HRPPD QA Test stand

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Goals

1. Setup a reasonable measurement setup which can be used to measure the QE of the HRPPD samples.
2. Determine the uniformity over the HRPPD photosensitive area.
3. Determine the variation of QE as a function of photon energy.

Principle to measure the Quantum efficiency

$$(Q.E.)\_Theoretical = \frac{\text{Number of converted p.e}}{\text{Photon flux}}$$

Principal source/s of uncertainty:

Determination of the Photon flux

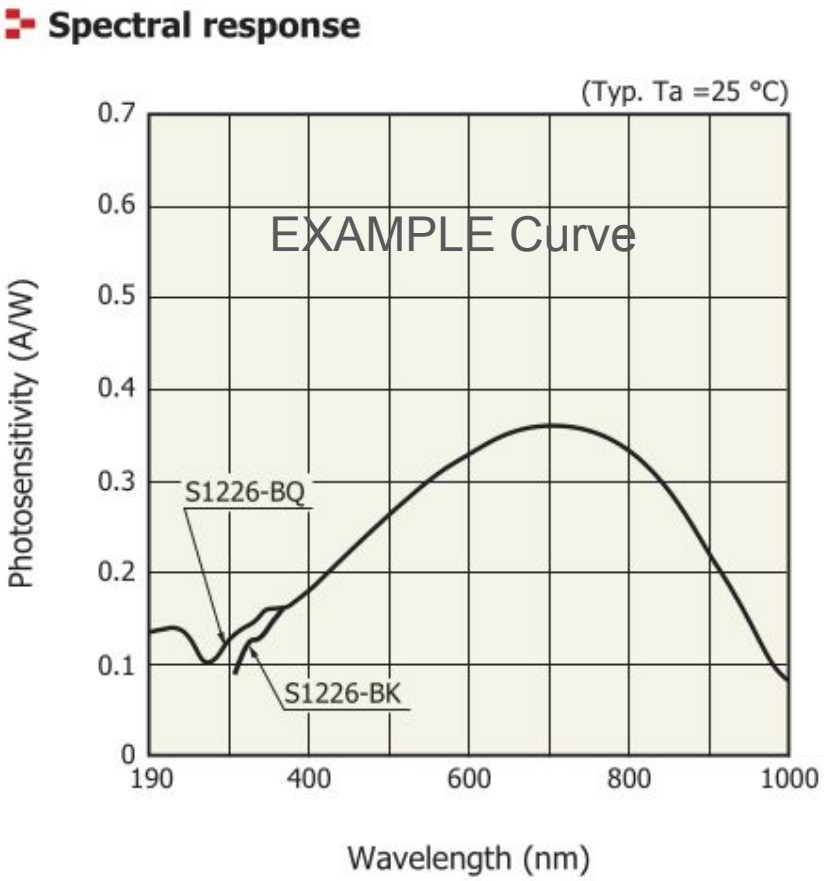
→ Monitor stability of the photon source over time!

→ A calibrated photodiode with known Q.E. to scale the HRPPD photocurrents.

$$(Q.E.)\_measured = (QE)\_standard * \frac{I\_HRPPD}{I\_std} * \frac{I\_ref1}{I\_ref2}$$

Here the currents are dark current subtracted from monitored current

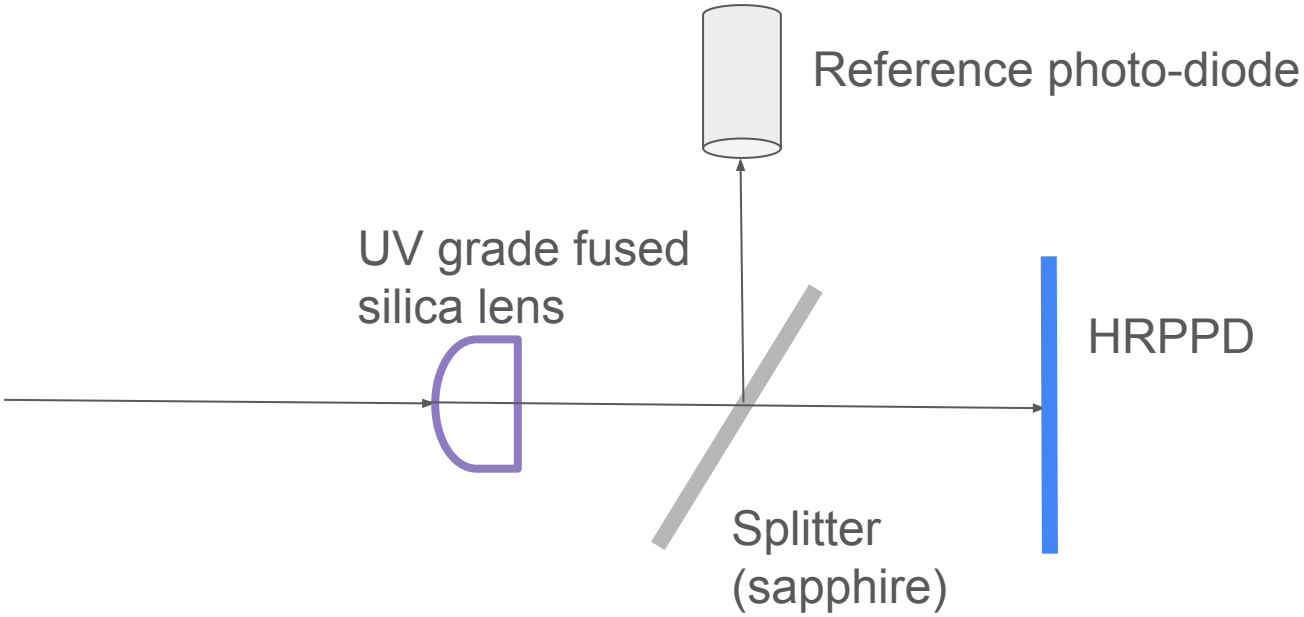
Photosensitivity and QE



$$QE = \left(\frac{S \cdot 1240}{\lambda} \right) \cdot 100\ [\%]$$

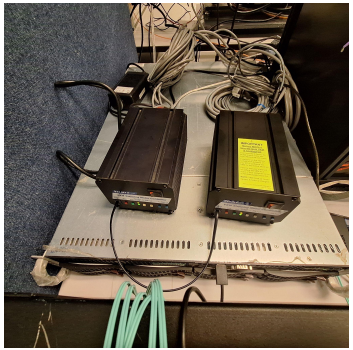
If the light flux is determined with given uncertainty and the photosensitivity of the photosensor of a photometer is well known, QE/photosensitivity of an uncalibrated photodiode can be determined assuming (and or verifying) the light flux did not change in time.

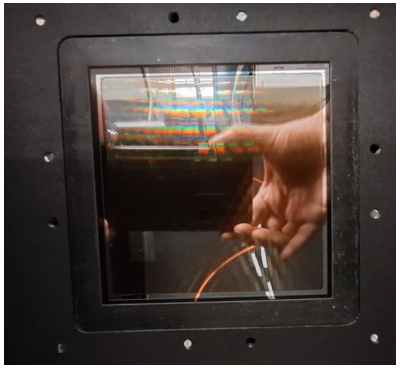
Schematic

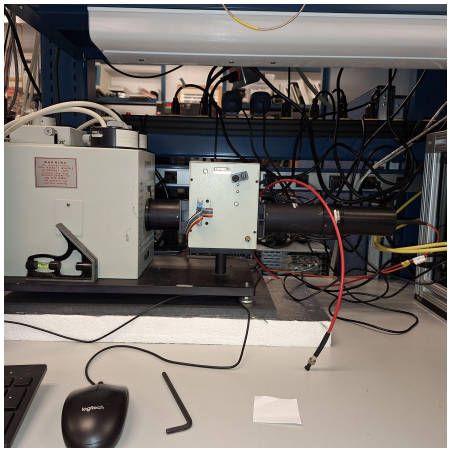

Reference photo-diode
UV grade fused
silica lens
HRPPD
Splitter
(sapphire)

