A GEM TPC with readout electronics based on TDC: first results

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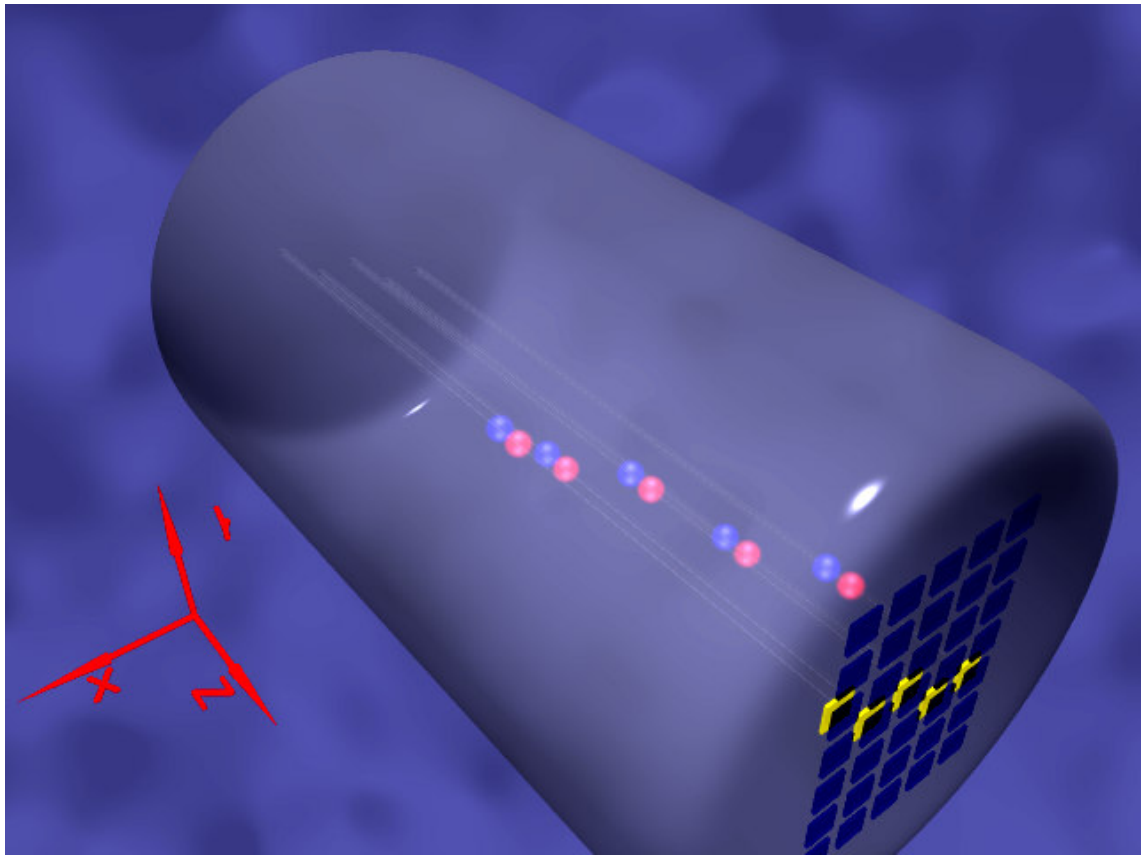
Drift time & charge measurement with TDC
Readout electronics
Experimental test on TPC
Conclusions and outlook

Track reconstruction with TPC

Main goal of a TPC is <u>track reconstruction</u>

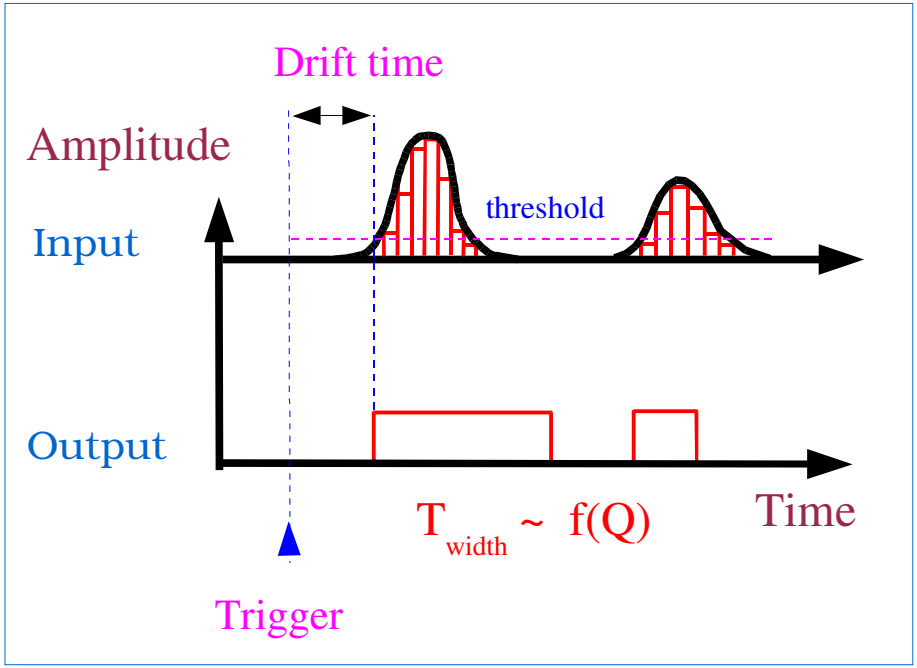
Readout pads: ***X &Y information***
Drift time: ***Z-coordinate***



