Longitudinal Spatial resolution in the case of InGrids

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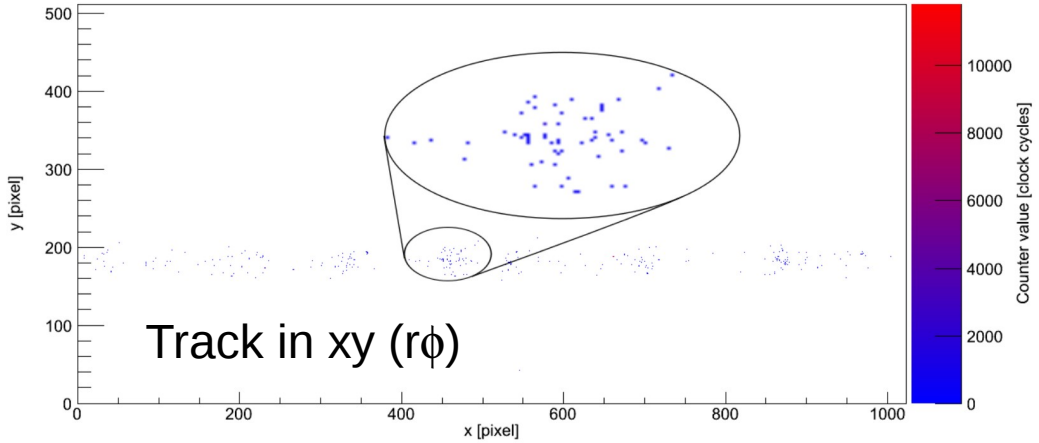
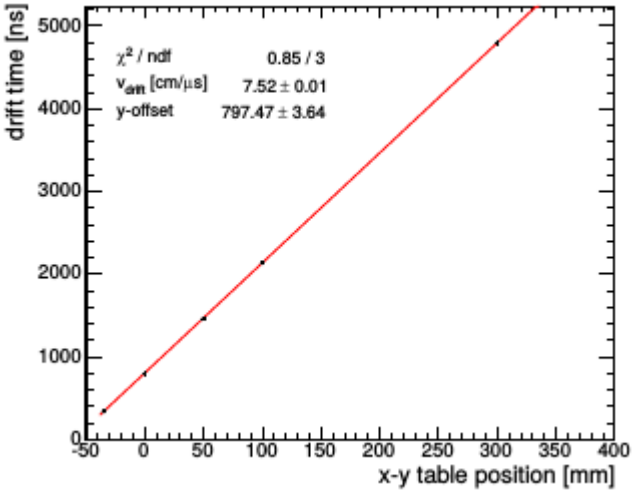
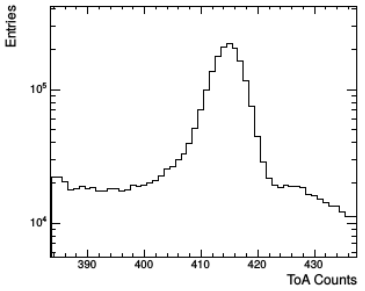
Method

Method, data and results are based on 1 Octoboard testbeam in 2013. Everything has been taken from the Master thesis of Robert Menzen, Available at:

http://www.lhc-ilc.physik.uni-bonn.de/research-groups/experimental-physics/prof.-k.-desch/results/theses?set_language=en







(d) Zoom-in on the beam position peak in the ToA spectrum

B in T	E_{Drift} in V cm^{-1}	v_{measured} in cm µs^{-1}	$v_{\text{simulated}}$ in cm µs^{-1}
0	130	5.53 ± 0.01	5.520 ± 0.004
0	230	7.52 ± 0.01	7.584 ± 0.003
1	130	5.46 ± 0.01	5.526 ± 0.003
1	230	7.33 ± 0.01	7.602 ± 0.003

