Update on MCP-PMT oszillations and first try of CE measurement

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

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ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

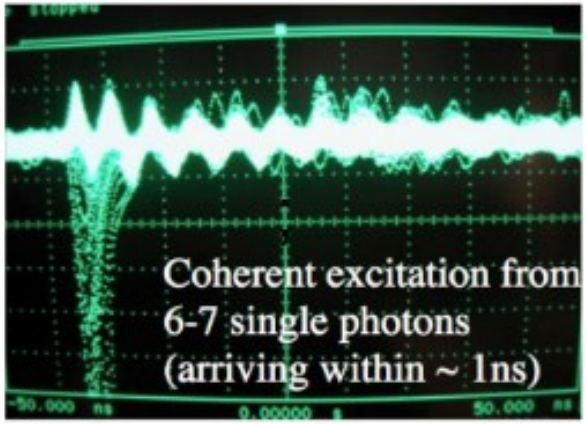
FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

NATURWISSENSCHAFTLICHE FAKULTÄT

Reminder: Oscillations in MCPs at higher intensities

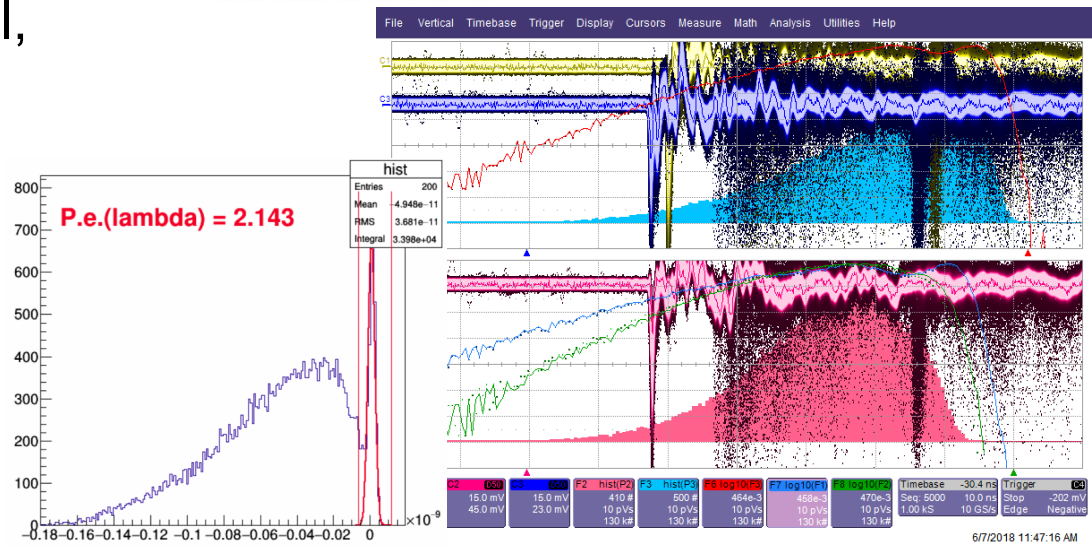
- Oscillations in Pixels at a few photoelectrons per pixel
- upper right corner: Jerry Vav'ra with old (2005) Photonis tube
- lower right: Hamamatsu JS0022 illumination of complete sensor (about 1,3 pe/pixel, 80 pe/sensor)
  x: 10 ns/div, y: 15 mV/div
  trigger: laser
- number of photo electrons:

$$\mathrm{pe} = -\ln(I_{Pedestal}/I_{all})$$



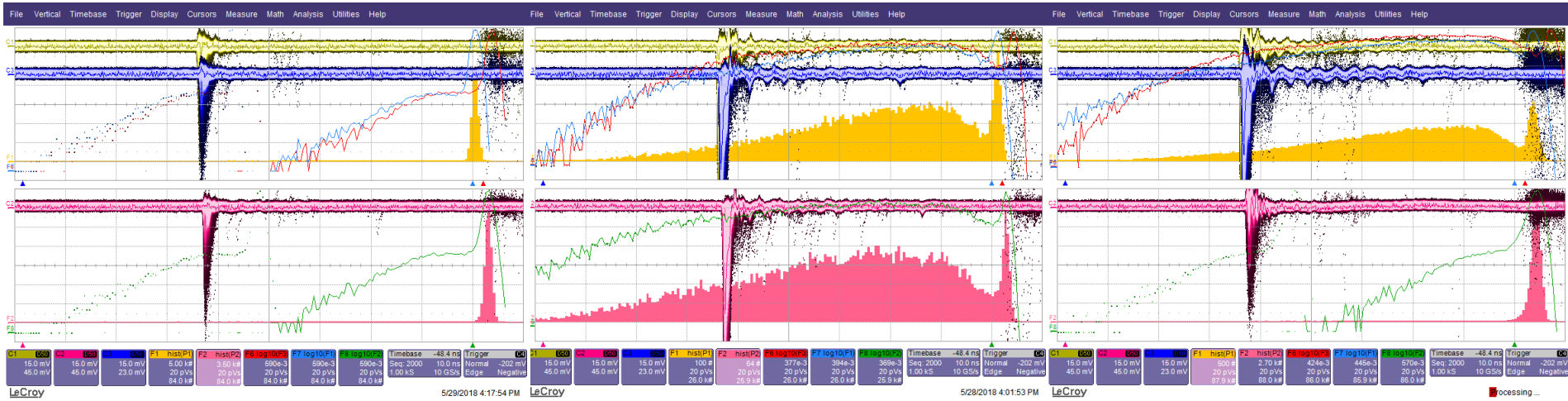
NIM A876 (2017) 141-144

11	12	13	14	15	16	17	18
21	22	23	24	25	26	27	28
31	32	33	34	35	36	37	38
41	42	43	44	45	46	47	48
51	52	53	54	55	56	57	58
61	62	63	64	65	66	67	68
71	72	73	74	75	76	77	78
81	82	83	84	85	86	87	88

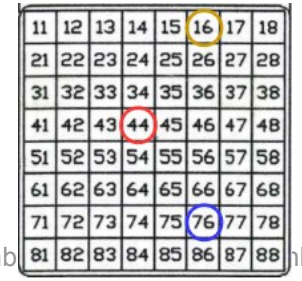


Reminder: Oscillations in MCPs at higher intensities

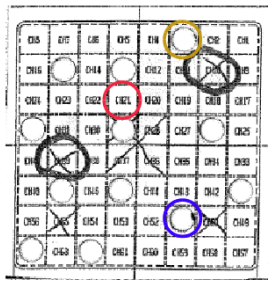
- Hamamatsu YH0250, ALD-coated, 10 µm pores, 10^6 gain,
- x: 10 ns/div, y: 15 mV/div, Trigger: Laser



nd2,6, without aperture,
0,08 pe/pixel,
5 pe/sensor



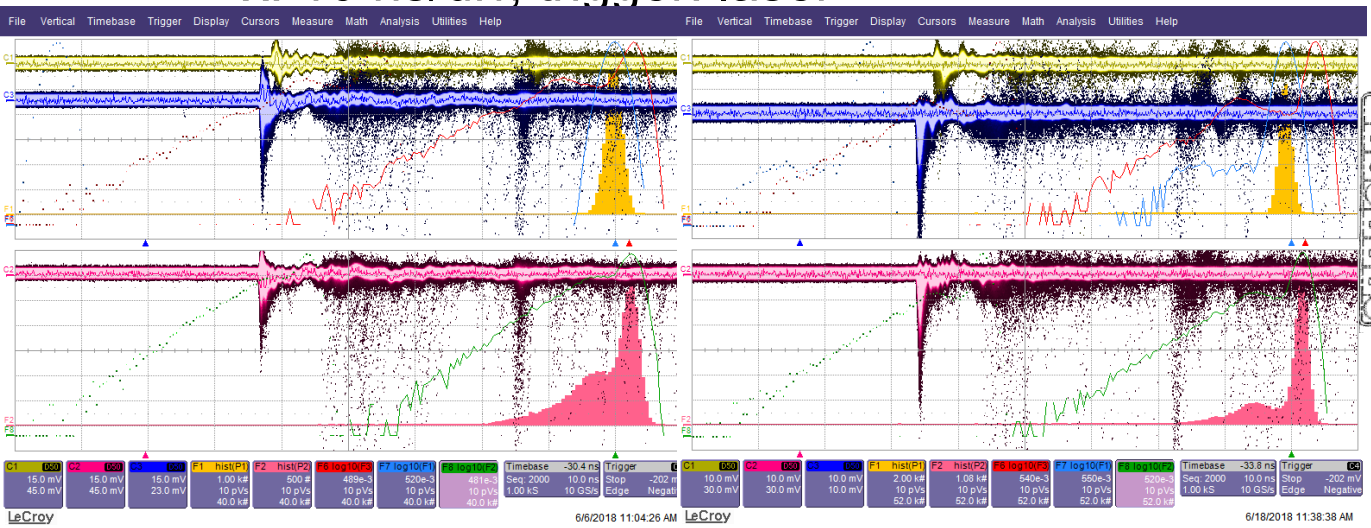
nd1,3, aperture with 3 holes,
2 pe/pixel,
6 pe/sensor

