The Belle II Neurotrigger Project

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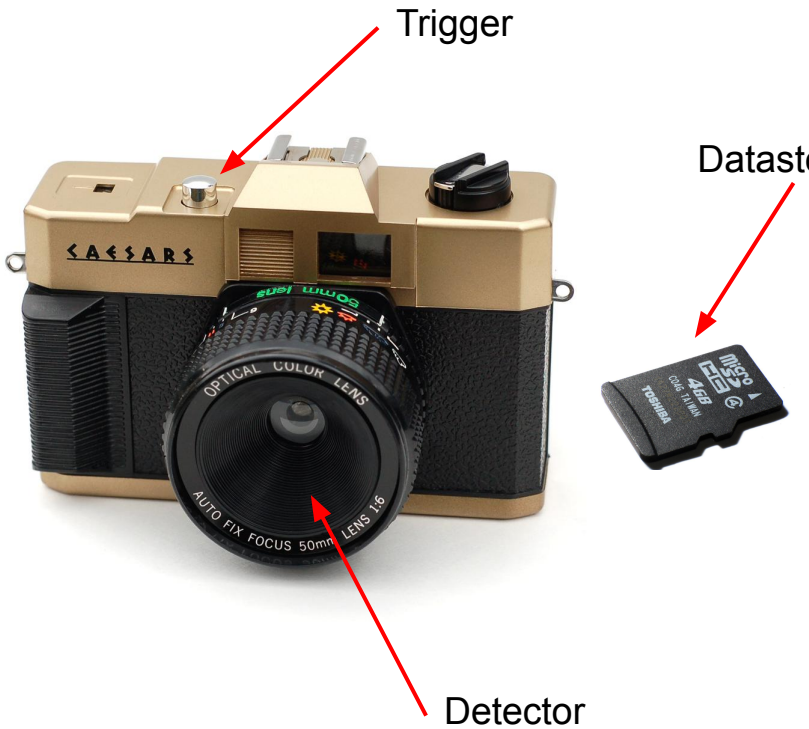
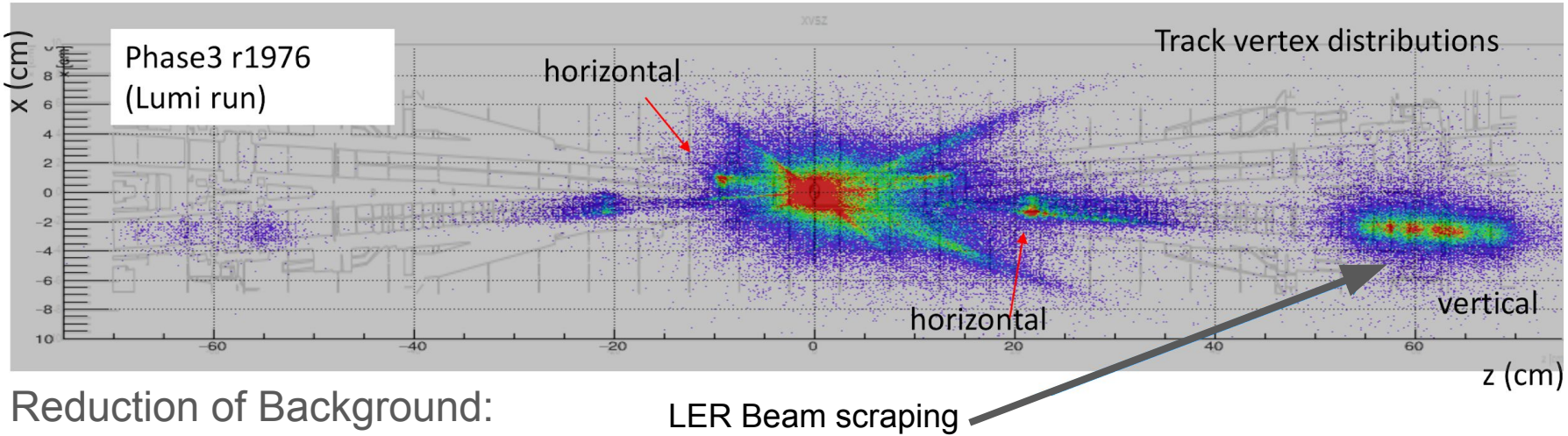
Why do we need trigger systems?



