Tracking in the Tau Trigger

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Overview

- **Tracking algorithms in High Level Trigger**
  - **Comparison of SiTrk/IDscan/TRT**
  - **Performance in various samples and scenarios**

- Cosmics

Tracking Algorithms in the Trigger

- Several tracking algorithms are available in the high level triggers
  - **Level 2**
    - **IDscan**
    - **SiTrk**
    - **TRT only**
  - **Event Filter**
    - **Affected by which algorithm is run at L2 since ROI is seeded**
    - **Switches are available for EF parameters (not addressed here)**
- Open questions for the slices to answer:
  - **Should we run all level 2 algorithms?**
  - **If not, how do we choose which algorithm is best for us?**
- There are no conclusions yet; I'll try to give you a tour of the issues as they are at the moment.

Tracking Algorithms

- IDscan
  - **Based on space point histogramming**
  1. **Determine z position of interaction point**
  2. **Group all space points in the ROI into (η,ϕ) bins**
  3. **Combinatorial tracking only inside groups of space points that point back to the determined primary vertex position is performed**

- The primary vertex finding does lead to some problems in pile-up scenarios as established by the tau RTT tests
  - **$Z \rightarrow \tau\tau$ with pile-up from 25ns bunch crossing at $\mathbb{L}=2x10^{33}$**

Tracking Algorithms

- Effect of pile-up in IDscan (muons)

	No pileup	Pileup
Single μ 100 GeV	0.996 ± 0.002	0.958 ± 0.007
Single μ 10 GeV	0.978 ± 0.005	0.933 ± 0.010
Z->μμ, > 25 GeV	0.996 ± 0.002	0.951 ± 0.006

(Emily Nurse)

- Zfinder algorithm:
  - Creates all possible pairs of SpacePoints within a phi-slice in the ROI.
  - Each pair gives z at beam line (histogram filled).
  - Histo maximum is the z position of interaction.

- Retune the algorithm's histogramming parameters
  - **Efficiency loss becomes 1-2% with pile-up instead of 4-5%**

Tracking Algorithms

- SiTrk
  1. Combinatorial matching of space points in order to form full tracks.
  2. Knowledge of the interaction z vertex coordinate is not needed in this algorithm
  3. Pairs of space points from subset of silicon layers are formed
     - Matching criteria applied
  4. Pairs are then combined and extended to outer layers
     - (again matching criteria applied)

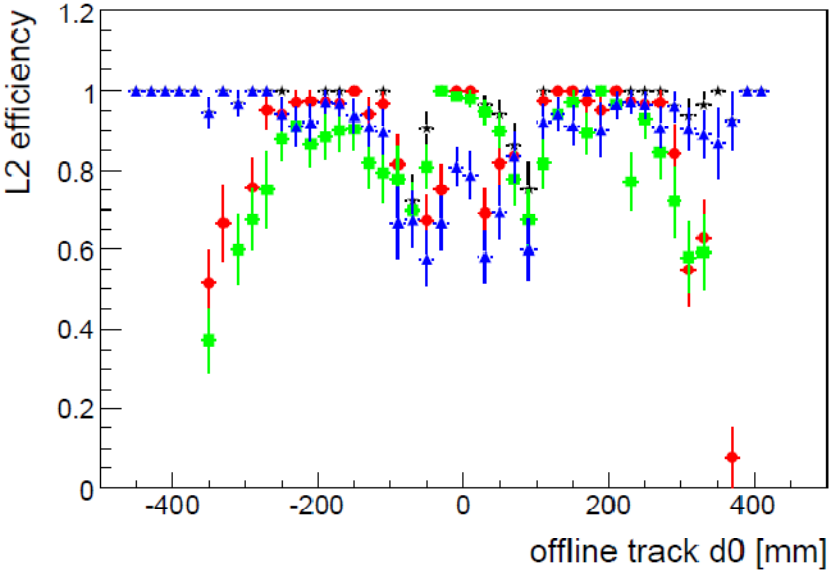
Tracking Algorithms

- TRT only
  - **Only TRT space points are used**
  1. **Calculate a set of trajectories in ϕ-R(z) space**
  2. **Histogram of TRT space points filled in 2dimensions (ϕ and curvature)**
  3. **Maxima correspond to tracks**
  4. **Hits can then be added to tracks which pass the thresholds**

