

A Convolutional Neural Network Algorithm for Automated Processing of LaCl₃ Scintillator Waveforms Incorporating Pulse Shape Discrimination and Pile-up Recovery

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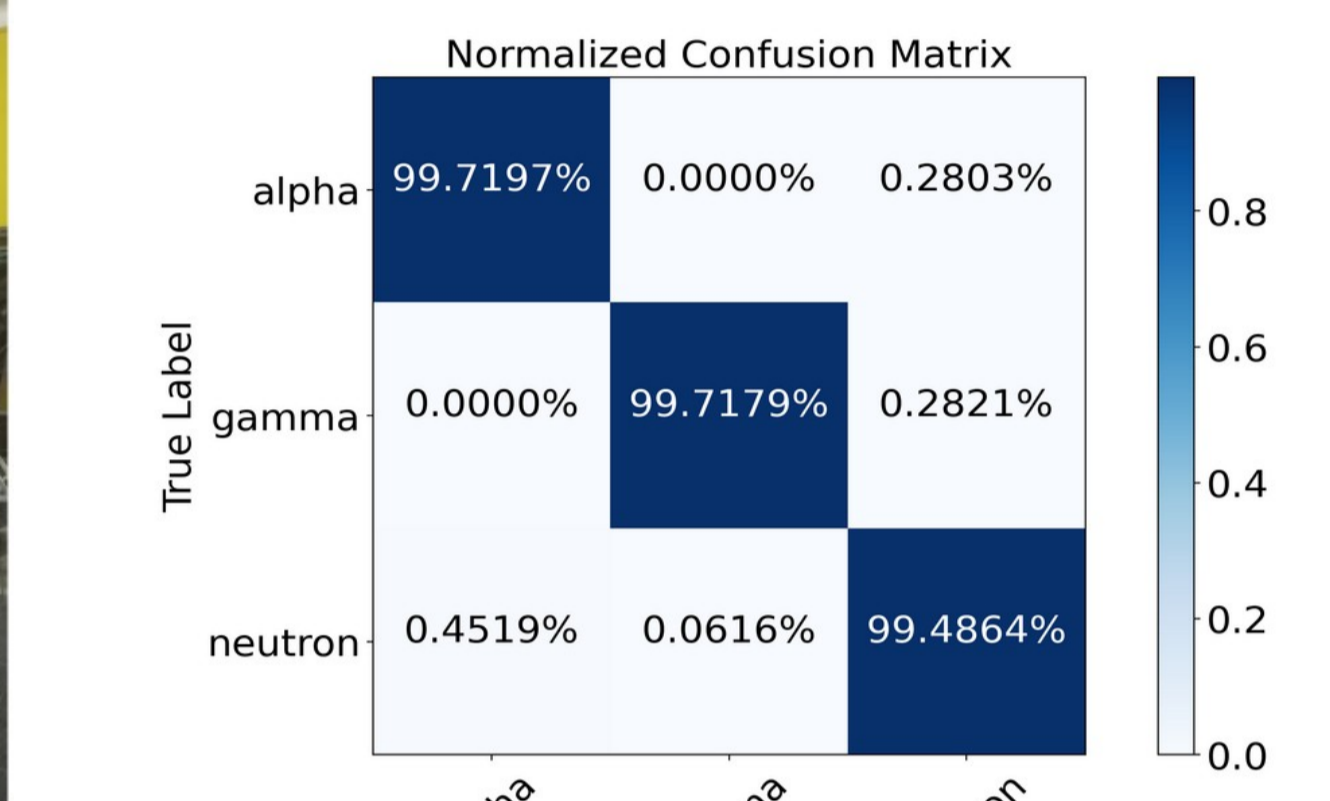
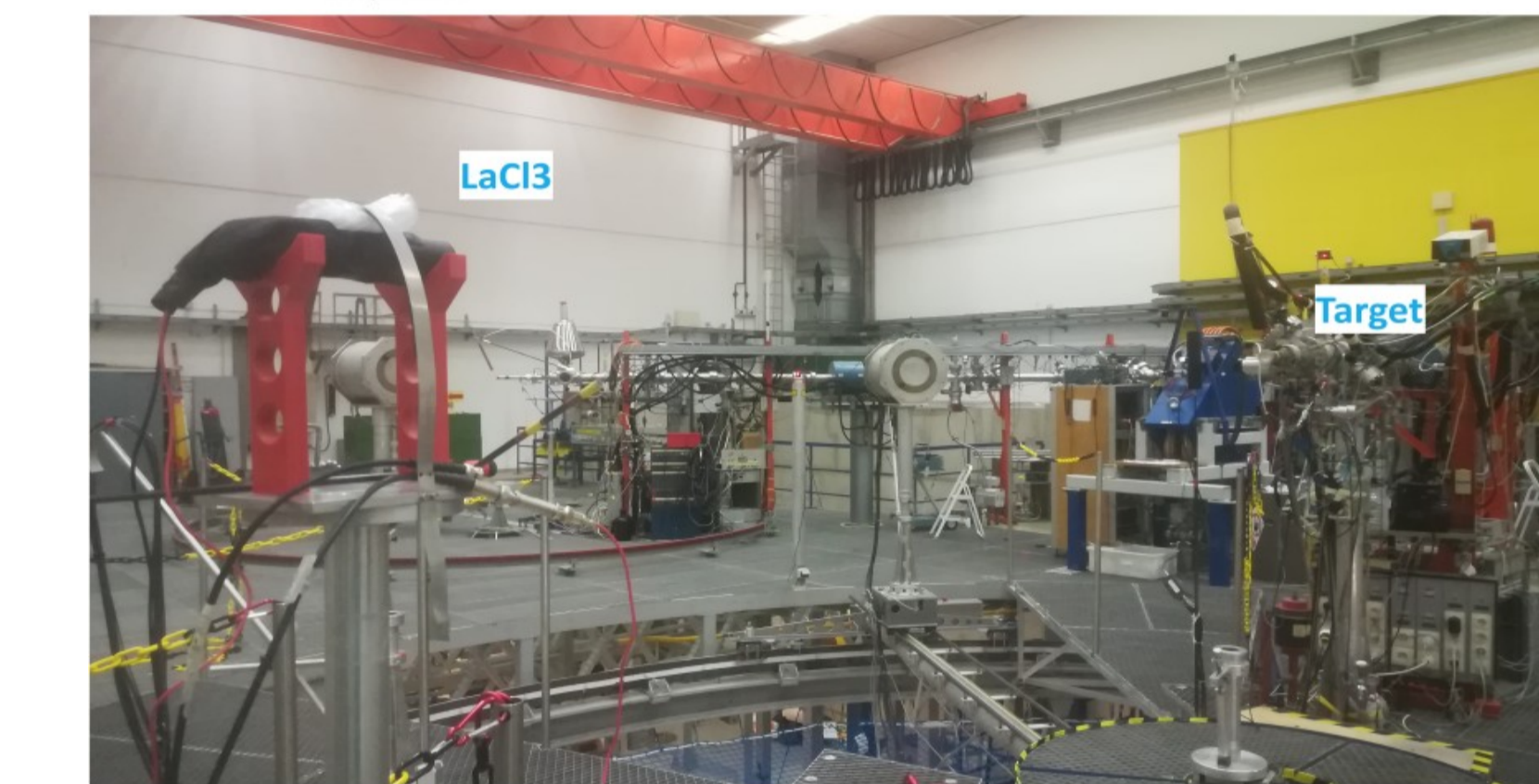
