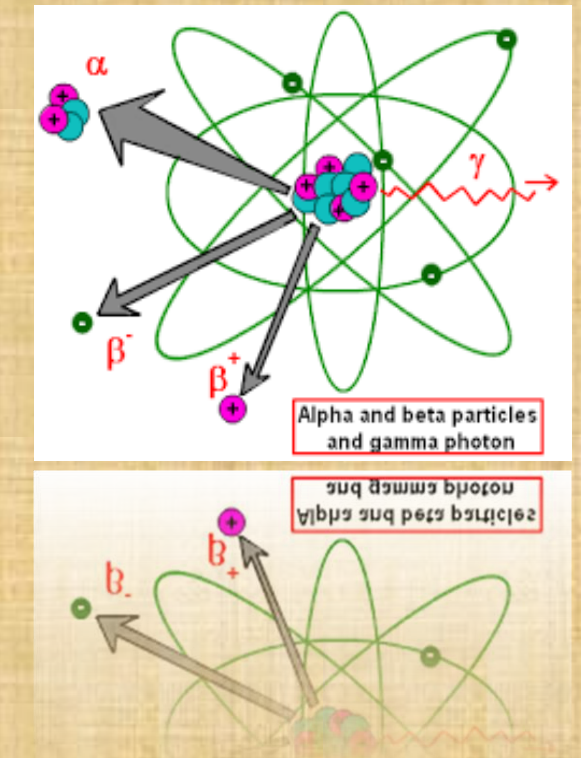
Studies of Systematic Uncertainties

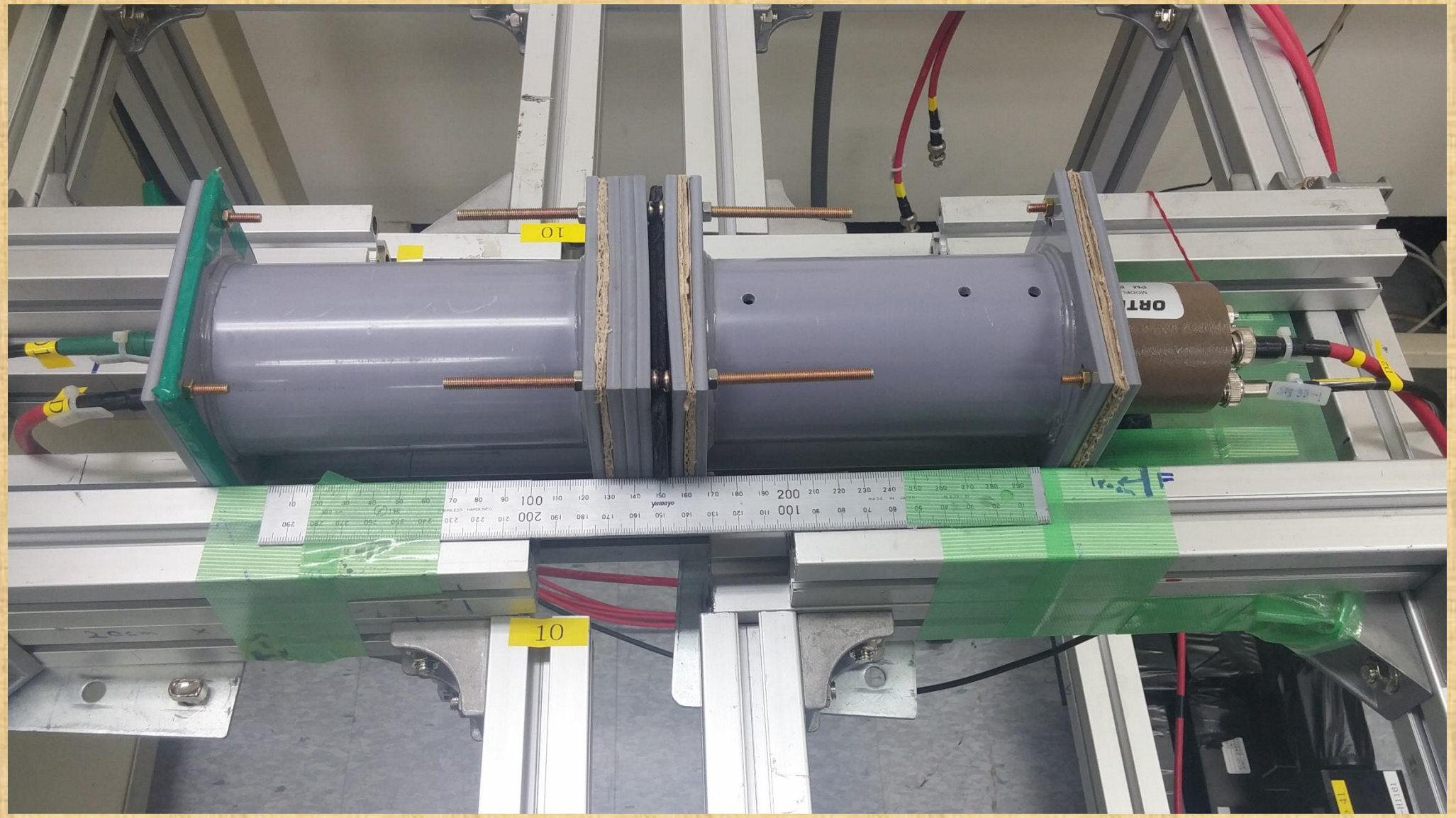


I.J Lugendo

Korea University

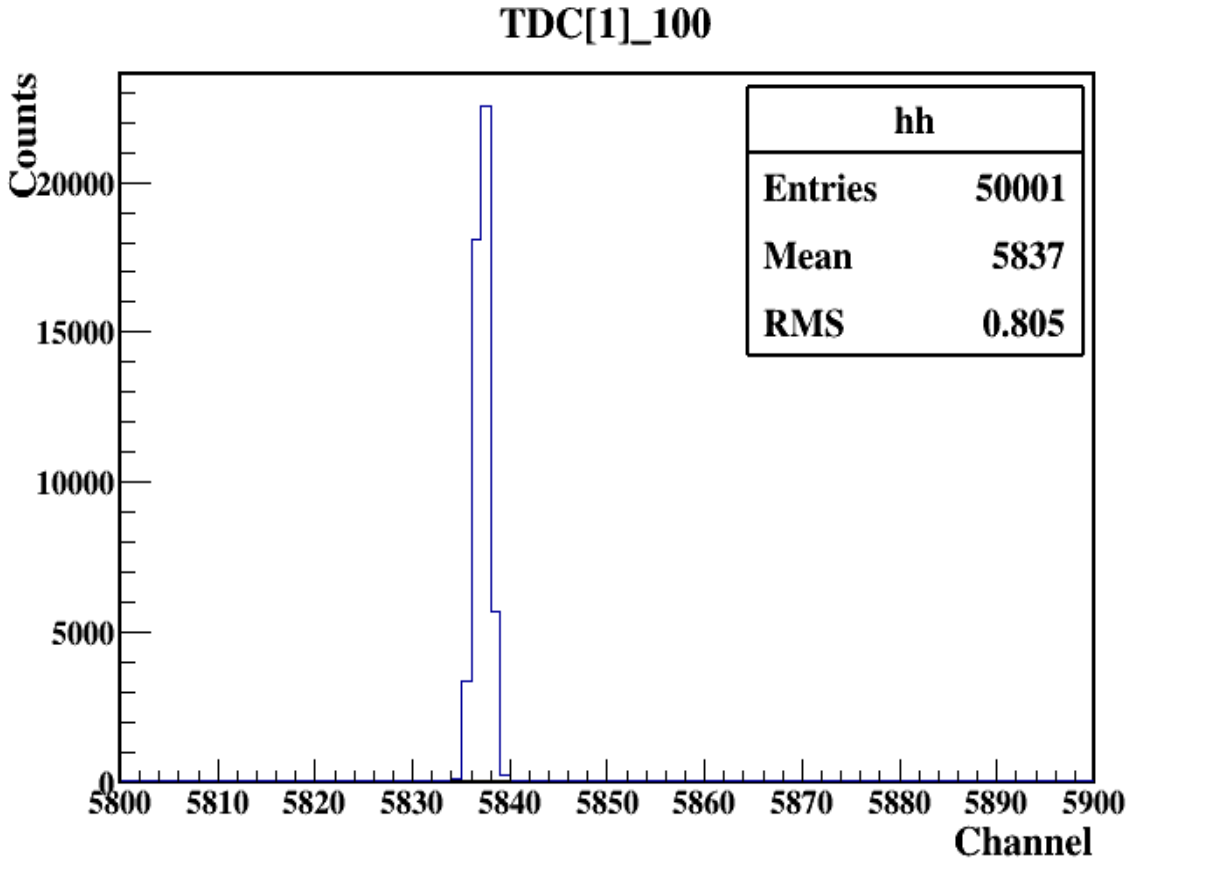
Lab Meeting, 05/08/2016

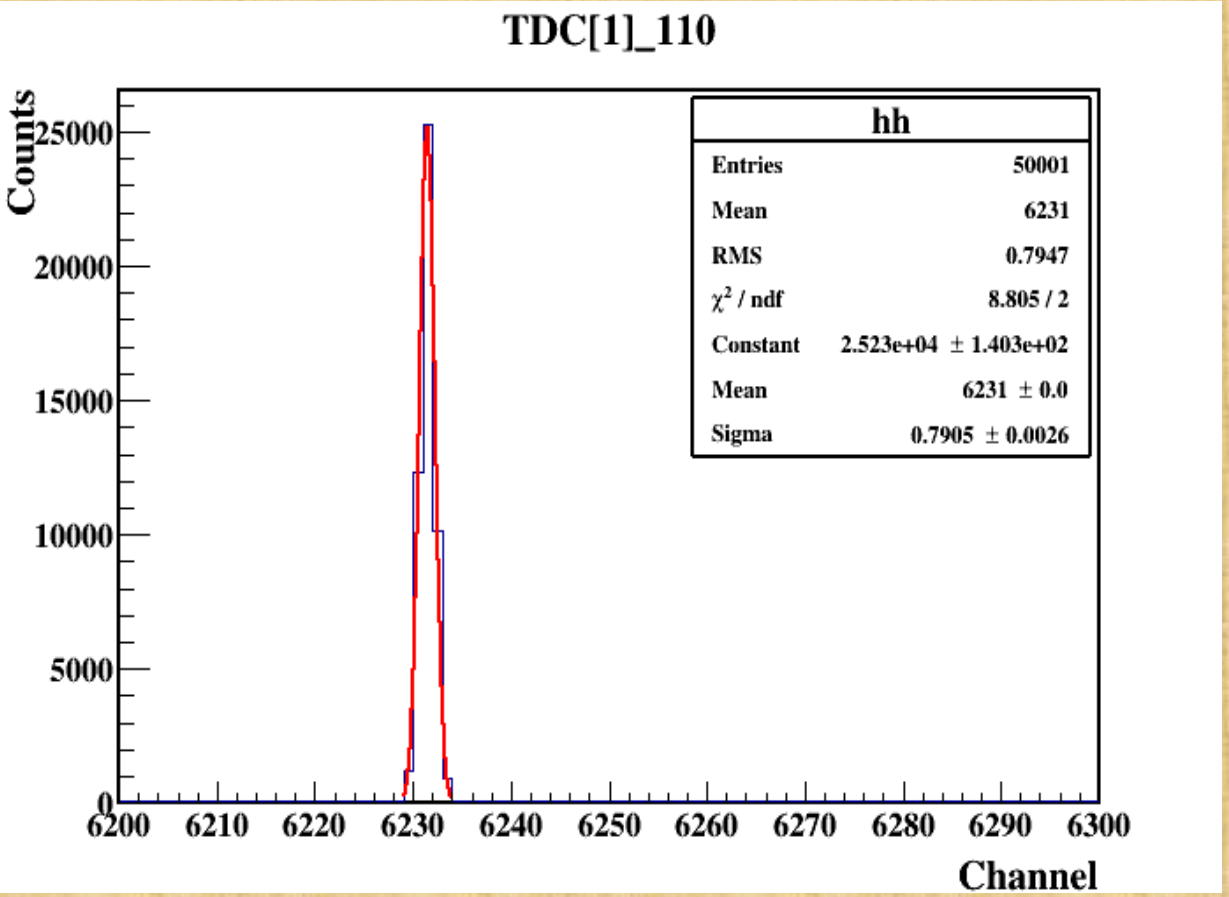
Detectors Setup



TDC Calibration

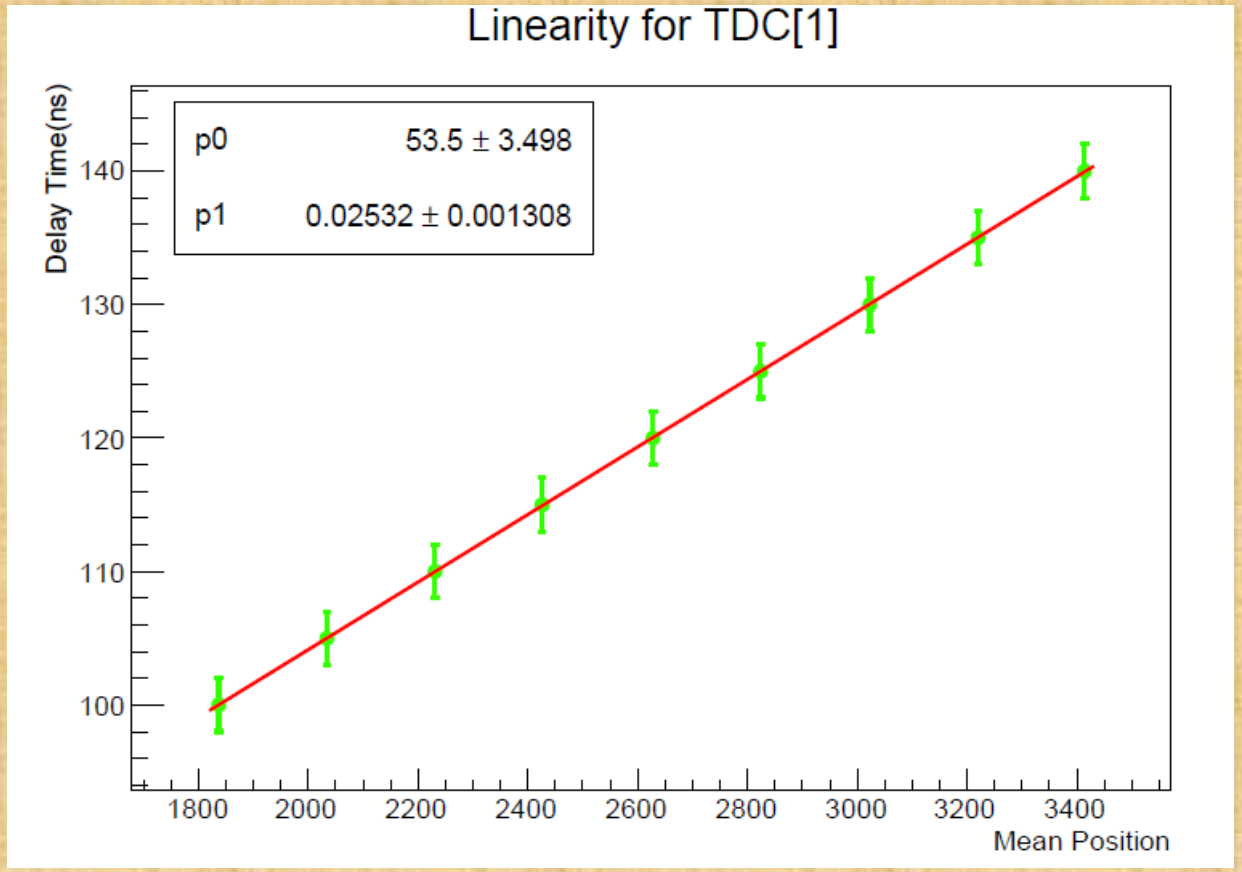
- **Clock Generator was used to study the TDC Time Resolution**

