

**Status** and **Plans**  
of the  
**Belle-II Tracking Software**

**Martin Heck**



# Outline

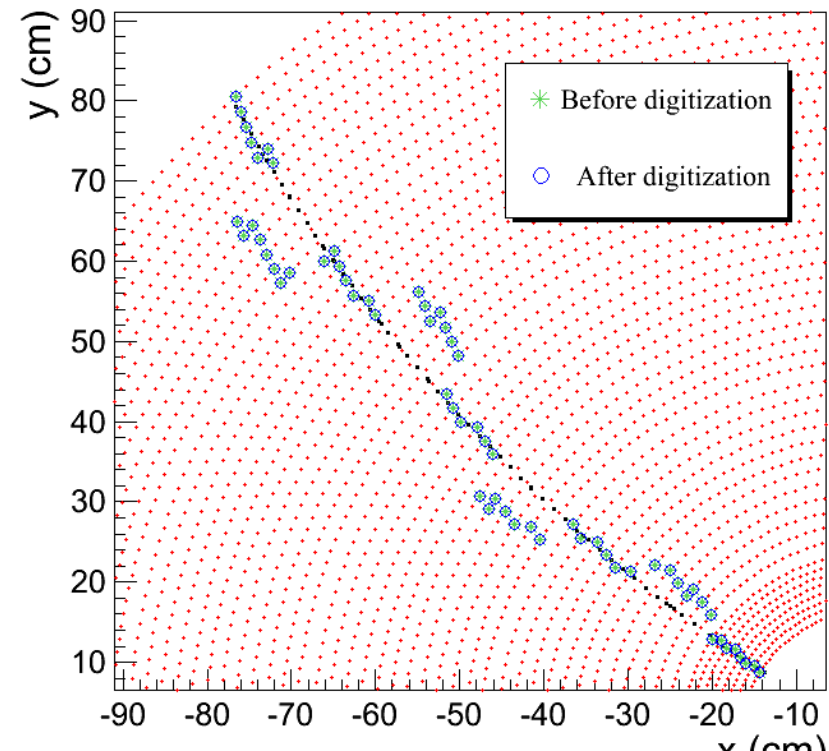
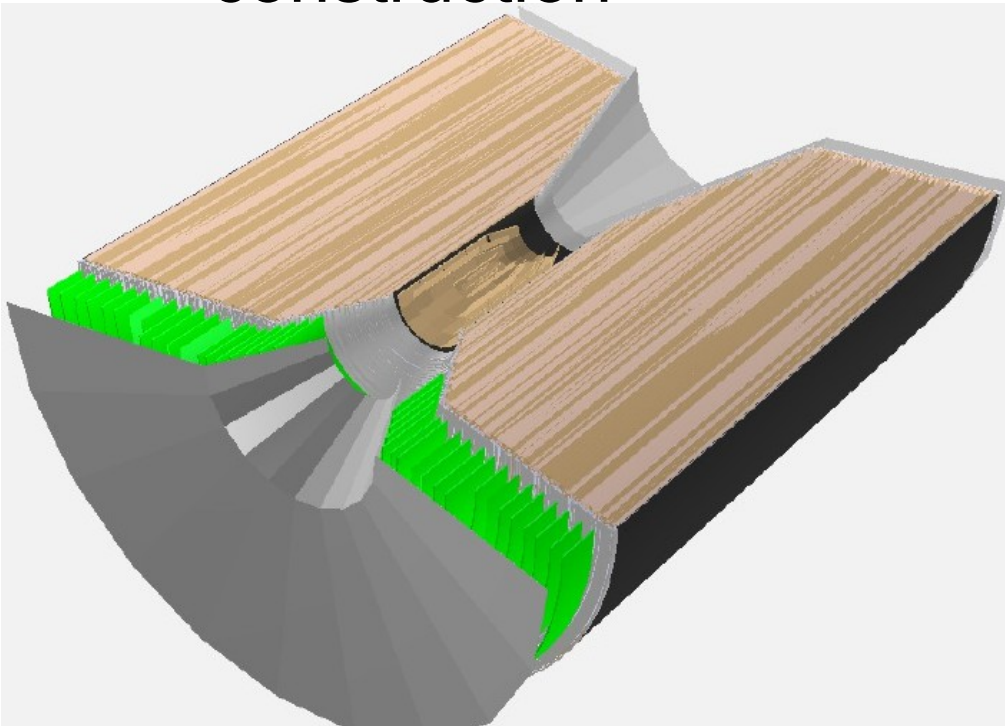
- Process Overview
  - Development Tools
- General Tracking Strategy
  - High Momentum Tracking
  - Low Momentum Tracking
  - Ultra Low Momentum Tracks
- Misc
- Summary

