



ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



Update on lifetime measurements



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supported by



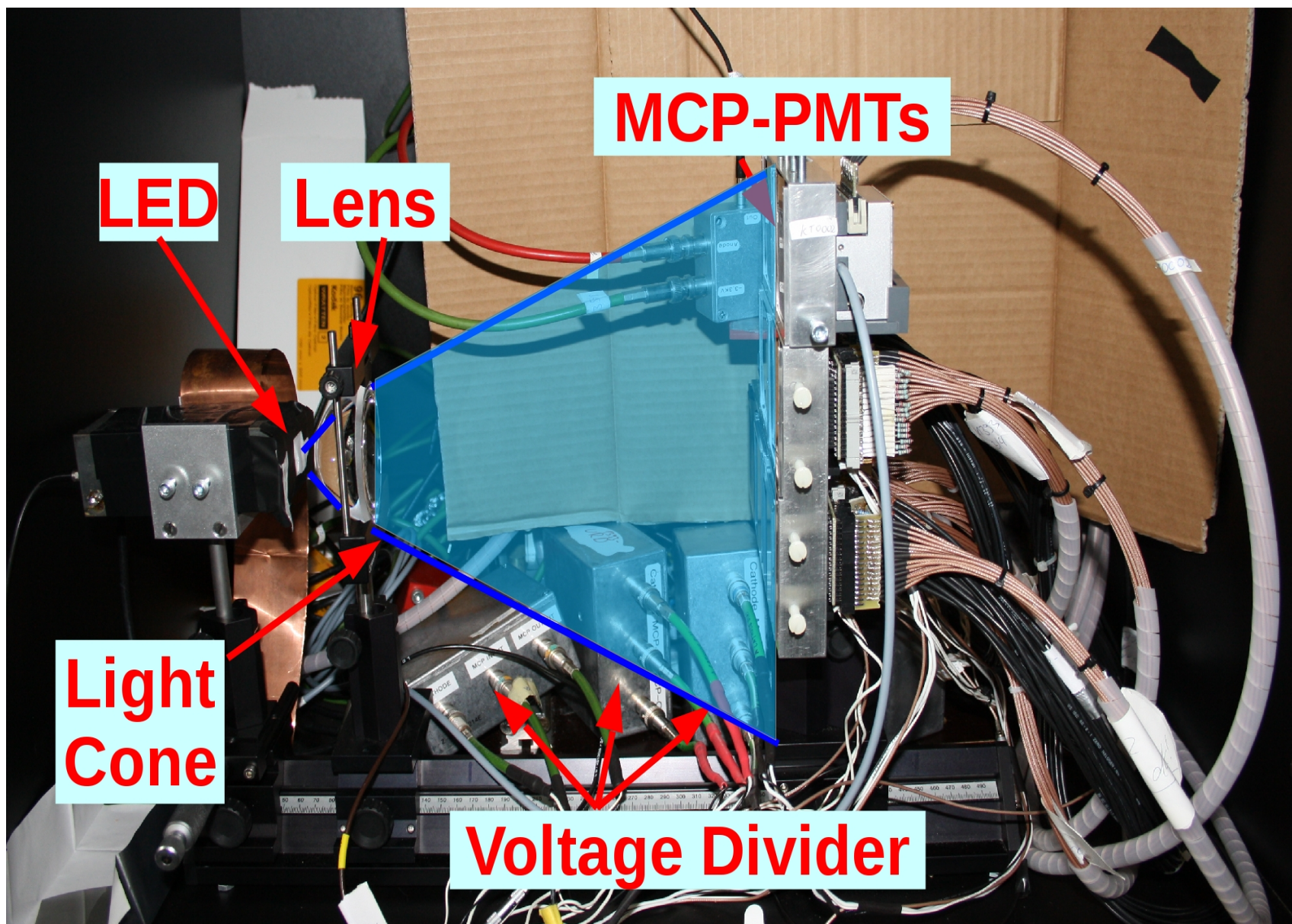
Bundesministerium
für Bildung
und Forschung



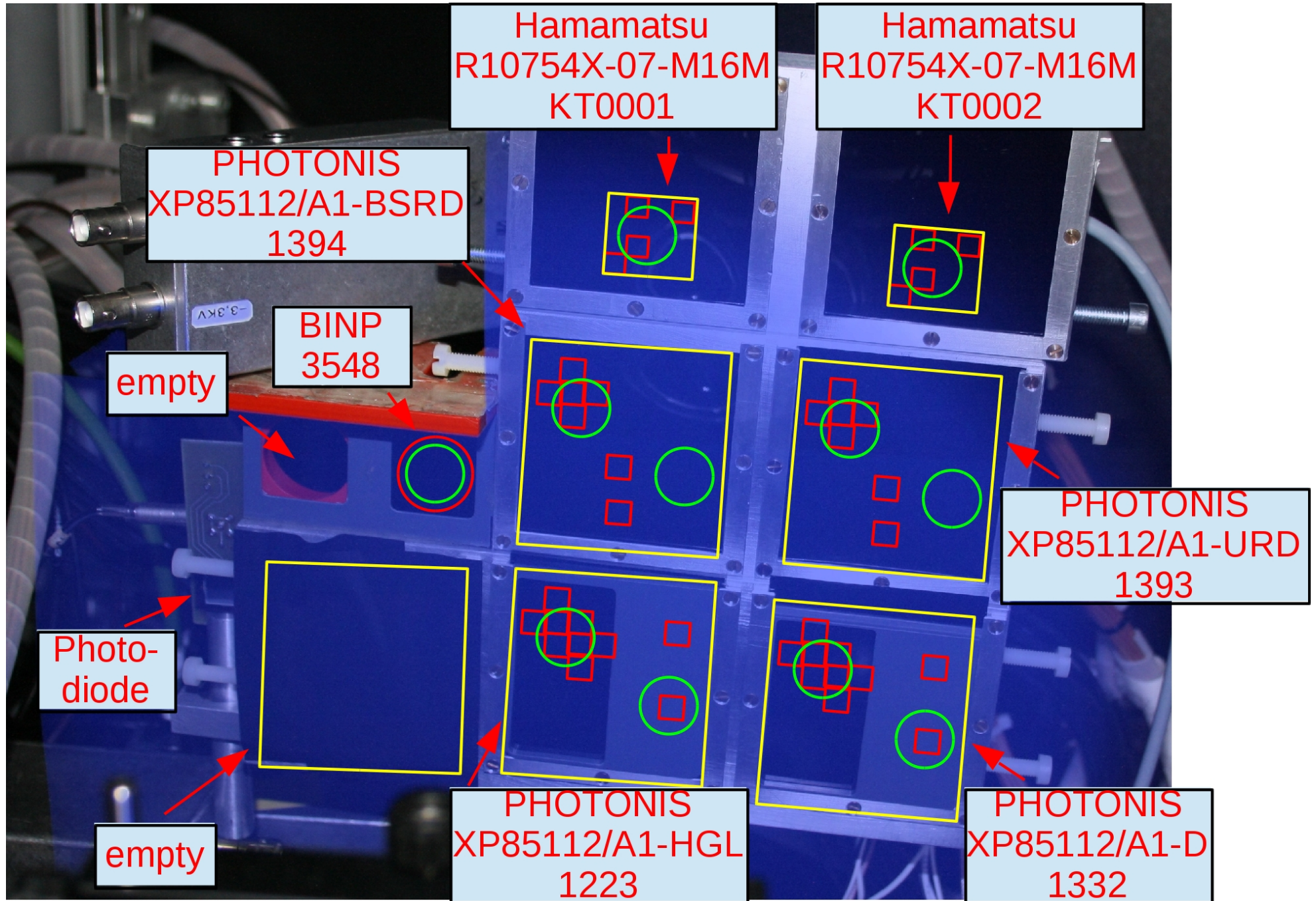
Overview

- Motivation
- New setup of lifetime measurements
- Results of the latest measurements for various devices concerning:
 - Darkcount rate
 - Gain
 - Quantum Efficiency measurements
 - QE surface scan
- Comparison with previous measurements
- Summary and outlook

Setup



Setup (2)

