Despite well-established equations and modern computational capabilities, physical modelling is only beginning to be used in cycling. Such theoretical approach allows to estimate the effect of an equipment or a strategy on the overall performance based on the physiological capabilities of the rider and external parameters. In this paper, we present results obtained from the recent realistic models for time trials developed in collaboration with a World Tour team in order to support sport directors and coaches in making the right decision in terms of strategy and equipment.

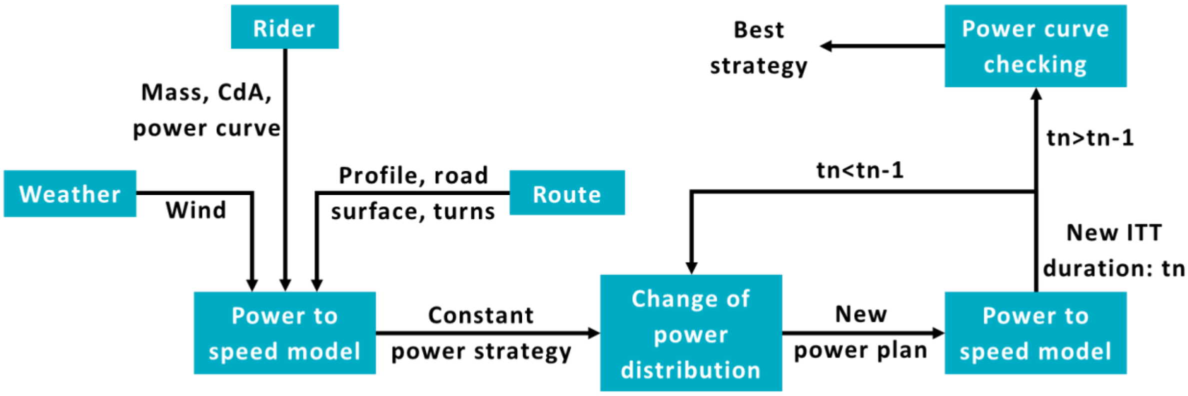

Figure 1 : Scheme detailing the main steps of the ITT model

It has been proven that adopting a power-variable strategy during Individual Time Trials (ITT) depending on terrain and wind can save a significant amount of time compared to a constant-power strategy. To determine the optimal power distribution, our algorithm operates accordingly to Fig.1. First, given the weather conditions (wind speed and direction), the properties of the route (profile, road surface and turns) and the rider (weight, CdA and power curve), the constant power distribution is determined. Based on this initial strategy, the route is split into different sections where the rider power will be varied. To find the best power segmentation, small amounts of power are transferred from one region to another, while keeping the average power constant. The time of each obtained power distribution is estimated from a physical model: the algorithm looks for the minimal duration until all possible configurations of regions have been tested. As a final step, to ensure the feasibility of the power strategy computed, the algorithm checks that the power curve of the suggested effort remains below the capabilities of the rider.

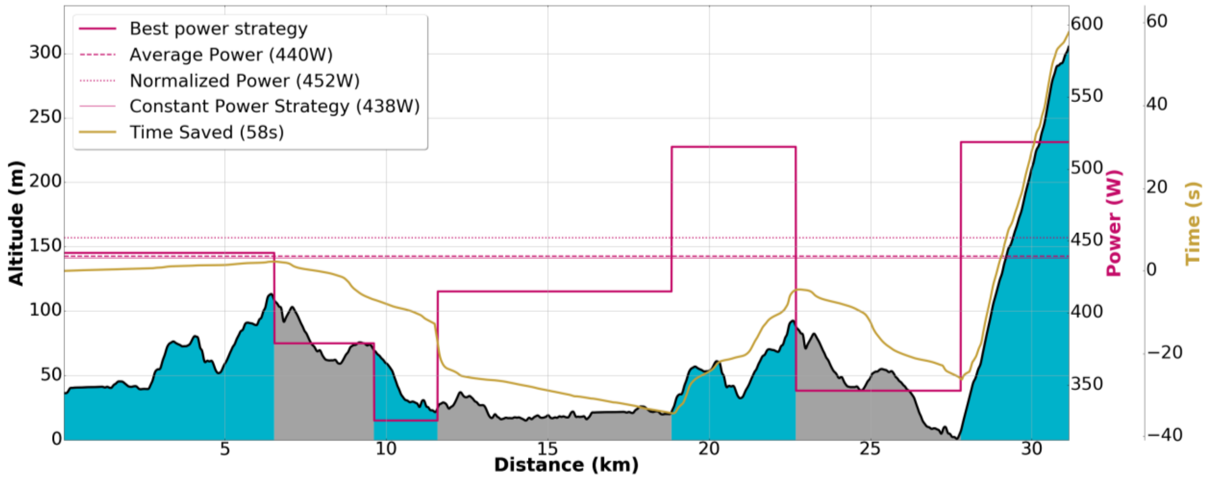

Figure 2: Best strategy for the world championship in Bergen

The optimal power distribution computed for a virtual professional rider on the route of the ITT world championship in Bergen is plotted in Fig.2. The suggested strategy allows gaining 58s over only 31km. The power curves on Fig.3.a show the feasibility of the suggested strategy. Such an algorithm can also be used for equipment selection (with respect to the wind conditions) as shown on Fig.3.b or to validate a potential bike change during an ITT.

