Update on lifetime measurements and first results with new Photek sensor

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ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

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Lifetime measurements

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Data from Oct 15, 2018

Illumination Overview QE (all sensors with ALD)

Film between MCP Two ALD layers Film in front of first MCP

	Manufacturer	Senor ID	IAC [mC/cm²]	QE start [%]	QE latest [%]	QE latest/QE start [%]
2 Inch	Photonis XP85112	9001332	15909	23.0	8.2	36
		9001393	20975	19.1	19.5	102
		9002108	728	21.7	21.3	98
1 Inch	Hamamatsu R10754X	KT0001 (M16M)	20090	21.7	5.2	24
		KT0002 (M16M)	19334	21.1	5.2	25
2 Inch	Hamamatsu R13266-07-M768 / M64	JS0022 (64 pix.)	4918	17.4	4.5	26
		JS0035 (64 pix.)	8049	25.5	24.7	97
		JS0018 (768 pix.)	1284	18.0	2.6	14
		JS0027 (768 pix.)	3162	24.3	22.5	93
		YH0250 (64 pix.)	2498	25.4	24.2	95

Data from Oct 15, 2018

Illumination Overview QE (all sensors with ALD)

High CE MCP Two ALD layers Film in front of first MCP

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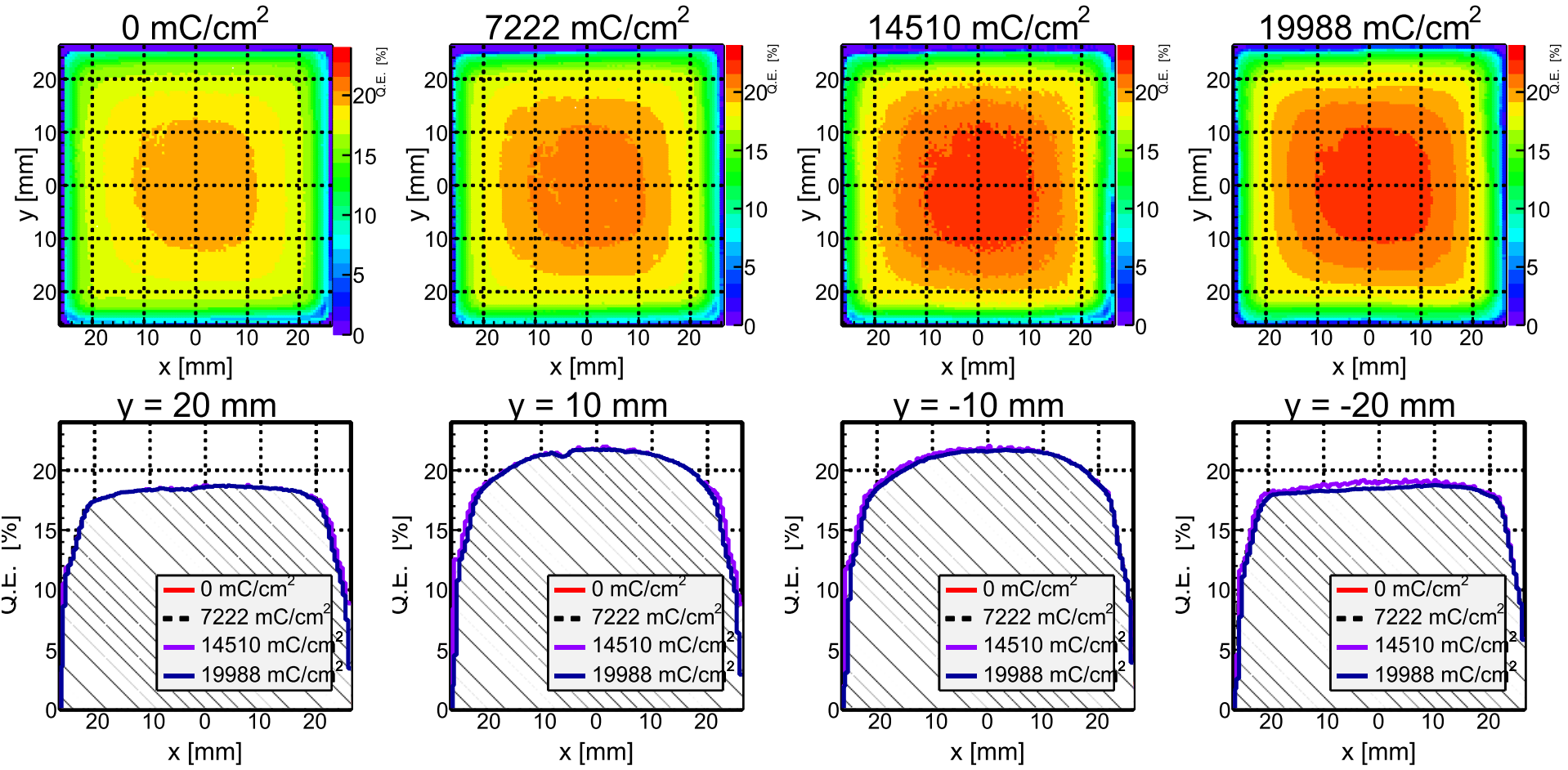
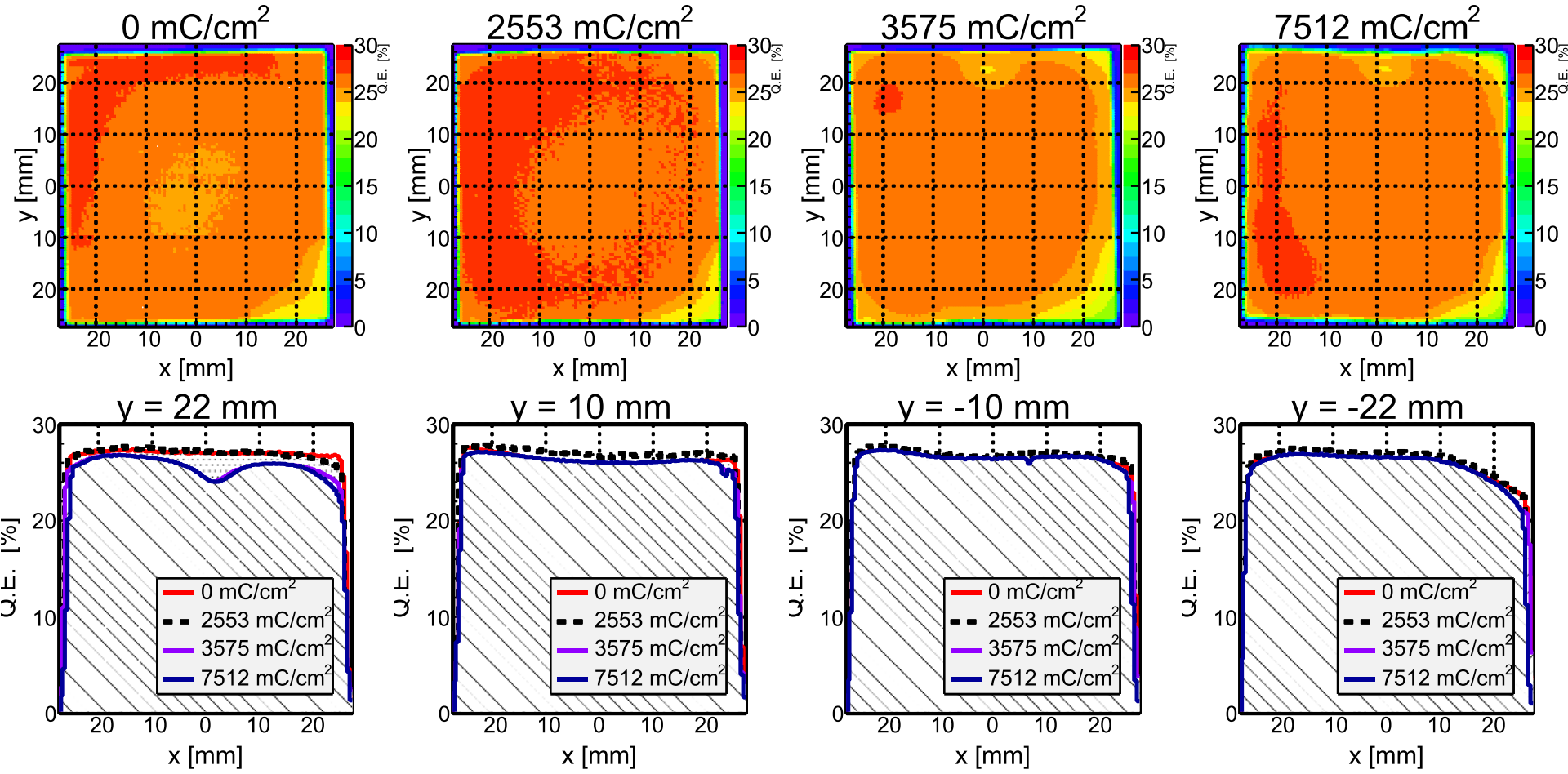
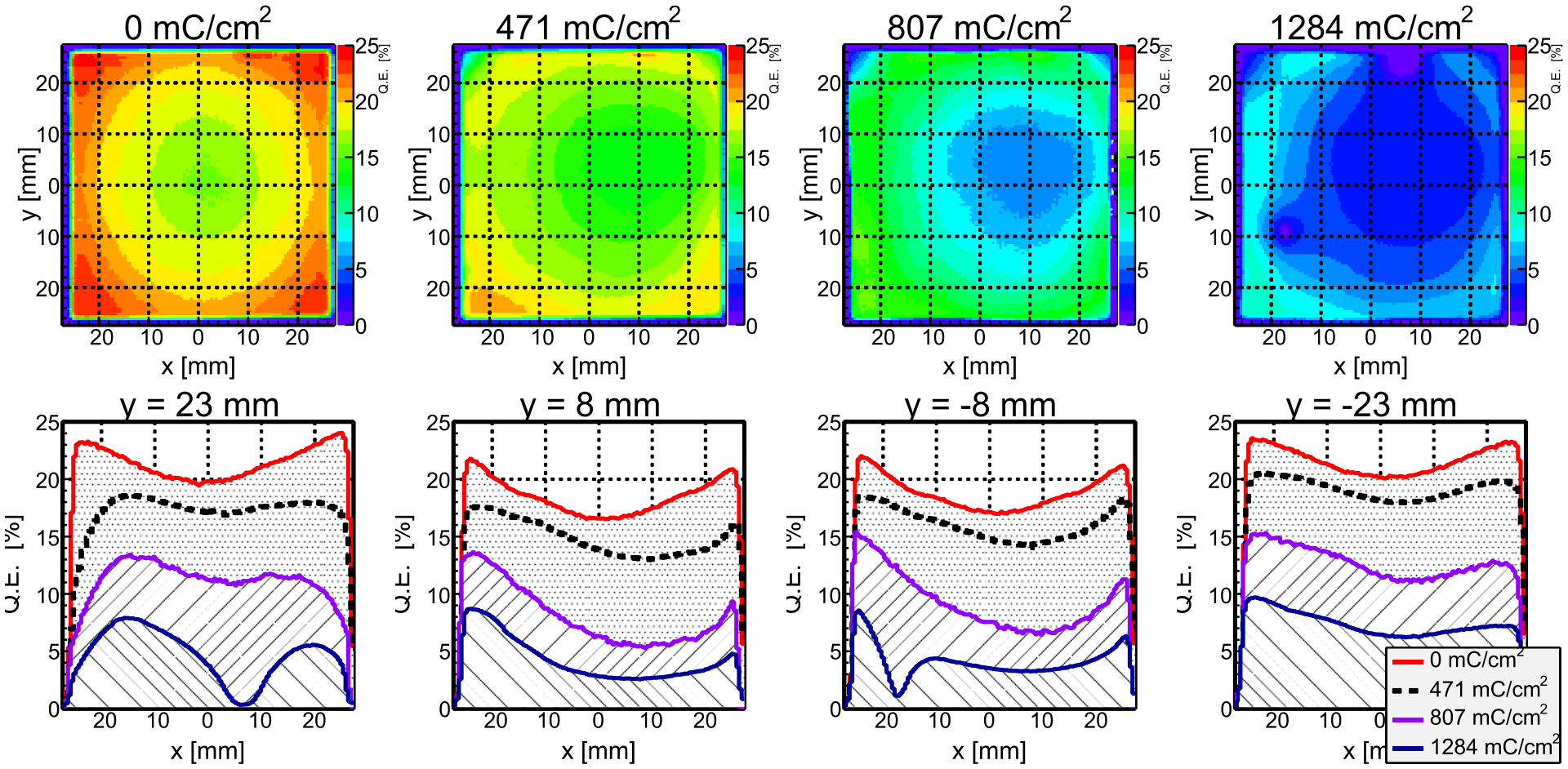
QE scan of Photonis 9001393-URD (double ALD)



