Tracking for taus

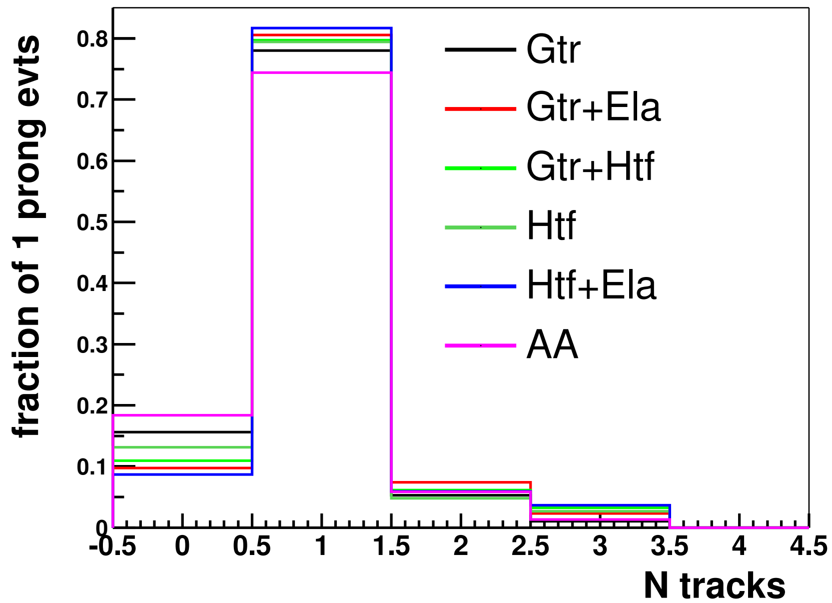
- "easy" first sign of taus: peaks at 1+3 tracks above background for taus
- problem: 3 prong tau decays: 3 relatively stiff track which tend to be very close (not checkable in data!)
- p10 efficiency for 1 prong tracks was about 90%, for 3 prongs around 80%, for 3 prongs to be reconstructed as three prongs$\rightarrow$ ($\mathbf{0.8^3 \approx 0.5}$)
- use invariant mass of taus as well as $\boldsymbol{\Sigma pT}$ of additional track in a 0.5 cone as variables for background rejection

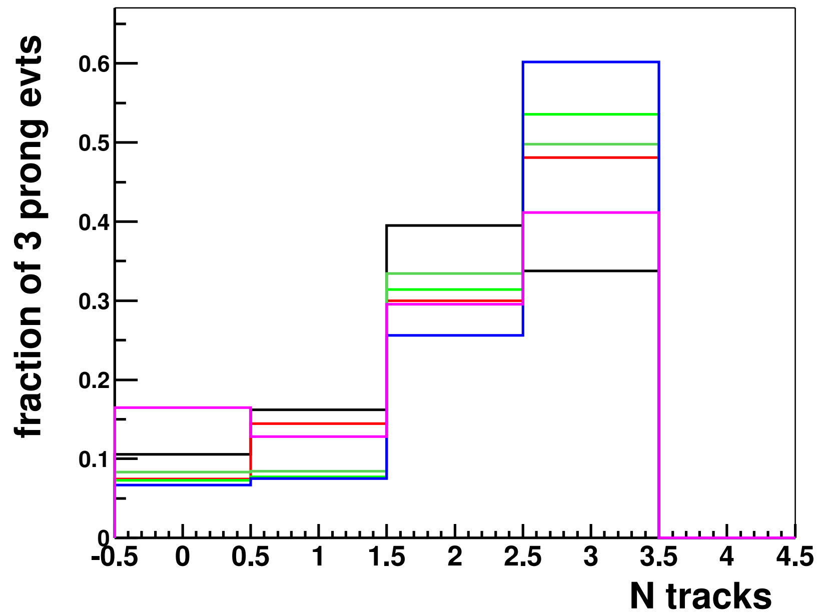
What was studied

- look at the τ objects in the processed single τ files
- background: used $H + Z \rightarrow 4b$ (b-jets are background to $Z \rightarrow \tau\tau \rightarrow$ lepton+hadronic τ)+ data (Run 155554) samples
- look at the number of matched tracks to 1 and 3 prong decays
- look at ΣpT of additional track for true and fake taus
- plot the invariant mass distributions of matched tracks

- for efficiency plots:
  use MCTAU (contains the charged daughters)
- look for the "closest" MC track to a "prong" (close in dR+pT)
- match MC to reco: uses tracking group χ^2 match

