Test of BC420 scintillator

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Outline

120cm Scintillator + SMD SiPM

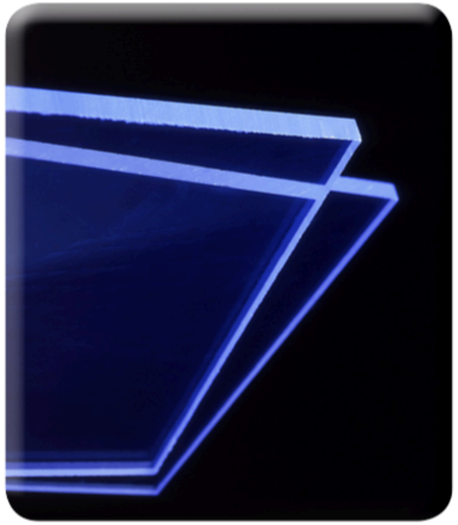
- Attenuation length
- Time resolution at different position

Technical attenuation length (TAL)

Scintillator from SAINT-GOBAIN: BC420

3.2cm x 5cm x 120cm

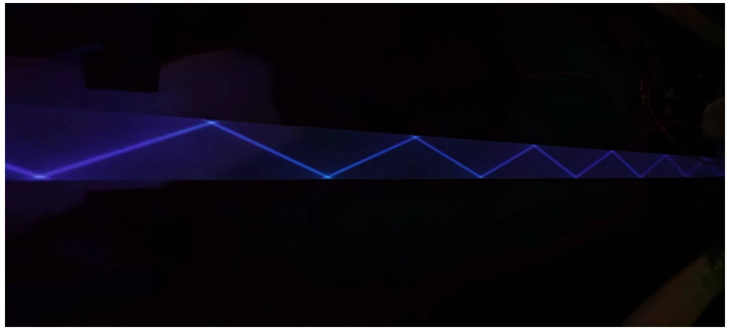
TAL depends on:
- Bulk transmission of the scintillator
- Geometry of scintillator
- Reflective property of the surfaces



	BC-418	BC-420	BC-422
Scintillation Properties			
Light Output, %Anthracene	67	64	55
Rise Time, ns	0.5	0.5	0.35
Decay Time (ns)	1.4	1.5	1.6
Pulse Width, FWHM, ns	1.2	1.3	1.3
Wavelength of Max. Emission, nm	391	391	370
Light Attenuation Length, cm*	NA**	140	NA**
Bulk Light Attenuation Length, cm	100	110	8
Atomic Composition			
No. H Atoms per cc ($x10^{22}$)	5.21	5.21	5.19
No. C Atoms per cc ($x10^{22}$)	4.74	4.74	4.71
Ratio H:C Atoms	1.100	1.100	1.102
No. of Electrons per cc ($x10^{23}$)	3.37	3.37	3.34

*The typical 1/e attenuation length of a 1x20x200cm cast sheet with edges polished as measured with a bialkali photomultiplier tube coupled to one end.

** Scintillator recommended for use in small sizes; therefore, the 1/e attenuation length values are not applicable.



$$N = N_1 \exp(-x/L_1) + N_2 \exp(-x/L_2)$$

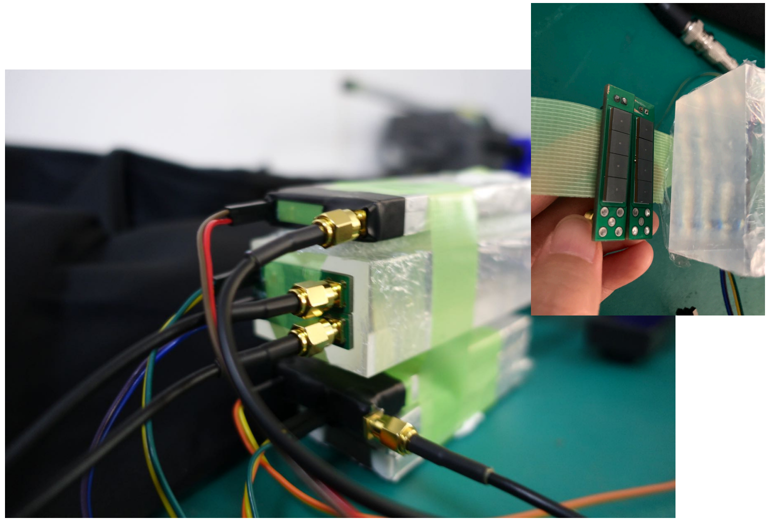
L1: TAL
X: distance
N: number of photons

Linear

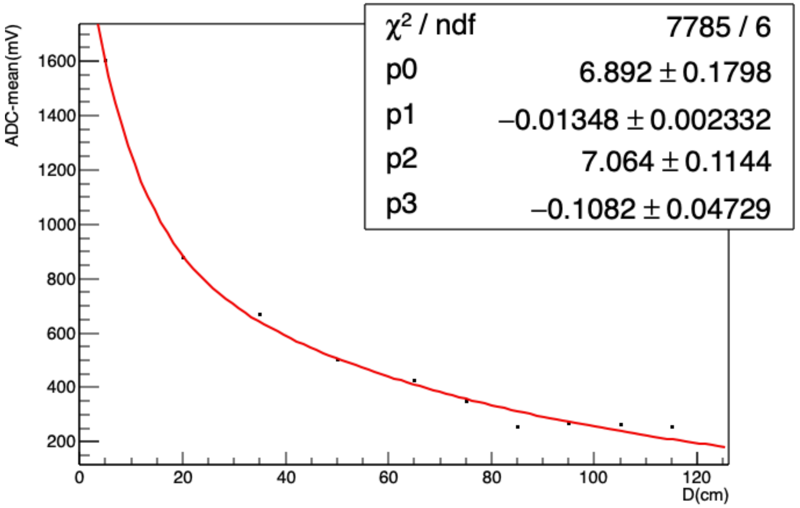
ADC mean

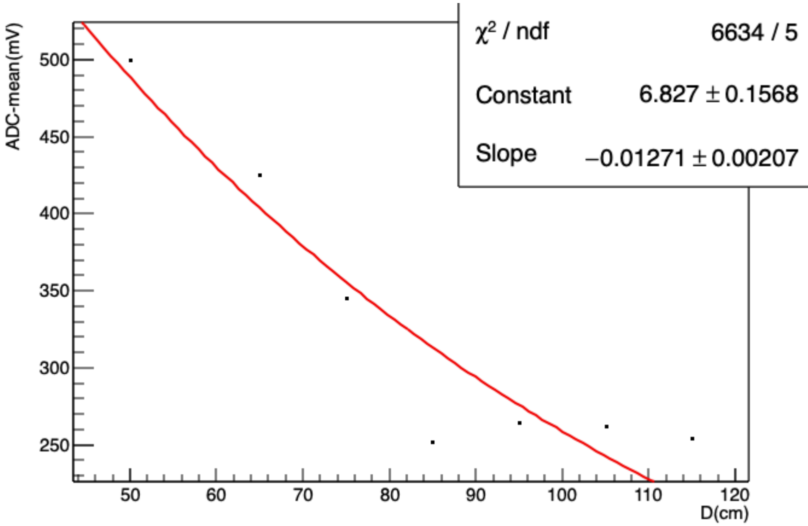
Technical attenuation length (TAL)

