

Timing performance of the SciTil Semi final results

Marius Chirita

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M. Böhm, A. Lehmann and the PANDA SciTil group

Outline

- Introduction
- Measurement Vienna
- Measurement Erlangen
- Conclusion

Introduction

Measurement Vienna

We did a bias- and a pulse height profile and optimized the PSI amplifier

Scintillators: EJ-232, EJ-228

New Hamamatsu SiPMs: S13360-3050-PE

Electronics: Photonique preamplifier

DAQ: Oscilloscope Lecroy waverunner 640zi

Measurement Erlangen

We did a position resolution scan across the whole scintillator surface after optimizing the threshold, the bias voltage and the wrapping. Highlights are presented

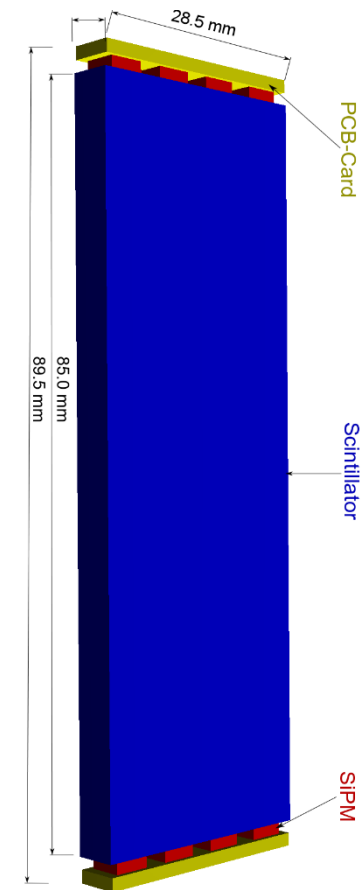
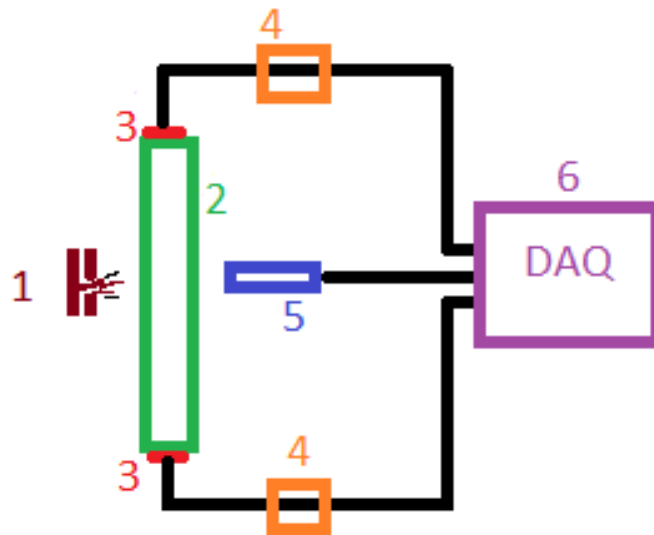
Scintillators: EJ-232, EJ-228

New Hamamatsu SiPMs: S13360-3050-PE

Electronics: 3 different versions of PSI amplifier (SMI, Erlangen, UK)

DAQ: VME 775

Measurement Vienna experimental setup



1... Sr90 source

2... Scintillator EJ-232, EJ-228

3... Hamamatsu SiPM boards

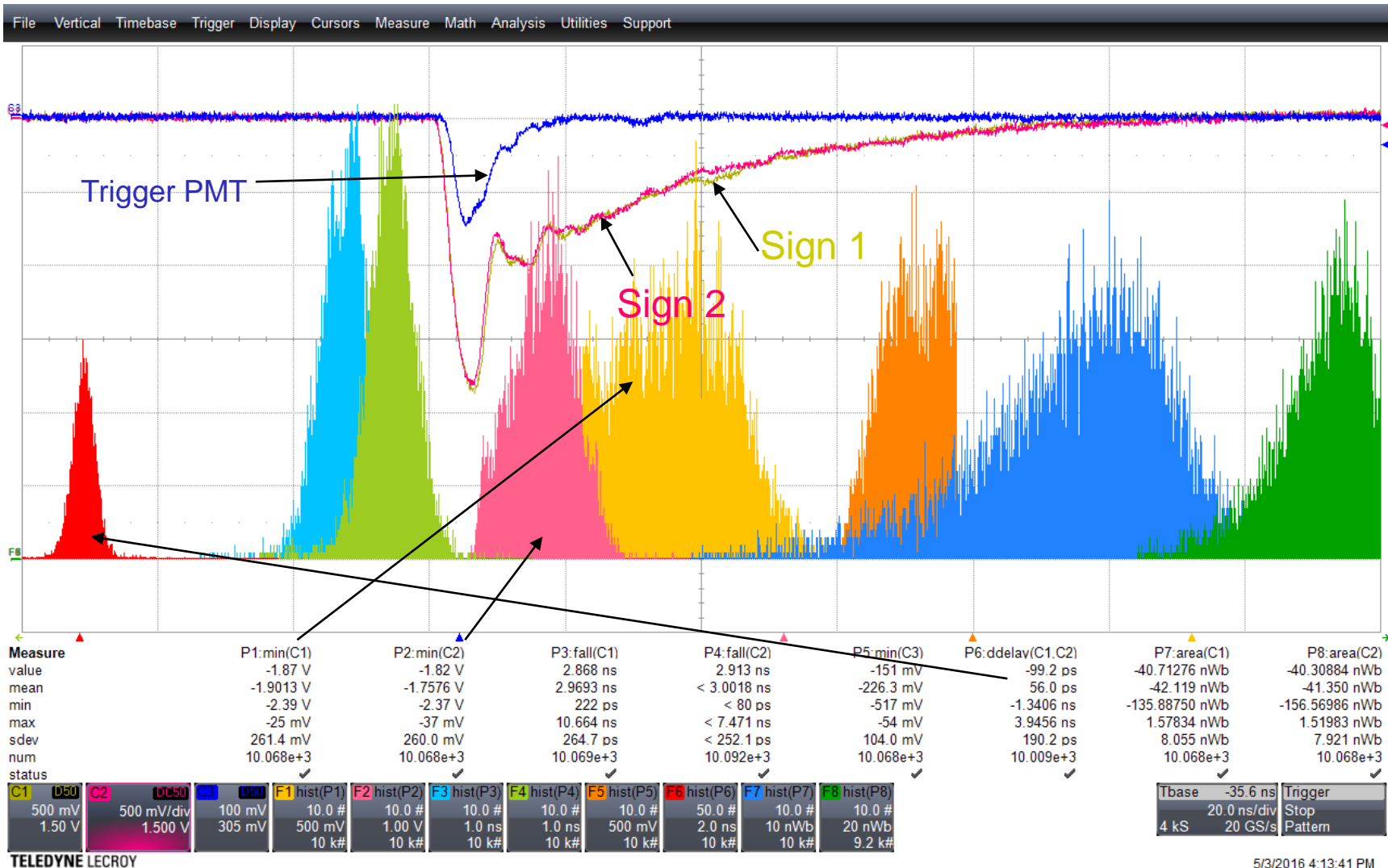
4... Photonique preamps

5... Hamamatsu PMT (trigger)

