# Forward Drift Chamber Beam Tests

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This document lays out the plans for a beam test with the small-scale Forward Drift Chamber (FDC) prototype. This 8 in $\times$ 8 in active area cathode chamber consists of 16 anode wires alternated with field-shaping wires. The wire plane is sandwiched between cathode planes with 32 cathode strips at $\pm 45^{\circ}$ with respect to the wires. The chamber could be reconfigured to include two wire planes and four cathode planes with relatively little investment of manpower, although several g10 frames would have to be manufactured to make the chamber gas tight.

There are two key aspects to the beam test that can improve our understanding of the chamber operation:

- High statistics resolution studies and signal characterization.
- $dE/dX$ studies.

Each of these is discussed in more detail in the following sections.

## 1 Resolution Studies

The current bench test resolution studies have been carried out using cosmic ray events. The trigger rate is less than a Hz and due to a limited number of readout channels, only a small central portion of the chamber is read out. Studies in beam would allow us to perform high statistics studies of the chamber resolution in a much more realistic noise environment. The resolution of the chamber in a beam test would allow us to characterize:

- Resolution vs. cathode strip length.
- Resolution vs. track angle.

- Resolution vs. particle momentum.
- Resolution vs. particle type.
- Double hit resolution.
- Resolution vs. chamber occupancy.
- Anode ADC vs. TDC resolution.
- Edge effects.

The resolution characterization versus strip length is an important test as the strips in the full-scale chamber will vary from ∼10 cm to ∼120 cm. Certainly the range of strip lengths in the small-scale prototype is much more restricted, ranging from roughly 13 cm to 29 cm. The double hit resolution is important to allow us sufficient events to develop our algorithms to separate multiple tracks passing through the chamber in an environment with more realistic accidental rates. Studies of resolution near the edge of the active readout are also an important aspect of these studies.

The studies would allow us to understand how the resolution is affected by cathode plane non-uniformities as the current prototype includes cathode planes with wrinkles and imperfections. We could also continue to characterize the cathode and anode signals, something that is necessary for the preamplifier and FADC design.

The studies of resolution versus track angle, particle momentum, and particle type would require external detectors to perform tracking and particle identification. If the chamber could be subject to a magnetic field, the chamber performance in the presence of such a field could also be characterized.

In order to perform these studies it would be essential to have sufficient channels of ADCs and TDCs to readout the full chamber complement. These tests could also allow us to study timing resolution from the anodes reading them out with either TDCs or ADCs. The nominal readout plans for the anodes assume that they will be readout with TDCs. However readout of the anodes with ADCs for the purpose of $dE/dX$ measurements might be necessary if this information cannot be successfully extracted from the cathodes. In this case we will require good timing resolution from the ADC measurements.

## 2 $dE/dX$ Studies

The most useful study of chamber $dE/dX$ resolution would involve readout of a chamber with multiple planes. Studies with one or two wire planes will still allow $dE/dX$ studies, albeit with a poorer resolution. A study of the region of momenta where particle identification can be performed with a single plane readout is shown in Fig. 1. This calculation is based on a parameterization of the $dE/dX$ resolution that was determined for multiple plane readout, and it is not clear if the parameterization is valid for the case of a single layer. From this study $K/\pi$ separation can only be performed below about 500 MeV/c and $p/K$ separation below about 900 MeV/c.

