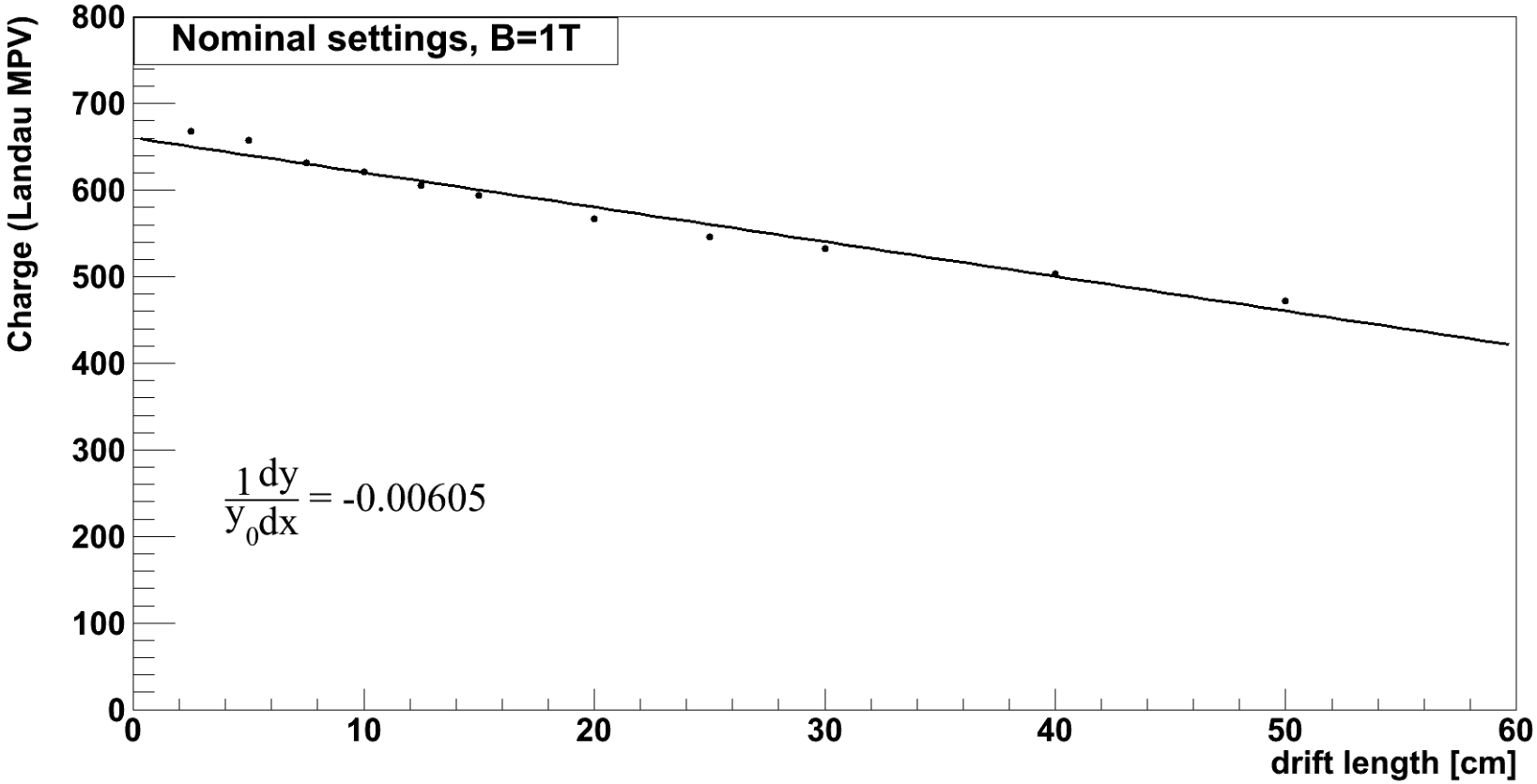
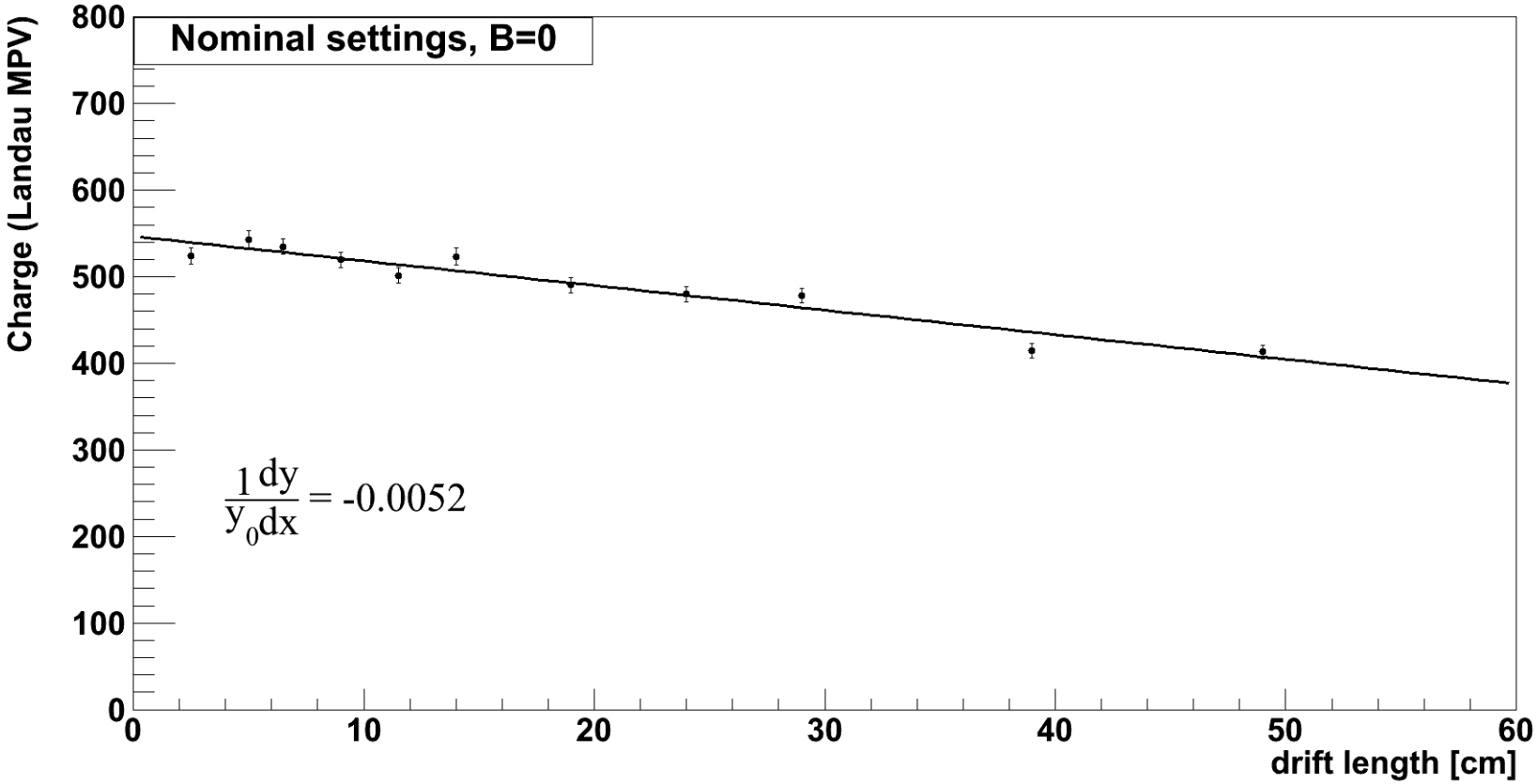
# Japanese LP1 test beam analysis

