



# Arduino Spectrum Analyzer

Haranko Mykyta, TSNUK 2015



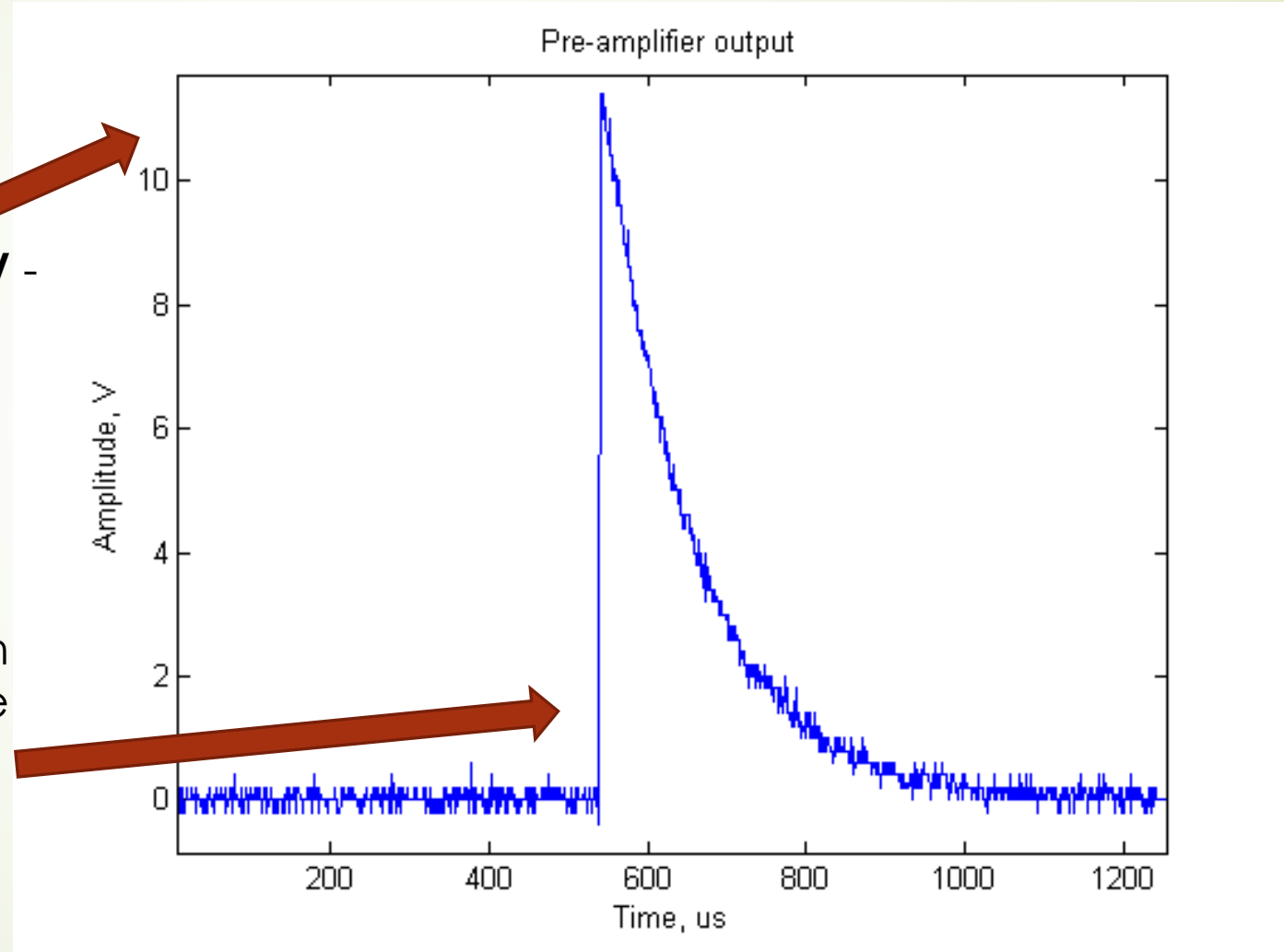
# Basic Idea

- Taking the pre-amplifier signal from the Germanium detector.
- Acquisition with Arduino (Arduino Due) developer board.
- Data transmission using Ethernet protocol
- Spectrum building and analyzing using Qt-based GUI.