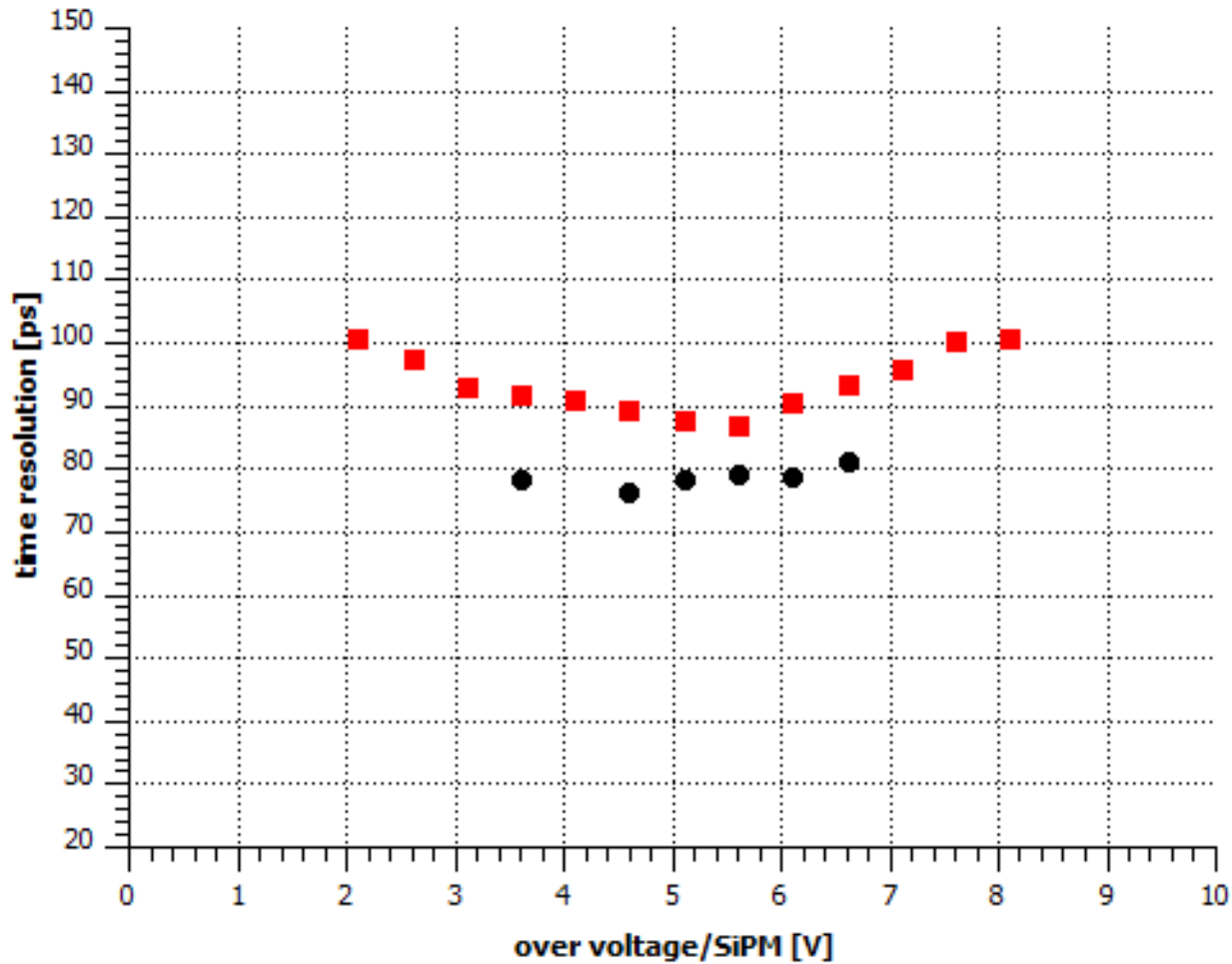
6... DAQ-Lecroy waverunner 640zi

Measurement Vienna

Signal shape, EJ-228 @5.6 oV/SiPM (230V)



Measurement Vienna bias profile

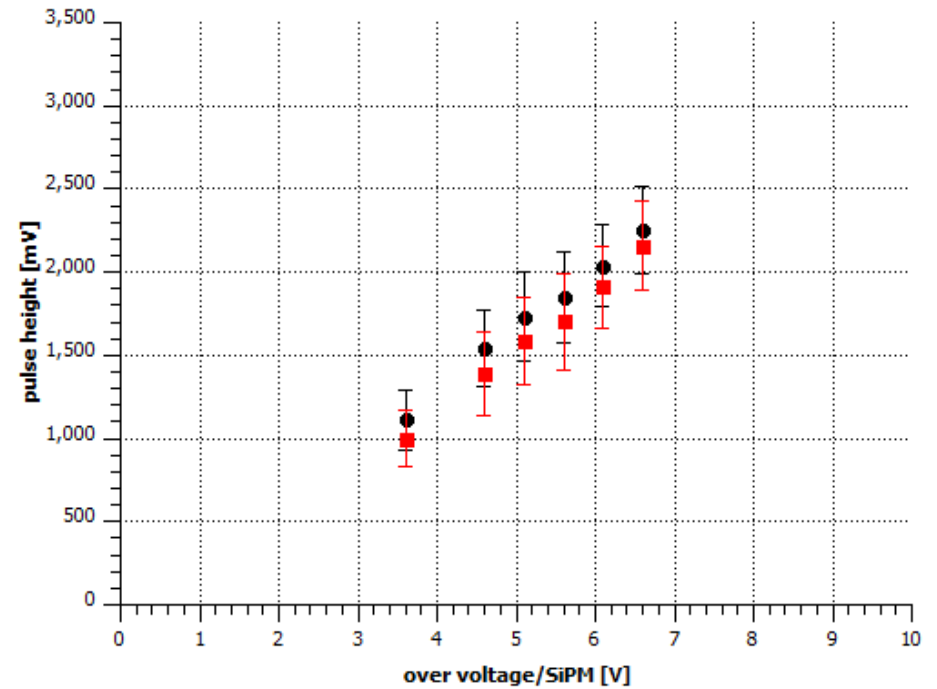
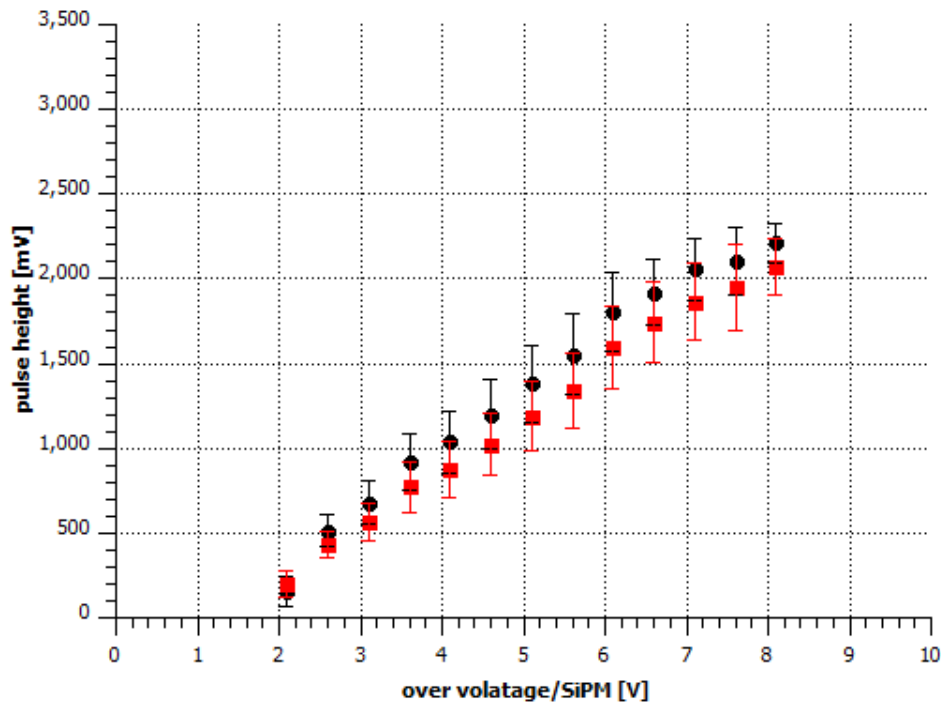


EJ-232
EJ-228

Measurement Vienna pulse height profile

Ej-232

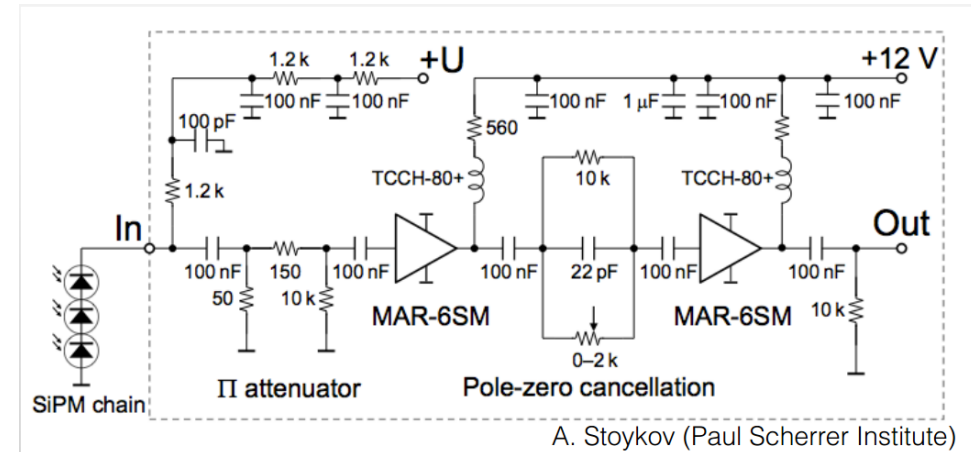
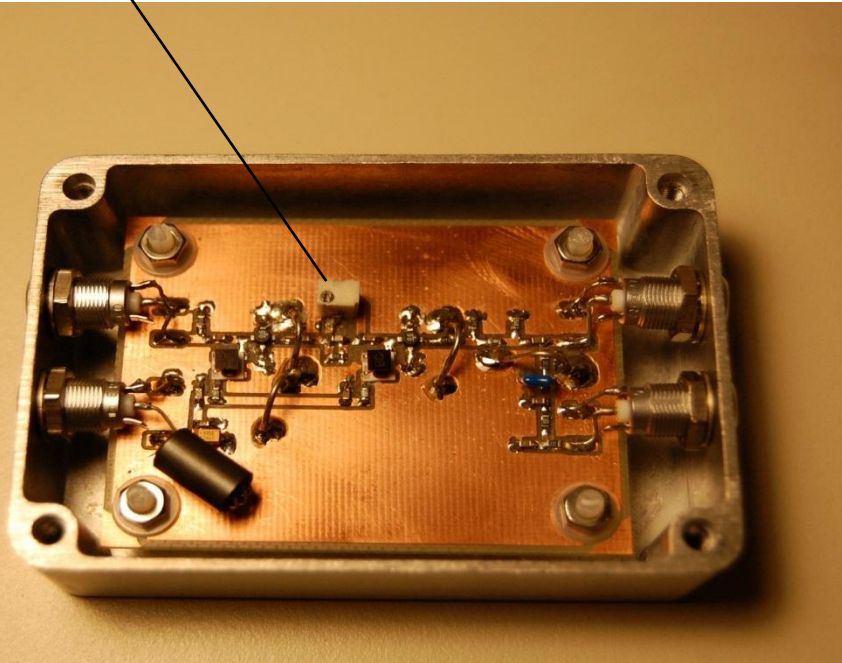
Ej-228



