GENFIT Tracking Tool in Marlin

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Excellence Cluster
Universe

Motivation and Context

- Optimization studies for Belle-II PXD built on Marlin framework (adapted to Belle-II needs)
  - Single track and full event simulation studies
  - Interested in tracker aspects: Pixel, Si Strip, Drift Chamber simulated
  - Tracking code crucial!

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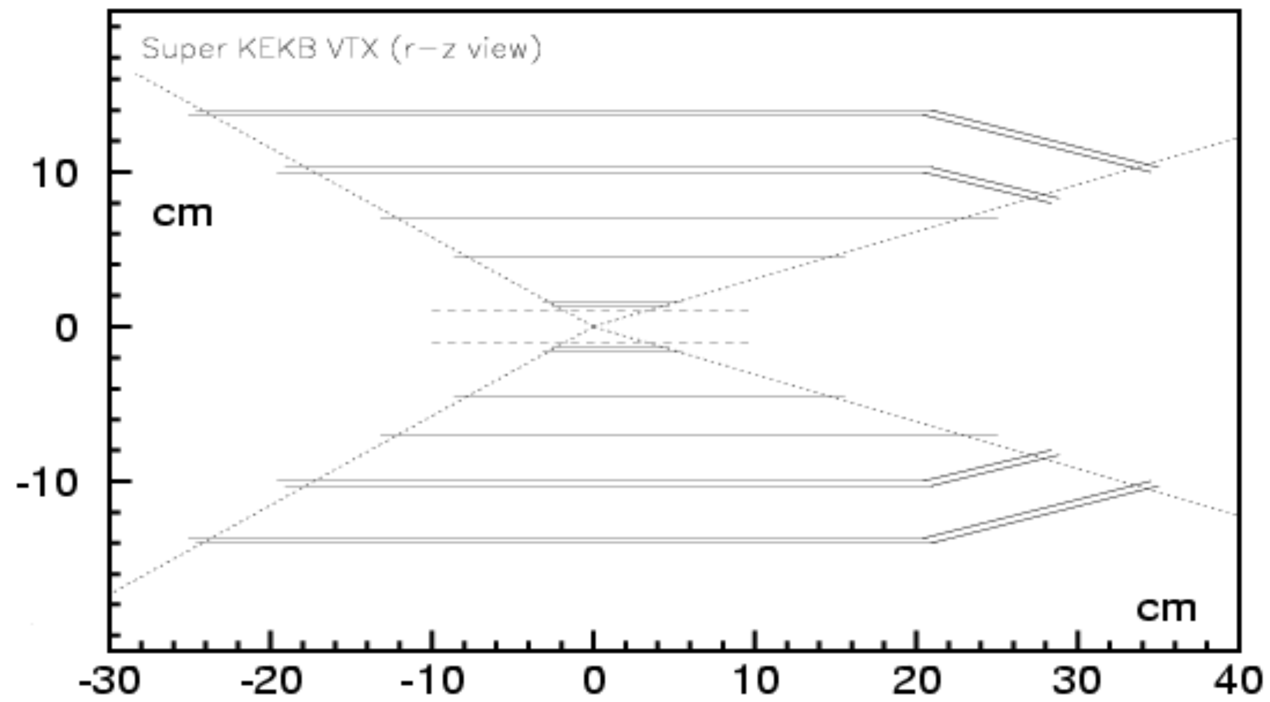
Belle silicon trackers:

- 2 layer pixel tracker PXD
- 4 layer double-sided silicon strips SVD
- outer three layers of SVD have slanted modules in forward region



