

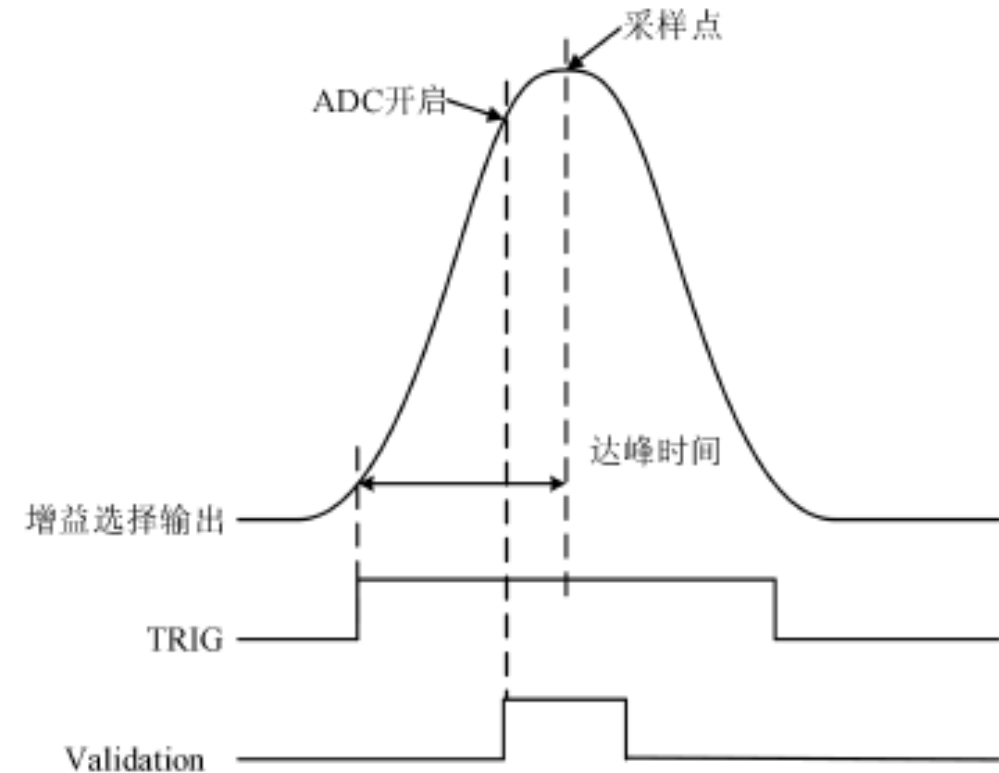
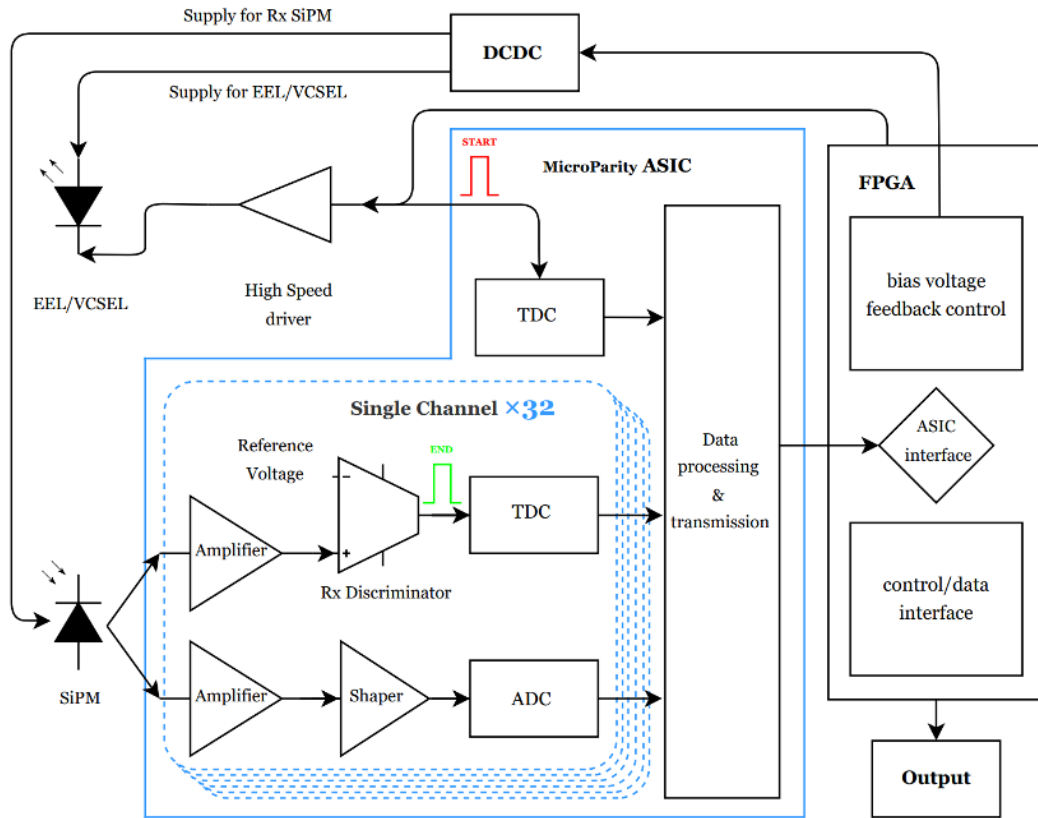
# Updates on Tests of MPT2321 and Design of Crystal Module