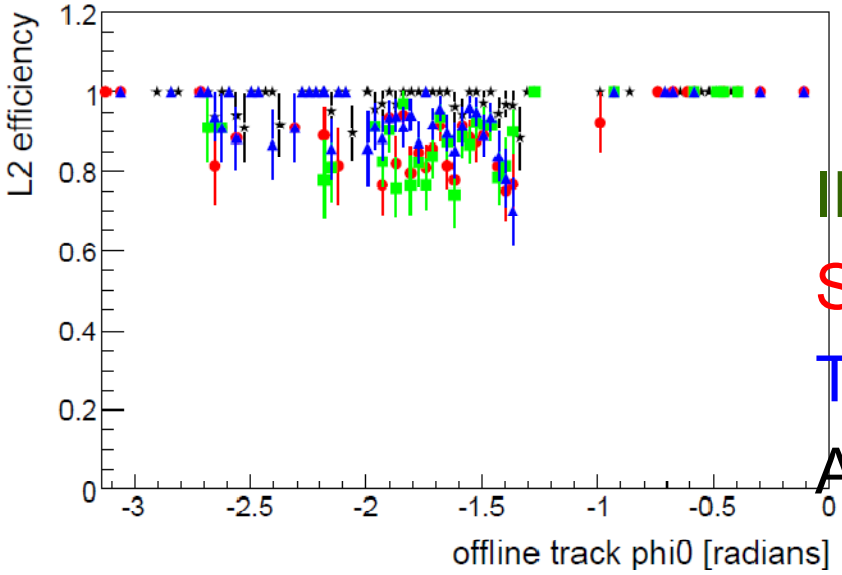
- For the tau slice a TRT only menu has been implemented
- Considered to be a back-up scenario for cases when silicon is not running

Tracking Algorithms in Cosmics

- Extensive efficiency studies in cosmics illustrate no great differences between IDscan and SiTrk
  - **But cosmics cannot tell us everything of course!**
- Tracks with ≥ 4 spacepoints, |z0|<40cm,abs(θ–π/2)<0.58 (run 91862):



