

GoldWind's Experience after 7 years of Lidar

Assisted Control

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1. Principle of LAC

Goldwind Lidar Assisted Control

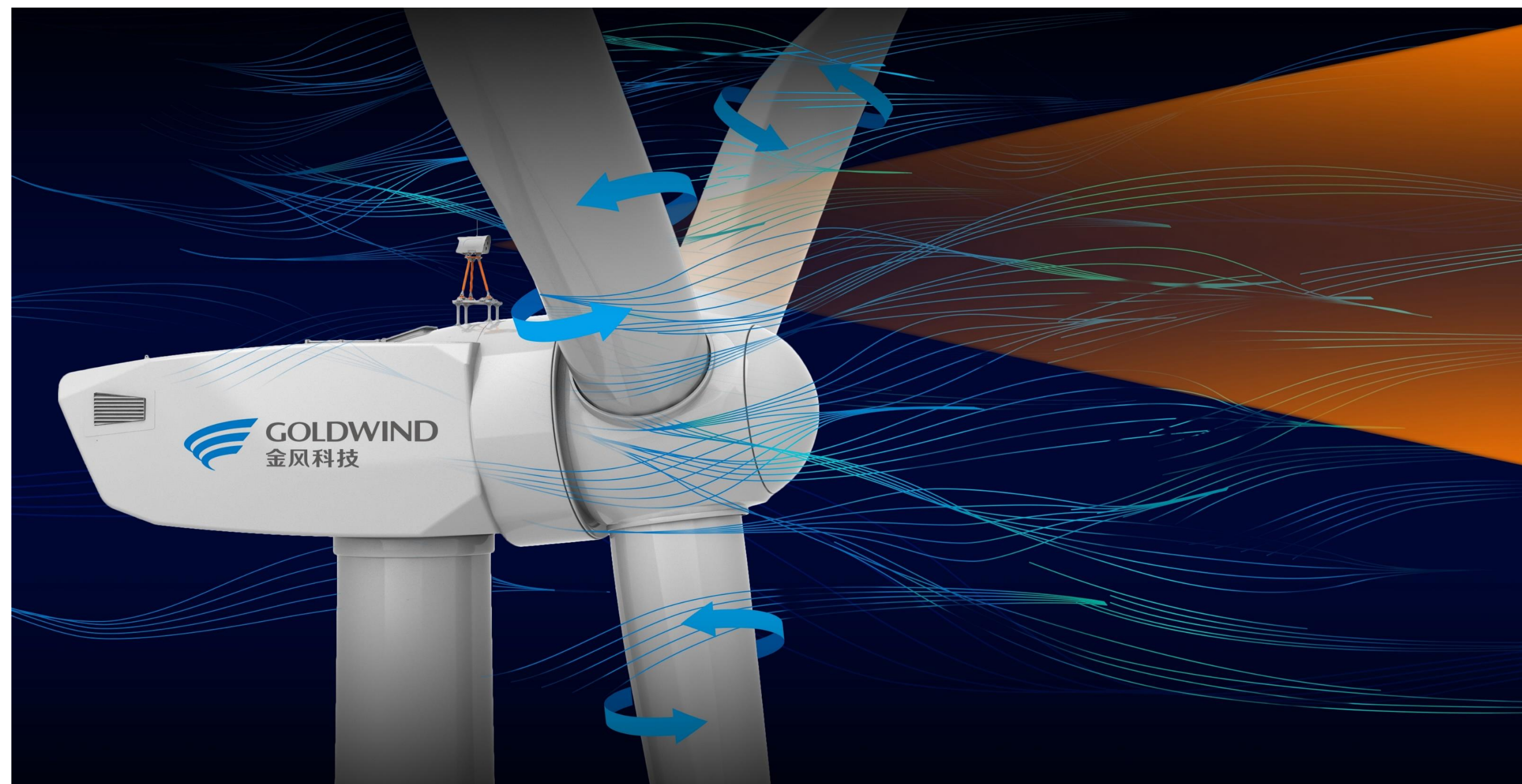
High Performance
LiDAR sensor



Wind Identification
Algorithm



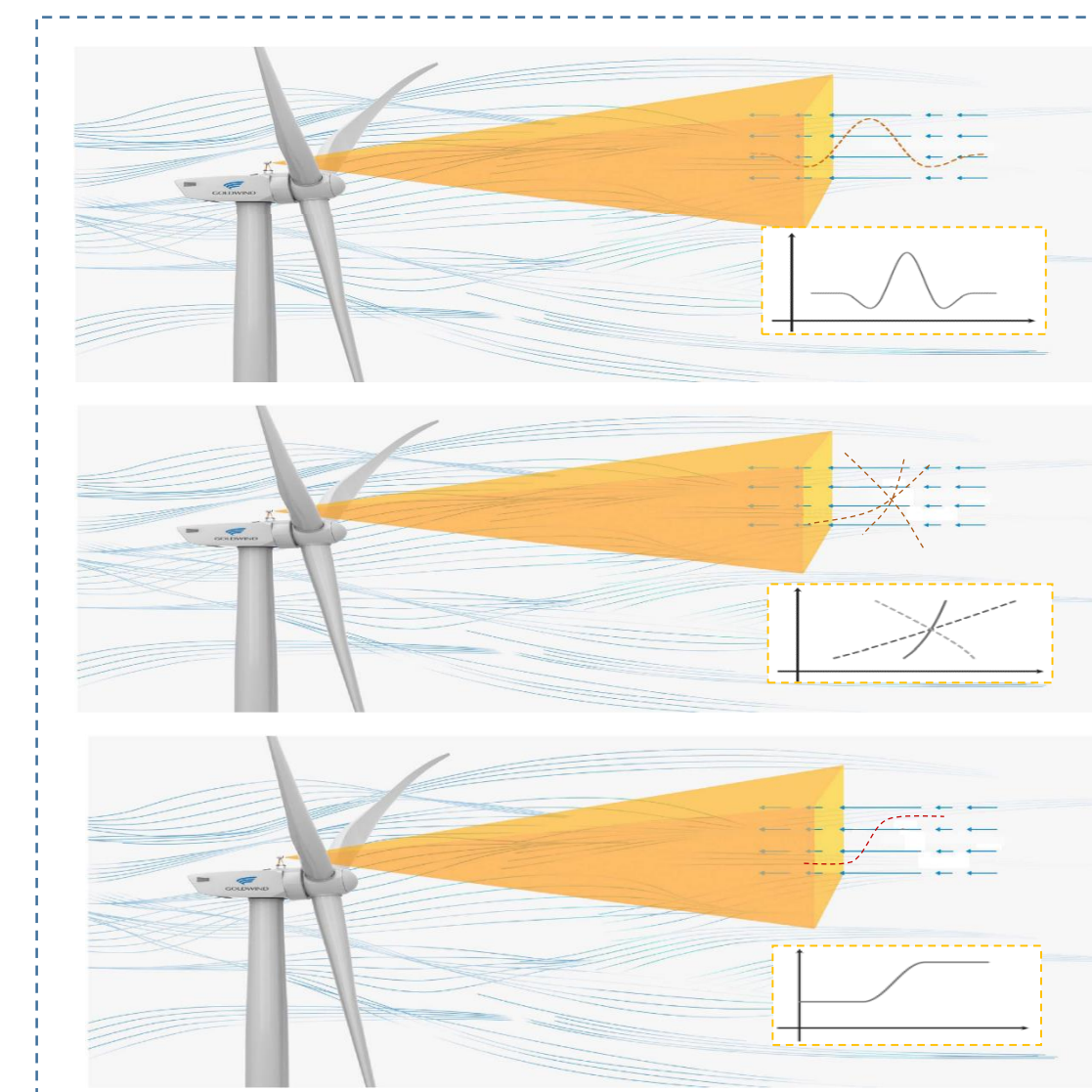
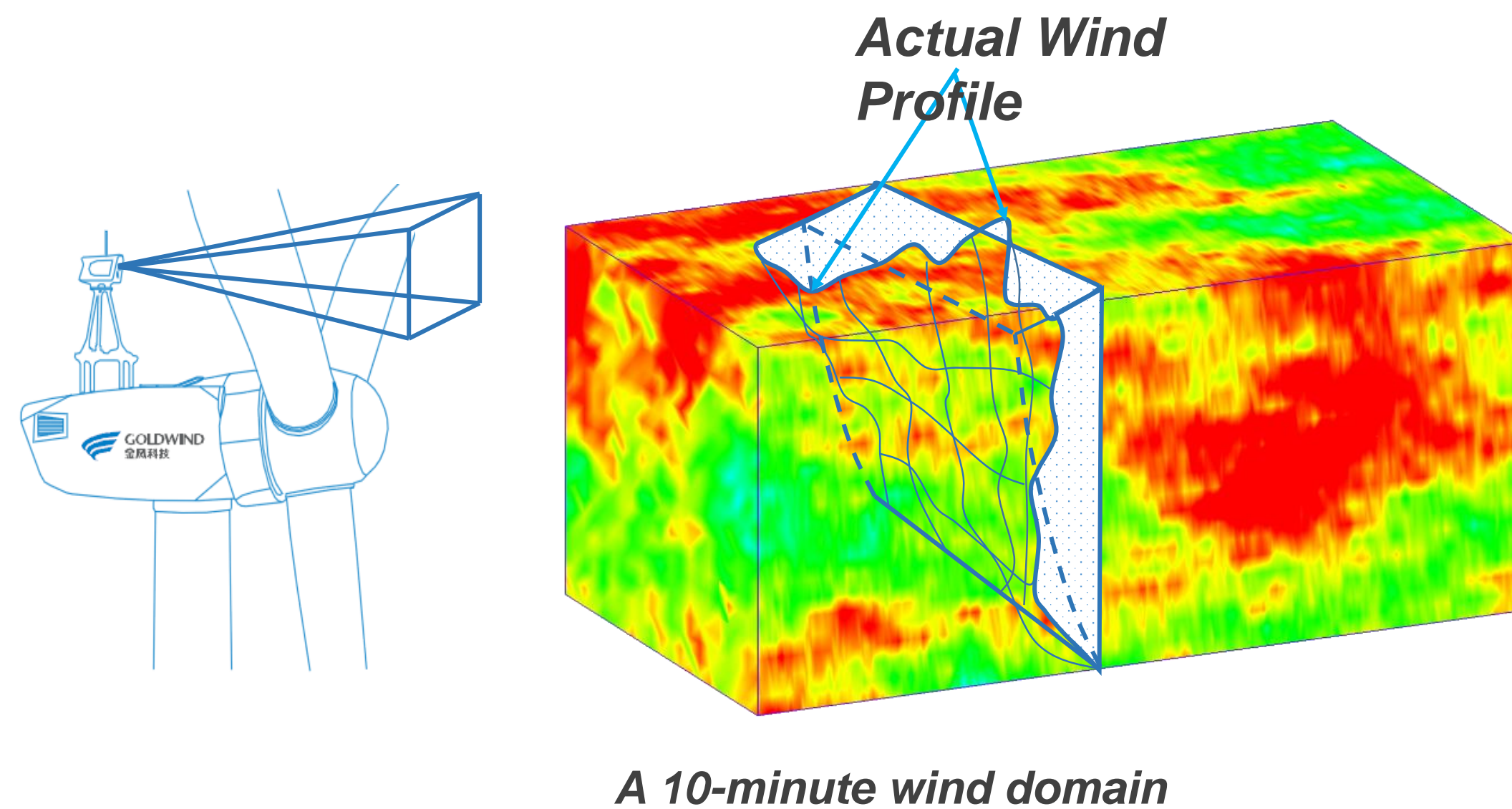
Advanced Turbine
Control



