Latest measurements of MCP-PMTs and first data of 9002220

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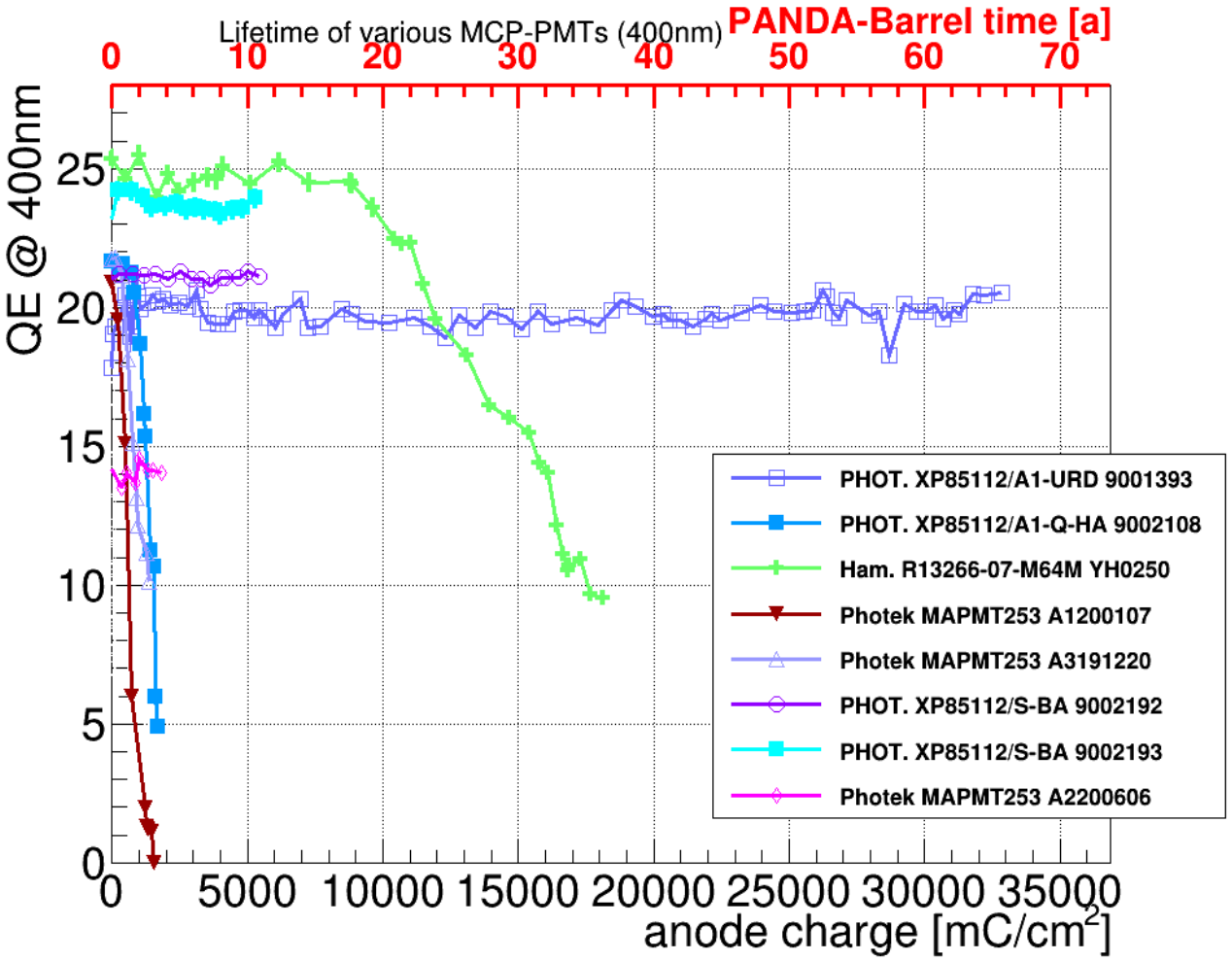
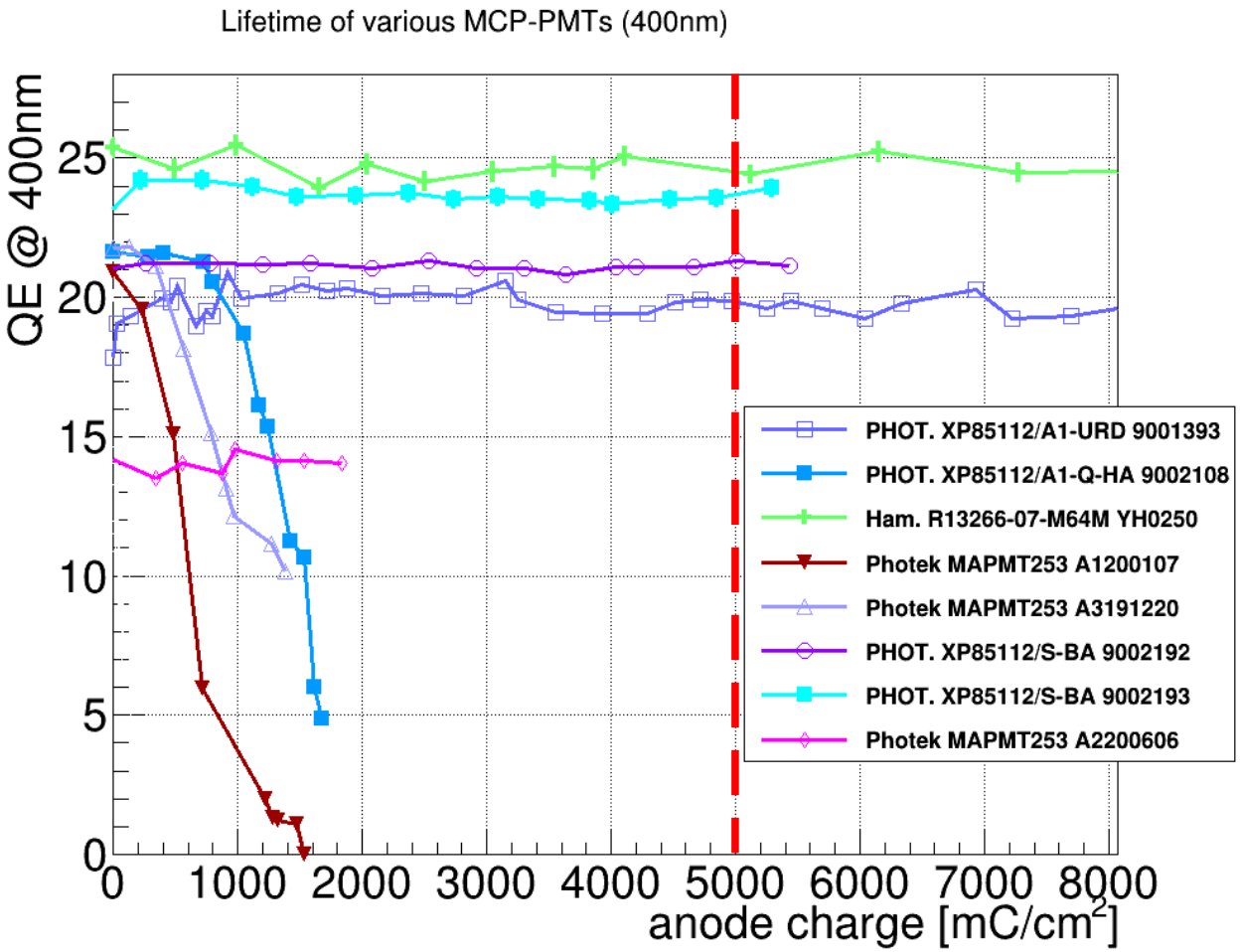
Lifetime data of latest sensors



- Most sensors with ALD coated MCPs have lifetime > 5 C/cm²
- 9001393 (2 ALD-layers) at over 65 years of PANDA