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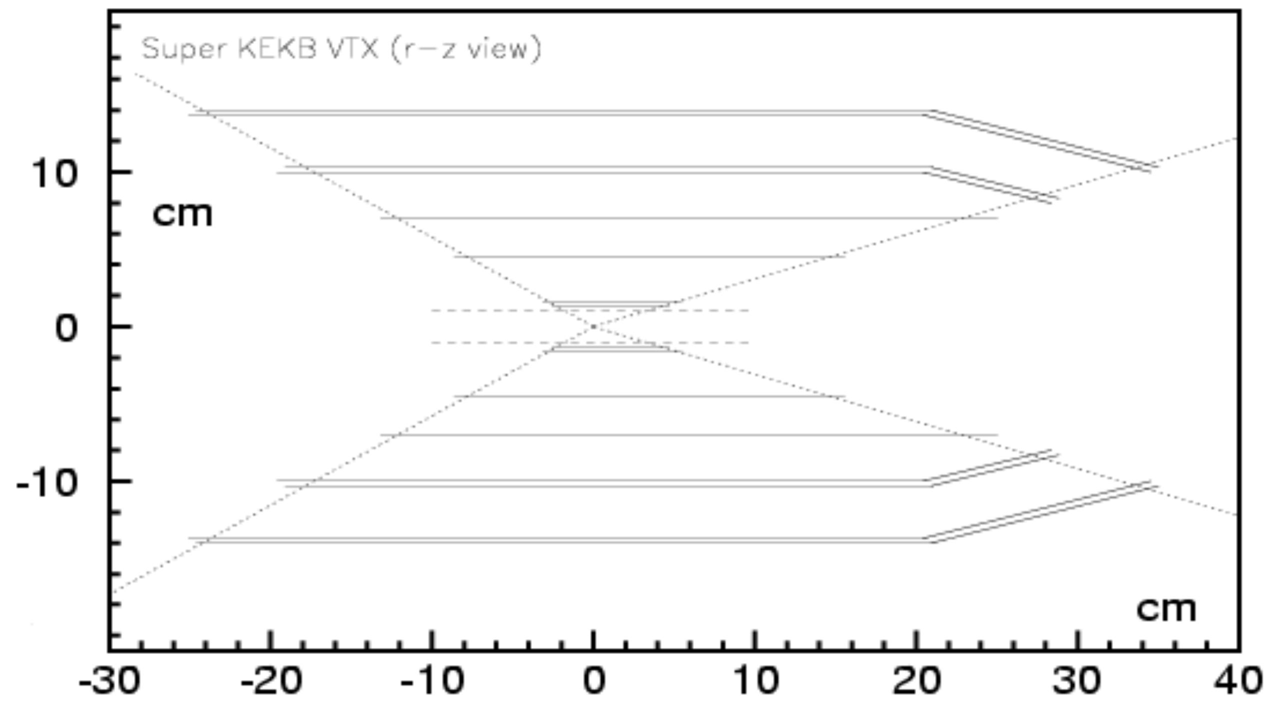


➩ Present tracking code in Marlin not sufficient for Belle-II: Slanted modules, strip detectors not handled correctly

➩ New tracking code needed, both for optimization studies in Marlin and for Belle-II software under development

