

Efficiency estimation of the SVD with DESY test beam data (April 2016)

Thomas Lück for the Pisa-group
+ some comments by Giulia

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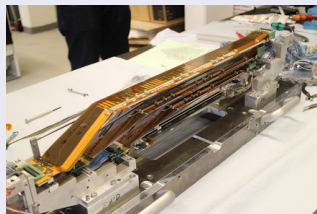
- Introduction
- DESY beam test
- Dataset
- Procedure
- Results
- Summary

- beam test in April at DESY (Hamburg)
- main purpose: test data acquisition
- use recorded data to quantify SVD performance
- Last test beam before Beast 2 by the end of 2016 (November/December)

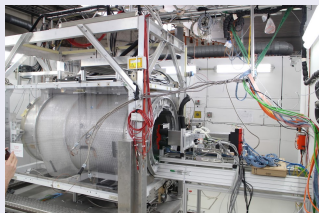
Experimental setup at DESY (Hamburg)

- combined test PXD + SVD
- e^- beam: $p = 2 - 5\text{GeV}$
- full readout chain same, geometry as Beast 2
- B-field: 0 - 1 T
- a total of around 340 runs
- ≈ 12 good runs (190×10^6 evt)

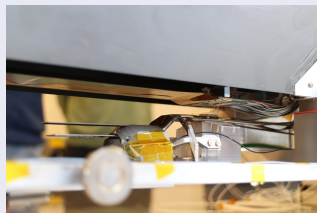
4 ladders SVD (without PXD)



VXD + magnet



2 PXD half ladders (under SVD)



pictures by Katsuro Nakamura

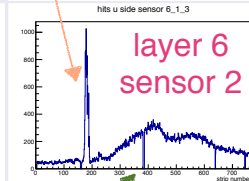
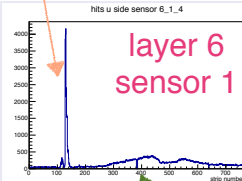
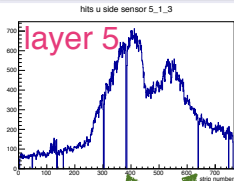
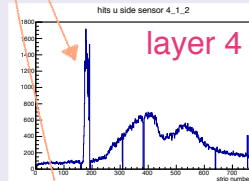
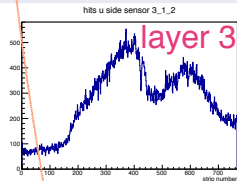
Data sample this analysis: run 329

maybe due to common mode subtraction? under investigation

unbiased hit maps u-direction (P-side, perpendicular to B field)

Dataset:

- $p=5$ GeV
- B-field: 1 T
- 2.3×10^6 evt.



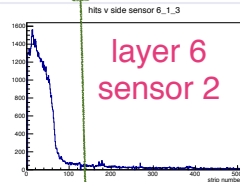
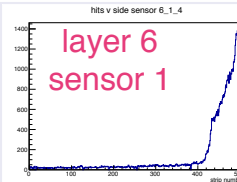
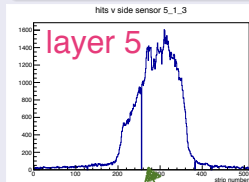
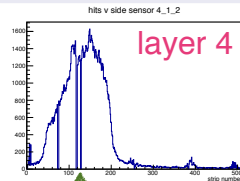
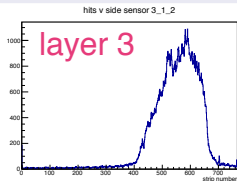
Note: Noisy strips are disabled at FADC level and are not available for offline reconstruction

Data sample for this analysis: run 329

unbiased hit maps v-direction (N-side)

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- $p=5$ GeV
- B-field: 1 T
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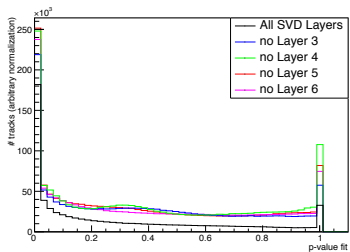
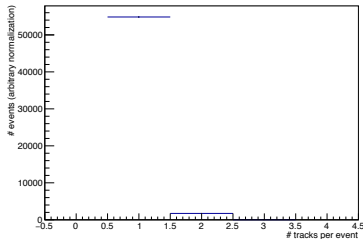
Note: Noisy strips are disabled at FADC level and are not available for offline reconstruction

Procedure

- avoid correlation between track finding and efficiency and do track finding and fitting on 3 of the 4 SVD layers
- use dedicated sector maps for VXDTF:
 - trained on 3 out of the 4 SVD layers
 - found track candidates contain only hits on the 3 SVD layers used for training
- use fitted track to predict position on the remaining layer (not used for tracking)
- count the number of hits (strips or clusters) within $300\mu m$ of the predicted track position
- calculate:
 - efficiency: $\epsilon = \frac{\#hits}{\#tracks}$
 - or inefficiency: $\eta = 1 - \epsilon$

