U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Testing Facilities and Capabilities at Sandia National Laboratories: Field Test Facilities O&M (SWiFT O&M)

Project ID #T2

Jonathan Berg

Sandia National Laboratories

FY17-FY18 Wind Office Project Organization

"Enabling Wind Energy Options Nationwide"

Technology Development	Market Acceleration & Deployment
Atmosphere to Electrons	Stakeholder Engagement, Workforce Development, and Human Use Considerations
Offshore Wind	Environmental Research
Distributed Wind	Grid Integration
Testing Infrastructure	Regulatory and Siting
Standards Support and International Engagement	
Advanced Components, Reliability, and Manufacturing	

Analysis and Modeling (cross-cutting)

Project Overview

T2: Testing Facilities and Capabilities at Sandia National Laboratories: Field Test Facilities O&M (SWiFT O&M)

Project Summary

The purpose of the Scaled Wind Farm Technology (SWiFT) Facility, being a DOE wind turbine test facility, is to provide the United States with world-class test capabilities for conducting innovative wind turbine and wind plant research & development. SWiFT's unique testing capabilities are derived from three key features: the turbines, the layout, and the wind resource.

Project Objective & Impact

SWiFT project objectives include 1) keeping operations running safely and smoothly by continuously implementing Sandia's Integrated Safety Management System and Work Planning & Control practices 2) keeping equipment in good working order through maintenance activities, and 3) providing operational support to WETO projects and other users of the facility to achieve their test objectives.

Project Attributes

Project Principal Investigator(s)

Jon Berg
jcberg@sandia.gov

DOE Lead

Gary Nowakowski
Gary.Nowakowski@ee.doe.gov

Project Partners/Subs

Texas Tech University (TTU)
TTU National Wind Institute
Group NIRE
Vestas-American Wind Technology, Inc.

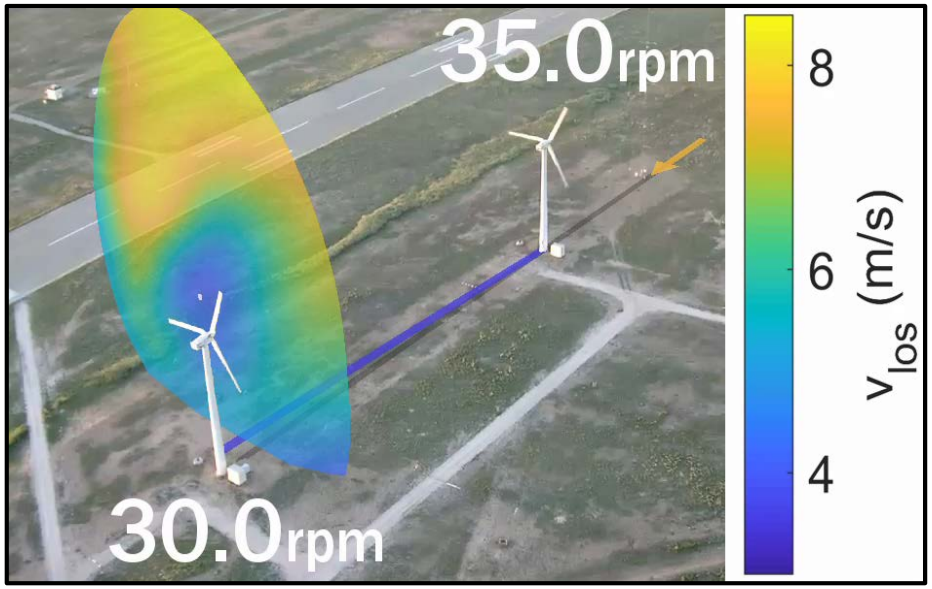
Project Duration

October 2014 – N/A (active, ongoing)