- Apparent charge loss
  - Situation
  - Possible explanations
  - Evaluating threshold effects
- Pulse analysis
  - 2D signal shape
  - Effect of induced signal

# Observed charge loss, B=1T



# Observed charge loss, B=0



# Hypotheses

- Electron absorption
  - Should contribute
  - Cannot explain the difference between B=0 and B=1T
- Threshold and noise effect
  - Affect hits differently for wider hits
- Gain variation
  - position? electron density?

# Evaluating threshold effects: extrapolate from the central charge

- Assuming a Gaussian signal:
  - The central pad would carry a fraction F of the charge

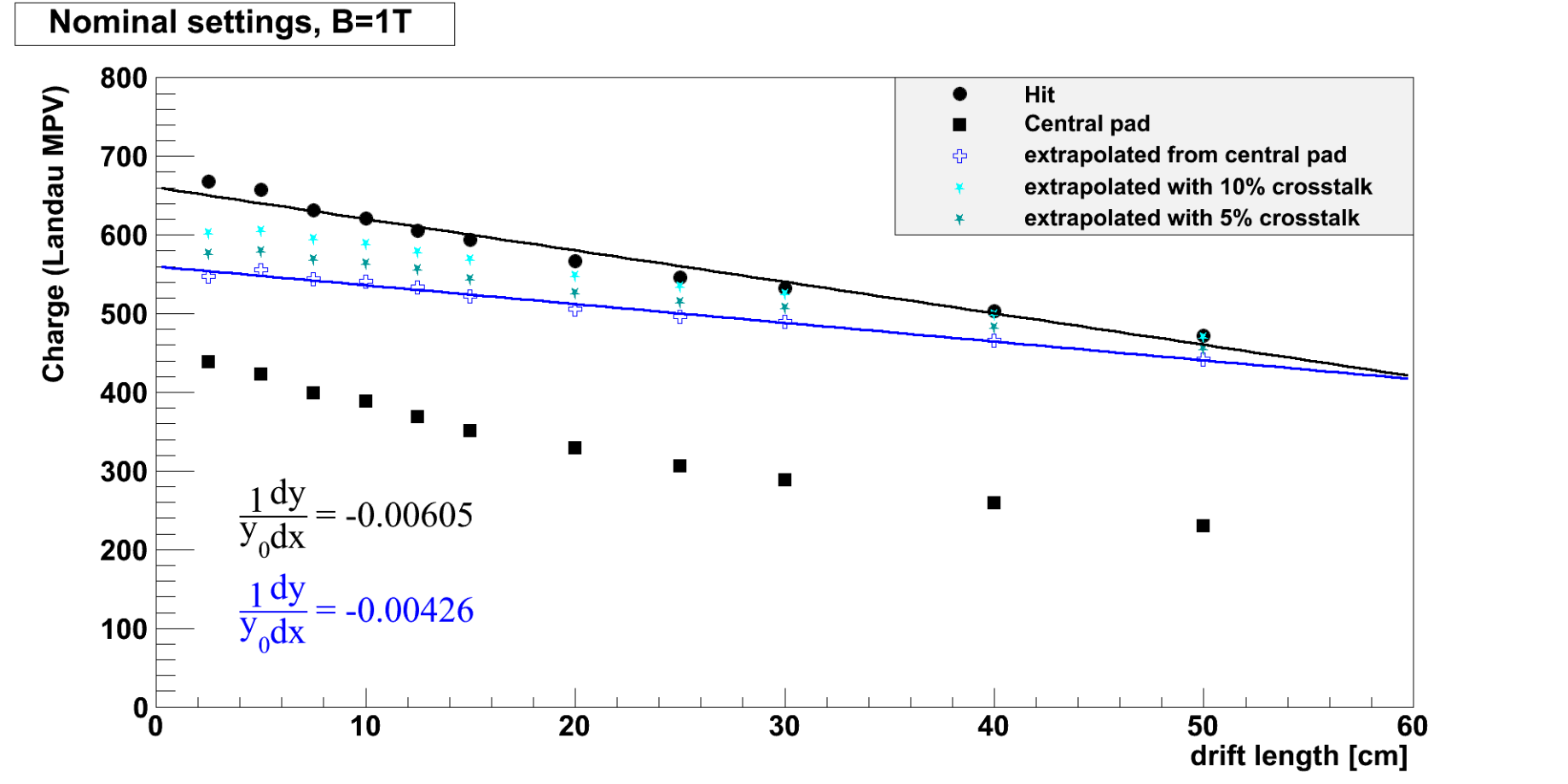
$$F = \left| \int_{dY-w/2}^{dY+w/2} N(0, \sigma_{PRF}; x)\, dx \right|$$

$$F = \frac{1}{2}\left( Erf\left(\frac{w/2-dY}{\sqrt{2}\sigma_{PRF}}\right) + Erf\left(\frac{w/2+dY}{\sqrt{2}\sigma_{PRF}}\right)\right)$$

*w = pad width*
*dY = Ypad - Yhit*

- It can be extended to include simple cross-talk between the pads
- Requires $\sigma_{PRF}$ (and the amount of crosstalk)

