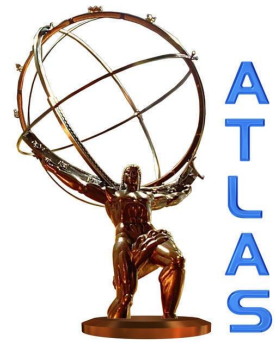
FTK tracking for τ triggering

Takashi Kubota[a], Vassili Kazanine[b]
[a] The University of Melbourne, [b] Budker Institue of Nuclear Physics

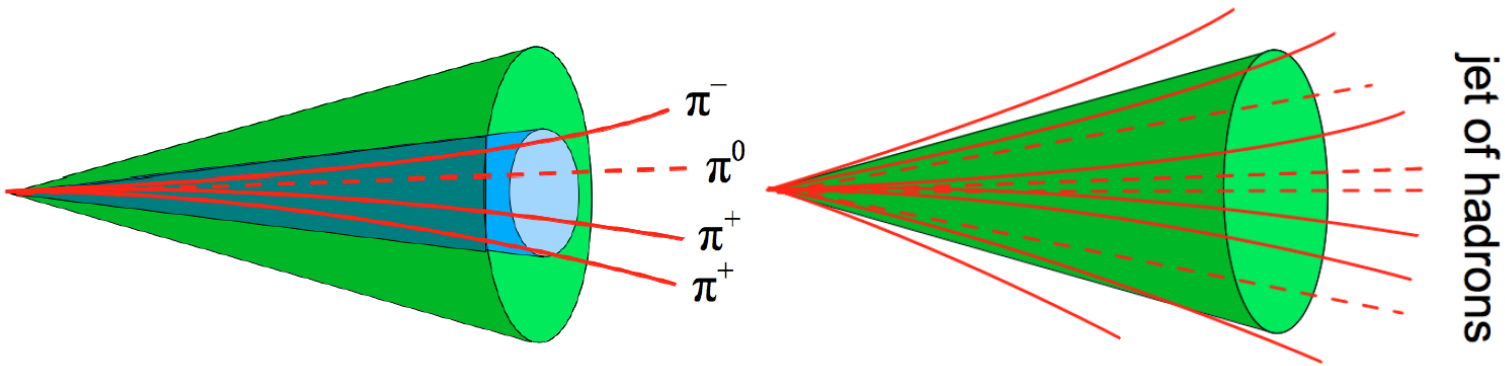
30 July 2013

THE UNIVERSITY OF MELBOURNE



Outline

- FTK is a novel system in the ATLAS triggering: Delivers a lot of advantages enabling ultra-fast track reconstruction right after L1 thus providing all tracks information to L2
  - In this talk we focus on the advantage of having all track infomation at L2 for τ triggering
- The signature of hadronically decaying tau:
  - a jet with (mostly) 1 or 3 charged tracks
  - in a narrow geometrical cone
- At L2, the rejection mostly comes from the information of the number of FTK tracks reconstructed in cones of given sizes
  - The number of tracks in the *signal cone*
  - The number of tracks in the *isolated cone (or ring)*
- In this talk, I show some results for defining the best cone sizes