MC multiplicity versus reconstructed



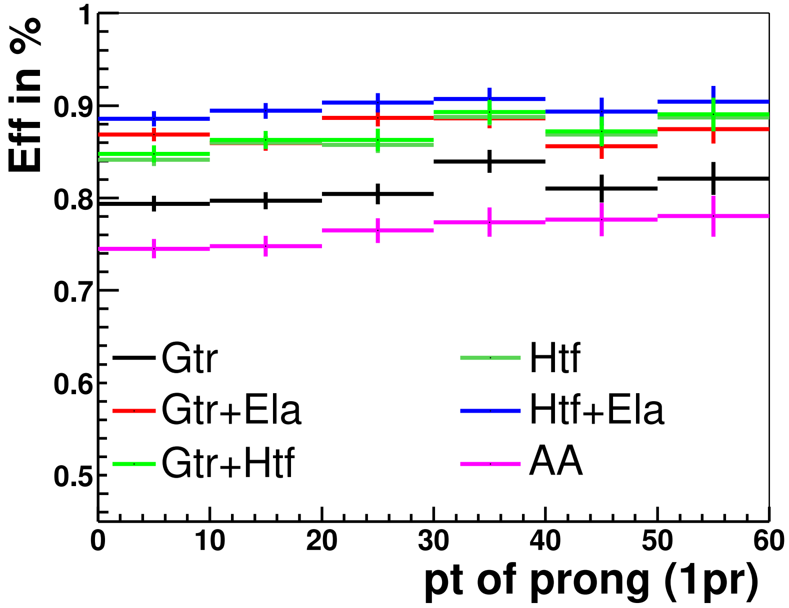


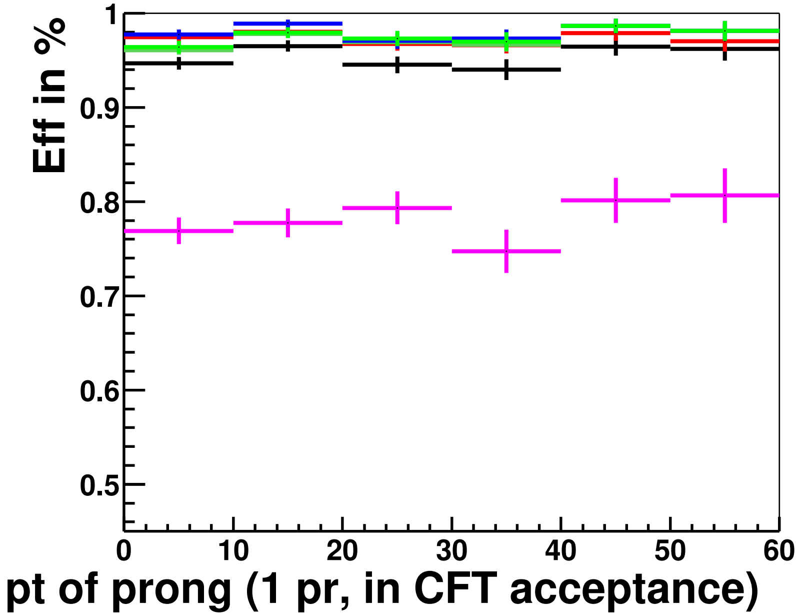
aa has the lowest efficiency highest achieved by htf, with 5% gain by using elastic reco in addition

Fraction of 3 prong events with all 3 tracks reconstructed:

Gtr	34%
Htf	48%
Gtr+Ela	49%
Htf+Ela	60%

Tracking efficiency versus pT (1 prong)



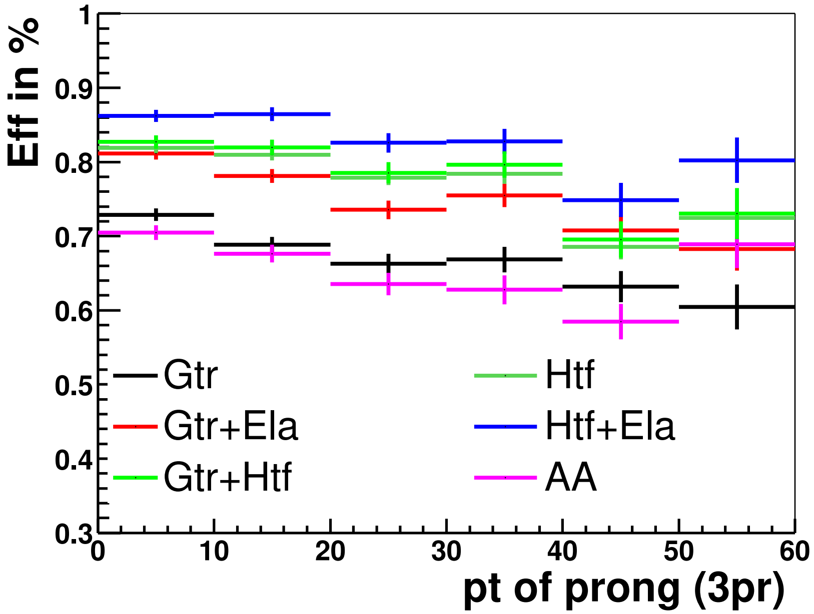


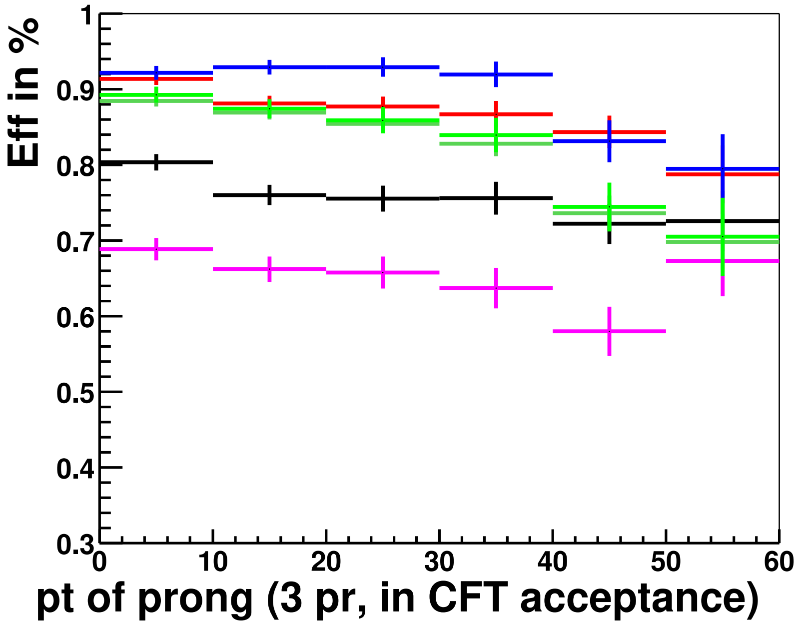
aa has the lowest efficiency (note: lowest statistics as well...)

highest efficiecy for Htf followed by elastic reco (about 4% higher than other algorithms)

for central track no diffence of algorithms (except for AA), efficiencies of about 97%

Tracking efficiency versus pT (3 prong)



