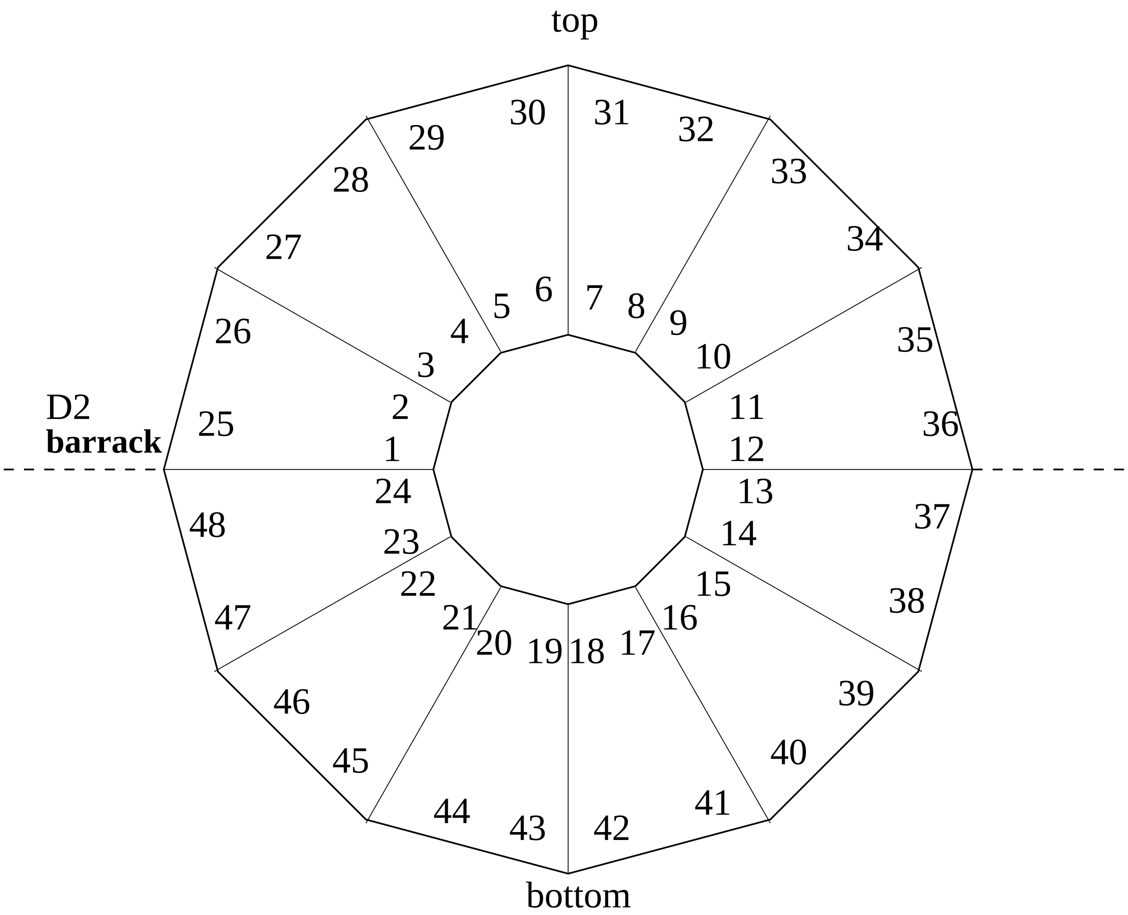
Calibration of the Barrel RICH

Ivo van Vulpen

The DELPHI Barrel RICH
The Barrel RICH calibration system
How to extract drift velocities
Complications (shorts)
Conclusions