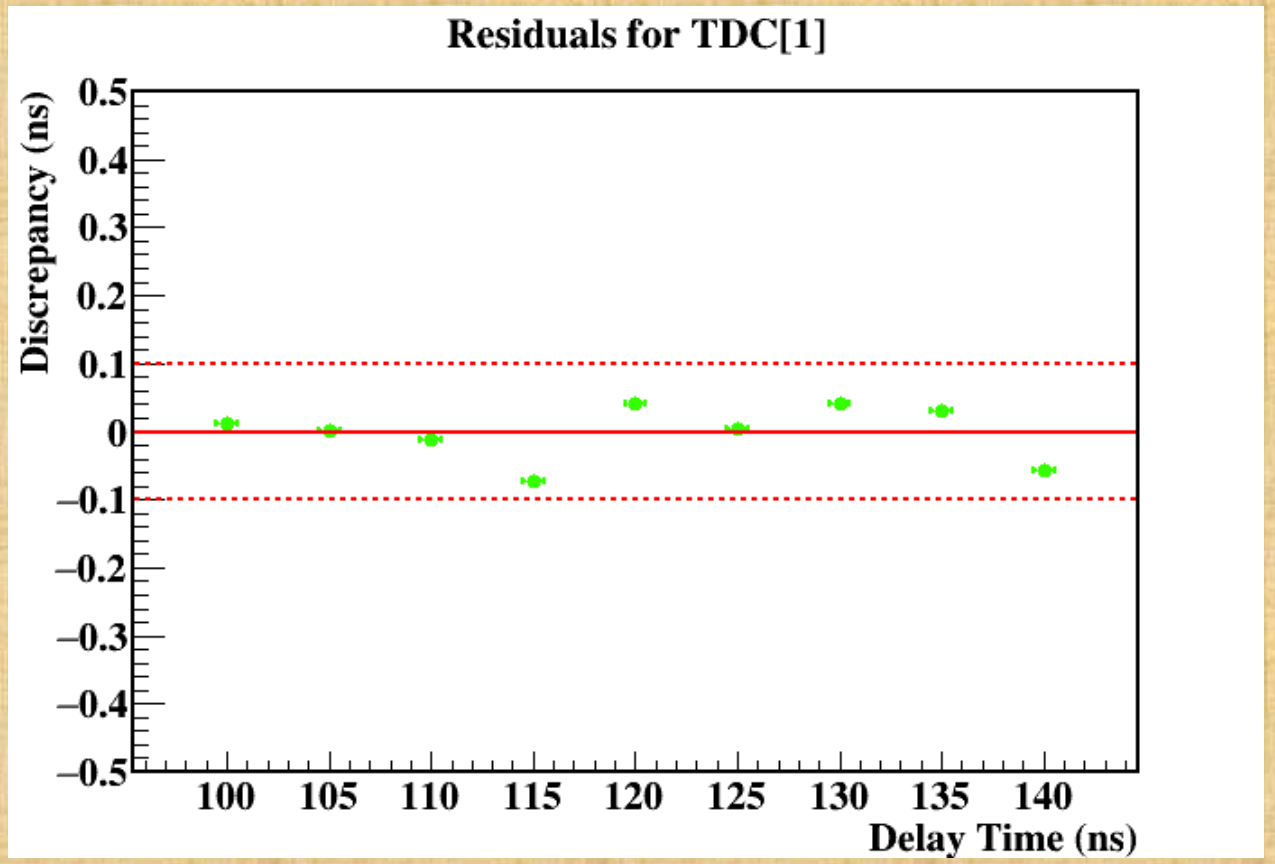




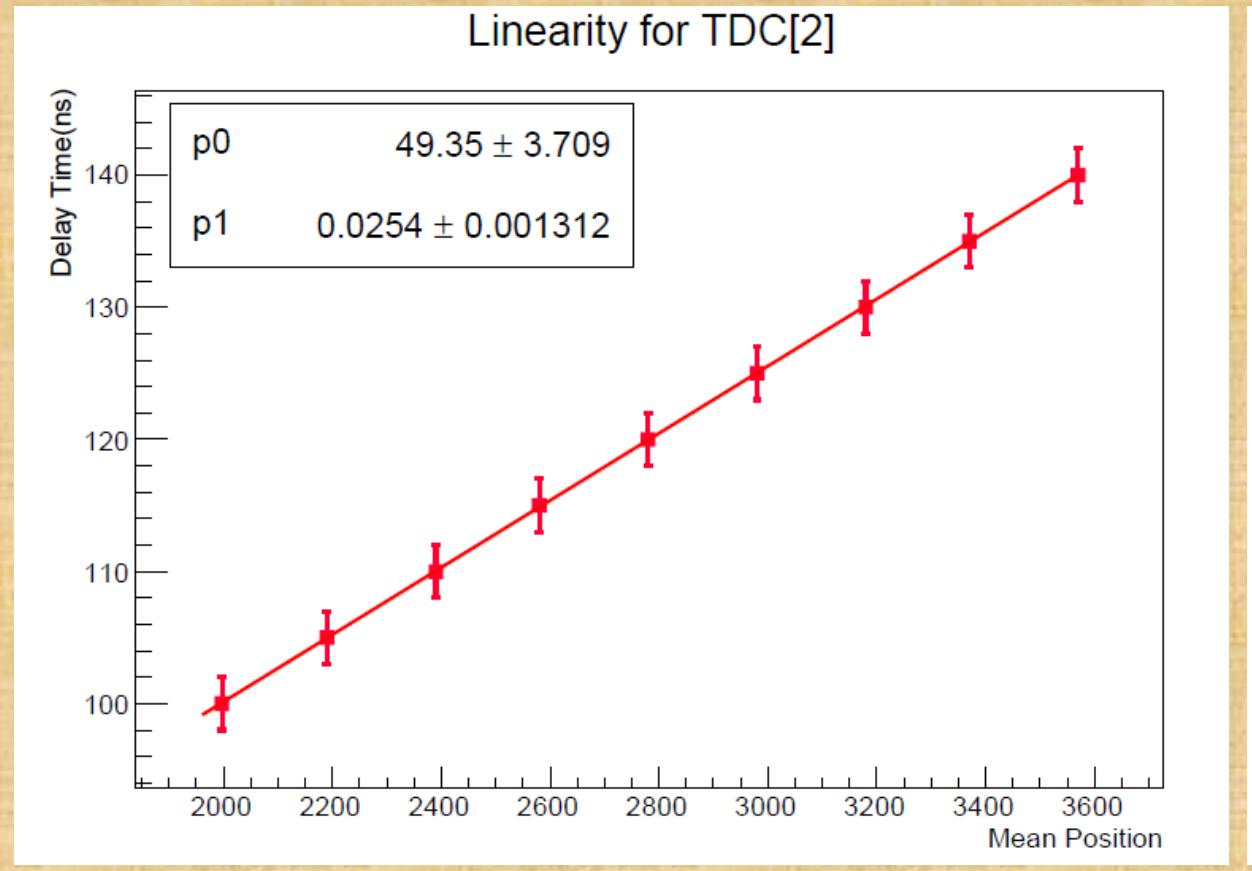
TDC Calibration

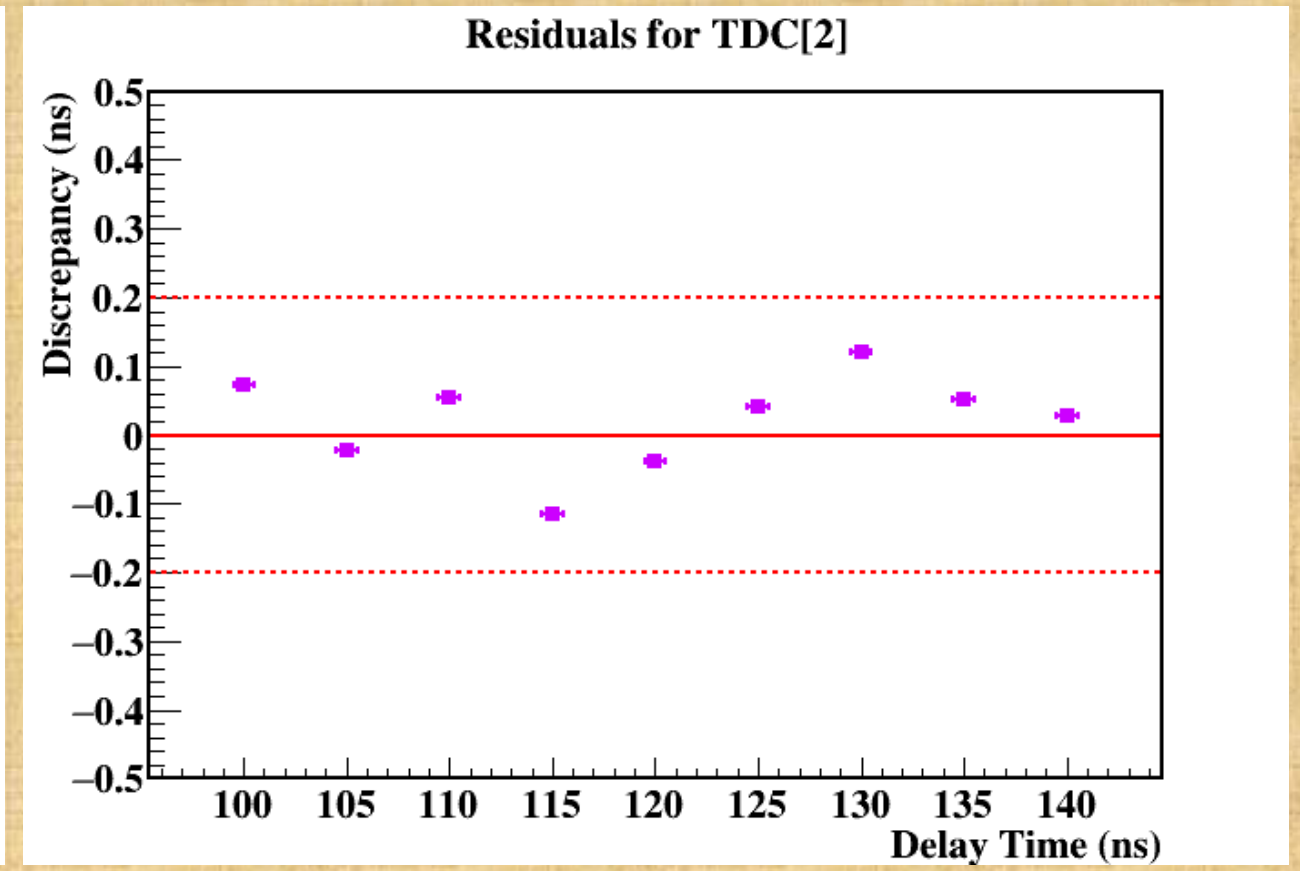
- **Left figure shows the straight line whose slope is the Time resolution of the TDC**
- **The Right picture shows the Discrepancy of the extrapolated channel numbers from the measured values**





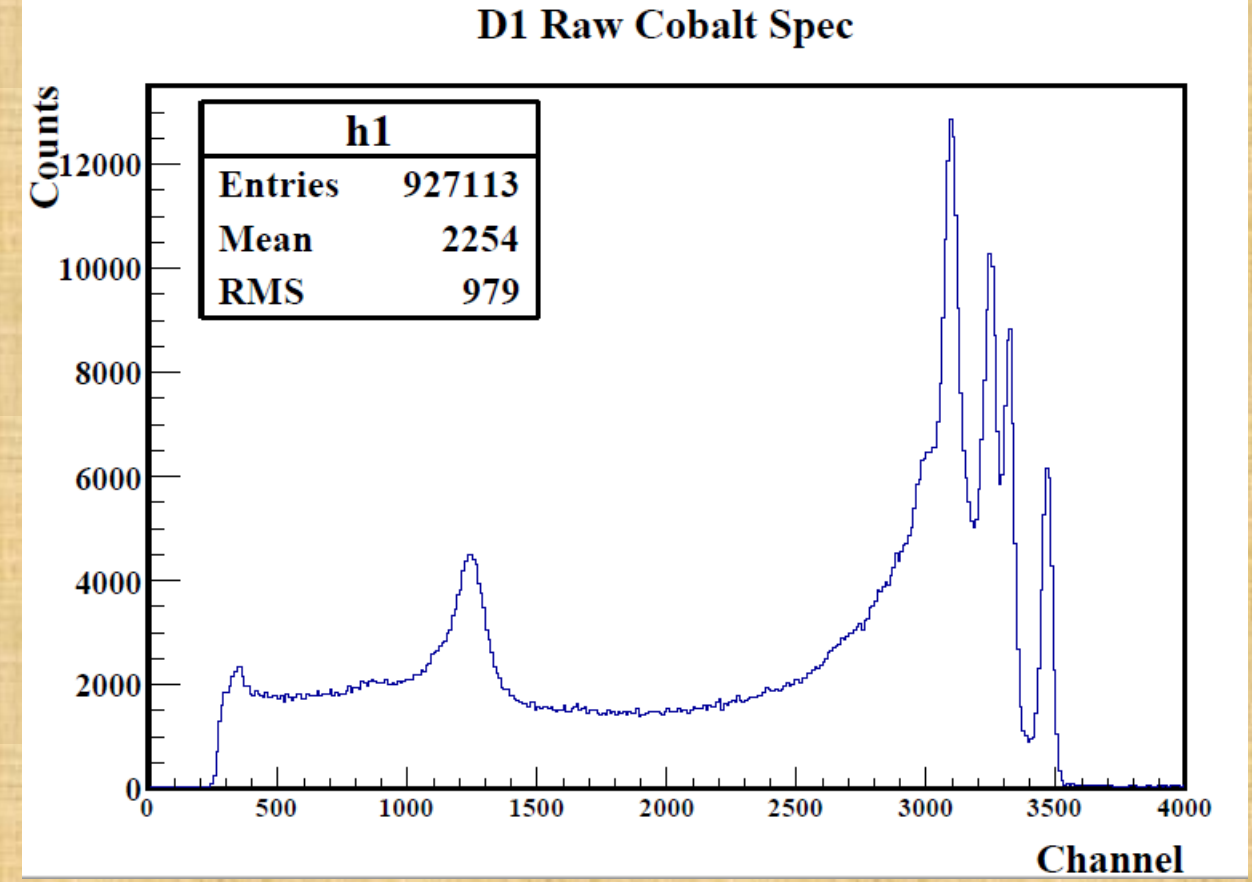
TDC Calibration

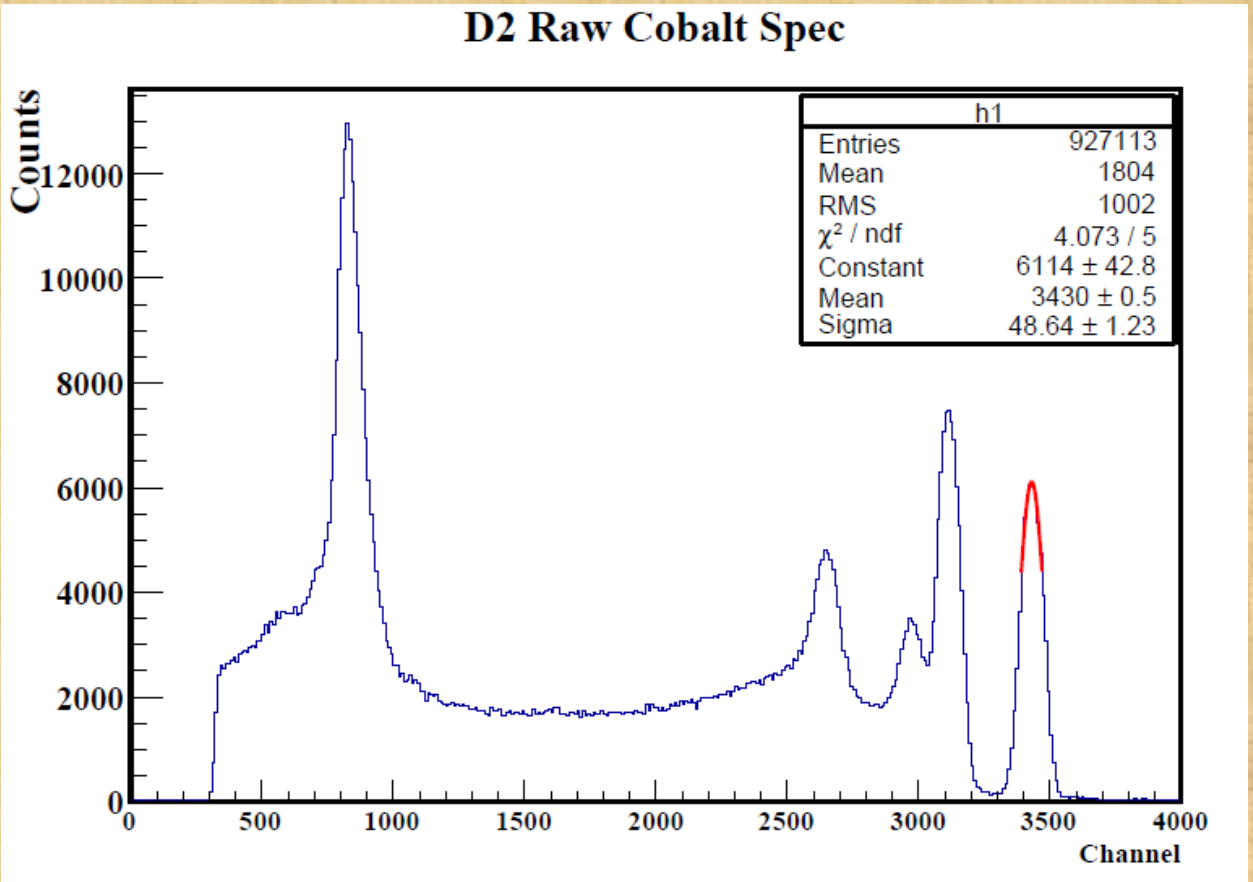




- **Thus the TDC Time Resolution for Channel 1 is 25.32 ps while for Channel 2 is 25.4 ps**

