Update on Lifetime Measurements, CE and ratestability with TRB system

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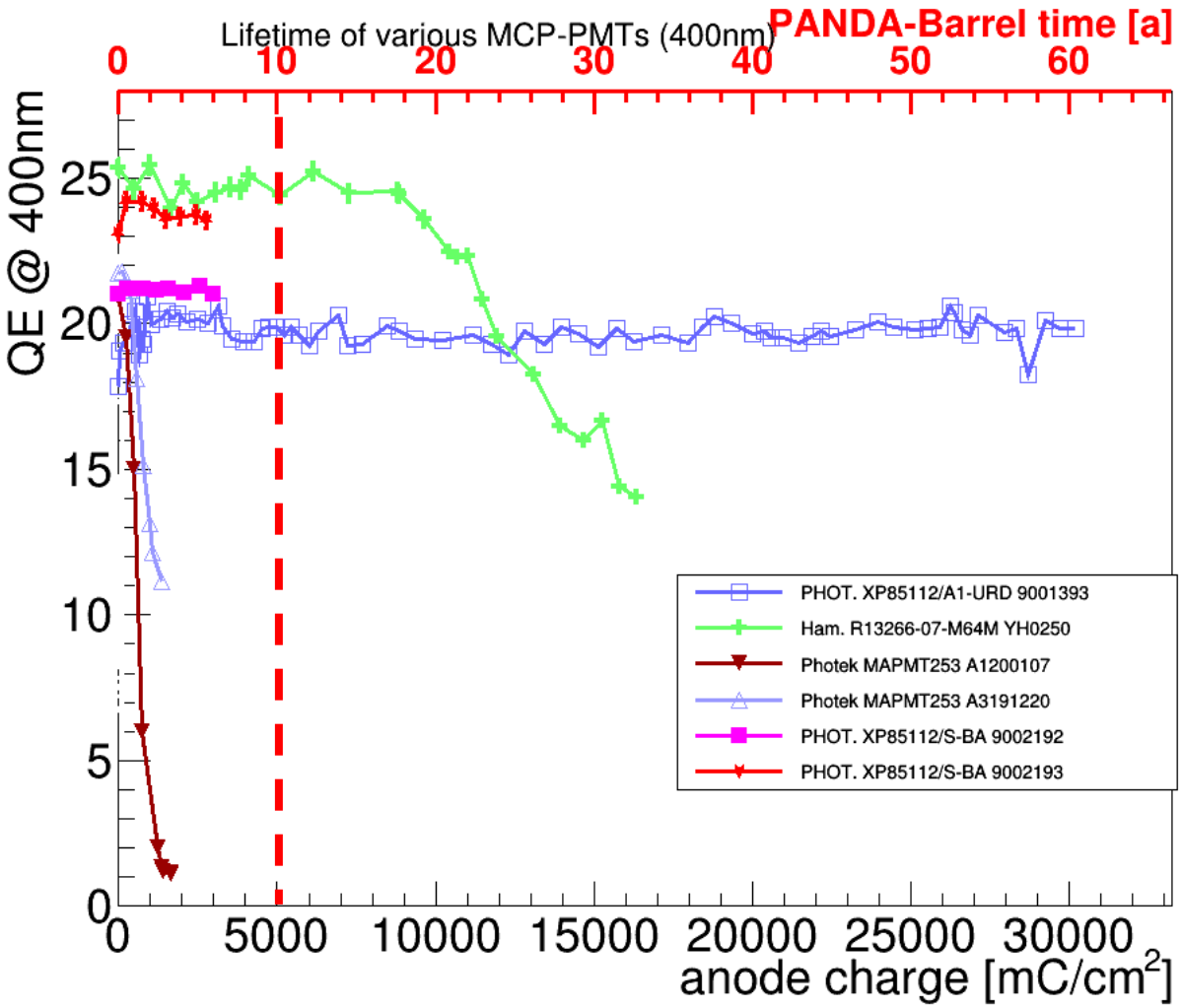
Lifetime data of latest sensors



