

PDE Measurement of Multi-Pixel Geiger-Mode Photodiodes

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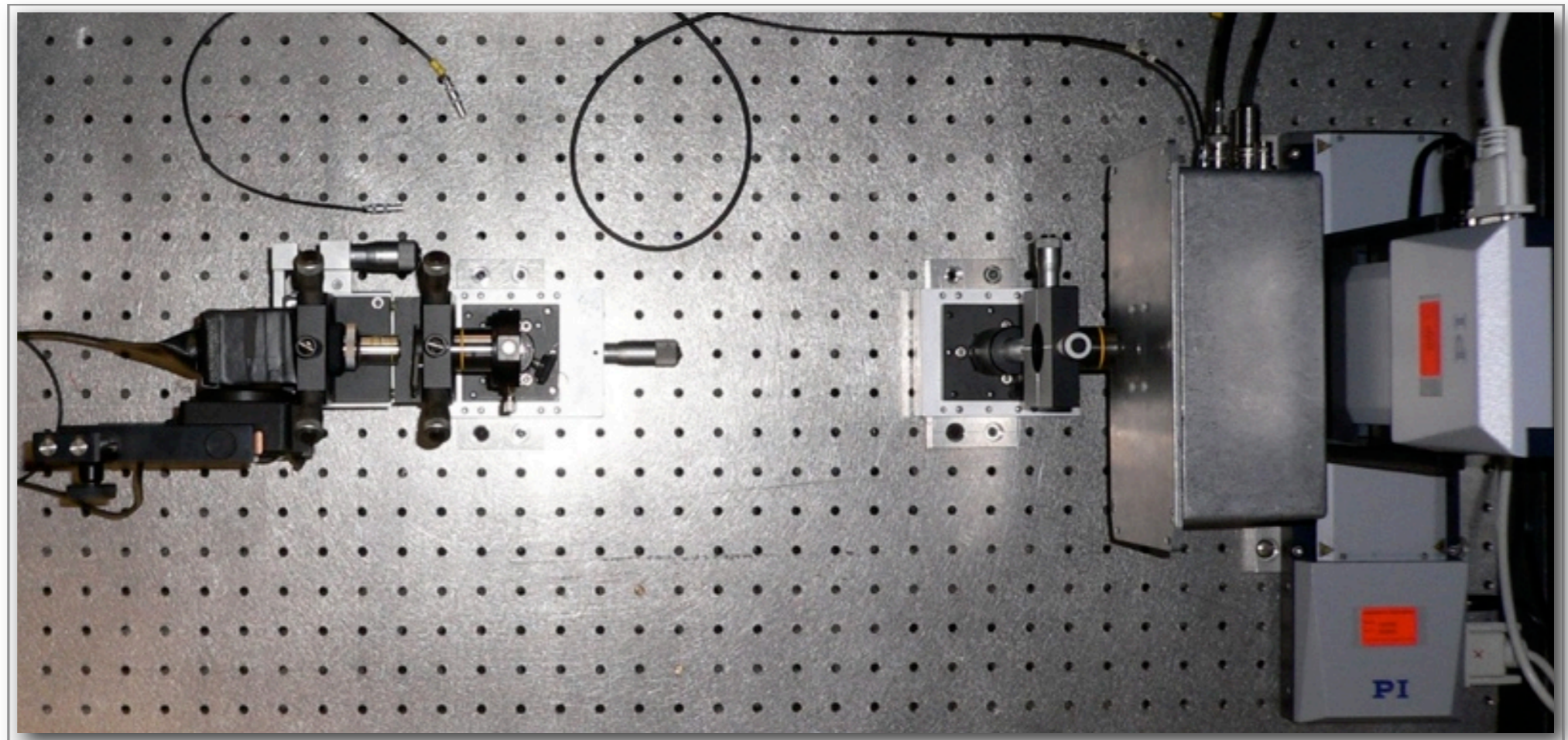
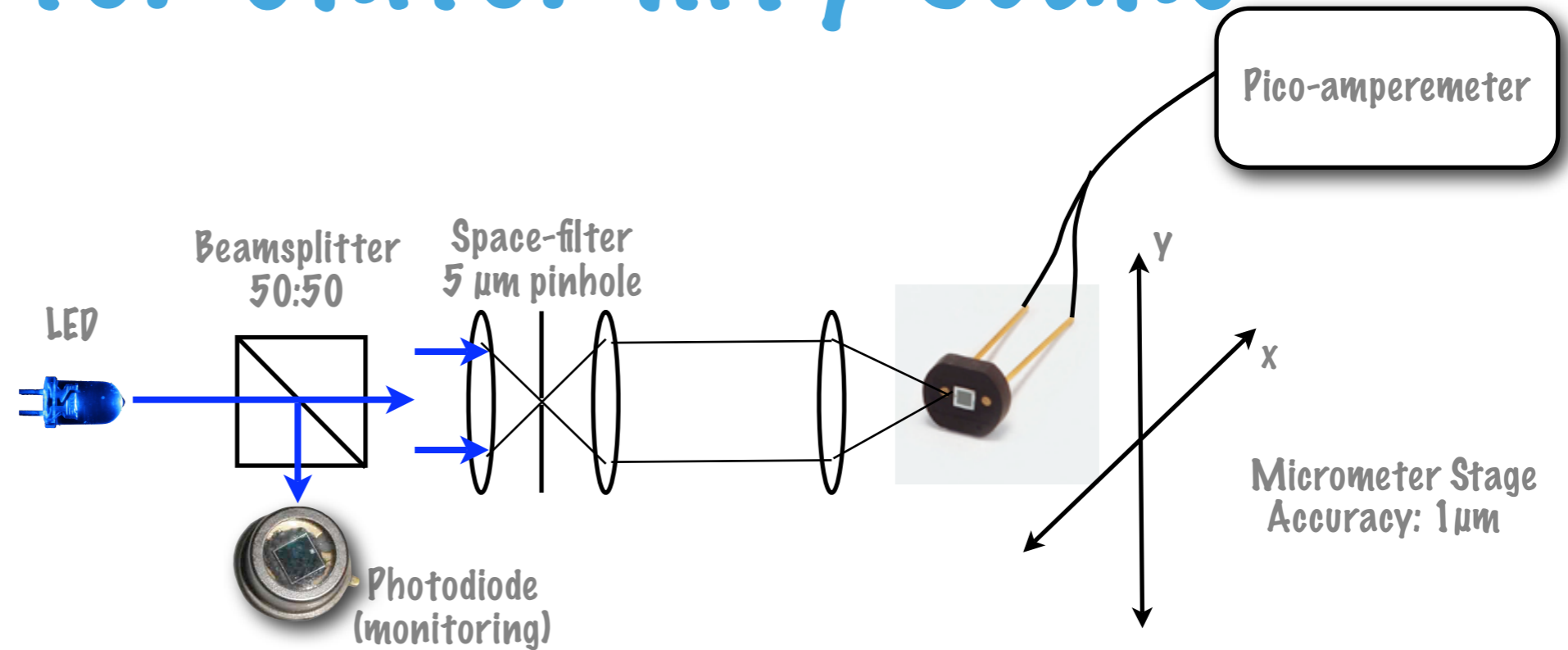
Outline

- I. Uniformity Scanning of MPPC 400Pixels & 1600Pixels
Setup, Results
- II. PDE-measurement
Current Setup Results
Outlook: New Setup