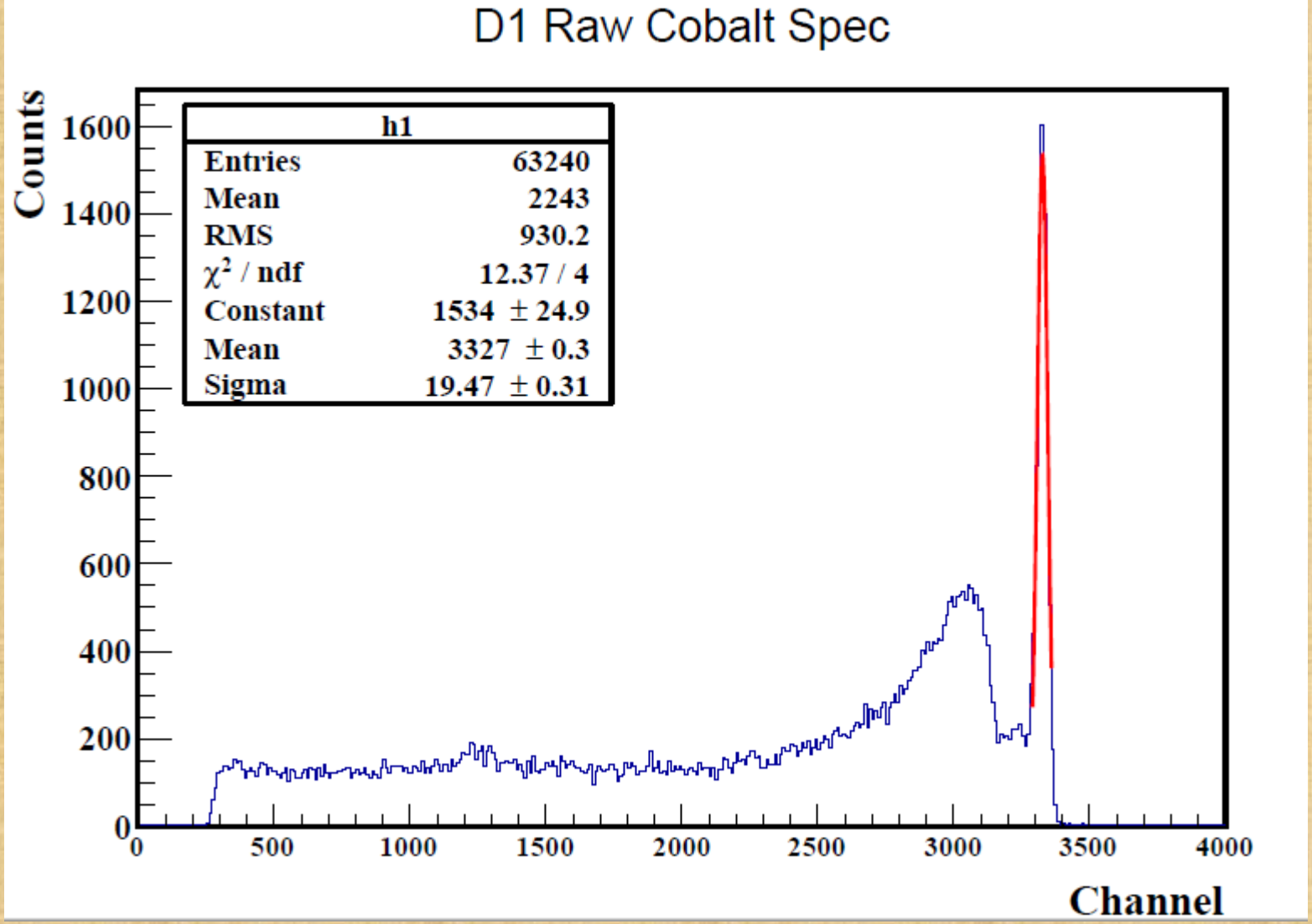
Making a Time Difference Spectrum



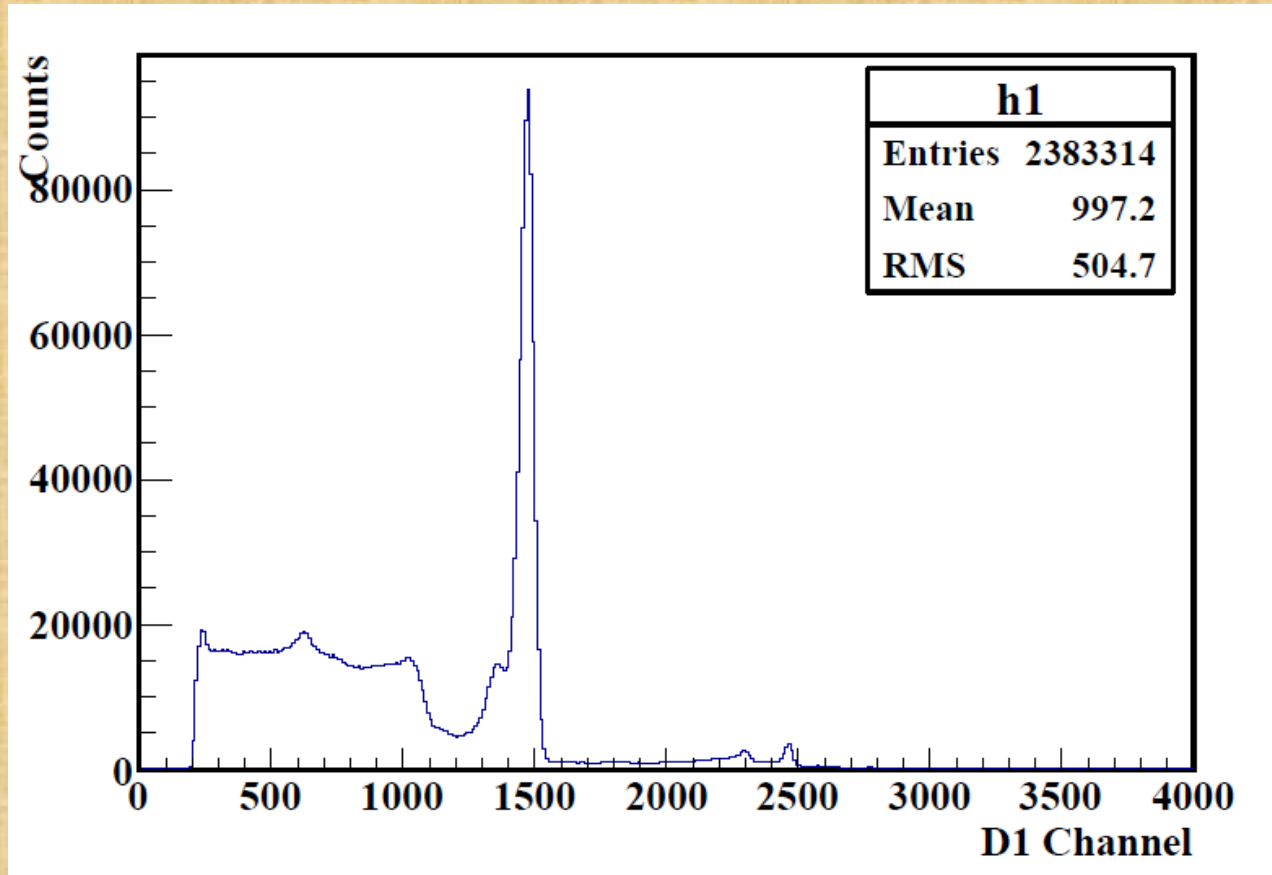


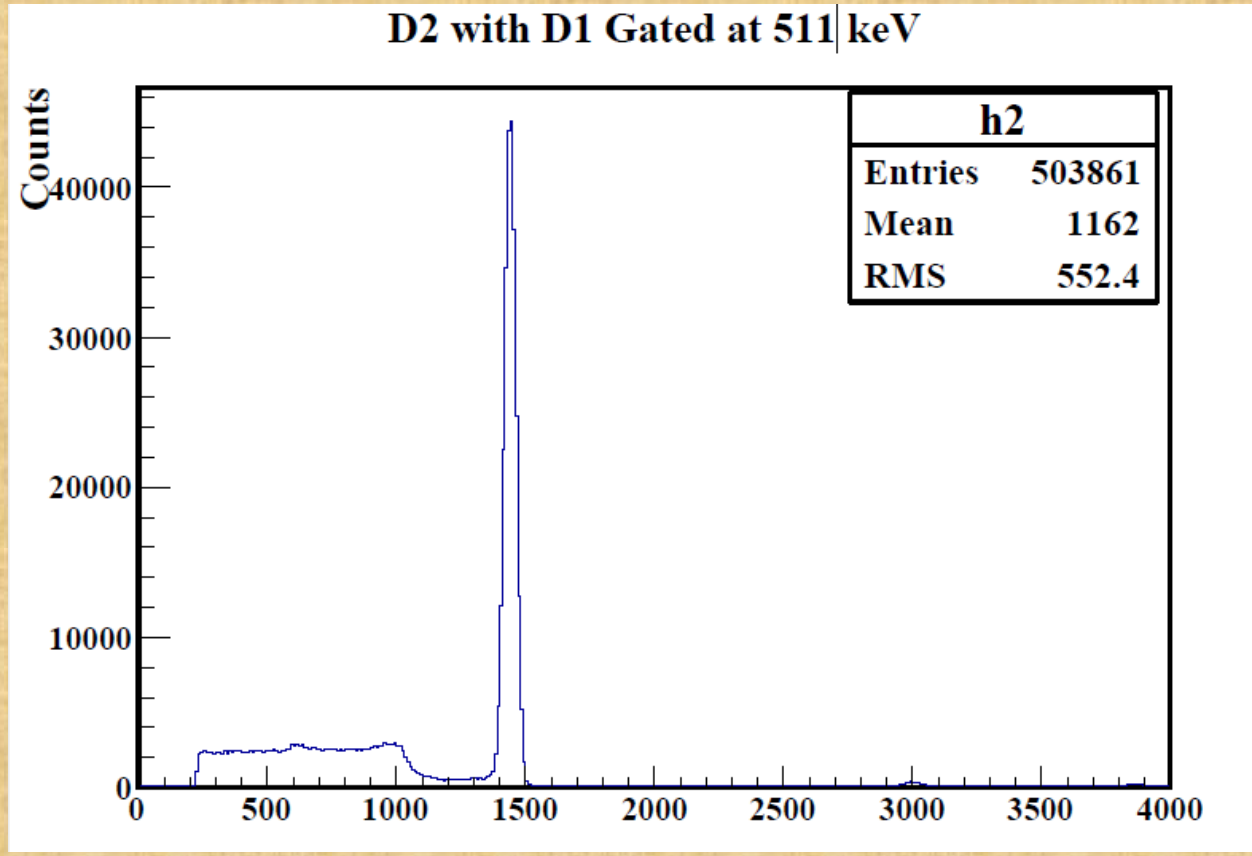
- **The peak region is defined by the Lower and Upper boundaries that are obtained by subtracting and adding the value of 1.6449*Sigma to the mean channel**