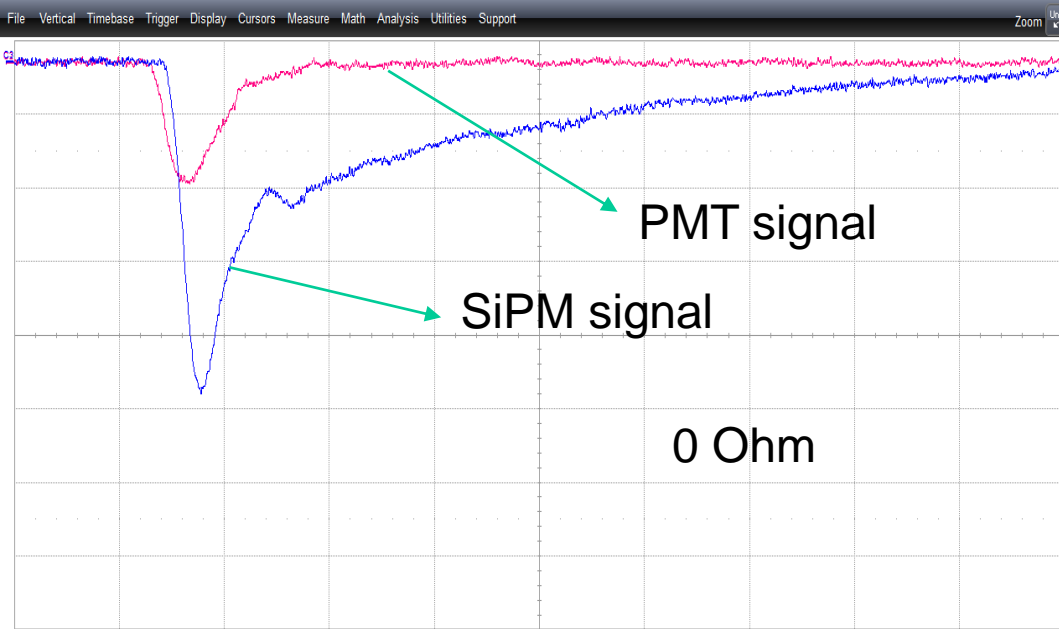
Channel1, Channel2

Measurement Vienna PSI amplifier

Potentiometer (0-3000 Ohm), goal: fast rise time

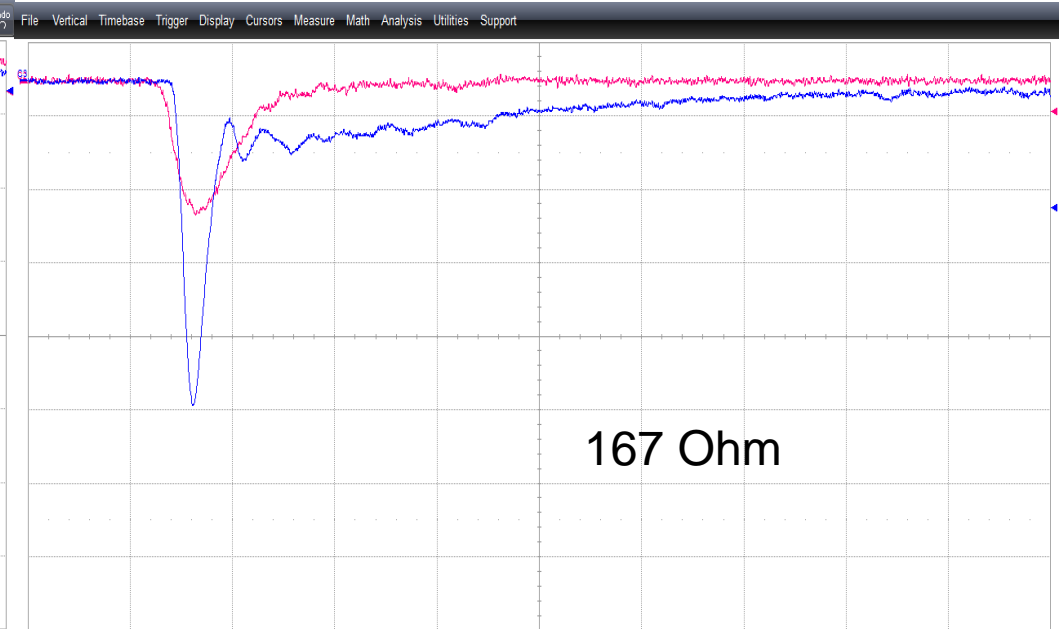


“Development of High Precision Timing Counter Based on Plastic Scintillator with SiPM Readout” Paolo W. Cattaneo et al



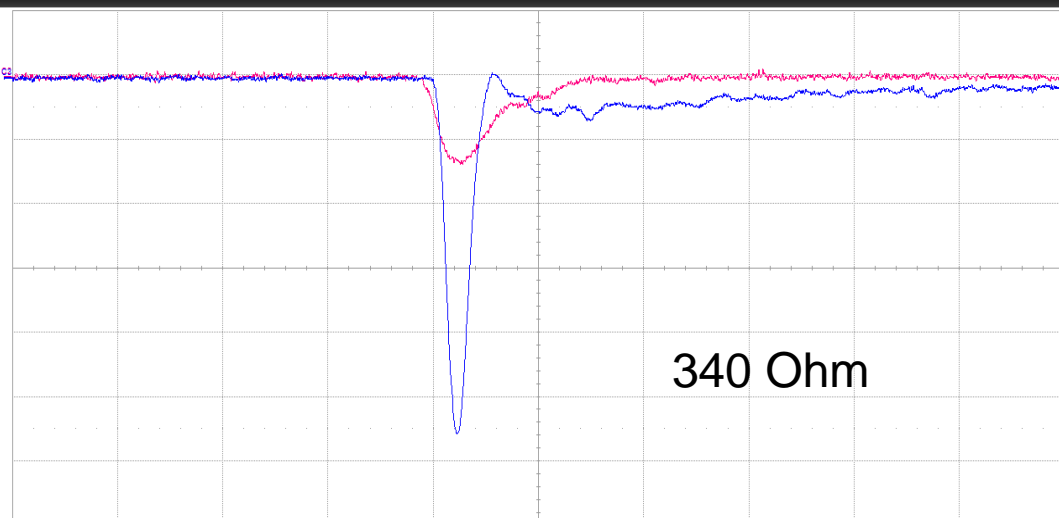
Measure	P1.min(C3)	P2.fall(C3)	P3.rise(C3)	P4.widn(C3)	P5.rms(C3)	P6.ddelay(C2,C3)	P7.---	P8.---
value	-902 mV	2.060 ns	42.801 ns	6.3817 ns	371.0 mV	1.7213 ns		
mean	< -816.6 mV	1.9788 ns	42.674 ns	7.364 ns	333.90 mV	1.4848 ns		
min	< -1.642 V	859 ps	30.433 ns	3.8707 ns	78.4 mV	182.7 ps		
max	< -183 mV	2.410 ns	52.145 ns	83.8422 ns	693.5 mV	2.1100 ns		
sdev	< 170.7 mV	143.3 ps	2.644 ns	5.775 ns	70.03 mV	253.8 ps		
num	906	902	867	874	1.528e+3	891		
status	✓	✓	✗	✗	✓	✓		

