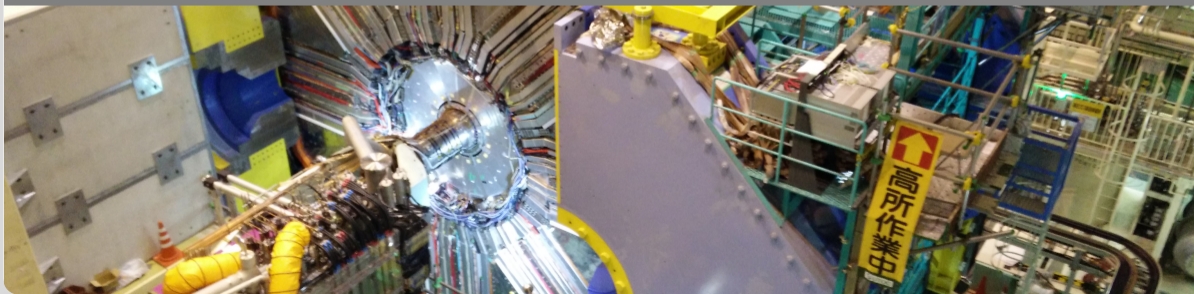


Belle II Tracking in Phase III with the Full Detector

Connecting The Dots 2018

Felix Metzner | 21.03.2018

KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT)

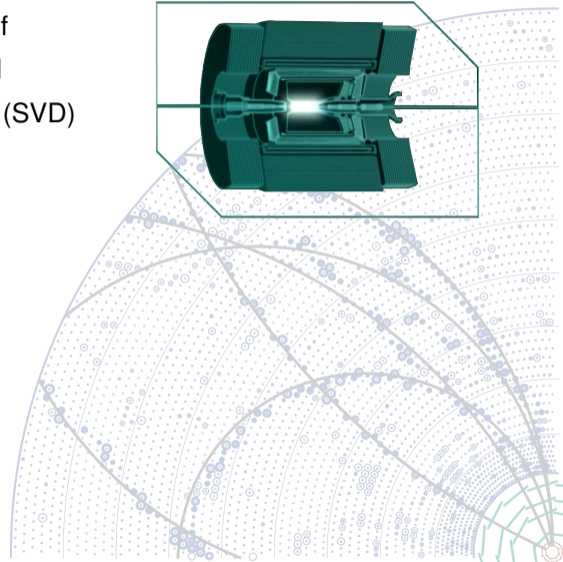
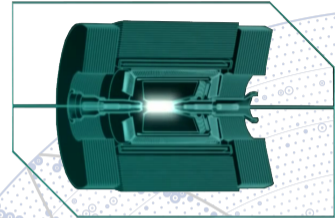
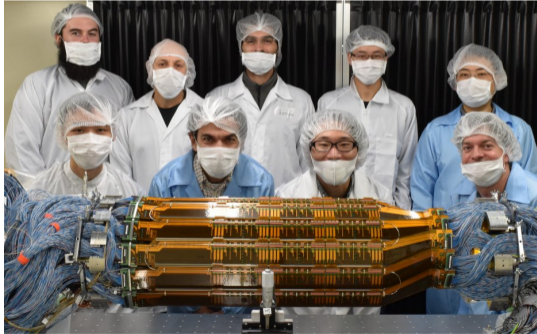


The Silicon Detectors

The inner vertex detector (VXD), which consists of

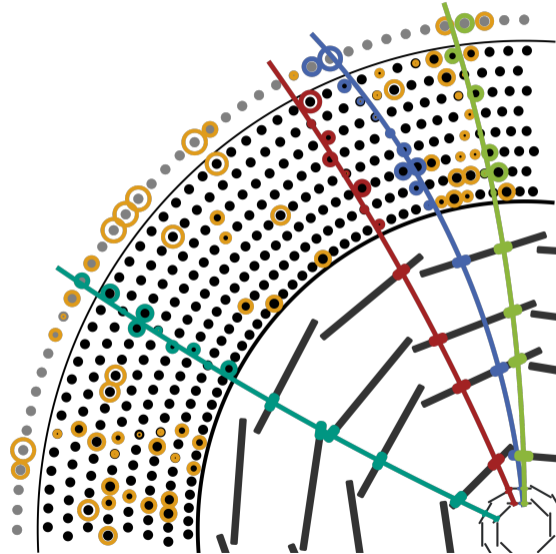
- 2 layers of DEPFET pixel sensors (PXD) and
- 4 layers of double-sided silicon strip sensors (SVD)

will be installed at the end of this year.



