Lifetime measurement and new Photonis sensor

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New high QE Photonis sensor XP85012 9002085

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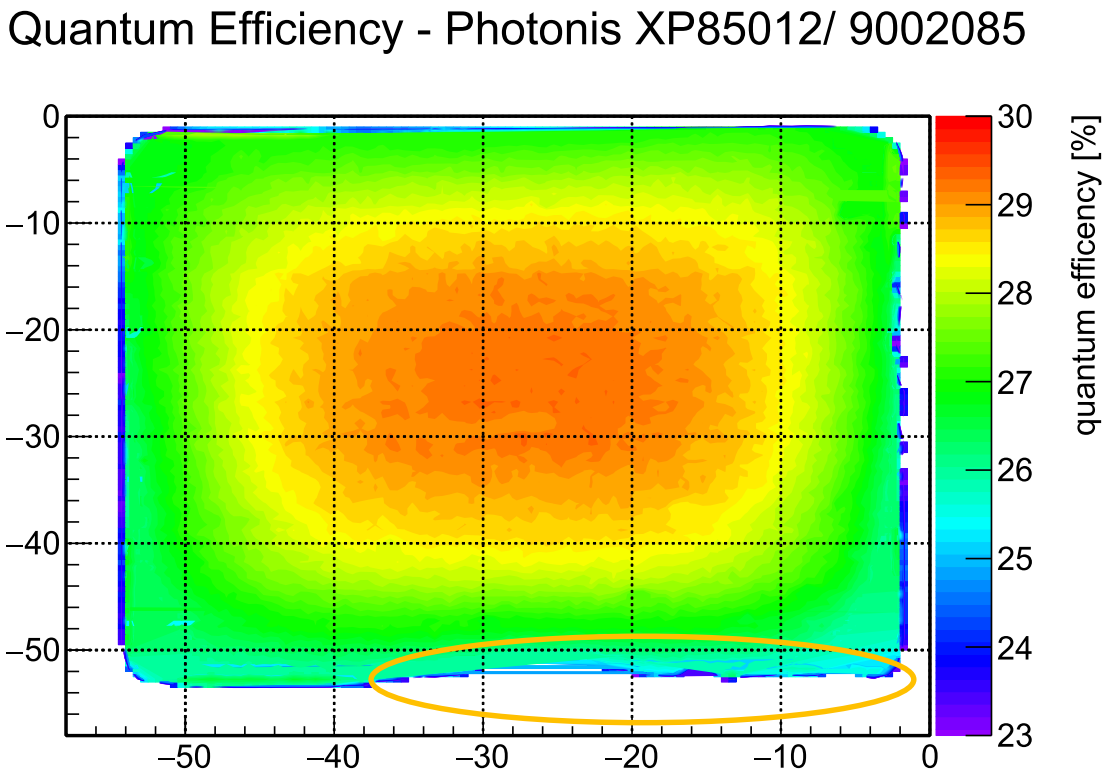
Photonis XP85012 9002085 (25µm)

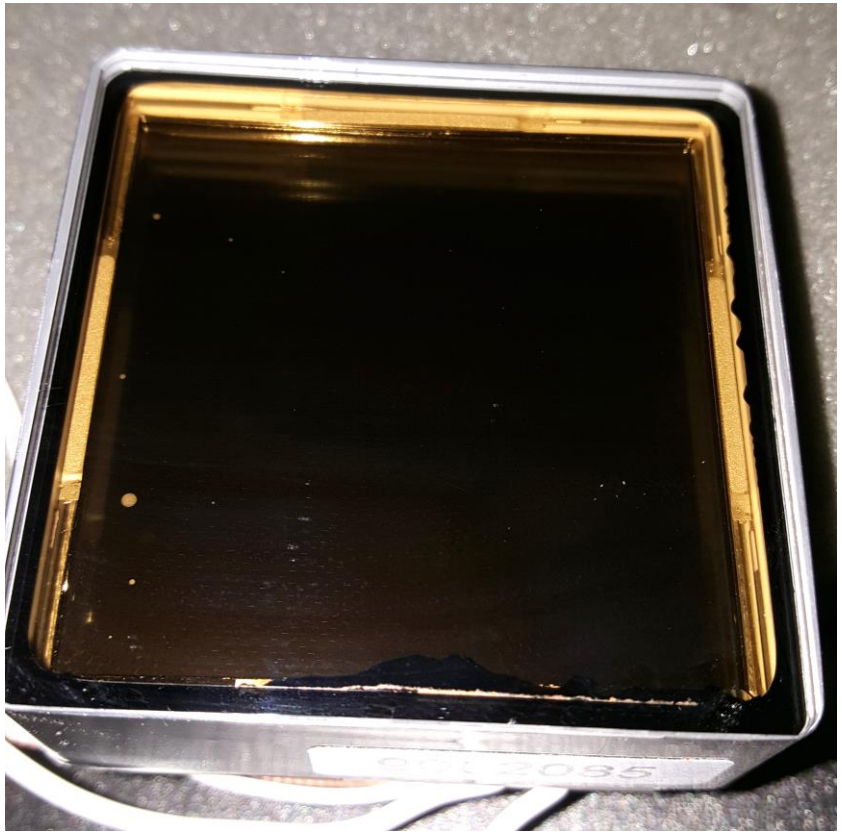
- 25µm MCP-PMT (no ALD coating)
- New developed photocathode material
- 10^6 Gain at 1600V

QE scan blue laser (372nm) Photonis 9002085

- QE uniform over surface (±2%)
- Higher QE towards middle of the sensor
- Marked area has reflective coating under window glass



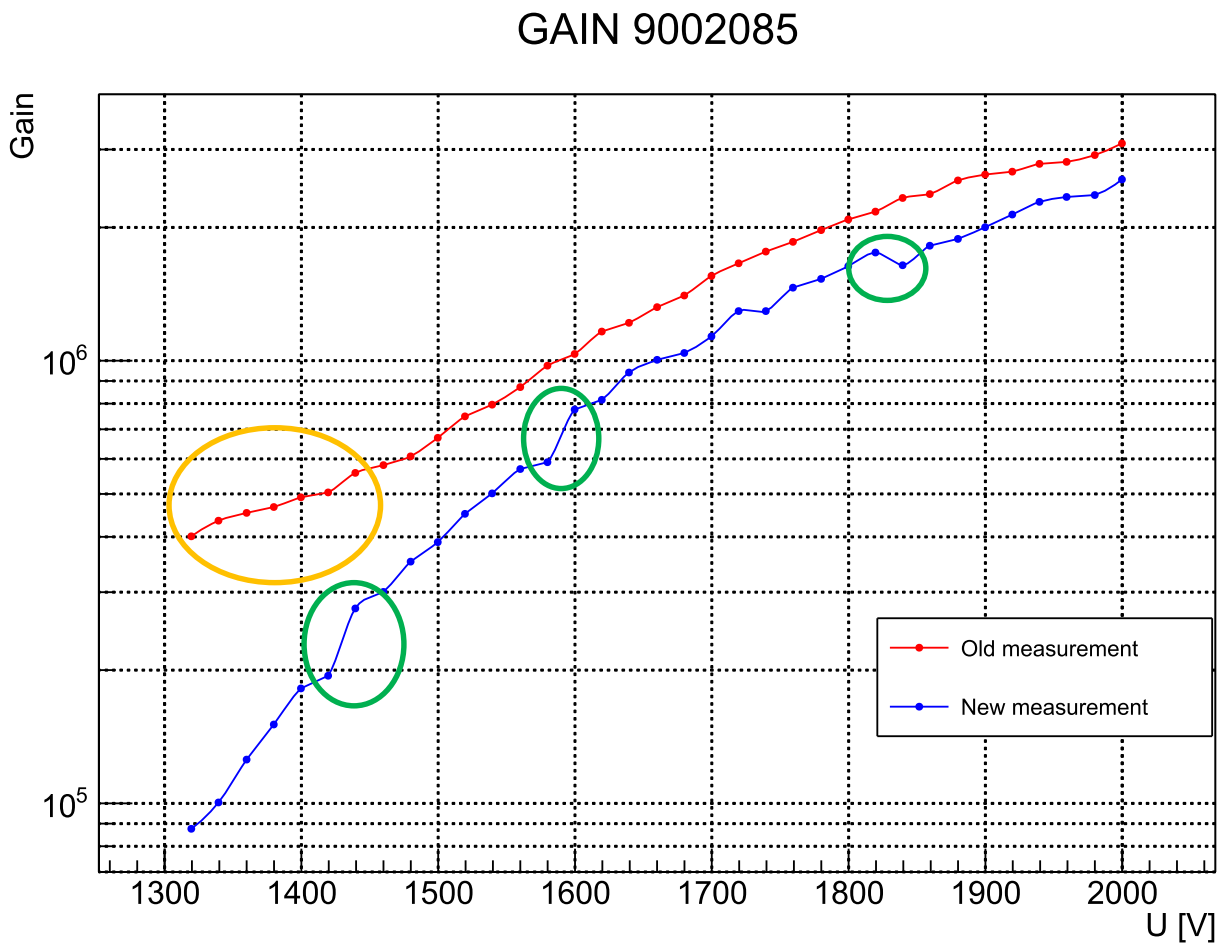
Photonis XP85012 9002085 (25µm)



