



# Time and Velocity Calibration from non-collimated source



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Neutron Capture Therapy

# Plan

- Motivation.
- Velocity Calibration.
- Time calibration.
- Preliminary Results.
- Summary

# How was it done till now - Velocity Calibration

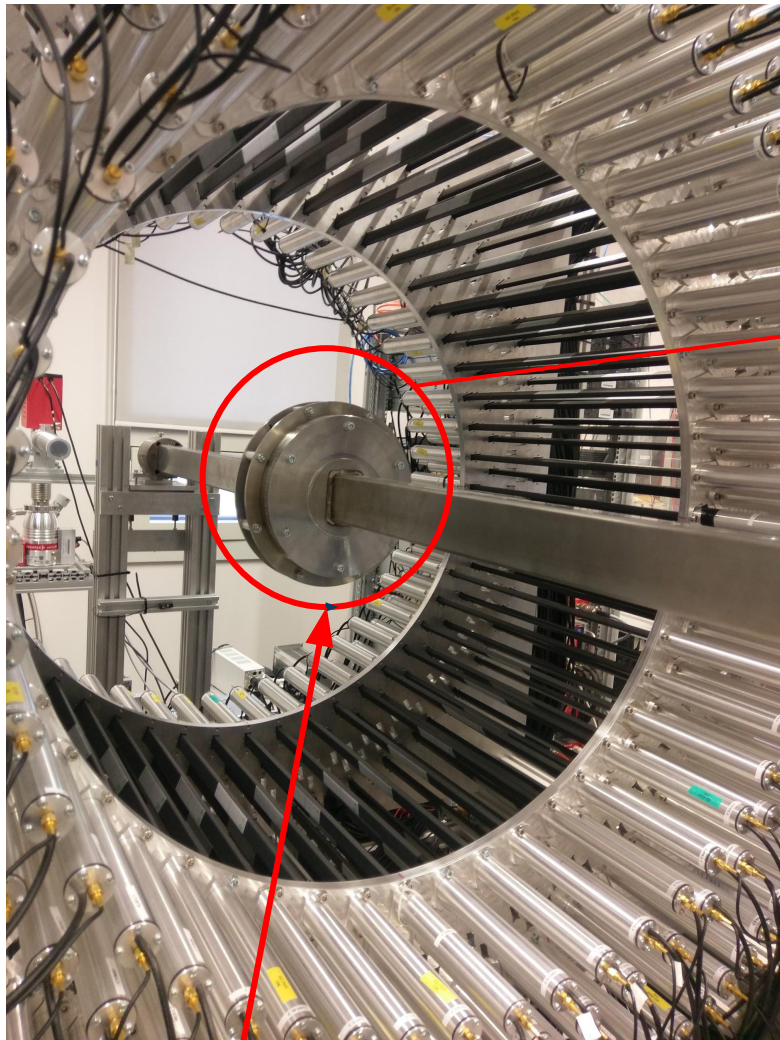
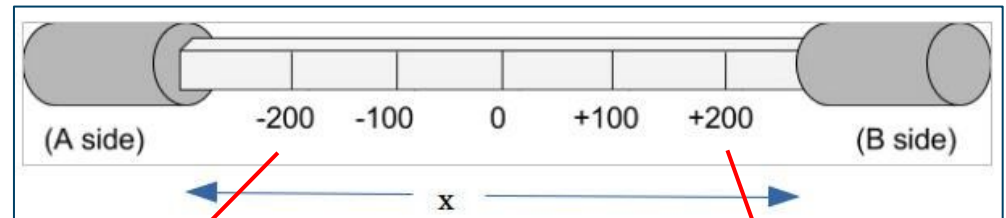
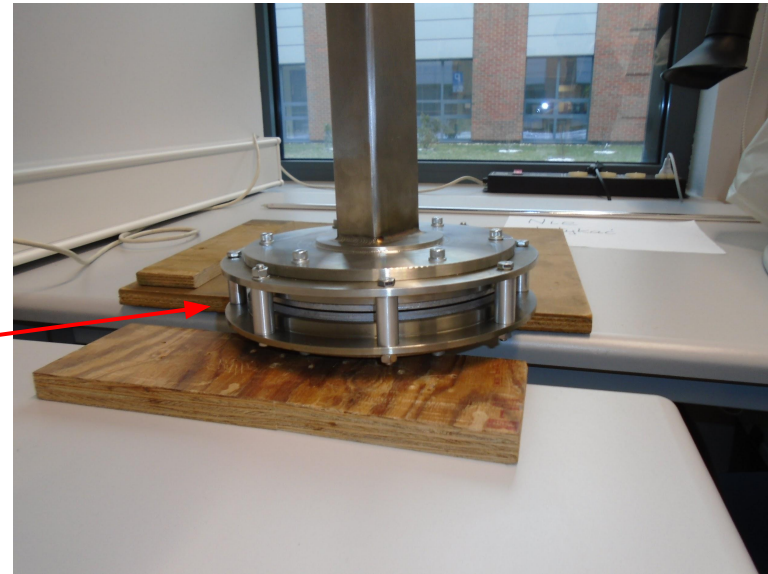
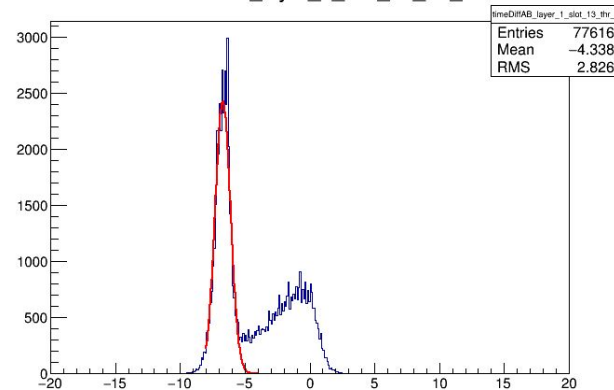


