

Timing Performance of A-PIC at High Rate

F. García¹, E. Oliveri², H. Müller²

¹Helsinki Institute of Physics - University of Helsinki

²GDD lab - CERN

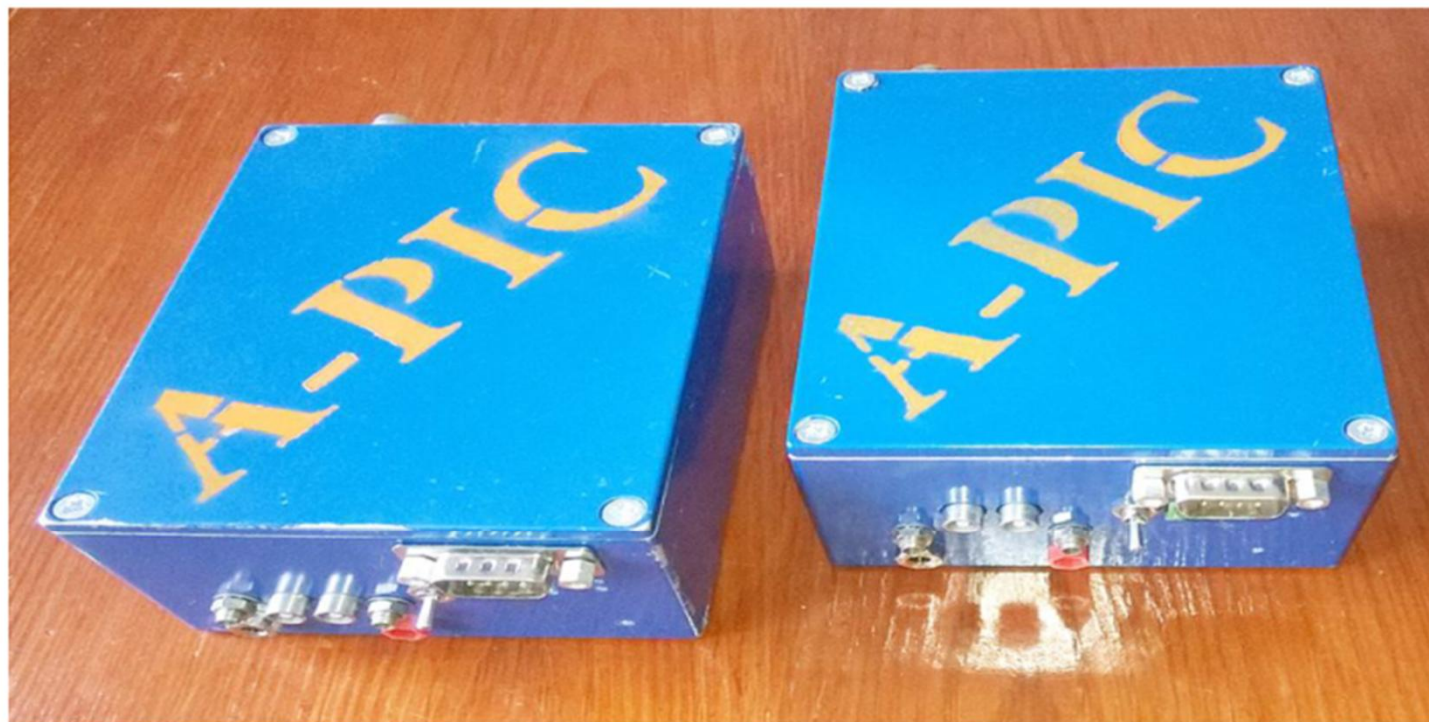
OUTLINE

1. WHAT is A-PIC
2. INTRODUCTION to the SETUP
3. MEASUREMENT SCHEME and A-PIC
4. INTENSITY SCAN from 50 kHz - 3.0 MHz
5. OUTLOOK

WHAT is A-PIC

Analogue Pickup Amplifier/Shapers APICs

H. Muller et al., A-PIC User manual



This activity, we kicked off already since beginning of 2012

Portable, battery-operated preamplifier-shaper for charge-generating detectors

WHAT is A-PIC (cont.)

Main Characteristics:

- Dual-polarity CSA preamplifier 2mV/fC (1mV / 3125 electrons)*
- CSA discharge time constant 5 μ s (max average signal rate 100 kHz)
- CSA intrinsic risetime 10ns
- Triple spark input protection
- Input leakage current < 50 fA
- BNC input 50..2000 OHM input impedance via potentiometer
- SHV input capacitive (4nF) up 5kV to BNC input
- CSA monitoring output of preamplifier (fixed gain 10)
- Variable amplifier gain = 1 ... 1000, via 20 turn potentiometer
- Gain Monitor output $V_{mon} = (-0) \dots (-2V)$ (1kOHM)
- 2nd order shaper with $\Gamma_{\gamma}(t)$ pulse-shape
- Two selectable peaking times (default = 100/8000 ns)**
- Complementary 50 Ohm linear outputs up +/- 0.3V***
- Complementary 1M Ohm Outputs up +/- 3V
- Baseline potentiometer 20 turn, +/- 2V
- Test pulse generator pushbutton (pos. charge injection @ 7 kHz to CSA input)
- Portable, metal box, 144 x 100 x 58 , ½ kG
- Autonomous operation via rechargeable Lithium battery 12 V / 2.5Ah
- Power consumption 70 mA (Battery charge current not included)
- Battery charge connector for solar panels 13-50V, 200 mA
- Battery Autonomy min. 24 h (fully charged)
- Battery charge-up indicator LED (green)
- Power indicator LED (red)
- Battery voltage range 12.5 (max)... 9.6V (min)
- Electronics operating voltage (+/- 4V25)
- Direct power (+ charger) via R232 cable to NIM modules (+/-12V)