Lifetime data of latest sensors

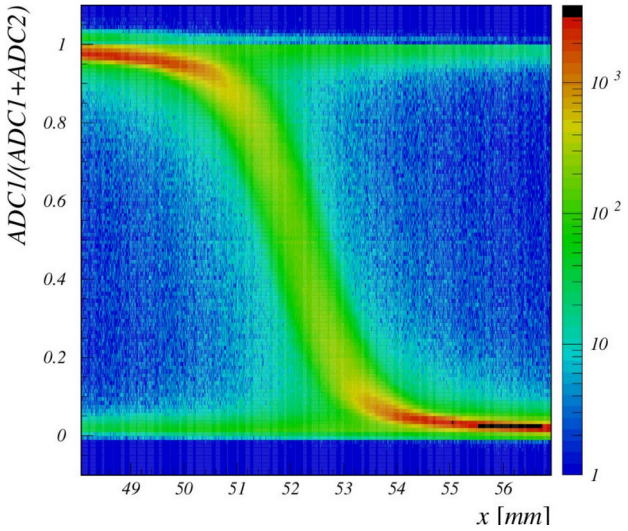


- Photonis 9002192, 9002193 reached > 5 C/cm² without loss unlike 9002108
- Photek A2200606 is at ~ 1.8 C/cm² without loss yet unlike A1200107 and A3191220

Charge asymmetry

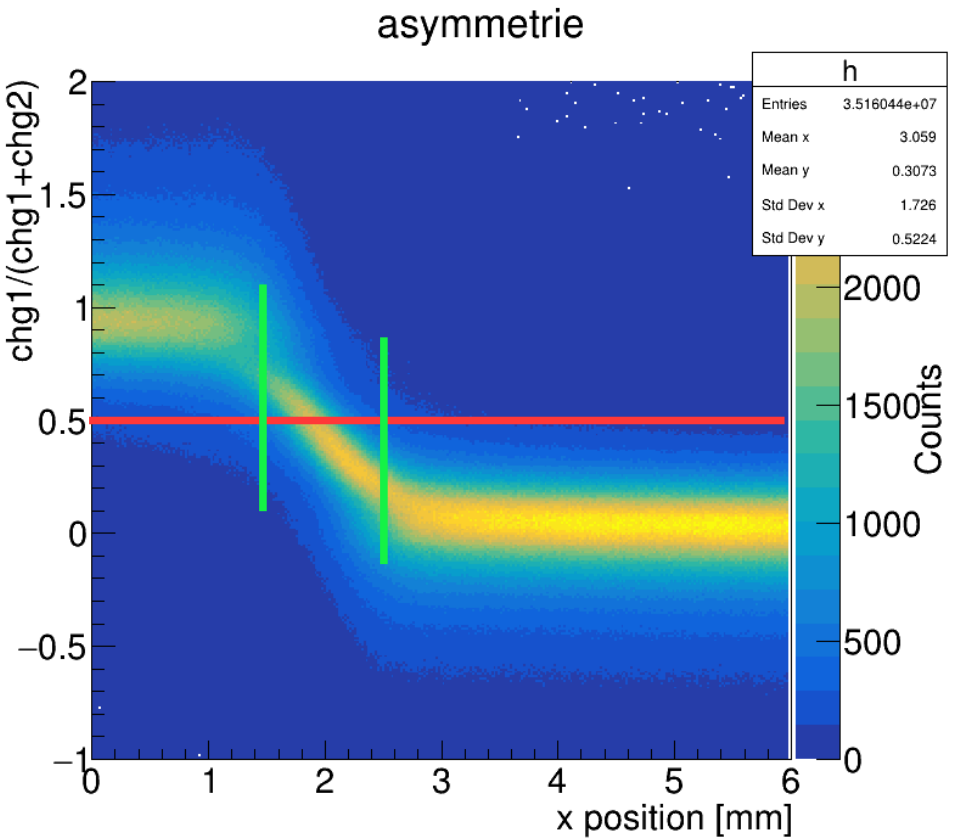
NIMA595 (2008) 169

- Reproduce plot of charge asymmetry of two pixels
- Obtained information:
  - Focus
  - Width of charge sharing cloud
- Setup:
  - Photonis 9002108
  - HV with 1:10:1-divider or three direct channels
  - Scan over transition between two pixels (47,57) with laser
  - CAEN Digitizer DT 5742B → Waveform of two pixels → charge
  - Calculate asymmetry by $\frac{Q_1}{Q_1+Q_2}$

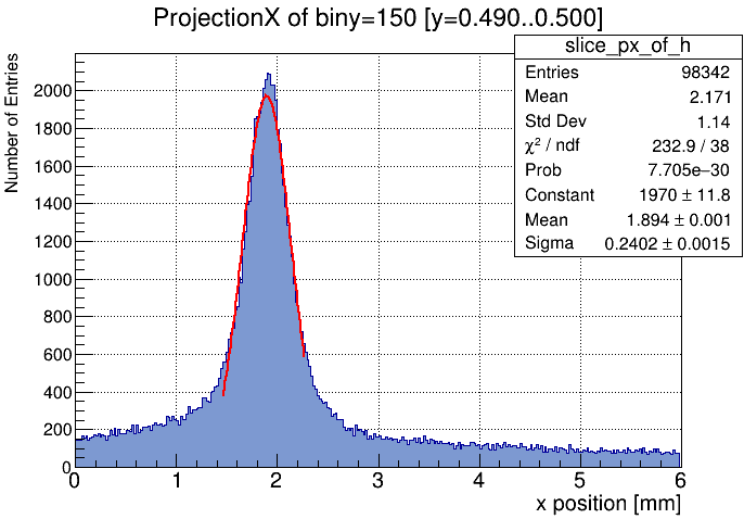


Charge asymmetry

- Example with charge threshold of 2 pVs (~30% mean signal height)



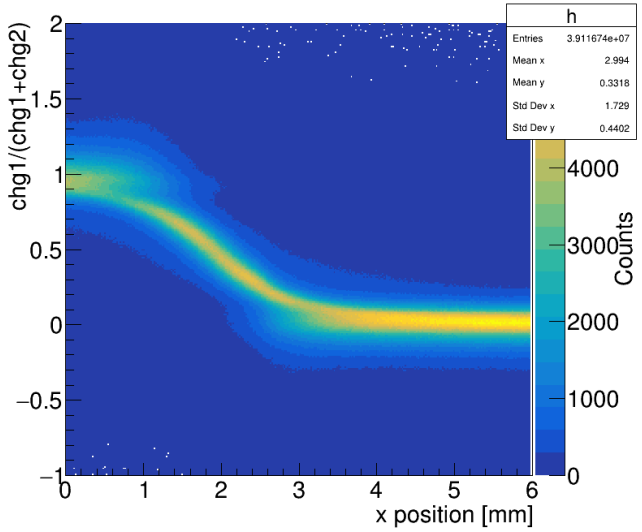
Red:
Width of projection
→ focus ~0.24 mm



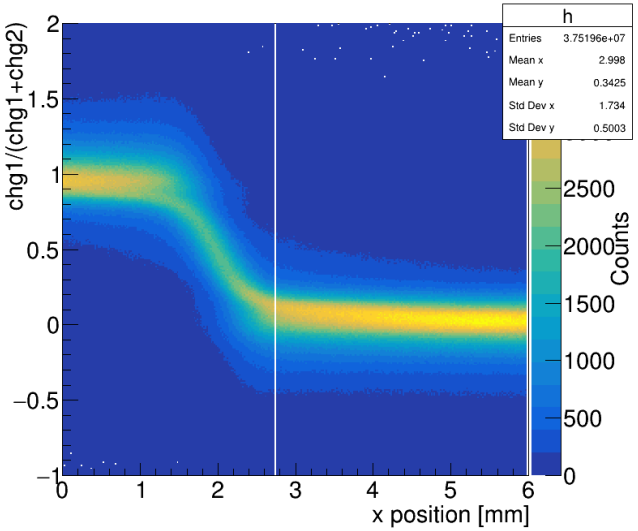
Green:
Width of transition
(0.3 < mean < 0.7)
→ charge sharing cloud ~0.46 mm

