First results from the VXD test beam 2016

Seeon Workshop 13.5.16

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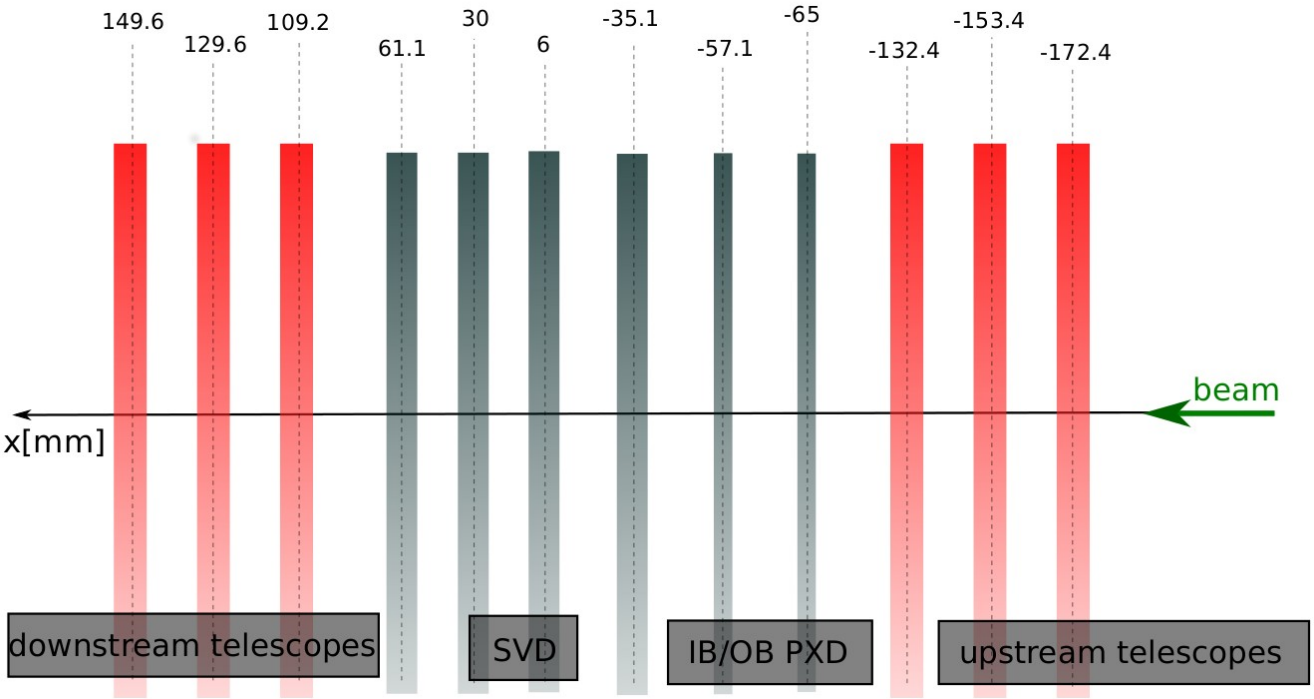
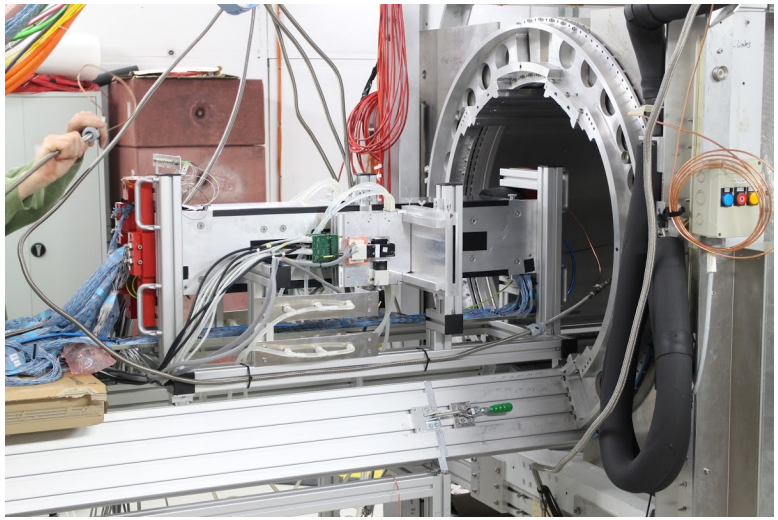
For the test beam crew

The idea of this talk

- Disclaimer: impossible to give comprehensive overview of test beam results.
  - Test beam ended ~1 week ago
- Many different experiments were carried out during 4 week beam time
  - Data taking with two PXD modules (IB+OB) at the same time
  - Data taking PXD+SVD inside a magnetic field of up to 1T
  - Integration of PXD+SVD with EUDET telescope
  - Real ROI tracking on HLT
  - Runs with high rate and runs with secondary Pb target
  - …
- I will try to give some orientation about:
  - What numbers to expect: Spatial resolution, gq, efficiency
  - What detector related questions are still open
  - And how to organize the analysis

Test beam geometry





:- 12 layers inside PCMag

:- Total lever arm ~320mm

:- Beam goes along +x

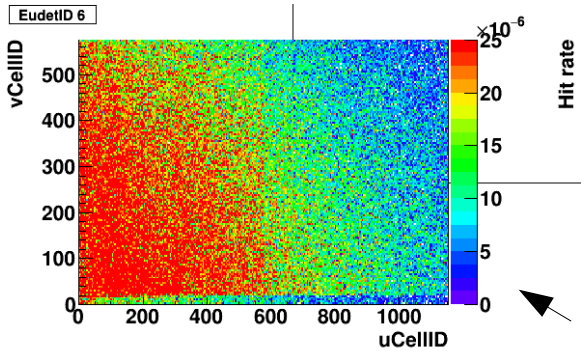
:- Magnetic field points +z (inside drawing plane)

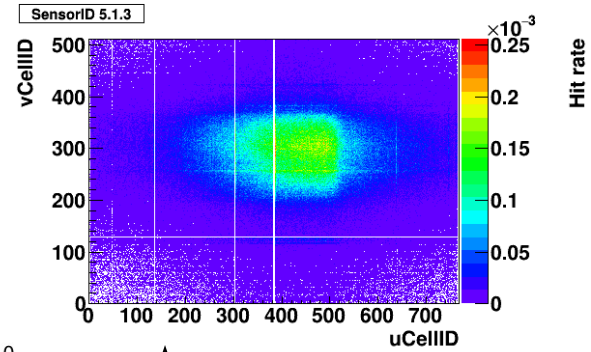
:- PXD+SVD distances almost as Belle II

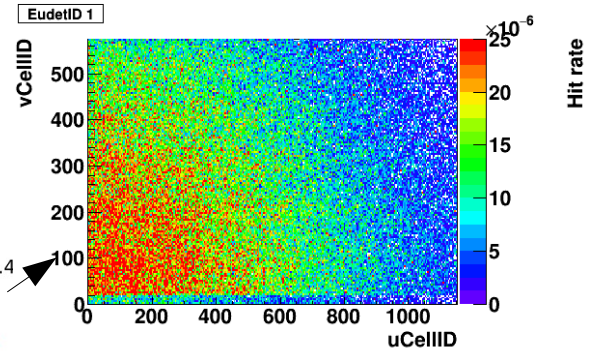
:- additional spacer move SVD 5mm from PXD.

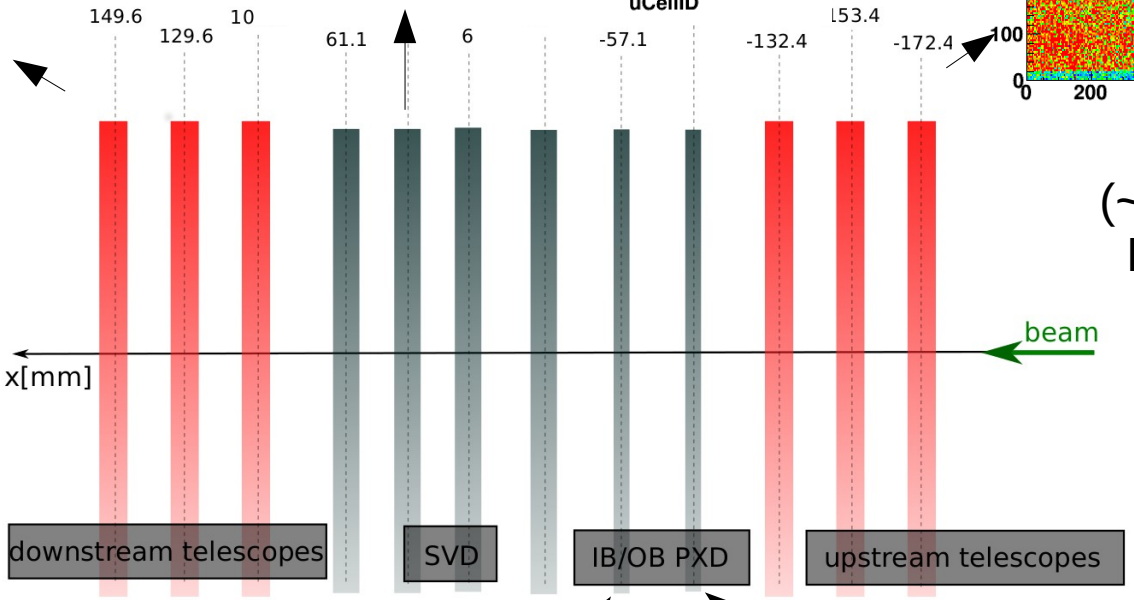
:- Tel. arms moved as close as possible to VXD

There are runs where all is working









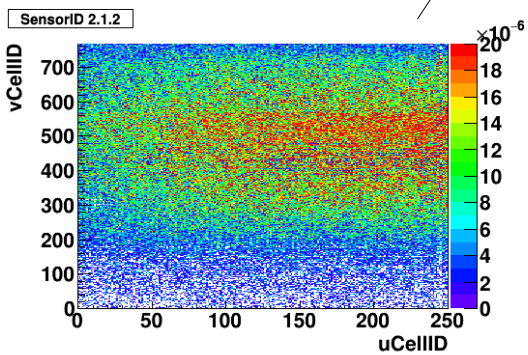
(~540k events from Belle runno 96)