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March 22, 2023

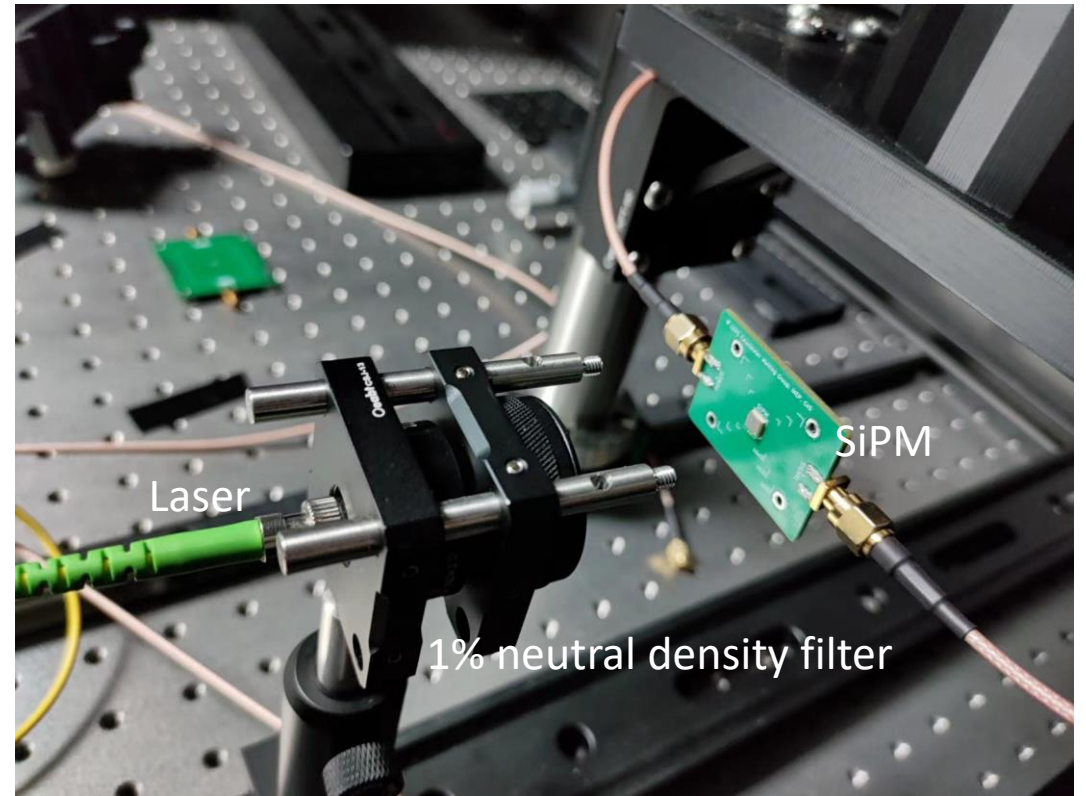
Scintillating Calorimeter Meeting

- 32 channel ASIC
- Dynamic range 1.8 nC (nominal):  $\sim 11250$  p.e. @ gain  $1 \times 10^6$



# Test stand for MPT2321

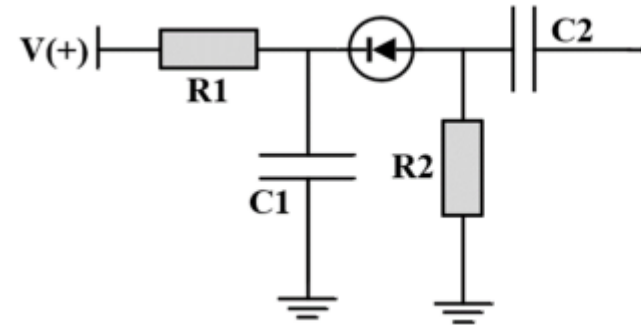
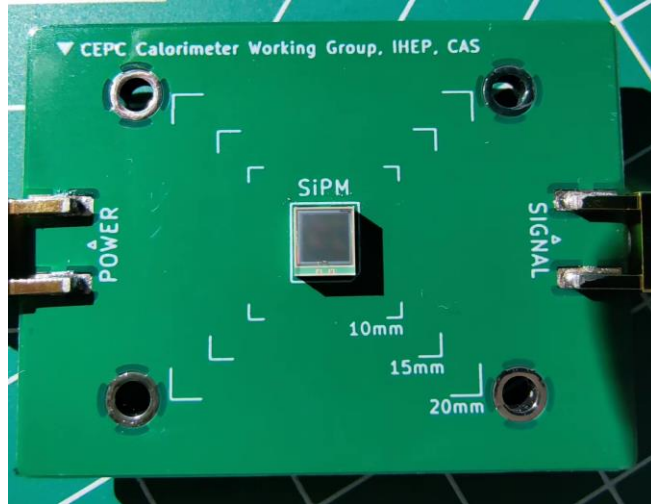
- MPT2321: 32 channel ASIC, dynamic range 1.8 nC (nominal):  $\sim 11250$  p.e. @ gain  $1 \times 10^6$
- Laser test stand: 405 nm picosecond laser + 1% ND filter