Technical Merit and Relevance

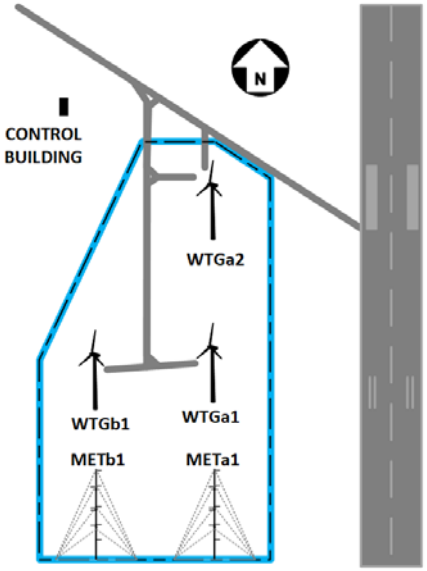
SWiFT's capabilities directly support Sandia's strategic contributions to WETO missions and goals in three areas:

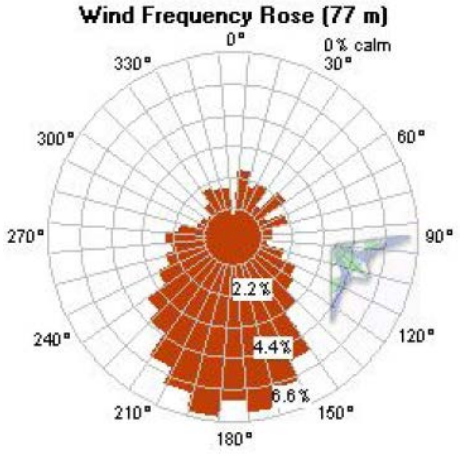
1) **Rotor systems innovation** – Open source and well characterized from *design* to *flight*
2) **Wind plant innovative experimentation** – Technology incubator for *wake* characterization and *turbine-turbine* interaction
3) **Wind plant performance** – Open datasets for model *verification*, *validation* and *uncertainty quantification*



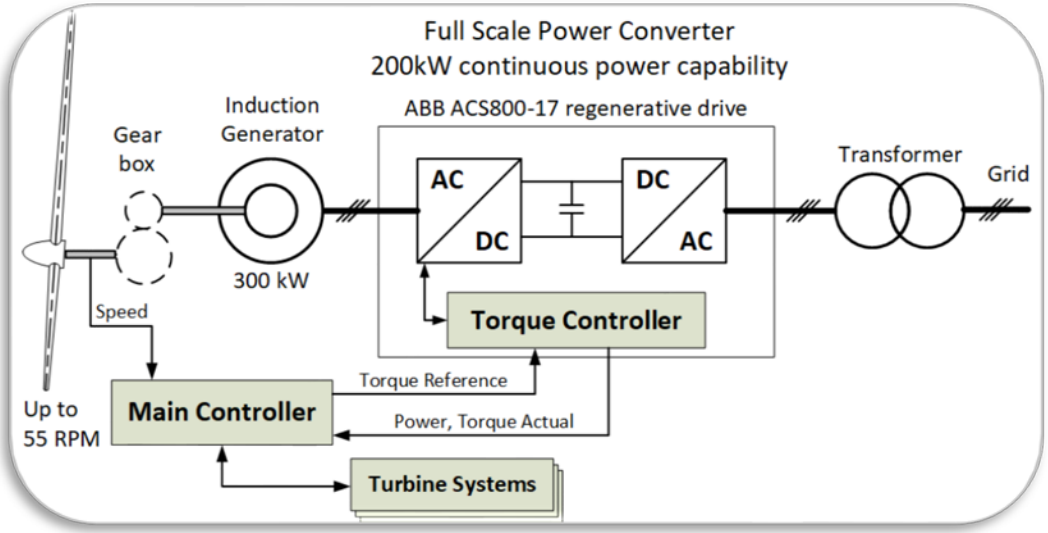
Technical Merit and Relevance

Ideal atmospheric conditions





Open source controller



Scaled for quicker deployment and testing

Approach and Methodology

- Commission all three turbines (TTU collaboration)
- Operations in support of research
  - National Rotor Testbed (NRT) (NREL, ORNL collaboration)
- Perform preventative and reactive maintenance
  - a1, a2 and b1 turbines (TTU)
  - Met towers (NREL)
  - Ground deployed Pentalum SPiDAR and turbine deployed Windar Photonics 4-beam LiDAR (TTU)
- Ensure Safe Operations
  - Experimental Activities & Safety Training
    - 50+ courses on safety and required readings for All staff and subcontractors working at the site
    - 12 specific roles with defined technical skills and training requirements