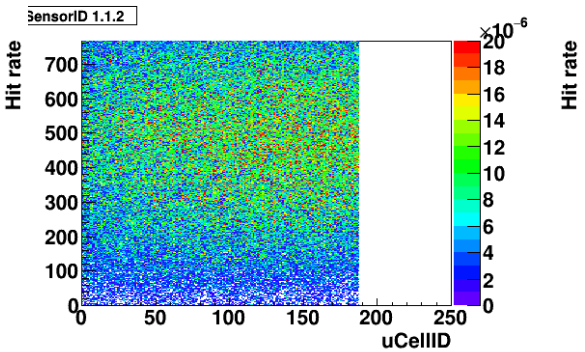
:- spot visible on all planes ;)

:- hits from all planes correlated ;)

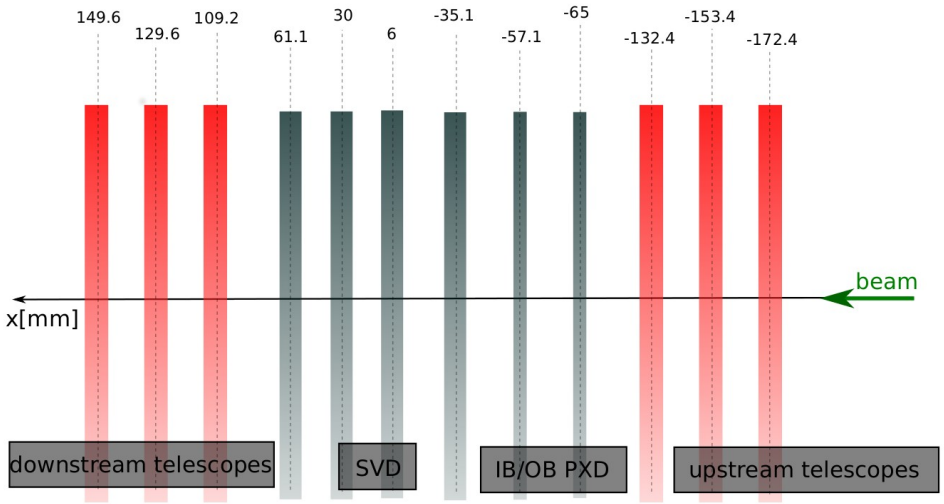
:- SVD hitmap (5.1.3) covers spot fully

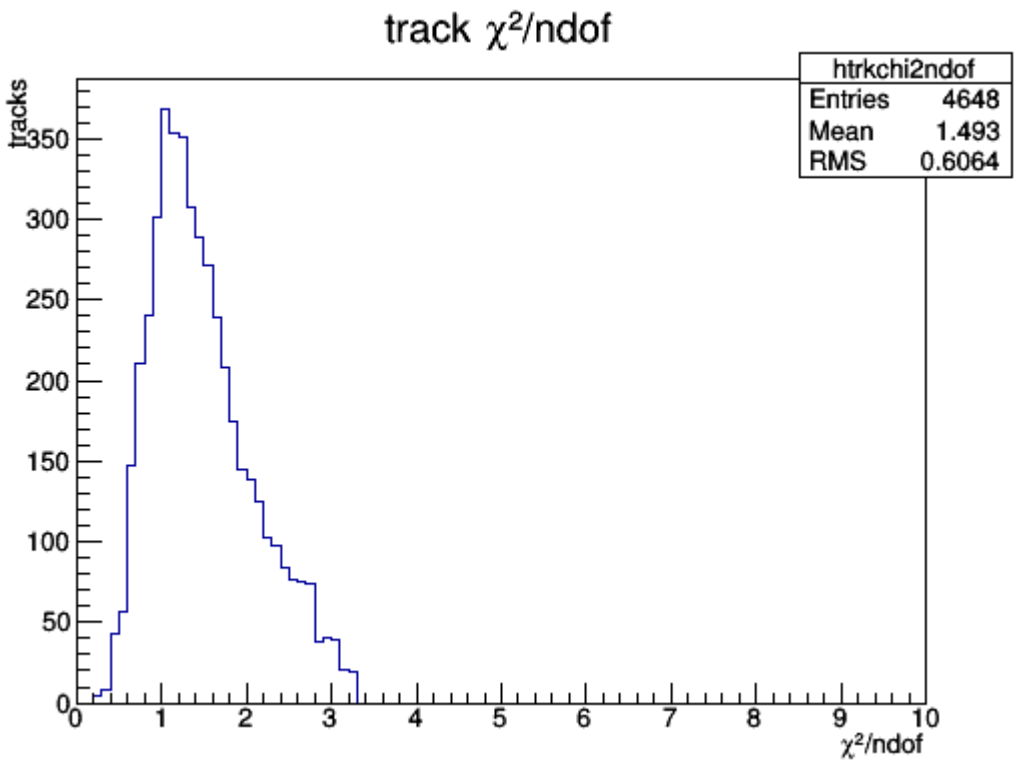
:- Shadow from scinti visible





12 layer tracking with telescope





:- Belle runno 96 allows 12 layer tracking (B = 0T; 5GeV electrons)

:- In ~540k events:

→ ~4500 tracks with >10 hits used to align the setup

→ this track sample used to align.

→ also well suited for resolution studies.

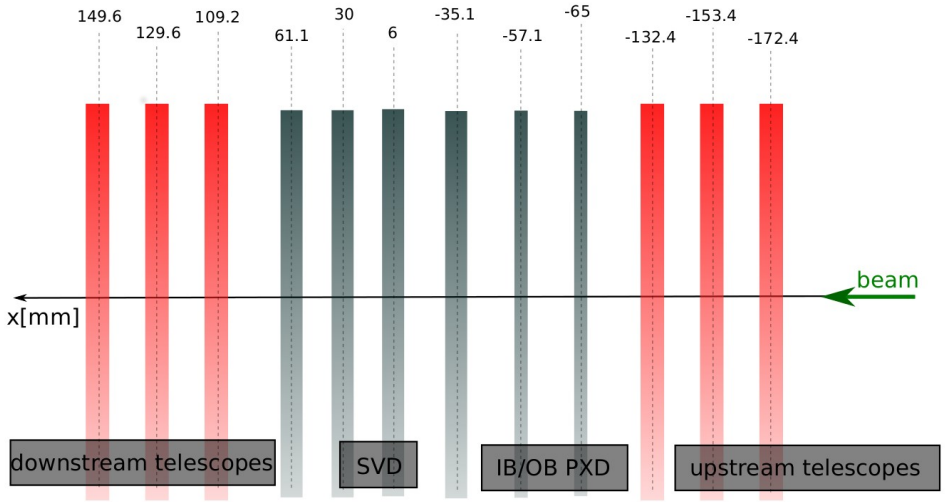
:- Analysis based on ILCSoft framework.

:- pre-alignment: based on hit correlation bands.

:- track based alignment: Kalman Alignment Algorithm (R. Frühwirth)

:- Fixed: x,y,z position of outermost telescopes planes

Residuals on telescope planes

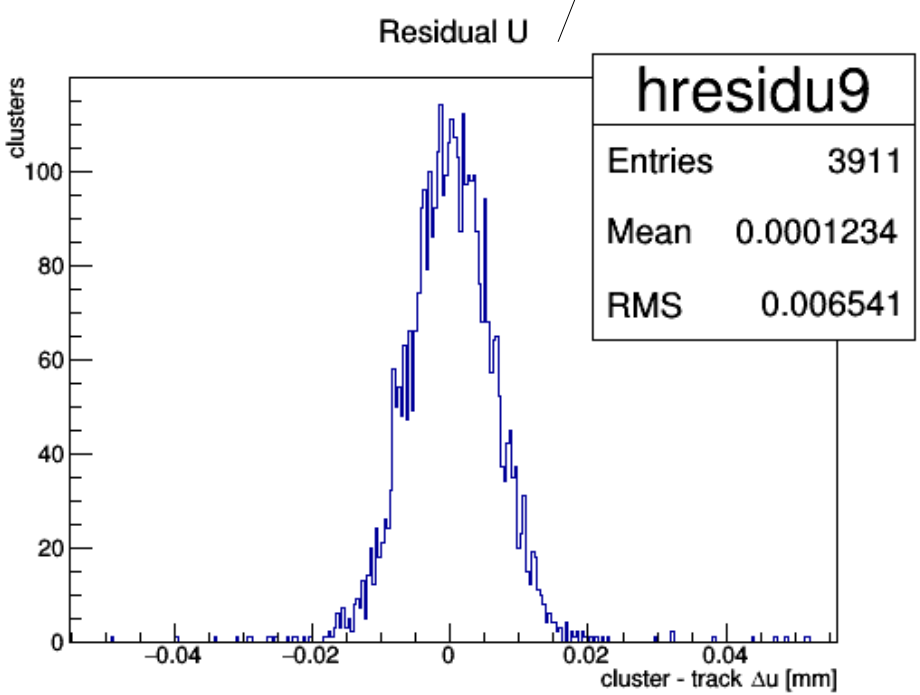


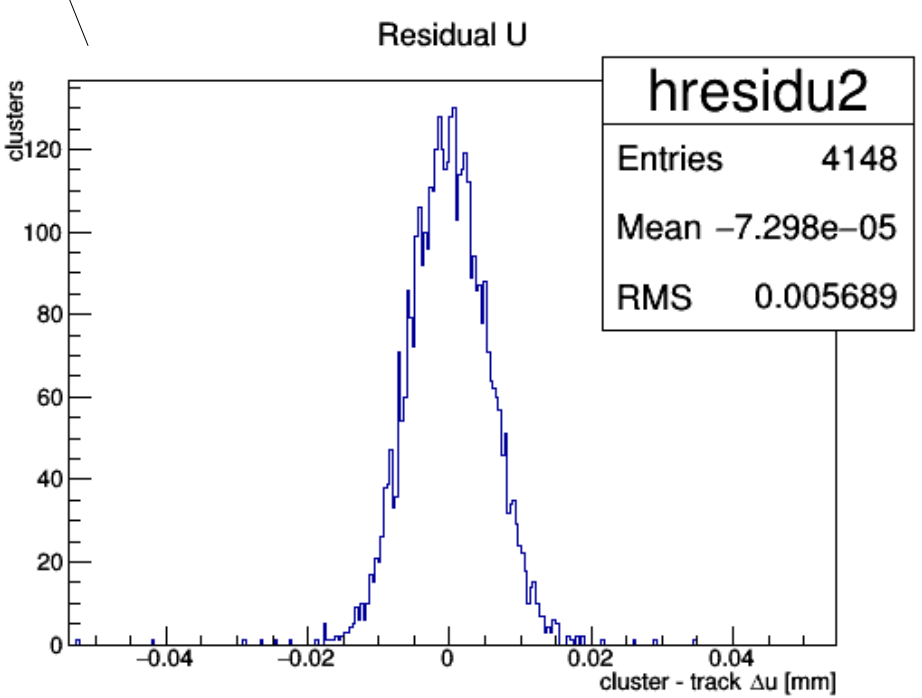
:- Belle runno 96 allows 12 layer tracking (B = 0T, 5GeV)

