Analysis of the 2008 Test Beam with 3D DDTC Detectors (Status Report)

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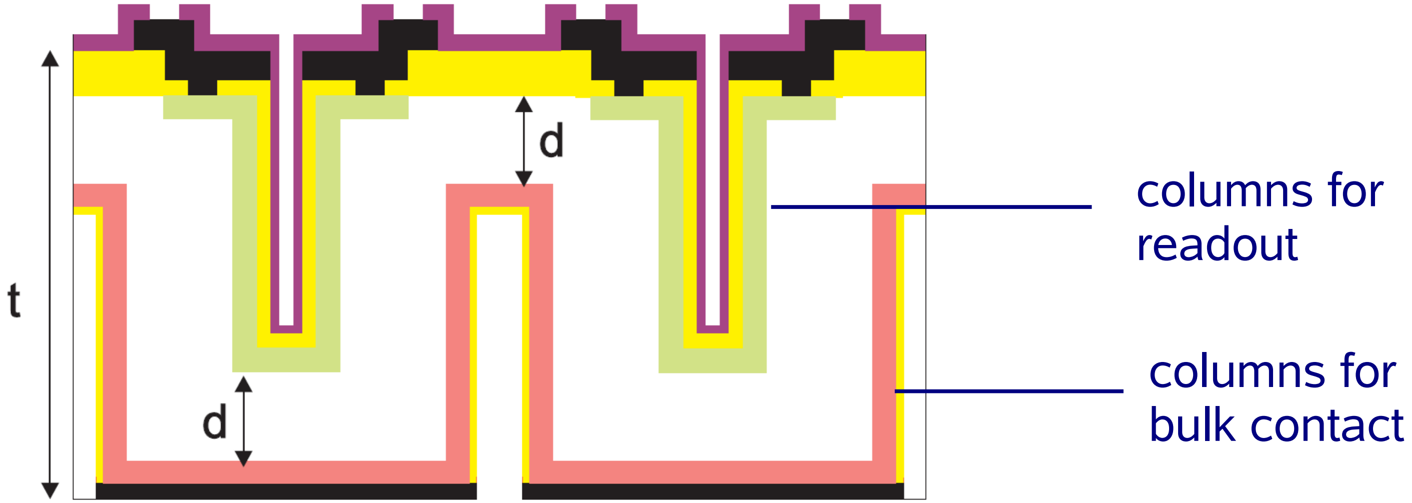
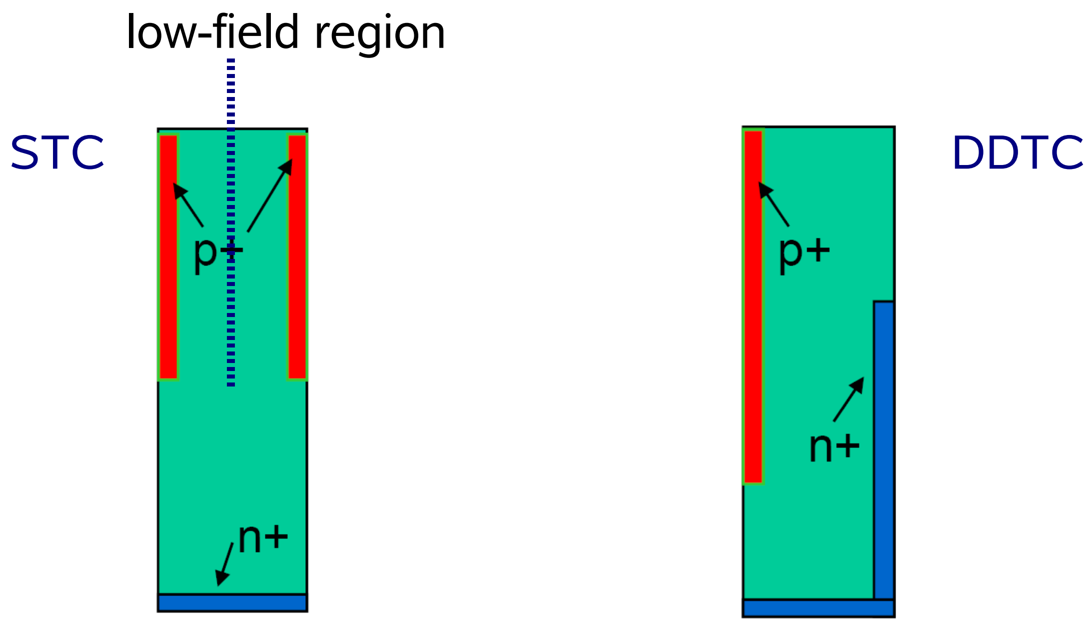
3D DDTC Detectors