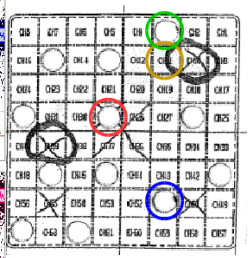


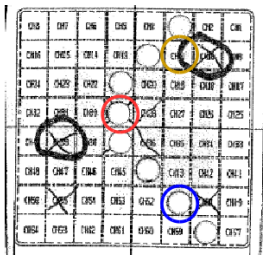
nd1,3, aperture with 12 holes,
2 pe/pixel,
24 pe/sensor

Oscillations in MCPs at higher intensities

- Hamamatsu JS0022, ALD-coated + film, 10 µm pores, 10^6 gain,
  x: 10 ns/div, trigger: laser







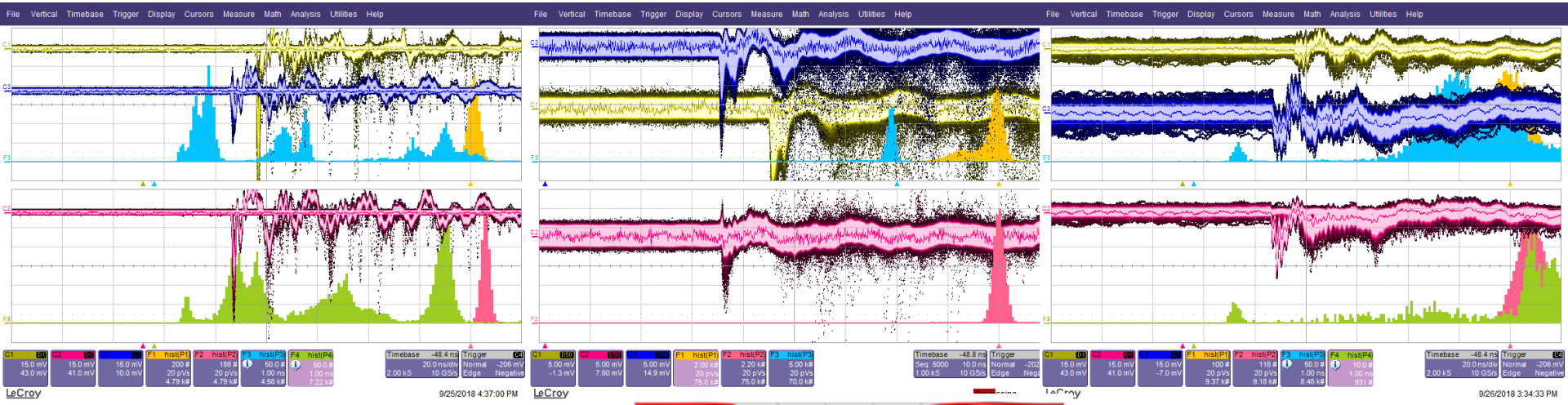
nd1,3, 12 hole aperture,
0,3 pe/p, 3,5 pe/s, y:
15mV/div with BP, other pixels grounded via 50 Ω

nd1,3, 8 hole aperture,
0,3 pe/p, 2,4 pe/s, y: 10 mV/div
w/o BP, other pixels are open

- different configurations with the other pixels show no difference (open, wired together, …)
- → seems to be effect in MCP

