Study on L2 FTK efficiency and rejection

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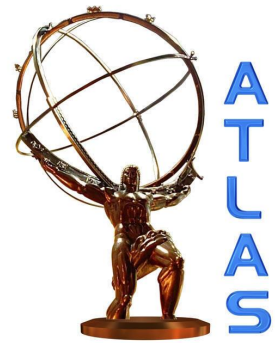


Overview

- TDR validation of FTK track multiplicity;
- ΔR distribution to assess the ΔR cuts used in matching, signal cone, isolation cone;
- Efficiency in τ-truth to L1RoI matching;
- Signal trigger efficiency on $H \longrightarrow \tau(h)\tau(h)$ and $H \longrightarrow \tau(l)\tau(h)$ samples;
- Background efficiency based on samples of $WH \longrightarrow l\nu qq$.

As a first step we are trying to reproduce TDR results and as further we will try to improve the fake rejection keeping a high efficiency.

Data samples

Signal ($VBFH \longrightarrow \tau\tau \longrightarrow hh$)
eos/atlas/user/v/vcavalie/VBFHR125hh_46_D3PD
Signal ($VBFH \longrightarrow \tau\tau \longrightarrow lh$)
eos/atlas/user/v/vcavalie/VBFHR125lh_46_D3PD
Background ($WH \longrightarrow qq$)
eos/atlas/user/v/vcavalie/WHuu_46_D3PD

TDR validation: offline τ-based selection details

No look at L1RoI information

Offline τ selection

- JetBDTSigMedium
- $P_T > 20$ GeV
- $|\eta| < 2.5$
- Veto on Leading track is in crack region ($1.37 < |\eta| < 1.52$)

Tracks selection

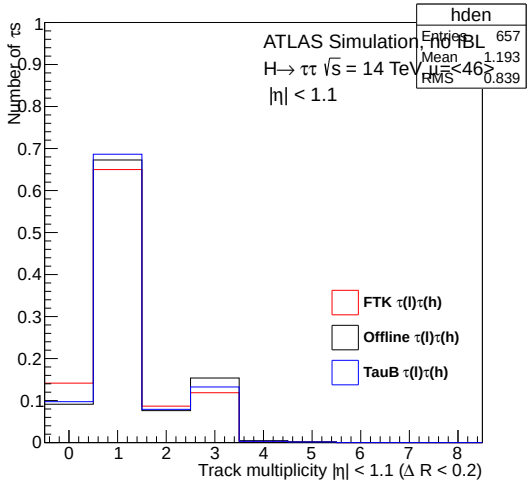
- $P_T > 2$ GeV
- $d_0 < 1.0$ mm
- $z_0 < 100$ mm
- (offline) (nPixHits + nPixelDeadSensors + nSCTHits + nSCTDeadSensors)> 8
- (offline) nPixHoles = 0
- if leading track exists Δz_0 (z_0 difference from leading track z_0) < 2.0 mm
- ΔR is from direction of the offline τ

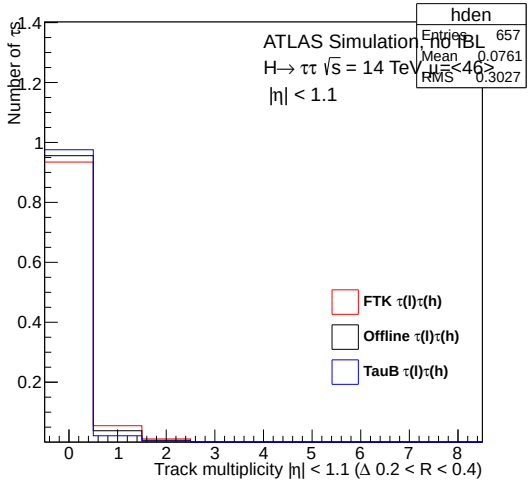
Using samples $\tau(l)\tau(h)$, background $HW \rightarrow uu$.

TDR validation: FTK multiplicity

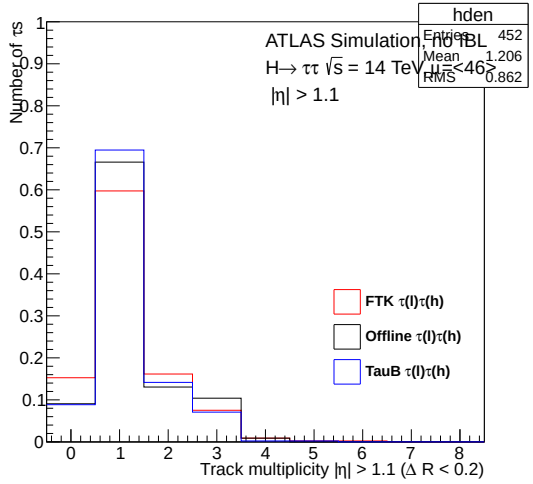
On the top – signal cone, on the bottom – isolation ring

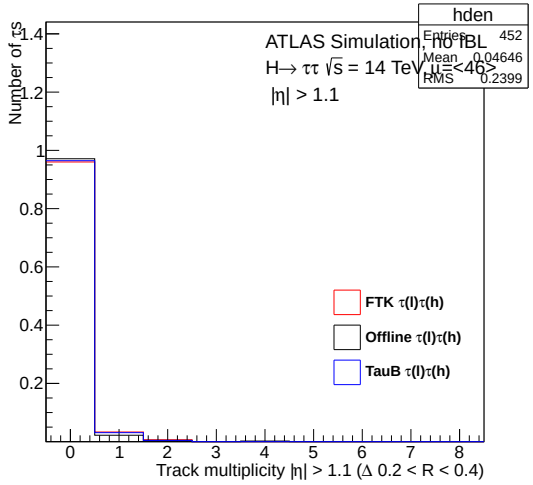
barrel





endcap





These distributions are the same in 3 validation groups. It was starting point of this study.

L1RoI: selection details

What we do:

1. for each L1RoI (named 'HA8') match FTK leading track in $\Delta R < 0.2$;
2. for each matched leading FTK track search for FTK tracks in $\Delta R < 0.1$ (signal cone) and $0.1 < \Delta R < 0.3$ (isolation ring);
3. L1RoI is also matched with $\Delta R < 0.2$ to τ-objects (tau_ and tau_jet) to allow pT dependence study;
4. Signal samples: L1RoI matched to true τ-s with $\Delta R < 0.2$.

Containers

- trig_L1_emtau_
- trig_L2_trk_Ftk_tau_
- trueTau_
- tau_
- tau_jet_

LeadFTK track selection

- Matched w/ L1_Roi('HA8') in $\Delta R < 0.2$
- $P_T > 2$ GeV
- $d_0 < 2.0$ mm
- $z_0 < 150$ mm

FTK tracks selection

- same as for LeadFTK
- Δz_0 (z_0 difference from leading track z_0) < 2.0 mm
- if no LeadFTK found use direction of L1RoI

τ selection

Used for offline and truth τ-s.

- $p_T > 8$GeV/c
- $|\eta| < 2.49$

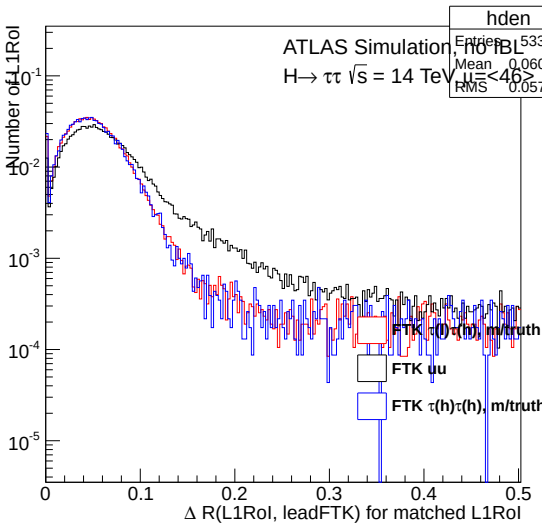
Changing from FTK-TDR

- Sometimes used "L1_TAU8" variable, which is event bool variable
  Use trig_L1_* objects information which satisfy HA8. And trig_L2_* is connected trig_L1_* using RoI information.
- Used L2RoI direction for counting #tracks → Use L1RoI direction
- Used ΔR^2 matching → Use square root and ΔR matching
- Used tau_jet_* variables for BKG efficiency
  → Use tau_ variables for also estimating efficien cy plots.
- Used definition for BKG efficiency
  $Bkg\ eff\ 1(3) = \frac{Denominator\ \&\&\ pass\ L2\ \&\&\ nTrk{=}1(3)}{Pass\ L1\ \&\&\ not\ truth\ match\ \&\&\ jet\ match}$
  → now we keep the old definition and use new:
  $Bkg\ eff = \frac{Denominator\ \&\&\ pass\ L2}{Pass\ L1\ \&\&\ not\ truth\ match\ \&\&\ offline\ match}$

