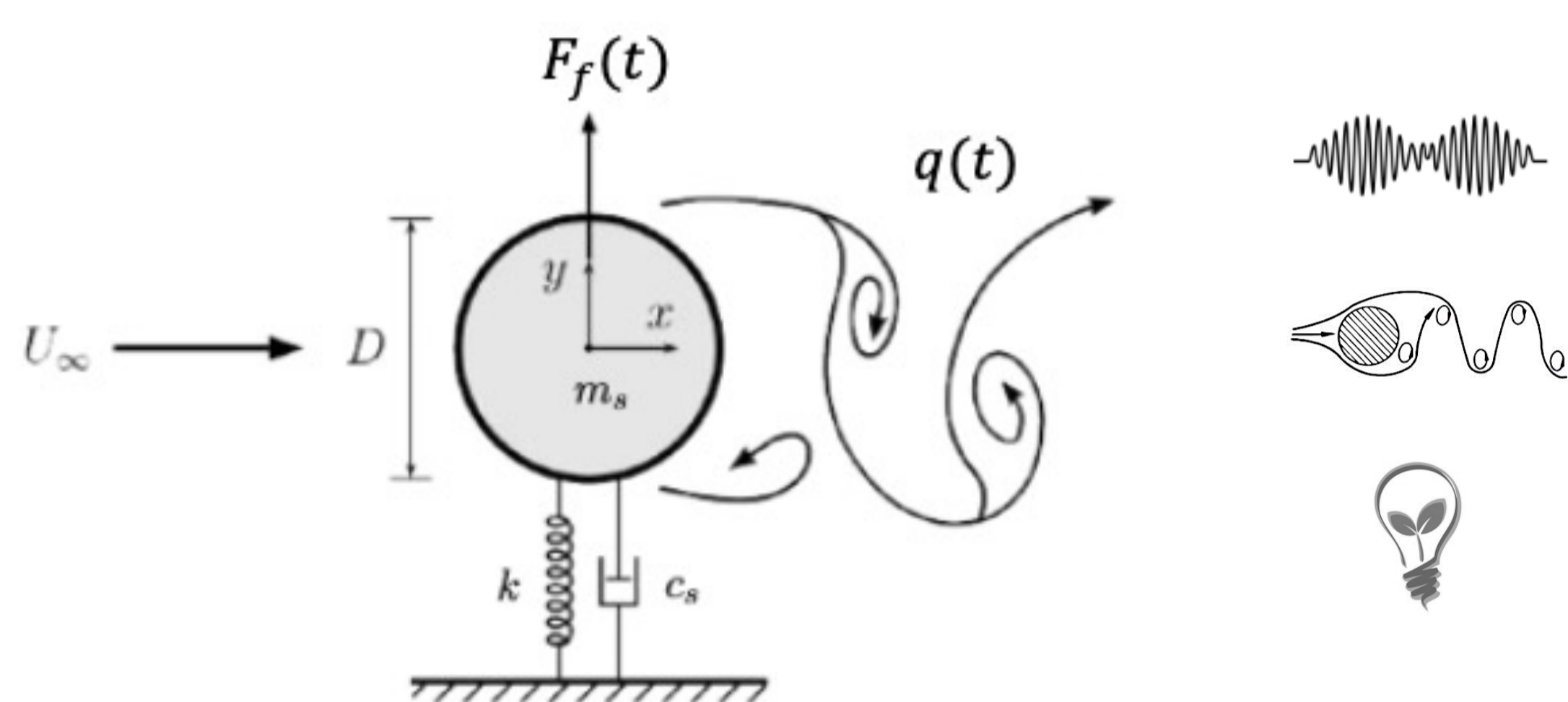




Energy harvesting module for the exploitation of flow-induced vibrations in water current

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What is flow-induced vibrations and how to exploit it ?



Fluid-structure interaction (FSI): coupling between structure motion and shear layer dynamics.