- Digital camera (Raw): 1920x1080x8bit@60fps = 120Mbyte/s
- Detector (Raw): >5x10^{5}x8bit@100000fps = 50GByte/s
- Data Storage is expensive
- Data rate is too high

Why do we need trigger systems?



Reduction of Background:

- Bhabha scattering
- beam-gas interactions
- Touschek effect

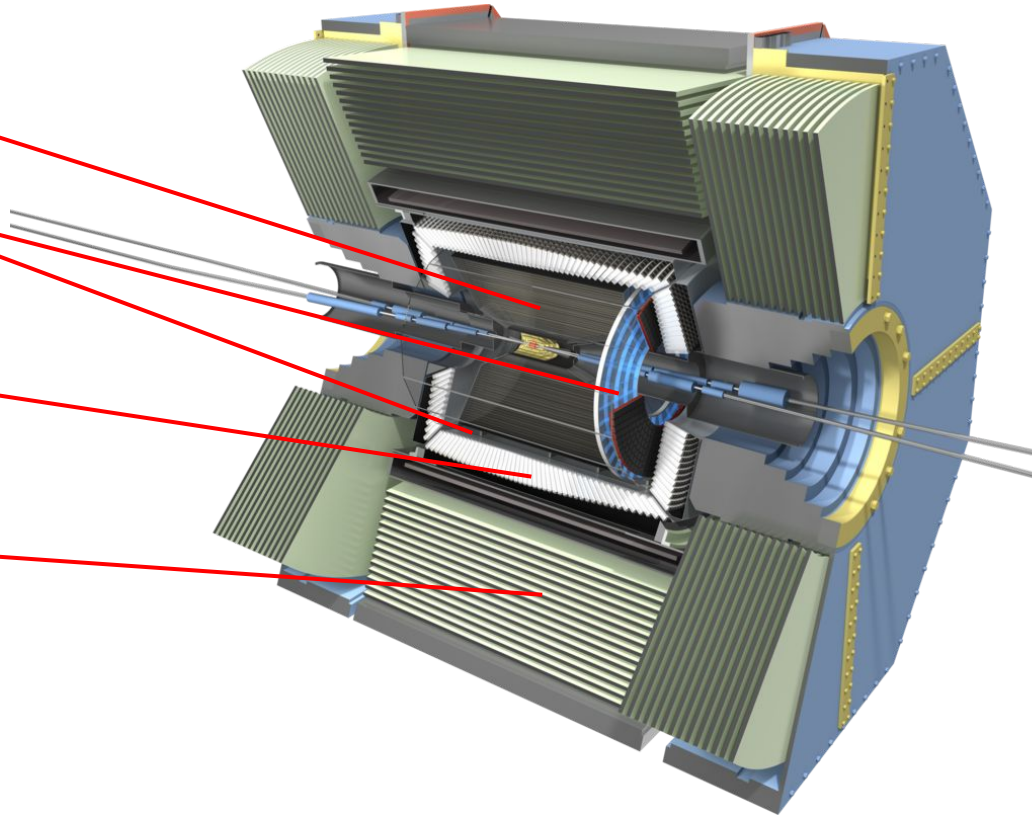
The Belle II L1 Trigger System

Central Drift Chamber (CDC)

