# MPGD: Six (+1) Concept in Search of an Author

# The author

## Six Concepts in Search of an Author

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**Authors:**

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# Active impurities filter

Aging is studied in the laboratory by irradiating the detector under scrutiny with an intense ionizing radiation, X-rays, or radioactive source; the proportional gain is measured at intervals, and when possible, the damaged electrodes are inspected under a microscope.

When operating in the cleanest conditions, the most frequent observation is the growth of a forest of sub-micron filaments, identified by several analytic methods to be mostly composed of silicones.

The common explanation for these observations is the presence in the gas flow of traces of traces of silicone-based molecules, released by frames, gas pipes, lubricants and other components.

A small counter with a large linear anode development, inserted in the gas flow, could help in removing pollutants before they enter the main conunter,

This naive concept needs to be supported by quantitative measurements and verifications.

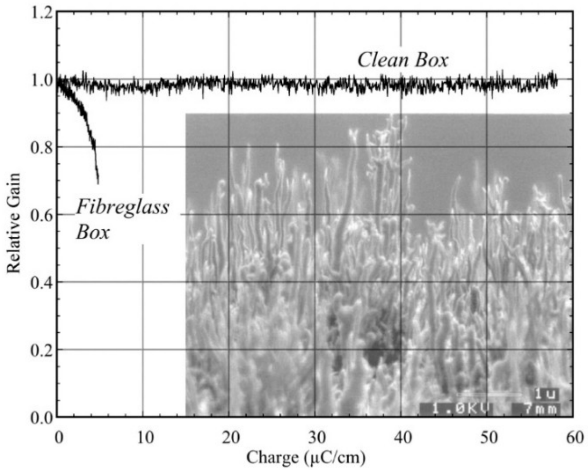


**Figure 1.** An example of the fast aging of micro-strip gas counter (MSGC) plates in clean or fibreglass assemblies, and of silicone filaments growth on a multiwire proportional chamber (MWPC) anode.

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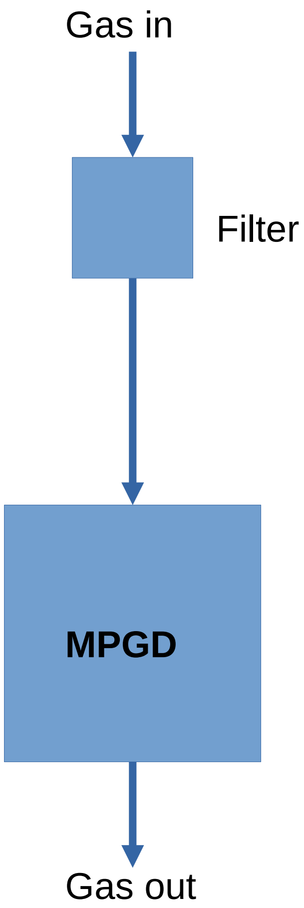

# Enhanced secondaty electron emission

A basic limit in the achievable time resolution og gaseous counters is set by the statistics of ionization energy loss. For fast charged particles, the mean distance between primary ionization clusters is around 300µm and the dispersion in the arrival time of electrons at the anodes is about 5 ns

To overcome this limit consists of coating the cathode of a gas counter with materials having large electron emissivity when trasversed by charged particles. As these secondary electrons travel through equal distance to the anode, the statistical time dispersion is reduced.

An example comes from a thin CsI layer 200µm thick with a special columnar structure to enhance the emissivity. Strong extraction field with the help of a grid is used.