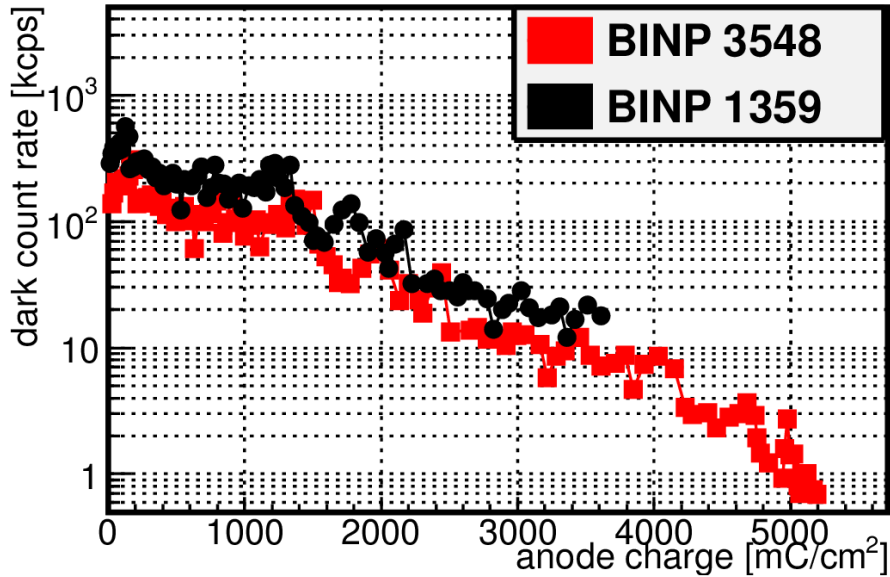


Illumination overview

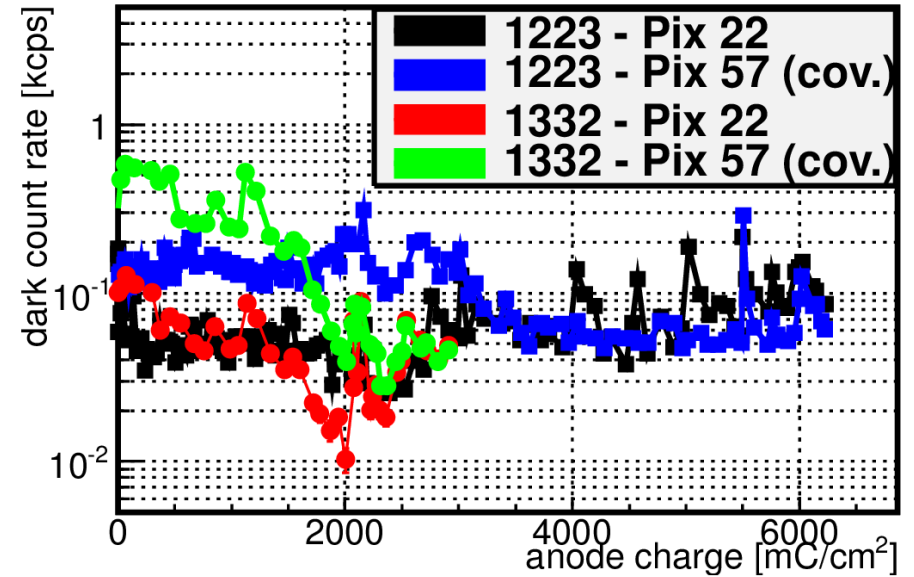
	BINP 1359/3548	PHOTONIS XP85112/A1-HGL 1223 / 1332	Hamamatsu R10754X-01-M16 JT0117	Hamamatsu R10754X-07-M16M KT0001 / KT0002
Int. Collect. Charge (Feb. 25 th) [mC/cm ²]	3060 / 5195	6240 / 2915	2085	1225 / 490
Max applied current per anode [nA]	315 / 346	56 / 59	45.3	71.4 / 40.3
Specified max. DC anode cur. [nA]	1000	47 (64 Chans.) 94 (32 Chans.)	100	100
Max Diff. Charge [mC/cm ² /d]	10.7 / 11.7	13.5 / 13.6	14.1	19.3 / 10.9
Number of QE-Scans	8 / 9	13 / 5	7	3 / 3
Anode area per pixel (cm ²)	2.54	0.36	0.32	0.32
Measured Channels	1	8 + 2 (unexposed) + MCP-Out	8	4
Illuminated area	100%	50%	100%	100%
Applied voltage (V) using voltage divider	3100 (+100)	2050 / 2000 2100 / 2050 illum.	3300	2400 / 2600