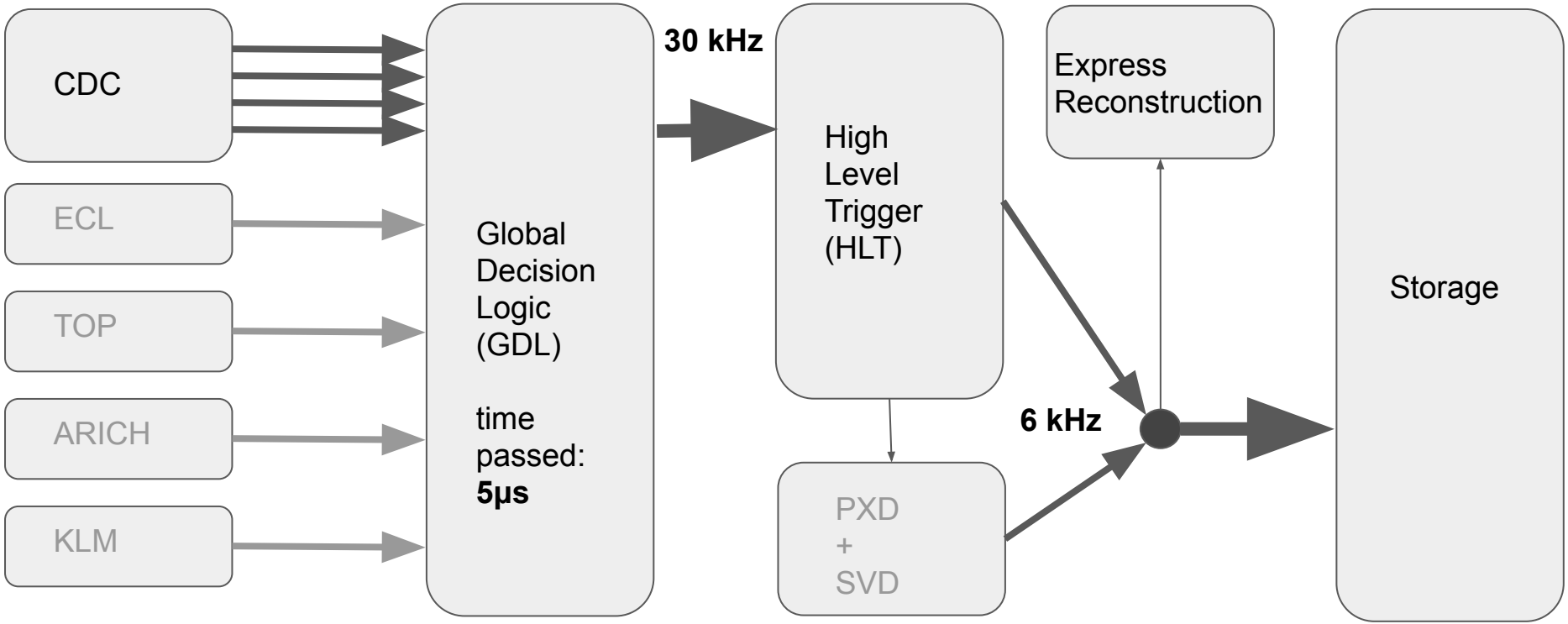
Particle Identification (PID)
(TOP + ARICH)

Electromagnetic Calorimeter
(ECL)

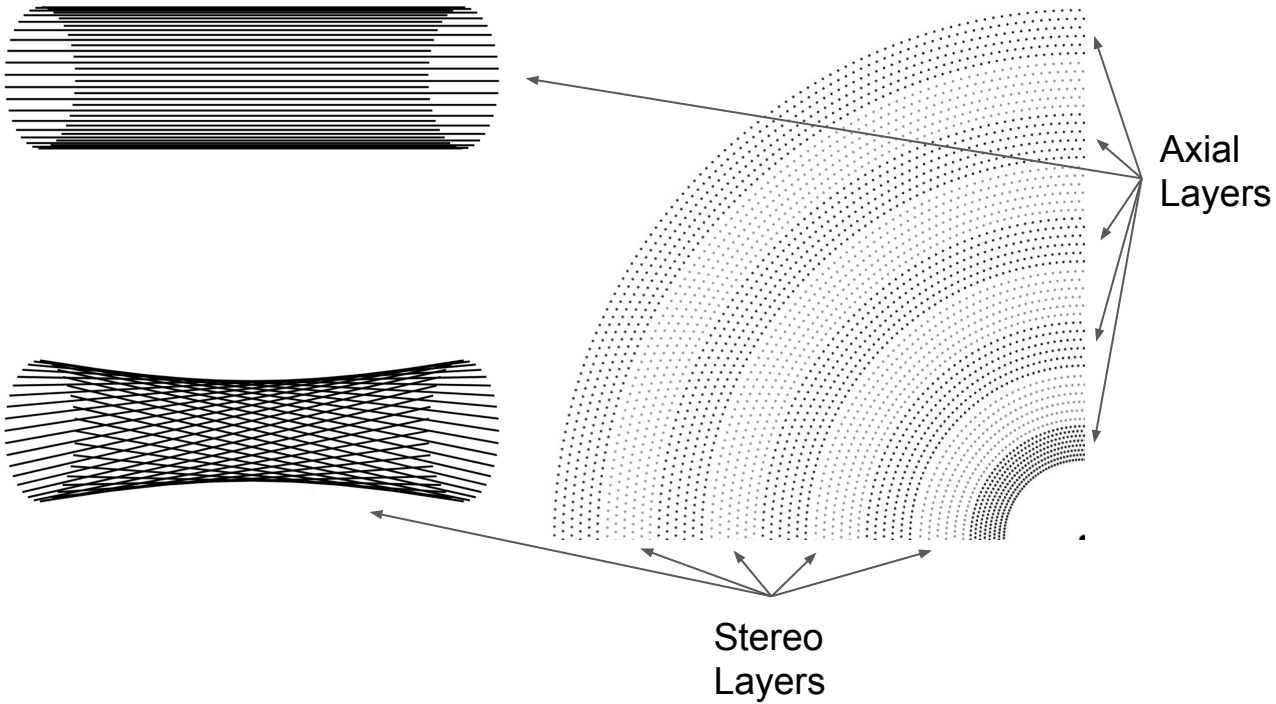
Scintillator Based KLong and
Muon Detector (KLM)



