# VERTICAL AXIS TIDAL TURBINE BEHAVIOUR IN A NON-UNIFORM VELOCITY PROFILE

## Objectives

- Effect of the **sheared velocity** on the behaviour of an **unducted twin vertical axis tidal turbine** (2-VATT)
- Impact of the **sheared flow** on the wake development of the 2-VATT

## Experimental set up

- Constant and steady incoming flow with a set velocity ( $U_0$) of 1 m/s
- Turbulence rate $I_\infty$ = 1,5%
- Specific grid is used to generate a sheared velocity profile

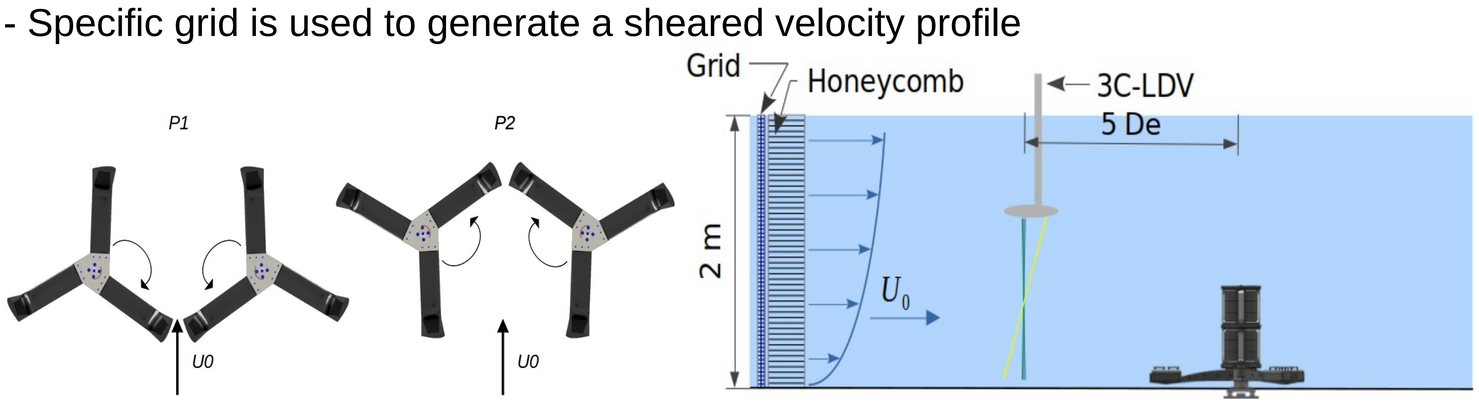


**Figure 1: Scheme of the two configurations P1 and P2 (left) experimental set up in the wave and current flume tank of *IFREMER* at Boulogne-sur-Mer (right).**

- Experimental tests are conducted on 1/20 scale model of the HQ 2.5 turbine
- Each rotor is made of N=3 blades with 60° phase shift between them
- VATT model with $H_{blade}$ = 0,315 m, $R_{rotor}$ = 0,235 m
- Evaluation of performance, loads and flow characteristics

## Turbine's wake development

- Maximum velocity deficit is located right behind the rotor column for both incoming velocity profile

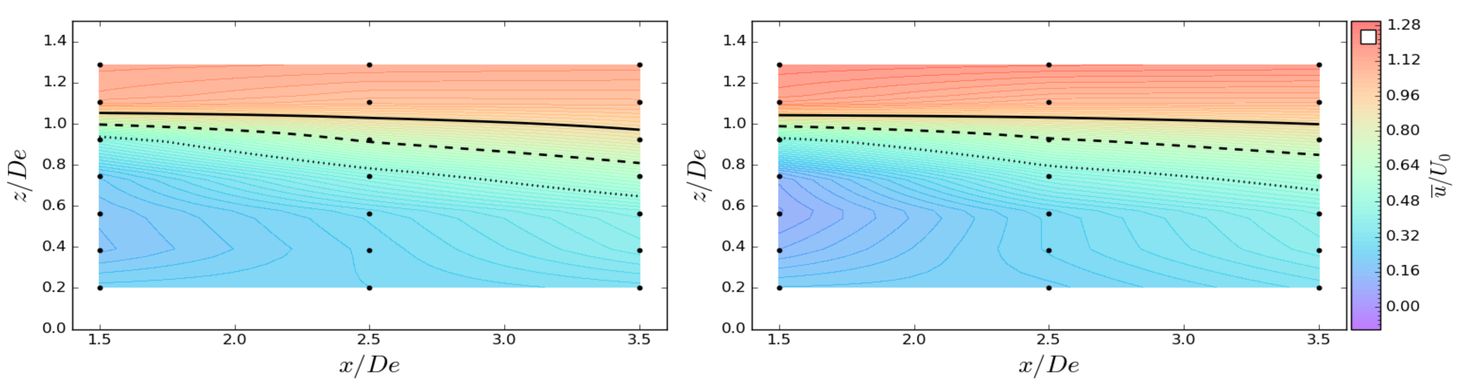


**Figure 4: Contours of the mean streamwise velocity in (*x,z*) planes behind the rotor column for uniform (left) and sheared (right) flow in P1 configuration.**

- Velocity passing over the model is 6% higher with the sheared velocity profile
- Maximum velocity deficit is 42% higher in sheared flow than in uniform flow

