# Drift Chamber Study in Tracc

Beomki Yeo

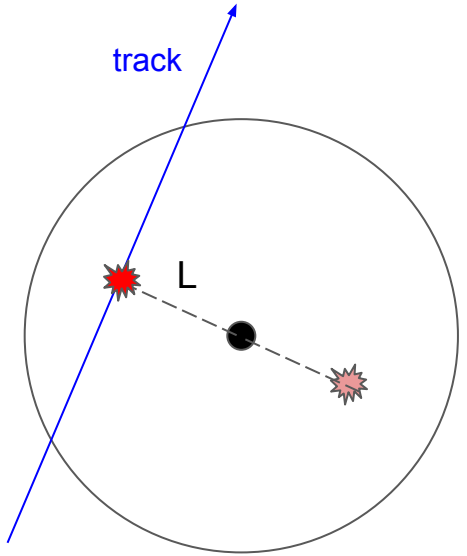




# Motivation

- One of the difficulties in wire measurement is the left-right ambiguity where we need to consider two hits for a measurement (one is real, the other is a ghost)
- On top of the LR ambiguity, the projection matrix for wire measurement is not quite correct in ACTS
  - It produces measurements with a non-negative drift distance!
- In traccc side, I've dealt with this issue by modifying the projection matrix properly
- In ACTS core side, there is an ongoing PR for this

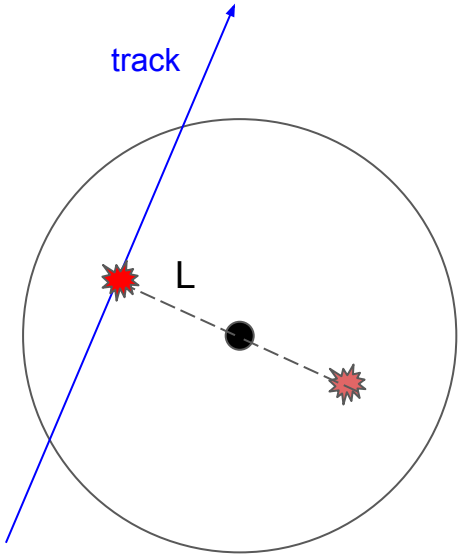
**Wire Measurement Schematics**



# Projection Matrix

- (Barrel) Pixel Detector
  - Local parameter: (x, y, theta, phi, q/p)
  - Measurement: (x, y)
  - Projection Matrix: $\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{pmatrix}$
- (Barrel) Strip Detector
  - Local parameter: (x, y, theta, phi, q/p)
  - Measurement: (x)
  - Projection Matrix: $\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \end{pmatrix}$
- **Wire Detector**, e.g. Straw tube or Drift Chamber
  - Local parameter: (±L, z, theta, phi, q/p), where L > 0
  - Measurement: (L)
  - Projection Matrix: $\begin{pmatrix} \pm 1 & 0 & 0 & 0 & 0 \end{pmatrix}$

**Wire Measurement Schematics**




The sign is determined by whether the DOCA is on left or right w.r.t wire

# Simulation & Reconstruction Setup

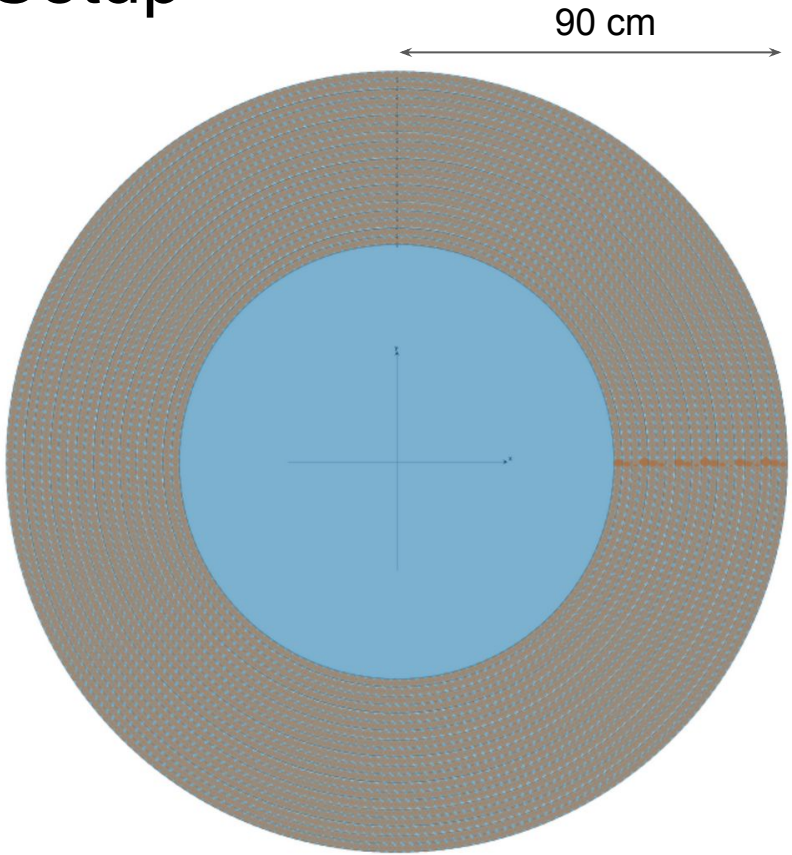
Simulation

- 20 layers of stereo wires
- 2 T bfield
- 100 GeV muon-like particles
- 20000 tracks
- Eta: [-1, 1]

