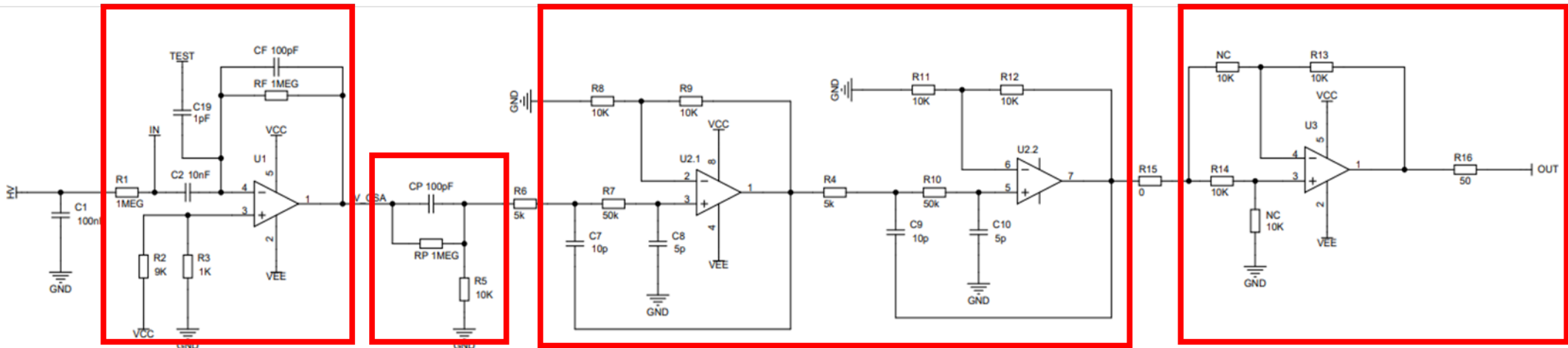
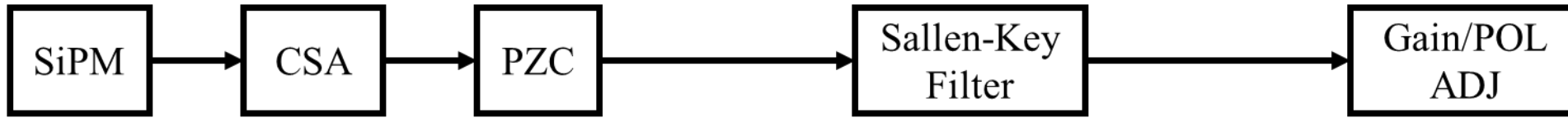


CEPC缪子探测器前端电子学 设计

邹世明

2024.9.2

前端电子学设计方案

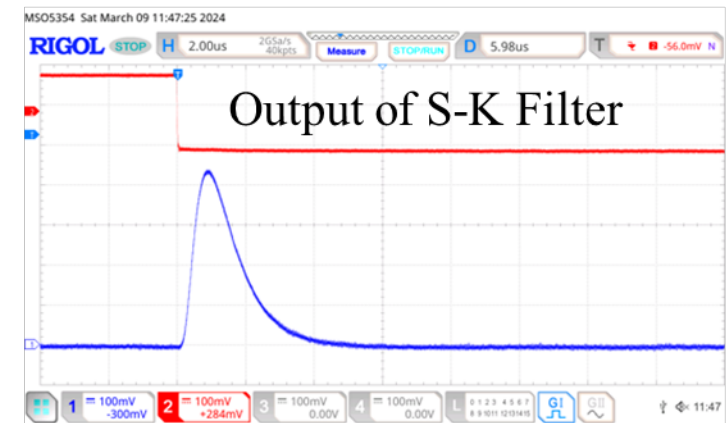
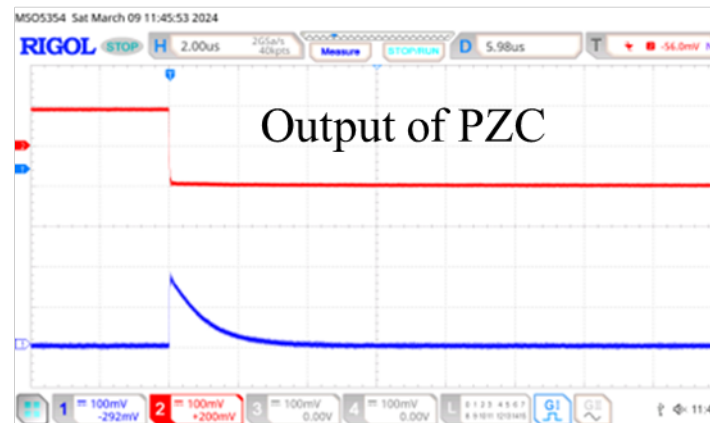
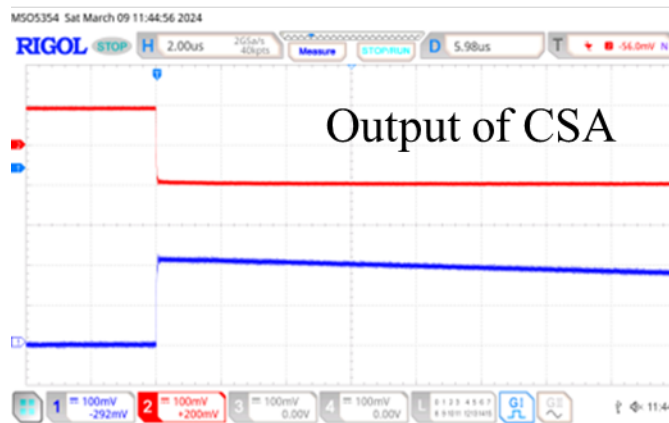


CSA

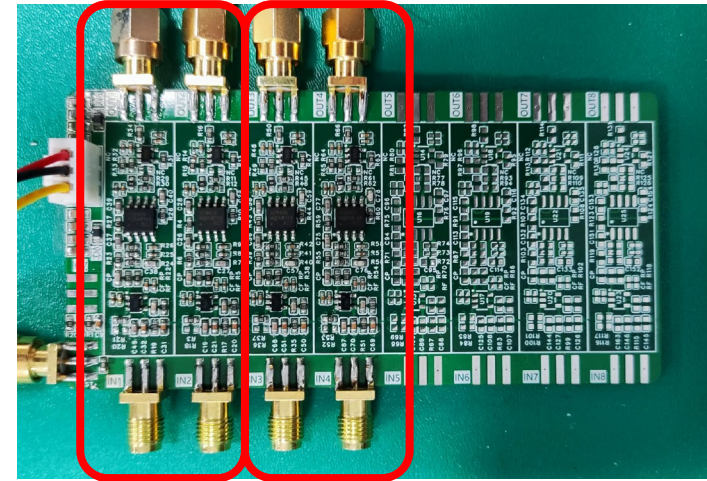
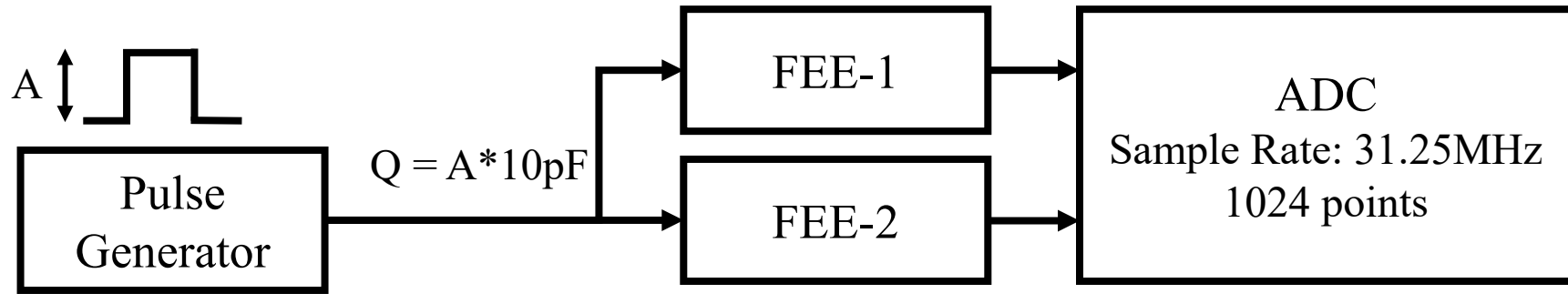
PZC

Sallen-Key Filter

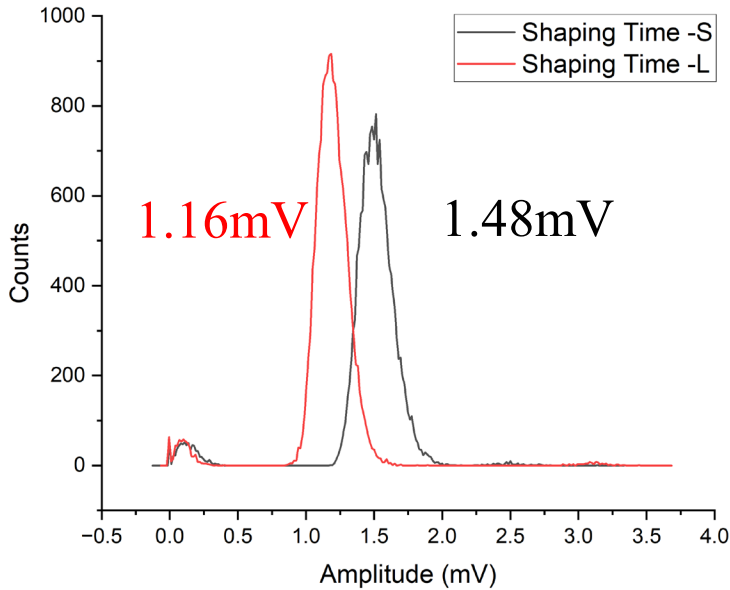
Gain/POL ADJ



不同成形时间的测试

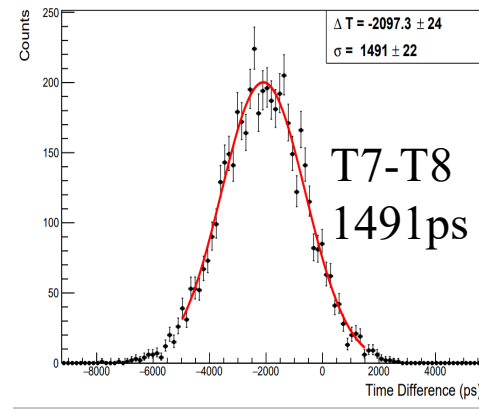
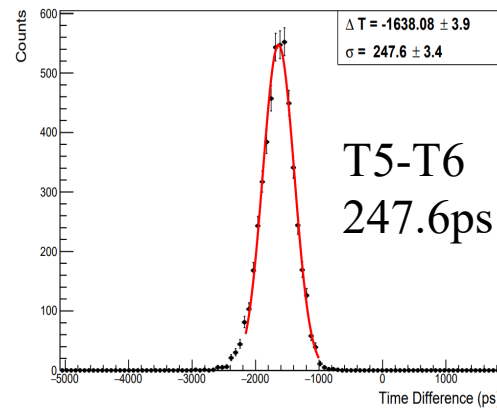


