



Pulse Recognition by using a Convolutional Neural Network (CNN)

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nTOF Meeting, Rome, 26 – 27 September 2022

CNN



Machine Learning

Supervised Learning

Predictive model based on input and output data

Classification

Classifying items into different categories

Regression

Predicting numerical value of an item

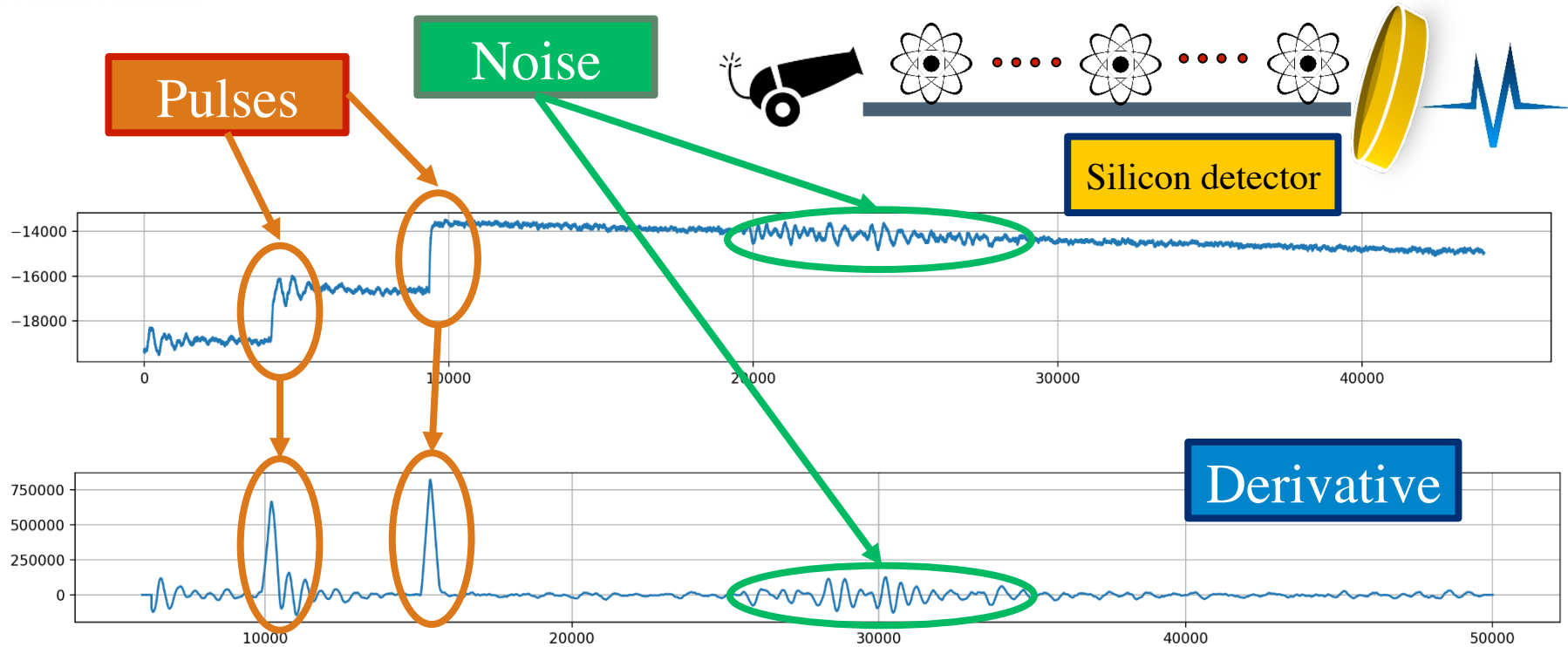
Unsupervised Learning

Group data based only on input data

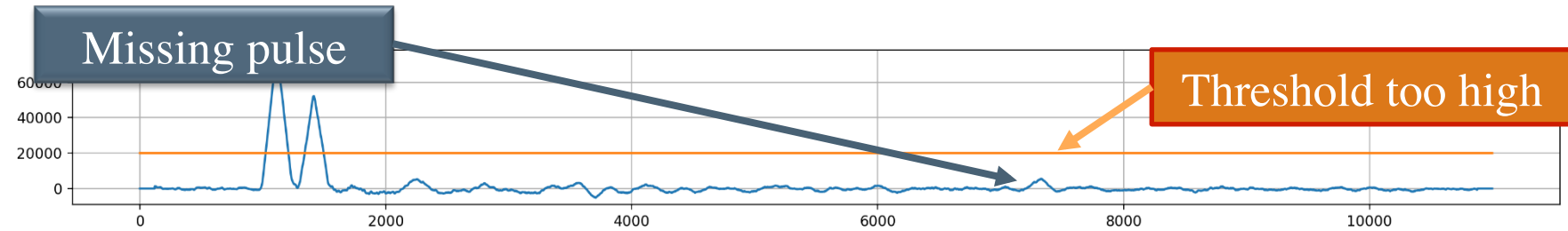
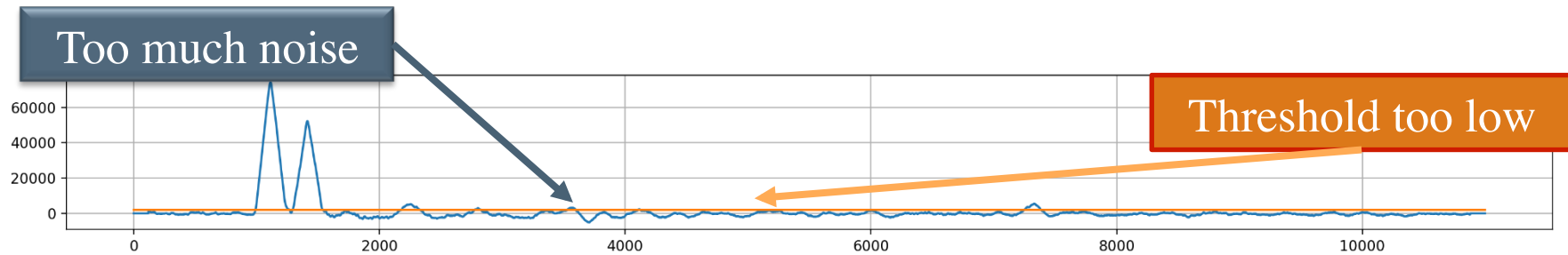
Clustering

Putting similar items together

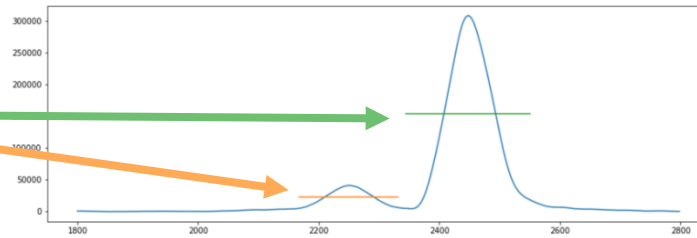
Peak detection with the use of the derivative



