# Laser doppler velocimetry technique to study the flow field in the nozzle and in the water jet of a Pelton turbine

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# Abstract

The constant availability of water from the mountain basins is crucial in order to feed the hydropower plants that represent currently the most important renewable energy source in many countries, like Italy. The long dry periods that are nowadays registered during the summers have imposed the managers of the hydropower plants to operate the machines at very low flow-rates, close to the lowest allowed values. In this work we focus our attention on the fluid-dynamics of the water jet of a Pelton machine and of the corresponding nozzle, with particular attention to the low flow-rate ranges. The nozzle has been manufactured in PMMA to be able to study the internal fluid-dynamics using the Laser Doppler Velocimetry (LDV) technique. The shape of the nozzle has been adapted to limit the laser beam distortion and an algorithm has been implemented to correct the position of the measurement volume and the evaluation of the velocity components. Moreover, a specific measurement layout has been implemented to study also the velocity of the water jet downstream the nozzle and to study the homogeneity of the flow velocity in the jet, which is a crucial characteristic to grant a proper operation of the Pelton runner. The set-up of the test bench and the LDV parameters are presented; the signal of the LDV receiver proved to be very consistent and reliable. Moreover, the results of the measurements have been used to validate CFD simulations and to extend the results of the analyses to other operating conditions of the Pelton nozzle.

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