- DDTC: "double-sided double type columns"
- Columnar electrodes of both doping types are etched into the detector from both wafer sides
- Columns are not etched through the entire detector
  - Charge collection expected to be similar to "full 3D" detectors, but the fabrication process is much simpler



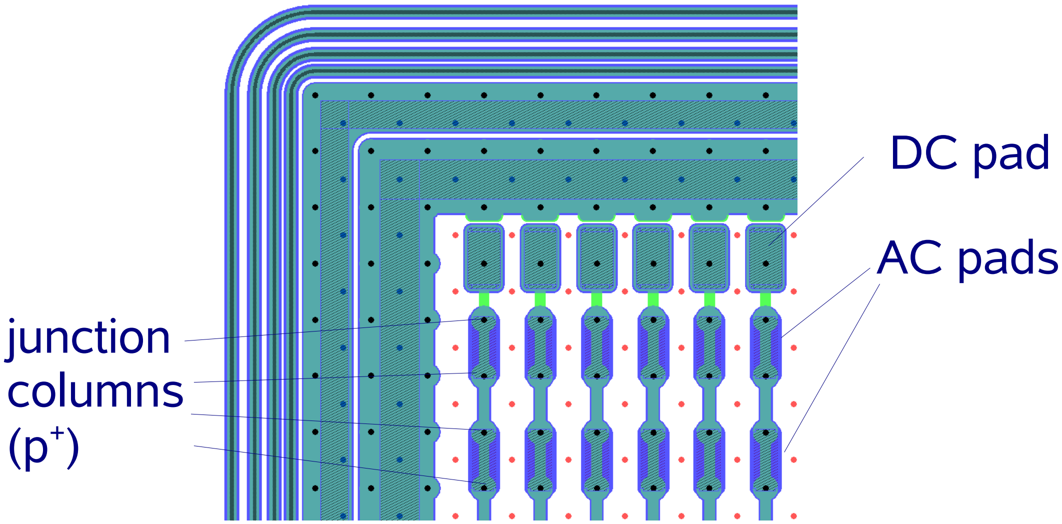
From STC to DDTC

- Much Experience has been gained with 3D STC (single type columns) detectors, see preceding talk by Ulrich Parzefall
- 3D DDTC design is expected to resolve the problems with low-field regions and low efficiency in 3D STC detectors



