Oxford Energy

Bridging Sustainability and Innovation with AI in Mobility and Energy Sector

Konstantina Vogiatzaki

Associate Professor of Engineering Science

Fellow at Somerville College, University of Oxford

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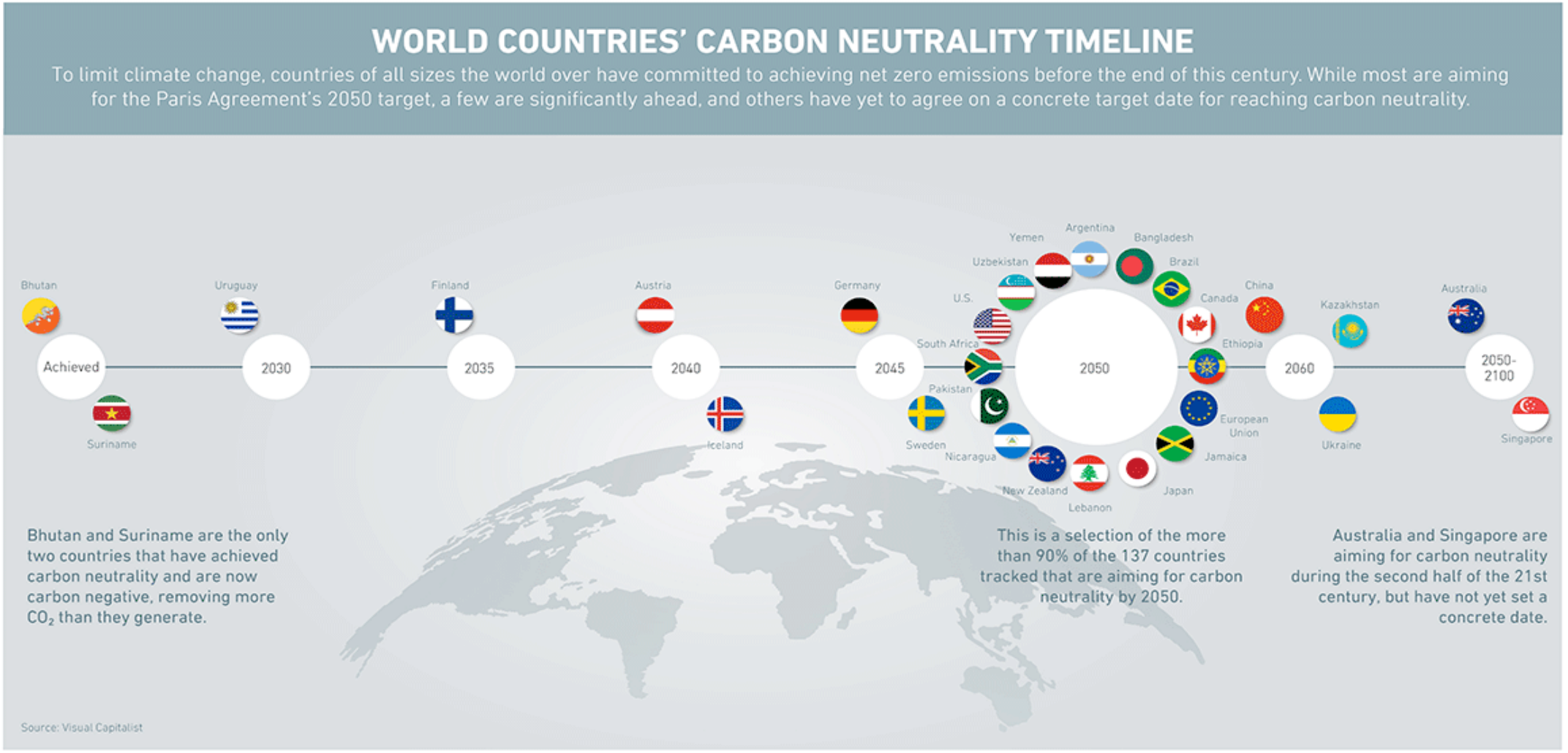
Why we need AI: Current … Climate



How can we speed up progress?

