Plans for Physics Studies for FTK TDR

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12.4.13

Outline

- April TDR: Building Physics case on foundation of object selection performance
- April TDR: Higgs to tau tau, the physics case focus
- Looking towards September: FTK in the TDAQ Phase 1 TDR

Making a convincing case for the April TDR

- The FTK TDR needs to make a compelling case that:

  (A) FTK can perform track reconstruction well at phase 1 luminosities (3e34)

  (B) Having well reconstructed, full ID coverage tracks at L2 at 3e34 helps the ATLAS physics program

- (A) will be proven through looking at
  - Efficiencies
  - Fake Rates
  - Resolutions

  for objects of interest at 3e34 (and other PU, see next slides)

- (B) will be shown first through improvements in the Higgs->tau tau event yield with an FTK-based tau trigger
  - Further physics case will be made in the September TDAQ TDR (see last section of this talk)

Performance Studies

- General Strategy:
  - Need to show efficiencies, fake rates and resolutions with respect to truth *and offline*
    - However, offline only validated to <mu> ~40 so need to make sure this is addressed properly
  - Need to show how performance changes with <mu> up to 3e34.
- Objects of interest:
  - Single track: Muons, electrons, pions
  - Multi-track objects: Taus, b-jets, primary vertices
  - Track-based object attributes: Lepton isolation, jet vertex fraction*
- Single track:
  - PU = 0 studies of efficiencies, resolutions for single particle samples
  - Higher PU studies of efficiencies, fake rates & resolutions from W/Z, WH and ttbar samples

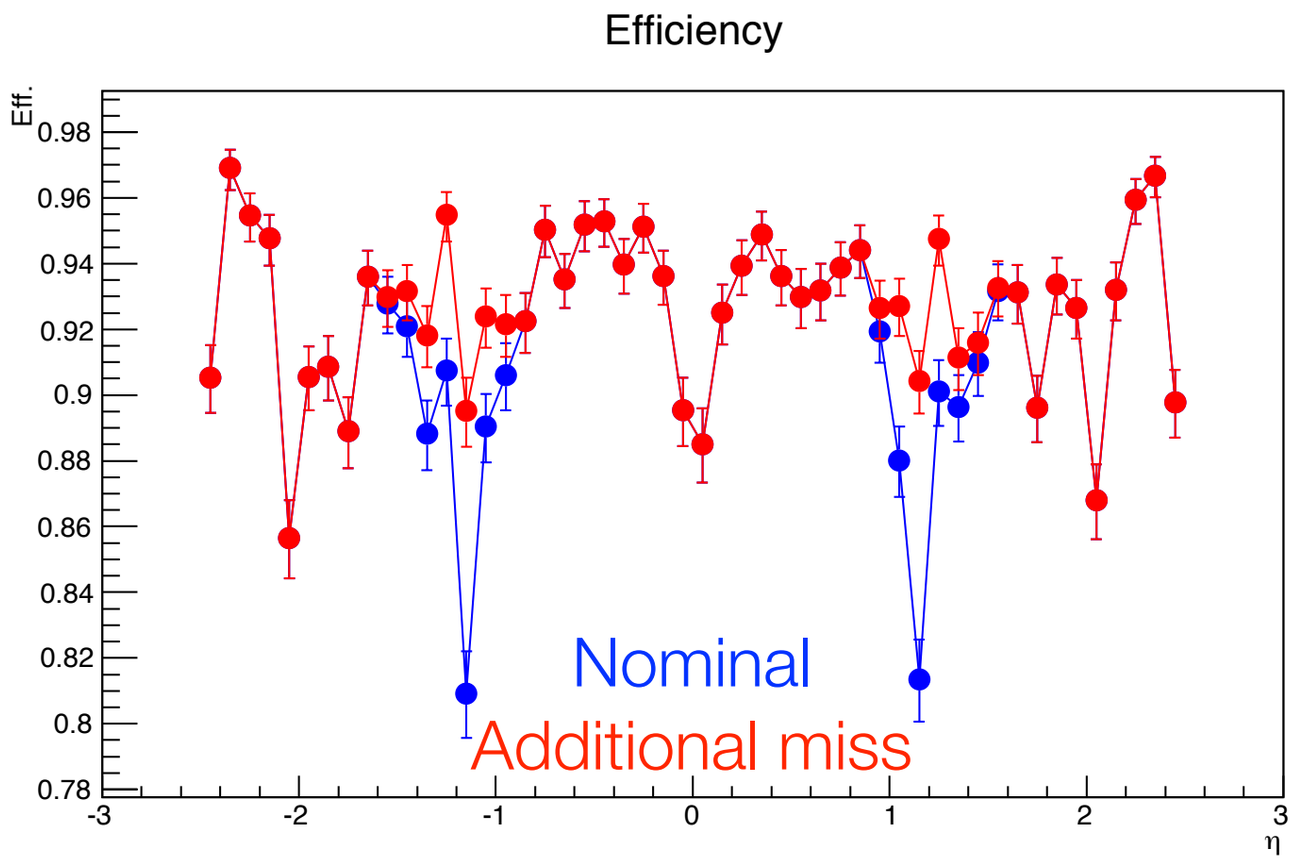
*TDAQ TDR

What <mu> to use?

