Brookhaven National Laboratory

Evaluation of PDE of HRPPD

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June 18th, 2025

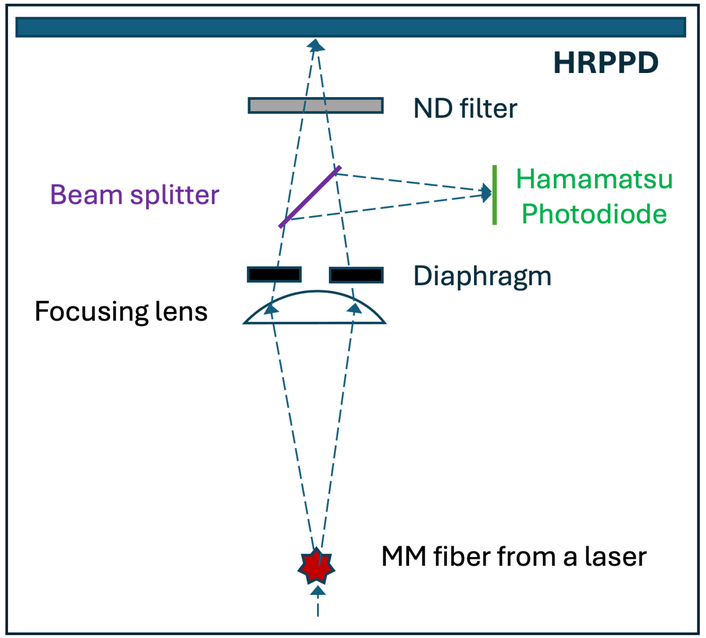
Schematic configuration for PDE

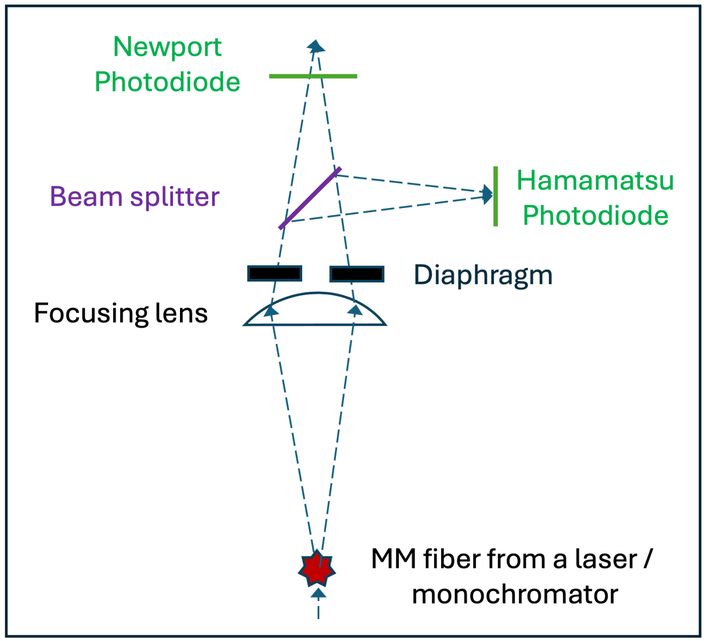
$$P(\text{no signal}) = \sum_{n=0}^{\infty} P(n)(1-p)^n, \quad (1)$$

where $P(n) = \frac{\lambda^n e^{-\lambda}}{n!}$.

$$P(\text{no signal}) = \sum_{n=0}^{\infty} \frac{(\lambda(1-p))^n e^{-\lambda}}{n!} = e^{\lambda(1-p)} \times e^{-\lambda} = e^{-\lambda p} \quad (2)$$

