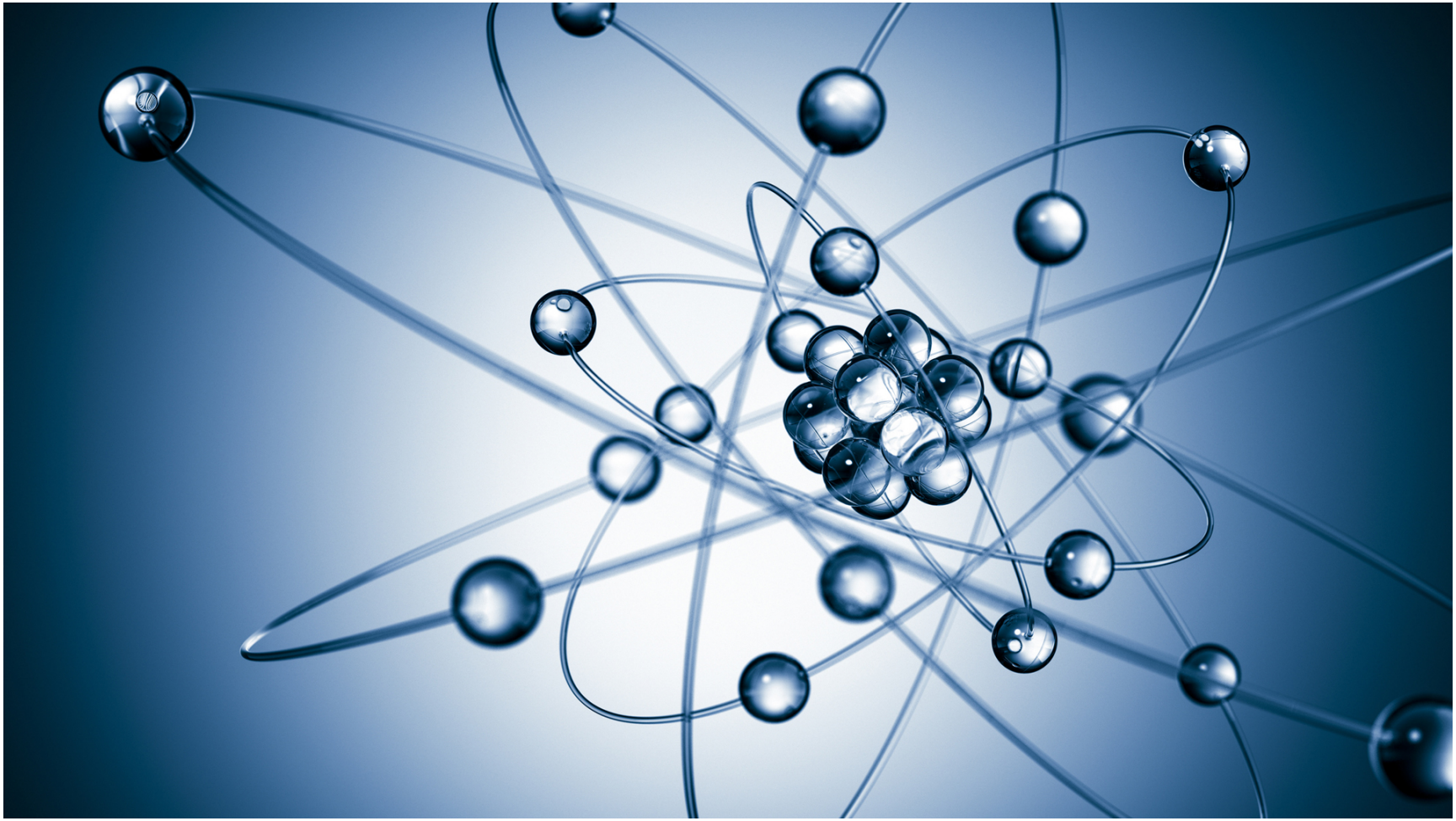

New experimental approach to probe the X17 existence

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A brief review on the Standard Model & Dark Matter:

$\Downarrow$

- Current knowledge of the nature at the fundamental level is described by the **SM**.
- SM theory seems to describe 5% of the entire content of the Universe. The other remaining part has **"unknown origin"**.
- The overwhelming unknown constituents are named as:

Dark Matter

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Some properties of DM:

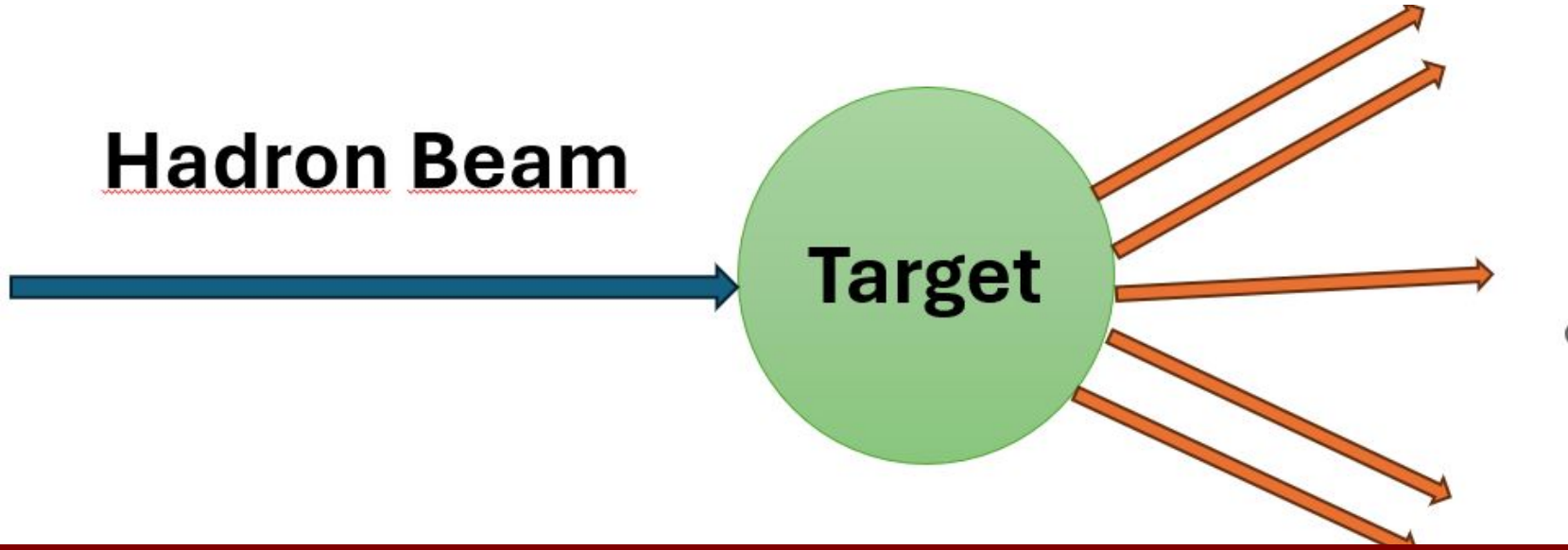
1- Either does not interact with the known ordinary matter (SM) or if interacts, then very weakly.
2- DM can be detected through their interactions with the SM objects.

A viable theoretical model suggests that:

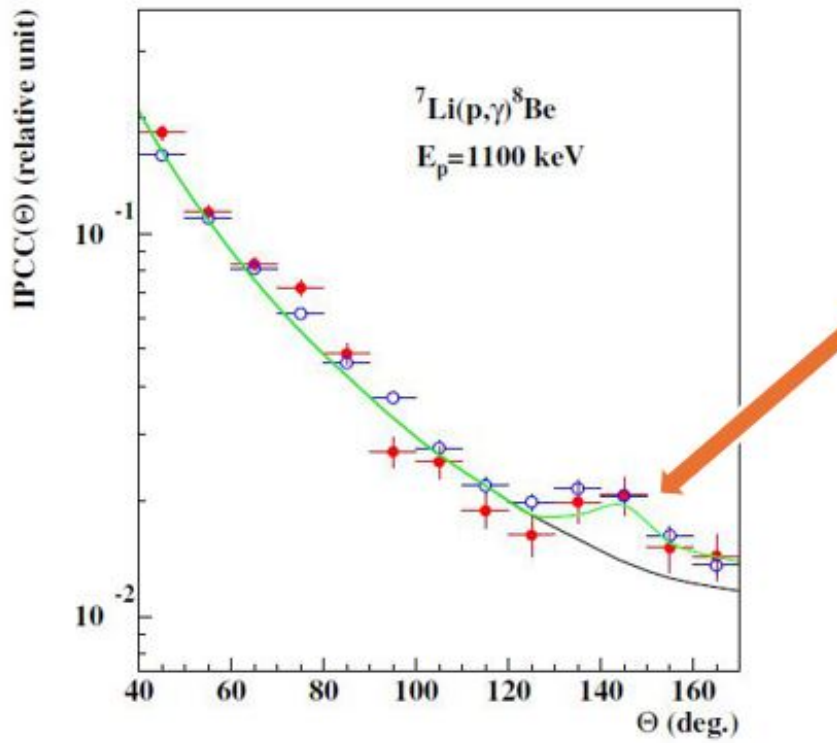
"Existence of 'Intermediate particles/fields' between SM and DM objects, provides interaction between DM and SM through the so called "**kinetic mixing**." "

