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Photon Transport Monte Carlo

- Some results for specific track configurations
- Timing biases ignoring variation in pulse height
- Ideas for parameterization of these effects (physical model)

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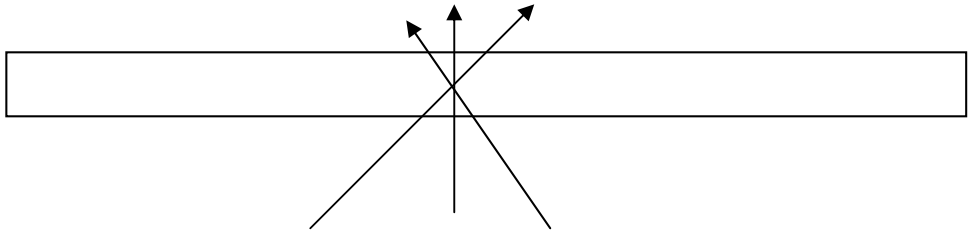
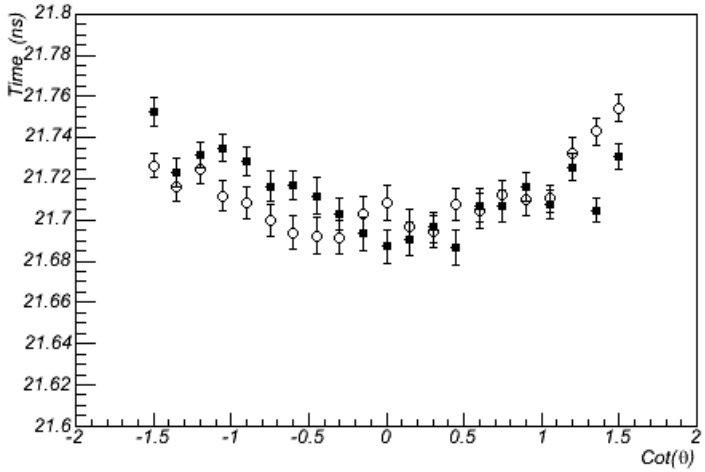
Overview

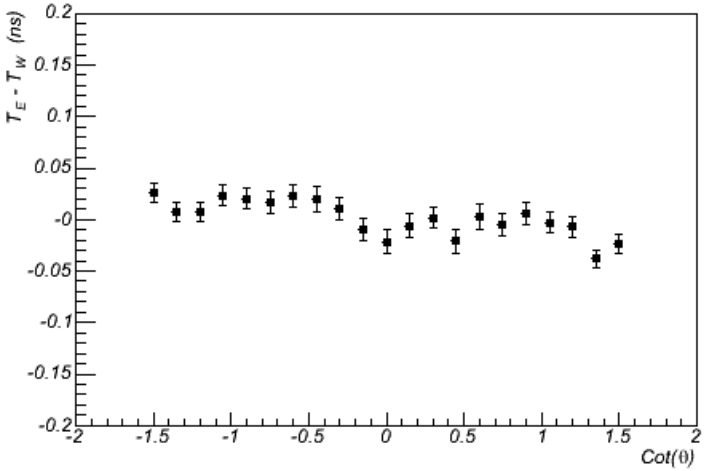
- Methods previously described on Sept 27.
- Applied to three configurations, all of which are currently treated as isochronous:
  - Cot(θ) at constant z,
  - path length at constant z, cot(θ),
  - β at constant z, cot(θ).
- All configurations result in large variations in pulse height.
- Time measured at constant fraction of 5% of the total pulse height.

Variation with cot(θ)

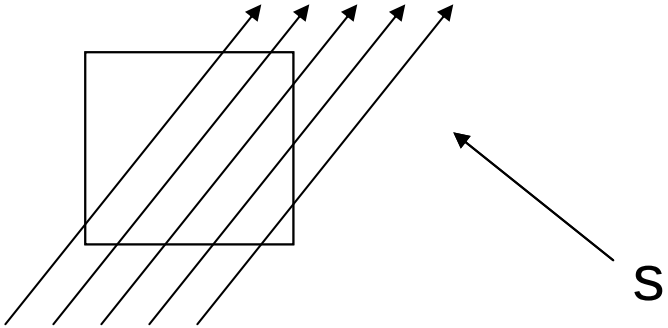


- 2 GeV/c muons at z=0
- Path length varies by about p 2
- Variation in time is about § 25 ps
- Smaller variation in ΔT

