3-D LDV Measurement and Analysis of Swirling Flow in a Pipe

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Earlier work on this subject done at Bochum has been reported in the papers by Kocherscheidt et al [1] and Rocklage-Marliani et al. [2]. These are results of experiments conducted in a refractive-index matched facility in which swirl was generated by a rotating tube bundle and measurements were done by 3-D laser-Doppler velocimeter. The Reynolds number for these measurements was 2.8×10^5, and the swirl number was in the range $0 - 1$. The data analysis, primarily focussed on the mean quantities, brought to light a salient feature of this flow. It is that the azimuthal motion in the core is virtually unaffected by the Reynolds shear stresses. This property manifests itself through the moment of the azimuthal velocity remaining constant on streamsurfaces. The size of the core in which the radial distribution of the azimuthal velocity is solid-body like, is generally larger at larger swirl numbers.

The present work is a continuation of these experiments at a Reynolds number of 1.17×10^5 in the swirl-number range $0 - 2$, and at a Reynolds number of 2.24×10^5 in the swirl number range $0.75 - 1.8$. Analysis of the mean-velocity data along the same lines essentially substantiates the earlier findings. This is the same as summarised in figs. 16 and 17 of [2].

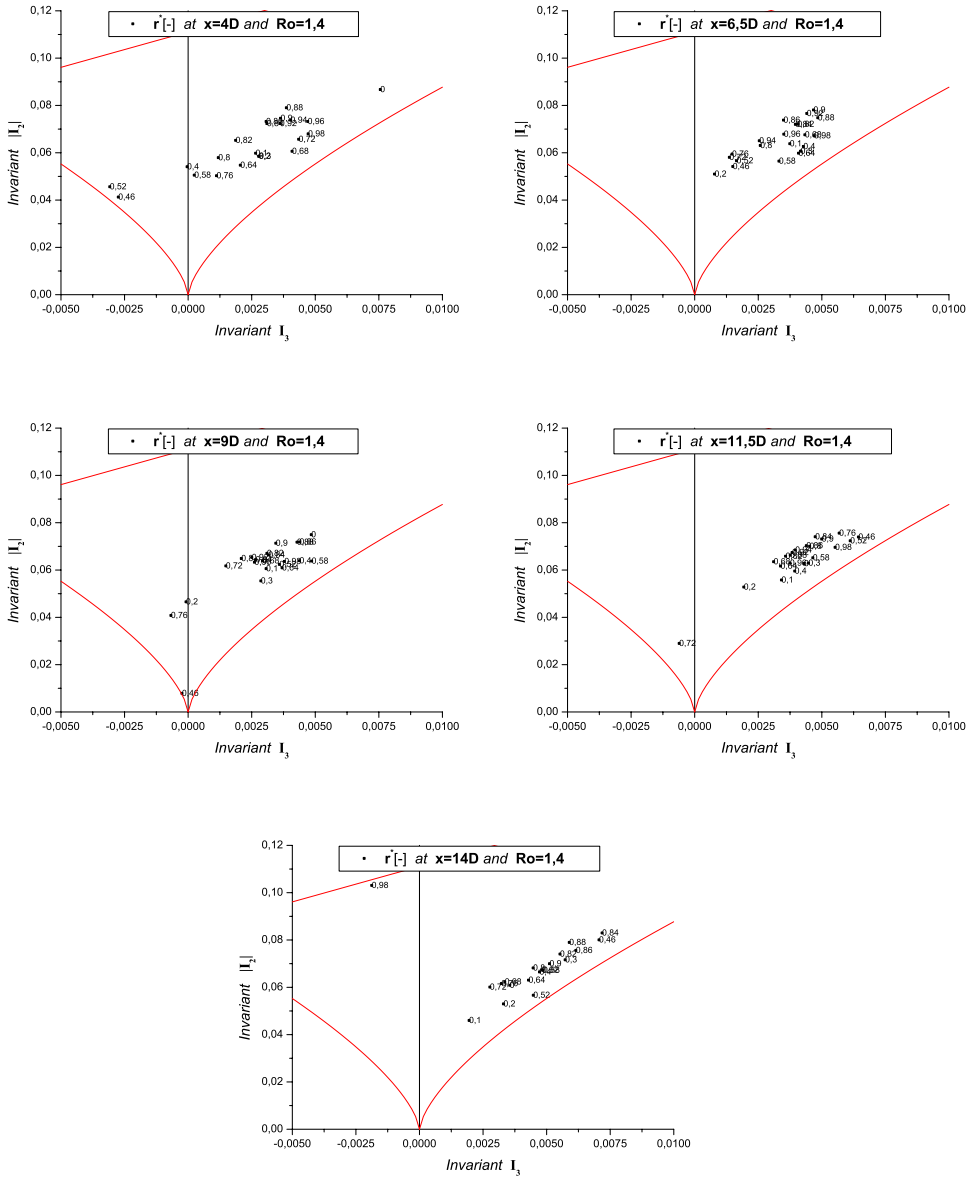
The data analysis has been extended to cover properties of the fluctuating motion. As a first step the quantities responsible for the production of the turbulent kinetic energy and of the components of the Reynolds normal and shear stresses, and the triple correlatios entering the budgets of these quantities have been evaluated from the measured data. A further step investiging into the properties of the fluctuating motion is preparation of the Lumley triangle from the measured data. Sample plots of the Lumley triangle are shown in the acompanying figure.

The data - raw as well as the processed data - are available on request for scientific research purposes. Requests for the same may be addressed to the first author of this report.

References

[1] H. Kocherscheidt, M. Schmidts and V. Vasanta Ram LDV measurements of the response of the swirling flow in a pipe to a rapid temporal change in swirl. Flow, Turbulence and Combustion, 69: 79-94, 2002.

[2] G. Rocklage-Marliani, M. Schmidts and V. Vasanta Ram Three-dimensional Laser-Doppler velocimeter measurements in swirling turbulent pipe flow. To appear (accepted for publication) in Flow, Turbulence and Combustion.



Lumley triangle for $Ro = 1,4$