# Process Overview

- High Level Trigger
  - Track Finding without PXD
    - High BKG level in PXD
  - Extrapolation to PXD to have strong data reduction  
→ tracks, that aren't found ONLINE will have NO PXD information!
- Offline Precision Fitting
  - Best Track Parameters (momentum, impact parameter,...)
  - Z Vertex Resolution needs to be good
    - ← Y(4S) gamma in Belle 2 is  $\sim 1.05$ , while it was 1.1 in Belle
    - B meson spacial separation only 40% of the one in Belle

# Development Tools [1]: Detector Simulation

- **STATUS:**
  - CDC simulation is the most advance in basf2
  - PXD & SVD simulation have been used with the ILC framework, but portation to basf2 is under construction

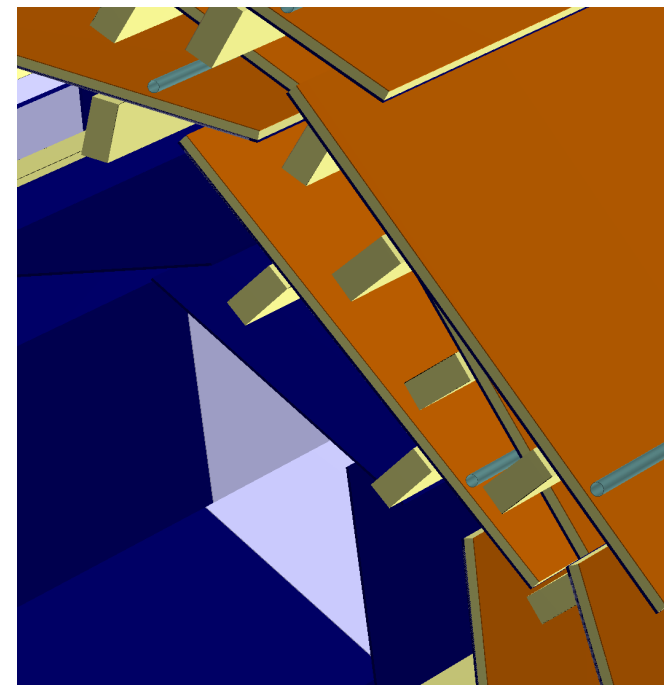
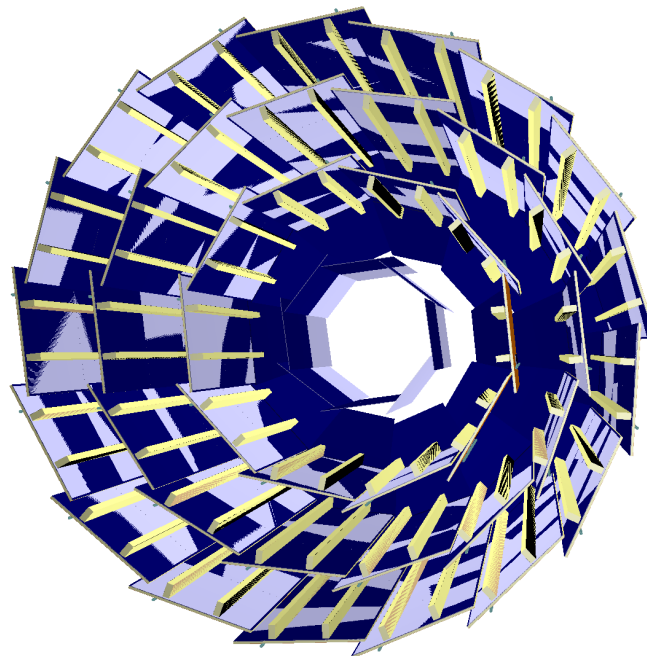
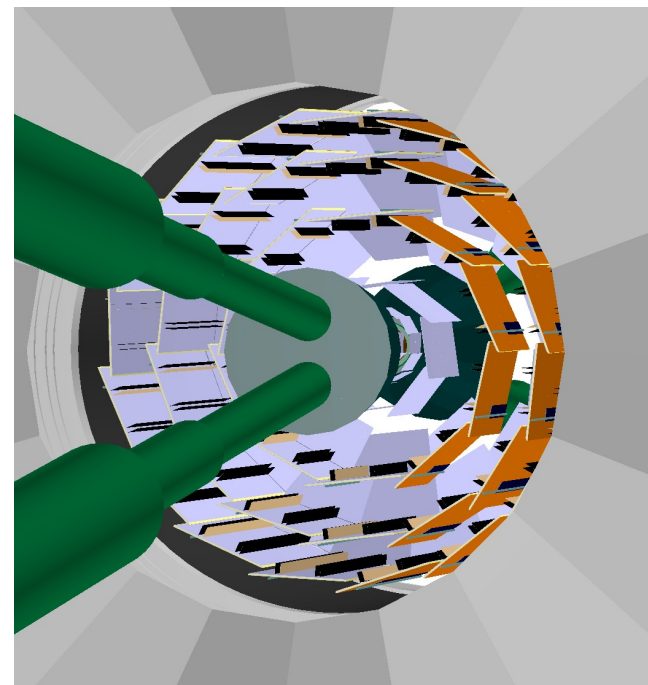


