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Search for the Electronic Decay of the Positive Pion (*).

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Summary. — A double focussing magnetic spectrometer of high transmission (1.8%) and good resolution (3.0%) was used in a search for the electronic decay of the positive pion. No evidence was found. The fraction of decays of the type $\pi \to e+\nu$ was found to be $f=(-0.4\pm 9.0)\cdot 10^{-6}$. The result appears to be statistically significant and thereby allows only a 1% probability that f could have a value greater than $2.1\cdot 10^{-5}$. From a search for electrons of momentum 60.3 MeV/c we could conclude that the fraction of decays of the type $\pi \to e+\gamma+\nu$ was $f_\gamma=(-2.0\pm 1.6)\cdot 10^{-4}$ assuming tensor interaction determines the spectrum. Much lower limits for this last process have been recently reported by Cassels and by Lokanathan.

1. – Introduction.

The normal decay of the charged pion is into a muon and a light neutral particle, presumed to be a neutrino. An alternative possibility, the decay into an electron instead of the muon, has never been observed. This seems par-

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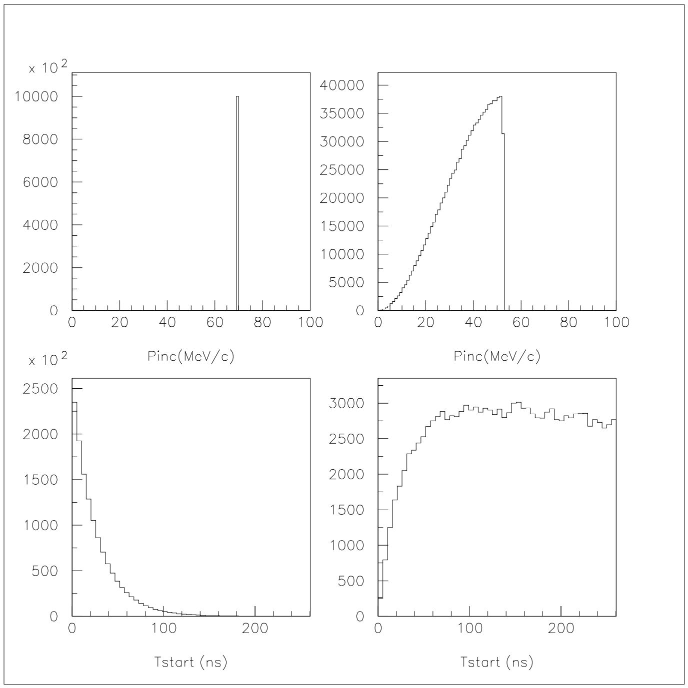

Figure 1: Starting e^+ momentum and time distributions.

4 Flags and Triggers

Given the starting position and direction one can determine whether the positron will hit SCT1 and predict its pathlength (PL$_p$) in that detector, assuming no other physics, for example, multiple scattering (MS) is turned on. If PL$_p \geq$ nT/10, where n= $1, 2, \ldots, 10$ and T is the thickness, then the flag SH(n)(should hit) is set. Note $10^6 - N[SH(n)] = N[\overline{SH(n)}]$is the number of events for which the flag is not set. GEANT keeps track of the entrance and exit positions in the counter as the track is transported with whatever physics is turned on and so the PL$_t$ from transport can be calculated. If PL$_t \geq$ nT/10 then the flag DH(n) (did hit) is set. The ratios,

$$
\begin{aligned}
SOg &= 1 - N[DH(n) \cdot SH(n)]/N[SH(n)], \qquad (1) \\
SIg &= N[DH(n) \cdot \overline{SH(n)}]/N[\overline{SH(n)}], \qquad (2)
\end{aligned}
$$

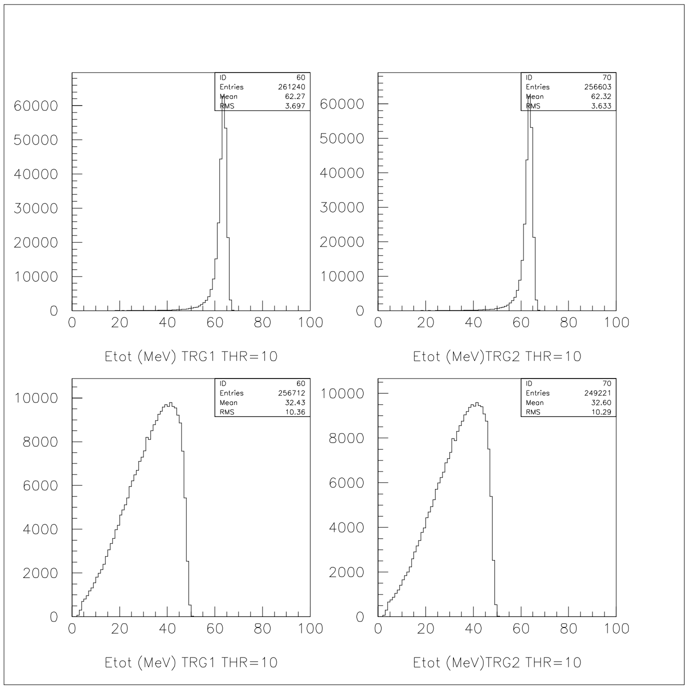

Figure 2: Total detected energy distributions for $\pi \rightarrow e$ decays (top), $\mu \rightarrow e$ decays (bot) The left, right spectra are for flags T1, 2 set, respectively.

theory. Both produce fluctuations. The former is more accurate, but requires more computing time by about a factor of three on my Alpha.

Table 2 indicates the size of various physics effects. It is for the case n=10 and R=(0.,0.5 cm), Z=(0.1,-0.1 cm). All entries are in percent and each condition requires two lines. The physics effect, A, B, MS, E1, or E2, if turned on, appears as a condition. For example, in the first entry only E2 is turned on. For this entry since A and B are off there is no chance of losing the e^+ and because MS and E1 are off it is not deviated from its predicted path. Thus SOg and SIg are identically zero. Also for the same reasons $SO1 \equiv SO2$ and $SI1 \equiv SI2$ as there can be no BS. However, the SO1,2 are not zero. This is because while PL$_p$ indicates that SH(10) is set, due to fluctuations in Eloss, the energy deposited in SCT1 may not exceed THR(10). Similarly in the SI1,2 case, PL$_p$ was too small to set SH(10), but because of Eloss fluctuations the energy deposited in SCT1 exceeds THR(10).