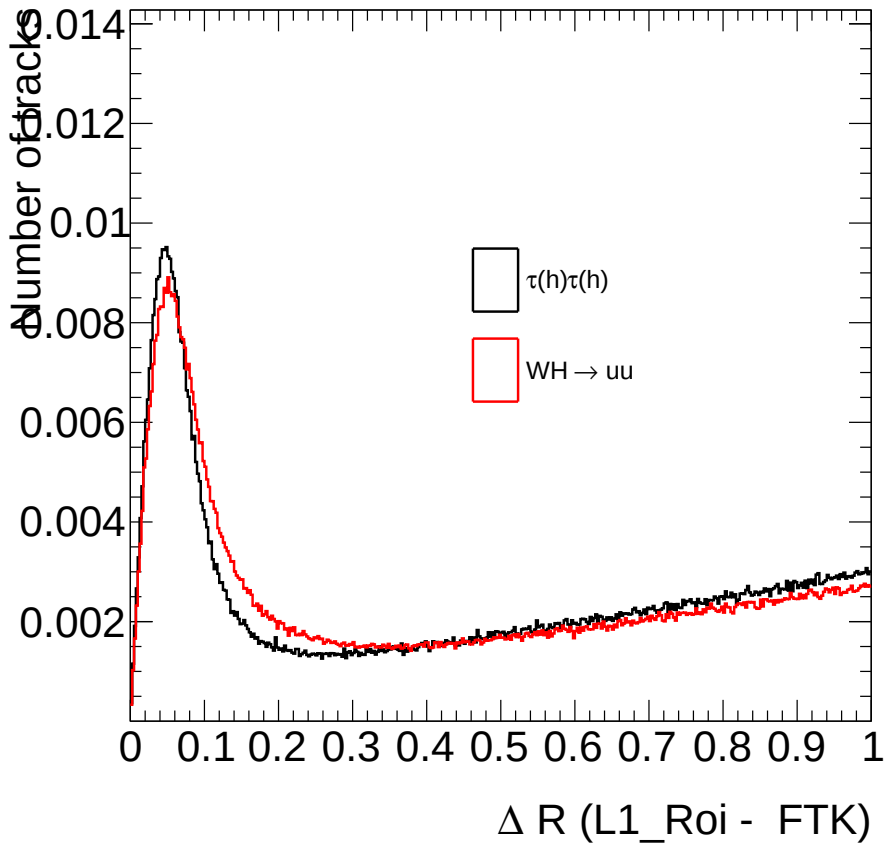
Conditions

- We have build a framework which integrates several codes that has been used for the TDR etc. (link to the TDR: https://cds.cern.ch/record/1552953/files/ATLAS-TDR-021.pdf?version=4)
- Two types of datasets are used (provided by Viviana, the same one as in the TDR):
  - τ jets sample ($VBF\ H \rightarrow \tau\tau$)
  - QCD jets sample ($WH \rightarrow uu$)
- The following cuts are applied on FTK tracks
  - $p_{\mathrm{T}} > 2$ GeV
  - $d_0 < 2.0$ mm
  - $z_0 < 100$ mm

FTK track density

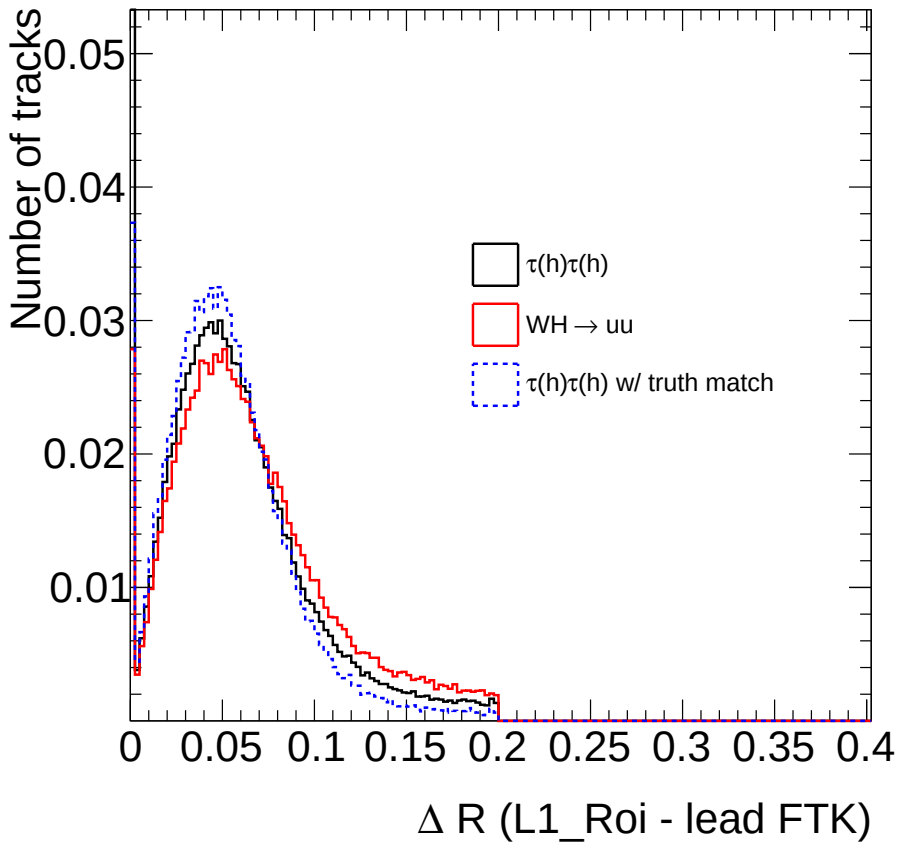
- FTK track density in terms of ΔR from the center of L1_Roi that pass L1_HA8
  - τ jets (in $VBF\ H \rightarrow \tau\tau$)
  - QCD jets (in $WH \rightarrow uu$)