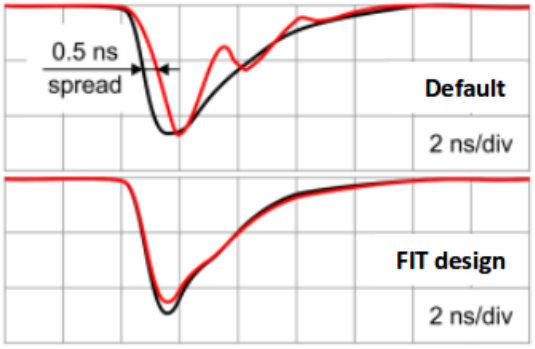
Oscillations in MCPs at higher intensities

- Idea (from ALICE collaboration, Performance of Planacon MCP-PMT photosensors under extreme working conditions, DIRC talk 2018 from Yu.A. Melikyan) : in-line resistors to damp down the oscillations



yellow: no resistor,
red: 50 Ω,
blue: 75 Ω,
other pixels wired together to ground

up: every pixel with 56 Ω



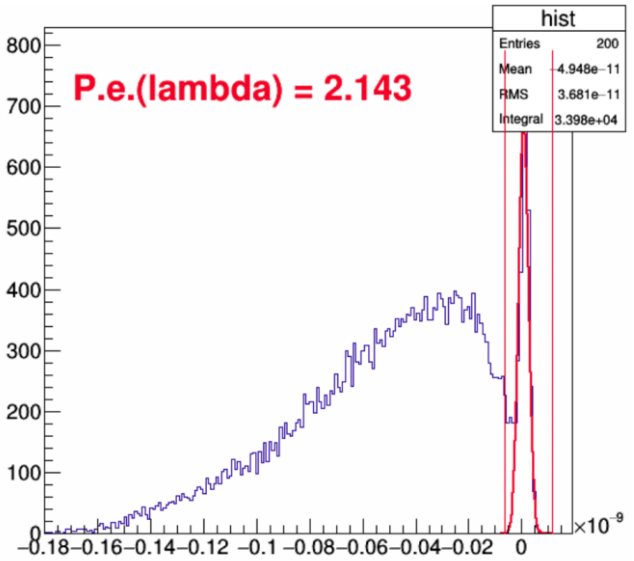
Problem at ALICE (left) comes from blockwise readout (up,
red: 16 pixel with 50 Ω,
yellow: 16 pixel with 75 Ω,
blue: 32 pixel with no resistor

Oscillations in MCPs at higher intensities

- simple in-line resistor will not help most likely
- maybe simulation with LTSpice? experts?
- Photonis is aware of this problem and tries to fix it

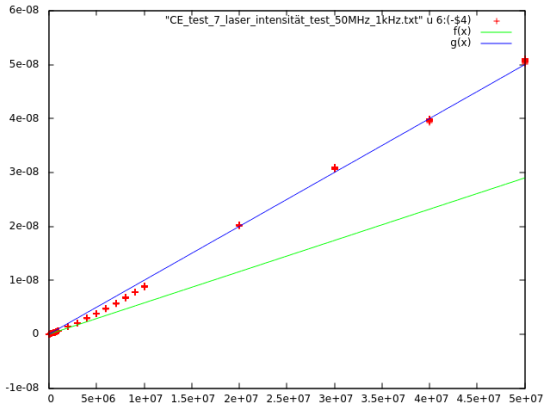
First try of collection efficiency (CE) measurement

- collection efficiency is the probability that a photoelectron creates a signal (losses due to missing the MCP pore / absorption, …)
- Photonis can measure it, so we want to try it, too
- idea: $\mathrm{CE} = N_{pe@anode@15kHz} \,/\, N_{pe@PC/MCP@15kHz}$
- first one is simple: Poisson distribution with charge spectrum (with a PiLas at 15 kHz and a nd-Filter for example)
- for the second one we need a little detour



