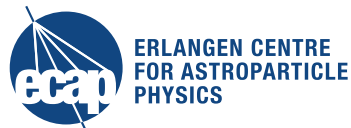


Update for quality assurance measurement setup for MCP-PMTs

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS

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Quality assurance for MCP-PMTs – Goals

- Need quality assurance (QA) of the ~300 MCP-PMTs for the DIRC detectors
- Efficient and semiautomatic measurement of:
 - Time resolution
 - Crosstalk
 - Darkcount rate
 - Afterpulsing
 - 2D quantum efficiency (QE)
 - QE vs. wavelength
 - 2D gain
 - Gain vs. Voltage
- For selected tubes further measurement of B-field behavior

Quality assurance for MCP-PMTs – Measurement Setup

- Surface scans using a 3-axis stepper with a PILAS Laser
- Using TRBv3 and PadiwaAmp2: time resolution, crosstalk, darkcount rate and afterpulsing, hopefully also gain
- Using Keithley 6487 picoamp: QE 2D
- Fallback solution for gain measurements using the picoamp

- TRB and Padiwa is a FPGA based DAQ
 - Padiwa FEE for discrimination
 - TRB for time and TOT measurement
 - DAQ is multihit capable

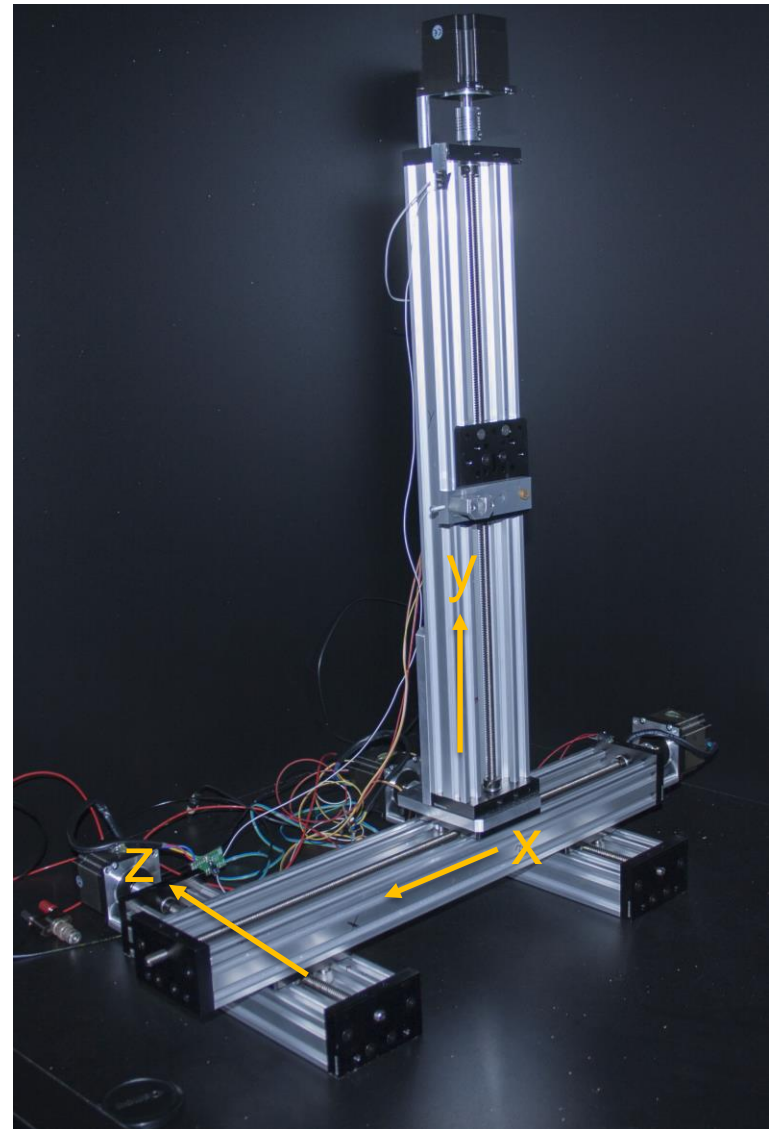
Measurement box

- Shielded with copper to block EMI

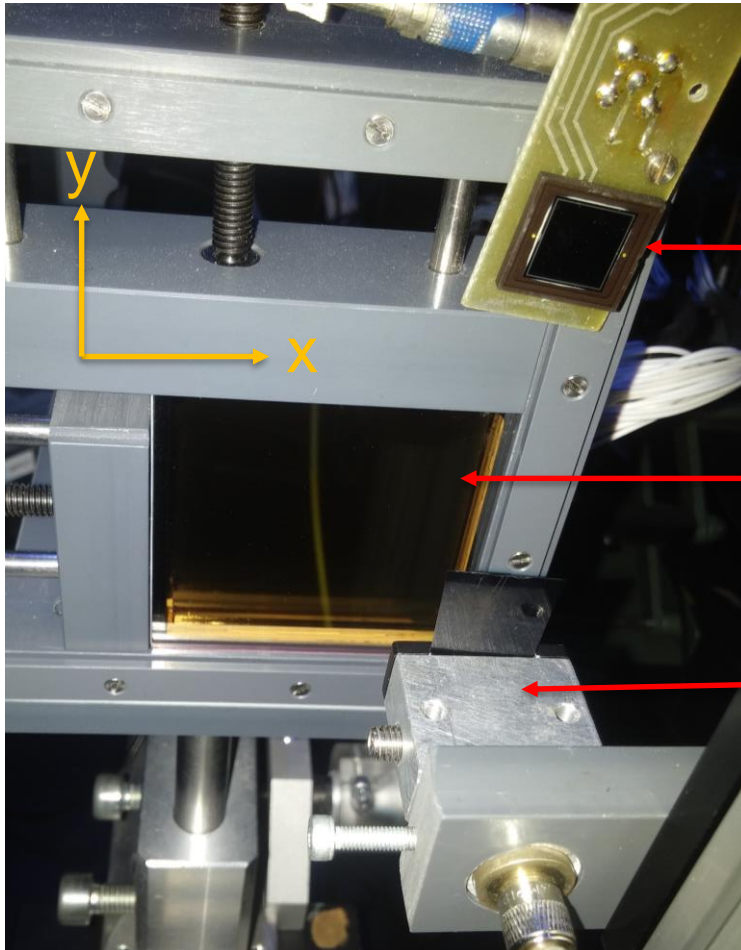


Stepper

- Total cost <500 €
- 3 axis stepper build from 4 linear actuators
- X and Y axis for sensor scanning, ~40 cm to drive
- Z axis for focusing the laser, ~15 cm to drive
- Position repetition accuracy below 5 μm
- Laser with microfocus and variable ND filter attached
- Spot size FWHM in focus ~10 μm
- With aperture FWHM ~30-40 μm



Measurement setup



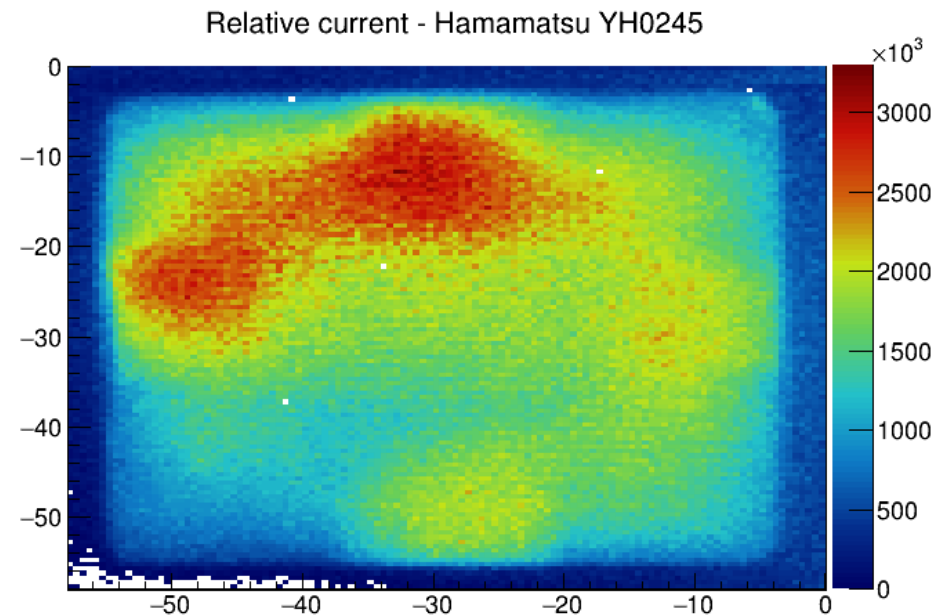
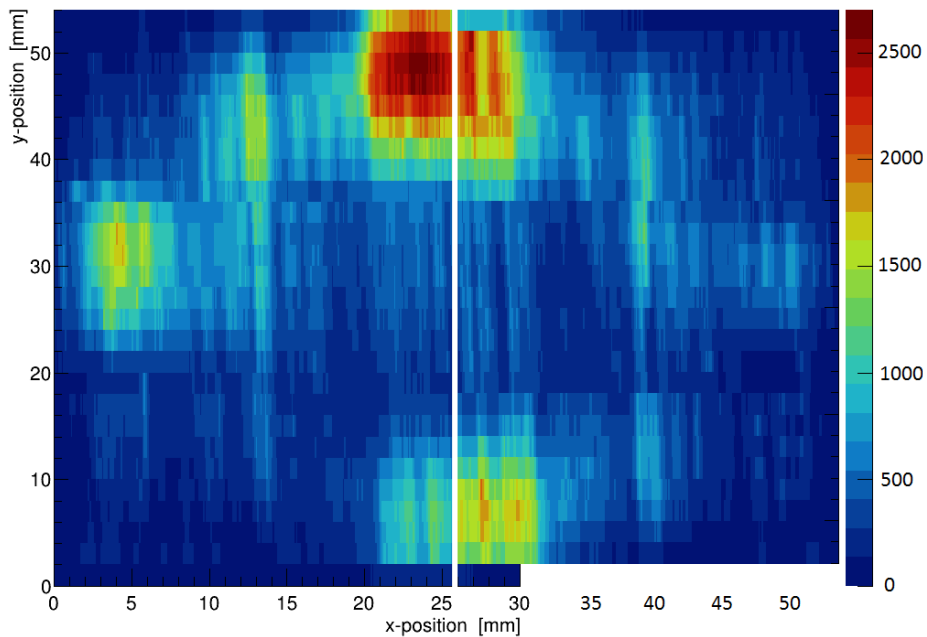
Photodiode