- Sealing material

Gain Photonis 9002085

- Old measurement:
  - Taken when sensor was received
  - Threshold problems
- New measurement:
  - Taken without threshold
  - Jumps when histogram range adjusted
  - overall lower gain
  - Maybe other pixel or integrated charge effect

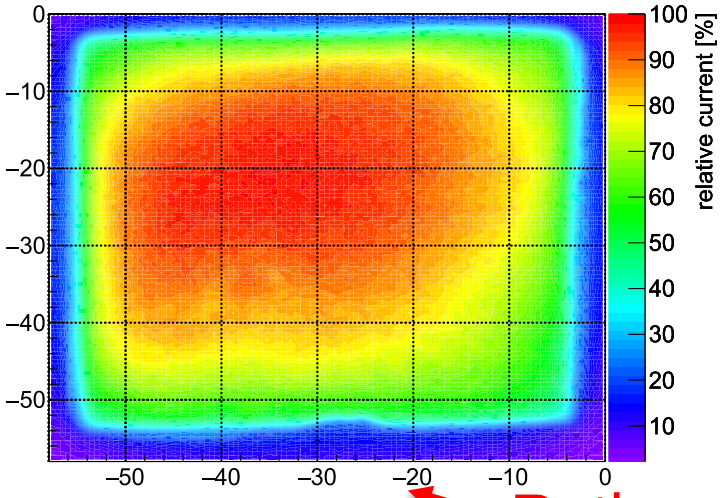


Gain scans Photonis 9002085

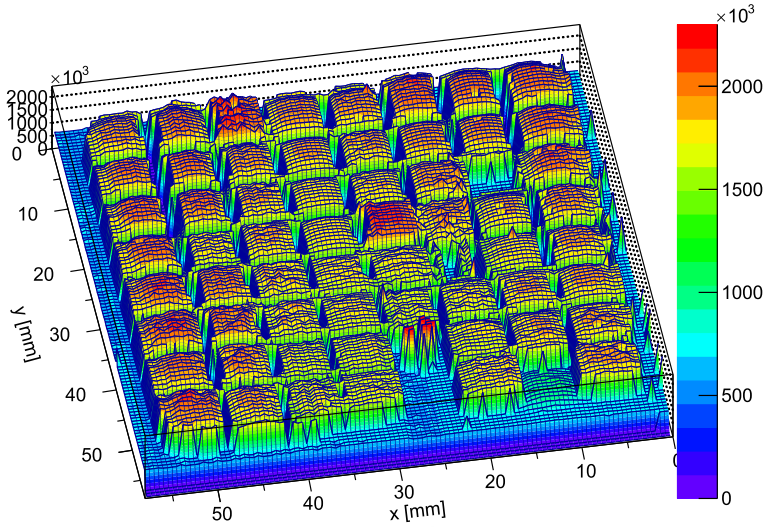
- Current of shortened anodes measured at 1.6kV (no single Photons)
- Relative gain
- Folded with QE

- Gain of pulse signals (single Photons)
- Measured at 1.6 kV
- 10x amplifiers LeCroy 612A

