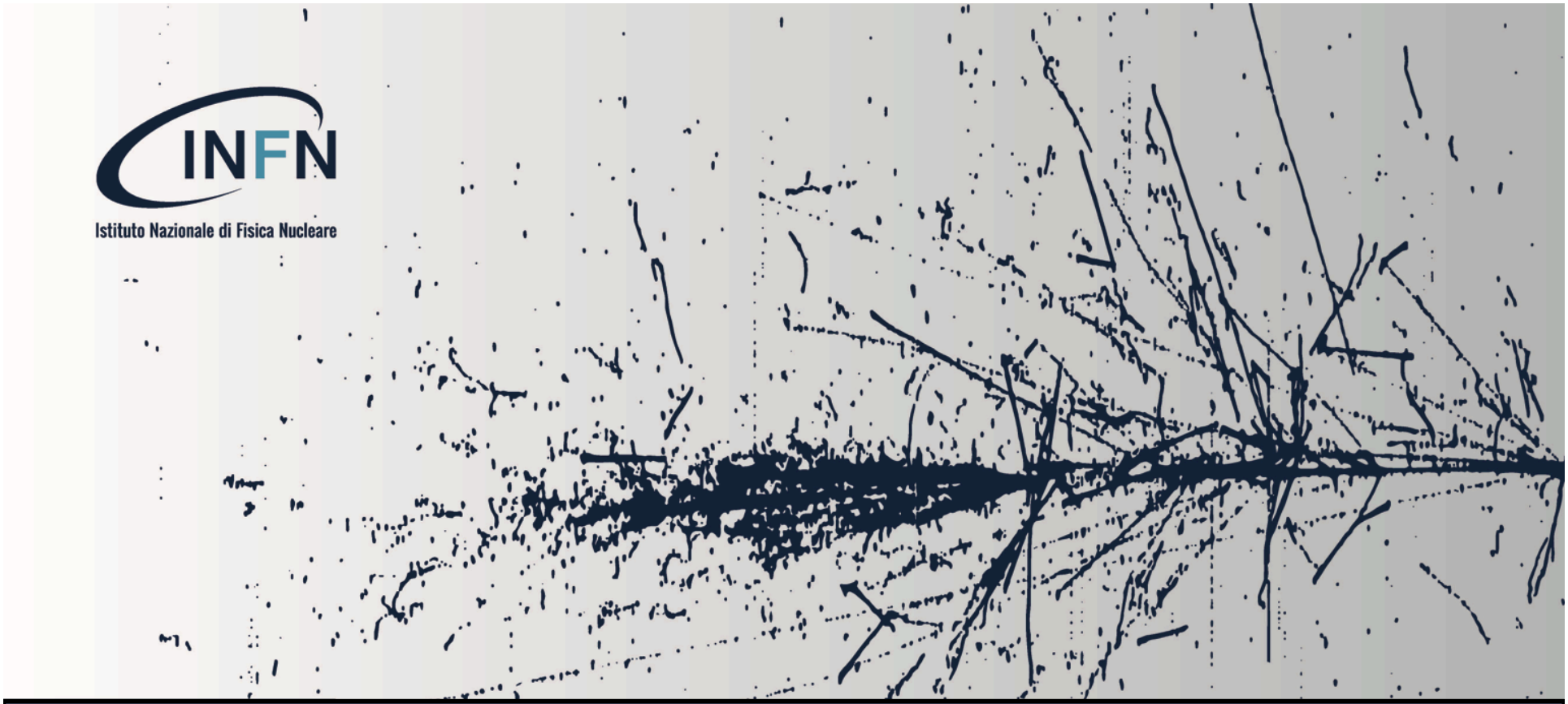


Pulse Recognition by using a Convolutional Neural Network (CNN)

