

Update on MCP Lifetime Measurements

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- Illumination overview
- Gain and darkcount rates versus C
- QE surface scans and trends
- Absolute and relative QE versus C
- Summary





Illumination Overview (1)

	Sensor ID	Integral charge (Feb. 16, 2015) [mC/cm ²]	Diff. charge (maximum) [mC/cm ² /d]	# of mea- surements	# of QE scans	Comments
Photonis XP85112	9001223	8658	13.5	153	15	Start: 23 Aug. 11 ongoing
	9001332	6076	21.8	57	8	Start: 12 Dec. 12 ongoing
	9001393	3145	11	21	4	Start: 23 Jan. 14 ongoing
Hamamatsu R10754X	JT0117 (M16)	2086	14.1	86	7	Start: 23 Aug. 11 Stop: 24 Jul. 12
	KT0001 (M16M)	6097	30.1	33	6	Start: 20 Aug. 13 ongoing
	KT0002 (M16M)	3571	20.1	28	7	Start: 21 Oct. 13 ongoing
BINP	1359	3616	10.6	90	8	Start: 21 Oct. 11 Stop: 06 May 13
	3548	6429	11.8	130	12	Start: 21 Oct. 11 ongoing

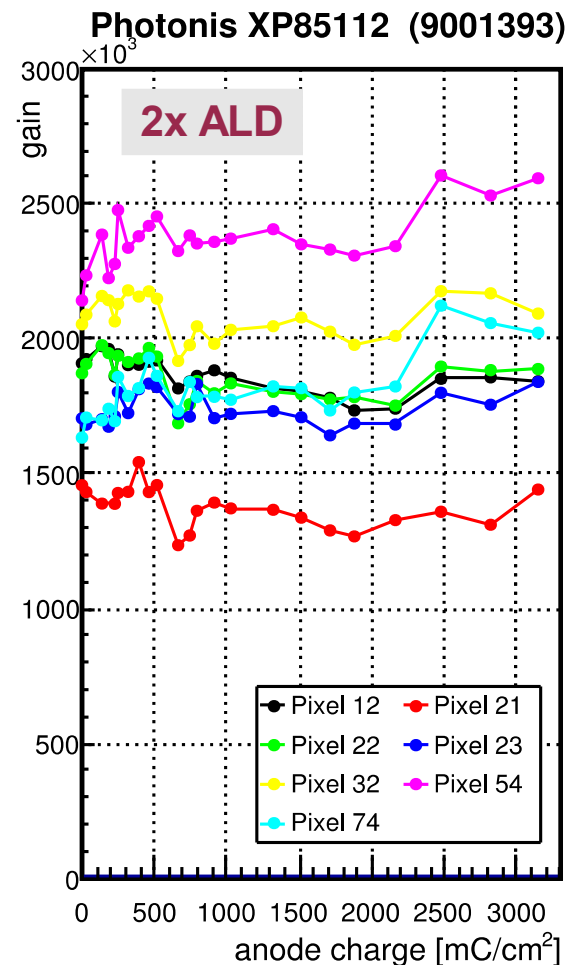
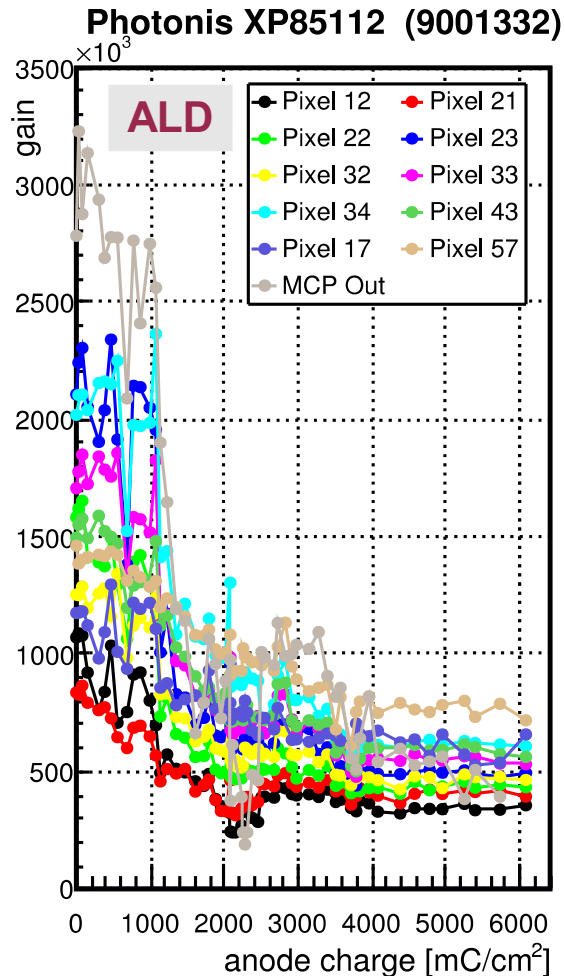
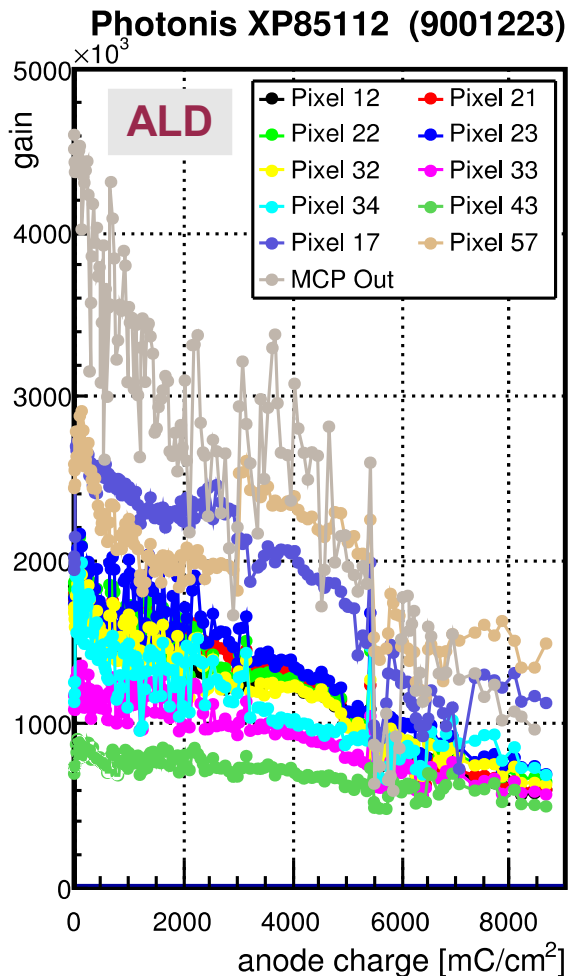


Illumination Overview (2)

	Sensor ID	Integral charge (Feb. 16, 2015) [mC/cm ²]	QE start [%]	QE latest [%]	QE latest / QE start [%]	Comments
Photonis XP85112	9001223	8658	22.11	8.76	40%	Start: 23 Aug. 11 ongoing
	9001332	6076	22.62	22.56	100%	Start: 12 Dec. 12 ongoing
	9001393	3145	19.05	20.6	108%	Start: 23 Jan. 14 ongoing
Hamamatsu R10754X	JT0117 (M16)	2086	19.97	9.32	47%	Start: 23 Aug. 11 Stop: 24 Jul. 12
	KT0001 (M16M)	6097	21.71	17.77	82%	Start: 20 Aug. 13 ongoing
	KT0002 (M16M)	3571	21.14	15.25	72%	Start: 21 Oct. 13 ongoing
BINP	1359	3616	12.27	9.06	74%	Start: 21 Oct. 11 Stop: 06 May 13
	3548	6429	12.23	4.97	41%	Start: 21 Oct. 11 ongoing

