SCCER SoE

SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

SMALL FLEX
Increase Flexibility in Small Hydropower Plants

C. Münch & all the project partners

In cooperation with the CTI

Energy
Swiss Competence Centers for Energy Research

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Commission for Technology and Innovation CTI

Context of the SmallFLEX project

Revision of the Swiss Energy Ordinance – 01.01.2018

Feed-in tariff at cost (KEV) has been changed to encourage small producers to produce electricity according to the demand or in other words to follow the energy market.

Even small hydropower plants have to be more flexible ! What can be the degree of freedom for small run-of-river HPP ?

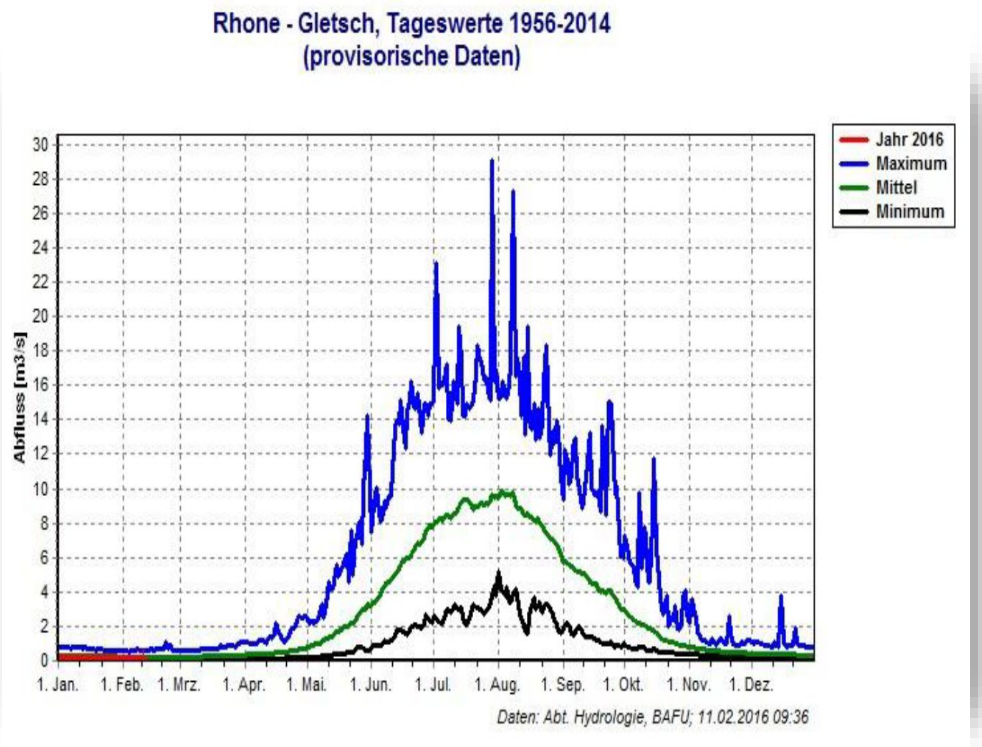
SMALL FLEX Project : a demonstrator to show how small hydropower plants can be flexible and provide winter peak energy as well as ancillary services, whilst remaining eco-compatible.