$\rightarrow$ the difference is visible but not significant: boost of the W boson for the QCD sample?
$\rightarrow$ we need QCD di-jet samples in near future to remove this bias



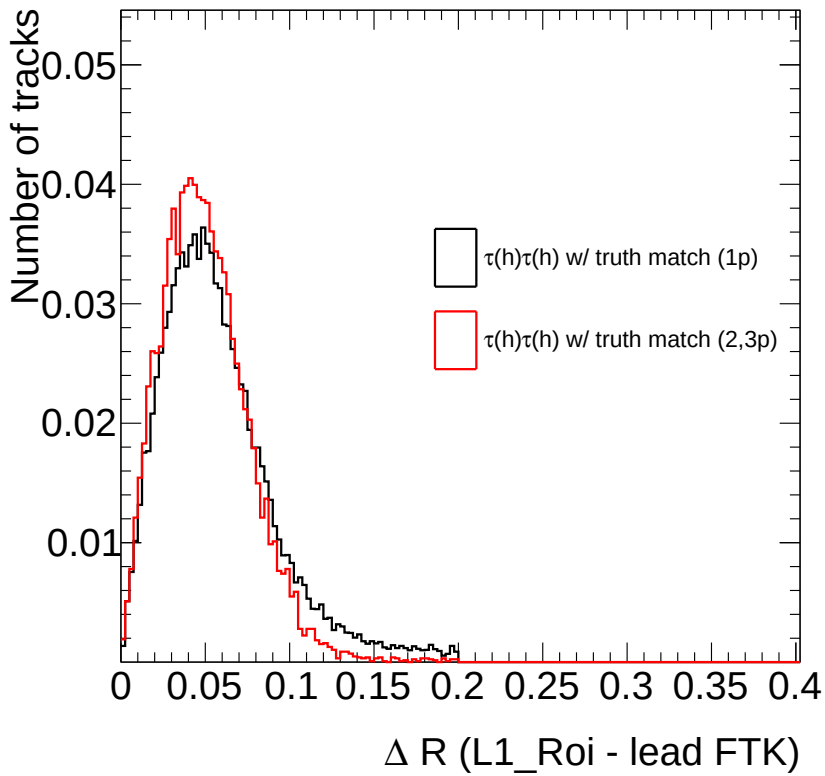
ΔR (L1_Roi - leading p_{T} track)

- ΔR from the center of L1_Roi that pass L1_HA8 to the highest-p_{T} FTK track in the Roi
- suggest $\Delta R \sim 0.2$ for leading track finding?



ΔR (L1_Roi - leading p_{T} track) (cont'd)