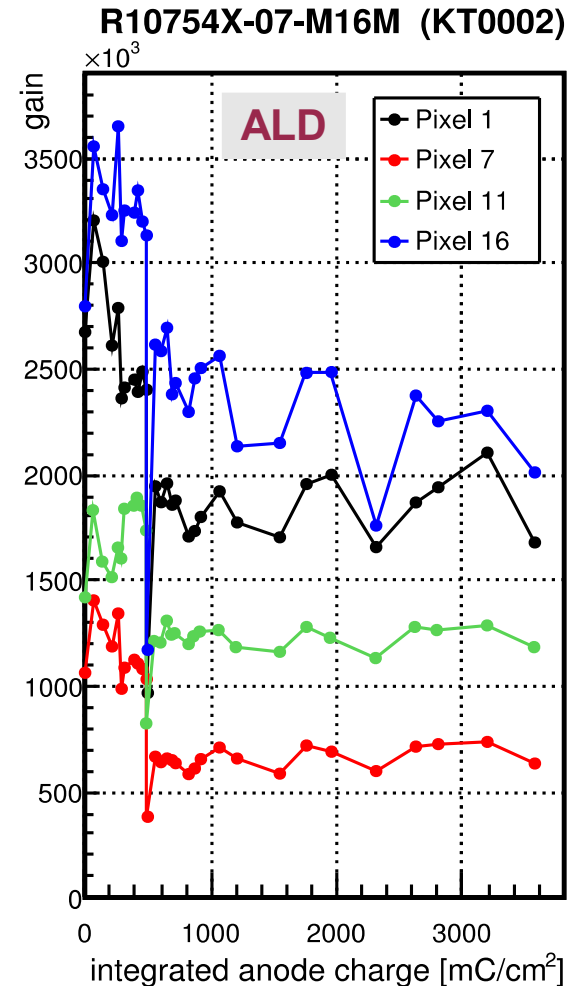
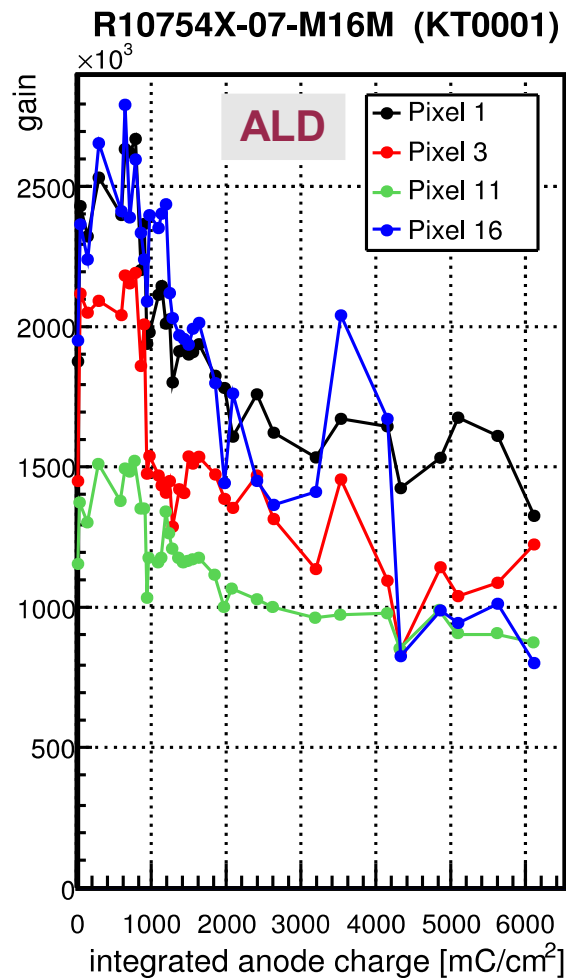
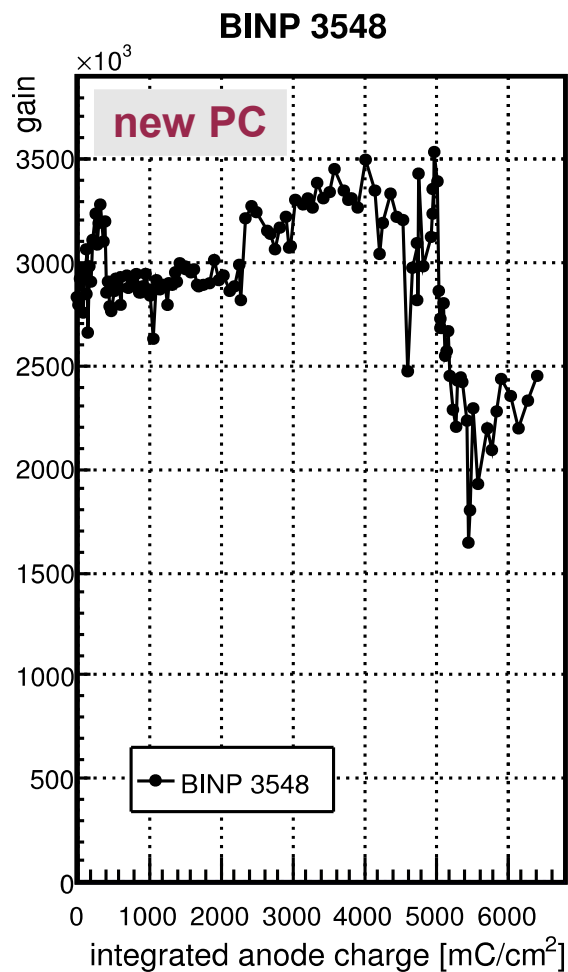


Gain vs. Charge (Photonis)



- Continuous gain changes in other Photonis MCP-PMTs
- **No gain changes in 9001393 (2 ALD layers)**

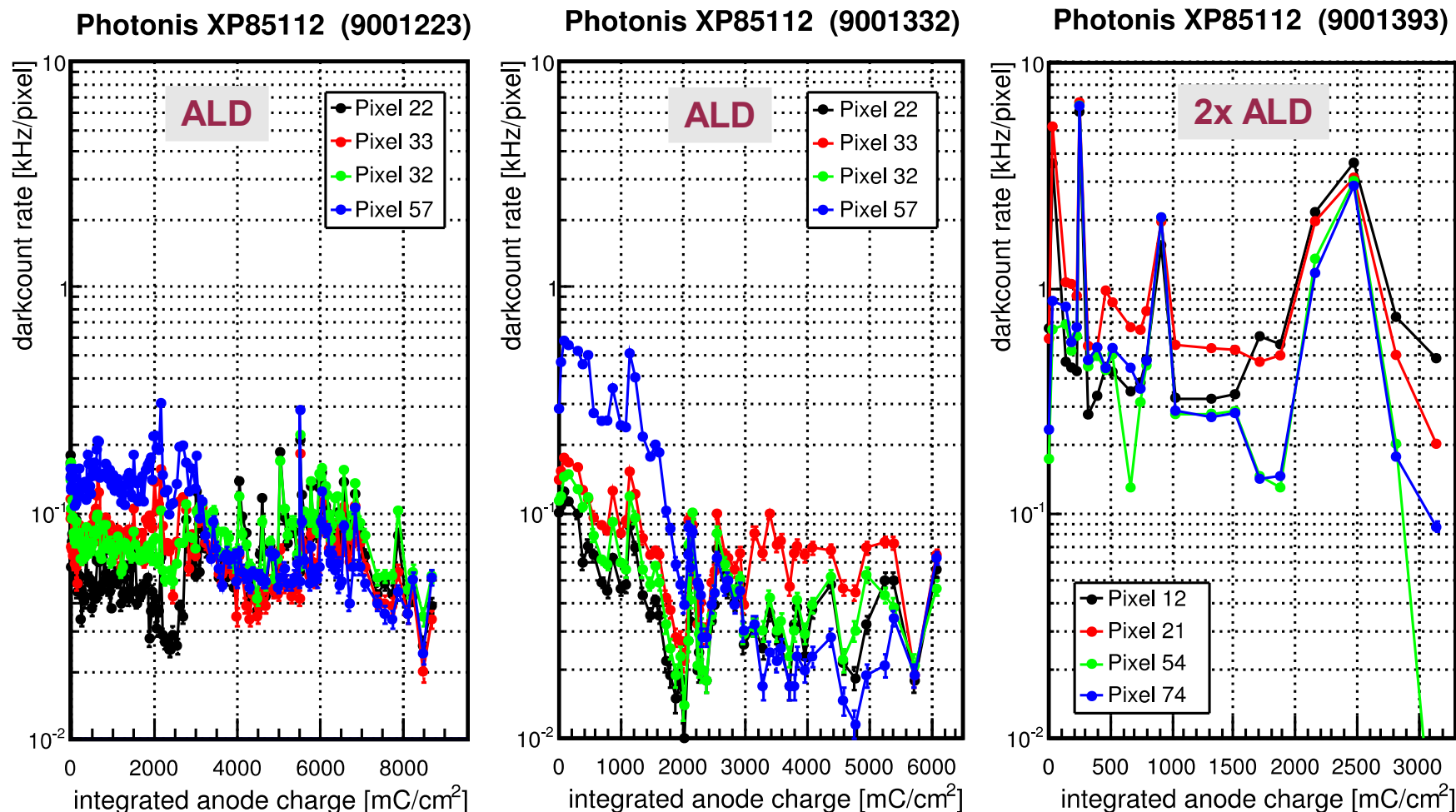
Gain vs. Charge (BINP + Hamam.)



