

# Update on Lifetime Measurements and short look on CE measurement setup

ERLANGEN CENTRE  
FOR ASTROPARTICLE  
PHYSICS

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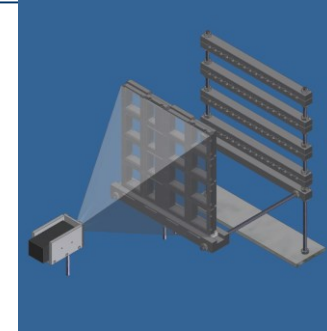
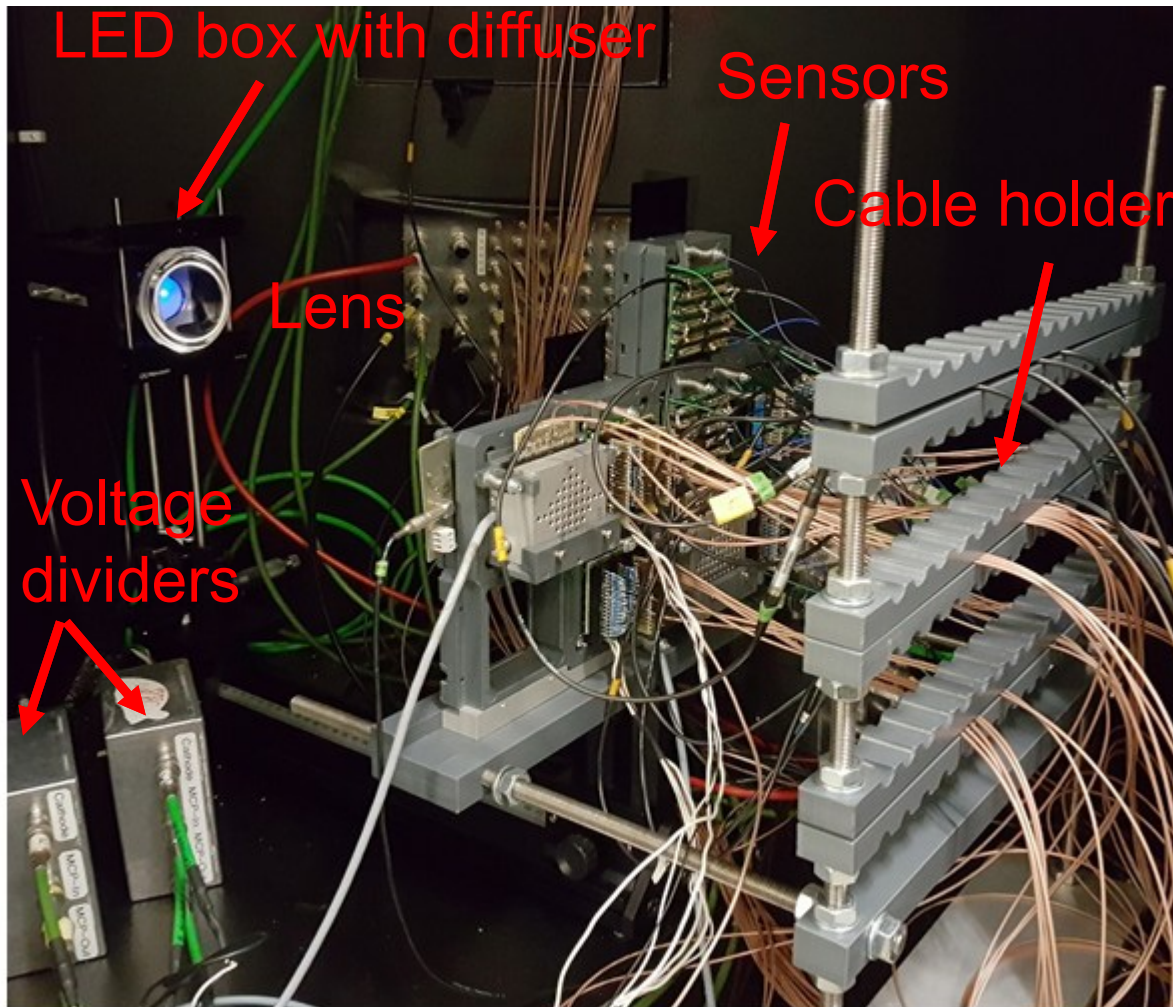
PANDA-Meeting 21/1, Mar 09, 2021