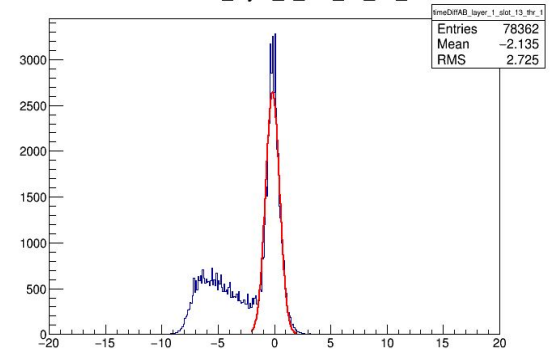
Fig.1-Collimator inside J-PET detector

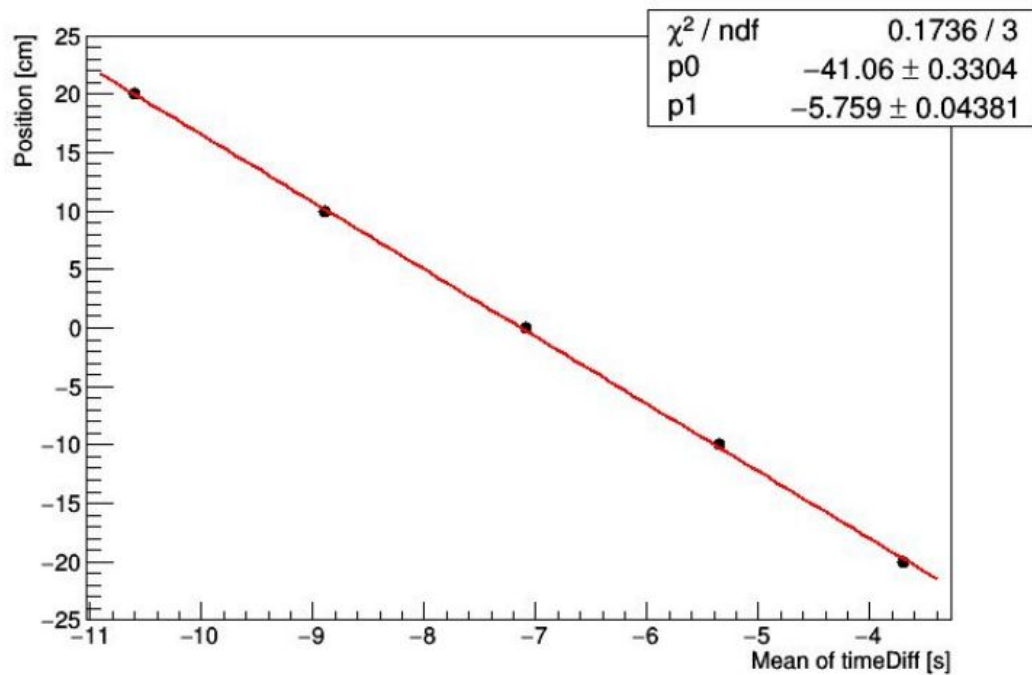


timeDiffAB\_layer\_1\_slot\_13\_thr\_1



timeDiffAB\_layer\_1\_slot\_13\_thr\_1





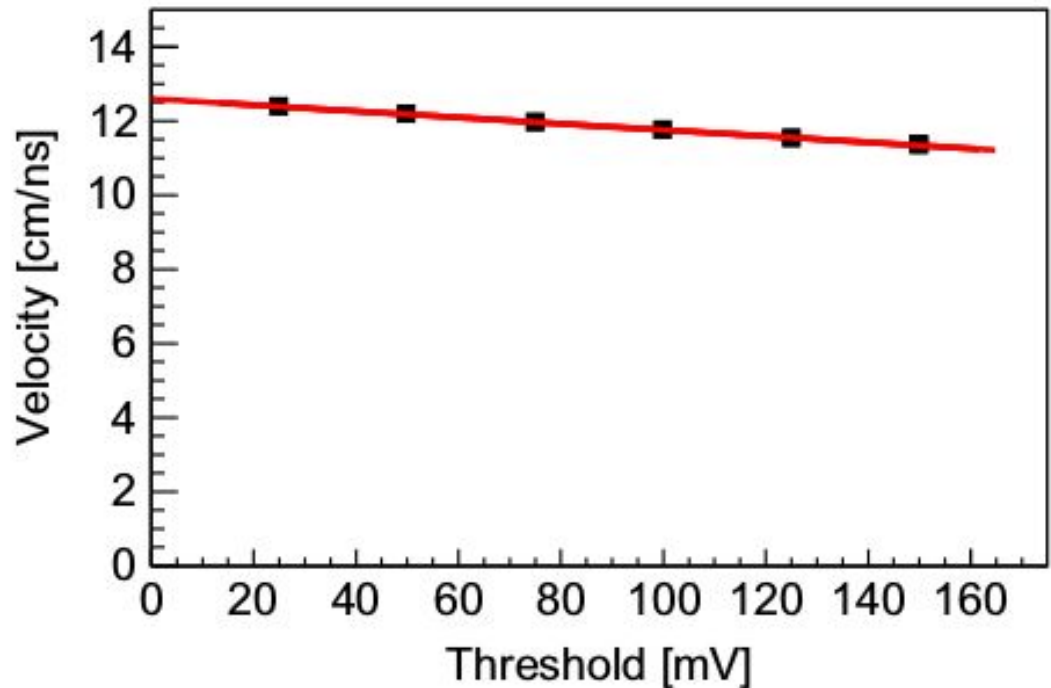
Effective signal speed in a scintillator

$$\text{Position} = p_0 + \Delta t * p_1$$

$$p_1 = \text{Vel}/2;$$

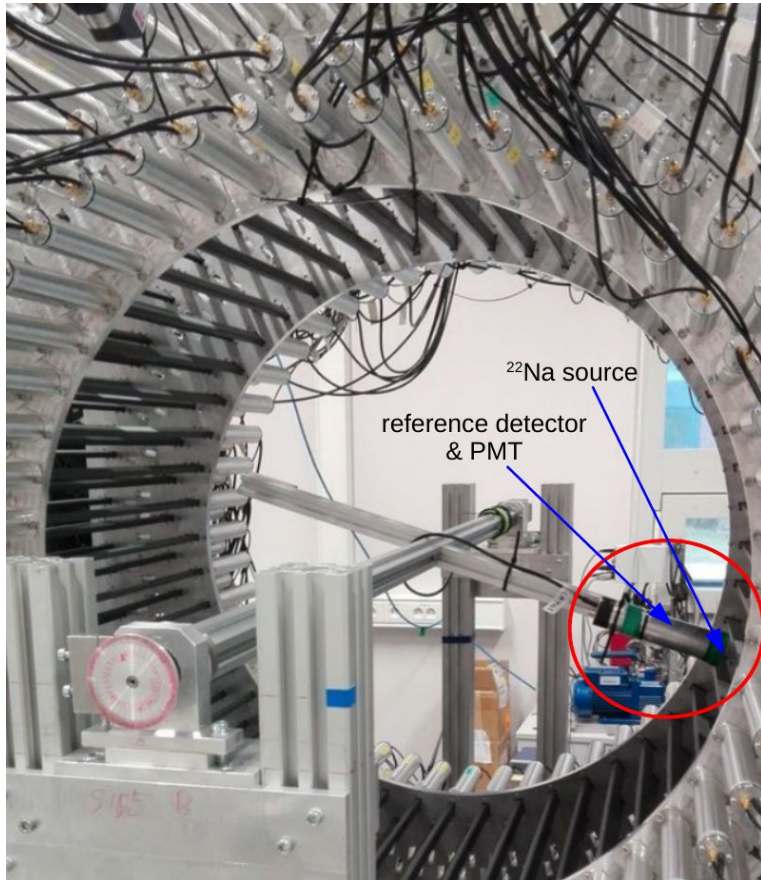
$$\text{Time Difference} = t_B - t_A$$

Effective speed of light inside scintillator strip as a function of the applied threshold.



