Results from the 2012 beam test of the Asian GEM modules

Ryo Yonamine (KEK)
Philippe Gros (Saga U')
Junping Tian (KEK)
Shin-ichi Kawada (Hiroshima U')

on behalf of LCTPC-Asia group

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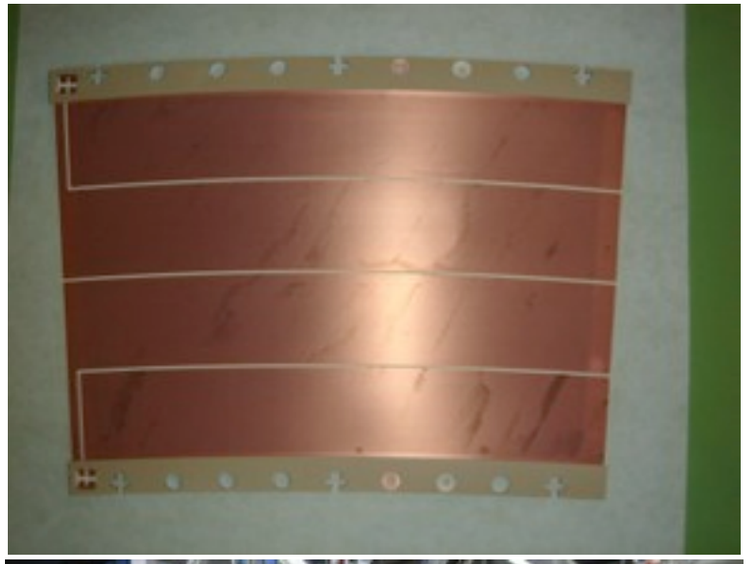
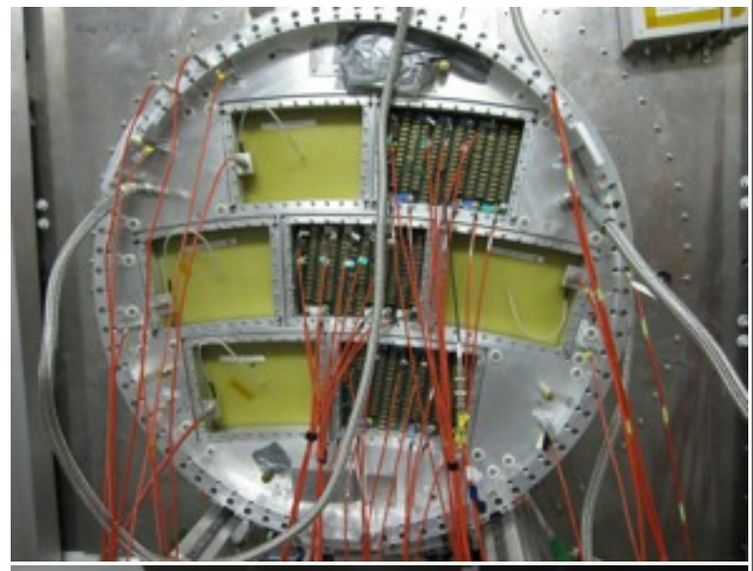
outline

- General results
  - pulse shape
  - hit efficiency
  - spatial resolution
- Charge loss issue
  - gain uniformity
  - discharge
  - cross talk
  - threshold effect
  - MC with real charge loss
- summary

Nov. 19 - Dec. 18, 2012 @ T24, DESY

Many thanks to the support of DESY and Lund TPC group!

Data and Reconstruction

- B=0T, B=1T
- z-scan: (2.5cm - 50cm)
- x-scan: (-2cm - 2cm)
- theta-scan: (-10°,10°)
- phi: (0°,10°)
- different gains, shaping times, threshold

Analysis Framework: MarlinTPC v01-11

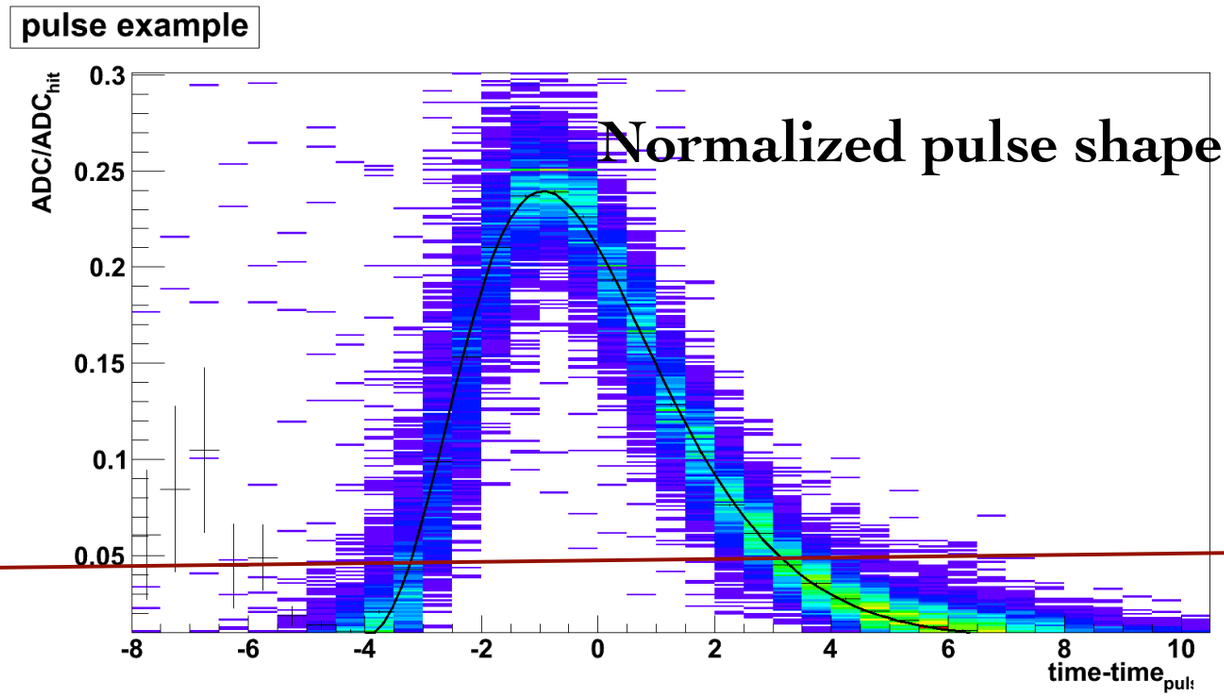
Reconstruction flow:

- pulse finder
- channel mapping
- row based hit finder
- tracking by kalman filter

data available on grid: /grid/ilc/tpc/2012/t24/jgem/rawdata

run infomation: http://www-hep.phys.saga-u.ac.jp/ILC-TPC/index.php?Large%20Prototype%201%2FTests%2FBeamTest%202012%2FData%20Taking#s51a2905

Pulse shape



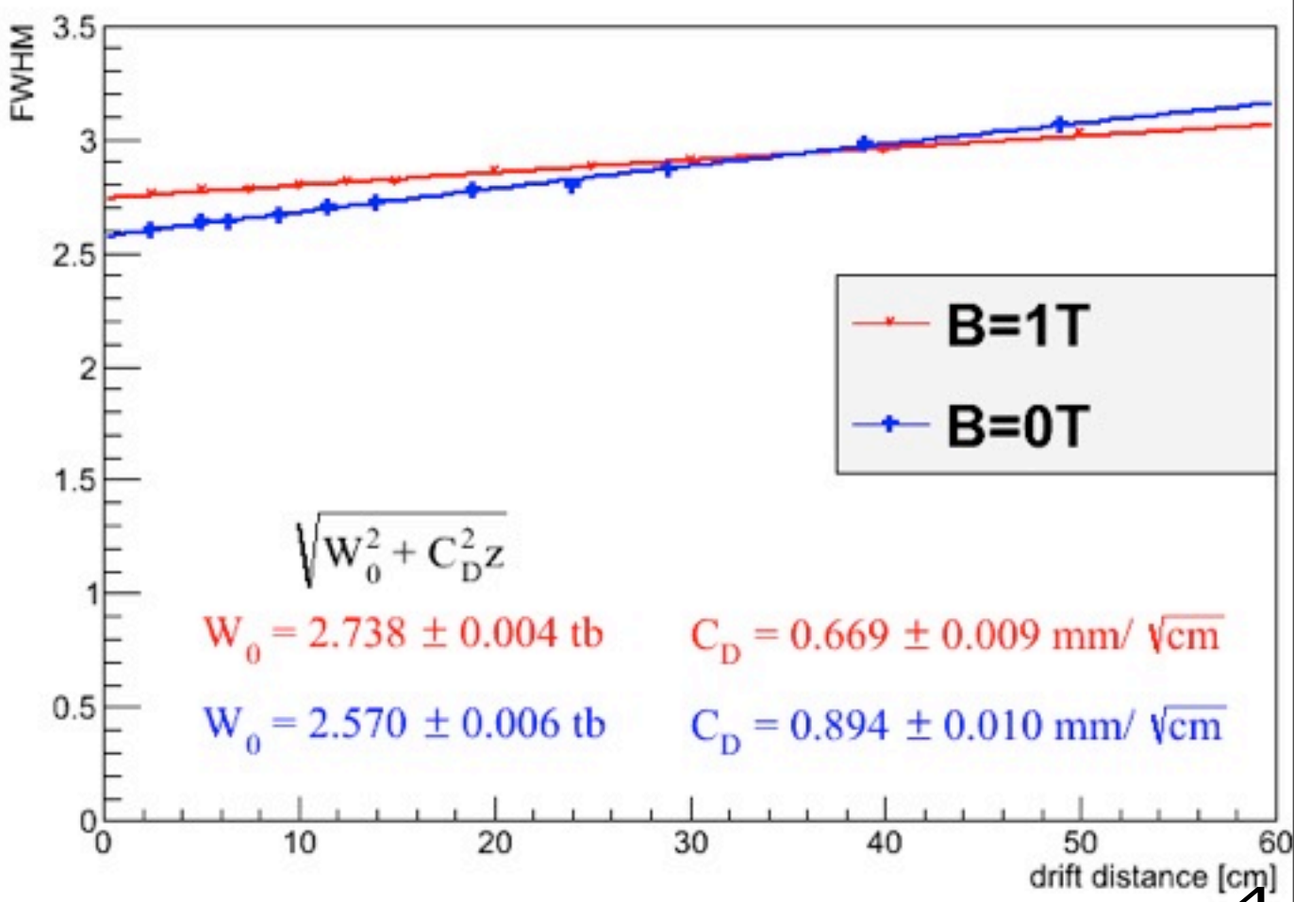
well-understood behavior, relative threshold used in pulser finder

