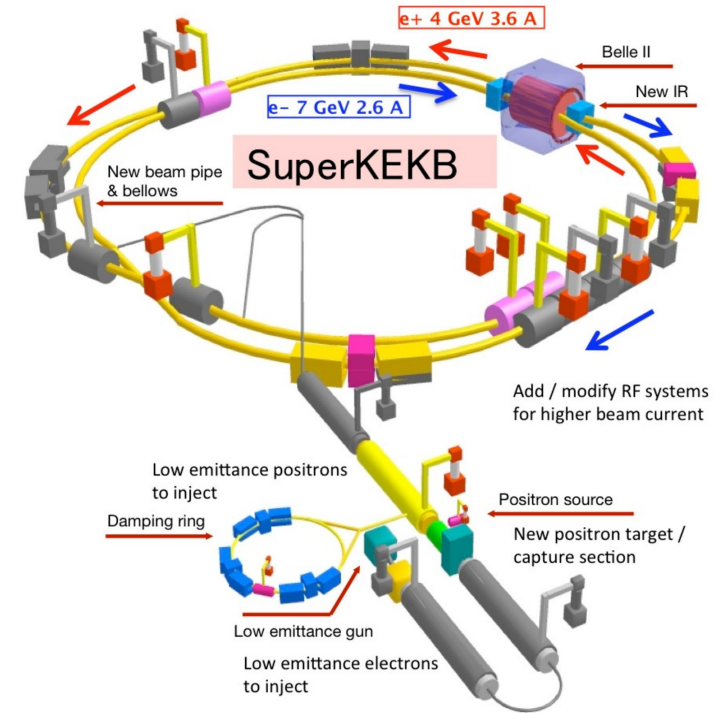
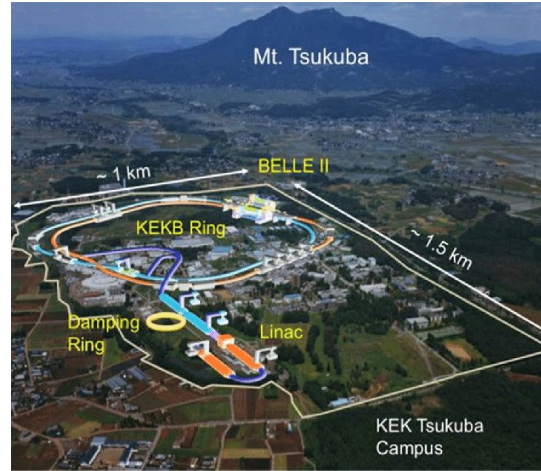


~~Towards a~~ Level 1 Single Track Z-Trigger in the Belle II Experiment

S. Baehr, J. Becker, C. Kiesling, A. Knoll, A. Lenz, F. Meggendorfer, S. Skambraks, K. Unger

The Belle II Experiment

- Located at the SuperKEKB in Tsukuba, Japan
- asymmetric e^+/e^- -collider operating at 10.58 GeV (Y(4S)-resonance for B-meson pair production)



