Abder Merakeb
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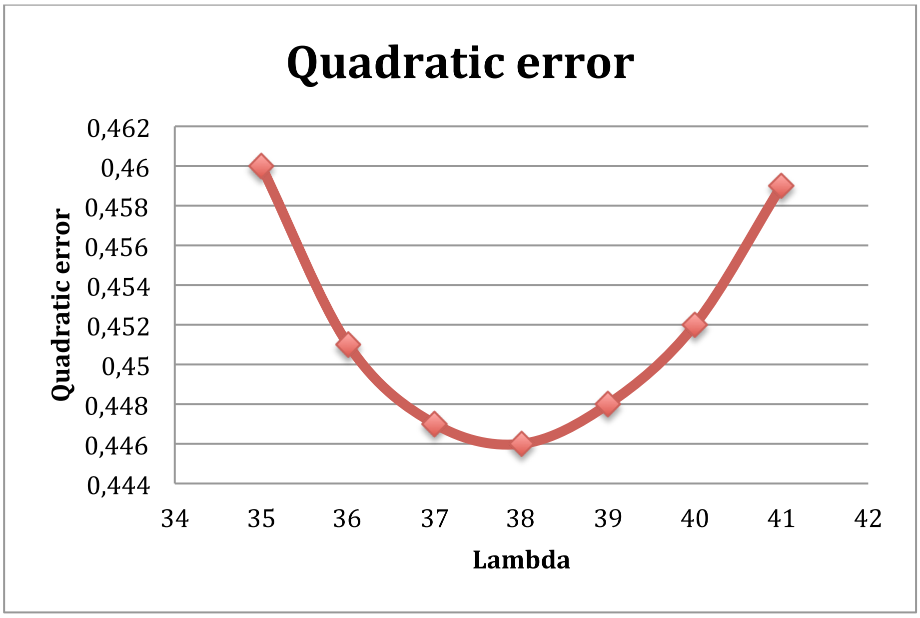
Reporting n°2

A. Photomultiplier test

I. Study of the Area's distributions

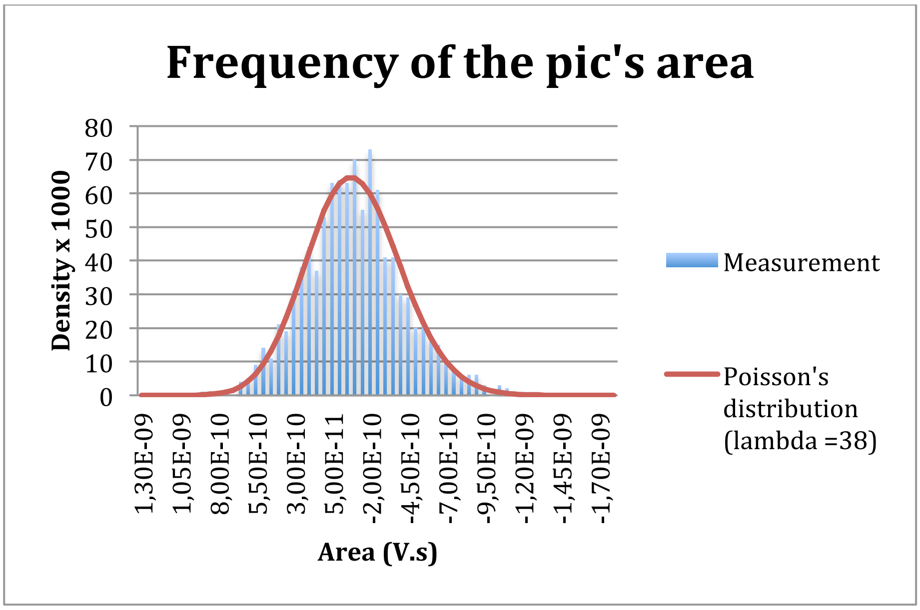
The trigger level selects peaks above a certain threshold. Because of that, we cannot fit directly the distribution as a Gaussian and we have to fit the histograms with a Poisson's distribution ($f(k) = e^{-\lambda} \frac{\lambda^k}{k!}$).