# Threshold effects

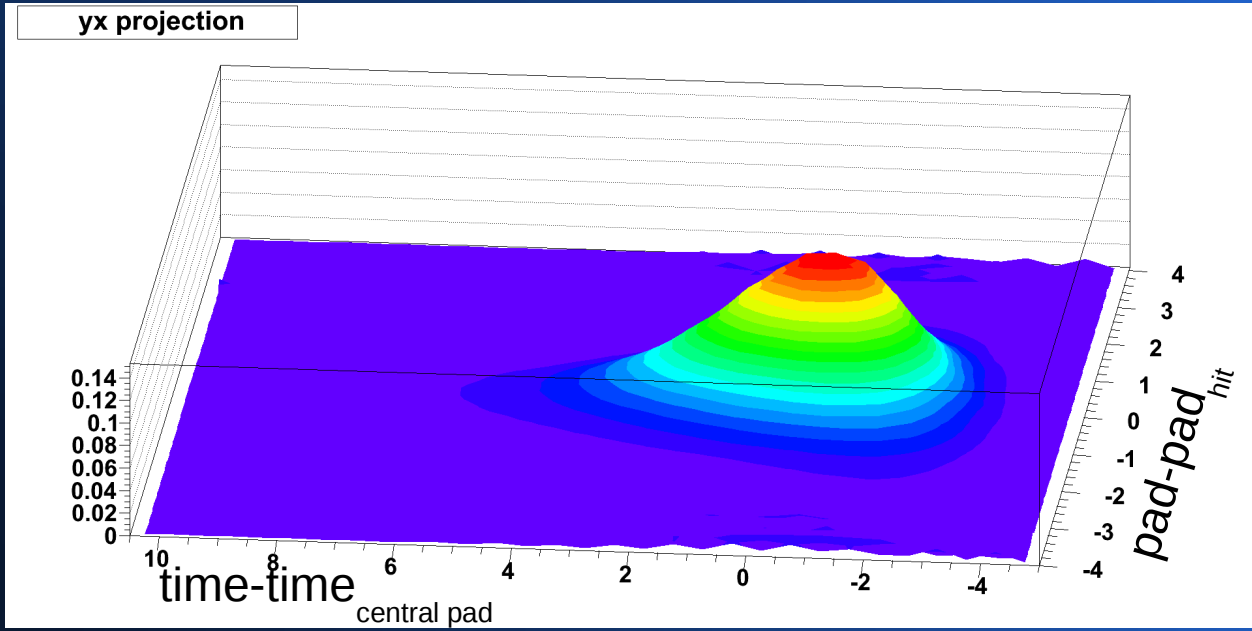



The apparent charge loss is smaller when extrapolating from the central pad
Including the crosstalk (estimated at 7%), the two method almost match

