$dE/dx$ and Particle Identification
Inside L-Tracker

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The Point

- Differentiate between particles based on their relative energy losses
- Particles providing false positive results
  - Simulated particles have 105 MeV/c
- Electron, Pion, Muon
Method of Tracking

• Monte Carlo tracking system
  – ‘Swim’ particles through tracker
• Fourth Order Runge-Kutta
  – Accurate, coinciding paths
  – 1 picosecond intervals
• Coordinate transformation
  – Particle within tracker vane
What it looks like
Stopping Power, $dE/dx$

• Approximate material as homogenous
• Bethe-Bloch for heavy particles
  – Ionization and atomic excitation
• Bremsstrahlung for electrons
  – Radiative losses dominate
• Energy recalculated at each step
Molière and Landau

- **Molière**
  - Multiple Coulomb scattering

- **Landau distribution**
  - Energy loss stochastic, fluctuations
  - Little likelihood of large energy loss
  - Generally, $\Delta E \ll E_0$
dE at Fixed Theta

- 200 simulations per particle per angle
- Tightly packed distributions
  - Easily discernable peaks
- Overlap of distributions
- Energy loss ratios

<table>
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<tr>
<th>Theta</th>
<th>$&lt;\Delta E_\pi/\Delta E_e&gt;$</th>
<th>$&lt;\Delta E_\mu/\Delta E_e&gt;$</th>
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<td>70</td>
<td>0.8886</td>
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dE, Theta Spectrum

- dE discernable across broad spectrum
  - Muons almost out of picture
- Inconsistencies
  - ‘Skimming’
Timing

- First and last hits in tracking chamber
- At given theta, difference of ~2 ns
So What?

- Ratios of energy loss tell us approximate ratio of $dE/dx$
- Ratio is indicative of relative signal strengths in drift chambers
- Timing difference between signals to be used to determining velocity/momentum differences, information about motion
Points of Error and Next Step

• This is a baseline study
  – Approximation of tracker material
  – Step sizes, skimming

• Next
  – Take time data of hits on individual tracker sections and calorimeter
  – Allow for more freedom in particle propagation
Conclusion

• Study of energy loss can narrow scope of data considered, increase confidence level of detection of conversion $e^-$

• More sophisticated studies should be done in the future to more accurately model $dE/dx$
  – Useful tool on data analysis

• Time resolution should be about one nanosecond