Result of TAL measurement



MEAN of ADC2+ADC3





L1: 74.2cm
L2: 9.2cm

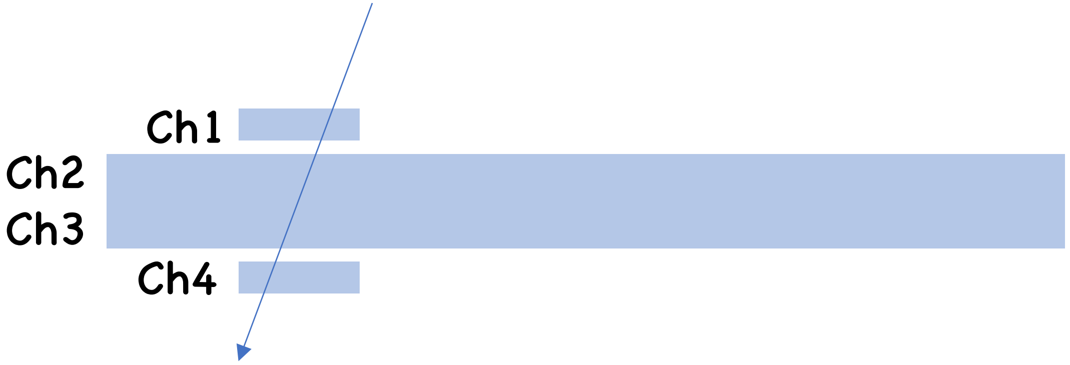
$N=N_0 exp(-x/L_1)$
L1=78.6cm

Ch1、ch4: 10cm trigger
Ch2、ch3: 4SiPMs in paranal as readout
Cosmic ray test
TH: ADC1&ADC4>100mV

Less than 110cm from specification
Unstable coupling between SiPM and scintillator
Only 300 events of each position