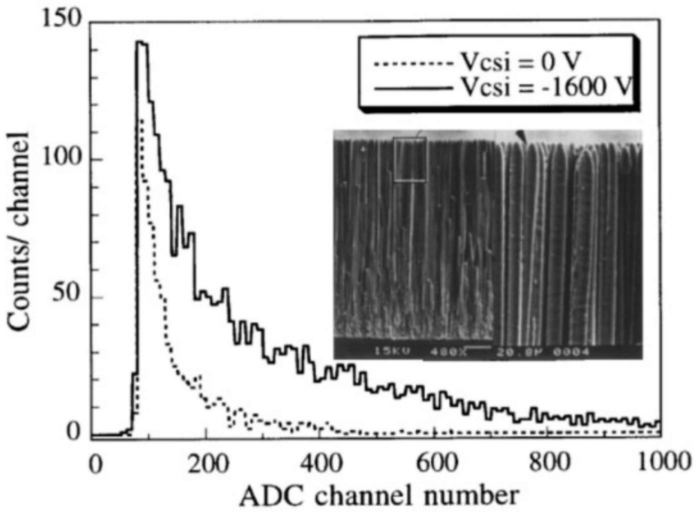


**Figure 2.** Detected signal enhancement on application of an extraction field on the CsI layer (full curve) compared to the ionization signal directly released by fast electrons (dashed curve). The inset shows a microscope view of a section through the columnar CsI layer [10].

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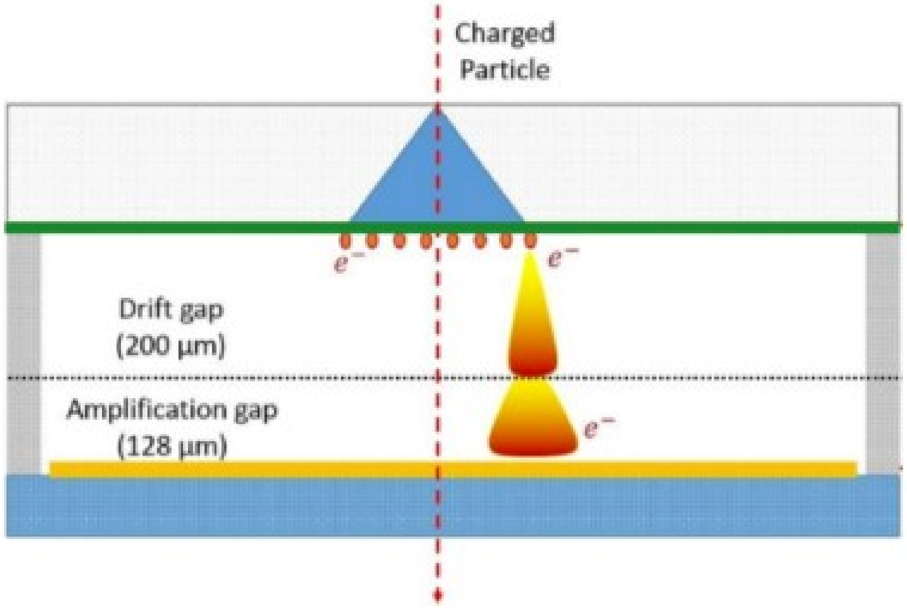


# Endoscopic X-Ray generator

Operating a GEM structure in vacuum is possible to reach accelerating potentials large enough to generate keV X-ray hitting a metal target. A narrow tubular GEM structure could then be used to manufacture a thin X-ray generator to be used for the endoscopic irradiation of delicate internal structure such as the prostate.

A thin cylindrical metallic container encloses a GEM-like electrode and a thin filament constitutes the electron emitter. The structure could be realized using a metallized ceramic tube.

After manufacturing the internal components, the pipe is evacuated and sealed.