Relative current - Photonis 9002085



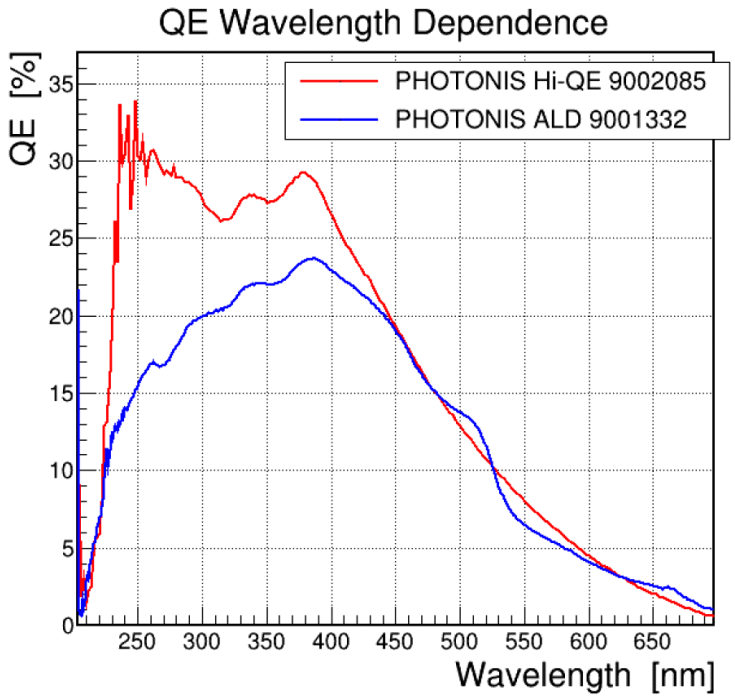
Photonis #2085 MCP Gain



Rather good agreement

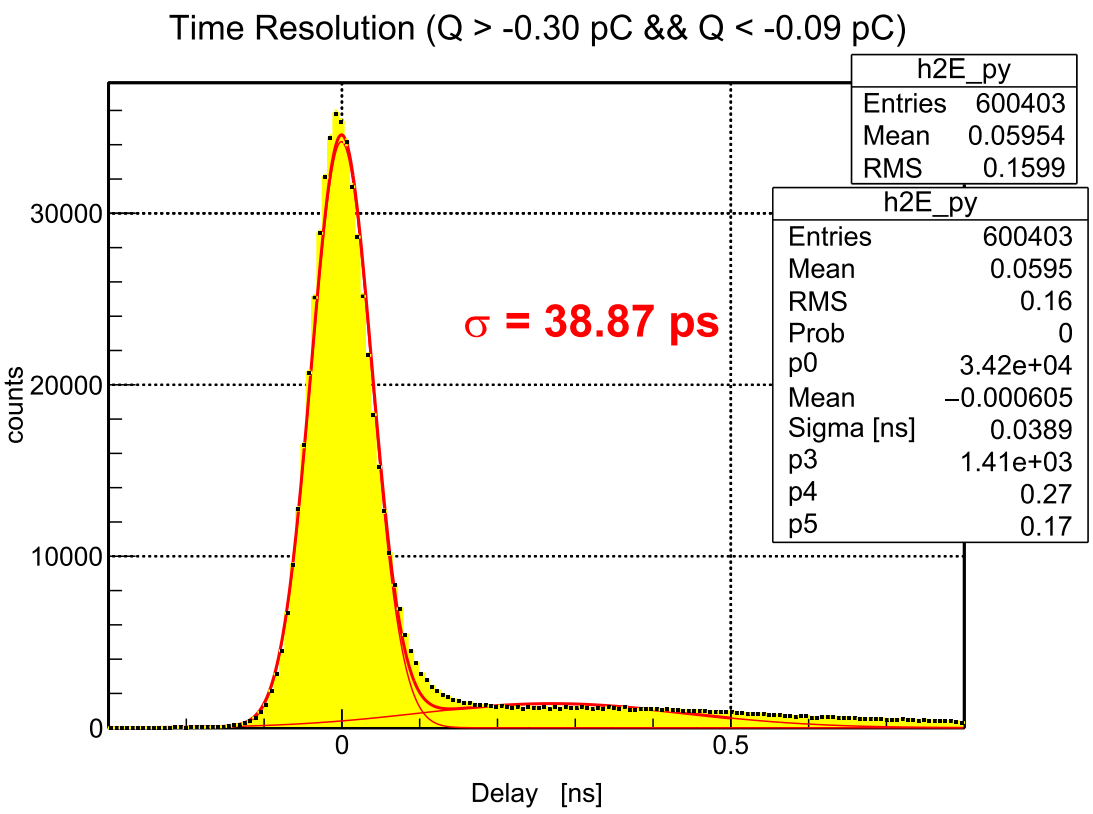
Wavelength dependent QE Photonis 9002085

- Higher QE in area from 250nm to 450nm
- Max QE of 29% at 380nm
- ➢ Very promising



Time resolution Photonis 9002085

- Measured with red laser and Oscilloscope
- 1.6 kV (10^6 Gain)
- 200x Fast amp ORTEC FTA 820 (impedance matched splitter)
- TDC threshold at 50 mV
- Time walk corrected
- Typical sigma for 25 µm
- Tail seems to be caused by sensor, same results with red and blue laser

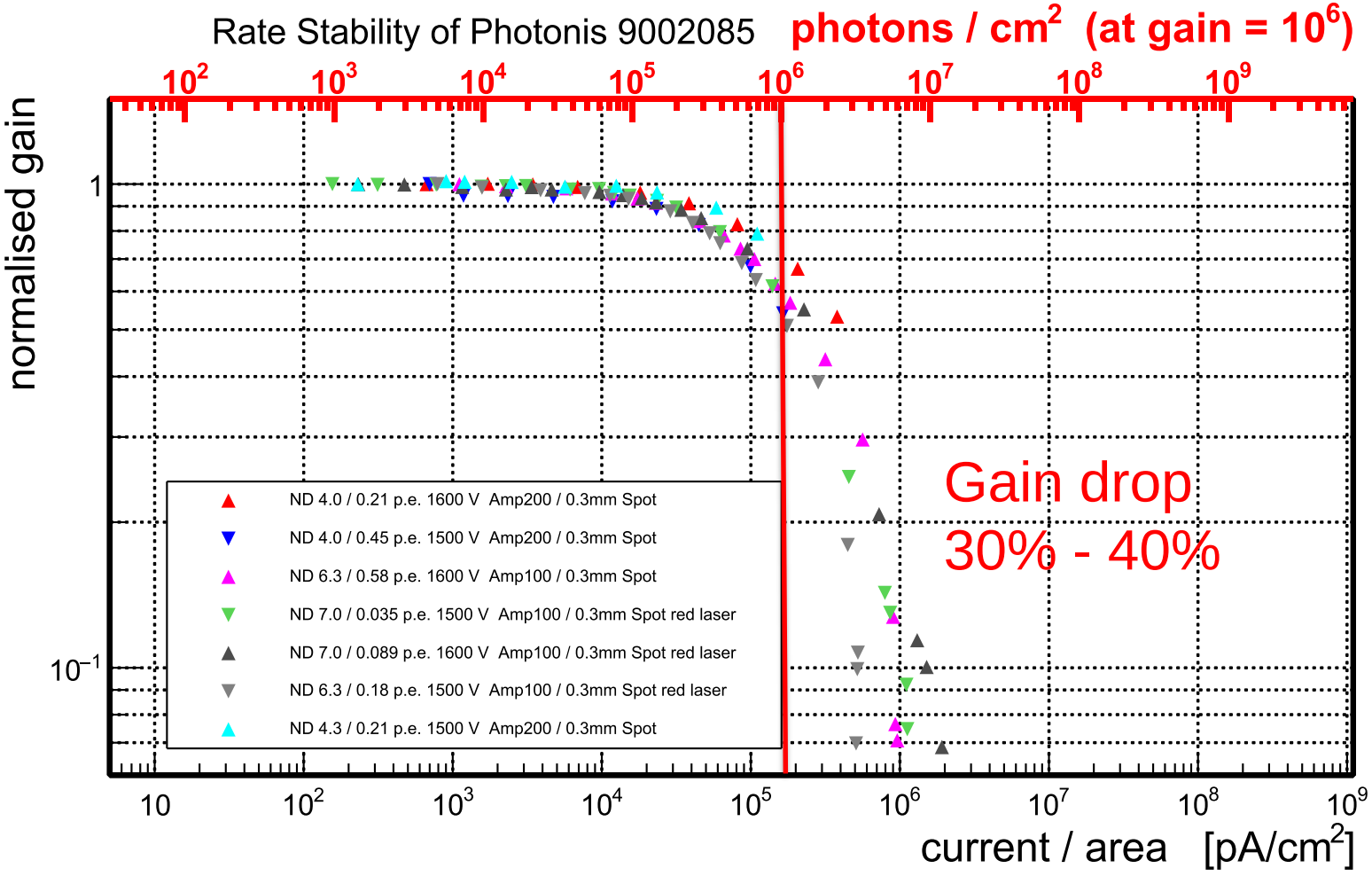


Rate stability Photonis 9002085

- Illuminated with single photons and laser spot of 3mm diameter on Pixel 44
- Amplified with 200x Fast amp ORTEC FTA 820 (impedance matched splitter for TDC)
- TDC threshold set to 20 mV
- Calculate p.e. count by ratio of pedestal and signal counts (Poisson mean)
- Charge calculated by multiplying average charge per event with laser frequency then normed to $1cm^2$ illuminated area
- Measured multiple curves (different filters and supply Voltages) to get different Poisson means

➢ All curves should show the same behavior

Rate stability Photonis 9002085



Photonis 2085 (25µm)

- No ALD coating
- Low supply voltage for 10^6 Gain
  - Photonis sensors in lifetime measurement need at least 2kV
- Low rate stability compared to other Photonis MCP-PMTs
  - Could be different to other Photonis tubes because of missing ALD coating
- Otherwise good performance
- Need to test also high QE tubes with ALD and 10µm pores

Results of latest measurements

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Data from January 23. 2017

Illumination Overview QE (all sensors with ALD)

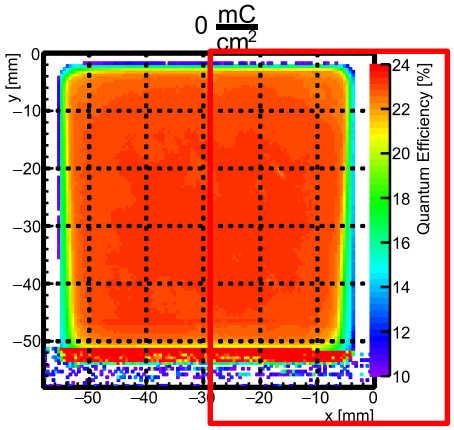
Film between MCP Two ALD layers Film in front of first MCP