Efficiency vs d0



Efficiency vs phi0

IDScan
SiTrack
TRT only
Any

S.Fratina

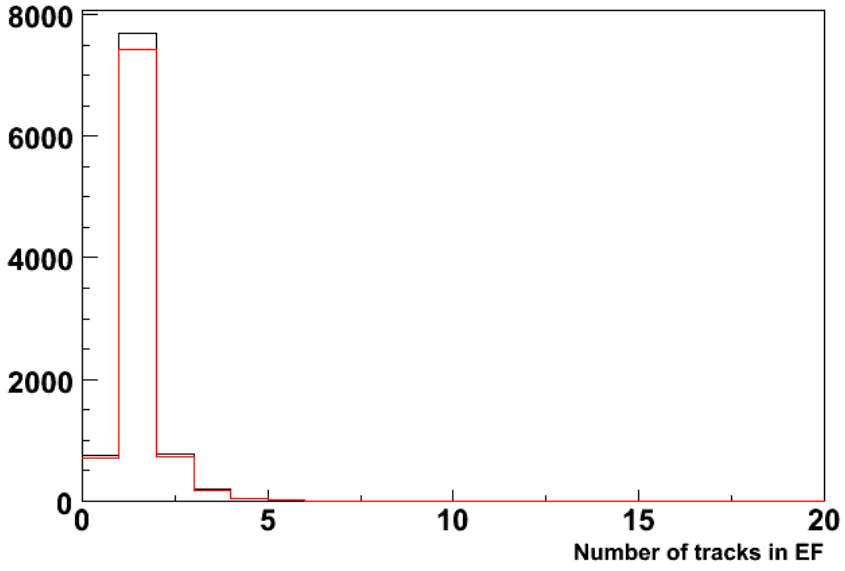
Tracking Algorithms in MC

- The tasks for slices are to:
  - **Examine the performance carefully before data taking to decide whether to run both algorithms**
  - **Formulate a plan to evaluate performance on early data**
- Tau track needs are different from other slices since:
  - **Typically lower momentum tracks than most other slices (except B physics)**
  - **Tracks in multi-prong tau decays are extremely close together**

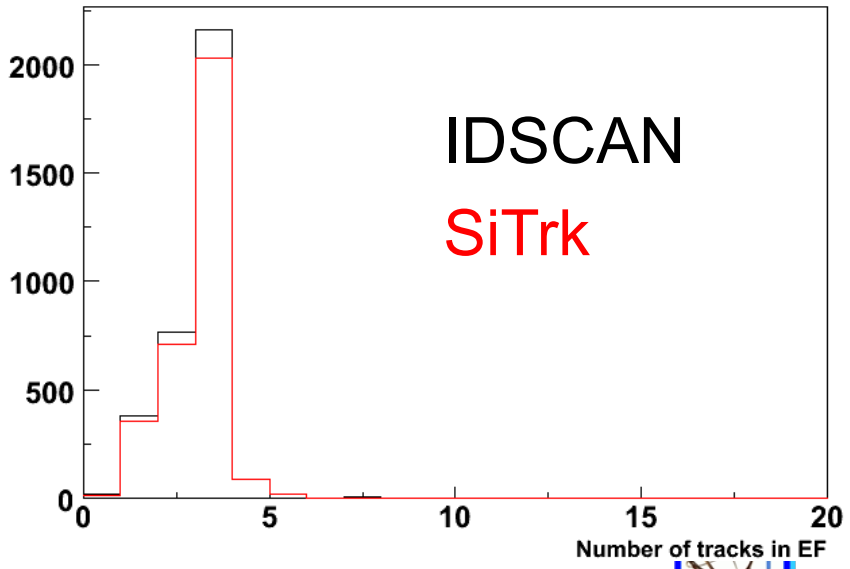
Comparing Algorithms

- Compare IDSCAN and SiTrk for tau decays into one and three prongs
  - W→τ ν (5107) Tau Trigger Performance ntuple 12, Athena 14.2.25.5, 14TeV sample
  - Number of EF tracks distribution very similar for the two algorithms, slightly worse performance for SiTrk