- Most sensors with ALD coated MCPs have lifetime > 5 C/cm²
- nothing really new, YH0250 and both Photeks are still decreasing, Photonis 9002192, 9002193 and 9001393 are not

CE measurement issues of Photonis 9002192 and 9002193

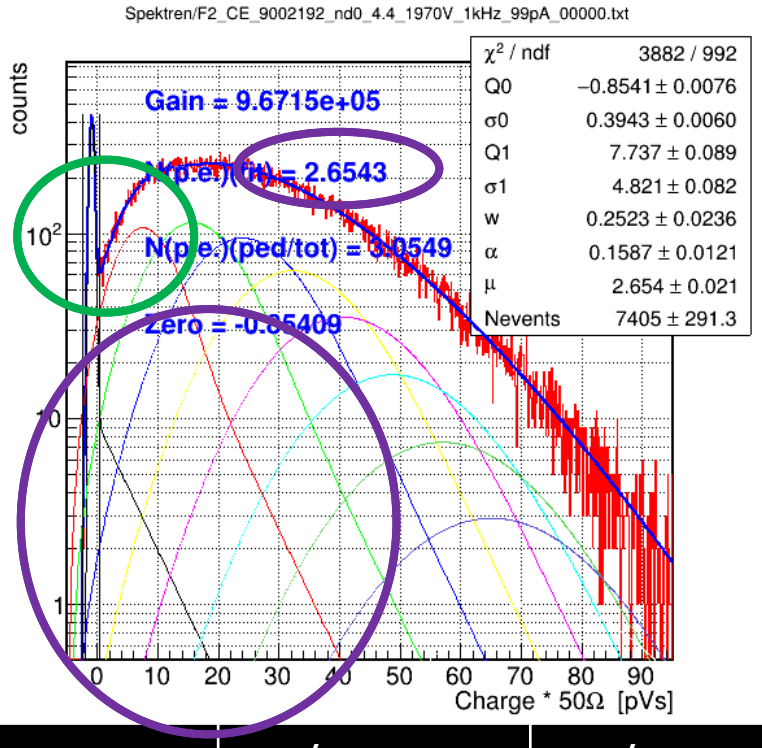
- Problem: different CE at different times:

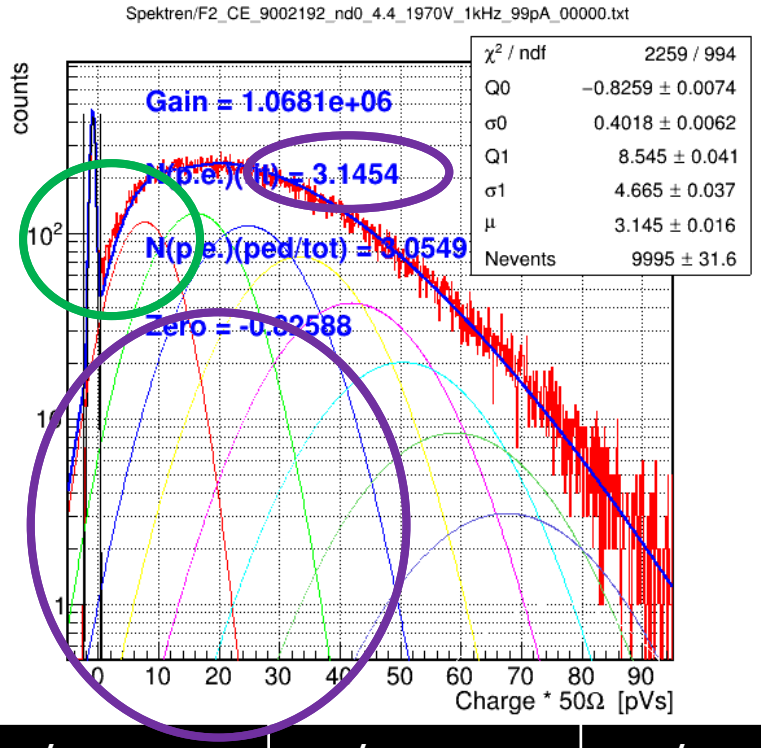
	07/2020	09/2020	10/2020	01/2021	03/2021
9002192	(76+/-2)%	(98+/-7)%	(17+/-1)%	(92+/-10)%	(71+/-2)%
9002193	(74+/-3)%	(85+/-7)%	(20+/-1)%	(83+/-4)%	(81+/-7)%