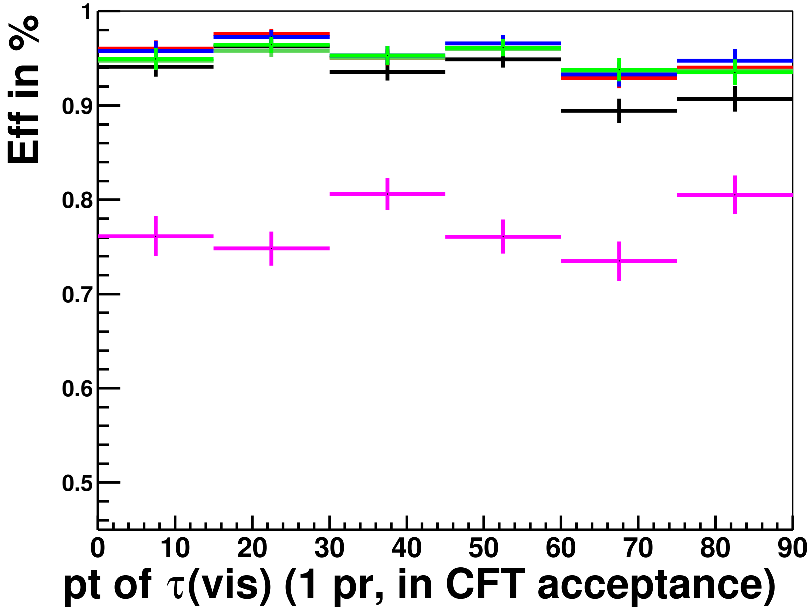


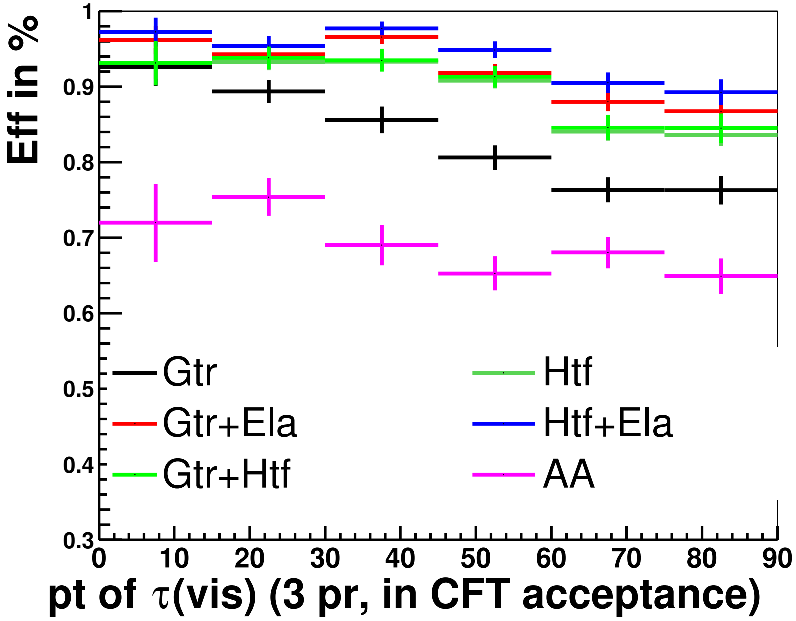
also for 3 prongs, AA has the lowest efficiecy

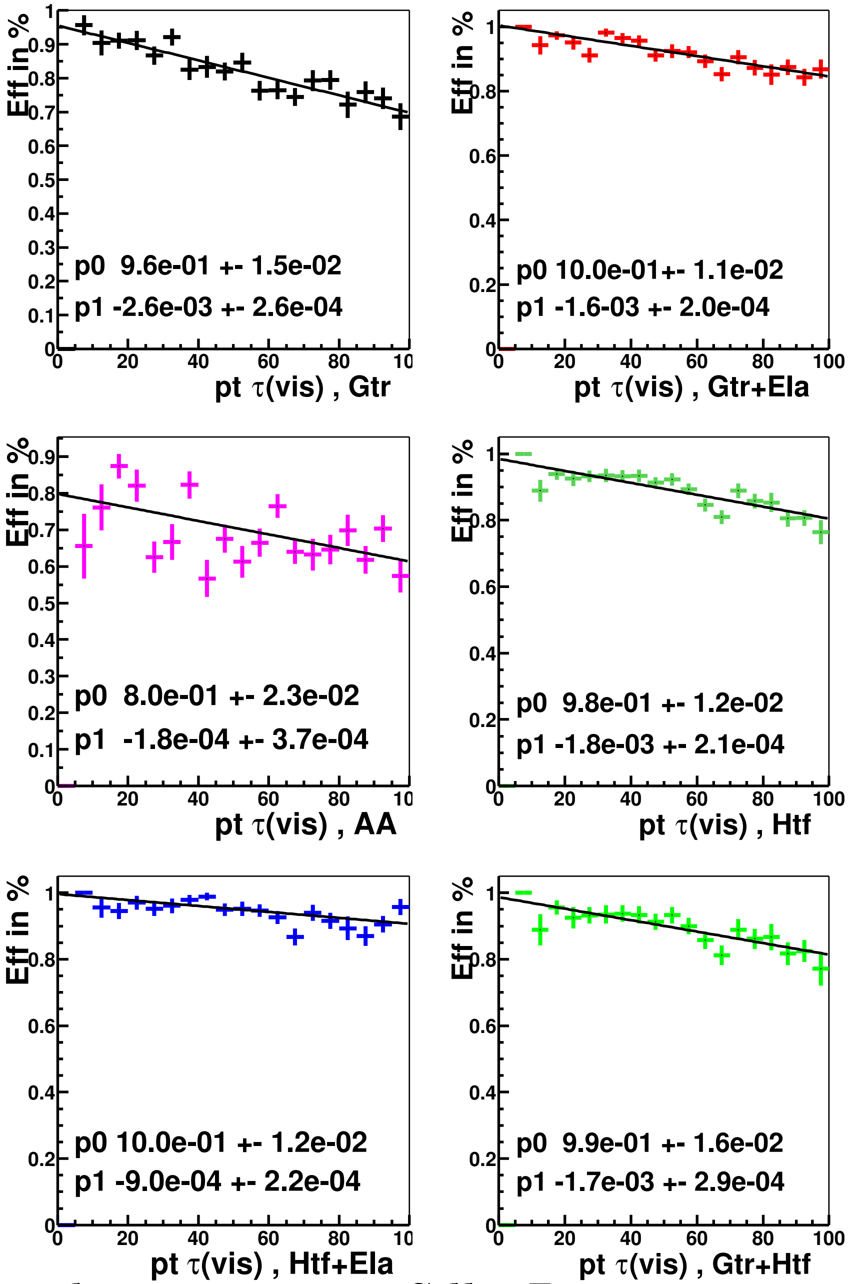
For other algorithms, Htf has the highest efficiency (not enhanced by combination with Gtr)
running elastic reco after Htf (or Gtr) $\rightarrow$ +5%

the 3 prong efficiency is above 90% in the central region compared to 80% in p10 (70% before that)

