# Gear Fitting For DownWind Stand-Up Paddle foil performance

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## Summary

The purpose of this study is to adapt the equipment of a professional DownWind (DW) Stand-Up Paddle (SUP) Foil Athlete Erwan JAUFFROY who had a creasy challenge in mind: Crossing –thanks to a hydrofoil (sort of small airplane) under is board- the 250 km distance between TOULON and CORSICA Island (Figure 1-a). But without any engine or sail (The FOIL CROSSING CHALLENGE). The goal is to minimise energy consumption, with an emphasis on his lower limb muscles.

## Introduction

DW SUP Foil is a brain new watersport activity. It consists to fly above the surface of the sea in the same direction as the wind thanks to the propulsion of the waves created at the surface of the water. The rider has meanly 3 gears to achieve his goal: a paddle in the hands giving propulsion for take-off, a board flying in the air under his feet and an hydrofoil under water keeping the board over the surface (Figure 1-b). Due to early birth of this sport, many brands offer a huge amount of new gear every week. Currently, the foil/board/paddle association is not based yet on any scientific fact demonstrating suitability for the practitioner. The aim of this work is to define this association from muscular energy measurements.

## Methods

This project is design to set a multi factorial experiment. A first demonstrator was design to set the process on land. A specific board has been modified (embedded strain gauges) in order to measure the force applied by the rider and his center of gravity (CG) position during the ride. Datas are collected through ARDUINO board and it gives a structural analysis of how exactly the rider act on the board. In addition the rider's body has been monitored too. Thank's to wireless Emgs (Cometa MiniWave Infinity) at a sample rate of 2000Hz. Electrodes were placed according to SENIAM recommendations after skin preparation. The leg muscles activity (Tibialis Anterior, Gastrocnemius Medialis) were recorded because these muscle are known to be the most expensive during riding sport [5]. Finally the full body position was analyzed with inertial units (Cometa WaveTrack) [1]. IMUs were calibrated using standing T-pose acquisition. Heart Rate (HR) was also recorded throughout the trials. Datas collected by EMGs was then filtered using a 4th order Butterworth filter with a cut-off frequency between 20 and 400Hz, rectification an a low pass frequency of 15Hz and then normalized using Matlab [3]. IMUs' signals were filtered using a Kallman filter until the Euler angles were obtained [4]. A professional rider performed the same 2km path through 40 knots strong wind DW ride the same day. The trace was tracked by Garmin GPS. After 10 min warm-up, 8 trials were performed following the order of an experimental design with adjustable factors of the hydrofoil: Mast longer, fuselage length, hydrofoil Rake and Wing-set. Each test was repeated 3 times and a separated by a 10 min break to avoid fatigue [2].

## Results and Discussion

The study emphasized the first downwind sup foil scenario, proving that gear parameters affect energy consumption and body position for riding sport. For example it has been showed a 32% reduction in Gastrocnemius Medialis of the back leg could be achieve by setting the gear properly.

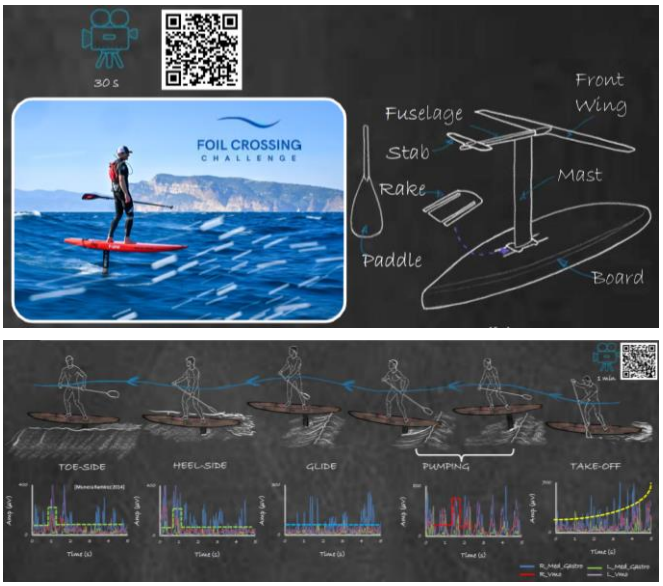


**Figure 1**: DW SUP Foil CHALLENGE, gear and scenario.

If we look closer to the emgs responses, we can clearly identify patterns (Figures 1). What is very interesting is that the speed obviously can't change, whatever the settings because the speed is produced by the swell. But to maintain this speed, the method prove that the body has to adapt its activity and we are able to find the 'perfect fit' for the rider.

## Conclusions

The power of gear fitting method has been confirmed by reducing energy consumption for the right gear setting. The gain value has no importance because it's only valid for one rider. But the method reveals its potential. We are starting to get answers to gear fitting for watersports.

## References

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