Small Flex Case study : KW Gletsch-Oberwald

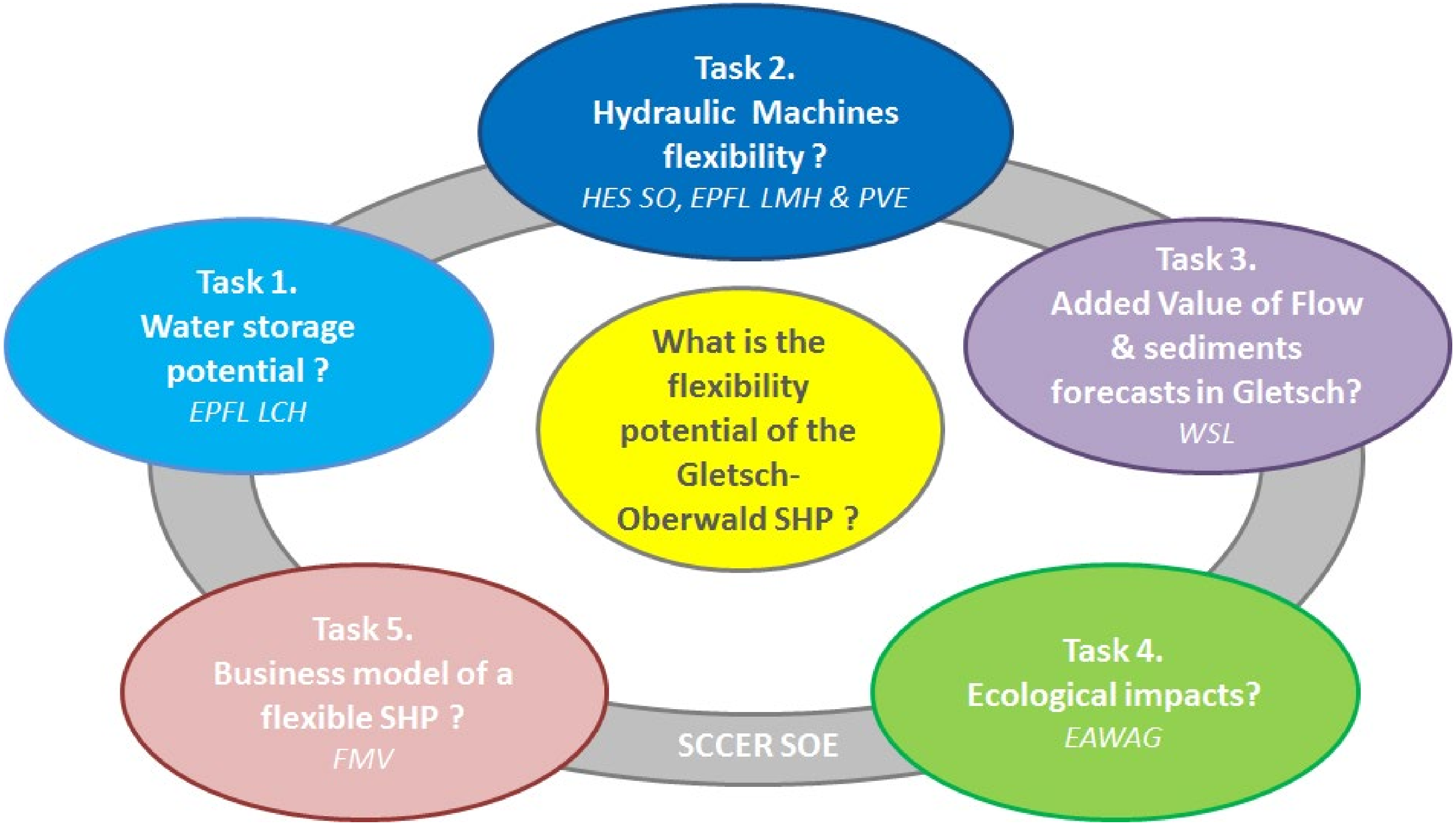
Run-of- the-river power plant

Net head :	288 mCE
Installed discharge :	5.7 m^3/s
Installed capacity :	14 MW
Expected production :	41 GWh/year
Mean gross capacity :	4.68 MW