One prong



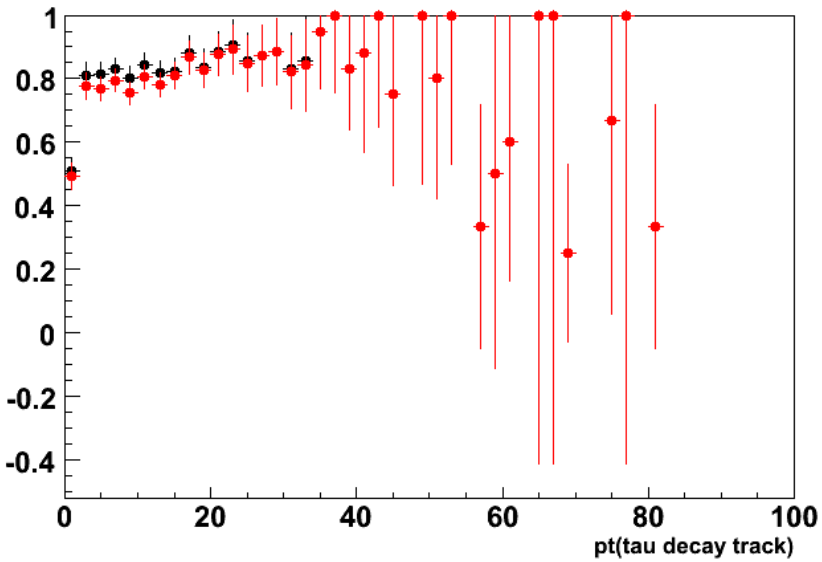
Three prong



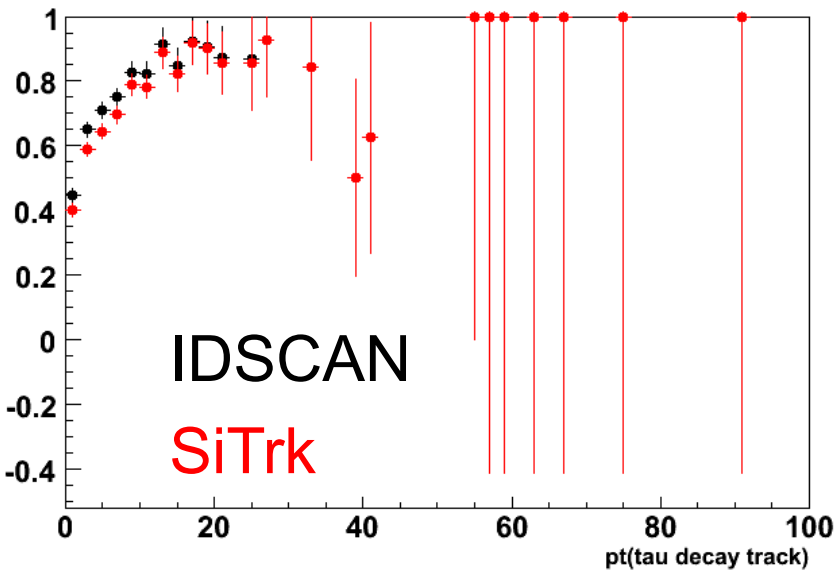
Comparing Algorithms

- L2 and EF combined efficiency per track as a function of track pt slightly lower for SiTrk
- Efficiency measured with respect to truth tracks – each track is matched by delta R requirement to a truth track