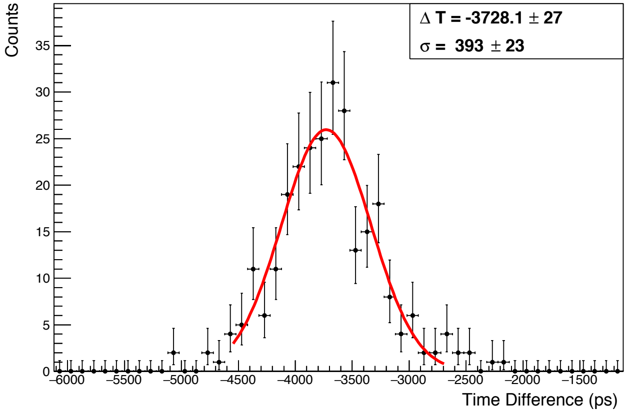
Time resolution

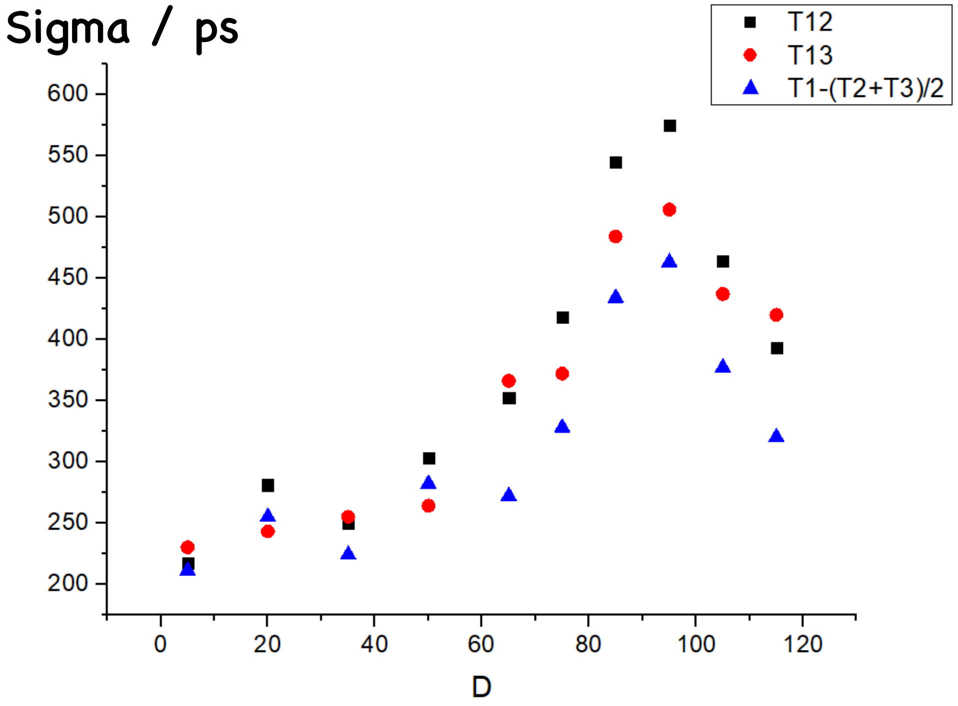
Result of time resolution measurement



Gaus fit

Time difference of two channel ⇨ Time resolution

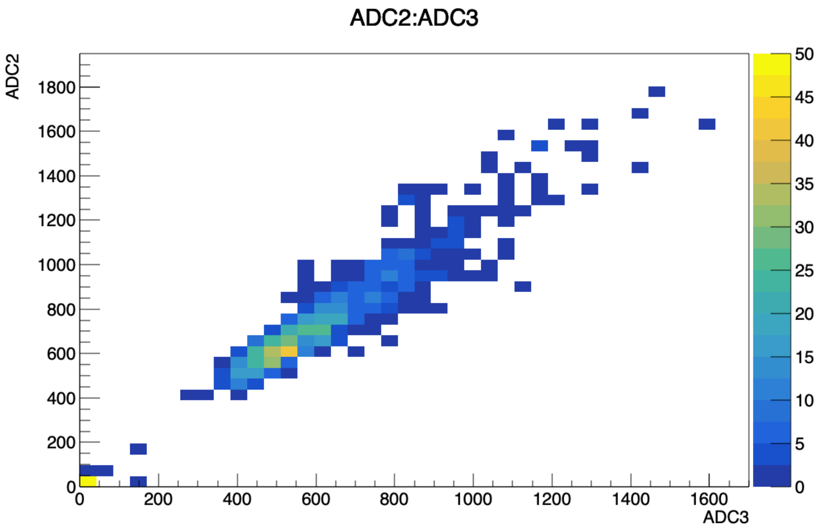


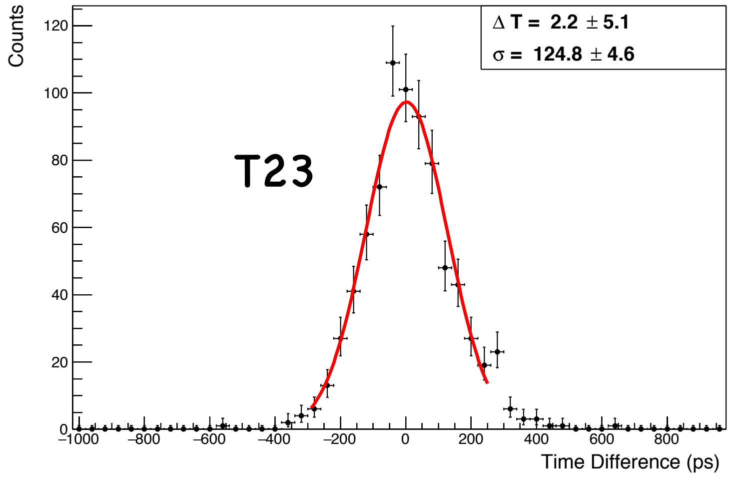


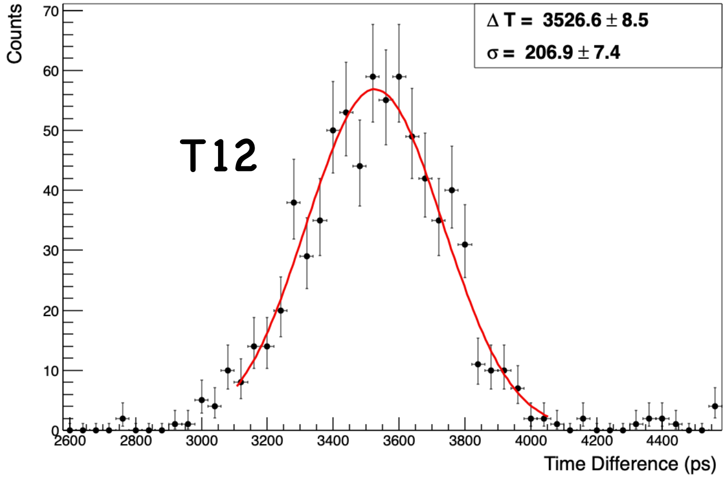
- ✓ Near end has good time resolution of ~130ps
- ✓ Time resolution became worse as distance increase
- ✓ More photon collection helps to improve time resolution

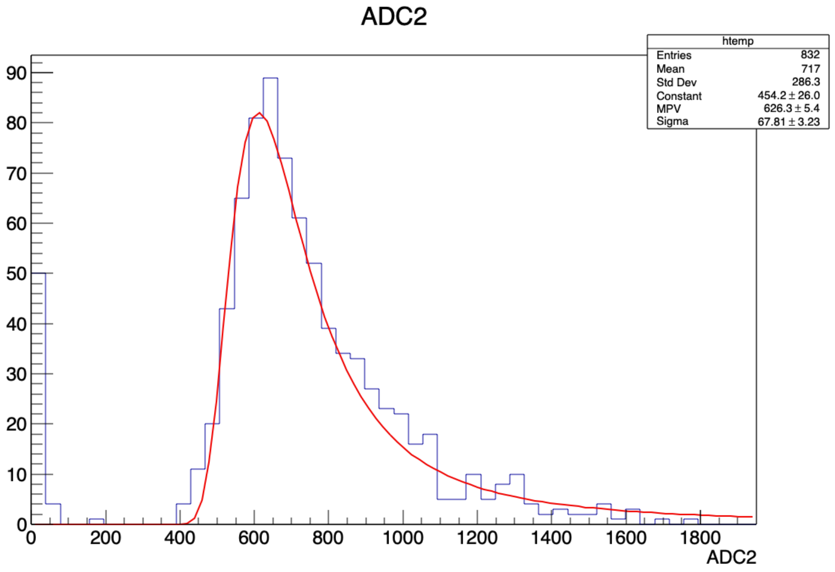
Time resolution

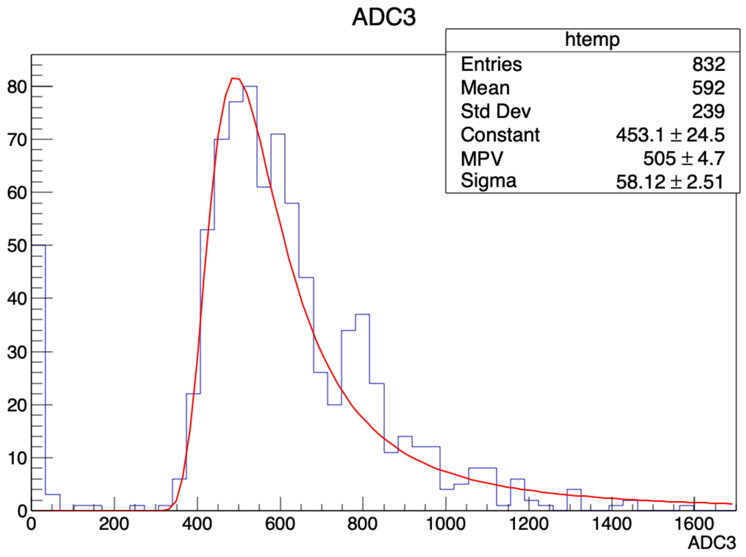
D: 5cm near end   With more events   Time difference between two channel