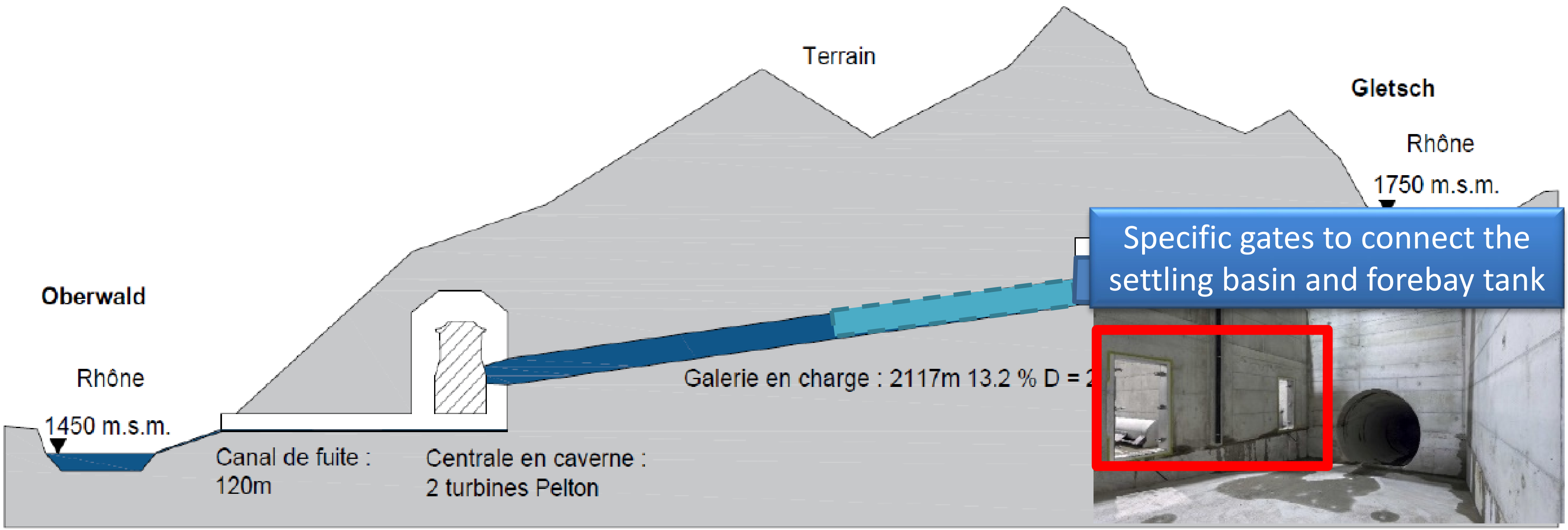
Commissioning : end of 2017



Project organisation



Small Flex Identified storage volume



Specific gates to connect the settling basin and forebay tank

1/3 headrace tunnel ~ 6’400 m^3

Settling basin and forebay tank ~ 2’500 m^3

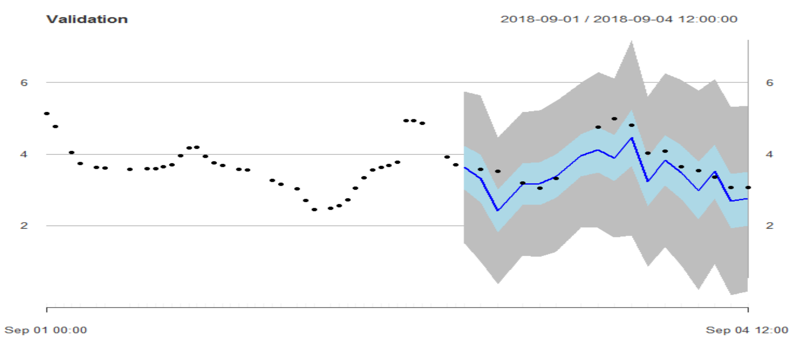
Additional volume for the 2nd campaign

Available volume for the 1st campaign

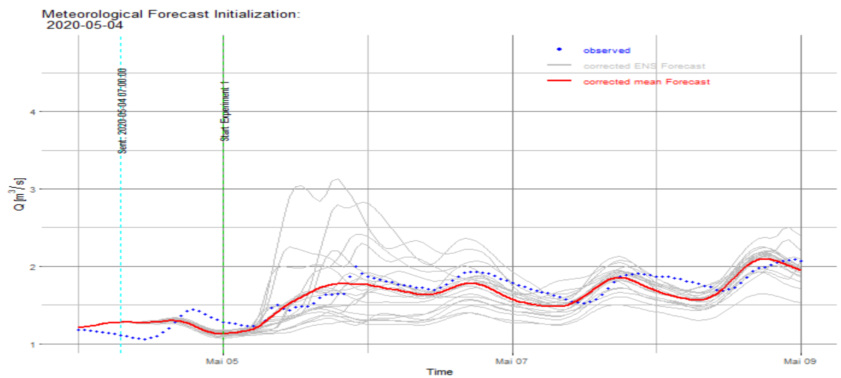
EPFL Hes·so

Forecast of the inflow

INCA-CH + COSMO1 forecast



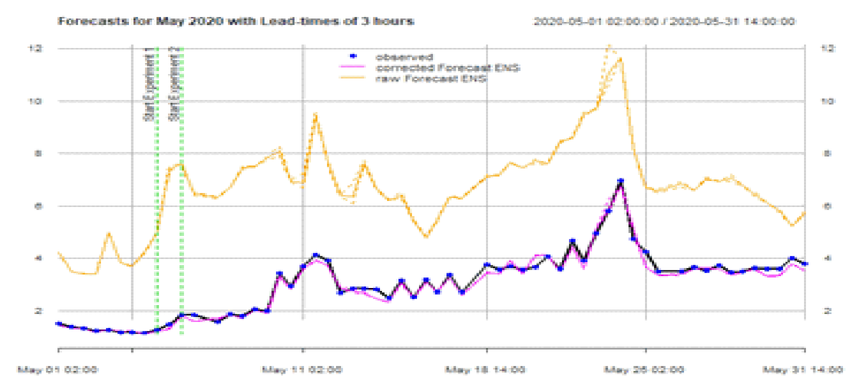
COSMO-E forecast for the test campaign



Operational forecast for the inflow at Gletsch:

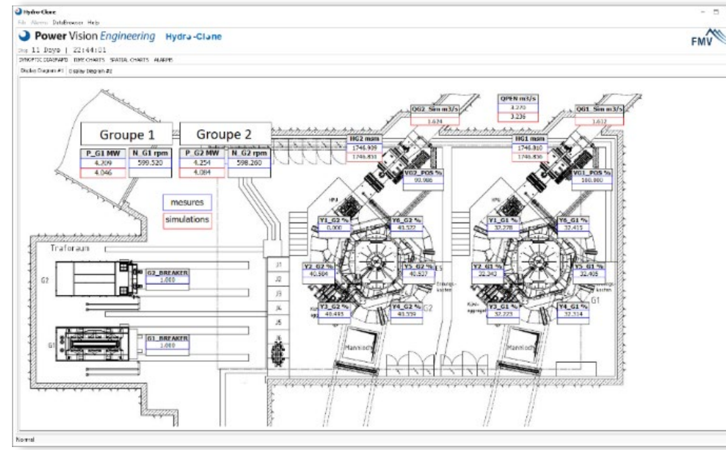
- INCA-CH forecast 6h
- Seamless extension combining INCA-CH + COSMO-1 forecast 33h
- + COSMO E – Ensemble forecast system (21 members) with lead-times of 5.5 days

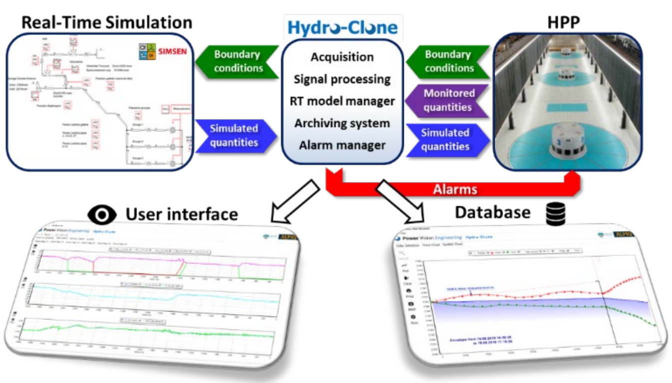
Validation of the forecast in May



Monitoring of the power plant

- Camera in the forebay chamber
- Turbidity measurements
- Monitoring of main quantities of the turbine
- **Hydro-Clone®** system for the whole power plant
- Field measurements & water level in the downstream alluvial area





