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Preliminary SVD Testbeam results

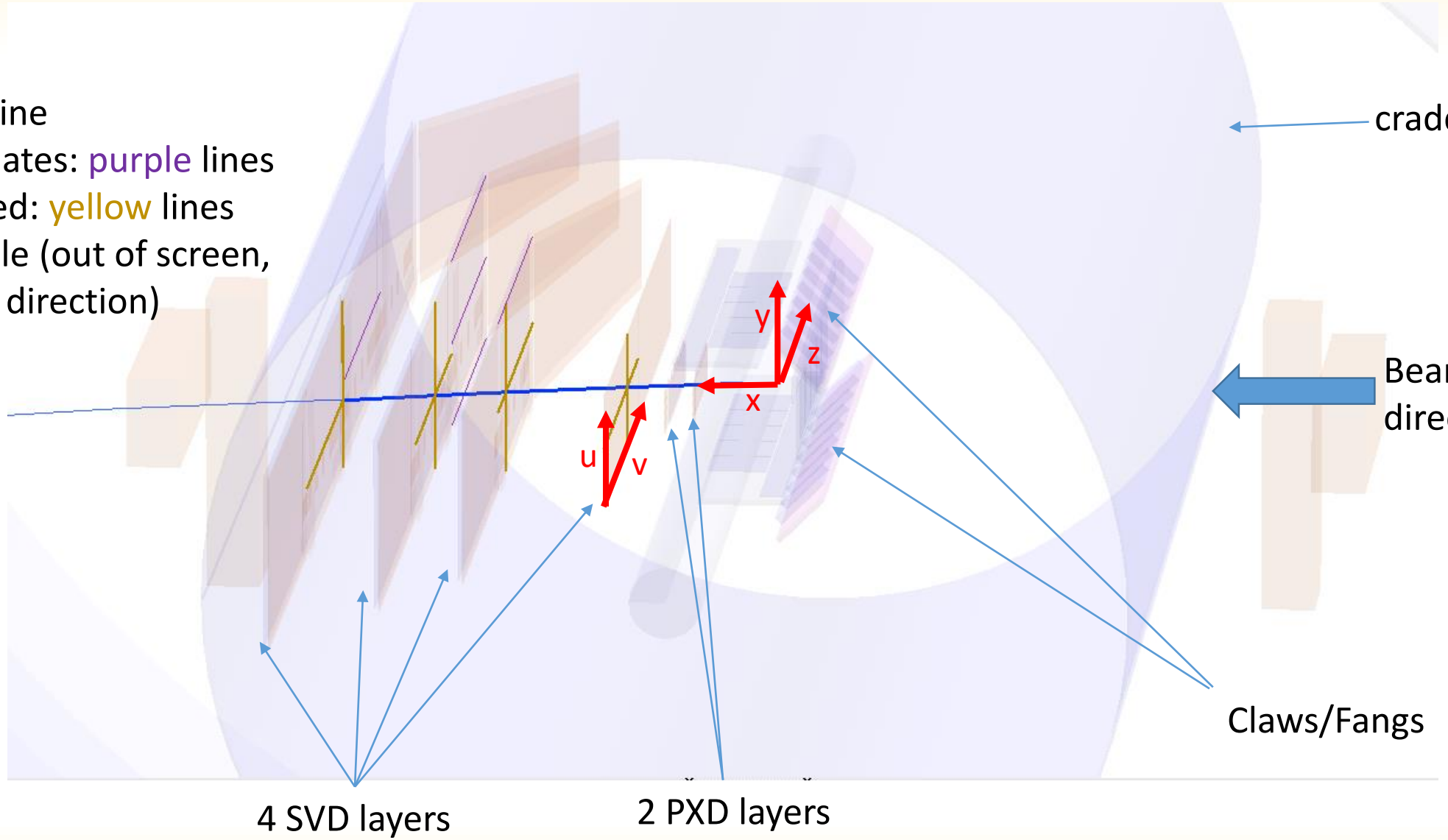
Seventh Belle II - Italia meeting
5 May 2017

Purpose of DESY Testbeam – February 2017

- Test performances of VXD modules
  - PXD: read 2 sensors for each layer
  - SVD: read 2 sensors for each layer (L4: CE, SBW L5, L6: CE, -Z)
  - Redout, slow control, stability, efficiency
- Full DAQ chain of Belle II
  - Test of HLT
  - 4-layers tracking with redesigned Track Finder (VXDTF2)
- Collect data in different conditions (beam energy, angle of incidence, magnetic field)

Testbeam setup (Event Display)

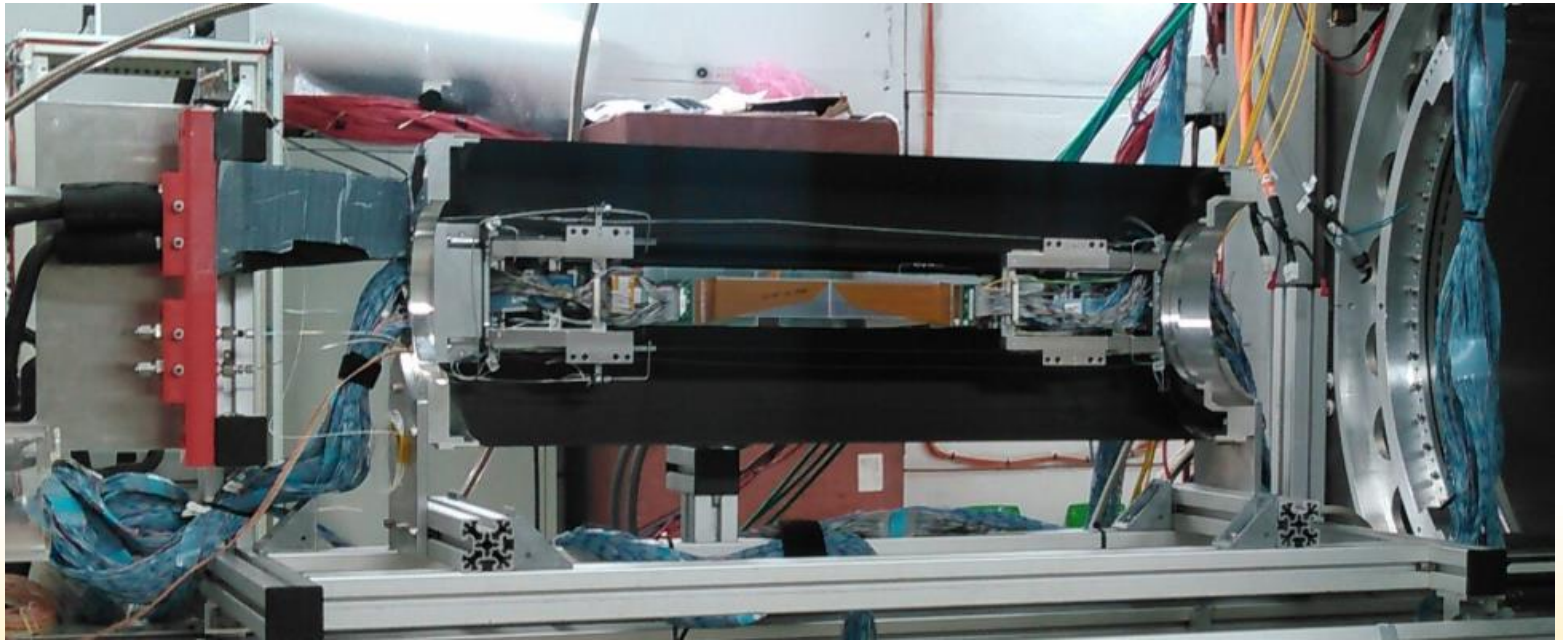
- Reco Track: blue line
- Strip/pixel candidates: purple lines
- Strip/pixel selected: yellow lines
- Magnet: not visible (out of screen, solenoid // beam direction)



