A local tracking algorithm for the Central Drift Chamber of Belle II.

Status update - online tracking meeting

Oliver Frost
Deutsches Elektronen-Synchrotron
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DESY HELMHOLTZ ASSOCIATION

Belle II

Überblick

> Reminder

> First stage

> Second stage

> Axial segment pair creation

> Reminder

> First stage

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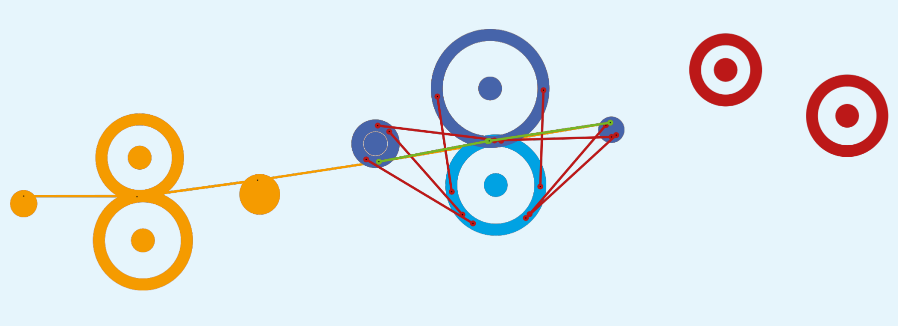
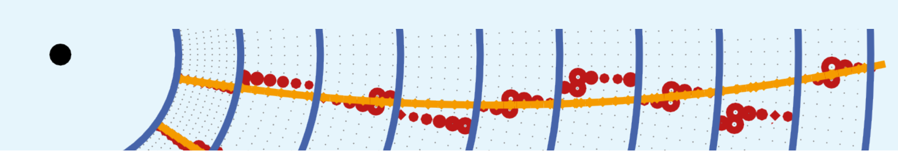
> Axial segment pair creation

Bottom-up in two stages

Combine hits in the same superlayer to segments



Combine segments to tracks



Cuts / weights to be optimized

Stop gaps

There are many positions, where acceptance decisions have to be made.
Tune each by comparing to Monte Carlo information.

First stage - productive

- Which facets do belong to the sought tracks?
- Which facets can be considered as the following along the sought track?

Second stage - in progress - filled with MC truth for now

- Which segment triples do belong to the sought tracks?
- Which segment triples can be considered as the following along the sought track?

Cuts / weights to be optimized

Stop gaps

There are many positions, where acceptance decisions have to be made.
Tune each by comparing to Monte Carlo information.

First stage - productive

- Which facets do belong to the sought tracks?
- Which facets can be considered as the following along the sought track?

Second stage - in progress

- **Which axial segment pairs belong to the same track?**
- **Which stereo segment inbetween two axial segment is in the same track?**
- Which segment triples can be considered as the following along the sought track?

- Reminder
- First stage
- Second stage
- Axial segment pair creation

Facet creation

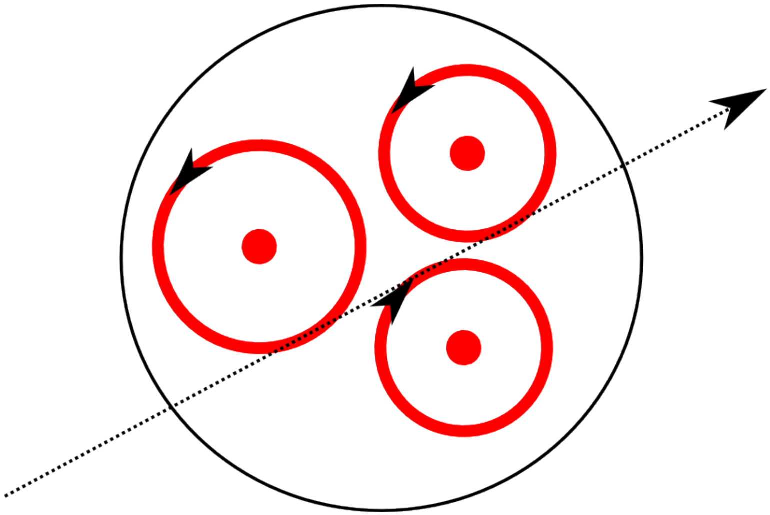
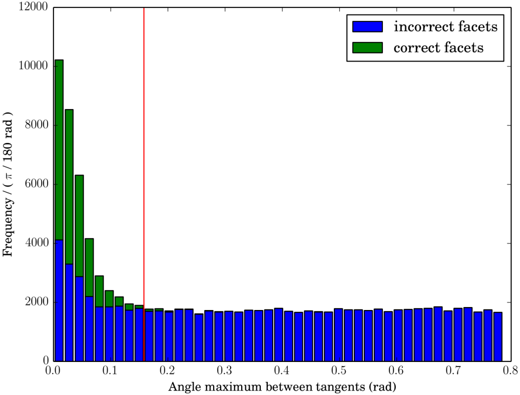


Abbildung: Selection facets from cominations of three closeby hits including a right left passage typotheses for each.

