INVESTIGATION OF METHODS FOR THE STUDY OF HYPERSONIC BOUNDARY LAYER TRANSITION

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Hypersonic boundary layer transition is an important phenomenon in high speed flight vehicles. Proper aerothermodynamic design of these vehicles is dependent upon accurate prediction of the skin friction, heat transfer, and turbulent mixing in the flow; all of which are directly affected by the laminar to turbulent transition of the boundary layer. The difficulties associated with making this prediction arise from a plethora of unsolved transition phenomena, the difficulty in separating the effects of these phenomena due to their interaction, and the fact that the known linear transition process can be bypassed. Current work at the von Karman Institute is focused on supporting the EXPERT Project as well as verifying and expanding upon the hypersonic transition knowledge base to improve upon transition prediction methods.

The purpose of this study is to investigate and expand upon available methods of high speed flow visualization and measurement in hypersonic boundary layers to provide further information about the transition process. A well known method used extensively at the von Karman Institute and throughout the world, Schlieren photography, was applied to provide general knowledge of hypersonic flows over different geometries. Variations of this technique and modern image processing methods were considered and tested to determine their value for research of hypersonic boundary layers. Finally, development and testing of a laser differential interferometer was performed with the goal of providing unsteady, non-intrusive measurements in a hypersonic boundary layer.

The limiting factors of the Schlieren technique in this area of research are discussed along with several possible improvements. The development and testing of the laser differential interferometer is described in detail to allow for repeatability and as a guide for further work and development. Though measurements in a hypersonic boundary layer were not able to be completed in the timeline of this project, this technique appears promising and a setup for use on a wind tunnel is being developed. The limiting factors and recommended improvements to the laser differential interferometer are identified.

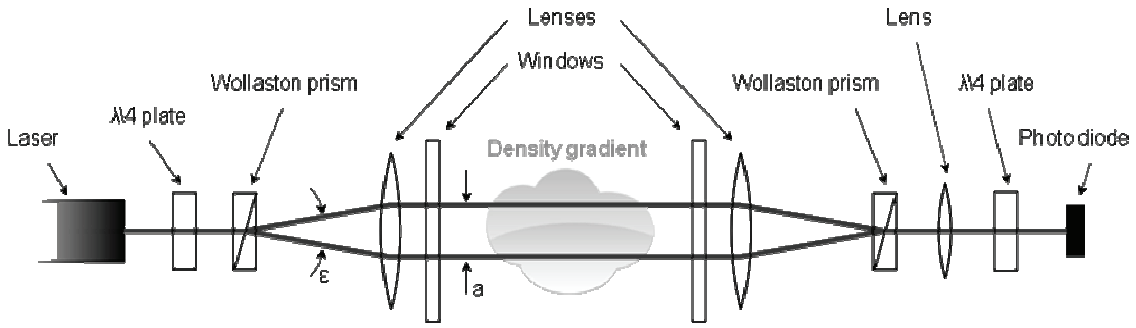

Figure 1: Schematic for a Basic Laser Differential Interferometer