Kaon Beam Reconstruction

The Work Before We Look at Secondary Kaons

Richie Diurba

diurb001@umn.edu

Kaons during Beam Run

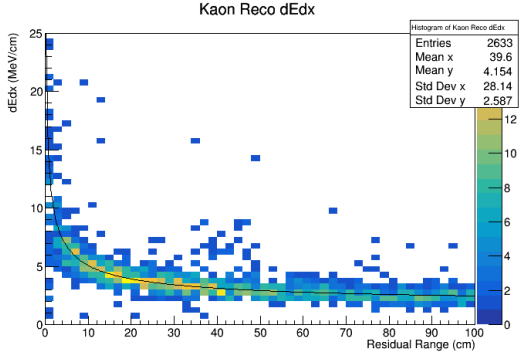
Copious amounts of kaons (0.03 per event at 3 GeV and 0.06 at 7 GeV)

P (GeV/c)	# of Spills	# of e^+	# of K^+	# of μ^+	# of p	# of π^+	Total # of Events	Beam Time (days)
1	70K	84K	≈ 0	70K	689K	625K	1.5M	19.4 days
2	16K	19K	9K	36K	336K	572K	1.0M	4.4 days
3	13K	16K	26K	17K	181K	540K	780K	3.6 days
4	11K	13K	19K	16K	107K	510K	660K	3.1 days
5	11K	13K	29K	13K	96K	510K	660K	3.1 days
6	11K	13K	36K	12K	94K	510K	660K	3.1 days
7	11K	13K	42K	8K	87K	510K	660K	3.1 days
Total	143K	171K	161K	172K	1.6M	3.8M	5.9M	39.7 days

Scheduled Beam Run for Kaons

The Goal

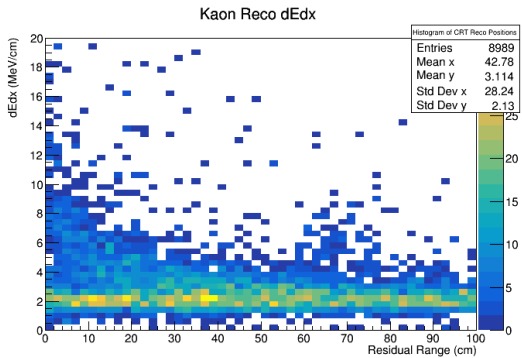
The most important thing DUNE needs is data on the Bragg peaks (See Daniel Pershey's May CM Talk). We want this!



dE/dx plot of kaons in MCC 11 using a chi-squared cut to eliminate interacting kaons using 3 GeV sample.

Using Heng-Ye's Track Length Cut on Protons on Kaons

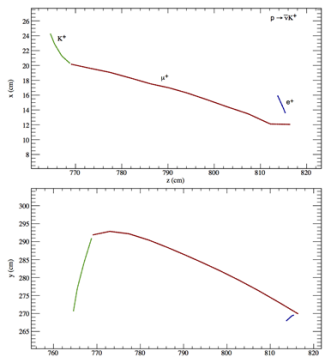
So we start, at best, with something like this.

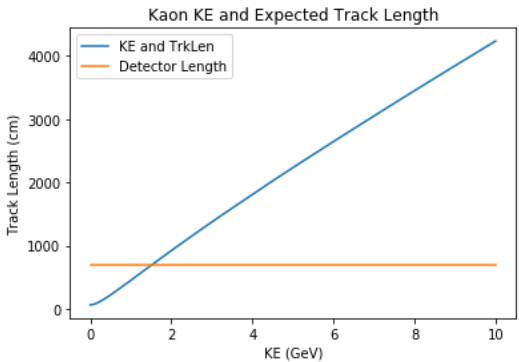


dE/dx plot of kaons in MCC 11 using a track length cut from the kinetic energy using 3 GeV sample.

The Problem

Kaons need to stop for us to use them in proton decay. They don't at our energies. (Thanks to Xin and Chao at BNL for access to BNL dE/dx kaon profile)

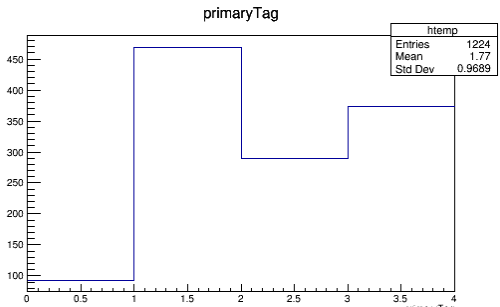




Hypothetical proton decay golden mode event display from Jennifer Raaf and Micahel Sorel (left). Kaon KE and track length using BNL data (right)

The Problem on Top of the Problem

Kaon "Daughtering" Makes this a little more complicated. If a kaon inelastically scatters, Pandora counts this as a separate particle. We have to stitch these PFParticles together then.