We have to choose the best lambda parameter of the Poisson's law. To do that, I have calculated the quadratic error for several values of lambda and have choose the lowest one:

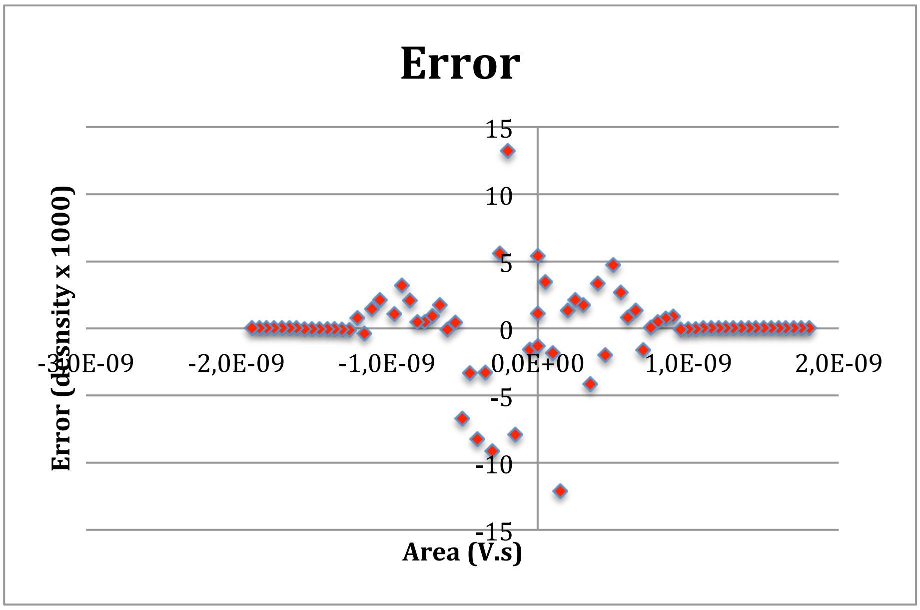


So that is the result of the fitting for an input of 1100 V in the PMT.

Quadratic error = 0.446



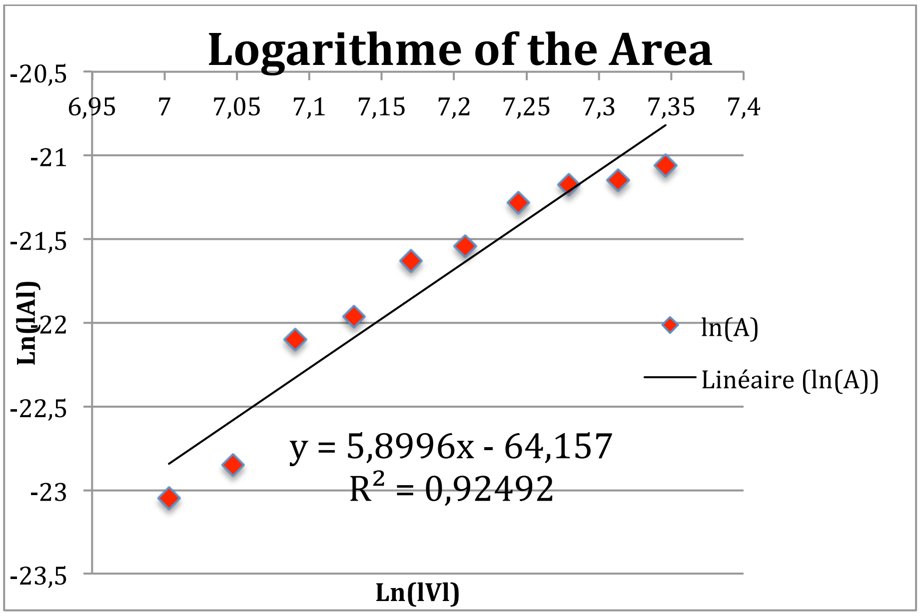
Moreover the error is well distributed. So it seems that we don't have systematic error



II. Study of the trend of the Area in function of the input Voltage

After doing all the fitting and having find the average of the output areas, we can trace the area in function of the input voltage

Hypothesis: $A \alpha V^x$



R = 96,2% (dependency between the growth of Ln(A) and the growth of Ln(V), we can think that the other 3.8% remains of other random process, like the noise for example)

$$A = e^{-64,157} V^{5,899}$$

$$A \approx 1,37 \times 10^{-28} V^{5,90}$$

As a conclusion, it seems that there is about 6 dynodes in the photomultiplier, but concretely, that is not the case. In fact there is 12 dynodes in the photomultiplier.

This difference between the theoretical result and the reality could be explained by the choice of the trigger level. Indeed, by choosing a trigger level which was too low, we could have missed a lot of signal revealing cosmic rays in low voltages (-1100V, -1150V).

I have already tried during the last measures to consider this fact and I had adapted the trigger level slightly between two measures, but that was not really precise.

