ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Update on lifetime measurements and latest MCP-TOF results

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

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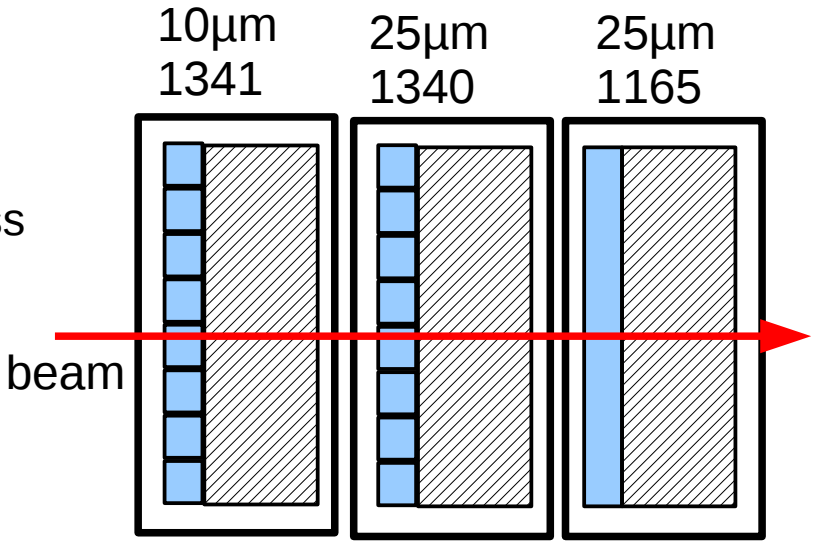
supported by

Bundesministerium für Bildung und Forschung

Overview

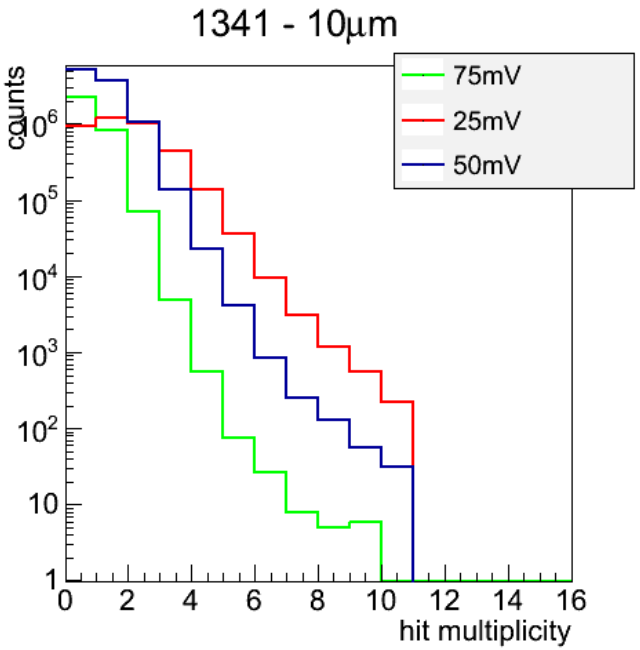
- New setup of MCP-TOF for GSI test beam in July/August
  - Hit pattern and hit multiplicity
  - Time resolution
- Results of the latest lifetime measurements
- Comparison with previous measurements
- Summary and outlook

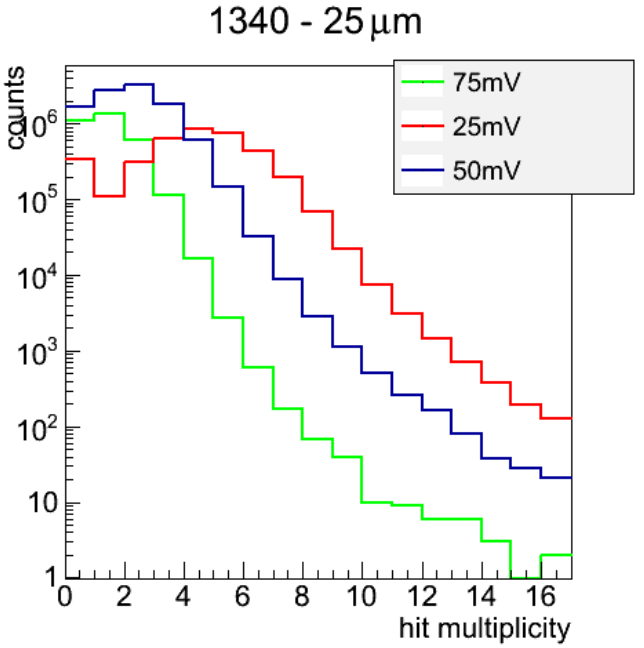
New Setup of MCP-TOF



- Situation:
  - One sensor (1337 - 25µm) destroyed (broken glass window)
  - Last measurements without shielded cables
- New setup (tested April 28 – May 1):
  - Shielded cables ~30cm for all channels
  - 3 MCP-PMTs:
    - 1x 10µm XP85112/A1 with 8x8 segmented PMMA radiator (1341)
    - 1x 25µm XP85012/A1-D with 8x8 seg. PMMA radiator (1340)
    - 1x 25µm XP85012 with unsegmented PMMA radiator (1165)
  - Sensors placed as close as possible to each other
  - Channels: 128 + 3 (MCP-Out), time + time over threshold
  - DAQ: TRBv3 (4 boards) with 9 PADIWAs
  - Beam: Pions with 2,7GeV/c, ~2h/day
- A lot problems with DAQ (new firmware, board communication, ...)
- no working hld-Converter → limited, but promissing data for next beam time

Results – Hit Multiplicity



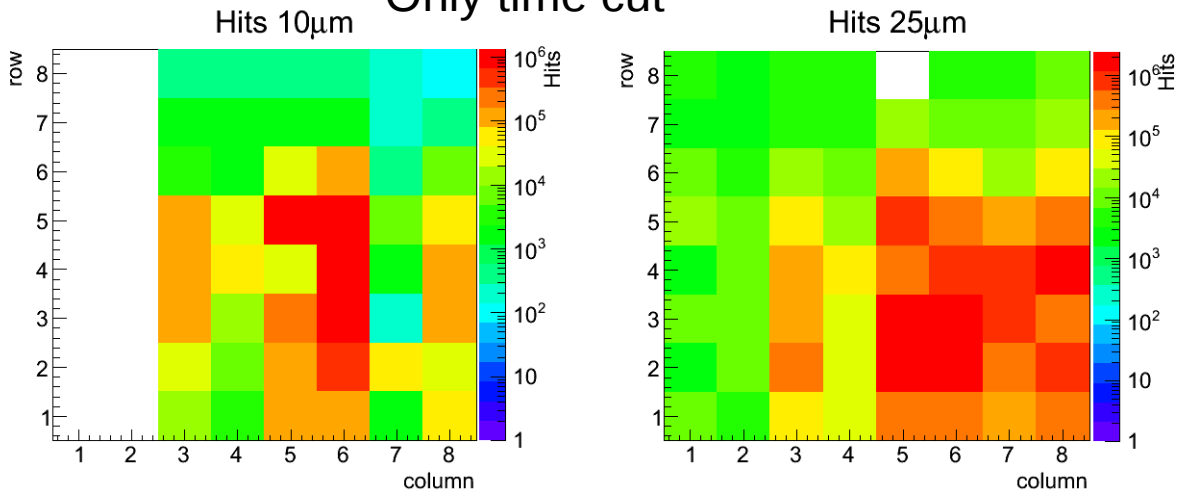


- High hit multiplicity → Very high amount of crosstalk
- Not enough time to find correct thresholds

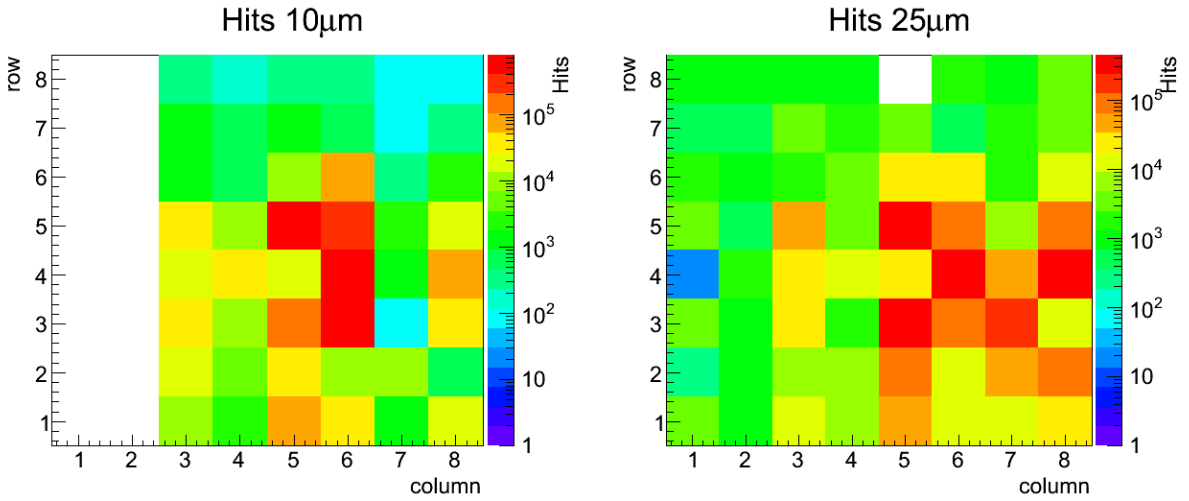
	10µm 25mV	10µm 75mV	25µm 25mV	25µm 75mV
Crosstalk probability	57,8%	**8.4%**	**97,5%**	35,6%

