Tracking Matching for τ-ID

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τ **Samples:**

single τ
(8000 events 0 mb
6000 2.5 poisson events)x

Z τ τ, 2.5 poisson min bias
(5000 events)

$t\bar{t}$, 2.5 poisson min bias
(5000 events, about 900 τs)

Track matching: currenly in reco

- start with τ object and loop over Charged Particles
  max 3 tracks

- get the track position at the preshower and recalculate the η of this position with respect to the D0 vertex ($\rightarrow$ fix wrong PV)

- if track is within an 0.5 $\eta - \phi$ cone of the τ, add it

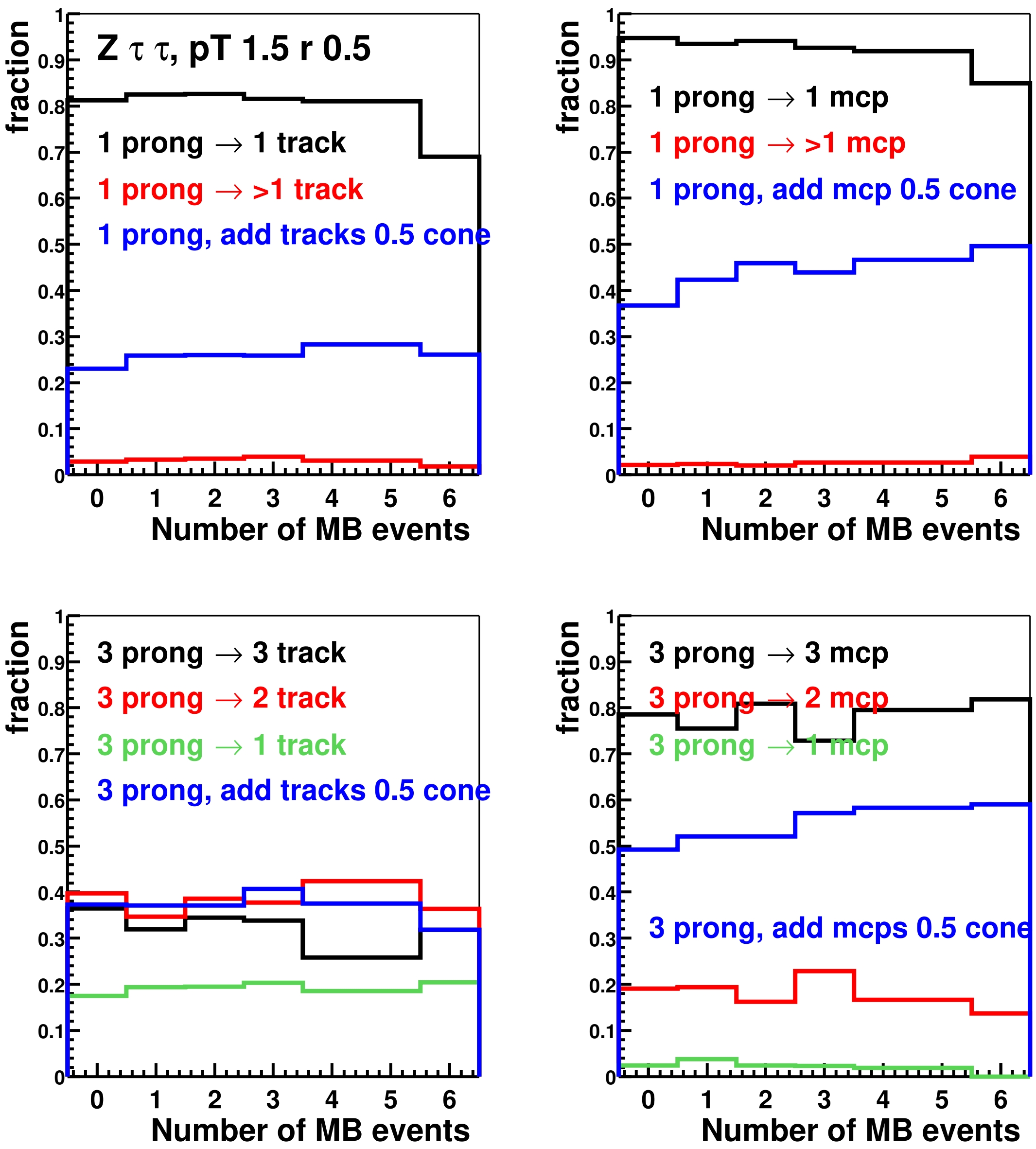
- if already one track found: Z_{track} within 5 cm of first track
  invariant mass of the tracks below 2 GeV

