中国科学院高能物理研究所
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Crystal ECAL Simulation & SiPM Calibration Experiment

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March 23, 2022

CEPC Scintillator Calorimeter Meeting

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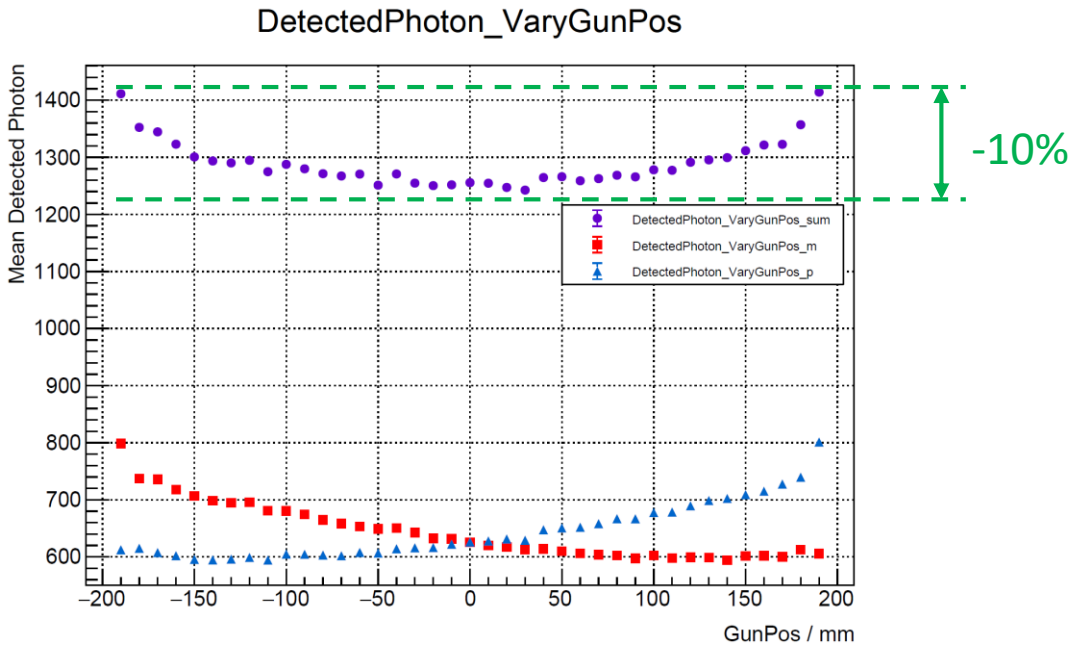
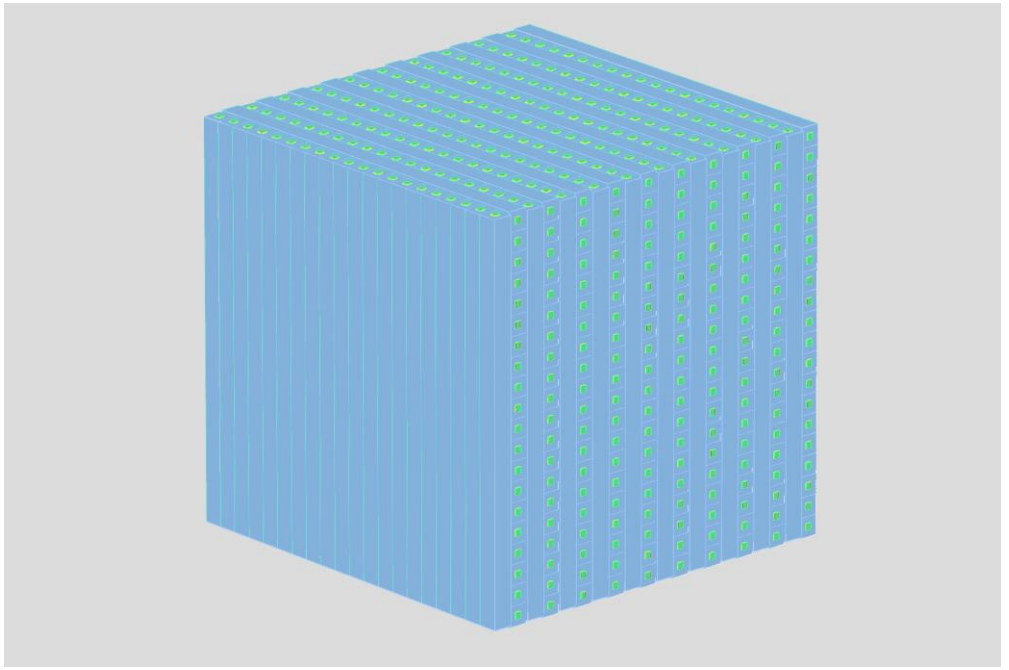
Motivation

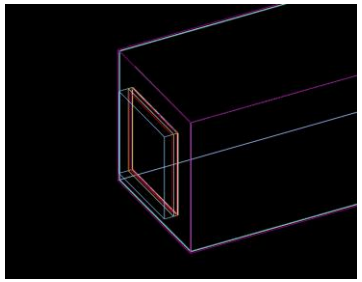
- Crystal ECAL
  - BGO crystal module
    - 400 mm long bar
    - Impact of 1D uniformity on energy resolution
- SiPM tests
  - Laser calibration: single photon
  - S/N of preamplifier versus gain
  - Potential of NDL SiPM

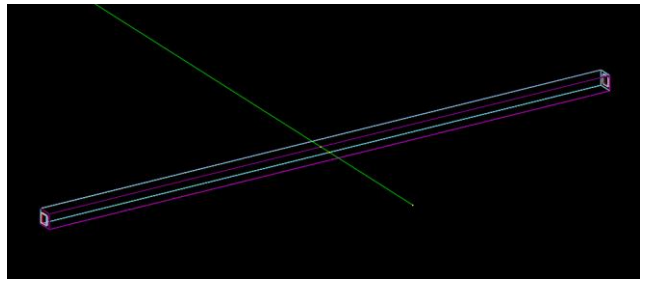
Crystal ECAL: 1D uniformity

- Simulation
  - 10×10×400 mm^3 BGO crystal Bar
  - Crossed bar, 40×40×28 module
  - 1-100 GeV e-
- 1D uniformity along bar length
  - 10% difference?
  - Impact on energy resolution
  - Simply described by a quadratic function

