Institute of High Energy Physics

Summary test beam

collaboration of (in no particular order): J. Lettenbichler, T. Schlüter, J. Rauch, G. Casarosa, E. Paoloni, T. Bilka, P. Kodys, P. Kvasnicka, R. Frühwirth Depfet Meeting in Seeon May 27th, 2014







Test Beam Setup at DESY Jan. 14

- mounted inside a solenoid magnet (1T)
- e- 2-6 GeV passes through solenoid (→ momentum spread
- telescope in front and back (3 layers each)
- PXD and SVD planes as in Belle II







Overview

PXD used in testbeam:

- 480x192 pixels each, 75x50µm²
- active area thinned to 50µm (Belle2: 75µm)
- otherwise as close as possible to final system as in final experiment: small pixel pitch / short side along bending direction
- only one PXD available in time for TB Still, this allowed exercising the whole readout chain





TB summary



Overview



SVD Layout in Belle II



SVD Layout in Testbeam



SVD Readout and Slow control rack (left)

SVD used in testbeam:

- one layer: 768x512 strips
- three layers: 768x768 strips
- Pitches 160µm, 75µm
- Readout by standard APV25 chips and Belle 2 COPPER system





Testbeam data flow



- data are read out after external trigger
- two-stage event building, SVD event built by Event builder #1
- SVD data processed by HLT and DatCon systems
- PXD buffered by ONSEN system
- DatCon and HLT determine ROIs on PXD
- pixel data within ROIs forwarded from ONSEN to Event builder #2
- the merged event ist stored to disk/tape
 This talk: focus on HLT software for data reduction
- HLT has only SVD data available
- HLT and DatCon control readout of PXD: only ROIs defined by them are stored to final event → data reduction > 1:10 planned

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HLT Data Processing Path

- same software as offline (basf2)
- structured in a sequence of data processing modules
- the sequence is controlled by a python slide
- data is transfered between modules by the Data Store
- Data Store contents can be read and written to disk, transferred over the net at any point of the processing
- HLT processing was running on a farm of three 8-core systems at 3 GHz





SVD-only tracking



Figure : Example reconstruction of a track through all four SVD planes

- CA based track finding
- Kalman-fit of the resulting track (genFit2)
- per-event time stays well within the hardware limits (<1ms average processing time)
- Goal: use these tracks for defining ROIs on the PXD
- detailed look on:

run 511, 1T, 3GeV, 6792 events, mean/median of 2/1 cluster combinations per layer **run 607**, 0T, 4GeV, 24080 events, mean/median of 9/9 cluster combinations per layer





SVD-only tracking

In tables rows represent the evaluated TF, columns represent the reference:

• R511 no align (eff: 59.86%, nClusters/TC: 6.11, 0.26 TCs/event, 145µs/event):

	0	1
0	3279	1725
1	1001	787

• R511 aligned (eff: 58.52%, nClusters/TC: 6.46, 0.44 TCs/event, 170µs/event):

	0	1
0	2627	1164
1	1653	1348

• R607 no align (eff: 61.65%, nClusters/TC: 7.88, 1.33 TCs/event, 3970µs/event):

	0	1
0	388	519
1	8715	14458

• R607 aligned (eff: 61.76%, nClusters/TC: 7.92, 1.34 TCs/event, 4140µs/event):

	0	1
0	353	458
1	8750	14519





SVD-only tracking

VXDTF: hitMapTotal U and V for at sensor 7.3.4







Track reconstruction worked



Figure : Momentum reconstruction with three different beam momentum settings

 Tracks could be fitted successfully (momentum spread to beam's passing through magnet, low momentum cutoff due to magnetic field and distance between magnet and detector)



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Definition of ROIs



Figure : Illustration of ROI determination

- the reconstructed track is extrapolated from the SVD to the PXD plane
- there an ROI is defined
- in this case it contains a barely visible PXD hit

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Extrapolation onto PXD

U intercept vs U cluster

V intercept vs V cluster



Figure : Correlations between extapolated tracks and PXD hits

- extrapolated tracks actually correlate with PXD hits
- event numbering correct, geometry correct (coordinate directions)
- misalignment within expected within mechanical precission



Definition of ROIs



Figure : ROI quality: residual defined as 2D difference between measured coordinate and ROI center.

 reconstructed ROIs are nicely centered on pixel hits, gaussian fit yields (141+/-2)µm in bending direction and (32.3 +/- 0.4) µm resolution at given





Test of ROI transmission by artificial ROI geometry.