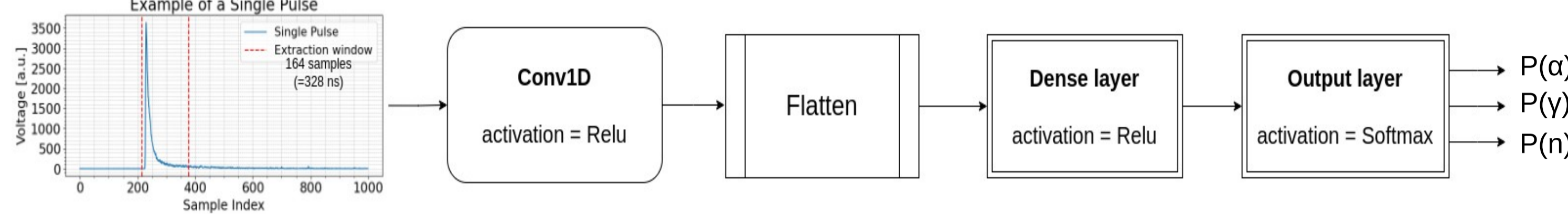
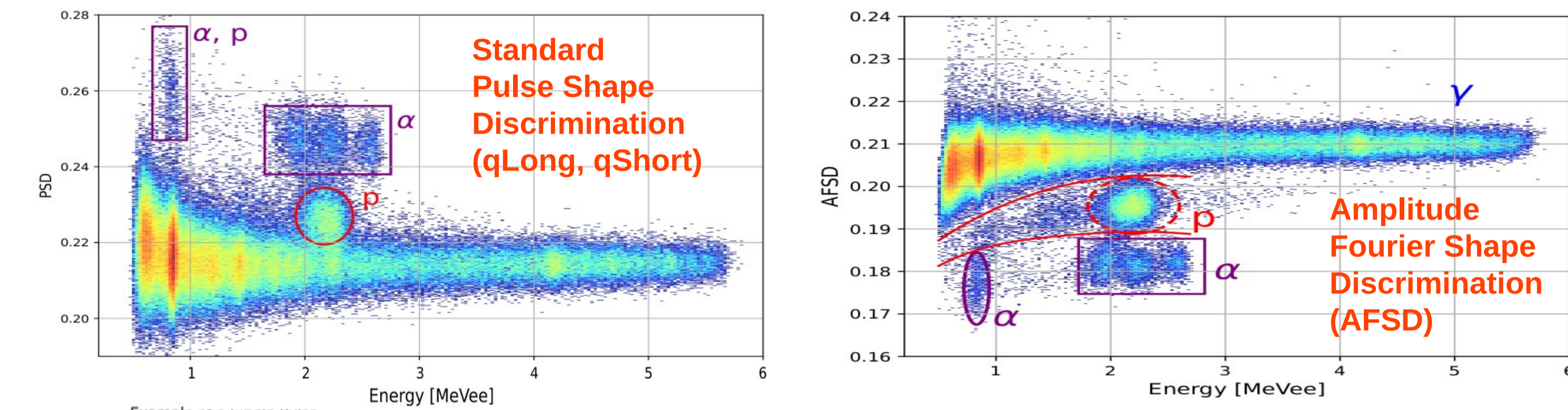
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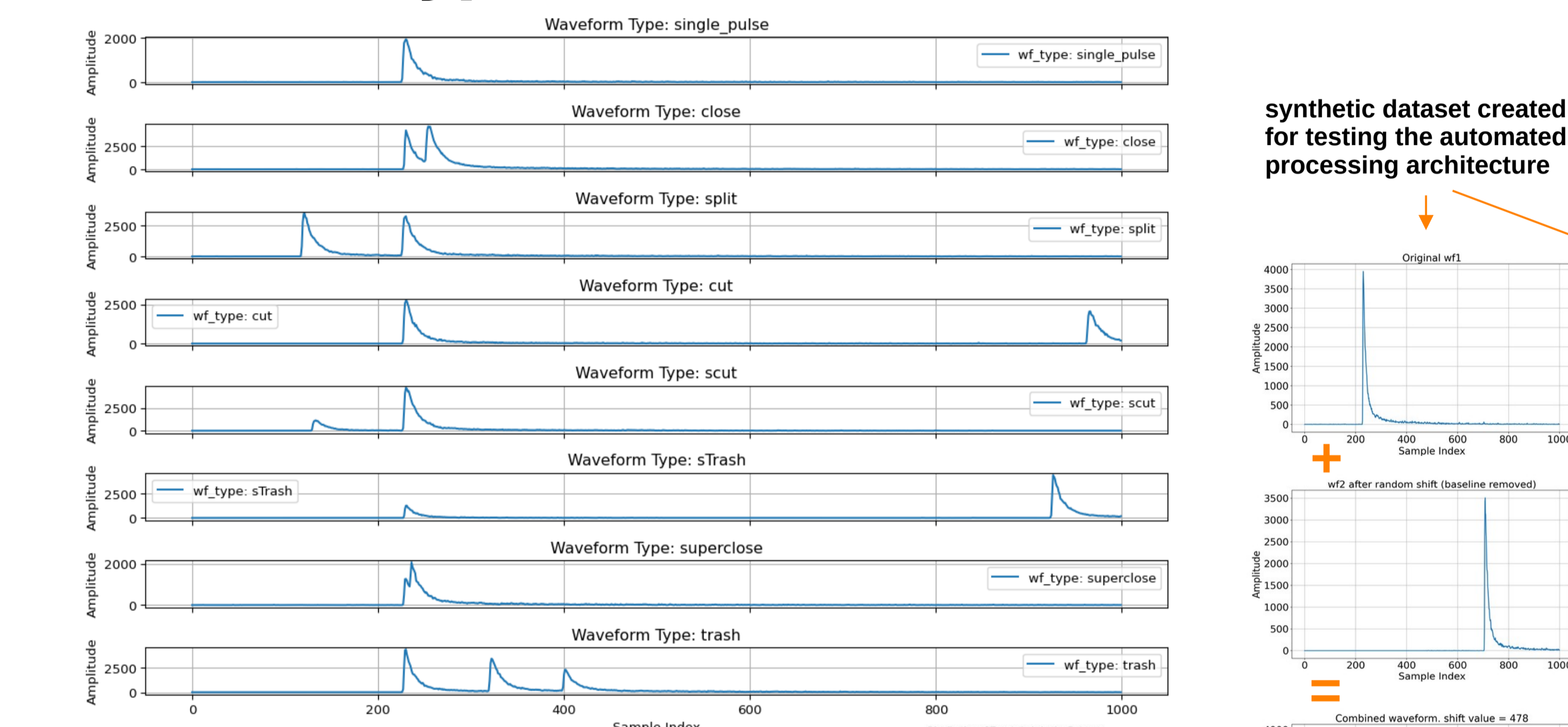