# Detector signal

Amplitude up to **12V** -  
to much for Arduino  
ADC

Signal width  $\sim 250\mu\text{s}$ . In  
usual operating mode  
Arduino ADC will take  
6-7 samples in this  
range ( **$40\mu\text{s}/\text{sample}$** ).

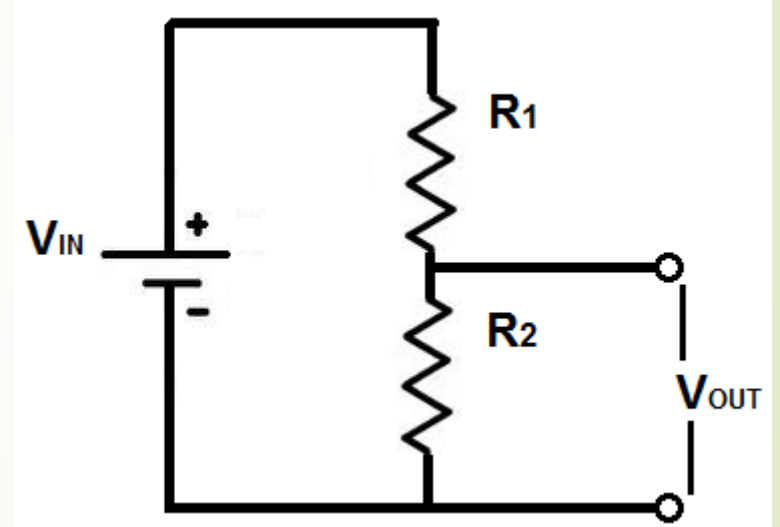
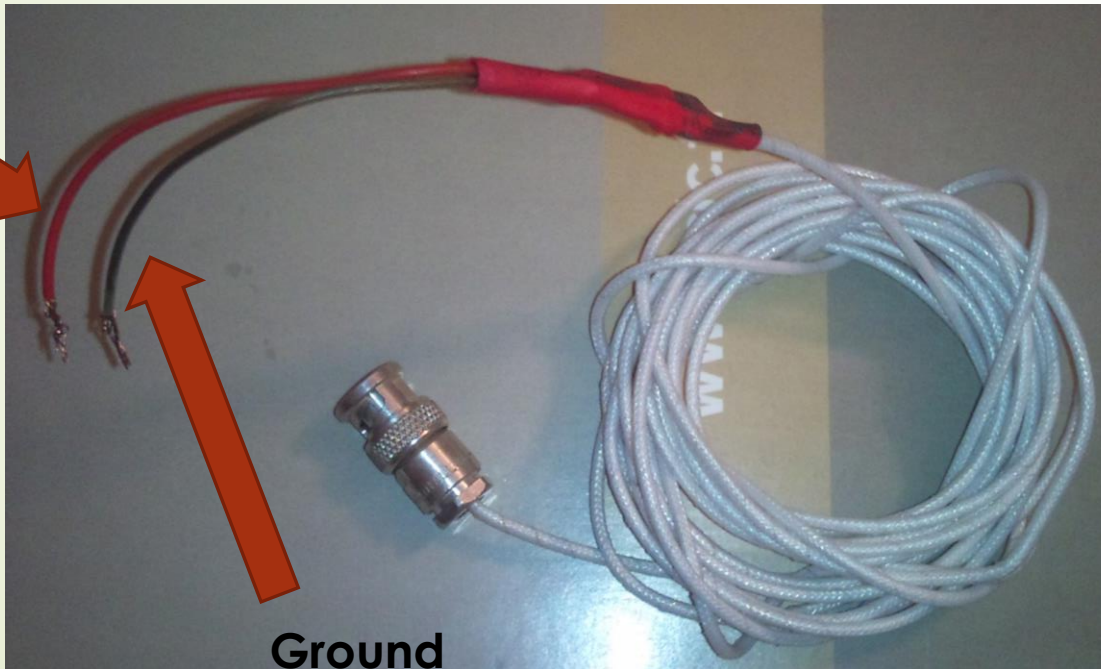


# Voltage Divider

- $R_1 = 7.5 \text{ k}\Omega$ .
- $R_2 = 1.5 \text{ k}\Omega$ .