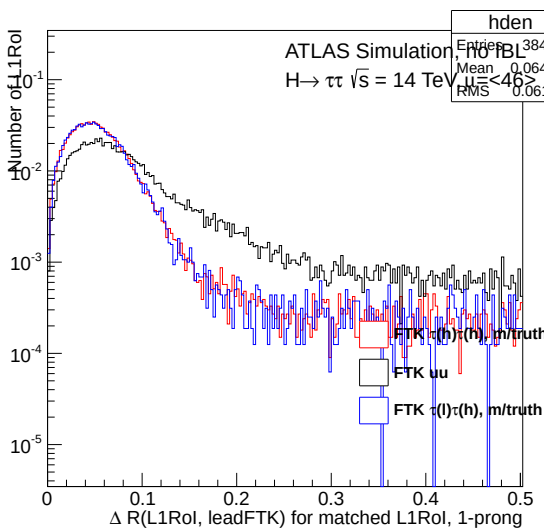
ΔR(L1RoI, leadFTK) - Checking the ΔR cut for leading FTK to L1RoI matching

Angle between matched L1RoI and leading FTK

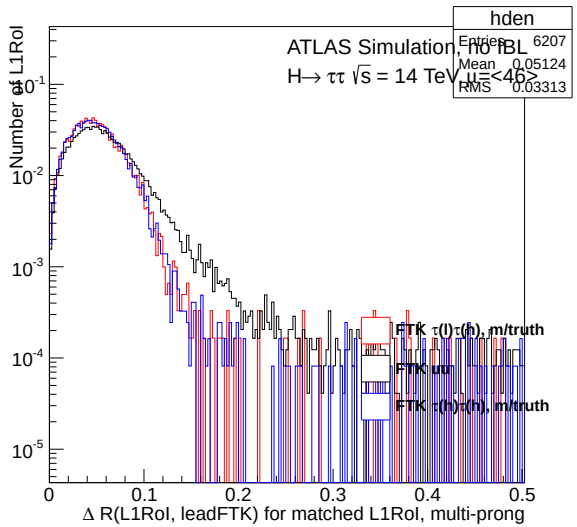
inclusive



1-prong: SigConeFTK=1



multi-prong
SigConeFTK=2,3

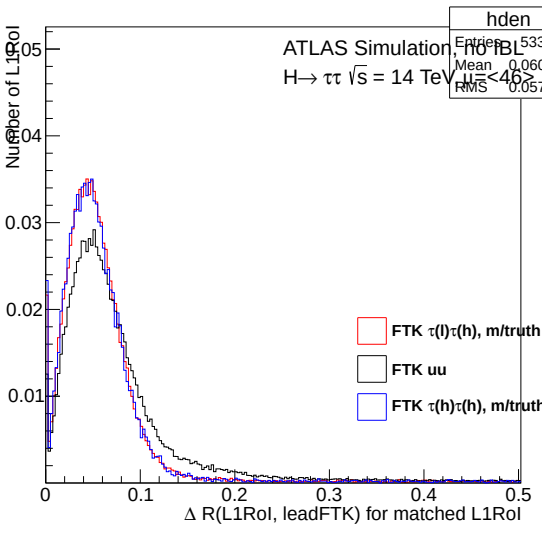


Distributions of ΔR for background a little bit wider. The value of $\Delta R = 0.2$ is maybe even too large.

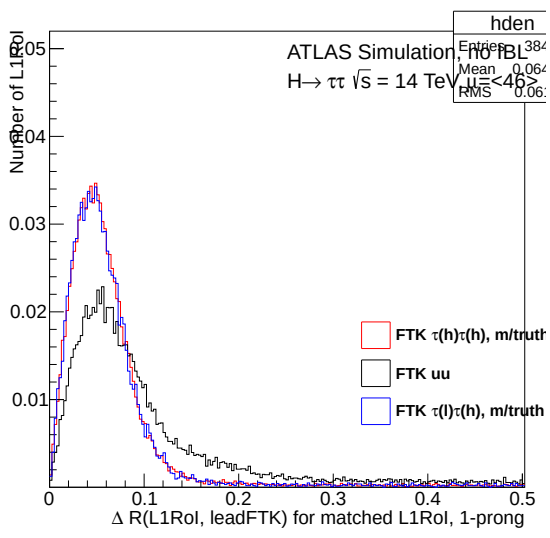
ΔR(L1RoI, leadFTK) - Checking the ΔR cut for leading FTK to L1RoI matching

Same plots as in previous page but in linear scale - Angle between matched L1RoI and leading FTK

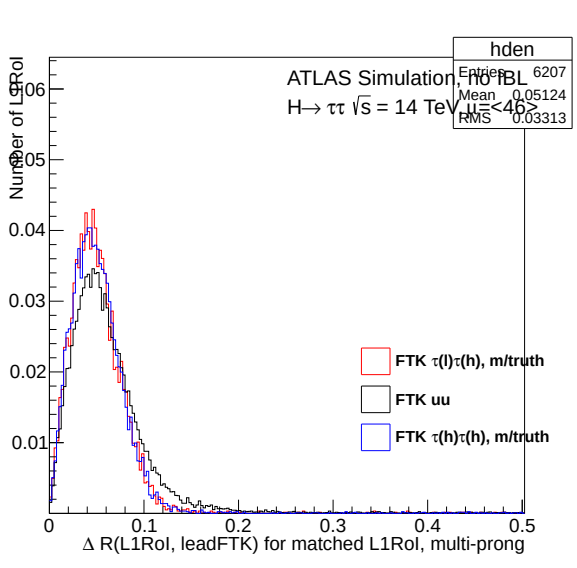
inclusive



1-prong: SigConeFTK=1



multi-prong: SigConeFTK=2,3

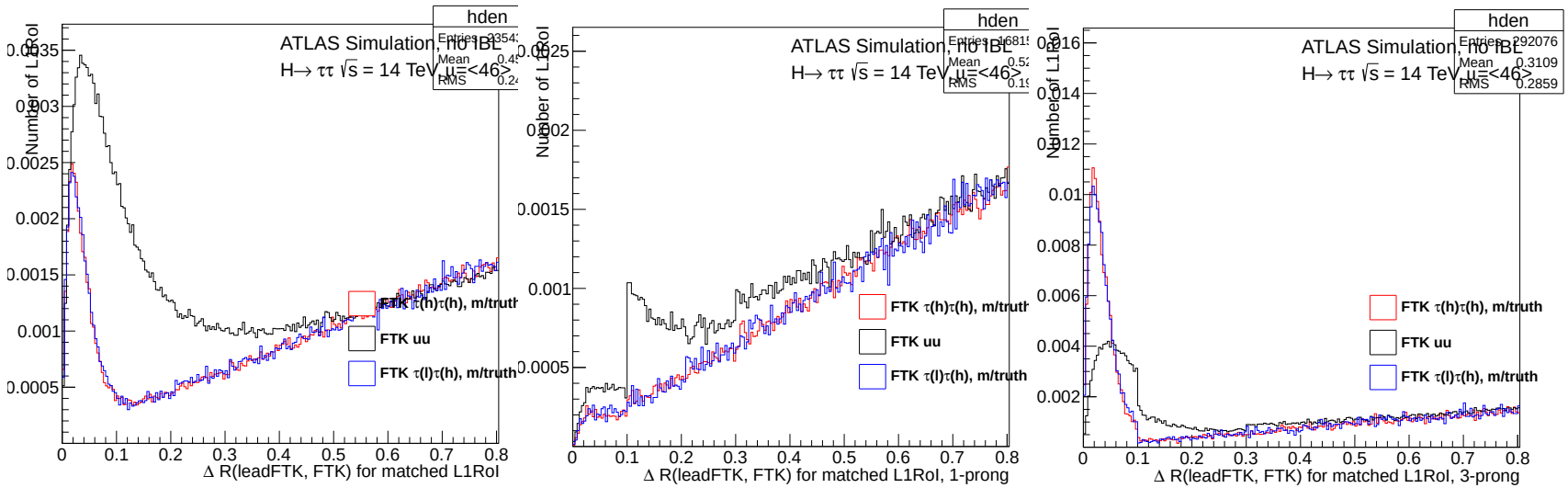


ΔR(leadFTK, FTK)