Achievable cut quality for facet creation



Cut details

$$\text{cut} = \frac{9}{180}\pi$$
$$\text{purity} = 46.75\%$$
$$\text{efficiency} = 98.74\%$$
$$\text{bkg rejection} = 81.85\%$$

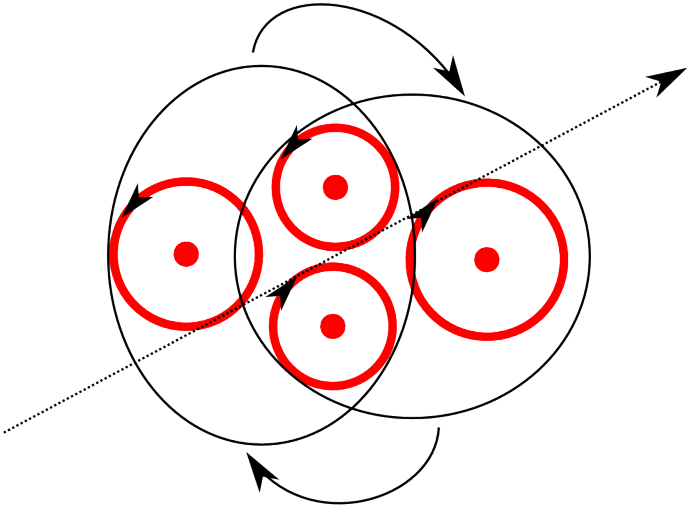
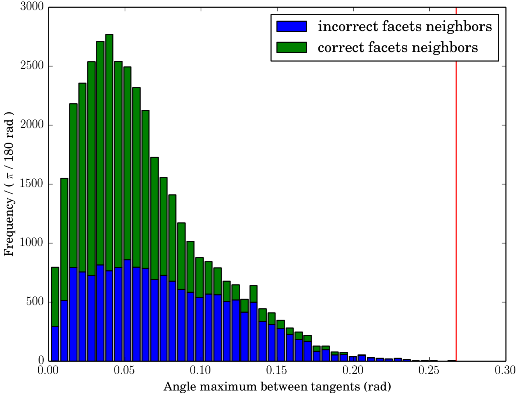


Abbildung: Generate connections of neighboring facets to form the graph edges.

Achievable cut quality for facet connections



Cut details

$$\text{cut} = \frac{20}{180}\pi$$

$$\text{purity} = 56.75\%$$

$$\text{efficiency} = 100\%$$

$$\text{bkg rejection} = 0\%$$

Conclusion for the first stage

Conclusion

- The graph of facets and neighbors contains the correct segments
- Achievable cut quality is sufficient and easy to find
  - Number of false facets and connections is limited
  - Only small number of variables to be considered
- Still some improvement possible, efficiencywise as well as speedwise.

- Reminder
- First stage
- Second stage
- Axial segment pair creation

Axial segment pair creation

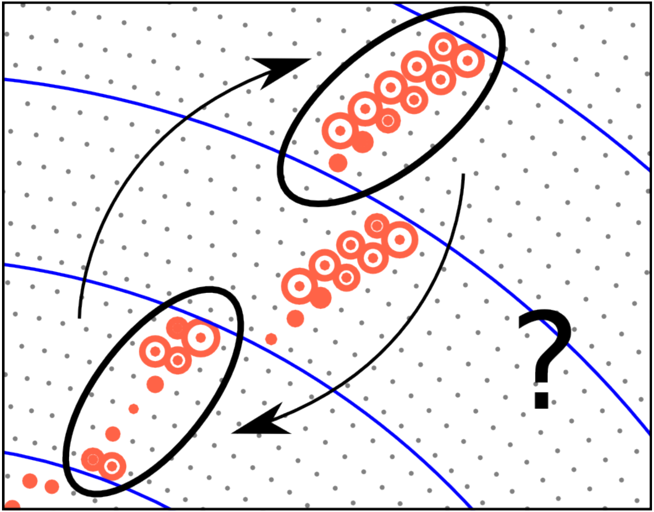


Abbildung: Make axial segment pairs by fitting and extrapolating with a two-dimensional circle for each segment

