The UK Turbulence Consortium

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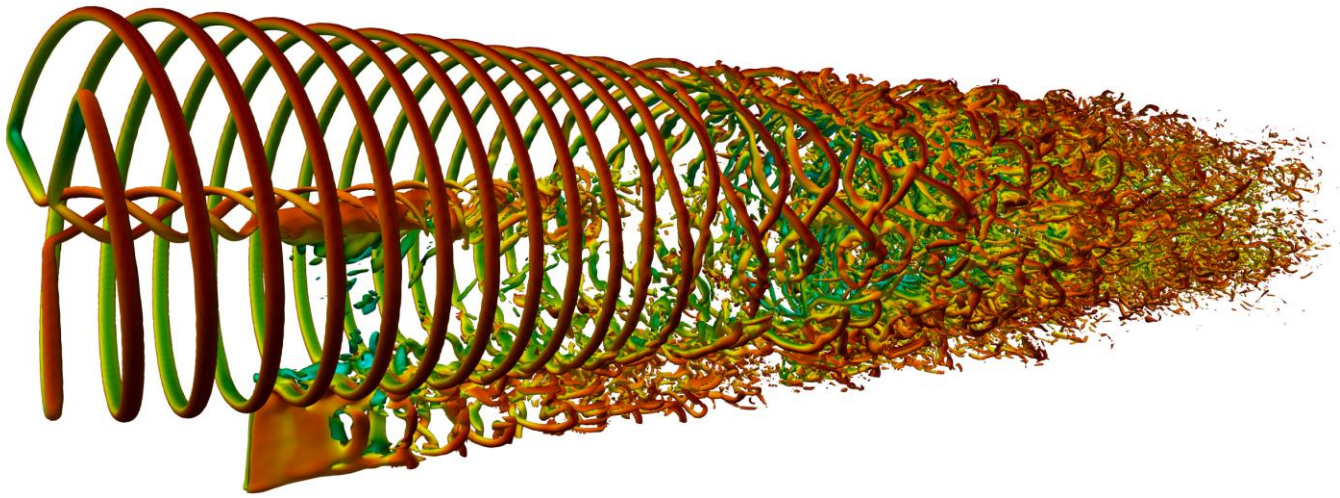
UK TURBULENCE CONSORTIUM



Turbulence

”Turbulence is the most important unsolved problem of classical physics”
Richard Feynman








UK Turbulence Consortium

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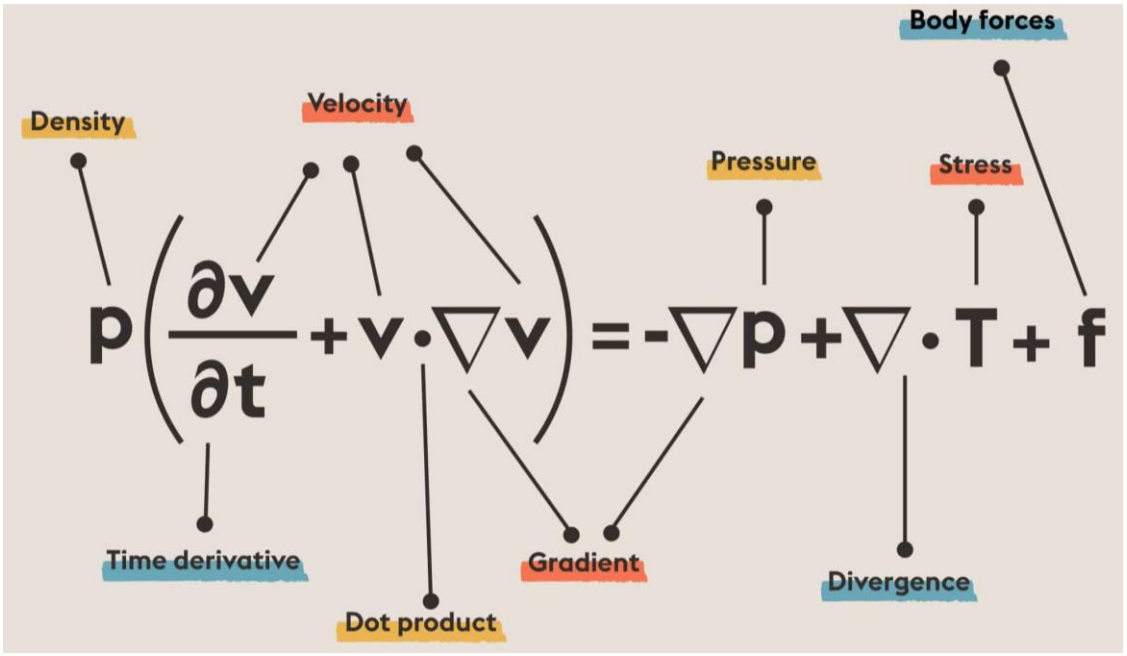