- Majority of studies will be based on *existing* MC11 samples, therefore need to restrict ourselves to:
  - 14 TeV MC11 <mu> = 69 for 3e34
  - 14 TeV MC11 <mu> = 46 for 2e34
- However, the full sim-digi-reco chain for these samples is not validated (reco has not been tuned at mu > 40), so need baseline samples to compare to:
  - 8TeV MC 12 <mu> = Data from 2012 configuration
  - 8 TeV MC 12 <mu> = 46 for to understand 8TeV/14TeV MC11/MC12 differences if necessary
- Studies at PU >= 46 will largely rely on truth for measures of performance, although offline will also be compared to:

Single Muon Efficiency

- Banks are trained and efficiency is evaluated (independently) with single muons
  - Flat pT spectrum, phi and eta
  - Flat in d0 up to 2mm, z0 up to 110mm
- Require 7/8 hits in pattern recognition, allow 1 additional miss in 2nd stage fitting
  - Allow additional miss in last layer of the SCT in first stage in barrel-endcap transition region



First look at from 46 PU ttbar sample

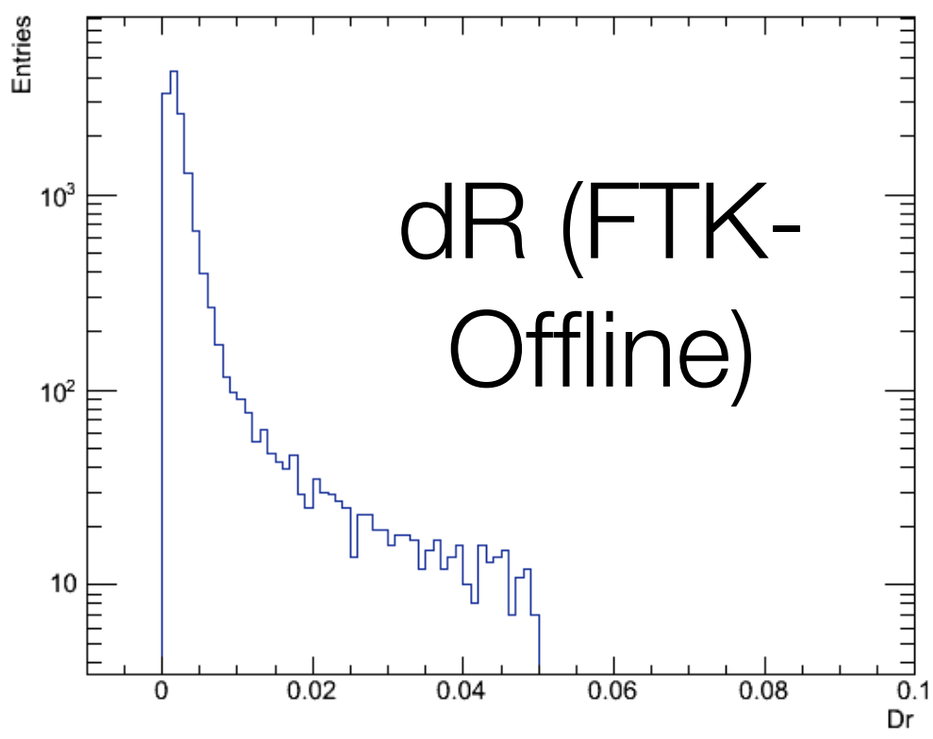
- Have been using some (old, MC10) 46 PU samples to do initial studies
- Used for developing tools and strategies for performance studies
  - Won't be used for TDR results

Matching To Offline

Match FTK tracks with pT > 1 GeV to offline tracks with:

- (nPix + nSCT) >= 10
- pT > 0.85 GeV

Match if dR(FTK,Offline) < 0.05



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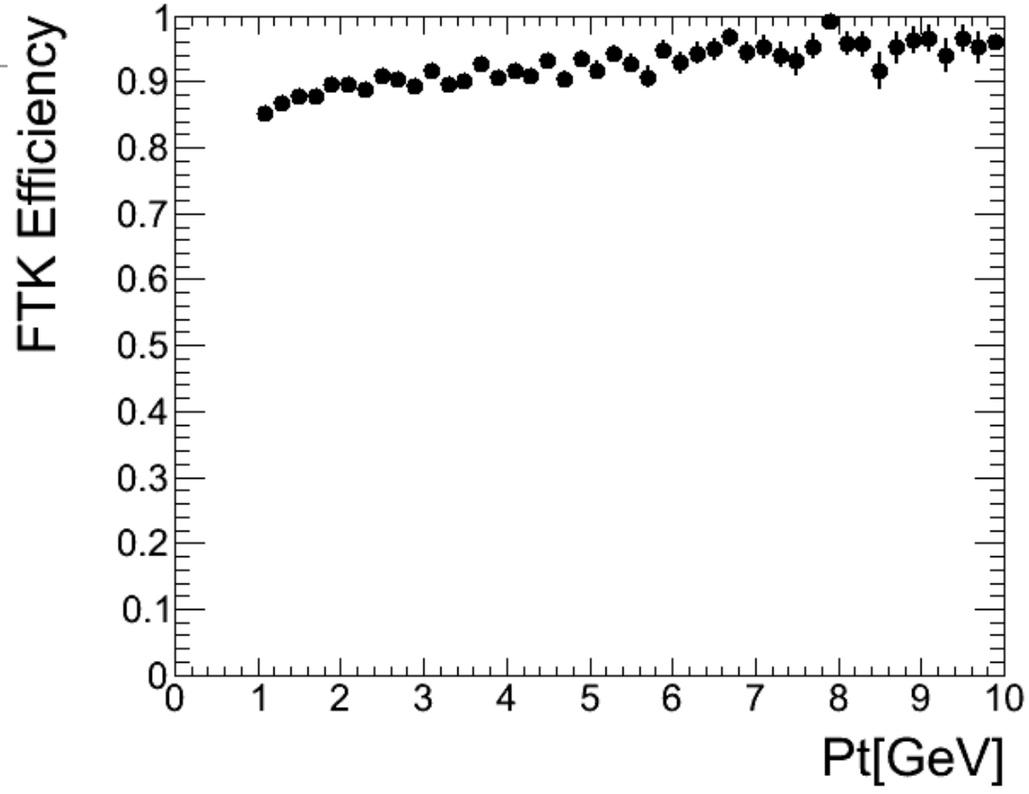
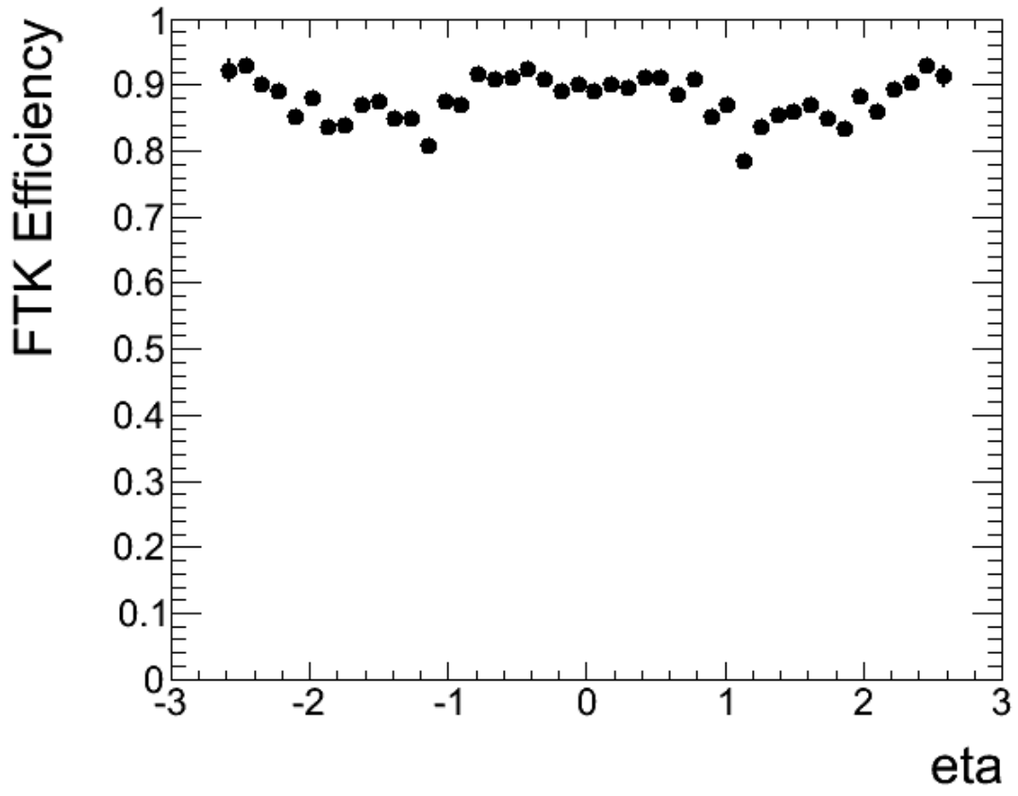
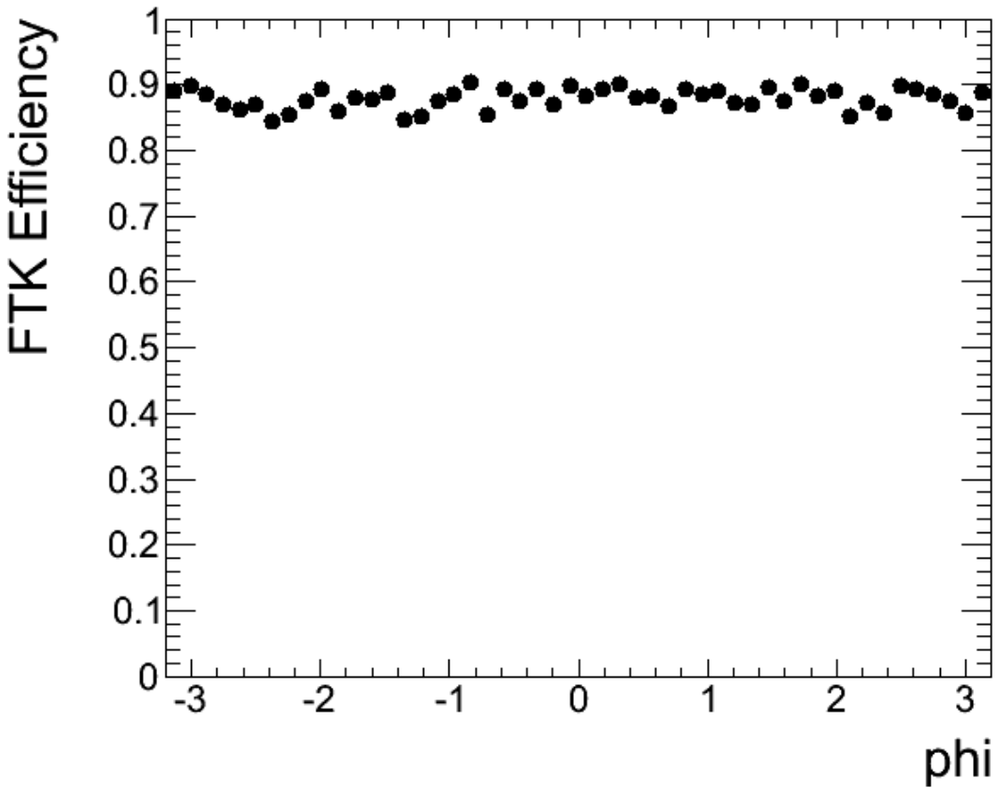
First look (con't)