## Parameters of lifetime measurements

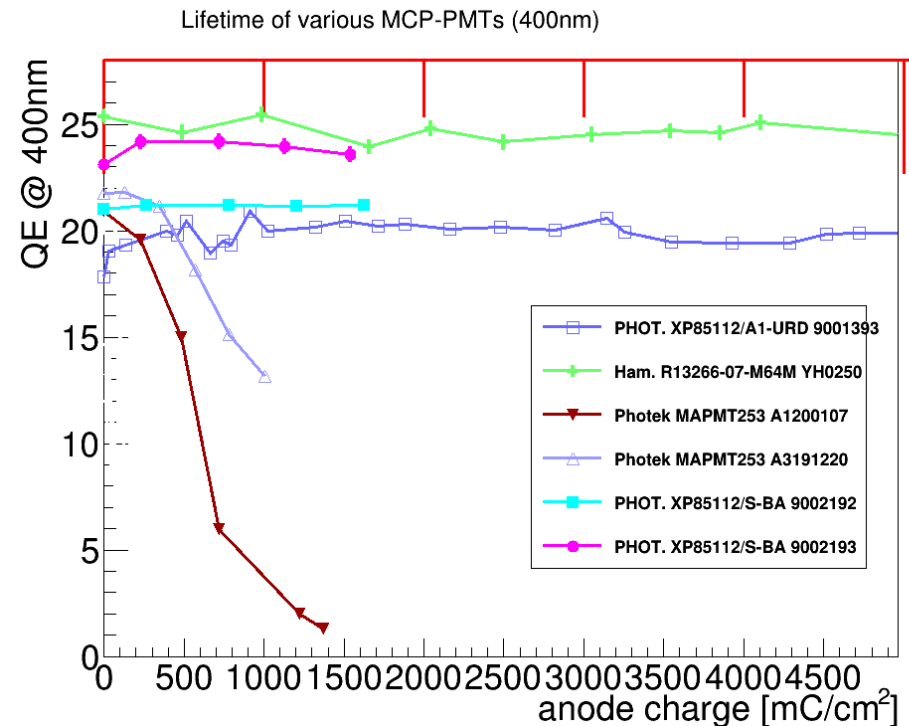
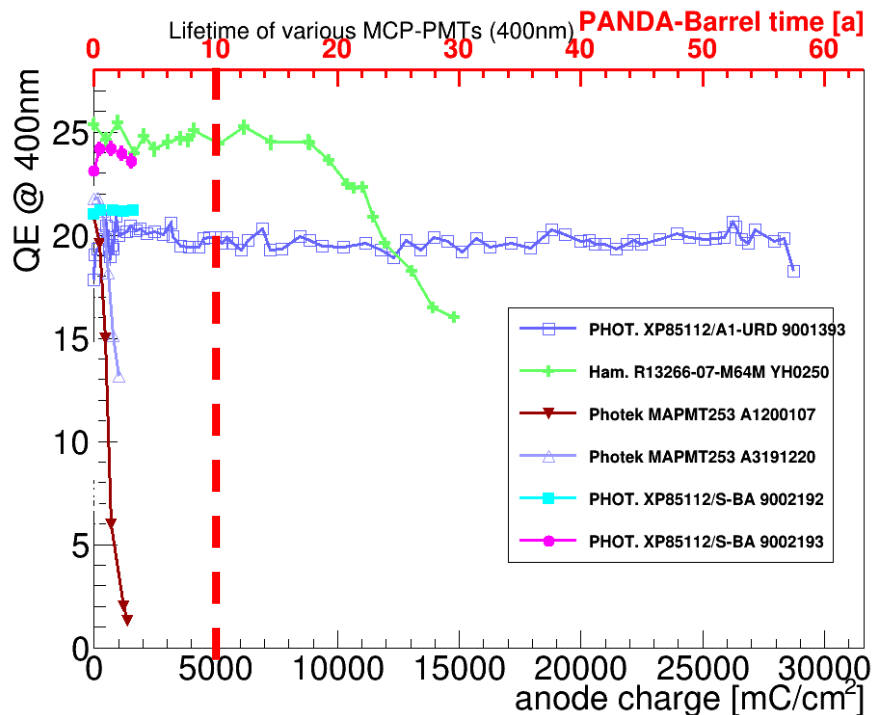
- **Goal:** Simultaneous measurement of different MCP-PMTs under similar conditions as in the PANDA-DIRCs
- Constant illumination with **1 MHz single photons**
  - All MCP-PMTs in **same** light spot
  - Permanent monitoring of integrated anode charge
- QE measurement:
  - Every few weeks:
    - **Wavelength spectrum** with Xenon arc lamp (75 W) and a monochromator ( $\Delta\lambda = 2 \text{ nm}$ , 250 nm - 800 nm)
    - Also measuring gain and dark counts
  - Every several months:
    - **Surface scans** with picosecond laser (372 nm, spot size:  $\varnothing \sim 0.5\text{-}1 \text{ mm}$ )