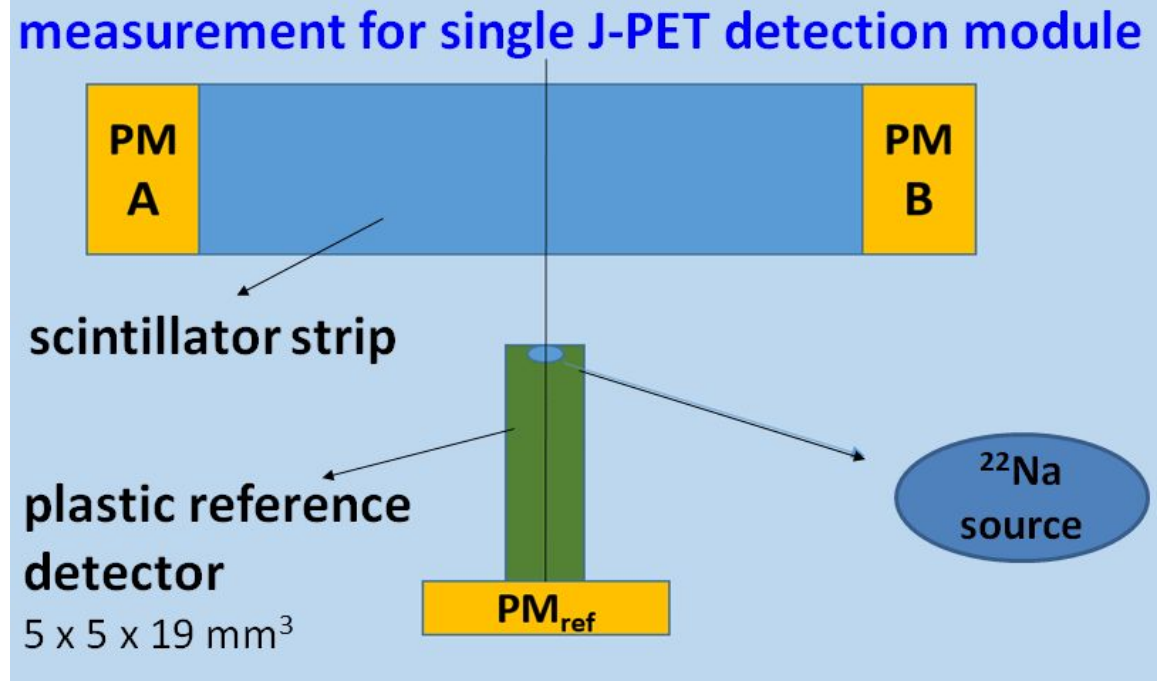


# How was it done till now -Time Calibration



- Scheme of measurement performed for a single detection module

- The Time calibration for the J-PET scanner is carried out based on measurements performed with reference detector.

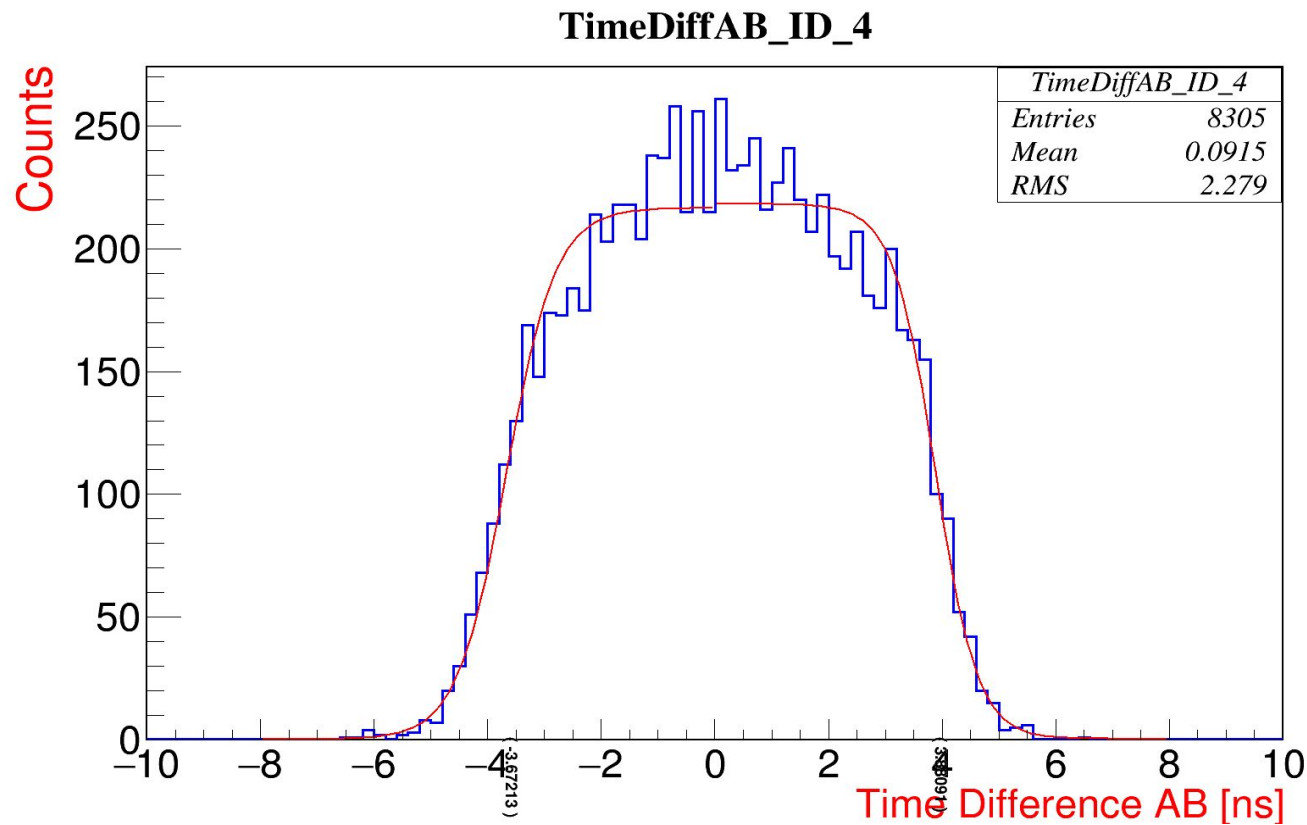


# Why New approach ?

Table : Comparison Between different calibration methods

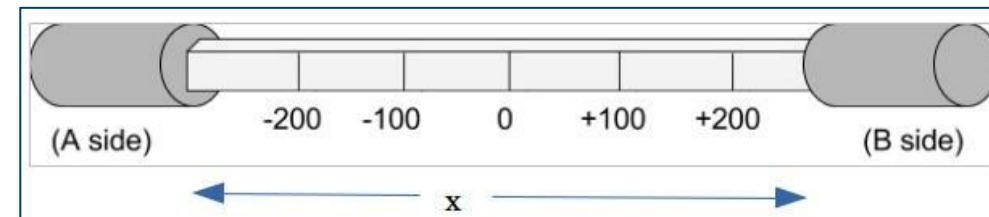
|               | Collimator          | Reference<br>Detector   | Source at center                       |
|---------------|---------------------|-------------------------|--|
| Calibration → | Time<br>Calibration | Velocity<br>Calibration | Both                                   |
| Time needed → | Around 15<br>hours  | 2 days                  | Data from measure-<br>ment can be used |