Power plant PLC
Data (Modbus)
fsample=10Hz

Hydro-Clone PC
Simulation,
Acquisition,
Data processing

SIMSEN

Hes·so Power Vision Engineering EPFL eawag aquatic research

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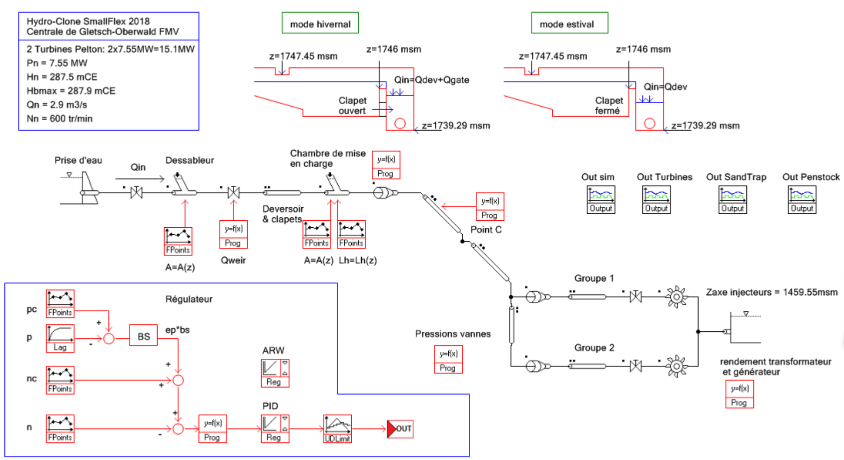
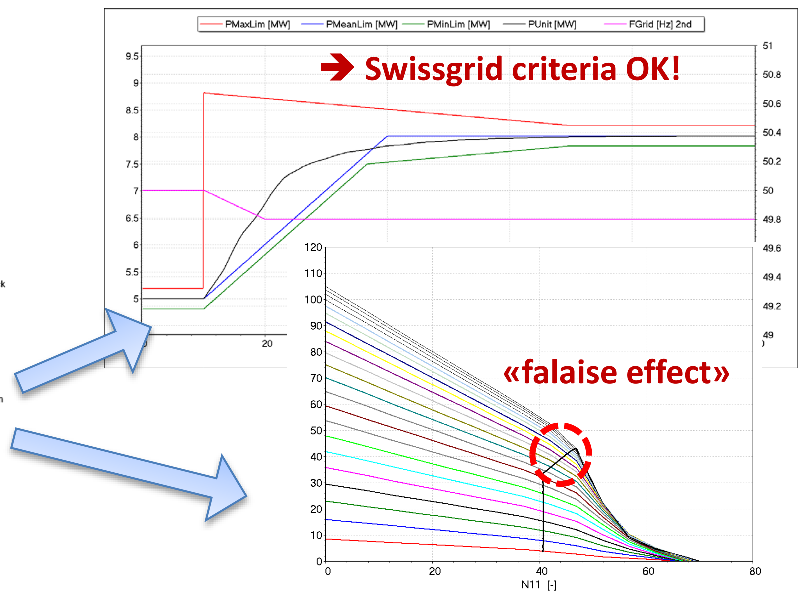
1D Simulation

1D Simsen simulation of the HPP to determine :

- frequency containment reserve (FCR) capability
- «Falaise effect» limits

Gletsch-Oberwald SIMSEN model with turbine governor





Power Vision Engineering

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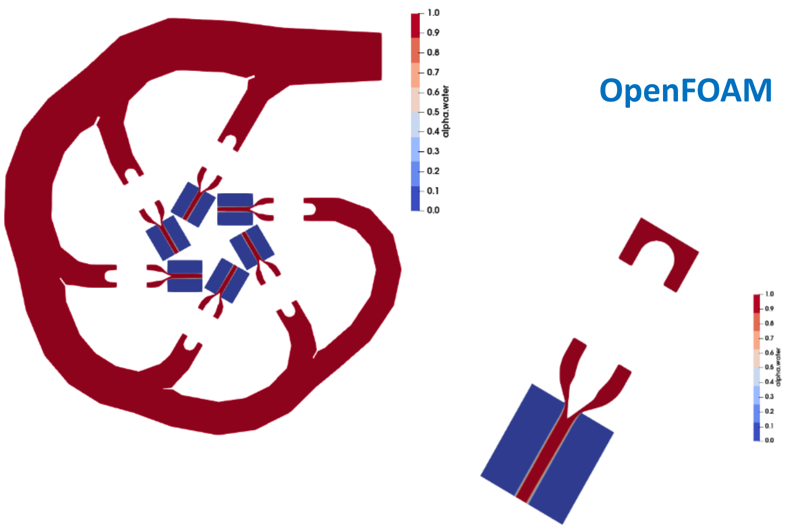
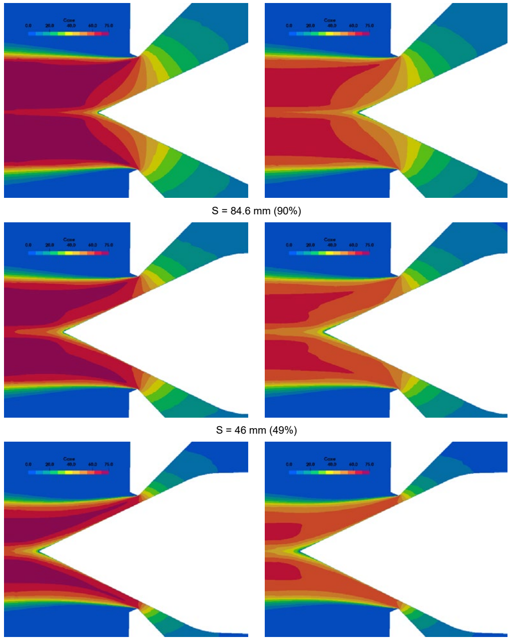
3D Flow Numerical simulation