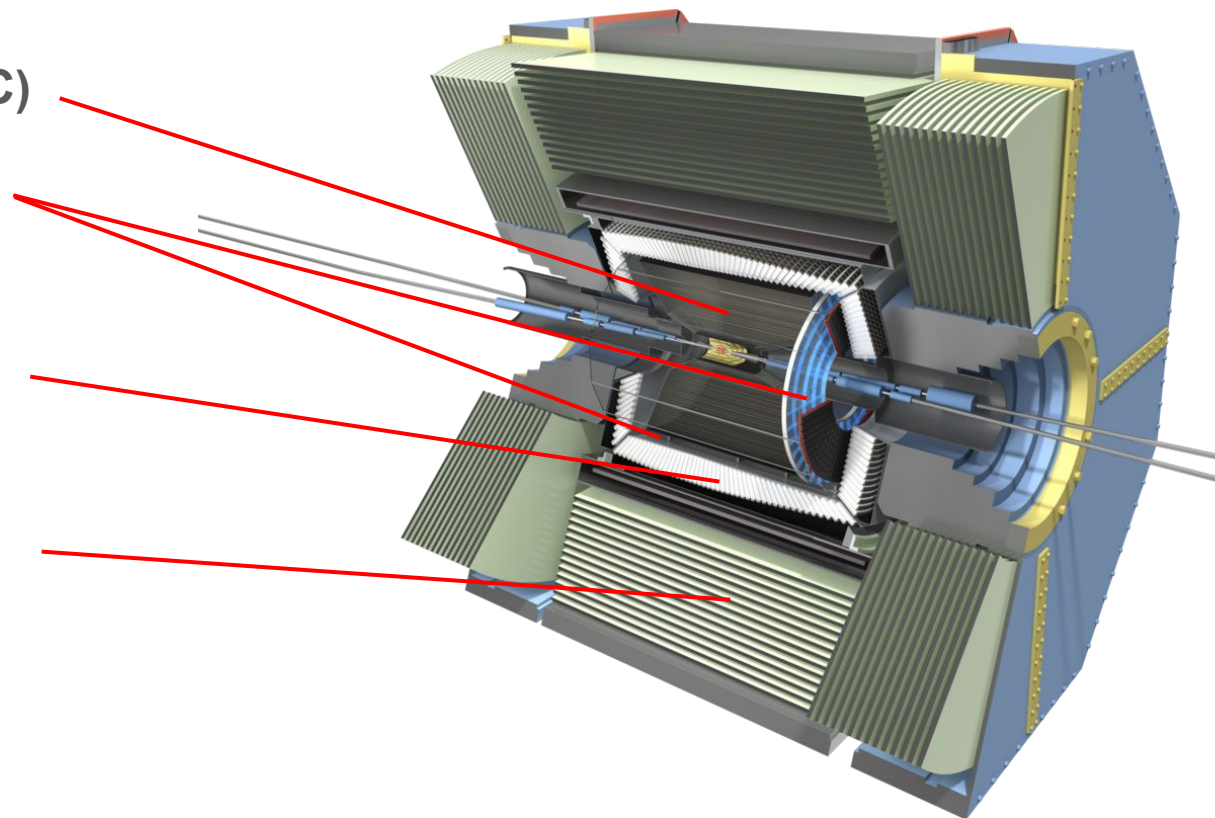
The Belle II L1 Trigger System

Central Drift Chamber (CDC)

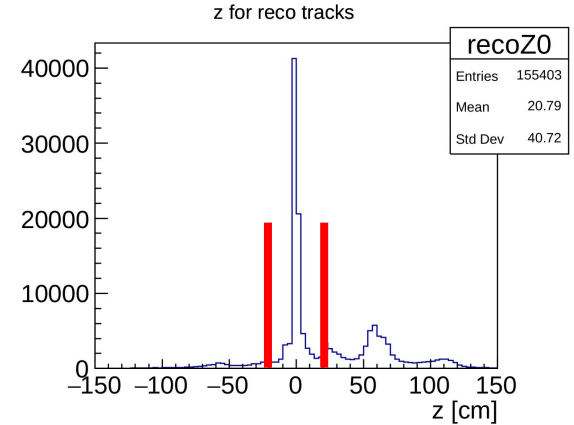
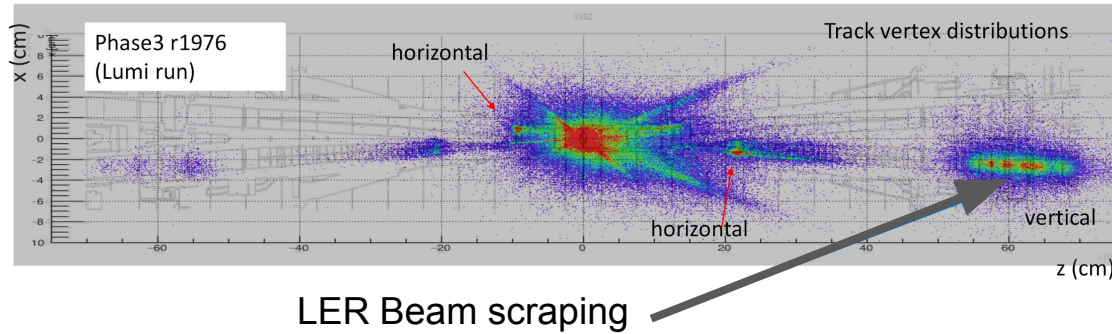
Particle Identification (PID)
(TOP + ARICH)

Electromagnetic Calorimeter
(ECL)

Scintillator Based KLong and
Muon Detector (KLM)