Angle between leading FTK and any FTK for matched L1RoI

Is signal cone well defined ?

inclusive 1-prong multi-prong

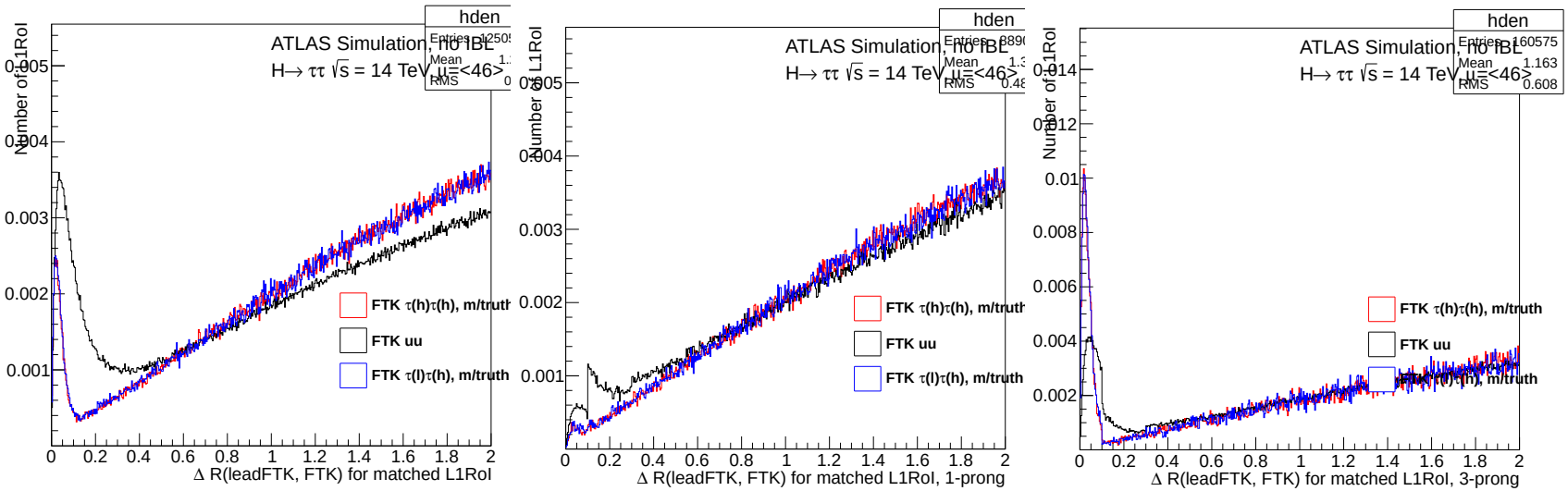


- In case of background the distribution is wider. The signal cone definition with $\Delta R < 0.1$ is good.
- For the 1/3 prong we have some signal (peak at low DR) where the signal is not defined as 1 prong because of the selection criteria in isolation cone: < 2 trks in isolation ring.

ΔR(leadFTK, FTK) - continued

Angle between leading FTK and any FTK for matched L1RoI - wide range

inclusive 1-prong multi-prong



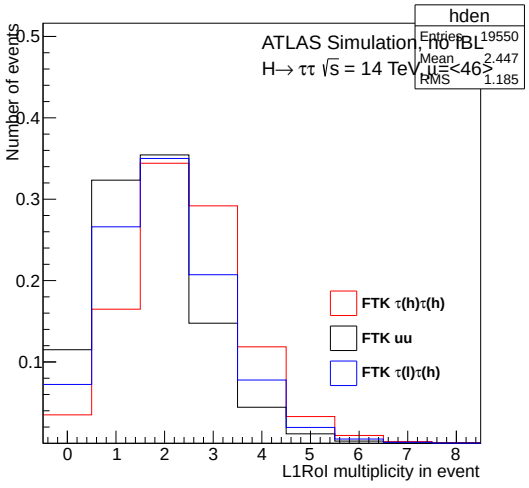
Previous plots in wide angle range.

The method

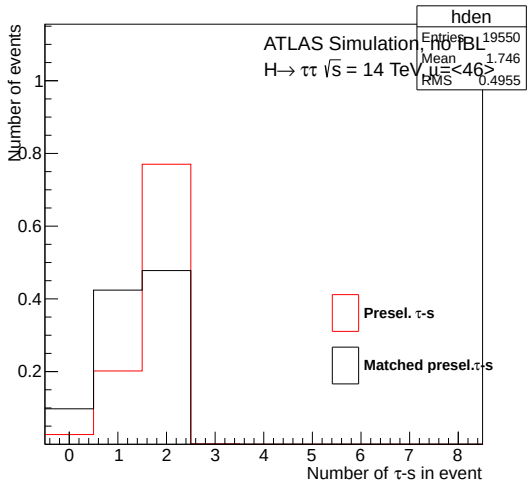
- Goal: estimate the efficiency of L1 HA8 triggering on tau in $H \rightarrow \tau(h)\tau(h) events$;
- Use HA8 a L1 trigger, datasample: VBFHtt125hh_46_D3PD;
- Approach: loop over true taus in events and find the L1RoI within $\Delta R < 0.2$ of true tau direction;
- Tau preselection: $p_T(\tau) > 8 GeV$, $|\eta(\tau)| < 2.49$.

Number of true taus in events

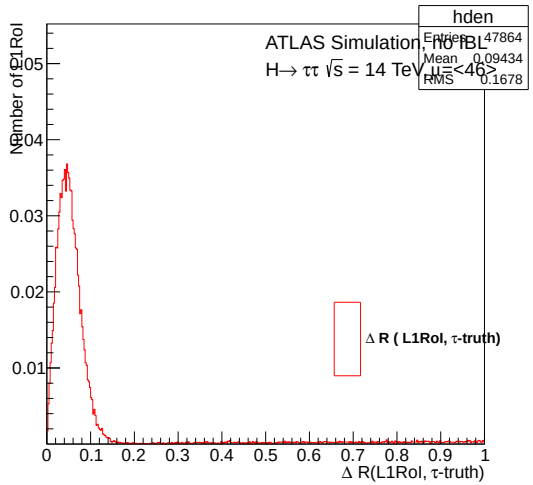
Number of L1RoI in event



Number of preselected τ-s in event



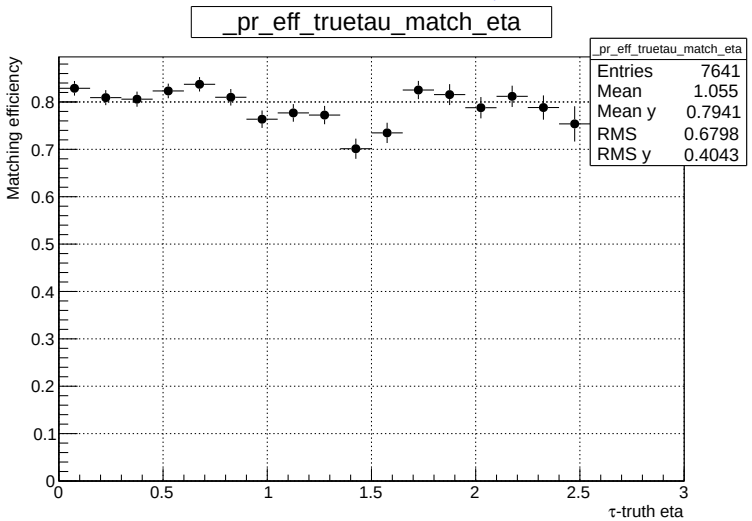
Why no matched? ΔR?



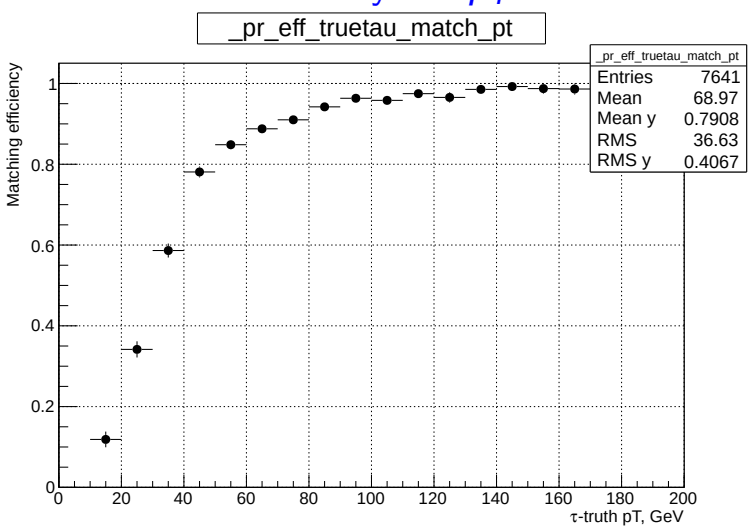
- Total number of true τ-s passing preselection: 90%;
- Total number of events with no true τ-s passing preselection: $\sim$3%;
- Total number of events with no L1RoI matched to true τ-s: $\sim$10%;
- Total number of preselected true τ-s matched to L1RoI: 78%;
- Why no matched? The ΔR distribution between true τ and the nearest L1RoI (right) shows that $\Delta R < 0.2$ for matching looks reasonable.

