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

M. Gelfusa, R. Rossi, M. Lungaroni, F. Belli, L. Spolladore, I. Wyss, P. Gaudio, A .Murari, JET Contributors

Nuclear Inst. and Methods in Physics Research, **A 974** (2020) 164198
https://doi.org/10.1016/j.nima.2020.164198

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.