

Update on lifetime measurements of MCP-PMTs

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS

D. Miehling, M. Böhm, S. Krauss,
A. Lehmann

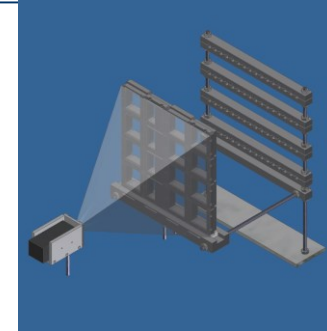
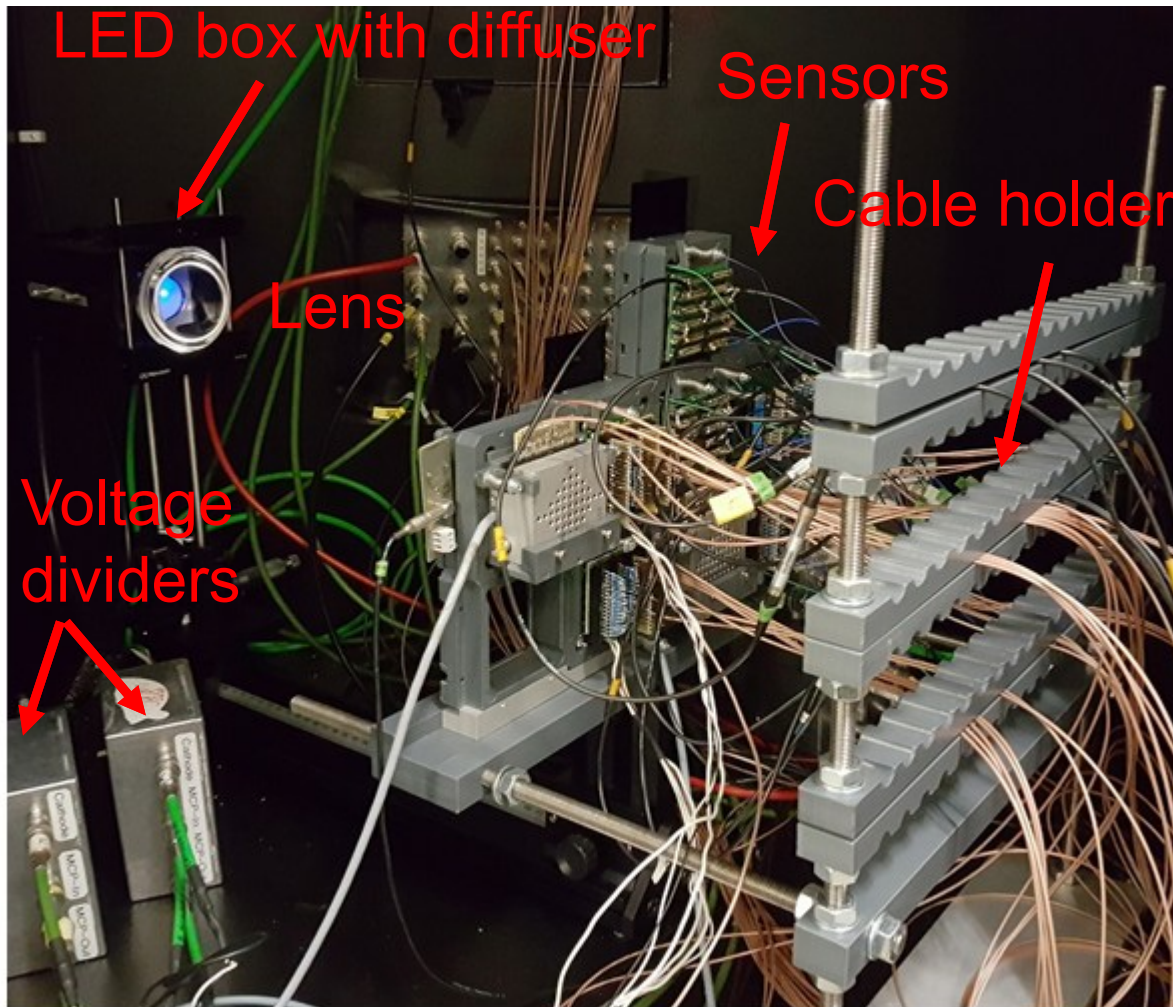
PANDA-Meeting 20/2 GSI, June 23, 2020