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Conclusions:

- the January 2014 Belle II VXD testbeam at DESY was a success
- the full data acquisition chain could be established
- we were successfully able to process data online with the same software as offline
- selective readout of PXD could be driven by online reconstruction
- thus, the data reduction scheme could be established
- system worked stably, several night-long data taking periods were completed successfully



TB summary









Testbeam Hamburg Jan. 2014

- Extremely informative, effective and stressful weeks
- Main goal achieved, tracking and ROI finding was possible
- TF was fast enough and stayed below RAM threshold
- Many short term decisions multiplied work to be done
- Revealed issues in the TF which have to be fixed
- Topic still not closed





Testbeam stuff to do (ongoing):

- Merging code with current release
- Solving issues which surfaced within the last few days
 - Memory corruption resulting in a segfault
 - Creating new secMaps for everything (secMap container changed)
- Verifying Telescope support again (was working in March, still the case after merging?)
- Visual (Display) and statistical (DQM-plots) verification of VXDTF performance





VXDTF redesign

- Essential for further steps
 - Improvement of test-coverage (near 100% is the goal, so far it's 10% at best)
 - Splitting into several modules increases flexibility
 - Preparation for new TFs (CKF, DAF (both using genFit)
 - Increase maintainability of the Code
- (Of course) has to be done asap (after TB finish)





Current state of this part of the reconstruction chain



[!!!] : shortcut for "a lot of important stuff which is not part of this discussion"





Future state of the trackFinder VXD-approach (event-part)







Planned SectorMapCreatorModule (beginRun/endRun)







VXDTF redesign stuff to do (pending):

• RunWise:

SecMapCreator: some basic stuff is working, done:
25%

- EventWise:
 - SpacePointCreator: working for PXD, done 40%
 - CA-module: toDo: restructuring code of VXDTF, 0%
 - CKF: use genFit::processTrackPartially for CKFimplementation, 0%

-DAF: genFit interface, 0%





Supervising Stefan Ferstl - project thesis

- Dealing with the issue of the VXDTF being a black box
- Covering everything and every step
- Output usable for detailed analysis or Display-module
- Analysis-output "Feature complete" only bug-fixing left
- Display, awaiting comments from Christian Pulvermacher



Supervising Thomas Fabian – bachelor thesis

- Detailed study of filters used for the CA (e.g. Angle3D)
- Done in several steps

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- Check of every single filter implemented (tracking/tests)
- Implementing improvements and three new filters
- Using output provided by Stefan for analysis of "usefulness" of each filter (doing correlations between filters, fake rate, ...) - goal: reduce number of filters, chose best ones
- Currently starting with last point, analysis
- A very time-consuming supervising task



Suporting Thomas Madlener – bachelor thesis

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- Study of using neuronal networks and a secMap for lowMomentum tracking (simplified matlab environment, but real Belle2-McData)
- Mostly supervised by Rudi, but I have to provide secMaps and mcData in their custom format, 95% done
- Kept me from working on previous topics but should be mostly done now





Outlook – May 2014

- F2F-Meeting, Pisa (now)
- DEPFET-Meeting, Seeon (Bavarian Metropolis 25.-28.5.)
- Meantime: working on TB-stuff (see slides 3-5)
- Goal: not being the showstopper for Tobias' trip to the real time conference (26.-30.5.) in Nara, Japan





Outlook – June 2014

- Tidy up the code a bit
- Implement minor things of the redesign, write tests
- Prepare for:
- tCSC 2014, Split 14.-22.6.
- Rest of the month learning
- Exam in statistics 30.6.





Outlook – Summer 2014

- July
 - Exam in classification and discriminant analysis 7.7.
 - Holidays
- August, September: finishing redesign
- Autumn
 - Starting CKF and DAF implementation
 - TB preparation (?)