:- Unbiased U residuals on M26 planes look ok

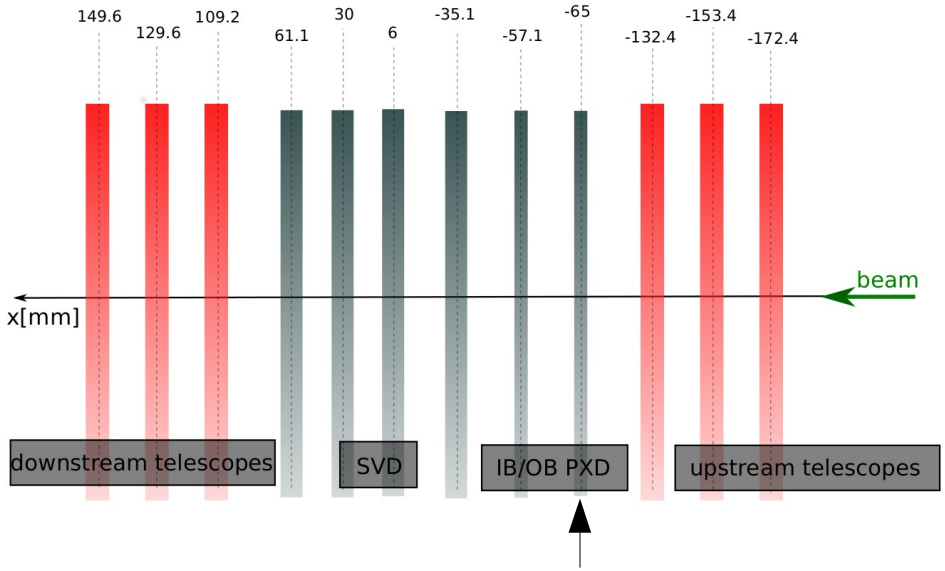
→ Residual RMS = 6.5um, 5.7um

→ Intrinsic resolution ~3.2um





Residuals on PXD-IB



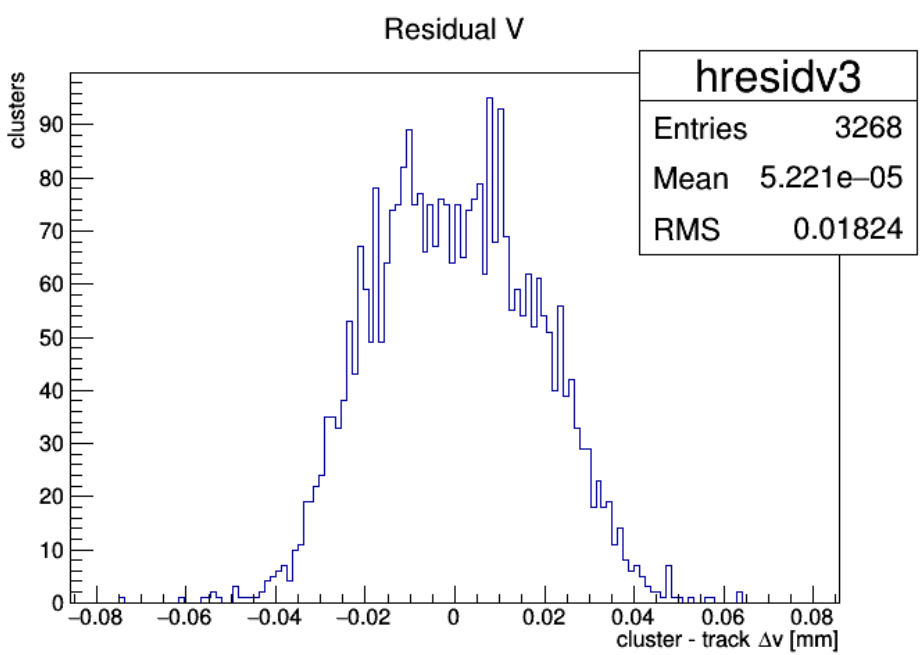
:- Unbiased residuals on PXD-IB plane (layer 1) look ok

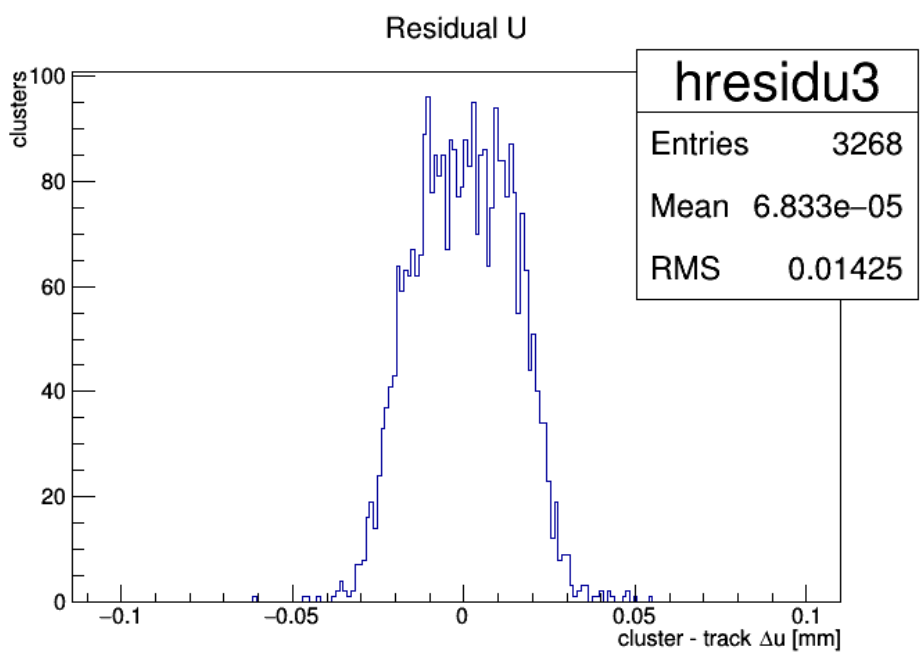
→ U RMS = 14.3um

→ V RMS = 18.2um

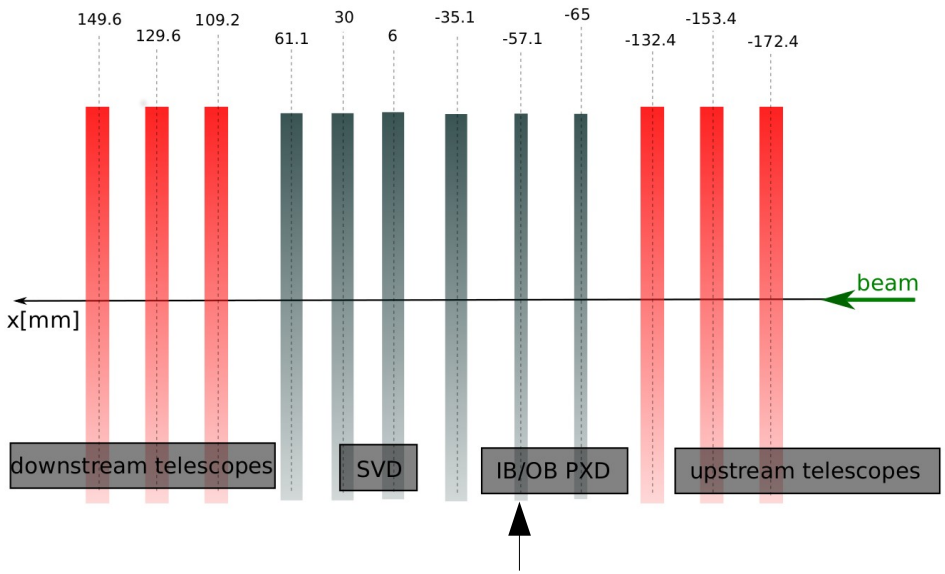
:- Compatible with pitch/sqrt(12)

:- V RMS is bigger because larger SVD strip pitch in V.





