

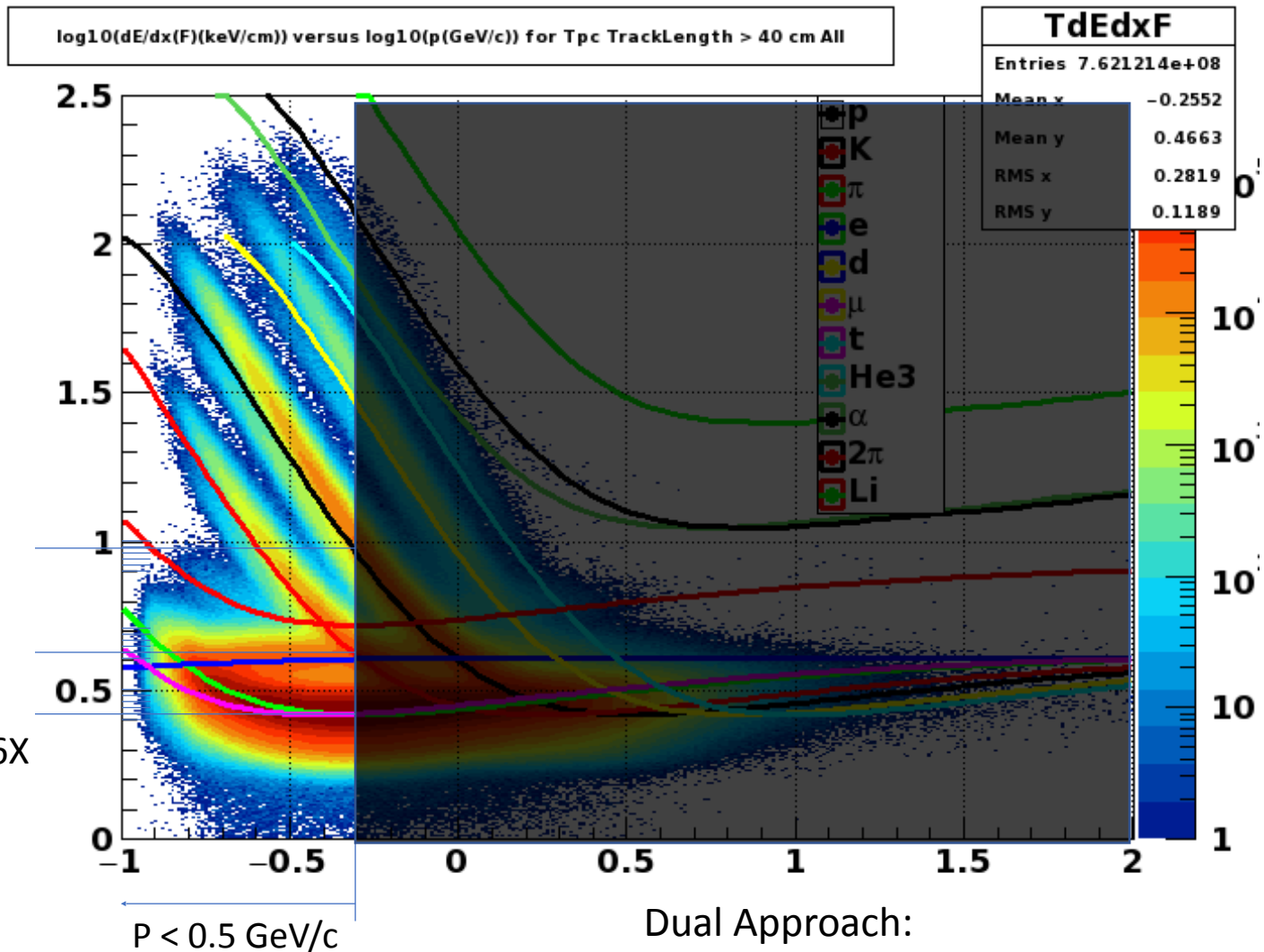


Low momentum PID at High B-field with GridPix

Current Group:

TK Hemmick, K Dehmelt, S Park, P Garg (SBU)
N Smirnov, (Yale)
J Kaminski (Bonn)

Restate the Problem

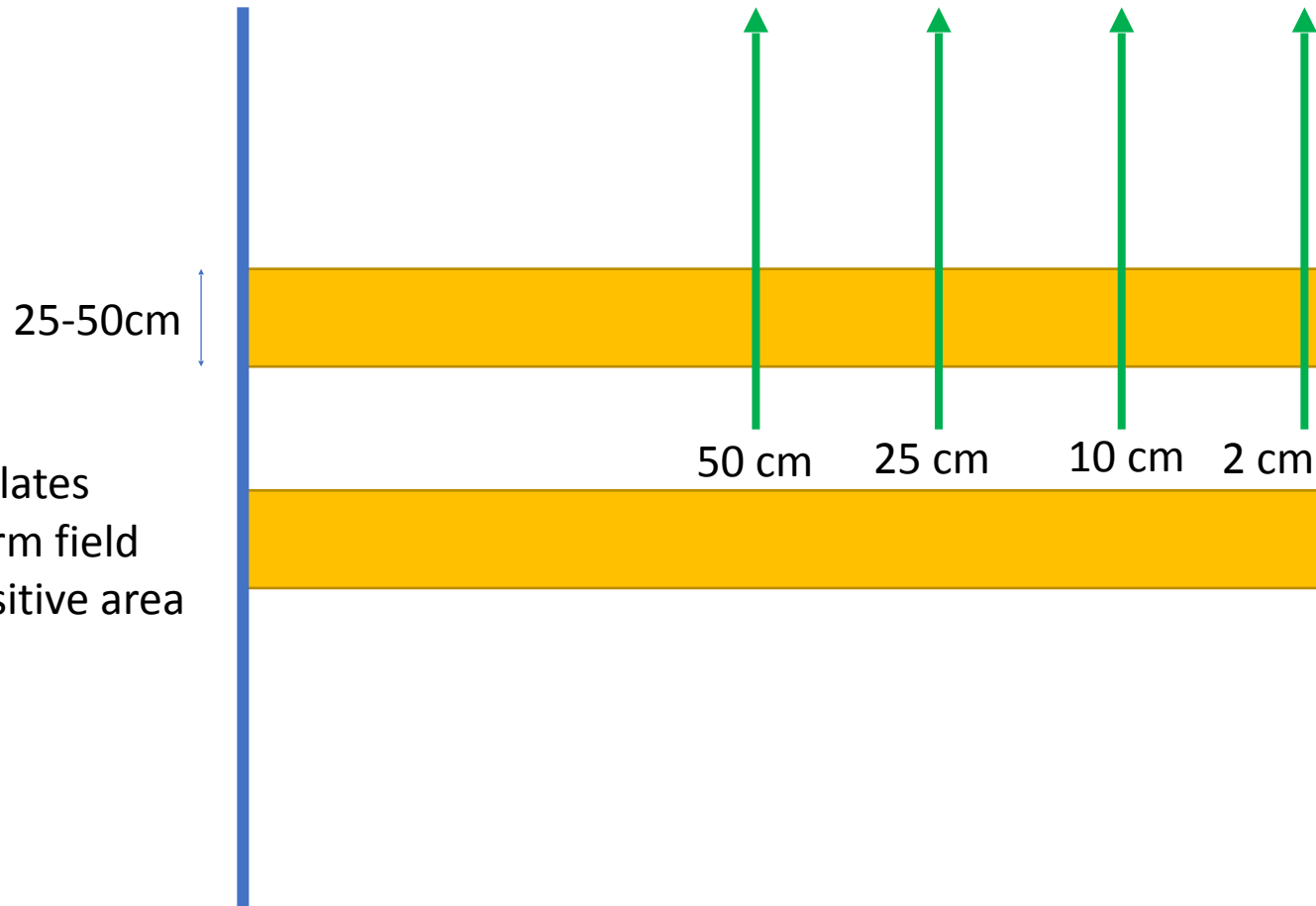


- DIRC has low-p limitations:
 - Curl Up (0.45 GeV/c)
 - Kaon threshold (0.47 GeV/c)
- Rather than lower the field:
 - PID at low radius.
 - dE/dx separations huge!
 - 1.6X pi-K
 - 2.25X K-p
 - GridPIX
 - Established
 - Robust
 - Excellent tracking