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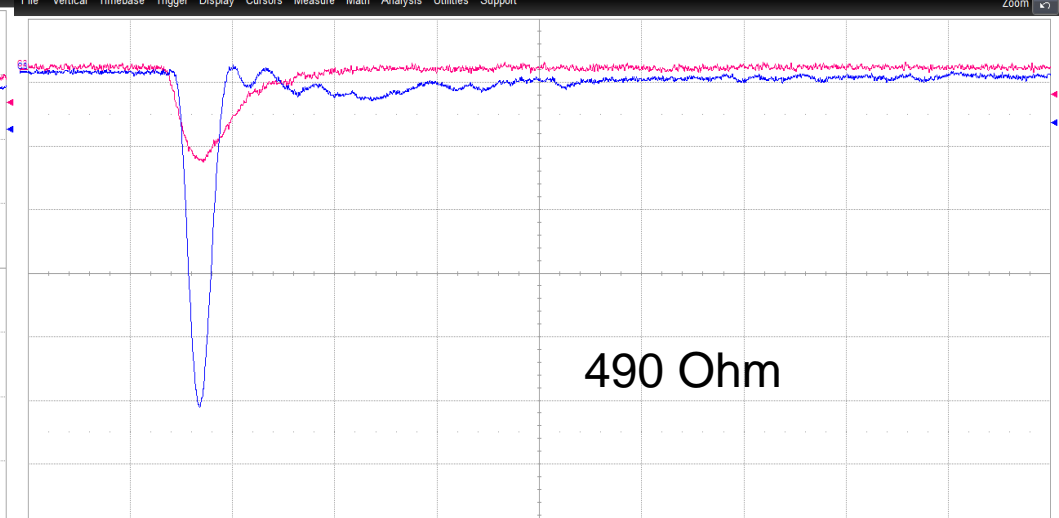
Measure	P1.min(C3)	P2.fall(C3)	P3.rise(C3)	P4.widn(C3)	P5.rms(C3)	P6.ddelay(C2,C3)	P7.---	P8.---
value	-443 mV	1.250 ns	3.046 ns	2.5698 ns	128.1 mV	917.3 ps		
mean	-392.08 mV	1.36118 ns	17.87 ns	2.7649 ns	117.89 mV	1.0167 ns		
min	-772 mV	994 ps	1.725 ns	2.1505 ns	67.6 mV	146.1 ps		
max	-205 mV	1.819 ns	37.796 ns	4.0988 ns	217.5 mV	1.8144 ns		
sdev	78.01 mV	97.53 ps	11.33 ns	255.9 ps	21.53 mV	179.0 ps		
num	2.161e+3	1.171e+3	1.622e+3	2.508e+3	1.583e+3	2.169e+3		
status	✓	✓	✗	✗	✓	✓		

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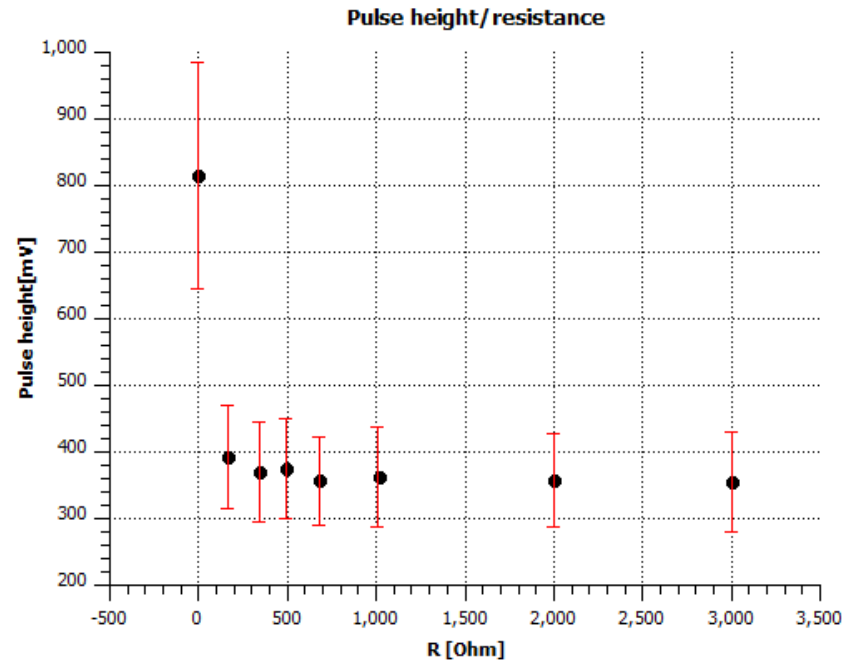
Measure	P1.min(C3)	P2.fall(C3)	P3.rise(C3)	P4.widn(C3)	P5.rms(C3)	P6.ddelay(C2,C3)	P7.---	P8.---
value	-552 mV	1.336 ns	1.935 ns	2.3940 ns	2.1 mV	945.8 ps		
mean	-371.83 mV	1.31428 ns	1.9587 ns	2.5407 ns	2.1052 mV	989.4 ps		
min	-664 mV	1.036 ns	1.303 ns	2.1233 ns	1.7 mV	370.8 ps		
max	-198 mV	1.819 ns	2.658 ns	3.2458 ns	21.1 mV	1.5431 ns		
sdev	75.06 mV	93.78 ps	228.7 ps	185.9 ps	648.7 uV	171.6 ps		
num	903	902	903	903	903	903		
status	✓	✓	✓	✗	✓	✓		

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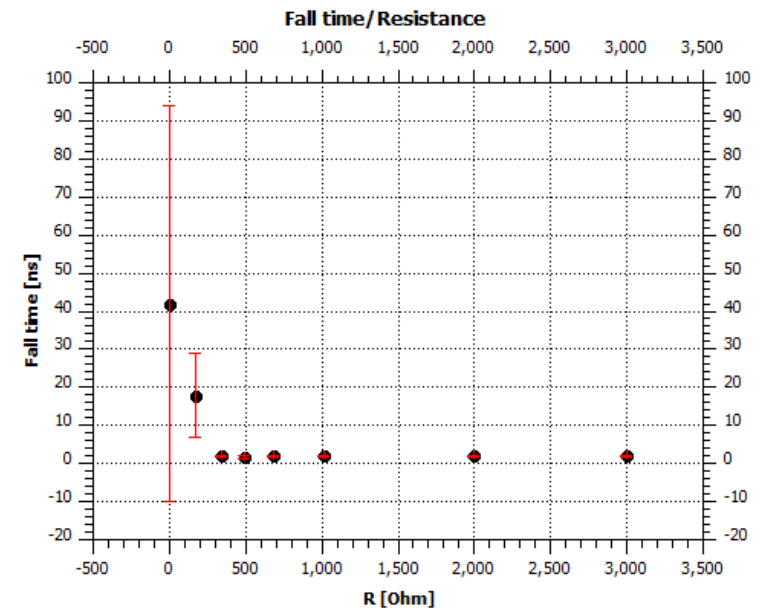
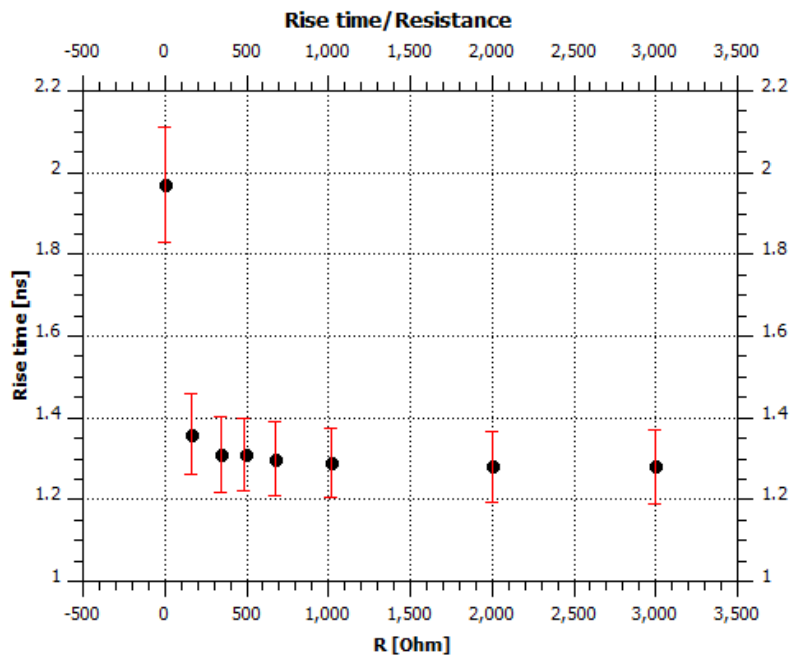


Measure	P1.min(C3)	P2.fall(C3)	P3.rise(C3)	P4.widn(C3)	P5.rms(C3)	P6.ddelay(C2,C3)	P7.---	P8.---
value	-527 mV	1.408 ns	1.668 ns	2.5242 ns	144.4 mV	831.6 ps		
mean	-376.87 mV	1.31434 ns	1.8462 ns	2.5194 ns	101.63 mV	957.6 ps		
min	-653 mV	1.081 ns	1.557 ns	2.0563 ns	51.4 mV	261.6 ps		
max	-190 mV	1.604 ns	2.635 ns	3.2196 ns	175.0 mV	1.5110 ns		
sdev	74.55 mV	88.51 ps	241.9 ps	184.7 ps	19.22 mV	180.2 ps		
num	500	499	500	500	500	500		
status	✓	✓	✓	✓	✓	✓		

