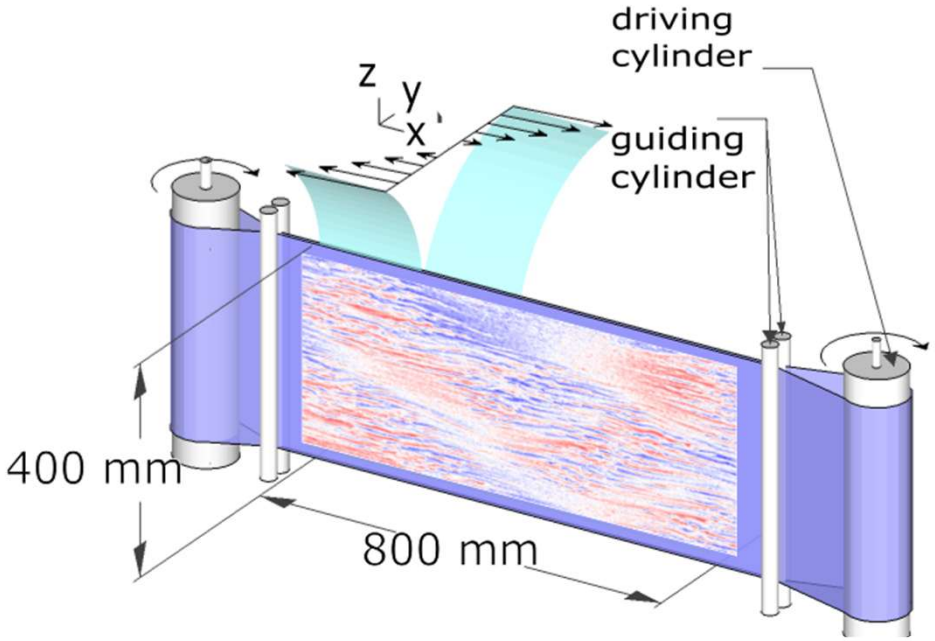
Experimental methods

Romain MONCHAUX

LMI - ENSTA

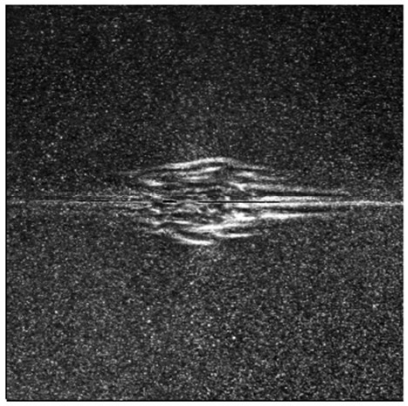
Institut Polytechnique de Paris

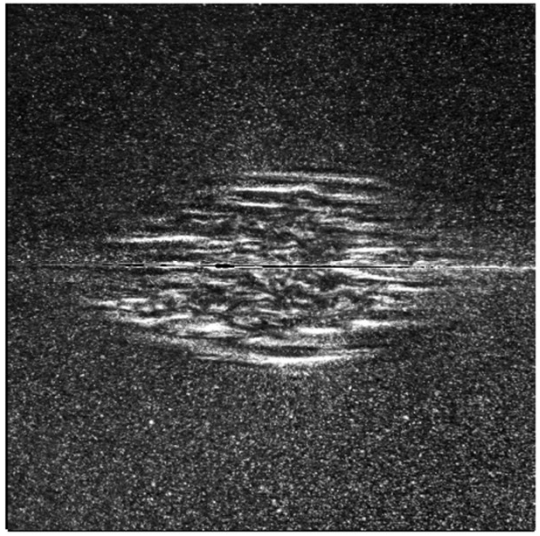


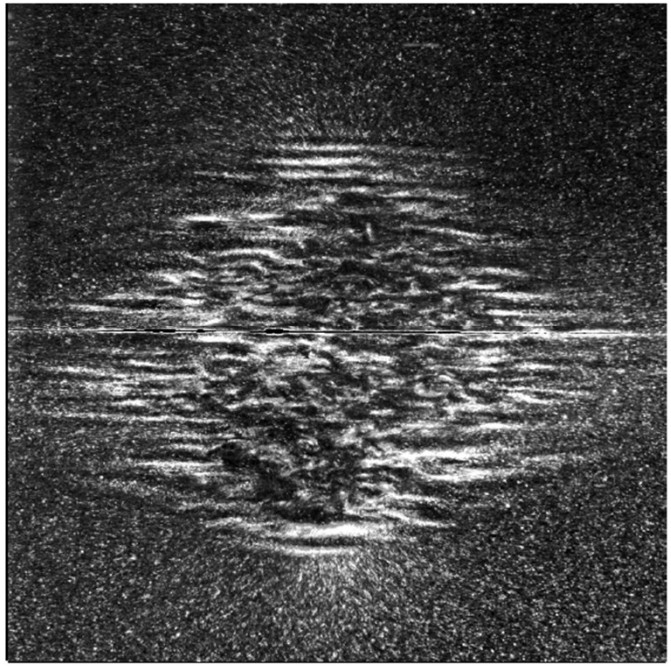
Transition to turbulence

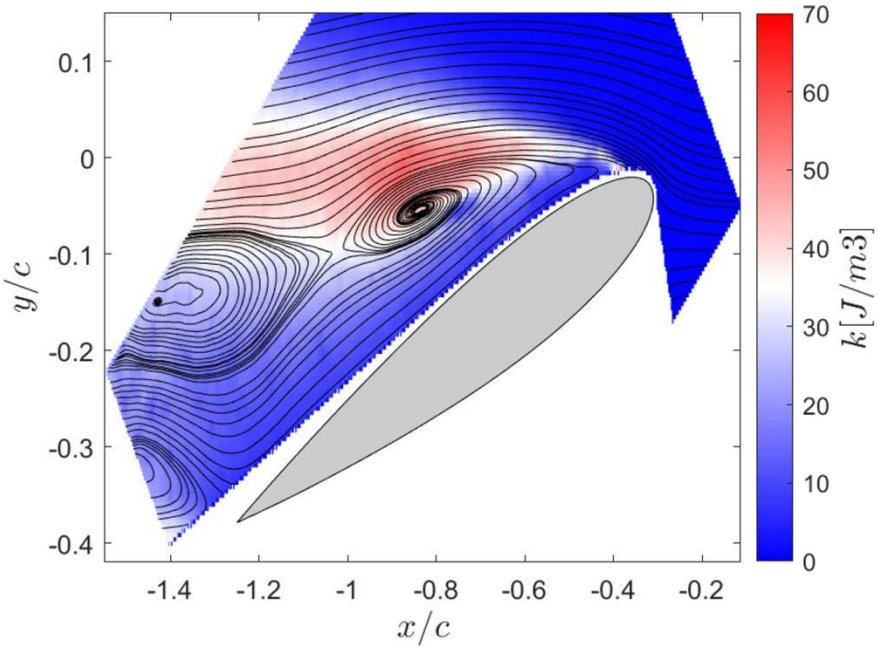