One prong



Three prong

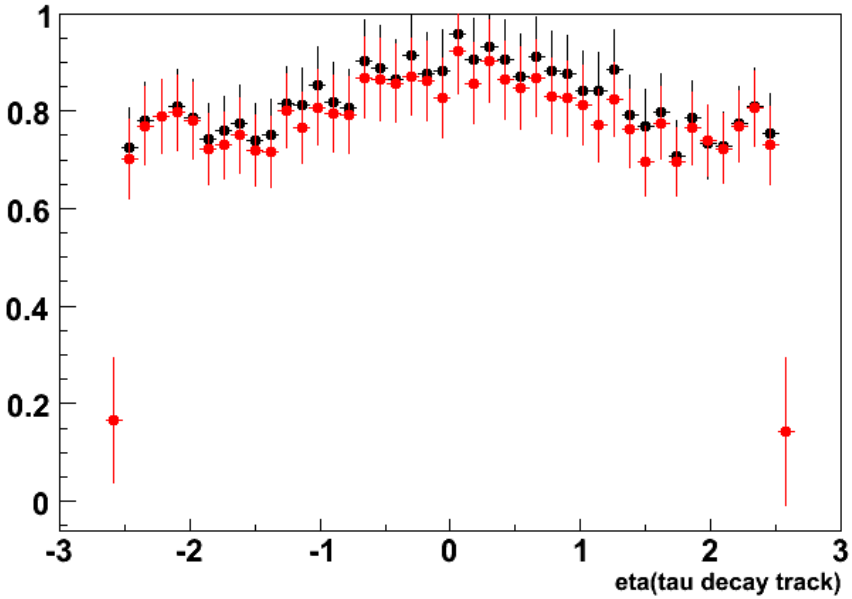


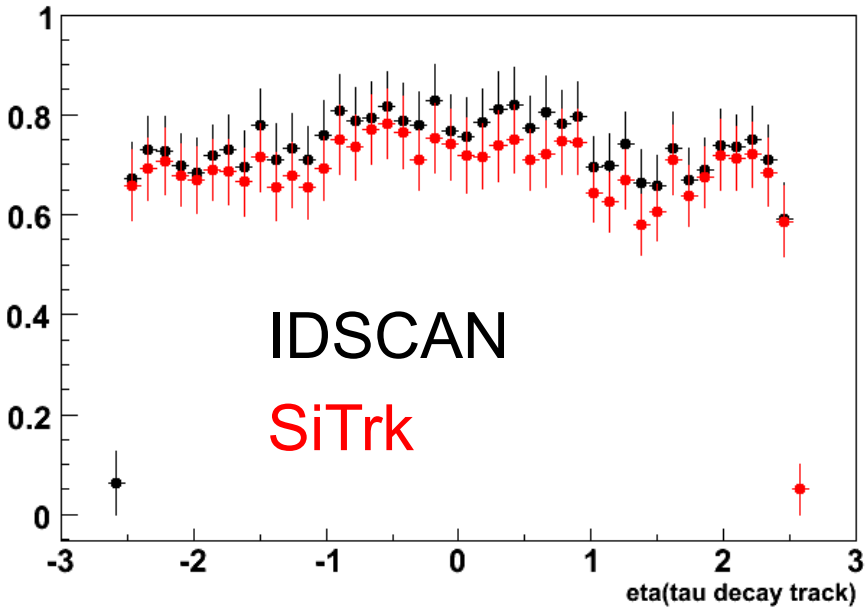
Comparing Algorithms

- L2 and EF combined efficiency as a function of track eta slightly lower for SiTrk