G. Vecchio, S. Amaducci, L. G. Cosentino, P. Finocchiaro (INFN - LNS)

nTOF Meeting, Rome, 26 – 27 September 2022

Machine Learning for Fast Pulse Recognition

Machine Learning

Supervised Learning
Predictive model based on input and output data

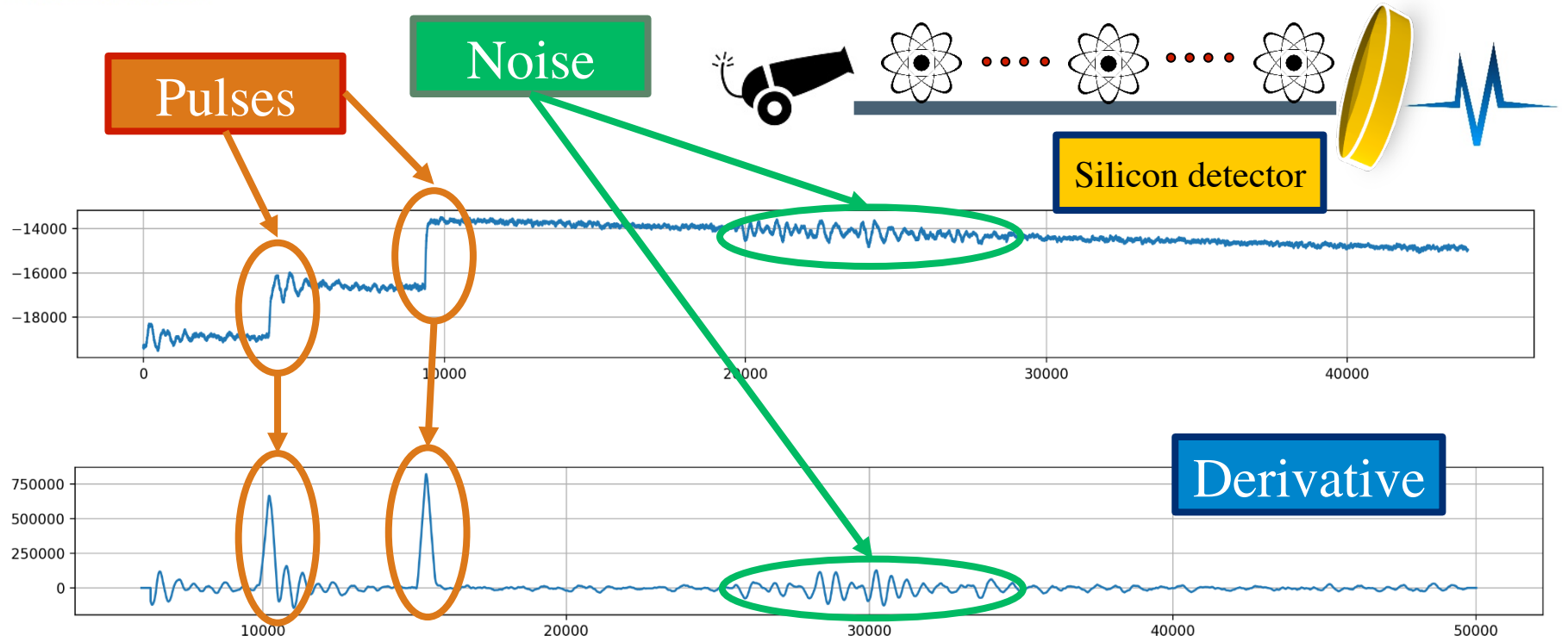
Classification
Classifying items into different categories

