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Experimental and numerical studies of hydropeaks in a 15 MW run-of-river Pelton powerplant.

A.Gaspoz, V. Hasmatuchi, J. Decaix, C. Nicolet, M. Dreyer, S. Alimirzazadeh, F. Avellan, C. Münch-Alligné

HES-SO Valais, School of Engineering, Hydroelectricity Group, CH-1950 Sion, Switzerland, @hevs.ch

Contexte

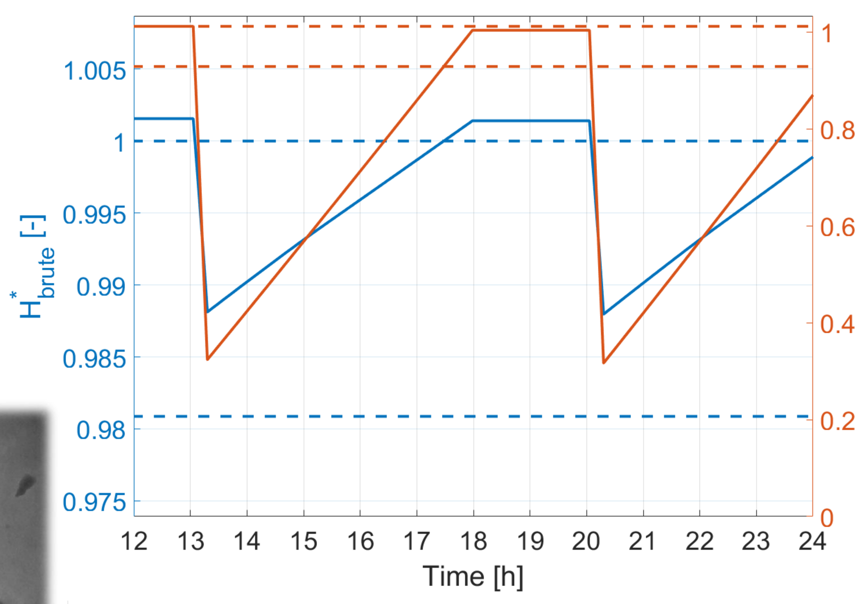
The Gletsch-Oberwald powerplant was commissioned at the end of 2017 and is equipped with two 7.55 MW Pelton turbine. The flow of the Rhône river is turbined throw 6 injectors per turbine near the village of Oberwald, canton of Valais, Switzerland, with a nominal head of 287.5 m. The owner is *Forces Motrices Valaisannes (FMV)* and they have decided to studie the faisability to sell network regulations services to the power grid manager, *SwissGrid.* The group *Hydroelectricity of the HES-SO in Sion, Valais,* in collaboration with *Powervision Engineering in Ecublens (PVE),* and the *Laboratoire de machine Hydraulique (LMH), EPFL in Lausanne*, have to determine the impact of hydropeaking on the hydraulic parts of the powerplant.

Parts of study

(1) Forebay: Respect of head limits – Analytical model => HES
Water surface behaviour – Observation by IR-camera => HES
Vortex phenomenon – Laboratory model [1] and CFD => HES
(2) Penstock: Transient phenomenon – 1D model calculated in real time by the numerical clone *Hydro-clone [2]* => PVE
(3) Injector: Jet quality, and discharge repartition – CFD => HES
(4) Runner: Torque effect on the Runner – FVPM [3] => LMH