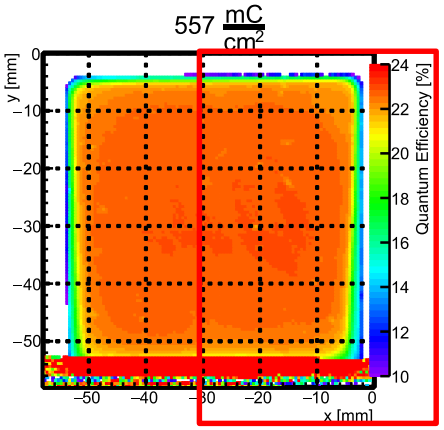
	Manufacturer	Senor ID	Integral Charge [mC/cm2]	QE start [%]	QE latest [%]	QE latest/QE start [%]
2 Inch	Photonis XP85112	9001223	9234	22.1	5.3	24
		9001332	14325	23.0	11.5	50
		9001393	11769	19.1	19.3	101
1 Inch	Hamamatsu R10754X	KT0001 (M16M)	15755	21.7	9.2	42
		KT0002 (M16M)	12502	21.1	10.1	48
2 Inch	Hamamatsu R13266-07-M768 / M64	JS0022 (64 pix.)	2258	17.4	10.9	63
		JS0035 (64 pix.)	997	25.5	25.8	101
		JS0018 (768 pix.)	548	18.0	12.3	68
		JS0027 (768 pix.)	562	24.3	22.9	94

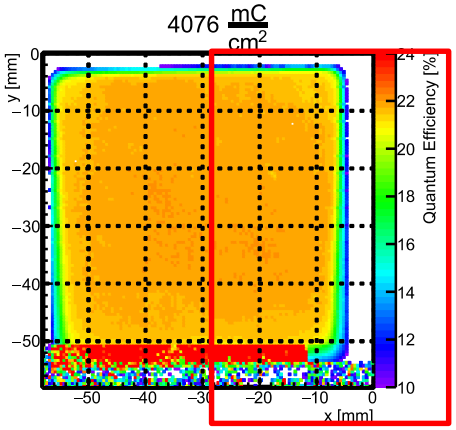
QE scan of Photonis 9001332 (ALD)

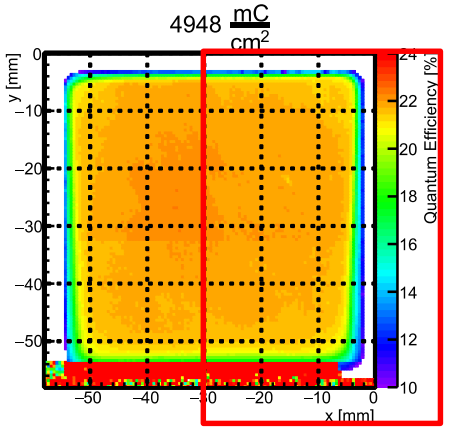
Covered (not illuminated)

