

Advanced pulse shape discrimination via machine learning for applications in thermonuclear fusion

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Abstract:

Pulse shape discrimination, to distinguish between neutrons and gamma rays, is a very important classification task in thermonuclear fusion. Gaussian Mixture Models and probabilistic Support Vector Machines have been applied to hundreds of thousands of pulses obtained with a counter based on the NE213 liquid scintillator. The results of the two completely independent mathematical methods are in very good agreement, the maximum discrepancy being of the order of 2%. The achieved classification also shows an excellent value for the figure of merit, a Mahalanobis type of distance, implemented to quantify statistically the separation between the two particle distributions. These two machine learning tools provide also the probability of each example being a neutron or a gamma ray, allowing more detailed studies of the distribution of pulses. The proposed methodology therefore clearly outperforms previous techniques in practically all aspects of the classification.