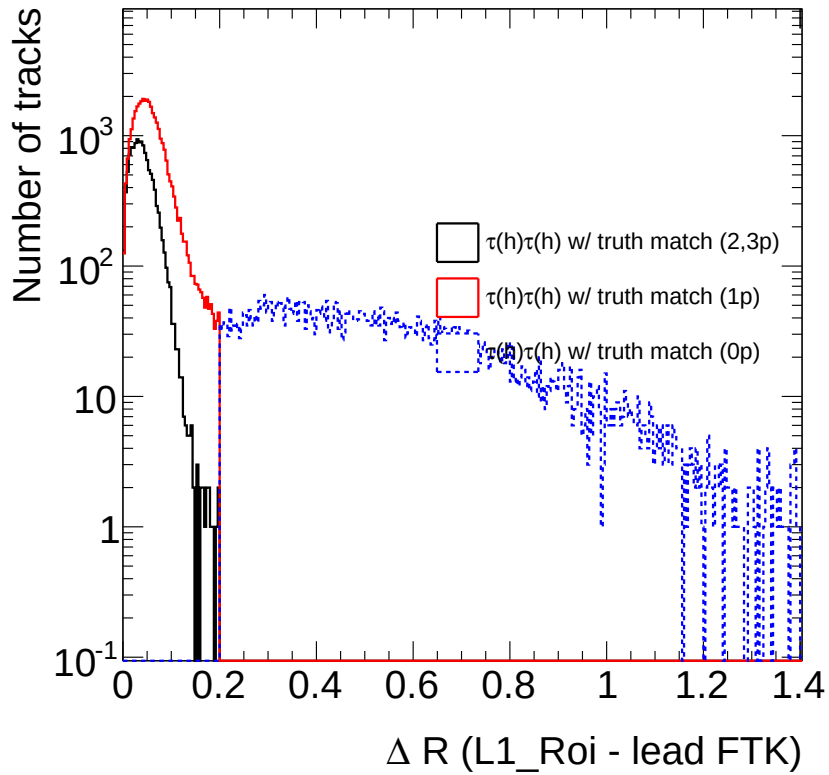
- ΔR from center of L1_Roi that pass L1_HA8 to the highest-p_{T} FTK track in the Roi
- 1-prong and 3-prong separately
  - 1-prong: # of FTK ($\Delta R < 0.1$) = 1 & # of FTK ($0.1 < \Delta R < 0.3$) ≤ 2
  - 2,3-prong: # of FTK ($\Delta R < 0.1$) = 2 or 3 & # of FTK ($0.1 < \Delta R < 0.3$) ≤ 2



ΔR (L1_Roi - nearest track)

- ΔR from center of L1_Roi that pass L1_HA8 to the nearest FTK track
  - 0-prong: # of FTK ($\Delta R < 0.1$) = 0 & # of FTK ($0.1 < \Delta R < 0.3$) ≤ 2
  - 1-prong: # of FTK ($\Delta R < 0.1$) = 1 & # of FTK ($0.1 < \Delta R < 0.3$) ≤ 2
  - 2,3-prong: # of FTK ($\Delta R < 0.1$) = 2 or 3 & # of FTK ($0.1 < \Delta R < 0.3$) ≤ 2

histograms are not normalized here, to see the relative fraction of 0-prong events

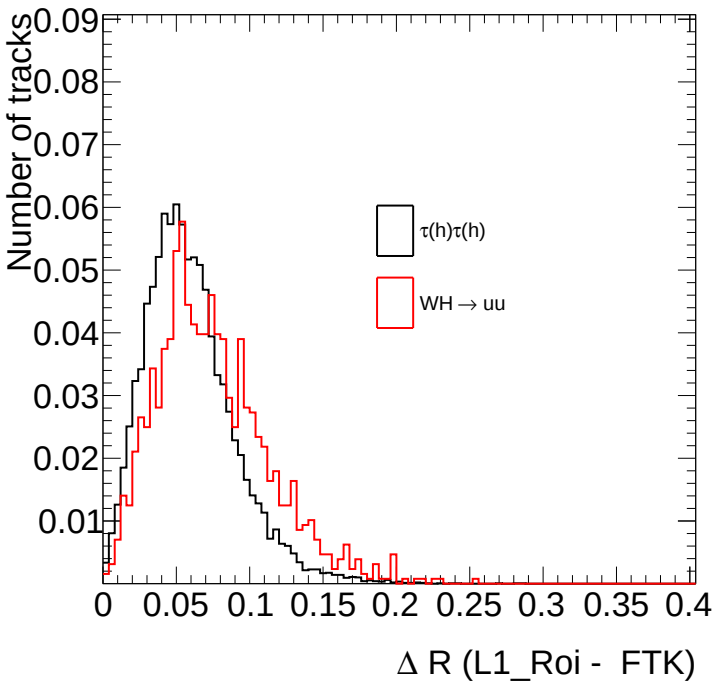


[# of 2,3-prong events : # of 1-prong events : # of 0-prong events] = [12564 : 33120 : 6399]
$\rightarrow$ worth doing some special treatments to salvage this 0-prong events