Particle identification (dE/dx)

comes for 'free', if charge of the pad signal is measured

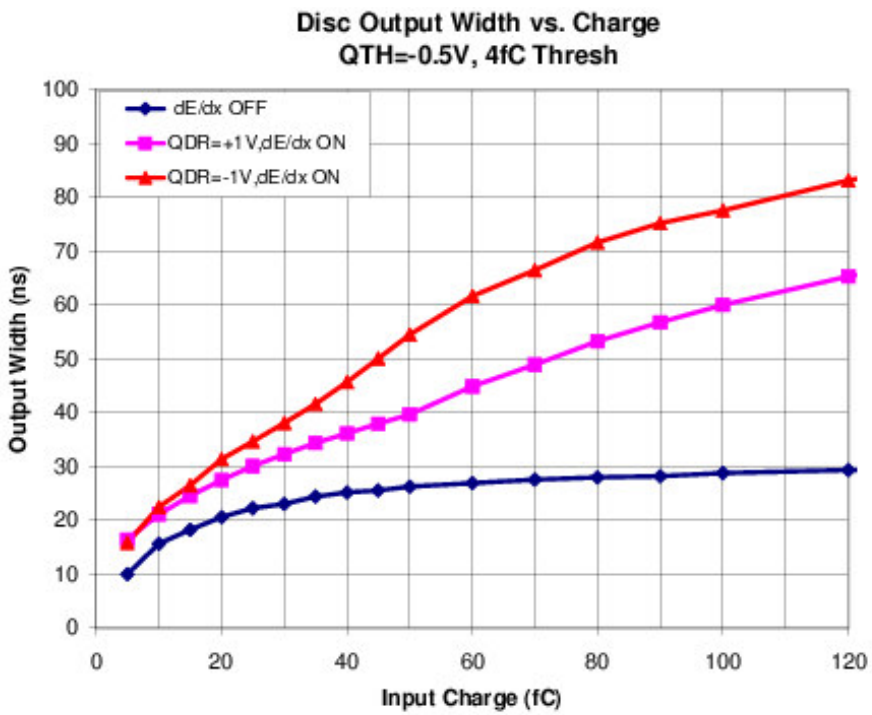
Charge measurement with Time-to-Digit Converter



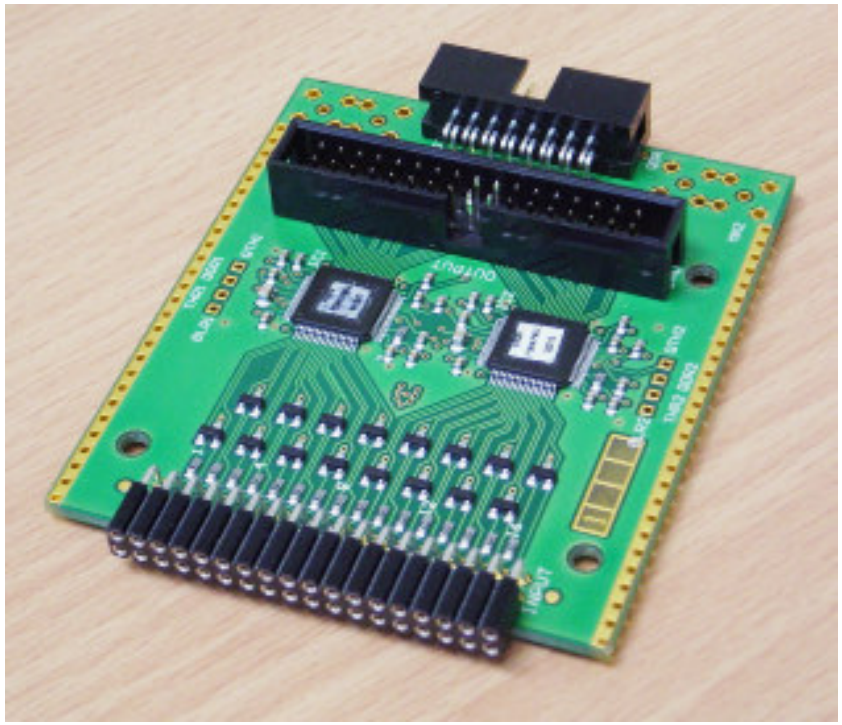
Main idea: use charge-to-time conversion technique