Results – 2D Hits

Only time cut

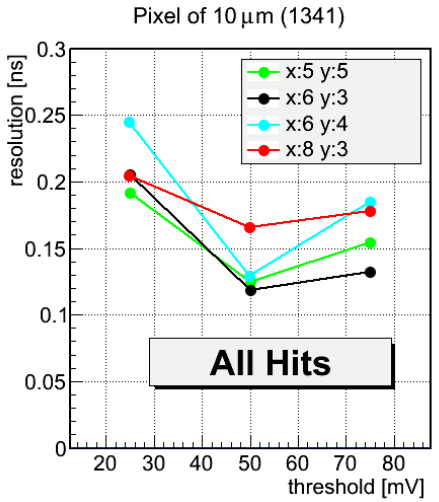


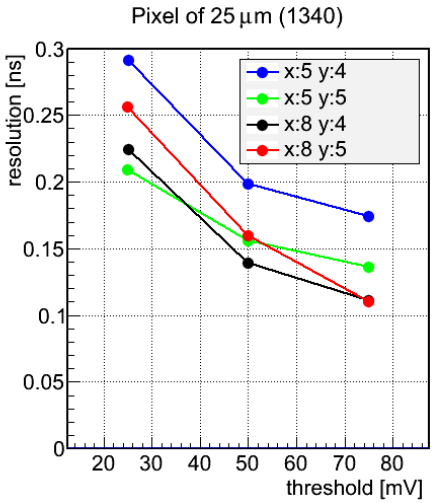
time cut and Hit Multiplicity = 1

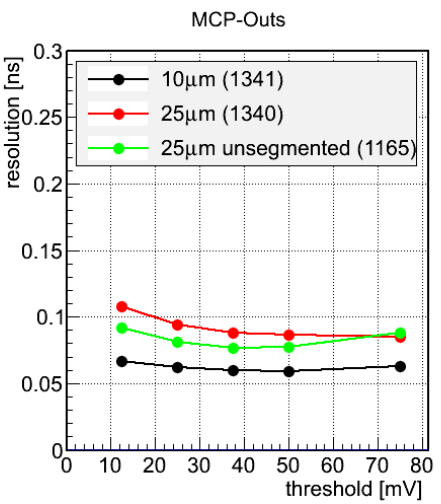


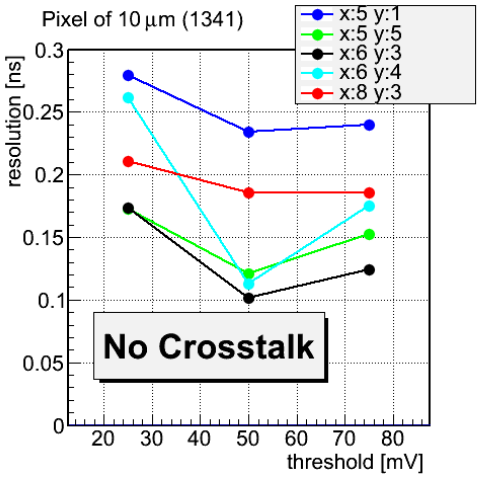
- Threshold: 50mV
- Crosstalk of 25µm clearly visible
- Straggling of Pions in 10µm?

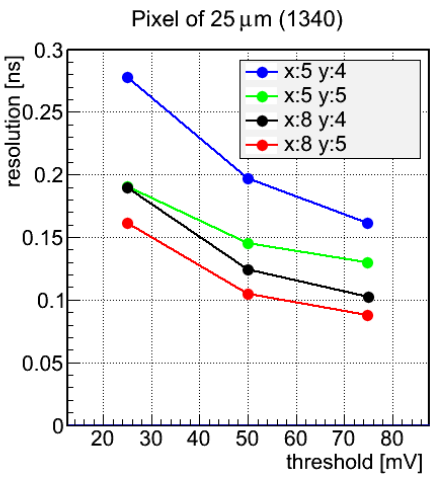
Results – Time resolution

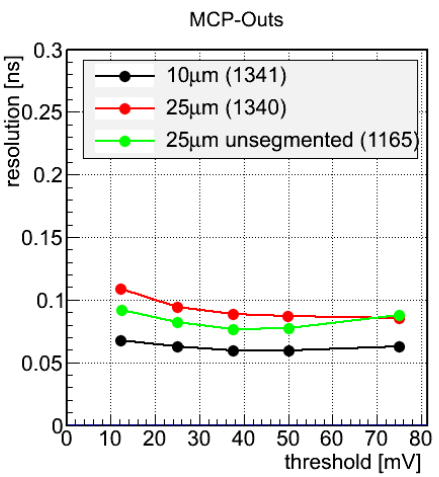






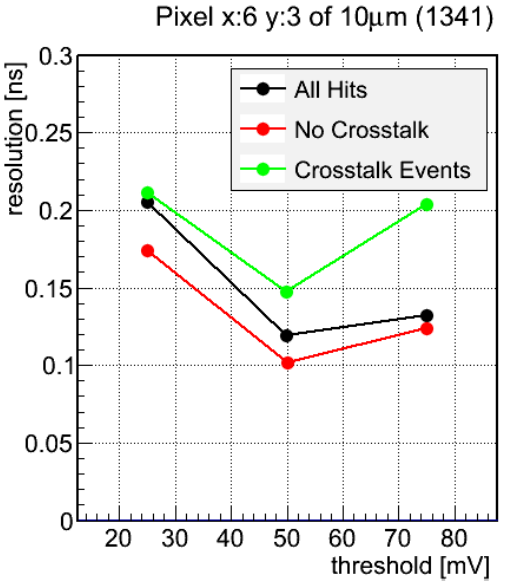


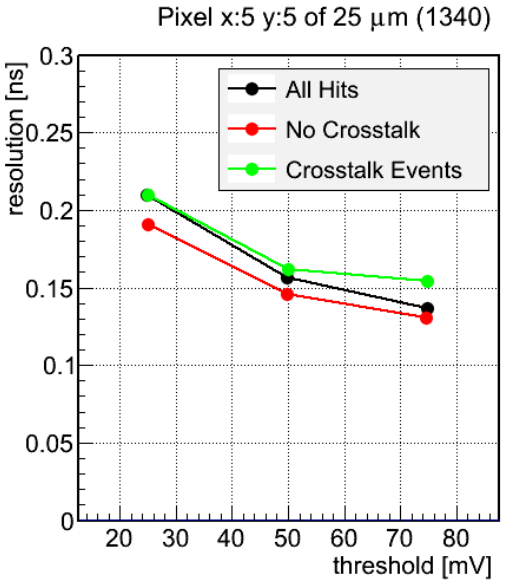


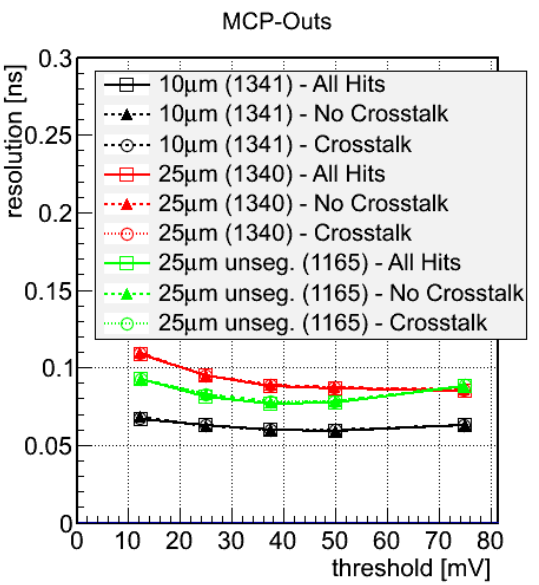


- Time resolution of 10µm better than 25µm (60ps/~83ps, MCP-Out)
- Single pixel resolution still worse than MCP-Out signal
- Threshold not optimal for pixel of 25µm