Variations because of different O_2 and H_2O content

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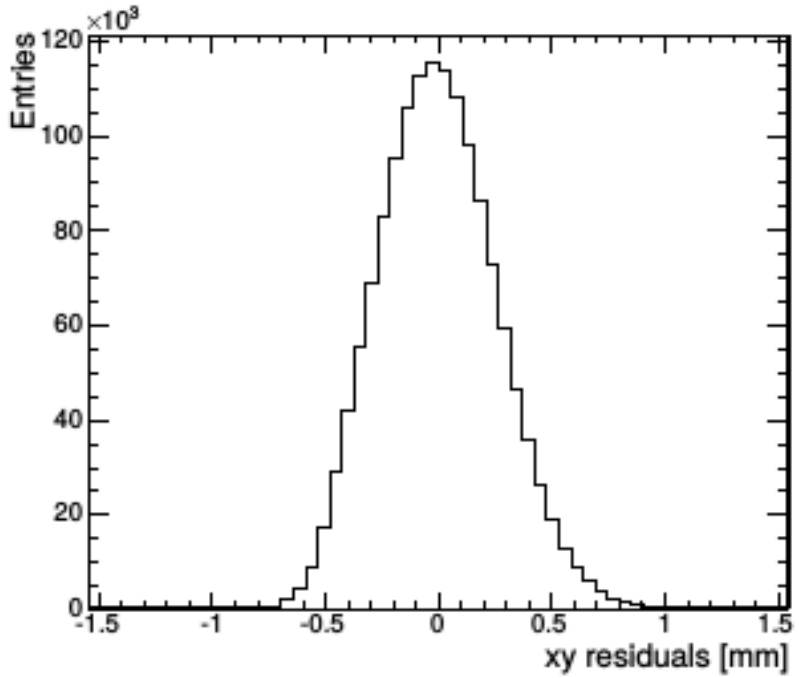
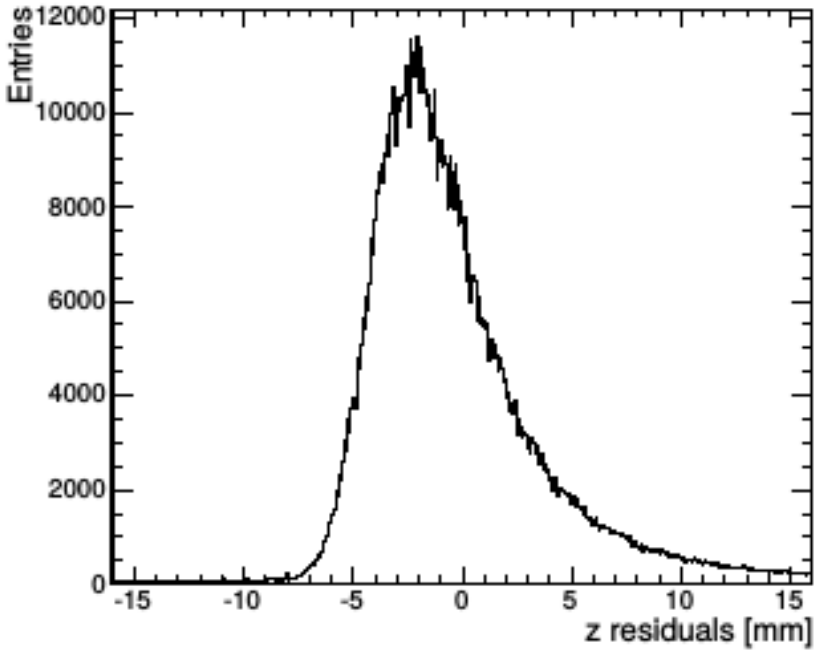
Method

- Compute residuals for tracks with n and n-1 hits
- Cut all hits which are outside of 5σ of the residual distribution
- Spatial resolution given by geometric mean of the RMS of the residuals with n and n-1: $\sigma_{\text{geo}} = \sqrt{\sigma_N \sigma_{N-1}}$



(a) xy residuals



(b) z residuals

Figure 5.21: xy and z residuals obtained from a run with $E_{\text{Drift}} = 230\,\text{V}\,\text{cm}^{-1}$, $B = 0\,\text{T}$ and $z = 58.8\,\text{mm}$.