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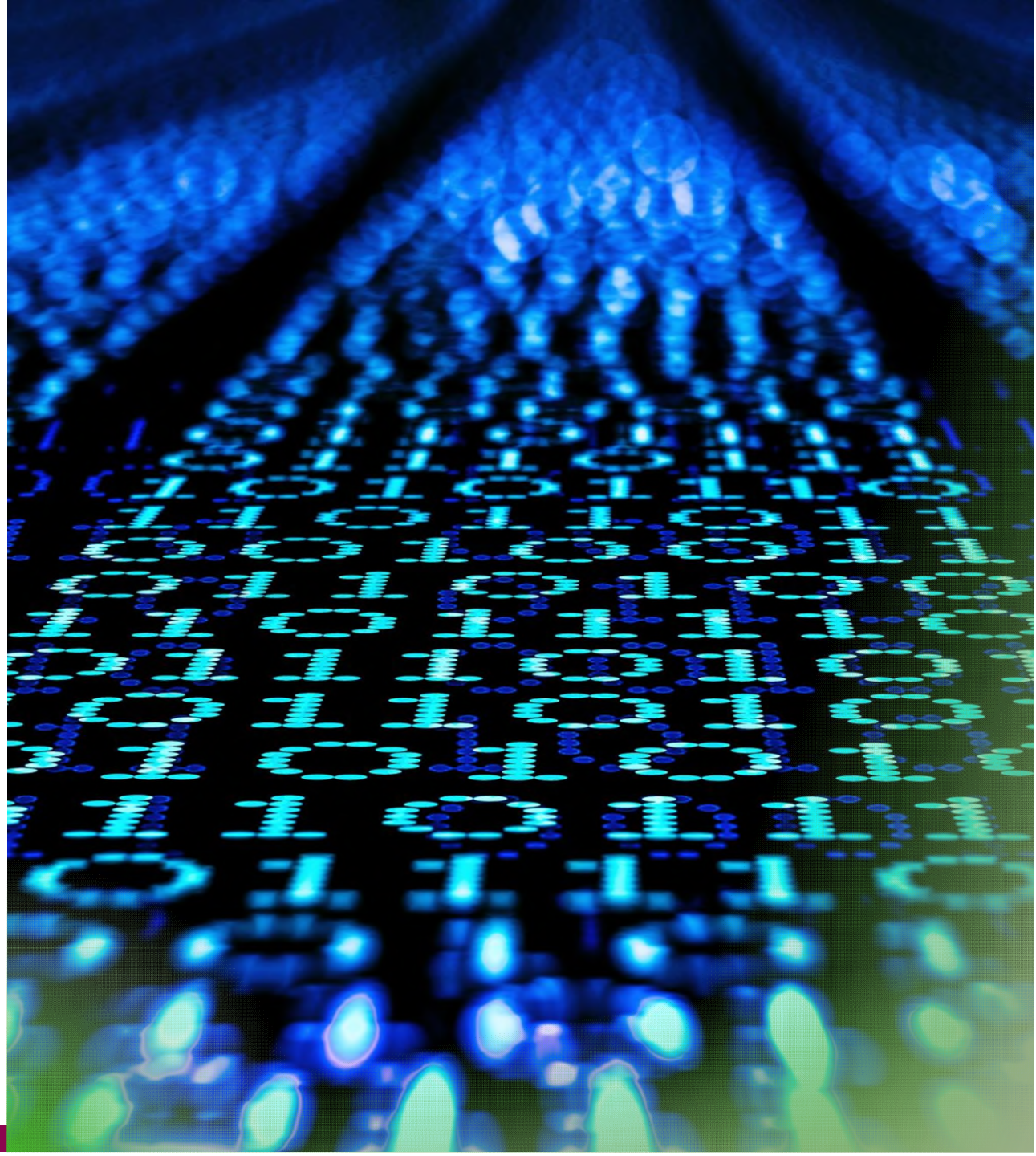
Digital Twins



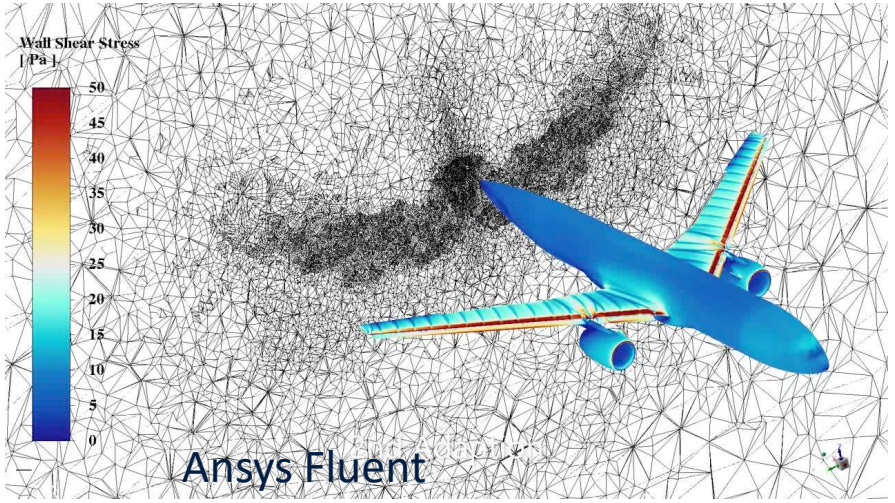
Digital Twins: What would you do if you had a …doppelgänger

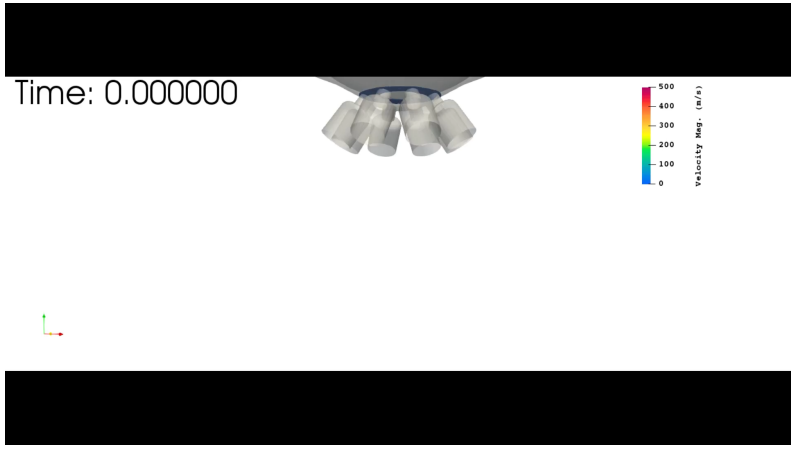
McKinsey & Company August 26, 2024

- Understand How Things Work
- Test Various Conditions (even in “dangerous operating manifolds”)
- Speed Up Manufacturing
- Active Control

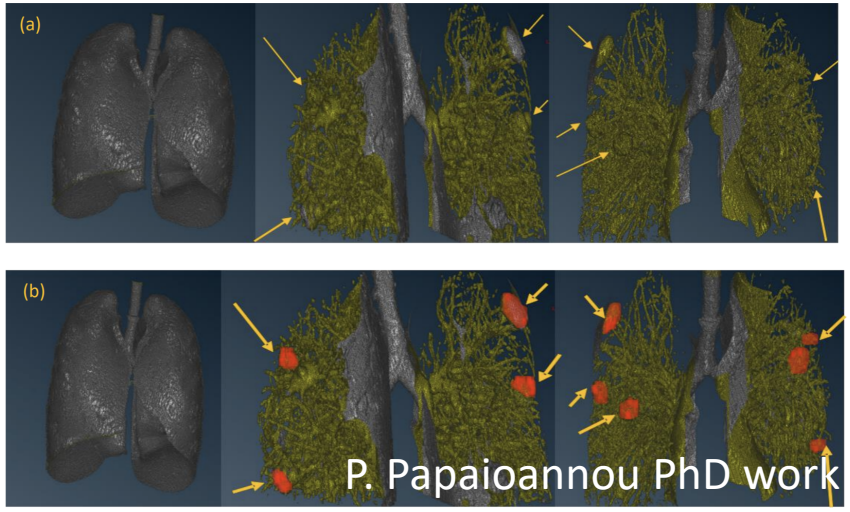
Computational Fluid Dynamics (CFD)