1 time bin = 50 ns

$$f(x) = A(\frac{t-t_0}{\tau})^4 e^{-\frac{t-t_0}{\tau}}$$

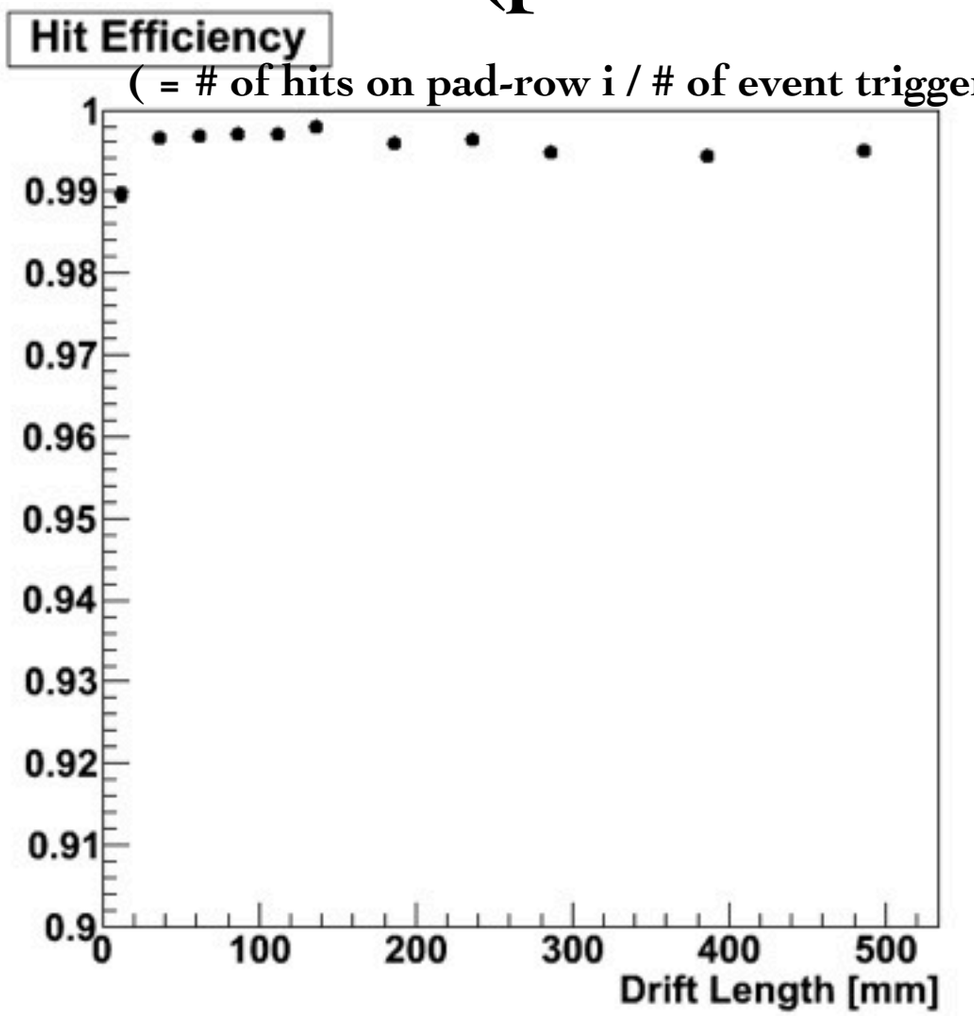
Γ = Full Width at Half Maximum

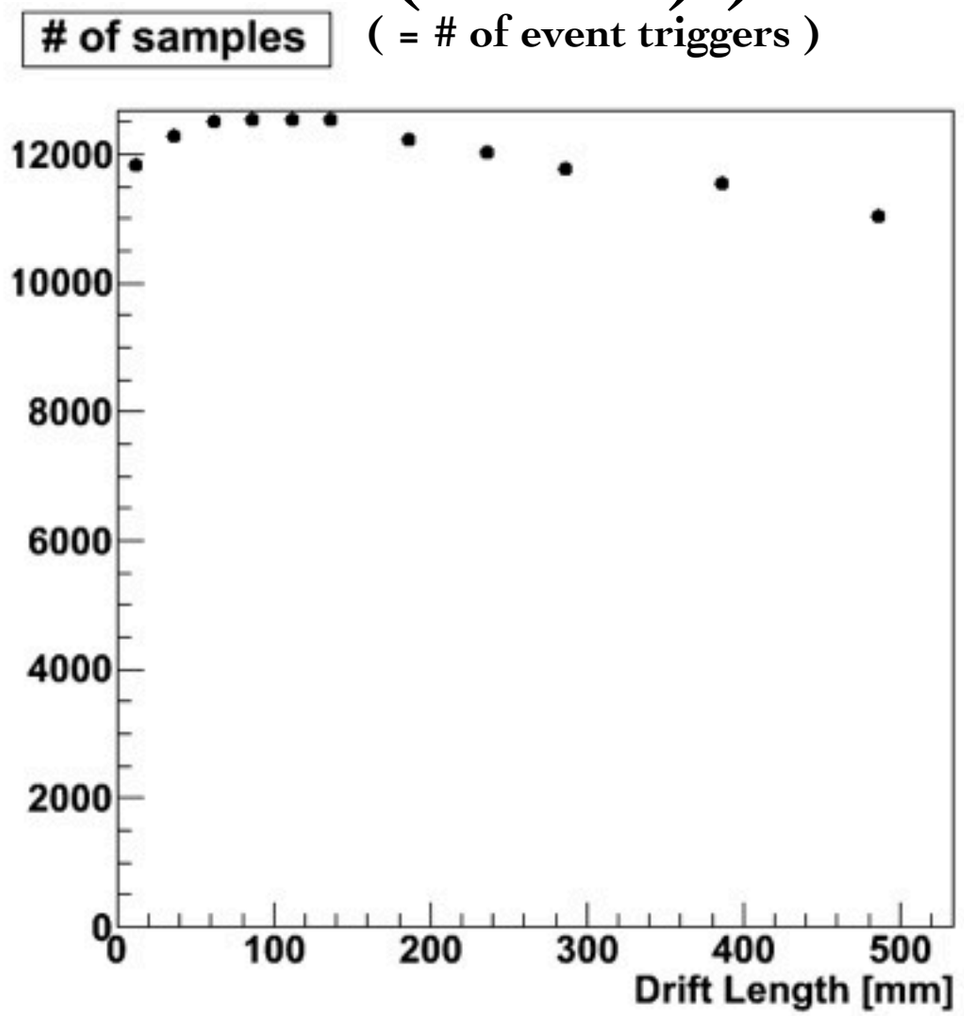
pulse width:
longitudinal diffusion

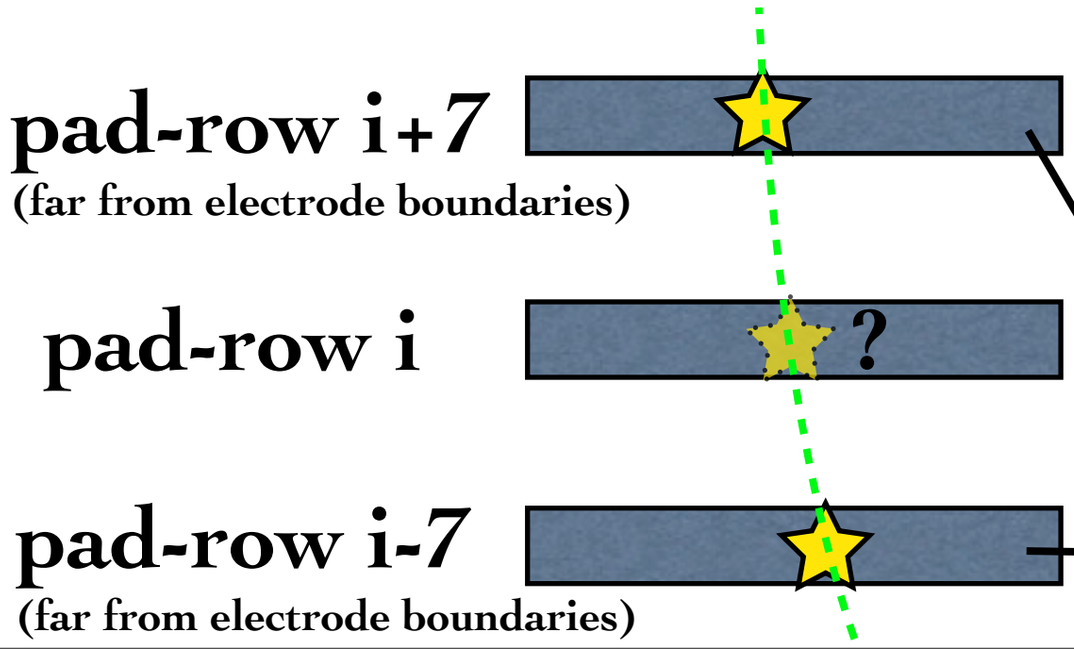


Hit efficiency

(pad-row 17 of module 3 (center))