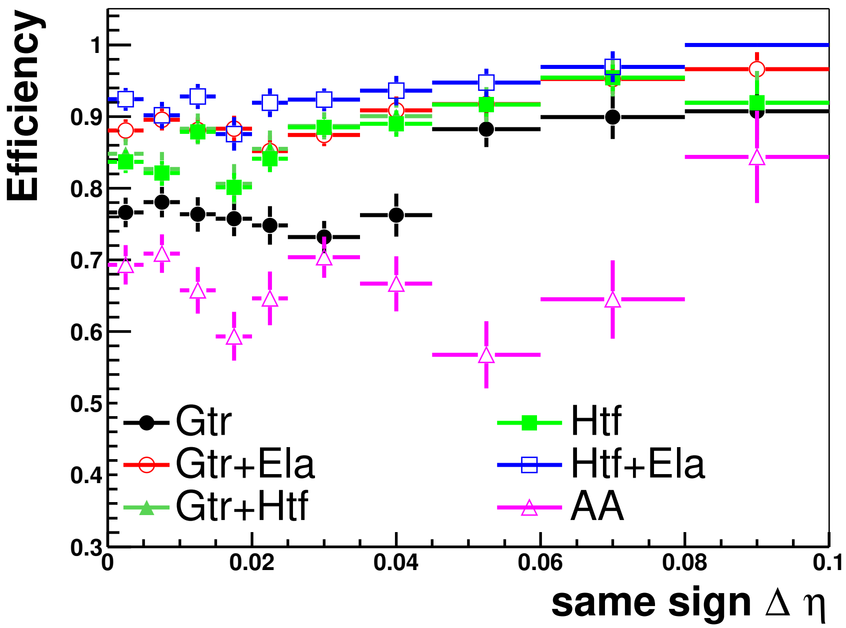
Tracking efficiency versus τ pT + fits

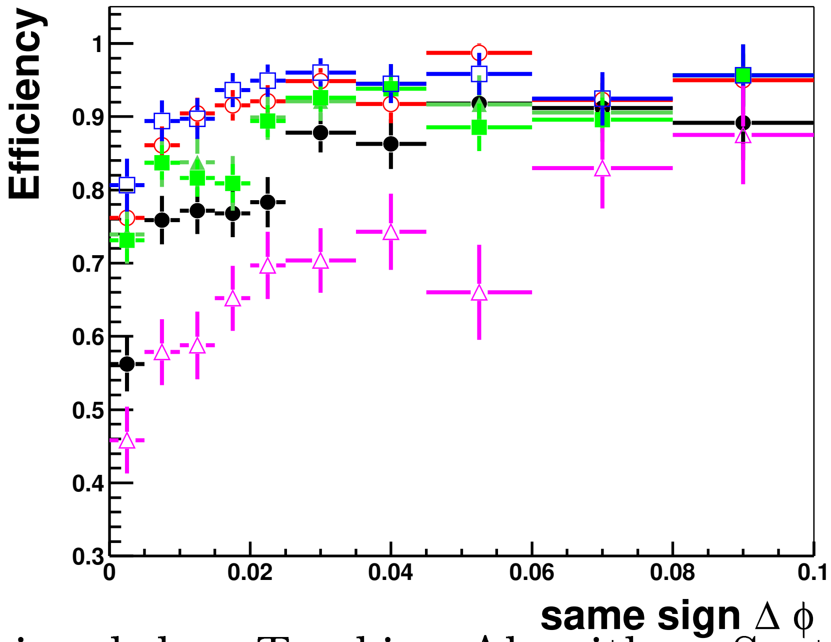






Tracking efficiency versus ΔR (3prong)