Dark count rate

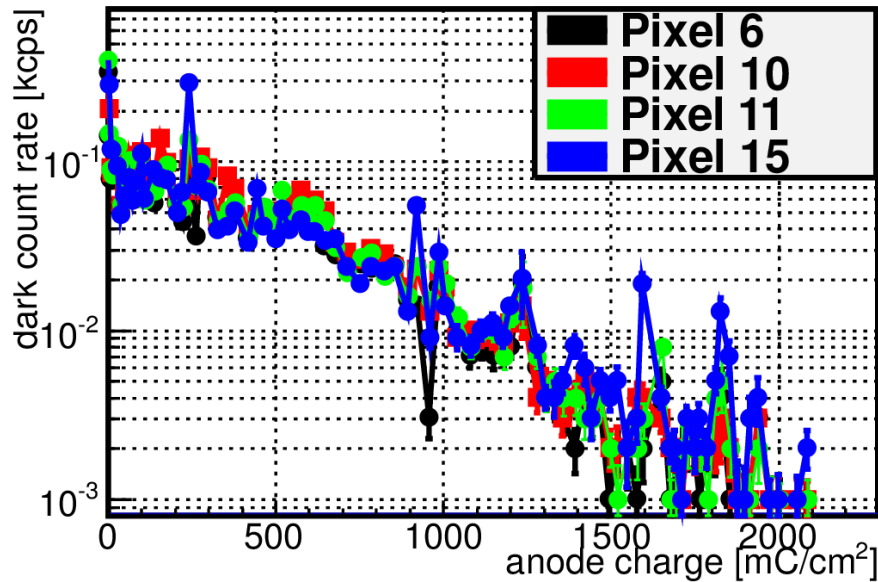
BINP 1359/3548



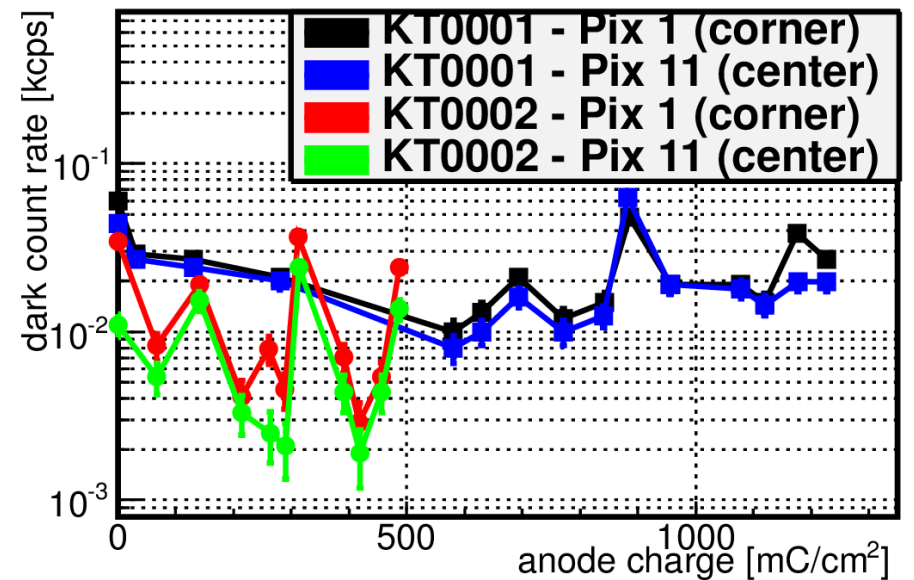
PHOTONIS XP85112/A1-HGL



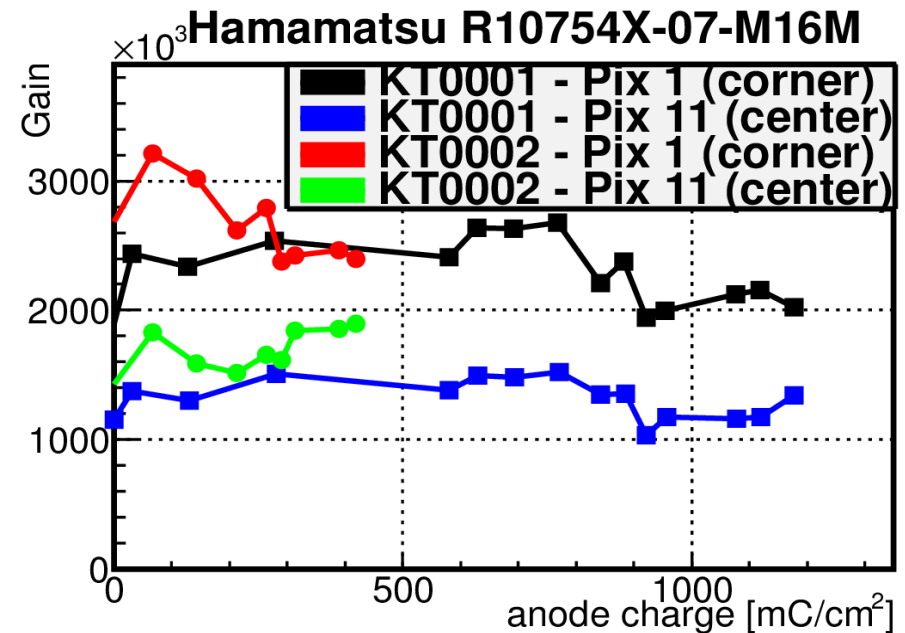
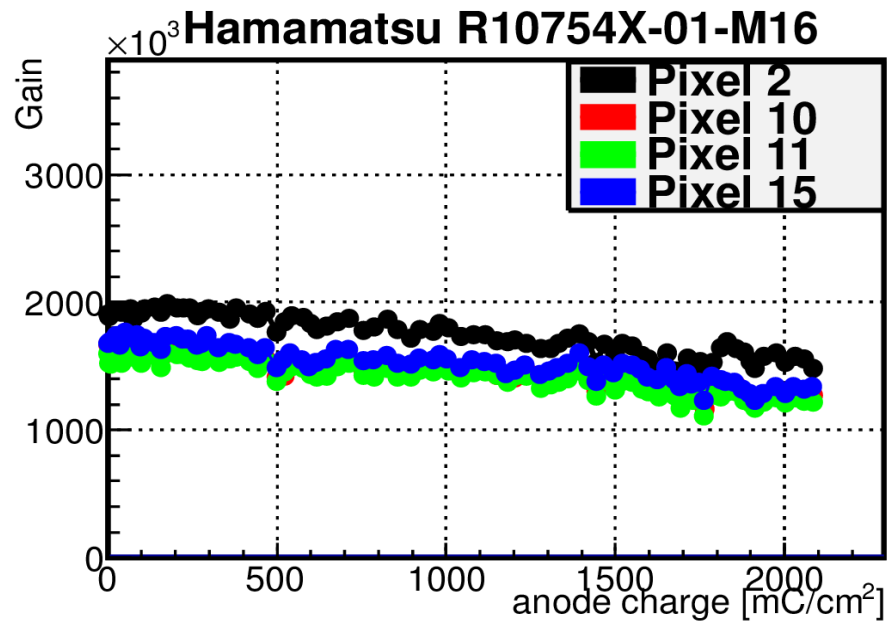
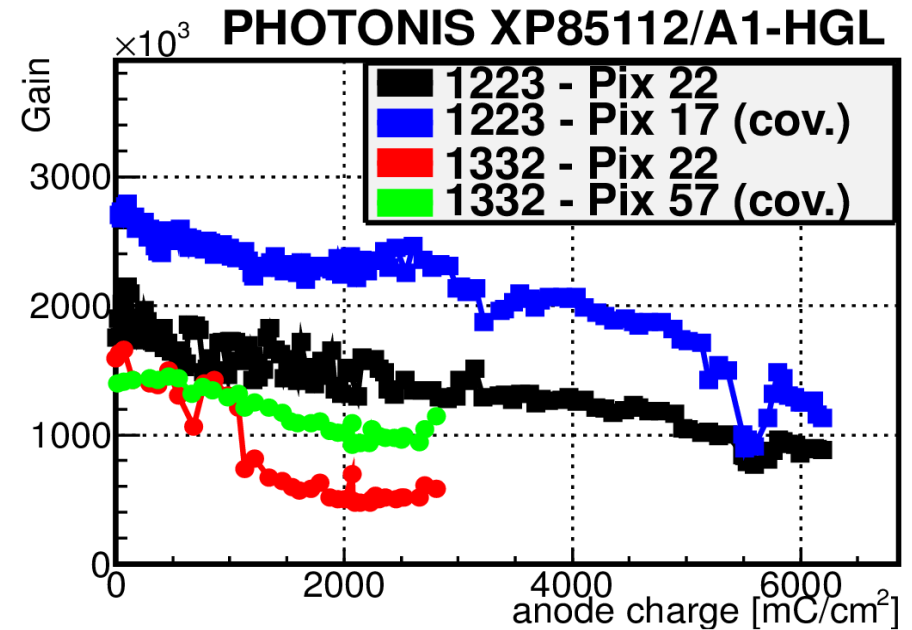
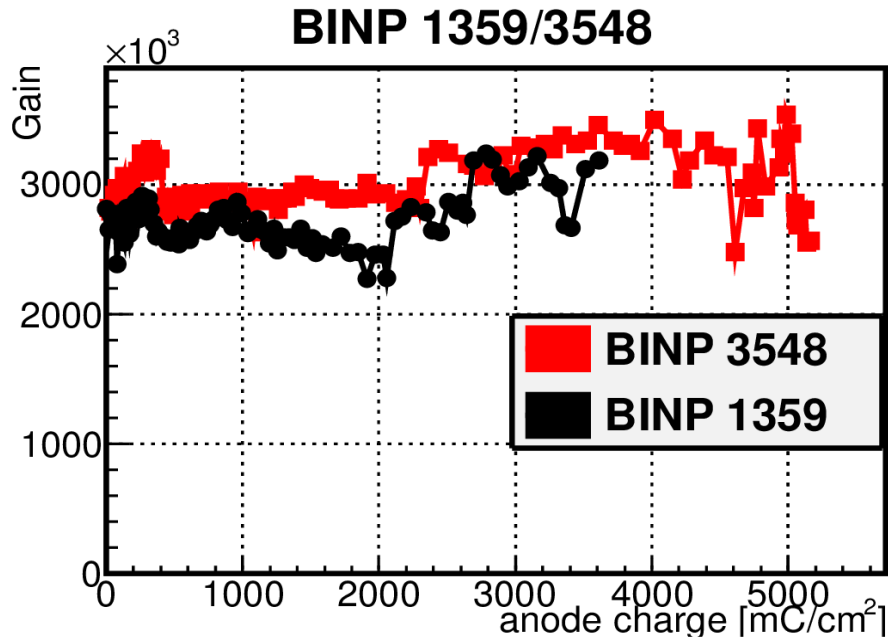
Hamamatsu R10754X-01-M16