$$p = \frac{ln(P(\text{no signal}))}{-\lambda} \quad (3)$$

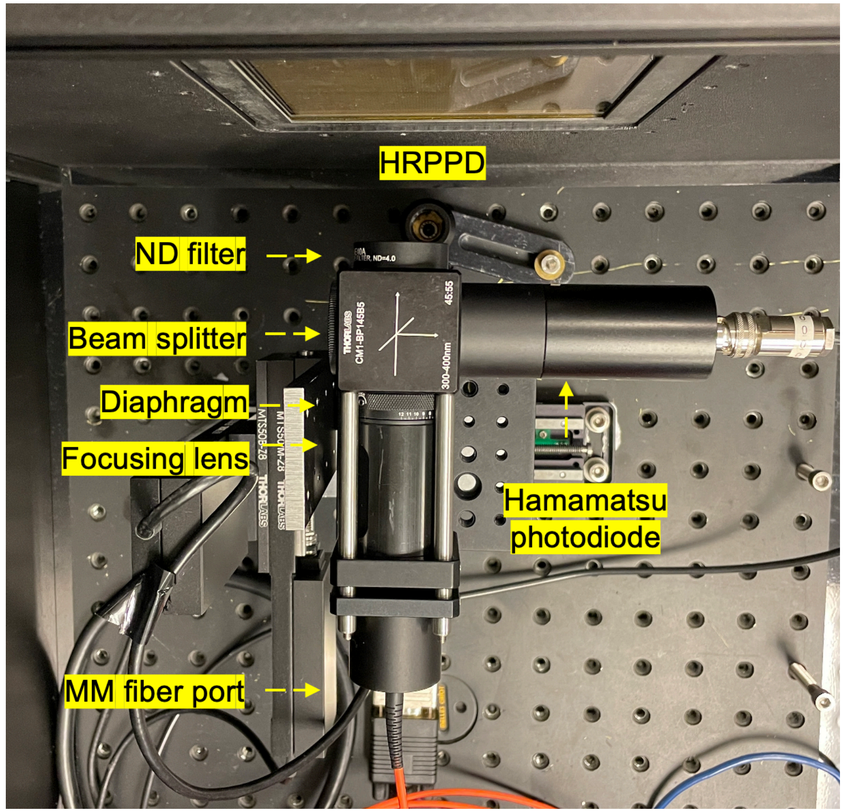


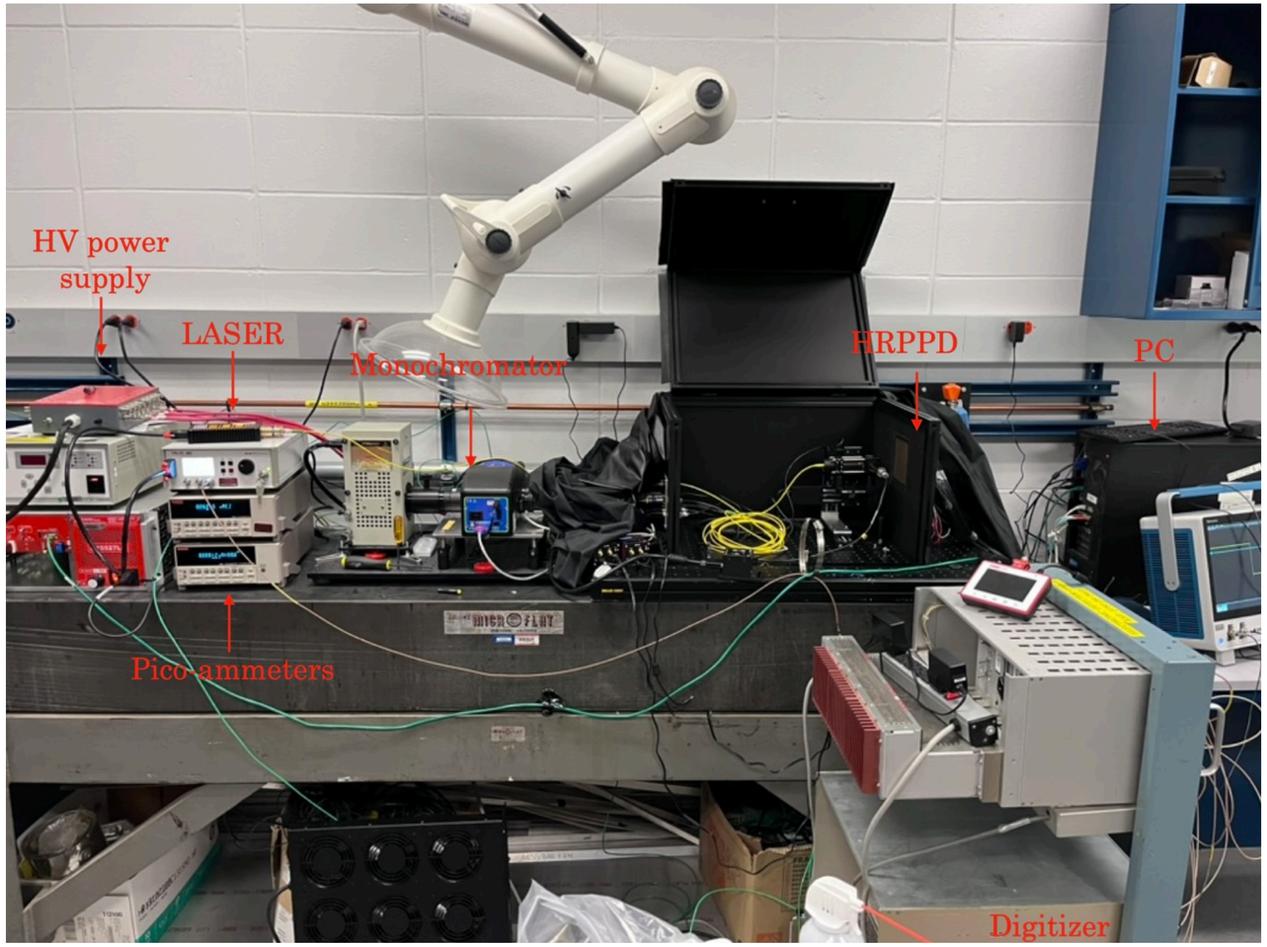


$$\lambda = \frac{I \cdot R}{e \cdot QE \cdot f \cdot A}$$

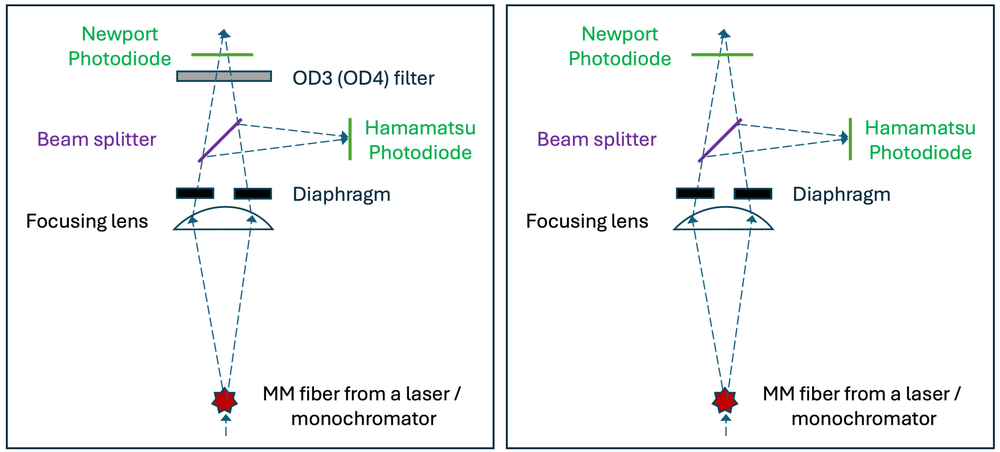
I is the current of the reference Hamamatsu photodiode, QE is its quantum efficiency at the laser wavelength, R is a ratio of the transmitted and the reflected light after the beam splitter at this wavelength, e is the elementary charge, f is a laser repetition rate, and A is an attenuation factor of the ND filter.

