

3. The Prompt Neutrino Beam

A prompt neutrino beam is one in which the primary proton beam is dumped into a relatively short, high-density target, such that all the protons interact in the dump. The pions and kaons, which ordinarily are the valued particles in neutrino beam design, interact before they have a chance to decay. The important particles in the beam dump interaction are the charmed particles, which decay leptonically before they can be absorbed, to produce e^- , e^+ , μ^- , μ^+ , and τ . The electrons are absorbed by the dump; the muons penetrate the dump (and present technical challenge in the design of such a beam); the τ 's also decay before interacting in the dump and produce an additional neutrino. The three flavors of neutrinos make up what is called the prompt neutrino beam. The Prompt Neutrino Beam designed and built for DONUT is described in detail in Reference [1].

The neutrino flux that was the result of the prompt neutrino beam system was calculated to consist of ν_μ (52%), ν_e (44%) and ν_τ (5%) (with equal numbers of ν and $\bar{\nu}$). On average, three neutrino interactions were recorded per hour at the emulsion targets under normal operating conditions (5×10^{14} 800 GeV protons per hour). A total of 4.5×10^{17} protons were used during the entire experiment. The neutrino spectrum has been measured to have a mean energy of 82 ± 5 GeV for the ν_μ component, in agreement with design expectations.