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

Data from June 15, 2020

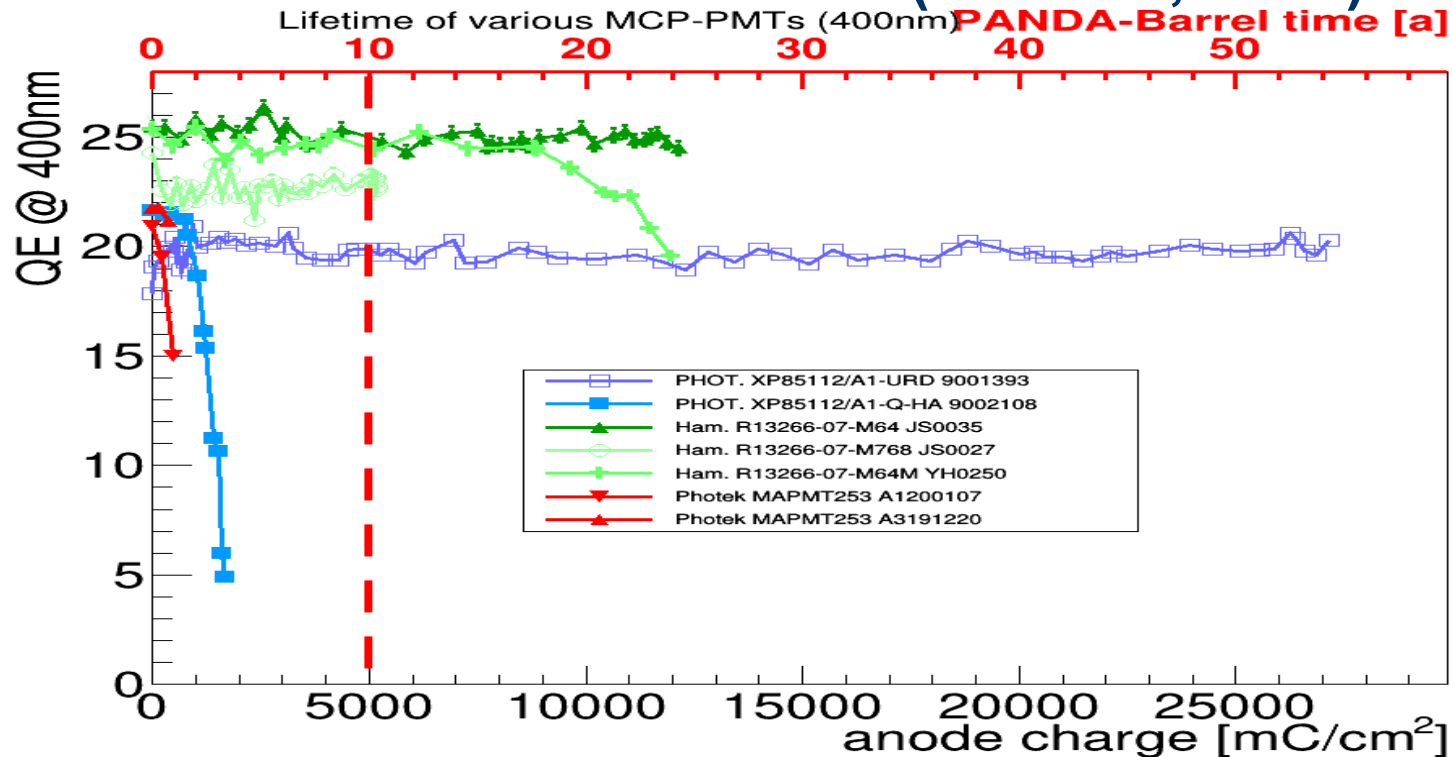
Illumination Overview QE (all sensors with ALD)

Two ALD layers Film in front of first MCP **be careful with this numbers (next slide)**

Manufacturer	Sensor ID	IAC [mC/cm ²]	QE start [%]	QE latest [%]	QE latest/QE start [%]
Photonis XP85112	9002108	1678	21.7	4.9	23
	9001393	27157	19.1	20.3	106
Photek MAPMT253	A1200107	742	20.9	~20	~95
	A3191220	588	21.7	~23	~105
Hamamatsu R13266-07- M768 / M64	YH0250 (64 pix.)	11971	25.4	19.6	77
	JS0035 (64 pix.)	12156	25.5	24.5	96
	JS0027 (768 pix.)	5181	24.3	22.7	93

removed in Oct 2019

Lifetime data of latest sensors (June 15, 2020)