- Canonical flow
- Fondamental issues

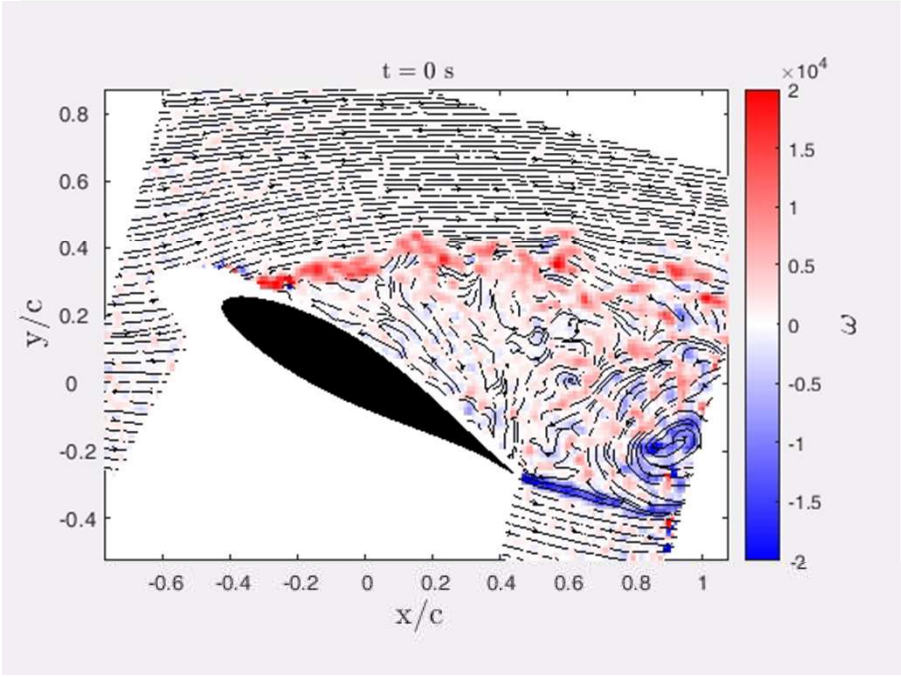
Collab: Ladhyx, LISN, IRPHE







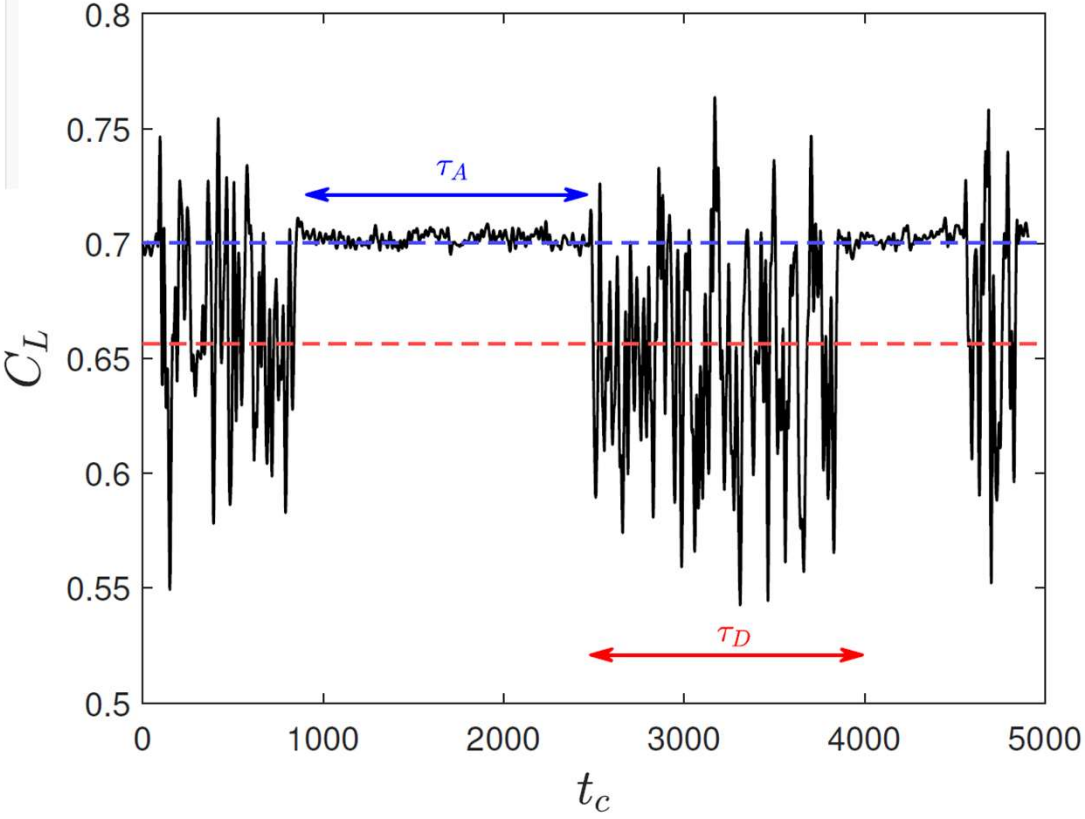




Aerodynamics

- Multistable states
- Aeroacoustic
- Long time dynamics

Collab: Ladhyx, LMFL, LMFA, EM2C

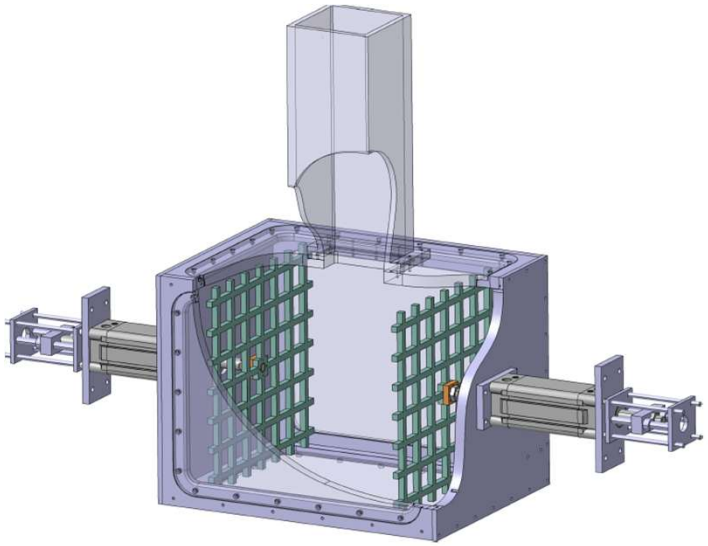