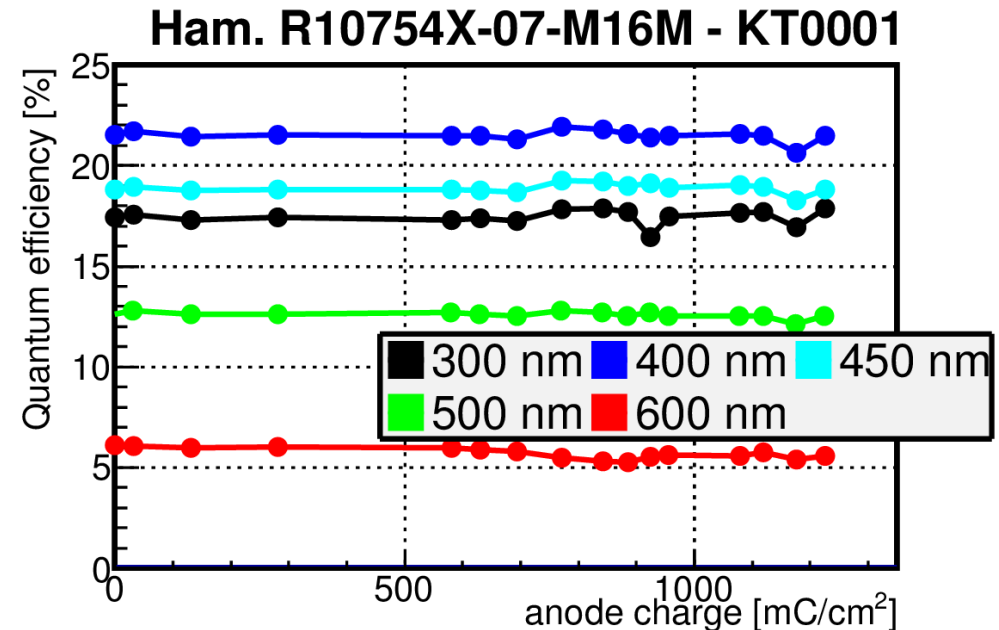
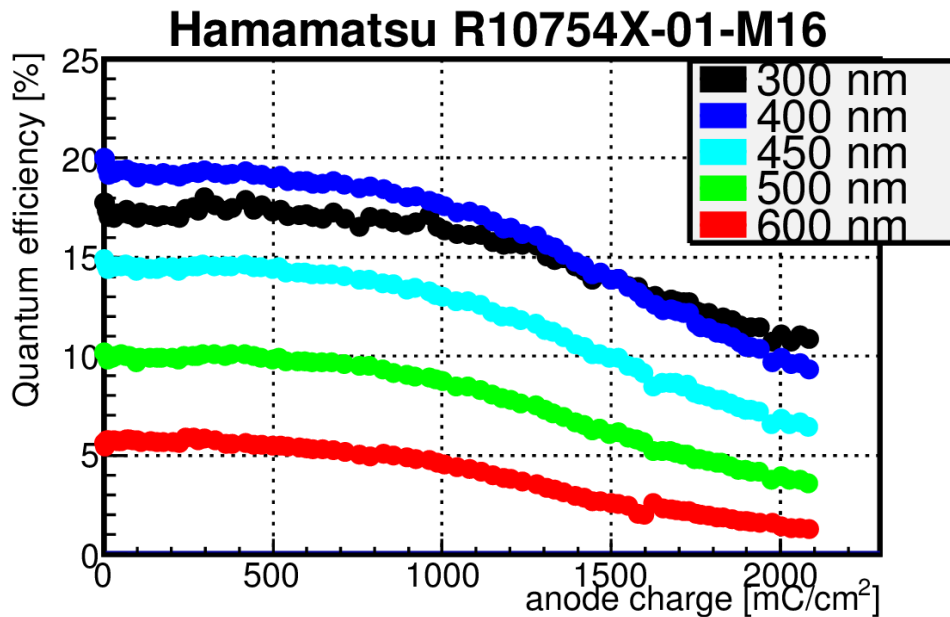
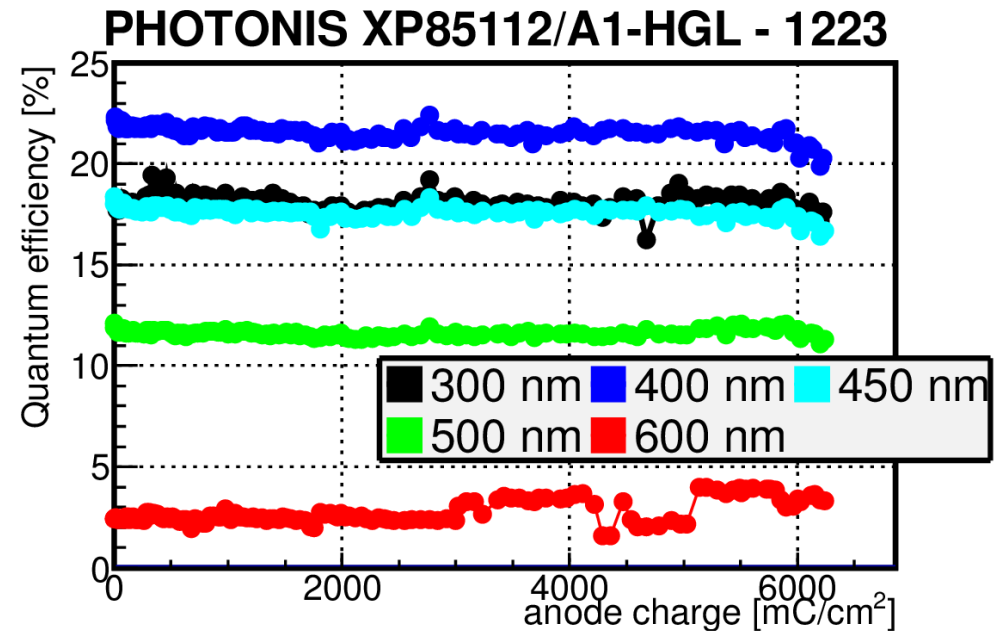
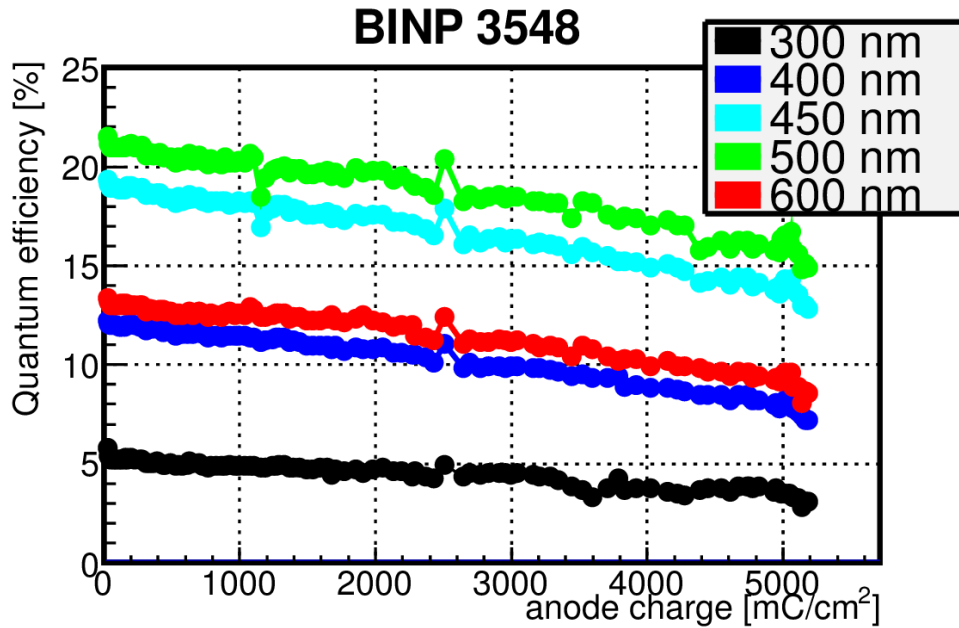
Hamamatsu R10754X-07-M16M



Gain



Spectral Quantum Efficiency

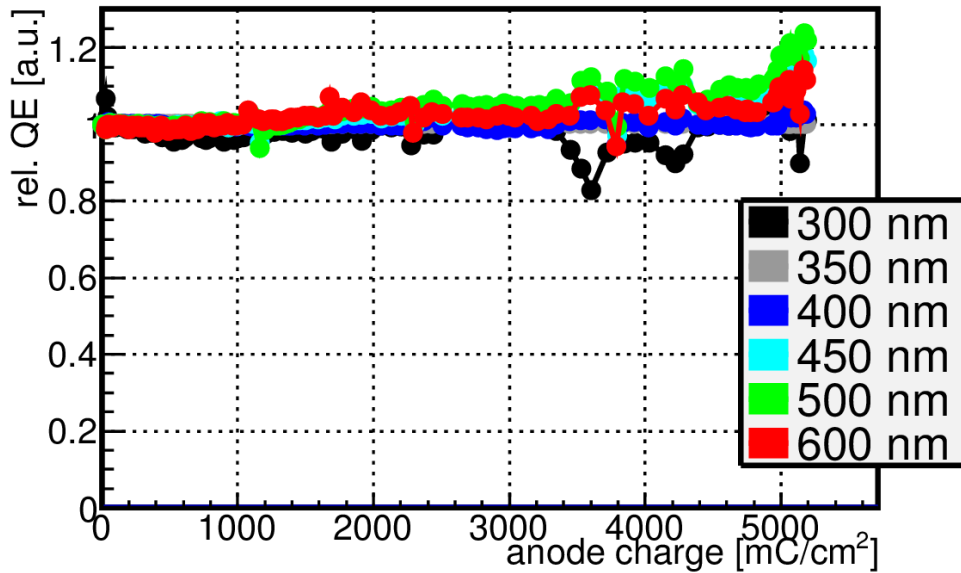


Relative QE

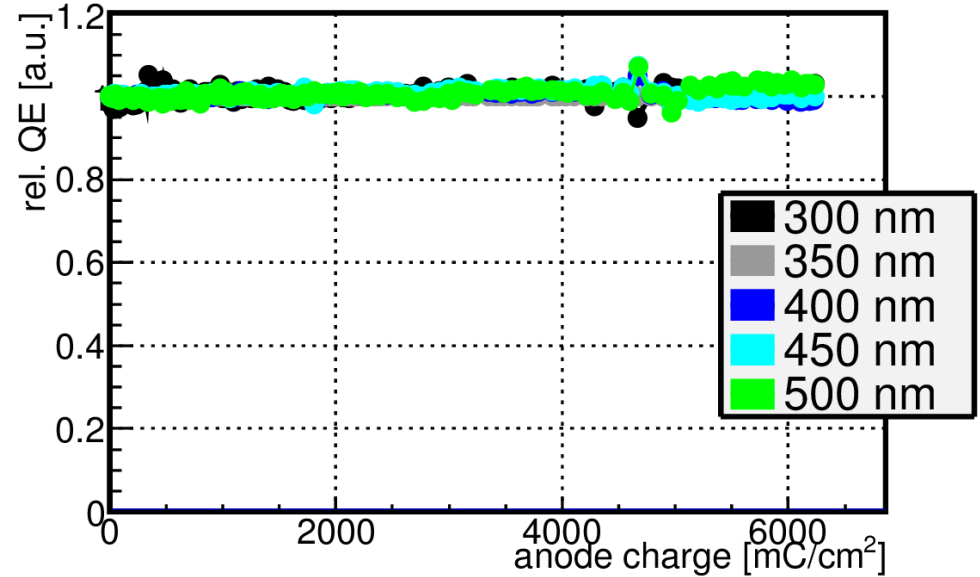
$$\text{rel. QE.} := \frac{QE(\lambda)}{QE_{Q=0}(\lambda)} / \frac{QE(\lambda_0)}{QE_{Q=0}(\lambda_0)} ; \lambda_0 = 350\text{nm}$$