CH5/CH6 Shaping time: 0.5us
CH7/CH8 Shaping time: 2.0us



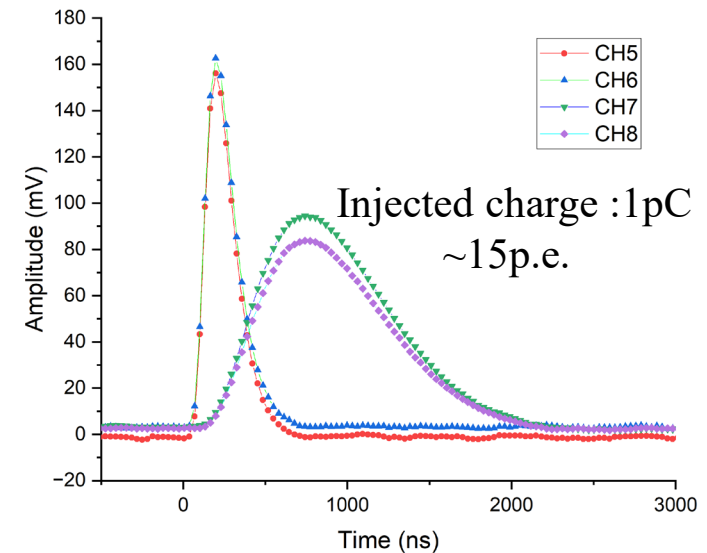
Noise Test (Peak-Peak)

Longer shaping time:
Lower noise, Slow rise time.

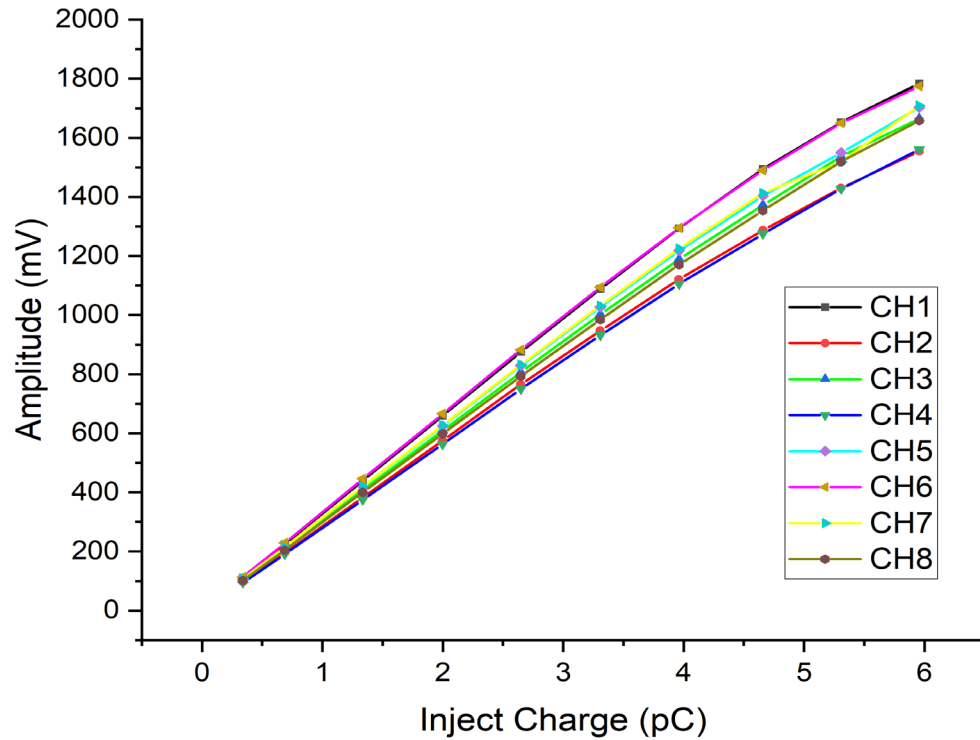


Time resolution Test

For low sampling rate of 31.25MHz:
Fast shaping time(0.5us), signal can only be sampled at 15~17 points, it can still achieve a time resolution of **200ps**, which is better than a slow shaping time.



线性范围测试



EQR15 11-3030D-S

Active Area: $3 \times 3 \text{ mm}^2$

Cell Number : $2500 / \text{mm}^2$

Gain: 4.0×10^5

Single Photon Charge: $1.6 \times 10^{-19} \times 4.0 \times 10^5 = 0.064 \text{ pC}$