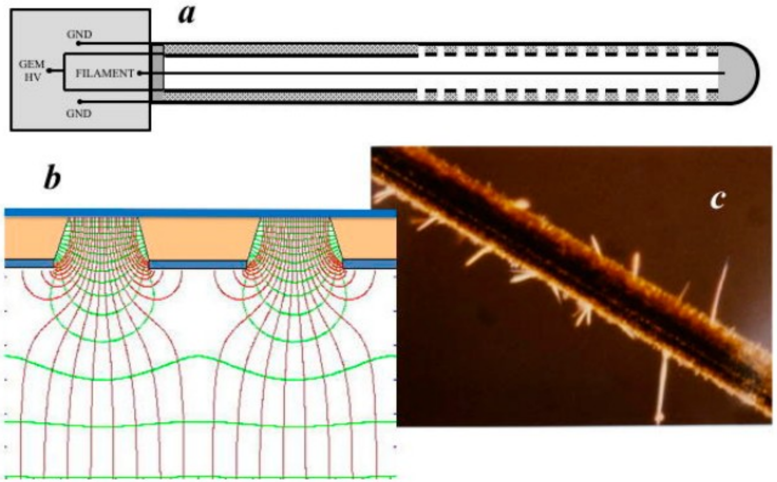



**Figure 3.** (**a**) Schematic of the gas electron multiplier (GEM)-based endoscopic X-ray generator (not to scale); (**b**) close-up of two GEM holes with the electric field lines; (**c**) example of sub-micron discharge-grown spikes on a thin wire.

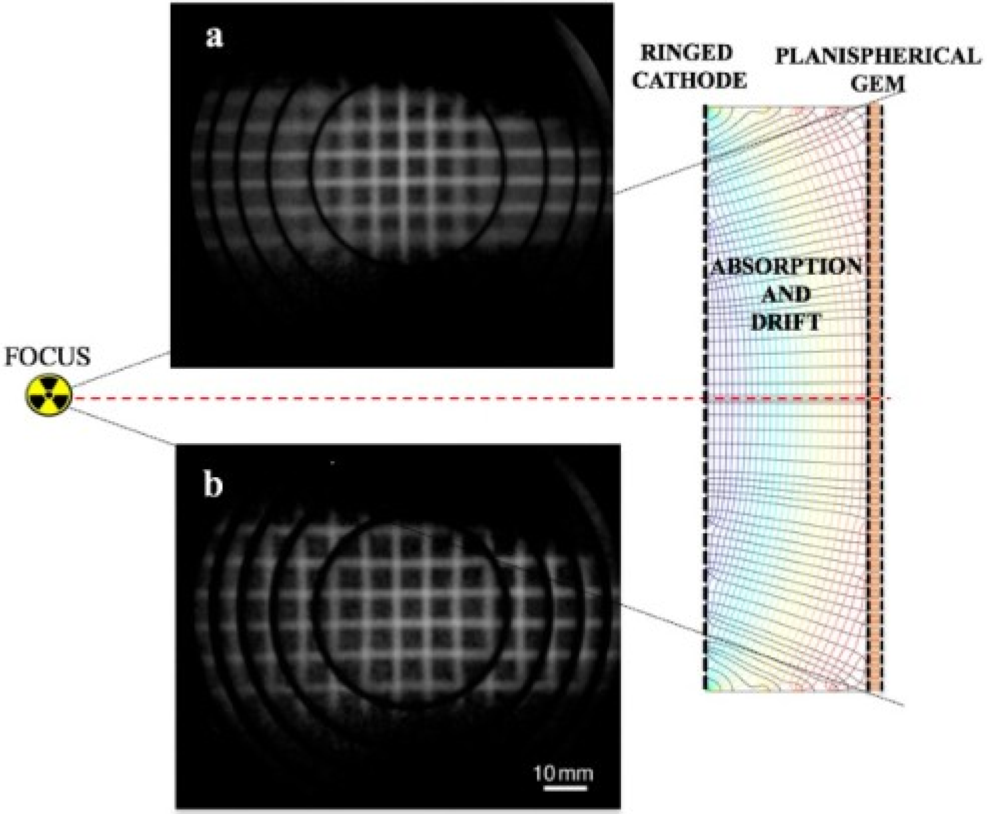
# Squaring the circle

The 10keV photon absorption in argon-based gaseous detectors is 8cm. A thick conversion gap is required for optical readout.

For non-parallel photon fields, this introduces a parallax error in the localization.

A planispherical chamber uses a specially designed GEM foil with the electrodes shaped as concentric rings.

Photons emitted at the focus of the structure convert along quasi-radial fields lines and provide a detected coordinate independent of the pentration.