Track Finder:
Used VXDTF1 in first runs and VXDTF2 in second part

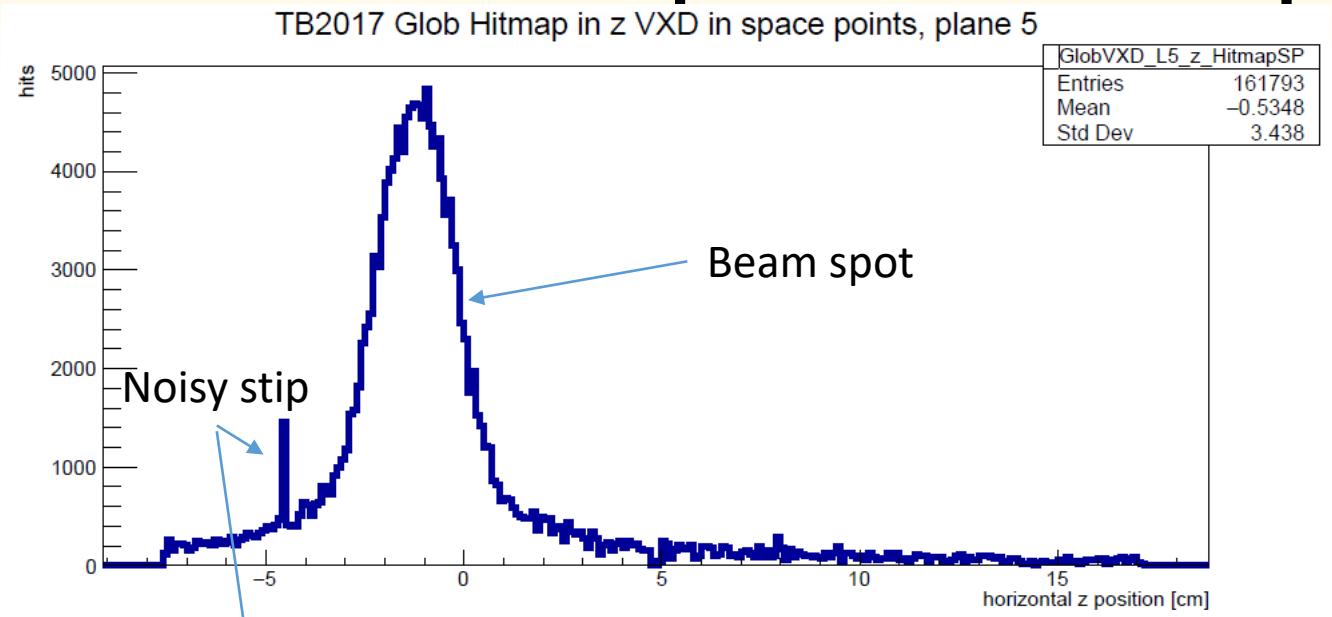
Testbeam in numbers

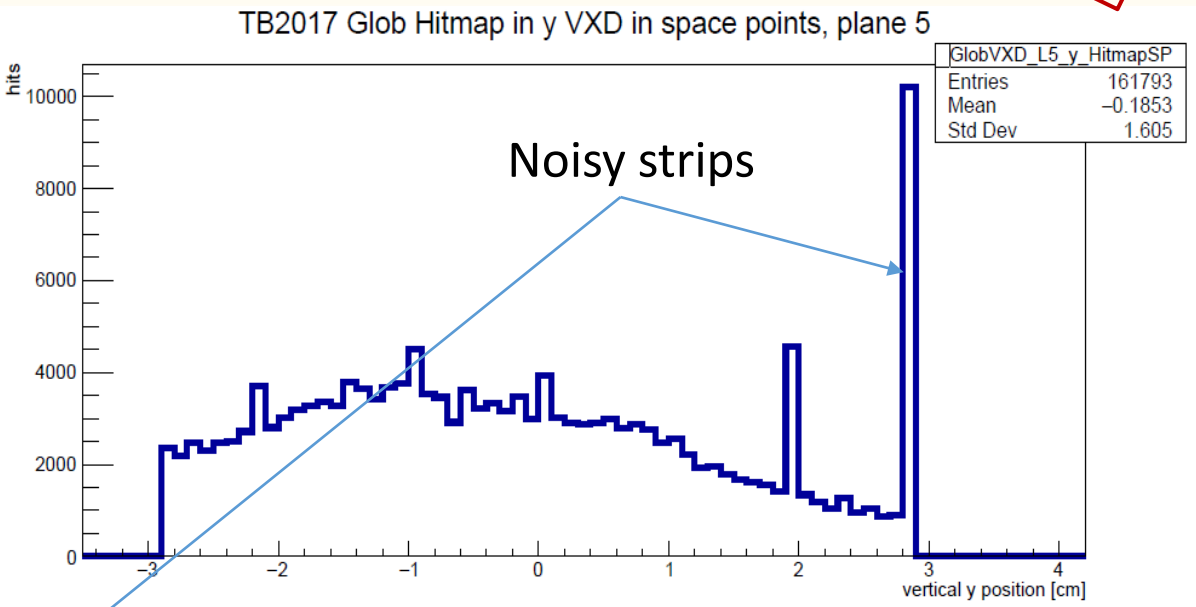
- 300 runs, about 320 millions events in total
  - 170 runs with VXDTF
  - 130 runs with VXDTF2
- Span of beam energy between 1 GeV and 5 GeV
- Span of Magnetic field between 0.25 T and 1.0 T
- Span of incidence angle between -5 and +25 degrees
- VXD temperature: -15 °C