Working with NREL to install Gill Sonic Anemometers on SWiFT met towers - 2018

Collaborations and Partnerships

Collaborations are a significant component of Sandia's approach

TEXAS TECH UNIVERSITY

GROUP NIR Renewable Energy Solutions

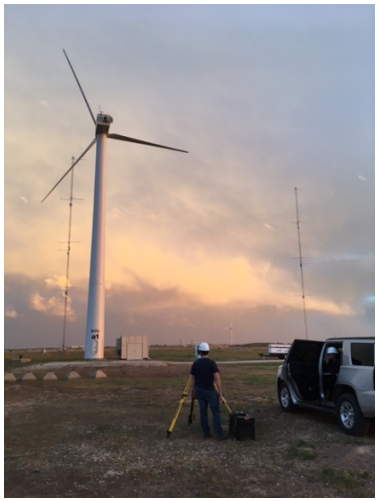
Vestas Wind. It means the world to us.™

NREL NATIONAL RENEWABLE ENERGY LABORATORY

tpi COMPOSITES

DTU Technical University of Denmark

OAK RIDGE National Laboratory



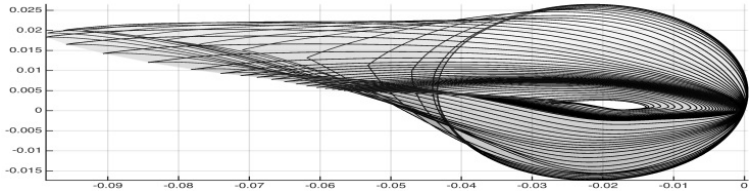
Accomplishments and Progress

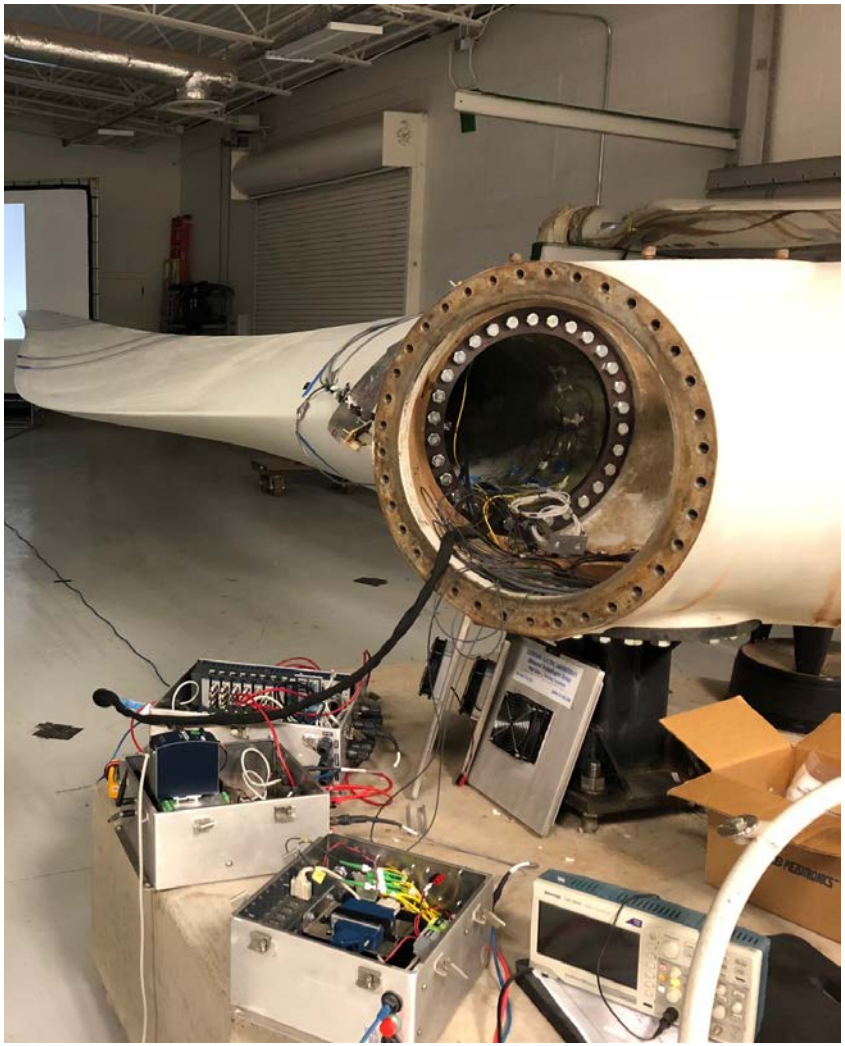
Major Project Milestones FY17 through FY19