The Barrel RICH layout

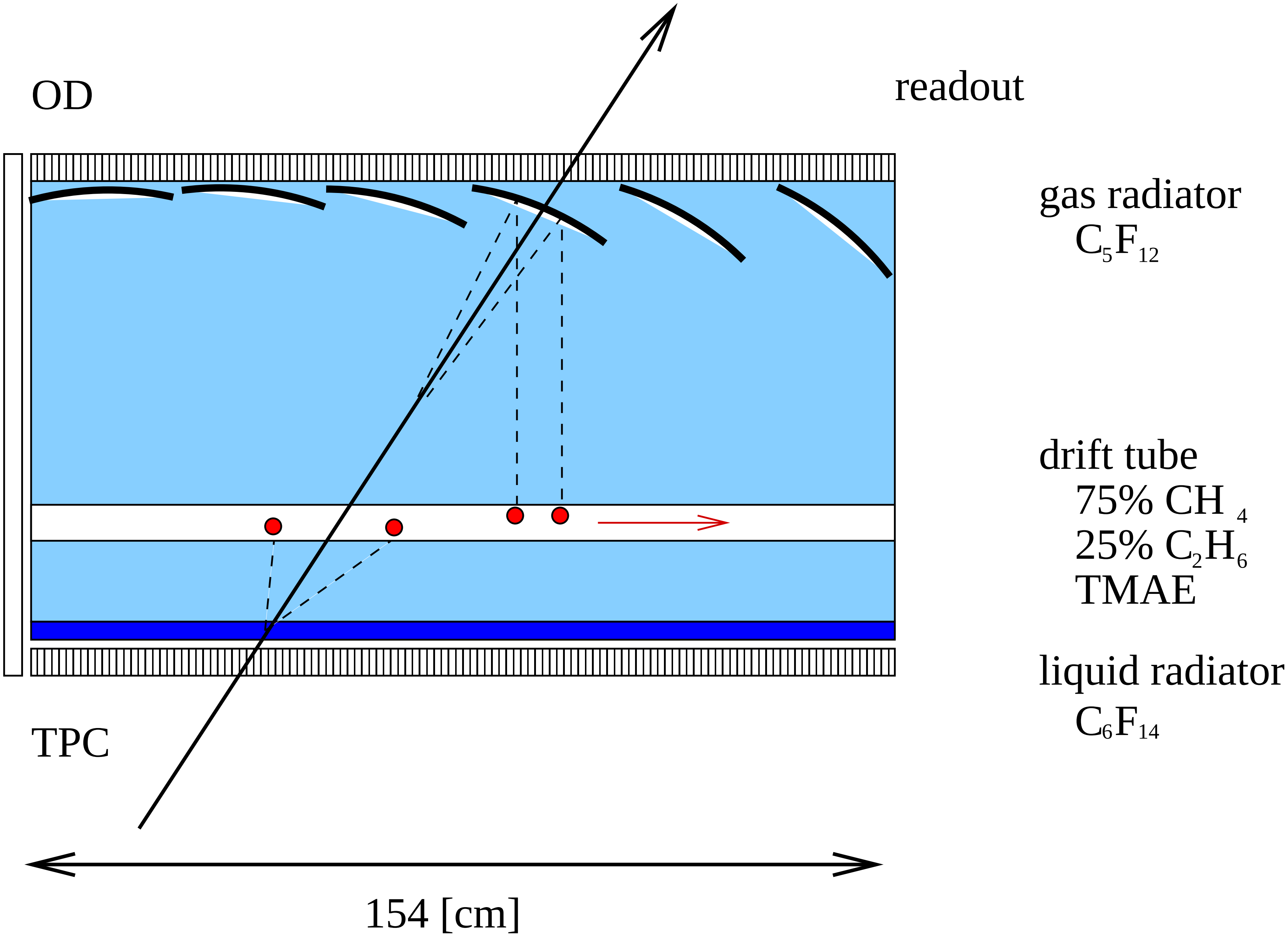


48 tubes grouped two by two in 24 bitubes

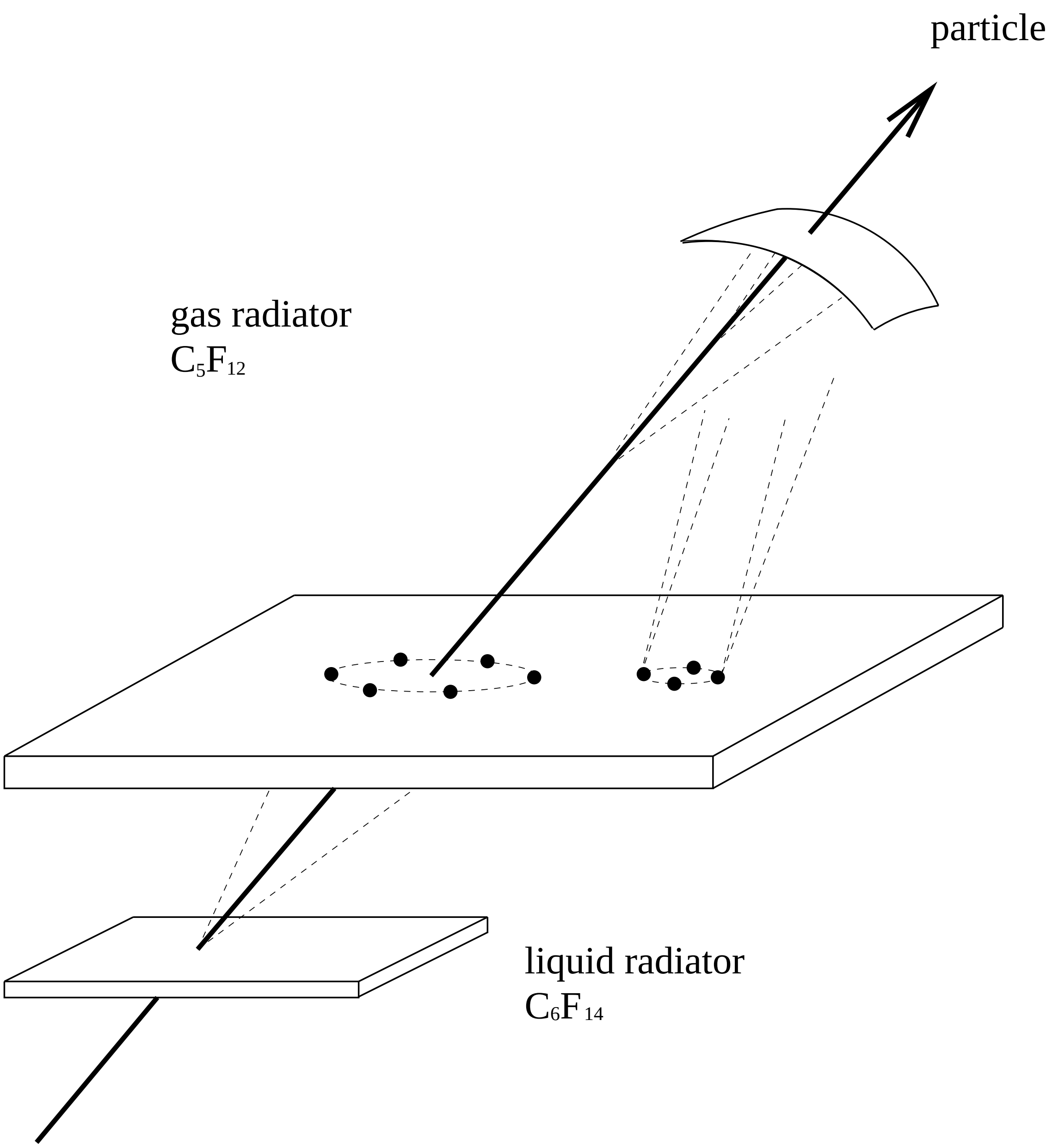
Per tube: readout
HV system

Per bitube: gas
driftfield (VHV)

side view chamber



Physics principles



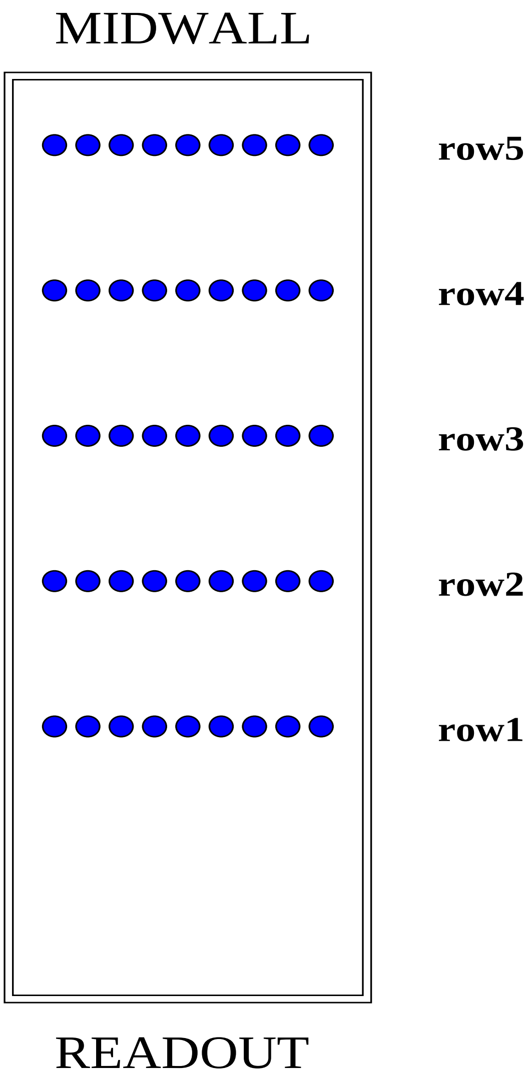
$$cos(\Theta_c) = [\beta\ n]^{-1} \qquad \text{and} \quad N_\gamma \propto sin^2(\Theta_c)$$

Inside an analysis the position of the Cherenkov photons has to be known quite accurately (required precision around 1 mm).

Calibration system

On each drift tube we have a grid of holes connected via optic fibers to a very fast and powerful UV lamp.

Per tube: 5 rows containing 9 holes each.



Maximum flash rate lamp: 0.2 Hz.

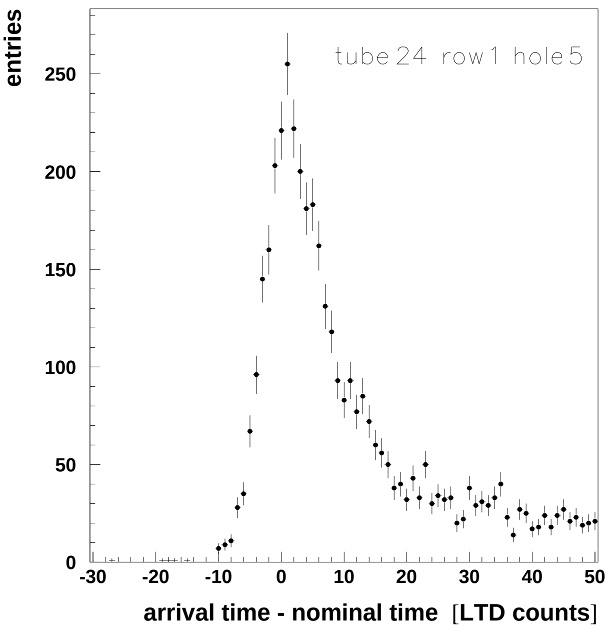
basic idea:

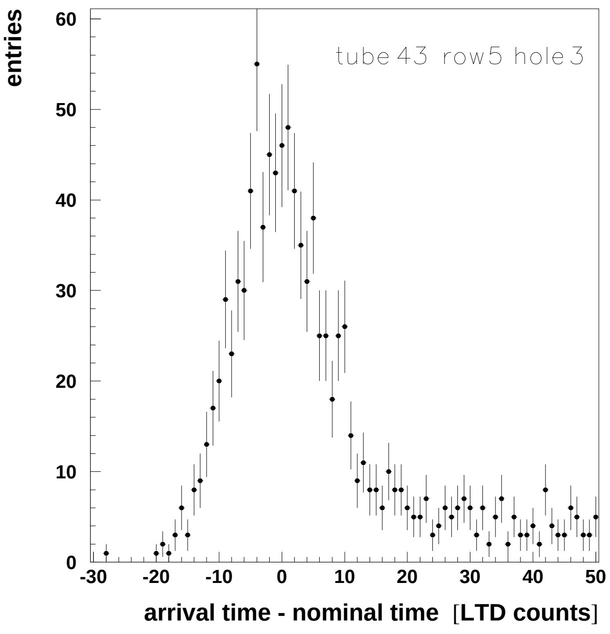
position holes	known
time lamp fired	known
arrival time signals	known

drift velocity

Calibration signals

Look at the arrival times of the photo electrons (pe's) produced by photons from the lamp.