Efficiency VS η, p_T

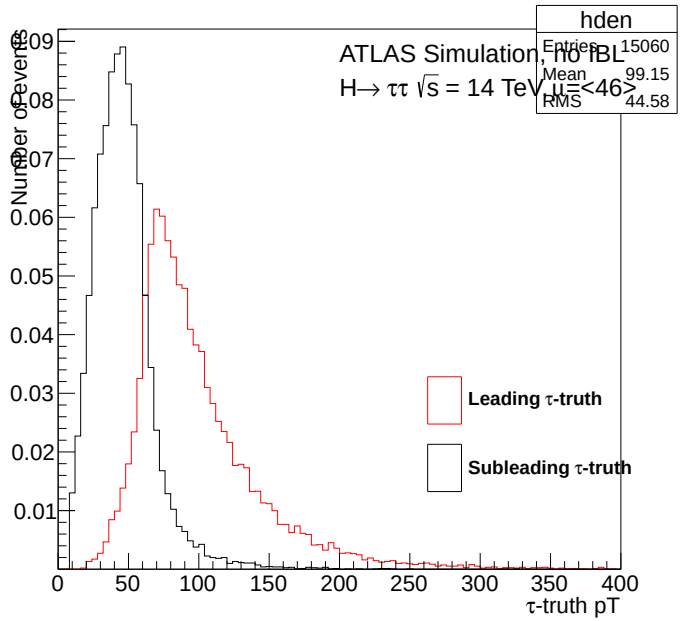
Efficiency VS η



Efficiency VS p_T



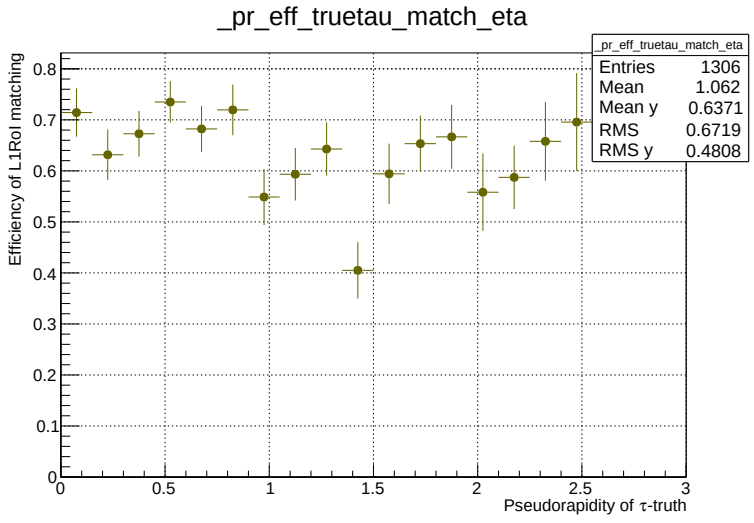
p_T for lead and 2nd τ-s



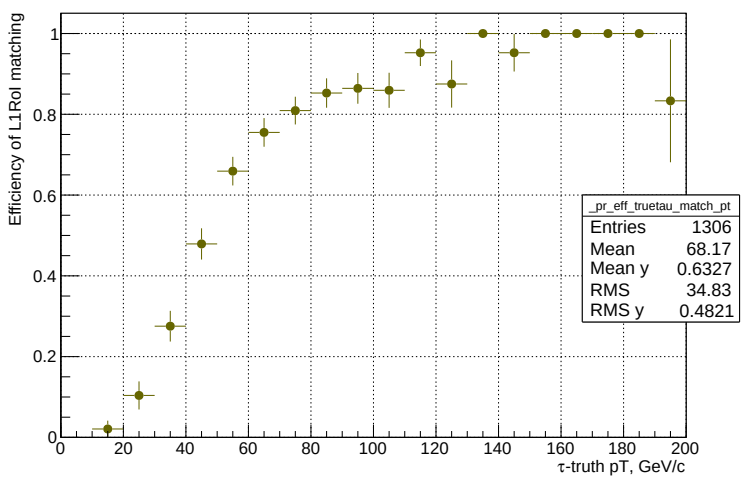
- Efficiency: # preselected true-τs && matched to L1RoI / # of preselected true-τs;
- η: moreless uniform distribution, slightly expressed crack-region;
- p_T: very dependant on p_T, smoothly arises, 80% of efficiency at 50 GeV/c;
- The matching inefficiency comes from the presence of low pT true τ-s.

Efficiency VS η, p_T: case of TAU15 trigger

Efficiency VS η



Efficiency VS p_T



- Total number of true τ-s passing preselection: 90%;
- Total number of events with no true τ-s passing preselection: $\sim$3%;
- Total number of events with no L1RoI matched to true τ-s: $\sim$18% (10%);
- Total number of preselected true τ-s matched to L1RoI: 64% (78%);

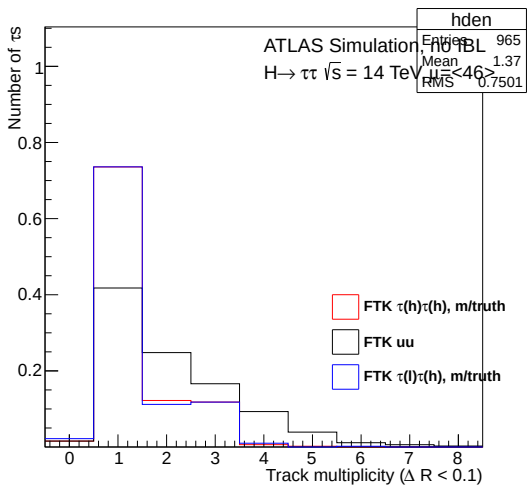
Number of FTK tracks: new L2 selection

The cone $\Delta R < 0.1$ around leading track is signal cone. The ring $0.1 < \Delta R < 0.3$ around leading track is isolation ring. Number of FTK tracks in cone and ring (nCone, nIso), respectively.

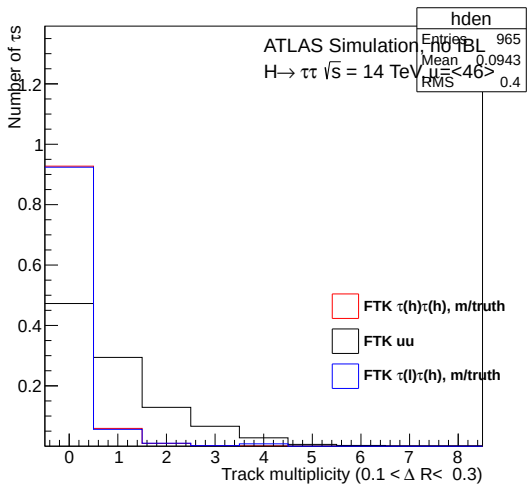
New L2 FTK selection

nIso < 2 and nCone $= 1$, 2 or 3 – 1-prong, 2-prong and 3-prongs correspondly.

