Measurement of hit reconstruction efficiency and resolution of the SVD sensors

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outline

Goals of this analysis

use data taken at the test beam to:

- measure the resolution of the SVD sensors
- measure the hit finding efficiency of the SVD sensors

Approach

- it was not clear to us if Telescope data will be available for analysis
- from experience with previous test beam: data taken with telescope might not be usable
- prepare analysis without using an external telescope
  - use "self tracking" approach

Analysis strategy

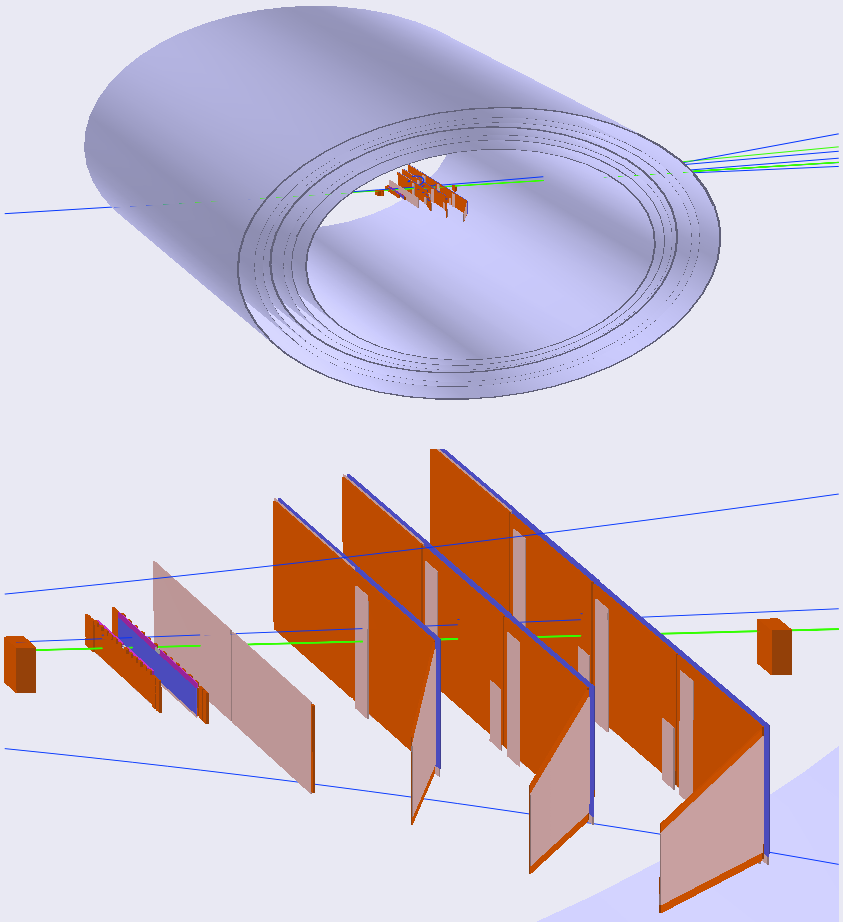
- use the basf2 software for reconstruction
- remove one SVD layer from the reconstruction (implemented by removing the SVDCluster)
- do track finding (VXDTF) and track fitting (GenFit) with one layer removed
- use the fitted GenFit track to predict the track position on the removed layer
- compare the predicted position with reconstructed position (cluster position) on the removed sensor layer:
  - measure the residual as reconstructed minus predicted position
  - use a cut and count approach to estimate the hit efficiency

Do MC-studies with the beam test geometry (basf2)

Used beam parameters:

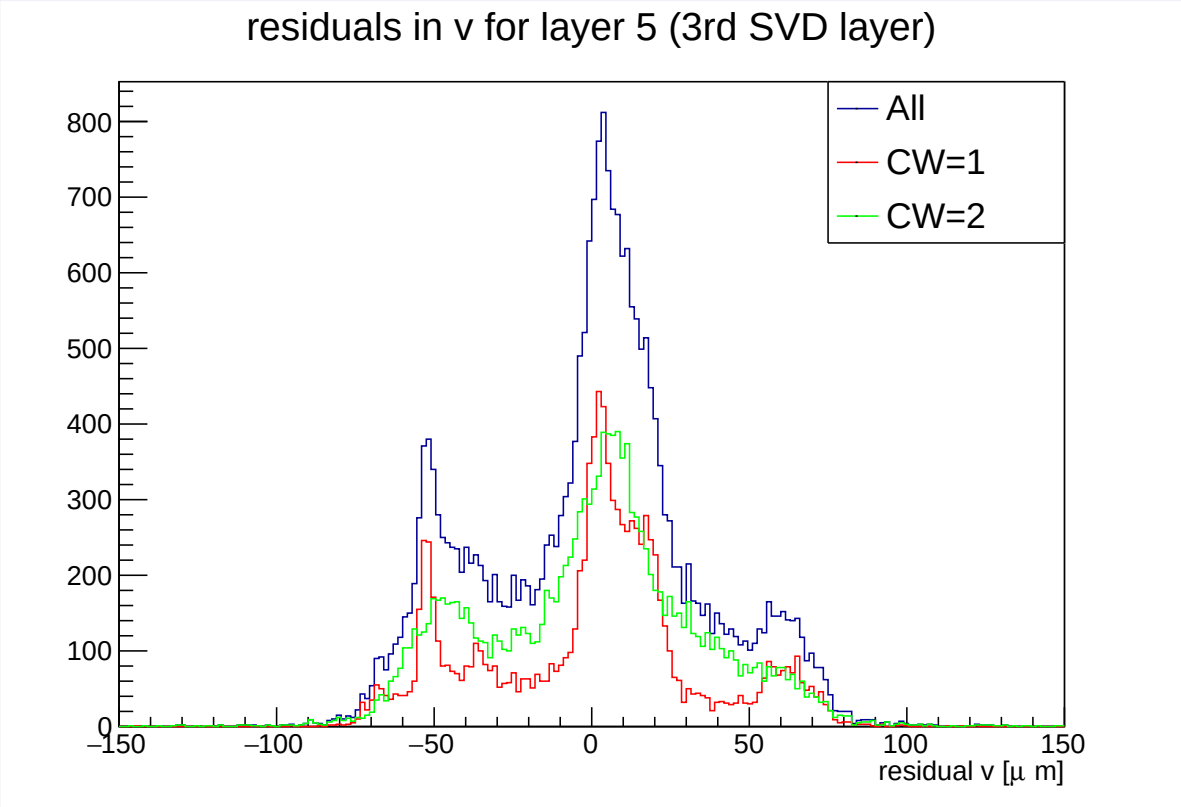
- single (primary) electron per event
- $\theta = 91°$; spread $\theta = 0.005°$ (σ Gaussian)
- $\phi = 0°$; spread $\phi = 0.005°$ (σ Gaussian)
- vertex outside Magnet $\vec{x} = (-100, 0, 0)cm$
- beam spot size 0.3 cm in x and z
- $p_{beam} = 6GeV$ spread $0.3GeV$ (σ Gaussian)