3D Flow numerical simulation in part of the turbine to

- predict the influence of the head reduction on the jet quality
- provide velocity profiles in the jet for the simulations in the Pelton runner

From nominal head to the lowest tested head



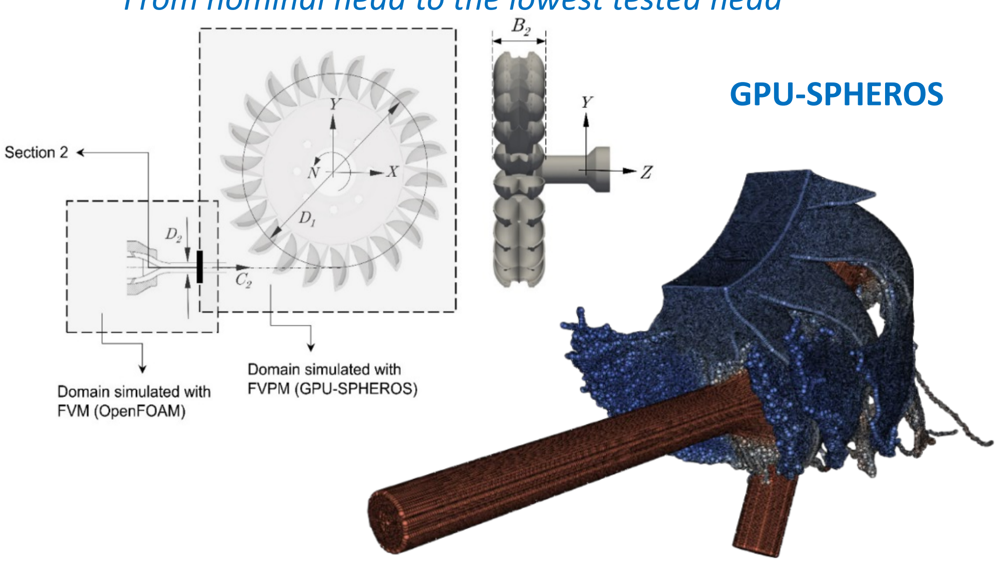


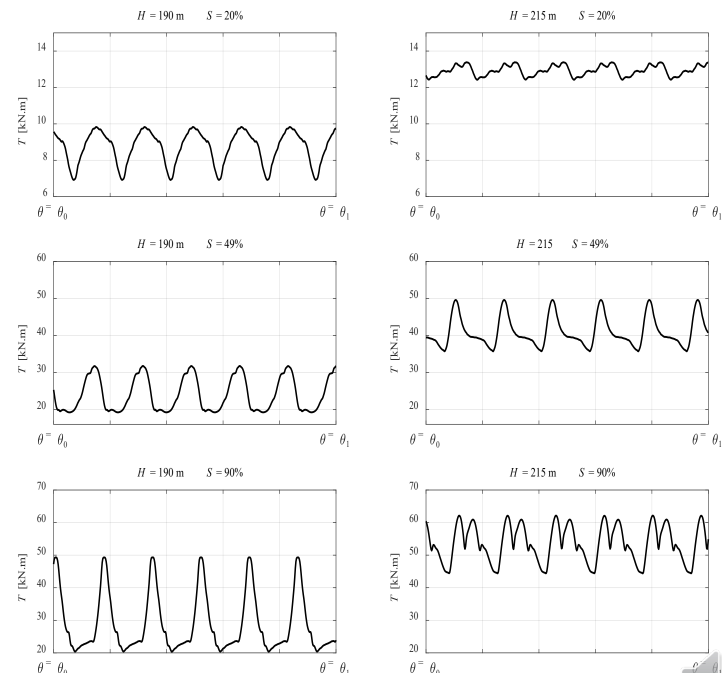
Hes·so

3D Flow Numerical simulation

3D Flow numerical simulation in part of the Pelton runner to predict the influence of the head reduction on the runner and subsequent fatigue.