- a1 Turbine
  - retrofit - Complete
  - pre-rotor recommissioning – 90% Complete
  - NRT Wake Scaling Preparation – Complete
- a2 Turbine
  - Installation - Complete
  - a2 full commissioning – 97% Complete
- b1 Turbine
  - Pre-rotor Commissioning – 0% Complete
  - Overall – 0% Complete
- Scheduled Maintenance, Inspections and Safety Reviews
  - Completed Annually
- Fully Commission a1, a2 and b1 at SWiFT
  - 60% Complete
- Met Towers
  - Sonic Anemometer replacement - Complete
  - Temperature, pressure and Rh sensor replacement – 20% Complete
- NRT Wake Scaling Preparation – Complete
- NRT Installation and post-rotor commissioning – 50% Complete

Accomplishments and Progress

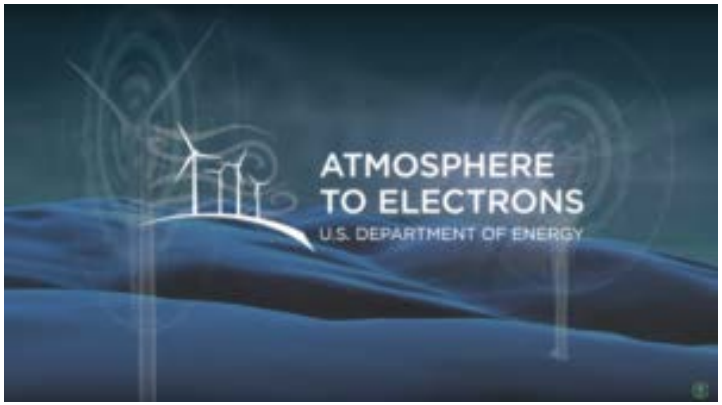
Rotor Systems Innovation at the National Rotor Testbed

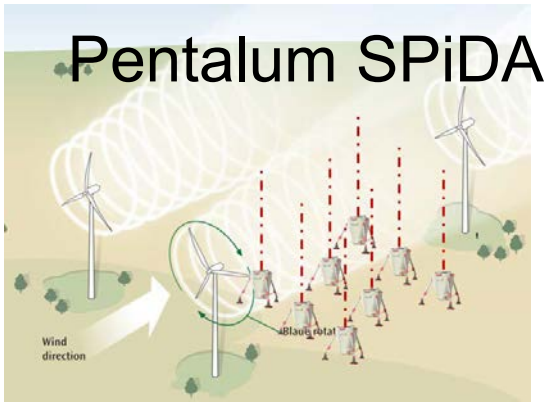


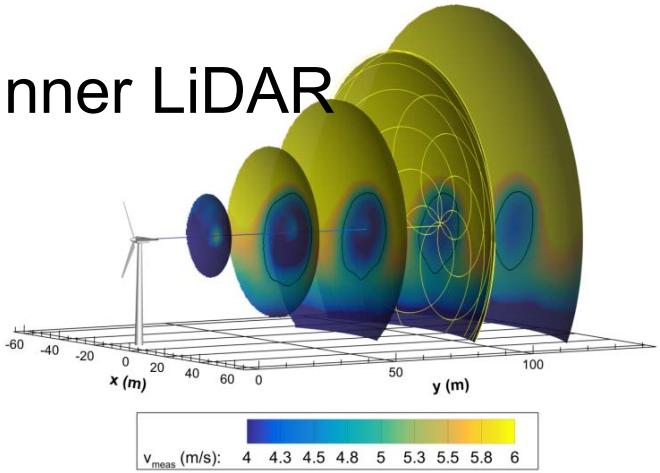


Accomplishments and Progress

Wind Plant Innovative Experimentation and Wind Plant Performance – supporting Atmosphere to Electrons