- if already three tracks: in addition: the charge has to be $\pm$ 1

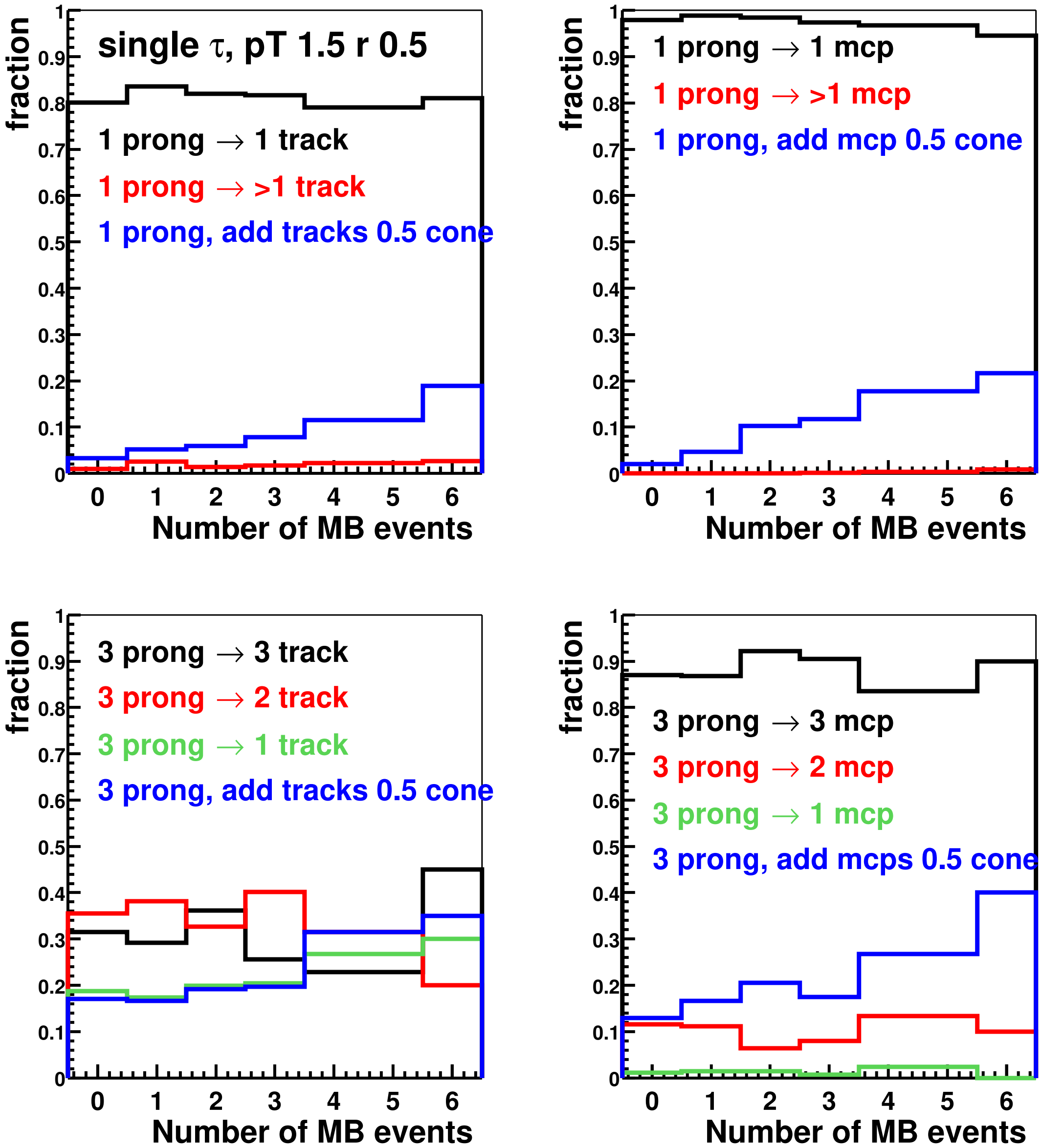
- for other tracks: Σ of pT

Number of matched track versus number of min bias events

done for tracks and (stable charged) MC particles
for a Z $\tau\tau$ file as function of N_{mb}



Number of matched tracks
- single τ event



very similar behaviour
as well as $t\bar{t}$ sample (within statistics)

Track matching and tracking efficiency

- 1 prong: 5% of lost tracks due to pT cut (compare to MCP)

- 10-15% tracking efficiency

- 3 prongs: only 40% found as 3 prong

- 20% due to matching (compare MCP)

- next 50% due to 70% single track efficiency in these events

Track matching method

- consider only events where all prongs were reconstructed

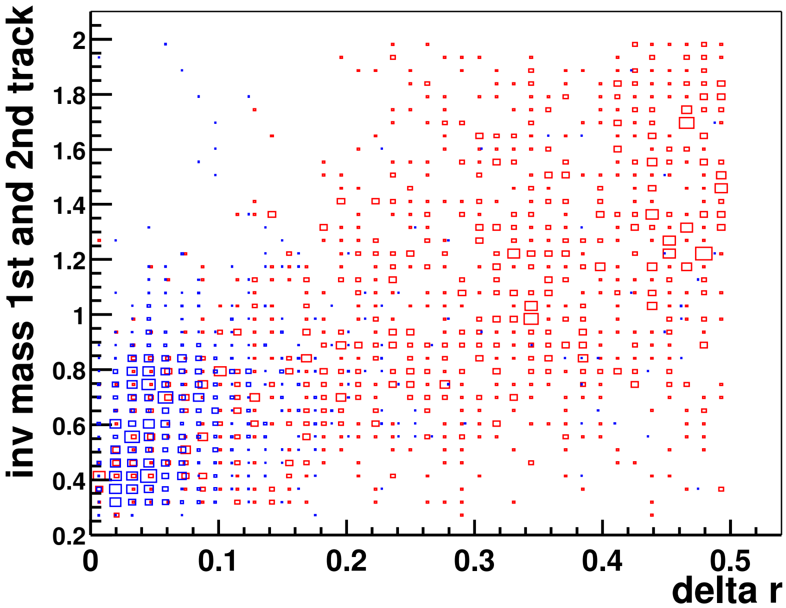
- vary pT threshold (0.5, 1.0 and 1.5 GeV) $\rightarrow$ not to pick up wrong tracks, tighten other "cuts"

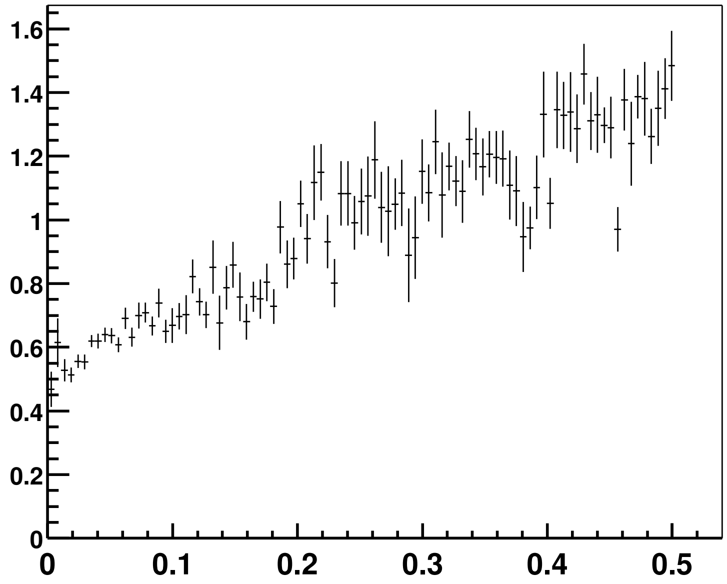
- cone: 0.2, 0.35 and 0.9 in $\eta - \phi$

- or inv mass of tracks:
  $m^2 = E_1 E_2 (1 - cos(\delta\phi))$

NB: in later plots a conesize of 0.2 is plotted as point at m_{inv} of 1 GeV, cone 0.35 at m_{inv} of 1.5 GeV and cone 0.5 at m_{inv} of 2 GeV