MCP-PMT

Laser with ND-Filter
or diffusor

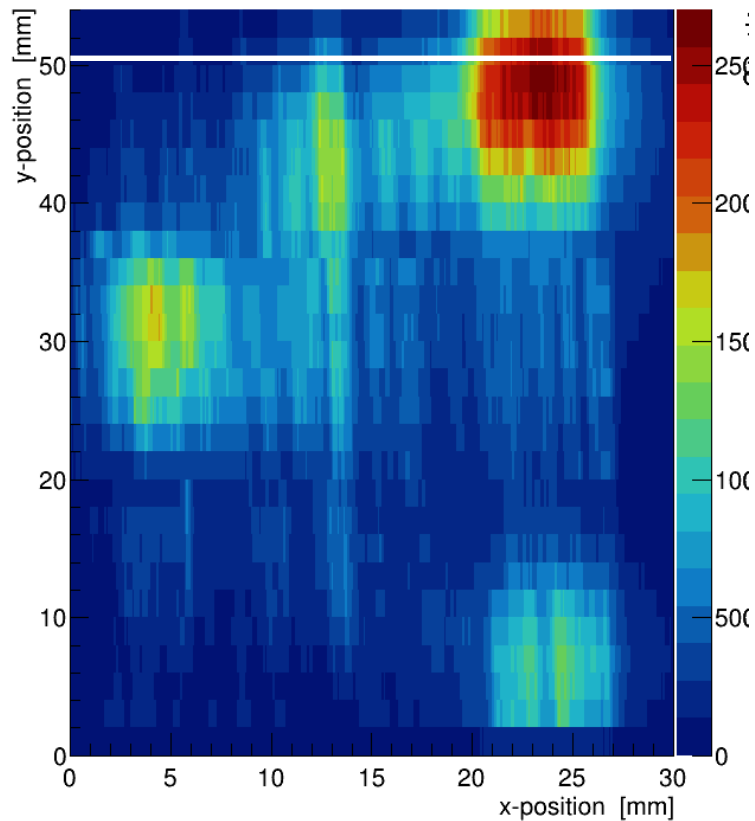
TRB scan of Hamamatsu R13266-07 YH0245

- Sensor has 128x6 pixels, for readout binned to 128x3 pixels
- Because of currently limited number of readout channels left and right half scanned independently
- Due to noise problems threshold set to 15mV, ~50%



TRB scan – Crosstalk

x-position vs y-position (with laser time cut) for (py 0, px 0) channel 0

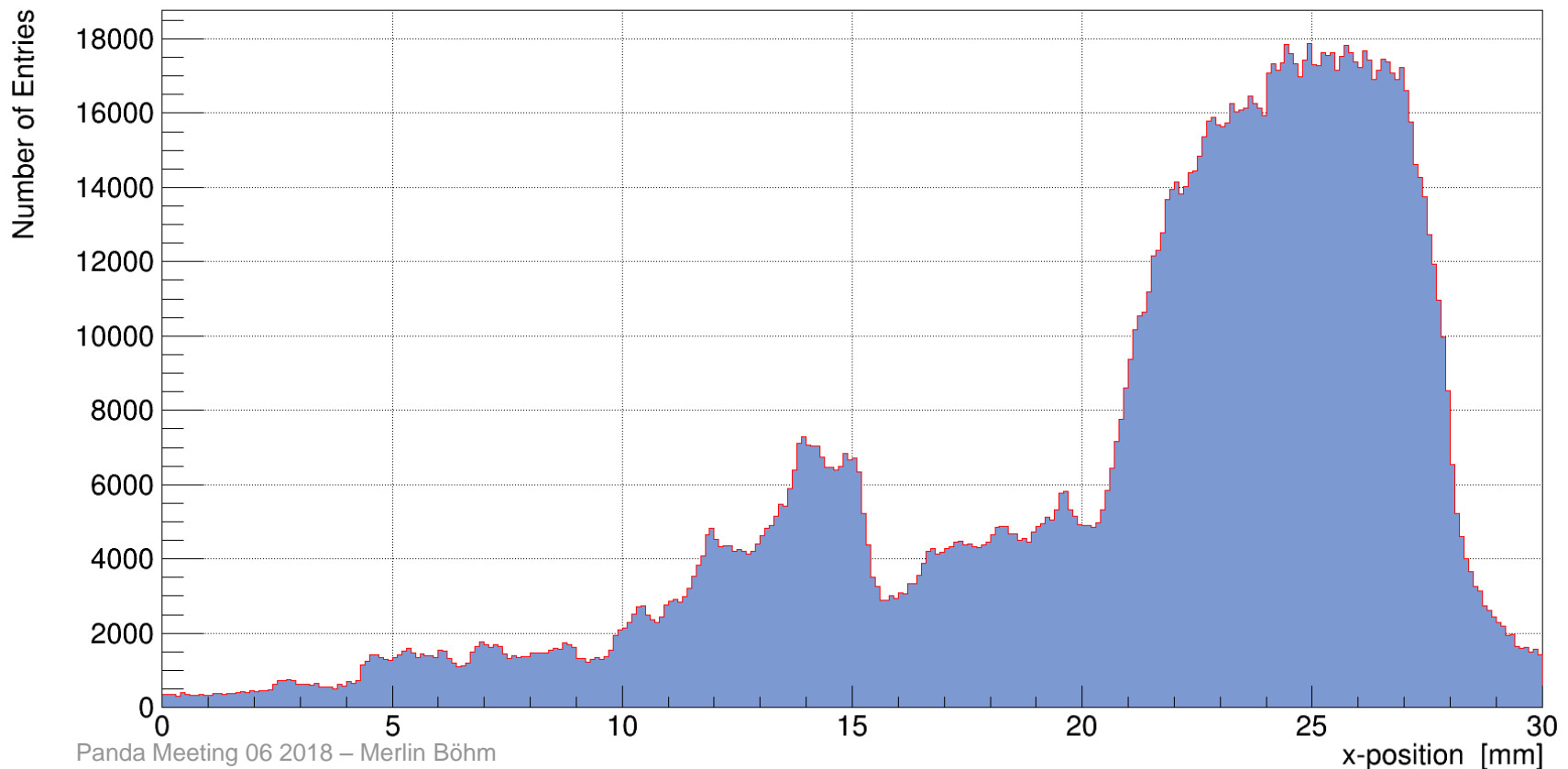


- Analysing crosstalk width
- Using left half of sensor

TRB scan – Crosstalk

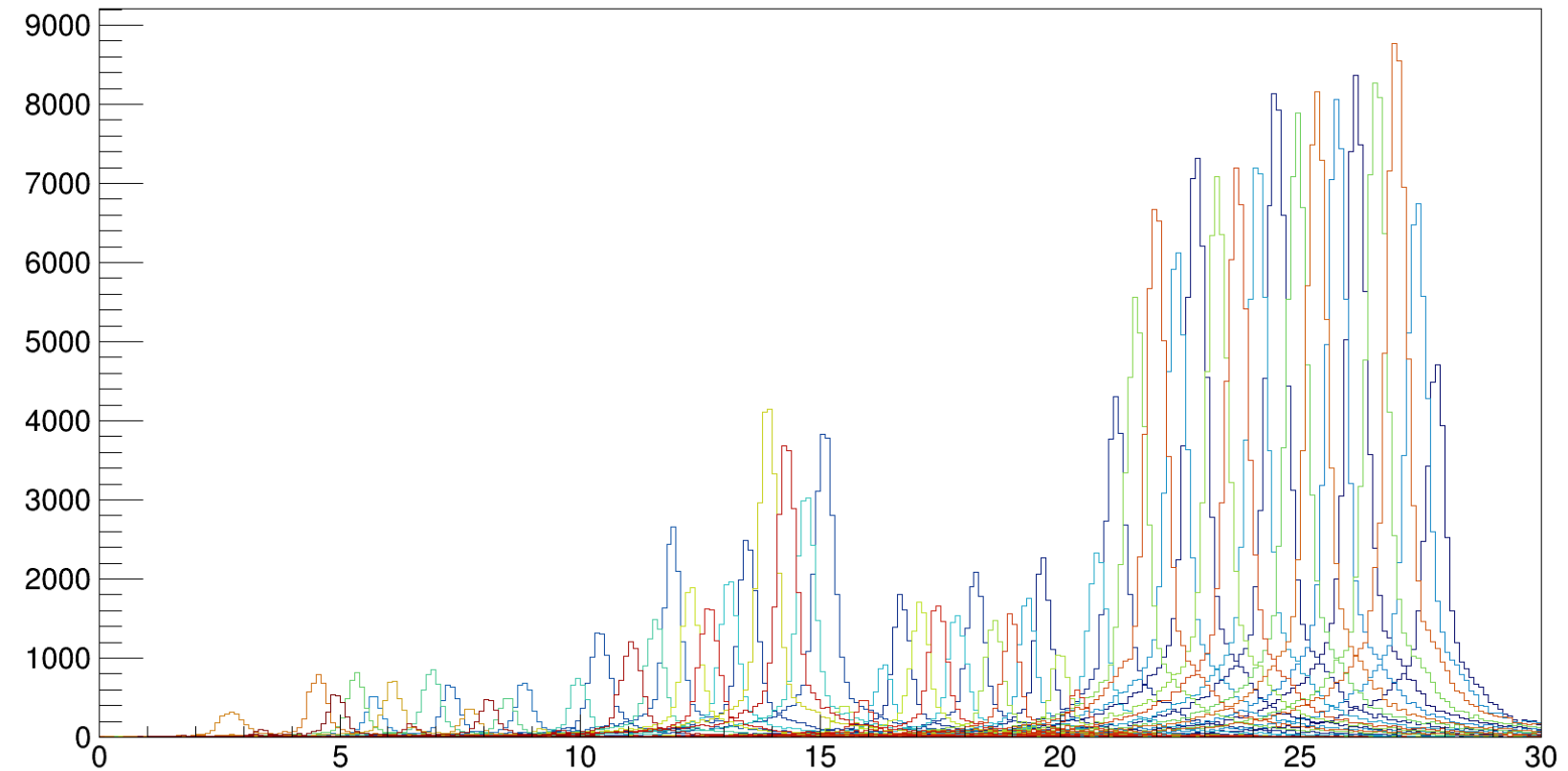
- Profile of the sum of all pixels

ProjectionX of biny=26 [y=50.0..52.0]