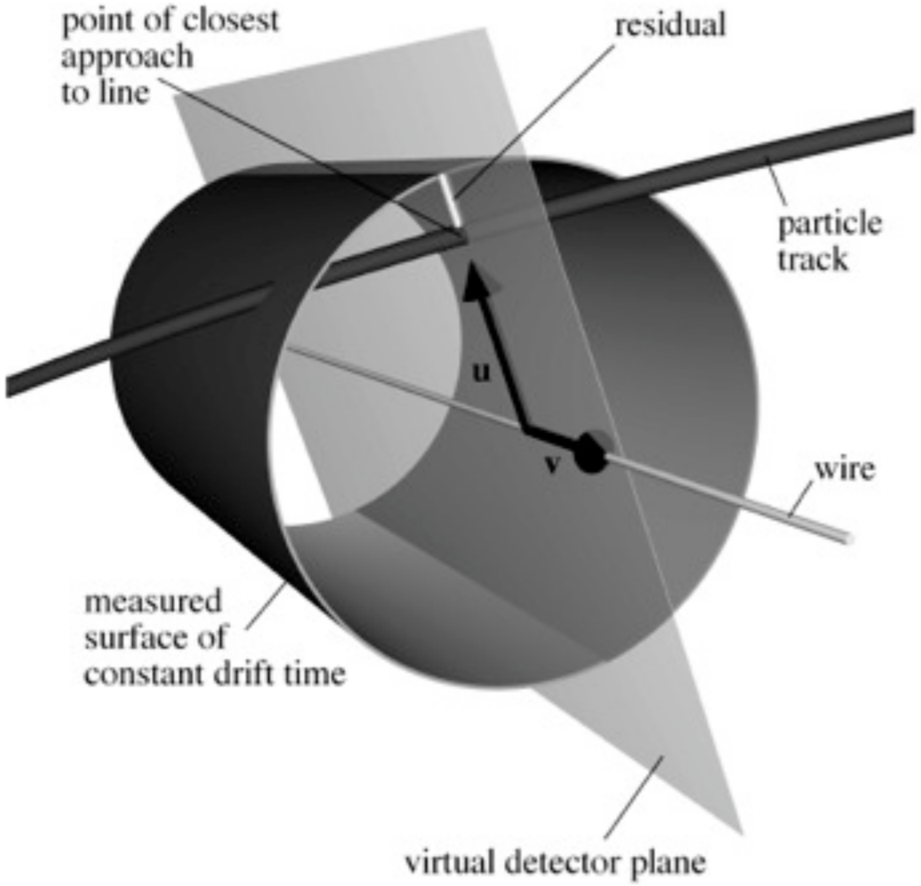
GENFIT Basics

- New framework for track fitting
- Developed at TU Munich, C. Höppner et al., arXiv:0911.1008 [hep-ex]
  - Code available at http://sourceforge.net/projects/genfit/

  - Developed as part of the PANDA computing framework for silicon & TPC tracking
  - Written in C++
  - Modular, highly object oriented design

GENFIT Features

- Hits are defined in detector planes: 1D for strips/wires, 2D for pixels, virtual detector planes in the case of drift tubes, TPC
- Different track extrapolation algorithms can be implemented
  - already available: GEANE, Runge-Kutta (under development)
- Simultaneous fitting of several track representations to the same set of hits:
  - Compare track representations
  - Track different phase space regions with different track models
  - Fit different mass hypotheses with the same track model