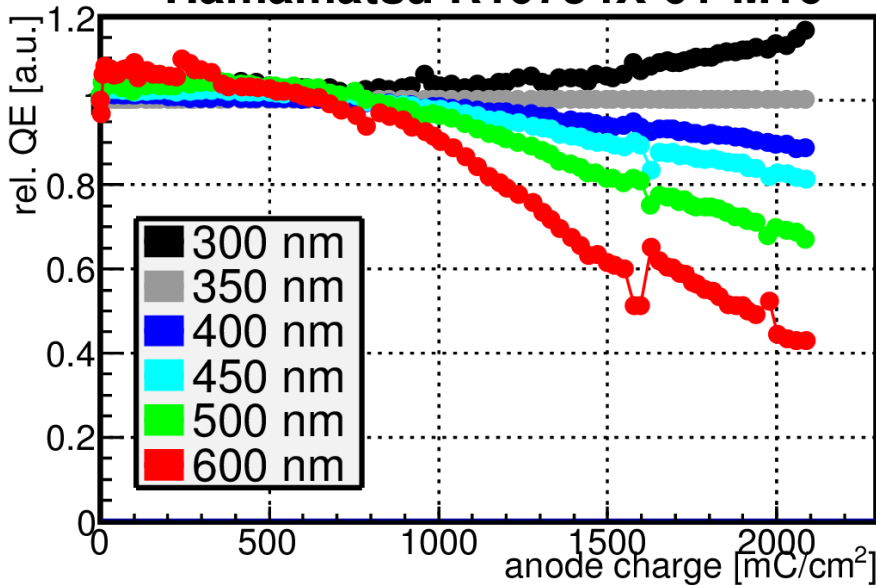
BINP 3548



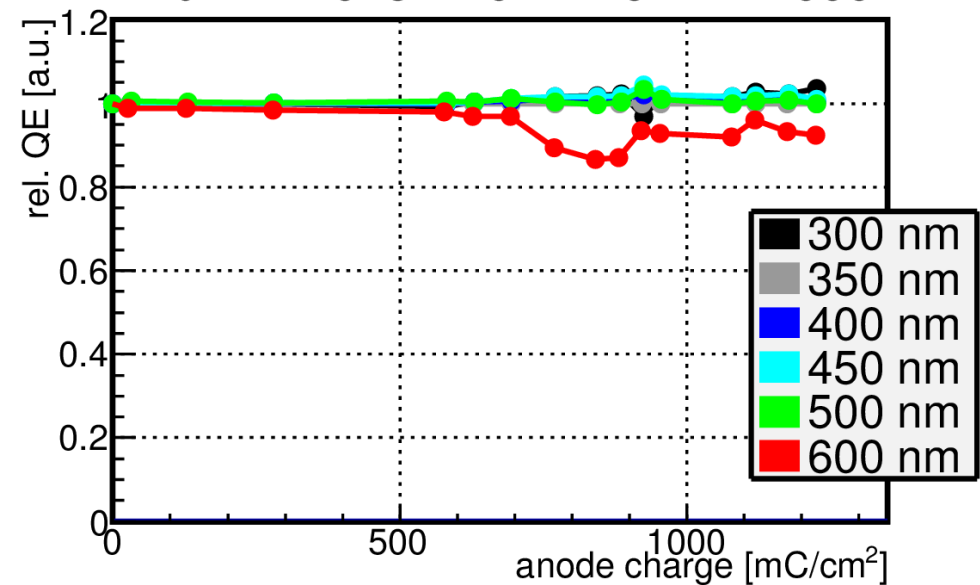
PHOTONIS XP85112/A1-HGL - 1223



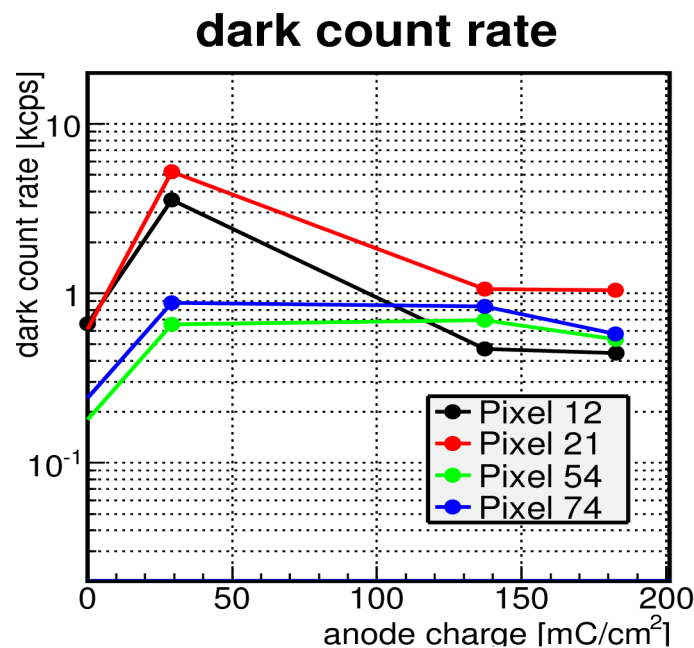
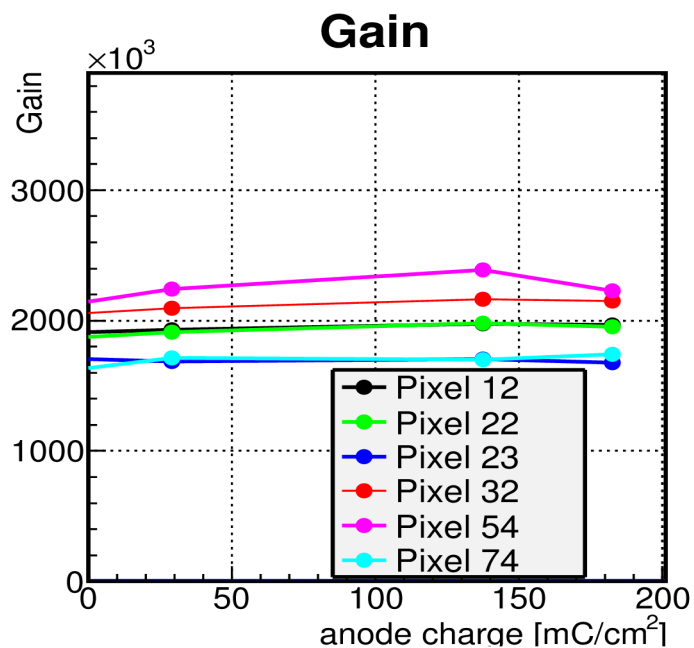
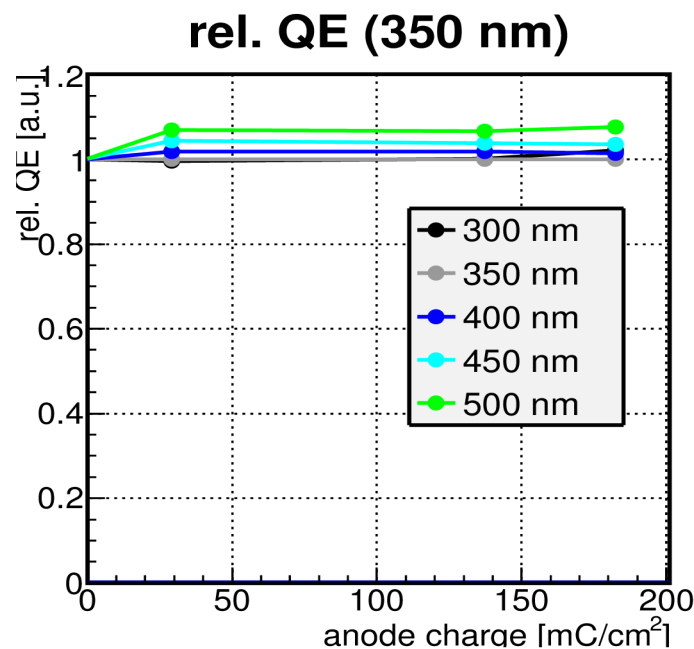
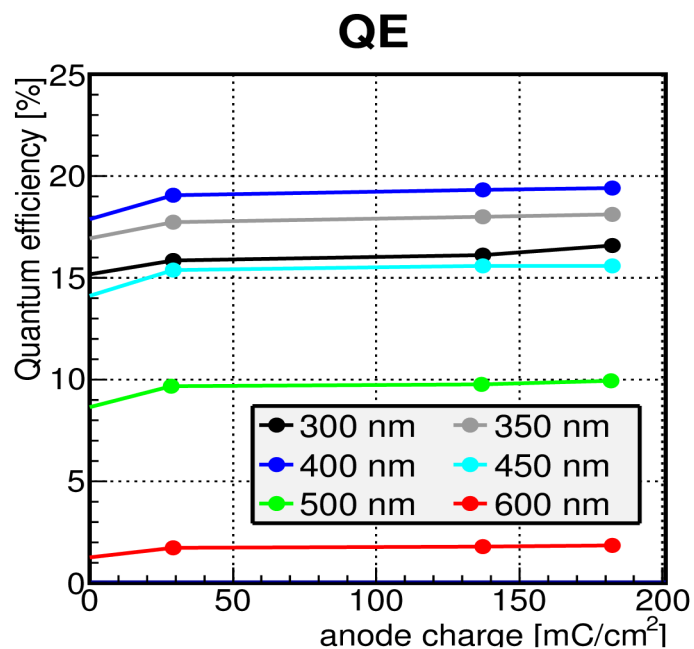
Hamamatsu R10754X-01-M16