# Prompt gamma imager

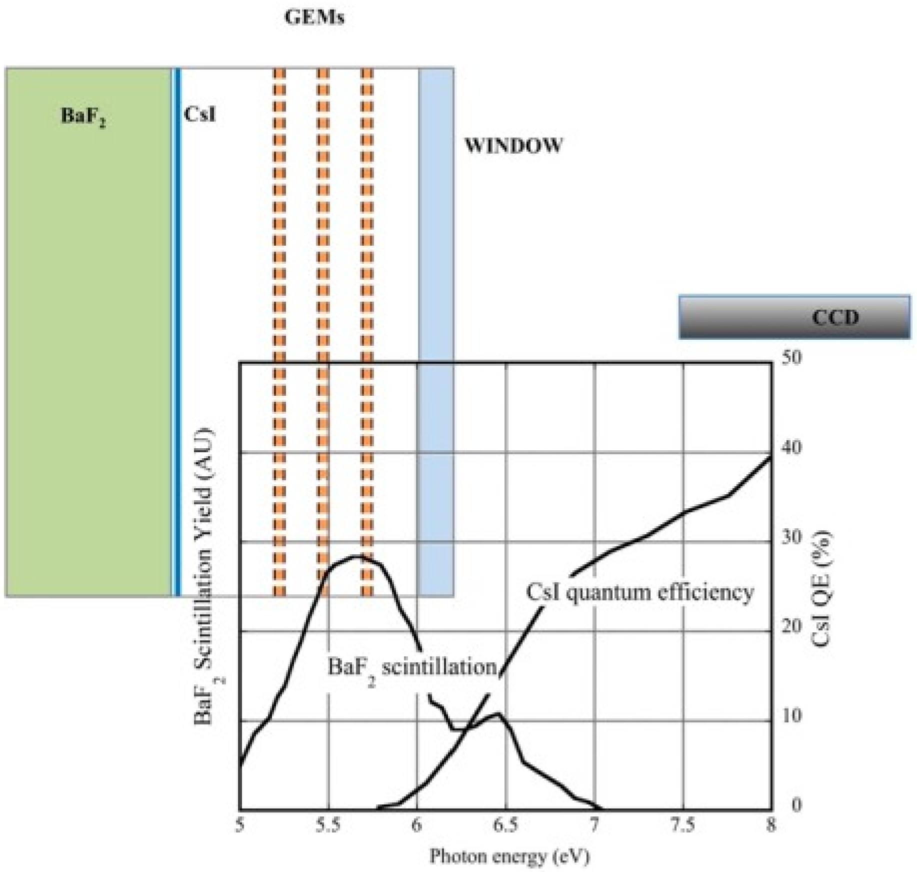
Hadrontherapy exploits the large increase in the differential energy loss of particles near the end of their penetration to target the neoplasms while sparing the surrounding tissues.

No realistic tools exist to proactively assess the position and penetration of the beams during the exposures.

The copious production of MeV photons is the most appealing outcomes of the beam-target interaction than can be exploited to this extent.

Pixelized, crystal based detectors with good resolution have been used with a complex electronic readout.

An alternative approach could be to use a monolithic scintillating crystal slab where the photon conversion takes place. Together with a CsI layer, the photo-conversion takes place and the electrons are detected.



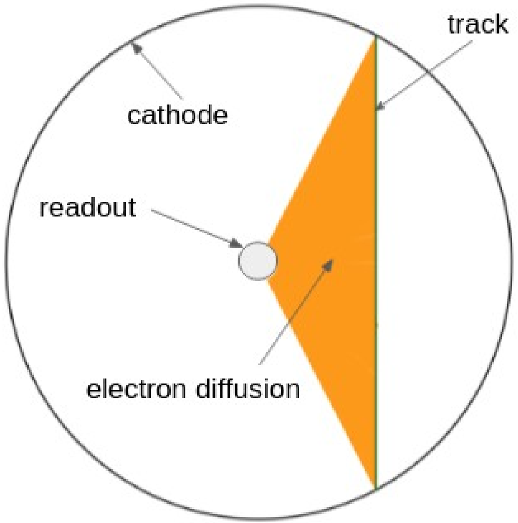
# Porous resistive dielectrics

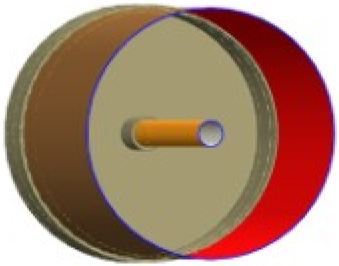
# µRtubes

µRwell  technology is cylindrically shaped with 1 cm radius and a large external sleeve of 22 cm diameter completes a radial tubulat TPC.