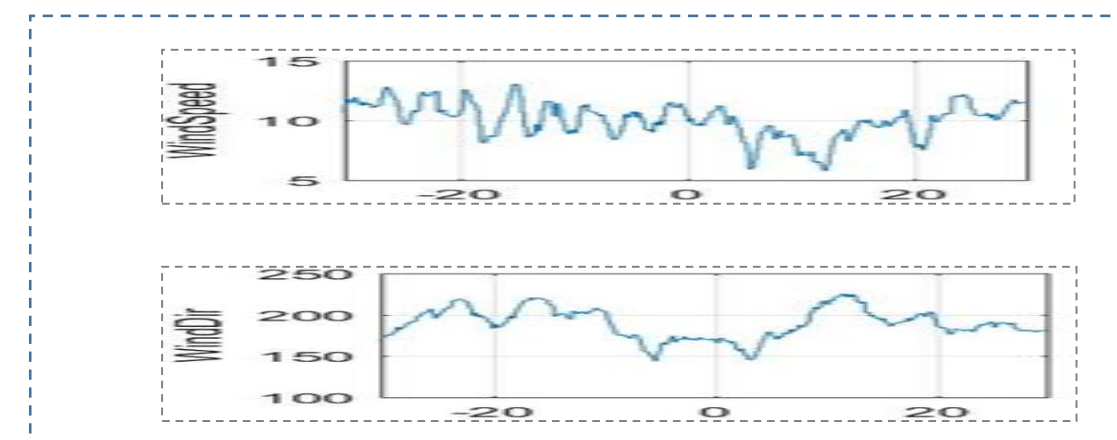
LiDAR sensor probes and analyzes the incoming flow in front of the rotor precisely.

Perceiving the wind in advance
Smart control on the turbine
Adjusting “with” the wind
Achieving synergy between wind and turbine

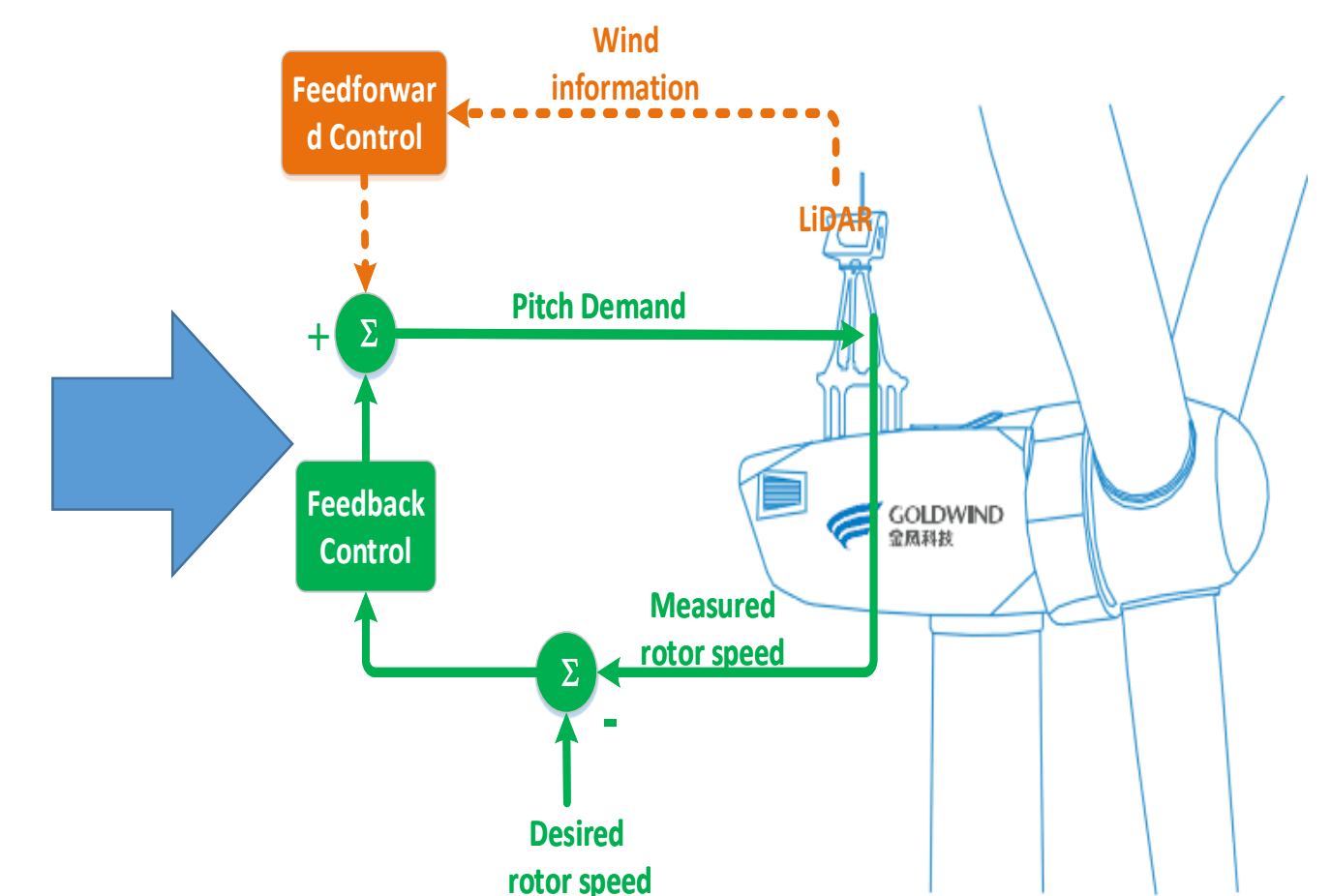
- “**reconstruct**” the entirety of inflow wind domain – incl. **wind speed, direction, turbulence intensity** and **wind shear** etc., and then “**translate**” such information into input data to the turbine’s control strategy.
- The Lidar Assisted Control system can intelligently control the turbines to act timely and accordingly in order to “match” the complex and changeable motions of the inflow wind, thus **reducing the turbine’s load** and in the meantime **optimizing energy yield**.



