Twin Test II

Giannis Chondromatidis
Research Assistant – Lab of Aerodynamics

TWEET-IE
Twin Wind tunnels for Energy & the EnvironmenT
INNOVATIONS - EXCELLENCE

POLITECNICO MILANO 1863
TU Delft

Agenda

1. Blind Test – Phase I Update
2. Power comparison: TUM vs NTUA
3. TWT2 – Publications
4. Blind Test – Phase II announcement

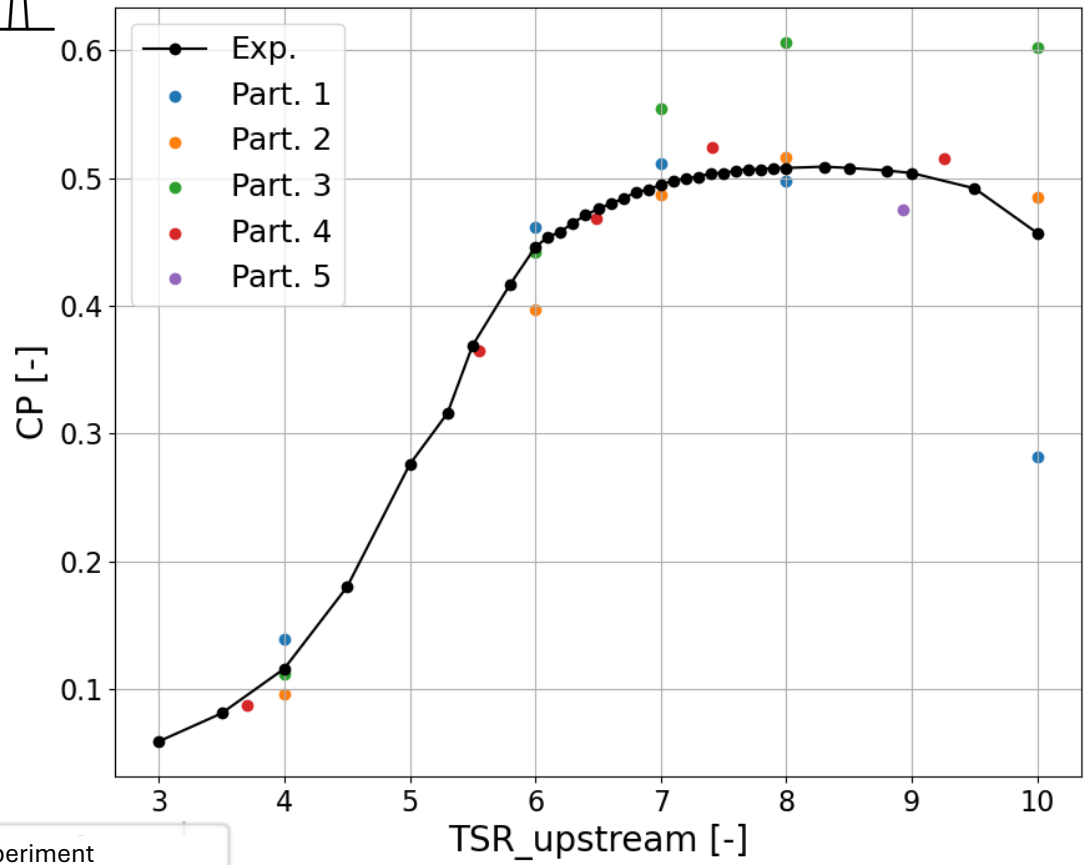
Blind Test – Participants

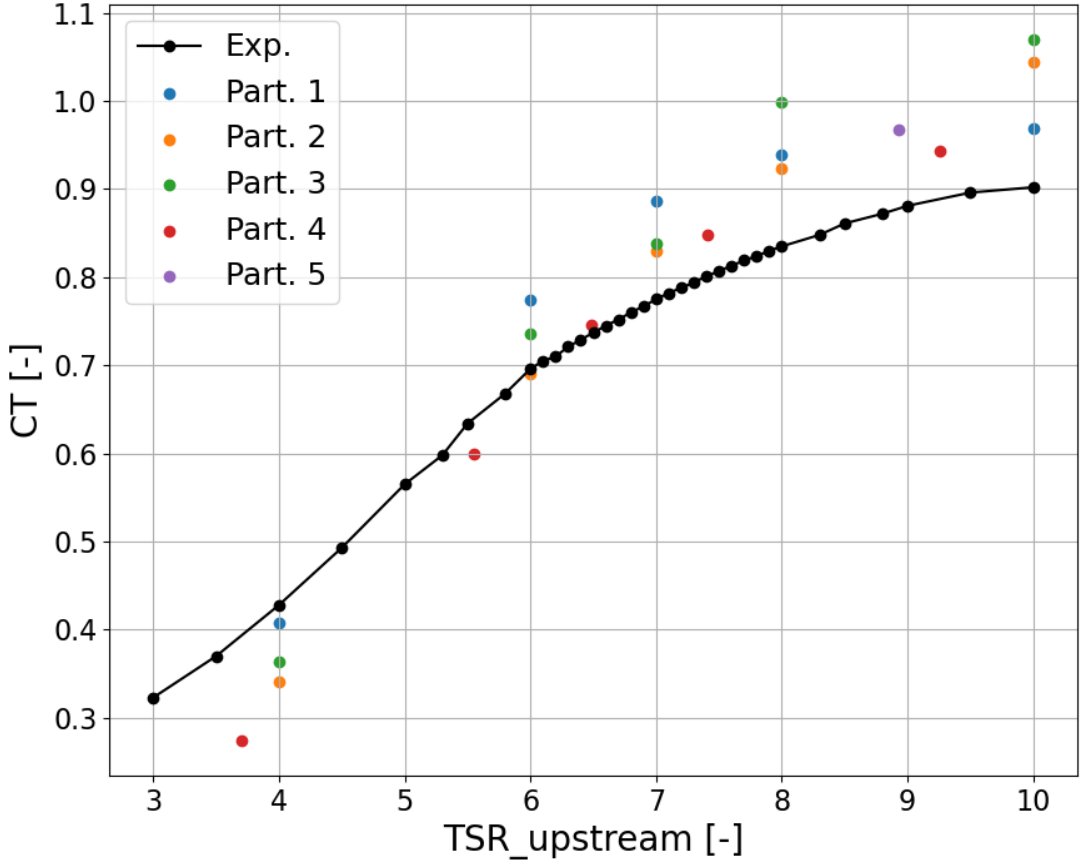
Participants	Simulation Type	Solver	Wall Modelling	Nacelle Modelling	Turbulence Model	Mesh	WT Modelling
1	BET	In-house	NO	NO	-	-	Free Vortex
2	URANS (compressible)	In-house	Viscous	NO	k-ω SST	8.5×10^6 unstr.	ALM (unknown)
3	LES (Incompressible)	Open-source	Inviscid	YES (wall functions)	Smagorinsky	20×10^6 unstr.	ALM (100 points)
4	LES (Incompressible)	In-house	Inviscid	No	Smagorinsky	120×10^6 unstr.	ALM (64 points)
5	LES (Incompressible)	Open-source	Inviscid	YES	Smagorinsky	28×10^6 unstr.	ALM (108 points)

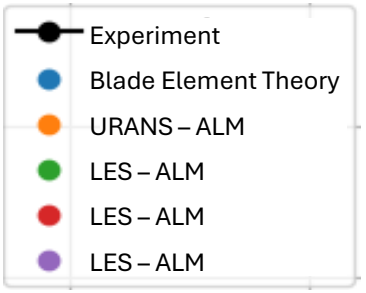
Phase I – Results (1)

Case 1 (Upstream WT var. Downstream fixed)