Two example events displayed



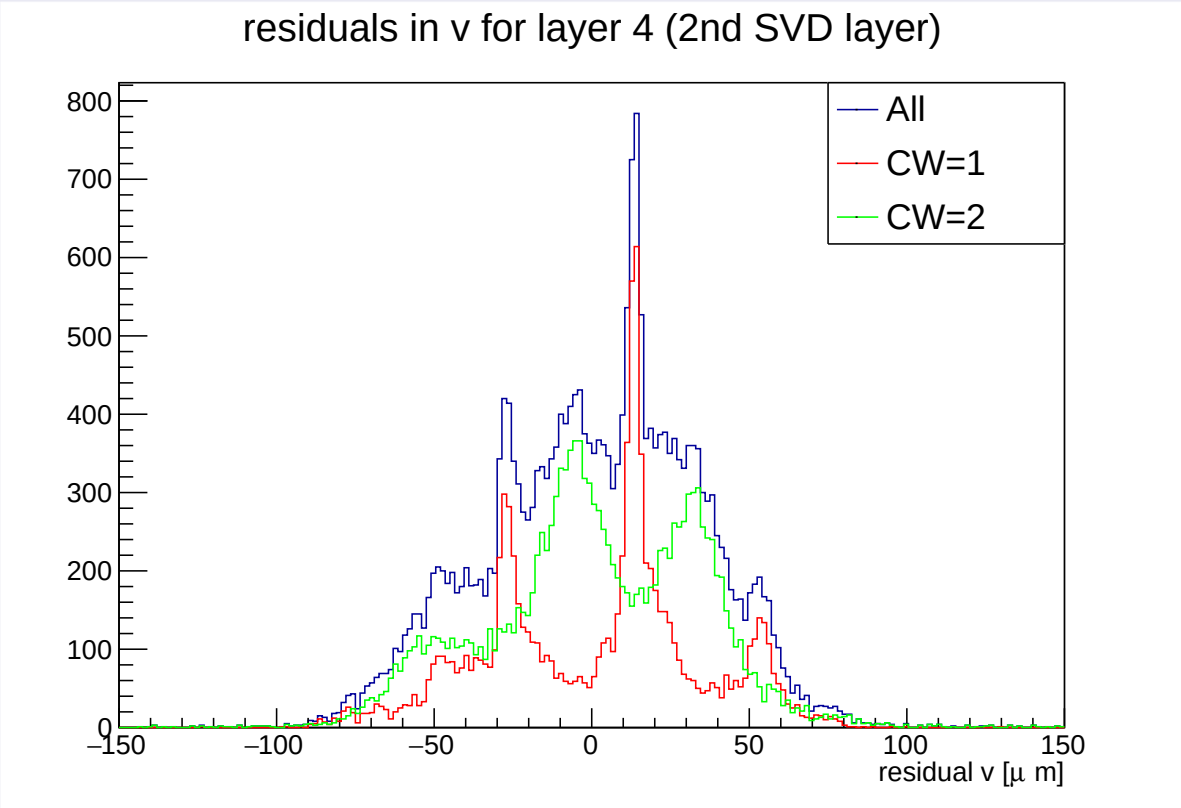
- for this example only SVD layers used (but same is observed if PXD layers are included)
- cuts applied p-value fit: $P > 0.05$; momentum $4.67 < p_{track} < 6.67 GeV$

Found strange structures in the v direction (n-side pitch = $240 \mu m$)



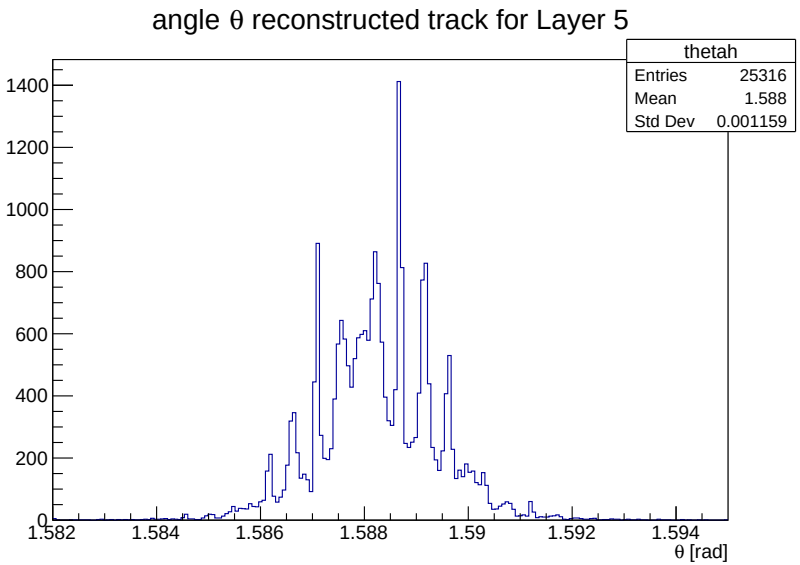
- for this example only SVD layers used (but same is observed if PXD layers are included)
- cuts applied p-value fit: $P > 0.05$; momentum $5.67 < p_{track} < 6.67 GeV$