One prong

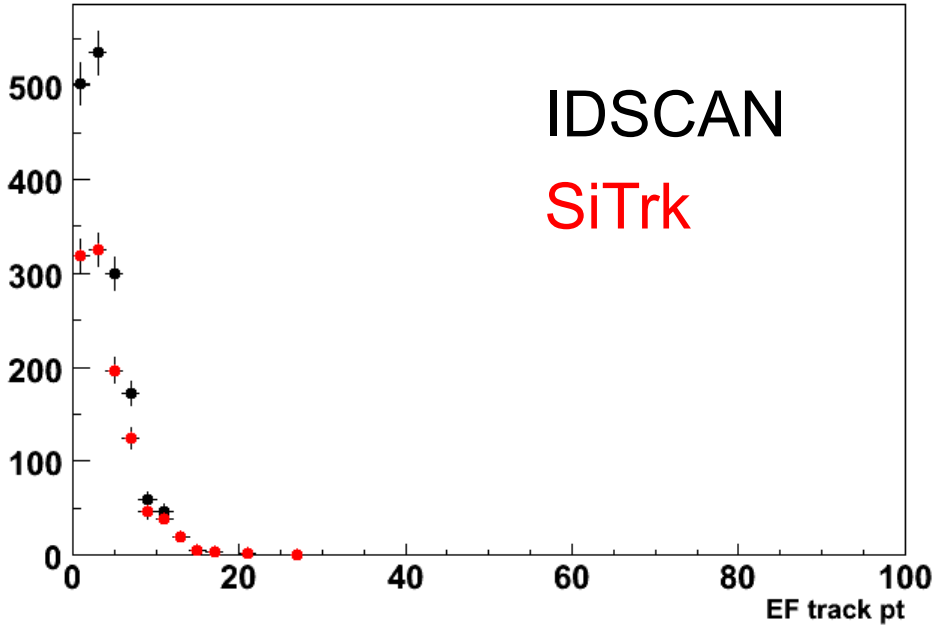
Three prong

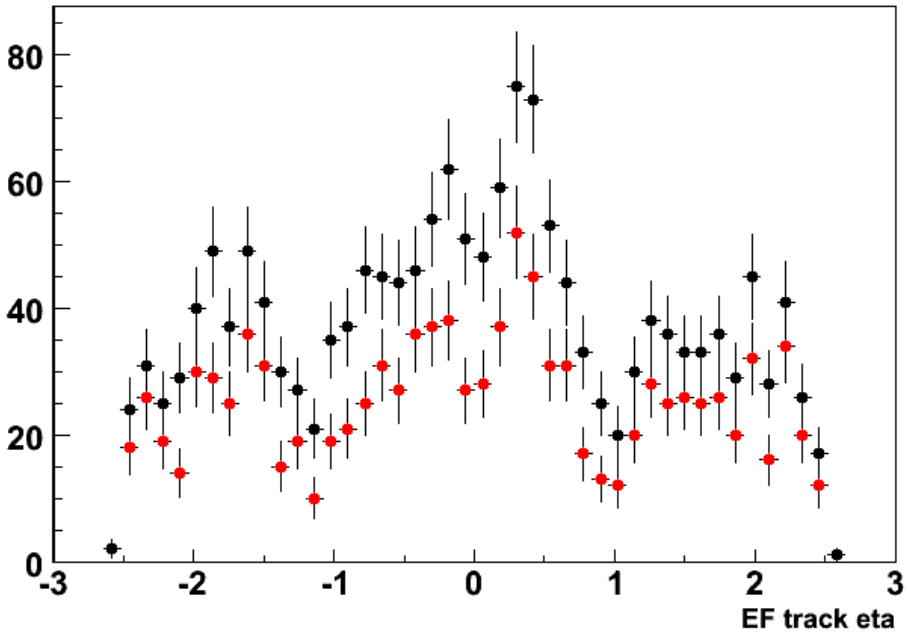




Tracks from Fake taus

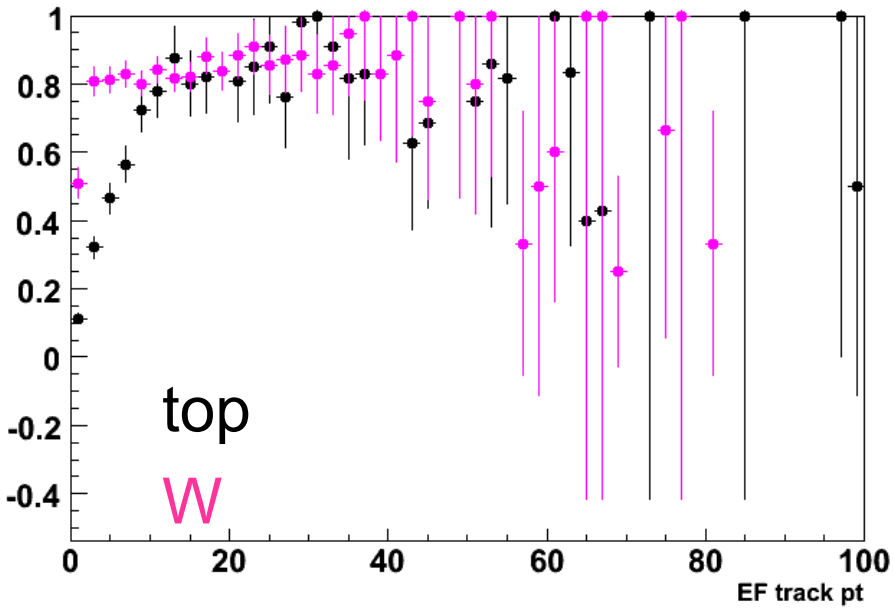
- Single jet pythia J0 sample (5009) used to test fake rates
  - **Suggests fake rate from IDscan higher than SiTrk**
  - **(but recall efficiency is higher for IDscan also)**