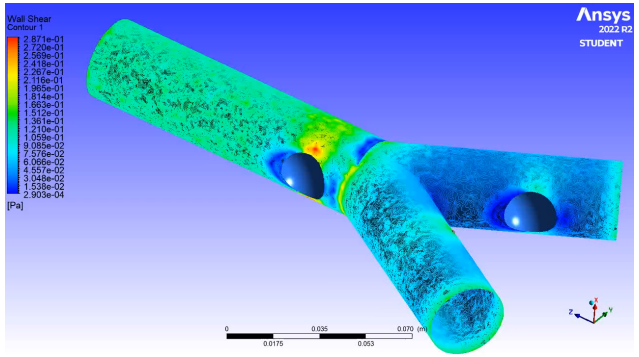
- A “traditional” tool of creating **Digital Twins of Fluid Systems**
- Combines applied mathematics, physics and high-performance computing
- Can be used to help understand how fluids move “around” or “inside” systems





P. McGinne, PhD work





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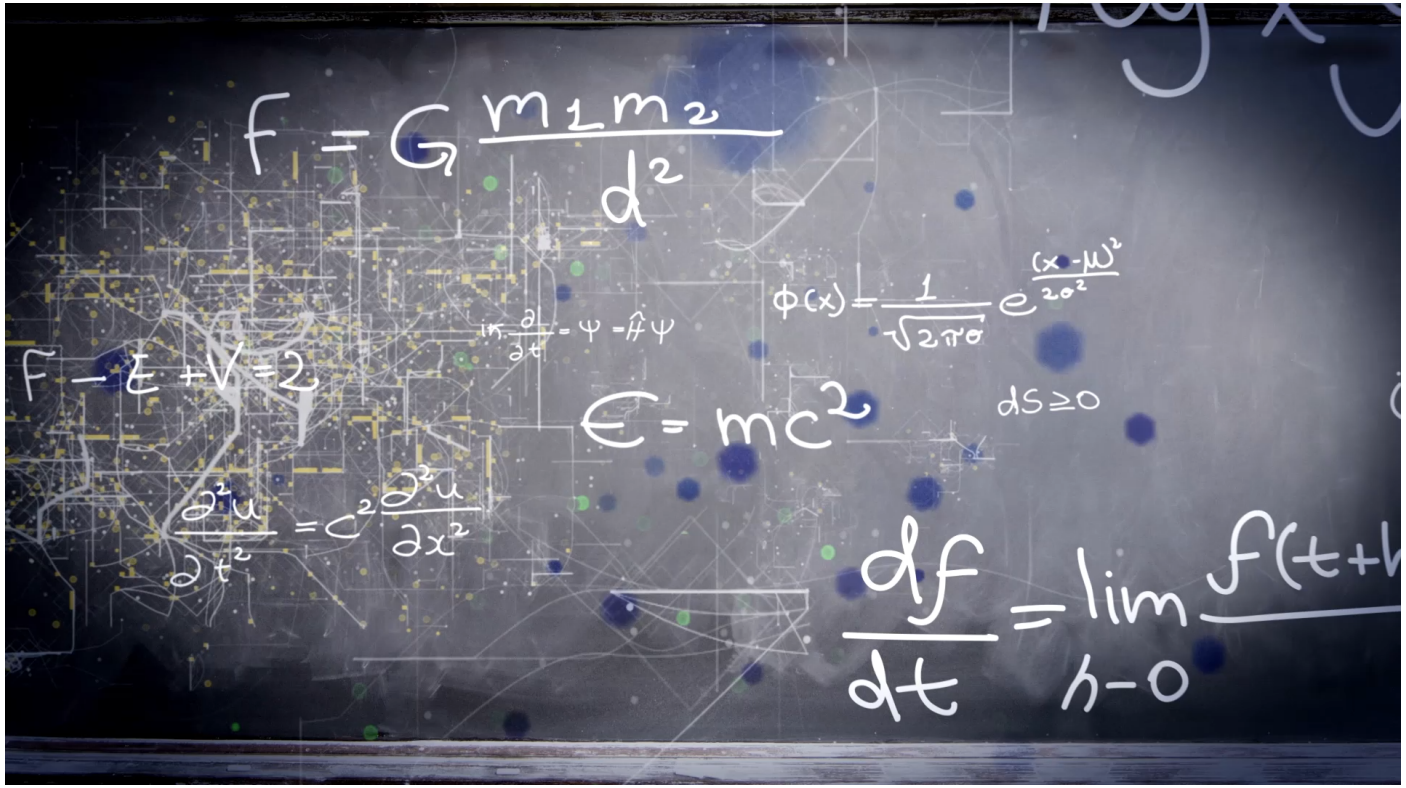
Machine Learning

Our world is full of “correlations” of input and outputs



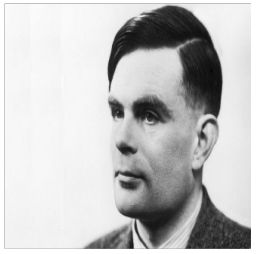
I.—COMPUTING MACHINERY AND INTELLIGENCE

By A. M. Turing

1. *The Imitation Game.*

I propose to consider the question, ‘Can machines think?’