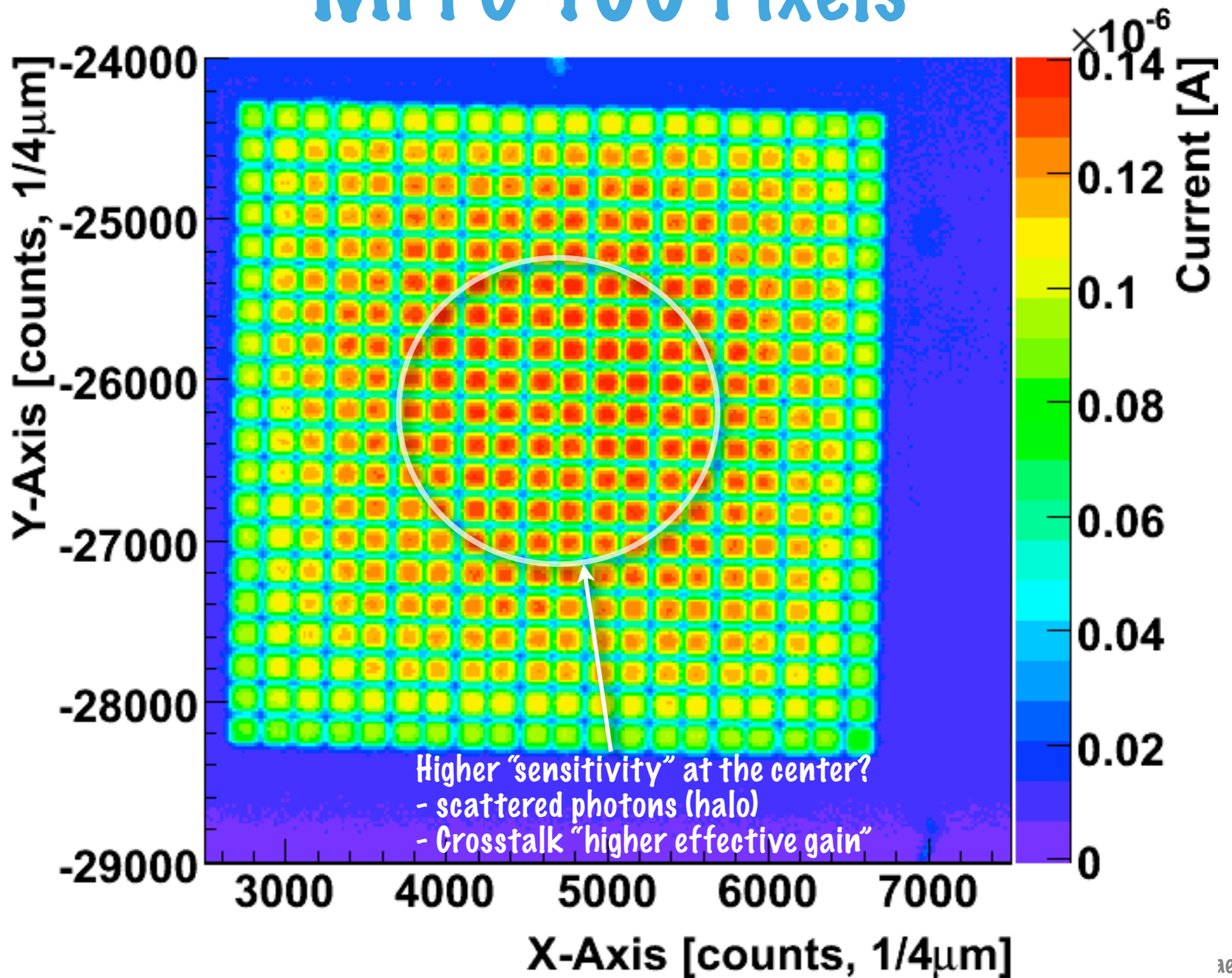
Setup for Uniformity Scans

New: Switch from Xe-Lamp to LED

- easy to handle
- pulsed operation (next step: gated QDC readout)
- but monitoring necessary!

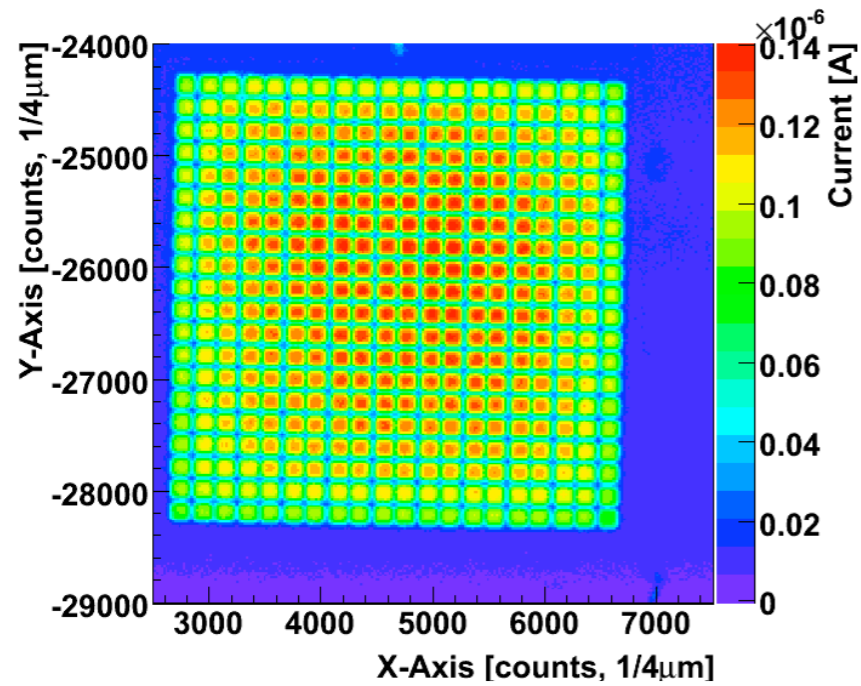


MPPPC 400 Pixels

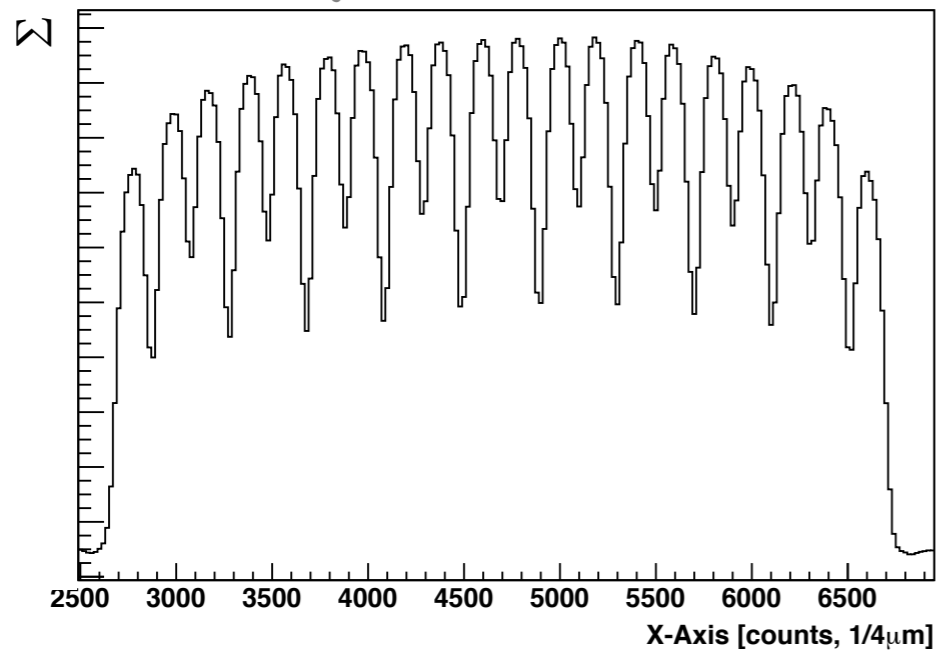


Projections

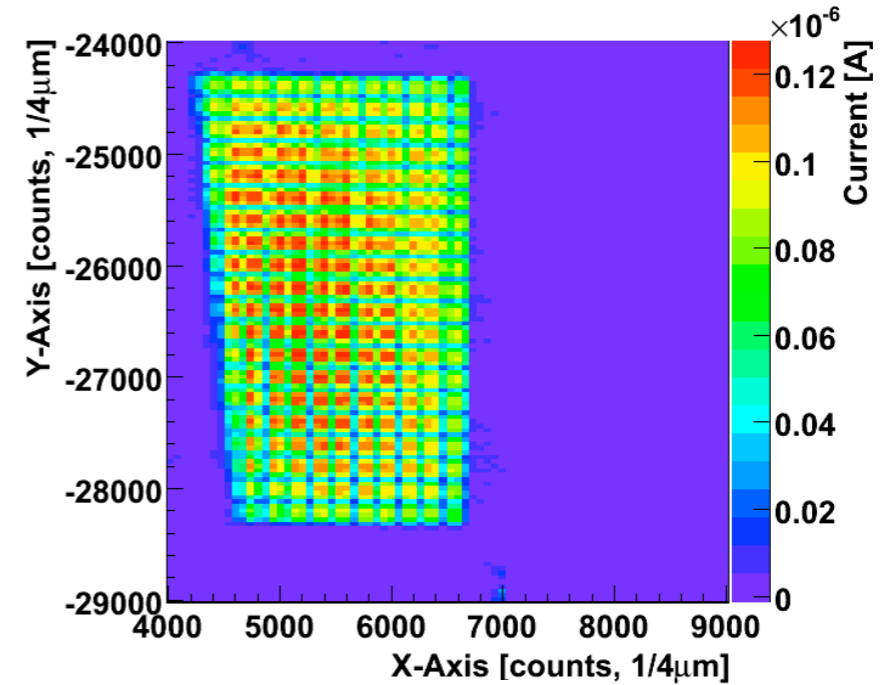
Area-Scan



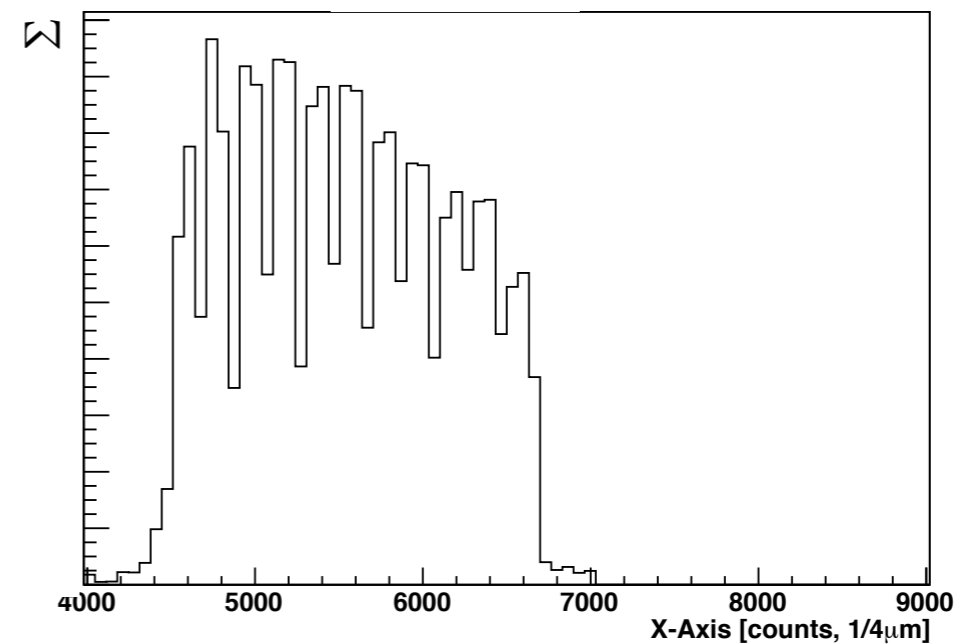
Projection x



~ One half covered with black tape:

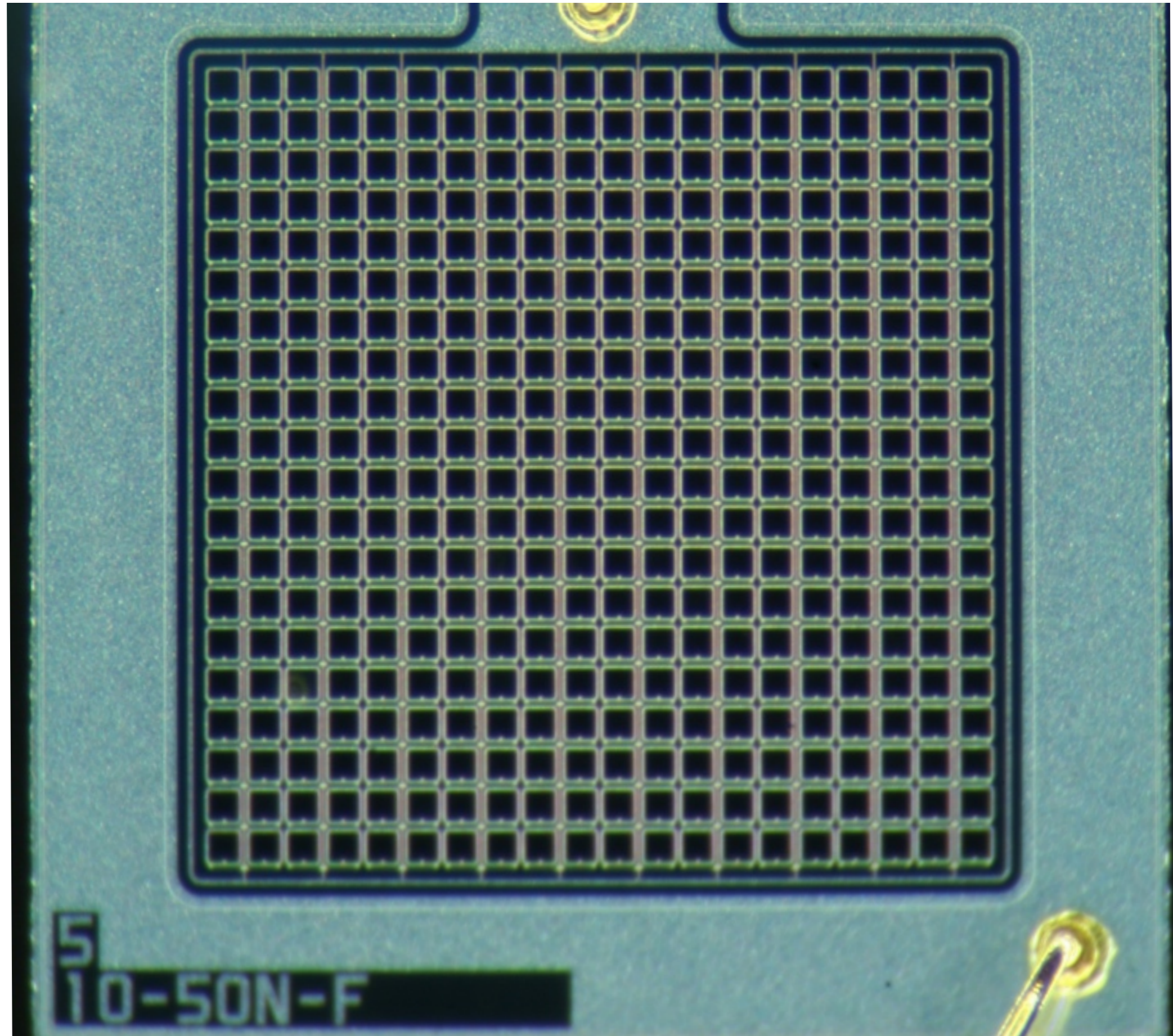


Projection x

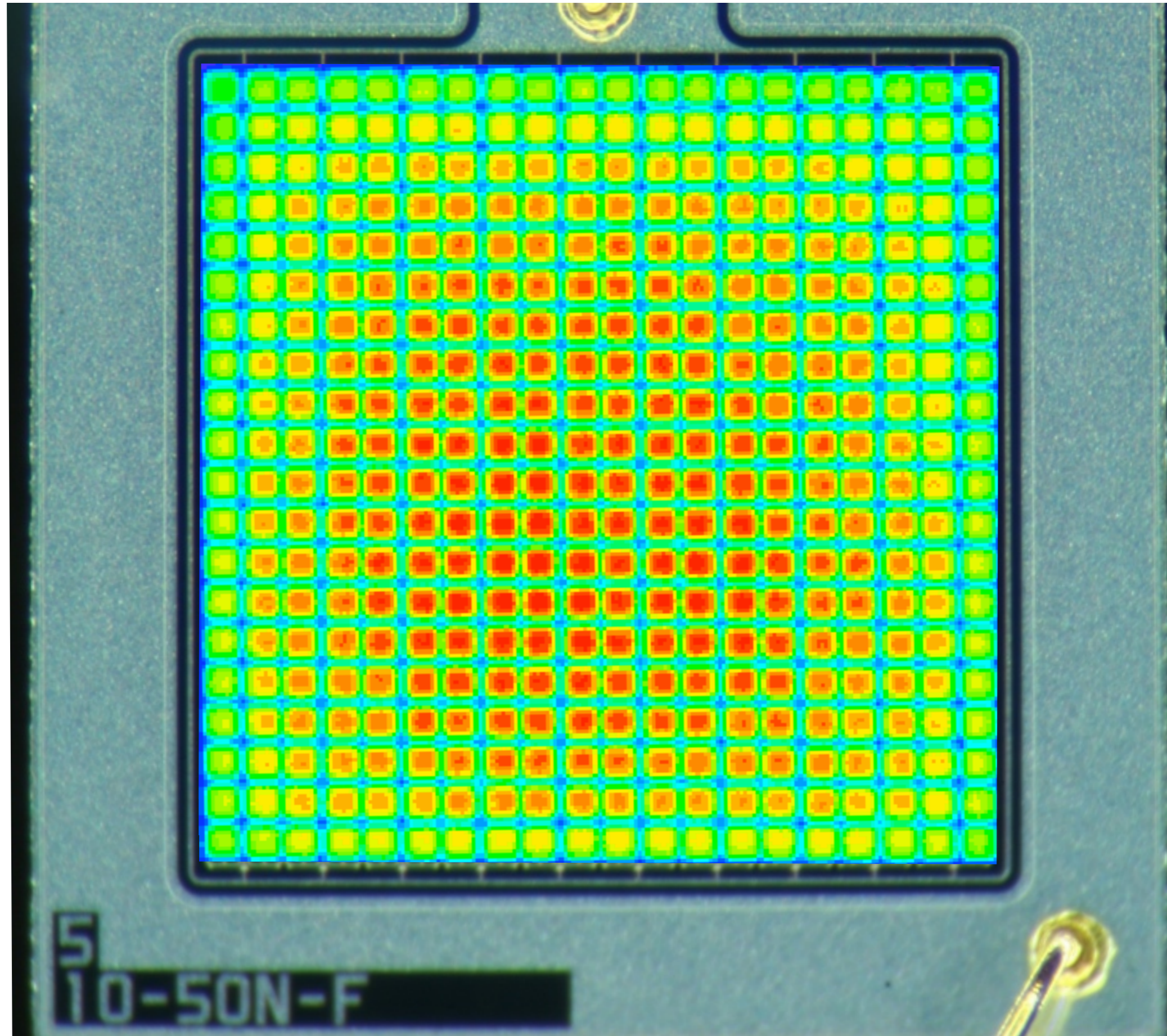


No halo around focussed light spot!
 Crosstalk can explain increased response in the center. (higher effective gain)

