Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Individual two level fluctuators in the tunneling conductance of Al/AlO$_x$/Al Josephson junctions for superconducting qubits[1] CHRISTOPHER NUGROHO, VLADIMIR ORLYANCHIK, DALE VAN HARLINGEN, University of Illinois at Urbana-Champaign — Two level system (TLS) defects in AlO$_x$ tunnel barriers can lead to low-frequency $1/f$ critical current noise and losses in coherent superconducting circuits. Understanding the nature of these defects and how to eliminate them are critical in order to achieve ultra-long coherence times. We present measurements of the tunneling conductance of ultrasmall, $A < (100\text{ nm})^2$, Al/AlO$_x$/Al shadow evaporated junctions. The tunneling conductance of these junctions exhibits several isolated TLSs, which permitted the detailed analysis of the individual switching rates and behavior of the TLSs. We have studied the thermal activation behavior of these TLSs, and in some cases observe a crossover into quantum-limited tunneling at lower temperatures. Tracking the TLS switching rates as a function of the applied voltage bias provides an estimate of the TLS charge dipole moment. In some quantum tunneling limited TLSs we have observed a non-equilibrium enhancement of the switching rates that cannot be explained by simple dissipative heating of the TLSs. Further investigations into these TLS defects may lead to the identification of their physical origins and strategies to eliminate them.

[1]Research funded by the Intelligence Advanced Research Projects Activity (IARPA)

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Date submitted: 14 Nov 2013 Electronic form version 1.4