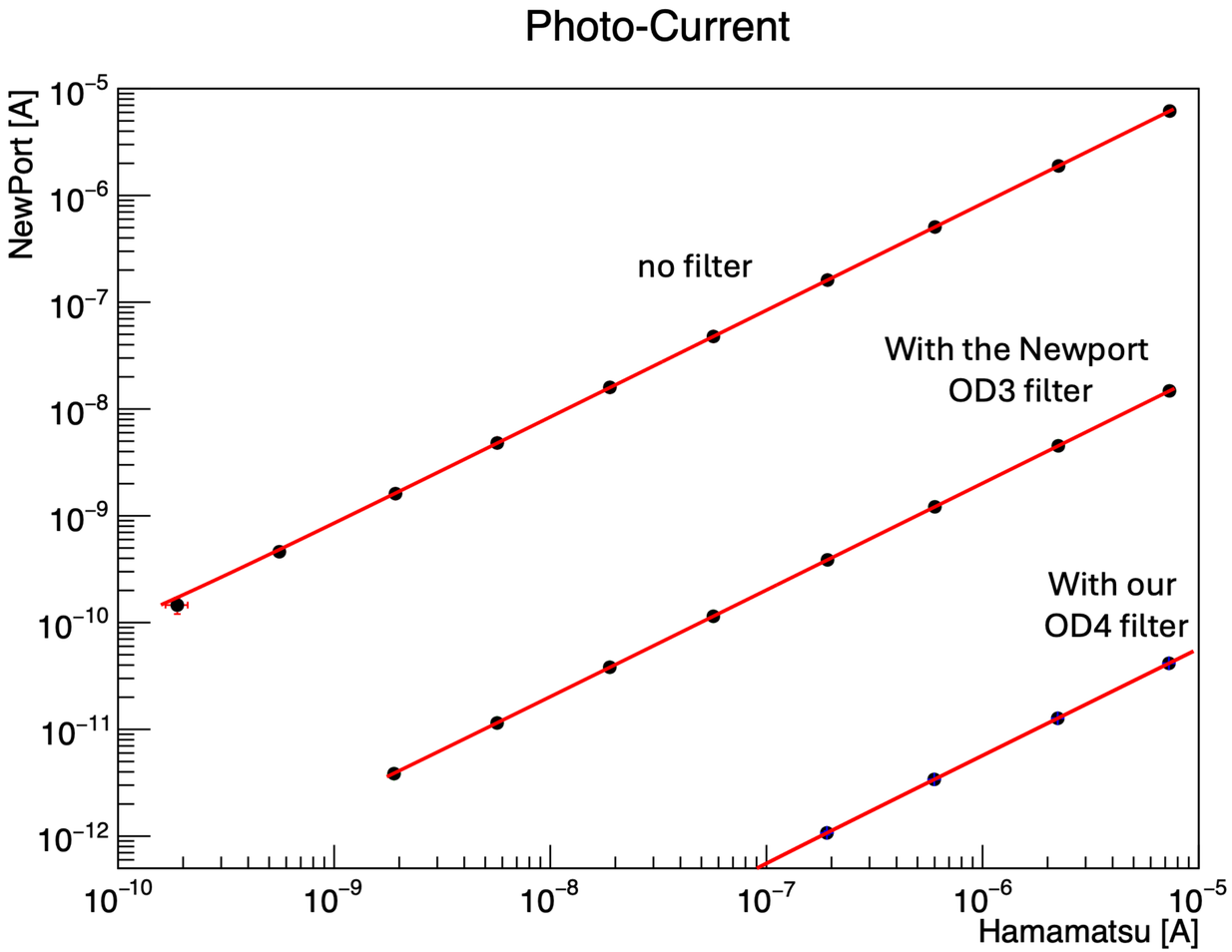
Setup


HRPPD
ND filter
Beam splitter
Diaphragm
Focusing lens
Hamamatsu photodiode
MM fiber port