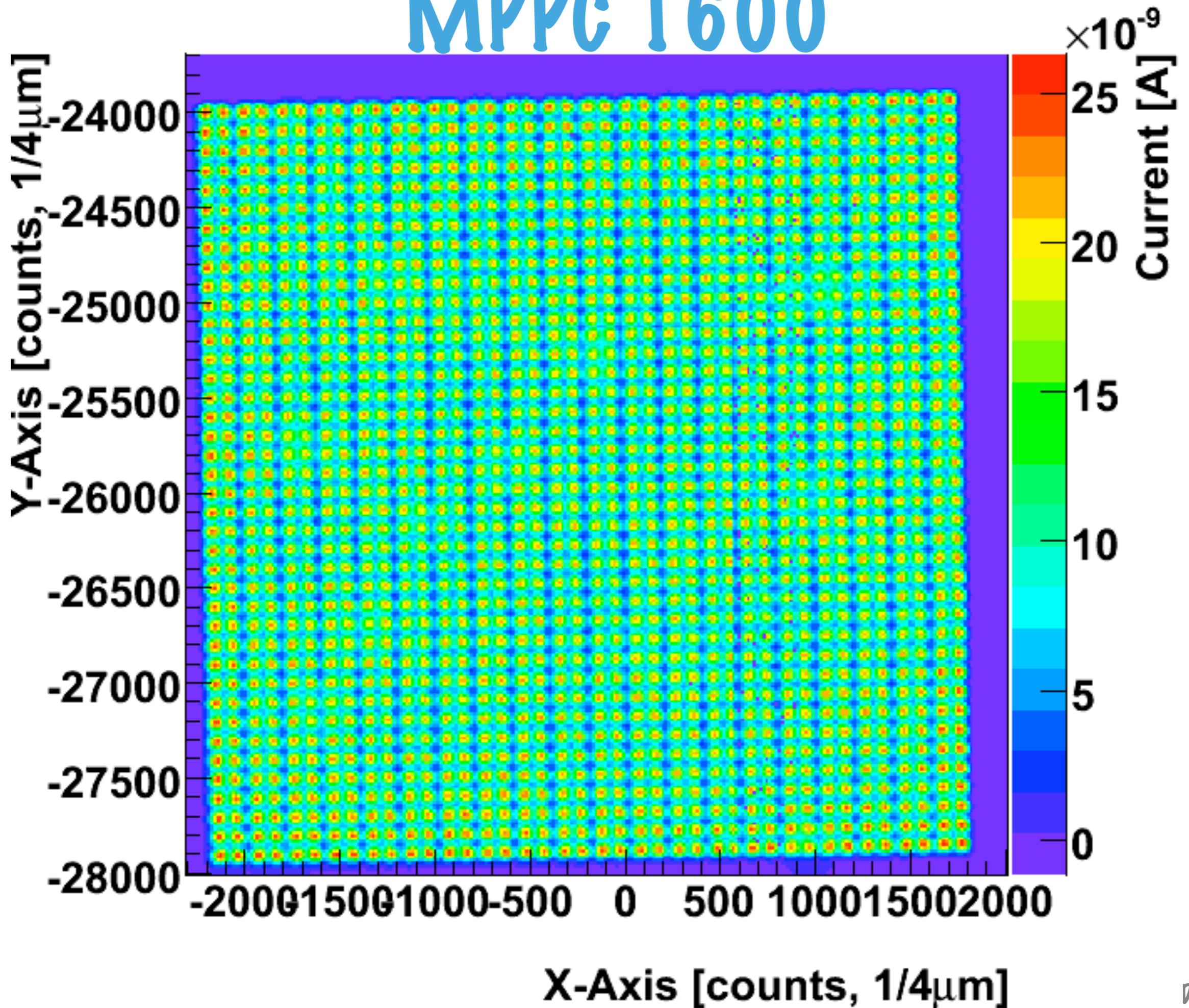
Positioning Accuracy



Positioning Accuracy

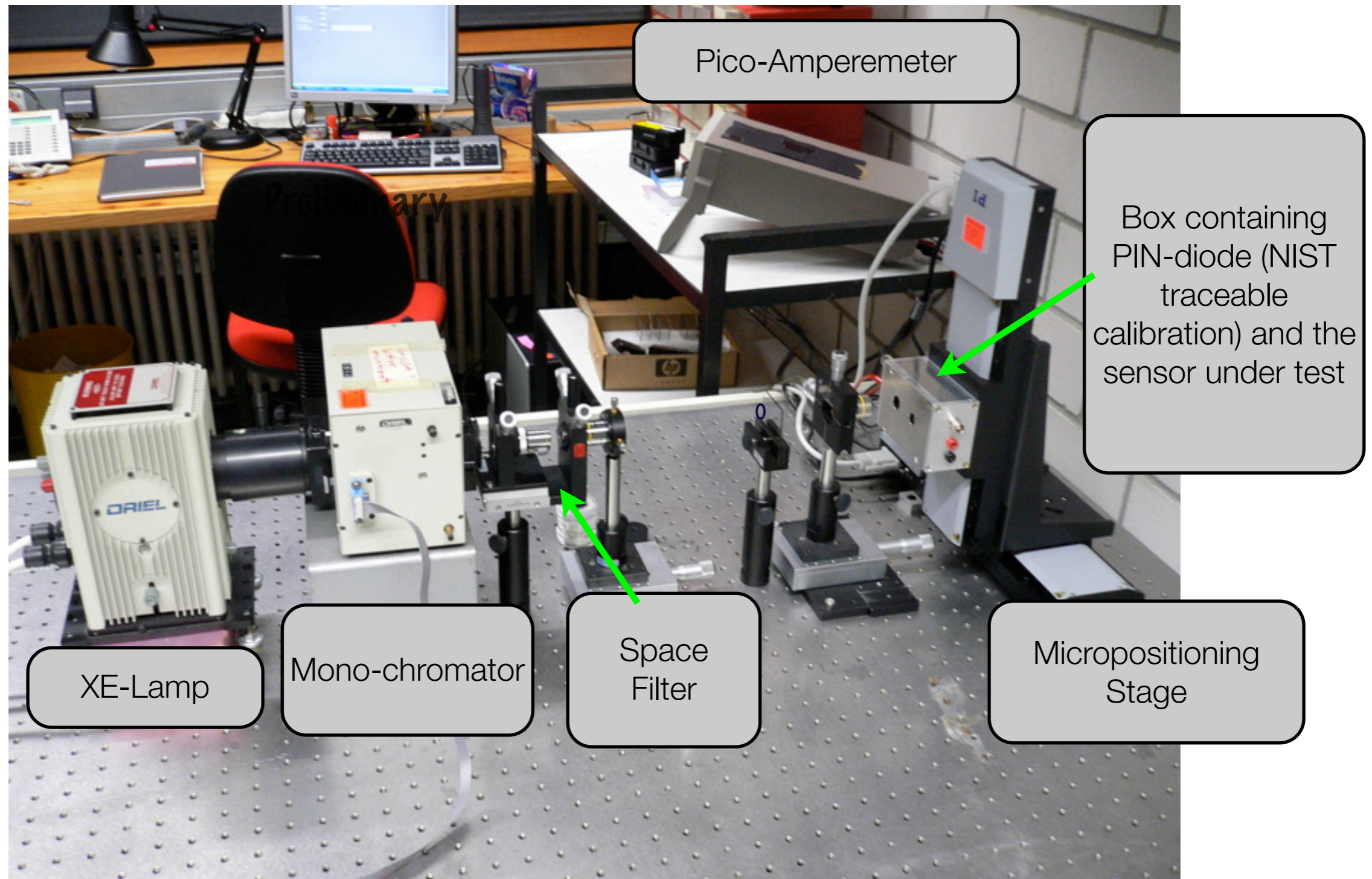


MPPC 1600



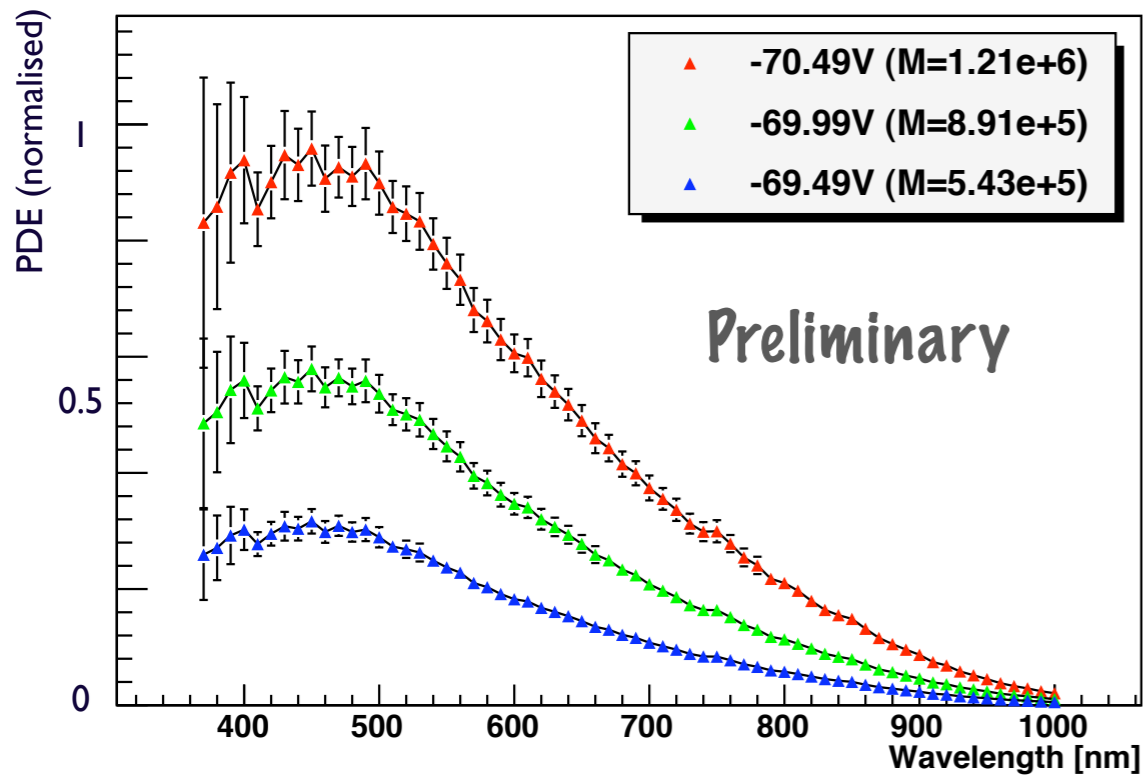
PDE-Measurement

PDE Measurement Setup (Current/Old)