Results – Time resolution (2)

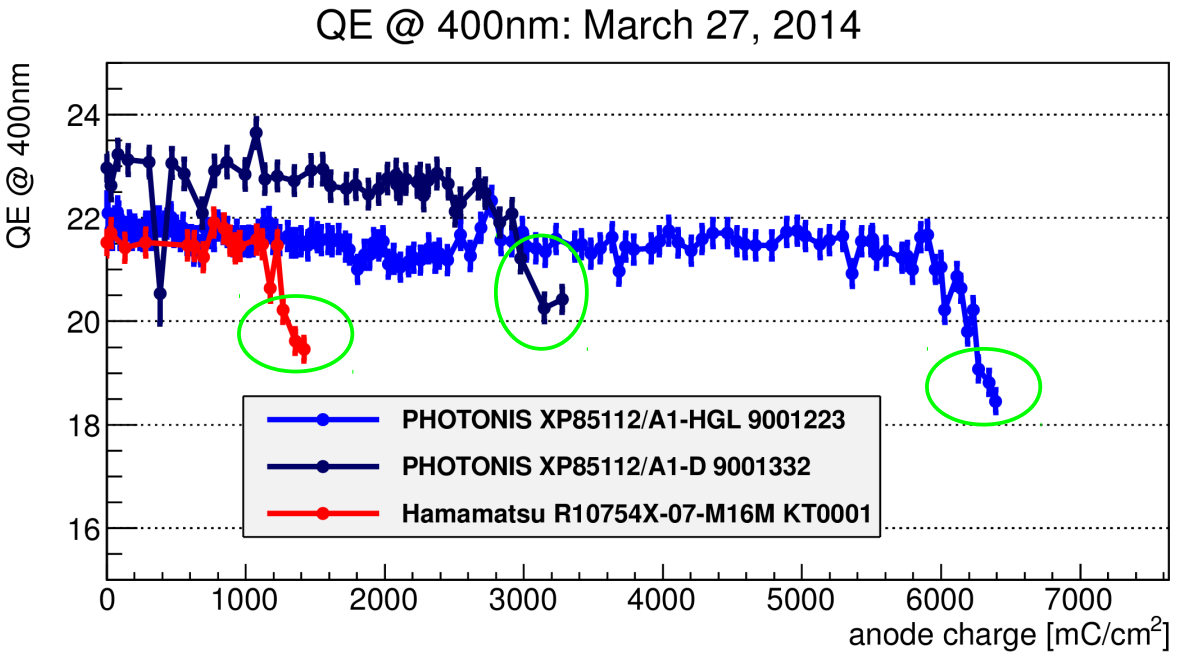






- Time resolution of pixels is worsen by crosstalk/charge sharing, more severe for 10µm device
- More thresholds needed, espec. for 25µm
- Time resolution of MCP-Out independend of crosstalk
  → expected since MCP-Out signal measured at 2nd MCP
- Time resolution of MCP-Out still better than of any pixel

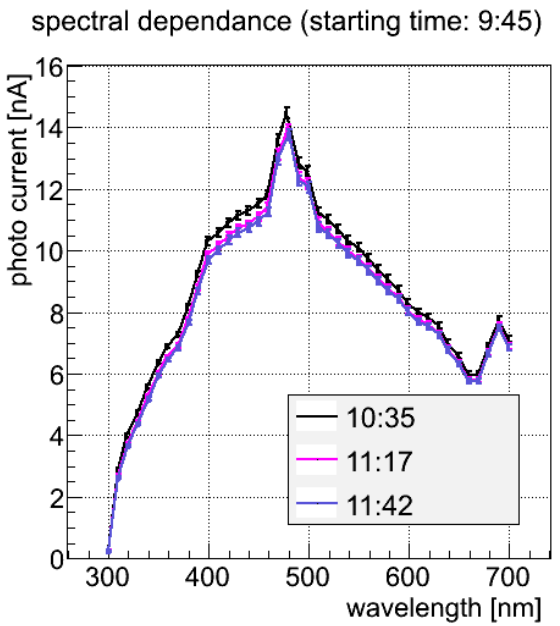
Problem with QE measurement

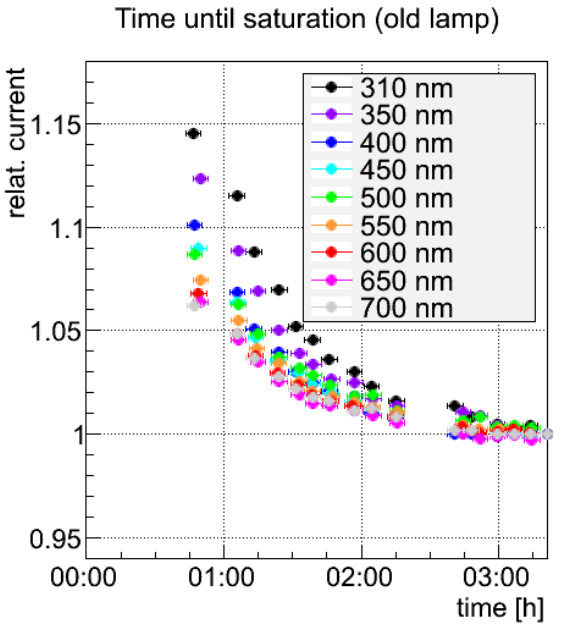


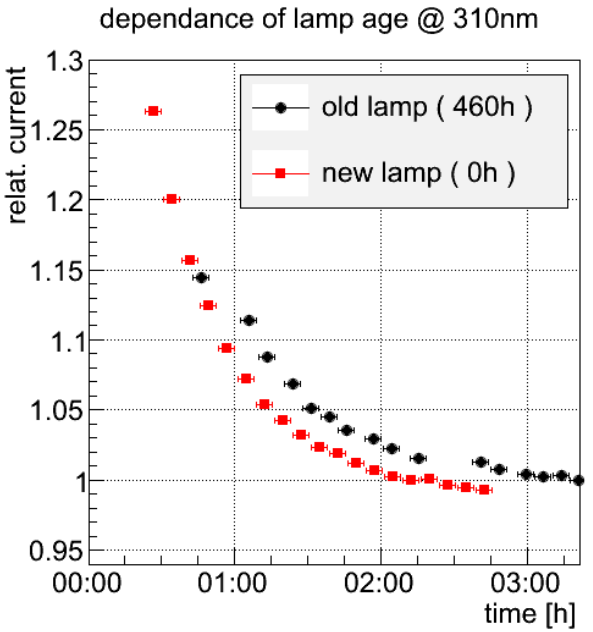
- All sensor dropped at the same time
- Ratio of QEs of different sensors stayed almost constant
- Higher wavelengths unaffected

  → systematic error with lamp or reference diode!

