Simulations for fSTAR tracking solutions

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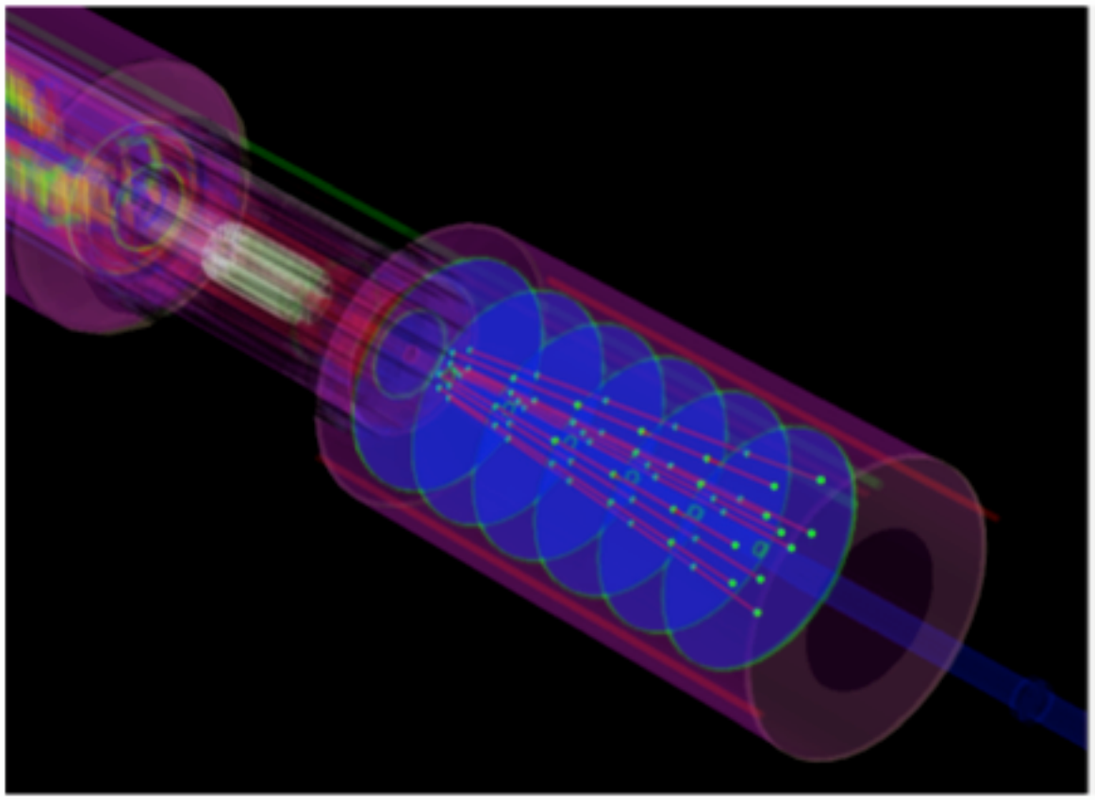
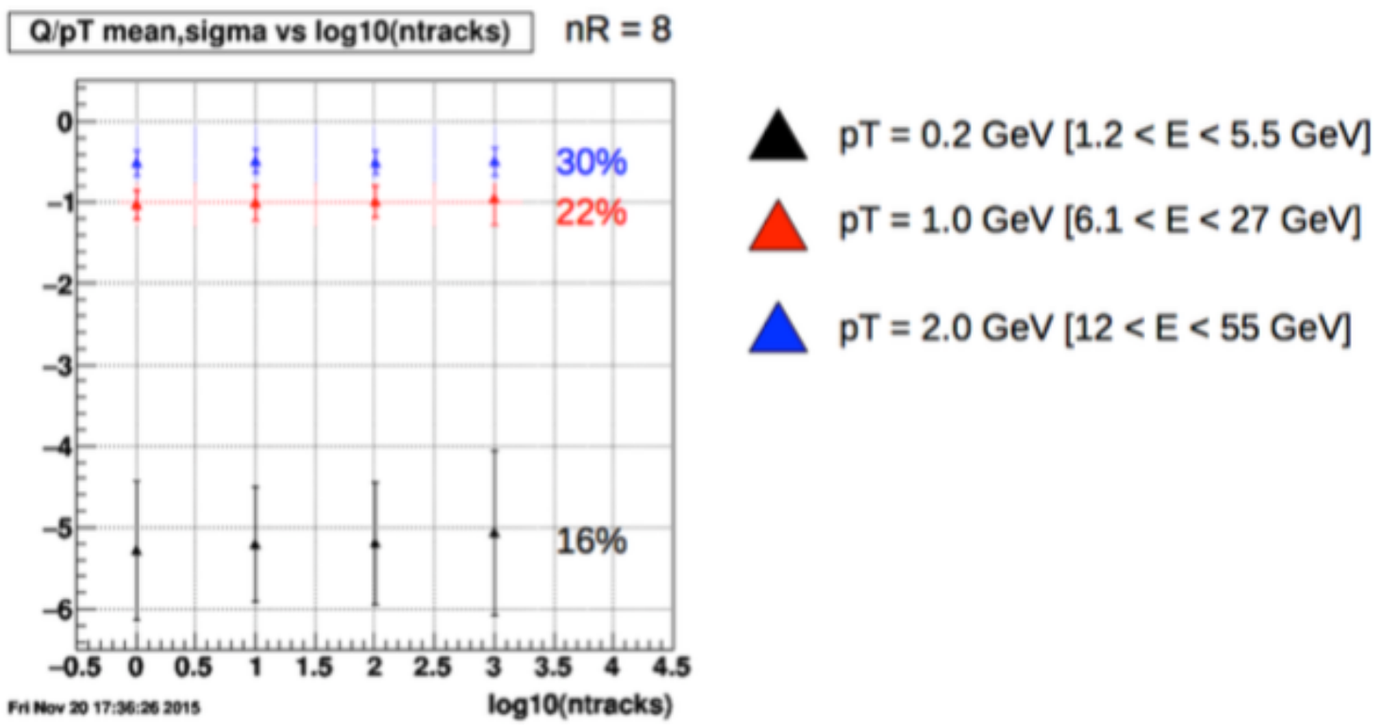
Introduction