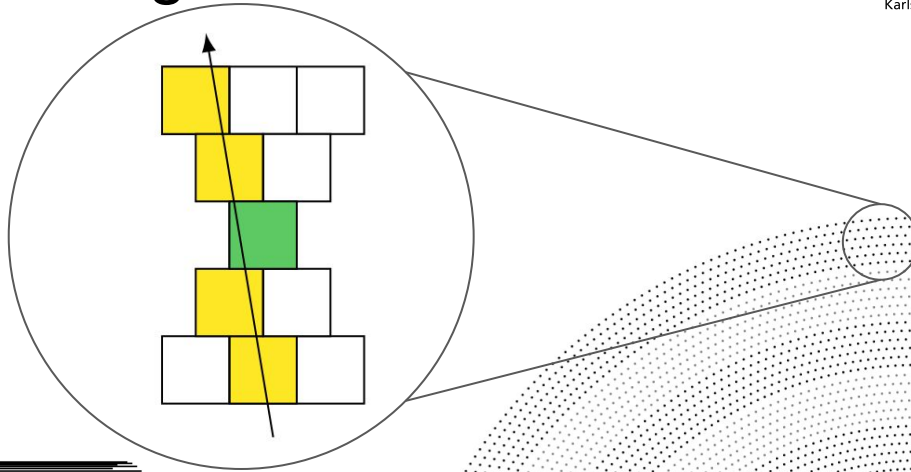


Goal of the Neurotrigger

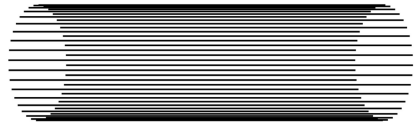


- Differentiate between physics and background
- **Introduce z-vertex cut at first trigger level**

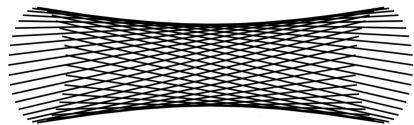
The Track Segment Finder



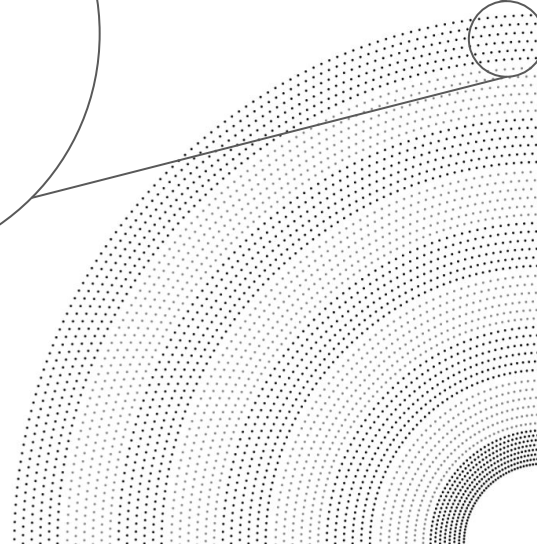
- Used for data reduction / background suppression
- Find hit patterns “Track Segments” within Superlayers (SL)
- 4 out of 5 Wire Layers in a SL need a Hit
- Outputs Track Segment Number, left/right information and the time of the priority wire (green)



Axial Superlayers

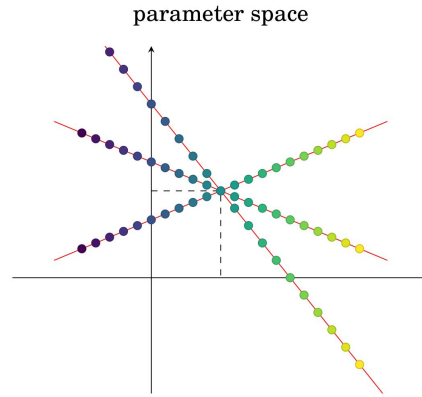
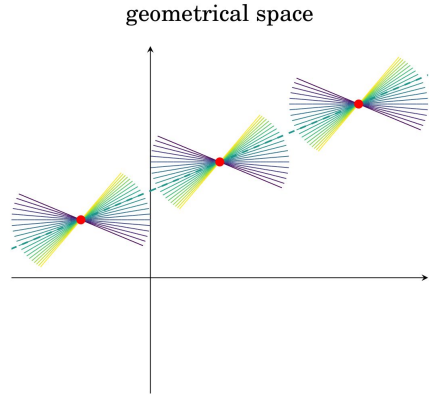


