Photonis 2150 Part 2, Afterglowing and DiRICH

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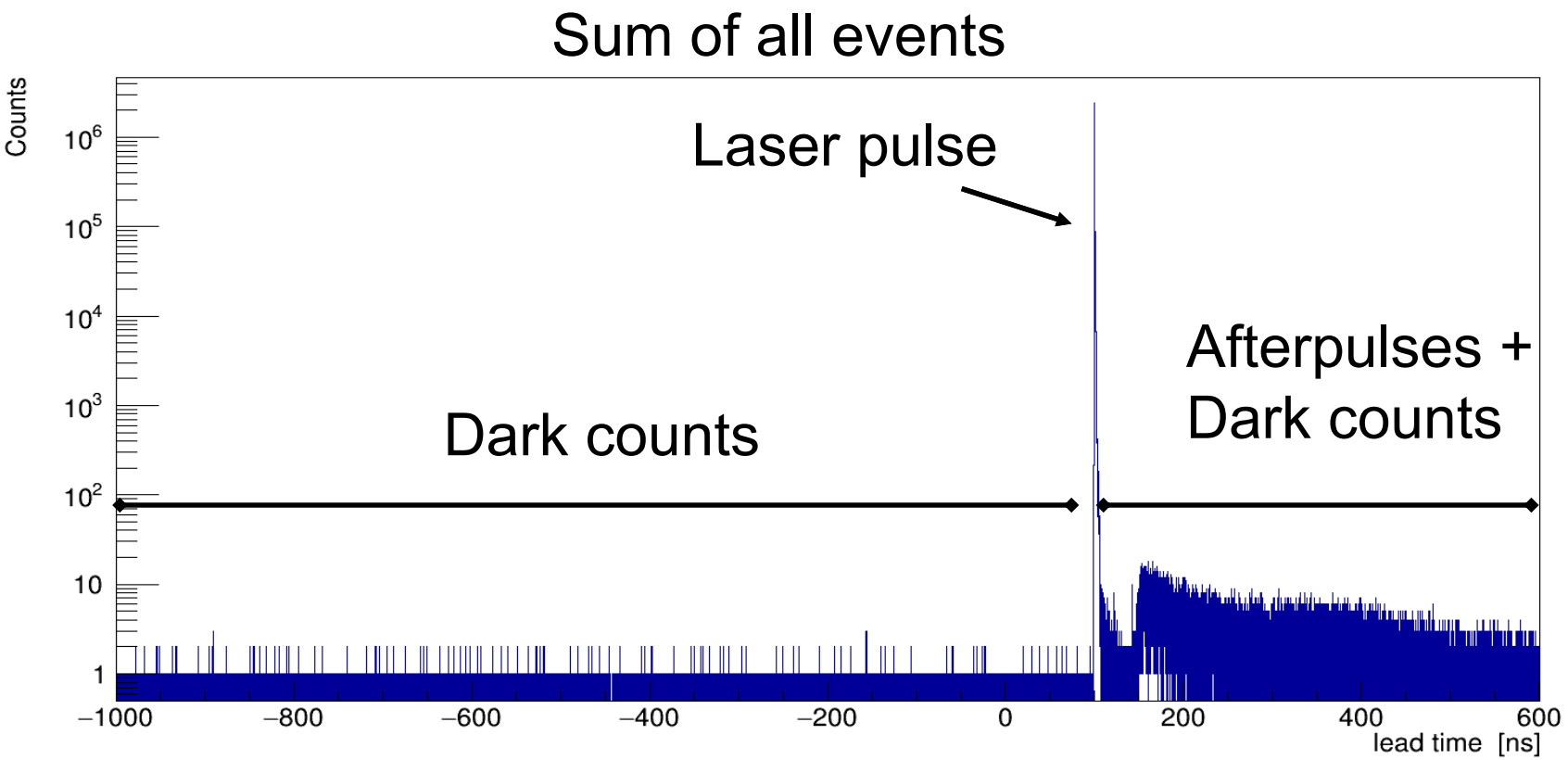
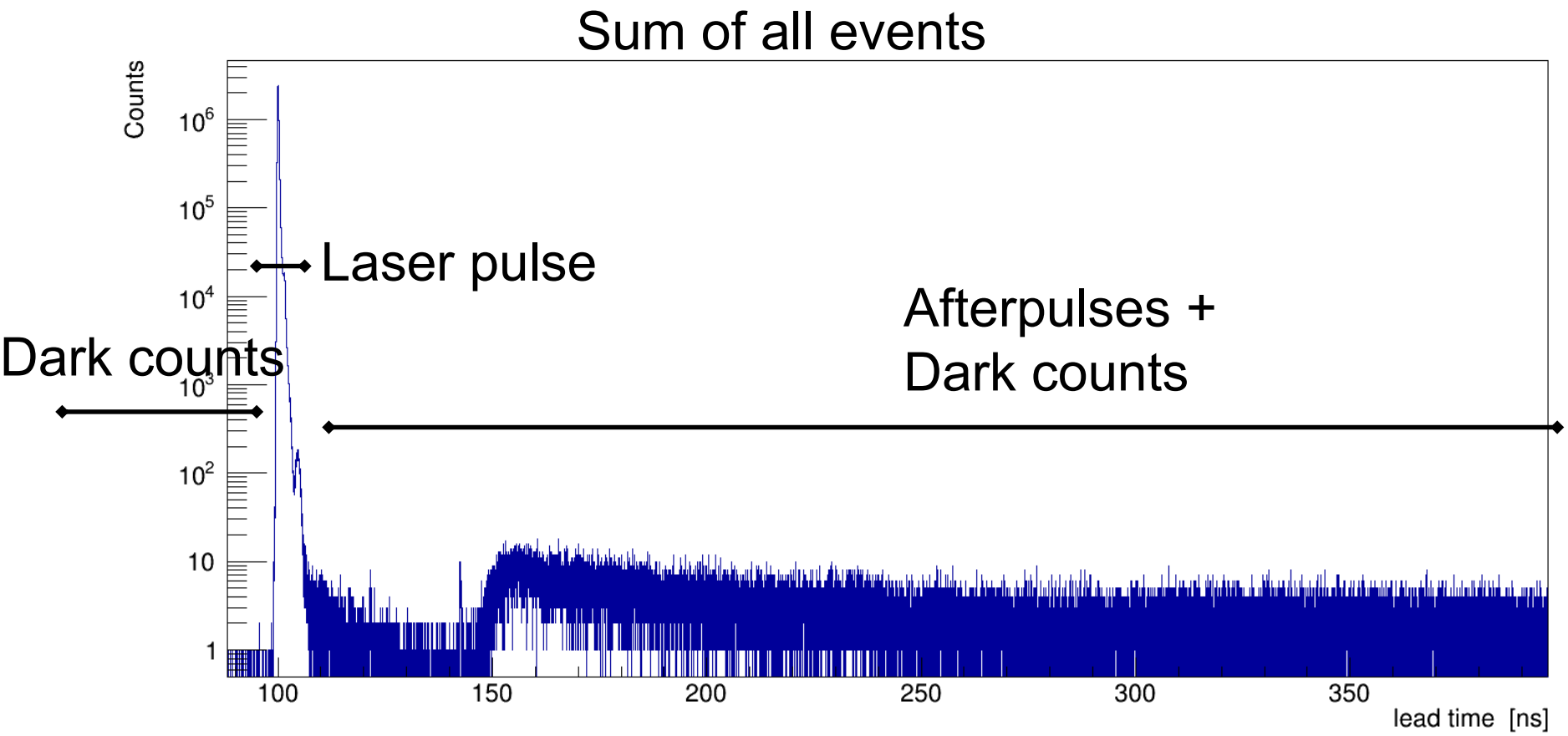
TRB measurements – Time spectrum