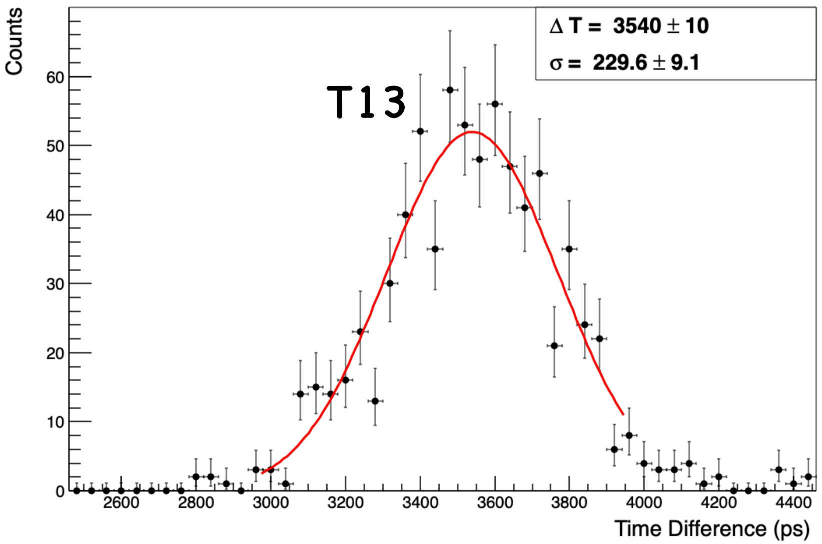






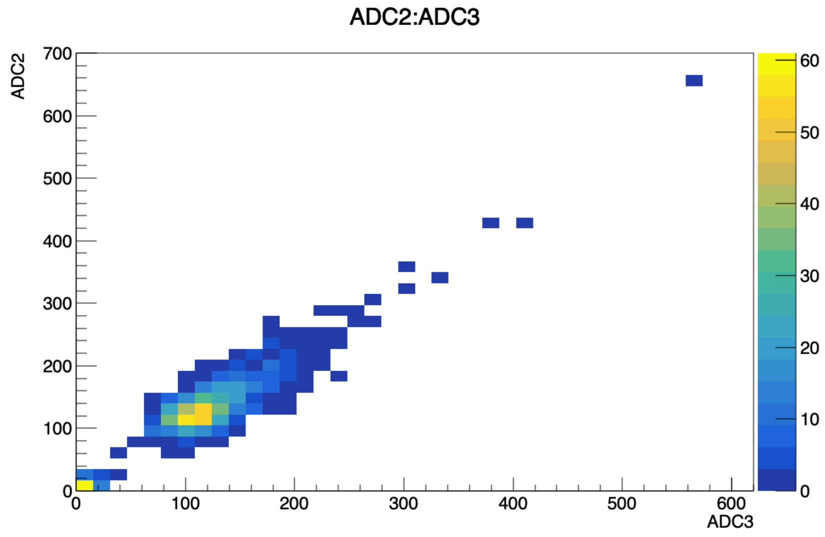


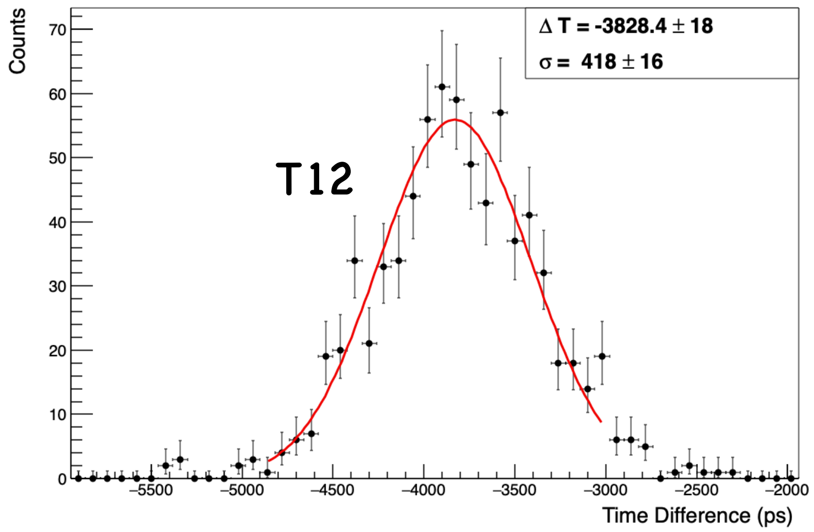


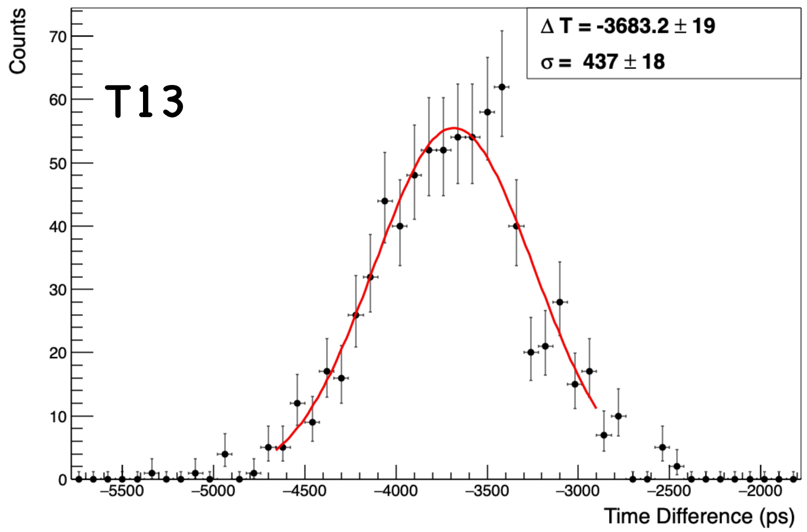


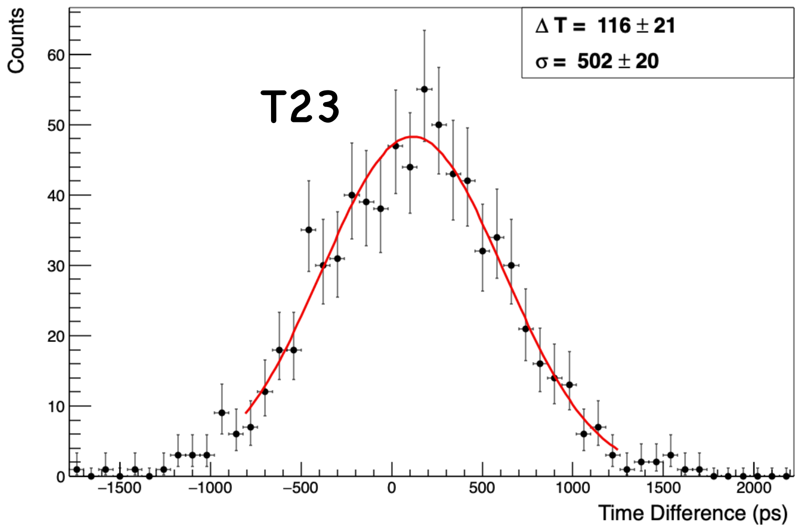
Time resolution

D: 115cm far end

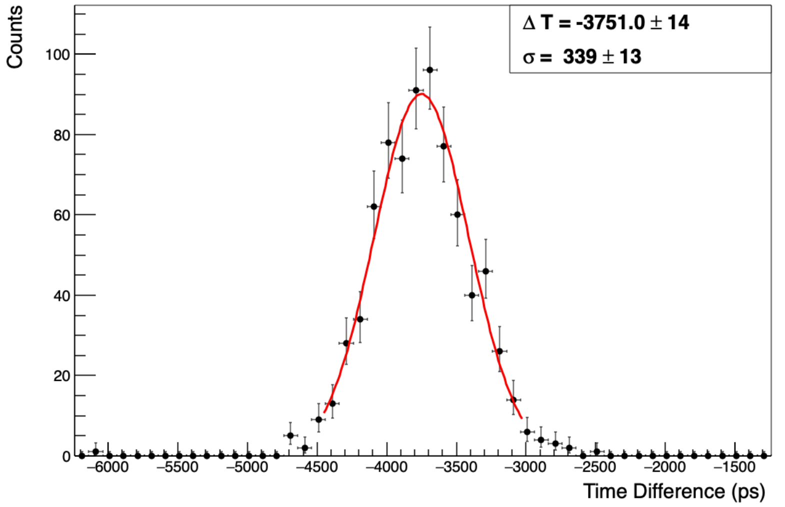






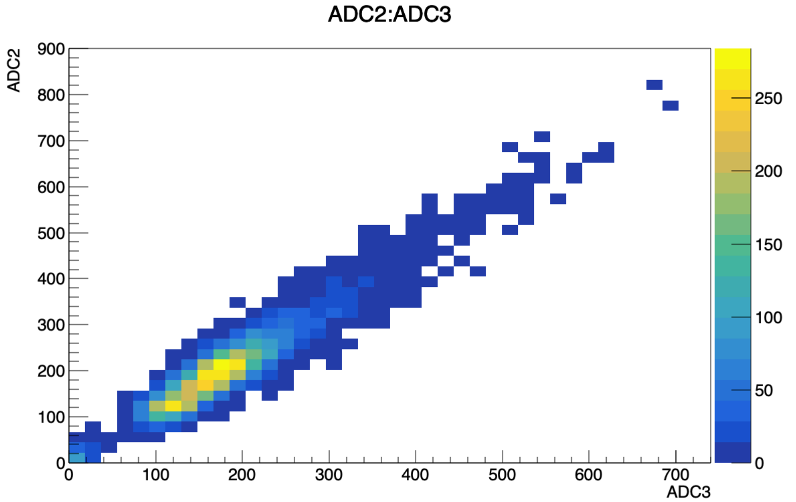


T1-average(T2、T3)

