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Thermal measurements and flow visualization of heat convection in a tilted channel

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Convection is the most important heat transport mechanism. We can find it not only in many natural situations such as stars, planet's atmosphere but also in half-natural situations such as industrial plants. Furthermore, the Rayleigh-Benard system, in which a fluid is cooled from above and heated from below, is one of the most studied systems in thermal convection. Nevertheless, in this configuration, the neighborhood of the plates controls the heat transfer. Therefore, we have to make a system in which the flow forgets the cold and the hot plate. We have built a vertical long channel which links two chambers : the hot one at the lower end and the cold one at the upper end. Moreover, this channel, which is hanged to a structure, can be tilted from an angle of 0 degree to 90 degrees. The experimental facility used for this purpose is a square channel with an inner area of 5*5 cm^2 m and with a height of 20 cm. The cell is filled with water and is heated at the bottom by Joule effect. At the top, the temperature is regulated by a thermal bath and the mean temperature of the bulk is 25°C . It is worth noticing that this configuration could correspond to heat pipes (without phase transformation) used in thermalisation systems or could model a vertical access pit of an underground carry.

In this paper, we want to highlight how the thermal convection in the bulk of the channel is. In the first part, the paper will be focused on the visualization of the flow into the channel thanks to particle image velocimetry (PIV) technique. We look at the mean velocity field (transverse and axial components) , the fluctuations of the mean velocity field and the shear Reynolds stress. Besides, we analyze how the influence of the power supply and the dependance of the tilt angle are. At last, we will interpret the PIV measurements in terms of turbulent viscosity and effective heat conduction and we will deduce from the PIV measurements the axial mean profile of temperature. Then, in a second part, we present new thermal measurements. Thanks to a new sensor inserted into the channel and which is not too intrusive, we have measured the axial mean profile of temperature for several tilt angle and several different power supplies. At last, in a third part, a model which allows to account for the competition between stratification and turbulence will be developed.