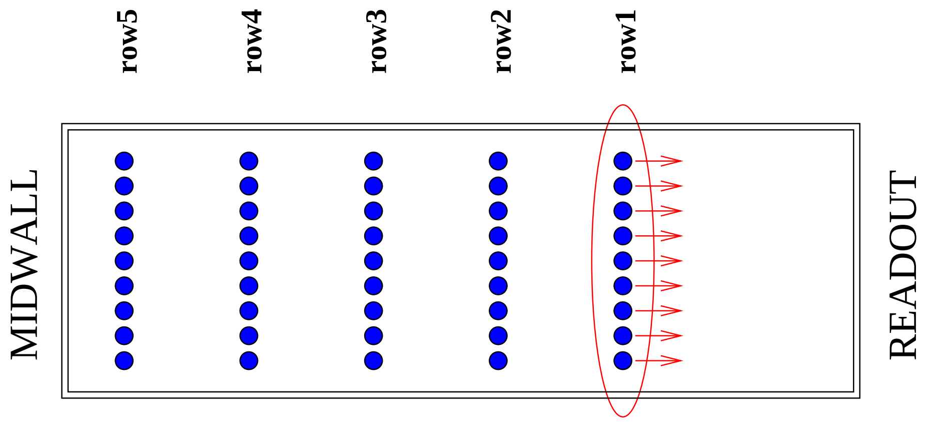


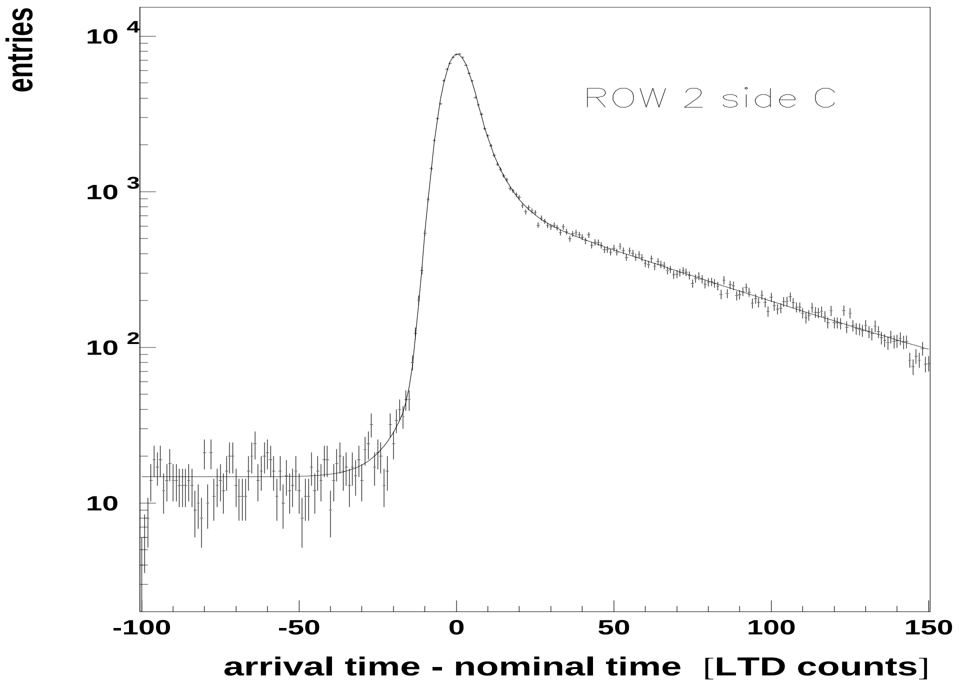
In order to fit the t_0 of each hole you need the exact shape of the distribution.

1 LTD count = 8.518 ns = 0.45 mm

Create templates

The arrival time distributions are the same for holes in a given row



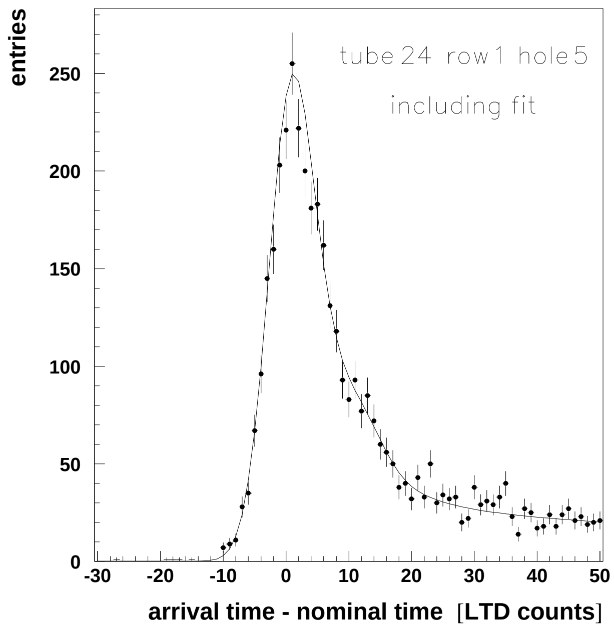


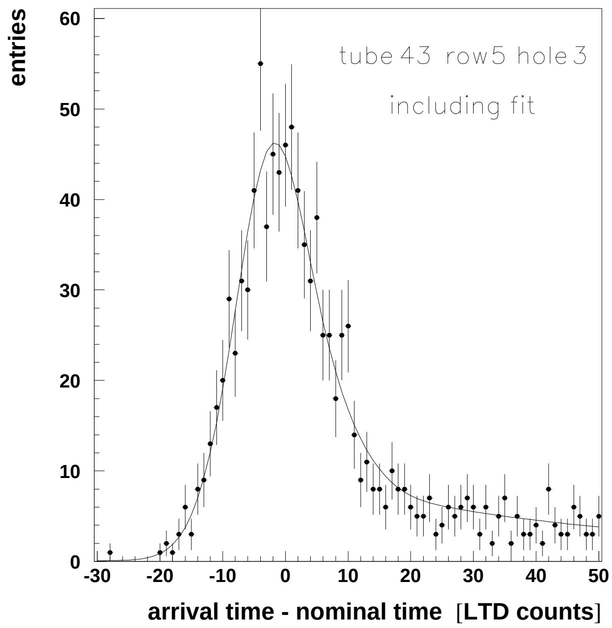
So, per row we have a template:

a gaussian	(the experimental resolution)
2 exponentials	(discharge of the lamp and "afterglow")
a flat background	(background + tails from other rows)

Fit arrival times

Fit the distribution per hole using the template leaving only t_0 free.

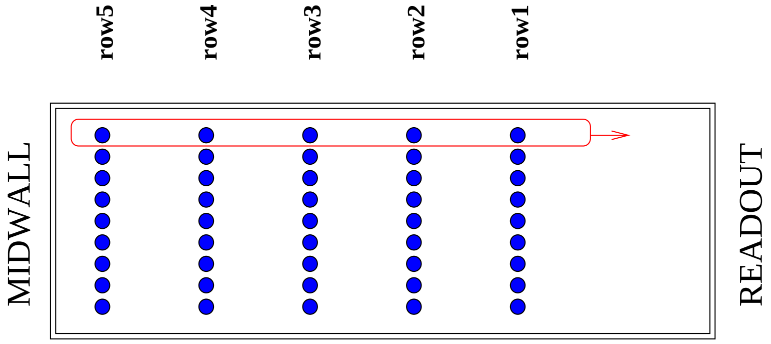




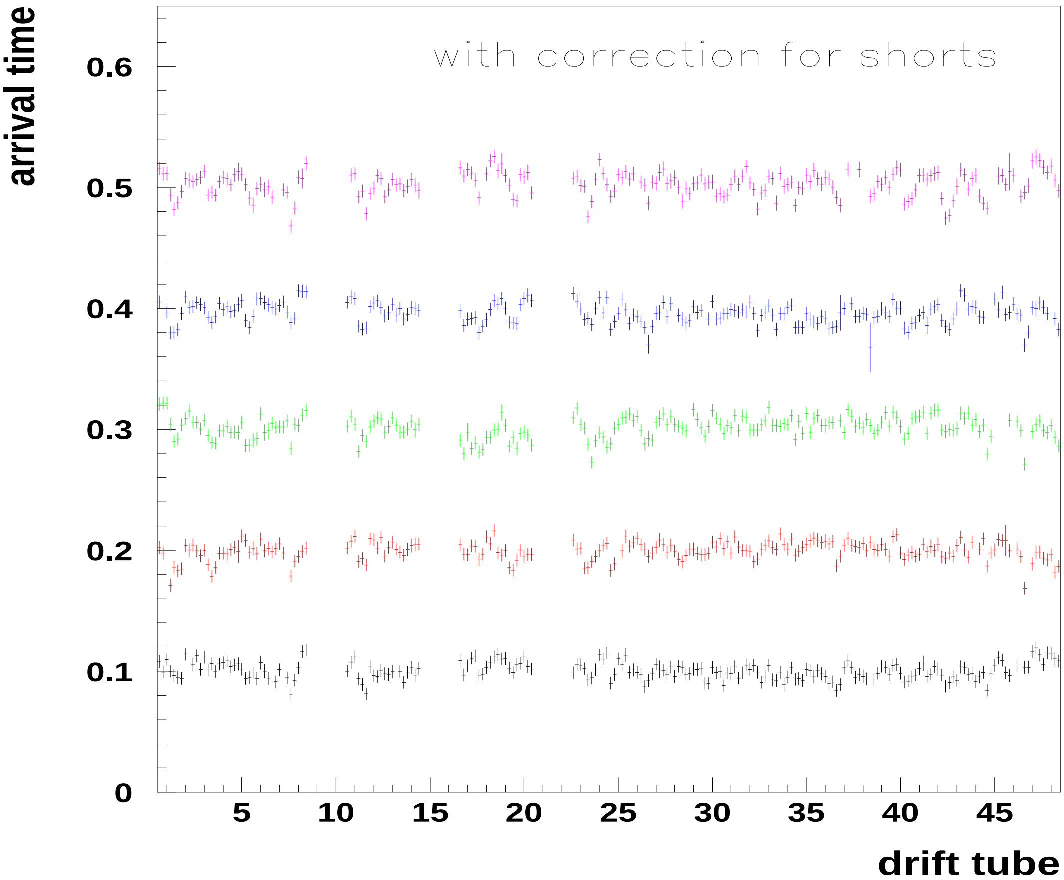
Now you have all necessary information to determine the drift velocity in a bitube.

Calculate drift velocities

The drift velocity is calculated per bitube, since they share the same gas supply and drift field.