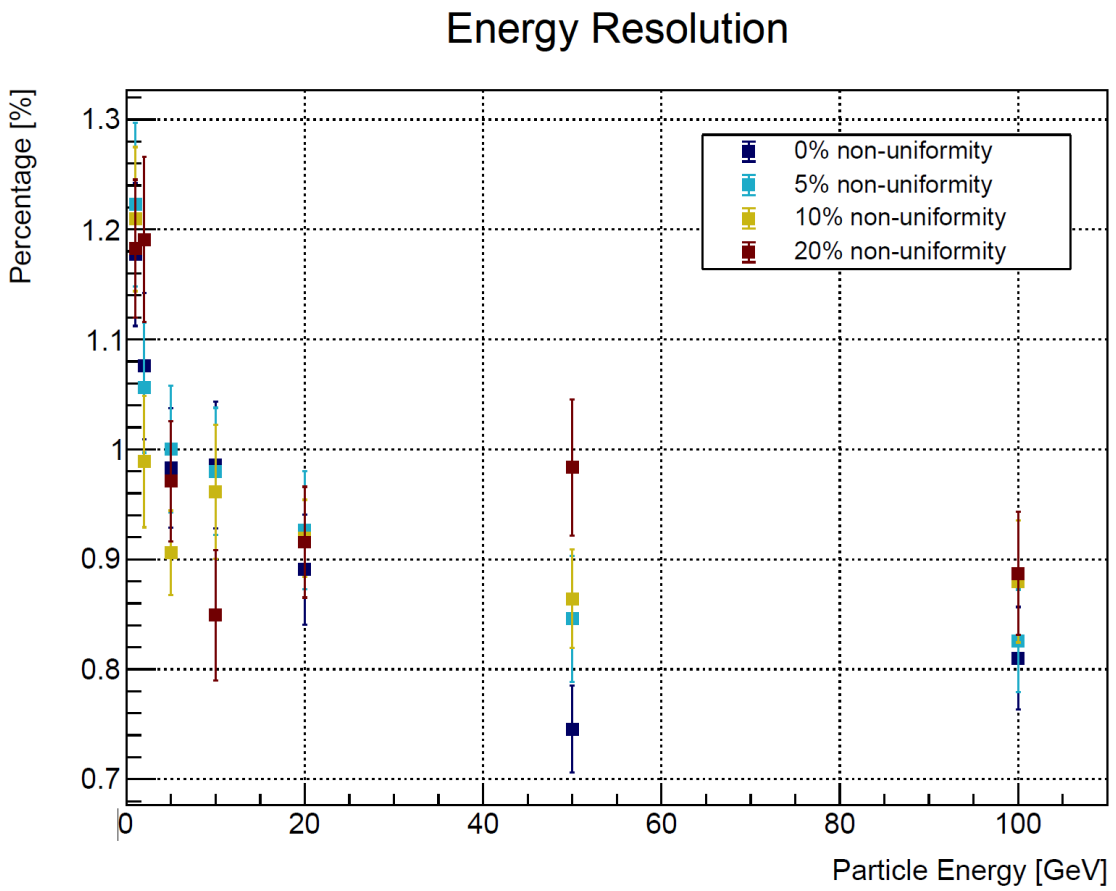








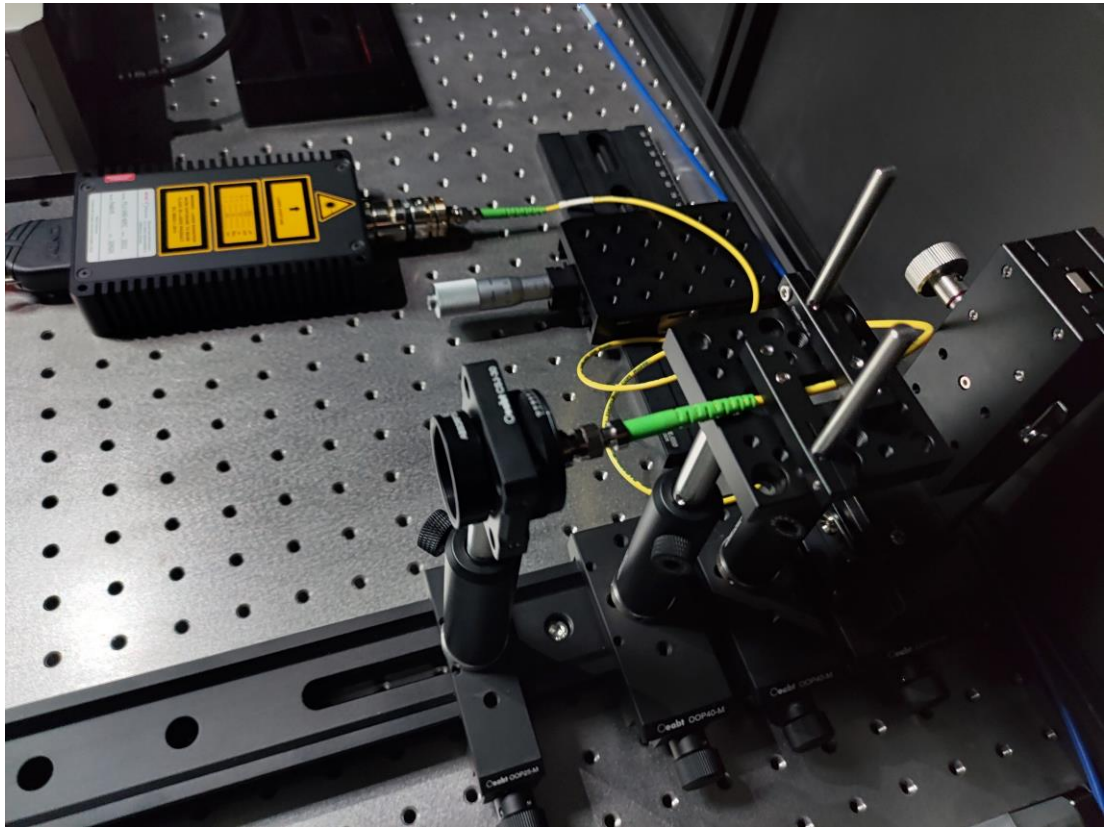
Crystal ECAL: 1D uniformity



- Energy resolution get worse when there is higher non-uniformity at high energy part
- Need more statistics (1000 events at present)