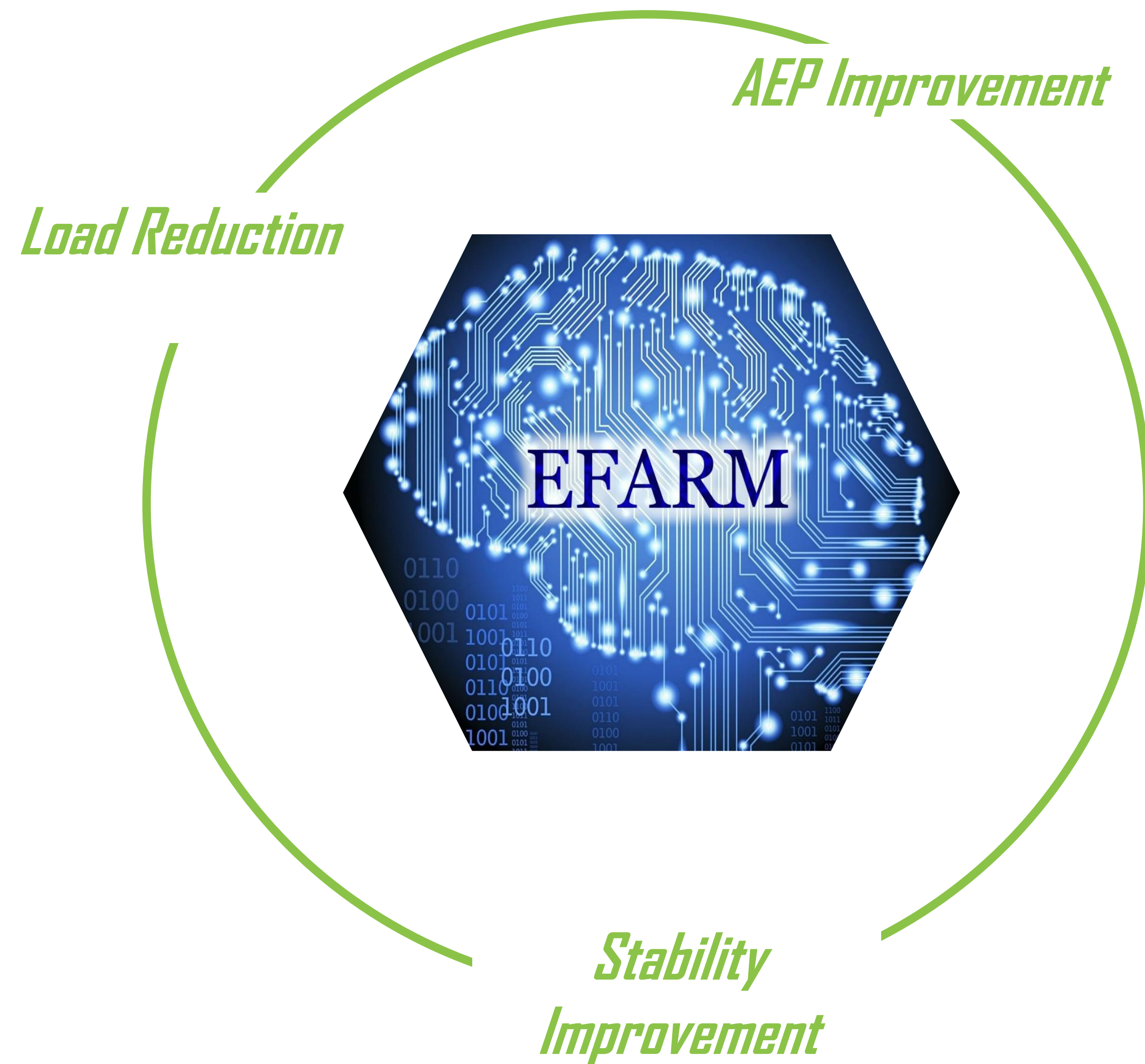
Extreme Wind Condition



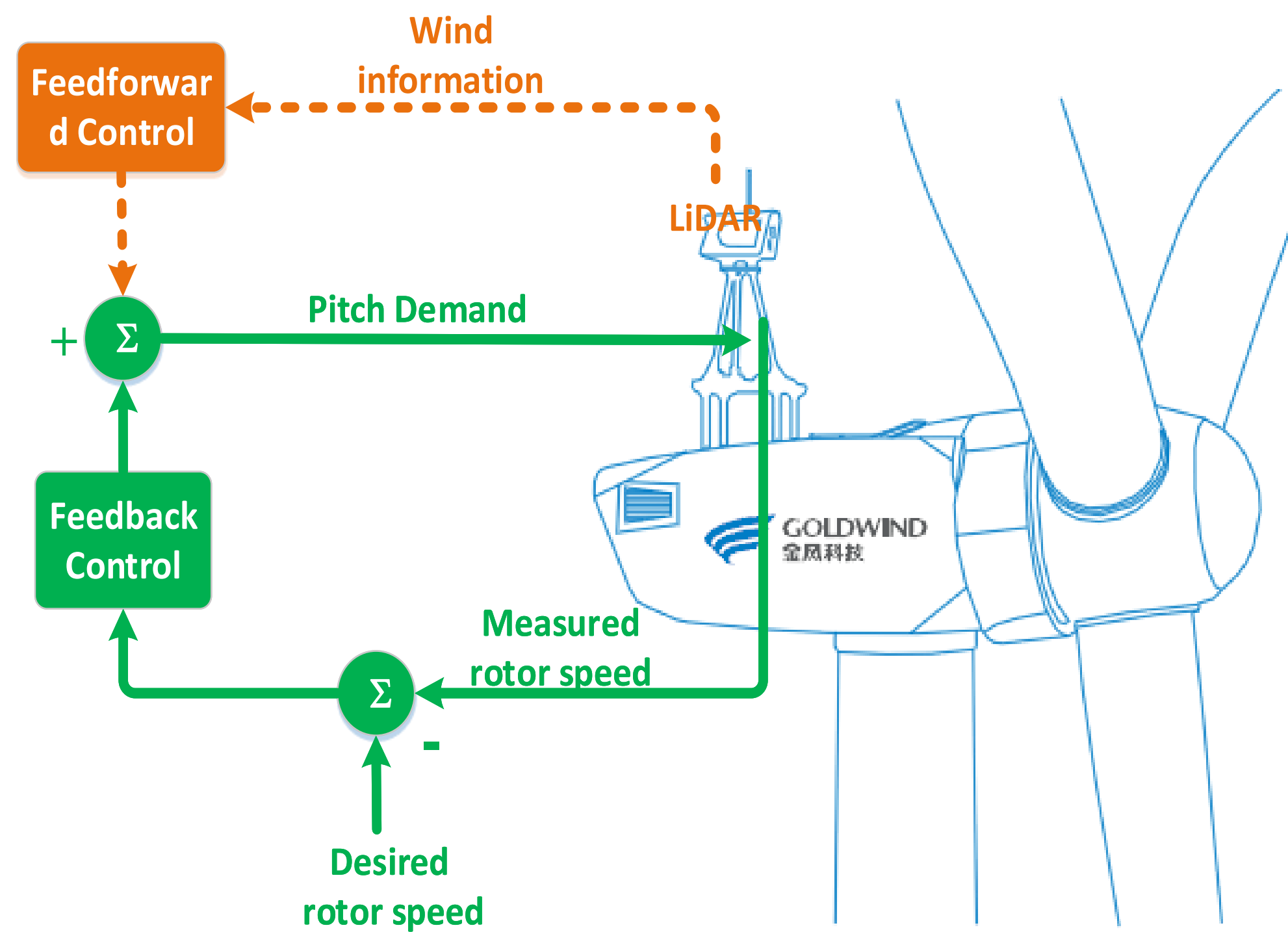
Extreme Turbulence Condition



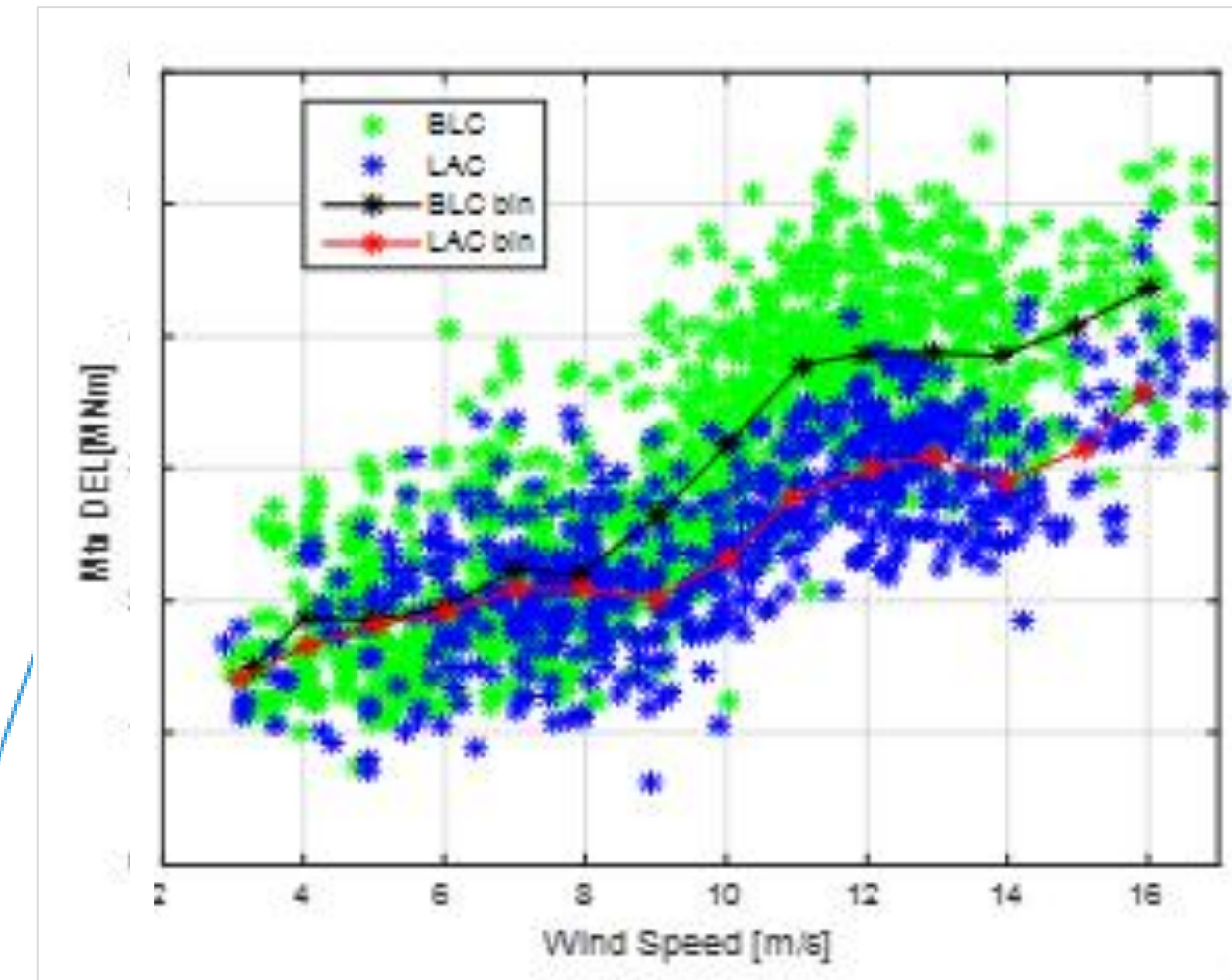