Aging of Xe-lamp

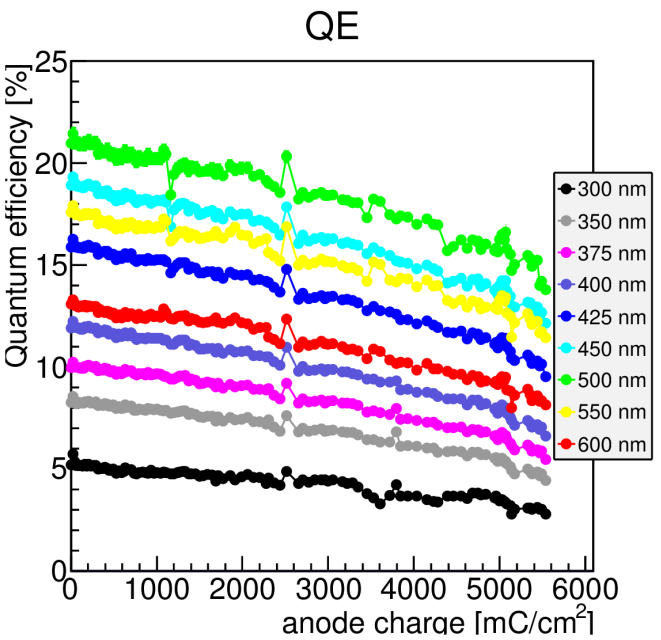


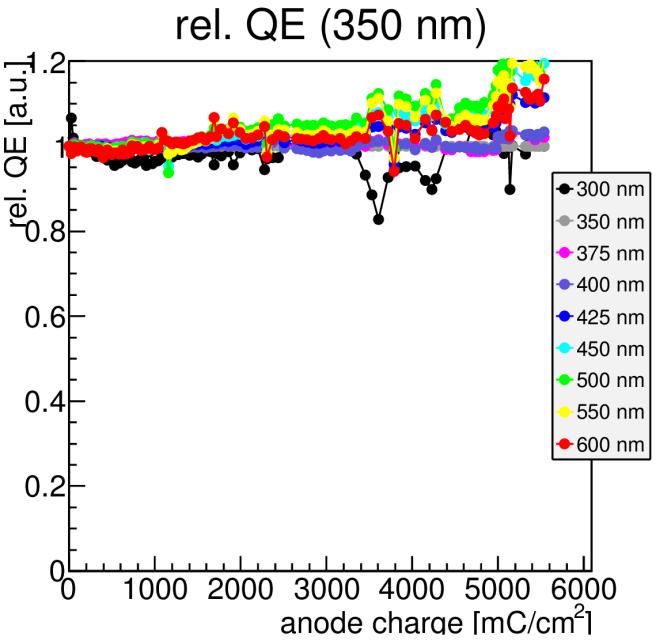


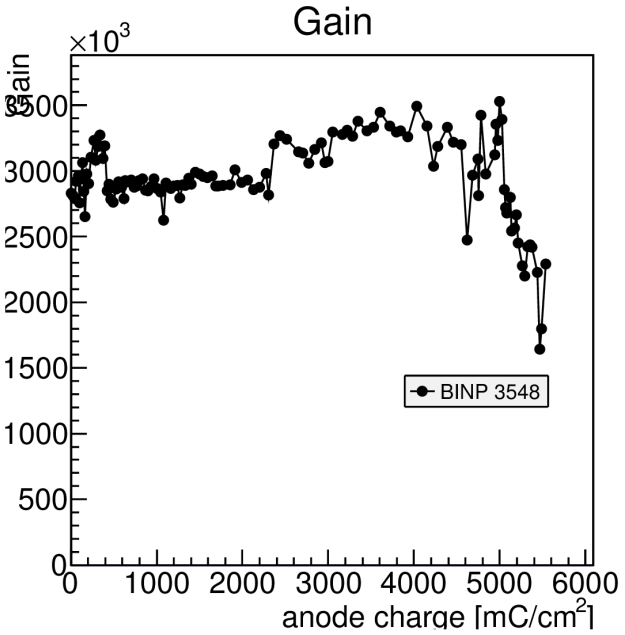


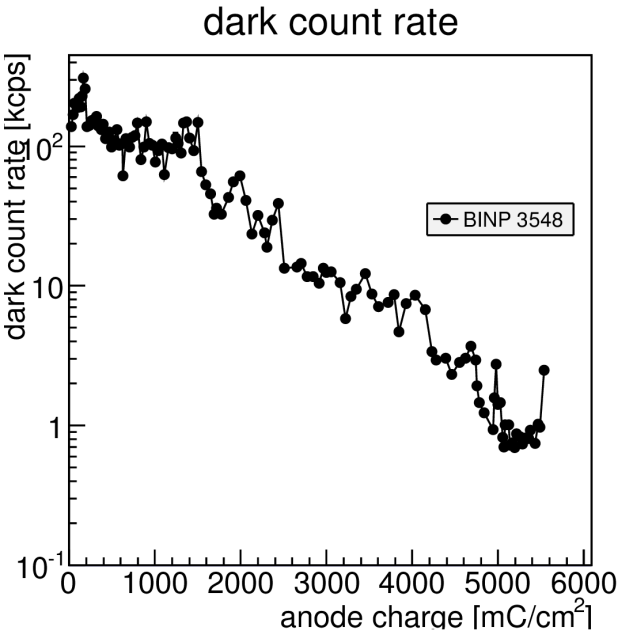
- Saturation of lamp flux is time dependend
- Lamp should be changed after 400 – 500 h (may explode!)
- Older lamp needs more time to stabilize

BINP 3548

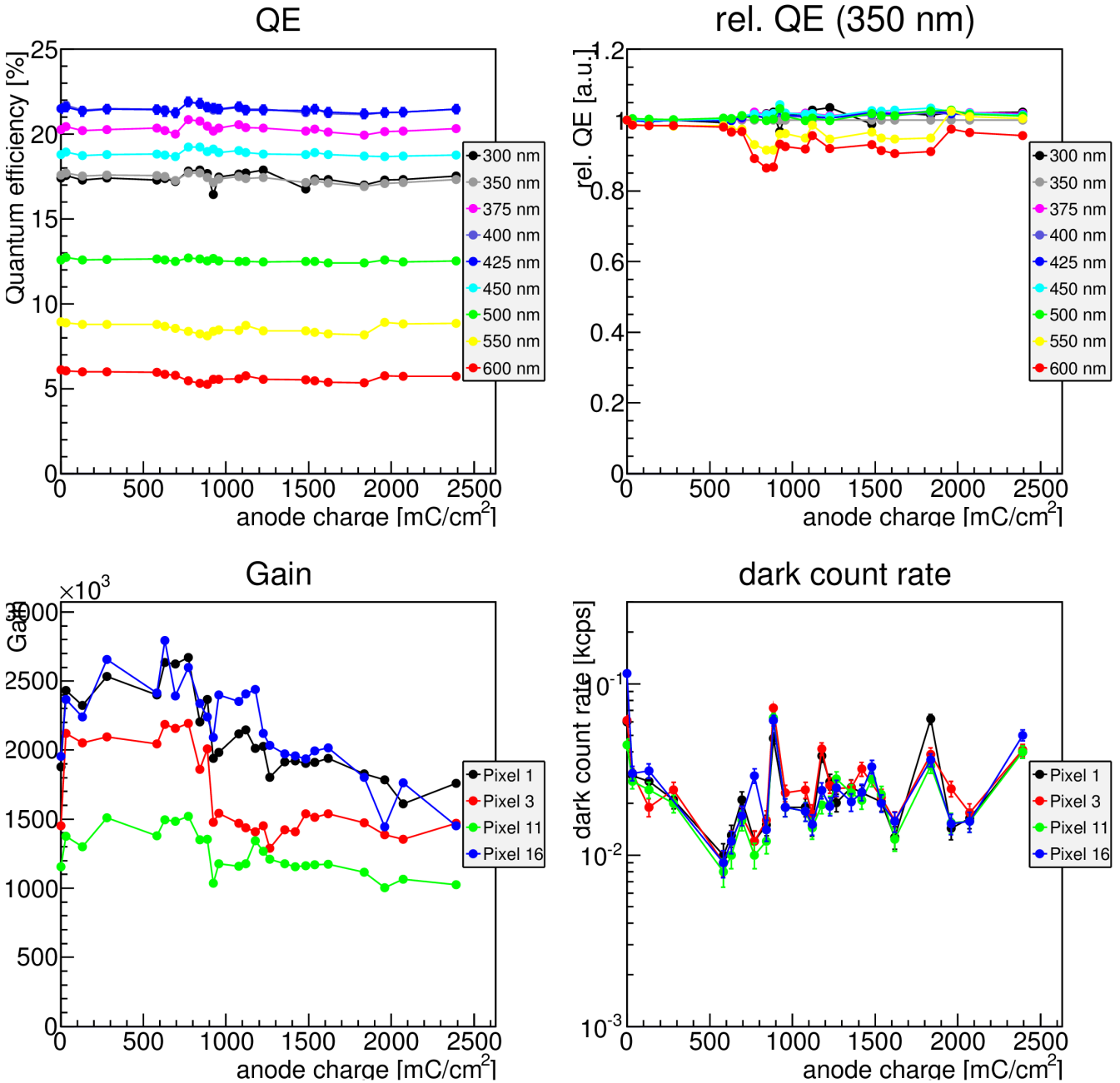

QE
Quantum efficiency [%]
anode charge [mC/cm^2]
300 nm
350 nm
375 nm
400 nm
425 nm
450 nm
500 nm
550 nm
600 nm


rel. QE (350 nm)
rel. QE [a.u.]
anode charge [mC/cm^2]
300 nm
350 nm
375 nm
400 nm
425 nm
450 nm
500 nm
550 nm
600 nm

