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LDA-Measurements of Jets in Crossflow for Effusion Cooling Applications

by

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ABSTRACT

There is a need for improved cooling of hot parts in gas turbines. Often is film cooling or effusion cooling used on the parts where the heat load is large. Modern numerical methods cannot predict the heat transfer on film-cooled walls, which includes many rows of holes. Better understanding of the topology of the flow field, how different vortices interact in multiple-row film cooling (effusion cooling) and how fluid packages with different densities affect the flow is therefore wanted. Laser-Doppler anemometry was used to examine the flow field of an oblique jet in a crossflow. The jet was situated in the third row of holes. The operational parameters used in this investigation was $Re_d = 6000$, $U_{jet}/U_0 = 0.8$, $T_{jet}/T_0 = 1$ and $_{jet}/\ _{0} = 1$ and the injection hole was slanted 30°. One major finding of the LDA measurements in the wake was the two counter-rotating foci close to the wall. In the foci shown in figure 1 the mean velocity field changed dramatically from 0 m/s to 10 m/s in just 0.4 mm. This is of the same magnitude as the wall gradient in a flat-plate boundary layer with the same free stream velocity. All Reynolds stresses are presented in several planes for the global flow field of the jet.

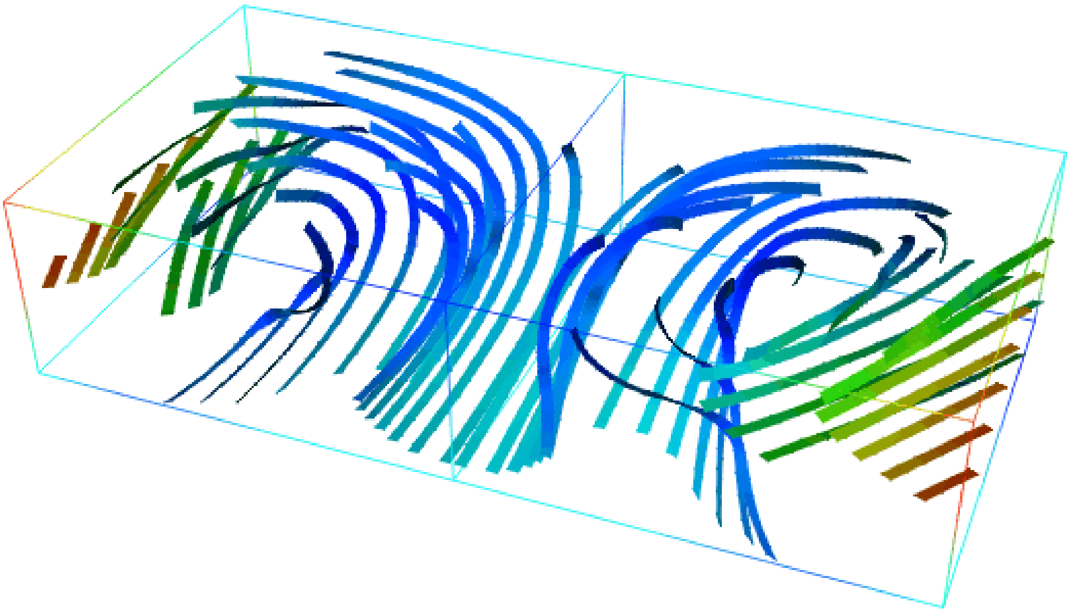

Fig. 1. Two counter-rotating foci near the wall in the wake of a jet in crossflow. The stream-ribbons are viewed from a downstream position and mirrored in the plane of symmetry for easier interpretation. The size of one volume is 0.9 mm × 0.9 mm × 0.4 mm and the centers are located at x/d = 1.5, y/d = 0.1 and z/d = ±0.1. The stream-ribbons are colored by the velocity magnitude (0 m/s-10 m/s).