Making a Time Difference Spectrum

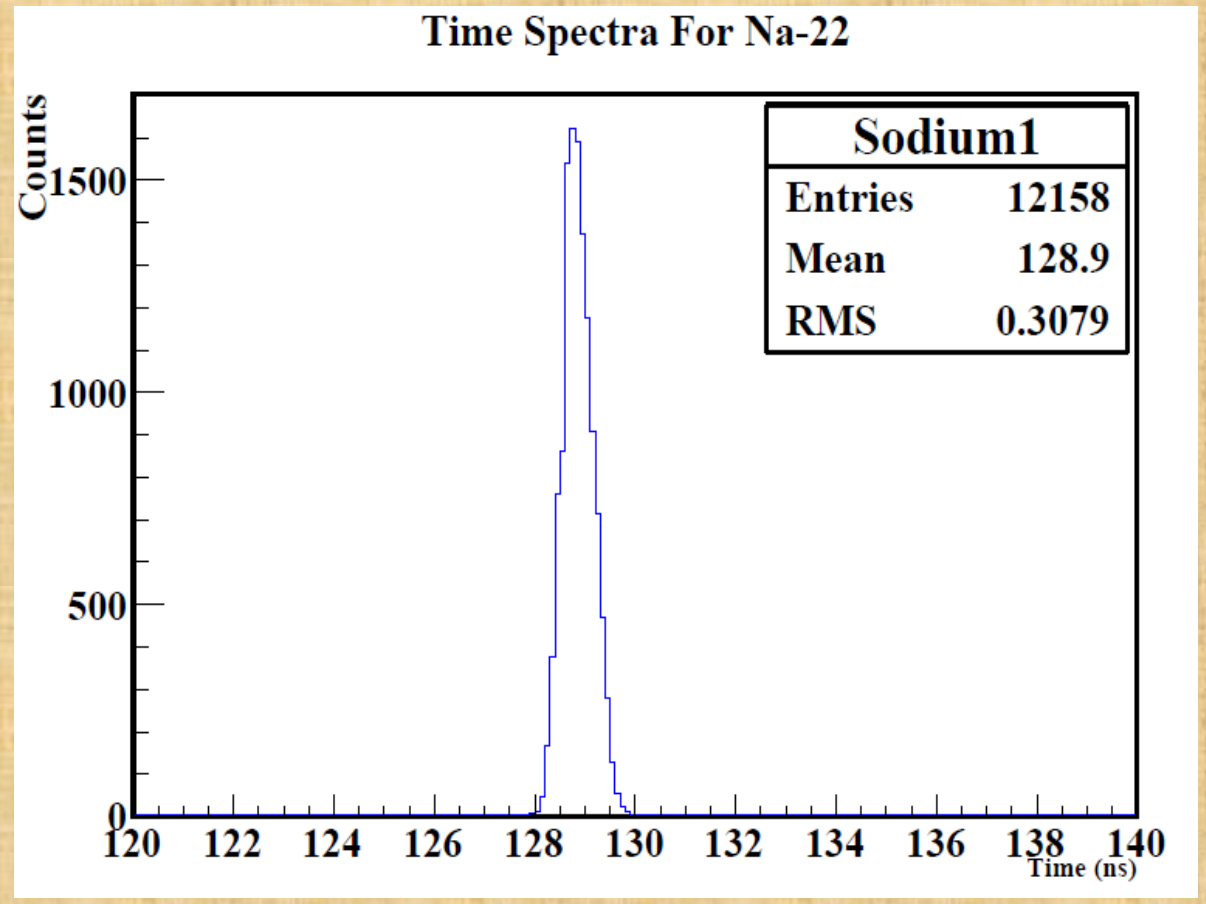


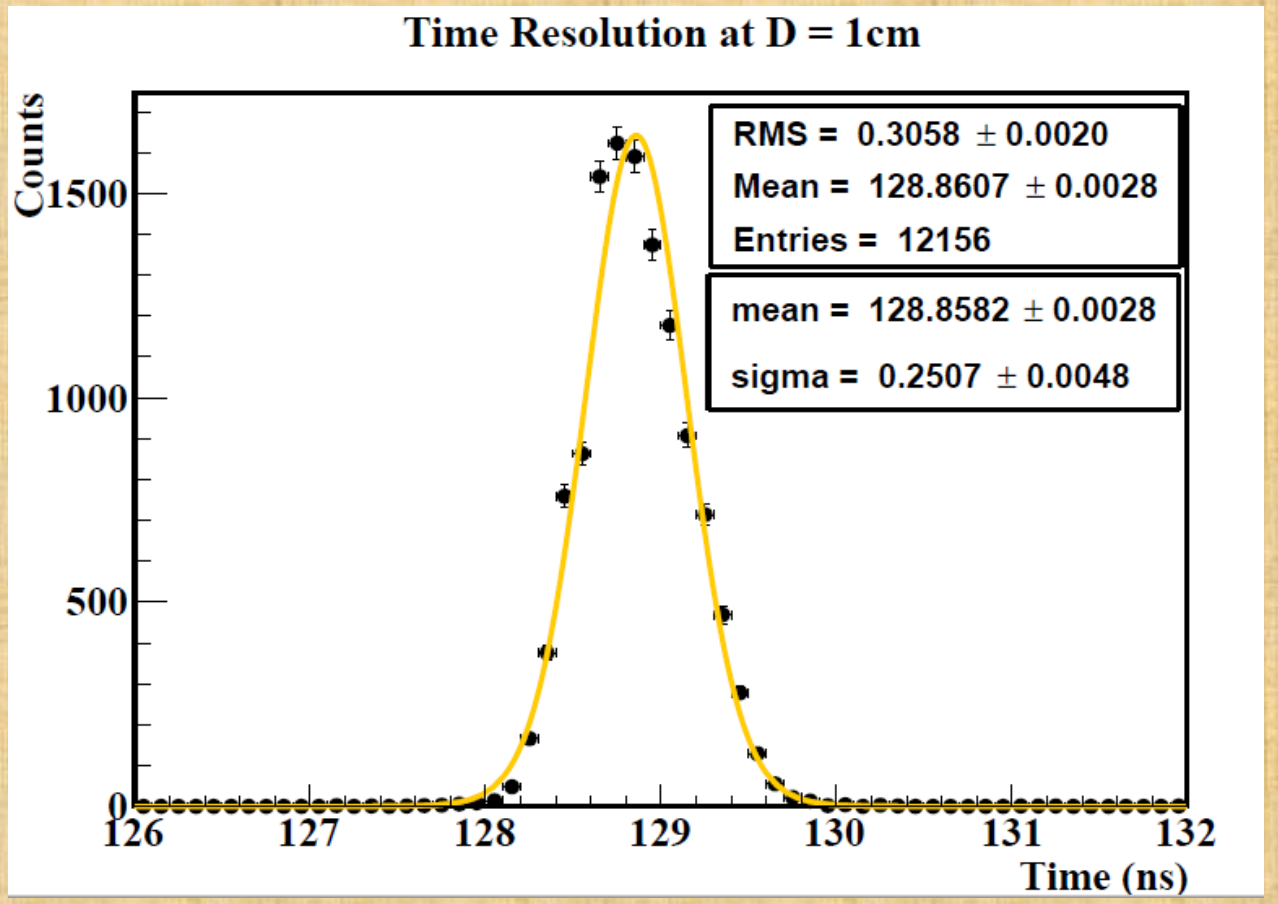
Na-22 Spectrum



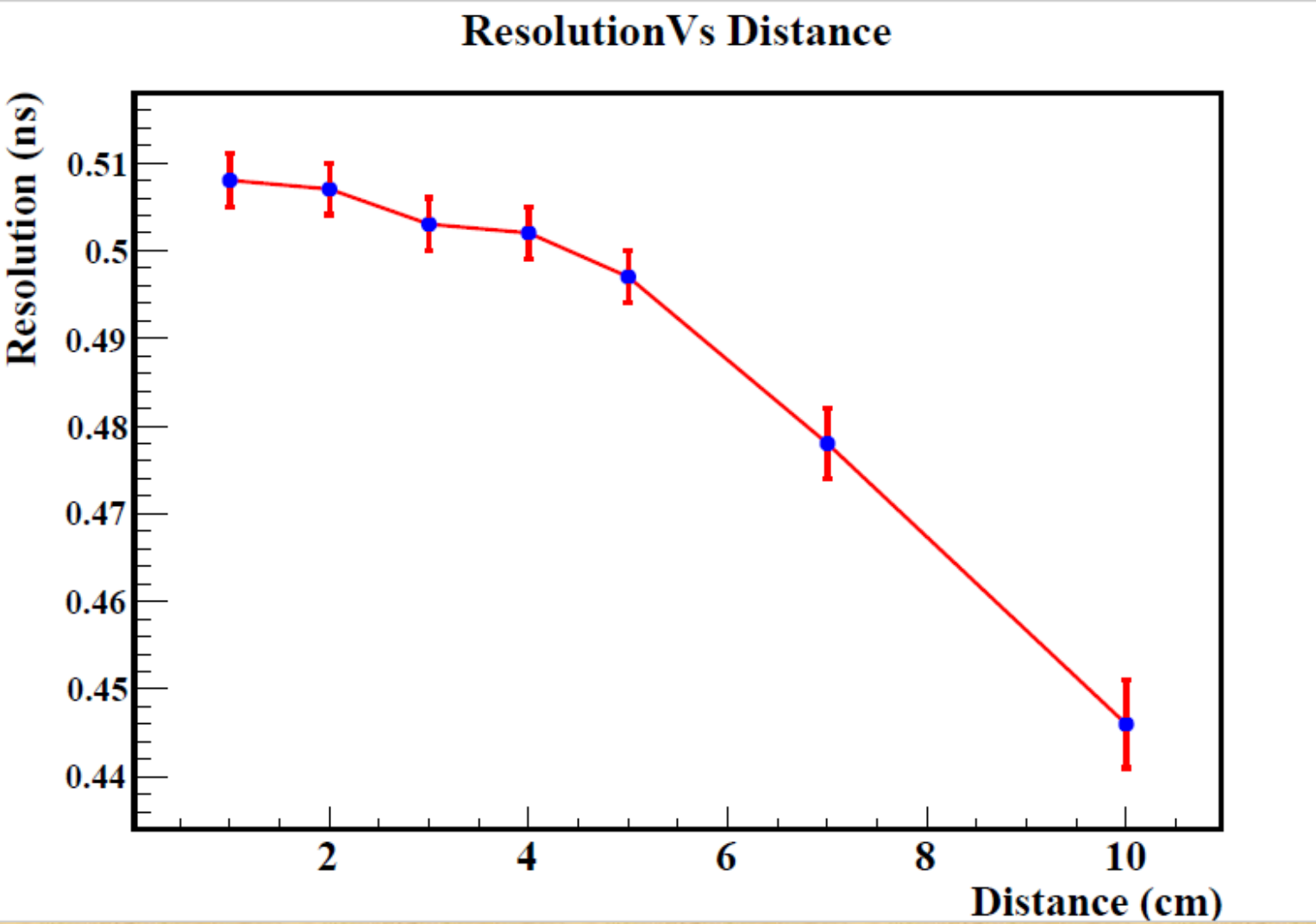


Influence of Distance between the Detectors



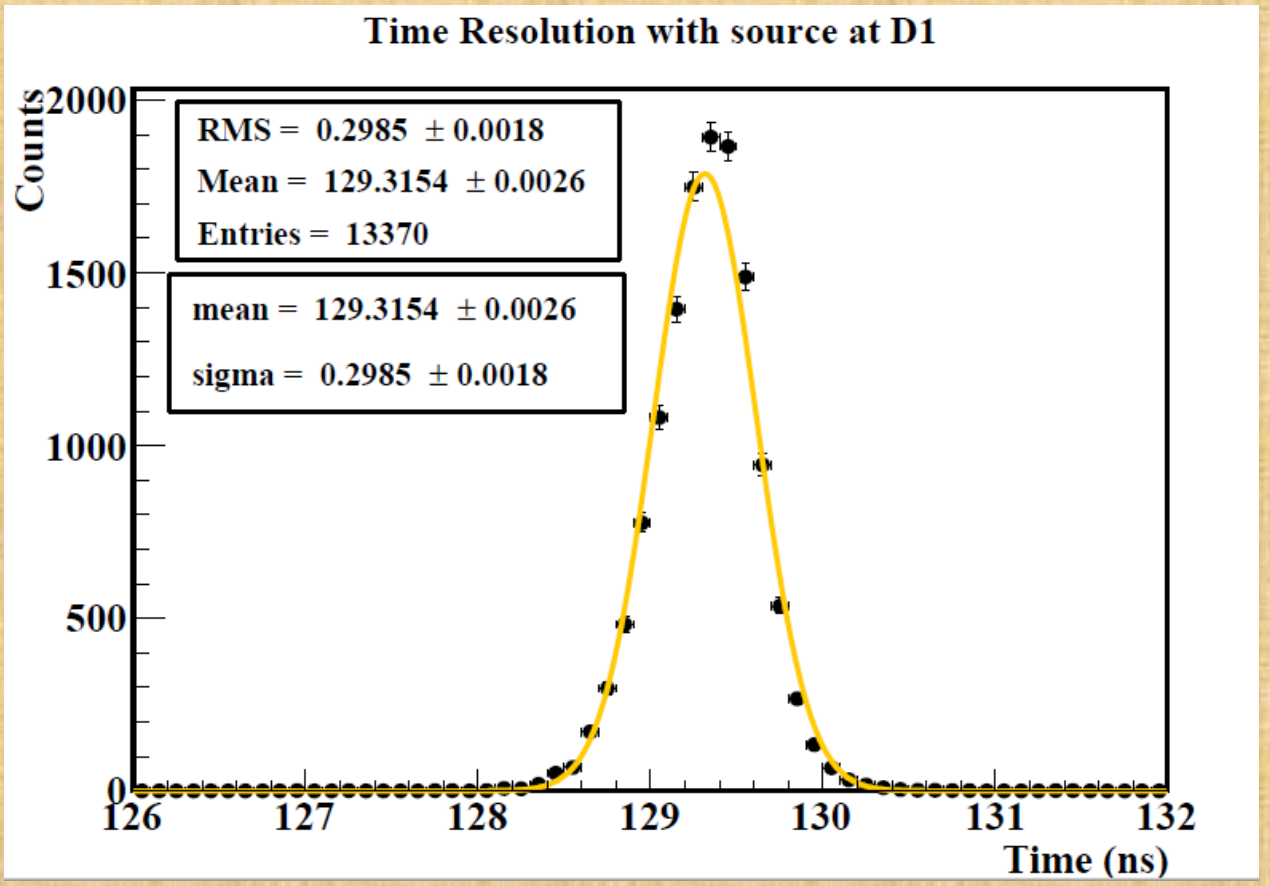


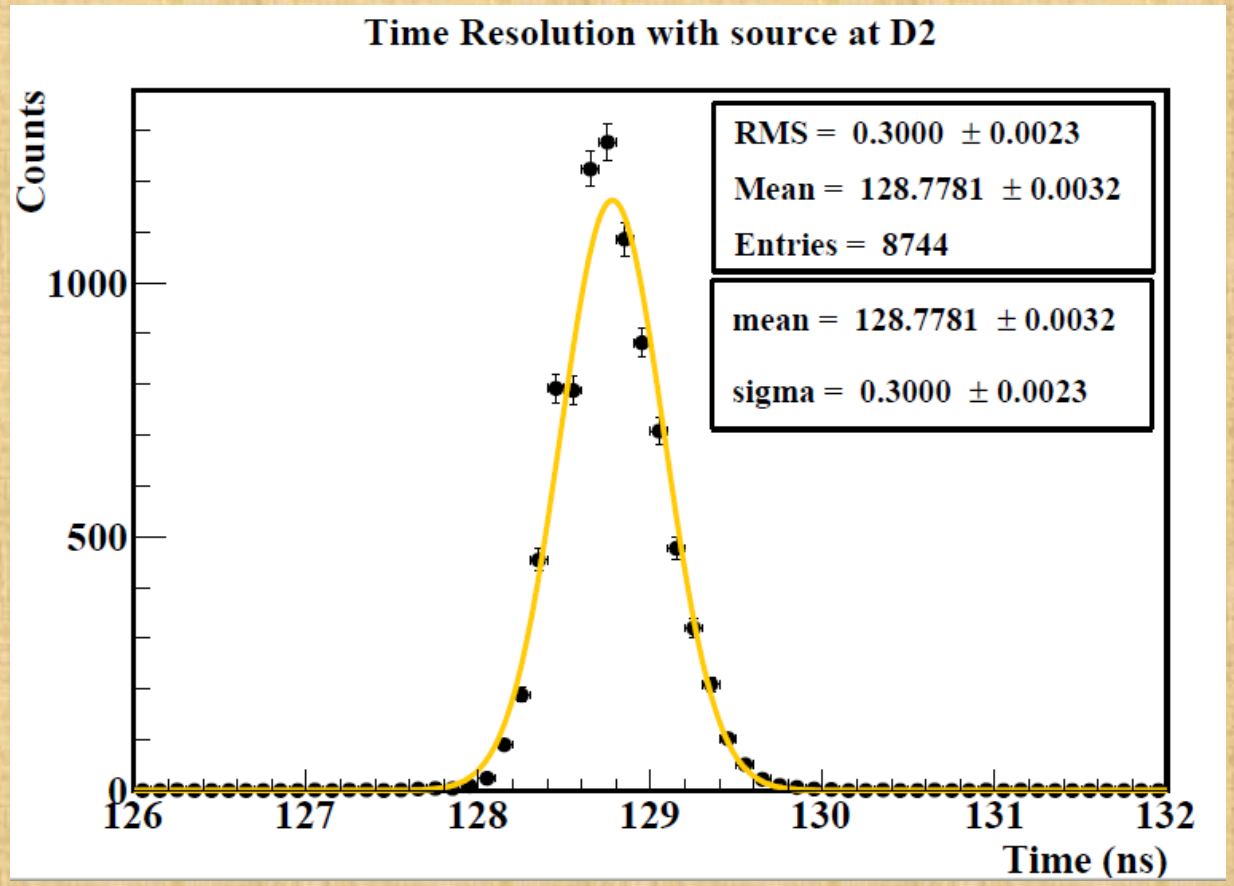
Influence of Distance between the Detectors



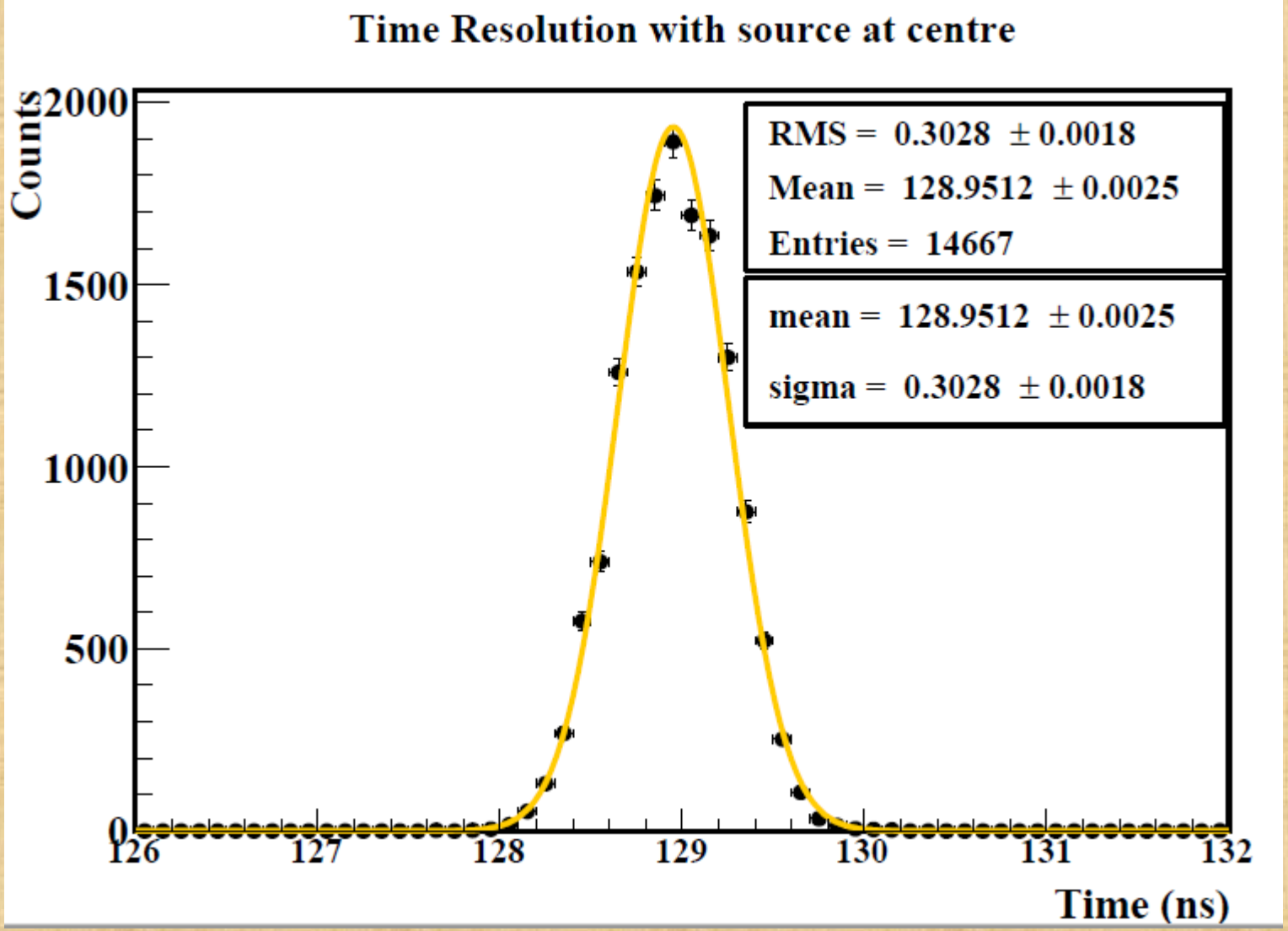
Resolution seem to be better when detectors are placed further apart.

Influence of Source Position





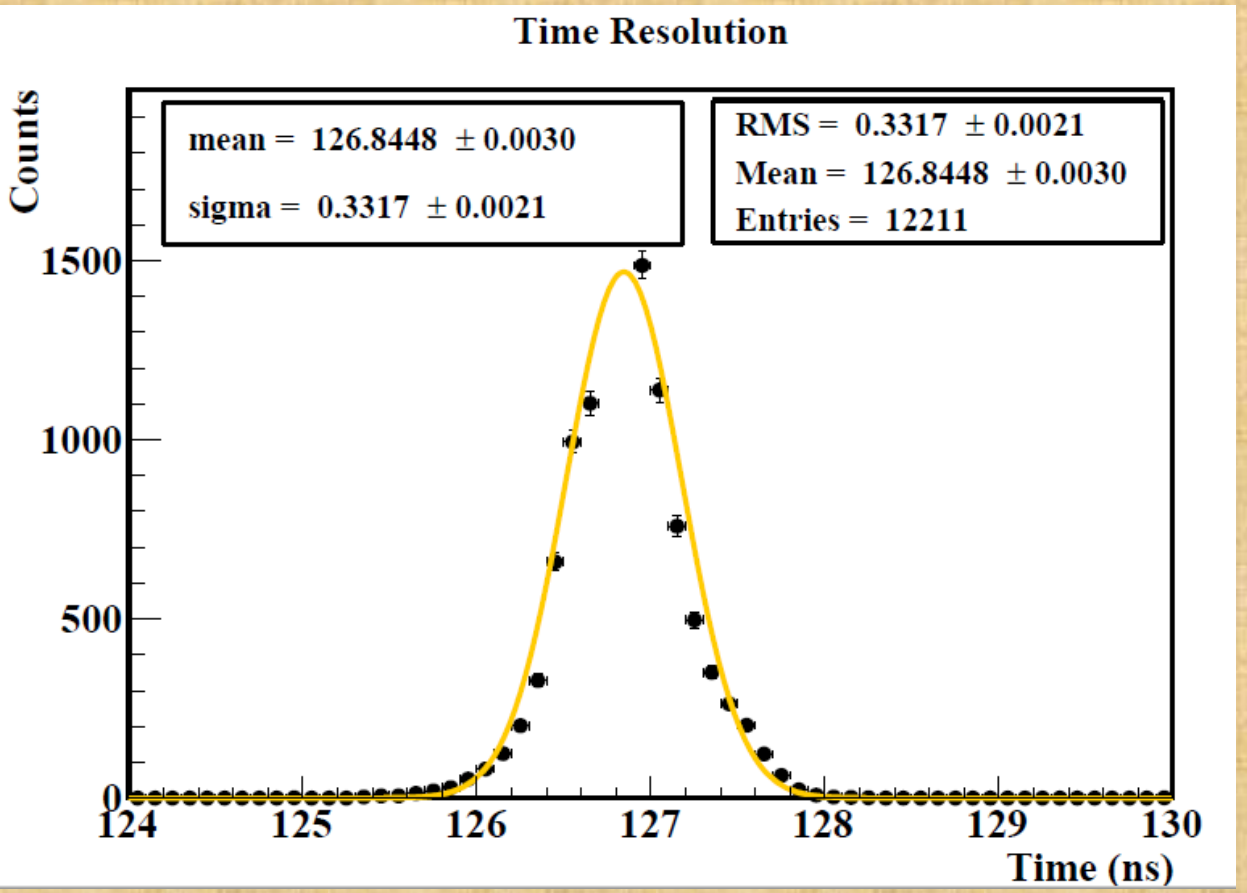
Influence of Source Position

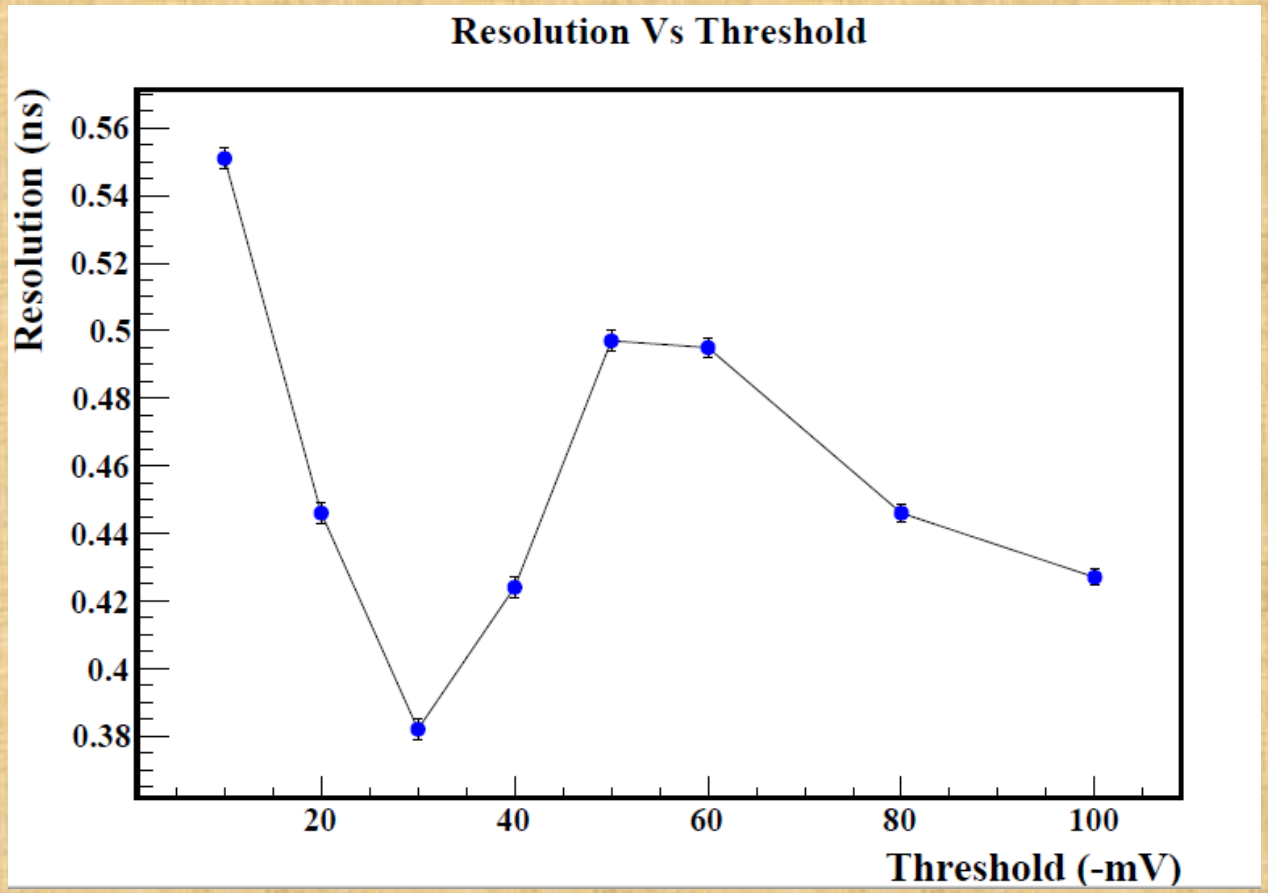


No Asymmetry observed when the source is placed between the Detectors

Influence of Discriminator Threshold

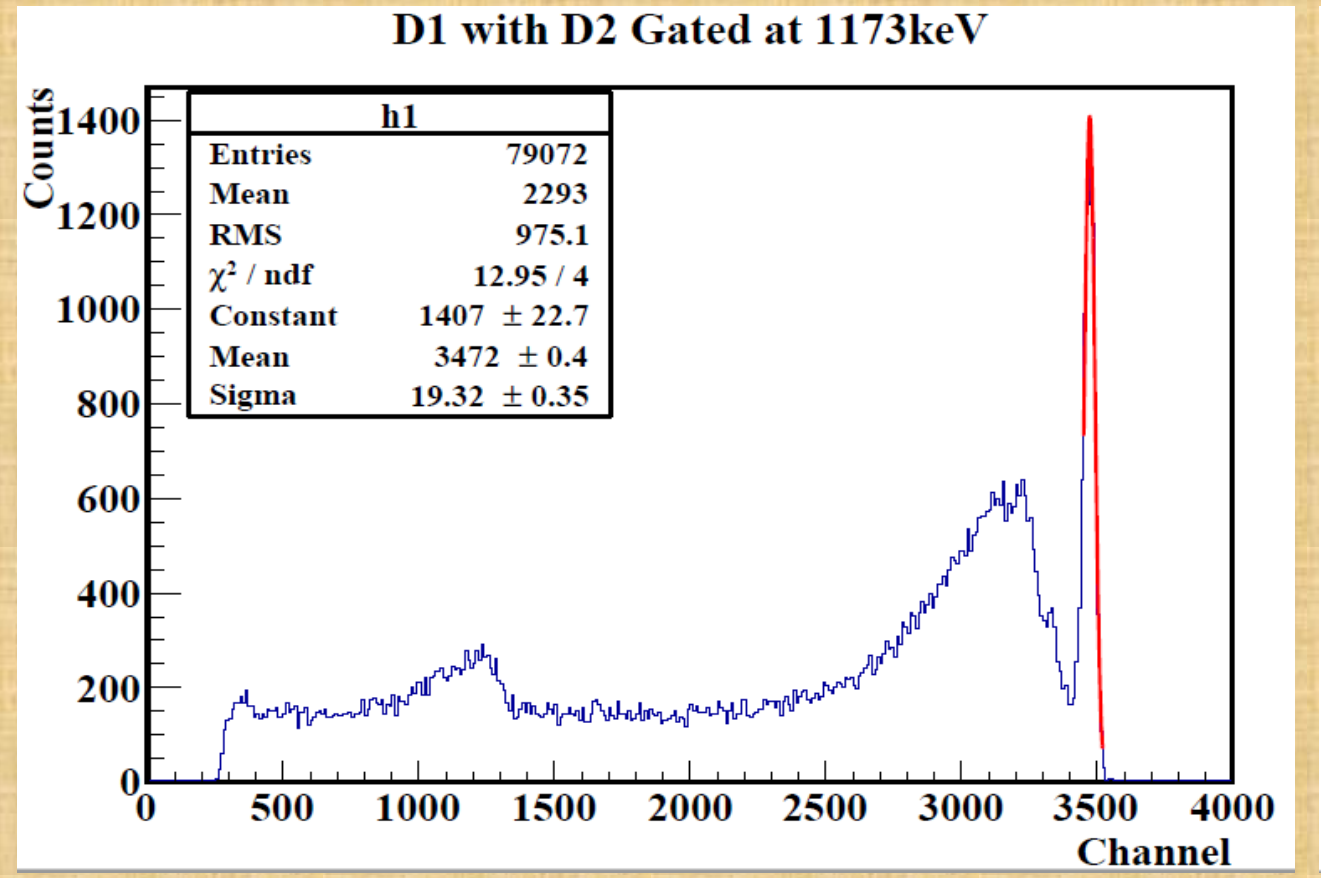
Best Time Resolution is obtained when the Discriminator Threshold is set to -30 mV