2. Benefits of LAC



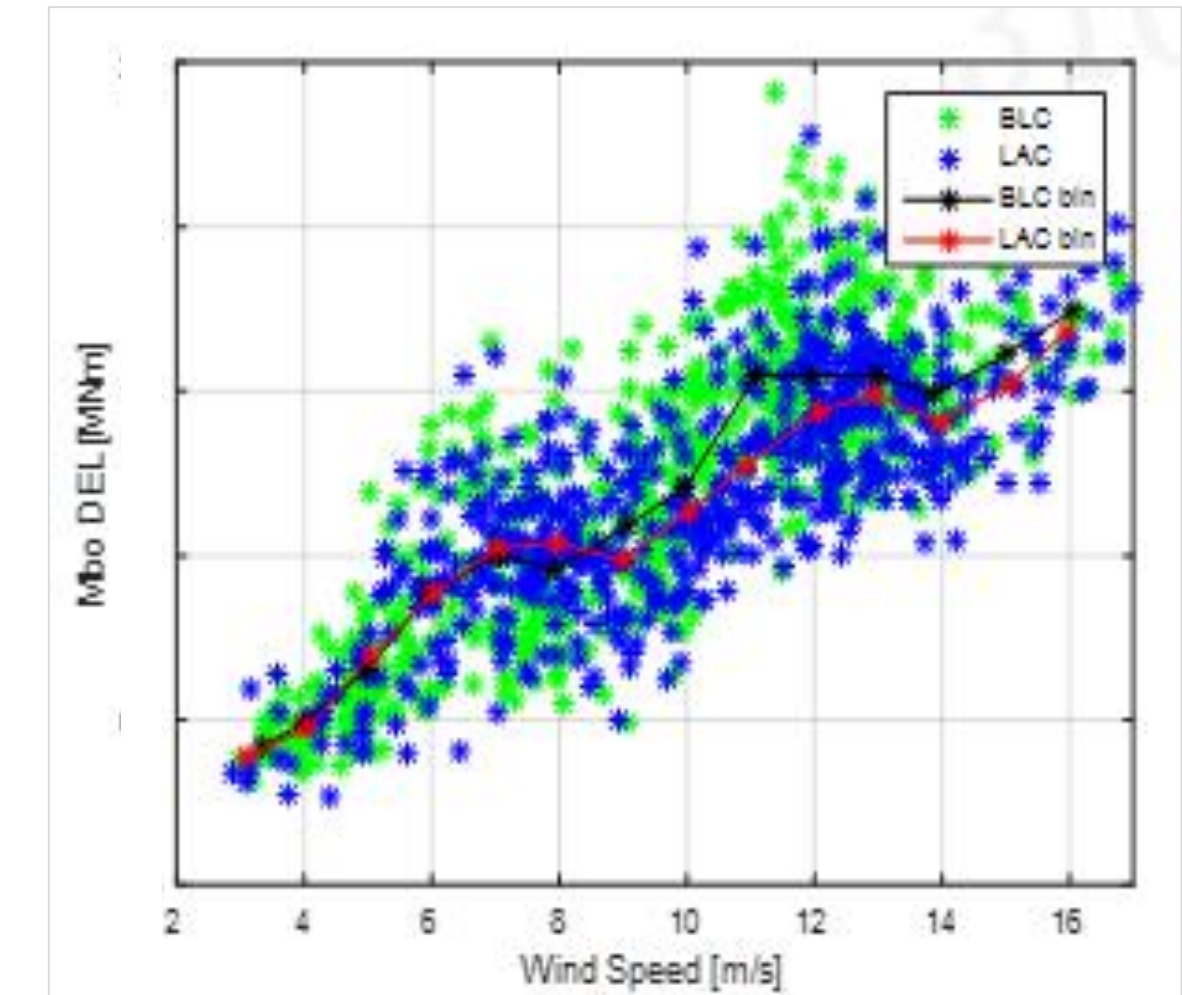
2.1 Load Reduction



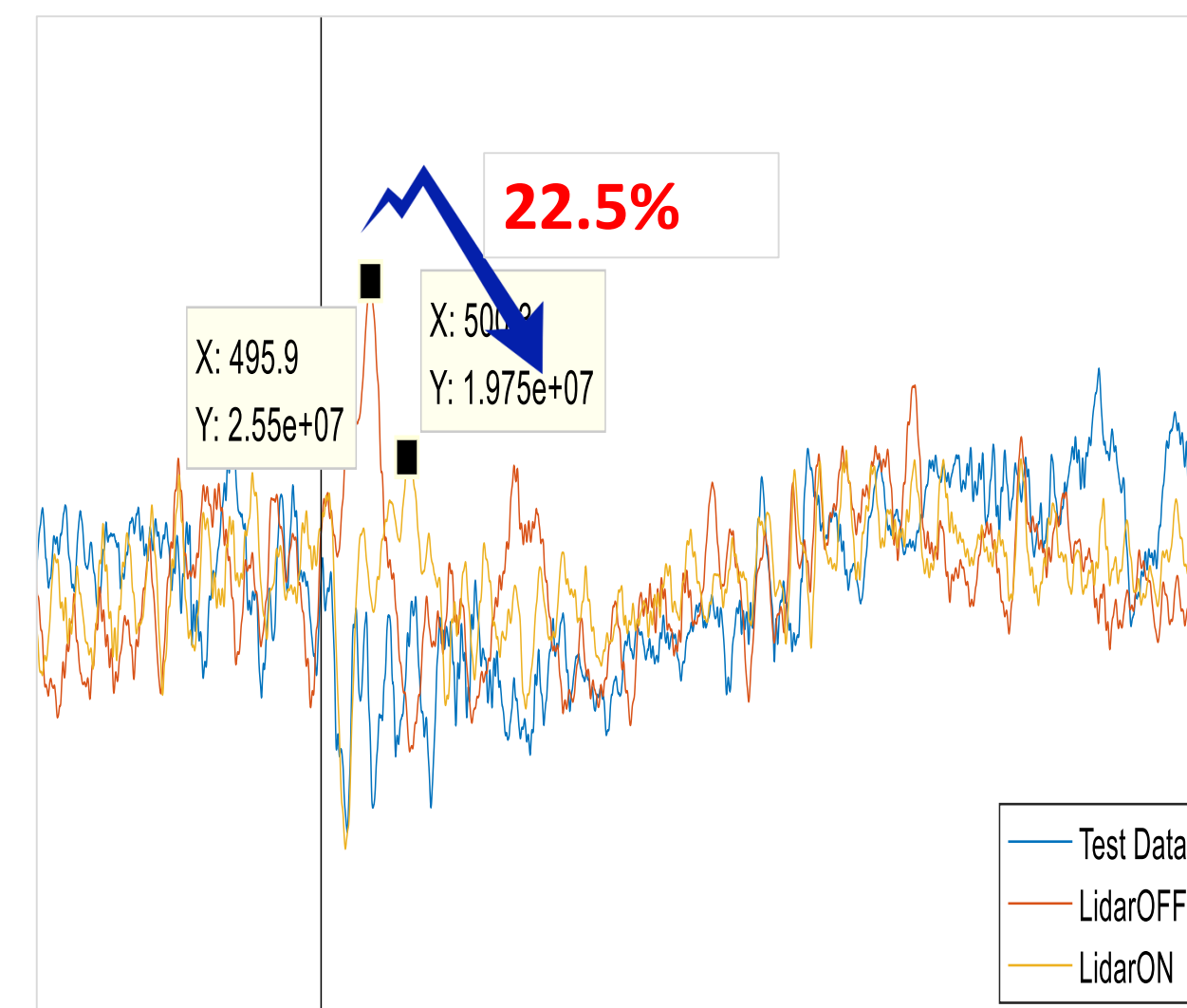
Tower Bottom Bending Moment (Measured)