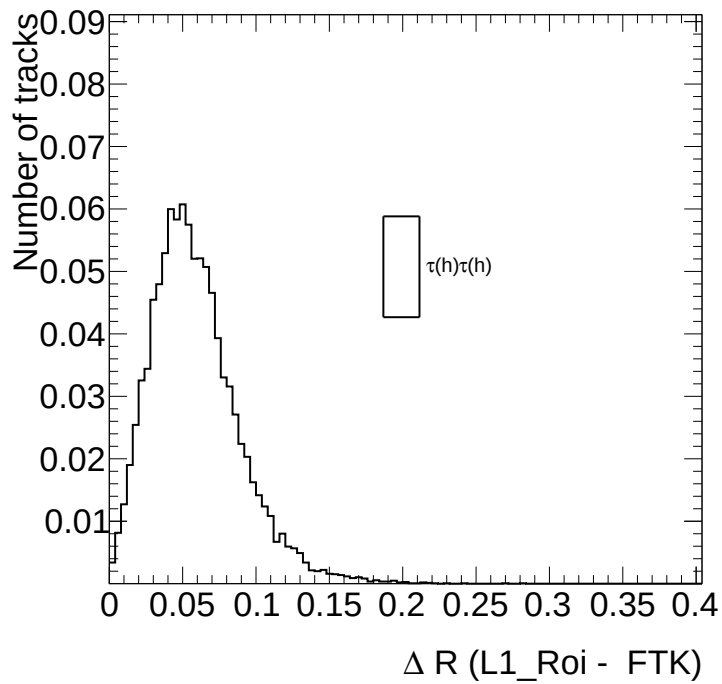
ΔR (L1_Roi - farthest track in offline τ)

- ΔR from the center of L1_Roi that pass L1_HA8 to the farthest track used for an offline τ
  - τ jets (in $VBF\ H \rightarrow \tau\tau$)
  - QCD jets (in $WH \rightarrow uu$)
- ΔR for the signal cone should be around from 0.1 to 0.2?

for tracks in offline τ



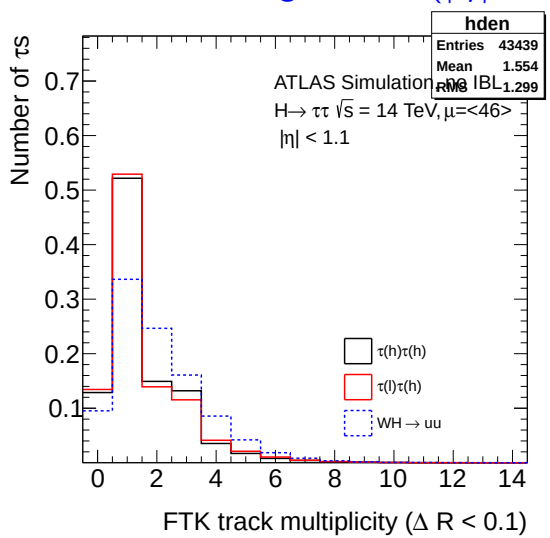
for tracks in offline τ matched with truth



