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Measurements of $|V_{us}|$ and Second Class Currents and Searches for Violation of Lepton Universality and CPT in Tau Decays at BABAR

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We report on a variety of results involving decays of the tau lepton using the very large sample of tau+tau- pairs produced in e+e- annihilation data collected with the BaBar detector at the PEP-II asymmetric-energy B Factory near a center-of-mass energy of 10.58 GeV. From measurements of the ratios of branching fractions: $B(\tau \rightarrow \mu \nu_{\text{bar}}) / B(\tau \rightarrow e \nu_{\text{bar}})$, $B(\tau \rightarrow \pi \nu) / B(\tau \rightarrow e \nu_{\text{bar}})$, and $B(\tau \rightarrow K \nu) / B(\tau \rightarrow e \nu_{\text{bar}})$ we test with high precision the Standard Model assumption of mu-e and tau-mu charged current lepton universality and provide a determination of the Cabibbo-Kobayashi-Maskawa matrix element $|V_{us}|$. Furthermore, we report on preliminary measurements of $\tau^{\pm} \rightarrow K^{\pm} n \pi^0 \nu_{\tau}$ with $n = 0, 1, 2, 3$ and $\tau^{\pm} \rightarrow \pi^{\pm} n \pi^0 \nu_{\tau}$ with $n = 3, 4$ as well as on the measurements of the branching fractions and hadronic mass distributions of $\tau \rightarrow K_S^0 \pi^{\pm} \nu_{\tau}$, $\tau \rightarrow K_S^0 \pi^{\pm} \pi^0 \nu_{\tau}$, $\tau \rightarrow K_S^0 \pi^{\pm} K^0_L \nu_{\tau}$. Data from the inclusive strange tau decay results are used in a different determination of $|V_{us}|$. We also report on our search for second class currents in $\tau \rightarrow \pi^{\pm} \eta \nu_{\tau}$, where the eta decays into $\pi^{\pm} \pi^0$ and our measurement of the tau mass. We obtain a test of CPT by measuring the difference between the masses of the tau+ and tau-.

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