$$U_2 = U \frac{R_2}{R_1 + R_2}$$

Signal



# Analog to Digital Converter

```
#define ADC_MR * (volatile unsigned int *) (0x400C0004) /*adc mode word*/
#define ADC_CR * (volatile unsigned int *) (0x400C0000) /*write a 2 to start conversion*/
#define ADC_ISR * (volatile unsigned int *) (0x400C0030) /*status reg -- bit 24 is data ready*/
#define ADC_ISR_DRDY 0x01000000
#define ADC_START 2
#define ADC_LCDR * (volatile unsigned int *) (0x400C0020) /*last converted low 12 bits*/
#define ADC_DATA 0x00000FFF
```

ADC in free mode.  
Acquisition time goes  
down to **2 us/sample**

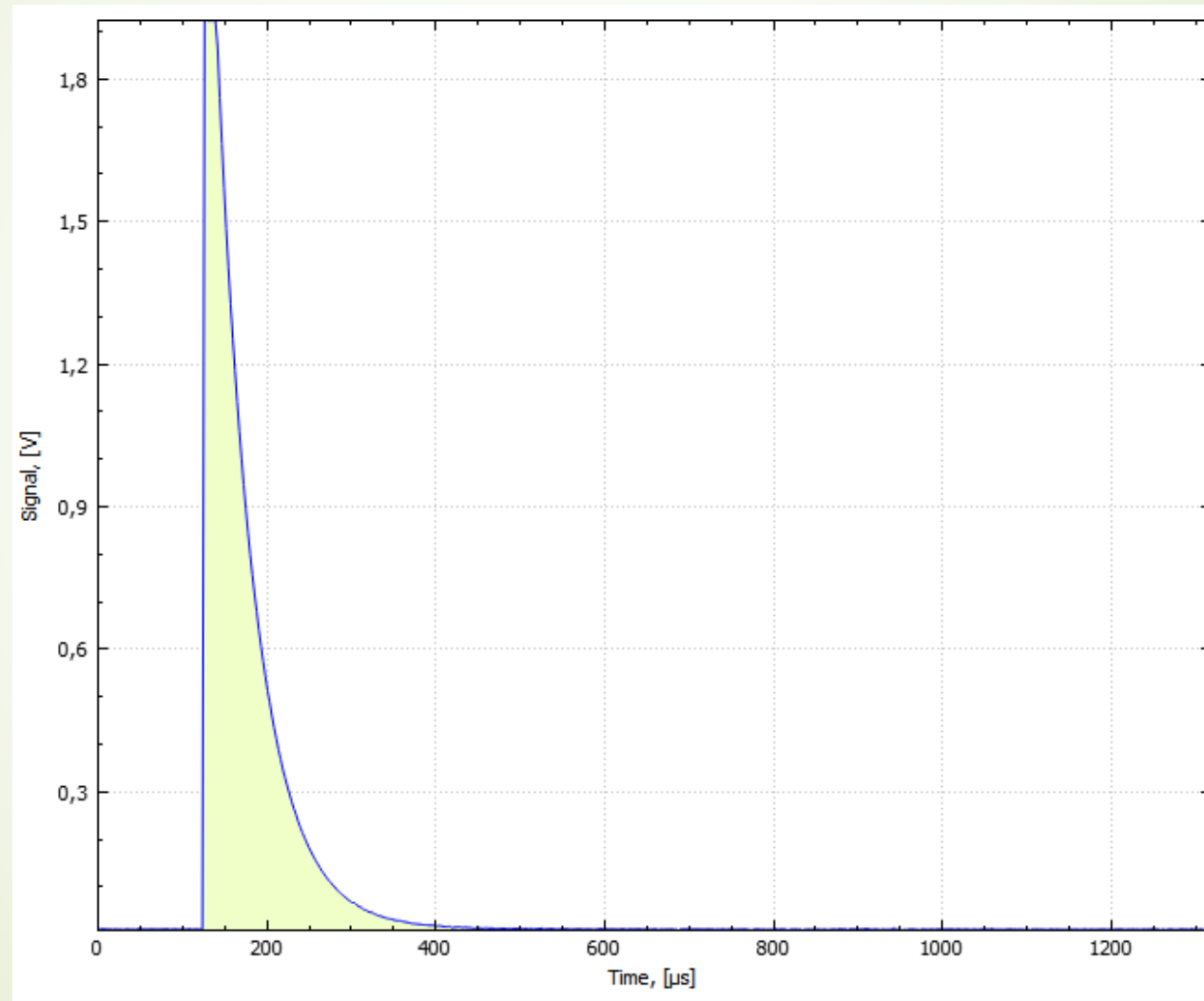


```
// first conversion
ADC_CR = ADC_START ;
while(1){
    // Wait for end of conversion
    while (!(ADC_ISR & ADC_ISR_DRDY));
    analog_data[j] = ADC_LCDR & ADC_DATA ;
    ADC_CR = ADC_START ;
}
```