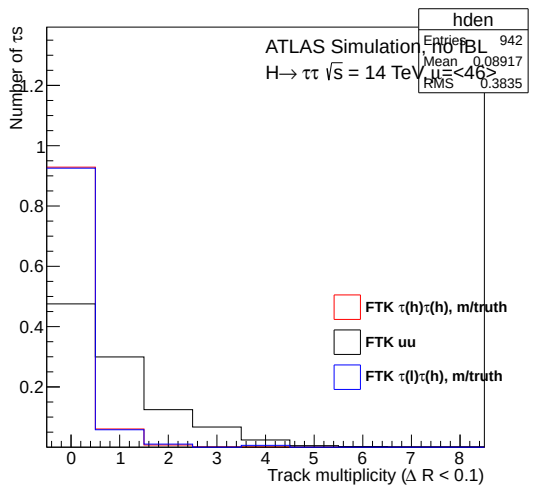
Signal cone $\Delta R < 0.1$



Isolation ring $0.1 < \Delta R < 0.3$



Isolation ring $0.1 < \Delta R < 0.3$ after applying cut on nSig



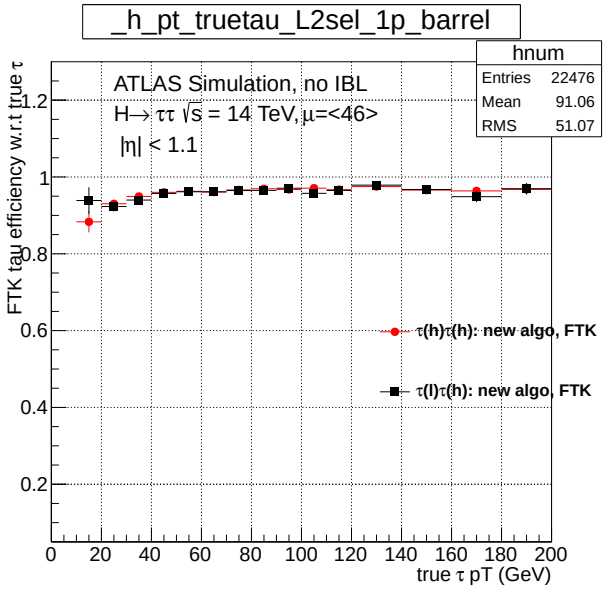
Efficiency and rejection

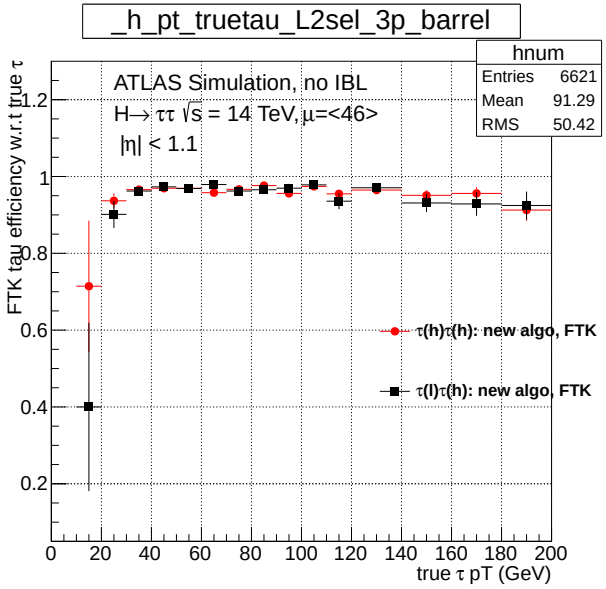
We determine signal efficiency as:
Sig 1p Eff = #(Denominator && L2 trigger) /
#(L1TAU8 objects && truth τ matched && true_tau_nProng=1)
Sig 3p Eff = #(Denominator && L2 trigger) /
#(L1TAU8 objects && truth τ matched && true_tau_nProng=1)
We determine background efficiency as:
Back Eff = #(Denominator && L2 trigger) /
#(L1TAU8 objects && not truth τ matched && offline τ matched)
Definition of rejection factor as in TDR is:
Jet 1p Eff = #(Denominator && L2 trigger && tau_jet_nTrack=1) /
#(L1TAU8 objects && not truth τ matched && jet τ matched)
Jet 3p Eff = #(Denominator && L2 trigger && tau_jet_nTrack=3) /
#(L1TAU8 objects && not truth τ matched && jet τ matched)
Jet Eff = #(Denominator && L2 trigger) /
#(L1TAU8 objects && not truth τ matched && jet τ matched)

Signal L2 efficiency w.r.t. true τ, barrel

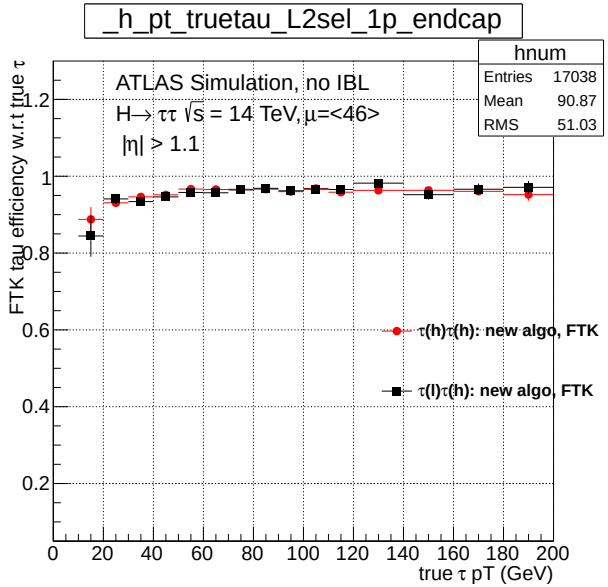
On the top – 1-prongs, on the bottom – 3-prongs events

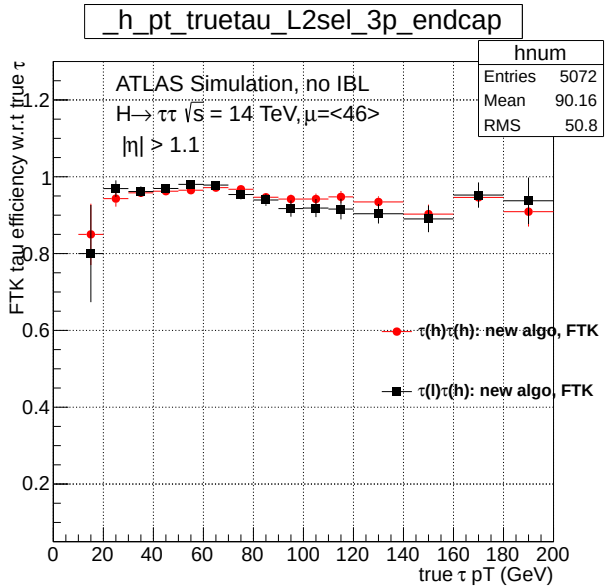
barrel





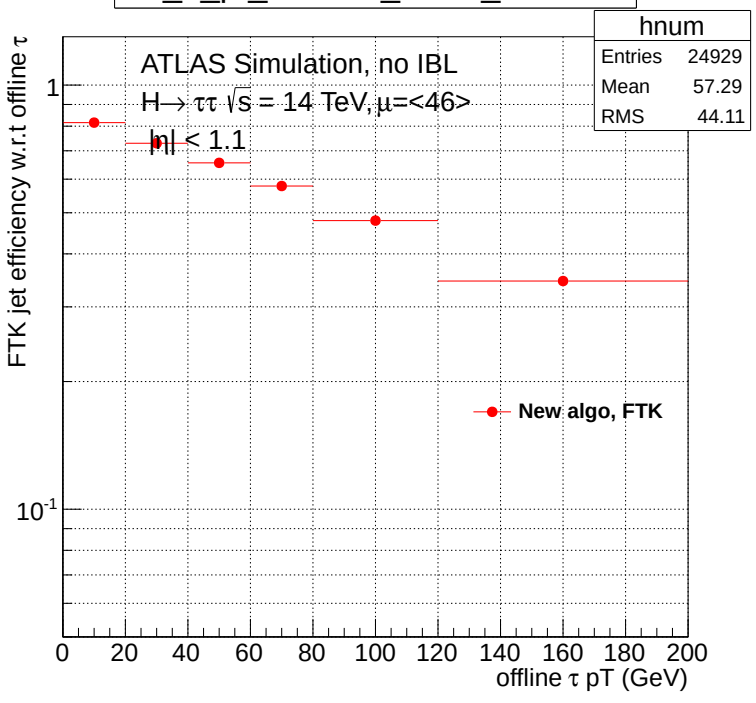
endcap



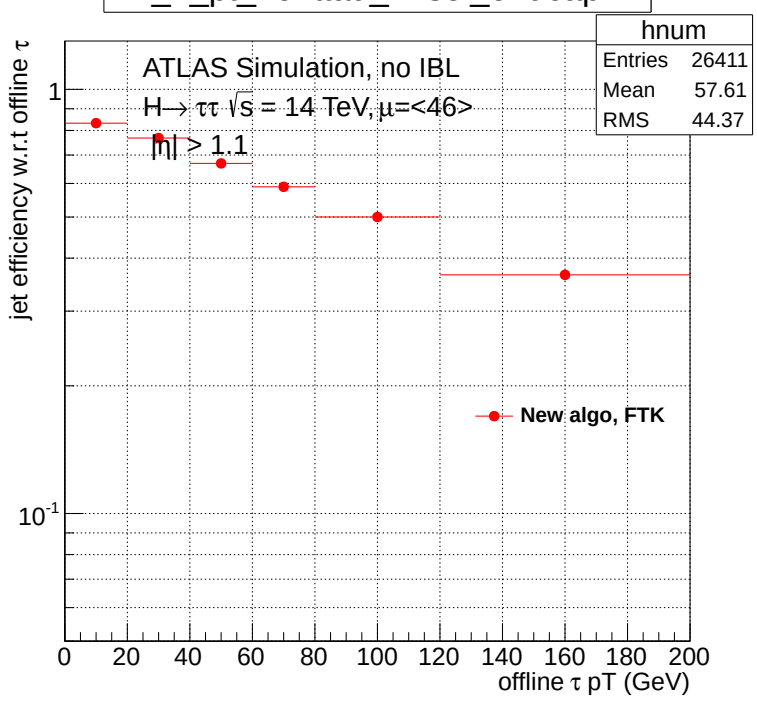


L2 background efficiency w.r.t. offline τ (tau_)