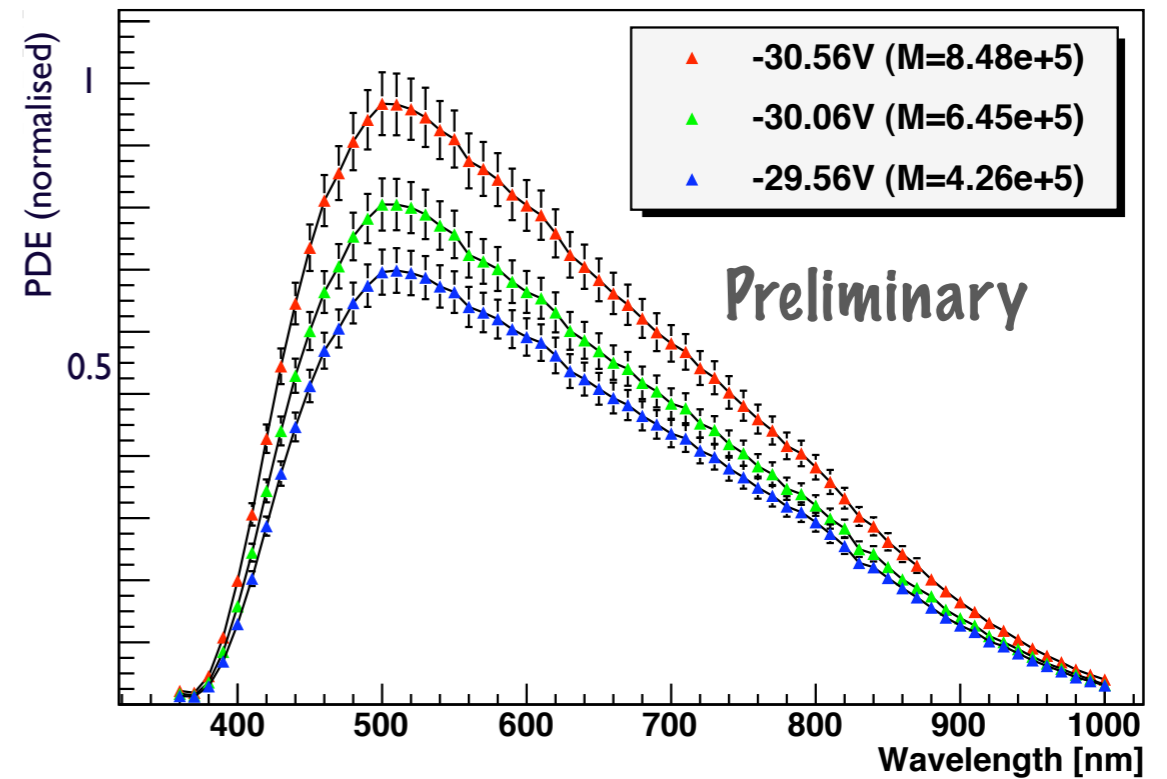


PDE Measurement Setup (Current/Old)

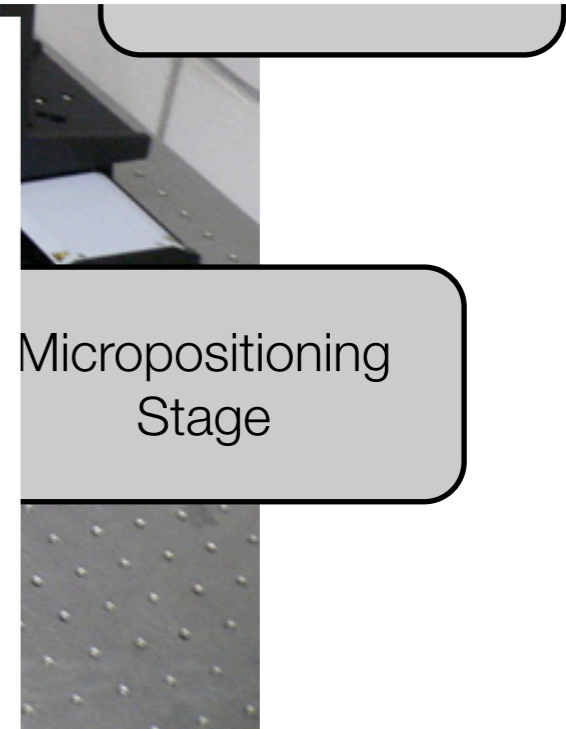
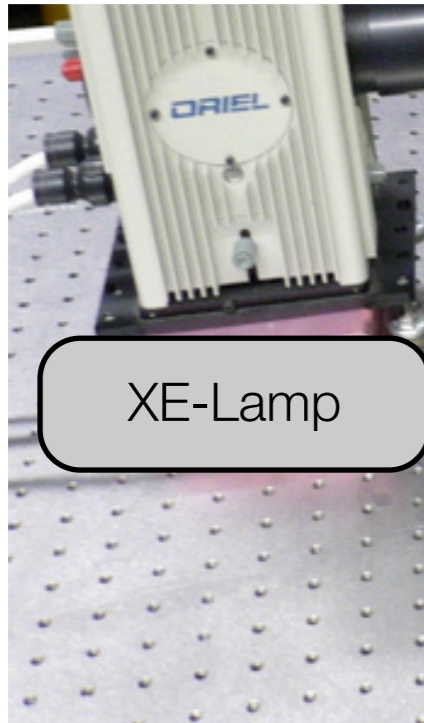
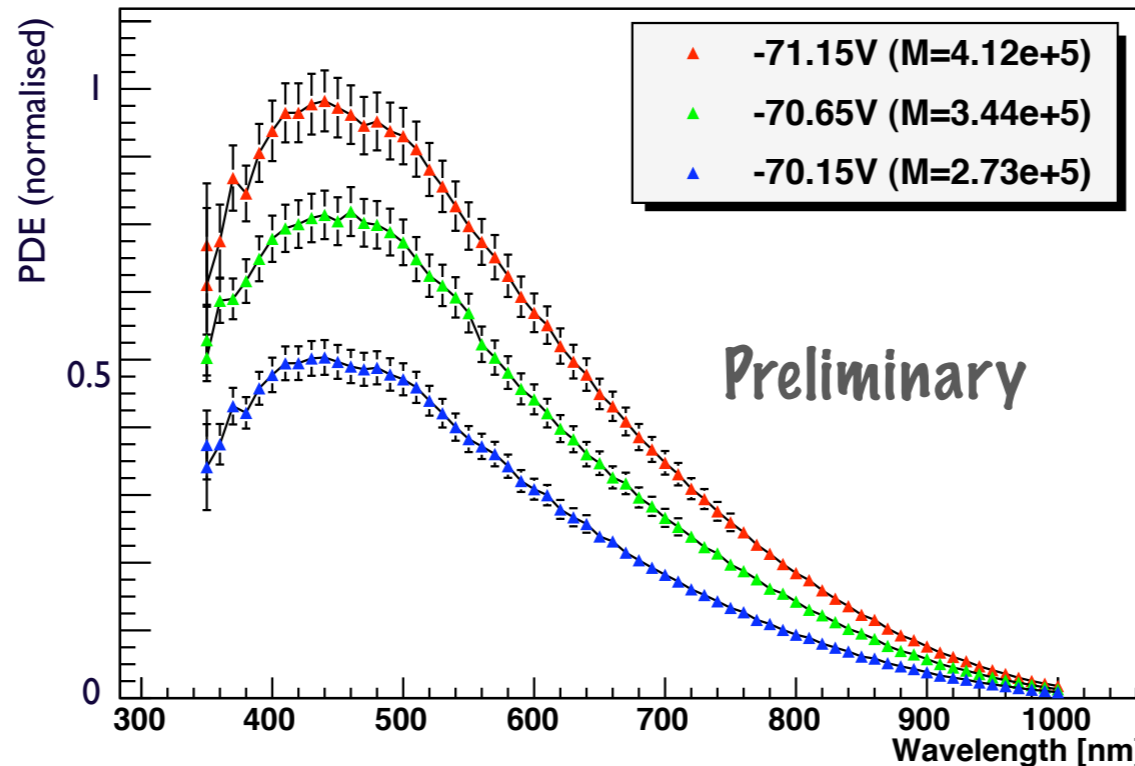
MPPC 400 pixels @ room temperature