The Trigger System and Data Flow

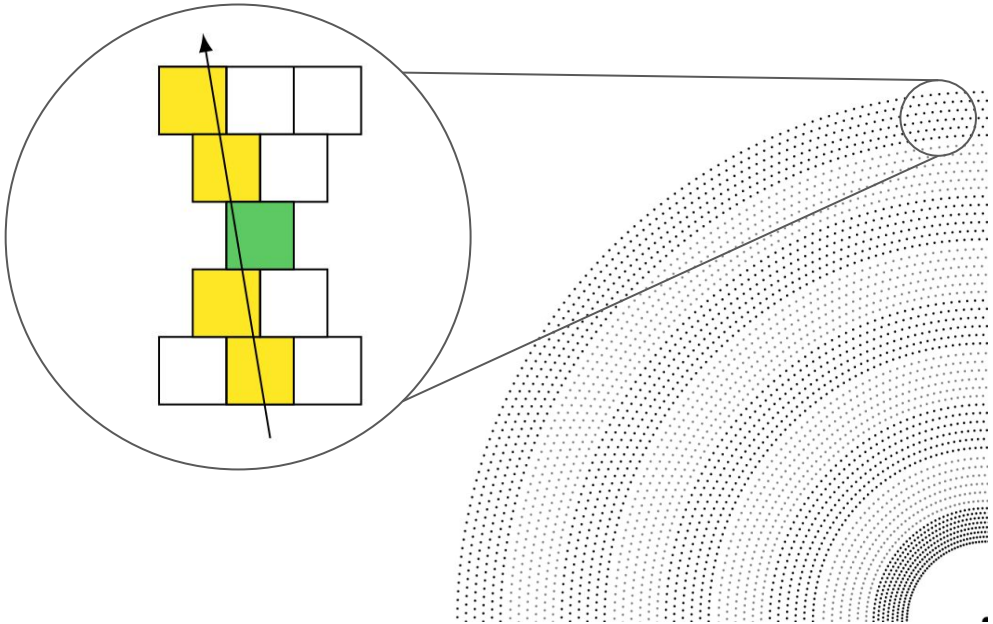


Central Drift Chamber (CDC)



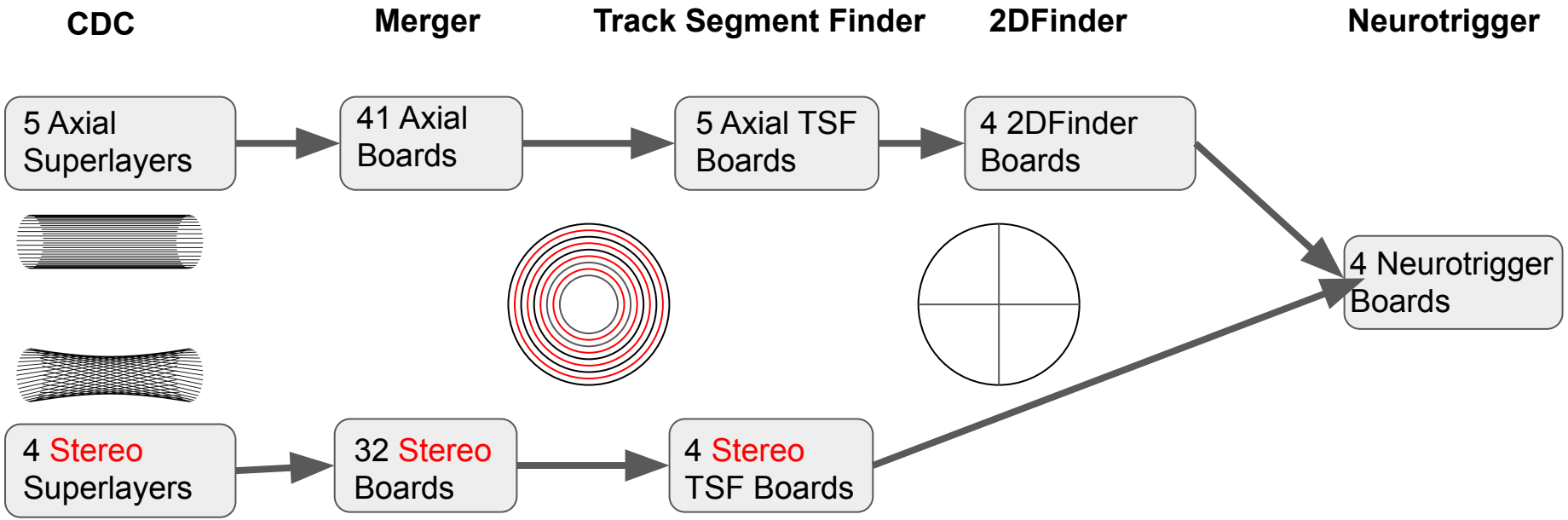
- 56 wire layers, total of 14436 sense wires
- divided into 9 Superlayers (5 Axial, 4 Stereo)