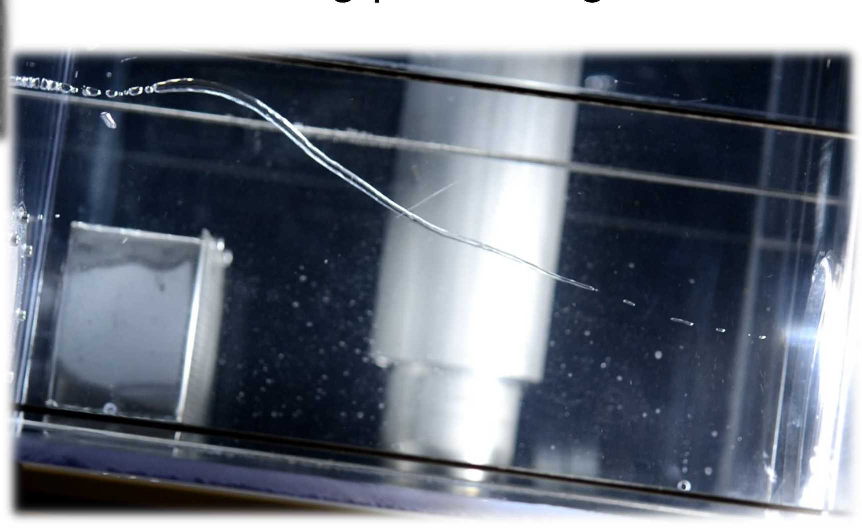
Results

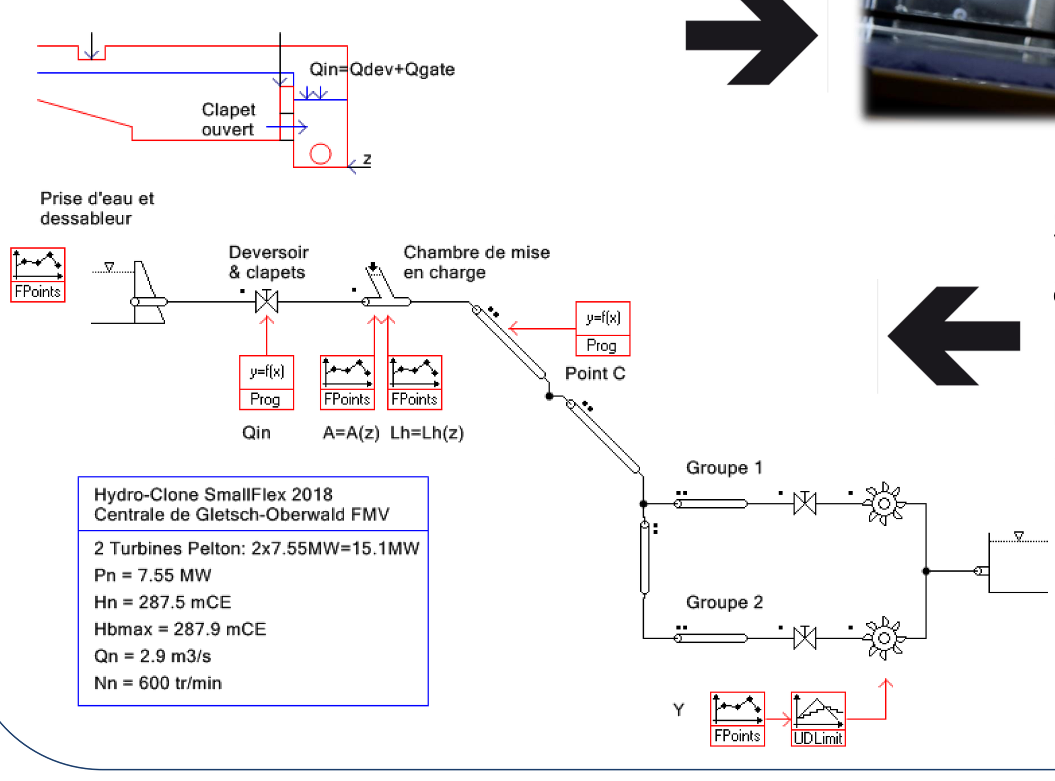
Prediction of head variation by hydropeaking – analytical model



