Examining ICARUS Cosmic Muon Signal Shapes

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(Dated: August 11, 2023)

In the search for new physics, such as sterile neutrinos, we must compare our experimental data to the case where this new physics does not exist, which is provided by simulations. However, our detectors and simulations are not perfect, so we need to be able to differentiate imperfections in our simulations, detector effects, and unknown unknowns from new physics. Thus, we need to accurately quantify ICARUS detector systematic uncertainties; in other words, we need to know how much difference between experiment and simulation we can expect due to only detector systematics, so when we see differences greater than this, we can be confident that they are due to new physics. To calculate this uncertainty, we study the waveforms, or signals, produced in ICARUS by cosmic muons. Ideally, we want to model these waveforms as Gaussians and compare the waveforms from experimental data to the waveforms from simulations to calculate the uncertainties, but first, we need to know how accurately these waveforms can be described by Gaussians. We examined the peak and the full width at half maximum (FWHM) of waveforms from simulations, and we produced plots of the distribution of peaks and FWHMs for these signals. We further studied how the distribution of peaks and FWHMs varied depending on where the cosmic muon was located in the detector. Ultimately, by comparing the actual distribution of peaks and FWHMs to the distribution predicted by the Gaussians, we hope to determine how accurately Gaussians can represent these waveforms.