Readout electronics

ASDQ: **A**mplifier-**S**haper-**D**iscriminator-**Q**(charge measurement), developed for CDF's Central Outer Tracker



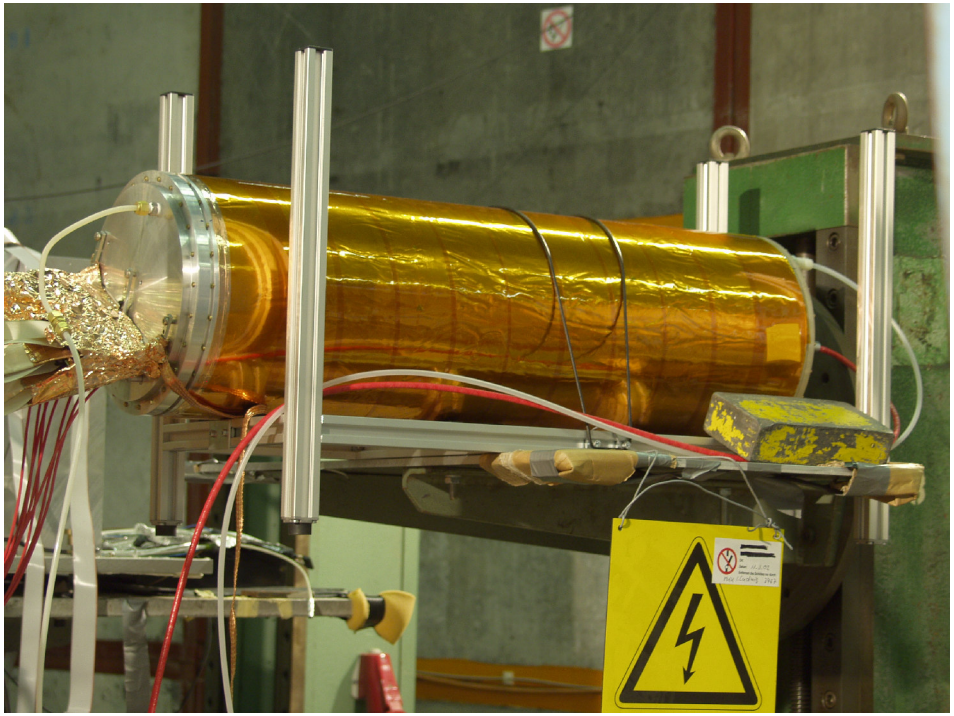
Typical performance curves of charge-to-time converstion with ASDQ (W. Bokhari, University of Pennsylvania)