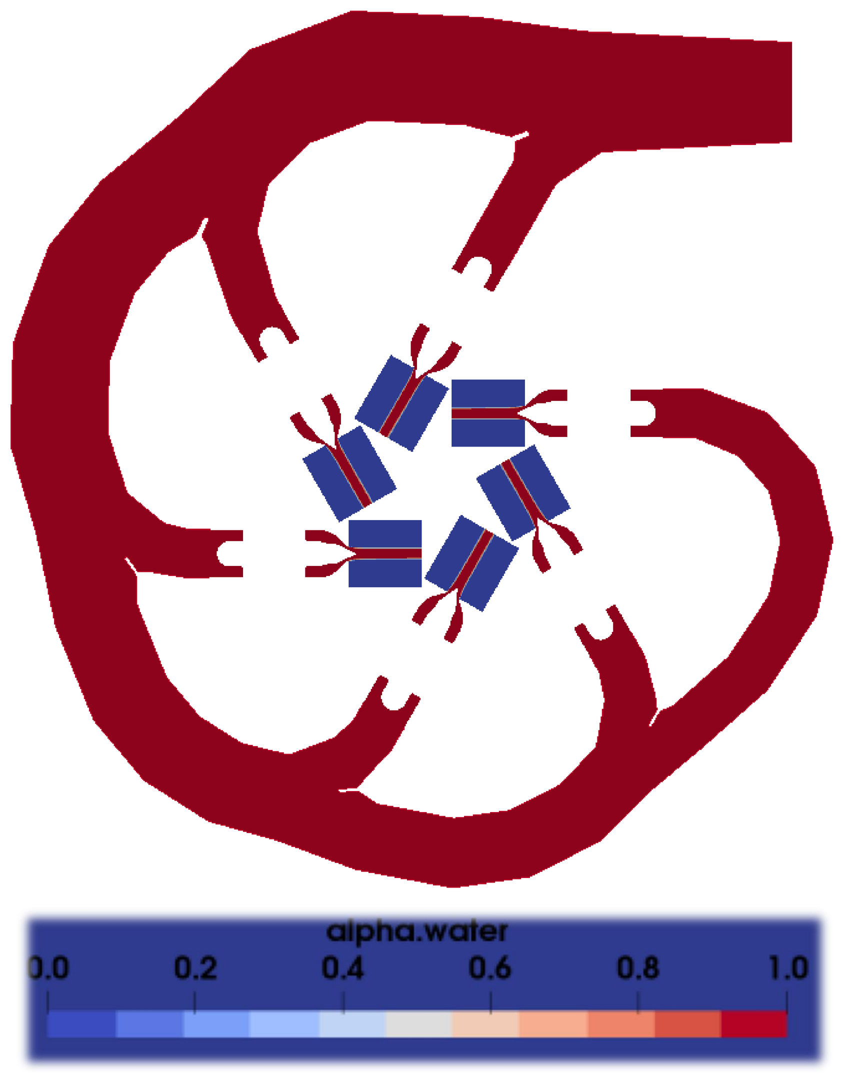
Water surface in the forebay during power augmentation