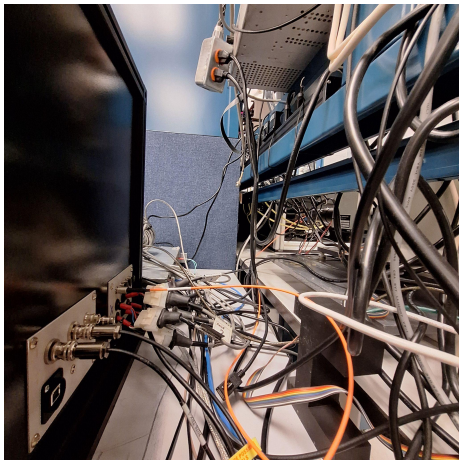
Instruments available

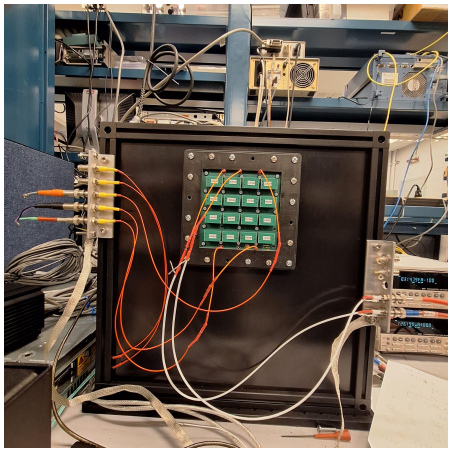
1. Oriel monochromator with a xenon lamp.
2. Keithley 6487 picoammeters X 2
3. Velmex motor setup moveable in X,Y,Z coordiantes
4. Photodiodes S1226-8BQ (HAMA) X 2
5. THORLabs photometer (350-1100 nm) S150C