Asymmetry dependent on anode voltage

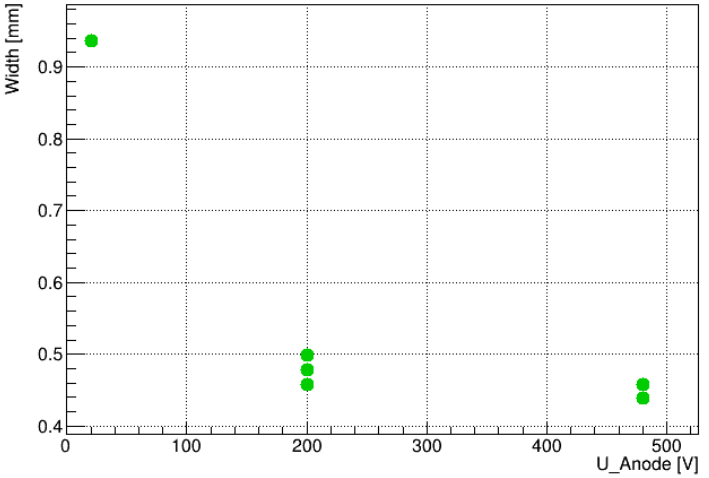
20 V



480 V



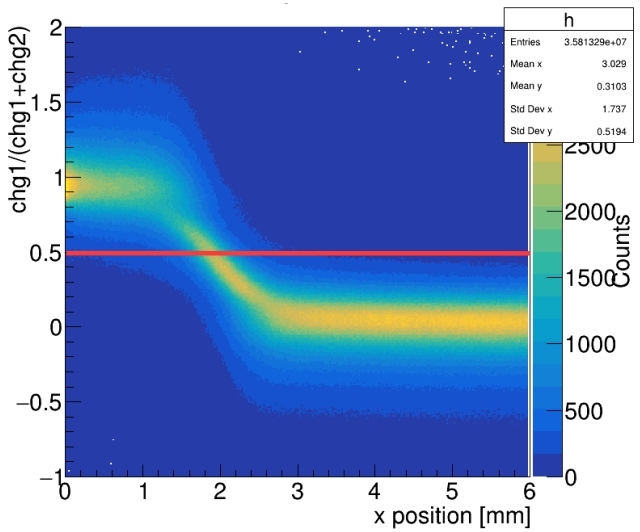
- Anode voltages:
  20 V, 200 V, 480 V
  (different measurements)



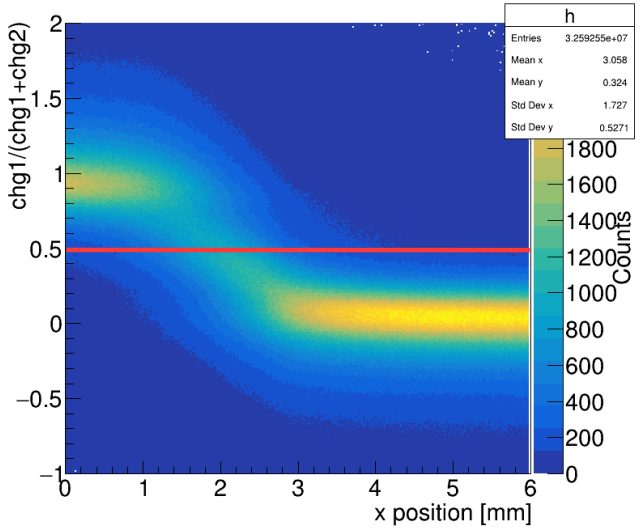
- Charge cloud width decreases with higher anode voltage
- No big difference between 200 V and 480 V
- Matches simulations

Asymmetry dependent on z-position of laser

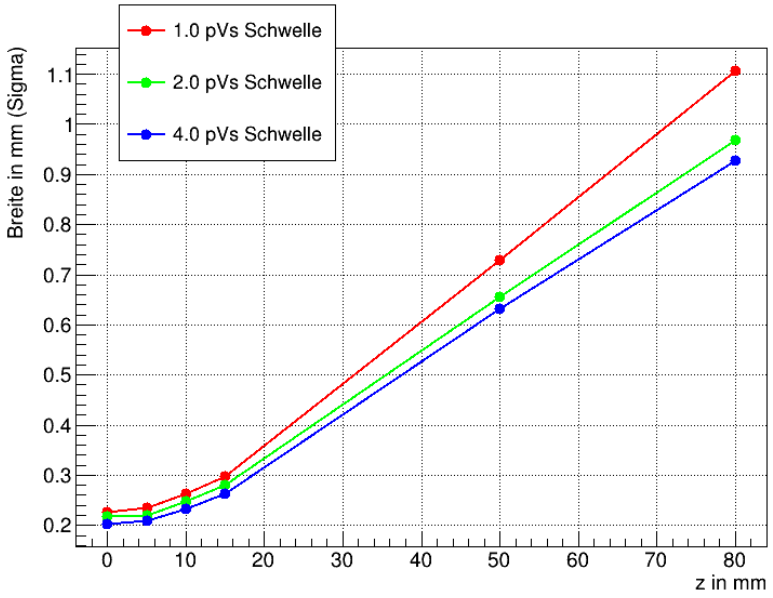
0 mm



50 mm



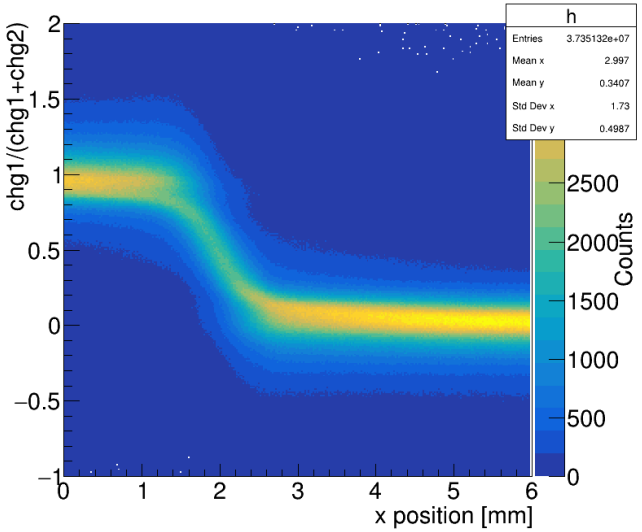
- Measurement for different z-positions of the laser (z = 0 mm → focus)



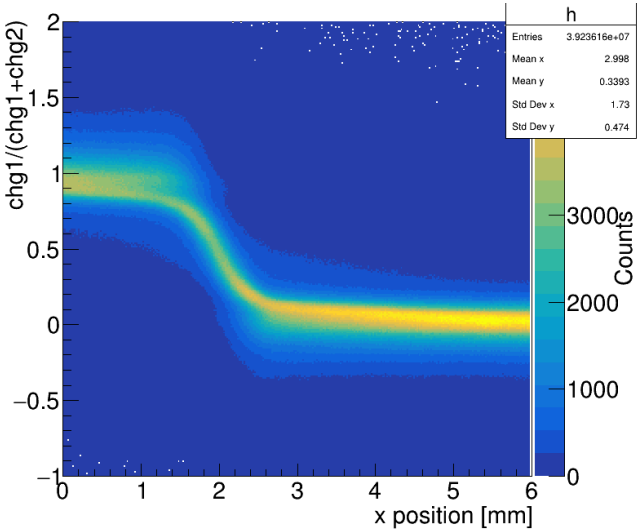
- Laserspot increases with z
- z = 0 mm → width ~ 0.2 mm
  → worse than expected
- Laser: Microfocus << 0.2 mm