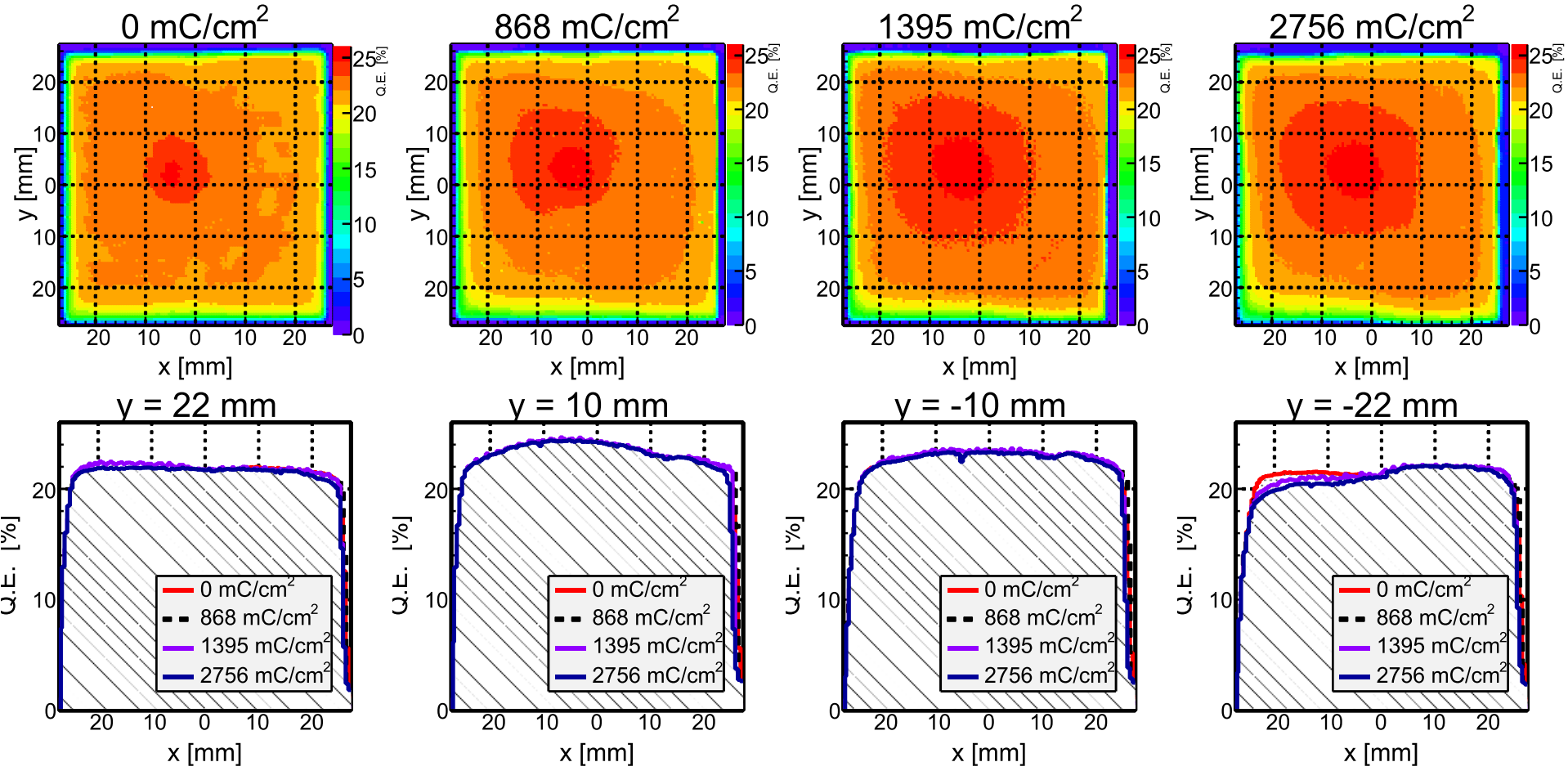
QE scan of Hamamatsu JS0035 (8x8, ALD)



