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Accelerating dark matter search in emulsion SHiP detector by Deep Learning

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We investigate the problem of dark matter detection in emulsion detector. Previously we have shown, that it is very challenging but possible to use emulsion films of OPERA-like detector in SHiP experiment to separate electromagnetic showers from each other, thus hypothetically separating neutrino events from dark matter. In this study, we have investigated the possibility of usage of Target Tracker (TT) stations in OPERA-like SHiP detector to identify the energy and position of the initial particle. The idea of such search is that unlike emulsion, TT are online detectors, benefiting of zero events pile up. Thus, online observation of the excess of events with proper energy can be a signal of a dark matter.
Two different approaches were applied: classical, using Gaussian Mixtures and machine learning based on a convolutional neural network with coordinate convolution layers for energy and longitudinal position prediction. Clusterization techniques were used for transverse coordinate estimation. The obtained results are about 25% for energy resolution and about 0.8 cm for position resolution in the longitudinal direction and 1 mm in the transverse direction, without any usage of the emulsion. Obtained results are comparable to the case of multiple showers separation in the emulsion.
The obtained results will be further used to optimise the cost and parameters of the proposed SHiP emulsion detector.

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