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Ultra-Fast Hadronic Calorimetry

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Calorimeters for particle physics experiments with integration time of a few ns will substantially improve the capability of the experiment to resolve event pileup and to reject backgrounds. In this paper the time development of hadronic showers induced by 30 and 60 GeV positive pions and 120 GeV protons is studied using Monte Carlo simulation and beam tests with a prototype of a sampling steel-scintillator hadronic calorimeter. In the beam tests, scintillator signals induced by hadronic showers in steel are sampled with a period of 0.2 ns and precisely time-aligned in order to study the average signal waveform at various locations with respect to the beam particle impact. Simulations of the same setup are performed using the MARS15 code. Both simulation and test beam results suggest that energy deposition in steel calorimeters develop over a time shorter than 2 ns providing opportunity for ultra-fast calorimetry. Simulation results for an "ideal" calorimeter consisting exclusively of bulk tungsten or copper are presented to establish the lower limit of the signal integration window.

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