*Depends on the estimate of* $\sigma_{PRF}$

# Pulse Analysis

- Using MarlinTPC hit finder
- 2D hit study

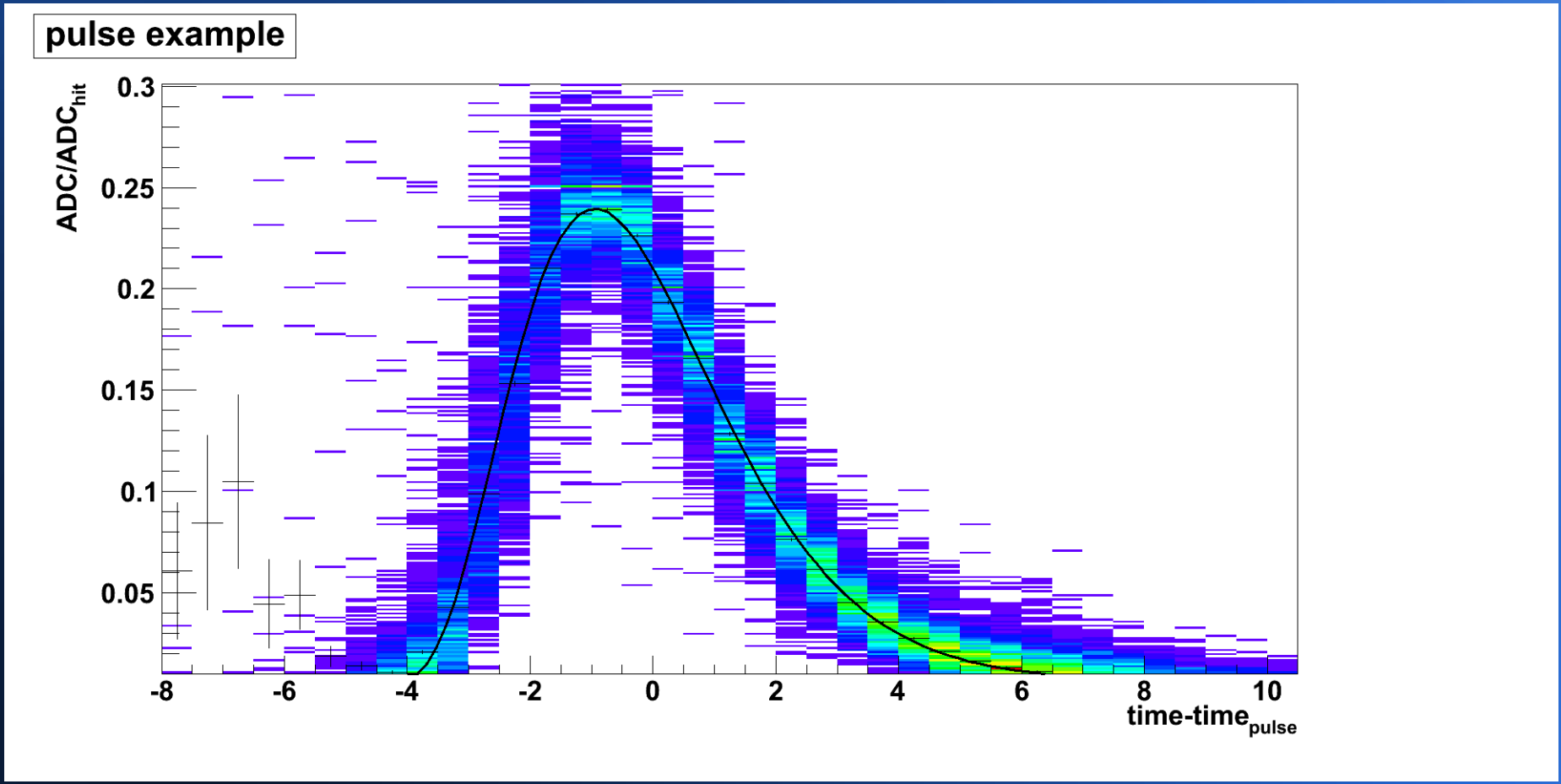


# Pulse definitions

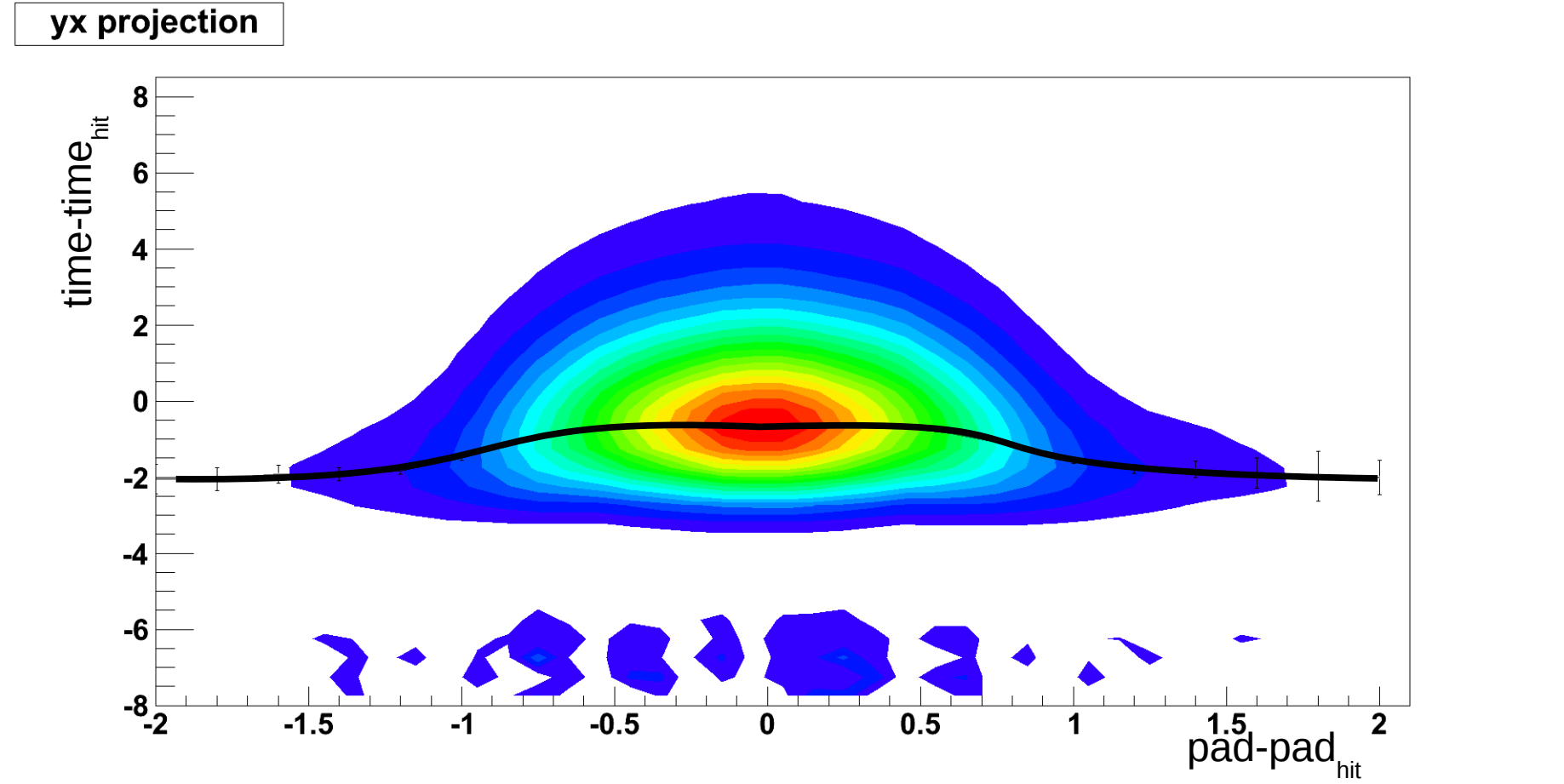
- Pulse time and charge
  - cog of bins above threshold
- Hit time
  - time of the central pulse
- Fitting function

$$F = A\, t^{P}\, \mathrm{e}^{-P\frac{t-t_0}{\tau}+P}$$

# Example

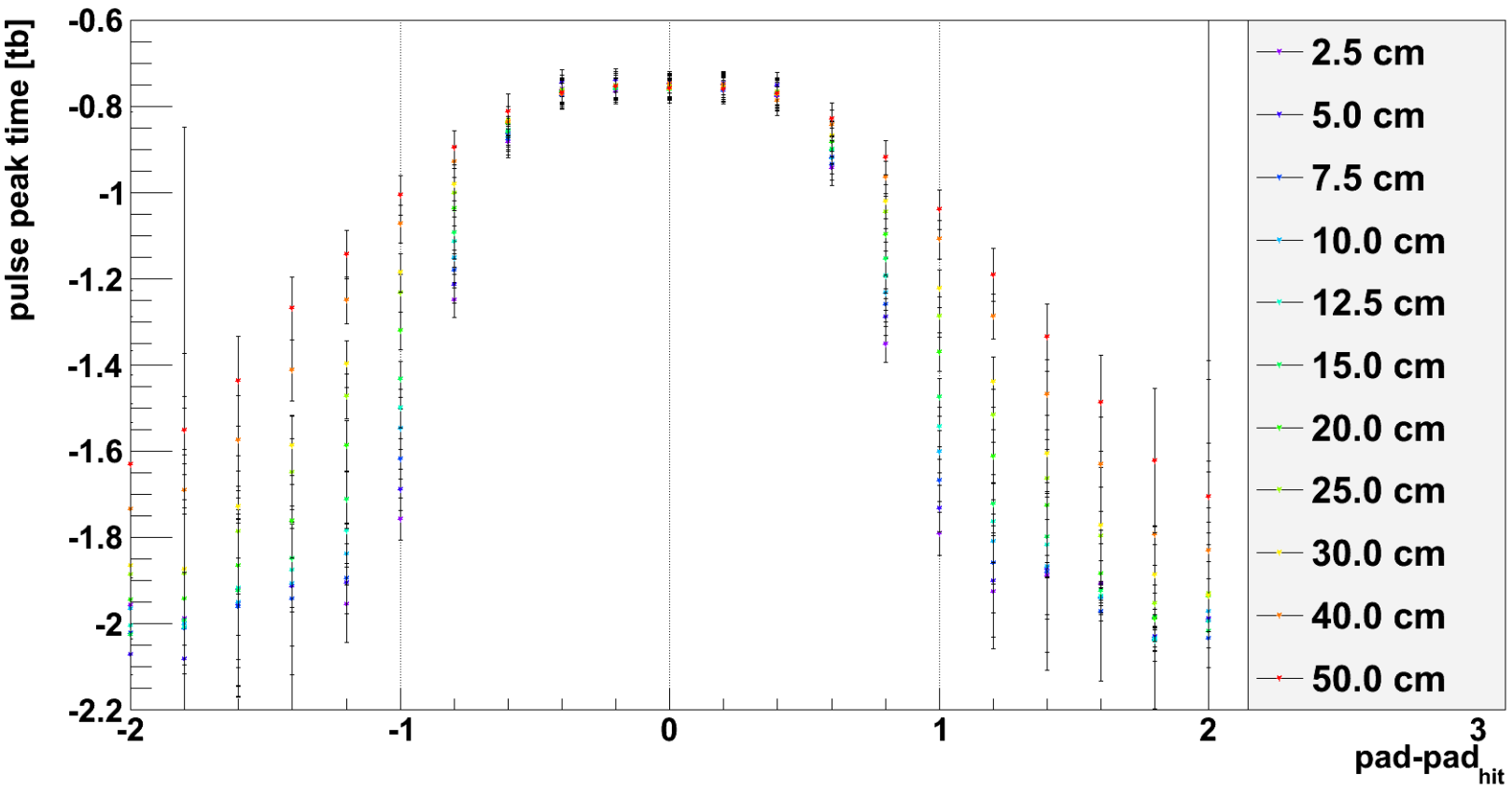

pulse example
ADC/ADC$_{hit}$
0.3
0.25
0.2
0.15
0.1
0.05
-8
-6
-4
-2
0
2
4
6
8
10
time-time$_{pulse}$

# Pulse timing




The signal away from the center of the hit appears to come **before** the main signal