Residuals on PXD-OB



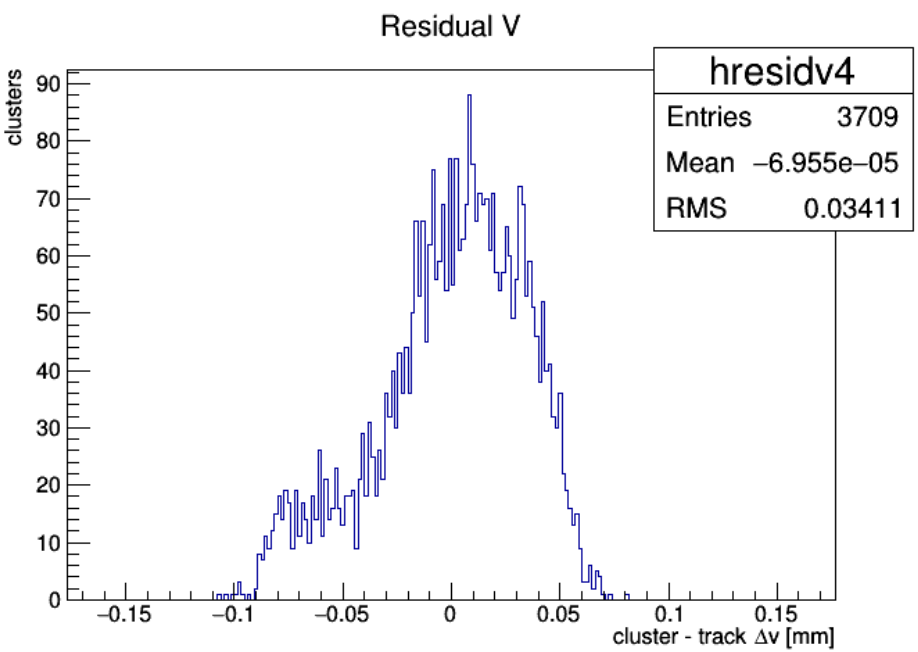
:- Unbiased residuals on PXD-OB Plane (layer 2) look ok

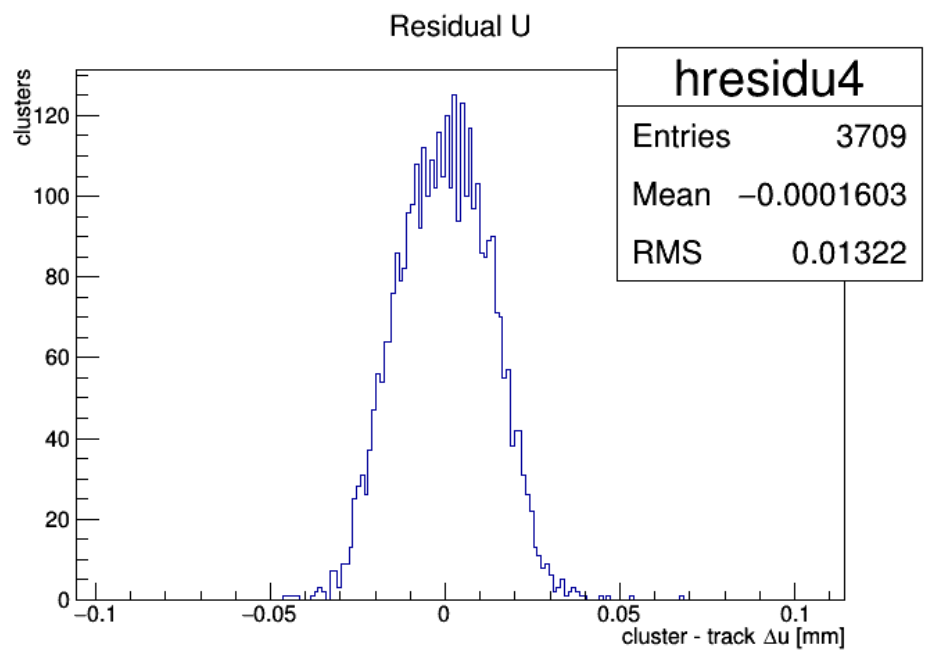
→ U RMS = 13.2um

→ V RMS = 34um

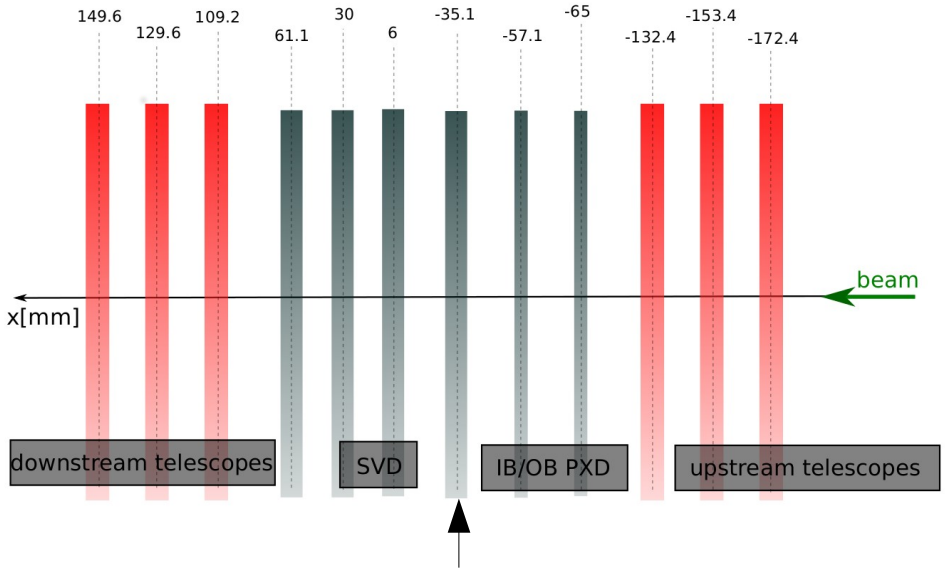
:- U compatible with pitch/sqrt(12)

:- V shows some small problems (mapping related)





What about residuals on the SVD



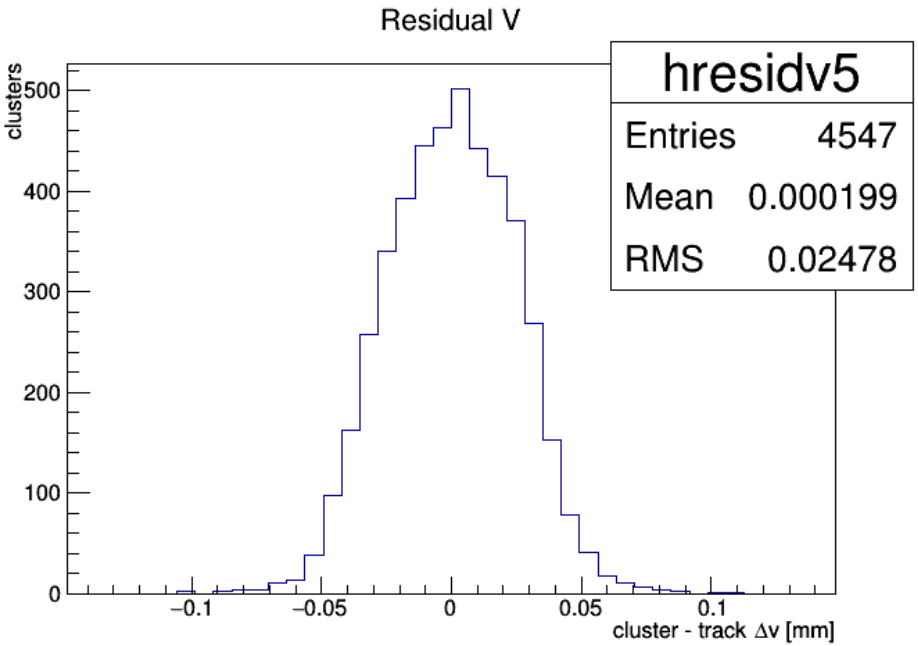
:- Unbiased residuals on Layer 3 (3.1.2) look ok

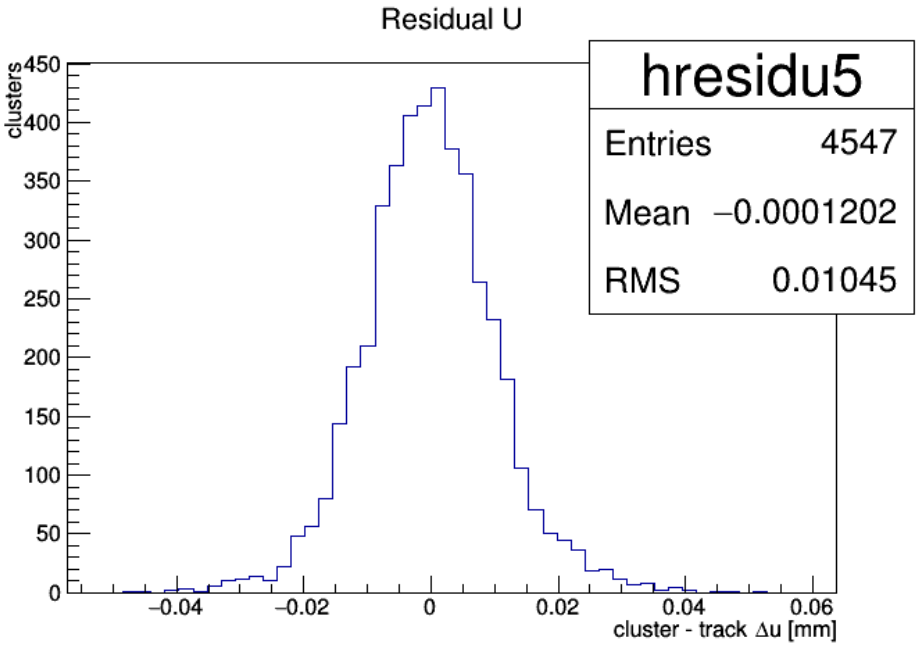
→ U RMS = 10.5um

→ V RMS = 24.8um

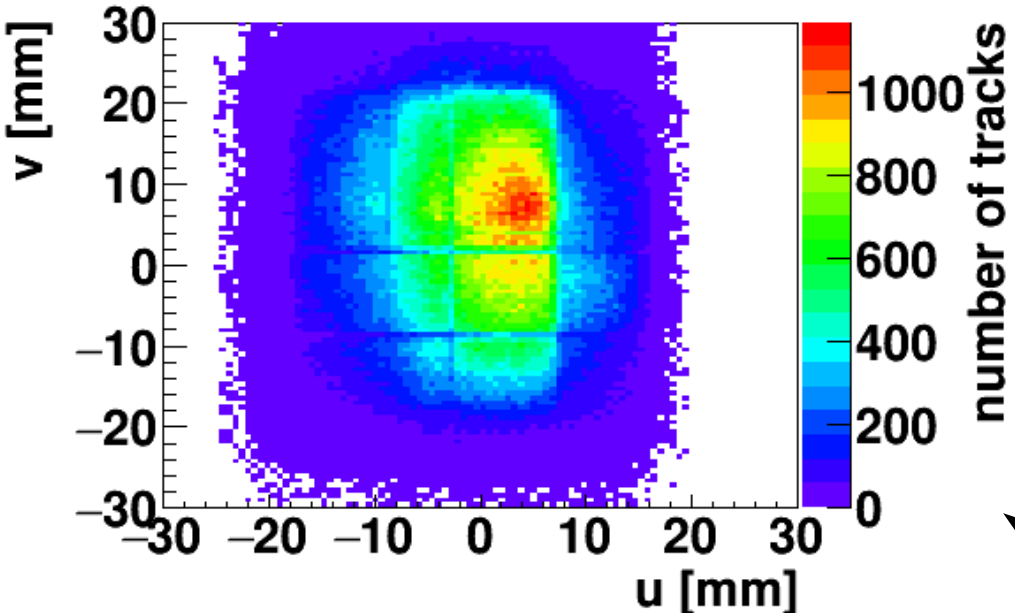
:- Compatible with pitch/2*sqrt(12)

