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Performance assessment of a new kinetic turbine prototype

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Objectives of this "pilot & demonstrator" project

- Design and construction of a first prototype of isokinetic turbine for artificial channels with a power of 1 kW
- Evaluation of its hydraulic performances in the tailrace canal of the Lavey run-of-river powerplant (Rhône river)
- Validation of the numerical simulation results
- Preparation of an industrialization phase to exploit this energetic potential in Switzerland and abroad

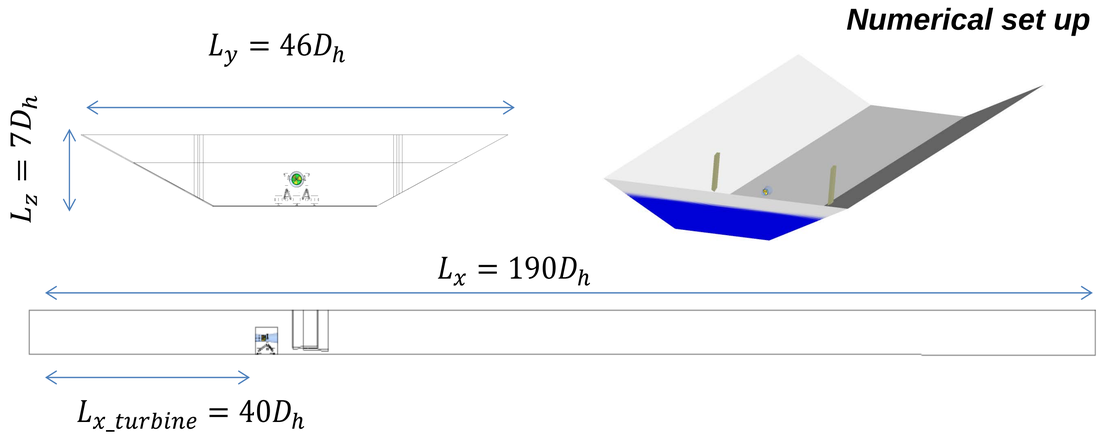
Pilot site

The pilot site to assess the performance of the first prototype is the tailrace channel of the run-of-the-river Lavey Hydropower plant in Switzerland. At the end of 2016, the open-air platform and the turbine have been installed in the tailrace channel.

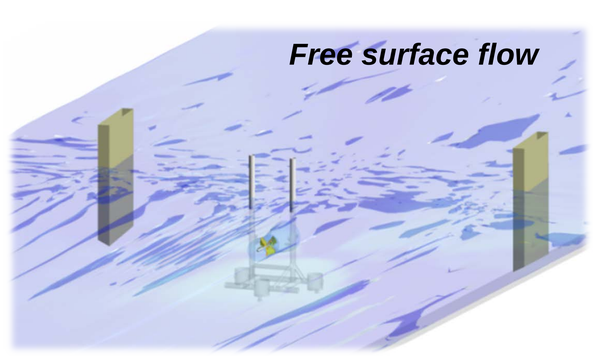
Numerical investigations

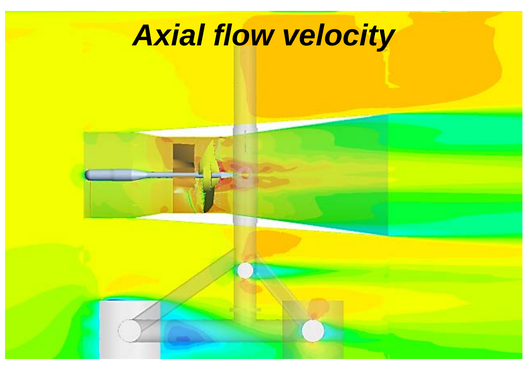
Unsteady multiphase homogeneous flow numerical simulations of the turbine in the tailrace channel of Lavey have been performed using the ANSYS CFX software. The incompressible Reynolds Averaged Navier–Stokes equations are solved using a finite volume approach. The set of equations is closed-formed and solved using a two-equation turbulence model: the Shear Stress Transport (SST) model. A hybrid mesh of 13 Millions of nodes is used.

Numerical set up



The numerical results have shown that the turbine has no impact on the available head of the Lavey powerplant. Moreover the Venturi effect of the duct and the specific design for the runner induce a strong acceleration of the flow inside the machine, as expected [1].

