Invited lecture

Sunday, 8:30a – 9:30am
Monarchy 4

Chairman: Ellen Longmire (University of Minnesota)

Chris Willert

DLR - Germany

The role of optical diagnostics in applied gas turbine combustor R&D - the tricky balance between customers' expectations, cost and the limits of physics

Abstract: The past decades have been characterized by considerable advancements of laser/optics 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 volume resolved velocity data, the use of PIV continues to play a secondary role in applied industrial research and is often side-lined with respect to conventional "established" point-wise measurement techniques. In many PIV applications, the acquired PIV data is mainly used for the "validation" of numerical methods, leaving the full potential provided by the spatio-temporal resolved PIV data untapped. The presentation will introduce several examples of utilization of advanced image-based measurement techniques such as PIV 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, oftentimes issues such as beam steering, light absorption, contamination or strong vibrations 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, but must be balanced against an increased instrumentation and processing effort.

Christian Willert heads the Department of Engine Measurement Technique at the Institute of Propulsion Technology of the German Aerospace Center (DLR). He received his BS degree in Applied Science from the University of California at San Diego (UCSD). Subsequent graduate work in experimental fluid mechanics at UCSD led to the development of several non-intrusive measurement techniques for application in water (particle tracing, 3-D particle tracking, digital particle image velocimetry) After receiving his Ph.D. he assumed a post-doctoral position at the Graduate Aeronautical Laboratories at the California Institute of Technology (GALCIT). In 1994, he joined DLR Goettingen's measurement sciences group as part of an exchange program between Caltech and DLR where he was strongly involved in the development of PIV for application in large scale industrial wind tunnels. With the move to the DLR Institute of Propulsion Technology in 1997 his focus shifted toward the development and application of optical velocimetry techniques in turbomachinery, with emphasis on PIV, planar Doppler Velocimetry (PDV), endoscopic imaging and flow visualization techniques. At the institute his department is devoted to continually developing and applying a wide variety of laser-optical velocimetry and spectroscopic techniques to compressors, turbines and high-pressure combustion facilities, both for in-house clients and industrial partners.