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

M. Bychkov[1], E. Frlež[1], W. Li[1], R. C. Minehart[1], D. Počanić[1], L. C. Smith[1], W. A. Stephens[1], B. Vandevender[1], Y. Wang[1], K. O. H. Ziock[1], W. Bertl[2], Ch. Broennimann[2], J. F. Crawford[2], M. Daum[2], R. Horisberger[2], D. Renker[2], S. Ritt[2], R. Schnyder[2], H. P. Wirtz[2], T. Kozlowski[3], B. G. Ritchie[4], V. A. Kalinnikov[5], N. V. Khomutov[5], A. S. Korenchenko[5], S. M. Korenchenko[5], N. P. Kravchuk[5], N. A. Kuchinsky[5], D. Mzhavia[6], Z. Tsamalaidze[6], I. Supek[7]

R-89-01.1, PIBETA Collaboration: VIRGINIA[1] - PSI[2] - SWIERK[3] - ARIZONA[4] - DUBNA[5] - TBILISI[6] - ZAGREB[7]

The PIBETA experiment aims to measure the pion beta decay ($\pi^+ \to \pi^0 e^+ \nu$) branching ratio to about 0.5 % in its current phase. The best experimental value at present has error limits of ~ 4 %, far exceeding the theoretical uncertainty of < 0.15 %.

During 2001 we have successfully concluded "production" data taking at the π^+ stopping rate of $\sim 9 \times 10^5$/s. The PIBETA detector system ran in the automatic mode with minimal human intervention, requiring that only two experimenters be physically present at the PSI site, with other collaborators working remotely.

We have also taken data at the reduced beam intensity of $\sim 9 \times 10^4$/s, necessary for the precise determination of the absolute calibration of the measurement. Fig. 1 shows the preliminary off-line analysis of the $\pi^+ \to e^+ \nu$ positron energy spectrum for the 1999/2000 data set, used to normalize the $\pi\beta$ branching ratio.

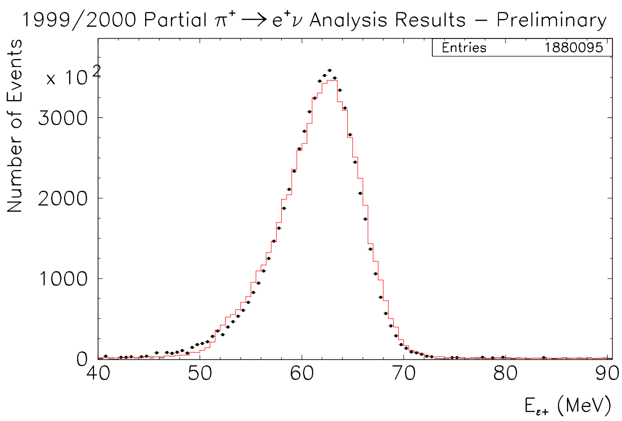

Figure 1: Measured $\pi^+ \to e^+ \nu$ energy spectrum (solid markers) and GEANT-simulated detector response (full histogram), used for the $\pi\beta$ beanching ratio normalization.

The most important result of the 2001 running period concerns the acquired event statistics. With $\sim$30 % of the data replayed and the most stringent off-line cuts we find >20,000 clean $\pi\beta$ events. Having studied the relaxation of the software cuts we expect eventually to recover $\sim$20% more data in the current sample bringing the total $\pi\beta$ up-to-date event count to $\geq 60,000$. The $\pi\beta$ timing spectrum is displayed in Fig. 3a.

Based on the analysis of the partial data sample to date we have extracted a preliminary $\pi\beta$ branching ratio:

$$BR_{\pi\beta} = [1.044 \pm 0.007(\mathrm{stat}) \pm 0.015(\mathrm{sys})] \times 10^{-8} \ .$$

The main contributions to the systematic uncertainty, the detector acceptance (1.0%) and the $\pi \to e\nu$ lineshape (1.0%), are being reduced in the ongoing analysis. A series of beam and equipment failures diverted much of our effort from the analysis to addressing the experimental problems, consequently slowing down the progess of our data analysis, as well as reducing the 2001 event statistics well below the planned total. As the experimental run finished at the end of 2001, we fully expect to make quick progress in the data analysis from this point on.

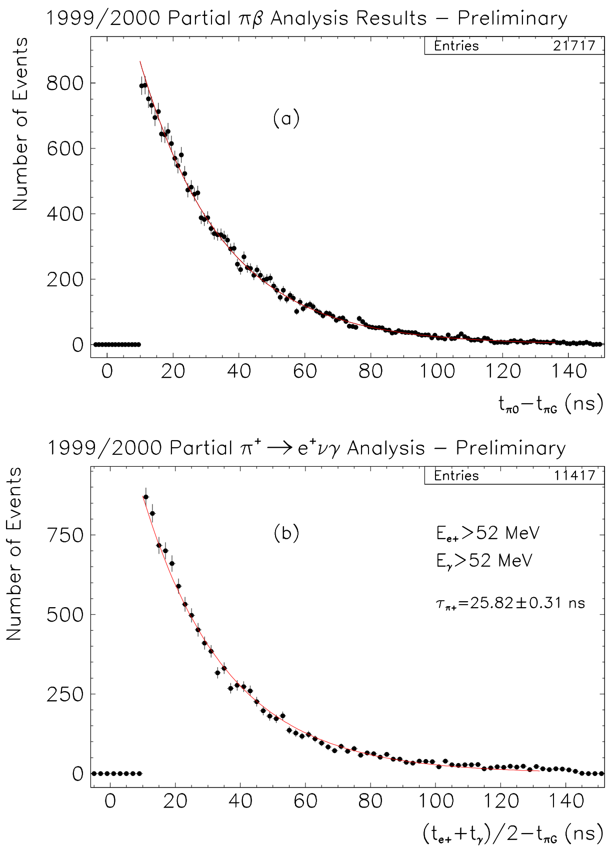

Figure 2: Timing spectra for $\pi\beta$ events [top panel, (a)] and 2-arm $\pi \to e\nu\gamma$ events [bottom panel, (b)].

In parallel with the pion beta and $\pi \to e\nu$ decays, we have also simultaneously recorded a large set of radiative decay events for the processes $\pi^+ \to e^+\nu\gamma$ and $\mu^+ \to e^+\nu\nu\gamma$. The PIBETA experiment will increase by almost two orders of magnitude the current world statistics for these processes. Fig. 2b illustrates the quality of our data by showing preliminary results of the partial data analysis of the radiative pion decay. Full analysis of these channels is required as a critical check of the overall experimental systematics.