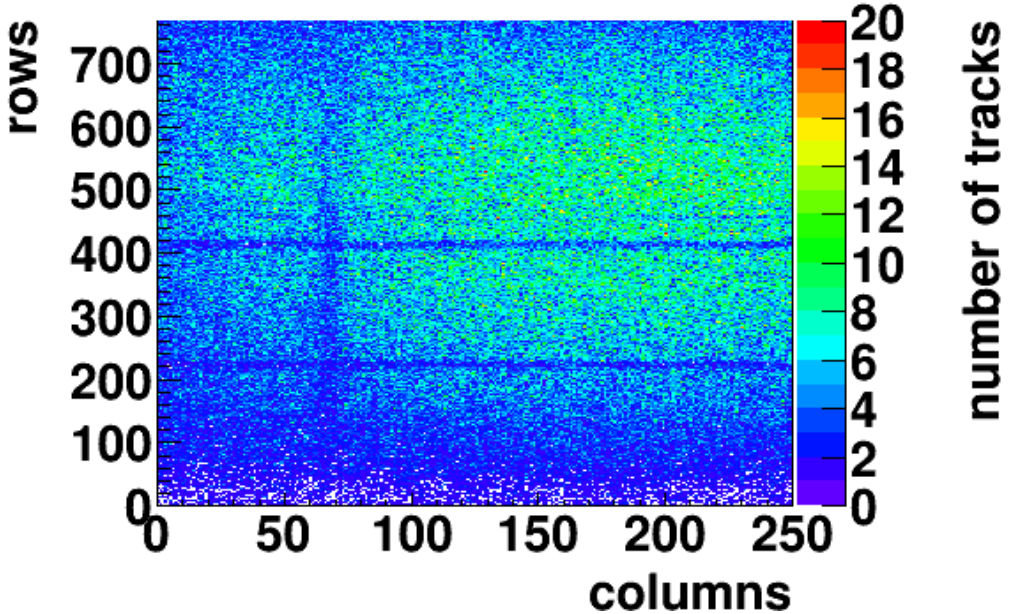
:- The pitch/2 part is because of the intermediate strips.





The PXD hit efficiency puzzle





:- Still looking at golden run 96

→ first 540k events

→ ~1.4Mio tracks in SVD alone with >3 hits

→ ~123k tracks extrapolated close to hit on PXD-IB

→ close == residual <0.4mm)

Hitmaps of SVD tracks on PXD-IB (1.1.2)

Blue (inefficient) stripes in beam spot originate from masked channels in the SVD (4.1.2, 5.1.3)

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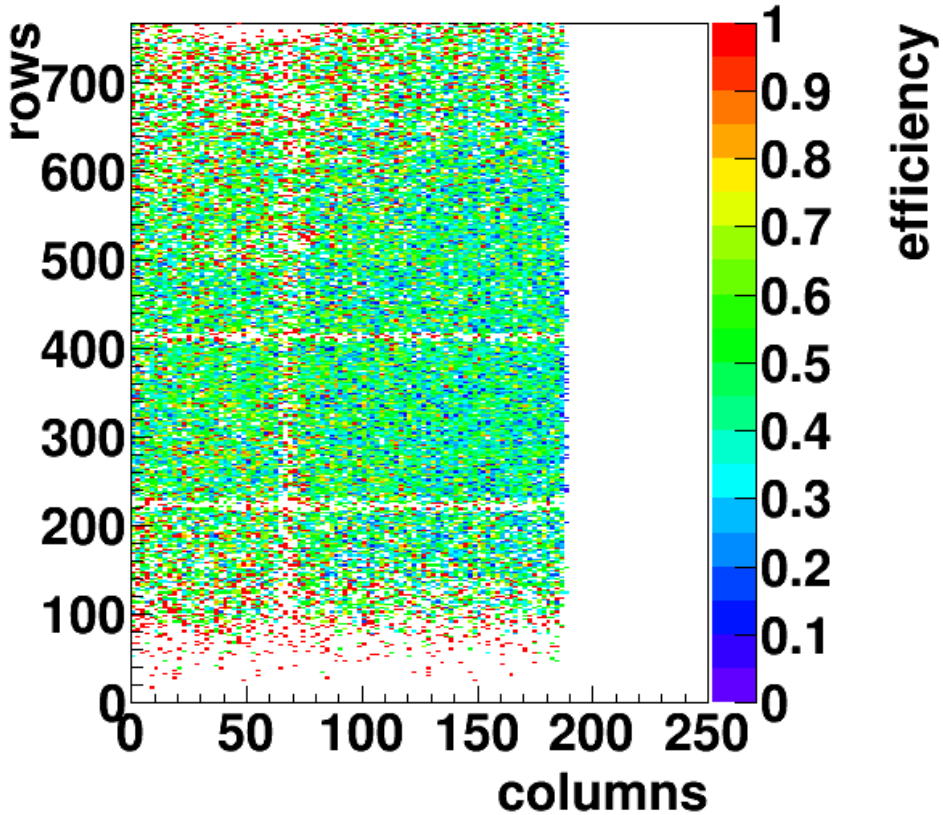


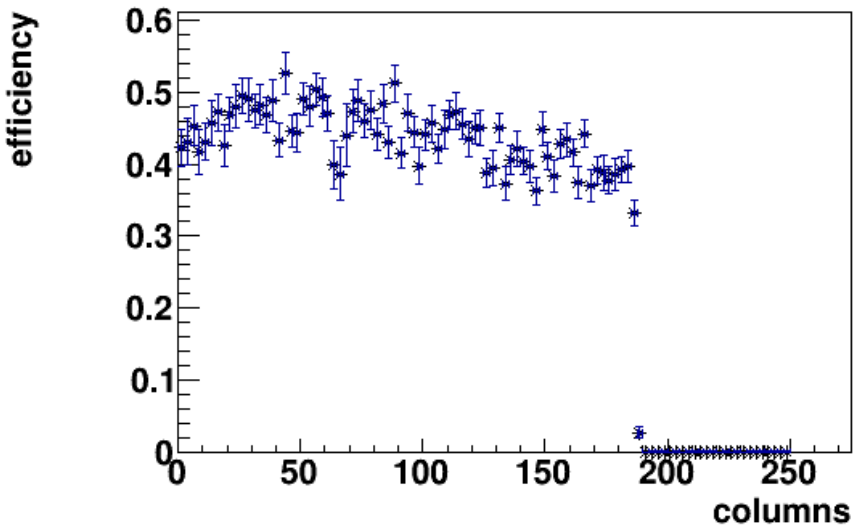
:- Estimate efficiency on PXD-IB

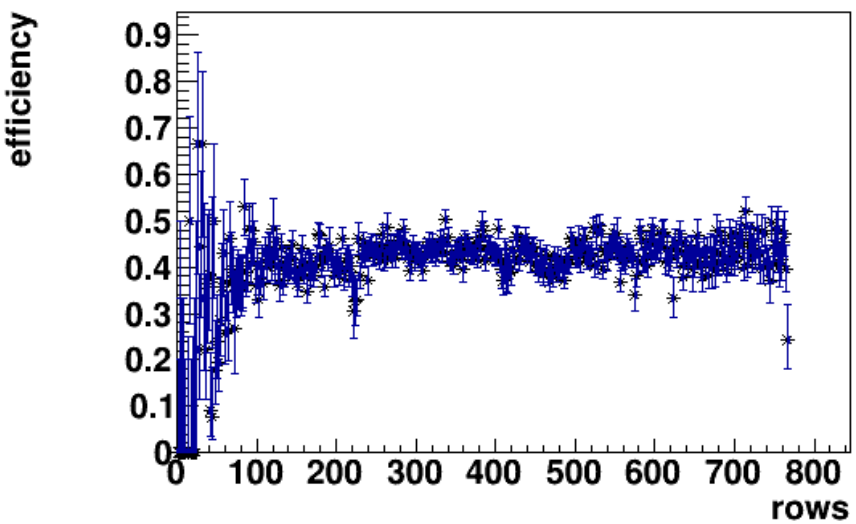
:- track sample: tracks with 3 SVD hits

:- DHP 4: link is down (no PXD data)

:- DHP 1-3: hit efficiency 45%

:- these number do not change with time (different ranges of event numbers)