ASDQ Fron-End electronics board 16 channels in area 67 mm x 78mm

Experimental test on TPC

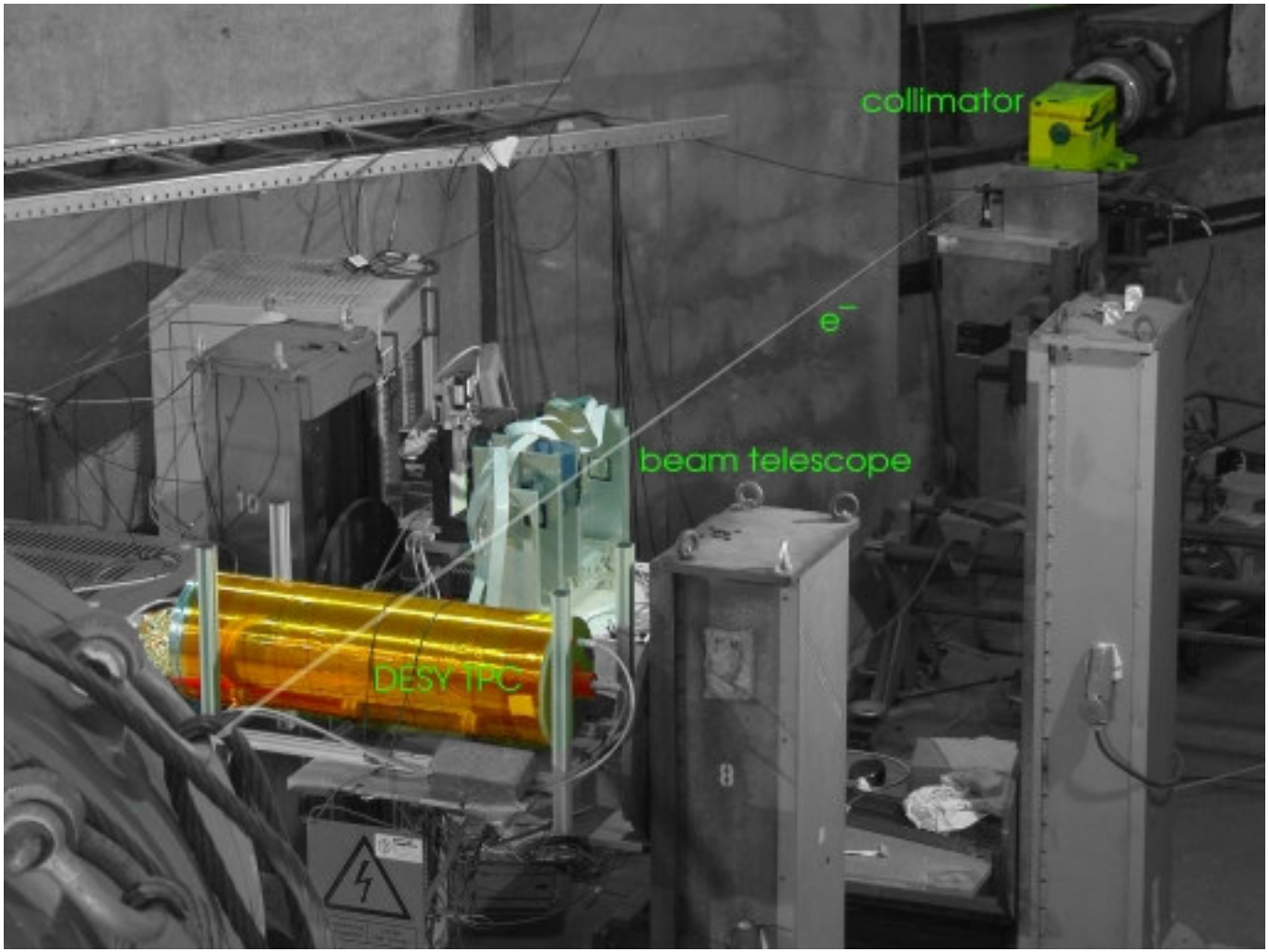
- "Medi-TPC" (Medium size TPC) with maximum drift length: 80cm.
- "TDR gas": Ar:CO:CH_4 (93:2:5)%
- Tripple GEM as preamplifier; GEMs @ 325V, 325V, 325V
- 192 readout pads of size: 2x6 mm^2



- 96 channels (6 ASDQ boards) in DAQ system

  (few dead and few hot channels were excluded from readout)

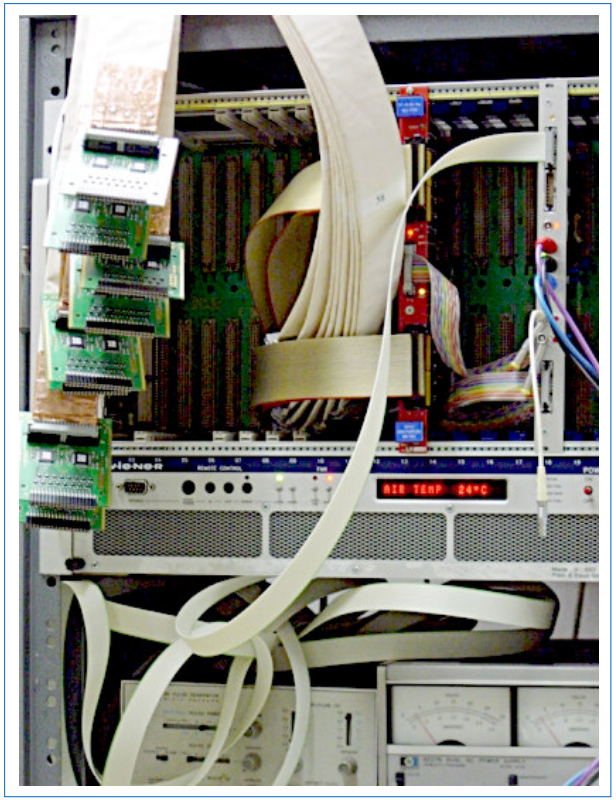
Experimental test on TPC: 6 GeV electron beam at DESY