Observations for rare nuclear transitions can be used to search for new hidden force-carrier particles at the MeV scale.

In this approach, a fixed target is irradiated with a hadron beam to produce excited states of a nucleous. The excited state decays and may emit new particles.



In 2016 Hungarian group reported an anomaly in the angular correlation of the electron-positron decay of the 1^+ excited level of ^8Be nucleus at 18.15 MeV.An enhancement at a folding angle close to the 140° was interpreted as a signature of decay via the emission of a **neutral boson** with a mass of around $m_x = 17$ MeV. A similar effect was reported by the same group in the decay of the lower 1^+ excited state of ^{8}Be at 17.6 MeV, and later in the 0^- excited state of ^{4}He at 21.01 MeV at a folding angle close to 115°.



Presentation of the peak

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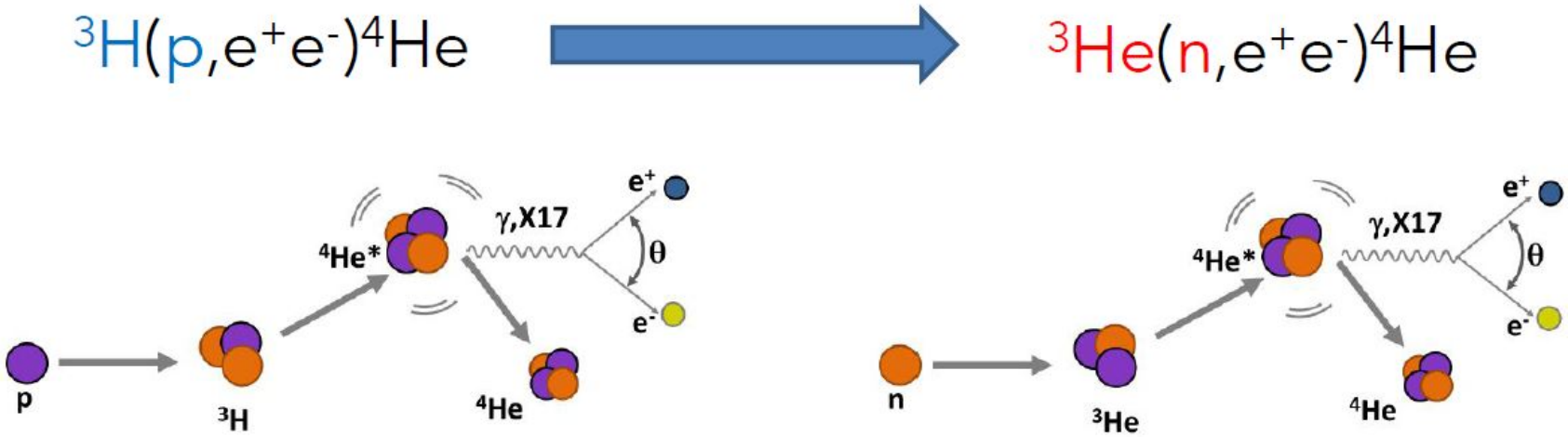
Result: The hypothetical X17 can be a candidate for DM.