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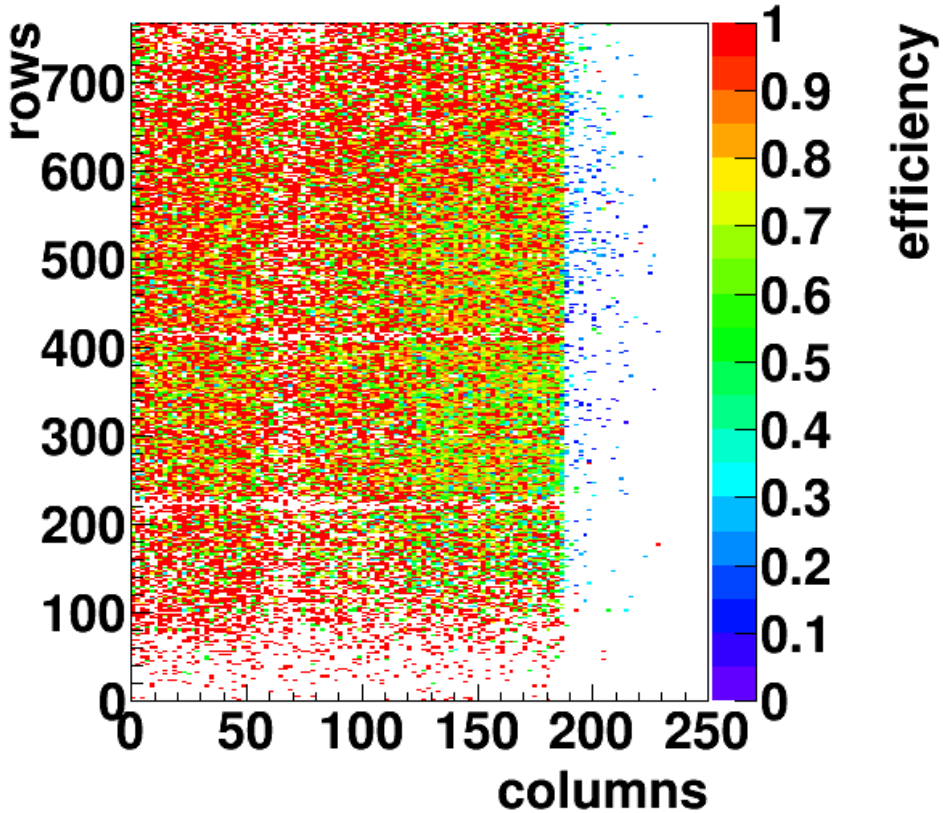


:- Estimate efficiency on PXD-IB

:- different track sample:

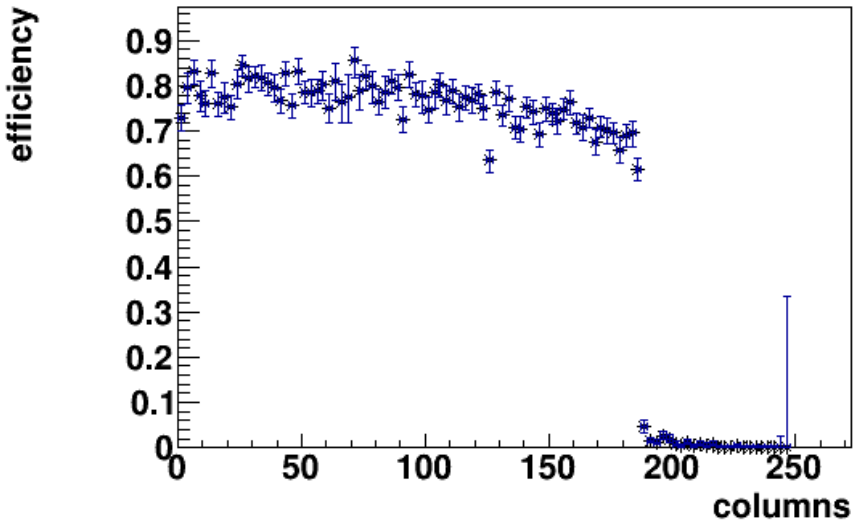
tracks with 3 SVD hits + PXD-OB hit

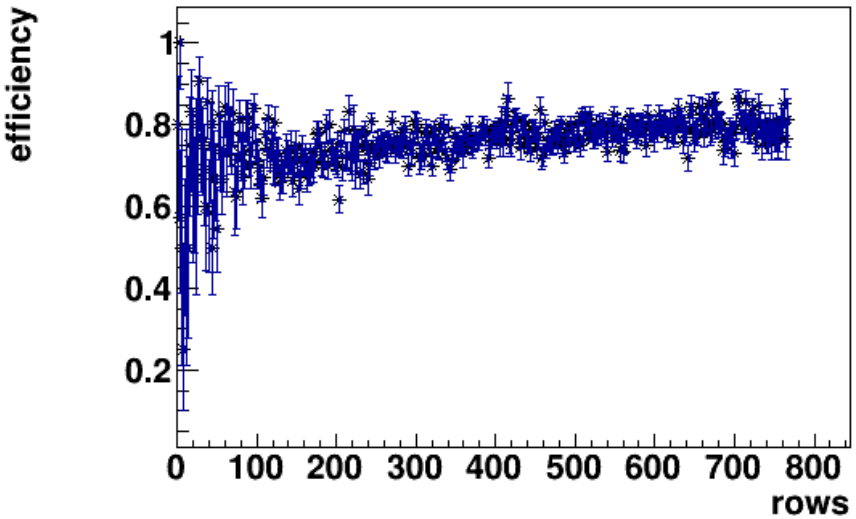
:- DHP 4: link is down (no data)

:- DHP 1-3: efficiency ~80%

:- inclusion of hit PXD-OB doubles the efficiency

:- reason: sensor? trigger delays? data loss in DAQ? soft electrons/positrons?





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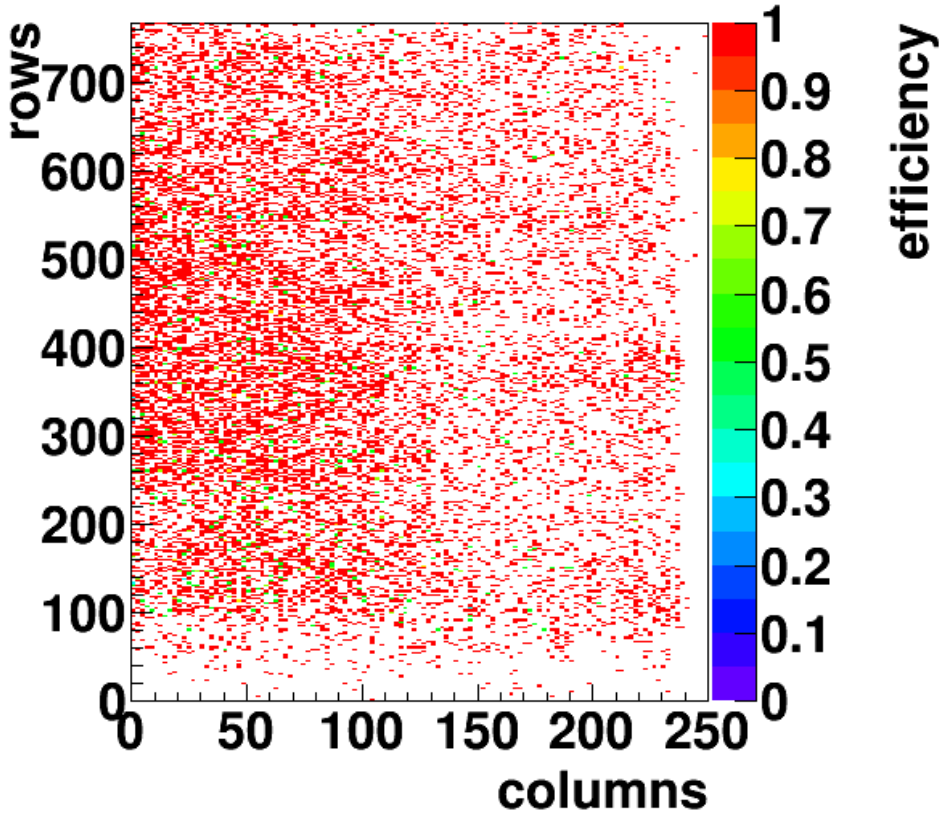
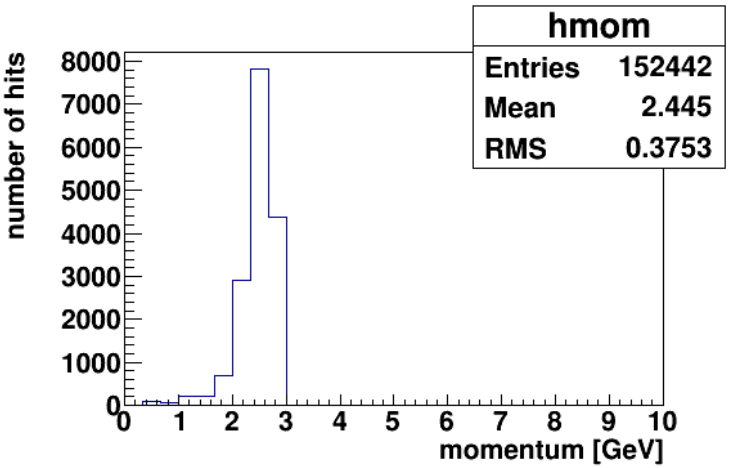
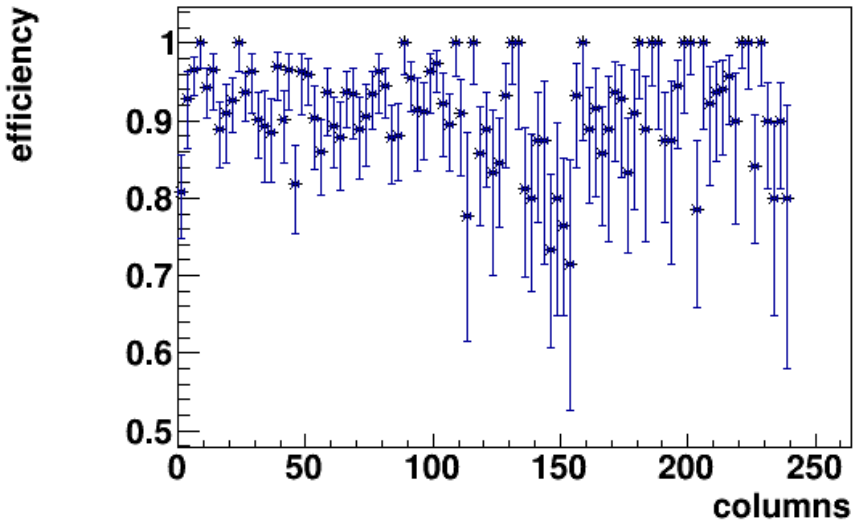