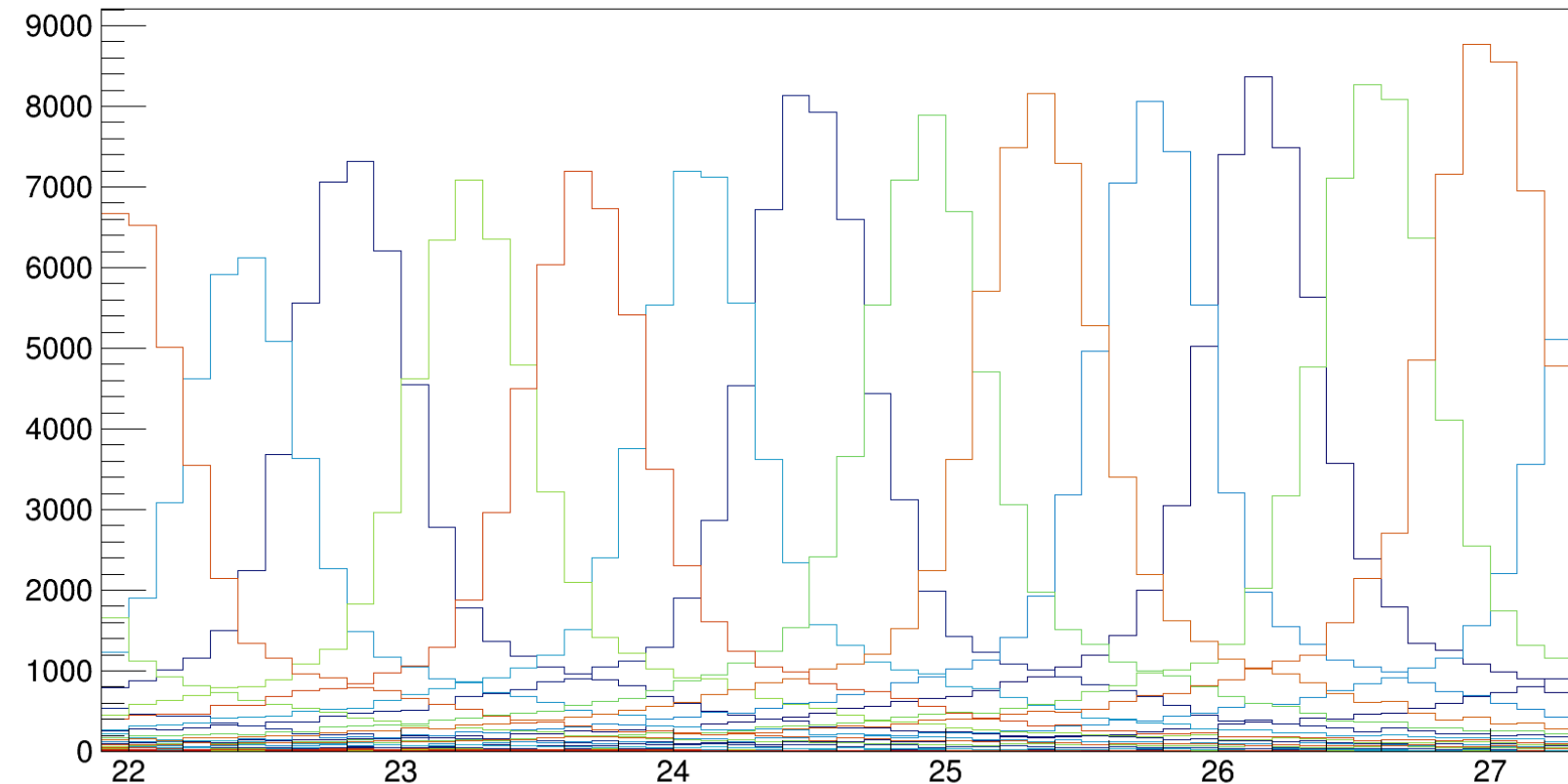
TRB scan – Crosstalk

- Profile of the individual pixels



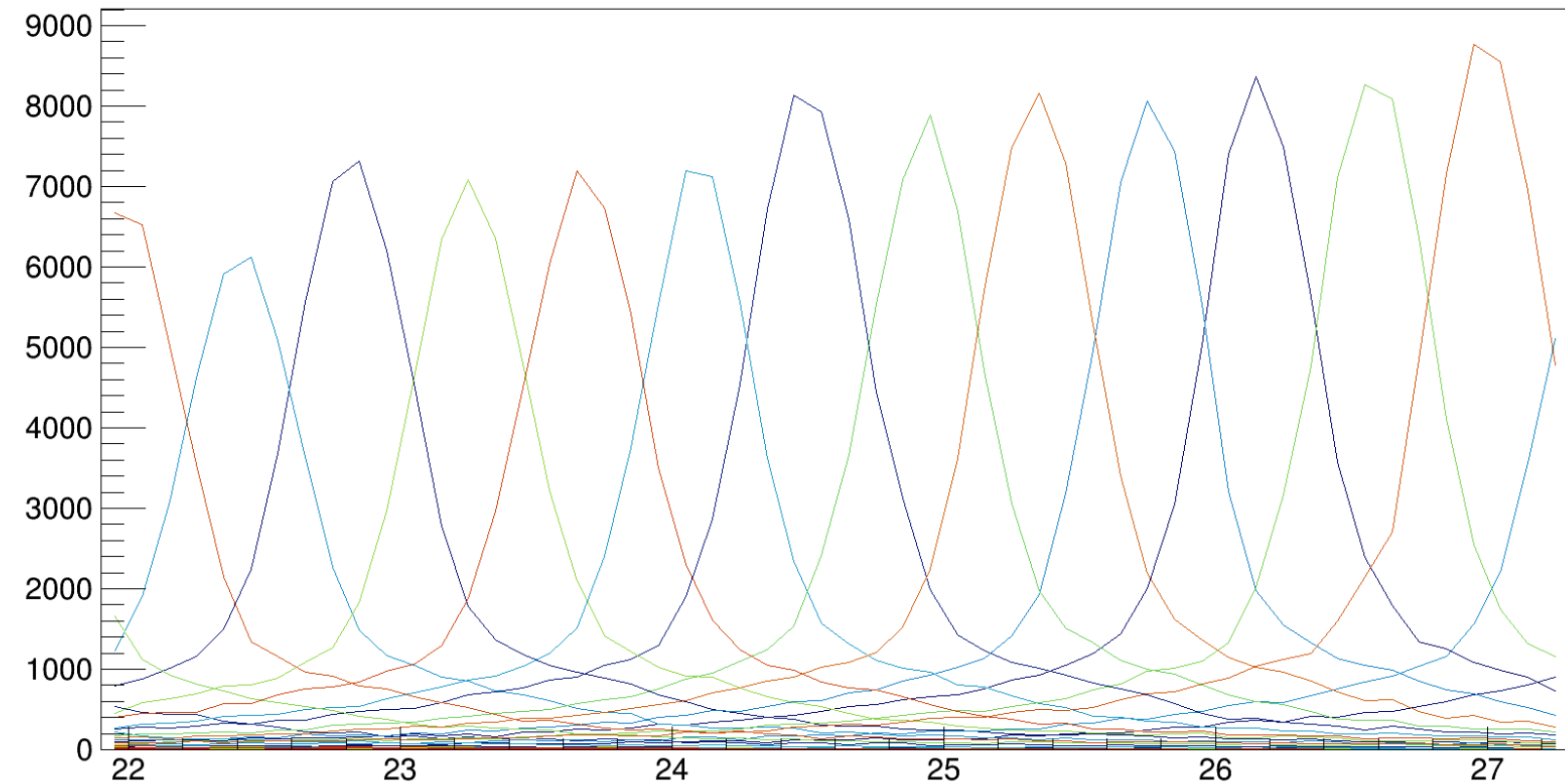
TRB scan – Crosstalk

- Profile of the individual pixels



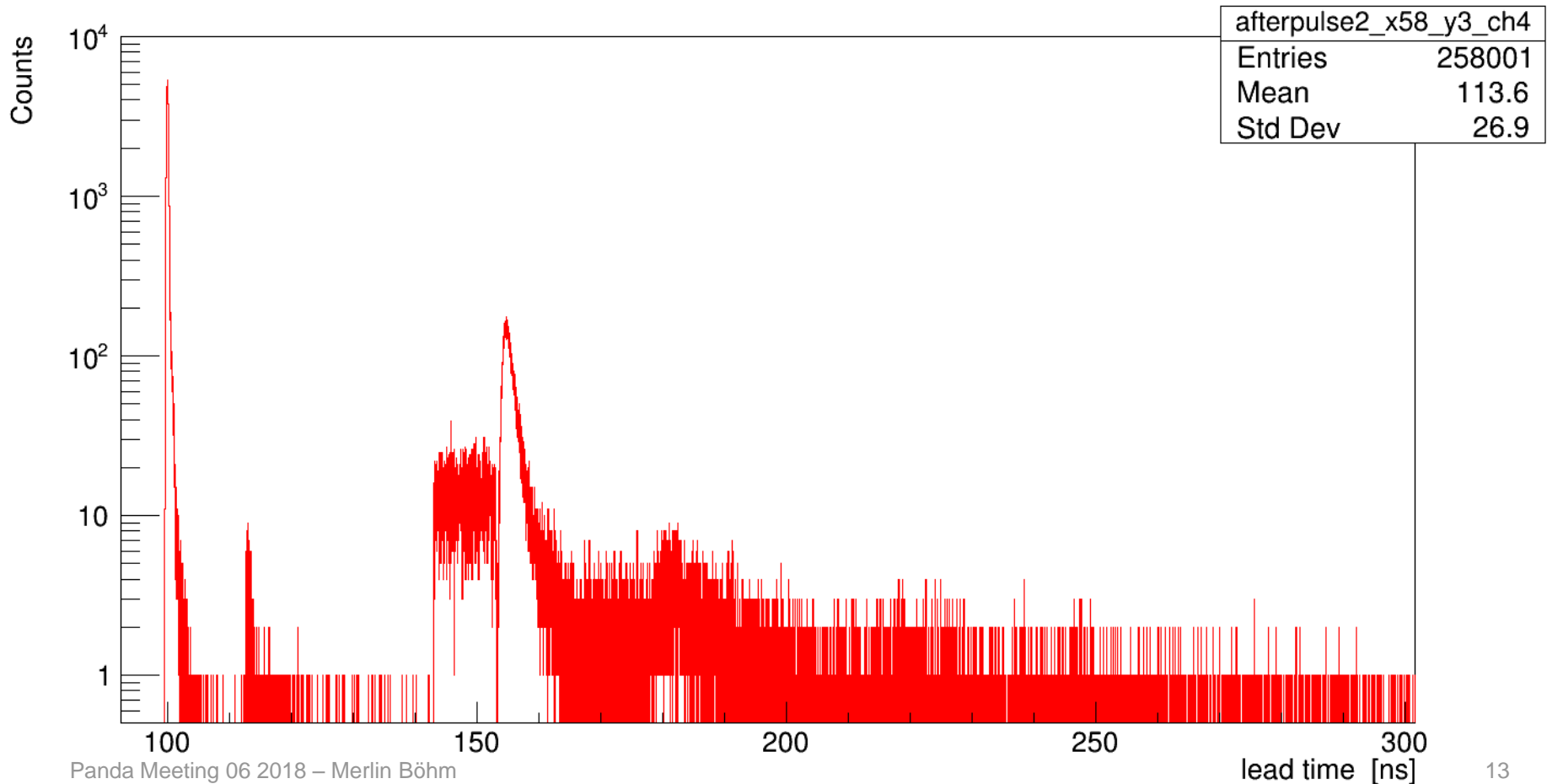
TRB scan – Crosstalk

