GlueX Particle ID

Paul Mattione, Carnegie Mellon University

Overview

- Sources of PID information:
  - Drift Chambers:
    - χ^2 from track reconstruction (charged)
    - χ^2 from dE/dx in the drift chambers (charged)
  - TOF/BCAL/FCAL:
    - χ^2 from time-of-flight (charged and neutral)
    - χ^2 from dE/dx in the TOF (charged)
- Calculate total χ^2, FOM for each PID hypothesis
- Particle ID: Hypothesis with highest FOM
- All information saved: User can perform custom PID

Track Reconstruction χ^2

* For each track candidate, create a track hypothesis for each PID
* Wire-based and time-based track reconstruction of each hypothesis
* Use track reconstruction χ^2 from time-based fit

$$\chi^2 = r C_r r^T$$

(r: Kalman-filtered residual, C: covariance matrix)

Drift Chamber dE/dx χ^2

- For each CDC/FDC hit used for the track:
  - Calculate the measured and most probable dE/dx (dx = path length in straw)
- Compare the total dE/dx's, calculate χ^2

$$\chi^2 = \frac{\left(\sum \frac{dE}{dx}_{Hit} - \sum \frac{dE}{dx}_{Probable}\right)^2}{\sigma^2_{\Delta \frac{dE}{dx}}}$$

Charged Particle TOF χ^2

- If both SC and TOF/BCAL/FCAL hits:
  - Project TOF/BCAL/FCAL time to track vertex (beamline POCA))
    - If hits in multiple systems: use BCAL, then TOF, then FCAL hits
    - TOF: best time resolution, but BCAL: significant energy loss
  - Select beam bunch with SC time, project RF time to track vertex
  - Compare projected times, calculate χ^2

$$\chi^2 = \frac{(t_{RF} - t_{Hit})^2}{\sigma^2_{\Delta t}}$$

(Times projected to vertex (beamline POCA))

Charged Particle TOF χ^2

- If **NOT** both SC and TOF/BCAL/FCAL hits:
  - Cannot calculate χ^2: Not enough timing information
    - If no SC hit cannot use RF time: this track may be an accidental (from another beam bunch)
      - If an accidental, a false PID may match the RF time

$$\chi^2 =: ($$

Neutral Particle TOF χ^2

* Neutral Track: each BCAL/FCAL shower that is not matched to **EACH** PID hypothesis of any charged track
* For each neutral track, create a hypothesis for each ID (γ , n) & vertex combination
  * Vertices: groups of charged tracks; if no charged tracks, then center of target
* Project BCAL/FCAL shower time to vertex, compare to vertex time: calculate χ^2

$$\chi^2 = \frac{(t_{Vertex} - t_{Shower})^2}{\sigma^2_{\Delta t}}$$

(Shower time projected to vertex)

TOF dE/dx χ^2

* Calculate the measured and most probable dE/dx
* Compare the total dE/dx's, calculate χ^2
* Can this be done for the BCAL as well?

$$\chi^2 = \frac{\left(\frac{dE}{dx}_{Hit} - \frac{dE}{dx}_{Probable}\right)^2}{\sigma^2_{\Delta\frac{dE}{dx}}}$$

Particle Classes

- Particle classes detailed at: http://www.jlab.org/Hall-D/software/wiki/index.php/Mattione_Particle_Classes
- PID information is saved at:
  - χ^2 from track reconstruction: DTrackTimeBased
  - χ^2 from dE/dx in the drift chambers: DTrackTimeBased
  - χ^2 from time-of-flight: DChargedTrackHypothesis and DNeutralTrackHypothesis
  - χ^2 from dE/dx in the TOF: NA, will be in DChargedTrackHypothesis
  - FOM: DChargedTrackHypothesis and DNeutralTrackHypothesis
  - PID: First DChargedTrackHypothesis in DChargedTrack, and first DNeutralTrackHypothesis in DNeutralTrack
- Vertex-independent data: DVertexIndependentResults
  - Contains DChargedTrack & DNeutralShowerCandidate