# Data Analysis

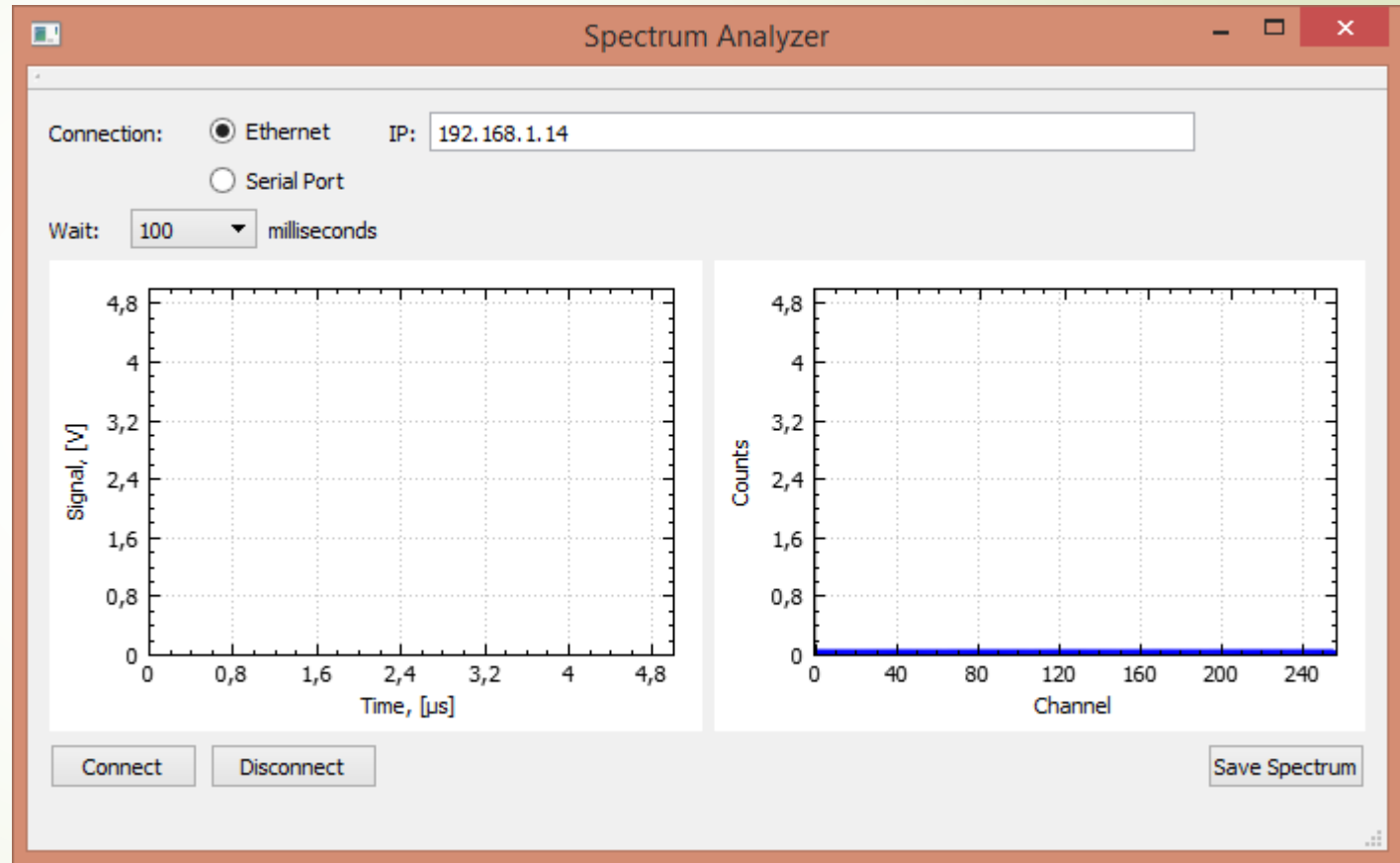
- Discrete Fourier Transform. ➡  $X_k \stackrel{\text{def}}{=} \sum_{n=0}^{N-1} x_n \cdot e^{-j2\pi kn/N}, \quad k \in \mathbb{Z} \text{ (integers)}$
- Filtering of the signal (in frequency domain).
- Inverse DFT.
- Integration over the time range.