The Track Segment Finder

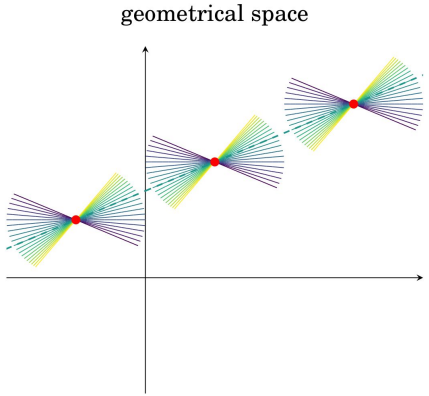


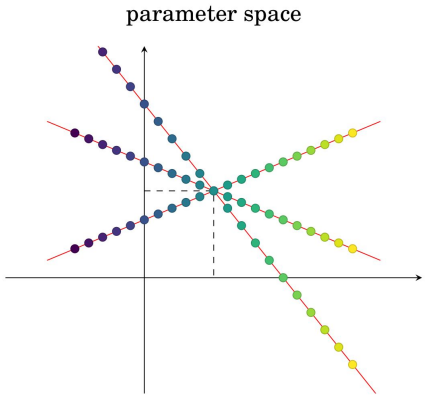
- Used for data reduction / background suppression
- Find hit patterns “Track Segments” within Superlayers (SL)
- 4 out of 5 Wire Layers in a SL need a Hit
- Outputs Track Segment Number, left/right information and the time of the priority wire (green)