PSD algorithm for LaCl₃



- Low Scatter Measurement Hall at PTB, Germany → Experimental data used for training and validation.
- Testing dataset measured at the NILE facility, UK

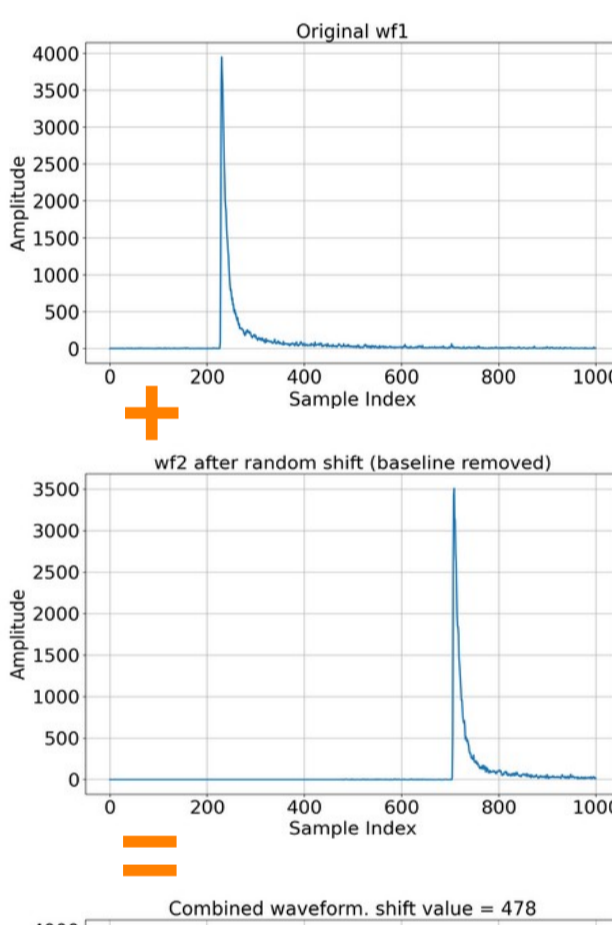
Types of raw waveforms



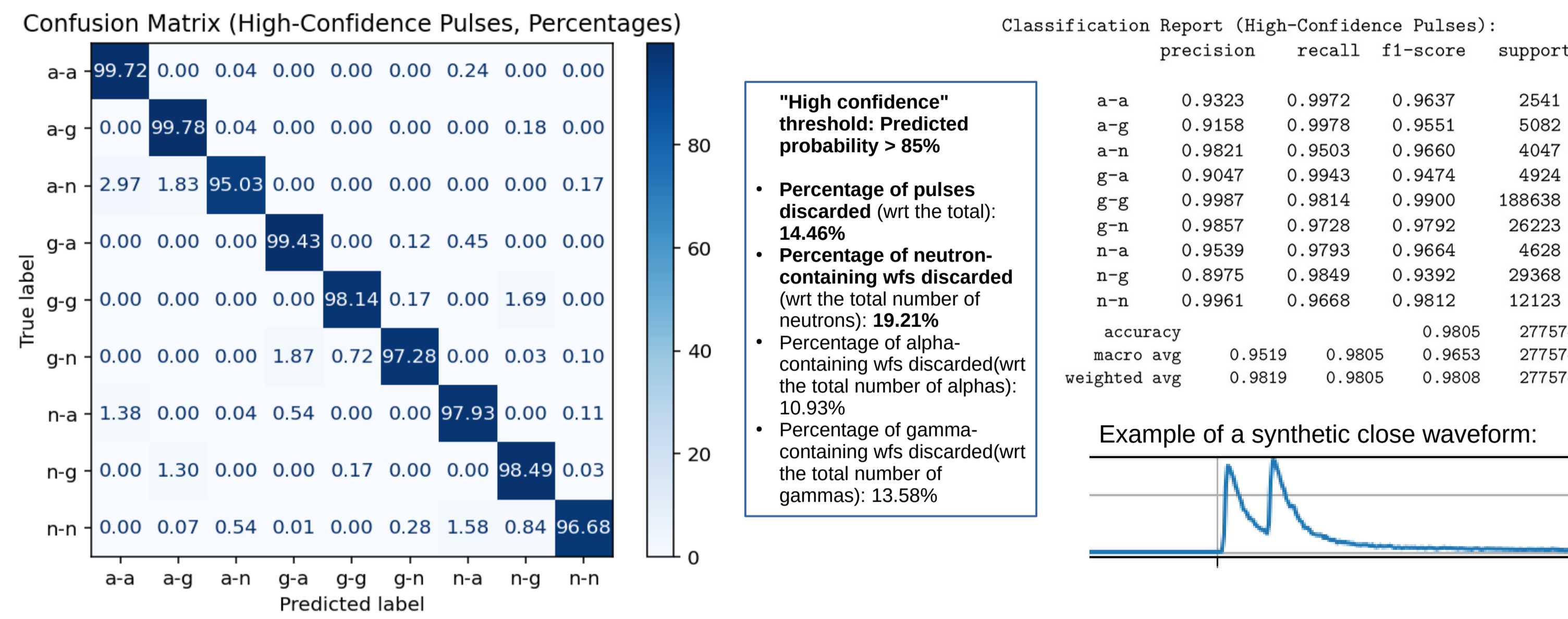
This classification of waveforms and their subsequent processing were inspired by the following work: Fu, C., Di Fulvio, A., Clarke, S. D., Wentzloff, D., Pozzi, S. A., & Kim, H. S. (2018). "Artificial neural network algorithms for pulse shape discrimination and recovery of piled-up pulses in organic scintillators". *Annals of Nuclear Energy*, 120, 410–421.