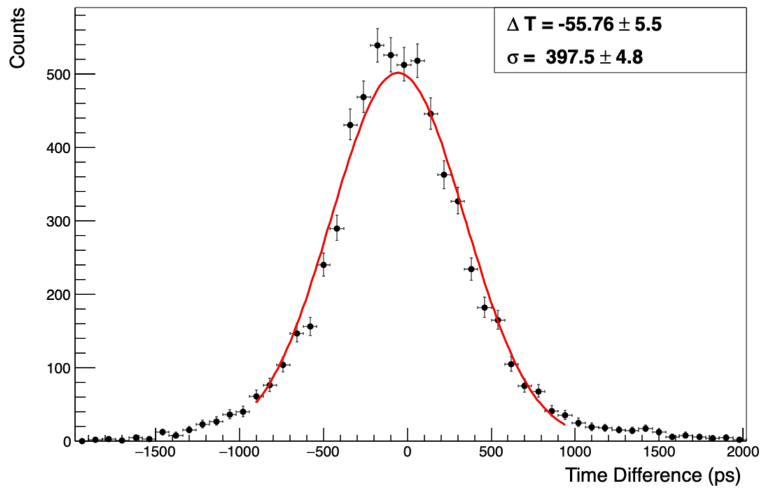


Time resolution

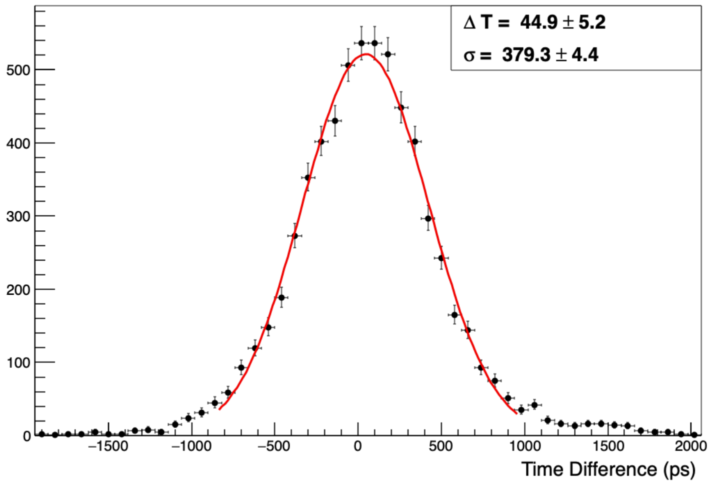
D: 60cm middle



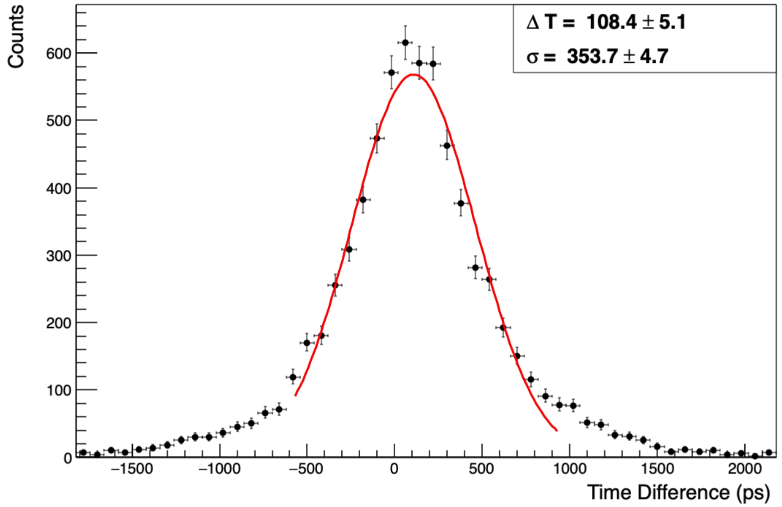
T12



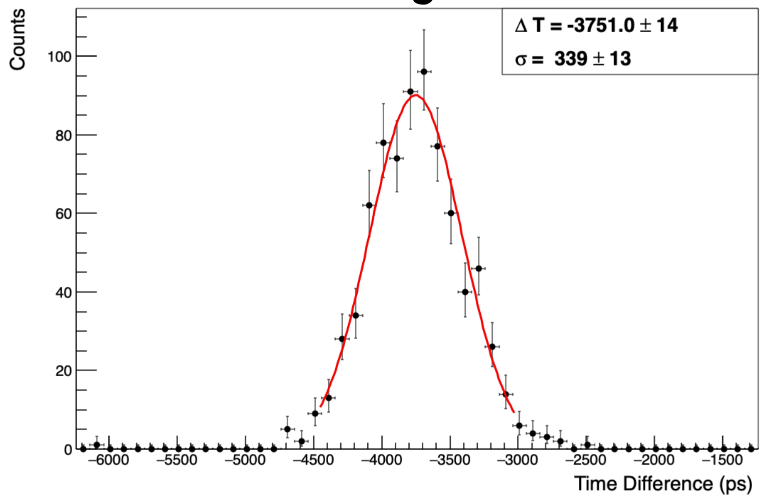
T13

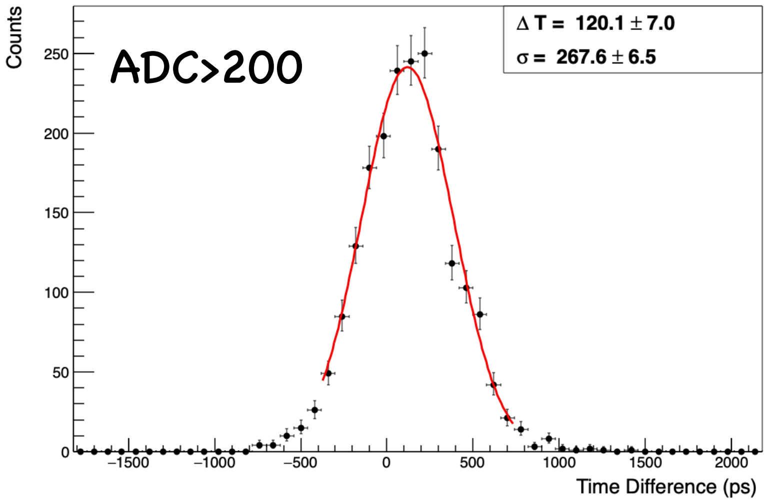


T23



T1-average(T2、T3)





Summary

- Time resolution of about 140 ps has been obtained at near end.
- Time resolution became worse as distance increase
- More photon collection helps to improve time resolution

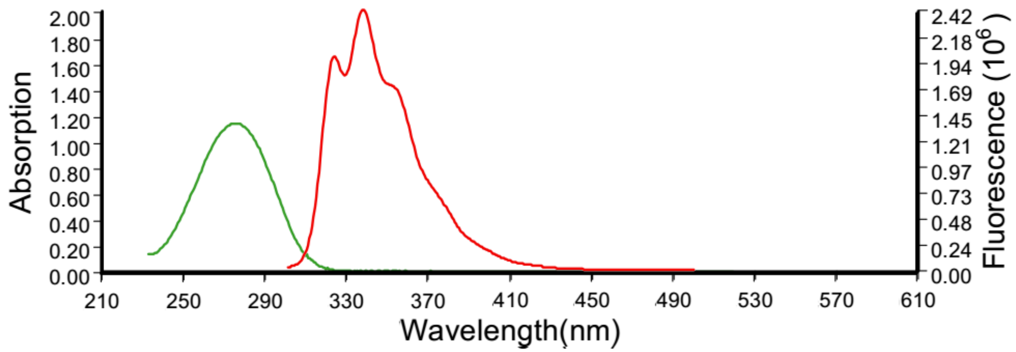
- Plans:
  - Design stable coupling
  - Set up of dark box
  - Test for more accurate TAL
  - Test with 2 SiPMs at two ends

Thank you!