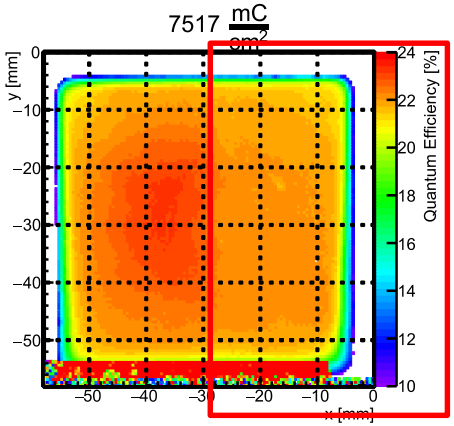
Clear sign of Cathode damage

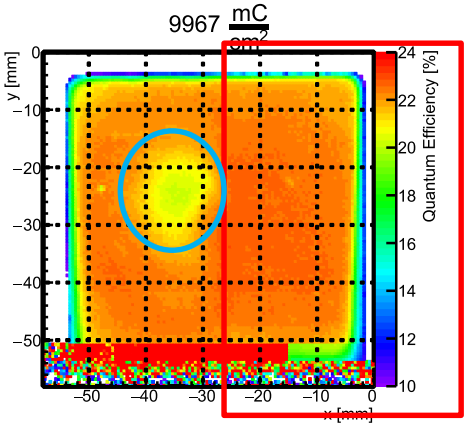


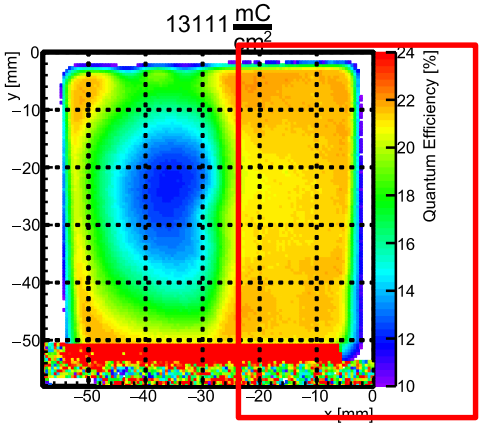


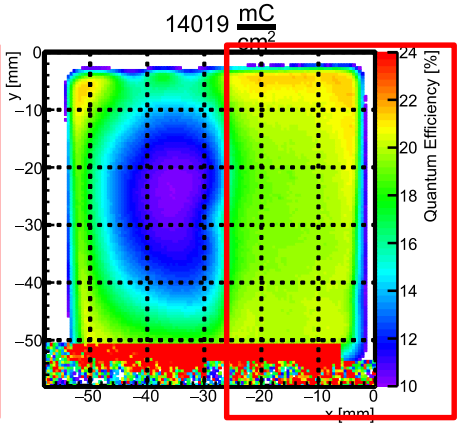






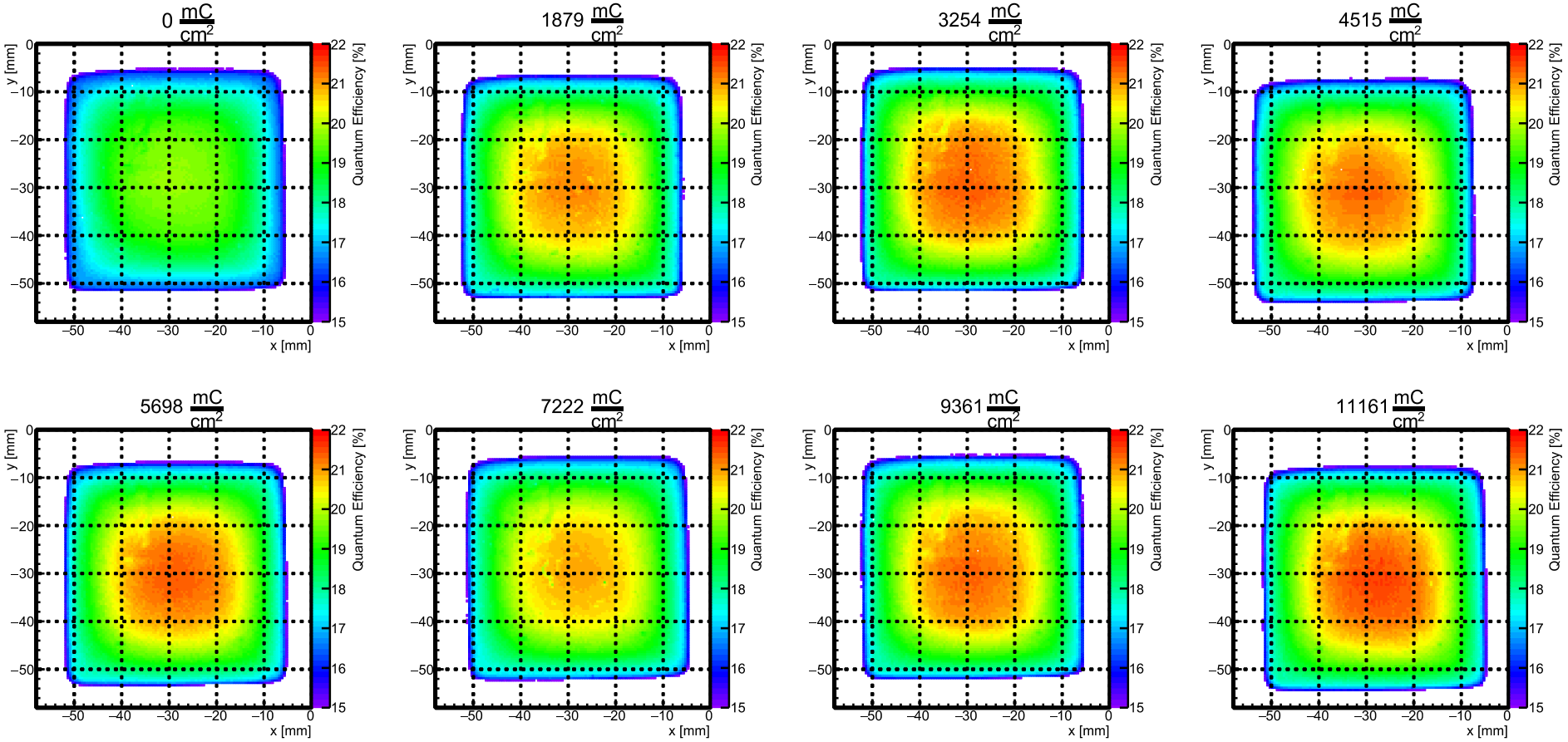






QE scan of Photonis 9001393-URD (ALD)

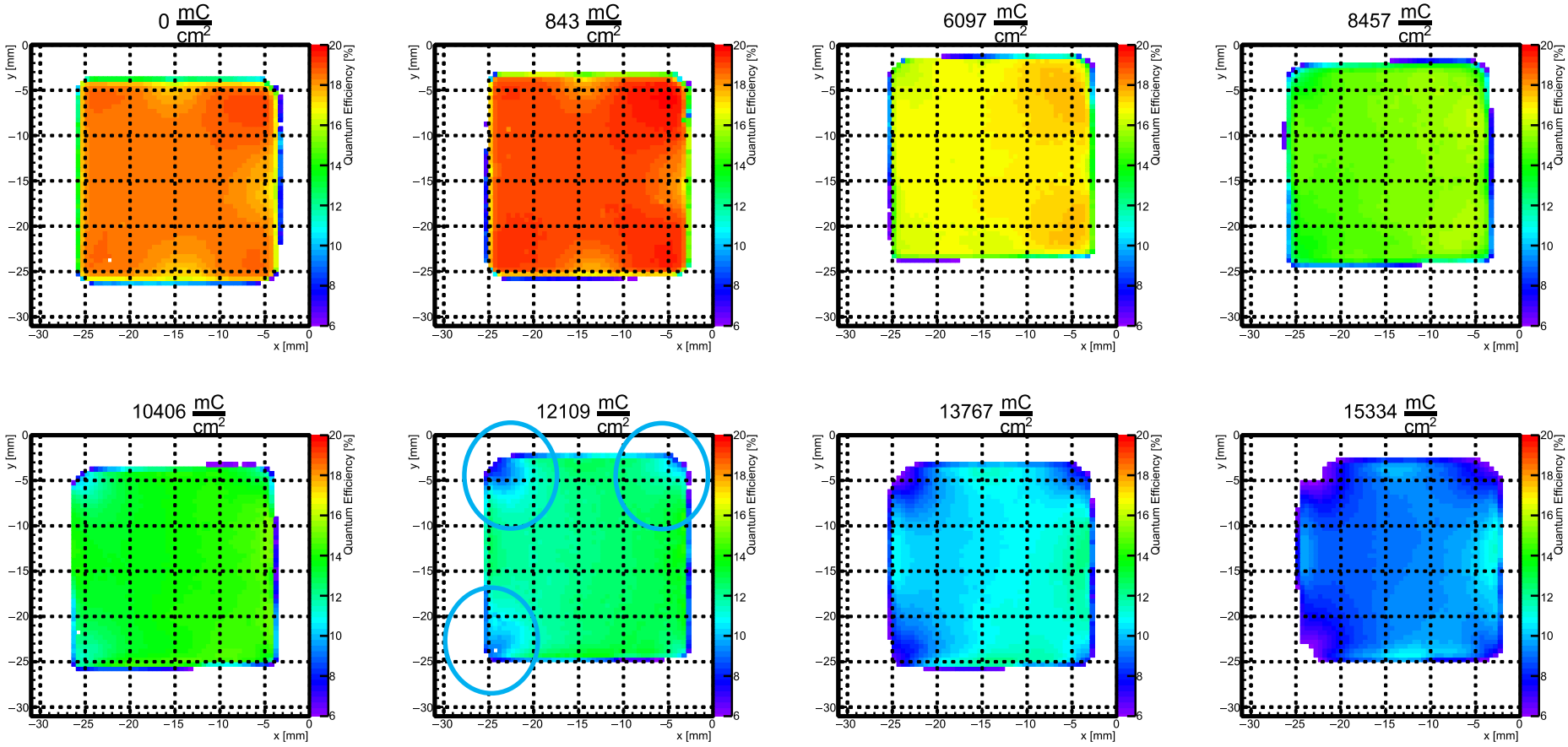
Not covered



QE scan of Hamamatsu KT0001 (ALD)