balanced dataset: "trash" contains sTrash, superclose, noisy, clipped, and spike pulses

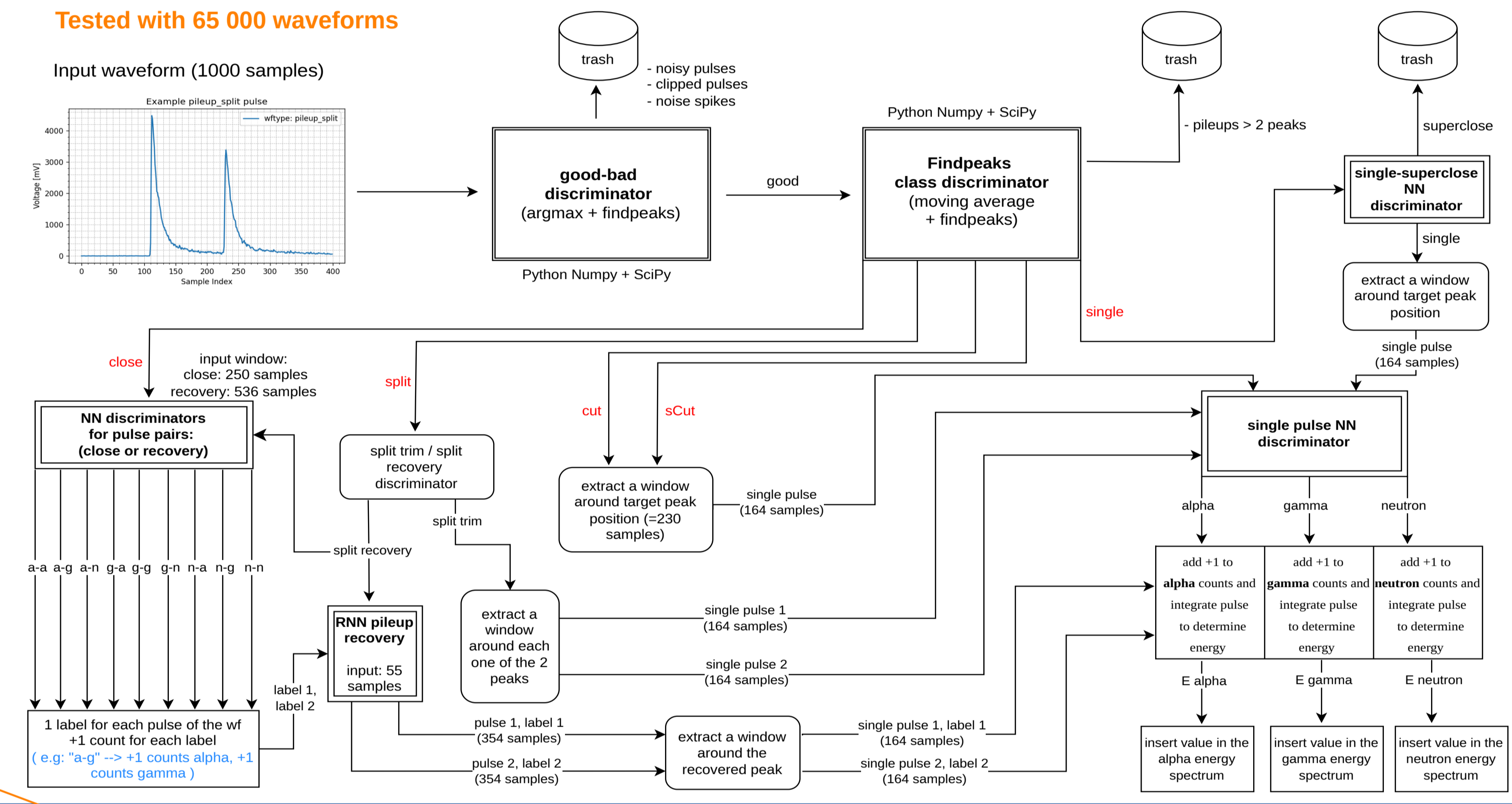
synthetic dataset created for testing the automated processing architecture



