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Time-Domain Measurements of Real-Space Magnetization Trajectories in Spin Torque Oscillators GRAHAM E. ROWLANDS, JIAN ZHU, Department of Physics and Astronomy, University of California, Irvine, JORDAN A. KATINE, Hitachi Global Storage Technologies, San Jose, CA, JUERGEN LANGER, Singulus Technologies, 63796 Kahl am Main, Germany, PEDRAM KHALILI AMIRI, KANG L. WANG, Department of Electrical Engineering, University of California, Los Angeles, ILYA N. KRIVOROTOV, Department of Physics and Astronomy, University of California, Irvine — We make time-domain measurements of the microwave signal emitted by spin torque nano-oscillators (STNOs) based on magnetic tunnel junctions with Fe-rich free layers. The perpendicular magnetic anisotropy of the free layer nearly cancels its easy-plane shape anisotropy, allowing the magnetization to undergo large amplitude precession. The microwave power emitted by such STNOs reaches values approaching 0.4 μW. We employ a high-gain low-noise amplifier to further amplify the emitted signal, thereby bringing it to a level ($\sim$ 0.5 V rms) far exceeding the noise floor (5mV rms) of a 12 GHz, 40 Gs/s storage oscilloscope used for time-domain measurements. Relying on the assumption that extrema of the measured voltage versus time trace correspond to the magnetization crossing the sample plane, we use these time-domain traces to reconstruct the statistical distributions of the azimuthal angles at which the magnetization vector of the free layer crosses the plane of the sample. We measure the evolution of these crossing angle distributions as a function of current density and compare to theoretical predictions.

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