I have my hopes, & very distinct ones, too, of one day getting cerebral phenomena such that I can put them into mathematical equations: in short, a law or laws for the mutual actions of the molecules of the brain Ada Lovelace (c1845)



Many Opportunities

1. Speed up simulations
2. Get access to areas and operating manifolds that are hard to experiment

The No Free Lunch Theorem

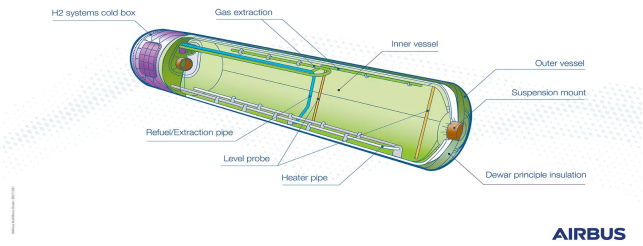
David Wolpert (1996, 1997)

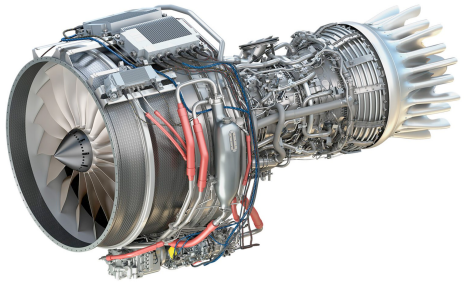
*According to the 'No Free Lunch Theorem', **no ML algorithm is universally superior**. Thus, the task of constructing such an algorithm is a **case-by-case** study. In particular, the choice of the learning algorithm is a key step in building an ML pipeline, and **many choices are available**, each suited for a particular problem and/or dataset.*

What is AI/ML vs What is not AI/ML

Components of H2 Integration

Liquid H_2 tank



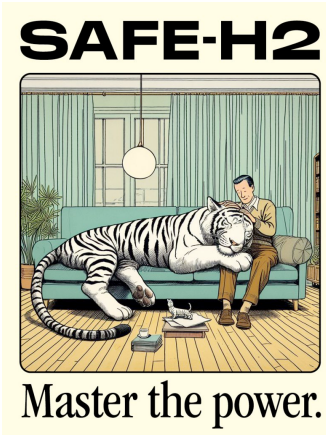


GE Passport Biz-jet engine

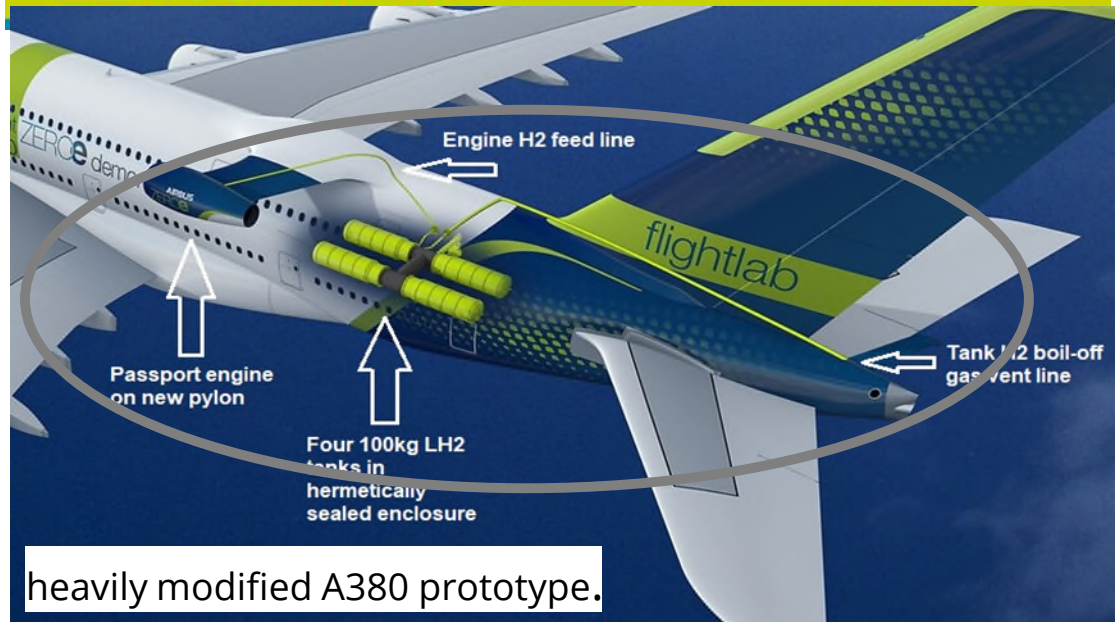
Cryo Storage (-253C)
Thermophysical Properties

Engine
Injection-Combustion Control

Safety
Mixing-Ignition-Detonation



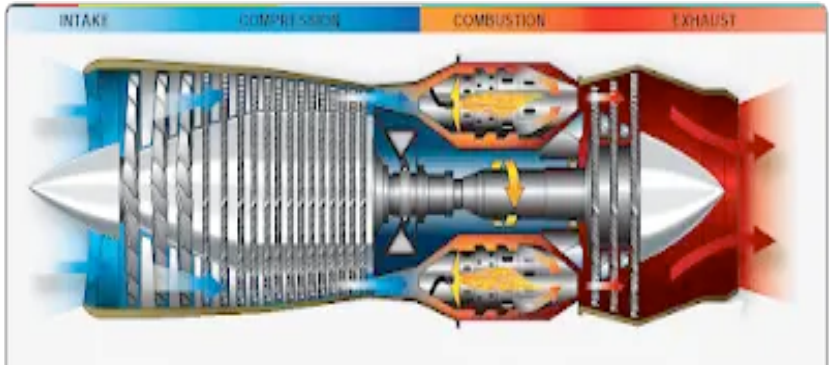
ZEROe Hydrogen combustion demonstrator

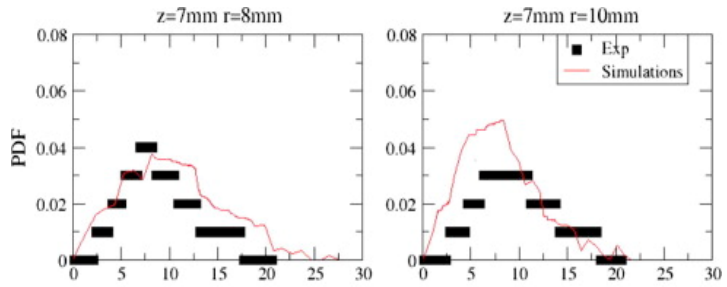


heavily modified A380 prototype.

