STAR Forward Tracking Update

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- Akio's page → https://www.star.bnl.gov/protected/spin/akio/fcs/index.html#2026

- FST Outer Sensor Gap Offset → https://www.star.bnl.gov/protected/spin/akio/fcs/fstgap/index.html
- FST Wedges reversed? → https://drupal.star.bnl.gov/STAR/system/files/FST_Wedge%20issues_ver_2.pdf
- FST Clusters in Real Data → https://www.star.bnl.gov/protected/spin/akio/fcs/FstSlowSim/fstclus/index.html
- FST Slow Sim Maker → https://www.star.bnl.gov/protected/spin/akio/fcs/FstSlowSim/Index.html

FST Outer Sensor Gap Offset

https://www.star.bnl.gov/protected/spin/akio/fcs/fstgap/index.html

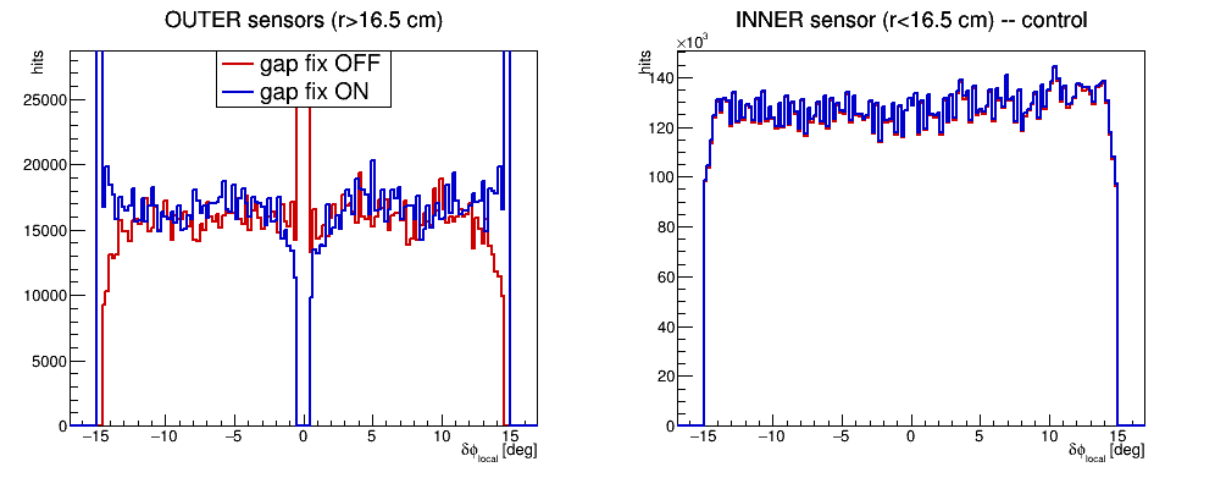
A FST wedge covers 30 degree in phi (12 wedges per disk)

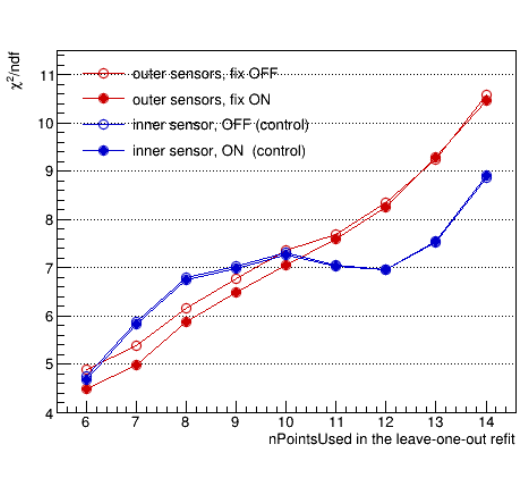
1 inner sensor

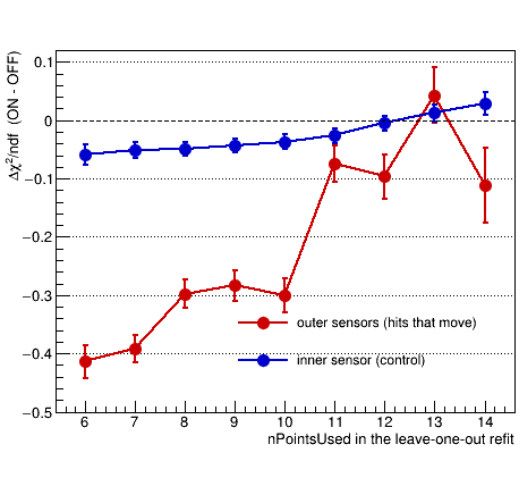
2 outer sensors with 1 degree gap

→ Code had 1 degree offsets sign reversed and 2 sensors were overlapping

→ Track quality improves after fix







Are there overlaps of strips at outer sensors at edge of wedges to next wedge?