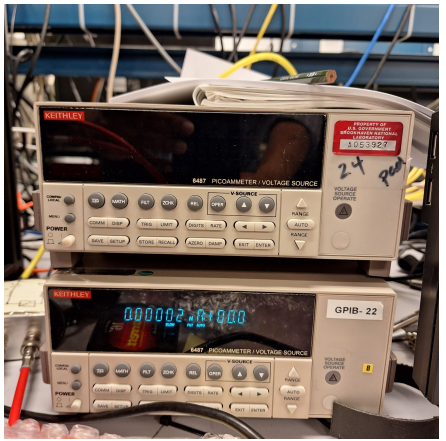




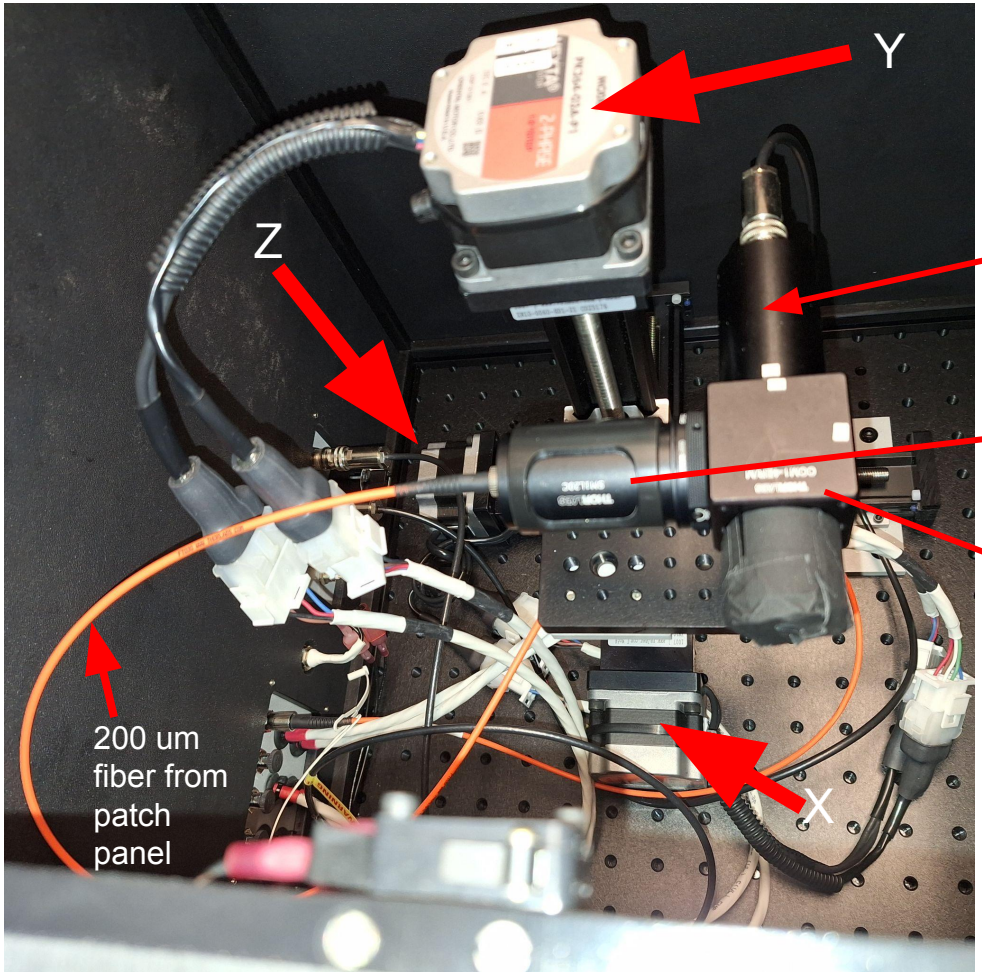


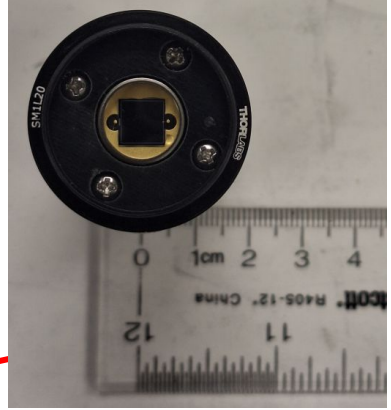






Setup inside

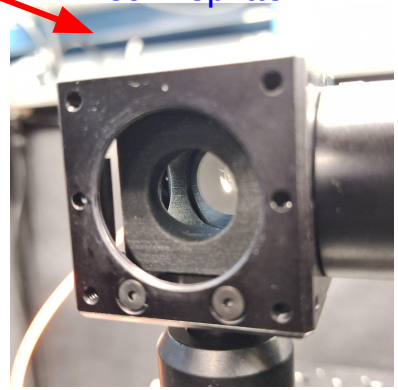




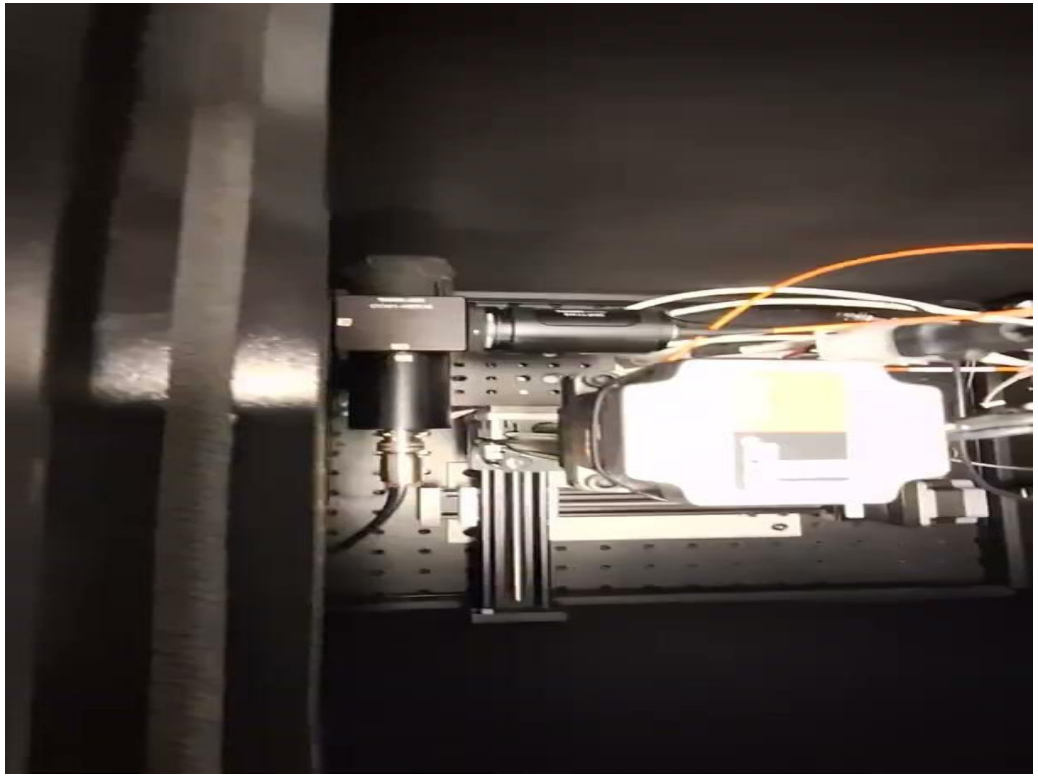
Ref photodiode

Focalizing lens

Beam splitter

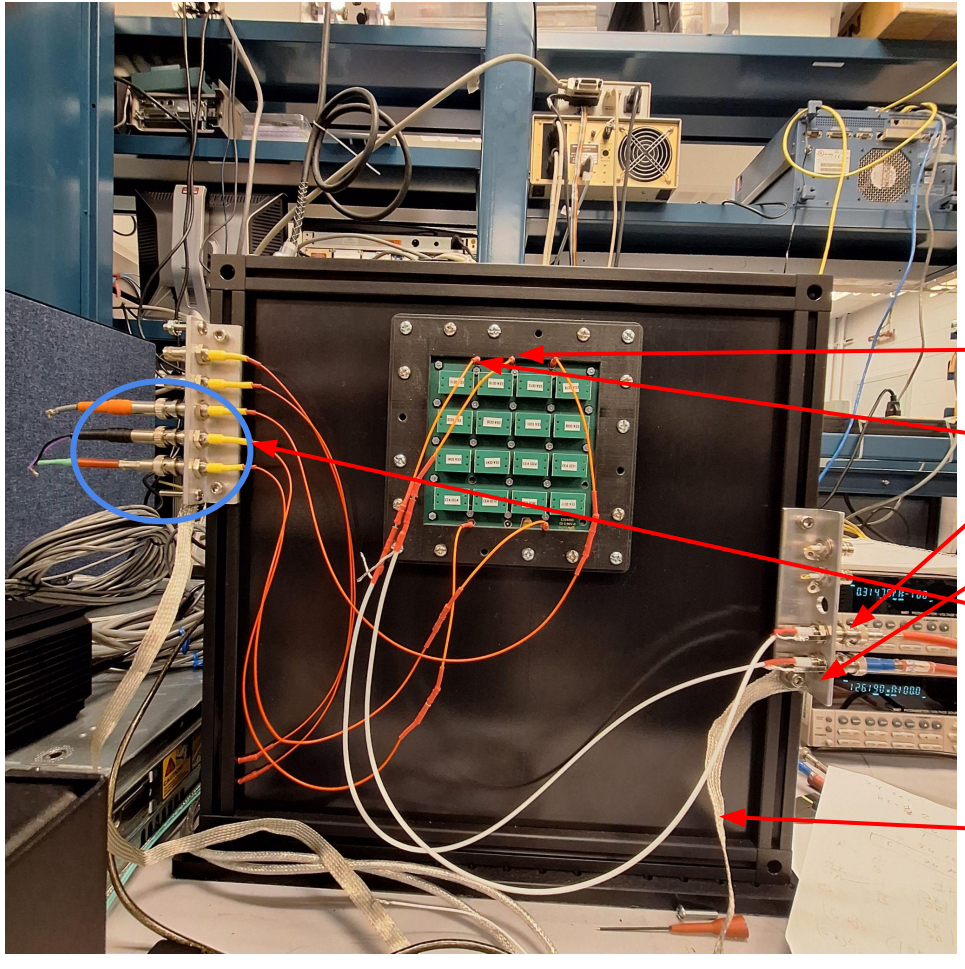


Motor movement



- Two Velmex controller are in DESY chain.
- The maximum Z position does not touch the HRPPD window.
- Enough available space to cover the substantial (out of HRPPD region)