- Goals:
  - Good tracking efficiency even in high multiplicity AA events
  - Good charge sign discrimination through p_T=2.0 GeV/c
- Framework:
  - Fully integrated AGML geometries in STAR's simulations
  - MC with 1, 10, 100, 100 muon tracks in 2.5<eta<4.0 acceptance, 2π originating from (0,0,0)
  - Utilize simple fast simulators
  - Utilize STAR's forward-capable "Stv" tracker
    - Assume the primary vertex position will be well-defined (~50 μm, e.g. reconstructed from TPC first) and used in reconstruction of forward tracks
- Two major configurations have been studied:
  - Silicon disks only
  - Silicon disks + sTGC planes

Silicon disks

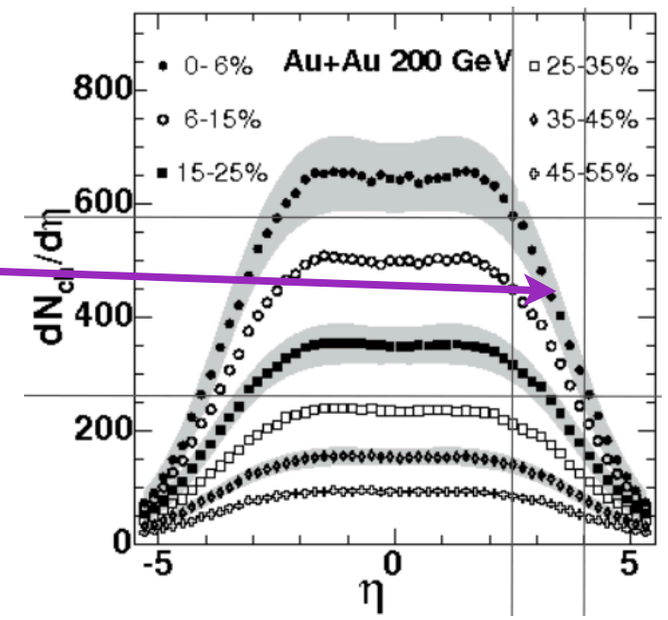


- z=70, 93.33, 116.66, 140, 163.33, 186.66 cm
- 12 wedges with 128 phi x 8 eta (radial) segmentation
- Good charge sign discrimination through p_T = 2 GeV
- Found some benefit to high-p_T reconstruction by rastering (transversely offsetting geometries) to avoid tracks globally falling into a single line of detector segments

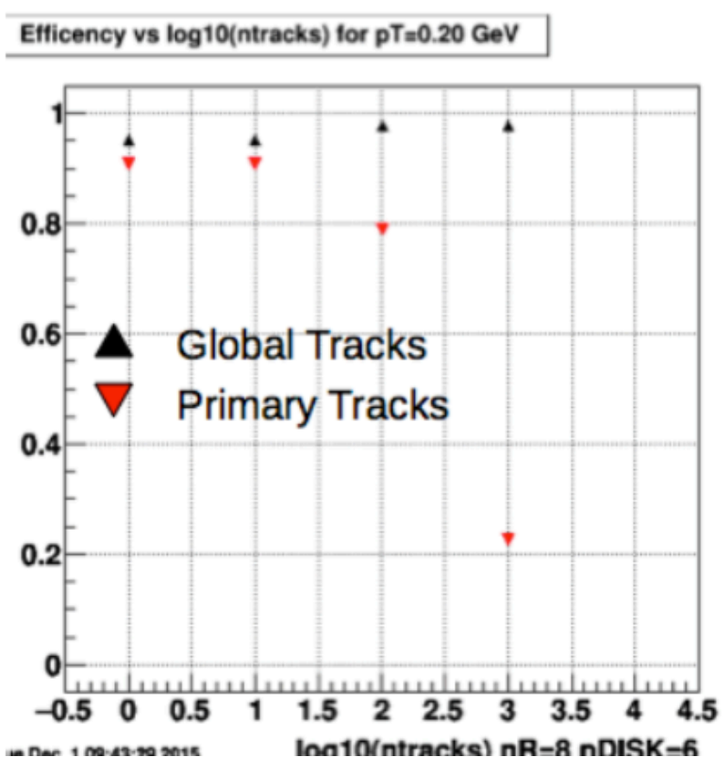


Silicon disks

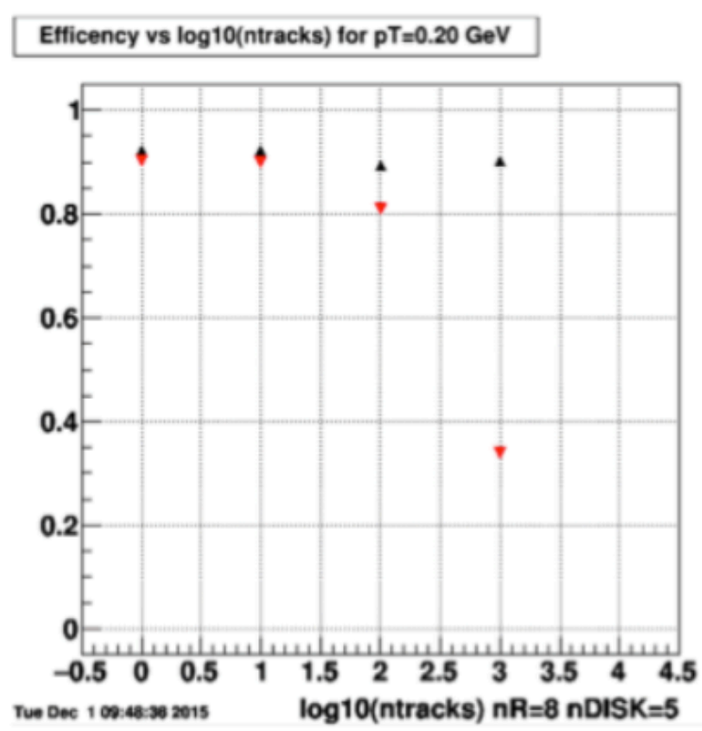
- Efficiencies drop at high track densities
  - Central AuAu200 will be several hundred
- Using only 4 disks brings efficiency losses
  - Implies the need for 5 (or 6 to cover hardware outages) disks