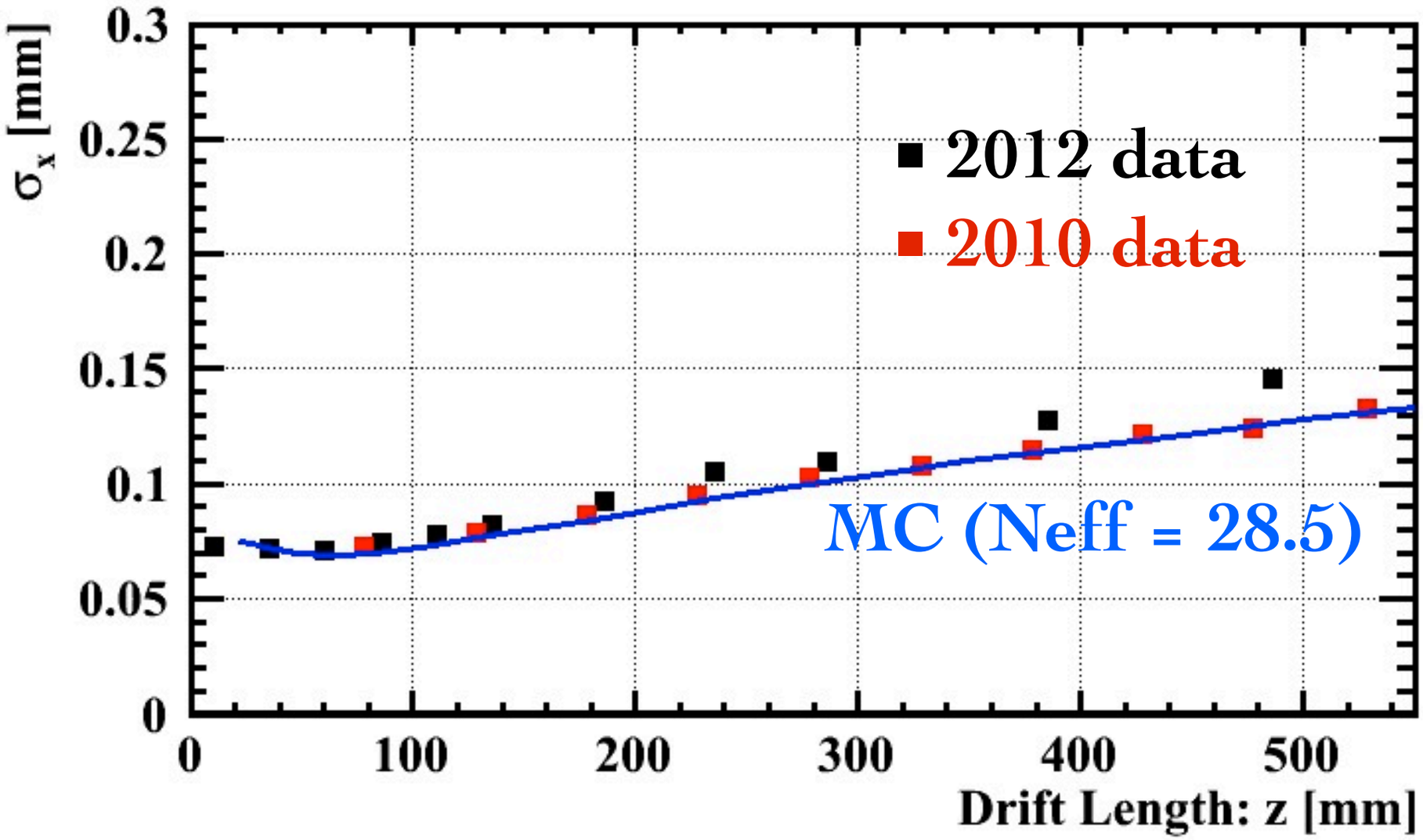


We checked if there is a hit on pad-row i while requiring hits on both pad-row i±7.

Used as a event trigger

xy-resolution

central module, row 17



An issue of charge loss

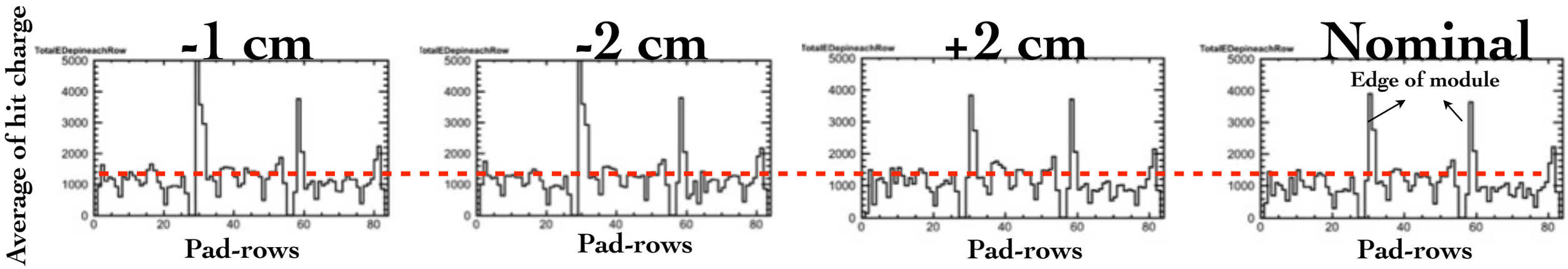
Apparent charge loss
as a function of drift length

The loss is too much compared
to measured oxygen content :
70ppm which corresponds to
-10% / 500mm.

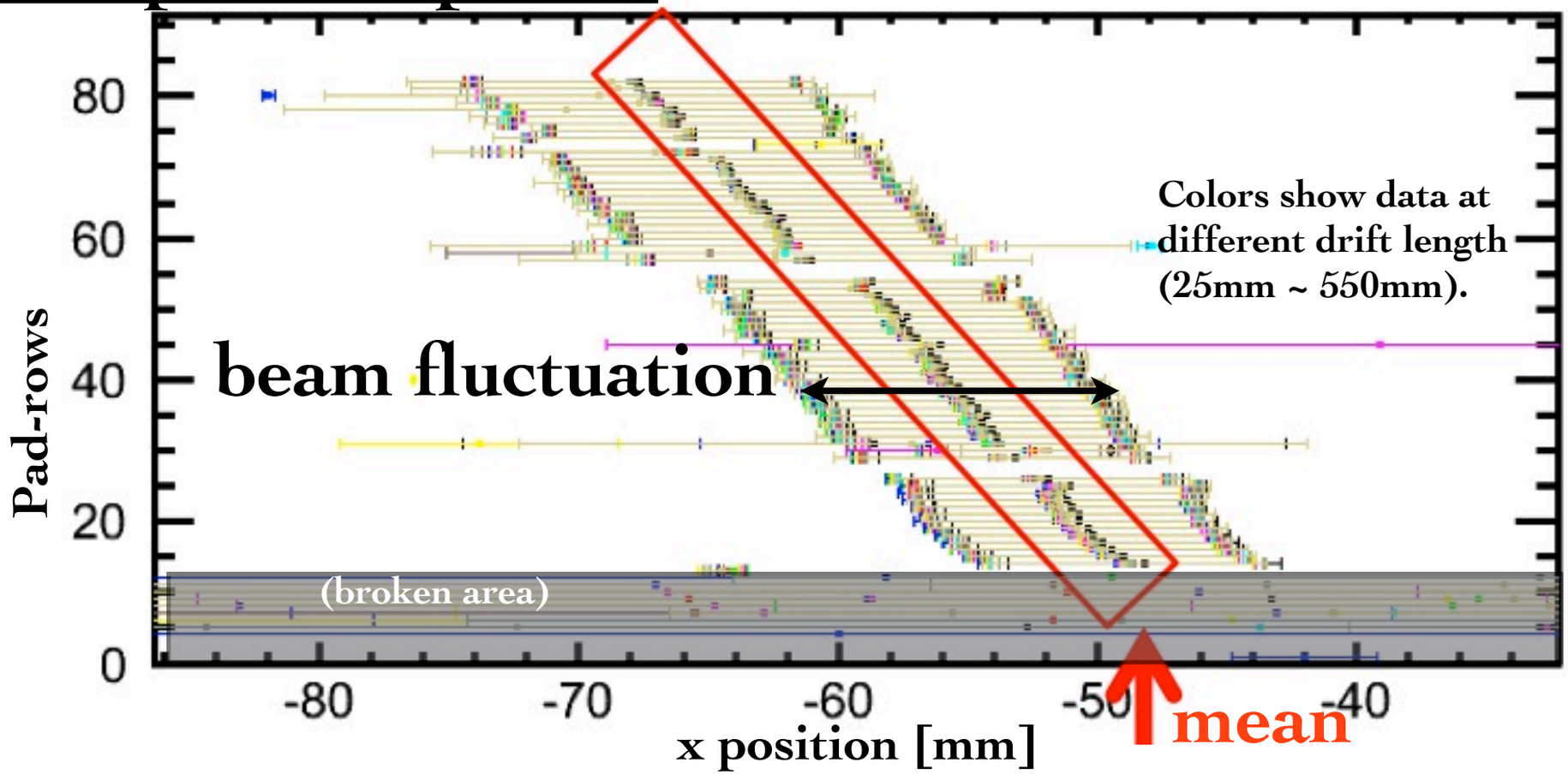
- Gain uniformity?
- Discharge effect?
- Crosstalk?
- Threshold effect?
- Real charge loss?