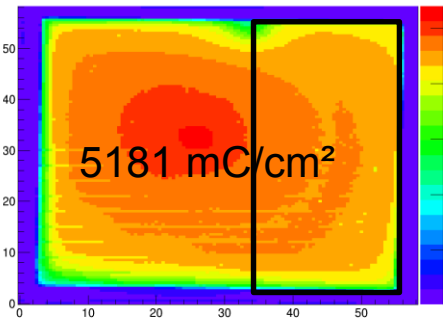
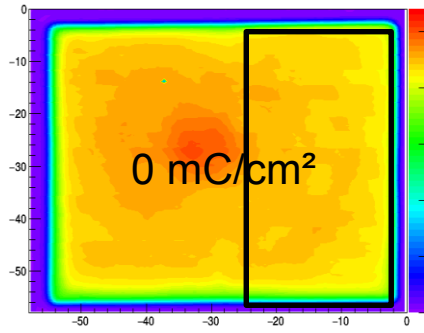
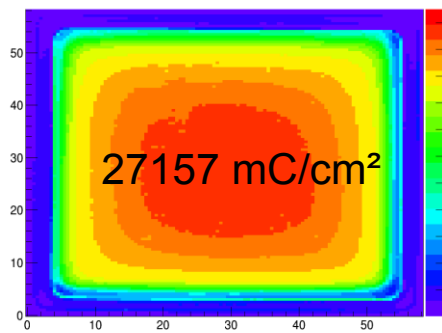
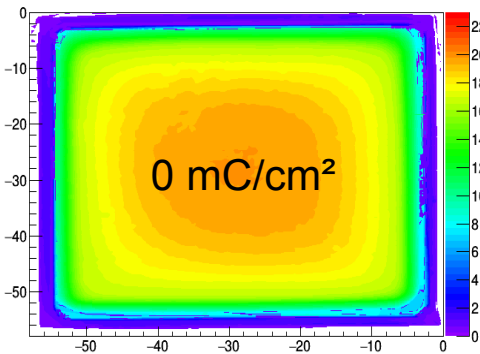


- Most sensors with ALD coated MCPs have lifetime > 5 C/cm²
- Photonis 9002108 and new Photeks have lifetime problems
- QE(λ) of Photeks can't be measured anymore due to too high darkcurrent (~ 100 nA and more), QE-Scans are possible after waiting for hours-days

QE scans of 2 inch ALD devices, Photonis+Hamamatsu

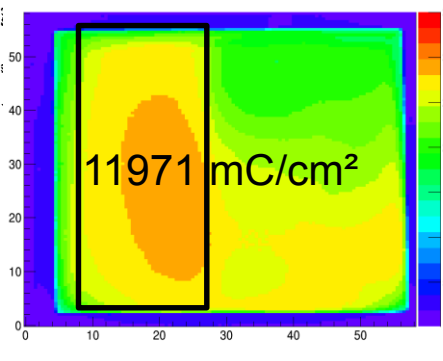
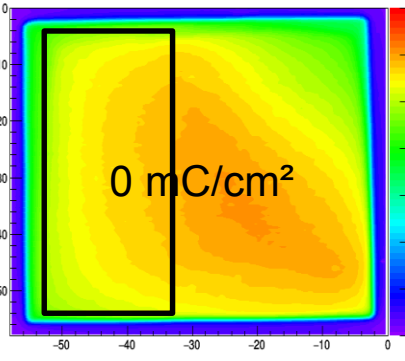
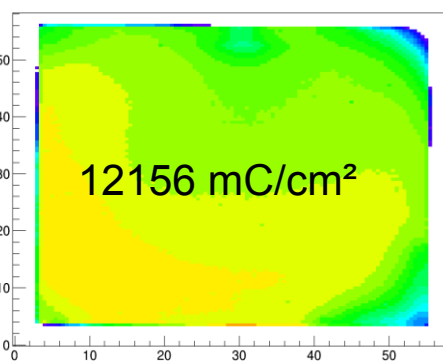
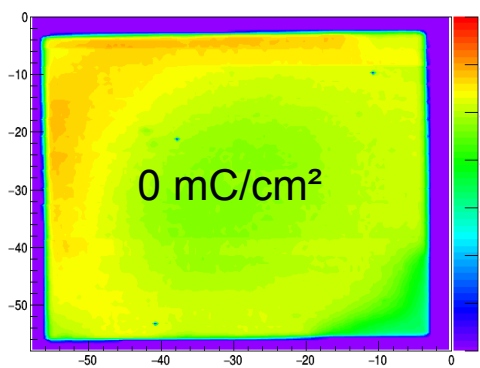
URD (8x8 pix, 2ALD layers)

