

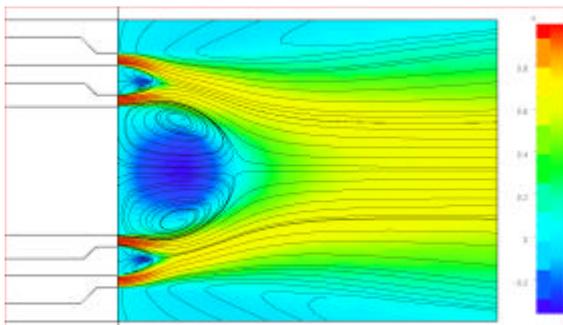
**LDV measurements in the nozzle region of a confined double annular burner: statistical analysis  
and model evaluation**

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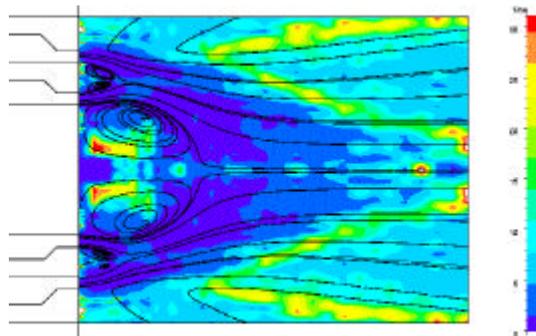
**ABSTRACT**

Industrial devices designed to handle fluid quite often create complex turbulent flows. This is the case, for example, with turbine engines, combustors and burners. Unfortunately these flows are still not well-understood, therefore difficult to model. To develop new theories as well as new models, empirical data are needed. We provide here LDV data for the cold flow of a double annular burner. The prototype burner consists of 2 confined coaxial annular jets, which discharge into a combustion chamber in a sudden expansion. This confined geometry generates several vortices, recirculation regions and separation lines. 2D LDV measurements have been performed in a region close to the nozzle exit. The main challenge with this type of flow configuration is to obtain a good axisymmetry of the measurements: this was estimated as being below 2% for mean velocities and below 3% for second moments of the velocities. The data have been taken on a very fine experimental grid: 36 traverses, each associated to 101 or 201 measurement locations. Color displays and section profiles are represented for mean velocities and second moments, and the streamlines of the flow are computed (see Fig. A and B below).

The fine grid used permitted the application of a new post-processing technique to the data. First the gradient velocity tensor has been estimated from the data. The accuracy of these estimates is checked using the incompressibility property. Then, since the stress, strain and vorticity tensors are known, the constitutive equation linking the stress tensor to mean velocity gradients could be experimentally studied, via the estimation of the invariants of the flow. Several invariants are represented, and some terms of a nonlinear quadratic constitutive equation are compared for different regions of the flow. This helps to indicate that the linear Boussinesq's hypothesis, at the basis of the classical  $k$ - turbulence model, is valid only for a limited region of the flows; for other regions, some nonlinear terms are dominant. Finally a characteristic time and dissipation rate can be extracted from the data, providing new insights of the physics of the flow.



**Fig. A** Streamlines of the flow and a display representing the normalized axial velocity.



**Fig. B** Streamlines of the flow and a display of the turbulent characteristic time as estimated by a post-processing technique.