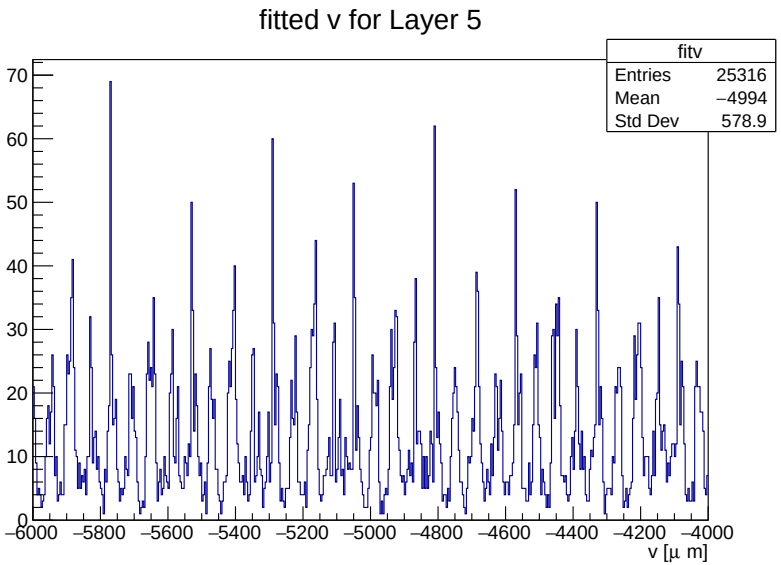
Found strange structures in the v direction (n-side pitch = $240 \mu m$)



Further investigation

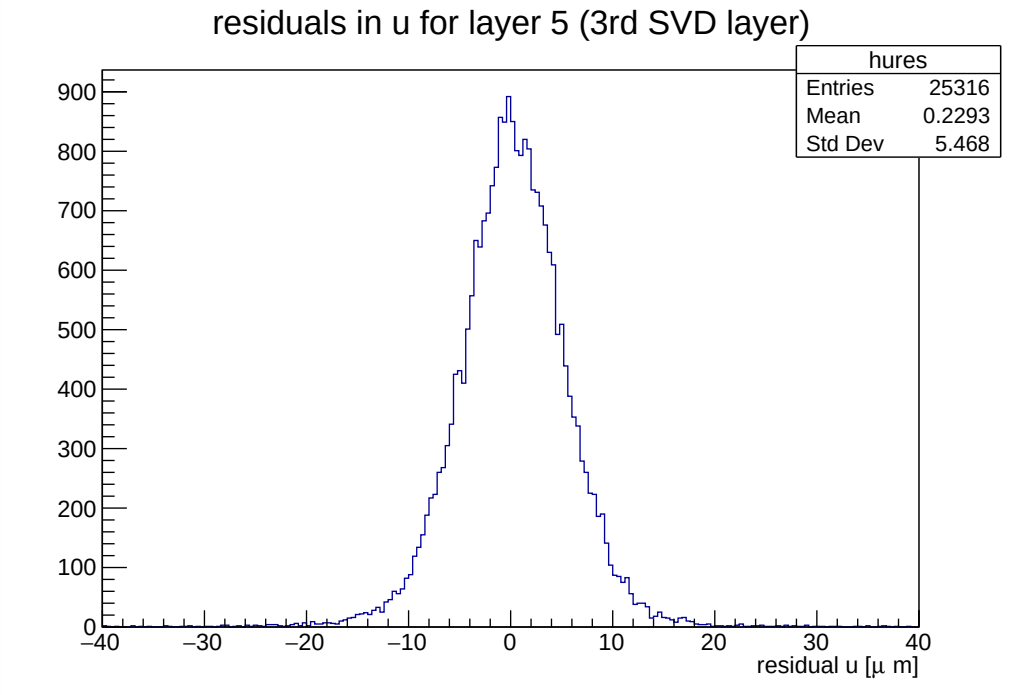
- fitted beam position correlated to underlying sensor structure (of other layers)
- therefore also correlated to the reconstructed position (of layer under investigation)