What I propose to do now, is to study the trigger level to have better measures to analyse.

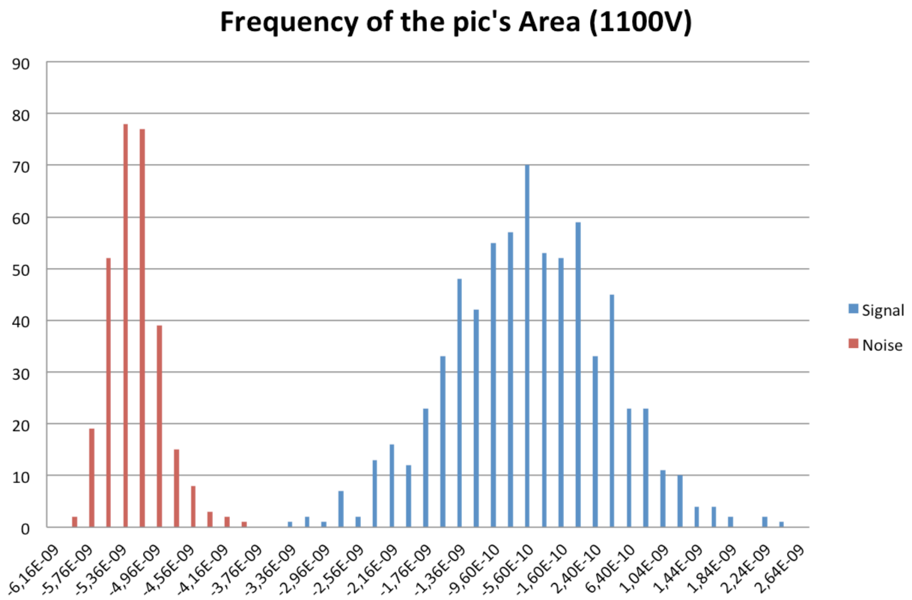
For that the trigger level must have 2 main roles:

- Eliminate the noise
- Give the same frequency of the measurements (to measure the "same" cosmic rays)

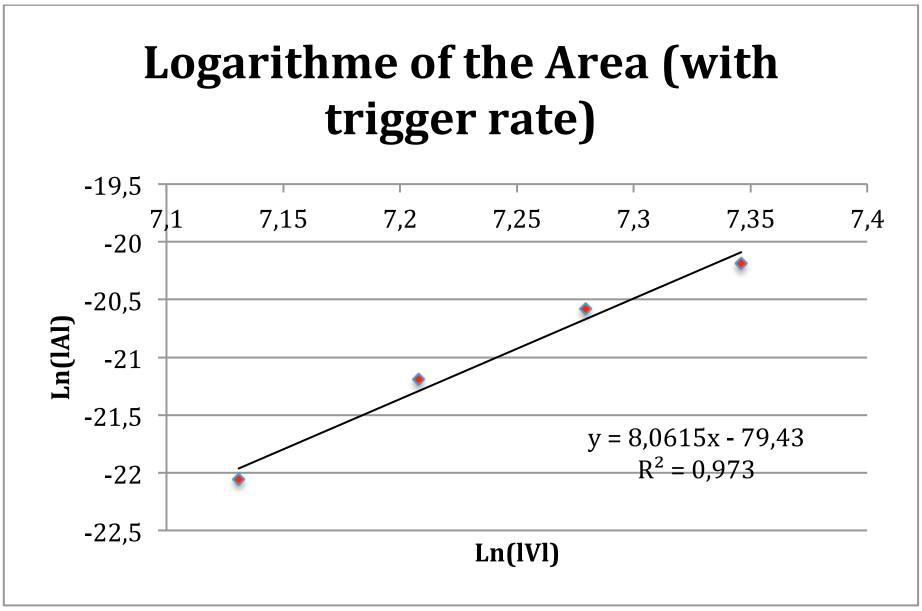
III. Improvement of the study with the trigger rate

Then, the measures will be more precise. Below are the final trigger levels and the frequency of the cosmic rays measured:

Input Voltage (V)	Trigger level (mV)	Trigger's rate (Hz)
-1150	-4.0	1.1
-1250	-9.3	1.4
-1350	-20.1	1.2
-1450	-41.1	1.3
-1550	-80.0	1.4



As we can notice in this bar graph, there is 2 poisson's distribution. The red one corresponds to the noise. So, we will have to erase it for our study to have more precise results. But at high voltage, the Noise's areas are nearly the same as the signal's area. It is so difficult to separate them.