Device Under Test

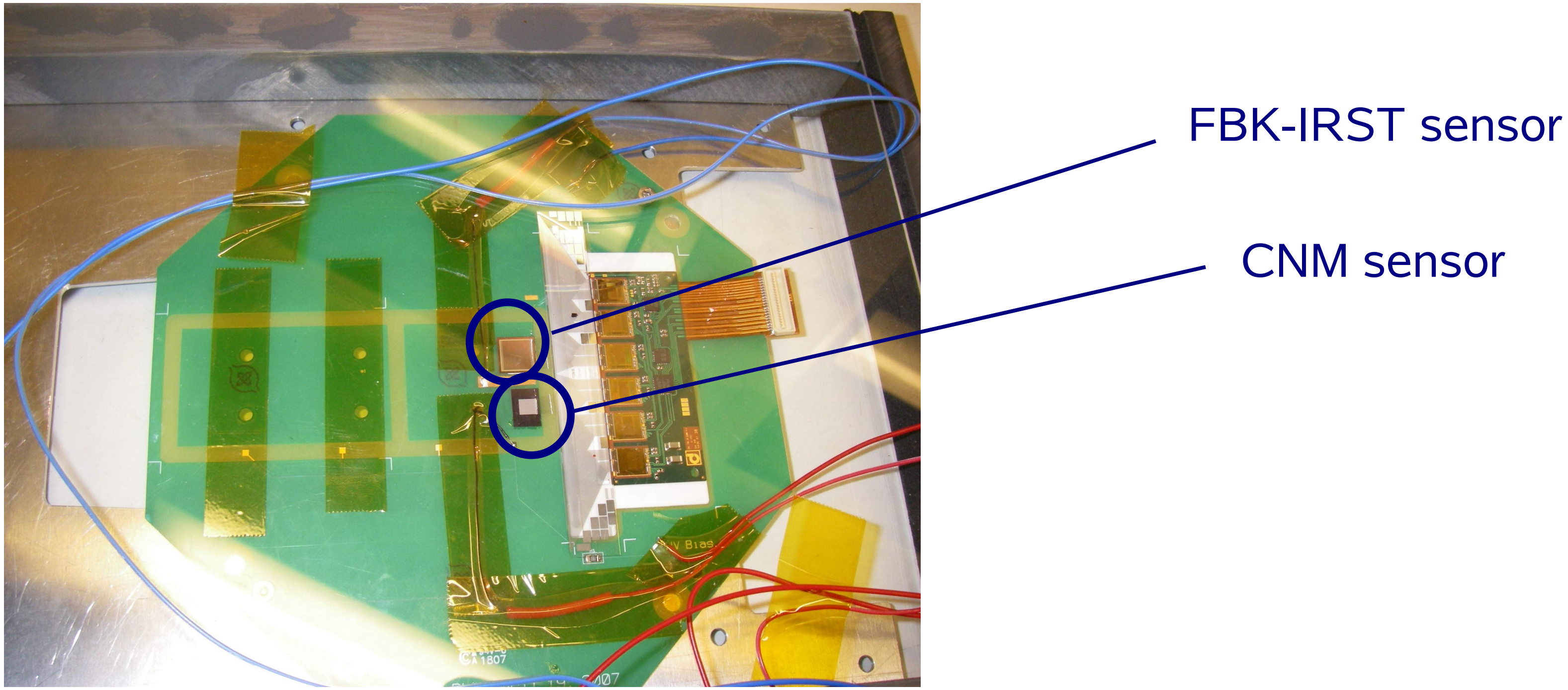
- Two microstrip 3D DDTC detectors tested
  - One produced by CNM (Barcelona), studied by Glasgow
  - One produced by FBK-IRST (Trento), studied by Freiburg
  - This talk focuses on the detector provided by FBK-IRST
- Columns on “front” side (p-doped) are joined to strips



Substrate Thickness	300 µm
Substrate type	n-type (FZ)
Strip pitch	100 µm
Depth of junction columns (front side)	190 µm
Depth of ohmic columns (back side)	160 µm
Strip Length	8.1 mm
Number of Strip	81
Column spacing in strips	100 µm

Module

- Readout: APV25, as used in CMS tracker
  - Analogue readout (40 MHz), 50 ns shaping time
  - Trigger accepted during the entire 25 ns clock window (no TDC), but sampling of the signal always at the same time
    → Average detected signal expected to be ≈ 10% lower