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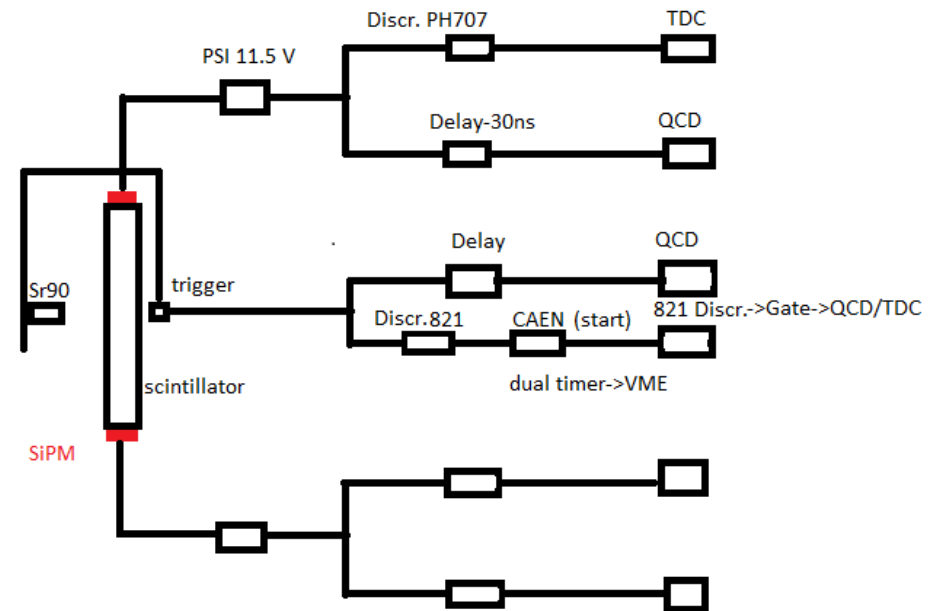
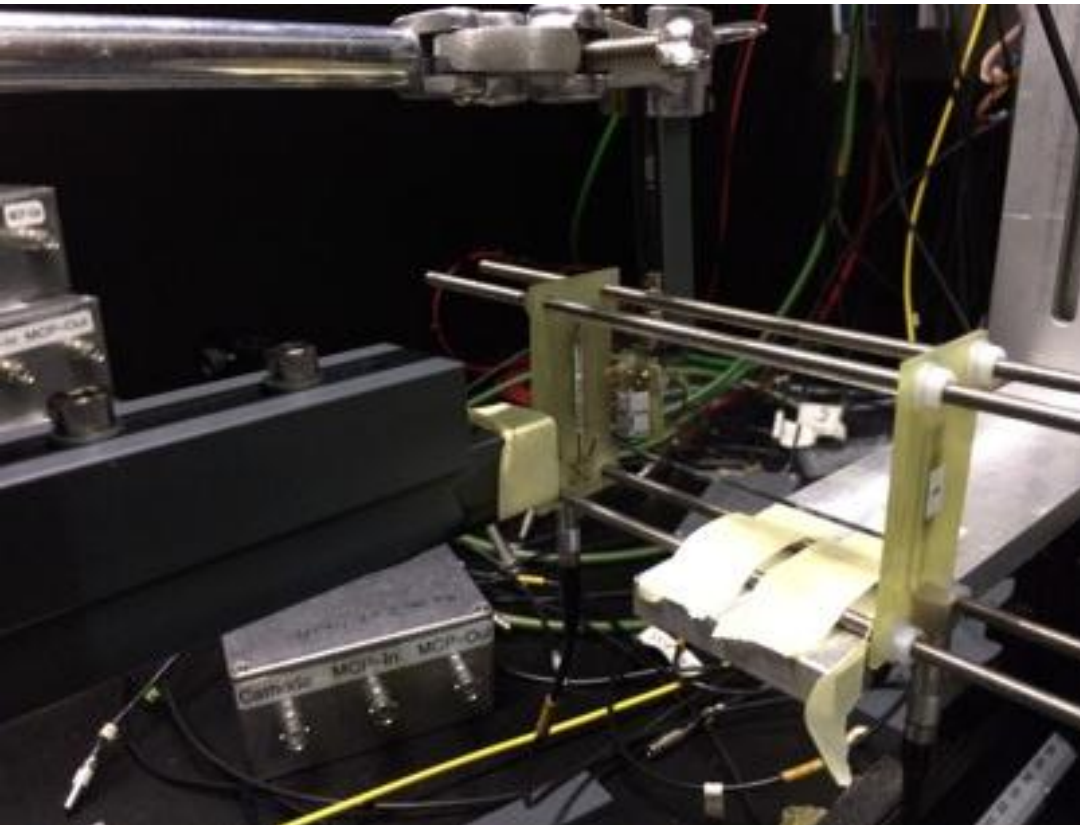


Conclusion: one should avoid setting the potentiometer under 300 Ohm



Measurement Erlangen

Experimental Setup



Measurement Erlangen

Noise level

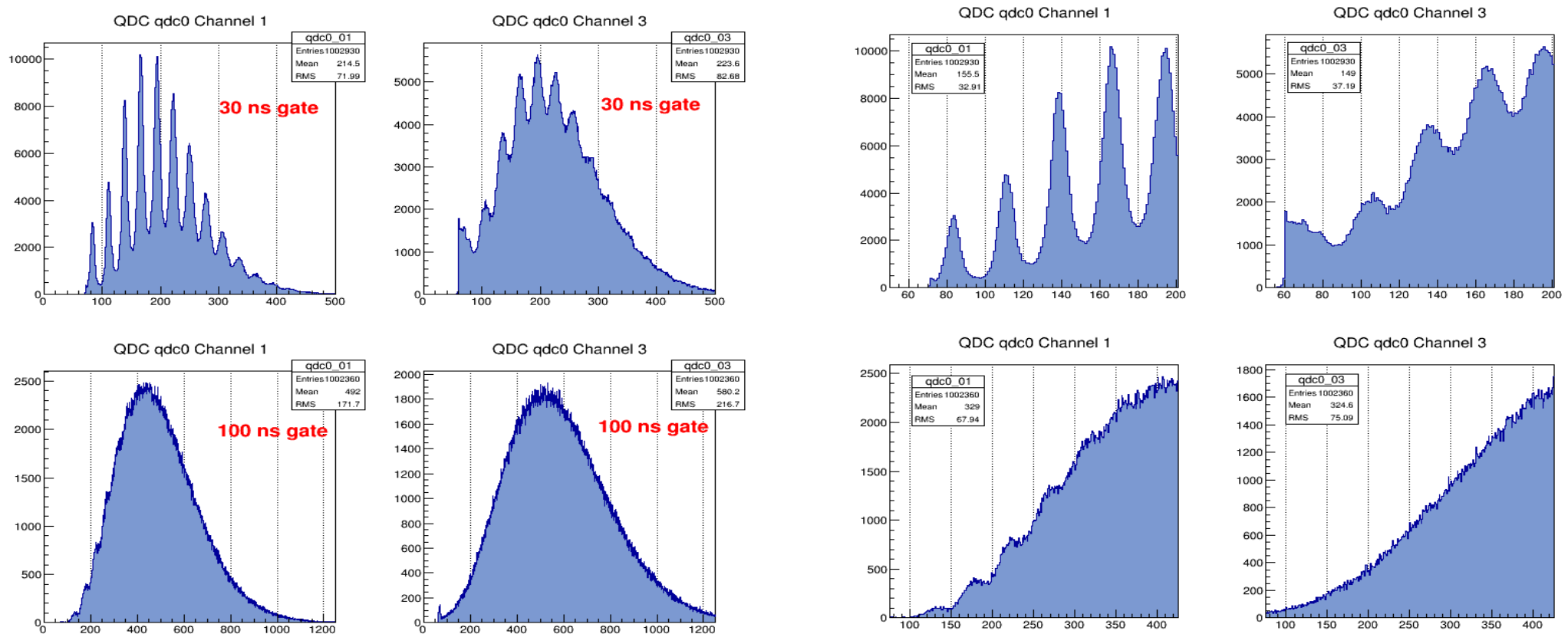


Trigger:
SiPM S12782 HPK, 67V+
Scintillator BC-420

3 Channels:
Trigger
Board1
Board2

Calibration of the QCD

SiPM bias 240V, 30 mV threshold, 20x amplified



rough results: peak distance with 30ns gate: 20 Channels

peak distance with 100ns gate: 50 Channels $\rightarrow \frac{50}{20} = 2.5 \text{ Ch} = 1 \text{ p.e}$