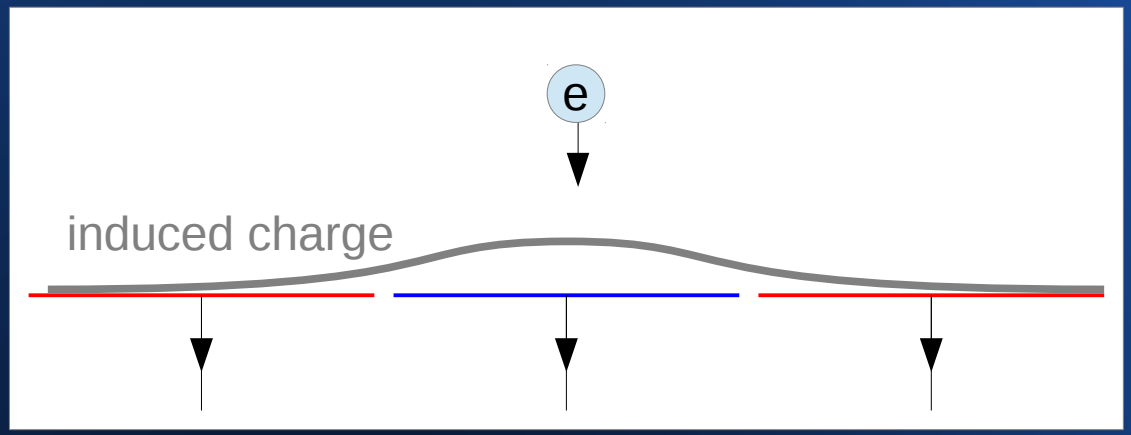
# Pulse timing

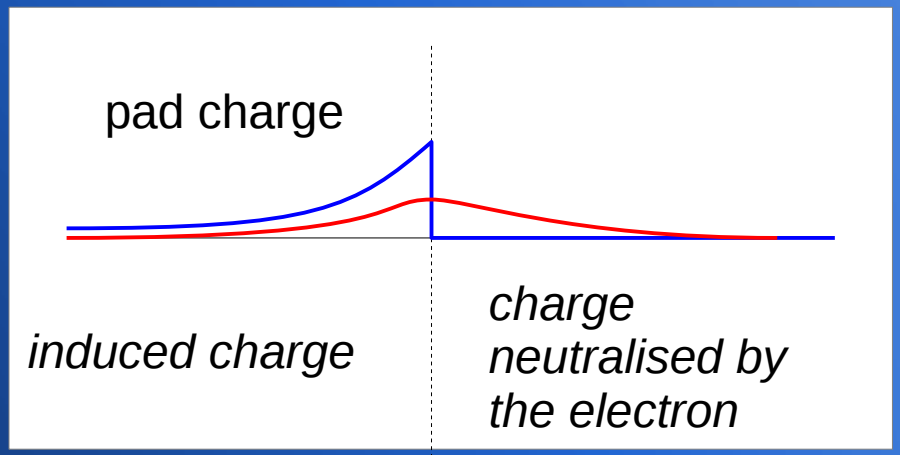


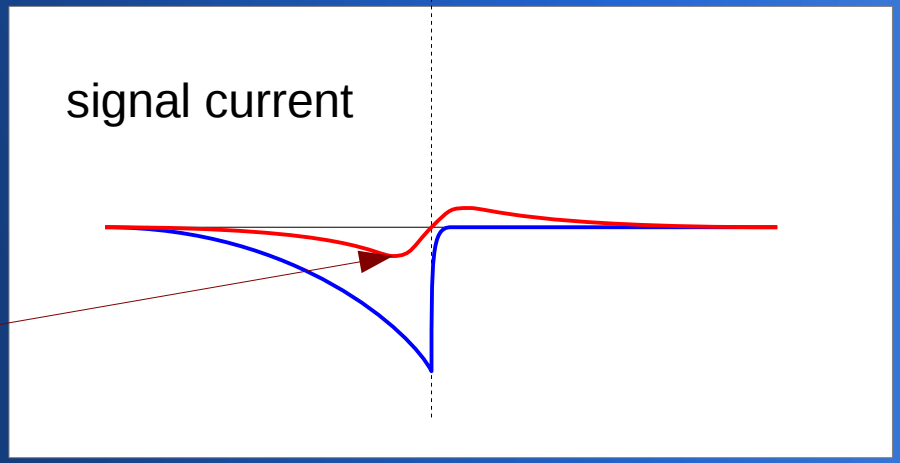

The effect is stronger at short drift distances

# Likely explanation: Induction on neighbour pad

When an electron reaches the pad, it induces a signal in the neighbour pads
The induced signal appears to be ahead of the main signal