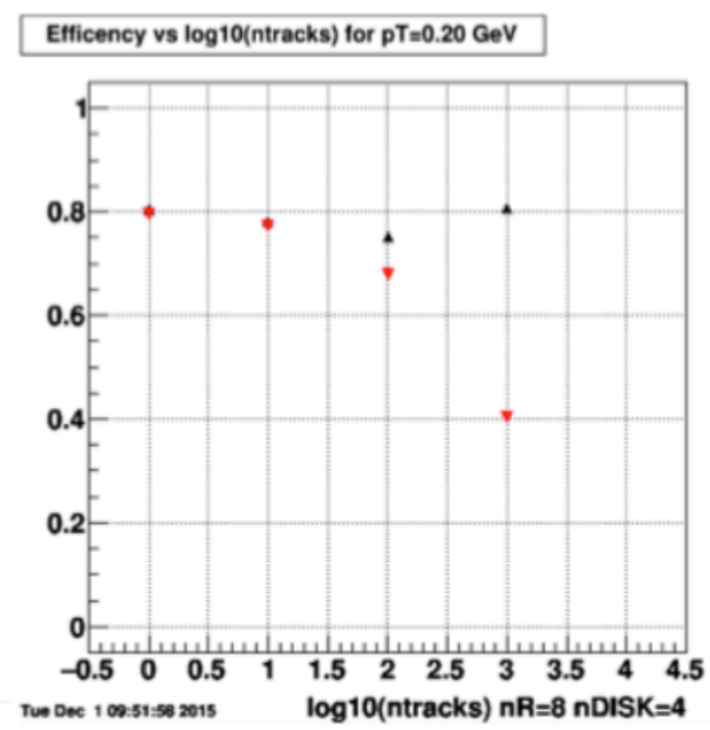
6 disk 8 R 128*12 PHI



5 disk 8 R 128*12 PHI

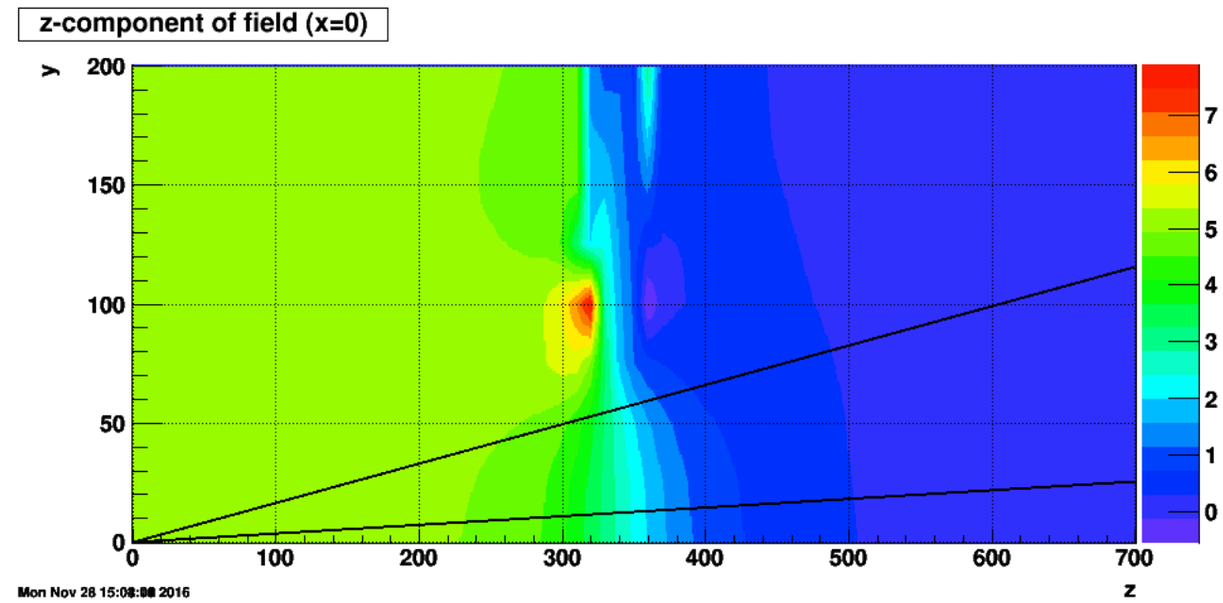


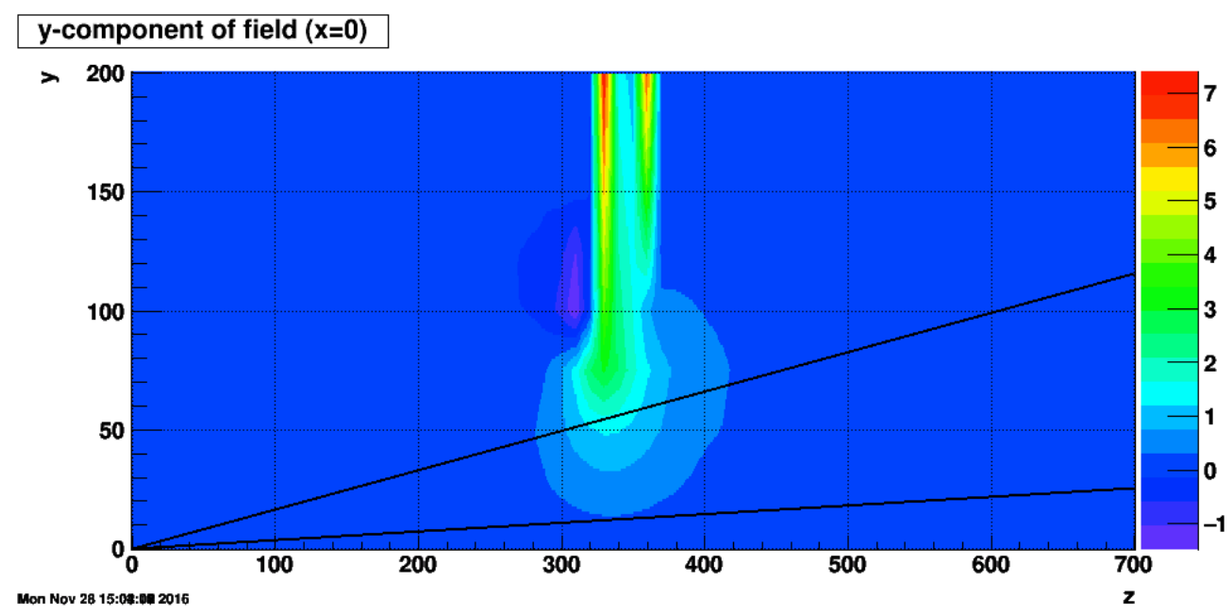
4 disk 8 R 128*12 PHI



sTGC placements

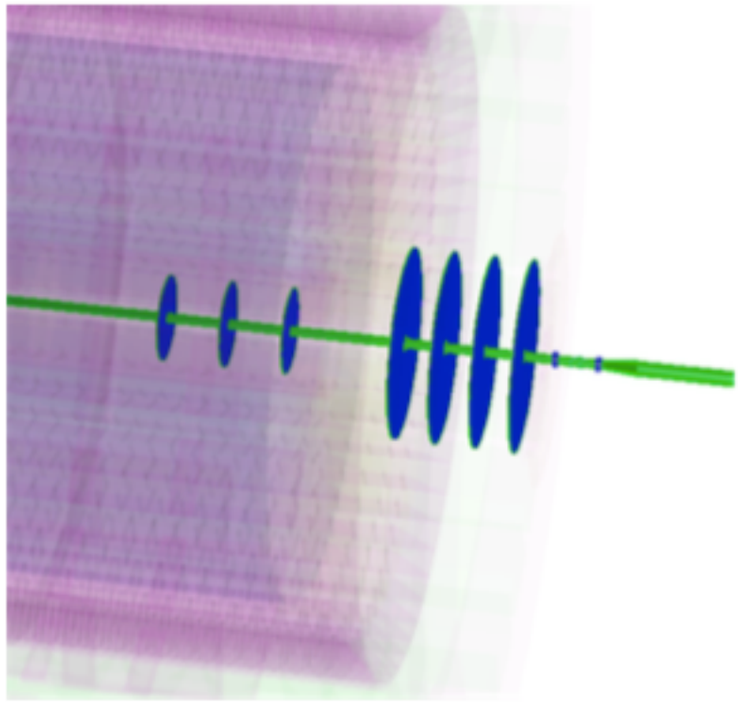
- How far out can we push the tracking?
  - Tracking through varying field orientations (i.e. from longitudinal through to transverse magnetic fields) not well-developed in STAR [in progress]
  - Mitigation:
    - Place tracking only out as far as where it is predominantly longitudinal
