High Reynolds Number Grid-Turbulence Experiment

A. Segalini, R. Örlü, P. H. Alfredsson & M. Bourgoin
Funding: STandUP for Wind, KTH, ESWIRP

Grid turbulence is a canonical turbulent flow that provides the basis for our current understanding of turbulence and for its modeling. However, there are several fundamental key issues regarding, for instance, the decay of the large- and small-scale structures in grid turbulence and their structure. To answer some of the issues and to improve the existing models, new high-resolution and high-Reynolds number data are required.

A new grid-turbulence experiment has been conducted at the ONERA wind tunnel in Modane in France funded by the ESWIRP European framework, conceived to probe the smallest scales of a canonical turbulent flow with very high Reynolds numbers. To achieve this, the largest scales of the turbulence need to be extremely big so that, even with the large separation of scales, the smallest scales would be well above the spatial and temporal resolution of the instruments. The ONERA wind tunnel in Modane (test section diameter of 8 m) was chosen as a limit of the biggest large scales achievable in a laboratory setting. A giant inflatable square grid (net spacing M=0.8 m) was conceived to induce slowly decaying homogeneous isotropic turbulence in a large region of the test section, with minimal structural risk. The Taylor-scale Reynolds number is estimated to be between 400 and 800, with Kolmogorov scales as large as a few mm. An international team or researchers collected hot-wire anemometry, ultrasound anemometry, resonant cantilever anemometry, fast Pitot-tube anemometry, cold-wire thermometry and high-speed particle tracking data of this canonical turbulent flow, gathering an unique dataset. This large database will become publicly available over the next 2 years but KTH researchers have already access to the data and will help to analyze the obtained data.

A. Aliseda & M. Bourgoin, Experimental study of homogeneous isotropic slowly-decaying turbulence in giant grid-wind tunnel set up. 67th Annual Meeting of the APS Division of Fluid Dynamics, 23-25 November, 2014, San Francisco, California.