1. The Belle II Silicon Vertex Detector

- Two pixel layers
- Four double-sided silicon layers

2. Motivation

- Important physics channel with low-momentum pion: $D^+ \to \pi^0 \ell^+ \ell^-$
- Define region of interest for pixel readout, data reduction

3. Track finding strategy

- Stepwise reduction of combinatorics
- Cellular automaton (CA) for finding track candidates
- Kalman filter for computing quality indicators
- Hopfield network for eliminating overlapping candidates

Schematic view of the low momentum track finder in Belle II

- Unsorted hits from tracks, background, ghost coming from an event
- Filters by distance, min&max, including virtual Segment
- Filters by angle and set of compatible sectors, allows momentum dependent setups
- Filters activated: dist3D, distXY, distZ, distNorm3D, distDeltaZ, angles3D, anglesXY, anglesRZ, deltaPt, zigZag
- Virtual segments connect the innermost hits with the interaction point

Cellular automaton

- The cellular automaton assigns states to each segment in a discrete time evolution process
- A string of neighbouring segments with decreasing states is a track candidate

Track candidate filter

- Candidates that form zig-zag patterns are discarded
- Candidates with large changes in $\pi_T$ are discarded

Track quality

- A quality indicator (QI) is computed for each track candidate
- Currently this is the number of hits in the track
- Later the QI will be computed by a preliminary track fit

4. An example

- Hopfield network finds best subset of compatible track
- Tracks with large quality indicators are preferred

5. Results

- Efficiency for two transverse momentum ranges, with and without PXD
  - Low: 60MeV/c – 70 MeV/c, 3 layers (w/o PXD)
    - Filters activated: distZ, distNorm3D, distDeltaZ, anglesRZ, deltaPt, zigZag
  - Low: 60MeV/c – 70 MeV/c, 5 layers (w/ PXD)
    - Filters activated: dist3D, distXY, distZ, distNorm3D, distDeltaZ, angles3D, anglesXY, anglesRZ, deltaPt, zigZag
  - High: 70MeV/c – 100 MeV/c, 4 layers (w/o PXD)
    - Filters activated: dist3D, distXY, distZ, distNorm3D, distDeltaZ, angles3D, anglesXY, anglesRZ, deltaPt, zigZag
  - High: 70MeV/c – 100 MeV/c, 6 layers (w/ PXD)
    - Filters activated: dist3D, distXY, distZ, distNorm3D, distDeltaZ, angles3D, anglesXY, anglesRZ, deltaPt, zigZag
  - 1000 events with 10 and 20 tracks each, no noise
    - No Kalman filter, no Hopfield network

<table>
<thead>
<tr>
<th>Momentum range</th>
<th># of layers</th>
<th># of tracks</th>
<th>clean</th>
<th>cont.</th>
<th>lost</th>
<th>recov.</th>
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<td>10 000</td>
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<td>0.4%</td>
<td>10.7%</td>
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<tr>
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<td>20 000</td>
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<td>1.1%</td>
<td>10.8%</td>
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<tr>
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<td>99.4%</td>
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<tr>
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<tr>
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</table>

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