barrel



endcap

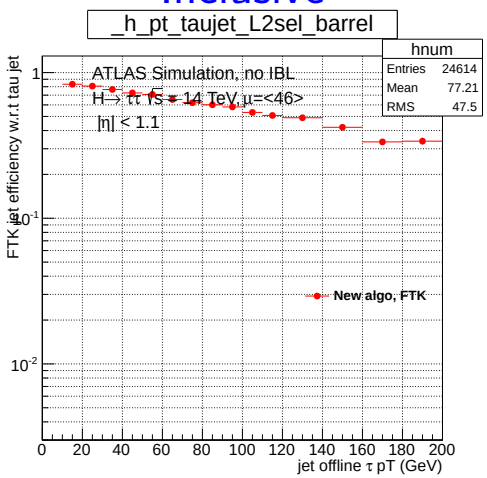


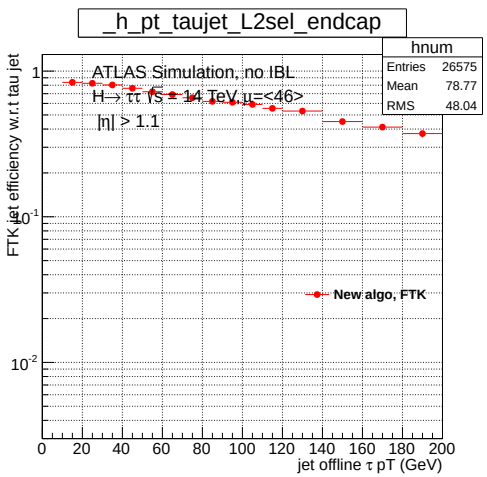
Bkg eff = #(Denominator && L2 trigger) /
#(L1TAU8 objects && not truth τ matched && offline τ matched)

L2 background efficiency w.r.t. offline τ jet (tau_jet_) – replication TDR plots

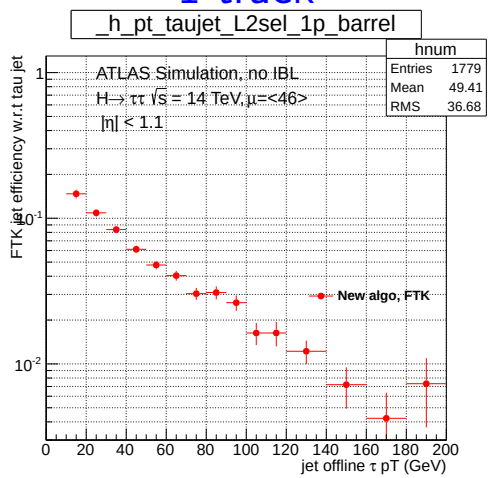
On the top – barrel, on the bottom – endcap

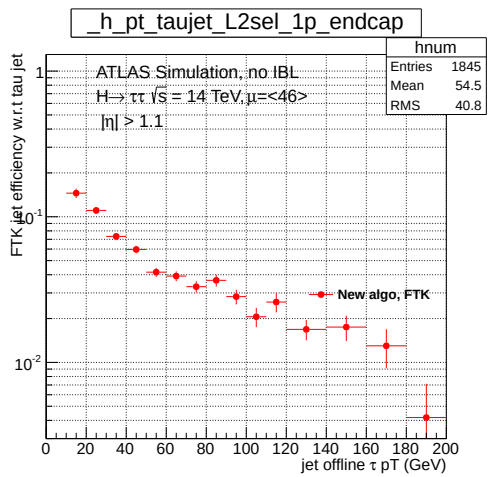
Inclusive



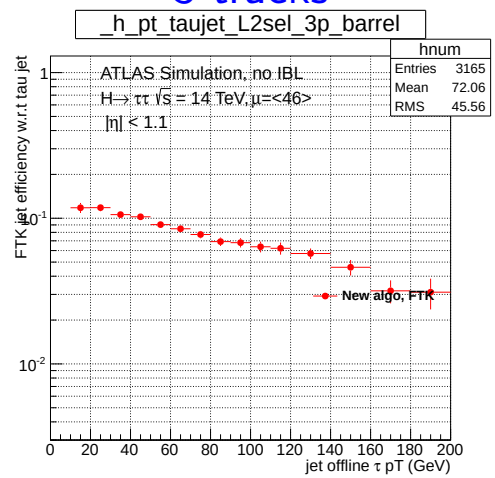


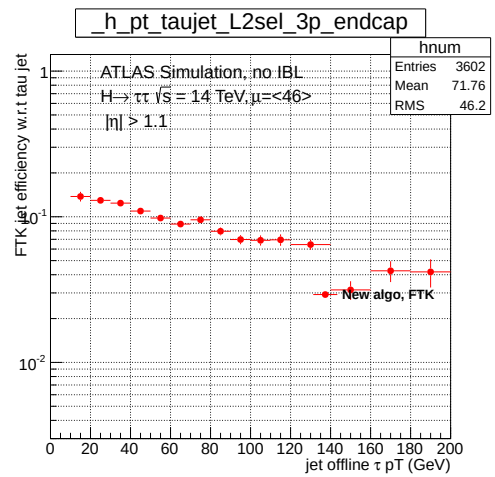
1-track





3-tracks



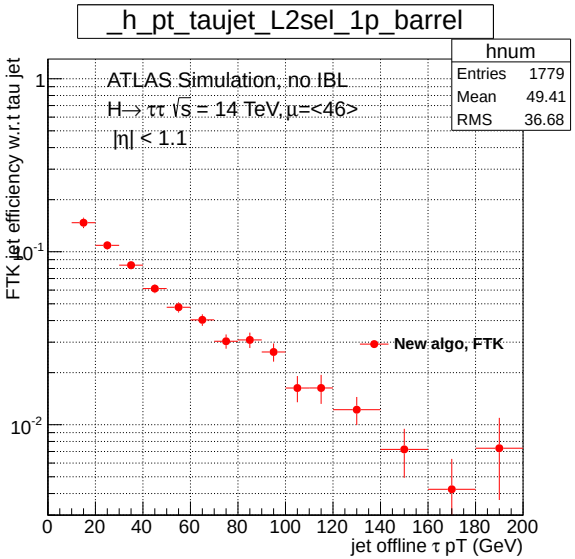


inclusive $\neq$ 1-track + 3-tracks

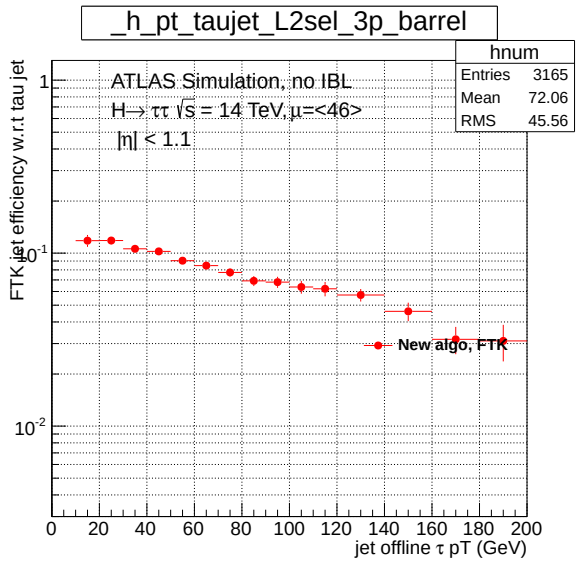
L2 efficiency w.r.t. offline τ jet, barrel: TDR comparison