→ Should we have 2 hits for a track from the same disk? Are we seeing that at edge?

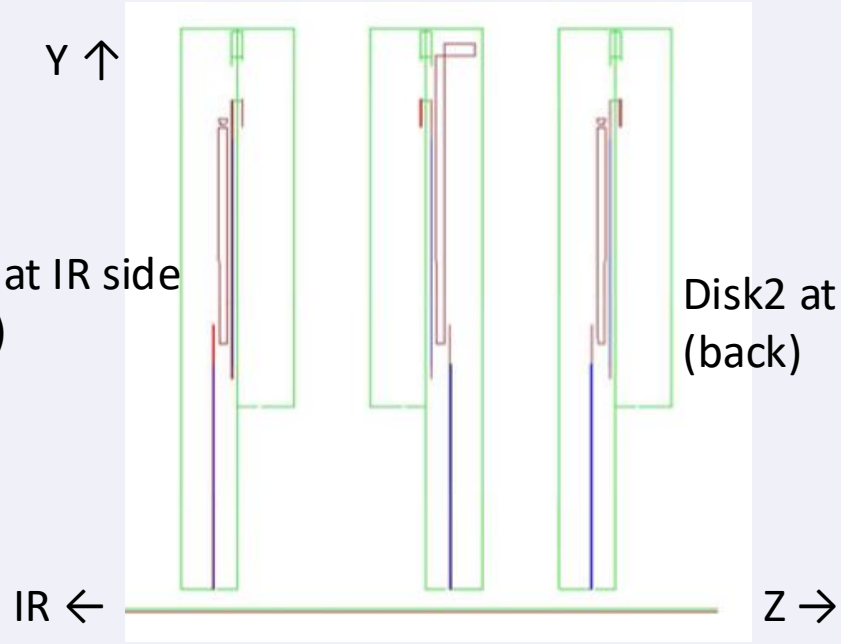
→ Do we add that to tracking?

FST Wedges reversed/flipped?

https://drupal.star.bnl.gov/STAR/system/files/FST_Wedge%20issues_ver_2.pdf

- FST wedges are placed at “front” (away from IR)/“back” (facing IR) for even/odd (disk0 & disk2) and odd/even (disk1) wedges
- GEANT geometry (xml file) has wedge#0 (phi=60-90 degree=near top & south/x>0) are at back (disk0 & disk2) and front (disk1)
- Offline code is consistent with GEANT geometry
- Flemming thinks both GEANT and Offline geometry got it wrong based on photos of the detector before installation
- If this is indeed true, hits near edge of wedges move up to ~30degree in phi, while hits at middle of wedge does not move as much
  - But ALL wedges does phi mirroring at the same time → FST only tracks still looks good (unless it goes over to next wedge within a track)
- It also moves hits in Z, especially for inner sensors (much less for outer sensors)

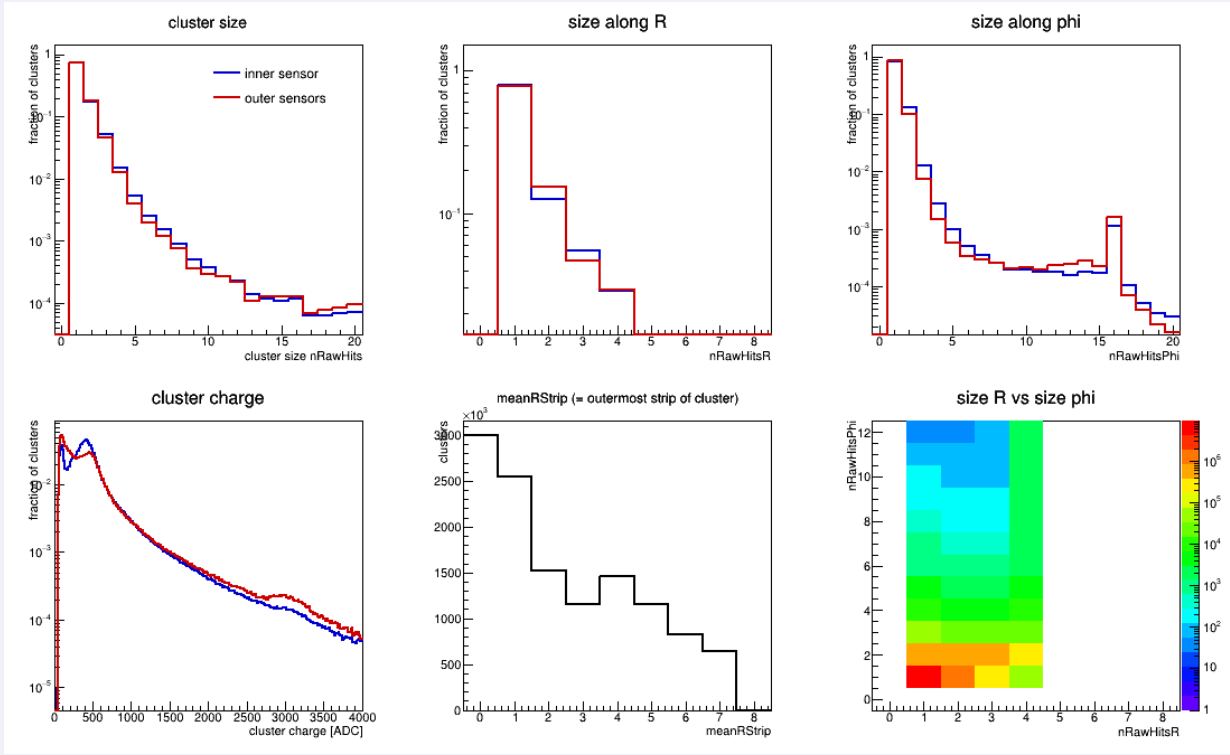
GEANT Drawing at x=+0.5cm (wedge=0)