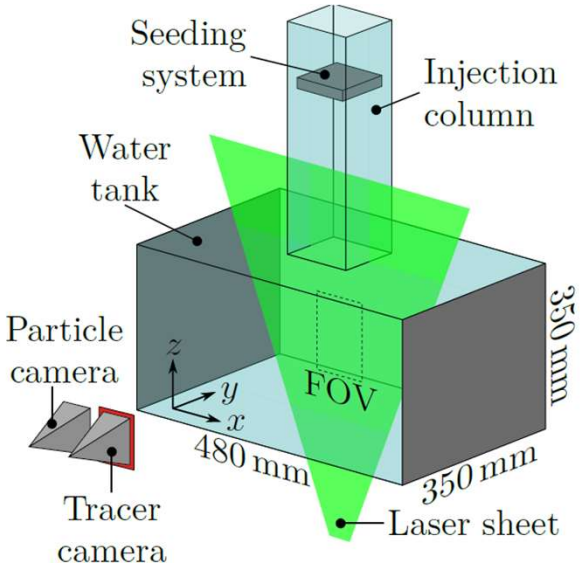
PhD/Post-doc offers !

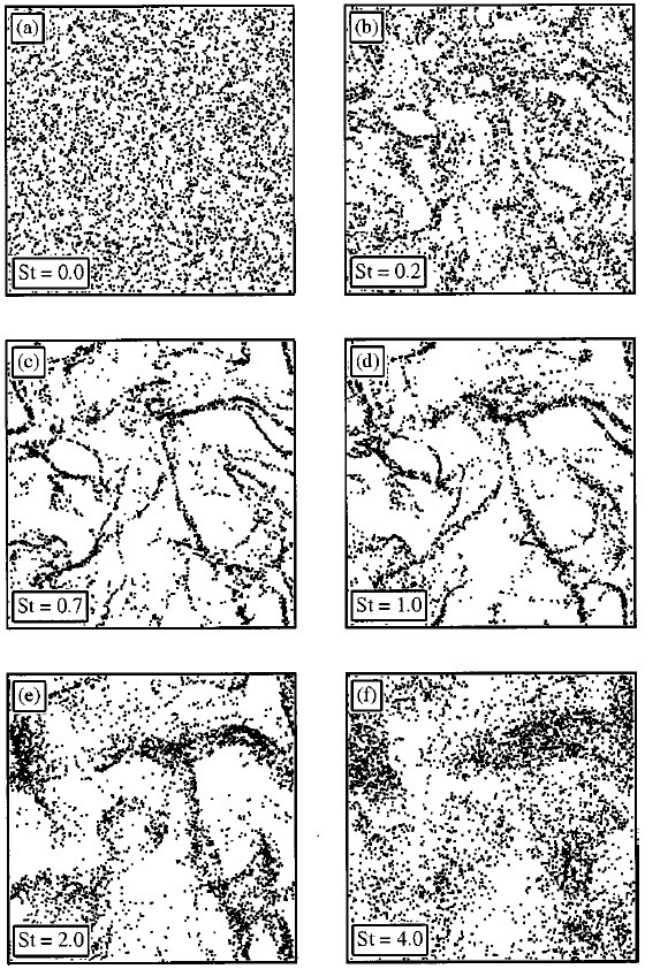
Inertial particles in turbulence

- Environmental issues
- Fondamental issues
- Challenging experiments

Collab: ENS-Lyon, IFPEN, LMFL, Buenos Aires







PhD/Post-doc offers !