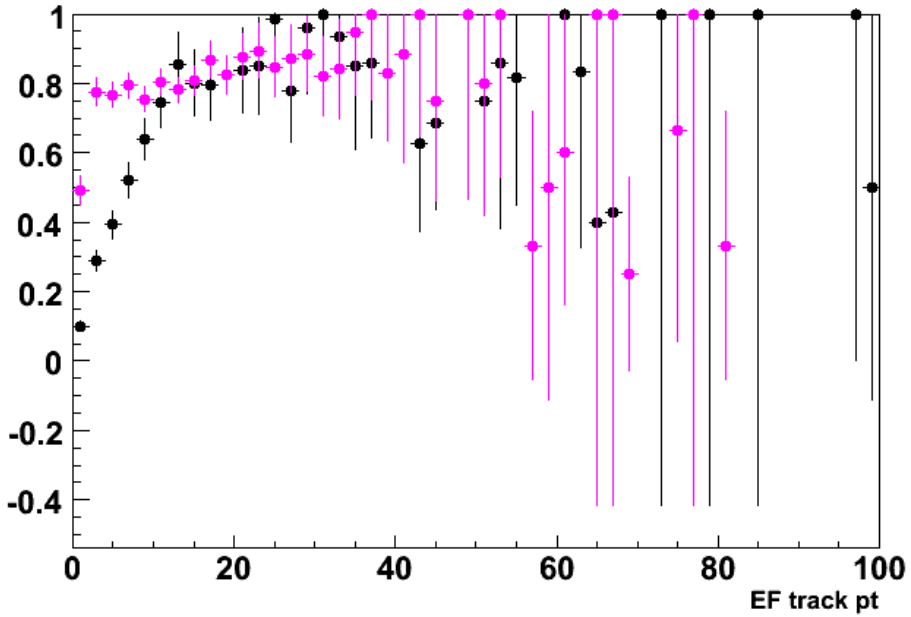


tt

- Efficiency in tt has been checked as a proxy to pile-up
  - 5200 sample, TTP12, 14TeV
  - SiTrk appears to cope worse at lower pt in the ttbar environment



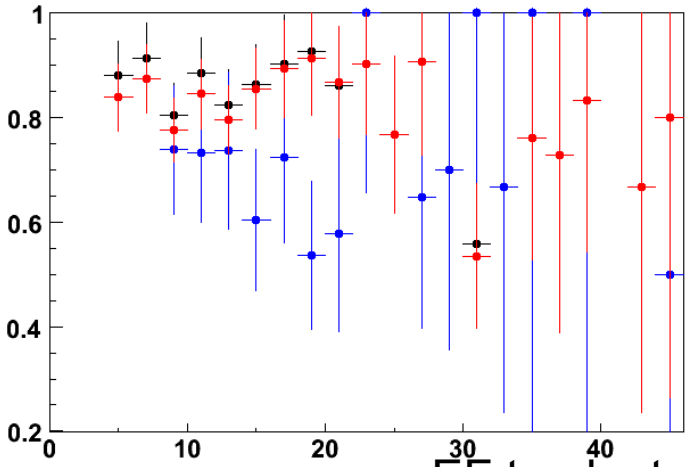
IDscan



SiTrk

TRT only algorithm

- The TRT provides low resolution η measurements and so matching to truth using delta R is not feasible
  - **Matched using delta Phi instead, though this is a poorer matching requirement**
- Shows that TRT algorithm gives reasonable performance
  - **Fake rates need to be checked**
  - **Bear in mind that this is a fall-back scenario for use when silicon is not running**