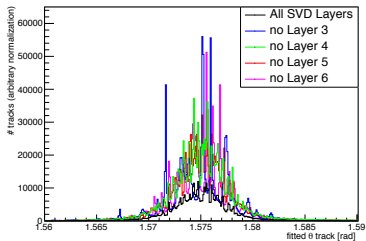
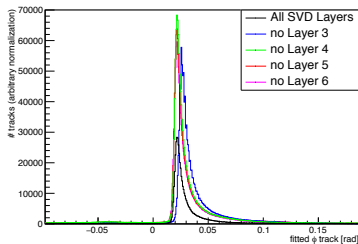
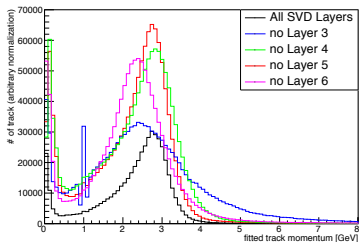
Event selection

- P-value for the track fit of $P > 0.02$
- only events with single track
- select only "high" momentum tracks $2 < p_{fit} < 4 \text{ GeV}$
- require a good accuracy of the extrapolated track position on the sensor:
 - fit uncertainty $< 30 - 70 \mu\text{m}$ (depending on layer and side)
- noisy and bkg. strips are masked



Selected tracks

- biased momentum caused by alignment
- Note: beam momentum is 5 GeV
- angles discretized

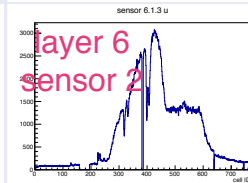
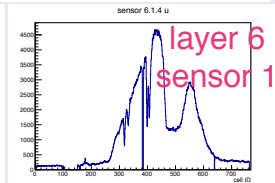
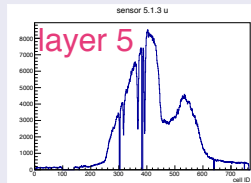
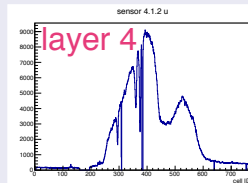
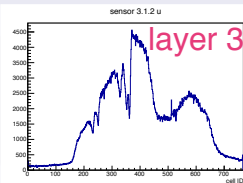


Hit maps for selected events

selected hits u-direction (P-side)

Note:

- some features are induced by selection



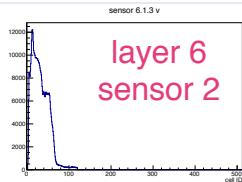
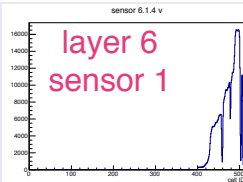
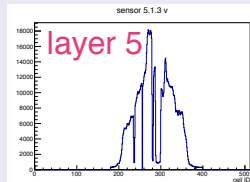
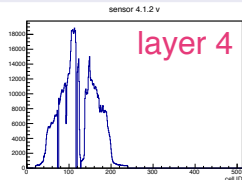
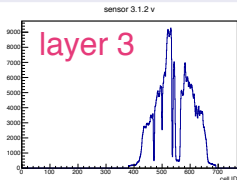
Hit maps for selected events

selected hits v-direction

(N-side)

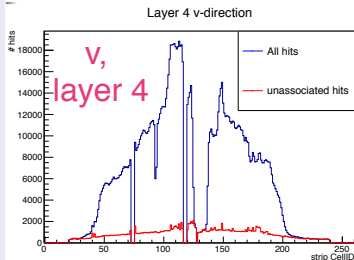
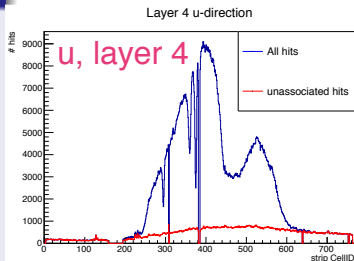
Note:

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Background estimation

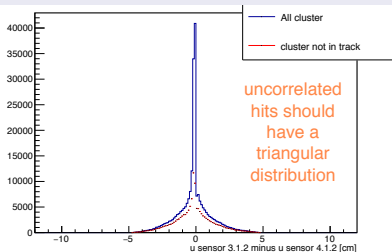
- observe background hits
 - hits not associated to track (distance $> 300\mu m$)
- estimate $P(bkg)$: probability background hit
- subtract number of background hits from number of counted hits:
 $\epsilon \Rightarrow \epsilon - P(bkg)$
- low background: $P(bkg) \leq 0.1\%$
- assign systematic uncertainty:
 $\sigma_{syst} = P(bkg)$