After correcting for known problems we get the following arrival time distributions: corresponding to: $V_d \approx 5.4$ cm/μs



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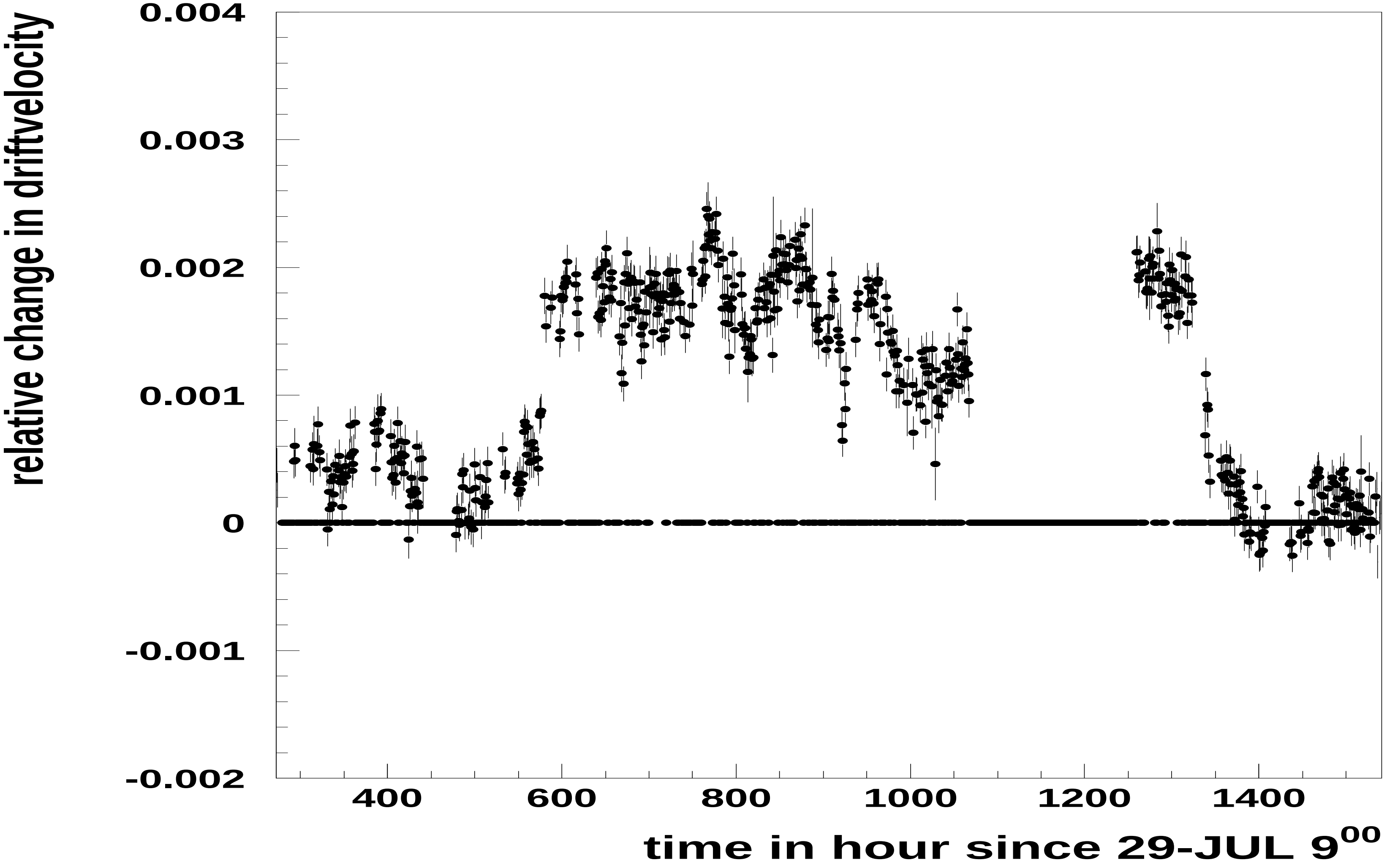
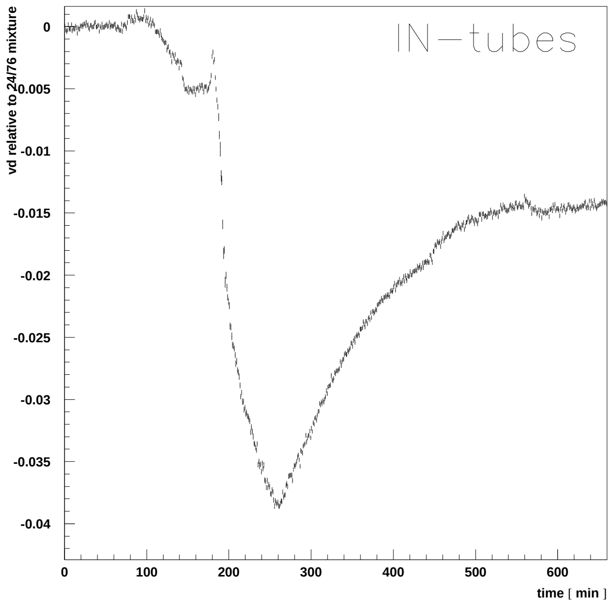
Stability of drift velocity

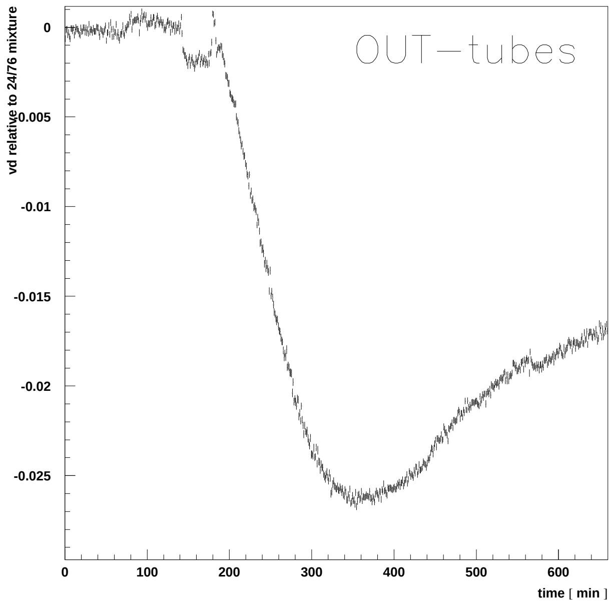


Different gas-mixture (influence on drift velocity)

Gas mixture and drift velocity relative to normal mixture:

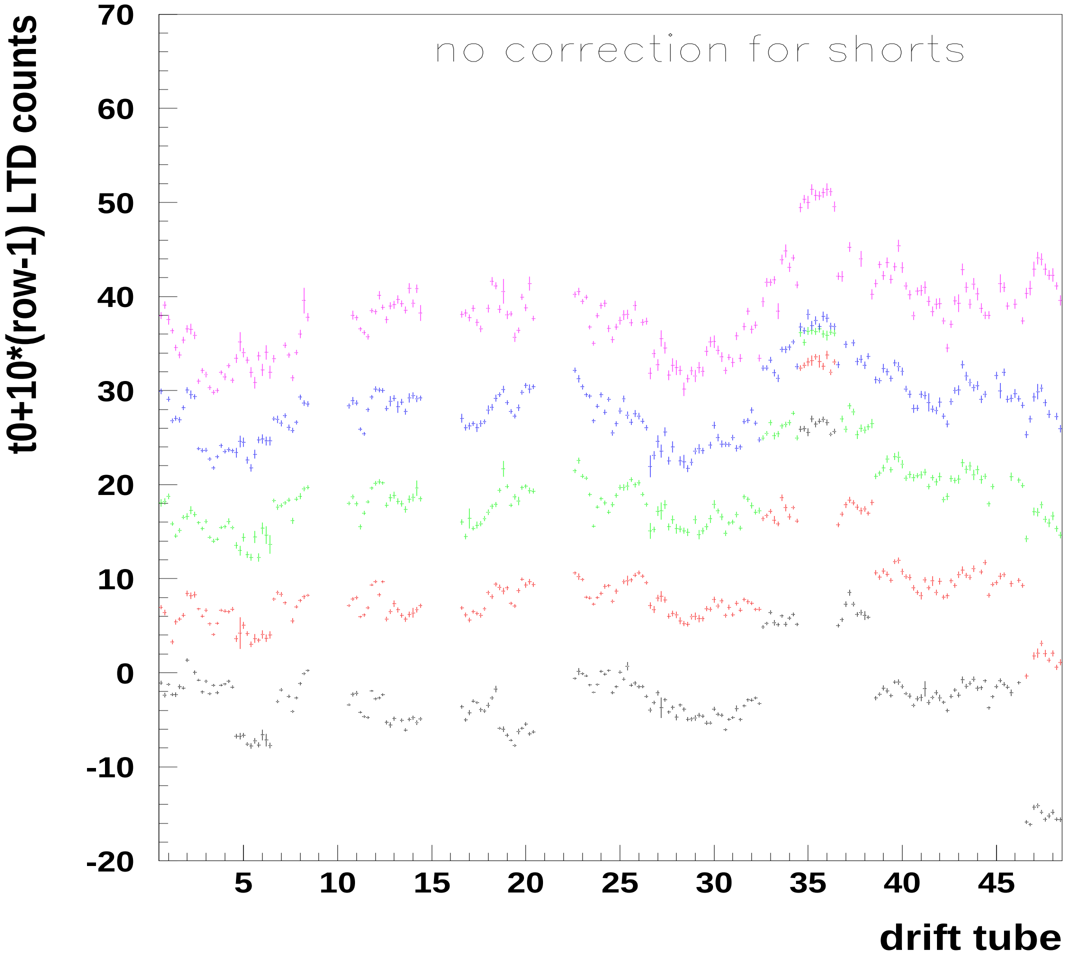
74% methane 26% ethane	- 0.7 %
75% methane 25% ethane	0.0 %
76% methane 24% ethane	+ 0.7 %