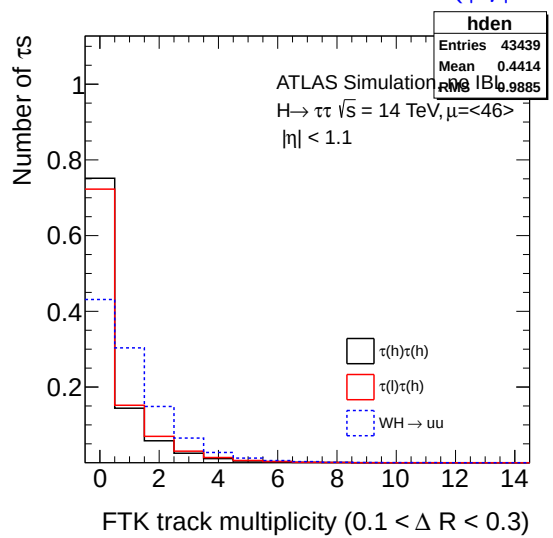
The number of FTK tracks

- A trial with the following configuration
  - find the leading p_{T} track in $\Delta R \leq 0.2$ from the Roi center
  - signal cone: $\Delta R \leq 0.1$
  - isolation ring: $0.1 \leq \Delta R \leq 0.3$
  - count # of tracks with $\Delta z_0 < 2.0$ mm from the leading track

FTK tracks in the signal cone ($|\eta| < 1.1$)



FTK tracks in the isolation cone ($|\eta| < 1.1$)

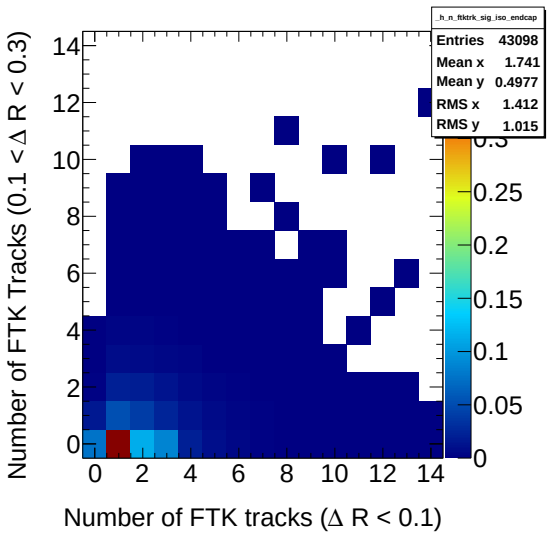


separation is visible between black (τ signal) and blue (QCD bkg.)

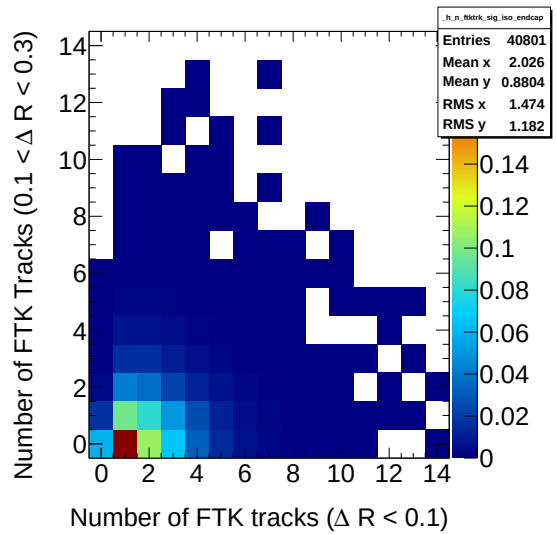
The number of FTK tracks (cont'd)

- A trial with the following configuration
  - find the leading p_{T} track in $\Delta R \leq 0.2$ from the Roi center
  - signal cone: $\Delta R \leq 0.1$
  - isolation ring: $0.1 \leq \Delta R \leq 0.3$
  - count # of tracks with $\Delta z_0 < 2.0$ mm from the leading track

τ jets in *VBF* $H \to \tau\tau$ ($|\eta| < 1.1$)



QCD jets in $WH \to uu$ ($|\eta| < 1.1$)



separation is visible between left (τ signal) and right (QCD bkg.)

Summary

- Studied relations between ΔR from the center of L1_Roi and FTK tracks
- Saw the # of FTK tracks distributions with the following configuration:
  - find the leading p_{T} track in $\Delta R \leq 0.2$ from the Roi center
  - signal cone: $\Delta R \leq 0.1$
  - isolation ring: $0.1 \leq \Delta R \leq 0.3$

$\rightarrow$ the difference between τ jets and QCD jets is visible.
$\rightarrow$ current QCD jets sample ($WH \rightarrow uu$) may not be ideal, need QCD di-jet samples
$\rightarrow$ will found an optimised point in terms of signal efficiency and background rejection