Dual Approach:

- Standalone Garfield (optimize detector)
- GEANT (integrate into full simulation)

Garfield Setup



- Use HUGE plates to get uniform field
- Limited sensitive area

- Simple Ntuple (for now)
- Designed to not change as studies evolve
- Ntuple: q, mass, p, theta, phi, zed, gas, B, E, track #, cluster #, x0, y0, z0, t0, xf, yf, zf, tf

ID

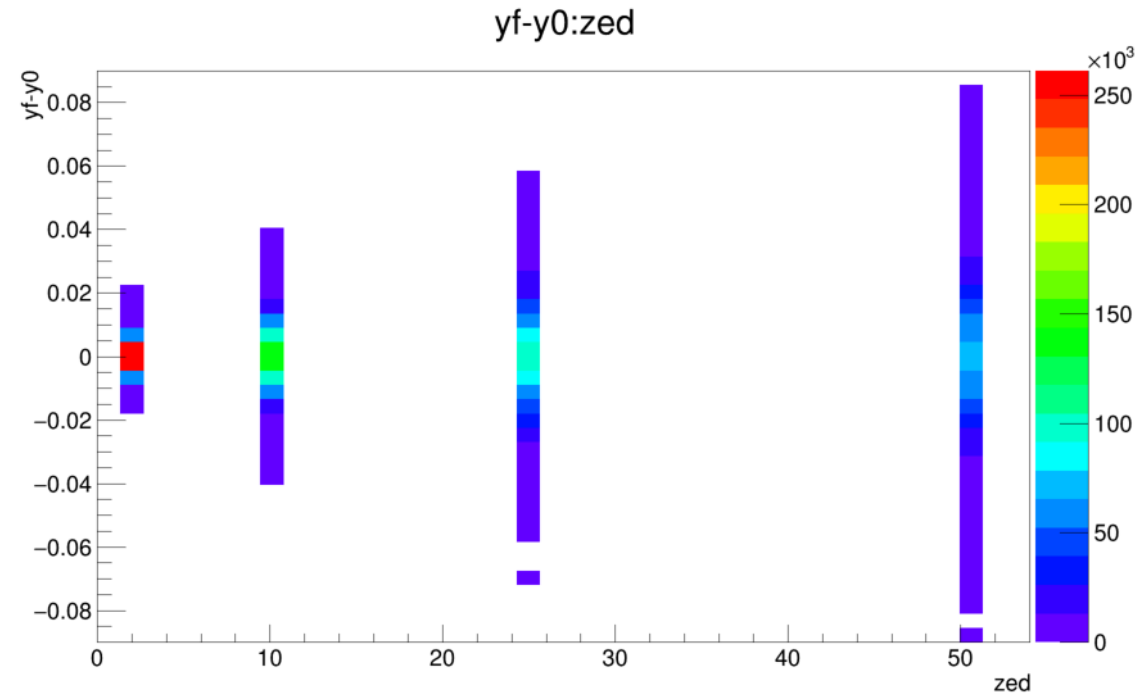
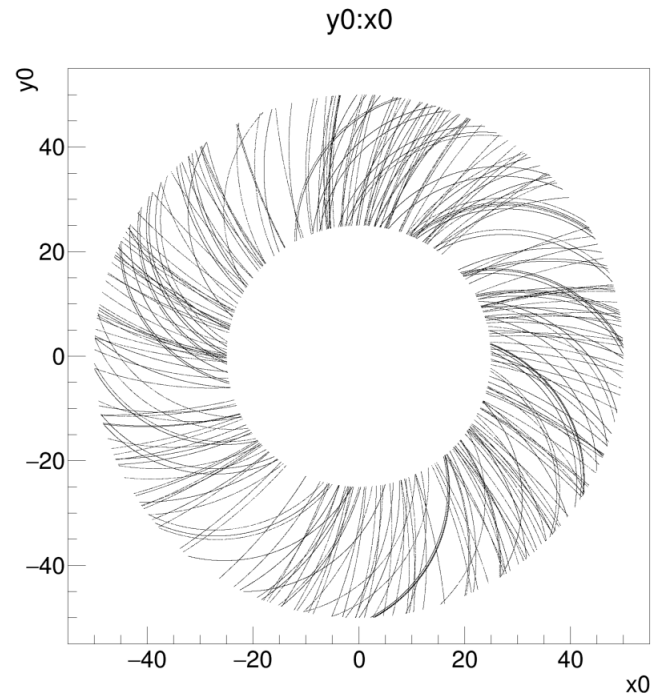
Kinematics