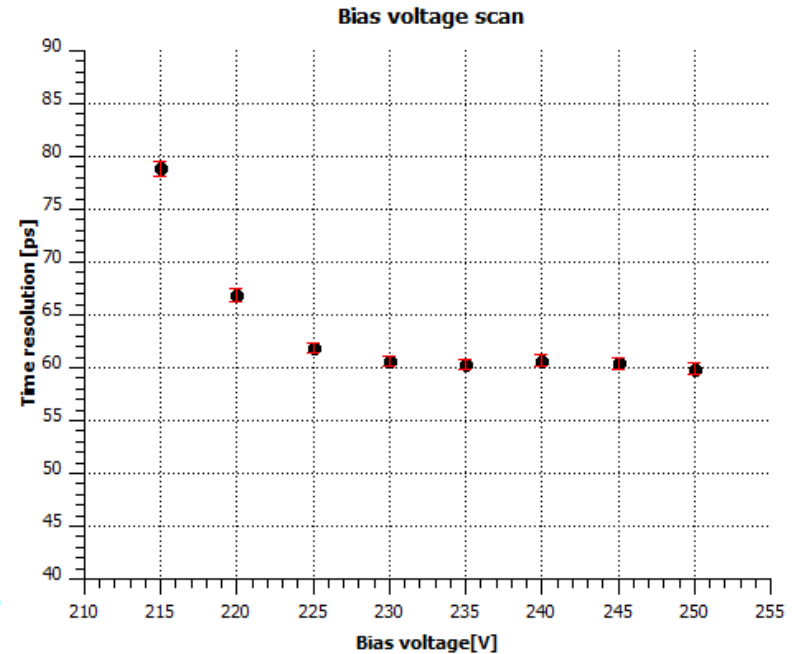
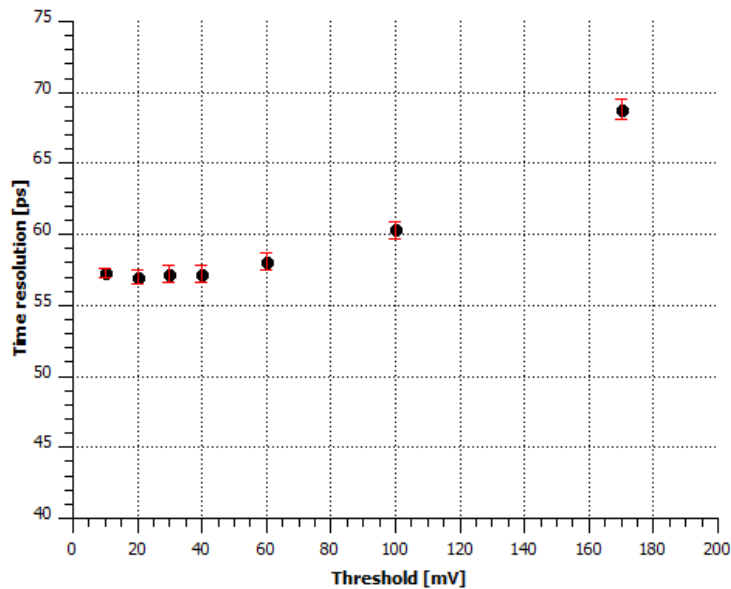
Measurement Erlangen

Signal shape and gate 100ns

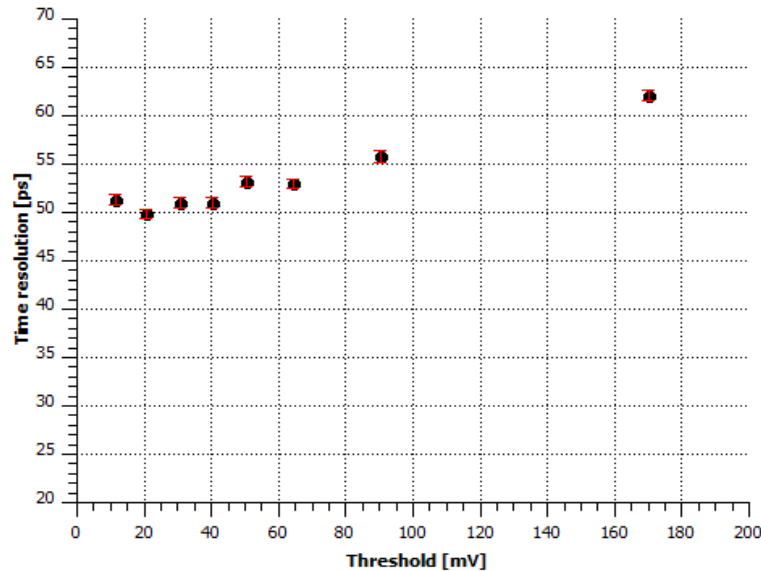


Long gate -> hard to calculate the single photon

Threshold scan for
EJ-228
Bias: 230V



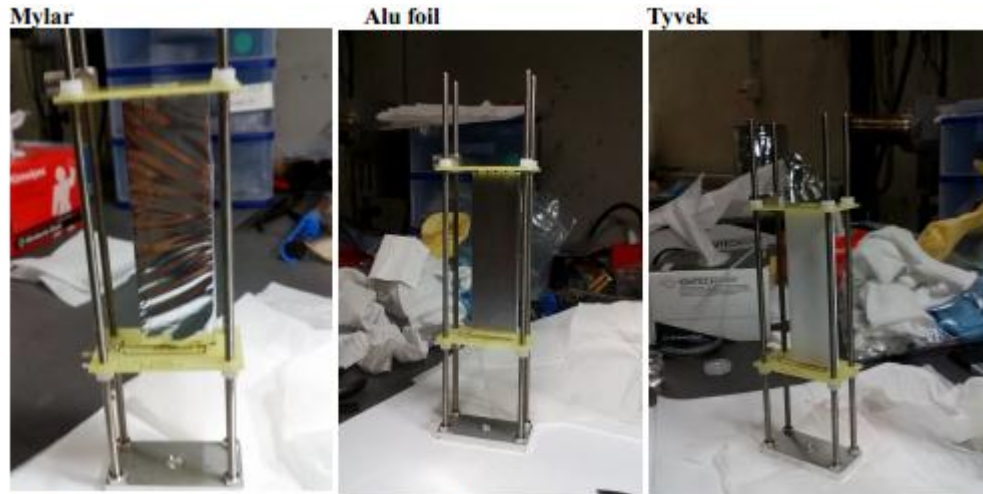
Threshold scan for
EJ-232
Bias: 240V



Best settings:
Threshold at -30 mV
Bias voltage 240 V

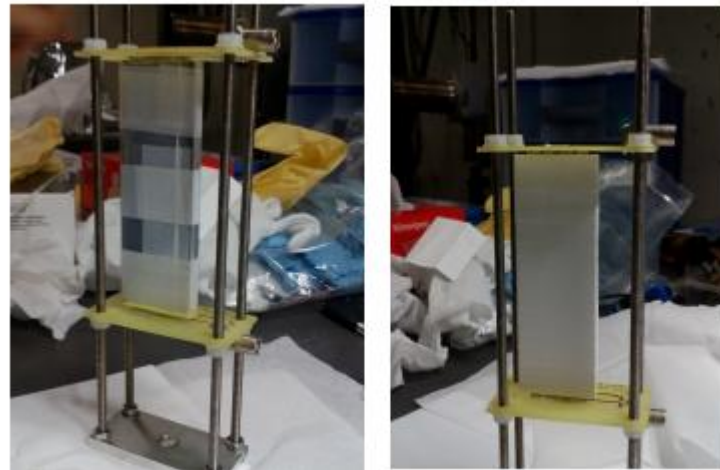
Measurement Erlangen

Wrapping (bias-240 V, threshold-50 mV, scan 9 points)



ESR

Teflon



EJ-232

Wrap type	Mean time res [ps]	Pulseheight [QDC.CH]
No wrapping	54.8 ± 0.3	690 ± 12
Mylar foil	52.7 ± 0.3	848 ± 11
Tyvek 1057D	54.9 ± 0.3	941 ± 8
ESR	55.2 ± 0.3	847 ± 7
Teflon tape	59.4 ± 0.3	975 ± 10
Alu foil	54.2 ± 0.3	821 ± 6