Basic idea:

Study of excited ^4He

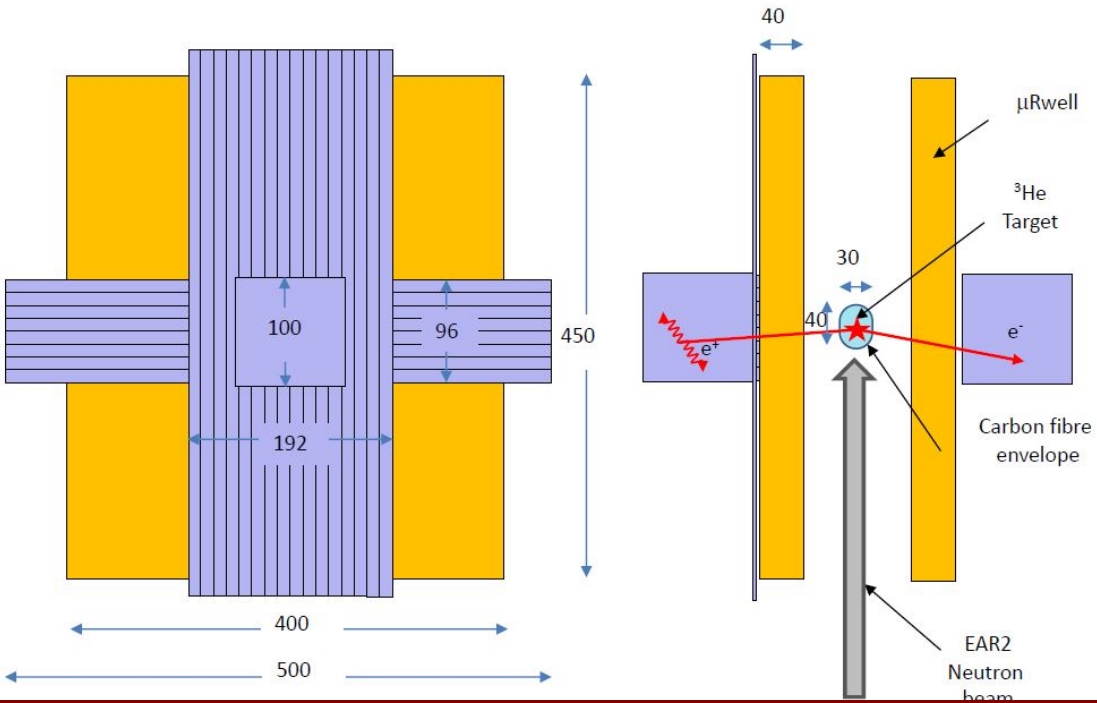
In the left part of the following photo which has been done by ATOMKI group, **proton** *beam has been used (for particle excitation) while in the other one* **neutron** *beam is intended to be utilized by the CERN n-ToF facility.*



Detector Prototype

In following, demonstrator has been shown. The detector is not the final one, but the experiment whole detector apparatus will look like this one.The main components of the μRwell are **scintillator bars as noise suppression and scintillator cubes as calorimeter.**

μRwell is used as a tracker in TPC mode.



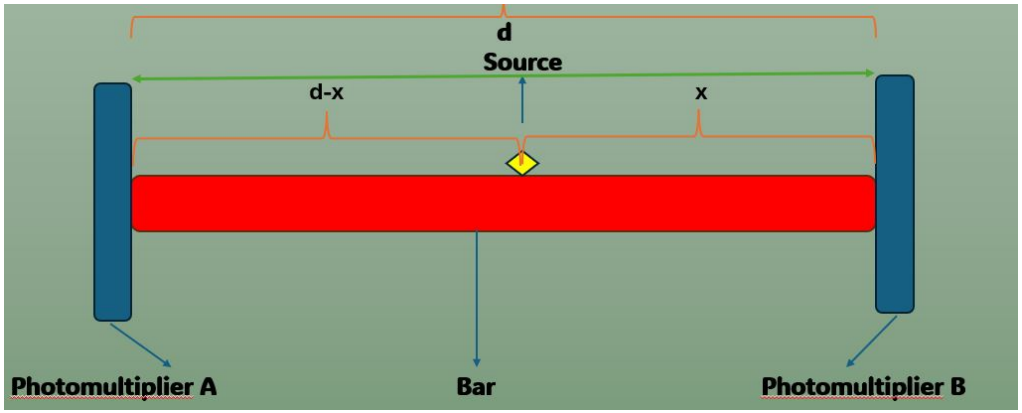
Preliminary optimization of scintillator bars:

Comparing the SiPMs response with the PMTs one

It should be mentioned that PMTs are sensitive to the magnetic field, while SiPMs are not and this is the main reason of using SiPM in the measurements.