FTK Efficiency w.r.t to offline

- have ~90% efficiency wrt offline







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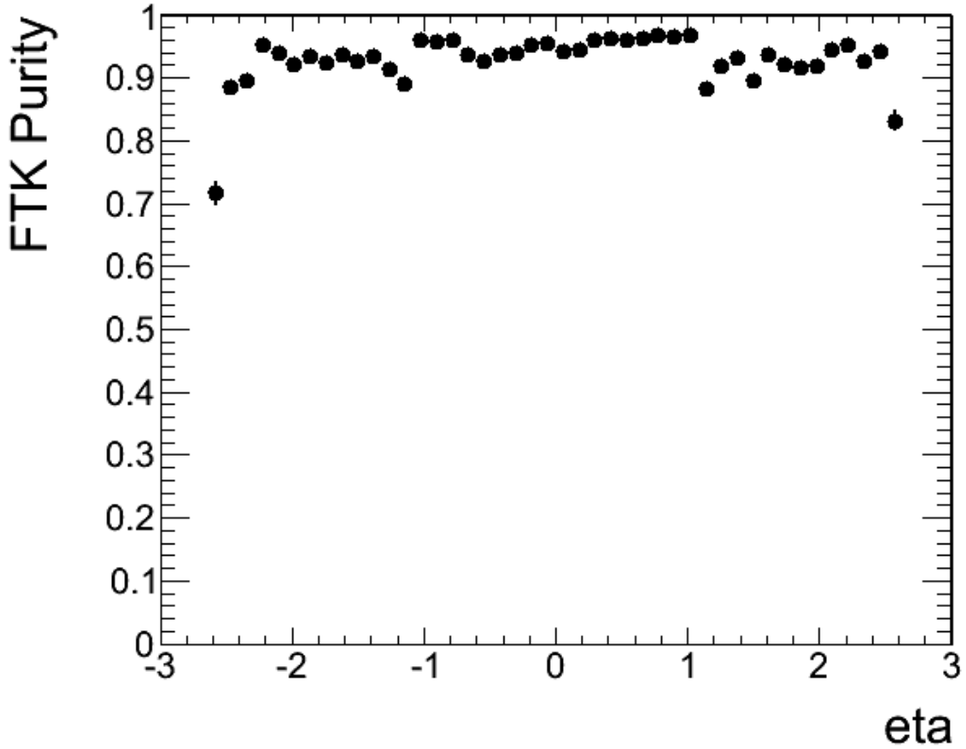
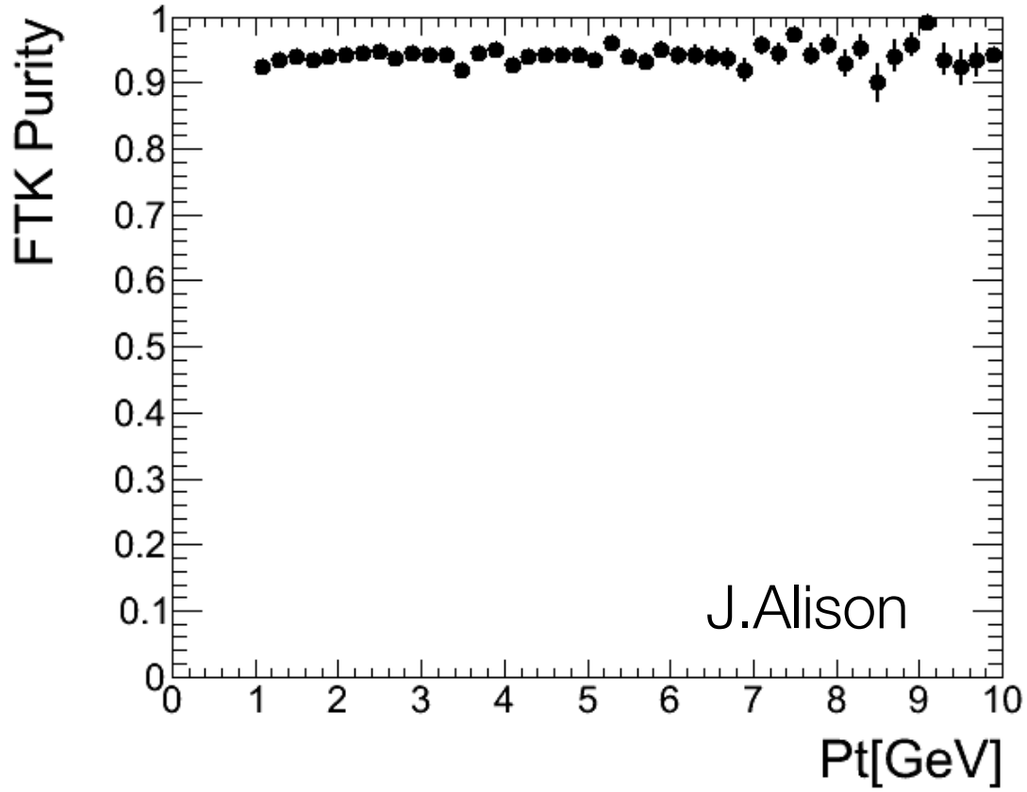
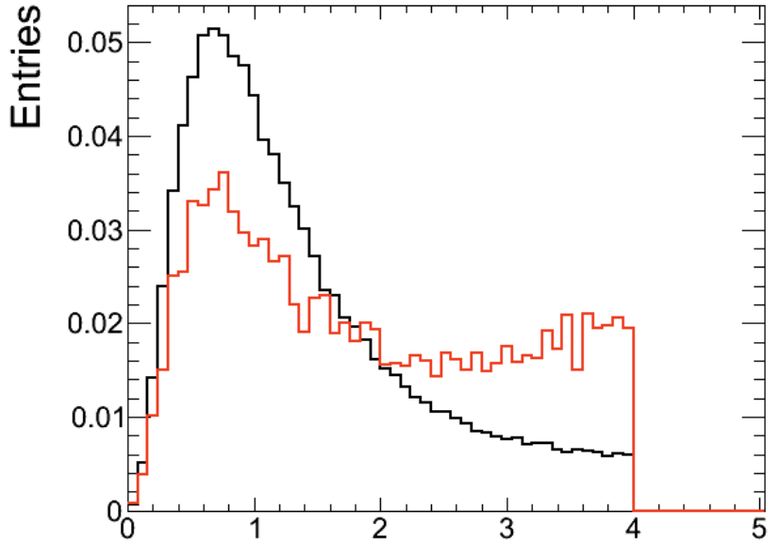
“Purity” w.r.t Offline





- “Purity” is the fraction of FTK tracks which are matched to offline tracks
- Have a dependence on eta and ~flat in p_T
- Chi2 distribution shows components or real and fake tracks in unmatched sample



FTK Tracks w/Matching Offline Track

FTK Tracks w/no Matching Offline Track

Higgs to tau tau: Physics Case Focus

- For April TDR focus on one physics case
  - Most promising is H->tau tau
- Two part approach:
  - Calculate tau performance optimized for efficiency(fake rate) on 120 GeV VBF Higgs->tautau sample(120 GeV WH->lnuqq sample)
  - Do a back of the envelope calculation based on existing H->tautau analysis to estimate improvement in number of events, potentially from
    - improved efficiency from restructuring tau chain
    - lowering L1 thresholds because ROI processing is faster.
- Tau slice has an emulator (fully validated and tested) running from the D3PD
- Plan is implement inside the emulator the recomputation of the variables needed by L2 and regenerate the trigger bit with FTK