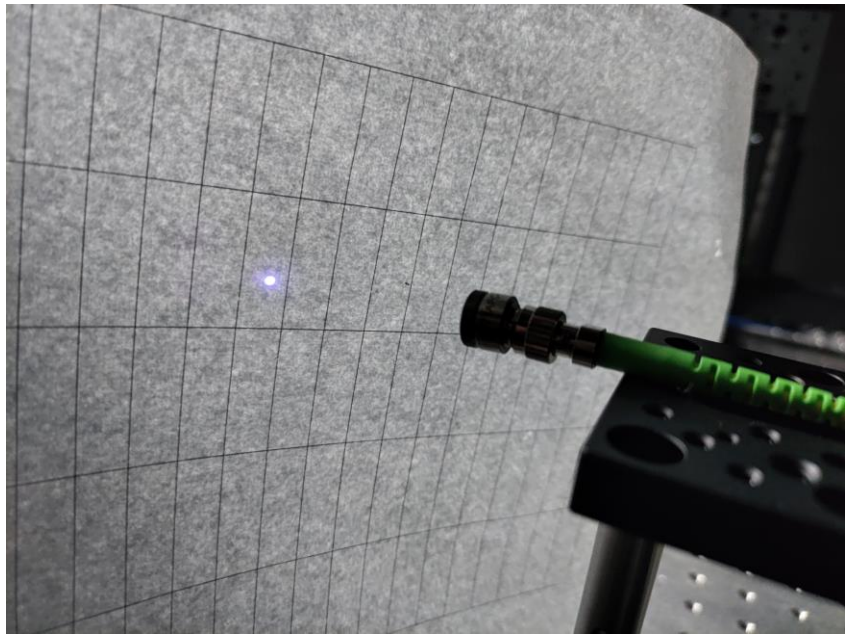
SiPM tests: laser setup

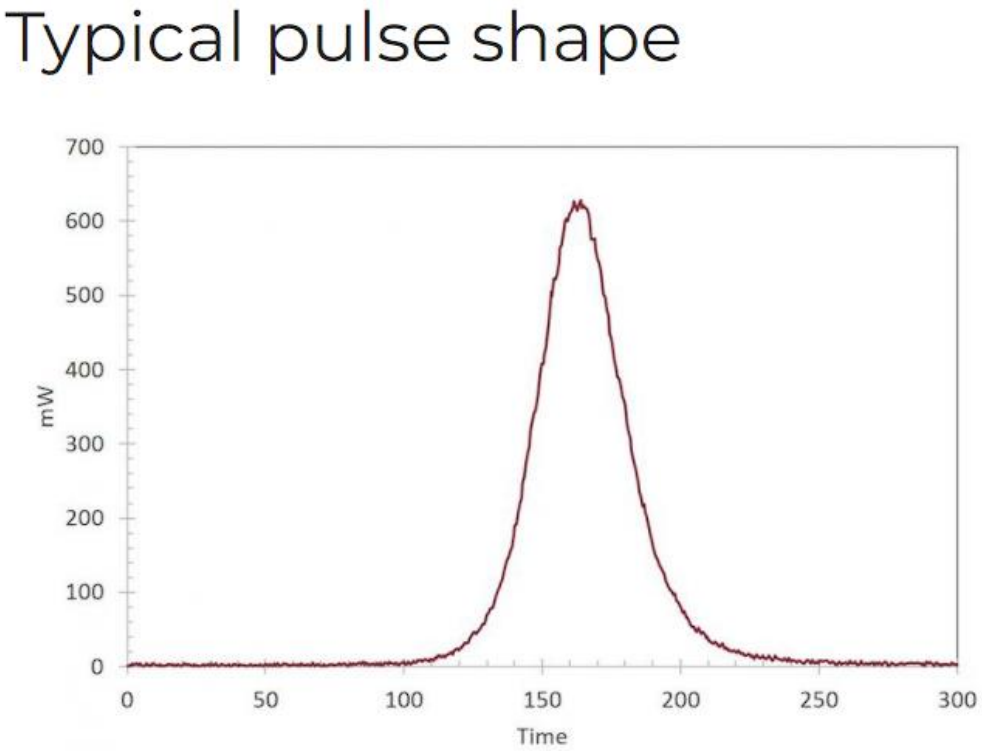
- NKT photonics: 405 nm picosecond laser
- 0.1% neutral density filter
- Laser collimation: spot diameter < 1mm



SiPM tests: laser setup

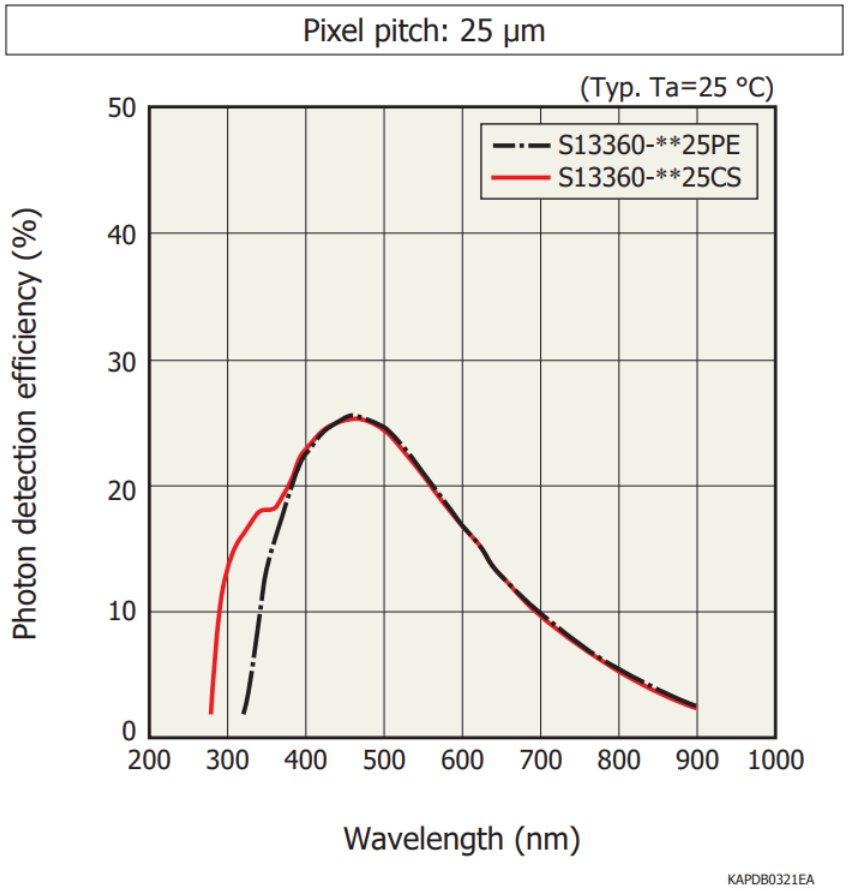
- Picosecond laser
  - Pulse width typically <60 ps
  - Timing jitter (<3 ps rms)
  - Continuously tunable laser intensity