    - Separate the issues: assume constant longitudinal field for now, demonstrating what can be done when the field is well-accounted; properly accounting is a longer term effort



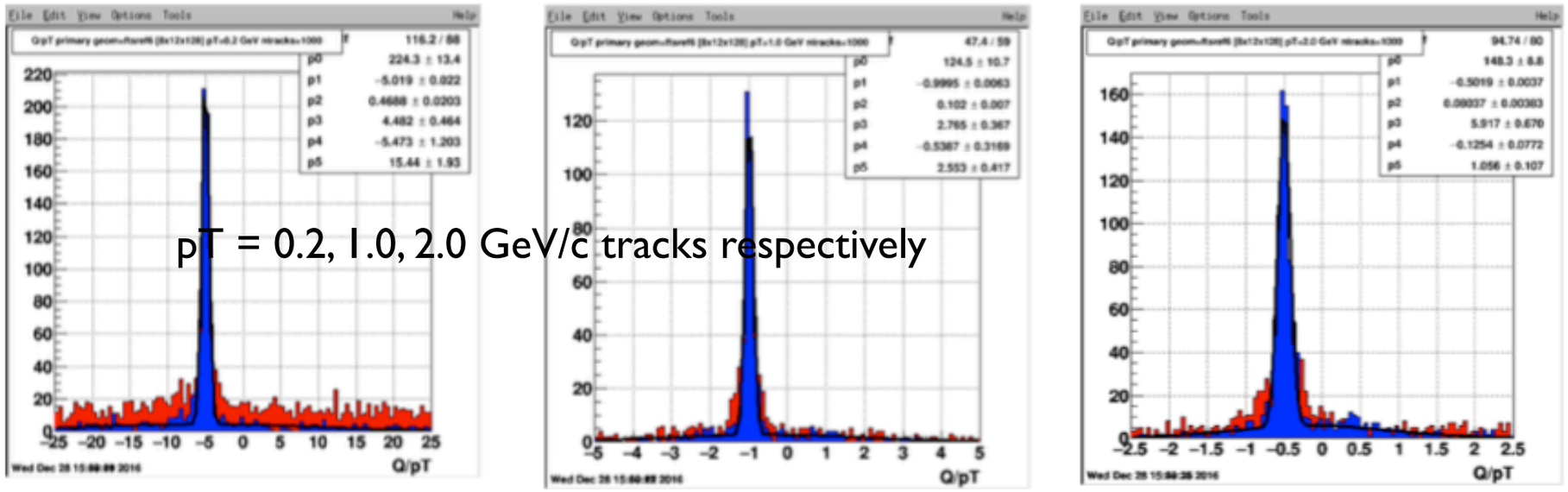


Silicon + sTGC

- Silicon disks at z = 93.33, 140, 186.66 cm
- sTGC z = 273, 303, 333, 363 cm
  - Orient strips to give better phi resolution (demonstrably improves efficiencies)
  - Rastering not particularly helpful
  - 5 sTGC disks no significant benefit over 4
- Good charge sign discrimination
  - Plots below show there are errant signs at just the few percent level



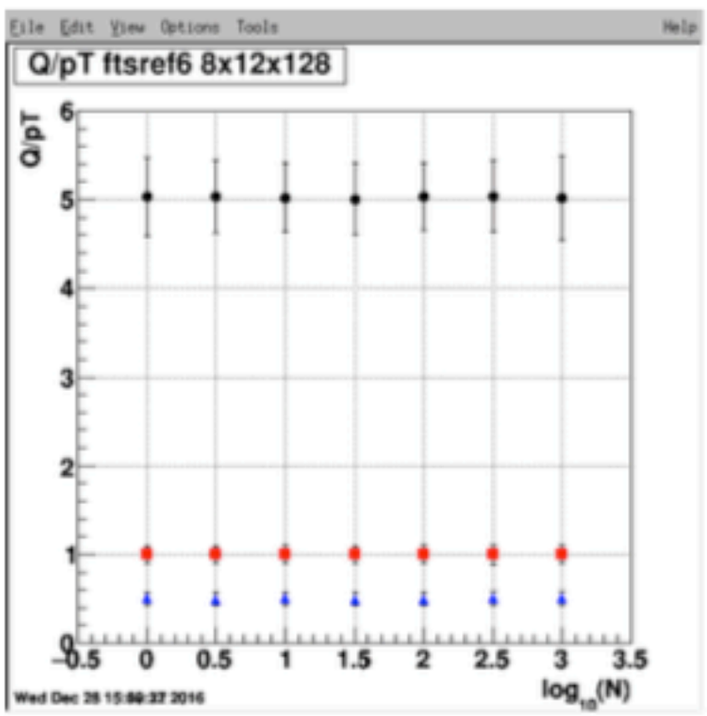
Blue: MC-matched global tracks
Red: fake global tracks

