The current global scenario, in which an ever increasing population with an ever growing transportation needs is coupled with a reduction in the fossil fuel production and increasing human-made pollution derived problems, leads automotive engine manufacturers to constant struggles for fuel consumption and emission reductions while keeping engine performance. One-dimensional simulation codes have become a key tool towards these objectives, but require continued accuracy refinements. Phenomena that were previously thought of a limited importance and could be extremely easily modelled now require the development of new methods to be accounted for. Among these phenomena are the turbocharger mechanical losses and the turbine behaviour under highly pulsating boundary conditions. This work is focused on the improvement of current one-dimensional models, for both mechanical losses prediction and high frequency pulsating flow turbine performance.

After reviewing the state-of-the-art in experimental measurement and fast simulation of automotive turbochargers, this work presents first a experimental study of several turbochargers working under both steady-state and unsteady operating conditions, focusing on the general performance of the turbine and the losses in the power transmission between it and the compressor, even including internal pressure measurements in one of the tested units. All the measurements are corrected due to heat transfer, getting the purely adiabatic behaviour. Furthermore, a CFD simulation campaign of a radial turbine has been performed, thus obtaining a detailed description of its internal behaviour under highly pulsating flow.

In the light of both the experimental and CFD-simulated results, a quasi-steady mechanical losses and a quasi-bidimensional turbine model have been developed. Both models have been validated using all the experimental and simulated data, proving a prediction accuracy improvements from the results of previous methods. The mechanical losses model offers a clear advantage over the usual practice of using a constant mechanical efficiency value for correcting the manufacturer's turbocharger map, whereas the turbine model has demonstrated potential for turbine map extrapolation and has improved the instantaneous results over classic one-dimensional turbine volute models for frequencies higher than 1000 Hz. Both models have been developed trying to keep a reduced computational cost, ensuring to exploit the specific characteristics of the processors where they are going to be run.