LadHyX Seminar — Feb. 22, 10:45

Graham Benham (Oxford University)

Reshaping low head hydropower: shape optimisation of a pipe with confined turbulent shear layers

Generation of hydropower electricity at low head (rivers and tides) is an attractive source of renewable energy if it can be made cost-effective. In this talk we study a novel type of low head hydropower which uses the Venturi effect to amplify the pressure drop across a turbine, thereby increasing cost-effectiveness. The efficiency depends on how the turbine wake mixes together with the main pipe flow in a turbulent shear layer. A simple model for the for the development of the confined shear layer is used to optimise the shape of the surrounding pipe so as to maximise hydropower efficiency. The model, comprising two plug flow regions separated by a linear shear layer, shows good agreement with both laboratory experiments and computational turbulence modelling. The simplicity and low computational cost of the model makes it ideal for such a shape optimisation problem, which we solve using a combination of numerical and analytical approaches. Finally, motivated by past experimental results which have shown that the addition of swirl (tangential velocity) can increase shear layer growth rates, we extend our model to account for swirl and investigate the implications on our channel shape optimisation problem.