- Measured time delay between laser pulse and pixel response

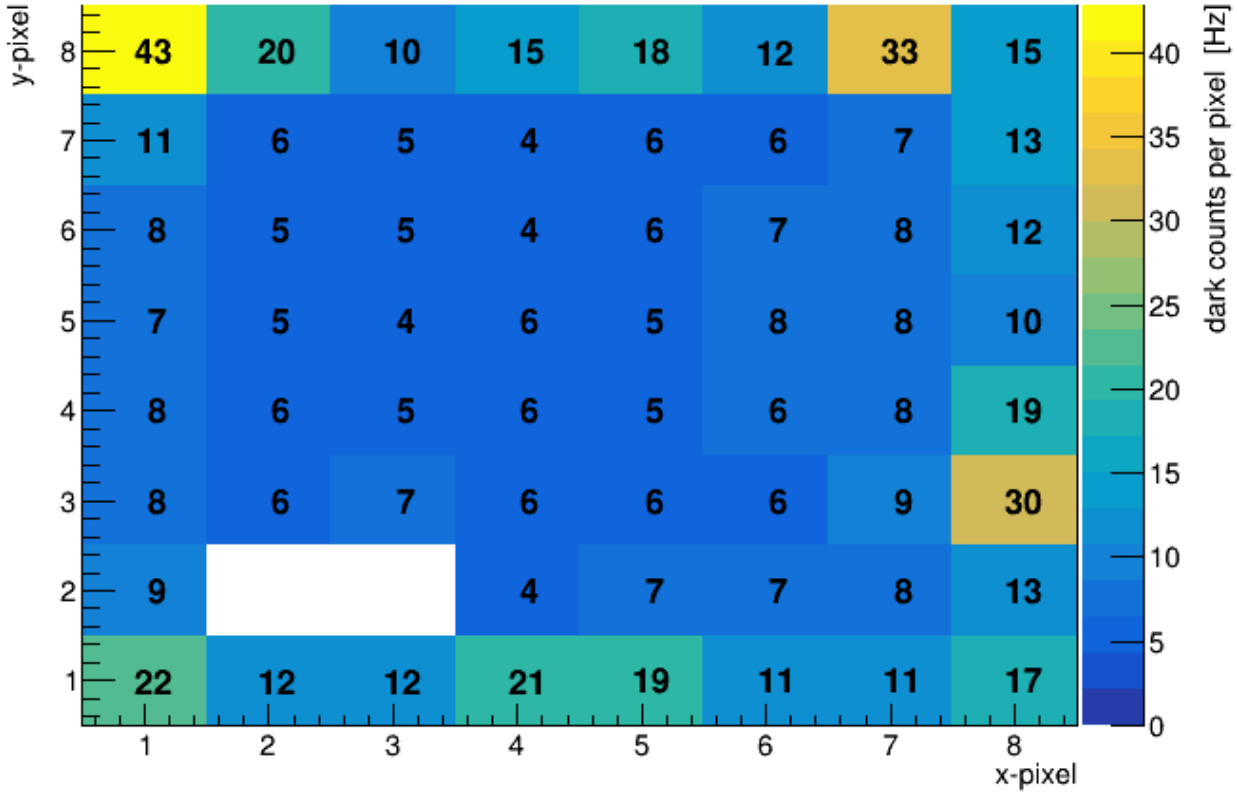
TRB measurements – Time spectrum zoomed



- Measured time delay between laser pulse and pixel response

TRB measurements – dark count rate

Photonis
9002150



- Threshold set to 0.1 p.e. (low noise background) at 2200V (0.7e6 gain)
- Whole Sensor 649 Hz, per Pixel average 10 Hz

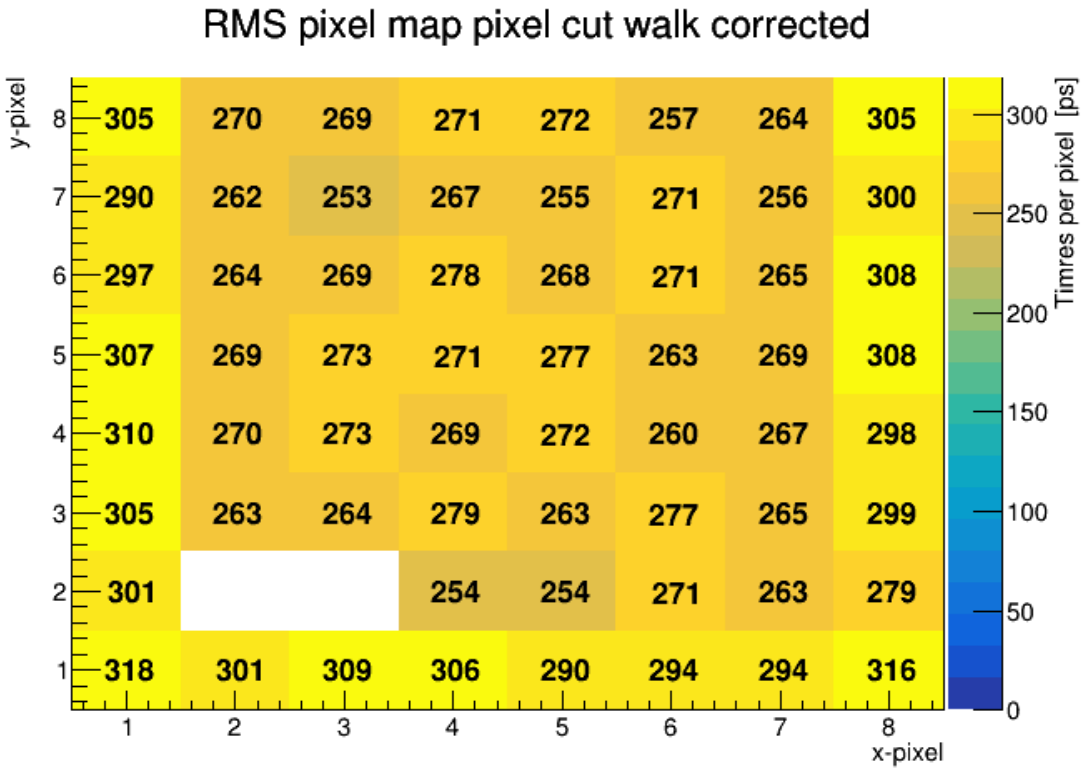
TRB measurements – Afterpulse probability

Photonis
9002150

- Threshold set to 0.1 p.e. (low noise background) at 2200V (0.7e6 gain)
- Whole sensor average afterpulse fraction 0.093%

TRB measurements – RMS time resolution

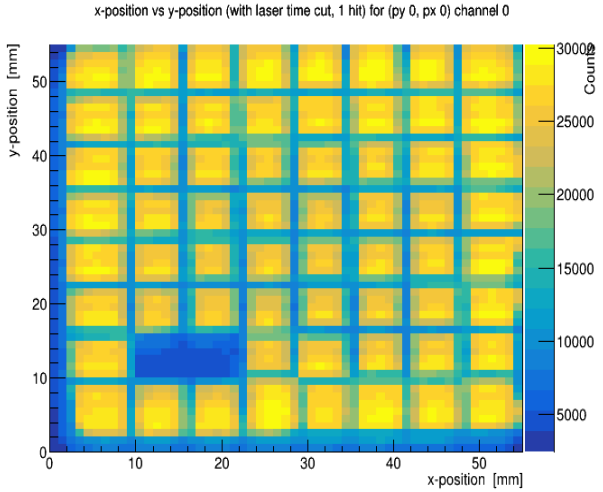
Photonis
9002150



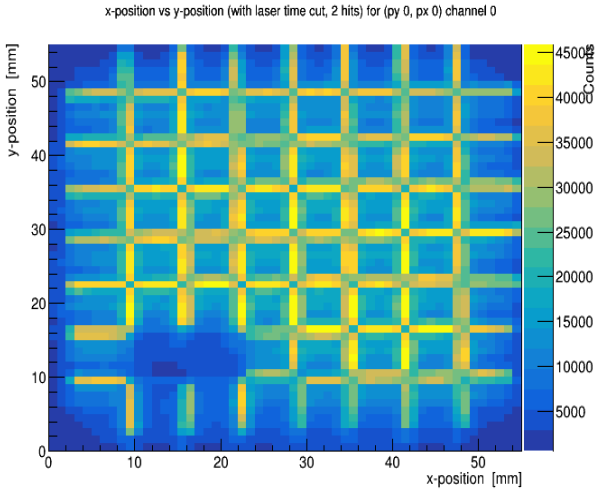
- Threshold set to 0.1 p.e. (low noise background) at 2200V (0.7e6 gain)
- Time window 90-110 ns
- Average time resolution of 280 ps dominated by readout electronics