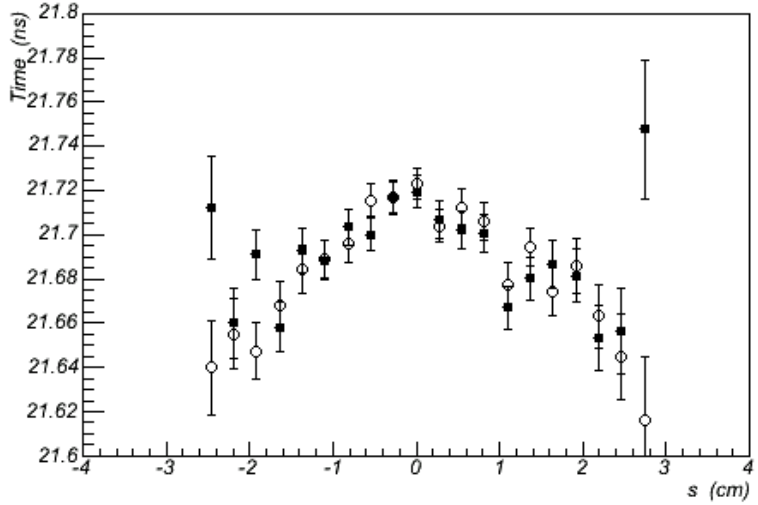


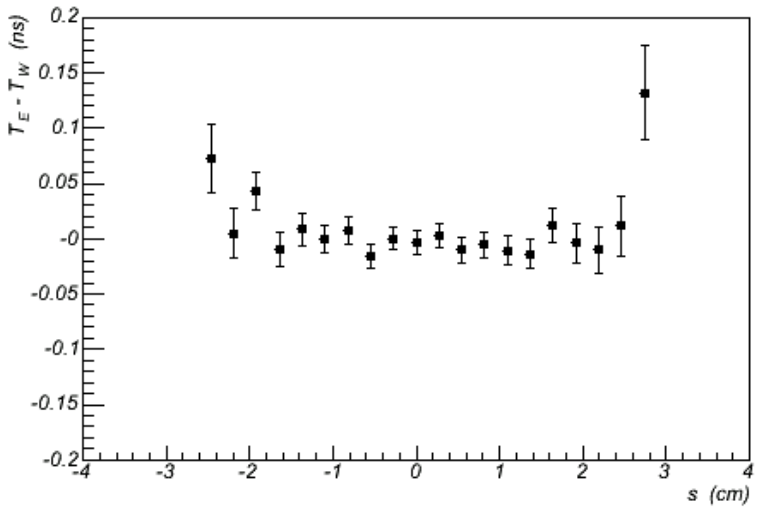


Variation with path length



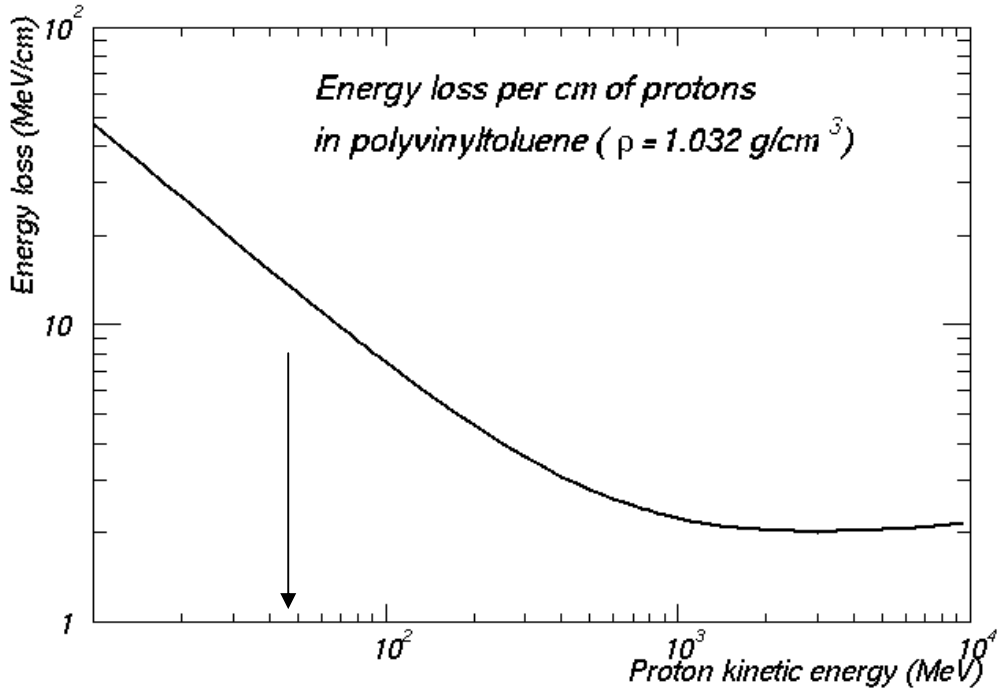
- 2 GeV/c muons at z=0, cot(θ)=0
- Significant variation of path length with ‘s’
- Variation in time of about § 25 ps