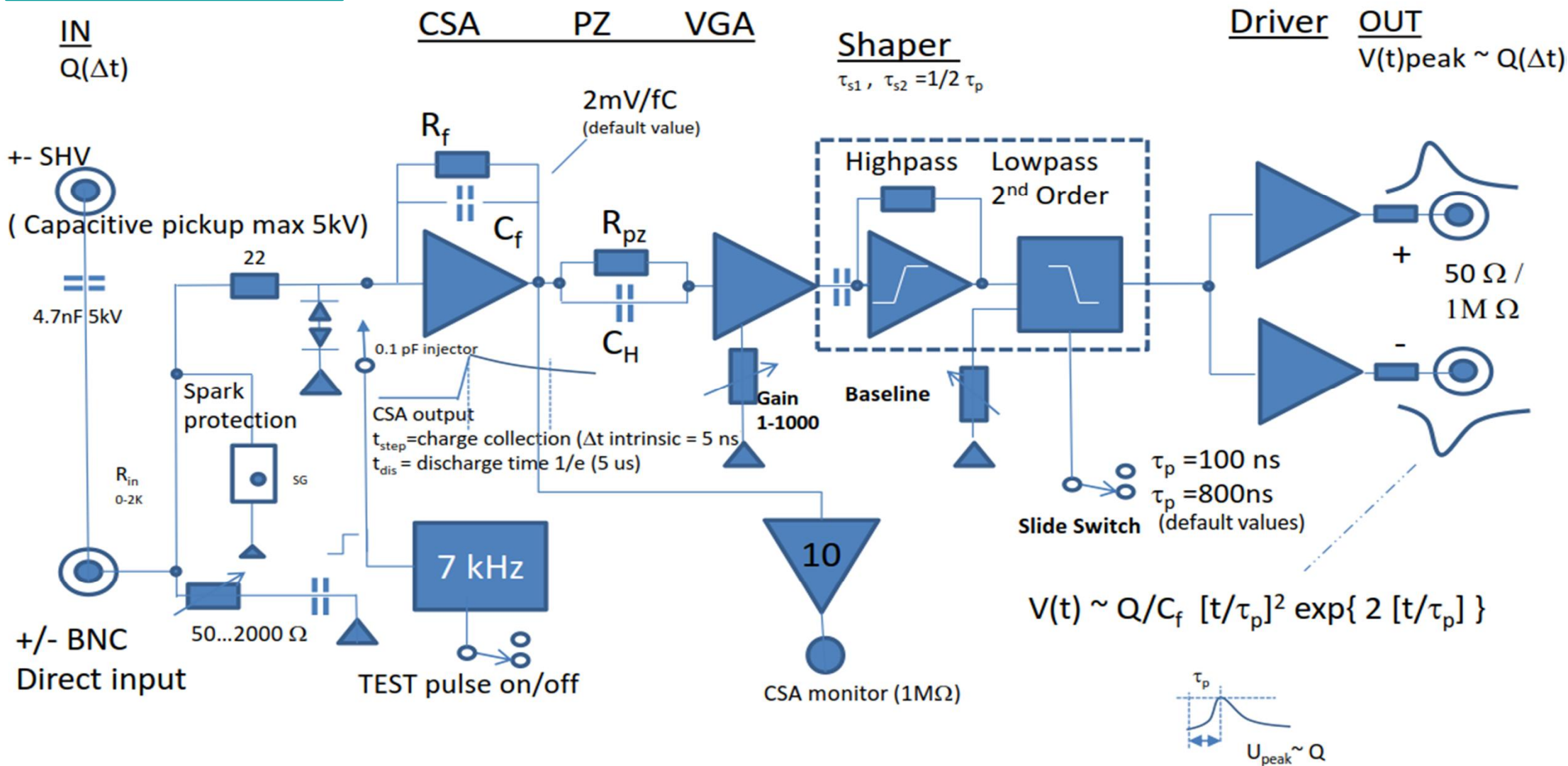
H. Muller et al., A-PIC User manual

- *lower gains by factor 5, 10, 20 on request
- **different shaping times (30ns ... 20 μ s) on request
- *** to be increased to +/- 1V in APIC 1.2 revision

WHAT is A-PIC (cont.)

Block Diagram:

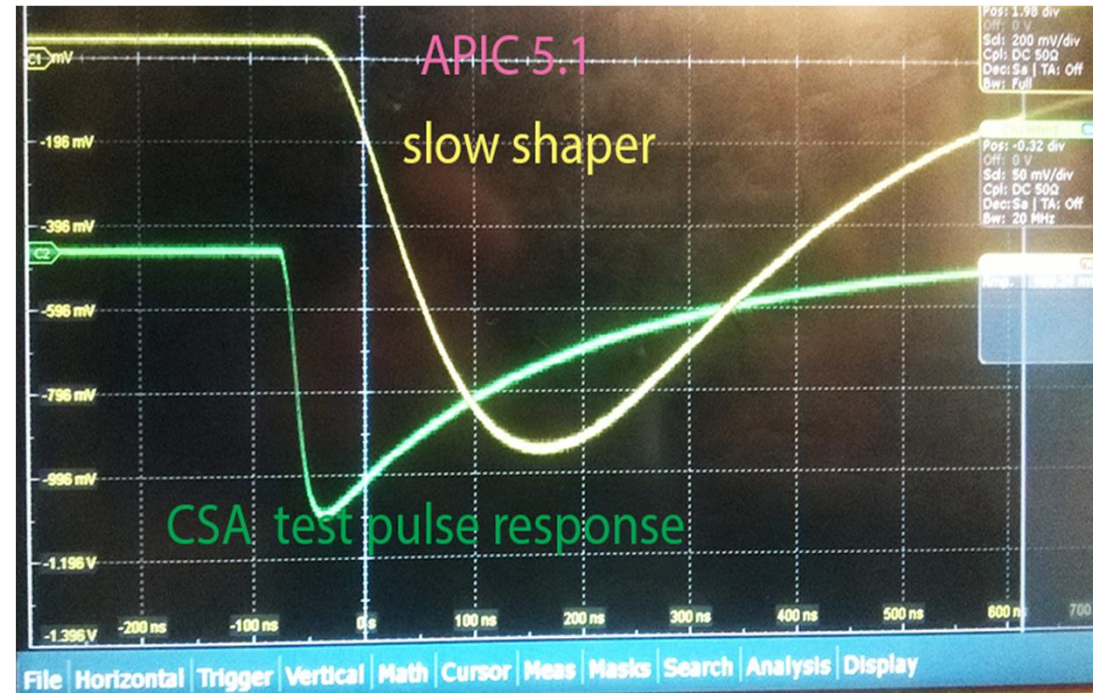
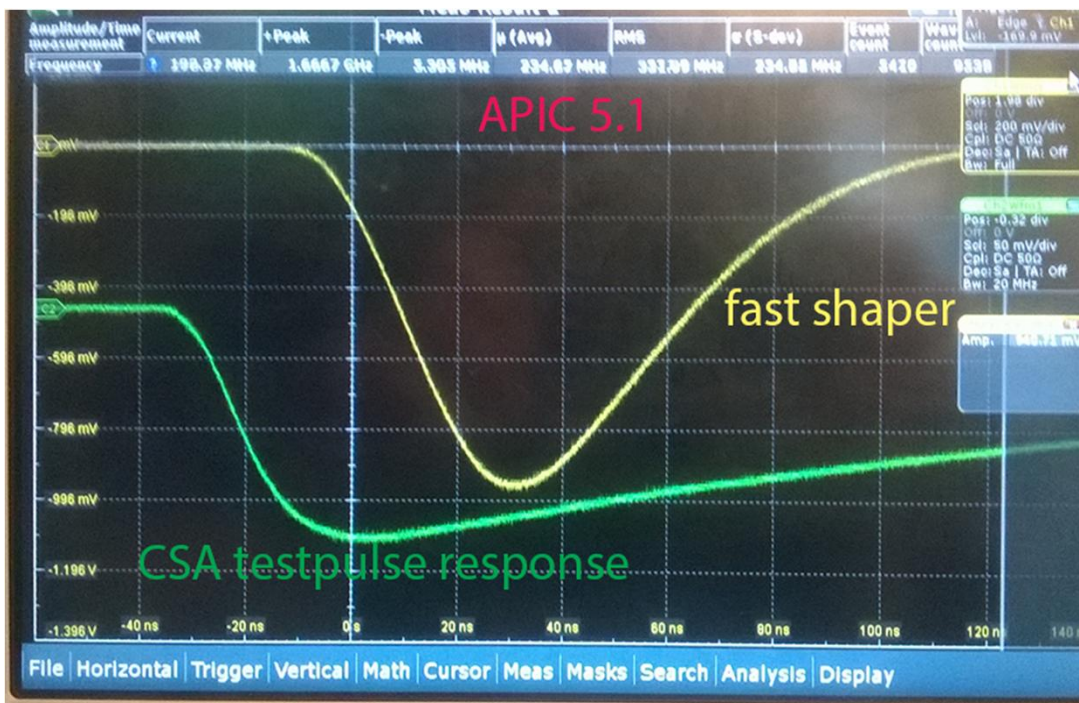
H. Muller et al., A-PIC User manual



