New Capabilities in KWFIT

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http://www.phys.ufl.edu/~avery/kwfit/

Acknowledgment

Thanks to all the people who have found bugs and made suggestions for how to improve KWFIT. It would be impossible for me alone to explore the full phase space of possible situations.

Definition

Kinematic fitting is a mathematical procedure in which one uses the physical laws governing a particle interaction or decay to improve the measurements describing the process.

Example:

$$D^0 \rightarrow K_s p^+ p^-$$

$$K_s \rightarrow p^+ p^-$$

Hypothesis is that decay happens at the beam spot

Constraints:

1. $p^+ p^-$ vertex for K_s (2*2–3 = 1)
2. K_s mass (1)
3. $D^0 \rightarrow K_s p^+ p^-$ vertex (3*2 = 6)

So a total of 1 + 1 + 6 = 8 degrees of freedom

Overview of Capabilities

Independent of CLEO

- Dependence only in track filling routines
- Allows one to interface it to fast MC routines

Single track list

- Charged particles, γ, π^0, K_s, Λ
- "Virtual" particles, e.g. D^0, B, anything you define
- Tracks have 7 indep. quantities and 7×7 cov. matrix
  p_x, p_x, p_x, E, x, y, z

Non-vertex constraints

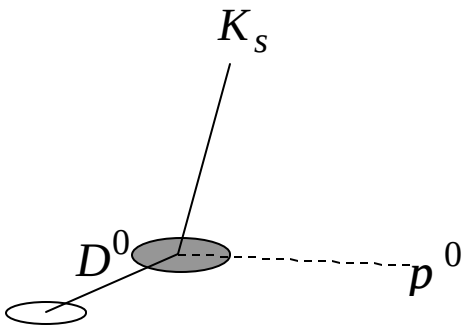
- Mass (1)
- Energy (1)
- Total momentum (1)
- 3-mom (3)
- 4-mom (4)
- Back-to-back (for m^+m^-) (5)

Vertex constraints

- Unknown 3-D (2*N–3)
- Known 3-D (initial cov. matrix) (2*N)
- Fixed 3-D (2*N)
- Beam spot (calls “known” case) (2*N)
- Unknown 2-D (2*N–3)
- Known 2-D (initial cov. matrix) (2*N)
- Fixed 2-D (2*N)
- “Double vertex” (2*N–3)

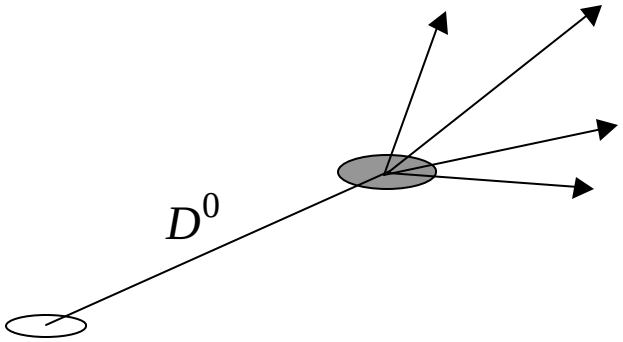
Double vertex case is useful to find decay vertex for decays of type

$$D^0 \to K_s p^0$$
$$K_s \to p^+ p^-$$
$$p^0 \to gg$$



Lifetime fitting Þ NEW!

- Fit for ct directly $\Rightarrow$ no multi-step procedure
- Correct accounting of all errors
- Uses all the information about the track, not just y
- You can smear x, z errors to reproduce "y only" method
- Keeps track of correlations of ct with other parameters



- kvtx_known_lifetime
- kvtx_beam_lifetime
- kvtx_fixed_lifetime
- kvtx_two_vertex_life

Building virtual particles

- Idea: apply vertex constraint to a set of particles to build a new particle with the correct 4-momentum at the fitted position. Full 7×7 covariance matrix computed.
- Compute track behaves like any other track, i.e., it can be moved, used in fits, etc.

Several ways of building virtual particles

- Unknown vertex
- Known vertex (covariance matrix)
- Beam vertex (calls “known vertex” case)
- Fixed vertex

Track quantities

- You can get info on almost any track quantity

  kget_track_param
  kget_track_covar
  kget_track_mass
  kget_track_energy
  kget_track_momentum
  kget_track_p4
  kget_track_pperp
  kget_track_phi
  kget_track_theta
  kget_track_dca_bend

Errors of track quantities

- You can get error of almost any track quantity in KWFIT
- Quick understanding of error behavior
  Plot errors without fitting lots of distributions

  kget_track_err_mass
  kget_track_err_energy
  kget_track_err_momentum
  kget_track_err_pperp
  kget_track_err_phi
  kget_track_err_theta
  kget_track_err_dca_bend

Working on CLEO 3 version

Replace energy by mass in internal representation Þ wait for CLEO 3

- Energy is too correlated with other momentum variables
- Mass shifts when constraints applied after mass constraint
- No fundamental problems