# SiPM configuration

- SiPM S13360-XX25PE
- 25 $\mu\text{m}$  pixel pitch,  $7 \times 10^5$  gain
- AC coupled connection

Type no.	Measurement conditions	Spectral response range $\lambda$ (nm)	Peak sensitivity wavelength $\lambda_p$ (nm)	Photon detection efficiency PDE <sup>++</sup> $\lambda = \lambda_p$ (%)	Dark count <sup>*5</sup>		Terminal capacitance $C_t$ (pF)	Gain $M$	Breakdown voltage $V_{BR}$ (V)	Crosstalk probability (%)	Recommended operating voltage $V_{op}$ (V)	Temperature coefficient at recommended operating voltage $\Delta TV_{op}$ (mV/°C)
					Typ. (kcps)	Max. (kcps)						
S13360-1325PE	V <sub>over</sub> = 5 V	320 to 900		25	70	210	60	$7.0 \times 10^5$		1	$V_{BR} + 5$	
S13360-3025CS		270 to 900			400	1200	320					
S13360-3025PE		320 to 900			400	1200	320					
S13360-6025CS		270 to 900			1600	5000	1280					
S13360-6025PE		320 to 900			1600	5000	1280					



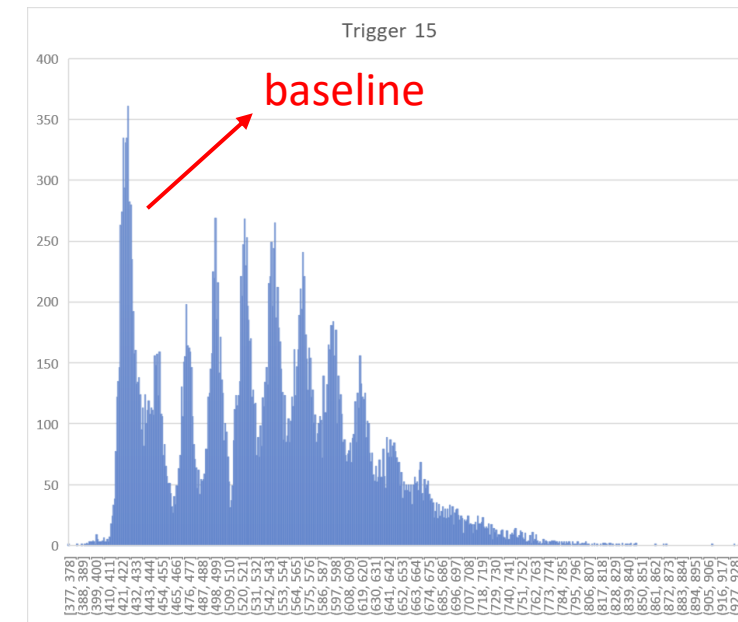
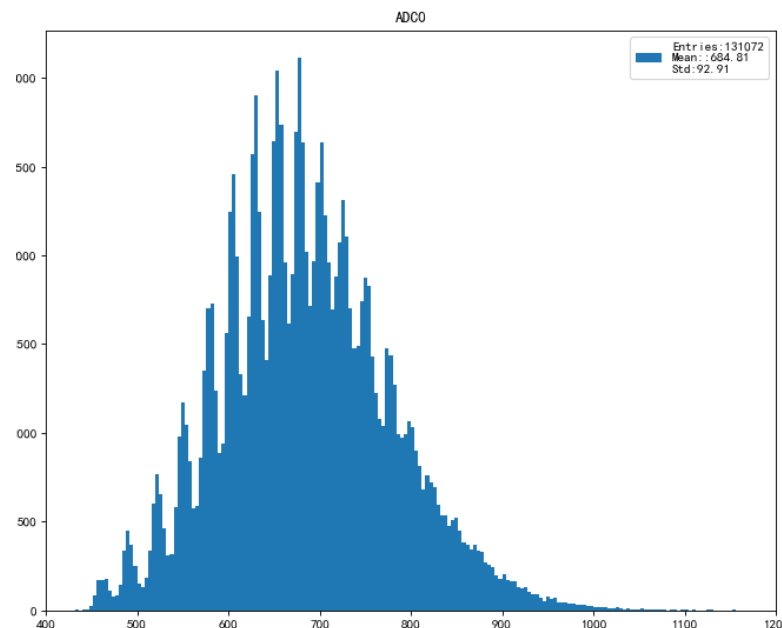
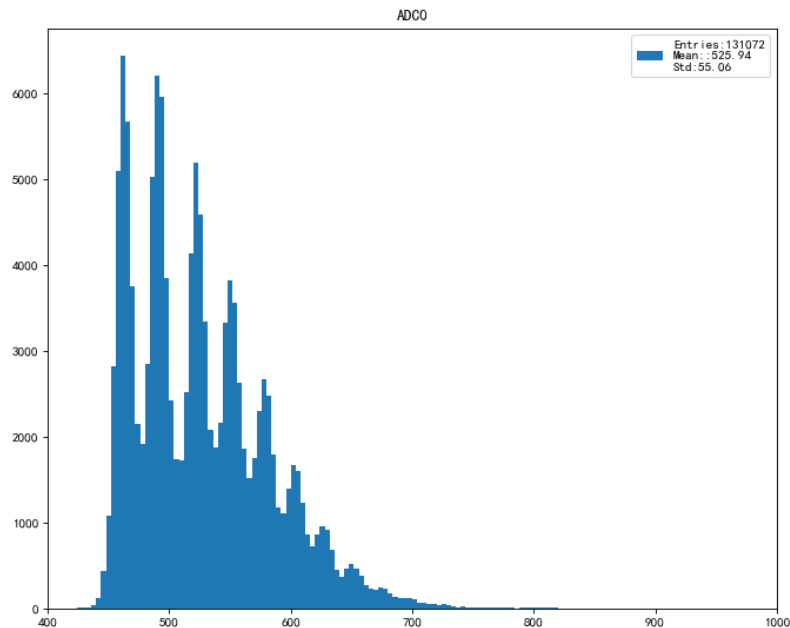
**R1 = 10 k $\Omega$**   
**R2 = 1 k $\Omega$**   
**C1 = 100 nF**  
**C2 = 10 nF**