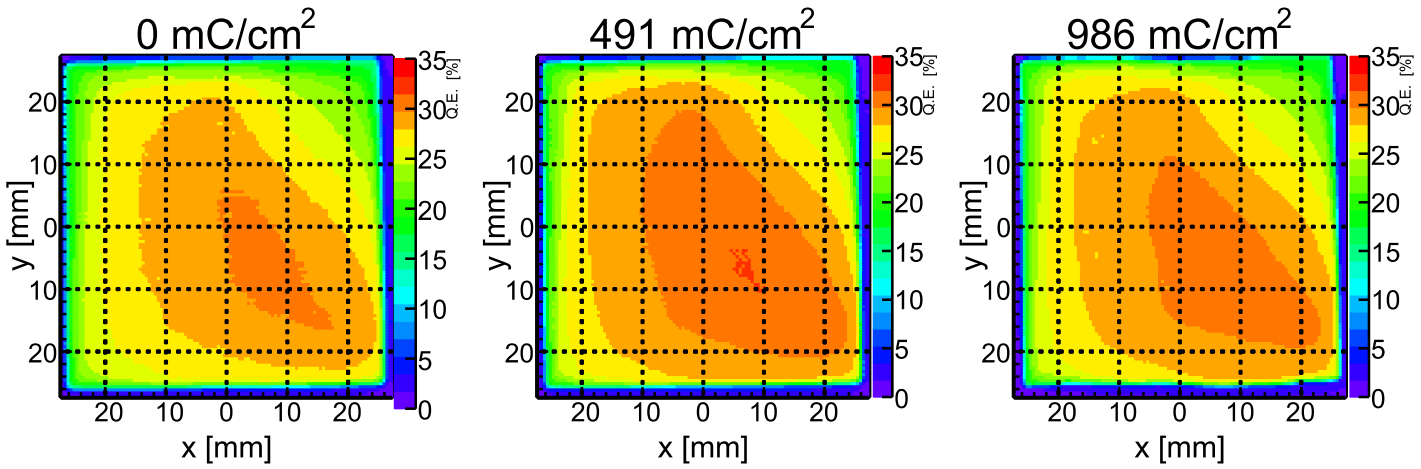
QE scan of Hamamatsu JS0018 (6x128, ALD)

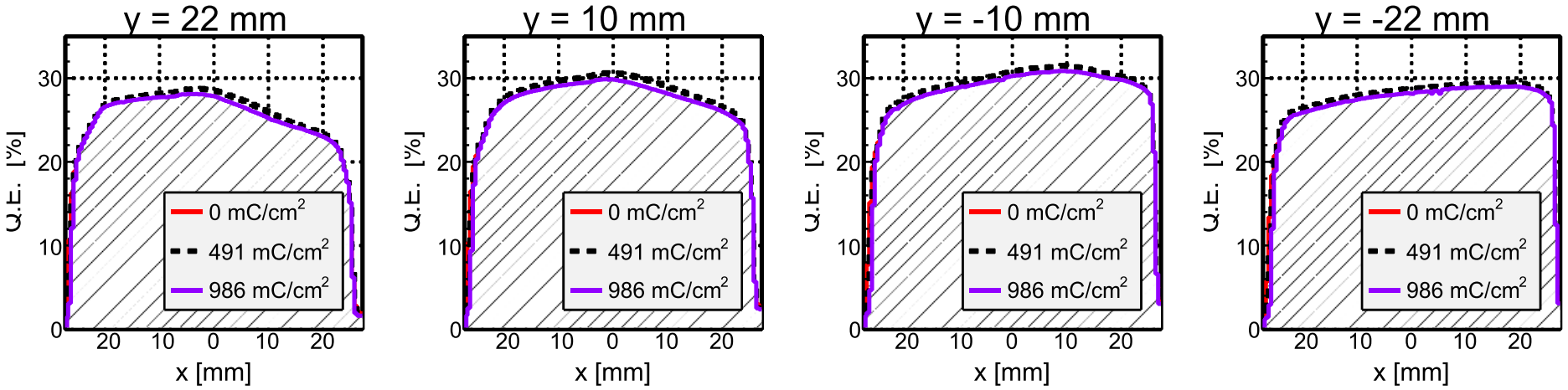


QE scan of Hamamatsu JS0027 (6x128, ALD)

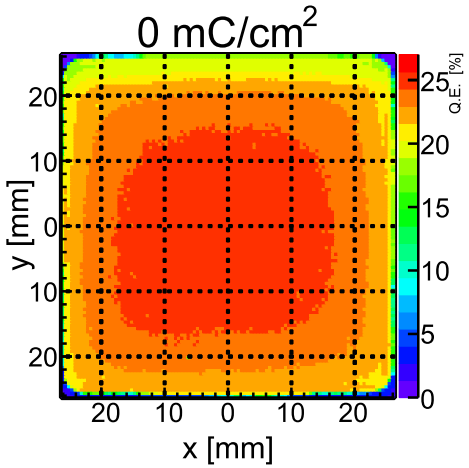


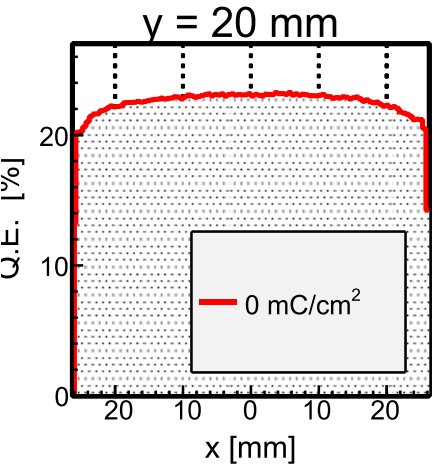
QE scan of Hamamatsu YH0250 (8x8, ALD)