# New approach - Fermi Fitting



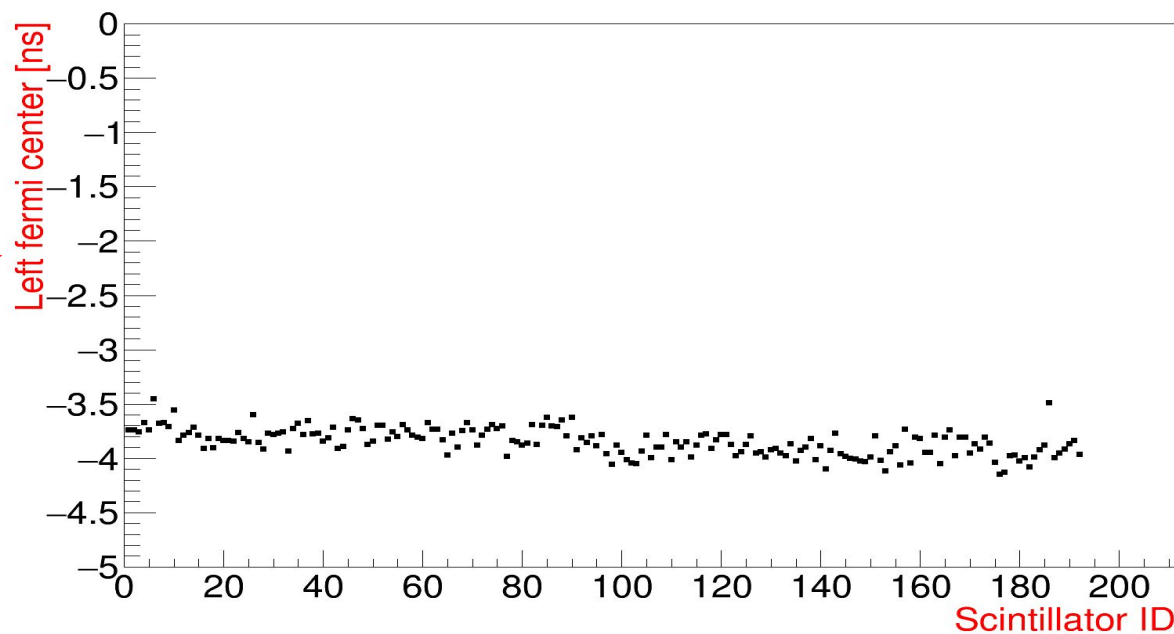
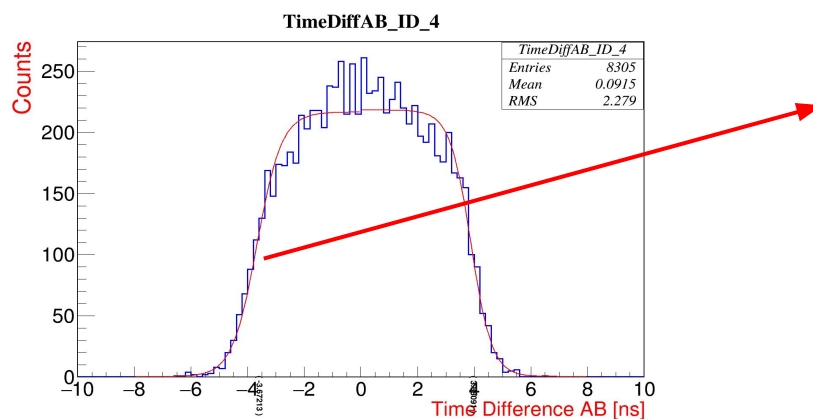
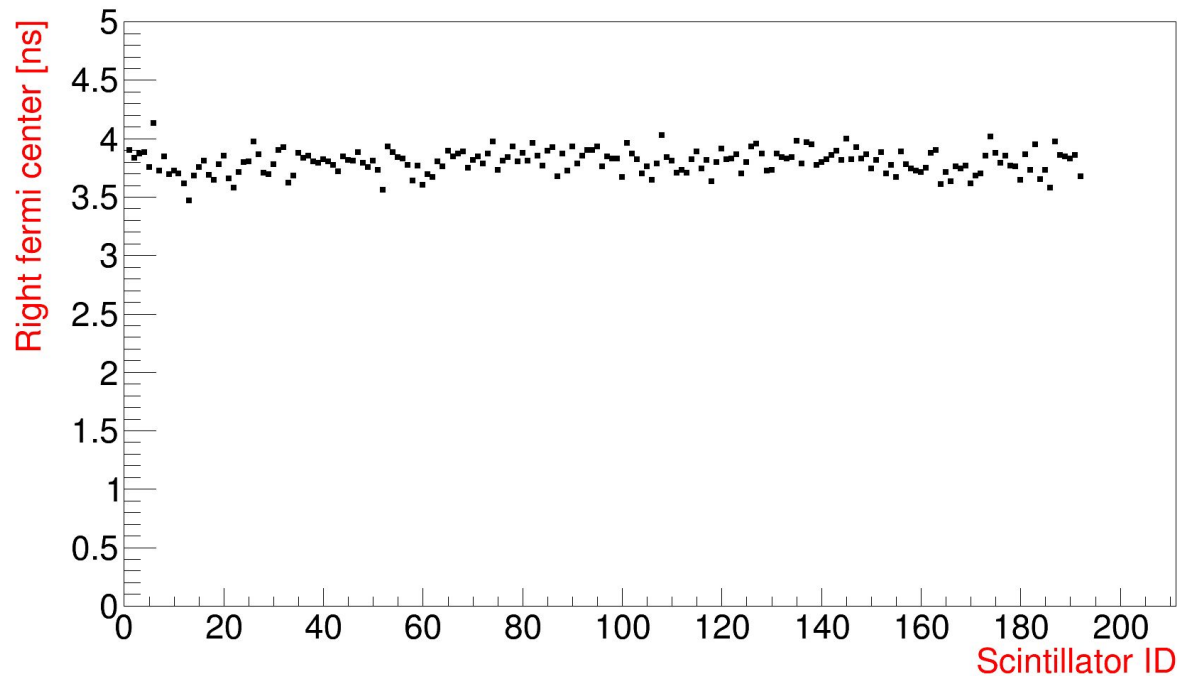
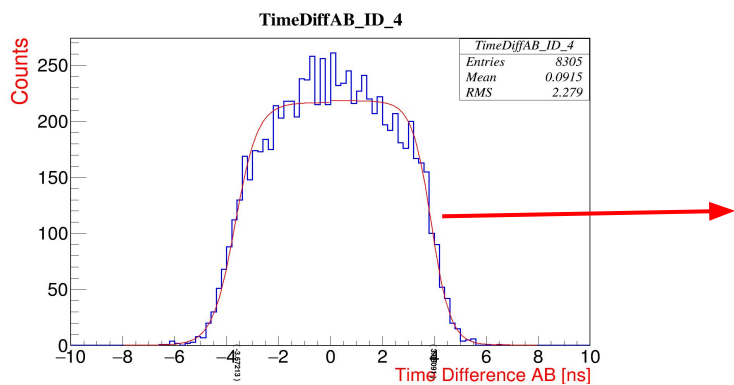
Courtesy to K.Dulski