# Details on Silicon Simulation

## Peter Kodys

# Prague status @end 09/2010

- **Implementation of SVD and PXD geometry in BASF2 (Christian Oswald, Peter Kodys): NEARLY FINISHED**
  - The implementation is usable
    - Only some fine details of dead material are still missing (PXD electronics & SVD slanted region and electronics)



# Prague status @end 09/2010 (cont'd)

- **Development of PXD and SVD digitization modules for BASF2 (Peter Kvasnicka, Zbynek Drasal: **IN PROGRESS****
  - “Do-nothing digitizer” finished (simulated tracker hits to normal tracker hits, unchanged)\*
  - Gaussian smearing digitizer in 7 days
  - Full digitizer using Zbynek’s ILCsoft digitizer by the following B2GM (however, we depend on details of geometry and data model that are in development, and we also have to allow reasonable time for testing)

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\* Similarly to the ILCsoft digitizer, the PXD digitizer will produce tracker hits from simulations. Production of digits is only done internally, and the final digitizer will output digits as an option. The SVD digitizer natively produces digits.

# Development Tools [2]: Background Simulation

- **STATUS**: No background simulation used for tracking studies so far
- **PLAN**: We should include most dominant backgrounds into the tracking studies before Christmas.



# General Tracking Strategy

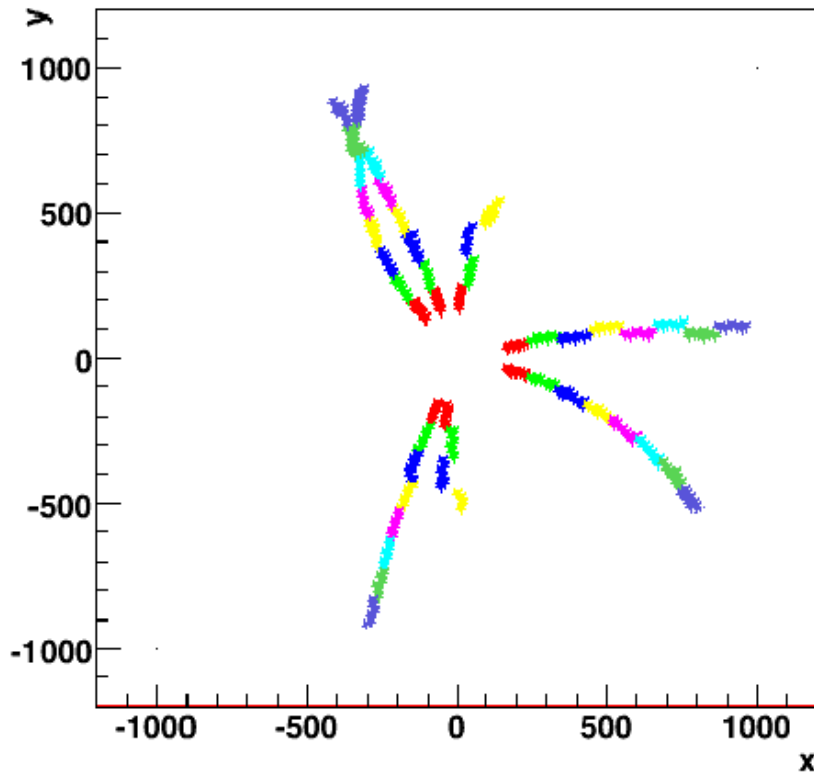
- Outside In / Inside Out
  - Lower Background density in outer layers
- Use of external Tools philosophy
  - GENFIT (Precision Fitting) – from the PANDA collaboration
  - RAVE (Vertexing) – used in CMS