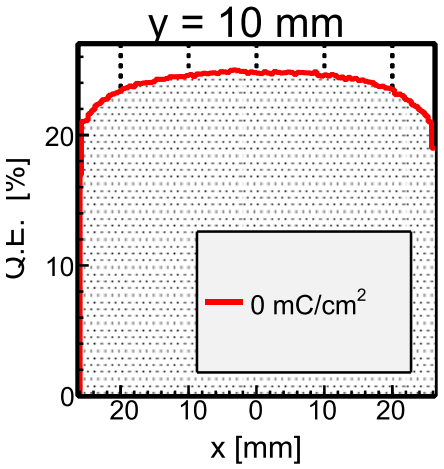


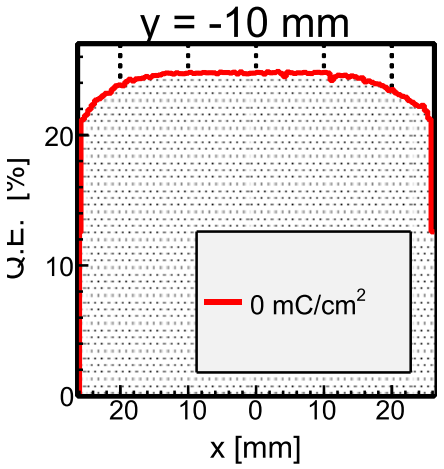


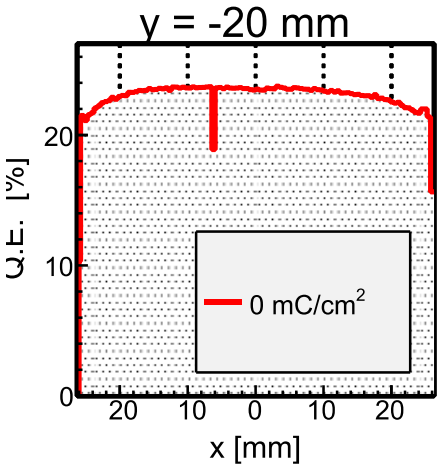
QE scan of Photonis 9002108 (High CE MCP)



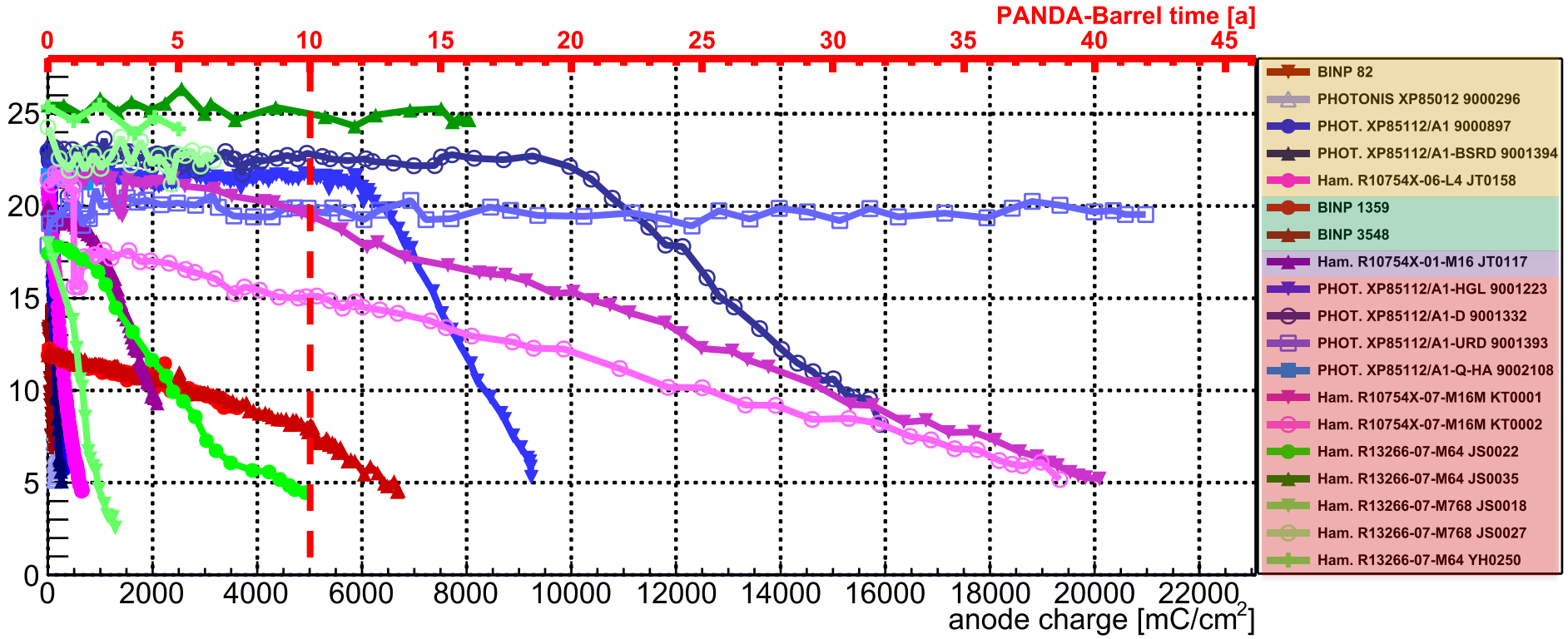








Lifetime data (QE in % @400 nm) (Oct 15, 2018)



- Most sensors with ALD coated MCPs have lifetime > 5 C/cm²
- All non ALD devices have a lifetime of < 200mC/cm²

No countermeasures
New cathode material
Film
ALD

Summary and outlook

- Double ALD Photonis tube (1393) at 21C/cm² without damage
- Old sensors taken out of illumination box (KT0001, KT0002, JS0018, JS0022)
- Photonis 9002108 with High CE included in setup

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Photek A1171005

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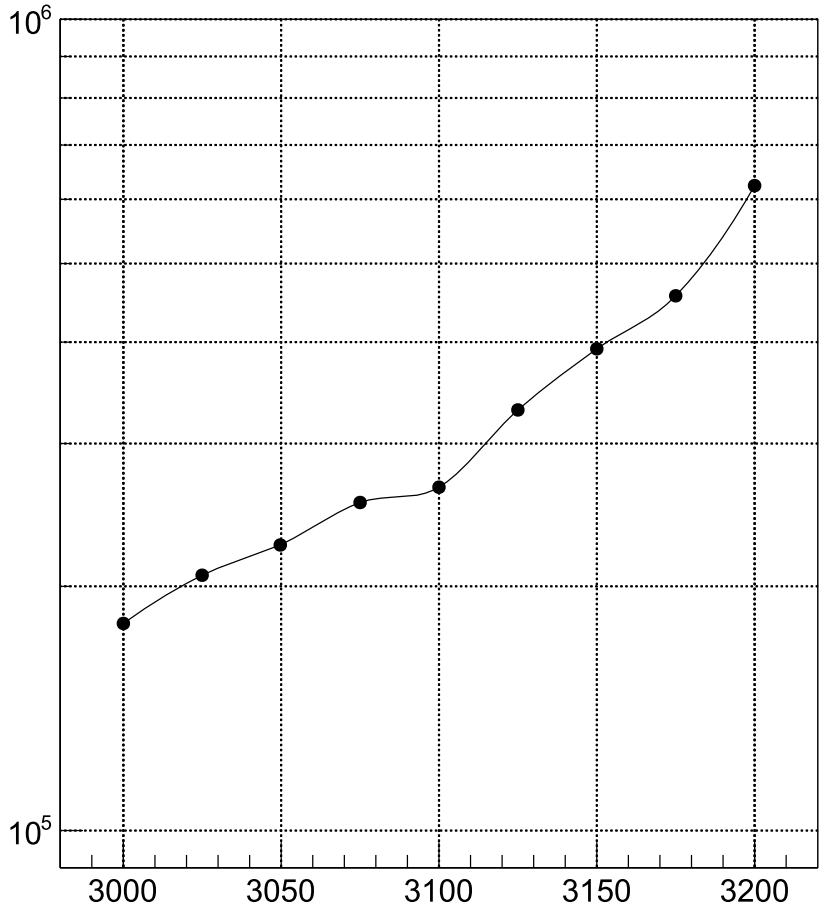
New device from Photek (A1171005)