	03/2019 (first try)	08/2020	10/2020	02/2021 (~0.5 pe)	02/2021 (~1.0 pe)	02/2012 (~2.5pe)
9002108	(95+/-9)%	(94+/-1)%	(99+/-3)%	(96+/-9%)	(93+/-12)%	(93+/-3)%

- 1. the differences are higher than our expectations (compared with „good“ and „bad“ measurements of the 9002108)
- 2. there seems to be a problem in Sept/Oct since we were in Juelich between them and the setup remained untouched in this time → either problem in our measurement or in the magnetic field
- test in 3T MRI on 10th March had no effect on the charge spectra
- investigations of effect 1 brought up a problem in the analysis of the charge spectra

- Problem: exponential part in fit function



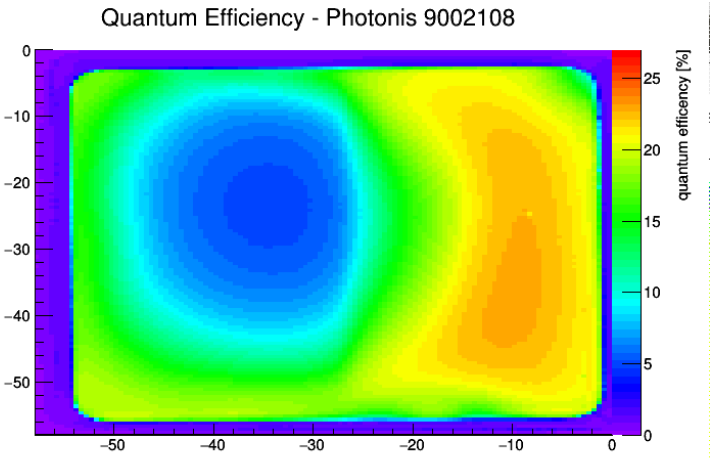


	07/2020	09/2020	10/2020	01/2021	03/2021
9002192	76%→86%	98%→105%	17%→17%	92%→92%	71%→87%
9002193	74%→86%	85%→91%	20%→22%	83%→91%	81%→87%

Now Jul, Jan and Mar are consistent and yield ~88%
but the low CE in Oct is still not explained

