Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

In Situ Measurements of the Flow around a Single Vertical-Axis Wind Turbine IAN BROWNSTEIN, DANIEL ARAYA, MATTHIAS KINZEL, JOHN DABIRI, Caltech — Laboratory studies of model vertical-axis wind turbines (VAWTs) are typically unable to match both the Reynolds number (Re) and tip speed ratio (TSR) of full-scale wind turbines. In order to match both relevant parameters, a quantitative flow visualization method was developed to take in situ measurements of the flow around full-scale VAWTs. An apparatus was constructed to deploy a horizontal sheet of smoke upstream of the turbine at the mid-span of the rotor. Quantitative results were obtained by tracking the evolution of this smoke sheet using a PIV algorithm. This method will be demonstrated through a comparative study of three- and five-bladed VAWTs at the Field Laboratory for Optimized Wind Energy (FLOWE) in Lancaster, CA. Additionally, results will be presented in comparison with previous laboratory studies to help determine the dependence of the flow physics on Re and TSR.

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Date submitted: 28 Jul 2014 Electronic form version 1.4