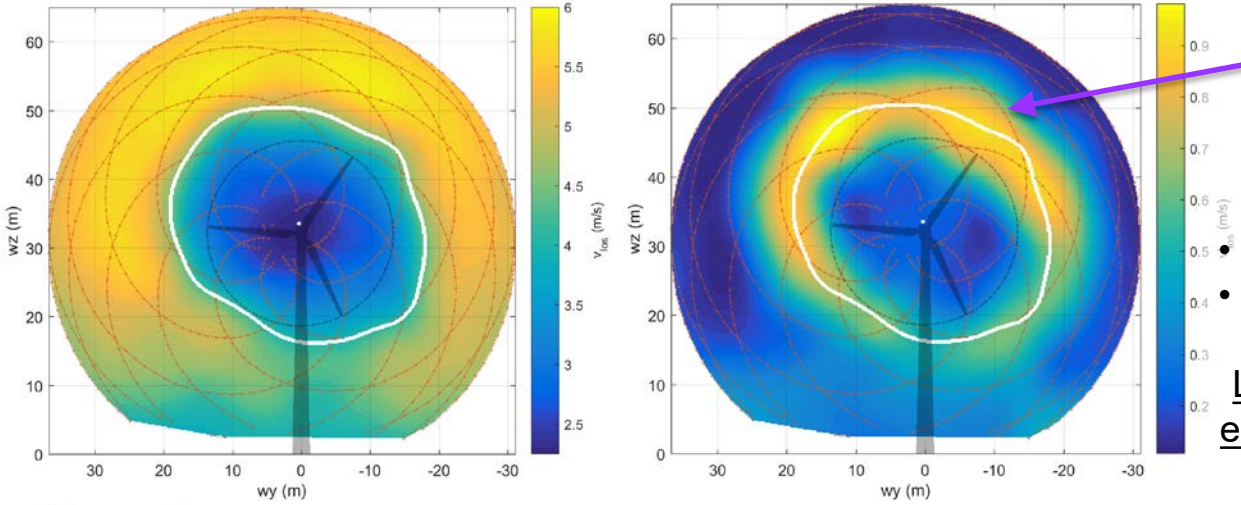






Accomplishments and Progress

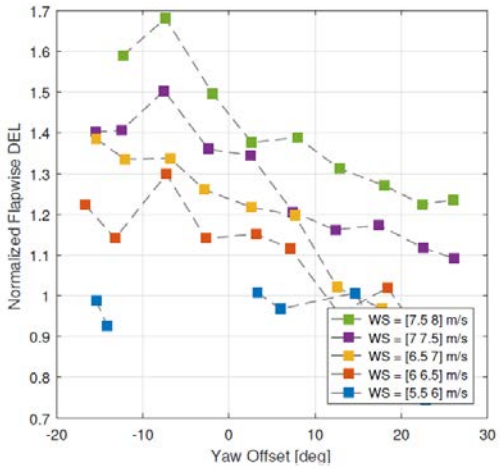
Wind Plant Innovative Experimentation – Inflow and Wakes



LiDAR beams are projected behind the wind turbine to measure the wake:

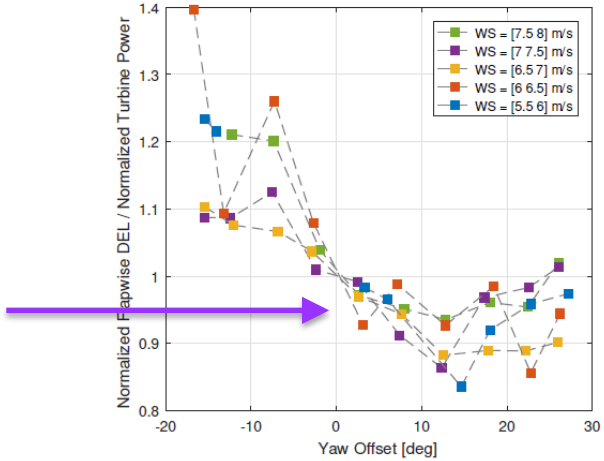
- Left Image – Line of Sight Velocity
- Right Image – Estimated Turbulence