WHAT is A-PIC (cont.)

Fast and Slow shaper response:

H. Muller et al., A-PIC User manual



τ_{peak} : 20 ns

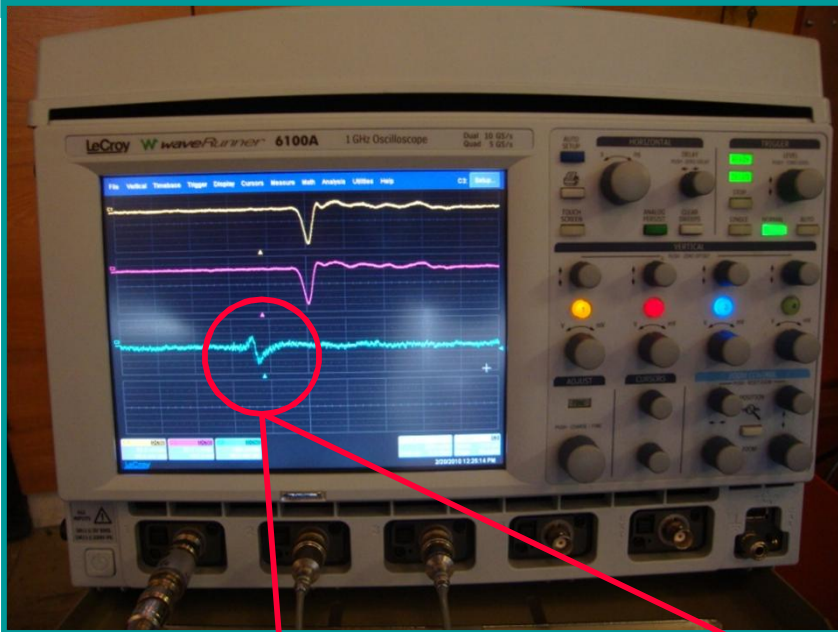
Full width pulse: 100 ns (5τ)

τ_{peak} : 120 ns

Full width pulse: 600 ns (5τ)

WHAT is A-PIC (cont.)

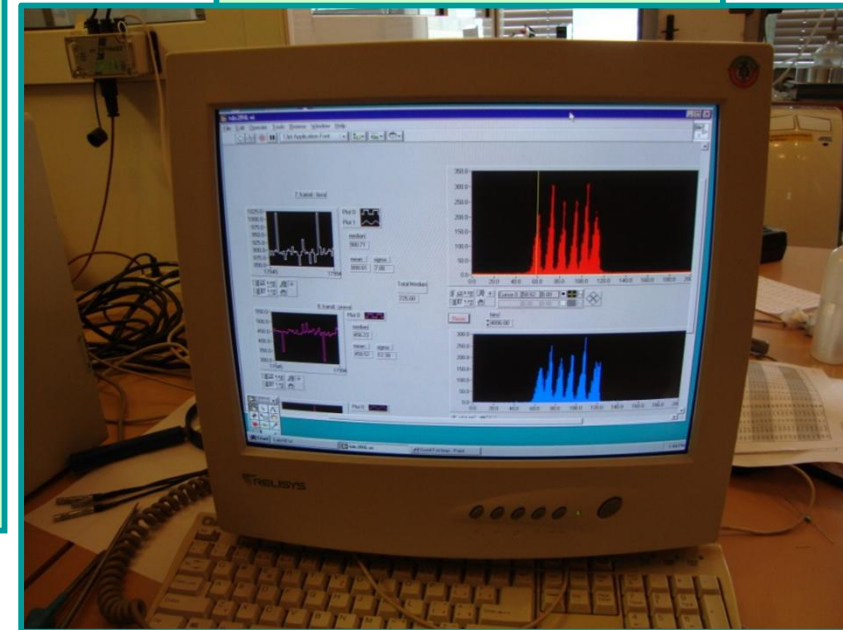
GEM-TPC test in lab



It can be observed:

- Signals from the delayed lines are very clean
- Same relative time between them
- Trigger signal bipolar, it can be that the 40% negative overshoot is due to e-transparency losses in the GEM 3

GEM-TPC tracking capabilities for ^{55}Fe



In the picture above there are multiple picks from the different source positions. The source was not very well collimated therefore a mm scale resolution on X was achieved and the trigger was taken from the bottom of the GEM3