● Moderate gain changes

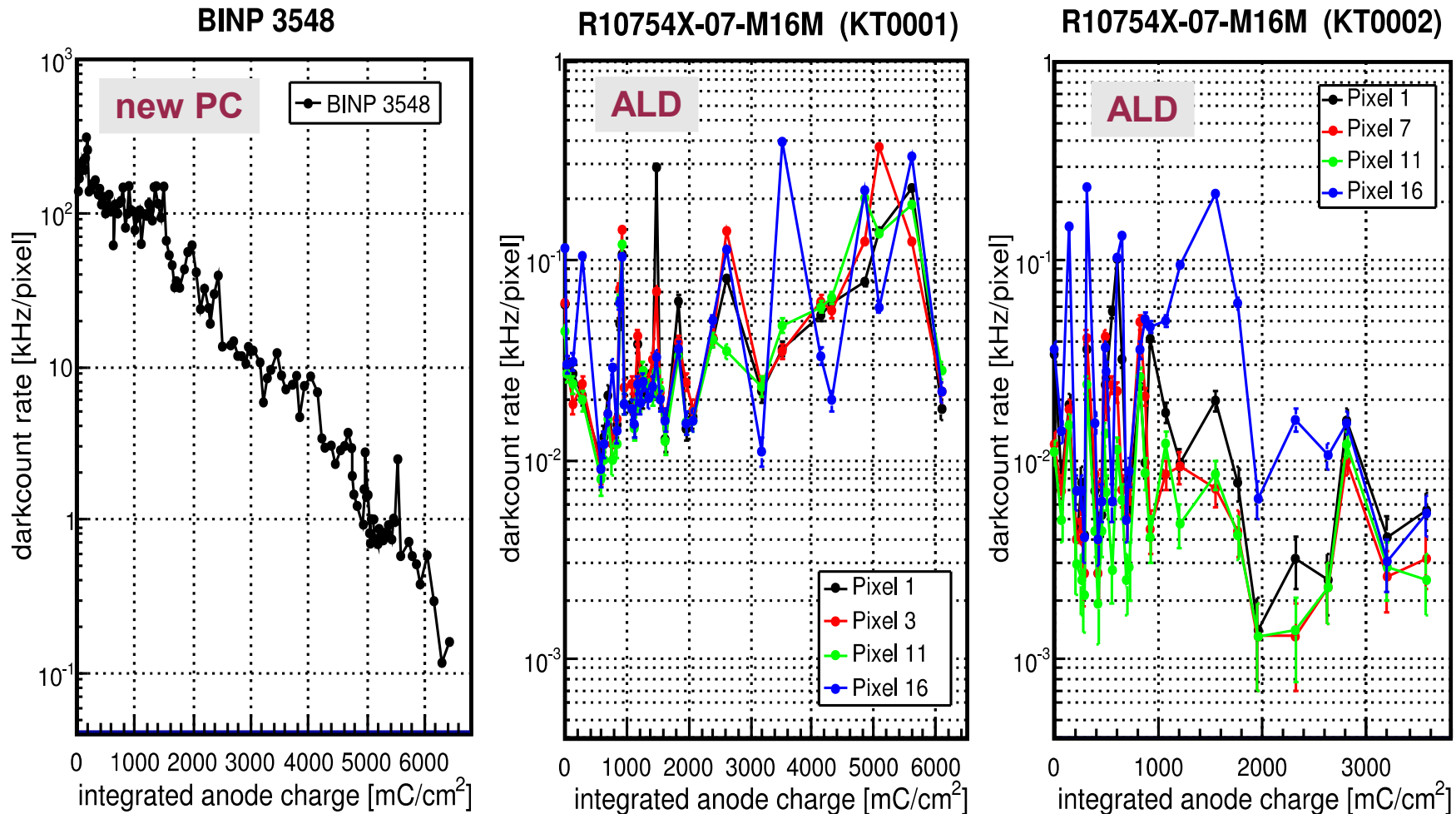
● Slight gain drop in KT0002, maybe because of HV spike

Darkcount vs. Charge (Photonis)



- Only few changes of darkcount rate for 9001223 and 9001393
- 9001332 shows significant drop in darkcount rate, then stable

Darkcount vs. Charge (BINP + Ham.)



- Only few changes of darkcount rate in Hamamatsu ALD tubes
- Big reduction in BINP



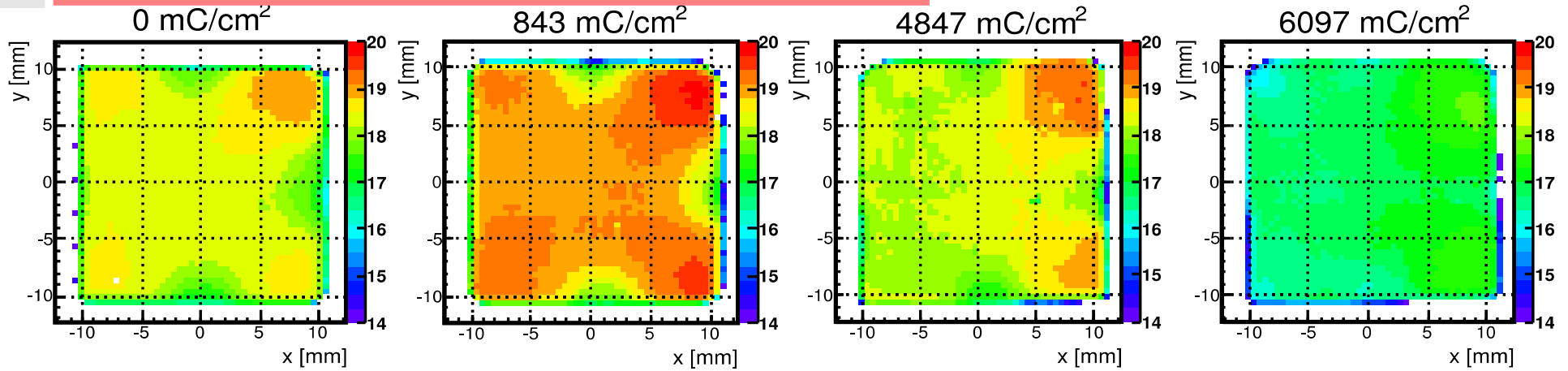
Q.E. Scans (Hamamatsu ALD)

Q.E. measured at 372 nm

ALD + film

Hamamatsu R10754X-07-M16M (KT0001)

22 mm

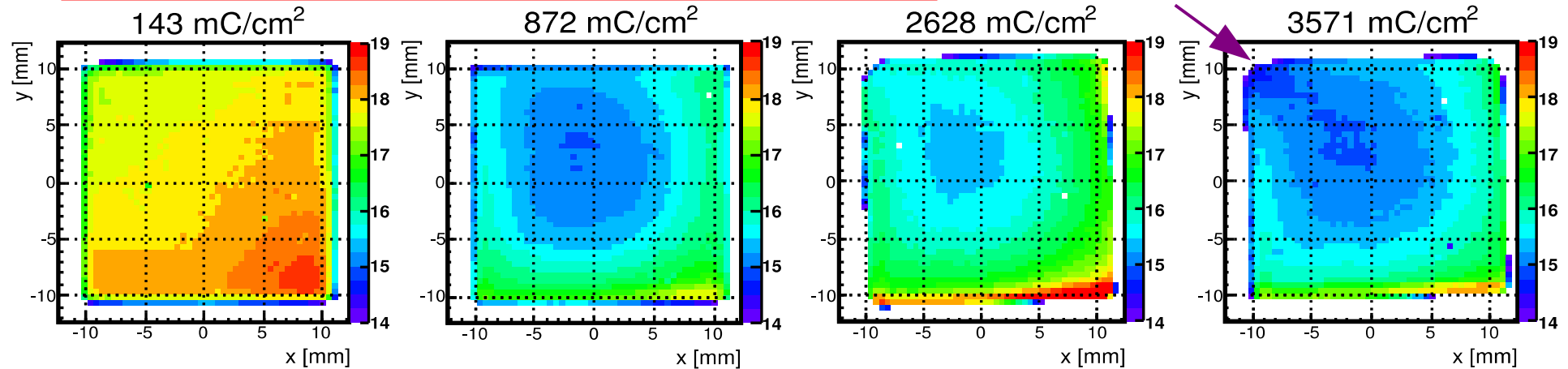


ALD + film

Hamamatsu R10754X-07-M16M (KT0002)

22 mm

? Beginning of damage ?