Circuitry



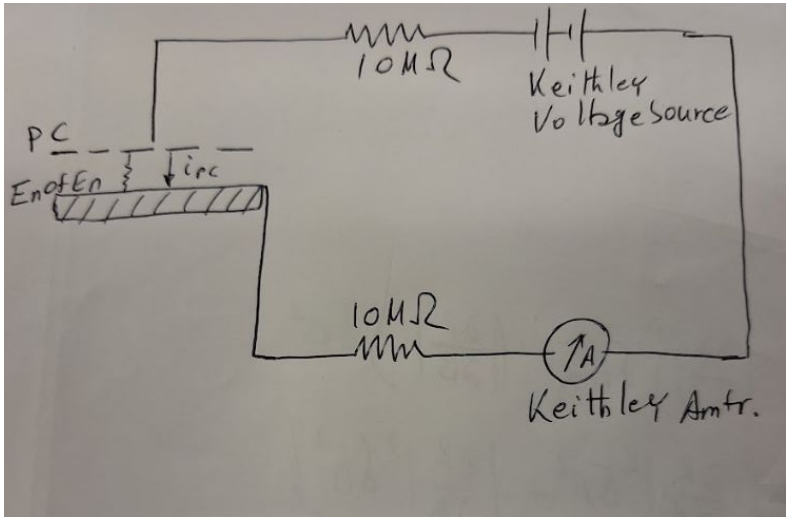
Voltage to PC

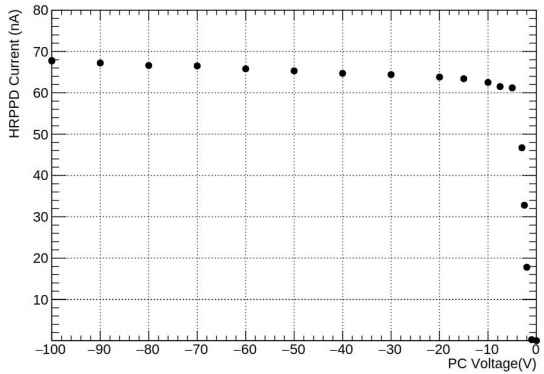
To entry of entry

Other electrodes grounded

Ensuring both panels are in ground

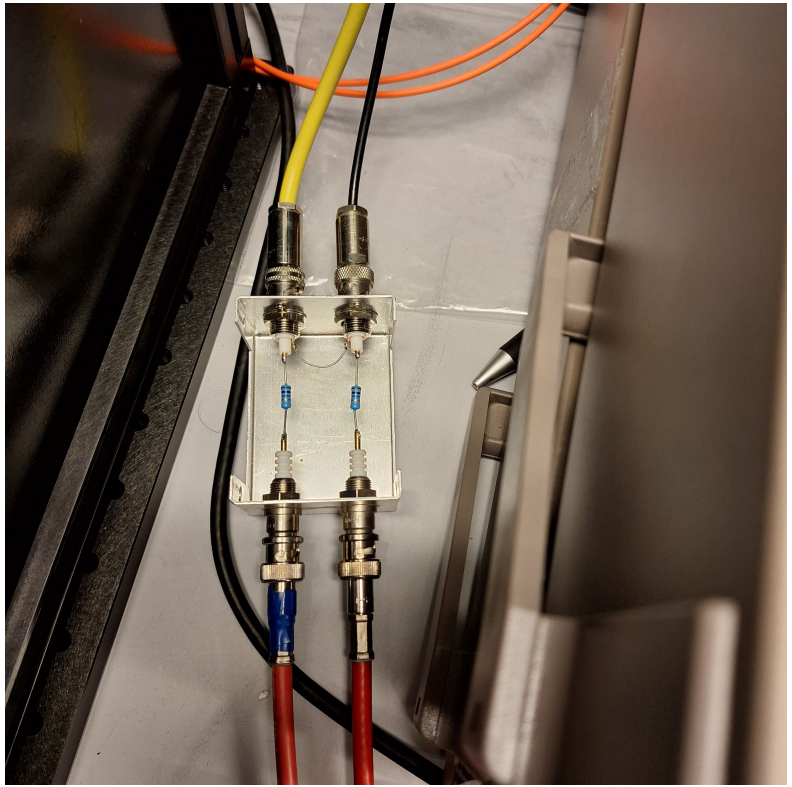
Voltage provider to HRPPD photocathode

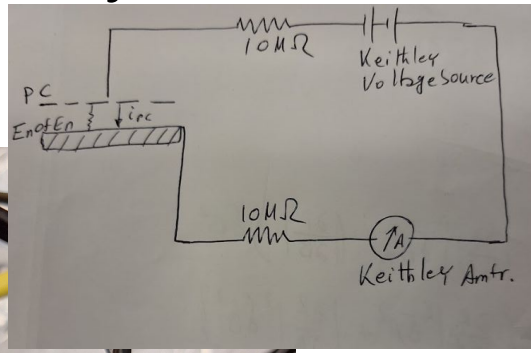


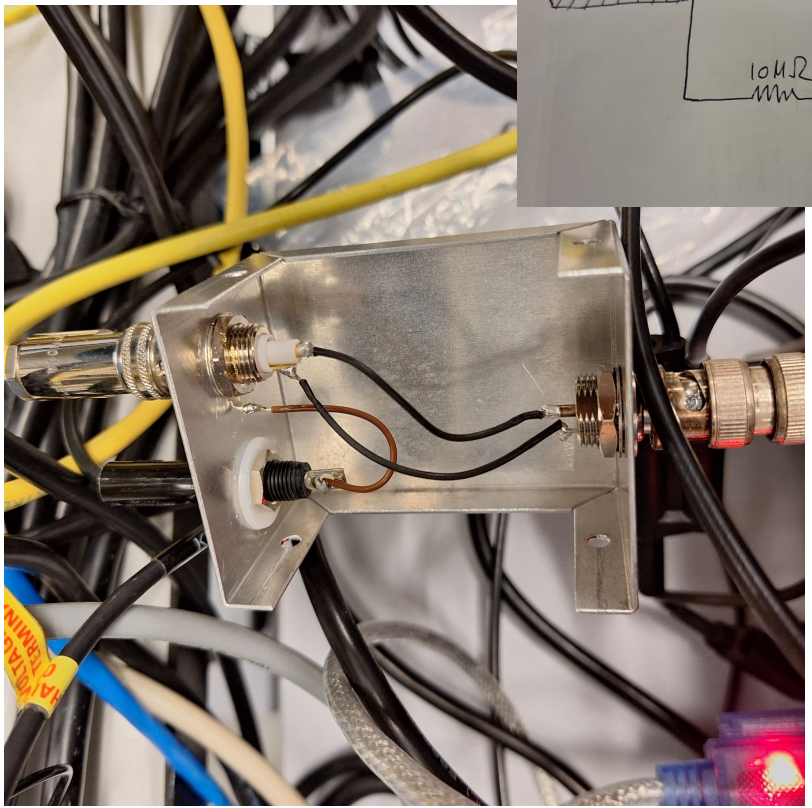


- The photocathode voltage has been provided by the Keithley voltage source.
- The circuit has been tested with a known resistance.
- Drift scan has been made to monitor photo-current as a function of applied voltage to PC. Broad plateau.
- Currently - 100V has been applied to the PC (after a drift scan).

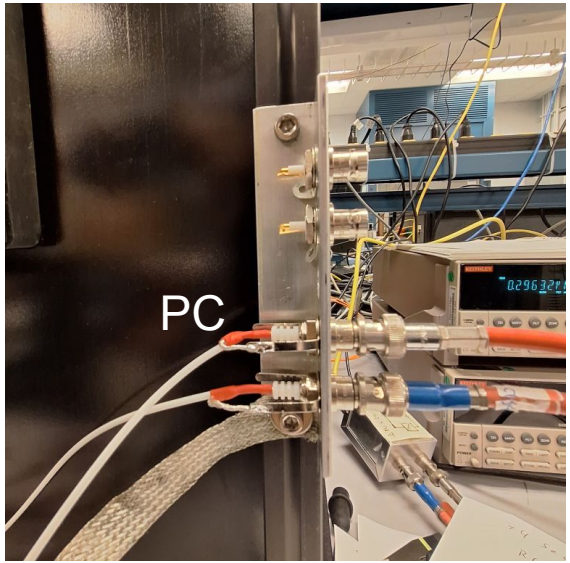
Voltage provider to HRPPD photocathode: circuitry

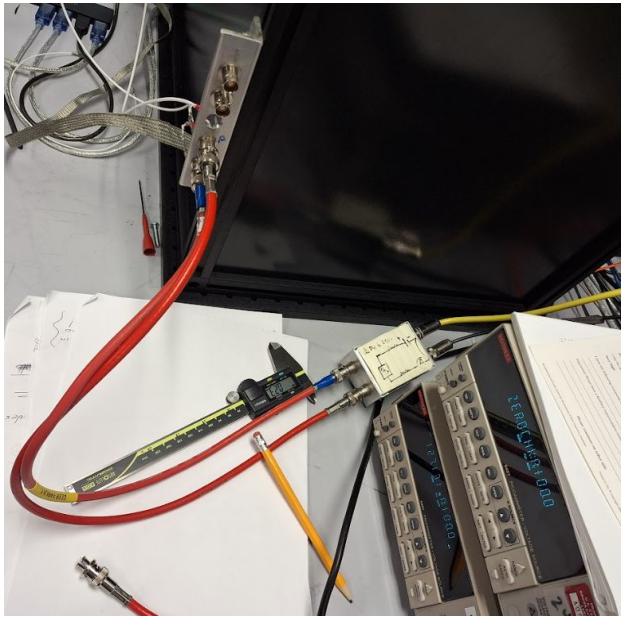


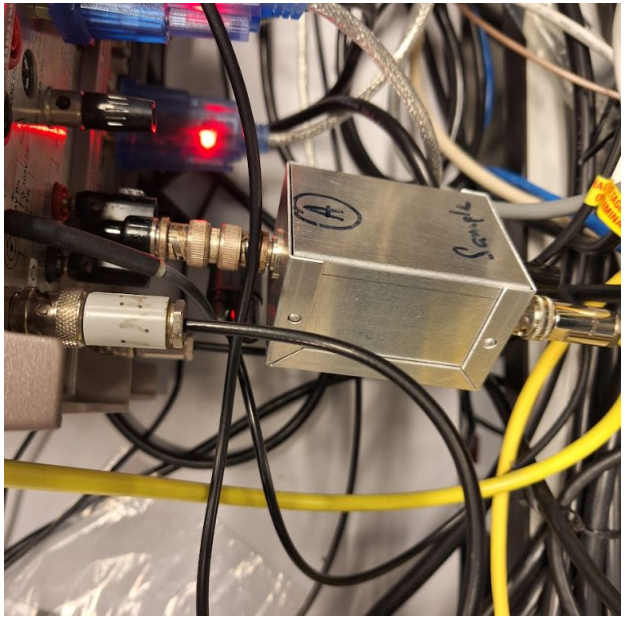




Voltage provider to HRPPD photocathode: circuitry



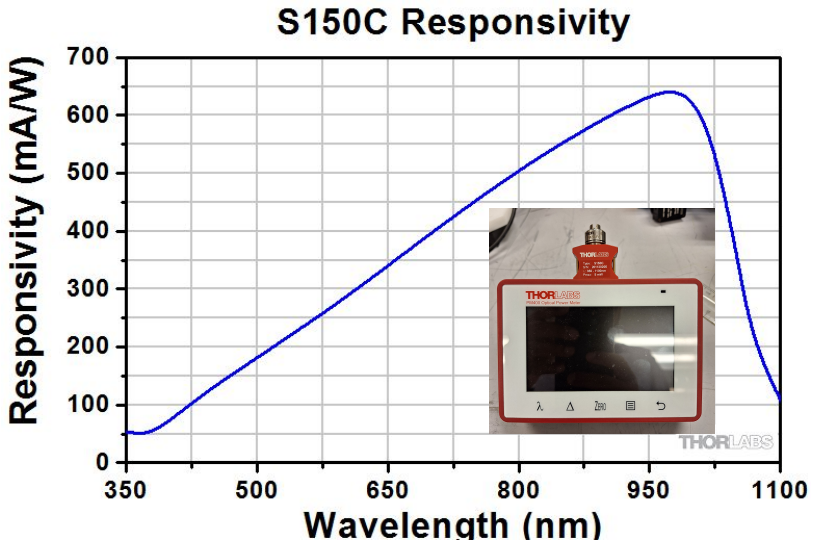




Grounding between
two panels ensured!

Original Plan (Modified)

- ❑ To determine the reflectivity of the beam splitter.
- ❑ Calibrate one of the photodiodes with the photometer
- ❑ Use this calibrated photodiode to use as a reference QE.



