GO-VIKING: managing vibration impact in nuclear power plants

Gathering expertise On Vibration ImpaKt In Nuclear power Generation

GO-VIKING is a Horizon Europe initiative bringing together some of the best expertise in fluid dynamics, flow-induced vibration (FIV) phenomena, and structural integrity of key Nuclear Power Plant (NPP) components all over the world. It aims at improving the operation and safety of contemporary nuclear power plants and the design evaluation of new reactor concepts.

Duration: June 2022 –May 2026

Coordinated by: Dr. Angel Papukchiev, GRS & Kevin Zwijsen, NRG

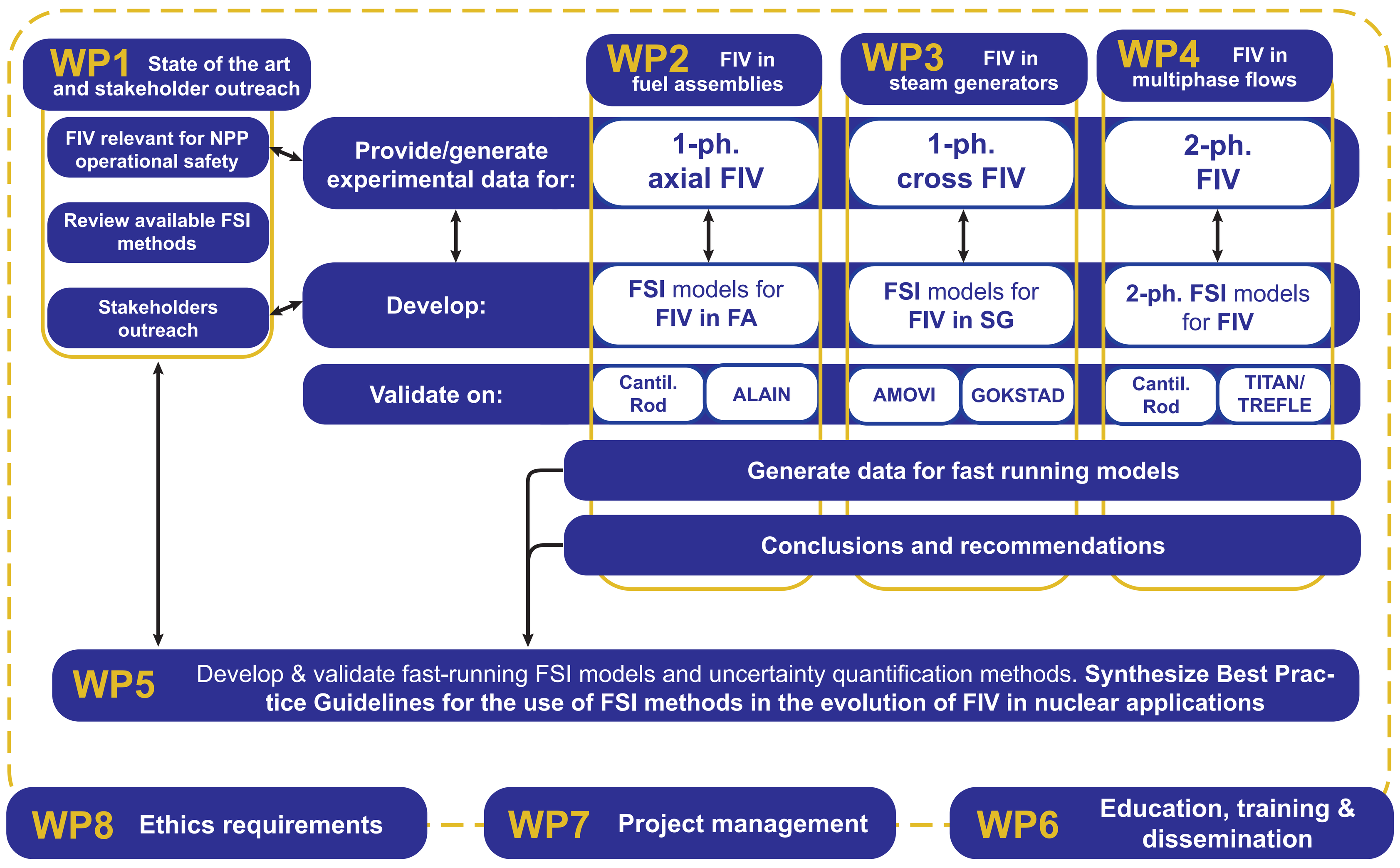
Objectives

- Generation of new experimental and high-resolution numerical data, relevant for nuclear fuel assemblies (FAs) and steam generators (SGs)
- Provision of validated fast-running fluid-structure interaction (FSI) tools with uncertainty quantification methods
- Training of stakeholders and graduates in numerical FIV analysis
- Expanded knowledge on efficiency, accuracy and reliability of FSI methods
- Synthesis of best practices for FIV analyses and highly increased expertise in FIV phenomena in NPP