Track matching method
invariant mass

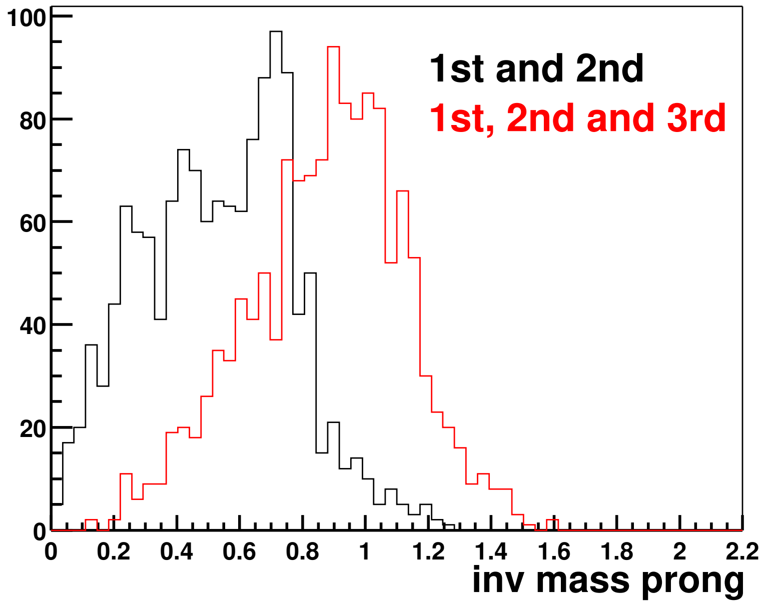


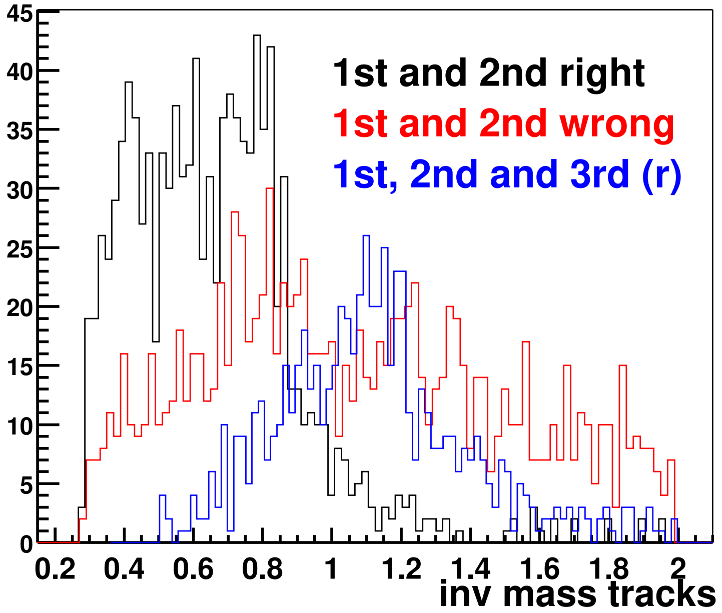


as expected: correlation of conesize ($\delta\phi$) and invariant mass

Track matching method

where to cut

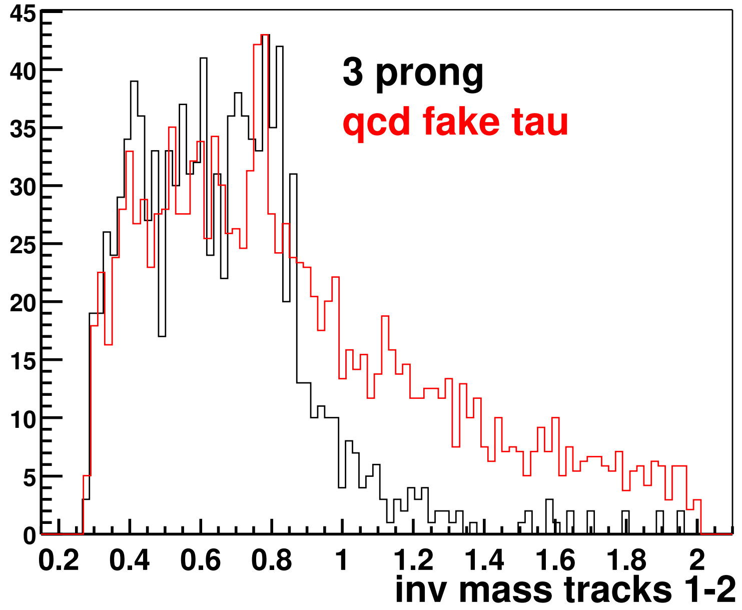


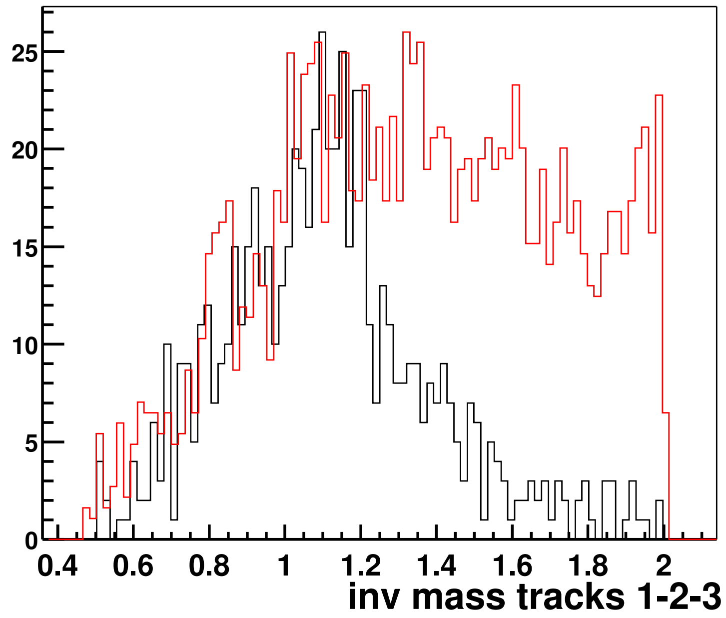


instead of having one cut, use two cuts:
a stronger one for the second tracks and a looser one for the 3rd track