JS0027 (6x128 pix., film)



JS0035 (8x8 pix., film)

YH0250 (8x8 pix., no film)



Covered

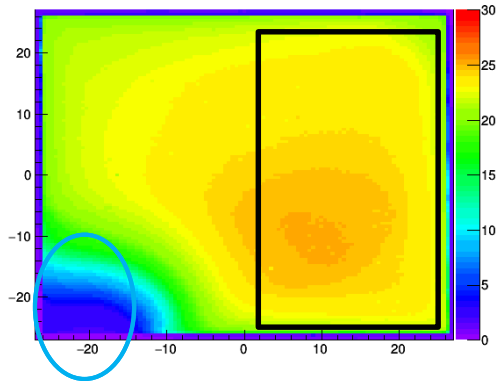
QE scans of Photek A3191220 (ALD)

Covered (not illuminated)

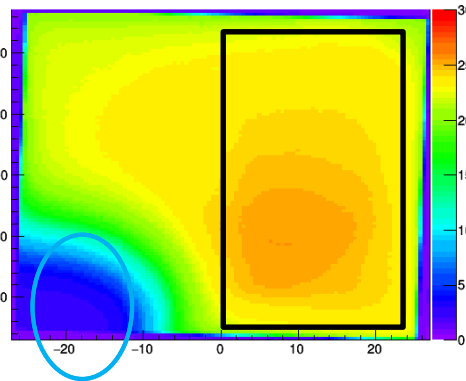
Clear sign of Cathode damage

- Aging starting from the corner

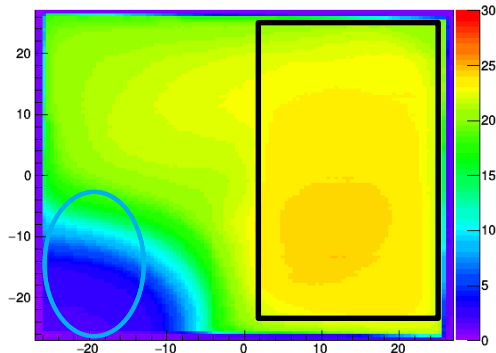
14_Feb_2020



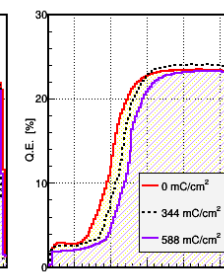
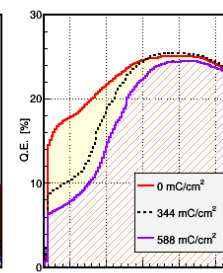
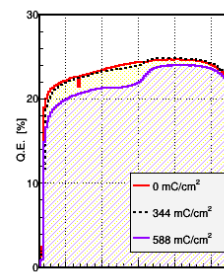
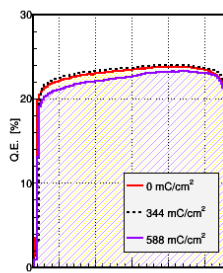
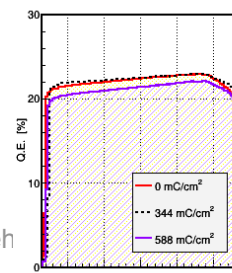
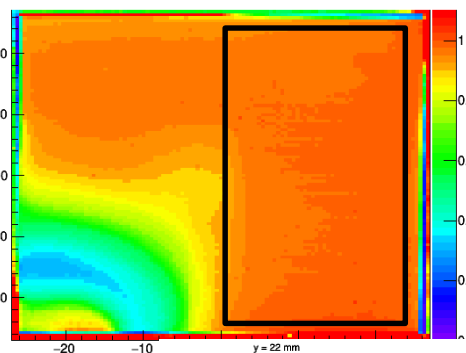
15_May_2020



21_Jun_2020



A3191220: newest histo / oldest histo



QE scans of Photek A1200107 (ALD)