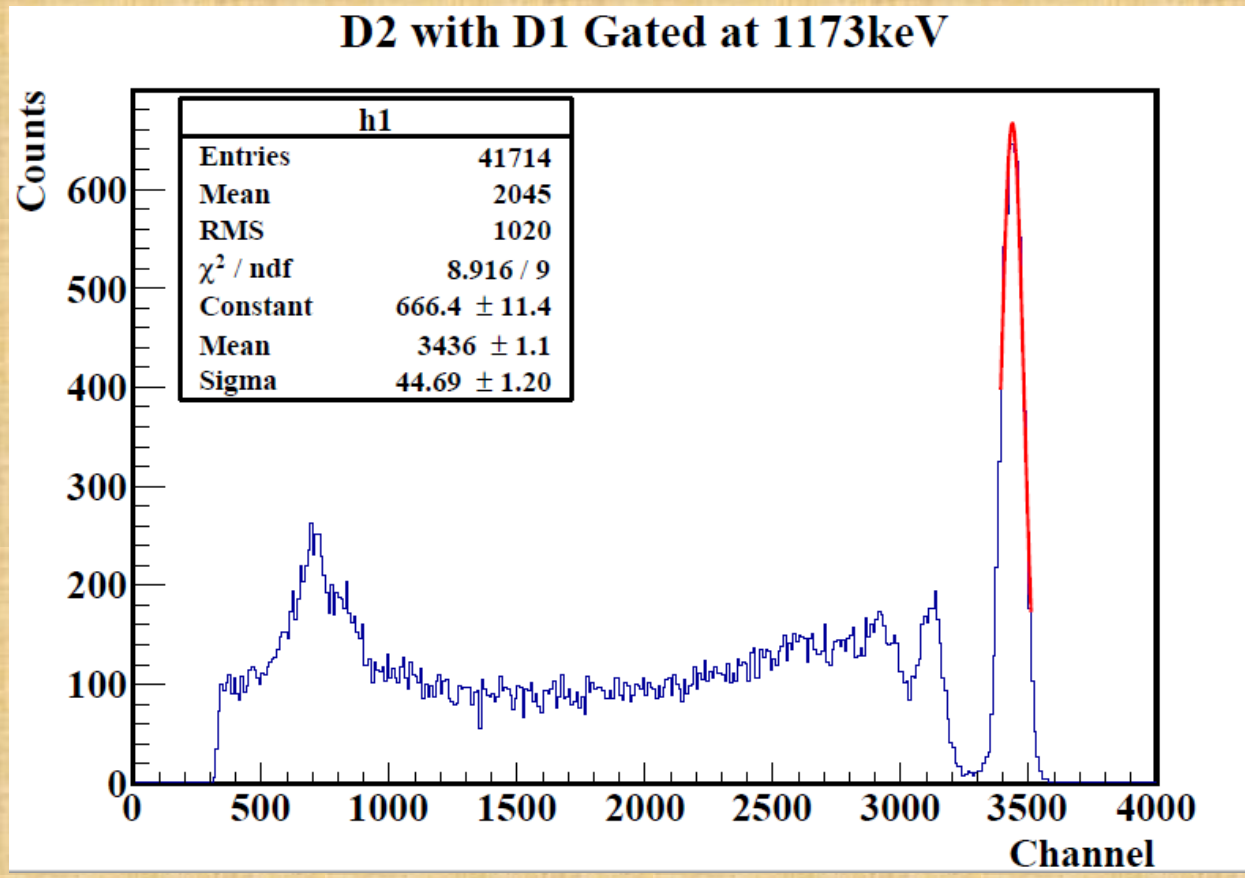




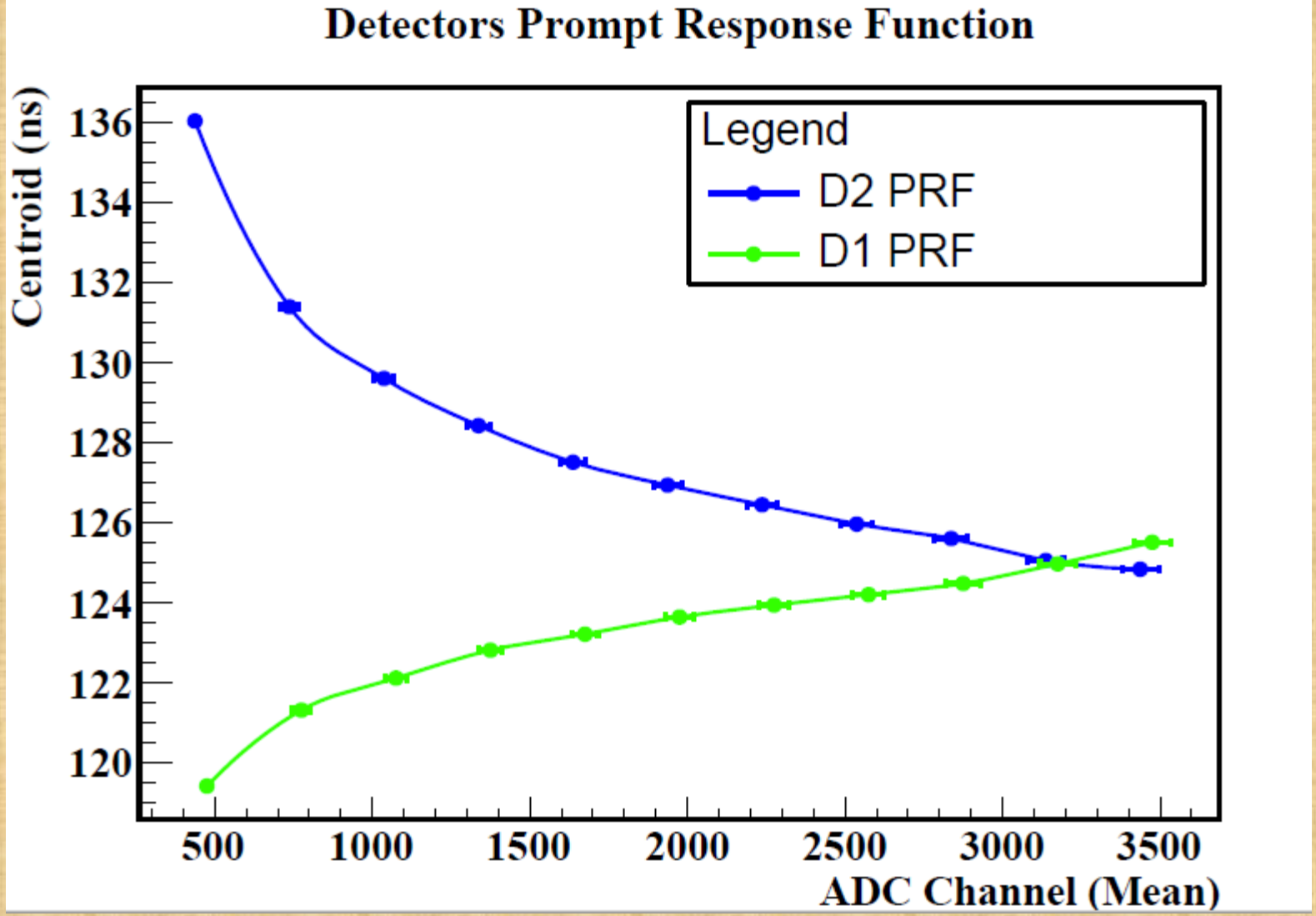
Prompt Response Function (PRF)

Prompt Response Function Developed from the coincidence events of Co-60 source.





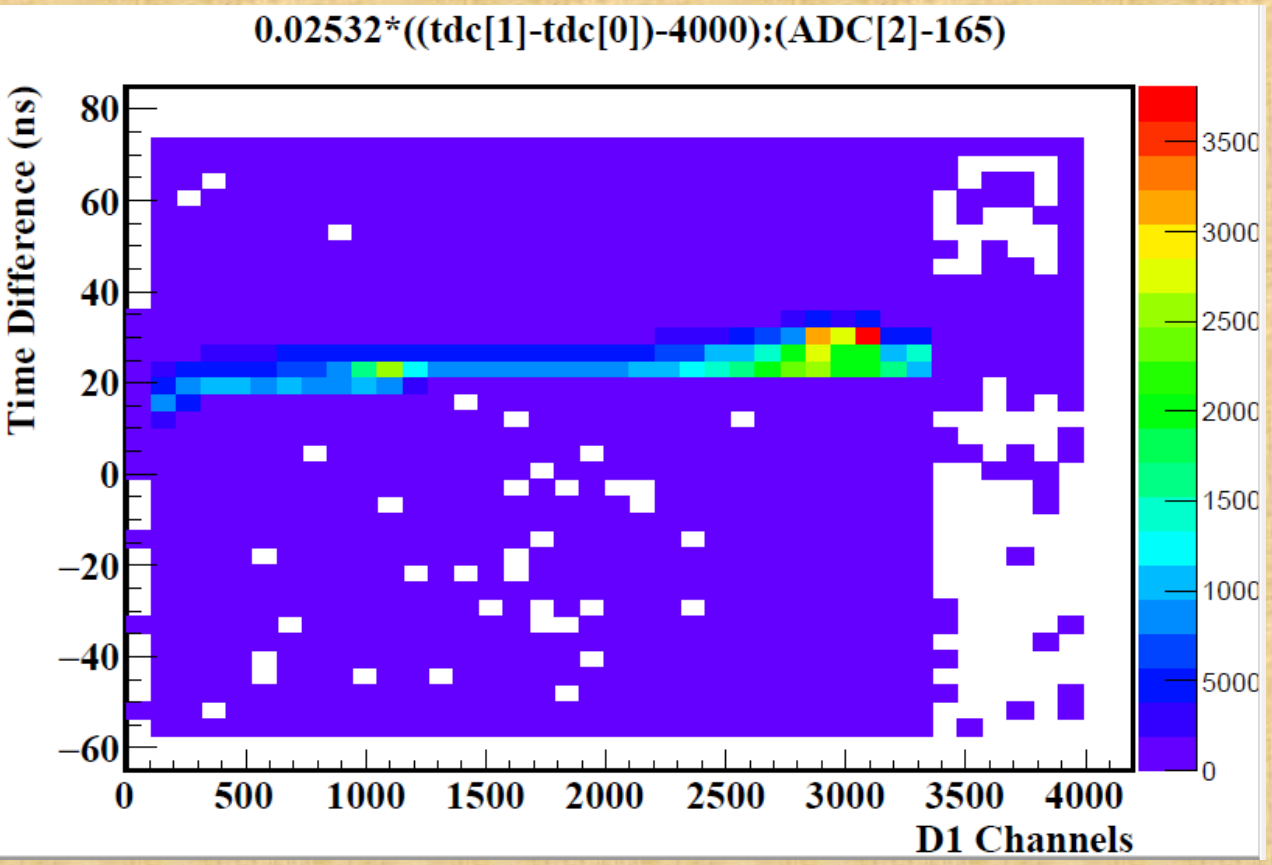
Prompt Response Function (PRF)

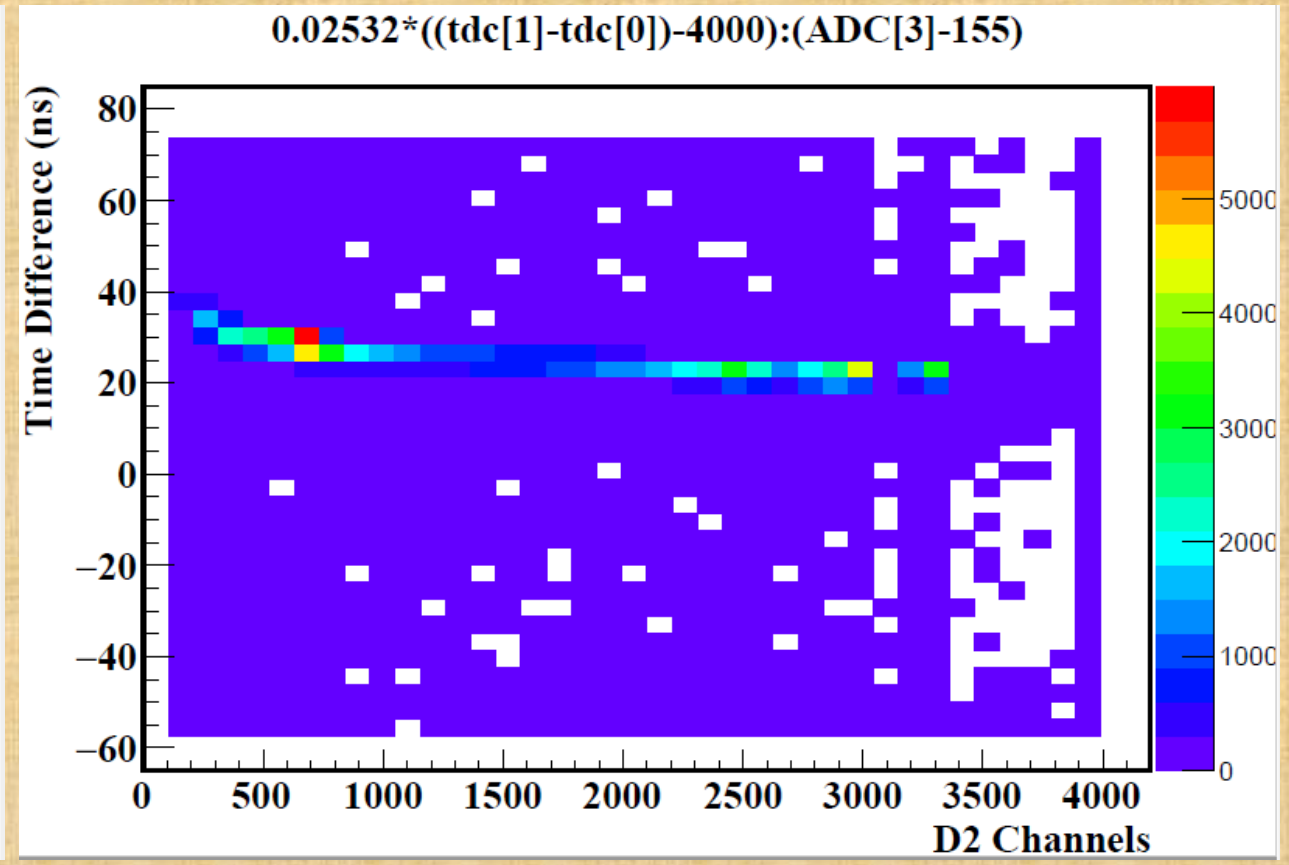


- **Some Asymmetry is observed at the low ADC values**
- **This Asymmetry is attributed to the Effect of Time Walk as well as possibilities of Cross-Talk Events**

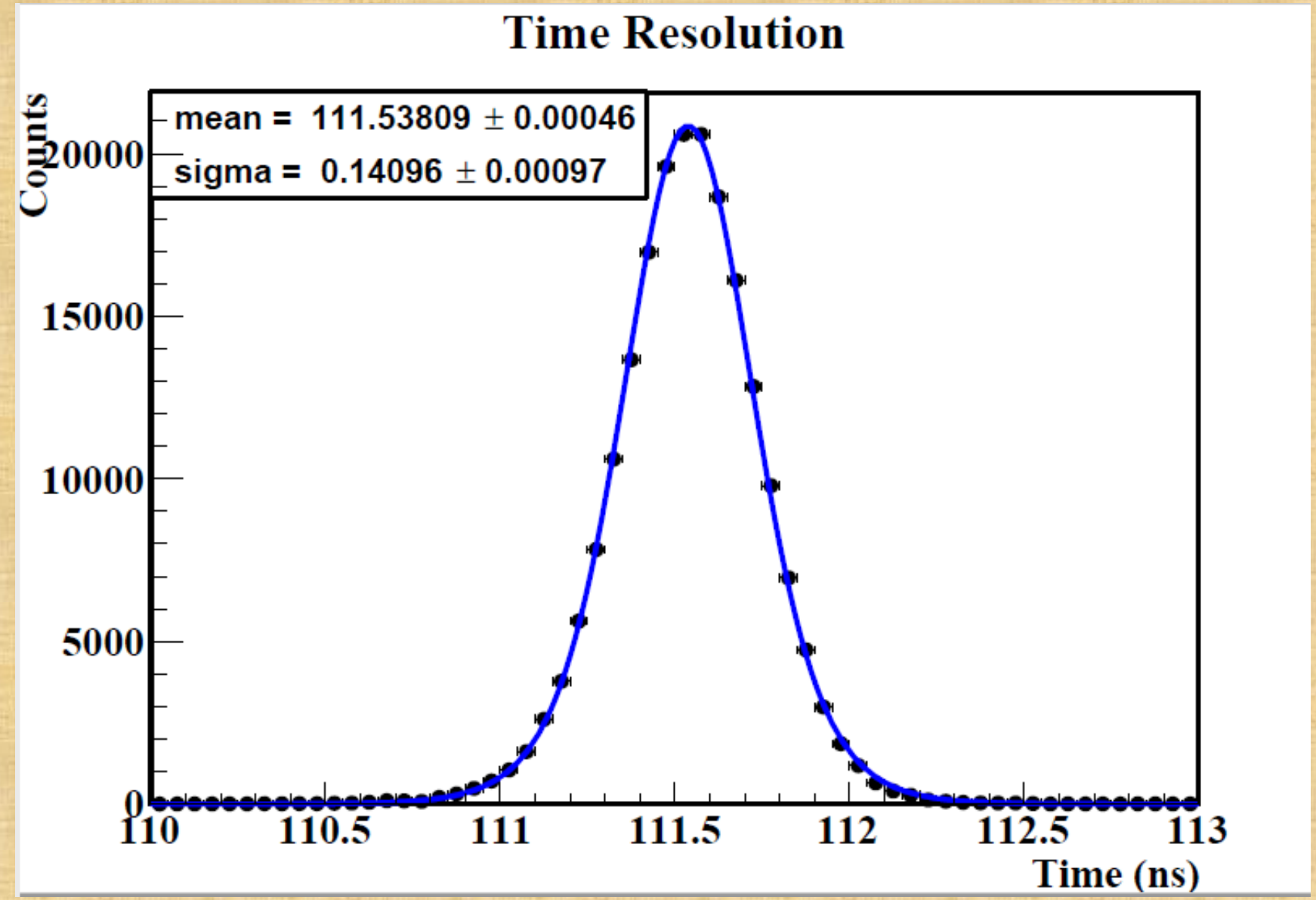
Time Walk Effect

Some Time Walk in the Low ADC channels?