R is better (98,6% depency between Ln(A) and Ln(V)). I tried to fit the poisson distribution with less noise but it was difficult for high voltage to differentiate the area of the signal and the area of the noise.

So, for now, the measures give:

$$A \approx 3{,}19 \times 10^{-35} V^{8{,}06}$$

Then, we can improve these measurements again by using root for example and fit the poisson distribution around a certain area.

B. ASIC board test

I. Brief review of ASIC board

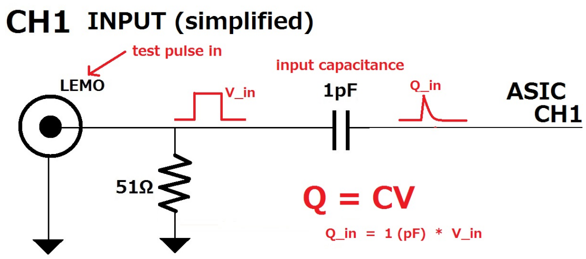


Fig. 1 : Simplified scheme of the ASIC and its role

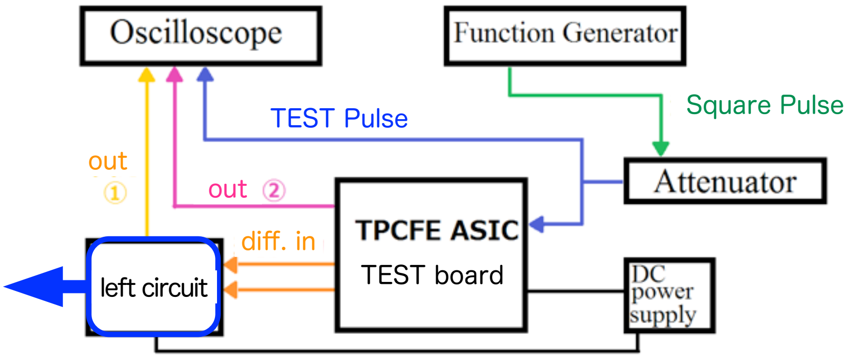


Fig. 2: Scheme of the principle of the measure (from Test board of TPCFE, Yokohama National University)

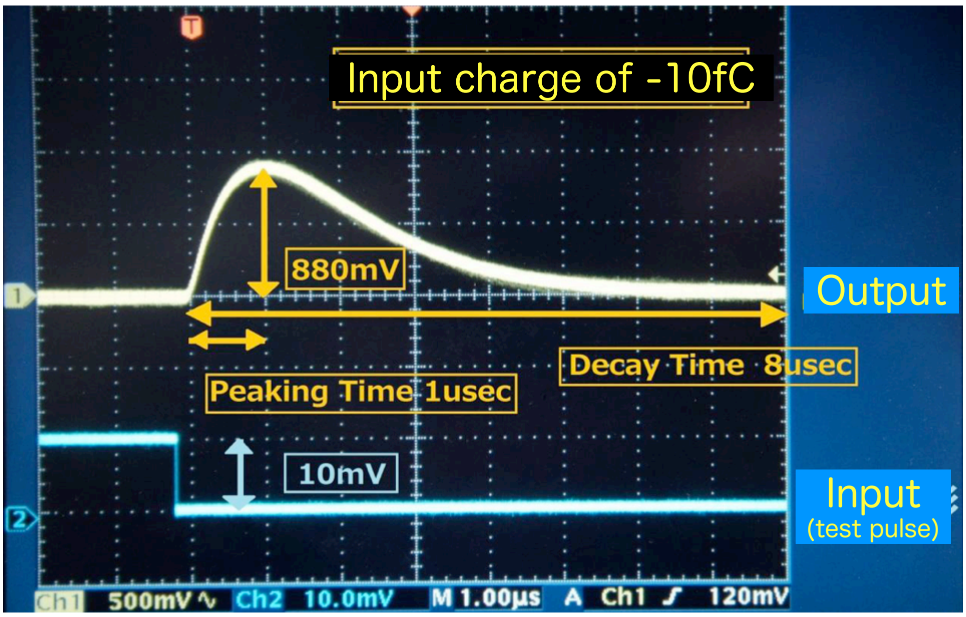


Fig. 3: Input test pulse and peak response (Input of -10mV -> -10fC)

We can simply convert input pulse into input charge by the relation: $Q_{in} = C * U_{in}$