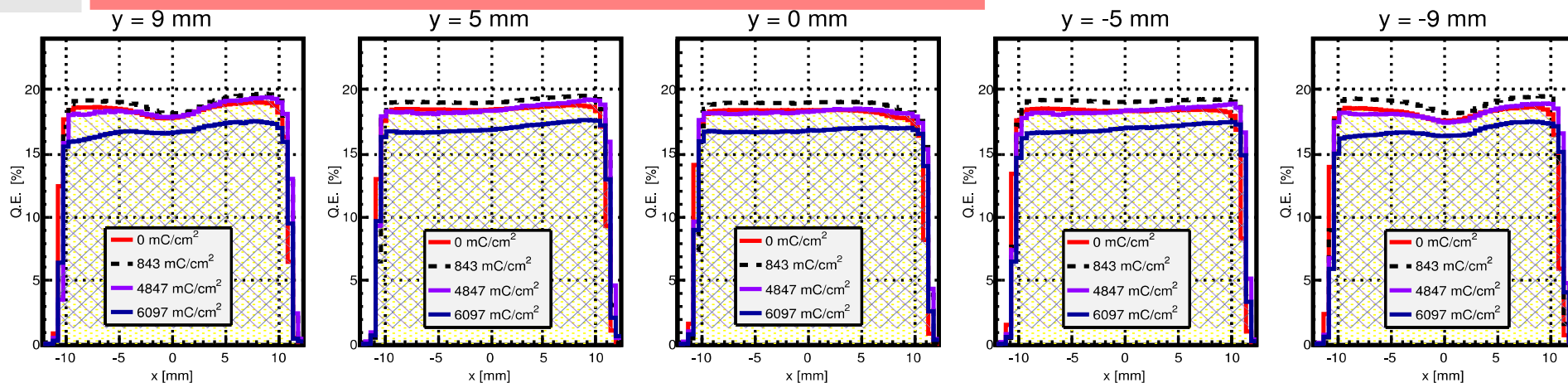


Q.E. Scan Projection (Hamamatsu ALD)

Q.E. measured at 372 nm

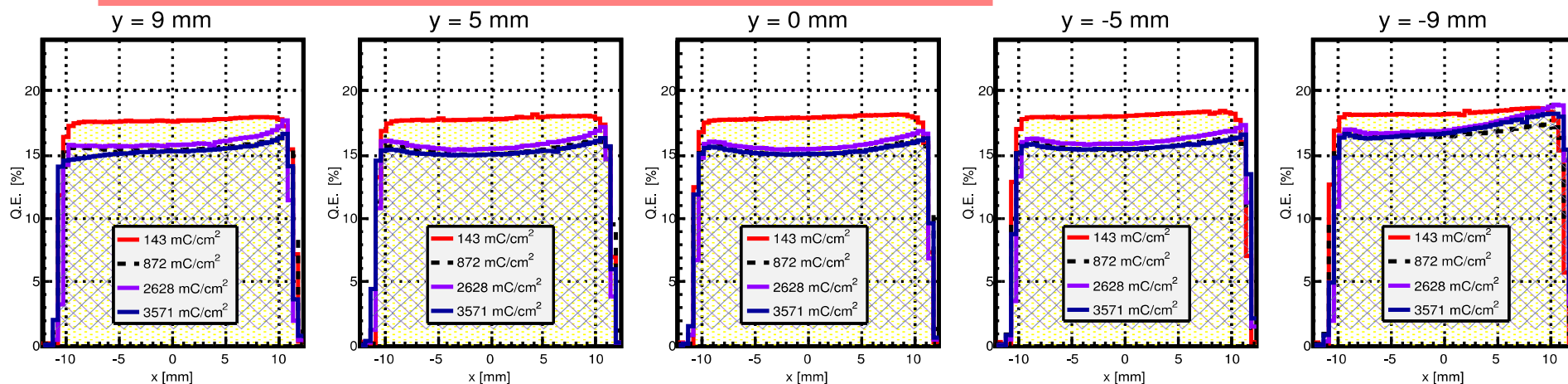
ALD + film

Hamamatsu R10754X-07-M16M (KT0001)



ALD + film

Hamamatsu R10754X-07-M16M (KT0002)



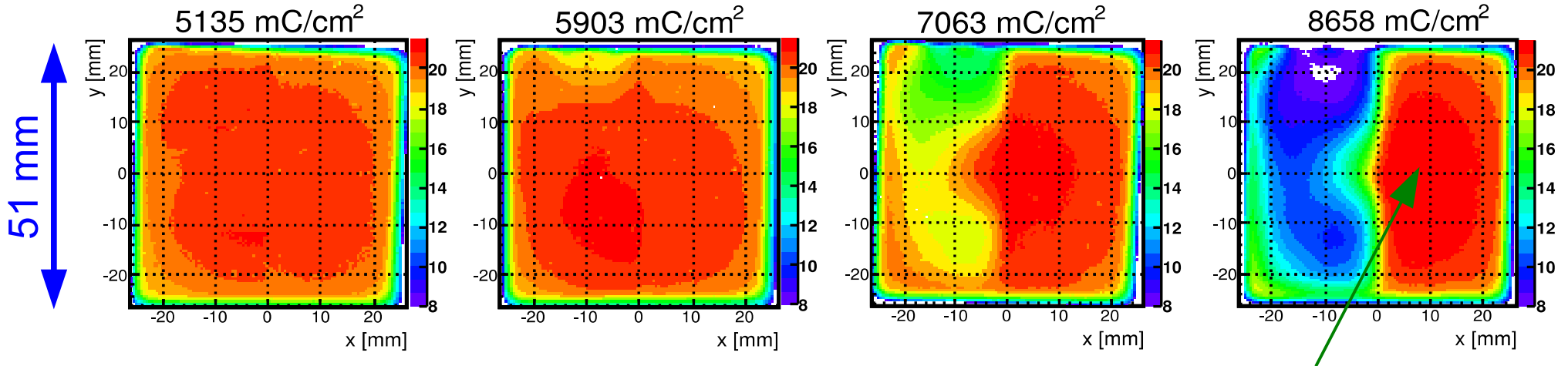


Q.E. Scans (PHOTONIS ALD)

Q.E. measured at 372 nm

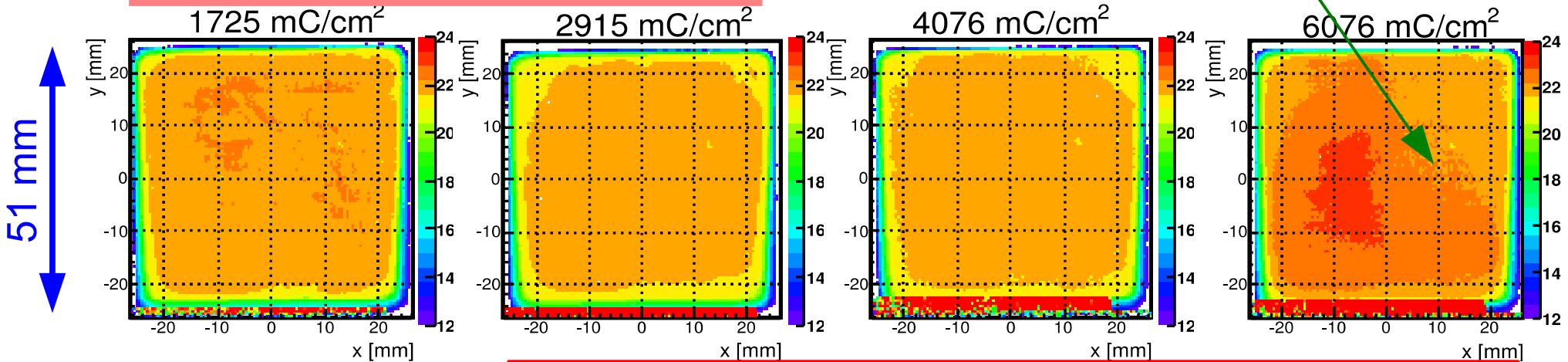
ALD

PHOTONIS XP85112 (9001223)



ALD

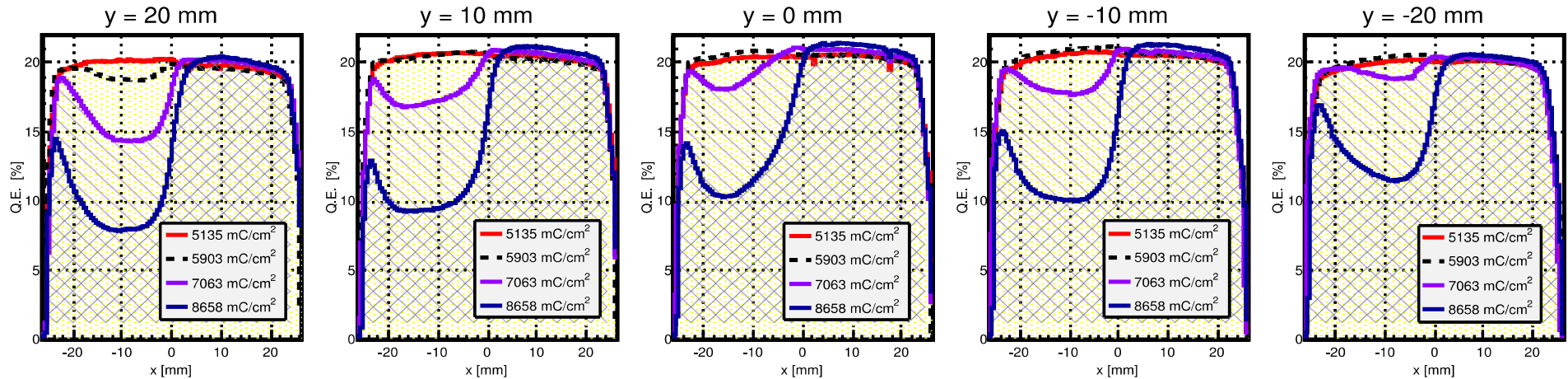
PHOTONIS XP85112 (9001332)



