LASER DIAGNOSTICS IN TURBOMACHINERY APPLICATIONS

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Résumé/Abstract

The past decades have been characterized by considerable advancements of laser / optical technology, imaging capabilities along with rapidly growing computing resources that in combination constituted the enabling technologies leading to the emergence of a wide variety of nowadays readily available image-based measurement techniques. Among these, particle image velocimetry (PIV) has made substantial impact on experimental fluid mechanics and associated fluid engineering fields, in part already through its capability of making complex fluid flows “visible” and quantifiable. Although fully capable of providing temporally and even volume resolved data, the use of advanced laser-optical methods continues to play a secondary role in applied industrial R&D and are often side-lined with respect to conventional “established” point-wise measurement techniques. In many cases, the acquired data is mainly used for the “validation” of numerical methods, leaving the full potential provided by the spatio-temporal resolved experimental data untapped.

The presentation will introduce several examples of utilization of advanced image-based measurement techniques in industrial R&D settings, mainly from the turbomachinery sector involving investigations of transonic compressor aerodynamics and measurements within combustion chambers operating at flight-relevant conditions. A prerequisite for making any optical measurements in these rough operating environments possible has been the direct involvement of the measurement specialists at the early stages of the rig design, for instance, to integrate optical accessibility to the areas of interest. Yet, issues such as beam steering, light absorption, contamination or strong vibrations oftentimes degrade the signal to unacceptable levels, requiring creative solution strategies. To improve the overall understanding of the underlying aero- and thermodynamics of the investigated component, the combination of measurement techniques has proven to be very valuable. Beyond this, more advanced, 3-D and high-speed imaging approaches still hold significant potential, as will be highlighted with a few examples from recent experiments. Of course the underlying effort of providing this sort of data must be balanced against significantly increased instrumentation and processing requirements.