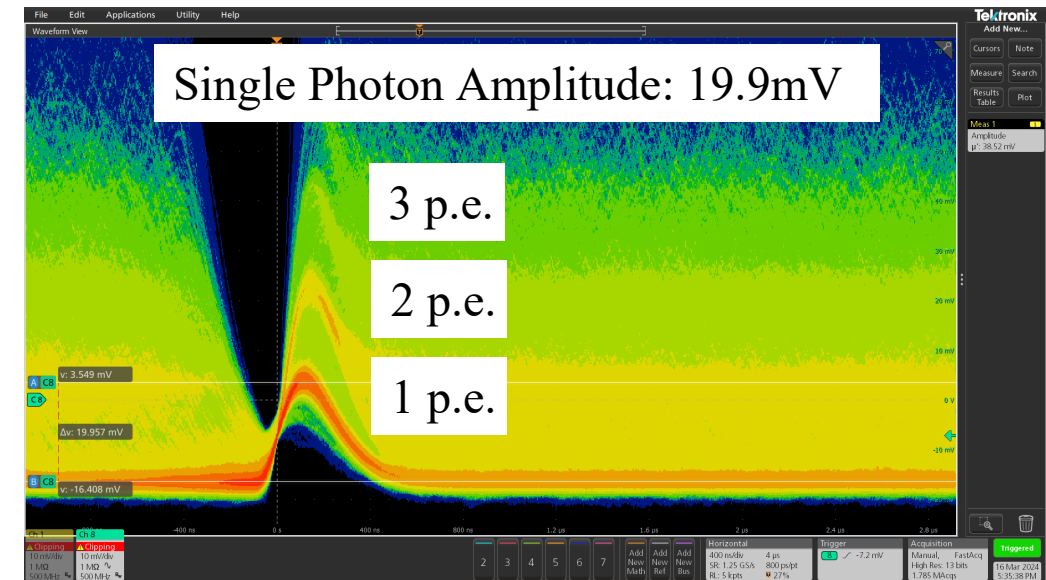


FEE Gain : $\sim 300 \text{ mV} / \text{pC}$

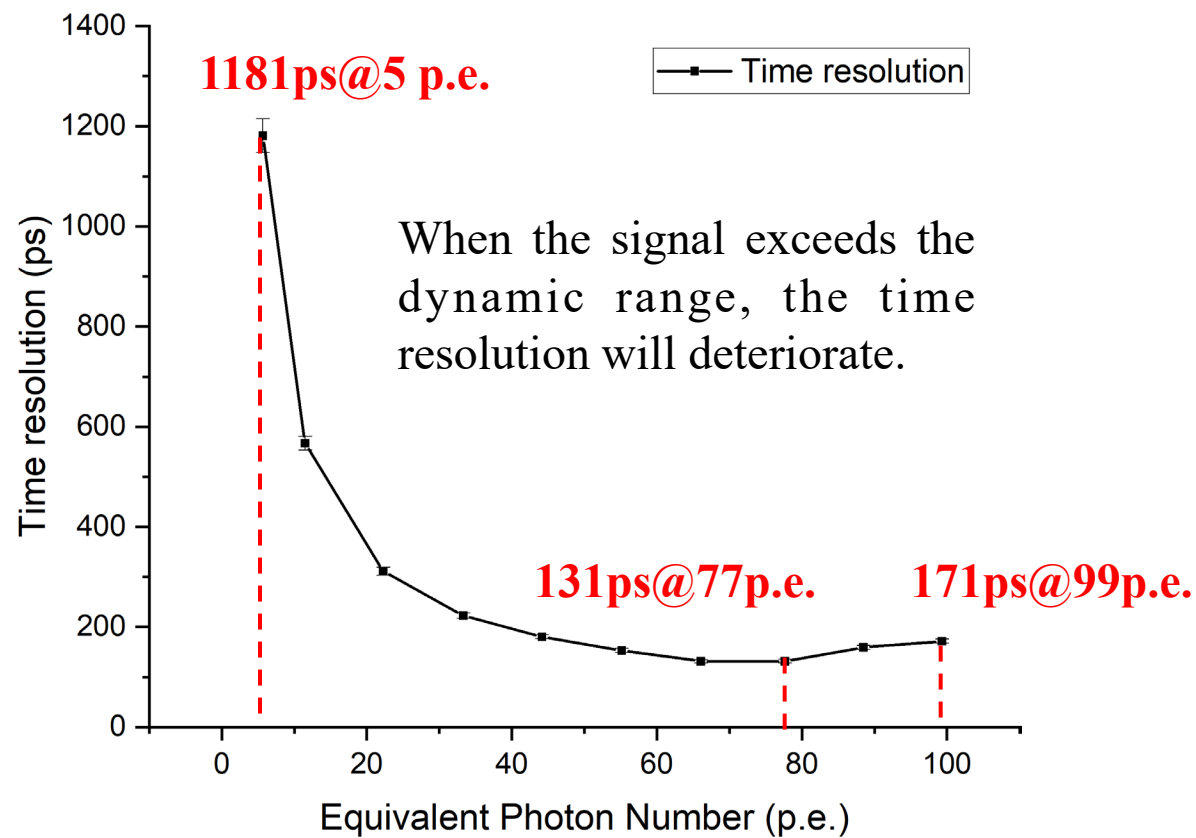
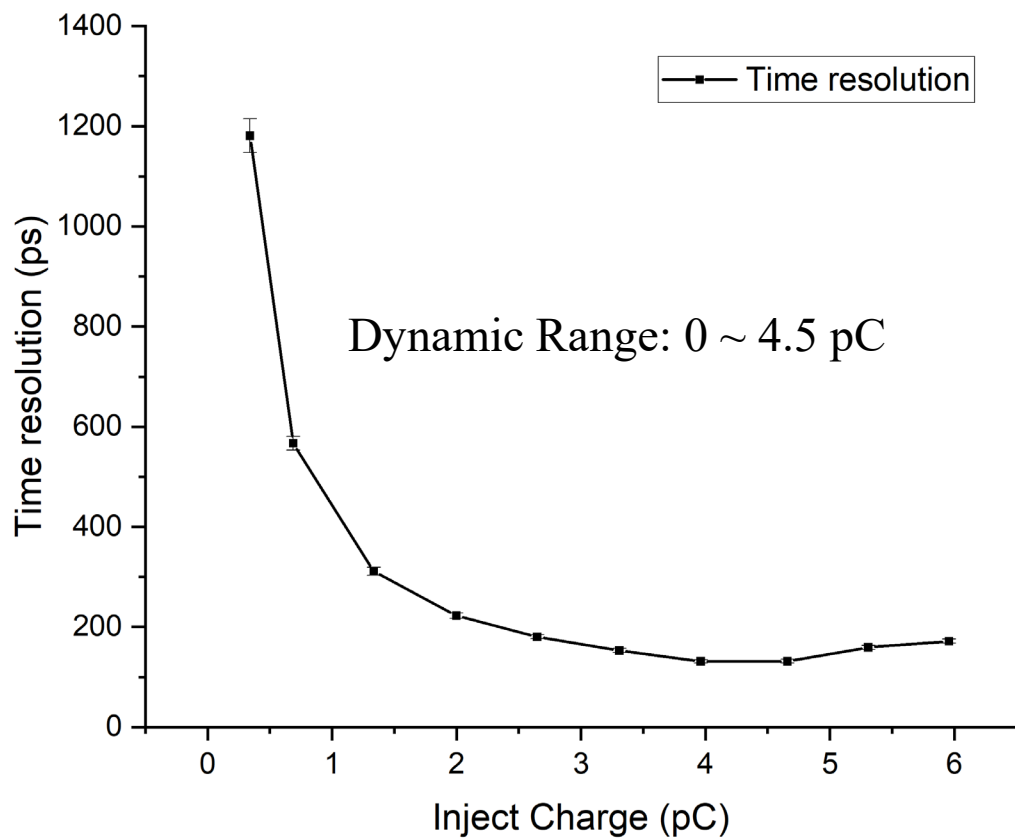
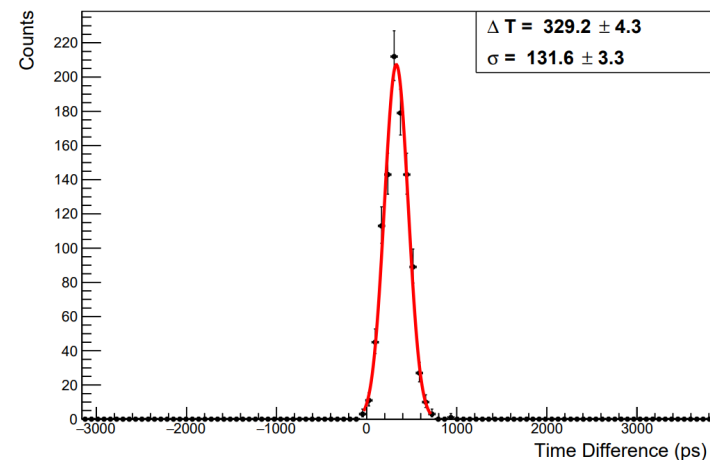
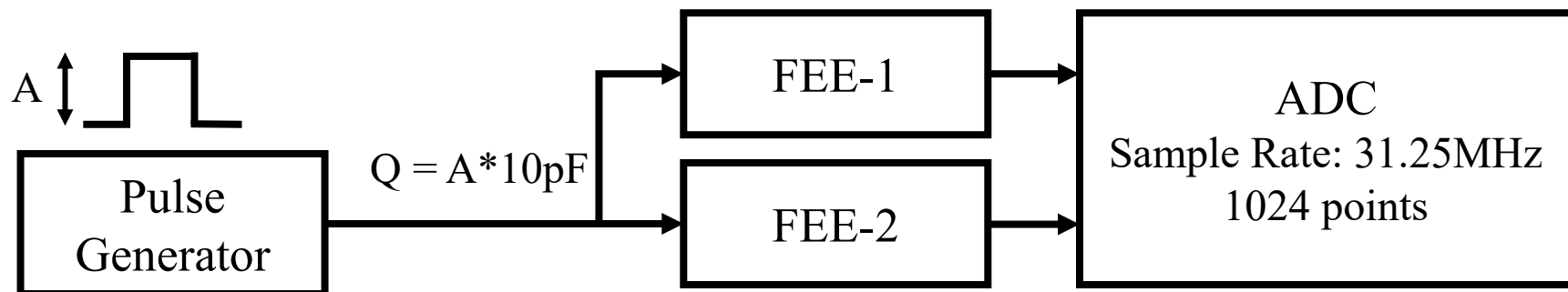
Dynamic Range: $0 \sim 4.5 \text{ pC}$ (70 p.e.)

Noise RMS: $\sim 1 \text{ mV}$ (0.05 p.e.)

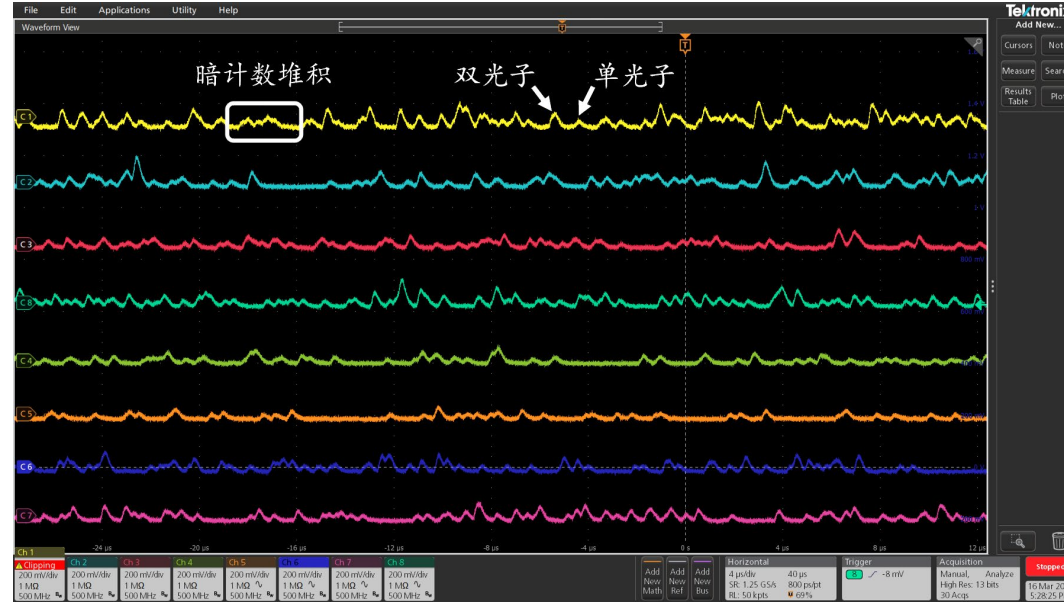
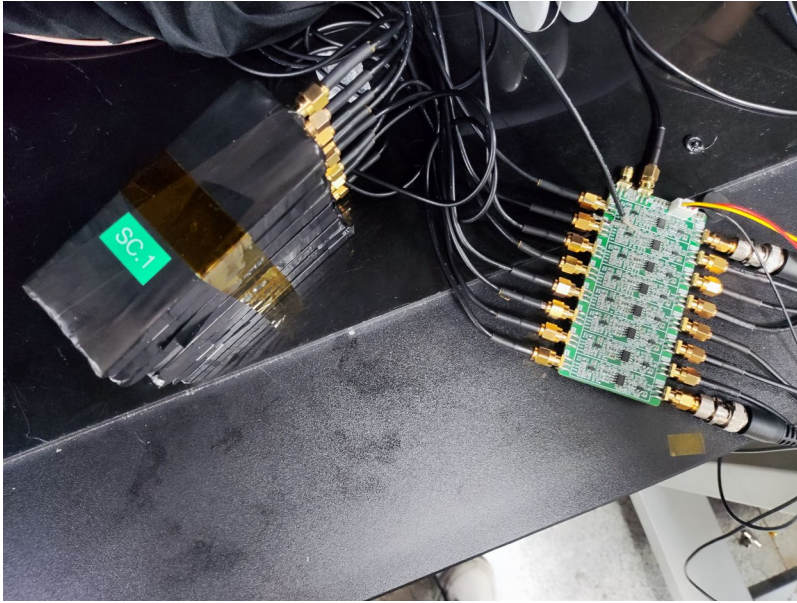
Rise Time : $\sim 50 \text{ ns}$