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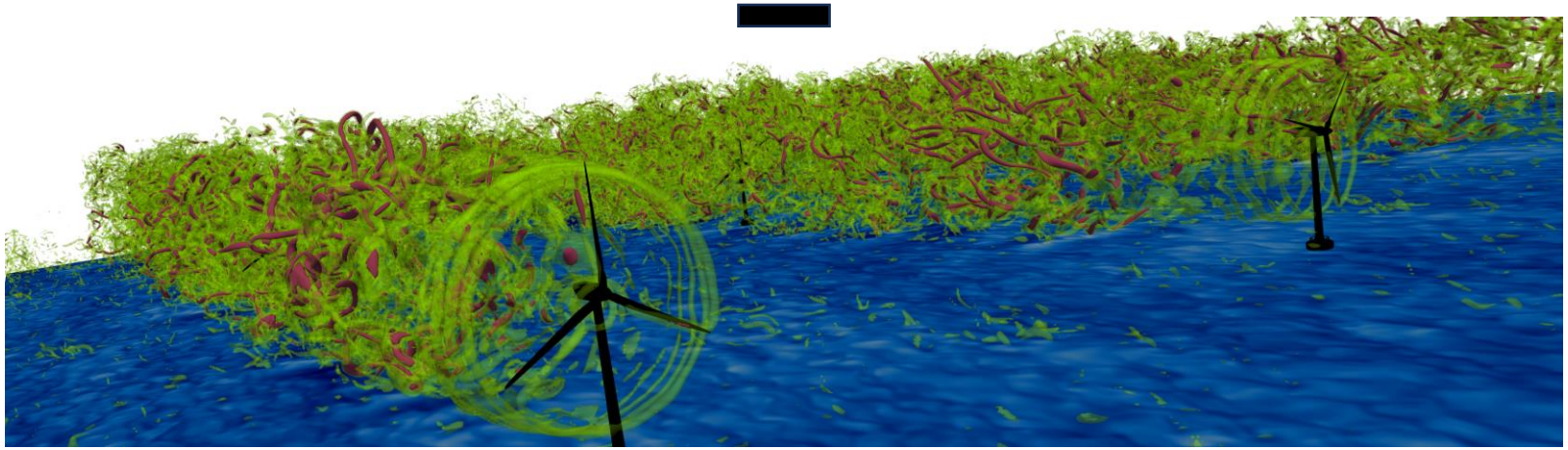
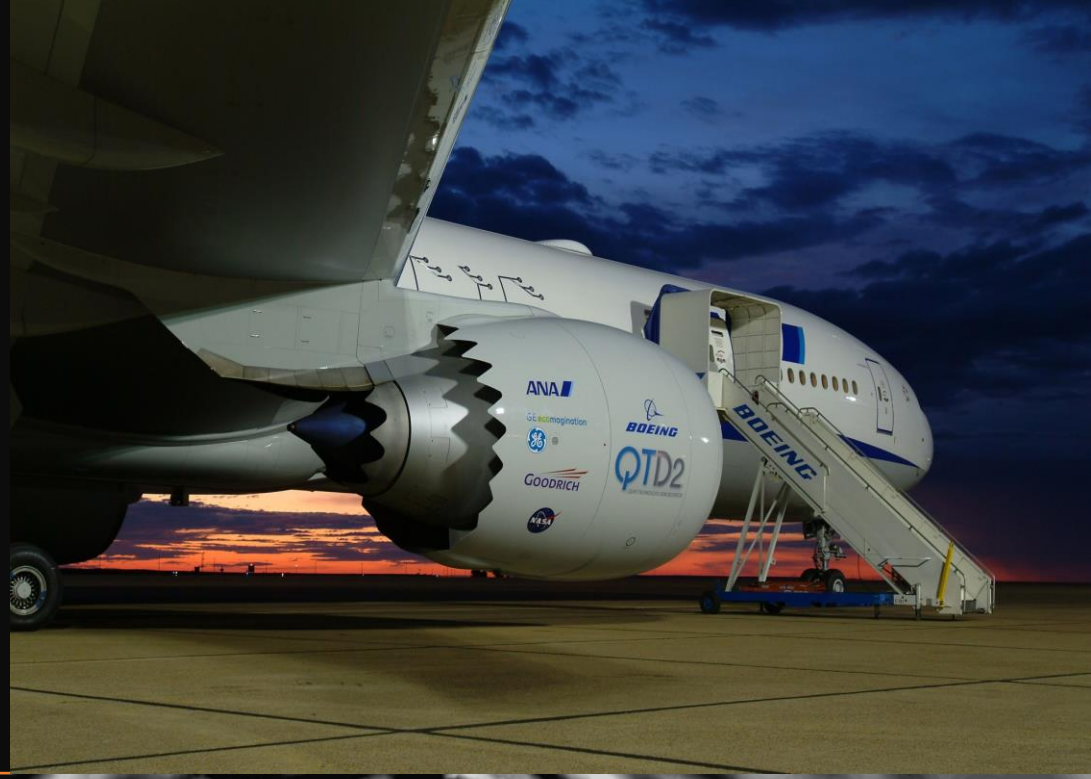
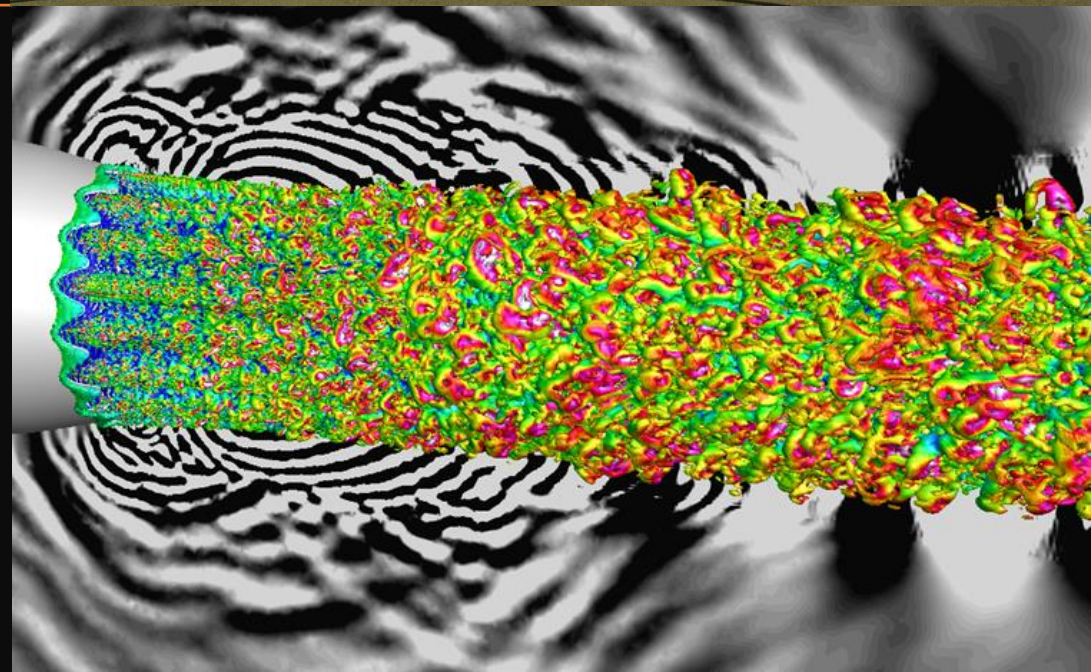


Aeroacoustics



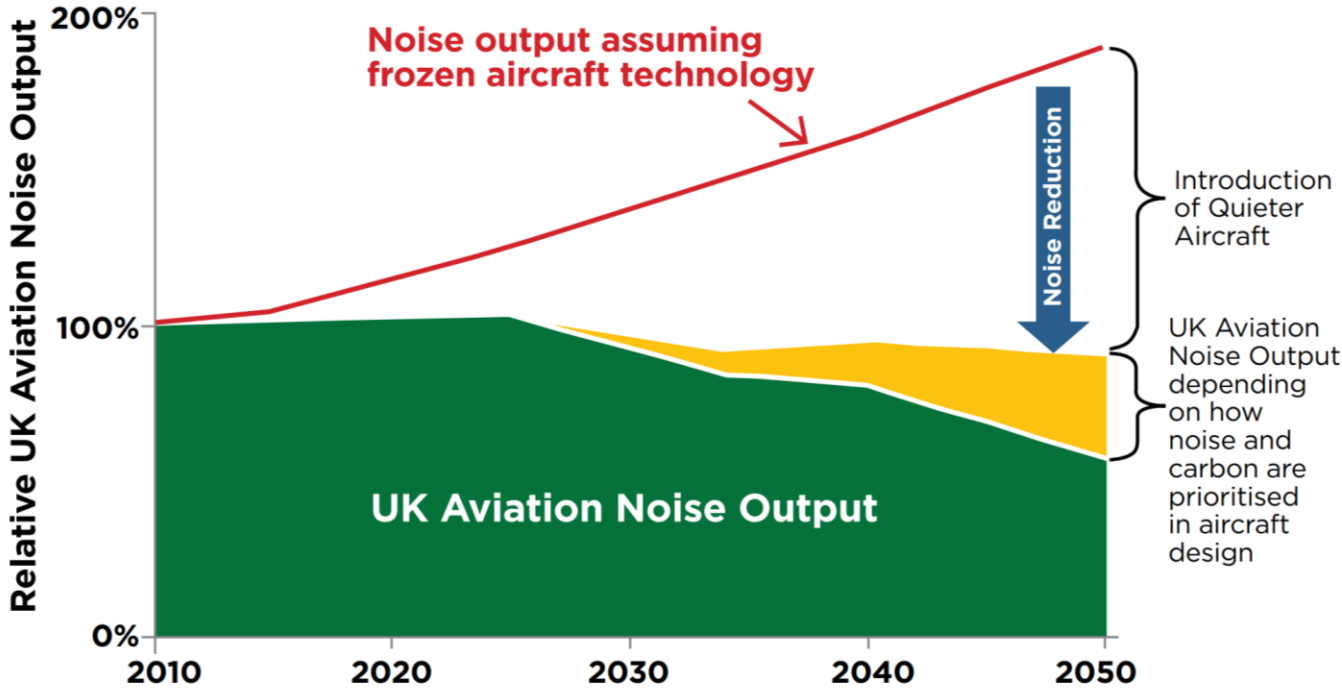


Aeroacoustics

	2000	2014	2050
Plane Passengers	1.5 billion	3 billion	16 billion
Freight/Cargo	17 million tonnes	46 million tonnes	400 million tonnes
Impact climate change	2%	3.5%	15%
Impacted people Noise (UK)	1 million	1.5 million	-

UK Aviation Noise Output

(Not Airport Specific)