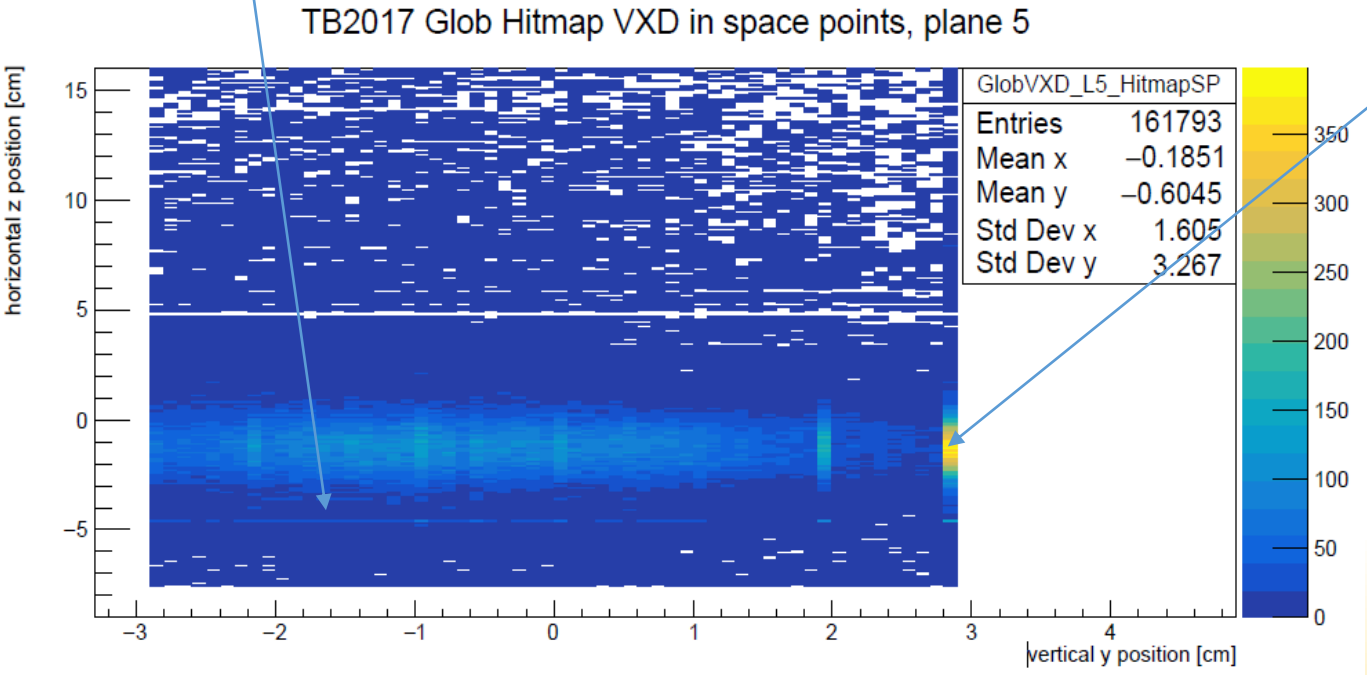


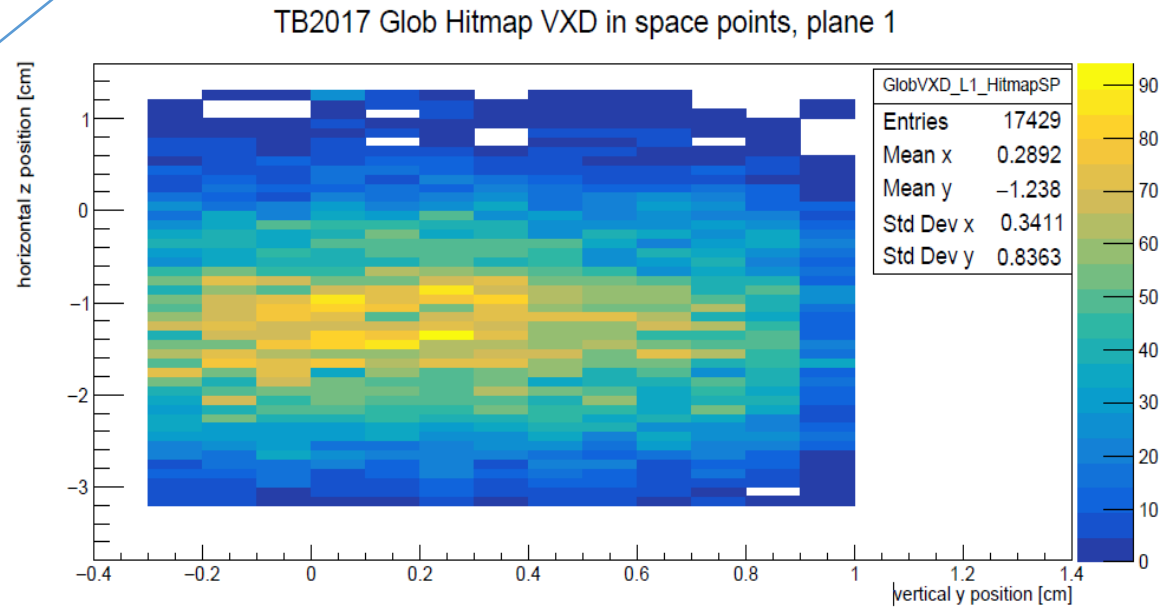
Validation plots – hitmaps

VXDTF2





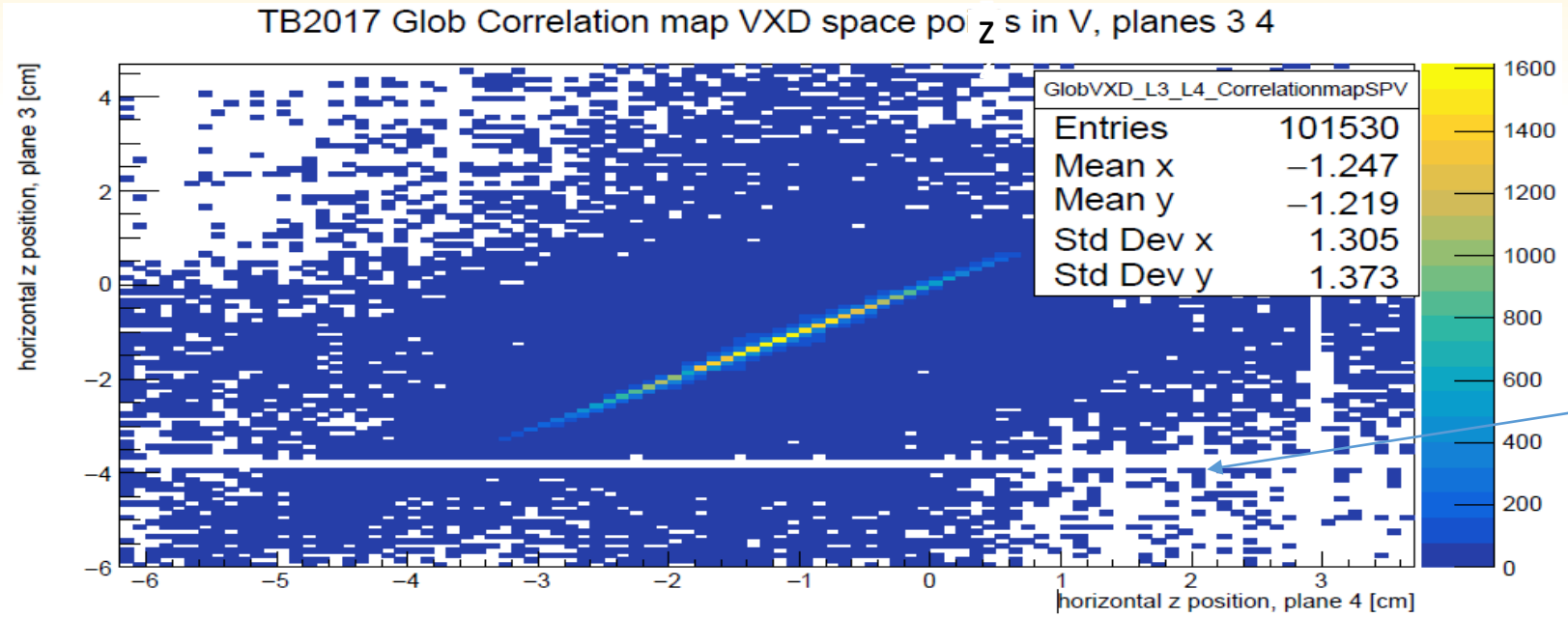




Validation plots - correlation

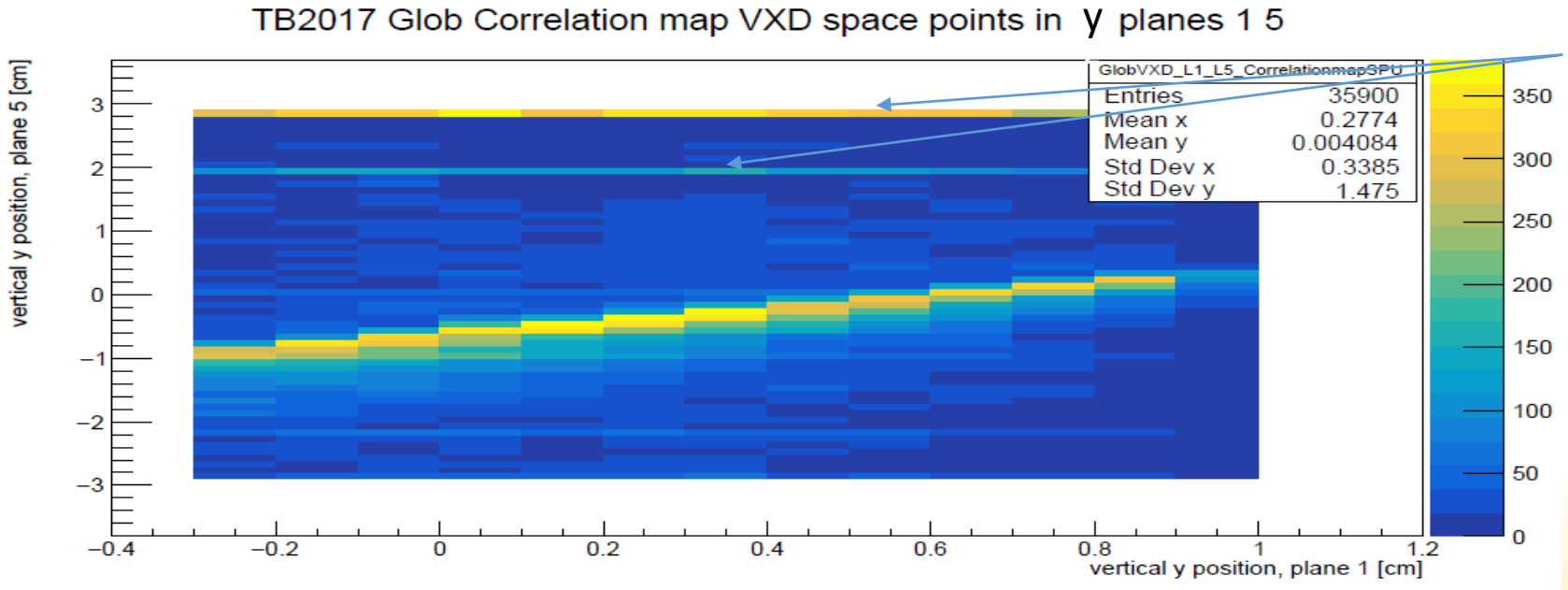
VXDTF2

Consecutive layers:



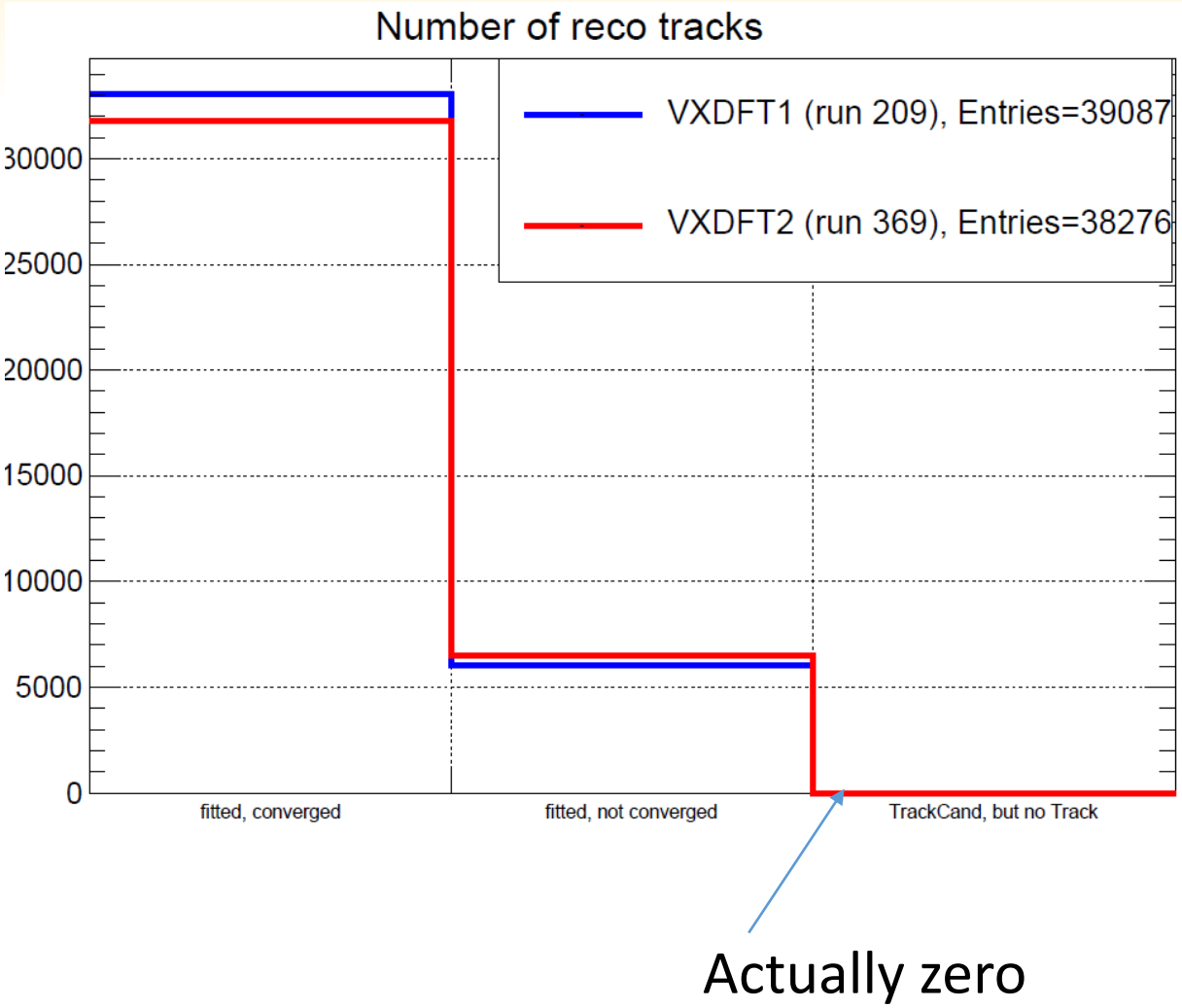
Different sensor effect

Far layers:



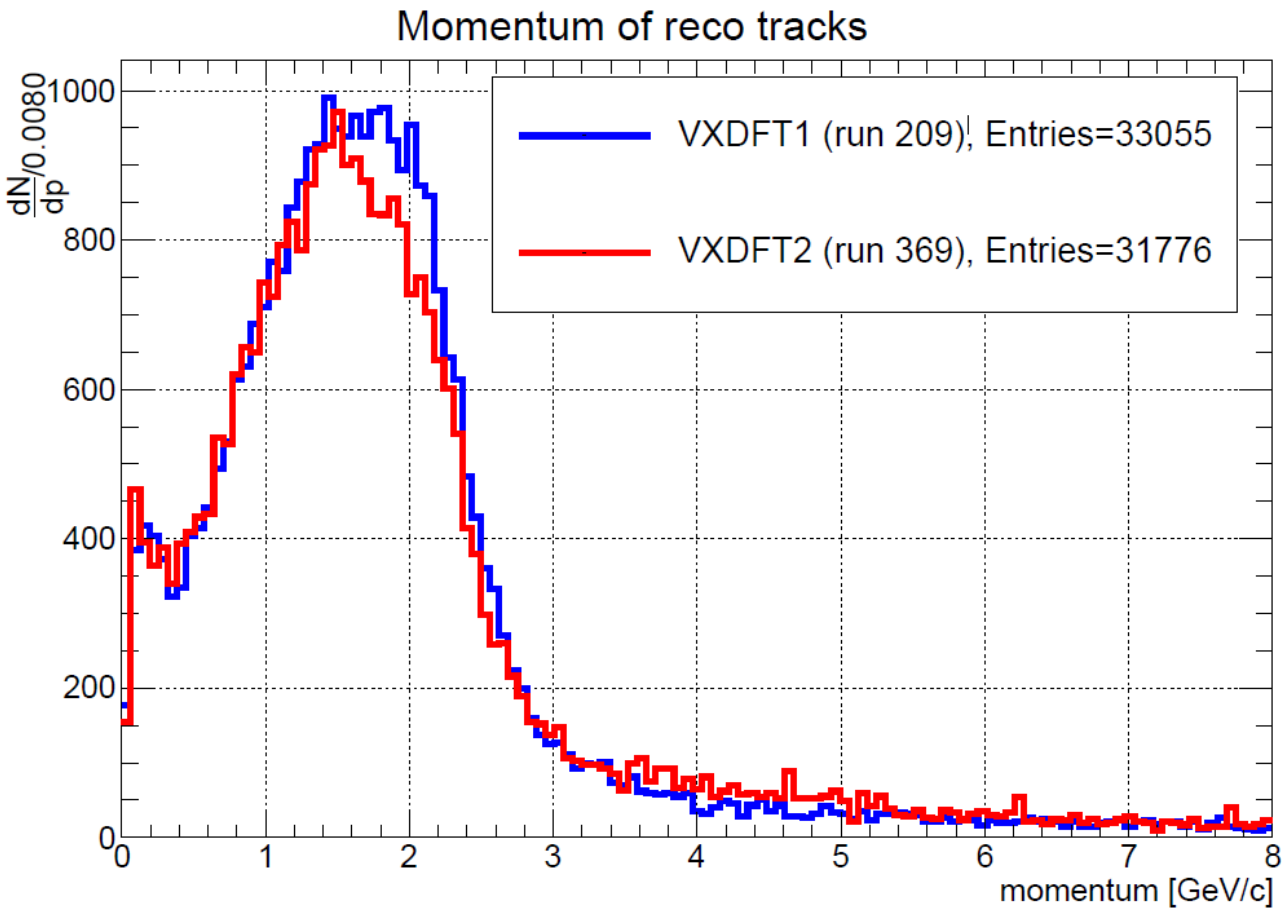
Noisy strip effect

Validation plots – VXDTF1 vs VXDTF2 (online tracking)