Detector

Electrons

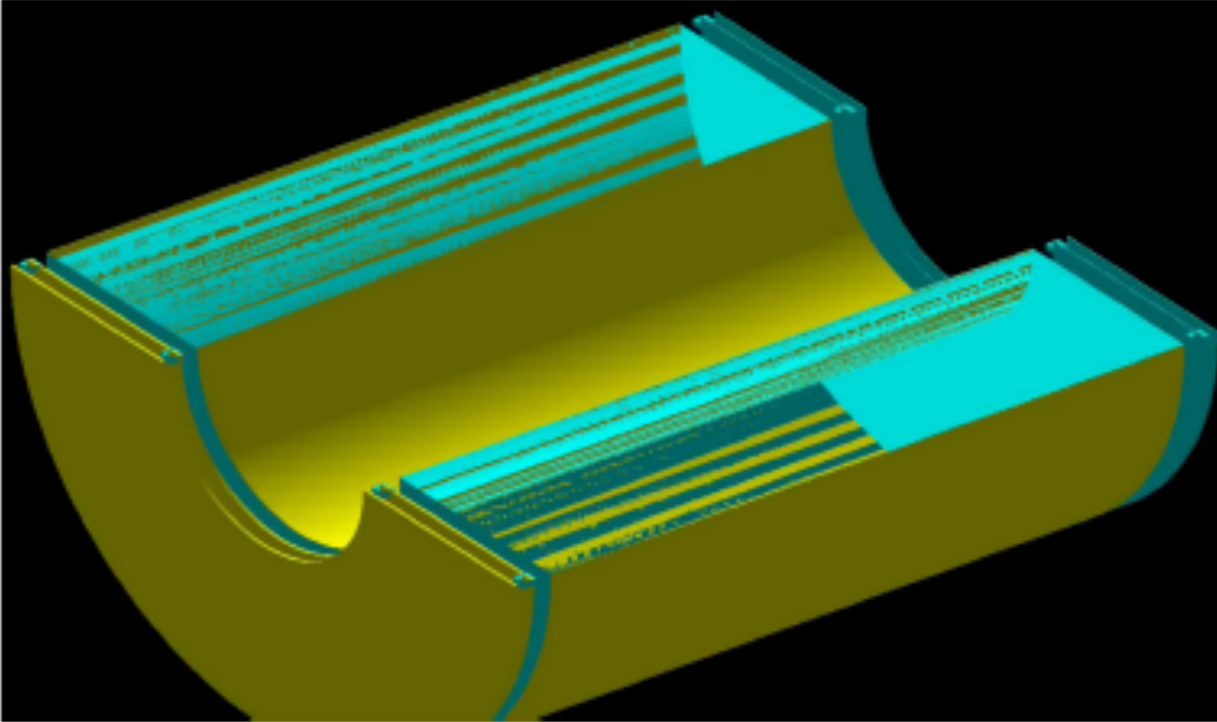
- Consider $r=0.5$ meter
- Defines $p(\text{max}) = 0.8 \text{ GeV}/c$
- P(list)
 - 0.2 0.4 0.6 0.8
- Z(list)
 - 2 10 25 50
- ID(list)
 - Pi, K, p
- Conditions:
 - $4*4*3 = 48$ conditions
- Gas(list)
 - T2K only (for now)
- B(list)
 - 3 T only (for now)
- E(list)
 - 130 V/cm

