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Monte Carlo Simulations of the PEN experiment: A Precision Measurement of $\pi \rightarrow e\nu(\gamma)$ Branching Ratio

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The PEN collaboration performed a precision measurement of the $\pi^+ \rightarrow e^+\nu_e(\gamma)$ branching ratio with the goal of obtaining a relative uncertainty of 5×10^{-4} or better at the Paul Scherrer Institute. A precision measurement of the branching ratio $\Gamma(\pi \rightarrow e\bar{\nu}(\gamma))/\Gamma(\pi \rightarrow \mu\bar{\nu}(\gamma))$ can be used to give mass bounds on "new", or non V−A, particles and interactions. This ratio also proves to be one of the most sensitive tests for lepton universality. The PEN detector consists of beam counters, an active target, a mini-time projection chamber, cylindrical multi-wire proportional chambers, a plastic scintillating hodoscope, and a spherical 240-module pure CsI electromagnetic calorimeter. The Geant4 Monte Carlo simulation is used to construct ultra-realistic events by digitizing energies and times, creating synthetic target waveforms, and fully accounting for photo-electron statistics. We focus on the detailed detector response to signal and background processes in order to sharpen the discrimination between them in the data analysis.

Primary author: Mr GLASER, Charles (University of Virginia)

Presenter: Mr GLASER, Charles (University of Virginia)

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