Trigger Signal before reshaping



Trigger Signal with rise and decay time reshaped

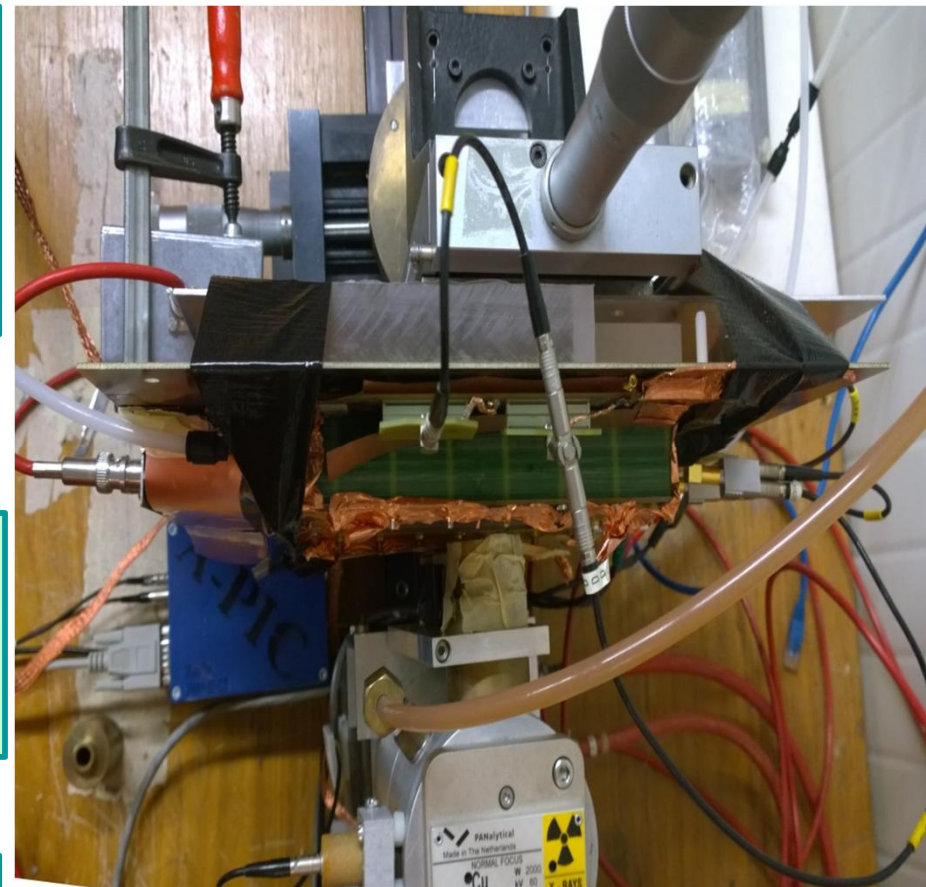
INTRODUCTION to the SETUP



Triple GEM detector:
Area: $10 \times 10 \text{ cm}^2$
Gain: 10^4
Gas Mixture: ArCO₂ (70/30)
 $\eta_{\text{primaries}} = 293e^-$

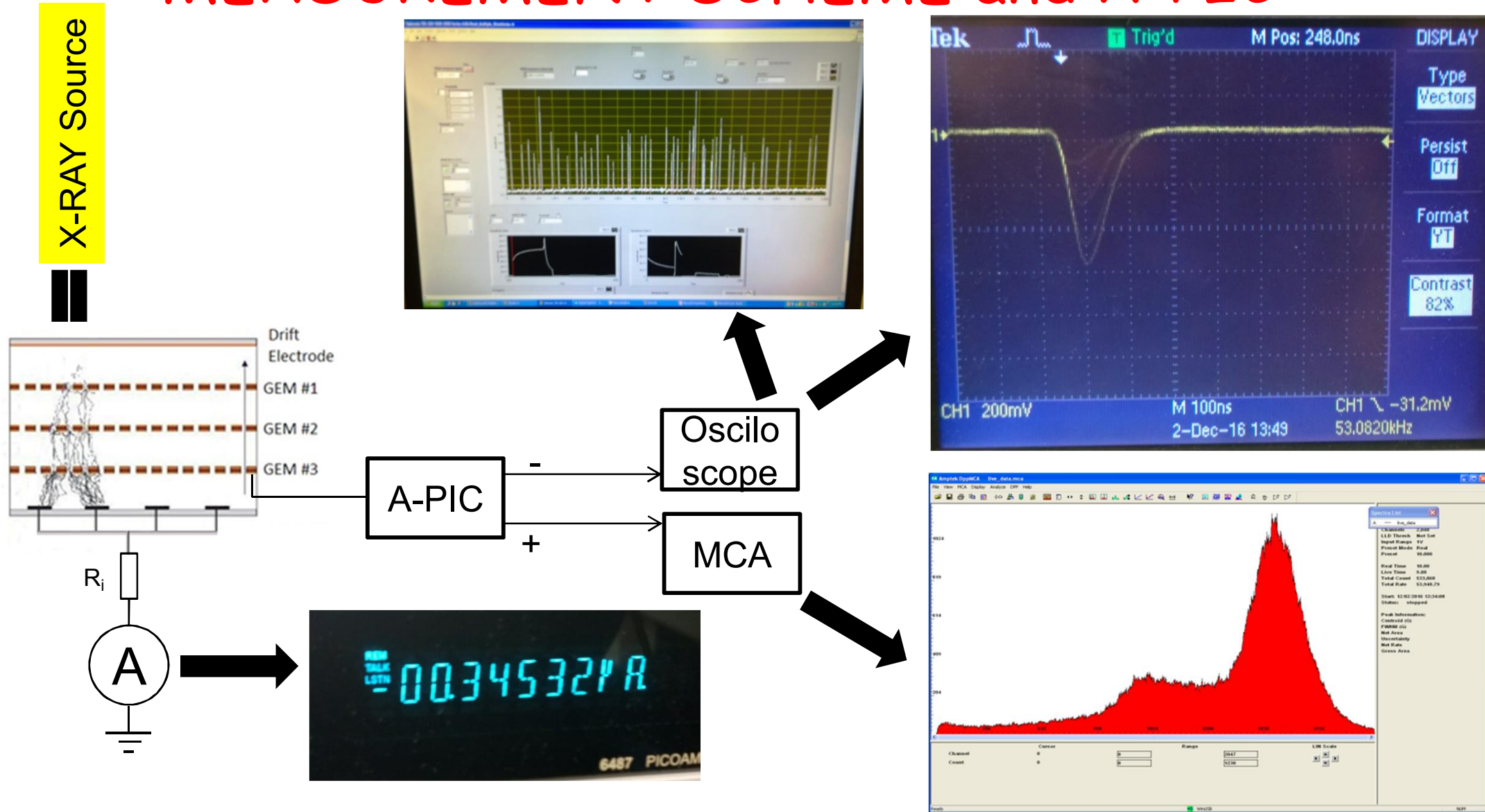
Collimator:
Diameter: 1.6 mm
Area: 8.04 mm^2
Fluence: $3.5 \cdot 10^3 - 3 \cdot 10^6 / \text{mm}^2$