HV power supply
LASER
Monochromator
HRPPD
PC
Pico-ammeters
Digitizer

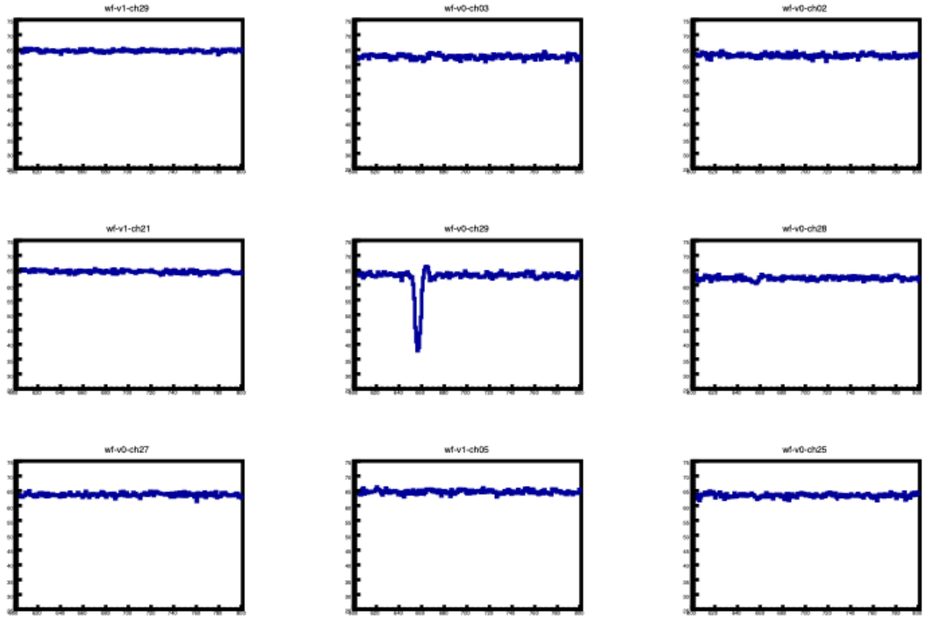
Calibration of the ND filter

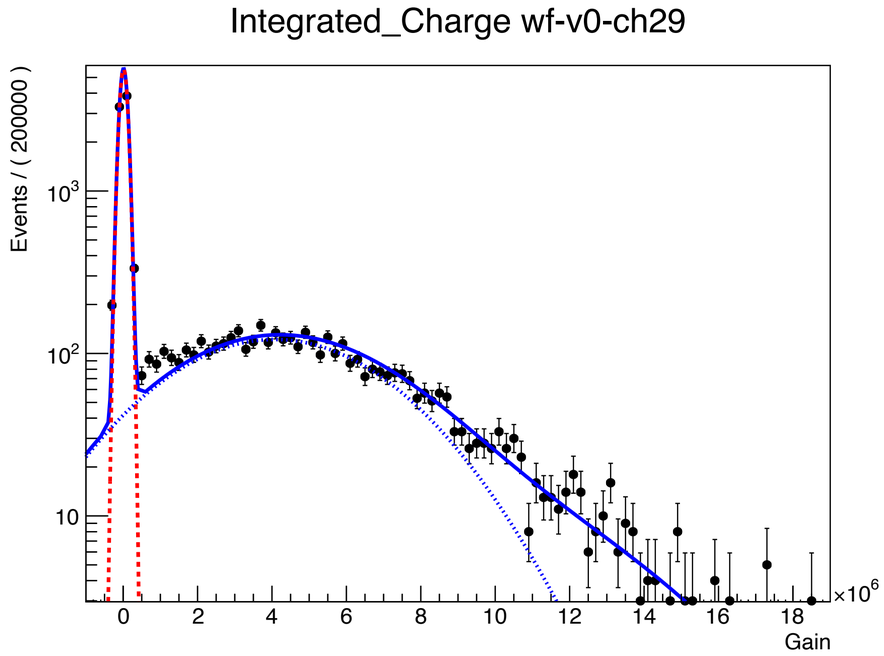




- The attenuation factor of OD4(OD3) is measured. Photo-current is tuned by varying laser frequency.