- Profile of the individual pixels



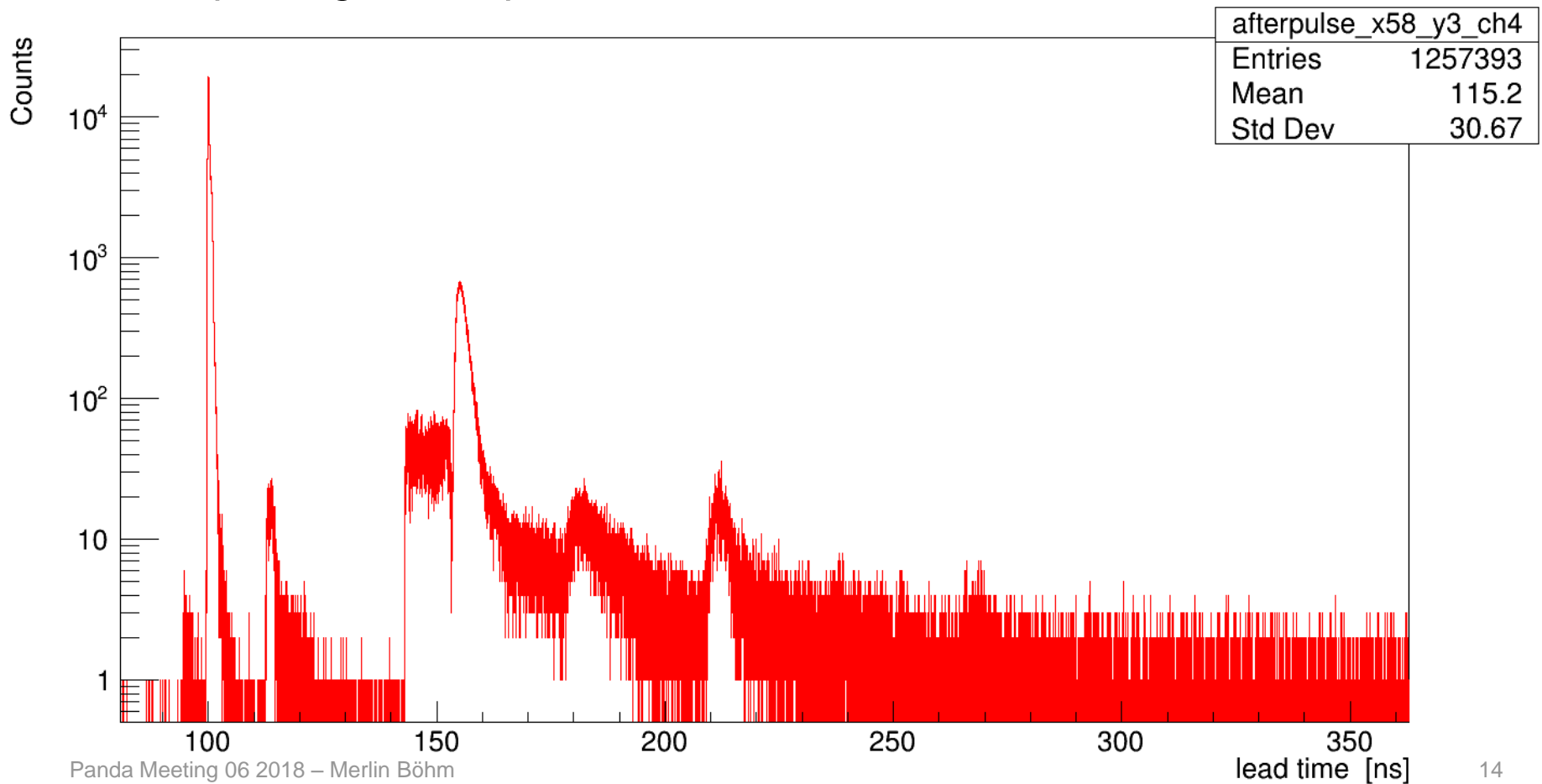
TRB scan – Afterpulsing

- Afterpulsing of one pixel, cut on laser position on the pixel



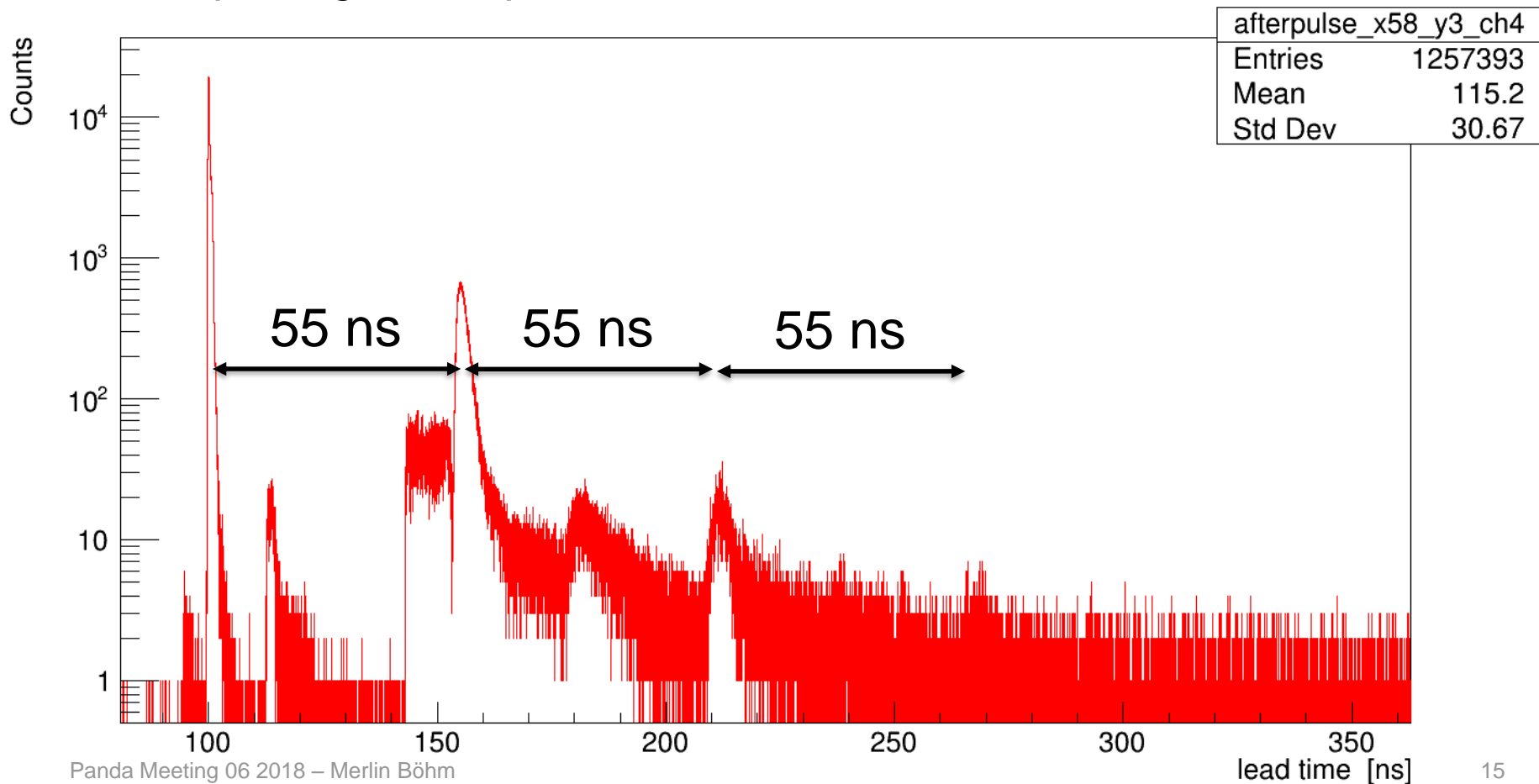
TRB scan – Afterpulsing

- Afterpulsing of one pixel, for all events