The Challenges of Tracking at Belle II

On average **11 tracks** per event...
We want all of those, but **not a single fake!**



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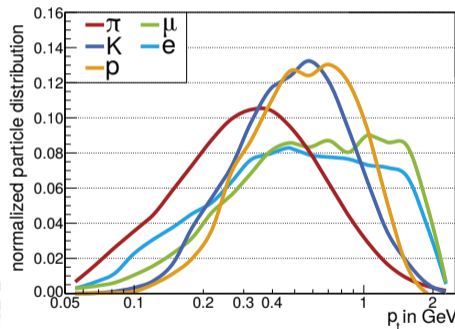
Low momentum particles

- Non-negligible fraction
- Multiple scattering

Beam-induced background

High occupancy due to background hits:

11 tracks \rightarrow 10^2 signal hits
vs. 10^4 background hits



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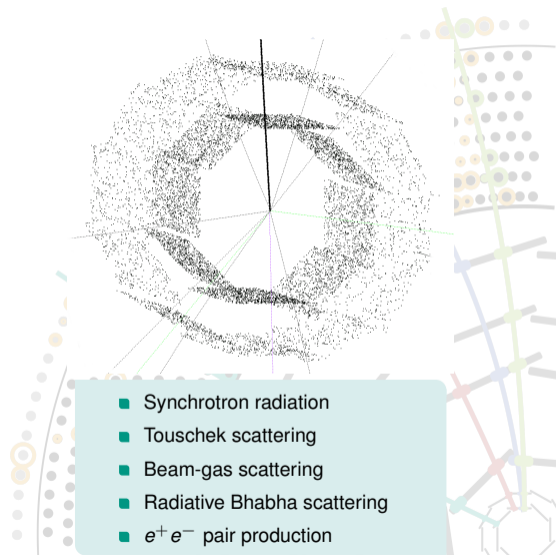
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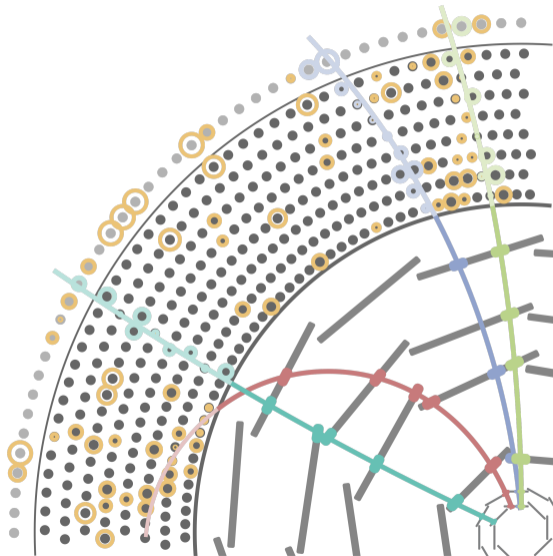
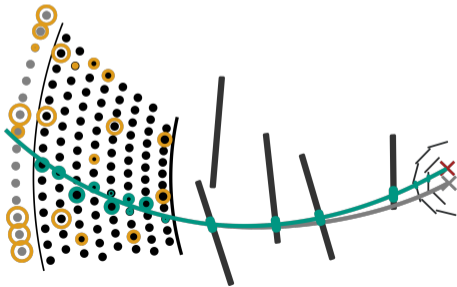
Utilizing the Silicon Detector Information

1. Improving the track parameters.

Better vertex resolution by adding VXD hits which are closer to the interaction point.

2. Tracking of low momentum particles.

Tracking particles which do not reach the CDC or get scattered.