# High Momentum (KEK + KIT)

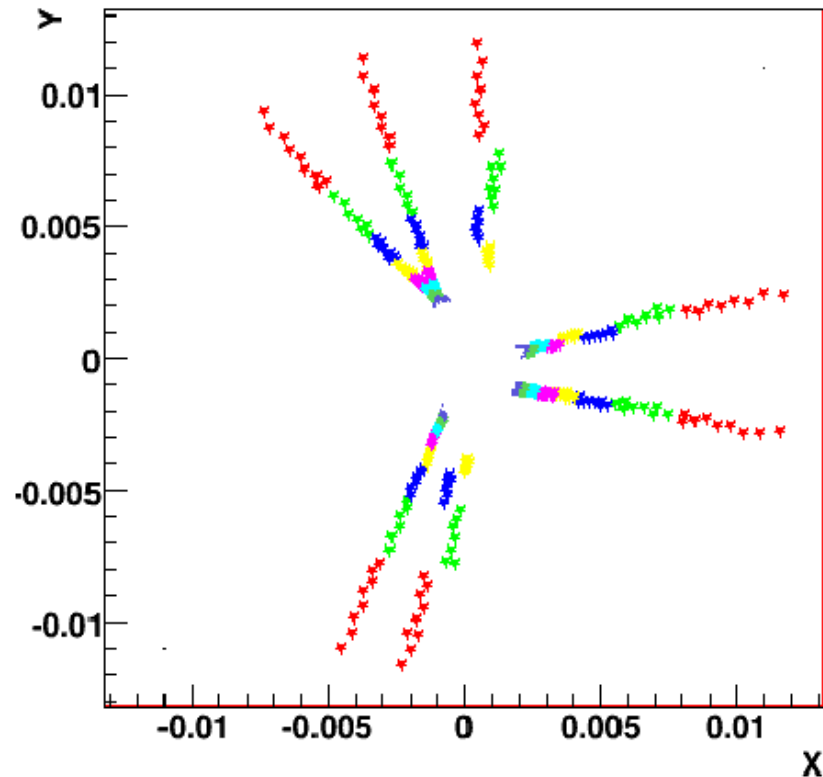
Y. Iwasaki, O. Brovchenko, M. Heck

- Find Track Segments in the outer part of the detector
- Create tracks by fitting in the “conformal plane”