Plan for H->tau tau

- Optimize *cone size* and algorithm for tau and then:
  - Use VBF H->tau tau to obtain FTK tau efficiency vs pT (relative to offline & HLT)
  - Use ttbar/WH ->light quarks to obtain FTK jet 'efficiency' vs pT
- Estimate the change in threshold allowed by the fake rate for an l+tau trigger from the strawman menu
  - using the jet pT spectrum from W+jets (keep the same the same rate)
- Calculate the increase in acceptance due to the lowered threshold for H->tau tau in the various topologies: ggF(+jet), boosted ggF, and VBF
- Further optimizations, including more radical changes to the tau trigger algorithms, will be considered for September TDR.

Tau Algorithm implemented

- For each tau object look at all the tracks (nearby the tau) in the event and select the highest pt one
- DeltaZ0 (tracks, highest pt track) < 2mm (standard in the tau algorithm)
- 2 cones are made with respect to the highest pt track: DeltaR =0.1 for core cone and Dr =0.3 for isolation cone (offline uses 0.2 and 0.4 respectively

"Classic"	"Integrated selection"
L1_TAU8	L1_TAU8
L2 calo FEX, L2 calo Hypo.	L2 tracking FEX (FTK -> TrigInDetTrack using "strategy-F" tracks), L2 FTK trk **Hypo**
L2 tracking (FTK -> TrigInDetTrack using "strategy-F" tracks)	L2 calo FEX.
L2 tau FEX, L2 tau Hypo.	L2 tau FEX, L2 tau Hypo.

- H->tautau (46 pileup) only 750event:
  - 20<Pt_tau < 40 : efficiency with respect to true taus STD: 46% FTK: 53%
  - 40<Pt_tau < 60 : efficiency with respect to true taus STD: 23% FTK: 27%
  - Pt_tau > 60 : efficiency with respect to true taus STD: 19% FTK: 20%
- Fake rate for ttbar (only 500 event):
- STD: 1.2% FTK: 0.8% (very small statistics so numbers are VERY PRELIMINARY)

Fitting into the September TDAQ TDR

- September TDAQ TDR needs to show two things:
  - How FTK performs with IBL
  - How FTK fits into the Phase 1 trigger strategy
- TDAQ Phase 1 upgrades will increase the L1 Trigger rate
  - FTK will be useful for further selection/rejection, particular for lowered* electron and muon thresholds
- TDAQ TDR focusing on
  - Higgs->tau tau:
    - e.g., ZH->lltautau, single lepton trigger at L1, FTK improved tau trigger at L2
  - Higgs->bb:
    - e.g., ZH->nunubb, jet or met trigger at L1, FTK improved jet finding (jvf), b-tagging, or improved MET at L2

*Lowered w.r.t no upgrade

September TDR (2)

- TDAQ TDR focus cont':
  - Boosted top:
    - FTK can help with jvf, primary vertex finding, btagging
  - FTK would like to add multi-b final states
    - Working on getting good models for this; e.g., bbH->bbbb, heavy pair produced new states, MET+ >= 2 bjets.

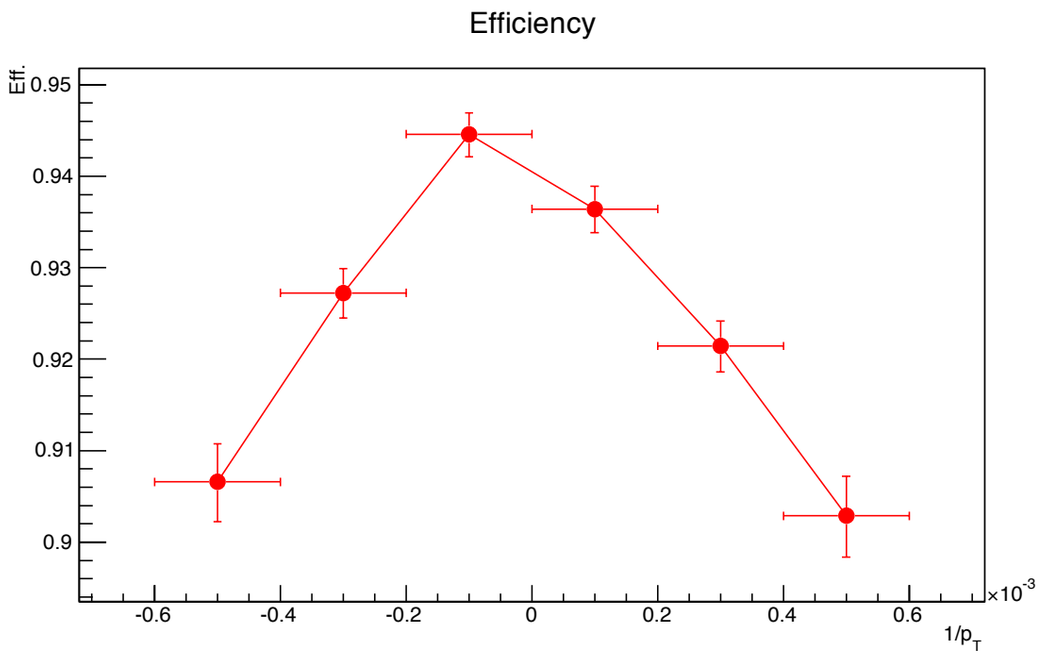
- Should be a natural fit into TDAQ TDR, but need FTK expertise integrated into the various trigger slices:
  - Already have FTK people working with the following:
    - Taus, beamspot, MET
  - Need to move our other studies (bs, lepton isolation, etc.) into slices
    - Likely to happen only after April TDR