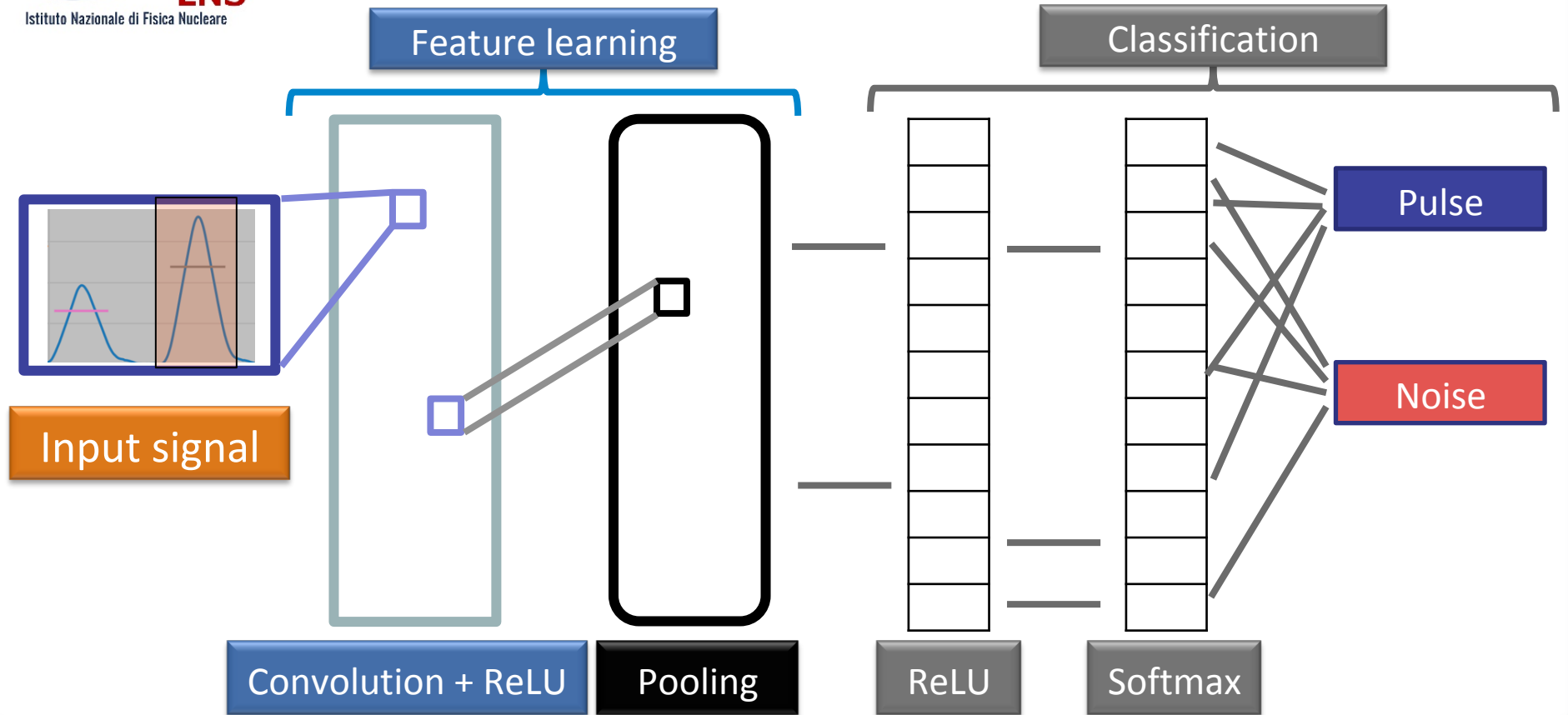
Traditional technique limits



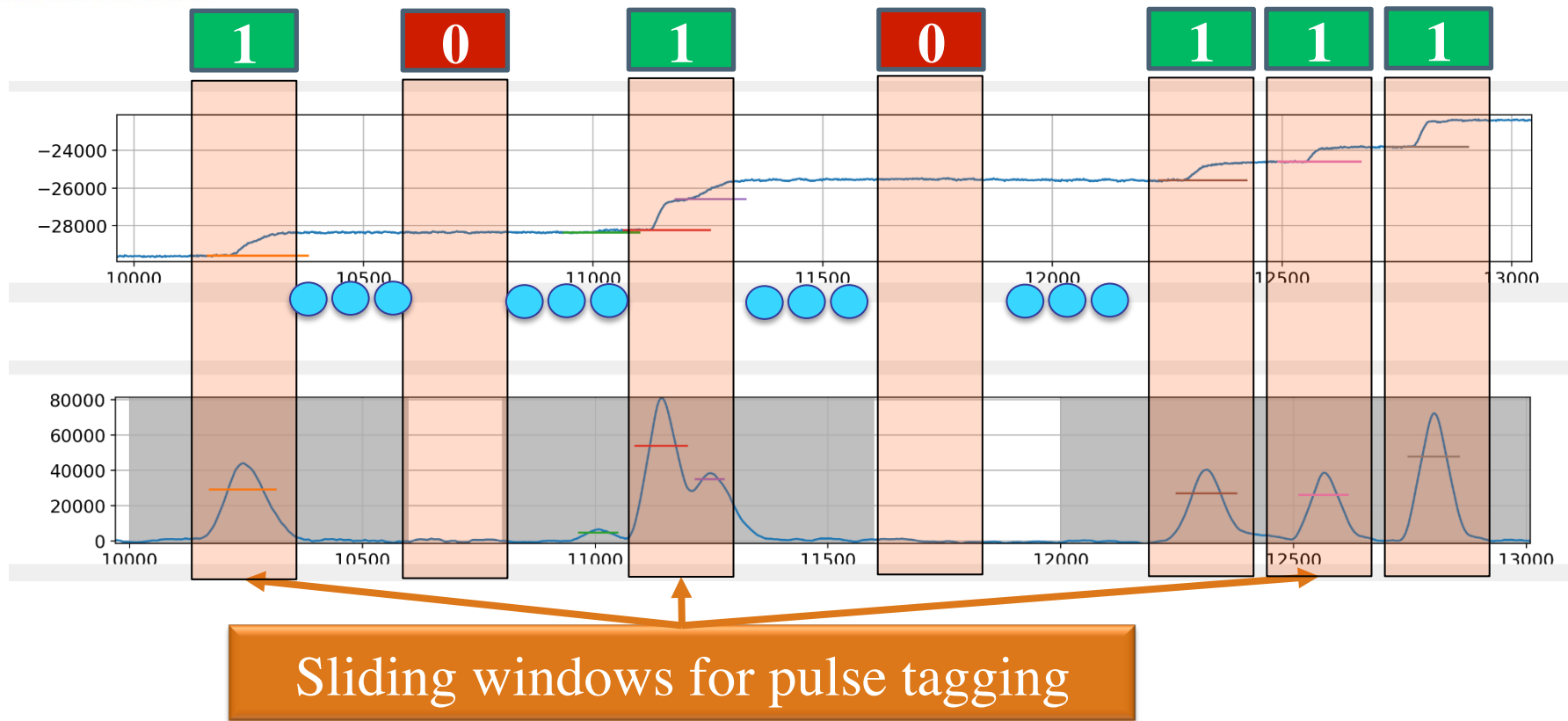
Adaptive thresholds



Convolutional Neural Network (CNN)



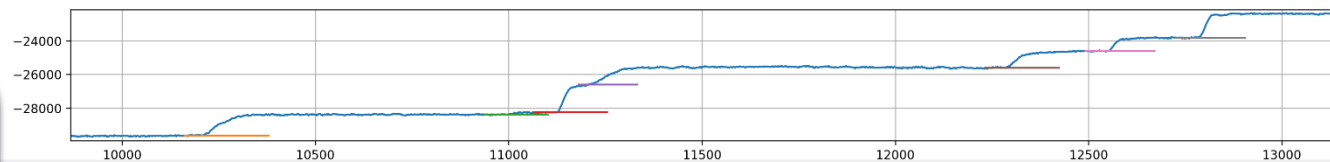
Input data processing: signal slicing



GUI for pulse recognition and signal analysis

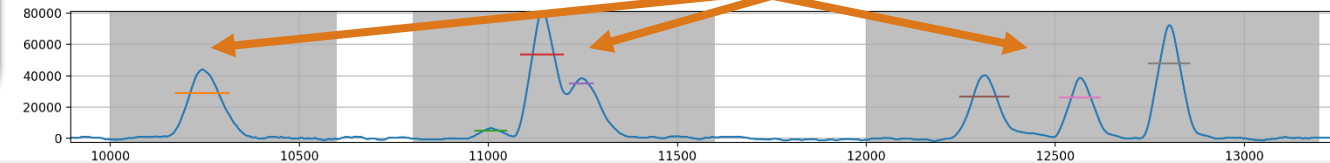
<< < | h_SADR_9_26_0 > +20 +50 +100 Trapezoidal filter Xmax: 13768 | Xmin: 6102 | Ymax: -22330.0 | Ymin: -29738.0

pan/zoom



Analysis of the output signal from the preamplifier acquired by silicon detectors

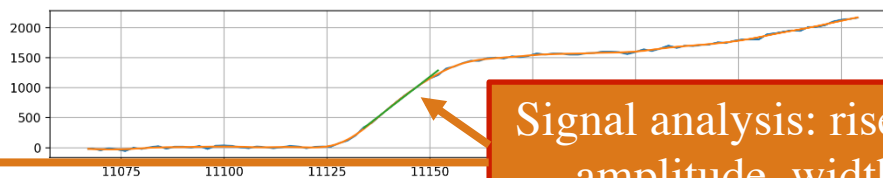
Pulse recognition with ML algorithm



Amplitude derivate: 80824.0 | Ampl: 1600.65 deltaT: 19.33 t0: 11134.11 t1: 11153.45 k: 53.18 | ampl_der: 33482.39 integral_der: 1124815.05 width_der: 40.29 | ampl_trap: 11960.67