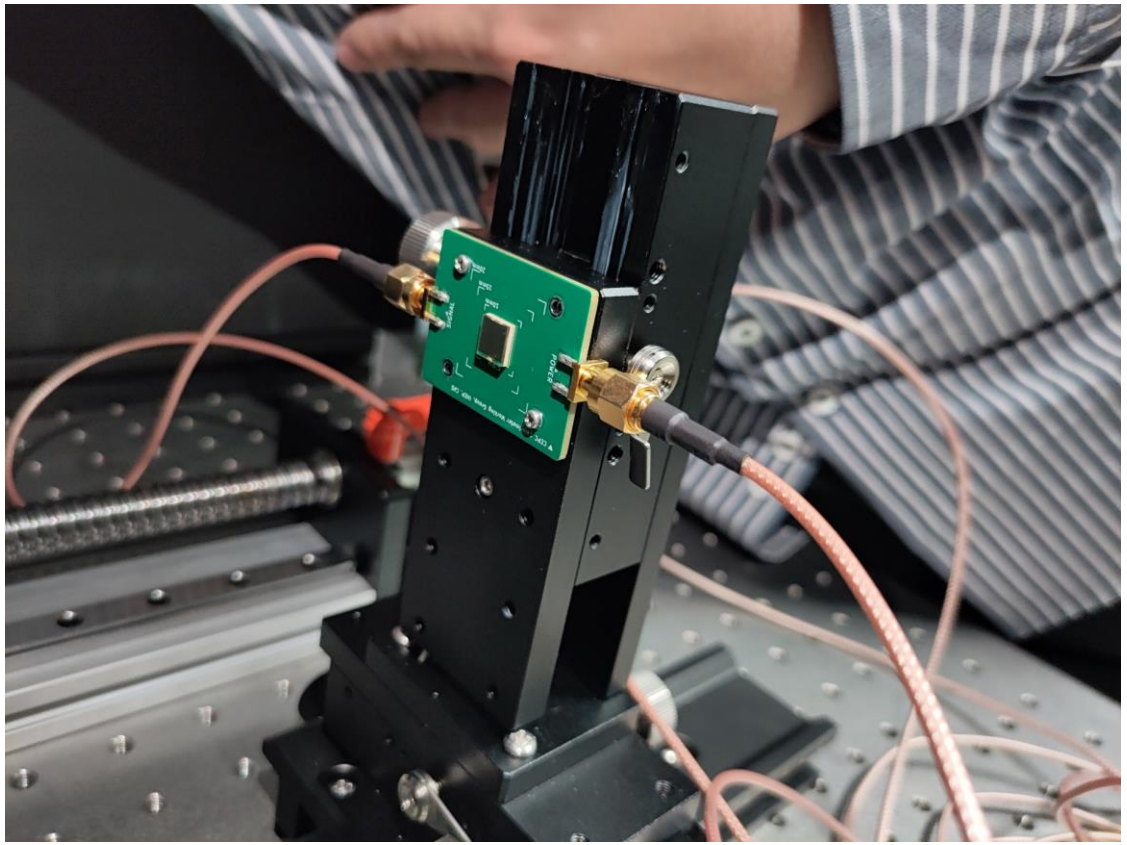




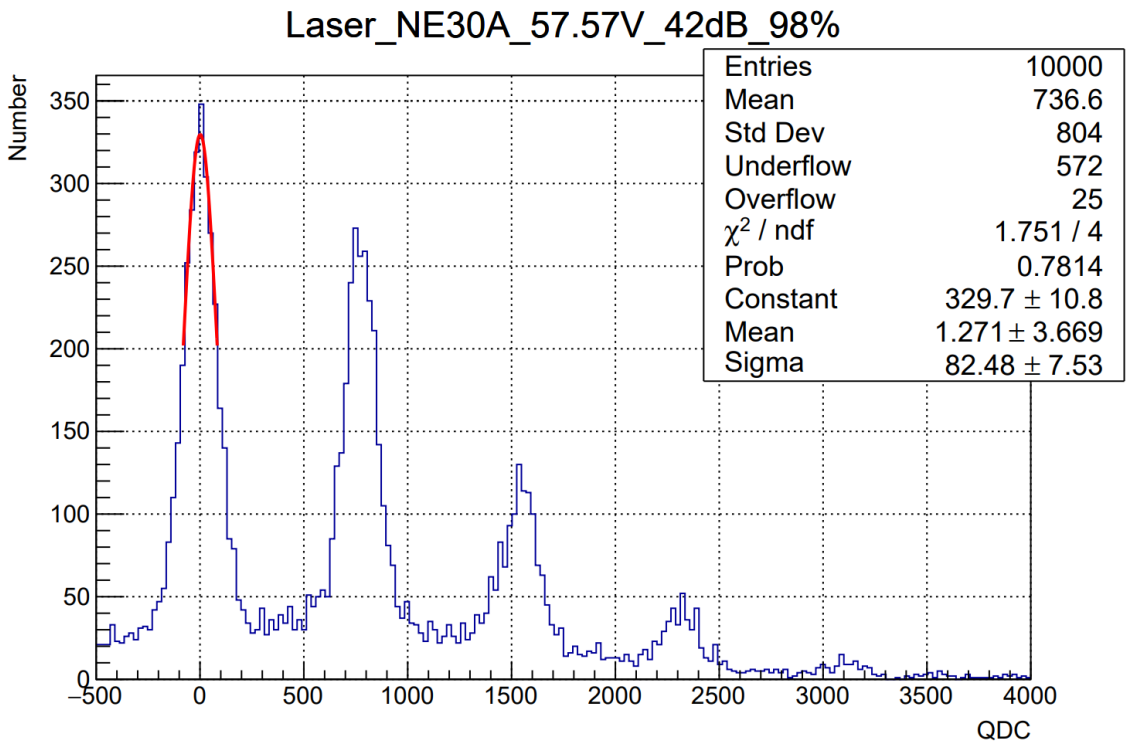
HAMAMATSU S13360 series

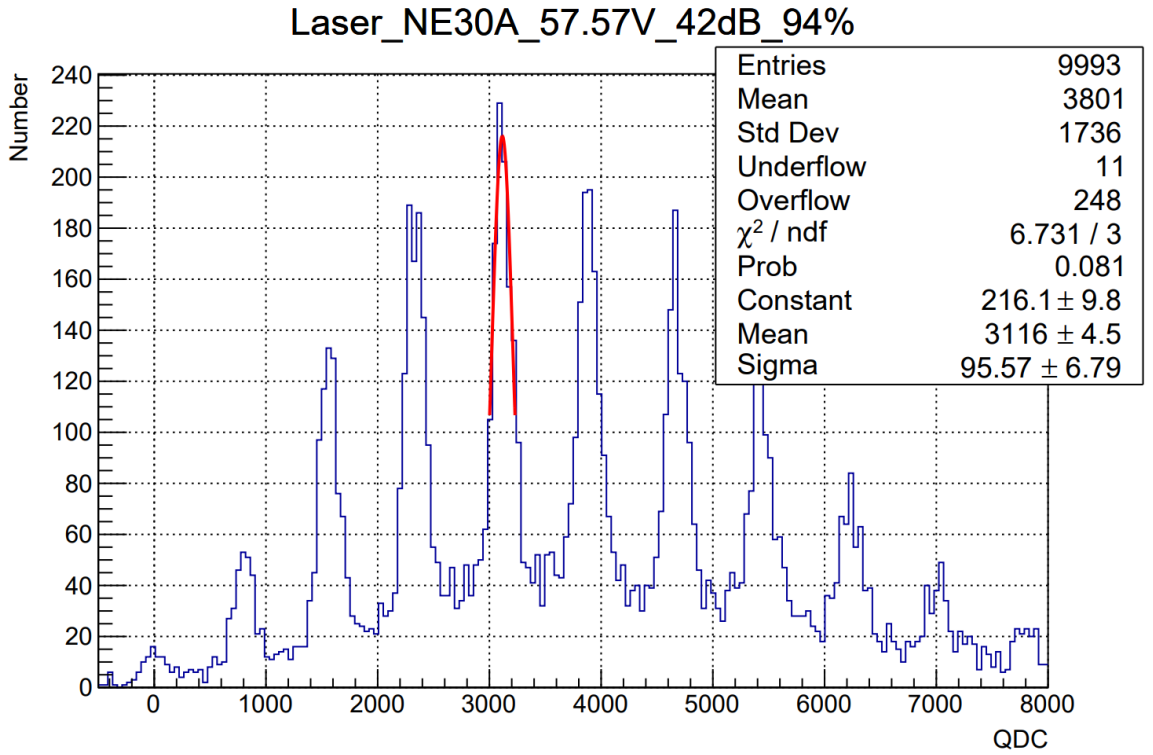
- S13360-6025PE: 25 µm, 6×6 mm
- Nominal gain= 7×10^5 from datasheet (at OV = 5 V)