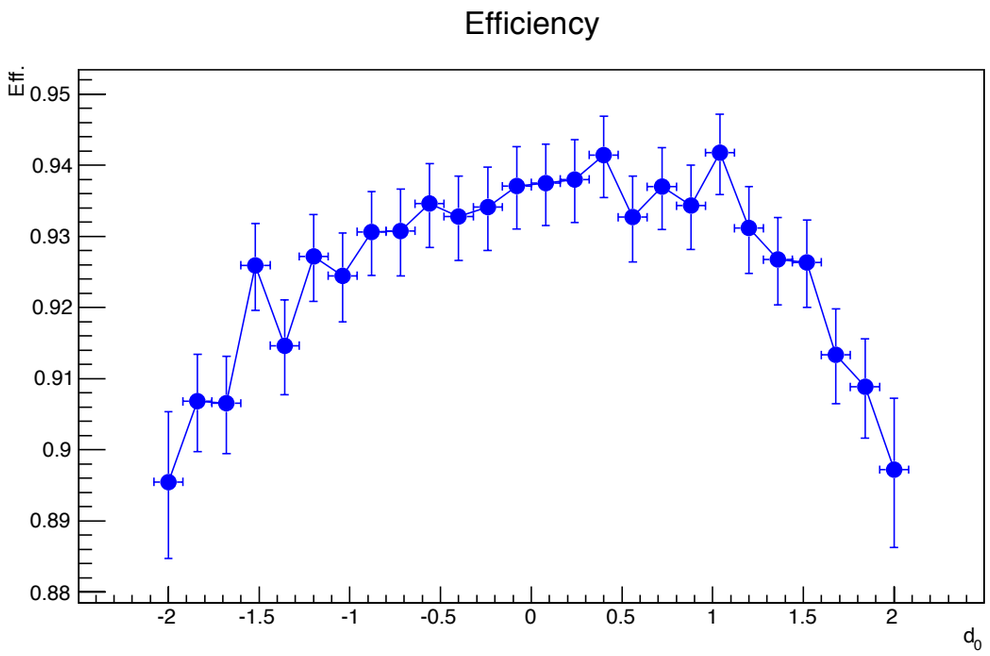
Conclusions

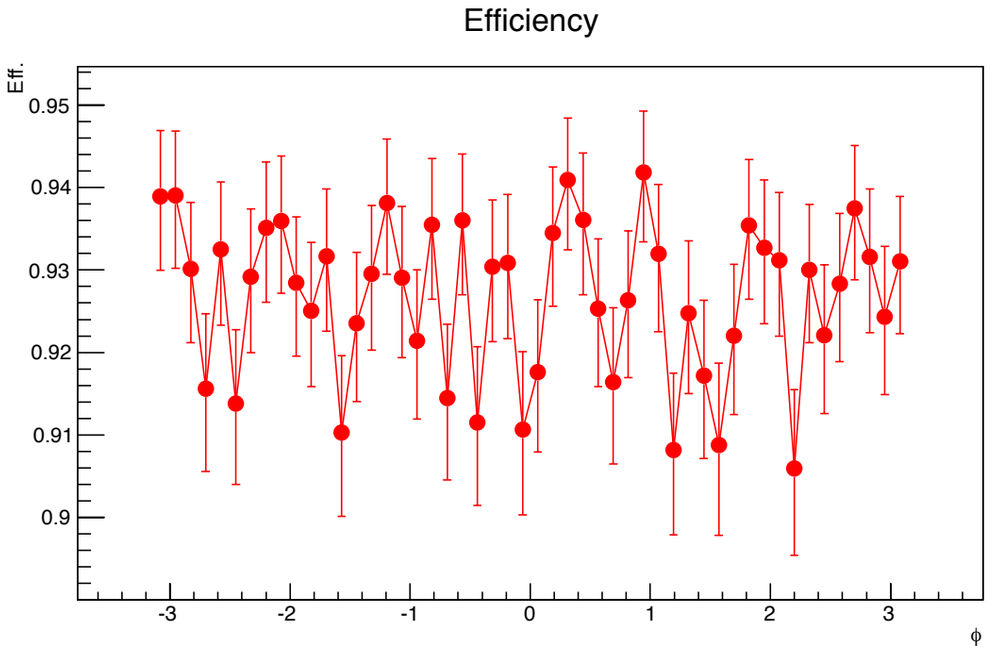
- April TDR will be based on MC 11 69 & 46 PU, with MC12 as a baseline comparison.
  - Will compare to both truth and offline
  - MC12 samples are important for having well understood baseline
- Studies have started on small samples to develop tools for the analysis
- Physics case for Higgs to tau tau will rely on showing improvements in tau trigger efficiency when integrating tracking at the beginning of the selection and using cone sizes similar to offline
- FTK needs to be integrated into TDAQ TDR studies
  - Many areas for usefulness, need to understand how best to exploit it