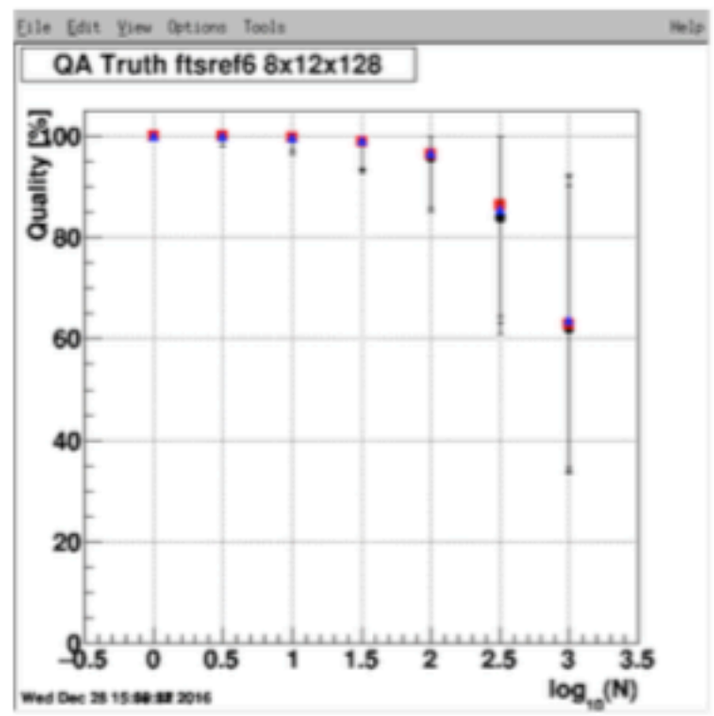


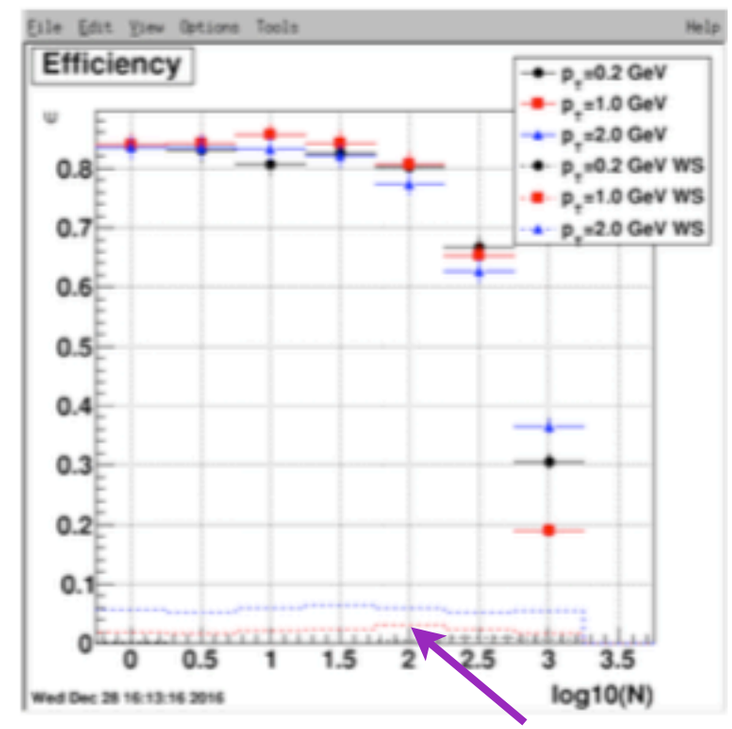
pT = 0.2, 1.0, 2.0 GeV/c tracks respectively

Silicon + sTGC

- Performance vs. multiplicity
  - "Shoulder" around a few hundred tracks
- NB: tracking efficiencies were improved for sTGC studies by introducing hit re-use methodology not employed for silicon-disk-only studies