Asymmetry dependent on photo cathode voltage

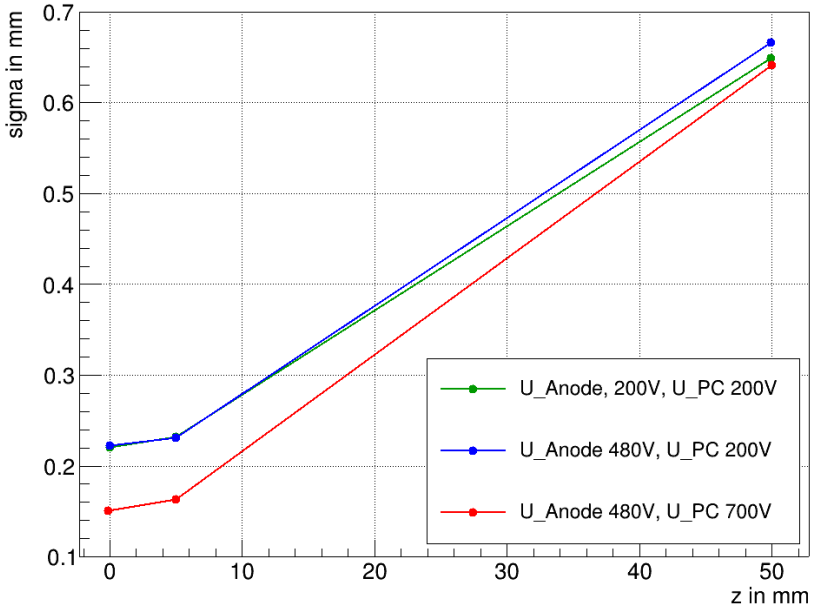
200 V



700 V



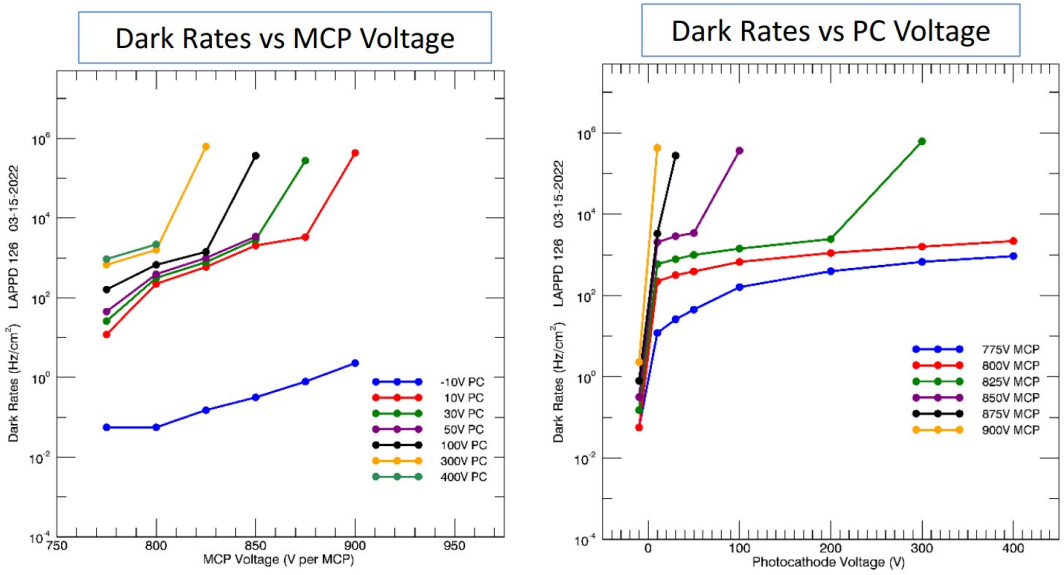
- cathode voltages: 200 V, 700 V
- z-positions: 0 mm, 5 mm, 50 mm



- Higher U_PC → narrower
- U_anode → no influence
- Distribution of primary electrons + laser focus = total p.e. distribution width at MCPIn

Dark current vs. voltages

- LAPPD sensors:
  Strange behaviour of dark rates dependent on MCP and PC voltage

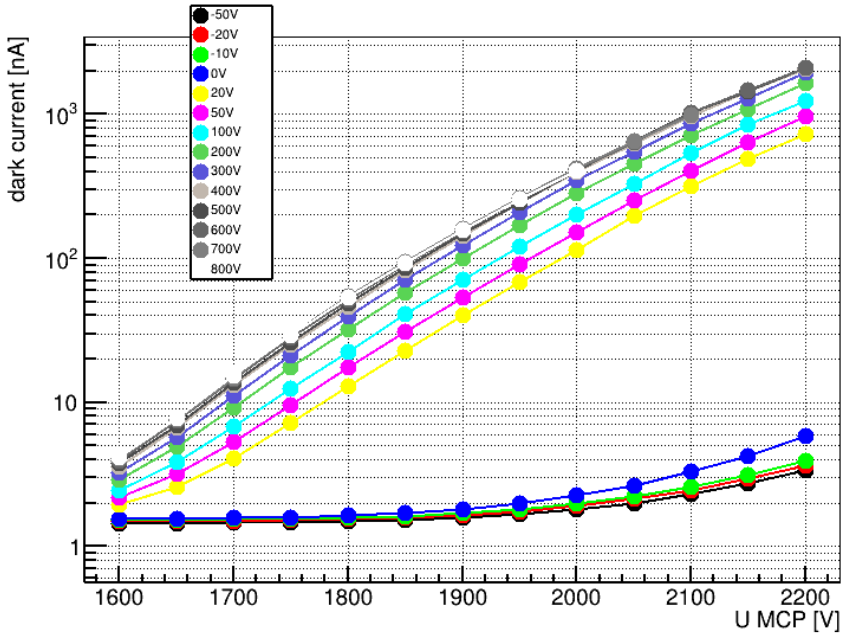


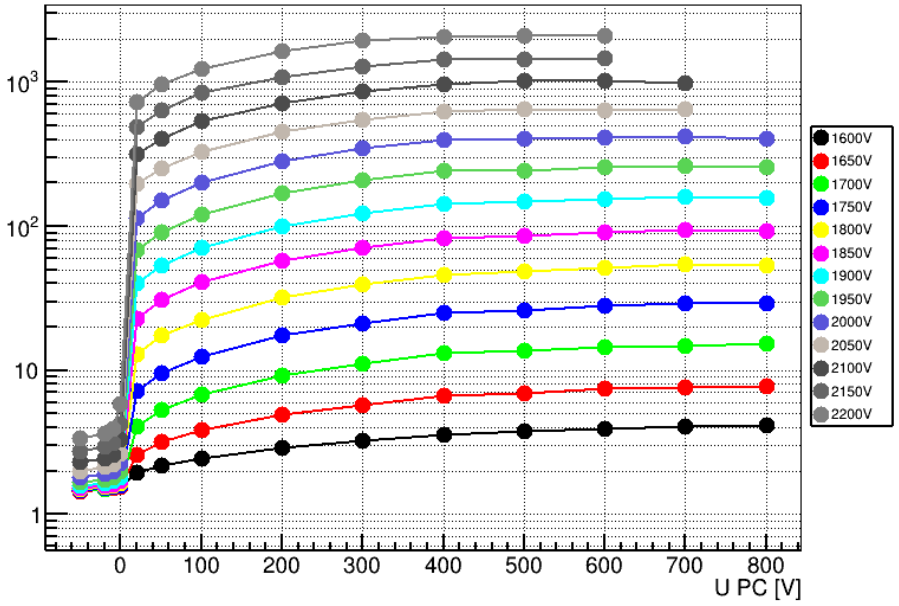
Plots from INCOM at LAPPD Workshop March 21, 2022

- Goal: reproduce these plots
- Principle: apply different MCP- and PC-voltages → Measure dark current of all shorted anode pixels
- Done for different Photonis sensors