Reconstruction

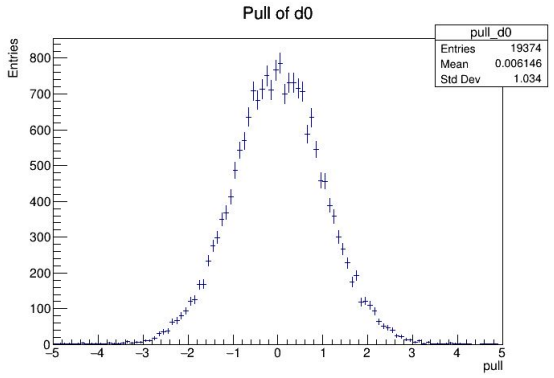
- Enough surface tolerance not to miss the wire (cross-section of wire is pretty small)
- Small step size ~ 1 mm
- Smear the initial track parameter enough

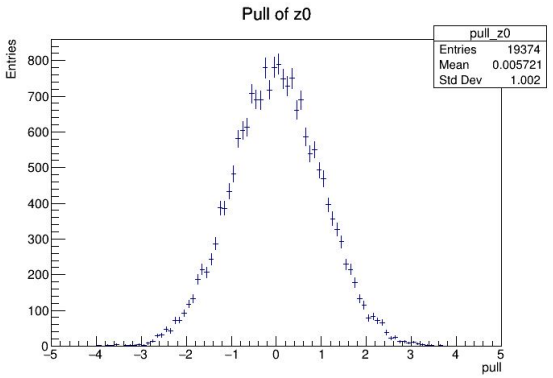
```
/// Standard deviations for seed track parameters
static constexpr std::array<scalar, e_bound_size> stddevs = {
    0.03 * detray::unit<scalar>::mm,
    0.03 * detray::unit<scalar>::mm,
    0.017,
    0.017,
    0.01 / detray::unit<scalar>::GeV,
    1 * detray::unit<scalar>::ns};
```