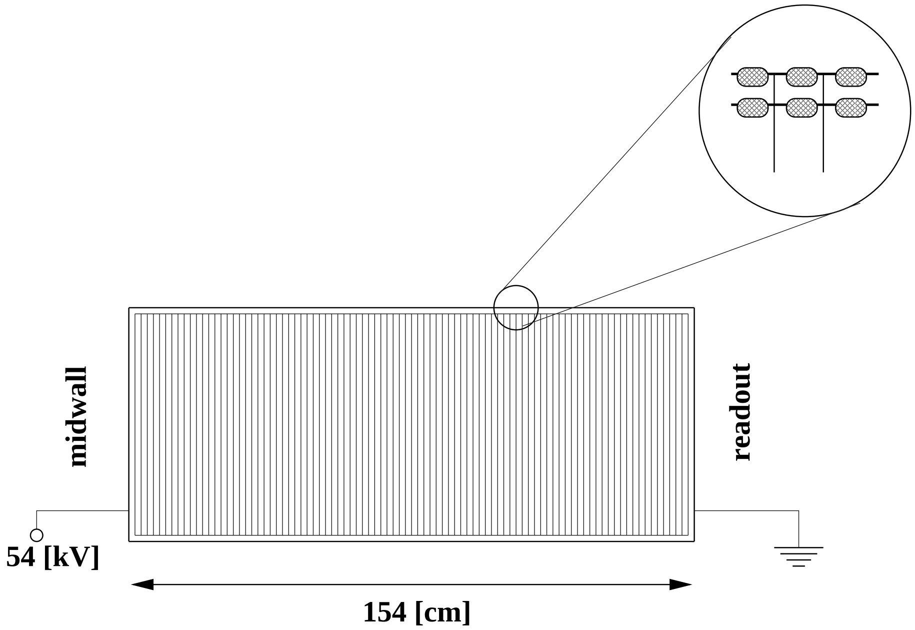
Some complications in the driftfield

If we would not correct for the known problems:



Here we see some strange effects, which are produced by the "known problems"......SHORTS

Shorts



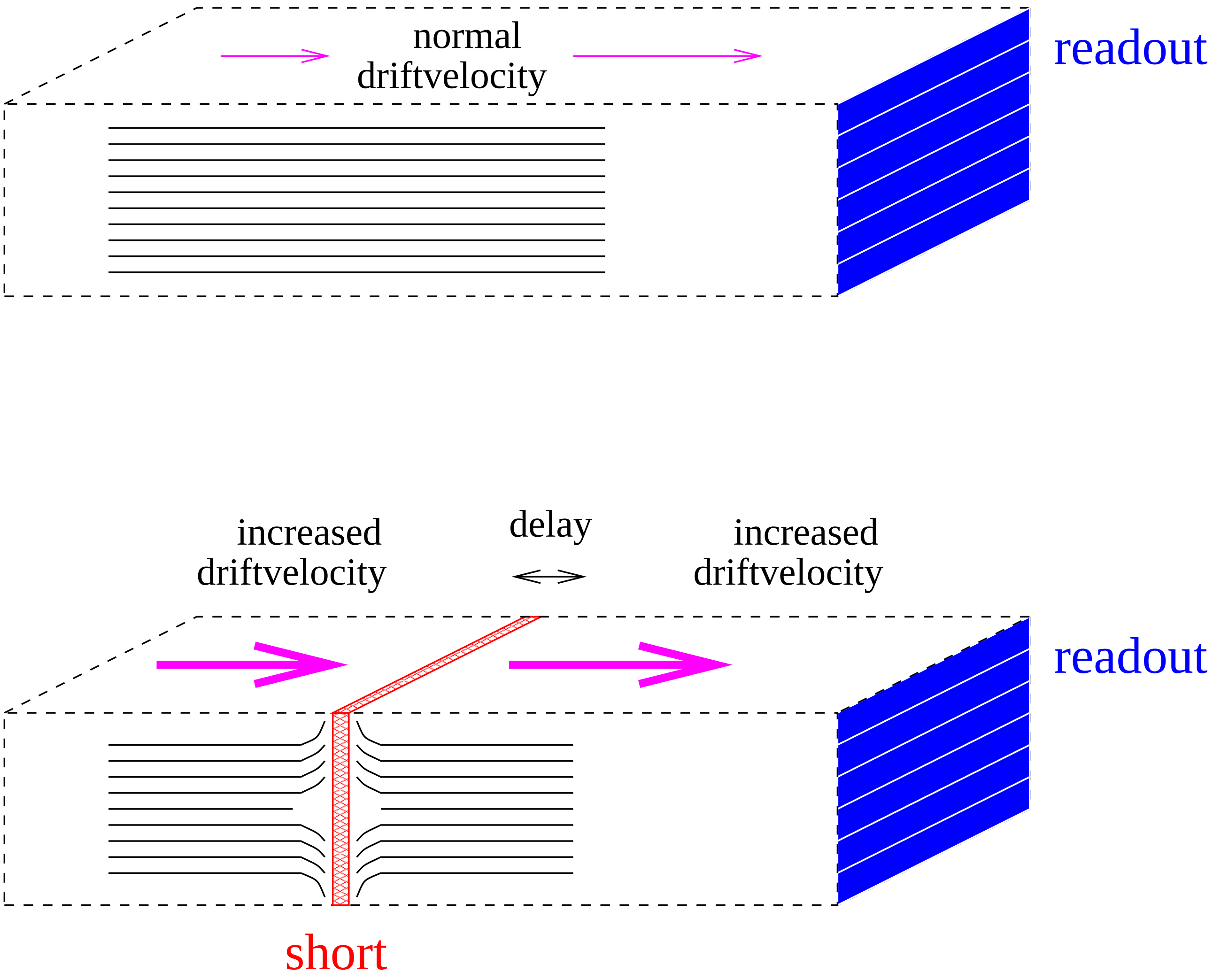
possible causes:
- loose/touching wires
  (shrinkage support structure by 0.1%)
- conductive connections

Shorts will disturb the field distribution (on the level of a bitube) and therefore change the drift of the photo electrons.

SHORTS:

What is the effect on the drift of pe's
How do you look for shorts.
Get some caracteristics.
How to correct for them.

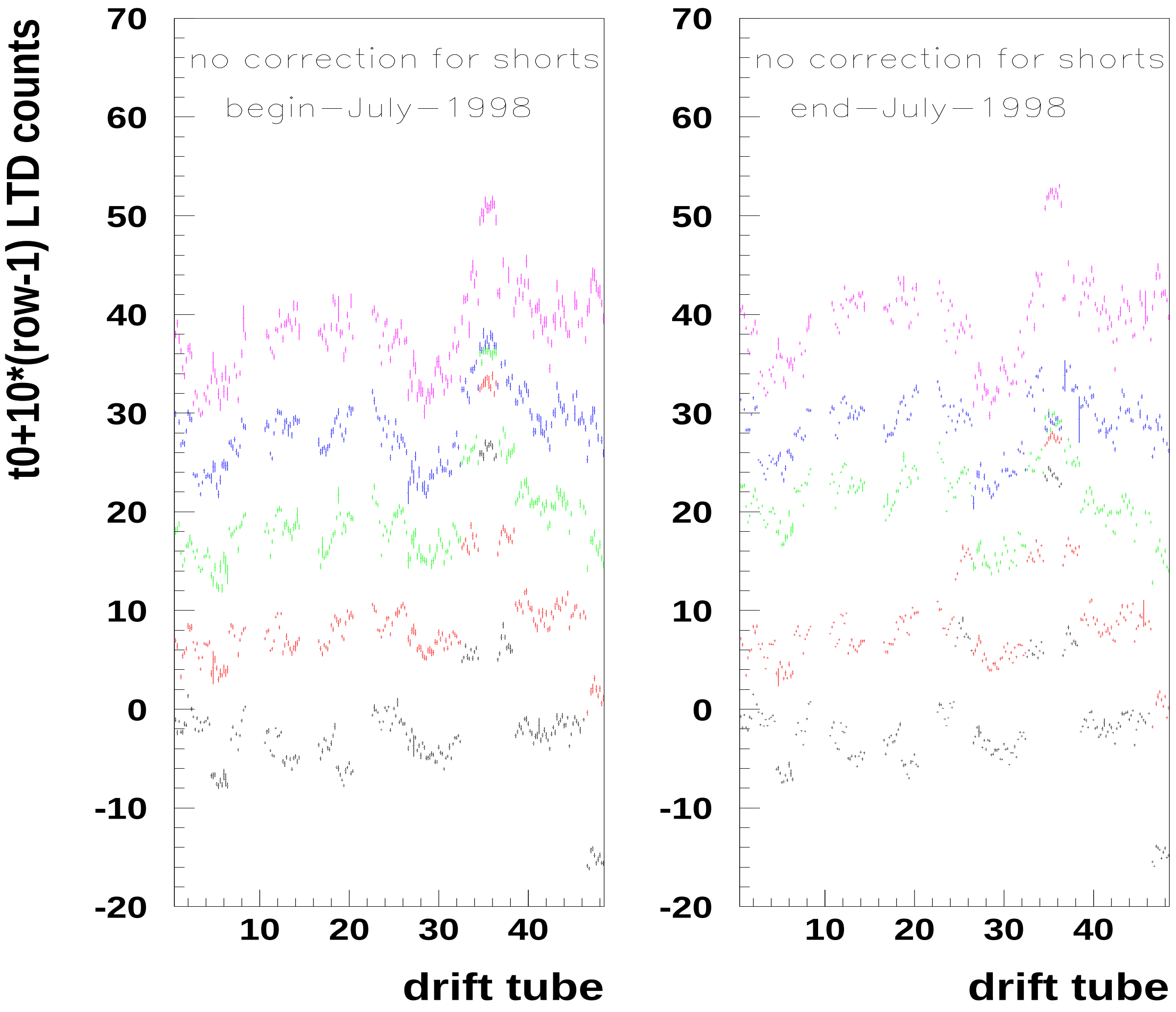
The effect of a short on the drift of photo electrons.