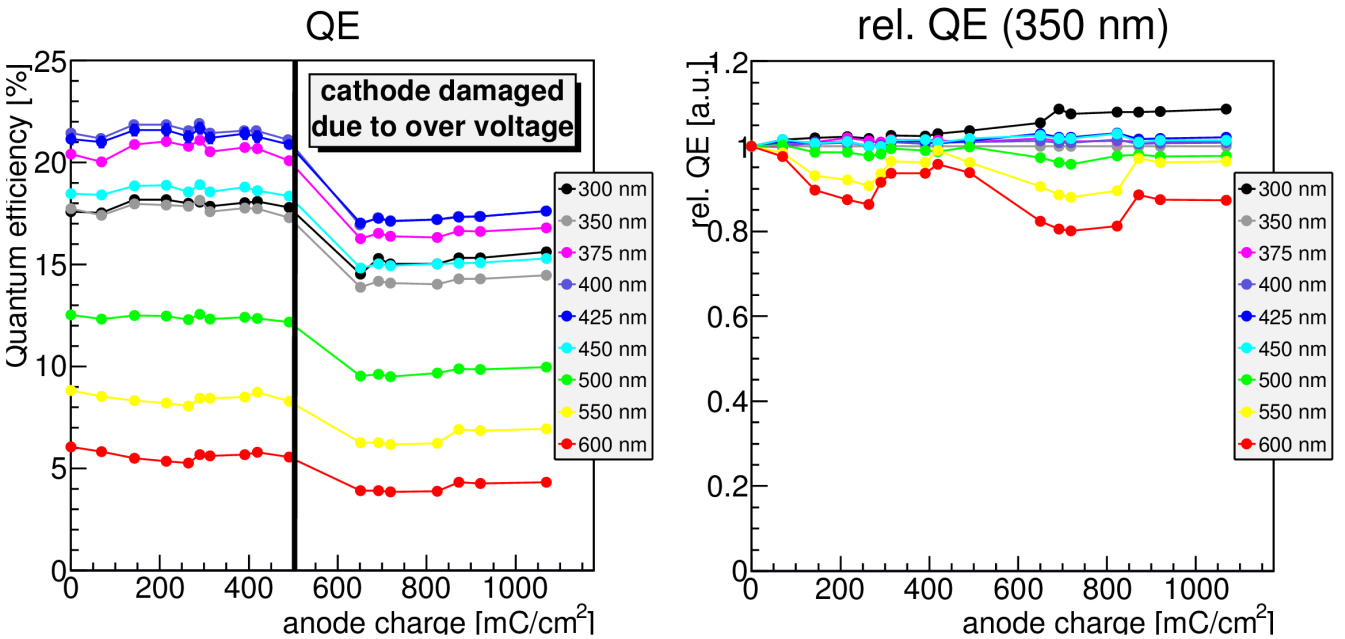

Gain
×10^3
Gain
anode charge [mC/cm^2]
BINP 3548

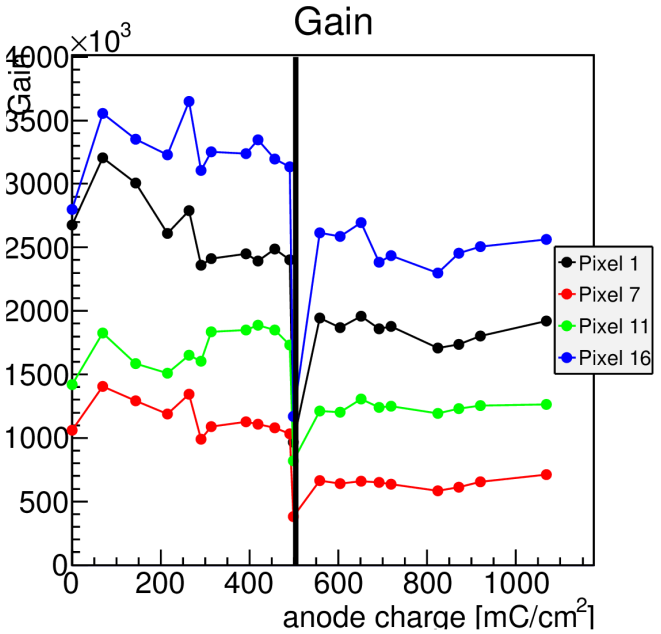

dark count rate
dark count rate [kcps]
anode charge [mC/cm^2]
BINP 3548

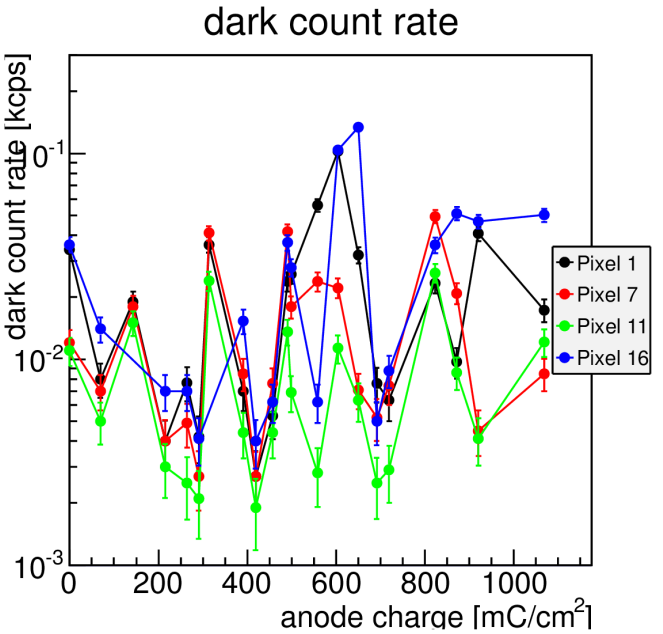
Ham. R10754X-07-M16M KT0001



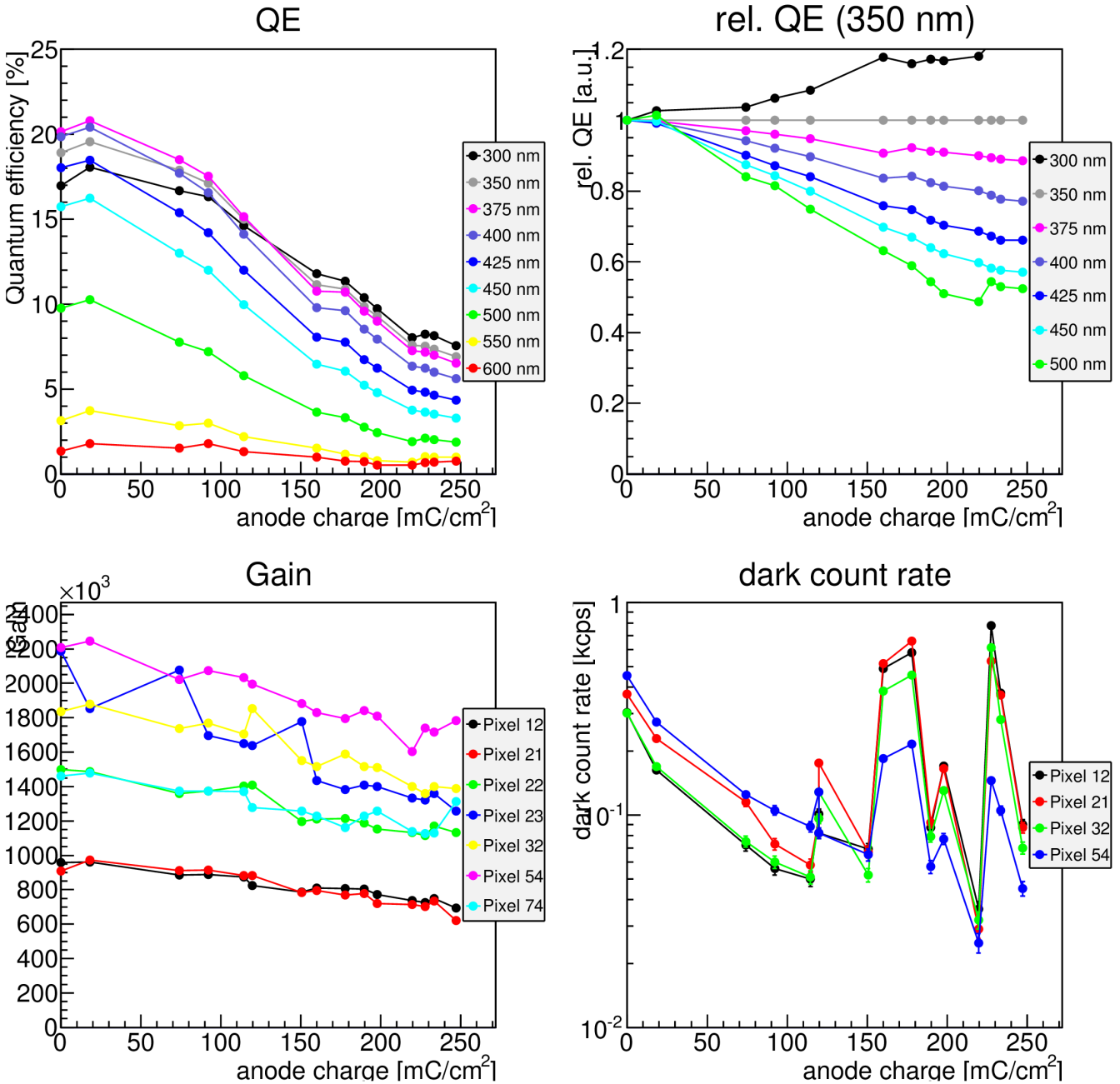
Ham. R10754X-07-M16M KT0002



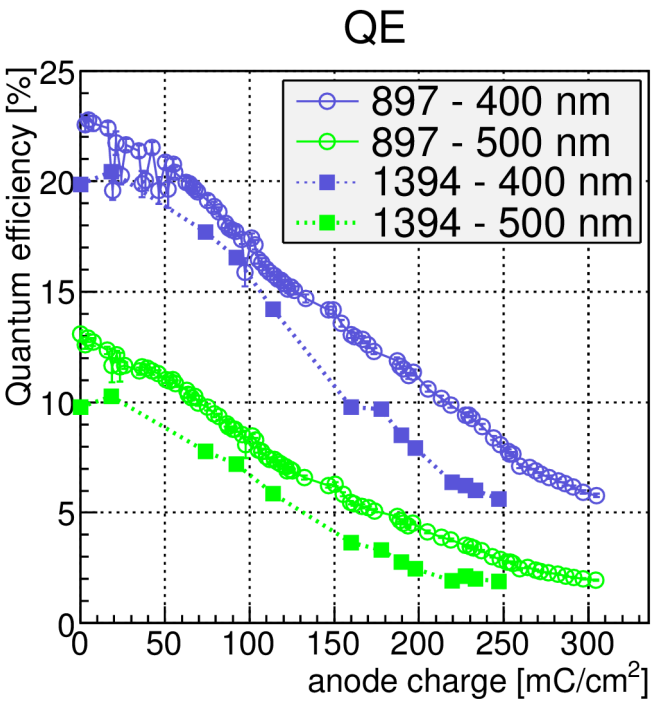


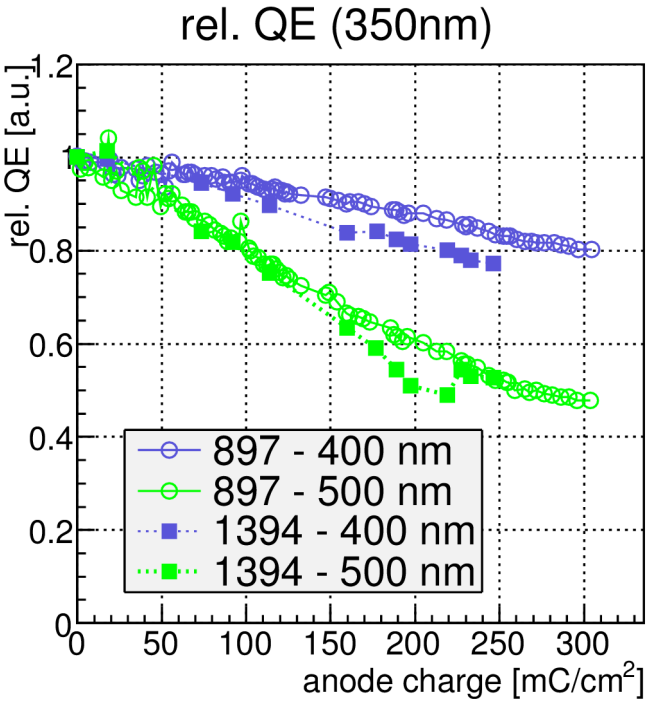