SensL SPMScint 1144 pixels @ room temperature

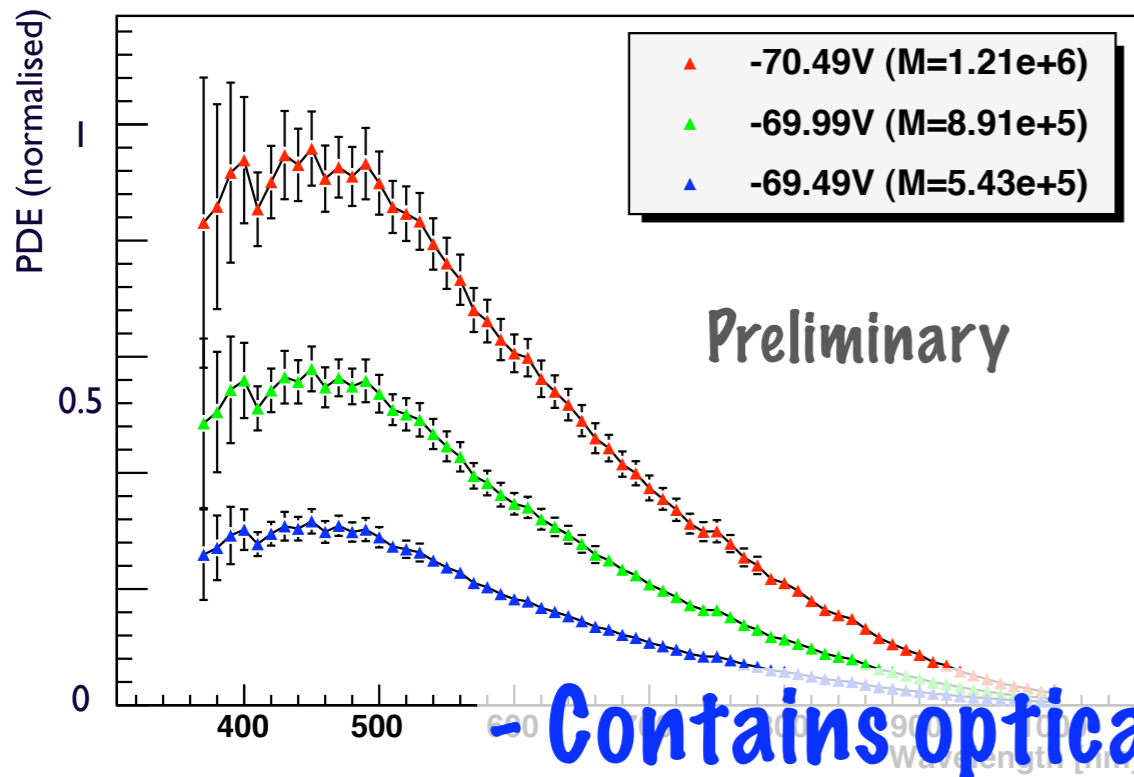


MPPC 1600 pixels @ room temperature

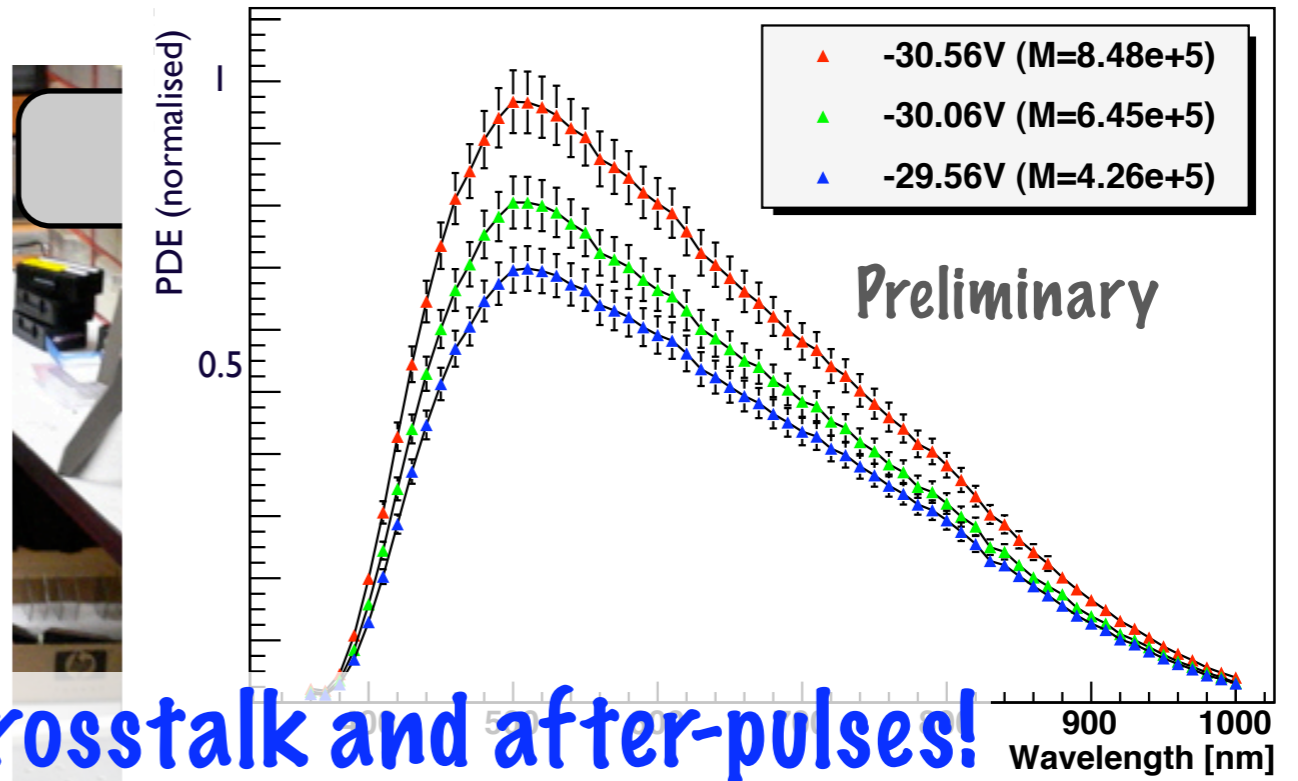


PDE Measurement Setup (Current/Old)

MPPC 400 pixels @ room temperature



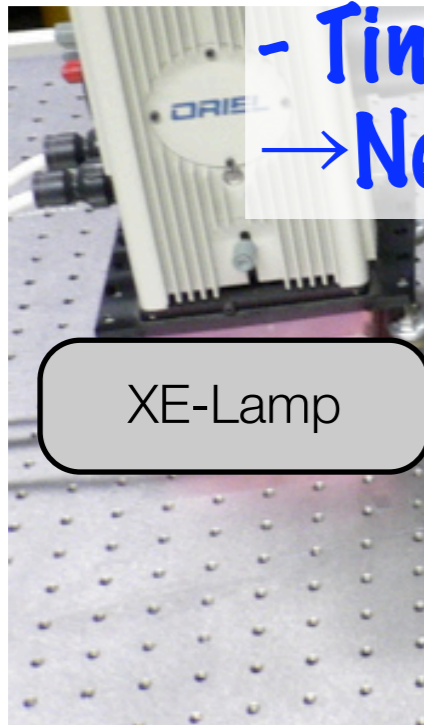
SensL SPMScint 1144 pixels @ room temperature



