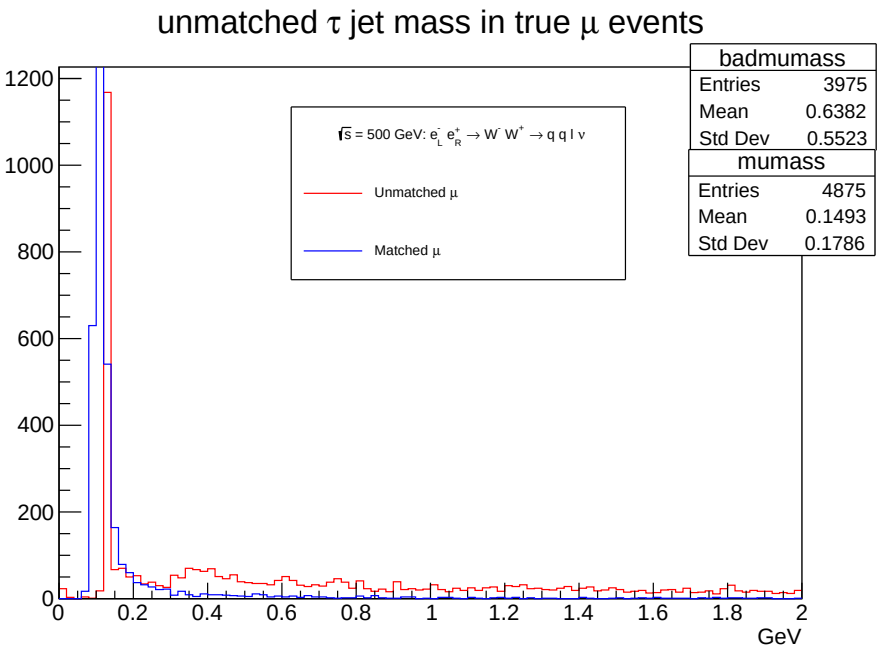


– No overlay shows these additional taus must be hadronic fragments

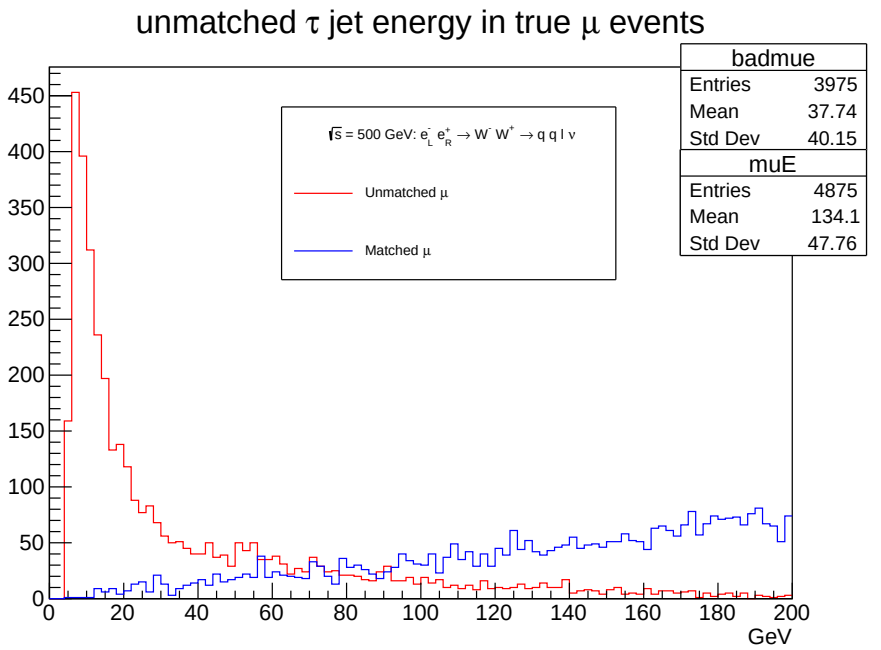
– Need to look at separation of tau and external jet activity, could be the best way to distinguish correct candidate

– τ matching can be slightly improved by using visible gen τ decay products rather than the gen τ

unmatched τ – true μ case

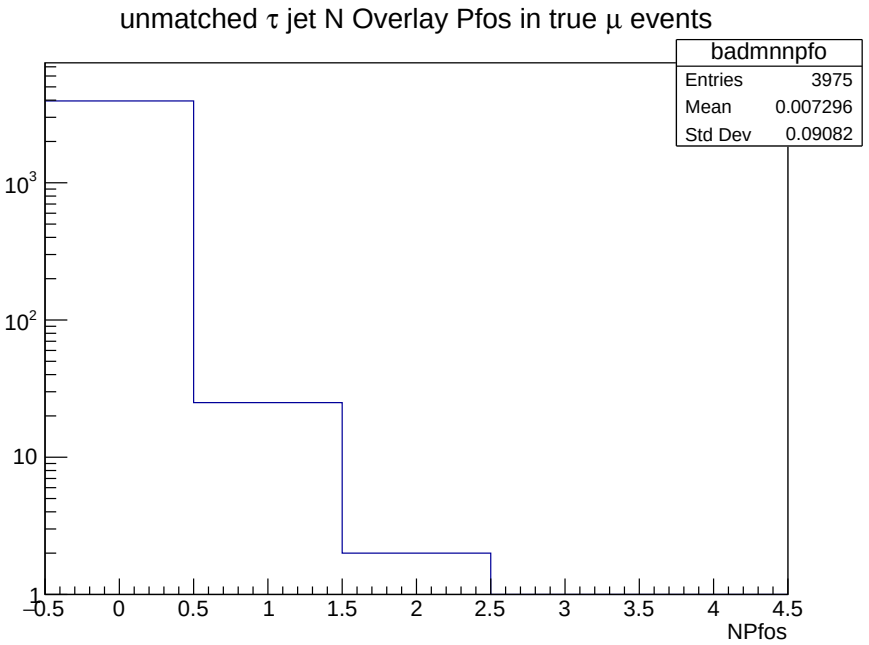


Clear mass seperation above 1 GeV



More clear energy separation than true τ case

unmatched w/ overlay – true μ case



μ case also rejects most overlay, where extra τs are coming from the hadronic jets

summary

- TauFinder looks promising
- need to try TauFinder on electron sample (In progress)
- need good selection variables for multi-tau candidate events
- need to explore/optimize tau finding variables e.g. cone-size etc.