Actually zero

Different runs at
same beam energy

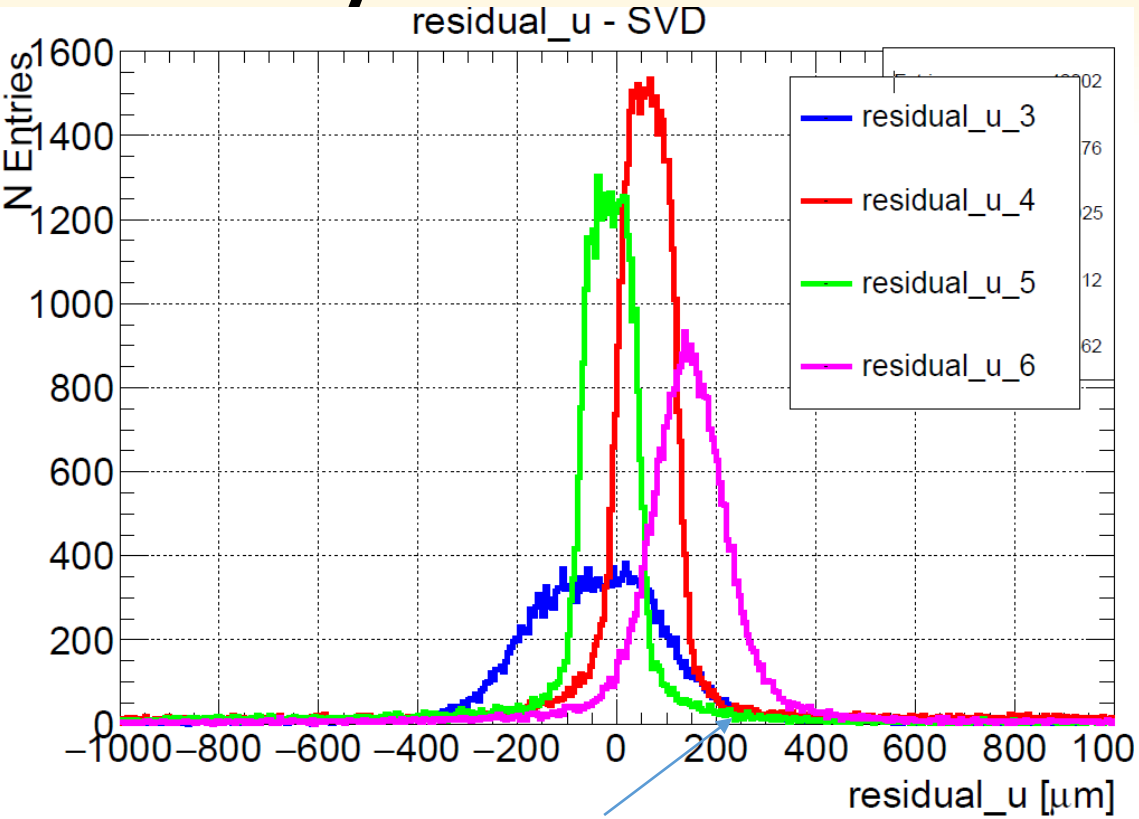


Current state – Hit Efficiency: strategy

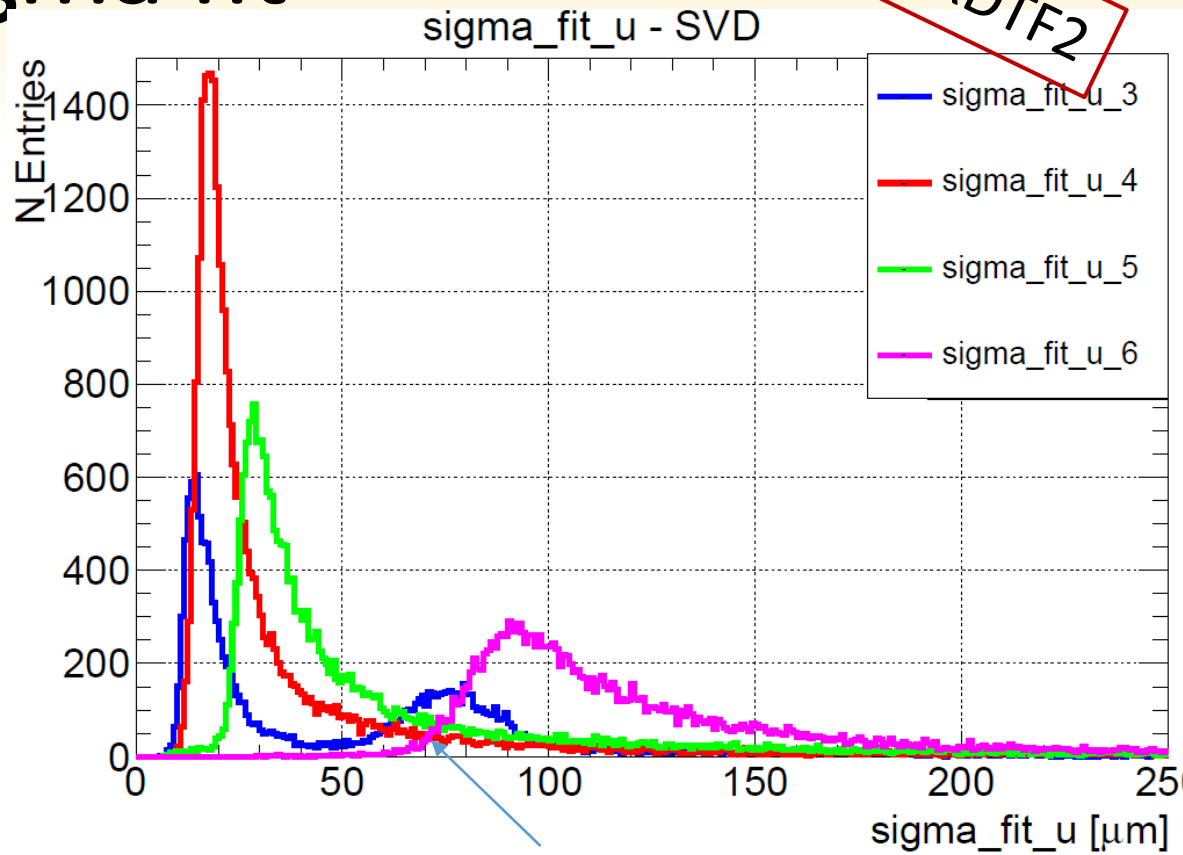
- Select a layer and remove it from tracking (training sectormaps too)
- Perform tracking on others layers ⟹ reco tracks obtained
- For each strips of selected layer evaluate some quality distributions:
  - Momentum (based only on reco tracks)
  - pValue (based only on reco tracks)
  - Errors on fit position (based only on reco tracks)
  - Residual: $\mathcal{R} = x_{layer} - x_{fit}$ with x_{layer} = measured position on selected layer
    x_{fit} =extrapolated position on selected layer
- Make cuts on quality distribution (different layer by layer and for u-v distributions)
- Evaluate efficiency (for each strips) as: $1 - \varepsilon = \frac{N_{\text{hit extrapolated}} - N_{\text{hit present}}}{N_{\text{hit extrapolated}}} + N_{\text{bkg norm}}$ in region defined by cuts if
- If $\Delta N \equiv N_{h.extrap.} - N_{h.pres} = 0 \Rightarrow \Delta N \equiv 0.7$ upper limit of mean (CL 90%) of a poisson distribution for zero observed events (so If I observe 0 events at 90% the mean is uder 0.7)

Quality cuts – Residuals & sigma fit

VXDTF2



Visible unalignment



2 population of tracks?

```
min_res_L3   -500
min_res_L4   -200
min_res_L5   -400
min_res_L6   -200

max_res_L3   200
max_res_L4   400
max_res_L5   200
max_res_L6   500
```

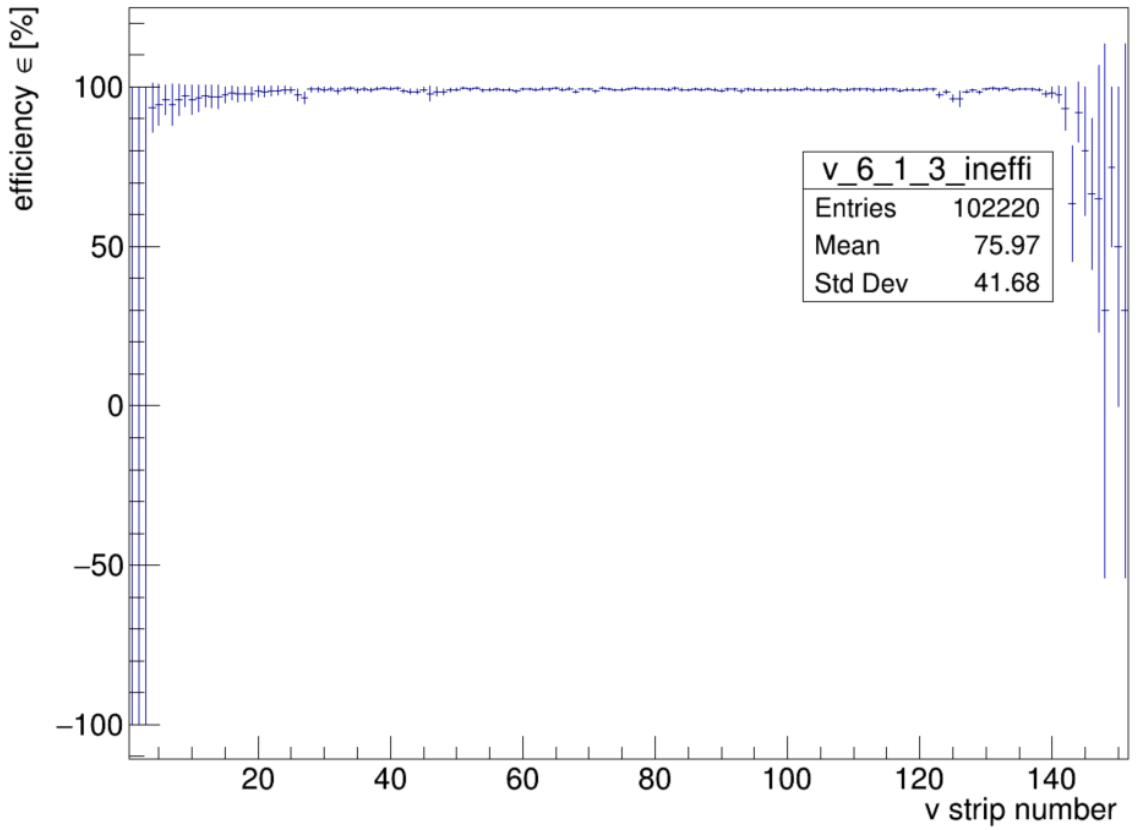
```
sigma_fit_u_cut_L3   50
sigma_fit_u_cut_L4   100
sigma_fit_u_cut_L5   100
sigma_fit_u_cut_L6   220

sigma_fit_v_cut_L3   70
sigma_fit_v_cut_L4   80
sigma_fit_v_cut_L5   80
sigma_fit_v_cut_L6   130
```

Hit Efficiency – results (examples)

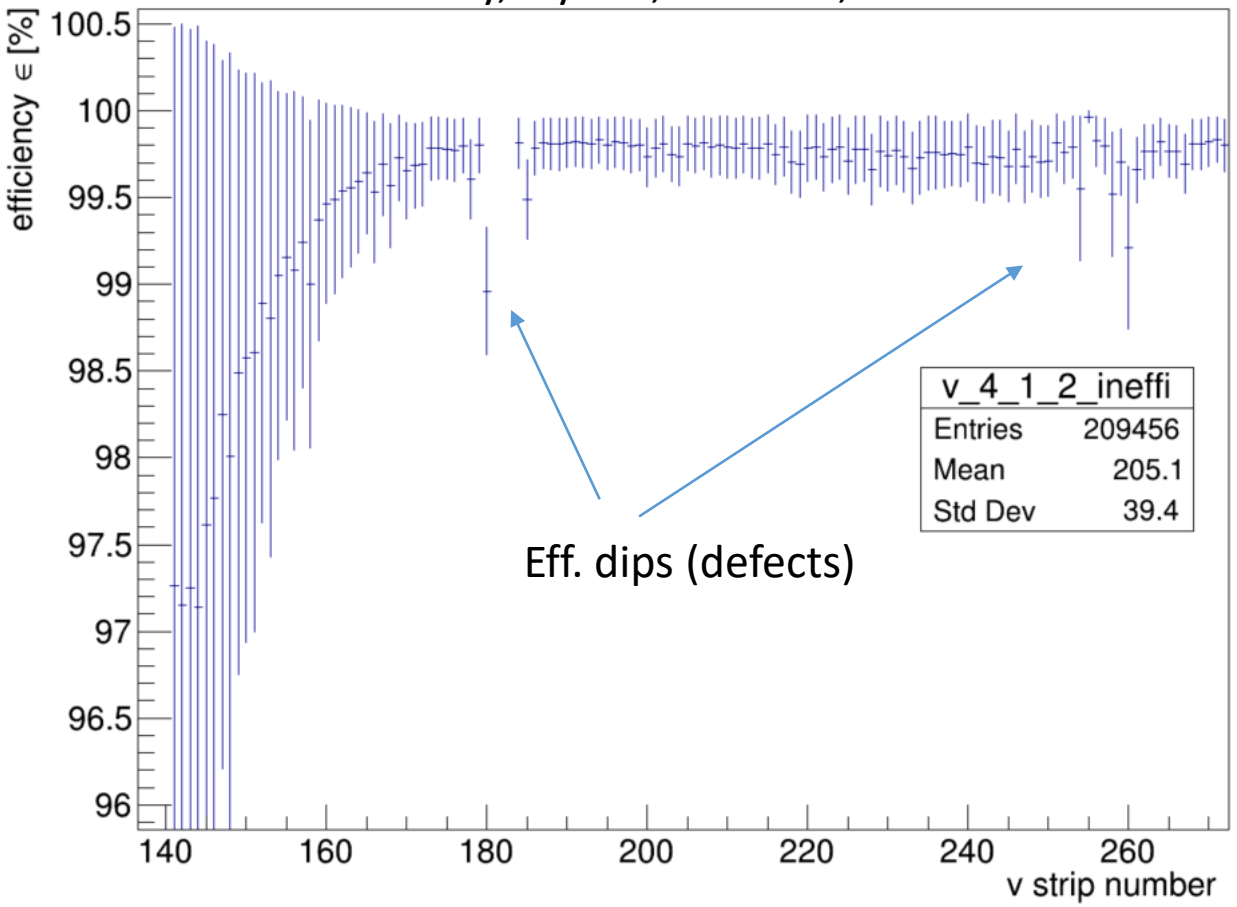
650k events (run 399, preliminary)