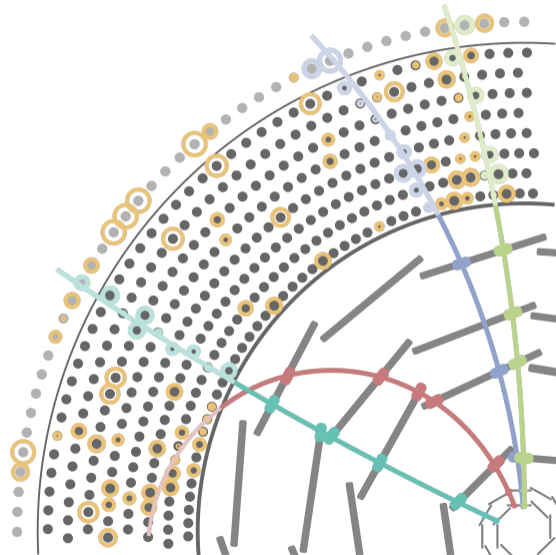
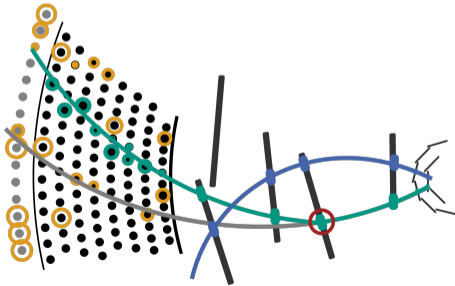
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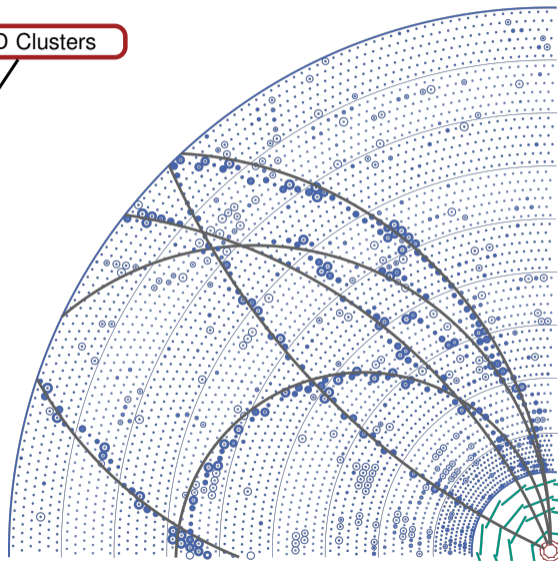
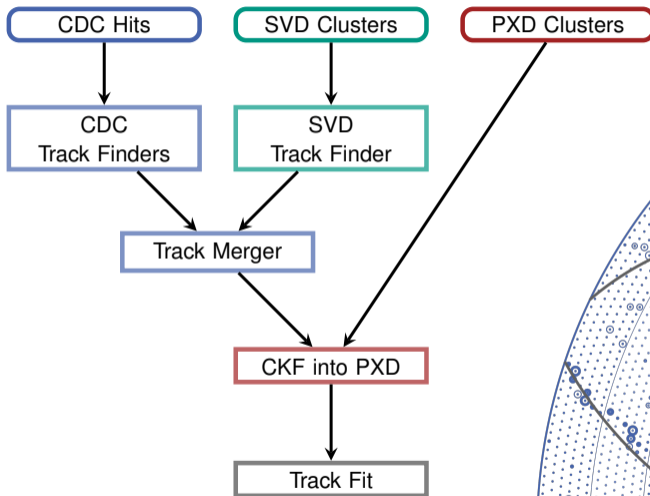
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The Flowchart to Catch Them All



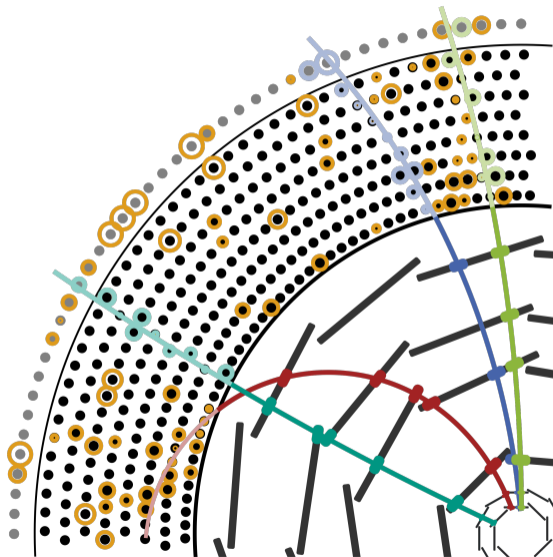
SVD Standalone Tracking

Cellular Automaton collects longest paths beginning with outermost 3D-hits.