Garfield Setup (offline Analysis)



- A few simple entries into the Ntuple for code development
- Diffusion noted as $\sqrt{\text{path length}}$
- Analysis framework getting close to producing real results...

GEANT and Fun4ALL Setup (by Sanghwa)

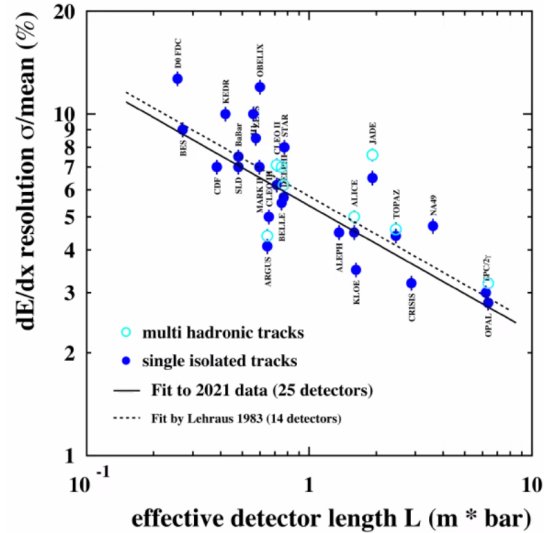
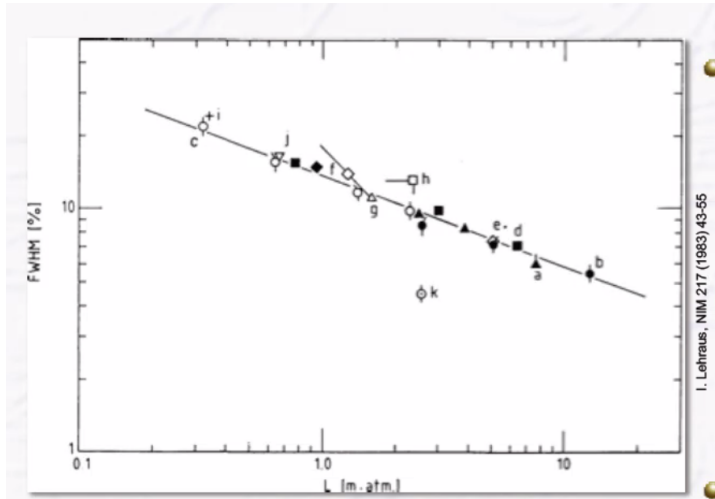


Preliminary Geometry in GEANT

Care required!