VXDTF2

Efficiency, layer 6, sensor 3, v-side



Efficiency, layer 4, sensor 2, v-side



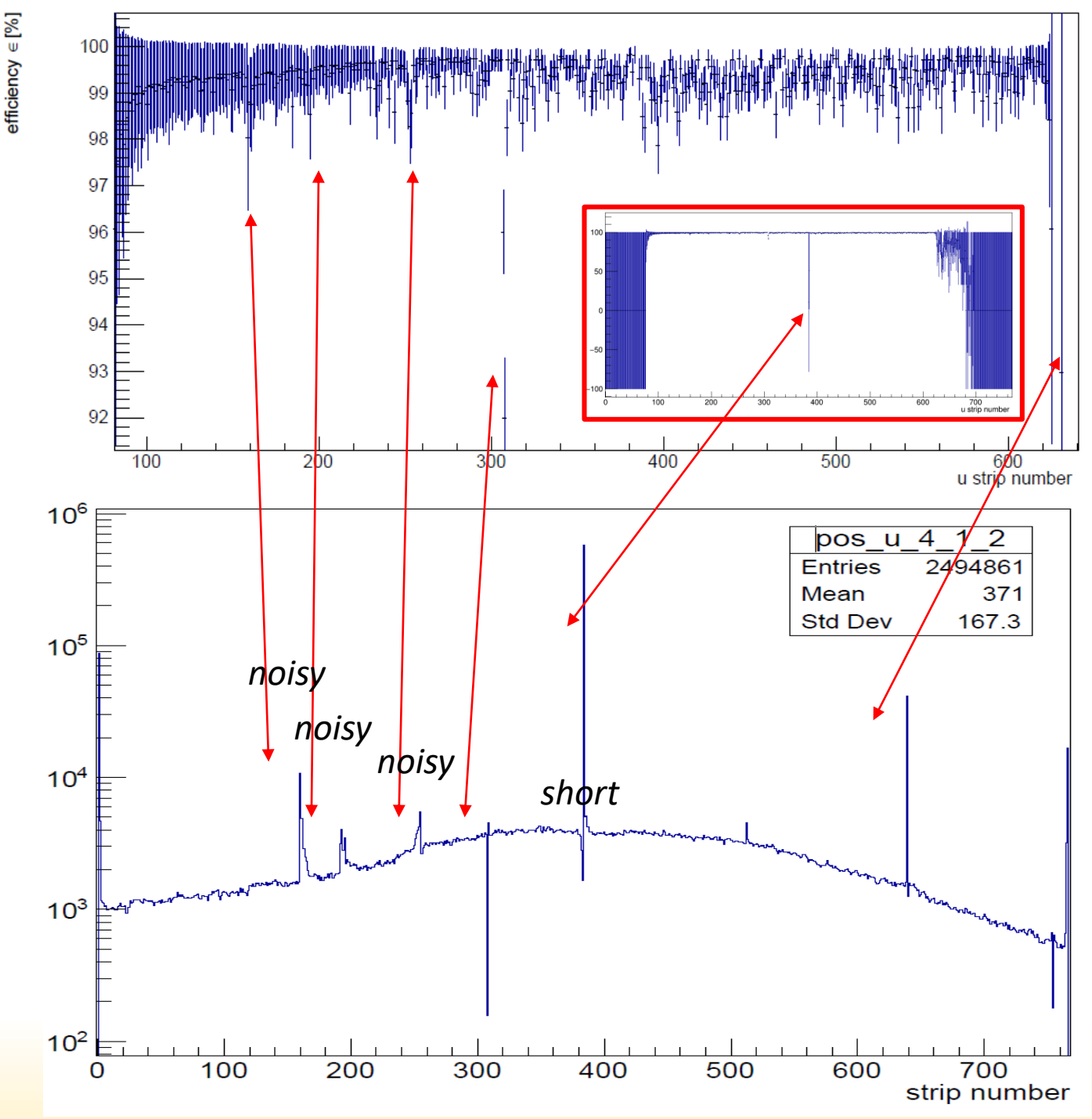
Hit Efficiency - dips

VXDTF2

Hit Efficiency,
Layer 4, sensor 2, u-side

- Dips in efficiency coherent with noisy strips or other defects of sensor
- Most of defect observed in hitpmap are alredy known on Hephy DB (*some examples shown*)

HitMap,
Layer 4, sensor 2, u-side



Track Finder Redesign test *(Pisa and KIT groups)*

VXDTF2

Why redesign?

- Main developer left
- Only on module for VXDTF: very difficult to maintain and debug

TB activity

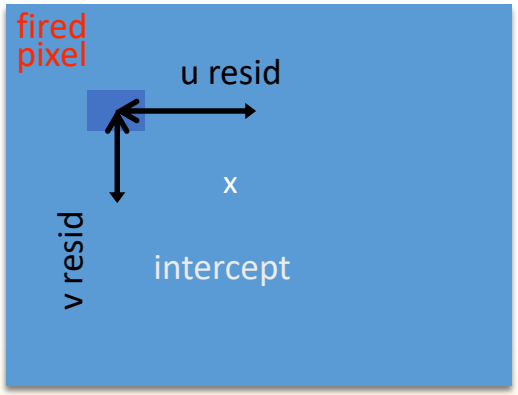
- First test on real data of VXDTF2
- VXDTF2 on HLT is able to recognize tracks, with reasonable efficiency
- Several bugs solved

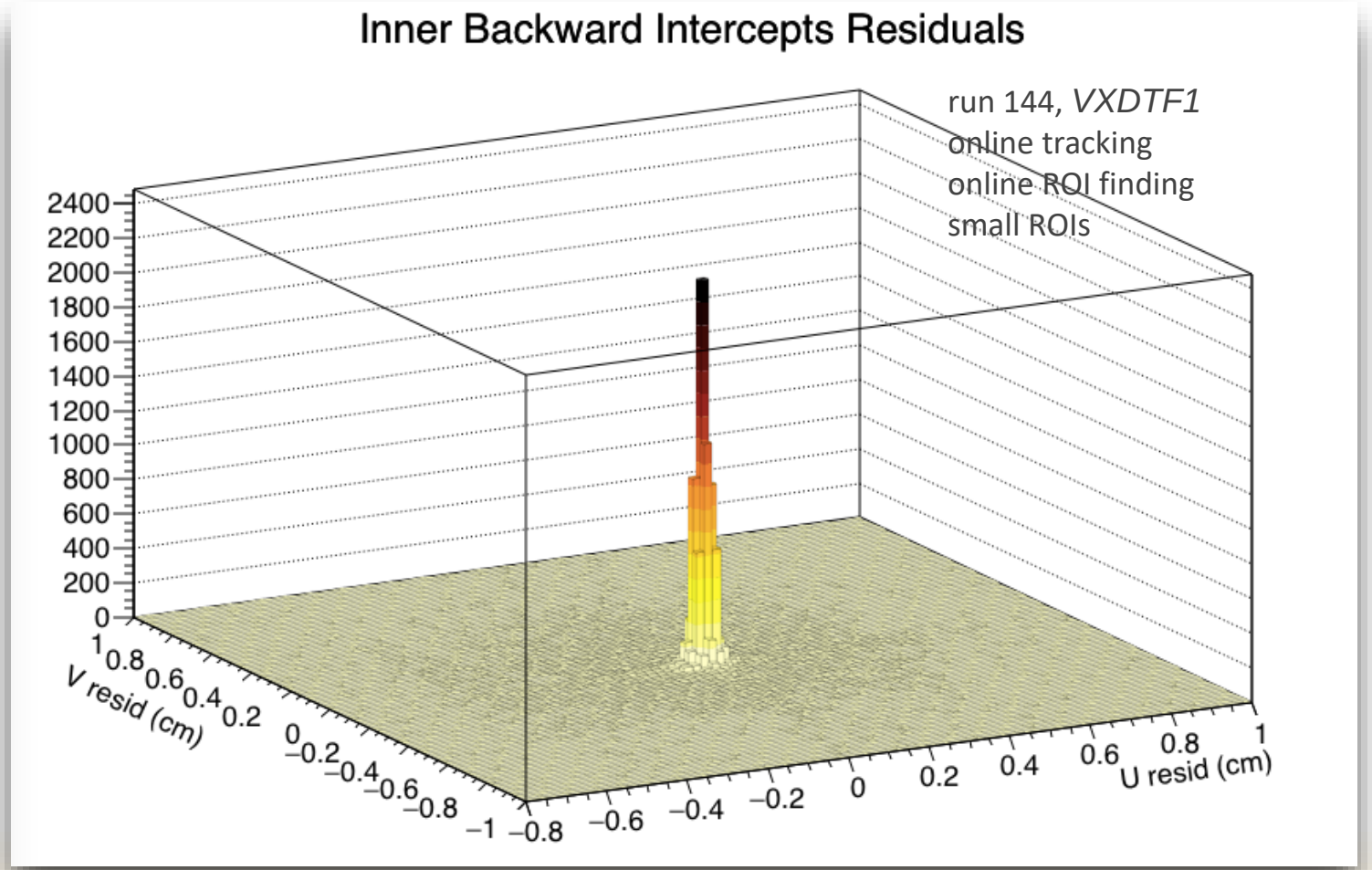
Region Of Interest of PXD (*G. Casarosa*)