X-ray Tube:
Anode: Cu
HV: 16 kV
Current: up to 3 mA



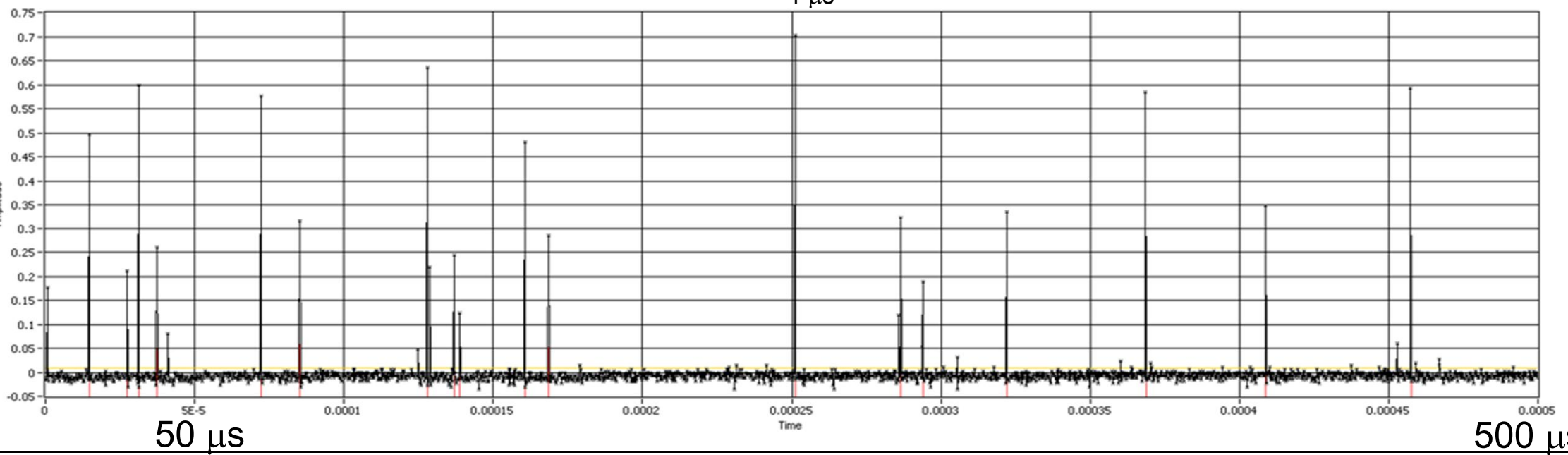
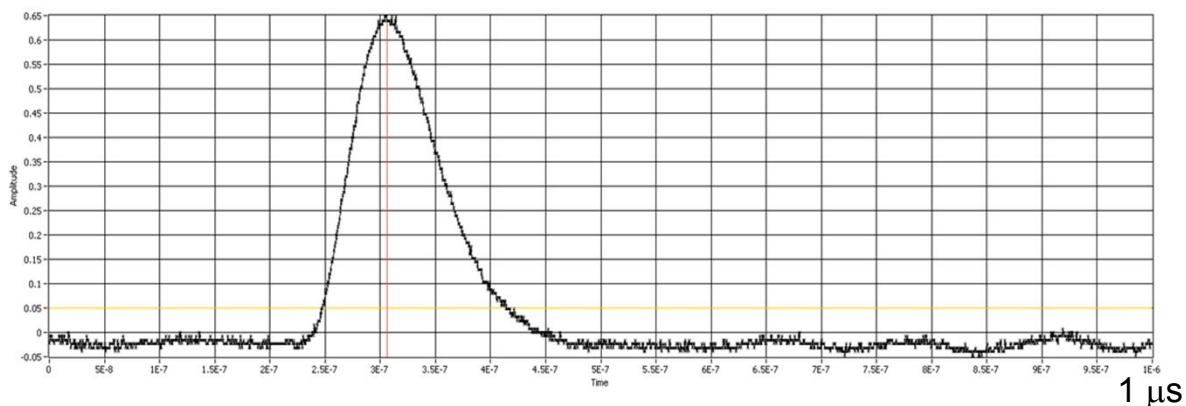
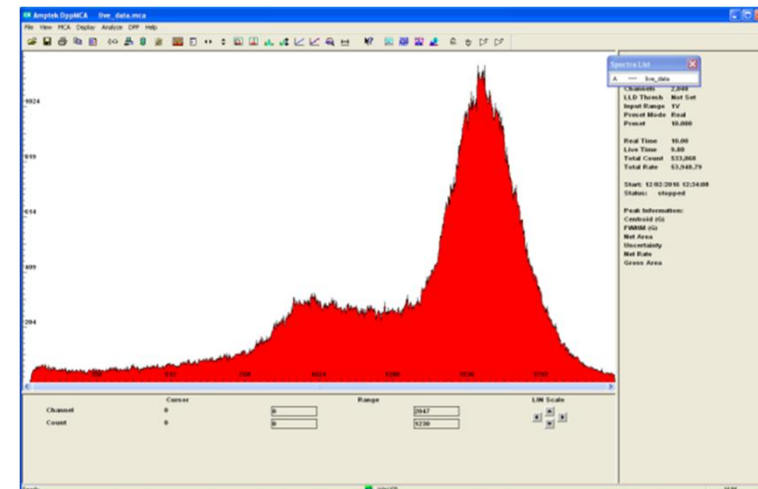
A-PIC:
 τ_{peak} : 30 ns
Full Width: 150 ns
Gain: 2mV/fC