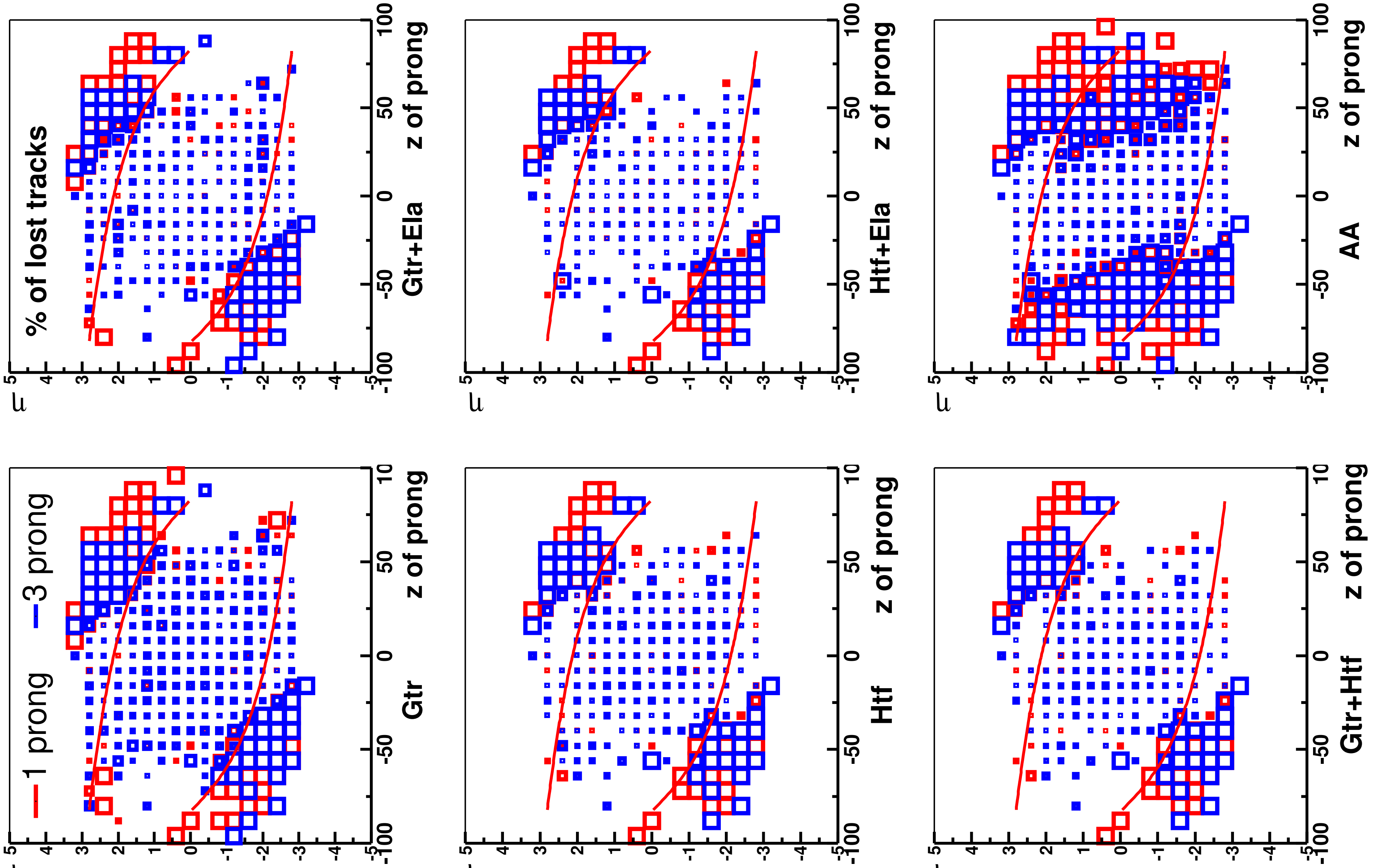


considered are tracks in 3 prong τ decays
within the CFT acceptance

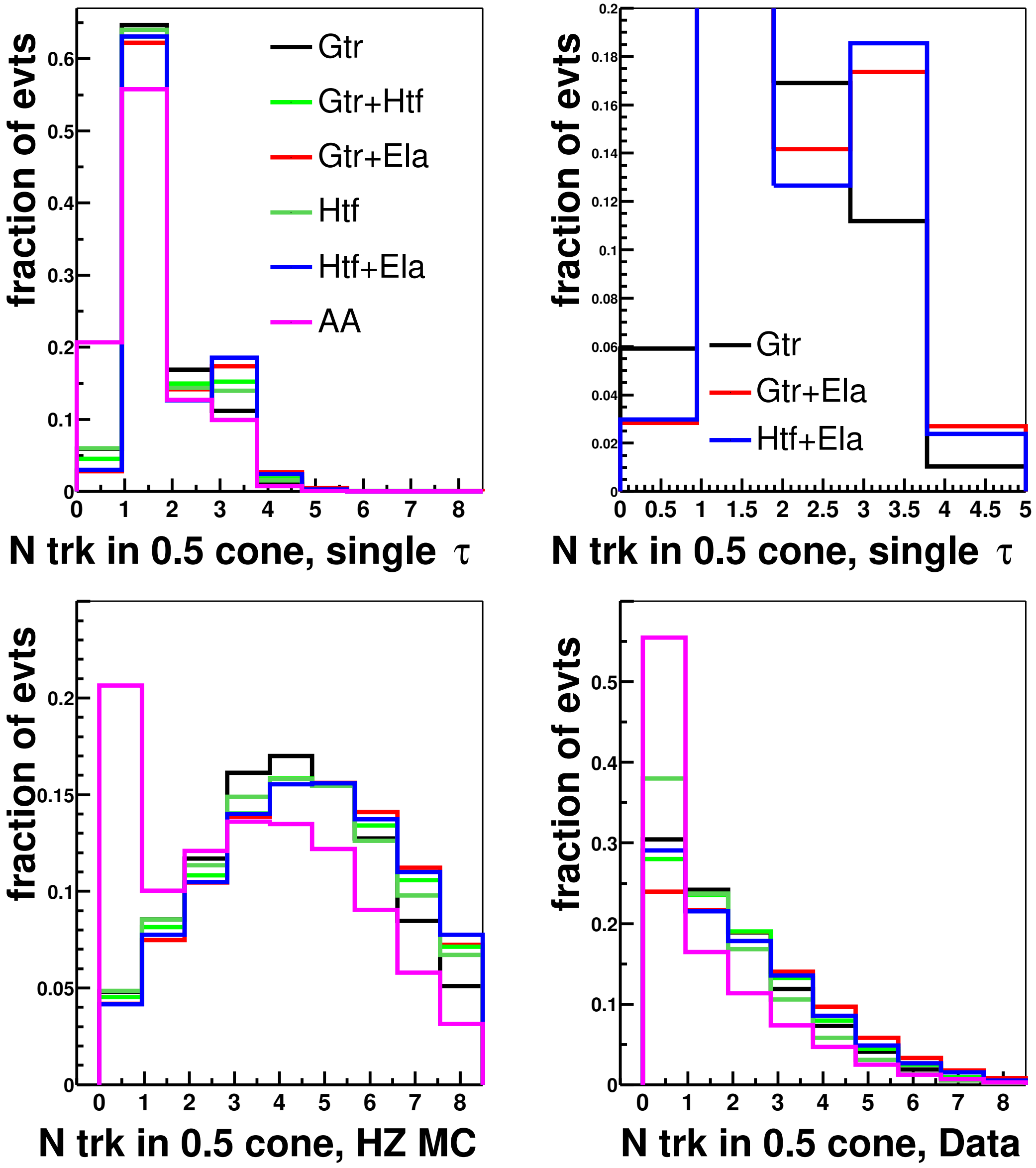
$\Delta\eta, \Delta\phi$ taken at DCA
same sign requirement so that track "stay close"

Tracks very close in space are more difficult $\longrightarrow$ lower efficiency for small $\Delta\phi$ for all algorithms