Data acquisition system

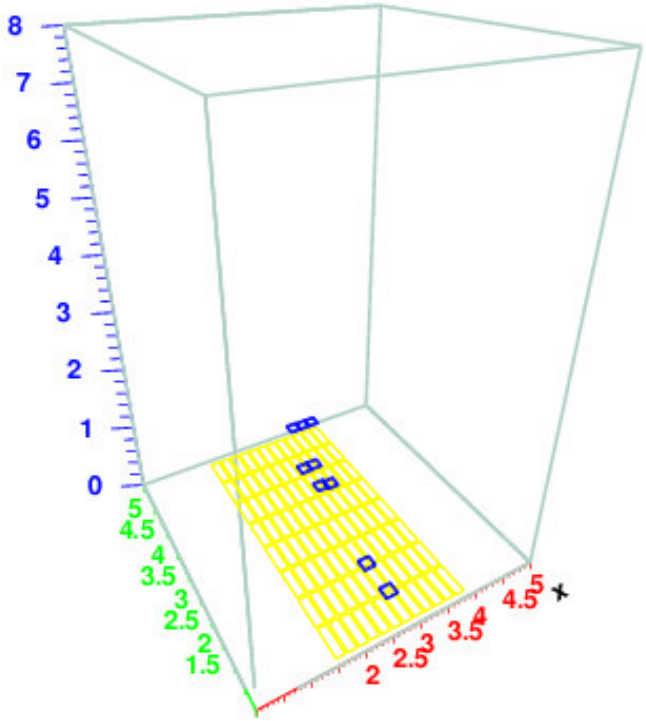
- Main component of the DAQ system:
  commercial 128 channel multi-hit TDC “CAEN v767”
  780 ps time bin size
  800 μs time range
  TDC chip developed at CERN

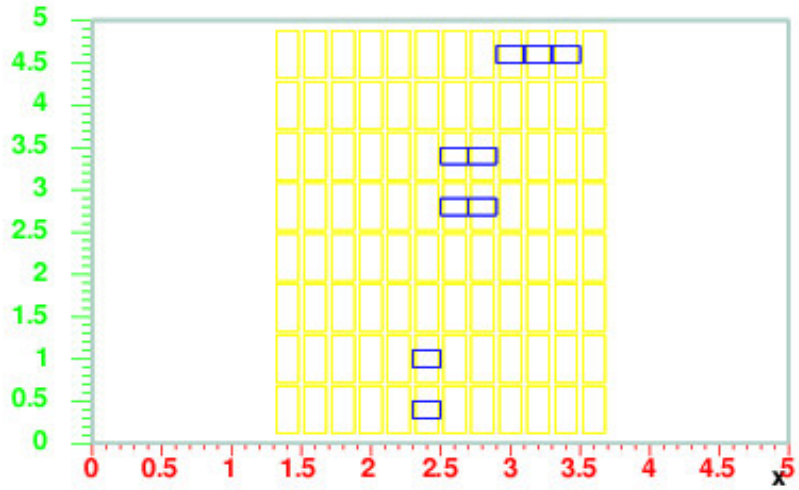
- 650 000+ events were recorded
  (~71 Megabytes in data-files)

