Stereo PIV measurements of turbulence generated by a rectangular fractal grid

C. Cuvier¹, S. Zheng², J. M. Foucaut¹
1: Laboratoire de Mécanique de Lille, 59651 Villeneuve d’Ascq Cedex, France
2: Department of Aeronautics, Imperial College London, SW7 2AZ, UK
* Correspondent author: jean-marc.foucaut@ec-lille.fr

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HIGHLIGHTS

• Two vertically aligned Stereoscopic PIV systems were used to look at the turbulence generated by a rectangular fractal grid at two Reynolds numbers.
• The spectra calculated from the small field of view SPIV data agree well with hot-wire measurements, indicating the validity of implementing Taylor’s hypothesis in turbulent flows with turbulence intensity of at least 17%U∞.
• The turbulence intensity profiles showed homogeneity at the grid center only for the spanwise component.
• The mean statistic profiles revealed the shear layer between the jet created by the center of the grid and the wake from the bars, and the shear layer contributes to the vertical component of turbulence intensity, while the streamwise turbulence intensity is mainly produced by the streamwise mean velocity gradient along the vertical direction.

ABSTRACT

In this paper we study the turbulent flow generated by a rectangular fractal grid in the wind tunnel at Lille Laboratory of Mechanics (LML). Two vertically aligned Stereoscopic PIV systems were used to look at the turbulence generated by a rectangular fractal grid at two Reynolds numbers. A total of 20,000 image pairs were acquired, and the data was processed by the modified version of the Matpiv toolbox by LML. A self-calibration similar to the one proposed by Wieneke (2005) was applied with the Soloff et al. (1997) reconstruction method. The results were compared with previous hot-wire measurements, and the mean statistics and pdf showed good agreement. The spectra of the inertial subrange calculated from the SPIV result also agreed with the hot-wire data, which validated the use of Taylor’s hypothesis under high turbulence intensities (17%U∞ in this case). The mean statistic profiles revealed the shear layer between the jet created by the center of the grid and the wake from the bars.