Caveat/s:

- ❑ The photometer photosensitivity is calibrated with 5% uncertainty.
- ❑ The photometer is sensitive only between 350-1100 nm.
- ❑ The acceptance of the photometer sensor surface will cut-away a region of light spot.

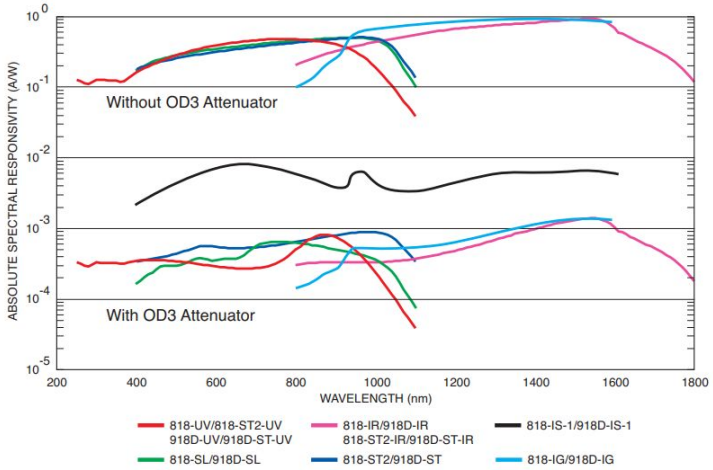
Solution:

Newport calibrated photodiode 818-UV/DB has been chosen for purchase.

Advantage:

1) **Calibrated with ~1.5% uncertainty in our working range.**
2) **Similar device as of INCOM.**

DOES NOT STOP US FROM HRPPD CURRENT MEASUREMENT!



Couple of observations

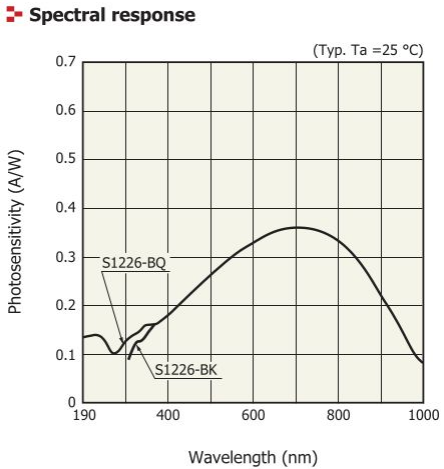
- With and without Applied ND filter (0.5) the photocurrent scales to factor three only around -10V applied voltage in the PC.

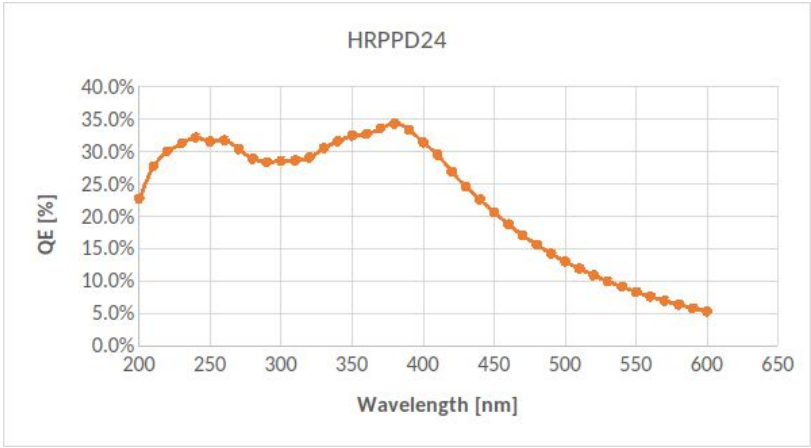
  At 400 nm ND(0.5) -100 V ~ 100 nA. W/o ND ~330 nA. @ -2.5 V 32 nA →53 nA

- Plateau has no effect on wavelength.
- First order compatibility with our reference plot at 475 nm.

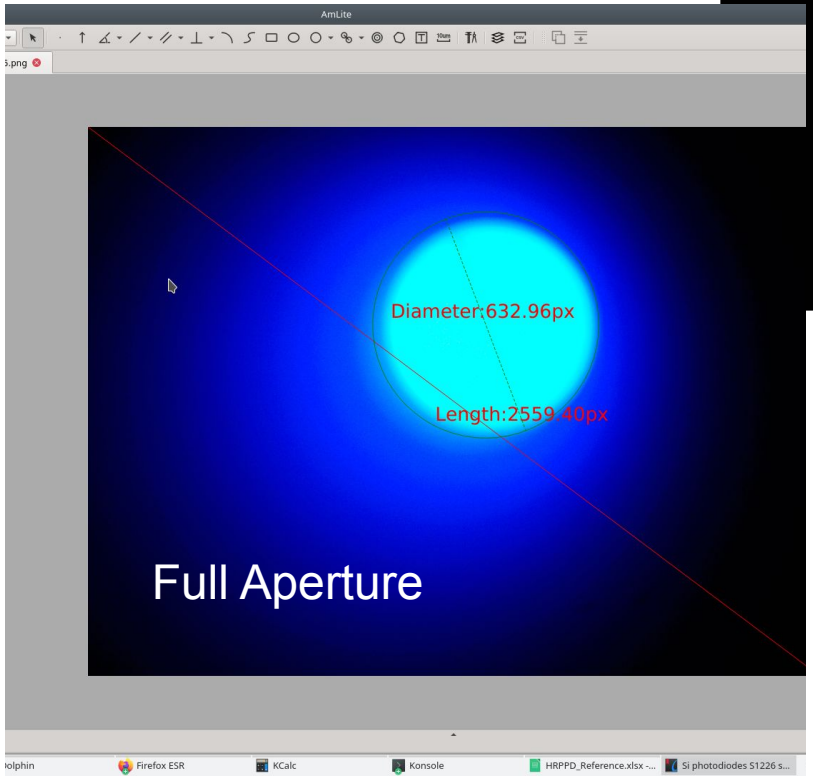
  With 0.5 ND filter we had seen ~67 nA currents at 475 nm. The photodiode current was ~156 nA (only 15% of light). This means that HRPPD is seeing factor three less current compared to photodiode with similar flux.

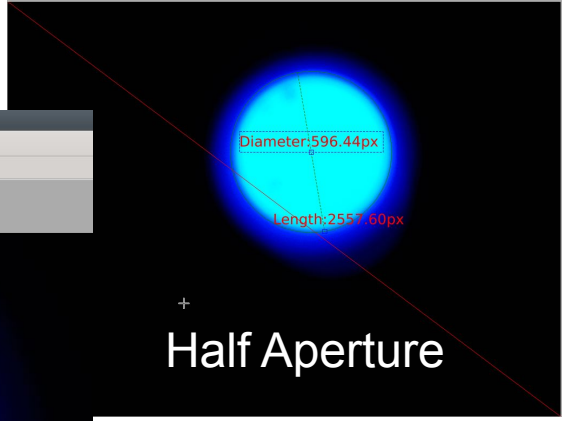
  The average photosensitivity of the photodiode around 475 is 0.3A/W. Translated to QE (diode) about 68%. So HRPPD QE should be around 15%!