User friendly interface developed in Python3 (PyQt5)

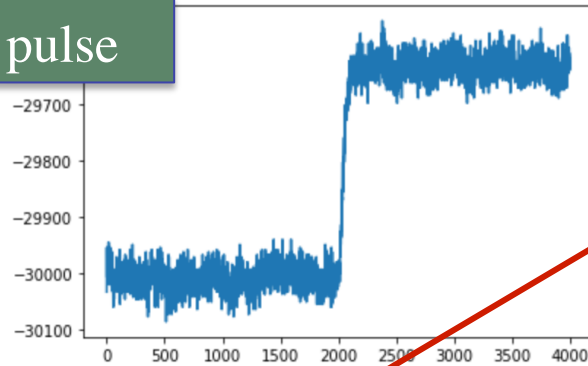
Start	Min	Stop	Integral
10211	x: 10244 y: 43934.5	x: 10287	2886960.0
10986	x: 11008 y: 6514.5	x: 11030	248893.5
11117	x: 11143 y: 80824.0	x: 11174	3941736.0
11230	x: 11247 y: 38331.5	x: 11265	1261779.5
12283	x: 12314 y: 40284.5	x: 12344	2127859.5
12542	x: 12566 y: 38624.5	x: 12594	1720335.0
12776	x: 12802 y: 72215.0	x: 12829	3262144.0



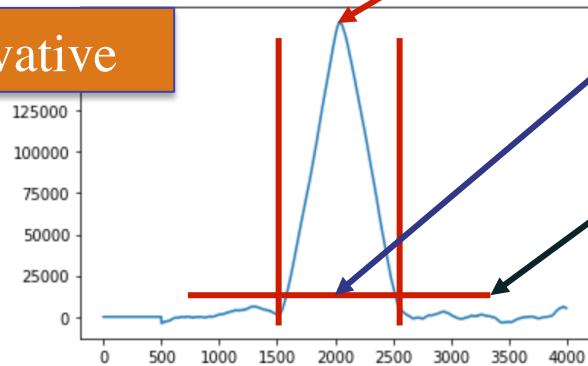
Signal analysis: rise time, amplitude, width...

Signal Analysis

Real pulse



Derivative



Amplitude: mean of # points around the peak

Width calculation at #% of the prominence

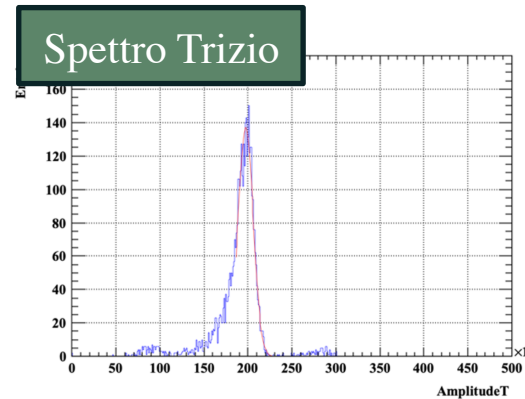
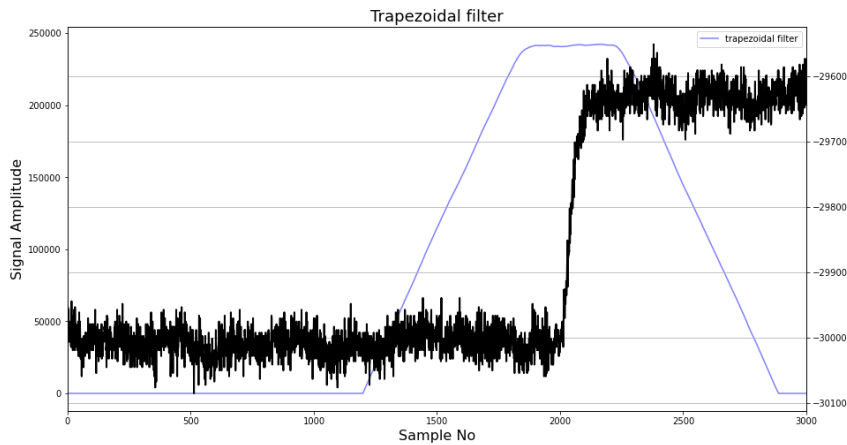
Integral calculation at #% of the prominence

