A PRECISE MEASUREMENT OF THE $\pi^+ \to \pi^0 e^+ \nu$ DECAY RATE

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Introduction

The PIBETA collaboration has proposed an experimental program at PSI with the aim to determine the rate of the pion beta decay with an uncertainty of ~0.5%.

1994 Results

In 1994 four main objectives were pursued in a test period in the $\pi E1$ channel:

- evaluation of a new active target consisting of scintillation fibers, and further improvement of the pion stopping distribution,
- energy resolution and linearity checks of the pure CsI-calorimeter using monoenergetic $e^{\pm}$'s from 10 to 70 MeV,
- development of the $\pi^+ \to e^+\nu$ trigger and study of the accompanying background reactions using dedicated electronics modules built at the University of Virginia, and
- determination of the energy response for tagged photons from $\pi^- p \to \pi^0 n$ at rest.

A beam of positive pions with a momentum of 116 MeV/c was stopped in the active target. It has a cylindrical shape with a diameter of 4 cm and consists of 69 plastic scintillating fibers, 3×3 mm^2 each and surrounded with 8 active "guard-ring" elements. The signals from the target fibers are used to monitor the position and the shape of the stopped pion beam. The diameter of the stopping distribution was 11 mm FWHM at incident pion rates between 1×10^4 and 1×10^6 π^+/s. The e^+ and μ^+ contaminations were 12% and 10%, respectively.

We instrumented a 26-detector section of the spherical pure CsI-calorimeter, inside a lightproof box equipped with temperature and humidity control. The energy resolution and the linearity of the CsI-detectors were tested with monoenergetic beams of electrons and positrons with an energy of 10, 20, 30, 50, and 70 MeV/c. The energy resolution in the central cluster was 4.5 MeV (6.4%) FWHM at 70 MeV $e^{\pm}$. The measured line shape agrees with the GEANT calculation convoluted with an average optical nonuniformity of 3%.

The positrons from the $\pi^+ \to e^+\nu$ decay were detected by a delayed coincidence between the stopped pion in the target and the e^+ in the calorimeter. The background from scattered pions was suppressed by a plastic veto counter in front of the CsI-calorimeter. The observed energy resolution of the 70 MeV positron peak (9% FWHM, see Fig. 1) and its separation from the Michel spectrum edge confirm the basic feasibility of our experimental method.

A separate set-up was used to measure the calorimeter response to tagged photons originating from the $\pi^- p \to \pi^0 n$ reaction at rest. The π^--beam was stopped in a liquid hydrogen target. Neutrons were detected in an array consisting of 30 plastic scintillation counters. One of the photons from the π^0-decay was detected in an array of 12 CsI tag detectors, while the energy of the second decay photon was measured in the calorimeter consisting of 26 pure CsI-crystals. In this way, the pion single-charge reaction was separated from the background using a neutron TOF-cut, and provided monoenergetic γ's in the CsI-crystals from π^0-decays.

Figures

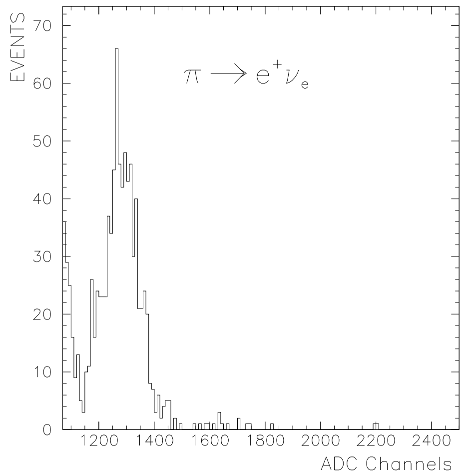

Figure 1: Energy spectrum of positrons from $\pi^+ \rightarrow e^+\nu$ decays, detected in the pure CsI-calorimeter.