Regression
Predicting numerical value of an item

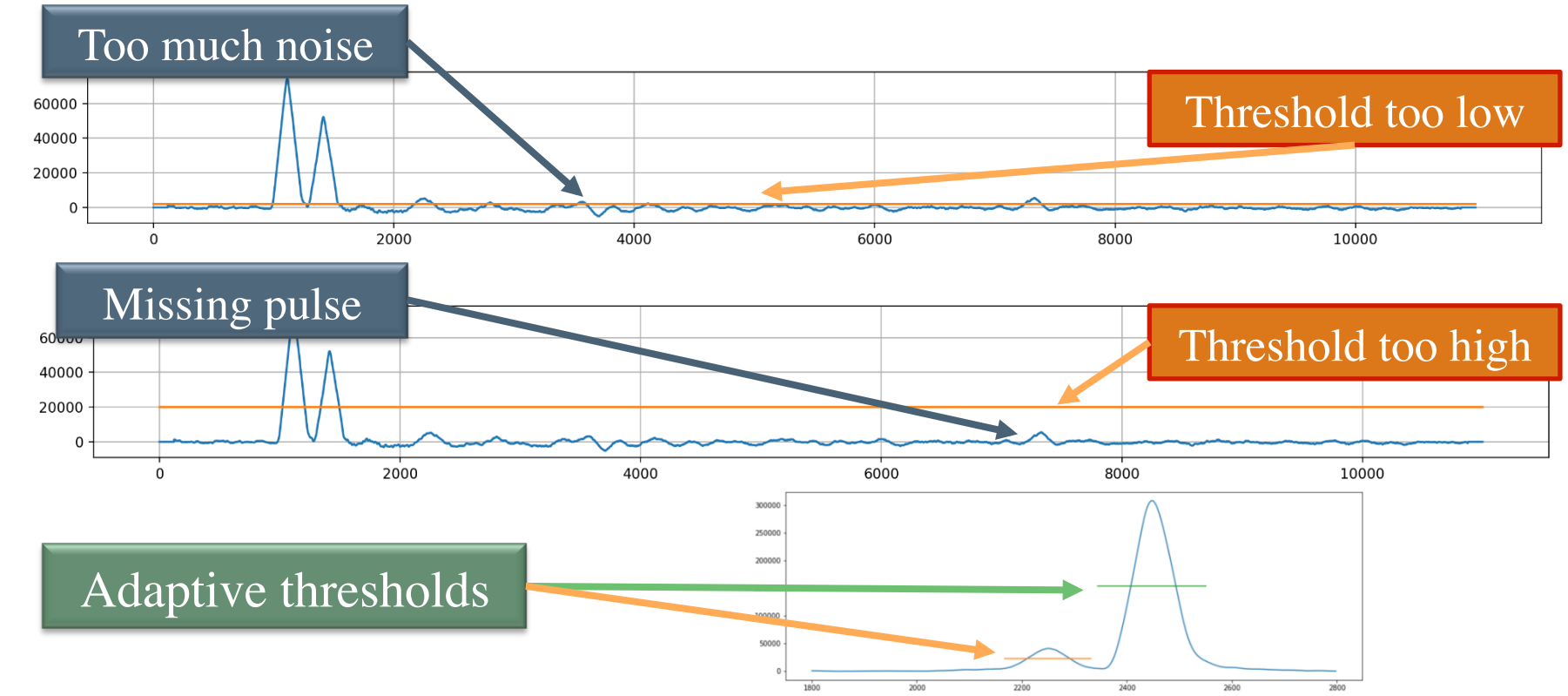
Unsupervised Learning
Group data based only on input data

Clustering
Putting similar items together

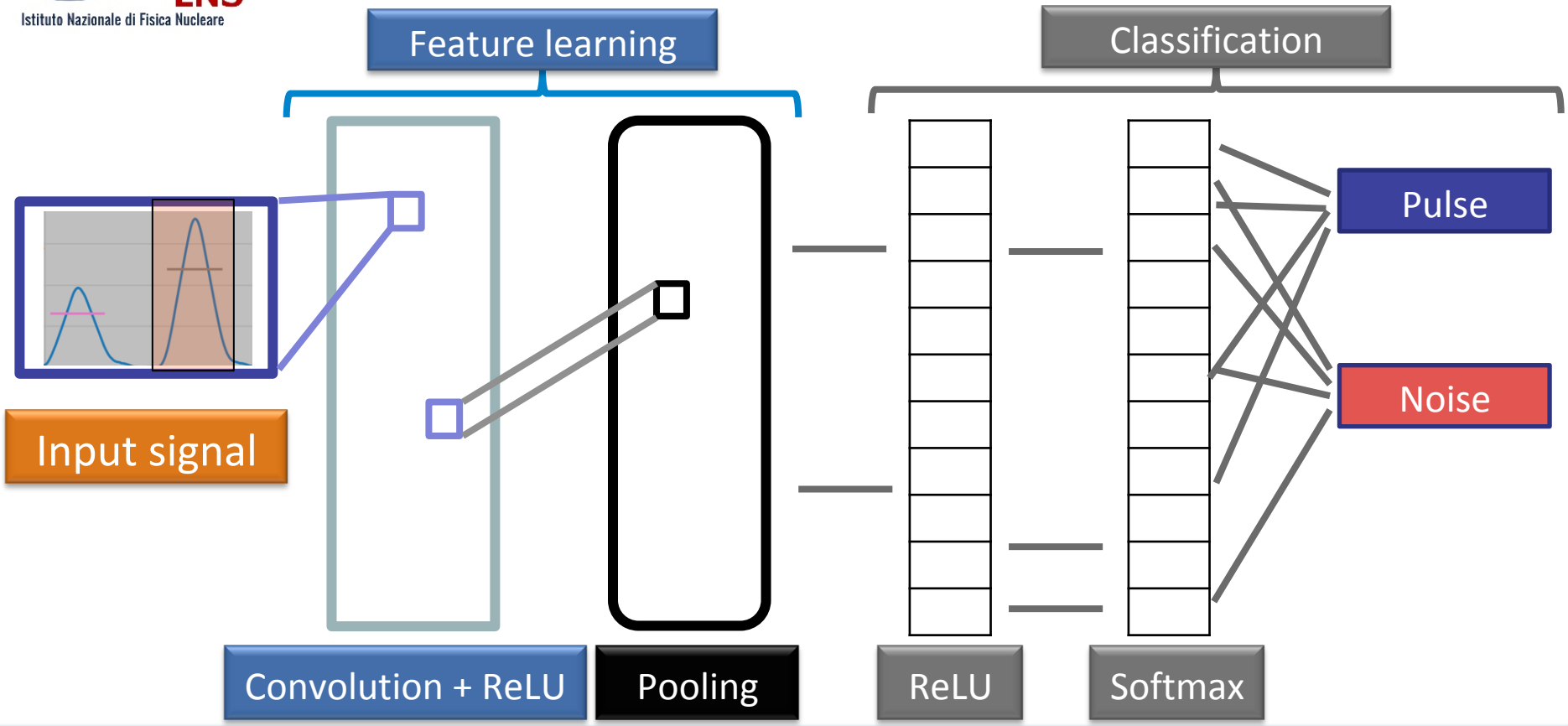
Peak detection with the use of the derivative