Gain Uniformity

x-position dependence --> No dependence



beam position profile



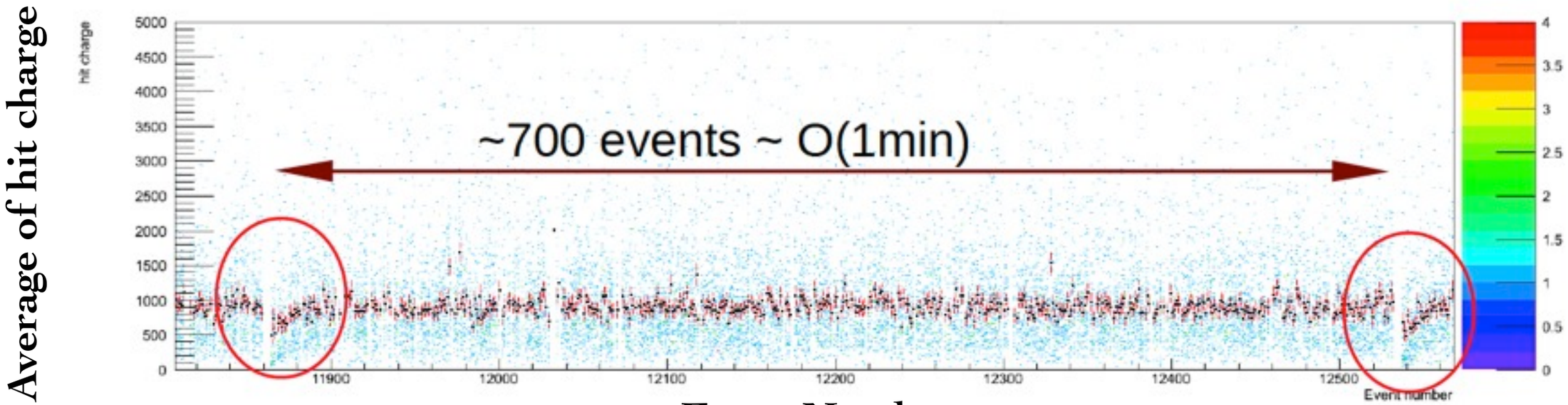
Within beam fluctuation including difference of drift length, gain should be almost same.

-->We should have same gain at each drift length.

-->Gain variance can not be the cause of the “charge loss”.

Discharge Events

Unfortunately we had some discharges during the beam test. A discharge can be identified as a gain drop.

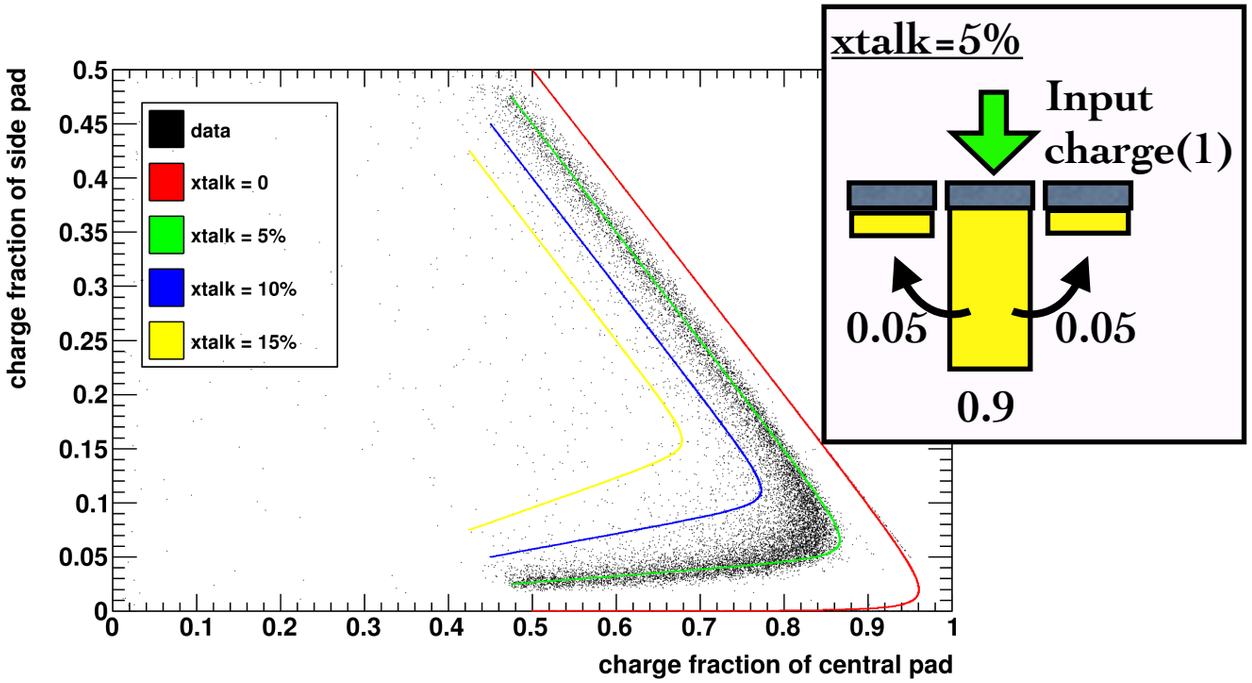


Event Number

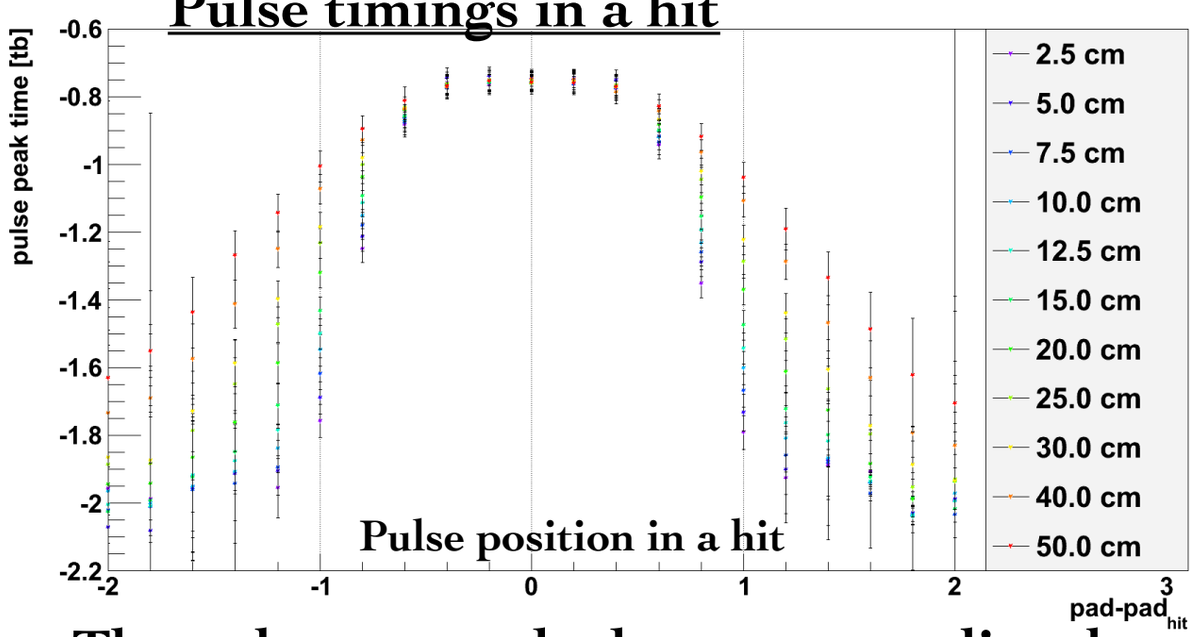
We removed these events from our analysis.