First try of collection efficiency (CE) measurement

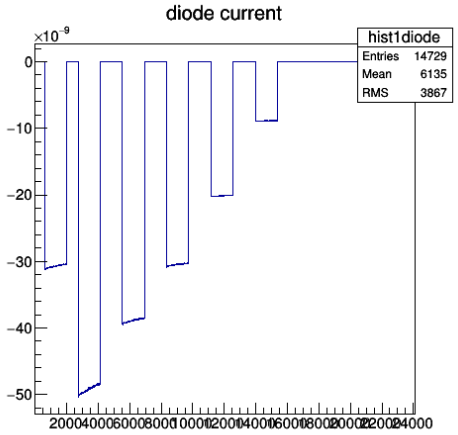
- use of QE-Setup (200V between PC and MCP and current measurement), with a beam splitter
- one beam goes to a photodiode to measure the intensity of the PiLas
- the other one goes through the nd-Filter to the sensor (1-2 photoelectrons per pulse) → extreme low current at the MCP → increase PiLas frequency to 10-50 MHz → increases current to 10pA level
- known problem: PiLas intensity is not linear
- $N_{pe@PC/MCP@15kHz} = \frac{1}{50MHz} \frac{I_{MCP@50MHz}}{e} / F$
- F corrects the non-linearity with the data from the photodiode
- $F = \frac{I_{Diode@50MHz}}{I_{Diode}@15kHz} \frac{15kHz}{50MHz}$
- $\mathrm{CE} = \frac{N_{pe@anode@15kHz} * e * 15kHz}{I_{MCP@50MHz}} \frac{I_{Diode@50MHz}}{I_{Diode@15kHz}}$

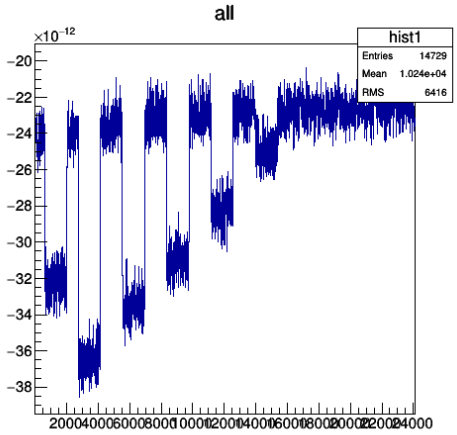


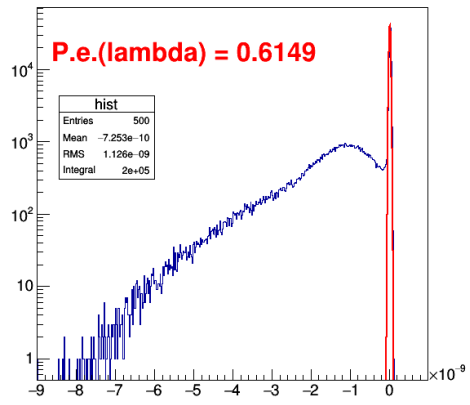
laser intensitiy with linear fit for high and low frequencies

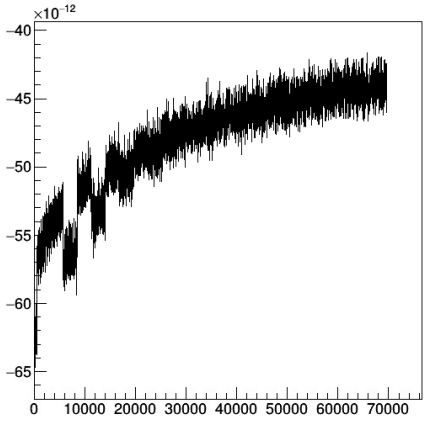
First try of collection efficiency (CE) measurement

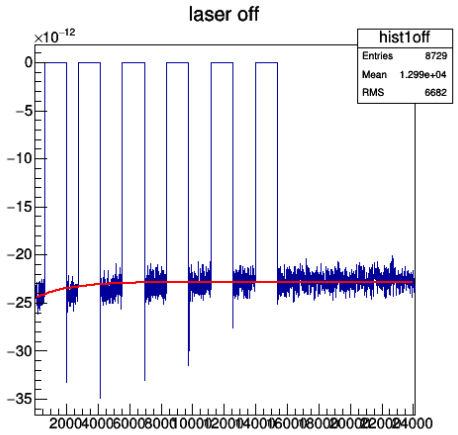
- Photonis 9001394 (BSRD) , 10 µm pores
- long cooldown (hours to days) required and/or fit