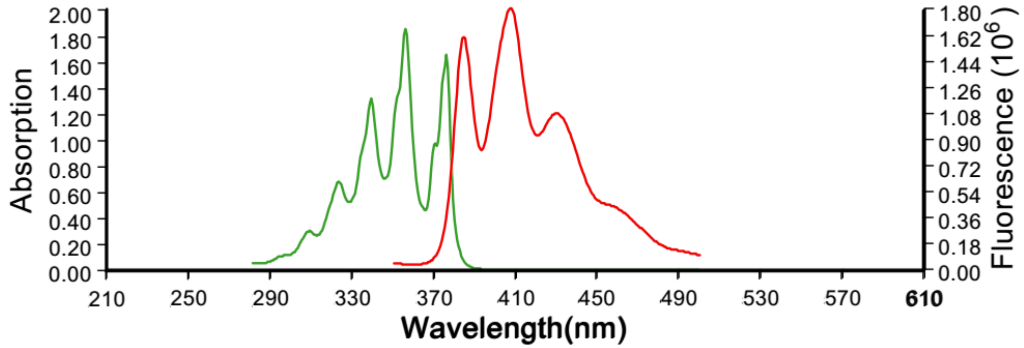
Back up

Back up

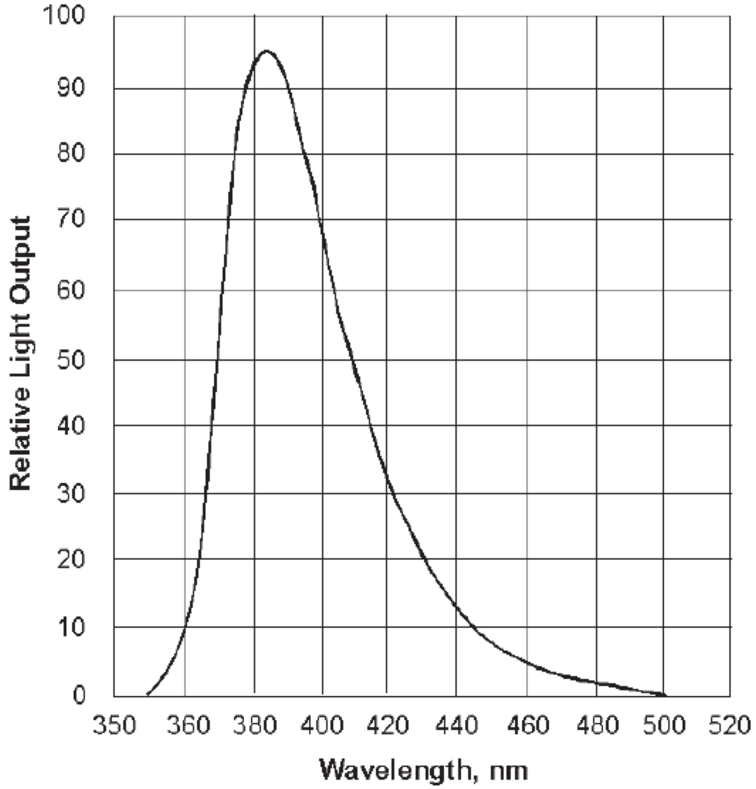
p-Terphenyl



POPOP

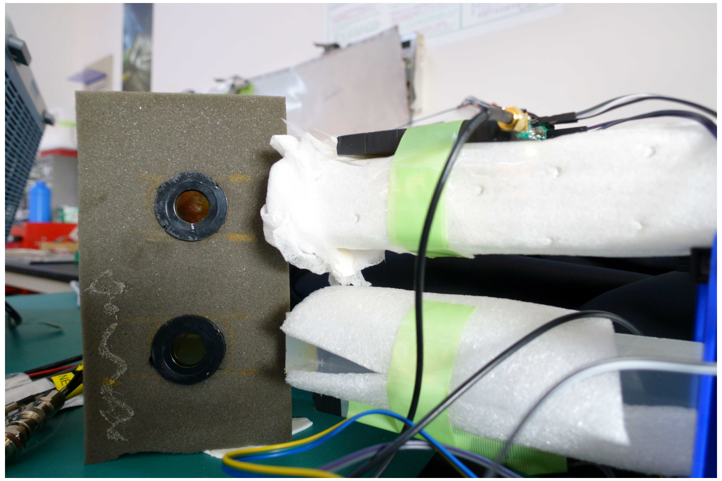


Emission Spectra
BC-420



Absorption (green) and emission (red) spectra of two fluorescent substances commonly used in plastic scintillators

Testing with two long Santi-Gobain scintillators



Two long strips from IHEP with excellent time resolution:

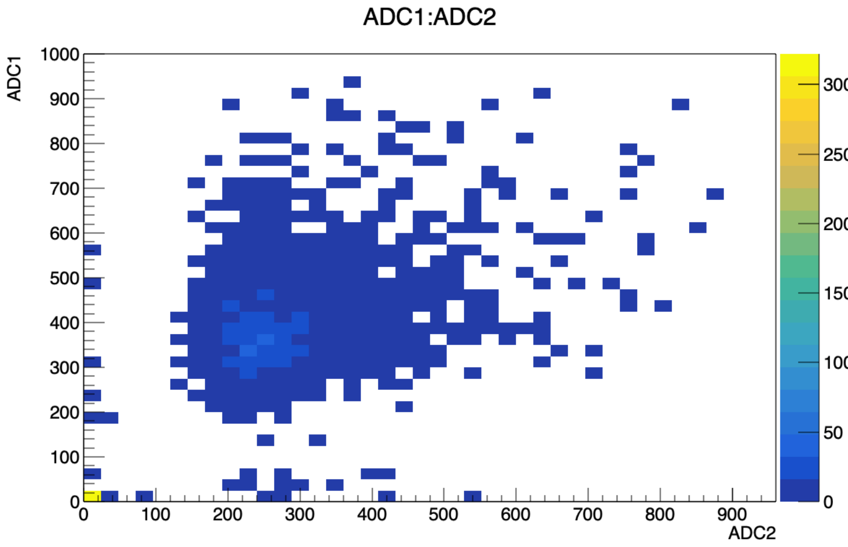
$3cm \times 5cm \times 1m$

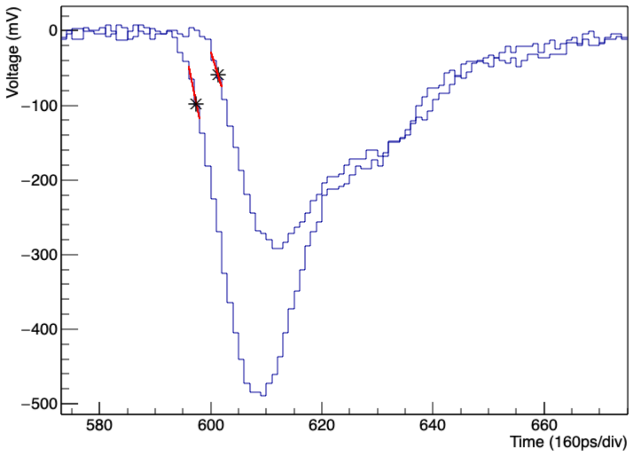
Two MCP-PMT

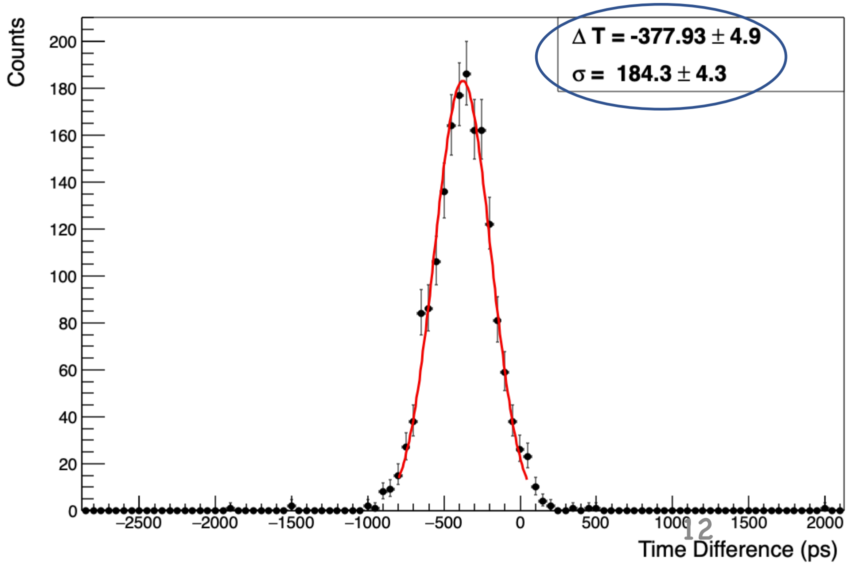
Trigger strips at near end:

$4cm \times 1cm \times 10cm$

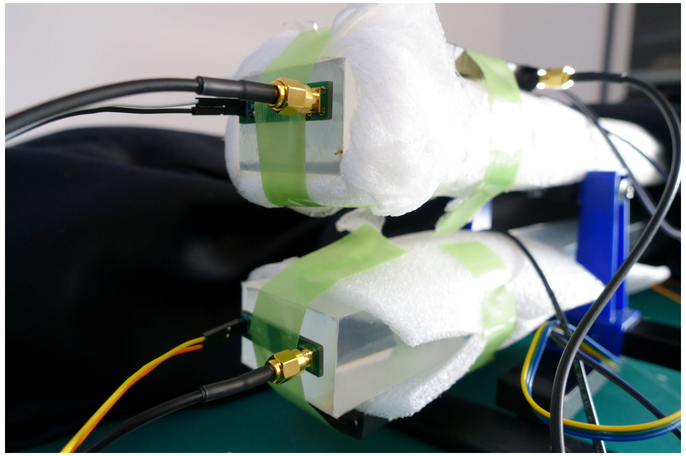
Time resolution: $< 130ps$

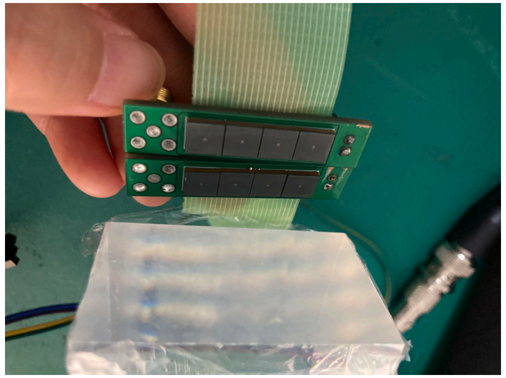


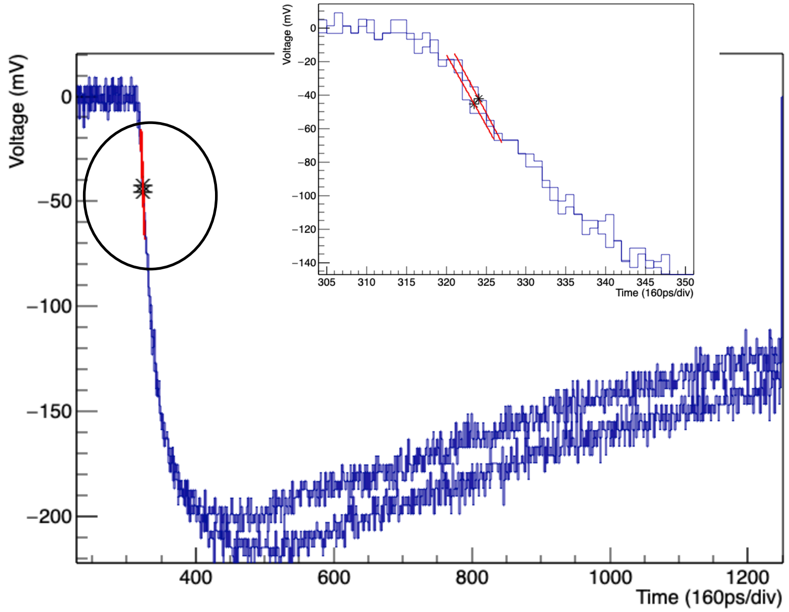




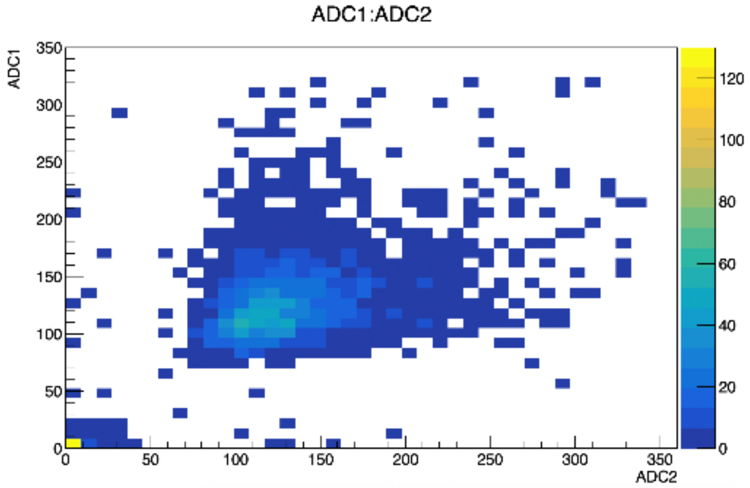
Santi-Gobain scintillators and SiPMs

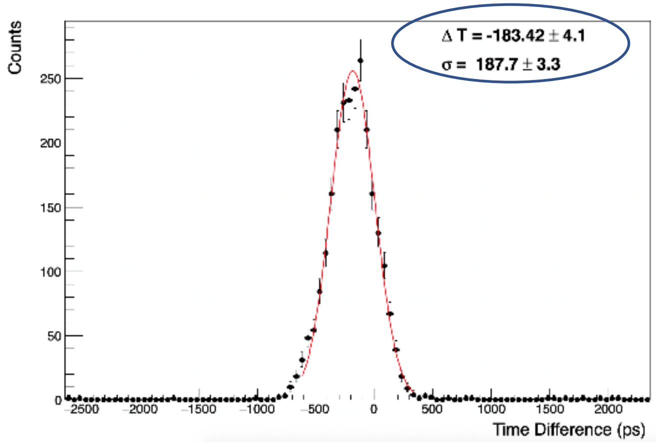






A combination of 4 pieces of $6mm \times 6mm$ SiPMs as the photon sensor.





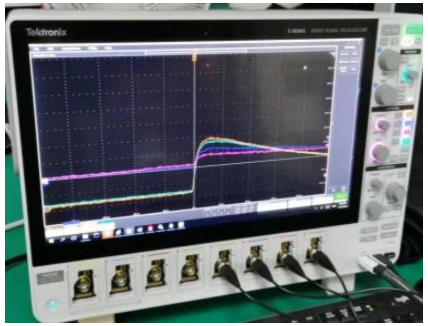
ADC>30

Almost a same performance as MCP-PMT for timing!!!