# MPT2321 test with S13360-1325PE

- Using Ch.26 and 10 pC range, auto trigger mode
- S13360-1325PE, 2668 pixels, DCR 70 kcps
- Single photon spectrum with different laser intensity

~25 ADC tics  
per photon

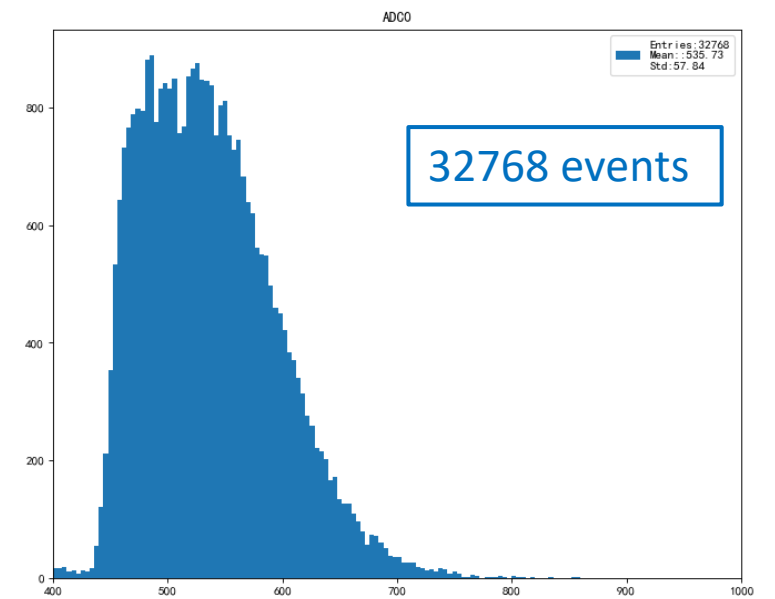
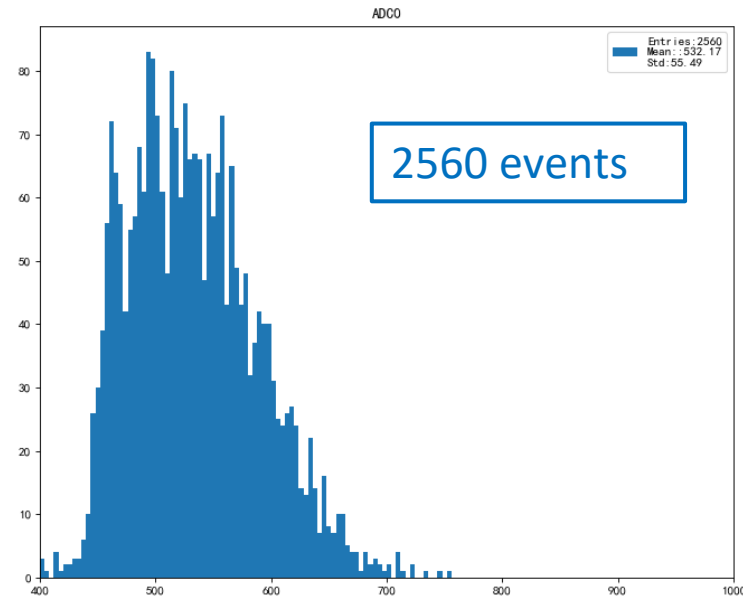
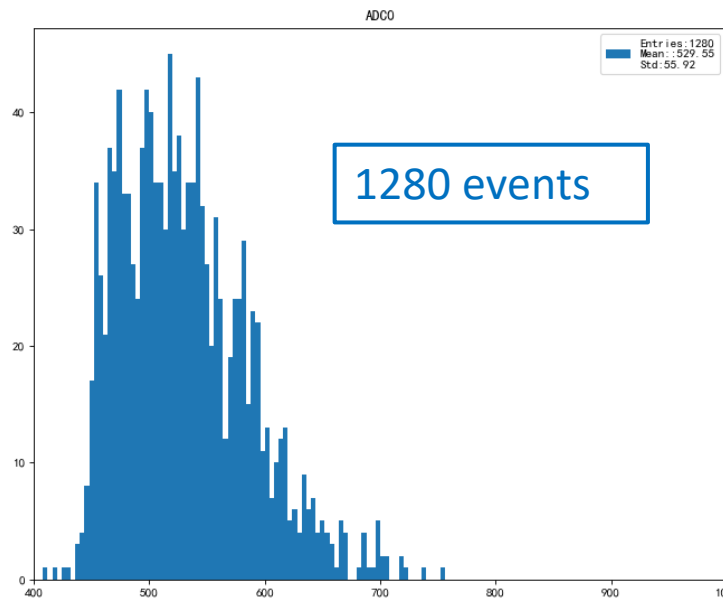