## Lifetime setup



- Pulsed LED inside aluminum Box
- Thorlabs engineered diffuser
  - In front of LED to get homogeneous light spot on sensors
- Holding construction for up to 16 sensors all illuminated by same LED
- Cable management behind sensors

## Lifetime data of latest sensors

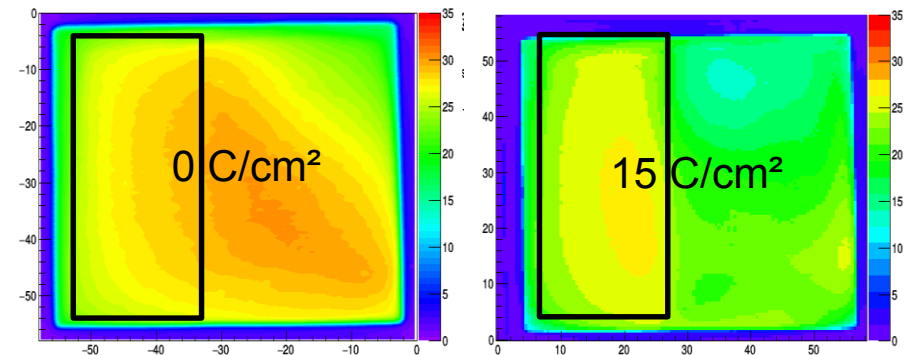
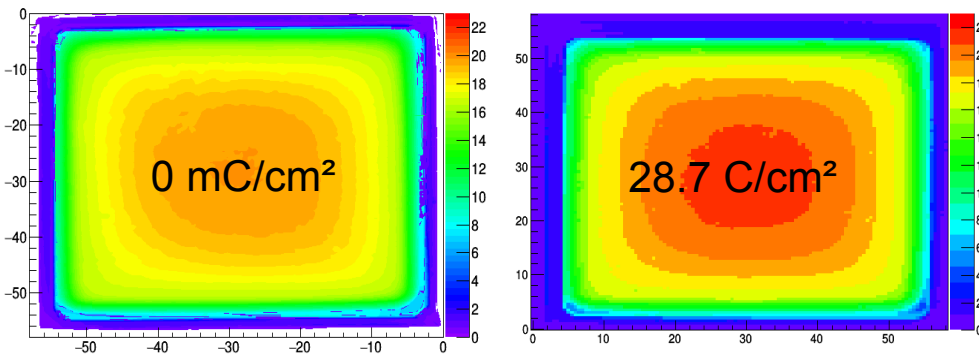


- Most sensors with **ALD coated MCPs** have **lifetime > 5 C/cm<sup>2</sup>**
- **QE( $\lambda$ ) of Photeks can't be measured anymore due to too high darkcurrent ( $\sim 100\text{nA}$  and more), QE-Scans are (sometimes) possible after waiting for hours-days**