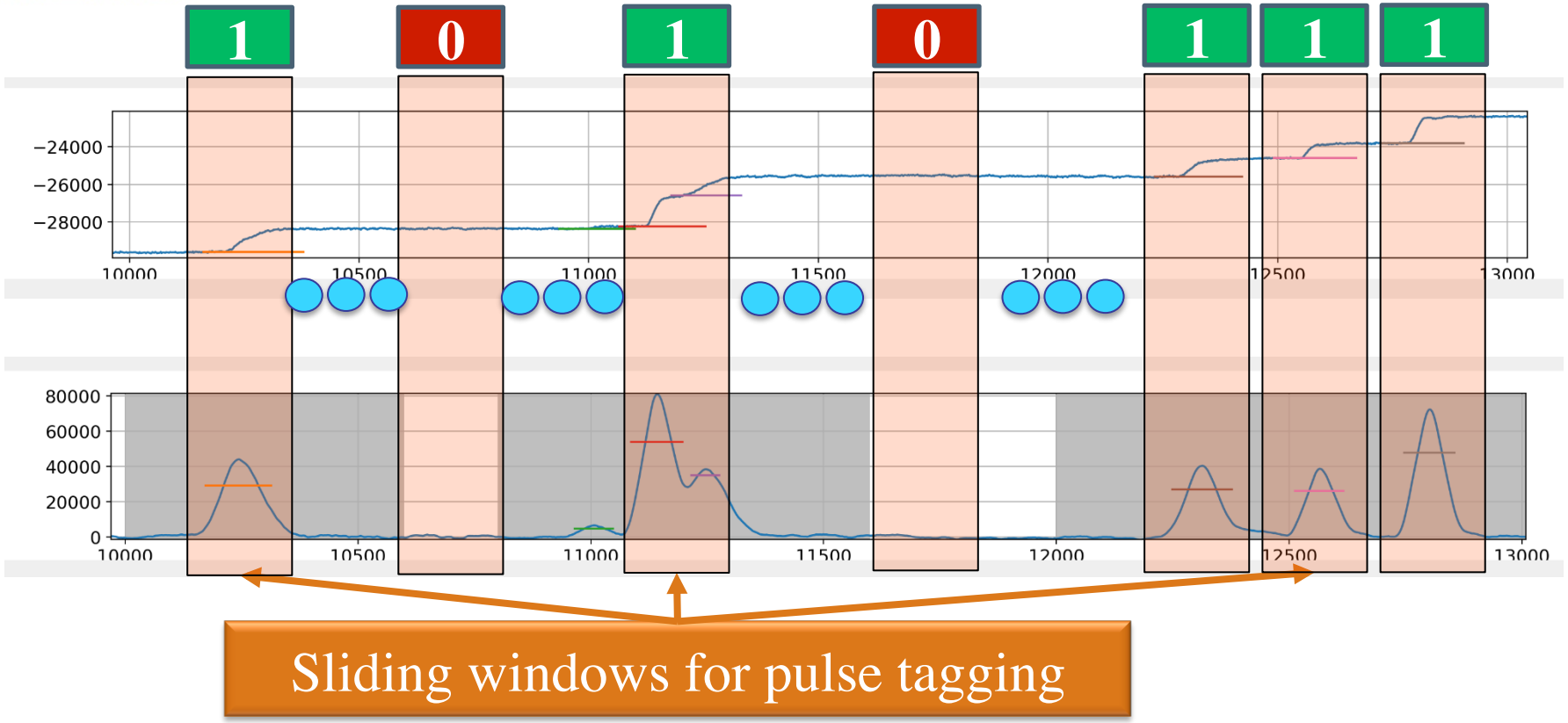
Traditional techinque limits