# Signal Sample

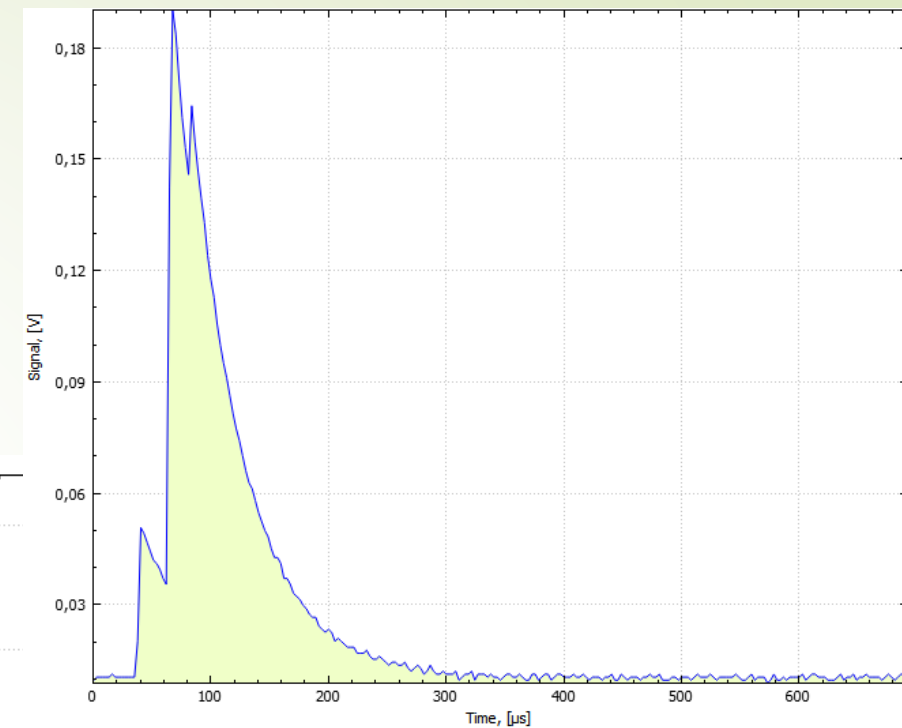
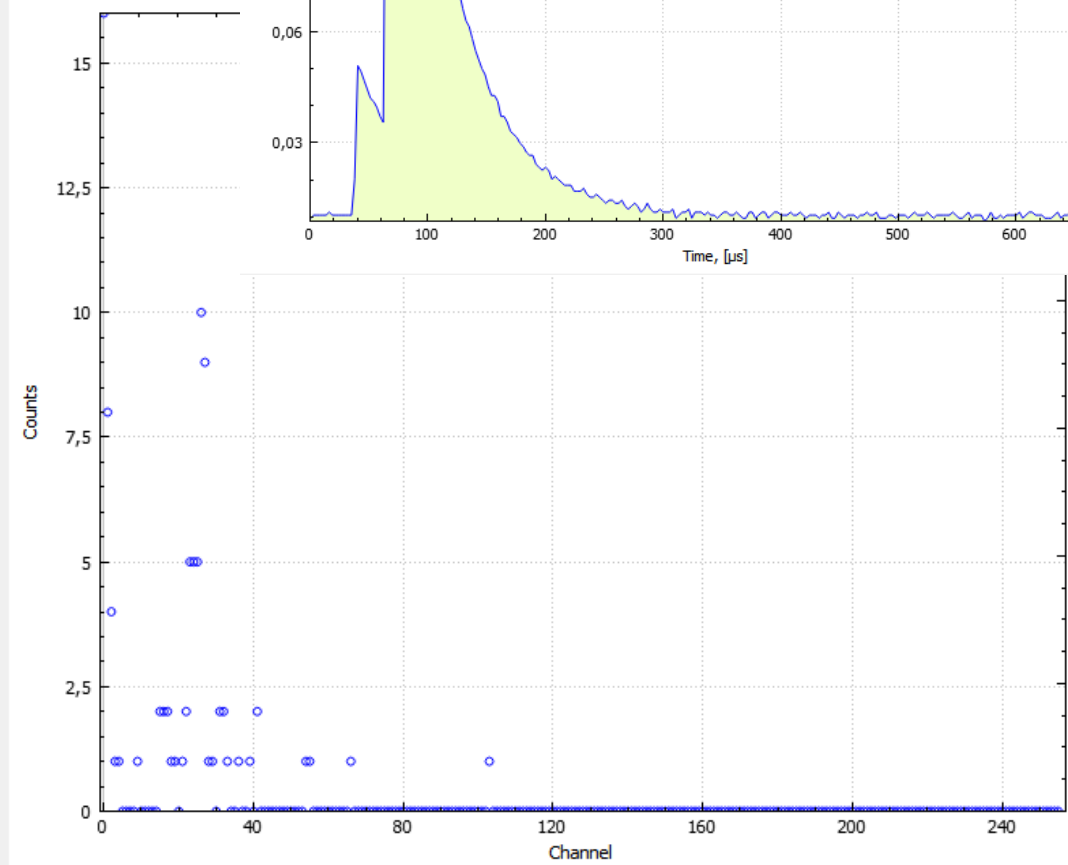
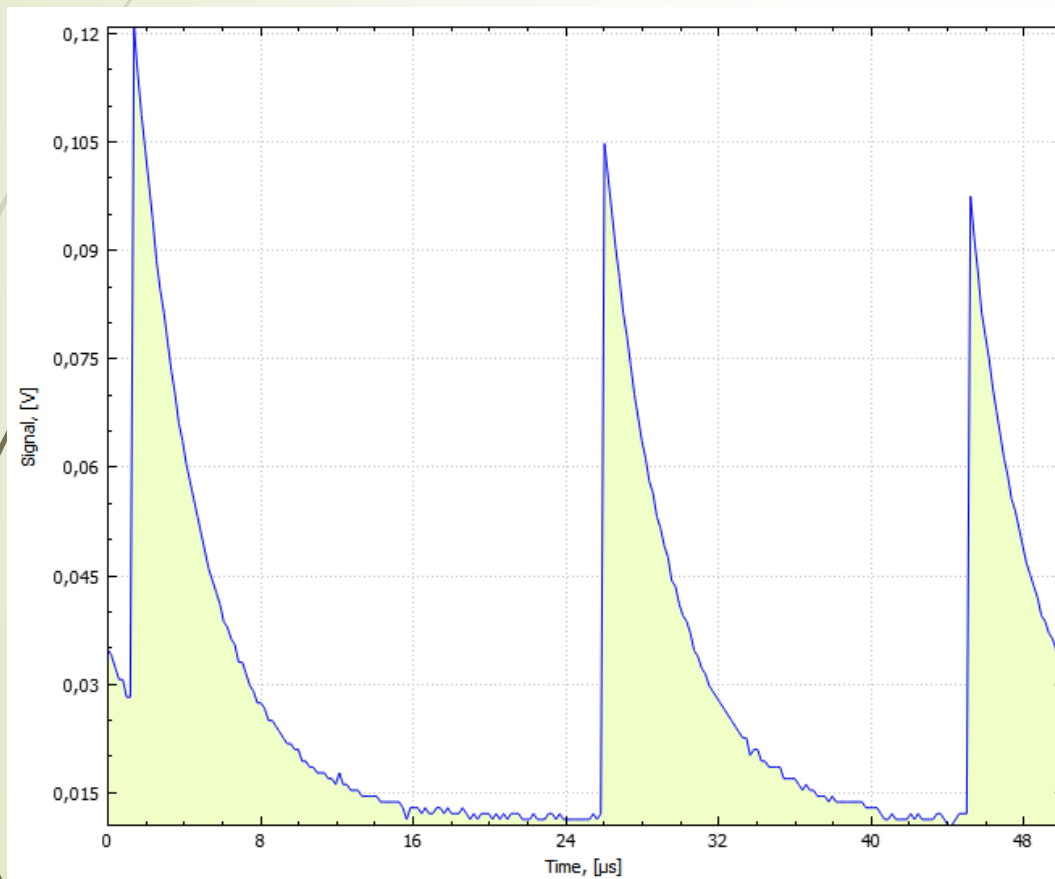


# Graphical User Interface

- Connection via TCP/IP
- Oscilloscope/Analyzer plotter
- Connection via Serial Port
- Saving Spectrum to the TXT file



# Problems





# Problems

- Signal overlay from different events
  - Arduino Ethernet connection problem – stops to send data without any reasons
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