In classroom (4 sessions):

23/09/2024

Intro

Hot wire

Laser Doppler Anemometry

30/09/2024

Particle Image Velocimetry and beyond

Set-up of numerical classes:

- *Matlab and Python*
- *Do you have a laptop ?*
- *Do you have Eduroam?*

07/10/2024 !! WARNING AM !!

Numerical classes on PÏV

Basics of signal processing (FFT, spectra, correlations, PDF, statistics)

Numerical classes

14/10/2024

Basics of signal processing (FFT, spectra, correlations, PDF, statistics)

Numerical classes

In the lab (12h – 3 sessions):

Session choice

Group 1: 21/10/2025, 04/11/2025, 18/11/2025
4 or 10 students
Group 2: 22/10/2025, 12/11/2025, 19/11/2025
4 or 10 students

Project choice:

- axisymetric jet + hot-wire (max 4 students)
- plane jet + hot wire (max 4 students)
- Taylor-Couette flow + Laser Doppler Anemometry (max 4 students)
- von Karman wake + Particle Image Velocimetry (max 4 students)
- Channel flow (max 4 students)

Choice done by 7th of October

Evaluation

25th November 2025

Oral defense on the project (12 minutes presentation)
•Project description (including bibliography)
•Tools and methods used
•Results and discussion
•Perspectives

Questions (10 + 10 minutes)
•On the defense
•On the whole lectures in classroom

Jury
• to be defined

Venue

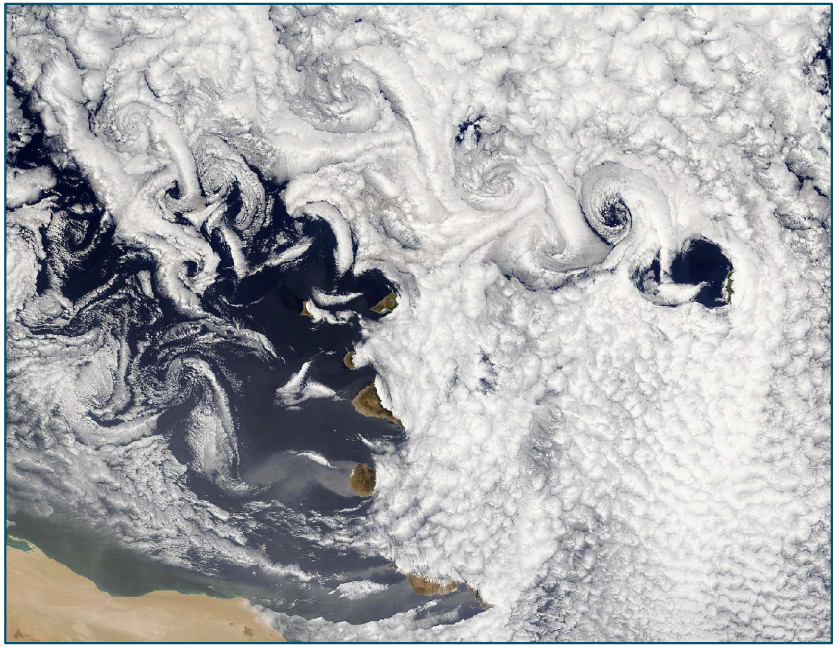
Pole de mécanique

Give me your badge number !