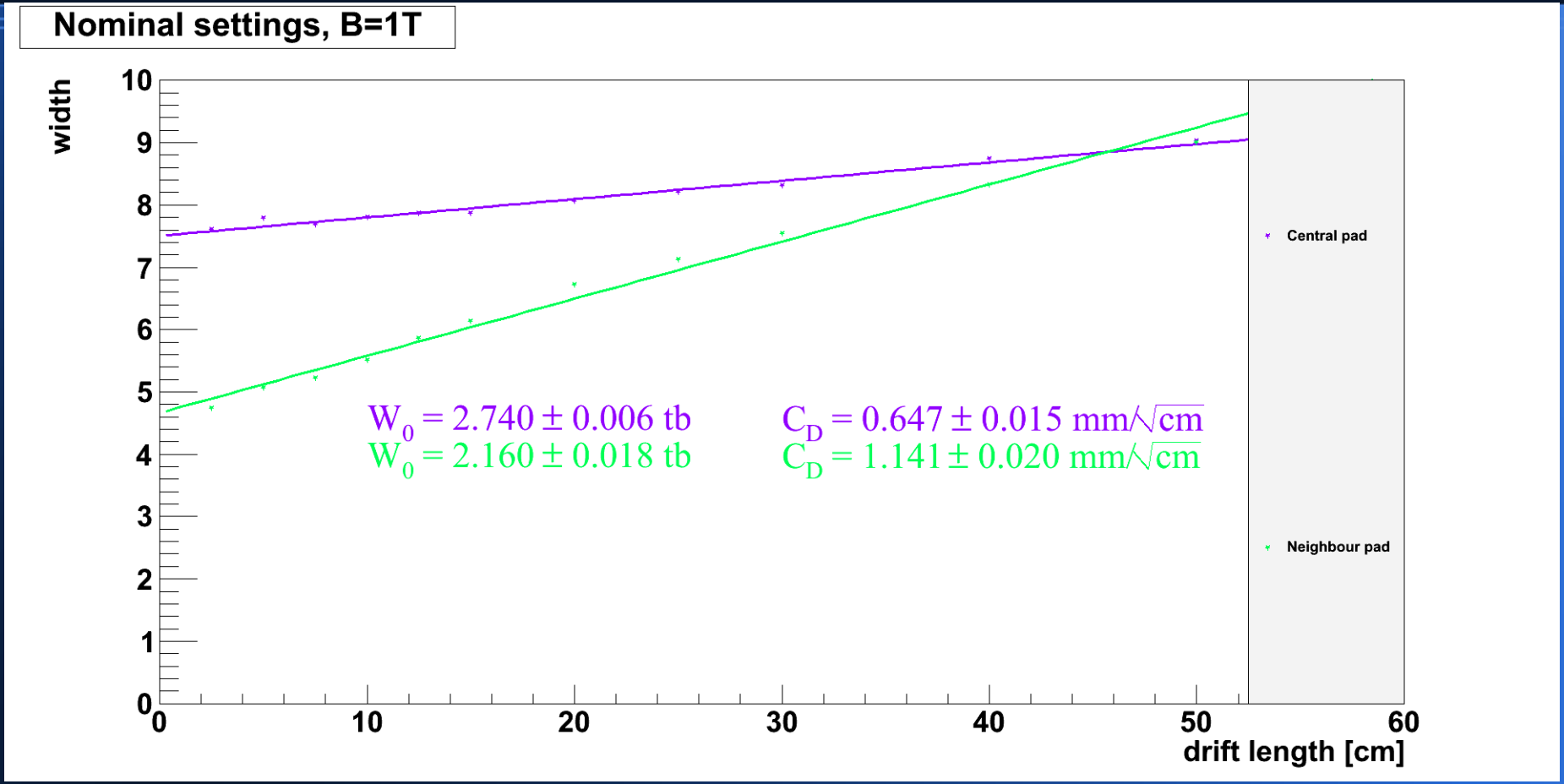



The induced signal arrives “before” the real one

# Pulse width, transverse diffusion




The pulse on the neighbour pads is narrower

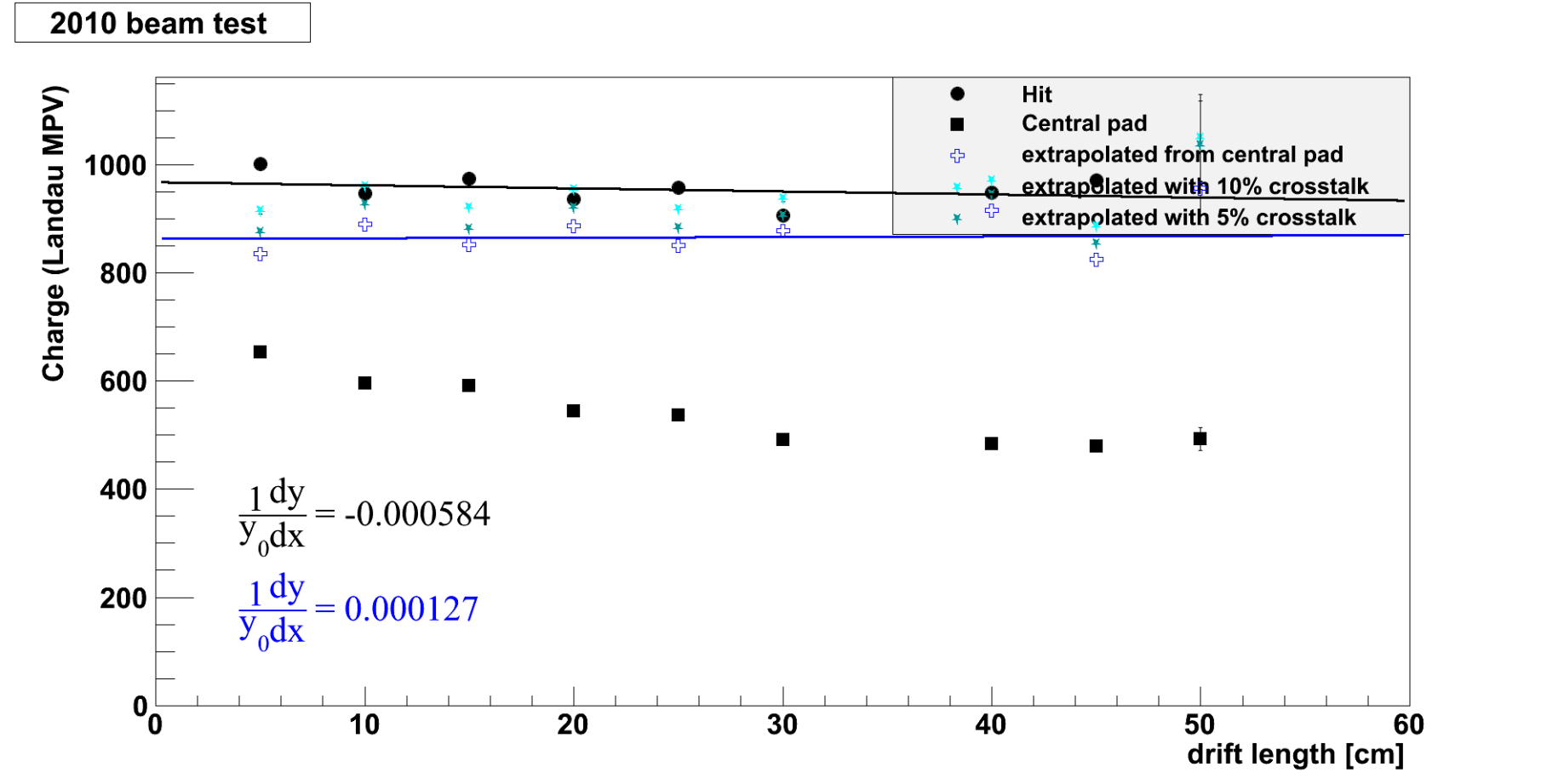
The effect is reduced by diffusion (more direct signal on the neighbours)