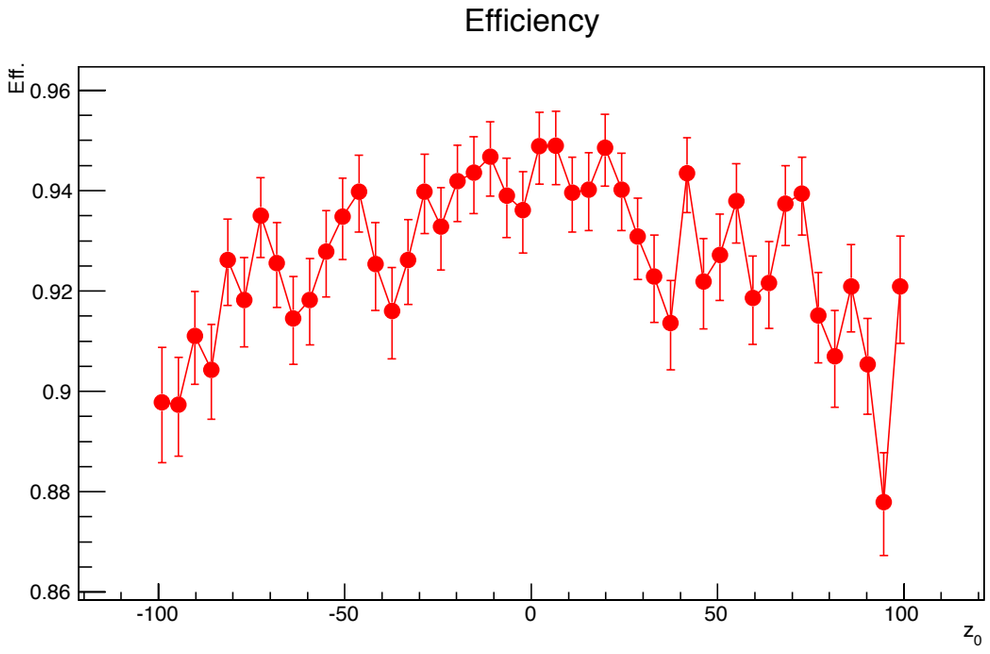
Back Up

FTK Efficiency for single muons









Note about comparisons at Phase 1 lumi

- While full reco is not validated at 3e34, tracking has been studied up to <mu> of 100.
- We can compare the FTK to offline track-only based variables at 2e34, 3e34 using guidance from ATL-COM-INDET-2009-055:
  - Cuts:
    - N pix + SCT > 8 + no pixel holes
    - |d0| < 1mm, |z0PV sinθ| < 1.5 mm
  - Fake tracks have < 50% of the hits from a single truth particle
  - “good” tracks have >= 50% of hits from single truth particle
- Will also use 2012 style cuts for 8 TeV comparisons:
  - NPix + NSCT > 6 , NBlay > 0
  - |d0PV| < 1.0 mm, |z0PV sinθ| < 1.5 mm

TDR Sample Production

- Full production system integration will take another several weeks (see Guido Volpi's talk) so using samples produced through group production with standalone code
  - 3 people running jobs, estimate ~1 week to produce highest priority samples
- Highest priority samples:
  - ttbar
  - VBF H->tautau
  - WH->lnu qq
  - WH->lnu bb
- MC11 46, 69 will be processed first, followed by MC12 when available
  - Digits should be available in ~1 week
- Will switch to production system when available

Performance Studies Con't

- Multi-track Objects:
  - Use WH (tautau, bb) , ttbar samples for variety of PU to show efficiencies & resolutions
  - Use WH ->qq for backgrounds at variety of PU
- Lepton Isolation is also studied with ttbar, W&Z samples @ variety of PU, with some lepton filtered bb samples for background and semi-leptonic ttbar for background