Segment triple creation

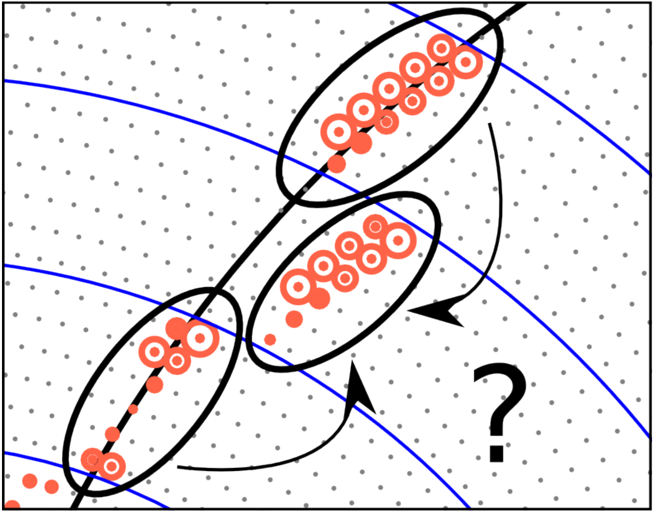


Abbildung: Combine axial segment pairs with intermediate stereo segment to segment triples

Segment triple connections

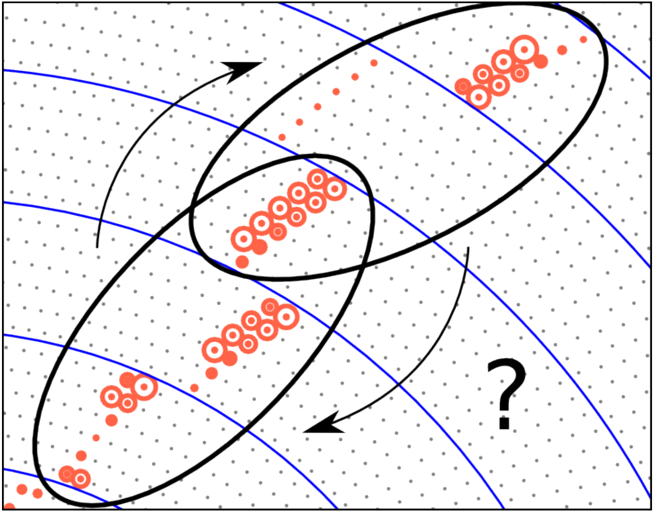


Abbildung: Generate connections of neighboring segment triples to form the graph edges.

- Reminder
- First stage
- Second stage
- **Axial segment pair creation**

Axial segment pair creation

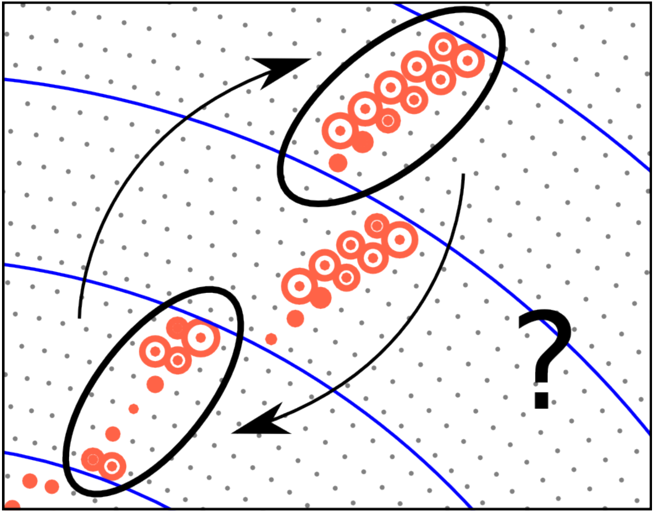


Abbildung: Make axial segment pairs by fitting and extrapolating with a two-dimensional circle for each segment

Challenge in the axial segment pair creation

Many false axial segment pairs

Input from 100 events (ball park):

- Number of true pairs : 2400
- Number of false pairs : 180000
- **Background to signal ratio 75**

Many variables to choose from

- Two dimensional fit for each segment
  - Extrapolations to begin, center, end of other segment
  - Travel distances to beginning, center and end of other segment
  - Direction of travel at beginning, center and end of segment
- Length of the segments (looser cut for shorter segments?)
- (Symmetric?) combinations of the former.