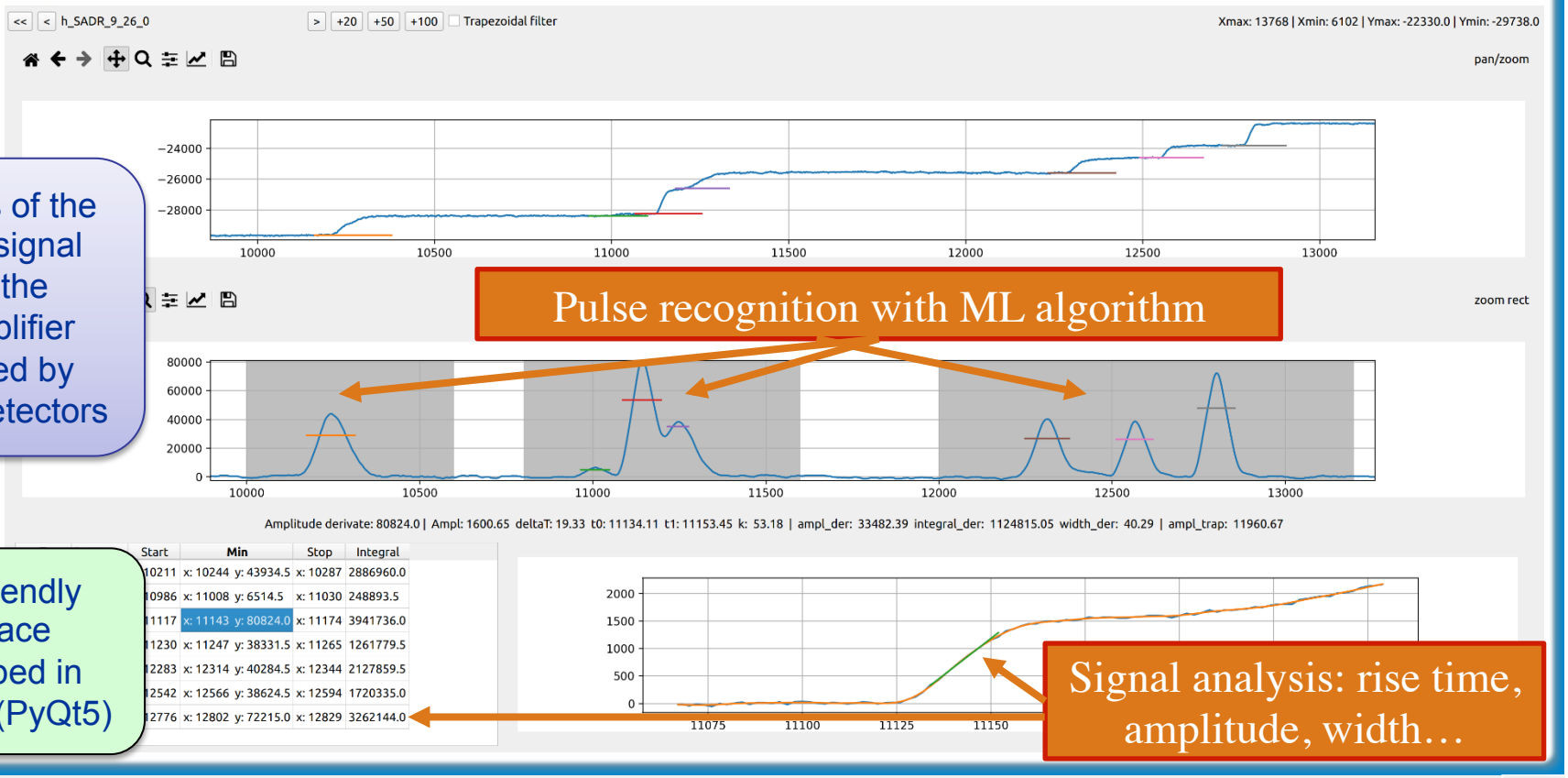
Convolutional Neural Network (CNN)