Dark current vs. voltages

- 946P541 → 3x100 pixel, no escalation

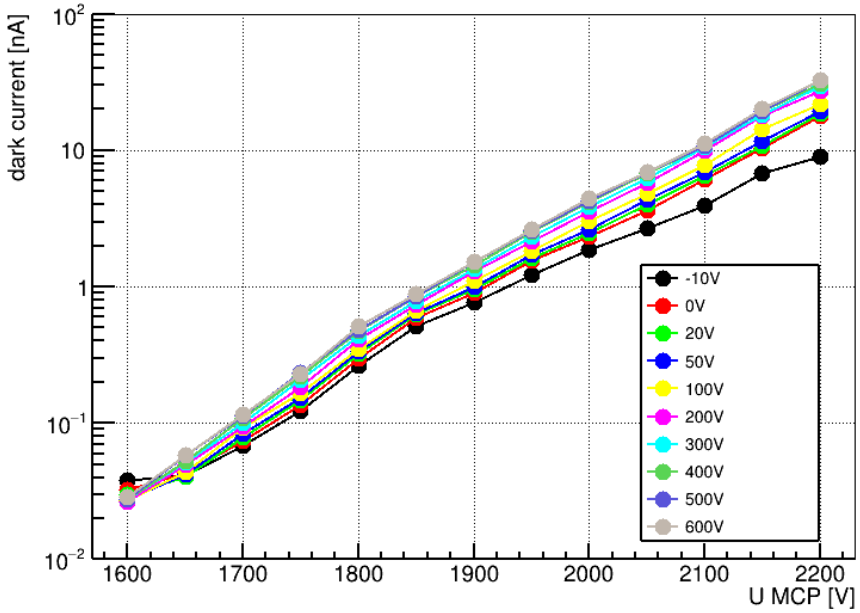


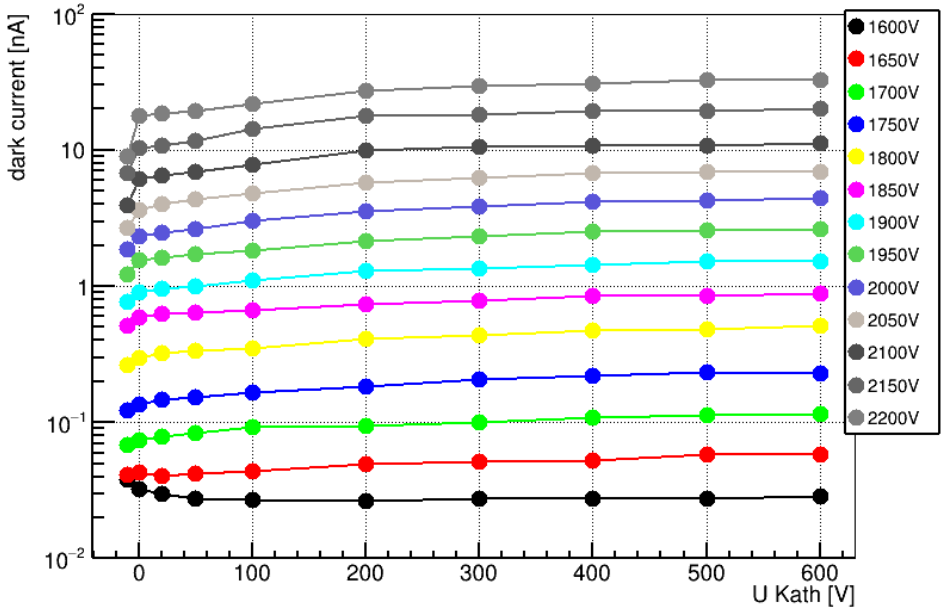


- Increase of dark current with MCP-voltage
- Slight increase of dark current with PC-voltage
- U_PC ≤ 0 V → less dark current

Dark current vs. voltages

- 9002108 → 8x8 pixel, no escalation

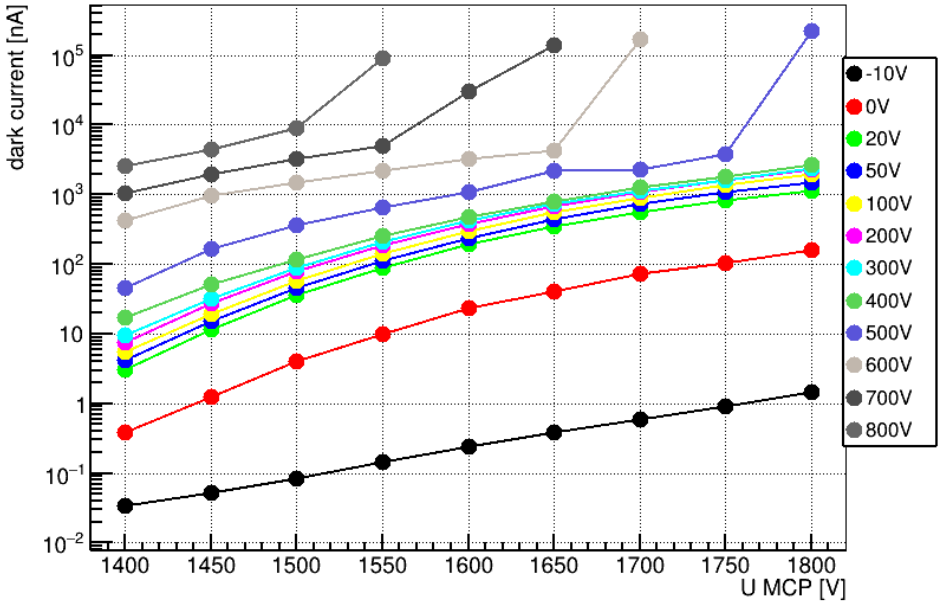


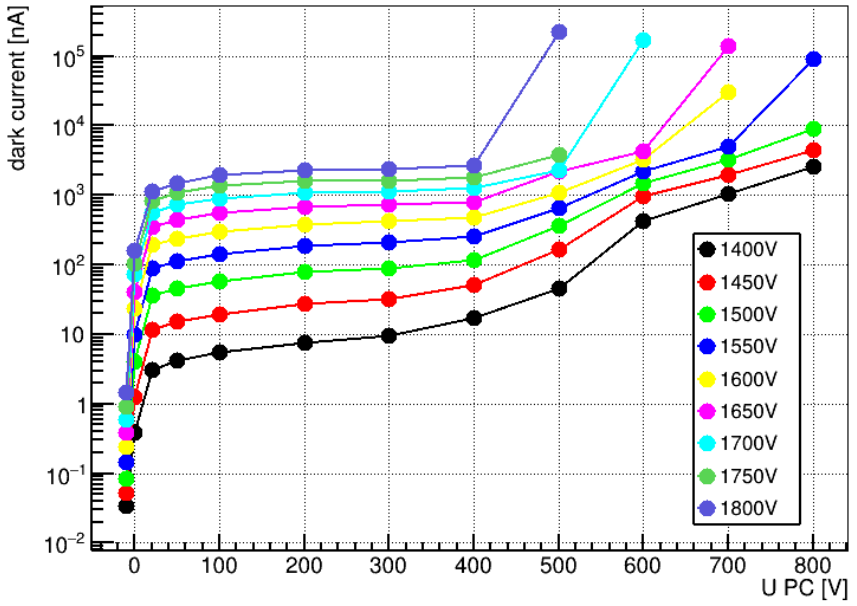


- Increase of dark current with MCP-voltage
- Slight increase of dark current with PC-voltage