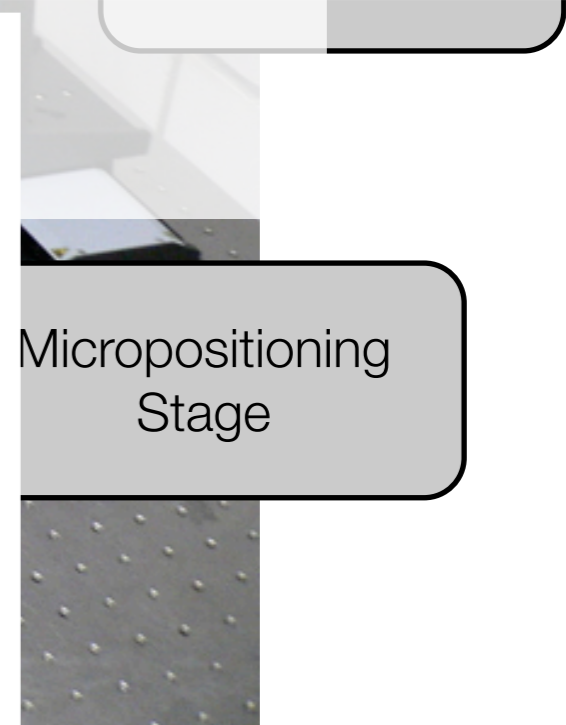
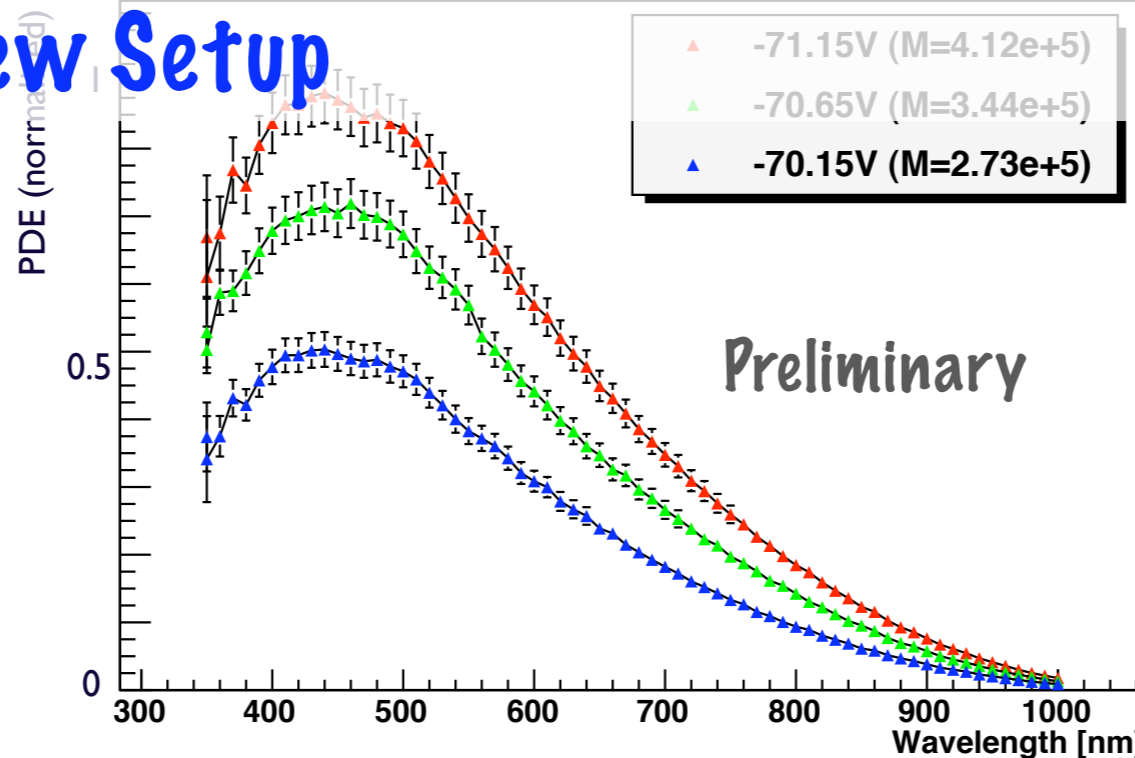
- Contains optical crosstalk and after-pulses!

- Time consuming alignment

→ New Setup



XE-Lamp



Micropositioning Stage

Outlook: New PDE Measurement Setup



Integrating Sphere

Calibrated Sensor
NIST-Traceable
(200-1100nm)

Optometer

$P_{Cal.}$

Gate from
LED-driver
0(100ns)



Aperture

SiPM

QDC

Setup Calibration

$$P_{SiPM} = R \cdot P_{Cal.}$$

$$\approx \frac{A_{Cal.}}{A_{SiPM}} \cdot P_{Cal.}$$

Pico-Amperemeter

- XE-Lamp (DC) (200nm-1100nm)
→ wavelength scanning
- Pulsed LED (375nm, 635nm, 870nm)
→ absolute PDE

First Measurements

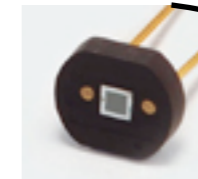
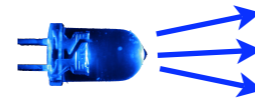
Photons are Poisson-distributed:

$$P(n, \lambda) = \frac{\lambda^n \cdot e^{-\lambda}}{n!} \Rightarrow P(0, \lambda) = e^{-\lambda}$$

$$\Rightarrow \lambda = -\ln \left(\frac{N_{\text{Ped.}}}{N_{\text{Tot.}}} \right)$$

Pedestal is not influenced by optical crosstalk and after-pulses!

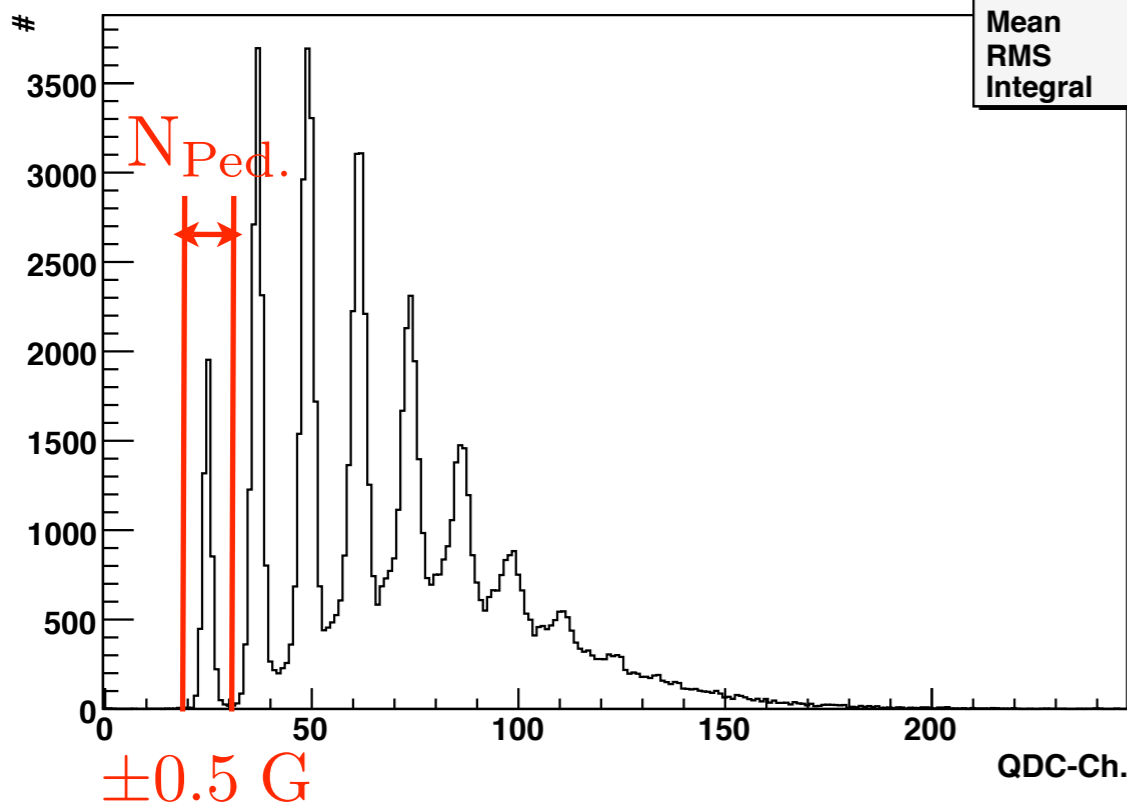
Not Referenced!