PHOT. XP85112/A1-(BSRD) - 1394



Stability of lifetime measurements





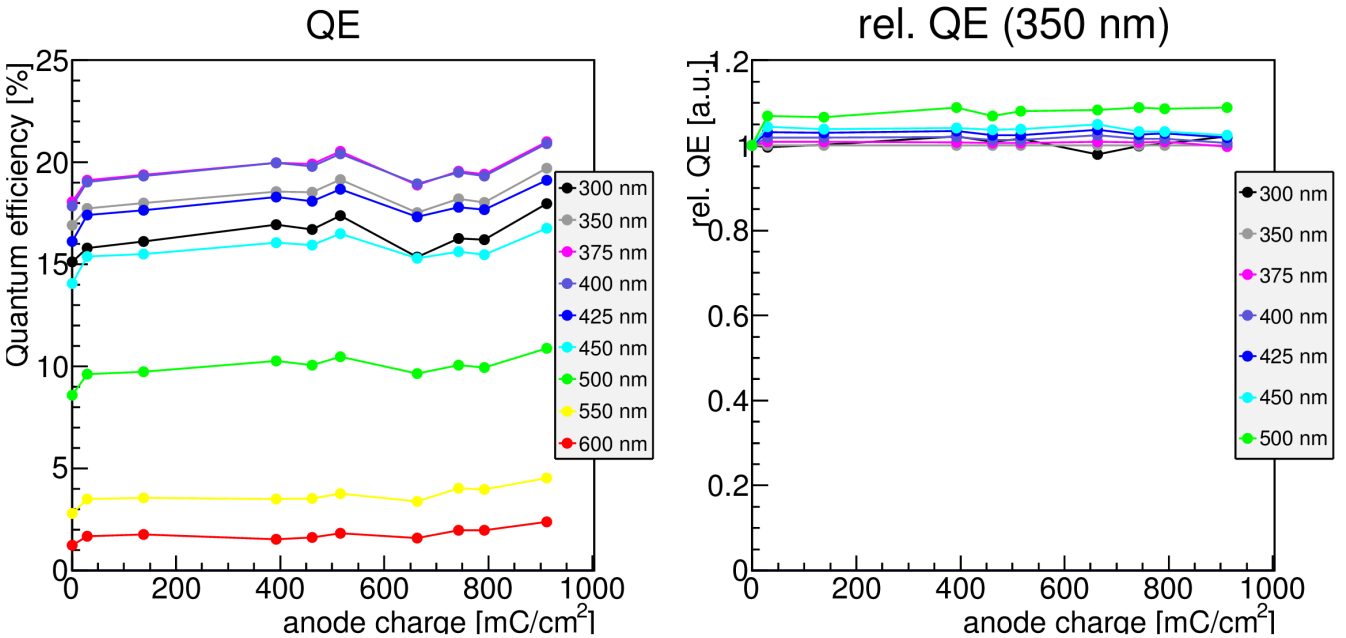
Both sensors should be identical, i.e. 10µm, without ALD:

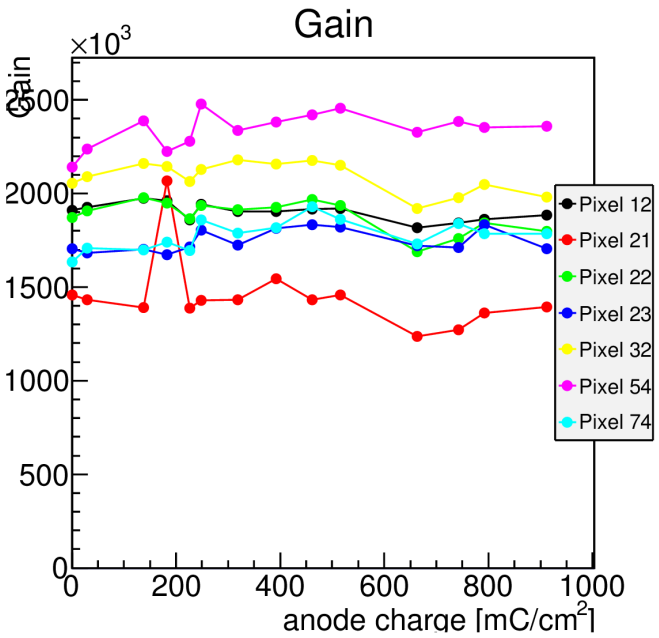
Rel. QE drops similiar, despite different pulse and photon rates:

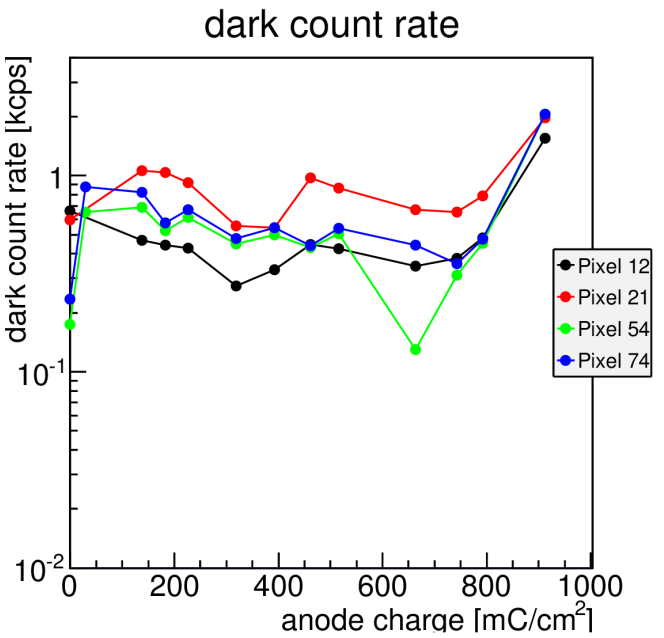
- 897: 250 – 650 kHz: 1.5 – 5 mC/cm²/d
- 1394: 1MHz: up to 6.4mC/cm²/d

→ Lifetime measurements seems to be stable and reliable!