# QE scans of 2 inch ALD devices, Photonis+Hamamatsu

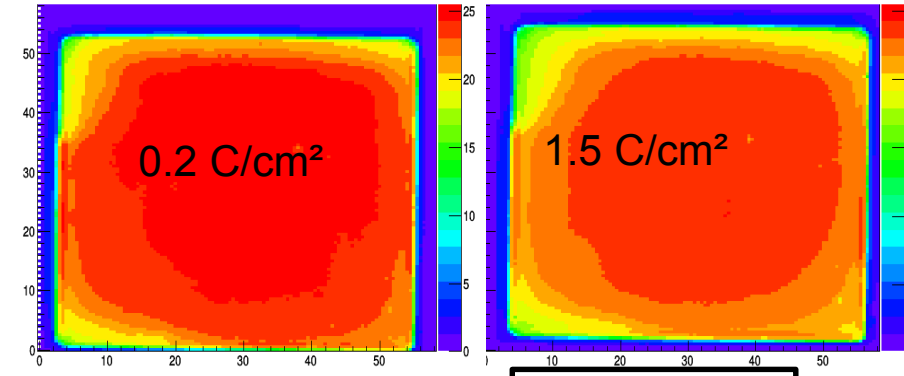
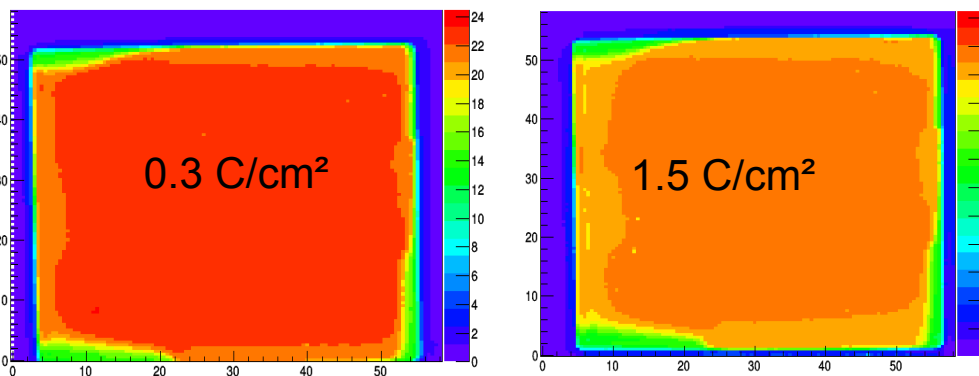
URD (8x8 pix, 2ALD layers)

YH0250 (8x8 pix., no film)



9002192 (8x8 pix., ALD)

9002193 (8x8 pix., ALD)



Covered

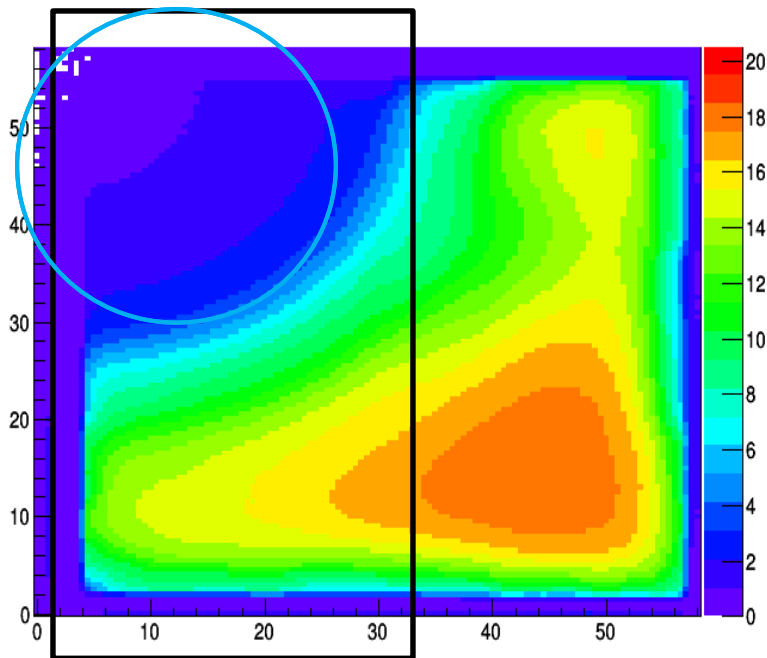
## QE scans of Photek A1200107(ALD)