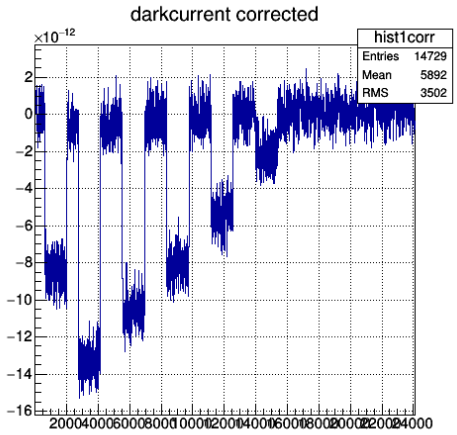






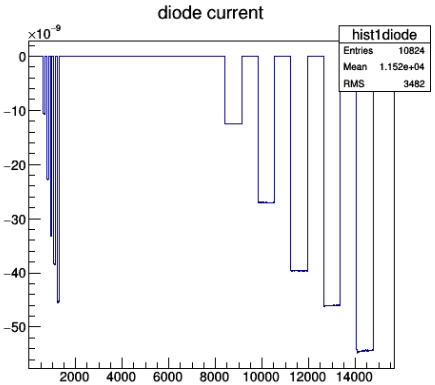


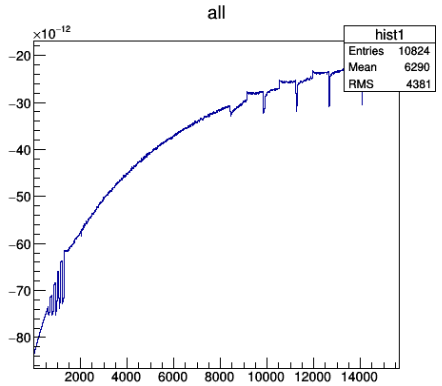


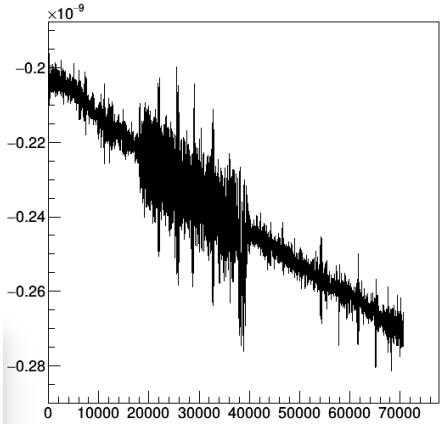


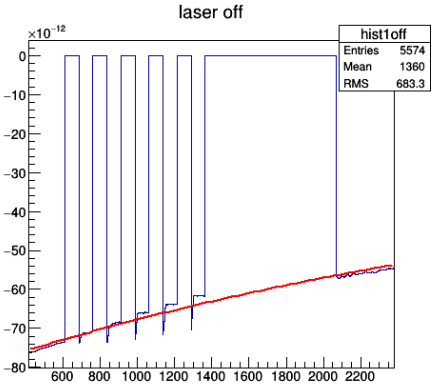
First try of collection efficiency (CE) measurement

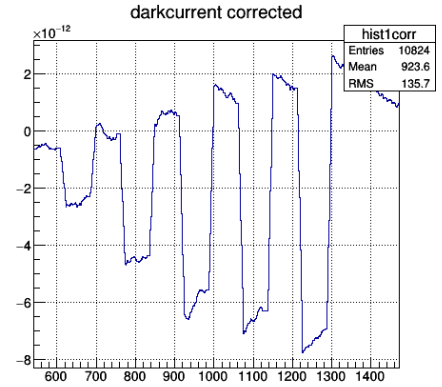
- Photonis 9002108 (Hi-CE) , 10 µm pores
- noise and laser problems
  → high errors on CE











First try of collection efficiency (CE) measurement

- results:

	50 MHz	40 MHz	30 MHz	20 MHz	10MHz
9001394 (try 1)	65%	62%	64%	63%	60%
9001394 (try 2)	63%	62%	63%	61%	70%

- ~60% for 9001394 seems reasonable
- 9002108 seems to be higher (70-130%), but final measurement is to be done

Summary

- oscillations and how to get rid of them need to be investigated further (Carstens talk?)
- waiting for Photonis‘ idea

- CE measurement seems to work in principle → next sensors will be Hamamatsu tubes to investigate the effect of the film on the CE
- remeasurement of Photonis Hi-CE tube

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Thank you for your attention!

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Backup: Oscillations in MCPs at higher intensities

- simple try in LTSpice