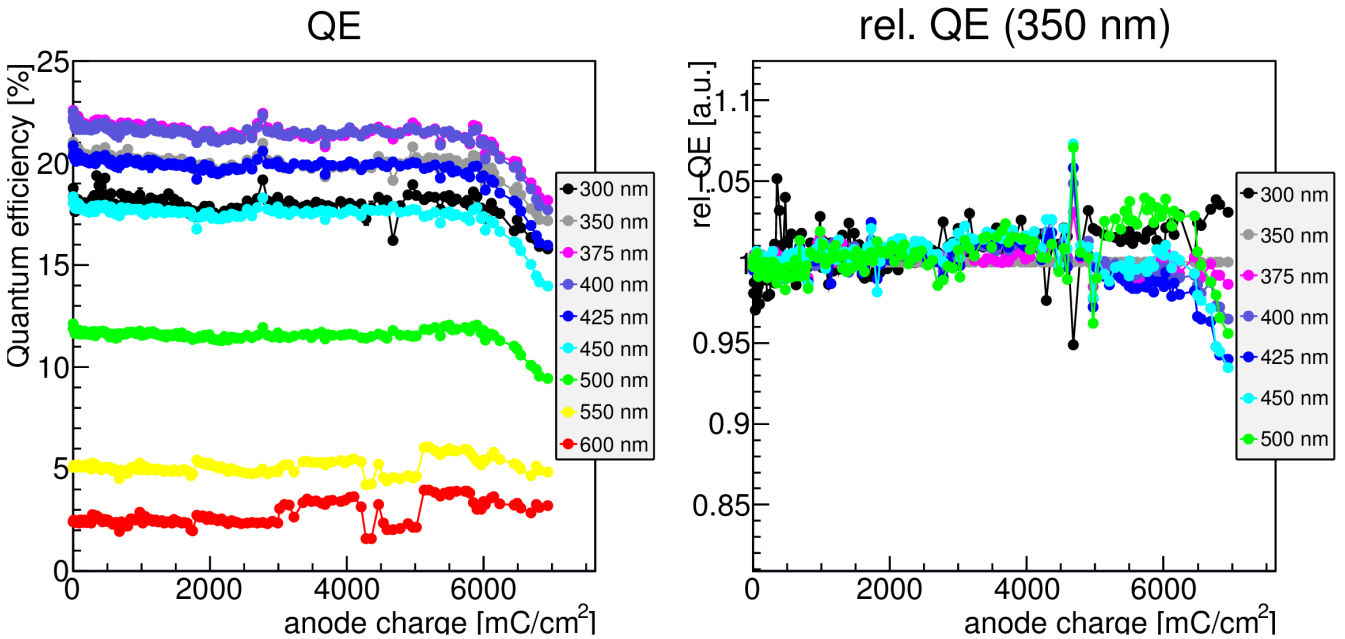
PHOT. XP85112/A1-URD - 1393

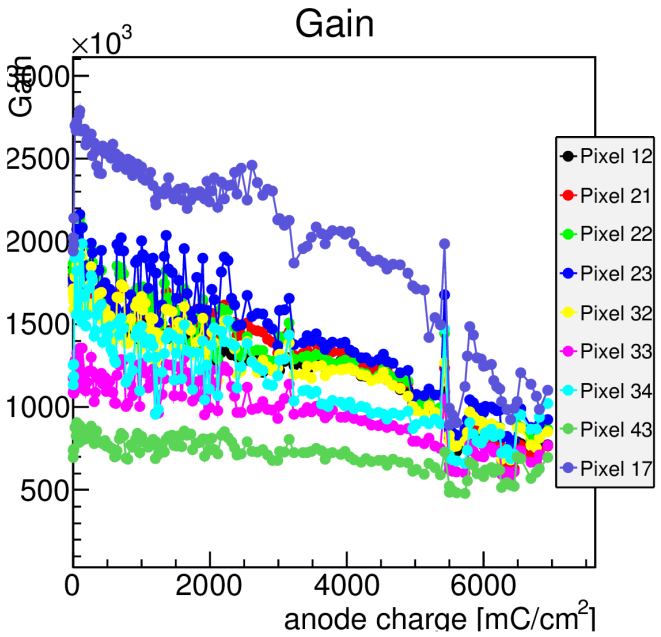


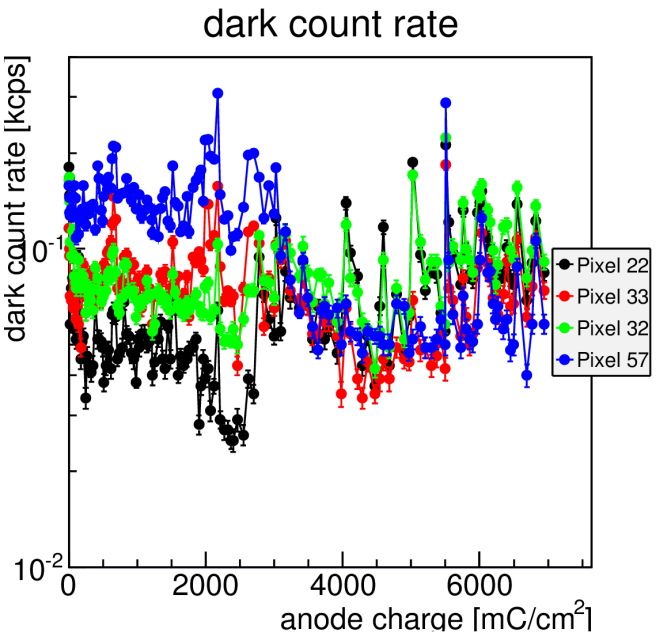




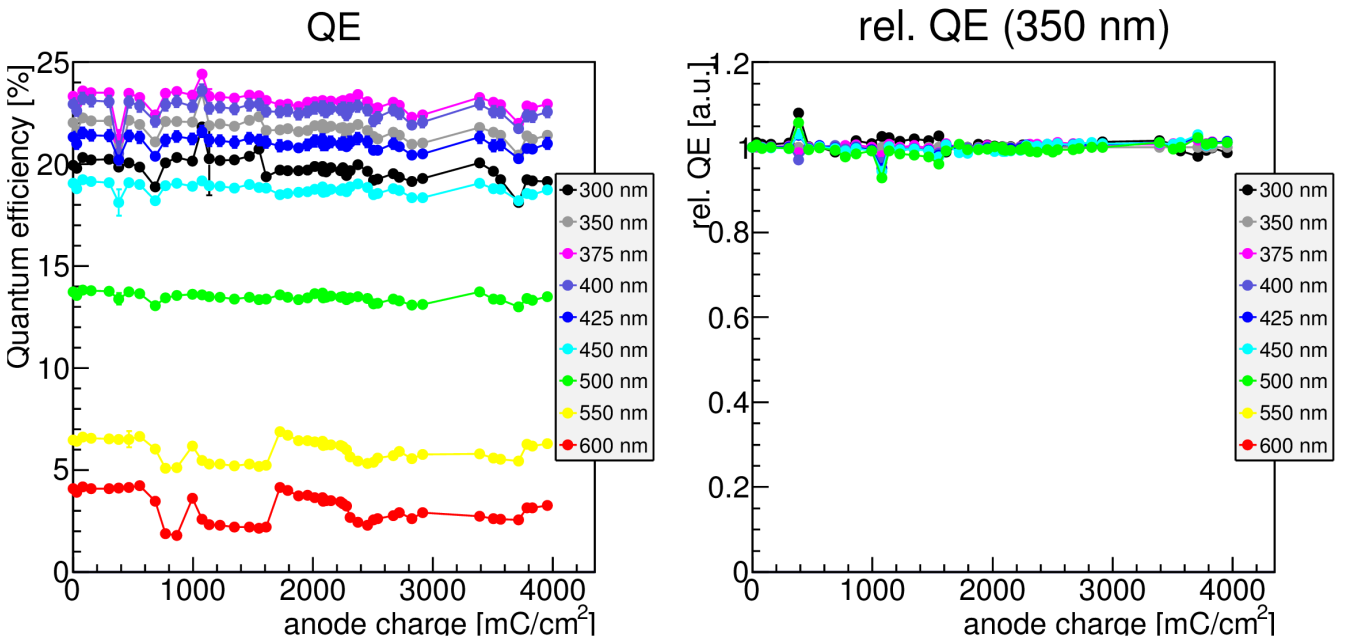
PHOT. XP85112/A1-HGL - 1223

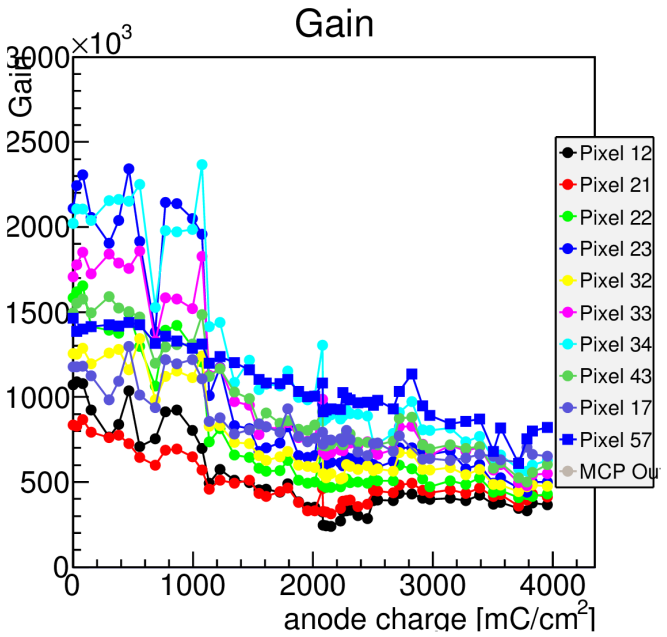


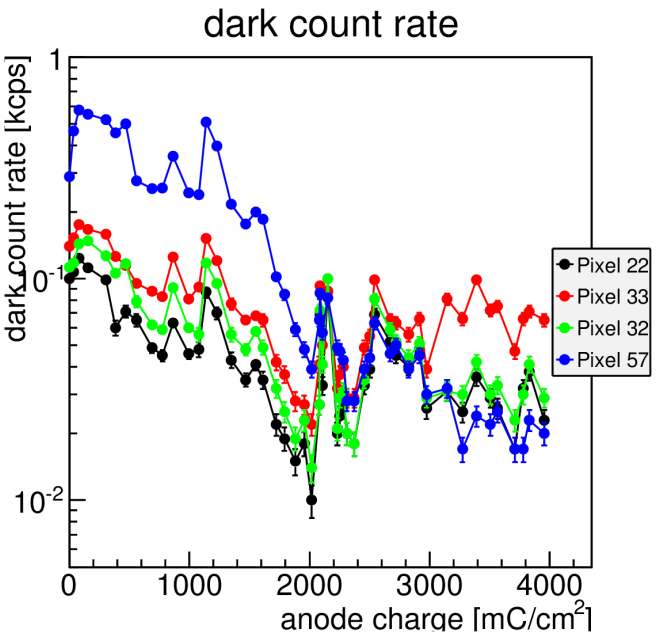




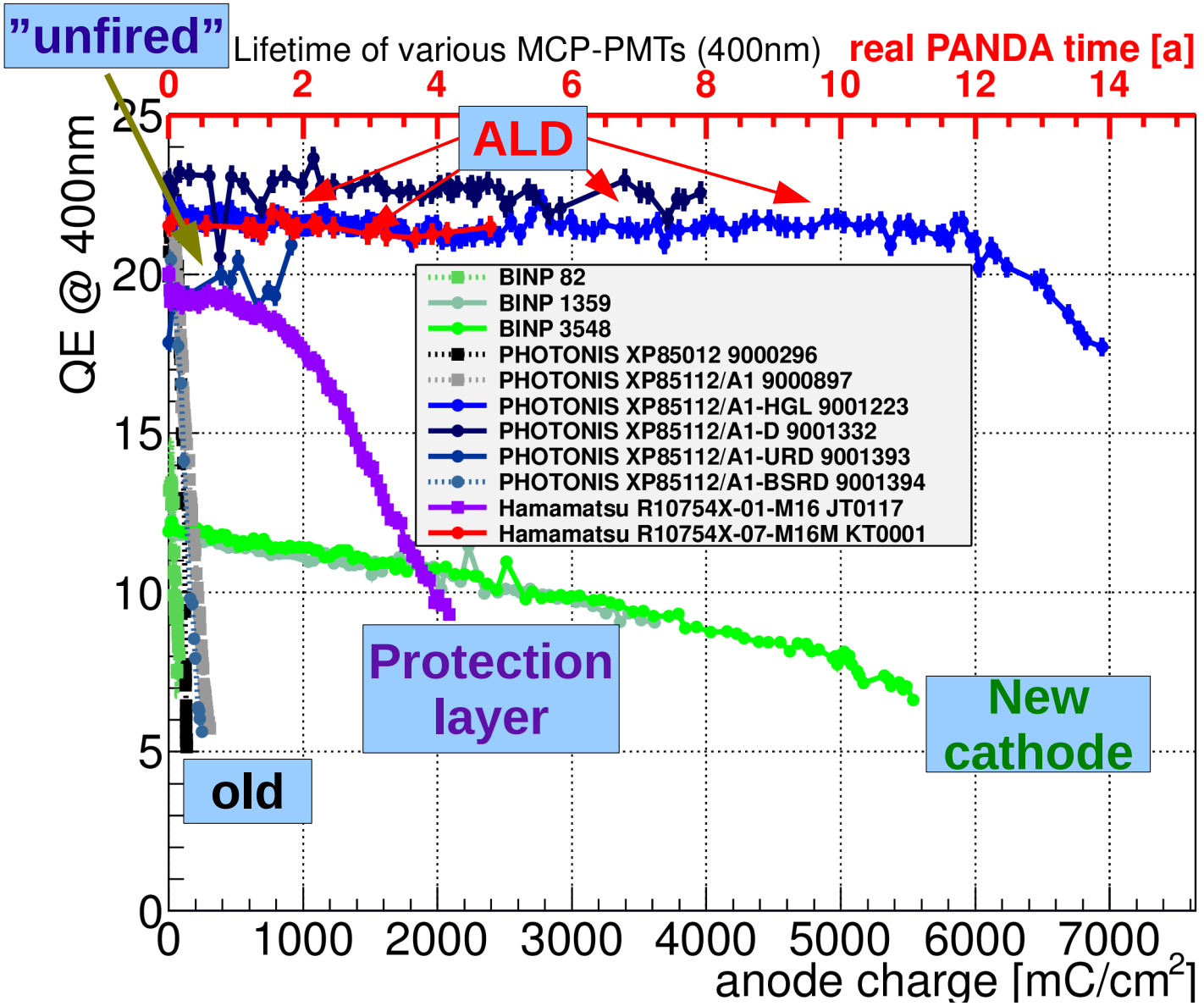
PHOT. XP85112/A1-D - 1332







Comparison with older MCP-PMTs



- No degradation for XP85112/A1-HGL – 1223, until 6C/cm². Aging clearly visible now!
- XP85112/A1-D – 9001332 has already passed 8 PANDA Barrel-Years!
- ALD coated Ham. MCP-PMTs has passed 2.4C/cm²

Summary and Outlook

- MCP-TOF improved with 10µm MCP-PMT and shielded cables:
  - Time resolution deteriorated by crosstalk
  - Thresholds for pixels not optimised due to lack of time
- Results of lifetime measurements:
  - ALD coated sensors:
    - XP85112/A1-HGL - 1223 has passed ~7C/cm² (~14 PANDA Barrel-years), aging of cathode has started at ~6C/cm²
    - XP85112/A1-D – 1332 (4C/cm²) and Ham. R10754-07-M16M KT0001 unchanged (2.4C/cm²)
  - QE of PHOT. XP85112/A1-URD – 1393 unchanged at 910mC/cm² (no ALD or coating!)
  - Lifetime of PHOT. XP85112/A1-(BSRD) - 1394 comparable to previous results
  - Lifetime setup is running stable and reliable for more than 4 years!