Not covered

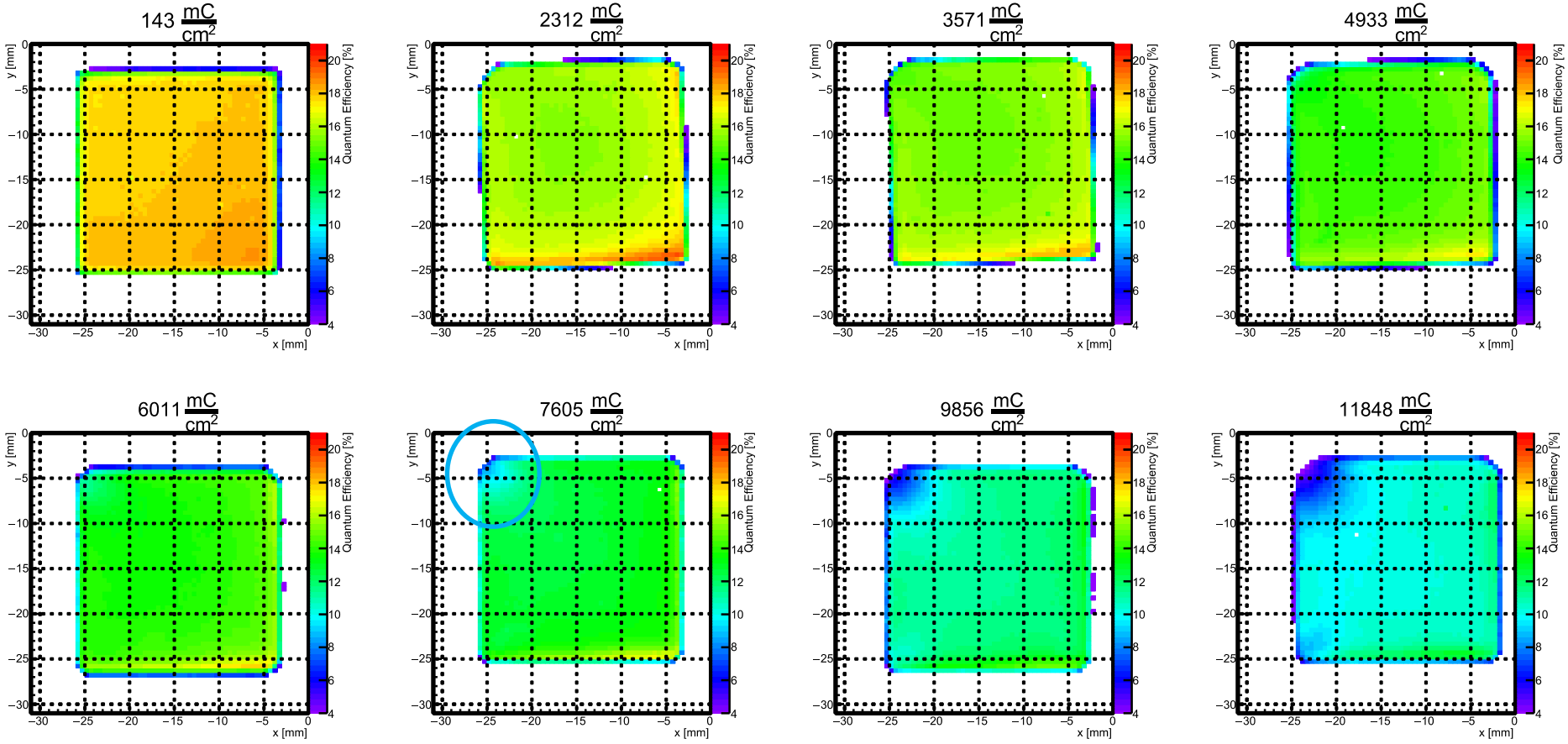
Clear sign of Cathode damage



QE scan of Hamamatsu KT0002 (ALD)

Not covered

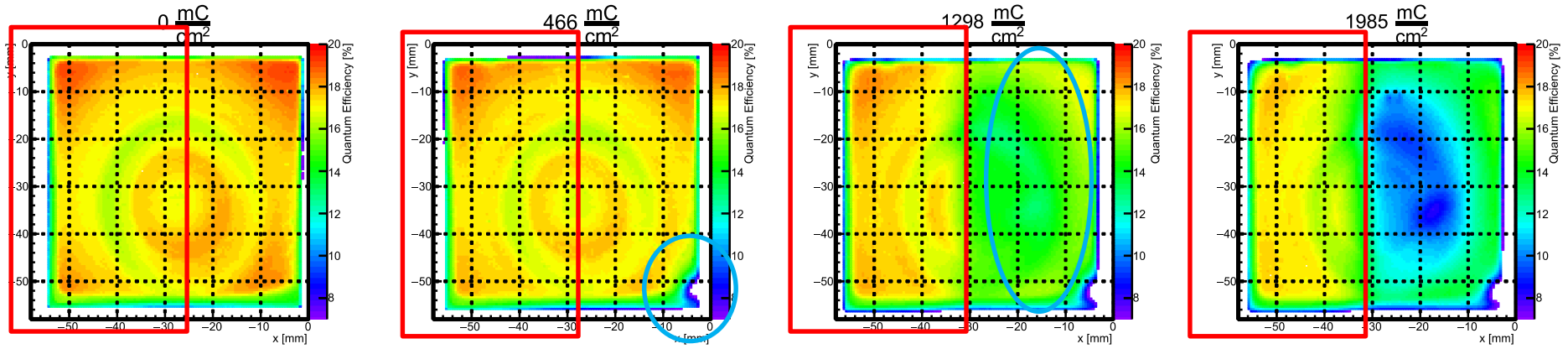
Clear sign of Cathode damage



QE scan of Hamamatsu JS0022 (8x8, ALD)

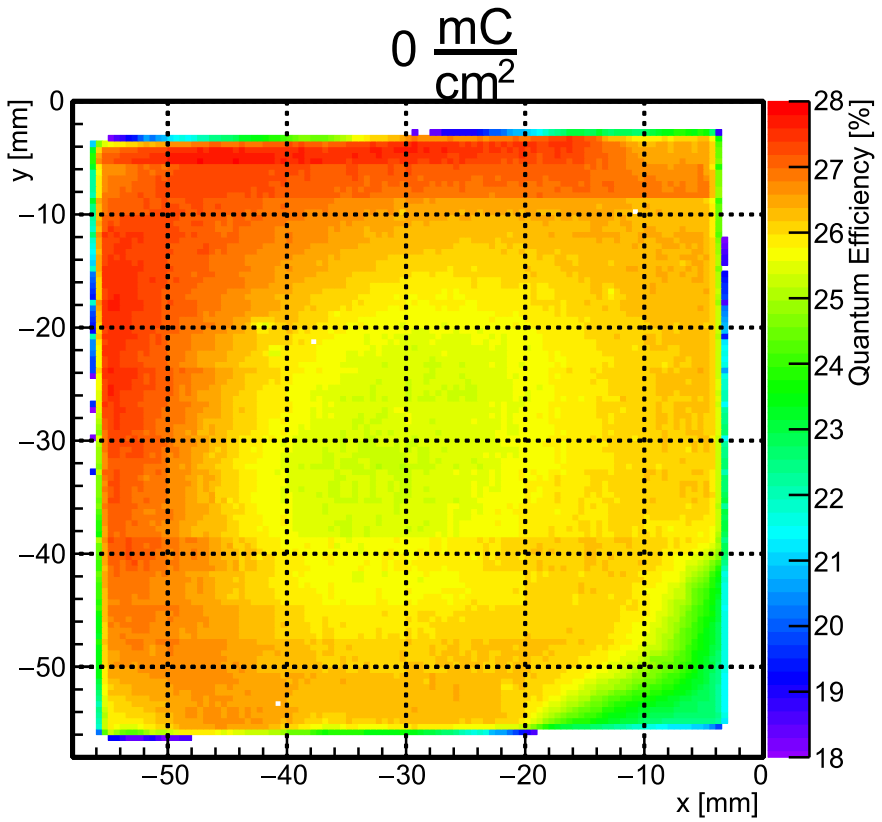
Covered (not illuminated)