Input data processing: signal slicing



GUI for pulse recognition and signal analysis



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

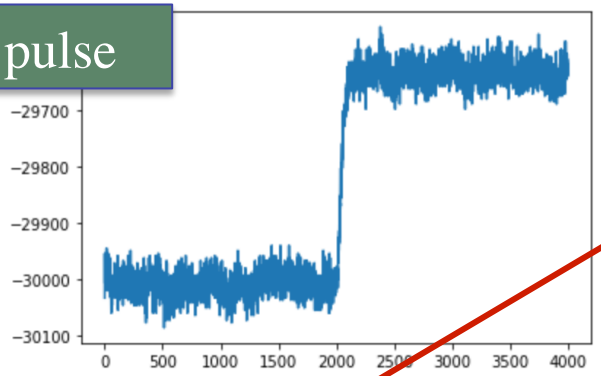
Pulse recognition with ML algorithm

User friendly interface developed in Python3 (PyQt5)

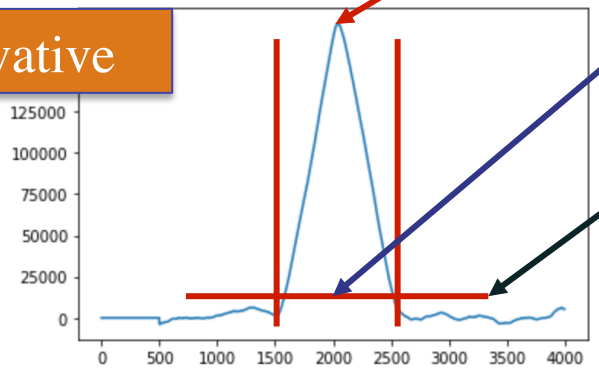
Signal analysis: rise time, amplitude, width…

Signal Analysis

Real pulse



Derivative



Amplitude: mean of # points around the peak

Width calculation at #% of the prominence

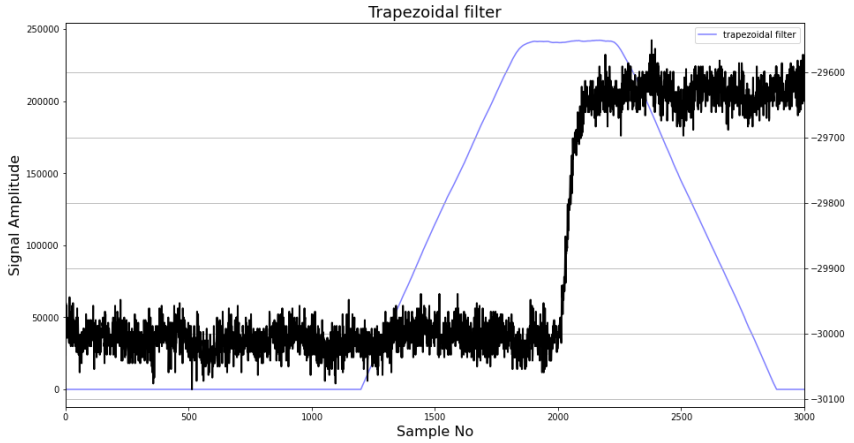
Integral calculation at #% of the prominence