MEASUREMENT SCHEME and A-PIC



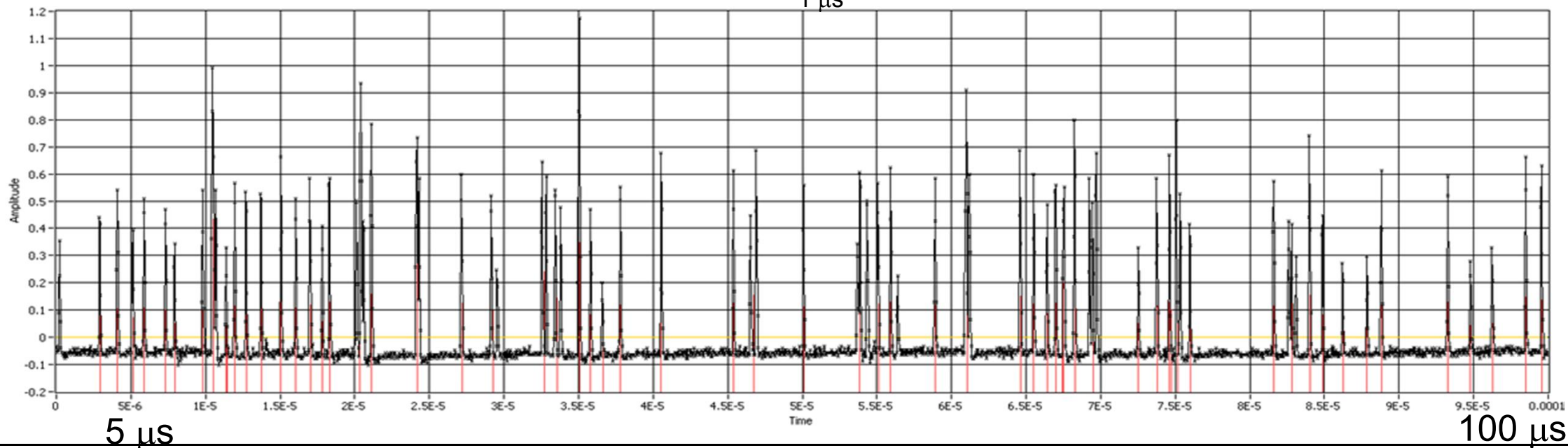
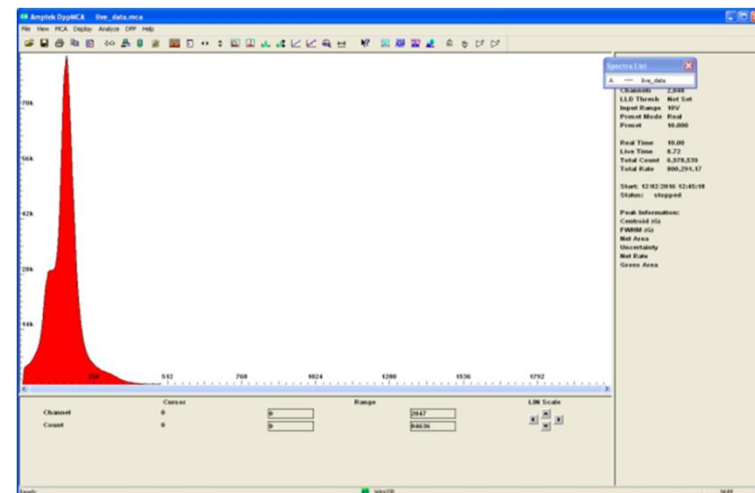
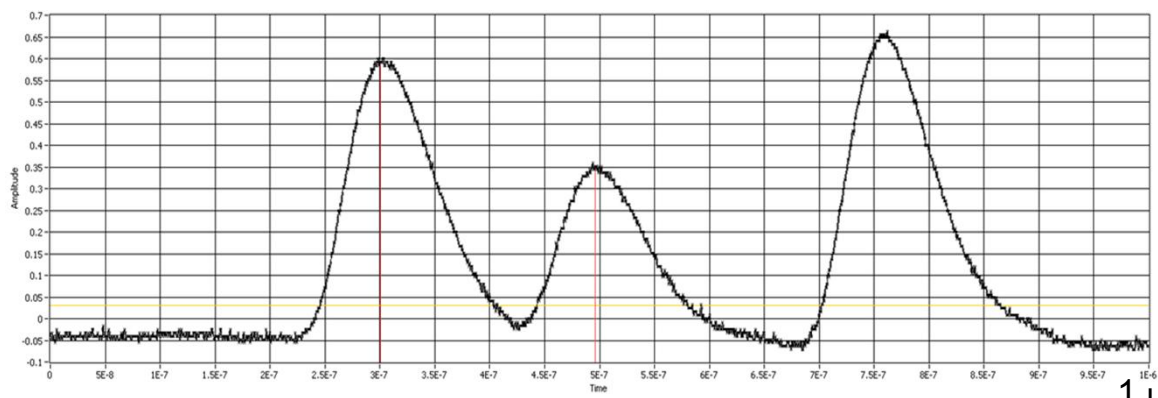
INTENSITY SCAN from 50 KHz - 3MHz

Fluence: $50 \cdot 10^3 \gamma/\text{mm}^2$



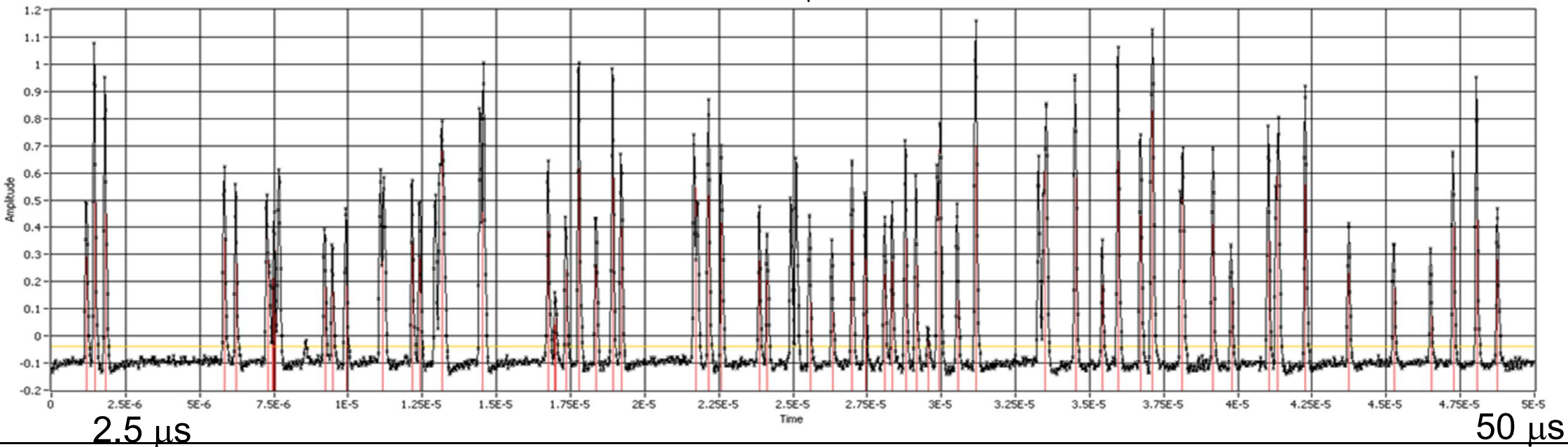
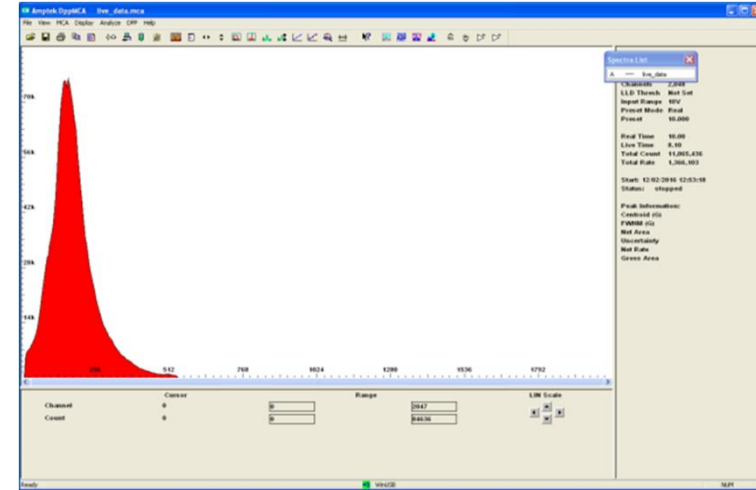
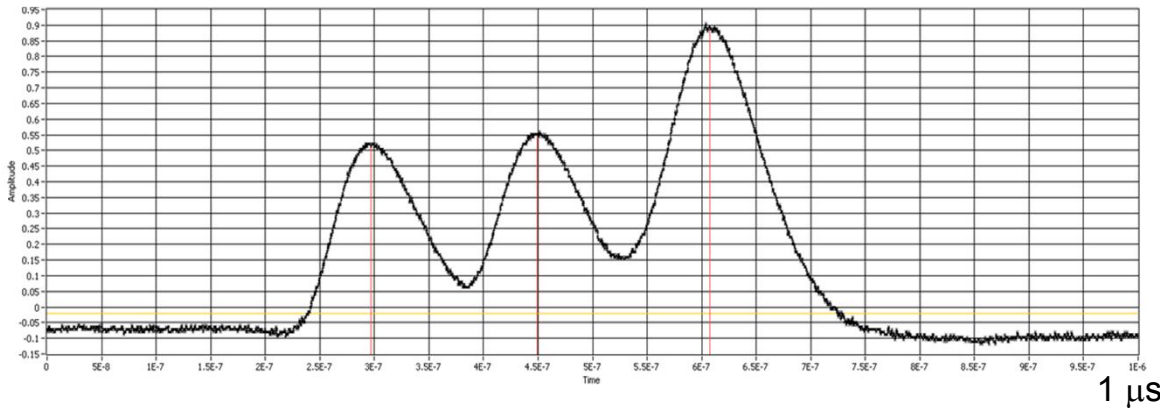
INTENSITY SCAN from 50 KHz - 3MHz

