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# Longitudinal Segmentation of Multi-readout Fiber Calorimeters by Timing

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We report on benchtop measurements and analysis techniques that enable us to effectively segment a fiber hadronic calorimeter longitudinally by fast digitization of pulse shapes. By combining sub-nanosecond digitization and silicon photomultipliers in a fiber calorimeter, we propose an enhancement to the traditional dual readout design that would provide benefits of both high-granularity and multi-readout. We demonstrate that better than 100 ps timing resolution, or roughly 2 cm longitudinal segmentation, is possible when highly sampled waveforms are processed using recurrent neural networks. In addition, we also show the merits to fiber calorimeters of machine learning techniques, namely Convolutional Neural Networks, Graph Neural Networks, and Recurrent Neural Networks. For instance, in the simple high granularity setup, we see that the CNN improves reconstructed energy resolution from ~40 to ~33 %/sqrt(E). These results indicate that the spatial distribution of energy deposition within the sensitive elements is both identifiable (able to be learned) and representative of underlying physical processes.

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