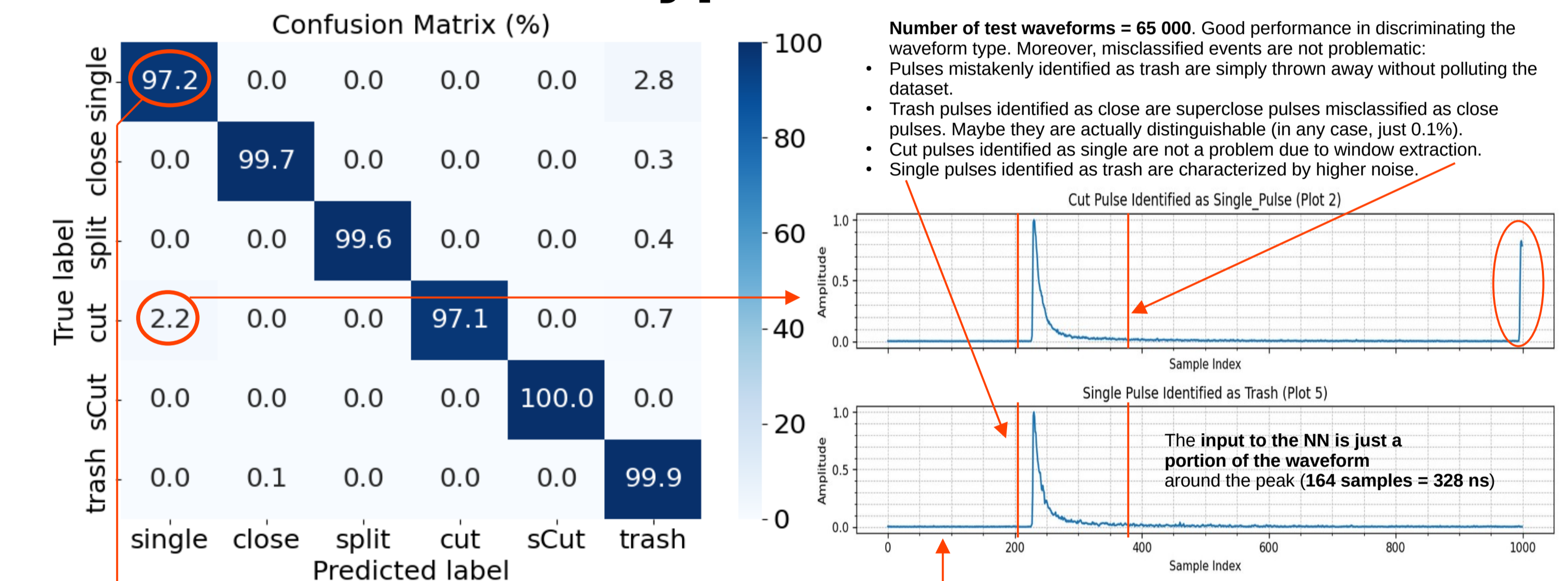
Close pulses discrimination



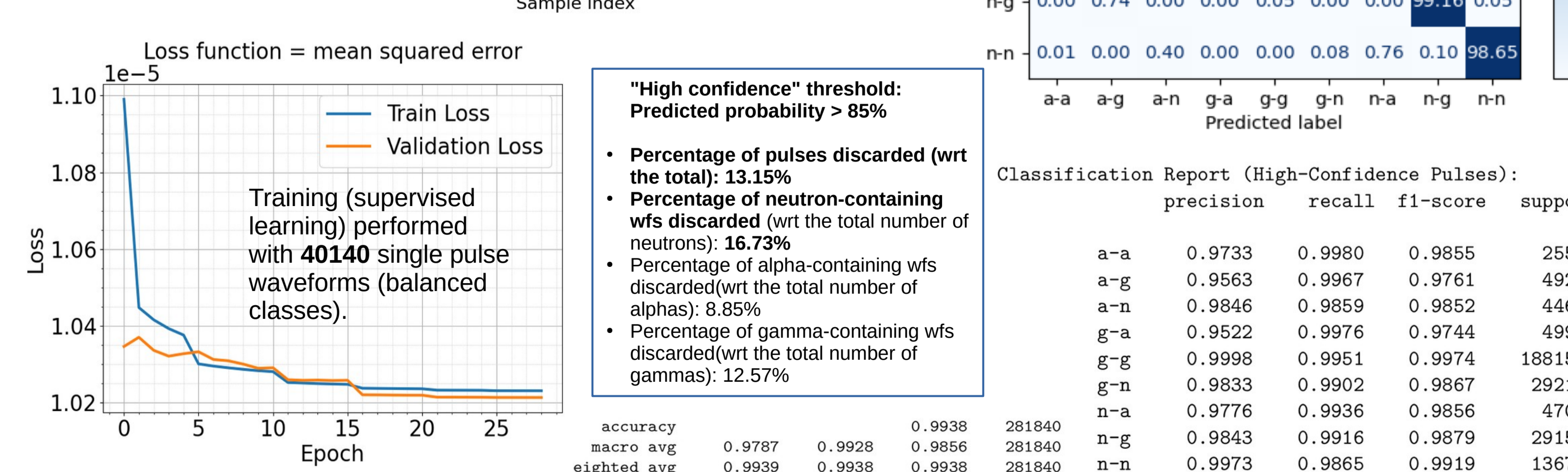