Drift Chamber Hits -  $r\phi$  plane



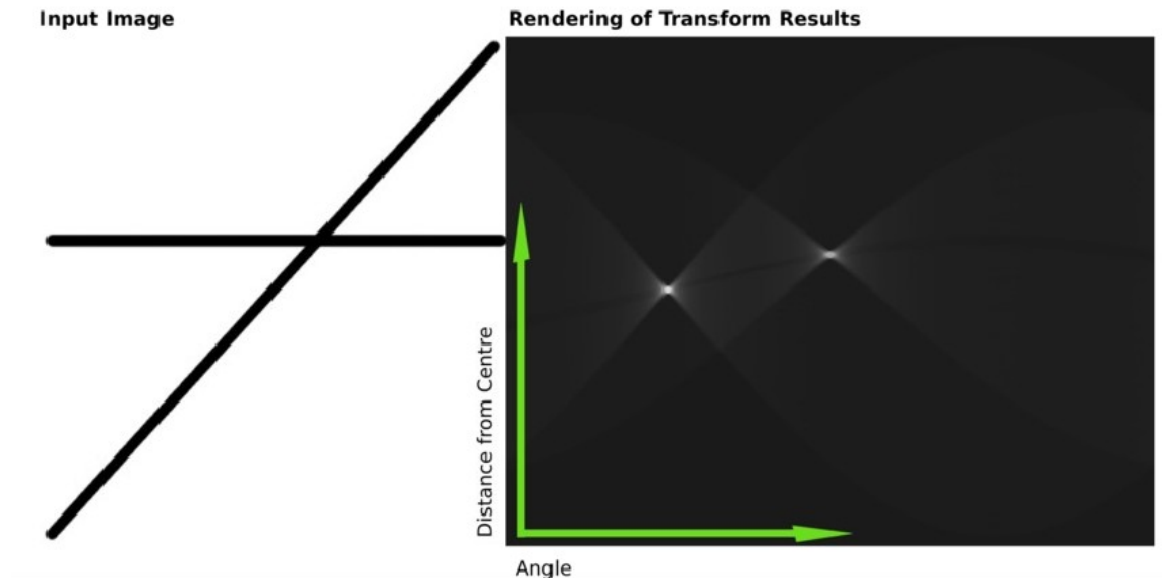
Conformal Plane



# cont.

- Further considerations

- Hough Algorithm  
much computing  
power, but can  
be easily adopted  
for GPU



- Using TrackSegments  
for Kalman Filter based approach  
→ much Computing power needed, but can probably  
handle more background
- In Karlsruhe, we work from scratch
- At KEK Belle tracking is adapted

# Low Momentum (Vienna)

- **STATUS:**

- First studies for silicon only tracking with ILC Software based simulation

- **PLANS:**

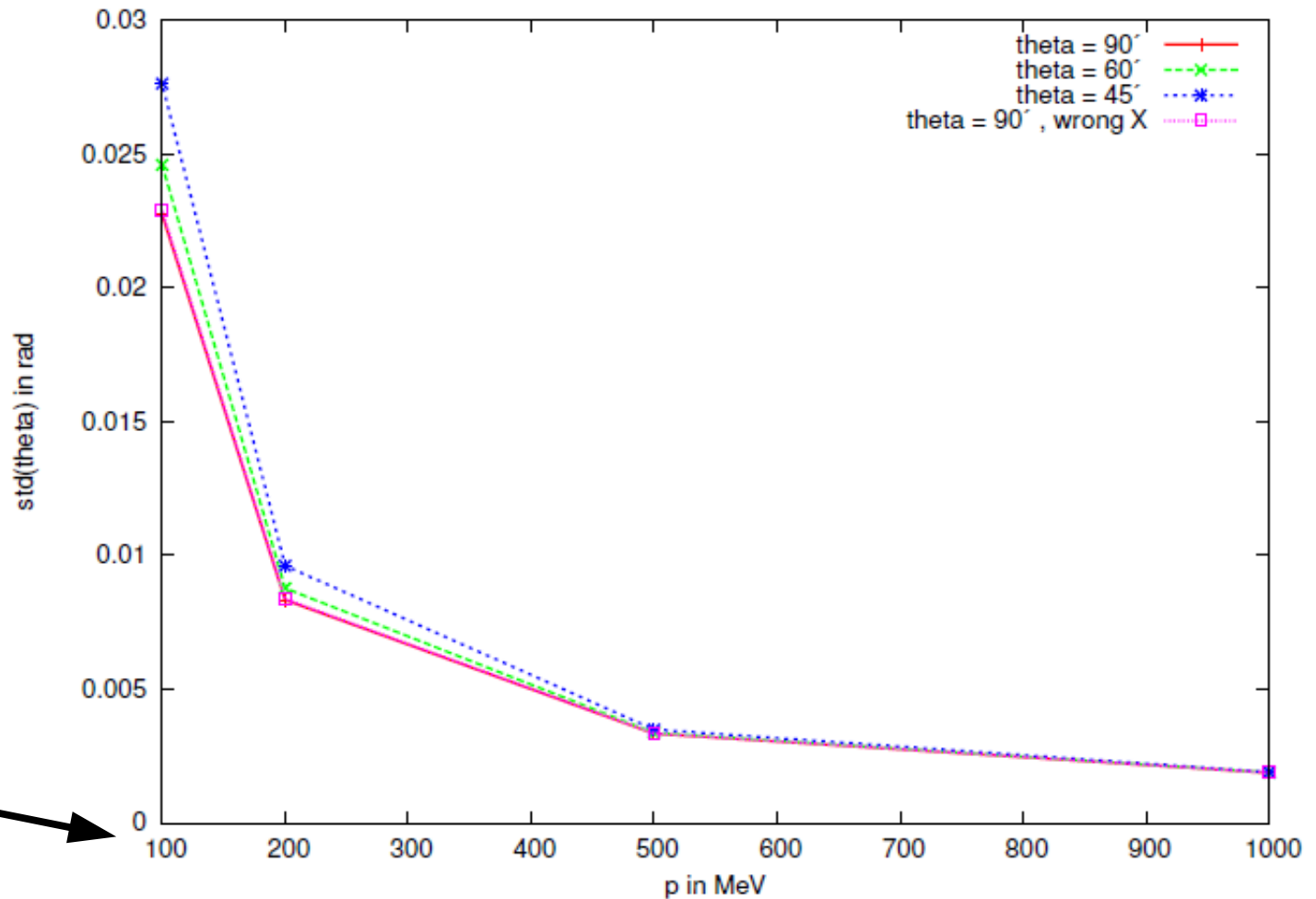
- Track Finding (Rudi Fruewirth):
  - Based on Combinatorial Kalman Filter (CKF)
    - Start with some seed and fit
    - Add Hits in unused layers, that can belong to the same track
    - Due to ambiguities more than one hit can be added, leading to **different track branches**, as well the no hit assumption can be used for a branch
    - Remove track branches with bad total chi-square, too many missing hits, which are subsets of other candidates
    - After having looked to all layers, the best candidate is chosen