Upstream WT

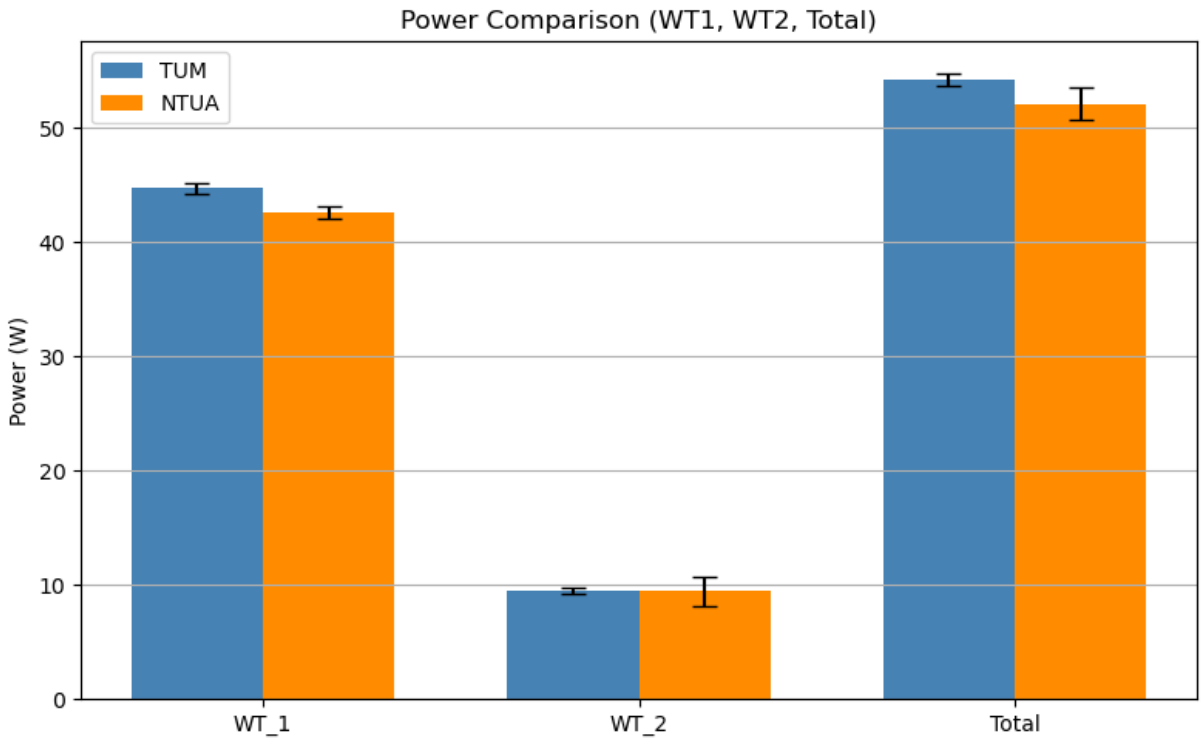


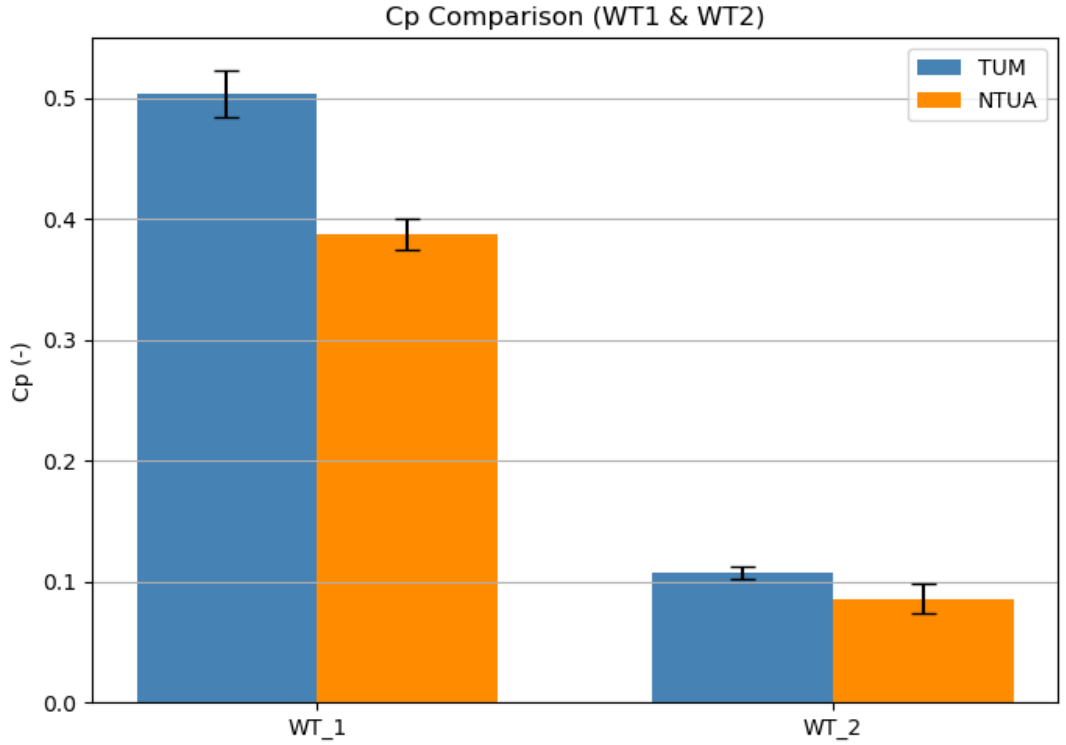




Power Difference TUM vs NTUA

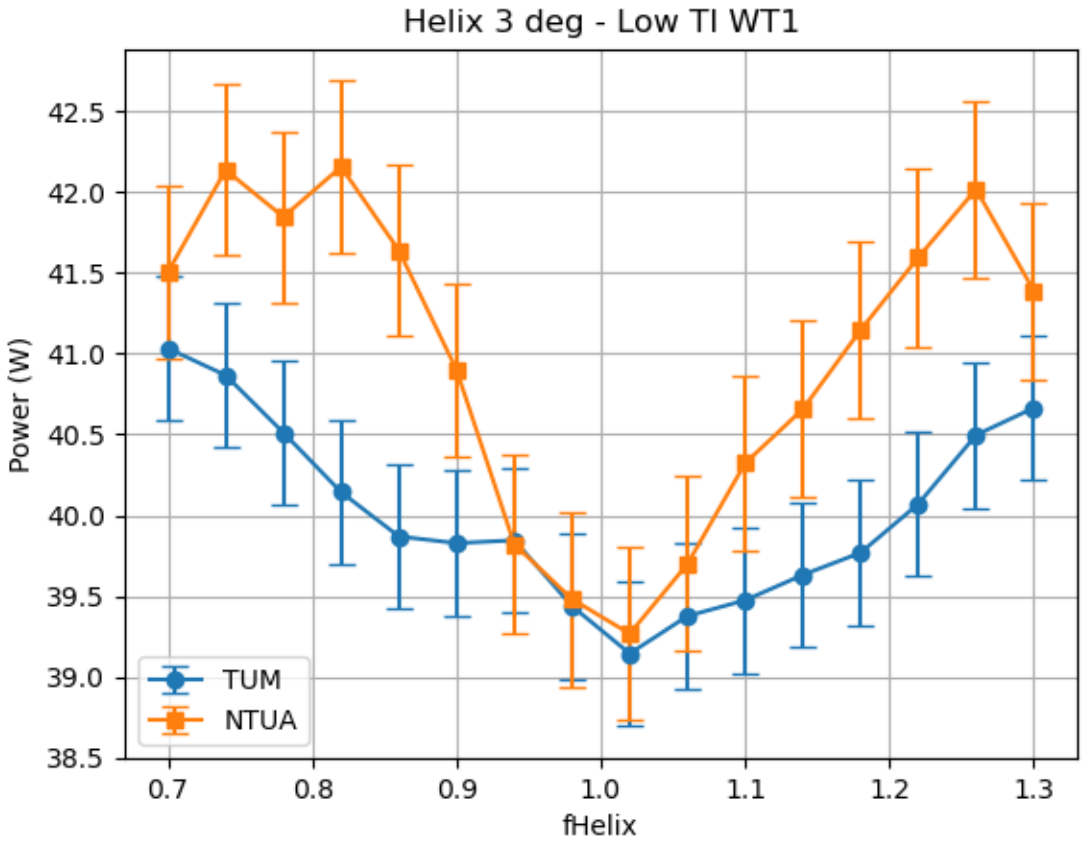
- Reference Power

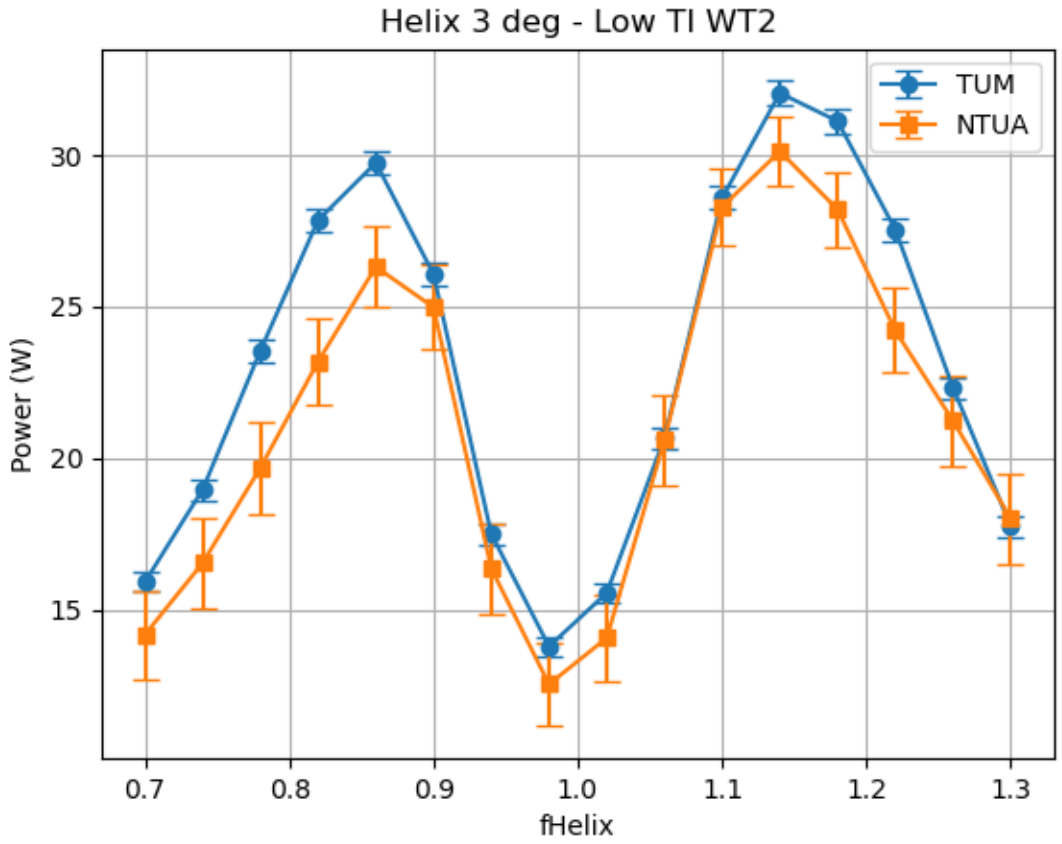




Power difference TUM vs NTUA – WT1 & 2

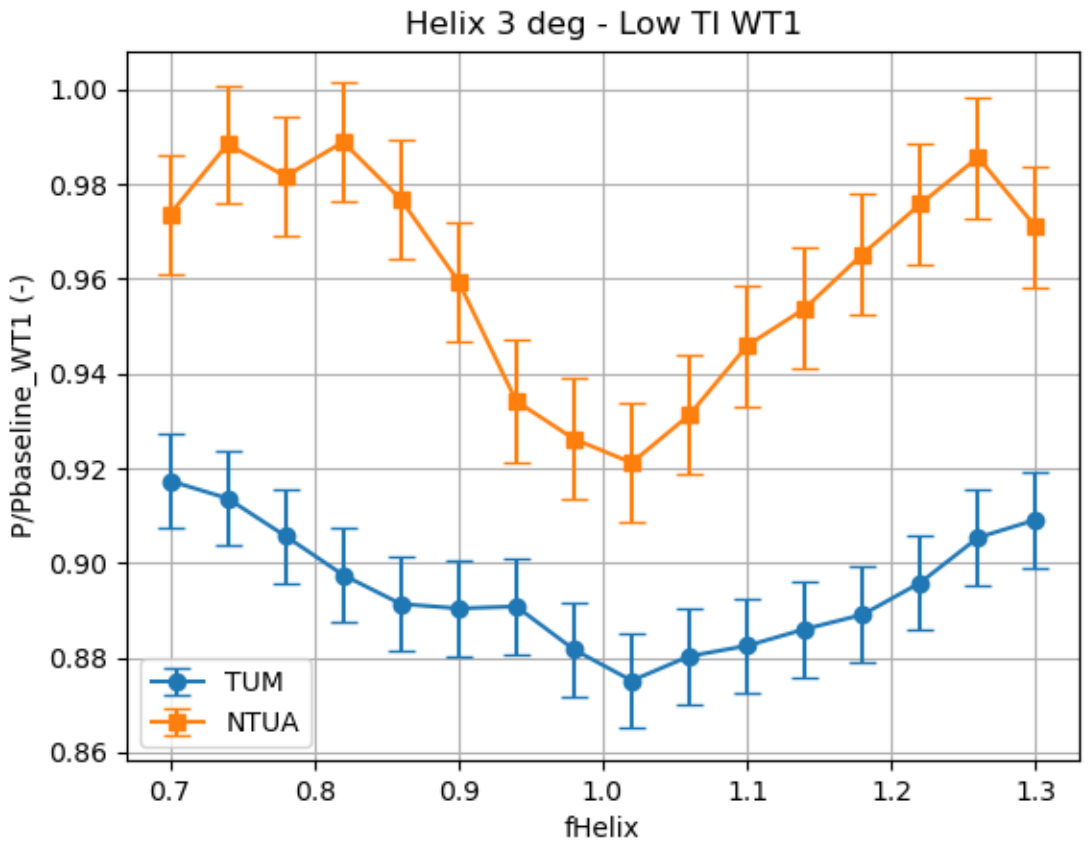
- Helix 3 deg – Low TI

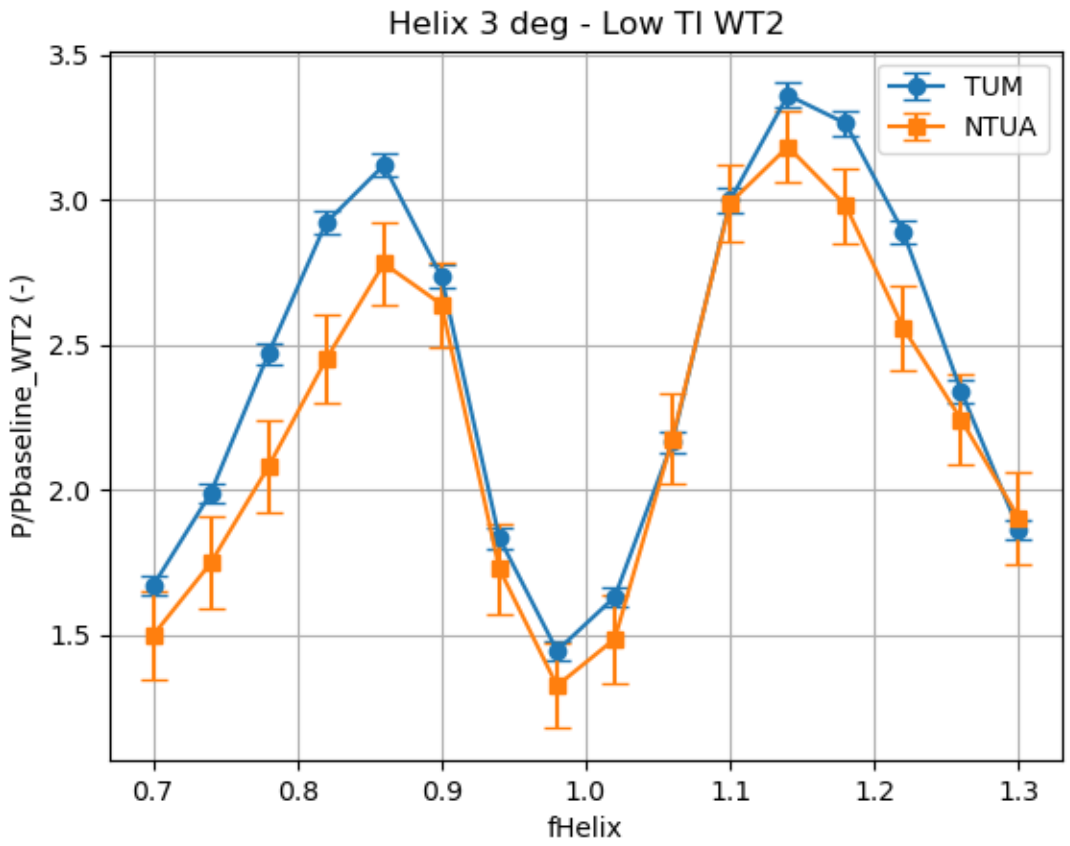




Normalized Power TUM vs NTUA – WT1 & 2

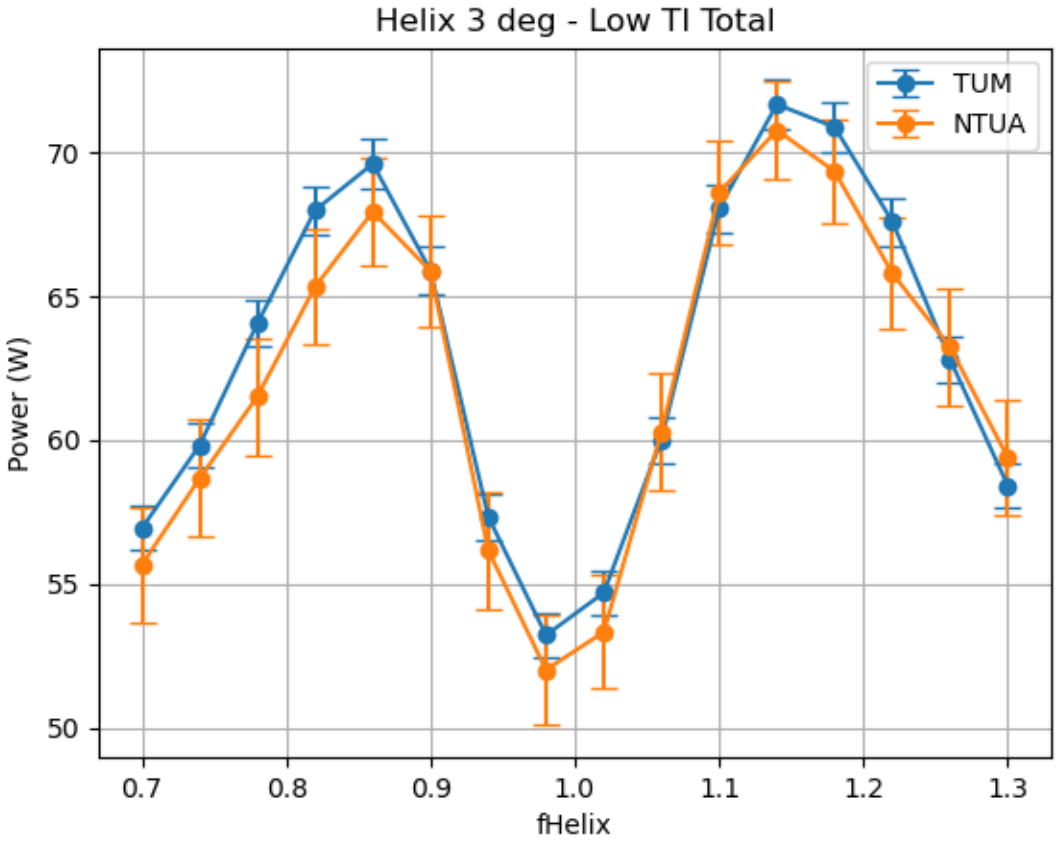
- Helix 3 deg – Low TI

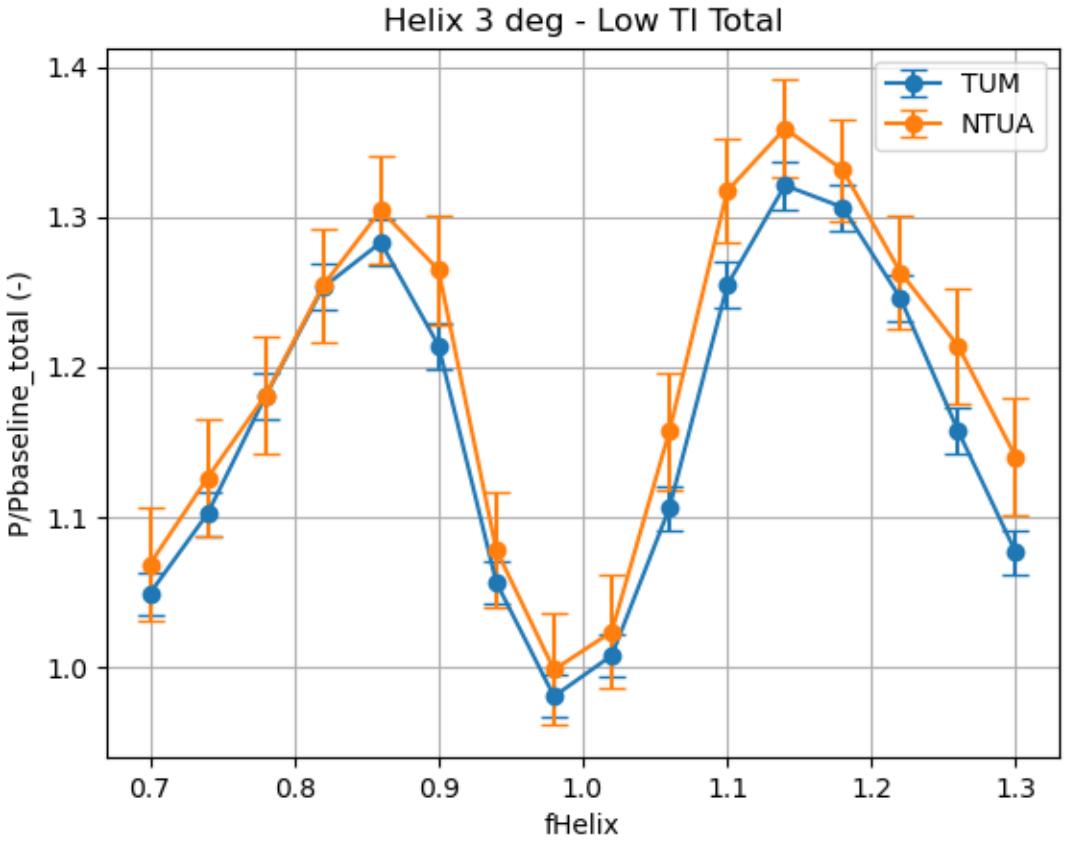




Power Comparison TUM vs NTUA – Total

- Helix 3 deg – Low TI





Blind Test – Publications

V. Pappa et al., “A blind test on wind turbine wake modelling based on wind tunnel experiments: Phase I – The benchmark case,”