Effects:
- Increase in drift velocity + delay right at short.
- Loss is number of measured photo electrons.
  (without B-field 20%, with B-field only 2%)

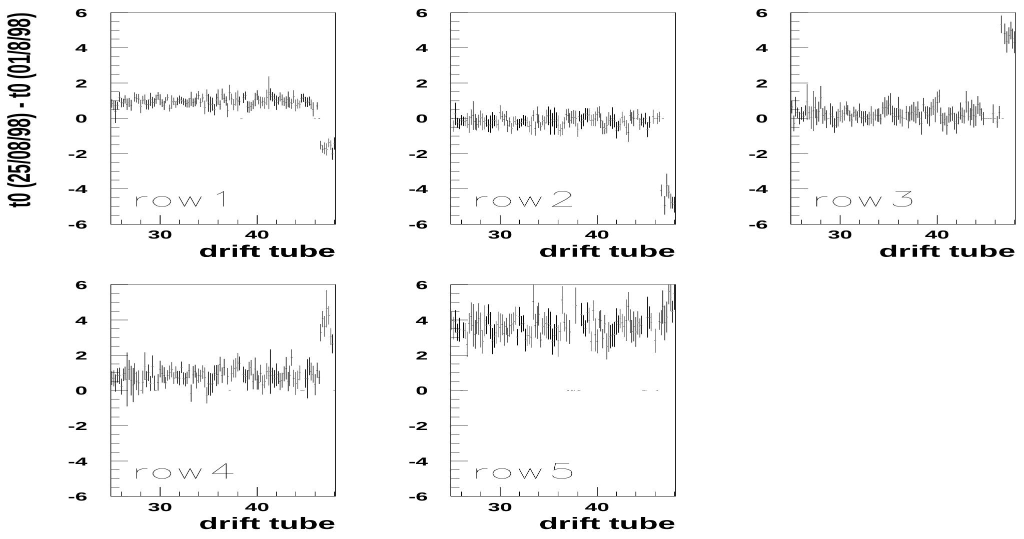
How to spot shorts

Look at differences in arrival times between different periods.

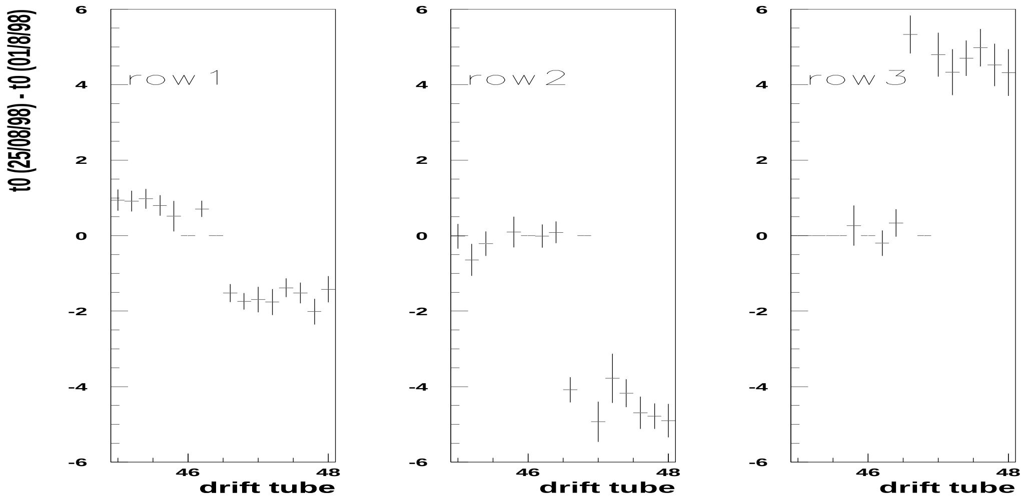


Much easier to look at differences per row.

Look at time differences for all holes per row



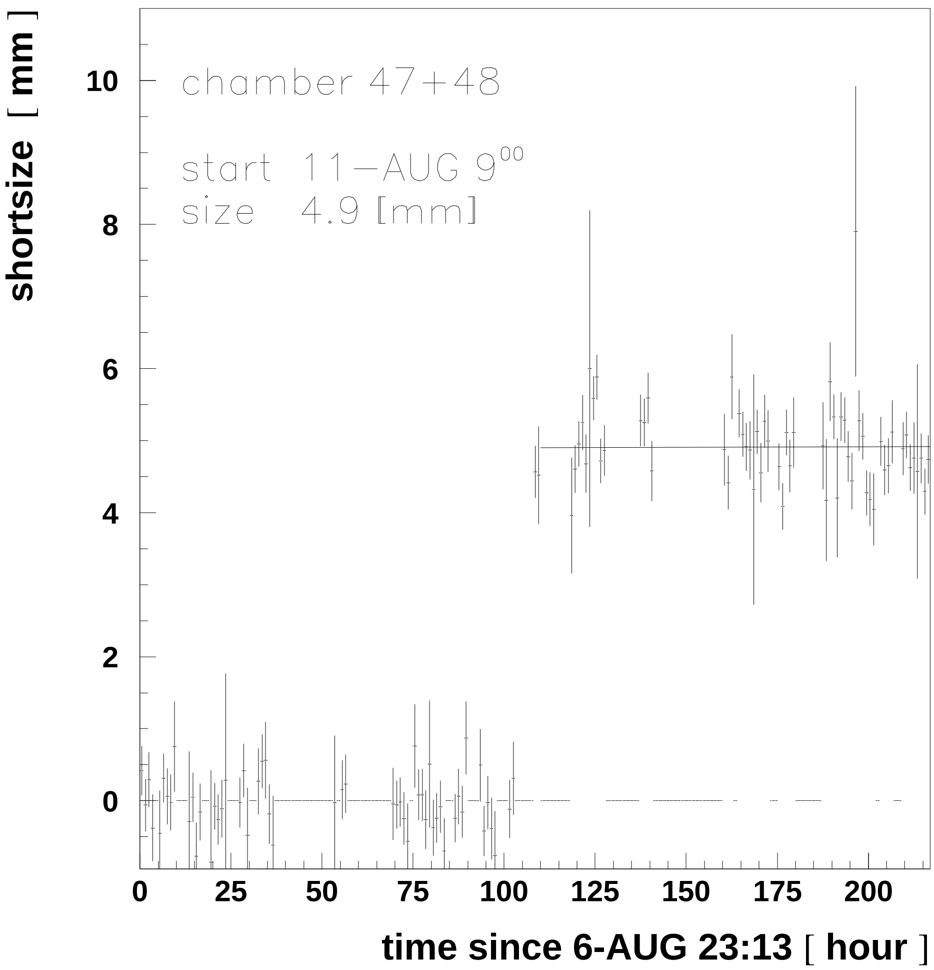
Zooming in on 47 + 48 row 1 to 3 we can clearly recognize the effect.



Indeed: Increase in drift velocity of 2 LTD counts per row
extra delay of 10 LTD counts between row 2 and 3.