https://www.rolls-royce.com/products-and-services/civil-aerospace.aspx

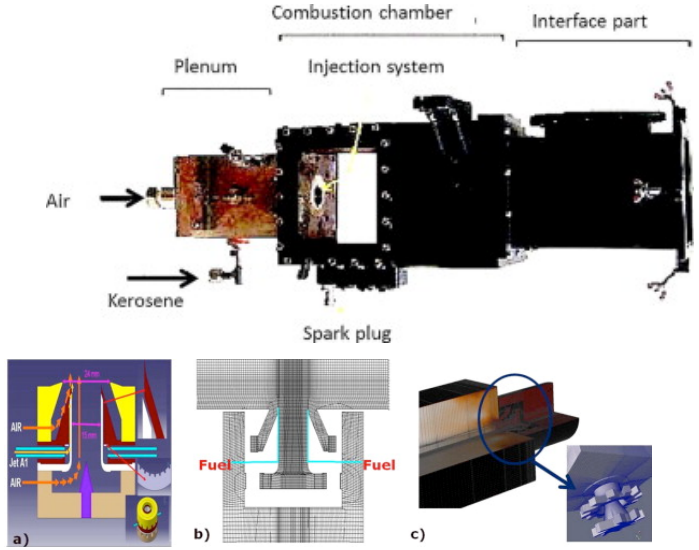
O(m)

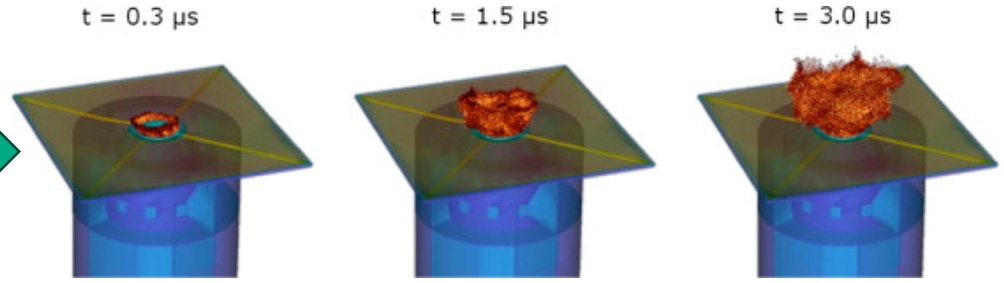




Droplet distribution

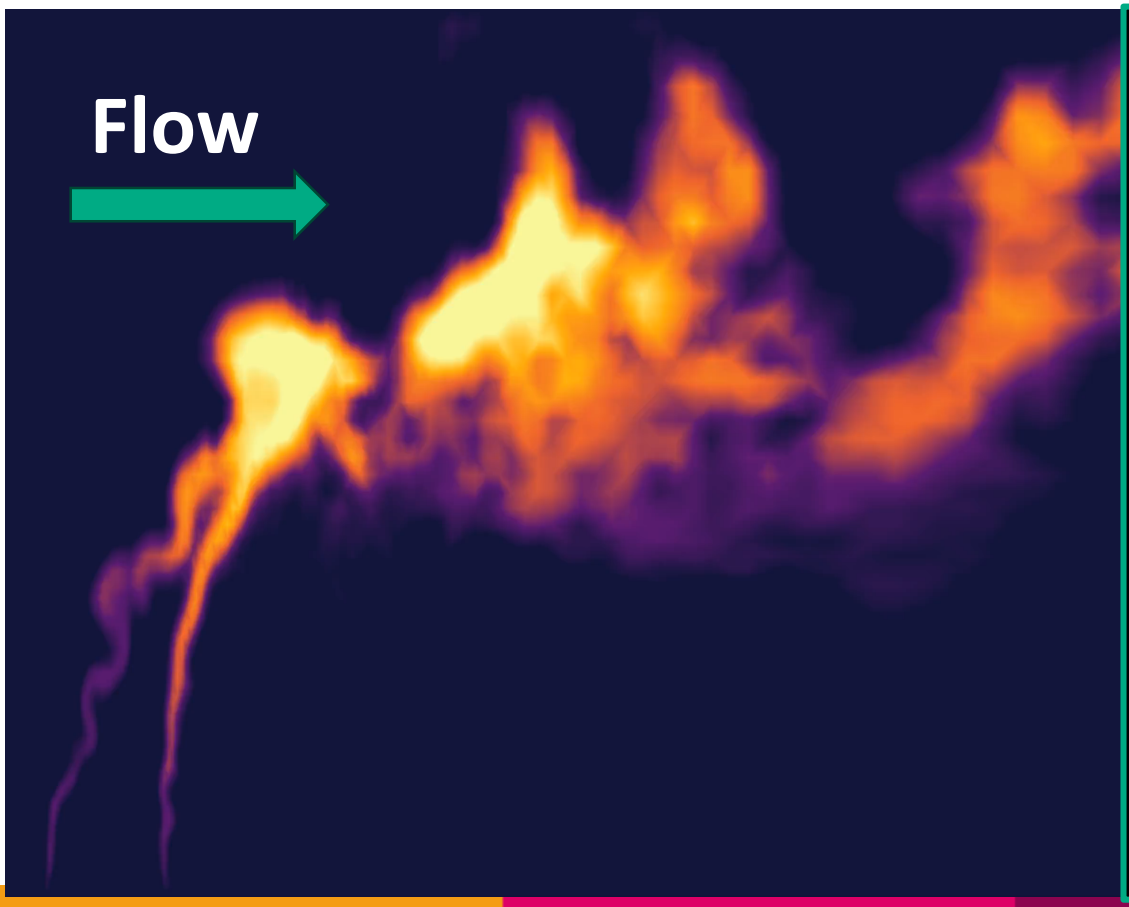
Vogiatzaki et al, Combustion and Flame, 2017

