Electronics response

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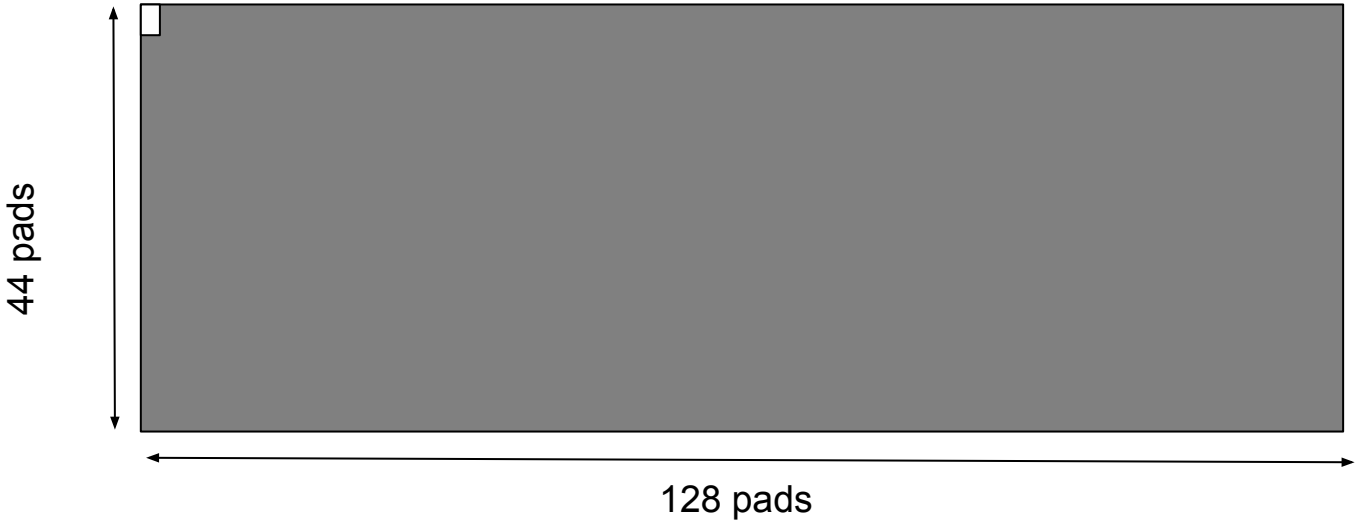
HYDRA meeting

Drift of the electrons

- Homogeneous **B** field parallel to the **E** drift field
- 2x2 mm^2 pad size
- Projection of the electrons into the pad-plane
- PadID= (44) * (Int_t)((projZ - ZOffset) / 0.2) +
  . (Int_t)((projX - XOffset) / 0.2);



Electronics response (1)

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➔ **Amplification** stage: random gain for each pad, following the Polya distribution

$$P_G(G/\bar{G};\theta) = \frac{(\theta+1)^{\theta+1}}{\Gamma(\theta+1)}\left(\frac{G}{\bar{G}}\right)^{\theta}\exp\left(-(\theta+1)\left(\frac{G}{\bar{G}}\right)\right)$$

➔ **Pad response**: The signal for each pad is

$$N(t) \propto \sum_{i=1}^{N} G_i * \exp\left(-3\frac{t-t_i}{\tau}\right)\sin\left(\frac{t-t_i}{\tau}\right)\left(\frac{t-t_i}{\tau}\right)^3$$

➔ The signal is **sampled** in time and white noise is added for each sample

➔ A **threshold** is applied to select pads for which SNR is larger than

$$5 * \sigma_{r.m.s.} \quad of\,the\,noise$$

Eur. Phys. J. A (2014) 50: 8 A. Obertelli

Electronics response (2)

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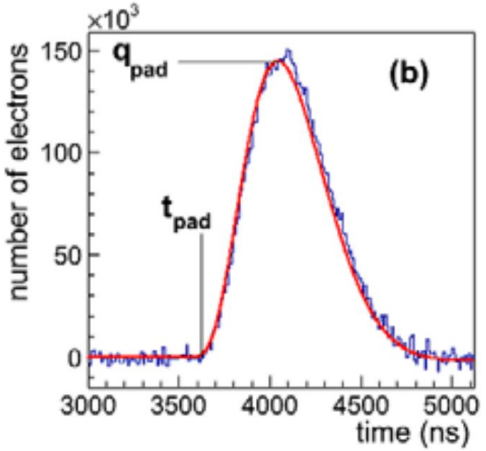
➔ Finally, the signal is analyzed by the following mathematical function

$$f(t) \propto Q_{pad} * \exp\left(-3\frac{t-t_{pad}}{\tau}\right) \sin\left(\frac{t-t_{pad}}{\tau}\right)\left(\frac{t-t_{pad}}{\tau}\right)^3$$