From nominal head to the lowest tested head





First campaign November 2018

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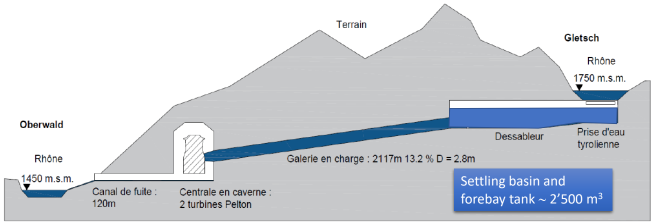
Smart storage used : **Settling basin & Forebay chamber**
On site Monitoring : **Power plant & alluvial area**



Provide the forecast of the discharge during the tests and participate to the set up of the program for the tests (WSL)

Define scenarios according to the available storage volume and monitor the sediments (EPFL)

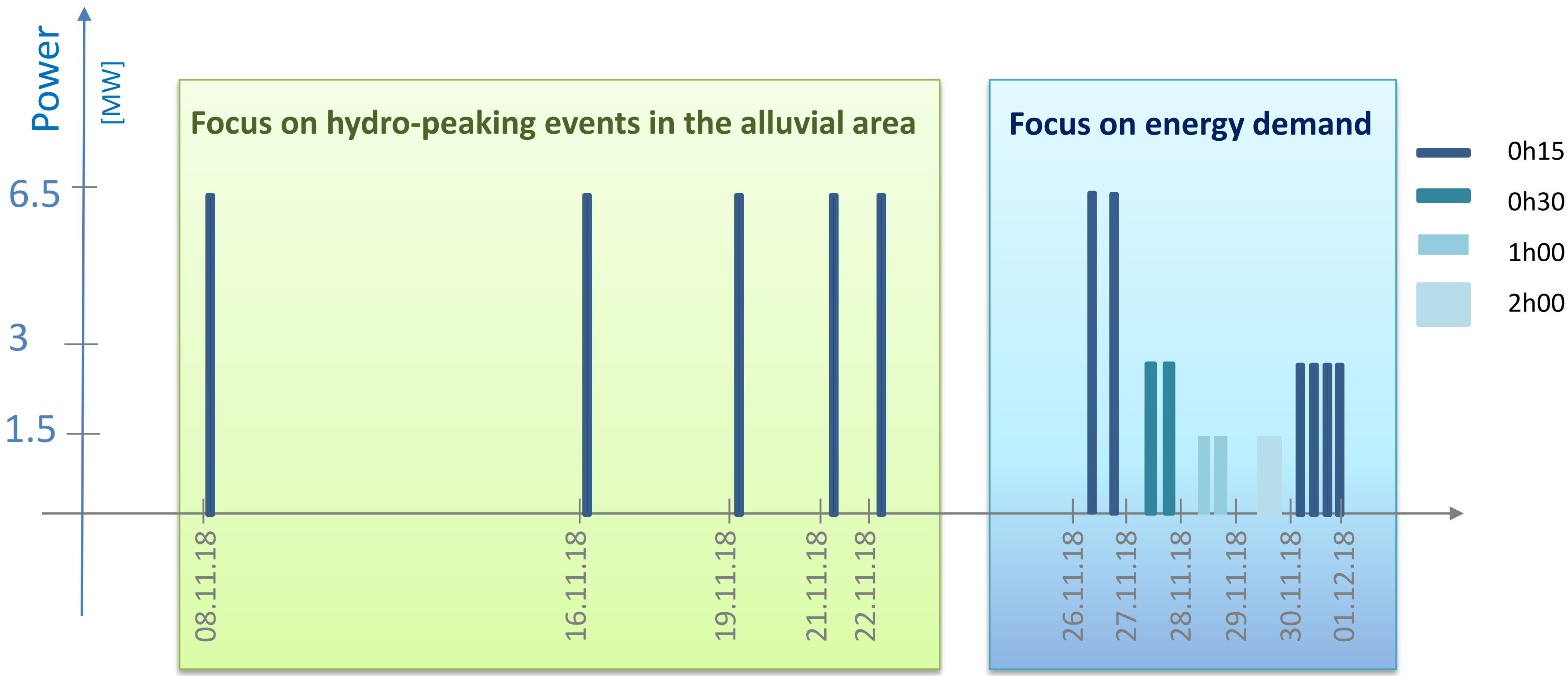
Propose a production program of the power plant for the tests and monitor the behavior of the power plant from the intake to the turbine. (Hes·so, FMV, EPFL, Power Vision Engineering)

Monitor the effect of hydropeaking on macroinvertebrates in the alluvial area. (eawag aquatic research)