Lost tracks in η-Z



Number of matched track in background events

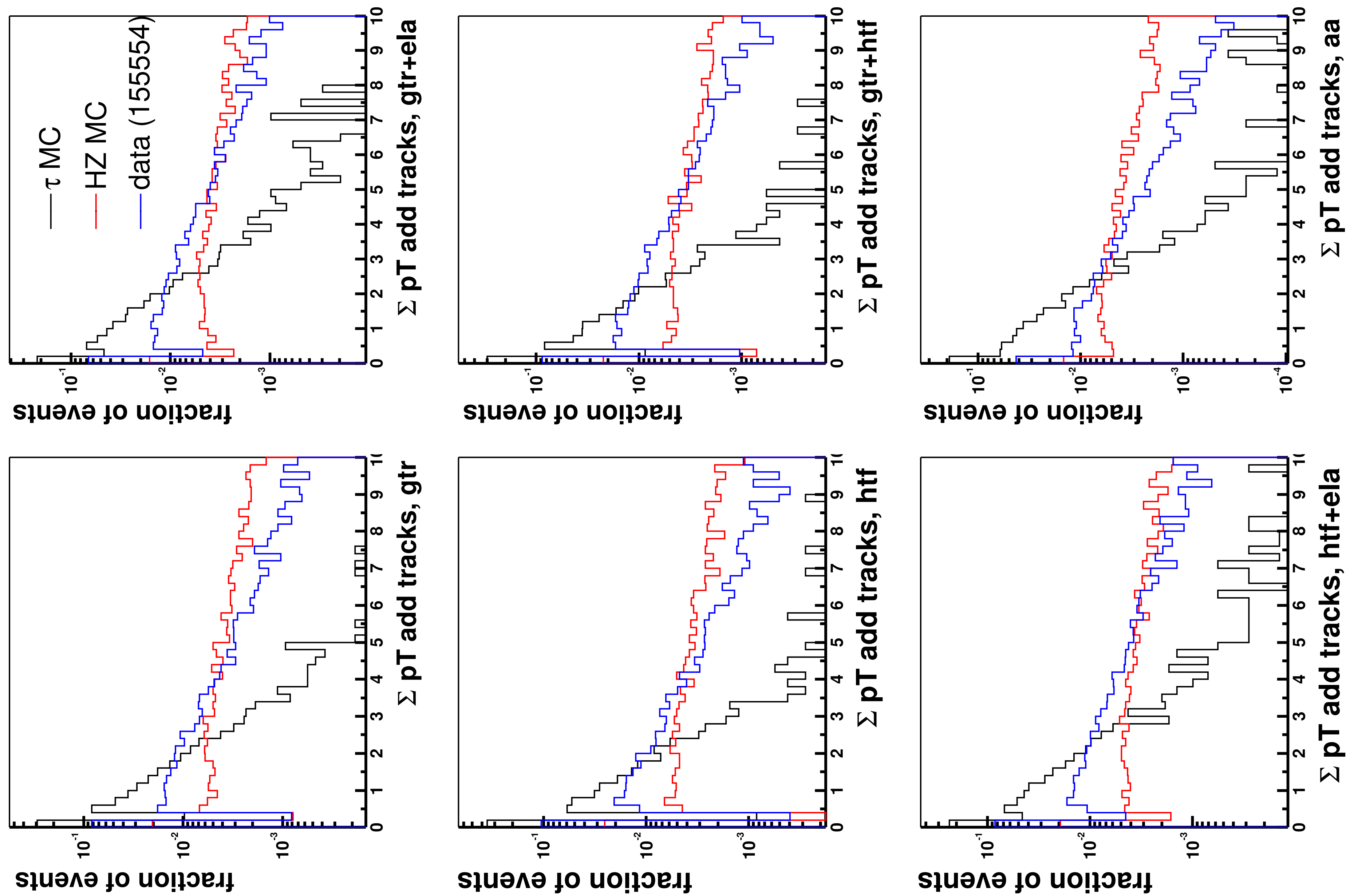


track pT>1, |detη| of τ candidate < 1.5

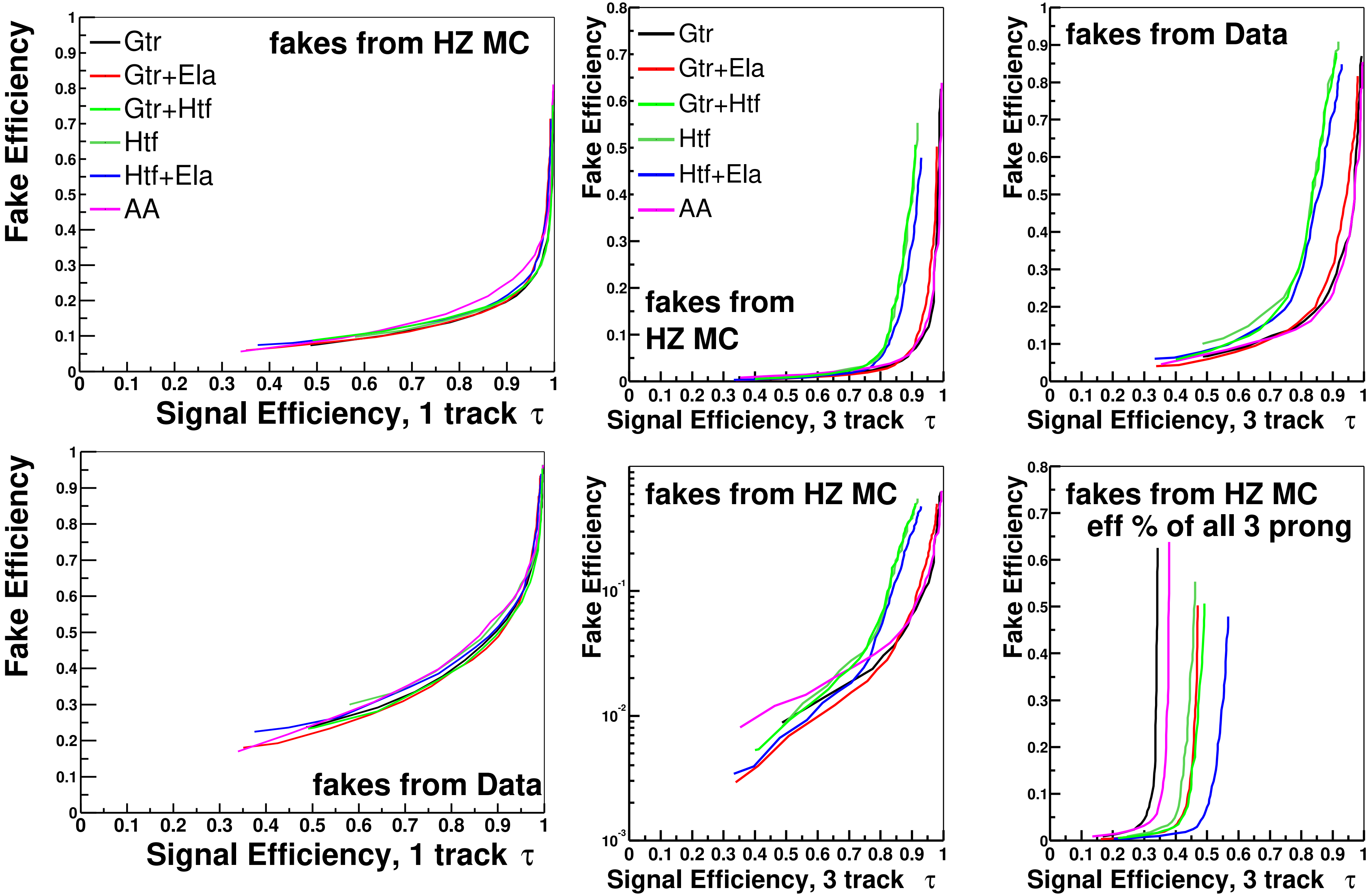
AA has a considerably lower efficiency as the other algorithms for both b-jets in MC and Data (Run 155554)

The higher efficiency for Htf combined with elastic reco compared to the other algorithms is not visible for Data
Htf+Ela is the only algotrithm with a visible 3 prong

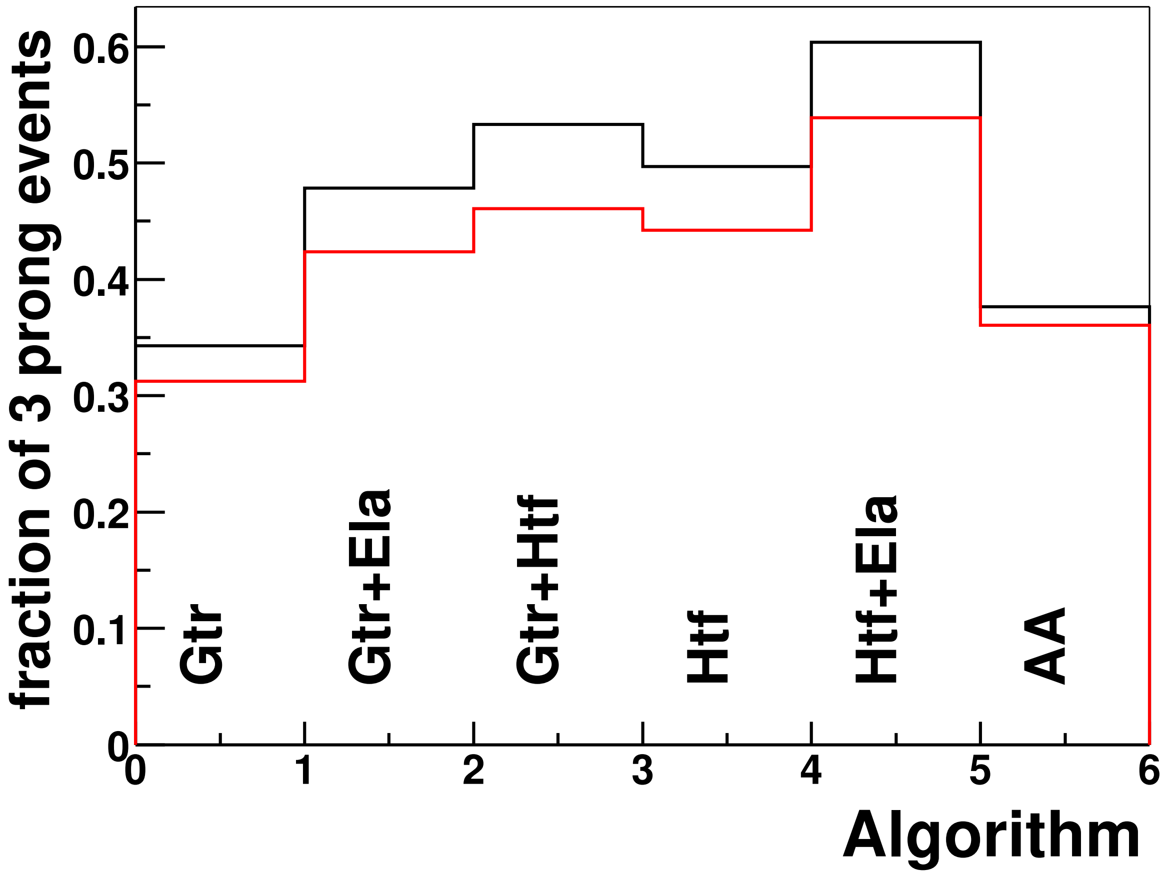
ΣpT of additional tracks in 0.5 cone - 1 track