➔ Qpad represents the total number of electrons collected on the pad

➔ t pad is the trigger time of the pad converted in a drift distance

Electronics response (3)

Gain	4000.
Theta	1.
Time Bin	20 [ns]
Shaping Time	300 [ns]
NoiseRMS**	700.
Threshold	3*700

**Electronics directly attached to the pad plane, no cables!

AGET

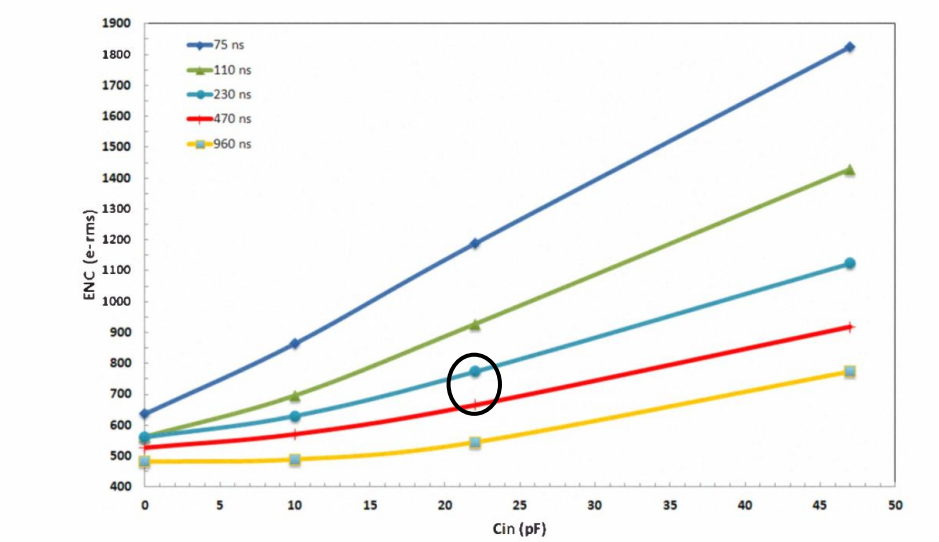


Fig. 9. ENC versus input capacitance for different peaking times (120 fC range, 100 MHz SCA write frequency).

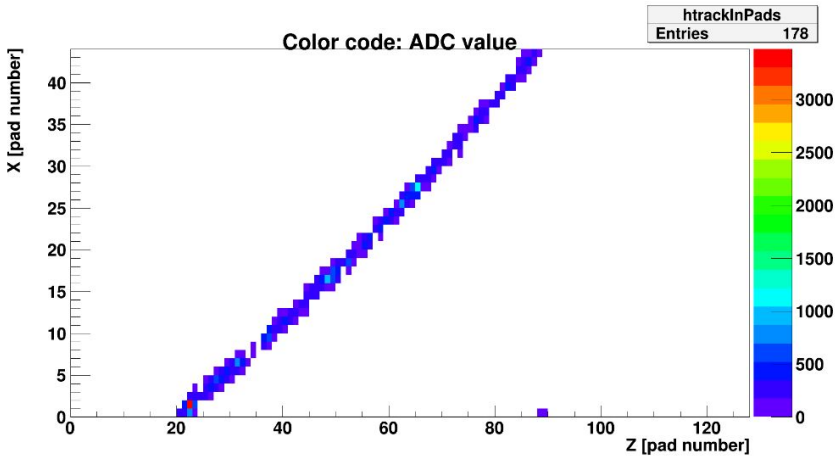
2011 IEEE Nuclear Science Symposium Conference Record, 2011, pp. 745-749