A radial electric field converge on the anode the ionization with a compact readout and a reduced electron diffusion,

The design optimizes the number of electronic channel per unit of volume, decreaseign sensibily the detector cost



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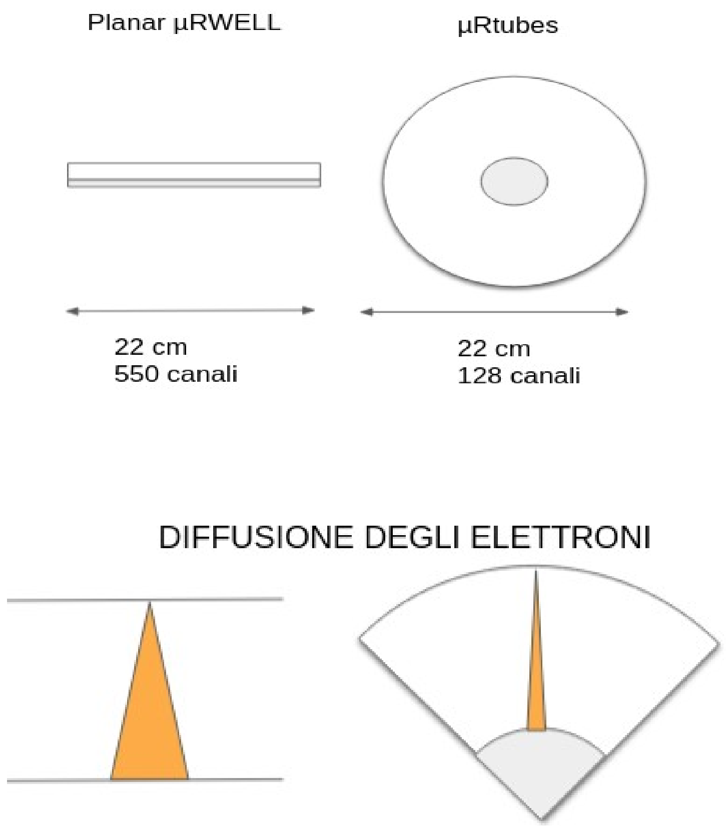