So many flows

Natural flows

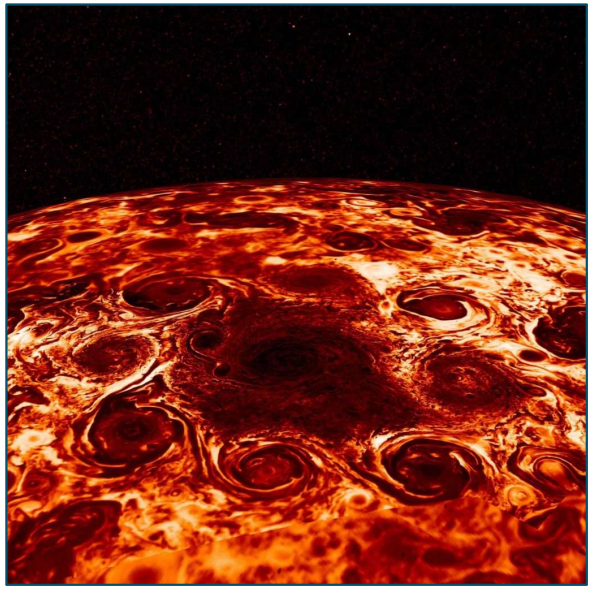
esa.int



wikipedia.org

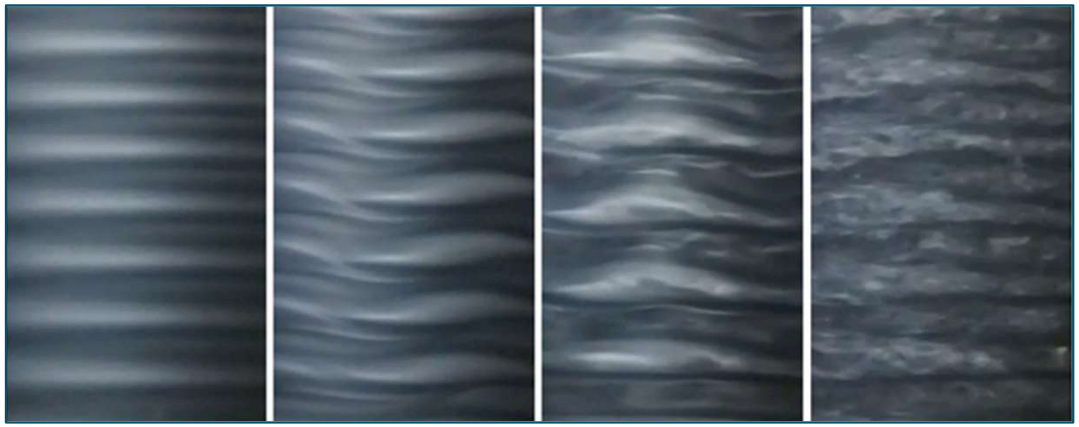
mdpi.com

M2 Fluid Mechanics - IPParis



oregonstate.edu

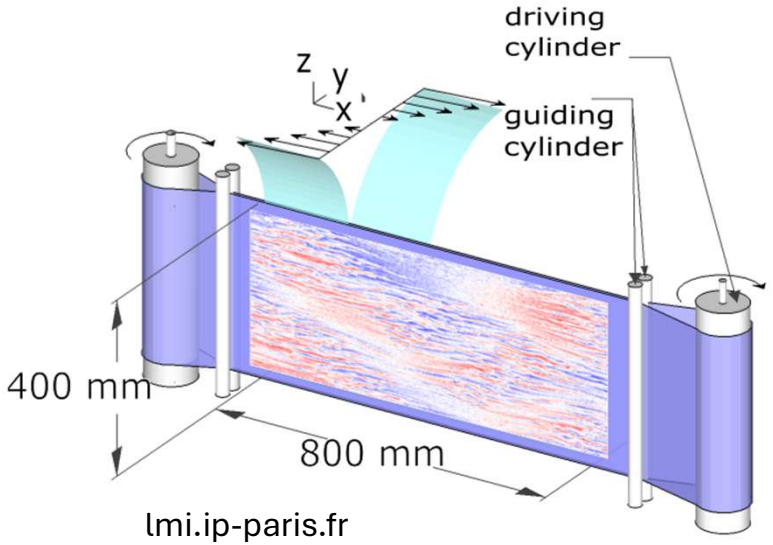
Academic flows



Taylor-Couette

lmi.ip-paris.fr

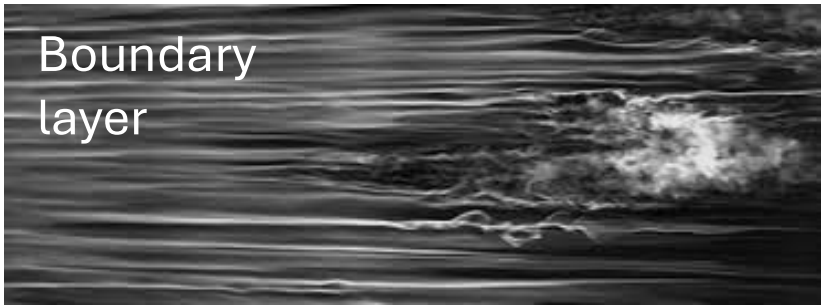
Increasing Re



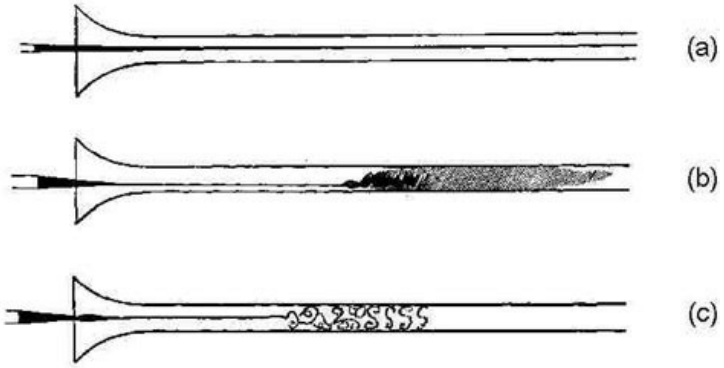
Plane Couette

lmi.ip-paris.fr

Ravinesh Deo



KTH

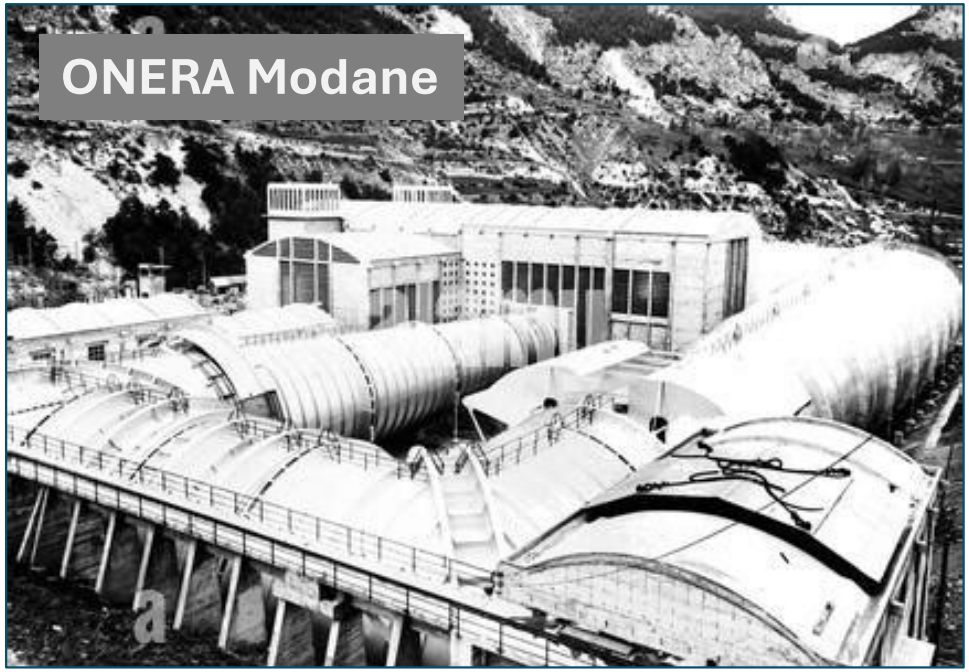


Pipe flow