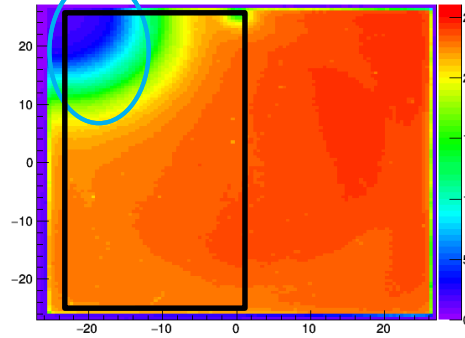
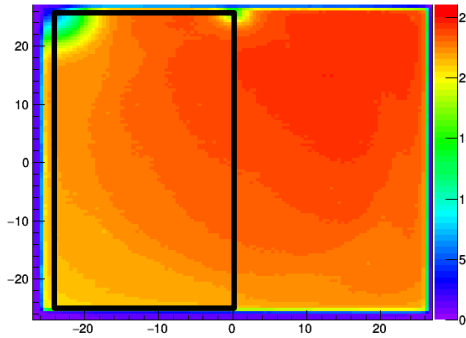
Covered (not illuminated)

Clear sign of Cathode damage

- Aging starting from the corner (on the non-illuminated side)

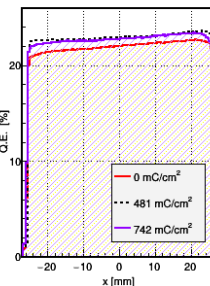
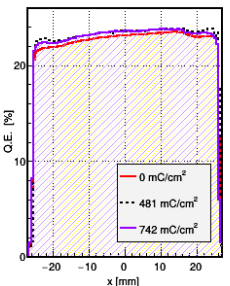
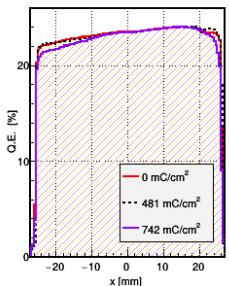
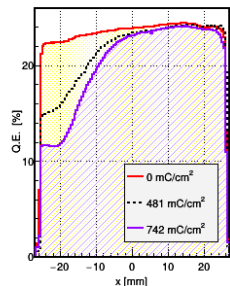
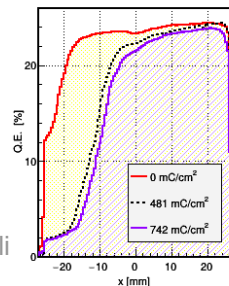
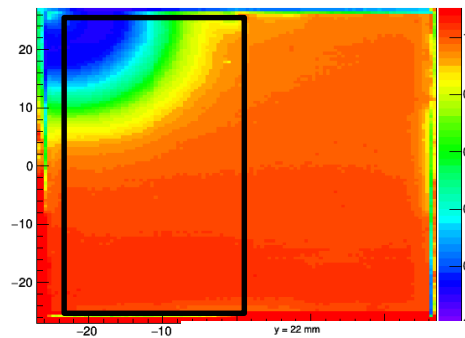
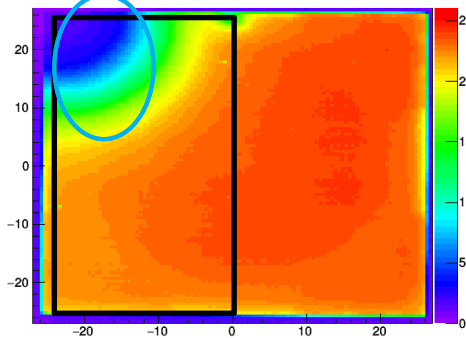
20_Feb_2020