Track matching method

m_{inv} track - τ versus QCD

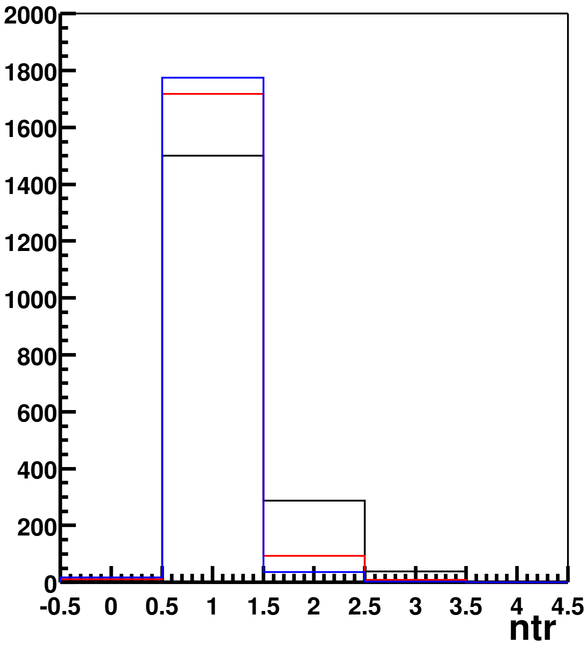


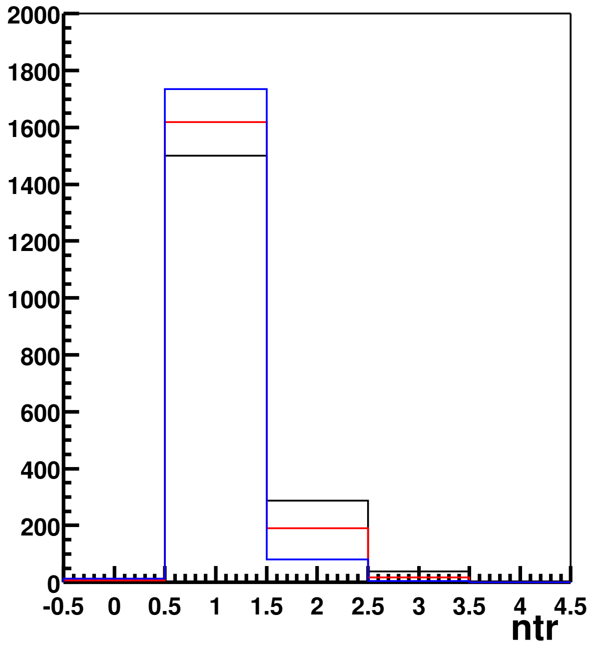


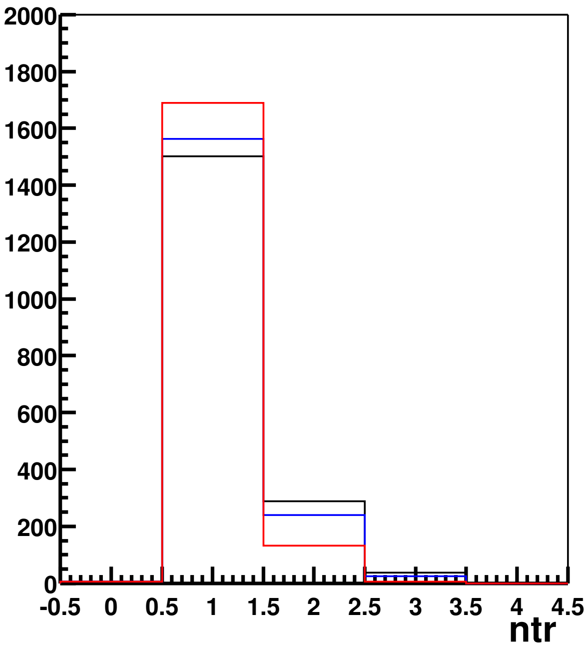
second cut could be stronger as well - so far left at 2 GeV

Track matching method

1 prong τs, one mass cut τs







tracks matched to 1 prong track found, no EM

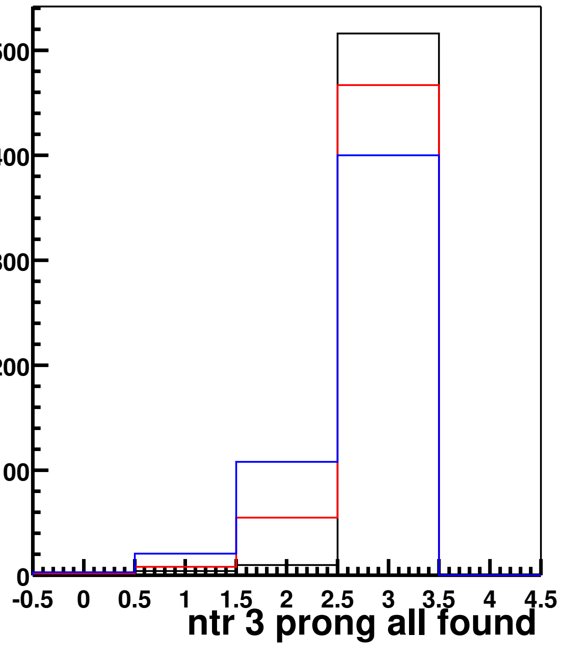
left upper, cone 0.5, mass 2 GeV
pT 0.5 GeV
pT 1.0 GeV
pT 1.5 GeV

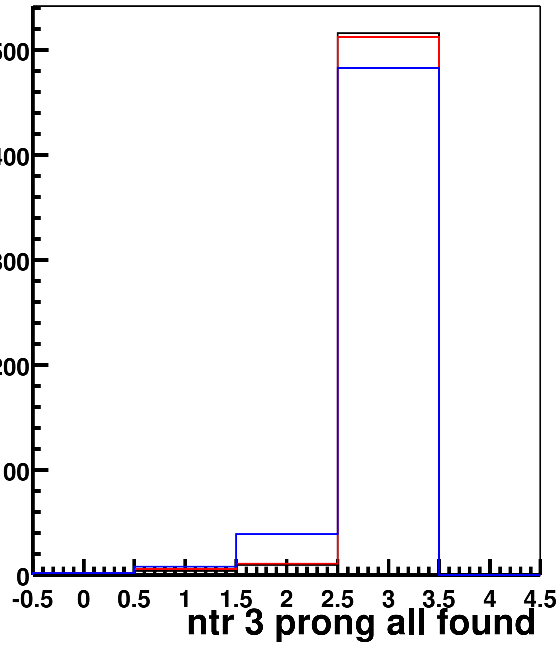
right upper, pT 0.5, mass 2 GeV
cone 0.5
cone 0.35
cone 0.2