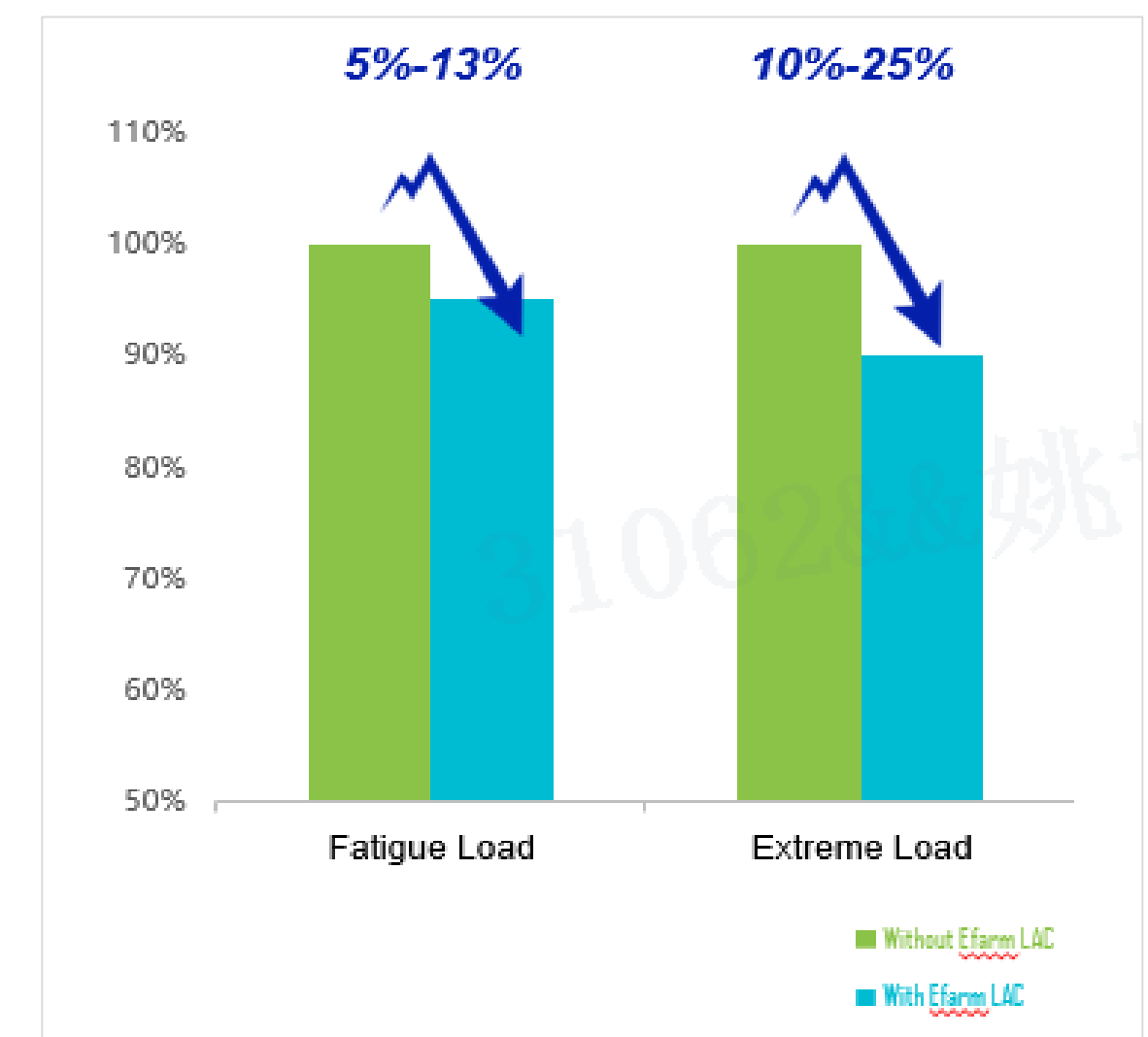
Blade Root Bending Moment (Measured)



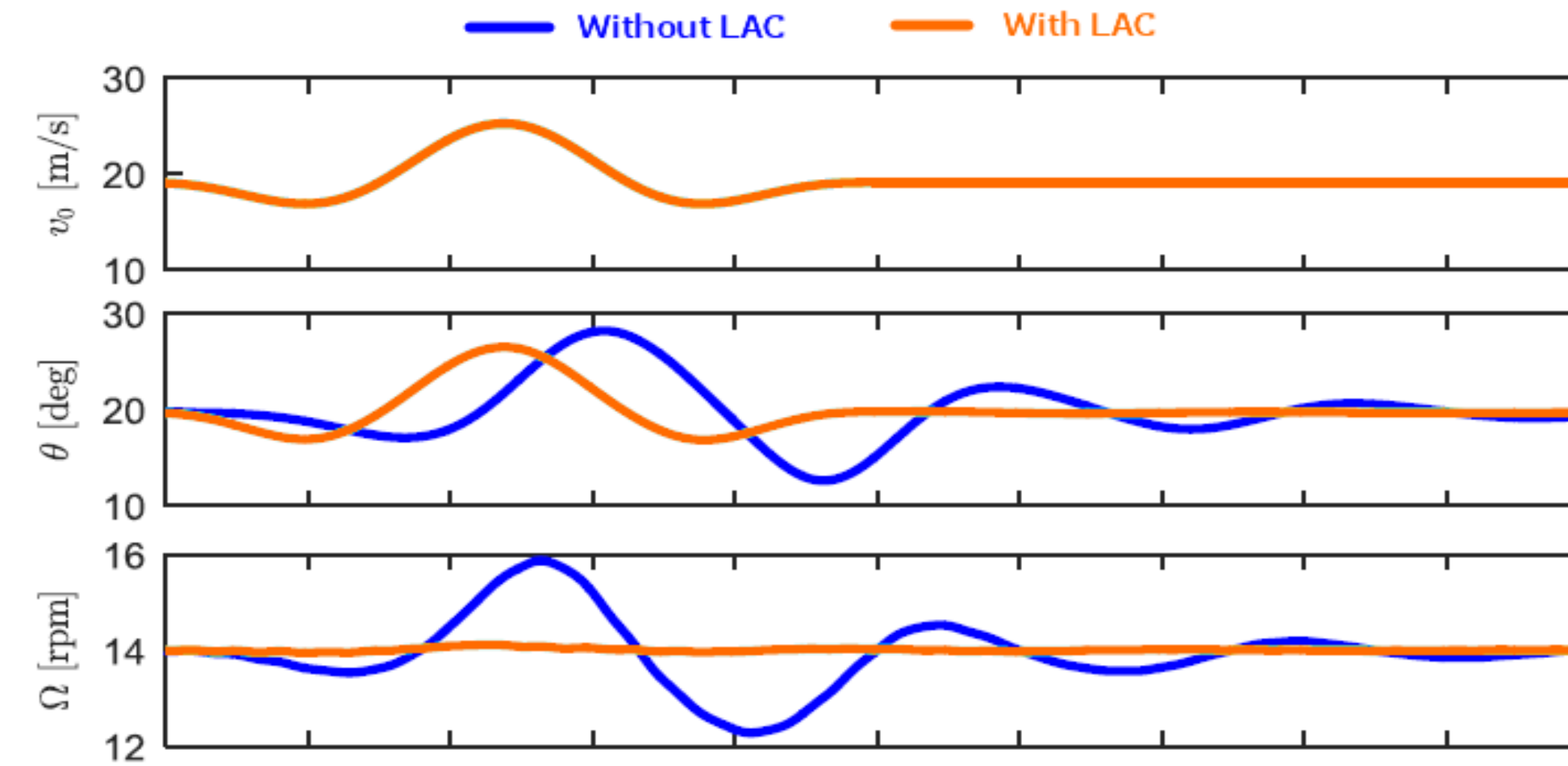
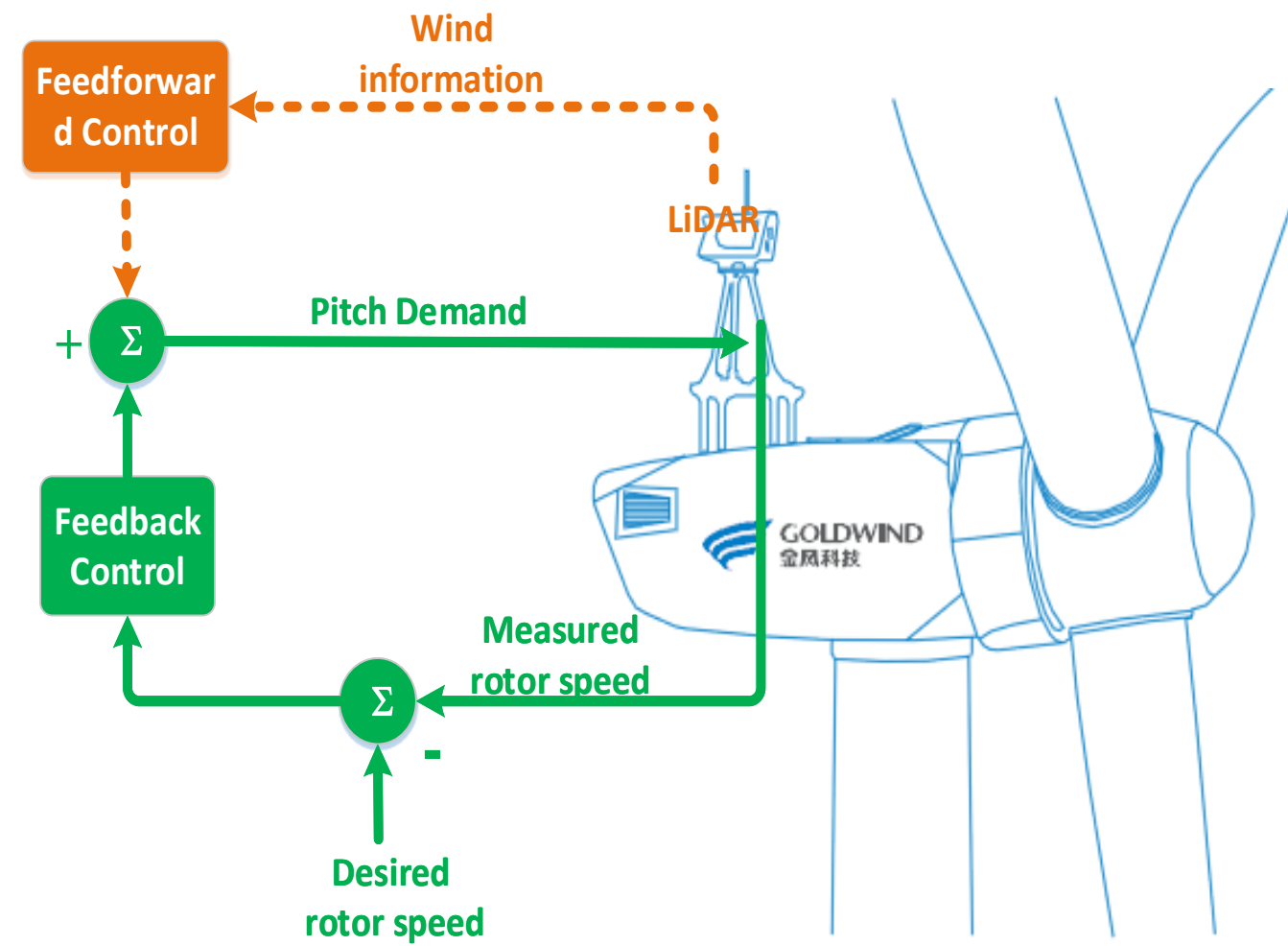
Extreme wind condition