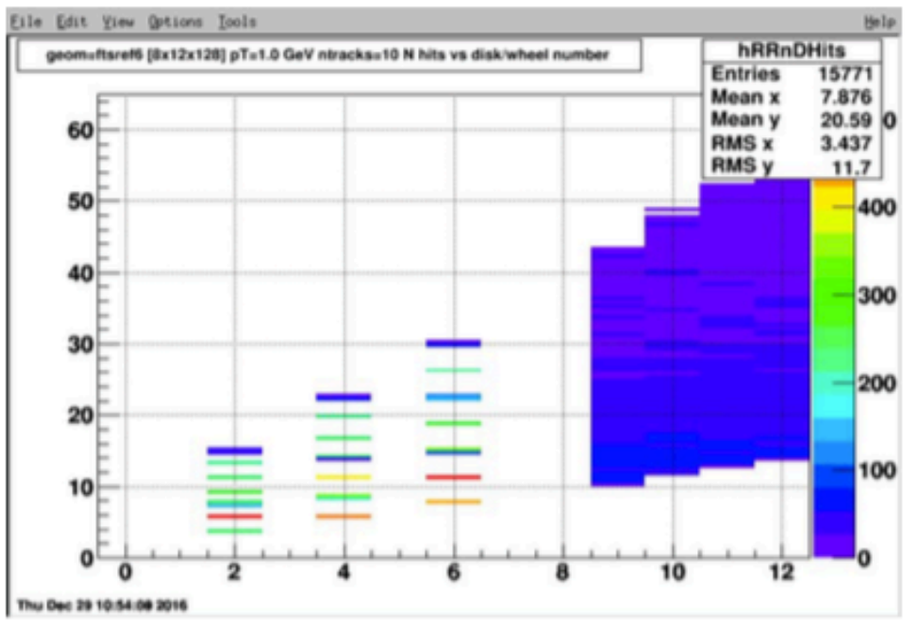


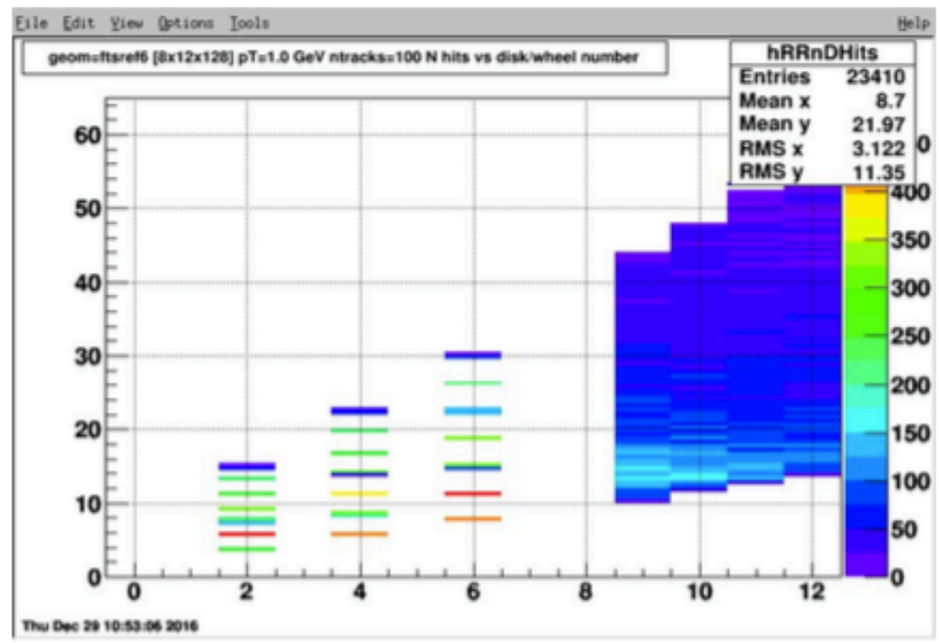
Level of charge sign misidentification

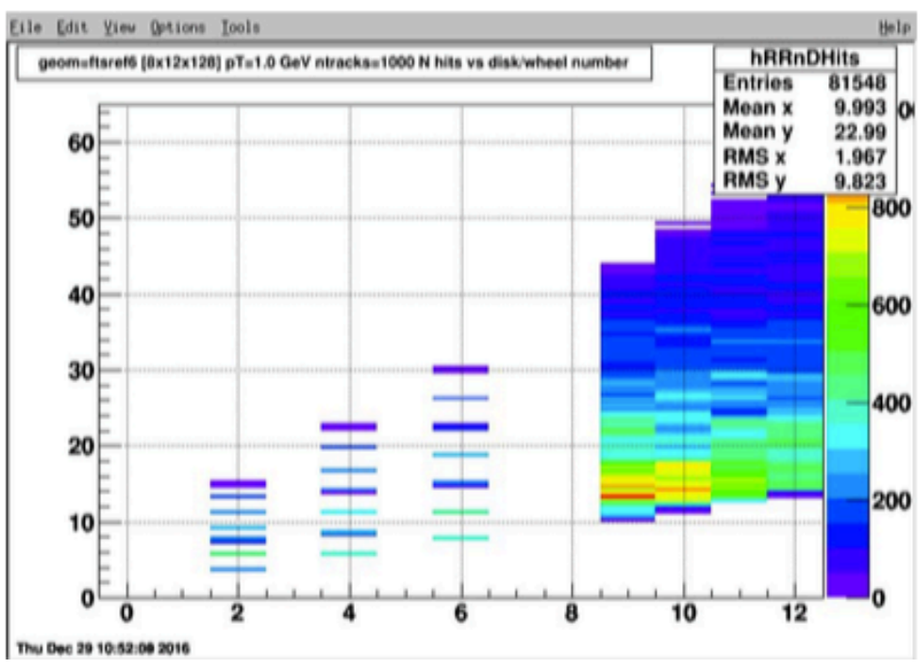
Quality: % of hits on reconstructed track that truly belong to the MC track

Silicon + sTGC

Hit Density vs Disk/Wheel number [y-axis is hit radius]





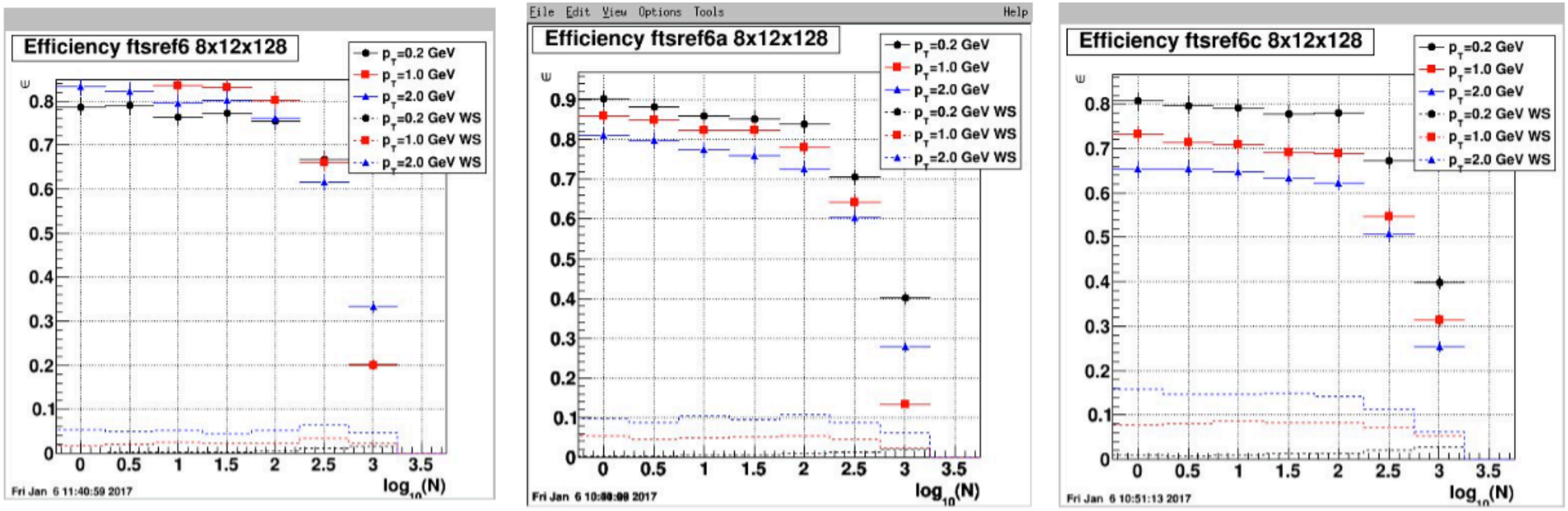


10, 100 and 100 tracks / event. (Total of ~2000 tracks in each sample.)

