PHD THESIS

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Flow manipulation for improved operation of hydraulic turbines

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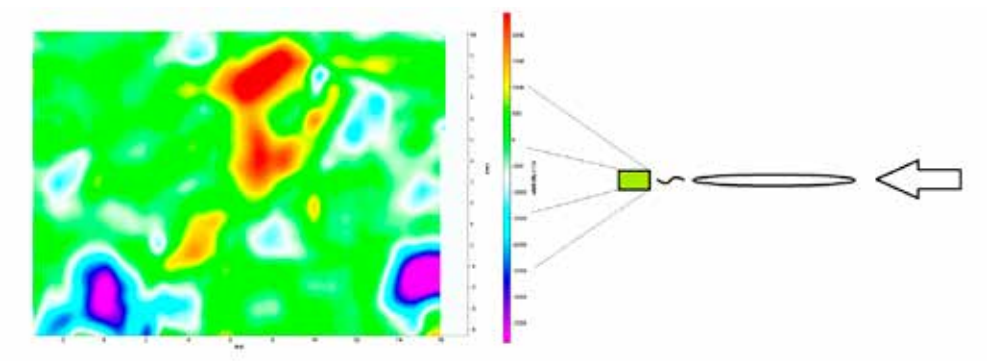
Background

In Francis turbines, modern industrial designs and installations are pushing the material costs to a minimum. This increases risk of turbine component failure, and recent failures in new hydropower installments point towards gaps in the understading of the complex fluid-structure interactions (FSI) present in the turbine. This work will focus on modifications to guide-vane design, in order to mitigate lock-in effects and provide insight to the rotor stator interaction in Francis turbines.

Particle image velocimetry (PIV) measurements will be utilized in order to study the wake of hydrofoils, coupled with vibration measurements of the structure. New guide vane designs, developed using computational fluid dynamics analysis will also be tested in situ on the Francis model test rig at the Waterpower Laboratory.

Once a functional protoype has been put forth, the foundation is laid for further optimization and life-time analysis of the design versus conventional designs.



PIV measurement of the wake of a hydrofoil taken in the Waterpower Laboratory at NTNU. Image is colored according to vorticity about the axis perpendicular to the imageplane, showing the vortices of alternating rotation in a turbulent Von Karman vortex street.