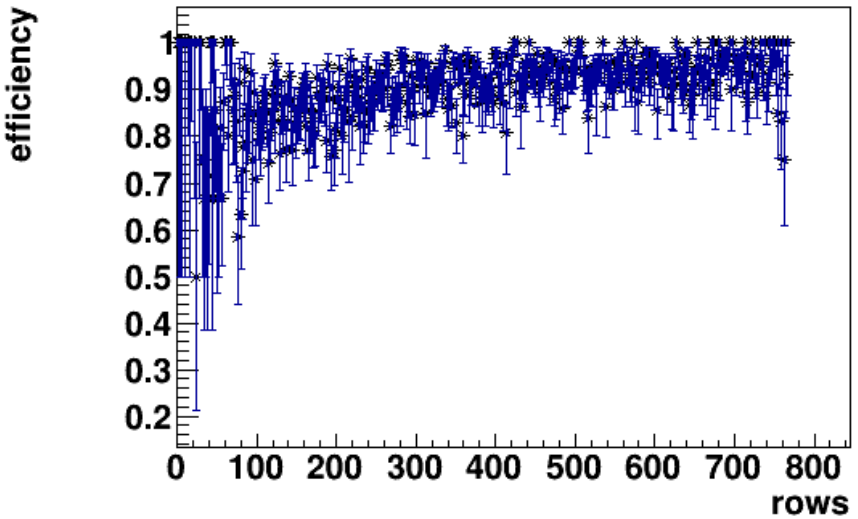
:- Efficiency on PXD-IB **run 128**

:- 0.4T , 2GeV beam, aligned with 12layers

:- track sample: 3x SVD hits + PXD-OB hit







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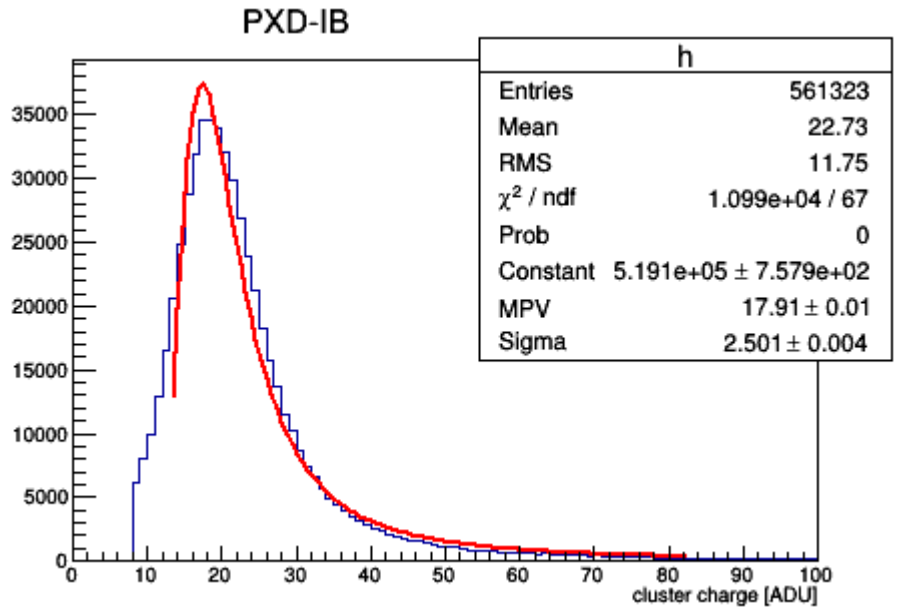
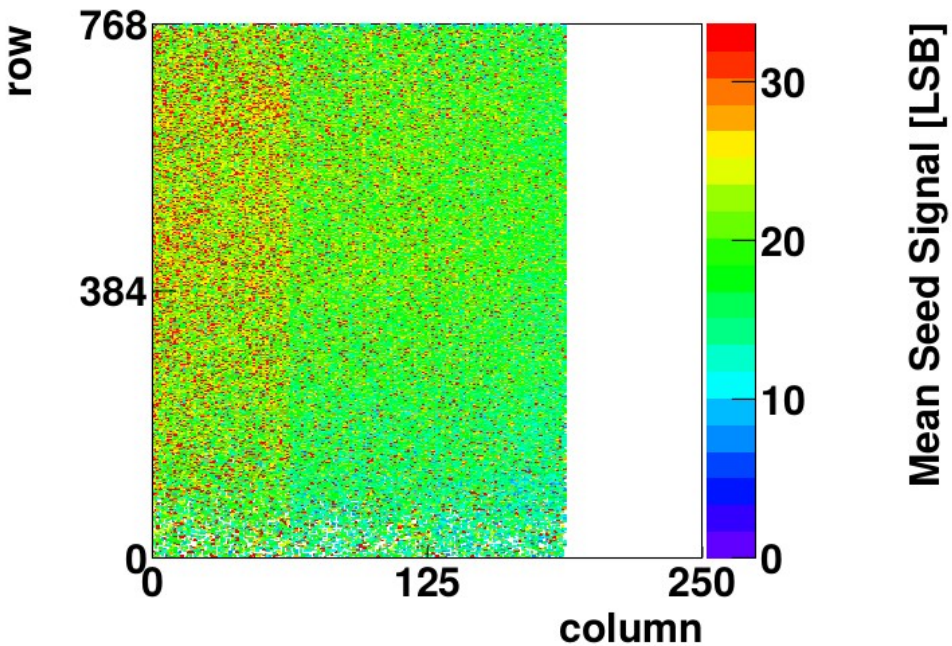
Response form PXD-IB





:- Looking at the hit data there is no reason tor bad efficiency (<80%)

:- Cluster Charge MPV ~18ADU

:- Noise probably below ~1LSB (see Harrison's talk)

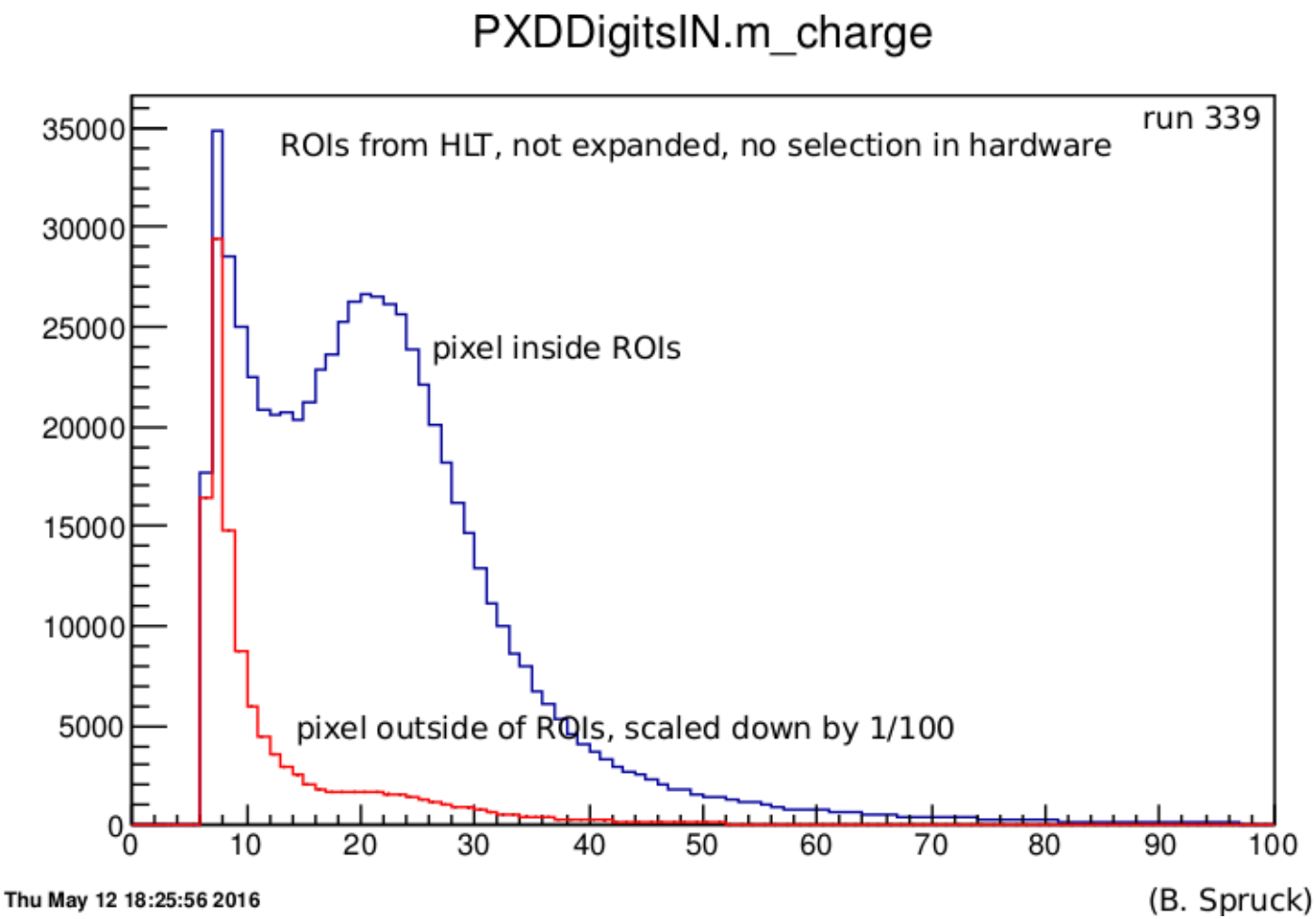
→ S/N is fine

:- The response from matrix is rather uniform even w/o much tuning ;)