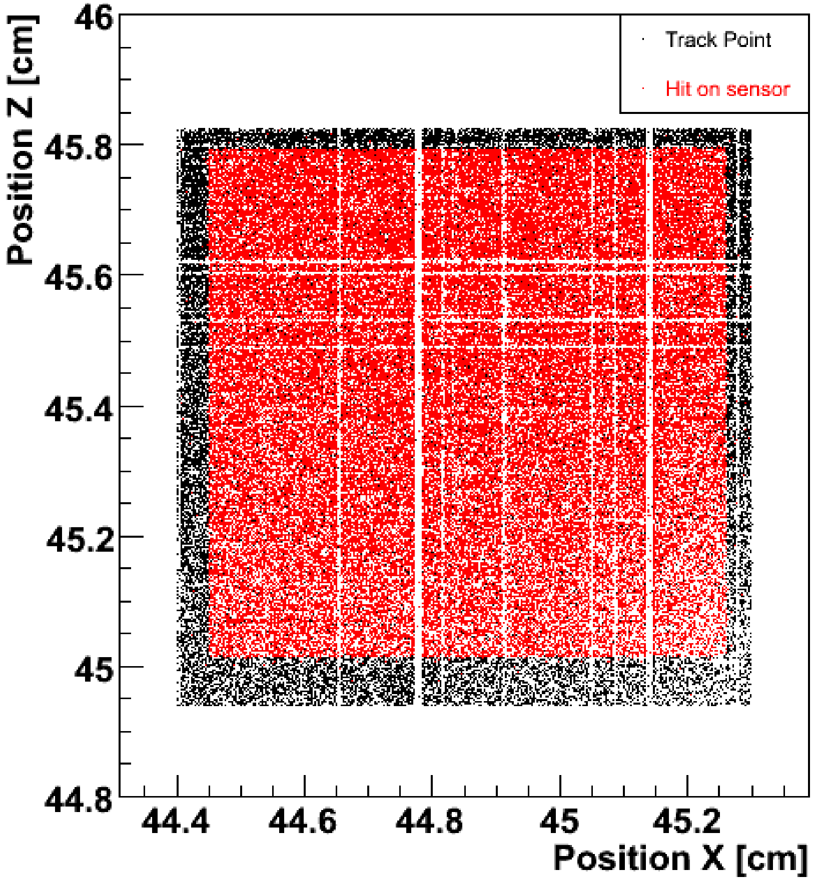
Test Beam July 2008

- CERN SPS, H2 beamline
- Test beam in the framework of RD50 and CMS, organised by the University of Helsinki
- Silicon Beam Telescope (SiBT), resolution ≈ 4 μm

- Teppo Maeenpaeae (University of Helsinki): Providing tracks, pedestal and noise data
  - Thank you!

Beam Coverage

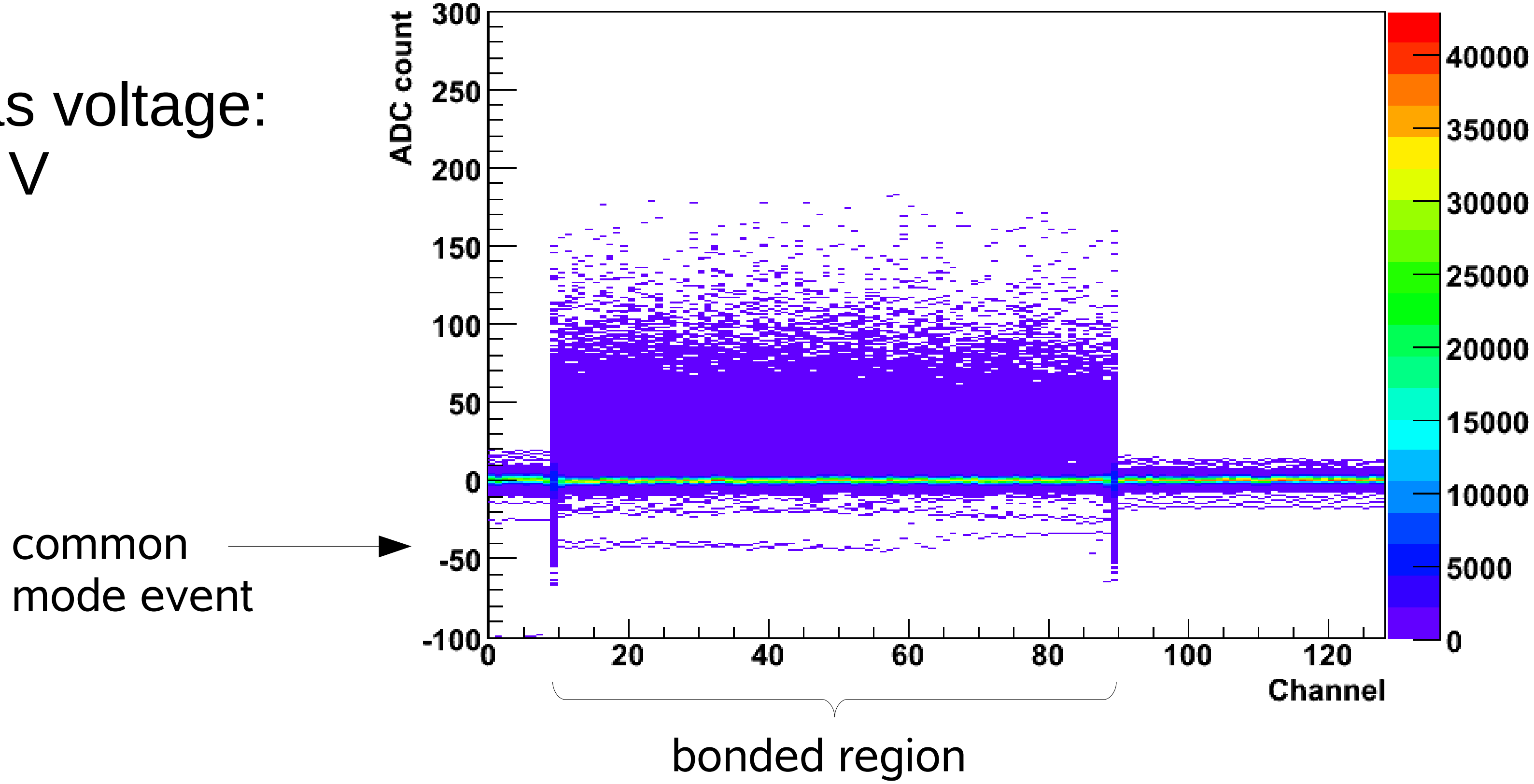
- The sensor area was covered by the beam entirely
- Cuts to define a "hit":
  - SNR ≥ 10
  - Take only events with one hit passing the cut