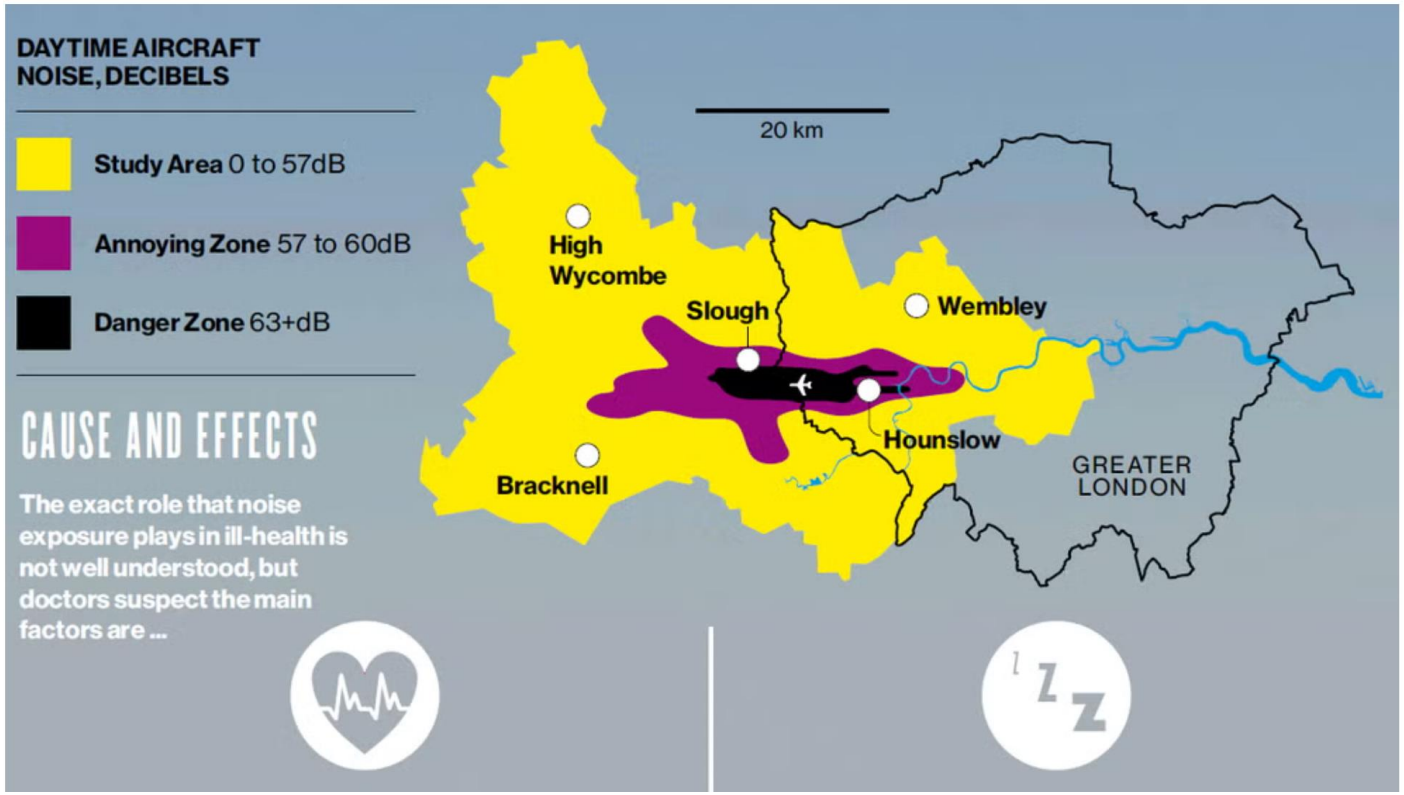


Aeroacoustics

Why living near an airport could be bad for your health

Studies reveal link between areas with high noise pollution and an increased risk of heart disease and stroke among residents

Charlie Cooper • Tuesday 08 October 2013 21:34 BST • Comments



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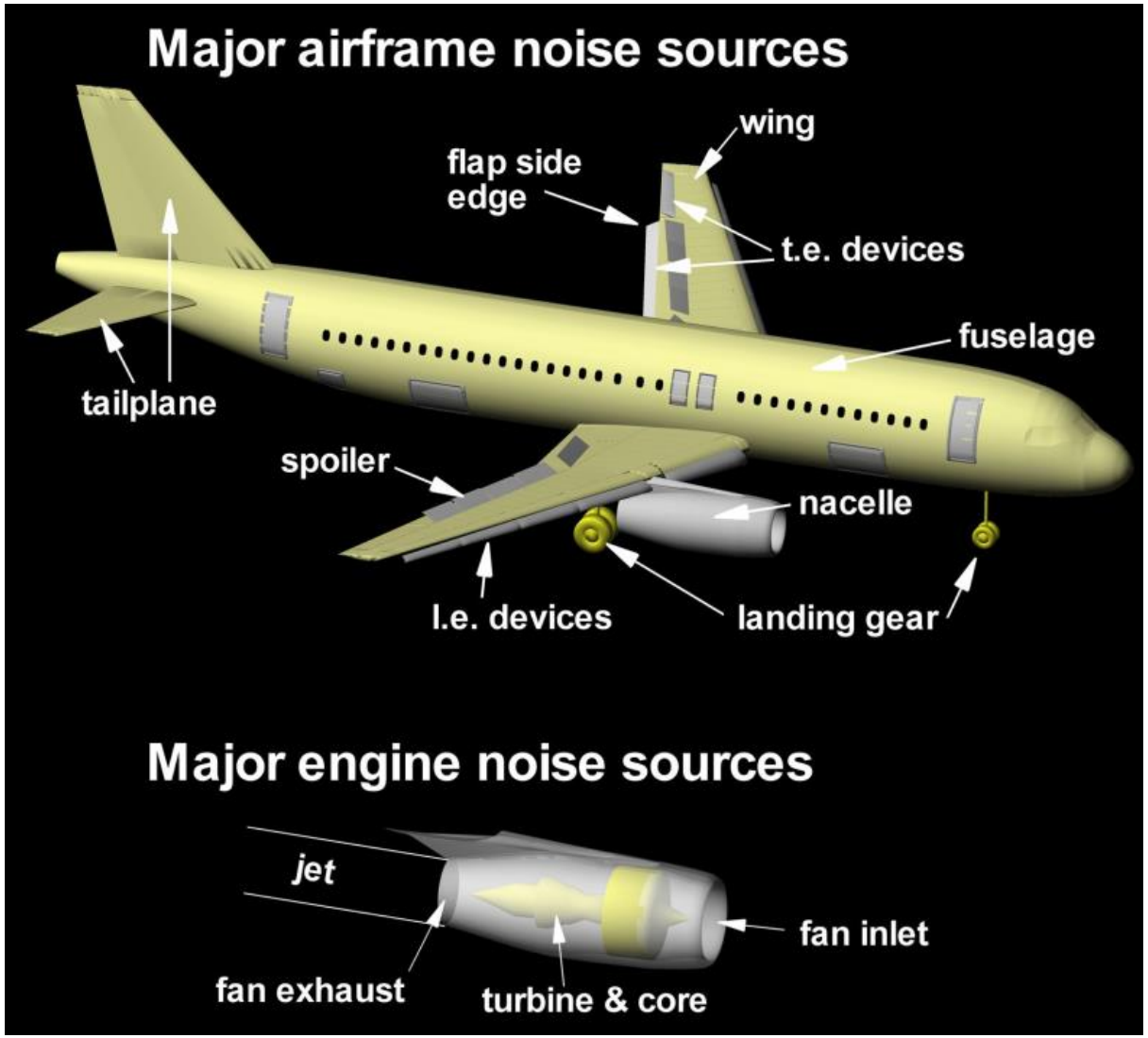