TRB measurements – Crosstalk

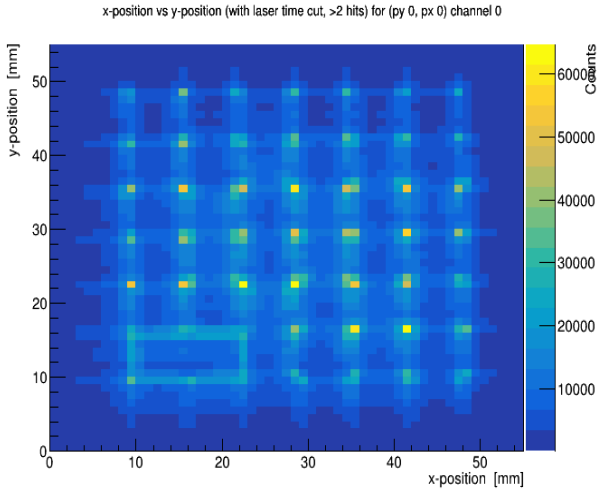
1 Hit



2 Hits



3 Hits

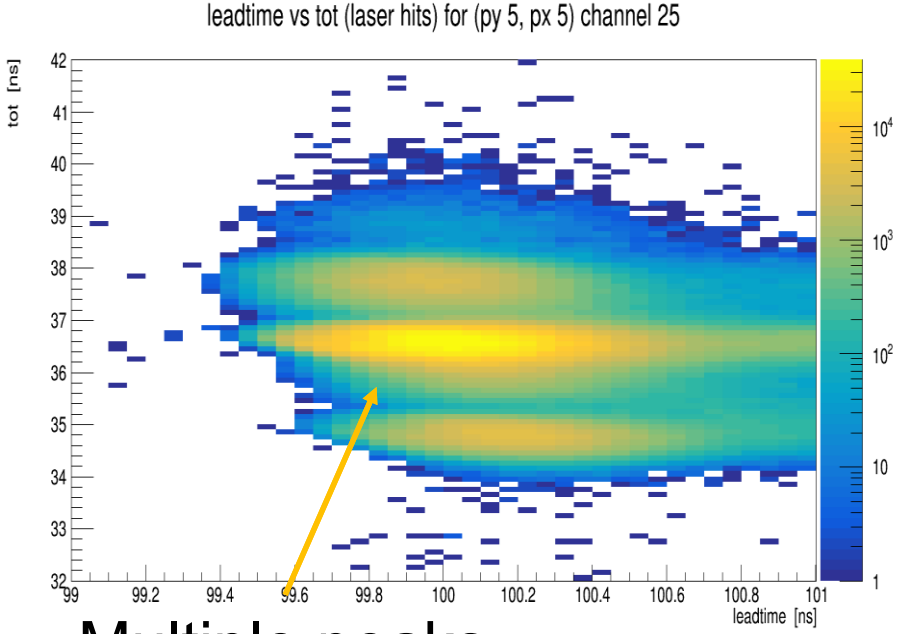


- Narrow time window of 1.5 ns, at 2200V (0.7e6 gain)
- 2 Pixels simultaneously hit reveals charge cloud width
- Charge cloud width ~1.6 mm FWHM
- 3 Pixels simultaneously hit reveals edge of pixels

TRB measurements – Ringing behavior

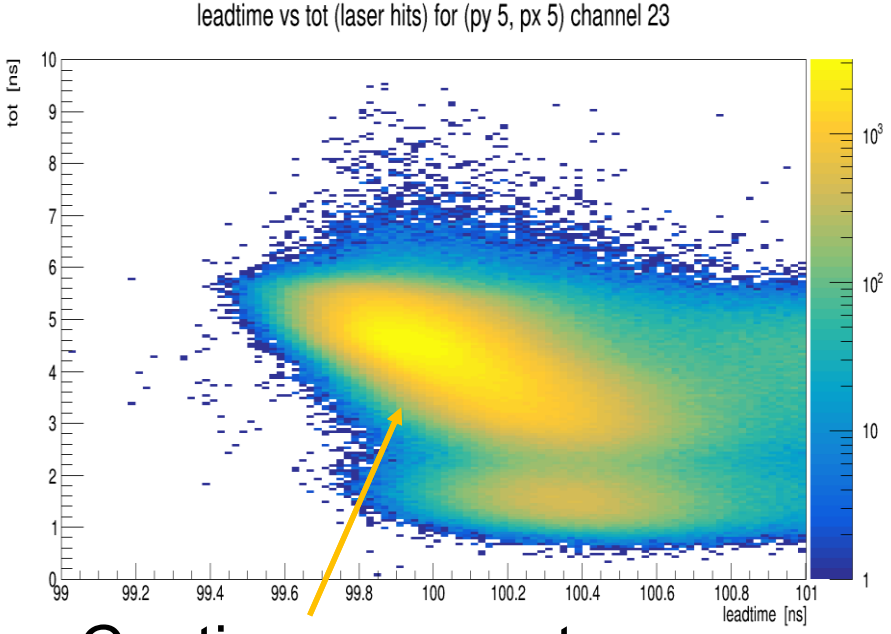
- Monitoring the time over threshold (tot) during scans
- Adding 50 Ohm parallel between signal and ground in the past showed less ringing (or much higher frequency) and no multiple peaks in tot spectra
- Photonis countermeasure: adding 75 Ohm, is effective, too

2108 (no countermeasure)



Multiple peaks

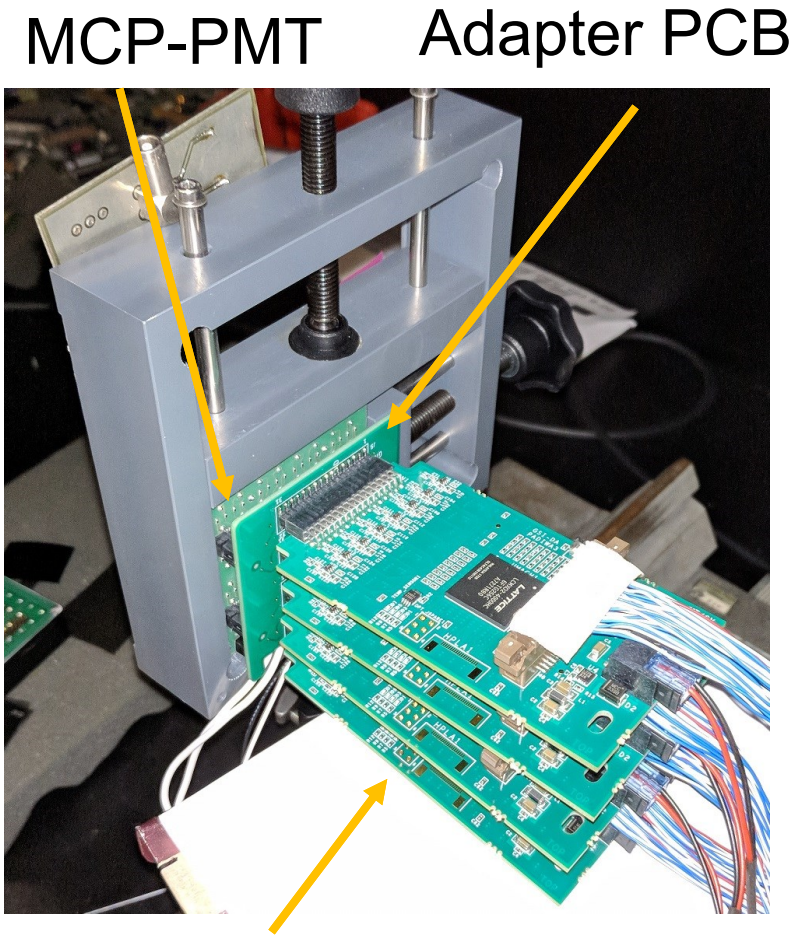
2150 (75 Ohm on Backplane)