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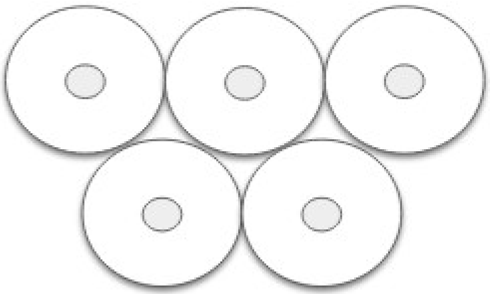
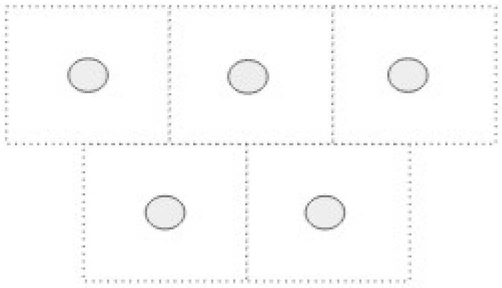
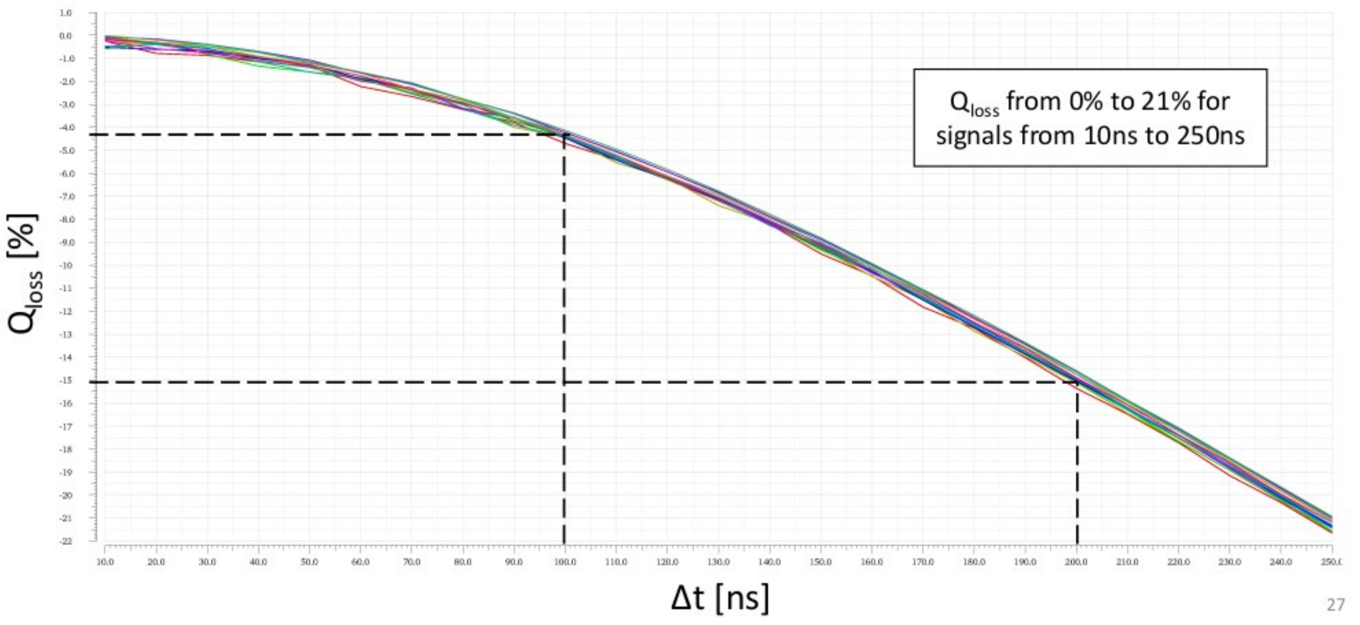