- Note: data receive parameter set to 1 (10) means we need to trigger 32 (320) events in 10 seconds (nominal)
- If the event rate is too low, the data taking will stop
- Laser frequency set to 100 kHz to get high enough signal rate

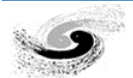


# MPT2321 test with S13360-3025PE

- Using Ch.26 and 10 pC range, **auto trigger mode**
- S13360-3025PE, 14400 pixels, DCR 400 kcps

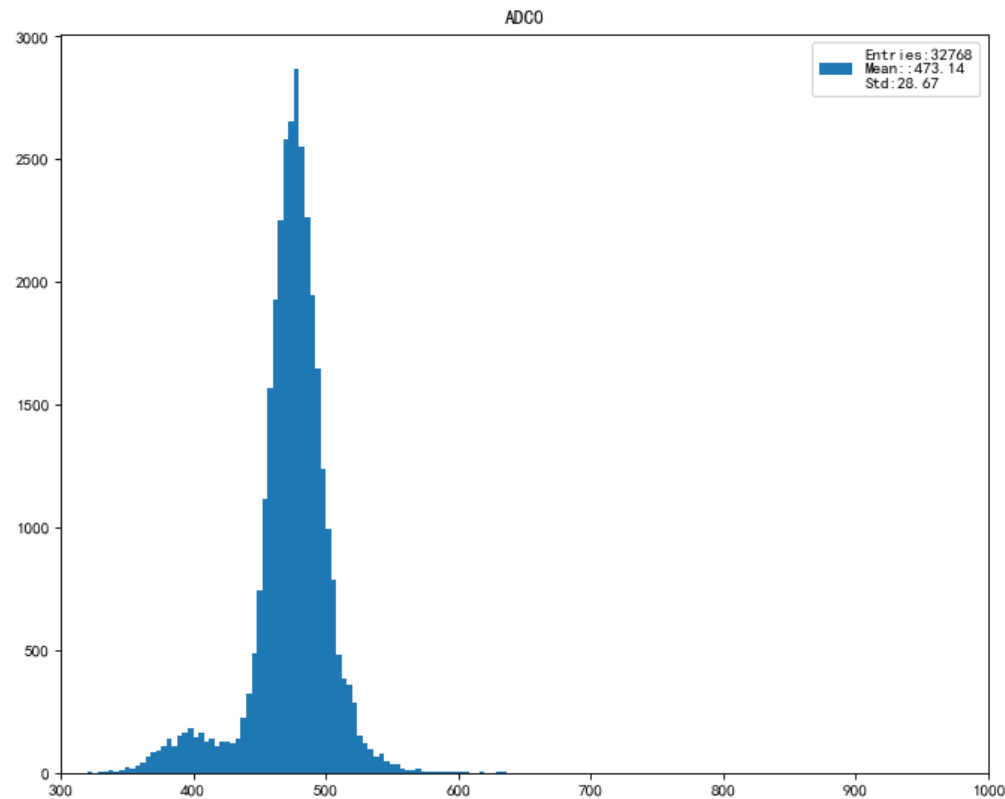


- Seems hard to perform single photon calibration
- Larger event number leads to larger contamination of the baseline? Too high DCR? Unstable power supply?

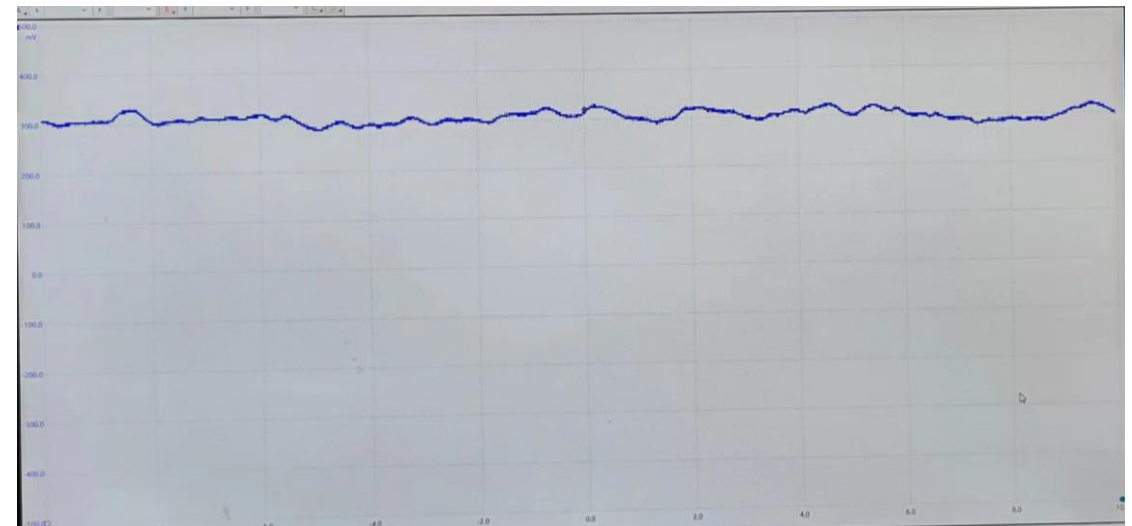


# MPT2321 test with S13360-6025PE

- Using Ch.26 and 10 pC range, **auto trigger mode**
- S13360-6025PE, 57600 pixels, DCR 1600 kcps

