VXDTF studies: Current Status of TrackCand Converter Modules

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Motivation for SpacePointTrackCand and Converter Modules

Why do we need SpacePointTrackCands and Converter Modules?

- FilterCalculator shall work with SpacePoints in the future
- Some of current problems should be circumvented by the use of SpacePoints
- VXDTF returns SPTCs (in the future) but genfit works with GFTCs $\rightarrow$ conversion in both directions needed

Glossary:

- SPTC - SpacePointTrackCand
- GFTC - genfit::TrackCand

Basic Working Principle of Converter Modules

- Using Relations between `Clusters` and `SpacePoints`
- exemplary for `GFTC2SPTCConverter`:

```
for all Cluster in GFTC do
  if Cluster not marked as used then
    clusterSPs ←
    Cluster.getRelationsFrom<SpacePoint>()
    tcSpacePoint ← get appropriate from ClusterSPs
    add tcSpacePoint to SpacePointTrackCand
    mark all Clusters used by tcSpacePoint as used
  end if
end for
add additional information to SpacePointTrackCand
```

- for `SPTC2GFTCConverter` vice versa without having to find appropriate Clusters

Getting the appropriate SpacePoint

GFTrackCand

detId	hitId
1	3
2	1
2	2
2	7
2	4

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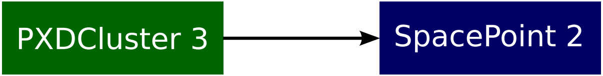

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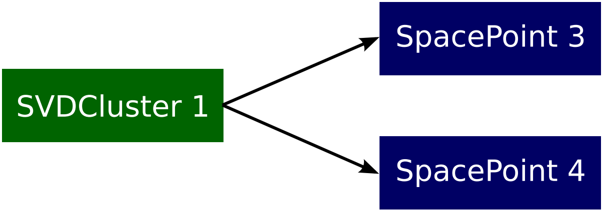

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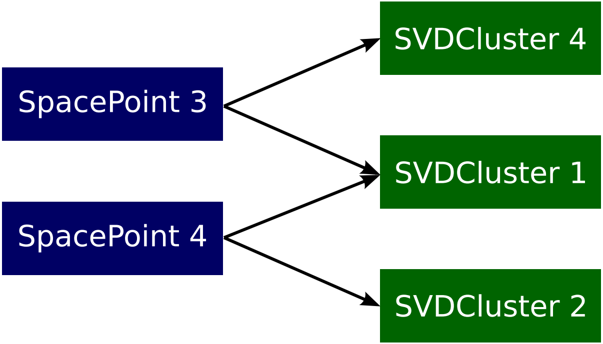

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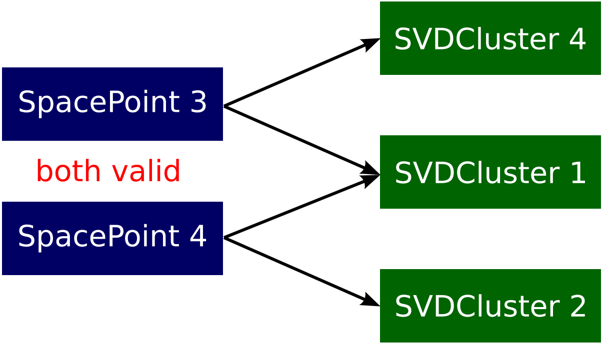

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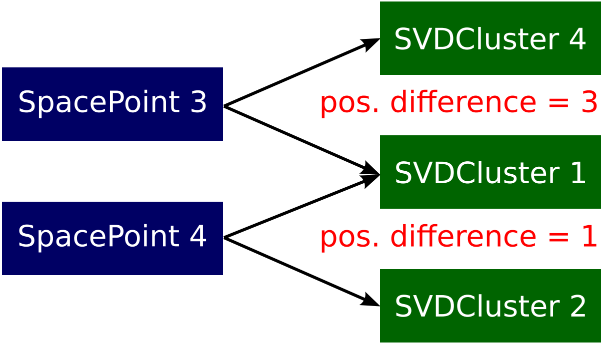