- A - Height of distribution
- B- Middle edge position
- C - Skewness
- D - Background



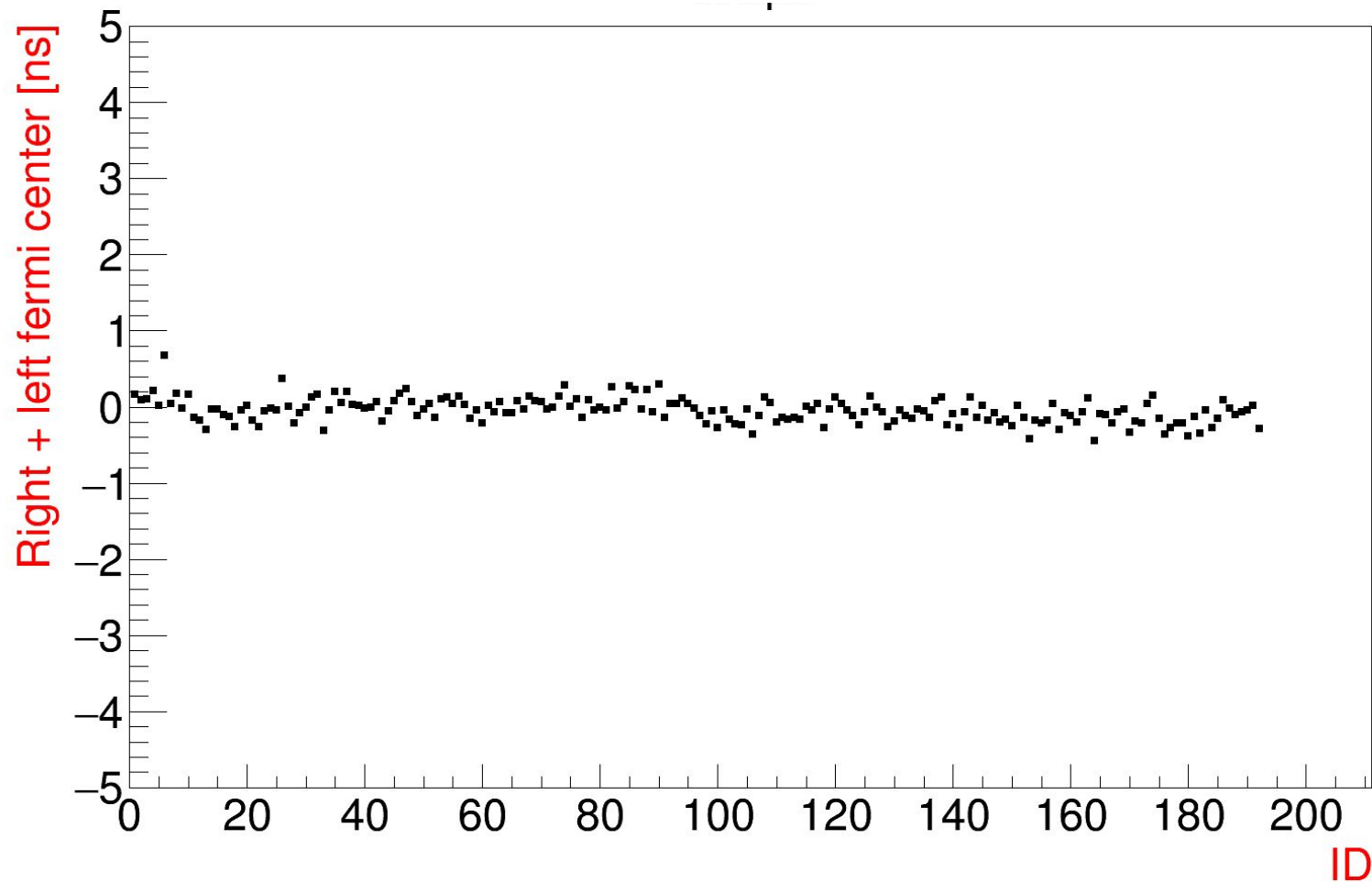
$$F = \frac{A}{e^{(x-B)/C} + 1} + D$$

$$V_{\text{eff}} = \frac{2x}{\Delta t}$$

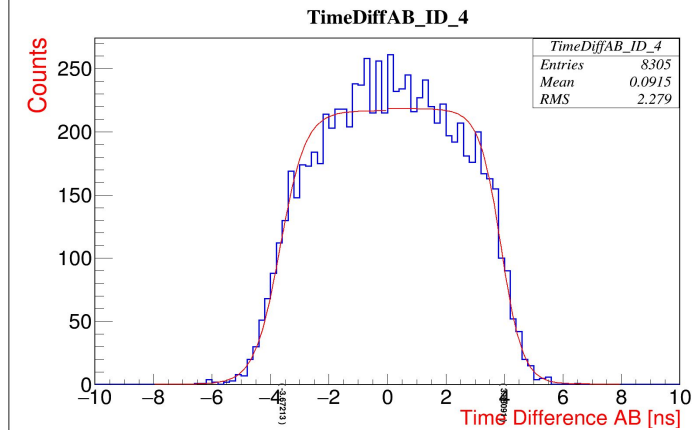
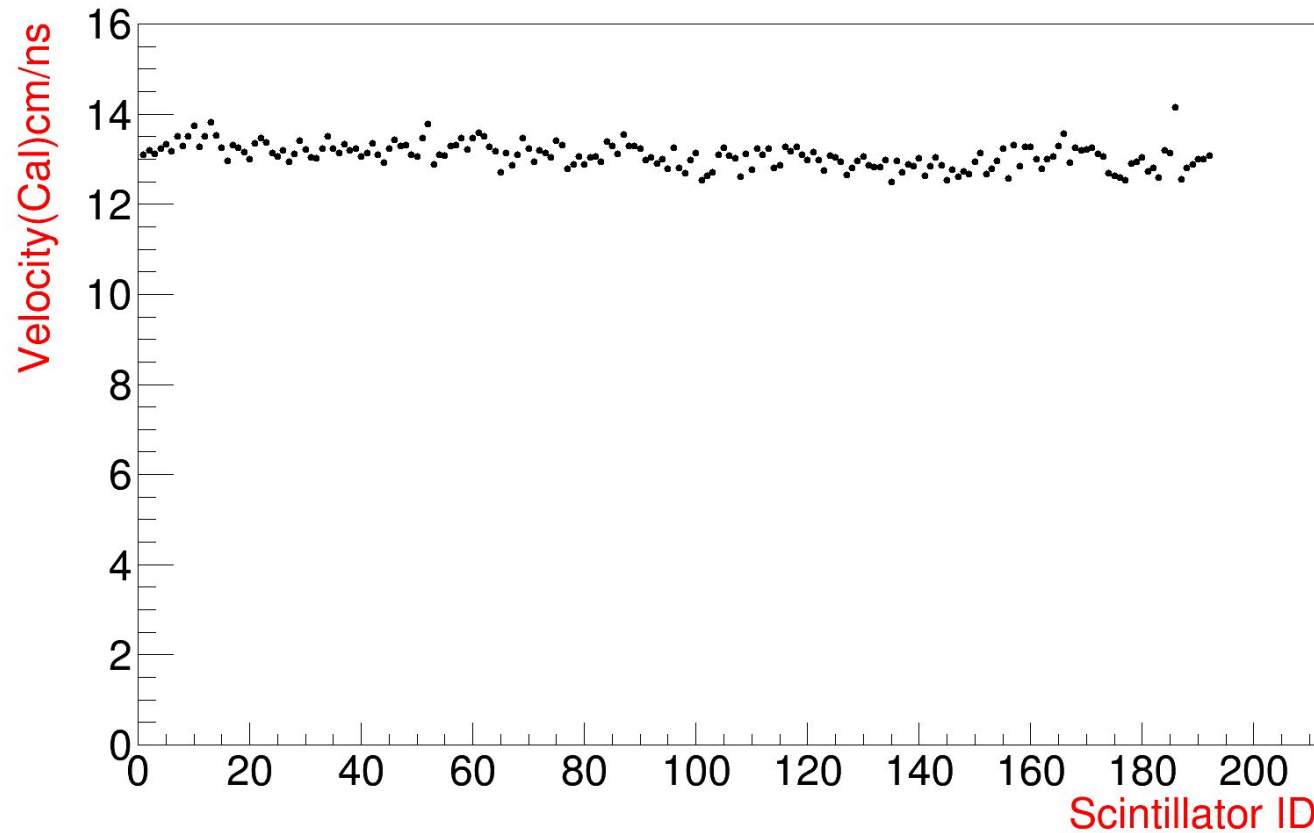