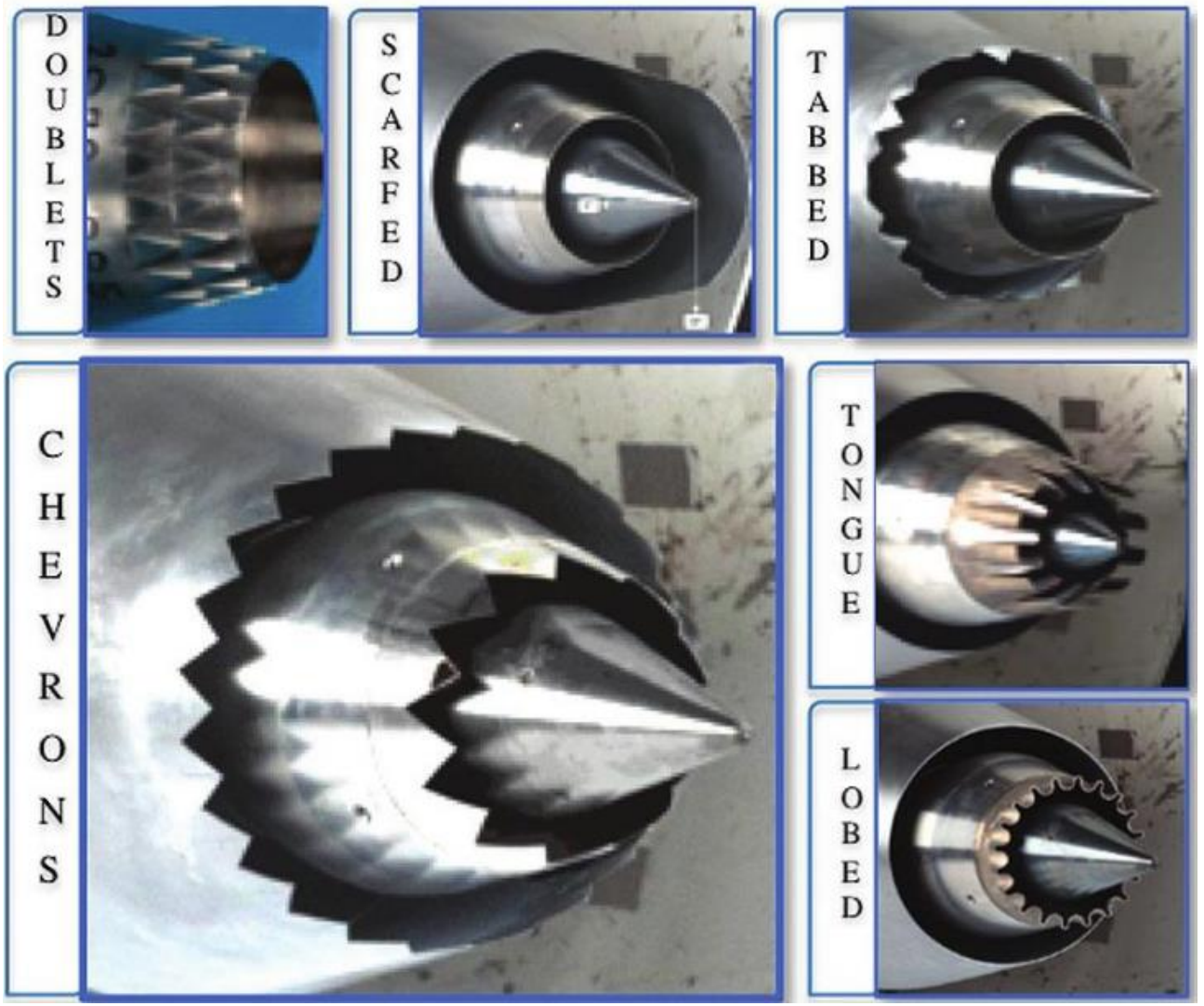

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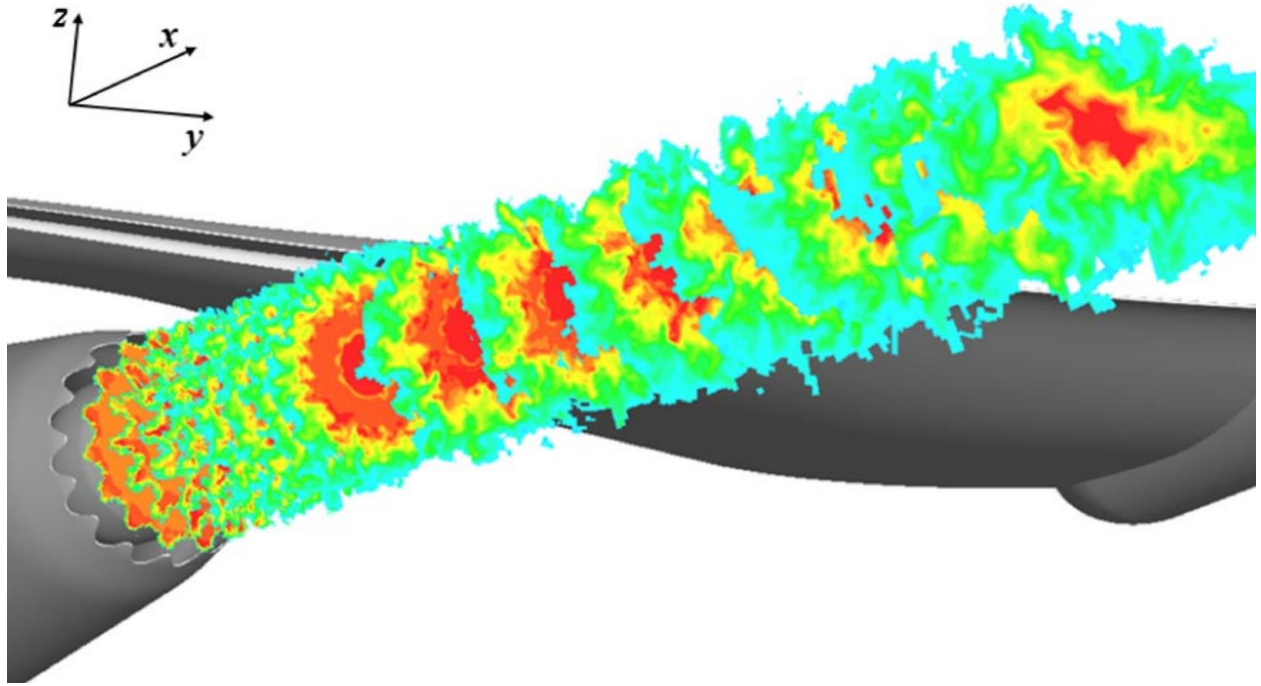