- First Photek device ever tested in Erlangen
- Readout like PHOTONIS Planacon series
- 10µm pores with ALD coating
- PC damaged (overbaked) by Photek
- Aluminum case necessary for pressure on readout backplane

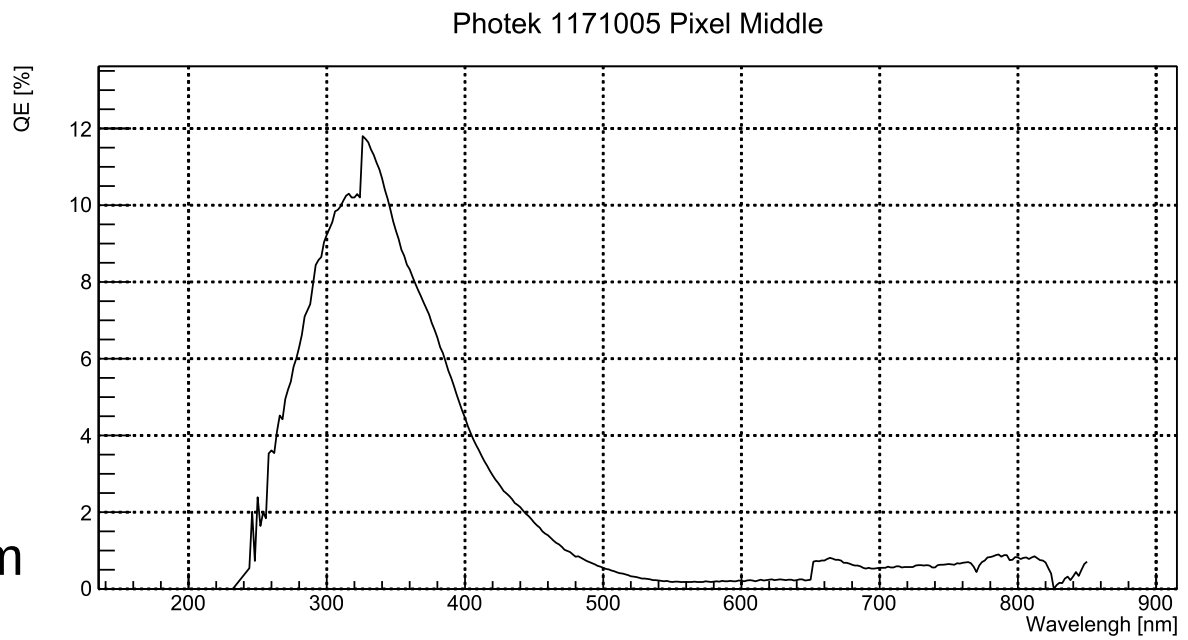
Gain vs voltage

- Measured with scope
- Signal 100x amplified with Ortec fast amp
- Gain calculated with gauss fit in histogram data (pedestal and signal)
- 10^6 not reachable
- Max gain $6 * 10^5$



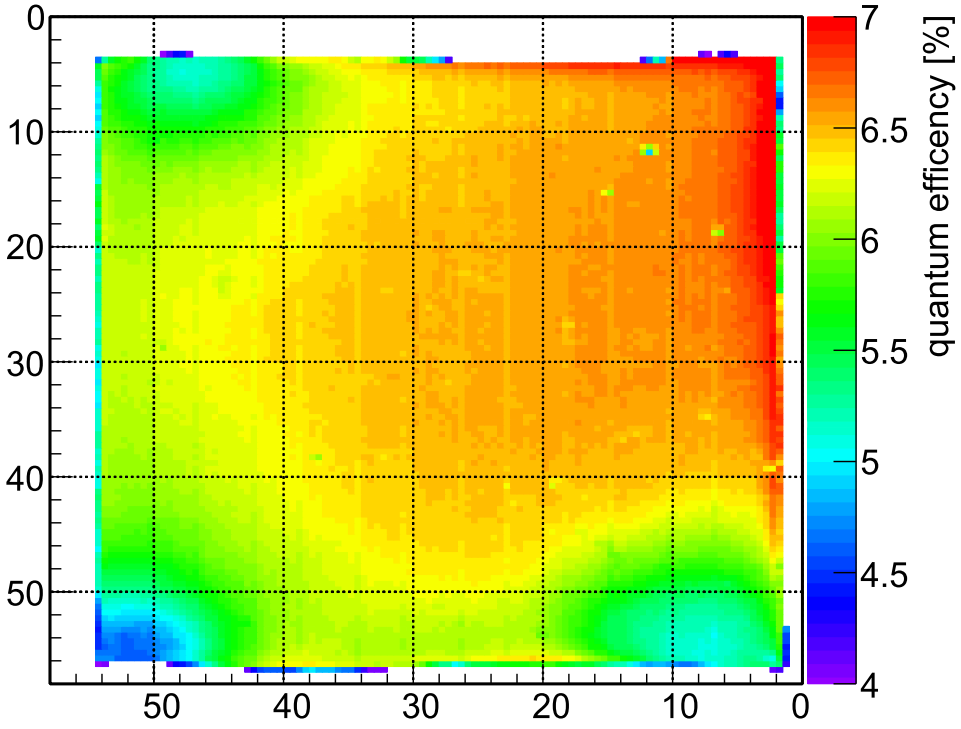
QE vs wavelength

- -200 V at cathode
- Current measured at MCP IN
- Calculated with photo diode current (known QE for each wavelength)
- Low overall QE (PC was overbaked)
- Max QE 12% at 350nm



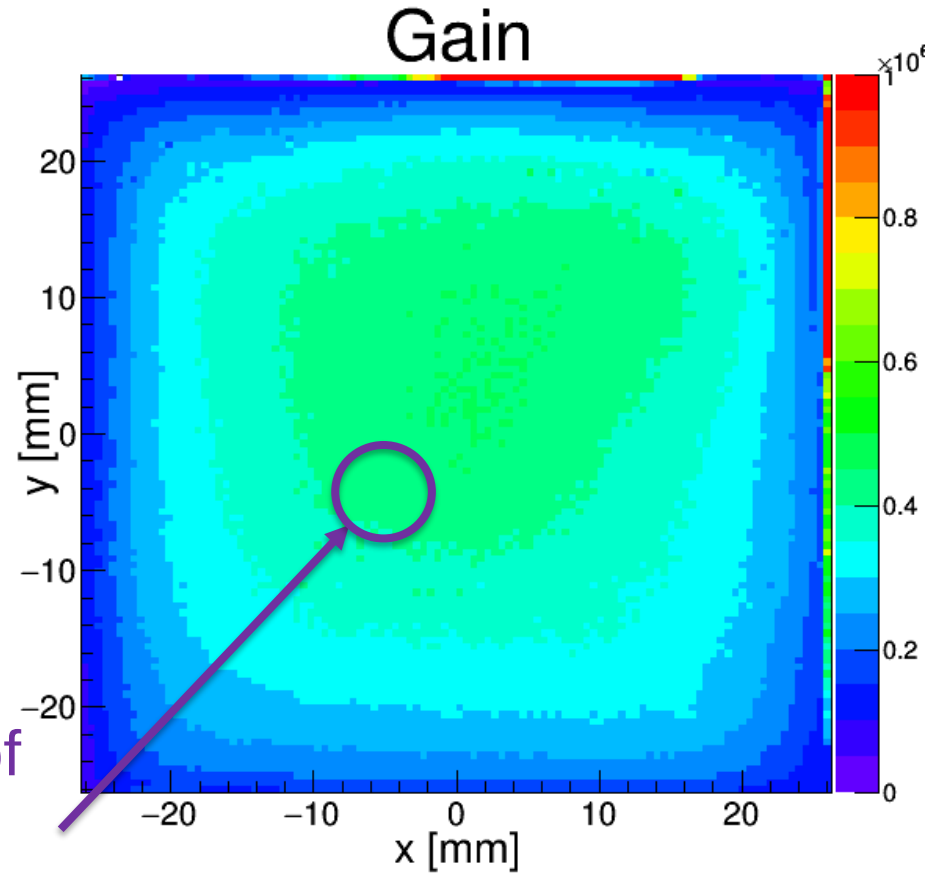
QE surface scan

- -200 V at cathode
- Current measured at MCP IN
- Calculated with photo diode current (known QE for wavelength)
- Scanned with 372 nm (blue)
- 0.5 mm steps across surface