15_May_2020

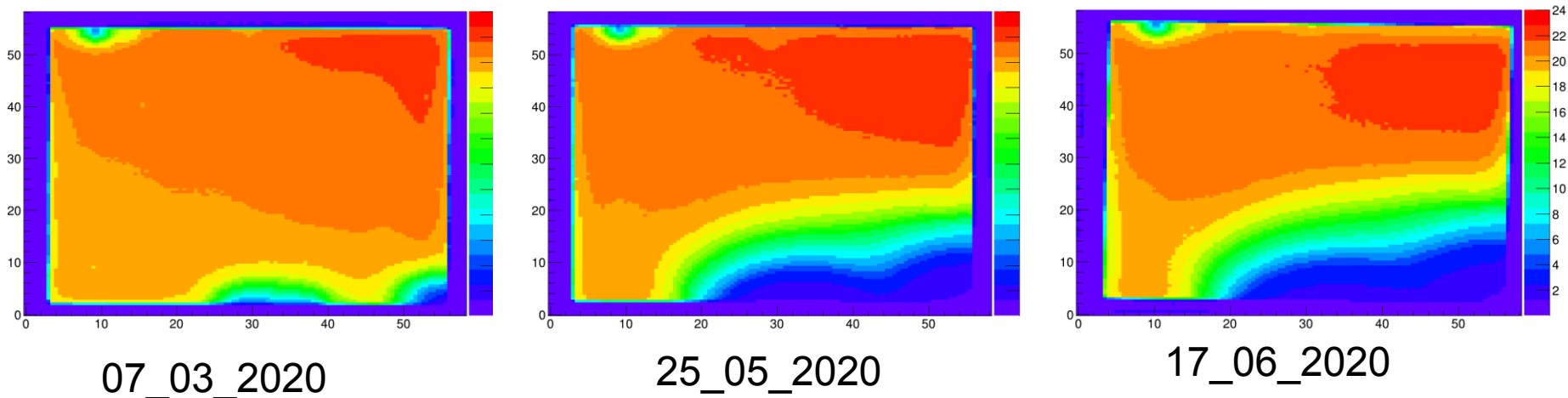


17_Jun_2020

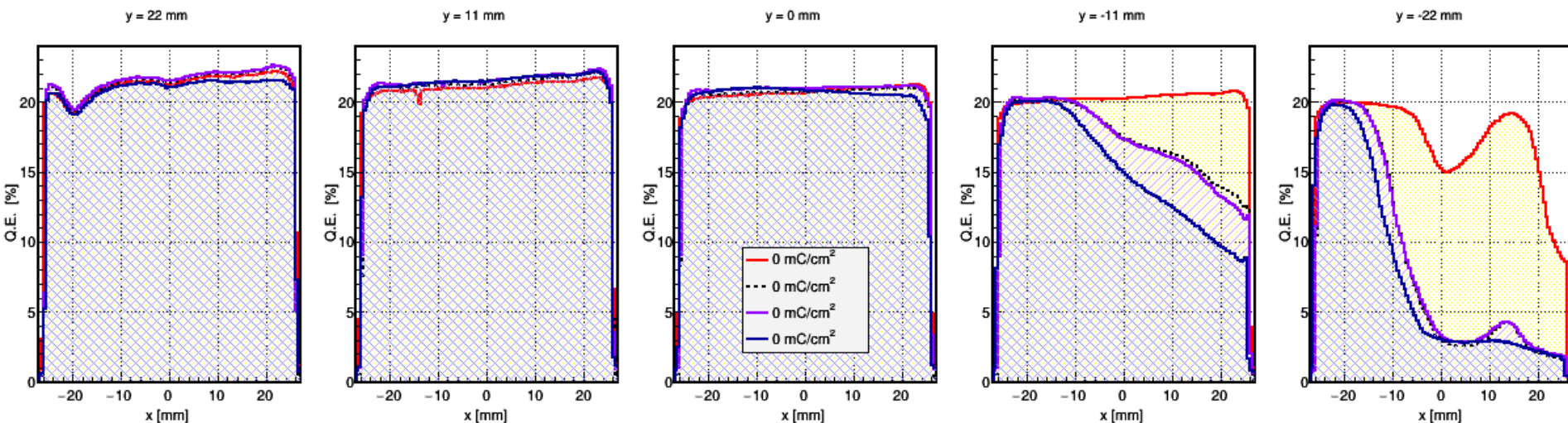
A1200107: newest histo / oldest histo



QE scans of Photek A1200116 (ALD, unofficial tube)



- Aging even with tube **not in use**



Summary

- Requirements: $> 5 \text{ C/cm}^2$ at 10^6 gain (50% duty cycle, 10 years)
- Photonis
 - Best sensor at 28 C/cm^2 without any sign of cathode damage
 - New sensor already damaged at 1.2 C/cm^2 , now at 1.6 C/cm^2 only $\sim 3\%$ QE left in the hole
- Hamamatsu:
 - Later produced (higher serial number) 2 inch tubes tend to have better performance
 - JS0035 now at 12 C/cm^2 seems to have a slow overall QE drop
 - YH0250's QE started dropping at $\sim 9 \text{ C/cm}^2$
- 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

GEFORDERT VOM



Bundesministerium
für Bildung
und Forschung

Thank you for your attention!

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



GEFORDERT VOM



Bundesministerium
für Bildung
und Forschung



ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

NATURWISSENSCHAFTLICHE
FAKULTÄT