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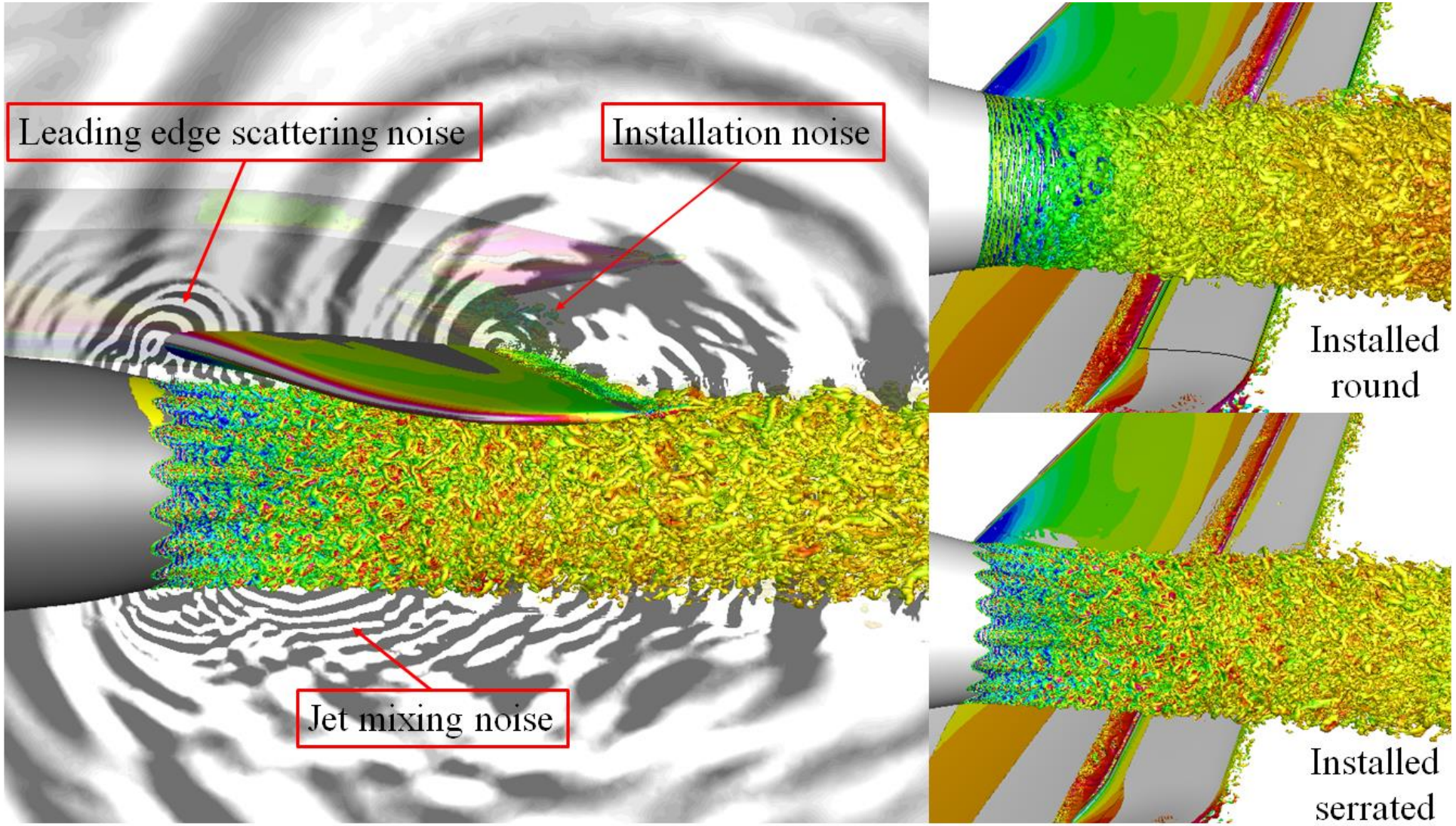

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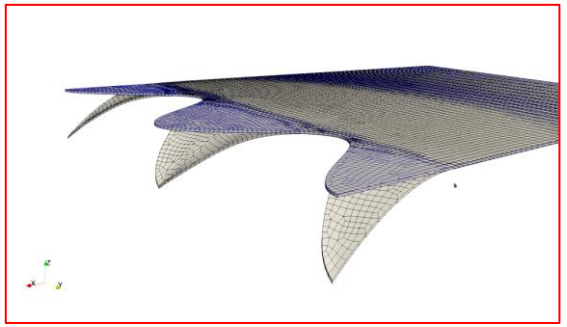
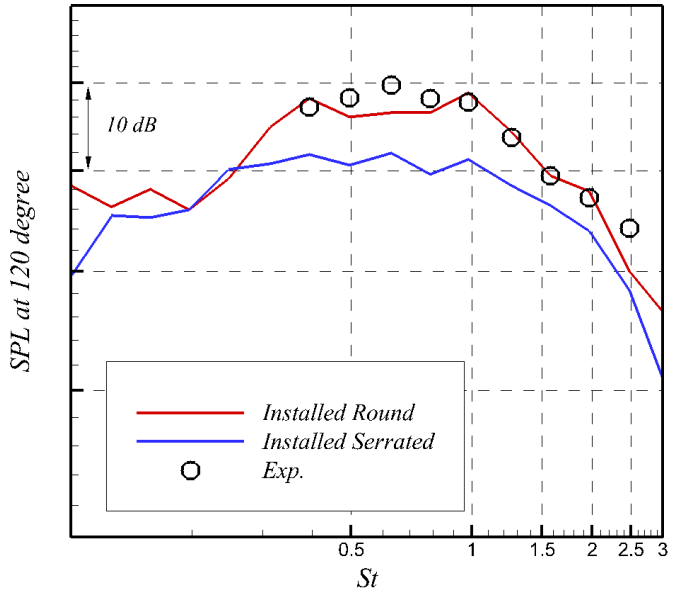
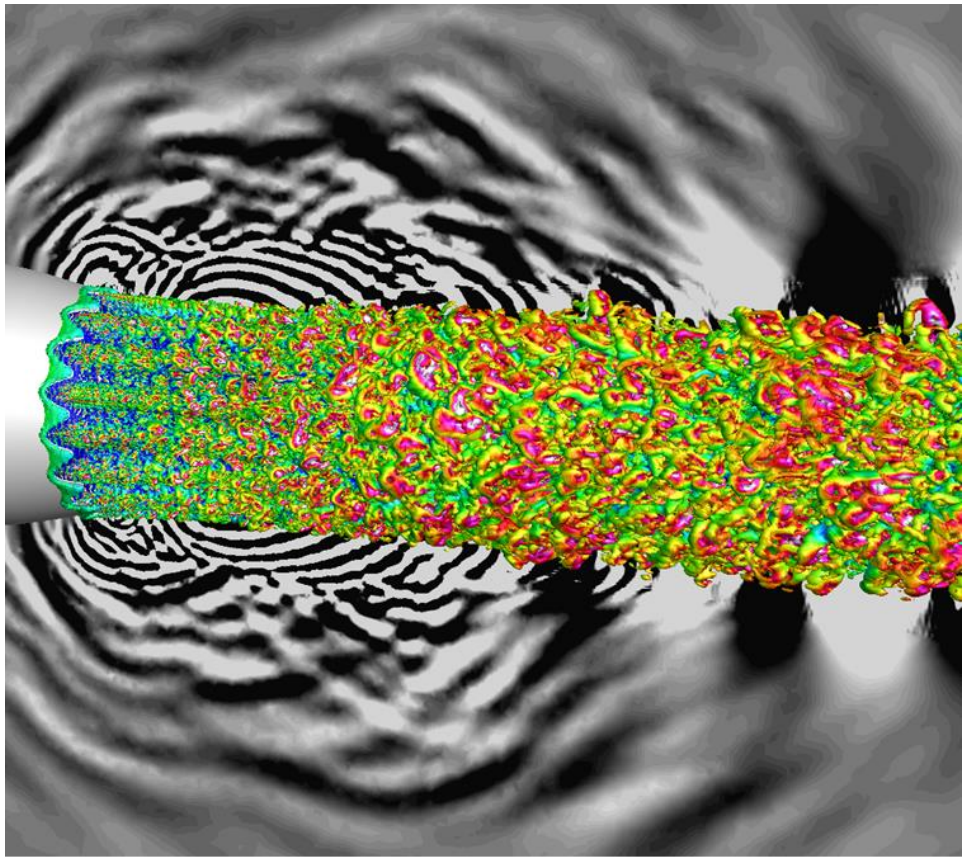
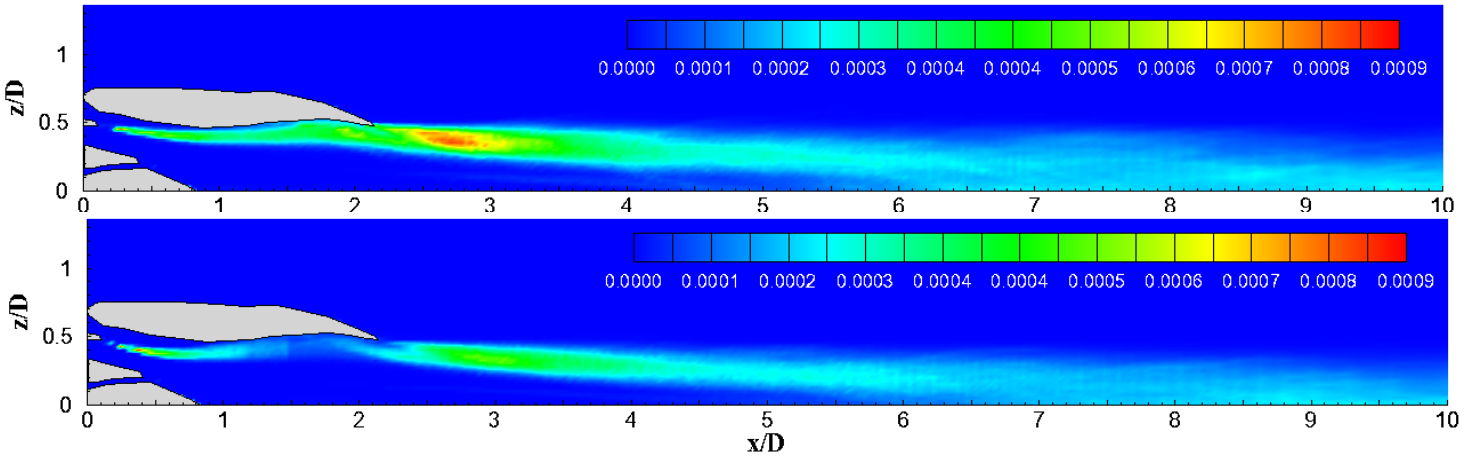