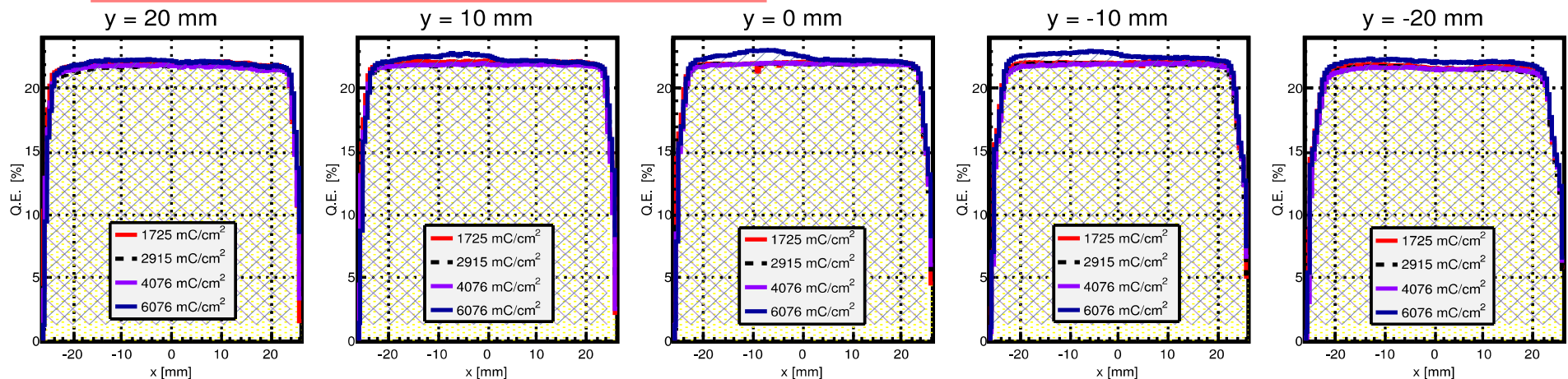
Q.E. Scan Projection (PHOTONIS ALD)

Q.E. measured at 372 nm

ALD PHOTONIS XP85112 (9001223)



ALD PHOTONIS XP85112 (9001332)

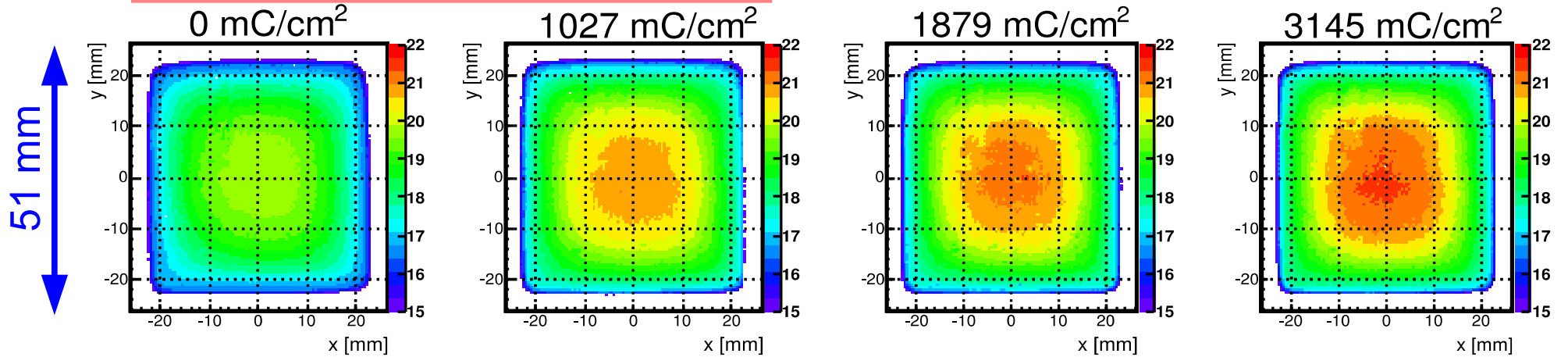




Q.E. Scans (Photonis & BINP)

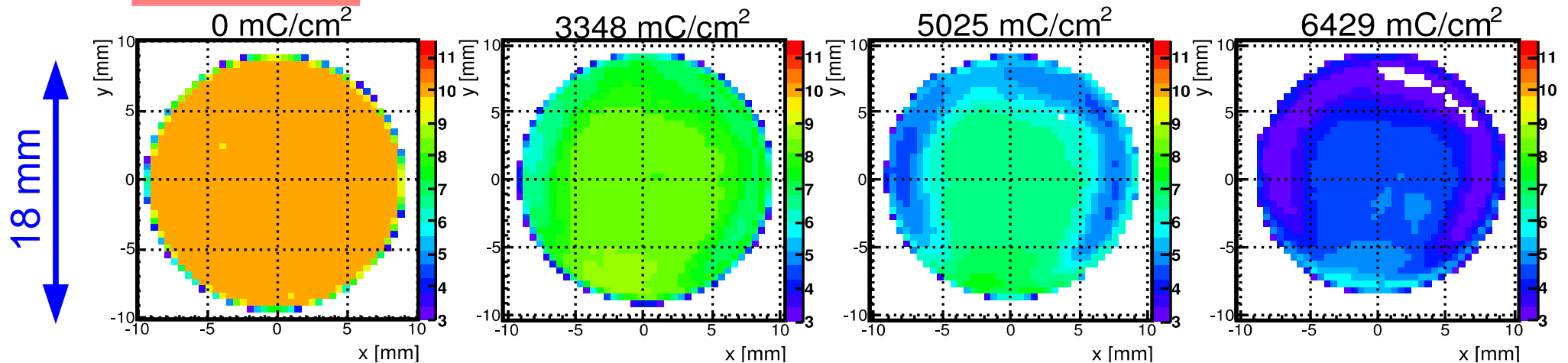
Q.E. measured at 372 nm

2x ALD **PHOTONIS XP85112 (9001393)**



new PC **BINP 3548**

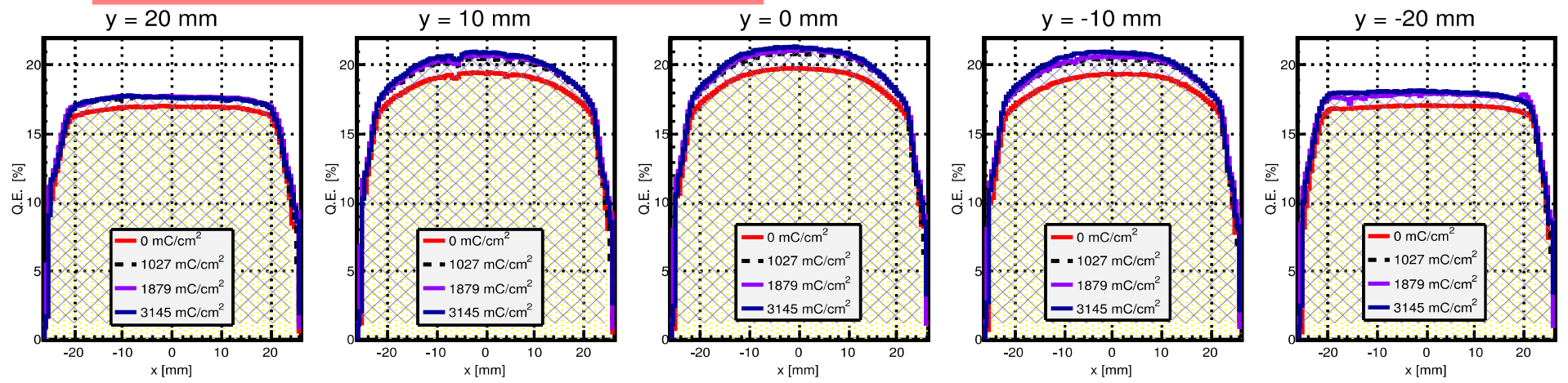
QE degradation evolves from rims and corners



Q.E. Scan Projection (Photonis & BINP)