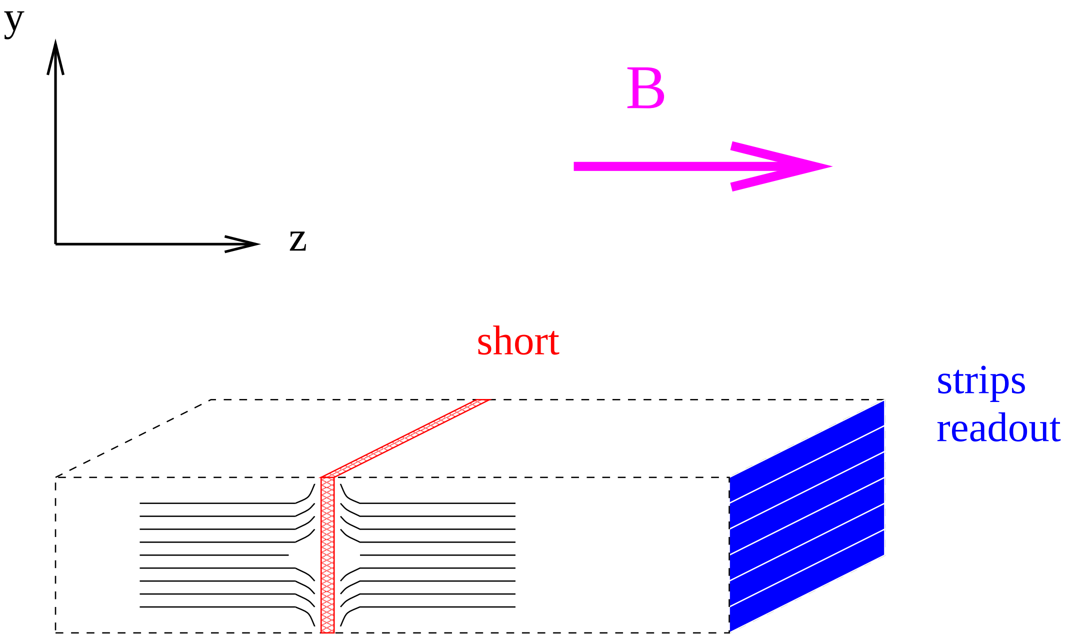
When did the short start ??

Fit the signals from this particular tube to an extra delay between row 2 and 3.

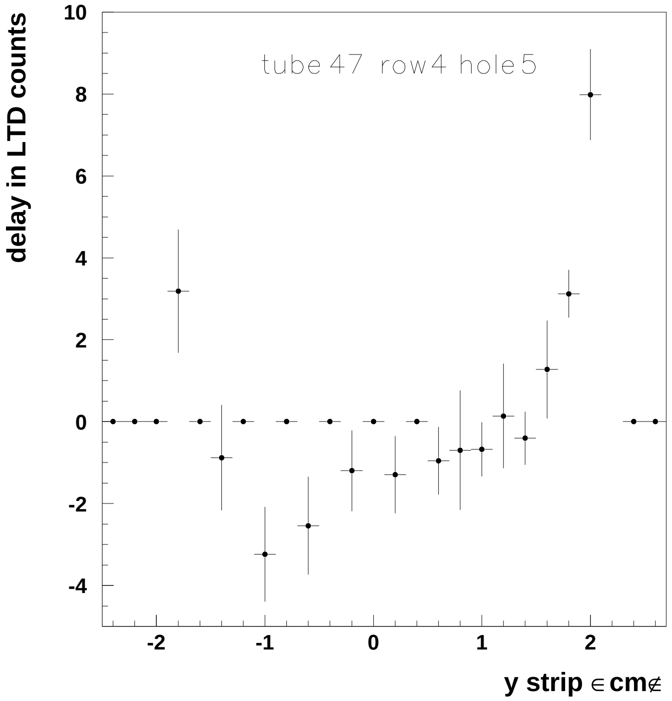


Knowing where it is and when it started you can correct for it inside the database.

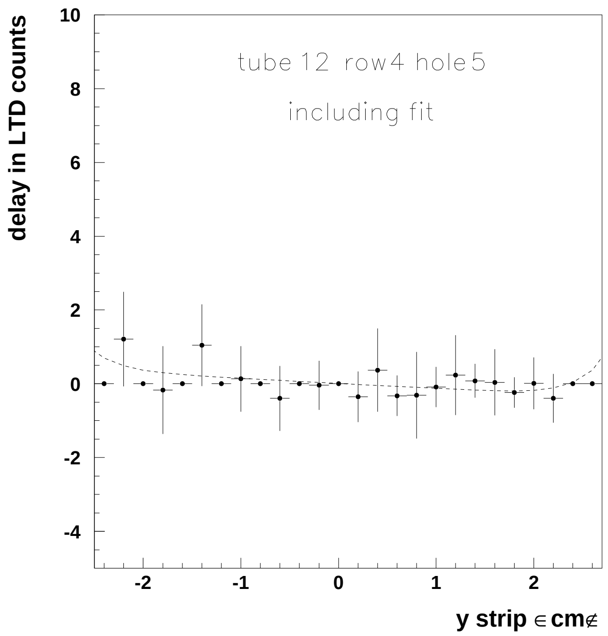
y-dependence of the shorts

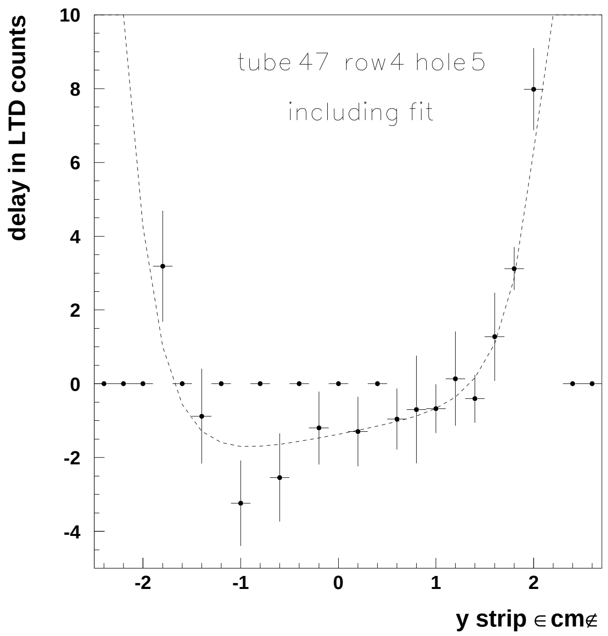


The delay of the photo electrons due to the short is also y-dependent:



y-dependence

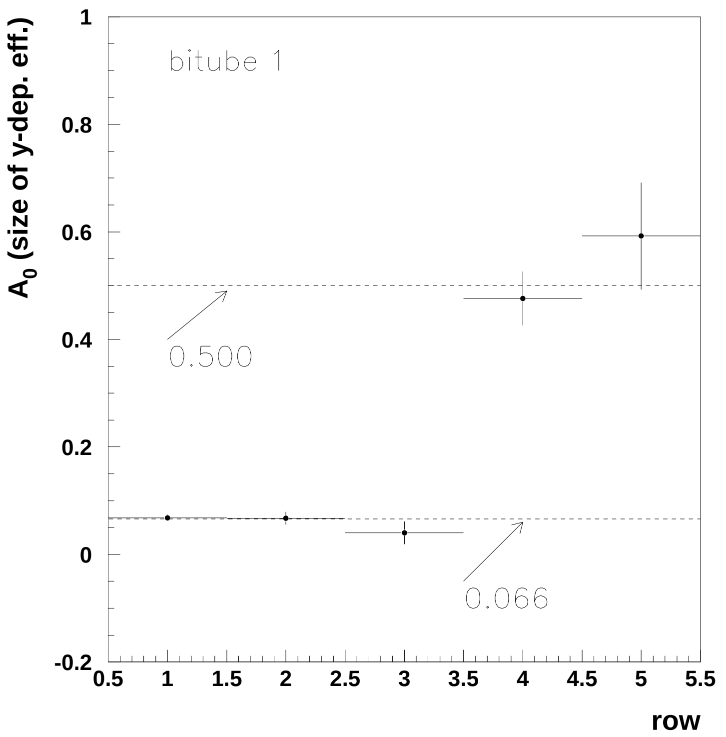




bitube without short

bitube with short

This effect will only influence the pe's produced after the short.



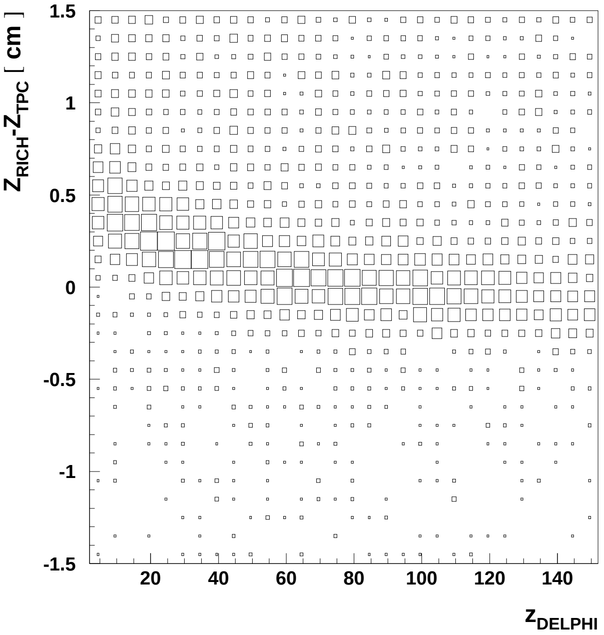
How to find the exact spot ??