Lower wind speeds bound by a ring of enhanced turbulence of the wake shear layer



Blade fatigue load was measured for various yaw angles and wind speeds

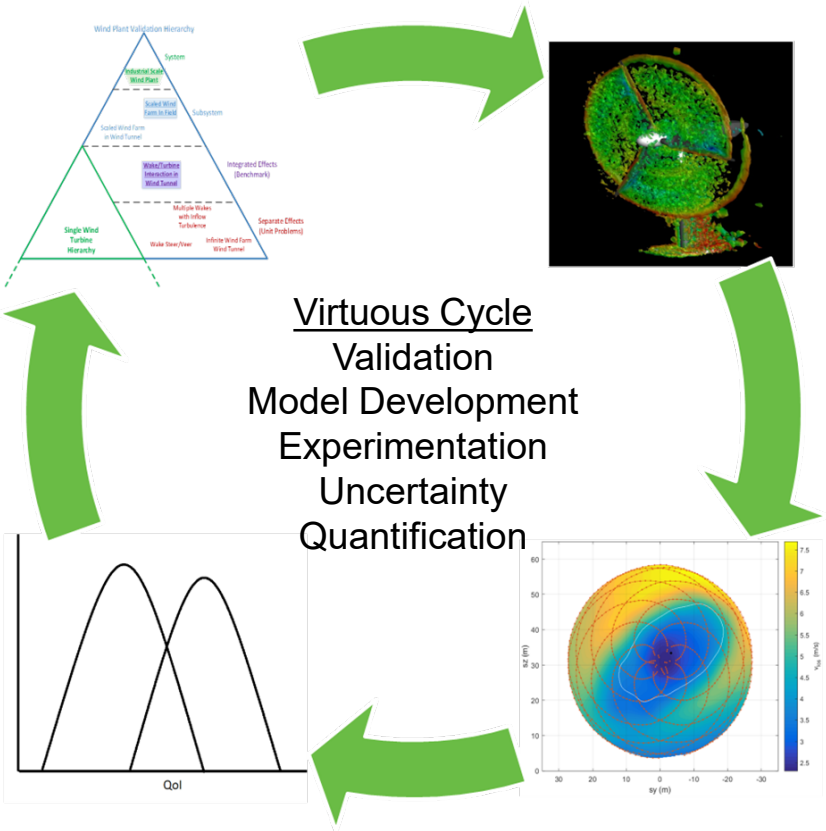
Wake steering experiment at SWiFT reveals that optimal operation of wind turbines is found at a slightly positive yaw



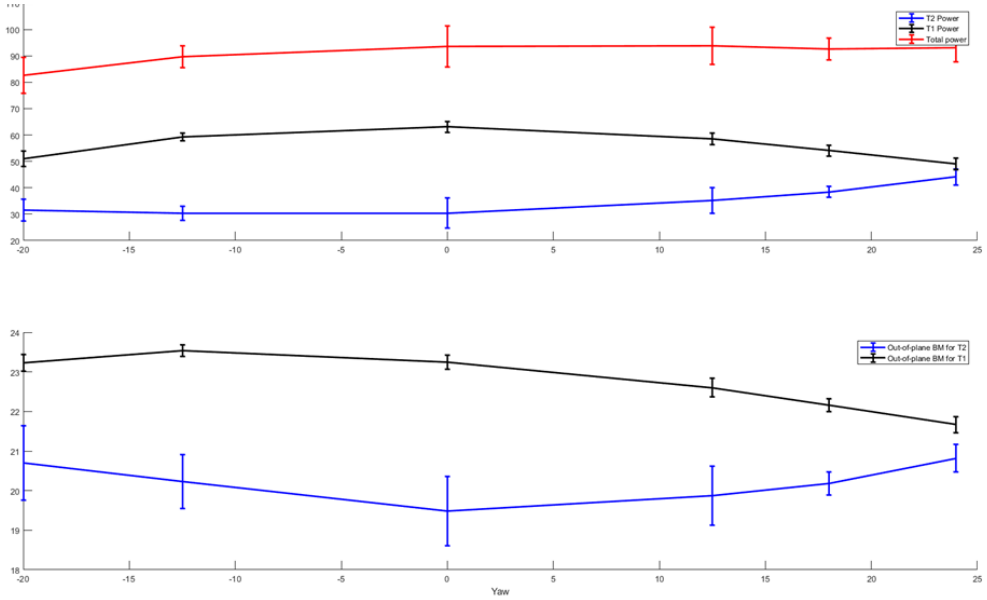
For each case, ratio of fatigue load to power was computed