Covered (not illuminated)

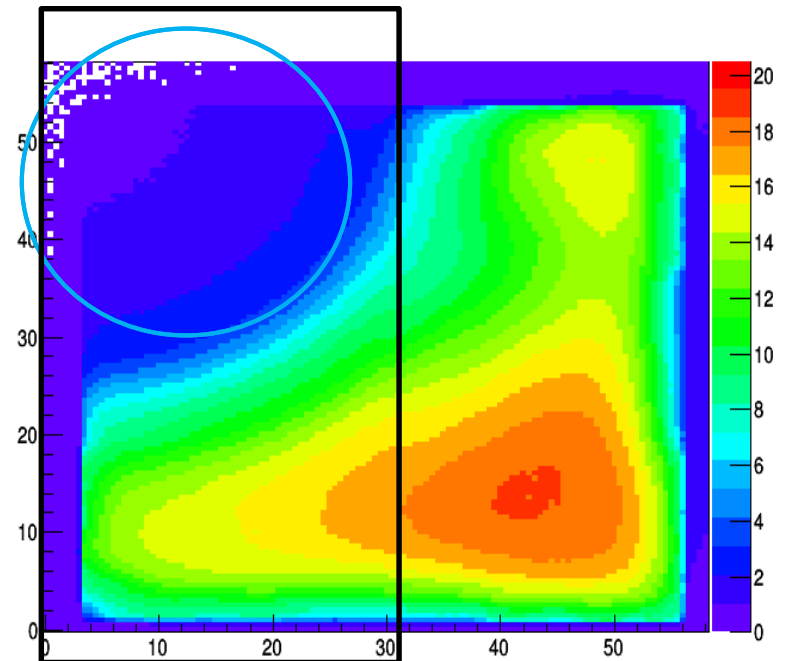
Clear sign of Cathode damage

- Aging starting from the corner

January 25 2021



March 1 2021



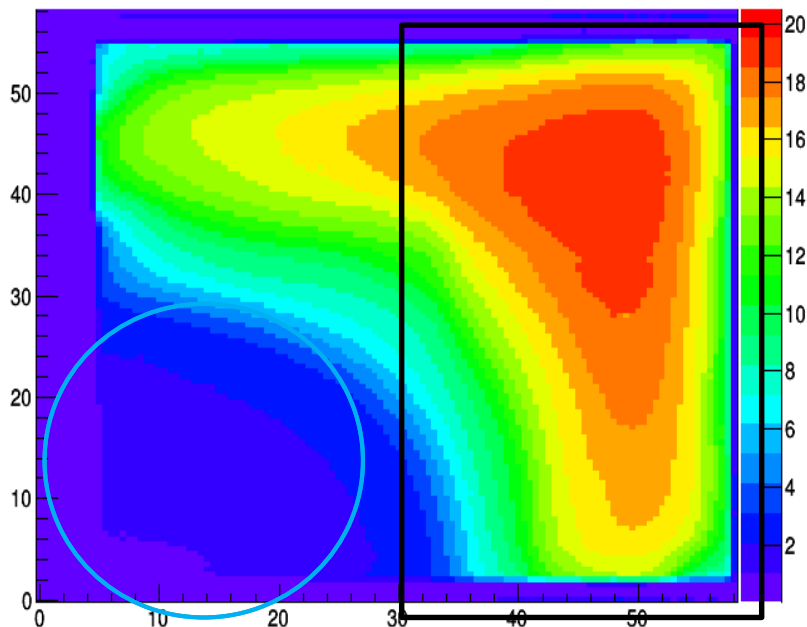
## QE scans of Photek A3191220 (ALD)