Time resolution

ch1、ch4

Ch2、ch3

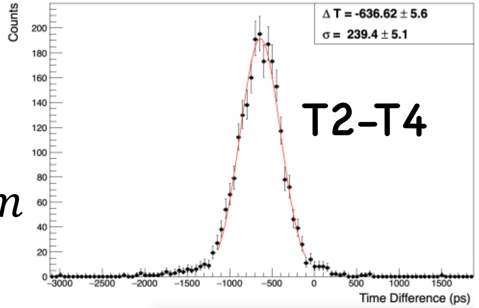


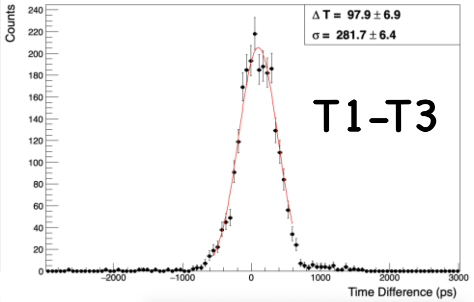
Time resolution:

T2,T3: 132.0 ± 3.3ps
T1,T2: 127.2 ± 2.7ps
T3,T4: 119.5 ± 2.0ps
T1,T3: 199.2 ± 4.5ps
T2,T4: 169.3 ± 3.6ps
T1,T4: 222.1 ± 4.4ps

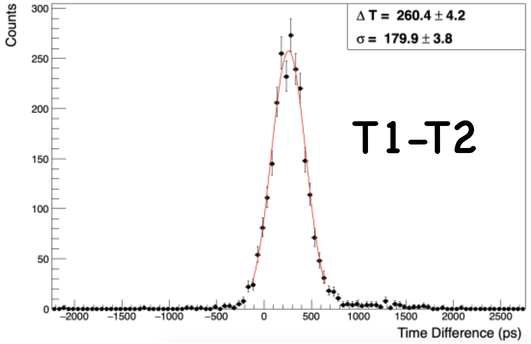
top to bottom ：1， 2， 3， 4

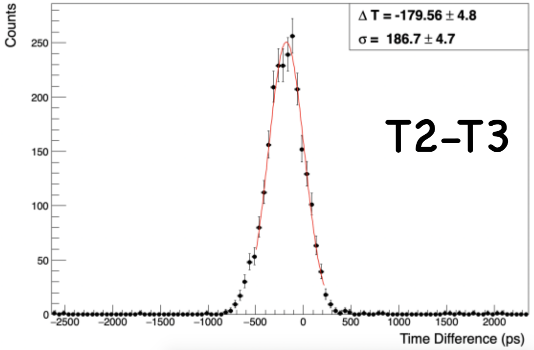
T2 and T3 with distance of $\sim 4cm$
T1 and T4 with distance of $\sim 10cm$

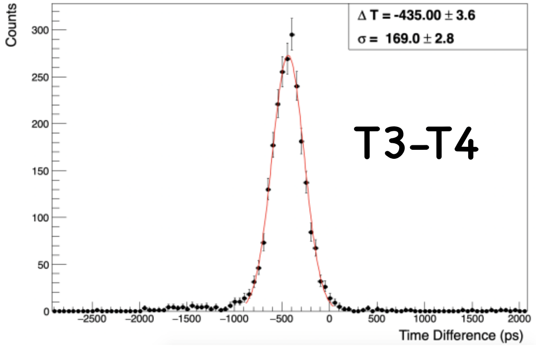


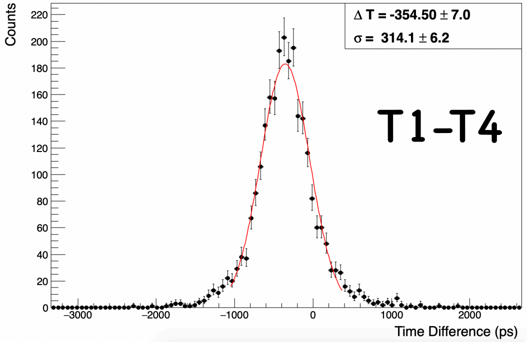


- Increase of time resolution is due to the velocity of CR.
- Velocity of CR should be taken into account.



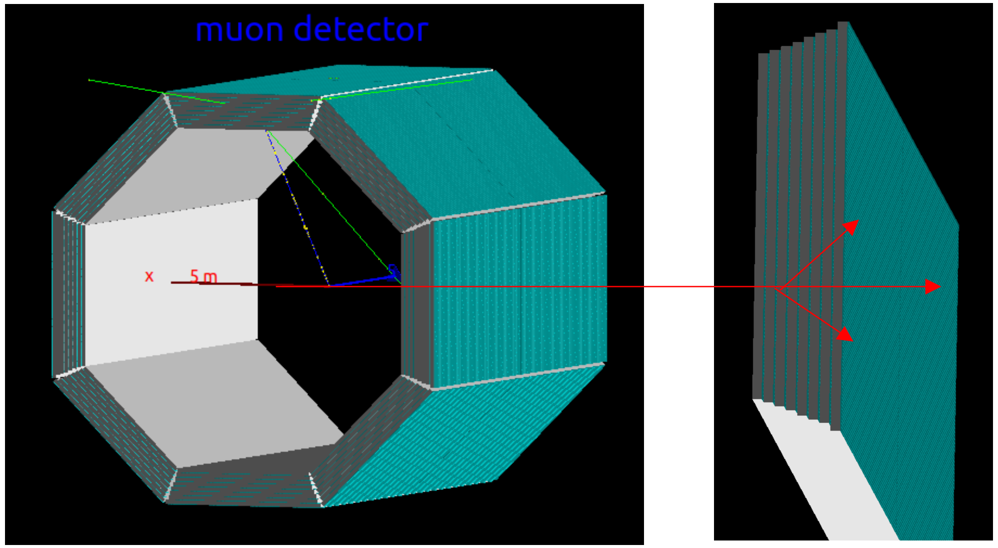


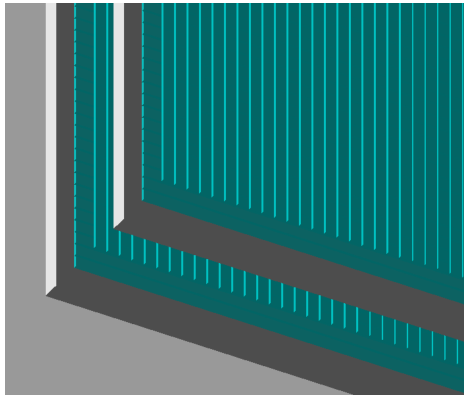




How about implementing timing?

- Two options of scintillator detector:
  - A. Cheap scintillator+WLS fibre+small SiPM, low cost for large size
  - B. Excellent scintillator+large SiPMs, reasonable cost with good timing
- We can combine them for LLP search, to extend the study area of CEPC
  - One sector far away from IP,
  - Measure the tracks with good spatial resolution,
  - Measure the TOF of tracks (and charge?) for velocity (and dEdx?).
  - The distance between layers can be tuned.





LLP decay

MATHUSLA

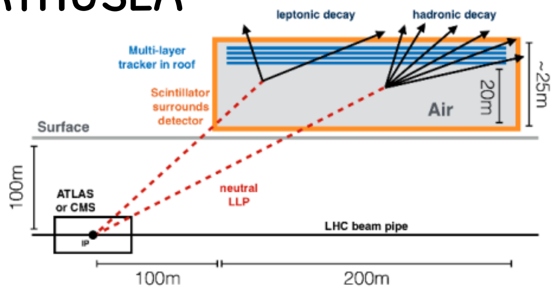


Fig. 1: Simplified detector layout showing the position of the 200 m × 200 m × 20 m LLP decay volume used for physics studies. The tracking planes in the roof detect charged particles, allowing for the reconstruction of displaced vertices in the air-filled decay volume. The scintillator surrounding the volume provides vetoing capability against charged particles entering the detector.