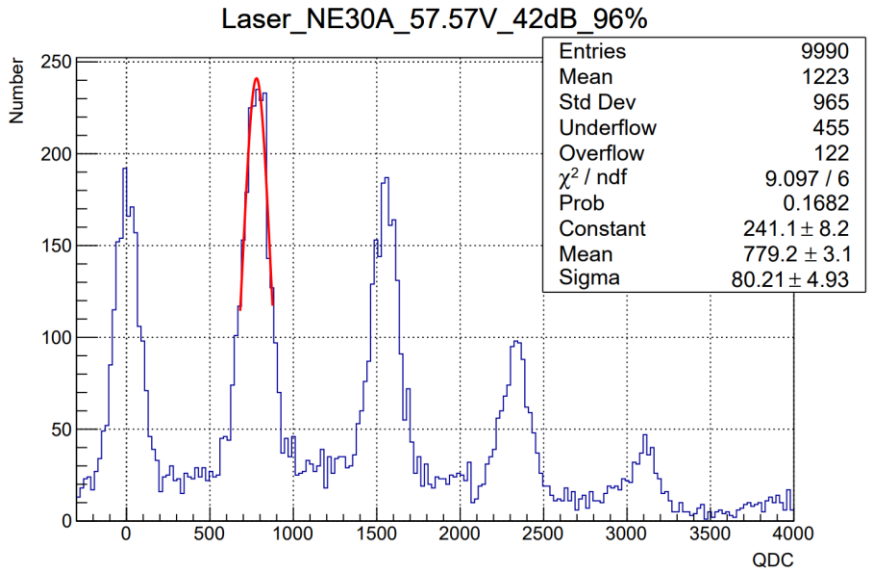
Change laser intensity

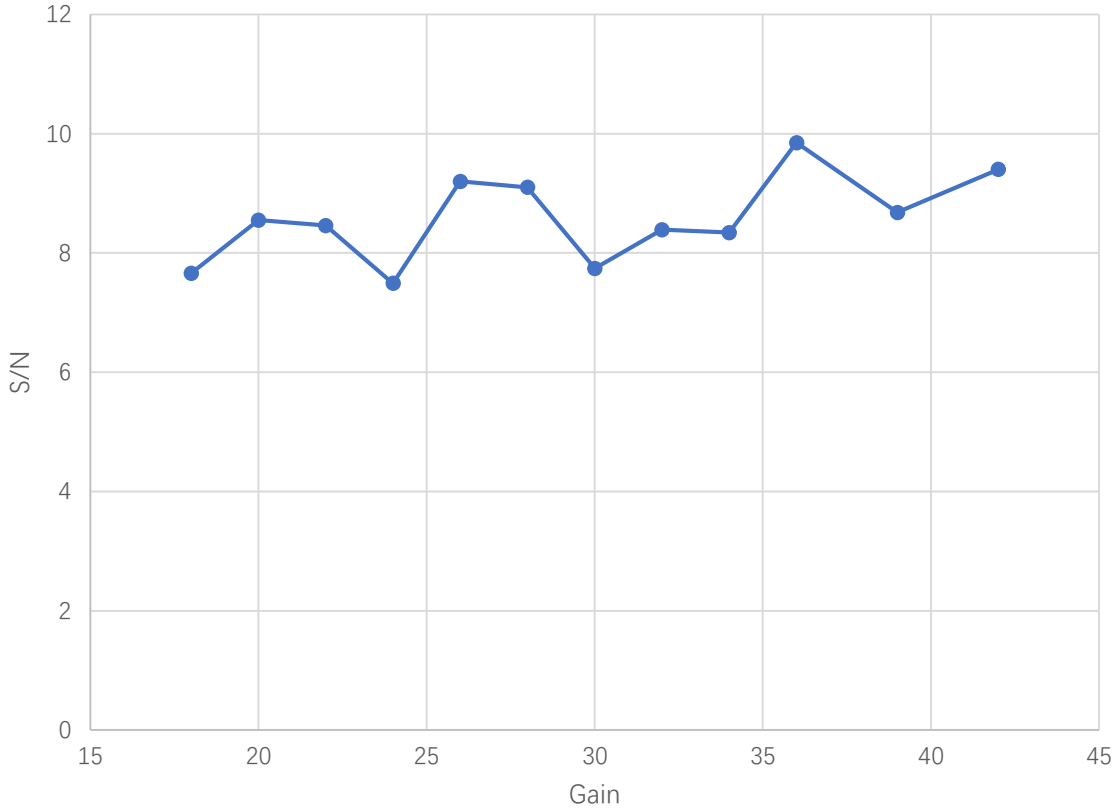




- Multiple photon peaks can be clearly distinguished

Change gain of preamplifier