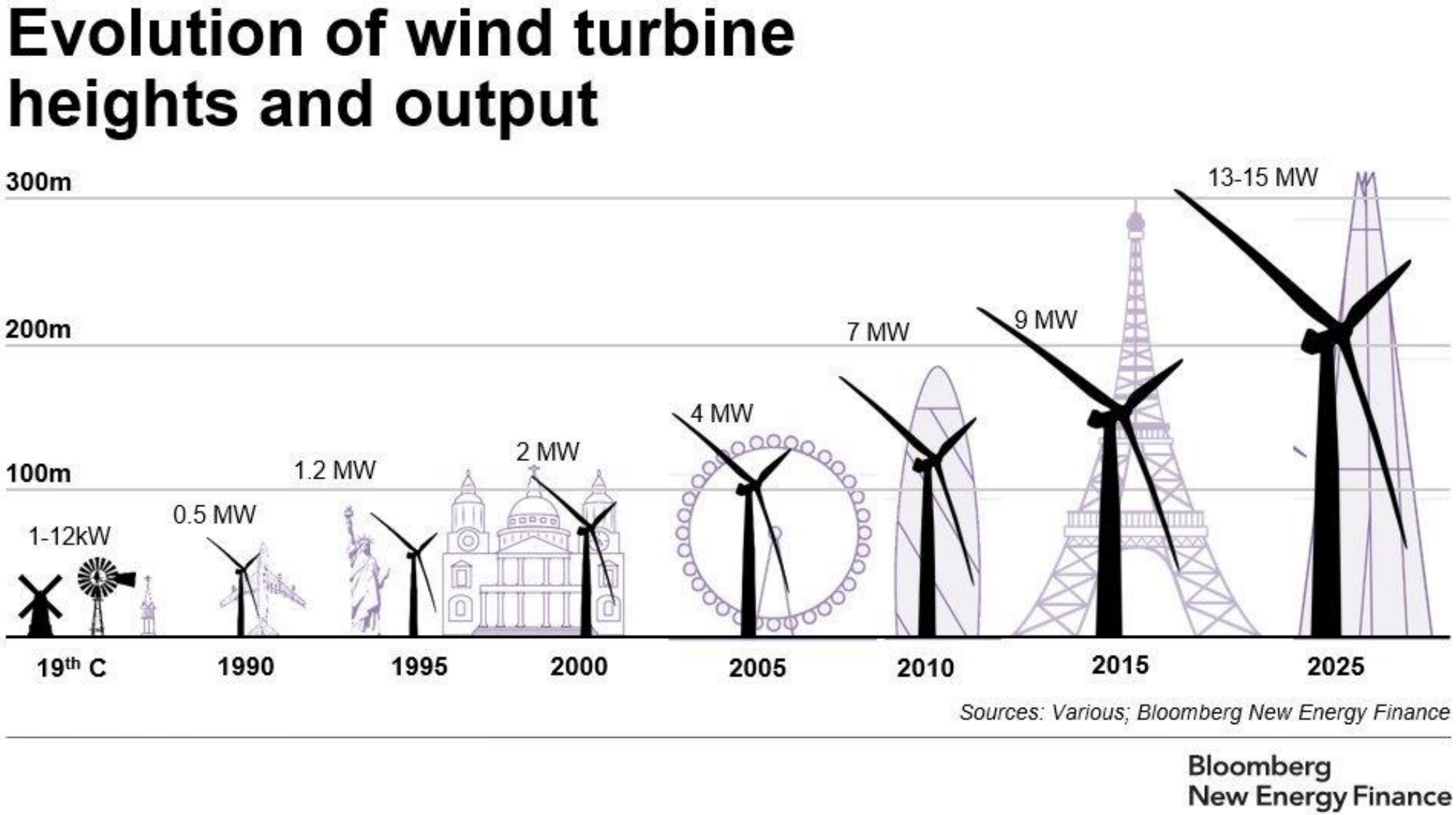






Control Wind Farms

Control Wind Farms



Control Wind Farms

A wind turbine in China has set a new world record for the most amount of electricity generated in a single day, after operating during typhoon conditions.

The Goldwind GWH252-16MW turbine, which was installed at an offshore wind farm in Fujian Province in June, produced 384.1 megawatt hours in a single day – enough to power roughly 170,000 homes.

The record was achieved on 1 September, according to state-owned power company China Three Gorges (CTG), surpassing the previous record set by Danish company Vestas in August.

Hornsea 2 Offshore Wind Farm

Powering over 1.4 million homes with green energy

Hornsea 2, located in the North Sea next to its sister project Hornsea 1, generates enough green energy to power over 1.4 million UK homes. As the world's largest offshore wind farm, it covers an area of 462 square kilometres (178 square miles).

1.32 GW
Total capacity

165
8 MW wind turbines

89 km
Distance from the Yorkshire coast

Mingyang presents 22-MW offshore wind turbine concept

MingYang wind turbine. Image by: Ming Yang Smart Energy Group @LinkedIn.

Chinese wind turbine manufacturer Ming Yang Smart Energy Group Ltd (SHA:601615) has presented a 22-MW offshore wind turbine model, the MySE 22MW, said to be the world's most powerful offshore turbine unveiled so far.

The model was presented at the China Wind Power 2023 last week and is "set for development between 2024 and 2025," according to a social media post by the company.

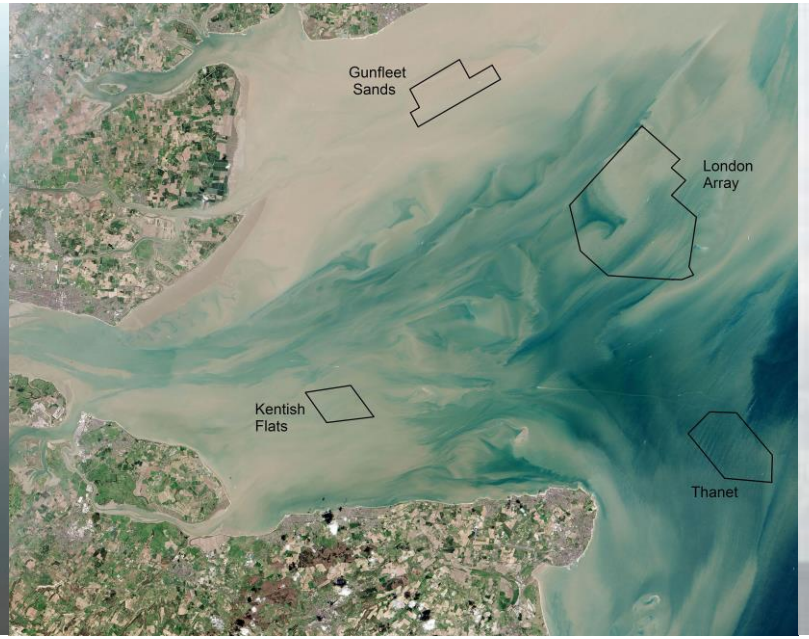
The giant turbine will have a rotor of over 310 metres and will be intended for high-wind regions. It will be suitable for both fixed-bottom and floating applications.