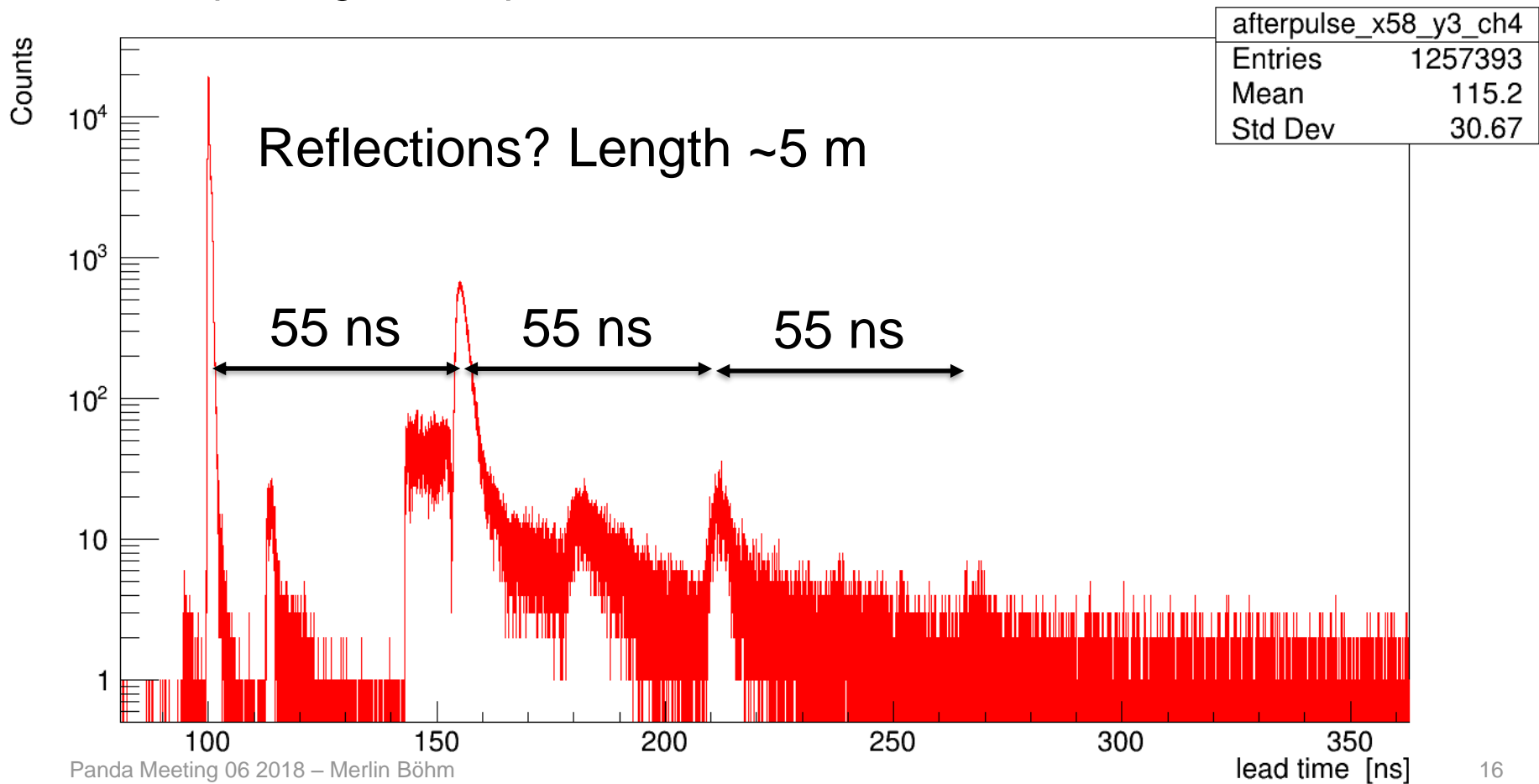
TRB scan – Afterpulsing

- Afterpulsing of one pixel, for all events



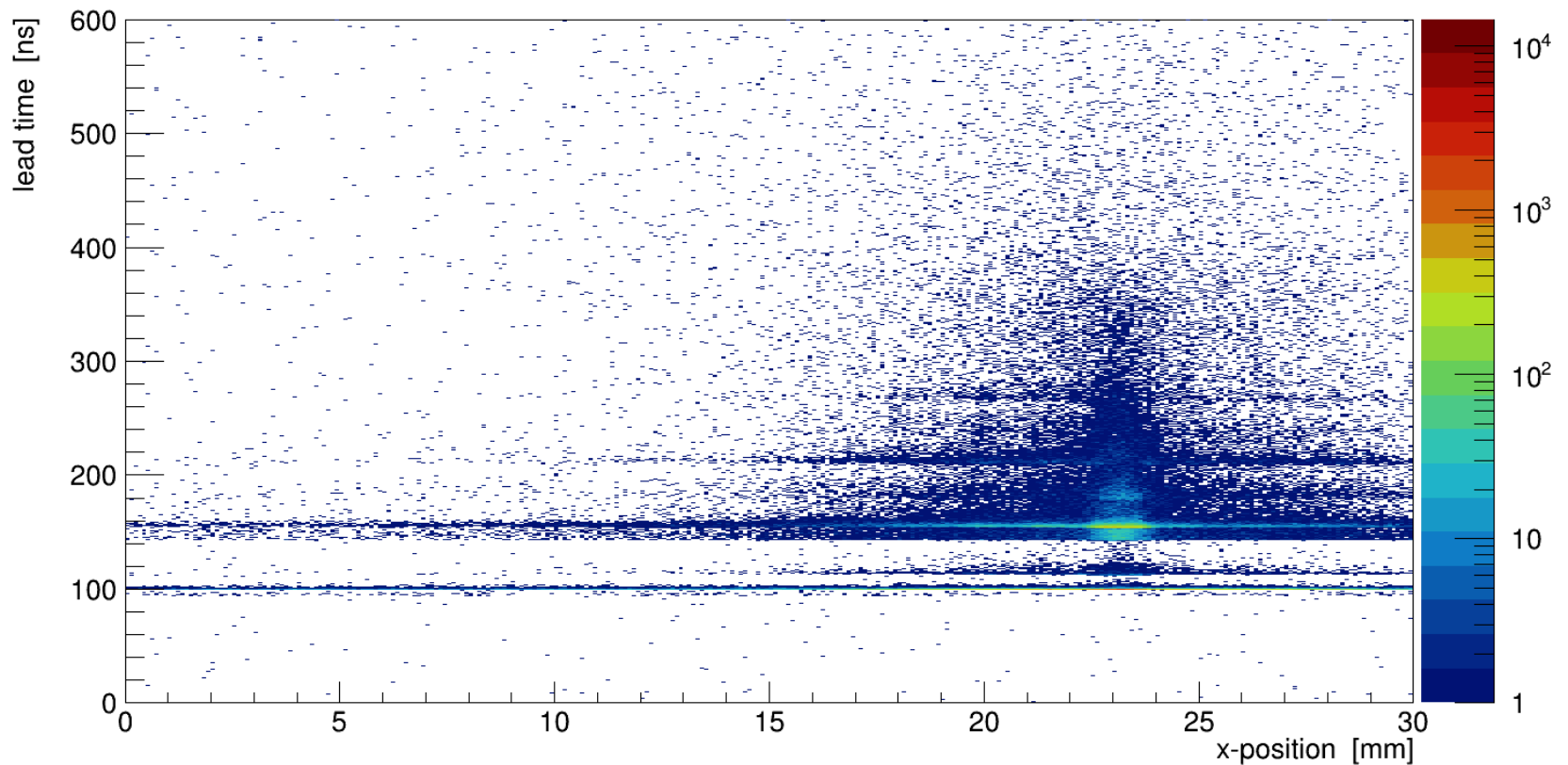
TRB scan – Afterpulsing

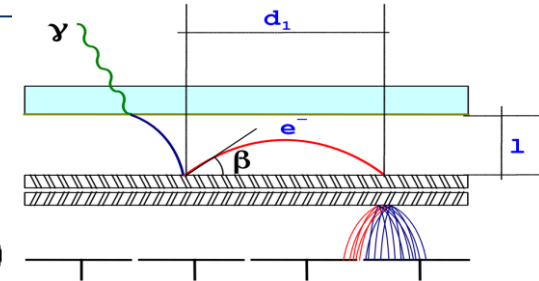
- Afterpulsing of one pixel, for all events