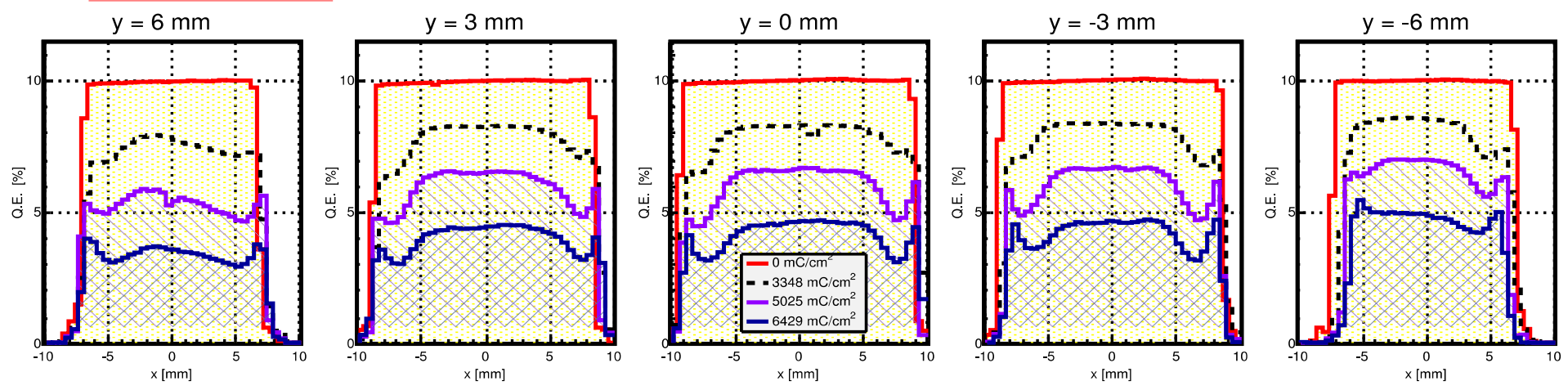
Q.E. measured at 372 nm

2x ALD PHOTONIS XP85112 (9001393)



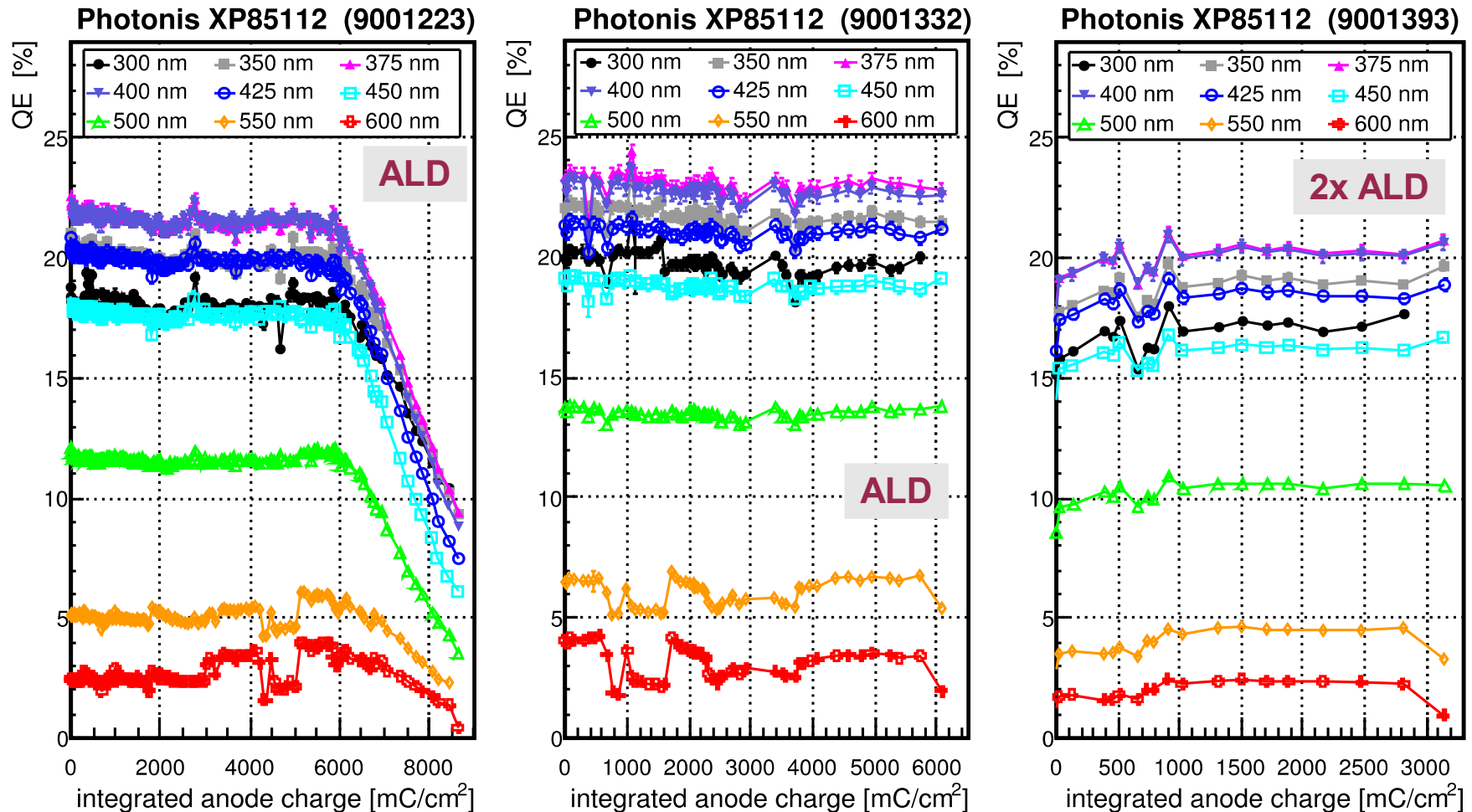
new PC BINP 3548

9001393 (2x ALD) shows lower QE at rims!



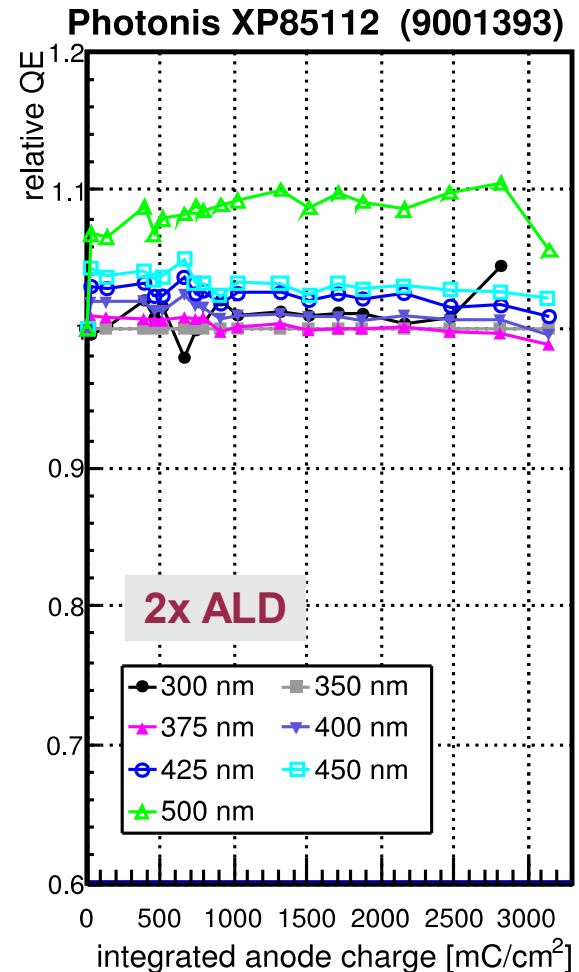
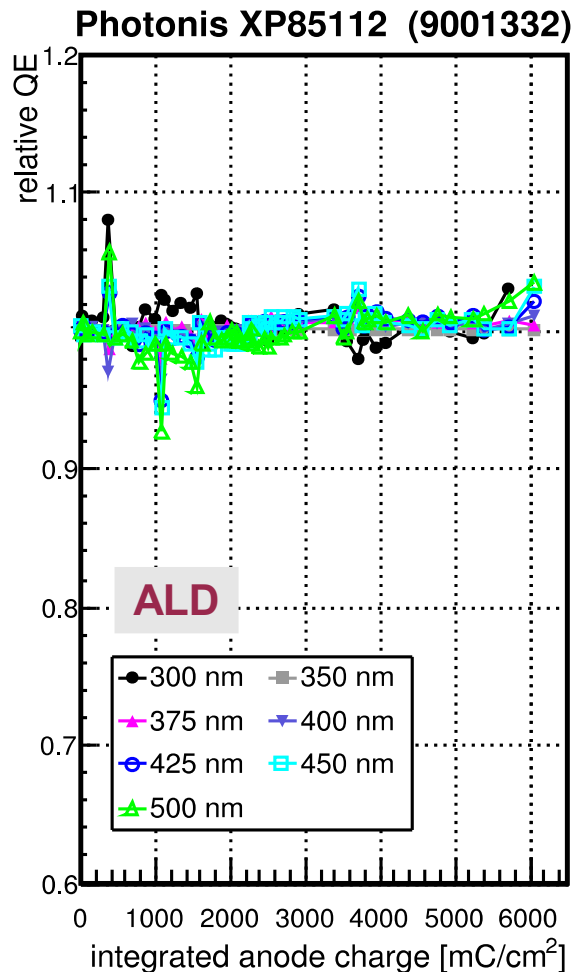
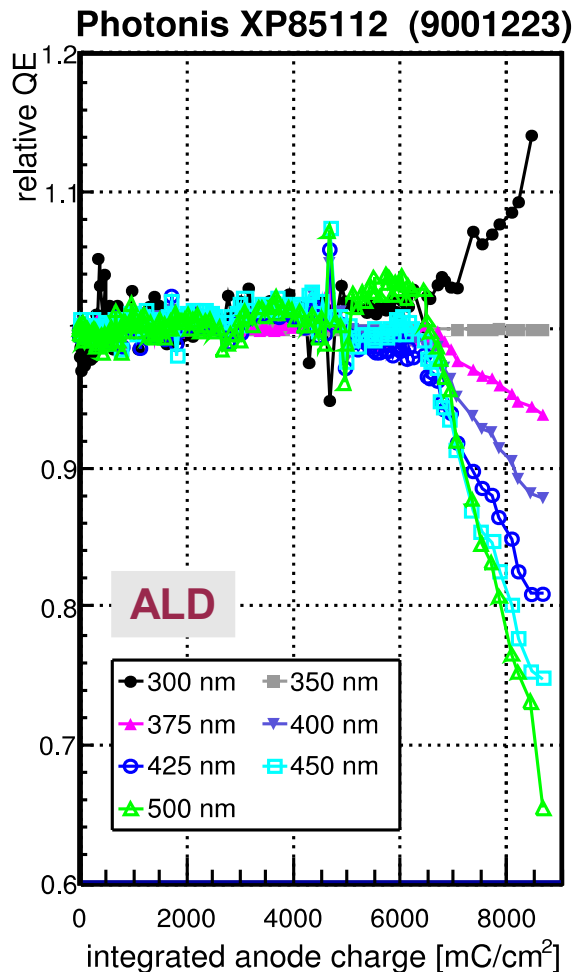


