Journal
Physical Review D, 32(3)

ISSN
2470-0010

Authors
Matteuzzi, C
Barklow, T
Boyarski, AM
et al.

Publication Date
1985-08-01

DOI
10.1103/physrevd.32.800

Brief Reports

Brief Reports are short papers which report on completed research which, while meeting the usual **Physical Review** *standards of scientific quality, does not warrant a regular article. (Addenda to papers previously published in the* **Physical Review** *by the same authors are included in Brief Reports.) A Brief Report may be no longer than 3½ printed pages and must be accompanied by an abstract. The same publication schedule as for regular articles is followed, and page proofs are sent to authors.*

Improved upper limit on ν_τ mass

C. Matteuzzi,* T. Barklow, A. M. Boyarski, M. Breidenbach, P. Burchat, D. L. Burke, J. M. Dorfan, G. J. Feldman, L. Gladney, G. Hanson, K. Hayes, R. J. Hollebeek, W. R. Innes, J. A. Jaros, D. Karlen, A. J. Lankford, R. R. Larsen, B. W. LeClaire, N. S. Lockyer,† V. Lüth, R. A. Ong, M. L. Perl, B. Richter, K. Riles, M. C. Ross, D. Schlatter,* J. M. Yelton,‡ and C. Zaiser
Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305

G. S. Abrams, C. de la Vaissiere,§ D. Amidei,** A. R. Baden, J. Boyer, F. Butler, G. Gidal, M. S. Gold, G. Goldhaber, L. Golding, J. Haggerty, D. Herrup, I. Juricic, J. A. Kadyk, M. E. Nelson,†† P. C. Rowson, H. Schellman, W. B. Schmidke, P. D. Sheldon, G. H. Trilling, and D. Wood
Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720

M. Levi* and T. Schaad
Department of Physics, Harvard University, Cambridge, Massachusetts 02138
(Received 12 February 1985)

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 mass[3] 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-

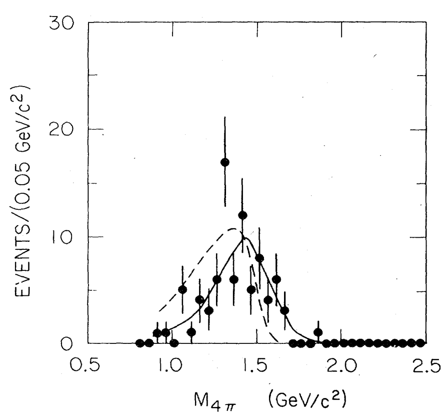

FIG. 1. Four-pion invariant-mass distribution of the selected events. The solid curve shows the expected spectrum for $m_{\nu_\tau}=0$ under the assumption that the four-pion τ decay mode is dominated by the ρ' resonance. The dashed curve shows the same spectrum for the assumption of $m_{\nu_\tau}=250$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

sumption that the four-pion state is dominated by the ρ' resonance of mass 1570 MeV/c^2 and width 510 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 $m_{\nu_\tau} < 143$ 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.

This work was supported in part by the Department of Energy, Contracts No. DE-AC03-76SF00515 (SLAC), No. DE-AC03-76SF00098 (LBL), and No. DE-AC02-76ER03064 (Harvard).

---

*Present address: CERN, CH-1211 Geneva 23, Switzerland.

†Present address: University of Pennsylvania, Philadelphia, PA 19104.

‡Present address: Oxford University, Oxford, England.

§Present address: Laboratoire de Physique Nucléaire et des Hautes Energies, Université Pierre et Marie Curie, F-75230 Paris, France.

**Present address: University of Chicago, Chicago, IL 60637.

††Present address: California Institute of Technology, Pasadena, CA 91125.

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

[2]There have been two recent upper limits on m_{ν_τ} from studies of the mass spectra of other τ decay modes. The DELCO collaboration has obtained an upper limit of 157 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 MeV/c^2 from a study of the $5\pi\nu$ decay mode [P. R. Burchat *et al.*, *ibid.* **54**, 2477 (1985)].

[3]Y. S. Tsai (private communication).

[4]A. 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)].