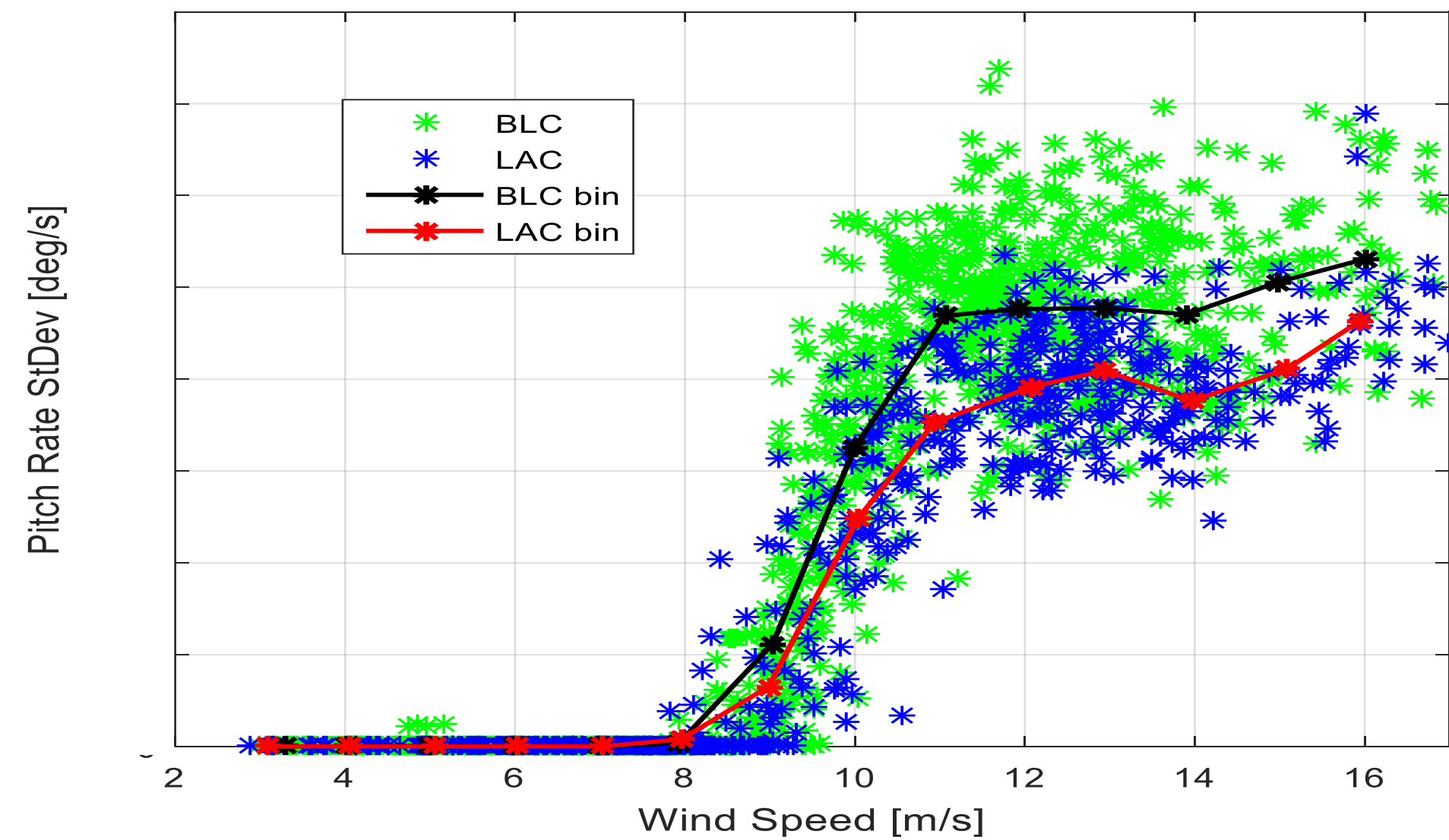
The main effects on fatigue and ultimate loads