Dark current vs. voltages

- 9002193 → 8x8 pixel, escalation

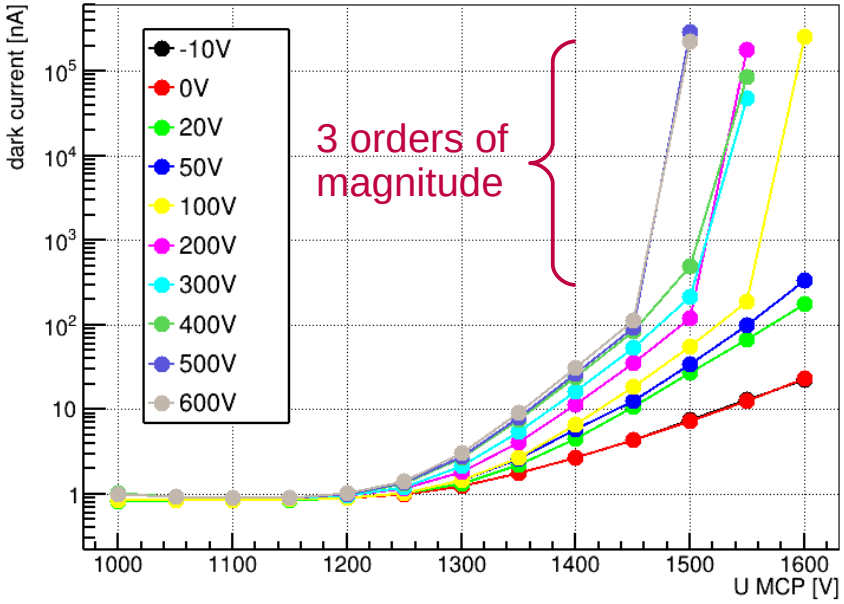


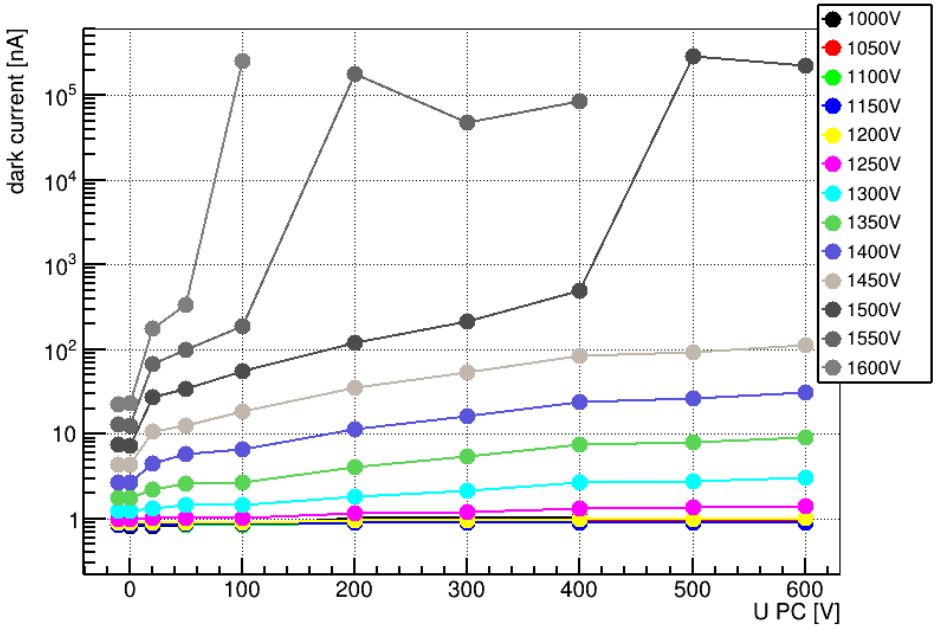


- Increase of dark current with MCP-voltage
- Slight increase of dark current with PC-voltage
- During escalation: „dark current“ independent of voltages

Dark current vs. voltages

- O37P541 → 3x100 pixel, escalation

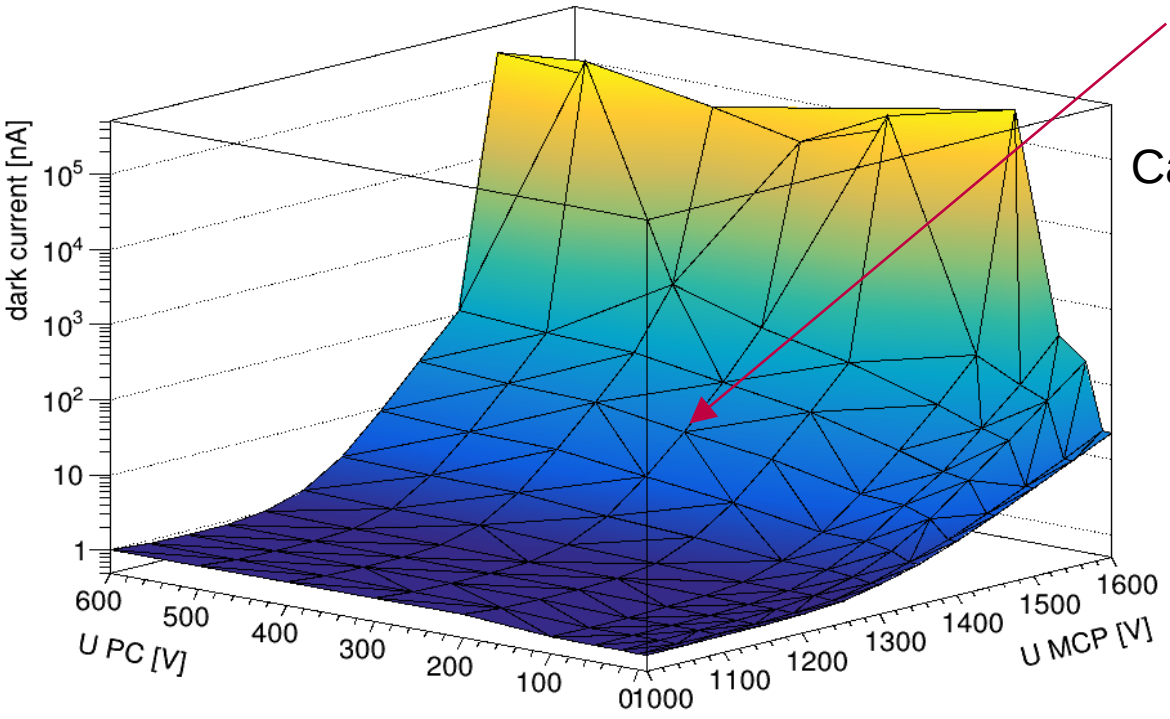




- Increase of dark current with MCP-voltage
- Slight increase of dark current with PC-voltage
- During escalation: „dark current“ independent of voltages

Dark current vs. voltages

- O37P541 → 3x100 pixel, escalation



- Use plots to find HV-combination with low risk of escalation

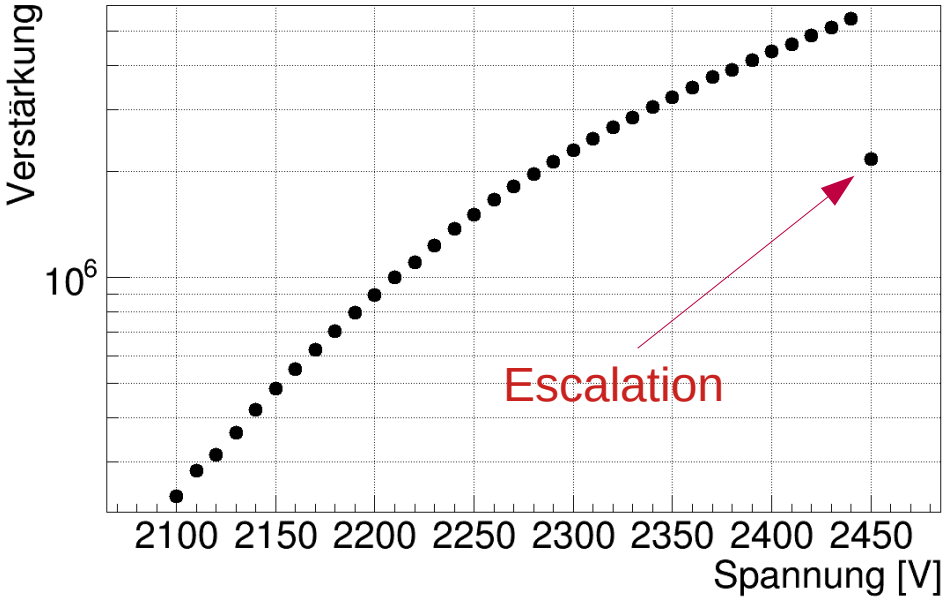
Caution:

- Escalation dependent on B-field
  → save point in B-field might still escalate without B-field
- Escalation not stable:
  → higher risk with illumination
  → after escalating, escalation starts earlier
- If sensor escalates, it needs to be switched off and to cool down a while

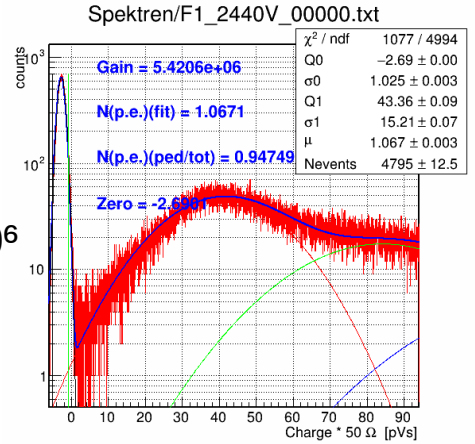
First measurements of Photonis 9002220

- Arrival of first sensor of mass production in Erlangen on Monday, May 23th
- Gaincurve (4:10:1 divider)
  → 10^6 gain at ~2225 V