Accomplishments and Progress

Wind plant performance – Verification, Validation & Uncertainty Quantification

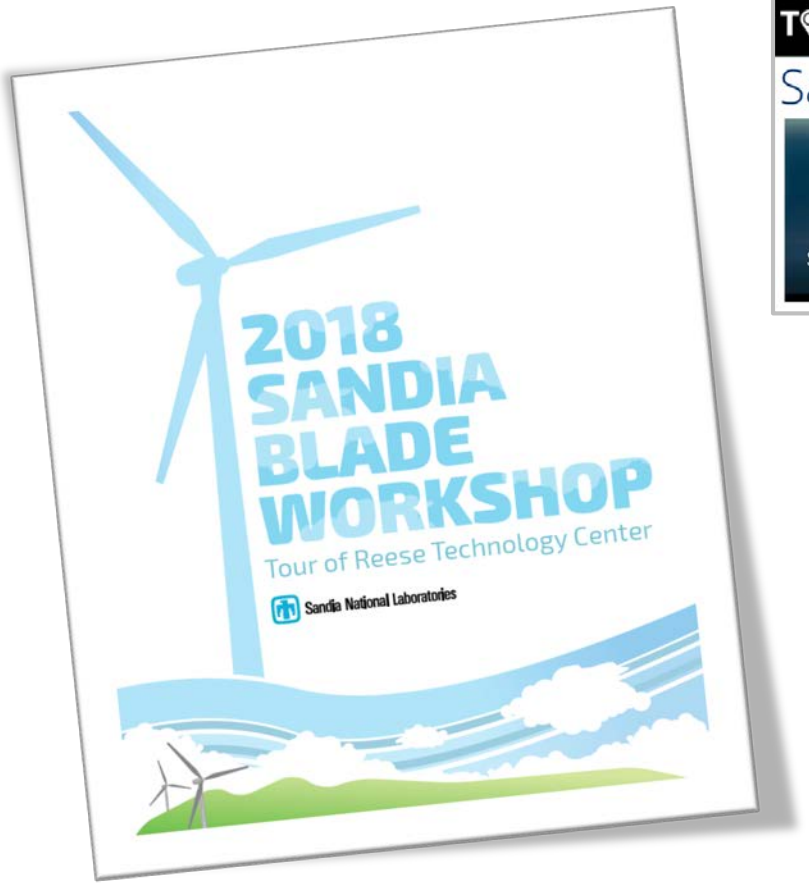


Power and Bending Moment vs. Yaw angle including uncertainty



Based on propagating measurement uncertainty using computational wake and turbine models (FAST.Farm)

Communication, Coordination, and Commercialization



- 8th Blade Workshop successfully held in 2018 at SWiFT
- Planning underway for 2020 workshop

tours.sandia.gov/SWIFT/

Upcoming Project Activities

- Complete the wind turbine commissioning started in FY18
- Execute the NRT Project test plan
- Continue to champion SWiFT as a best-in-class, center of excellence in wind research and blade design

Re-deployment of Pentalum SPIDAR LiDAR units with TTU

TTU X- and Ka-Band Radar

Microgrid R&D with TTU and GroupNIRE

GLEAMM
GLOBAL LABORATORY FOR ENERGY ASSET MANAGEMENT AND MANUFACTURING

Motor Control, ATS, Switchboard