PIBETA NOTE: **Timing Offset Between $\pi^+ \to e^+\nu_e$ Positrons and $\pi\beta$ Photons**
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This note summarizes some GEANT Monte Carlo results done by E. Frlež up to June 1995 on the simulation of the CsI calorimeter TDCs.

Note on Timing Difference for 70 MeV Positrons and Photons

We have simulated the TDC response for $\pi^+ \to e^+\nu_e$ positrons and $\pi\beta$ photon pairs showering in the CsI crystal ball. The particle vertices in the target were sampled from experimentally measured distribution. The shower development in the CsI detectors was tracked by the GEANT subroutine.

The scintillation light generated by the shower particles was propagated through CsI material to the PMT sensitive surface at each tracking step. The discriminator trigger level was fixed at 2 MeV deposited energy. The PMT timing was associated with the mean time weighted by the deposited energy when the 2 MeV discriminator threshold was surpassed.

The top panel on Fig. 1. shows the positron TDC histograms. The dotted line represents the distribution of energy deposition times as seen from the center of the PMT while the full line takes into account assumed 400 ps rms walk in light propagation and the PMT timing response. The bottom panel shows the equivalent histograms for photons from $\pi\beta$ decay. The positron response was delayed for 200 ps with the respect to the average photon detection time because the photons convert throughout the detector volume.

The alternative models that used different discriminator thresholds (1–3 MeV) and different temporal weighting of shower energy depositions (e.g., the equal weights and the time at the threshold) gave mean TDC values that differed by less than 10 ns. The target uncertainty for this correction is $\sim$25 ps which gives $\sim$0.1% error limits.

We will carefully study the 3D tomography data to confirm the light propagation delay of the tagged cosmic muons as a function of energy deposition position. The goal will be to experimentally confirm both the TDC offsets and the timing resolution used in the model. Right now we have recorded the large statistics cosmics runs for for all the CsI crystals.

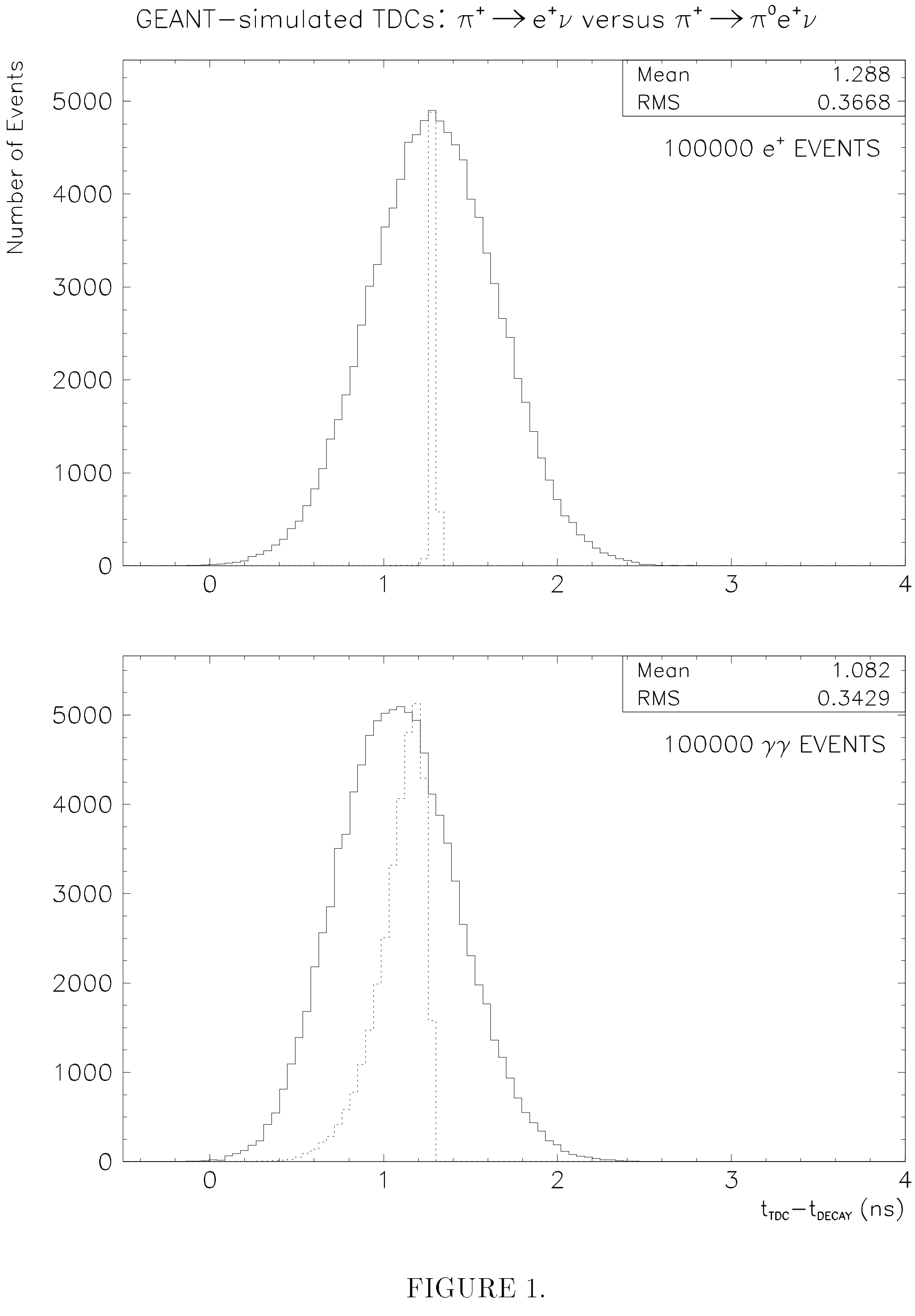
GEANT−simulated TDCs: $\pi^+ \rightarrow e^+\nu$ versus $\pi^+ \rightarrow \pi^0 e^+\nu$
Number of Events
Mean 1.288
RMS 0.3668
100000 e^+ EVENTS
Mean 1.082
RMS 0.3429
100000 $\gamma\gamma$ EVENTS
$t_{TDC}-t_{DECAY}$ (ns)
0
1000
2000
3000
4000
5000
0
1
2
3
4

FIGURE 1.