The news follows the presentation of the MySE 18.X-28X model in January.

The MySE 22MW was unveiled together with a large onshore wind turbine, the MySE 11-233, which is now in production at Mingyang's Inner Mongolia base. The company said this machine is tailored for the challenging conditions of desert and Gobi regions. With rotor diameters ranging from 233 to 243 meters and tower heights from 130 to 200 meters.

Control Wind Farms

- London Array: 175 wind turbines, 3.6 MW each, total 630 MW, can provide electricity for 500,000 homes [in theory]
- Capacity factor (actual output divided by the theoretical capacity): ~45%
- Increased capacity of 50 MW by wake steering → 40,000 more homes



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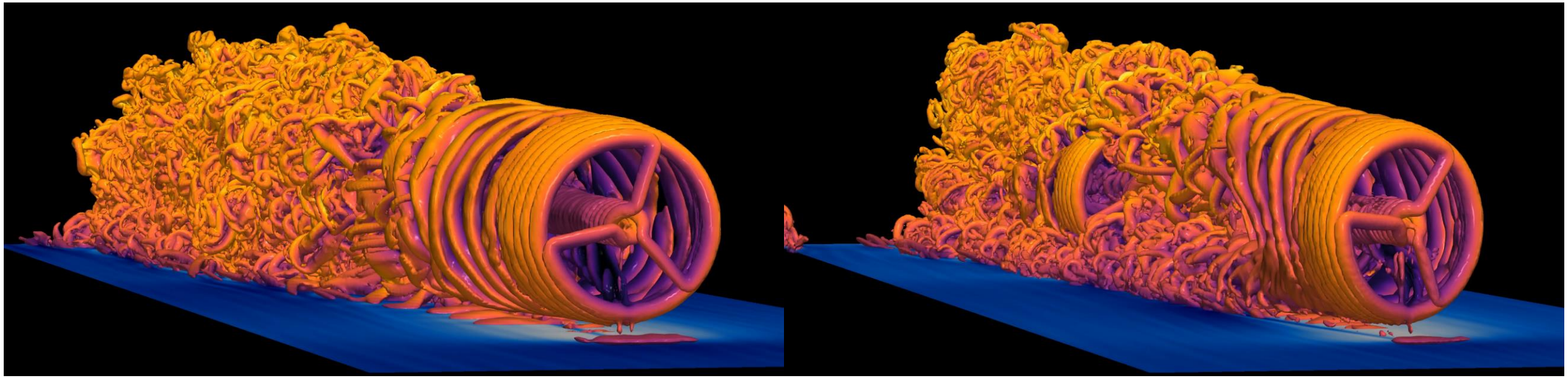
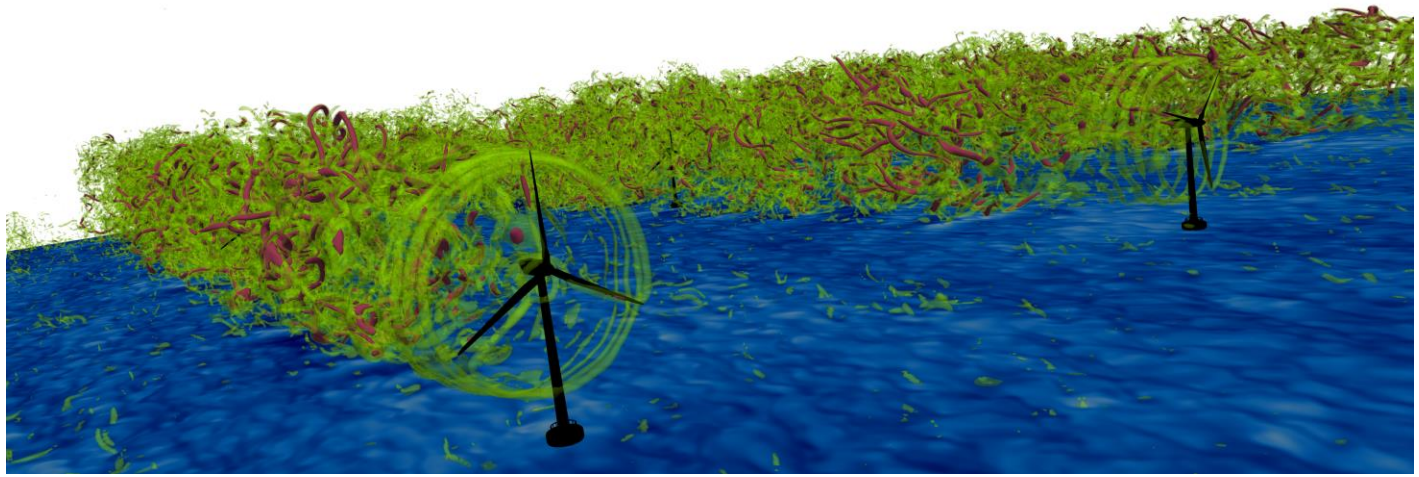
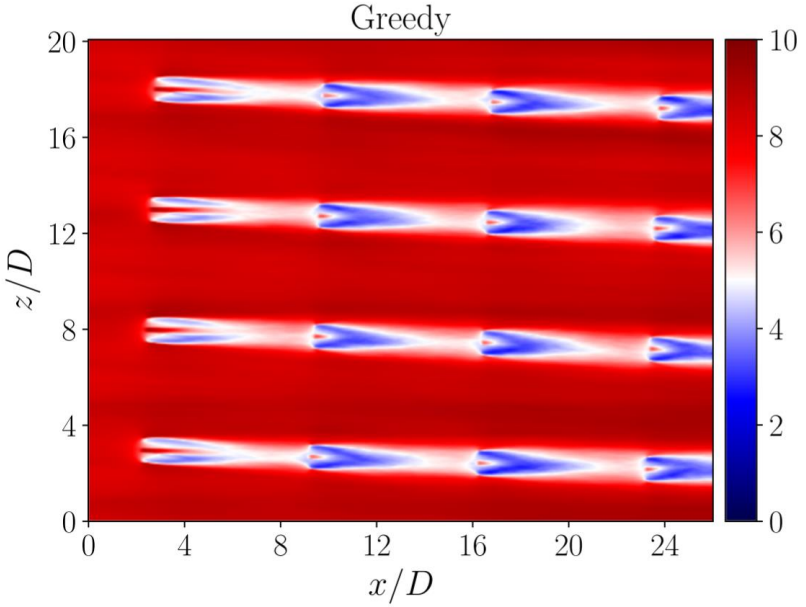
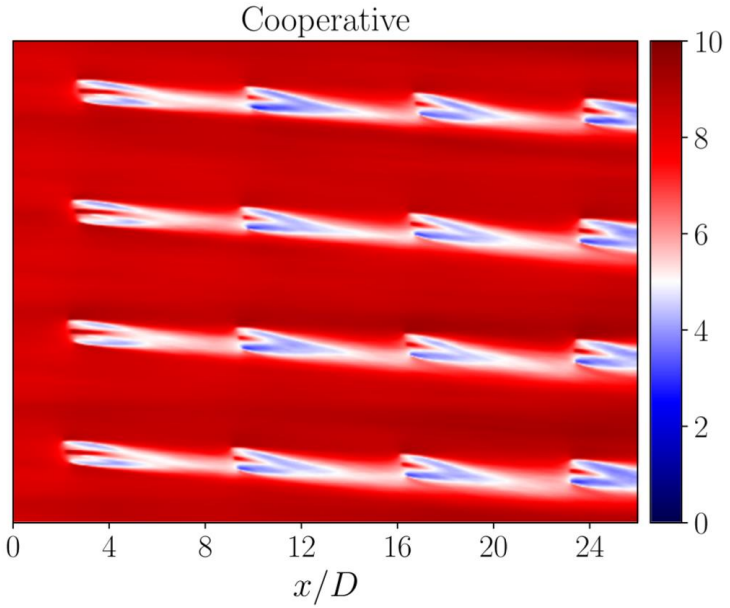
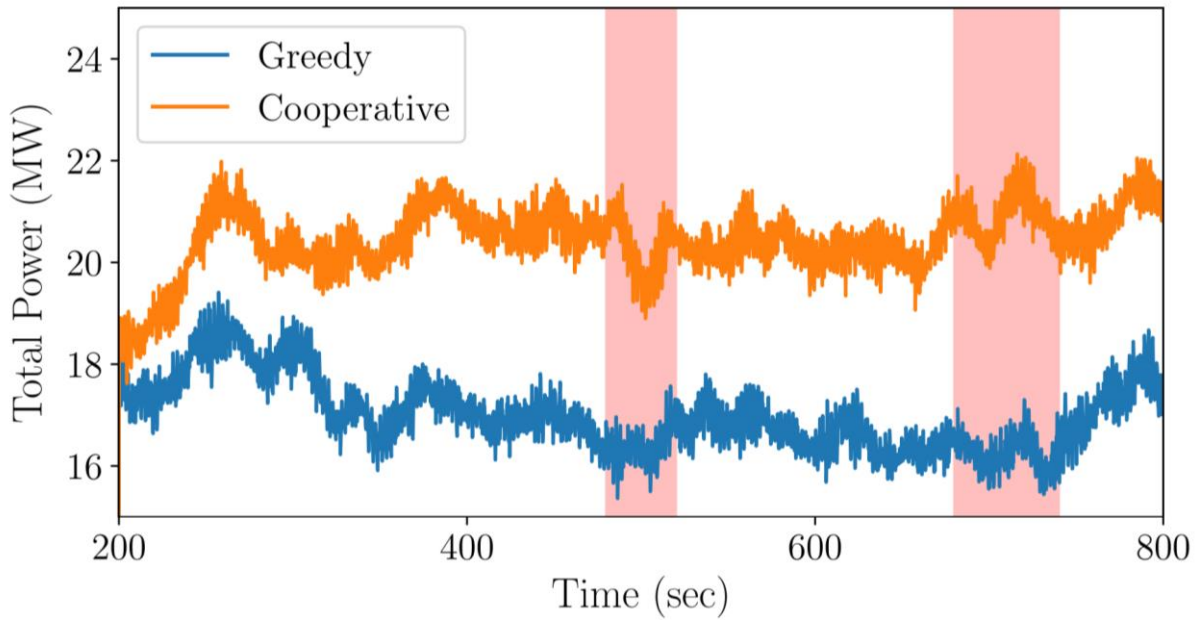