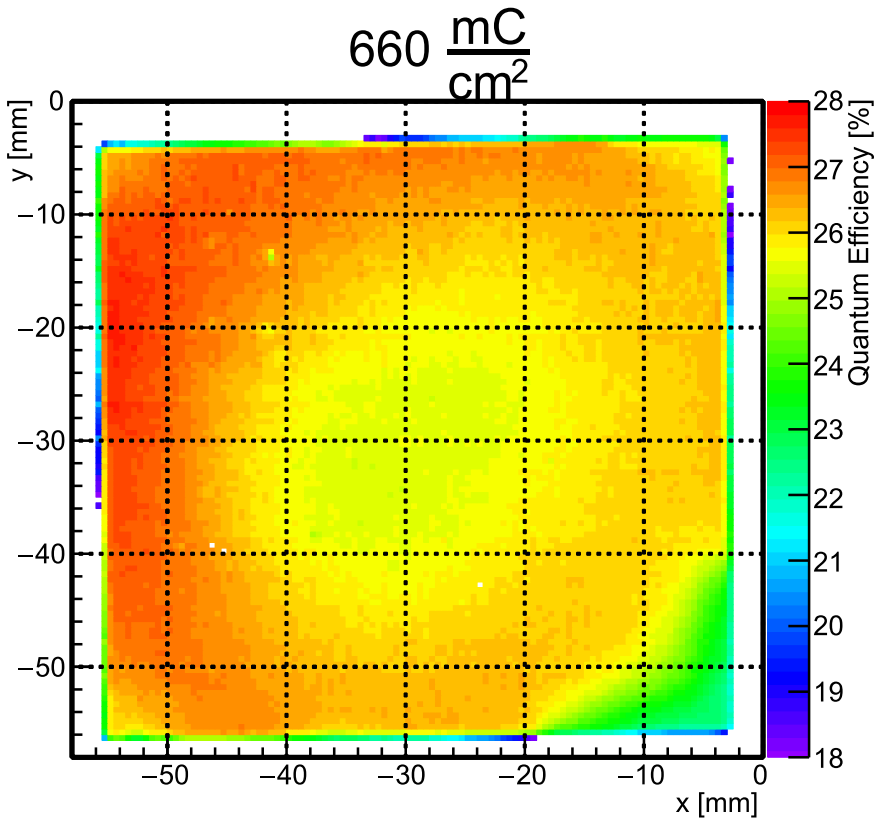
Clear sign of Cathode damage



QE scan of Hamamatsu JS0035 (8x8, ALD)

Not covered

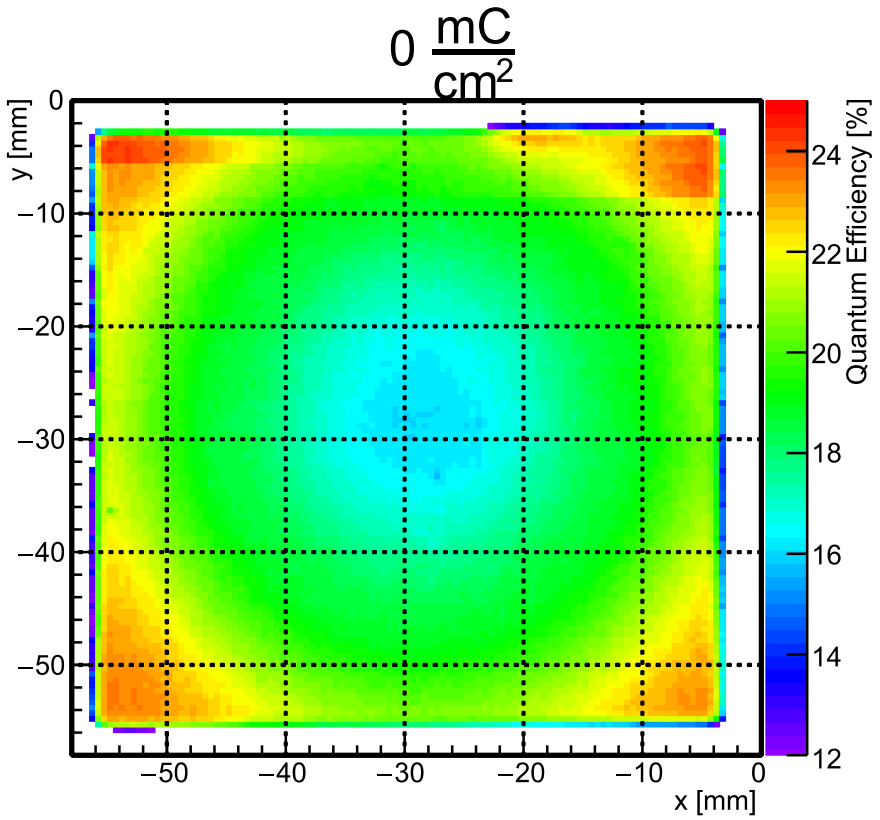


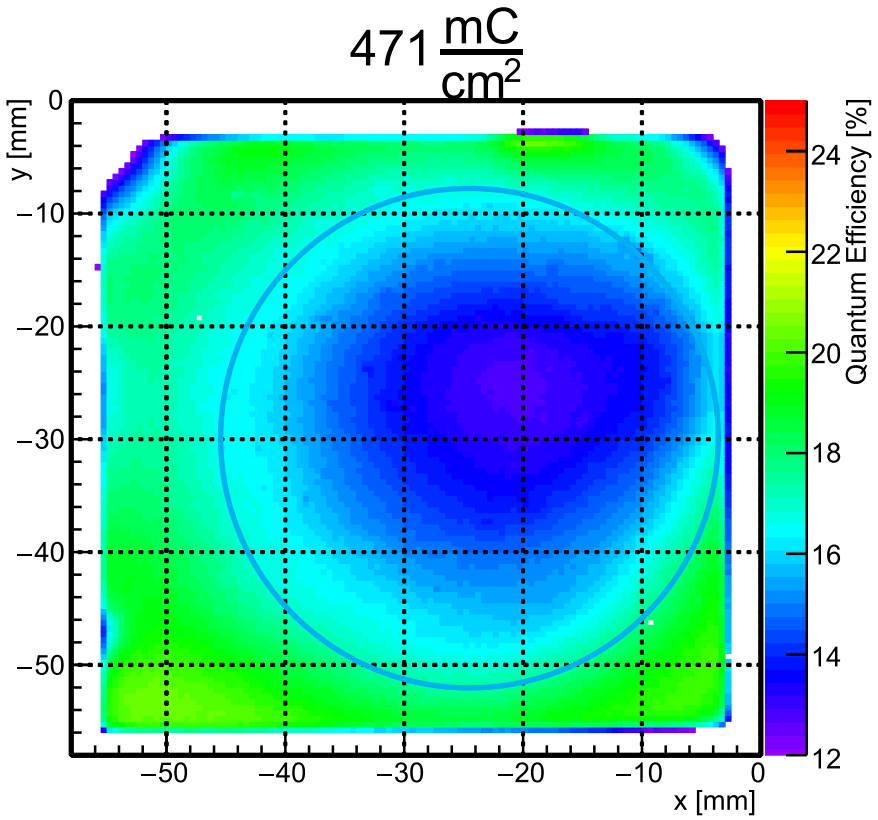


QE scan of Hamamatsu JS0018 (6x128, ALD)