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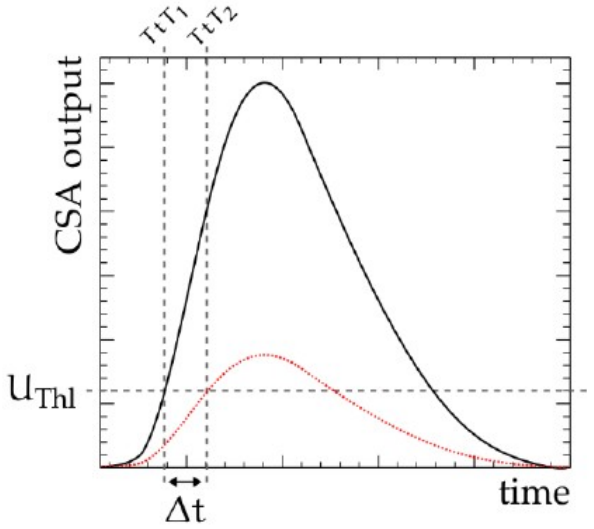
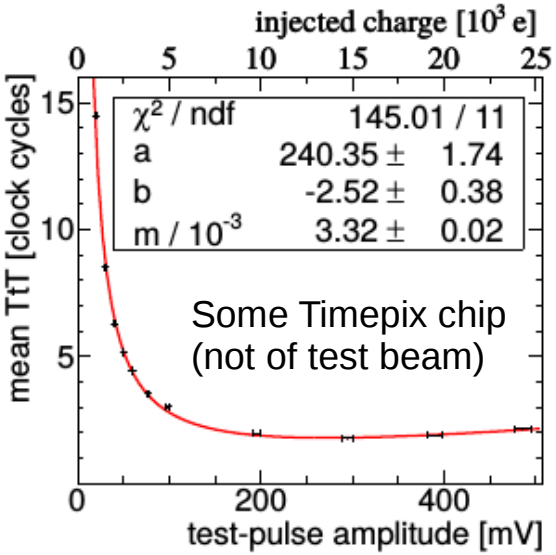
4 Effects of degradation

1.) Time walk, for low charges detected by a constant threshold





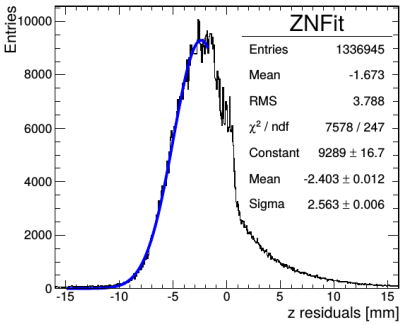


Figure 5.30: z residuals at $z = 10$ mm. The blue curve represents the timewalk correction.

2.) 40 MHz clock, T_c = 25 ns

$$\Delta t_d = \sqrt{\Delta t^2_{\text{Shutter}} + \Delta\left(\frac{n}{f_{\text{clock}}}\right)^2} \approx \Delta t_d = \sqrt{\frac{2T_c^2}{12}} \xrightarrow{v_d(E=230\ \text{V/cm})} \sigma_{z,ro} = \frac{T_c v_d}{\sqrt{6}} \approx 750\ \mu\text{m}$$

3.) Field distortions

- He didn't have time to look at this, but are expected to be large

4.) Diffusion – everyone knows – for single electrons the diffusion limit (from Magboltz) is shown in a blue dotted curve in the next pictures