Vortex-induced vibrations (VIV): type of FSI induced by alternate vortices shed in the wake of the symmetric body.

Green energy harvesting: convert energy of the structure's motion induced by energy transfer from the flow into mechanical or electrical energy.

Energy harvester module



Elastically-mounted rigid circular cylinder immersed in water current and experiencing vibrations induced by the formation of quasi-periodic vortical structures.



Low-mass platform mounted on air bearing systems coupled with a DC motor/generator for real-time simulation of arbitrary linear/non-linear forcing laws such as varying damping and/or stiffness.

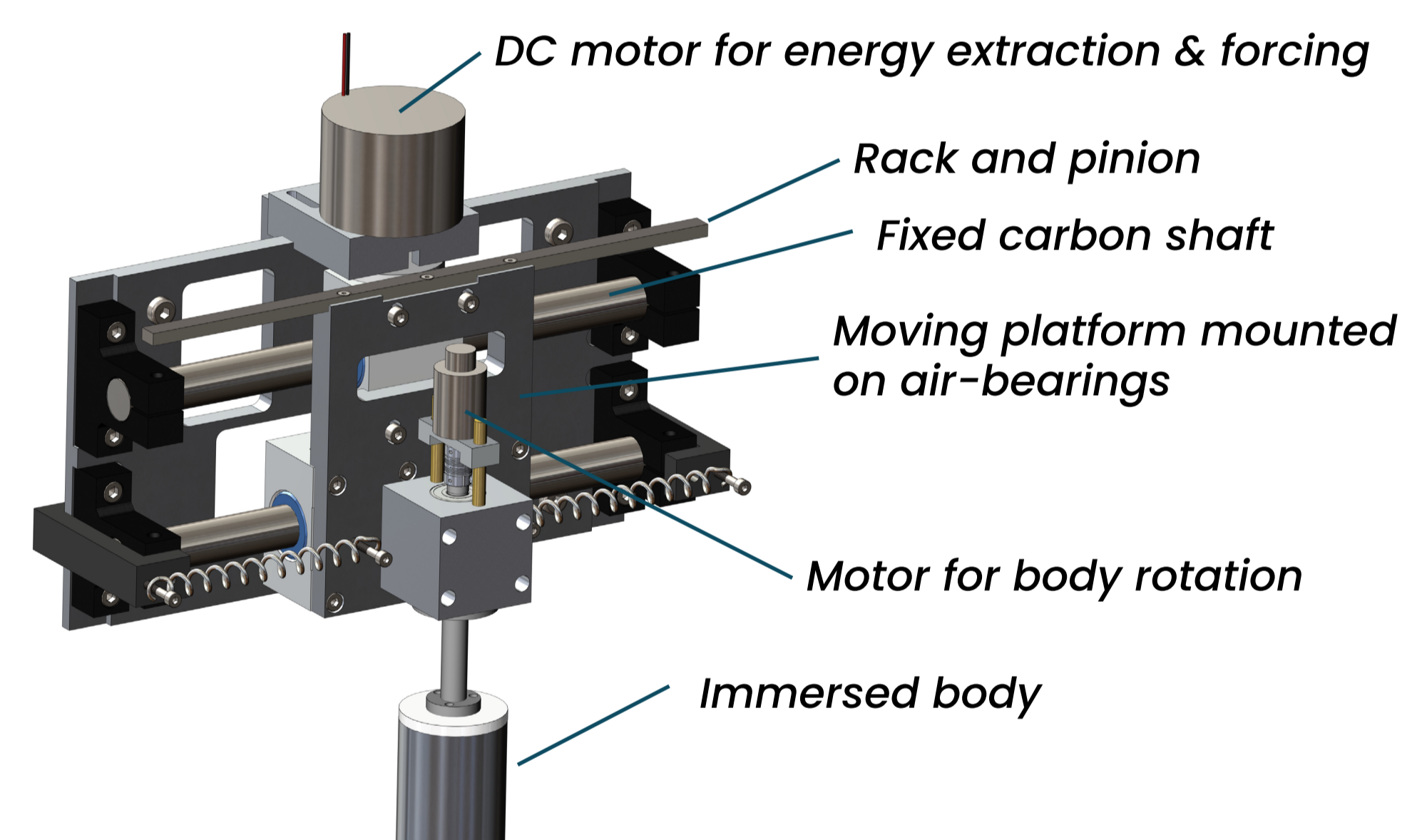
$$m\ddot{y}(t) + c\dot{y}(t) + ky(t) = F_y(t) + F_\mu(t) + F_{DC}(t)$$