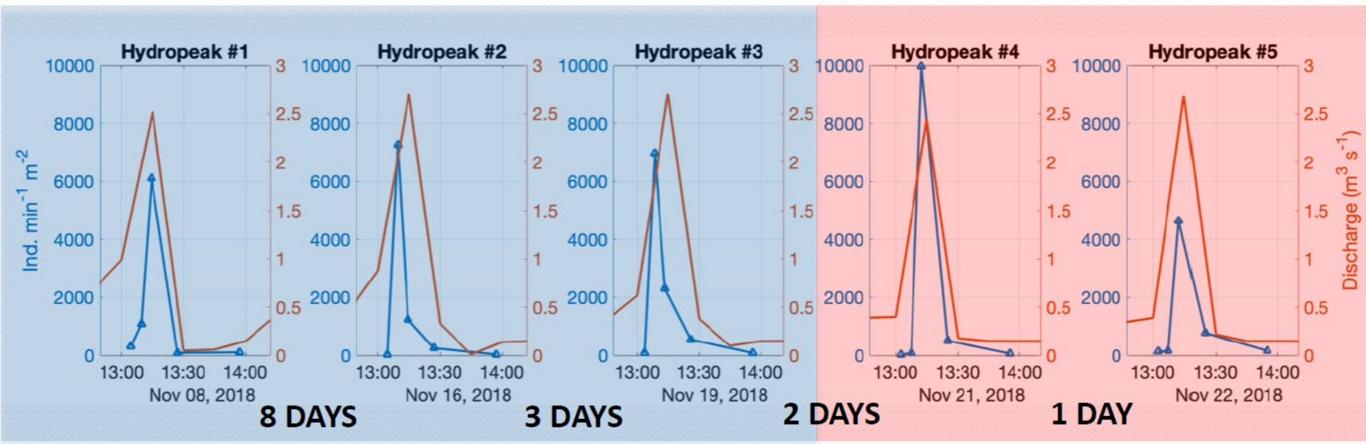
First campaign November 2018

1st & 2nd weeks : 5 production peaks of 15min to generate hydro-peaking events in the alluvial area

3rd week : **Full program** with several production peaks between 15min and 2 hours with different amplitudes at least one daylight peak



First campaign November 2018



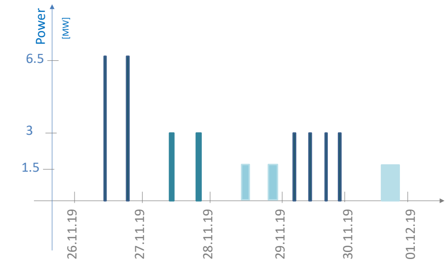
No significant change observed in the drift abundance, but clear decreasing trends for some individual taxa, for recovery times between hydropeaking events decreasing from 8 days to 24 hours.

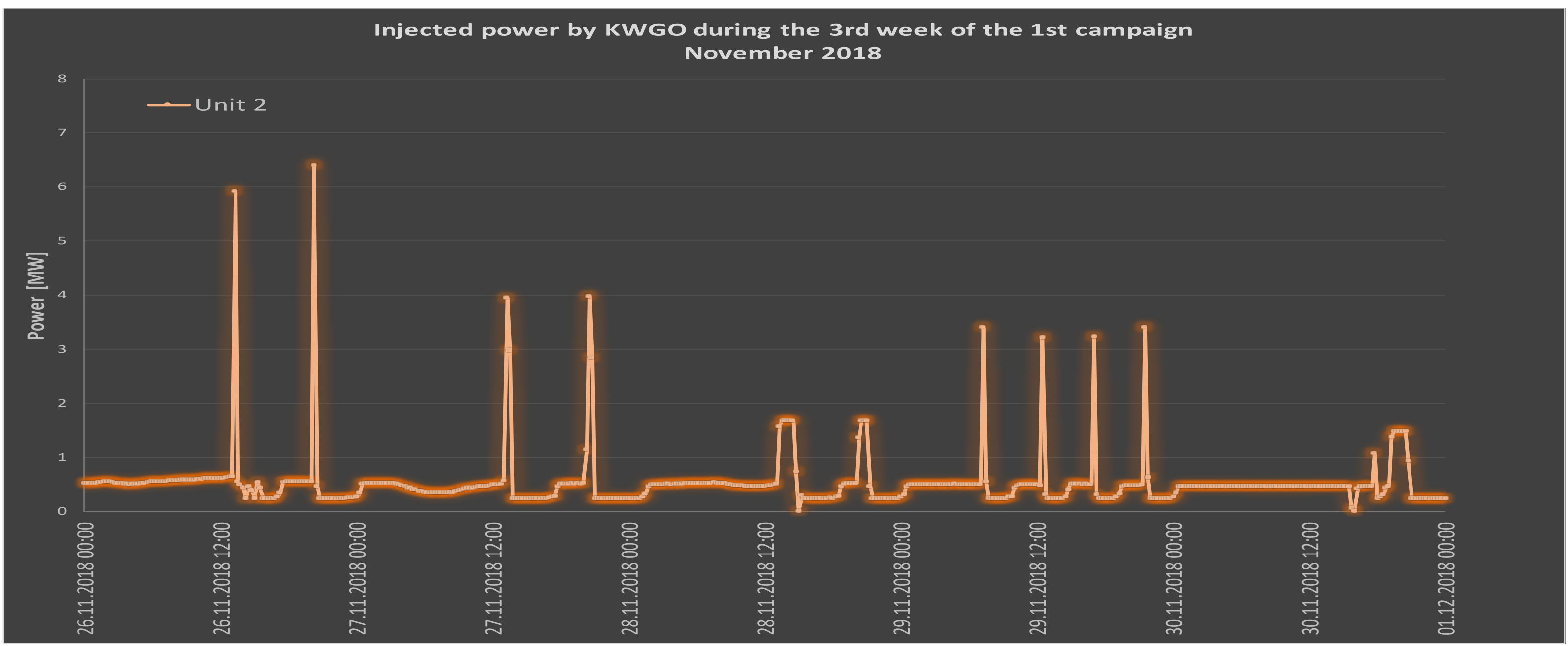
➡ **Careful monitoring of longer term ecosystem response required in case of pilot implementation.**

"Macroinvertebrate recovery to varying hydropeaking frequency: a small hydropower plant experiment", C. K. Aksamit, M. Carolli, D. Vanzo, C. Weber, M. Schmid, under revision, Frontiers