# Conclusions

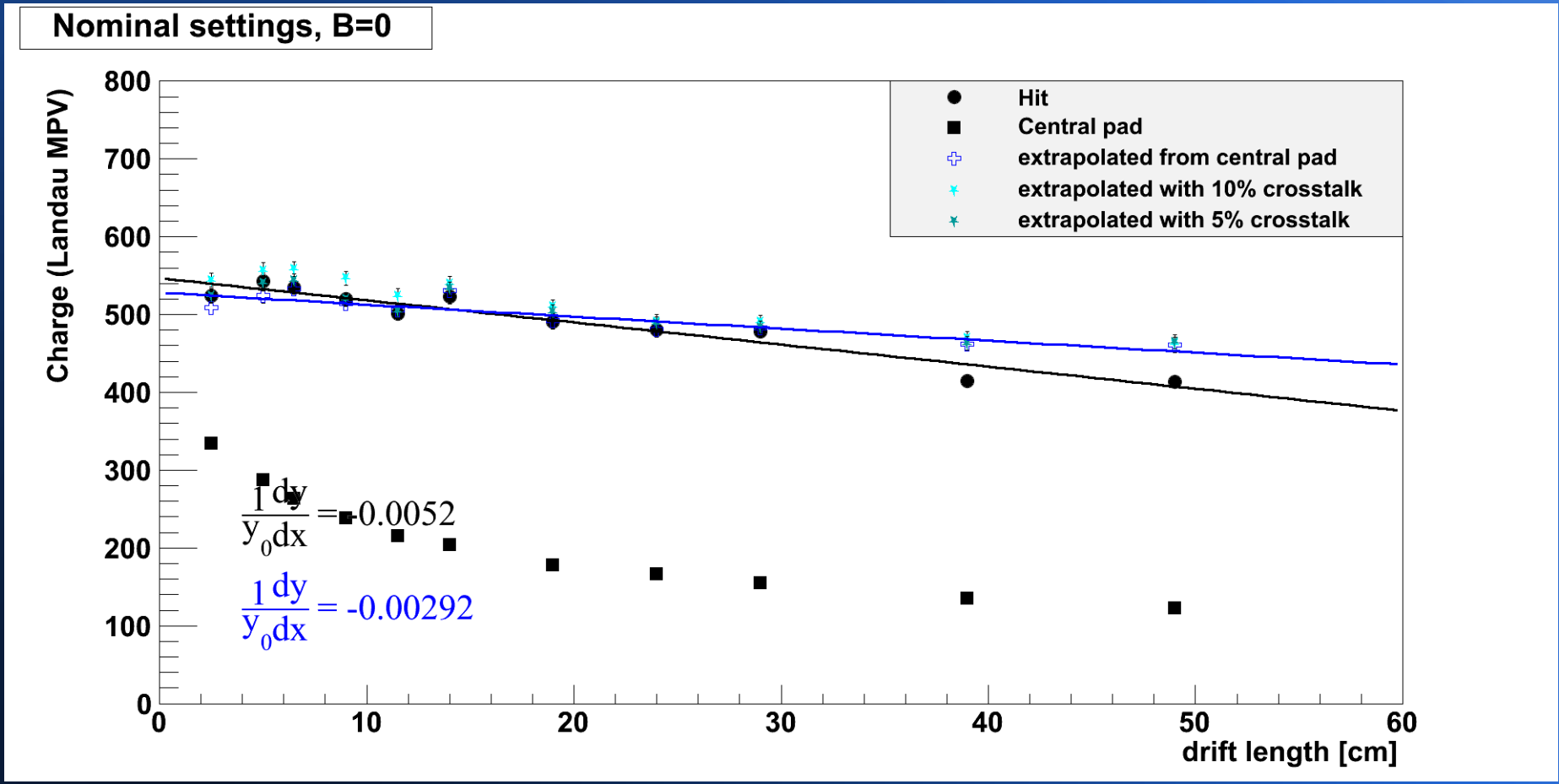
- Apparent charge loss
  - No clear explanation yet
  - Need more quantitative approach
  - Ultimately, we need Neffective
- Pulse shape
  - Very clean signals
  - Well understood behaviour