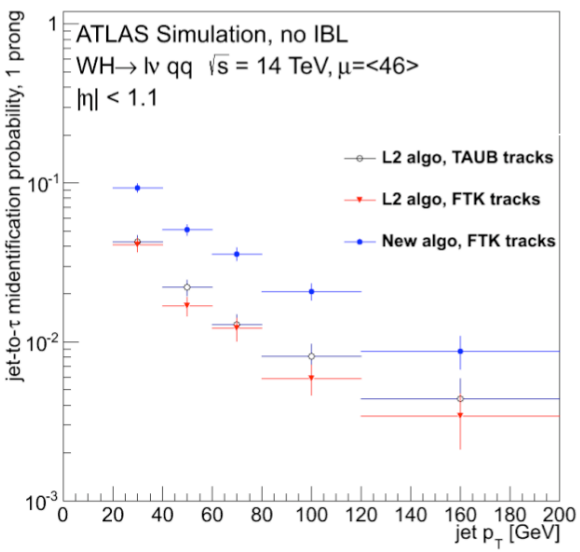
On the top – out result, on the bottom – TDR

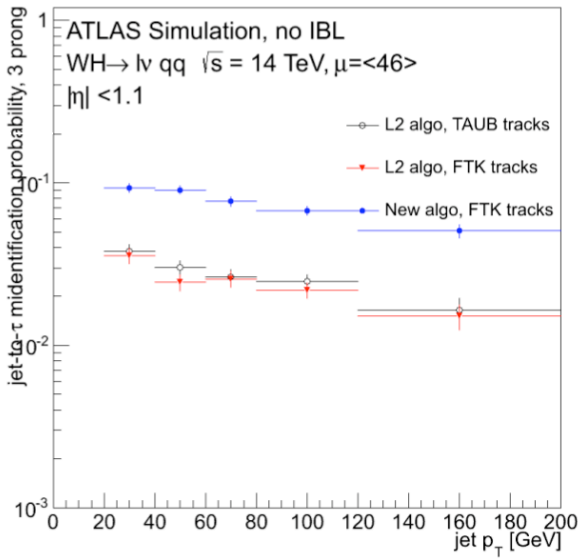
1-track



3-tracks



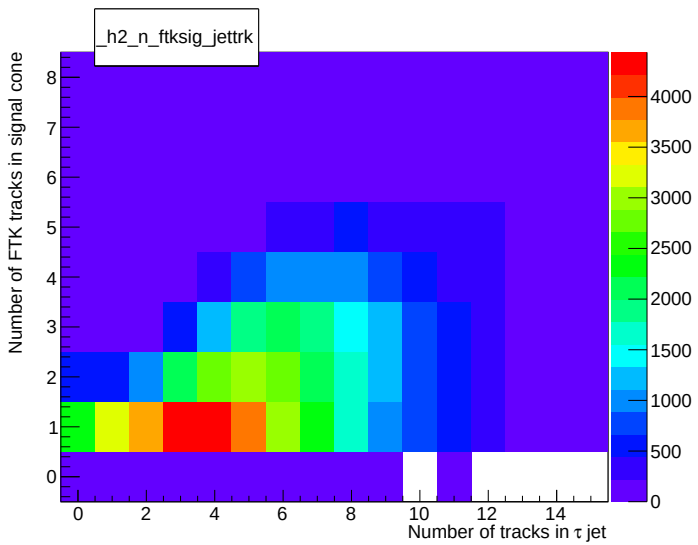




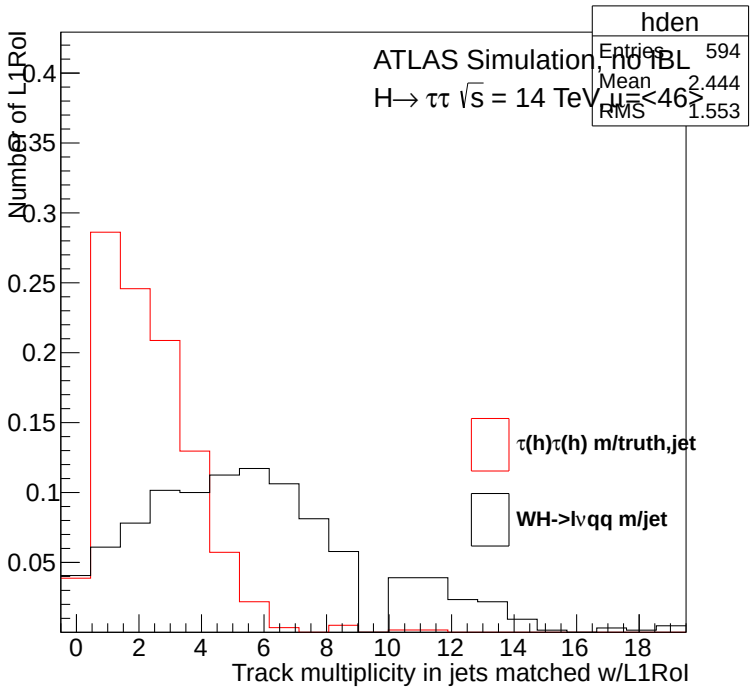
Relatively good agreement.

Tracks in jet VS FTKs in signal cone

Jet tracks vs #FTK in s. cone



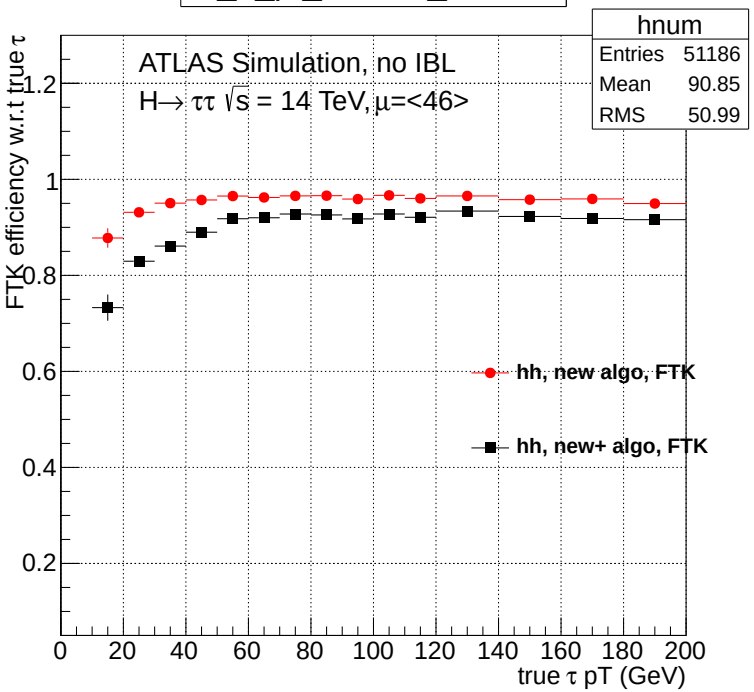
Tracks mult in jets



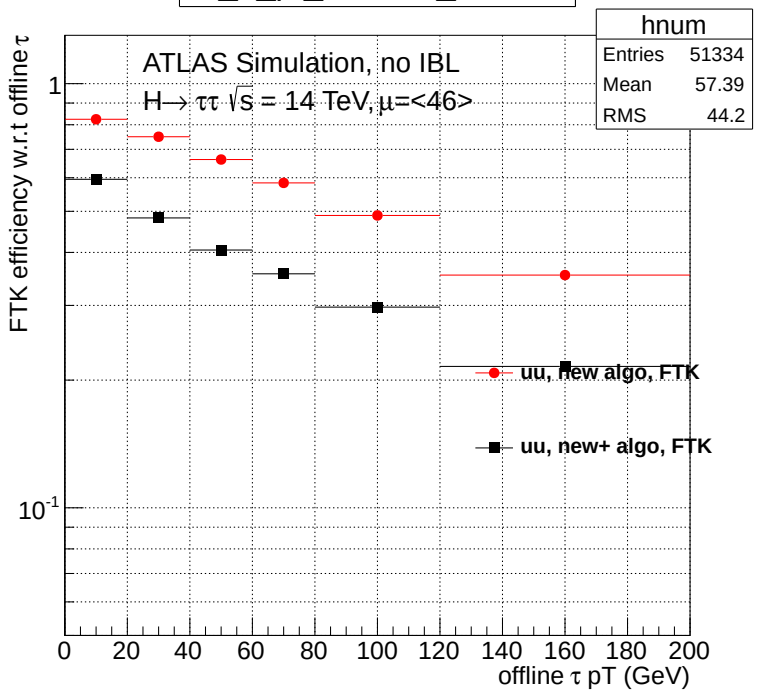
The number of tracks in jets (tau_jet_nTrk) and number of FTK in signal cone are quite different. The multiplicity of tracks in jets is higher, so the determination of 1/3 prong efficiency using tau_jet_nTrk to determine 1/3 prong categories is wrong.

