Status of the HEC–Calibration Analysis

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Outline

- *Calibration Method*
  - *Theoretical transfer function (t_0 def.)*
  - *Pulse fitting and accuracy of the fit*
- *The digital filtering method (@Cleland)*
  - *Amplitude and Time filter*
- *Application of the Filter (@hec_adc)*
- *Performance of the Filter*
  - *Principle timing problems*
  - *Determination of t_0*
  - *Amplitude reconstruction*
- *Conclusions*

Calibration Method

Theoretical transfer function (t_0 def.)

$$g(t) = I(t) * h_{pa}(t) * h_{sh}(t)$$

where:

$$h_{pa}(s) = \frac{1}{1+\tau_{\mathrm{pa}} s}$$

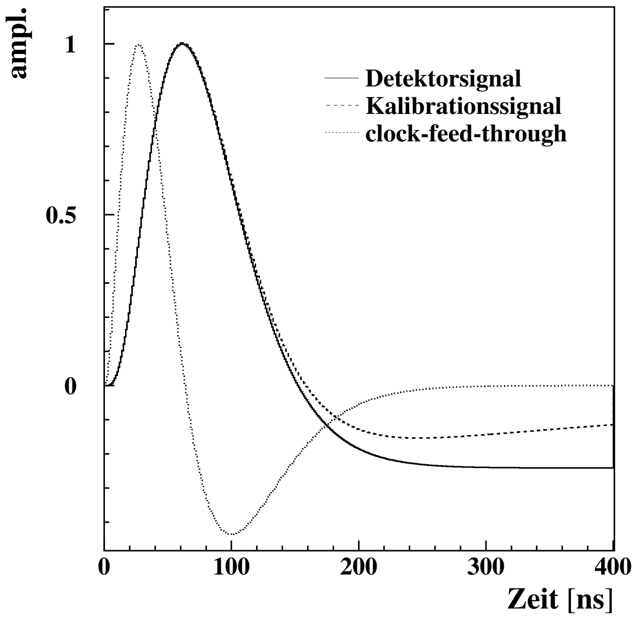
$$h_{sh}(s) = \frac{\tau_{\mathrm{sh}}}{(1+\tau_{\mathrm{sh}} s)^3}$$

for calibration:

$$I(t) = I_0 \cdot e^{-\frac{t}{\tau_{exp}}} + I_{clk} \cdot \delta(t)$$

for physical signals:

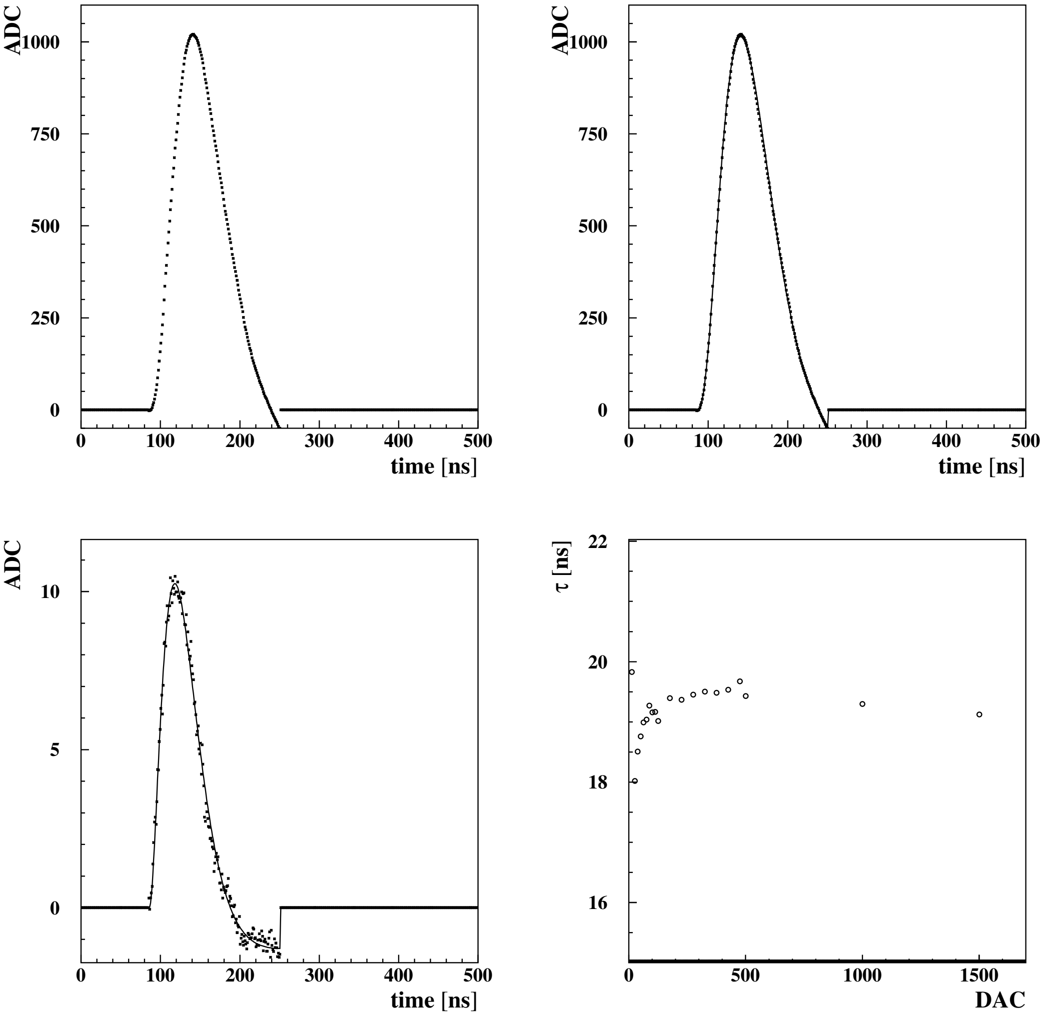
$$I(t) = I_0 \cdot (1 - \frac{t}{\tau_{drift}})$$



Well defined starting point t_0=0

Pulse fitting and accuracy

typical signals in calibration (Ch.57)

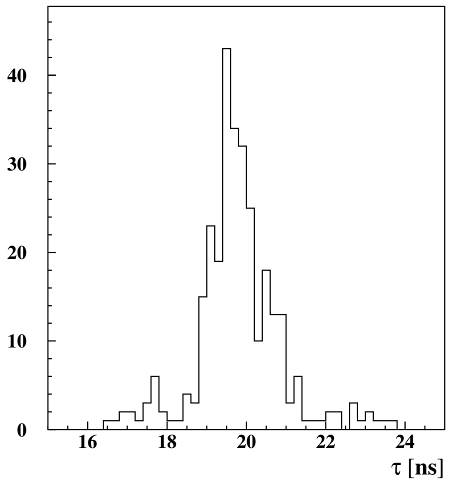


here:

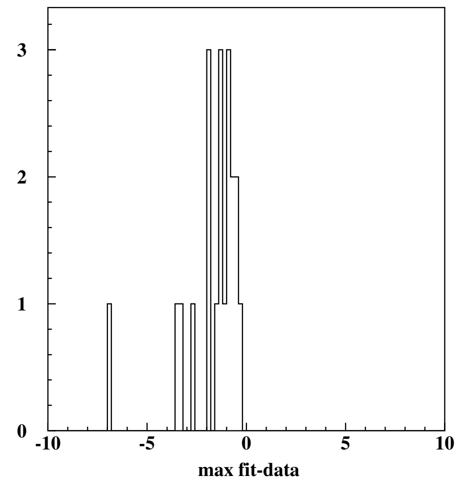
$$\tau = \tau_{pa} = \tau_{sh}$$

Pulse fitting and accuracy

distribution of all fitted time const.



accuracy of the amplitude reconstruction (Ch.57)