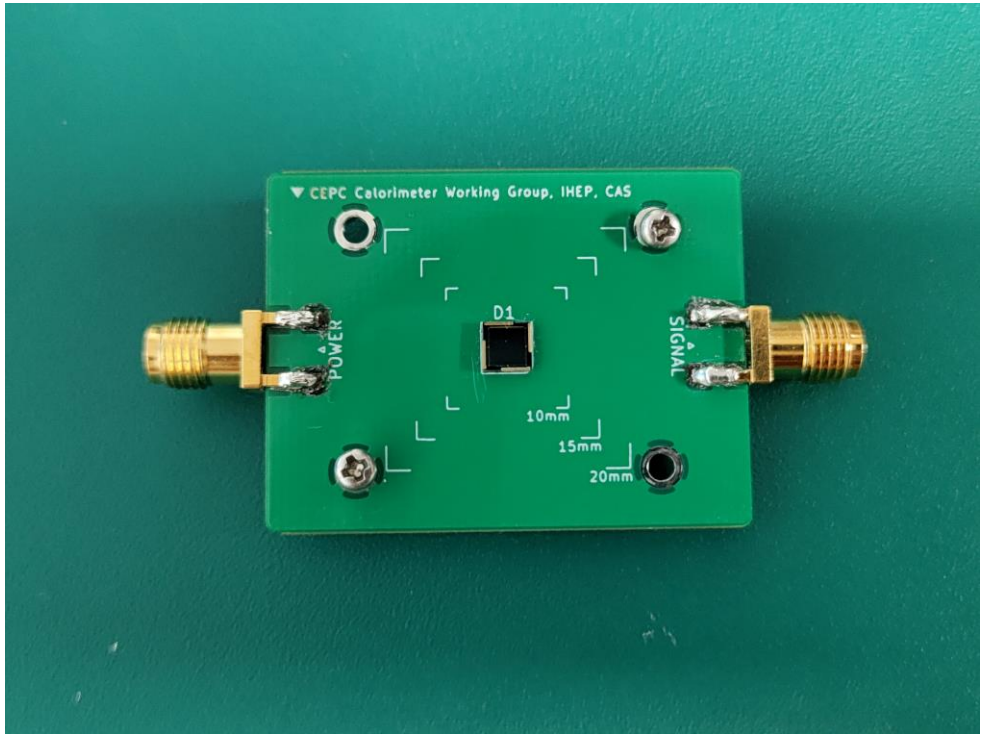


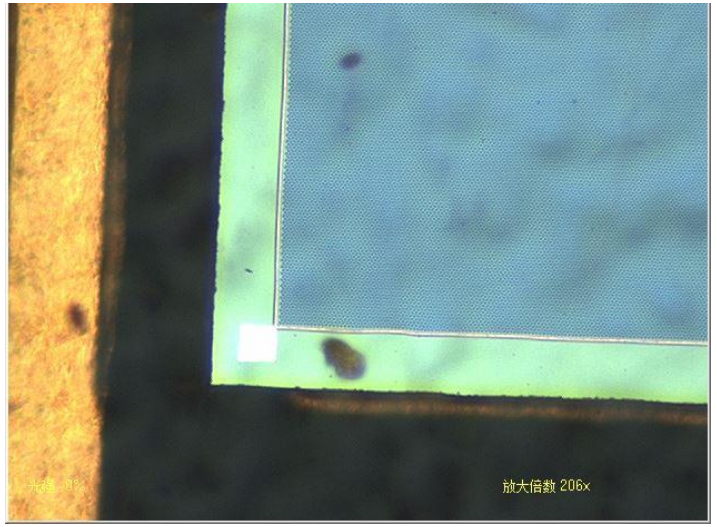
$S/N = Mean_{1pe}/Sigma_{0pe}$

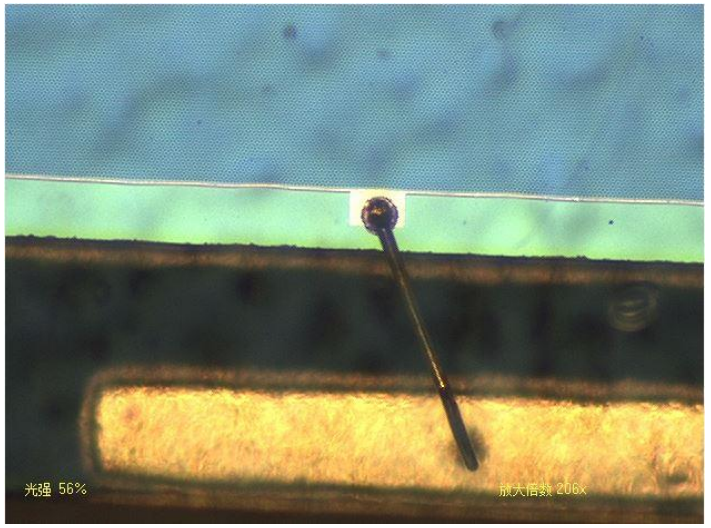
- S/N does not change much form 18 dB to 42 dB