时间分辨测试

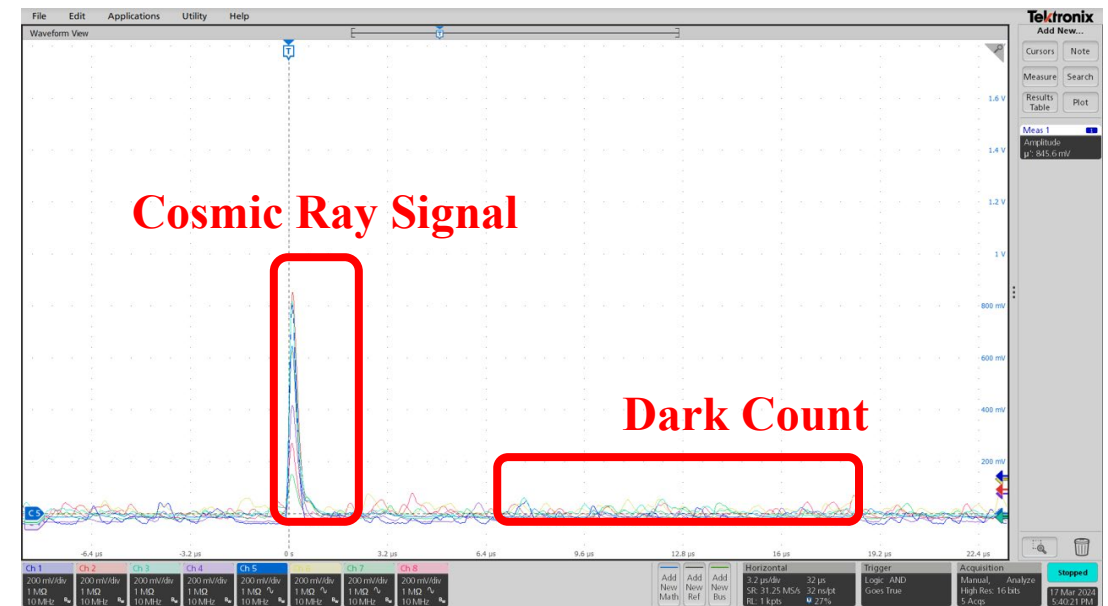
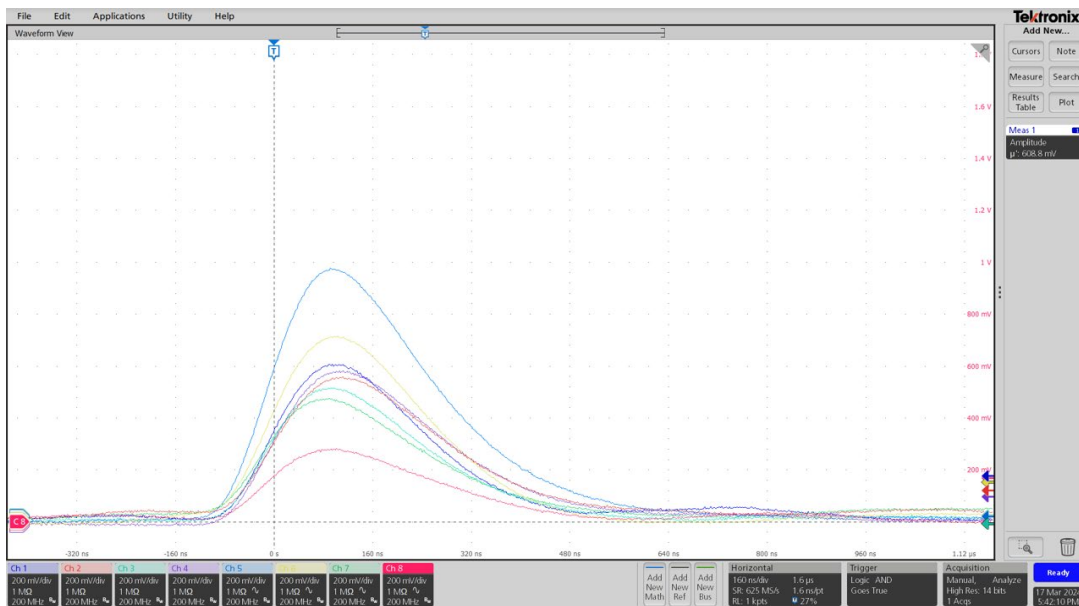


宇宙线测试



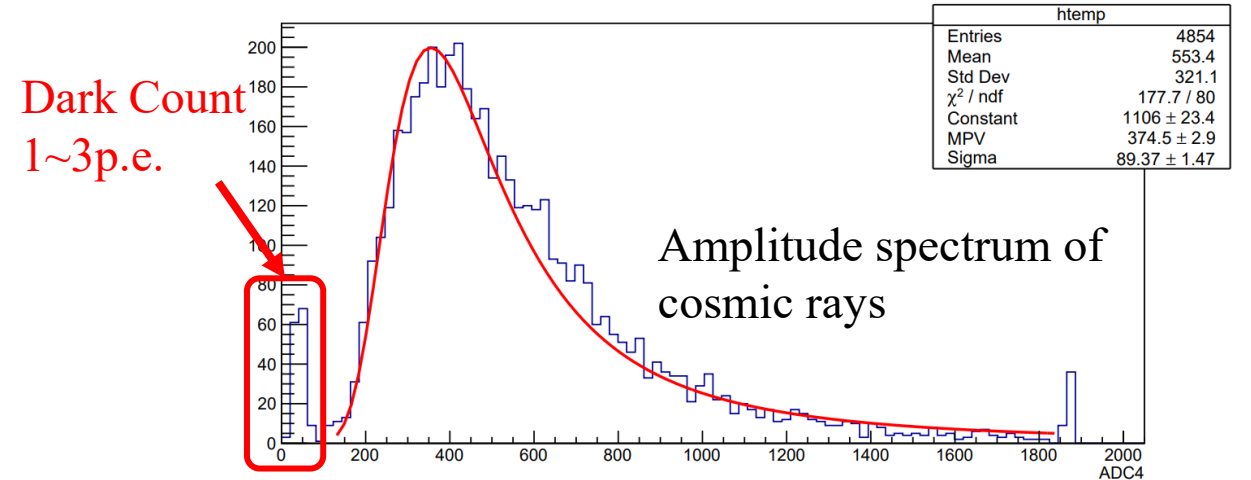
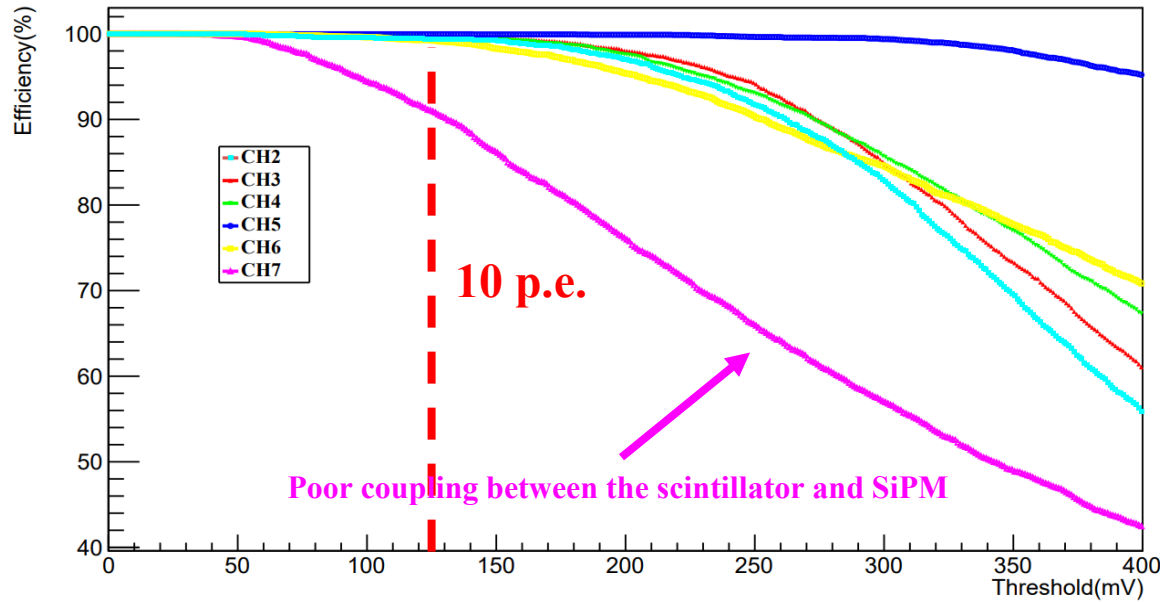
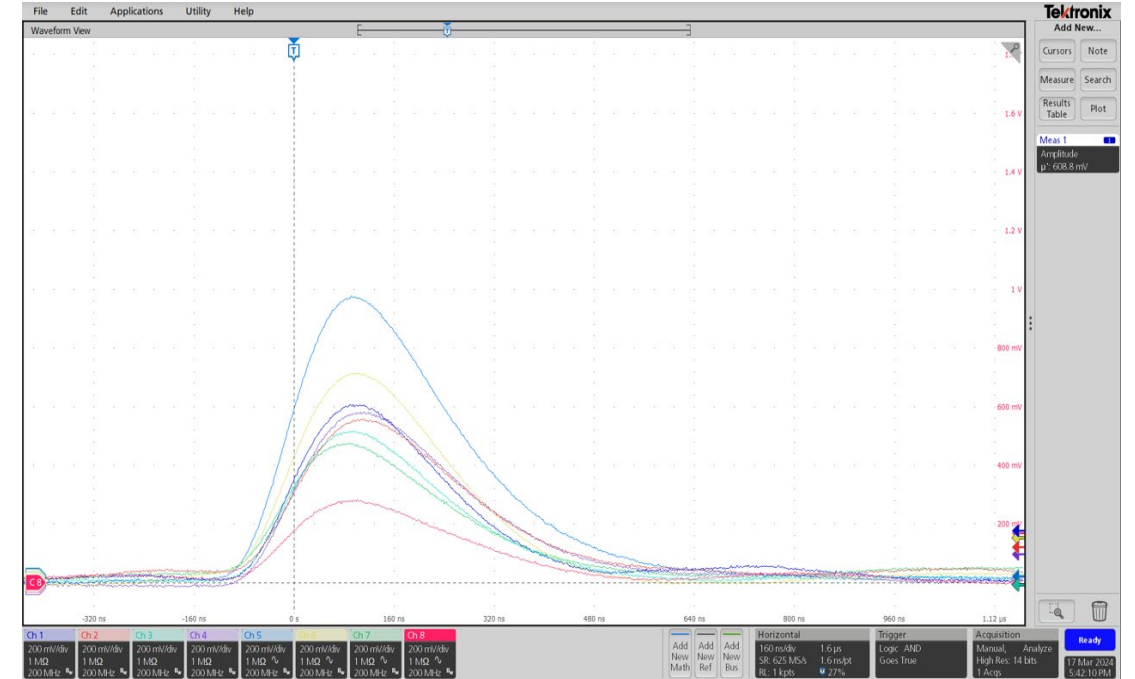
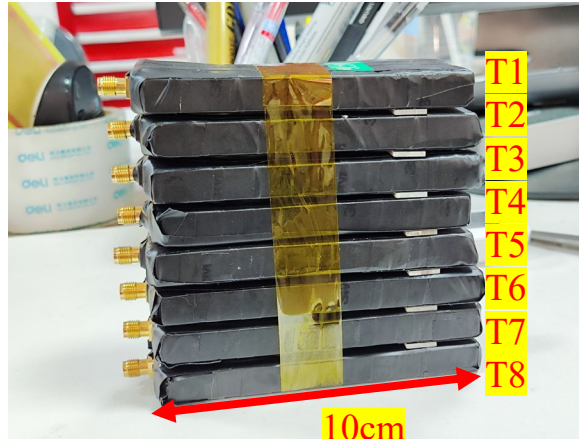
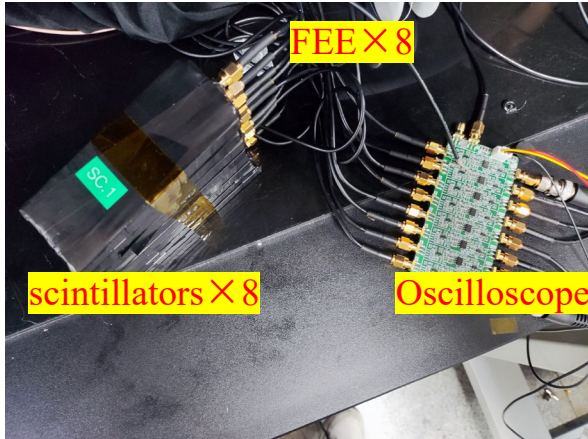
Dark Count: 2.25 MHz
cross-talk: ~20%