Histogram of MCC Truth Tag for a 7 GeV MCC 11 sample. 0=Other, 1=primary beam, 2=kaon inelastic, 3=pion upscatter

Analysis Plan

There are a ton of details within these statements.

1. Measure kaon dE/dx for non-stopping kaons. (I am here)
2. Find beam pions and look for daughter kaons.
3. Find Bragg peaks of kaons to measure dE/dx.

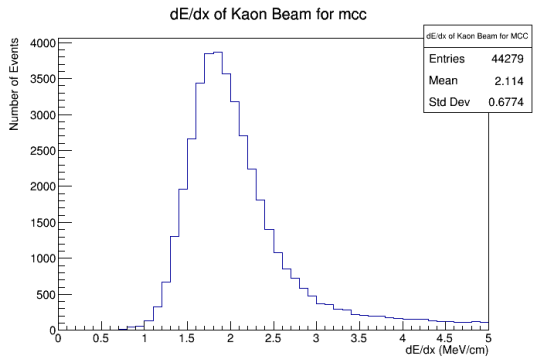
Analysis Plan

Measuring beam kaons.

- Find kaon sample and filter out beam events with kaons.
- Collect dQ/dx values and then XYZ-correct the dQ/dx.
- Use the recombination formula to take corrected dQ/dx and measure dE/dx.
- Find summary dE/dx, can also use these kaons for a higher energy kaon cross section (Similar to Elena Gramellini's LArIAT *thesis*)

Kaons from the Beam

All plots seen are just x-corrected for dQ/dx. Differences observed may be due to need to also calibrate out YZ non-uniformity.

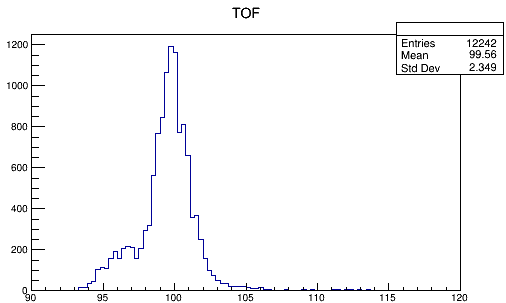


Kaon MCC for 6 GeV beam. Expected dE/dx from BNL is 2.3 MeV/cm so the fractional difference is approx. 8%.

Kaons 3 GeV

Cannot use as protons and kaons look almost identical!

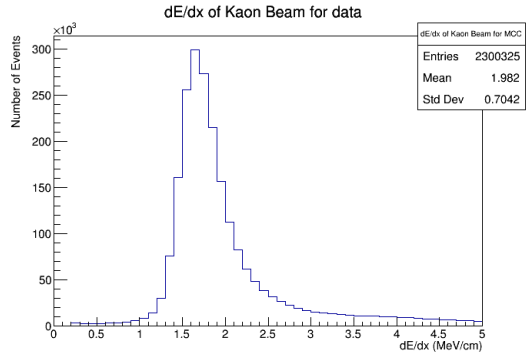
- Both have TOF within 90-110 ns.
- Both Cherenkov detectors stay null (From Alex Booth and Jake Calcutt).
- dE/dx are within 1% between each other (From BNL data).



Kaon bump is the left little bump and the large spike comes from protons. Notice how wide the proton TOF spread is.

Kaons 6-7 GeV

- Run-by-run dE/dx and dQ/dx calibration necessary for precision value. I used Ajib's run 5809 calibration.
- Uses Cherenkov light as a logic gate to separate kaon data sample. High pressure detector should see light, low pressure should not see light.



Kaon dE/dx for run 5770. Expected dE/dx is 2.3 MeV/cm.

Moving Forward

- Work on developing SCE dQ/dx maps for runs not covered yet.
- Find out if that 6% difference is a YZ-correction effect.
- Run through data and MCC until we get around 1k events.

Conclusion

- Long road for a NDK-specific ProtoDUNE kaon study.
- Understanding dE/dx for beam kaons is the first step to finding out how to deal with pion "daughters."