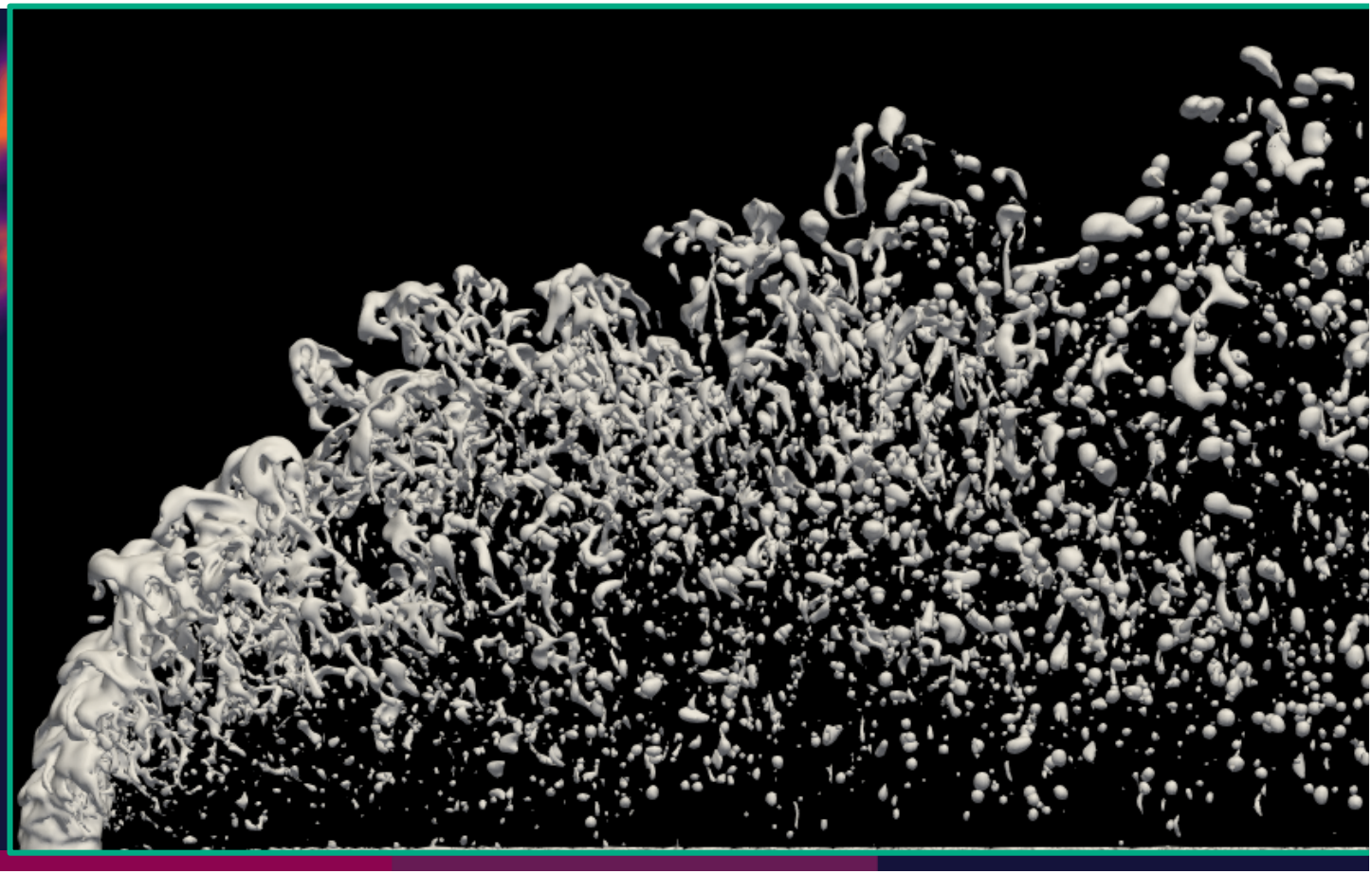




O(μm)