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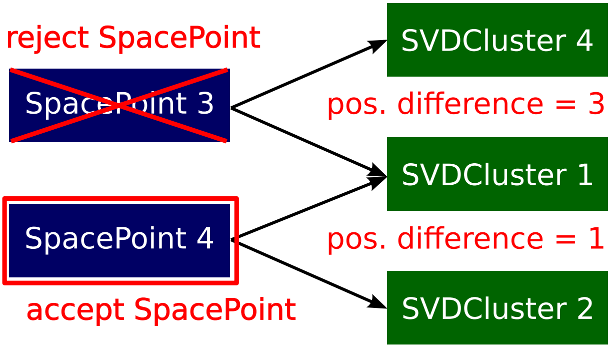

Getting the appropriate SpacePoint

GFTrackCand

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SVDCluster 7 → SpacePoint 5

⋮

Getting the appropriate SpacePoint

Features of the appropriate SpacePoint:

- Clusters are contained in SpacePoint and not already used by another SpacePoint $\rightarrow$ SpacePoint is valid
- Clusters have a position difference of 1 $\rightarrow$ TrackCandHits appear in consecutive order in GFTC

Current Problems/Issues:

- Clusters of GFTC not checked for same sorting parameter $\rightarrow$ can lead to wrong ordered TrackCandHits in back transformation
- Efficiency rather low if the strictest possible checks are enabled $\rightarrow \sim 70 - 75\ \%$ (for GFTC to SPTC)

Checking if a TrackCand is curling

Checking if a SPTC is curling by comparing the direction of flight for two consecutive SpacePoints (for all SpacePoints in the SPTC):

- if direction of flight changes for one SpacePoint $\rightarrow$ SPTC is curling, can be split at this SpacePoint
- else $\rightarrow$ SPTC is not curling

Checking if a TrackCand is curling

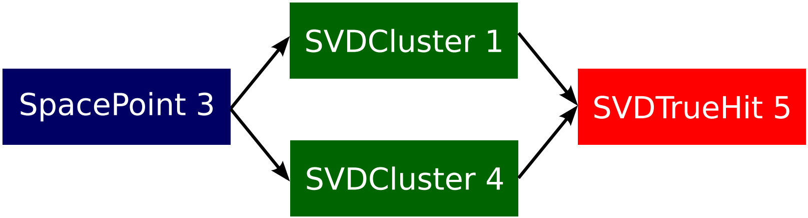
Algorithm for getting the direction of flight:

$\vec{P} \leftarrow$ `TrueHit.getGlobalMomentum()`
$\vec{X} \leftarrow$ `TrueHit.getGlobalPosition()`
$L_P \leftarrow (\vec{X} + \vec{P})$`.Perp()`
$L_X \leftarrow (\vec{X})$`.Perp()`
if $L_P > L_X$ **then**
  `dirOfFlight` is outwards
else
  `dirOfFlight` is inwards
end if

Note: `Perp()` returns the radial component in cylindrical coordinates, ρ

Issue with TrueHits

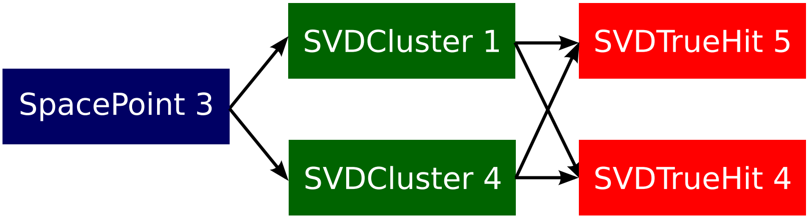
From SpacePoint to TrueHit, ideal case:



Issue with TrueHits

From SpacePoint to TrueHit, 'issue cases':

more than one shared TrueHit



Issue with TrueHits

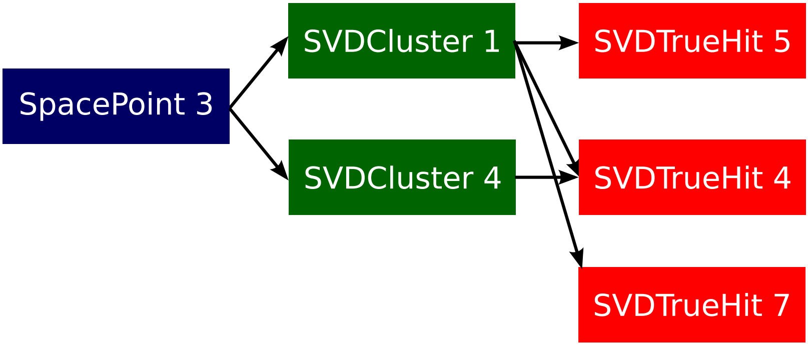
From SpacePoint to TrueHit, 'issue cases':