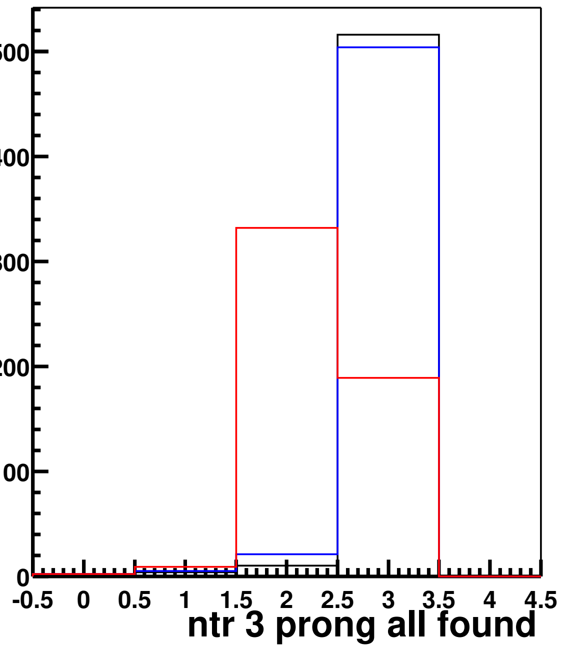
left bottom, pT 0.5, cone 0.5
mass 2 GeV
mass 1.5 GeV
mass 1 GeV

Track matching method

3 prong τs, one mass cut







tracks matched to 3 prong all found

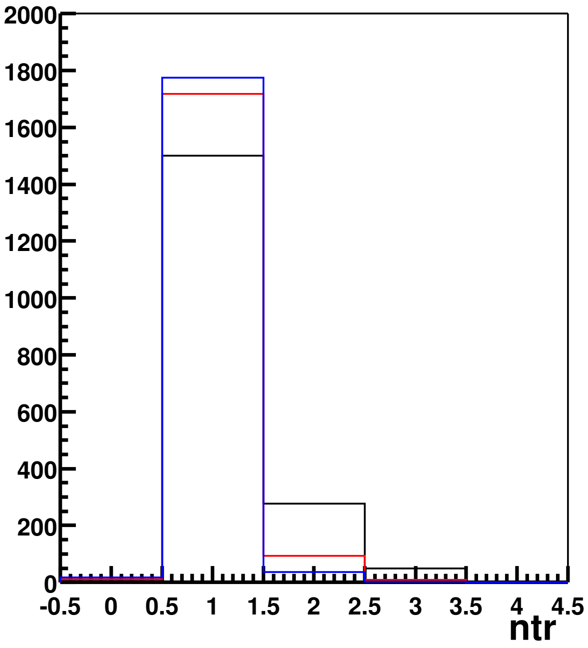
left upper, cone 0.5, mass 2 GeV
pT 0.5 GeV
pT 1.0 GeV
pT 1.5 GeV

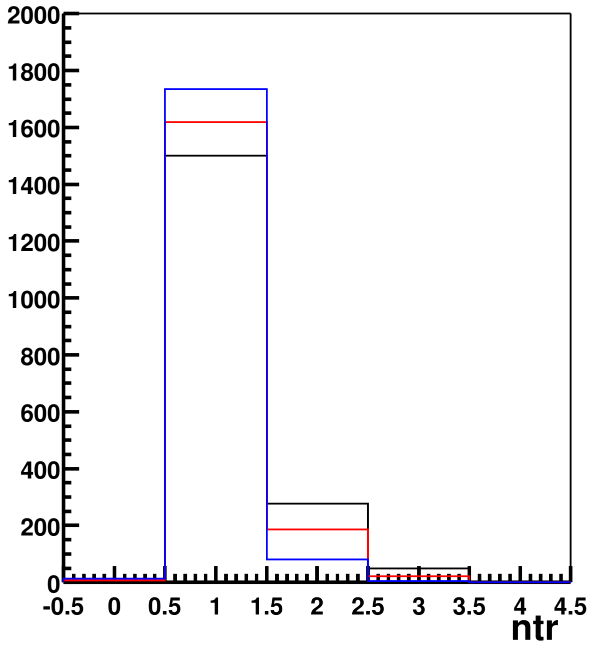
right upper, pT 0.5, mass 2 GeV
cone 0.5
cone 0.35
cone 0.2

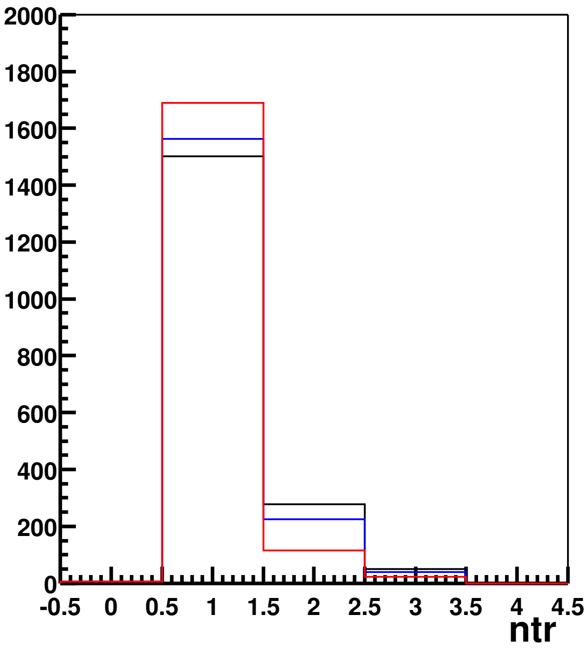
left bottom, pT 0.5, cone 0.5
mass 2 GeV
mass 1.5 GeV
mass 1 GeV

Track matching method

1 prong τs, two mass cut τs







tracks matched to 1 prong track found, no EM

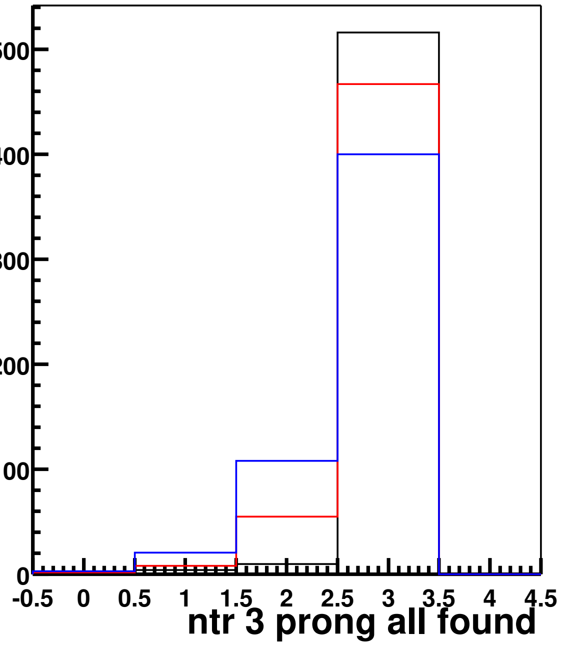
left upper, cone 0.5, mass 2 GeV
pT 0.5 GeV
pT 1.0 GeV
pT 1.5 GeV