Jet in a Crossflow

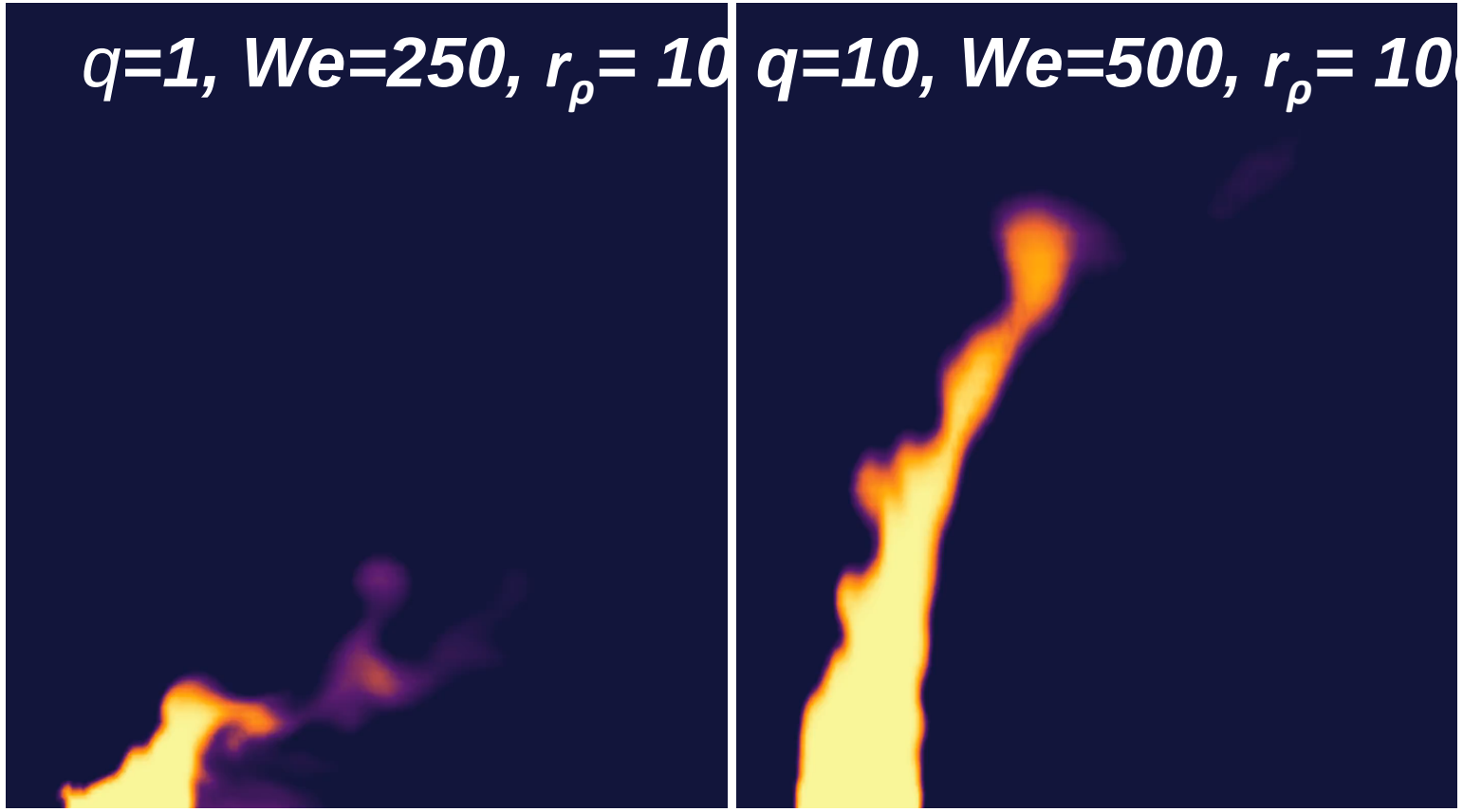




Primary Breakup in JIC

Primary Break-up:

- Different liquid deformation observed
- Break-up mechanisms strongly affected by *We, q,* r_ρ
- Strong variation in the droplet population produced