Cross talk and Induction Signals

Indicating cross talk(5%+5%)



Indicating induction signals



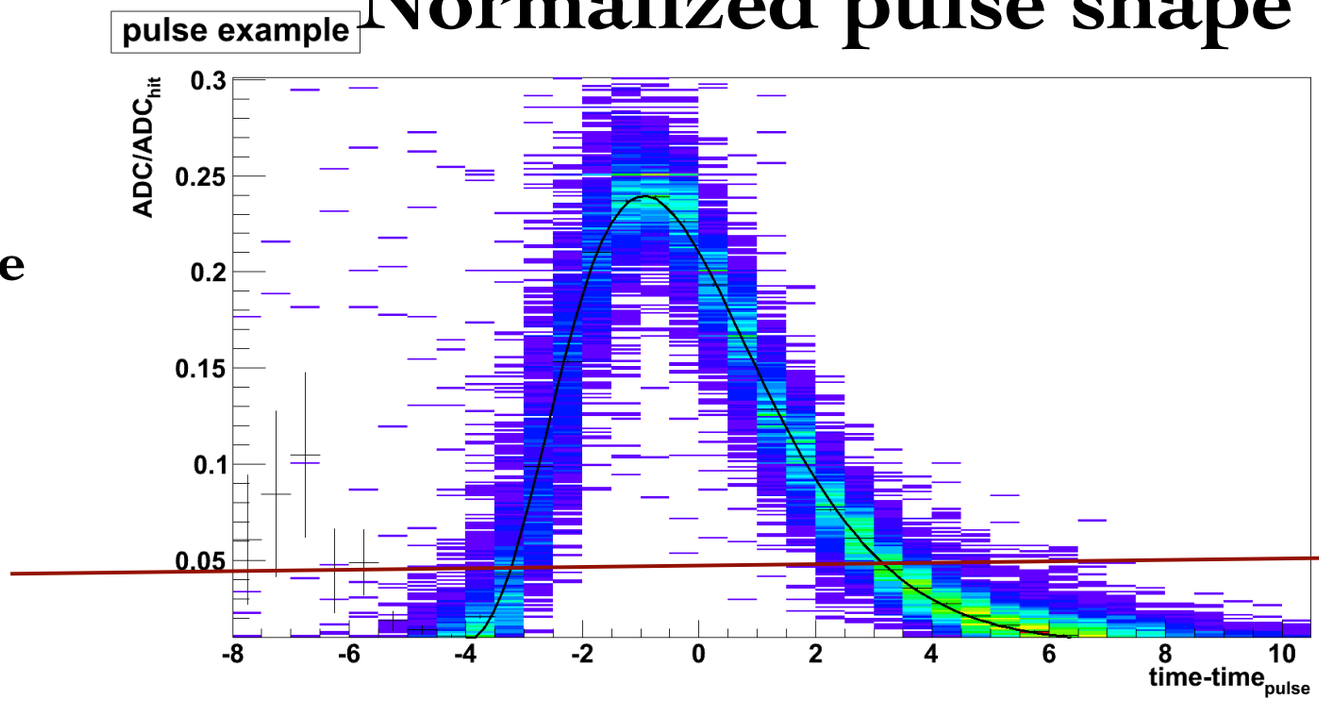
The pulses around edges come earlier than that of center. -->There seems to be some contribution from induction signals.

We took these effects into a MC simulation and checked the behavior of hit charge as a function of drift length.
But we were not able to reproduce the “charge loss”.
--> These can not be the cause of the “charge loss”.

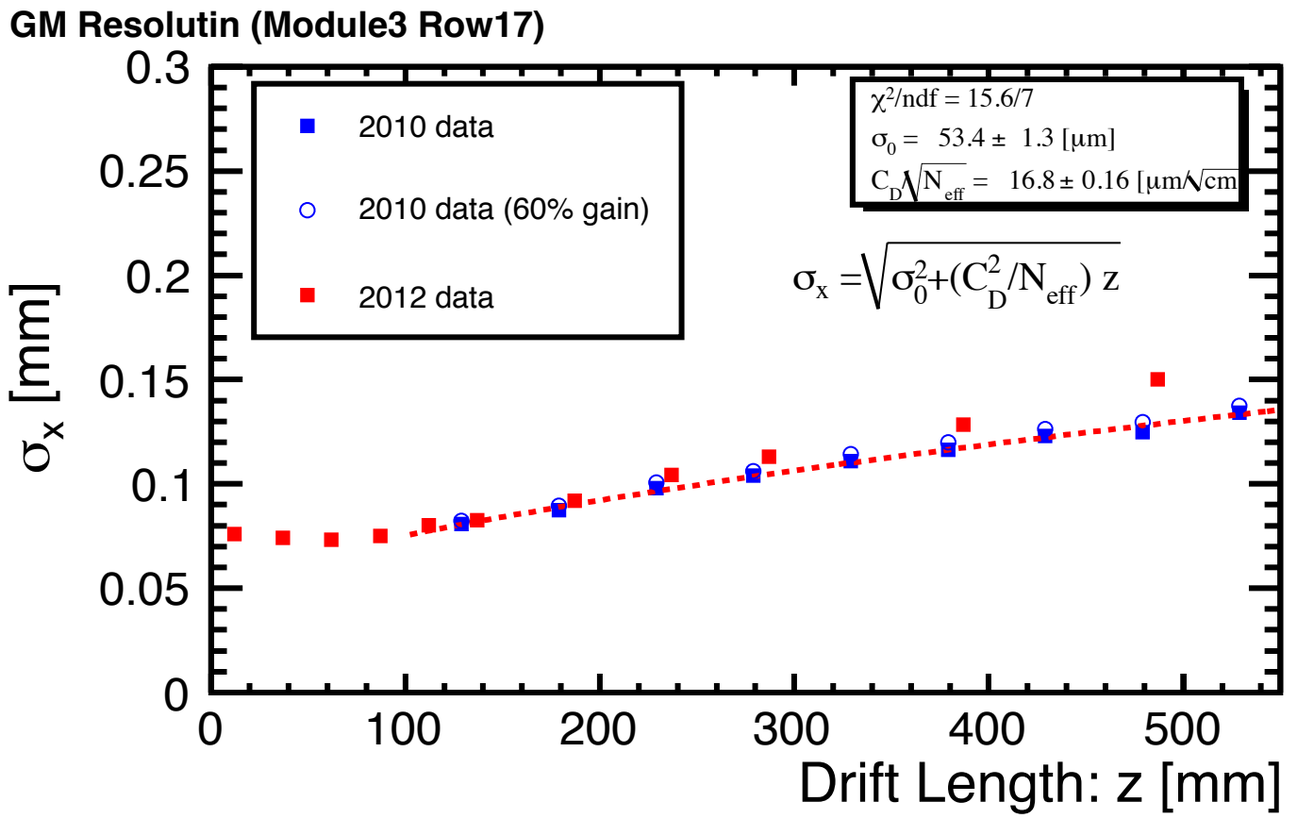
Threshold Effect (Pulse)

In order to cut equally the pulse tail, we introduced thresholds(start/end) being relative to the peak.
--> No big difference in “charge loss”

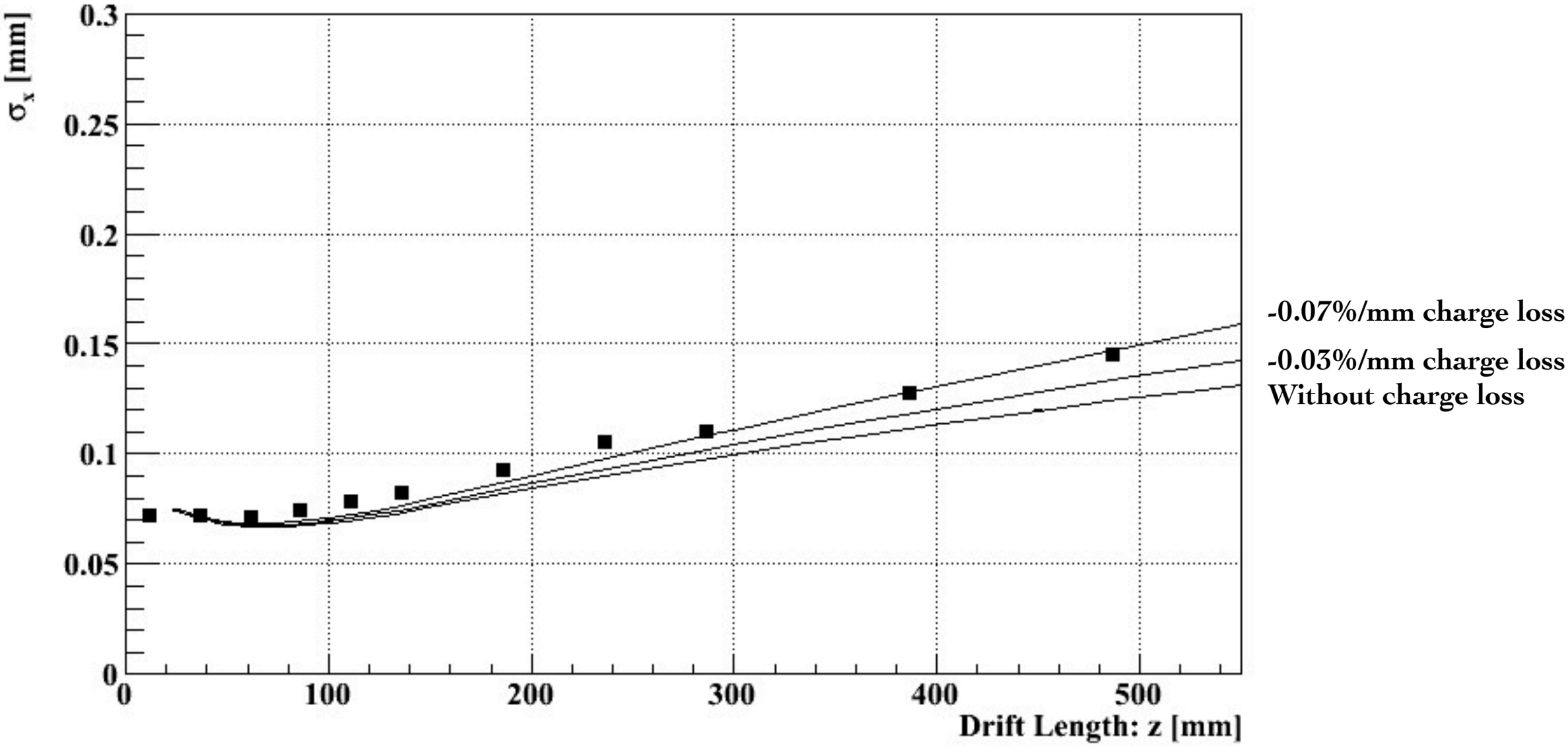
Normalized pulse shape



threshold check with 2010 data: technically reduce the gain by 40%



MC with real charge loss



Neff = 28.5 (consistent with 2010 data)

0.07%/mm --> 30%loss at 500 mm

--> consistent with charge sum behavior

charge loss?

