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A statistical model for the leakage of backgrounds mitigated by pulseshape discrimination methods

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In many types of scintillator-based dark matter experiments, pulse shape discrimination (PSD) is used to mitigate backgrounds. The leakage probability of events mitigated through PSD into the region of interest (ROI) is an important parameter used to define the ROI and to inform the ROI background model. Determining the leakage probability requires an understanding of the distribution of backgrounds in the PSD parameter. This is especially important in liquid argon based experiments, where electromagnetic background in recent and planned experiments requires PSD to remove 10ˆ7 to 10ˆ9 events from the energy ROI. As experiments push down the energy threshold, the distribution of signal events in the PSD parameter can no longer assumed to be Gaussian. Thus, properly modelling the signal event distribution in the PSD parameter also becomes important not just to understand the background but also to locate the ROI.
We present a physics-based statistical model to describe the distribution of events in the common prompt-fraction-based PSD parameters. The model can be used for different types of backgrounds as well as to describe the distribution of signal events.

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