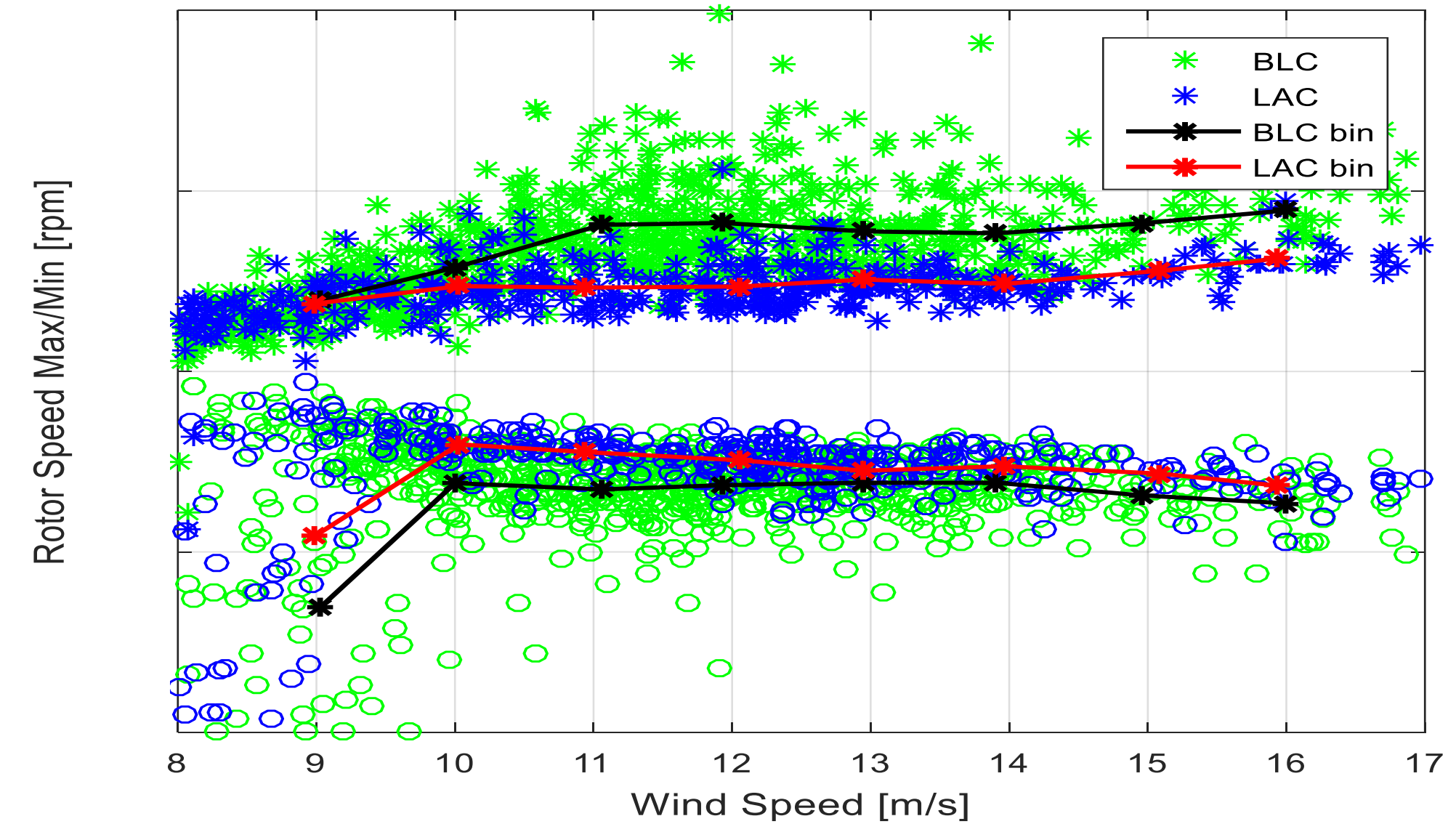
2.2 Stability Improvement



Reduce pitch fluctuation



Improve rotor speed stability



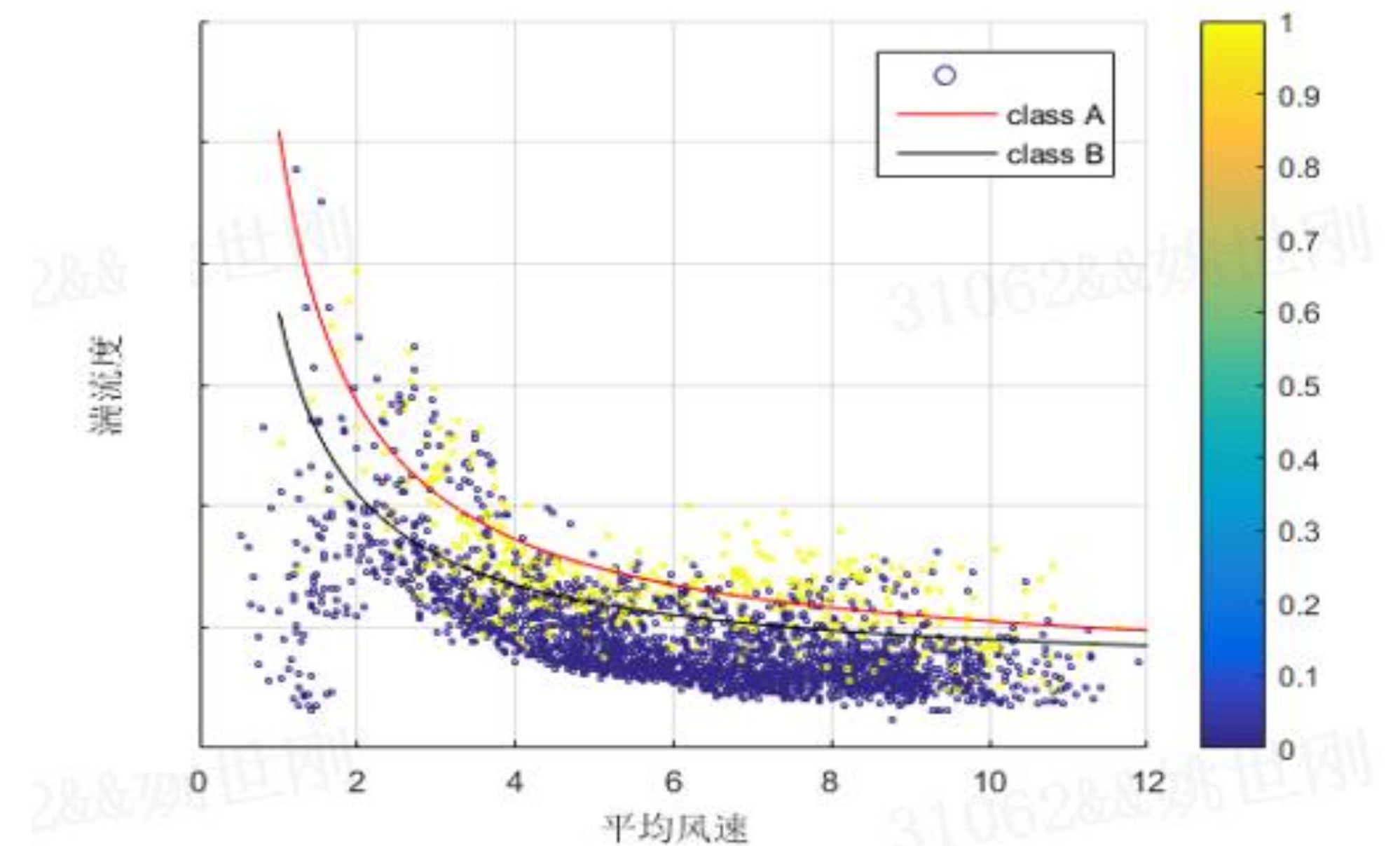
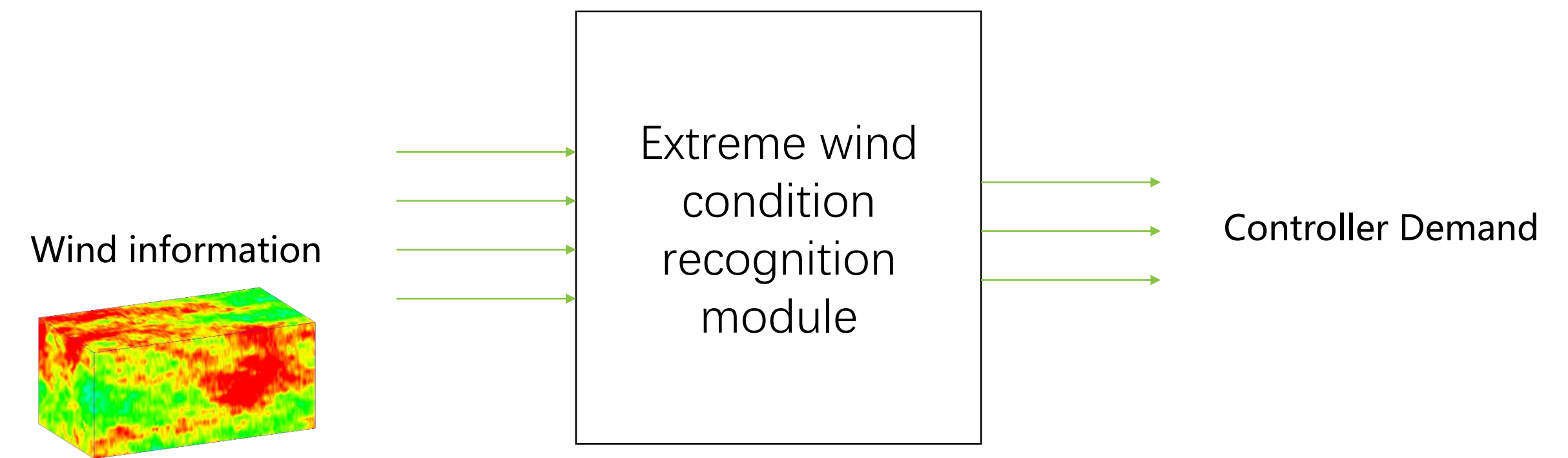
2.2 Stability Improvement



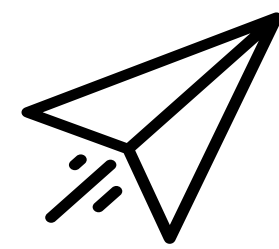
mountain terrain wind farms

Analyzing a large amount of data on mountain terrain wind farms, it was found that:

- ① The vibration of the wind turbine occurs mainly when high turbulence intensity occurs, near Class A turbulence intensity
- ② According to the analysis of Lidar wind measurement information, several typical wind speed characteristics are strongly correlated with vibration,