## Calculated Time calibration using left and right edges



# Calculated One - Velocity Calibration



$$X = \frac{\Delta t}{2} \cdot V_{\text{eff}}$$

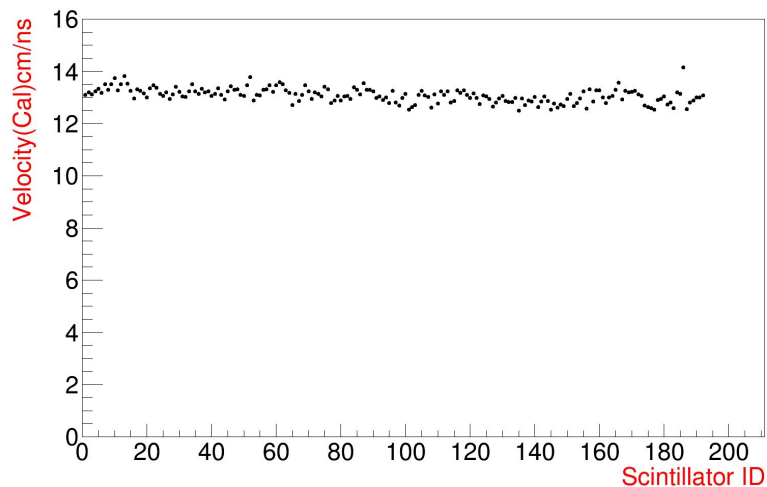
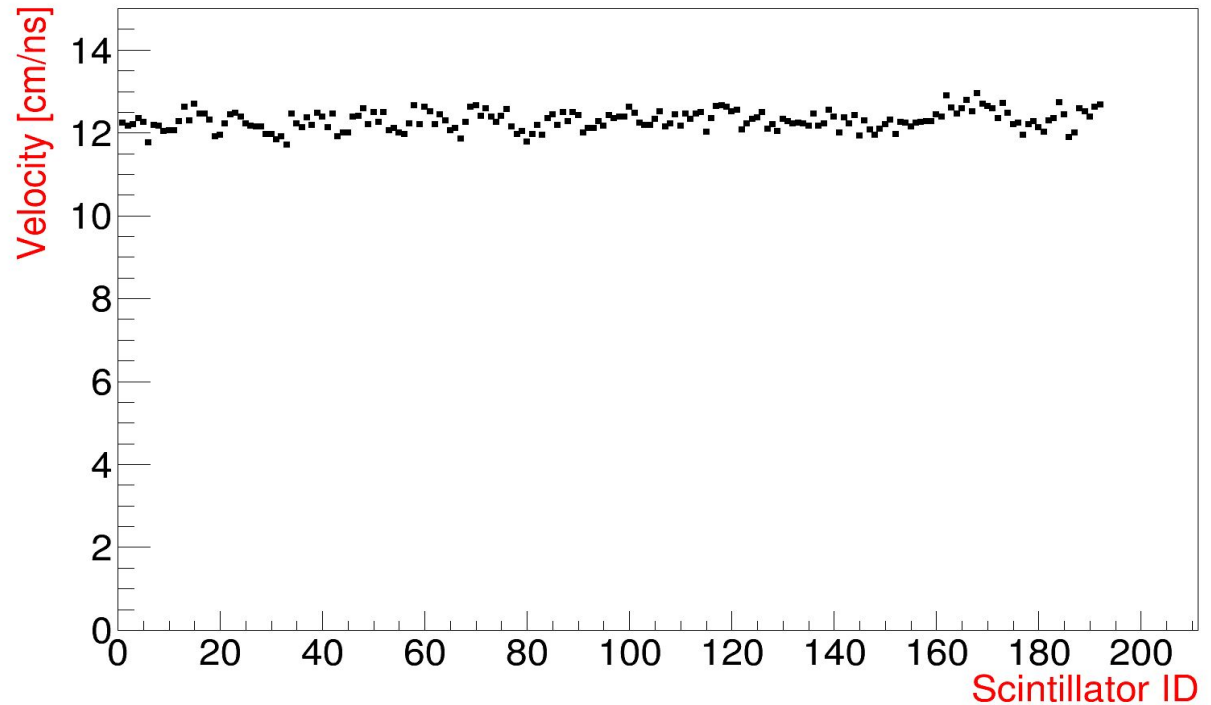


$$V_{\text{eff}} = \frac{2X}{\Delta t}$$

X = 50 cm (length of scintillator)  
 $\Delta t$  = Right.fermi - Left.femi[ns]