ADC vs Channel

- Pedestal subtracted ADC distribution from a physics run as a function of the readout channel

- bias voltage: 40 V



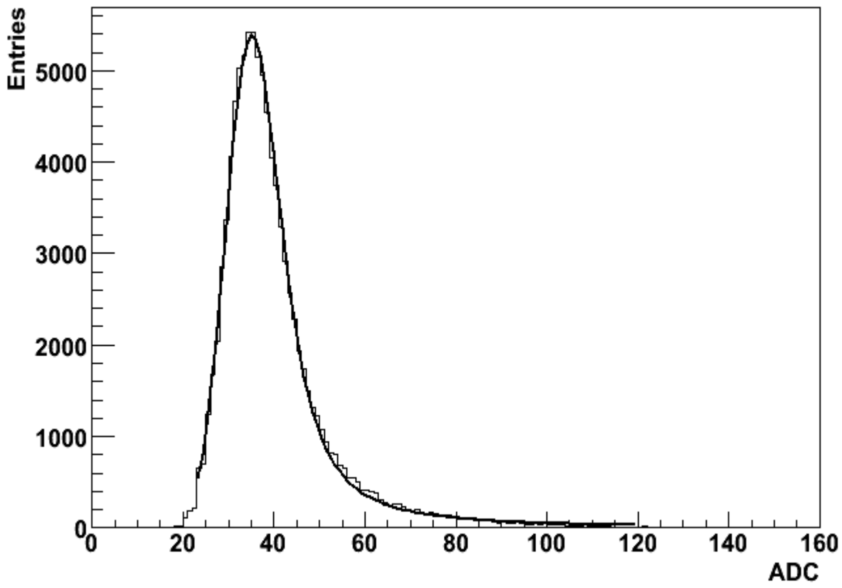
Landau distribution

- ADC distribution with fit of a convoluted Landau and Gaussian

- Bias voltage: 40 V, SNR ≥ 10
- Result:

Landau MP= (33.32±0.02) ADC counts

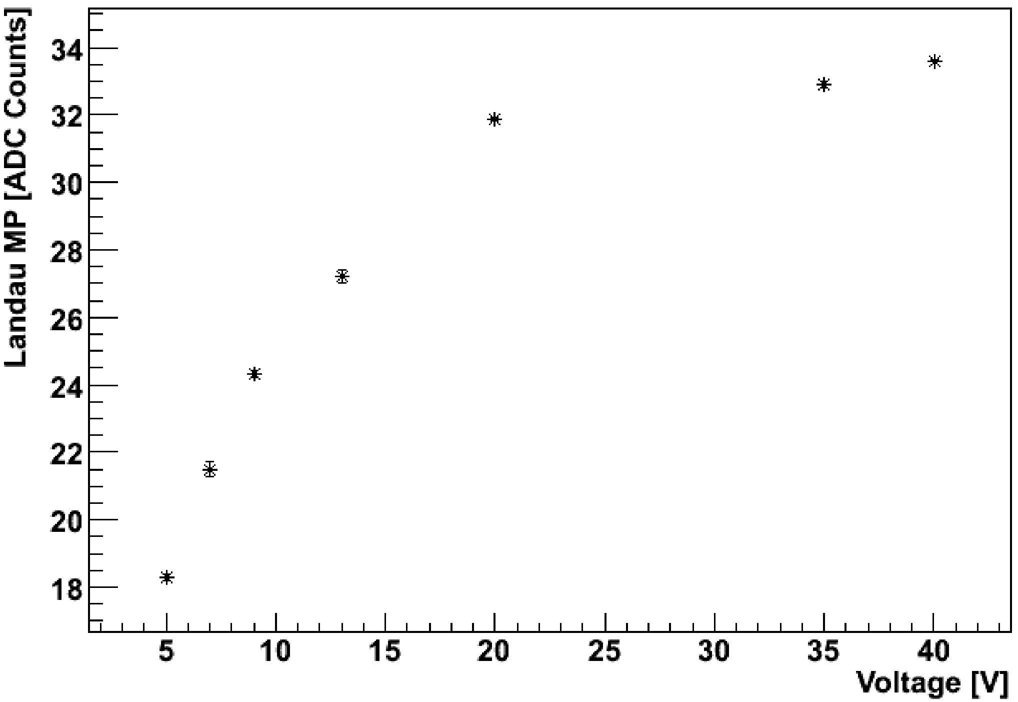
- Calibration ADC counts → charge so far not available
- Histogram contains data from all bonded strips (not position resolved)



