Institut für Fluid- und Thermodynamic
Lehrstuhl für Strömungsmechanik
Prof. Dr.-Ing. Holger Foysi

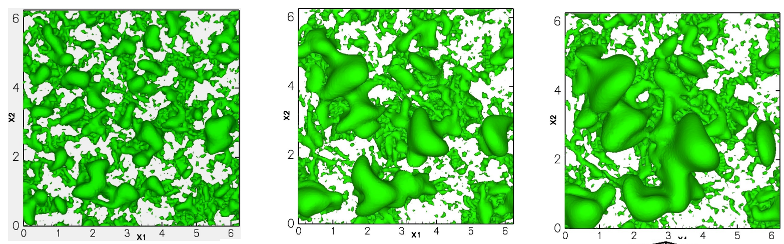
UNIVERSITÄT SIEGEN * Lehrstuhl für Strömungsmechanik * 57068 Siegen

MASTERARBEIT

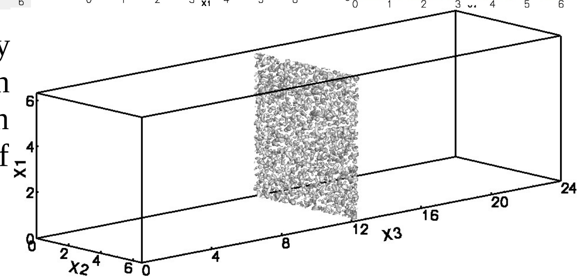
Vibrating Grid Turbulence

Wavelet Analysis of DNS Data

Description of the problem:



Free-shear turbulent diffusion with no production due to a mean-velocity gradient. Turbulence is homogeneous in the plane perpendicular to the diffusion. Grid is vibrating at a sufficiently small amplitude but at a large frequency. In such a case, the balance between diffusion of turbulent energy and the dissipation rate maintains the turbulence field statistically stationary. The turbulence generated by oscillating grid has often been used as a simple field to understand the effect of turbulence on the mixing processes in a stratified fluid or reveal the mechanism of gas transfer at the air-water interface due to turbulence.



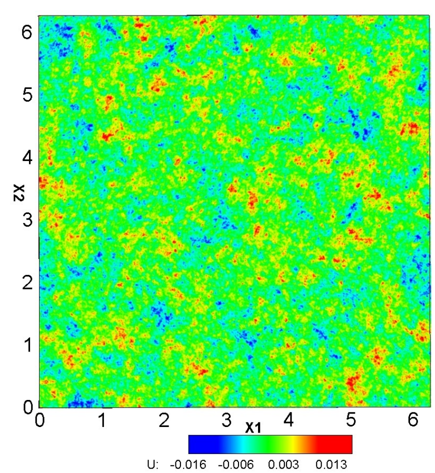
$$\frac{\partial u_i}{\partial t} + u_j \frac{\partial u_i}{\partial x_j} = -\frac{1}{\rho}\frac{\partial p}{\partial x_i} + \nu \frac{\partial^2 u_i}{\partial x_j \partial x_j} + f_i$$

$$f_i = \frac{n^2 S}{2}\left\{\left|\frac{\delta_{i3}}{4}\cos\left(\frac{2\pi}{M}x_1\right)\cos\left(\frac{2\pi}{M}x_2\right)\right|\sin(nt) + \frac{\beta_i}{4}\right\}$$

Numerical simulations for three different Reynolds numbers (based on an amplitude and frequency of the grid) **Re = 500, 1000, 3000** were performed using a spectral code. A huge amount of DNS results were accumulated that needs to be post-processed and analyzed statistically using existing subroutines written in FORTRAN.

Tasks:

- Understanding the basics of a small Fourier-Galerkin spectral code
  - plotting and analyzing the statistics of physical variables from DNS data;
  - visualization of DNS data using VISIT, PARAVIEW, etc;
- MATLAB: Wavelet Toolbox™
  - Continuous and Discrete wavelet analyses of 1D and 2D turbulent signals (1D and 2D data analysis).



Required qualifications:

- Basic knowledge in FORTAN and MATLAB;
- Basics of fluid dynamics.