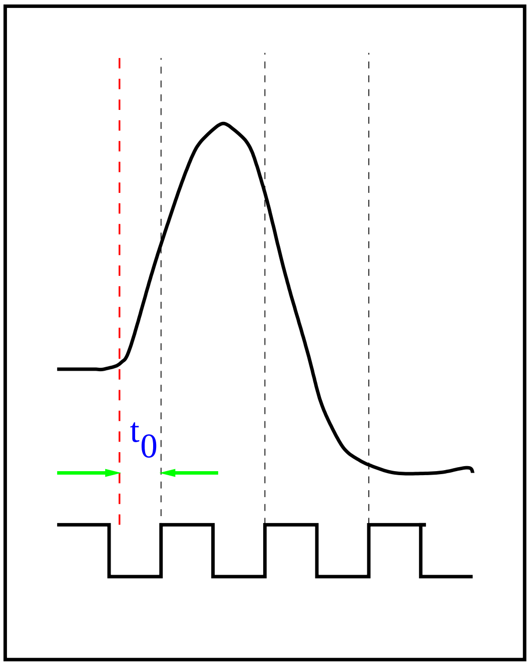


Digital filtering method

equivalent to the χ^2-approach (Cleland), minimize:

$$\chi^2(A, t_0) = \sum_{ij} (S_i - A \cdot g(t_i - t_0) V_{ij} (S_j - A \cdot g(t_j - t_0))$$

where:
t_0: is the time difference between the sampling CLK and the beginning of the signal.



calculation of the amplitude and time filter with variable t_0, $0 < t_0 < 25$ ns

$$A = \sum_i \mathrm{wa}_i(t_0) \cdot S_i$$

$$A \cdot \tau = \sum_i \mathrm{wt}_i(t_0) \cdot S_i$$

where $t_0 = \tau$
But: method allows small deviations of t_0 from the real value of τ

Implementation of the Filter in the hec_adc Prg.

Iterative method can be used to calculate t_0

$\longrightarrow$ starting value t_0=12.5 ns

$\longrightarrow$ calculate τ

$\longrightarrow$ setting t_0=τ

$\longrightarrow$ redo the analysis until (t_0 - τ_{new}) $<$ δt

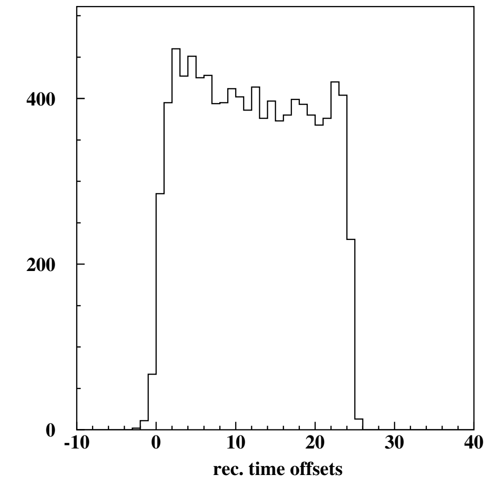
Performance of the Filter

Principle timing problems:

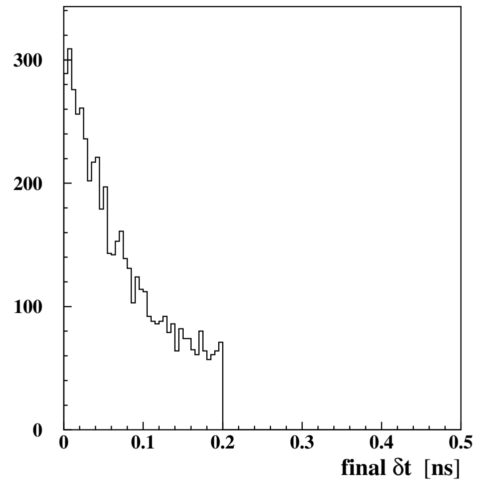
- cable propagation times
- particle propagation times
- shower propagation inside of the calorimeter

reconstruction of t_0 for Run 8444:

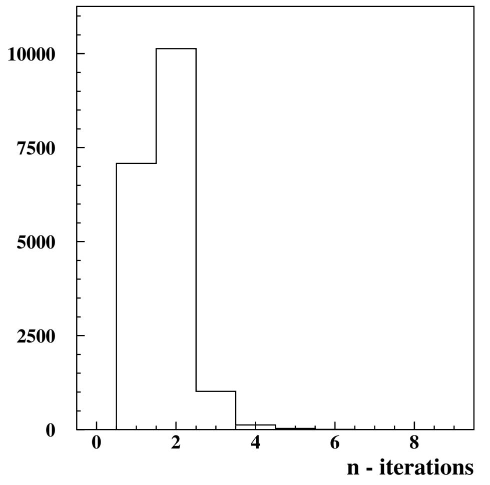
distribution of t_0:



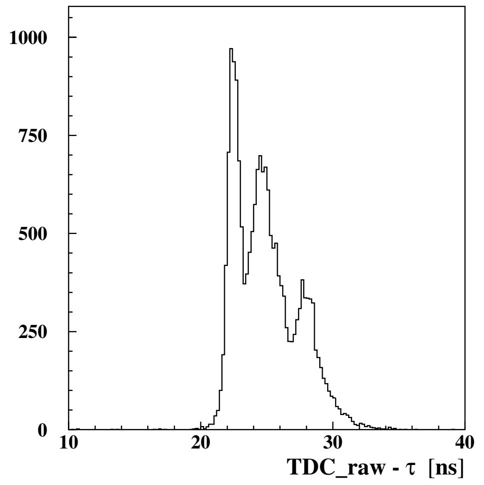
final $\delta\,\tau$:



number of iterations:



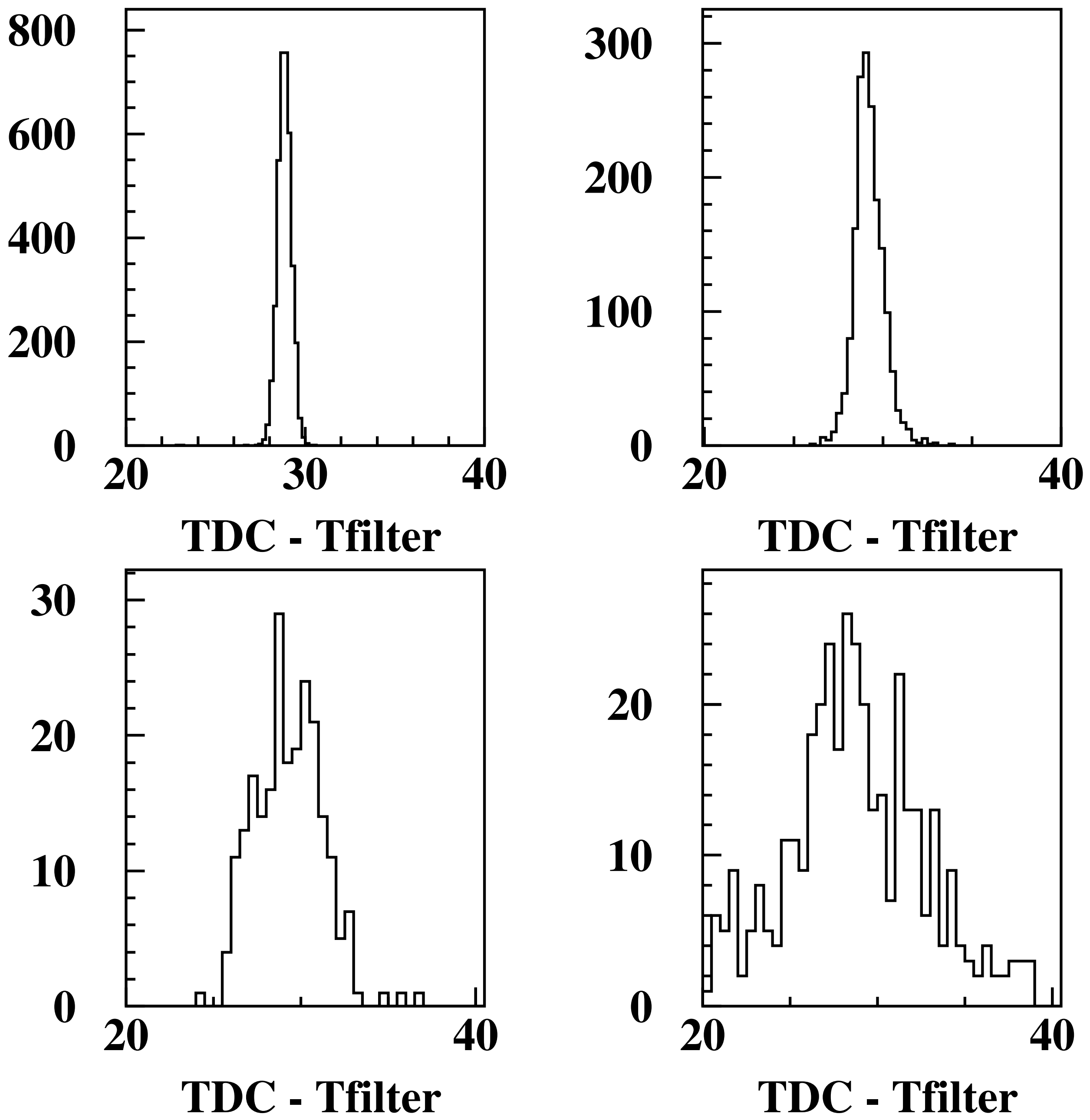
TDC_raw - t_0:



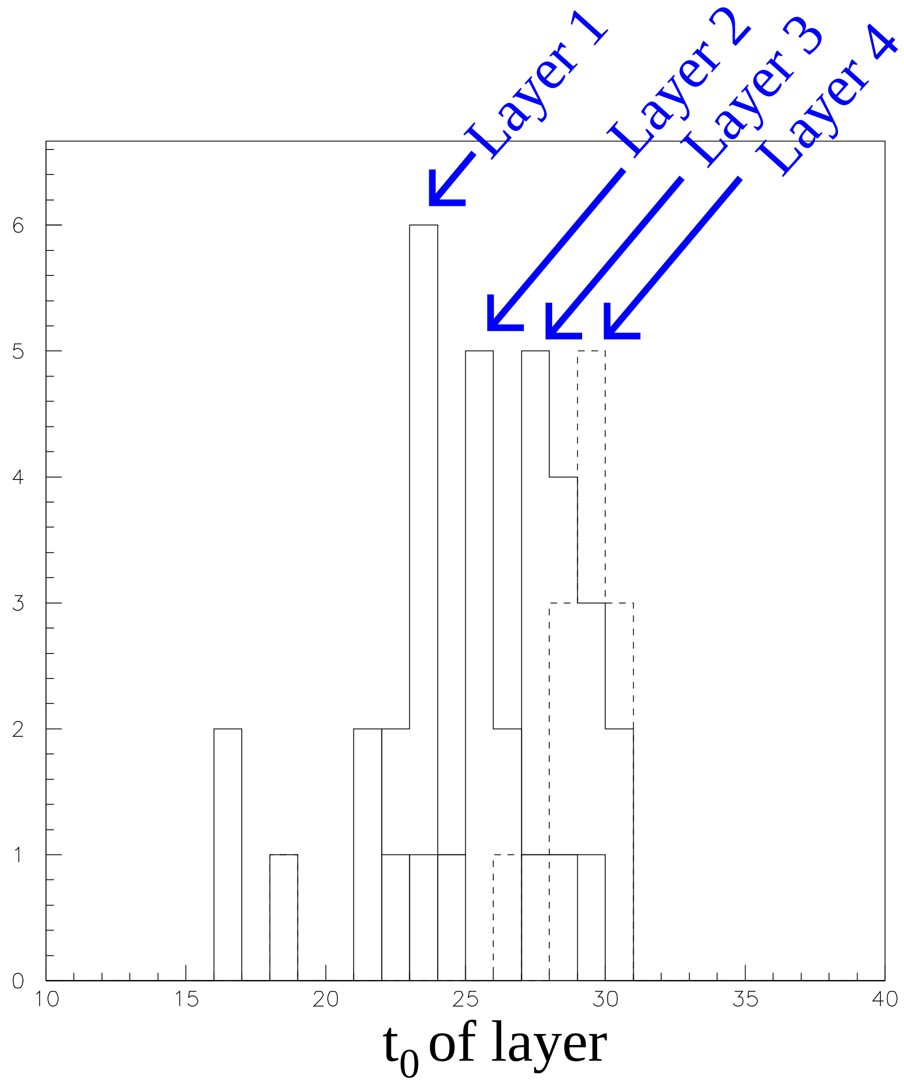
Performance of the Filter

Amplitude dependence of the timing accuracy:

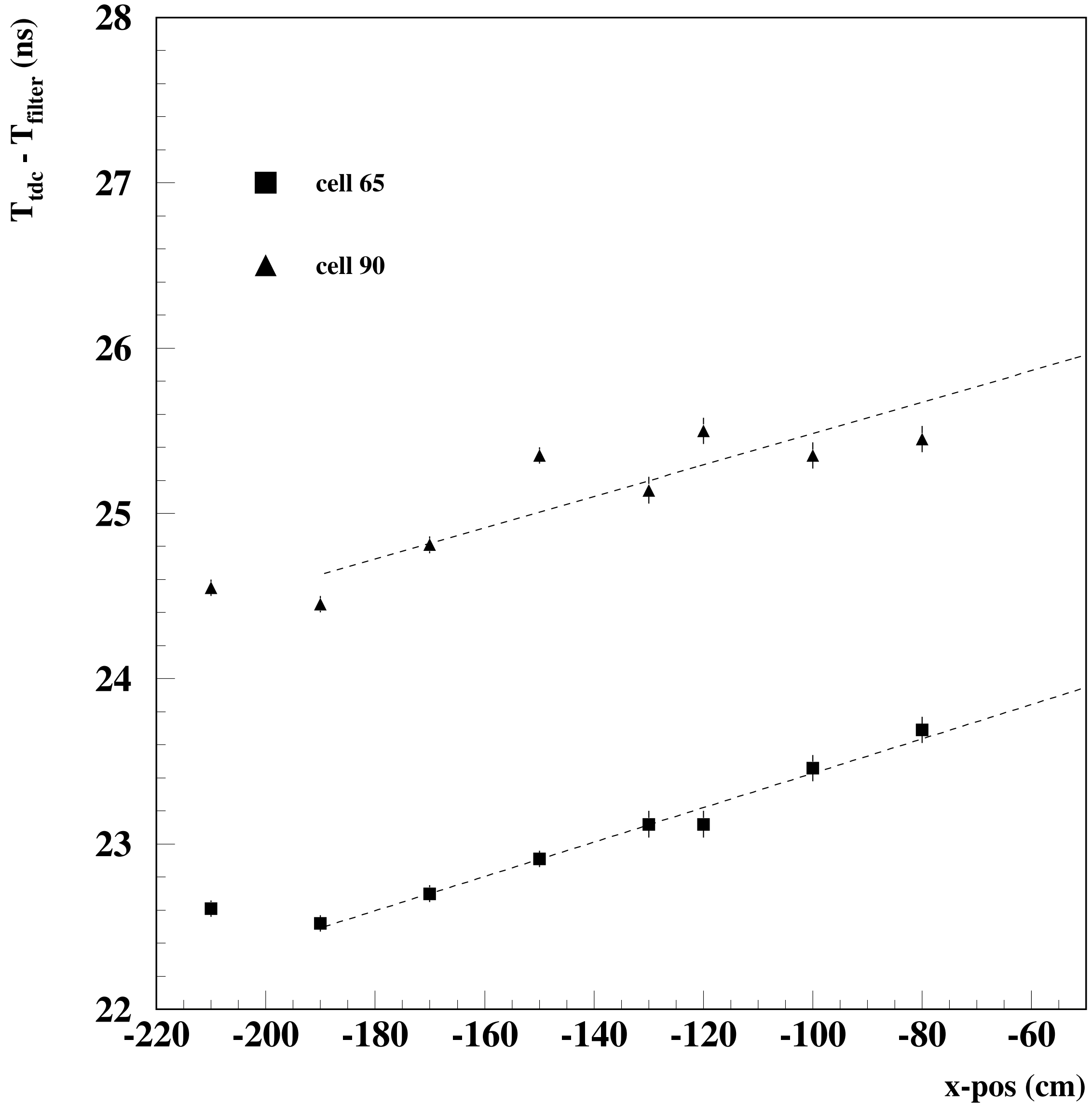
Run 9184 Cell 57:
Ampl. > 200, 200-100, 100-50, < 50:



Distribution of rec. of t_0–values

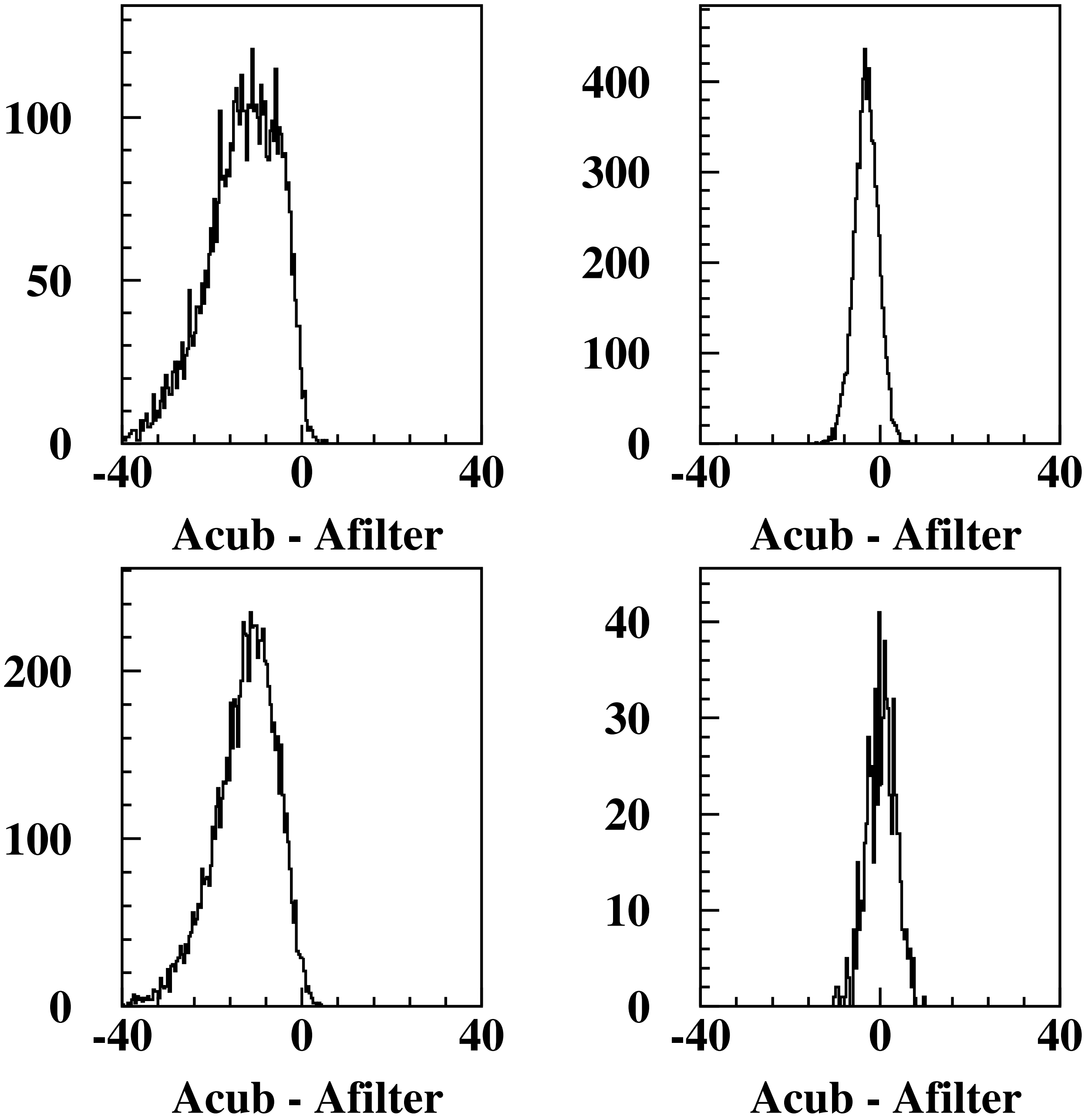


X-Position dependence of t_0



Amplitude reconstruction

for Run 9184, ADC-channels 57,58,82,83:



Conclusions

- *the digital time filter can be used iterative to measuer the t_0 values*
  - *the iteration method shows a fast convergens*
  - *a time resolution of about 0.5 ns is reachable*
  - *effects of particle/cable propagation times can be compensated*
- *the amplitude reconstruction for large ADC values is systematically to small*
- *one time constance is not enough to describe the transfer function of all channels*