Continuous spectrum

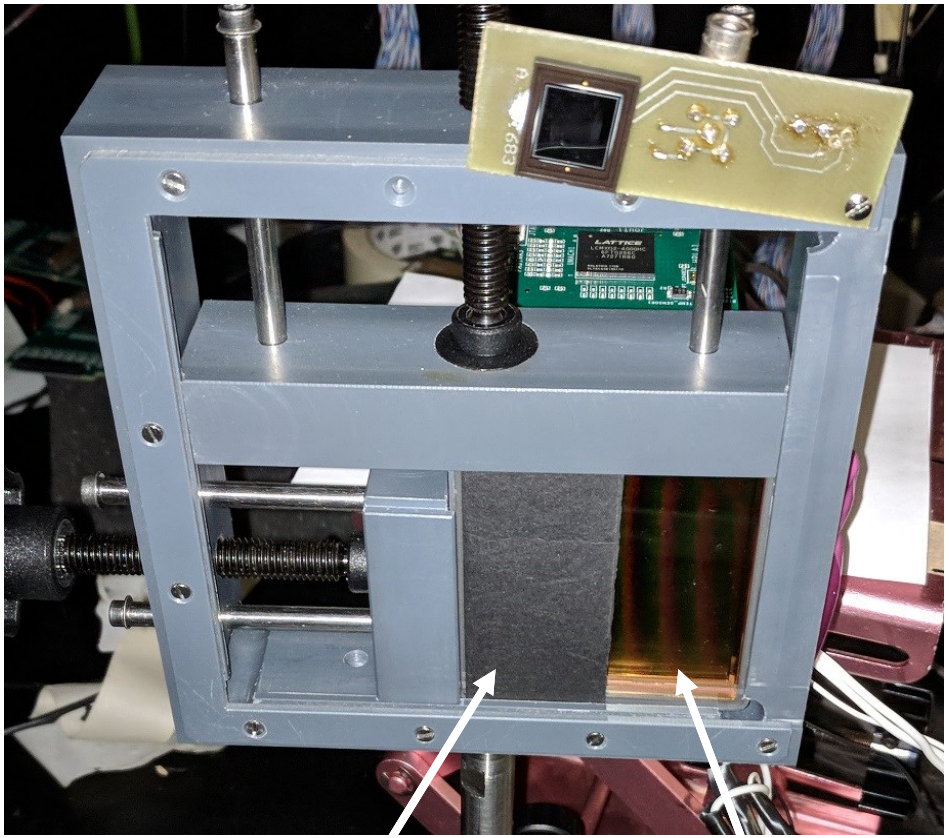
TRB measurements – Crosstalk behavior

- Cover half of the MCP-PMT and look at the number of simultaneous hits in a 15 ns window around the laser peak on the covered and open side at different thresholds
- Adjust ND-Filter to get ~1 p.e./Pixel ($\bar{n}_{pe}$)
- Adjust the voltage to get the same signal height distribution