- reconstructed residual in u for layer 5 $res = 5.5\mu m$
- looks good compared to digital resolution $10.8\mu m$

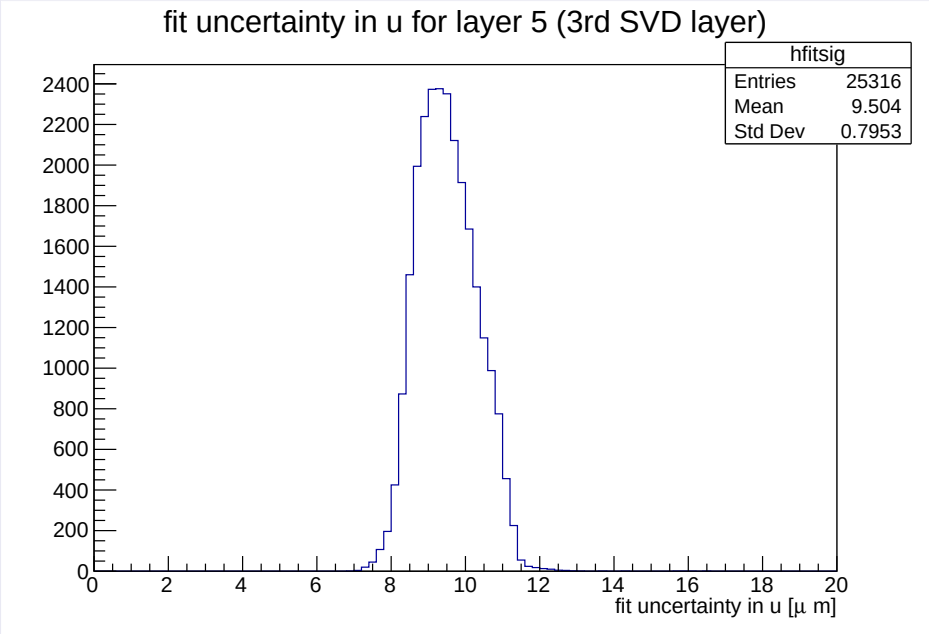
Measured residual for layer 5 u direction



- too good to be true ...

- mean fit uncertainty $\approx 9.5\mu m$
- measured residual $res = 5.5\mu m$ much better than fit uncertainty (yes, we are "that good")
- here intrinsic resolution of sensor not included
- also results for u direction not reliable (due to correlations with other layers)

Distribution of fit uncertainty in u for layer 5



Very preliminary results for the hit efficiency

- currently only counting 2D hits (will be changed to 1D clusters)
- cut on residual: $res./\sigma_{total} < 3$ in u and v; with $\sigma^2_{total} = \sigma^2_{digital} + \sigma^2_{fit}$
- "cut and count" for data and compare with counted true hits (MC)

Obtained results for the hit efficiency (very preliminary)

layer	2D hit efficiency		
	from MC	SVD as telescope	PXD+SVD as telesc.
3	0.971 ± 0.001	0.956 ± 0.002	0.986 ± 0.001
4	0.974 ± 0.001	0.987 ± 0.001	0.988 ± 0.001
5	0.978 ± 0.001	0.991 ± 0.001	0.993 ± 0.001
6	0.976 ± 0.001	0.983 ± 0.001	0.989 ± 0.001

- uncertainties statistical only
- currently investigating observed discrepancies