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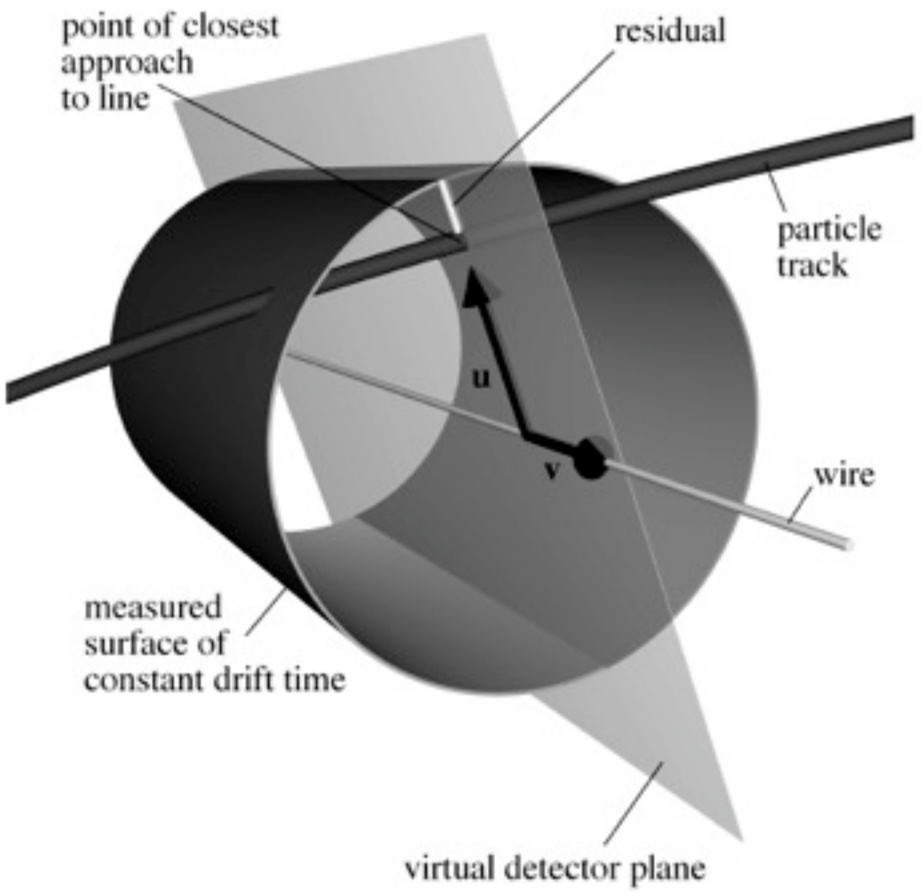
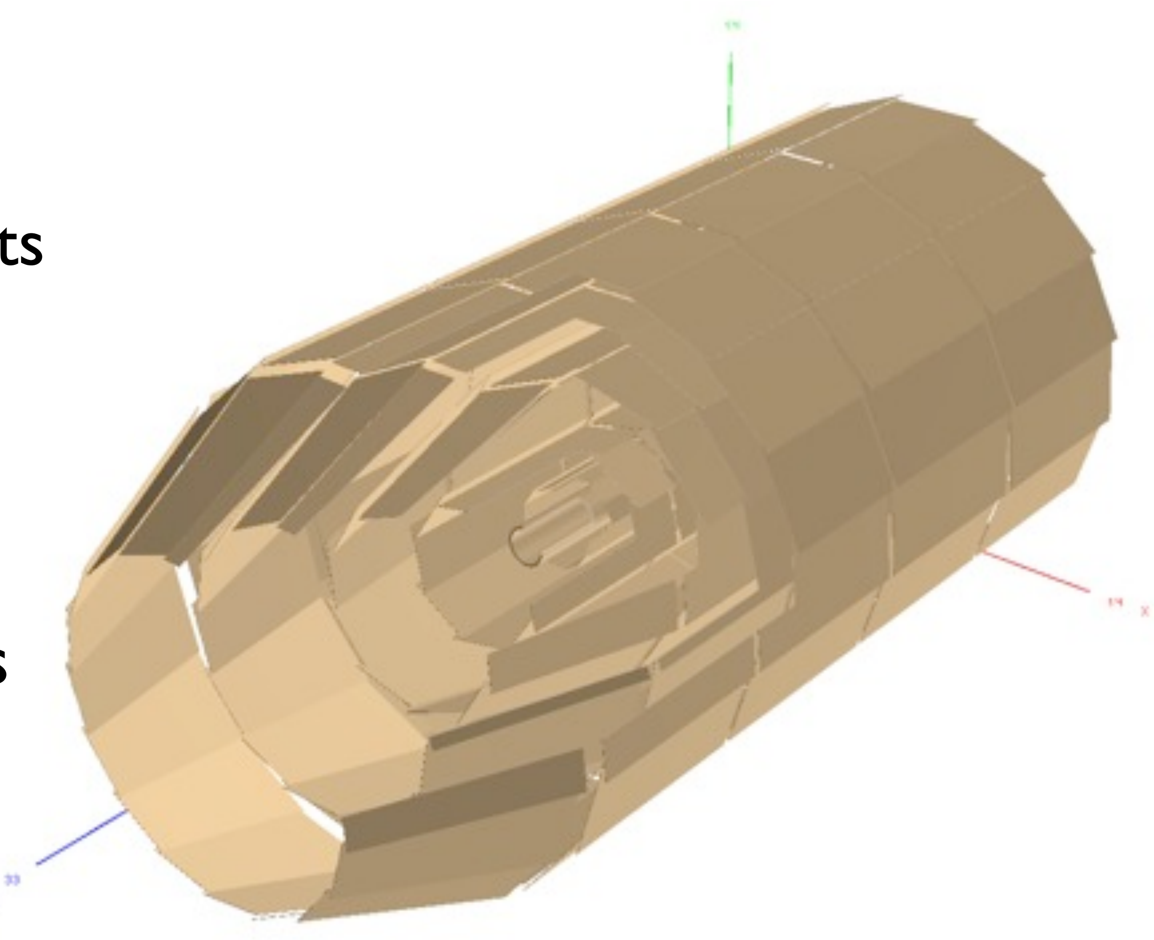
- Different track fitting algorithms can be implemented:
  - already available: a validated Kalman Filter



Geometry

- GENFIT itself is independent of the geometry description
- The geometry is accessed by the track representations
- Both currently available track representations (GEANE, Runge-Kutta) use TGeo (ROOT)