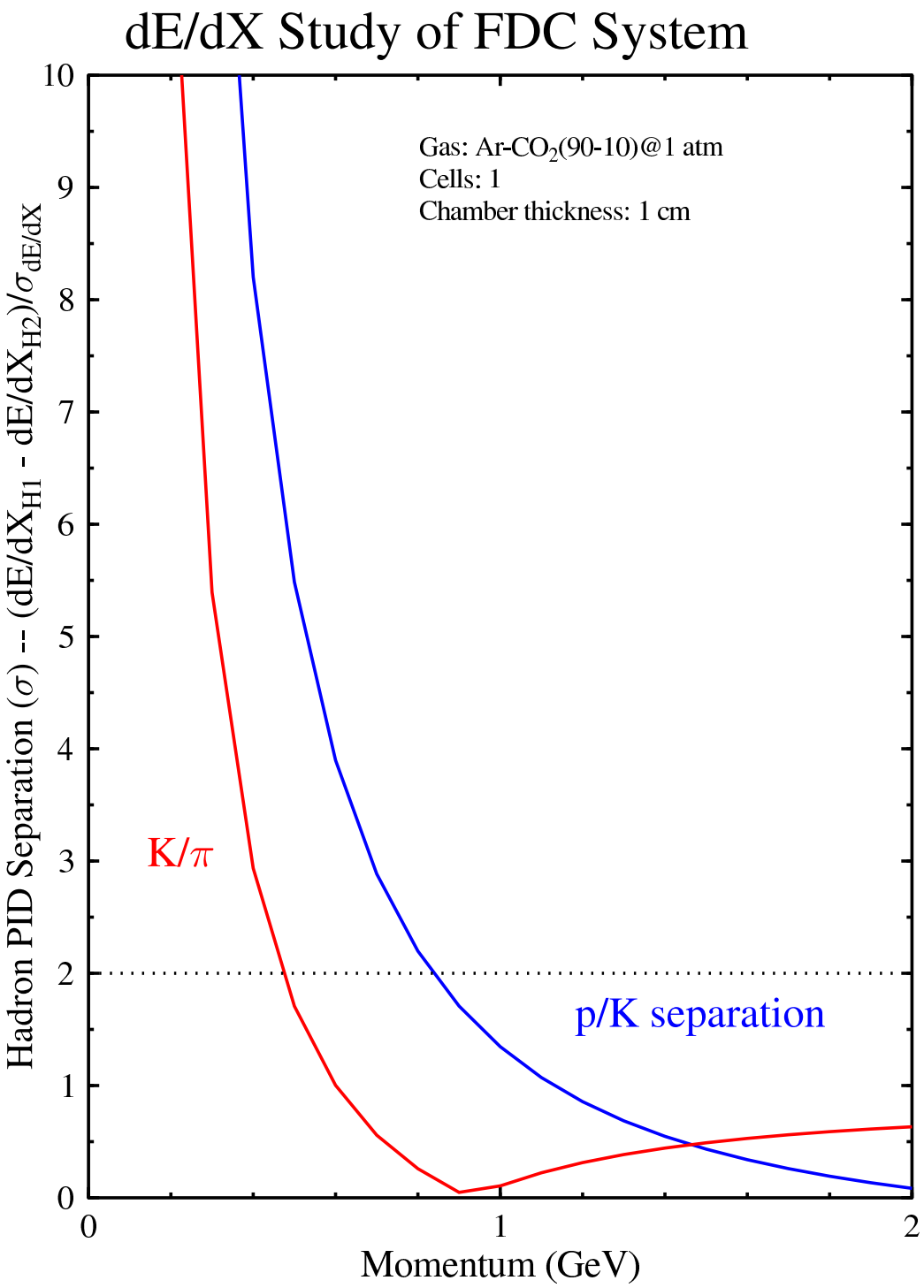


Figure 1: Calculation of the separation (in $\sigma$) between different particle species vs. momentum. The calculations are shown for a single readout layer with a chamber thickness of 1 cm and an Argon-$CO_2$ gas mixture (90%-10%).

A useful test would be to compare signal integrals from the anodes and cathodes. While this could also be done on the bench, the studies in beam would be valuable as well. This would help us to address the possibility of achieving the advertised $\pi/K$ and $K/p$ separation for readout of the cathodes. This could be compared to $dE/dX$ information from the ADC readout of the anodes.

In order to perform these studies successfully in beam, other beam line instrumentation would be required to define the track angle, track momentum, and particle type. Due to limited manpower it is not sensible to devote time and energy to expanding the small-scale prototype to include more than two planes. This would have a significant impact on the development of the full-scale prototype. It may be that full $dE/dX$ resolution studies will have to await the full-scale FDC prototype that will be designed and constructed in 2006-2007.