Q.E.(λ) vs. Charge (Photonis)



- 9001223: Q.E. drops significantly above $\sim 6 \text{ C/cm}^2$
- **Others: if at all, only moderate Q.E. changes seen**

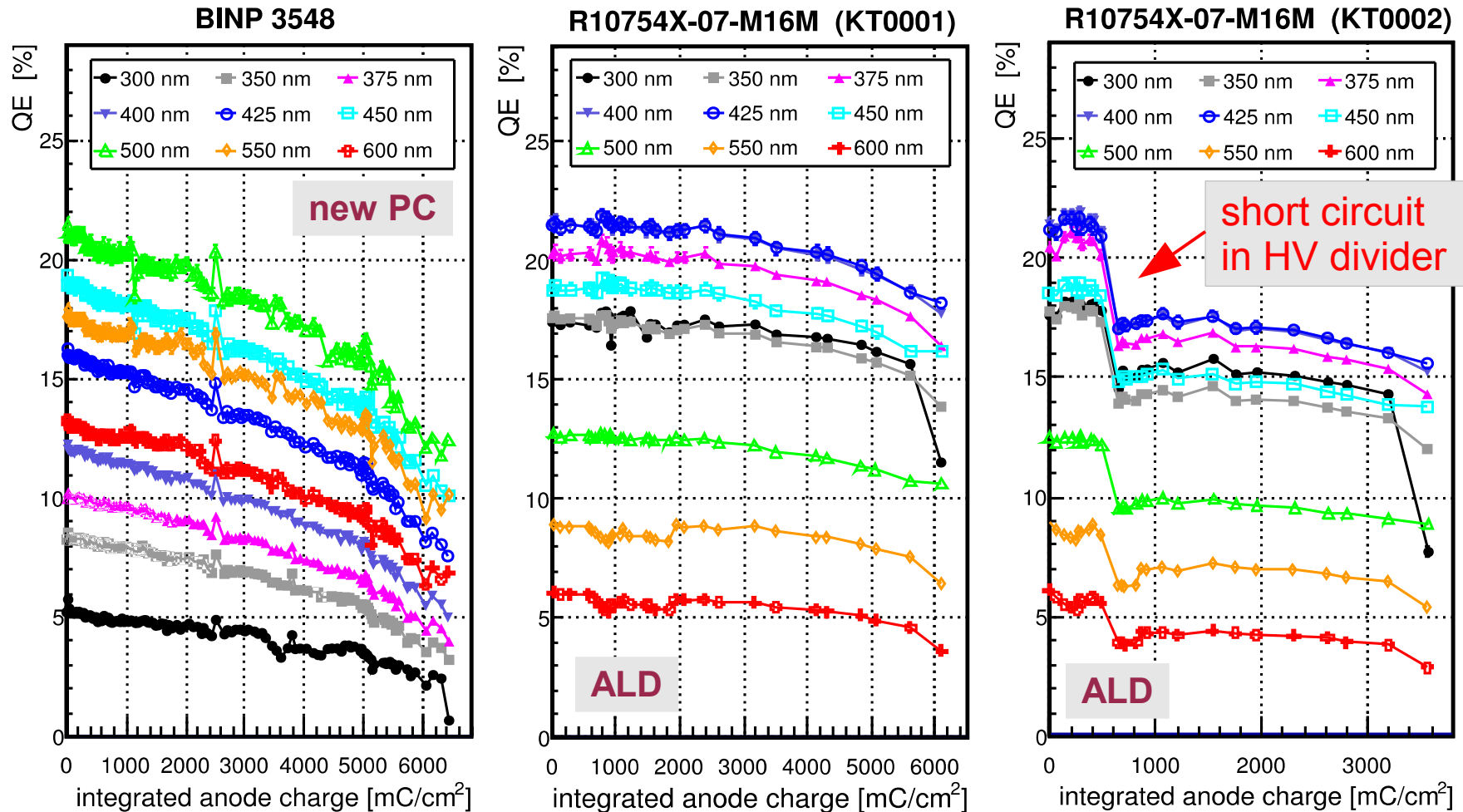
Rel. Q.E.(λ) vs. Charge (Photonis)