Neighboring 3D-hits are given by a set of **filters**:

- Evaluating duplets and triplets of 3D-hits
- Individual for every sensor
- Learned from simulation

⇒ Reduction of combinatorics
⇒ Allows for multiple scattering



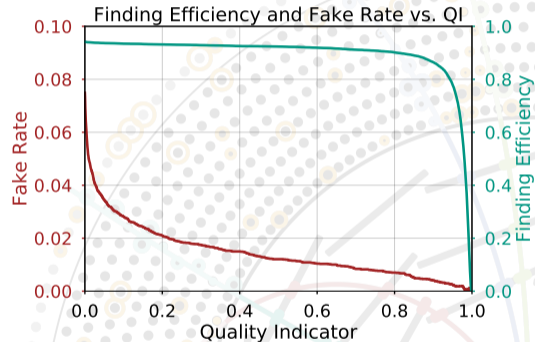
SVD Standalone Tracking

The **final set of tracks** is chosen from all paths such that **no tracks share a SVD hit**.

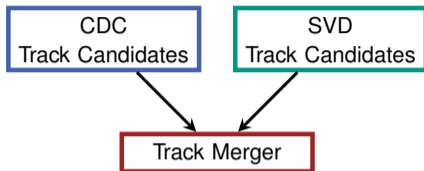
For competing paths a **quality estimation** is employed:

- Based on fitting 3D-hit triplets
[A. Schöning, arXiv:1408.5536v1]
- Combine fit result with additional detector information via MVA method

⇒ Successful resolution of hit overlaps
⇒ Discriminator against fake tracks



Track **Merging** with a Combinatorial Kalman Filter (CKF)

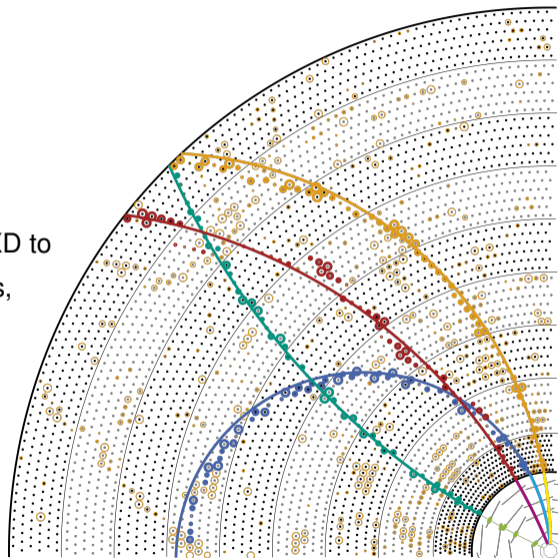


Extrapolation of CDC track candidates into the VXD to

- merge them with found SVD track candidates, or
- pick up unassigned SVD cluster.

⇒ Extrapolation considers material effects.

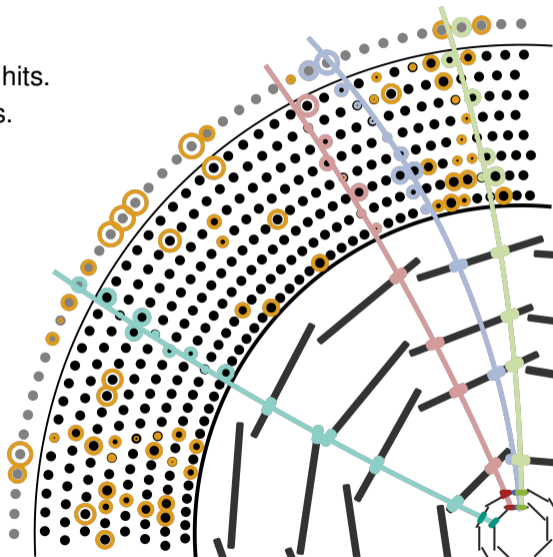
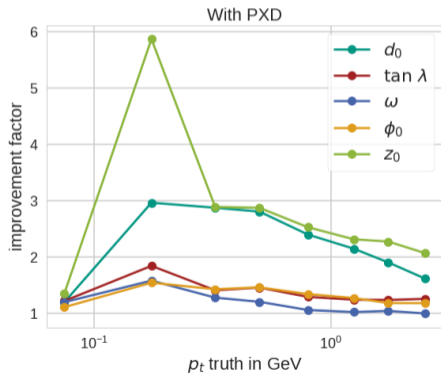
⇒ MVA filters allow to adapt to different particle momenta.