Signal Analysis

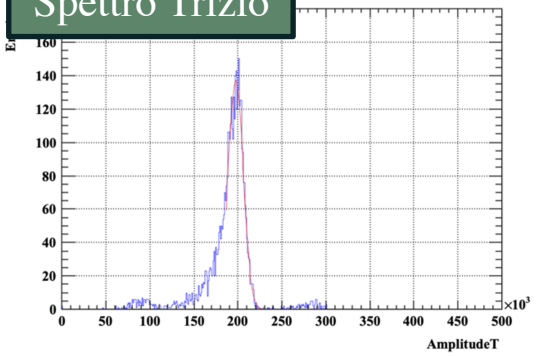
In caso di segnali isolati (no pile up)

Lower Neutron Energy

Gradi di libertà: rise time e flat top



Spettro Trizio



FWHM Amplitude using Trapezoidal Filter:

10.1904 %

Specifications:

Prominence derivative: 0.97

Number of points for the estimation of the trapezoid amplitude: 200

k: 500

m: 500

Spettro con TFA -> risoluzione 8/9%

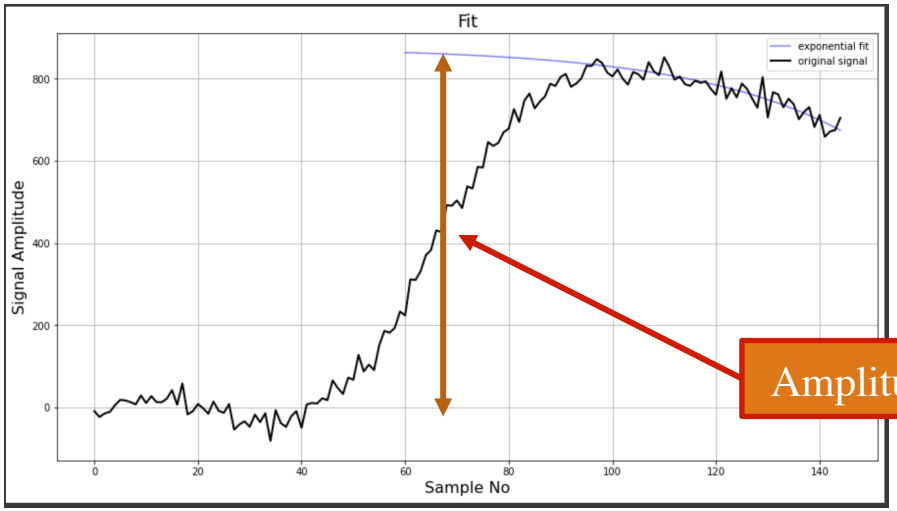
Spettro con migliore risoluzione -> risoluzione 10%

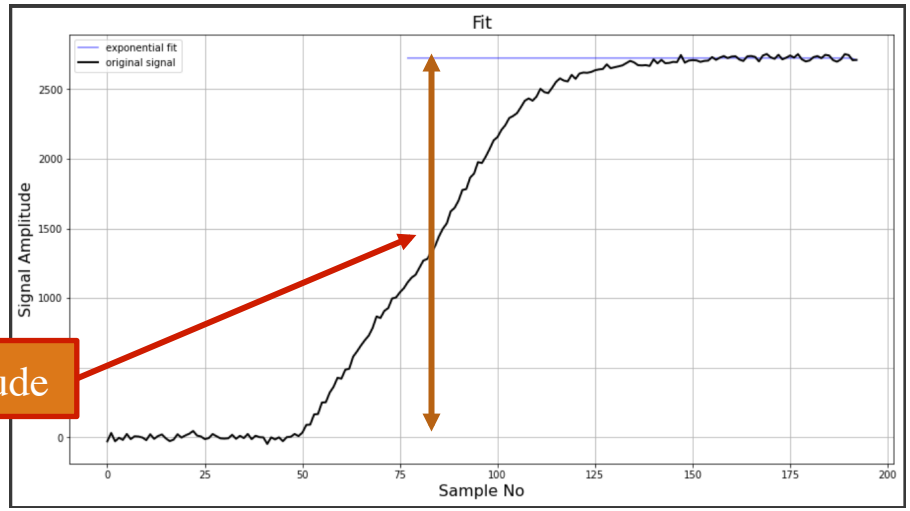
Signal Analysis

In caso di segnali impilati (pile up)

Esempio misura ampiezza con fit esponenziale:

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





Amplitude

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