- ROI Finding modules run on HLT as soon as detectors where working
- Different ROI parameters tried (full-frame ROIs, small ROIs, …): no problems encountered

- the finding algorithm was slightly changed in order to cope with different TB geometry wrt BelleII
- efficiency ~90% evaluated on simulation, not optimised

Region Of Interest





Future Plans with testbeam data

Tilted geometry:

- Repeat the hit-efficiency analysis with tilted geometry (angular span)

VXDTF2 Performance:

- Currently used VXDTF2 online but VXDTF1 offline (more stable, and hit-efficiency results should be TF-independet)
- Useful to use VXDTF2 offline: tracking efficiency, fake rate studies…

Signal to Noise Ratio

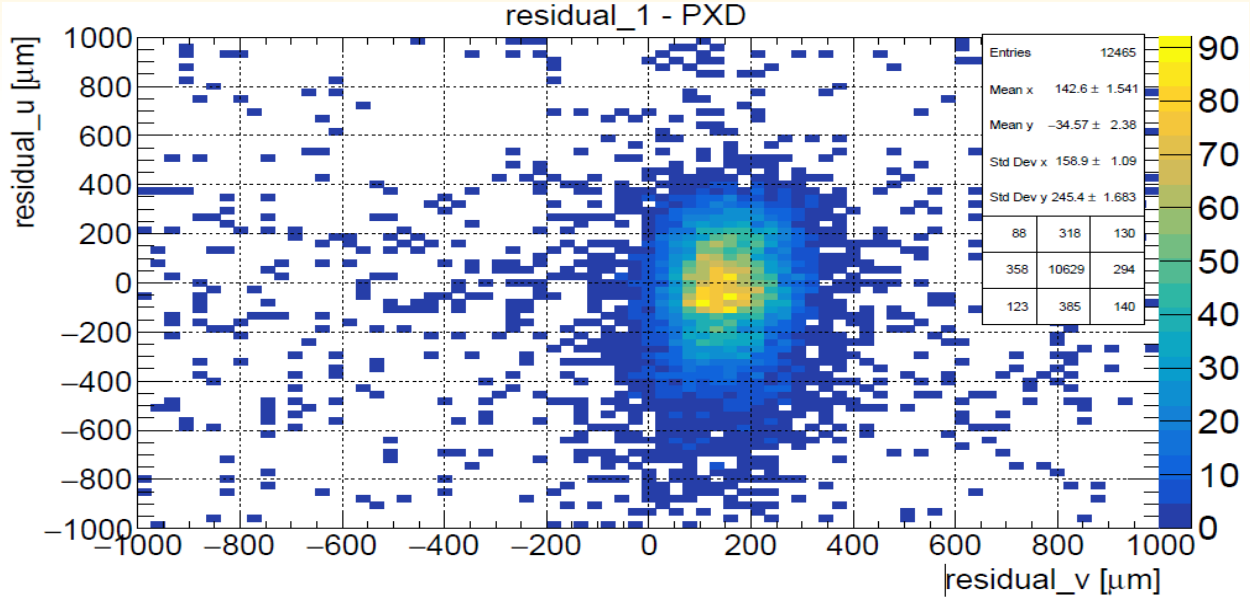
- Use the collected .xml data (no-beam runs) to extract noise
- Define a way to compare the noise with a signal sampling («collected charge definition»)

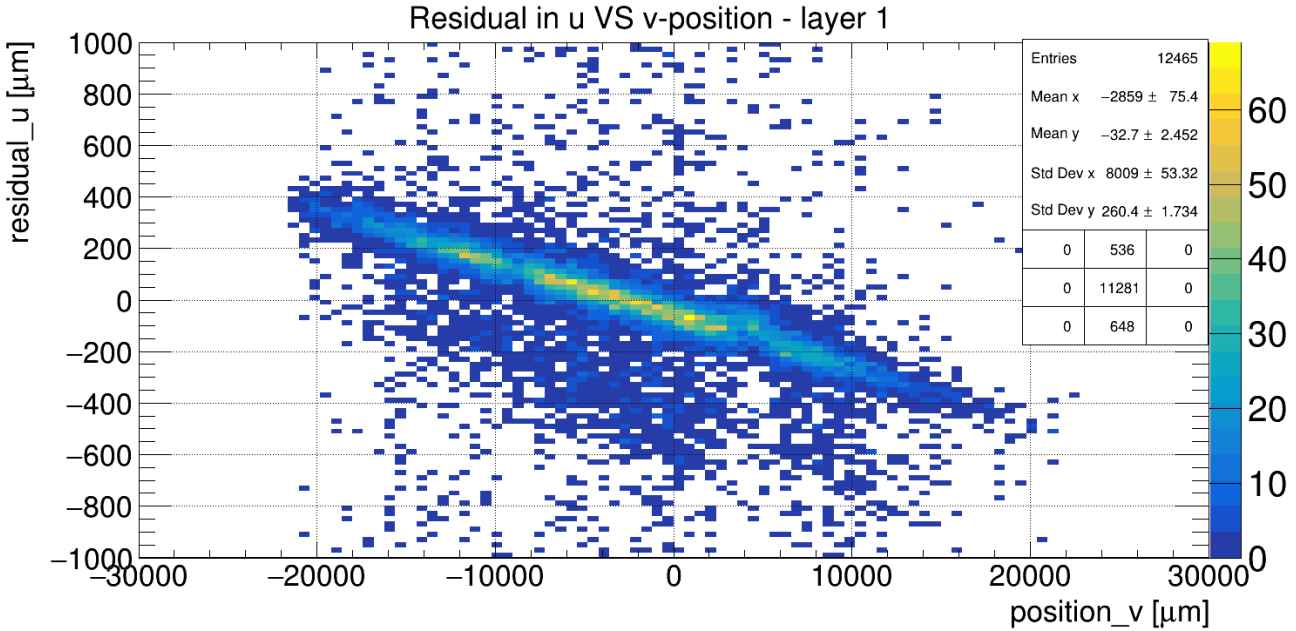
BACKUP SLIDES

Validation plots – alignment

NB: Preliminary studies using PXD data

VXDTF2





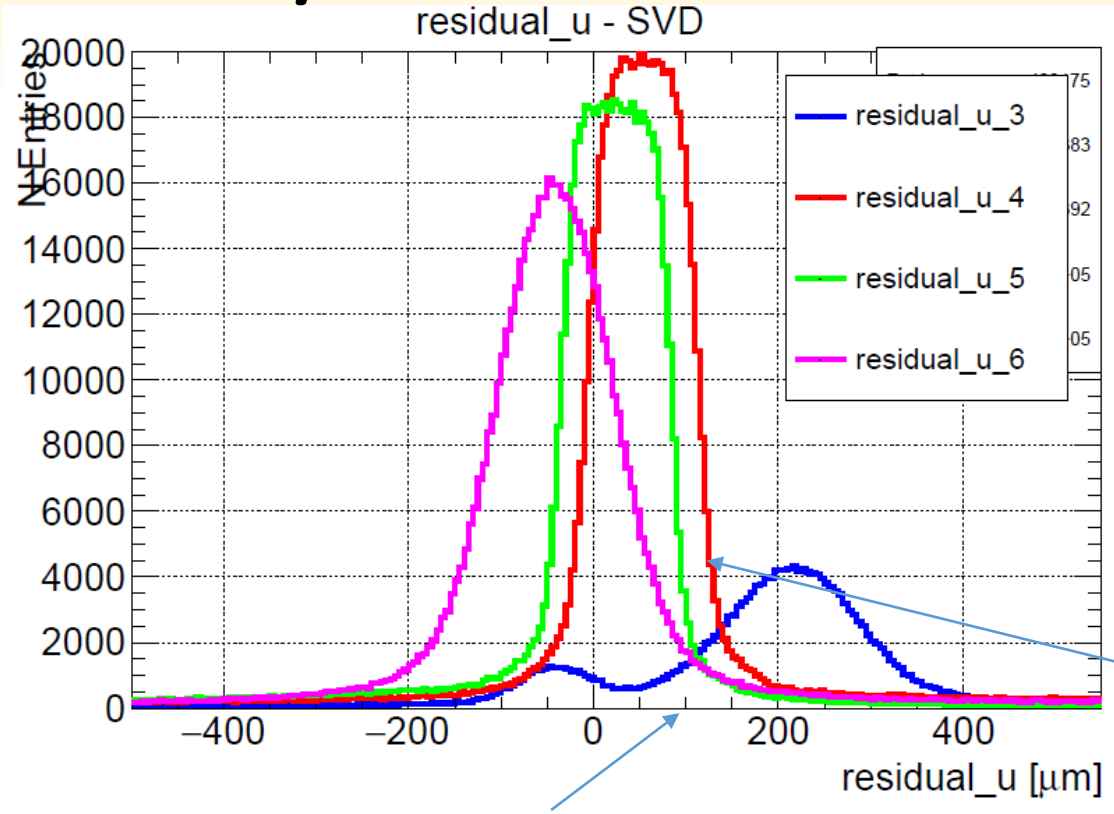
Translation: +140 um in v, -25 um in u

Rotation: 0.02 rad

Strongly necessary alignment!
(from aligment group)

