Scintillator bar tests – Fe-55 with collimator

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1. Motivations of this tests.

After discussing with Gaston and accepting his suggestions on the first small note issued last week , I have taken a set of new data using same source(Fe-55) with a collimator which has been designed and produced by Juan in ∼5 minutes, ⌣̈ .

Again, we discussed the second version of my note which issued yesterday. A "fine" ADC cut has been applied to same data as above and new results are presented in this one.

2. Setup and software

The setup almost has no change except one collimator has been added which is made of two-fold(two layers) of copper foil.

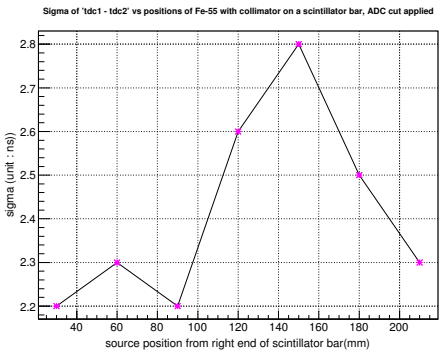
The software has been change a little bit : individual TDC1 and TDC2 analysis have been commented, and ADC cut has been added to do "TDC1 - TDC2" analysis. Besides, ADC cut has been changed, please see section 3.2.

3. Results

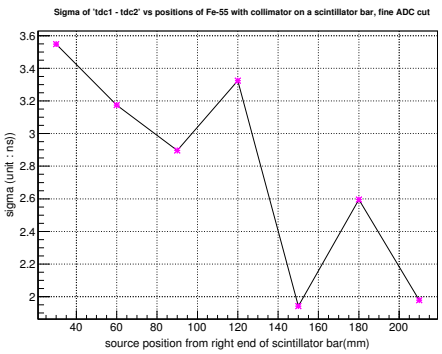
3.1. The whole picture of "TDC1 - TDC2" .

With a collimator, the sigma values of "TDC1 - TDC2" in seven different positions is shown in figure 1. Be aware, figure 1a is the results with "coarse" ADC cut, figure 1b is the results without "fine" ADC cut.

More info on two ADC cut can be found in section 3.2. For sigma values of each point in figure 1a, please see section 3.3.



1a. Fe-55 with a collimator, "coarse" ADC cut has been applied.



1b. Fe-55 with a collimator, "fine" ADC cut has been applied.

Figure 1: The timing results of Fe-55 using a collimator, two kinds of ADC cut .

3.2. Typical ADC spectra.

Two typical ADC spectra are shown in figure 2. In each position, the shape of "ADC1" and "ADC2" have almost similar shape.

In this note, "coarse" ADC cut is "ADC $<$ 1000" for both tubes. "fine" ADC cut is "$60 < ADC1 < 120$ & $110 < ADC2 < 125$".

3.3. "TDC1 - TDC2" in each position of Fe-55.

To each point of figure 1a, two PMTs' timing are filled in histogram and fit with a Gaussian function, as shown in figure 3.

3.4. Study on photon propagation in a scintillator bar.

At each point of a scintillator bar, the timing difference of two PMTs, saying "TDC1 - TDC2", can be considered as an independent way to check if the result is reliable or not.

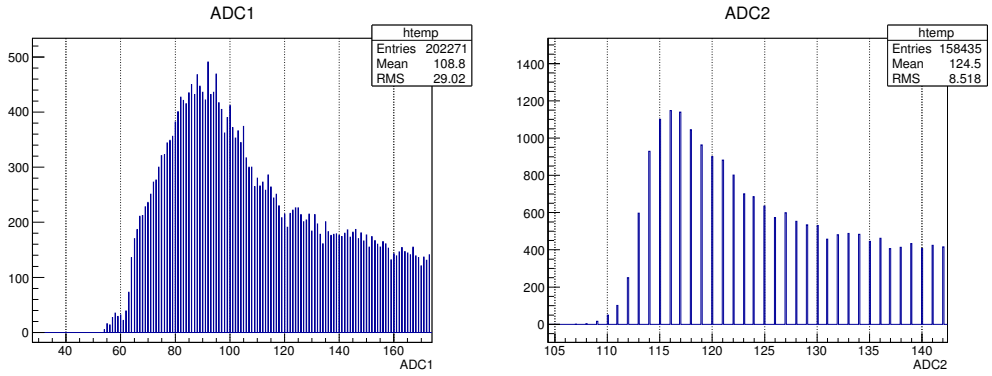
Figure 4, is the "old and wrong" version of this study : the X axis is "TDC1 - TDC2"; the Y axis is the positions of Fe-55 source was put. The "p1" value in statistical box was (wrongly)considered as the speed of photon propagating in a scintillator bar, which is $97mm/ins = 0.97 \times 10^8 m/s \approxeq 1/3c$.