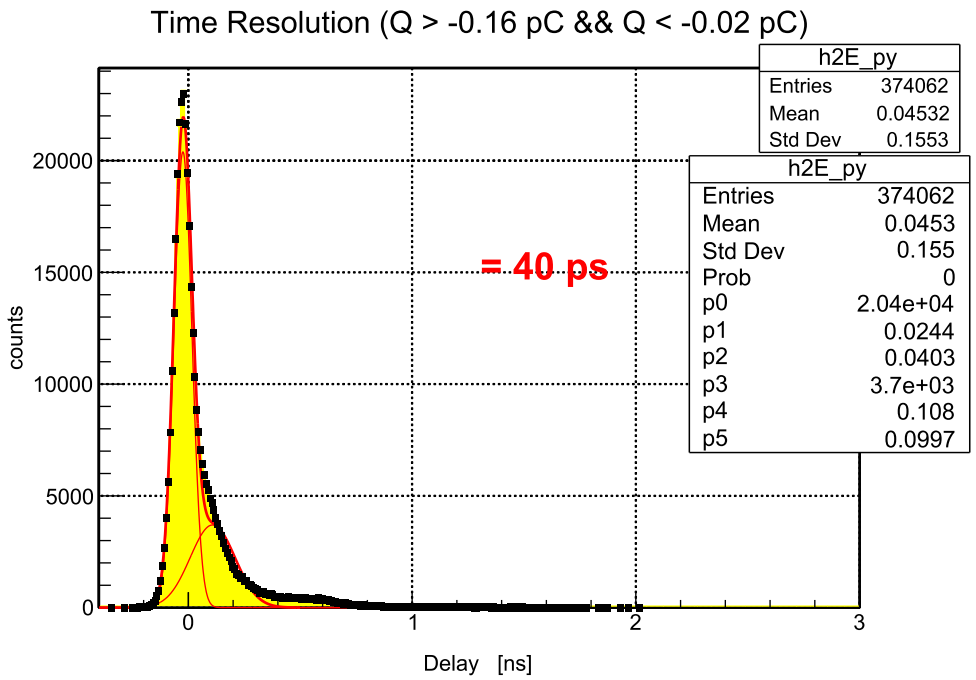
Current gain scan

- Scanning at approximately $6 * 10^5$ gain
- Measuring shortened anode current
- Scan is folded with QE of the sensor
  - Has to be divided by QE
- Gain then scaled to known value of one pixel

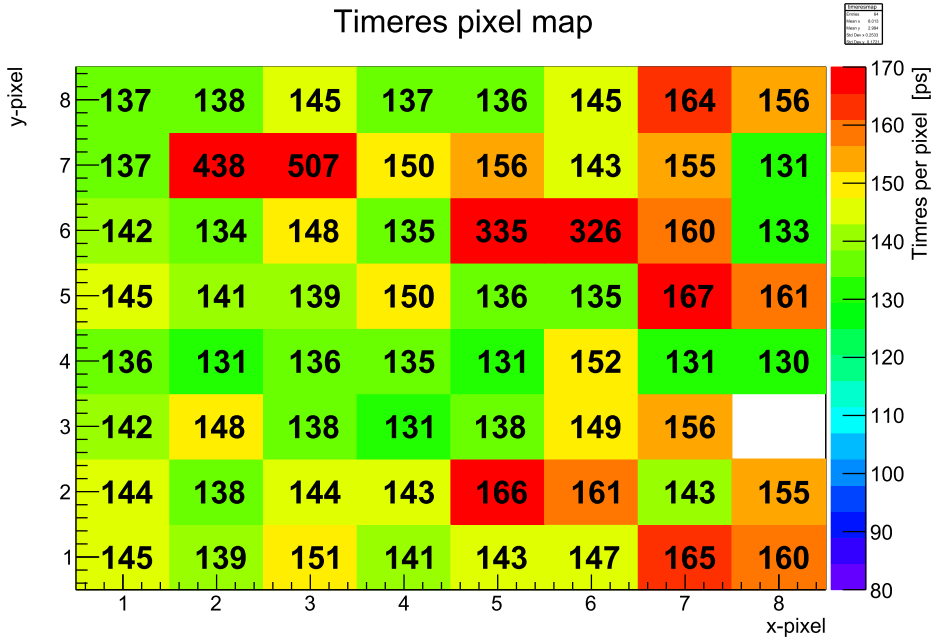


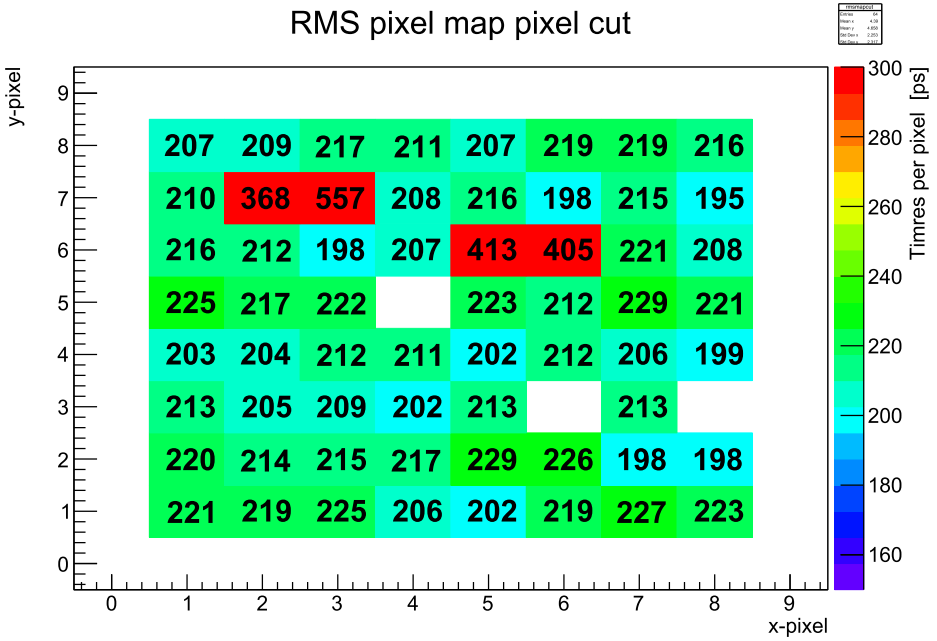
Time resolution

- Measured with scope at $6 * 10^5$ gain
- Blue laser at 15 kHz and 46 % tune
- 200x amplified signal then impedance matched splitting and low discriminator threshold (40mV) (just above noise band)
- Time walk corrected spectra
- σ 40 ps (RMS 155 ps)