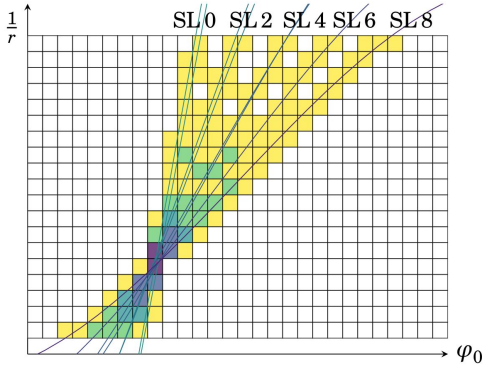
The Neurotrigger Data Flow

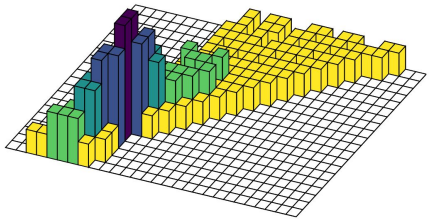


The 2D Finder



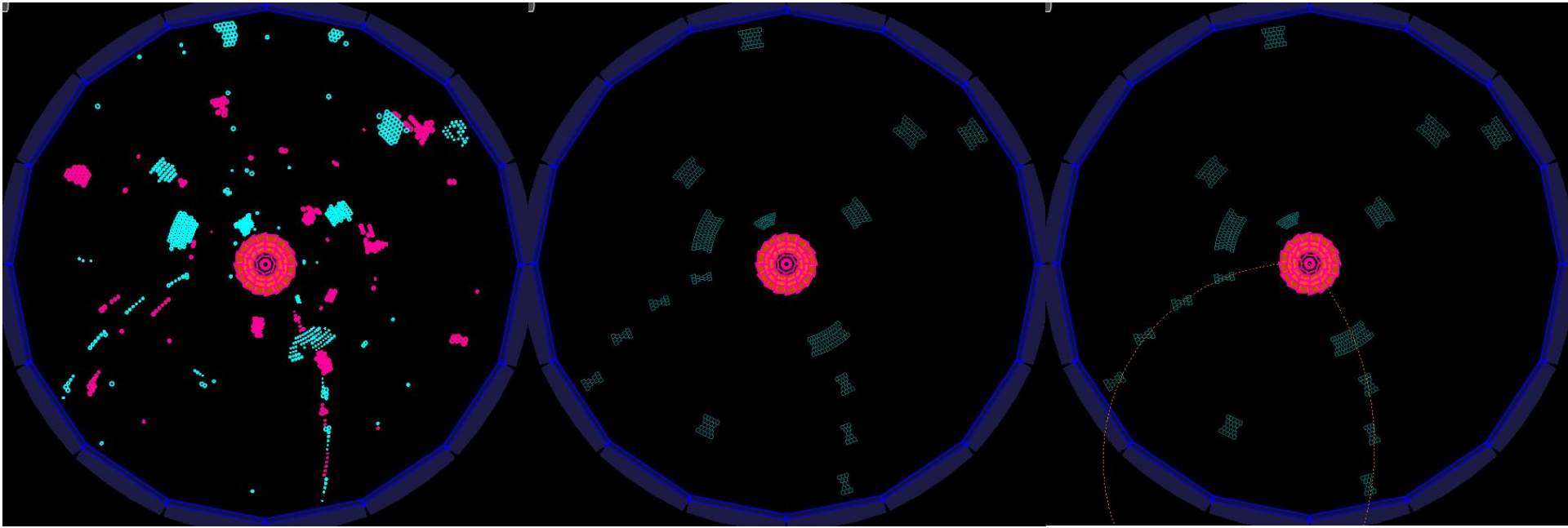






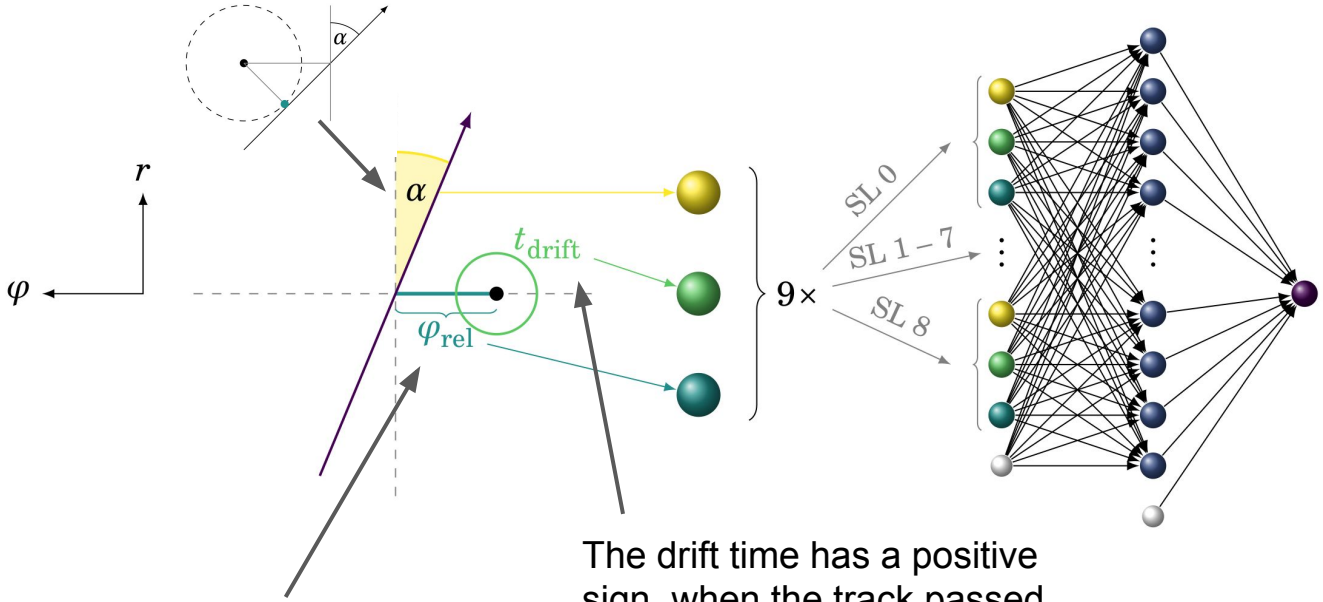
- Finds 2-dimensional Tracks without z-information
- Takes only Axial Track Segments as Input
- Uses the Hough-Transformation: **Every Point in the geometrical space corresponds to a line in the parameter space**
- only when a 2D-Track is found, the Neurotrigger starts