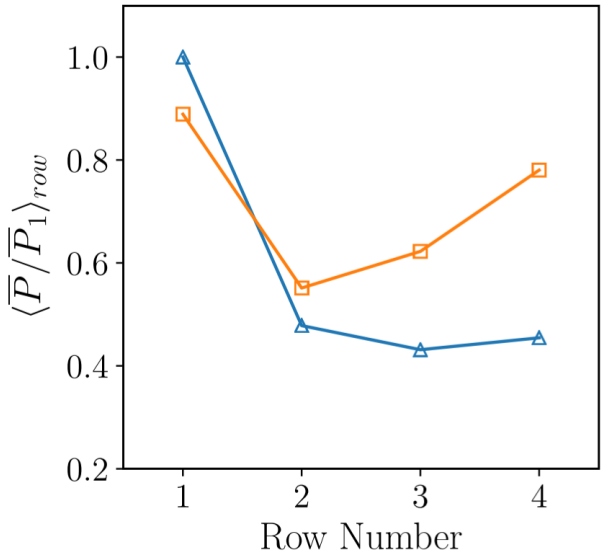


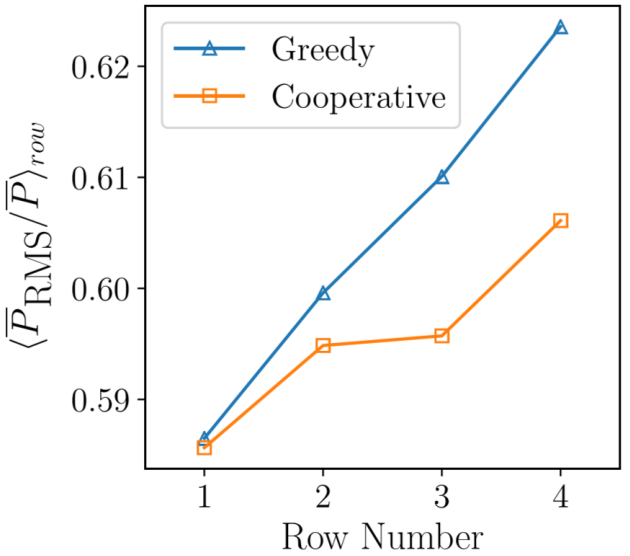
Control Wind Farms











Exascale? We are ready!

Critical challenges for exascale computing (in general):

- Power-usage restrictions / decrease in processor clock rates, an increase in core counts, more complex memory hierarchies and less available memory bandwidth per core
- Diverse mix of heterogeneous and homogeneous / many-core systems along with multi-level memory hierarchies and programming paradigms
- Bandwidth limitation → reducing data movement: control load unbalance and minimise (global) communications
- Growing gap between compute capacity versus I/O capabilities
- Domain Specific Language that separates the science source (what is to be computed) from its parallel implementation (how to program the hardware) is emerging as the way forward but not so easy in practice

Exascale? We are ready!

Opportunities for exascale turbulence simulations:

- New normal: high-fidelity simulations of turbulent flows based on 100-1,000 billion mesh points / cells with 10-100 million cores for 100-1,000 hours
- Only a small increase in flow regime (x3-x5)
- Opportunity for multi-physics high-fidelity simulations
- Mandatory shift to high-order methods
- Generation of database for improved/new turbulence models
- Great potential to combine machine learning algorithms and our tools (turbulence modelling, flow reconstruction, optimisation, design)
- Huge opportunity for UQ (increase confidence/robustness of our tools)

Exascale? We are ready!

Turbulence AT THE EXASCALE

EXCALIBUR IO

2DECOMP&FFT

OP-DSL

SENGA+

uDALES

OpenSBLI

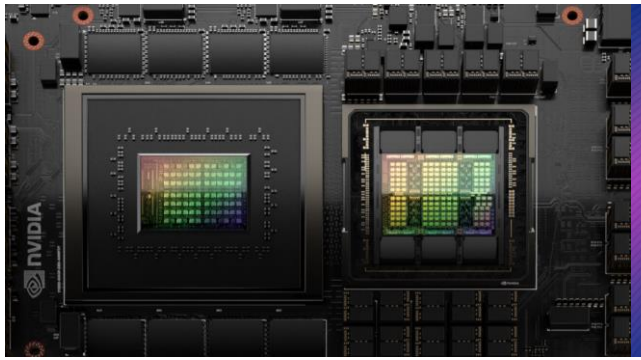
Xcompact3d
in turbulence we trust

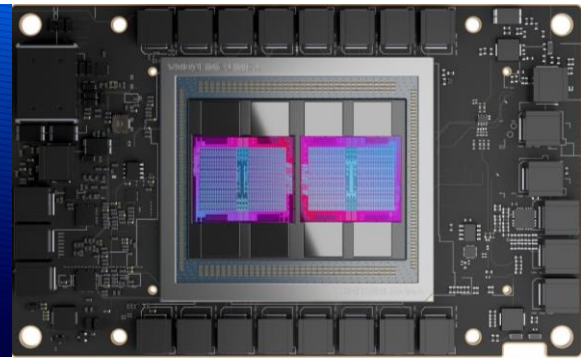
PyFR

2 approaches:

Domain Specific Languages & multi-backend codebases

2024/2025 TARGET: simulations on 5,000/10,000 GPUs





Thank you!

The UK Turbulence Consortium

https://www.ukturbulence.co.uk/

X/Twitter: @ukturbulence