Signal Analysis

In caso di segnali isolati (no pile up)

Lower Neutron Energy

Gradi di libertà: rise time e flat top



FWHM Amplitude using Trapezoidal Filter:

10.1904 %

Specifications:

Prominence derivative: 0.97

Number of points for the estimation of the trapezoid amplitude: **300**

k: 500

m: 500

Spettro con TFA -> risoluzione 8/9%

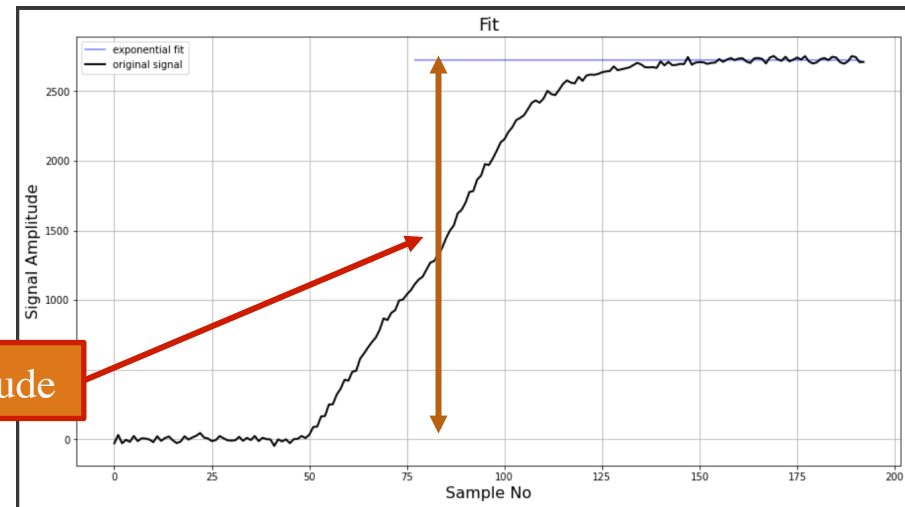
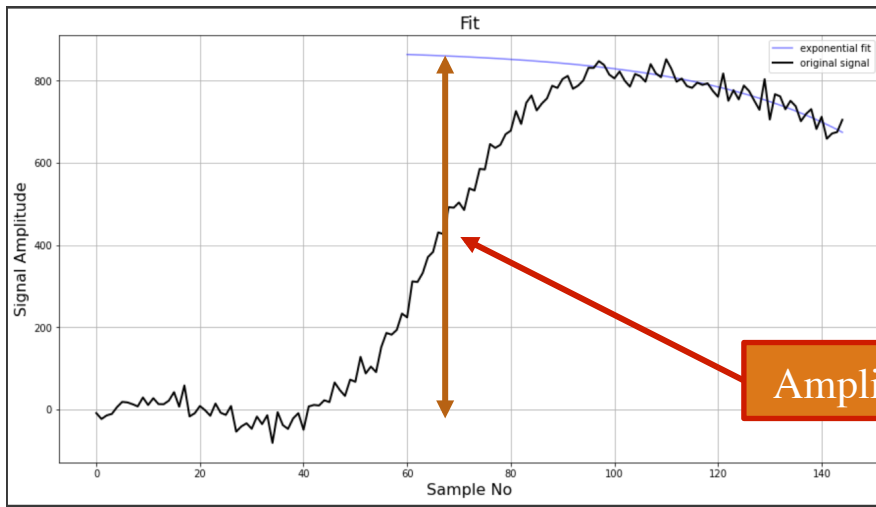
Spettro con migliore risoluzione -> risoluzione 10%

Signal Analysis

In caso di segnali impilati (pile up)

Esempio misura ampiezza con fit esponenziale:

$$a_0 \pm e^{a_1} \cdot e^{a_2 \cdot x}$$



Utilizzato per elevata densità di segnali (alta energia)

Conclusions

Procediamo analizzando i segnali per un fine tuning e un'ottimizzazione della routine per arrivare ad avere un software stabile, robusto e con prestazioni spettroscopiche confrontabili con le tecniche tradizionali, estendendo l'efficienza ad energia elevate, ove le tecniche tradizionali non sono adeguate.

Next step -> Analisi dei segnali acquisiti in EAR2