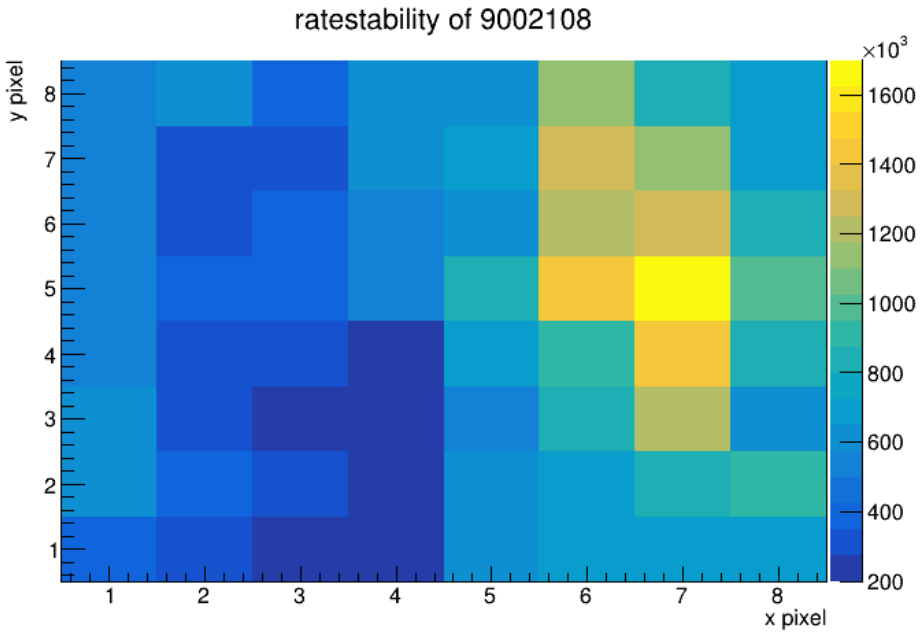
ratestability with TRB system

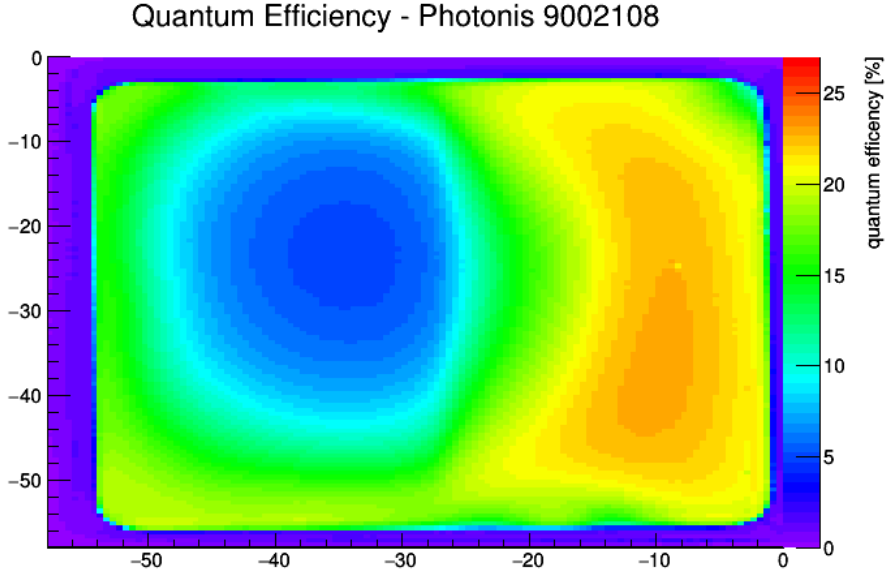
- idea: measuring count rates with Padiwas/Dirich while illuminating the whole surface with increasing laser frequency → position dependent ratestability
- first try with 9002085 showed that regions with higher anode current (gain+qe) have a higher ratestability (instead of a lower one!)
- to confirm this we tried the 9002108 which is (almost) dead on one side
- surprising result: the dead side has lower ratestability



ratestability with TRB system

- the z axis is the frequency where the sensor has less than 80% of the expected count rate (so higher frequency where this happens means higher ratestability)