NDL EQR06 series

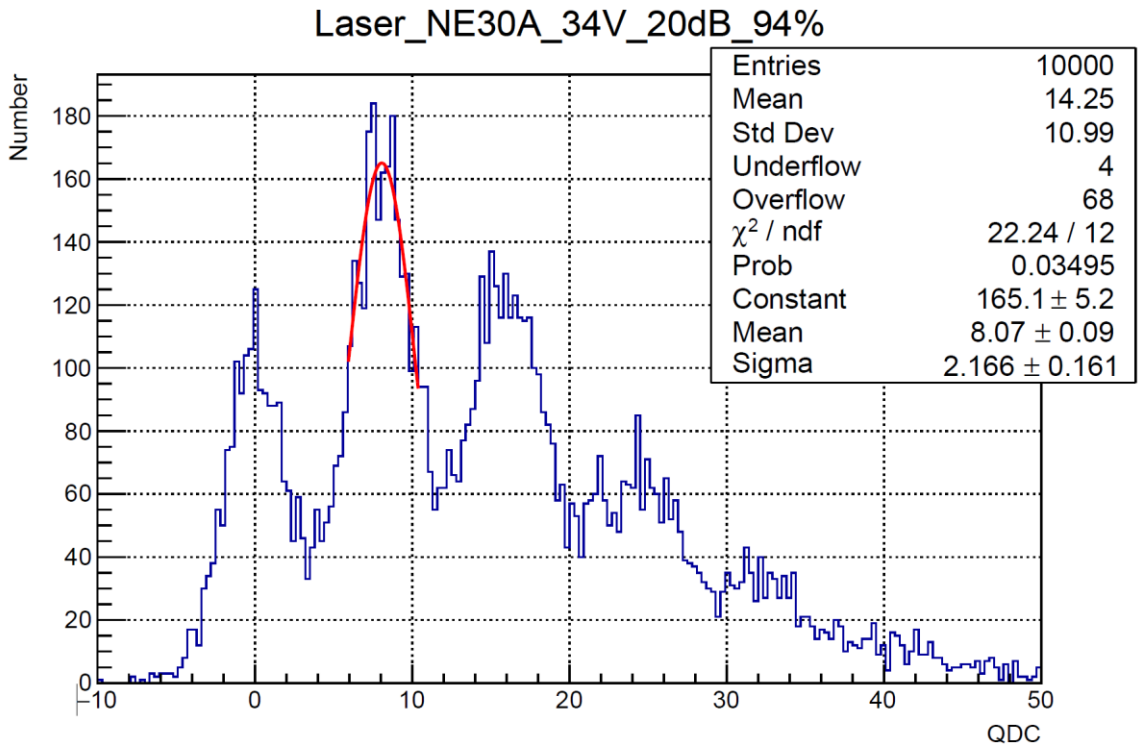
- 11-3030D-S: 6 μm, 3×3 mm
- Nominal gain= 8×10^4 from datasheet (at OV = 8 V)