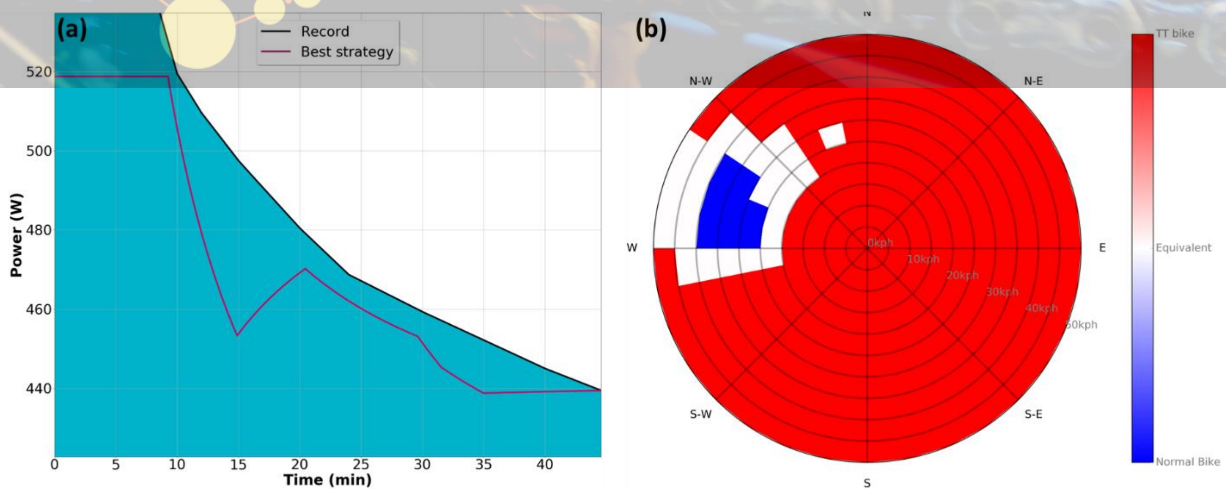

Figure 3: a) Power curves of the best ITT strategy and over the last 3 months. b) Best equipment to select (red=TT bike, blue=Classic road bike) depending on wind

The theoretical foundations of the TTT algorithms are similar to the ITT model. The route is split into regions on which the algorithm computes the optimal pull duration and power output when every rider of the team is successively leading the group. Moreover, the algorithm allows to determine the exact moment when it is worth dropping one or more riders of the team to save time by testing a variety of different strategies. Histogram of fig.4.b indicates the optimal pull duration while fig.4.a shows the averaged power and pull power of every rider of a virtual professional team on each region of the TTT world championship in Bergen. The graphs of this figure come from the best strategy among the tested ones and consists in dropping riders 2 and 5 after 28.6km.

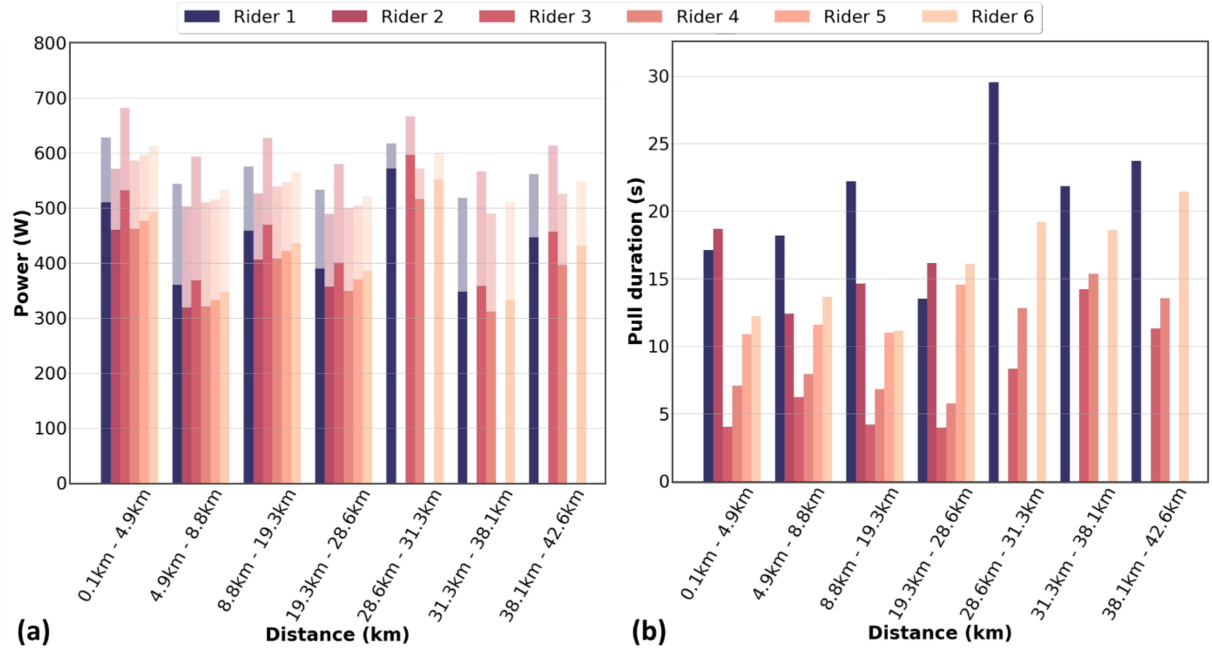

Figure 4 : Average power and pull power (a) and pull duration (b) of every rider on each split of the race

In addition to these physical models, machine learning can be applied to derive more complex features and support the fine tuning of the algorithms presented. We believe that such computational approach to cycling will not only allow to make optimal strategic decisions, but will also support the technological developments in this field.