The 2D Finder



CDC Hits | CDC Axial Track Segments | CDC 2DFinder Tracks

The Neurotrigger

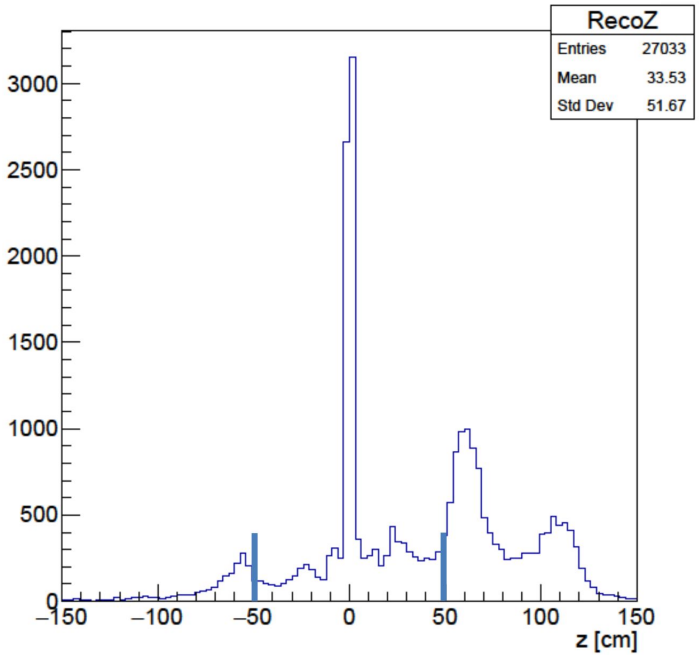


- Multilayer Perceptron with 1 hidden layer
- Inputs:
  - Crossing angle
  - Drift time
  - φ relative to 2DTrack
- Outputs:
  - z vertex
  - θ angle

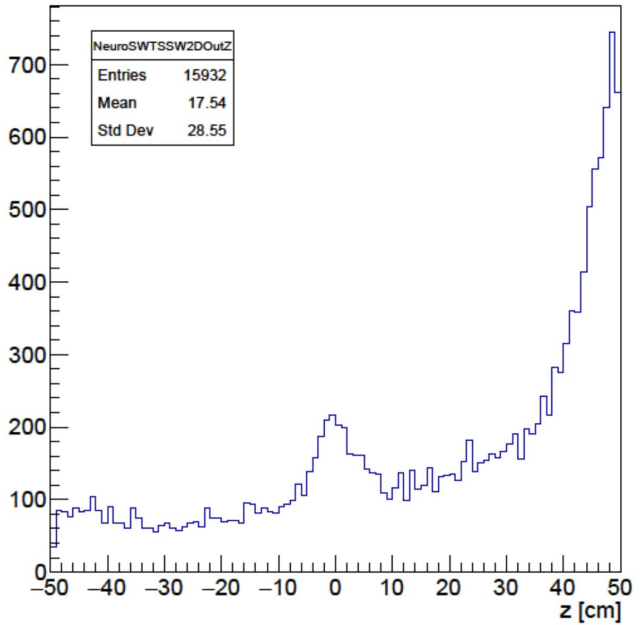
Delta φ relative to the 2DTrack. For Axial TS this is 0.

The drift time has a positive sign, when the track passed on the right side, and a negative sign if it passed on the left.

The Neurotrigger Performance in Phase 3



Reconstructed Z-Vertex



Z-Vertex determined by the Neurotrigger

Conclusions

- The (simulated) Neurotrigger works with real data
- Once the hardware implementation is ready, we will be able to reduce the dataflow at least by half
- Studies for improving the trigger performance are ongoing

Thanks for Your Attention!