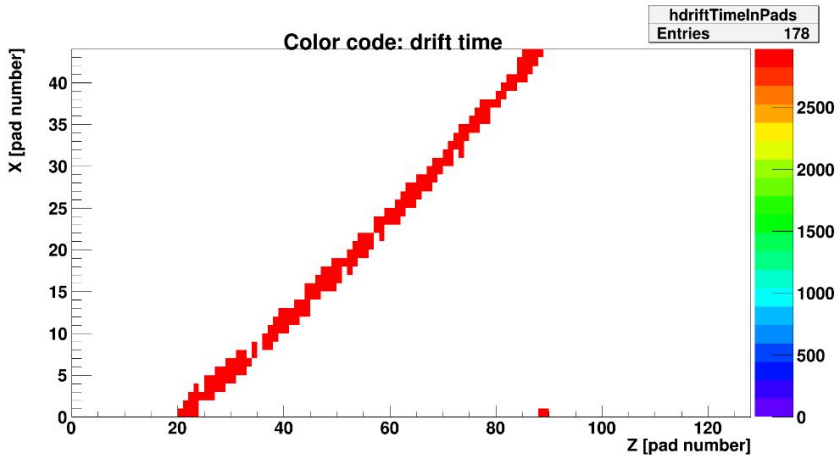
ADC Value conversion

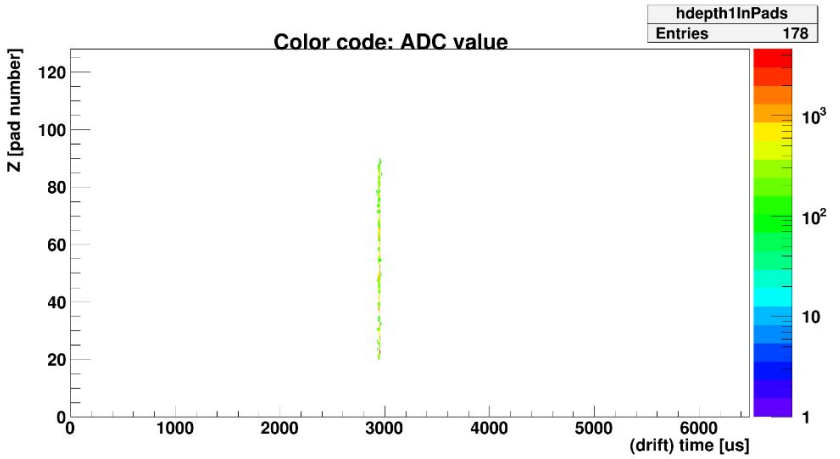
- 12 bits electronics→ 4096 channels
- electronics dynamic range 120 fC
- To convert number of electrons (q) to ADC values we need to scale the signal by:

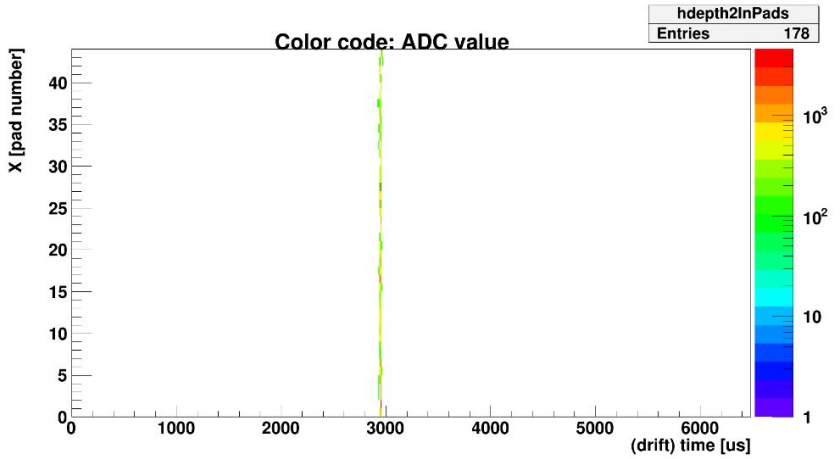
$$ADC = q \frac{4096}{\left(\frac{1.2 \cdot 10^{-13}\ C}{1.6 \cdot 10^{-19}\ C}\right)} = q \cdot 5.46 \cdot 10^{-3}$$