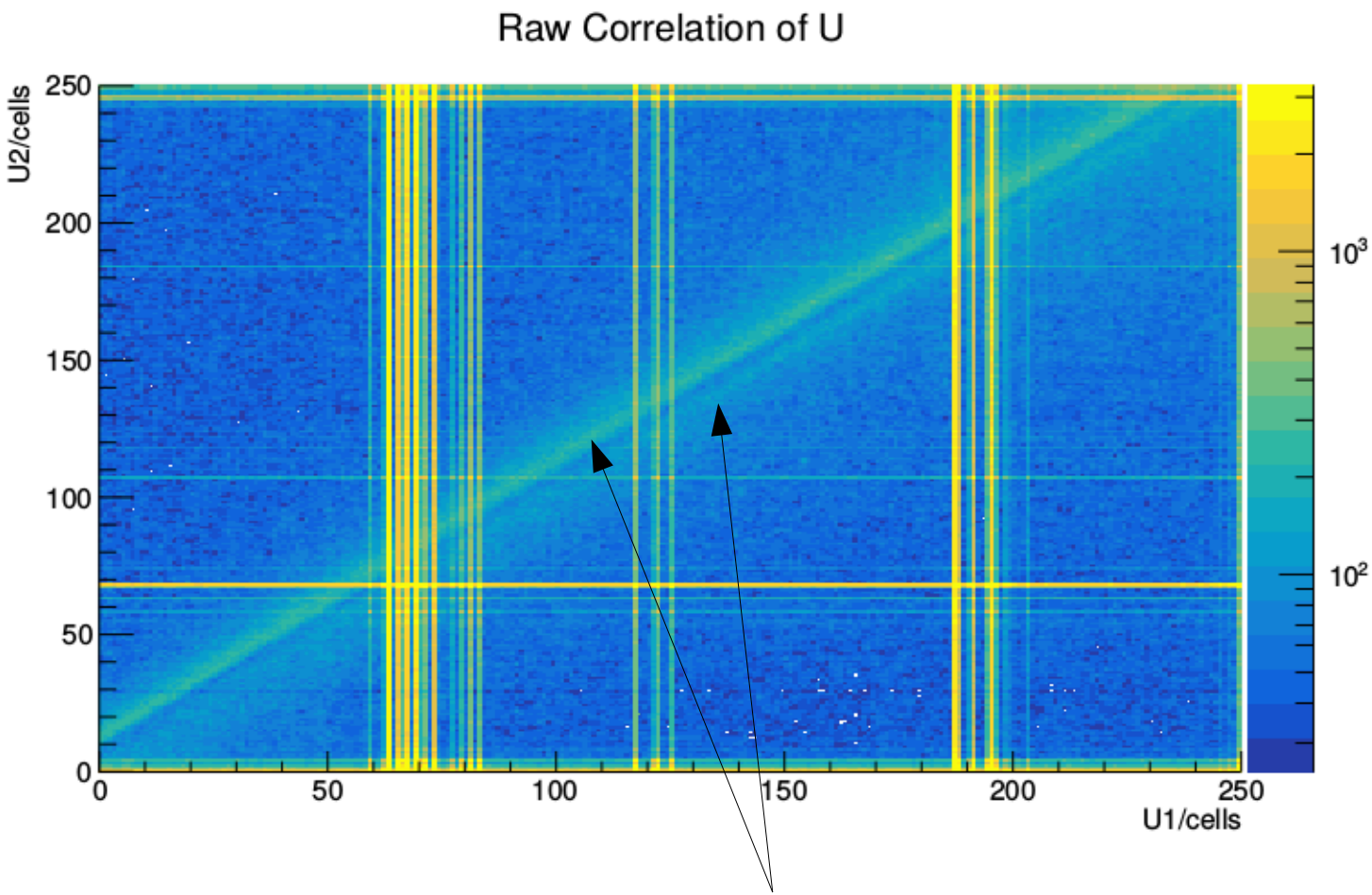
:- apart from link problems >95% of pixels give response.

[Low gain mode: 130nA pro ADU]
[GateOn not very aggressive (-2V)]

Some more results on ROIs



Some results from Pb target in B field



Two correlation bands appear with small offset;
The strong one form electrons, weak one from
Positrons created in Pb target.

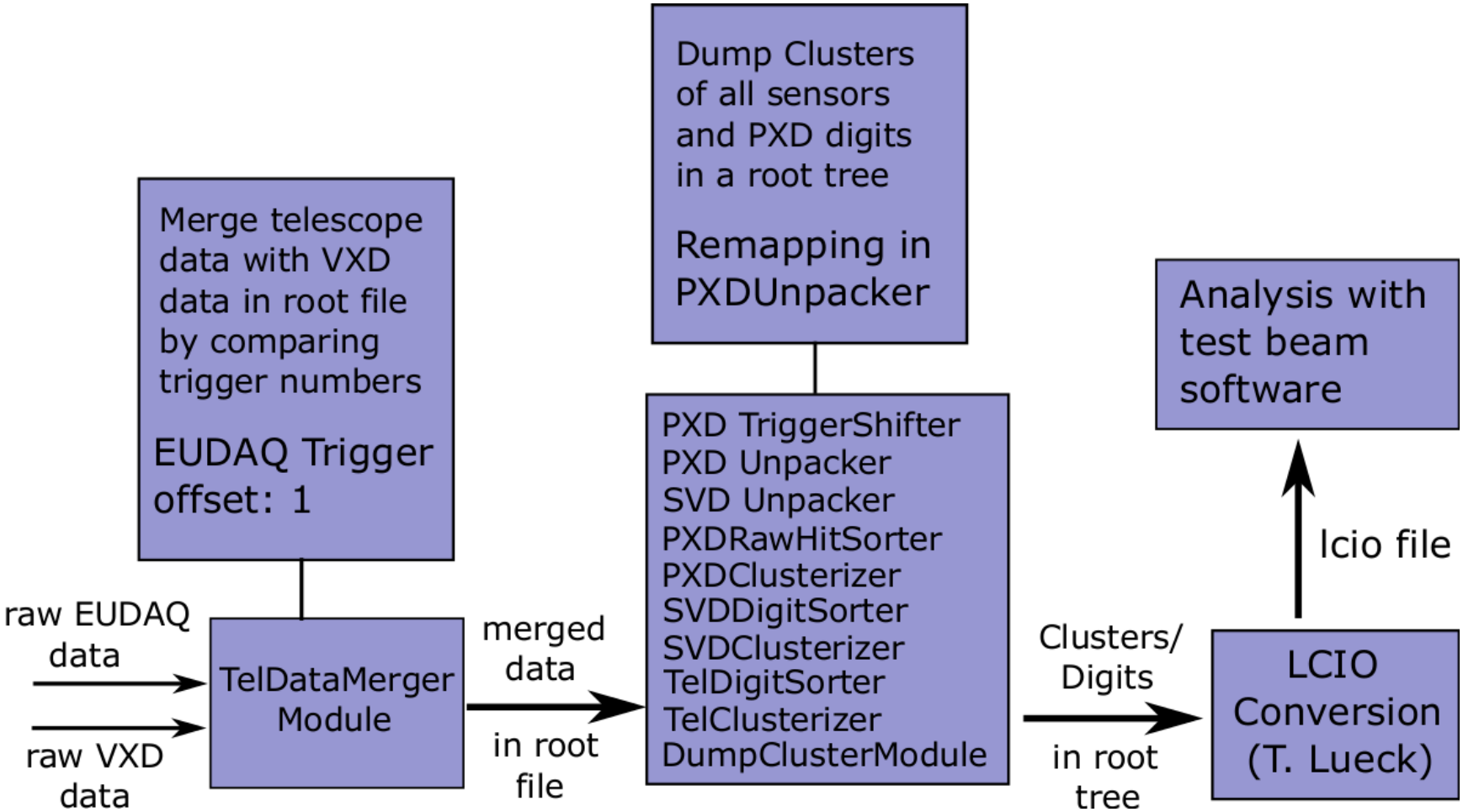
Organization of TB analysis

- Communication between interested people should be channeled over common mailing list:
  - DEPFET-TB@LISTSERV.UNI-HEIDELBERG.DE
- Data comes from different DAQs and is available at different sites
  - BonnDAQ data: available in Bonn; no ONSEN processing; there is a input module and unpacker for basf2
  - Telescope data: available from Prague servers; merger module available in basf2
  - PocketDAQ data (root and sroot files): available from Prague servers
- The electronic logbook (elog) hosted at DESY gives a first hint where to look
  - https://www-h1.desy.de/belle2elog/
- However, the elog is incomplete (many runs missing) and run entries not always correct.
  - Many reasons for that …
  - But clear need for common place to collect correct information for runs relevant to analysis groups.
  - Google spreadsheets proved to be good platform.
- To speed up analysis, we should organize more or less regular video meetings among all interested groups.
  - MPP, Pisa, Prague, Göttingen, Giessen, Mainz, Bonn, …
  - And make sure all important topics are covered by at least one group.

Summary & conclusion

- Analysis of test beam data in full swing at different sites (see also Zdenek's talk)
- Performance of our PXD modules seems quite satisfactory
  - Modules just worked using operating parameters from other beam and lab tests.
  - There is lot of headroom for improvements with better optimization of voltages and ASICs.

- Some open questions for hardware experts:
  - Finalization of re-mapping
  - Documentation of re-mapping and data formats in software and as Belle 2 note; request from software group.
  - Efficiency puzzle: Efficiency for finding a PXD hit from extrapolating a SVD track is ~50%.
  - Need for a DQM module to monitor (count) errors detected during the unpacking of data in express reco.


Merge telescope data with VXD data in root file by comparing trigger numbers
EUDAQ Trigger offset: 1
raw EUDAQ data
raw VXD data
TelDataMerger Module
merged data
in root file
Dump Clusters of all sensors and PXD digits in a root tree
Remapping in PXDUnpacker
PXD TriggerShifter
PXD Unpacker
SVD Unpacker
PXDRawHitSorter
PXDClusterizer
SVDDigitSorter
SVDClusterizer
TelDigitSorter
TelClusterizer
DumpClusterModule
Clusters/ Digits
in root tree
LCIO Conversion (T. Lueck)
lcio file
Analysis with test beam software