Reynolds

Wind tunnels

scuderiafans.com

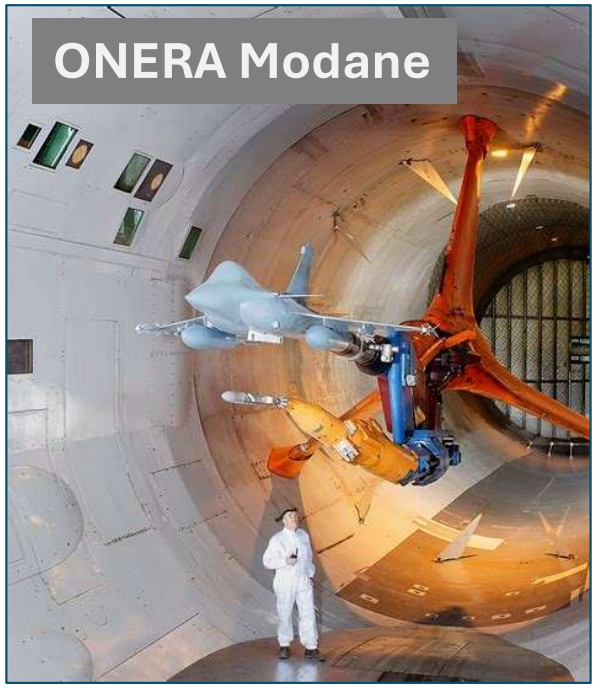


alamy.com

Industrial wind tunnels

- Large dimensions
- High level equipments

soufflerie2a.com



bksv.com

Wind tunnels

lmfl.cnrs.fr

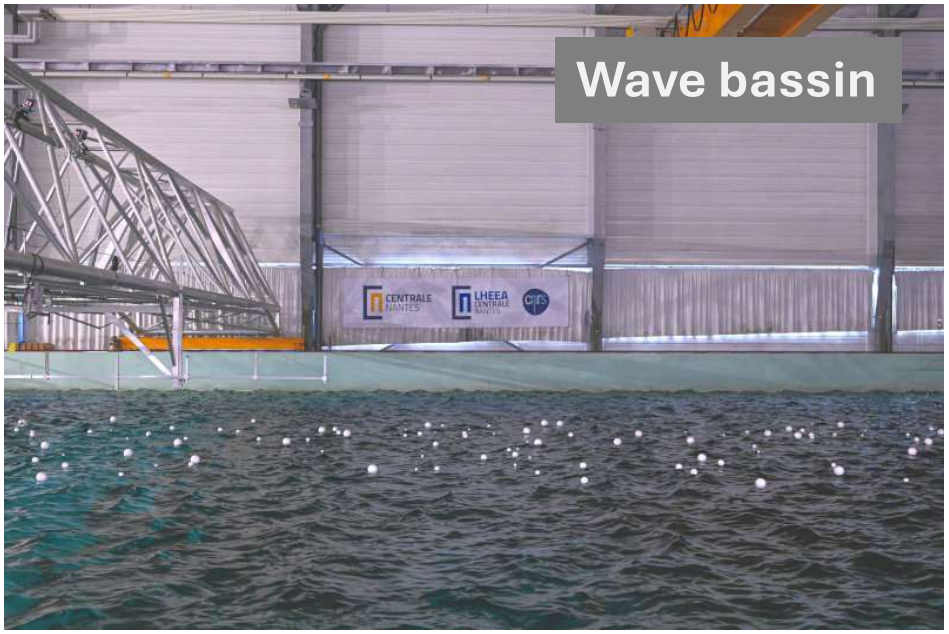
Laboratories wind tunnels

- Smaller dimensions
- Dedicated equipments

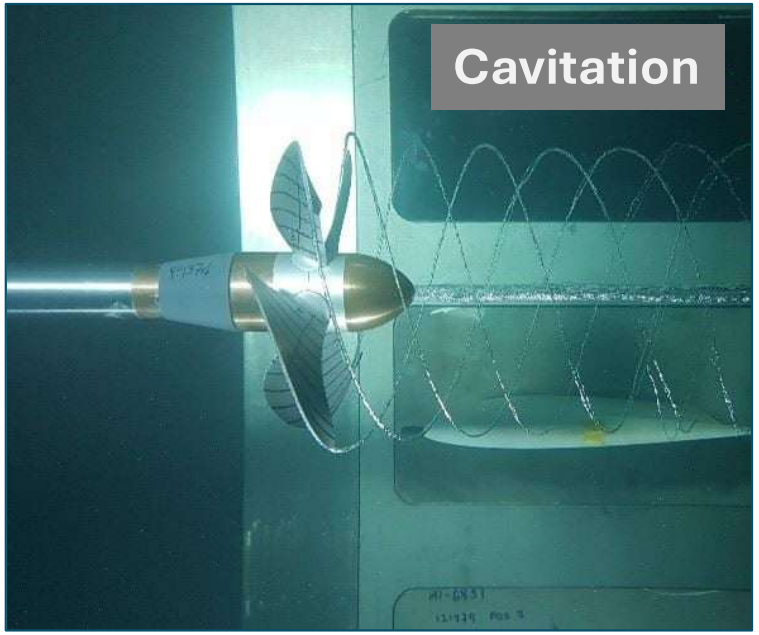
lmi.ip-paris.fr

dlr.de

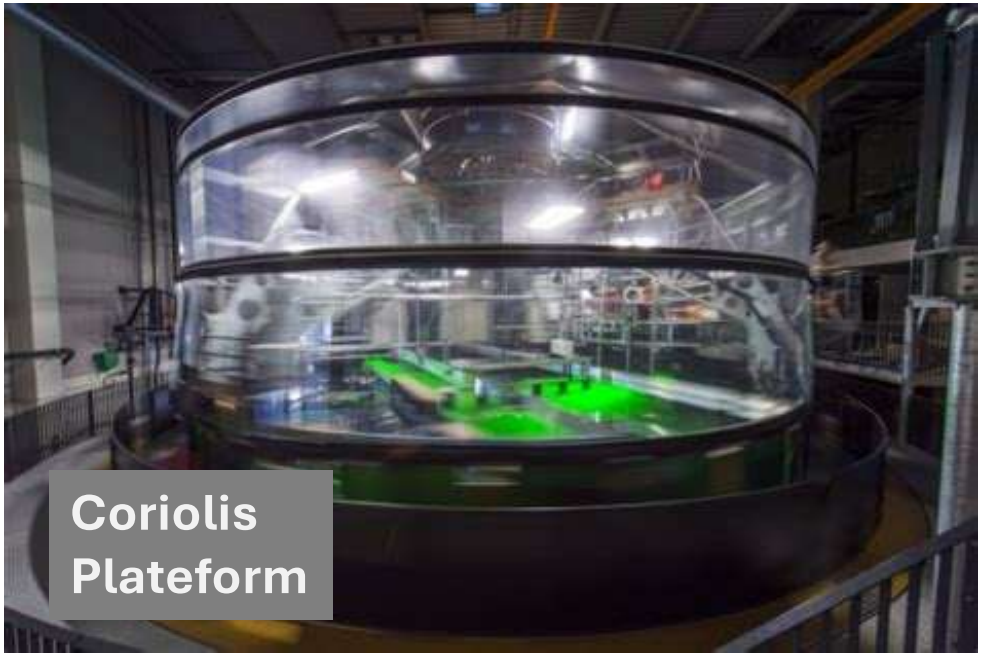
Model experiments



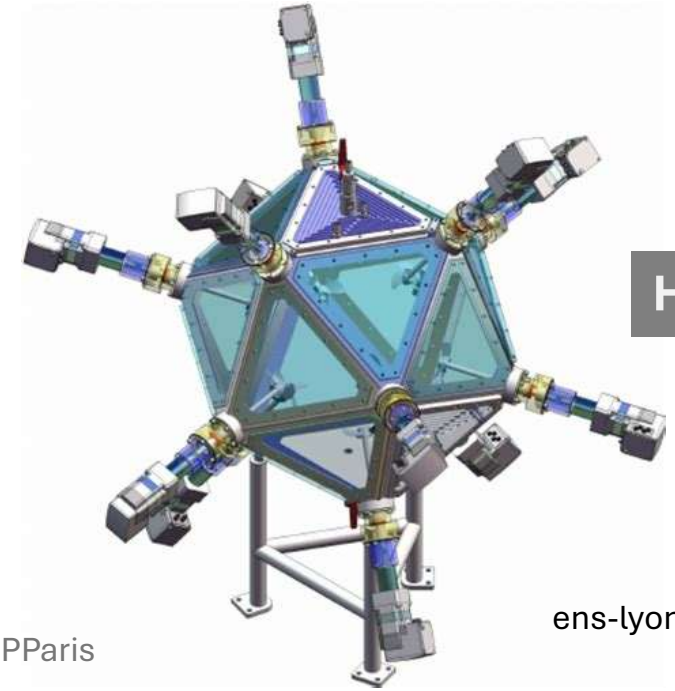