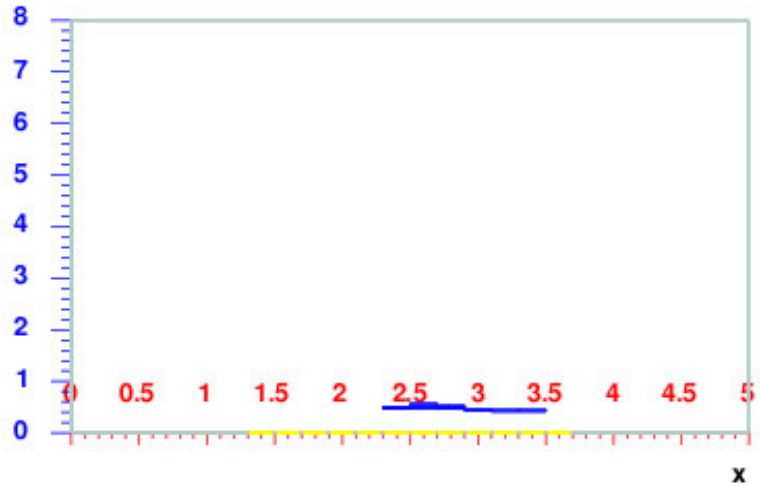


Hunt for a track

GEM voltages boosted: 334V & 334V & 326V
TPC tilted : φ = arctg (2mm/6mm) ≈ 18°





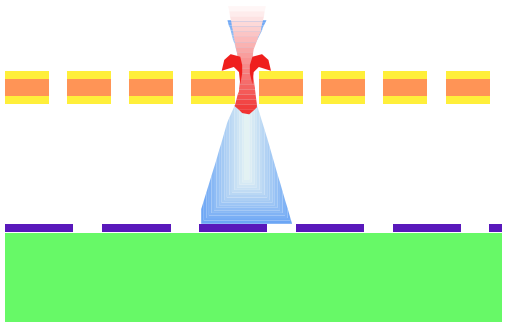


Only few hits seen on the track.

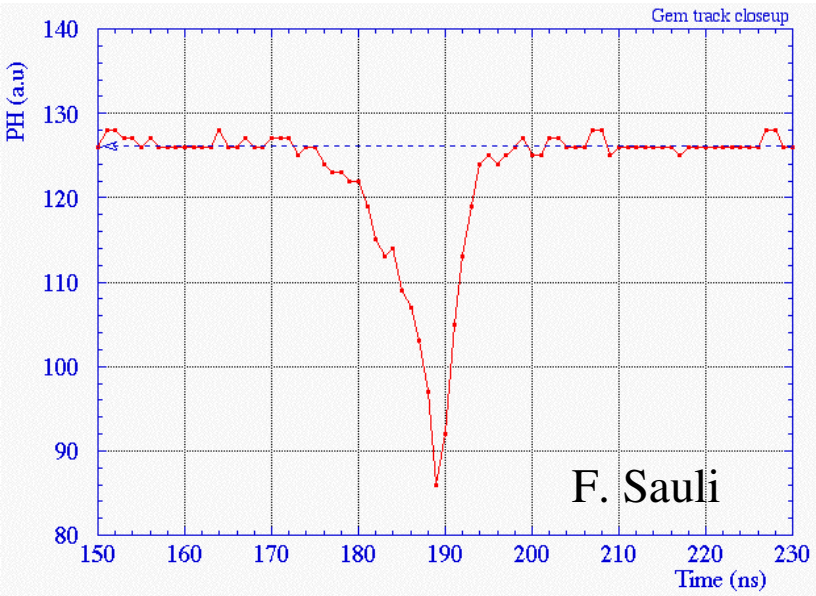
One of the possible causes: short integration time of the ASDQ preamplifier (~8 ns peaking time, 28 ns integration time)