TRB Scans – Time spectrum

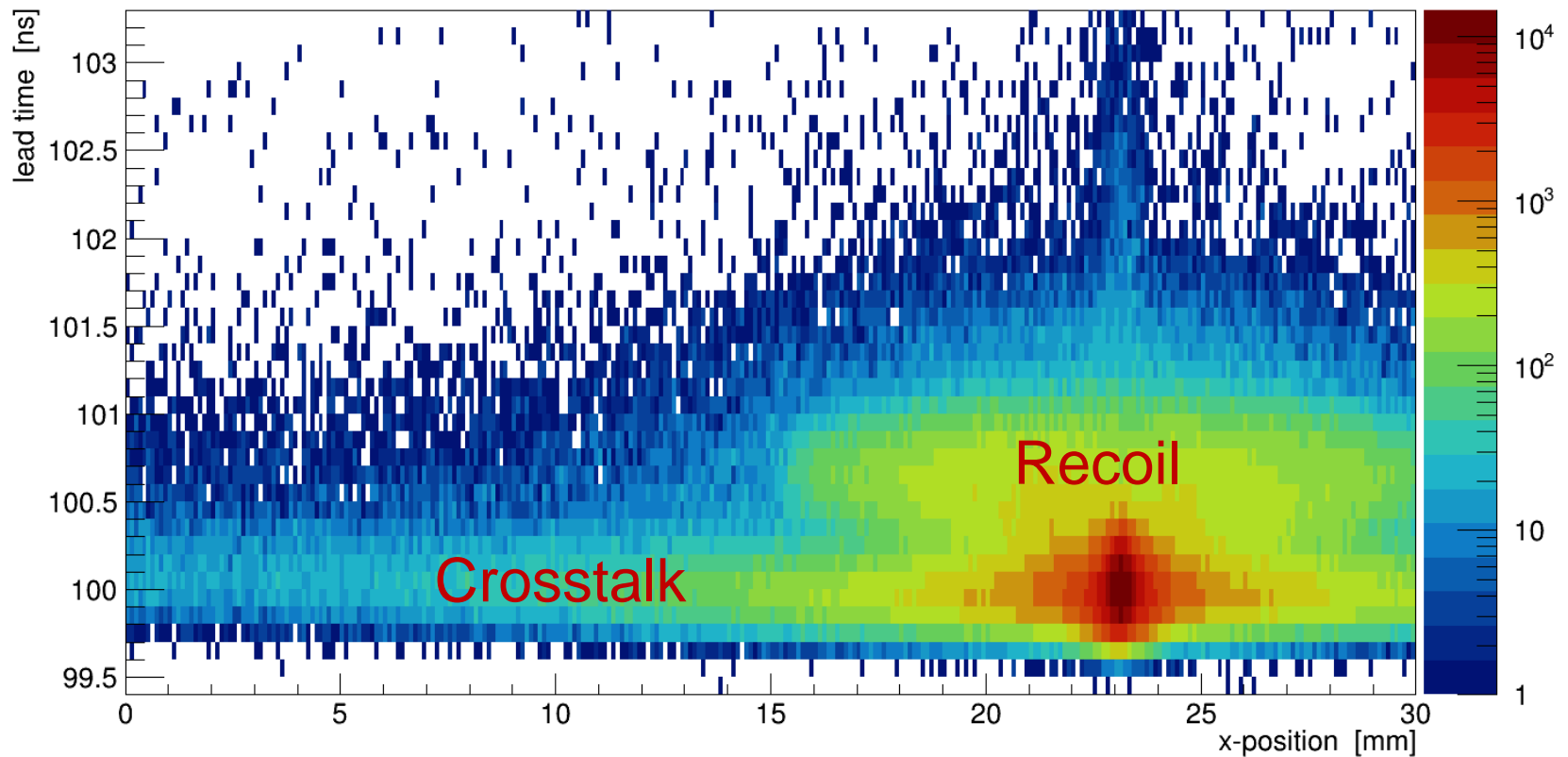
x-position vs leadtime (all hits) for (py 3, px 58) channel 4





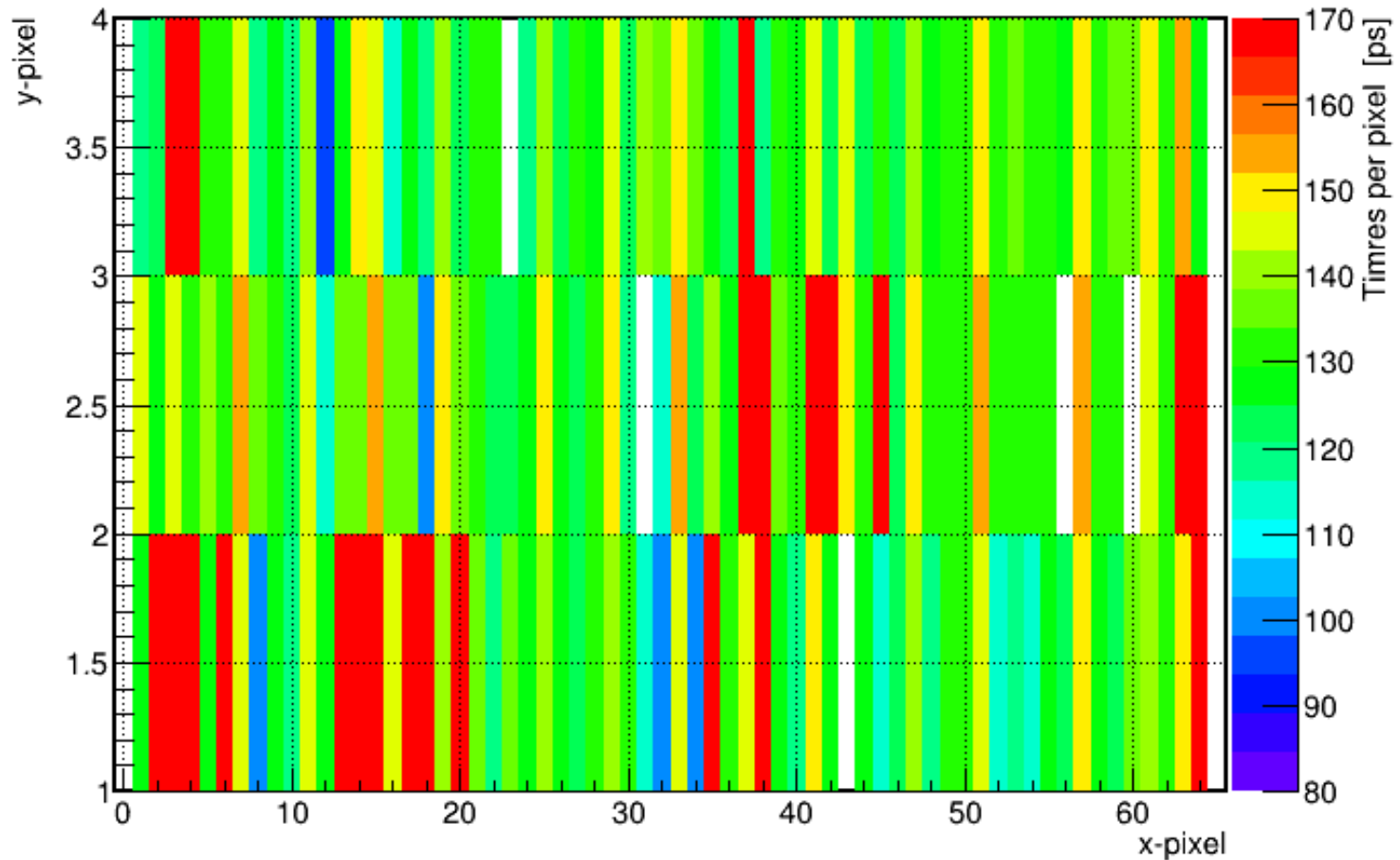
TRB Scans – Time spectrum

x-position vs leadtime (all hits) for (py 3, px 58)