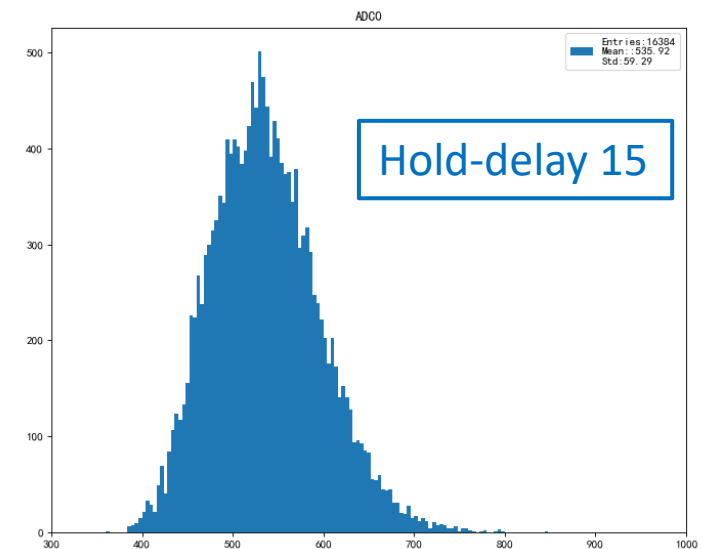
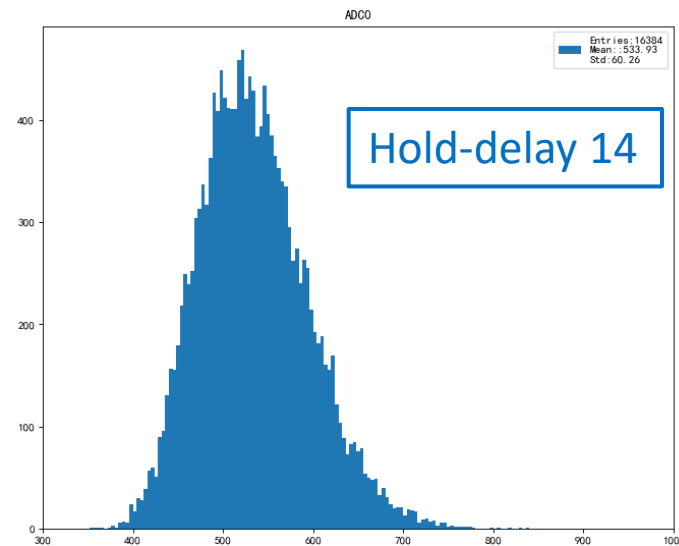
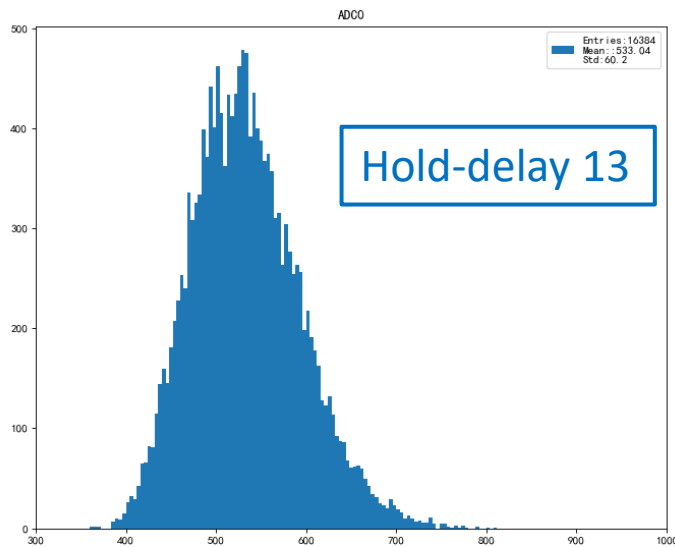


- We cannot see photon peaks
- DCR seems too high, the high gain wave-shaping is unstable

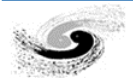


# External trigger test with S13360-3025PE

- Using Ch.26 and 10 pC range
- External trigger from laser driver
- S13360-3025PE, 14400 pixels, DCR 400 kcps