Landau MP vs Bias Voltage

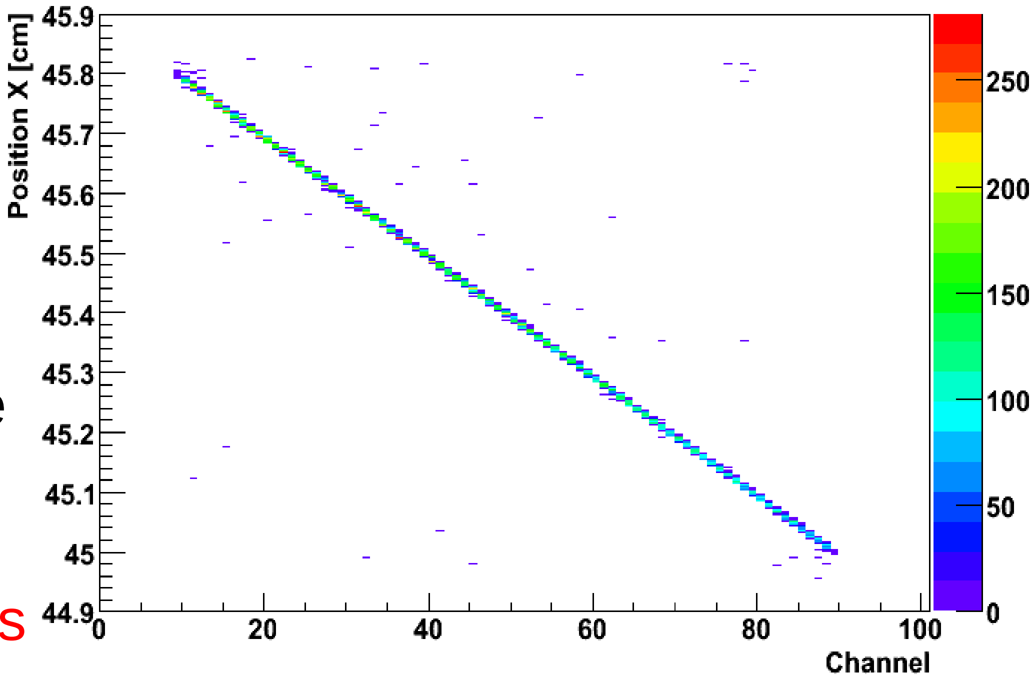
- Fit of convoluted Landau and Gaussian for runs with different voltages

- Different SNR cuts applied
- Error bars: only statistical error from the fit



Track Position vs Channel

- Clear Correlation between track position and Channel number visible, as expected
- Cut applied:
  - SNR ≥10
  - Take only events with one hit
- Clear correlation shows:
  - Noise is removed by the cut almost completely
  - Apparently no synchronisation problems between telescope and device under test



