KinKal: A Kinematic Kalman Filter Track Fit Package

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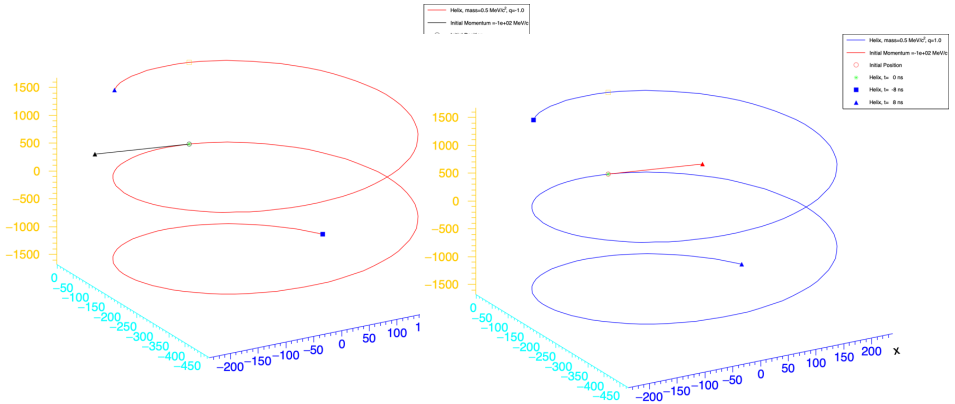
Kinematic Kalman Fit Concept

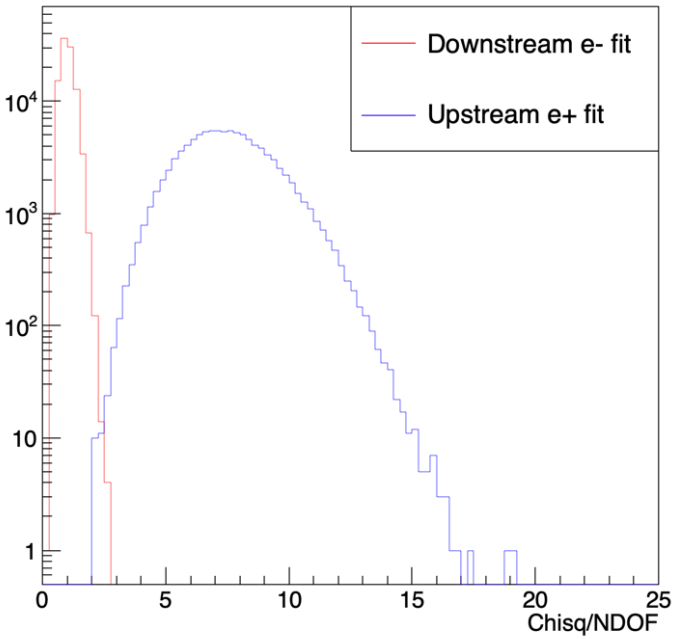
- Work in covariant 4D space
  - **P** = (P_x, P_y, P_z) → (P_x, P_y, P_z, m)
  - **X** = (x,y,z) → **X** = (x, y, z, t)
- Explicitly choose the particle mass
  - $m \in \{e, \mu, \pi, K, P, \ldots\}$
- Explicitly choose the time flow
  - particle direction = hit time order
- Use time as the parametric variable of the fit
  - **X** pos = position(L); → **X** pos = position(t);
- Make time (t_0) an explicit track fit parameter
- Template the fit on the trajectory class
  - IPHelix $\mathbf{P} \equiv \{d_0, \phi_0, \omega, z_0, \tan(\lambda), t_0\}$, LHelix $\mathbf{P} \equiv \{R, \Lambda, C_x, C_y, \phi_0, t_0\}$, …
- Support time as a measurement dimension
  - Residual can be either ΔTOCA or ΔDOCA
- Hard-coded algebraic derivatives for measurements and materials
- https://github.com/KFTrack/KinKal

Kinematic Fit Direction and PID Sensitivity Through Timing

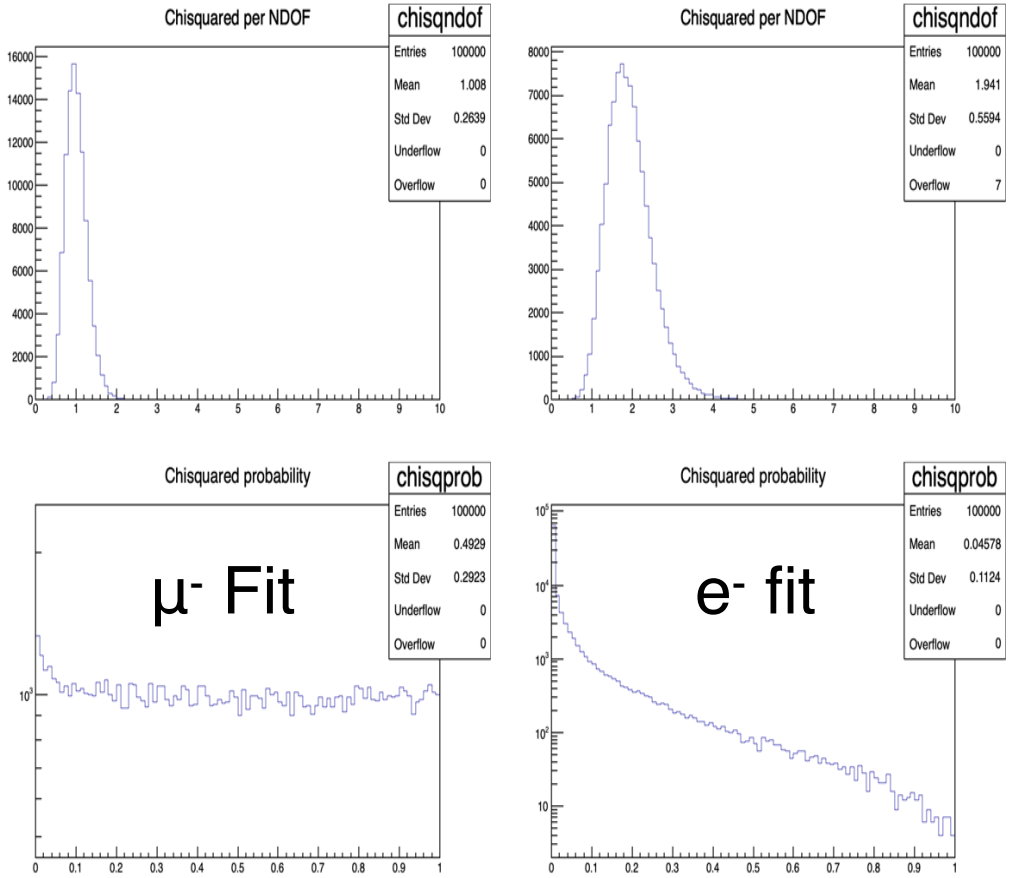
Fit simulated downstream e^- as downstream or upstream e^-



Chisquared per DOF



Fit simulated μ^- as μ^- or e^-



$Prob_e > 0.02$ eliminates 70% of μ^- particles, 97% efficient for e^-