A supervised Machine Learning Approach for Shape sensitive Detector Pulse Discrimination in Positron Spectroscopy Applications

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The acquisition of high-quality positron spectra is crucial for a profound analysis, i.e. the correct decomposition to obtain the *true* parameters. Since the introduction of digital spectrometers for the techniques of PALS and CDBS, this is generally achieved by applying various (software-based) filters/corrections on the digitized output-pulses from photomultipliers/HPGe-detectors prior to spectra generation. For instance, pile-up events can be easily detected and subsequently rejected by applying pulse-area/shape sensitive filters, which significantly increases the peak-to-background ratio.

Here, we present a novel approach for shape-sensitive discrimination of detector output-pulses using supervised machine learning (ML) based on a simple probabilistic classification model: the *naive Gaussian Bayes classifier*. In general, *naive Bayes* methods find wide application for many real-world problems such as famously applied for email spam filtering, text categorization or document classification. Their algorithms are relatively simple to implement and, moreover, perform extremely fast compared to more sophisticated methods in *training* and *predicting* on high-dimensional datasets, e.g. detector-output pulses.

We compared the quality and decomposability of lifetime spectra acquired on pure metals from a single measurement (pulse stream): (1) generated by applying the ML approach (software: pyDMLDetectorPulseDiscriminator [1]) to lifetime spectra generated using DDRS4PALS software (2) with and (3) without filters applied [2].

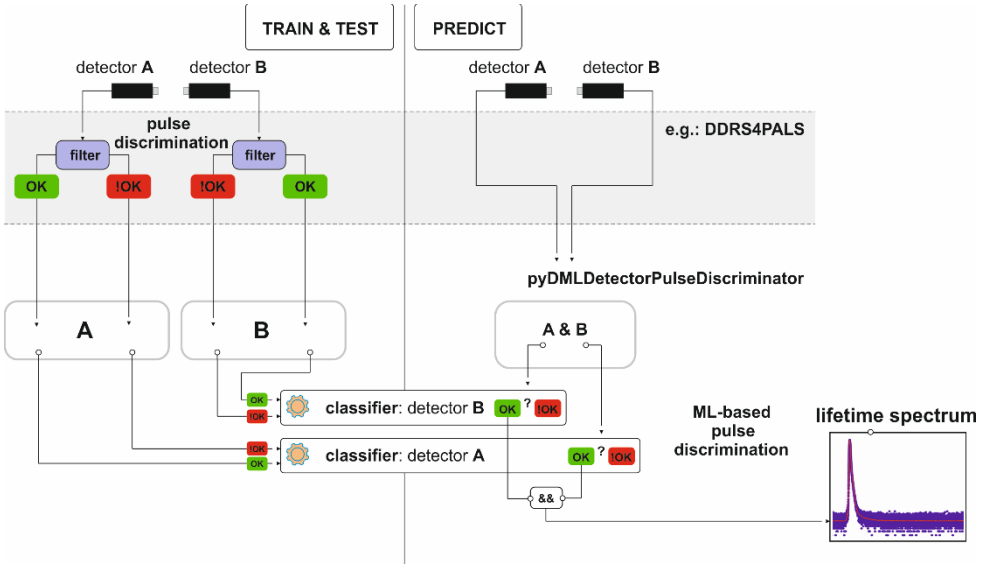

Figure 1 *Basic principle of the here presented supervised machine learning (ML) approach for shape-sensitive discrimination of detector output-pulses for the technique of PALS.*

References

[1] D. Petschke, dpscience/DMLLTDetectorPulseDiscriminator v1.0, *Zenodo*, (2019).
[2] D. Petschke, dpscience/DDRS4PALS v1.08, *Zenodo*, (2019).

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