

Conditions for a successful integration of CFD and experiments in fluid dynamics: the computational investigator point of view

Abstract

The present paper discusses the lessons learned from a few code validation studies, as well as joint numerical & experimental investigations of flows carried out over the past few years at the von Karman Institute, some of which in collaboration with the Fluid mechanics Laboratory at the Université Libre de Bruxelles, from the point of view of the computational investigator.

The first example considered is the hypersonic flow over a blunted cone, which was the object of a joint numerical and experimental study. The methodology followed to investigate the origin of the discrepancies between computed and measured heat fluxes on the cone is described in detail. It is concluded that the discrepancies are due to a difference in inflow conditions, related to non-uniformities in flow conditions across the test section.

The second example concerns a code validation study of the flow in a transonic nozzle experimentally studied by J. Délery at ONERA. The influence of turbulence models and three-dimensional effects was investigated, but unfortunately the results remained inconclusive.

The last two examples deal with high enthalpy flows in inductively coupled plasma facilities, and are closely related. A methodology to determine thermal protection materials' catalytic efficiency combining computational simulations and experimental measurements, originally developed at the Institute for Problems in Mechanics, Moscow is presented, in particular the connections between measurements and computational simulations. One of the quantities experimentally measured is the pressure at the tip of a pitot probe. In the original IPM methodology, the dynamic pressure obtained from the measurements was related to the plasma jet properties using the classical pitot formula. The validity of this formula for high temperature low Reynolds number flows was investigated by a detailed computational study of the flow around the pitot probe.