Figure 5, is the "new and correct" version of this study : the X axis is "TDC1 - TDC2"; the Y axis is the distance of photon propagating in a scintillator bar. Be ware, the Y axis is obtained by the following table. The total length of a scintillator is $250mm$.

3.5. More comment on photon propagation in a scintillator bar.

Since the scintillator bar we tested has a infraction index of ∼1.6, which means the light propagates inside of the bar is supposed be a constant speed of $c/1.6 = 0.63c$.

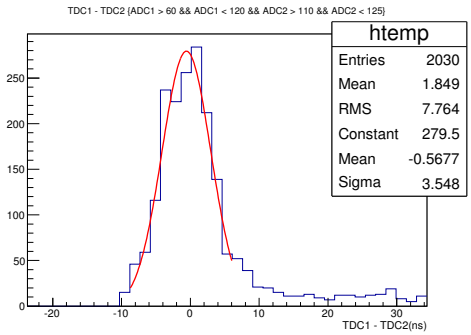
Consistently, we can get a similar result from our fit result, which is $v = 194mm/ns = 1.94 \times 10^8 m/s = 1.94/3c = 0.65c$(c = the speed of light).



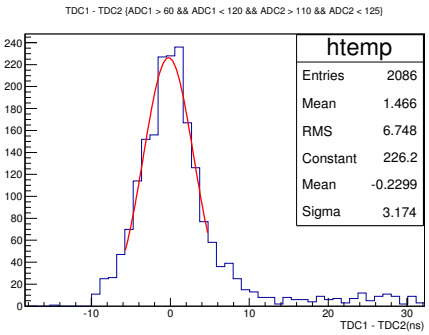
2a. Typical ADC1 .

2b. Typical ADC2.

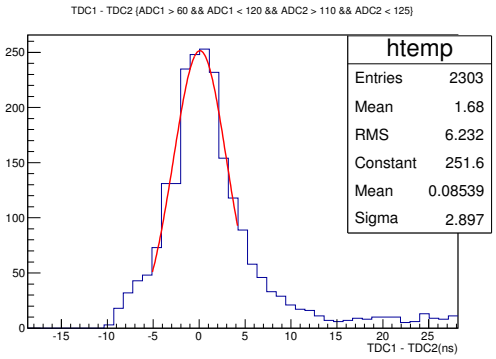
Figure 2: Typical ADC spectrum.



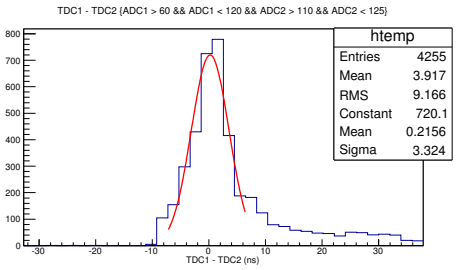
3a. 30mm from right end.



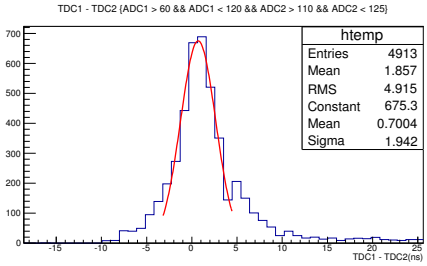
3b. 60mm from right end.



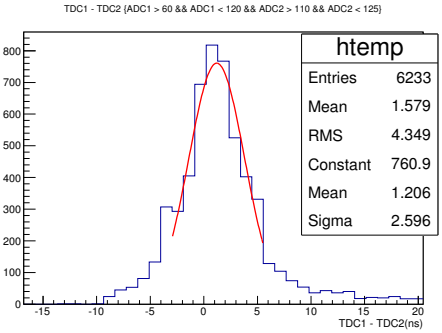
3c. 90mm from right end.



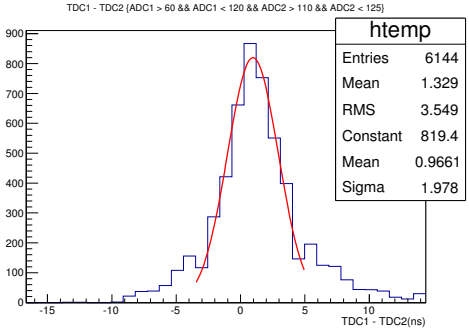
3d. 120mm from right end.