# Backup

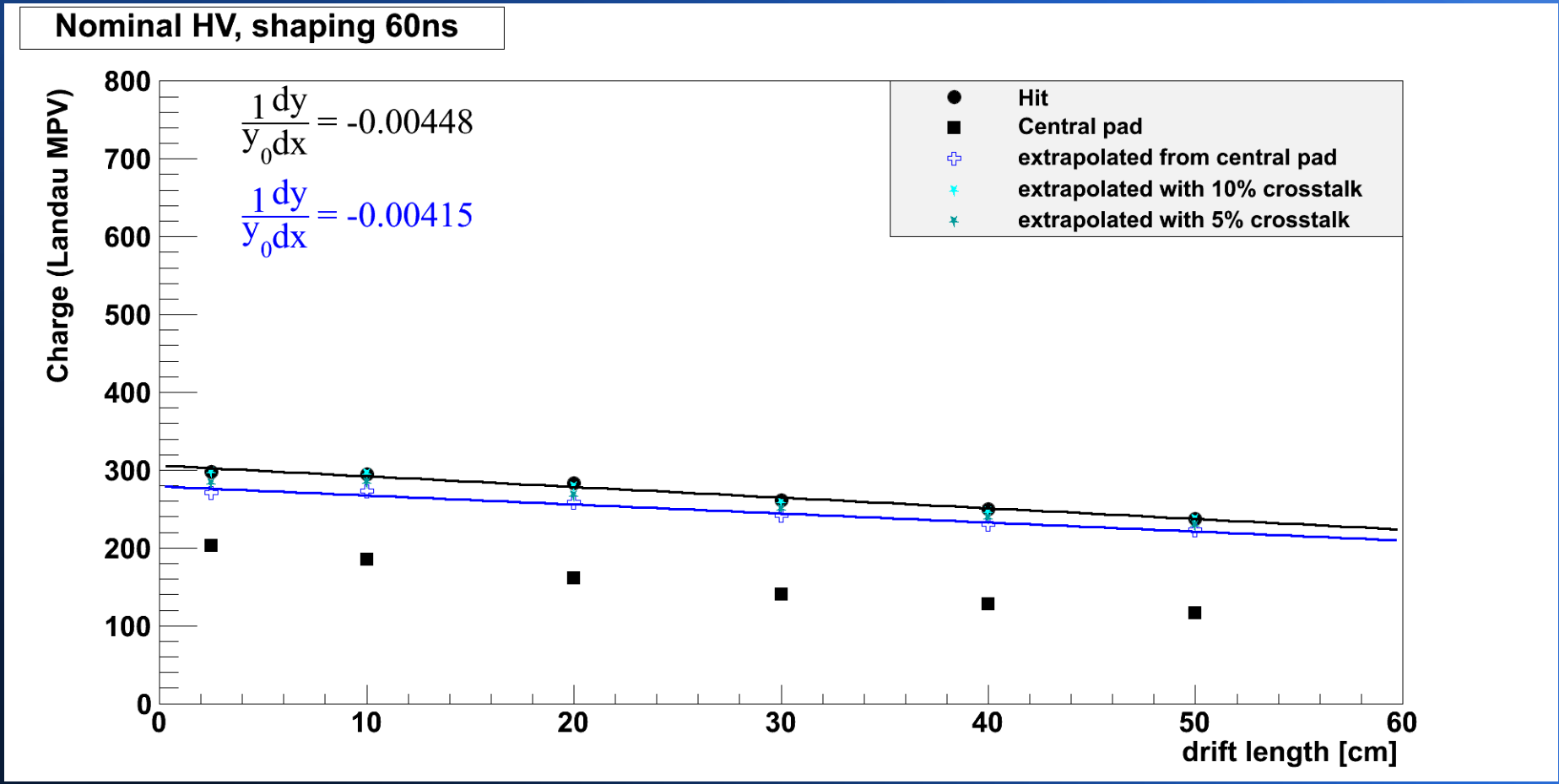
# 2010 data: no charge loss



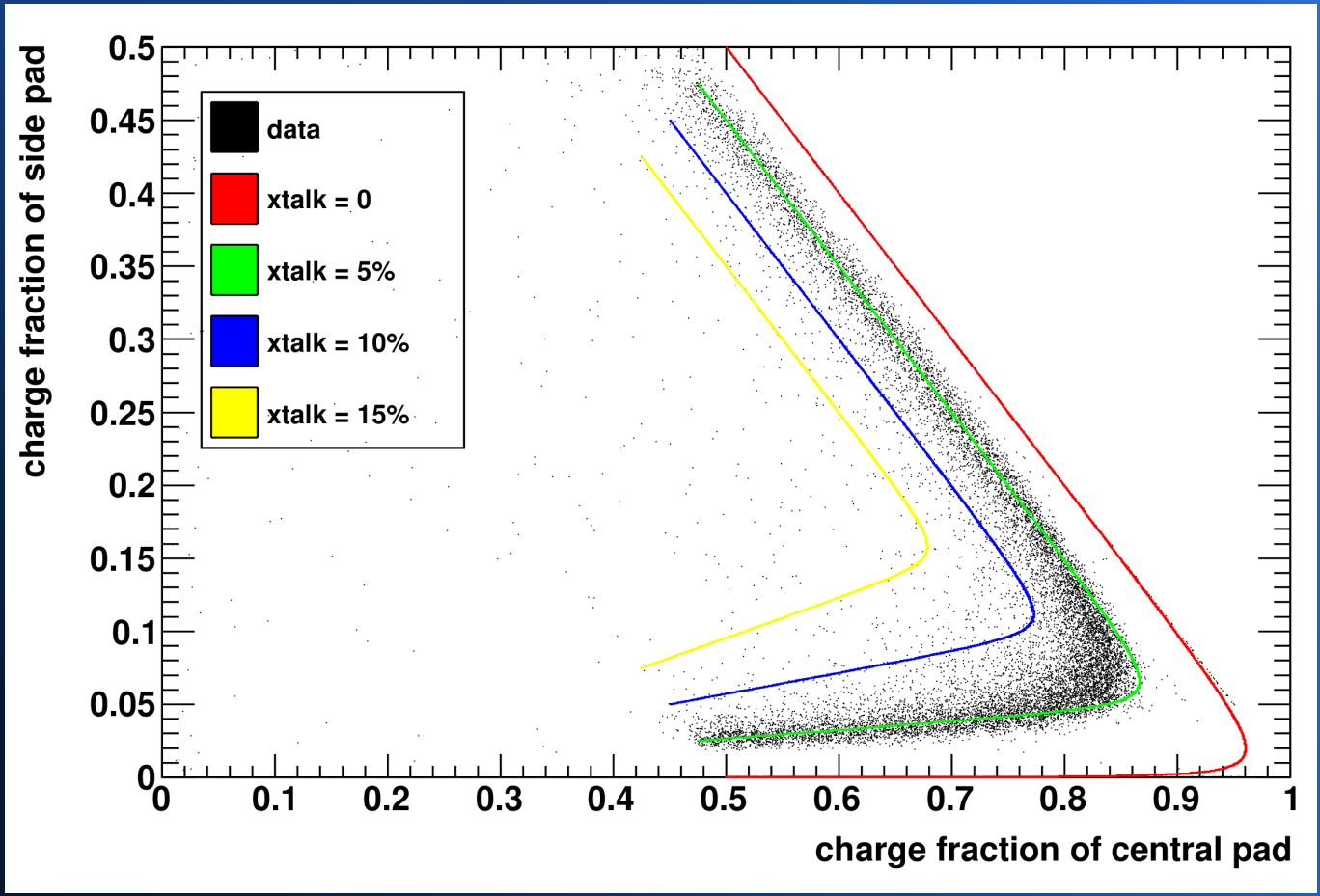
# B=0T, smaller charge loss



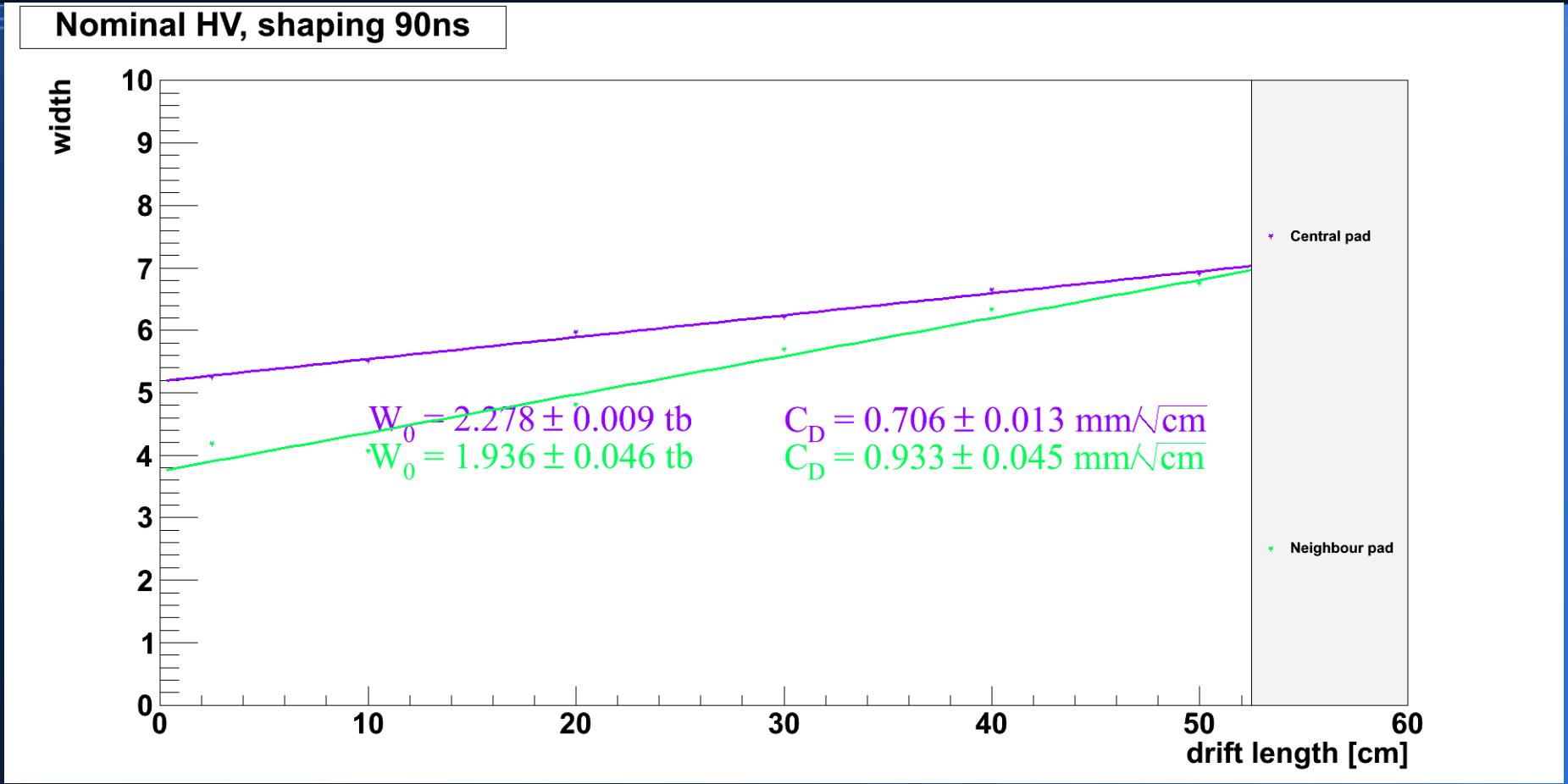
# shaper 60ns, smaller charge loss



# Cross talk


charge fraction of side pad
charge fraction of central pad
data
xtalk = 0
xtalk = 5%
xtalk = 10%
xtalk = 15%
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

# Pulse width, shaper 90ns



# Pulse width, shaper 60ns