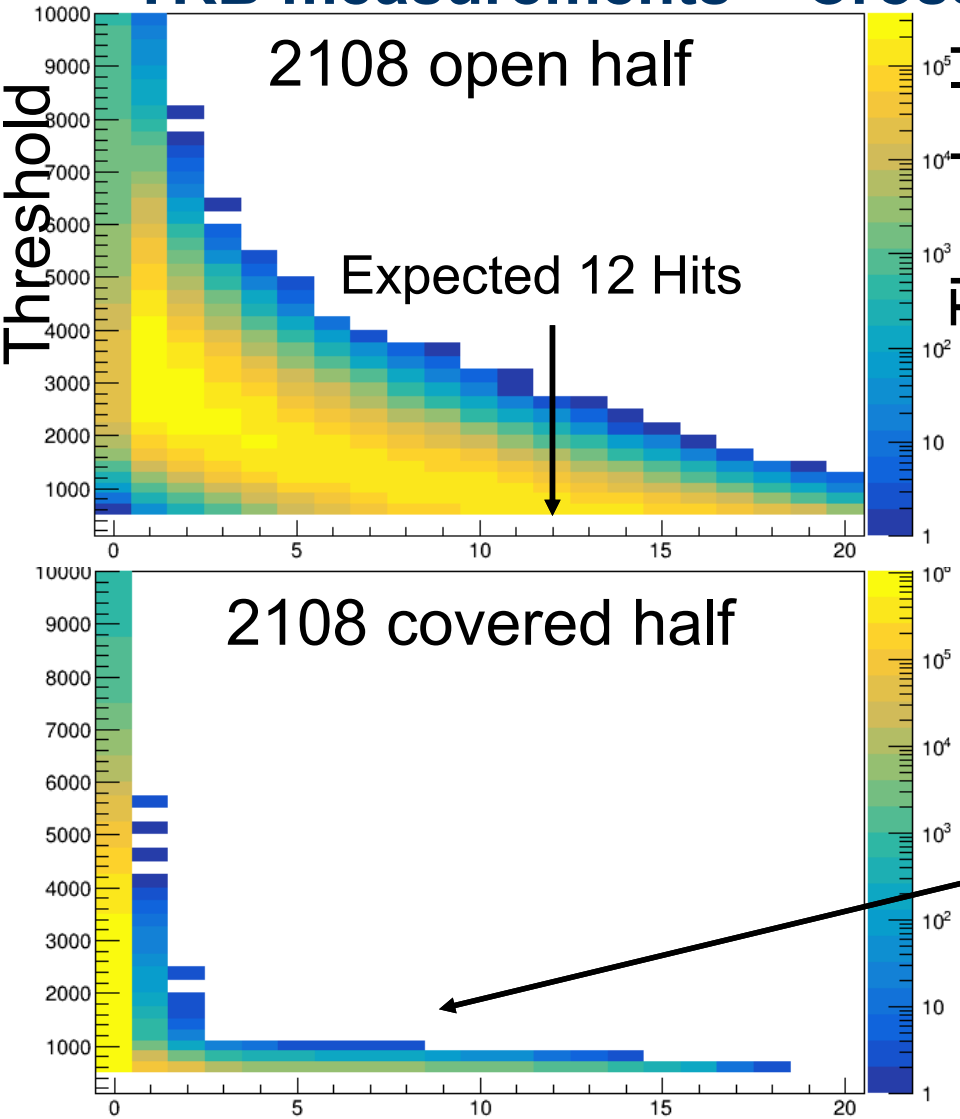
TRB measurements – Crosstalk behavior

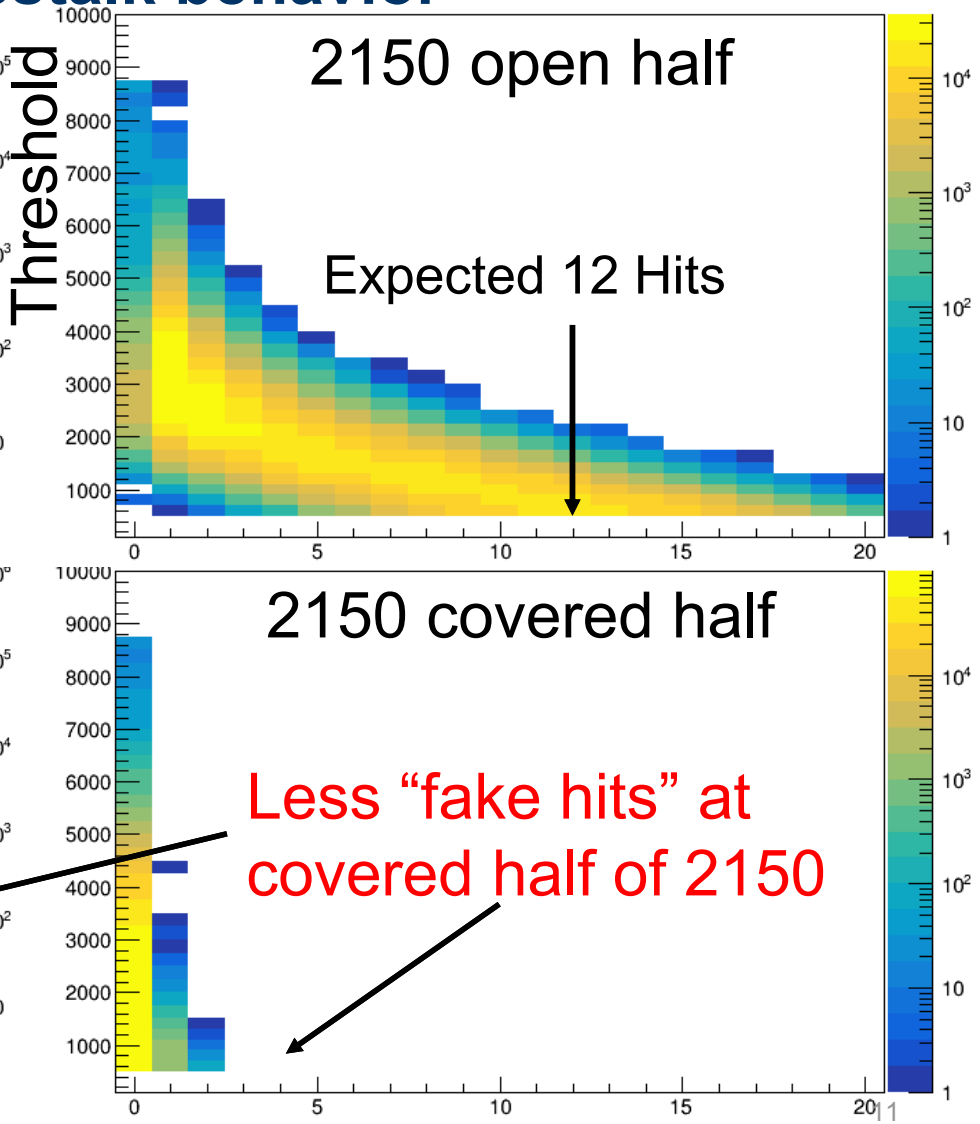
- Reading out only the 3 most left and right rows so partially covered pixels don't distort the result
- On the covered half only crosstalk from oscillation should be seen
- Illuminated half:
  18 pixels * (1-P(0)) = 12 hits expected
  (P(0) = exp(-$\bar{n}_{pe}$) with $\bar{n}_{pe}$= 1)
- On 2108 crosstalk events with up to 18 Hits/Laser pulse at low threshold can be observed, on 2150 only 2 hits
- Crosstalk signal height also 25% smaller on 2150 compared to 2108
- Photonis countermeasures against crosstalk seem to be effective



Covered half Open half

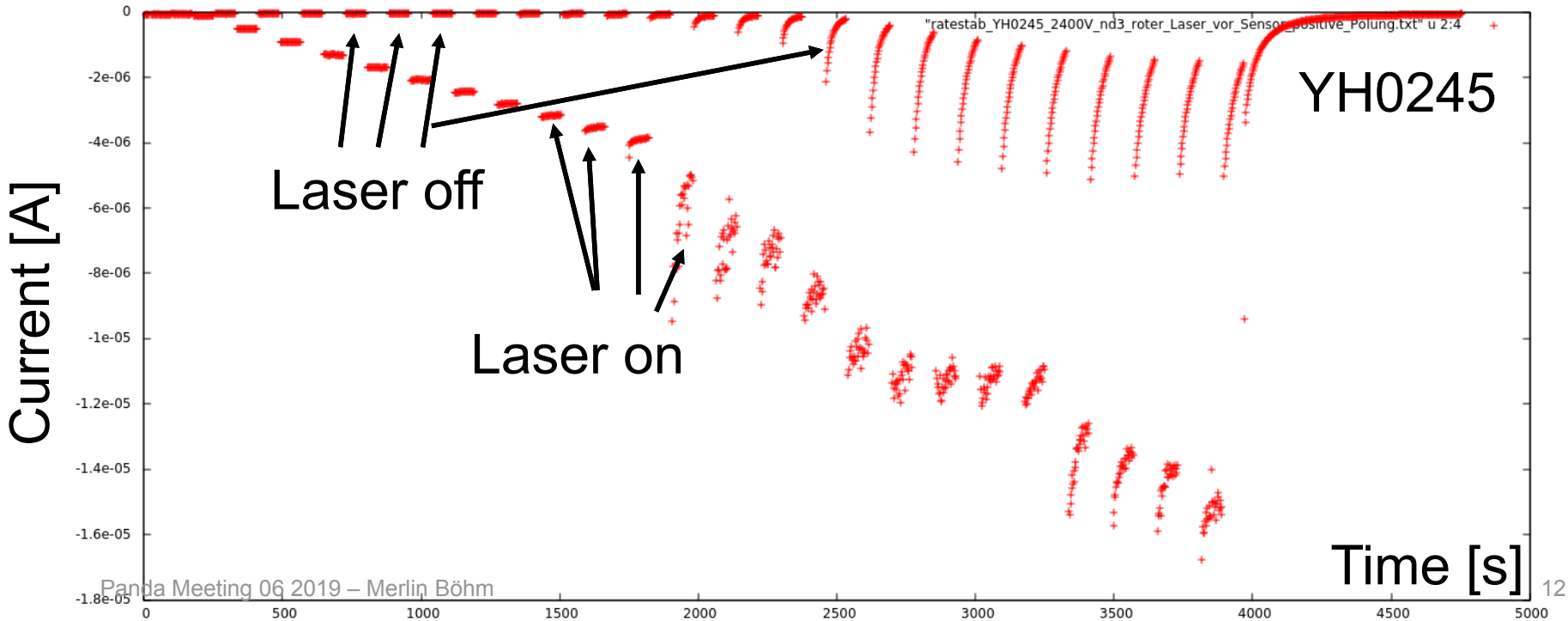
TRB measurements – Crosstalk behavior





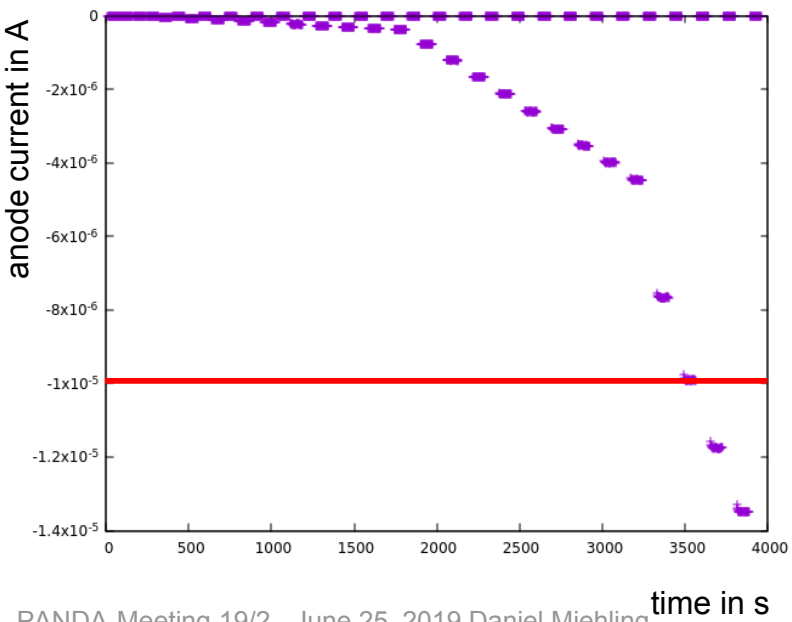
New feature: afterglowing?