Vortex rope core @ 150% of the maximum power – reduced scale

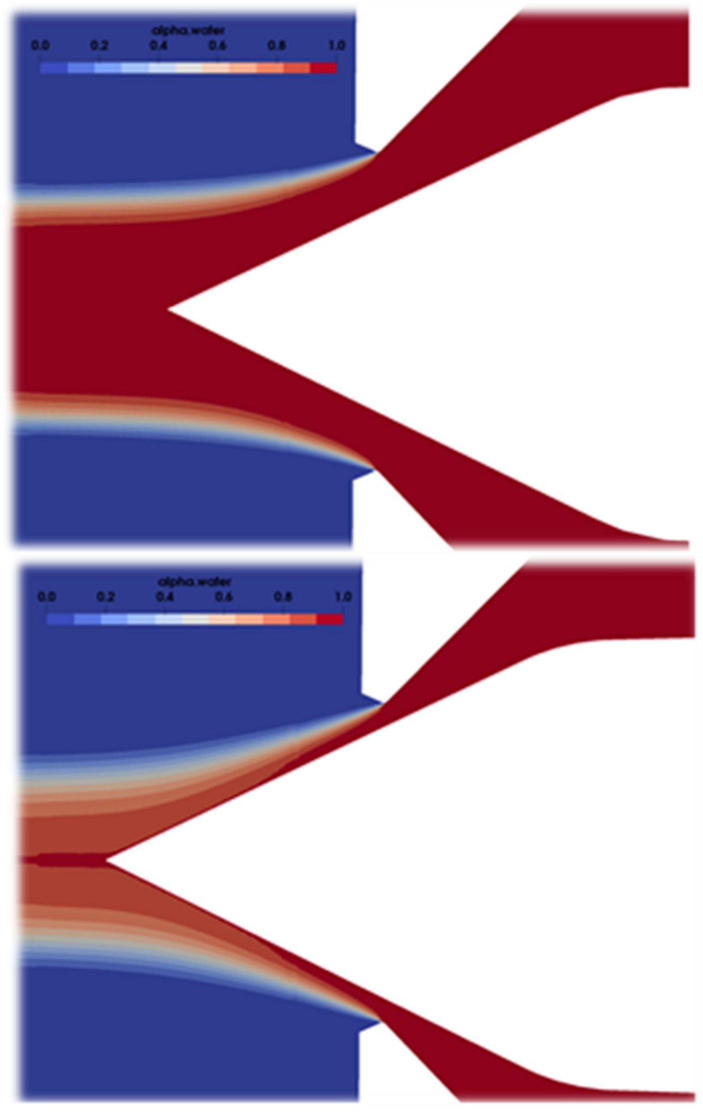




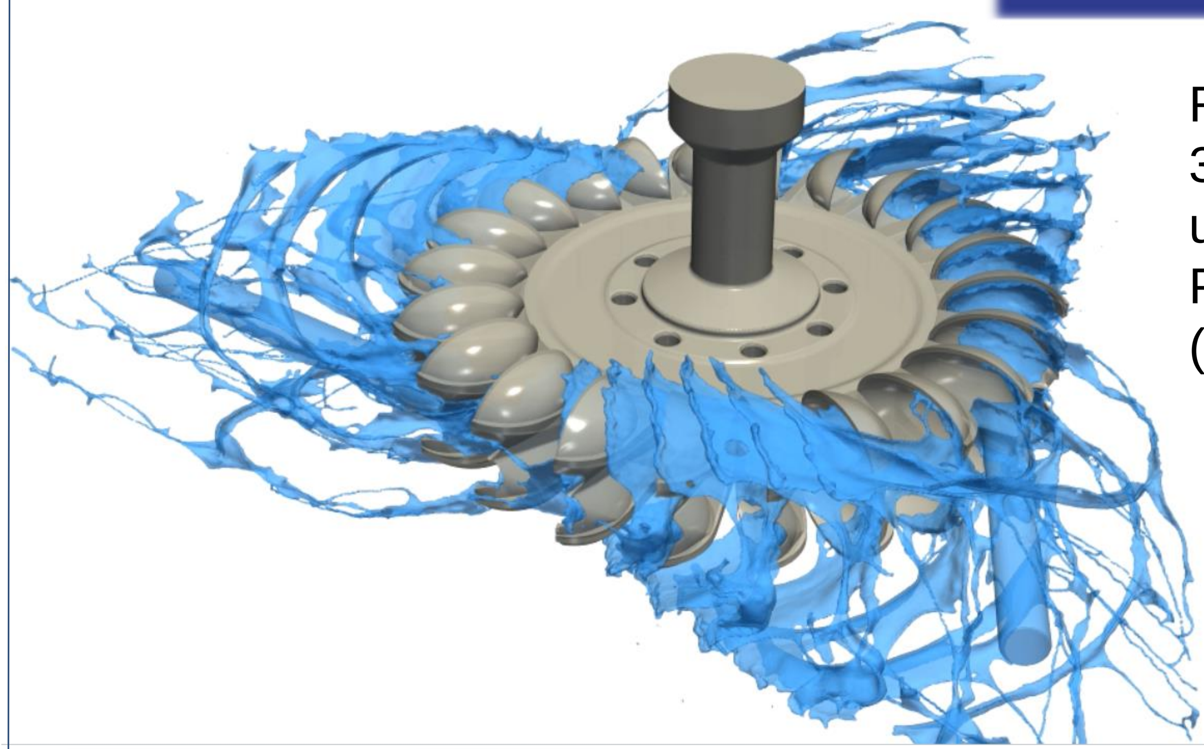
Simsen model for transient analysis of the hydraulic part Modele used to create a numerical clone of the powerplant



CFD multiphase results of the water volume fraction in the turbine splitter, with the 6 injectors



CFD results of the jet at different nozzle position



Results of simulation of 3 jet on the runner - using Finite Volume Particle Method (FVPM)

Conclusion

This project indicate that the calculation of each hydraulic element in a powerplant, separately, is possible with relative good quality of results. The challenge is to couple the different results of some simulation as boundary conditions for other simulation. This process can be one-way or two-way. Furthermore, the prediction of behaviour of each element in transient situation is also a challenge, specifically for numerical investigation.

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SCCER SoE

Power Vision Engineering

FMV

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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[2] Nicolet, C., Béguin, A., Bollaert, E., Boulicaut, B., & Gros, G. (2015). Real-time simulation monitoring system for hydro plant transient surveys Int. *Journal on Hydropower & Dams*, *22*(5), 62-69.

[3] S Alimirzazadeh, T Kumashiro, S Leguizamón, A Maertens, E Jahanbakhsh, K Tani and F Avellan· GPU-accelerated Pelton turbine simulation using finite volume particle method coupled with linear eddy viscosity models. IOP Conference Series: Earth and Environmental Science 2019. Vol 240