no shared TrueHits

Issue with TrueHits

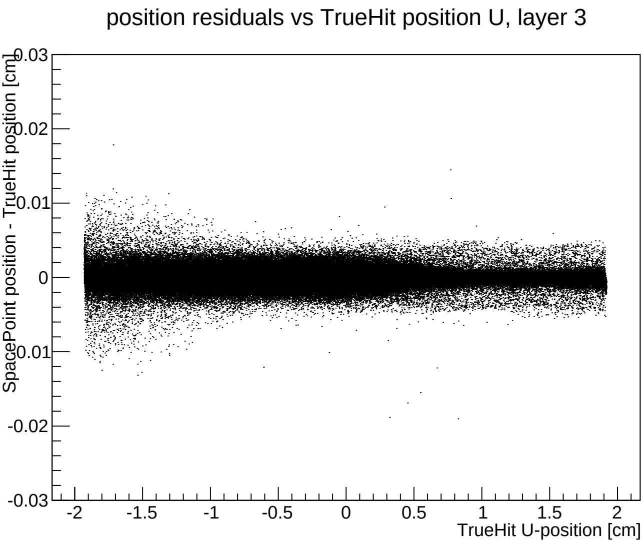
From SpacePoint to TrueHit, 'issue cases':

shared and unshared TrueHits



Issue with TrueHits

Position residuals vs. TrueHit position, with 'ideal cases':



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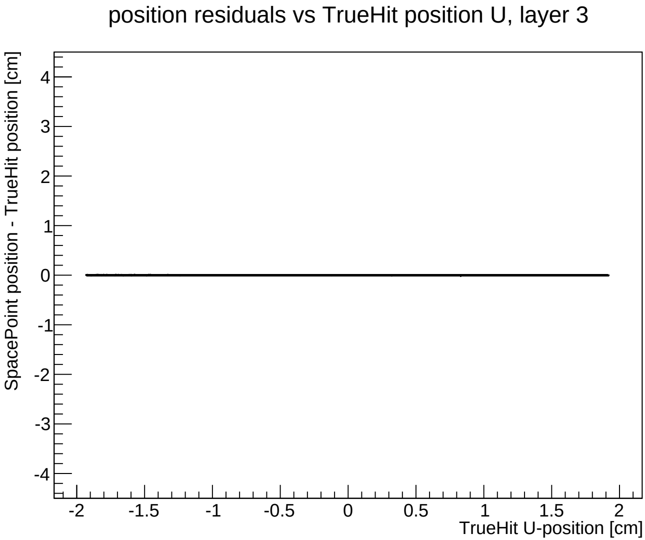

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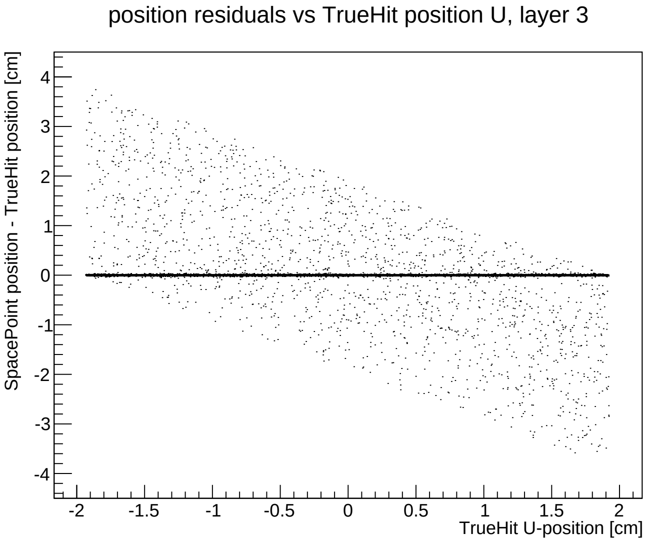