Increasing track density results in increase in hit density in the inner-most radii of the FTS wheels -- wire chamber ambiguities...

Silicon + sTGC

- Placement of silicon disks is a trade-off game



Disks shifted east (toward vertex)
Efficiency drops
Wrong sign *decreases*

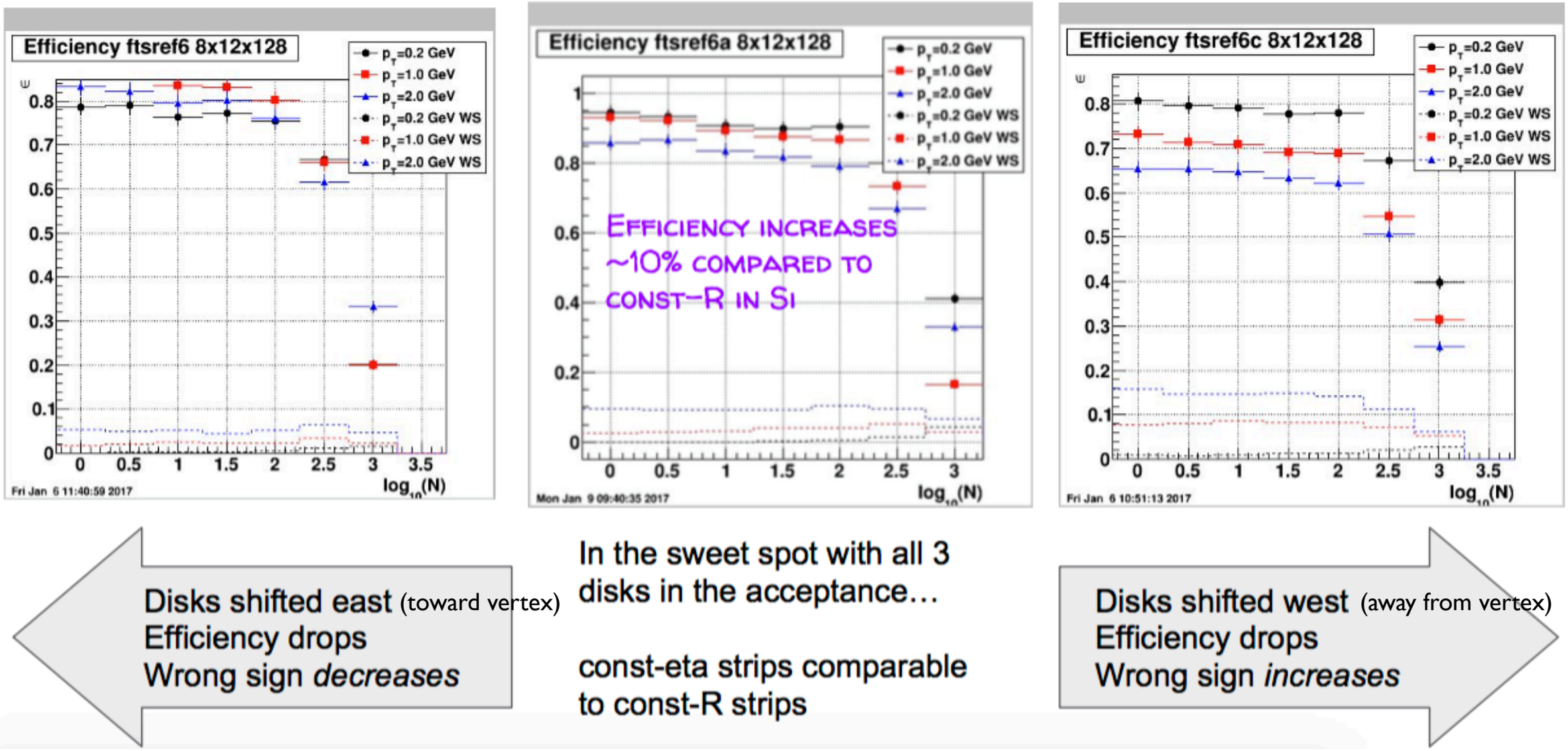
In the sweet spot with all 3 disks in the acceptance…