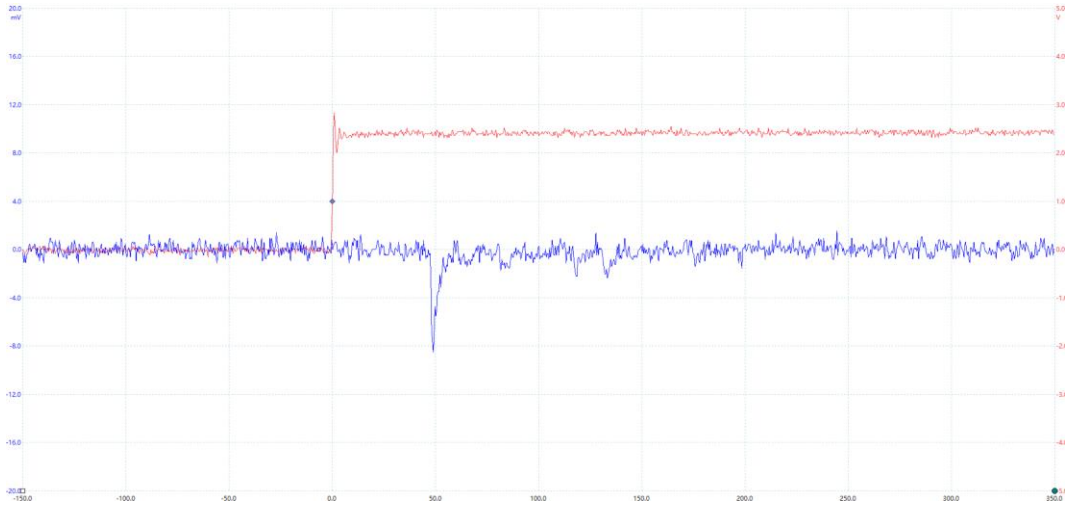


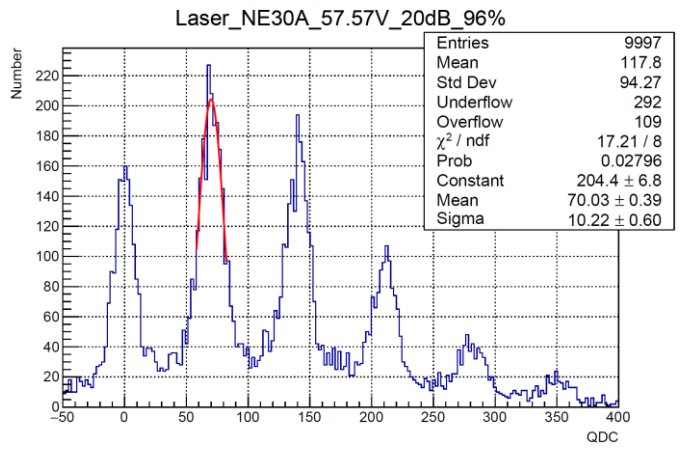




NDL EQR06 series







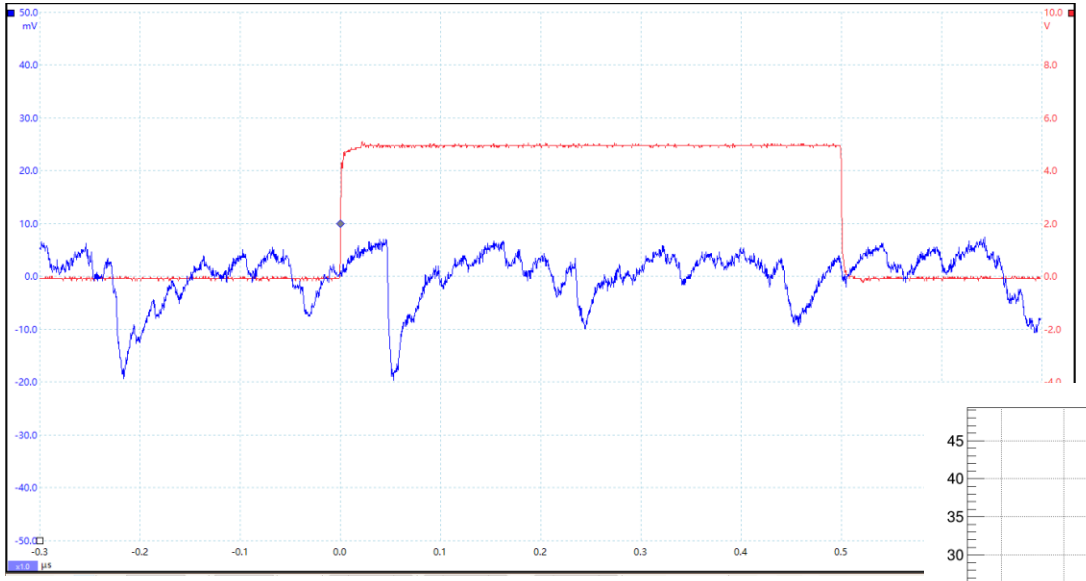
- Narrower pulse shape
- Worse single photon peak resolution
- Fewer detected photon

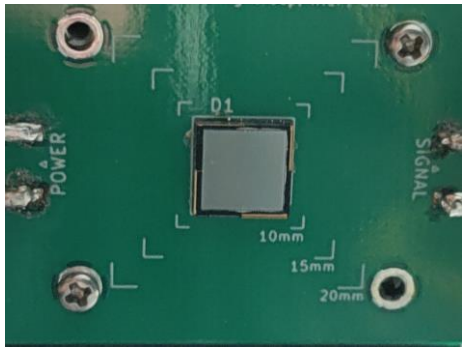
Gain: NDL vs HPK

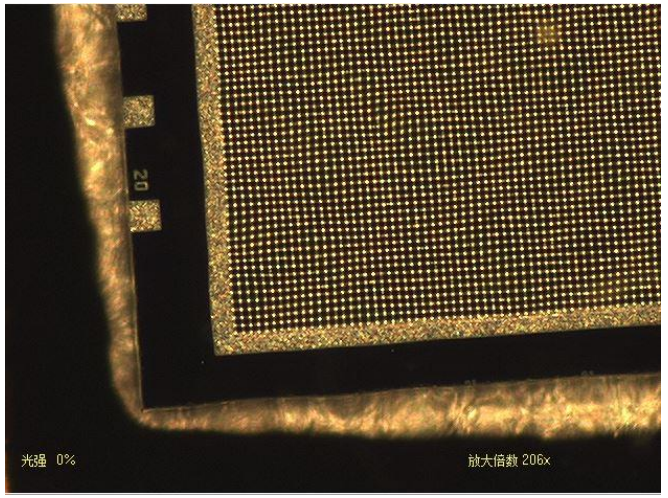
$8\times10^4 / 7\times10^5 \approx$ 8.07 / 70.03

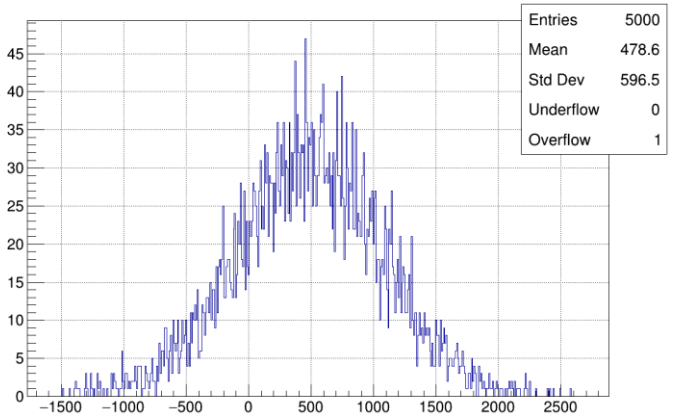
NDL EQR15 series

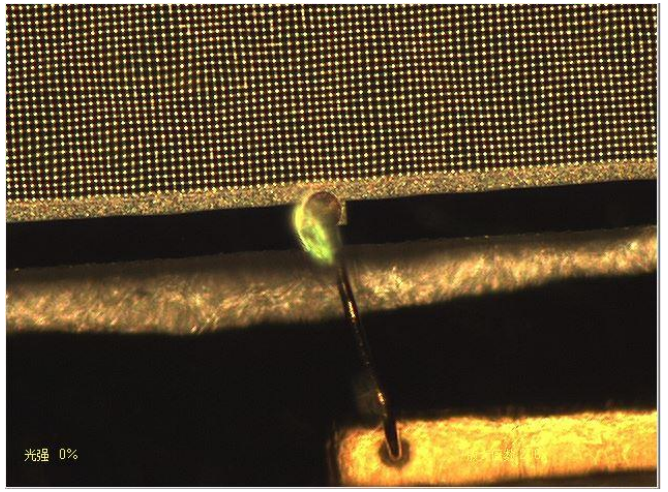
- 11-6060D-S: 15 µm, 6×6 mm











- Too many thermal noise signals
- Unstable baseline
- Unable to see single photon spectrum