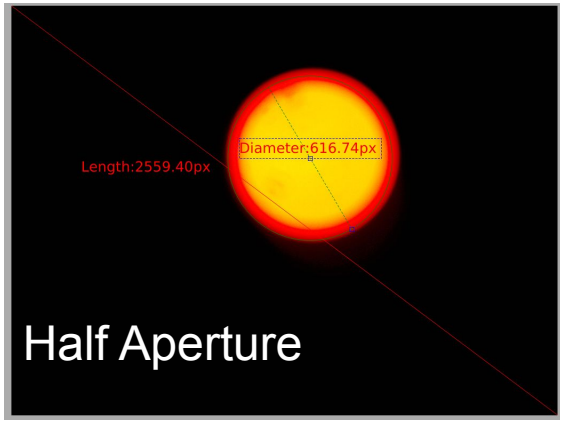




Beamspot





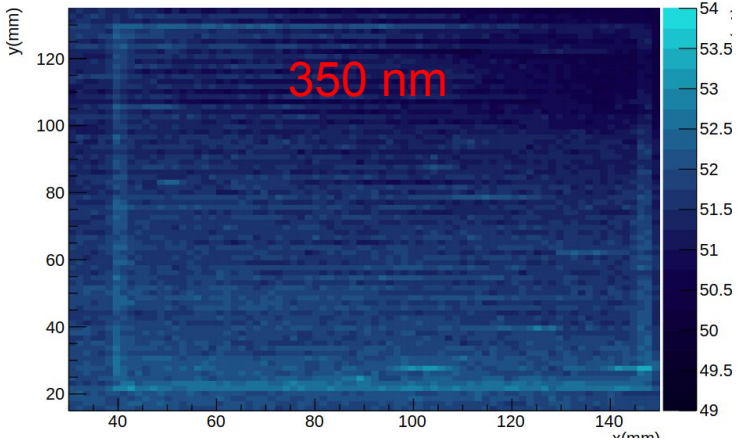


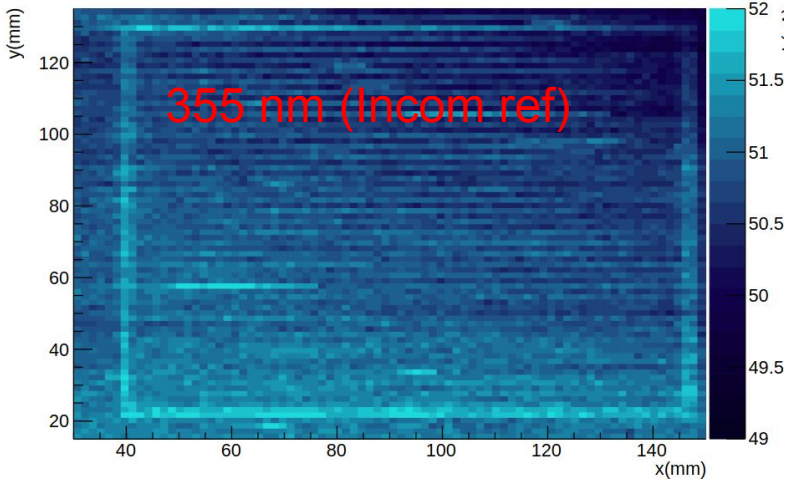
Each pixel is 2.5X2.5 micron.
Leading to beam spot of ~1.5-1.6 mm
(at the camera).

Similar size in
Window of
HRPPD →

Scanning step size→ 1.5 mm

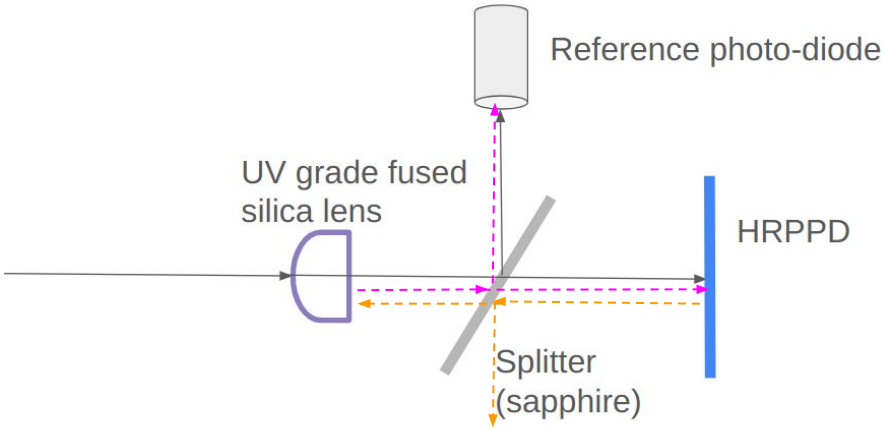
Uniformity of currents (Photodiode)





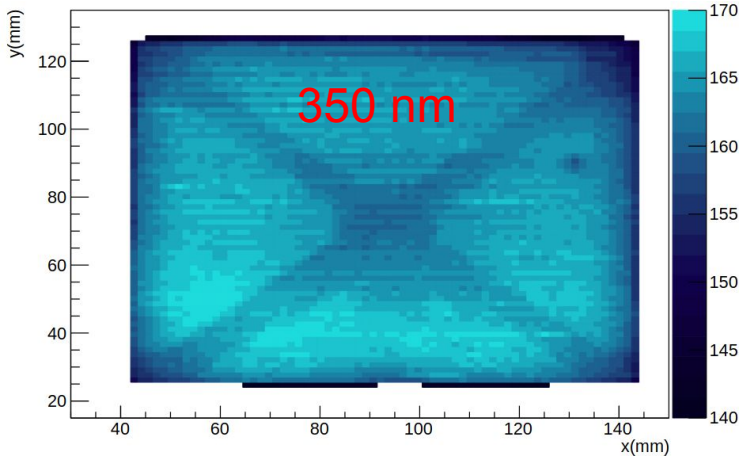
Light fluctuation structure seen along scanning direction! ‘

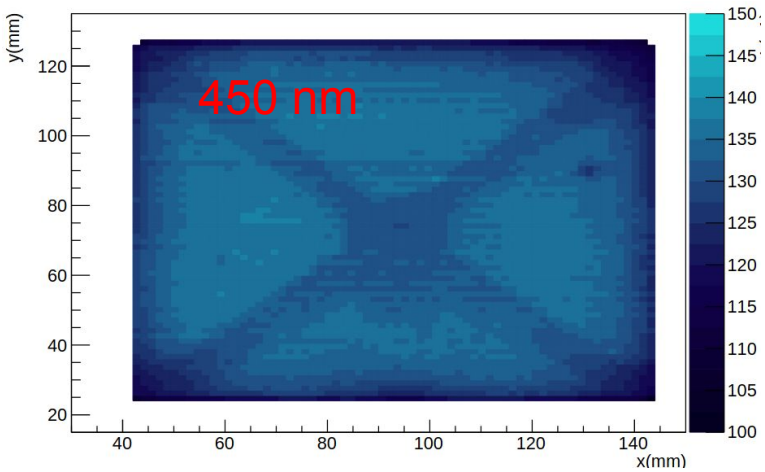
Image of the HRPPD border

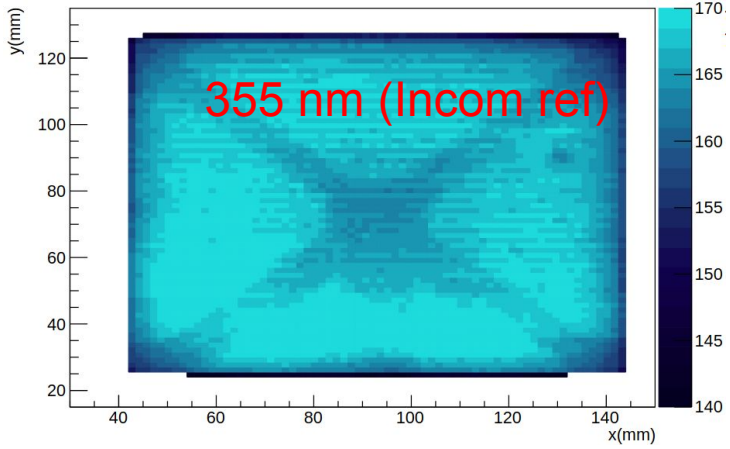


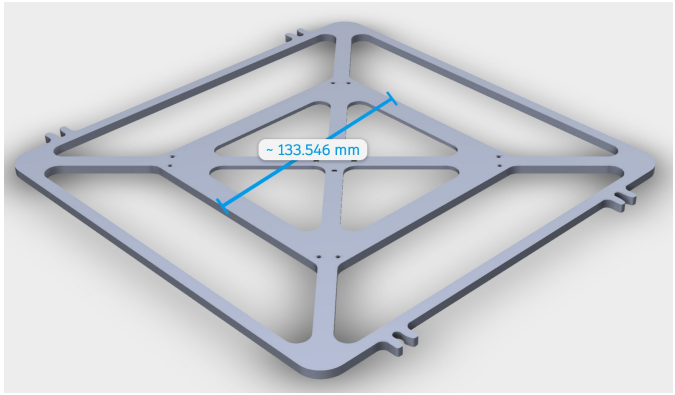
Irreducible systematics from the metallic surface!