IDSCAN

SiTrk

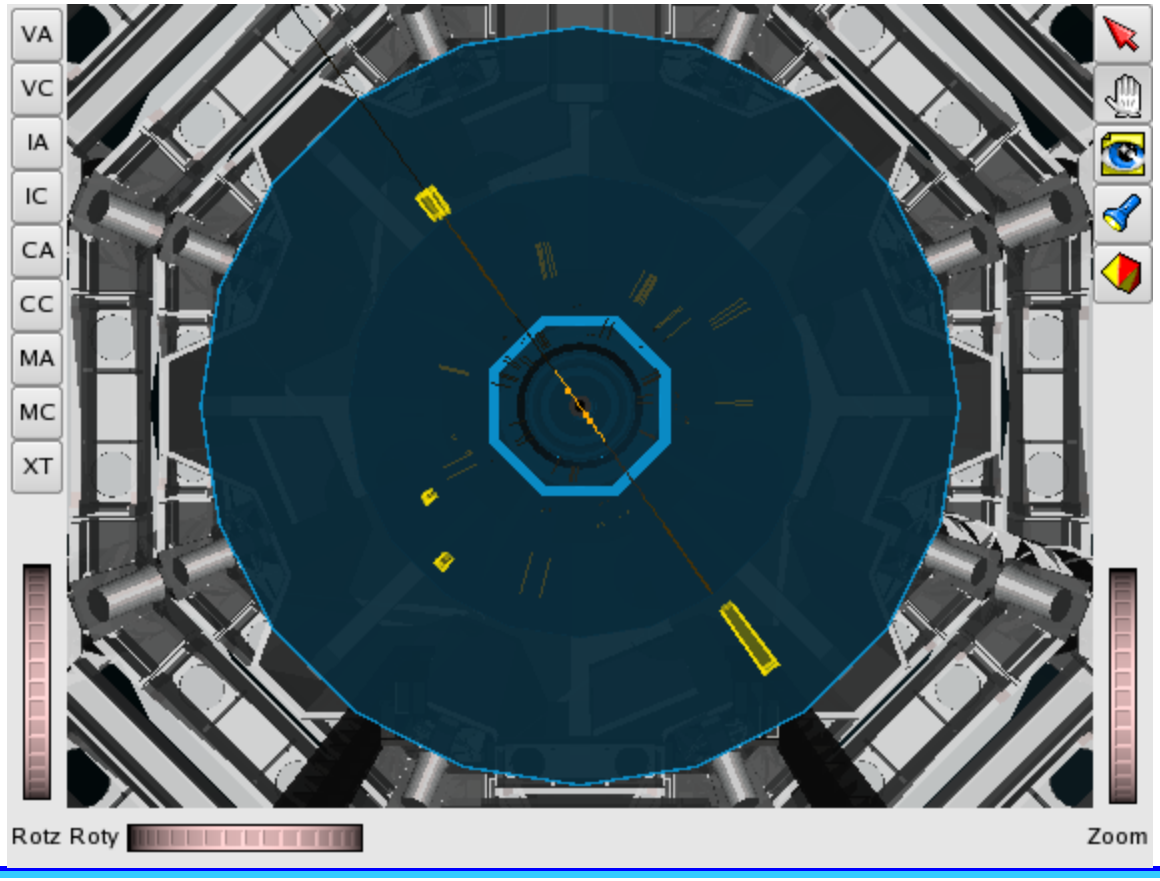
TRT

Summary of the Algorithm Studies

- Algorithm studies are a work in progress
  - **Need to do a complete study of all tau trigger thresholds**
  - **Examine performance in all physics samples**
  - **Check performance with displaced beam spot**
  - **Use full sample size**
- Study results together with other slices who are working on the same questions, each with slightly different tracking “needs”
- When data comes, can see more clearly:
  - **Real occupancies**
  - **Pile-up effects**
  - **Effect of misalignments**
- Should be ready to examine each algorithm
  - **Some of this machinery is already there**

Cosmic Event Displays

- **Events in the tau trigger (tauNoCut) where we find that**
  - **Tau trigger was fired**
  - **Track is present!**



Cosmic Event Displays