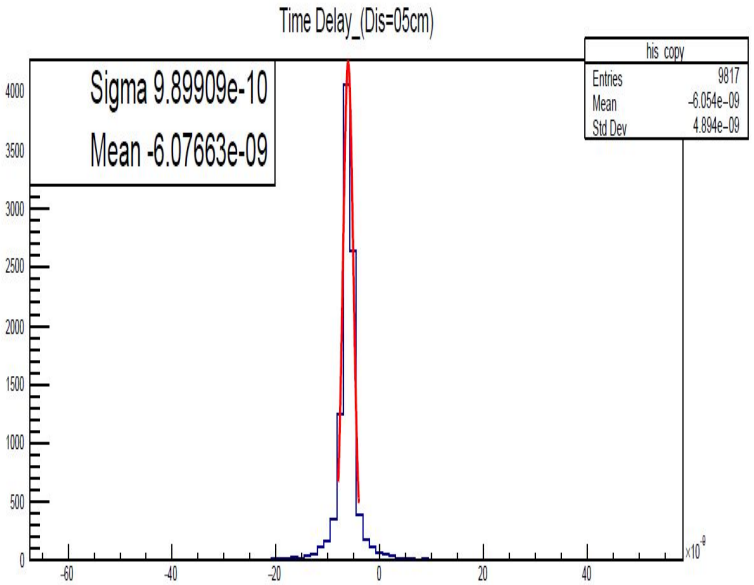
The test conditions have been assumed the same for both of the implemented tests with the PMTs and SiPMs.

Another benefit of using SiPMs is their smallness in comparison with the PMTs.

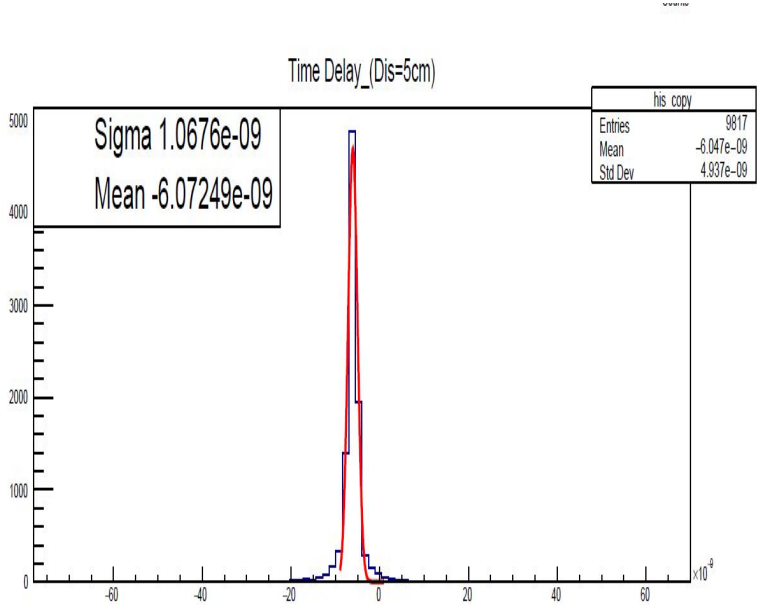


The source is: ^{90}Sr

In summary, both of the two PMTs and SiPMs represent the response of the two ends of the scintillator bar.