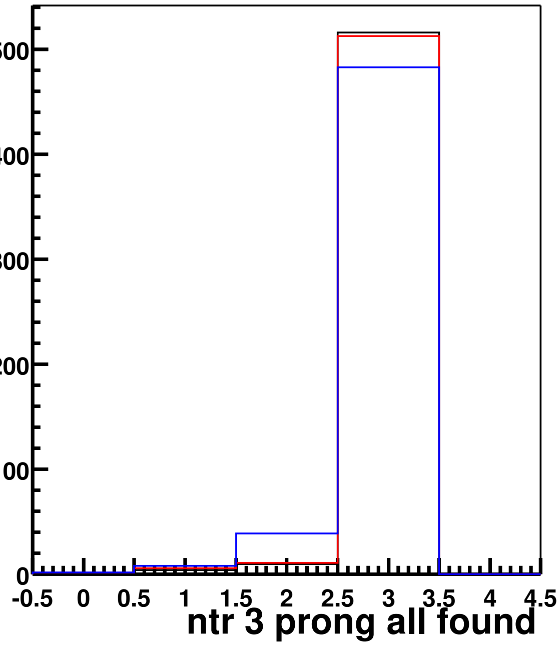
right upper, pT 0.5, mass 2 GeV
cone 0.5
cone 0.35
cone 0.2

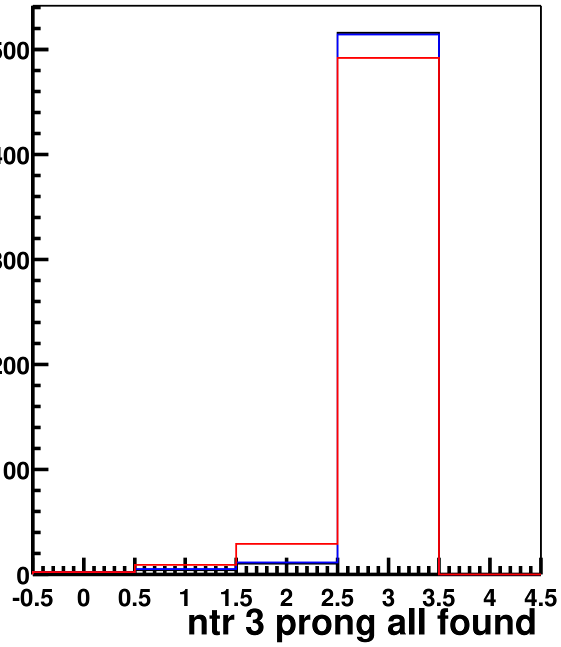
left bottom, pT 0.5, cone 0.5
mass 1-2 2 GeV
mass 1-2 1.5 GeV
mass 1-2 1 GeV

Track matching method

3 prong τs, two mass cut







tracks matched to 3 prong all found

left upper, cone 0.5, mass 2 GeV
pT 0.5 GeV
pT 1.0 GeV
pT 1.5 GeV

right upper, pT 0.5, mass 2 GeV
cone 0.5
cone 0.35
cone 0.2

left bottom, pT 0.5, cone 0.5
mass 1-2 2 GeV
mass 1-2 1.5 GeV
mass 1-2 1 GeV

Track matching method

as expected:

- lowering the pT cut adds additional tracks to 1 prong

- lowering the one and only pT cut cuts strongly into 3 prongs

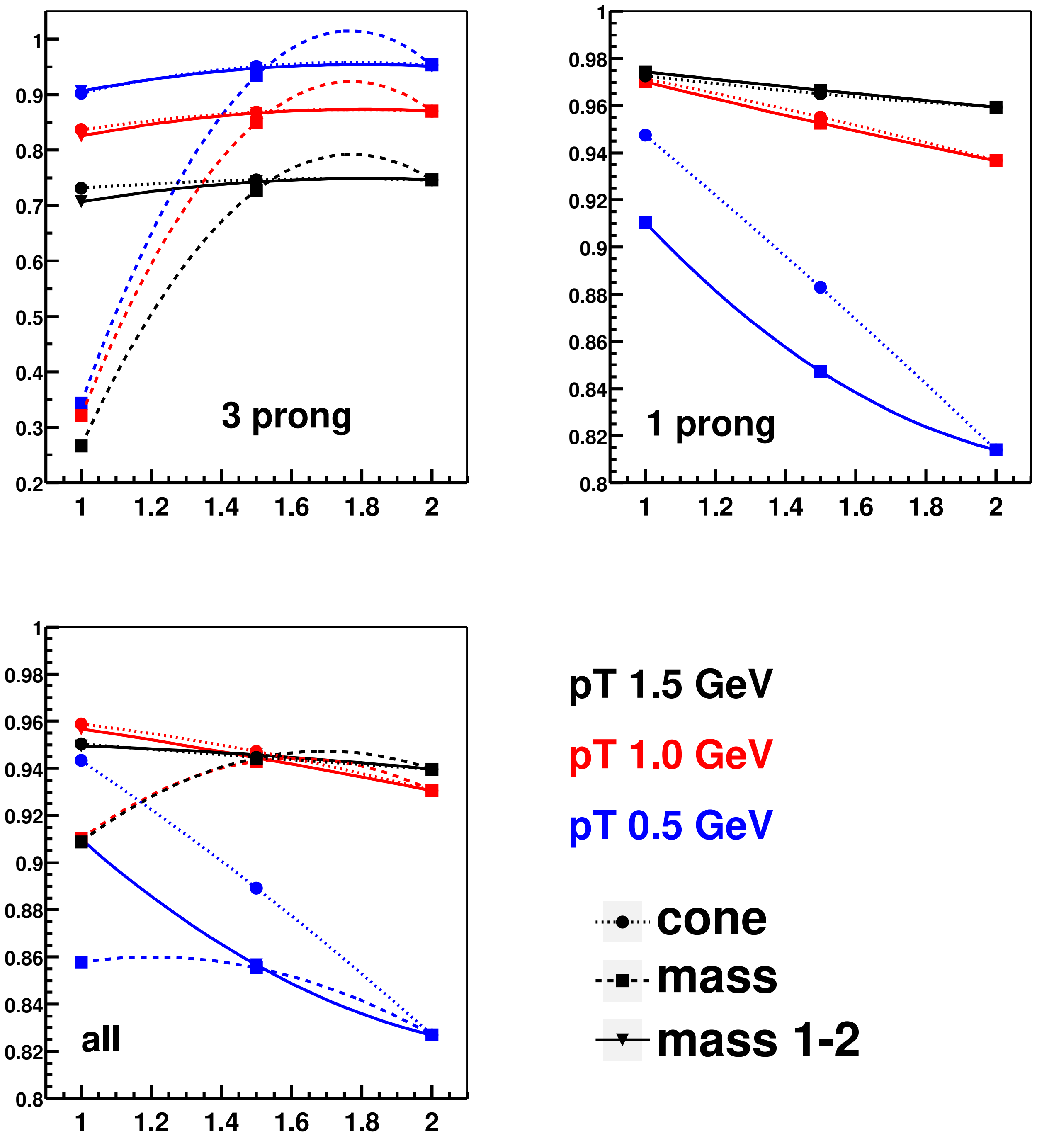
- tighening the cone and lowering the 1-2 invariant mass cut has about the same effect

right track:
look for tracks closest to the charged τ daughter
require $\delta\eta - \phi <$0.02

right matches:
all tracks were reconstucted and all and only the right tracks were matched to the τ