Stereo Superlayers

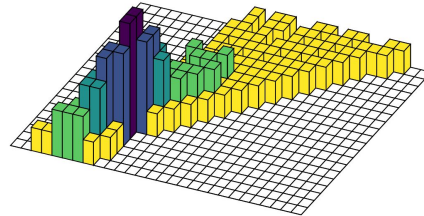
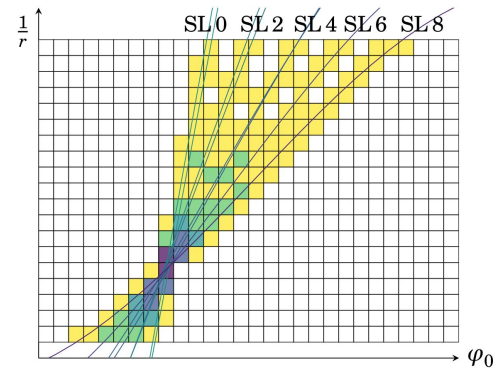


A S A S A S A S A

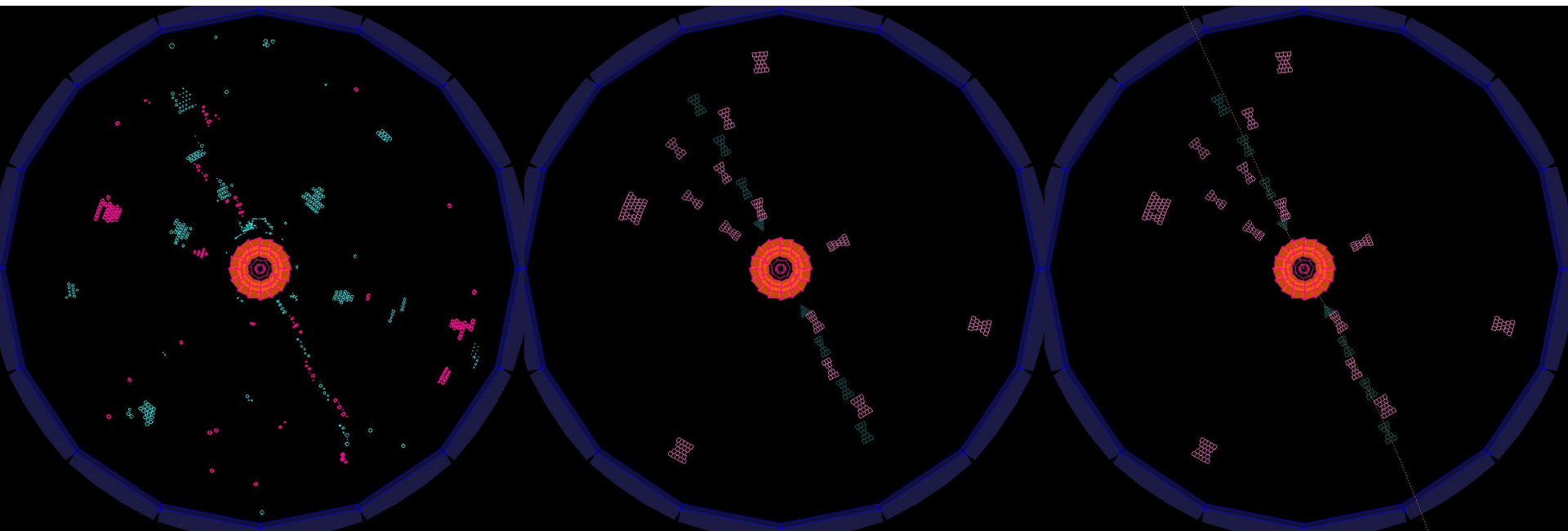
The 2D Finder



- 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**