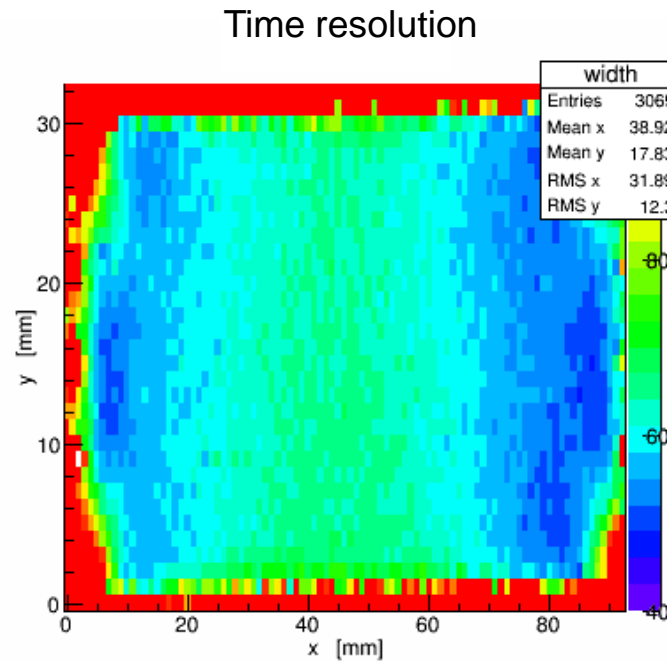
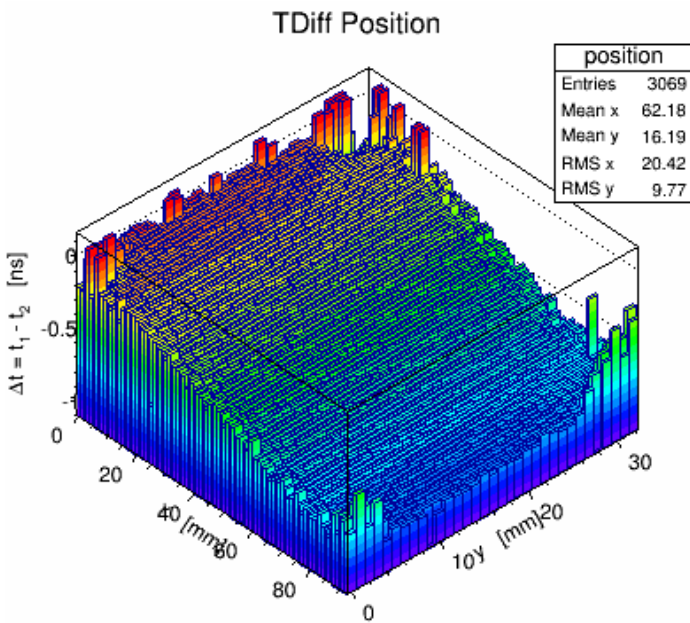
EJ-228

Wrap type	Mean time res [ps]	Pulseheight [QDC.CH]
No wrapping	61.2 ± 0.3	887 ± 10
Mylar foil	59.7 ± 0.3	1063 ± 7