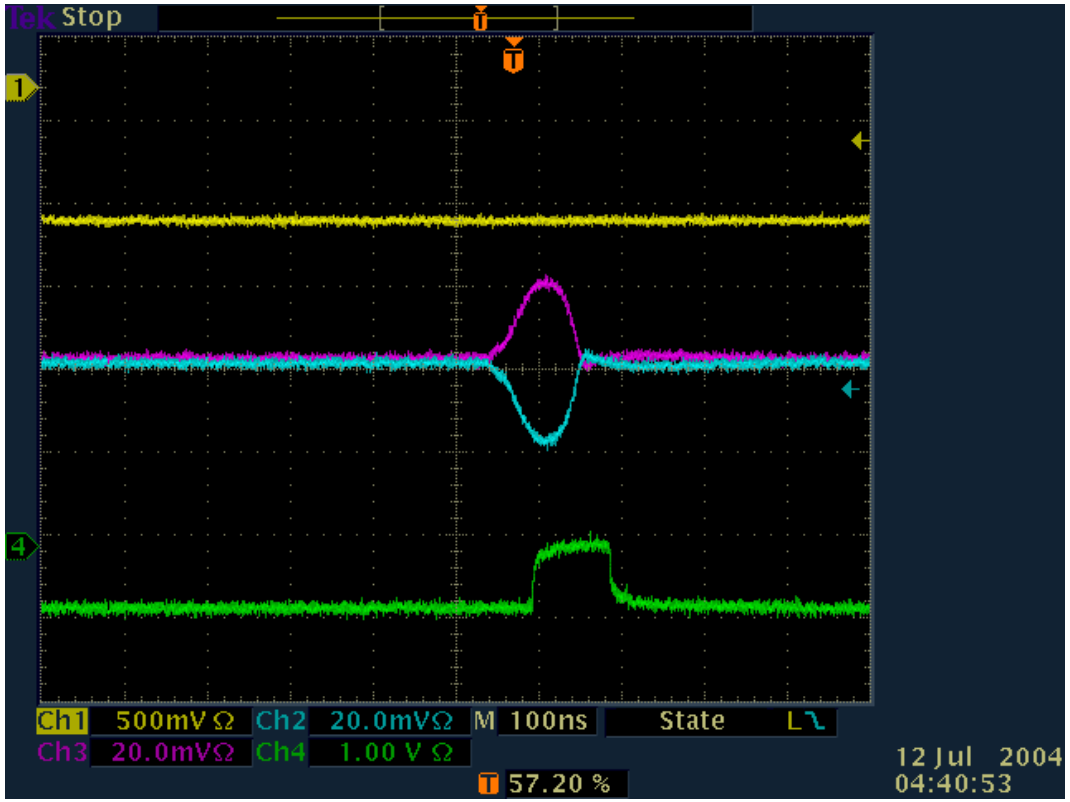
Signals from TPC pad

The total length of the detected signal corresponds to the electron drift time in the induction gap:



Full Width 20 ns (for 2 mm gap):

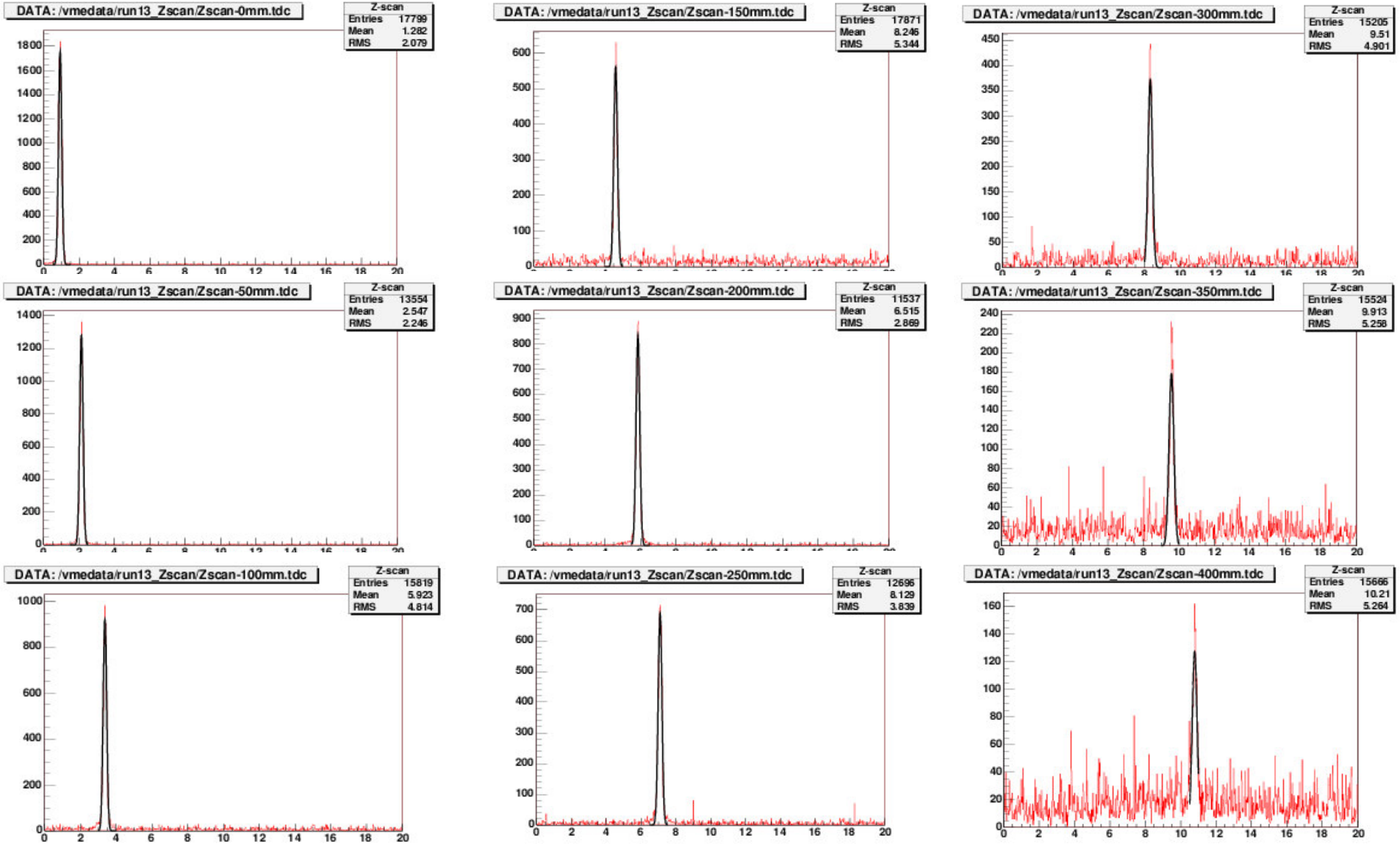




Cyan and magenta – analog monitor of ASDQ amplifier

Green – digital output of ASDQ (monitored before TDC input)