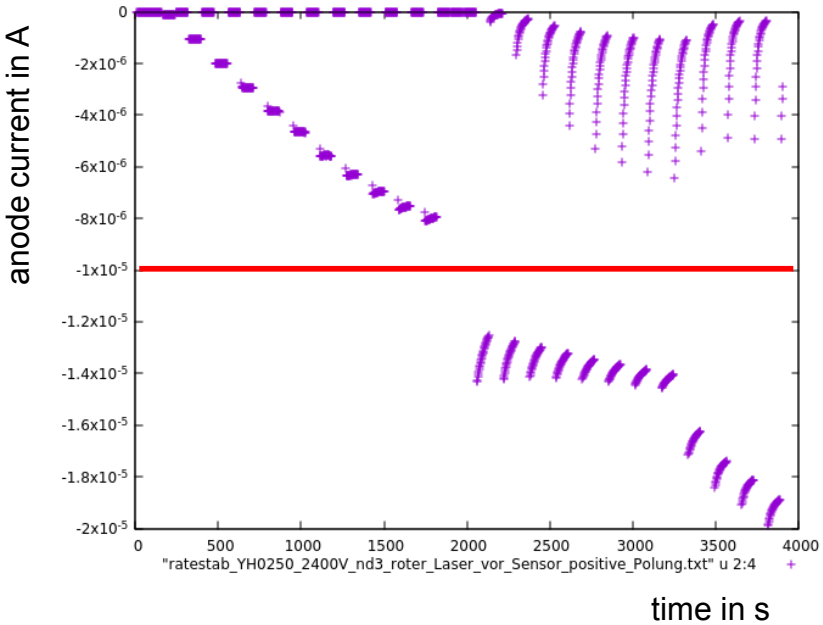
- After illuminating MCP-PMTs with high intensity light the darkcount rate is significantly increased
- The count rate decays within several seconds
- This effect can also be observed during our rate stability measurements:



New feature: afterglowing?

- left: Photonis 9001393-URD
- right: Hamamatsu YH0250
- red line corresponds to 2MHz photonrate per cm²





New feature: afterglowing?

- With current measurements: this feature seems to occur with both Photonis and Hamamatsu tubes and affects only ALD-tubes

- no effect:
  Photonis 9001341 (non-ALD tube)

- almost no or a small effect:
  Photonis 9001393 (two-ALD), 9001394 (ALD), 9002108 (ALD), 9002150 (ALD);
  Hamamatsu JS0026 (ALD?, Gießen), JS0035 (ALD)

- a strong effect:
  Hamamatsu YH0245 (ALD?, Gießen), YH0250 (ALD)

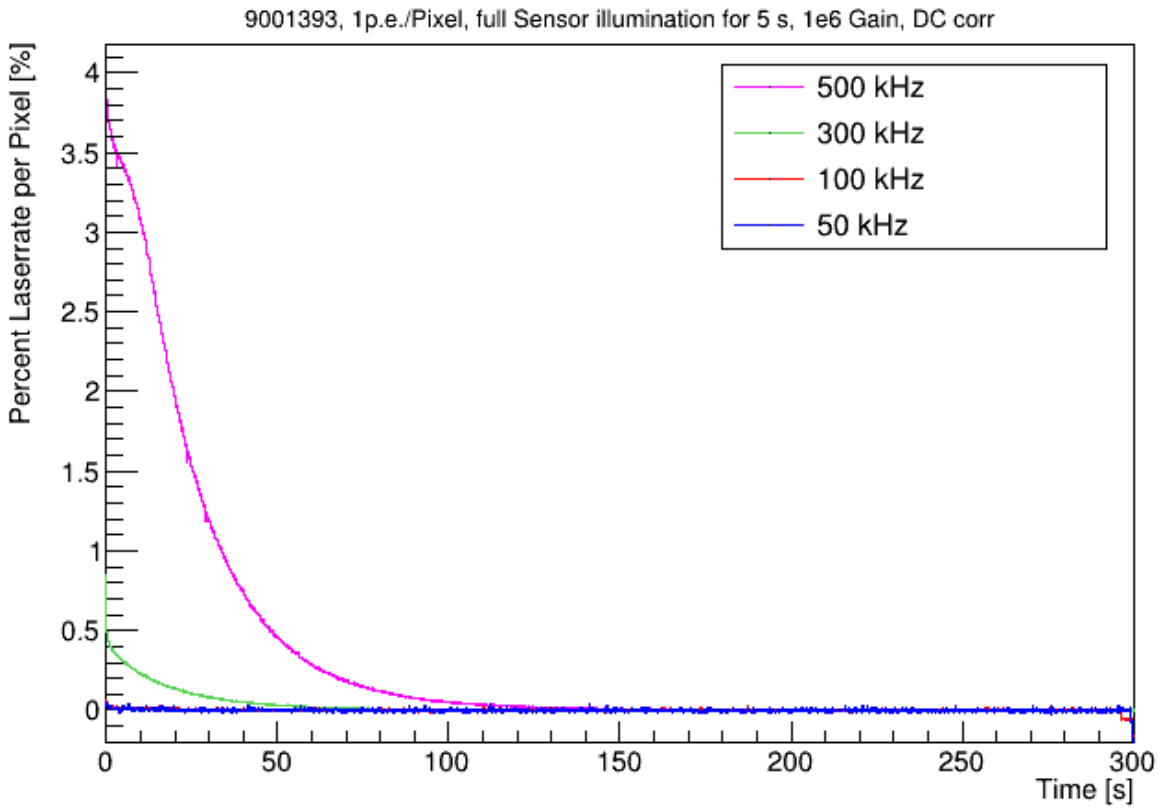
New feature: afterglowing?

- comment: the summary on the last slide is preliminary since (most of) the data is from old ratestability measurements and only „bycatch“

- more investigations needed with both current measurements and PADIWA and/or DiRiCH

