

Status of tracking software

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What you can do right now

- simulate tracks with a particle gun
- pass the smeared simulated hits from any combination of PXD, SVD and CDC to a simple Kalman filter or a deterministic annealing filter
- get the results as either a simple object containing the helix parameters or a heavy object which can calculate track parameters and their covariance matrix at any given point
- pass the fitted tracks to a vertex fitter that returns vertex parameters and covariance matrix
- several ways to statistically analyze the the fitted results
- what can be done with the vxd pattern recognition will be covered by Jakob's talk



What does not work right now

- simulation plus tracking the hole detector: basf2 often crashes \implies have to add different detector parts one by one to see which causes trouble.
- the module `VertexFitterStatistics` often crashes (I already have an idea why but no time to fix it so far)
- the track fitter troughs exceptions when feeded with curling tracks
- at low energies (100 MeV) genfit fail to fit a small percentage of tracks



how does it work

- implementation of the fitting algorithms is inside external packages
- genfit for track fitting (TU Munich) still lots of development going on. We basf2 tracking developers also sometimes implement new features directly in genfit
- rave for vertex fitting (HEPHY). Working basf2 module relatively new in SVN
- to test if track fitting is working on your machine execute e.g. the steering file `trackFitChecker.py` in `tracking/examples`



how does it work in detail

- for a good overview of the tracking package (what which module does, with what options, how the data flows...) read the tracking tutorial slides made by Oksana (KIT) for the last B2GM/Computing Workshop in November.
- URL:
<http://wwwhephy.oeaw.ac.at/u3w/n/nadler/www/tt.pdf>
- Vertexing was not ready in November therefore not in the tutorial slides
- any question about or problems with tracking software?
Write to belle2_software@bpost.kek.jp or
belle2_tracking@bpost.kek.jp



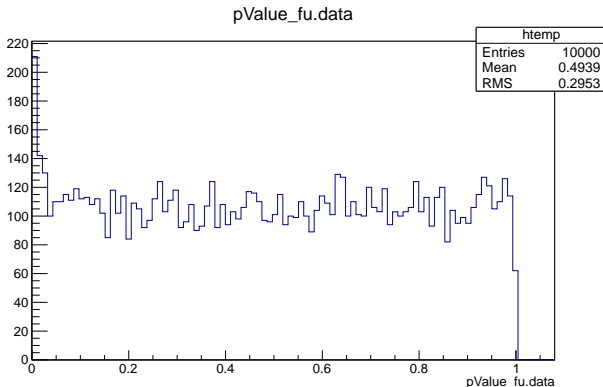
Status of track fit quality

- for a long time the tracking group had the problem of non perfect tracking results under perfect condition (1 GeV $\mu^{+/-}$ only Gaussian smearing etc.)
- because genfit is new and under development we searched for bugs there for a long time without success
- since October suspicion rose that geant4 was the problem
- additionally an asymmetry of the fitted muon curvature was presented at B2GM
- now there is good evidence that both was caused by a specific geant4 EM MSC model called “Wentzel”



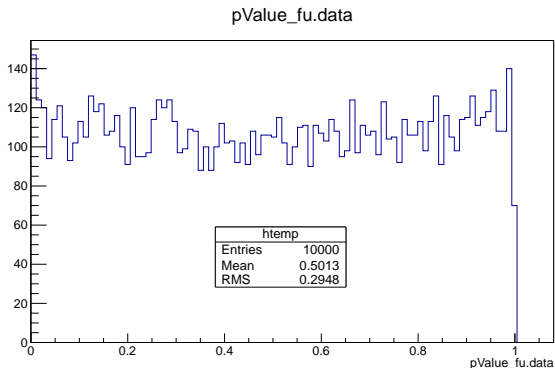
p value histogram

calculated from forward updated total χ^2 values. 1 GeV μ^\pm .
QGSP_BERT physics list



p value histogram

calculated from forward updated total χ^2 values. 1 GeV μ^\pm .
QGSP_BERT physics list Wentzel deactivated



Wentzel model bug or feature?

- in Geant4 Wentzel model is classified as EM MSC effect but only active for μ in QGSP_BERT lists
- e.g. π use only Urban90 model but μ use Urban90 *and* Wentzel. Seems arbitrary.
- at 1 GeV 1% of μ have scattering angles around 0.02 rad when passing one SVD layer cause the momentum fit to fail (e.g. 500 MeV instead 1 GeV)
- we should talk with Geant4 developers about this



Material effects: How to continue

- the correct treatment of material effects is important for low momentum track reconstruction
- the exact impact of different Geant4 models on tracking needs to be understood \implies will continue to investigate this
- while it should always be possible to tune a track reconstruction to a simulation this does not guarantee best performance when dealing with real data



Idea to solve this problem

- Rudi Frühwirth suggested estimating material effects from data instead just inserting them
- normally track fitting uses semi-empirical formulas to calculate:
 - mean energy loss of tracks
 - standard deviation for energy loss fluctuation of tracks
 - standard deviation for scattering of tracks
- it could be better to estimate these parameters from data



The current short term plans are:

- make tracking in basf2 more robust (more testing with full geometry instead of just the inner tracking detectors)
- investigate reason for curling track problems in genfit (I already implemented sorting but more work is needed)
- understand impact of different Geant4 models on track trajectories
- test “real” performance of DAF when full digitizer and background for hole VXD are implemented

The current middle term plans are:

- implement and test a “material effects estimator”



The End

Any advice, suggestions, questions and comments are very welcome