Preprocessing Combined

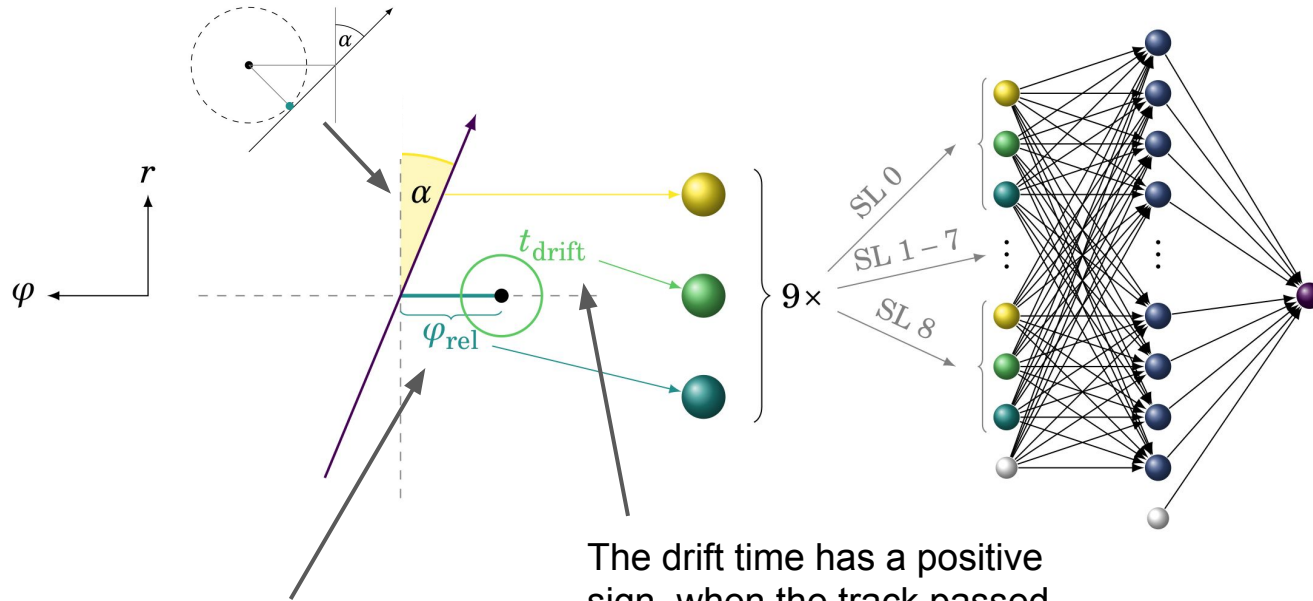


CDC Hits

CDC Track Segments

CDC 2DFinder Tracks

The Neurotrigger



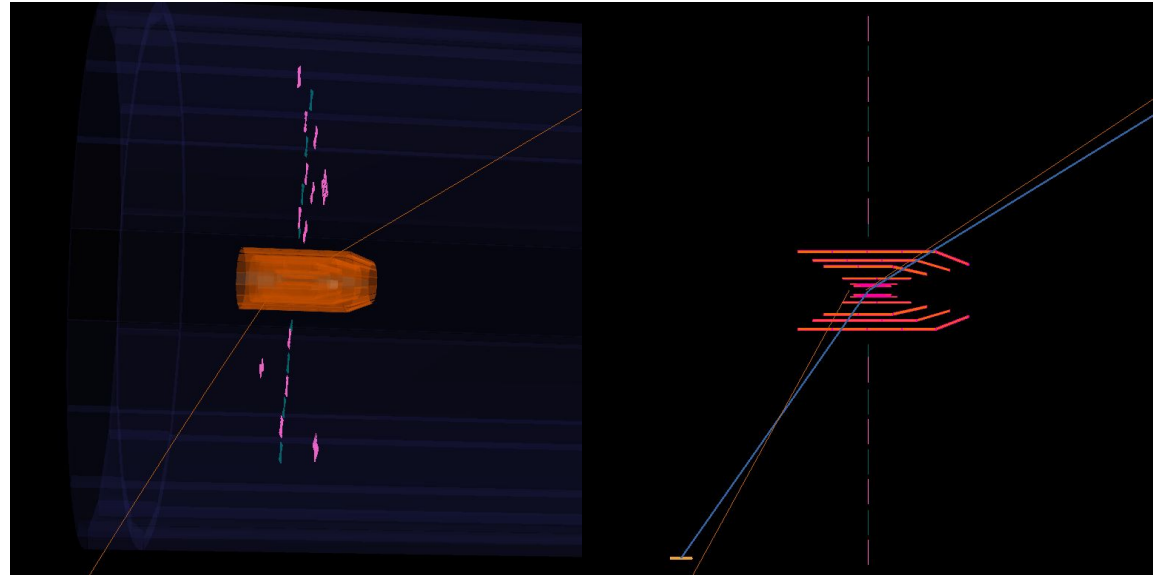
Delta φ relative to the 2DTrack. For Axial TS this is 0.