Impacts

- Shorter NPP outages, increased plant availability and lower staff exposure through less leaking fuel rods and steam generator tubes
- Reduced probability of steam generator tube rupture accidents enhance the reactor safety
- The development and application of accurate and efficient FSI tools and methods improve the understanding of FIV phenomena
- Such programs support vendors in the design, regulators in the safety evaluation, and operators in the deployment of innovative nuclear systems

Structure

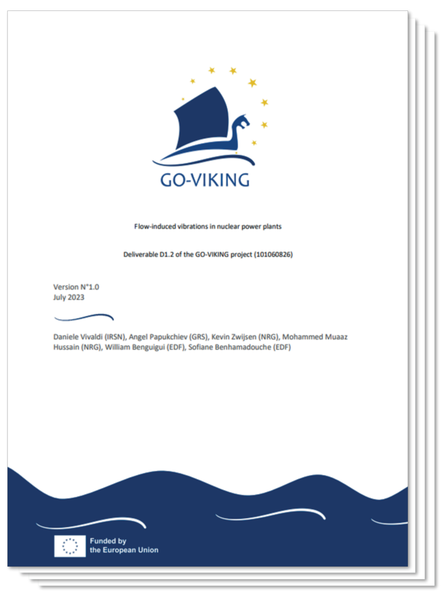


Our achievements

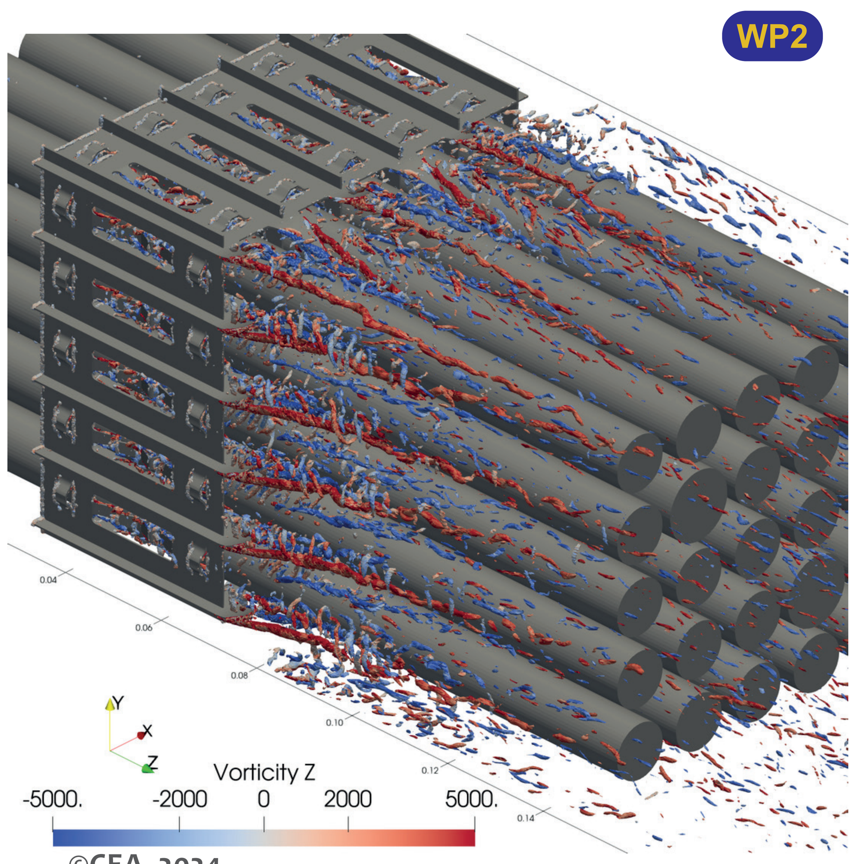
WP1

A thorough review on FIV in NPPs focused on:

- FIV phenomena occuring in NPPs
- Numerical methods for their evaluation
- FIV experiments