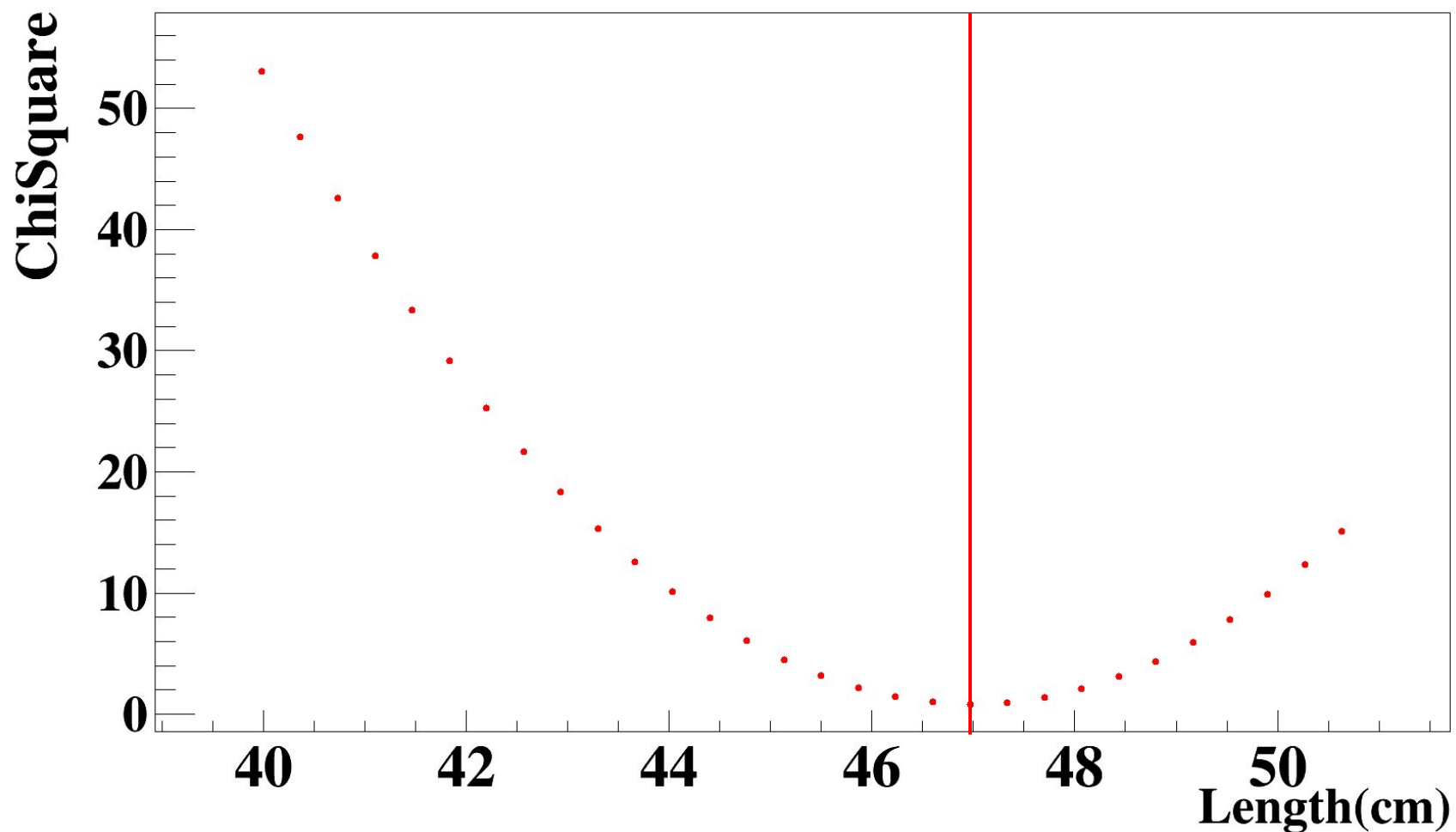
# Experimental - Velocity Calibration

Calibration from collimator



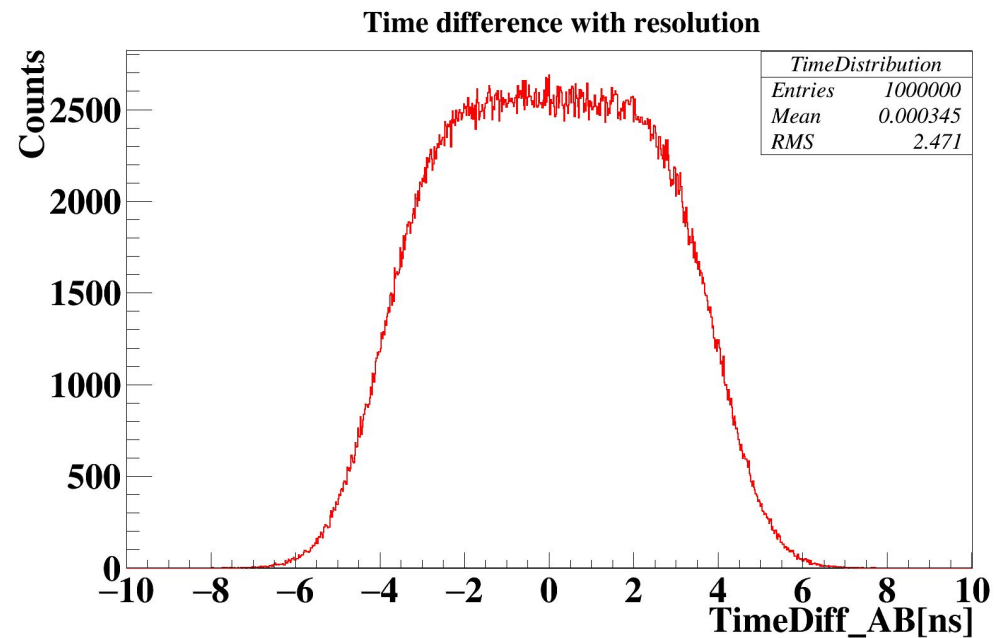
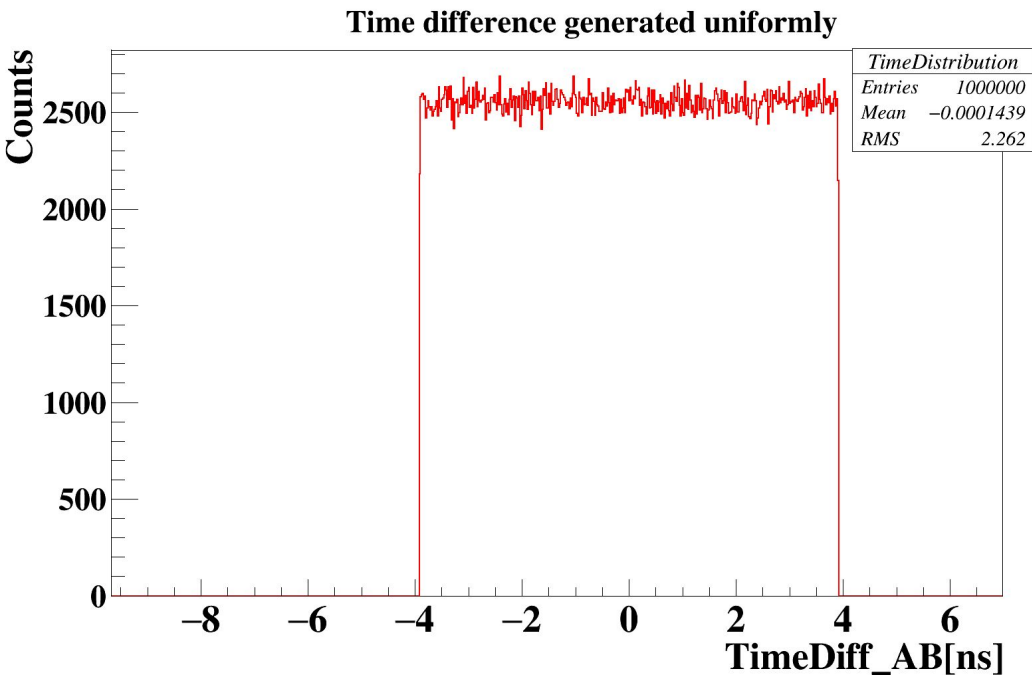
# Chi<sup>2</sup> fitting