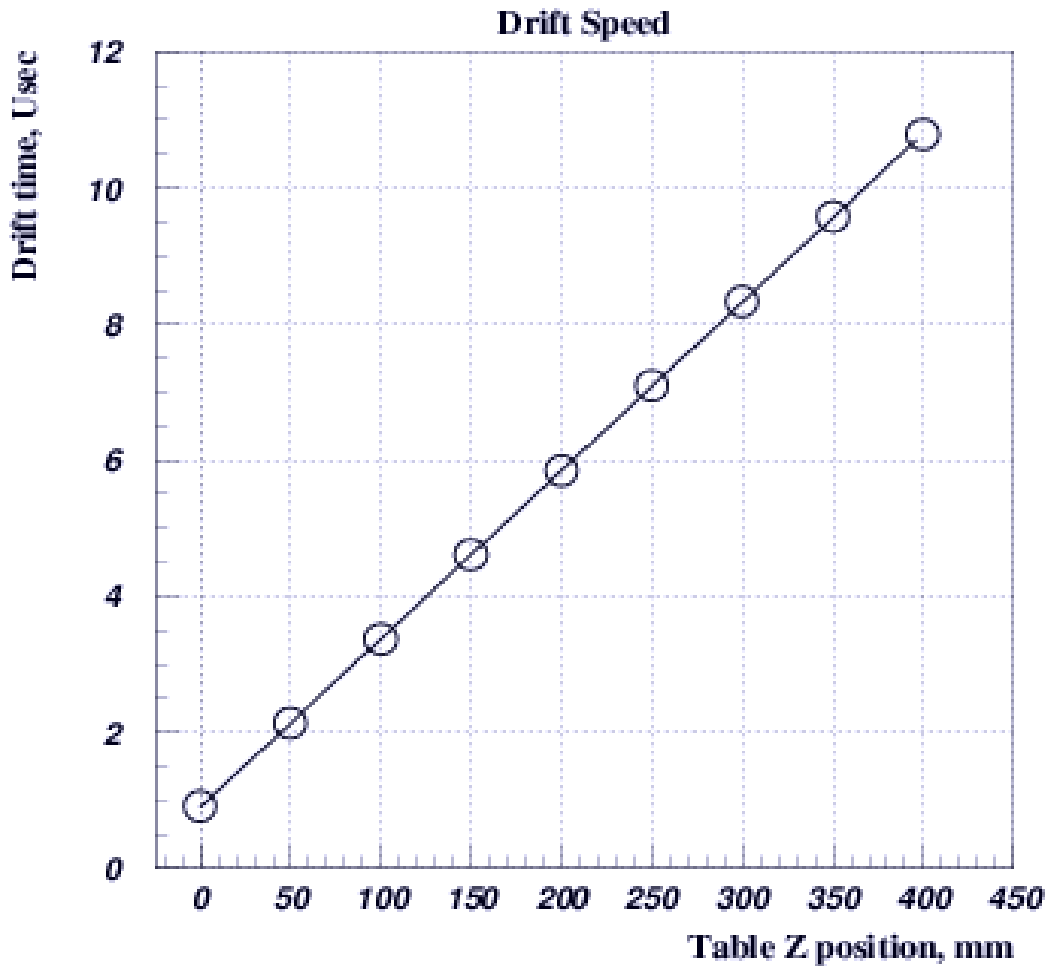
Z-scan with 6GeV electron beam



~ 6000 events in every of 9 runs

Time, microseconds

Z-scan with 6GeV electron beam



Drift speed: 40.4 mm/usec

Conclusions and outlook

- A prototype of TPC readout electronics based on TDC was built
- Measured drift speed (40.4mm/usec) in good consistency with previous measurements performed on Medi-TPC with the same gas mixture
- Charge information data was not yet analyzed
- Better understanding of signal development in induction gap is required
- Study will be continued with laser setup on large DESY TPC