Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Examination of the Charge Quantum in a Single-Electron Pump
MARK W. KELLER, NEIL M. ZIMMERMAN, NIST, ALI L. EICHENBERGER, METAS — In single-electron tunneling (SET) circuits, charge moves in discrete quanta that are generally assumed to carry a charge of exactly e, the free electron charge. To the extent that this is true, SET devices have an important role to play in fundamental metrology by providing a solid-state current source that is directly linked to a fundamental constant of nature. But is the SET charge quantum in fact exactly e? We discuss why this is not a trivial question and present an experimental answer to the question: by placing a known number of SET charge quanta onto a known capacitor, and by measuring the resulting voltage across the capacitor using a Josephson voltage standard, we compare the SET charge quantum to e. We find that the SET charge quantum is equal to e within a relative standard uncertainty of 1 part in 10^6, a constraint that is ~ 100 times smaller than the best previous result. This measurement is expected to reach an uncertainty ~ 3 parts in 10^7 in the near future, at which point it will also give useful information on possible corrections to the Josephson constant, $K_J = 2e/h$.

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Date submitted: 20 Nov 2006 Electronic form version 1.4