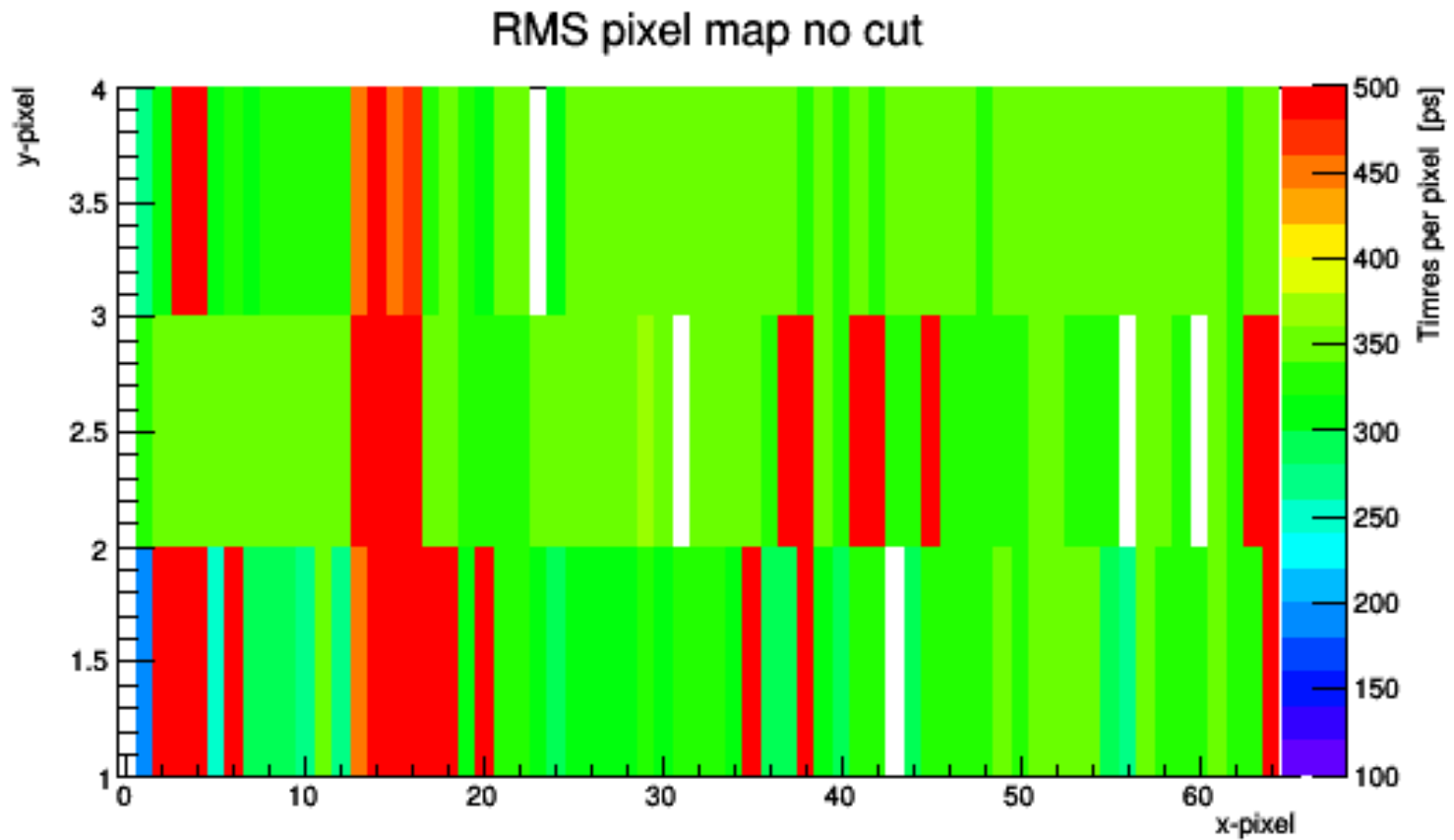


TRB scans – Time resolution sigma

Timeres pixel map

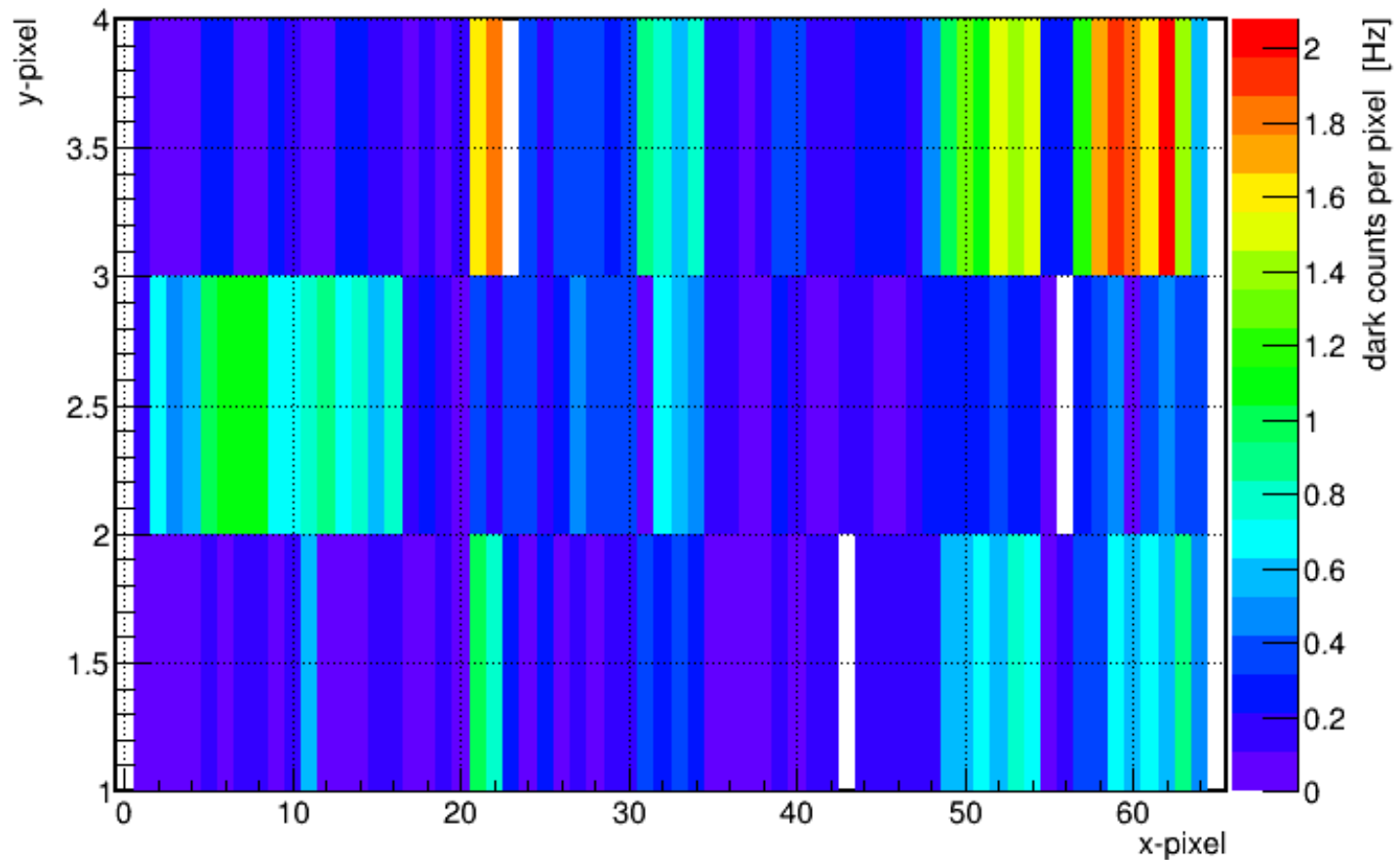


TRB scans – Time resolution RMS



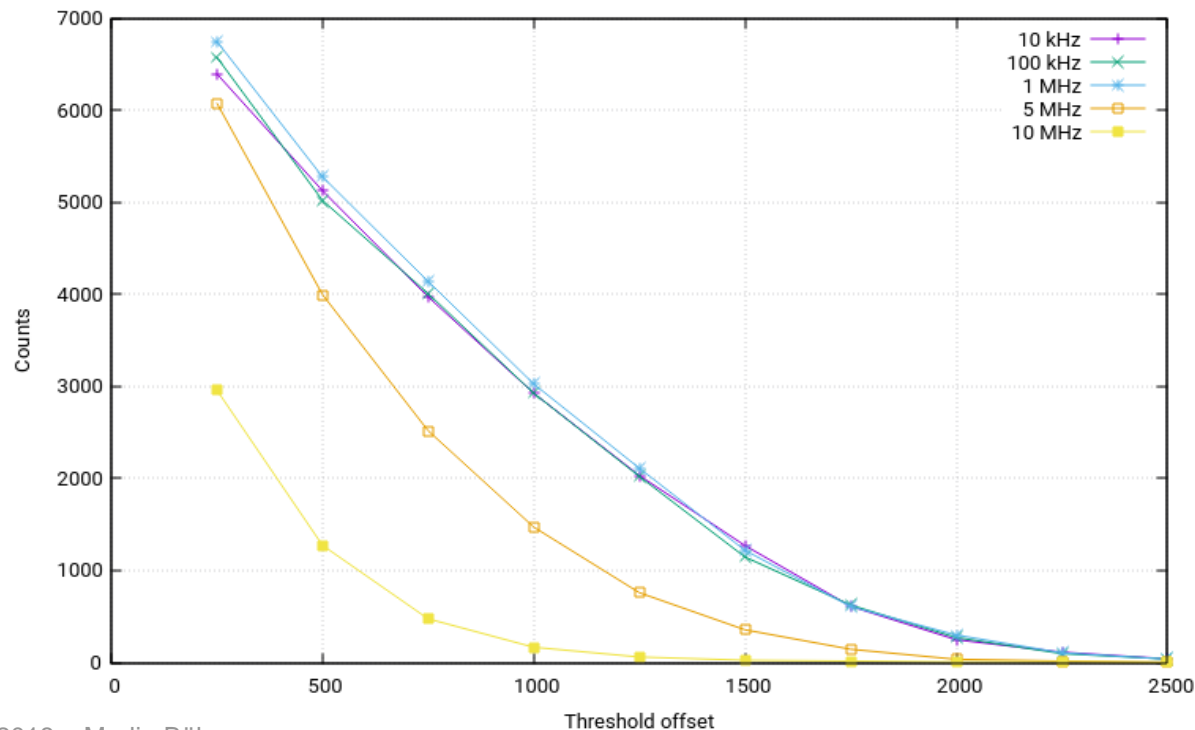
TRB scans – Dark counts

darkcount pixel map



Current status – measuring rate stability with TRB DAQ

- Sensor fully illuminated with single photons
- TOT does not change when MCPs saturates and the gain drops
- Measuring the count rate vs. threshold offset and laser rate