High dark count rates resulting in time jitter will significantly reduce time resolution.

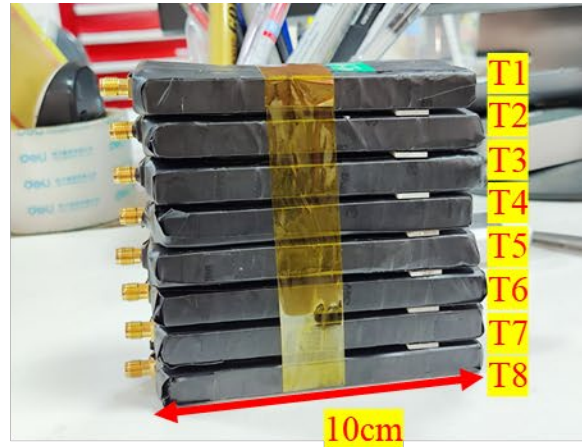
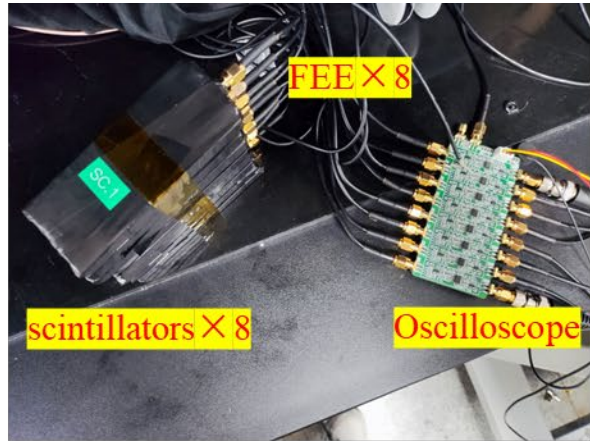


宇宙线测试-探测效率

Trigger: Coincidence between CH1 and CH8



宇宙线测试-时间分辨



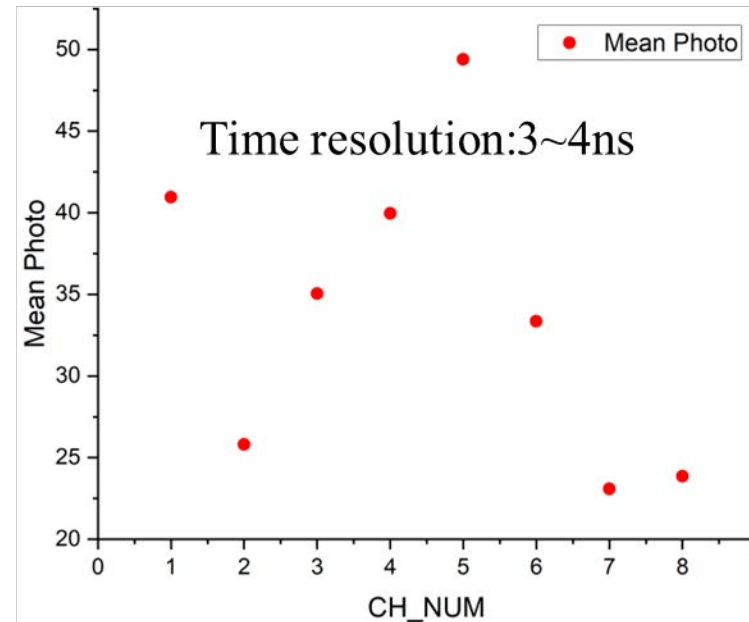
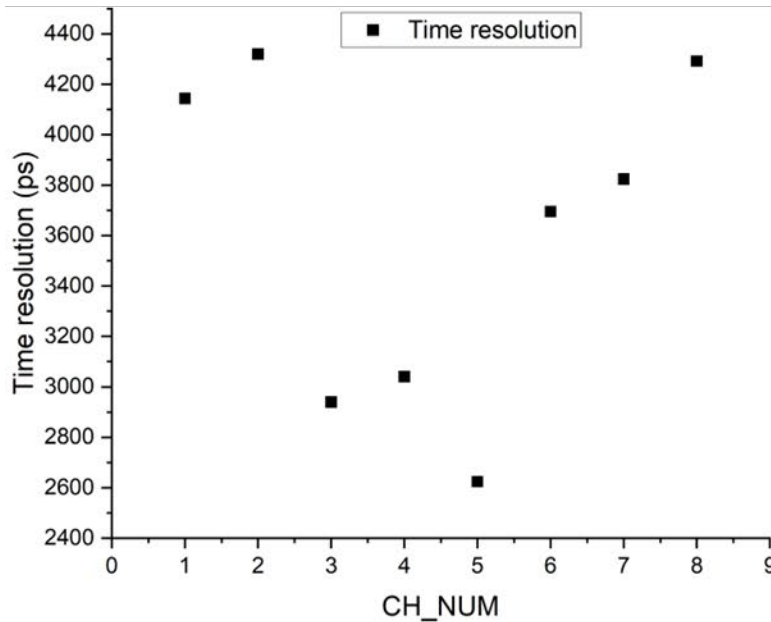
$$T1-T3 \rightarrow \sigma_{T1-T3}$$



$$T_0 = (T1+T3) / 2 \quad \sigma_{T0} = \sigma_{T1-T3} / 2$$



$$T_{0-2} = T_0 - T_2 \quad \sigma_{T0-2} = \sqrt{\sigma_{T0}^2 + \sigma_{T2}^2}$$



Collecting more photons corresponds to better time resolution.

Average time for N scintillators:

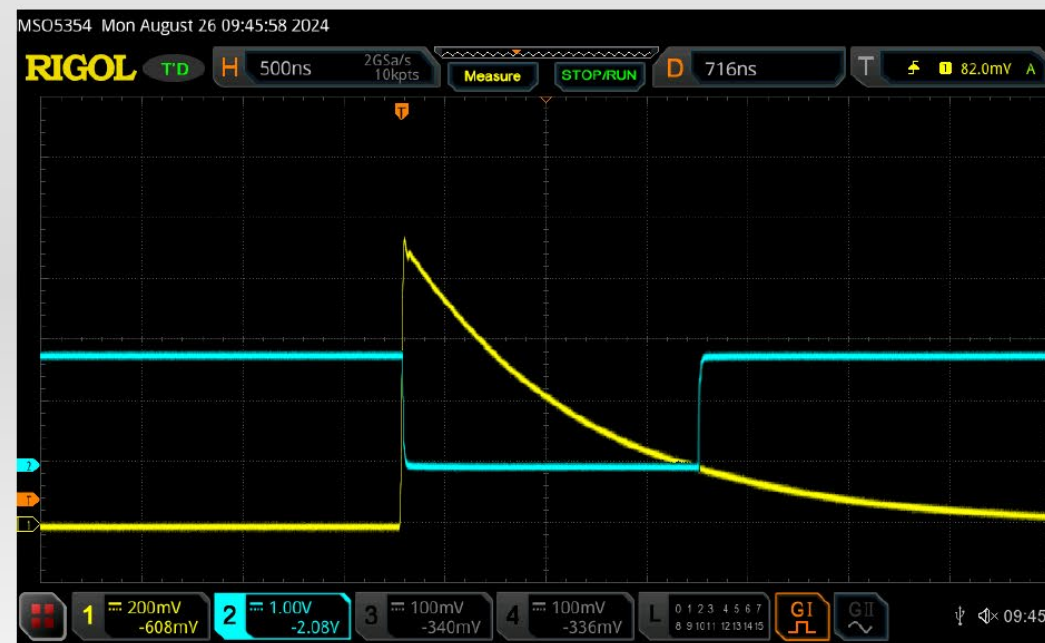
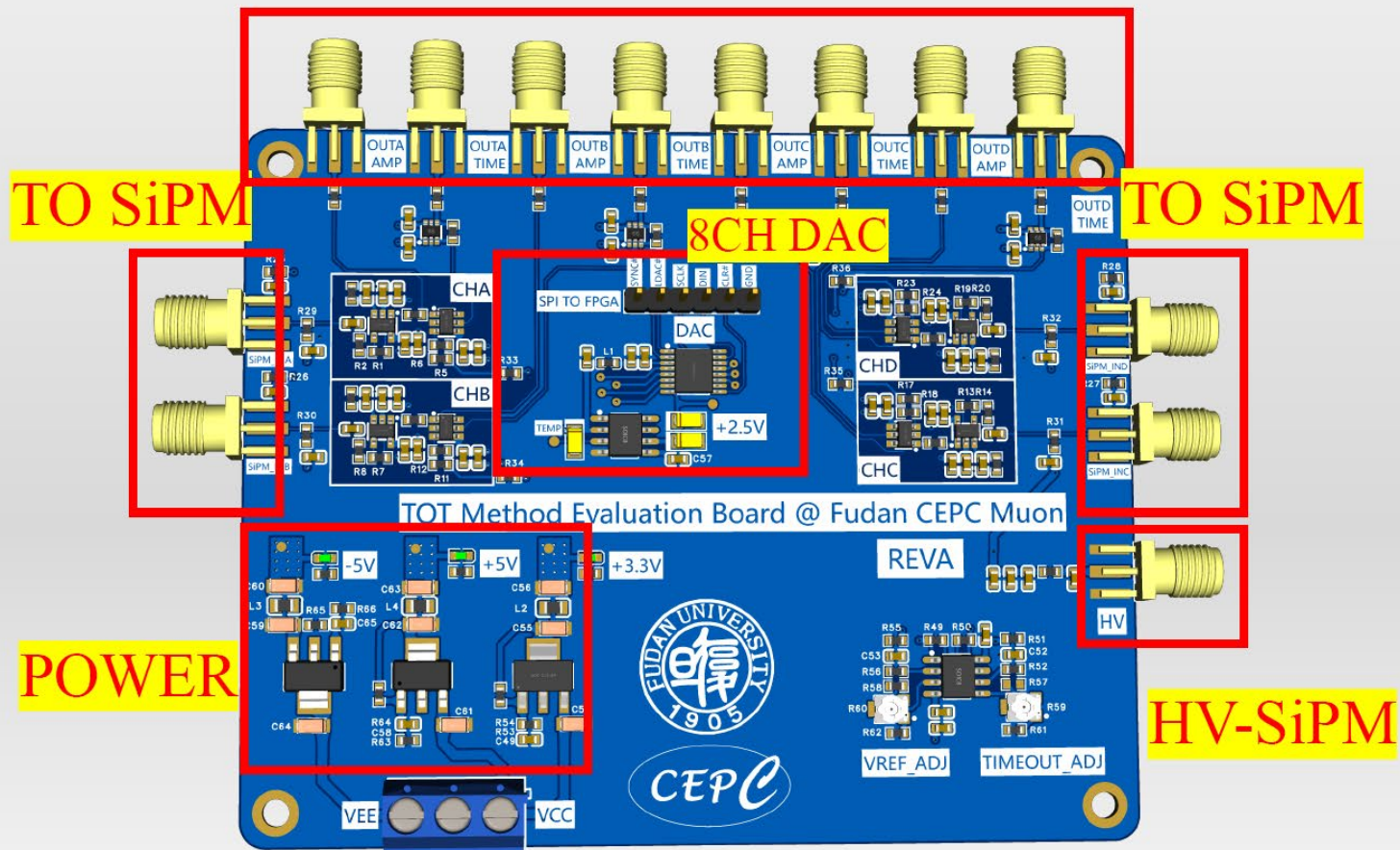
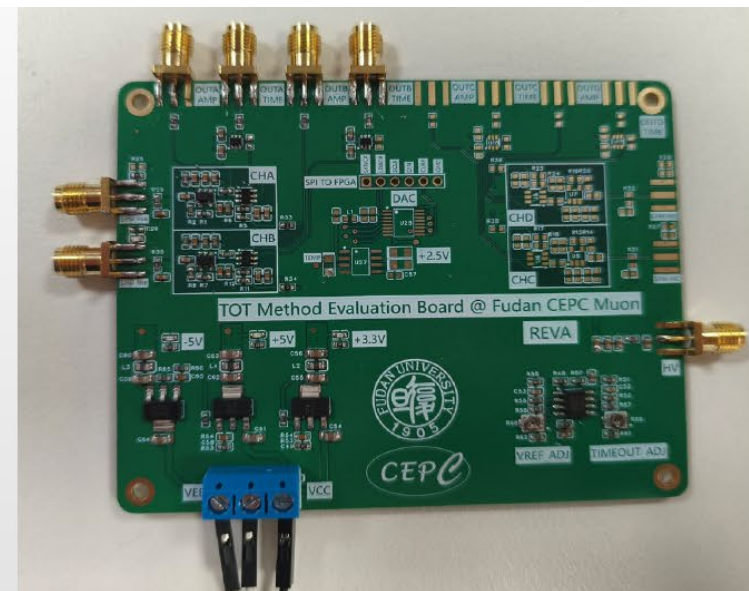
$$\sigma_{TN} = \sigma_T / \sqrt{N}$$

TOT(Time Over Threshold)方案的研究

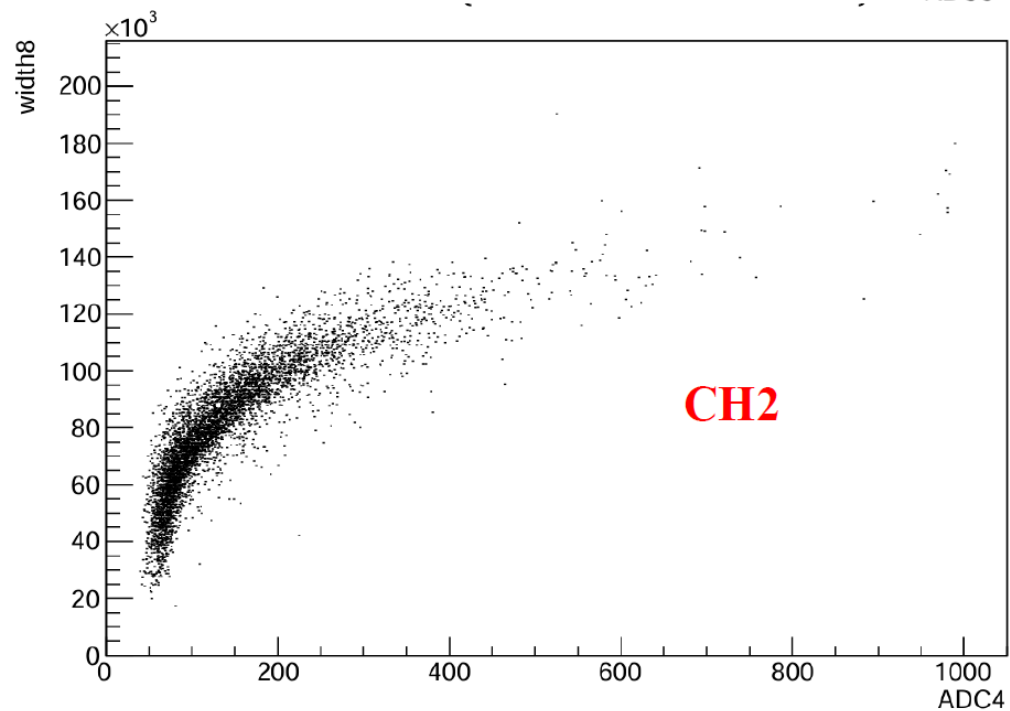
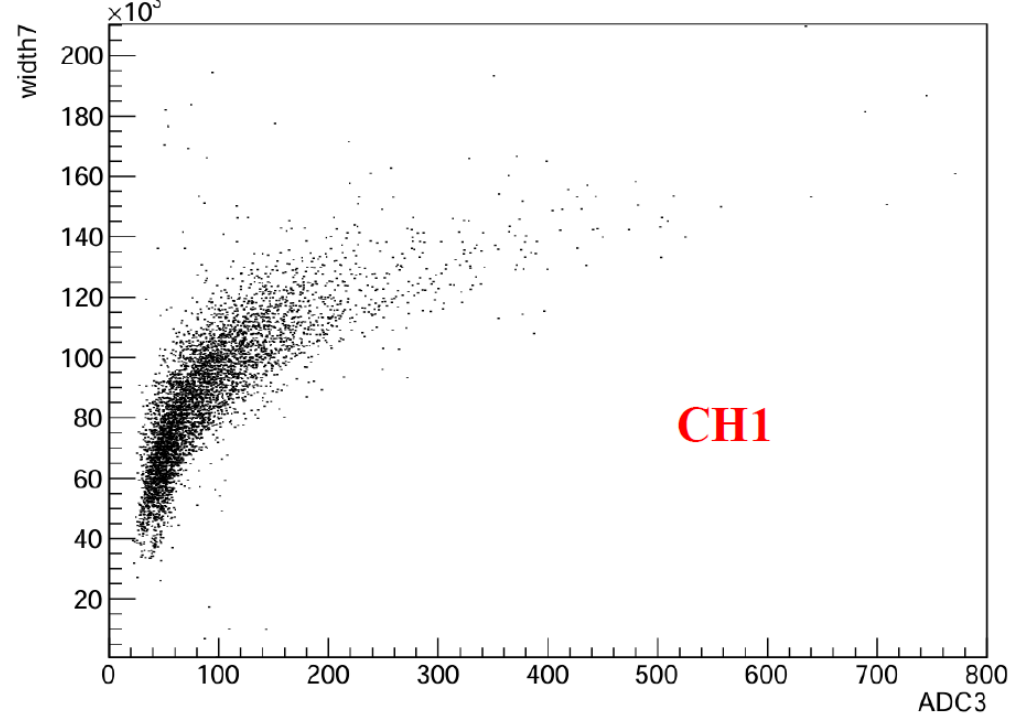
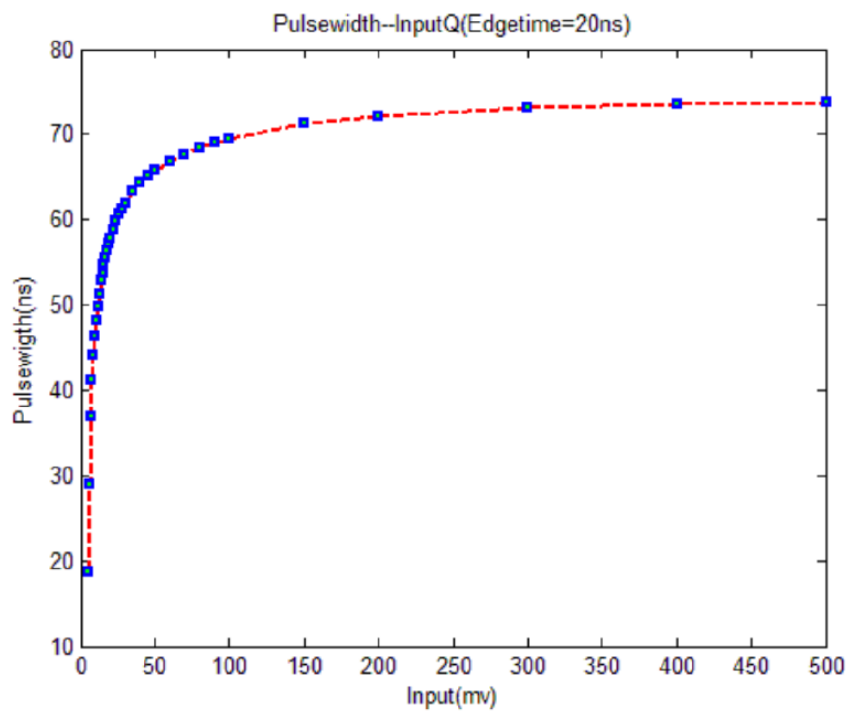
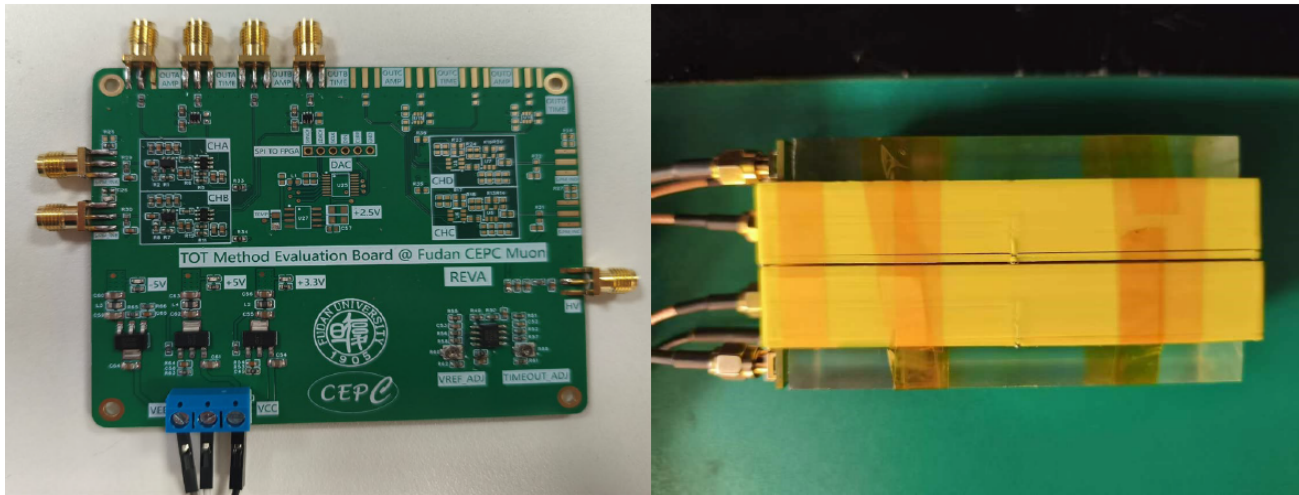
OUT-TIME&OUT-AMP