J Phys Conf Ser, vol. 2767, no. 9, p. 092053, Jun. 2024, doi: 10.1088/1742-6596/2767/9/092053.

Wind Energy Science Conference – Nantes, June 2025
“A Blind Test on Wind Turbine Wake Modelling: Benchmark Results and Next Steps”

Status: Abstract submitted and accepted ✓

WAKE Conference – Uppsala, June 2025
“A blind test on wind turbine wake modelling: Benchmark results and Phase II announcement”

Status: Paper submitted and accepted ✓

Other:
Experimental investigation of the turbulence intensity effect on active wake control mechanisms

A blind test on wind turbine wake modelling: Benchmark results and Phase II announcement

I Chondromatidis[1], V Pappa[1], B S Dsouza[2], A Sciacchitano[2], S Tamaro[3], F V Mühle[3], F Campagnolo[3] and M Manolesos[1]

[1] School of Mechanical Engineering, National Technical University of Athens, Athens, Greece
[2] Aerospace Engineering, Delft University of Technology, Delft, the Netherlands
[3] Wind Energy Institute, Technical University of Munich, Munich, Germany

*E-mail: marinos@fluid.mech.ntua.gr

Abstract. Accurate modelling of wind turbine wakes is critical for optimizing wind farm performance, but the complexity of wake interactions poses significant challenges. This study presents a two-phase blind test campaign, part of the Horizon Europe TWEET-IE project, designed to benchmark numerical models and investigate wake control strategies using wind tunnel experiments. Conducted with tandem wind turbine models at the Technical University of Munich and the National Technical University of Athens, the tests include inflow, load, power, and wake velocity measurements under controlled conditions. Phase I serves as an open-data benchmarking exercise for a baseline scenario without wake control, while Phase II introduces active individual blade pitch control to the upstream turbine, challenging participants to simulate advanced wake dynamics. This paper reviews Phase I results and details the experimental framework for Phase II, providing a foundation for advancing wake modelling and control in wind energy research.

1. Introduction

As the wind energy industry continues to grow, optimizing wind farm design and operation becomes increasingly important. Accurate modelling of wind turbine wakes is a key aspect, as these wakes and their interactions significantly influence energy production, turbine placement, and operational strategies. However, capturing the complexity of turbine wakes remains a challenging task due to the intricate interplay between wake dynamics, atmospheric boundary layer behaviour, and wind farm configurations [1]. Additionally, implementing effective wake control strategies can dramatically enhance a wind farm's energy output while reducing the levelized cost of energy, thereby improving the financial viability of wind energy projects. Achieving these outcomes relies on precise wake modelling to identify optimal control methods and operational practices [2].