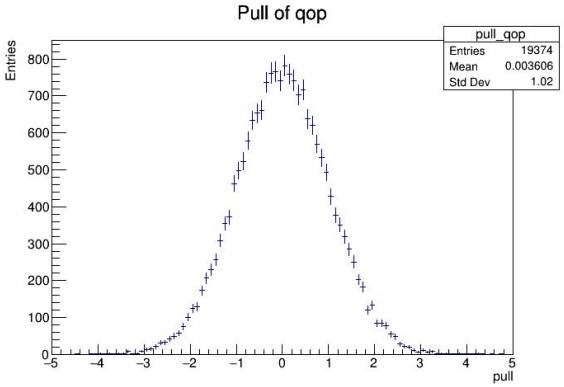


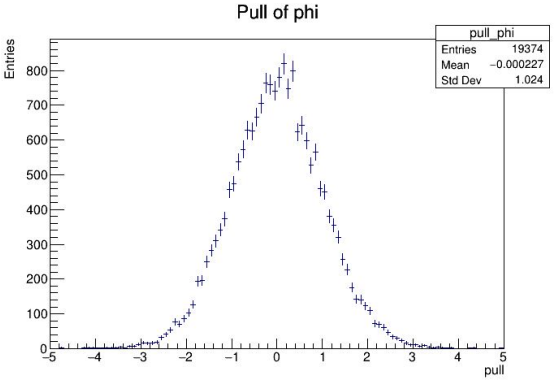

Courtesy of J. Niermann

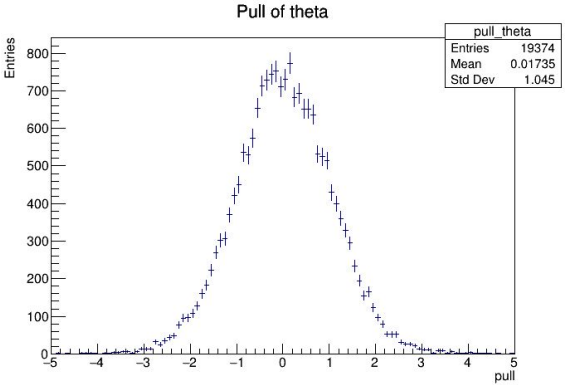
# KF Pull Value Distributions



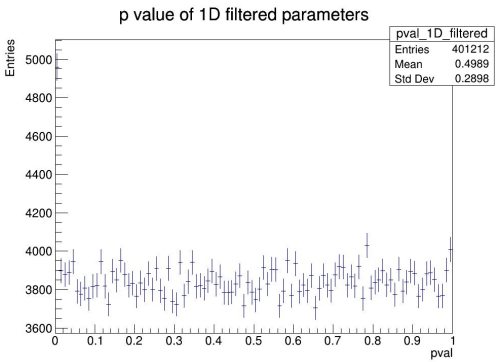



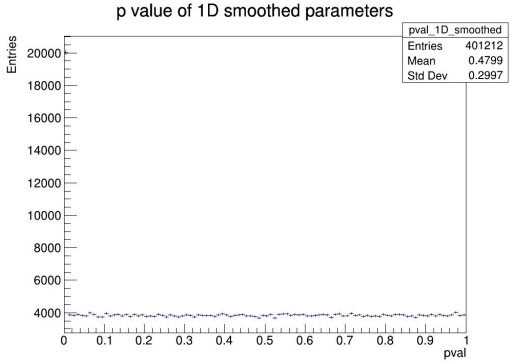




- ~600 out of 20000 events failed in track fitting

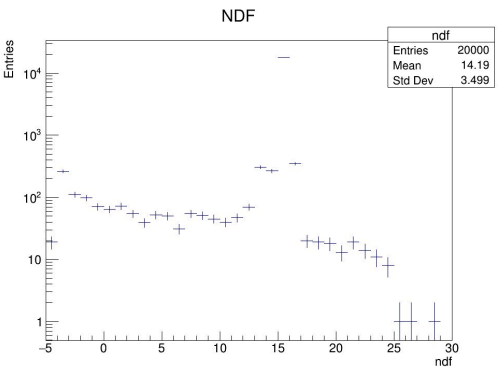
# KF Fitting Quality

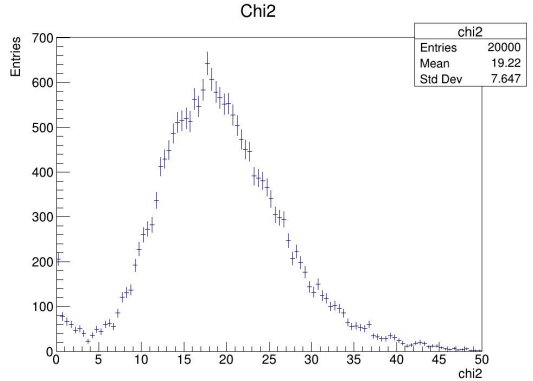
- Measurement-level fitting quality

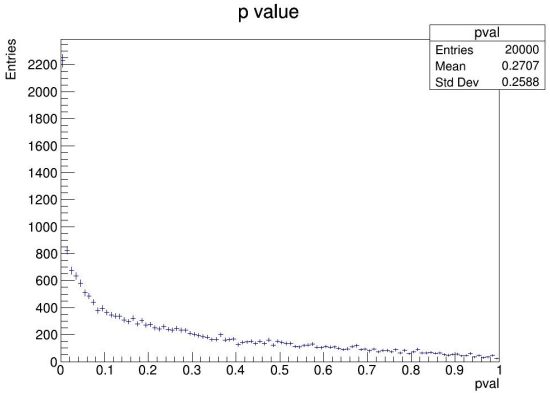



- Track-level fitting quality

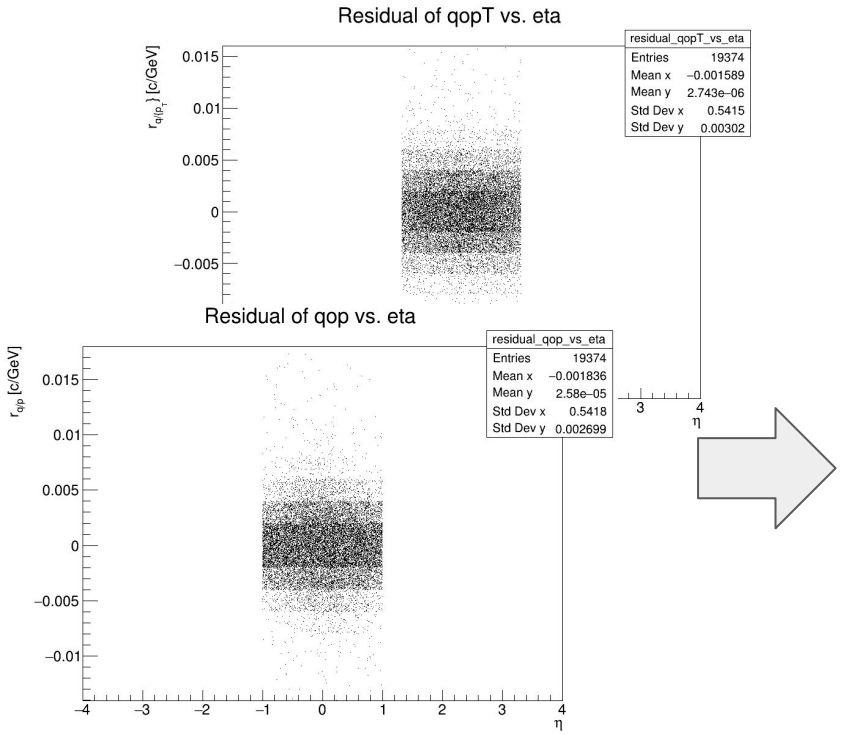


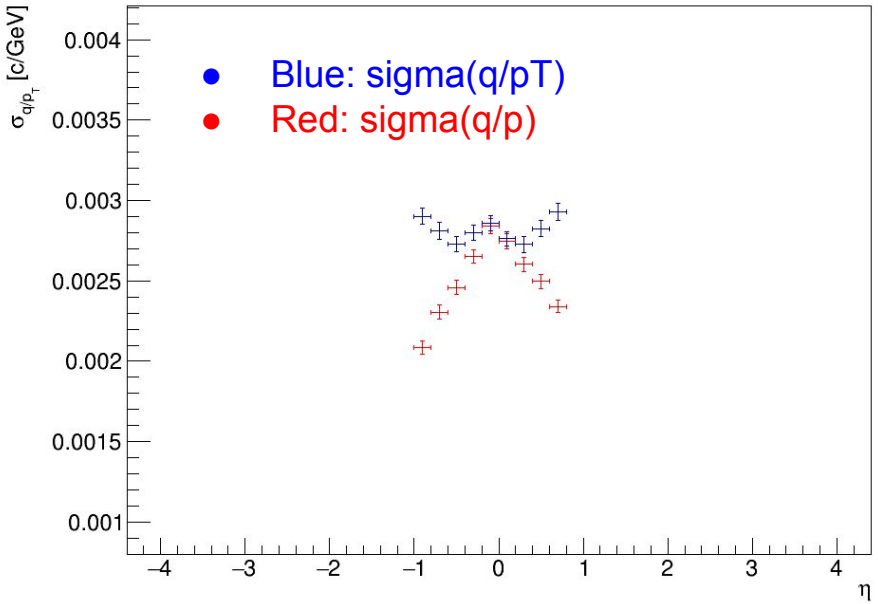




- Successful tracks should meet NDF > (#layers - 5) = 15

# KF Momentum Resolutions



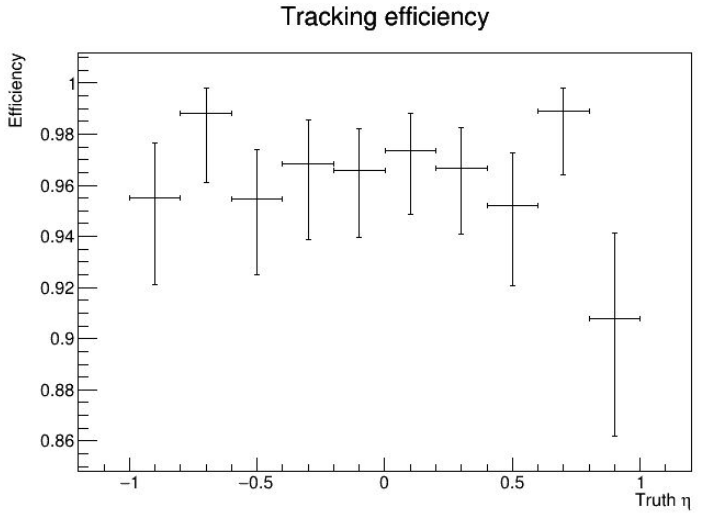

- Currently don't understand the boundaries in residual plots … :/



# CKF results with Low Occupancy

- CKF was also tested with low number of particles (100 tracks per event)
  - Currently the combinatorics explosion occurs too frequently with ~1000 tracks
  - A fix is ongoing to allow the high number of branches in CKF

- Tracking efficiency doesn't look bad



# Summary

- In traccc side, a wire measurement study was done with the drift chamber.
  - Projection matrix was modified properly to get the non-negative drift distance
- There are still some questions mark in residual plots but early result looks quite promising
- However, it should be noted that this study (or Kalman filter) can not resolve the left-right ambiguity - Just take this study as a baseline for the future methods
- As future methods, we can think of:
  - Applying the CKF for left and right hit, if one can control the combinatorics
  - Applying the Deterministic Annealing Filter (DAF) as Belle2 does