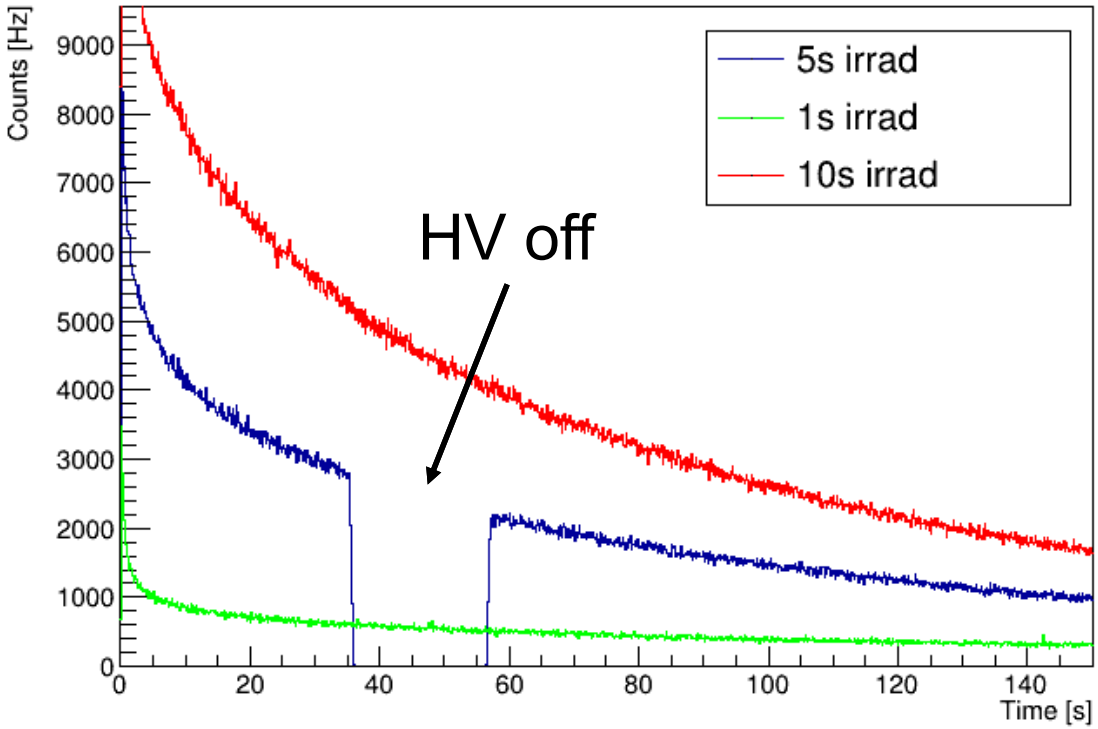
Afterglowing – further investigations with 9001393 with TRB

- Illuminating the full MCP-PMT PC for 5s with 1p.e./Pixel, then turn off the laser and measure the count rate
- Higher illumination intensity results in more afterglow
- Observed up to 10% afterglow events compared to the laser rate



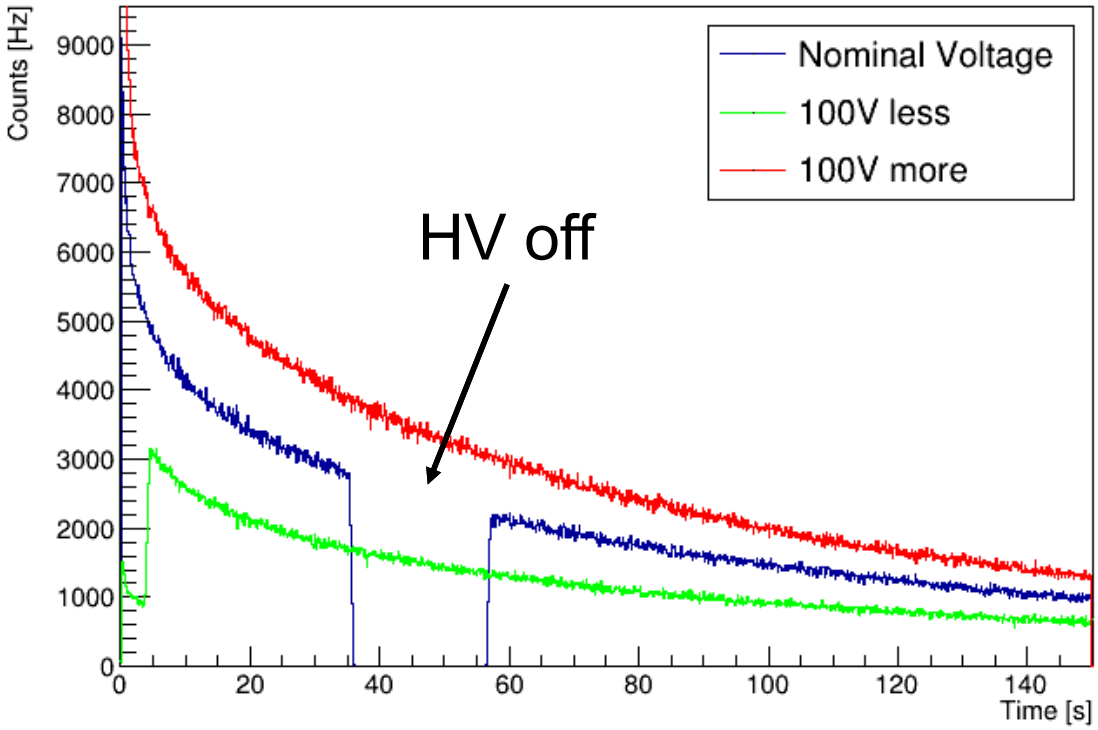
Afterglowing – further investigations with 9001393 with TRB

- Illuminating the full MCP-PMT PC for different amount of time with 1p.e./Pixel, then turn off the laser and measure the count rate
- Longer illumination intensity results in more afterglow
- Turning off the HV has no effect on the decay



Afterglowing – further investigations with 9001393 with TRB

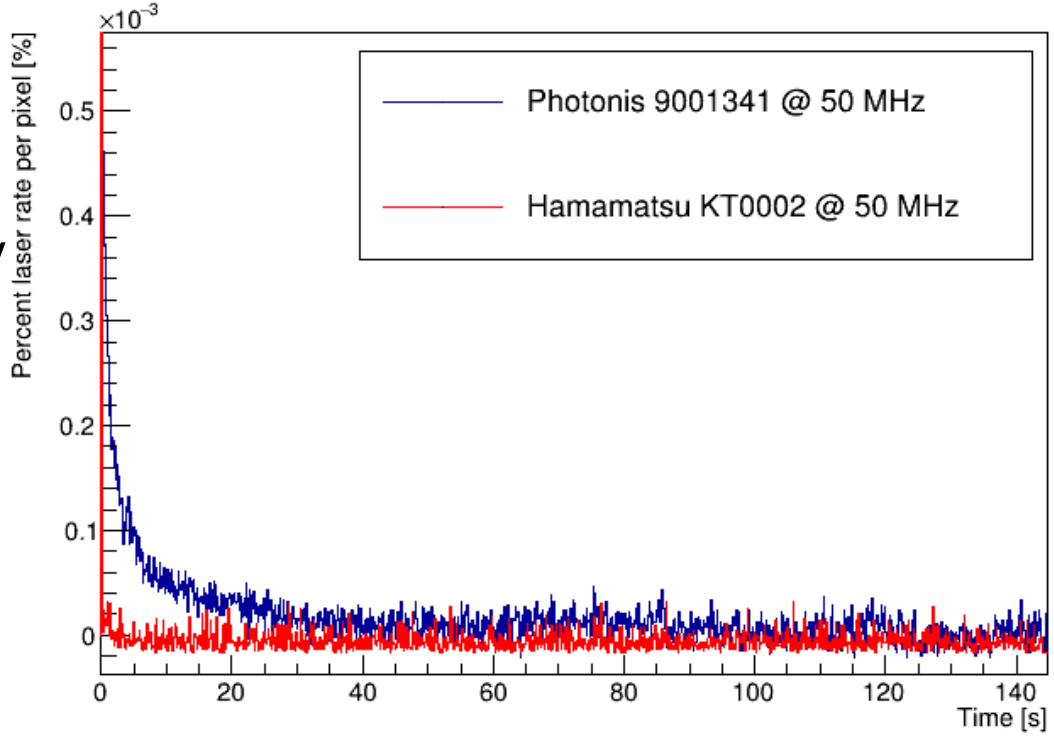
- Illuminating the full MCP-PMT PC for 5s with 1p.e./Pixel and altered HV, then turn off the laser and measure the count rate
- Amount of afterglow is gain dependent
- Turning off the HV has no effect on the decay



Afterglowing – further investigations

- Further observations:
- Afterglowing must be an effect of the ALD-Layer because:
- Only MCP-PMTs with ALD-Layer affected
- No afterglow when turning on only the PC bias voltage on during illumination