FST Clusters in Real data

- https://www.star.bnl.gov/protected/spin/akio/fcs/FstSlowSim/fstclus/index.html

- Analysis on MuDst for run23081008, 13 files, 128,749 events, 12,302,393 clusters
- ~85% single phi strip clusters
- ~80% single R strip clusters
- Same phi & multi R strips clusters
  - Up to 4 R strips in a sensor and NOT needed to be r-adjacent! (hits in R=0 and R=3 with no hits in R=1 & 2 will be clustered)
  - Intended to kill cross talks in same phi strips?
  - Hit position is assigned from the largest R hit (and not mean R, not smallest R, not biggest charge hit's R)… Why?
    → This need careful look & help from experts
- Small peak (0.13%) at clusters with 16 phi strips
  - Aligned to fixed 16-strip boundaries in APV
  - Exist on all APVs
  - No cut on this… We are feeding them to tracking

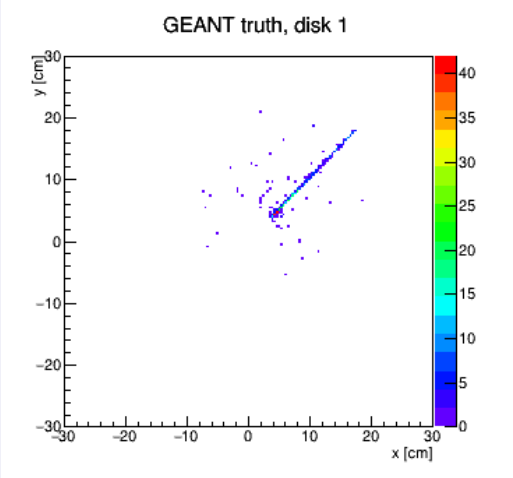


FST Slow Sim Maker

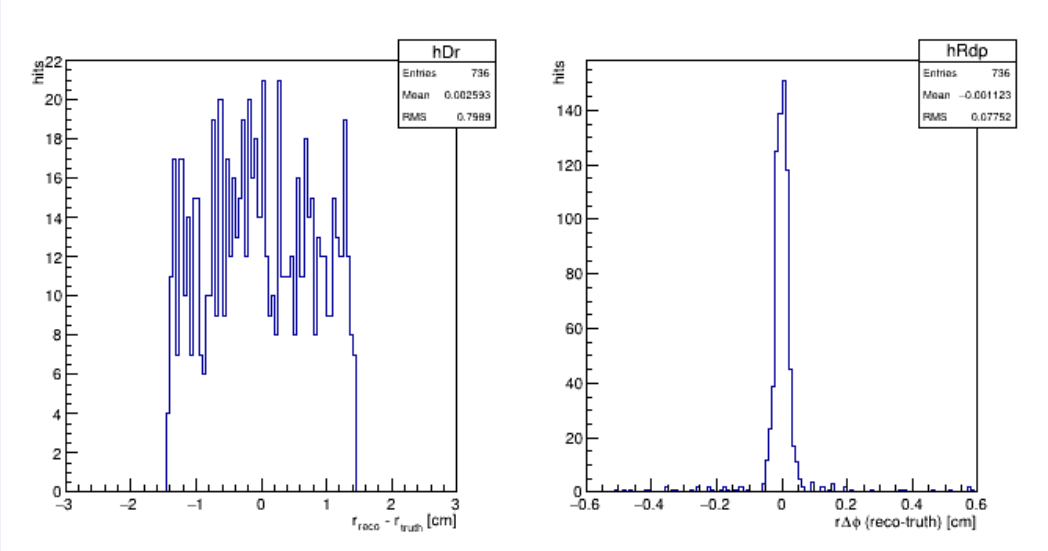
https://www.star.bnl.gov/protected/spin/akio/fcs/FstSlowSim/Index.html

