

Brief Reports

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Improved upper limit on ν_τ mass

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We update our previous analysis of the $\tau \rightarrow 3\pi^\pm \pi^0 \nu$ decay mode by the addition of new data to obtain an improved upper limit on the ν_τ mass of 143 MeV/ c^2 at the 95% confidence level.

The Mark II collaboration has previously reported an upper limit on the ν_τ mass^{1,2} from an analysis of e^+e^- annihilation data corresponding to an integrated luminosity of 158 pb⁻¹. This Brief Report gives an update of that result based on all the statistics collected by the Mark II detector up to its removal from the beam line of the PEP storage ring at SLAC. The total integrated luminosity used here is 220 pb⁻¹, with all data taken at a center-of-mass energy of 29 GeV.

The method to determine the ν_τ mass is the same as described in Ref. 1. We measure the 4π invariant-mass spectrum from the $\tau \rightarrow 3\pi^\pm \pi^0 \nu$ decay mode near its end point where it is sensitive to the ν_τ mass. A sample of $e^+e^- \rightarrow \tau^+\tau^-$ was selected in which one of the τ 's decayed to $3\pi^\pm \pi^0 \nu$ and the opposite one to one charged particle. Two photons, detected in the liquid-argon calorimeter, were required to accompany the three charged pions, and to be consistent with the hypothesis that they were the decay products of a π^0 . The two photons were then kinematically constrained to the π^0 mass. Eighty-three $\tau \rightarrow 3\pi^\pm \pi^0 \nu$ decays were reconstructed and satisfied all of the event-selection requirements.¹ From a Monte Carlo simulation, we estimate that 2.5 of these events are background from hadronic events, $e^+e^- \rightarrow q\bar{q}$.

Figure 1 shows the 4π invariant-mass spectrum. The region above 1.5 GeV/ c^2 was compared with the expected behavior for different values of the ν_τ mass³ and different

assumptions about the four-pion state. This region contains 22 events including an estimated background of 2.2 events. A maximum-likelihood method was applied to determine an upper limit from the events in this region under the as-

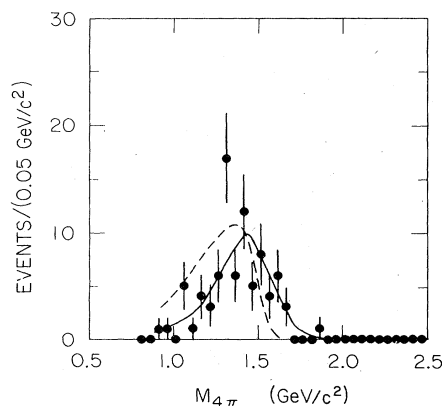


FIG. 1. Four-pion invariant-mass distribution of the selected events. The solid curve shows the expected spectrum for $m_{\nu_\tau} = 0$ under the assumption that the four-pion τ decay mode is dominated by the ρ' resonance. The dashed curve shows the same spectrum for the assumption of $m_{\nu_\tau} = 250$ MeV/ c^2 .

sumption that the four-pion state is dominated by the ρ' resonance of mass $1570 \text{ MeV}/c^2$ and width $510 \text{ MeV}/c^2$ (Ref. 4). After including uncertainties in background, invariant-mass resolution, and the mass and width of the ρ' , we obtain an upper limit of $m_{\nu\tau} < 143 \text{ MeV}/c^2$ at the 95% confidence level. The limit is not sensitive to the assumption of ρ' dominance; it becomes slightly more restrictive if

one assumes that the 4π final state is distributed purely according to phase space.

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¹C. Matteuzzi *et al.*, Phys. Rev. Lett. **52**, 1869 (1984). The upper limit reported in this reference was $m_{\nu\tau} < 164 \text{ MeV}/c^2$ at the 95% confidence level.

²There have been two recent upper limits on $m_{\nu\tau}$ from studies of

the mass spectra of other τ decay modes. The DELCO collaboration has obtained an upper limit of $157 \text{ MeV}/c^2$ from a study of the $KK\pi\nu$ decay mode [G. B. Mills *et al.*, Phys. Rev. Lett. **54**, 624 (1985)], and the Mark II collaboration has obtained an upper limit of $125 \text{ MeV}/c^2$ from a study of the $5\pi\nu$ decay mode [P. R. Burchat *et al.*, *ibid.* **54**, 2477 (1985)].

³Y. S. Tsai (private communication).

⁴A. Cordier *et al.*, Phys. Lett. **109B**, 129 (1982). We use this result from e^+e^- annihilation rather than the full Particle Data Group summary since the conserved-vector-current hypothesis relates the four-pion spectra measured in e^+e^- annihilation directly to that measured in τ decay [H. B. Thacker and J. J. Sakurai, *ibid.* **36B**, 103 (1971); Y. S. Tsai, Phys. Rev. D **4**, 2821 (1971)].