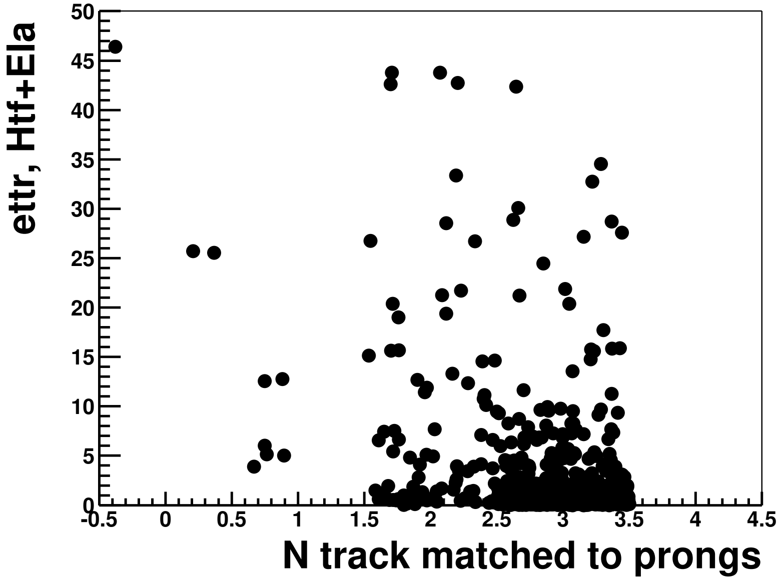


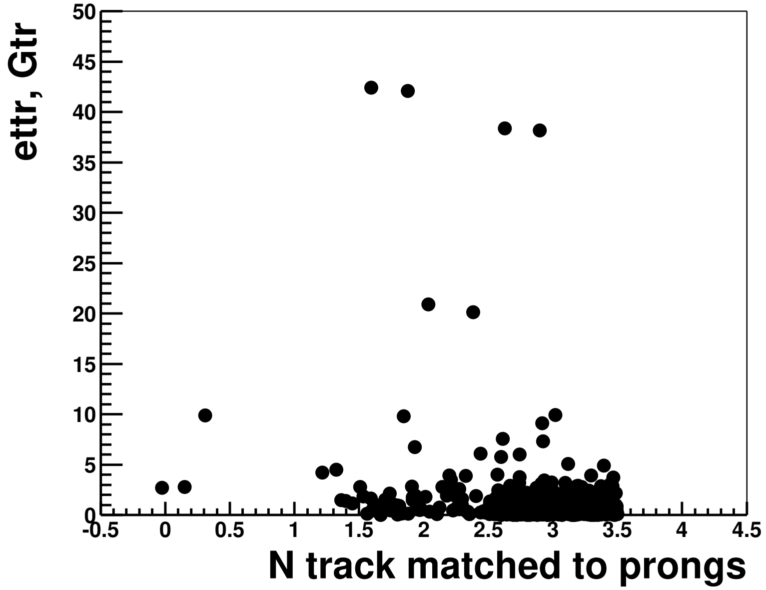
ΣpT of additional tracks in 0.5 cone



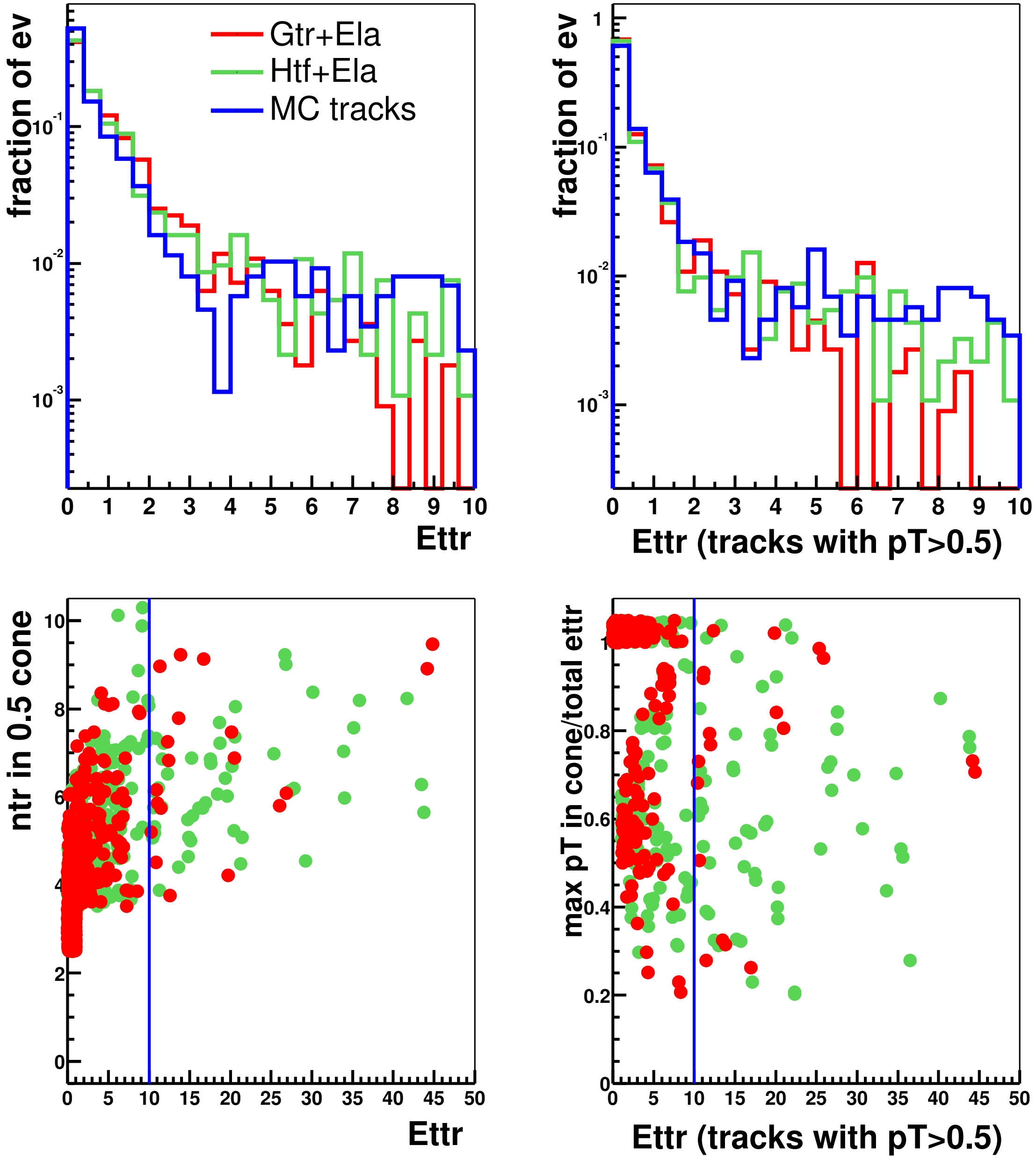
High ettr events - wrong matches?