Approach

- Careful examination of all available variables
- Thoroughly investigation of cut combinations
- Guided by multivariate feature selection techniques (e.g. NeuroBayes)

Example - good variable

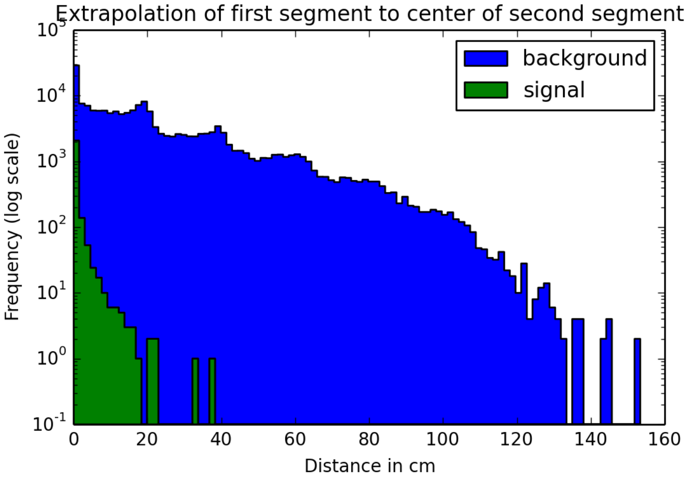


Abbildung: Well behaved distance of extrapolation to center of following segment.

Example - variable with unexpected behaviour

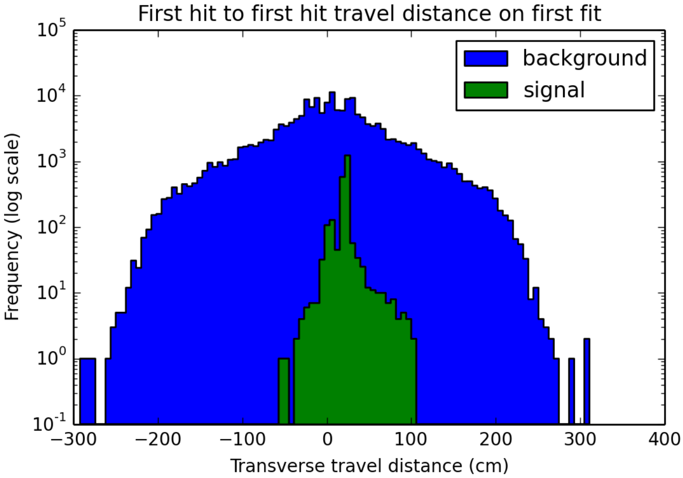


Abbildung: Travel distance from first hit to first hit of correct axial segment pairs in is negative at times.

Current cut criterion

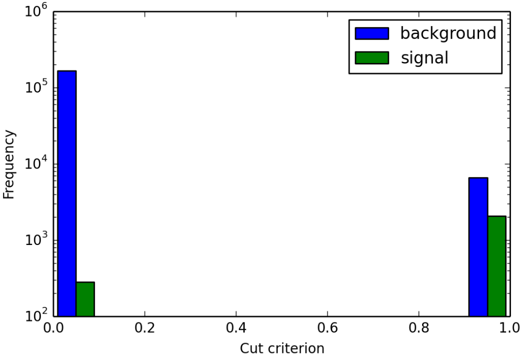
Accept if all are fullfilled

- Second segment lies after first segment as seen from first fit.
- First segment lies before second segment as seen from second fit.
- Second segment has increasing travel distance as seen from first fit.
- First segment has increasing travel distance as seen from second fit.
- Extrapolation should not lie far apart ($< 7\ cm$)
- Angle of travel distances not to large ($< 2\ rad$)

Comment

- All cuts seem reasonable wide.
- Still signal is lost due to the negative signs in the travel distances, where it should not be.

Achievable cut quality for axial segment pair connections



Cut details

$$\text{purity} = 23.78\%$$
$$\text{efficiency} = 88.03\%$$
$$\text{bkg rejection} = 96.16\%$$

Conclusion for the second stage

Conclusion

- Achievable cut quality is much lower than expected,
- due to the high background in the sample.
- Though all cuts seem reasonable 12% of the signal are lost.
- Still three times more wrong pairs compared to true pairs remain after the cut.
- However is this a purity level we can build upon?