After Correction of Compton Events

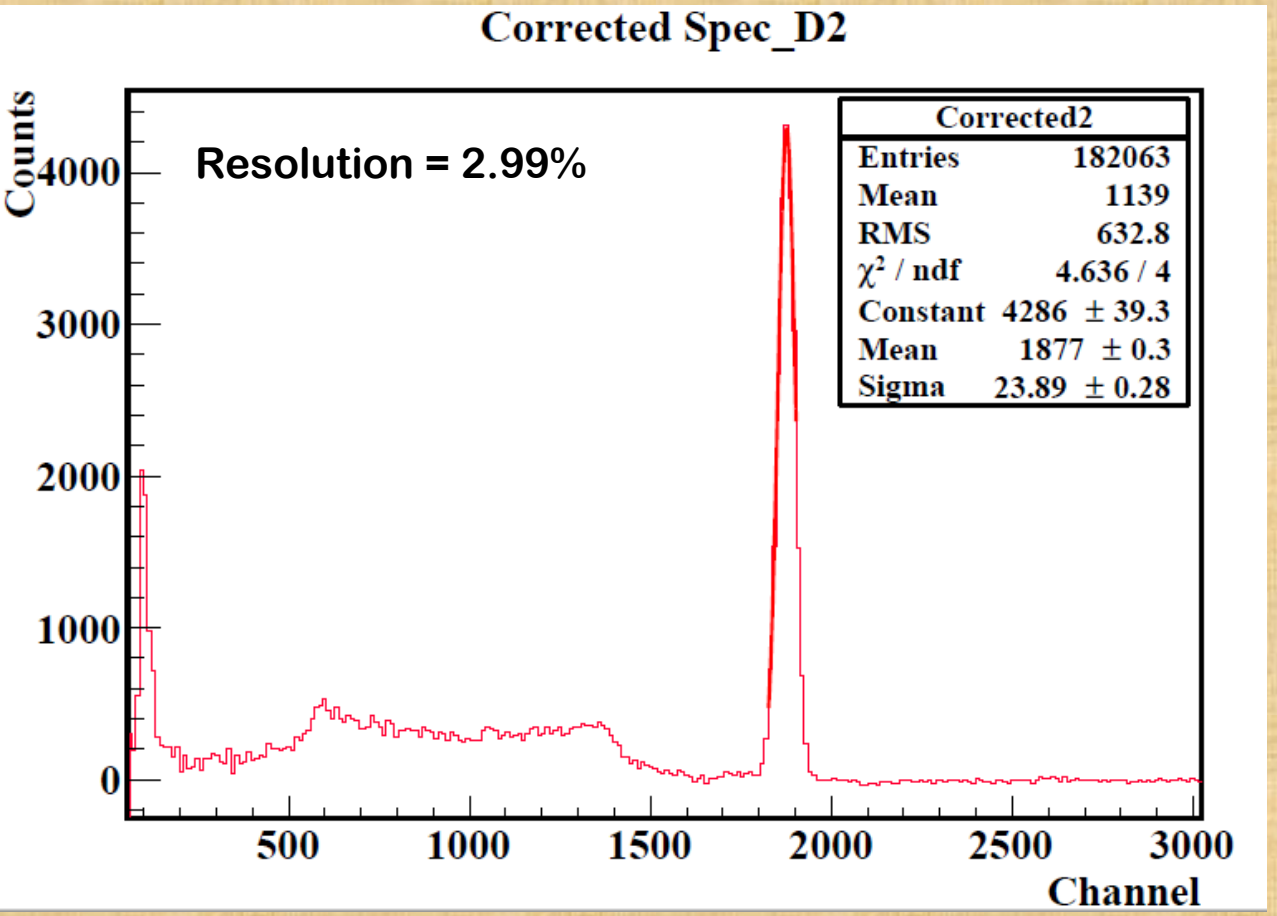


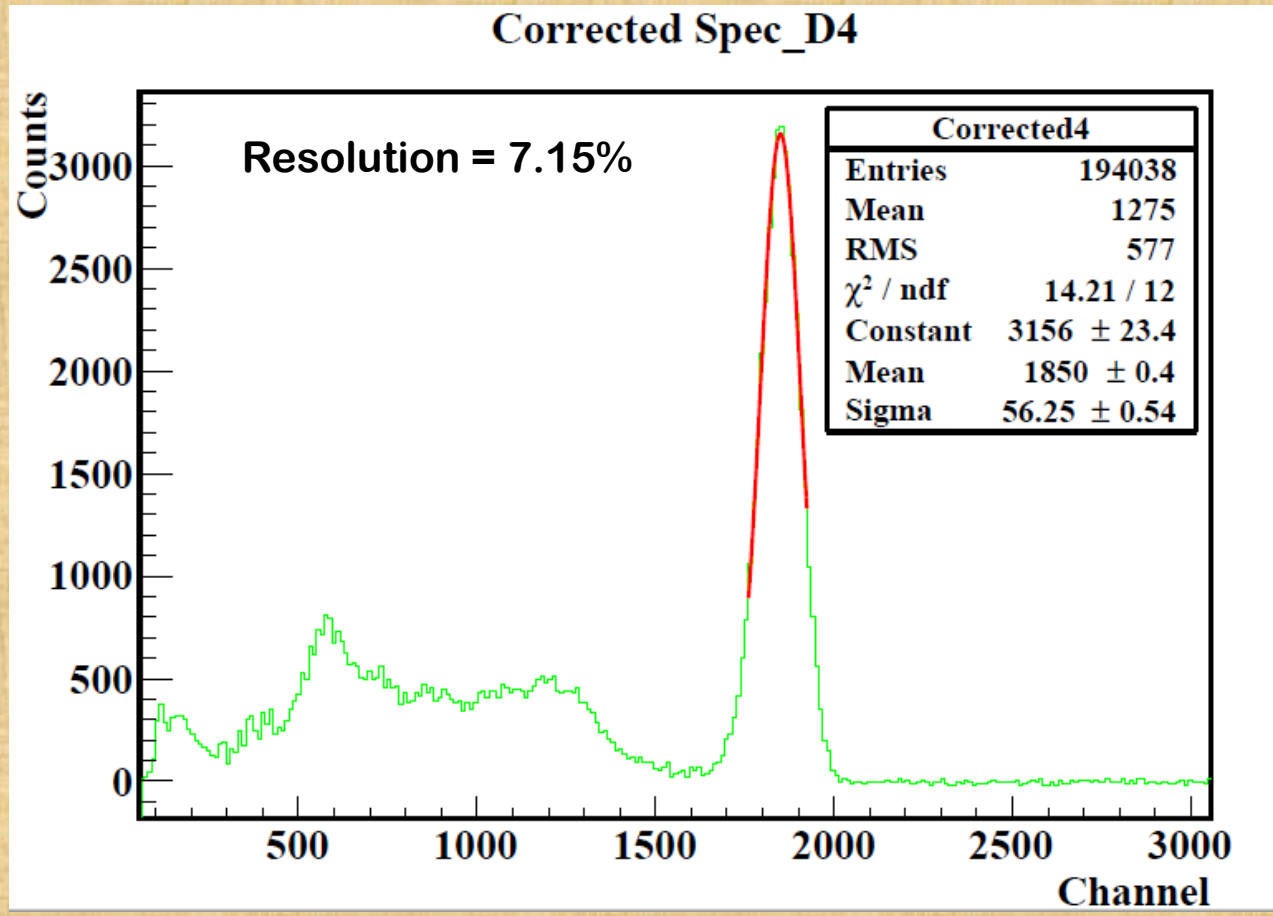
THANK YOU FOR LISTENING!!

JAH BLESS YOU!!

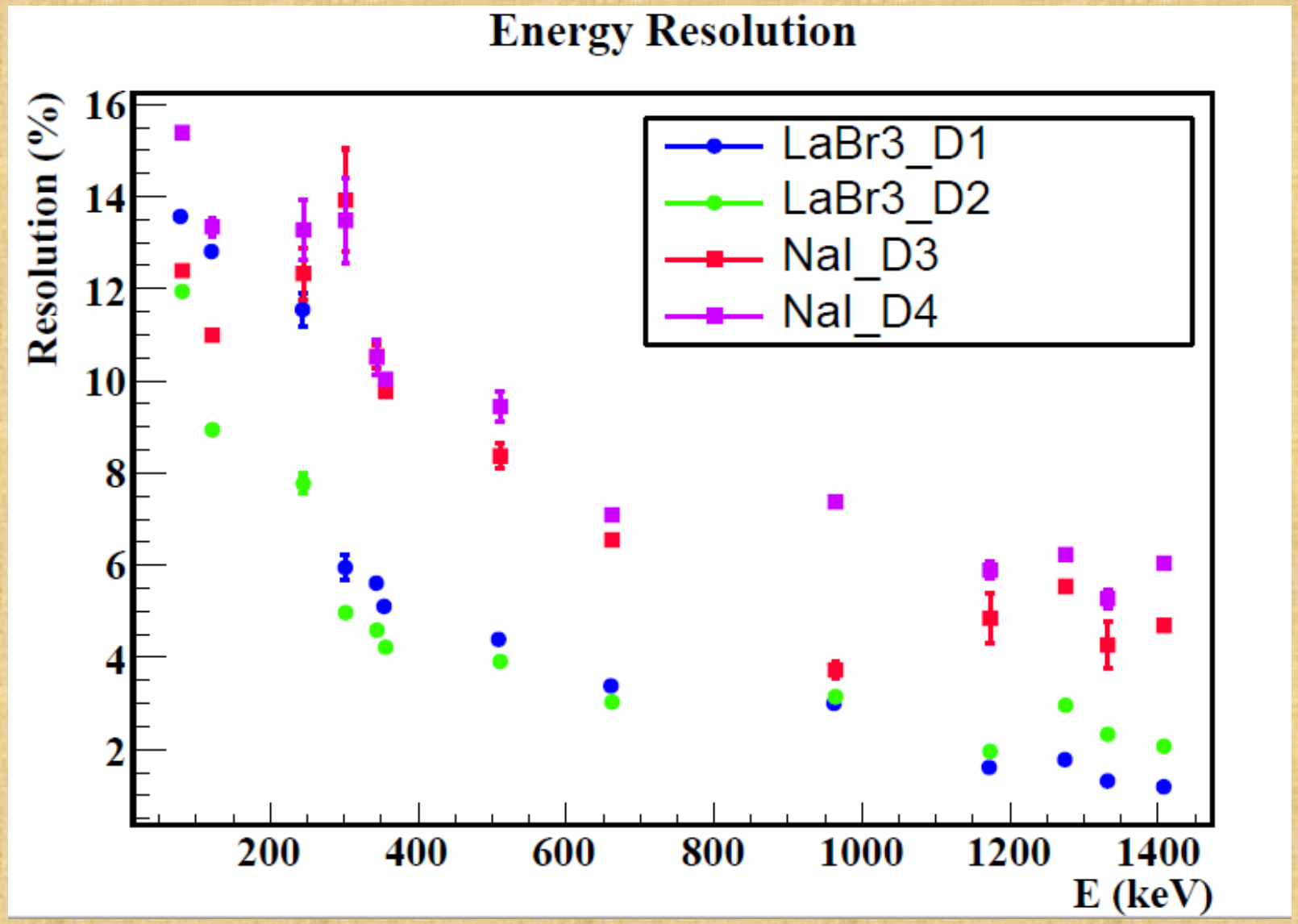
Blank

BACKUP

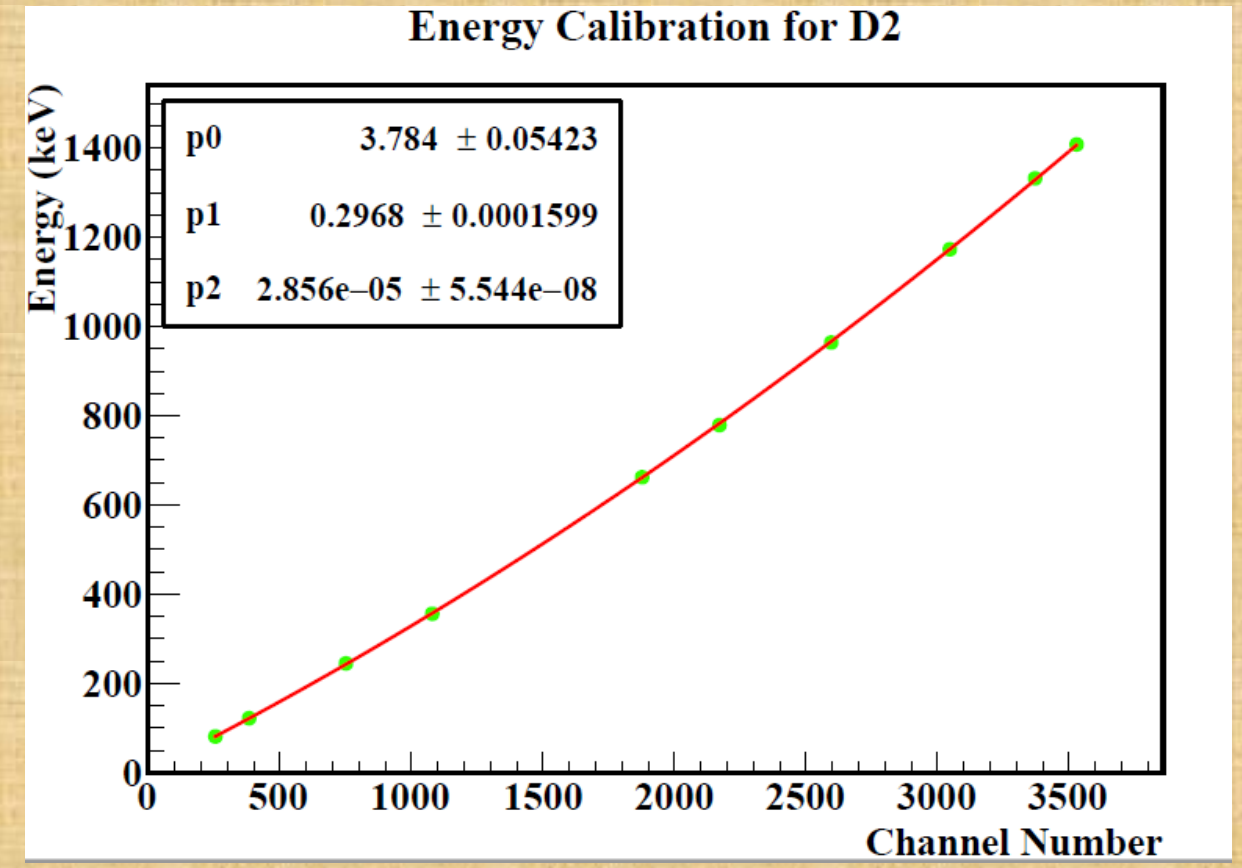

Corrected Spec_D2
Resolution = 2.99%
Corrected2
Entries 182063
Mean 1139
RMS 632.8
χ² / ndf 4.636 / 4
Constant 4286 ± 39.3
Mean 1877 ± 0.3
Sigma 23.89 ± 0.28
Counts
Channel


Corrected Spec_D4
Resolution = 7.15%
Corrected4
Entries 194038
Mean 1275
RMS 577
χ² / ndf 14.21 / 12
Constant 3156 ± 23.4
Mean 1850 ± 0.4
Sigma 56.25 ± 0.54
Counts
Channel