# cont.

- Precision Fitting Kalman Filter (Moritz Nadler)
  - Simplified Matlab based simulation
  - As long as total matter is ~correct, 10% X uncertainties in each layer have little influence (Simulation uses 1mm Si/layer to have “strong” matter effects)

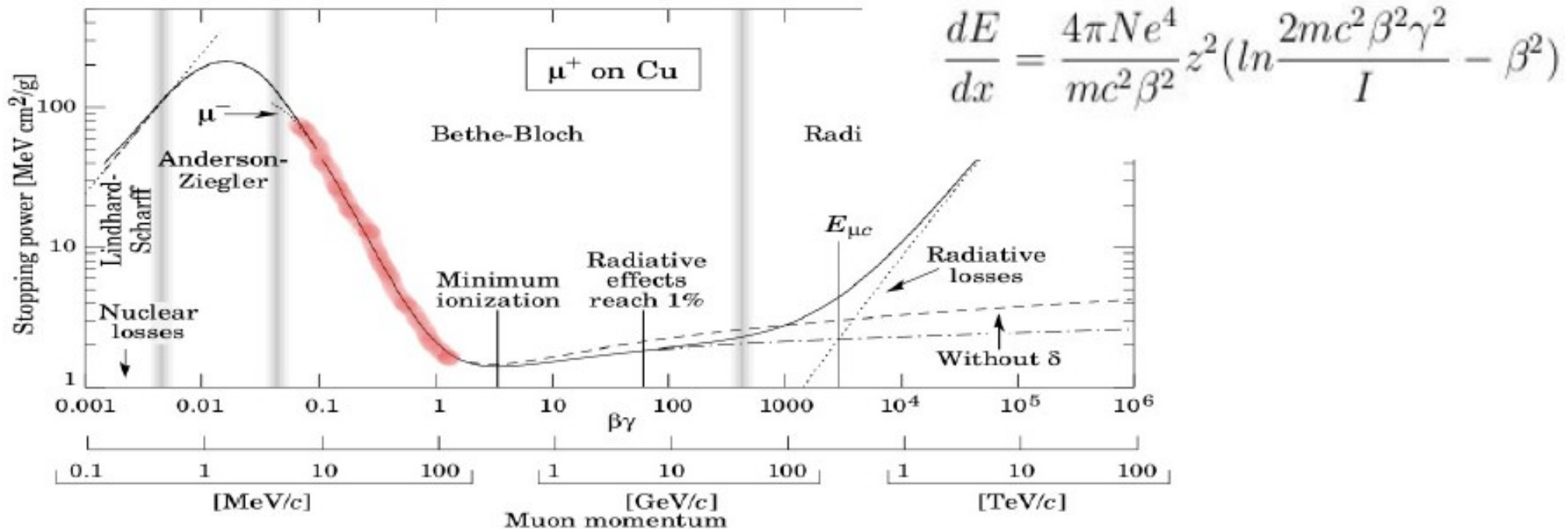
Uncertainty on polar angle of momentum.