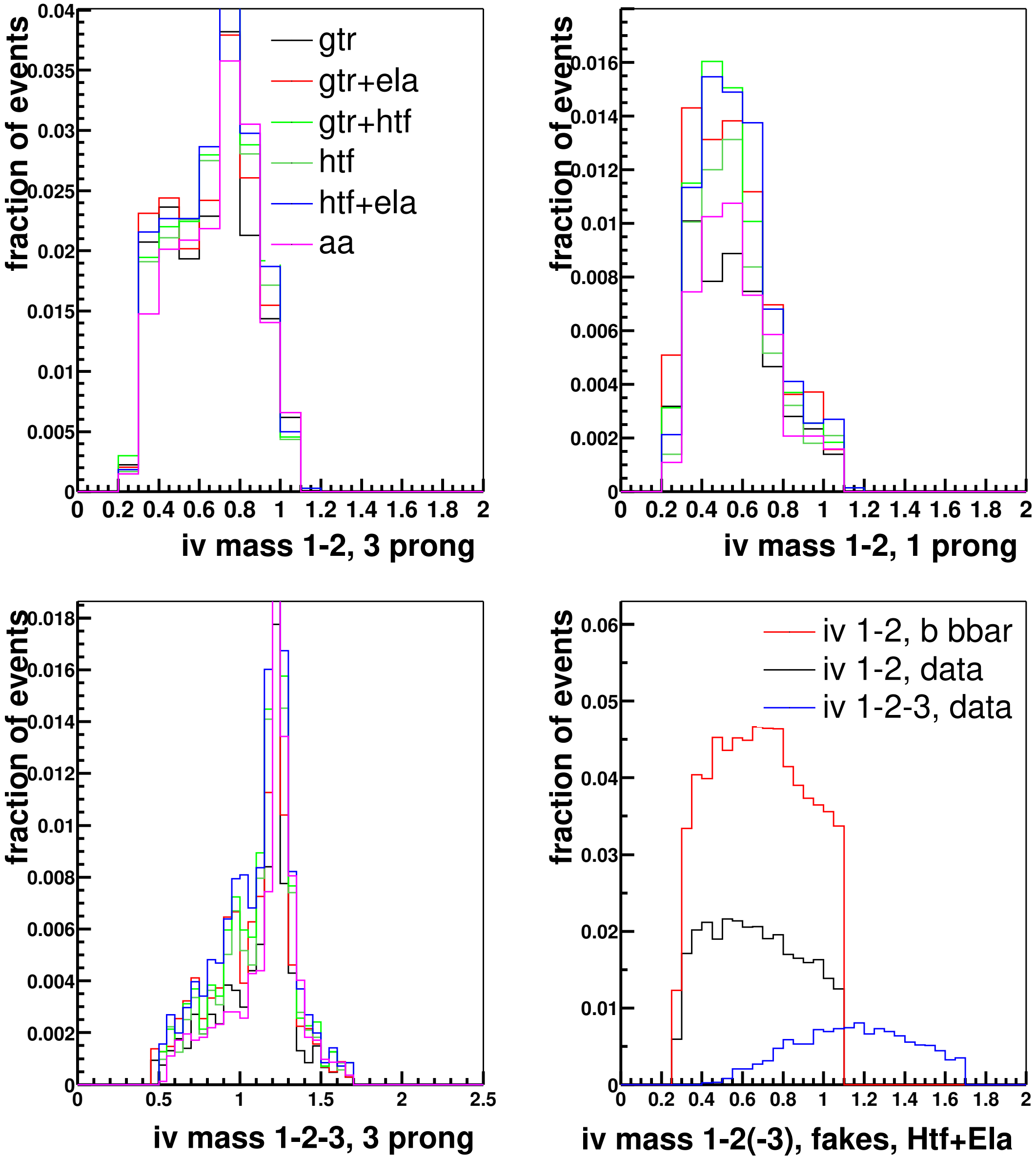




ΣpT of additional tracks in 0.5 cone - High ettr events



The invariant masses of the matched tracks



The signal invariant mass distributions are undistinguishable for all tracking algorithms

Summary

- 1-prong efficiencies 98% (central, all algorithms except AA)
  whole region: 90% best (Htf+Ela)
- 3 prong efficiencies 93% central, 85% while region,
  Htf+Ela best, gain 8% over Gtr alone
- fraction 1 prongs as 1 prongs: 81%
  fraction 3 prongs as 3 prongs: 60%
- for found tracks: invariant mass of $\boldsymbol{\tau}$ tracks similar for all algorithms
- number of matched tracks in background events:
  b-Jets (MC): mostly 3 tracks, AA+Gtr less tracks
  Data: falling distribution, steper for AA
- rejection of QCD: use $\boldsymbol{\Sigma pT}$ add. tracks in 0.5 (ettr)
  Data + b-Jets: similar rejections for ettr on 1-track candidates