- Use a signal generator as a trigger?
- Need more repetitive tests

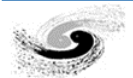




# Requirements for CEPC

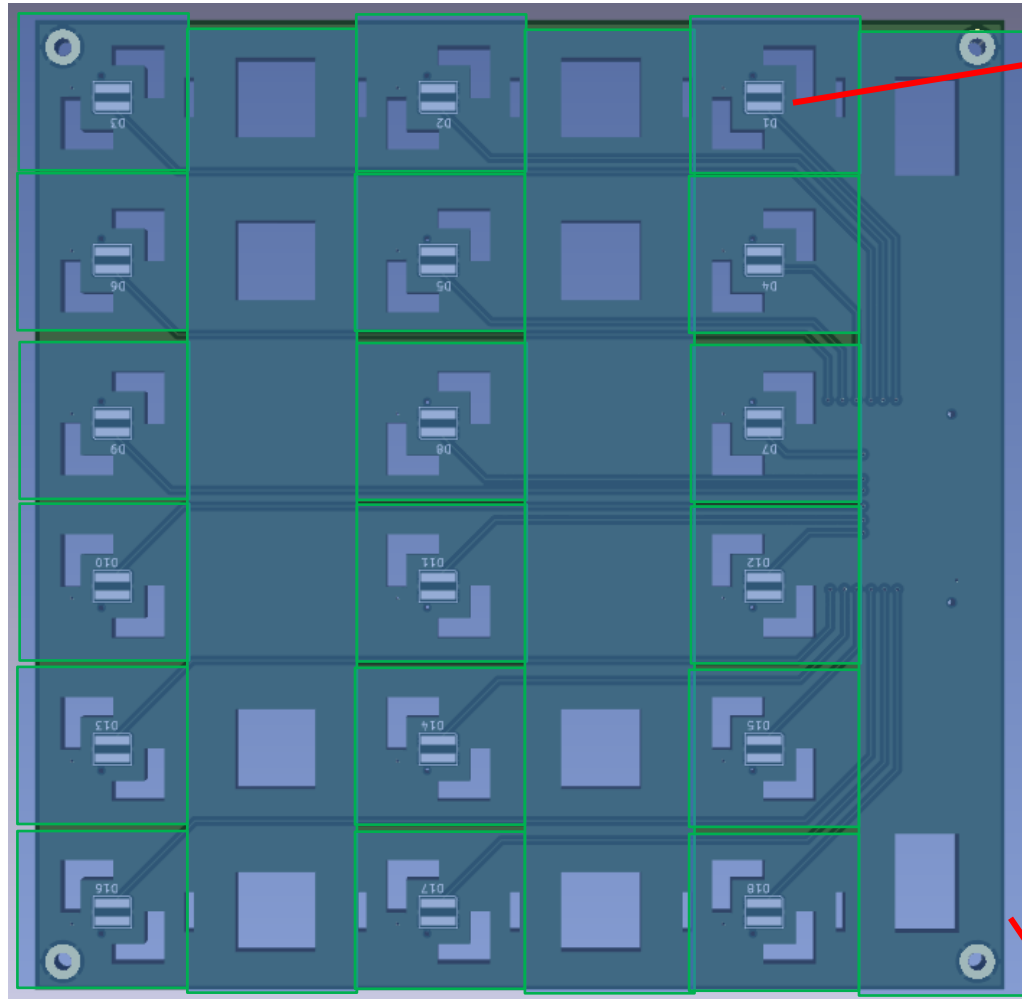
Key Parameters	Value/Range	Remarks
MIP light yield	> 200 p.e./MIP	8.9 MeV/MIP in 1 cm BGO
Dynamic range	0.1~10 <sup>3</sup> MIPs	Energy range from ~1 MeV to ~10 GeV
Energy threshold	0.1 MIP	Equivalent to ~1 MeV energy deposition
Timing resolution	~400 ps	Limits from G4 simulation (validation needed)
Crystal non-uniformity	< 1%	After calibration
Temperature stability	Stable at ~0.05 Celsius	Reference of CMS ECAL
Gap tolerance	~100 μm	TBD via module development

- Dynamic range: 1000 MIPs in a crystal with dual readout, which means 500 MIPs for one SiPM
- 500 MIPs equals 50,000 photons, for NDL EQR06 11-3030D-S SiPM with  $8 \times 10^4$  gain, charge at least 640 pC
- Consider some headroom for system and potential performance improvement...