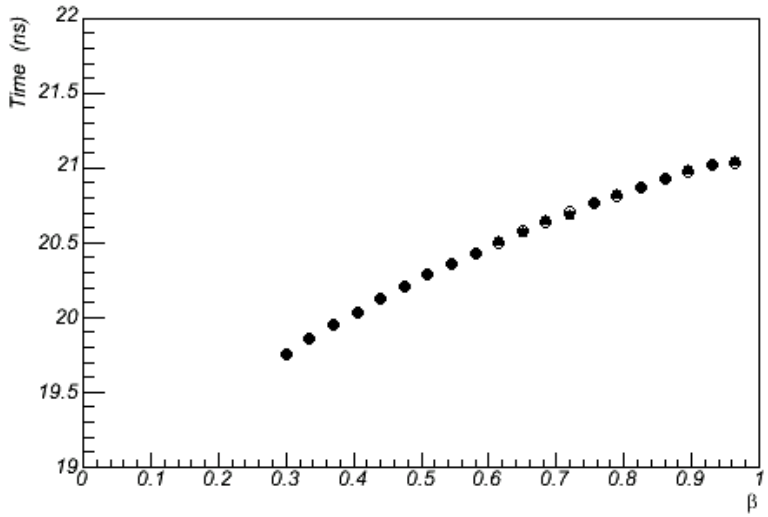
Variation with β

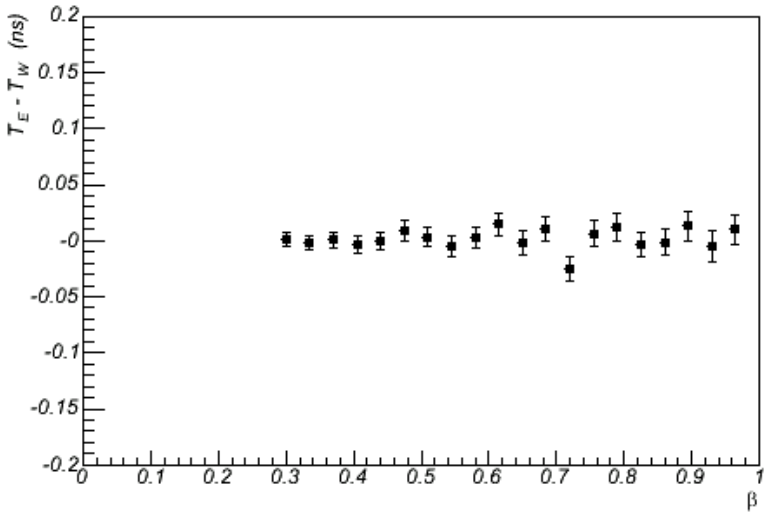
- Muon momentum varied from 30 MeV to 300 MeV.
- Factor of 10 variation in dE/dx with β:



Variation in β

- This is approximately p>300 MeV/c for protons.
- Time variation is of the order of ns
- Time difference is essentially unbiased





Observations so far

- Several effects introduce § 25 ps variations in single channel timing measurements
- Many are cancelled in ΔT
- Systematic effects would be enhanced for average time
- Possible source of the correlations observed in the data

“Physical” models

- For a particular configuration (z, cos(θ), path length, β, but not particle type), pulses will have the same *average* shape.
- Amplitude determined by the Landau fluctuations in energy loss.
- Light front due to ionization at a point in the bar has a z-dependent shape.
- Light front due to path through the bar is the convolution of the point response.

Point response function

- Voltage pulse is V(t).
- Discriminator fires when $V(t) - V_0 = 0$.
- ADC measures Q / $\int_t^{t+\Delta t} V(\tau)\, d\tau$.
- Q probably depends mainly on z.
- Walk correction needs to be parameterized by $Q/\langle Q \rangle$.

Next steps

- Validate point response physical model:
  - Generate point response function with high statistics at several points in z
  - Convolute with various track configurations
  - Compare with full Monte Carlo
- Treatment of walk correction:
  - Not necessary to fully validate ADC response model for testing point response hypothesis
  - Compare constant fraction with fixed threshold results