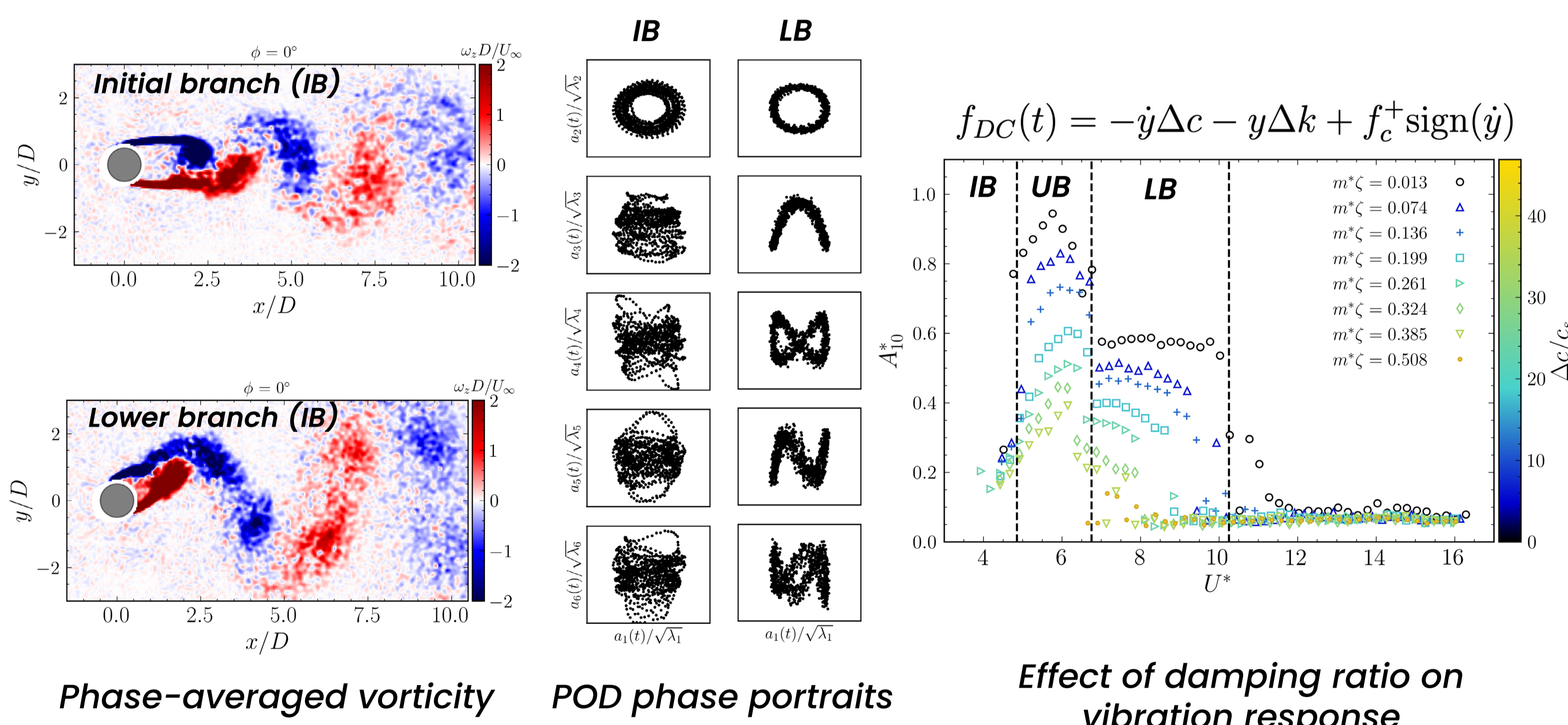
Full characterization of the vibration and flow responses thanks to advanced metrology and low-order reduced modelling strategies.