WP2



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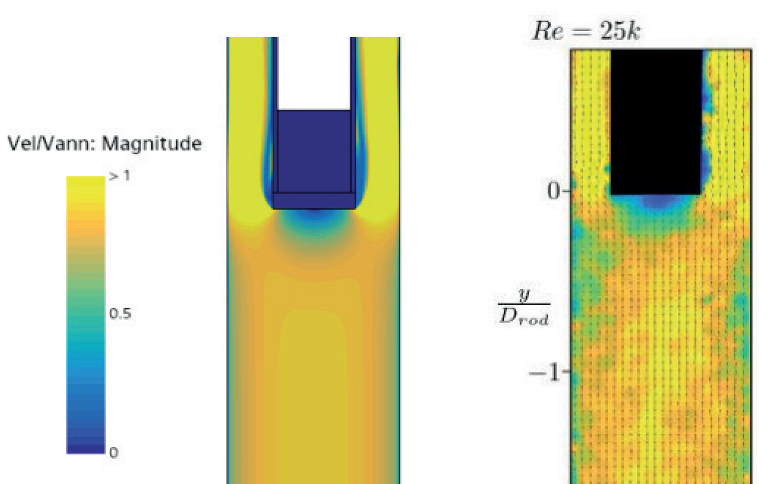

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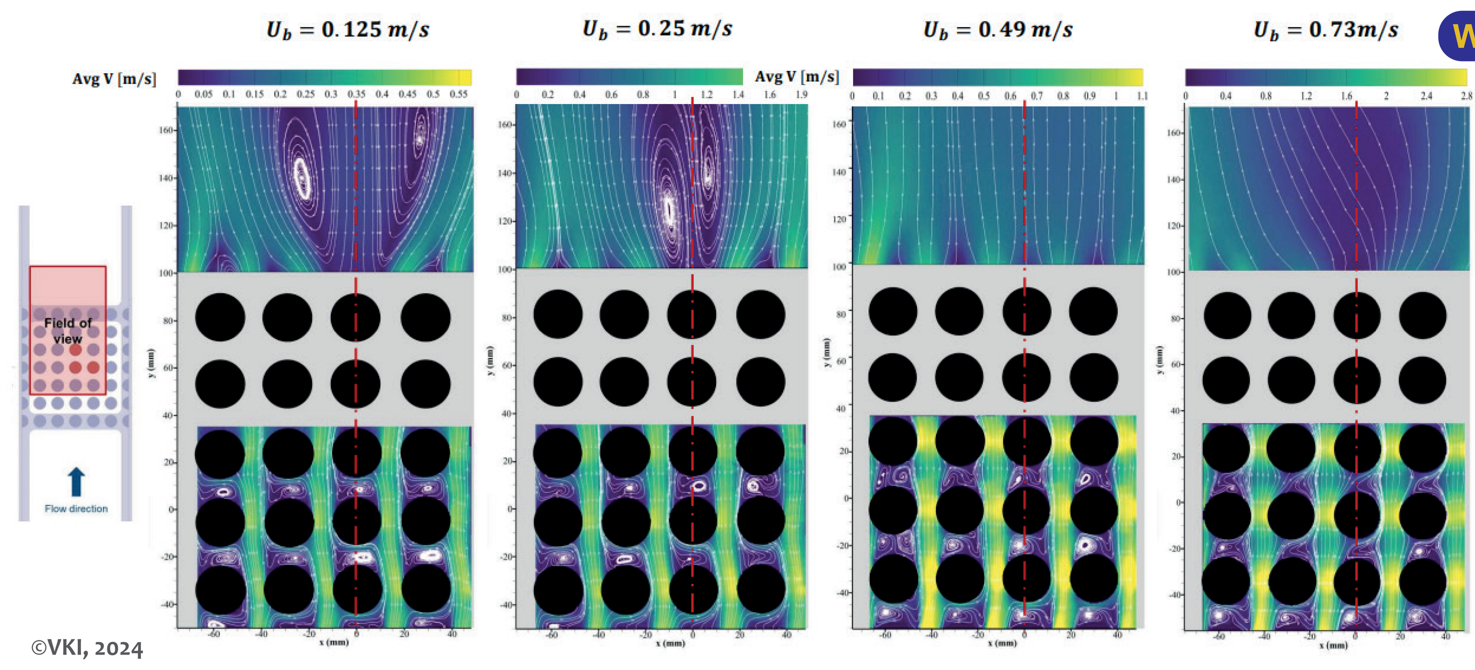
- High- and medium-resolution simulations performed for the Cantilever Rod and ALAIN fuel bundle experiments
- The analyses revealed the vibration characteristics of the Cantilever rod with different tips
- Large Eddy Simulation appears necessary for the calculation of the Turbulence-Induced Vibrations in ALAIN rod bundle