# Signal duration impact: charge

## Ballistic deficit vs signal duration (E-branch)



# Signal duration impact: time

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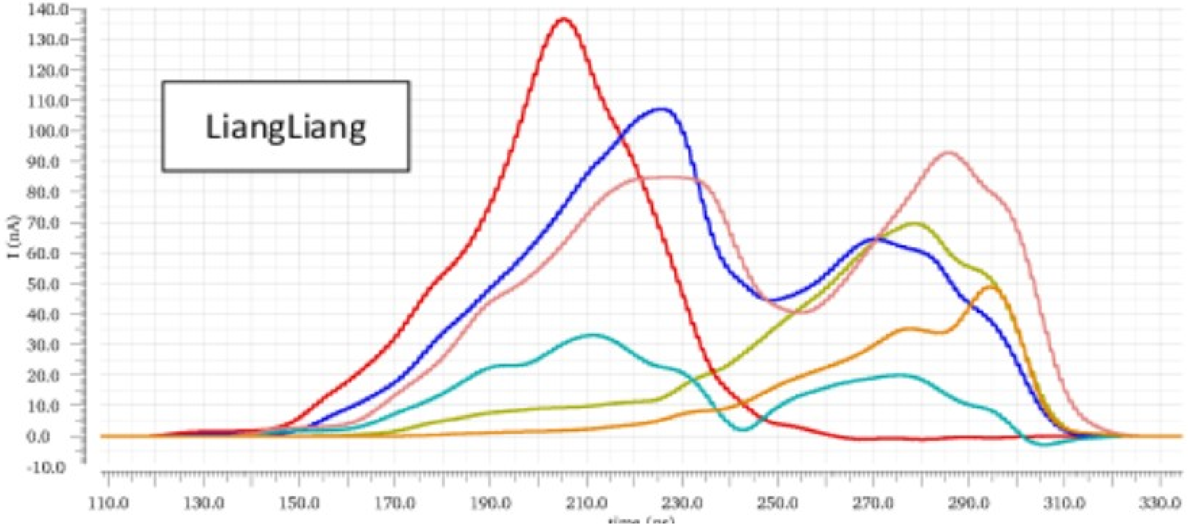
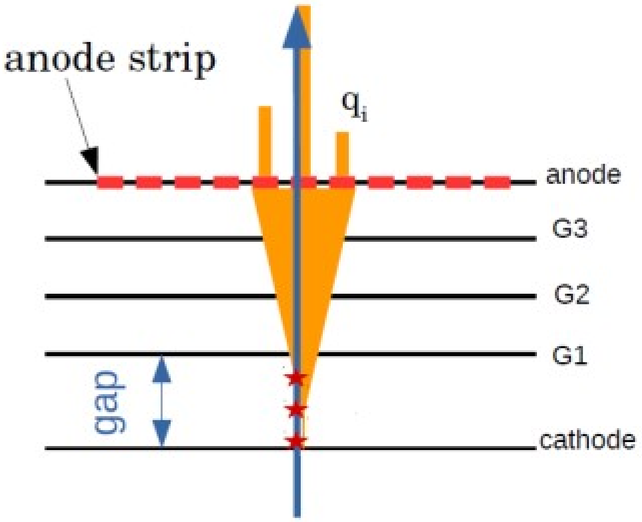


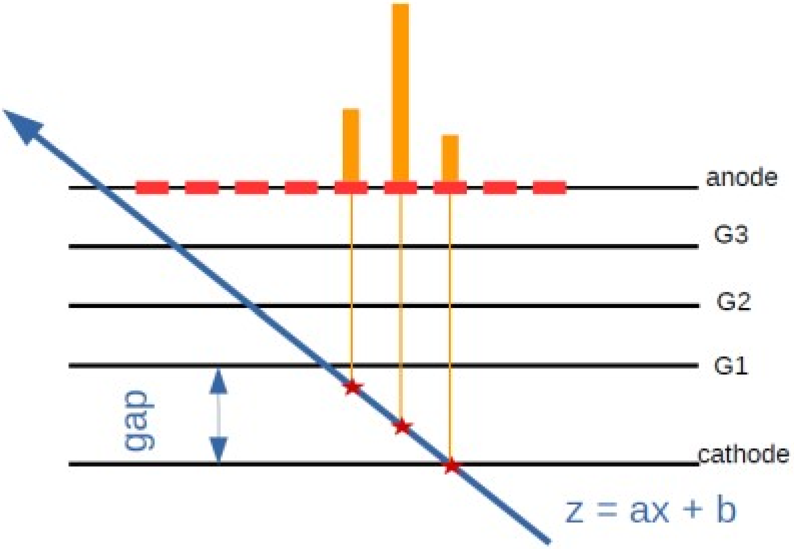
# Charge and Time based algorithms

## Charge centroid




$$x_{CC} = \frac{\sum_i^{N_{hit}} Q_{hit,i}\, x_{hit,i}}{\sum_i^{N_{hit}} Q_{hit,i}}$$