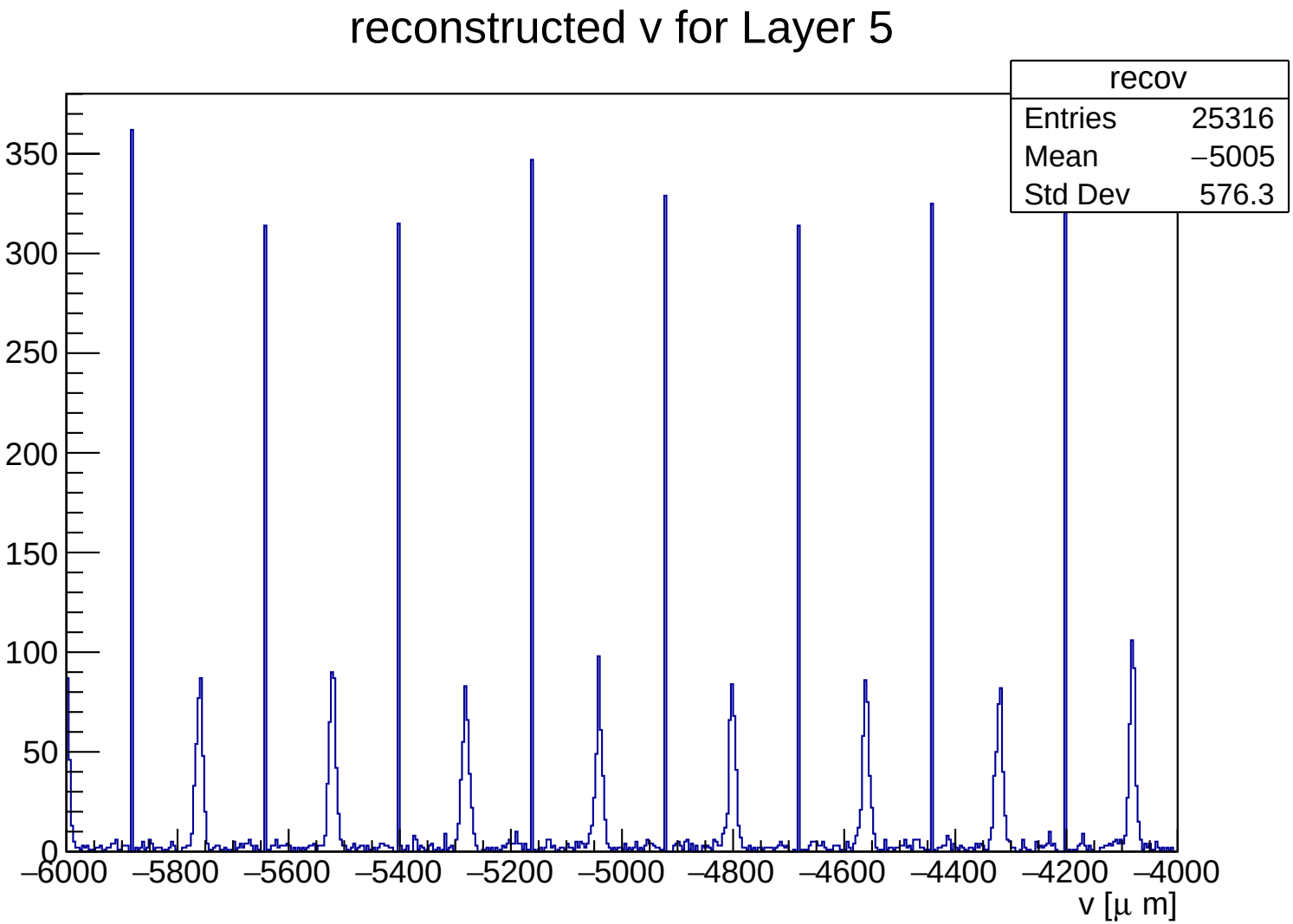
Summary

- measure hit efficiencies might be possible with self tracking approach
- observed residuals heavily biased:
  - self tracking does not work as expected
  - to measure resolutions we do need a (working) telescope

Conclusion

- we do need a "working" telescope

BACKUP


reconstructed v for Layer 5
recov
Entries 25316
Mean −5005
Std Dev 576.3
350
300
250
200
150
100
50
0
−6000 −5800 −5600 −5400 −5200 −5000 −4800 −4600 −4400 −4200 −4000
v [μ m]