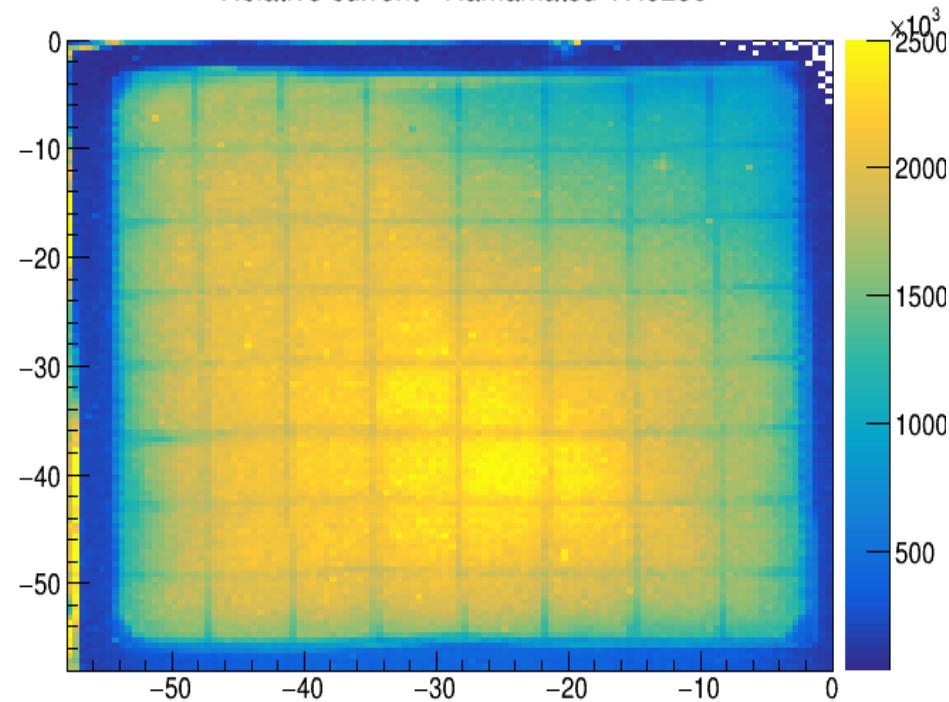


Hamamatsu
YH0250

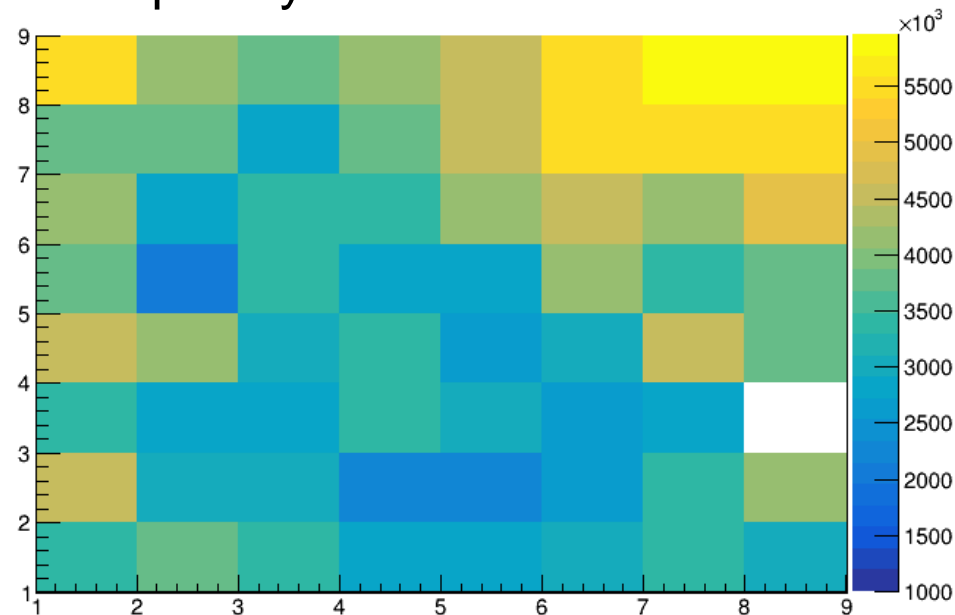
Current status – measuring rate stability with TRB DAQ

- Comparing gain distribution with frequency dependent gain drop

Relative current - Hamamatsu YH0250



Frequency when count rate <80%

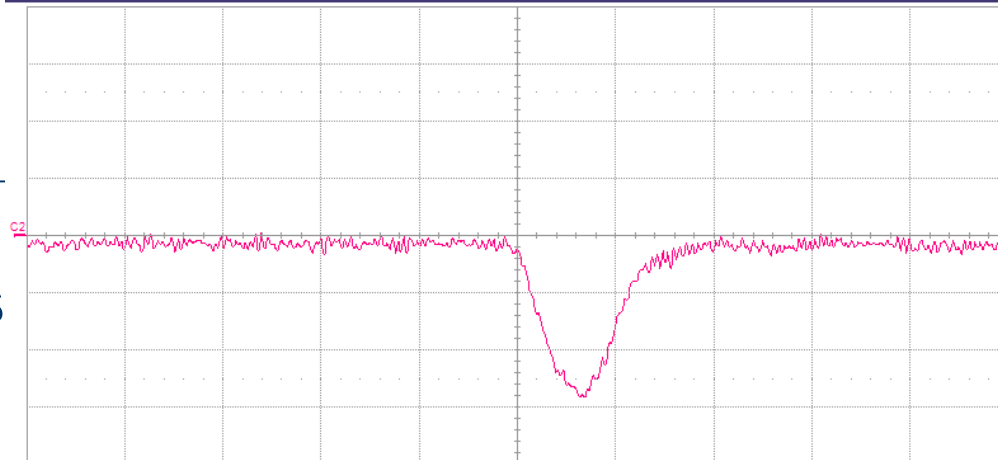


First measurements with PadiwaAmp2

- Can measure charge
- Have small transformer to eliminate noise
- Amplification similar to DiRich
- Time resolution with MCP signals ~ 130 ps, similar to Padiwa1 and 3
- Still waiting for working scripts for threshold searching and setting,...

First meas

- Can measu
- Have small
- Amplificatic
- Time resol



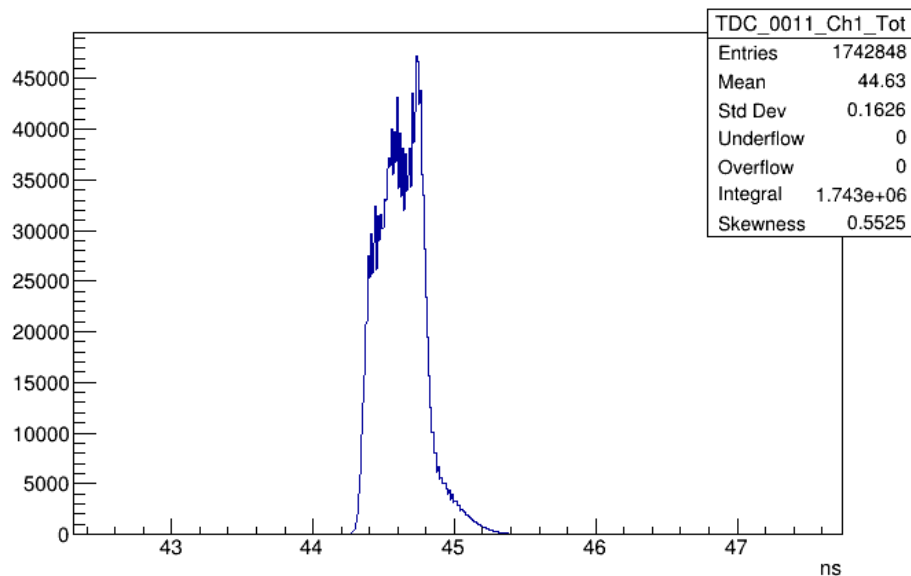
Measure	P1:ampl(C2)	P2:area(C2)	P3:wid@lv(C1)	P4:wid@lv(C2)	P5:dt@lv(F3,F4)	P6:time@lv(Z1)	P7:area(C2)	P8:area(C4)
value	57.15 mV	-236.520 pVs						
mean	55.3857 mV	-211.11643 pVs						
min	36.34 mV	-241.939 pVs						
max	60.02 mV	-176.367 pVs						
sdev	2.8828 mV	10.75590 pVs						
num	2.748e+3	2.748e+3						
status		.R.						

C2 DCS0
20.0 mV/div
0.00 mV ofst
LeCroy

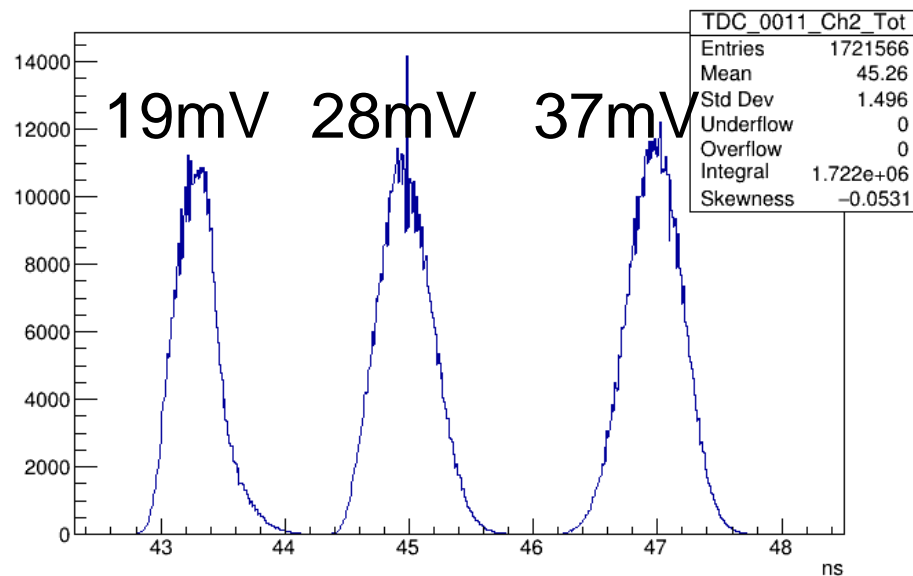
Timebase -100 ps Trigger C2
5.00 ns/div Stop -10.2 mV
1.00 kS 20 GS/s Edge Negative
6/4/2018 7:58:29 PM

adiwa1 and 3

TDC_0011 Ch1 Time over threshold 19:45:23 2018-06-04 Analysis/Histograms/TDC_0011/Ch1/TDC_0011_Ch1_Tot



TDC_0011 Ch2 Time over threshold 19:45:15 2018-06-04 Analysis/Histograms/TDC_0011/Ch2/TDC_0011_Ch2_Tot



Summary and Outlook

- Summary:
 - DAQ extended to 192 channels
 - First PadiwaAmp2 running
- Outlook:
 - Need investigation of YH0245 results
 - Getting used to MCPs with high amount of channels
 - Still waiting for DIRICH DAQ for test measurements
 - Expand DAQ to >300 channels