(a) Time-Delay of PMTA and PMTB for dis 5cm

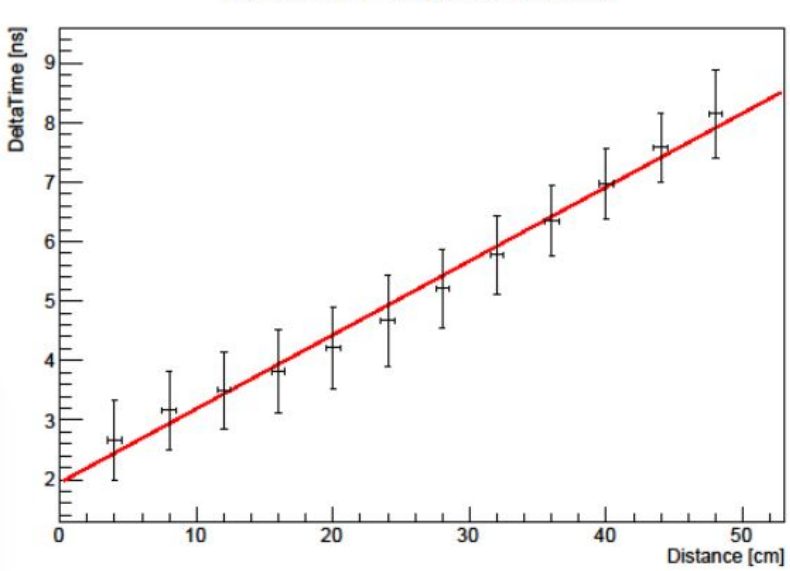


(b) Time-Delay of SiPMA and SiPMB for dis 5cm

At the final step, the light speed has been reported as:

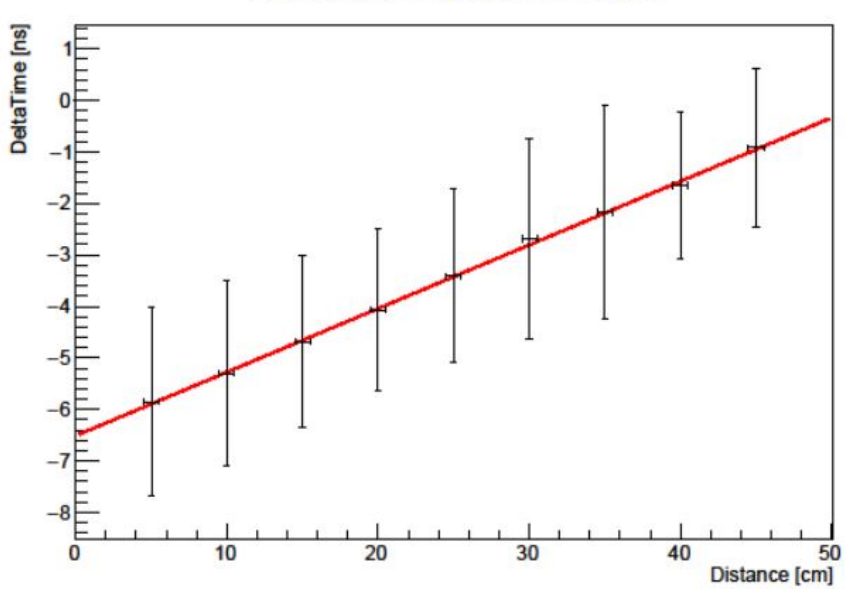
PMT

light speed in bar: 16.1072 cm/ns
refractive index estimated: 1.86252



SiPM

light speed in bar: 16.1963 cm/ns
estimated bar refractive index: 1.85227



Light speed in bar: 16.1072cm/ns Light speed in bar: 16.1963cm/ns

Refraction index : 1.86252 Refraction index: 1.85227

Upcoming Work

We will check the SiPM response at the gamma flash.In fact, in n-ToF we have a quite large signal at the beginning of the events. This signal will surely produce saturation in the detector.

It is important to know how long the saturation will stay and also how to handle it.

$\Longrightarrow$ **This saturation should be handled.**

- Three anomalies have been recently observed in experiments performed at the 2 MV accelerator of ATOMKI, Debrecen (Hungary). The anomaly consists in an excess of e^+e^- pairs at large relative angle in the ^{7}Li(p,e^+e^-)^{8}Be, ^{3}H(p,e^+e^-)^{4}He and ^{11}B(p,e^+e^-)^{12}C nuclear reactions.
- These anomalies have been interpreted as the signature of a BOSON (called X17) with mass M_{X17}=17 MeV which could be a mediator of a fifth force.
- An experiment is being prepared for the verification of the X17 to know whether X17 exists or not!
- Preliminary tests were successful. At the moment, we are working in understanding the SiPM response to the gamma flash and μ*Rwell* TPC mode exploitation.

Thank You