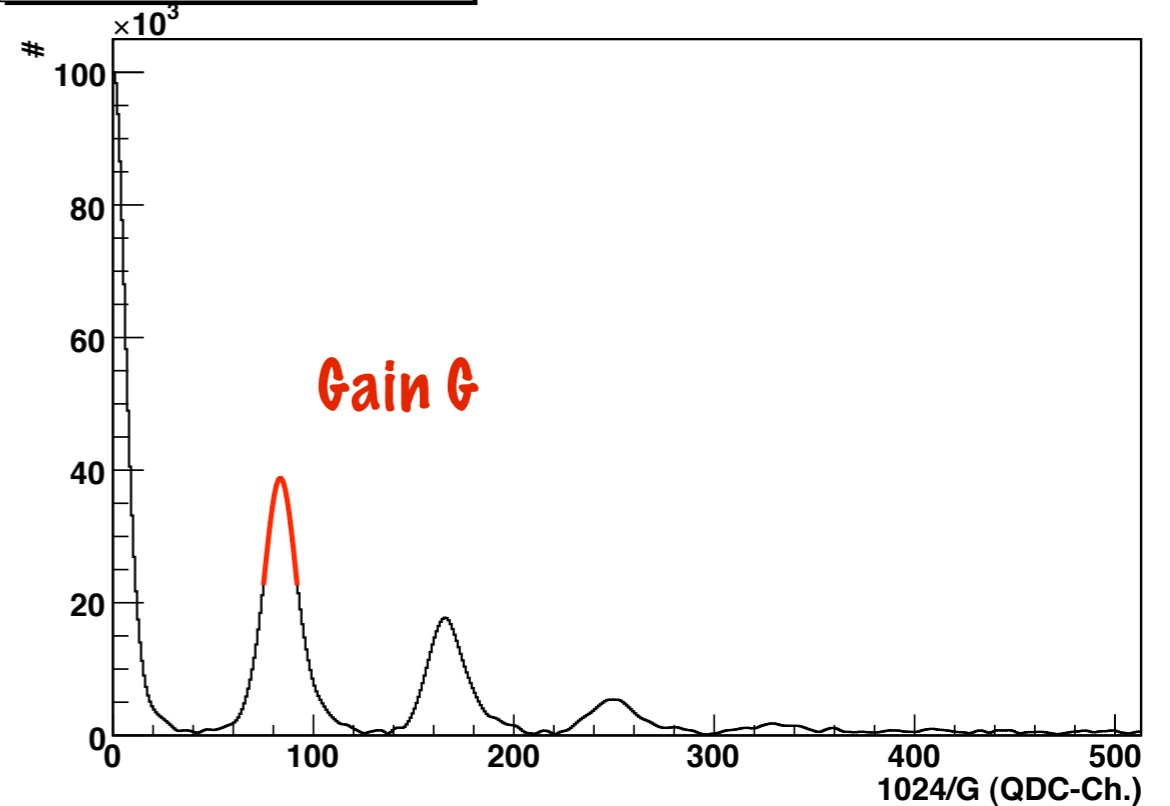
Gate from LED-Driver



Single Photoelectron Spectrum

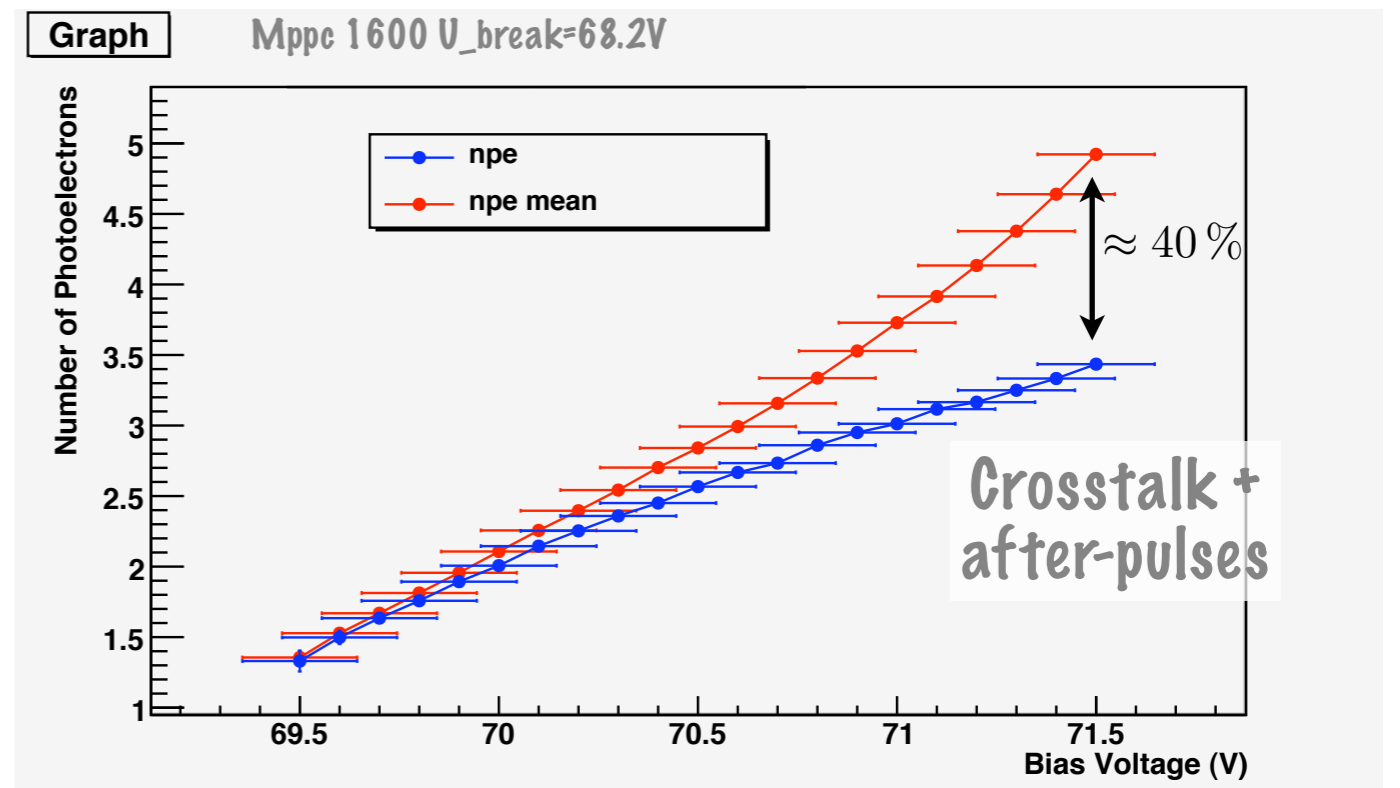
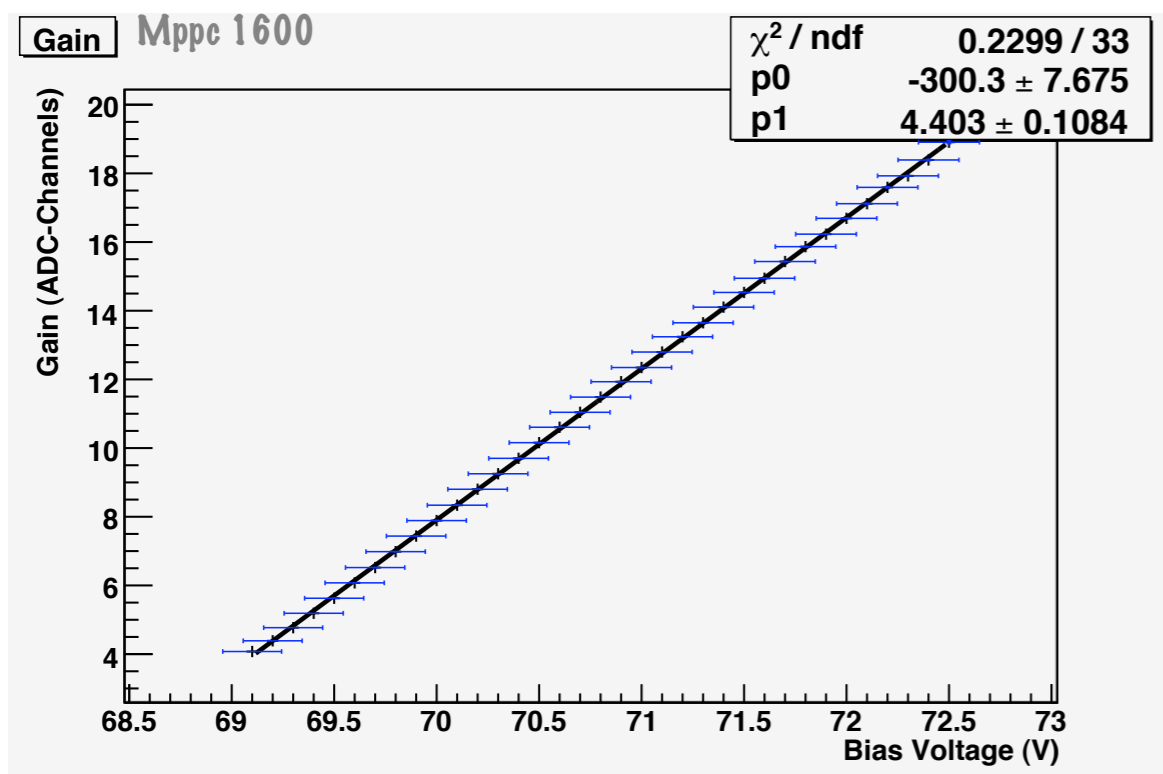


Fourier Transformation



First Measurements

- LABVIEW based DAQ-system
- Automated measurement of gain and number of photons



Npe and therefore PDE is strongly influenced by optical crosstalk and after-pulses

Summary & Outlook

- Setup for Uniformity-scan ready
- TODO: Switch from current measurement (cw), to pulsed readout. (local crosstalk studies)
- New Setup for PDE-measurements without crosstalk and after-pulses will be ready soon
- Automatic measurement of the number of photoelectrons from Poisson-statistics