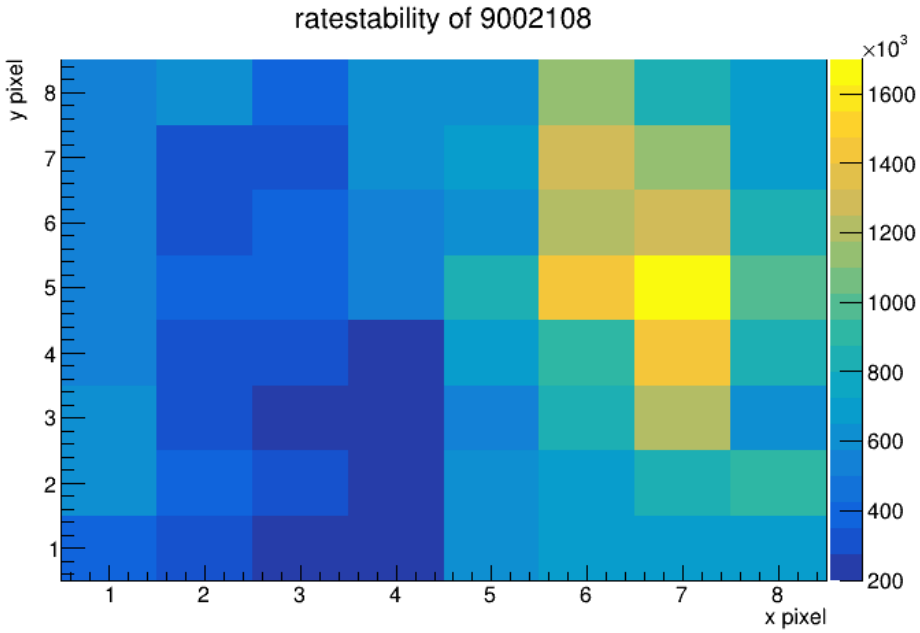


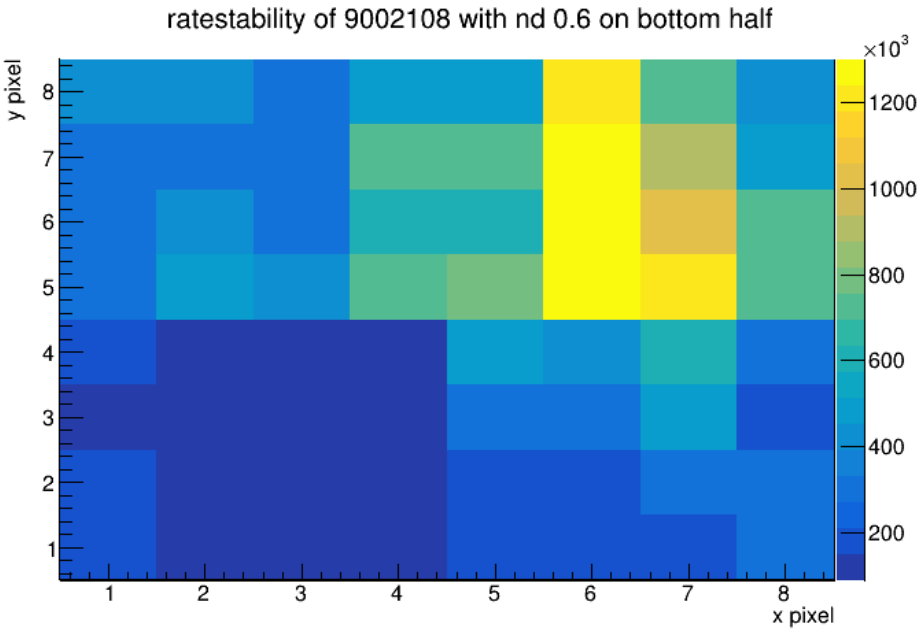


- we could not really believe this so we added a nd-filter to the bottom half

ratestability with TRB system

- so it seems that the more electrons reach the anode the higher the ratestability





ratestability with TRB system

- first theory: consider the sensor pulls 100nA, 10 nA on the left (dead) side, 90 nA on the right, the total possible current be 150nA
- now if we double the intensity the left side would need 20nA and the right 180nA but with only 150nA available in total there are missing
  - 45nA [$(180 - 150/200 * 180)$nA] on the right side but only
  - 5nA [$(20 - 15/20 * 20)$nA] on the left side
- so the lack of electrons is a factor of ~10 higher on the right so some electrons of the left side will go to the right side instead (otherwise there would be a potential difference in the two sides) which leads to lower ratestability on areas with smaller electron flux

- → it seems the behaviour for local and global ratestability differs due to the global maximum current flowing over the MCPs

Summary

- issues with CE are solved and understood
- surprising result for position dependent ratestability for full illumination

- Photonis
  - Best sensor at >30 C/cm² without any sign of cathode damage
  - 9002192&9002193 look good so far
- Hamamatsu:
  - Later produced (higher serial number) 2 inch tubes tend to have better performance
  - YH0250's QE started dropping at ~9 C/cm²
- Photek:
  - both (all three) sensors already show aging effects, no matter if the side was illuminated or covered or the sensor even was off
  - our assumption: „microleaks" as called by Hamamatsu, as both Hamamatsu and Photonis experienced these when starting with 2 inch tubes

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Thank you for your attention!

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