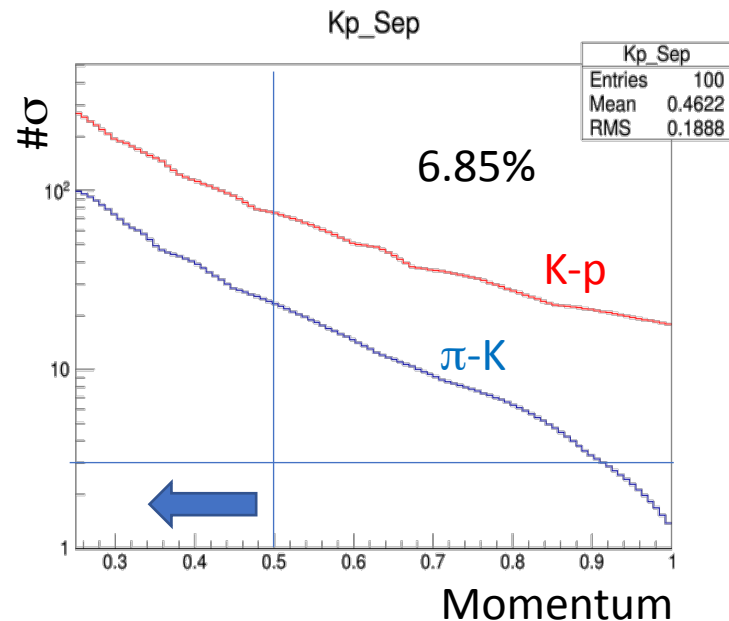
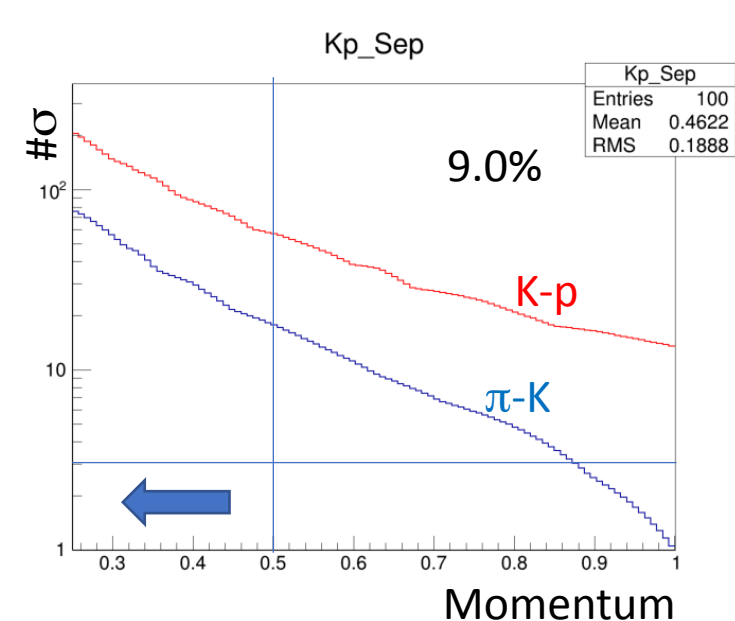
- Default GEANT insufficient job for ionization
- Electron-by-electron in clusters vital.

Anticipated dE/dx Resolution



● Fit by *Lehraus 1983*:
dE/dx res. = $5.7 * L^{-0.37}$ (%)

● Fit in 2021 (25 large detectors):
dE/dx res. = $5.4 * L^{-0.37}$ (%)



Lehraus Plot

- Using 5.4 as a standard TPC
 - $5.4 * (0.25)^{-0.37} = 9.0$
- Measured for GridPIX (truncated Mean)
 - 4.1% at 1 meter
 - $4.1 * (0.25)^{-0.37} = 6.85$
 - This was the prior assumption quoted by us.
- Roughly 20 sigma at 0.5 GeV/c
- Useful range overlaps with DIRC

Overly Simplified Momentum Resolution

- Figure of Merit:

- $\sigma_p \propto \frac{\sigma_{hit}}{\sqrt{N_{meas}}} \equiv \text{Figure of Merit}$

- Can be compared to Silicon with detailed Monte Carlo
- Here is simple-minded estimate

- $\text{Figure of Merit}(Si) = \frac{20 \mu m}{\frac{\sqrt{12}}{\sqrt{4}}} = 2.9 \mu m$

- Gas:

- Including efficiency ~3000 electrons (minimum!) per track
- Each suffers digitization ($\sigma = 55 \mu m / \sqrt{12} = 16 \mu m$)

- $\text{Diffusion}(\text{Length}) = 25 \frac{\mu m}{\sqrt{cm}} \sqrt{L}$

- D(2cm) = 35 μm → FOM = 0.70 μm
- D(25cm) = 125 μm → FOM = 2.3 μm
- D(50cm) = 176 μm → FOM = 3.2 μm
- D(100cm) = 250 μm → FOM = 4.6 μm

- Although ignoring many significant effects, initial result is on the order of the layers of silicon.

