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Spectral and phase average analysis of a model horizonal-axis wind turbine (HAWT) wake at high Reynolds numbers[1] ALEXANDER PIQUE, Princeton University, MARK A. MILLER, Pennsylvania State University, MARCUS HULTMARK, Princeton University — The interactions between HAWT wake-flows and downstream turbines can affect wind farm power output. However, our ability to model such flows and interactions is limited. A reason for the limited understanding is a lack of detailed wake studies at field-similar Reynolds numbers, which can be in excess of 100 million. Experimental data acquired in the wake of a HAWT model (20cm diameter) obtained within the High Reynolds Number Testing Facility (HRTF) at Princeton University, will be presented. The HRTF is a high-pressure wind tunnel, that can pressurize the working fluid, air, up to 238 bar, while maintaining flow speeds up to 10m/s. Streamwise velocity measurements at Reynolds numbers up to 7.2×10^6 at five different downstream locations, from 0.77 to 5.52 diameters, were acquired. Flow measurements were obtained using the nanoscale thermal anemometry probe (NSTAP), which offers spatial and temporal resolution well beyond conventional hot-wires capabilities. Wake-flow characterization will be presented through an investigation of streamwise velocity variance profiles, spectral characteristics, and phase averaged mean velocity profiles. From these profiles, discussions on tip vortex evolution and vortex structure population will be made.

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