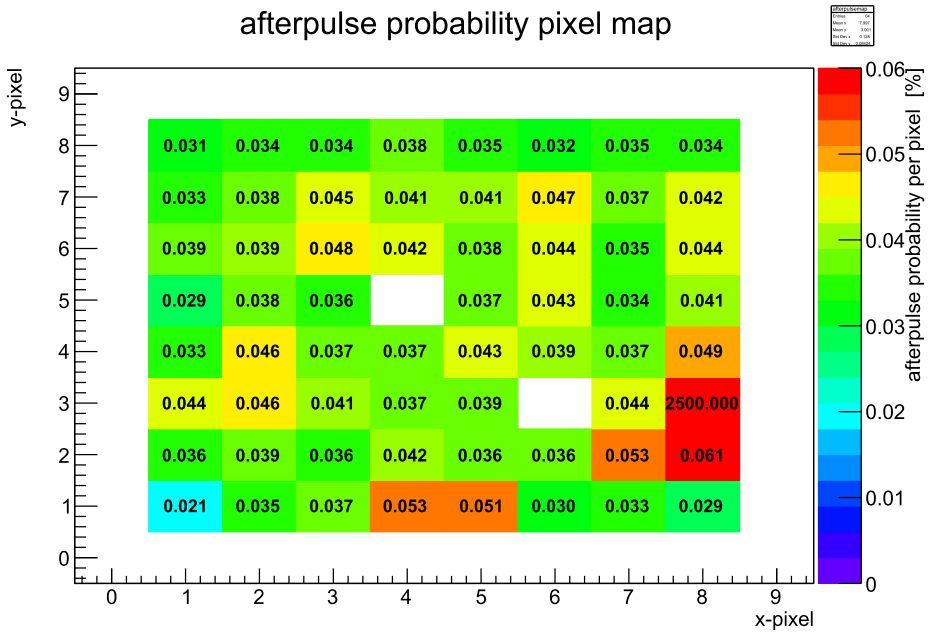
TRB measurements – Time resolution

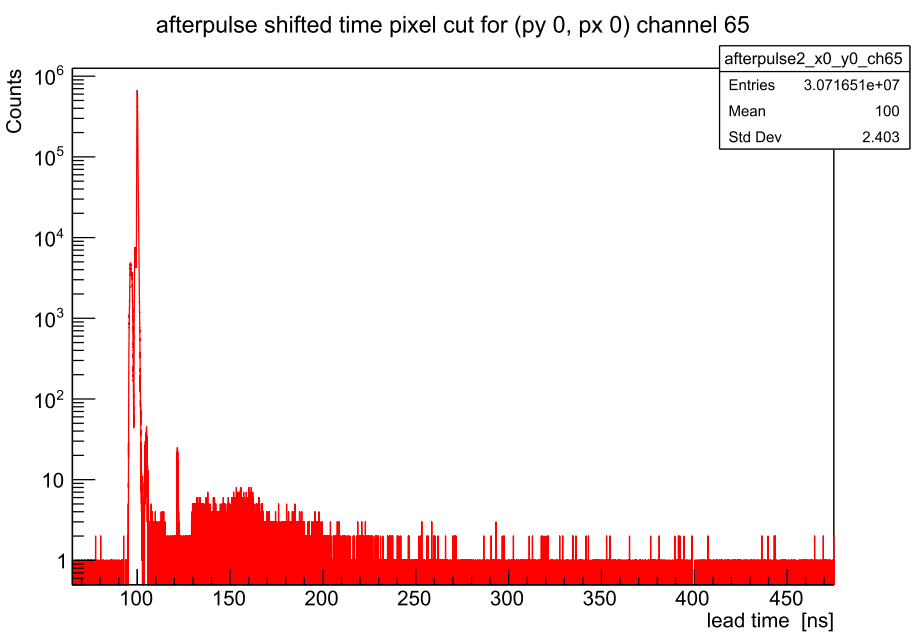




- Left: sigma of gaussian fit on TDC spectrum (130-510ps)
- Right: RMS values of TDC spectra (195-560ps)
- Overall performance seems slightly better than comparable Photonis tubes

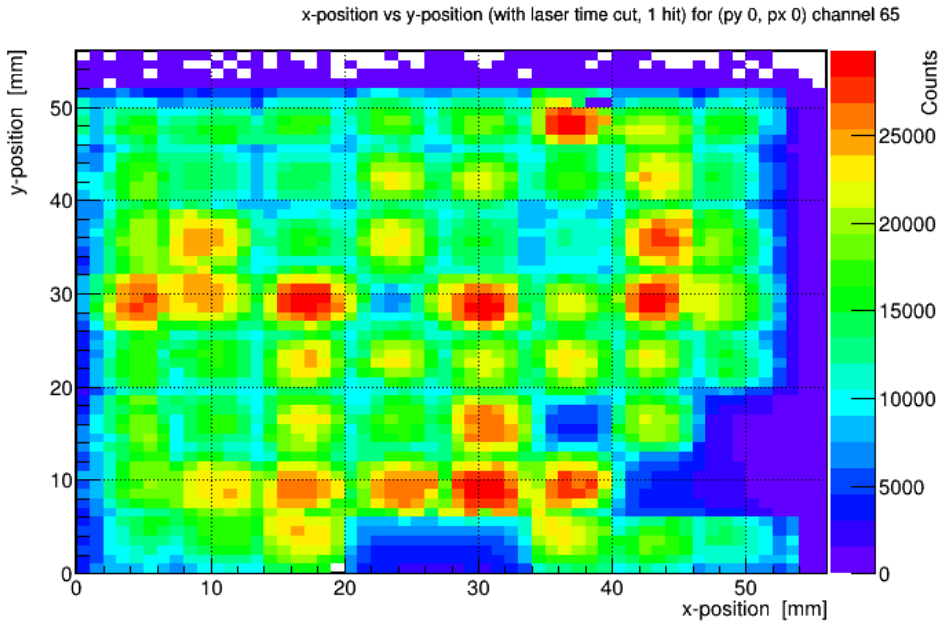
TRB measurements - Afterpulsing

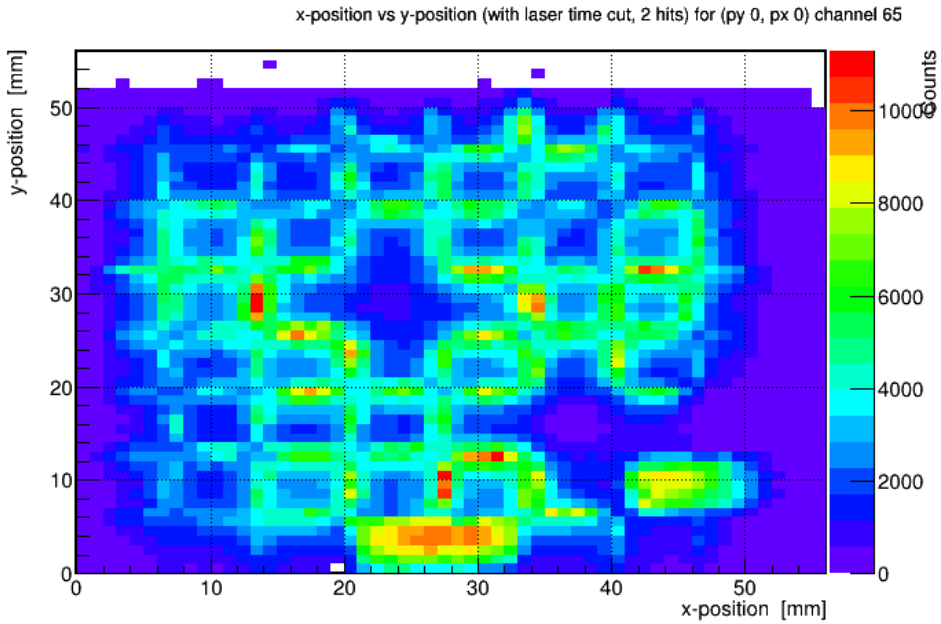




- Low after pulsing probability (0.02%-0.06%)
- One “dead” channel with high counts