✓- Gain uniformity --> no gain variation
✓- Discharge effect --> removed
✓- Crosstalk, induction signals --> no effect
✓- Threshold effect (pulse/hit reconstruction) --> no change
✓- Neff (spatial resolution) --> consistent with decreasing Neff

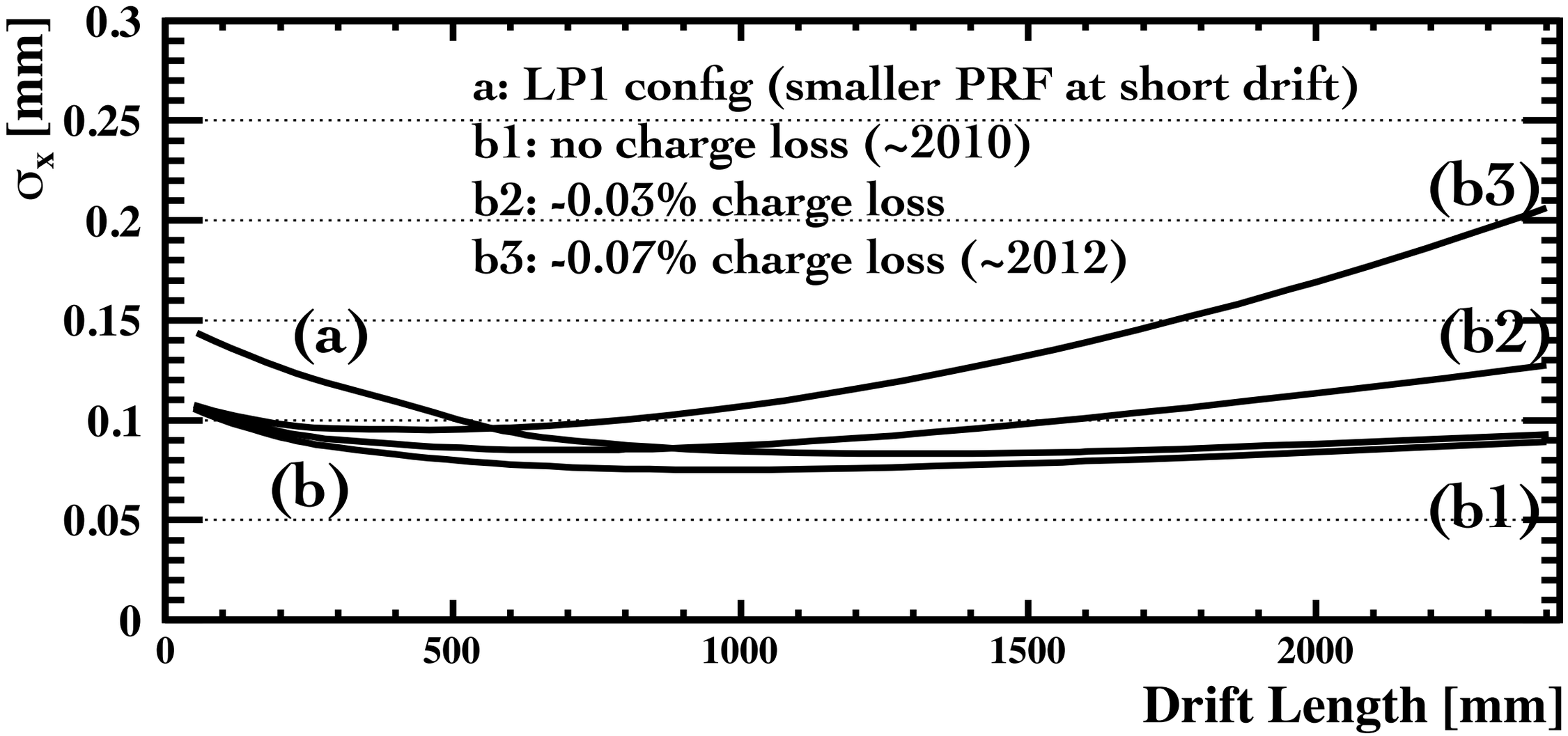
The data supports that we really lost seed electrons.

Extrapolation to the ILD-TPC (MC)

Drift length 600mm --> 2400mm

B 1 T --> 3.5 T

Ryo's Simulation



gas : Ar-CF4-isoC4H10 (95:3:2) (T2Kgas)
pad height = 5.26 mm
pad width = 1.16 mm
Neff = 28.5
Cd = 30 microns / sqrt(cm) at 3.5 T
sigma_prf = 0.20 mm (a), 0.26 mm (b) at 3.5 T

it is essential to measure the key parameters (Neff, PRF..) at 3.5 T

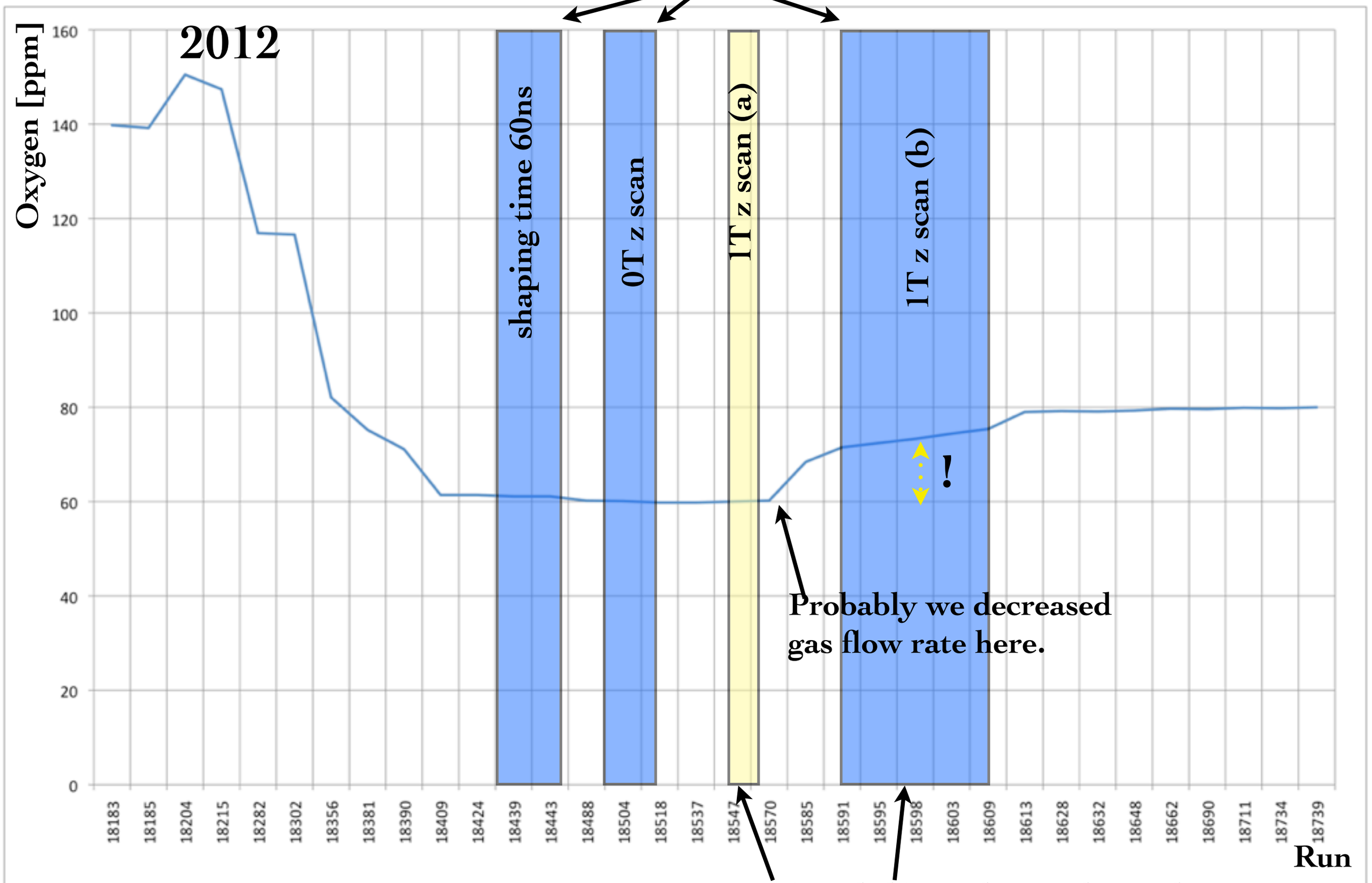
Summary

- lots of data taken during the 2012 beam test: generally the Asian GEM is working well, high hit efficiency, longitudinal diffusion, reasonable point resolutions.
- confirmed gain uniformity, cross talk.
- discharge need be solved in future module.
- indicate real charge loss in our test.
- confirmed resolution of 2010 data which can meet the requirement of ILD-TPC.
- further analyses are still going on.