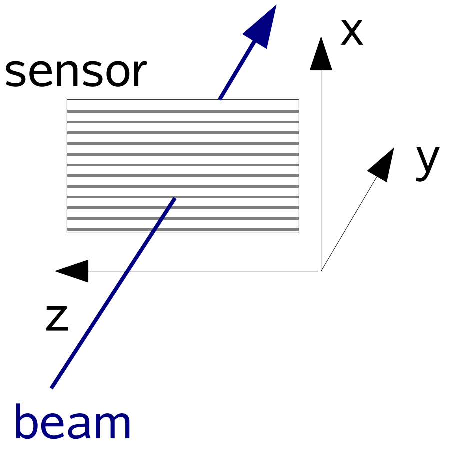
Alignment

- For position resolved analysis: find rotation and translation between sensor and track coordinate system
  - Minimisation of residuals: difference between point of incidence given by the telescope and given by the device under test
- Fit: Minimizing $$\chi^2 = \sum \left[\frac{\left(x^{telescope} - x^{sensor}\right)^2}{\sigma_x^2} + \frac{\left(z^{telescope} - z^{sensor}\right)^2}{\sigma_z^2} \right]$$

$$where \quad \sigma_x = \frac{pitch}{\sqrt{(12)}}$$

$$\sigma_z = \frac{strip \quad length}{\sqrt{(12)}}$$

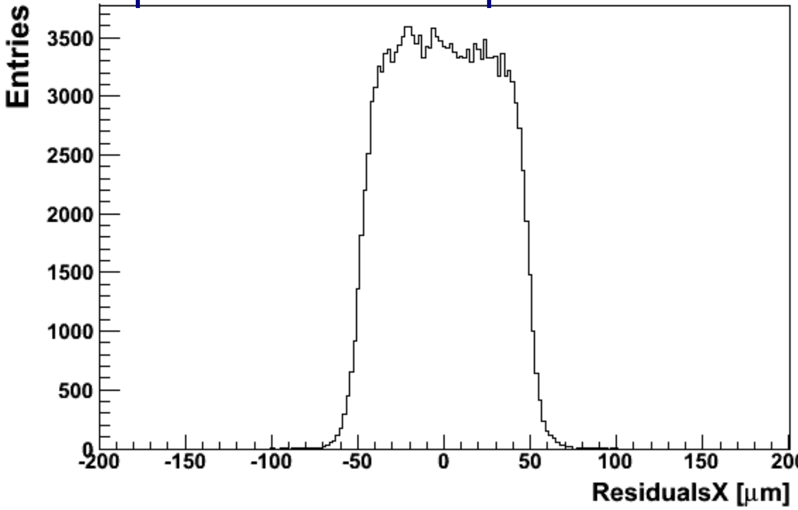
$$z^{sensor} = \frac{1}{2} strip \quad length$$



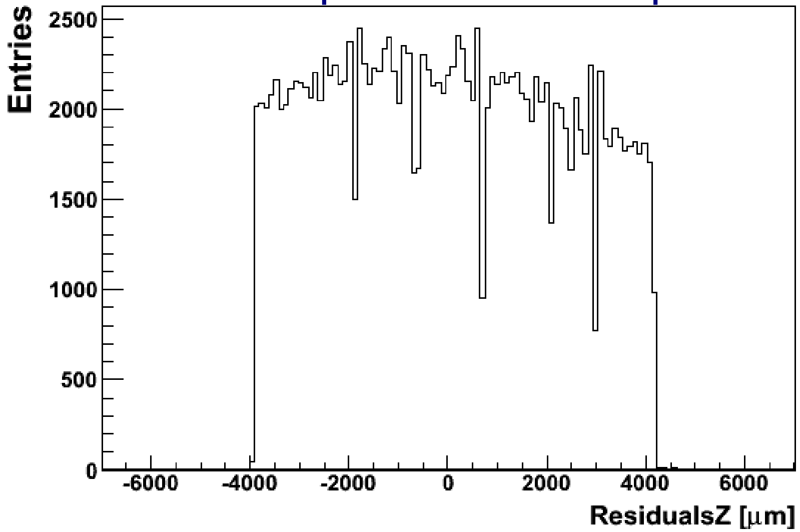
Alignment: Results

- Sensor positioned perpendicularly in the beam
- Expected residual RMS:
  - Perpendicular to strips: RMS≈pitch/sqrt(12)= 28.9 µm
  - Parallel to strips: RMS≈strip length/sqrt(12)= 2338 µm

Perpendicular to strips: RMS=28.8 µm



Parallel to strips: RMS=2295 µm



- Measured RMS below the expected ones
  - After further validation: position resolved analysis can start!

Conclusion / Outlook

- Analysis of the test beam has just started
- First Checks show: data seem to be promising
- Alignment seems to work (although still has to be validated)
- Next steps: Position resolved analysis of charge collection, efficiency etc.