Görtler vortices arise in boundary layers along concave surfaces due to centrifugal effects. These streamwise vortices are one of the three known principal sources of instability that lead to transition from laminar to turbulent flow. There are a number of flow situations where the fluid encounters concave curvature, e.g., the lower surface of an LFC supercritical wing. This experiment was the first of its kind to study the development of Görtler vortices on an airfoil with a significant pressure gradient.

A six-foot chord experimental model was tested in the Low-Turbulence Pressure Tunnel. Görtler vortices were visualized using sublimating chemicals. The streamwise vortices were observed as alternating light and dark streaks on the surface due to the differential shear stress pattern of the vortex layer. Each pair of light and dark streaks together indicate one wavelength of the counter-rotating streamwise vortex layer. A five-beam laser velocimeter was used to measure the three velocity components in the boundary layer and a dedicated computer system was used to record and process the data.

Theoretical studies of the Görtler instability have shown that the vortex amplification varies with free stream velocity (i.e., with Reynolds number and Görtler number). An experimental investigation would be expected to show a vortex spacing corresponding to the theoretically predicted maximum amplified wavelength. However, previous experiments which were conducted in curved channels with zero pressure gradient have not found this correlation. Indeed, the wavelength was found to be almost independent of free-stream velocity probably indicating that some portion of the test apparatus, such as turbulence damping screens, has "selected" the wavelength. In the present experiment, the Görtler number was varied by changing the free-stream velocity. The experimentally determined wavelength fell near the theoretically predicted maximum amplified wavelength and clearly varied with Görtler number as predicted. These results probably were obtained because of the excellent low-turbulence environment and the absence of the opposite channel wall in this experiment.

There remain considerable discrepancies between the various theoretical models of the Görtler vortex phenomena. These discrepancies are the most significant in the region of the neutral curve where disturbance amplification begins. However, all of these theoretical models agree as to the predicted correlation between spacing and Görtler number. The results of the present experiment confirm this important correlation thus lending increased credibility of the theoretical predictions.

CITATION: For experimentally demonstrating the theoretically predicted correlation between Görtler number and vortex spacing on an airfoil in the LaRC/LTPT using advanced measurement techniques.