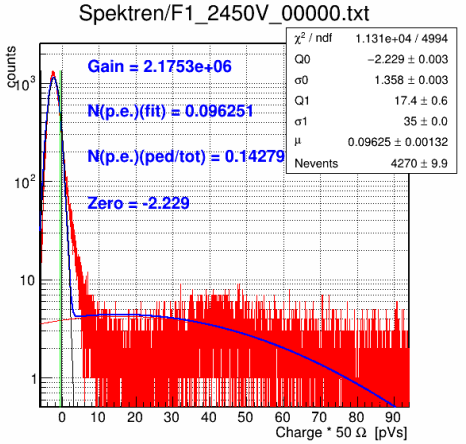
9002220



2440 V
→ Gain = 5.4 · 10^6

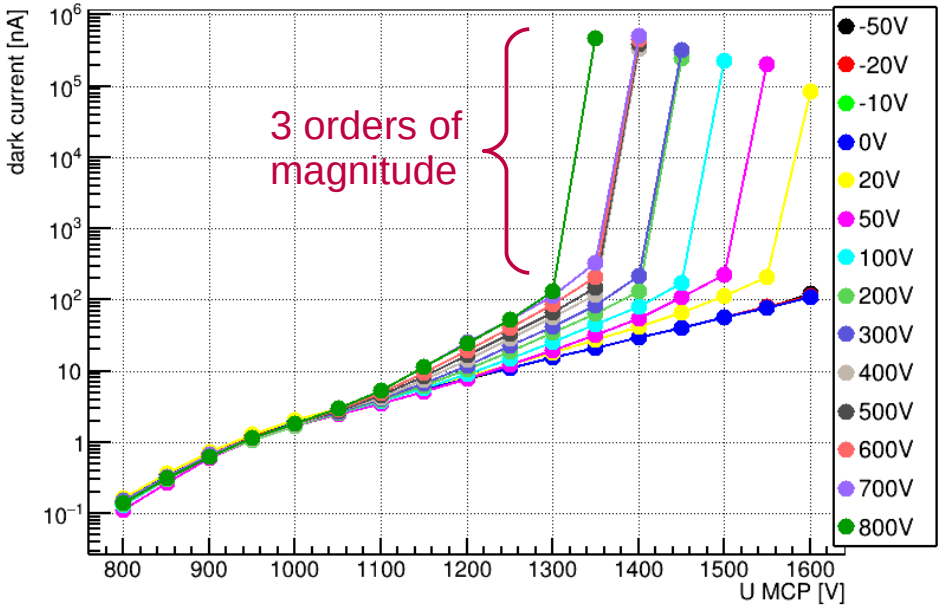


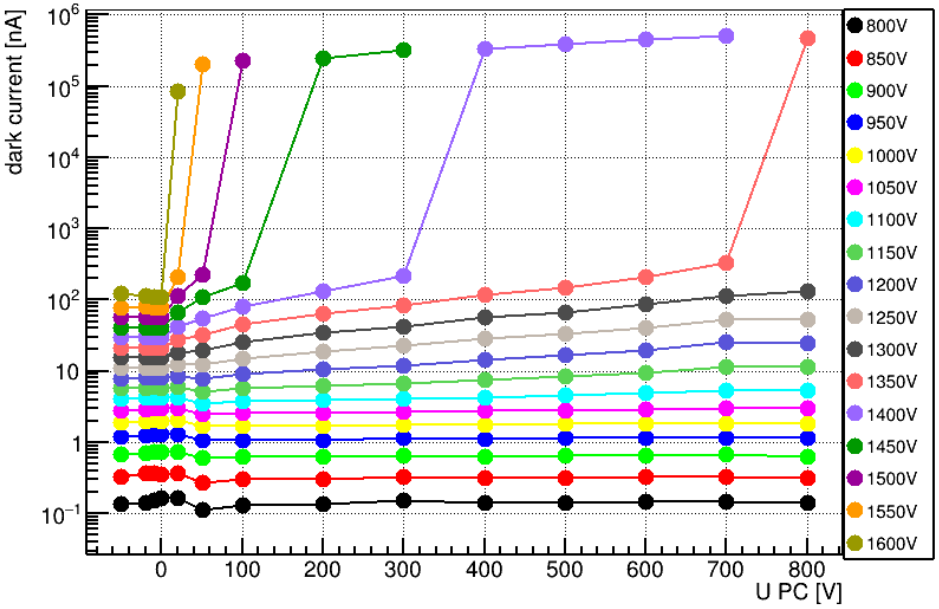
2450 V
→ Escalation



First measurements of Photonis 9002220

- Dark current vs. voltages

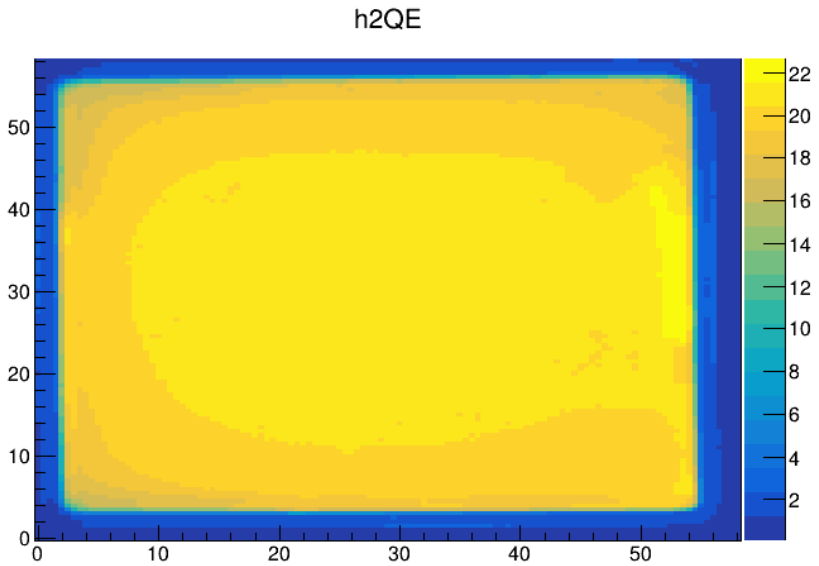


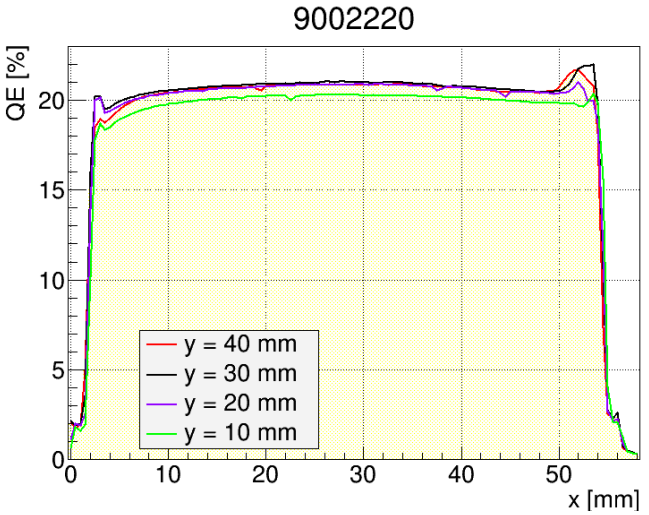


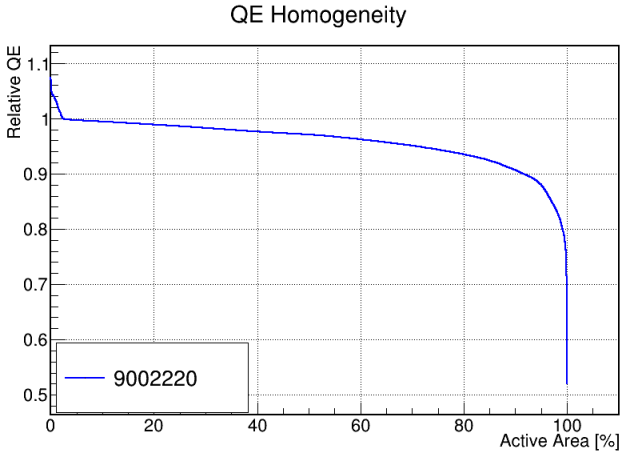
- Increase of dark current with MCP-voltage
- Slight increase of dark current with PC-voltage
- During escalation: „dark current“ independent of voltages