Count signal



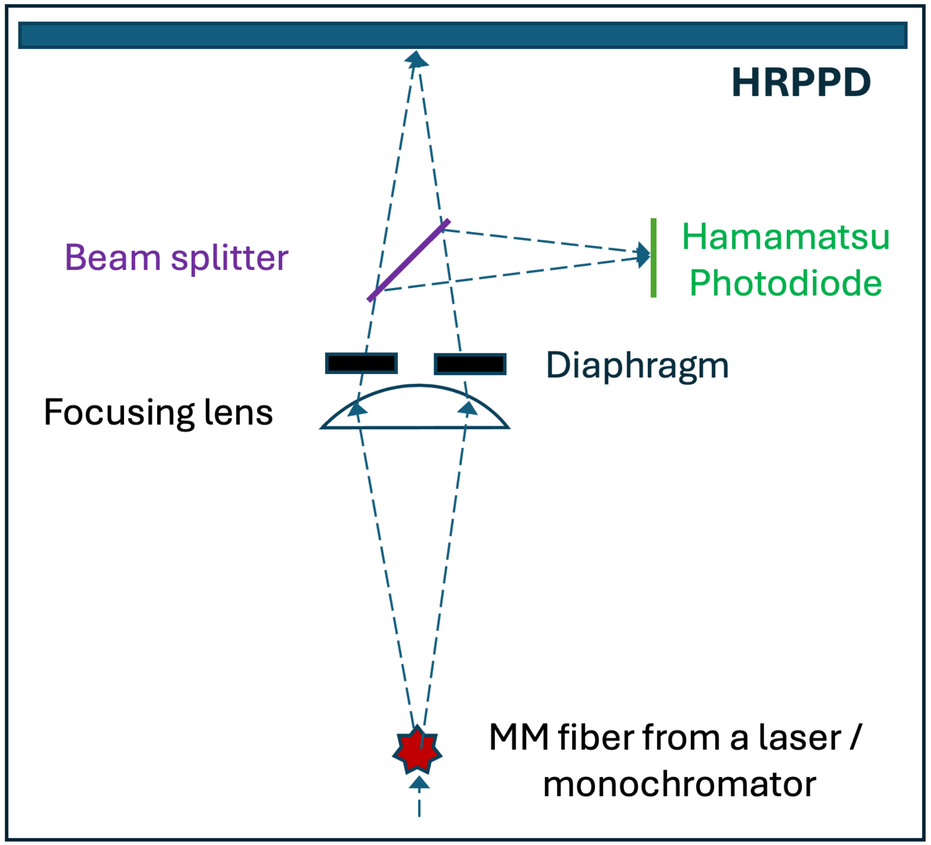


- Central channel and four nearby connecting neighbor channels are used. Events lie above 3 sigma of the pedestal peak (red dashed line) counts as signal detected.

tune	λ	events above threshold	PDE
36.0%	4.978 ± 0.010	61.4 ± 0.4%	18.9 ± 0.2%
46.0%	3.713 ± 0.007	51.7 ± 0.5%	19.4 ± 0.3%
52.4%	2.573 ± 0.013	39.8 ± 0.4%	19.5 ± 0.3%

Errors are statistical only.

QE measurement



light source	HRPPD PC current	QE
PiLas laser @ 40 MHz, tune 0%	~2006 nA	23.1 ± 0.3 %
PiLas laser @ 30 MHz, tune 0%	~1575 nA	22.7 ± 0.3 %
PiLas laser @ 20 MHz, tune 0%	~1173 nA	22.9 ± 0.3 %
PiLas laser @ 10 MHz, tune 0%	~625 nA	23.3 ± 0.2 %
PiLas laser @ 1 MHz, tune 0%	~56 nA	24.3 ± 0.1 %
PiLas laser @ 40 MHz, tune 0%	~1916 nA	22.0 ± 0.4 %
PiLas laser @ 40 MHz, tune 60%	~957 nA	22.7 ± 0.3 %
PiLas laser @ 40 MHz, tune 80%	~634 nA	23.0 ± 0.2 %
PiLas laser @ 40 MHz, tune 93%	~340 nA	23.3 ± 0.3 %
Monochromator	~63 nA	22.9 ± 0.1 %

$$CE = PDE/QE = 79\%$$

- PC current readout from entry of MCP#1.

Next step

- Beam splitter changed!

Backup

MCP under microscope