Some remarks on the combinatorial Kalman filter

R. Frühwirth

Tracking meeting

HEPHY Institute of High Energy Physics

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ÖAW Austrian Academy of Sciences

Combinatorial Kalman filter

Basics

- Combined track finding and fitting proposed for ZEUS by P. Billoir and S. Qian in NIMA 294 (1990) 219–228
  - After each prediction step, search for closest hit
  - Accept if χ^2-distance below threshold
- Combinatorial extension, called “concurrent track evolution”, for HERA-B published by R. Mankel in NIMA 395 (1997) 169–184
  1. Start with a seed and make a prediction step
  2. After prediction step, look for compatible hits
  3. For each hit, clone the state vector and perform the update step
  4. Add one cloned state vector to allow for missing hits
  5. Perform prediction step on all state vectors
  6. Go to step 2
- Standard method in CMS and ATLAS, several seeding steps for different classes of tracks: primary, secondary, high p_T, low p_T, ...

Combinatorial Kalman filter

Trimming

- Combinatorial explosion possible in high track density
- After each update step, “bad” candidates are discarded
- Requires quality indicator based on
  - Local and total χ^2
  - Number of missing hits so far
  - Number of hits in the candidate
  - Current number of track candidates
  - ...
- Hard upper limit on the current number of candidates may be required
- Final selection of best candidate
  - Select immediately from the surviving candidates
  - Defer until all seeds have been followed, global arbitration

Combinatorial Kalman filter

Implementation

- Python version in cylindrical geometry available
- KF and DAF in GENFIT expect a track candidate
- With CKF, set of relevant sensors and hits not known in advance
- Each state vector needs to be propagated separately, no common reference track
- GENFIT methods for navigation, extrapolation, updating can hopefully be used