Uniformity of currents (HRPPD)

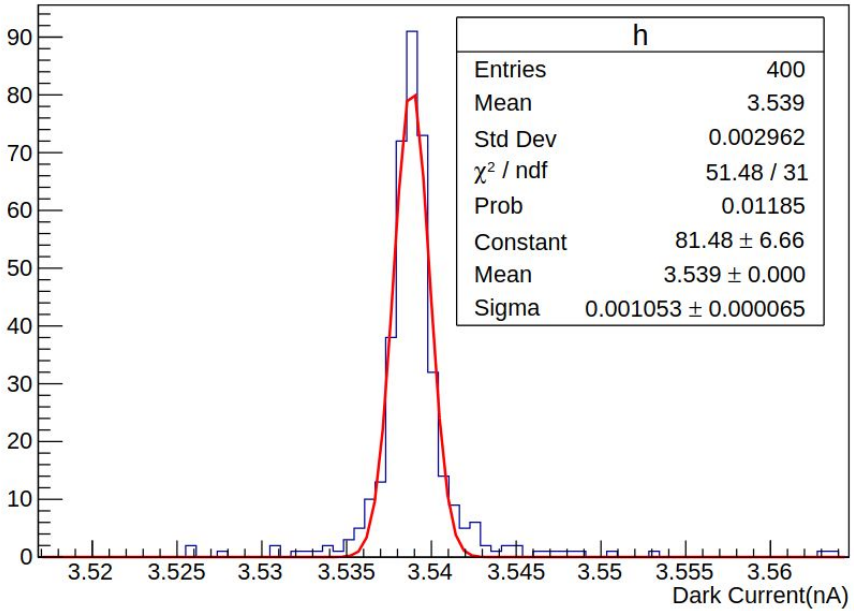


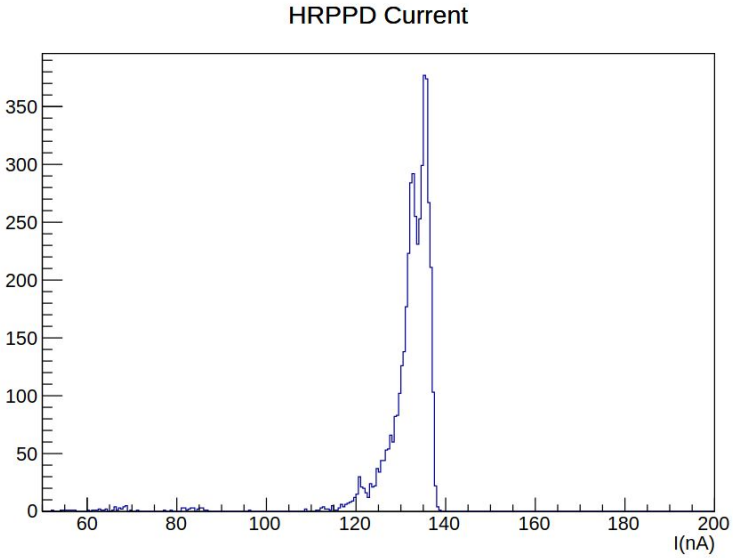


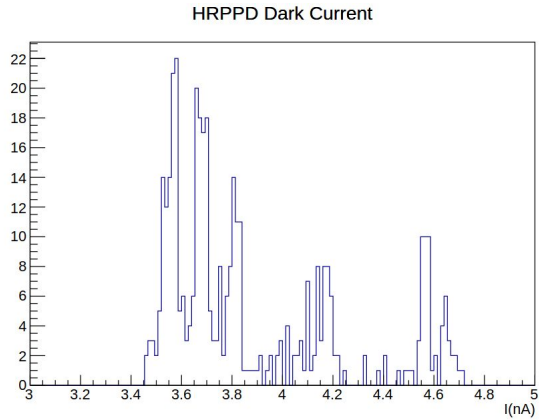




Dark current and HRPPD current

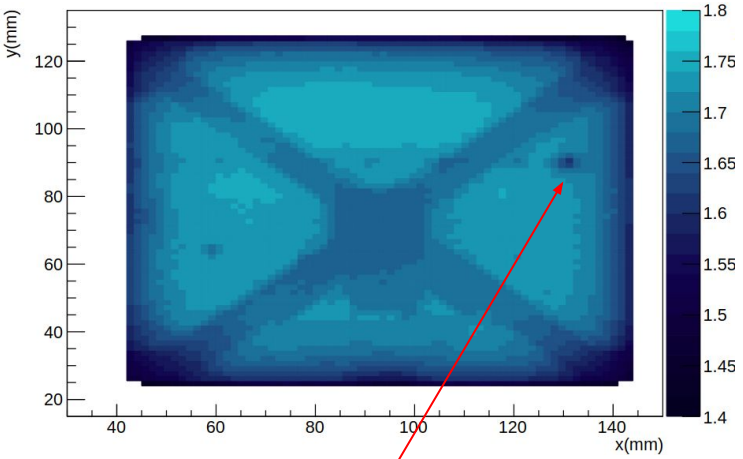




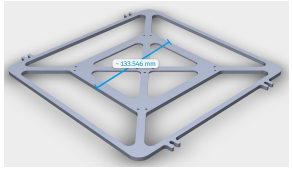


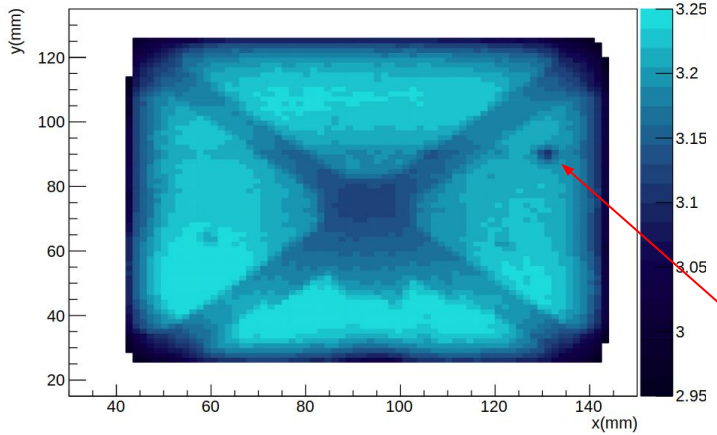
Uniformity of current ratio (HRPPD to photodiode)