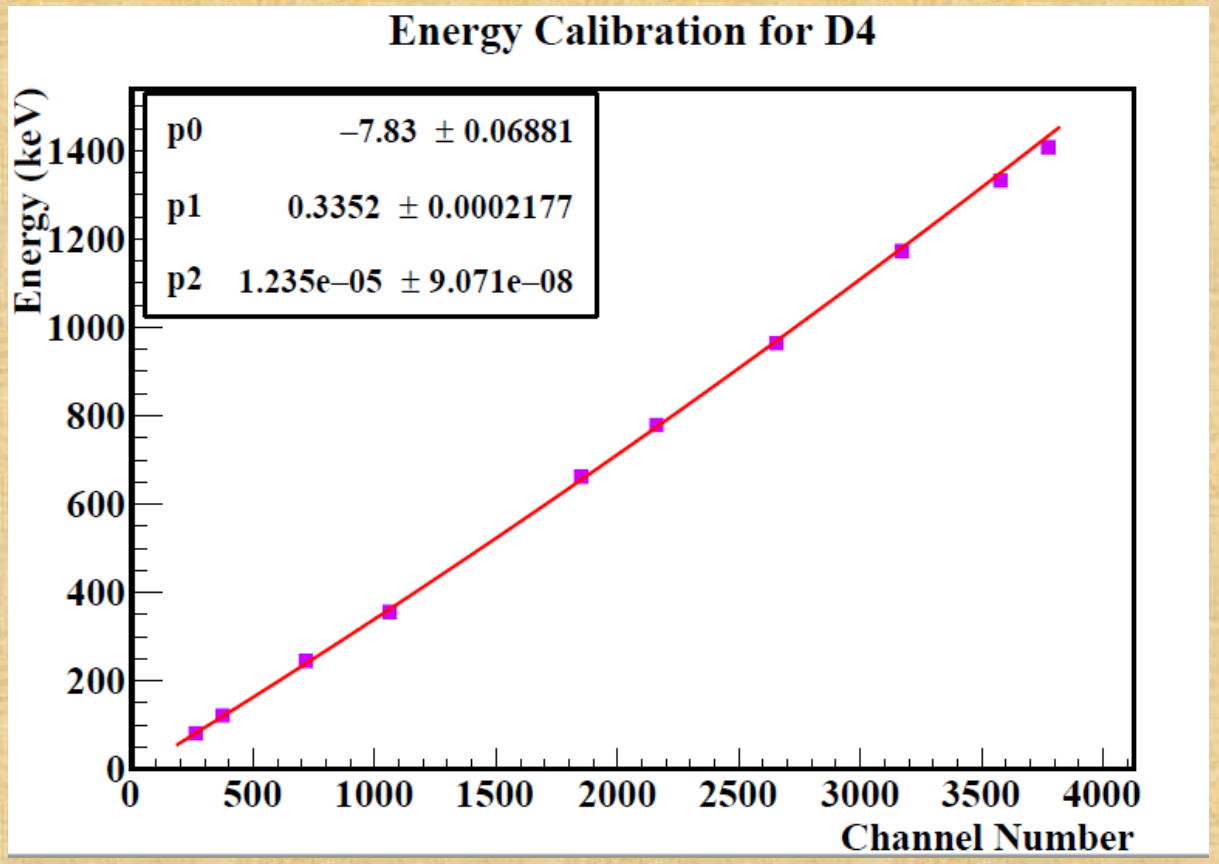
Energy Resolution Comparison



Energy Calibration

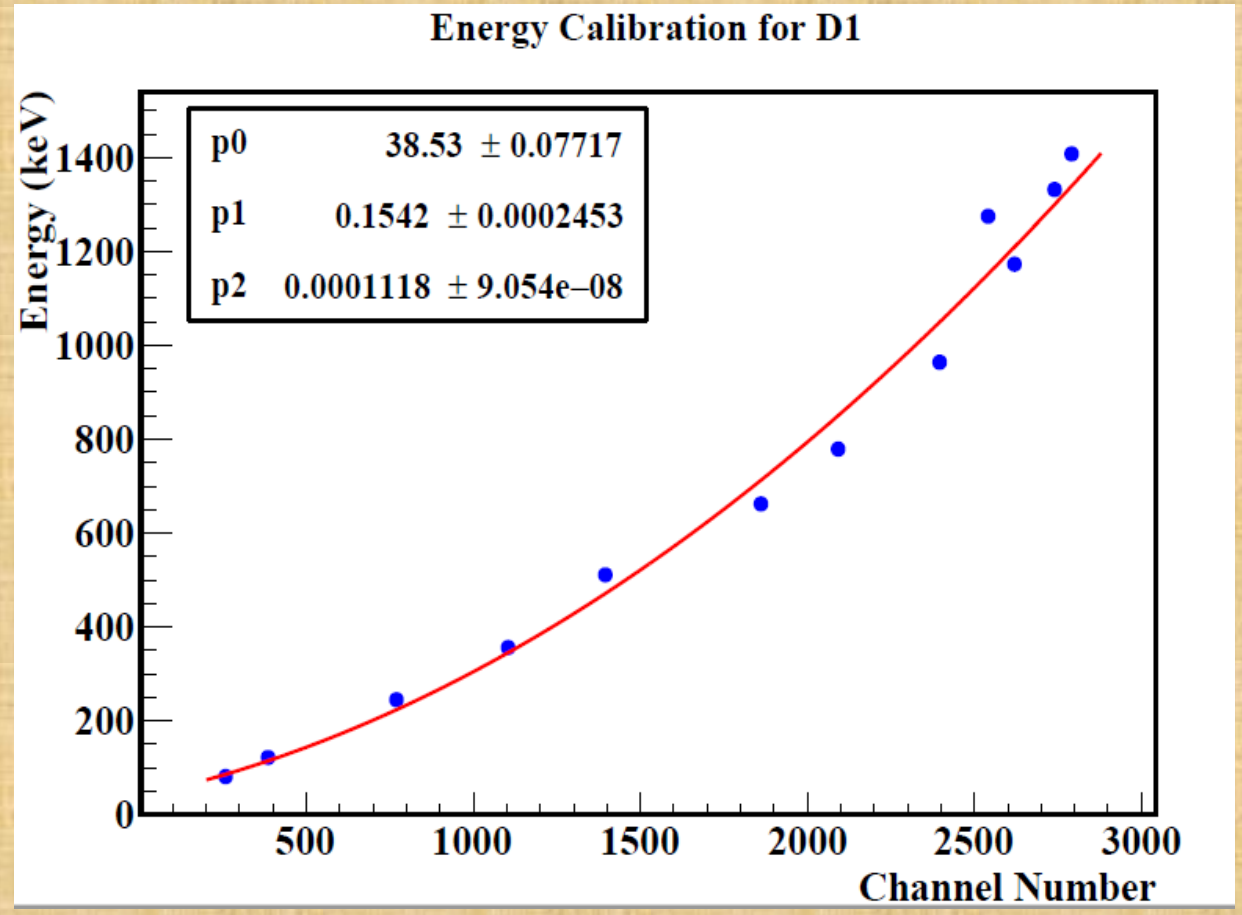


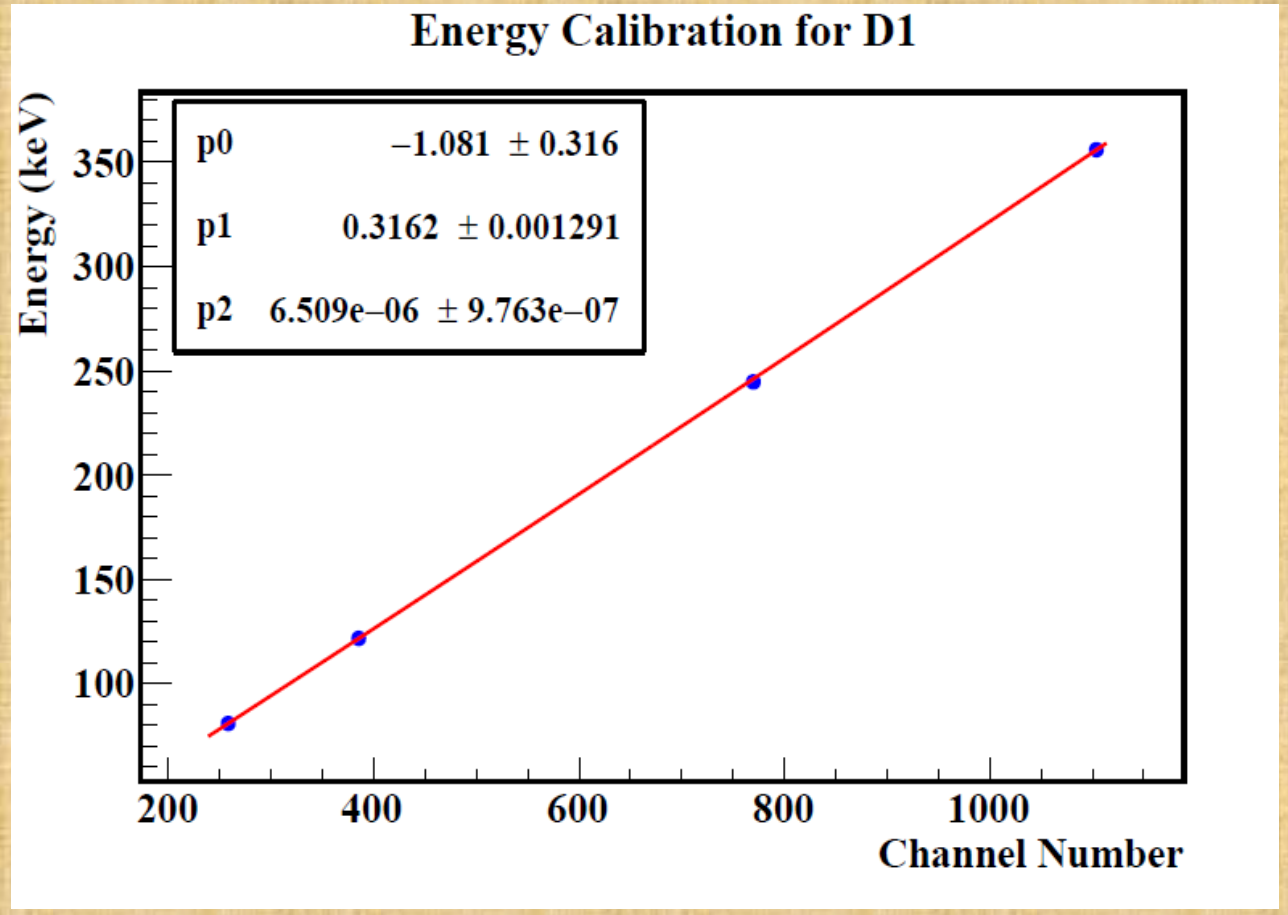
Large LaBr3



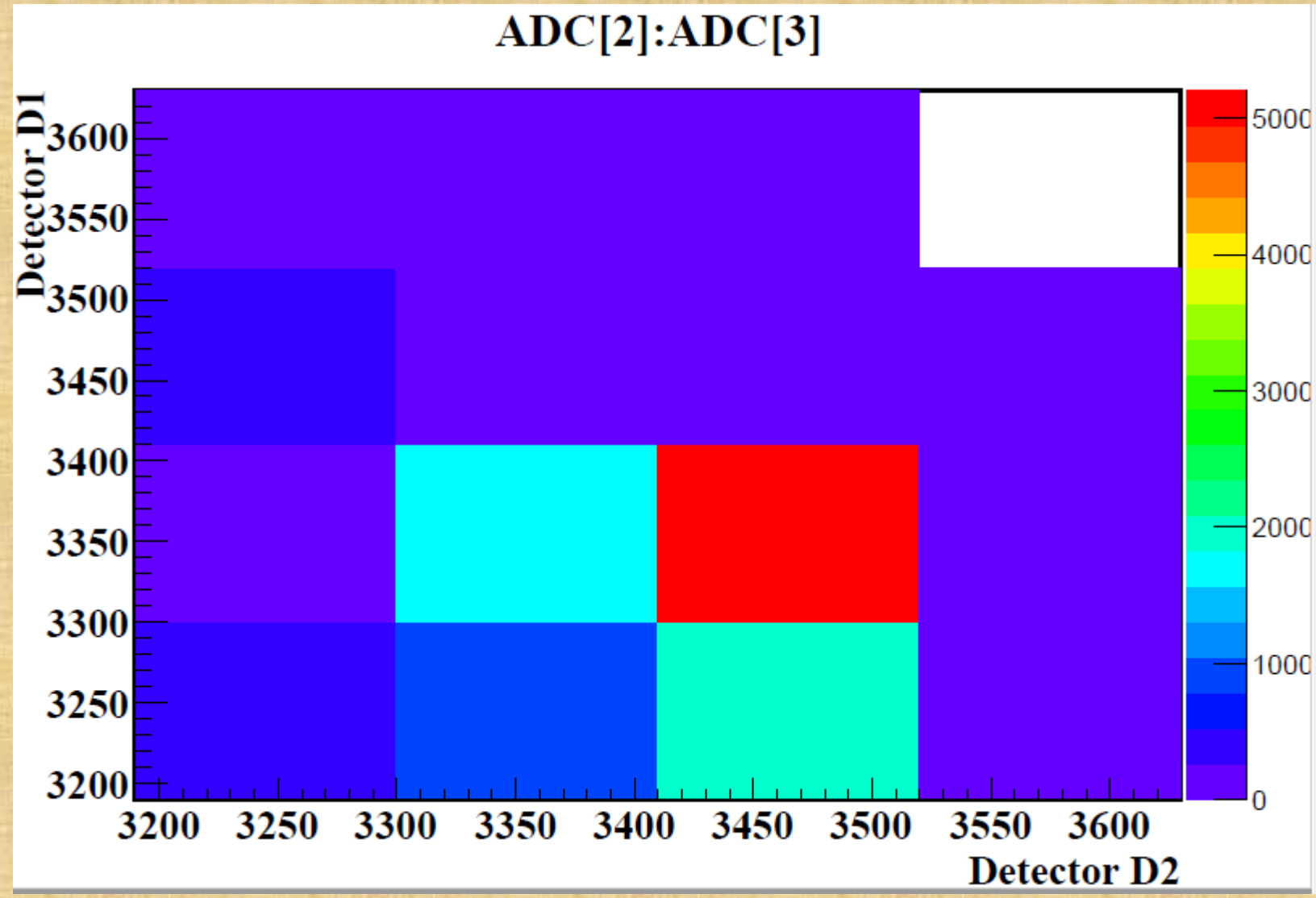
NaI(Tl)

