Tracking with TRF++

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TRF++

- **TRF++ is a suite of Object-Oriented packages devoted to track finding and fitting.**
- **Modular, generic, supports most geometries used in collider detectors.**
- **Detector element descriptions, hit descriptions (1D and 2D with errors), propagators, multiple scattering, energy loss, fitters.**

Track Definition

- **We define a track as an ordered list of hits (or misses) at measurement surfaces along with the best fit at that surface (TrackStates).**
- **The track fit consists of five parameters appropriate to the surface plus one parameter which is provided by the constraint that the track lie on the surface.**

Surfaces

- Surfaces generally correspond to geometric shapes representing detector devices.
- They provide a basis for tracks, and constrain one of the track parameters.
- The track vector at a surface is expressed in parameters which are “natural” for that surface.
- Cylinder, XYPlane, ZPlane, DCA

Detector

- A Detector **describes a collection of** Layers **which are organized in a hierarchy of detectors.**
- Layers **describe the geometry of the detector by holding** Surfaces**, either directly or through sub** Layers

Propagators

- Propagators **propagate a track (with or without covariance matrix) to a new surface.**
  - Propagators **to and from all the surfaces are defined, *e.g.***
    - **PropCylCyl**
    - **PropDcaCyl**
    - **PropXYZ**
- **Currently defined for homogeneous fields.**

Interactions with Material

- **Interactions with material affect the track state by perturbing the track covariance matrix (*e.g.* stochastic processes such as MCS) or the track vector itself (dE/dx).**
- **This behavior is encapsulated in an abstract** Interactor
  - **Specific instances inherit from this, such as** ThinCylMs.
  - **Energy loss is handled by abstract** DeDX
    - DeDxBethe or DeDxFixed

Track Fitting

- Can be combined with track finding to accomplish both tasks at once.
  - Assumes road-following approach.
  - Introduce Paths, which define track-finding strategies. Run-time configurable.
- Can also fit hits which have been identified as constituents of a track by a separate pattern recognition package.

Track Fitting

- Pattern recognition program delivers a list of hits and an estimate of the global track parameters.
- Track Fit uses the Kalman Filter algorithm to reconcile the track hypothesis with the hit measurements in an iterative manner.
- After fitting each hit, the track covariance matrix is updated to account for the effects of MCS, and the track vector is modified to account for dE/dx.
- The track is then propagated to the next surface.

Track Fitting

- χ^2 at each surface can be used to reject outliers or search for kinks caused by decays in flight or bremsstrahlung.
- Misses are added with a probability which reflects the efficiency of the detector
  - Cut on combined probability, not number of misses.
- End up with the best fit at the extrema of the track, project to vertex or calorimeter.
  - Smoothing gives the best fit at all points.

Simulations

- Simulators are provided to generate hits and account for MCS and energy loss.
- Can be used for fast simulation:
  - Particles from MC event are propagated to each detector element.
  - The appropriate hit is generated from the intersection of the track with the surface.
  - Track vector is smeared for MCS and modified for energy loss, then propagated to next element.

TRF++

- C++ version developed at D0 for use in RunII.
- Detector-specific packages form a thin layer on top of the core trf++ functionality.
  - Access detector-specific data/geometry, feed into trf++ format.
  - Return tracks in experiment-specific format.
- However, written to C++ standard, and required compliant compiler.
  - gcc 2.95 and MSVC++v6 not compliant!

TRF++

- gcc 3 much more compliant, compiles trf++.
  - Not yet available under cygwin.
- Just starting with MSVC++.Net
- Hope to be able to start work incorporating trf++ into LCD environment on Linux while understanding limitations (if any) on Windows.