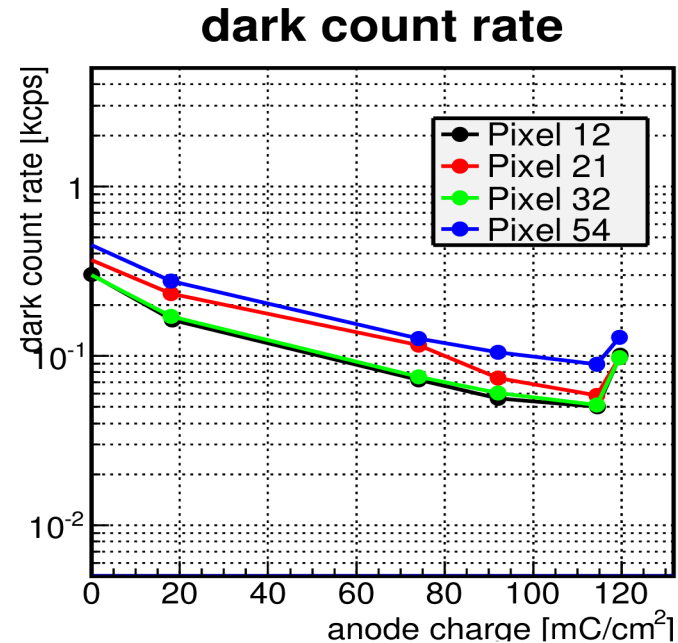
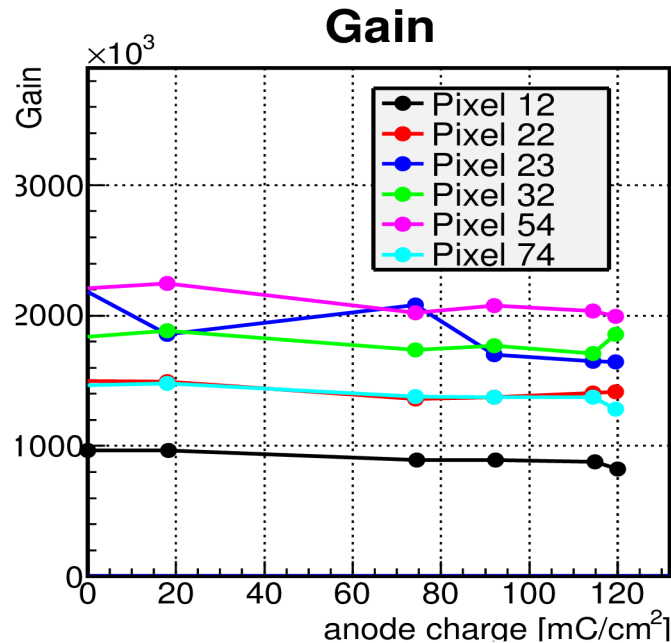
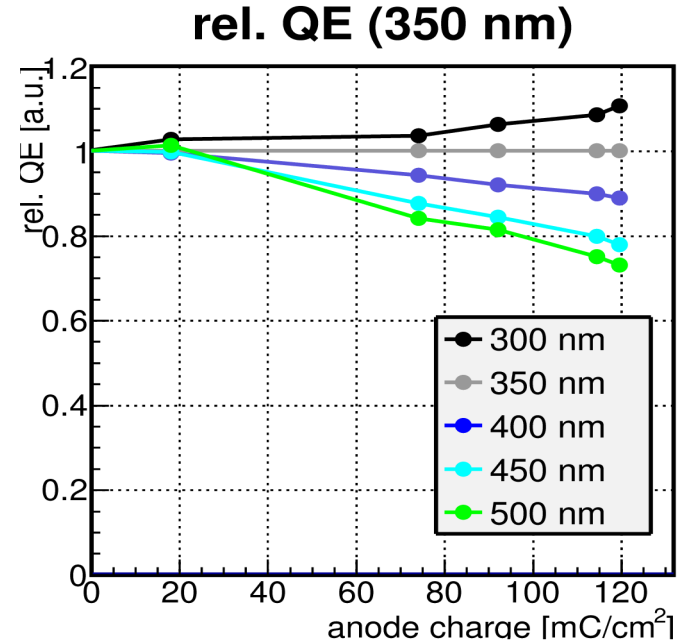
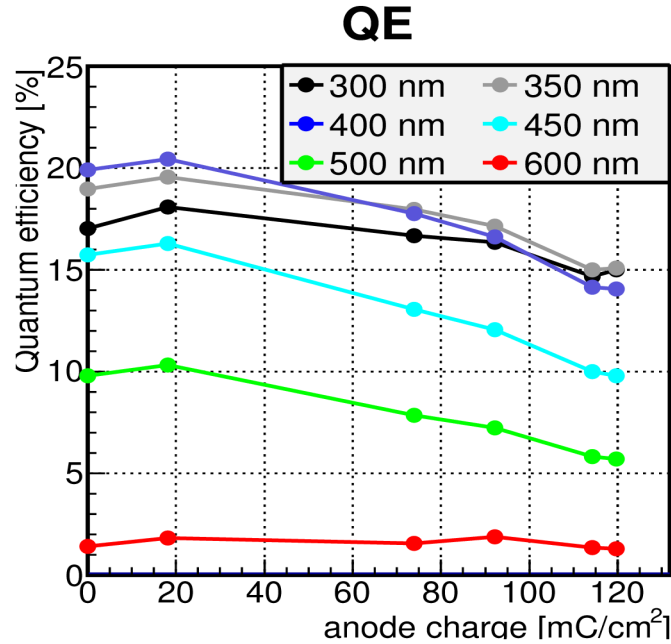
Ham. R10754X-07-M16M - KT0001



PHOT. XP85112/A1-URD - 1393



PHOT. XP85112/A1-(BSRD) - 1394



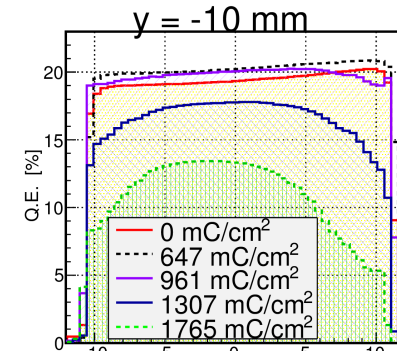
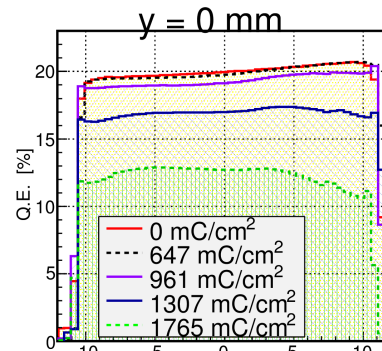
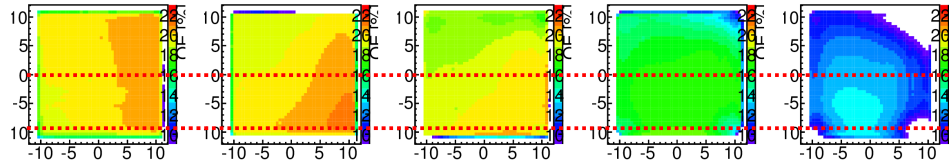
QE surface scan

Reminder:

Hamamatsu R10754X-01-M16

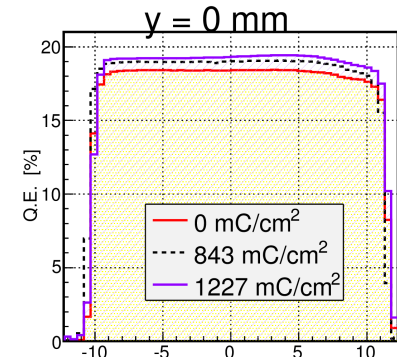
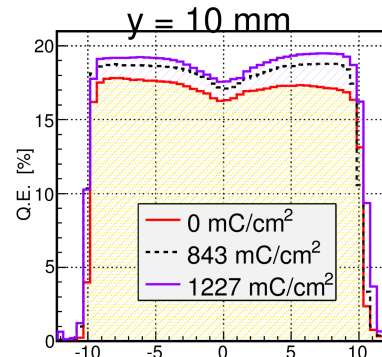
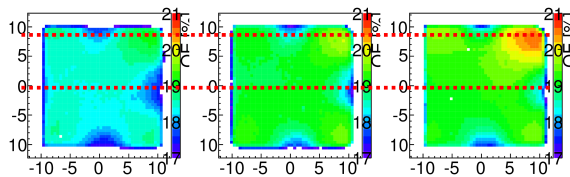