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.

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

The Neurotrigger

- Combines Tracks found in the 2D plane (perpendicular to the beam axis) with Stereo Track Segments
- Gives an estimate for the track Z vertex and the elevation angle Θ

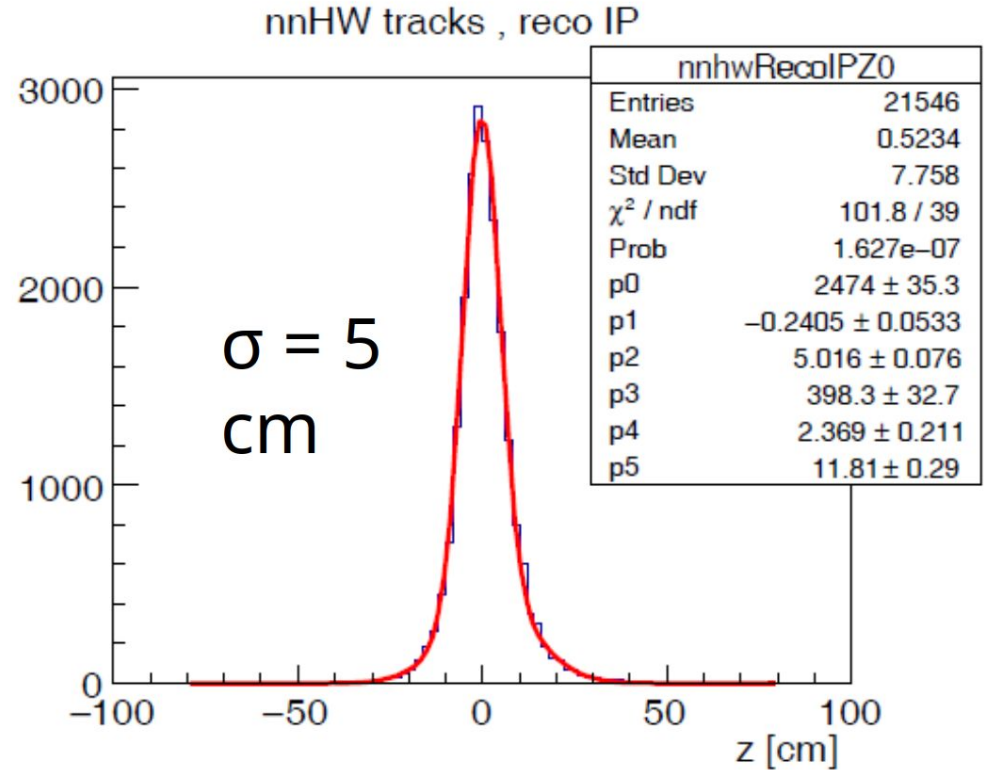
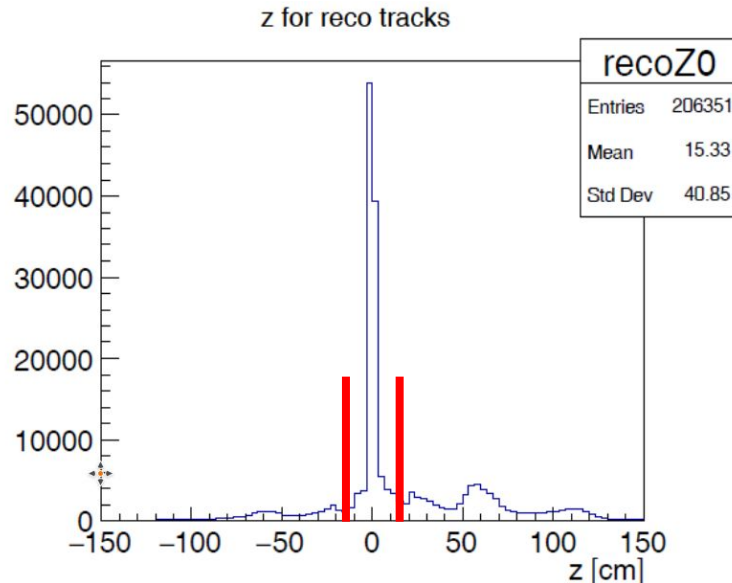


Neurotrigger Tracks

Reconstructed Tracks in blue

ΔZ Resolution

- ΔZ resolution at interaction point (IP) between Neurotracks and reconstructed tracks: 5cm
- Cut at $3\sigma \rightarrow |z| = 15\text{cm}$