Quality cuts – Residuals & sigma fit run 399

VXDTF2



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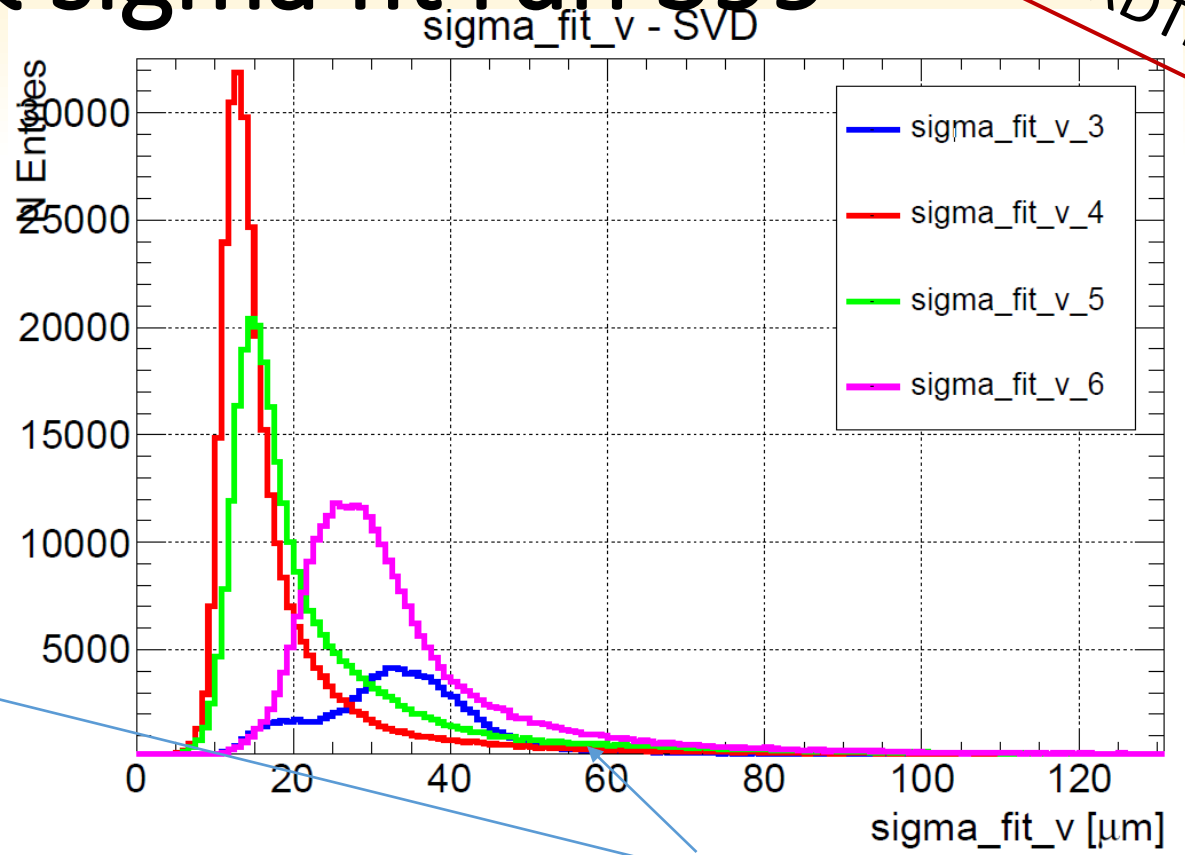
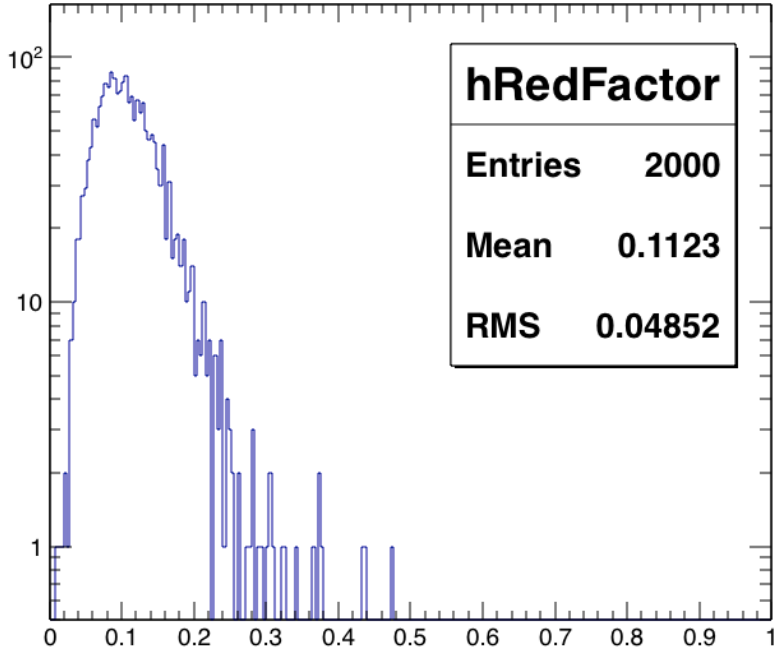


2 population of tracks?

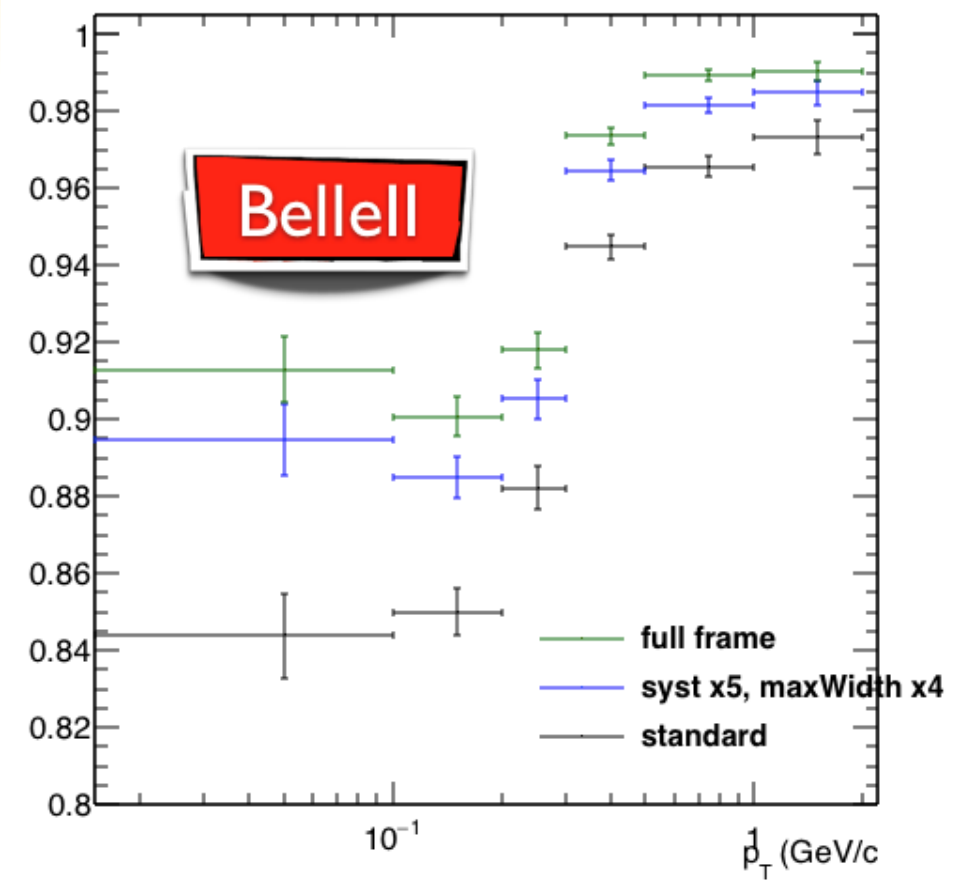
Region Of Interest of PXD (*G. Casarosa*)

➞ real**TF**, larger ROIs but not too large

- syst = 1mm (x5), maxWidth x4
- ε_{PTD} = (94.1±0.1)%
- 1% have too small ROIs
- 4.6% miss the intercept
- the reduction factor average is 11%, with an RMS of 5% and maximum below 50%



ROI efficiency SVD+CDC realTF



$$\varepsilon_{PTD} = \frac{\text{\# Particles with at least one related RecoTrack and one related PXD Digit inside a ROI}}{\text{\# Particles with at least one related RecoTrack and one related PXD Digit}}$$