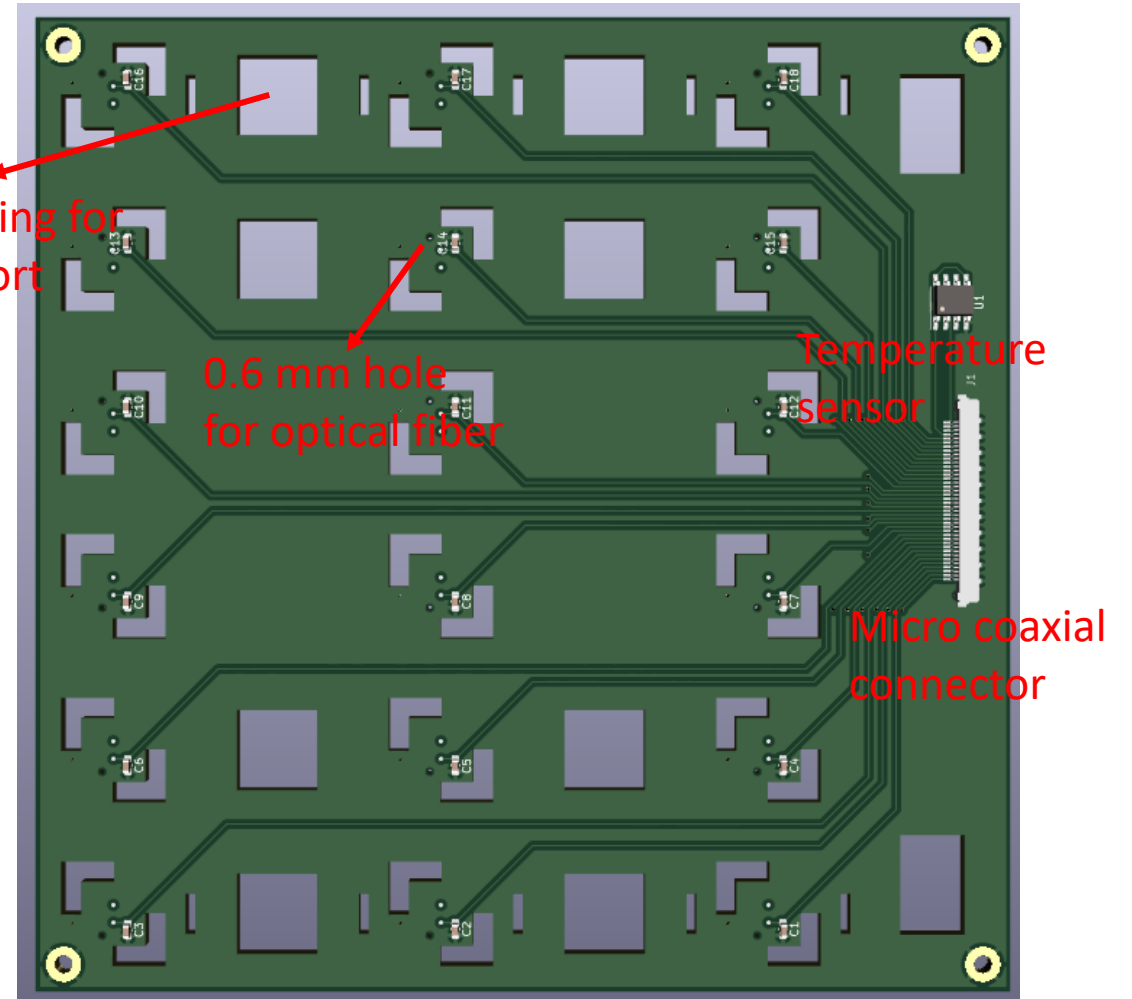


# New PCB for crystal module

Front side



Back side



Crystal

SiPM

Opening for support

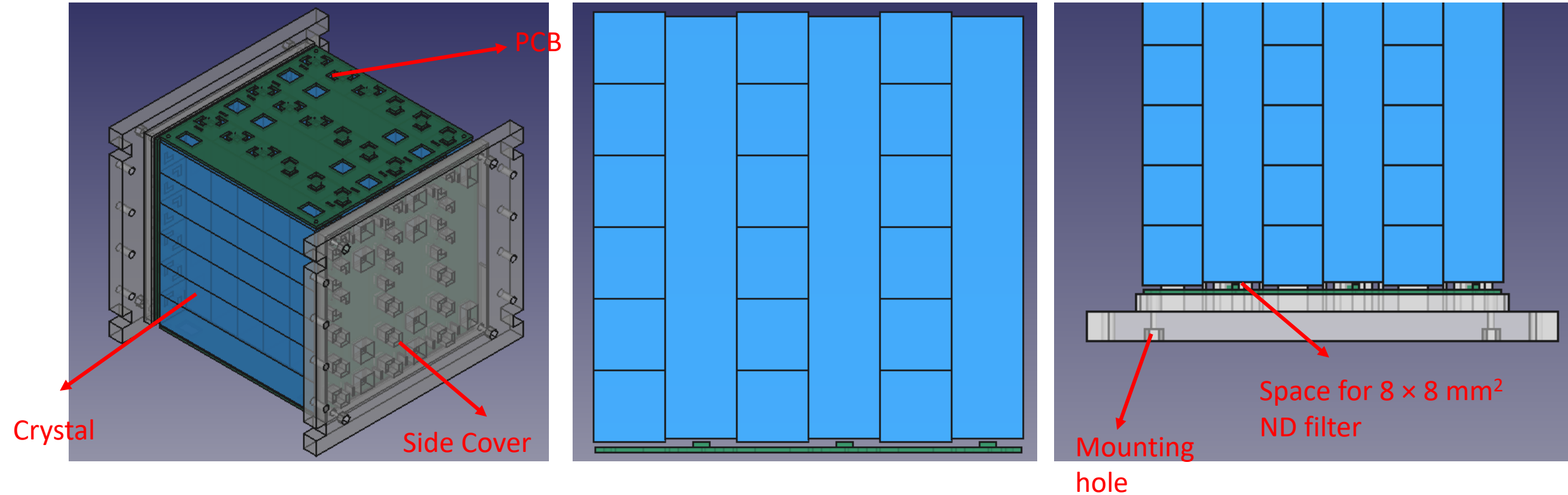
0.6 mm hole for optical fiber

Temperature sensor

Micro coaxial connector



# New support for crystal module



- Still working on other side covers....