const-eta strips comparable to const-R strips

Disks shifted west (away from vertex)
Efficiency drops
Wrong sign *increases*

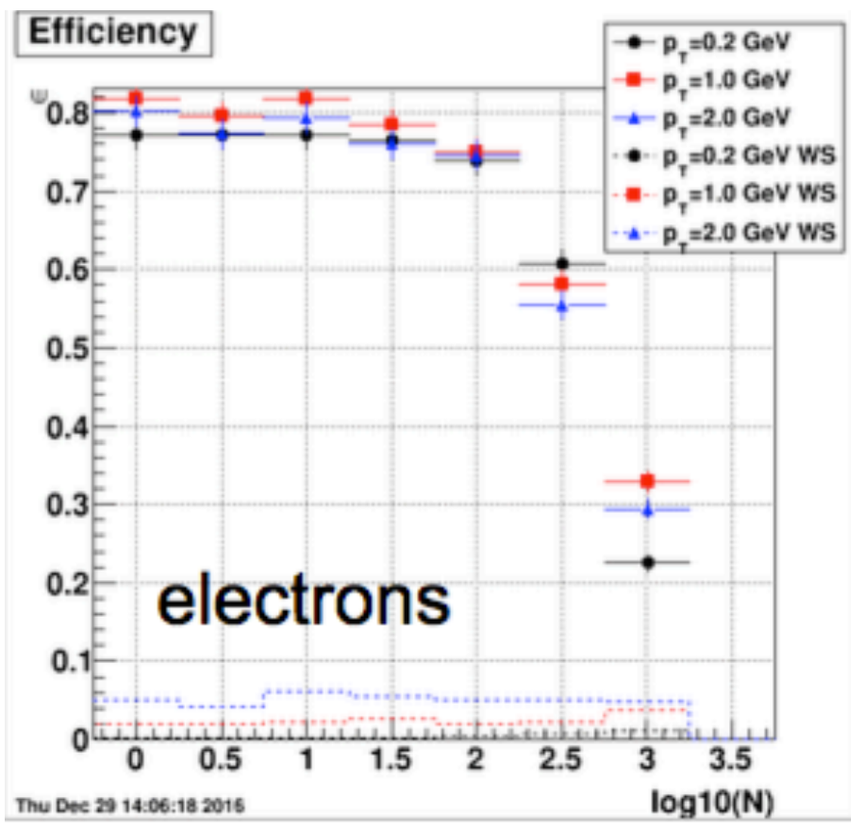
Silicon + sTGC

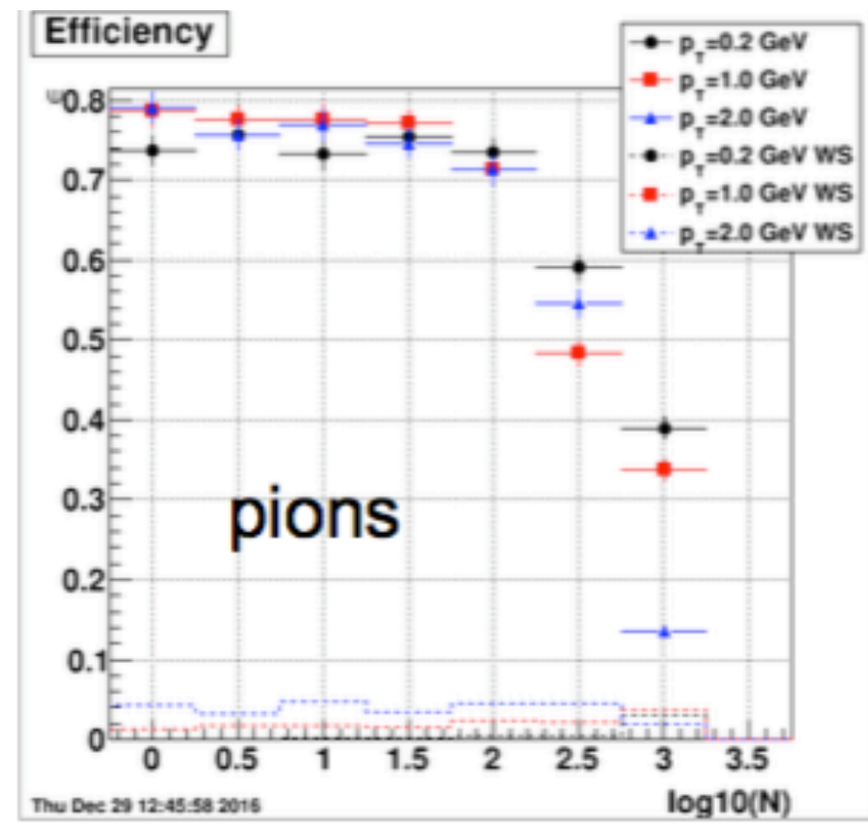
- Changes to segmentation strategies show room for improvement

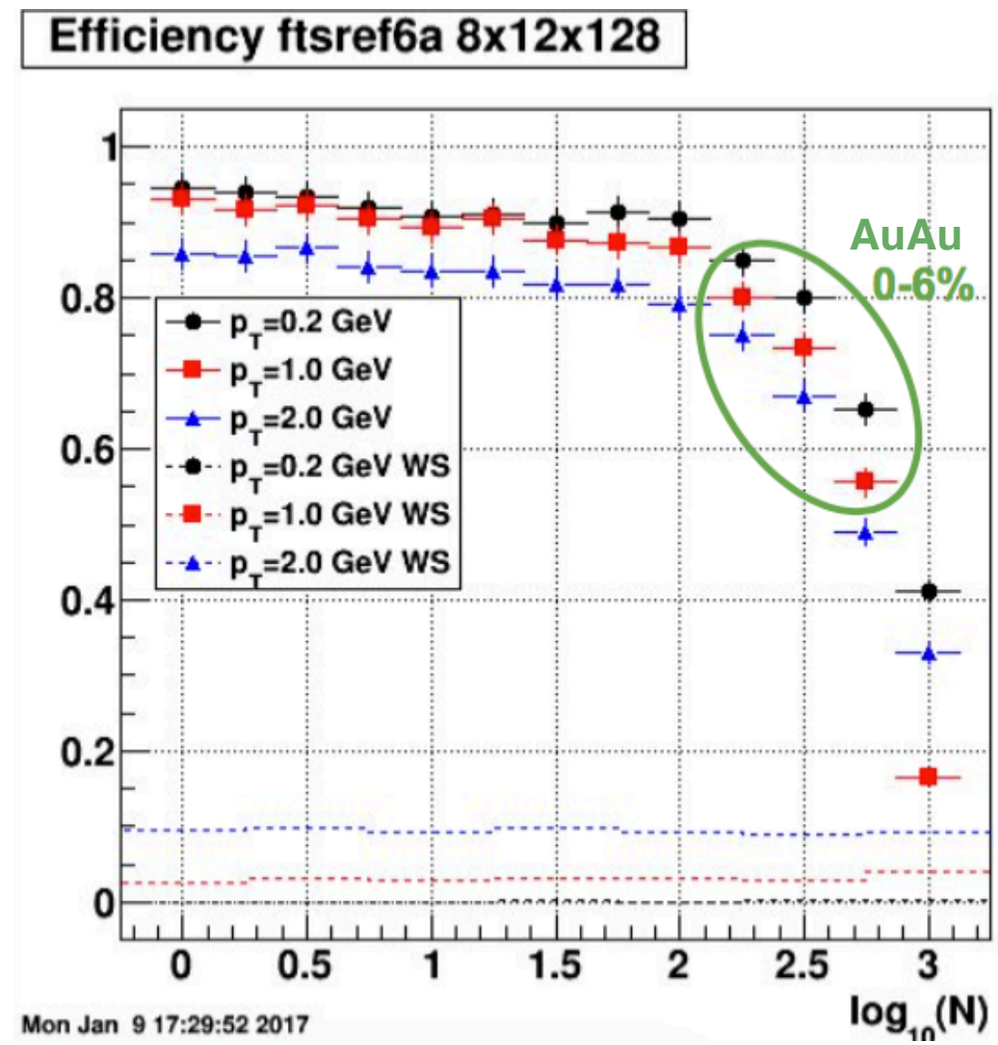


Species independence

- Ran MC with electrons and pions instead of muons and found no notable differences





Summary

- Full simulation in STAR (modulo slow detector simulators) with real tracking demonstrating ability to meet physics-based requirements
- Continuing R&D on tracking improvements:
  - Full accounting of magnetic field
  - Reducing ghost hits from sTGCs (ambiguities in matching of strip and pad hits)
  - Tree search for track-finding (slower, but may be worth it)
  - Modifications to the usual outside-in method of finding hits for tracks