II. Baseline voltages

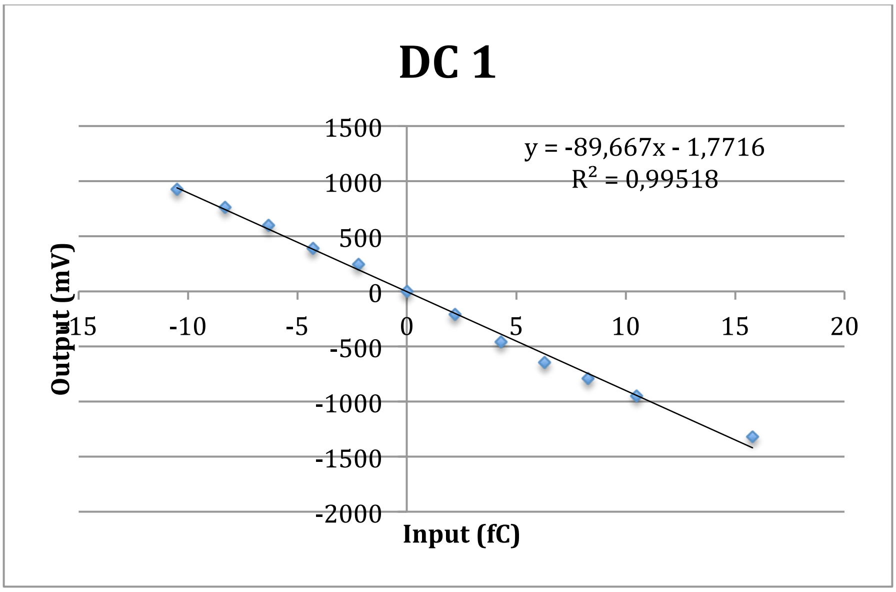
These are the baseline voltage of the 16 channels:

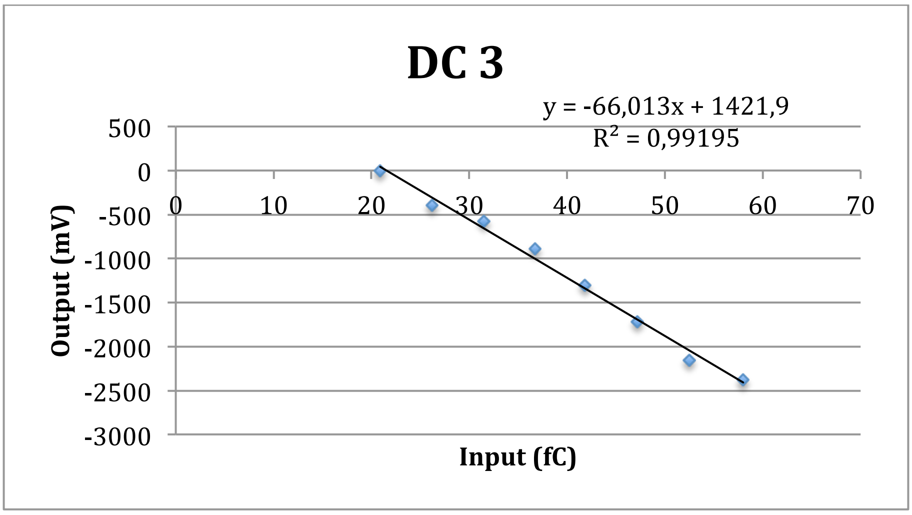
Channel	Baseline (mV)	Channel	Baseline (mV)
1	280	9	1218
2	795	10	740
3	1220	11	870
4	-1245	12	160
5	730	13	745
6	70	14	1218
7	1218	15	-505
8	345	16	1219

These baselines allows us to see different output voltage in the 16 channels because of the "Voltage of saturation" of the amplifier.

III. Measures of the 16 channels

Here is the example of 2 channel (DC1 and DC3) with respective baseline voltages of +280 and +1220 V. Please refer to the power point to see all the channel.





We shall have the same slop in all the channel as the gain of the ASIC is the same in all outputs. So, I had studied the distribution of all the 16 slopes to find the rms and the precision of the measurements. Here are the result obtained :

$$rms = \frac{1}{16}\sqrt{\sum_{ch_1}^{ch_{16}} slope^2}$$

$$\boxed{rms = 7.31 mV.fC^{-1}}$$

$$\boxed{\overline{slope} = -78,24 mV.fC^{-1}}$$

$$e\% = \frac{rms}{\overline{slope}}$$

$$\boxed{e\% = 9,35\%}$$