3-D LDV Measurement and Analysis of Swirling Flow in a Pipe
By Vasanta Ram, V., Michiel, J., Oerlue, R., Schmitz, I. and (Ms.) Ji, Nan
Ruhr University Bochum, D 44780 Bochum, Germany

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
$2.8 \times 10^5$, 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 num-
ber of $1.17 \times 10^5$ in the swirl-number range $0 - 2$, and at a Reynolds number of
$2.24 \times 10^5$ 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 correlations entering the budgets of these quantities
have been evaluated from the measured data. A further step investigating 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
accompanying 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
of the response of the swirling flow in a pipe to a rapid temporal change in swirl.
Laser-Doppler velocimeter measurements in swirling turbulent pipe flow. To ap-
pear (accepted for publication) in Flow, Turbulence and Combustion.
Lumley triangle for $Ro = 1.4$