- Our modified ILC framework uses a newly developed geometry system
  - A TGeo hierarchy is built from XML documents
  - A Marlin processor loads the TGeo hierarchy into memory from a root file or creates it on-the-fly from XML documents
- All Marlin processors and GENFIT can access the TGeo hierarchy using "gGeoManager"



GENFIT in Marlin: Proof of Principle

- Simulation of 2 tracking subdetectors of Belle II detector with Mokka (single muons)
  - Pixel Vertex Detector (PXD), Silicon Strip Detector (SVD)

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  - Create Runge-Kutta track representation with muon mass hypothesis
  - Create GENFIT track and add track representation

GENFIT in Marlin: Proof of Principle

- Add hits to track:
  - Smear hit ➪ "Digitization"
  - Find sensitive volume that fired hit (uses cellIDDecoder and TGeo)
  - Create detector plane from sensitive volume transformation matrix
  - Assign hit to track using
    - the local position of the hit on the sensitive volume (u,v coordinates),
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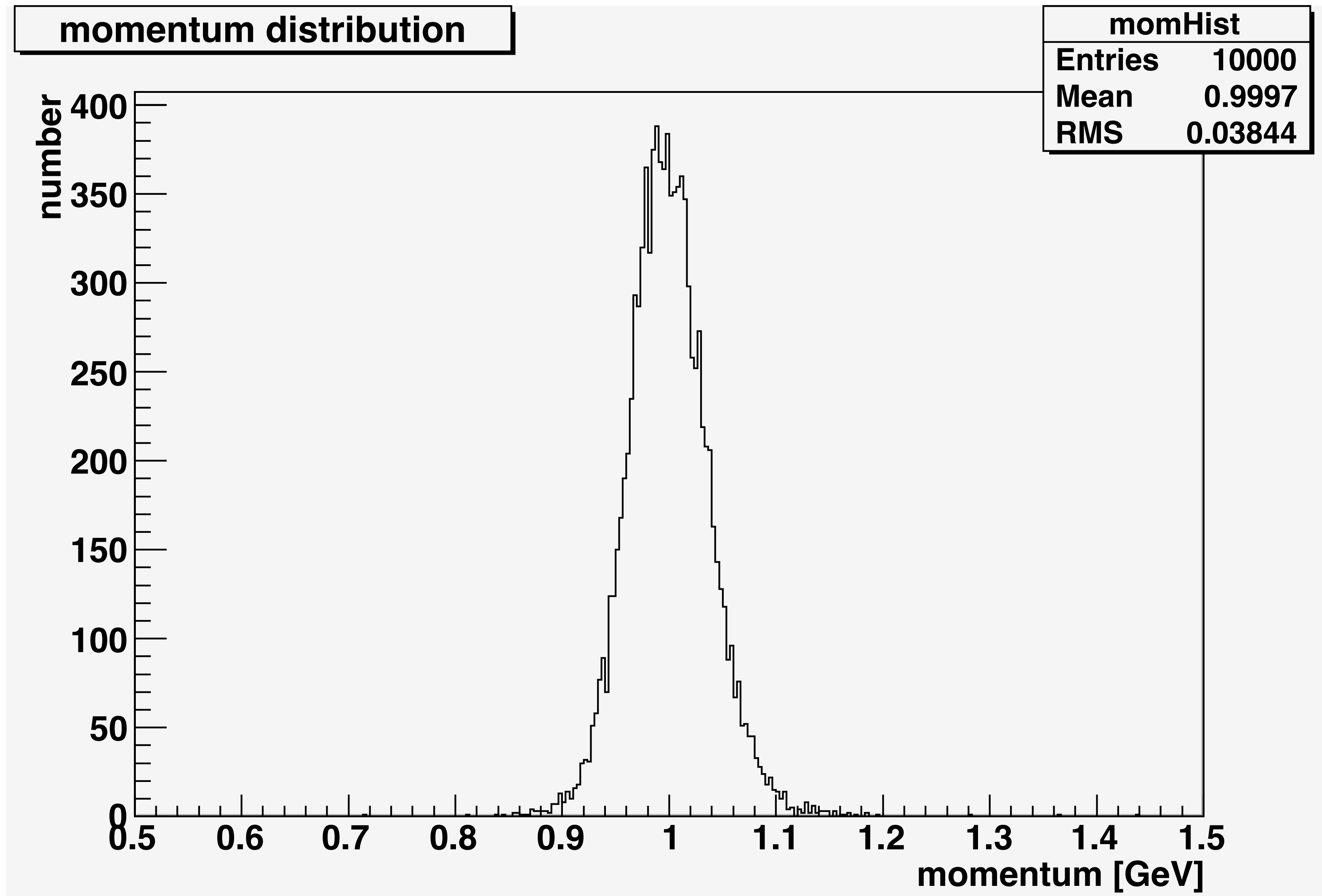
➩ Run the Kalman filter