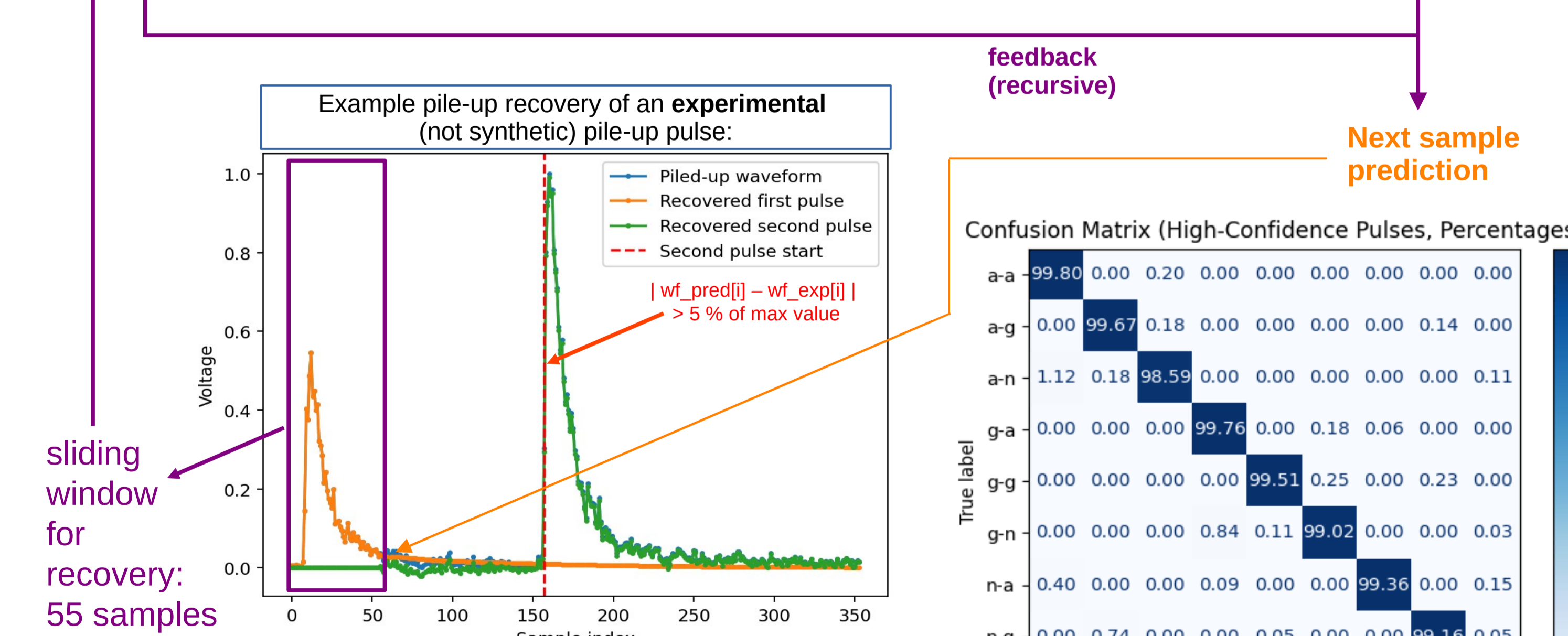
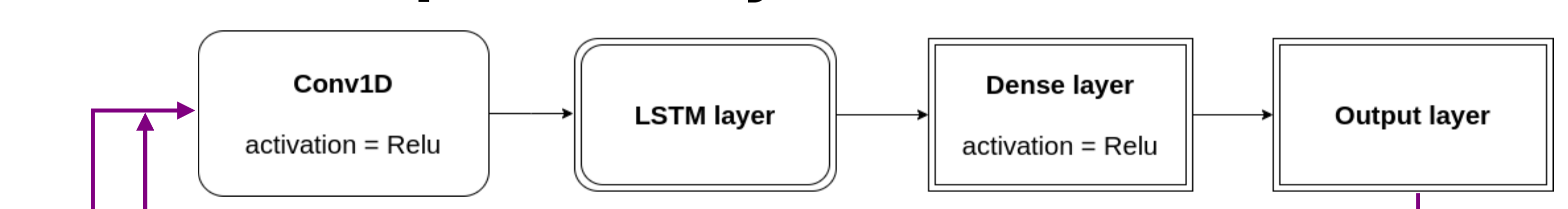
Automated processing architecture