- StFstFastSimMaker skips clustering & geometry & mapping by producing xyz hit points from GEANT hits
- Copy from StIstSlowSimMaker to make StFstSlowSimMaker
- MC chain will run (almost) identical makers as real data chain
  g2t_fsi_hit -> StFstSlowSimMaker -> "fstRawAdcSimu" -> StFstRawHitMaker -> StFstClusterMaker -> StFstHitMaker
- FST clusters in real data (see previous page)
  - https://www.star.bnl.gov/protected/spin/akio/fcs/FstSlowSim/fstclus/index.html
  - Most of hits (~85%) are single phi strip clusters
- For now, StFstSlowSimMaker creates
  - Single strip hit per GEANT hit (not making ~10% of >=2 strips clusters)
  - Charge model is from IST → 3.87 MeV/cm and MIP = 441 ADC
  - No noise
- Expected R and Phi residuals with small test single particle MC samples
- Need full test with PYTHIA MC

Hits from
45 degree electrons

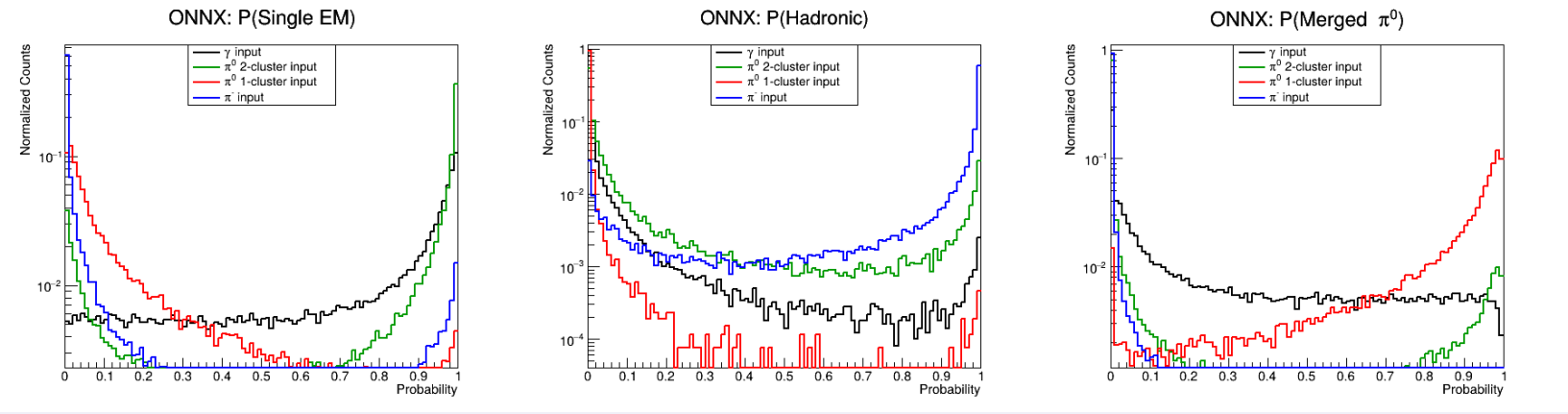


dR and R*dPhi



Ecal Cluster Categorization using ML for EPIC forward ECAL

- Started with ROOT TMVA but it was suggested to use ONNX for parallel processing (and better ML options?)
- Now using ONNX + Catboost (needs library and python modules… I've struggled a bit on matching versions)
- 3 way categorization : Single EM shower, Merged pi0, Hadron
- 34 input variables : Cluster Energy, x, y, # of hits, Radius, Dispersion, SigmaMin, SigmaMax, 5x5 tower energies, energy outside 5x5



- Trained to equal sample of gamma,pi0,pi- MC samples of 0-80GeV
  - Pi0 samples at low energy with 2 clusters
    - → single EM shower (training) sample
- Purity is for this (unrealistic) MC sample mix
- Naturally, it gets very hard to tell single gamma (or electron) from merged pi0 at high energy. It requires careful studies to quote efficiency & purity numbers

→ Still need to reconcile with old study of

"~5% π0 contamination @ 50GeV π0"

A student (Xilin) is interested in porting this to STAR FCS (EPIC forward Ecal codes with both TMVA and ONXX available)

1. Pico DST analysis code? MuDst->Pico DST afterburner? Or StEvent Maker for future BFC option?
2. TMVA or ONNX?