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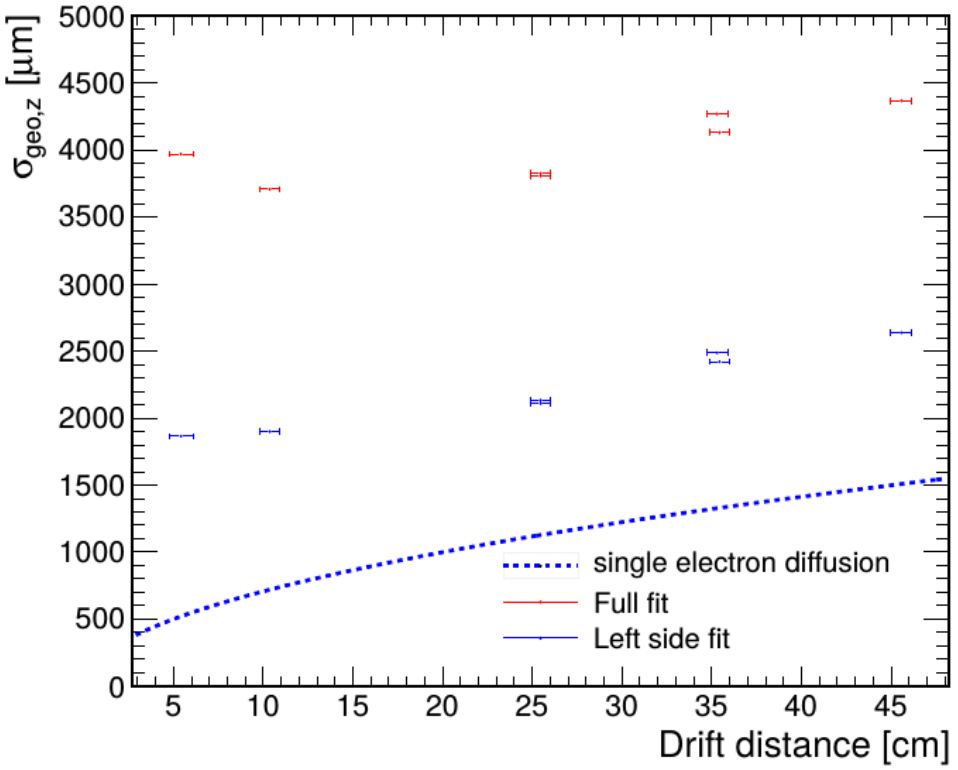
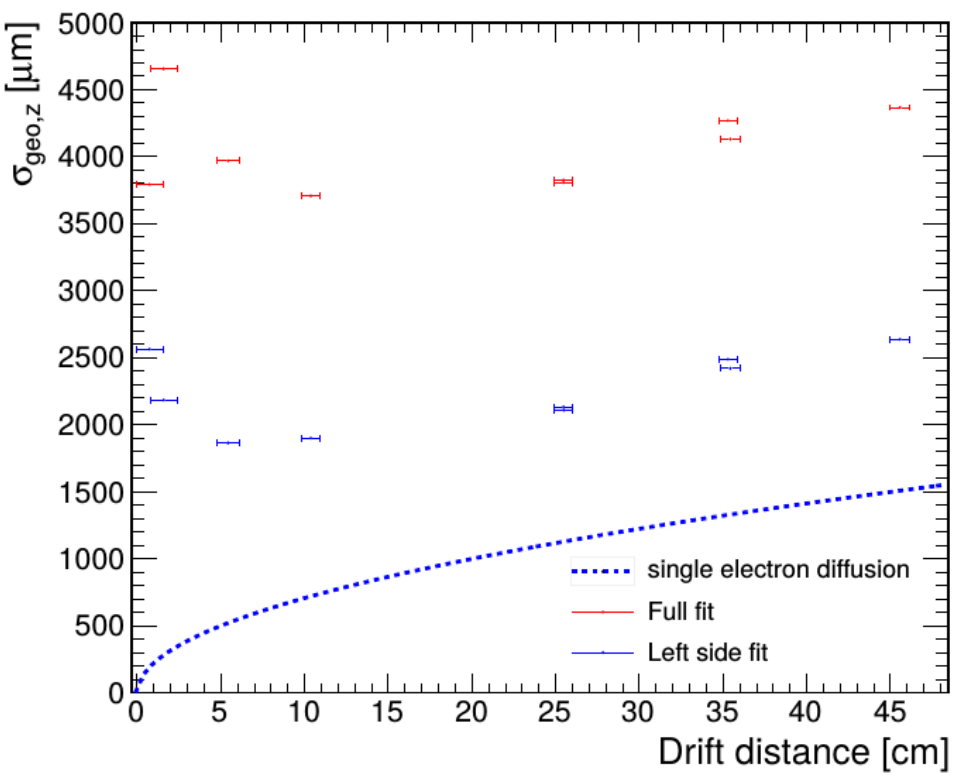
Longitudinal spatial resolution



(a) z resolution $B = 0\,\mathrm{T}$



(b) z resolution $B = 1\,\mathrm{T}$

Figure 5.29: Longitudinal resolution obtained from runs with $E_{\mathrm{Drift}} = 230\,\mathrm{V\,cm^{-1}}$, and $B = 0\,\mathrm{T}$ and $B = 1\,\mathrm{T}$.

Outlook

Better results are expected for the last test beam, since a 80 MHz clock was used at the end.

Everything will be much better with Timepix3:

- 1.7 ns clock
- both Time and charge measurement per pixel
  → time walk can be corrected
- field forming electrode around every chips seems possible
  → much less field distortions (independent of TP3)