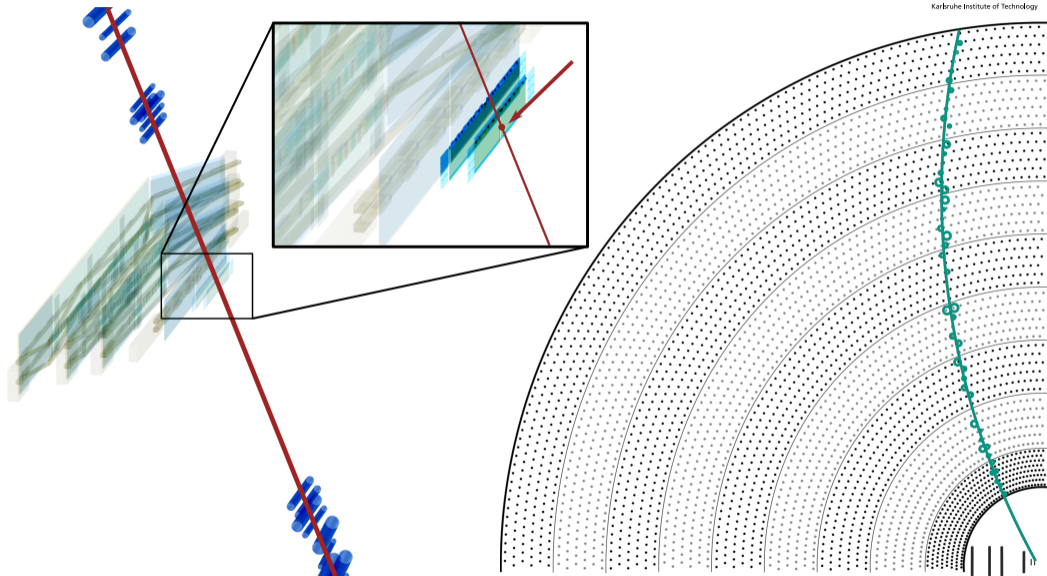
Picking up **Pixel Hits** with the CKF

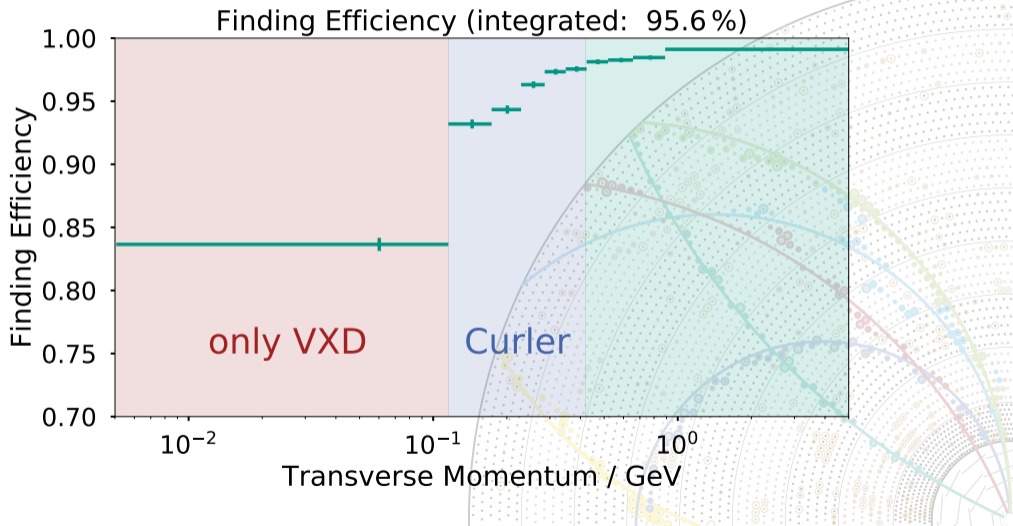
Adding pixel hits via CKF into PXD.

- ⇒ High purity despite high number of background hits.
- ⇒ Significant improvement of the track parameters.



A Pixel Hit from a Cosmic Track





Conclusion

At Belle II separate approaches are employed for track finding in the CDC and SVD.

CKF-based methods are used to merge tracks and pick up pixel hits.

The combined application of these algorithms was **tested successfully on simulation** and is **ready to face data from collisions** in Phase III.

Thank You for Your Attention!