Energy Calibration for Small LaBr3

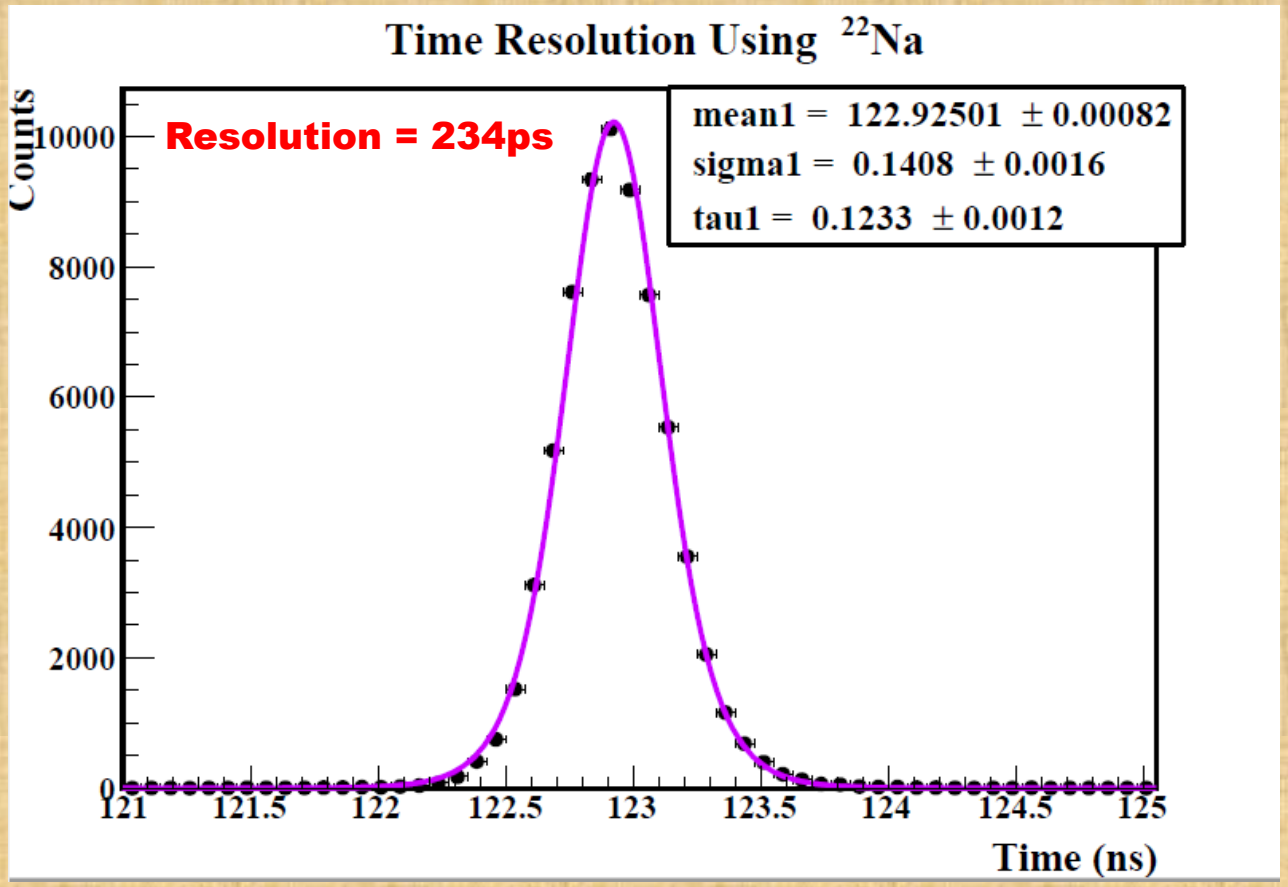




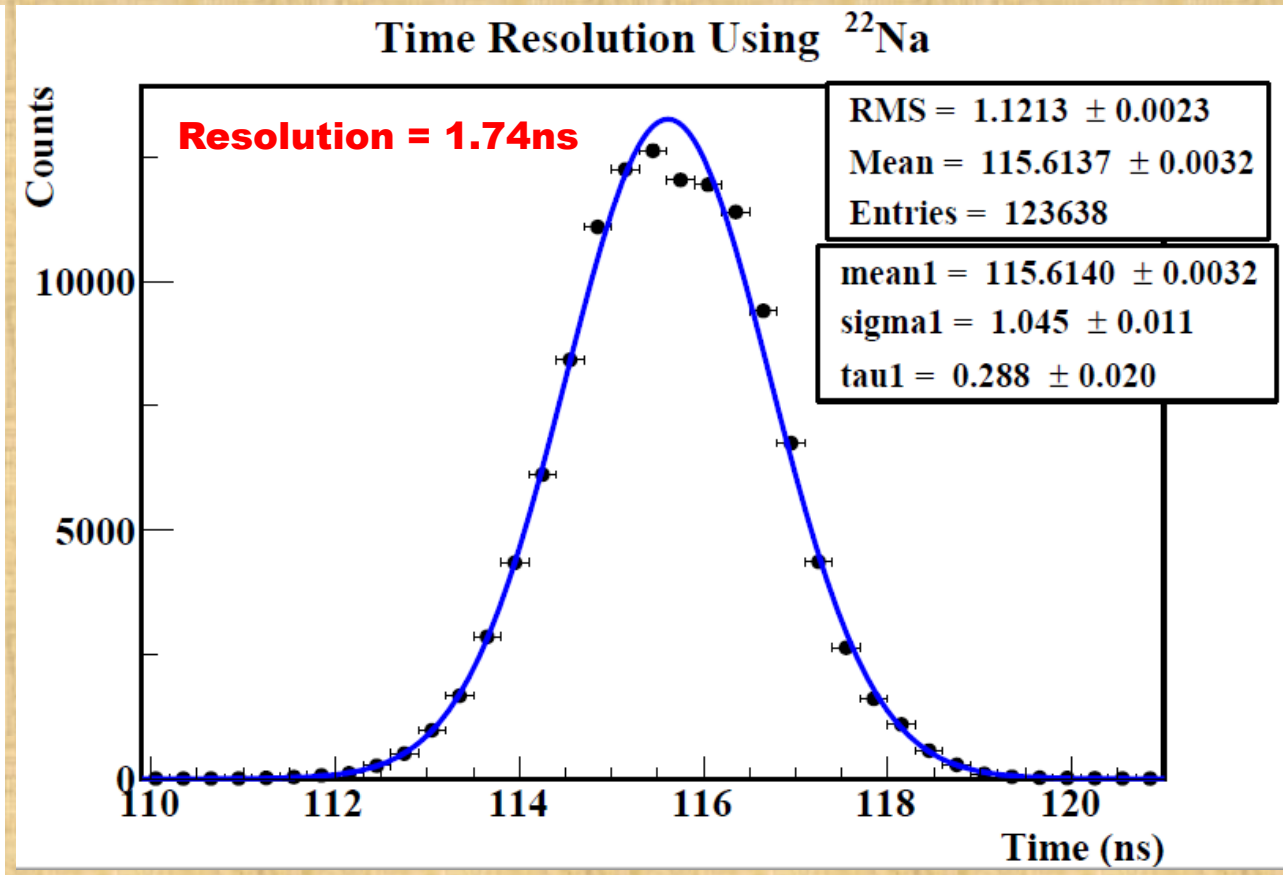
Selection of Coincident Events



Time Resolution

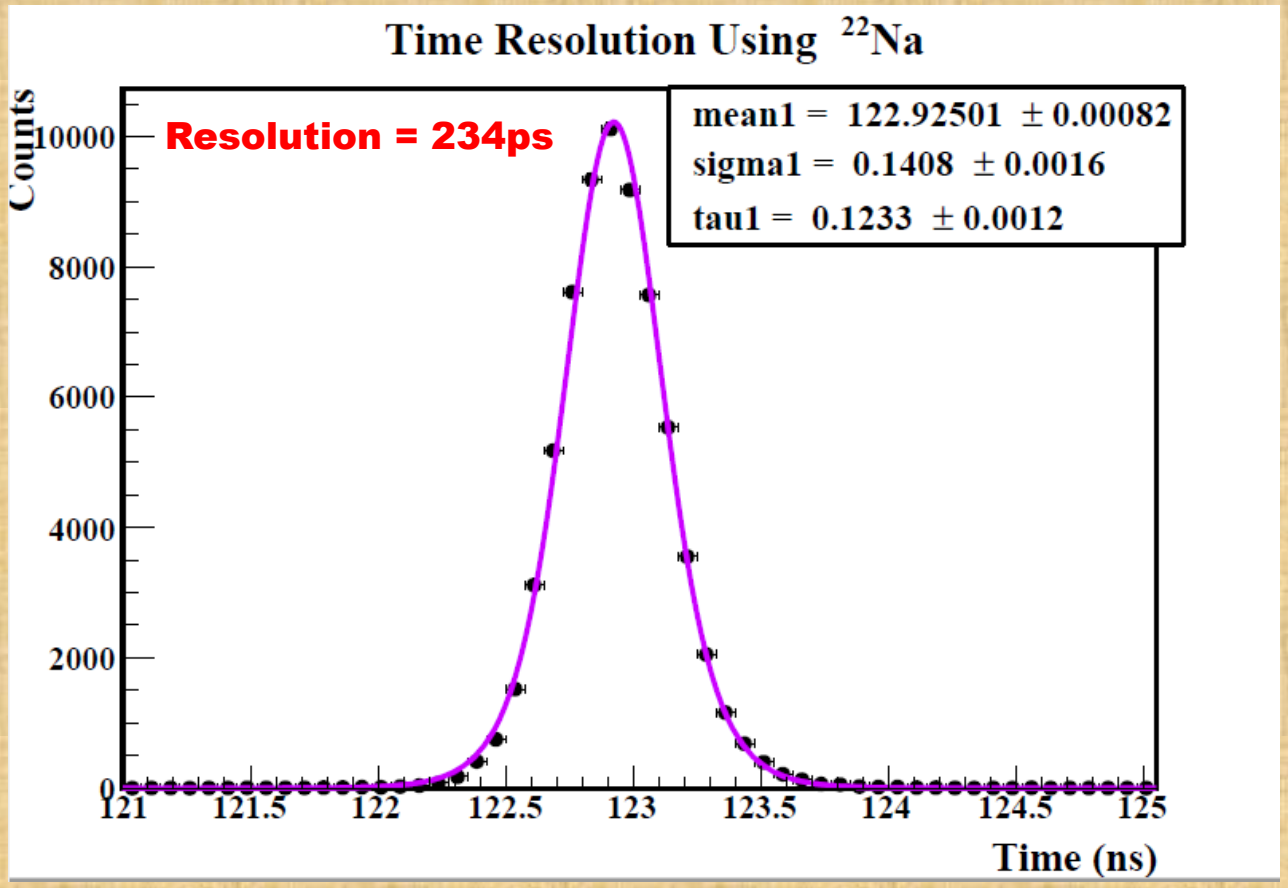


Time Resolution using LaBr3 Detectors

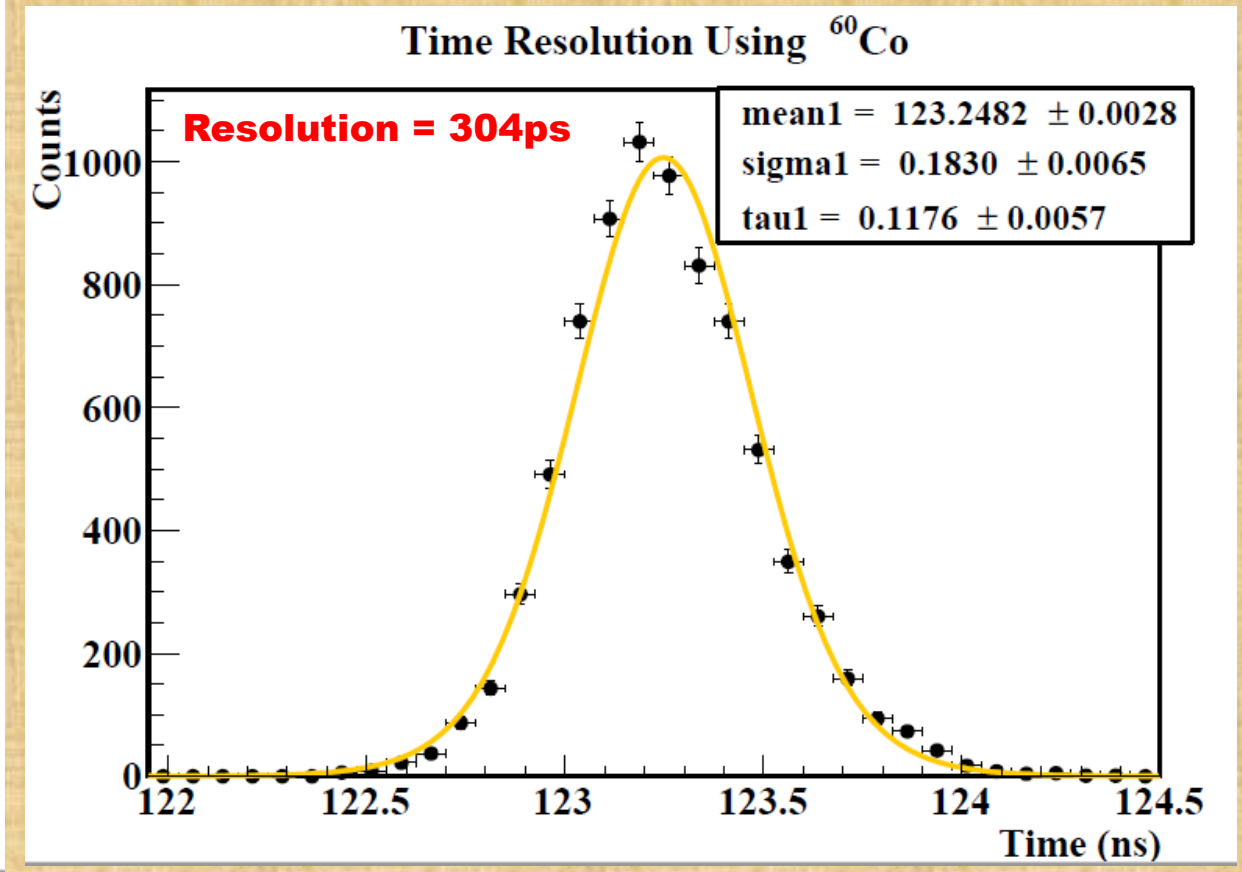


Time Resolution using NaI(Tl) Detectors

Time Resolution



Time Resolution using LaBr3 Detectors

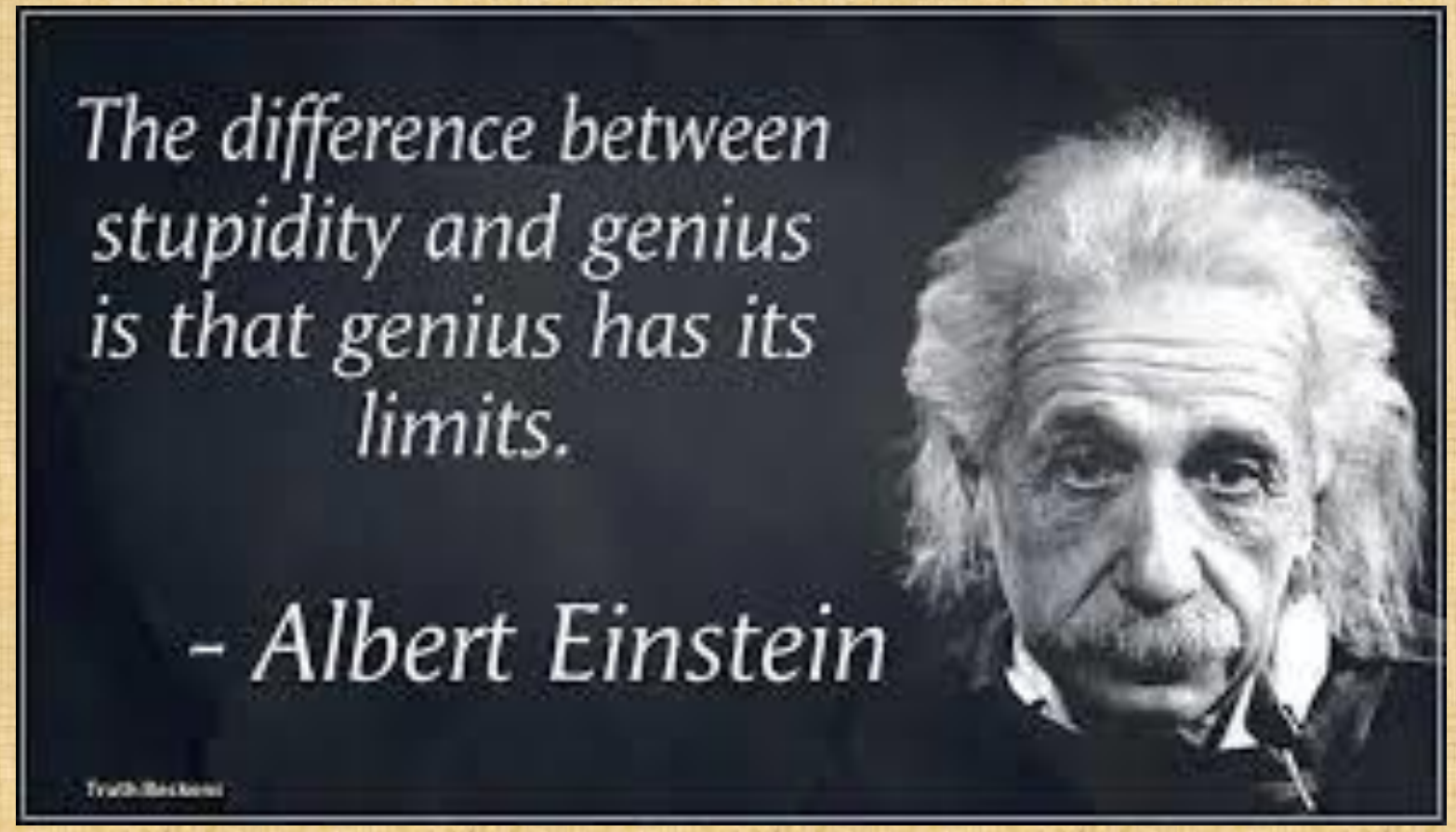


Time Resolution using LaBr3 Detectors

Summary and Forward Works

- Time Resolution of the system can indeed be improved by the use of LaBr3 detectors which have faster decay time.
- Low count rate and of the small LaBr3 poses some difficulties in the experiment.
- Currently, an experiment is running to measure the Lifetime of 81 keV state of 133Cs.
- Further Data Analysis will be carried out to determine measurement uncertainties which could include Time Walk effect, Background Contribution, Compton Scattering events etc.
- Correction of these effects could lead to a better System Time Resolution.

THANK YOU FOR LISTENING!!



JAH BLESS YOU!!

Backup

Accidental Coincidence and Selection of Peak Region

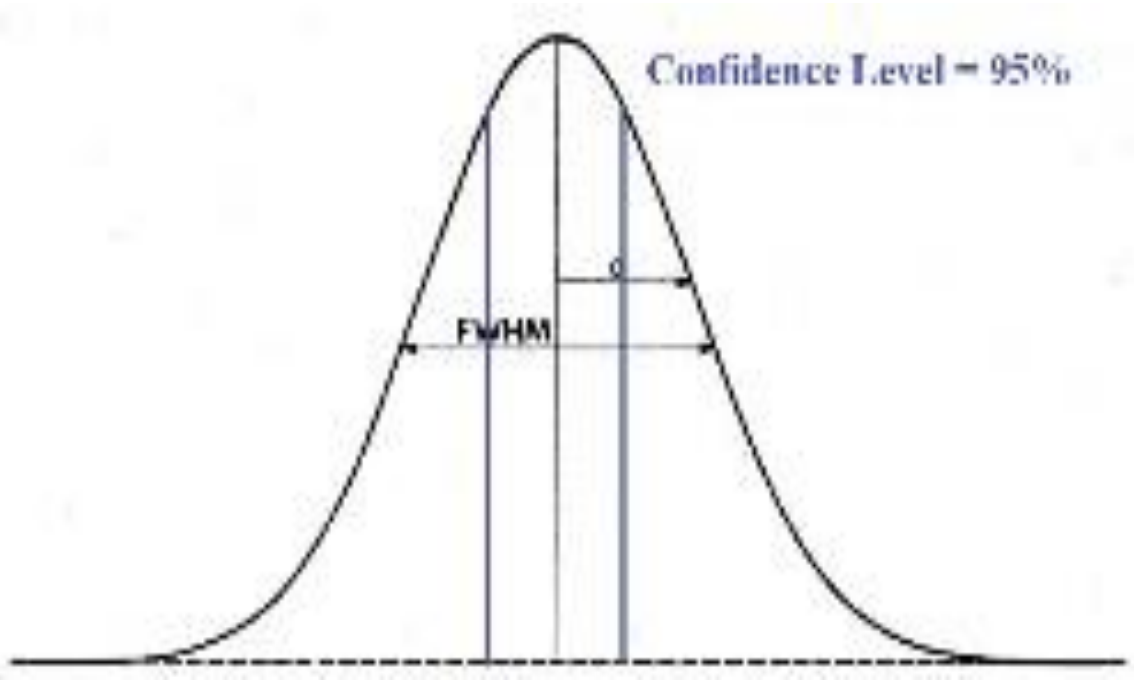
The ratio of True coincident events to Accidental coincident events is calculated as;

$$N_0 = 7955Bq$$
$$\tau = 107ns$$

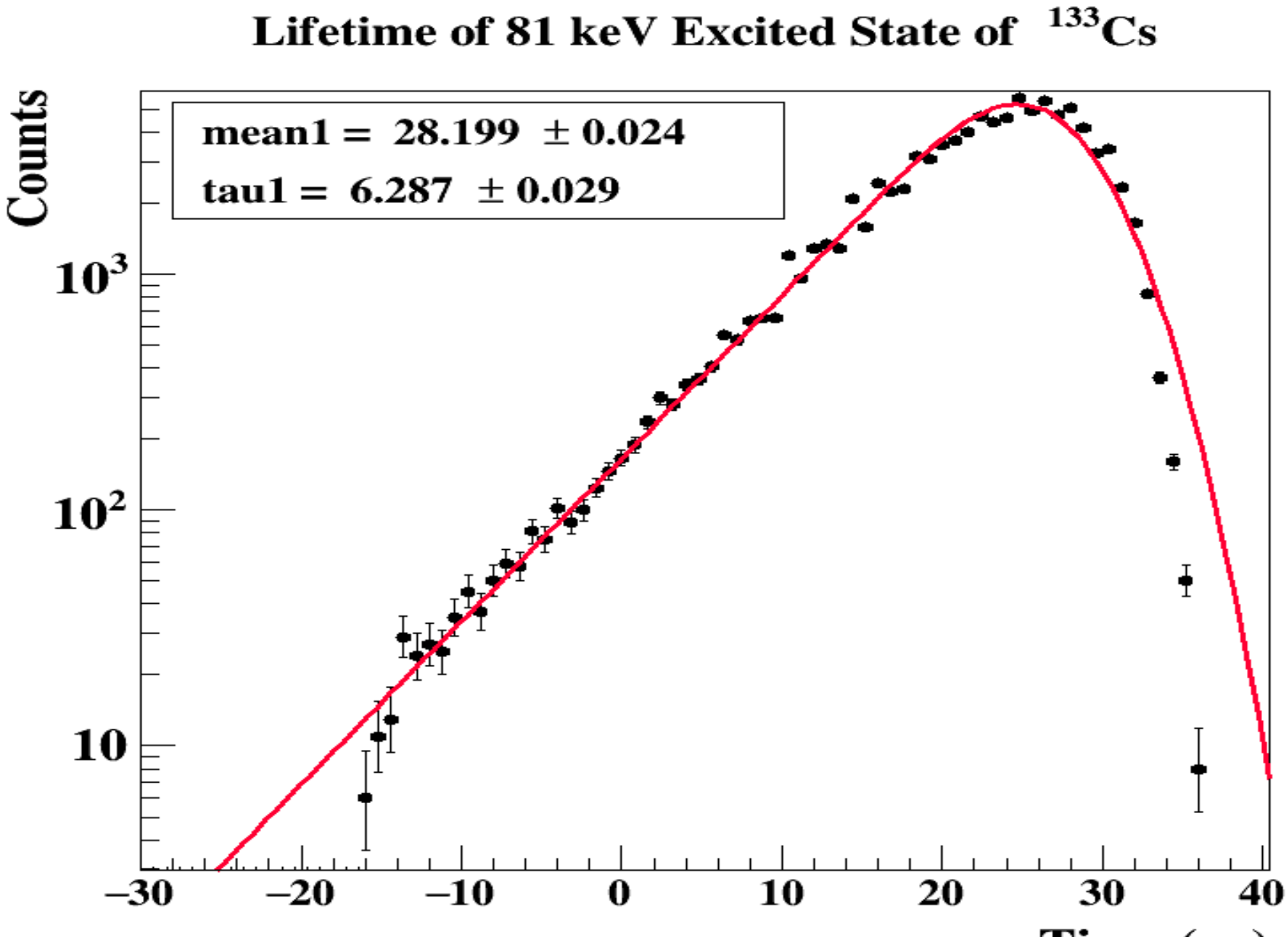
$$\frac{N_C}{N_A} = \frac{1}{2N_0\tau} = 587$$

Offline selection of coincident peaks is done using the following range,

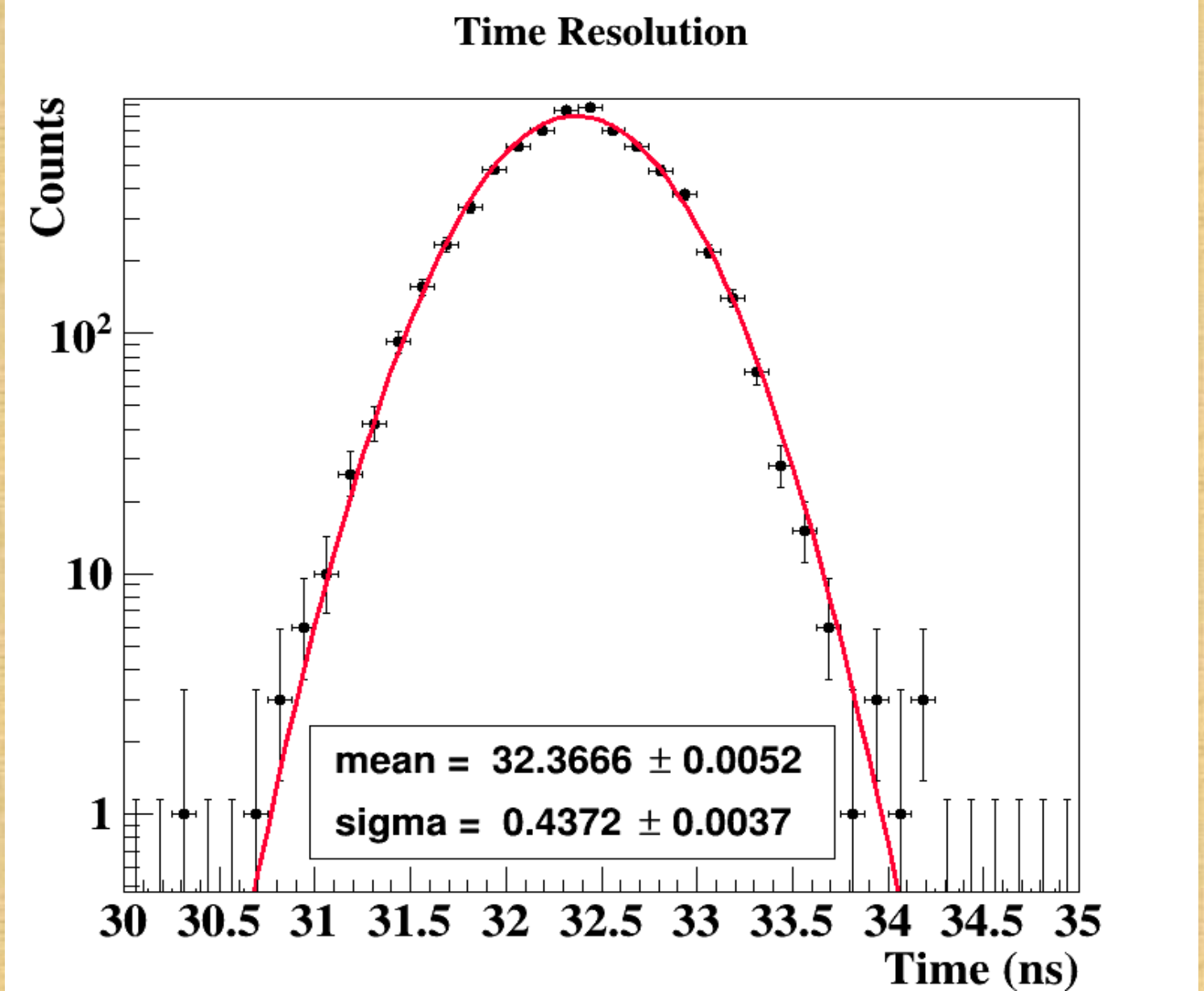
$$R = (\mu - 1.645\sigma, \mu + 1.645\sigma)$$



Lifetime of 81 keV state using 2nd Transition



Time Resolution of the System



- An advantage is taken of the fact that the lifetime of the 1173 keV state of Co-60 is very short.

- With the results shown in the picture on the left,

Resolution = FWHM = 1.03ns

Search for Better Scintillators?

Parameter	NaI(Tl)	CsI(Pure)	$LaBr_3$	BaF_2	CsI(Tl)	$PbWo_4$
Resolution (%)	6 – 7	17 –185	3 – 4	12	4 – 5	
Decay Time (ns)	250	35 (s), 6 (f)	16	0.6 – 0.8 (f) 630 (s)	1000	6
Light Yield (Photons/Mev)	40,000	2000	63,000	1800 (f), 10000 (s)	54,000	200
Wavelength (nm)	415	315	380	180 – 240 (f) 310 (s)	565	420
Density (g/cm^3)	3.67	4.51	5.29	4.88	4.5	8.3