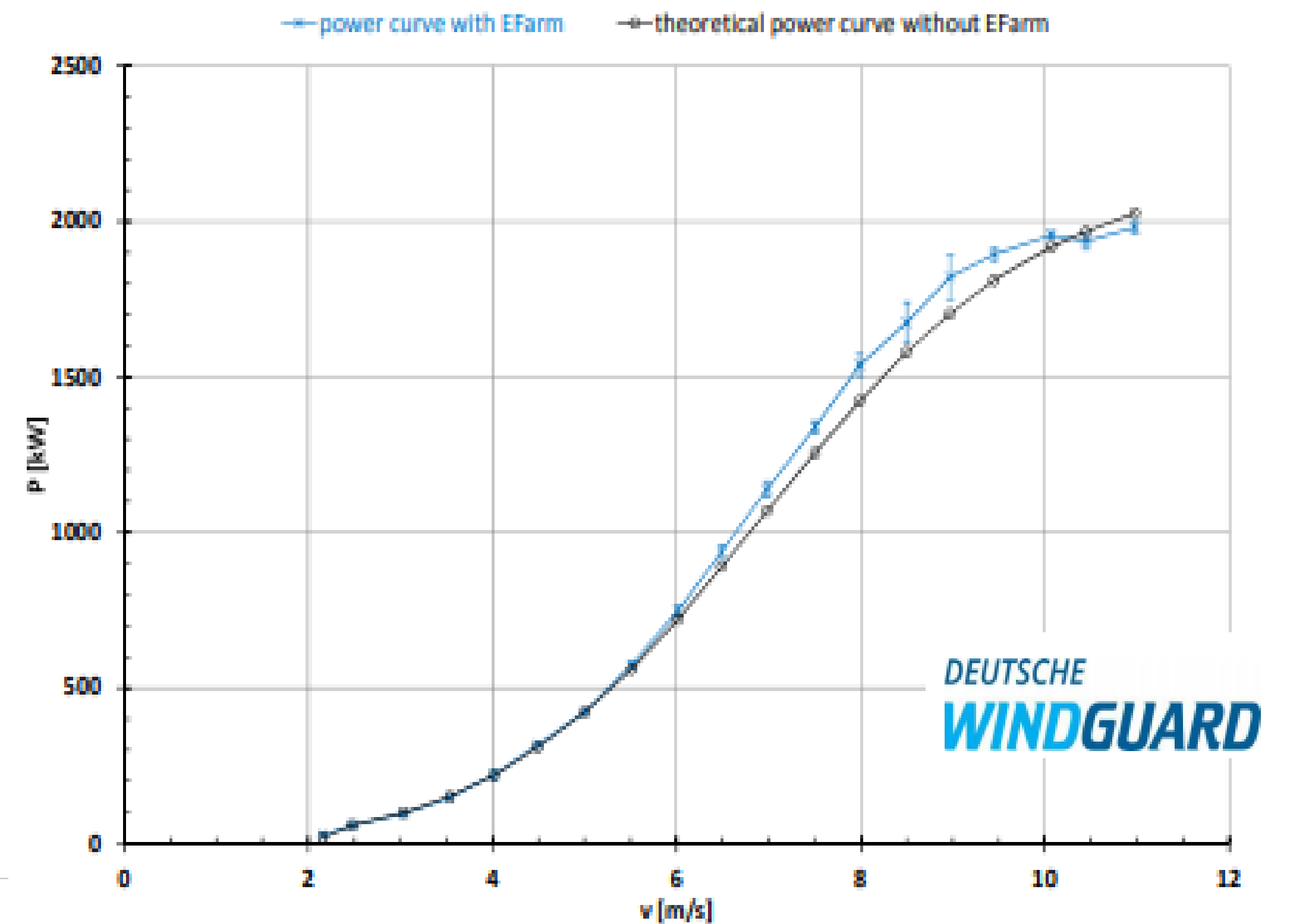
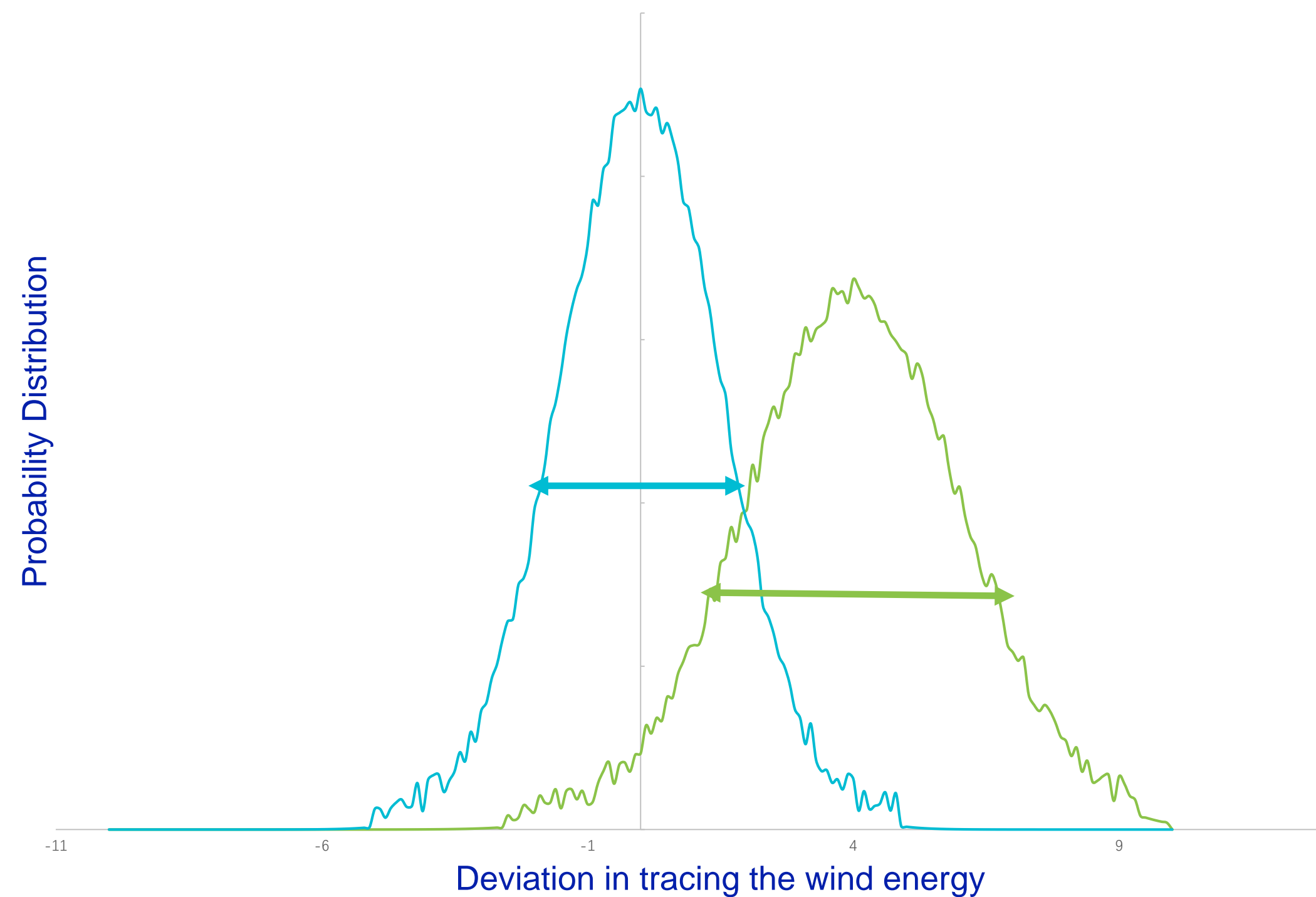
2.3 AEP Improvement



Energy Yield Increase

Reducing yaw misalignment, deviations of wind energy tracing, and minimizing the wind turbine downtimes caused by extreme wind conditions.

Reducing deviations in tracing the wind energy



3. Achieved so far

Start theoretical research and technology development

2012

2013

LiDAR Sensor Prototype test(2 beams)



2014

task 32 lidar

Lidar Assisted control development

2015

Prototype Test



2016

2nd generation LiDAR sensor (4 beams) development and Test



2017

DNV-GL certification



- Having acquired **DNV-GL technology qualification**
- Having acquired **DNV-GL component certificate**

Industrialization

2018

1000 turbines , around 3 GW

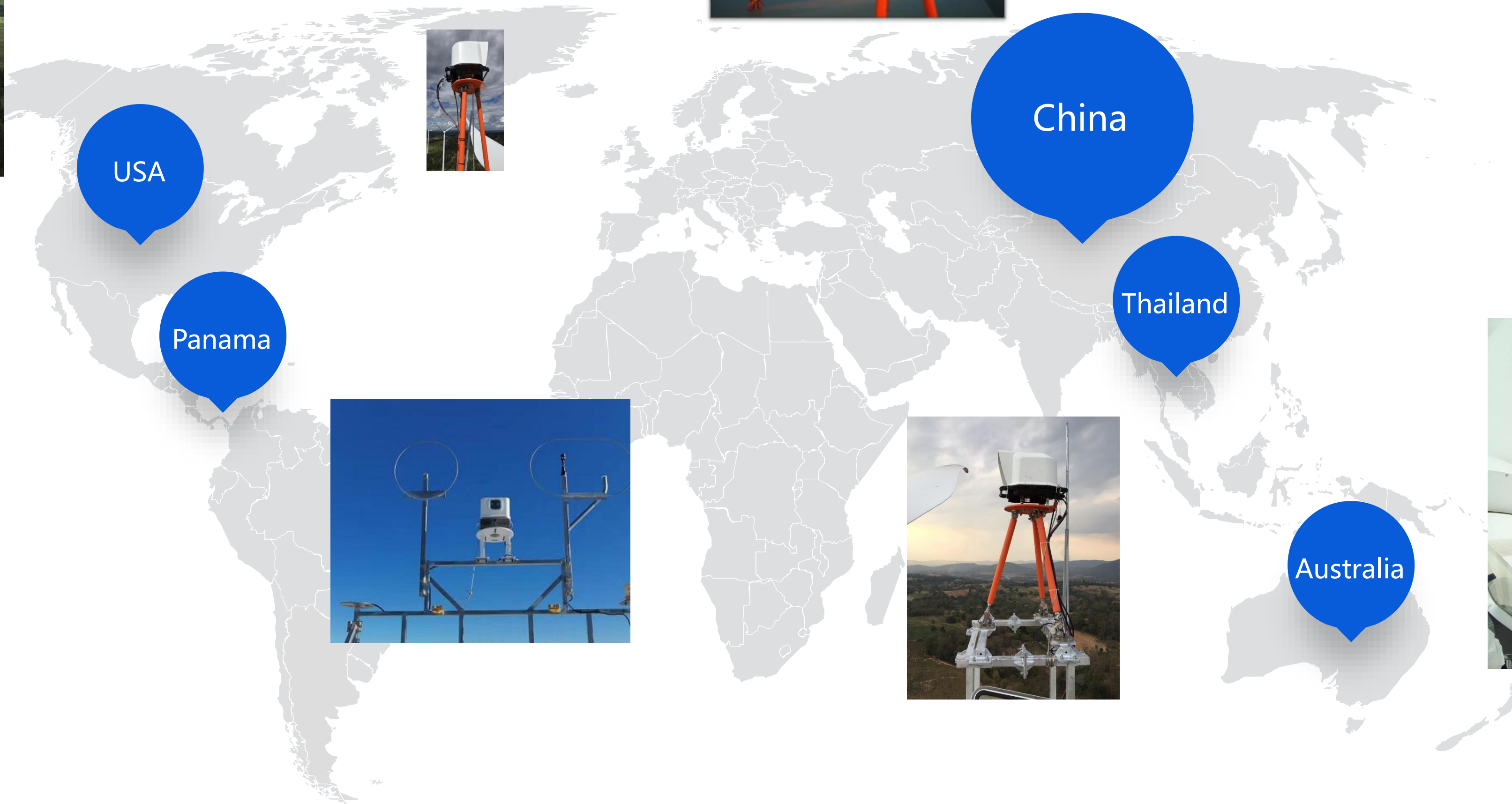
2021



2023

3000 turbines

3. Achieved so far



3000+ Wind turbines

5. Future possibilities

- More and more wind turbine with Lidar, and many Lidar measurement data.
- New technology ('2nd LAC'), like. Machine learning etc





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