WP3



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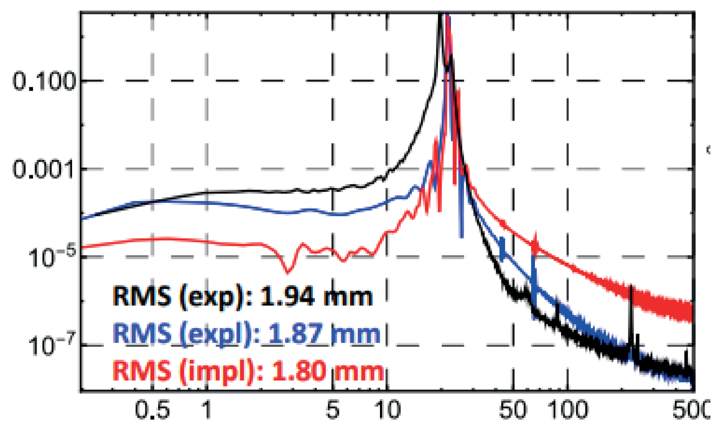
- First experimental runs in the brand new GOKSTAD facility generated valuable flow and vibration response data
- High- and medium-resolution analyses performed for the AMOVI single tube and tube bundle experiments
- Vibration frequencies and AMOVI tube displacements in good agreement with data



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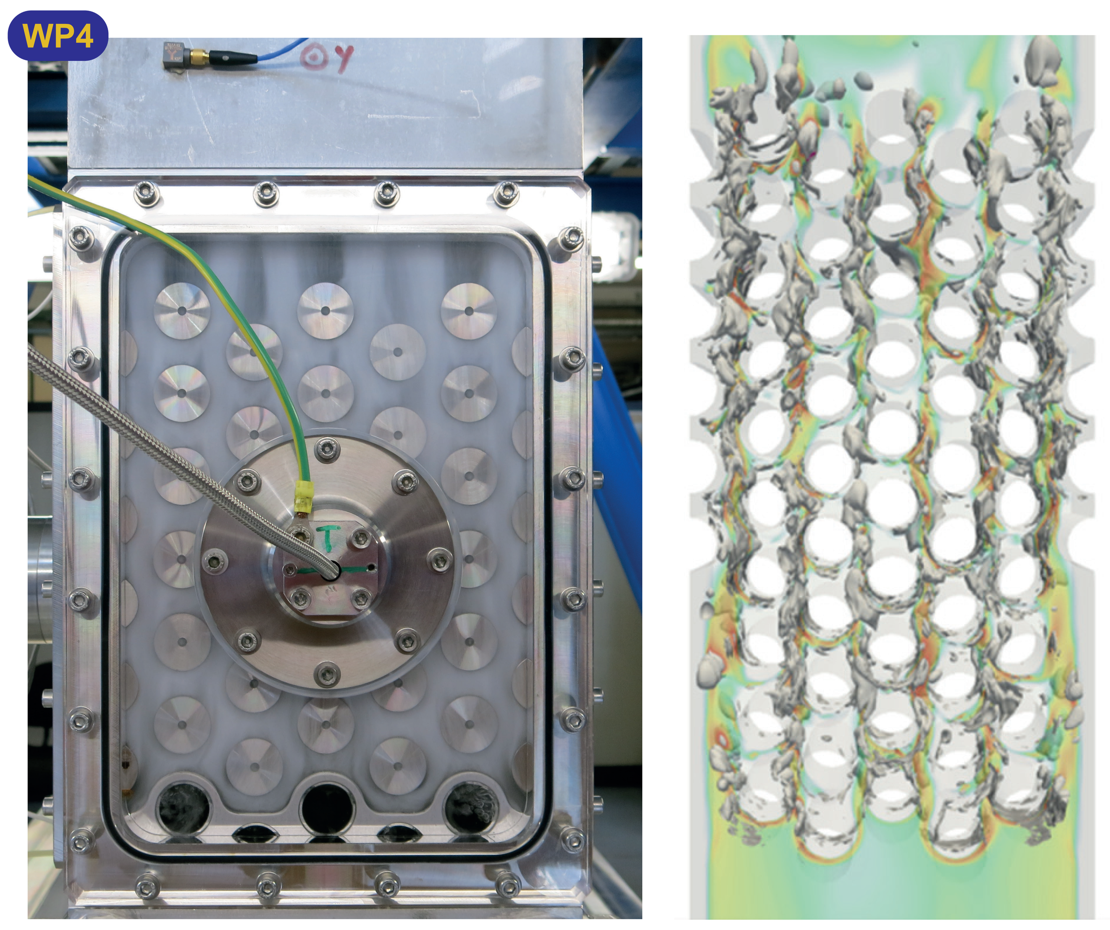
WP4