450 nm

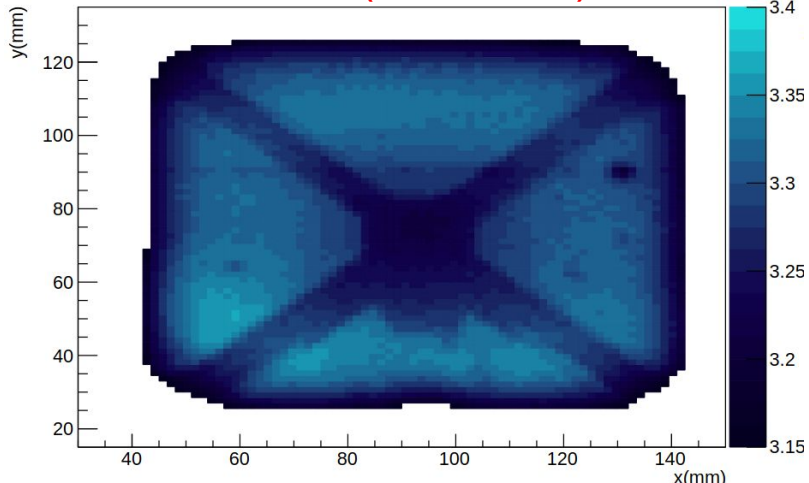


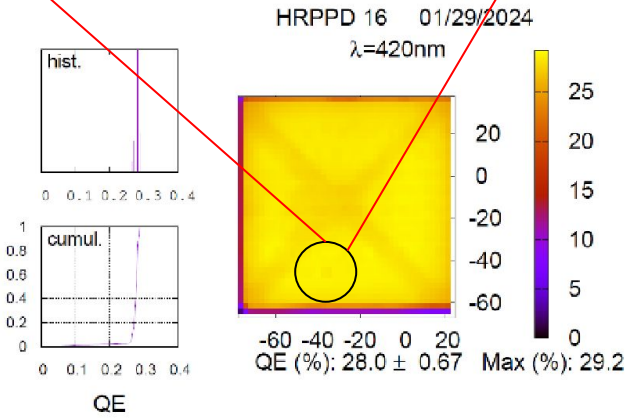
350 nm



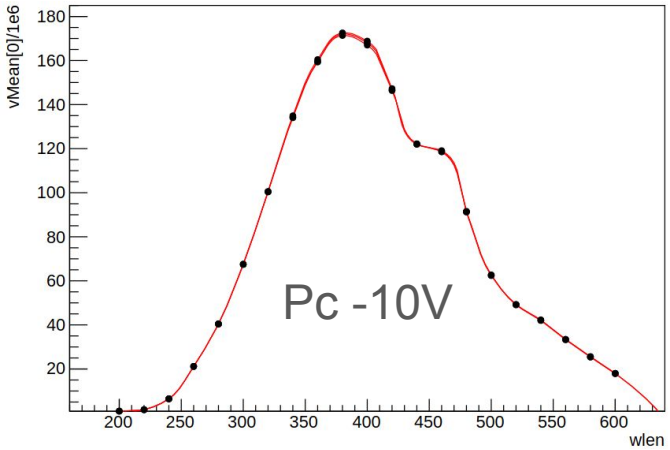


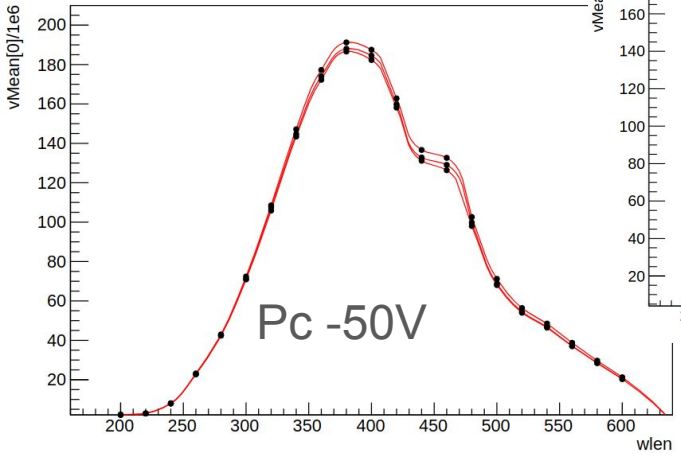
355 nm (Incom ref)

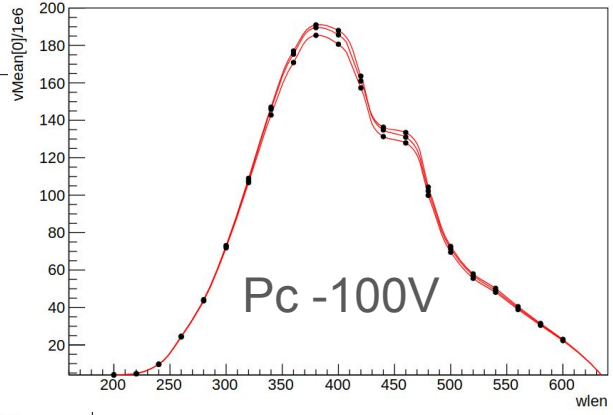


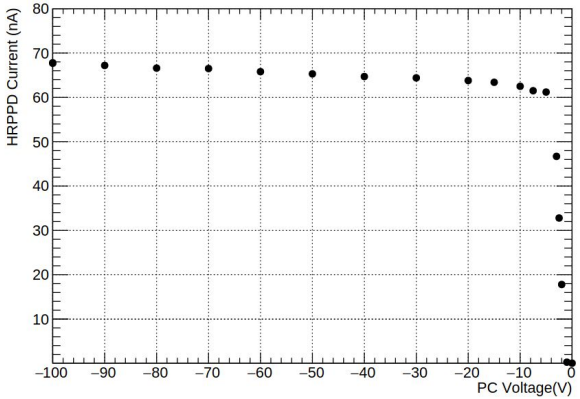


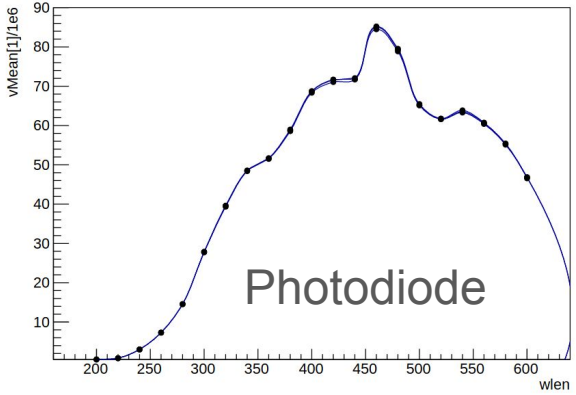
Lambda Scans (different positions and different pc V)





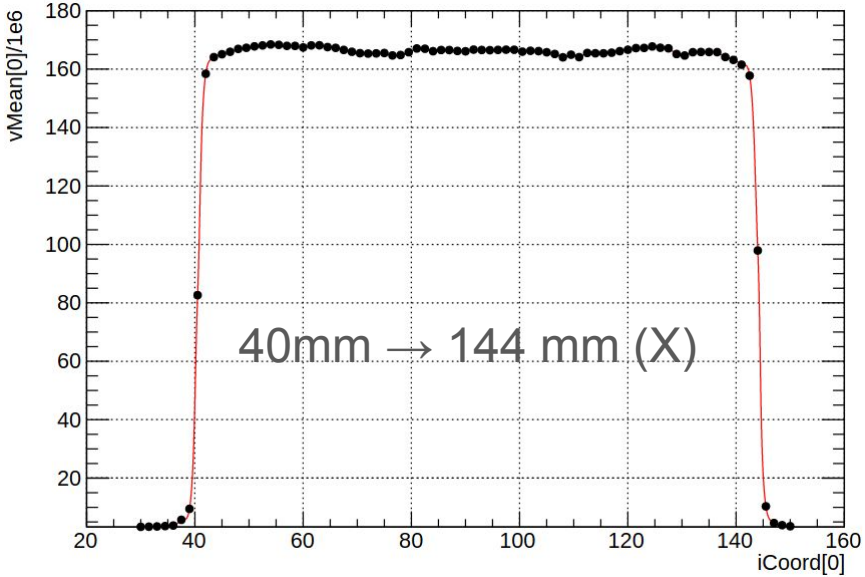


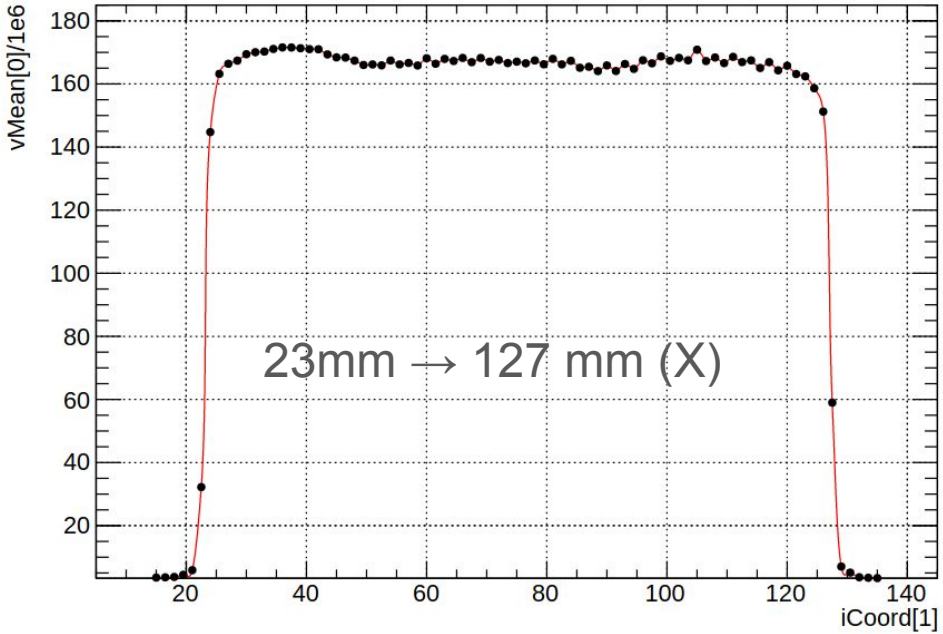




1) No light from monochromator below 225 nm
2) Currents in HRPPD compatible with drift scan

Edges





Roughly the active area edges are ~ 104 mm

Conclusions

- The set-up looks promising
- Couple of mechanical changes have to made (minor)
- With calibrated photodiode absolute QE will be measured. It does not stop the HRPPD current measurement.
- The data taking can be speed up.
- All scripts and automation will be uploaded in git.