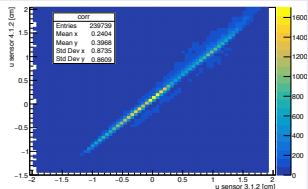
Track finding/fitting inefficiency

- no cuts applied on track
 - tracks found with all 4 SVD layers
 - remove clusters used for tracks
 - investigate remaining clusters
- ⇒ correlation between all SVD layers
- ⇒ "un-found" tracks

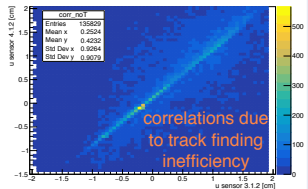
difference in u position of clusters on sensors 3.1.2 and 4.1.2



sensors 3.1.2 and 4.1.2,
all cluster



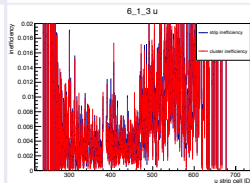
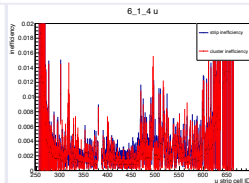
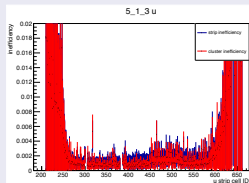
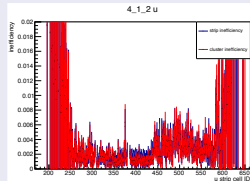
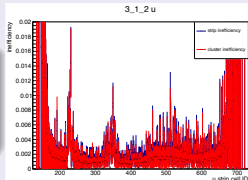
sensors 3.1.2 and 4.1.2,
clusters not used in track



Preliminary results for inefficiencies u-direction

- very high efficiencies
- some inefficiencies by known defects, new defects and selection

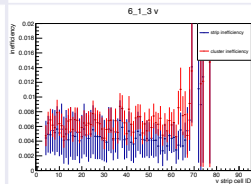
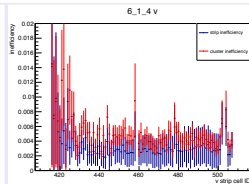
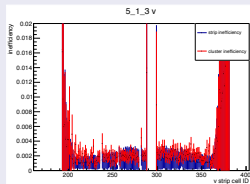
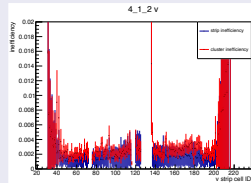
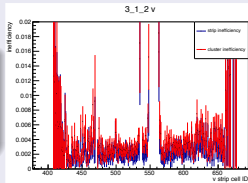
- shown are only strips which see beam



Preliminary results for inefficiencies v-direction

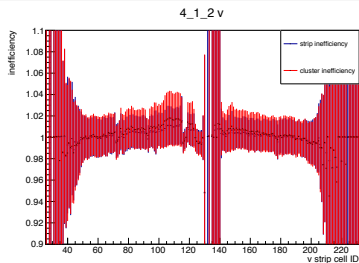
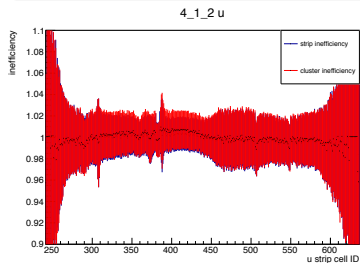
- very high efficiencies
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- shown are only strips which see beam



Check the procedure:

- add 1000 μm to the fitted position
- repeat the analysis
- estimated inefficiencies should be 1



Summary

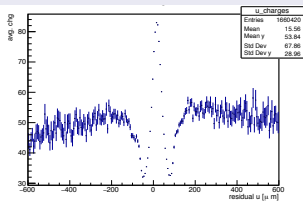
- estimated the hit efficiency of the SVD
- average efficiencies $> 99\%$

Outlook

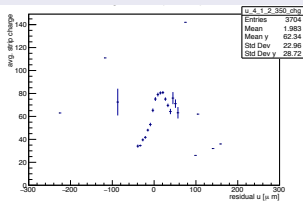
- use proper alignment
- include Telescope and PXD cluster to improve the analysis
- look into resolution studies
- revise background subtraction

THE END

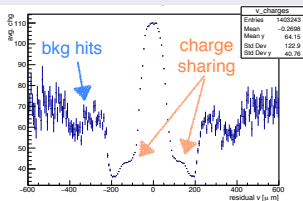
avg. strip charge vs residual all strips u-direction



avg. strip charge vs residual u-direction, for single strip (closest to track)



avg. strip charge vs residual all strips v-direction



avg. strip charge vs residual v-direction, for single strip