Building on these challenges, the present paper expands upon previous work [3], where a two-phase blind test study was designed to advance the field of wake modelling. The blind test initiative aims at enhancing wake modelling accuracy by benchmarking numerical models against open experimental data, improving confidence in wake modelling methodologies. Initially introduced at the TORQUE 2024 conference, the blind test seeks to evaluate numerical

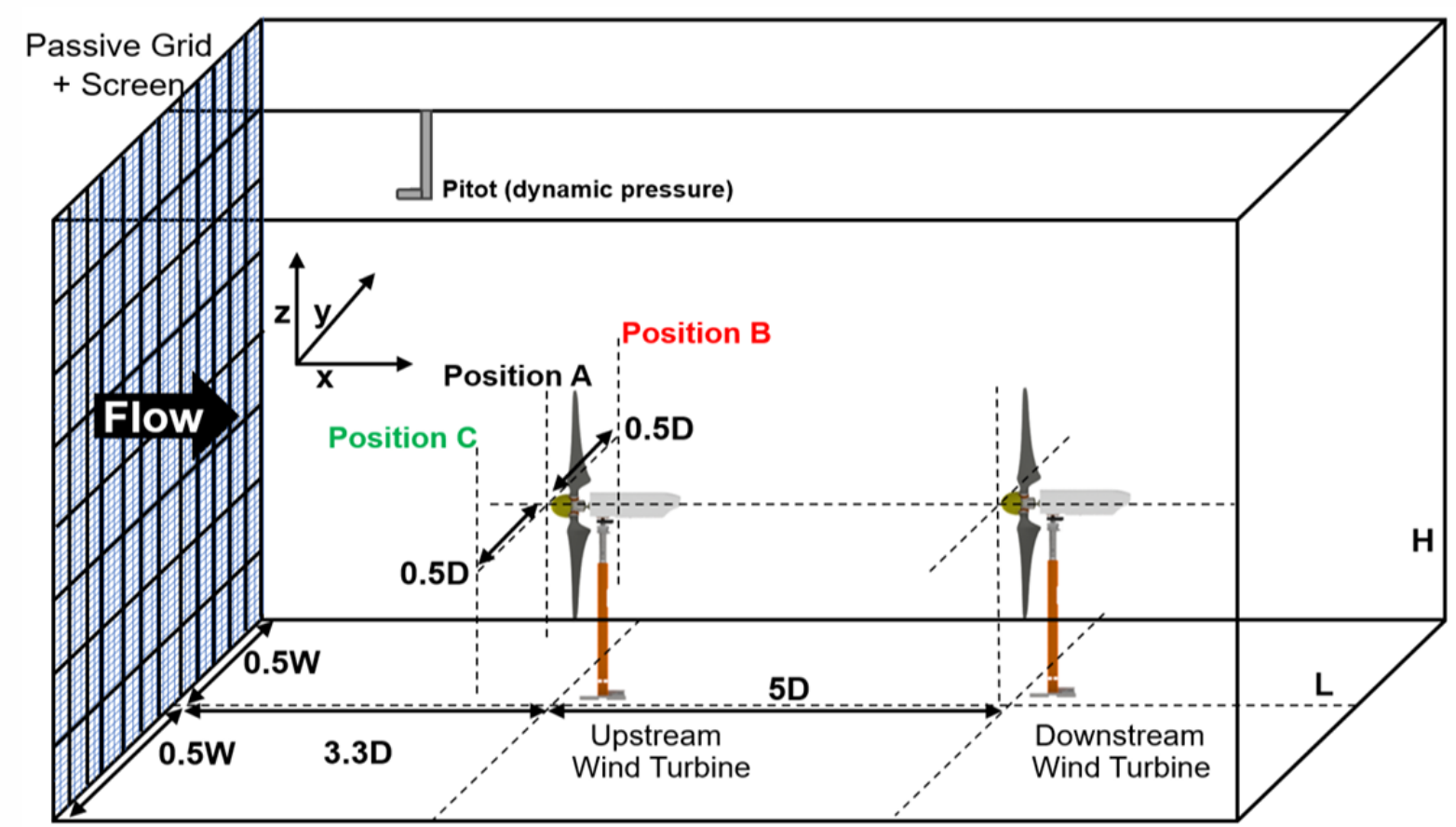
Blind Test – Phase II

Experiments conducted at NTUA

2 aligned G1 WTs placed 5D apart

Low and High Turbulence Intensity

Particle Tracking Velocimetry



Case 1
Both WTs

UWT @ 850 RPM
DWT @ 531 RPM
Baseline scenario

Case 2
Both WTs

DWT auto RPM
UWT fixed RPM - variable
$f_{helix} \in [0.7, 1.3]$

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Thank you for your attention!

Acknowledgements

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National Technical University of Athens
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KIT Karlsruhe Institute of Technology
TU Delft Delft University of Technology
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