First measurements of Photonis 9002220

- QE-Scan



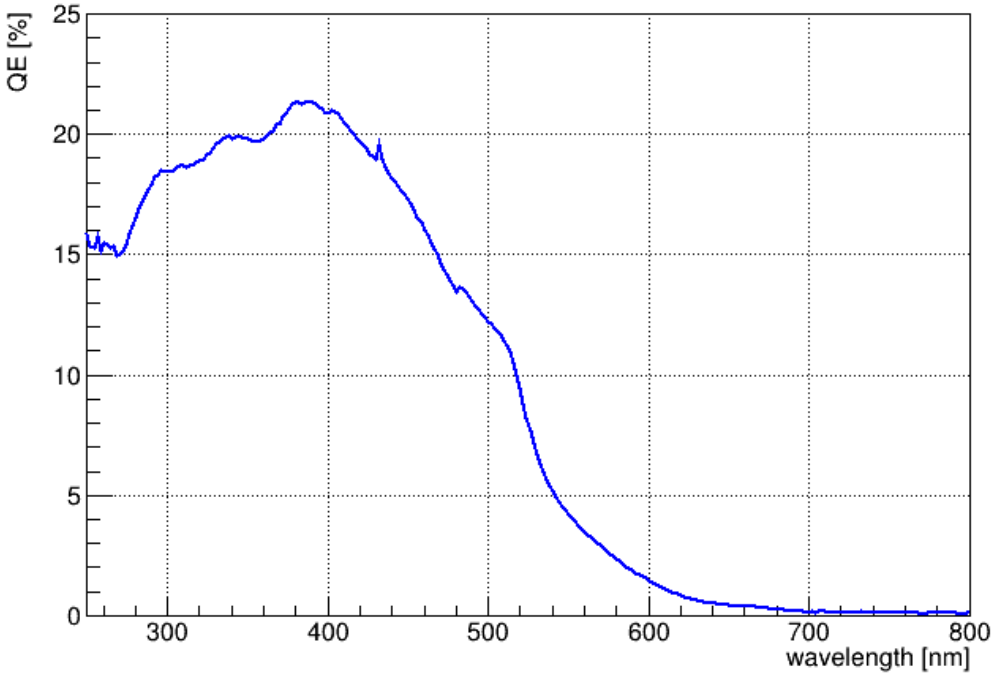




- 200 V between PC and MCP-In
- With 372 nm PiLas
- Good homogeneity with small increase towards right edge
- Maximum QE ~22%

First measurements of Photonis 9002220

- Wavelength dependent QE

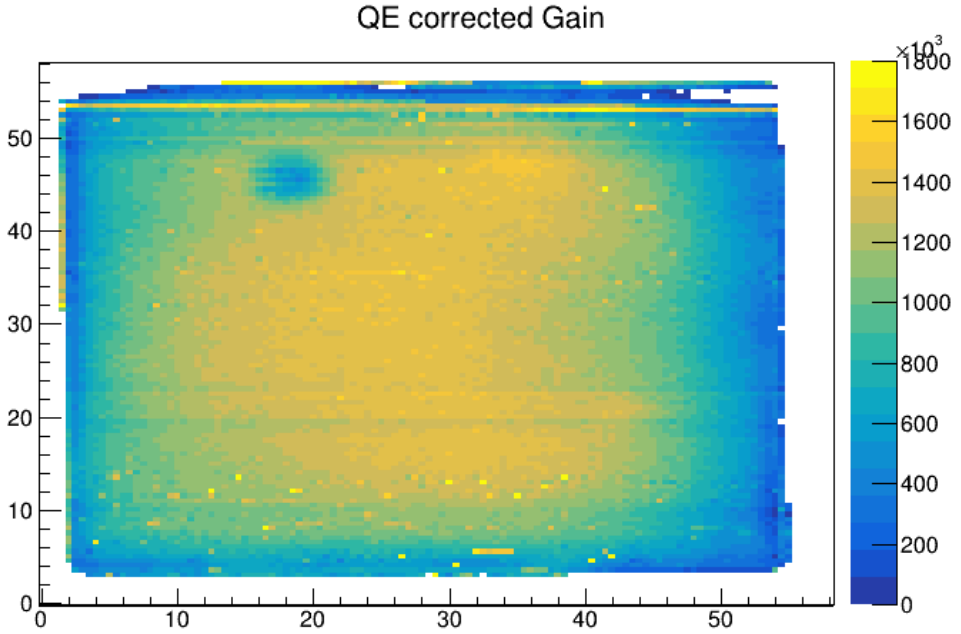


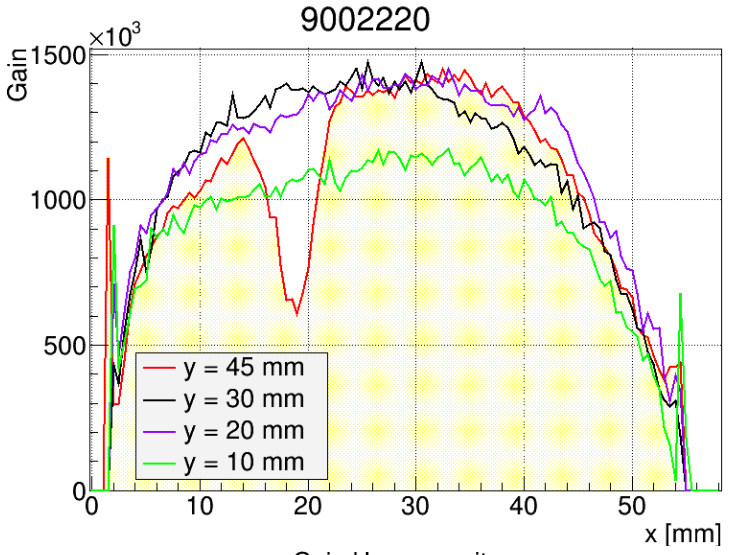
Setup:
- Xenon arc lamp with monochromator
- Position 22,23,32,33 illuminated
- 200V between PC and MCP-In

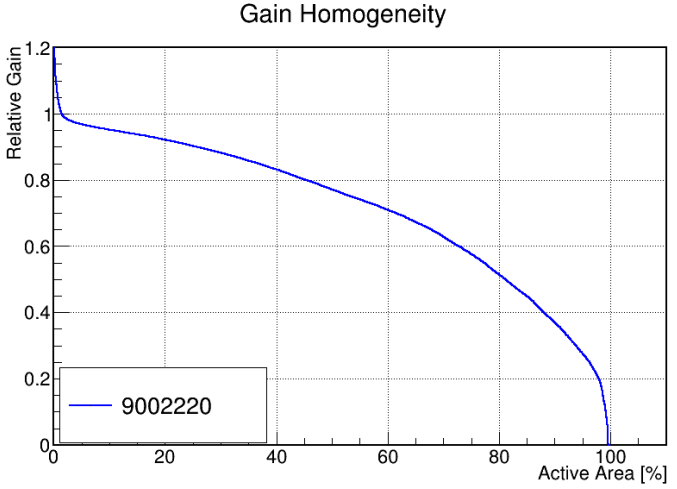
- Peak-QE: 21.3% at ~382 nm

First measurements of Photonis 9002220

- Gain-Scan







- Measured with three HV-channels:
  PC-MCP-In: 200 V, MCPs: 1400 V,
  MCP-Out-anode: 200 V
- Measurement noisy
- Hole: probably due to measurement

Summary

- Charge asymmetry plots:
  - Total width = focus + distribution of primary electrons
  - Charge cloud width in agreement with simulations
- Dark current vs. Voltages:
  - LAPPD sensors similar to escalating Photonis sensors → escalation as well?
- New sensor: Photonis 9002220
  - Escalation
  - Gain and QE value and homogeneity okay
  - More measurements (TRB-Scan, rate capability, …) planned

Mass evaluation

- Measurements for all sensors:
  - Gain curve
  - Gain-Scan
  - QE-Scan
  - Rate capability (current mode)
  - TRB-Scan
  - Wavelength dependent QE
  - Time resolution (CAEN digitizer)
  - Escalation
- Measurements for some sensors:
  - CE
  - Rate capability (pulse mode)
- Measurements for few sensors
  - Life time
  - Time resolution (Oscilloscope)
  - Behavior in magnetic field

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Dark current vs. voltages

- 9002220 → new sensor
- escalation