Optimization of energy efficiency thanks to virtual damping and stiffness control. Simulation of generator laws.

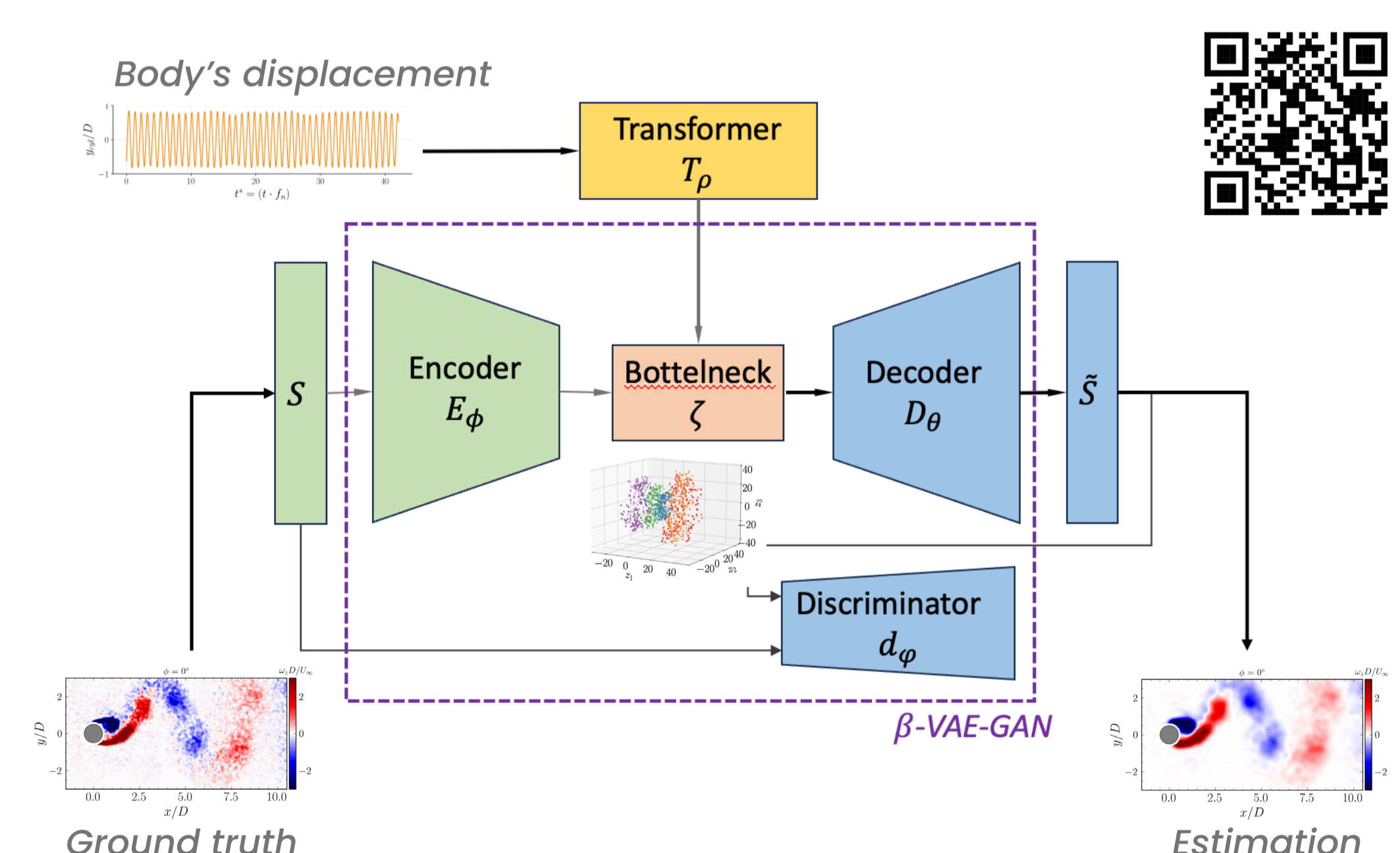


Schematic view of the damper-spring system



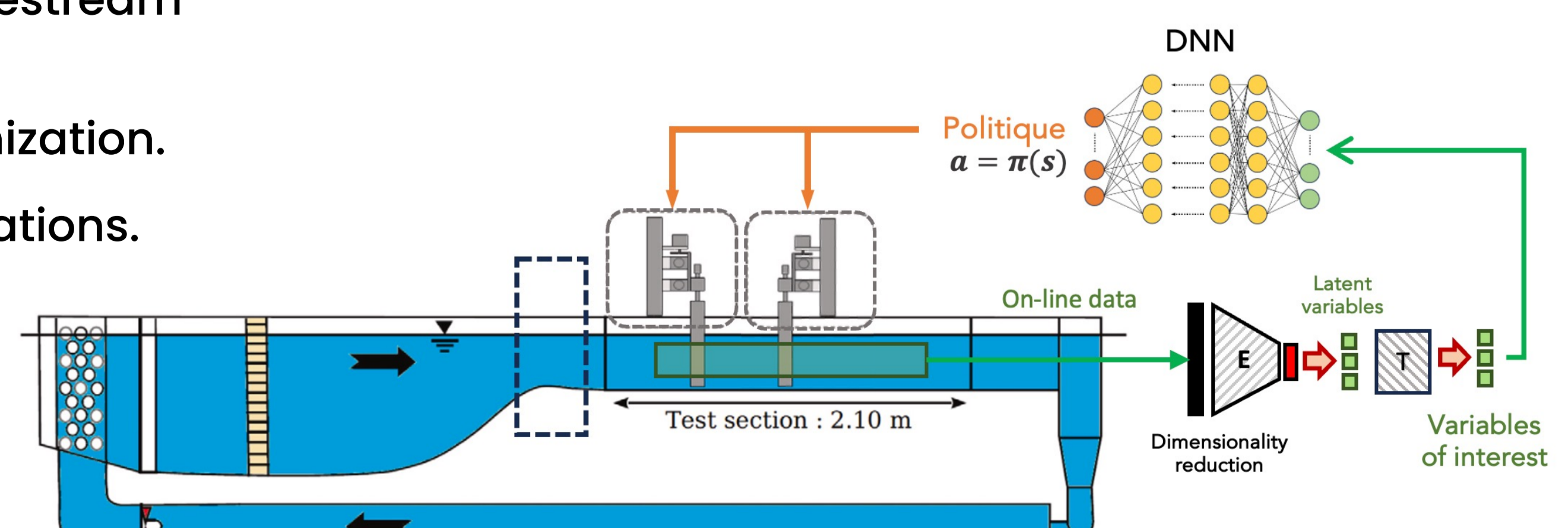
AI-driven low-order prediction

Hybrid β -variational Autoencoder-Generative Adversarial Network (β -VAE-GAN) architecture with masked convolutions to extract dominant flow features into a compact latent space while preserving fidelity at solid-fluid interfaces.



Prospective work

- Simulation of real flow environments : influence of freestream turbulence and/or large-scale incoming perturbations.
- Application of machine learning techniques for control/optimization.
- Association of modules for exploitation of wake-induced vibrations.
- Technology Readiness Level (TRL) increase.



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