First Results I

- Simulation of Belle-II Silicon (PXD + SVD) in Mokka
  - Single muons, 1 GeV, $\theta = 85^\circ$
  - Caveat: No material effects yet in Runge-Kutta track extrapolation!

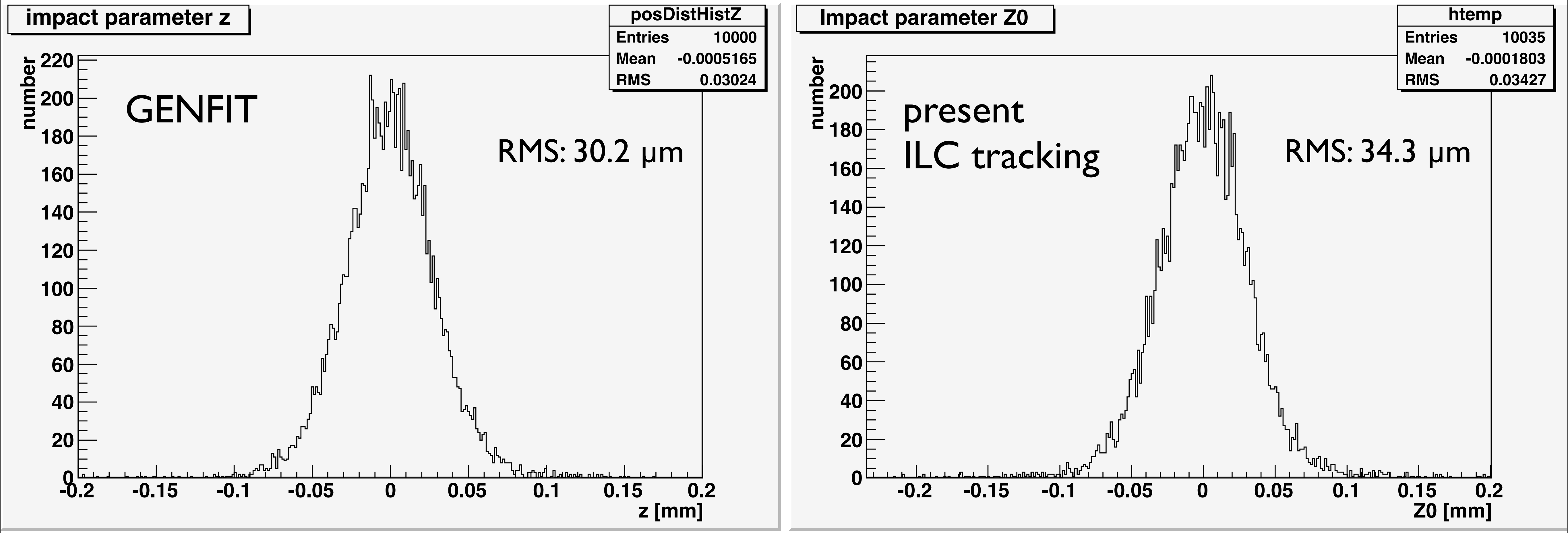


Momentum resolution, 1 GeV muons

already now: slightly better performance than existing tracking

First Results II

- Z-Vertex reconstruction crucial in B Physics: Provides time resolution for time-dependent CP violation measurements



Impact parameter resolution
1 GeV muons

Outlook

- Further development of GENFIT ongoing
  - Material treatment being included in RK track extrapolation, expect results very soon
- More work on integration in Marlin & Belle-II framework
  - Issues with track representation: Not compatible with LCIO out of the box
  - In the process of writing a small tool for quick & dirty track simulations in ROOT without Geant4 simulation for fast test & development
- Potentially: Test also with ILD detector model