TRB measurements - Crosstalk

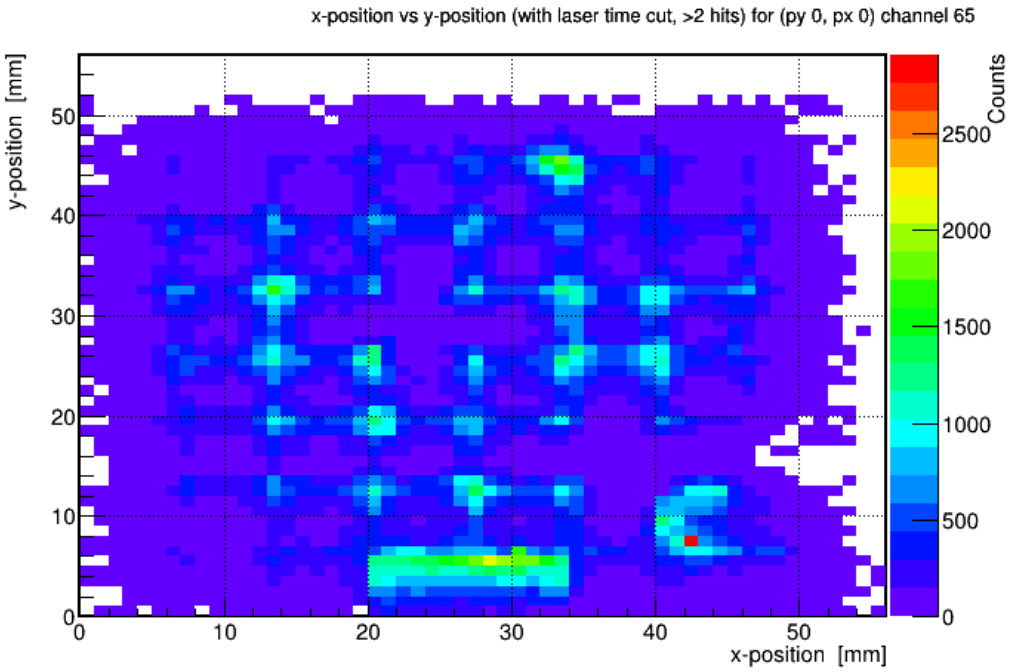




- One hit (left) shows separated pixels
- 2 hits (right) shows borders between pixels
- Some dead channels (Padiwa)

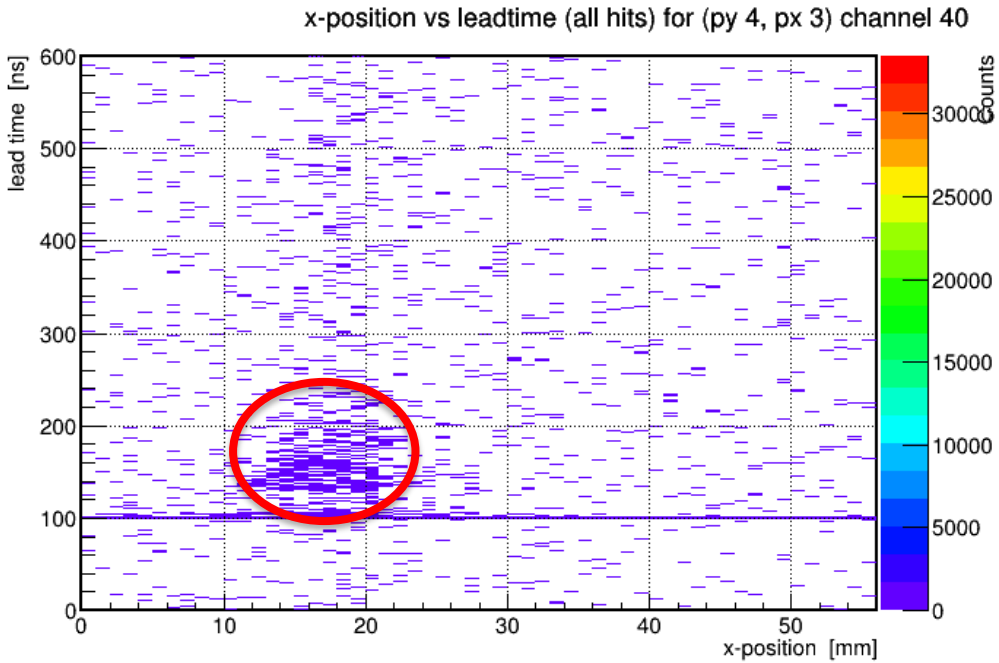
TRB measurements - Crosstalk

- 3 hits (right) shows corners where 4 Pixels can be hit
- Area at the bottom seems to have shortened pixels
- Overall Crosstalk behavior is more comparable to Photonis than Hamamatsu

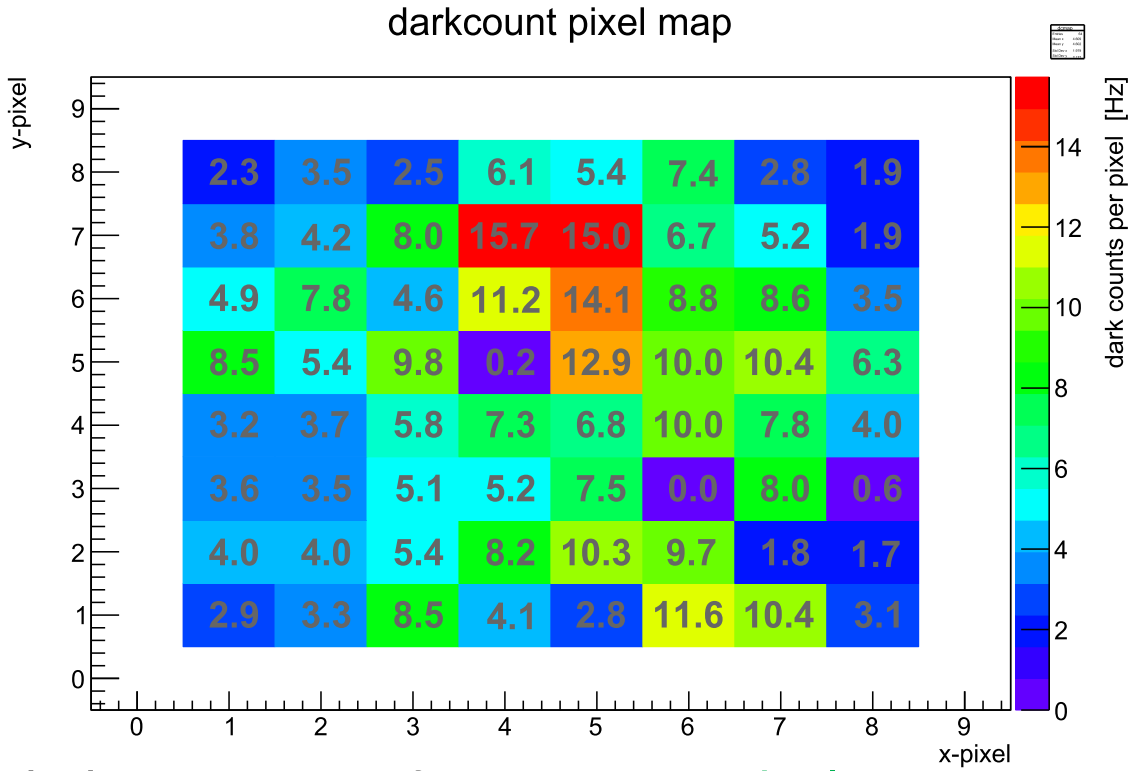


TRB measurements – recoil electrons

- Recoil electrons shown for one channel
- Compared to other sensors low rate of recoil electrons



TRB measurements – dark counts



- Very low dark count rate of 2-16 Hz per pixel
- Comparable to DC rates of Hamamatsu sensors

Summary and outlook

- Overall good performance of Photek tube
  - Low DC
  - Low after pulsing
  - Good time resolution

- Very high voltage needed, 10^6 gain not reachable

- Looking forward to get tube with better QE when available

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Thank you for your attention!

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