Fluence: $500 \cdot 10^3 \gamma/\text{mm}^2$



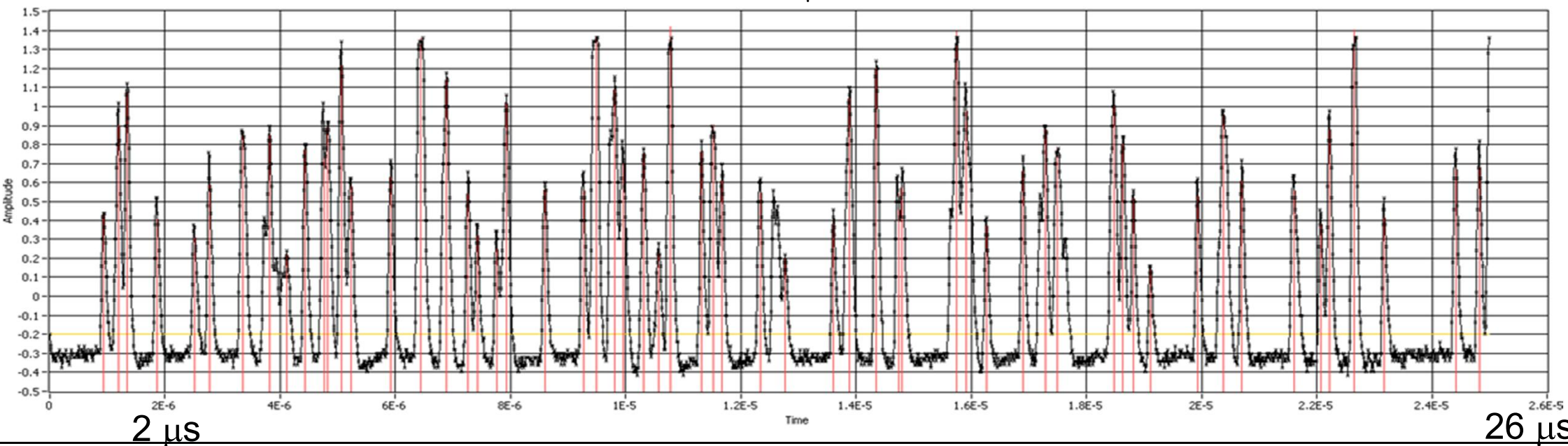
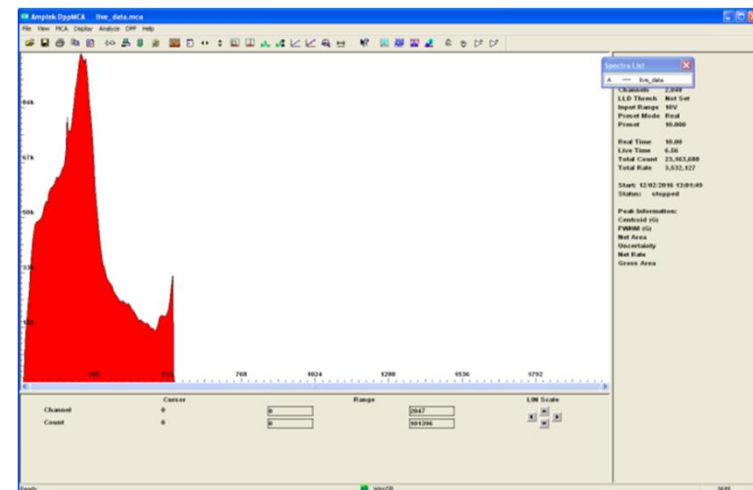
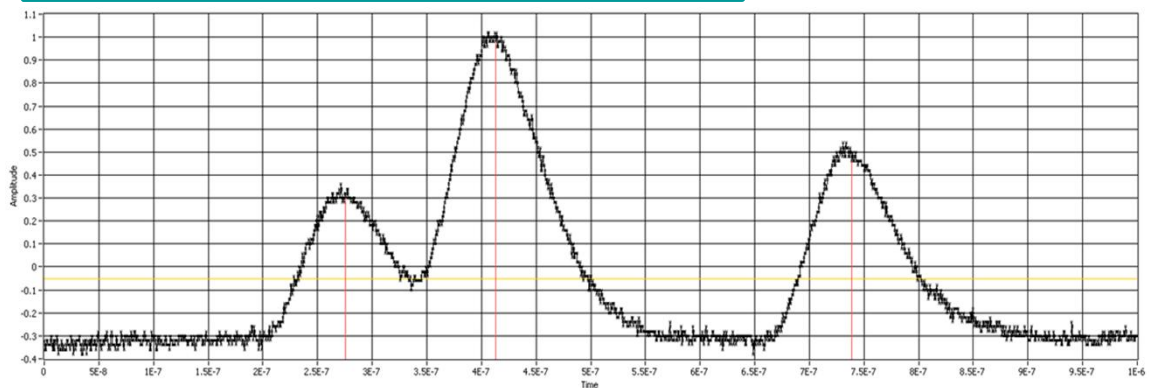
INTENSITY SCAN from 50 KHz - 3MHz