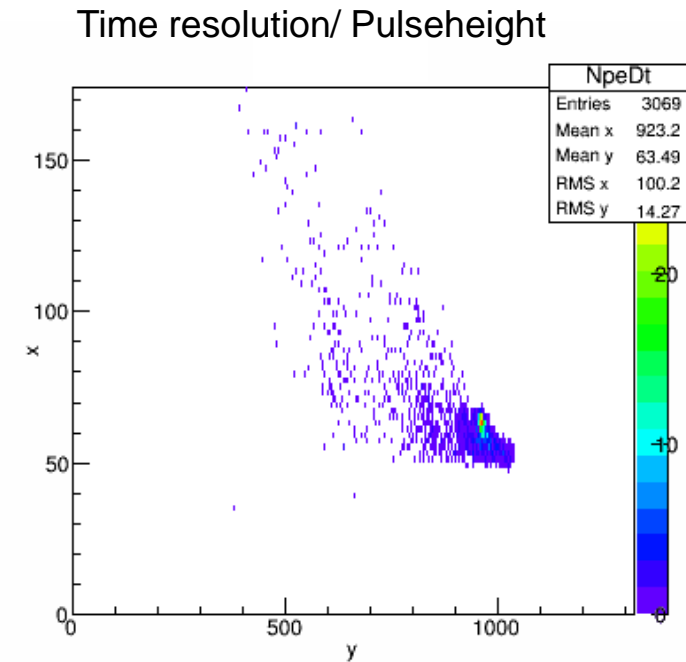
Measurement Erlangen

3069 positions (EJ-228, mylar foil), SMI preamplifier

HV: 240V, threshold: -30 mV, 2000 events/position

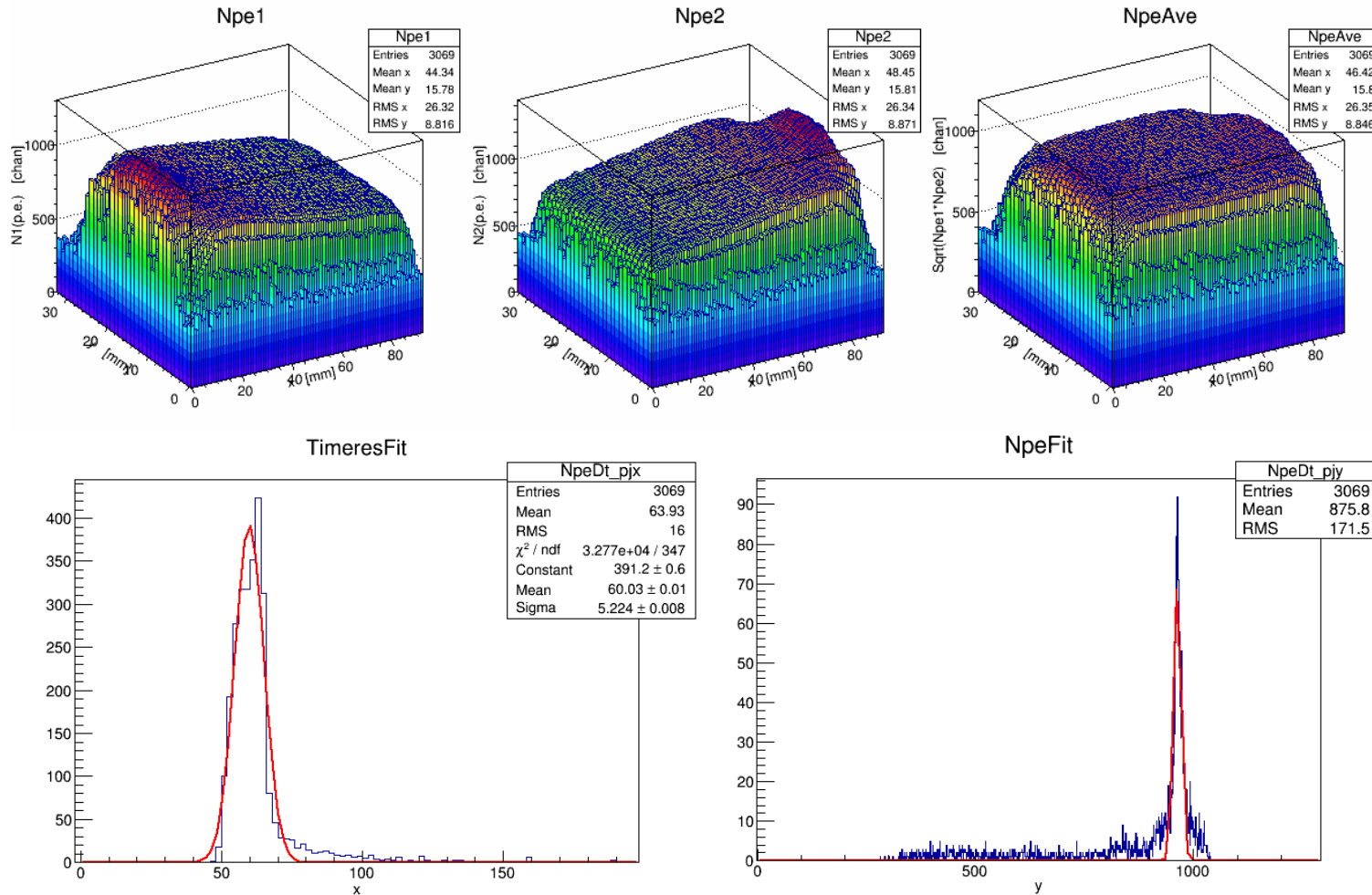


Mean time resolution ~60 ps



Measurement Erlangen

3069 positions (EJ-228, mylar foil), SMI preamplifier

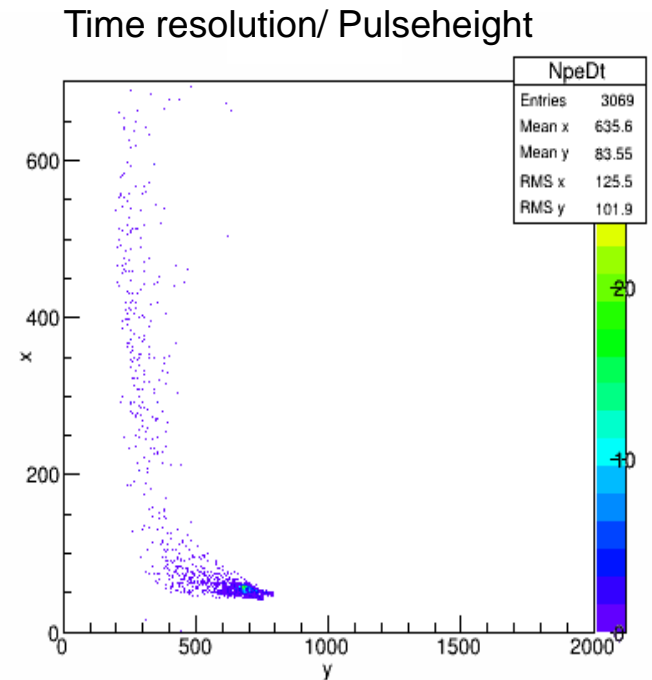
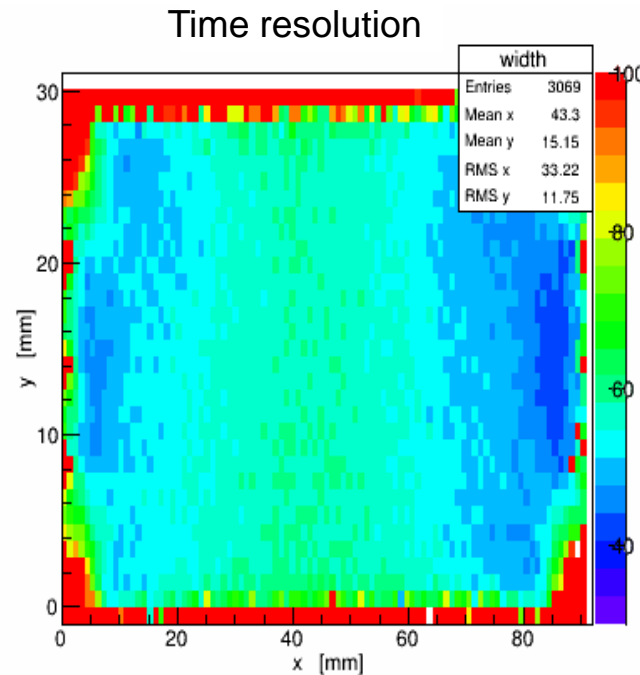
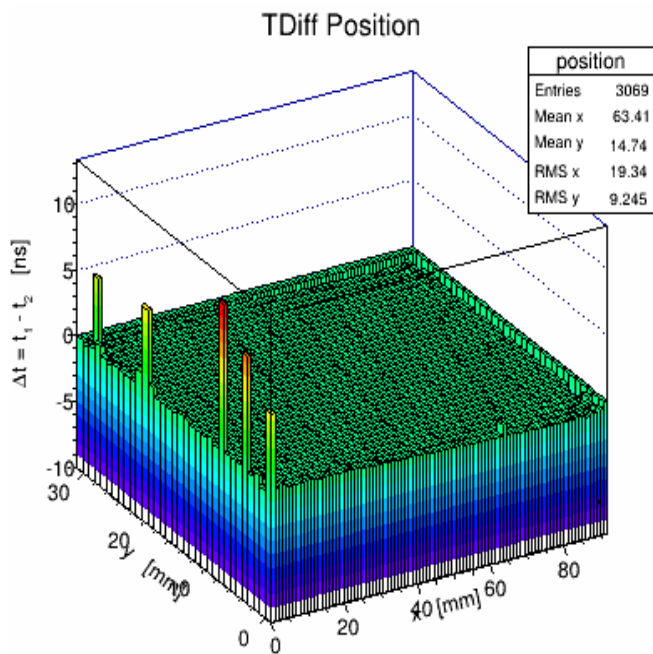


Mean pulse
height = 875.8 QCD.CH
~ 328 Photons

Measurement Erlangen

3069 positions (EJ-232, mylar foil), SMI preamplifier

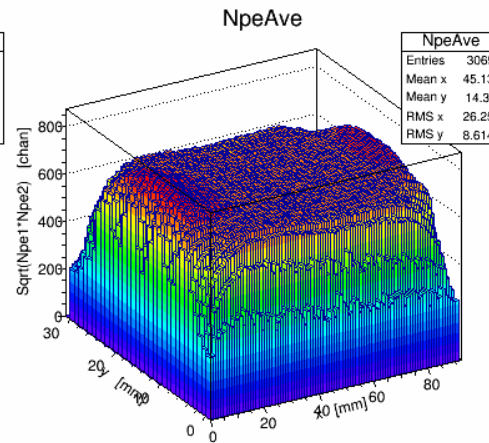
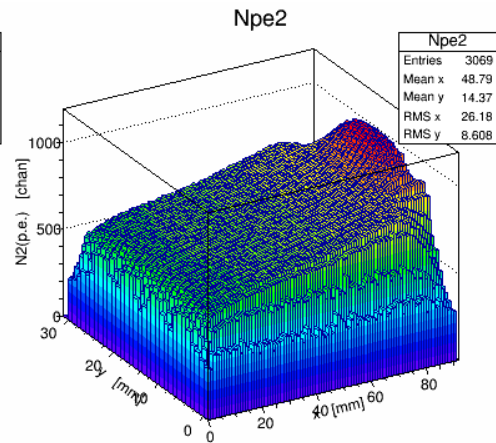
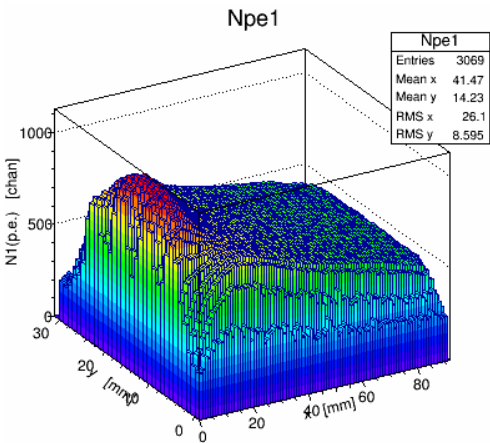
HV: 240V, threshold: -30 mV, 2000 events/position



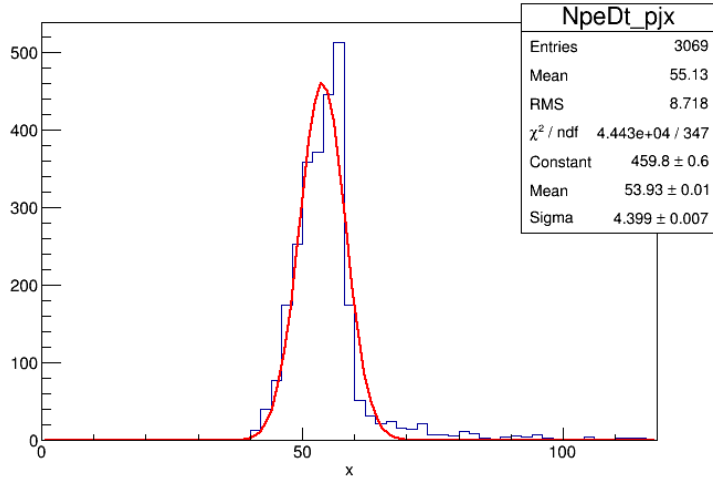
Mean time resolution ~ 53.9 ps

Measurement Erlangen

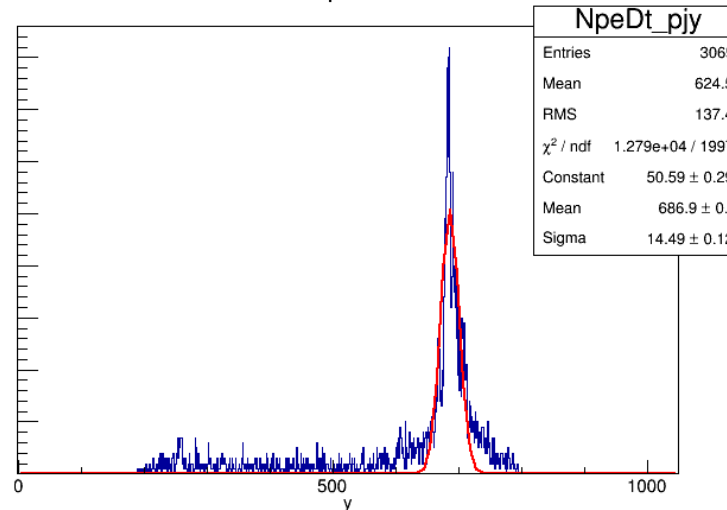
3069 positions (EJ-232, mylar foil), SMI preamplifier



TimeresFit



NpeFit



Mean pulse
height = 687 QCD.CH
~ 274.8 p.e

Conclusion

Best value for the time resolution: 53.9 ps with EJ-232 wrapped in Mylar foil

This value is already the mean time resolution of a total of 3069 positions distributed across the scintillator surface.

EJ-228 provides more light but slightly worse time resolution. We get a better time resolution with PSI preamps than with photonique preamps.

Outlook: do the time-walk correction of the data