Back up

Oxygen data

The runs we checked so far.

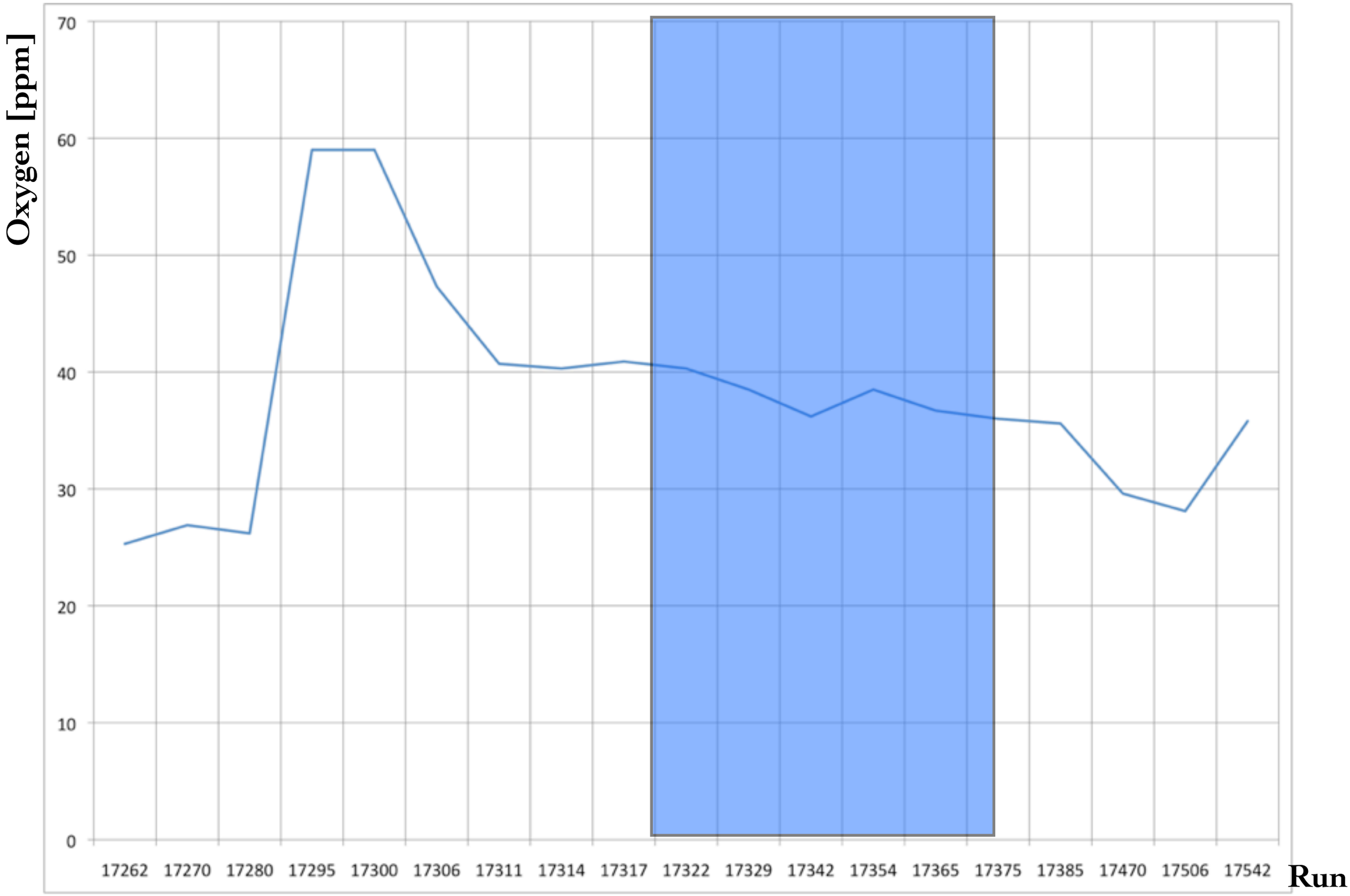


Oxygen could be the cause ?

(a) and (b) can be good samples to check the oxygen effect.

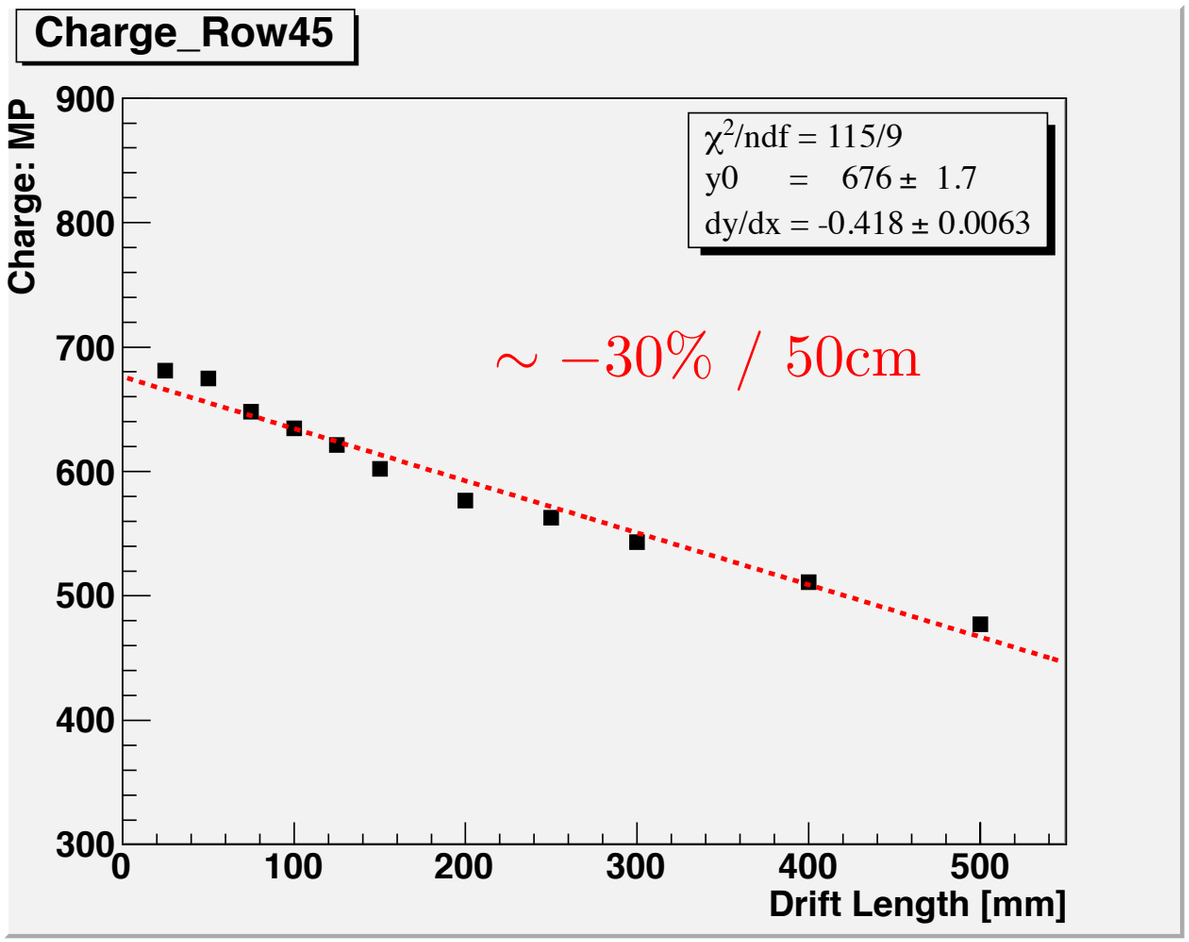
2010 Oxygen data

The runs we analyzed.