Fluence: $1 \cdot 10^6 \gamma/\text{mm}^2$



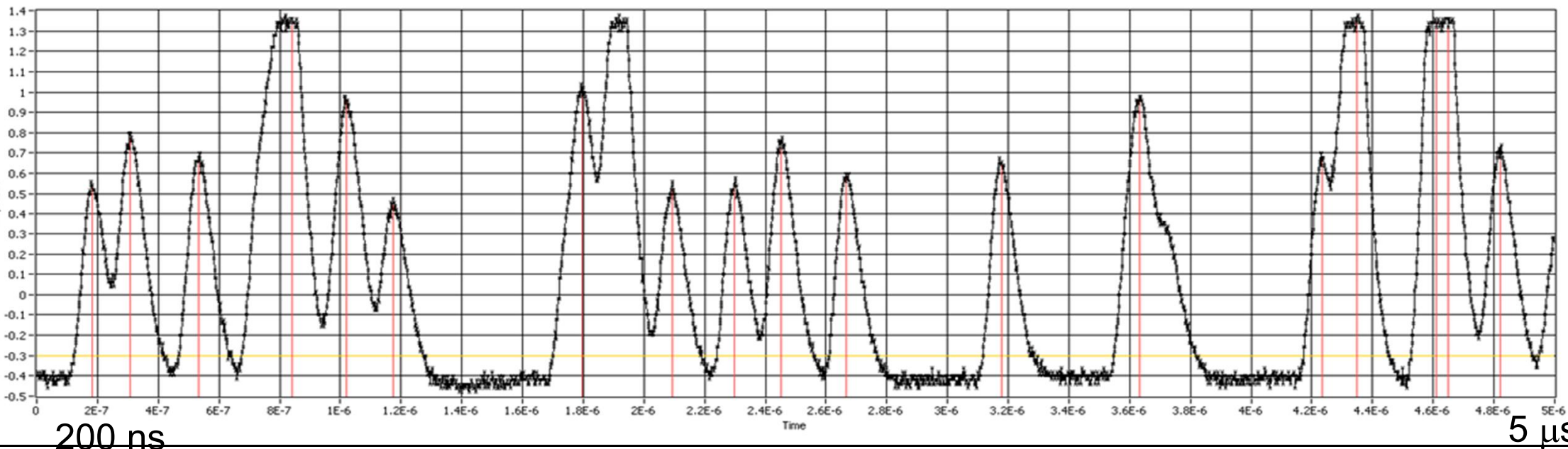
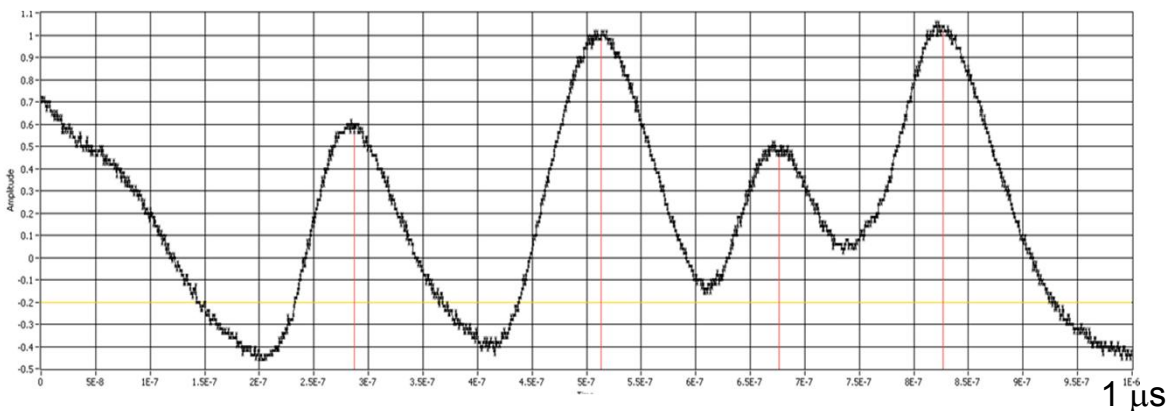
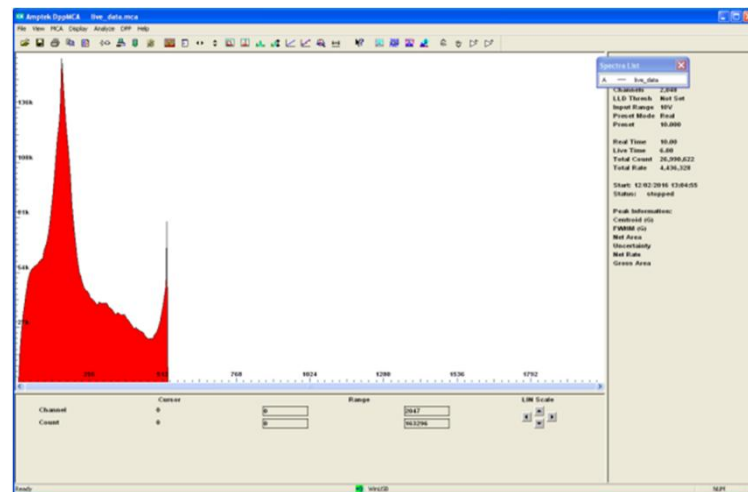
INTENSITY SCAN from 50 KHz - 3MHz

Fluence: $2 \cdot 10^6 \gamma/\text{mm}^2$



INTENSITY SCAN from 50 KHz - 3MHz

Fluence: $3 \cdot 10^6 \gamma/\text{mm}^2$



OUTLOOK

1. Detailed study of its Linearity at low/High rate
2. Saturation effects
3. Sparks resistance
4. Baseline shift possible mitigations