# **Tracking Overview**

## Where we stand – and where we want to go

**Basically running stable** 

Christian Wessel Belle II Germany FSP Meeting 19<sup>th</sup> to 21<sup>st</sup> of September 2022



HELMHOLTZ

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  - Phi, Omega, d0, z0, lambda = 90° thetr - Vertex position, momentum, charge  $y = \frac{1}{x} \frac{q_0}{q_0}$ IP POCA

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  - Vertex position, momentum, charge
- But HOW?



### **Tracking in Belle II**



### **Tracking Performance in Belle II with the full Chain**

#### **Basically running stable**



### **Issues in Tracking – Performance**

#### Fake and clone tracks

- Fake tracks are tracks without MC counterpart based on their hit content
  - Random combinations of hits
  - Actual tracks from background processes,
    e.g. low angle (very fwd / bwd) e+e- scattering
  - We don't want either
- Clone tracks are (parts of) tracks that are found multiple times
  - Curling tracks where different parts are not matched severe issue around lambda = 0°
  - Tracks where CDC and VXD part are not matched  $\rightarrow$  can happen anywhere in the tracking volume

#### Tracks with displaced vertices

- Tracking performance significantly degrades for tracks that aren't from the origin
  - $K_{s}^{0}$  daughters, DM decay particles, decays in flight

### Slow pions from D\* decays

 Slow pions are hard to find: multiple scattering and energy loss – improvement in efficiency will improve D\* efficiency



### **Issues in Tracking – Software**

#### Long execution time

- Several track **finding** algorithms take a long time per event
  - Potentially limits maximum HLT rate
    - Either reduce execution time, or build larger HLT (or with more modern hardware)
  - For optimisation: deep dive into tracking C++ code
  - Change tracking chain: SVD to CDC?
    - Start with SVD track finding end extrapolate outwards
    - Limiting factor at the moment: SVD-To-CDC-CKF performance
- Track **fitting** is slow
  - We rely on the the Deterministic Annealing Filter (DAF) from GenFit
  - Executed multiple times par event at multiple stages
  - Improve or replace GenFit both is difficult





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### **Summary**

- Tracking generally is in a good shape, especially physics performance wise but we need to prepare for the future
  - Unknown background rates and HLT throughput
  - Unknown amount of future HLT resources (= CPU types, RAM (speed and amount), ...)
- Improve execution time for both track finding and track fitting
  - Important for both HLT and offline reproduction and MC production
  - Refactoring of some core parts necessary (CDC track finding, GenFit)
- Reduce fake and clone rate
  - Merge clone tracks and avoid fake tracks or tag them accordingly
  - Hard to distinguish fake and clone tracks on data w/o MC information
  - These likely will involve MVAs and not so much deep dive into the code
- You can search on Jira BII software for keyword "tracking", or in B2TRACKING for open tasks

## Thank you

#### Contact

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