Not covered

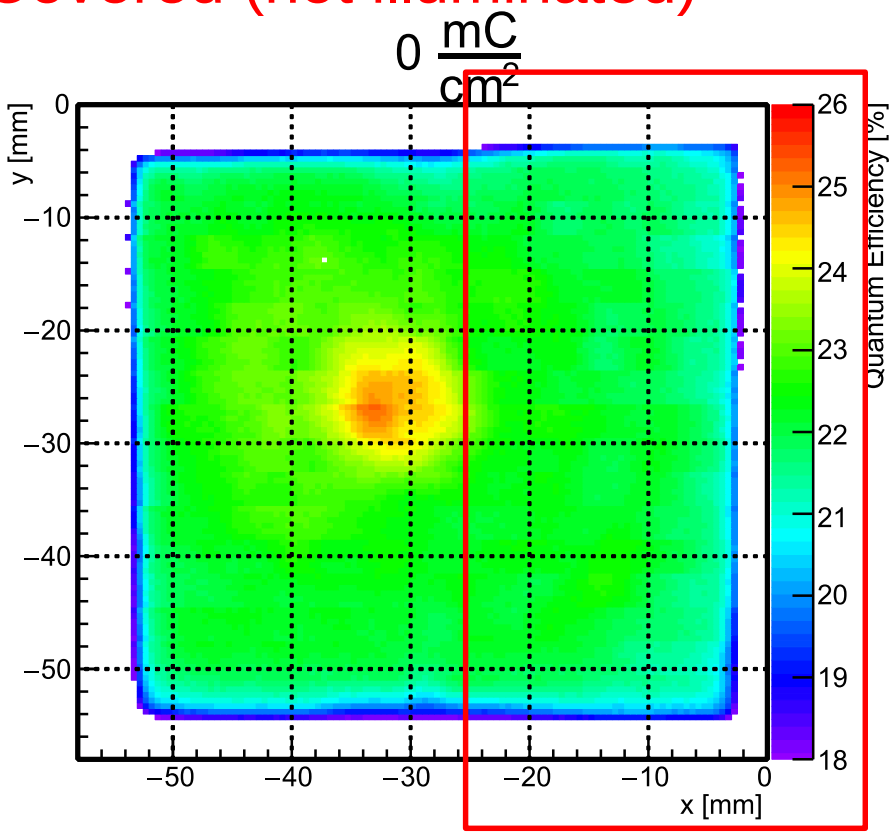
Clear sign of Cathode damage

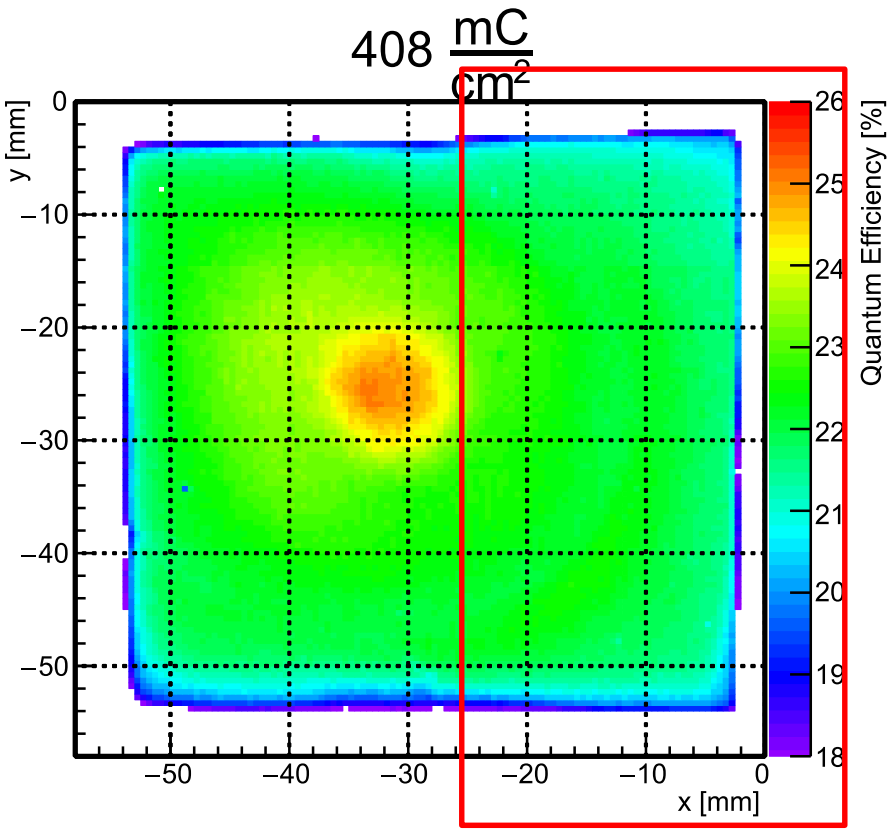




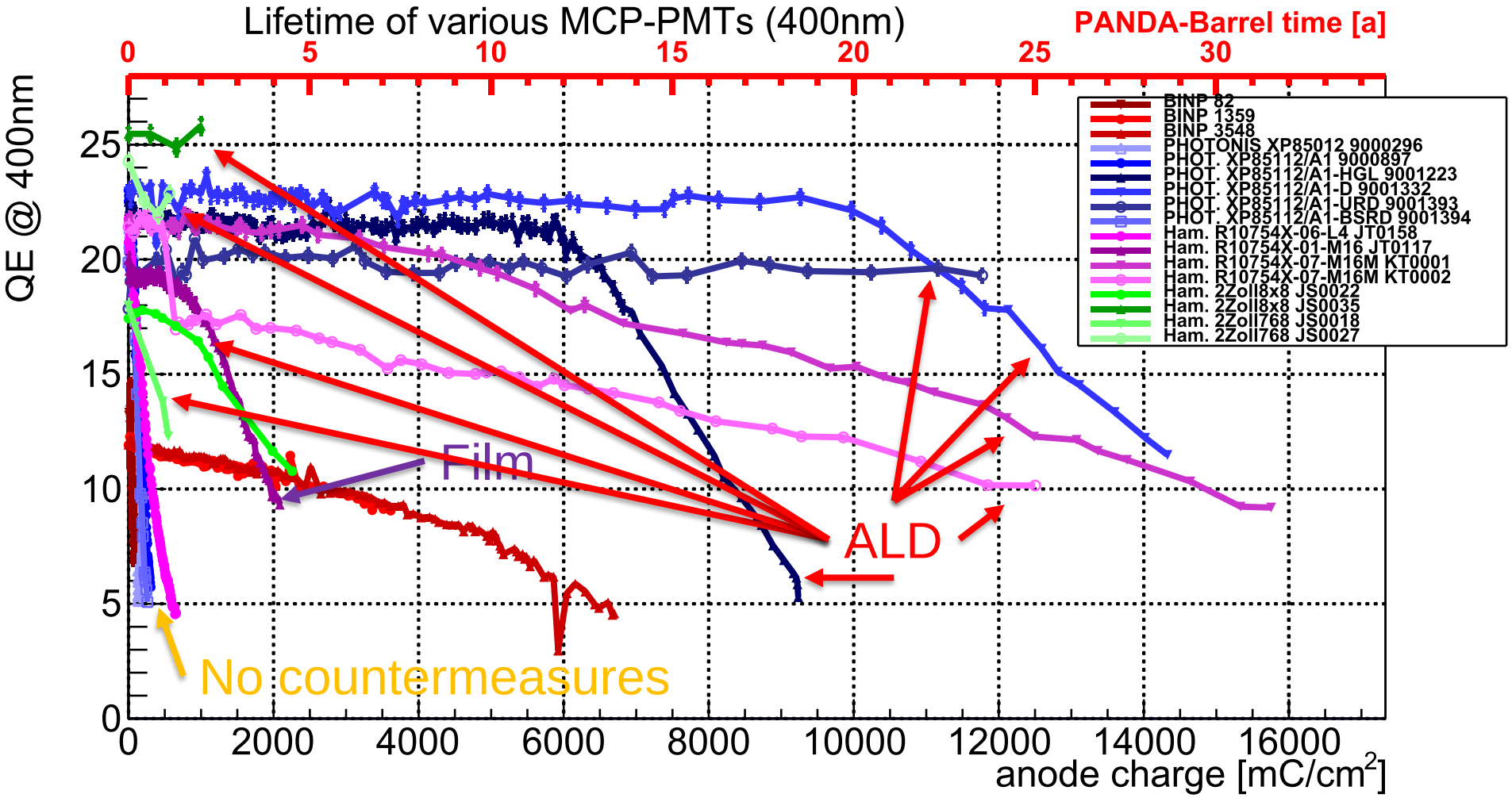
QE scan of Hamamatsu JS0027 (6x128, ALD)

Covered (not illuminated)





Lifetime data of all sensors (January 23. 2017)



Summary and outlook

- Promising results with new Photonis prototype
  - 10^6 Gain at 1600V (relative low supply voltage)
  - High QE in region 250nm to 450nm
  - Rather uniform QE and gain distribution over sensor surface
  - Good time resolution (for 25µm pores)

- Trend of better performance with newer Hamamatsu 2 inch sensors
  - Better homogeneity of photo cathode surface (QE)
  - No PC damage seen yet (JS0027 and JS0035)

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Thank you for your attention!

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