## Micro-TPC

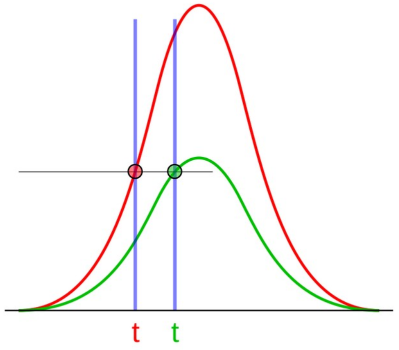



$$x_{\mu TPC} = \frac{gap/2 - b}{a}$$

# Impact on the time measurements

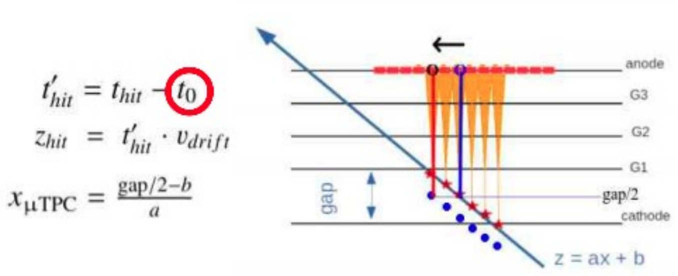
**Time-walk**: the signal amplitude affects the time measurement. The correlation between charge and time is studied as a function of the threshold levels

0-80 ns contributions




**Time-reference**: Tiger chip are synchronized but the time measurement of the same event can differ due to geometrical differences (i.e. routing, strip length, etc)

0-40 ns contributions

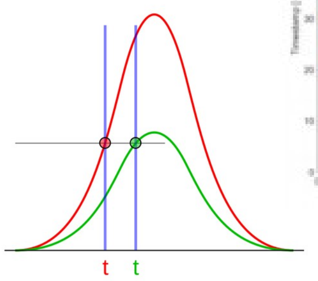


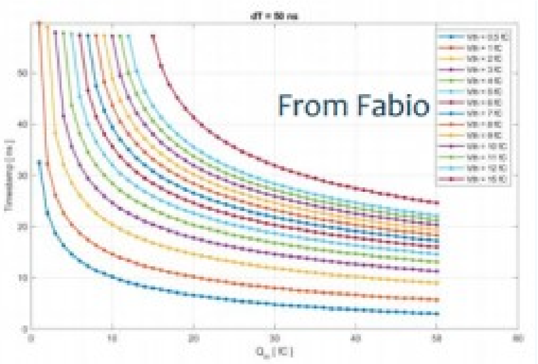

**Time-propagation**: The signal propagation from the induction point on the strip and the electronic channel affects the time measurements

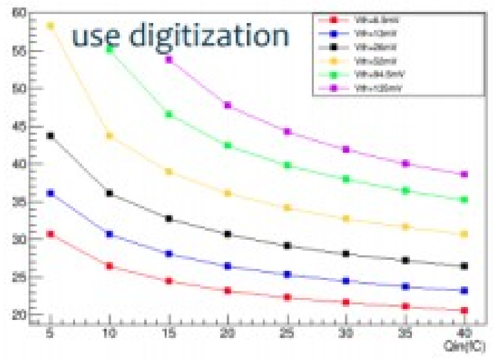
0-5 ns contributions

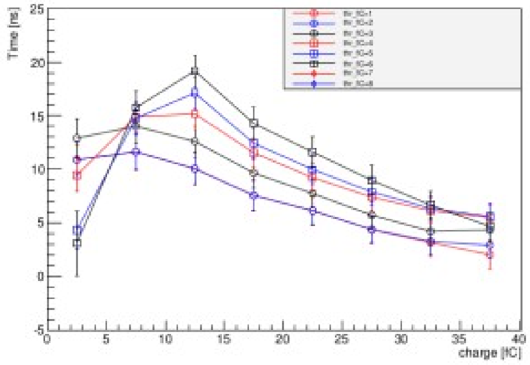
| | Strip X | Strip V |
|---|---|---|
| Layer 2 | 0.51$c$ | 0.59$c$ |
| Layer 3 | 0.35$c$ | 0.57$c$ |

# The example of the Time-Walk




Experimental with injected signal

Simulation

Experimental with real signal

# Outlook

- Detector knowledge depends on the experimental and simulation measurement
- Simulations are very powerfull to test the detector in a wide range of configuration but it needs an accurate tuning
- The results interpretation from experimental and simultaions depends strongly by the tools used and the analysis performed
- Charge and time measurement depends both by the detector and the electronics
- Good spatial resolution performance needs an homogeneous time measurement