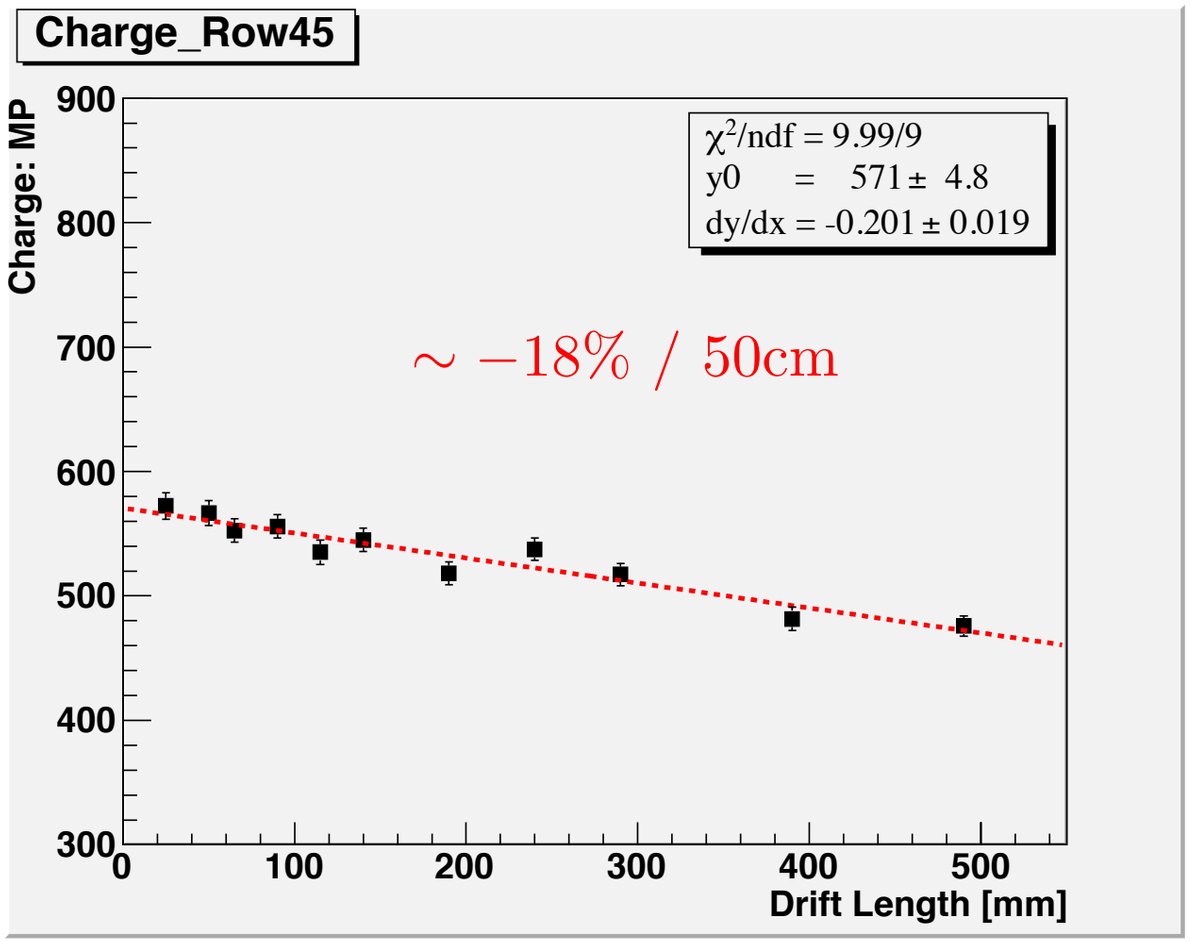


charge by row

B=1T

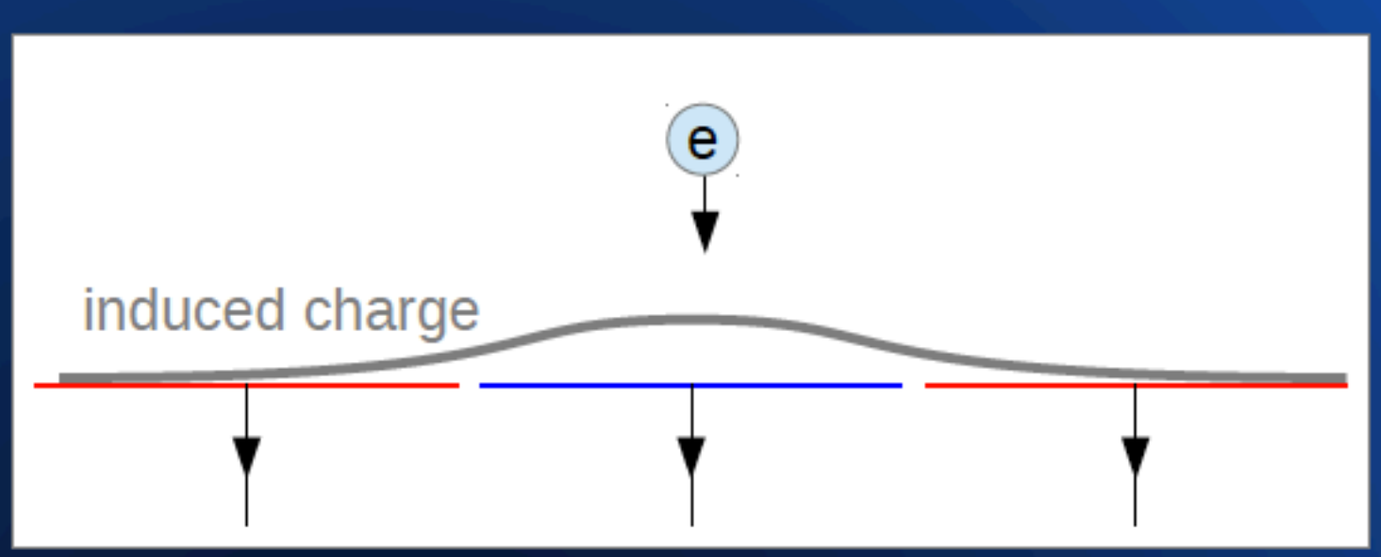


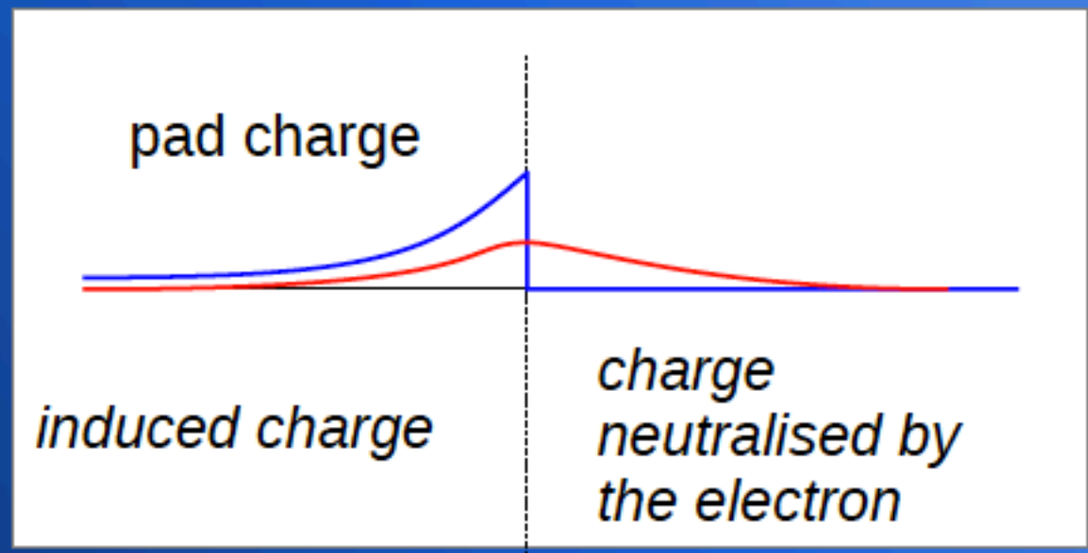
B=0T

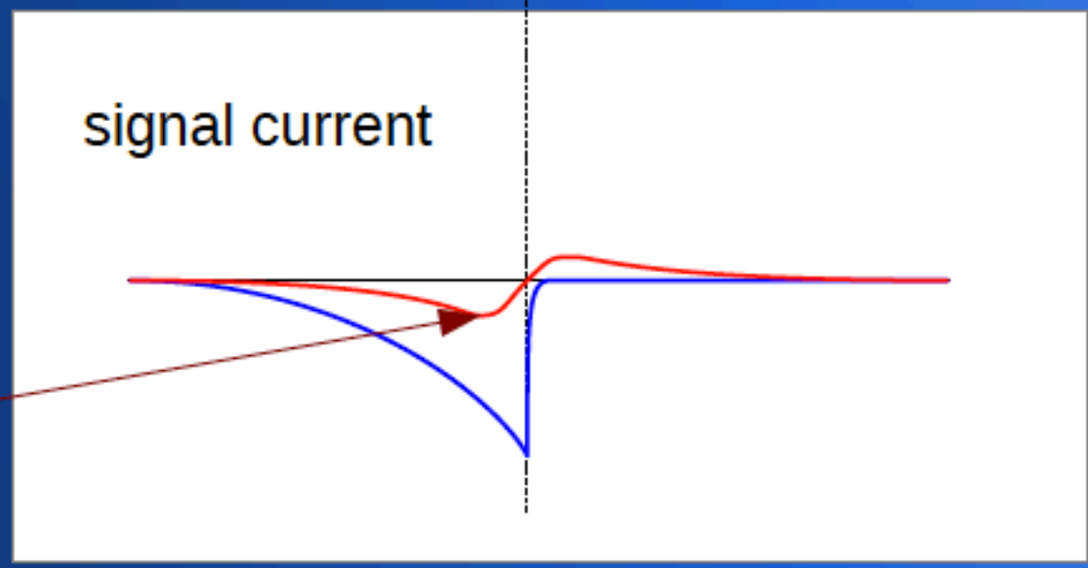


Likely explanation: Induction on neighbour pad

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