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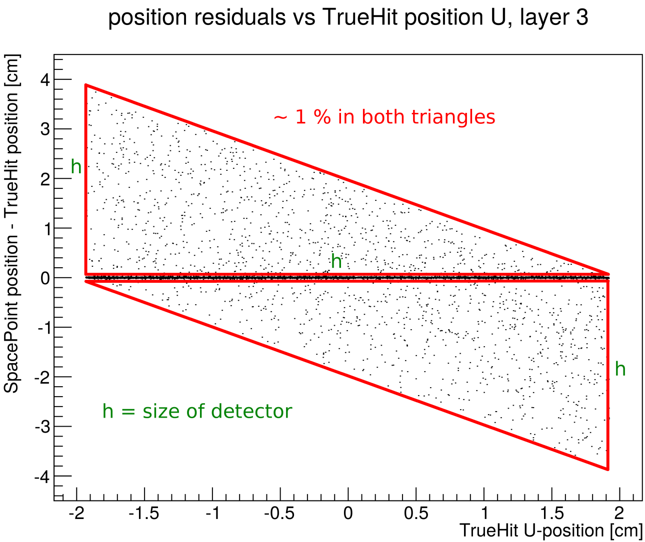


Outlook: The Topic Of My Thesis

Development of a Neural Network Based Track Finder for the Belle II Vertex Detector and Implementation in the Belle II Software Framework

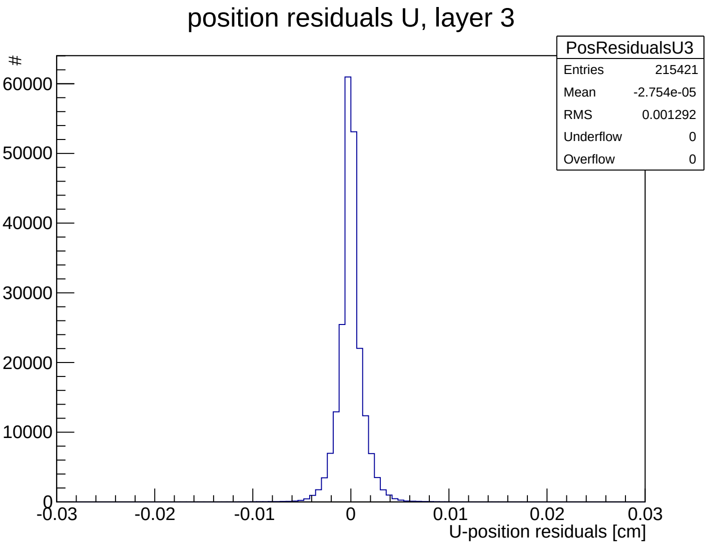
Goals and Next Steps:

- first step: towards generating an enhanced SectorMap with neural networks
- related: feed CA with prior information from neural networks
- long term goal: quality estimation of track candidates with neural networks
- already done: simple MATLAB studies on segment finding (in testbeam setup) with simple neural networks

Thank You!

Supplementary

Histograms of position residuals for ideal cases



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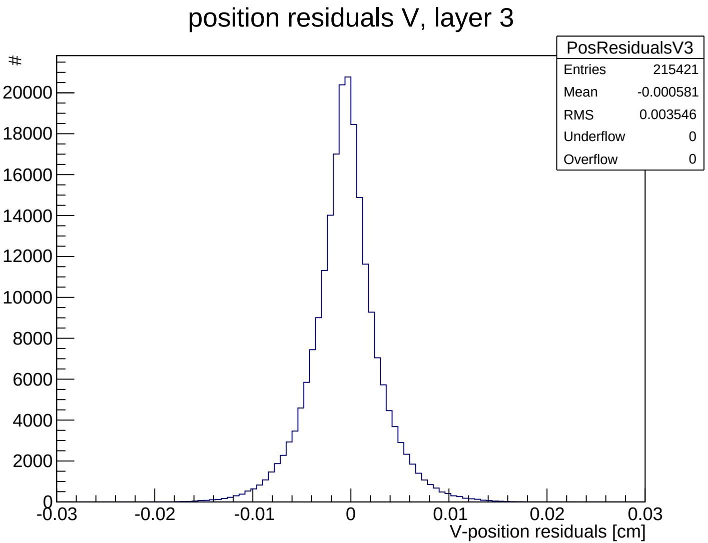

Position Residuals vs TrueHit position for PXD