Covered (not illuminated)

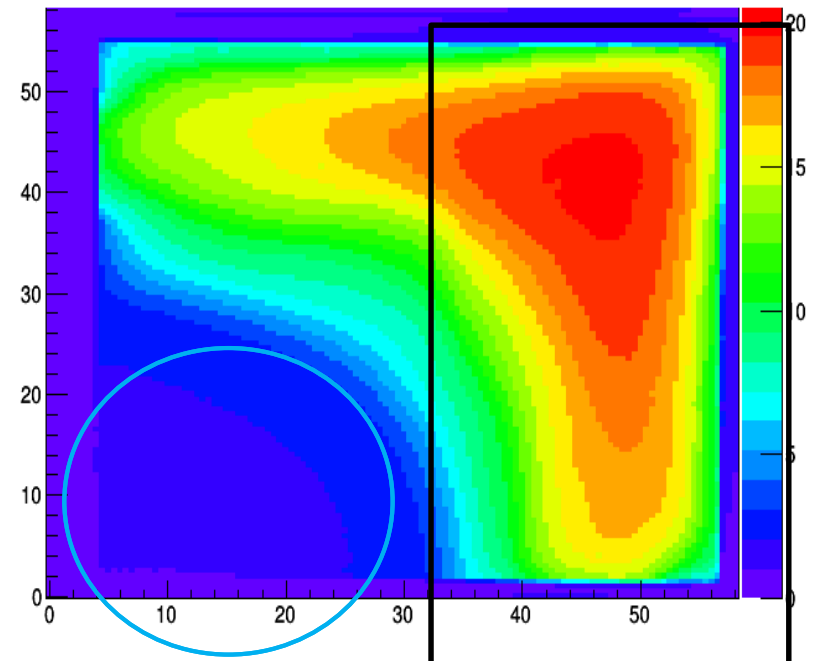
Clear sign of Cathode damage

- Aging starting from the corner

January 25 2021



March 1 2021



## CE measurement issues of Photonis 9002192 and 9002193 (Reminder)

- first CE measurement in July: both sensors: only ~75%,
- second CE measurement in September (directly before Juelich):
  - 9002192: ~95% CE
  - 9002193: ~85% CE
- third CE measurement in October (directly after Juelich):
  - 9002192: ~17% CE
  - 9002193: ~20% CE
- no setup changes between second and third measurement, even almost the same illumination levels, but the number of photoelectrons in the charge spectrum is a factor of 4-5 lower, which has direct impact on the CE
- → measurements with 9002108 to confirm setup
- need to investigate whether this is a real effect of the magnetic field (test in 3T MRI tomorrow)



## CE measurements with 9002108

- 9002108 was the first Hi-CE tube from Photonis (~90-95% CE )
- measurements in Aug 20 (~93%), Oct 20 (~87%) and now in Feb 21 again (with different illumination levels/setup):
  - ~2.5 p.e: ~90% CE
  - ~1 p.e : ~94% CE
  - ~0.4 p.e: ~95% CE
- → setup seems not to be the problem

## Summary

- CE setup look good, 9002192 and 9002193 in MRI (3T) tomorrow for further tests
- Requirements:  $> 5 \text{ C/cm}^2$  at  $10^6$  gain (50% duty cycle, 10 years)
- Photonis
  - Best sensor at  $29 \text{ C/cm}^2$  without any sign of cathode damage
  - 9002192&9002193 look good so far
  - Photek:
    - both (all three) sensors already show aging effects, no matter if the side was illuminated or covered or the sensor even was off
    - our assumption: „microleaks“ as called by Hamamatsu, as both Hamamatsu and Photonis experienced these when starting with 2 inch tubes
- Hamamatsu:
  - Later produced (higher serial number) 2 inch tubes tend to have better performance
  - YH0250's QE started dropping at  $\sim 9 \text{ C/cm}^2$

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# Thank you for your attention!

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