PHOTONIS 9001332 and 9001393: no wavelength dependence yet

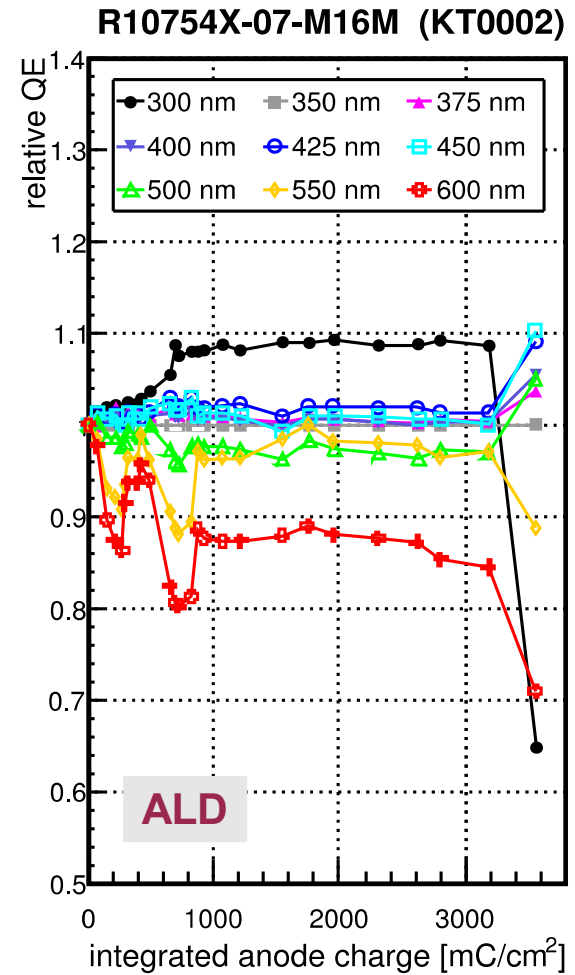
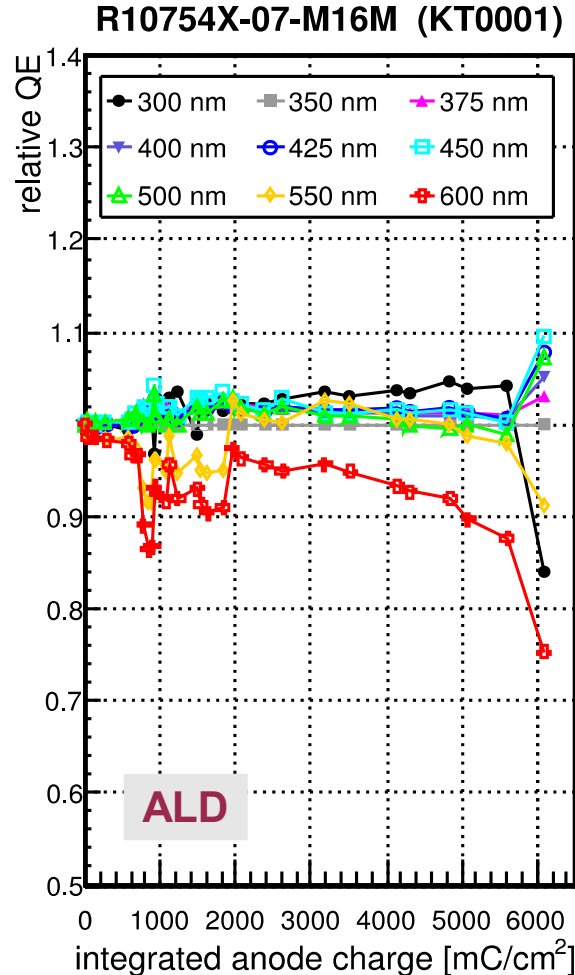
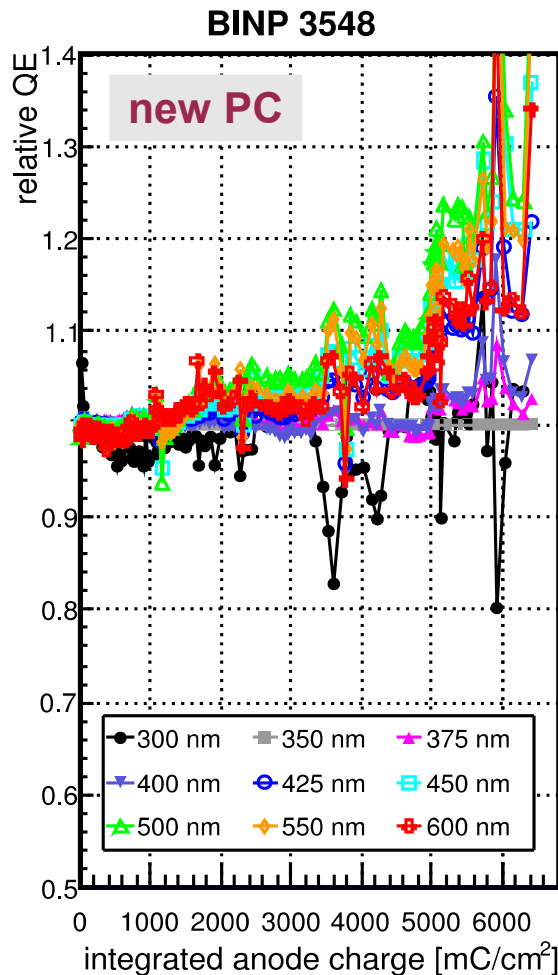
PHOTONIS 9001223: red drops faster than blue starting at 6 C/cm²

Q.E.(λ) vs. Charge (BINP + Ham.)



- KT0002: QE step at 0.5 C/cm² (because of HV spike !!)
- **BINP: Q.E. drops continuously**

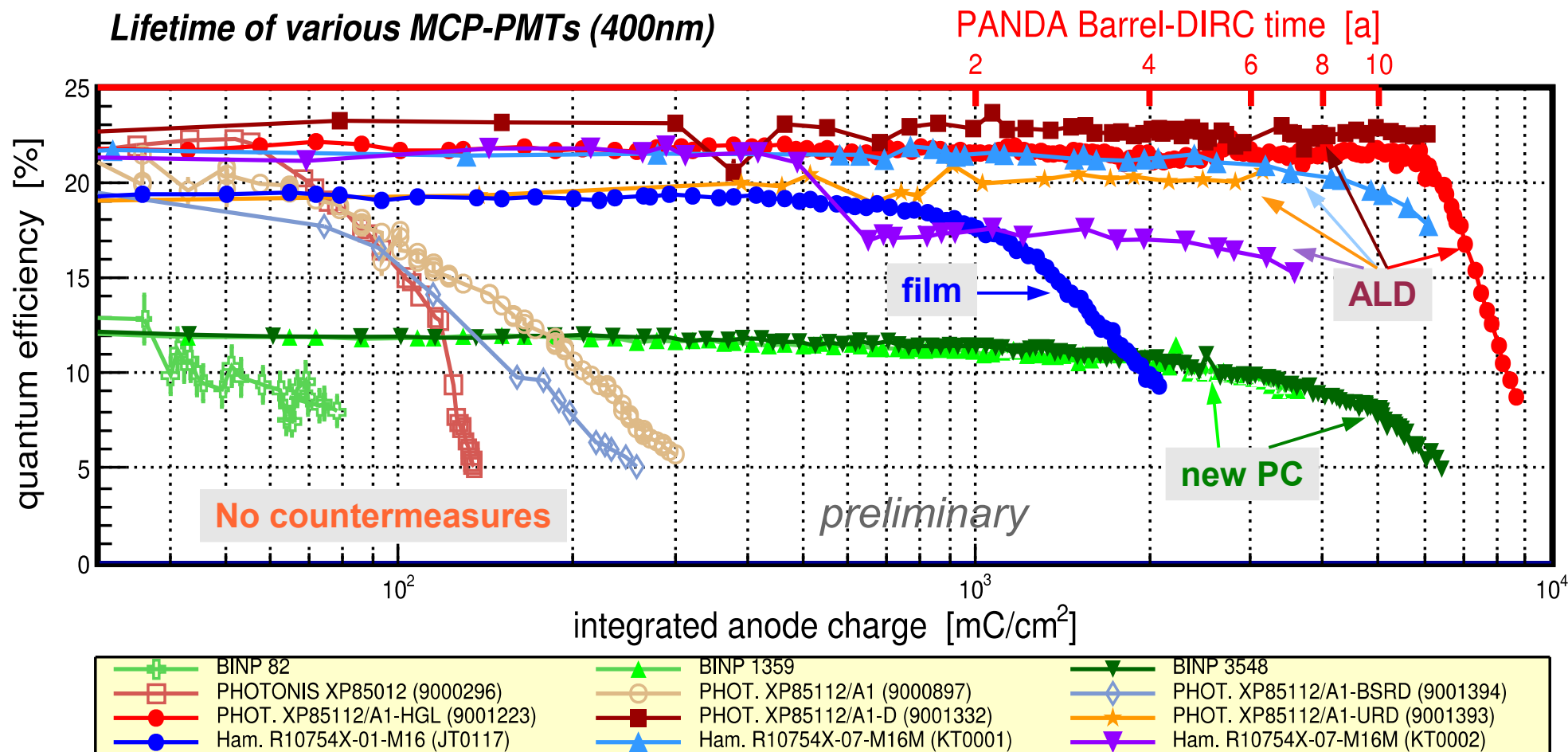
Rel. Q.E.(λ) vs. Charge (BINP+Ham.)



Ham. R10754X-M16M: no clear tendency seen

BINP 3548: slopes are hard to interpret

Lifetime of MCP-PMTs (Feb. 2015)



- MCP-PMT with film: Q.E. starts degrading above $\sim 1 \text{ C}/\text{cm}^2$
- 1 inch ALD Hamamatsu MCP-PMTs: small QE drop at $5 \text{ C}/\text{cm}^2$
- MCP-PMTs with ALD layers: **very good performance to $5 \text{ C}/\text{cm}^2$**



Summary

- Trends in gains and darkcount rate not so obvious
- All ALD-coated MCP-PMTs show good performance up to $>3 \text{ C/cm}^2$
- QE of PHOTONIS MCP-PMTs
 - **9001223 started dropping at 6 C/cm^2 , but only at illuminated side**
 - 9001332 still good (no degradation) at 6 C/cm^2
 - 9001393 with 2 ALD-layers: no degradation seen up to now
- QE of Hamamatsu MCP-PMTs (ALD-coated)
 - KT0001: Only moderate degradation seen up to 6 C/cm^2
 - KT0002: drop at 0.5 C/cm^2 caused by HV spike, otherwise still okay