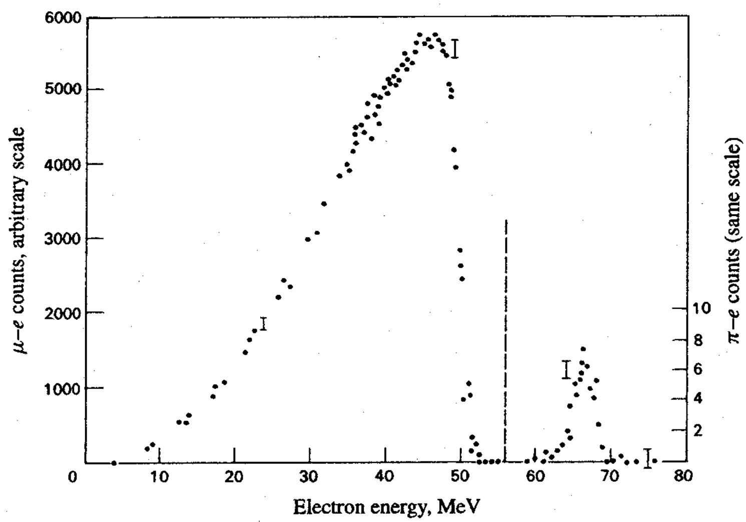

Fig. 7.10. Positron spectrum from positive pions coming to rest in an absorber. It shows at the right a narrow peak around 70 MeV, from the rare $\pi^+ \to e^+ + \nu_e$ decay, standing out above the broad spectrum from the muon decay, $\mu^+ \to e^+ + \nu_e + \bar{\nu}_\mu$, that follows, subsequent on the predominant $\pi^+ \to \mu^+ + \nu_\mu$ decay. Note the change in vertical scale for these rare events.

This result is in exact agreement with the prediction of A coupling, after small radiative corrections to (7.22), and was a major triumph for the $V - A$ theory. Figure 7.10 shows a typical positron spectrum observed from positive pions stopped by an absorber. The rare $\pi \to e + \nu$ process yields positrons of unique energy, about 70 MeV. They are accompanied by the much more numerous positrons from the decay sequence $\pi^+ \to \mu^+ + \nu_\mu$ followed by $\mu^+ \to e^+ + \nu_e + \bar{\nu}_\mu$. The spectrum from muon decay extends to 50 MeV. Rejection of electrons from muon decay is based on momentum and on the timescale (the mean life of the pion is 25 ns, that of the muon 2200 ns), as well as the absence of a muon pulse in the counters.

Today the $V - A$ nature of the (charged-current) weak interaction is accepted, and the above branching ratio provides a test of the universality of the $W^\pm$ coupling to the electron and the muon, as given in (7.4). Of course this universality was tacitly assumed in deriving (7.22).

7.11 Neutral weak currents

The production at accelerators of intense beams of high energy neutrinos and antineutrinos, from the early 1960s onwards, led to dramatic developments in our