ec-nantes.fr



sintef.io

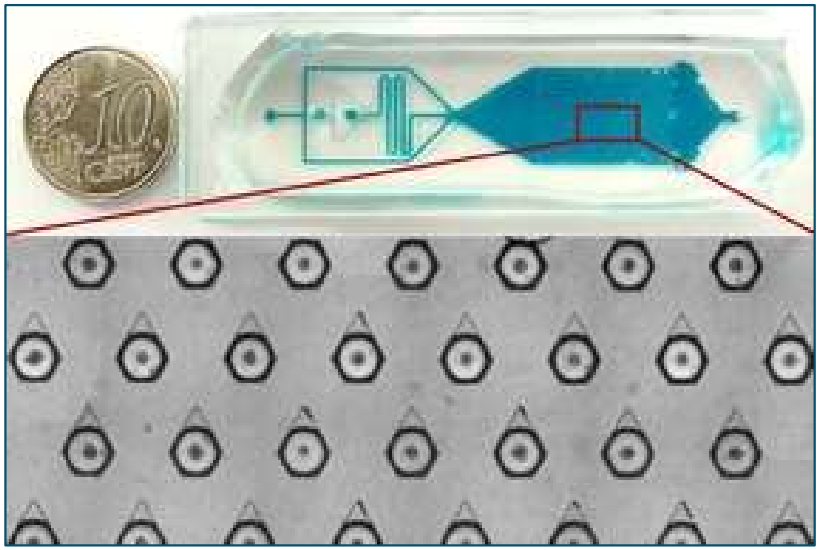


legi.grenoble-inp.fr

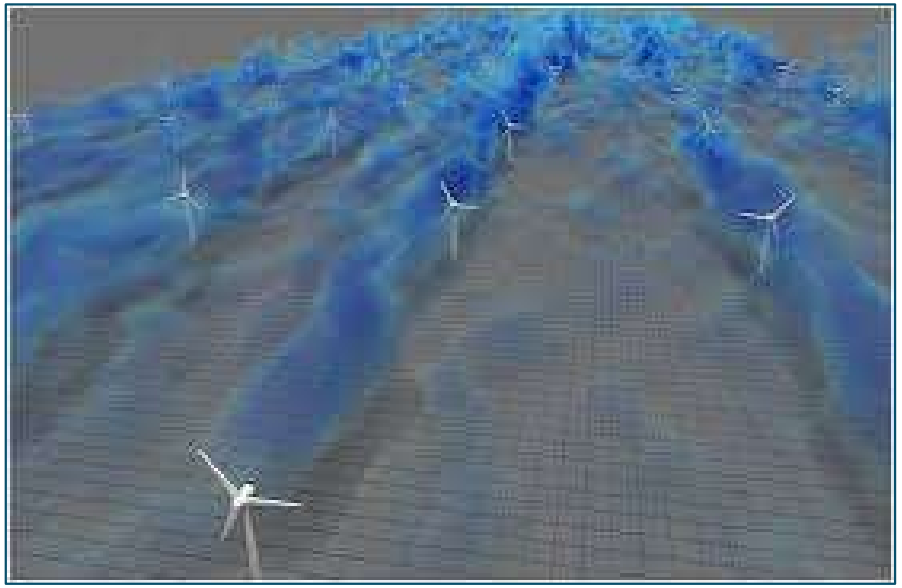


ens-lyon.fr

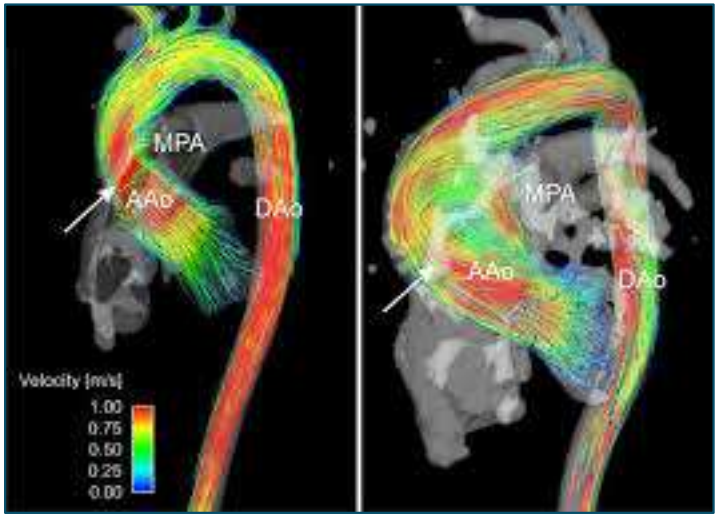
Fluid structure interactions



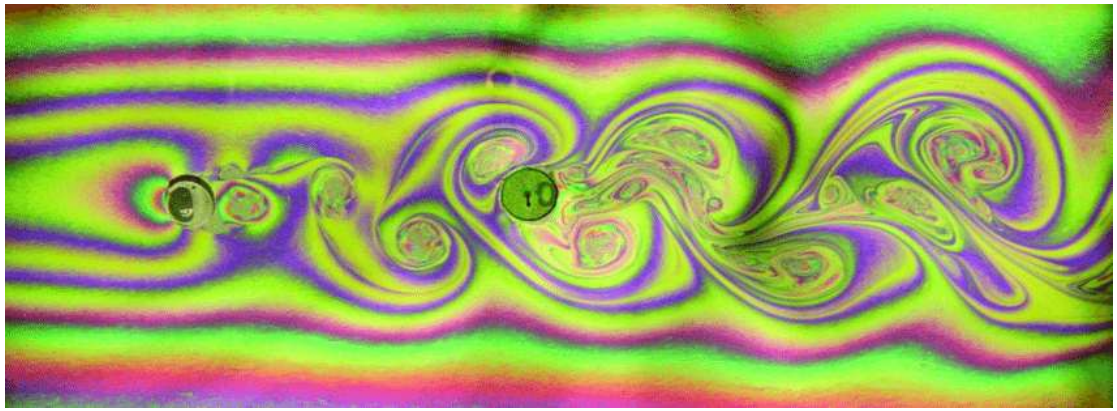
ladhyx.polytechnique.fr



Richard Stevens



Julio Garcia



William Hobbs

Beyond visualizations

Navier-Stokes equations

$$\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u} \cdot \nabla)\mathbf{u} = \nu \nabla^2 \mathbf{u} - \frac{1}{\rho}\nabla p + \frac{1}{\rho}\mathbf{f}$$

Measurable quantities

- Velocity field
- Vorticity field
- Pressure field
- Velocity gradients
- Wall shear stresses
- Acceleration field
- Lagrangian vs Eulerian fields
- Aerodynamic efforts
- Physical vs Fourier spaces
- …

⟹ **Wide range of measurement techniques**

Beyond visualizations

Navier-Stokes equations

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Full 3D
2D3C
2D2C
2D1C
1D
0D
Time resolved or not