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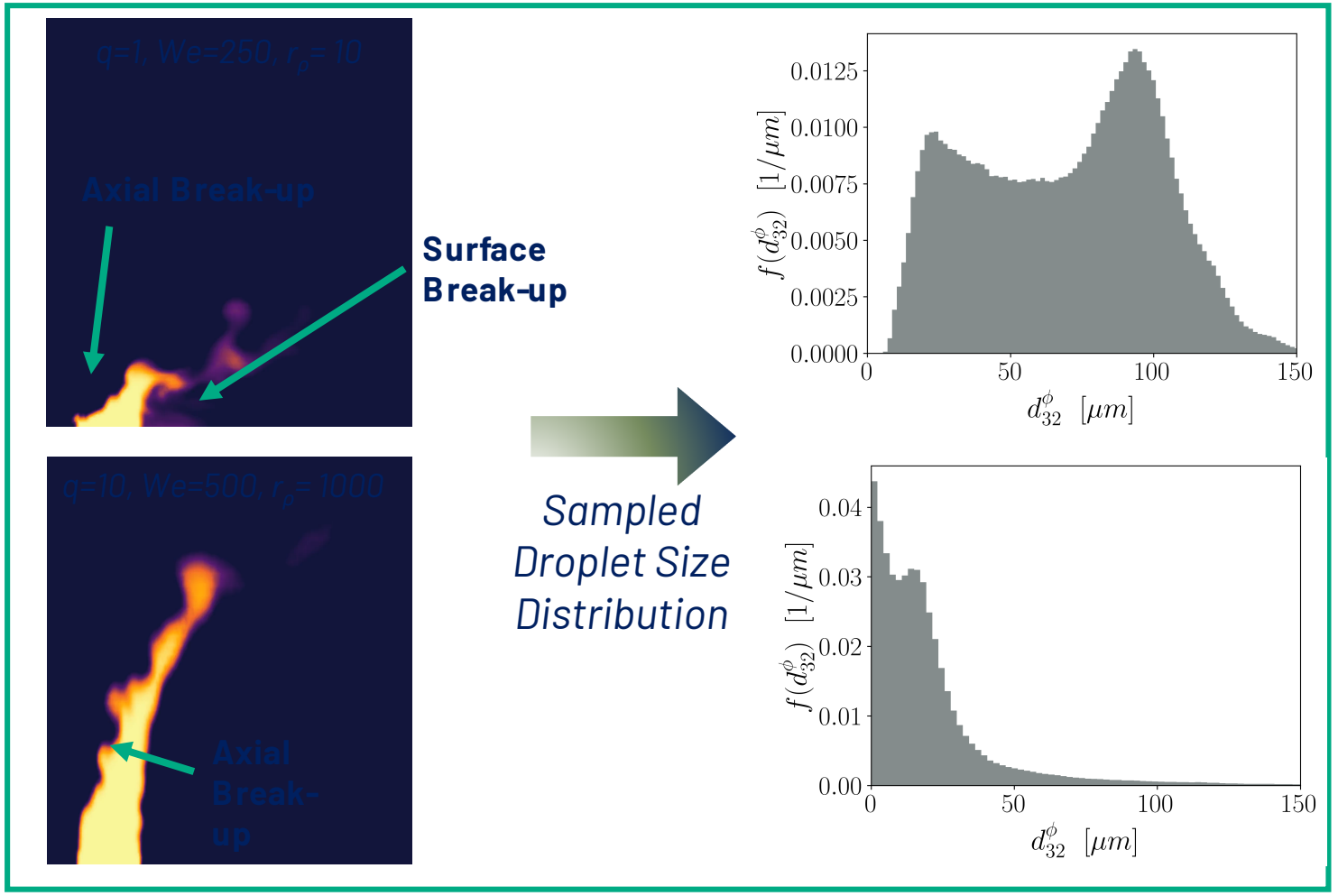
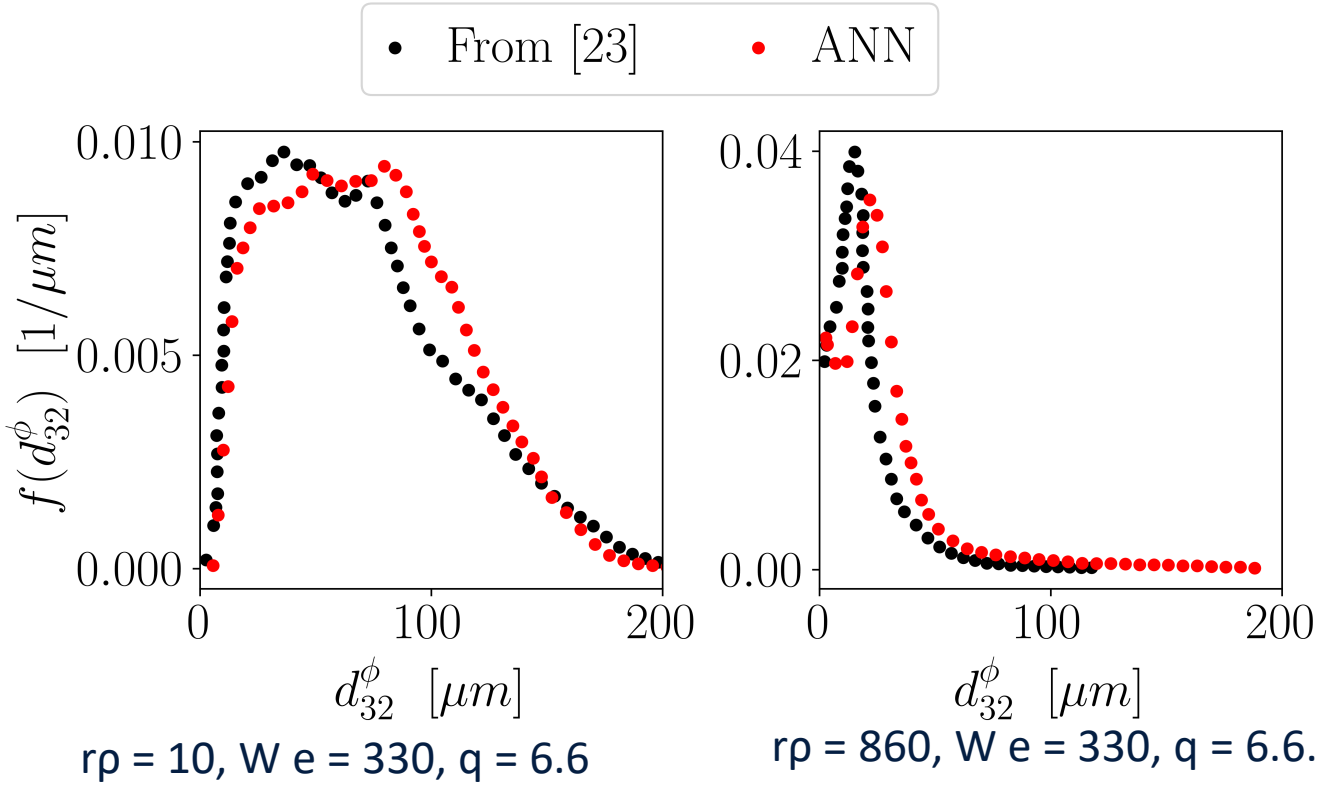
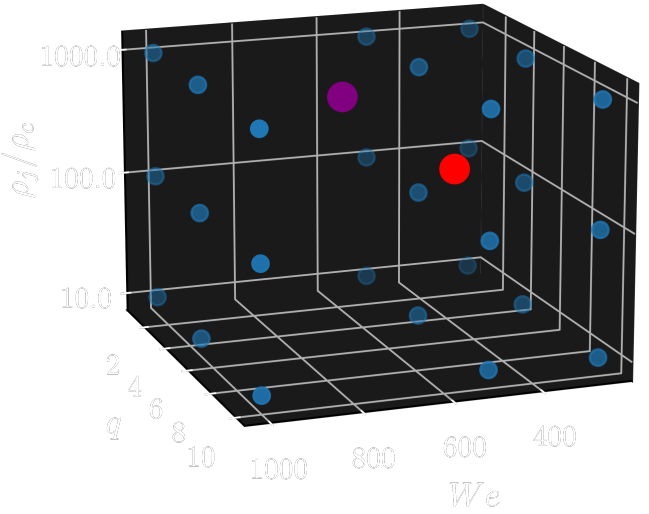


ANN Droplets



rρ = 10, W e = 330, q = 6.6

rρ = 860, W e = 330, q = 6.6.



Trained DSDs obtained in less than a minute (LES: each case 144 hours on 32 CPUs)

[23]: G. Tretola, K. Vogiatzaki S. Navarro-Martinez, Effect25 of the density ratio variation on the dynamics of a liquid jet injected into a gaseous cross-flow, Physics of27Fluids 33 (9) (2021) 092120

Thank you !

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