Not yet tested at the really low momentum



# Ultra Low Momentum (Krakow)

- Karol Adamczyk is trying to estimate Momentum from dE/dx



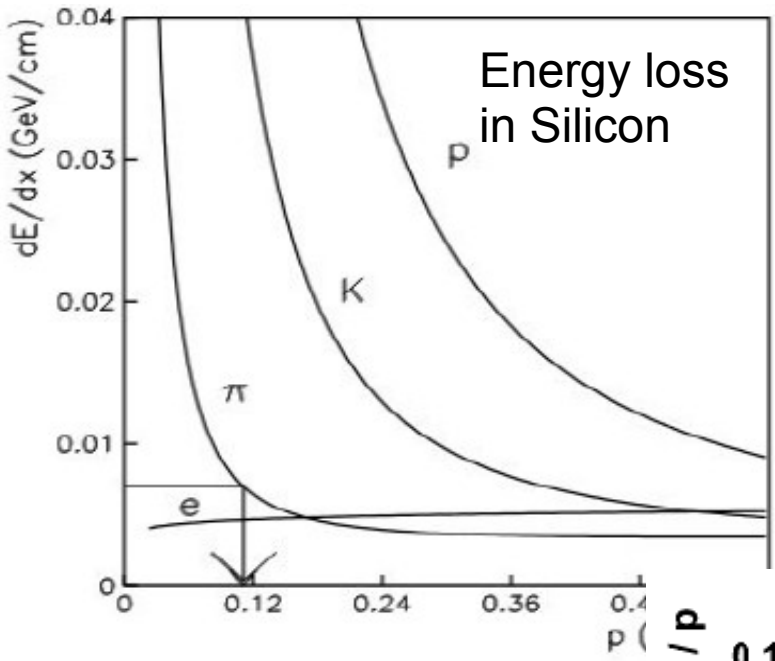
ctd.

Preliminary, somewhat buggy results

are promising:

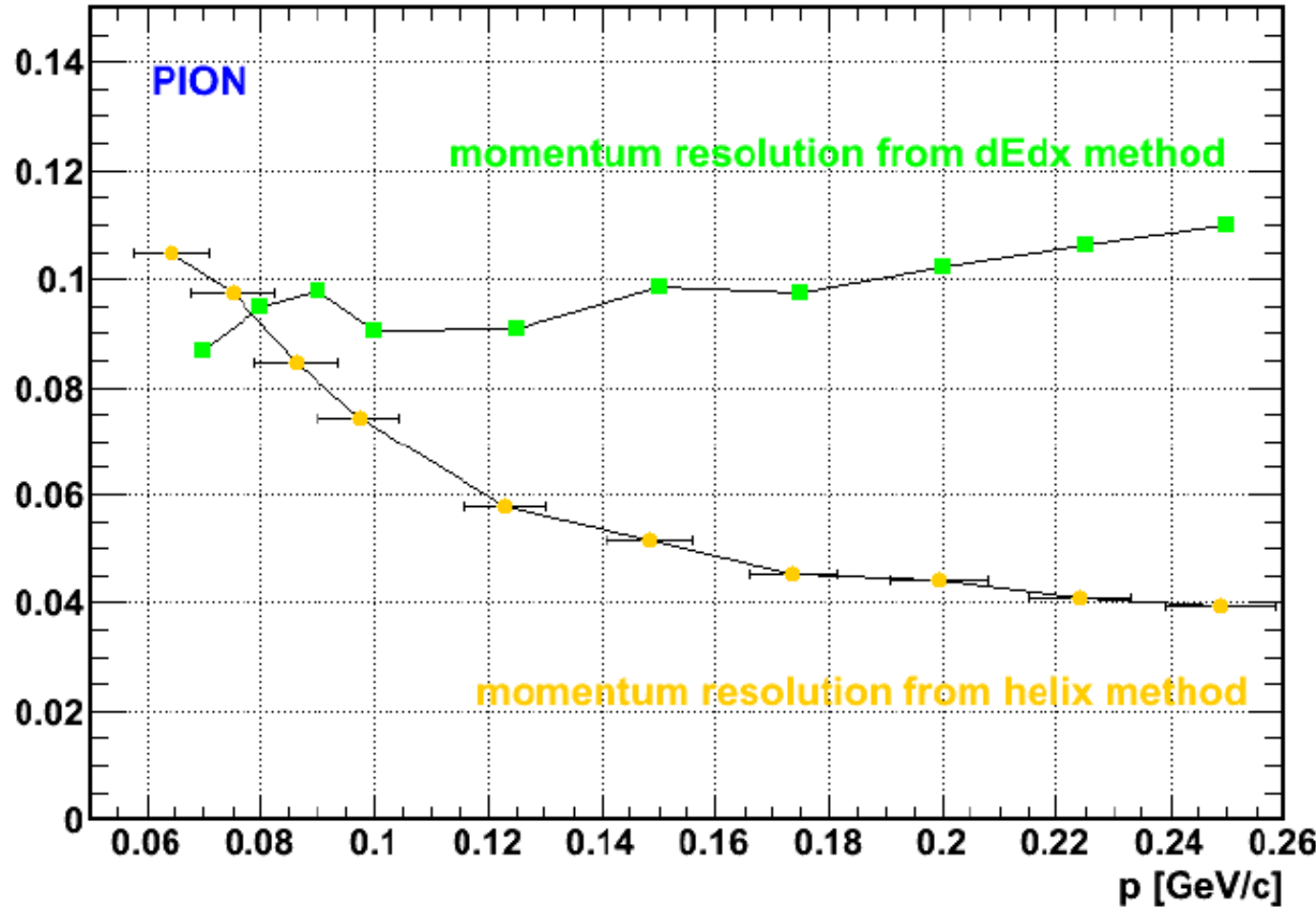
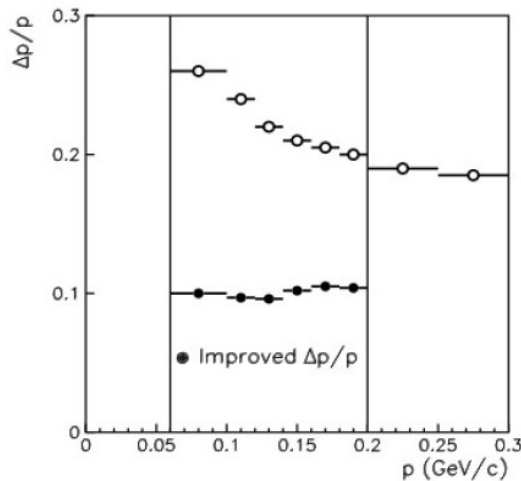
In the Momentum (not transversal)

Range of 70 to 80 MeV, there is most likely something to win with this method.



Possible cross check with classic tracking!

Comparable with Alice paper results



# Misc

- **Coordination of Database issues** important to have everything (especially alignment constants) available for offline tracking.
- **Data Model** etc. must be defined, some requirements from the Tracking Side...
- **Alignment** is currently not a high priority, but there were some promising studies by Martin Ritter (MPI) with Millepede



# Summary

- Development Tools for Tracking and External Package Use is well under way
- $dE/dx$  based momentum estimation seems to be feasible → Silicon Detector Hits, that show high  $dE/dx$  should be saved even if there is no track, that matches!
- Classic Tracking development has begun, but without full detector and background simulation progress was mainly through case studies