There are 2 problems with the above method:

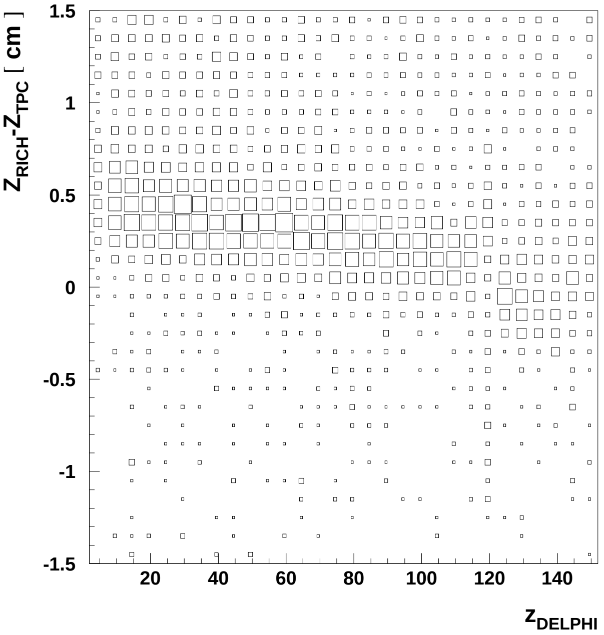
1] This procedure up to now cannot tell you where exactly the short is.

2] What to do in the 3 bitubes without calibration.

Look at differences (in z) between TPC and RICH tracks:



tube without short

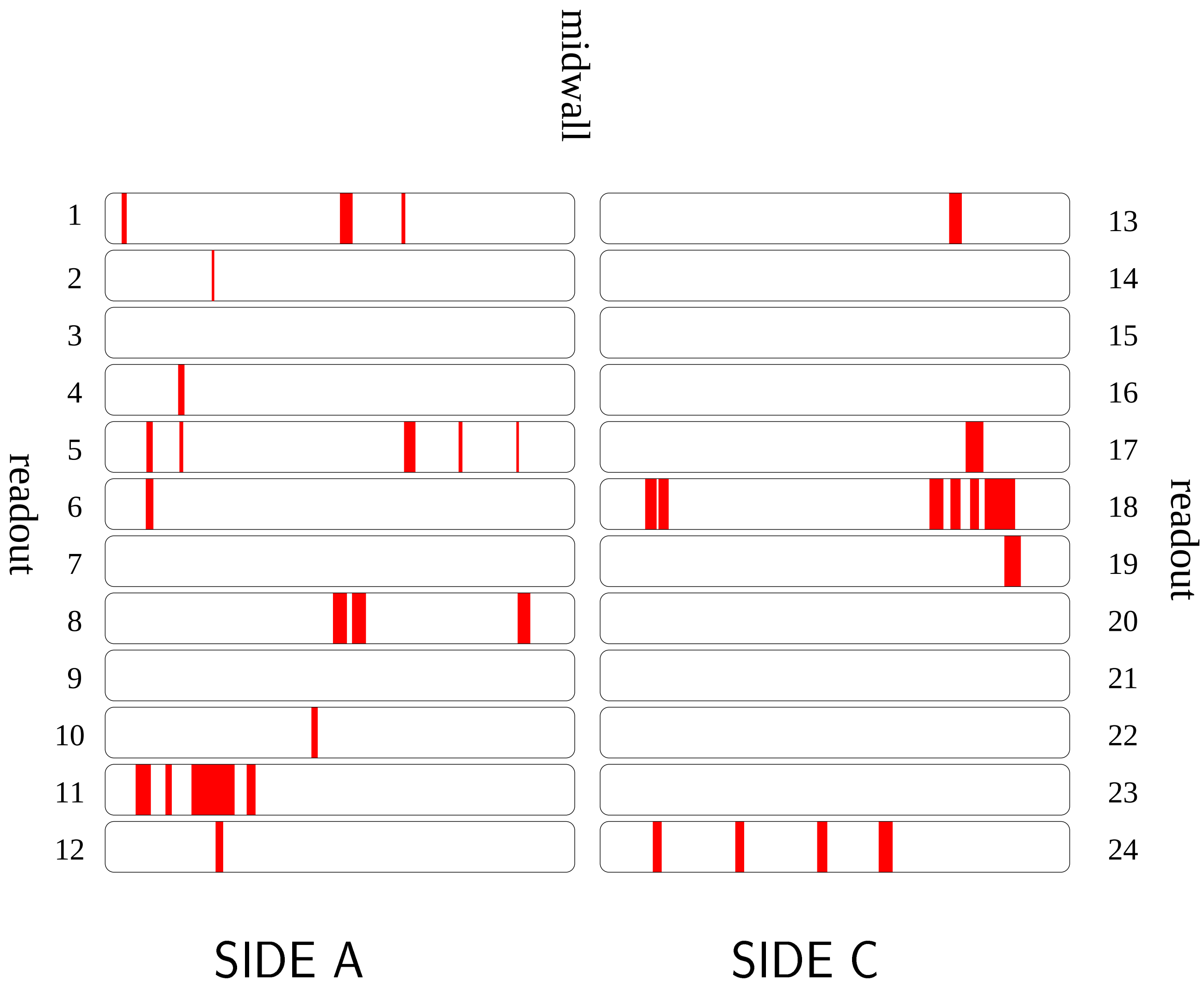


tube with short

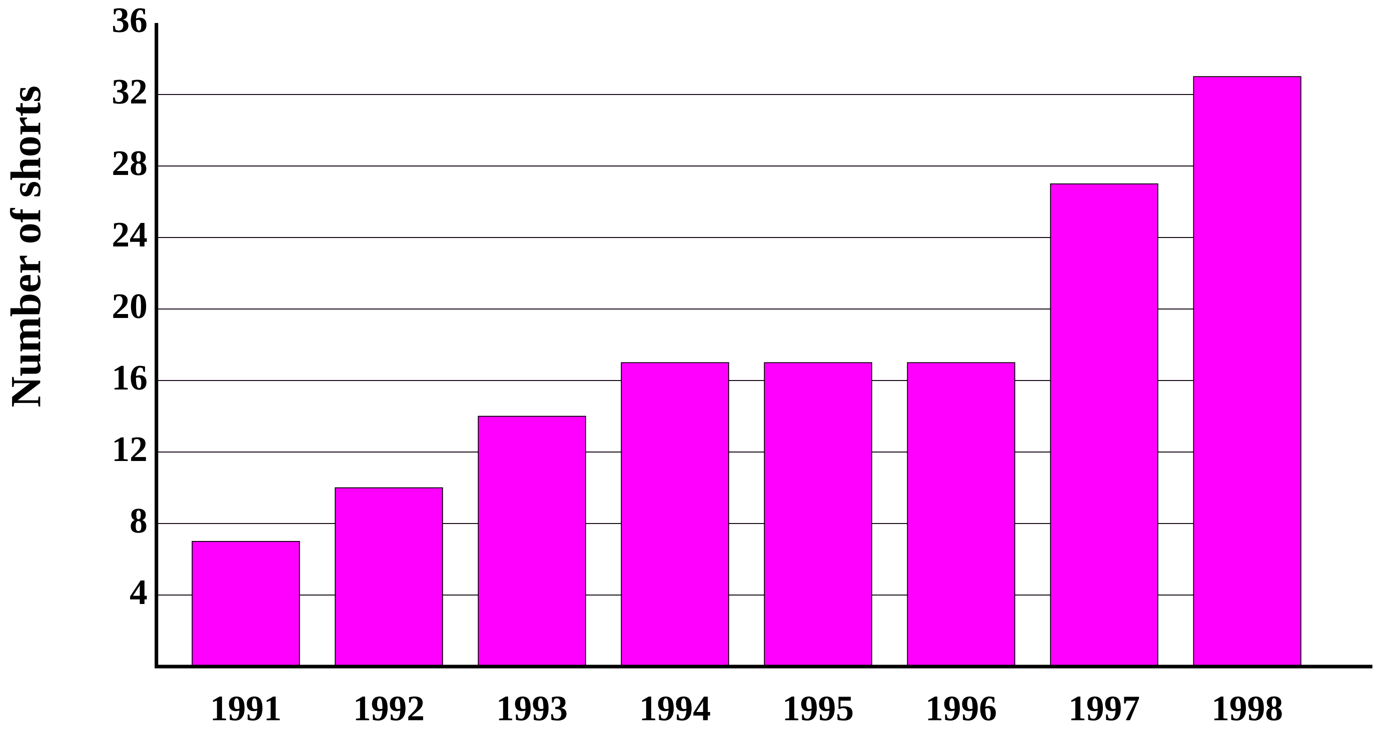
A short will create a discontinuity in the distribution.

All shorts in the barrel RICH

In total there are now in total 33 shorts in the barrel RICH.



Time evolution of the shorts



Conclusions

- We monitor changes in drift velocities continuously
  ... we do that with high precission
  ... it seems extremely stable
- There are problems (shorts)
  ... they can be identified and corrected for
- 1998 data quality is in good shape