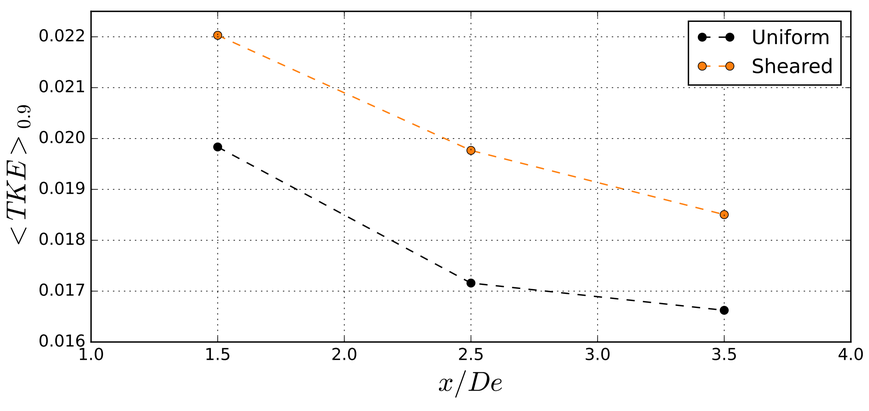


**Figure 5: Evolution of the mean TKE in uniform and sheared flow (surface average over the region delimited by 0,9 $U_0$)**

- Global dynamics are ensured by the nature of the incoming flow
- Sheared flow shows a stronger kinetic energy density downstream of the turbine
- Sheared flow leads to a 10% increase in velocity fluctuations

## VATT's behaviour

- Angular distribution of the torque is more impacted by the presence of the sheared velocity profile in P1 configuration
- P1 sheared case shows 6 unevenly distributed peaks corresponding to the passage of the 6 blades that compose the column

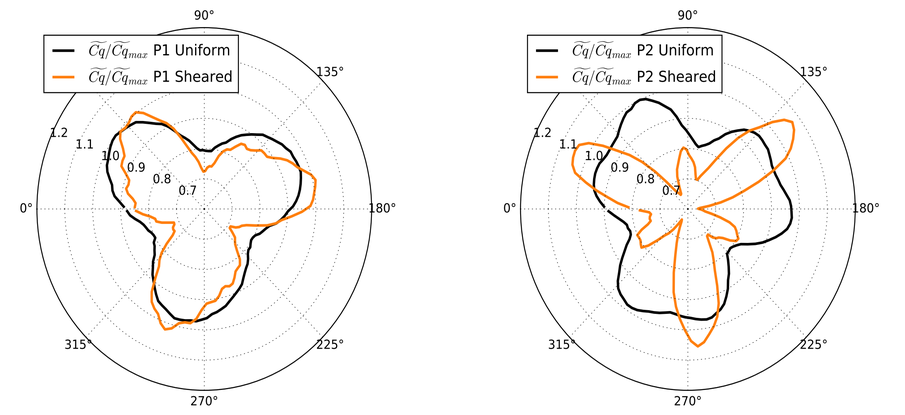


**Figure 2: Angular distribution of the torque of one column in P1 (left) and P2 (right) at the optimal tip speed ratio for uniform and sheared flow.**

- Study of torque distribution for each stage
- Asymmetry between the upper and lower rotors due to the difference in relative velocity
- Upper rotor produces 1,4 times more than the lower rotor for the sheared profile case

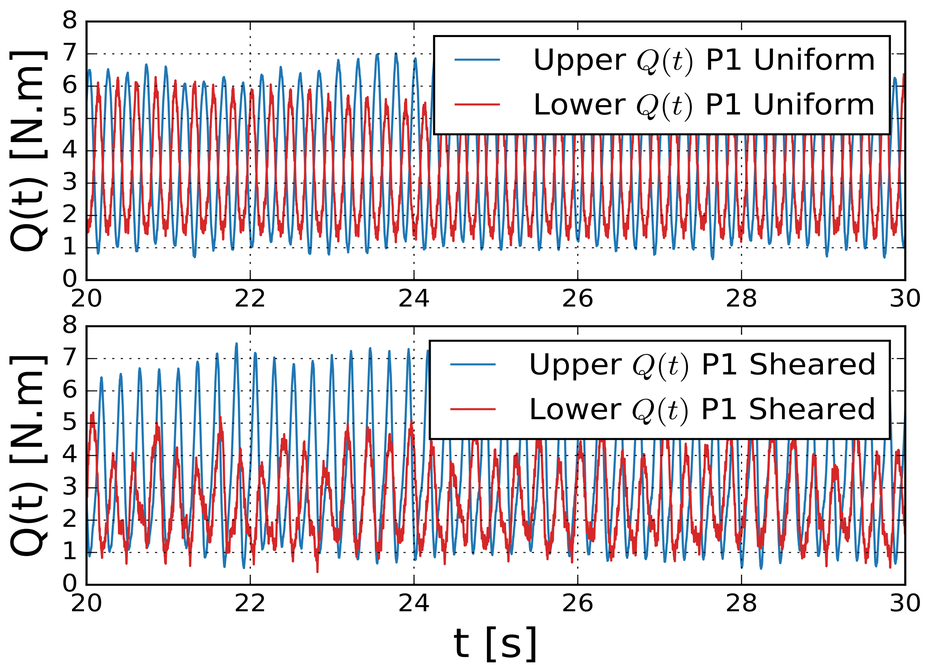


**Figure 3: Time history of the torque for the upper and lower rotors in the P1 configuration for uniform (top) and sheared (bottom) flow.**

## Results

- Impact of the upstream sheared flow on torque distribution
- Asymmetry between upper and lower rotors that can lead to significant structural fatigue
- Modification of the near wake field and wake dynamics by the upstream sheared flow

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