$$\chi^2 = \sum \frac{(\text{Fermi velocity} - \text{Collimator velocity})^2}{\text{Collimator velocity}}$$



# Simulation of Time difference

- Monte Carlo simulation – Source was placed at center

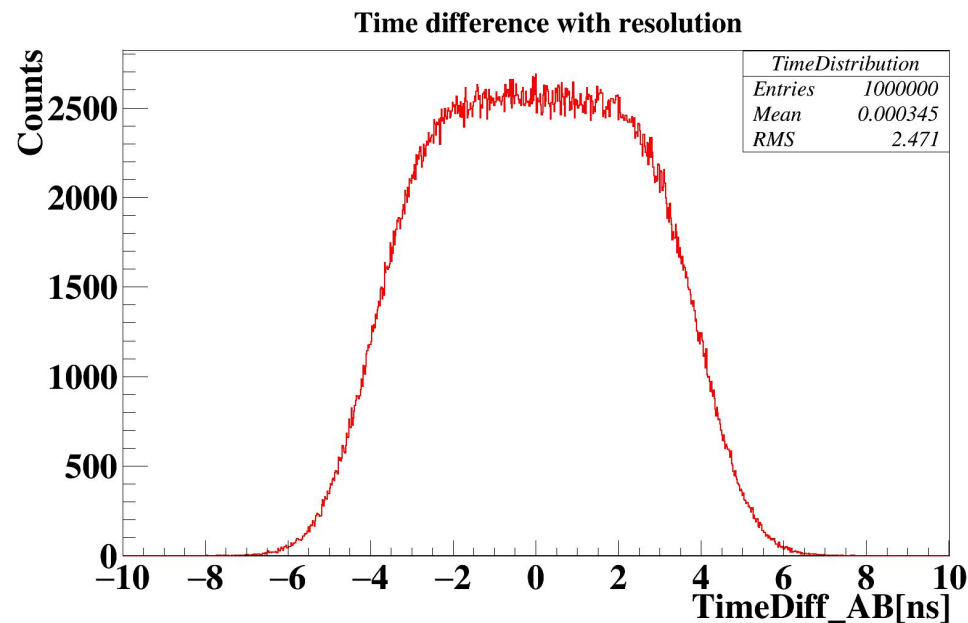


$$V_{\text{eff}} = \frac{2x}{\Delta t}$$

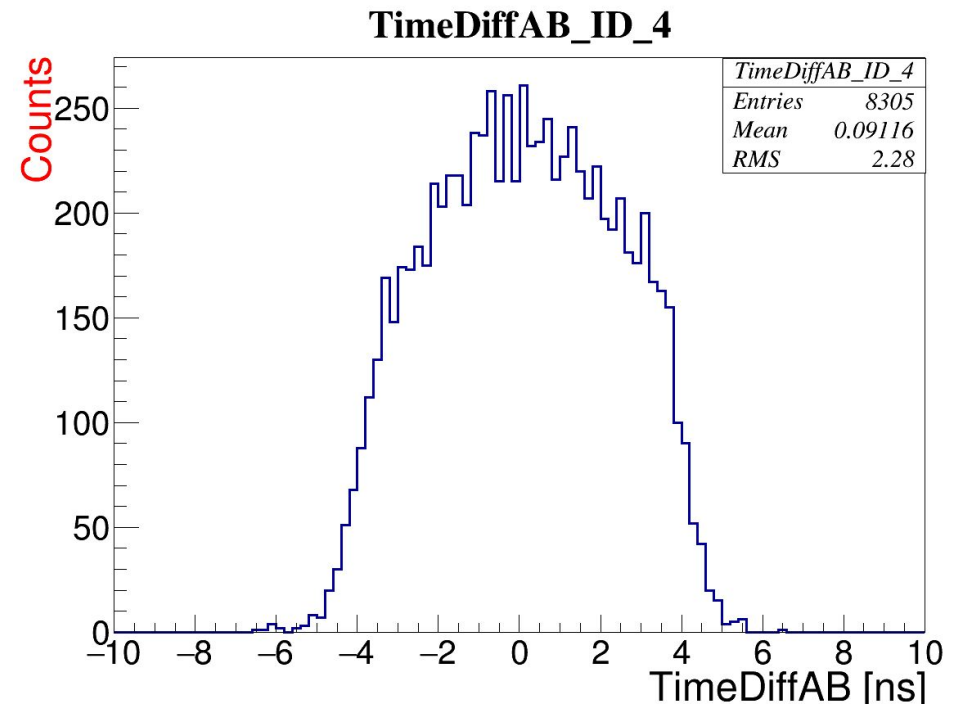
Time Difference =  $t_B - t_A$   
X = length of scintillator

# Comparison simulations and Experiment

## Simulated Spectrum



## Experimental Spectrum



$$\text{Time Difference} = t_B - t_A$$

RUN5 - with small chamber and Source position - approx(o,o,o)



# Summary

- Fermi function can be use to calibrate velocity and time.
- Checked actual length of scintillator seen by the source.
- Started to do Monte carlo simulations of time difference spectrum.

Thank You