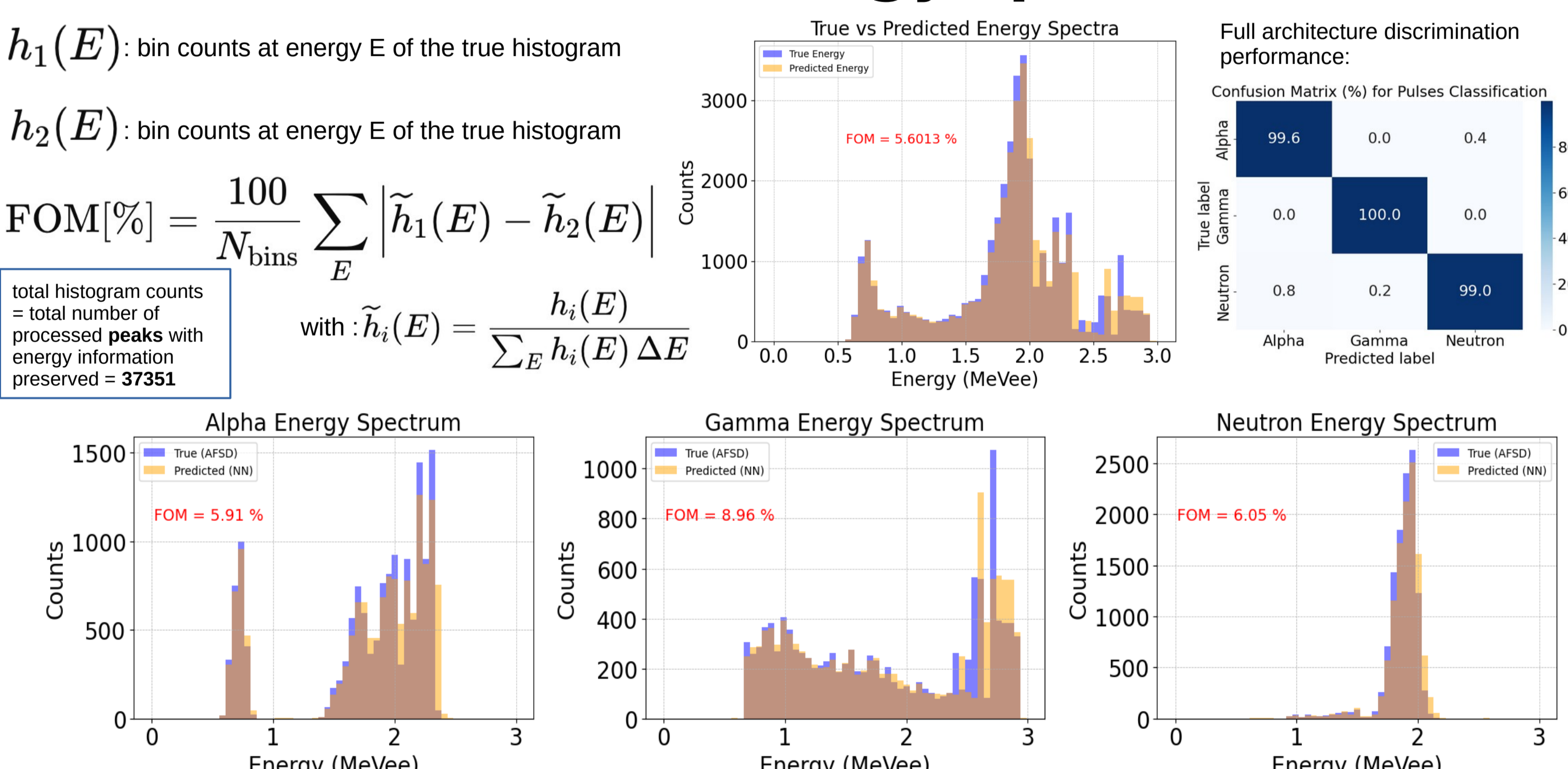
Waveform type discrimination



Pile-up recovery and discrimination



Recovered energy spectra



Conclusions

An algorithm based on Convolutional Networks (CNNs) has been developed for automated processing of data from measurements performed with a LaCl₃ scintillator. The algorithm processes raw input waveforms and classifies them based on their type, rejecting those identified as potentially dangerous for dataset pollution. Pile-up waveforms are identified and recovered with a Recursive Neural Network to become individual pulses. The only exception are the waveforms of type "close pile-up", which are only labeled without determining the energy information of their pulse pairs. Different CNNs predict the particle type associated to each pulse, selecting the label among "alpha", "gamma", and "neutron". Training and testing of the CNNs were performed using experimental data from two different neutron facilities: PTB (Germany) and NILE (UK). The algorithm will be tested in a nuclear fusion environment using data acquired from the MAST-U experiment (UK).

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