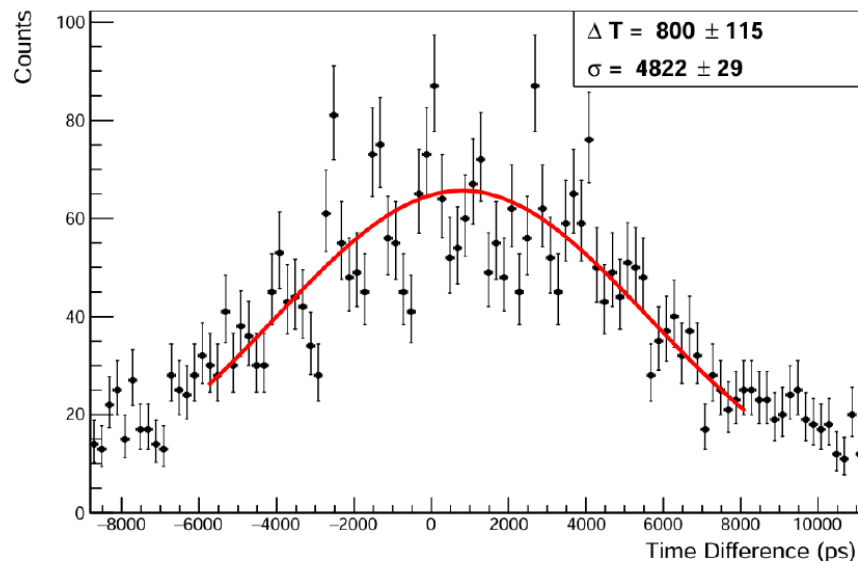
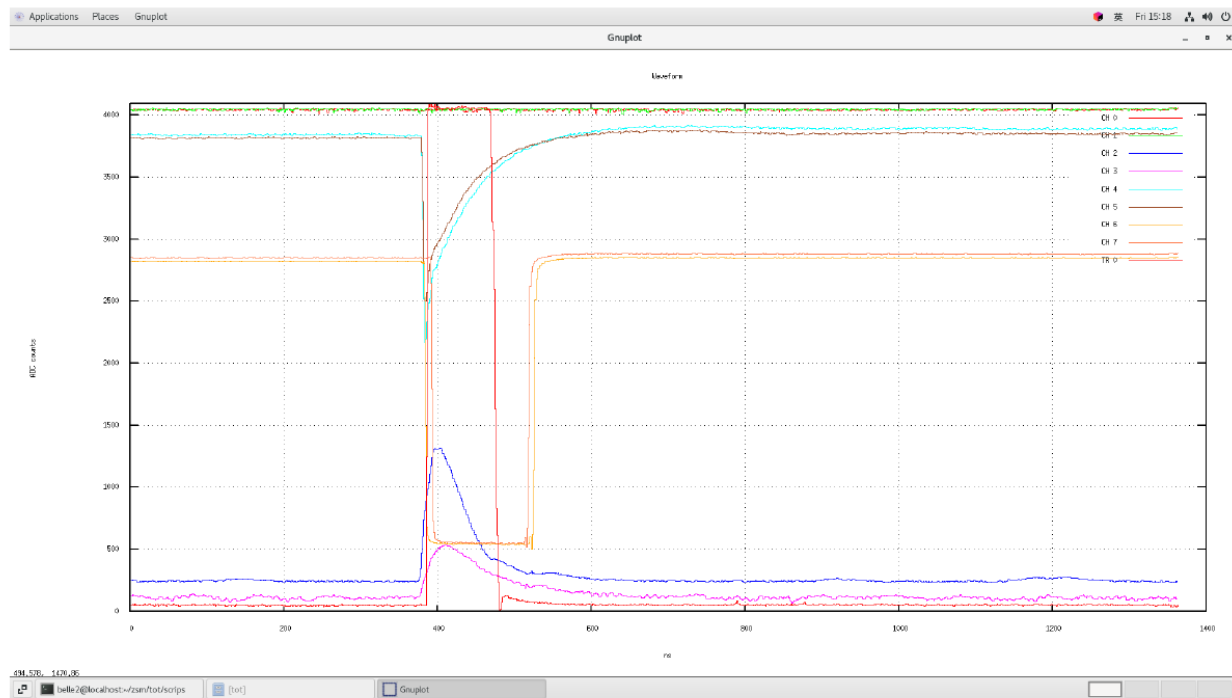
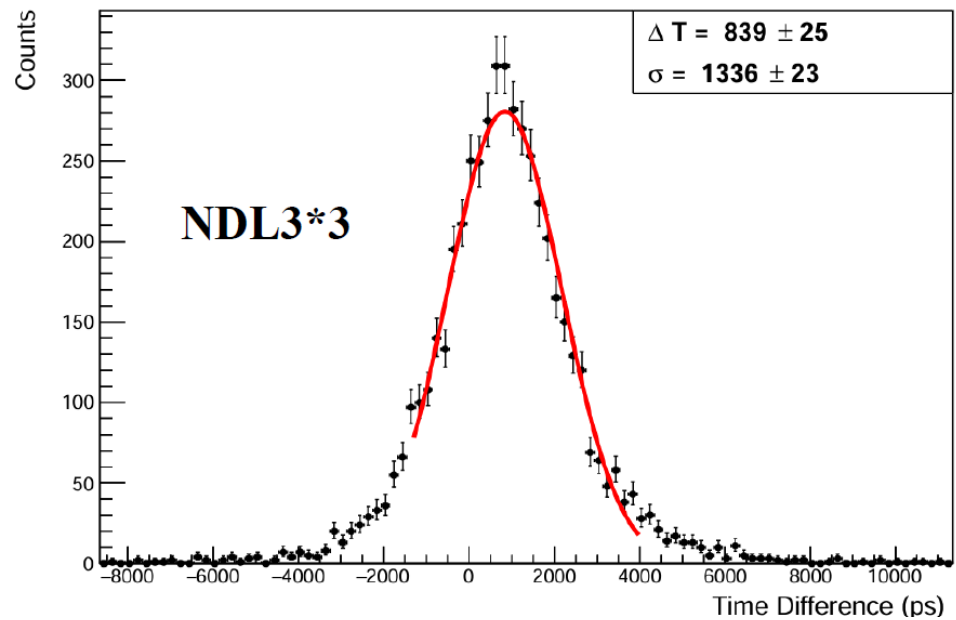
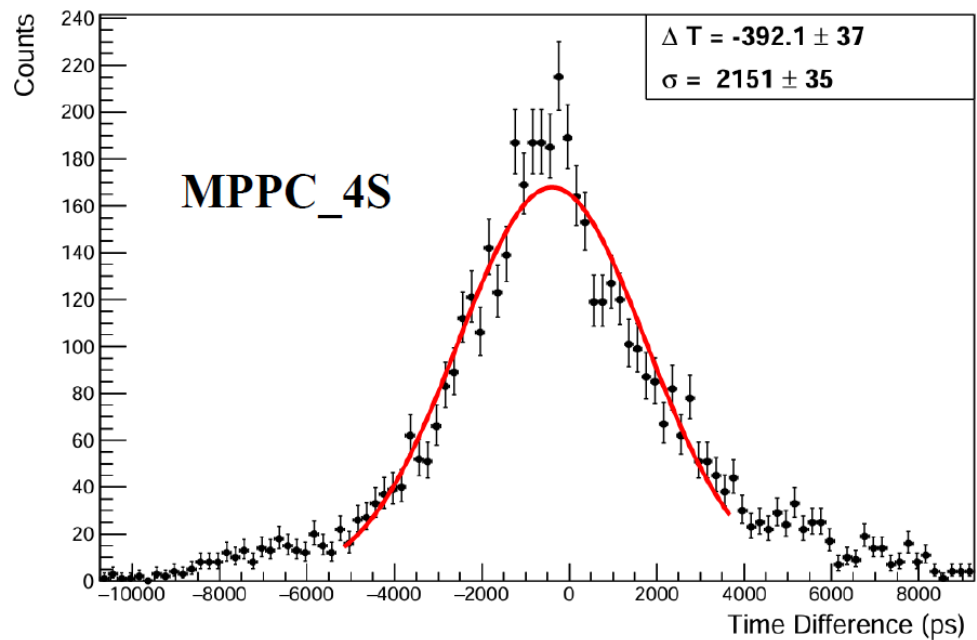
8CH DAC AD5628
4CH For HV_ADJ
4CH For TH_ADJ