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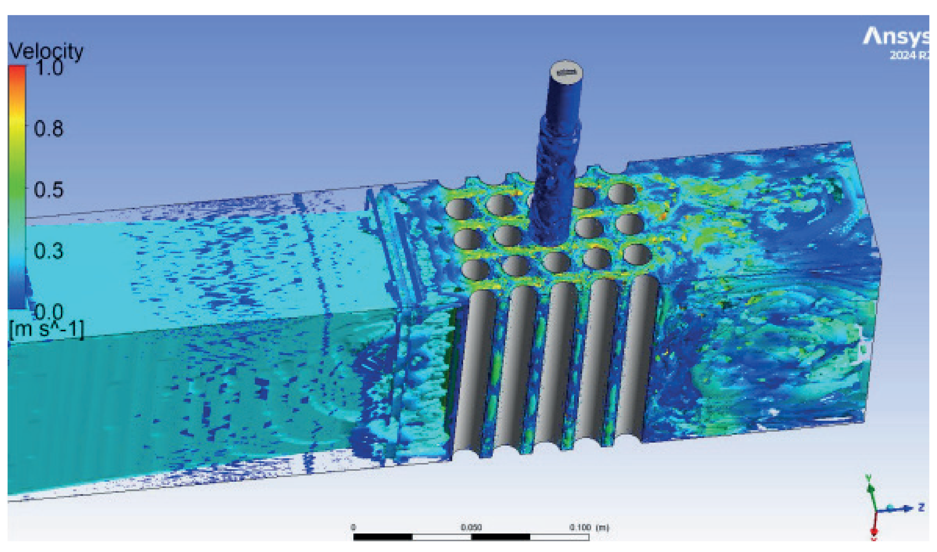
- The two-phase Cantilever Rod experiment analyzed with different multiphase methods
- First two-phase simulations of TITAN and TREFLE experiments provided valuable insights into the capabilities of the various multiphase modeling approaches for FIV applications
- Two-phase inlet flow conditions (bubble size and distribution) need special attention, since these significantly influence the numerical results

WP5



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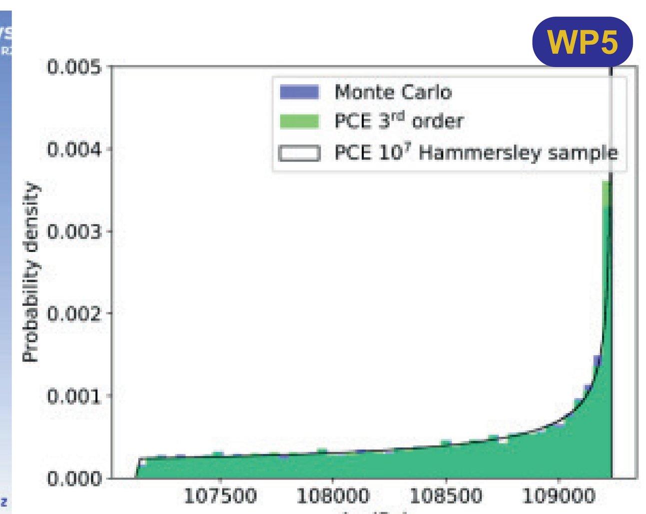

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- Fast-running methods for the fluid and solid domains developed to speed-up the computationally expensive FSI analyses
- First validation of the new methods on AMOVI show good agreement with data
- Polynomial Chaos Expansion and Bayesian framework identified as good candidates for quantification of uncertainties in FSI analyses

Partners

GRS, NRG, Universiteit Gent, LGI, EDF, TU Delft, VTT, framatome, IRSN, von Karman Institute for Fluid Dynamics, IPP Centre, enea, Vattenfall, cea, PennState, EDF*, Manchester

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