- Higher MCP resistance leads to more afterglow
- Photonis as well as Hamamatsu MCP-PMTs are affected



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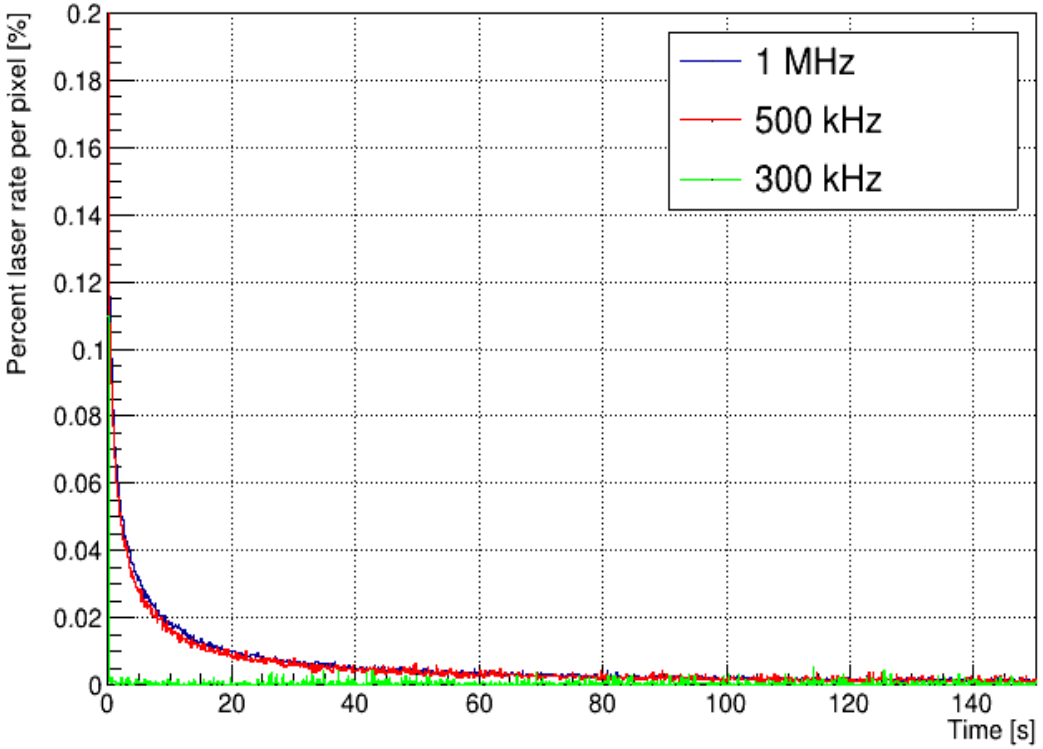
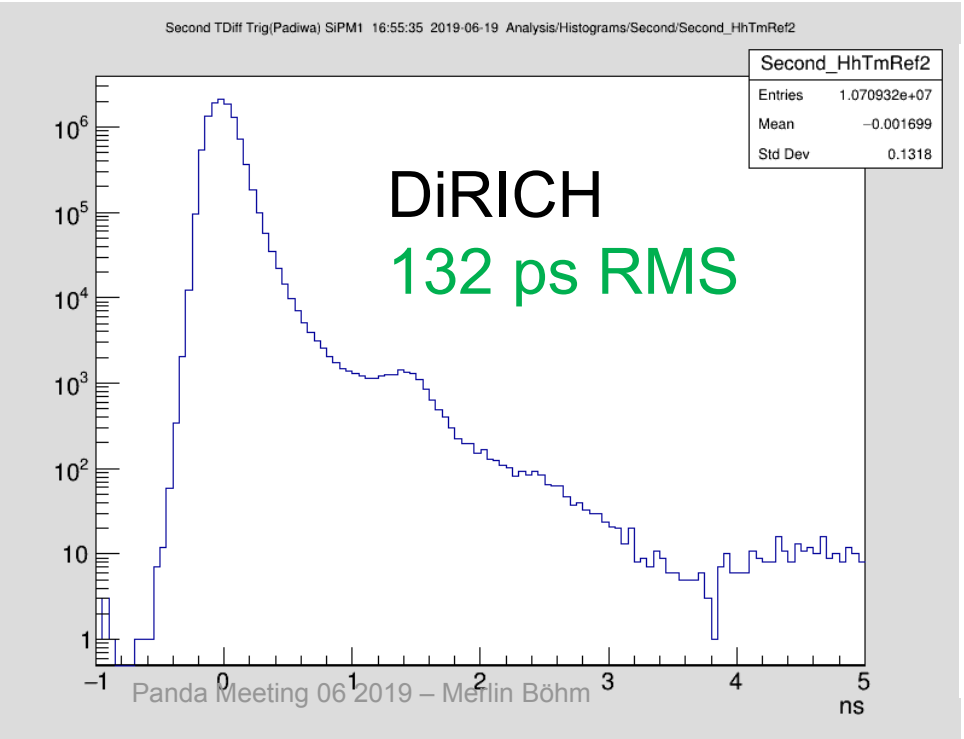
Hamamatsu YH0250

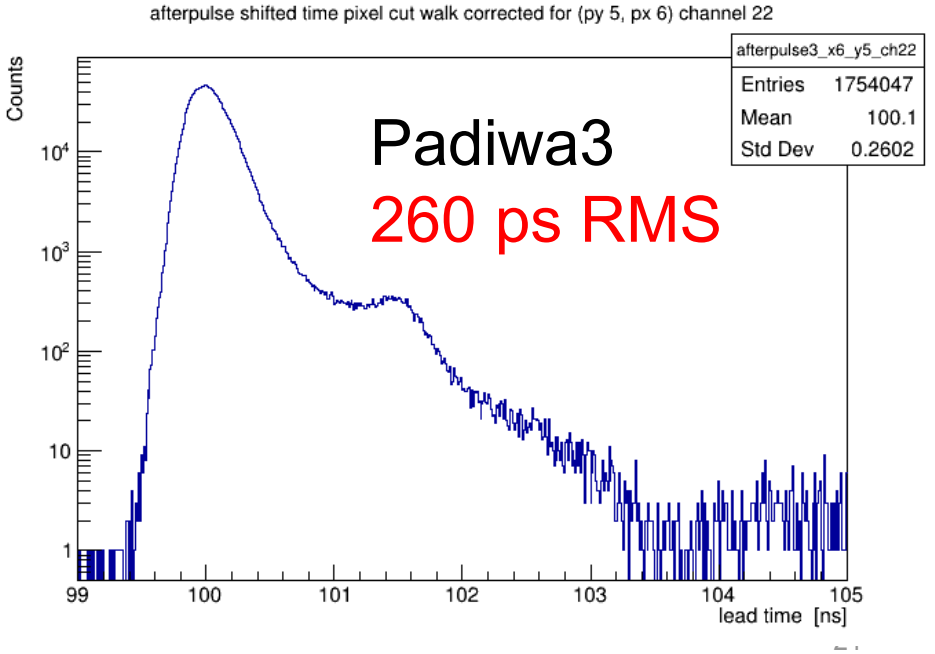


First DiRICH measurements

- Got a DiRICH system to test different input configurations of the DiRICH
- Time resolution measured with MCP-PMTs significantly better than Padiwa/TRB3



Photonis 2150



Summary

- Photonis 2150: Time resolution RMS of 171ps (scope) and ~279ps (PADIWA/TRB), but 132 ps with DiRich
- low darkcount rate and low afterpulse probability
- crosstalk behavior compared to 9002108 much better
- better ringing behaviour than former 9002108 tube

- MCP-PMT afterglowing after heavy illumination, is rate, duration, gain and MCP resistance dependent, investigation ongoing

- First DiRICH measurement very promising, but investigation ongoing