0 $\frac{\text{mC}}{\text{cm}^2}$ 647 $\frac{\text{mC}}{\text{cm}^2}$ 961 $\frac{\text{mC}}{\text{cm}^2}$ 1307 $\frac{\text{mC}}{\text{cm}^2}$ 1765 $\frac{\text{mC}}{\text{cm}^2}$



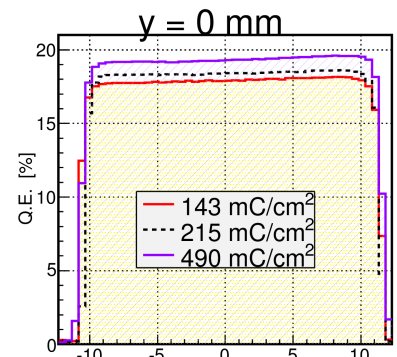
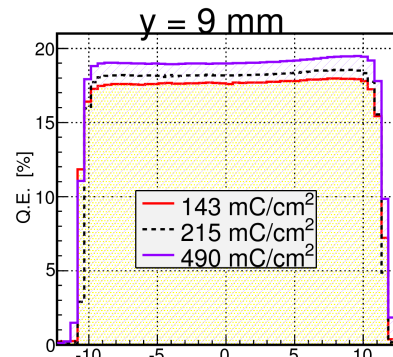
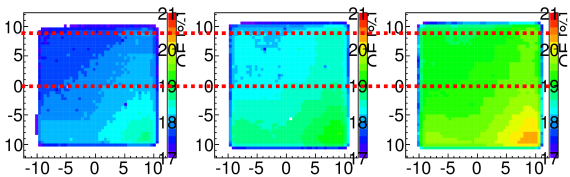
Ham.R10754X-01-M16M - KT0001

0 $\frac{\text{mC}}{\text{cm}^2}$ 843 $\frac{\text{mC}}{\text{cm}^2}$ 1227 $\frac{\text{mC}}{\text{cm}^2}$



Ham.R10754X-01-M16M - KT0002

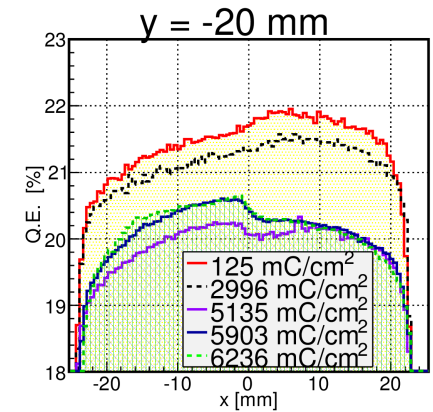
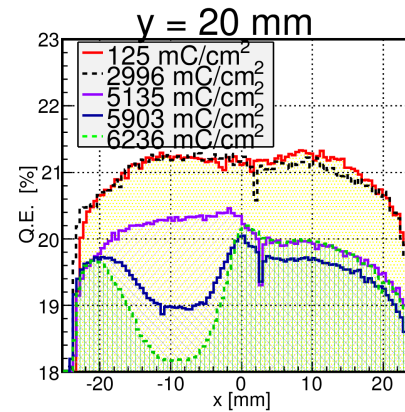
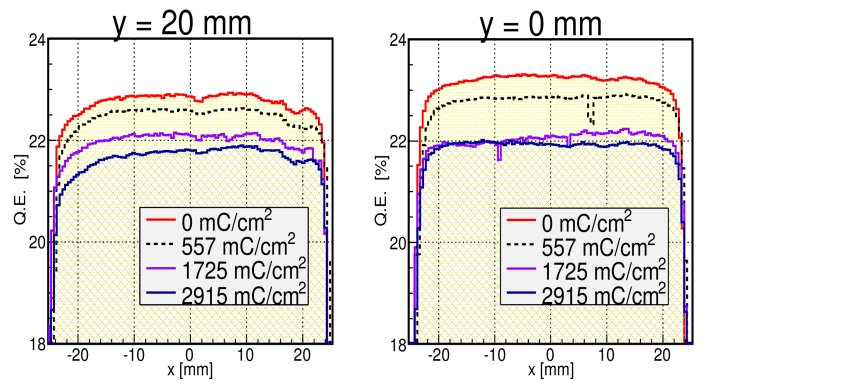
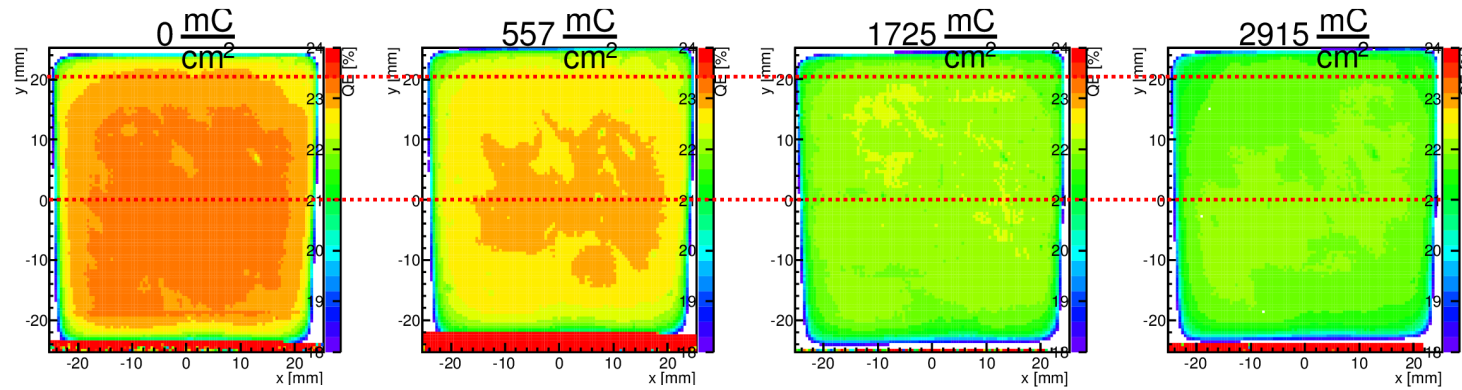
143 $\frac{\text{mC}}{\text{cm}^2}$ 215 $\frac{\text{mC}}{\text{cm}^2}$ 490 $\frac{\text{mC}}{\text{cm}^2}$



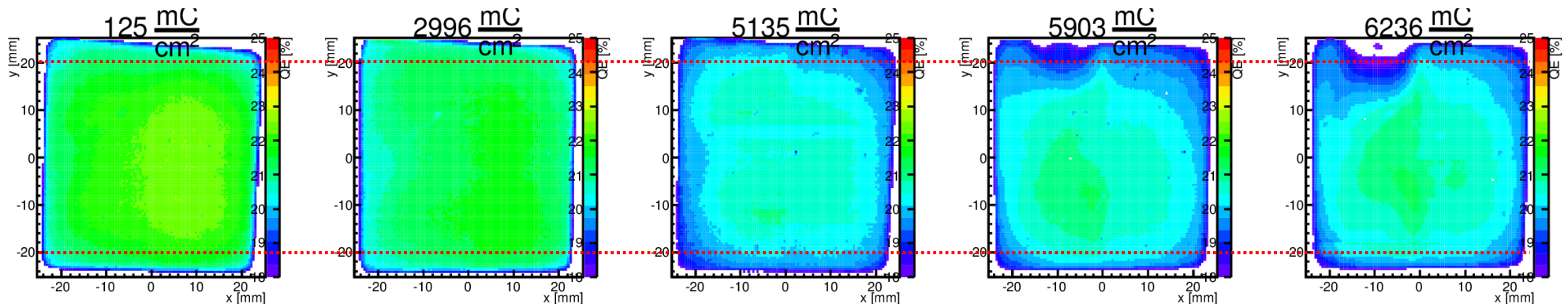
Lifetime of ALD protected MCPs of Ham. seems to be larger, but more data is needed

QE surface scan (2)