Pad plane response

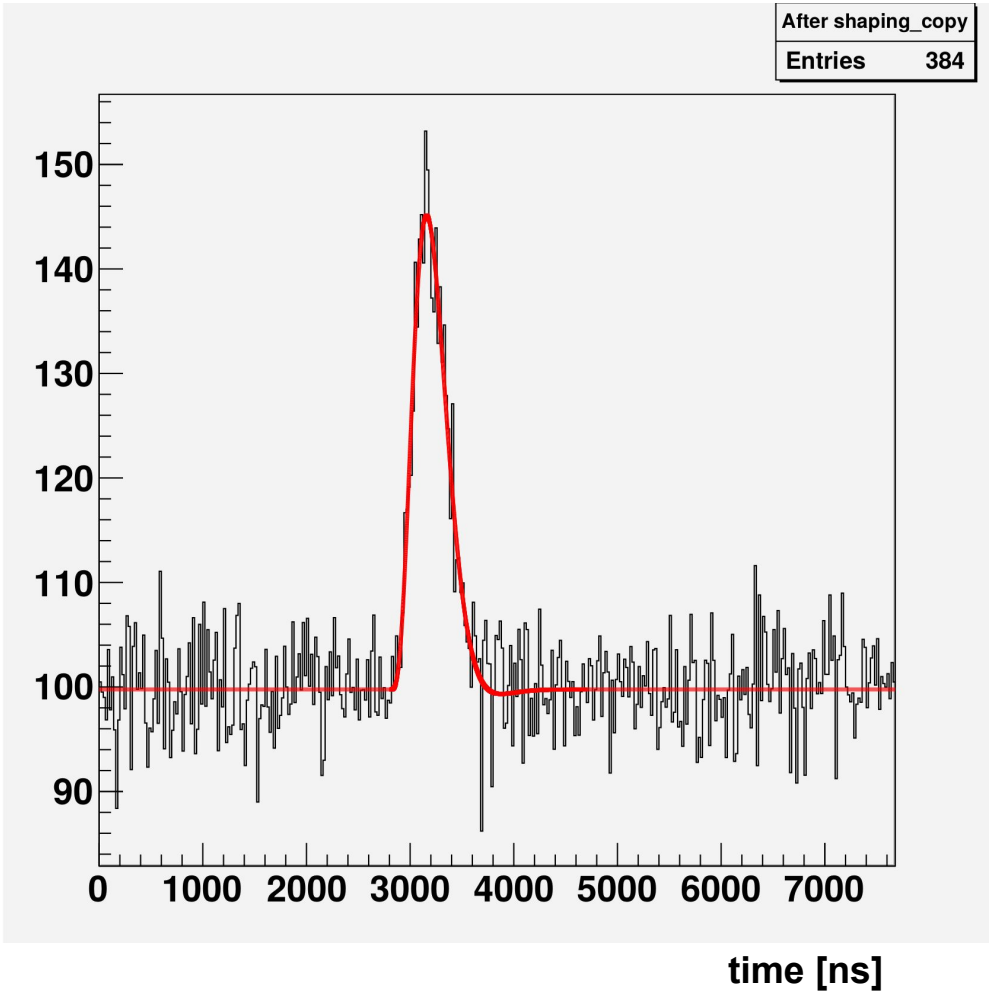








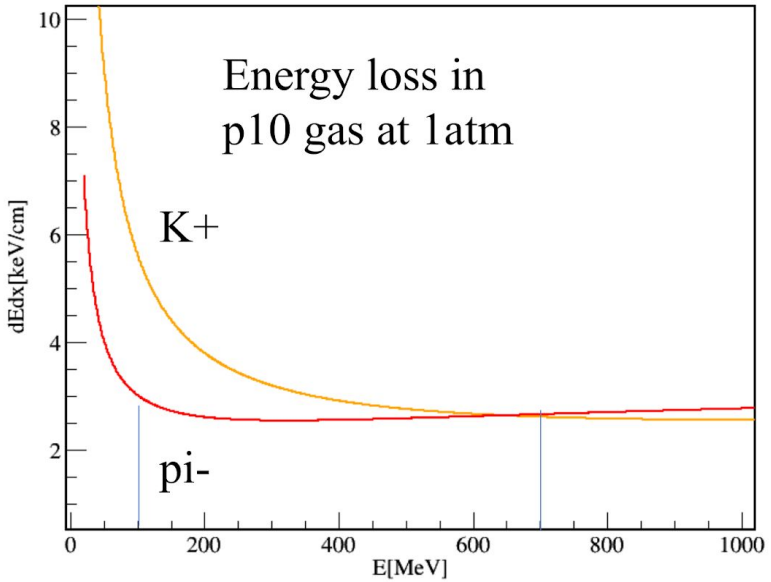
Example of a signal



← ADC Offset of 100

Amplitude estimation

Assumption:



- ➔ Energy loss=3keV/cm
- ➔ W= 30eV (Ar 26 eV, CH4=28eV)
- ➔ pad size= 2*2mm^2
- ➔ track cross the pad for 1mm
- ➔ Gain= 4000

Amplitude estimation.

- ➔ Energy loss in 1mm:

$$E_{1mm} = 3\,\frac{keV}{cm} * 0.1\,cm = 300\,eV$$

- ➔ Number of electrons produced:

$$n_{e^-} = \frac{300\,eV}{30\,eV} = 10\,e^-$$

- ➔ These are amplified by the MM→ 40000 electrons
- ➔ Finally, converted in ADC value:

$$ADC = 40000 \cdot 5.46 \cdot 10^{-3} = 218$$