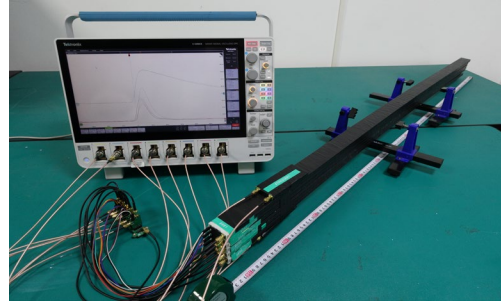
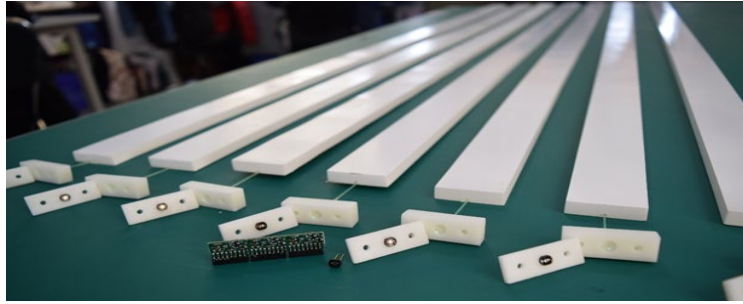
TOT输出信号宽度测试



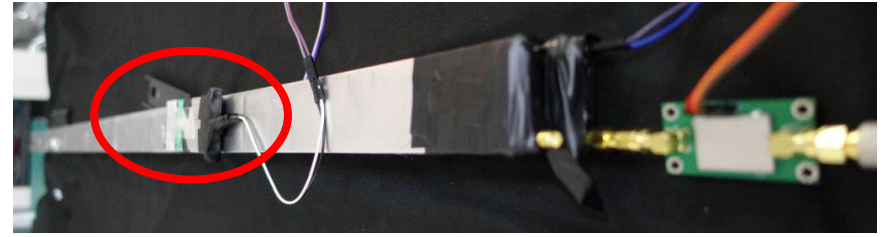
TOT时间分辨测试



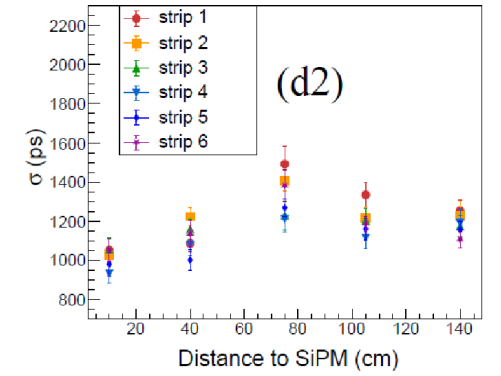
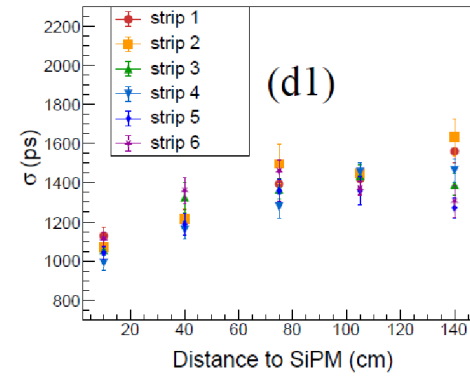
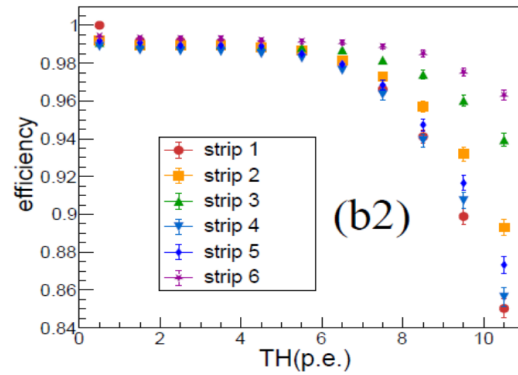
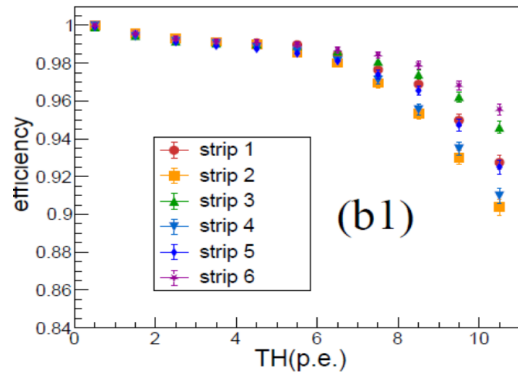
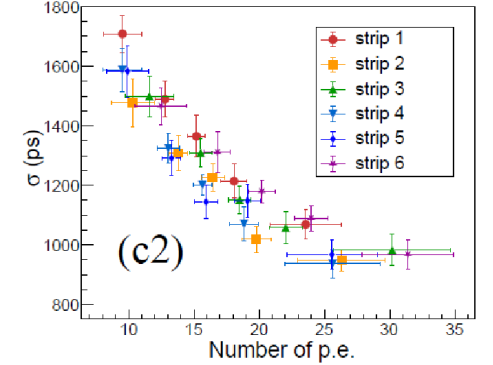
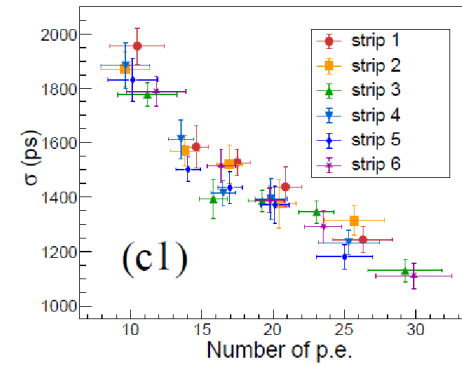
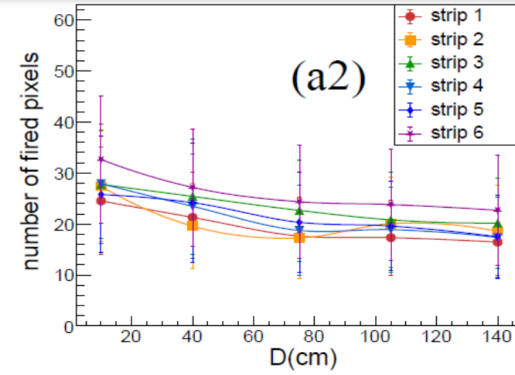
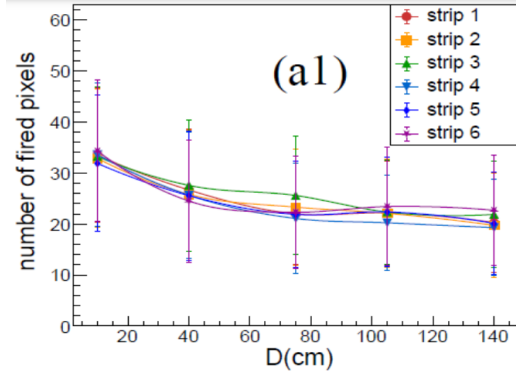
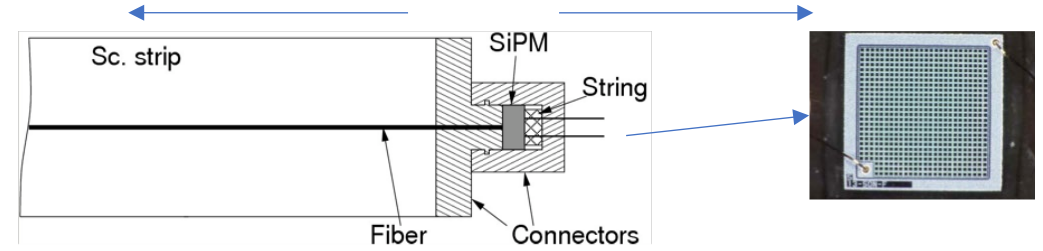
Back UP



Trigger



X



NDL

MPPC

NDL

MPPC