3b. 150mm from right end.



3c. 180mm from right end.



3d. 210mm from right end.

Figure 3: The timing results of Fe-55 in different positions using a collimator, fine ADC cut has been applied.

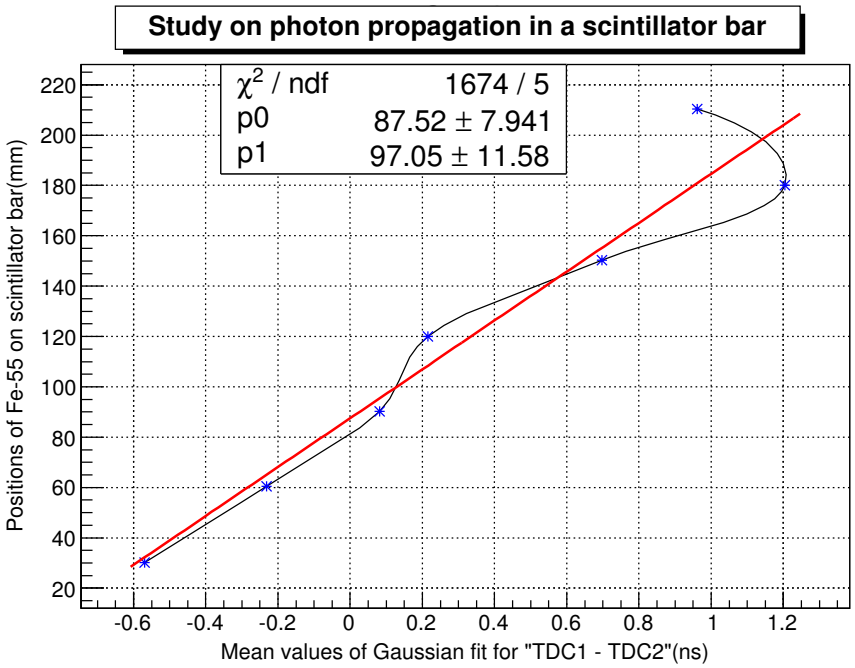


Figure 4: Study on photon propagation in a scintillator bar

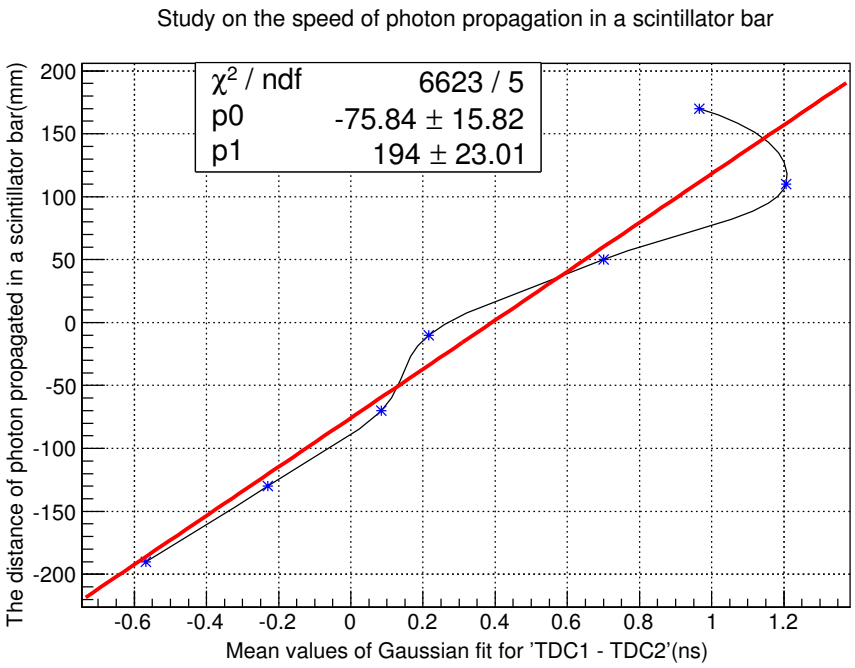


Figure 5: Corrected study on photon propagation in a scintillator bar

Table 1: Positions of Fe-55 convert to the distance of photon propagation

Positions of Fe-55 on a scintillator bar, $X(mm)$	**30**	**60**	**90**	**120**	**150**	**180**	**210**
Distance of photon propagation, $D = D_R - D_L(mm)$	-190	-130	-70	-10	50	110	170