PHOTONIS
XP85112/A1-D - 1332

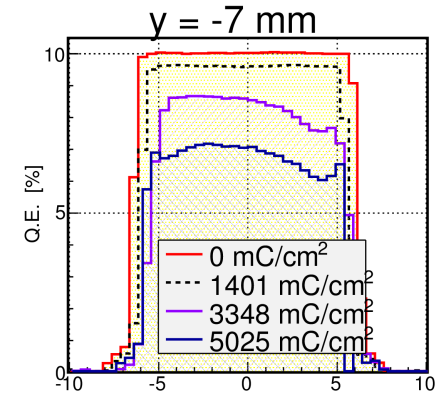
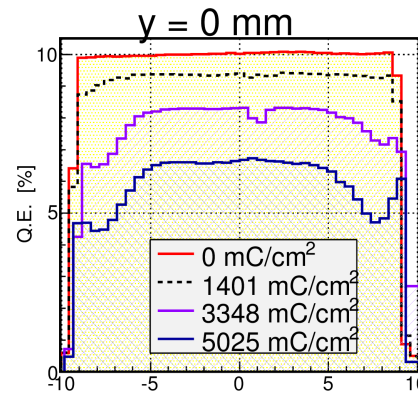
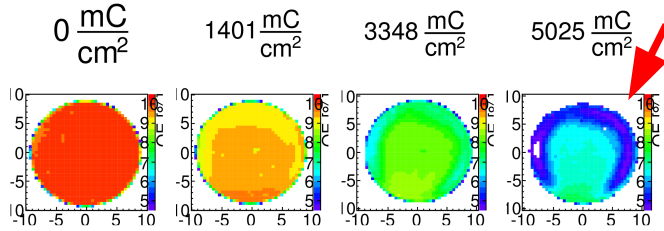


PHOTONIS
XP85112/A1-HGL - 1223

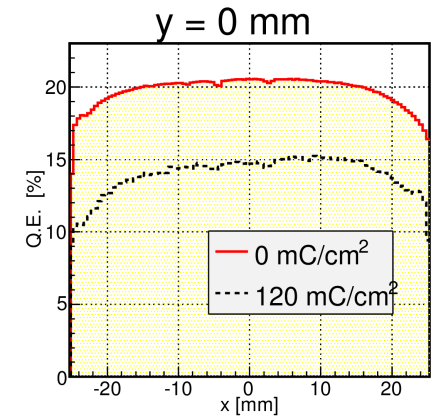
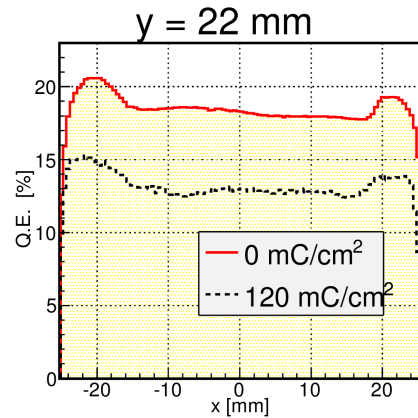
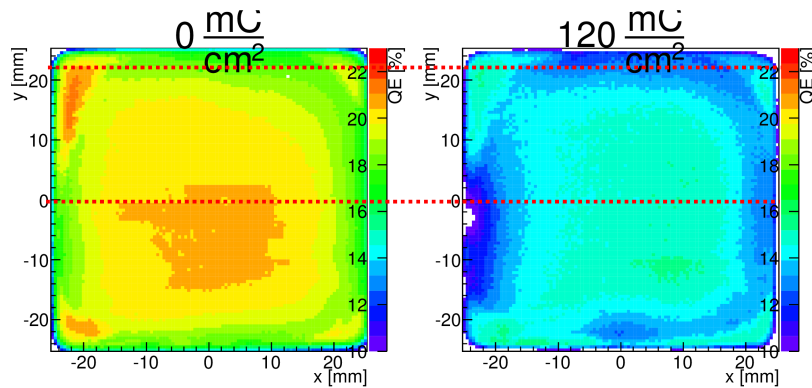


QE surface scan (3)

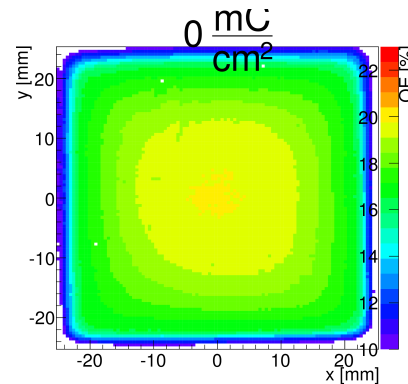
BINP 3548



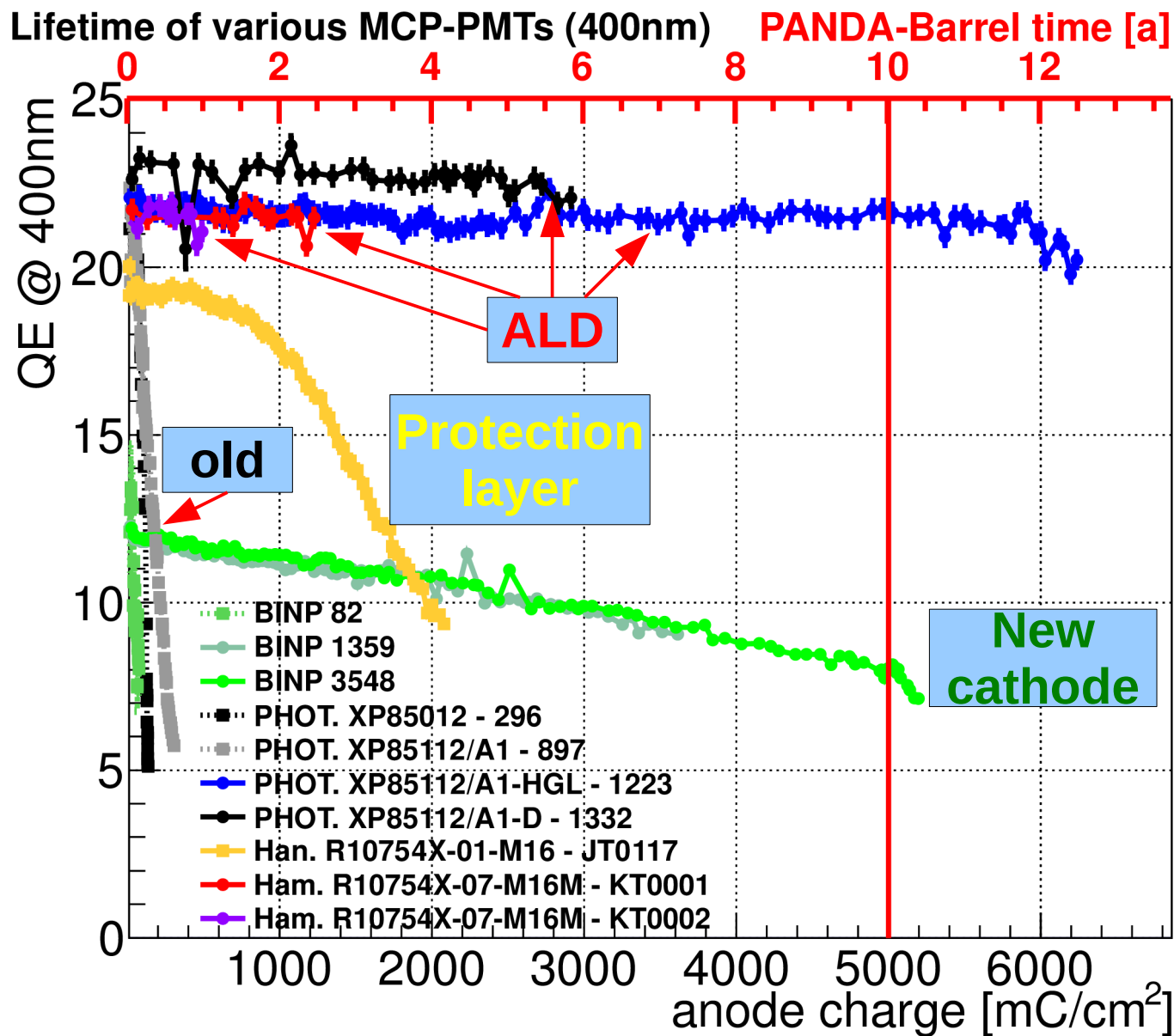
PHOT.XP85112/A1-(BSRD) - 1394



PHOT.
XP85112/A1-URD - 1393



Comparison with older MCP-PMTs



- No degradation for XP85112/A1-HGL – 1223, until 12 PANDA Barrel-Years. Decline recently started.
- XP85112/A1-D – 9001332 has already passed 6 PANDA Barrel-Years!
- More data for Ham. ALD coated MCP-PMTs needed!
- Performance of BINP 3548 is still good
- **ALD is most promising technique**

Summary and Outlook

- DAQ moved to VME
- Results of lifetime measurements:
 - XP85112/A1-HGL - 1223 has passed $\sim 6.2\text{C}/\text{cm}^2$ (**~ 12.5 PANDA Barrel-years**), first hints of aging \rightarrow currently checked with another device (1332)
 - More data for Ham. R10754-07-M16M needed, but promising so far
 - Lifetime measurement of PHOT. XP85112/A1-URD - 1393 has started
 - Lifetime of PHOT. XP85112/A1-(BSRD) - 1394 comparable to previous results
 - Aging of BINP 3548 is ongoing
 - Surface scans reveal faster aging areas:
 - Aging of BINP 3548 continues
 - R10754X-07-M16M needs more data
 - XP85112/A1-HGL - 1223 aging has started at upper edge