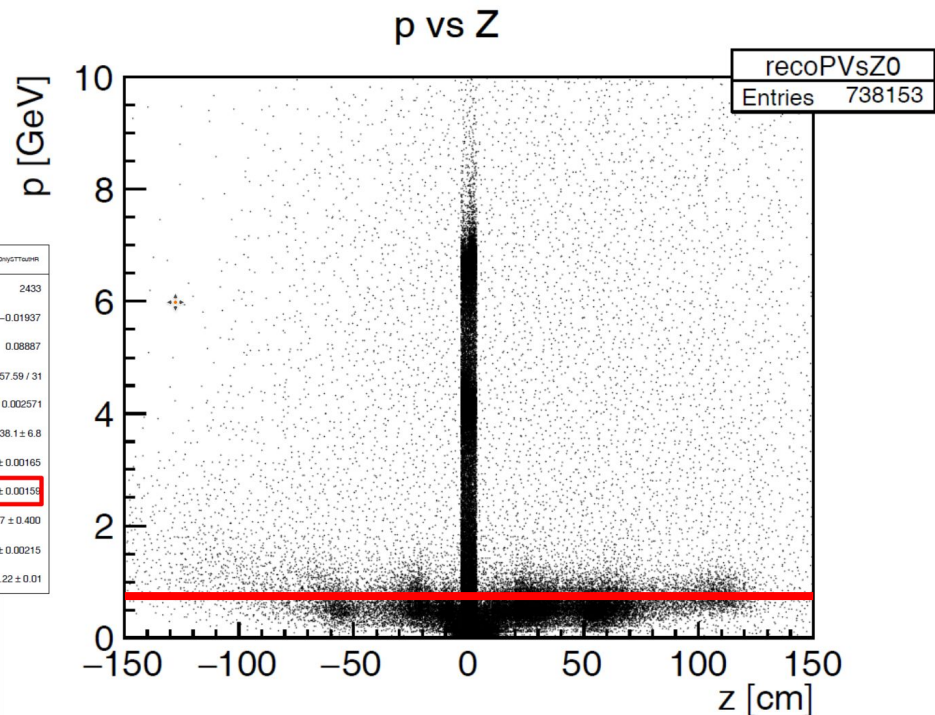
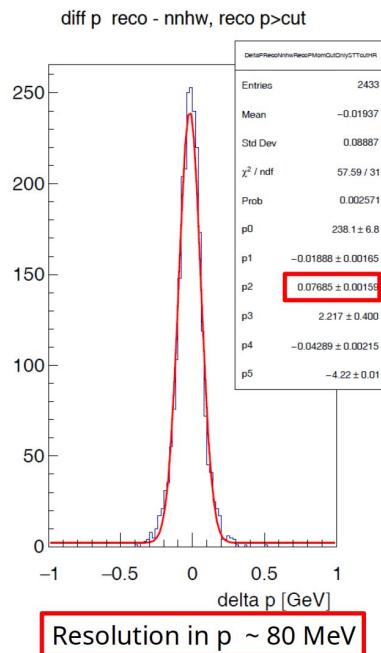
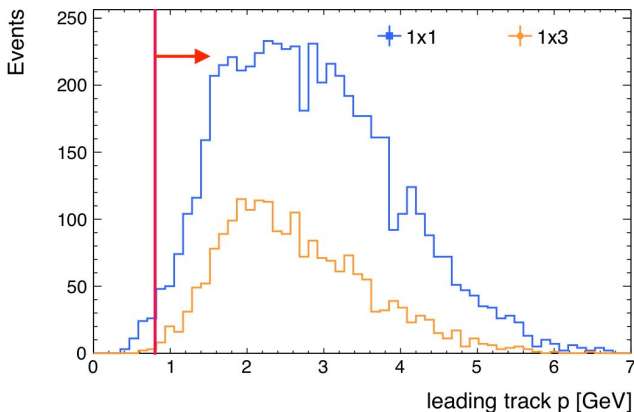