First campaign November 2018

Adopting the smart storage operations allows to increase the energy production and provide ancillary services



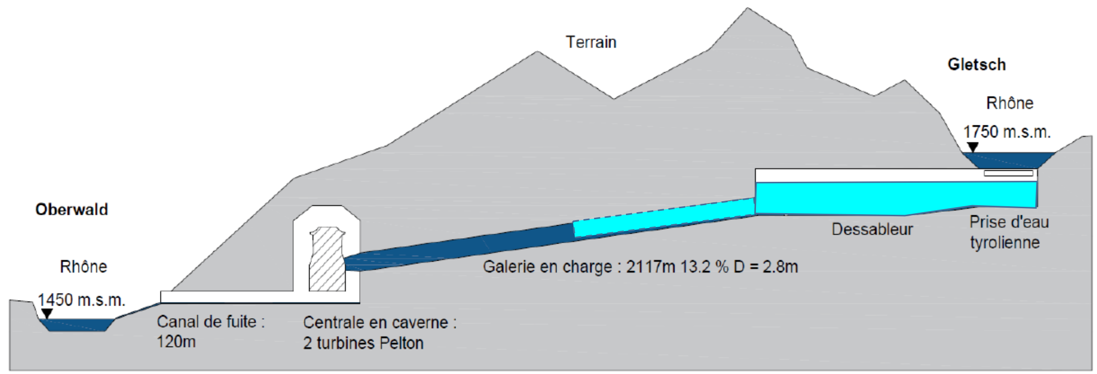


"Introducing flexibility in alpine small hydropower plants using smart storage",
Zordan J., Manso P. A., Gaspoz A., Münch-Alligné C., Crettenand S. Proceedings of the Hydro2019, Porto, Portugal

Second campaign
May 2020

Smart storage used :

Settling basin, Forebay chamber
& part of the headrace tunnel



Settling basin + forebay tank
+ 1/3 headrace tunnel ~ 8'900 m^3

On site Monitoring :

Power plant & water level in the alluvial area

Provide the forecast of the discharge during the tests

Propose a production program of the power plant for the tests and monitor the behavior of the power plant from the intake to the alluvial area.

Second campaign May 2020

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2 days campaign : 3 cycles of headrace tunnel dewatering/filling using the **full storage capacity** in safe conditions to provide production peaks

"Production flexibility of small run-of-river power plants: KWGO case study", A.Gaspoz, J. Decaix, V. Hasmatuchi, M. Dreyer, C. Nicolet, S. Crettenand, C. Münch-Alligné presented at Hydro2020 on IEA Hidden Hydro Session

2nd Campaign May 2020

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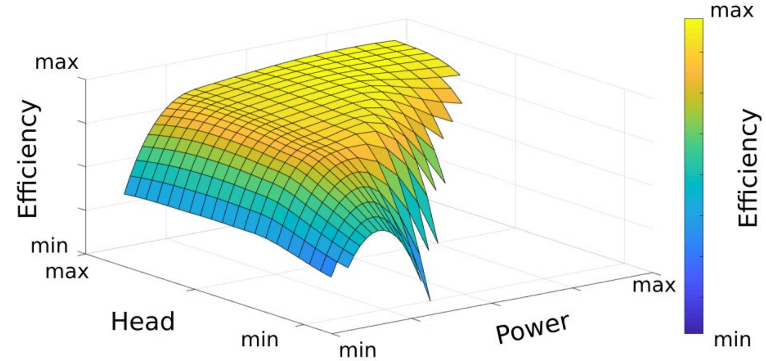
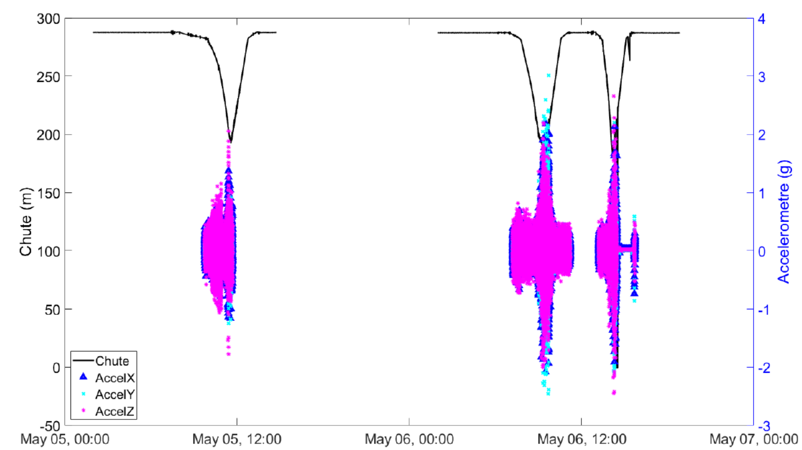
Investigation of the HPP behavior for different operating conditions.

Determination of the on-site global efficiency hill chart with the "Falaise effect"

Flexibility of the HPP has been challenged up to the final target.

Identification of the operation limits using the smart storage.





Finalization of data analysis and economical analysis on-going, expected for the end of 2020

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Acknowledgements

Schweizerische Eidgenossenschaft
Confédération suisse
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Confederaziun svizra

Office fédéral de l'énergie OFEN

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FMV

Hes·so

POWER VISION ENGINEERING

EPFL

WSL

eawag aquatic research

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