An attempt to implement modified selection on FTK

signal eff



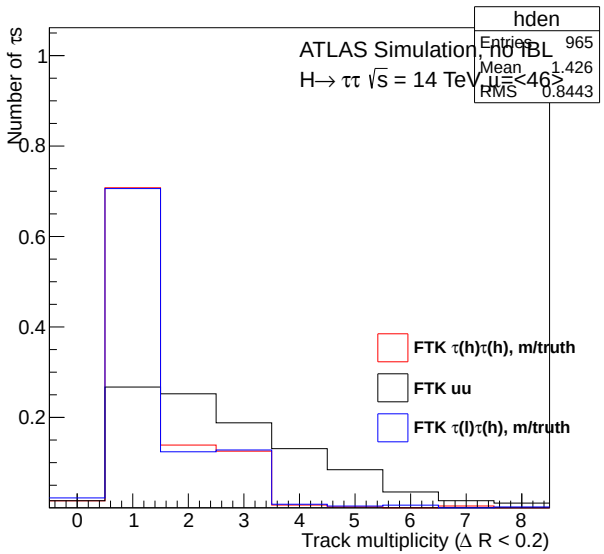
bkg eff



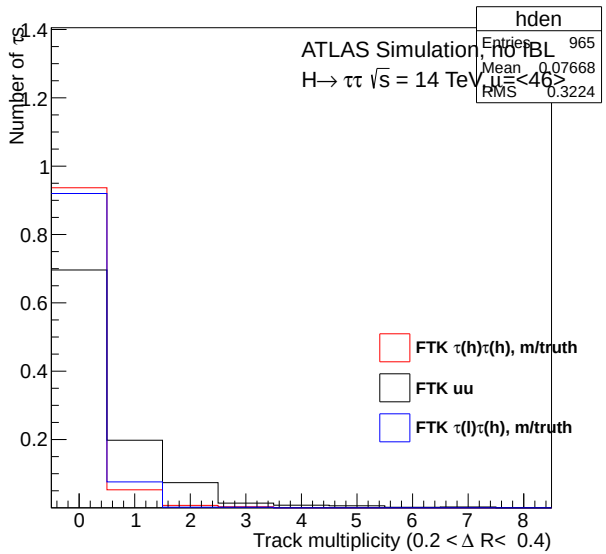
- We modify selection on nIso, from $nIso < 2$ to $nIso = 0$;
- Doing so, we descrease signal efficiency on ∼5-7% and gain background suppression on $20 - 40\%$.

FTK multiplicity: modified cone size

Signal cone $\Delta R < 0.2$

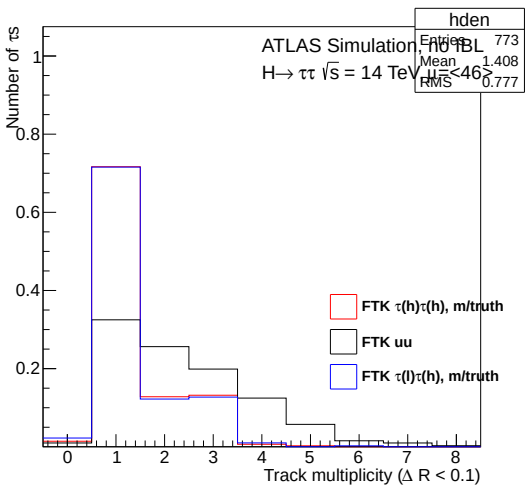


Isolation ring $0.2 < \Delta R < 0.4$

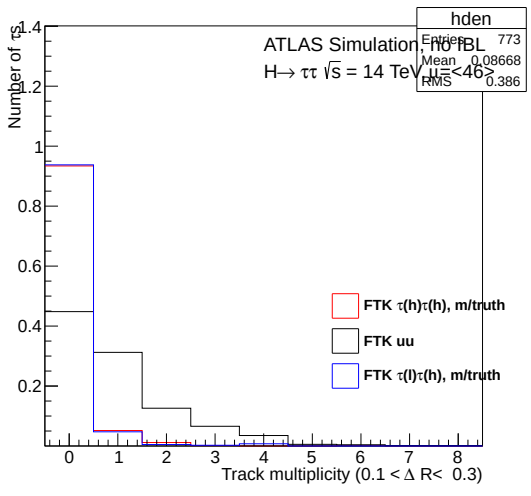


FTK multiplicity for HA15 trigger

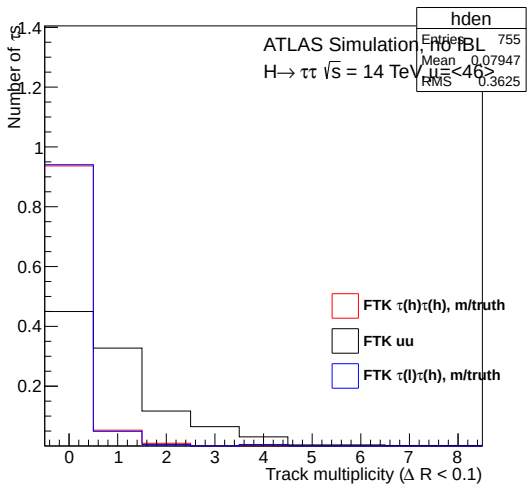
Signal cone $\Delta R < 0.1$



Isolation ring
$0.1 < \Delta R < 0.3$

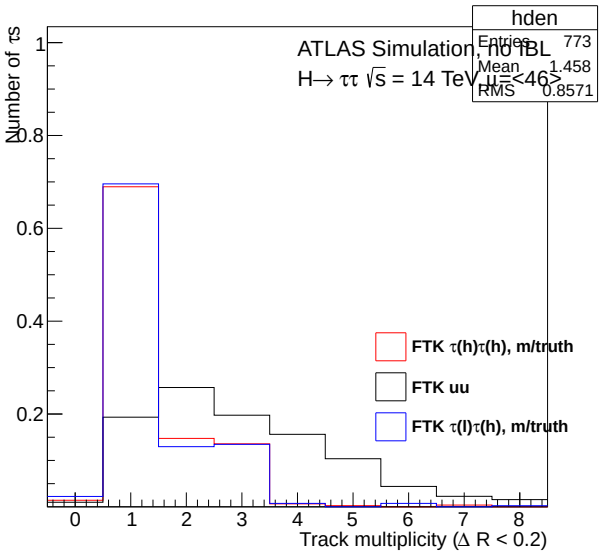


Isolation ring
$0.1 < \Delta R < 0.3$ after
applying cut on nSig

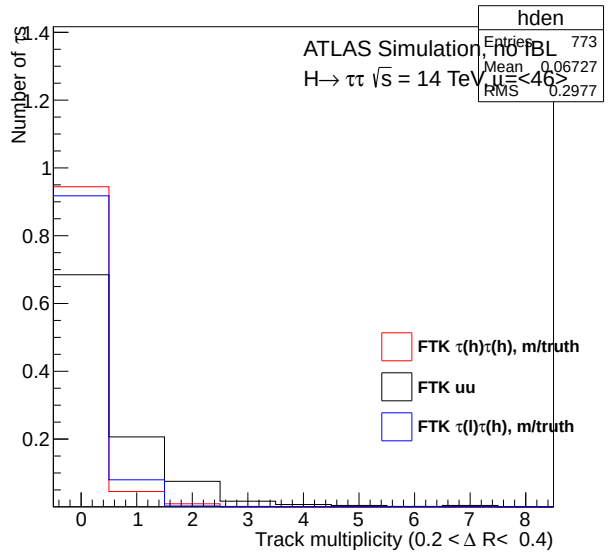


FTK multiplicity for HA15 trigger: modified cone size

Signal cone $\Delta R < 0.2$



Isolation ring $0.2 < \Delta R < 0.4$



Conclusions and future plan

- We need to validate basic distributions with other groups;
- Improve the rejection factor optimizing: DR thresholds, pT thresholds and selection criteria;
- Add for comparison TauB and old FTK algorithm into efficiencies plot;
- Use other appropriate triggers (HA12I, HA20I) that suggested by trigger community;
- New background samples ..