**Project Title:** Structure and Modes of Supersonic Base Flow

**Advisers:** Prof. J. Craig Dutton (AE) and Prof. Gregory S. Elliott (AE)

**Project Description:**
This project is centered on the measurement of the instantaneous, three-component velocity fields across characteristic planes and volumes of the near-wake of a supersonic base flow. In particular, three-component, planar, stereo particle image velocimetry (PIV) measurements and three-component, volumetric, tomographic PIV measurements are being made in the initial shear layer, recirculation, recompression, reattachment, and trailing wake regions of this separated flow. The complete mean velocity vector and Reynolds stress tensor are reported across all planes examined. In addition, detailed analyses of the stereo PIV datasets are performed to determine the characteristic planar structure and modes of the base flow using methods including proper orthogonal decomposition, empirical mode decomposition, 2D FFT, and others. Similarly, the tomographic PIV data are analyzed using structure-identification techniques comparable to those used in CFD to determine the characteristic three-dimensional, volumetric structure of the flow in the regions examined. These methods include use of the $Q$-criterion, the $\lambda_2$-criterion, and the swirling strength criterion. The characteristic structures and modes determined from the experiments are compared to those predicted by previous direct numerical simulations at substantially lower Reynolds numbers. In this project, you will obtain experience using state-of-the-art fluid velocity measurement techniques, as well as experience with analysis methods used for the resulting data.

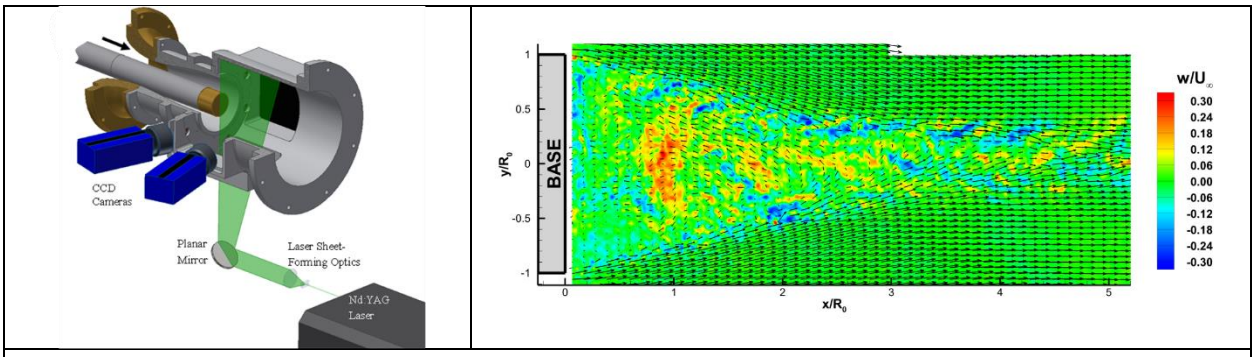


**Fig. 1** Supersonic base flow facility and instantaneous velocity image

**Student Background and Expected Research Activities:**
We are seeking a highly motivated student who is interested in *experimental* fluid dynamics research. Previous experience with optical diagnostic methods, specifically PIV, is not necessary. Previous fluid dynamics course work, especially in compressible flow, is desirable. The chosen student will be given a project of his/her own to help support this Army Research Office-supported project.

**Points of Contact:**
Prof. J. Craig Dutton (jcdutton@illinois.edu) and Prof. Gregory S. Elliott (elliottg@illinois.edu)

**Funding:**
Army Research Office (ARO), Grant No. W911NF-15-1-0194