Controlling the Trigger Rate

- with a Z-Cut at $|z|=15\text{cm}$,
STT Trigger rate is $\sim 1\text{kHz}$

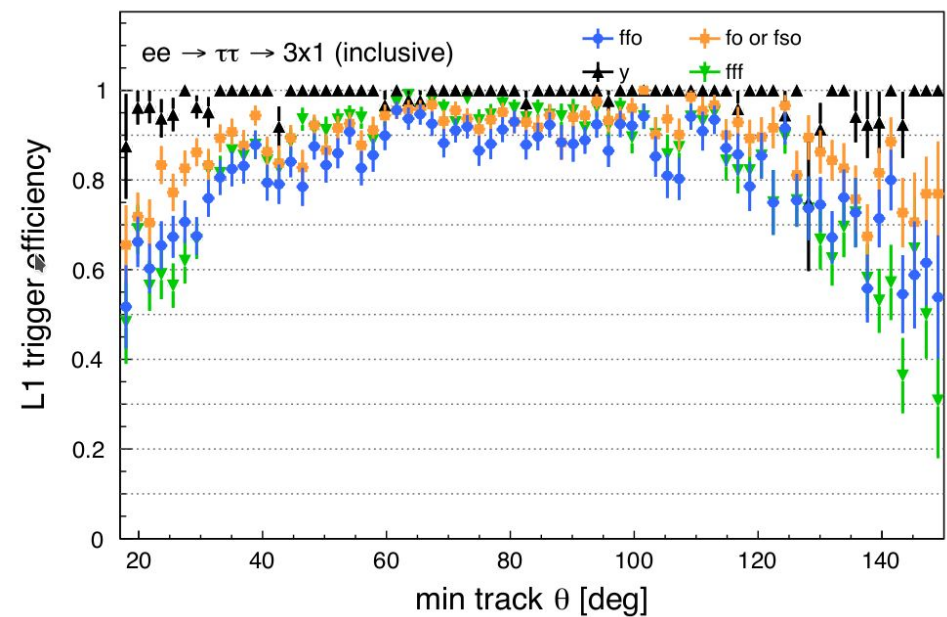
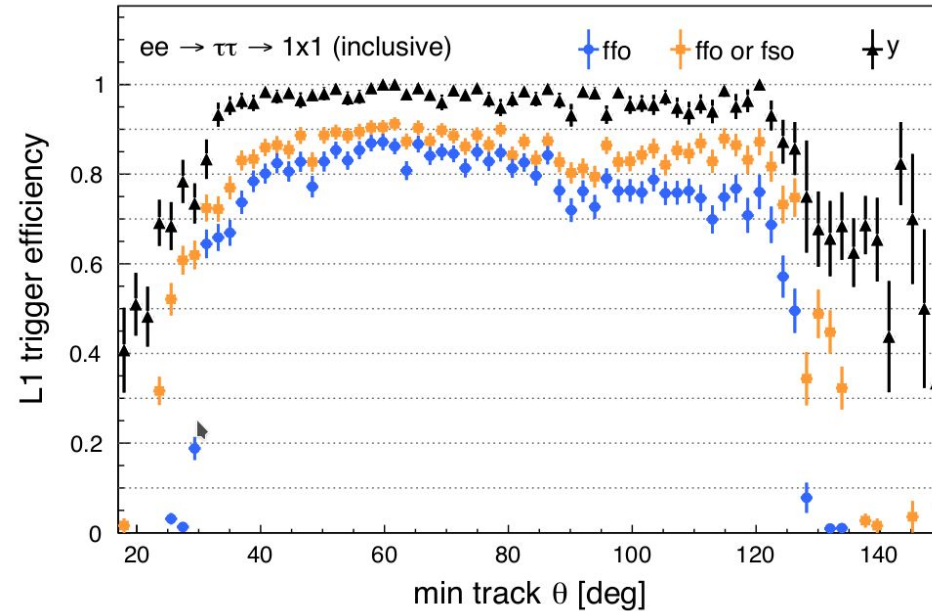
→ Introduce Cut at
 $P=0.7\text{GeV!}$

→ Resulting Trigger rate:
 $\sim 200\text{Hz!}$



Efficiency for 1 & 3 PRONGS

Plots by P.Rados, A.Rostomyan (DESY)



STT (here “ γ ”) Trigger provides major efficiency gains both in the barrel and the endcap region of the detector

Conclusions and Outlook

- Successful operation of the world's first L1 Single Track Trigger "STT" in current luminosity runs at Belle II
- Major improvements compared to "old" 2 and 3 Track Triggers

- Goal for the Future: Further improve the ΔZ resolution, so we can lower the P cut