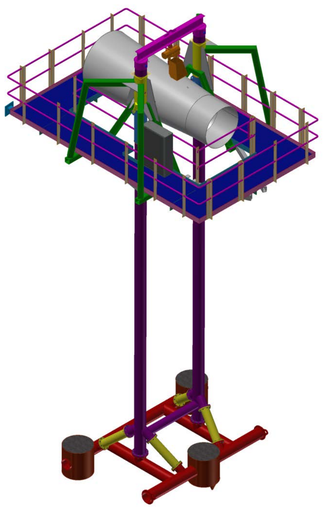




Experimental investigation

To measure the performance of the kinetic turbine on the pilot site, a specific instrumentation has been set up [2]:

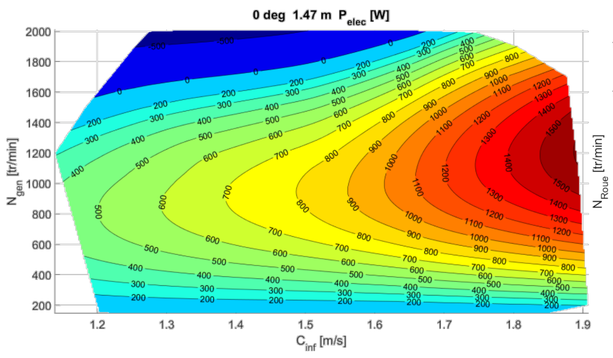
- Acquisition/control system
- River boat equipped with an ADCP system
- Electrical multimeter
- Onboard instrumentation



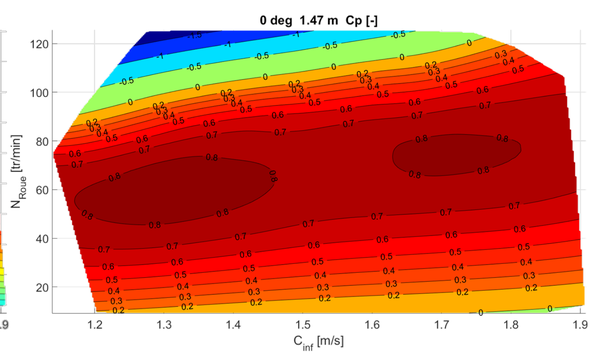
Performance assessment

The turbine performance is obtained by measuring the produced electrical power compared to the available hydraulic power [3]. The objective of the project to reach 1kW with the turbine has been largely outshined with a maximal electrical power measured of 1.5 kW.

Electrical power production

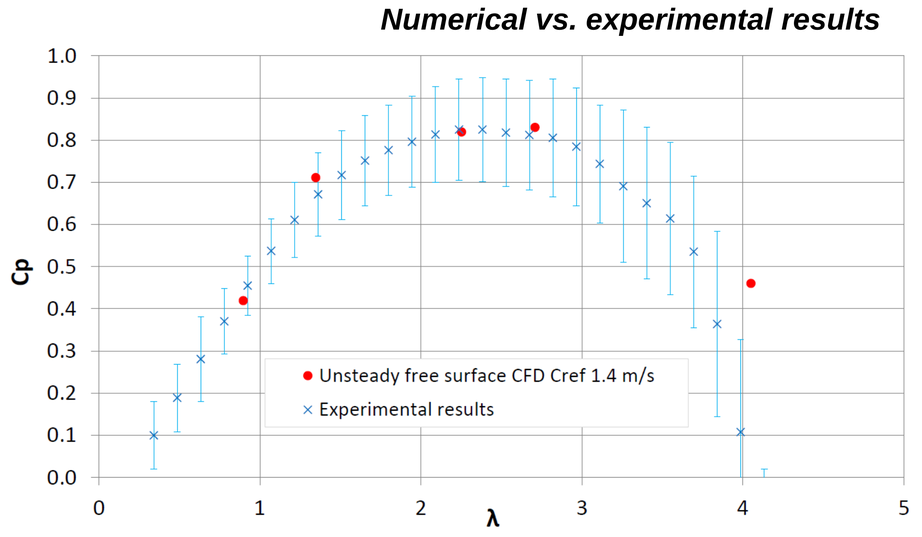


Power coefficient



The numerical and experimental performances have been compared and a very good agreement is observed:

Numerical vs. experimental results



Conclusions and perspectives

These investigations have shown that:

- The objective of the project to produce 1kW with a new prototype of a kinetic turbine has been reached.
- Unsteady two phase flow numerical simulations allow to predict performance fairly accurately at BEP.
- The next step is the installation of a farm of kinetic turbines to investigate the influence of the machines between each other.

Acknowledgements

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[3] S. Richard, A. Gaspoz, V. Hasmatuchi, N. Brunner, S. Chevailler, C. Münch-Alligné, 2017, "Development of an experimental protocol to assess the new kinetic turbine performance", Annual conference, SCCER SoE, Zurich.