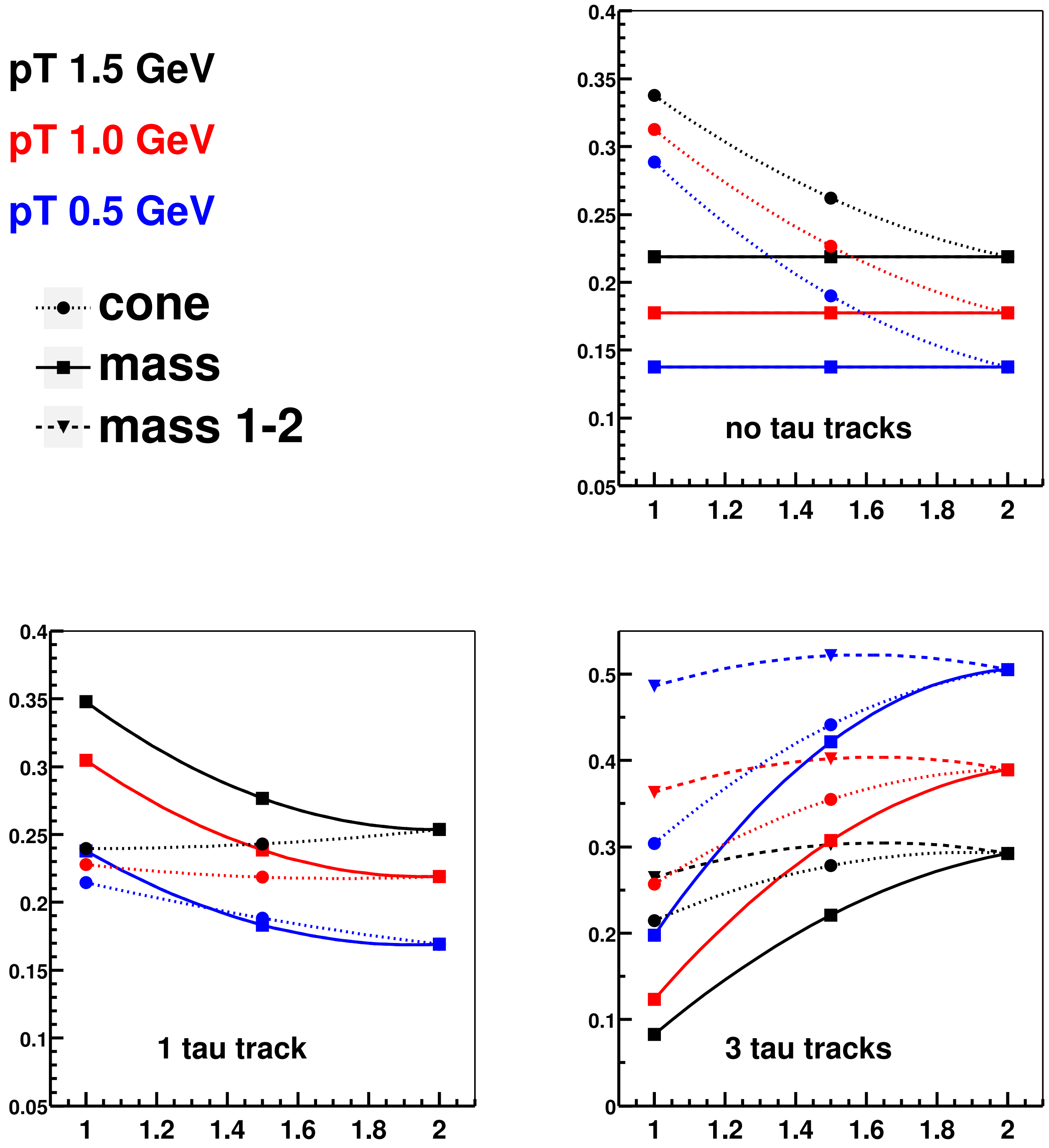
Track matching method

match quality

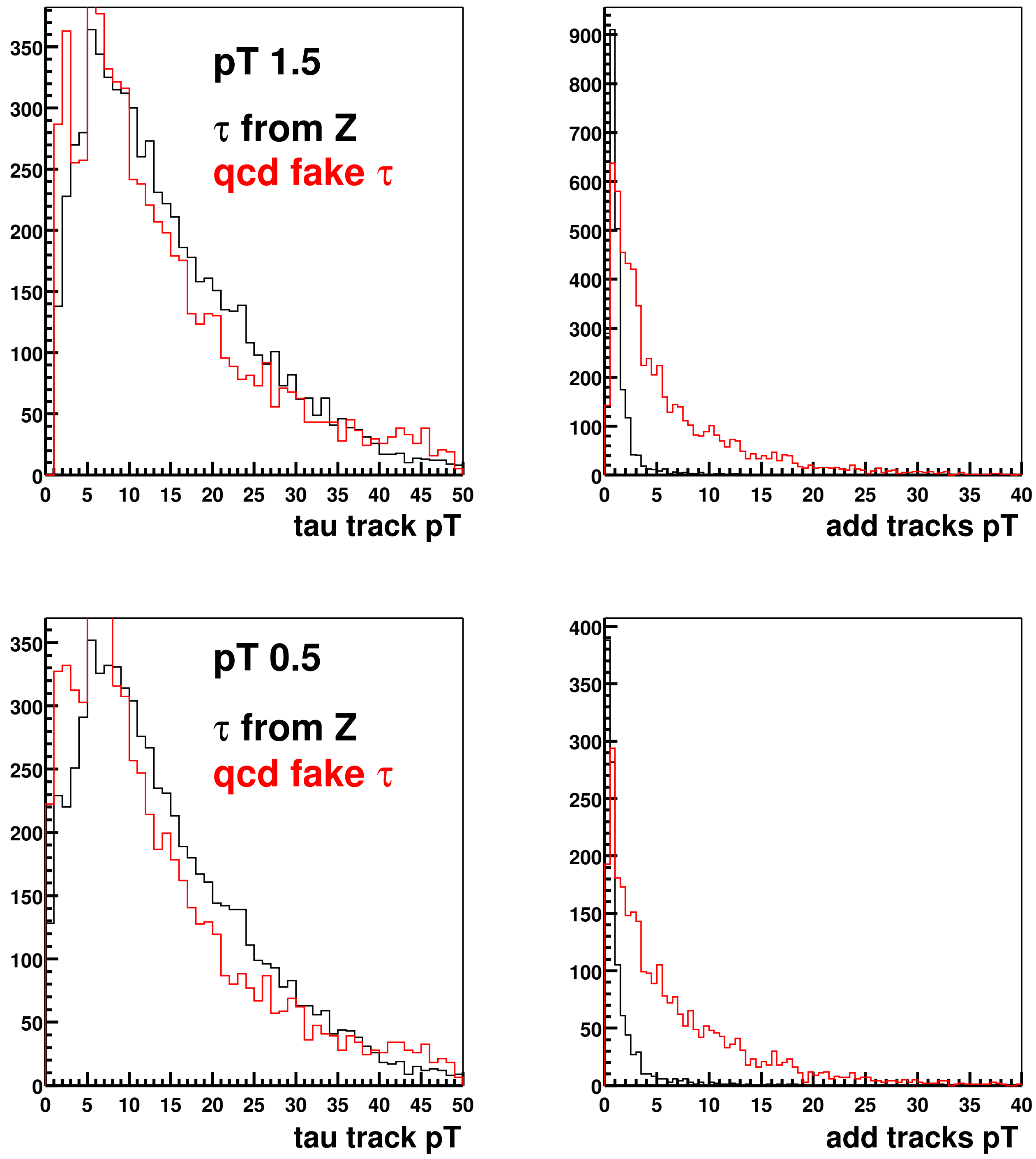


Track matching method

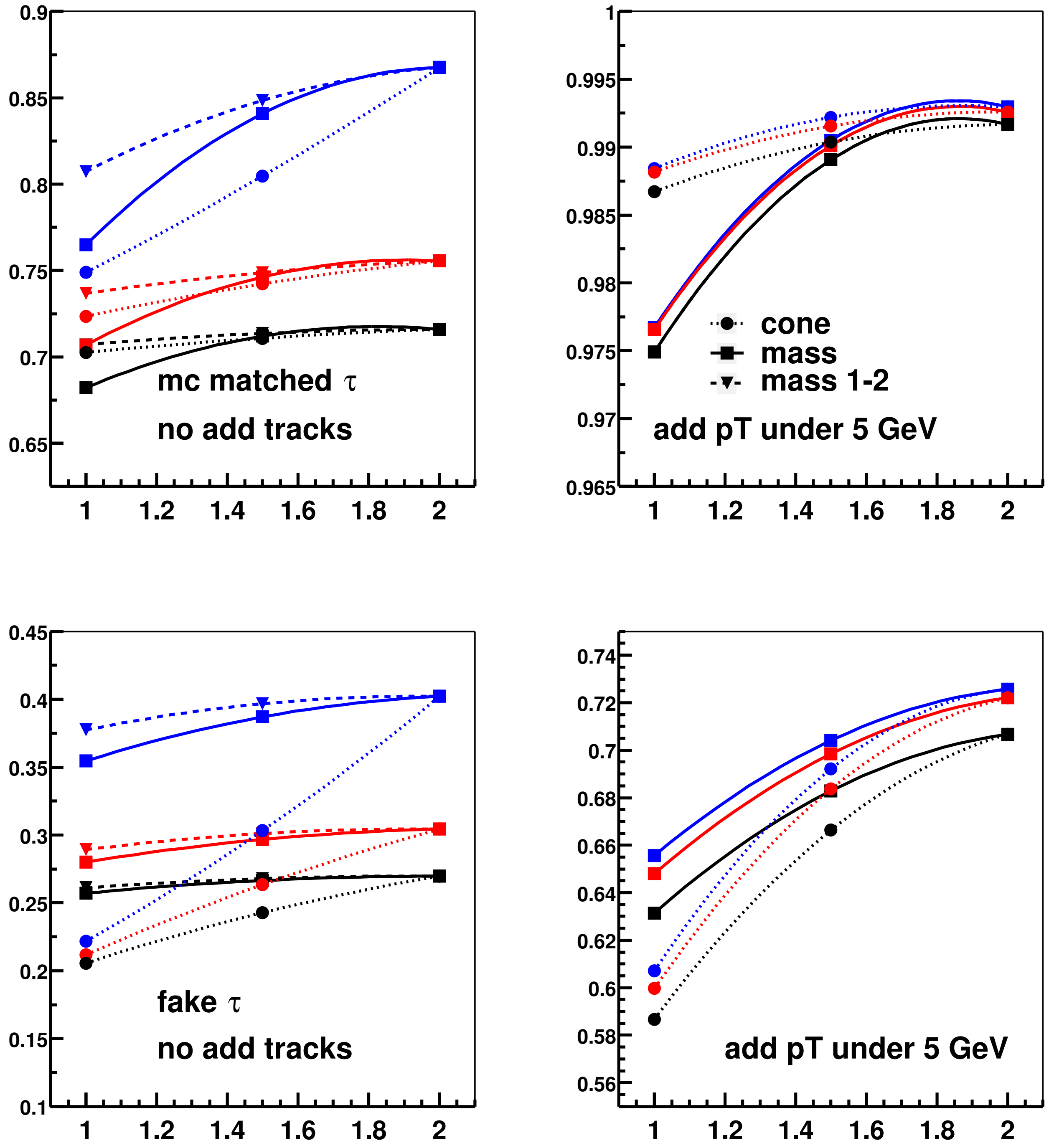
fake τs from QCD



Additional tracks in 0.5 $\eta - \phi$ cone



Cut on additional tracks for QCD rejection



Track matching method summary

(currently) best methods:

- pT of 1.0 and inv mass on 2^{nd} track of 1 GeV
- pT of 1.0 cone of 0.2
- pT cut of 0.5 GeV and cone of 0.2 (best for 3 prong, overall a bit worse)

if QCD rejection is considered as well:

pT 0.5, r 0.2 is favoured

the currently chosen scheme works worse both

for "efficiency" and QCD rejection

Important:

all these conclusions might change with changing tracking efficiencies!