LOCAL VELOCITY MEASUREMENTS IN THE SHREK EXPERIMENT AT HIGH REYNOLDS NUMBER

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Abstract We report preliminary results obtained using new local velocity probes in the Superfluid Helium high REynold number von Kármán flow (SHREK) experiment for different forcing conditions. The presentation will focus on the validation of the signals obtained from a hot-wire and a total head pressure tube in both normal and superfluid phases of liquid helium.

The SHREK experiment (SuperFluid von Kármán experiment) has been designed to compare properties of superfluid turbulence with ordinary turbulence. The SHREK experiment (see Fig. 1) makes particularly use of the phase transition experienced by helium at $T_\lambda \approx 2.2$ K, thus allowing to make experiments at very high Reynolds values with normal (above T_λ) and superfluid helium (below T_λ) [3, 7]. The experimental setup is described in [4]. It consists of a cylinder of radius $R = 0.39\,\mathrm{m}$ and height $H = 1.2\,\mathrm{m}$ (Fig. 1). The fluid is mechanically stirred by a pair of coaxial impellers. The impellers are disks of radius $0.925R$, fitted with 8 radial blades of height $0.2R$ and curvature radius $0.4625R$. The impellers rotation rate f_1 and f_2 can be varied independently from 0.1 to 2 Hz and the total dissipated power can range from 120W at 1.6 K to 400W above 1.9 K. This experiment benefits from high flexibility of flow conditions, due to the large variation of helium properties over the available temperature range (1.6 K to 5 K). Both superfluid and normal turbulence measurements are possible in the same experiment, with adjustable fraction of the superfluid component (from $\approx 85\%$ at 1.6 K to 0% above T_λ).

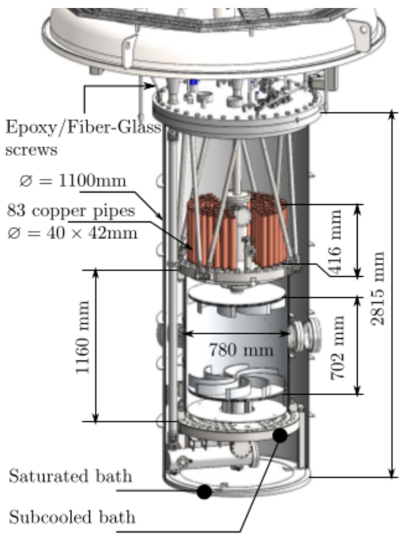

Figure 1. Schematic view of the experimental setup and the impellers blade profile

Besides global measurements[6] (torques and calorimetry), the experiment was designed to enable local measurements in the equatorial plane or next to the impellers. In the sequel, we present two new sensors, a Platinum-Rhodium hot wire and a new design of miniature Pitot anemometers, that were successfully operated in SHREK experiment to obtain local velocity measurements.

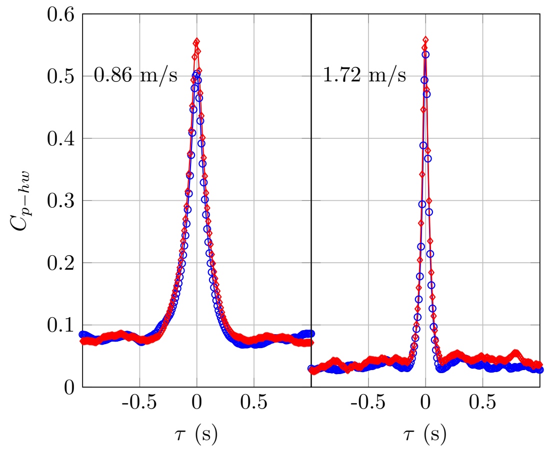

Figure 2. Inter-correlation coefficient of a Pitot tube and a hot-wire signals obtained in He I (red diamonds) and He II (blue circles). Acquisitions performed in HeJet experiment [1]

First we bring new insight in the understanding of the signal of hot-wires in He II (see [2]). In particular, we show that the inter-correlation coefficient of the signal of a hot-wire with the signal of a Pitot tube (for which the design can be found in [7]), is the same in He II as in He I where the signal can reliably be interpreted as a velocity (see Fig. 2). We also show preliminary velocity measurements obtained in SHREK using this kind of hot-wire.
Second, we report the first results obtained using novel miniature total head pressure tube (Pitot tube), obtained for a large range of rotation frequencies f_1 and f_2, in both normal and superfluid regime. The Pitot Helmholtz frequency is ≈450 Hz giving useful bandwidth somewhat higher. The sensitivity is in the 10^{-7} m^2/s^2 range and can be further improved by combination of 2-amplifiers. The results are compared with results obtained in a scale 1:4 experiment, operated in Saclay with water [5].

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